RAPID reference manual

BaseWare

RAPID reference part 1, Instructions A-Z

RobotWare-OS 4.0

ABB

RAPID reference manual
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Revision B

BaseWare
RAPID reference part 1, Instructions A-Z

RobotWare-OS 4.0

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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

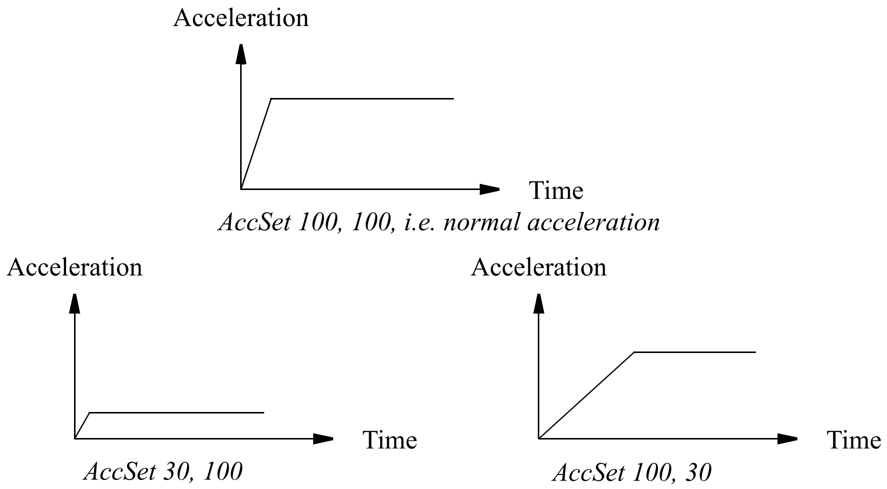
AccSet Acc Ramp

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.



AccSet 100, 100, i.e. normal acceleration

AccSet 30, 100 *AccSet 100, 30*

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

	Described in:
Positioning instructions	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 MechUnit

MechUnit *(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

If this instruction is preceded by a move instruction, that move instruction must be programmed with a stop point (*zonedata* fine), not a fly-by point, otherwise restart after power failure will not be possible.

Syntax

ActUnit
    [MechUnit ':='] < variable (VAR) of *mecunit*> **';'**

Related information

	<u>Described in:</u>
Deactivating mechanical units	Instructions - *DeactUnit*
Mechanical units	Data Types - *mecunit*
More examples	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

	Described in:
Incrementing a variable by 1	Instructions - *Incr*
Decrementing a variable by 1	Instructions - *Decr*
Changing data using an arbitrary expression, e.g. multiplication	Instructions - *:=*

“:=” - 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

	Described in:
Expressions	Basic Characteristics - *Expressions*
Non-value data types	Basic Characteristics - *Data Types*
Assigning an initial value to data	Basic Characteristics - *Data* Programming and Testing
Manually assigning a value to data	Programming and Testing

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

	Described in:
Stopping for program actions	Instructions - *Stop*
Stopping after a fatal error	Instructions - *EXIT*
Terminating program execution	Instructions - *EXIT*
Only stopping robot movements	Instructions - *StopMove*

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_namex* 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

	Described in:
Calling procedures	Basic Characteristic - *Routines* *User's Guide - The programming language RAPID*

CancelLoad - Cancel loading of a module

CancelLoad is used to cancel the loading of a module that is being or has been loaded with the instruction *StartLoad.*

CancelLoad can be used only between the instruction Startload ... WaitLoad.

Example

CancelLoad load1;

The load session *load1* is cancelled.

Arguments

CancelLoad LoadNo

LoadNo Data type: *loadsession*

Reference to the load session, fetched by the instruction *StartLoad.*

Examples

```
VAR loadsession load1;

StartLoad “HOME:”\File:=”PART_B.MOD”,load1;
...
IF ................
   CancelLoad load1;
   StartLoad “HOME:”\File:=”PART_C.MOD”,load1;
ENDIF
...
WaitLoad load1;
```

The instruction *CancelLoad* will cancel the on-going loading of the module PART_B.MOD and make it possible to in stead load PART_C.MOD.

Error handling

If the variable specified in argument *LoadNo* is not in use, meaning that no load session is in use, the system variable ERRNO is set to ERR_LOADNO_NOUSE. This error can then be handled in the error handler.

Syntax

```
CancelLoad
   [ LoadNo ':=' ] < variable (VAR) of loadsession > ';'
```

Related information

	Described in:
Load a program module during execution	Instructions - *StartLoad*
Connect the loaded module to the task	Instructions - *WaitLoad*
Load session	Data Types - *loadsession*
Load a program module	Instructions - *Load*
Unload a program module	Instructions - *UnLoad*
Accept unsolved references	System Parameters - *Controller/Task/BindRef*

CirPathMode - Tool reorientation during circle path

CirPathMode (Circle Path Mode) makes it possible to select different modes to reorientate the tool during circular movements.

Example

CirPathMode \PathFrame;

Standard mode for tool reorientation in the actual path frame from the start point to the *ToPoint* during all succeeding circular movements.
This is default in the system.

CirPathMode \ObjectFrame;

Modified mode for tool reorientation in actual object frame from the start point to the *ToPoint* during all succeeding circular movements.

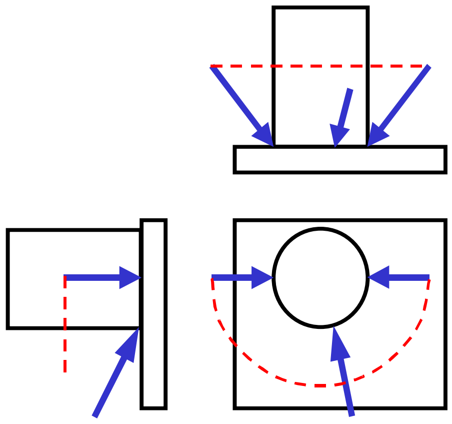
CirPathMode \CirPointOri;

Modified mode for tool reorientation from the start point via the programmed *CirPoint* orientation to the *ToPoint* during all succeeding circular movements.

Description

PathFrame

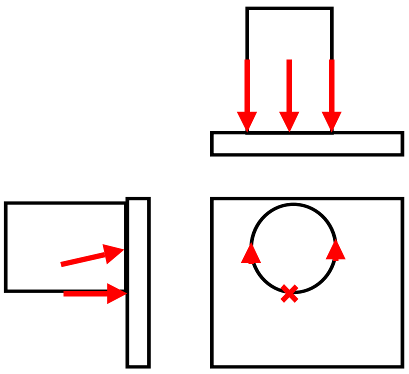
The picture shows the tool reorientation for the standard mode *\PathFrame*.



The arrows shows the tool from wrist centre point to tool centre point for the programmed points.
The path for the wrist centre point is dotted in the figure.

The *\PathFrame* mode make it easy to get the same angle of the tool around the cylinder. The robot wrist will not go through the programmed orientation in the *CirPoint.*

Use of standard mode *PathFrame* with fixed tool orientation:

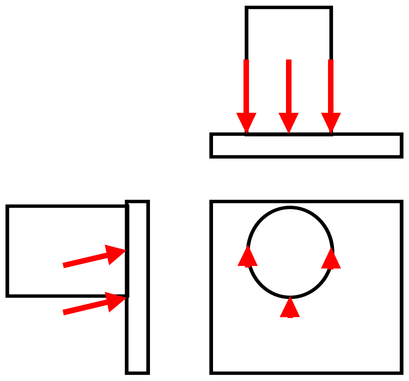


This picture shows the obtained orientation of the tool in the middle of the circle using a leaning tool and *PathFrame* mode.

Compare with the figure below when *ObjectFrame* mode is used

ObjectFrame

Use of modified mode *ObjectFrame* with fixed tool orientation:



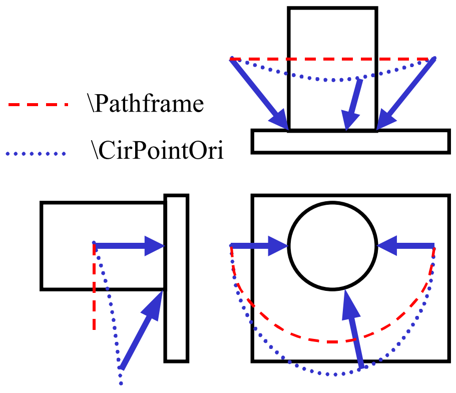
This picture shows the obtained orientation of the tool in the middle of the circle using a leaning tool and *ObjectFrame* mode.

This mode will make a linear reorientation of the tool in the same way as for *MoveL*. The robot wrist will not go through the programmed orientation in the *CirPoint*.

Compare with the figure above when *PathFrame* mode is used

CirPointOri

The picture shows the different tool reorientation between the standard mode *PathFrame* and the modified mode *CirPointOri*.



The arrows shows the tool from wrist centre point to tool centre point for the programmed points.
The different paths for the wrist centre point are dotted in the figure.

The *CirPointOri* mode will make the robot wrist to go through the programmed orientation in the *CirPoint*.

Arguments

CirPathMode [\PathFrame] | [\ObjectFrame] | [\CirPointOri]

[\PathFrame] Data type: *switch*

During the circular movement the reorientaion of the tool is done continuous from the start point orientation to the *ToPoint* orientation in the actual path frame.
This is the standard mode in the system.

[\ObjectFrame] Data type: *switch*

During the circular movement the reorientaion of the tool is done continuous from the start point orientation to the *ToPoint* orientation in the actual object frame.

[\CirPointOri] Data type: *switch*

During the circular movement the reorientaion of the tool is done continuous from the start point orientation to the programmed *CirPoint* orientation and further to the *ToPoint* orientation.

Only programming *CirPathMode;* without any switch result in the same as *CirPointOri \PathFrame;*

Program execution

The specified circular tool reorientation mode applies for the next executed robot circular movements of any type (*MoveC, SearchC, TriggC, MoveCDO, MoveCSync, ArcC, PaintC ...*) and is valid until a new *CirPathMode* (or obsolete *CirPathReori)* instruction is executed.

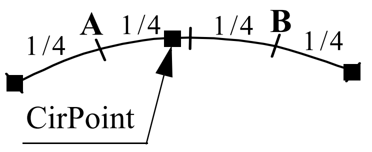
The standard circular reorientation mode (*CirPathMode \PathFrame*) is automatically set

- at a cold start-up
- when a new program is loaded
- when starting program executing from the beginning.

Limitations

The instruction only affects circular movements.

When using the *CirPointOri* mode, the *CirPoint* must be between the points **A** and **B** according to the figure below to make the circle movement to go **through** the programmed orientation in the *CirPoint.*



If working in wrist singularity area and the instruction *SingArea \Wrist* has been executed, the instruction *CirPathMode* has no effect because the system then select another tool reorientation mode for circular movements (joint interpolation).

This instruction replace the old instruction *CirPathReori*
(will work even in future but will not be documented any more).

Syntax

```
CirPathMode
    ['\'PathFrame] | ['\'ObjectFrame] | ['\'CirPointOri] ';'
```

Related information

	<u>Described in:</u>
Interpolation	Motion Principles - *Positioning during Program Execution*
Motion settings data	Data Types - *motsetdata*
Circular move instruction	Instructions - *MoveC*

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

	Described in:
Incrementing a variable by 1	Instructions - *Incr*
Decrementing a variable by 1	Instructions - *Decr*

ClearIOBuff - Clear input buffer of a serial channel

ClearIOBuff (*Clear I/O Buffer*) is used to clear the input buffer of a serial channel. All buffered characters from the input serial channel are discarded.

Example

```
VAR iodev channel2;
...
Open "com2:", channel2 \Bin;
ClearIOBuff channel2;
```

The input buffer for the serial channel referred to by *channel2* is cleared.

Arguments

ClearIOBuff IODevice

IODevice Data type: *iodev*

The name (reference) of the serial channel whose input buffer is to be cleared.

Program execution

All buffered characters from the input serial channel are discarded. Next read instructions will wait for new input from the channel.

Limitations

This instruction can only be used for serial channels.

Error handling

If trying to use the instruction on a file, the system variable ERRNO is set to ERR_FILEACC. This error can then be handled in the error handler.

Syntax

ClearIOBuff
  [IODevice ':='] <variable (**VAR**) of *iodev*>';'

Related information

	Described in:
Opening a serial channel	RAPID Summary - *Communication*

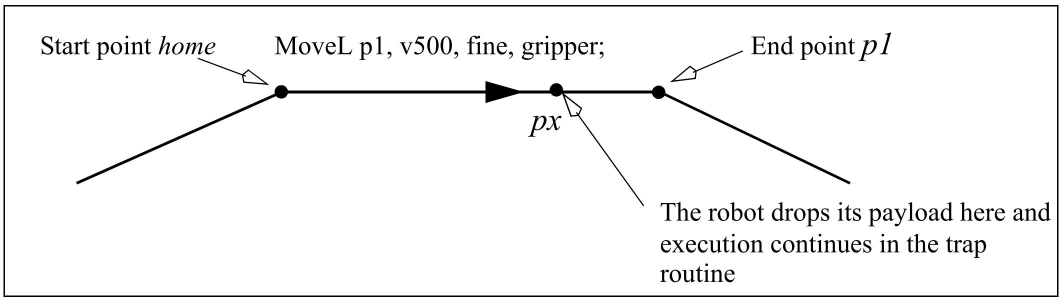
ClearPath - Clear current path

ClearPath (*Clear Path*) clear the whole motion path on the current motion path level (base level or *StorePath* level).

With motion path means all the movement segments from any move instructions which has been executed in RAPID but not performed by the robot at the execution time of
ClearPath.

The robot must be in a stop point position or must be stopped by *StopMove* before the instruction *ClearPath* can be executed.

Example


Start point *home*
MoveL p1, v500, fine, gripper;
End point *p1*
px
The robot drops its payload here and execution continues in the trap routine

In the following program example, the robot moves from the position *home* to the position *p1.* At the point *px* the signal *di1* will indicate that the payload has been dropped. The execution continues in the trap routine *gohome.* The robot will stop moving (start the braking) at *px*, the path will be cleared, the robot will move to position *home.* The error will be raised up to the calling routine *minicycle* and the whole user defined program cycle *proc1* .. *proc2* will be executed from beginning one more time.

```
VAR intnum drop_payload;
CONST errnum ERR_DROP_LOAD := 1;

PROC minicycle()
    ..........
    proc1;
    ..........
    ERROR (ERR_DROP_LOAD)
        RETRY;
ENDPROC
```

```
PROC proc1()
    ..........
    proc2;
    ..........
ENDPROC

PROC proc2()
    CONNECT drop_payload WITH gohome;
    ISignalDI \Single, di1, 1, drop_payload;
    MoveL p1, v500, fine, gripper;
    ...........
    IDelete drop_payload
ENDPROC

TRAP gohome
    StopMove \Quick;
    ClearPath;
    IDelete drop_payload;
    MoveL home, v500, fine, gripper;
    RAISE ERR_DROP_LOAD;
    ERROR
        RAISE;
ENDTRAP
```

If the same program is being run but **without** *StopMove* **and** *ClearPath* in the trap routine *gohome*, the robot will continue to position *p1* before going back to position *home.*

If programming *MoveL home* with flying-point (zone) instead of stop-point (*fine*), the movement is going on during the *RAISE* to the error handler in procedure *minicycle* and further until the movement is ready.

Syntax

ClearPath ';'

Related information

	Described in:
Stop robot movements	Instructions - *StopMove*
Error recovery	RAPID Summary - *Error Recovery* Basic Characteristics - *Error Recovery*

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

	Described in:
Other clock instructions	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.

Error handling

If the clock runs for 4,294,967 seconds (49 days 17 hours 2 minutes 47 seconds) it becomes overflowed and the system variable ERRNO is set to ERR_OVERFLOW.

The error can be handled in the error handler.

Syntax

```
ClkStart
    [ Clock ’:=’ ] < variable (VAR) of clock > ’;’
```

Related information

	Described in:
Other clock instructions	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.

Error handling

If the clock runs for 4,294,967 seconds (49 days 17 hours 2 minutes 47 seconds) it becomes overflowed and the system variable ERRNO is set to ERR_OVERFLOW.

The error can be handled in the error handler.

Syntax

ClkStop
    [Clock ’:=’] < variable (**VAR**) of *clock* > ’;’

Related Information

	Described in:
Other clock instructions	RAPID Summary - *System & Time*
More examples	Instructions - *ClkStart*

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)
’!’ {<character>} <newline>

Related information

	Described in:
Characters permitted in a comment	Basic Characteristics- *Basic Elements*
Comments within data and routine declarations	Basic Characteristics- *Basic Elements*

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

	Described in:
Conditions (logical expressions)	Basic Characteristics - *Expressions*
IF with several instructions	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 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

	Described in:
Handling different configurations	Motion Principles - *Robot Configuration*
Robot configuration during linear movement	Instructions - *ConfL*

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 IRB 5400 robot the monotoring is always off independent of what is specified in ConfL.

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;
```

The robot moves to the programmed position and orientation, but to the closest possible axis configuration, which can be different from the programmed.

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 there's a risk that the configuration of the programmed position not will be attained from the current position.

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.
- A simple rule to avoid problems, both for *ConfL\On* and *\Off*, is to insert intermediate points to make the movement of each axis less than 90 degrees between points or more precisely, the sum of movements for any of the pairs of axes (1+4), (1+6), (3+4) or (3+6) should not exceed 180 degrees. If *ConfL\Off* is used with a big movement, it can cause stops directly or later in the program with error *50050 Position outside reach* or *50080 Position not compatible.*
  In a program with *ConfL\Off* it's recommended to have movements to known configurations points with "*ConfJ\On + MoveJ*" or "*ConfL\On + SingArea\Wrist + MoveL*" as start points for different program parts.

Syntax

```
ConfL
   [ '\' On] | [ '\' Off] ';'
```

Related information

	Described in:
Handling different configurations	Motion and I/O Principles- *Robot Configuration*
Robot configuration during joint movement	Instructions - *ConfJ*

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

	Described in:
Opening a file or serial channel	RAPID Summary - *Communication*

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

	Described in:
Summary of interrupts	RAPID Summary - *Interrupts*
More information on interrupt management	Basic Characteristics- *Interrupts*

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 MechUnit

MechUnit *(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.

If this instruction is preceded by a move instruction, that move instruction must be programmed with a stop point (*zonedata* fine), not a fly-by point, otherwise restart after power failure will not be possible.

Syntax

DeactUnit
    [MechUnit ':='] < variable (VAR) of *mecunit***> ';'**

Related information

	Described in:
Activating mechanical units	Instructions - *ActUnit*
Mechanical units	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

	Described in:
Incrementing a variable by 1	Instructions - *Incr*
Subtracting any value from a variable	Instructions - *Add*
Changing data using an arbitrary expression, e.g. multiplication	Instructions - *:=*

DitherAct - Enables dither for soft servo

DitherAct is used to enable the dither functionality, which will reduce the friction in soft servo for IRB 7600.

Examples

SoftAct \MechUnit:=IRB, 2, 100;
WaitTime 2;
DitherAct \MechUnit:=IRB, 2;
WaitTime 1;
DitherDeact;
SoftDeact;

Dither is enabled only for one second while in soft servo.

```
DitherAct \MechUnit:=IRB, 2;
SoftAct \MechUnit:=IRB, 2, 100;
WaitTime 1;
MoveL p1, v50, z20, tool1;
SoftDeact;
DitherDeact;
```

Dither is enabled for axis 2. Movement is delayed one second to allow sufficient transition time for the SoftAct ramp. If *DitherAct* is called before *SoftAct*, dither will start whenever a *SoftAct* is executed for that axis. If no *DitherDeact* is called, dither will stay enabled for all subsequent *SoftAct* calls.

Arguments

DitherAct [\MechUnit] Axis [\Level]

[\MechUnit] *(Mechanical Unit)* Data type: *mecunit*

The name of the mechanical unit. If argument is omitted, it means activation of the soft servo for specified robot axis.

Axis Data type: *num*

Axis number (1-6).

[\Level] Data type: *num*

Amplitude of dither (50-150%). At 50%, oscillations are reduced (increased friction). At 150%, amplitude is maximum (may result in vibrations of endeffector). The default value is 100%.

Program execution

DitherAct can be called before, or after *SoftAct*. Calling *DitherAct* after *SoftAct* is faster, but has other limitations.

Dither is usually not required for axis 1 of IRB 7600. Highest effect of friction reduction is on axes 2 and 3.

Dither parameters are self-adjusting. Full dither performance is achieved after three or four executions of SoftAct in process position.

Limitations

Calling *DitherAct* after *SoftAct* may cause unwanted movement of the robot.The only way to eliminate this behaviour is to call *DitherAct* before *SoftAct*. If there still is movement, *SoftAct* ramp time should be increased.

However, when calling *DitherAct* before *SoftAct* the robot **must be in a fine point**. Also, **leaving the fine point is not permitted** until the transition time of the ramp is over. **This might damage the gear boxes**.

The transition time is the ramp time, which varies between robots, multiplied with the ramp factor of the SoftAct-instruction.

Dithering is not available for axis 6.

Dither is always deactivated when there is a power failure.

The instruction is only to be used for IRB 7600.

Syntax

DitherAct
  ['\' MechUnit ':=' < variable (**VAR**) of *mecunit* >]
  [Axis ':='] < expression (**IN**) of *num* >
  ['\' Level ':=' < expression (**IN**) of *num* >] ';'

Related information

	Described in:
Activating Soft Servo	Instructions - *SoftAct*
Behaviour with the soft servo engaged	Motion and I/O Principles - *Positioning during program execution*
Disable of dither	Instructions - *DitherDeact*

DitherDeact - Disables dither for soft servo

DitherDeact is used to disable the dither functionality for soft servo of IRB 7600.

Examples

DitherDeact;

Deactivates dither on all axis.

Program execution

DitherDeact can be used at any time. If in soft servo, dither stops immediatley on all axis. If not in soft servo, dither will not be active when next *SoftAct* is executed.

Syntax

DitherDeact ‘;’

Related information

	Described in:
Activating dither	Instructions - *DitherAct*

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

	Described in:
Definition of offset using two positions	Instructions - *EOffsOn*
Definition of offset using values	Instructions - *EOffsSet*
Deactivation of the robot's motion displacement	Instructions - *PDispOff*

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 \Inpos := inpos50, tool1;
EOffsOn *;
```

Activation of an offset for external axes. Since a stop point that is accurately defined 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

[\ExeP] *(Executed Point)* Data type: *robtarget*

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.

ProgPoint *(Programmed Point)* Data type: *robtarget*

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 <u>one</u> 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 - *EOffsOff*
Definition of offset using values	Instructions - *EOffsSet*
Displacement of the robot's movements	Instructions - *PDispOn*
Coordinate Systems	Motion Principles- *Coordinate Systems*

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 2).
- As long as this offset is active, all positions will be displaced 100 mm in the direction of the x-axis.

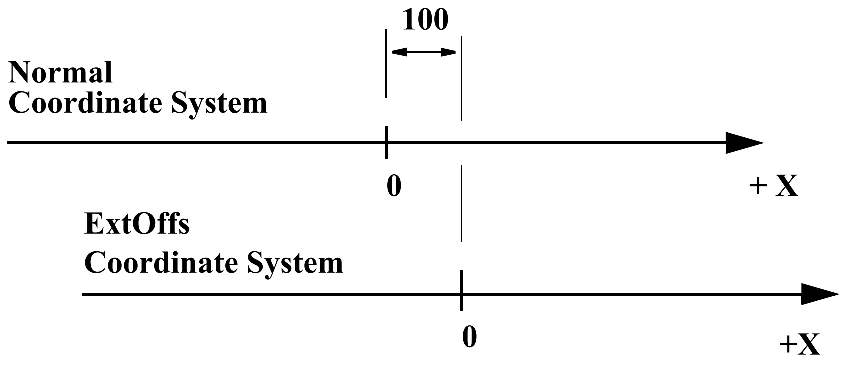


Figure 2 Displacement of an external axis.

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 <u>one</u> 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

	<u>Described in:</u>
Deactivation of offset for external axes	Instructions - *EOffsOff*
Definition of offset using two positions	Instructions - *EOffsOn*
Displacement of the robot's movements	Instructions - *PDispOn*
Definition of data of the type *extjoint*	Data Types - *extjoint*
Coordinate Systems	Motion Principles- *Coordinate Systems*

ErrWrite - Write an error message

ErrWrite (Error Write) is used to display an error message on the teach pendant and write it in the robot message log.

Example

```
ErrWrite “PLC error”, “Fatal error in PLC” \RL2:=”Call service”;
Stop;
```

A message is stored in the robot log. The message is also shown on the teach pendant display.

```
ErrWrite \ W, “ Search error”, “No hit for the first search”;
RAISE try_search_again;
```

A message is stored in the robot log only. Program execution then continues.

Arguments

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

[\W]	*(Warning)*	Data type: *switch*

Gives a warning that is stored in the robot error message log only (not shown directly on the teach pendant display).

Header Data type: *string*

Error message heading (max. 24 characters).

Reason Data type: string

Reason for error (line 1 of max. 40 characters).

[\RL2] *(Reason Line 2)* Data type: *string*

Reason for error (line 2 of max. 40 characters).

[\RL3] *(Reason Line 3)* Data type: *string*

Reason for error (line 3 of max. 40 characters).

[\RL4] *(Reason Line 4)* Data type: *string*

Reason for error (line 4 of max. 40 characters).

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

	Described in:
Display a message on the teach pendant only	Instructions - *TPWrite*
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

	Described in:
Stopping program execution temporarily	Instructions - *Stop*

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 program is executed in continuous mode, it will start to execute the next cycle. If the execution is in cycle mode, the execution will stop at the first instruction in the main routine.

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 execution

Execution of *ExitCycle* in the MAIN program task, results in the following in the MAIN task:

- On-going robot movements stops
- All robot paths that are not performed at all path levels (both normal and *StorePath* level) are cleared
- All instructions that are started but not finished at all execution levels (both normal and TRAP level) are interrupted
- The program pointer is moved to the first instruction in the main routine
- The program execution continues to execute the next cycle

Execution of *ExitCycle* in some other program task (besides MAIN) results in the following in the actual task:

- All instructions that are started but not finished on all execution levels (both normal and TRAP level) are interrupted
- The program pointer is moved to the first instruction in the main routine
- The program execution continues to execute the next cycle

All other modal things in the program and system are **not** affected by *ExitCycle* such as:

- The actual value of variables or persistents
- Any motion settings such as *StorePath-RestoPath* sequence, world zones, etc.
- Open files, directories, etc.
- Defined interrupts, etc.

When using *ExitCycle* in routine calls and the entry routine is defined with “Move PP to Routine ...” or “Call Routine ...”, *ExitCycle* breaks the current cycle and moves the PP back to the first instruction in the entry routine (instead of the main routine as specified above).

Syntax

```
ExitCycle’;’
```

Related information

	Described in:
Stopping after a fatal error	Instructions - *EXIT*
Terminating program execution	Instructions - *EXIT*
Stopping for program actions	Instructions - *Stop*
Finishing execution of a routine	Instructions - *RETURN*

FOR - Repeats a given number of times

FOR is used when one or several instructions are to be repeated a number of times.

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.

If the loop counter name is the same as any data that already exists in the actual scope, the existing data will be hidden in the FOR loop and not affected in any way.

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 evaluated.
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 step values, in combination with exact termination conditions for the FOR loop, cannot be used (undefined whether or not the last loop is running).

Remarks

If the number of repetitions is to be repeated as long as a given expression is evaluated to a *TRUE* value, the *WHILE* instructions should be used instead.

Syntax

(EBNF)
FOR <loop variable> **FROM** <expression> **TO** <expression>
 [**STEP** <expression>] **DO**
 <instruction list>
ENDFOR
<loop variable> ::= <identifier>

Related information

	Described in:
Expressions	Basic Characteristics - *Expressions*
Repeats as long as...	Instructions - *WHILE*
Identifiers	Basic Characteristics - *Basic Elements*

GetSysData - Get system data

GetSysData fetches the value and optional symbol name for the current system data of specified data type.

With this instruction it is possible to fetch data for and the name of the current active Tool , Work Object or PayLoad (for robot).

Example

```
PERS tooldata curtoolvalue := [TRUE, [[0, 0, 0], [1, 0, 0, 0]],
                                   [0, [0, 0, 0], [1, 0, 0, 0], 0, 0, 0]];
VAR string curtoolname;
```

```
GetSysData curtoolvalue;
```

Copy current active tool data value to the persistent variable *curtoolvalue*.

```
GetSysData curtoolvalue \ObjectName := curtoolname;
```

Copy also current active tool name to the variable *curtoolname*.

Arguments

GetSysData   DestObject [\ ObjectName]

DestObject Data type: *anytype*

Persistent for storage of current active system data value.

The data type of this argument also specifies the type of system data (Tool, Work Object or PayLoad) to fetch.

[\ObjectName] Data type: *string*

Option argument (variable or persistent) to also fetch the current active system data name.

Program execution

When running the instruction *GetSysData* the current data value is stored in the specified persistent in argument *DestObject*.

If argument *\ObjectName* is used, the name of the current data is stored in the specified variable or persistent in argument *ObjectName*.

Current system data for Tool or Work Object is activated by execution of any move instruction or can be manually set in the jogging window.

Syntax

```
GetSysData
    [ DestObject':='] < persistent(PERS) of anytype>
    ['\'ObjectName':=' < expression (INOUT) of string> ] ';'
```

Related information

	Described in:
Definition of tools	Data Types - *tooldata*
Definition of work objects	Data Types - *wobjdata*
Set system data	Instructions - *SetSysData*

GetTrapData - Get interrupt data for current TRAP

GetTrapData is used in a trap routine to obtain all information about the interrupt that caused the trap routine to be executed.

To be used in trap routines generated by instruction *IError,* before use of the instruction *ReadErrData*.

Example

```
VAR trapdata err_data;

GetTrapData err_data;
```

Store interrupt information in the non-value variable *err_data*.

Arguments

GetTrapData TrapEvent

TrapEvent Data type: *trapdata*

Variable for storage of the information about what caused the trap to be executed.

Limitation

This instruction can only be used in a TRAP routine.

Example

```
VAR errdomain err_domain;
VAR num err_number;
VAR errtype err_type;
VAR trapdata err_data;
.
TRAP trap_err
   GetTrapData err_data;
   ReadErrData err_data, err_domain, err_number, err_type;
ENDTRAP
```

When an error is trapped to the trap routine *trap_err*, the error domain, the error number, and the error type are saved into appropriate non-value variables of the type *trapdata*.

Syntax

```
GetTrapData
   [TrapEvent ':='] <variable (VAR) of trapdata>';'
```

Related information

	Described in:
Summary of interrupts	RAPID Summary - *Interrupts*
More information on interrupt management	Basic Characteristics- *Interrupts*
Interrupt data for current TRAP	Data Types - *trapdata*
Orders an interrupt on errors	Instructions - *IError*
Get interrupt data for current TRAP	Instructions- *GetTrapData*
Gets information about an error	Instructions - *ReadErrData*

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

	Described in:
Label	Instructions - *label*
Other instructions that change the program flow	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

	Described in:
Definition of load data	Data Types - *loaddata*
Definition of tool load	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

	Described in:
Summary of interrupts	RAPID Summary - *Interrupts*
Temporarily disabling an interrupt	Instructions - *ISleep*
Temporarily disabling all interrupts	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, that 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 starts generating, executed in "first in - first out" order in the queue.

IEnable is active by default. *IEnable* is automatically set

- at a cold start-up
- when starting program execution from the beginning of *main*
- after executing one cycle (passing *main*) or executing *ExitCycle*

Syntax

IDisable';'

Related information

	Described in:
Summary of interrupts	RAPID Summary - *Interrupt*
Permitting interrupts	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

	Described in:
Summary of interrupts	RAPID Summary - *Interrupts*
Permitting no interrupts	Instructions - *IDisable*

IError - Orders an interrupt on errors

IError (*Interrupt Errors*) is used to order and enable an interrupt when an error occurs.

Error, warning, or state change can be logged with *IError*.
Refer to the *User Guide - Error Management, System and Error Messages* for more information.

Example

```
VAR intnum err_int;
...
CONNECT err_int WITH err_trap;
IError COMMON_ERR, TYPE_ALL, err_int;
```

Orders an interrupt in RAPID and execution of the TRAP routine *err_trap* each time an error, warning, or state change is generated in the system.

Arguments

IError   ErrorDomain [\ErrorId] ErrorType Interrupt

ErrorDomain Data type: *errdomain*

The error domain that is to be monitored.
Refer to predefined data of type *errdomain*.
To specify any domain, use COMMON_ERR.

[\ErrorId] Data type: *num*

Optionally, the number of a specific error that is to be monitored.
The error number must be specified without the first digit (error domain) of the complete error number.
E.g. 10008 Program restarted, must be specified as 0008 or only 8.

ErrorType Data type: *errtype*

The type of event, such as error, warning, or state change, that is to be monitored.
Refer to predefined data of type *errtype*.
To specify any type, use TYPE_ALL.

Interrupt Data type: *intnum*

The interrupt identity. This should have been previously connected to a trap routine by means of the instruction CONNECT.

Program execution

The corresponding trap routine is automatically called when an error occurs, in the specified domain, of the specified type and optionally with the specified error number. When this has been executed, program execution continues from where the interrupt occurred

Example

```
VAR intnum err_interrupt;
VAR trapdata err_data;
VAR errdomain err_domain;
VAR num err_number;
VAR errtype err_type;
...
CONNECT err_interrupt WITH trap_err;
IError COMMON_ERR, TYPE_ERR, err_interupt;
...
IDelete err_interrupt;
...
TRAP trap_err
    GetTrapData err_data;
    ReadErrData err_data, err_domain, err_number, err_type;
    ! Set domain no 1 ... 13
    SetGO go_err1, err_domain;
    ! Set error no 1 ...9999
    SetGO go_err2, err_number;
ENDTRAP
```

When an error occurs (only error, not warning, or state change), the error number is retrieved in the trap routine and its value is used to set 2 groups of digital outputs.

Limitation

It is not possible to order an interrupt on internal errors.

