ABB

ROBOTICS

Application manual

Continuous Application Platform

Trace back information:
Workspace 24A version a8
Checked in 2024-02-26
Skribenta version 5.5.019

Application manual
Continuous Application Platform

RobotWare 7.14

Document ID: 3HAC083246-001

Revision: C

Original instructions.

Table of contents

This page is intentionally left blank

Overview of this manual

About this manual

This manual describes the option *Continuous Application Platform* and contains instructions for the configuration.

This manual describes RobotWare 7.

Who should read this manual?

This manual is intended for:

- Personnel responsible for installations and configurations of robot application software
- Personnel responsible for robot system configuration
- System integrators

Prerequisites

The reader should have the required knowledge of:

- System parameter configuration
- RAPID programming

References

References	Document ID
Application manual - Controller software OmniCore	*3HAC066554-001*
Technical reference manual - RAPID Instructions, Functions and Data types	*3HAC065038-001*
Technical reference manual - RAPID Overview	*3HAC065040-001*

Revisions

Revision	Description
A	Released with RobotWare 7.7.
B	Released with RobotWare 7.10. • New instructions added: *CapAPTrSetupAI - Setup an At-Point-Tracker controlled by analog input signals on page 41*, *CapAPTrSetupAO - Setup an At-Point-Tracker controlled by analog output signals on page 44*, *CapAPTrSetupPERS - Setup an At-Point-Tracker controlled by persistent variables on page 47*, *ICapPathPos - Get center line robtarget when weaving on page 93*. • New data type added: *capaptrreferencedata - Variable setup data for At-Point-Tracker on page 97*. • Corrected graphics.
C	Released with RobotWare 7.14. • Added optional argument `Deactivate` on the instruction `CapRemoveSupervision`. • Minor corrections.

1 Continuous Application Platform

Introduction

The Continuous Application Platform (CAP) consists of a number of RAPID instructions and data types that make development of continuous applications easier, faster, and more robust.

The basic idea of CAP is to separate synchronization of the robot movement from control of the application process. CAP provides a toolbox for movement synchronization, which is used by the application layer in RAPID to control the application process. By this, two things are achieved:

- The CAP core is robust and generic.
- The application layer is easy to customize.

CAP offers subscription of a variety of process events (`ICap`) that the application builder will use in the application layer to synchronize the application process to the robot movement.

Limitations

The first version of CAP for RobotWare 7 does not support MultiMove. Therefore MultiMove related argument in CAP instructions -e.g. \Id, \Track, etc - cannot be used. Support will be made available when OmniCore hardware for MultiMove is available.

This page is intentionally left blank

2 Functionality of CAP

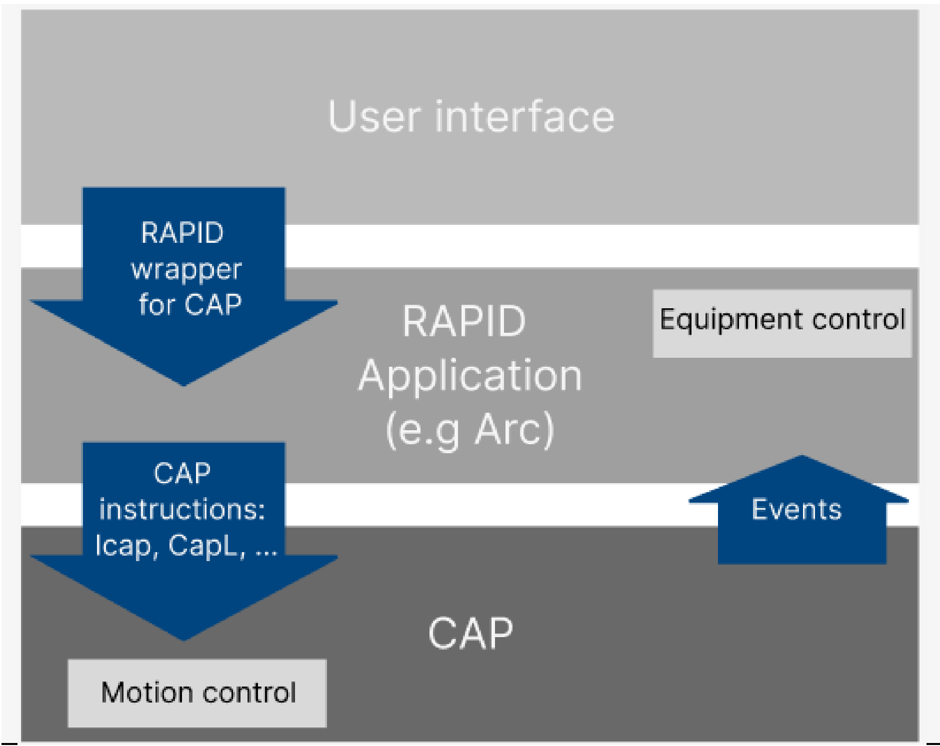
Description of CAP

With CAP it is possible to synchronize a continuous application process with the TCP movement of a robot.