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.

```
VAR intnum err_interrupt;
```

```
PROC main ( )
    CONNECT err_interrupt WITH err_trap;
    IError COMMON_ERR, TYPE_ERR, err_interupt;
    WHILE TRUE DO
    :
    :
    ENDWHILE
ENDPROC
```

Interrupts are activated at the beginning of the program. These instructions are then kept outside the main flow of the program.

```
PROC main ( )
    VAR intnum err_interrupt;
    CONNECT err_interrupt WITH err_trap;
    IError COMMON_ERR, TYPE_ERR, err_interupt;
    :
    :
    IDelete err_interrupt;
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

IError
    [ErrorDomain ':='] <expression (**IN**) of *errdomain*>
    ['\'ErrorId':=' <expression (**IN**) of *num*>']' ','
    [ErrorType ':='] <expression (**IN**) of *errtype*> ','
    [Interrupt ':='] <variable (**VAR**) of *intnum*>';'

Related information

	Described in:
Summary of interrupts	RAPID Summary - *Interrupts*
More information on interrupt management	Basic Characteristics- *Interrupts*
Error domains, predefined constants	Data Types - *errdomain*
Error types, predefined constants	Data Types - *errtype*
Get interrupt data for current TRAP	Instructions - *GetTrapData*
Gets information about an error	Instructions - *ReadErrData*

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

	Described in:
Conditions (logical expressions)	Basic Characteristics - *Expressions*

Incr - Increments by 1

Incr is used to add 1 to a numeric variable or persistent.

Example

Incr reg1;

1 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

	Described in:
Decrementing a variable by 1	Instructions - *Decr*
Adding any value to a variable	Instructions - *Add*
Changing data using an arbitrary expression, e.g. multiplication	Instructions - *:=*

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 3).

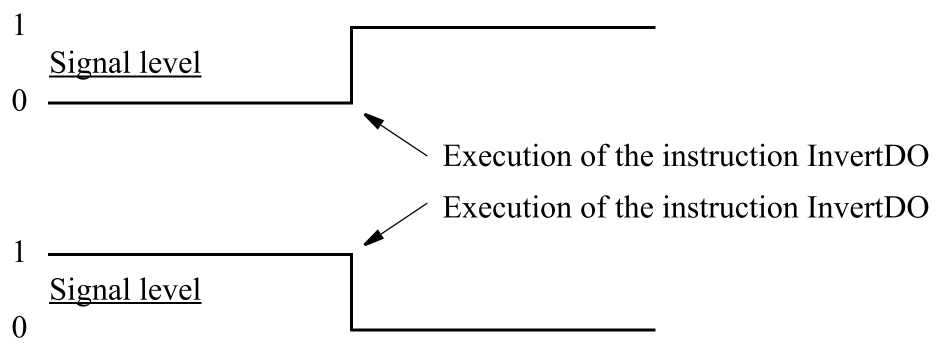

1
Signal level
0
Execution of the instruction InvertDO
Execution of the instruction InvertDO
1
Signal level
0

Figure 3 Inversion of a digital output signal.

Syntax

InvertDO
    [Signal ':='] < variable (**VAR**) of *signaldo* > ';'

Related information

	<u>Described in:</u>
Input/Output instructions	RAPID Summary - *Input and Output Signals*
Input/Output functionality in general	Motion and I/O Principles - *I/O Principles*
Configuration of I/O	System Parameters

IODisable - Disable I/O unit

IODisable is used to disable an I/O unit during program execution.

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

CONST string cell1:=”cell1”;

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 0-5 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.

Error handling

Following recoverable errors can be generated. The errors can be handled in an error handler. The system variable ERRNO will be set to:

ERR_IODISABLE	if the time out time runs out before the unit is disabled.
ERR_CALLIO_INTER	if an IOEnable or IODisable request is interrupted by another request to the same unit.
ERR_NAME_INVALID	if the unit name don’t exist or if the unit isn’t allowed to be disabled.

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

	Described in:
Enabling an I/O unit	Instructions - *IOEnabl*e
Input/Output instructions	RAPID Summary - *Input and Output Signals*
Input/Output functionality in general *I/O Principles*	Motion and I/O Principles -
Configuration of I/O	User's Guide - *System Parameters*

IODNGetAttr - Get attribute from I/O-unit

IODNGetAttr (*I/O DeviceNet Get Attribute*) is used to get an attribute from an I/O unit on the DeviceNet.

Examples

```
VAR string name;
...
IODNGetAttr "dsqc328", "6,20 01 24 01 30 07,17,20", name \Timeout:=3;
```

This will get the product name from the I/O unit *dsqc328*. The product name will be stored in the string variable *name*. Timeout after *3* seconds.

```
VAR string serialno;
...
IODNGetAttr "dsqc328", "6,20 01 24 01 30 06,9,4", serialno;
```

This will get the serial number from the I/O unit *dsqc328*. The value will be stored in the string variable *serialno*. Timeout after default 5 seconds.

Arguments

IODNGetAttr UnitName Path GetValue [\Timeout]

UnitName Data type: *string*

The name of the I/O unit (same name as configured).

Path Data type: *string*

The values for the path are found in the EDS file. For a more detailed description see the Open DeviceNet Vendor Association *“DeviceNet Specification rev. 2.0”*.

GetValue Data type: *string*

The value of the attribute will be stored in this string variable. The string length is limited to 30 characters.

[\Timeout] Data type: *num*

The period of waiting time permitted, expressed in seconds.

Default timeout 5 second, if this argument is omitted.

Program execution

The program is waiting until the I/O unit has answered.

If the *Timeout* runs out before the I/O unit has answered, the error handler will be called, if there is one, with the error code ERR_IODN_TIMEOUT.
If there is no error handler, the execution will be stopped.

Error handling

Following recoverable errors can be generated. The errors can be handled in an error handler. The system variable ERRNO will be set to:

ERR_IODN_TIMEOUT	If the timeout time runs out before the unit has answered back to confirm ready.
ERR_NAME_INVALID	If the unit name doesn't exist
ERR_MSG_PENDING	A message is already sent to the unit. Wait a short while (e.g. 100ms) and try again.

Syntax

IODNGetAttr
    [UnitName ':='] < expression (**IN**) of *string* > ','
    [Path ':='] < expression (**IN**) of *string* > ','
    [GetValue ':='] < variable (**VAR**) of *string* >
    ['\' Timeout ':=' < expression (**IN**) of *num* >] ';'

Related information

	Described in:
Open DeviceNet Vendor Association	*DeviceNet Specification rev. 2.0*
Configuration of I/O	User's Guide - *System Parameters*
Configuration of I/O	IO Plus User's Guide
Configuration of I/O	RAPID Developer's Manual - *System Parameters*
Input/Output functionality in general	Motion and I/O Principles - *I/O Principles*
Input/Output instructions	RAPID Summary - *Input and Output Signals*
Set I/O unit attribute	Instructions - *IODNSetAttr*

IODNSetAttr - Set attribute for an I/O-unit

IODNSetAttr (*I/O DeviceNet Set Attribute*) is used to set an attribute for an I/O unit on the DeviceNet.

Examples

IODNSetAttr "dsqc328", "6,20 1D 24 01 30 65,8,1", ”5” \Timeout:=3;

This will set the filter time to *5* for the falling edge on insignal *1* on the unit *dsqc328*. Timeout after 3 seconds.

IODNSetAttr "dsqc328", "6,20 1D 24 01 30 64,8,1", ”4”;

This will set the filter time to *4* for the rising edge on insignal *1* on the unit *dsqc328*. Timeout after default 5 seconds.

Arguments

IODNSetAttr UnitName Path SetValue [\Timeout]

UnitName Data type: *string*

The name of the I/O unit (same name as configured).

Path Data type: *string*

The values for the path is found in the EDS file. For a more detailed description see the Open DeviceNet Vendor Association “*DeviceNet Specification rev. 2.0”*.

SetValue Data type: *string*

The value to set the attribute to. The string length is limited to 30 characters.

[\Timeout] Data type: *num*

The period of waiting time permitted, expressed in seconds.

Default timeout 5 second, if this argument is omitted.

Program execution

The program is waiting until the I/O unit has answered.

If the *Timeout* runs out before the I/O unit has answered, the error handler will be called, if there is one, with the error code ERR_IODN_TIMEOUT. If there is no error handler, the execution will be stopped.

Error handling

Following recoverable errors can be generated. The errors can be handled in an error handler. The system variable ERRNO will be set to:

ERR_IODN_TIMEOUT	If the timeout time runs out before the unit has answered back to confirm ready.
ERR_NAME_INVALID	If the unit name doesn't exist.
ERR_MSG_PENDING	A message is already sent to the unit. Wait a short while (e.g. 100ms) and try again.

Syntax

IODNSetAttr
    [UnitName ':='] < expression (**IN**) of *string* > ','
    [Path ':='] < expression (**IN**) of *string* > ','
    [SetValue':='] < expression (**IN**) of *string* >
    ['\' Timeout':=' < expression (**IN**) of *num* >] ';'

Related information

	Described in:
Open DeviceNet Vendor Association	*DeviceNet Specification rev. 2.0*
Configuration of I/O	User's Guide - *System Parameters*
Configuration of I/O	IO Plus User's Guide
Configuration of I/O	RAPID Developer's Manual - *System Parameters*
Input/Output functionality in general	Motion and I/O Principles - *I/O Princi-ples*
Input/Output instructions	RAPID Summary - *Input and Output Signals*
Get I/O unit attribute	Instructions - *IODNGetAttr*

IOEnable - Enable I/O unit

IOEnable is used to enable an I/O unit during program execution.

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

CONST string cell1:="cell1";

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*).

Error handling

Following recoverable errors can be generated. The errors can be handled in an error handler. The system variable ERRNO will be set to:

ERR_IOENABLE	if the time out time runs out before the unit is enabled.
ERR_CALLIO_INTER	if an IOEnable or IODisable request is interrupted by another request to the same unit.
ERR_NAME_INVALID	if the unit name don’t exist or if the unit isn’t allowed to be disabled.

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

	Described in:
More examples	Instructions - *IODisabl*e
Disabling an I/O unit	Instructions - *IODisabl*e
Input/Output instructions	RAPID Summary - *Input and Output Signals*
Input/Output functionality in general	Motion and I/O Principles - *I/O Principles*
Configuration of I/O	User's Guide - *System Parameters*

ISignalAI - Interrupts from analog input signal

ISignalAI (Interrupt Signal Analog Input) is used to order and enable interrupts from an analog input signal.

Example

```
VAR intnum sig1int;
CONNECT sig1int WITH iroutine1;
ISignalAI \Single, ai1, AIO_BETWEEN, 1.5, 0.5, 0, sig1int;
```

Orders an interrupt which is to occur the first time the logical value of the analog input signal *ai1* is between *0.5* and *1.5*. A call is then made to the *iroutine1* trap routine.

```
ISignalAI ai1, AIO_BETWEEN, 1.5, 0.5, 0.1, sig1int;
```

Orders an interrupt which is to occur each time the logical value of the analog input signal *ai1* is between *0.5* and *1.5*, and the absolute signal difference compared to the stored reference value is bigger than *0.1*.

```
ISignalAI ai1, AIO_OUTSIDE, 1.5, 0.5, 0.1, sig1int;
```

Orders an interrupt which is to occur each time the logical value of the analog input signal *ai1* is lower than *0.5* or higher than *1.5*, and the absolute signal difference compared to the stored reference value is bigger than *0.1*.

Arguments

ISignalAI [\Single] Signal Condition HighValue LowValue DeltaValue [\DPos] | [\DNeg] 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: *signalai*

The name of the signal that is to generate interrupts.

Condition Data type: *aiotrigg*

Specifies how *HighValue* and *LowValue* define the condition to be satisfied:

- AIO_ABOVE_HIGH:logical value of the signal is above HighValue
- AIO_BELOW_HIGH:logical value of the signal is below HighValue
- AIO_ABOVE_LOW:logical value of the signal is above LowValue
- AIO_BELOW_LOW:logical value of the signal is below LowValue
- AIO_BETWEEN:logical value of the signal is between LowValue and HighValue
- AIO_OUTSIDE:logical value of the signal is above HighValue or below LowValue
- AIO_ALWAYS:independently of HighValue and LowValue

HighValue Data type: *num*

High logical value to define the condition.

LowValue Data type: *num*

Low logical value to define the condition.

DeltaValue Data type: *num*

Defines the minimum logical signal difference before generation of a new interrupt. The current signal value compared to the stored reference value must be greater than the specified *DeltaValue* before generation of a new interrupt.

[\DPos] Data type: *switch*

Specifies that only positive logical signal differences will give new interrupts.

[\DNeg] Data type: *switch*

Specifies that only negative logical signal differences will give new interrupts.

If none of *\DPos* and *\DNeg* argument is used, both positive and negative differences will generate new interrupts.

Interrupt Data type: *intnum*

The interrupt identity. This interrupt should have previously been connected to a trap routine by means of the instruction CONNECT.

Program execution

When the signal fulfils the specified conditions (both *Condition* **and** *DeltaValue*), a call is made to the corresponding trap routine. When this has been executed, program execution continues from where the interrupt occurred.

Conditions for interrupt generation

Before the interrupt subscription is ordered, each time the signal is sampled, the value of the signal is read, saved, and later used as a reference value for the *DeltaValue* condition.

At the interrupt subscription time, if specified *DeltaValue* = 0 **and** after the interrupt subscription time always at each time the signal is sampled, its value is then compared to *HighValue* and *LowValue* according to *Condition* and with consideration to *DeltaValue,* to generate or not generate an interrupt. If the new read value satisfies the specified *HighValue* and *LowValue Condition*, but its difference compared to the last stored reference value is less or equal to the *DeltaValue* argument, no interrupt occurs. If the signal difference is not in the specified direction, no interrupts will occur. (argument *\DPos* or *\DNeg*).

The stored reference value for the *DeltaValue* condition is updated with a newly read value for later use at any sample, if the following conditions are satisfied:

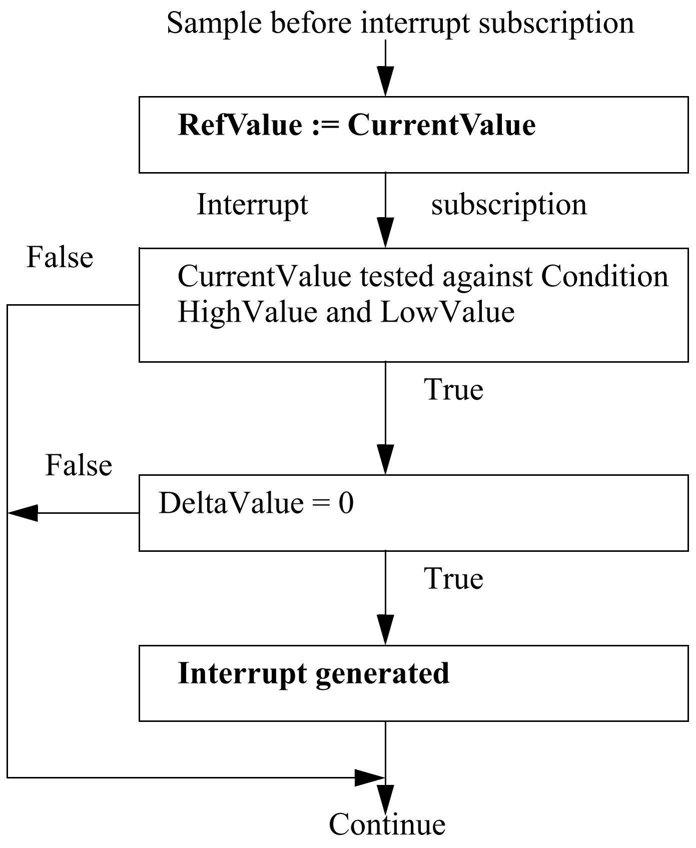
- Argument *Condition* with specified *HighValue* and *LowValue* (within limits)
- Argument *DeltaValue* (sufficient signal change in any direction, independently of specified switch *\DPos* or *\DNeg*)

The reference value is only updated at the sample time, not at the interrupt subscription time.

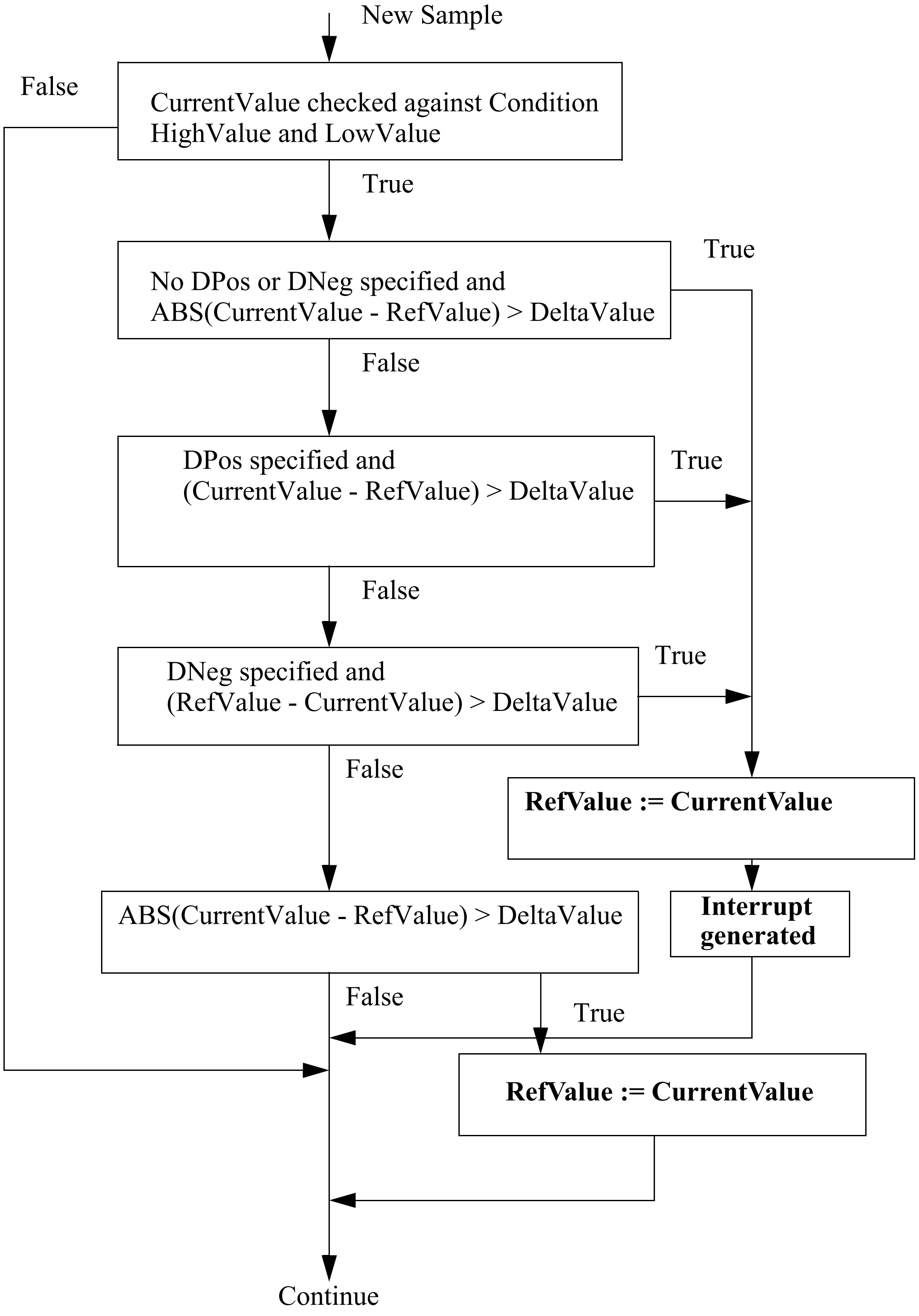
An interrupt is also generated at the sample for update of the reference value, if the direction of the signal difference is in accordance with the specified argument (any direction, *\DPos* or *\DNeg*).

When the *\Single* switch is used, only one interrupt at the most will be generated.
If the switch *\Single* (cyclic interrupt) is not used, a new test of the specified conditions (both *Condition* **and** *DeltaValue*) is made at every sample of the signal value, compared to the current signal value and the last stored reference value, to generate or not generate an interrupt.

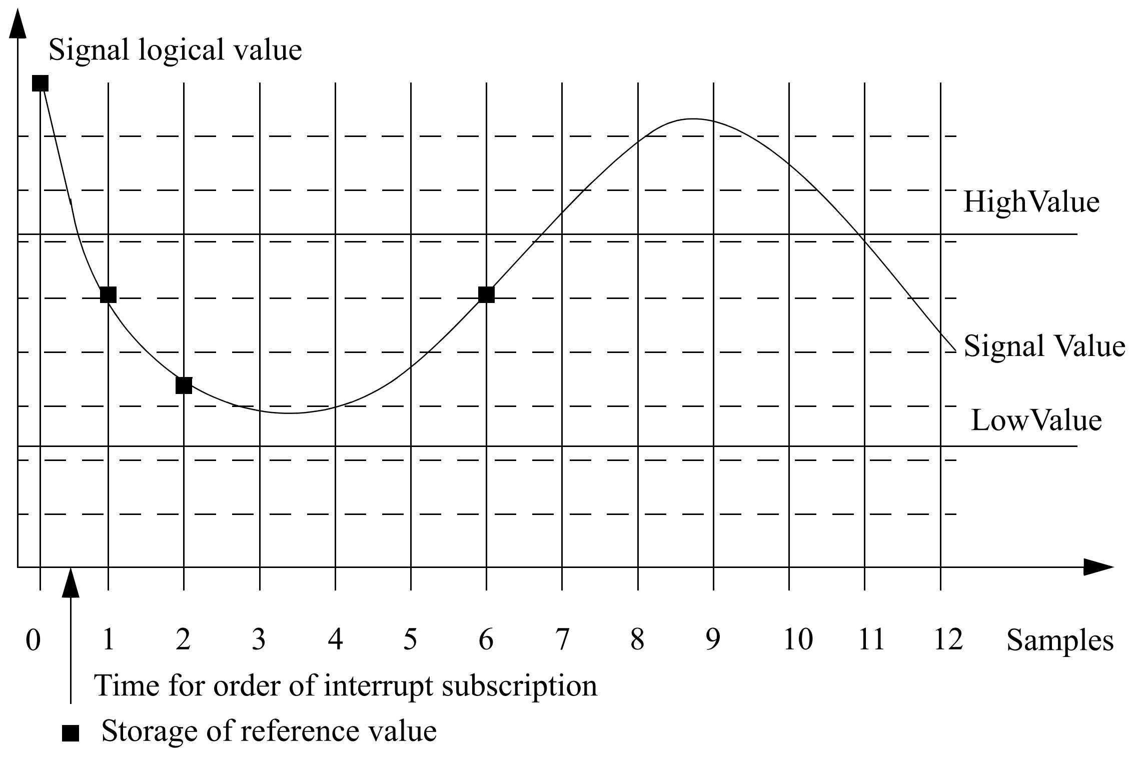
Condition for interrupt generation at interrupt subscription time



Condition for interrupt generation at each sample after interrupt subscription


New Sample
False
CurrentValue checked against Condition HighValue and LowValue
True
No DPos or DNeg specified and ABS(CurrentValue - RefValue) > DeltaValue
True
False
DPos specified and (CurrentValue - RefValue) > DeltaValue
True
False
DNeg specified and (RefValue - CurrentValue) > DeltaValue
True
False
RefValue := CurrentValue
ABS(CurrentValue - RefValue) > DeltaValue
Interrupt generated
False
True
RefValue := CurrentValue
Continue

Example 1 of interrupt generation



Assuming the interrupt is ordered between sample 0 and 1, the following instruction will give the following results:

```
ISignalAI ai1, AIO_BETWEEN, 6.1, 2,2, 1.0, sig1int;
```

sample 1 will generate an interrupt, because the signal value is between *High-Value* and *LowValue* and the signal difference compared to sample 0 is more than *DeltaValue*.

sample 2 will generate an interrupt, because the signal value is between *High-Value* and *LowValue* and the signal difference compared to sample 1 is more than *DeltaValue*.

samples 3, 4, 5 will not generate any interrupt, because the signal difference is less than *DeltaValue*.

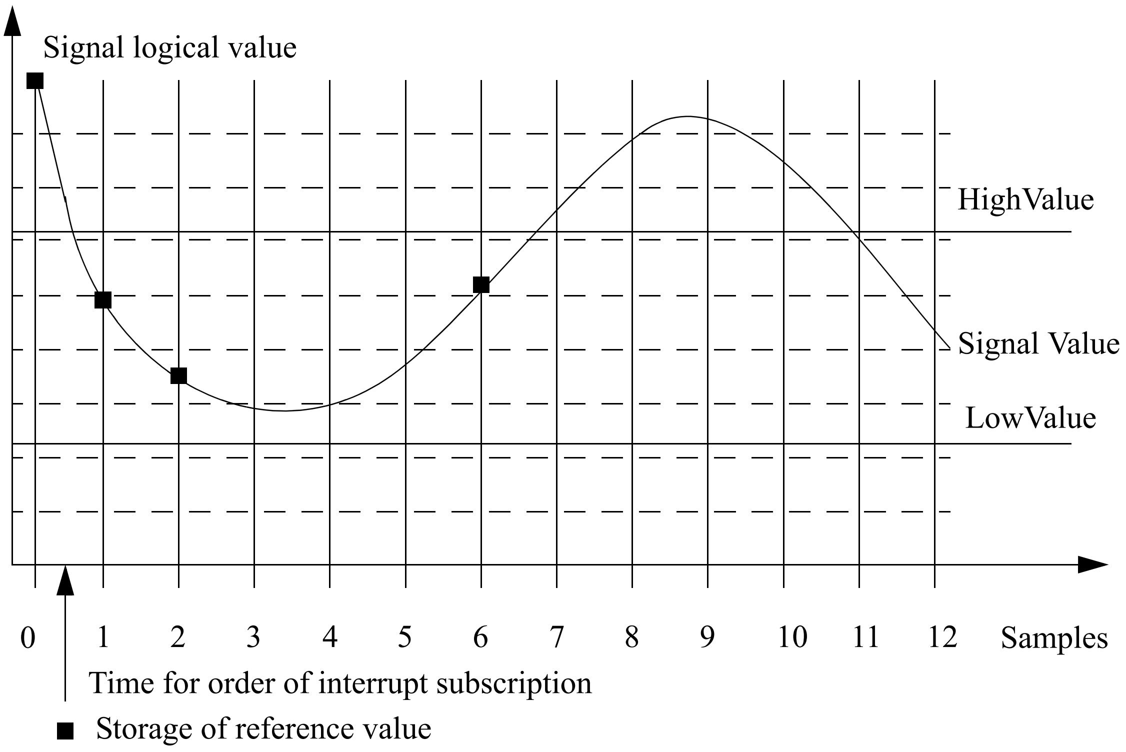
sample 6 will generate an interrupt.

samples 7 to 10 will not generate any interrupt, because the signal is above *HighValue*

sample 11 will not generate any interrupt, because the signal difference compared to sample 6 is equal to *DeltaValue*.

sample 12 will not generate any interrupt, because the signal difference compared to sample 6 is less than *DeltaValue*.

Example 2 of interrupt generation



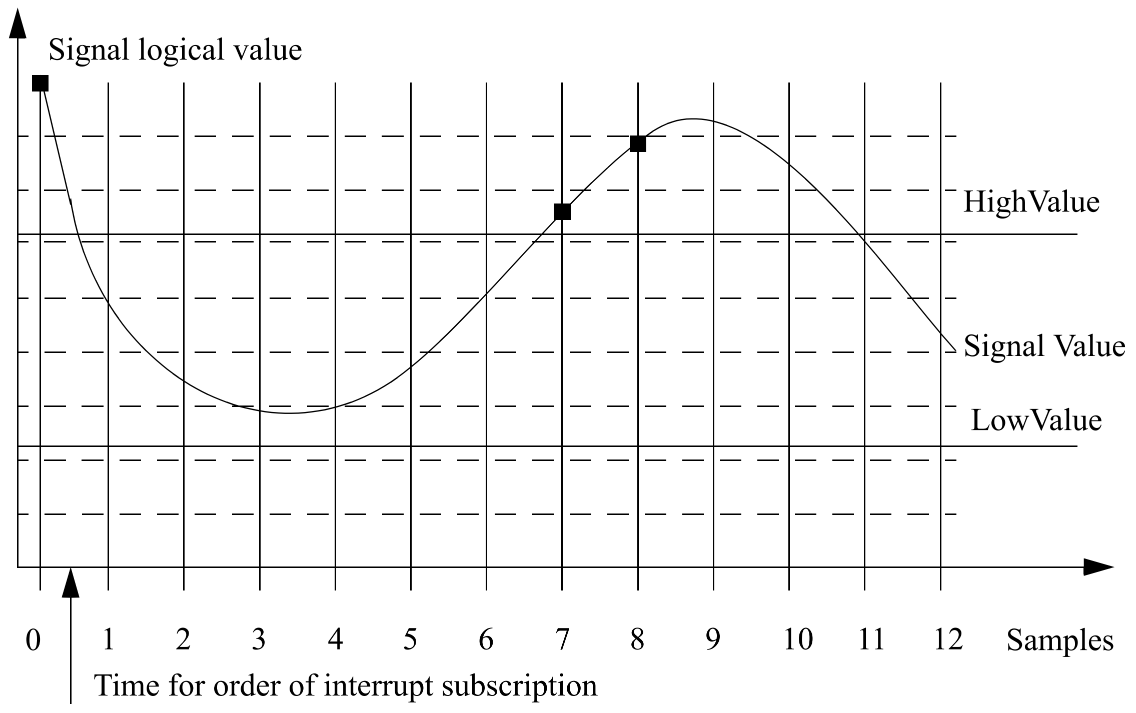
Assuming the interrupt is ordered between sample 0 and 1, the following instruction will give the following results:

ISignalAI ai1, AIO_BETWEEN, 6.1, 2,2, 1.0 \DPos, sig1int;

A new reference value is stored at sample 1 and 2, because the signal is within limits and the absolute signal difference between the current value and the last stored reference value is greater than 1.0.
No interrupt will be generated because the signal changes are in the negative direction.

sample 6 will generate an interrupt, because the signal value is between *High-Value* and *LowValue* and the signal difference in the positive direction compared to sample 2 is more than *DeltaValue*.

Example 3 of interrupt generation



■ Storage of reference value

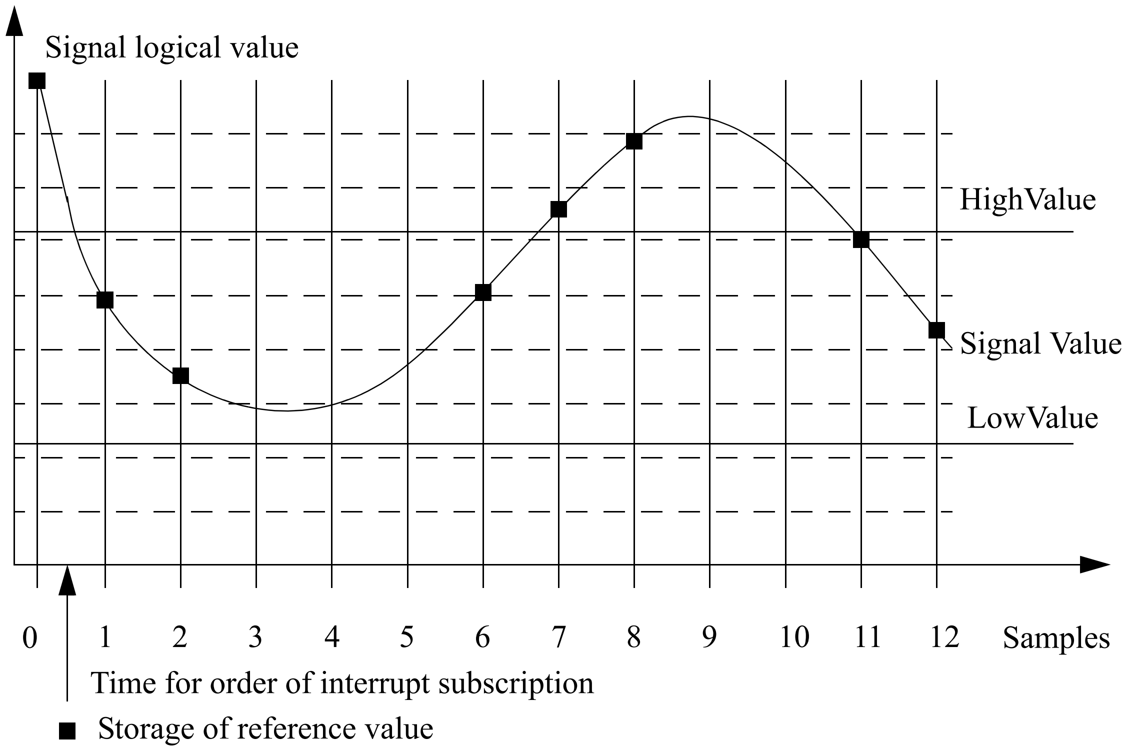
Assuming the interrupt is ordered between sample 0 and 1, the following instruction will give the following results:

ISignalAI \Single, ai1, AIO_OUTSIDE, 6.1, 2,2, 1.0 \DPos, sig1int;

A new reference value is stored at sample 7, because the signal is within limits and the absolute signal difference between the current value and the last stored reference value is greater than 1.0

sample 8 will generate an interrupt, because the signal value is above *HighValue* and the signal difference in the positive direction compared to sample 7 is more than *DeltaValue*.

Example 4 of interrupt generation



Assuming the interrupt is ordered between sample 0 and 1, the following instruction will give the following results:

ISignalAI ai1, AIO_ALWAYS, 6.1, 2,2, 1.0 \DPos, sig1int;

A new reference value is stored at sample 1 and 2, because the signal is within limits and the absolute signal difference between the current value and the last stored reference value is greater than 1.0

sample 6 will generate an interrupt, because the signal difference in the positive direction compared to sample 2 is more than *DeltaValue*.

sample 7 and 8 will generate an interrupt, because the signal difference in the positive direction compared to previous sample is more than *DeltaValue*.

A new reference value is stored at sample 11 and 12, because the signal is within limits and the absolute signal difference between the current value and the last stored reference value is greater than 1.0

Error handling

If there is a subscription of interrupt on an analog input signal, an interrupt will be given for every change in the analog value that satisfies the condition specified when ordering the interrupt subscription. If the analog value is noisy, many interrupts can be generated, even if only one or two bits in the analog value are changed.

To avoid generating interrupts for small changes of the analog input value, set the *DeltaValue* to a level greater than 0. Then no interrupts will be generated until a change of the analog value is greater than the specified *DeltaValue*.

Limitations

The *HighValue* and *LowValue* arguments should be in the range: logical maximum value, logical minimum value defined for the signal.

HighValue must be above *LowValue*.

DeltaValue must be 0 or positive.

The limitations for the interrupt identity are the same as for *ISignalDI.*

Syntax

ISignalAI
    ['\'Single',']
    [Signal':=']<variable (**VAR**) of *signalai*>','
    [Condition':=']<expression (**IN**) of *aiotrigg*>','
    [HighValue':=']<expression (**IN**) of *num*>','
    [LowValue':=']<expression (**IN**) of *num*>','
    [DeltaValue':=']<expression (**IN**) of *num*>
    ['\'DPos] | ['\'DNeg] ','
    [Interrupt':=']<variable (**VAR**) of *intnum*>';'

Related information

	Described in:
Summary of interrupts	RAPID Summary - *Interrupts*
Definition of constants	Data Types - *aiotrigg*
Interrupt from analog output signal	Instructions - *ISignalAO*
Interrupt from digital input signal	Instructions - *ISignalDI*
Interrupt from digital output signal	Instructions - *ISignalDO*
More information on interrupt management	Basic Characteristics - *Interrupts*
More examples	Data Types - *intnum*
Related system parameters (filter)	System Parameters - *IO Signals*

ISignalAO - Interrupts from analog output signal

ISignalAO (Interrupt Signal Analog Output) is used to order and enable interrupts from an analog output signal.

Example

```
VAR intnum sig1int;
CONNECT sig1int WITH iroutine1;
ISignalAO \Single, ao1, AIO_BETWEEN, 1.5, 0.5, 0, sig1int;
```

Orders an interrupt which is to occur the first time the logical value of the analog output signal *ao1* is between *0.5* and *1.5*. A call is then made to the *iroutine1* trap routine.

```
ISignalAO ao1, AIO_BETWEEN, 1.5, 0.5, 0.1, sig1int;
```

Orders an interrupt which is to occur each time the logical value of the analog output signal *ao1* is between *0.5* and *1.5*, and the absolute signal difference compared to the previous stored reference value is bigger than 0.1.