The synchronization between robot movement and application layer is handled via predefined RAPID events. These events trigger trap routines in RAPID (*Predefined events on page 23*), where the application builder implements the RAPID code to control the application process.

CAP enables the RAPID user to order supervision of I/O signals depending on the TCP movement of the robot (*Supervision on page 14*).

For synchronization of movement and process, the process is divided into different phases. For every process phase CAP can supervise a number of digital I/O signals (*Process phases on page 12*).



xx1200000163

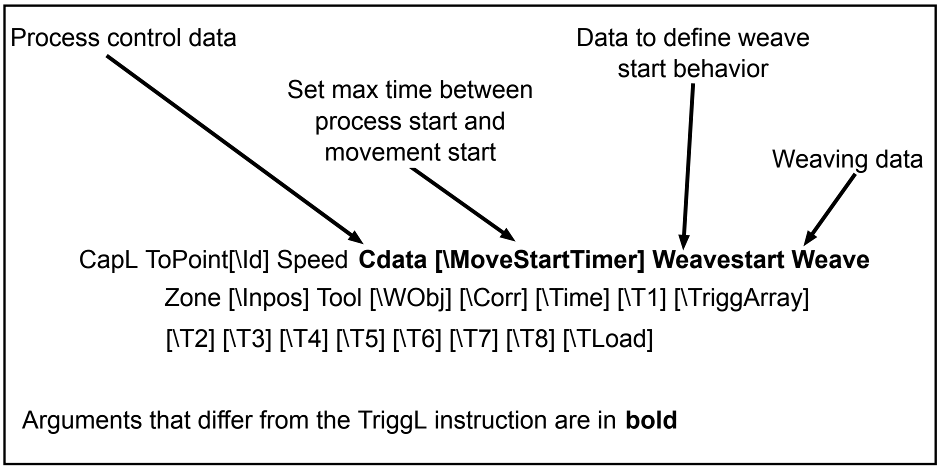
Continues on next page

2.1 Robot movement

Instructions and TCP movement

A CAP movement instruction (`CapL` or `CapC`) is similar to other movement instructions (for example, `MoveL`, `TriggL`). Compared to the `TriggL` instruction it contains also the information necessary for CAP. That information is given through the arguments `Cdata`, `Weavestart` and `Weave`.

The motion synchronization is handled by the CAP process - there is one process for each RAPID task that controls a robot, which uses CAP in its application. This CAP process is active over several CAP movement instructions from the first instruction (`Cdata.first_instr = TRUE`)) to the last instruction (`Cdata.last_instr = TRUE`) see *capdata - CAP data on page 99*.



xx2300000231

During continuous execution the robot movement speed with active application process is defined by `Cdata.speed_data`. For step-wise execution (forward or backward) the robot movement speed is defined by `Speed` - CAP will in this case automatically inhibit the application process.

For more information on programming CAP movement instructions see *Programming examples on page 37*.

Process phases

CAP provides four different process phases. The application builder uses these phases to synchronize the robot movement with the application process:

- PRE
- MAIN
- POST1
- POST2

Each process phases has associated supervision lists for I/O signal supervision (*Supervision on page 14*).

Continues on next page

During the application process phases CAP generates a number of events that the application builder connects to RAPID TRAP routines in the application layer. These TRAP routines contain application code to control the application process.

2.2 Supervision

Introduction to supervision

CAP supervises I/O signals during execution of the application process and generates supervision errors if any of the supervised signal fails.

Supervision is set up from the RAPID application level, see *CapSetupSupervision - Setup conditions for signal supervision in CAP on page 82*.

Supervision phases

There are two different types of supervision phases:

- Handshake supervision.
- Status supervision.