```
ISignalAO ao1, AIO_OUTSIDE, 1.5, 0.5, 0.1, sig1int;
```

Orders an interrupt which is to occur each time the logical value of the analog output signal *ao1* is lower than *0.5* or higher than *1.5*, and the absolute signal difference compared to the previous stored reference value is bigger than 0.1.

Arguments

ISignalAO [\Single] Signal Condition HighValue LowValue DeltaValue [\DPos] | [\DNeg] 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: *signalao*

The name of the signal that is to generate interrupts.

Condition
Data type: *aiotrigg*

Specifies how *HighValue* and *LowValu*e define the condition to be satisfied:

AIO_ABOVE_HIGH:	logical value of the signal is above HighValue
AIO_BELOW_HIGH:	logical value of the signal is below HighValue
AIO_ABOVE_LOW:	logical value of the signal is above LowValue
AIO_BELOW_LOW:	logical value of the signal is below LowValue
AIO_BETWEEN:	logical value of the signal is between LowValue and HighValue
AIO_OUTSIDE:	logical value of the signal is above HighValue or below LowValue
AIO_ALWAYS:	independently of HighValue and LowValue

HighValue
Data type: *num*

High logical value to define the condition.

LowValue
Data type: *num*

Low logical value to define the condition.

DeltaValue
Data type: *num*

Defines the minimum logical signal difference before generation of a new interrupt. The current signal value compared to the previous stored reference value must be greater than the specified *DeltaValue* before generation of a new interrupt.

[\DPos]
Data type: *switch*

Specifies that only positive logical signal differences will give new interrupts.

[\DNeg]
Data type: *switch*

Specifies that only negative logical signal differences will give new interrupts.

If neither of the *\DPos* and *\DNeg* arguments are used, both positive and negative differences will generate new interrupts.

Interrupt
Data type: *intnum*

The interrupt identity. This interrupt should have previously been connected to a trap routine by means of the instruction CONNECT.

Program execution

See instruction *ISignalAI* for information about:

- Program execution
- Condition for interrupt generation
- More examples

Same principles are valid for *ISignalAO* as for *ISignalAI*.

Limitations

The *HighValue* and *LowValue* arguments should be in the range: logical maximum value, logical minimum value, defined for the signal.

HighValue must be above *LowValue*.

DeltaValue must be 0 or positive.

The limitations for the interrupt identity are the same as for *ISignalDO*.

Syntax

ISignalAO
    ['\'Single',']
    [Signal':=']<variable (**VAR**) of *signalao*>','
    [Condition':=']<expression (**IN**) of *aiotrigg*>','
    [HighValue':=']<expression (**IN**) of *num*>','
    [LowValue':=']<expression (**IN**) of *num*>','
    [DeltaValue':=']<expression (**IN**) of *num*>
    ['\'DPos] | ['\'DNeg] ','
    [Interrupt':=']<variable (**VAR**) of *intnum*>';'

Related information

	Described in:
Summary of interrupts	RAPID Summary - *Interrupts*
Definition of constants	Data Types - *aiotrigg*
Interrupt from analog input signal	Instructions - *ISignalAI*
Interrupt from digital input signal	Instructions - *ISignalDI*
Interrupt from digital output signal	Instructions - *ISignalDO*
More information on interrupt management	Basic Characteristics - *Interrupts*
More examples	Data Types - *intnum*
Related system parameters (filter)	System Parameters - *IO Signals*

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. *high/low*). The signal is edge-triggered upon changeover to 0 or 1.

TriggValue 2 or symbolic value *edge* can be used for generation of interrupts on both positive flank (0 -> 1) and negative flank (1 -> 0).

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 4).

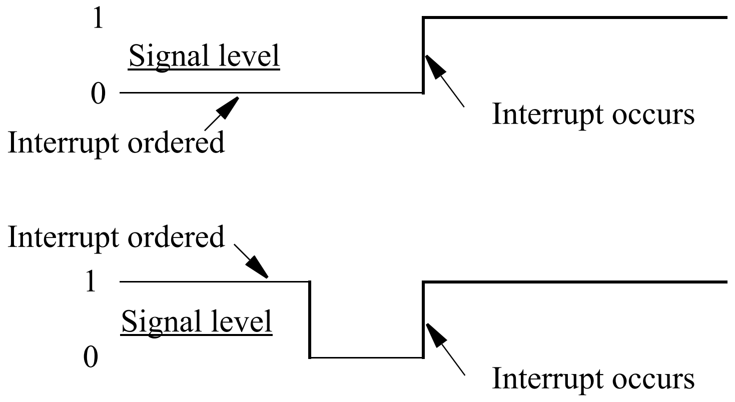


Figure 4 Interrupts from a digital input signal at signal level 1.

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 sig1int;
    CONNECT sig1int WITH iroutine1;
    ISignalDI di1, 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;
    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 *signaldi* > ','
    [TriggValue ':='] < expression (**IN**) of *dionum* >','
    [Interrupt ':='] < variable (**VAR**) of *intnum* > ';'

Related information

	Described in:
Summary of interrupts	RAPID Summary - *Interrupts*
Interrupt from an output signal	Instructions - *ISignalDO*
More information on interrupt management	Basic Characteristics - *Interrupts*
More examples	Data Types - *intnum*

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. *high/low*). The signal is edge-triggered upon changeover to 0 or 1.

TriggValue 2 or symbolic value *edge* can be used for generation of interrupts on both positive flank (0 -> 1) and negative flank (1 -> 0).

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 0 or 1, 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 5).

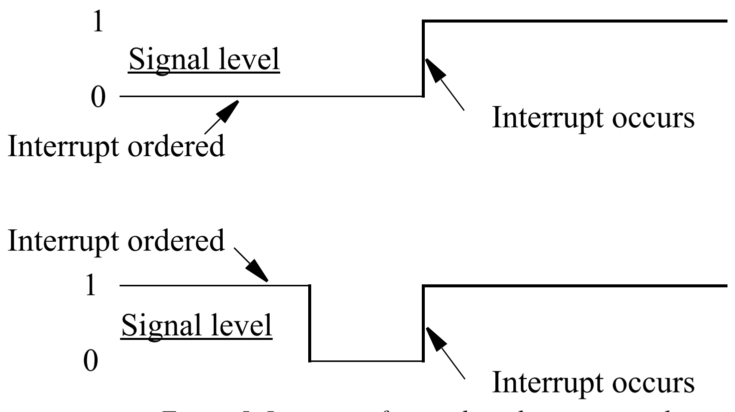


Figure 5 Interrupts from a digital output signal at signal level 1.

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.

```
VAR intnum sig1int;
```

```
PROC main ( )
    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

	Described in:
Summary of interrupts	RAPID Summary - *Interrupts*
Interrupt from an input signal	Instructions - *ISignalDI*
More information on interrupt management	Basic Characteristics- *Interrupts*
More examples	Data Types - *intnum*

ISleep - Deactivates an interrupt

ISleep (Interrupt Sleep) is used to deactivate an individual interrupt temporarily.

During the deactivation time, any generated interrupts of the specified type are discarded without any trap execution.

Example

```
ISleep sig1int;
```

The interrupt *sig1int* is deactivated.

Arguments

ISleep Interrupt

Interrupt	Data type: *intnum*

The variable (interrupt identity) of the interrupt.

Program execution

Any generated interrupts of the specified type are discarded without any trap execution, until the interrupt has been re-activated by means of the instruction *IWatch*. Interrupts which are generated while *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

	Described in:
Summary of interrupts	RAPID Summary - *Interrupts*
Enabling an interrupt	Instructions - *IWatch*
Disabling all interrupts	Instructions - *IDisable*
Cancelling an interrupt	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

	Described in:
Summary of interrupts	RAPID Summary - *Interrupts*
More information on interrupt management	Basic Characteristics- *Interrupts*

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:=ArrIndx(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

	Described in:
Summary of interrupts	RAPID Summary - *Interrupts*
More information on interrupt management	Basic Characteristics- *Interrupts*

IWatch - Activates an interrupt

IWatch (Interrupt Watch) is used to activate an interrupt which was previously ordered but was deactivated with *ISleep*.

Example

```
IWatch sig1int;
```

The interrupt *sig1int* that was previously deactivated is activated.

Arguments

IWatch Interrupt

Interrupt	Data type: *intnum*

Variable (interrupt identity) of the interrupt.

Program execution

Re-activates interrupts of the specified type once again. However, interrupts generated during the time the *ISleep* instruction was in effect, are ignored.

Example

```
VAR intnum sig1int;
CONNECT sig1int WITH iroutine1;
ISignalDI di1,1,sig1int;
.
ISleep sig1int;
weldpart1;
IWatch sig1int;
```

During execution of the *weldpart1* routine, no interrupts are permitted from the signal *di1*.

Error handling

Interrupts which have not been ordered are not permitted. If the interrupt number is unknown, the system variable ERRNO is set to ERR_UNKINO (see “Date types - errnum”). The error can be handled in the error handler.

Syntax

```
IWatch
    [ Interrupt ':=' ] < variable (VAR) of intnum > ';'
```

Related information

	Described in:
Summary of interrupts	RAPID Summary - *Interrupts*
Deactivating an interrupt	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

	Described in:
Identifiers	Basic Characteristics- *Basic Elements*
Moving program execution to a label	Instructions - *GOTO*

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.

A program or system module can be loaded in static (default) or dynamic mode:

Static mode

Tabell 1 How different operations affects static loaded program or system modules

	Set PP to main from TP	Open new RAPID program
Program Module	Not affected	Unloaded
System Module	Not affected	Not affected

Dynamic mode

Tabell 2 How different operations affects dynamic loaded program or system modules

	Set PP to main from TP	Open new RAPID program
Program Module	Unloaded	Unloaded
System Module	Unloaded	Unloaded

Both static and dynamic loaded modules can be unloaded by the instruction *UnLoad*.

Example

```
Load \Dynamic, diskhome \File:="PART_A.MOD";
```

Load the program module PART_A.MOD from the *diskhome* into the program memory. *diskhome* is a predefined string constant "*HOME*:". Load the program module in the dynamic mode.

Arguments

Load [\Dynamic] FilePath [\File]

[\Dynamic] Data type: *switch*

The switch enables load of a program module in dynamic mode. Otherwise the load is in static mode.

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 *Tasks* is set (BindRef = NO). However, when the program is started or the teach pendant function Program/File/Check is used, no check for unresolved references will be done if the parameter BindRef = NO. There will be a run time error on execution of an unresolved reference.

Another way to use references to procedures that are not in the task from the beginning, is to use *Late Binding.* This makes it possible to specify the procedure to call with a string expression, quoted between two % (see example). In this case the *BindRef* parameter could be set to YES (default behaviour). The *Late Binding* way is preferable.

For loading of program that contains a main procedure to a main program (with another main procedure), see example below.

Examples

More general examples

Load \Dynamic, "HOME:/DOORDIR/DOOR1.MOD";

Loads the program module *DOOR1.MOD* from *HOME:* at the directory *DOORDIR* into the program memory. The program module is loaded in the dynamic mode.

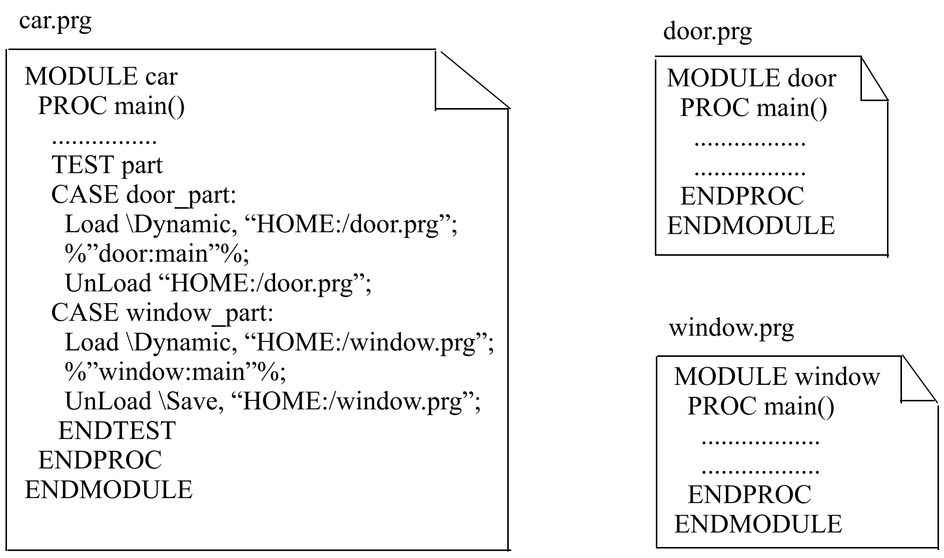
Load "HOME:" \File:="DOORDIR/DOOR1.MOD";

Same as above but another syntax, and the module is loaded in the static mode.

```
Load\Dynamic, "HOME:/DOORDIR/DOOR1.MOD";
%”routine_x”%;
UnLoad "HOME:/DOORDIR/DOOR1.MOD";
```

Program module *DOOR1.MOD*, will be binded during execution (late binding).

Loaded program contains a main procedure



car.prg

```
MODULE car
  PROC main()
    ................
    TEST part
    CASE door_part:
      Load \Dynamic, “HOME:/door.prg”;
      %”door:main”%;
      UnLoad “HOME:/door.prg”;
    CASE window_part:
      Load \Dynamic, “HOME:/window.prg”;
      %”window:main”%;
      UnLoad \Save, “HOME:/window.prg”;
     ENDTEST
  ENDPROC
ENDMODULE
```

door.prg

```
MODULE door
  PROC main()
    ................
    ................
  ENDPROC
ENDMODULE
```

window.prg

```
MODULE window
  PROC main()
    .................
    .................
  ENDPROC
ENDMODULE
```

The above example shows how You can load program which includes a *main* procedure. This program can have been developed and tested separate and later loaded with *Load* or *StartLoad ... WaitLoad* into the system useing some type of main program framewok. In this example *car.prg*, which load other programs *door.prg* or *window.prg*.

In the program *car.prg* you load *door.prg* or *window.prg* located at “HOME:”. Because the *main* procedures in *door.prg* and *window.prg* after the loading are considered **LOCAL** in the module by the system, the procedure calls are made in the following way: %”*door:main”%* or %”*window: main”%*. This syntax is used when you want to get access to **LOCAL** procedures in other modules, in this example procedure *main* in module *door* or module *window.*

Unloading the modules with *\Save* argument, will again make the *main* procedures to be global in the saved program.

If You, when the module *car* or *window* are loaded in the system, set program pointer to *main* from any part of the program, the program pointer will always be set to the global *main* procedure in the main program, *car.prg* in this example.

Limitations

Avoid ongoing robot movements during the loading.

Avoid using the floppy disk for loading since reading from the floppy drive is very time consuming.

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
    ['\'Dynamic ',']
    [FilePath':=']<expression (IN) of string>
    ['\'File':=' <expression (IN) of string>]';'
```

Related information

	Described in:
Unload a program module	Instructions - *UnLoad*
Load a program module in parallel with another program execution	Instructions - *StartLoad-WaitLoad*
Accept unresolved references	System Parameters - *Controller / Tasks / BindRef*

MechUnitLoad - Defines a payload for a mechanical unit

MechUnitLoad is used to define a payload for an external mechanical unit.
(The payload for the robot is defined with instruction *GripLoad*)

This instruction should be used for all mechanical units with dynamic model in servo to achieve the best motion performance.

The *MechUnitLoad* instruction should always be executed after execution of the instruction *ActUnit*.

Example

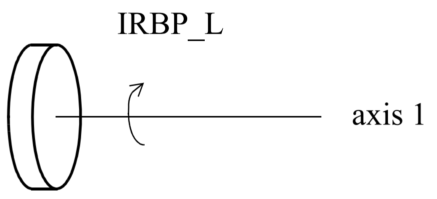


Figure 6 A mechanical unit named IRBP_L of type IRBP L.

ActUnit IRBP_L;
MechUnitLoad IRBP_L, 1, load0;

Activate mechanical unit *IRBP_L* and define the payload *load0* corresponding to no load (at all) mounted on axis *1*.

ActUnit IRBP_L;
MechUnitLoad IRBP_L, 1, fixture1;

Activate mechanical unit *IRBP_L* and define the payload *fixture1* corresponding to fixture *fixture1* mounted on axis *1*.

ActUnit IRBP_L;
MechUnitLoad IRBP_L, 1, workpiece1;

Activate mechanical unit *IRBP_L* and define the payload *workpiece1* corresponding to fixture and work piece named *workpiece1* mounted on axis *1*.

Arguments

MechUnitLoad MechUnit AxisNo Load

MechUnit *(Mechanical Unit)* Data type: *mecunit*

The name of the mechanical unit.

AxisNo *(Axis Number)* Data type: *num*

The axis number, within the mechanical unit, that holds the load.

Load Data type: *loaddata*

The load data that describes the current payload to be defined.

Program execution

After execution of *MechUnitLoad*, when the robot and external axes have come to a standstill, the specified load is defined for the specified mechanical unit and axis. This means that the payload is controlled and monitored by the control system.

The default payload at cold start-up, for a certain mechanical unit type, is the pre-defined maximal payload for this mechanical unit type.

When some other payload is used, the actual payload for the mechanical unit and axis should be redefined with this instruction. This should always be done after activation of the mechanical unit.

The defined payload will survive a power failure restart.
The defined payload will also survive a restart of the program after manual activation of some other mechanical units from the jogging window.

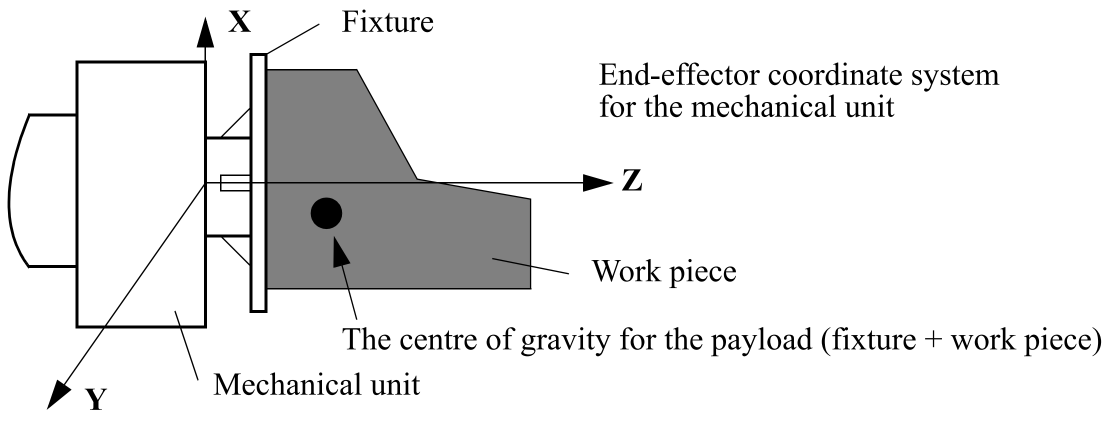

X
Fixture
End-effector coordinate system
for the mechanical unit
Z
Work piece
The centre of gravity for the payload (fixture + work piece)
Y
Mechanical unit

Figure 7 Payload mounted on the end-effector of a mechanical unit.

Example

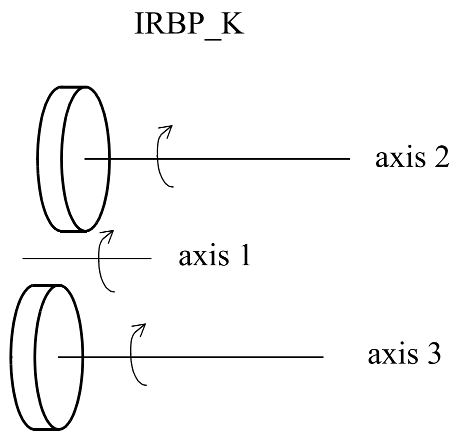


Figure 8 A mechanical unit named IRBP_K of type IRBP K with three axes.

```
MoveL homeside1, v1000, fine, gun1;
...
ActUnit IRBP_K;
```

The whole mechanical unit *IRBP_K* is activated.

```
MechUnitLoad IRBP_K, 2, workpiece1;
```

Defines payload *workpiece1* on the mechanical unit *IRBP_K* axis *2*.

```
MechUnitLoad IRBP_K, 3, workpiece2;
```

Defines payload *workpiece2* on the mechanical unit *IRBP_K* axis *3*.

```
MoveL homeside2, v1000, fine, gun1
```

The axes of the mechanical unit *IRBP_K* move to the switch position *homeside2* with mounted payload on both axes *2* and *3*.

Limitations

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

MechUnitLoad
  [MechUnit ’:=’] < variable (VAR) of *mecunit***> ’,’**
  [AxisNo ‘:=’] <expression (IN) of *num* **‘,’**
  [Load ’:=’] < **persistent** (**PERS**) **of** *loaddata* > ’;’

Related information

	Described in:
Identification of payload for external mechanical units	LoadID&CollDetect - Program *muloadid.prg*
Mechanical units	Data Types - *mecunit*
Definition of load data	Data Types - *loaddata*
Definition of payload for the robot	Instructions - *GripLoad* Data Types - *tooldata*

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.

Example of use:

- 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 [\NoEOffs] Speed [\V] | [\T]
Zone [\Z] [\Inpos] Tool [\WObj]**

[\Conc] *(Concurrent)* Data type: *switch*

Subsequent instructions are executed while the robot is moving. 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.

ToJointPos (*To Joint Position*) Data type: *jointtarget*

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).

[**NoEOffs**] (*No External Offsets)* Data type: *switch*

If the argument *NoEOffs* is set, then the movement with *MoveAbsJ* is not affected by active offsets for external axes.

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.

[\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.

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.

[\Inpos] *(In position)* Data type: *stoppointdata*

This argument is used to specify the convergence criteria for the position of the robot's TCP in the stop point. The stop point data substitutes the zone specified in the *Zone* parameter.

Tool Data type: *tooldata*

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.

[\WObj] *(Work Object)* Data type: *wobjdata*

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

A movement with *MoveAbsJ* is not affected by active program displacement and if executed with switch *\NoEOffs, there will be* no offset for external axes.
Without switch *\NoEOffs,* the external axes in the destination target are affected by active offset for external axes.

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 an 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 p5, v2000, fine \Inpos := inpos50, grip3;

The tool, *grip3*, is moved along a non-linear path to an absolute joint position *p5*. The robot considers it to be in the point when 50% of the position condition and 50% of the speed condition for a stop point *fine* are satisfied. It waits at most for 2 seconds for the conditions to be satisfied. See predefined data *inpos50* of data type *stoppointdata*.

MoveAbsJ \Conc, *, v2000, z40, grip3;

The tool, *grip3*, is moved along a non-linear path to an absolute joint position stored in the instruction. Subsequent logical instructions are executed while the robot moves.

MoveAbsJ \Conc, * \NoEOffs, v2000, z40, grip3;

Same movement as above but the movement is not affected by active offsets for external axes.

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

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).

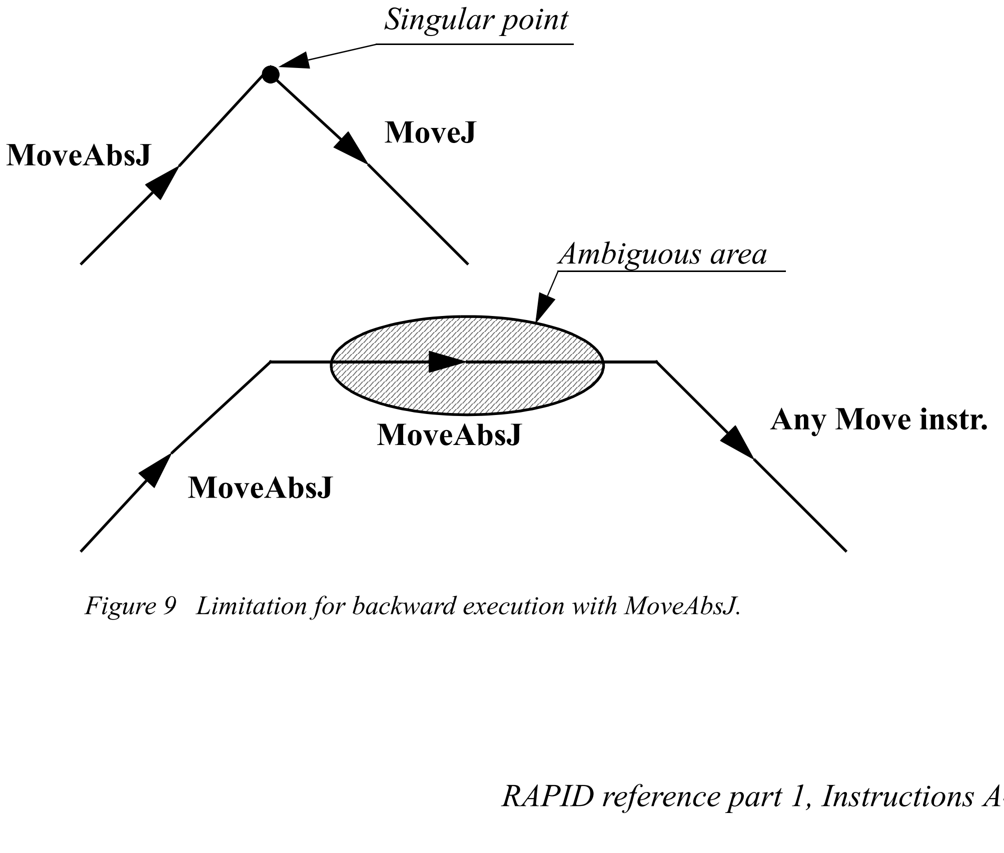


Figure 9 Limitation for backward execution with MoveAbsJ.

Syntax

```
MoveAbsJ
  [ '\' Conc ',' ]
  [ ToJointPos ':=' ] < expression (IN) of jointtarget >
  [ '\' NoEoffs ] ','
  [ 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 > ]
  [ '\' Inpos ':=' < expression (IN) of stoppointdata > ] ','
  [ Tool ':=' ] < persistent (PERS) of tooldata >
  [ '\' WObj ':=' < persistent (PERS) of wobjdata > ] ';'
```

Related information

	Described in:
Other positioning instructions	RAPID Summary - *Motion*
Definition of jointtarget	Data Types - *jointtarget*
Definition of velocity	Data Types - *speeddata*
Definition of zone data	Data Types - *zonedata*
Definition of stop point data	Data Types - *stoppointdata*
Definition of tools	Data Types - *tooldata*
Definition of work objects	Data Types - *wobjdata*
Motion in general	Motion and I/O Principles
Concurrent program execution	Motion and I/O Principles - *Synchronisation Using Logical Instructions*

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 10.

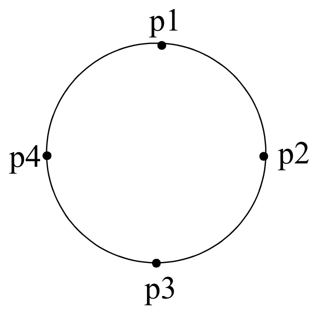


Figure 10 A complete circle is performed by two MoveC instructions.

Arguments

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

[\Conc] *(Concurrent)* Data type: *switch*

Subsequent 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.

[\Inpos] *(In position)* Data type: *stoppointdata*

This argument is used to specify the convergence criteria for the position of the robot's TCP in the stop point. The stop point data substitutes the zone specified in the *Zone* parameter.

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 reoriented 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 11).

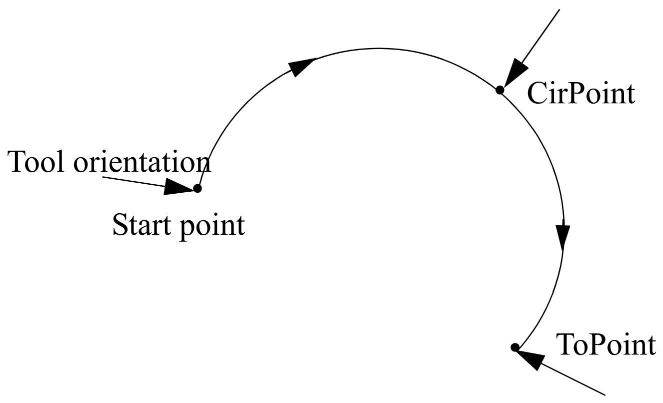


Figure 11 Tool orientation during circular movement.

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 p5, p6, v2000, fine \Inpos := inpos50, grip3;

The TCP of the tool, *grip3*, is moved circularly to a stop point *p6*. The robot considers it to be in the point when 50% of the position condition and 50% of the speed condition for a stop point *fine* are satisfied. It waits at most for 2 seconds for the conditions to be satisfied. See predefined data *inpos50* of data type *stoppointdata.*

MoveC \Conc, *, *, v500, z40, grip3;

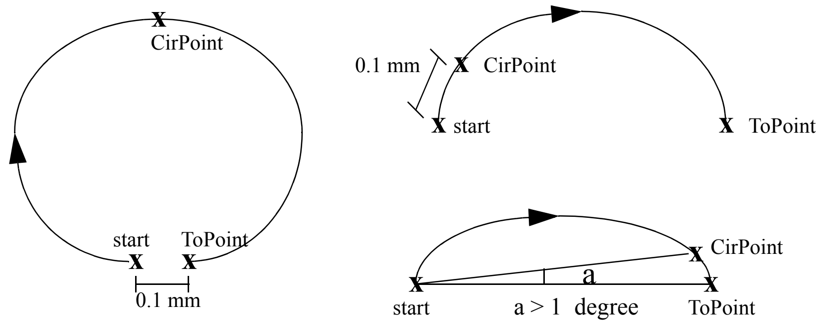
The TCP of the tool, *grip3*, is moved circularly to a position stored in the instruction. The circle point is also stored in the instruction. Subsequent logical instructions are executed while the robot moves.

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

There are some limitations in how the *CirPoint* and the *ToPoint* can be placed, as shown in the figure below.



- Minimum distance between start and *ToPoint* is 0.1 mm
- Minimum distance between start and *CirPoint* is 0.1 mm
- Minimum angle between *CirPoint* and *ToPoint* from the start point is 1 degree

The accuracy can be poor near the limits, e.g. if the start point and the *ToPoint* on the circle are close to each other, the fault caused by the leaning of the circle can be much greater than the accuracy with which the points have been programmed.

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 *robtarget* > ','
[ToPoint ':='] < expression (**IN**) of *robtarget* > ','
[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* >]
['\' Inpos ':=' < expression (**IN**) of *stoppointdata* >] ','
[Tool ':='] < persistent (**PERS**) of *tooldata* >
['\' WObj ':=' < persistent (**PERS**) of *wobjdata* >]
['\' Corr]';'

Related information

	<u>Described in:</u>
Other positioning instructions	RAPID Summary - *Motion*
Definition of velocity	Data Types - *speeddata*
Definition of zone data	Data Types - *zonedata*
Definition of stop point data	Data Types - *stoppointdata*
Definition of tools	Data Types - *tooldata*
Definition of work objects	Data Types - *wobjdata*
Writes to a corrections entry	Instructions - *CorrWrite*
Motion in general	Motion and I/O Principles
Coordinate systems	Motion and I/O Principles - *Coordinate Systems*
Concurrent program execution	Motion and I/O Principles - *Synchronisation Using Logical Instructions*

MoveCDO - Moves the robot circularly and sets digital output in the corner

MoveCDO (*Move Circular Digital Output*) is used to move the tool centre point (TCP) circularly to a given destination. The specified digital output is set/reset in the middle of the corner path at the destination point. During the movement, the orientation normally remains unchanged relative to the circle.

Examples

MoveCDO p1, p2, v500, z30, tool2, do1,1;

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*. Output *do1* is set in the middle of the corner path at *p2.*

Arguments

MoveCDO CirPoint ToPoint Speed [\T] Zone Tool [\WObj] Signal Value

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.

[\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.

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.

Signal Data type: *signaldo*

The name of the digital output signal to be changed.

Value Data type: *dionum*

The desired value of signal (0 or 1).

Program execution

See the instruction *MoveC* for more information about circular movement.

The digital output signal is set/reset in the middle of the corner path for flying points, as shown in Figure 12.

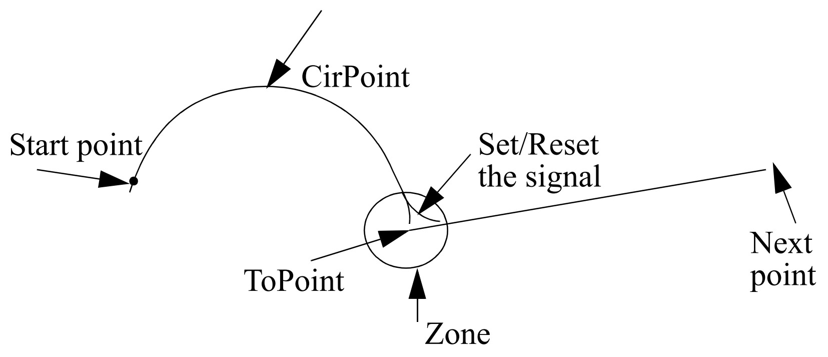


Figure 12 Set/Reset of digital output signal in the corner path with MoveCDO.

For stop points, we recommend the use of “normal” programming sequence with *MoveC* + *SetDO*. But when using stop point in instruction *MoveCDO*, the digital output signal is set/reset when the robot reaches the stop point.

The specified I/O signal is set/reset in execution mode continuously and stepwise forward but not in stepwise backward.

Limitations

General limitations according to instruction *MoveC.*

Syntax

```
MoveCDO
   [ CirPoint ’:=’ ] < expression (IN) of robtarget > ’,’
   [ ToPoint ’:=’ ] < expression (IN) of robtarget > ’,’
   [ Speed ’:=’ ] < expression (IN) of speeddata >
               [ ’\’ T ’:=’ < expression (IN) of num > ] ’,’
   [ Zone ’:=’ ] < expression (IN) of zonedata > ’,’
   [ Tool ’:=’ ] < persistent (PERS) of tooldata >
   [ ’\’ WObj ’:=’ < persistent (PERS) of wobjdata > ] ’,’
   [ Signal ’:=’ ] < variable (VAR) of signaldo>] ‘,’
   [ Value ‘:=’ ] < expression (IN) of dionum > ] ’;’
```

Related information

	Described in:
Other positioning instructions	RAPID Summary - *Motion*
Definition of velocity	Data Types - *speeddata*
Definition of zone data	Data Types - *zonedata*
Definition of tools	Data Types - *tooldata*
Definition of work objects	Data Types - *wobjdata*
Motion in general	Motion and I/O Principles
Coordinate systems	Motion and I/O Principles - *Coordinate Systems*
Movements with I/O settings	Motion and I/O Principles - *Synchronisation Using Logical Instructions*

MoveCSync - Moves the robot circularly and executes a RAPID procedure

MoveCSync (*Move Circular Synchronously*) is used to move the tool centre point (TCP) circularly to a given destination. The specified RAPID procedure is executed at the middle of the corner path in the destination point. During the movement, the orientation normally remains unchanged relative to the circle.

Examples

MoveCSync p1, p2, v500, z30, tool2, “proc1”;

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*. Procedure *proc1* is executed in the middle of the corner path at *p2.*

Arguments

MoveCSync CirPoint ToPoint Speed [\T] Zone Tool [\WObj] ProcName

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.

[\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.

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.

ProcName *(Procedure Name)* Data type: *string*

Name of the RAPID procedure to be executed at the middle of the corner path in the destination point.

Program execution

See the instruction *MoveC* for more information about circular movements.

The specified RAPID procedure is executed when the TCP reaches the middle of the corner path in the destination point of the *MoveCSync* instruction, as shown in Figure 13:

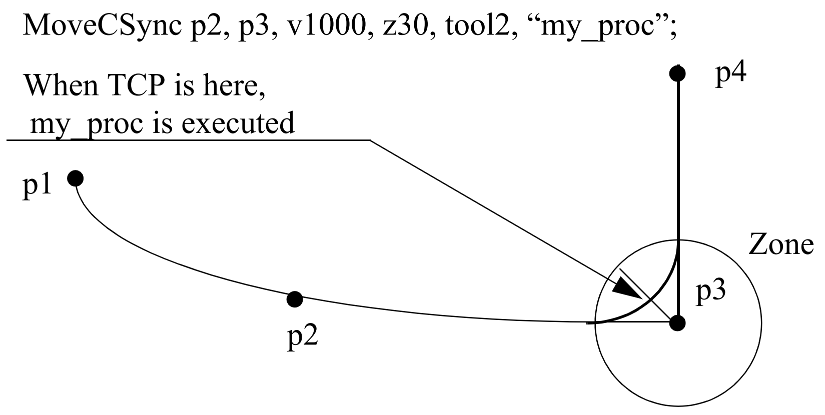


Figure 13 Execution of user-defined RAPID procedure at the middle of the corner path.

For stop points, we recommend the use of "normal" programming sequence with *MoveC* + other RAPID instructions in sequence.

Execution of the specified RAPID procedure in different execution modes:

Execution mode:	Execution of RAPID procedure:
Continuously or Cycle	According to this description
Forward step	In the stop point
Backward step	Not at all

Limitation

General limitations according to instruction *MoveC.*

Switching execution mode after program stop from continuously or cycle to stepwise forward or backward results in an error. This error tells the user that the mode switch can result in missed execution of a RAPID procedure in the queue for execution on the path. This error can be avoided if the program is stopped with StopInstr before the mode switch.

Instruction *MoveCSync* cannot be used on TRAP level.
The specified RAPID procedure cannot be tested with stepwise execution.

Syntax

```
MoveCSync
   [ CirPoint ':=' ] < expression (IN) of robtarget > ','
   [ ToPoint ':=' ] < expression (IN) of robtarget > ','
   [ Speed ':=' ] < expression (IN) of speeddata >
               [ '\' T ':=' < expression (IN) of num > ] ','
   [ Zone ':=' ] < expression (IN) of zonedata > ','
   [ Tool ':=' ] < persistent (PERS) of tooldata >
   [ '\' WObj ':=' < persistent (PERS) of wobjdata > ] ','
   [ ProcName ':=' ] < expression (IN) of string > ] ';'
```

Related information

	Described in:
Other positioning instructions	RAPID Summary - *Motion*
Definition of velocity	Data Types - *speeddata*
Definition of zone data	Data Types - *zonedata*
Definition of tools	Data Types - *tooldata*
Definition of work objects	Data Types - *wobjdata*
Motion in general	Motion and I/O Principles
Coordinate systems	Motion and I/O Principles - *Coordinate Systems*

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, *tool*2, 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]
[\Inpos] Tool [\WObj]**

[\Conc] *(Concurrent)* Data type: *switch*

Subsequent instructions are executed while the robot is moving. 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.

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 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 moves. 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.

[\Inpos] *(In position)* Data type: *stoppointdata*

This argument is used to specify the convergence criteria for the position of the robot's TCP in the stop point. The stop point data substitutes the zone specified in the *Zone* parameter.

Tool Data type: *tooldata*

The tool in use when the robot moves. The tool centre point is the point moved to the specified destination point.

[\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.

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 p5, v2000, fine \Inpos := inpos50, grip3;

The TCP of the tool, *grip3*, is moved a non-linear path to a stop point *p5*. The robot considers it to be in the point when 50% of the position condition and 50% of the speed condition for a stop point *fine* are satisfied. It waits at most for 2 seconds for the conditions to be satisfied. See predefined data *inpos50* of data type *stoppointdata*.

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 robtarget > ','
    [ 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 > ]
    [ '\' Inpos ':=' < expression (IN) of stoppointdata > ] ','
    [ Tool ':=' ] < persistent (PERS) of tooldata >
    [ '\' WObj ':=' < persistent (PERS) of wobjdata > ] ';'
```

Related information

	Described in:
Other positioning instructions	RAPID Summary - *Motion*
Definition of velocity	Data Types - *speeddata*
Definition of zone data	Data Types - *zonedata*
Definition of stop point data	Data Types - *stoppointdata*
Definition of tools	Data Types - *tooldata*
Definition of work objects	Data Types - *wobjdata*
Motion in general	Motion and I/O Principles
Coordinate systems	Motion and I/O Principles - *Coordinate Systems*
Concurrent program execution	Motion and I/O Principles - *Synchronisation Using Logical Instructions*

MoveJDO - Moves the robot by joint movement and sets digital output in the corner

MoveJDO (*Move Joint Digital Output*) 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 specified digital output signal is set/reset at the middle of the corner path.