As mentioned in *Process phases on page 12*, the CAP application process is divided into four process phases. Each of those phases has three supervision phases:

Process phase	Start handshake supervision phase	Status supervision phase	End handshake supervision phase
PRE	START_PRE	PRE	END_PRE
MAIN	START_MAIN	MAIN	END_MAIN
POST1	START_POST1	POST1	END_POST1
POST2	START_POST2	POST2	END_POST2

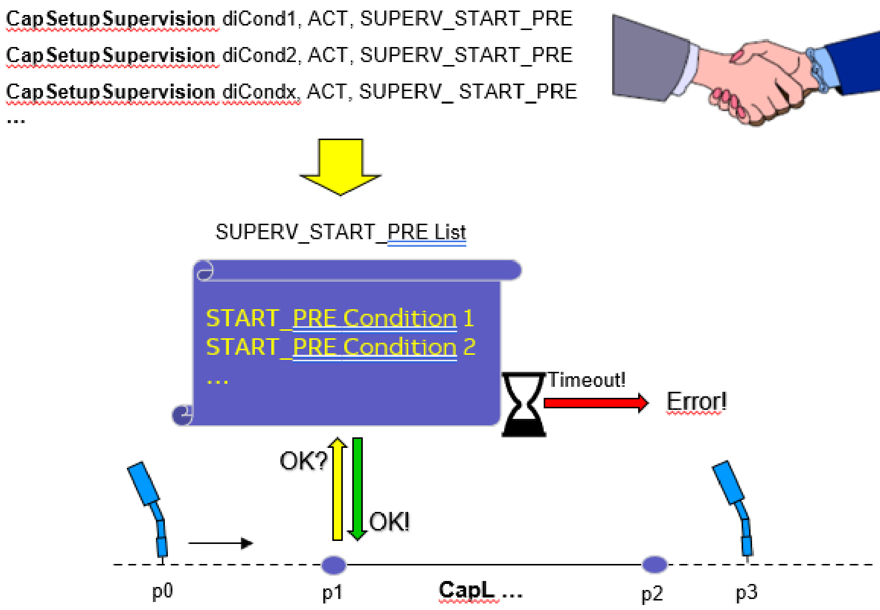
Handshake supervision

There is one handshake supervision phase prior to each status supervision phase to insure the start conditions, and another handshake supervision phase after to insure the end conditions.

It is possible to specify a time-out for handshake supervisions. If a time-out is specified and expires before all supervision conditions are fulfilled, an ERROR is generated. The time-out can also be set to last forever, that is, the CAP process will be waiting for all supervision requests to be fulfilled. The time-out times are

Continues on next page

specified in `supervtimeouts` which is part of the `capdata`. If no handshake supervision is set up that phase is skipped.



xx2300000243

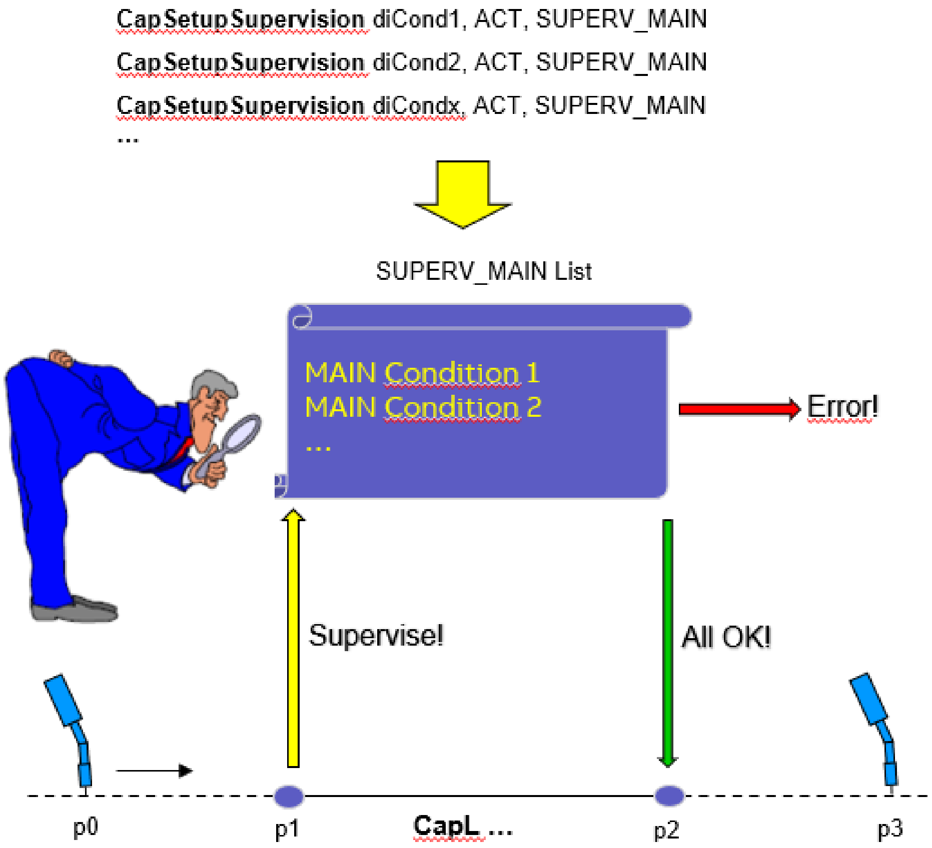
These are the handshake supervision phases.

- START_PRE
- END_PRE
- START_MAIN
- END_MAIN
- START_POST1
- END_POST1
- START_POST2
- END_POST2

Continues on next page

Status supervision

For status supervision phases all conditions that the application builder specified for it (`CapSetupSupervision`) are supervised (see figure below).



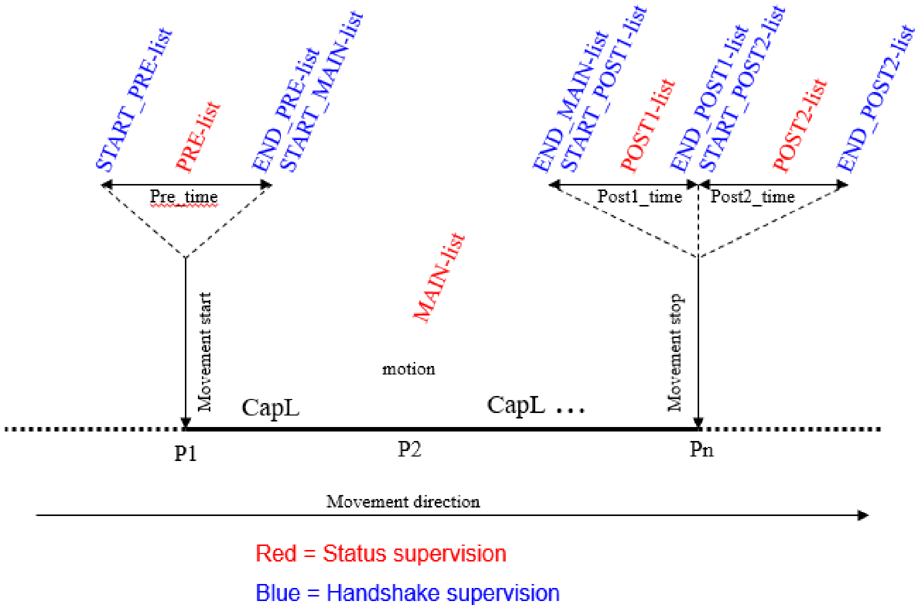
xx2300000244

The component `proc_times` in `capdata` defines the duration of the process phases `PRE`, `POST1`, and `POST2`. If supervision is requested during any of these phases, the duration time for each phase must be bigger than zero; otherwise the supervision will fail. No time has to be specified for the MAIN phase, because this time is defined by the movement of the robot.

These are the status supervision phases.

- PRE
- MAIN
- POST1
- POST2

Continues on next page



xx2300000232

2.3 Supervision and process phases

Phases

The process phases PRE, POST1, and POST2 are common to one single CAP process path, that is:

- the first CAP instruction that starts or restarts the CAP process is the only one that has a PRE supervision phase. At restart the presence of this phase depends on the setting of pre_phase in the data type `restartblkdata`. See *restartblkdata - blockdata for restart on page 113*.
- the last CAP instruction (`last_instr` = `TRUE` in `capdata`) that terminates the CAP process, is the only one that has the phases POST1 and POST2. See *capdata - CAP data on page 99*.

PRE phase

When the robot reaches the start point of the path, all conditions in the START_PRE supervision list must be fulfilled before the application process can enter the status supervision phase PRE. If a time-out is specified and the conditions cannot be met within that time, the application process is stopped, and an error is sent.

During the PRE phase all conditions defined in the PRE supervision list must be fulfilled. If some of these conditions fail, the application process is stopped and an error message is sent.

After the PRE phase all conditions in the END_PRE supervision list must be fulfilled before the application process can end the PRE process phase. If a time-out is specified and the conditions cannot be met within that time, the application process is stopped, and an error is sent.

When using *flying start* this phase will not be available, but the duration time can be used to create an ignition delay.

Summary

- Starts when all conditions in the START_PRE supervision list are met.
- Supervised by the PRE supervision list.
- Ends when all conditions in the END_PRE supervision list are met.

MAIN phase

All conditions in the START_MAIN supervision list must be fulfilled before the application process can enter the status supervision phase MAIN. If a time-out is specified and the conditions cannot be met within that time, the application process is stopped, and an error is sent.

During the MAIN phase all conditions defined in the MAIN supervision list must be fulfilled. If some of these conditions fail, the application process is stopped and an error message is sent.