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

```
MoveJDO p1, vmax, z30, tool2, do1, 1;
```

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*. Output *do1* is set in the middle of the corner path at *p1*.

Arguments

MoveJDO ToPoint Speed [\T] Zone Tool
[\WObj] Signal Value

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 tool reorientation and external axes.

[\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.

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 point.

[\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.

Signal Data type: *signaldo*

The name of the digital output signal to be changed.

Value Data type: *dionum*

The desired value of signal (0 or 1).

Program execution

See the instruction *MoveJ* for more information about joint movement.

The digital output signal is set/reset in the middle of the corner path for flying points, as shown in Figure 14.

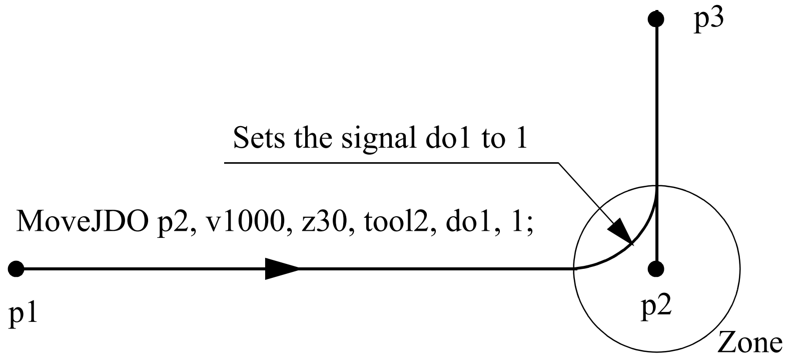


Figure 14 Set/Reset of digital output signal in the corner path with MoveJDO.

For stop points, we recommend the use of “normal” programming sequence with *MoveJ* + *SetDO*. But when using stop point in instruction *MoveJDO*, the digital output signal is set/reset when the robot reaches the stop point.

The specified I/O signal is set/reset in execution mode continuously and stepwise forward but not in stepwise backward.

Syntax

```
MoveJDO
   [ ToPoint ’:=’ ] < expression (IN) of robtarget > ’,’
   [ Speed ’:=’ ] < expression (IN) of speeddata >
               [ ’\’ T ’:=’ < expression (IN) of num > ] ’,’
   [ Zone ’:=’ ] < expression (IN) of zonedata > ’,’
   [ Tool ’:=’ ] < persistent (PERS) of tooldata >
   [ ’\’ WObj ’:=’ < persistent (PERS) of wobjdata > ] ’,’
   [ Signal ’:=’ ] < variable (VAR) of signaldo>] ‘,’
   [ Value ‘:=’ ] < expression (IN) of dionum > ] ’;’
```

Related information

	Described in:
Other positioning instructions	RAPID Summary - *Motion*
Definition of velocity	Data Types - *speeddata*
Definition of zone data	Data Types - *zonedata*
Definition of tools	Data Types - *tooldata*
Definition of work objects	Data Types - *wobjdata*
Motion in general	Motion and I/O Principles
Coordinate systems	Motion and I/O Principles - *Coordinate Systems*
Movements with I/O settings	Motion and I/O Principles - *Synchronisation Using Logical Instructions*

MoveJSync - Moves the robot by joint movement and executes a RAPID procedure

MoveJSync (*Move Joint Synchronously)* 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 specified RAPID procedure is executed at the middle of the corner path in the destination point.

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

MoveJSync p1, vmax, z30, tool2, “proc1”;

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*. Procedure *proc1* is executed in the middle of the corner path at *p1*.

Arguments

MoveJSync ToPoint Speed [\T] Zone Tool [\WObj] ProcName

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 tool reorientation and external axes.

[\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.

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 point.

[\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.

ProcName *(Procedure Name)* Data type: *string*

Name of the RAPID procedure to be executed at the middle of the corner path in the destination point.

Program execution

See the instruction *MoveJ* for more information about joint movements.

The specified RAPID procedure is executed when the TCP reaches the middle of the corner path in the destination point of the *MoveJSync* instruction, as shown in Figure 15:

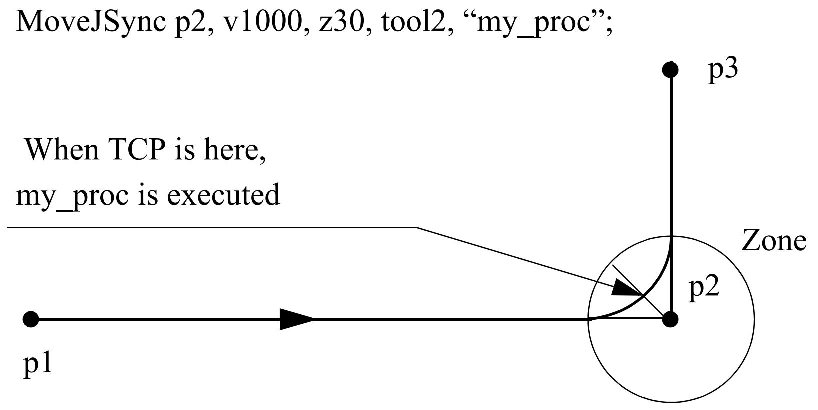


Figure 15 Execution of user-defined RAPID procedure in the middle of the corner path.

For stop points, we recommend the use of "normal" programming sequence with *MoveJ* + other RAPID instructions in sequence.

Execution of the specified RAPID procedure in different execution modes:

Execution mode:	Execution of RAPID procedure:
Continuously or Cycle	According to this description
Forward step	In the stop point
Backward step	Not at all

Limitation

Switching execution mode after program stop from continuously or cycle to stepwise forward or backward results in an error. This error tells the user that the mode switch can result in missed execution of a RAPID procedure in the queue for execution on the path. This error can be avoided if the program is stopped with StopInstr before the mode switch.

Instruction *MoveJSync* cannot be used on TRAP level.
The specified RAPID procedure cannot be tested with stepwise execution.

Syntax

```
MoveJSync
    [ ToPoint ':=' ] < expression (IN) of robtarget > ','
    [ Speed ':=' ] < expression (IN) of speeddata >
                    [ '\' 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 > ] ','
    [ ProcName':=' ] < expression (IN) of string > ] ';'
```

Related information

	Described in:
Other positioning instructions	RAPID Summary - *Motion*
Definition of velocity	Data Types - *speeddata*
Definition of zone data	Data Types - *zonedata*
Definition of tools	Data Types - *tooldata*
Definition of work objects	Data Types - *wobjdata*
Motion in general	Motion and I/O Principles
Coordinate systems	Motion and I/O Principles - *Coordinate Systems*

MoveL - Moves the robot linearly

MoveL is used to move the tool centre point (TCP) linearly to a given destination. When the TCP is to remain stationary, this instruction can also be used to reorientate the tool.

Example

MoveL p1, v1000, z30, tool2;

The TCP of the tool, *tool*2, is moved linearly to the position *p1,* with speed data *v1000* and zone data *z30*.

MoveL *, v1000\T:=5, fine, grip3;

The TCP of the tool, *grip3*, is moved linearly to a fine point stored in the instruction (marked with an *). The complete movement takes *5* seconds.

Arguments

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

[\Conc] *(Concurrent)* Data type: *switch*

Subsequent 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.

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.

[\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.

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.

[\Inpos] *(In position)* Data type: *stoppointdata*

This argument is used to specify the convergence criteria for the position of the robot's TCP in the stop point. The stop point data substitutes the zone specified in the *Zone* parameter.

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.

[\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 tool or coordinated external axes are used, this argument must be specified in order to perform a linear movement relative to the work object.

[\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 position as follows:

- The TCP of the tool is moved linearly at constant programmed velocity.
- The tool is reoriented 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 p5, v2000, fine \Inpos := inpos50, grip3;

The TCP of the tool, *grip3*, is moved linearly to a stop point *p5*. The robot considers it to be in the point when 50% of the position condition and 50% of the speed condition for a stop point *fine* are satisfied. It waits at most for 2 seconds for the conditions to be satisfied. See predefined data *inpos50* of data type *stoppointdata.*

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 robtarget > ’,’
   [ 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 > ]
   [ ’\’ Inpos ’:=’ < expression (IN) of stoppointdata > ] ‘,’
   [ Tool ’:=’ ] < persistent (PERS) of tooldata >
   [ ’\’ WObj ’:=’ < persistent (PERS) of wobjdata > ]
   [ ’\’ Corr ]’;’
```

Related information

	Described in:
Other positioning instructions	RAPID Summary - *Motion*
Definition of velocity	Data Types - *speeddata*
Definition of zone data	Data Types - *zonedata*
Definition of stop point data	Data Types - *stoppointdata*
Definition of tools	Data Types - *tooldata*
Definition of work objects	Data Types - *wobjdata*
Writes to a corrections entry	Instructions - *CorrWrite*
Motion in general	Motion and I/O Principles
Coordinate systems	Motion and I/O Principles - *Coordinate Systems*
Concurrent program execution	Motion and I/O Principles - *Synchronisation Using Logical Instructions*

MoveLDO - Moves the robot linearly and sets digital output in the corner

MoveLDO (*Move Linearly Digital Output*) is used to move the tool centre point (TCP) linearly to a given destination. The specified digital output signal is set/reset at the middle of the corner path.

When the TCP is to remain stationary, this instruction can also be used to reorient the tool.

Example

```
MoveLDO p1, v1000, z30, tool2, do1,1;
```

The TCP of the tool, *tool2,* is moved linearly to the position *p1,* with speed data *v1000* and zone data *z30*. Output *do1* is set in the middle of the corner path at *p1*.

Arguments

MoveLDO ToPoint Speed [\T] Zone Tool [\WObj] Signal Value

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.

[\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.

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.

[\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.

Signal Data type: *signaldo*

The name of the digital output signal to be changed.

Value Data type: *dionum*

The desired value of signal (0 or 1).

Program execution

See the instruction *MoveL* for more information about linear movements.

The digital output signal is set/reset in the middle of the corner path for flying points, as shown in Figure 16.

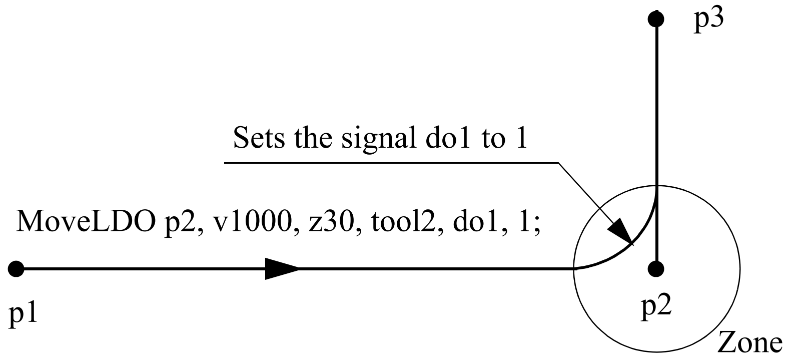


Figure 16 Set/Reset of digital output signal in the corner path with MoveLDO.

For stop points, we recommend the use of "normal" programming sequence with *MoveL* + *SetDO*. But when using stop point in instruction *MoveLDO*, the digital output signal is set/reset when the robot reaches the stop point.

The specified I/O signal is set/reset in execution mode continuously and stepwise forward but not in stepwise backward.

Syntax

```
MoveLDO
  [ ToPoint ':=' ] < expression (IN) of robtarget > ','
  [ Speed ':=' ] < expression (IN) of speeddata >
            [ '\' T ':=' < expression (IN) of num > ] ','
  [ Zone ':=' ] < expression (IN) of zonedata > ','
  [ Tool ':=' ] < persistent (PERS) of tooldata >
  [ '\' WObj ':=' < persistent (PERS) of wobjdata > ] ','
  [ Signal ':=' ] < variable (VAR) of signaldo>] ','
  [ Value ':=' ] < expression (IN) of dionum > ] ';'
```

Related information

	Described in:
Other positioning instructions	RAPID Summary - *Motion*
Definition of velocity	Data Types - *speeddata*
Definition of zone data	Data Types - *zonedata*
Definition of tools	Data Types - *tooldata*
Definition of work objects	Data Types - *wobjdata*
Motion in general	Motion and I/O Principles
Coordinate systems	Motion and I/O Principles - *Coordinate Systems*
Movements with I/O settings	Motion and I/O Principles - *Synchronisation Using Logical Instructions*

MoveL Sync - Moves the robot linearly and executes a RAPID procedure

MoveLSync (*Move Linearly Synchronously*) is used to move the tool centre point (TCP) linearly to a given destination.The specified RAPID procedure is executed at the middle of the corner path in the destination point.

When the TCP is to remain stationary, this instruction can also be used to reorient the tool.

Example

MoveLSync p1, v1000, z30, tool2, “proc1”;

The TCP of the tool, *tool2,* is moved linearly to the position *p1,* with speed data *v1000* and zone data *z30*. Procedure *proc1* is executed in the middle of the corner path at *p1*.

Arguments

MoveLSync ToPoint Speed [\T] Zone Tool [\WObj] ProcName

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.

[\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.

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.

[\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.

ProcName *(Procedure Name)* Data type: *string*

Name of the RAPID procedure to be executed at the middle of the corner path in the destination point.

Program execution

See the instruction *MoveL* for more information about linear movements.

The specified RAPID procedure is executed when the TCP reaches the middle of the corner path in the destination point of the *MoveLSync* instruction, as shown in Figure 17:

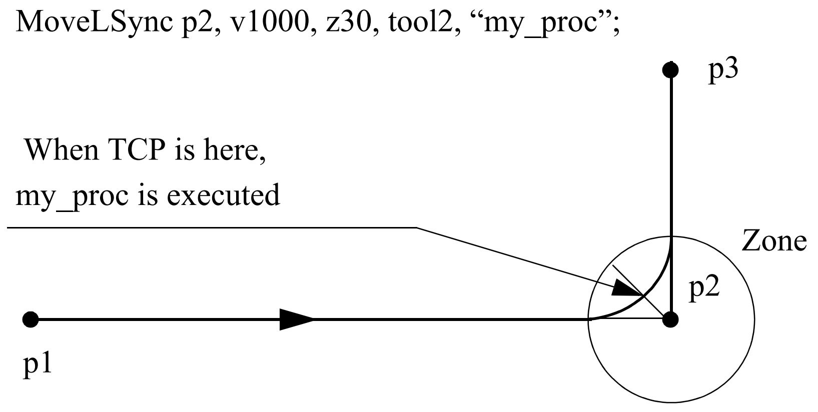


Figure 17 Execution of user-defined RAPID procedure in the middle of the corner path.

For stop points, we recommend the use of “normal” programming sequence with *MoveL* + other RAPID instructions in sequence.

Execution of the specified RAPID procedure in different execution modes:

Execution mode:	Execution of RAPID procedure:
Continuously or Cycle	According to this description
Forward step	In the stop point
Backward step	Not at all

Limitation

Switching execution mode after program stop from continuously or cycle to stepwise forward or backward results in an error. This error tells the user that the mode switch can result in missed execution of a RAPID procedure in the queue for execution on the path. This error can be avoided if the program is stopped with StopInstr before the mode switch.

Instruction *MoveLSync* cannot be used on TRAP level.
The specified RAPID procedure cannot be tested with stepwise execution.

Syntax

MoveLSync
    [ToPoint ’:=’] < expression (**IN**) of *robtarget* > ’,’
    [Speed ’:=’] < expression (**IN**) of *speeddata* >
                [’\’ T ’:=’ < expression (**IN**) of *num* >] ’,’
    [Zone ’:=’] < expression (**IN**) of *zonedata* > ’,’
    [Tool ’:=’] < persistent (**PERS**) of *tooldata* >
    [’\’ WObj ’:=’ < persistent (**PERS**) of *wobjdata* >] ’,’
    [ProcName‘:=’] < expression (**IN**) of *string* >] ‘;’

Related information

	Described in:
Other positioning instructions	RAPID Summary - *Motion*
Definition of velocity	Data Types - *speeddata*
Definition of zone data	Data Types - *zonedata*
Definition of tools	Data Types - *tooldata*
Definition of work objects	Data Types - *wobjdata*
Motion in general	Motion and I/O Principles
Coordinate systems	Motion and I/O Principles - *Coordinate Systems*

MToolRotCalib - Calibration of rotation for moving tool

MToolRotCalib (Moving Tool Rotation Calibration) is used to calibrate the rotation of a moving tool.

The position of the robot and its movements are always related to its tool coordinate system, i.e. the TCP and tool orientation. To get the best accuracy, it is important to define the tool coordinate system as correctly as possible.

The calibration can also be done with a manual method using the TPU (described in User's Manual - *Calibration*).

Description

To define the tool orientation, you need a world fixed tip within the robot's working space.

Before using the instruction *MToolRotCalib*, some preconditions must be fulfilled:

- The tool that is to be calibrated must be mounted on the robot and defined with correct component *robhold* (*TRUE*).
- If using the robot with absolute accuracy, the load and centre of gravity for the tool should already be defined.
  LoadIdentify can be used for the load definition.
- The TCP value of the tool must already be defined. The calibration can be done with the instruction *MToolTCPCalib*.
- *Tool0*, *wobj0* and *PDispOff* must be activated before jogging the robot.
- Jog the TCP of the actual tool as close as possible to the world fixed tip (origin of the tool coordinate system) and define a *jointtarget* for the reference point *RefTip*.
- Jog the robot without changing the tool orientation so the world fixed tip is pointing at some point on the positive z-axis of the tool coordinate system and define a *jointtarget* for point *ZPos*.
- Jog optionally the robot without changing the tool orientation so the world fixed tip is pointing at some point on the positive x-axis of the tool coordinate system and define a *jointtarget* for point *XPos*.

As a help for pointing out the positive z-axis and x-axis, some type of elongator tool can be used.

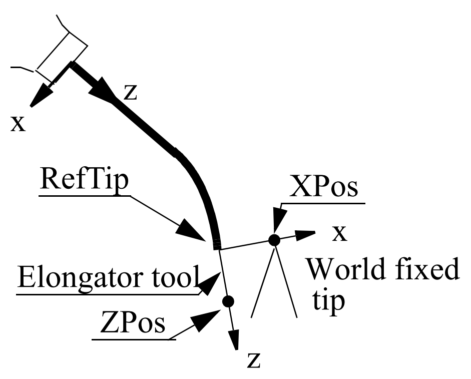


Figure 18 Definition of jointtarget for RefTip, ZPos and optional XPos

Example

```
! Created with the world fixed tip pointing at origin, positive z-axis and positive
! x-axis.
CONST jointtarget pos_tip := [...];
CONST jointtarget pos_z := [...];
CONST jointtarget pos_x := [...];
```

PERS tooldata tool1:= [TRUE, [[20, 30, 100], [1, 0, 0 ,0]],
[0.001, [0, 0, 0.001], [1, 0, 0, 0], 0, 0, 0]];

! Instructions for creating or ModPos of pos_tip, pos_z and pos_x

```
MoveAbsJ pos_tip, v10, fine, tool0;
MoveAbsJ pos_z, v10, fine, tool0;
MoveAbsJ pos_x, v10, fine, tool0;
```

Only tool calibration in the z direction

```
MToolRotCalib pos_tip, pos_z, tool1;
```

The tool orientation (*tframe.rot*) in the z direction of *tool1* is calculated. The x and y directions of the tool orientation are calculated to coincide with the wrist coordinate system.

Calibration with complete tool orientation

```
MToolRotCalib pos_tip, pos_z \XPos:=pos_x, tool1;
```

The tool orientation (*tframe.rot*) of *tool1* is calculated.

Arguments

MToolRotCalib RefTip ZPos [\XPos]Tool

RefTip Data type: *jointtarget*

The reference tip point.

ZPos Data type: *jointtarget*

The elongator point that defines the positive z direction.

[\XPos] Data type: *jointtarget*

The elongator point that defines the x positive direction. If this point is omitted, the x and y directions of the tool will coincide with the corresponding axes in the wrist coordinate system.

Tool Data type: *tooldata*

The name of the tool that is to be calibrated.

Program execution

The system calculates and updates the tool orientation (*tfame.rot*) in the specified *tool-data.* The calculation is based on the specified 2 or 3 *jointtarget*. The remaining data in tooldata such as TCP (*tframe.trans*) is not changed.

Syntax

MToolRotCalib
[RefTip ':='] < expression (**IN**) of *jointtarget* > ','
[ZPos ':='] < expression (**IN**) of *jointtarget* >
['\'XPos ':=' < expression (**IN**) of *jointtarget* >] ','
[Tool ':='] < persistent (**PERS**) of *tooldata* > ';'

Related information

	Described in:
Calibration of TCP for a moving tool	Instructions - *MToolTCPCalib*
Calibration of TCP for a stationary tool	Instructions - *SToolTCPCalib*
Calibration TCP and rotation for a stationary tool	Instructions - *SToolRotCalib*

MToolTCPCalib - Calibration of TCP for moving tool

MToolTCPCalib (Moving Tool TCP Calibration) is used to calibrate Tool Centre Point - TCP for a moving tool.

The position of the robot and its movements are always related to its tool coordinate system, i.e. the TCP and tool orientation. To get the best accuracy, it is important to define the tool coordinate system as correctly as possible.

The calibration can also be done with a manual method using the TPU (described in User's Manual - *Calibration*).

Description

To define the TCP of a tool, you need a world fixed tip within the robot's working space.

Before using the instruction *MToolTCPCalib*, some preconditions must be fulfilled:

- The tool that is to be calibrated must be mounted on the robot and defined with correct component *robhold* (*TRUE*).
- If using the robot with absolute accuracy, the load and centre of gravity for the tool should already be defined.
  LoadIdentify can be used for the load definition.
- *Tool0*, *wobj0* and *PDispOff* must be activated before jogging the robot.
- Jog the TCP of the actual tool as close as possible to the world fixed tip and define a *jointtarget* for the first point p1.
- Define a further three positions p2, p3, and p4, all with different orientations.

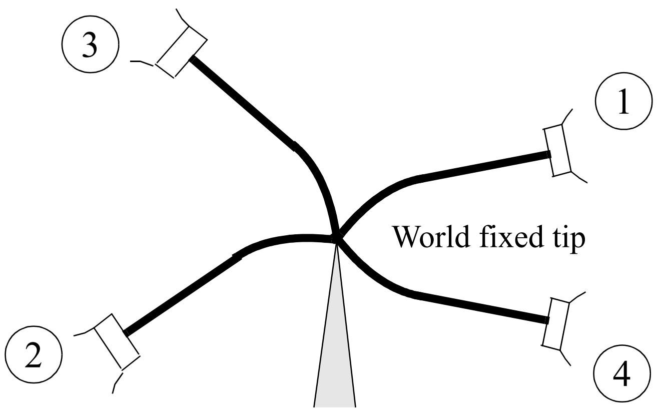


Figure 19 Definition of 4 jointtargets p1 ... p4.

Example

```
! Created with actual TCP pointing at the world fixed tip
CONST jointtarget p1 := [...];
CONST jointtarget p2 := [...];
CONST jointtarget p3 := [...];
CONST jointtarget p4 := [...];

PERS tooldata tool1:= [ TRUE, [[0, 0, 0], [1, 0, 0 ,0]],
          [0.001, [0, 0, 0.001], [1, 0, 0, 0], 0, 0, 0]];
VAR num max_err;
VAR num mean_err;
...
! Instructions for createing or ModPos of p1 - p4
MoveAbsJ p1, v10, fine, tool0;
MoveAbsJ p2, v10, fine, tool0;
MoveAbsJ p3, v10, fine, tool0;
MoveAbsJ p4, v10, fine, tool0;
...
MToolTCPCalib p1, p2, p3, p4, tool1, max_err, mean_err;
```

The TCP value (*tframe.trans*) of *tool1* will be calibrated and updated. *max_err* and *mean_err* will hold the max. error in mm from the calculated TCP and the mean error in mm from the calculated TCP, respectively.

Arguments

MToolTCPCalib Pos1 Pos2 Pos3 Pos4 Tool MaxErr MeanErr

Pos1 Data type: *jointtarget*

The first approach point.

Pos2 Data type: *jointtarget*

The second approach point.

Pos3 Data type: *jointtarget*

The third approach point.

Pos4 Data type: *jointtarget*

The fourth approach point.

Tool Data type: *tooldata*

The name of the tool that is to be calibrated.

MaxErr Data type: *num*

The maximum error in mm for one approach point.

MeanErr Data type: *num*

The average distance that the approach points are from the calculated TCP, i.e. how accurately the robot was positioned relative to the tip.

Program execution

The system calculates and updates the TCP value in the wrist coordinate system (*tfame.trans*) in the specified *tooldata.* The calculation is based on the specified 4 *joint-target*. The remaining data in tooldata, such as tool orientation (*tframe.rot*), is not changed.

Syntax

```
MToolTCPCalib
        [ Pos1 ':=' ] < expression (IN) of jointtarget > ','
        [ Pos2 ':=' ] < expression (IN) of jointtarget > ','
        [ Pos3 ':=' ] < expression (IN) of jointtarget > ','
        [ Pos4 ':=' ] < expression (IN) of jointtarget > ','
        [ Tool ':=' ] < persistent (PERS) of tooldata > ','
        [ MaxErr ':=' ] < variable (VAR) of num > ','
        [ MeanErr ':=' ] < variable (VAR) of num > ';'
```

Related information

	Described in:
Calibration of rotation for a moving tool	Instructions - *MToolRotCalib*
Calibration of TCP for a stationary tool	Instructions - *SToolTCPCalib*
Calibration of TCP and rotation for a stationary tool	Instructions - *SToolRotCalib*

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 "HOME:" \File:= "LOGFILE1.DOC", logfile \Write;
```

The file *LOGFILE1.DOC* in unit *HOME:*, 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 (I/O device) that is to be opened, e.g. "HOME:", "TEMP:", "flp1:"(option), “com2:” or “pc:”(option).

Tabell 3 Different I/O device in the system

I/O device name	Full file path	Type of I/O device
"HOME:"	"/hd0a:/xxxx/" 1)	Flashdisk
"TEMP:"	"/hd0a:/temp/"	Flashdisk
"flp1:"	"flp1:"	Floppy disk
"com2:" 2)	-	Serial channel
“pc:” 3)	“/c:/temp/” 4)	Mounted disk

1) ”xxxx” means the system name, defined when booting the system
2) User defined serial channel name, defined in system parameters
3) Application protocol, local path, defined in system parameters
4) Application protocol, server path, defined in system parameters

[\File] Data type: *string*

The name of the file to be opened, e.g. "LOGFILE1.DOC" or "LOGDIR/LOGFILE1.DOC"

The complete path can also be specified in the argument *Object*, “HOME:/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 or serial channel.

[\Read] Data type: *switch*

Opens a 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 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 file or serial channel for writing. If the selected file already exists, anything subsequently written is written at the end of the file.

Open a file or serial channel with *\Append* and without the *\Bin* arguments. The instruction opens a character-based file or serial channel for writing.

Open a file or serial channel with *\Append* and *\Bin* arguments. The instruction opens a binary file or serial channel for both reading and writing.

The arguments *\Read*, *\Write*, *\Append* are mutually exclusive. If none of these are specified, the instruction acts in the same way as the *\Write* argument for character-based files or a serial channel (instruction without *\Bin* argument) and in the same way as the *\Append* argument for binary files or a serial channel (instruction with *\Bin* argument).

[\Bin] Data type: *switch*

The file or serial channel is opened in a binary mode.
If none of the arguments *\Read*, *\Write* or *\Append* are specified, the instruction opens a binary file or serial channel for both reading and writing, with the file pointer at the end of the file

The set of instructions to access a binary file or serial channel is different from the set of instructions to access a character-based file.

Example

```
VAR iodev printer;
...
Open "com2:", printer \Bin;
WriteStrBin printer, "This is a message to the printer\0D";
Close printer;
```

The serial channel *com2:* 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 file or serial channel is opened so that it is possible to read from or write to it.

It is possible to open the same physical file several times at the same time, but each invocation of the *Open* instruction will return a different reference to the file (data type *iodev*). E.g. it is possible to have one write pointer and one different read pointer to the same file at the same time.

The *iodev* variable used when opening a file or serial channel must be free from use. If it has been used previously to open a file, this file must be closed prior to issuing a new *Open* instruction with the same *iodev* variable.

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*>] ','
  [IODevice ':='] <variable (**VAR**) of *iodev*>
  ['\'Read] | ['\'Write] | ['\'Append]
  ['\'Bin] ';'

Related information

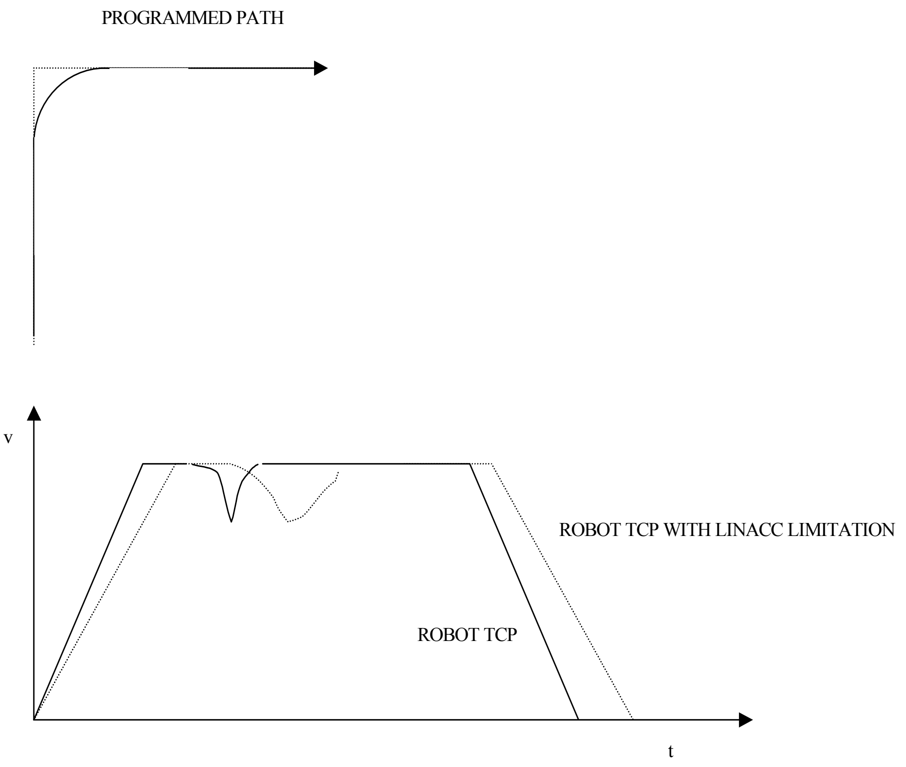
	Described in:
Writing to and reading from files or serial channel	RAPID Summary - *Communication*

PathAccLim - Reduce TCP acceleration along the path

PathAccLim (Path Acceleration Limitation) is used to set or reset limitations on TCP acceleration and/or TCP deceleration along the movement path.

The limitation will be performed along the movement path, i.e the acceleration in the path frame. It is the tangential acceleration/deceleration in the path direction that will be limited.

The instruction does not limit the total acceleration of the equipment, i.e. the acceleration in world frame, so it can not be directly used to protect the equipment from large accelerations.



Example

PathAccLim TRUE \AccMax := 4, TRUE \AccMin := 4;

TCP acceleration and TCP deceleration is limited to $4 m/s^2$.

PathAccLim FALSE, FALSE;

The TCP acceleration and deceleration is reset to maximum (default).

Arguments

PathAccLim AccLim [\AccMax] DecelLim [\DecelMax]

AccLim Data type: *bool*

TRUE if there is to be a limitation of the acceleration, FALSE otherwise.

[\AccMax] Data type: *num*

The absolute value of the acceleration limitation in m/s^2. Only to be used when *AccLim* is TRUE.

DecelLim Data type: *bool*

TRUE if there is to be a limitation of the deceleration, FALSE otherwise.

[\DecelMax] Data type: *num*

The absolute value of the deceleration limitation in m/s^2. Only to be used when *DecelLim* is TRUE.

Program execution

The acceleration/deceleration limitations applies for the next executed robot segment and is valid until a new *PathAccLim* instruction is executed.

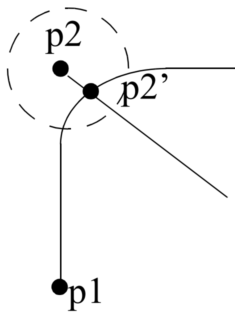
The maximum acceleration/deceleration (PathAccLim FALSE, FALSE) are automatically set

- at a cold start-up
- when a new program is loaded
- when starting program executing from the beginning.

If combination of instruction *AccSet* and *PathAccLim,* the system reduce the acceleration/deceleration in following order

- according *AccSet*
- according *PathAccLim*

Example



MoveL p1, v1000, fine, tool0;
PathAccLim TRUE\AccMax := 4, FALSE;
MoveL p2, v1000, z30, tool0;
MoveL p3, v1000, fine, tool0;
PathAccLim FALSE, FALSE;

TCP acceleration is limited to $4 m/s^2$ between p1 and p3.