Continues on next page

All conditions in the END_MAIN supervision list must be fulfilled before the application process can end the MAIN process phase. If the conditions cannot be met within that time, the application process is stopped, and an error is sent.

Summary

- Starts when all conditions in the START_MAIN supervision list are met.
- Supervised by the MAIN supervision list.
- Ends when all conditions in the END_MAIN supervision list are met.

POST1 phase

All conditions in the START_POST1 supervision list must be fulfilled for the application process to be allowed to enter the POST1 status supervision phase. If a time-out is specified for START_POST1 and the conditions cannot be met within that time, the application process is stopped, and an error is sent.

During the POST1 phase all conditions defined in the POST1 supervision list must be fulfilled. If some of these conditions fail, the application process is stopped and an error message is sent.

All conditions in the END_POST1 supervision list must be fulfilled for the application process to end the POST1 process phase. If the conditions cannot be met within that time, the application process is stopped, and an error is sent.

This phase is not available for *flying start*.

Summary

- Starts when all conditions in the START_POST1 supervision list are met.
- Supervised by the POST1 supervision list.
- Ends when all conditions in the END_POST1 supervision list are met.

POST2 phase

All conditions in the START_POST2 supervision list must be fulfilled for the application process to be allowed to enter the POST2 status supervision phase. If a time-out is specified for START_POST2 and the conditions cannot be met within that time, the application process is stopped, and an error is sent.

During the POST2 phase all conditions defined in the POST2 supervision list must be fulfilled for the application process to end the POST2 process phase, i.e. to end the CAP process. If some of these conditions fail, the application process is stopped and an error message is sent.

This phase is not available for *flying start*.

Summary

- Starts when all conditions in the START_POST2 supervision list are met.
- Supervised by the POST2 supervision list.
- Ends when all conditions in the END_POST2 supervision list are met.

2.4 Motion delay

Description

Motion delay gives the user the possibility to delay the start of the robot movement. This can be used for example with laser cutting, where the movement must not be started before the material has been penetrated. The time for the motion delay is specified in `capspeeddata`. See *capspeeddata - Speed data for CAP on page 102*.

This functionality is not available for *flying start*.

2.5 Programming recommendations

Corner zones

A sequence of CAP movement instructions shall have corner zones (for example, `z10`) on the path.

For example:

```
MoveL p10,v100,fine,tool;
CapL p20,v50,cdata,nowvst,nowv,z20,tool;
CapC p30,p40,v50,cdata,nowvst,nowv,z20,tool;
CapL p50,v50,cdata,nowvst,nowv,z20,tool;
CapL p60,v50,cdata,nowvst,nowv,fine,tool;
MoveL p70,v100,fine,tool;
```

If the last movement instruction before the first CAP instruction in a sequence starts from a corner zone, CAP will start the application process with a *flying start*.

If the last instruction of a sequence of CAP instructions ends in a corner zone, CAP will end the application process with a *flying end*.

Within a sequence of CAP instructions, avoid logical instructions that take long time. That may cause error *50024 Corner path failure* and *110013 Application process interrupted*, which means that a corner zone is converted to a fine point, the application process is interrupted and restarted with the next CAP instruction.

2.6 Program execution

Corner zones

If `last_instr` is set to `TRUE` in `capdata` in the middle of a sequence of CAP instructions, the application process is ended with all end phases, as described in *Process phases on page 12*. Which phases are executed, depends on the presence of *flying end*. The following CAP instruction will start the process again, with all start phases as described in *Process phases on page 12*. Which phases are executed, depends on the presence of *flying start*.

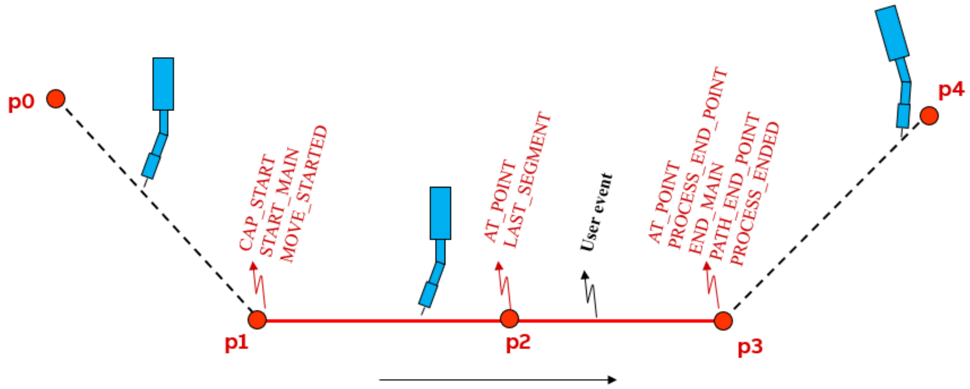
If a fine point occurs in the middle of a sequence of CAP instructions without `last_instr` set to `TRUE` in `capdata`, the application process will not be interrupted, the program execution will proceed to the next CAP instruction in advance (prefetch), and the movement will execute a corner zone `z0`.