MoveL p1, v1000, fine, tool0;
MoveL p2, v1000, z30, tool0;
PathAccLim **TRUE\AccMax :=3**, TRUE\DecelMax := 4;
MoveL p3, v1000, fine, tool0;
PathAccLim FALSE, FALSE;

TCP acceleration is limited to $3 m/s^2$ between p2’ and p3
TCP deceleration is limited to $4 m/s^2$ between p2’ and p3

Limitations

The minimum acceleration/deceleration allowed is 0.5 m/s^2.

Error handling

If the parameters *AccMax* or *DecelMax* is set to a value too low, the system variable ERRNO is set to ERR_ACC_TOO_LOW. This error can then be handled in the error handler.

Syntax

PathAccLim
[AccLim ’:=’] < expression (**IN**) of *bool* >
[‘\’AccMax ’:=’ <expression (**IN**) of *num* >]’,’
[DecelLim ’:=’] < expression (**IN**) of *bool*>
[‘\’DecelMax ‘:=’ <expression (**IN**) of *num* >]’;’

Related information

	Described in:
Positioning instructions	RAPID Summary - *Motion*
Motion settings data	Data Types - *motsetdata*
Reduction of acceleration	Instructions - *AccSet*

PathResol - Override path resolution

PathResol (Path Resolution) is used to override the configured geometric path 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 parameter *PathSampleTime* is decreased. A value for parameter *PathSampleTime* which is too low, may however cause CPU load problems in some demanding applications. However, use of the standard configured path resolution (*PathSampleTime* 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 parameter *PathSampleTime*.

Low performance external axes may cause CPU load problems during coordination. Increase the parameter *PathSampleTime*.

Arc-welding with high frequency weaving may require high resolution of the interpolated path. Decrease the parameter *PathSampleTime*.

Small circles or combined small movements with direction changes can decrease the path performance quality and increase the cycle time. Decrease the parameter *PathSampleTime*.

Gluing with large reorientations and small corner zones can cause speed variations. Decrease the parameter *PathSampleTime*.

Example

```
MoveJ p1,v1000,fine,tool1;
PathResol 150;
```

With the robot at a stop point, the path sample time is increased to *150*% of the configured.

Arguments

PathResol PathSampleTime

PathSampleTime Data type: *num*

Override as a percent of the configured path sample time.
100% corresponds to the configured path sample time.
Within the range 25-400%.

A lower value of the parameter *PathSampleTime* improves the path resolution (path accuracy).

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 sample time 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 sample time can be read from the variable *C_MOTSET* (data type *motsetdata*) in the component *pathresol*.

Limitations

If this instruction is preceded by a move instruction, that move instruction must be programmed with a stop point (*zonedata* fine), not a fly-by point, otherwise restart after power failure will not be possible.

Syntax

PathResol
[PathSampleTime ':='] < expression (IN) of num> ';'

Related information

	Described in:
Positioning instructions	Motion and I/O Principles- *Movements*
Motion settings	RAPID Summary - *Motion Settings*
Configuration of path resolution	System Parameters - *CPU Optimization*

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

	Described in:
Definition of program displacement using two positions	Instructions - *PDispOn*
Definition of program displacement using values	Instructions - *PDispSet*

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 \Inpos := inpos50, tool1;
PDispOn *, tool1;
```

Activation of a program displacement (parallel movement). Since a stop point that is accurately defined 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 20.

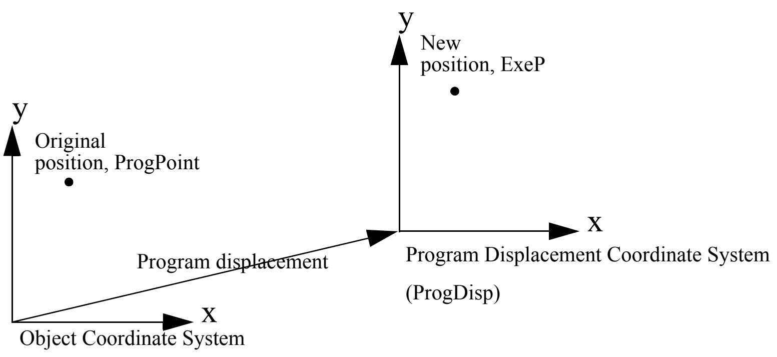


Figure 20 Displacement of a programmed position using program displacement.

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 21).

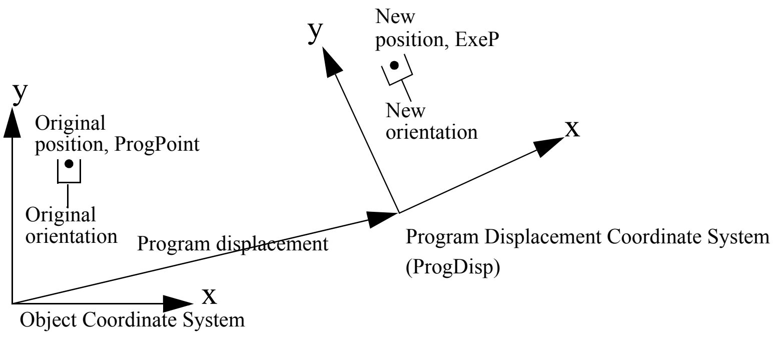


Figure 21 Translation and rotation of a programmed position.

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 \Inpos := inpos50, tool1;
draw_square;
MoveL p20, v500, fine \Inpos := inpos50, tool1;
draw_square;
MoveL p30, v500, fine \Inpos := inpos50, 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 22.

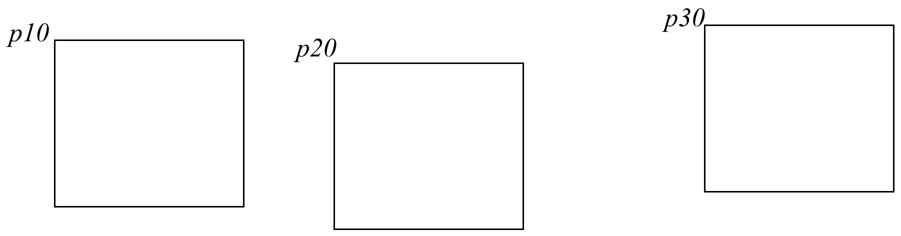


Figure 22 Using program displacement, motion patterns can be reused.

```
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 *robtarget* **>] ',']**
  [ProgPoint ':='] < expression (IN) of *robtarget* **> ','**
  [Tool ':='] < persistent (PERS) of *tooldata***>**
  ['\'WObj ':=' < persistent (PERS) of *wobjdata***>] ';'**

Related information

	Described in:
Deactivation of program displacement	Instructions - *PDispOff*
Definition of program displacement using values	Instructions - *PDispSet*
Coordinate systems	Motion Principles - *Coordinate Systems*
Definition of tools	Data Types - *tooldata*
Definition of work objects	Data Types - *wobjdata*
More examples	Instructions - *PDispOff*

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 23).
- As long as this program displacement is active, all positions will be displaced 100 mm in the direction of the x-axis.

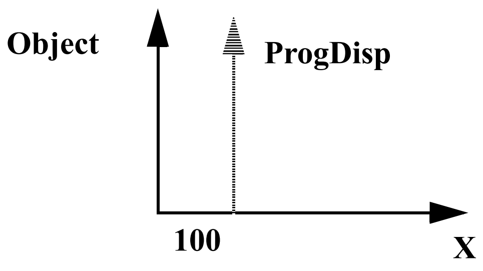


Figure 23 A 100 mm-program displacement along the x-axis.

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 24.

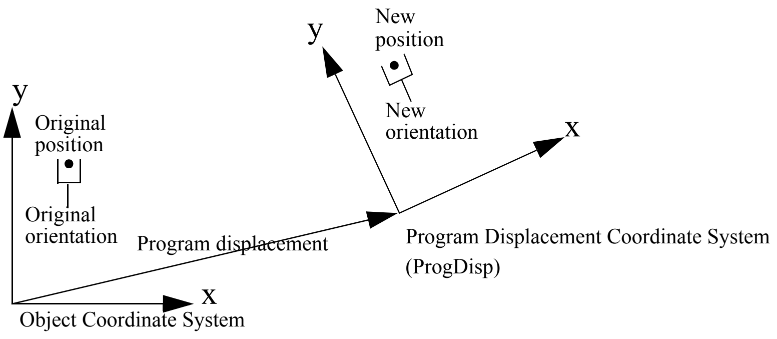


Figure 24 Translation and rotation of a programmed position.

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

	Described in:
Deactivation of program displacement	Instructions - *PDispOff*
Definition of program displacement using two positions	Instructions - *PDispOn*
Definition of data of the type *pose*	Data Types - *pose*
Coordinate systems	Motion Principles- *Coordinate Systems*
Examples of how program displacement can be used	Instructions - *PDispOn*

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 do1;
   .

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 do1*.

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

	Described in:
Arguments, parameters	Basic Characteristics - *Routines*
More examples	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*.

```
! Program task MAIN
PulseDO \High, do3;
! At almost the same time in program task BCK1
PulseDO \High, do3;
```

Positive pulse (value 1) is generated on the signal *do3* from two program tasks at almost the same time. It will result in one positive pulse with a pulse length longer than the default 0.2 s or two positive pulses after each other with a pulse length of 0.2 s.

Arguments

PulseDO [\High] [\PLength] Signal

[\High]	*(High level)*	Data type: *switch*

Specifies that the signal value should always be set to high (value 1) when the instruction is executed, independently of its current state.

[\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 25).

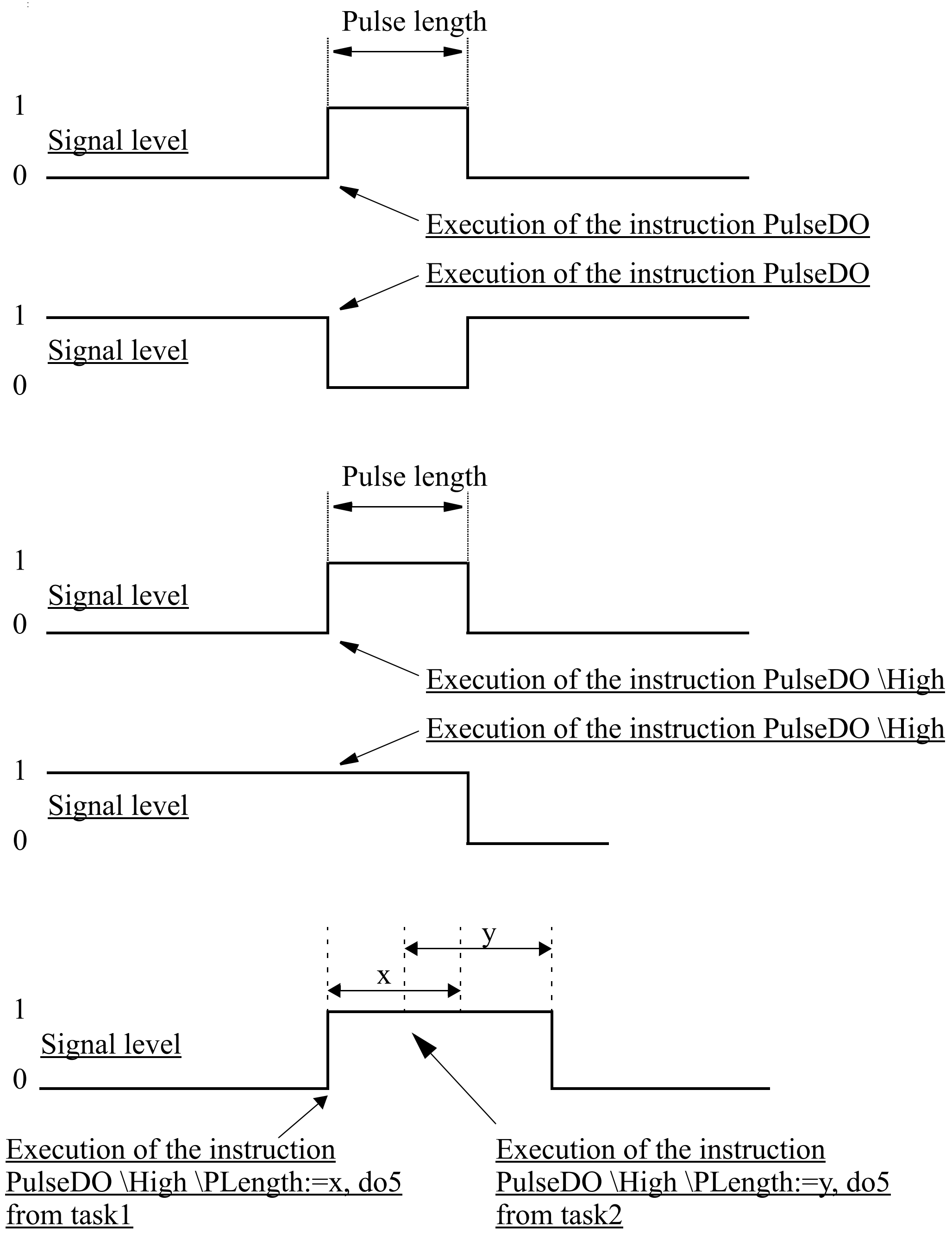

Pulse length
1
Signal level
0
Execution of the instruction PulseDO
Execution of the instruction PulseDO
1
Signal level
0
Pulse length
1
Signal level
0
Execution of the instruction PulseDO \High
Execution of the instruction PulseDO \High
1
Signal level
0
y
x
1
Signal level
0
Execution of the instruction PulseDO \High \PLength:=x, do5 from task1
Execution of the instruction PulseDO \High \PLength:=y, do5 from task2

Figure 25 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
   [ [ '\'High]
   [ '\'PLength ':=' < expression (IN) of num >] ',' ]
   [ Signal ':=' ] < variable (VAR) of signaldo > ';'
```

Related information

	Described in:
Input/Output instructions	RAPID Summary - *Input and Output Signals*
Input/Output functionality in general	Motion and I/O Principles - *I/O Principles*
Configuration of I/O	User's Guide - *System Parameters*

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. A RAISE instruction in a routine's error handler has also another feature, it can be used for long jump (see "Error Recovery With Long Jump"). With a long jump it is possible to propagate an error from an error handler from a deep neested call chain to a higher level in one step.

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

	Described in:
Error handling	Basic Characteristics - *Error Recovery*
Error recovery with long jump	Basic Characteristics - *Error Recovery*
Booking error numbers	Instructions - *BookErrNo*

ReadAnyBin - Read data from a binary serial channel or file

ReadAnyBin (Read Any Binary) is used to read any type of data from a binary serial channel or file.

Example

```
VAR iodev channel2;
VAR robtarget next_target;
...
Open "com2:", channel2 \Bin;
ReadAnyBin channel2, next_target;
```

The next robot target to be executed, next_target, is read from the channel referred to by *channel2*.

Arguments

ReadAnyBin IODevice Data [\Time])

IODevice Data type: *iodev*

The name (reference) of the binary serial channel or file to be read.

Data Data type: *ANYTYPE*

The VAR or PERS to which the read data will be stored.

[\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 in use also during program stop and will be noticed in the RAPID program at program start.

Program execution

As many bytes as required for the specified data are read from the specified binary serial channel or file.

Limitations

This instruction can only be used for serial channels or files that have been opened for binary reading.

The data to be read by this instruction must have a *value* data type of *atomic*, *string*, or *record* data type. *Semi-value* and *non-value* data types cannot be used.

Array data cannot be used.

Note that the VAR or PERS variable, for storage of the data read, can be updated in several steps. Therefore, always wait until the whole data structure is updated before using read data from a TRAP or another program task.

Error handling

If an error occurs during reading, the system variable ERRNO is set to ERR_FILEACC.

If timeout before the read operation is finished, the system variable ERRNO is set to ERR_DEV_MAXTIME.

If there is a checksum error in the data read, the system variable ERRNO is set to ERR_RANYBIN_CHK.

If the end of the file is detected before all the bytes are read, the system variable ERRNO is set to ERR_RANYBIN_EOF.

These errors can then be dealt with by the error handler.

Example

```
CONST num NEW_ROBT:=12;
CONST num NEW_WOBJ:=20;
VAR iodev channel;
VAR num input;
VAR robtarget cur_robt;
VAR wobjdata cur_wobj;

Open "com2:", channel\Bin;

! Wait for the opcode character
input := ReadBin (channel \Time:= 0.1);
TEST input
CASE NEW_ROBT:
    ReadAnyBin channel, cur_robt;
CASE NEW_WOBJ:
    ReadAnyBin channel, cur_wobj;
ENDTEST

Close channel;
```

As a first step, the opcode of the message is read from the serial channel. According to this opcode a robtarget or a wobjdata is read from the serial channel.

Syntax

ReadAnyBin
[IODevice':='] <variable (**VAR**) of *iodev*>','
[Data':='] <var or pers (**INOUT**) of *ANYTYPE*>
['\'Time':=' <expression (**IN**) of *num*>]';'

Related information

	Described in:
Opening (etc.) of serial channels or files	RAPID Summary - *Communication*
Write data to a binary serial channel or file	Instructions - *WriteAnyBin*

ReadErrData - Gets information about an error

ReadErrData is to be used in a trap routine, to get information (domain, type, number and intermixed strings %s) about an error, a state change, or a warning, that caused the trap routine to be executed.

Refer to *User Guide - Error Management, System and Error Messages* for more information.

Example

```
VAR errdomain err_domain;
VAR num err_number;
VAR errtype err_type;
VAR trapdata err_data;
VAR string string1;
VAR string string2;
...
TRAP trap_err
    GetTrapData err_data;
    ReadErrData err_data, err_domain, err_number,
    err_type \Str1:=string1 \Str2:=string2;
ENDTRAP
```

When an error is trapped to the trap routine *trap_err*, the error domain, the error number, the error type and the two first intermixed strings in the error message are saved into appropriate variables.

Arguments

ReadErrData TrapEvent ErrorDomain ErrorId ErrorType [\Str1] [\Str2] [\Str3] [\Str4] [\Str5]

TrapEvent Data type: *trapdata*

Variable containing the information about what caused the trap to be executed.

ErrorDomain Data type: *errdomain*

The error domain to which the error, state change, or warning that occurred belongs. Ref. to predefined data of type *errdomain*.

ErrorId Data type: *num*

The number of the error that occurred.
The error number is returned without the first digit (error domain) and without the initial zeros of the complete error number.
E.g. 10008 Program restarted, is returned as 8.

ErrorType Data type: *errtype*

The type of event such as error, state change, or warning that occurred.
Ref. to predefined data of type *errtype*.

[\Str1] ... [\Str5] Data type: *string*

The string holding information that is intermixed into the error message. There could be up to five strings in a message. *Str1* holds the first string, *Str2* holds the second string and so on. Information about how many strings there are in a message is found in *User Guide - Error Management, System and Error Messages.* The intermixed string are maked as %s, %d or %f in that document.

Program execution

The *ErrorDomain, ErrorId, ErrorType and Str1 ... Str5* variables are updated according to the contents of *TrapEvent*.

If different events are connected to the same trap routine, the program must make sure that the event is related to error monitoring. This can be done by testing that INTNO matches the interrupt number used in the instruction *IError*;

Example

```
VAR intnum err_interrupt;
VAR trapdata err_data;
VAR errdomain err_domain;
VAR num err_number;
VAR errtype err_type;
...
CONNECT err_interrupt WITH trap_err;
IError COMMON_ERR, TYPE_ERR, err_interupt;
...
IDelete err_interrupt;
...
TRAP trap_err
    GetTrapData err_data;
    ReadErrData err_data, err_domain, err_number, err_type;
    ! Set domain no 1 ... 13
    SetGO go_err1, err_domain;
    ! Set error no 1 ...9999
    SetGO go_err2, err_number;
ENDTRAP
```

When an error occurs (only errors, not warning or state change), the error number is retrieved in the trap routine and its value is used to set 2 groups of digital outputs.

Limitation

It is not possible obtain information about internal errors.

Syntax

```
ReadErrData
    [TrapEvent ':='] <variable (VAR) of trapdata>','
    [ErrorDomain ':='] <variable (VAR) of errdomain>','
    [ErrorId':='] <variable (VAR) of num>','
    [ErrorType ':='] <variable (VAR) of errtype>
    ['\'Str1 ':='<variable (VAR) of string>]
    ['\'Str2 ':='<variable (VAR) of string>]
    ['\'Str3 ':='<variable (VAR) of string>]
    ['\'Str4 ':='<variable (VAR) of string>]
    ['\'Str5 ':='<variable (VAR) of string>]';'
```

Related information

	Described in:
Summary of interrupts	RAPID Summary - *Interrupts*
More information on interrupt management	Basic Characteristics- *Interrupts*
Error domains, predefined constants	Data Types - *errdomain*
Error types, predefined constants	Data Types - *errtype*
Orders an interrupt on errors	Instructions - *IError*
Get interrupt data for current TRAP	Instructions - *GetTrapData*

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

	Described in:
Setting a digital output signal	Instructions - *Set*
Input/Output instructions	RAPID Summary - *Input and Output Signals*
Input/Output functionality in general	Motion and I/O Principles - *I/O Principles*
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 robtarget 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

Only the movement path data is stored with the instruction *StorePath*.
If the user wants to order movements on the new path level, the actual stop position must be stored directly after *StorePath* and before *RestoPath* make a movement to the stored stop position on the path.

If this instruction is preceded by a move instruction, that move instruction must be programmed with a stop point (*zonedata* fine), not a fly-by point, otherwise restart after power failure will not be possible.

Syntax

RestoPath';'

Related information

	Described in:
Storing paths	Instructions - *StorePath*
More examples	Instructions - *StorePath*

RETRY - Resume execution after an error

The *RETRY* instruction is used to resume program execution after an error, starting with (re-executing) the instruction that caused the error.

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. The maximum number of retries can be configured in *System Parameters (System miscellaneous)*.

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

	Described in:
Error handlers	Basic Characteristics - *Error Recovery*
Configure maximum number of retries	System Parameters - *System miscellaneous*
Continue with the next instruction	Instructions - *TRYNEXT*

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 do1;
    .

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 do1*.

```
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 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

	Described in:
Functions and Procedures	Basic Characteristics - *Routines*
Trap routines	Basic Characteristics - *Interrupts*
Error handlers	Basic Characteristics - *Error Recovery*

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 "HOME:"\File := "bin_file",dev \Write;
Close dev;

! Open the binary file with \Bin switch for binary read and write access
Open "HOME:"\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.*

Error handling

If an error occurs during the rewind, the system variable ERRNO is set to ERR_FILEACC. This error can then be handled in the error handler.

Syntax

```
Rewind
   [IODevice ':='] <variable (VAR) of iodev>';'
```

Related information

	Described in:
Opening (etc.) of files	RAPID Summary - *Communication*

Save - Save a program module

Save is used to save a program module.

The specified program module in the program memory will be saved with the original (specified in *Load* or *StartLoad*) or specified file path.

It is also possible to save a system module at the specified file path.

Example

```
Load "HOME:/PART_B.MOD";
...
Save "PART_B";
```

Load the program module with the file name *PART_B.MOD* from *HOME:* into the program memory.

Save the program module *PART_B* with the original file path *HOME:* and with the original file name *PART_B.MOD*.

Arguments

Save [\Task] ModuleName [\FilePath] [\File]

[\Task] Data type: *taskid*

The program task in which the program module should be saved.

If this argument is omitted, the specified program module in the current (executing) program task will be saved.

For all program tasks in the system, predefined variables of the data type *taskid* will be available. The variable identity will be "taskname"+"Id", e.g. for the MAIN task the variable identity will be MAINId, TSK1 - TSK1Id etc.

ModuleName Data type: *string*

The program module to save.

[\FilePath] Data type: *string*

The file path and the file name to the place where the program module is to be saved. 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,* it must be specified with this argument.

The argument *\FilePath* can only be omitted for program modules loaded with *Load* or *StartLoad-WaitLoad* and the program module will be stored at the same destination as specified in these instructions. To store the program module at another destination it is also possible to use the argument *\FilePath*.

To be able to save a program module that previously was loaded from the teach pendant, external computer, or system configuration, the argument *\FilePath* must be used.

Program execution

Program execution waits for the program module to finish saving before proceeding with the next instruction.

Example

```
Save  "PART_A" \FilePath:="HOME:/DOORDIR/PART_A.MOD";
```

Save the program module *PART_A* to *HOME:* in the file *PART_A.MOD* and in the directory *DOORDIR*.

```
Save  "PART_A" \FilePath:="HOME:” \File:=”DOORDIR/PART_A.MOD";
```

Same as above but another syntax.

```
Save \Task:=TSK1Id, "PART_A" \FilePath:="HOME:/DOORDIR/PART_A.MOD";
```

Save program module *PART_A* in program task *TSK1* to the specified destination. This is an example where the instruction *Save* is executing in one program task and the saving is done in another program task.

Limitations

TRAP routines, system I/O events and other program tasks cannot execute during the saving operation. Therefore, any such operations will be delayed.

The save operation can interrupt update of PERS data done step by step from other program tasks. This will result in inconsistent whole PERS data.

A program stop during execution of the *Save* instruction can result in a guard stop with motors off and the error message "20025 Stop order timeout" will be displayed on the Teach Pendant.

Avoid ongoing robot movements during the saving.

Error handling

If the program module cannot be saved because there is no module name, unknown, or ambiguous module name, the system variable ERRNO is set to ERR_MODULE.

If the save file cannot be opened because of permission denied, no such directory, or no space left on device, the system variable ERRNO is set to ERR_IOERROR.

If argument *\FilePath* is not specified for program modules loaded from the Teach Pendant, System Parameters, or an external computer, the system variable ERRNO is set to ERR_PATH.

The errors above can be handled in the error handler.

Syntax

Save
    ['\' Task ':=' <variable (**VAR**) of *taskid*> ',']
    [ModuleName ':='] <expression (**IN**) of *string*>
    ['\' FilePath ':='<expression (**IN**) of *string*>]
    ['\' File ':=' <expression (**IN**) of *string*>] ';'

Related information

	Described in:
Program tasks	Data Types - *taskid*

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 di1, 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 *di1* changes to active, the position is stored in *sp*.

SearchC \Stop, di2, sp, cirpoint, p10, v100, probe;

The TCP of the *probe* is moved circularly towards the position *p10*. When the value of the signal *di2* changes to active, the position is stored in *sp* and the robot stops immediately.

Arguments

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

[\Stop] *(Stiff 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 distance before it stops and is not moved back to the searched position, i.e. to the position where the signal changed.

[\SStop] *(Smooth Stop)* Data type: *switch*

The robot movement is stopped as quickly as possible, while keeping the TCP close to or on the path (smooth stop), when the value of the search signal changes to active. However, the robot is moved only a small distance before it stops and is not moved back to the searched position, i.e. to the position where the signal changed. *SStop* is faster then *PStop*. But when the robot is running faster than 100 mm/s, it stops in the direction of the tangent of the movement which causes it to marginally slide of the path.

[\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*, *\SStop 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 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: *robtarget*

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: *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). *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*, *\PStop* or *\SStop*, 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 26.

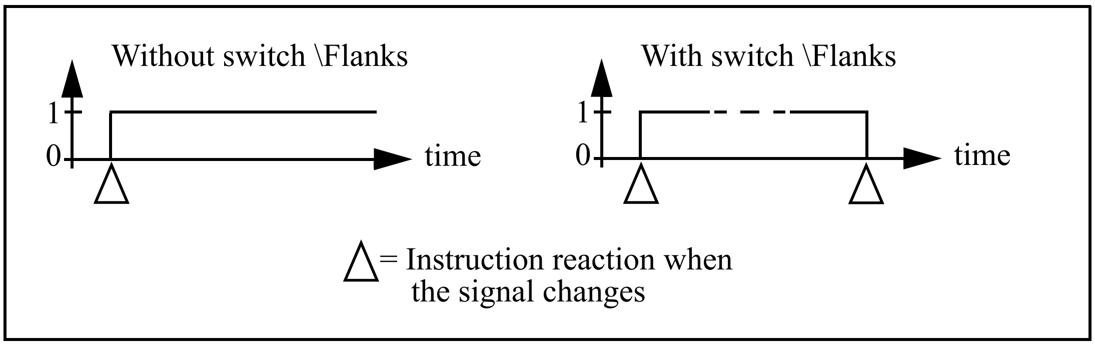


Figure 26 Flank-triggered signal detection (the position is stored when the signal is changed the first time only).

Example

SearchC \Sup, di1\Flanks, sp, cirpoint, p10, v100, probe;

> The TCP of the *probe* is moved circularly towards the position *p10*. When the value of the signal *di1* changes to active or passive, the position is stored in *sp*. If the value of the signal changes twice, program execution stops.

Limitations

General limitations according to instruction MoveC.

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 27 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).

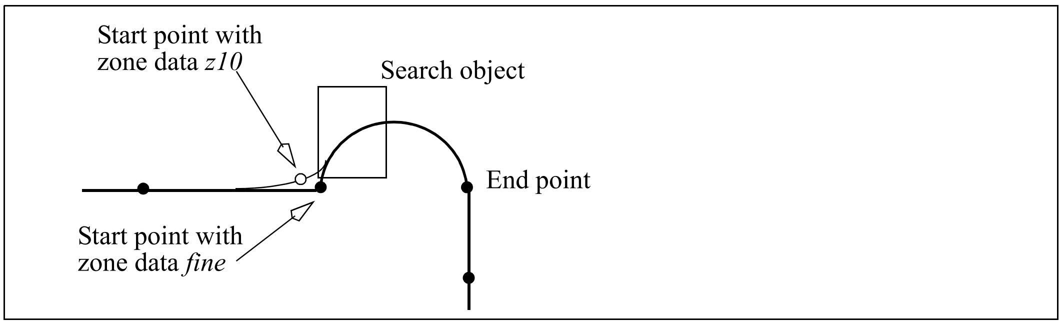


Figure 27 A match is made on the wrong side of the object because the wrong zone data was used.

Repetition accuracy for search hit position with TCP speed 20 - 1000 mm/s
0.1 - 0.3 mm.

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) 15-25 mm
- with TCP near path (switch \SStop) 4-8 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 ','] | ['\' SStop ','] | ['\' Sup ',']
  [Signal ':='] < variable (**VAR**) of *signaldi* >
      ['\' Flanks]','
  [SearchPoint ':='] < var or pers (**INOUT**) of *robtarget* > ','
  [CirPoint ':='] < expression (**IN**) of *robtarget* > ','
  [ToPoint ':='] < expression (**IN**) of *robtarget* > ','
  [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

	Described in:
Linear searches	Instructions - *SearchL*
Writes to a corrections entry	Instructions - *CorrWrite*
Circular movement	Motion and I/O Principles - *Positioning during Program Execution*
Definition of velocity	Data Types - *speeddata*
Definition of tools	Data Types - *tooldata*
Definition of work objects	Data Types - *wobjdata*
Using error handlers	RAPID Summary - *Error Recovery*
Motion in general	Motion and I/O Principles
More searching examples	Instructions - *SearchL*

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 di1, 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 *di1* changes to active, the position is stored in *sp*.

SearchL \Stop, di2, sp, p10, v100, probe;

The TCP of the *probe* is moved linearly towards the position *p10*. When the value of the signal *di2* changes to active, the position is stored in *sp* and the robot stops immediately.

Arguments

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

[\Stop] *(Stiff 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 distance before it stops and is not moved back to the searched position, i.e. to the position where the signal changed.

[\SStop] *(Smooth Stop)* Data type: *switch*

The robot movement is stopped as quickly as possible, while keeping the TCP close to or on the path (smooth stop), when the value of the search signal changes to active. However, the robot is moved only a small distance before it stops and is not moved back to the searched position, i.e. to the position where the signal changed. *SStop* is faster then *PStop*. But when the robot is running faster than 100 mm/s it stops in the direction of the tangent of the movement which causes it to marginally slide off the path.

[\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*, *\SStop* 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: *robtarget*

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: *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). *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*, *\PStop or \SStop*, 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 28.

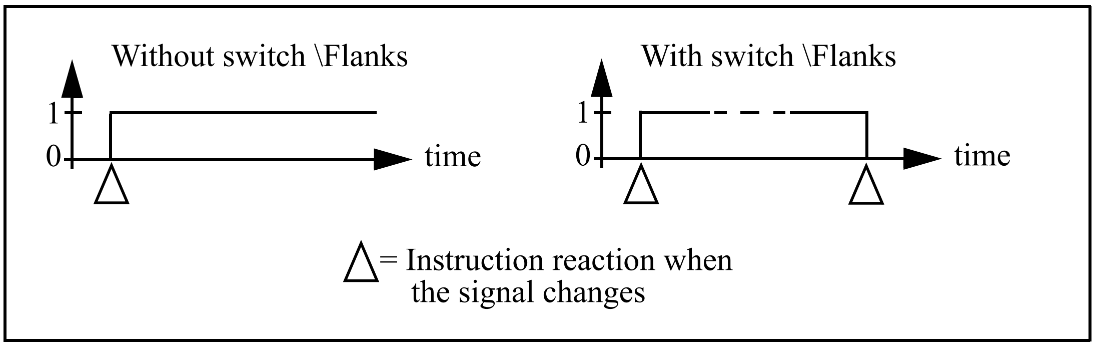


Figure 28 Flank-triggered signal detection (the position is stored when the signal is changed the first time only).

Examples

```
SearchL \Sup, di1\Flanks, sp, p10, v100, probe;
```

The TCP of the *probe* is moved linearly towards the position *p10*. When the value of the signal *di1* 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, di1, sp, p10, v100, tool1;
MoveL sp, v100, fine \Inpos := inpos50, 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 *di1* 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 *di1* changes to active, the position is stored in *sp*. The robot is moved back to this point using an accurately defined stop 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 29 to Figure 31 illustrate examples of things that may go wrong when zone data other than *fine* is used.

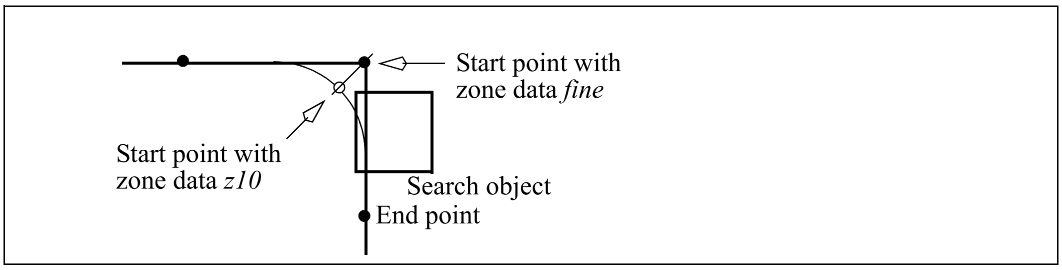


Figure 29 A match is made on the wrong side of the object because the wrong zone data was used.

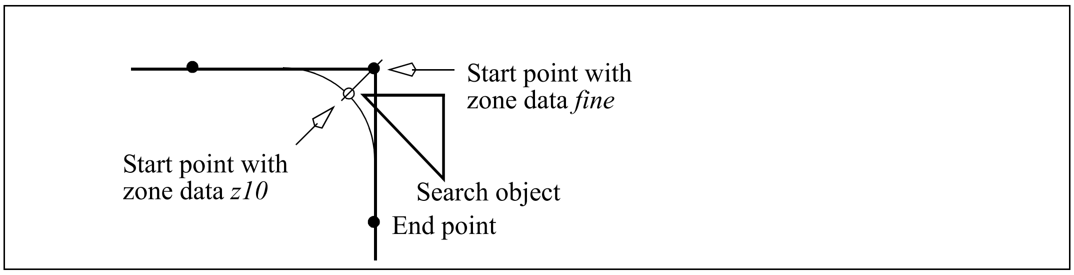


Figure 30 No match detected because the wrong zone data was used.

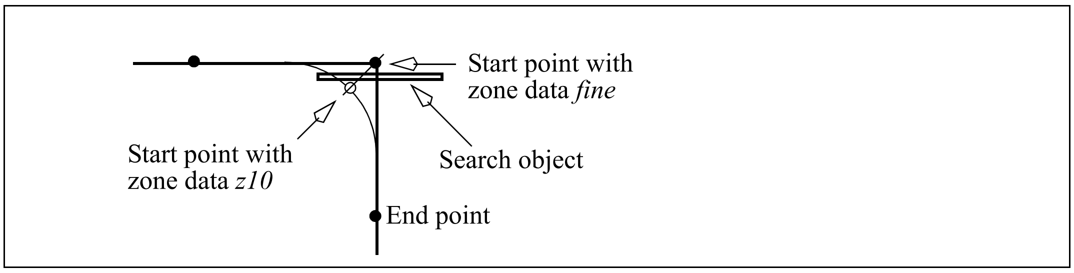


Figure 31 No match detected because the wrong zone data was used.

Repetition accuracy for search hit position with TCP speed 20 - 1000 mm/s
0.1 - 0.3 mm.

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) 15-25 mm
- with TCP near path (switch \SStop) 4-8 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, di1, 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
```

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 ’,’] | [ ’\’ SStop ’,’] | [ ’\’ Sup ’,’ ]
   [ Signal ’:=’ ] < variable (VAR) of signaldi >
            [‘\’ Flanks] ’,’
   [ SearchPoint ’:=’ ] < var or pers (INOUT) of robtarget > ’,’
   [ ToPoint ’:=’ ] < expression (IN) of robtarget > ’,’
   [ 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

	Described in:
Circular searches	Instructions - *SearchC*
Writes to a corrections entry	Instructions - *CorrWrite*
Linear movement	Motion and I/O Principles - *Positioning during Program Execution*
Definition of velocity	Data Types - *speeddata*
Definition of tools	Data Types - *tooldata*
Definition of work objects	Data Types - *wobjdata*
Using error handlers	RAPID Summary - *Error Recovery*
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

There is a short delay before the signal physically gets its new value. If you do not want the program execution to continue until the signal has got its new value, you can use the instruction *SetDO* with the optional parameter *\Sync*.

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

	Described in:
Setting a digital output signal to zero	Instructions - *Reset*
Change the value of a digital output signal	Instruction - *SetDO*
Input/Output instructions	RAPID Summary - *Input and Output Signals*
Input/Output functionality in general	Motion and I/O Principles - *I/O Principles*
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 32.

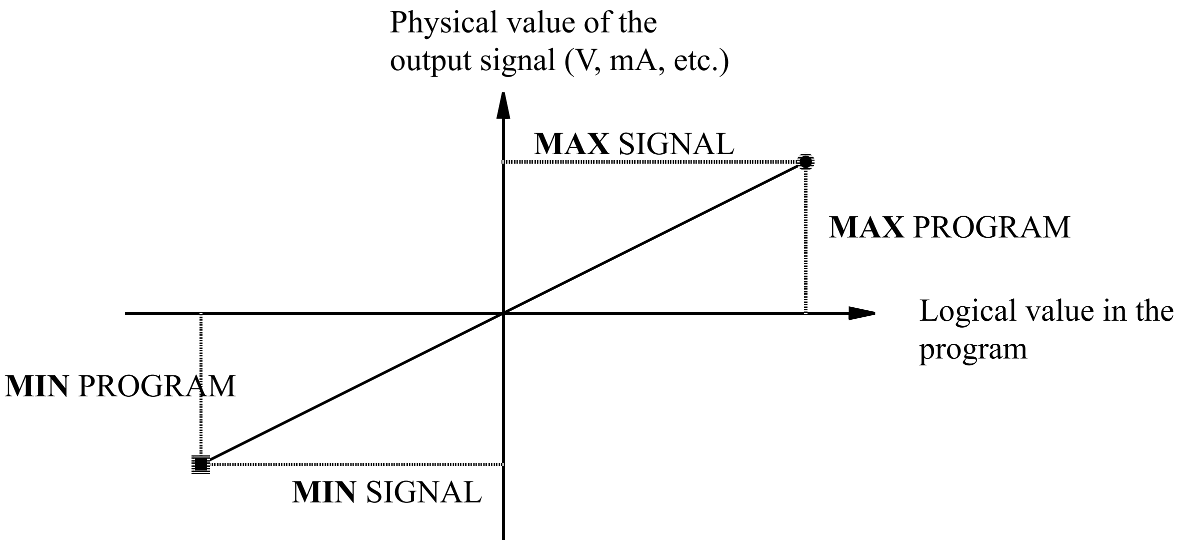

Physical value of the output signal (V, mA, etc.)
MAX SIGNAL
MAX PROGRAM
Logical value in the program
MIN PROGRAM
MIN SIGNAL

Figure 32 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 - *Input and Output Signals*
Input/Output functionality in general	Motion and I/O Principles - *I/O Principles*
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 or synchronisation.

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.

SetDO \Sync ,do1, 0;

The signal *do1* is set to *0*. Program execution waits until the signal is physically set to the specified value.

Arguments

SetDO [\SDelay]|[\Sync] Signal Value

[\SDelay] *(Signal Delay)* Data type: *num*

Delays the change for the amount of time given in seconds (max. 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.

[\Sync] *(Synchronisation)* Data type: *switch*

If this argument is used, the program execution will wait until the signal is physically set to the specified value.

If neither of the arguments *\SDelay* or *\Sync* are used, the signal will be set as fast as possible and the next instruction will be executed at once, without waiting for the signal to be physically set.

Signal Data type: *signaldo*

The name of the signal to be changed.

Value Data type: *dionum*

The desired value of the signal 0 or 1.

Tabell 4 System interpretation of specified Value

Specified Value	Set digital output to
0	0
Any value except 0	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* > ','] |['\' Sync ',']
  [Signal ':='] < variable (**VAR**) of *signaldo* > ','
  [Value ':='] < expression (**IN**) of *dionum* > ';'

Related information

	Described in:
Input/Output instructions	RAPID Summary - *Input and Output Signals*
Input/Output functionality in general	Motion and I/O Principles - *I/O Principles*
Configuration of I/O	User's Guide - *System Parameters*

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 (max. 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:

No. of signals	Permitted value	No. of signals	Permitted value
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

	Described in:
Other input/output instructions	RAPID Summary - *Input and Output Signals*
Input/Output functionality in general	Motion and I/O Principles - *I/O Principles*
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.

SingArea is also used to define linear and circular interpolation for robots with less than six axes.

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).

Robots with less than six axes may not be able to reach an interpolated tool orientation. By using SingArea \Wrist, the robot can achieve the movement but the orientation of the tool will be slightly changed.

```
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.

Robots with less than six axes may not be able to reach a programmed tool orientation. As a result the robot will stop.

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). Also used for linear and circular interpolation of robots with less than six axes where the tool orientation is allowed to differ.

[\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.

If none of the arguments are specified, program execution automatically uses the robot's default argument. For robots with six axes the default argument is *\Off*.

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, program execution automatically uses the */Off* argument for robots with six axes. Robots with less than six axes may use either the */Off* argument (IRB640) or the */Wrist* argument by default. This is automatically set in event routine SYS_RESET.

- at a cold start-up
- when a new program is loaded
- when starting program executing from the beginning.

Syntax

```
SingArea
    [ ’\’ Wrist ] | [ ’\’ Off ] ’;’
```

Related information

	Described in:
Singularity	Motion Principles- *Singularity*
Interpolation	Motion Principles - *Positioning during Program Execution*

SkipWarn - Skip the latest warning

SkipWarn (Skip Warning) is used to skip the latest requested warning message to be stored in the Service Log during execution in running mode continuously or cycle (no warnings skipped in FWD or BWD step).

With *SkipWarn* it is possible to repeatedly do error recovery in RAPID without filling the Service Log with only warning messages.

Example

```
    %"notexistingproc"%;
    nextinstruction;
ERROR
    IF ERRNO = ERR_REFUNKPRC THEN
        SkipWarn;
        TRYNEXT;
    ENDIF
ENDPROC
```

The program will execute the *nextinstruction* and no warning message will be stored in the Service Log.

Syntax

SkipWarn ';'

Related information

	Described in:
Error recovery	RAPID Summary - *Error Recovery* Basic Characteristics - *Error Recovery*
Error number	Data Types - *errnum*

SoftAct - Activating the soft servo

SoftAct (Soft Servo Activate) is used to activate the so called “soft” servo on any axis of the robot or external mechanical unit.

Example

SoftAct 3, 20;

Activation of soft servo on robot axis *3*, with softness value *20*%.

SoftAct 1, 90 \Ramp:=150;

Activation of the soft servo on robot axis *1*, with softness value *90*% and ramp factor *150*%.

SoftAct \MechUnit:=orbit1, 1, 40 \Ramp:=120;

Activation of soft servo on axis *1* for the mechanical unit *orbit1*, with softness value *40*% and ramp factor *120*%.

Arguments

SoftAct [\MechUnit] Axis Softness [\Ramp]

[\MechUnit] *(Mechanical Unit* Data type: *mecunit*

The name of the mechanical unit. If this argument is omitted, it means activation of the soft servo for specified robot axis.

Axis Data type: *num*

Number of the robot or external axis to work with soft servo.

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 (>= 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

Soft servo for any robot or external axis is always deactivated when there is a power failure. This limitation can be handled in the user program when restarting after a power failure.

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
['\'MechUnit ':=' < variable (VAR) of mecunit> ',']
[Axis ':='] < expression (IN) of num> ','
[Softness ':='] < expression (IN) of num>
['\'Ramp ':=' < expression (IN) of num>]';'

Related information

	Described in:
Behaviour with the soft servo engaged	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 and external 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 (>= 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 ramp factor is 100 %.

Program execution

The soft servo is deactivated for all robot and external axes.

Syntax

```
SoftDeact
   [ '\'Ramp ':=' < expression (IN) of num> ]';'
```

Related information

	Described in:
Activating the soft servo	Instructions - *SoftAct*

SpyStart - Start recording of execution time data

SpyStart is used to start the recording of instruction and time data during execution.

The execution data will be stored in a file for later analysis.

The stored data is intended for debugging RAPID programs, specifically for multi-tasking systems (only necessary to have *SpyStart* - *SpyStop* in one program task).

Example

```
SpyStart “HOME:/spy.log”;
```

Starts recording the execution time data in the file *spy.log* on the *HOME:* disk.

Arguments

SpyStart File

File Data type: *string*

The file path and the file name to the file that will contain the execution data.

Program execution

The specified file is opened for writing and the execution time data begins to be recorded in the file.

Recording of execution time data is active until:

- execution of instruction SpyStop
- starting program execution from the beginning
- loading a new program
- next warm start-up

Limitations

Avoid using the floppy disk (option) for recording since writing to the floppy is very time consuming.

Never use the spy function in production programs because the function increases the cycle time and consumes memory on the mass memory device in use.

Error handling

If the file in the *SpyStart* instruction can’t be opened then the system variable ERRNO is set to ERR_FILEOPEN (see “Data types - errnum”). This error can then be handled in the error handler.

File format

```
TASK            INSTR     IN        CODE          OUT

MAIN            FOR i FROM 1 TO 3 DO 0:READY :0
MAIN            mynum := mynum+i; 1:READY :  1
MAIN            ENDFOR    2:        READY :  2
MAIN            mynum := mynum+i; 2:READY :  2
MAIN            ENDFOR    2:        READY :  2
MAIN            mynum := mynum+i; 2:READY :  2
MAIN            ENDFOR    2:        READY :  3
MAIN            SetDO do1,1; 3:     READY :  3
MAIN            IF di1=0 THEN 3:    READY :  4
MAIN            MoveL p1, v1000,fine,tool0;  4:WAIT :14
----- SYSTEM TRAP-----
MAIN            MoveL p1, v1000, fine, tool0;111:READY :111
MAIN            ENDIF     108:      READY :  108
MAIN            MoveL p2, v1000,fine,tool0; 111:WAIT :118
----- SYSTEM TRAP-----
MAIN            MoveL p2, v1000, fine, tool0;326:READY :326
MAIN             SpyStop;  326:
```

TASK column shows executed program task
INSTR column shows executed instruction in specified program task
IN column shows the time in ms at enter of the executed instruction
CODE column shows if the instruction is READY or
if the instruction WAIT for completion at **OU**T time
OUT column shows the time in ms at leave of the executed instruction

All times are given in ms (relative values).

----- SYSTEM TRAP----- means that the system is doing something else than execution of RAPID instructions.

If procedure call to some NOSTEPIN procedure (module) the output list shows only the name of the called procedure. This is repeated for every executed instruction in the NOSTEPIN routine.

Syntax

SpyStart
  [File':=']<expression (**IN**) of *string*>';'

Related information

	Described in:
Stop recording of execution data	Instructions - *SpyStop*

SpyStop - Stop recording of time execution data

SpyStop is used to stop the recording of time data during execution.

The data, which can be useful for optimising the execution cycle time, is stored in a file for later analysis.

Example

```
SpyStop;
```

Stops recording the execution time data in the file specified by the previous *SpyStart* instruction.

Program execution

The execution data recording is stopped and the file specified by the previous *SpyStart* instruction is closed.
If no *SpyStart* instruction has been executed before, the *SpyStop* instruction is ignored.

Examples

```
IF debug = TRUE SpyStart "HOME:/spy.log";
produce_sheets;
IF debug = TRUE SpyStop;
```

If the debug flag is true, start recording execution data in the file *spy.log* on the *HOME:* disk, perform actual production; stop recording, and close the file *spy.log*.

Limitations

Avoid using the floppy disk (option) for recording since writing to the floppy is very time consuming.

Never use the spy function in production programs because the function increases the cycle time and consumes memory on the mass memory device in use.

Syntax

```
SpyStop';'
```

Related information

	Described in:
Start recording of execution data	Instructions - *SpyStart*

StartLoad - Load a program module during execution

StartLoad is used to start the loading of a program module into the program memory during execution.

When loading is in progress, other instructions can be executed in parallel.
The loaded module must be connected to the program task with the instruction *WaitLoad*, before any of its symbols/routines can be used.

The loaded program module will be added to the modules already existing in the program memory.

A program or system module can be loaded in static (default) or dynamic mode:

Static mode

Tabell 5 How different operations affect a static loaded program or system modules

	Set PP to main from TP	Open new RAPID program
Program Module	Not affected	Unloaded
System Module	Not affected	Not affected

Dynamic mode

Tabell 6 How different operations affect a dynamic loaded program or system modules

	Set PP to main from TP	Open new RAPID program
Program Module	Unloaded	Unloaded
System Module	Unloaded	Unloaded

Both static and dynamic loaded modules can be unloaded by the instruction *UnLoad*.

Example

```
VAR loadsession load1;
! Start loading of new program module PART_B containing routine routine_b
! in dynamic mode
StartLoad \Dynamic, diskhome \File:=”PART_B.MOD”, load1;
! Executing in parallel in old module PART_A containing routine_a
%”routine_a”%;
! Unload of old program module PART_A
UnLoad diskhome \File:=”PART_A.MOD”;
! Wait until loading and linking of new program module PART_B is ready
WaitLoad load1;


! Execution in new program module PART_B
%”routine_b”%;
```

Starts the loading of program module *PART_B.MOD* from *diskhome* into the program memory with instruction *StartLoad*. In parallel with the loading, the program executes *routine_a* in module PART_A.MOD. Then instruction *WaitLoad* waits until the loading and linking is finished. The module is loaded in dynamic mode.

Variable *load1* holds the identity of the load session, updated by *StartLoad* and referenced by *WaitLoad*.

To save linking time, the instruction *UnLoad* and *WaitLoad* can be combined in the instruction *WaitLoad* by using the option argument *\UnLoadPath.*

Arguments

StartLoad [\Dynamic] FilePath [\File] LoadNo

[\Dynamic]

Data type: *switch*

The switch enables loading of a program module in dynamic mode. Otherwise the loading is in static mode.

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.

LoadNo

Data type: *loadsession*

This is a reference to the load session that should be used in the instruction *WaitLoad* to connect the loaded program module to the program task.

Program execution

Execution of *StartLoad* will only order the loading and then proceed directly with the next instruction, without waiting for the loading to be completed.

The instruction *WaitLoad* will then wait at first for the loading to be completed, if it is not already finished, and then it will be linked and initialised. The initialisation of the loaded module sets all variables at module level to their init values.

Unsolved references will be accepted if the system parameter for *Tasks/BindRef* is set to NO. However, when the program is started or the teach pendant function *Program Window/File/Check Program* is used, no check for unsolved references will be done if *BindRef* = NO. There will be a run time error on execution of an unsolved reference.

Another way to use references to instructions that are not in the task from the beginning, is to use *Late Binding.* This makes it possible to specify the routine to call with a string expression, quoted between two %%. In this case the *BindRef* parameter could be set to YES (default behaviour). The *Late Binding* way is preferable.

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.

For loading of program that contains a *main* procedure to a main program (with another *main* procedure), see instruction *Load.*

Examples

```
StartLoad \Dynamic, “HOME:/DOORDIR/DOOR1.MOD”, load1;
```

Loads the program module *DOOR1.MOD* from the *HOME:* at the directory *DOORDIR* into the program memory. The program module is loaded in dynamic mode.

```
StartLoad \Dynamic, "HOME:" \File:="/DOORDIR/DOOR1.MOD", load1;
```

Same as above but with another syntax.

```
StartLoad "HOME:" \File:="/DOORDIR/DOOR1.MOD", load1;
```

Same as the two examples above but the module is loaded in static mode.

```
StartLoad \Dynamic, "HOME:" \File:="/DOORDIR/DOOR1.MOD", load1;
...
WaitLoad load1;
```

is the same as

```
Load \Dynamic, "HOME:" \File:="/DOORDIR/DOOR1.MOD";
```

Error handling

If the variable specified in argument *LoadNo* is already in use, the system variable ERRNO is set to ERR_LOADNO_INUSE. This error can then be handled in the error handler.

Syntax

StartLoad
  [‘\’Dynamic ‘,’]
  [FilePath ’:=’] <expression (**IN**) of *string*>
  [’\’File ’:=’ <expression (**IN**) of *string*>] ’,’
  [LoadNo ’:=’] <variable (**VAR**) of *loadsession*> ’;’

Related information

	Described in:
Connect the loaded module to the task	Instructions - *WaitLoad*
Load session	Data Types - *loadsession*
Load a program module	Instructions - *Load*
Unload a program module	Instructions - *UnLoad*
Cancel loading of a program module	Instructions - *CancelLoad*
Accept unsolved references	System Parameters - *Controller/Task/ BindRef*

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.

If the robot is moving at the time *StartMove* is executed, the system variable ERRNO is set to ERR_ALRDY_MOVING.

These errors can then be handled in the error handler.

Syntax

```
StartMove';'
```

Related information

	Described in:
Stopping movements	Instructions - *StopMove*
More examples	Instructions - *StorePath*

SToolRotCalib - Calibration of TCP and rotation for stationary tool

SToolRotCalib (Stationary Tool Rotation Calibration) is used to calibrate the TCP and rotation of a stationary tool.

The position of the robot and its movements are always related to its tool coordinate system, i.e. the TCP and tool orientation. To get the best accuracy, it is important to define the tool coordinate system as correctly as possible.

The calibration can also be done with a manual method using the TPU (described in User's Manual - *Calibration*).

Description

To define the TCP and rotation of a stationary tool, you need a movable pointing tool mounted on the end effector of the robot.

Before using the instruction *SToolRotCalib*, some preconditions must be fulfilled:

- The stationary tool that is to be calibrated must be stationary mounted and defined with the correct component *robhold* (*FALSE*).
- The pointing tool (*robhold TRUE*) must be defined and calibrated with the correct TCP values.
- If using the robot with absolute accuracy, the load and centre of gravity for the pointing tool should be defined.
  LoadIdentify can be used for the load definition.
- The pointing tool, *wobj0* and *PDispOff* must be activated before jogging the robot.
- Jog the TCP of the pointing tool as close as possible to the TCP of the stationary tool (origin of the tool coordinate system) and define a *robtarget* for the reference point *RefTip*.
- Jog the robot without changing the tool orientation so the TCP of the pointing tool is pointing at some point on the positive z-axis of the tool coordinate system and define a *robtarget* for point *ZPos*.
- Jog the robot without changing the tool orientation so the TCP of the pointing tool is pointing at some point on the positive x-axis of the tool coordinate system and define a *robtarget* for point *XPos*.

As a help for pointing out the positive z-axis and x-axis, some type of elongator tool can be used.

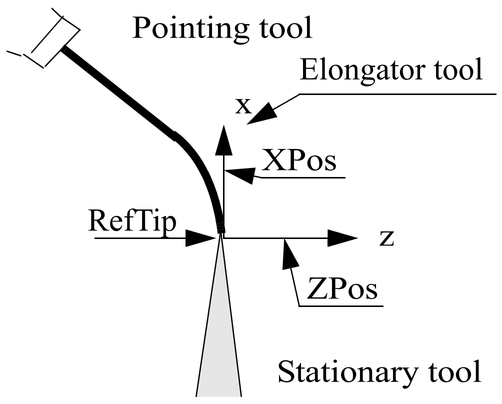


Figure 33 Definition of robtargets RefTip, ZPos and XPos

Example

```
! Created with pointing TCP pointing at the stationary tool coordinate system
CONST robtarget pos_tip := [...];
CONST robtarget pos_z := [...];
CONST robtarget pos_x := [...];

PERS tooldata tool1:= [ FALSE, [[0, 0, 0], [1, 0, 0 ,0]],
                [0, [0, 0, 0], [1, 0, 0, 0], 0, 0, 0]];

! Instructions for creating or ModPos of pos_tip, pos_z and pos_x
MoveJ pos_tip, v10, fine, point_tool;
MoveJ pos_z, v10, fine, point_tool;
MoveJ pos_x, v10, fine, point_tool;

SToolRotCalib pos_tip, pos_z, pos_x, tool1;
```

The position of the TCP (*tframe.trans*) and the tool orientation (*tframe.rot*) of *tool1* in the world coordinate system is calculated and updated.

Arguments

SToolRotCalib RefTip ZPos XPos Tool

RefTip Data type: *robtarget*

The reference tip point.

ZPos Data type: *robtarget*

The elongator point that defines the positive z direction.

XPos Data type: *robtarget*

The elongator point that defines the positive x direction.

Tool Data type: *tooldata*

The name of the tool that is to be calibrated.

Program execution

The system calculates and updates the TCP (*tframe.trans*) and the tool orientation (*tfame.rot*) in the specified *tooldata.* The calculation is based on the specified 3 *robtarget*. The remaining data in *tooldata* is not changed.

Syntax

SToolRotCalib
[RefTip ':='] < expression (**IN**) of *robtarget* > ','
[ZPos ':='] < expression (**IN**) of *robtarget* > ','
[XPos ':='] < expression (**IN**) of *robtarget* > ','
[Tool ':='] < persistent (**PERS**) of *tooldata* > ';'

Related information

	Described in:
Calibration of TCP for a moving tool	Instructions - *MToolTCPCalib*
Calibration of rotation for a moving tool	Instructions - *MToolRotCalib*
Calibration of TCP for a stationary tool	Instructions - *SToolTCPCalib*

SToolTCPCalib - Calibration of TCP for stationary tool

SToolTCPCalib (Stationary Tool TCP Calibration) is used to calibrate the Tool Centre Point - TCP for a stationary tool.

The position of the robot and its movements are always related to its tool coordinate system, i.e. the TCP and tool orientation. To get the best accuracy, it is important to define the tool coordinate system as correctly as possible.

The calibration can also be done with a manual method using the TPU (described in User's Manual - *Calibration*).

Description

To define the TCP of a stationary tool, you need a movable pointing tool mounted on the end effector of the robot.

Before using the instruction *SToolTCPCalib*, some preconditions must be fulfilled:

- The stationary tool that is to be calibrated must be stationary mounted and defined with the correct component *robhold* (*FALSE*).
- The pointing tool (*robhold TRUE*) must be defined and calibrated with the correct TCP values.
- If using the robot with absolute accuracy, the load and centre of gravity for the pointing tool should be defined.
  LoadIdentify can be used for the load definition.
- The pointing tool, *wobj0* and *PDispOff* must be activated before jogging the robot.
- Jog the TCP of the pointing tool as close as possible to the TCP of the stationary tool and define a *robtarget* for the first point p1.
- Define a further three positions p2, p3, and p4, all with different orientations.
- It is recommended that the TCP is pointed out with different orientations to obtain a reliable statistical result, although it is not necessary.

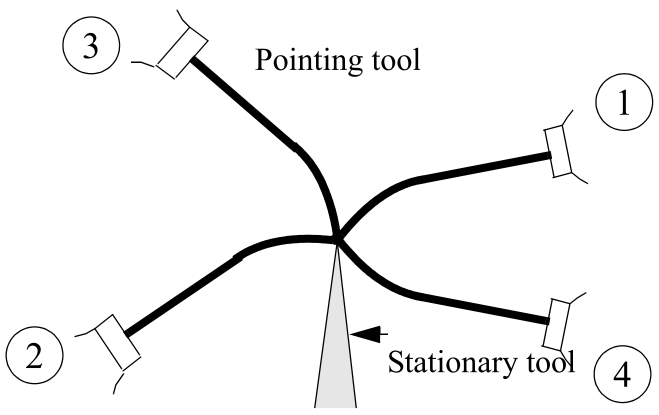


Figure 34 Definition of 4 robtargets p1...p4

Example

```
! Created with pointing TCP pointing at the stationary TCP
CONST robtarget p1 := [...];
CONST robtarget p2 := [...];
CONST robtarget p3 := [...];
CONST robtarget p4 := [...];

PERS tooldata tool1:= [ FALSE, [[0, 0, 0], [1, 0, 0 ,0]],
                    [0.001, [0, 0, 0.001], [1, 0, 0, 0], 0, 0, 0]];
VAR num max_err;
VAR num mean_err;

! Instructions for creating or ModPos of p1 - p4
MoveJ p1, v10, fine, point_tool;
MoveJ p2, v10, fine, point_tool;
MoveJ p3, v10, fine, point_tool;
MoveJ p4, v10, fine, point_tool;

MToolTCPCalib p1, p2, p3, p4, tool1, max_err, mean_err;
```

The TCP value (*tframe.trans*) of *tool1* will be calibrated and updated. *max_err* and *mean_err* will hold the max error in mm from the calculated TCP and the mean error in mm from the calculated TCP, respectively.

Arguments

SToolTCPCalib   Pos1 Pos2 Pos3 Pos4 Tool MaxErr MeanErr

Pos1 Data type: *robtarget*

The first approach point.

Pos2 Data type: *robtarget*

The second approach point.

Pos3 Data type: *robtarget*

The third approach point.

Pos4 Data type: *robtarget*

The fourth approach point.

Tool Data type: *tooldata*

The name of the tool that is to be calibrated.

MaxErr Data type: *num*

The maximum error in mm for one approach point.

MeanErr Data type: *num*

The average distance that the approach points are from the calculated TCP, i.e. how accurately the robot was positioned relative to the stationary TCP.

Program execution

The system calculates and updates the TCP value in the world coordinate system (*tfame.trans*) in the specified *tooldata.* The calculation is based on the specified 4 *robtarget*. The remaining data in tooldata, such as tool orientation (*tframe.rot*), is not changed.

Syntax

MToolTCPCalib
[Pos1 ’:=’] < expression (**IN**) of *robtarget* > ’,’
[Pos2 ’:=’] < expression (**IN**) of *robtarget* > ’,’
[Pos3 ’:=’] < expression (**IN**) of *robtarget* > ’,’
[Pos4 ’:=’] < expression (**IN**) of *robtarget* > ’,’
[Tool ’:=’] < persistent (**PERS**) of *tooldata* > ’,’
[MaxErr ’:=’] < variable (**VAR**) of *num* > ’,’
[MeanErr ’:=’] < variable (**VAR**) of *num* > ’;’

Related information

	Described in:
Calibration of TCP for a moving tool	Instructions - *MToolTCPCalib*
Calibration of rotation for a moving tool	Instructions - *MToolRotCalib*
Calibration of TCP and rotation for a stationary tool	Instructions - *SToolRotCalib*

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.

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

If this instruction is preceded by a move instruction, that move instruction must be programmed with a stop point (*zonedata* fine), not a fly-by point, otherwise restart after power failure will not be possible.

Syntax

```
Stop
[ ’\’ NoRegain ]’;’
```

Related information

	Described in:
Stopping after a fatal error	Instructions - *EXIT*
Terminating program execution	Instructions - *EXIT*
Only stopping robot movements	Instructions - *StopMove*

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.

Arguments

StopMove [\Quick]

[\Quick] Data type: *switch*

Stops the robot on the path as fast as possible.

Without the optional parameter *\Quick*, the robot stops on the path, but the braking distance is longer (same as for normal Program Stop).

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 robtarget 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 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 robtarget 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 ['\'Quick] ';'
```

Related information

	Described in:
Continuing a movement	Instructions - *StartMove*
Store - restore path	Instructions - *StorePath - RestoPath*

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 robtarget 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 the movement path data is stored with the instruction *StorePath*.
If the user wants to order movements on the new path level, the actual stop position must be stored directly after *StorePath* and before *RestoPath* make a movement to the stored stop position on the path.

Only one movement path can be stored at a time.

Syntax

StorePath‘;’

Related information

	Described in:
Restoring a path	Instructions - *RestoPath*
More examples	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

	Described in:
Expressions	Basic Characteristics - *Expressions*

TestSignDefine - Define test signal

TestSignDefine is used to define one test signal for the robot motion system.

A test signal continuously mirrors some specified motion data stream, for example, torque reference for some specified axis. The actual value at a certain time can be read in RAPID with the function *TestSignRead*.

Only test signals for external robot axes can be reached.
For use of the test signal for the master robot axes or the need for use of not predefined test signals, please contact the nearest ABB Flexible Automation centre.

Example

```
TestSignDefine 1, resolver_angle, Orbit, 2, 0,1;
```

Test signal *resolver_angle* connected to channel *1,* will give the value of the resolver angle for external robot *Orbit* axis *2,* sampled at 100 ms rate.

Arguments

TestSignDefine   Channel SignalId MechUnit Axis   SampleTime

Channel Data type: *num*

The channel number 1-12 to be used for the test signal.
The same number must be used in the function *TestSignRead* for reading the actual value of the test signal.

SignalId Data type: *testsignal*

The name or number of the test signal.
Refer to predefined constants described in data type *testsignal.*

MechUnit *(Mechanical Unit)* Data type: *mecunit*

The name of the mechanical unit.

Axis Data type: *num*

The axis number within the mechanical unit.

SampleTime Data type: *num*

Sample time in seconds.

For sample time < 0.004 s, the function *TestSignRead* returns the mean value of the latest available internal samples as shown in the table below.

Tabell 7 Specification of sample time

Sample Time in seconds	Result from TestSignRead
0	Mean value of the latest 8 samples generated each 0.5 ms
0.001	Mean value of the latest 4 samples generated each 1 ms
0.002	Mean value of the latest 2 samples generated each 2 ms
Greater or equal to 0.004	Momentary value generated at specified sample time
0.1	Momentary value generated at specified sample time 100 ms

Program execution

The definition of test signal is activated and the robot system starts the sampling of the test signal.

The sampling of the test signal is active until:

- A new *TestSignDefine* instruction for the actual channel is executed
- All test signals are deactivated with execution of instruction *TestSignReset*
- All test signals are deactivated with a warm start of the system

Error handling

If there is an error in the parameter *MechUnit*, the system parameter ERRNO is set to ERR_UNIT_PAR. If there is an error in the parameter *Axis*, ERRNO is set to ERR_AXIS_PAR.

Syntax

TestSignDefine
[Channel ':='] < expression (**IN**) of *num*> ','
[SignalId ':='] < expression (**IN**) of *testsignal*> ','
[MechUnit ':='] < variable (**VAR**) of *mecunit*> ','
[Axis ':='] < expression (**IN**) of *num*> ','
[SampleTime ':='] < expression (**IN**) of *num* > ';'

Related information

	Described in:
Test signal	Data Types - *testsignal*
Read test signal	Functions - *TestSignRead*
Reset test signals	Instructions - *TestSignReset*

TestSignReset - Reset all test signal definitions

TestSignReset is used to deactivate all previously defined test signals.

Example

TestSignReset;

Deactivate all previously defined test signals.

Program execution

The definitions of all test signals are deactivated and the robot system stops the sampling of any test signals.

The sampling of defined test signals is active until:

- A warm start of the system
- Execution of this instruction *TestSignReset*

Syntax

TestSignReset';'

Related information

	Described in:
Define test signal	Instructions - *TestSignDefine*
Read test signal	Functions - *TestSignRead*

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

	Described in:
Writing on the teach pendant	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 ?”, stEmpty, stEmpty, stEmpty, “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 35). 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.

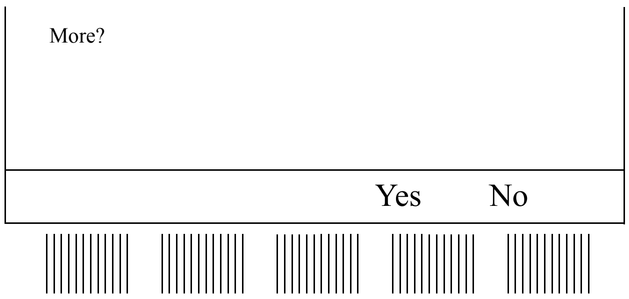


Figure 35 The operator can input information via the function keys.

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 *(Function key text)* Data type: *string*

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 the predefined string constant *stEmpty* with value 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?”, stEmpty, stEmpty, stEmpty, “Yes”, “No”
\MaxTime:= 600
    \DIBreak:= di5\BreakFlag:= errvar;
IF reg1 = 4 or OR errvar = ERR_TP_DIBREAK THEN
    MoveL service, v500, fine, tool1;
    Stop;
ENDIF
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.

Error handling

If there is a timeout (parameter *\MaxTime*) before an input from the operator, the system variable ERRNO is set to ERR_TP_MAXTIME and the execution continues in the error handler.

If digital input is set (parameter *\DIBreak*) before an input from the operator, the system variable ERRNO is set to ERR_TP_DIBREAK and the execution continues in the error handler.

These situations can then be dealt with by the error handler.

Predefined data

```
CONST string stEmpty := “”;
```

The predefined constant *stEmpty* should be used for Function Keys without prompts. Using *stEmpty* instead of “”saves about 80 bytes for every Function Key without prompts.

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

	Described in:
Writing to and reading from the teach pendant	RAPID Summary - *Communication*
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: *signaldi*

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.

Error handling

If there is a timeout (parameter *\MaxTime*) before an input from the operator, the system variable ERRNO is set to ERR_TP_MAXTIME and the execution continues in the error handler.

If a digital input is set (parameter *\DIBreak*) before an input from the operator, the system variable ERRNO is set to ERR_TP_DIBREAK and the execution continues in the error handler.

These situations can then be dealt with by the error handler.

Syntax

TPReadNum
   [Answer’:=’] <var or pers (**INOUT**) of *num*>’,’
   [String’:=’] <expression (**IN**) of *string*>
   [’\’MaxTime ’:=’ <expression (**IN**) of *num*>]
   [’\’DIBreak ’:=’ <variable (**VAR**) of *signaldi*>]
   [’\’BreakFlag ’:=’ <var or pers (**INOUT**) of *errnum*>] ’;’

Related information

	Described in:
Writing to and reading from the teach pendant	RAPID Summary - *Communication*
Entering a number on the teach pendant	Production Running
Examples of how to use the arguments MaxTime, DIBreak and BreakFlag	Instructions - *TPReadFK*

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 before the current Teach Pendant 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 before current	=	Latest used Teach Pendant Window Teach Pendant Window.
TP_SCREENVIEWER Viewer	=	*Screen Viewer Window*, if the Screen option is active.

Predefined data

```
CONST tpnum TP_PROGRAM := 1;
CONST tpnum TP_LATEST := 2;
CONST tpnum TP_SCREENVIEWER := 3;
```

Program execution

The selected Teach Pendant Window will be activated.

Syntax

```
TPShow
   [Window':='] <expression (IN) of tpnum> ';'
```

Related information

	Described in:
Communicating using the teach pendant	RAPID Summary - *Communication*
Teach Pendant Window number	Data Types - *tpnum*

TPWrite - Writes on the teach pendant

TPWrite (Teach Pendant Write) is used to write text on the teach pendant. The value of certain data can be written as well as text.

Examples

```
TPWrite "Execution started";
```

The text *Execution started* is written on the teach pendant.