If execution of logical instructions in the middle of a sequence of CAP instructions take so long time, that a programmed corner path is converted to a fine point (*50024 Corner path failure*), the application process is interrupted (*110013 Application process interrupted*) without executing the end phases described in *Process phases on page 12*.

2.7 Predefined events

Description

The predefined CAP events, which occur during the CAP process, can be connected to RAPID TRAP routines. To do this, the RAPID instruction `ICap` is used before running the first CAP movement instruction. This enables the user to synchronize application process equipment with the robot movement. See *ICap - connect CAP events to trap routines on page 88*.



xx2300000245

2.8 Coupling between phases and events

Phases and events

Conditional events

Events for flying start/end

	Phase	Events
PRE	START_PRE	CAP_PF_RESTART RESTART AT_RESTARTPOINT FLY_START CAP_START START_PRE PRE_STARTED
	PRE	
	END_PRE	END_PRE PRE_ENDED
MAIN	START_MAIN	START_MAIN MAIN_STARTED
	MAIN	STOP_WEAVESTART WEAVESTART_REG MOTION_DELAY STARTSPEED_TIME MAIN_MOTION MOVE_STARTED AT_ERRORPOINT EQUIDIST CENTERLINE CAP_STOP AT_POINT NEW_INSTR LAST_SEGMENT PATH_END_POINT PROCESS_ENDPOINT FLY_END
	END_MAIN	END_MAIN MAIN_ENDED LAST_INSTR_ENDED
POST1	START_POST1	START_POST1 POST1_STARTED
	POST1	
	END_POST1	END_POST1 POST1_ENDED

Continues on next page

	Phase	Events
POST2	START_POST2	START_POST2 POST2_STARTED
	POST2	
	END_POST2	END_POST2 POST2_ENDED PROCESS_ENDED

All events are listed in alphabetical order in *ICap - connect CAP events to trap routines on page 88*.

User events

The CAP movement instructions `CapL` and `CapC` offer the possibility to define trigger events (switches `\T1` to `\T8` and `\TriggArray`). These trigger events can be coupled to CAP movement instructions with `TriggIO`, `TriggEquip` or `TriggInt`. See *CapL - Linear CAP movement instruction on page 64* and *CapC - Circular CAP movement instruction on page 50*.

2.9 Error handling

Description

Two different types of error can occur during execution of the RAPID instructions `CapL` or `CapC`:

- Recoverable error: these errors can be handled in a RAPID error handler, see error handling for *CapL - Linear CAP movement instruction on page 64*. The system variable ERRNO is set and the user can check the value of ERRNO in the error handler, to get information about which error occurred and choose adequate recovery measures. For recoverable errors it is possible to use the RAPID instructions `RETRY, TRYNEXT, StartMoveRetry` in the error handler. An error message is generated.
- Fatal error: if such an error occurs, the robot controller has to be restarted. A fatal error message is generated.

Continues on next page

2.9.1 Recoverable errors

Introduction

Recoverable errors can be handled in a RAPID error handler. The application builder can choose to use `RETRY` or `StartMoveRetry` several times, depending on the application and the type of error. If for example, the arc in an arc welding application does not strike the first time, it makes sense to retry arc ignition several times. If these attempts are unsuccessful the error may be raised to the next level of RAPID (`RAISE`) or (only available in a `NOSTEPIN / NOVIEW` module) to user level (`RaiseToUser`) - see examples below.

Errors from CapL and CapC

Errors from the movement instructions `CapL` and `CapC` are CAP specific. See *CapL - Linear CAP movement instruction on page 64* and *CapC - Circular CAP movement instruction on page 50*. That means, that those error codes have to be translated to application specific error codes in the error handler, to make it easier for users of that application to understand the error message. After translation of the error, the new, application specific error code is raised to the user (`RAISE new_err_code`) - see *Example 1 on page 28*.

These errors should be converted to application specific errors, depending on the type of application that is built on top of CAP. To achieve this the `ERRNO` has to be checked in the error handler. See *Example 1 on page 28*.

Suppose a supervised signal fails in the MAIN supervision phase. The end user should not get a general `CAP_MAIN_ERR` error. The application layer should return a more specific error, since this error depends on how CAP is used by the RAPID application. If several signals are supervised during a supervision phase, all these signals have to be checked in the application error handler to identify the error more specifically.