```
TPWrite "No of produced parts="\Num:=reg1;
```

If, for example, the answer to *No of produced parts=5*, enter 5 instead of *reg1* on the teach pendant.

Arguments

TPWrite String [\Num] | [\Bool] | [\Pos] | [\Orient]

String		Data type: *string*

The text string to be written (a maximum of 80 characters).

[\Num]	*(Numeric)*	Data type: *num*

The data whose numeric value is to be written after the text string.

[\Bool]	*(Boolean)*	Data type: *bool*

The data whose logical value is 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.

Program execution

Text written on the teach pendant always begins on a new line. When the display is full of text, this text is moved up one line first. Strings that are longer than the width of the teach pendant (40 characters) are divided up into two lines.

If one of the arguments *\Num*, *\Bool*, *\Pos* or *\Orient* is used, its value is first converted to a text string before it is added to the first string. The conversion from value to text string takes place as follows:

Argument	Value	Text string
\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

	Described in:
Clearing and reading the teach pendant	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. 6) 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*.

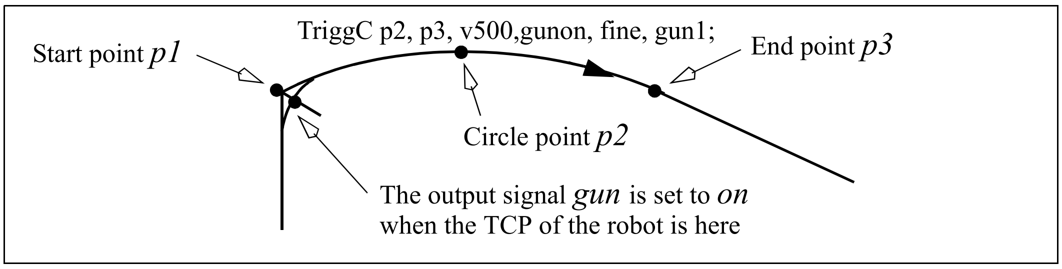

Start point *p1*
TriggC p2, p3, v500,gunon, fine, gun1;
End point *p3*
Circle point *p2*
The output signal *gun* is set to *on*
when the TCP of the robot is here

Figure 36 Example of fixed-position IO event.

Arguments

TriggC [\Conc] CirPoint ToPoint Speed [\T] Trigg_1[\T2] [\T3] [\T4] [\T5] [\T6] Zone [\Inpos] Tool [\WObj] [\Corr]

[\Conc] *(Concurrent)* Data type: *switch*

Subsequent 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 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*.

[\T5] (*Trigg 5)* Data type: *triggdata*

Variable that refers to trigger conditions and trigger activity, defined earlier in the program using the instructions *TriggIO, TriggEquip* or *TriggInt*.

[\T6] (*Trigg 6)* 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.

[\Inpos] *(In position)* Data type: *stoppointdata*

This argument is used to specify the convergence criteria for the position of the robot's TCP in the stop point. The stop point data substitutes the zone specified in the *Zone* parameter.

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.

Error handling

If the programmed *ScaleValue* argument for the specified analog output signal *AOp* in some of the connected *TriggSpeed* instructions, results is out of limit for the analog signal together with the programmed *Speed* in this instruction, the system variable ERRNO is set to ERR_AO_LIM.

If the programmed *DipLag* argument in some of the connected *TriggSpeed* instructions,
is too big in relation to the used Event Preset Time in System Parameters, the system variable ERRNO is set to ERR_DIPLAG_LIM.

These errors can be handled in the error handler.

Limitations

General limitations according to instruction MoveC.

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 *robtarget* > ','
   [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* >]
   ['\' T5 ':=' < variable (**VAR**) of *triggdata* >]
   ['\' T6 ':=' < variable (**VAR**) of *triggdata* >] ','
   [Zone ':='] < expression (**IN**) of *zonedata* >
   ['\' Inpos ':=' < expression (**IN**) of *stoppointdata* >]','
   [Tool ':='] < persistent (**PERS**) of *tooldata* >
   ['\' WObj ':=' < persistent (**PERS**) of *wobjdata* >]
   ['\' Corr]';'

Related information

	Described in:
Linear movement with triggers	Instructions - *TriggL*
Joint movement with triggers	Instructions - *TriggJ*
Definition of triggers	Instructions - *TriggIO*, *TriggEquip, TriggInt or TriggCheckIO*
Writes to a corrections entry	Instructions - *CorrWrite*
Circular movement	Motion Principles - *Positioning during Program Execution*
Definition of velocity	Data Types - *speeddata*
Definition of zone data	Data Types - *zonedata*
Definition of stop point data	Data Types - *stoppointdata*
Definition of tools	Data Types - *tooldata*
Definition of work objects	Data Types - *wobjdata*
Motion in general	Motion Principles

TriggCheckIO - Defines IO check at a fixed position

TriggCheckIO is used to define conditions for testing the value of a digital, a group of digital, or an analog input or output signal at a fixed position along the robot's movement path. If the condition is fulfilled there will be no specific action, but if it is not, an interrupt routine will be run after the robot has optionally stopped on path as fast as possible.

To obtain a fixed position I/O check, *TriggCheckIO* compensates for the lag in the control system (lag between servo and robot).

The data defined is used for implementation in one or more subsequent *TriggL*, *TriggC* or *TriggJ* instructions.

Examples

```
VAR triggdata checkgrip;
VAR intnum intno1;

CONNECT intno1 WITH trap1;
TriggCheckIO checkgrip, 100, airok, EQ, 1, intno1;

TriggL p1, v500, checkgrip, z50, grip1;
```

The digital input signal *airok* is checked to have the value *1* when the TCP is *100* mm before the point *p1*. If it is set, normal execution of the program continues; if it is not set, the interrupt routine *trap1* is run.

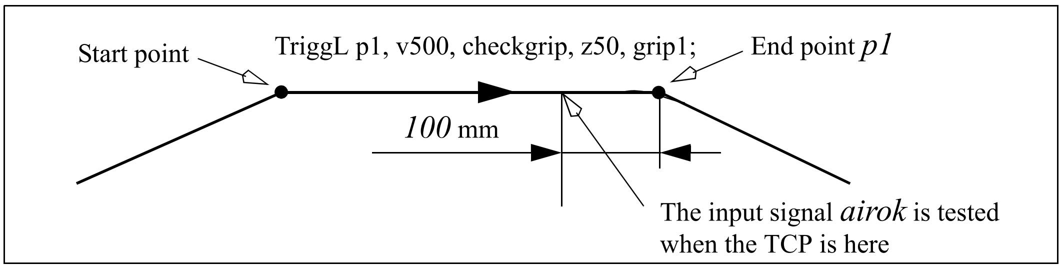

Start point
TriggL p1, v500, checkgrip, z50, grip1;
End point p1
100 mm
The input signal airok is tested when the TCP is here

Figure 37 Example of fixed-position IO check.

Arguments

TriggCheckIO TriggData Distance [\Start] | [\Time] Signal Relation CheckValue [\StopMove] 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 I/O check 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.

Signal Data type: *signalxx*

The name of the signal that will be tested. May be anytype of IO signal.

Relation Data type: *opnum*

Defines how to compare the actual value of the signal with the one defined by the argument *CheckValue*. Refer to the *opnum* data type for the list of the predefined constants to be used.

CheckValue Data type: *num*

Value to which the actual value of the input or output signal is to be compared (within the allowed range for the current signal).

[\StopMove] Data type: *switch*

Specifies that, if the condition is **not** fulfilled, the robot will stop on path as quickly as possible before the interrupt routine is run.

Interrupt Data type: *intnum*

Variable used to identify the interrupt routine to run.

Program execution

When running the instruction *TriggCheckIO*, 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 *TriggCheckIO*:

<u>The distance specified in the argument *Distance*:</u>

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).

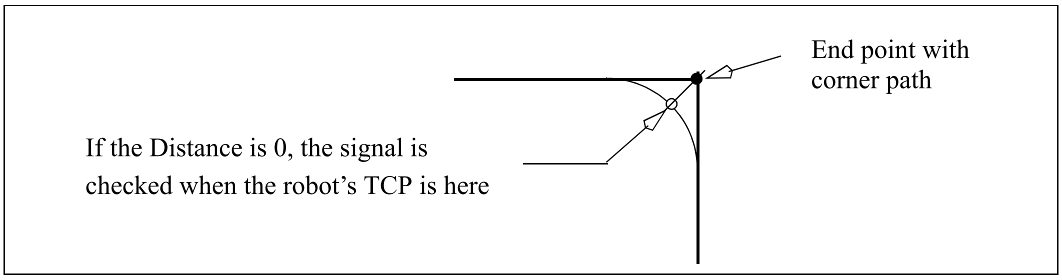

End point with corner path
If the Distance is 0, the signal is checked when the robot's TCP is here

Figure 38 Fixed position I/O check on a corner path.

The fixed position I/O check will be done 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*...).

When the TCP of the robot is at specified place on the path, following I/O check will be done by the system:

- Read the value of the I/O signal
- Compare the read value with *CheckValue* according specified *Relation*
- If the comparision is TRUE, nothing more is done
- If the comparison is FALSE following is done:
- If optional parameter *\StopMove* is present, the robot is stopped on the path as quick as possible
- Generate and execute the specified TRAP routine

Examples

```
VAR triggdata checkgate;
VAR intnum gateclosed;
CONNECT gateclosed WITH waitgate;
TriggCheckIO checkgate, 150, gatedi, EQ, 1 \StopMove, gateclosed;
TriggL p1, v600, checkgate, z50, grip1;
        ....

TRAP waitgate
        ! log some information
        ...
        WaitDI gatedi,1;
        StartMove;
ENDTRAP
```

The gate for the next workpiece operation is checked to be open (digital input signal *gatedi* is checked to have the value *1*) when the TCP is *150* mm before the point *p1*. If it is open, the robot will move on to *p1* and continue; if it is not open, the robot is stopped on path and the interrupt routine *waitgate* is run. This interrupt routine logs some information and typically waits for the conditions to be OK to execute a *StartMove* instruction in order to restart the interrupted path.

Limitations

I/O checks with distance (without the argument *\Time*) is intended for flying points (corner path). I/O checks with distance, using stop points, results in worse accuracy than specified below.

I/O checks with time (with the argument *\Time*) is intended for stop points. I/O checks with time, using flying points, results in worse accuracy than specified below.

I/O checks 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 that the current braking time, the IO check 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 test of digital inputs +/- 5 ms.
Typical repeat accuracy values for test of digital inputs +/- 2 ms.

Syntax

```
TriggCheckIO
    [ TriggData ':=' ] < variable (VAR) of triggdata> ','
    [ Distance ':=' ] < expression (IN) of num>
    [ '\' Start ] | [ '\' Time ] ','
    [ Signal ':=' ] < variable (VAR) of anytype> ','
    [ Relation ':=' ] < expression (IN) of opnum> ','
    [ CheckValue ':=' ] < expression (IN) of num>
    [ '\' StopMove] ','
    [ Interrupt ':=' ] < variable(VAR) of intnum> ';'
```

Related information

	Described in:
Use of triggers	Instructions - *TriggL*, *TriggC*, *TriggJ*
Definition of position-time I/O event	Instruction - *TriggIO,TriggEquip*
Definition of position related interrupts	Instruction - *TriggInt*
More examples	Data Types - *triggdata*
Definition of comparison operators	Data Types - *opnum*

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.

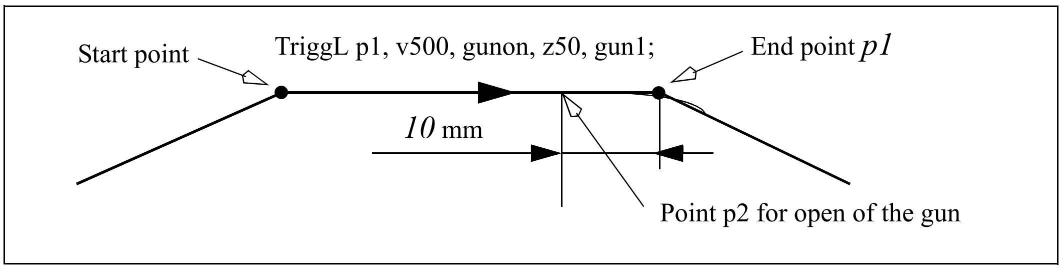

Start point
TriggL p1, v500, gunon, z50, gun1;
End point *p1*
10 mm
Point p2 for open of the gun

Figure 39 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.

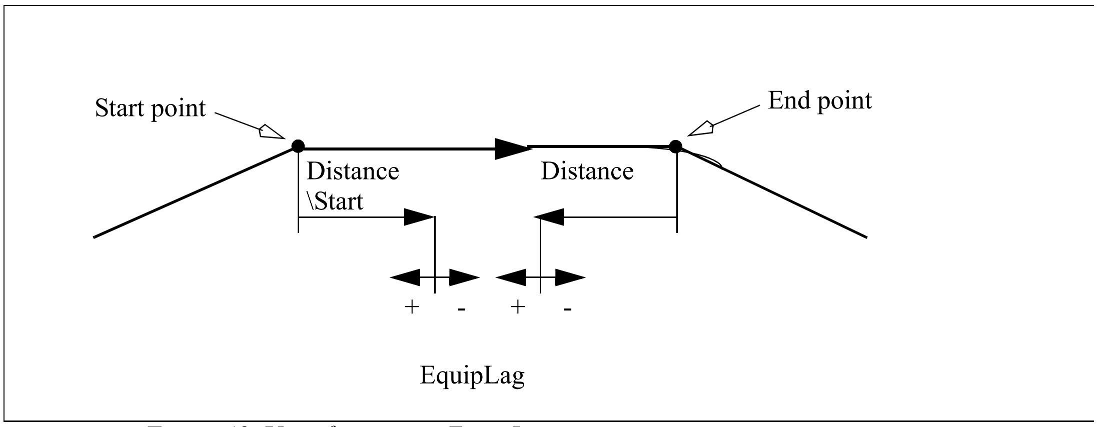


Figure 40 Use of argument EquipLag.

[\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*:

<u>The distance specified in the argument *Distance*:</u>

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).

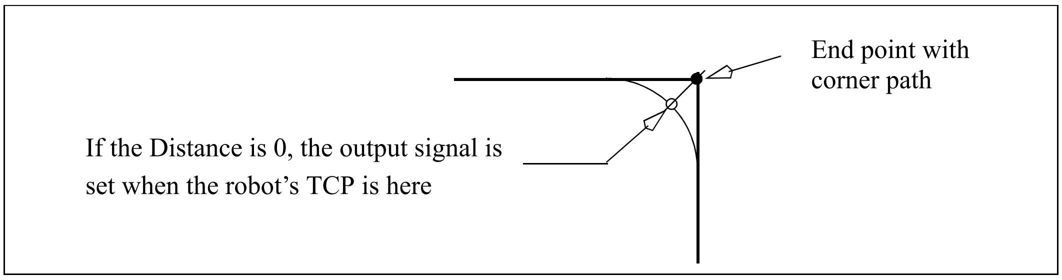

End point with corner path
If the Distance is 0, the output signal is set when the robot's TCP is here

Figure 41 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*.

Error handling

If the programmed *SetValue* argument for the specified analog output signal *AOp* is out of limit, the system variable ERRNO is set to ERR_AO_LIM. This error can be handled in the error handler.

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 that 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.

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>
  [ '\' Inhib ':=' < persistent (PERS) of bool> ] ','
```

Related information

	Described in:
Use of triggers	Instructions - *TriggL*, *TriggC*, *TriggJ*
Definition of other triggs	Instruction - *TriggIO, TriggInt*
More examples	Data Types - *triggdata*
Set of I/O	Instructions - *SetDO*, *SetGO*, *SetAO*
Configuration of Event preset time	User's guide System Parameters - *Manipulator*

TriggInt - Defines a position related interrupt

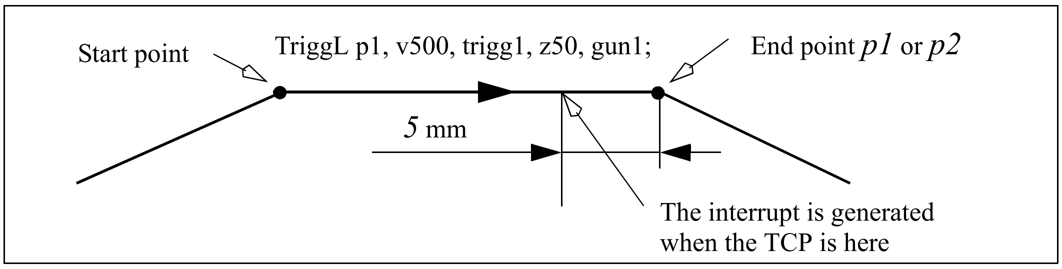
TriggInt is used to define conditions and actions for running an interrupt routine at a position on the robot's movement path.

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.


Start point
TriggL p1, v500, trigg1, z50, gun1;
End point p1 or p2
5 mm
The interrupt is generated when the TCP is here
Figure 42 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*:

<u>The distance specified in the argument *Distance*:</u>

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).

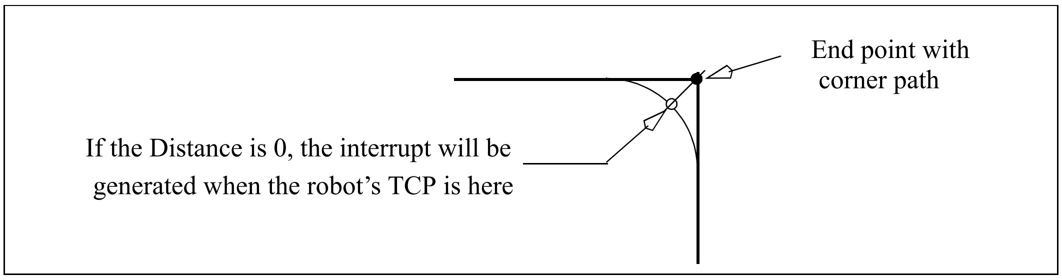

End point with corner path
If the Distance is 0, the interrupt will be generated when the robot's TCP is here

Figure 43 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 \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 that 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

	Described in:
Use of triggers	Instructions - *TriggL*, *TriggC*, *TriggJ*
Definition of position fix I/O	Instruction - *TriggIO, TriggEquip*
More examples	Data Types - *triggdata*
Interrupts	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*.

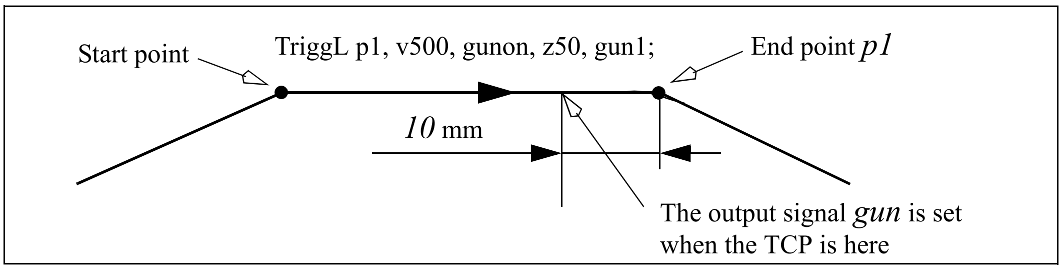

Start point
TriggL p1, v500, gunon, z50, gun1;
End point *p1*
10 mm
The output signal *gun* is set when the TCP is here

Figure 44 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, group, or analog output signal.

Only used to delay setting of 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*:

<u>The distance specified in the argument *Distance*:</u>

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).

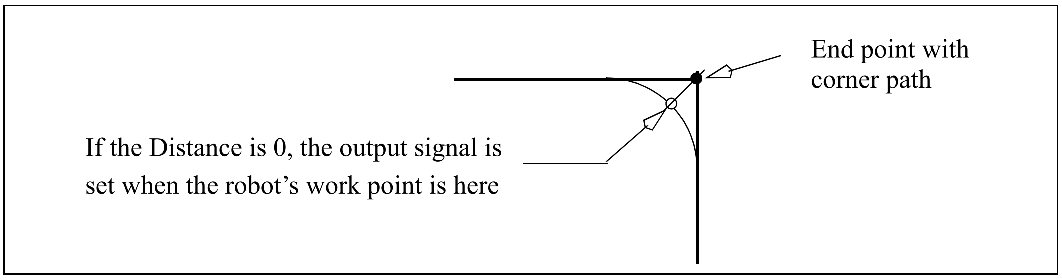

End point with corner path
If the Distance is 0, the output signal is set when the robot's work point is here

Figure 45 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*.

Error handling

If the programmed *SetValue* argument for the specified analog output signal *AOp* is out of limit, the system variable ERRNO is set to ERR_AO_LIM. This error can be handled in the error handler.

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 that 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.

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

	Described in:
Use of triggers	Instructions - *TriggL*, *TriggC*, *TriggJ*
Definition of position-time I/O event	Instruction - *TriggEquip*
Definition of position related interrupts	Instruction - *TriggInt*
More examples	Data Types - *triggdata*
Set of I/O	Instructions - *SetDO*, *SetGO*, *SetAO*

TriggJ - Axis-wise robot movements with events

TriggJ (TriggJoint) is used to set output signals and/or run interrupt routines at fixed positions, at the same time as the robot is moving quickly from one point to another when that movement does not have be in a straight line.

One or more (max. 6) 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*.

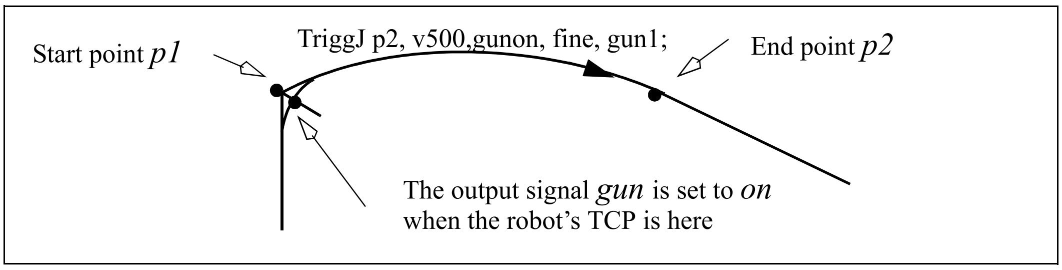

Start point *p1*
TriggJ p2, v500,gunon, fine, gun1;
End point *p2*
The output signal *gun* is set to *on* when the robot's TCP is here

Figure 46 Example of fixed-position IO event.

Arguments

TriggJ [\Conc] ToPoint Speed [\T] Trigg_1 [\T2] [\T3] [\T4] [\T5] [\T6] Zone [\Inpos] Tool [\WObj]

[\Conc] *(Concurrent)* Data type: *switch*

Subsequent logical instructions are executed while the robot is moving. 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, the subsequent instruction is only executed after the robot has reached the specified 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*.

[\T5] (*Trigg 5)* Data type: *triggdata*

Variable that refers to trigger conditions and trigger activity, defined earlier in the program using the instructions *TriggIO, TriggEquip* or *TriggInt*.

[\T6] (*Trigg 6)* 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.

[\Inpos] *(In position)* Data type: *stoppointdata*

This argument is used to specify the convergence criteria for the position of the robot's TCP in the stop point. The stop point data substitutes the zone specified in the *Zone* parameter.

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.

Error handling

If the programmed *ScaleValue* argument for the specified analog output signal *AOp* in some of the connected *TriggSpeed* instructions, results in out of limit for the analog signal together with the programmed *Speed* in this instruction, the system variable ERRNO is set to ERR_AO_LIM.

If the programmed *DipLag* argument in some of the connected *TriggSpeed* instructions,
is too big in relation to the Event Preset Time used in System Parameters, the system variable ERRNO is set to ERR_DIPLAG_LIM.

These errors can be handled in the error handler.

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 sequence 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 > ]
    [ '\' T5 ':=' < variable (VAR) of triggdata > ]
    [ '\' T6 ':=' < variable (VAR) of triggdata > ] ','
    [Zone ':=' ] < expression (IN) of zonedata >
    [ '\' Inpos ':=' < expression (IN) of stoppointdata > ]','
    [ Tool ':=' ] < persistent (PERS) of tooldata >
    [ '\' WObj ':=' < persistent (PERS) of wobjdata > ] ';'
```

Related information

	Described in:
Linear movement with triggs	Instructions - *TriggL*
Circular movement with triggers	Instructions - *TriggC*
Definition of triggers	Instructions - *TriggIO*, *TriggEquip TriggInt or TriggCheckIO*
Joint movement	Motion Principles - *Positioning during Program Execution*
Definition of velocity	Data Types - *speeddata*
Definition of zone data	Data Types - *zonedata*
Definition of stop point data	Data Types - *stoppointdata*
Definition of tools	Data Types - *tooldata*
Definition of work objects	Data Types - *wobjdata*
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. 6) 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*.

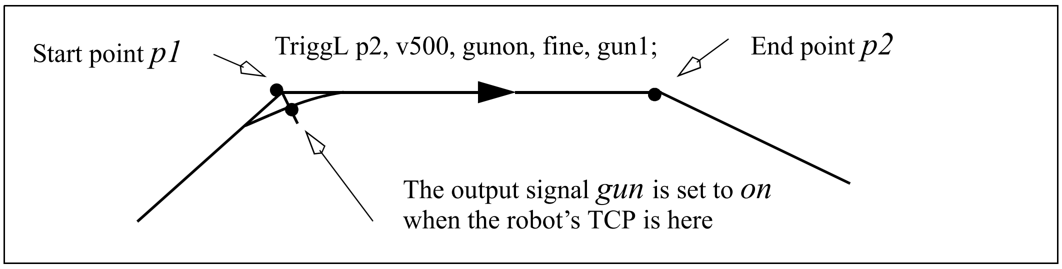

Start point *p1*
TriggL p2, v500, gunon, fine, gun1;
End point *p2*
The output signal *gun* is set to *on*
when the robot's TCP is here

Figure 47 Example of fixed-position IO event.

Arguments

TriggL [\Conc] ToPoint Speed [\T] Trigg_1 [\T2] [\T3] [\T4] [\T5] [\T6] Zone [\Inpos] Tool [\WObj] [\Corr]

[\Conc] *(Concurrent)* Data type: *switch*

Subsequent 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*.

[\T5] (*Trigg 5)* Data type: *triggdata*

Variable that refers to trigger conditions and trigger activity, defined earlier in the program using the instructions *TriggIO, TriggEquip* or *TriggInt*.

[\T6] (*Trigg 6)* 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.

[\Inpos] *(In position)* Data type: *stoppointdata*

This argument is used to specify the convergence criteria for the position of the robot's TCP in the stop point. The stop point data substitutes the zone specified in the *Zone* parameter.

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.

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;
...
TriggL p1, v500, trigg1, fine, gun1;
TriggL 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.

Error handling

If the programmed *ScaleValue* argument for the specified analog output signal *AOp* in some of the connected *TriggSpeed* instructions, results in out of limit for the analog signal together with the programmed *Speed* in this instruction, the system variable ERRNO is set to ERR_AO_LIM.

If the programmed *DipLag* argument in some of the connected *TriggSpeed* instructions,
is too big in relation to the Event Preset Time used in System Parameters, the system variable ERRNO is set to ERR_DIPLAG_LIM.

These errors can be handled in the error handler.

Limitations

If the current start point deviates from the usual, so that the total positioning length of the instruction *TriggL* is shorter than usual (e.g. at the start of *TriggL* 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 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”.

Syntax

TriggL
  ['\' 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* >]
  ['\' T5 ':=' < variable (**VAR**) of *triggdata* >]
  ['\' T6 ':=' < variable (**VAR**) of *triggdata* >] ‘,’
  [Zone ':='] < expression (**IN**) of *zonedata* >
  ['\' Inpos ':=' < expression (**IN**) of *stoppointdata* >]‘,’
  [Tool ':='] < persistent (**PERS**) of *tooldata* >
  ['\' WObj ':=' < persistent (**PERS**) of *wobjdata* >]
  ['\' Corr]';'

Related information

	Described in:
Circular movement with triggers	Instructions - *TriggC*
Joint movement with triggers	Instructions - *TriggJ*
Definition of triggers	Instructions - *TriggIO*, *TriggEquip*, *TriggInt or TriggCheckIO*
Writes to a corrections entry	Instructions - *CorrWrite*
Linear movement	Motion Principles - *Positioning during Program Execution*
Definition of velocity	Data Types - *speeddata*
Definition of zone data	Data Types - *zonedata*
Definition of stop point data	Data Types - *stoppointdata*
Definition of tools	Data Types - *tooldata*
Definition of work objects	Data Types - *wobjdata*
Motion in general	Motion Principles

TRYNEXT - Jumps over an instruction which has caused an error

The TRYNEXT instruction is used to resume execution after an error, starting with the instruction following the instruction that caused the error.

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 assigned 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

	Described in:
Error handlers	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

	Described in:
Tuning servos	Instructions - *TuneServo*

TuneServo - Tuning servos

TuneServo is used to tune the dynamic behavior 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*.

Avoid doing TuneServo commands at the same time as the robot is moving. It can result in momentary high CPU loads causing error indication and stops.

Note. To obtain optimal tuning it is essential that the correct load data is used. Check on this before using *TuneServo*.

Generally, optimal tuning values often differ between different robots. Optimal tuning may also change with time.

Improving path accuracy

For robots running at lower speeds, TuneServo can be used to improve the path accuracy by:

- Tuning tune_kv and tune_ti (see the tune types description below).
- Tuning friction compensation parameters (see below).

These two methods can be combined.

Other possibilities to improve the path accuracy:

- Decreasing path resolution can improve the path. Note: a value of path resolution which is too low will cause CPU load problems.
- The accuracy of straight lines can be improved by decreasing acceleration using AccSet. Example: AccSet 20, 10.

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 behavior. 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_dg

Tune_dg can reduce overshoots on rare occasions. Normally it should not be used.

Tune_df should always be tried first in cases of overshoots.

Tuning of tune_dg can be performed with large steps in tune value (e.g. 50%, 100%, 200%, 400%).

Never use tune_dg when the robot is moving.

Tune_dh

Tune_dh can be used for reducing vibrations and overshoots (e.g. large flexible load).

Tune value must always be lower than 100. Tune_dh increases path deviation and normally also increases cycle time.

Example:

IRB6400 with large flexible load which vibrates when the robot has stopped. Use tune_dh with tune value 15.

Tune_dh should only be executed for one axis. All axes in the same mechanical unit automatically get the same tune_value.

Never use tune_dh when the robot is moving.

Tune_di

Tune_di can be used for reducing path deviation at high speeds.

A tune value in the range 50 - 80 is recommended for reducing path deviation. Overshoots can increase (lower tune value means larger overshoot).

A higher tune value than 100 can reduce overshoot (but increases path deviation at high speed).

Tune_di should only be executed for one axis. All axes in the same mechanical unit automatically get the same tune_value.

Tune_dk, Tune_dl

Only for ABB internal use. Do not use these tune types. Incorrect use can cause oscillating movements or torques that can damage the robot.

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 speeds (< 500 mm/s).

Recommended values: tune_kv 100 - 180%, tune_ti 50 - 100%. Tune_kp should not be used for robot axes. Values of tune_kv/tune_ti which are too high or too low will cause vibrations or oscillations. Be careful if trying to exceed these recommended values. Make changes in small steps and avoid oscillating motors.

Always tune one axis at a time. Change the tuning values in small steps. Try to improve the path where this specific axis changes its direction of movement or where it accelerates or decelerates.

Never use these tune types at high speeds or when the required path accuracy is fulfilled.

Friction compensation: tune_fric_lev and tune_fric_ramp

These tune types can be used to reduce robot path errors caused by friction and backlash at low speeds (10 - 200 mm/s). These path errors appear when a robot axis changes direction of movement. Activate friction compensation for an axis by setting the system parameter *Friction ffw on* to TRUE (topic: Manipulator, type: Control parameters).

The friction model is a constant level with opposite sign of the axis speed direction. *Friction ffw level (Nm)* is the absolute friction level at (low) speeds and is greater than *Friction ffw ramp (rad/s) (see figure)*.

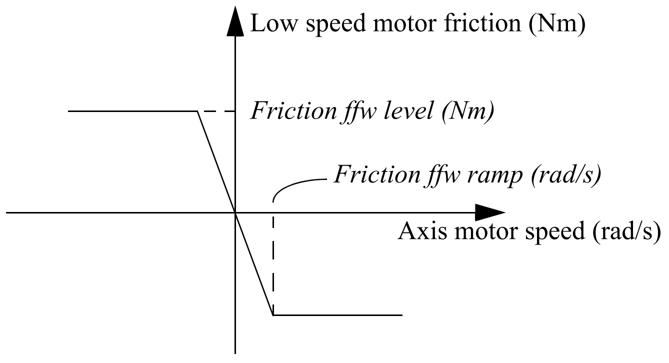


Figure 48 Friction model

Tune_fric_lev overrides the value of the system parameter *Friction ffw level.*

Tuning *Friction ffw level* (using tune_fric_lev) for each robot axis can improve the robots path accuracy considerably in the speed range 20 - 100 mm/s. For larger robots (especially the IRB6400 family) the effect will however be minimal as other sources of tracking errors dominate these robots.

Tune_fric_ramp overrides the value of the system parameter *Friction ffw ramp*. In **most** cases there is no need to tune the *Friction ffw ramp*. The default setting will be appropriate.

Tune one axis at a time. Change the tuning value in small steps and find the level that minimises the robot path error at positions on the path where this specific axis changes direction of movement. Repeat the same procedure for the next axis etc.

The final tuning values can be transferred to the system parameters. Example:

Friction ffw level = 1. Final tune value (tune_fric_lev) = 150%.

Set Friction ffw level = 1.5 and tune value = 100% (default value) which is equivalent.

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*, *TUNE_TI*, *TUNE_FRIC_LEV*, *TUNE_FRIC_RAMP*, *TUNE_DG*, *TUNE_DH*, *TUNE_DI*. Type *TUNE_DK* and *TUNE_DL only for ABB internal use.* 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.

Limitations

Any active servo tuning are always set to default values at power fail.
This limitation can be handled in the user program at restart after power failure.

Syntax

TuneServo
  [MecUnit ':='] < variable (VAR) of *mecunit*> **','**
  [Axis ':='] < expression (IN) of num> ','
  [TuneValue ':='] < expression (IN) of num>
  ['\' Type ':=' <expression (IN) of *tunetype*>**]';'**

Related information

	Described in:
Other motion settings	Summary Rapid - *Motion Settings*
Types of servo tuning	Data Types - *tunetype*
Reset of all servo tunings	Instructions - *TuneReset*
Tuning of external axes	System parameters - *Manipulator*
Friction compensation	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* or *StartLoad - WaitLoad*.

Example

```
UnLoad diskhome \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*). *diskhome* is a predefined string constant "HOME:".

Arguments

UnLoad [\ErrIfChanged] | [\Save] FilePath [\File]

[\ErrIfChanged] Data type: *switch*

If this argument is used, and the module has been changed since it was loaded into the system, the instruction will throw the error code ERR_NOTSAVED to the error handler if any.

[\Save] Data type: *switch*

If this argument is used, the program module is saved before the unloading starts. The program module will be saved at the original place specified in the *Load* or *StartLoad* instruction.

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* or *StartLoad* 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* or *StartLoad* instruction.

Program execution

To be able to execute an *UnLoad* instruction in the program, a *Load* or *StartLoad - WaitLoad* 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 finish unloading before the execution proceeds with the next instruction.

After that the program module is unloaded and the rest of the program modules will be linked.

For more information see the instructions *Load* or *StartLoad-Waitload*.

Examples

```
UnLoad "HOME:/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 "HOME:" \File:="DOORDIR/DOOR1.MOD";
```

Same as above but another syntax.

```
Unload \Save, "HOME:" \File:="DOORDIR/DOOR1.MOD";
```

Same as above but save the program module before unloading.

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* or *StartLoad*), the system variable ERRNO is set to ERR_UNLOAD.

If the argument ErrIfChanged is used and the module has been changed, the execution of this routine will set the system variable ERRNO to ERR_NOTSAVED.

Those errors can then be handled in the error handler.