No error handler

If no error handler can be found or there is an error handler, but it does not handle the error - that is, none of the instructions `RETRY`, `StartMoveRetry`, `TRYNEXT`, `RETURN` or `RAISE` are present in the error handler - the active robot path is cleared. That means, that neither *regain to path* nor *backing on the path* is possible. At restart of program execution the robot movement starts from the current position of the TCP, which might result in a *path shortcut*.

Start phase supervision errors

If a START_MAIN phase supervision error occurs during *flying start*, the movement is stopped at the end of the *START_MAIN distance* and at restart the application process is handled like an ordinary restart after an error - with all user defined restart functionality like *scrape start*, *start delay*, etc.

Continues on next page

Examples

Below there are two examples of different error handling type. It is recommended to implement error handling as shown in example 2, where the CAP application process survives and no extra code has to be executed in a retry from user level. See *Example 2 on page 29*.

The `SkipWarn` instruction in the error handlers is used to prevent the CAP specific error from being sent to the error log. For an application user (for example, Arc Welding) CAP specific errors are not interesting. The errors shown in the event log shall be application specific.

Example 1

This is an example with RAPID modules that are not `NOSTEPIN / NOVIEW`. If the error is sent to the RAPID main routine using `RETRY`, the CAP process will exit.

A `RETRY` order in the error handler case `MY_AW_ERR_1` will continue execution and make a retry on `arcl_move_only`. After a retry in the calling RAPID routine a new CAP process will be created when the `CapL` instruction is executed and the value of `example_count1` will be 2 .

```
MODULE CAP_EXAMPLE1
VAR num example1_count:=0;
PROC main()
  MoveJ p10,v200,fine,tool0;
  arcl_move_only p11, v20, z20, tool0;
  ERROR
    TEST ERRNO
    CASE MY_AW_ERR_1:
      StartMoveRetry;
    CASE MY_AW_ERR_2:
      EXIT;
    DEFAULT:
      EXIT;
    ENDTEST
ENDPROC

LOCAL PROC arcl_move_only (robtarget ToPoint, speeddata Speed,
     zonedata Zone, PERS tooldata Tool \PERS wobjdata WObj \switch
     Corr)

example1_count := example1_count + 1;
CapL Topoint, Speed, IntCdata, IntWeavestart, IntWeave, Zone, Tool
     \wobj?wobj;
ERROR
  ResetIoSignals;

  IF no_of_retries > 0 THEN
    IF err_cnt < no_of_retries THEN
      err_cnt := err_cnt + 1;
      Skipwarn; !Remove CAP error from event log err_code :=
           new_aw_errMsg();
      StartMoveRetry;
```

Continues on next page

```
      ELSE
        err_cnt := 0;
        Skipwarn;
        err_code := new_aw_errMsg();
        RAISE err_code;
        !Kills the CAP process, and raises mapped error
      ENDIF
    ELSE
      Skipwarn;
      err_code := new_aw_errMsg();
      RAISE err_code;
        !Kills the CAP process, and raises mapped error
    ENDIF
  ENDPROC

  FUNC errnum new_aw_errMsg (\switch W)
    VAR errnum ret_code;
    TEST ERRNO
    CASE CAP_PRE_ERR:
      ! Check of signals here
      ret_code := AW_EQIP_ERR;
    ENDTEST

    RETURN ret_code;
  ENDFUNC
  ENDMODULE
```

Example 2

This is an example with one RAPID module `CAP_EXAMPLE2`, where main is located. Another module that is `NOVIEW` and `NOSTEPIN`, contains the procedure `arcl_move_only`, which encapsulates the process control. If the error is raised to the main routine (`RaiseToUser \Resume`), the CAP process is still active. The `RETRY` order in the error handler case MY_AW_ERR_1 will continue execution and make a retry directly on the `CapL` instruction. The example_count1 will be 1 when executing the `CapL` instruction after a retry from the user level.