Syntax

UnLoad
  ['\'ErrIfChanged ','] | ['\'Save ',']
  [FilePath':=']<expression (**IN**) of *string*>
  ['\'File':=' <expression (**IN**) of *string*>]';'

Related information

	Described in:
Load a program module	Instructions - *Load* Instructions - *StartLoad-WaitLoad*
Accept unresolved references	System Parameters - *Controller,* System Parameters - *Tasks*, System Parameters - *BindRef*

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: *signaldi*

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 execution

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.

In manual mode, if the argument *\Inpos* is used and *Time* is greater than 3 s, an alert box will pop up asking if you want to simulate the instruction. If you don´t want the alert box to appear you can set system parameter SimMenu to NO (System Parameters, Topics:Communication, Types:System misc).

Syntax

WaitDI
  [Signal ':='] < variable (**VAR**) of *signaldi* > ','
  [Value ':='] < expression (**IN**) of *dionum* >
  ['\'MaxTime ':='<expression (**IN**) of *num*>]
  ['\'TimeFlag':='<variable (**VAR**) of *bool*>] ';'

Related information

	Described in:
Waiting until a condition is satisfied	Instructions - *WaitUntil*
Waiting for a specified period of time	Instructions - *WaitTime*

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.

In manual mode, if the argument *\Inpos* is used and *Time* is greater than 3 s, an alert box will pop up asking if you want to simulate the instruction. If you don´t want the alert box to appear you can set system parameter SimMenu to NO (System Parameters, Topics:Communication, Types:System misc).

Syntax

WaitDO
 [Signal ':='] < variable (**VAR**) of *signaldo* > ','
 [Value ':='] < expression (**IN**) of *dionum* >
 ['\'MaxTime ':='<expression (**IN**) of *num*>]
 ['\'TimeFlag':='<variable (**VAR**) of *bool*>] ';'

Related information

	Described in:
Waiting until a condition is satisfied	Instructions - *WaitUntil*
Waiting for a specified period of time	Instructions - *WaitTime*

WaitLoad - Connect the loaded module to the task

WaitLoad is used to connect the module, if loaded with *StartLoad*, to the program task.

The loaded module must be connected to the program task with the instruction *WaitLoad* before any of its symbols/routines can be used.

The loaded program module will be added to the modules already existing in the program memory.

This instruction can also be combined with the function to unload some other program module, in order to minimise the number of links (1 instead of 2).

Example

```
VAR loadsession load1;
...
StartLoad "HOME:/PART_A.MOD", load1;
MoveL p10, v1000, z50, tool1 \WObj:=wobj1;
MoveL p20, v1000, z50, tool1 \WObj:=wobj1;
MoveL p30, v1000, z50, tool1 \WObj:=wobj1;
MoveL p40, v1000, z50, tool1 \WObj:=wobj1;
WaitLoad load1;
%"routine_x"%;
UnLoad "HOME:/PART_A.MOD";
```

Load the program module *PART_A.MOD* from *HOME:* into the program memory. In parallel, move the robot. Then connect the new program module to the program task and call the routine *routine_x* in the module *PART_A*.

Arguments

WaitLoad [\UnloadPath] [\UnloadFile] LoadNo

[\UnloadPath] Data type: *string*

The file path and the file name to the file that will be unloaded from the program memory. The file name should be excluded when the argument *\UnloadFile* is used.

[\UnloadFile] Data type: *string*

When the file name is excluded in the argument *\UnloadPath,* then it must be defined with this argument.

LoadNo

Data type: *loadsession*

This is a reference to the load session, fetched by the instruction *StartLoad,* to connect the loaded program module to the program task.

Program execution

The instruction *WaitLoad* will first wait for the loading to be completed, if it is not already done, and then it will be linked and initialised. The initialisation of the loaded module sets all variables at module level to their init values.

Unsolved references will be accepted, if the system parameter for *Tasks/BindRef* is set to NO. However, when the program is started or the teach pendant function *Program Window/File/Check Program* is used, no check for unsolved references will be done if *BindRef* = NO. There will be a run time error on execution of an unsolved reference.

Another way to use references to instructions, that are not in the task from the beginning, is to use *Late Binding.* This makes it possible to specify the routine to call with a string expression, quoted between two %%. In this case the *BindRef* parameter could be set to YES (default behaviour). The *Late Binding* way is preferable.

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.

For loading of program that contains a *main* procedure to a main program (with another *main* procedure), see instruction *Load*.

Examples

```
StartLoad  "HOME:/DOORDIR/DOOR2.MOD",  load1;
...
WaitLoad  \UnloadPath:="HOME:/DOORDIR/DOOR1.MOD", load1;
```

Load the program module *DOOR2.MOD* from *HOME:* in the directory *DOORDIR* into the program memory and connect the new module to the task. The program module *DOOR1.MOD* will be unloaded from the program memory.

```
StartLoad  "HOME:" \File:="DOORDIR/DOOR2.MOD",  load1;
! The robot can do some other work
WaitLoad  \UnloadPath:="HOME:" \File:= "DOORDIR/DOOR1.MOD",  load1;
```

Is the same as the instructions below but the robot can do some other work during the loading time and also do it faster (only one link).

```
Load  "HOME:"  \File:="DOORDIR/DOOR2.MOD";
UnLoad "HOME:" \File:="DOORDIR/DOOR1.MOD";
```

Error handling

If the file specified in the *StartLoad* instruction cannot be found, the system variable ERRNO is set to ERR_FILNOTFND at execution of *WaitLoad*.

If argument *LoadNo* refers to an unknown load session, the system variable ERRNO is set to ERR_UNKPROC.

If the module is already loaded into the program memory, the system variable ERRNO is set to ERR_LOADED.

The following errors can only occur when the argument *\UnloadPath* is used in the instruction *WaitLoad*:

- If the program module specified in the argument *\UnloadPath* cannot be unloaded because of ongoing execution within the module, the system variable ERRNO is set to ERR_UNLOAD.
- If the program module specified in the argument *\UnloadPath* cannot be unloaded because the program module is not loaded with *Load* or *StartLoad-WaitLoad* from the RAPID program, the system variable ERRNO is also set to ERR_UNLOAD.

These errors can then be handled in the error handler.

Note that RETRY cannot be used for error recovery for any errors from *WaitLoad*.

Syntax

```
WaitLoad
   [ [ '\' UnloadPath ':=' <expression (IN) of string> ]
     [ '\' UnloadFile ':=' <expression (IN) of string>  ] ',' ]
   [ LoadNo ':=' ] <variable (VAR) of loadsession> ';'
```

Related information

Load a program module during execution	Instructions - *StartLoad*
Load session	Data Types - *loadsession*
Load a program module	Instructions - *Load*
Unload a program module	Instructions - *UnLoad*
Cancel loading of a program module	Instructions - *CancelLoad*
Accept unsolved references	System Parameters - *Controller/Task/BindRef*

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.
Min. value 0 s. Max. value no limit. Resolution 0.001 s.

Program execution

Program execution temporarily stops for the given amount of time. Interrupt handling and other similar functions, nevertheless, are still active.

In manual mode, if the argument *\Inpos* is used and *Time* is greater than 3 s, an alert box will pop up asking if you want to simulate the instruction. If you don´t want the alert box to appear you can set system parameter SimMenu to NO (System Parameters, Topics:Communication, Types:System misc).

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 and the instruction is preceded by a move instruction, that move instruction must be programmed with a stop point (*zonedata* fine), not a fly-by point, otherwise restart after power failure will not be possible.

Argument *\Inpos* cannot be used together with SoftServo.

Syntax

```
WaitTime
   ['\'InPos',']
   [Time ':='] <expression (IN) of num>';'
```

Related information

	Described in:
Waiting until a condition is met	Instructions - *WaitUntil*
Waiting until an I/O is set/reset	Instruction - *WaitDI*

WaitUntil - Waits until a condition is met

WaitUntil is used to wait until a logical condition is met; for example, it can wait until one or several inputs have been set.

Example

```
WaitUntil di4 = 1;
```

Program execution continues only after the *di4* input has been set.

Arguments

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

[\InPos] Data type: *switch*

If this argument is used, the robot and external axes must have stopped moving before the condition starts being evaluated.

Cond Data type: *bool*

The logical expression that is to be waited for.

[\MaxTime] Data type: *num*

The maximum period of waiting time permitted, expressed in seconds. If this time runs out before the condition is set, 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 execution

If the programmed condition is not met on execution of a *WaitUntil* instruction, the condition is checked again every 100 ms.

When the robot is waiting, the time is supervised, and if it exceeds the max time value, the program will continue if a *TimeFlag* is specified, or raise an error if it’s not. If a *TimeFlag* is specified, this will be set to TRUE if the time is exceeded, otherwise it will be set to false.

In manual mode, if the argument *\Inpos* is used and *Time* is greater than 3 s, an alert box will pop up asking if you want to simulate the instruction. If you don´t want the alert box to appear you can set system parameter SimMenu to NO (System Parameters, Topics:Communication, Types:System misc).

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 s*econds, 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 and the instruction is preceded by a move instruction, that move instruction must be programmed with a stop point (*zonedata* fine), not a fly-by point, otherwise restart after power failure will not be possible.

Argument *\Inpos* can’t be used together with SoftServo.

Syntax

```
WaitUntil
   ['\'InPos',']
   [Cond ':='] <expression (IN) of bool>
   ['\'MaxTime ':='<expression (IN) of num>]
   ['\'TimeFlag':='<variable (VAR) of bool>] ';'
```

Related information

	Described in:
Waiting until an input is set/reset	Instructions - *WaitDI*
Waiting a given amount of time	Instructions - *WaitTime*
Expressions	Basic Characteristics - *Expressions*

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 *vmax.v_tcp* 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.

*) Max. TCP speed for the used robot type and normal pratical TCP values.
The RAPID function *MaxRobSpeed* returns the same value.

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

	Described in:
Definition of velocity	Data Types - *speeddata*
Max. TCP speed for this robot	Function - *MaxRobSpeed*
Positioning instructions	RAPID Summary - *Motion*

WHILE - Repeats as long as ...

WHILE is used when a number of instructions are to be repeated as long as a given condition expression evaluates to a *TRUE* value.

Example

```
WHILE reg1 < reg2 DO
    ...
    reg1 := reg1 + 1;
ENDWHILE
```

Repeats the instructions in the *WHILE*-block as long as *reg1 < reg2*.

Arguments

WHILE   Condition   DO ...   ENDWHILE

Condition Data type: *bool*

The condition that must be evaluated to a *TRUE* value for the instructions in the *WHILE*-block to be executed.

Program execution

1. The condition expression is evaluated. If the expression evaluates to a *TRUE* value, the instructions in the *WHILE*-block are executed.
2. The condition expression is then evaluated again and if the result of this evaluation is *TRUE*, the instructions in the *WHILE*-block are executed again.
3. This process continues until the result of the expression evaluation becomes *FALSE*. The iteration is then terminated and the program execution continues from the instruction after the *WHILE*-block.
   If the result of the expression evaluation is *FALSE* at the very outset, the instructions in the *WHILE*-block are not executed at all and the program control transfers immediately to the instruction that follows after the *WHILE*-block.

Remarks

If it is possible to determine the number of repetitions, the *FOR* instruction can be used.

Syntax

(EBNF)
WHILE <conditional expression> **DO**
    <instruction list>
ENDWHILE

Related information

	Described in:
Expressions	Basic Characteristics - *Expressions*
Repeats a given number of times	Instructions - *FOR*

WorldAccLim - Control acceleration in world coordinate system

WorldAccLim (World Acceleration Limitation) is used to limit the acceleration/deceleration of the tool (and gripload) in the world coordinate system.

Only implemented for robot type IRB5400-04 with track motion.

The limitation will be achieved in the gravity centre point of the actual tool, actual gripload (if present) and the mounting flange of the robot, all together.

Example

WorldAccLim \On := 3.5;

Acceleration is limited to $3.5 m/s^2$.

WorldAccLim \Off;

The acceleration is reset to maximum (default).

Arguments

WorldAccLim   [\On] | [\Off]

[\On]	Data type: *num*

The absolute value of the acceleration limitation in m/s^2.

[\Off]	Data type: *switch*

Maximum acceleration (default).

Program execution

The acceleration limitations applies for the next executed robot segment and is valid until a new *WorldAccLim* instruction is executed.

The maximum acceleration (*WorldAccLim \Off*) is automatically set

- at a cold start-up
- when a new program is loaded
- when starting program executing from the beginning.

It is recommended to use just one type of limitation of the acceleration. If a combination of instructions *WorldAccLim, AccSet and PathAccLim is done,* the system reduces the acceleration/deceleration in following order

- according *WorldAccLim*
- according *AccSet*
- according *PathAccLim*

Limitations

Can only be used together with robot type IRB5400-04 with track motion.

The minimum acceleration allowed is 1 m/s^2.

Error handling

If the argument *On* is set to a value too low, the system variable ERRNO is set to ERR_ACC_TOO_LOW. This error can then be handled in the error handler.

Syntax

WorldAccLim
    [‘\’On ’:=’ <expression (**IN**) of *num* >] | [‘\’Off]’;’

Related information

	Described in:
Positioning instructions	RAPID Summary - *Motion*
Motion settings data	Data Types - *motsetdata*
Reduction of acceleration	Instructions - *AccSet*
Limitation of acceleration along the path	Instructions - *PathAccLim*

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:

Argument	Value	Text string
\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.

Example

```
VAR iodev printer;
.
Open "com2:", 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 *com2:*. 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

	Described in:
Opening a file or serial channel	RAPID Summary - *Communication*

WriteAnyBin - Writes data to a binary serial channel or a file

WriteAnyBin (Write Any Binary) is used to write any type of data to a binary serial channel or file.

Example

```
VAR iodev channel2;
VAR orient quat1 := [1, 0, 0, 0];
...
Open "com2:", channel2 \Bin;
WriteAnyBin channel2, quat1;
```

The orient data quat1 is written to the channel referred to by *channel2*.

Arguments

WriteAnyBin IODevice Data

IODevice Data type: *iodev*

The name (reference) of the binary serial channel or file for the writing operation.

Data Data type: *ANYTYPE*

The VAR or PERS containing the data to be written.

Program execution

As many bytes as required for the specified data are written to the specified binary serial channel or file.

Limitations

This instruction can only be used for serial channels or files that have been opened for binary writing.

The data to be written by this instruction must have a *value* data type of *atomic*, *string*, or *record* data type. *Semi-value* and *non-value* data types cannot be used.

Array data cannot be used.

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;
VAR robtarget cur_robt;

Open "com2:", 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 current robot position
    cur_robt := CRobT(\Tool:= tool1\WObj:= wobj1);
    WriteAnyBin channel, cur_robt;
ENDIF

Close channel;
```

The current position of the robot is written to a binary serial channel.

Syntax

WriteAnyBin
[IODevice':='] <variable (**VAR**) of *iodev*>','
[Data':='] <var or pers (**INOUT**) of *ANYTYPE*>';'

Related information

	Described in:
Opening (etc.) of serial channels or files	RAPID Summary - *Communication*
Read data from a binary serial channel or file	Functions - *ReadAnyBin*

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 "com2:", 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

	Described in:
Opening (etc.) of serial channels	RAPID Summary - *Communication*
Convert a string to a byte data	Functions - *StrToByte*
Byte data	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 "com2:", 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>';'
```

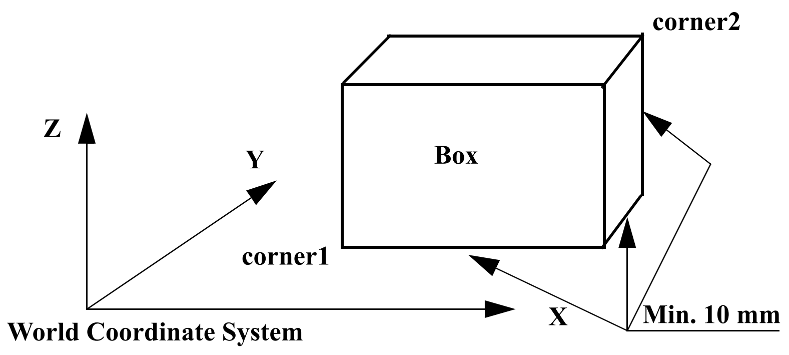
Related information

	Described in:
Opening (etc.) of serial channels	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 for 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>';'
```

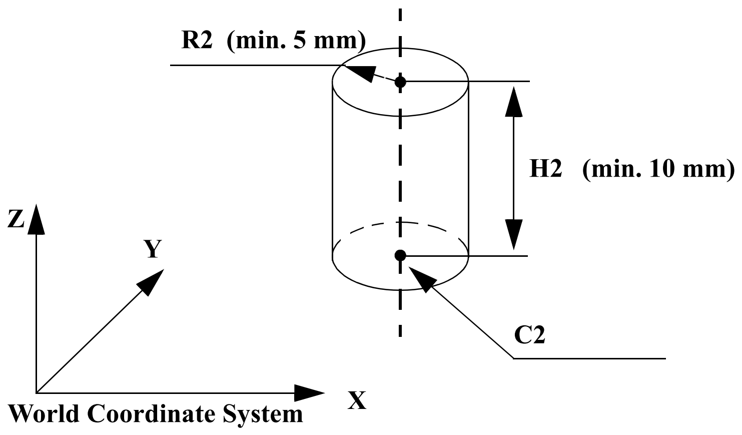
Related information

	Described in:
World Zones	Motion and I/O Principles - *World Zones*
World zone shape	Data Types - *shapedata*
Define sphere-shaped world zone	Instructions - *WZSphDef*
Define cylinder-shaped world zone	Instructions - *WZCylDef*
Define a world zone for home joints	Instruction - *WZHomeJointDef*
Define a world zone for limit joints	Instruction - *WZLimJointDef*
Activate world zone limit supervision	Instructions - *WZLimSup*
Activate world zone digital output set	Instructions - *WZDOSet*

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 *robtarget* 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

	Described in:
World Zones	Motion and I/O Principles - *World Zones*
World zone shape	Data Types - *shapedata*
Define box-shaped world zone	Instructions - *WZBoxDef*
Define sphere-shaped world zone	Instructions - *WZSphDef*
Define a world zone for home joints	Instruction - *WZHomeJointDef*
Define a world zone for limit joints	Instruction - *WZLimJointDef*
Activate world zone limit supervision	Instructions - *WZLimSup*
Activate world zone digital output set	Instructions - *WZDOSet*

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 wzone;
...
PROC ...
   WZLimSup \Temp, wzone, volume;
   MoveL p_pick, v500, z40, tool1;
   WZDisable wzone;
   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

	Described in:
World Zones	Motion and I/O Principles - *World Zones*
World zone shape	Data Types - *shapedata*
Temporary world zone data	Data Types - *wztemporary*
Activate world zone limit supervision	Instructions - *WZLimSup*
Activate world zone set digital output	Instructions - *WZDOSet*
Activate world zone	Instructions - *WZEnable*
Erase world zone	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 or the robot/external axes (zone in joints) 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 *\Before* 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.

If a stationary worldzone is used, the signal must be write protected for access from the user (RAPID, TP). Set Access = System for the signal in System Parameters.

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 (or robot/external joint position) is supervised and the output will be set, when the robot's TCP position (or robot/external joint position) is inside the volume (*\Inside*) or comes close to the border of the volume (*\Before*).

If use of *WZHomeJointDef* or *WZLimJointDef* together with *WZDOSet*, the digital output signal is set, only if all active axes with joint space supervision are before or inside the joint space.

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 *World-Zone*.

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 dio*num*>';'

Related information

	Described in:
World Zones	Motion and I/O Principles - *World Zones*
World zone shape	Data Types - *shapedata*
Temporary world zone	Data Types - *wztemporary*
Stationary world zone	Data Types - *wzstationary*
Define straight box-shaped world zone	Instructions - *WZBoxDef*
Define sphere-shaped world zone	Instructions - *WZSphDef*
Define cylinder-shaped world zone	Instructions - *WZCylDef*
Activate world zone limit supervision	Instructions - *WZLimSup*
Signal access mode	User's Guide - System Parameters I/O Signals

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 wzone;
...
PROC ...
   WZLimSup \Temp, wzone, volume;
   MoveL p_pick, v500, z40, tool1;
   WZDisable wzone;
   MoveL p_place, v200, z30, tool1;
   WZEnable wzone;
   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

	Described in:
World Zones	Motion and I/O Principles - *World Zones*
World zone shape	Data Types - *shapedata*
Temporary world zone data	Data Types - *wztemporary*
Activate world zone limit supervision	Instructions - *WZLimSup*
Activate world zone set digital output	Instructions - *WZDOSet*
Deactivate world zone	Instructions - *WZDisable*
Erase world zone	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 wzone;
...
PROC ...
   WZLimSup \Temp, wzone, volume;
   MoveL p_pick, v500, z40, tool1;
   WZDisable wzone;
   MoveL p_place, v200, z30, tool1;
   WZEnable wzone;
   MoveL p_home, v200, z30, tool1;
   WZFree wzone;
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

	Described in:
World Zones	Motion and I/O Principles - *World Zones*
World zone shape	Data Types - *shapedata*
Temporary world zone data	Data Types - *wztemporary*
Activate world zone limit supervision	Instructions - *WZLimSup*
Activate world zone set digital output	Instructions - *WZDOSet*
Deactivate world zone	Instructions - *WZDisable*
Activate world zone	Instructions - *WZEnable*

WZHomeJointDef - Define a world zone for home joints

WZHomeJointDef (World Zone Home Joint Definition) is used to define a world zone in joints coordinates for both the robot and external axes to be used as a HOME or SERVICE position.

Example

```
VAR wzstationary home;
...
PROC power_on()
    VAR shapedata joint_space;
    CONST jointtarget home_pos := [ [ 0, 0, 0, 0, 0, -45],
        [ 0, 9E9, 9E9, 9E9, 9E9, 9E9] ];
    CONST jointtarget delta_pos  := [ [ 2, 2, 2, 2, 2, 2],
        [ 5, 9E9, 9E9, 9E9, 9E9, 9E9] ];
    ...
    WZHomeJointDef \Inside, joint_space, home_pos, delta_pos;
    WZDOSet \Stat, home \Inside, joint_space, do_home, 1;
ENDPROC
```

Definition and activation of stationary world zone *home*, that sets the signal *do_home to 1,* when all robot axes and the external axis *extax.eax_a* are at the joint position *home_pos* (within +/- *delta_pos* for each axes) during program execution and jogging. The variable *joint_space* of data type *shapedata* are used to transfer data from the instruction *WZHomeJointDef* to the instruction *WZDOSet*.

Arguments

WZHomeJointDef [\Inside] | [\Outside] Shape MiddleJointVal DeltaJointVal

\Inside Data type: *switch*

Define the joint space inside the *MiddleJointVal +/- DeltaJointVal.*

\Outside Data type: *switch*

Define the joint space outside the *MiddleJointVal +/- DeltaJointVal* (inverse joint space).

Shape Data type: *shapedata*

Variable for storage of the defined joint space (private data for the system).

MiddleJointVal Data type: *jointtarget*

The position in joint coordinates for the centre of the joint space to define. Specifies for each robot axes and external axes (degrees for rotational axes and mm for linear axes). Specifies in absolute joints (not in offset coordinate system *EOffsSet-EOffsOn* for external axes).
Value 9E9 for some axis means that the axis should not be supervised.
Not active external axis gives also 9E9 at programming time.

DeltaJointVal Data type: *jointtarget*

The +/- delta position in joint coordinates from the centre of the joint space. The value must be greater than 0 for all axes to supervise.

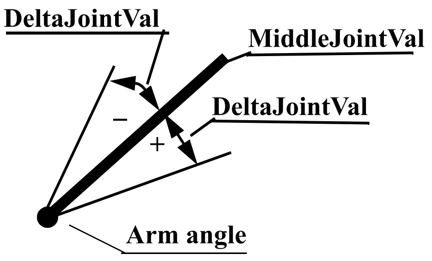


Figure 49 Definition of joint space for rotational axis

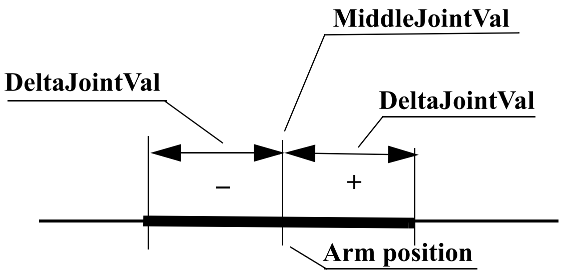


Figure 50 Definition of joint space for linear axis

Program execution

The definition of the joint space is stored in the variable of type *shapedata* (argument *Shape*), for future use in *WZLimSup* or *WZDOSet* instructions.

If use of *WZHomeJointDef* together with *WZDOSet*, the digital output signal is set, only if all active axes with joint space supervision are before or inside the joint space.

If use of *WZHomeJointDef* with outside joint space (argument *\Outside*) together with *WZLimSup*, the robot is stopped, as soon as one active axes with joint space supervision reach the joint space.

If use of *WZHomeJointDef* with inside joint space (argument *\Inside*) together with *WZLimSup*, the robot is stopped, as soon as the last active axes with joint space supervision reach the joint space. That means that one or several axes but not all active and supervised axes can be inside the joint space at the same time.

At execution of the instruction *ActUnit* or *DeactUnit* for activation or deactivation of mechanical units, will the supervision status for HOME position or work area limitation be updated.

Limitations

⚠ Only active mechanical units and it's active axes at activation time of the word zone (with instruction *WZDOSet* resp. *WZLimSup*), are included in the supervision of the HOME position resp. the limitatation of the working area. Besides that, the mecanical unit and it's axes must still be active at the movement from the program or jogging to be supervised.

For example, if one axis with supervision is outside it's HOME joint position but is deactivated, doesn't prevent the digital output signal for the HOME joint position to be set, if all other active axes with joint space supervision are inside the HOME joint position. At activation of that axis again, will it bee included in the supervision and the robot system will the be outside the HOME joint position and the digital output will be reset.

Syntax

WZHomeJointDef
    ['\'Inside] | ['\'Outside]','
    [Shape':=']<variable (**VAR**) of *shapedata*>','
    [MiddleJointVal ':=']<expression (**IN**) of *jointtarget*>','
    [DeltaJointVal ':=']<expression (**IN**) of *jointtarget*>';'

Related information

	Described in:
World Zones	Motion and I/O Principles - *World Zones*
World zone shape	Data Types - *shapedata*
Define box-shaped world zone	Instructions - *WZBoxDef*
Define cylinder-shaped world zone	Instructions - *WZCylDef*
Define sphere-shaped world zone	Instructions - *WZSphDef*
Define a world zone for limit joints	Instruction - *WZLimJointDef*
Activate world zone limit supervision	Instructions - *WZLimSup*
Activate world zone digital output set	Instructions - *WZDOSet*

WZLimJointDef - Define a world zone for limitation in joints

WZLimJointDef (World Zone Limit Joint Definition) is used to define a world zone in joints coordinates for both the robot and external axes to be used for limitation of the working area.

With *WZLimJointDef* it is possible to limitate the working area for each robot and external axes in the RAPID program, besides the limitation that can be done with *System Parameters/Manipulator/Arm/irb_.../Upper joint bound ... Lower joint bound.*

Example

```
VAR wzstationary work_limit;
...
PROC power_on()
    VAR shapedata joint_space;
    CONST jointtarget low_pos  := [ [ -90, 9E9, 9E9, 9E9, 9E9, 9E9],
        [ -1000, 9E9, 9E9, 9E9, 9E9,
    CONST jointtarget high_pos := [ [ 90, 9E9, 9E9, 9E9,9E9, 9E9],
        [ 9E9, 9E9, 9E9, 9E9, 9E9, 9E9] ];
    ...
    WZLimJointDef \Outside, joint_space, low_pos, high_pos;
    WZLimSup \Stat, work_limit, joint_space;
ENDPROC
```

Definition and activation of stationary world zone *work_limit*, that limit the working area for robot axis 1 to -90 and +90 degreeds and the external axis *extax.eax_a* to -1000 mm during program execution and jogging. The variable *joint_space* of data type *shapedata* are used to transfer data from the instruction *WZLimJointDef* to the instruction *WZLimSup*.

Arguments

WZLimJointDef [\Inside] | [\Outside] Shape LowJointVal HighJointVal

\Inside

Data type: *switch*

Define the joint space inside the *LowJointVal ... HighJointVal.*

\Outside

Data type: *switch*

Define the joint space outside the *LowJointVal ... HighJointVal* (inverse joint space).

Shape

Data type: *shapedata*

Variable for storage of the defined joint space (private data for the system).

LowJointVal

Data type: *jointtarget*

The position in joint coordinates for the low limit of the joint space to define. Specifies for each robot axes and external axes (degrees for rotational axes and mm for linear axes). Specifies in absolute joints (not in offset coordinate system *EOffsSet-EOffsOn* for external axes).
Value 9E9 for some axis means that the axis should not be supervised for low limit. Not active external axis gives also 9E9 at programming time.

HighJointVal

Data type: *jointtarget*

The position in joint coordinates for the high limit of the joint space to define. Specifies for each robot axes and external axes (degrees for rotational axes and mm for linear axes). Specifies in absolute joints (not in offset coordinate system *EOffsSet-EOffsOn* for external axes).
Value 9E9 for some axis means that the axis should not be supervised for high limit. Not active external axis gives also 9E9 at programming time.

(*HighJointVal-LowJointVal*) for each axis must be greater than 0 for all axes to supervise for both low and high limits.

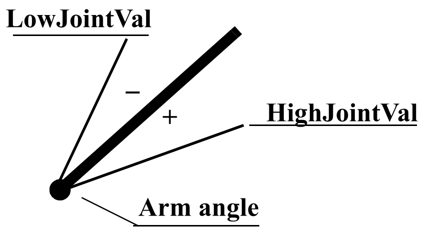


Figure 51 Definition of joint space for rotational axis

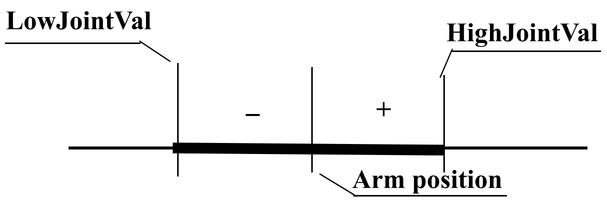


Figure 52 Definition of joint space for linear axis

Program execution

The definition of the joint space is stored in the variable of type *shapedata* (argument *Shape*), for future use in *WZLimSup* or *WZDOSet* instructions.

If use of *WZLimJointDef* together with *WZDOSet*, the digital output signal is set, only if all active axes with joint space supervision are before or inside the joint space.

If use of *WZLimJointDef* with outside joint space (argument *\Outside*) together with *WZLimSup*, the robot is stopped, as soon as one active axes with joint space supervision reach the joint space.

If use of *WZLimJointDef* with inside joint space (argument *\Inside*) together with *WZLimSup*, the robot is stopped, as soon as the last active axes with joint space supervision reach the joint space. That means that one or several axes but not all active and supervised axes can be inside the joint space at the same time.

At execution of the instruction *ActUnit* or *DeactUnit* will the supervision status be updated.

Limitations

Only active mechanical units and it's active axes at activation time of the word zone (with instruction *WZDOSet* resp. *WZLimSup*), are included in the supervision of the HOME position resp. the limitatation of the working area. Besides that, the mecanical unit and it's axes must still be active at the movement from the program or jogging to be supervised.

For example, if one axis with supervision is outside it's HOME joint position but is deactivated, doesn't prevent the digital output signal for the HOME joint position to be set, if all other active axes with joint space supervision are inside the HOME joint position. At activation of that axis again, will it bee included in the supervision and the robot system will the be outside the HOME joint position and the digital output will be reset.

Syntax

WZLimJointDef
    ['\'Inside] | ['\'Outside]','
    [Shape':=']<variable (**VAR**) of *shapedata*>','
    [LowJointVal ':=']<expression (**IN**) of *jointtarget*>','
    [HighJointVal ':=']<expression (**IN**) of *jointtarget*>';'

Related information

	Described in:
World Zones	Motion and I/O Principles - *World Zones*
World zone shape	Data Types - *shapedata*
Define box-shaped world zone	Instructions - *WZBoxDef*
Define cylinder-shaped world zone	Instructions - *WZCylDef*
Define sphere-shaped world zone	Instructions - *WZSphDef*
Define a world zone for home joints	Instruction - *WZHomeJointDef*
Activate world zone limit supervision	Instructions - *WZLimSup*
Activate world zone digital output set	Instructions - *WZDOSet*

WZLimSup - Activate world zone limit supervision

WZLimSup (World Zone Limit Supervision) is used to define the action and to activate a world zone for supervision of the working area of the robot.

After this instruction is executed, when the robot's TCP reaches the defined world zone or when the robot/external axes reaches the defined world zone in joints, the movement is stopped both during program execution and when jogging.

Example

```
VAR wzstationary max_workarea;
...
PROC POWER_ON()
    VAR shapedata volume;
    ...
    WZBoxDef \Outside, volume, corner1, corner2;
    WZLimSup \Stat, max_workarea, volume;
ENDPROC
```

Definition and activation of stationary world zone *max_workarea*, with the shape of the area outside a box (temporarily stored in *volume*) and the action work-area supervision. The robot stops with an error message before entering the area outside the box.

Arguments

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

\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.*

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 or the robot/external axes joint position is supervised. If it reaches the defined area the movement is stopped.

If use of *WZLimJointDef* or *WZHomeJointDef* with outside joint space (argument *\Outside*) together with *WZLimSup*, the robot is stopped, as soon as one active axes with joint space supervision reach the joint space.

If use of *WZLimJointDef* or *WZHomeJointDef* with inside joint space (argument *\Inside*) together with *WZLimSup*, the robot is stopped, as soon as the last active axes with joint space supervision reach the joint space. That means that one or several axes but not all active and supervised axes can be inside the joint space at the same time.

At execution of the instruction *ActUnit* or *DeactUnit* will the supervision status be updated.

Example

```
VAR wzstationary box1_invers;
VAR wzstationary box2;

PROC wzone_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>';'
```

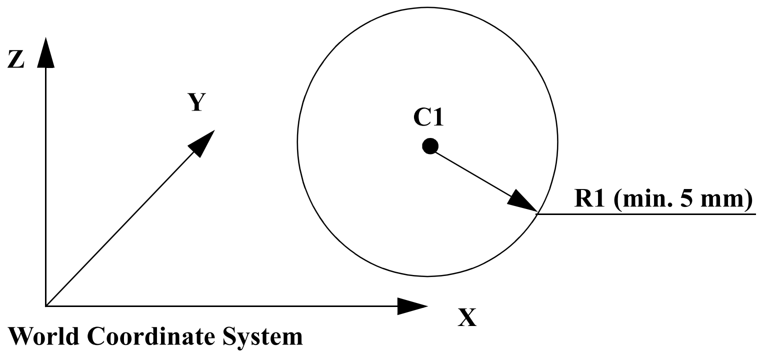
Related information

	Described in:
World Zones	Motion and I/O Principles - *World Zones*
World zone shape	Data Types - *shapedata*
Temporary world zone	Data Types - *wztemporary*
Stationary world zone	Data Types - *wzstationary*
Define straight box-shaped world zone	Instructions - *WZBoxDef*
Define sphere-shaped world zone	Instructions - *WZSphDef*
Define cylinder-shaped world zone	Instructions - *WZCylDef*
Define a world zone for home joints	Instruction - *WZHomeJointDef*
Define a world zone for limit joints	Instruction - *WZLimJointDef*
Activate world zone digital output set	Instructions - *WZDOSet*

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

	Described in:
World Zones	Motion and I/O Principles - *World Zones*
World zone shape	Data Types - *shapedata*
Define box-shaped world zone	Instructions - *WZBoxDef*
Define cylinder-shaped world zone	Instructions - *WZCylDef*
Define a world zone for home joints	Instruction - *WZHomeJointDef*
Define a world zone for limit joints	Instruction - *WZLimJointDef*
Activate world zone limit supervision	Instructions - *WZLimSup*
Activate world zone digital output set	Instructions - *WZDOSet*

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