> **Note**
>
> The instruction `RaiseToUser` can only be used in `NOVIEW` and/or `NOSTEPIN` module.

```
MODULE CAP_EXAMPLE2

VAR num example1_count:=0;

PROC main()
  MoveJ p10,v200,fine,tool0;
  arcl_move_only p11, v20, z20, tool0;

  ERROR
    TEST ERRNO
```

Continues on next page

```
    CASE MY_AW_ERR_1:
      StartMoveRetry;
    CASE MY_AW_ERR_2:
      EXIT;
    DEFAULT:
      EXIT;
    ENDTEST
ENDPROC
ENDMODULE

MODULE ARCX_MOVE_ONLY(NOSTEPIN, NOVIEW)
LOCAL PROC arcl_move_only(robtarget ToPoint, speeddata Speed,
     zonedata Zone, PERS tooldata Tool \PERS wobjdata WObj \switch
     Corr)
example1_count:=example1_count + 1;

  CapLTopoint, Speed, IntCdata, IntWeavestart, IntWeave, Zone, Tool
       \wobj?wobj;
ERROR
  ResetIoSignals;

  IF no_of_retries > 0 THEN
    IF err_cnt < no_of_retries THEN
      err_cnt := err_cnt + 1;
      Skipwarn;
      err_code := new_aw_errMsg();
      StartMoveRetry;
    ELSE
      err_cnt := 0;
      Skipwarn;
      err_code := new_aw_errMsg();
      RaiseToUser \Resume \ErrorNumber:=err_code;
    ENDIF
  ELSE
    Skipwarn;
    err_code := new_aw_errMsg();
    RaiseToUser \Resume \ErrorNumber:=err_code;
  ENDIF
ENDPROC

FUNC errnum new_aw_errMsg (\switch W)
  VAR errnum ret_code;
  TEST ERRNO
  CASE CAP_PRE_ERR:
    ! Check of signals here
    ret_code := AW_EQIP_ERR;
  ENDTEST
  RETURN ret_code;
ENDFUNC
ENDMODULE
```

Continues on next page

The `errnum` raised to the calling routine `arcl_move_only` is `AW_EQIP_ERR`, that is, the CAP error `CAP_PRE_ERR` is replaced by `AW_EQIP_ERR` and the CAP error will not appear in the error log (topic *Process*).

2.10 Restart

Description

If the execution of a `CapL/CapC` instruction is stopped due to a recoverable error or a program stop, it is possible to let the robot back a certain distance on the programmed path before restart of the process. The backing distance has to be specified in `capdata`, see *capdata - CAP data on page 99*.

Units

In CAP the following units are used:

length	mm
time	s
speed	mm/s
angle	degree

Tuning

Using the RAPID instruction `CapRefresh`, it is possible to change the active value of (tune) the following data during execution:

`weavedata` components:

- `active`
- `width`
- `height`
- `bias`

`weavestartdata` components:

- `active`

`capdata` components:

- `speed_data.main`
- `restart_dist`

Example

The example changes the main speed and weave within a TRAP.

```
VAR intnum intno0;

PROC main()
  IDelete intno0;
  CONNECT intno0 WITH MainMotionTrp;
  ICap intno0, MAIN_MOTION;
  CapL p11, v100, cdata1, weavestart, weave, fine, tool0;
ENDPROC

TRAP MainMotionTrp
  cdata1.speed_data.main := 23;
  weave.width := 5;
ENDTRAP
```

Continues on next page

Note

In this example the TRAP-routine is inside the main module. The recommendation is that all TRAP-routines should be executed by a background task.

2.11 System event routines

Introduction

CAP is not aware of any process equipment, i.e. the control of process equipment has to be handled in TRAP routines connected to CAP events set up with `ICap`, see *ICap - connect CAP events to trap routines on page 88*. It is also possible, but not recommended, to use shelf-hooks (stop-, start-, restart-, ...) to activate and deactivate process equipment.

Any error (fatal or recoverable) or RAPID program stop with an active CAP application process, generates the `ICap` event `CAP_STOP`. CAP always demands that a TRAP routine is connected to `CAP_STOP`. This TRAP routine has to deactivate external equipment. If anything unexpected happens in the controller software, the stop shelf on system level takes the system to a fail-safe state, but it does not stop the application process. Keep in mind that TRAP execution is stopped when RAPID execution of a NORMAL task is stopped. Therefore the TRAP connected to `CAP_STOP` has to be placed in a STATIC or SEMISTATIC task.

Exceptions

Not all errors can be handled in shelf-hooks or in the TRAP routine connected to `CAP_STOP`. If the system, for some reason, is forced to system failure state, all execution of RAPID code is immediately stopped and TRAP routines might not be executed due to high load in the controller. To handle this situation, CAP offers the possibility to register digital signals together with a signal state (0 or 1) using the RAPID instruction `CapSetDOAtStop`. At any RAPID execution stop, CAP will set all signals that were registered, to the respective registered state. It is highly recommended to register signals in CAP that stop the application process.

2.12 Limitations

Limitations

- Execution of RAPID instructions that take long time (e.g. writing to file, `WaitTime`, ...) between CAP movement instructions (`CapL`, `CapC`) will delay the execution of the next movement instruction. That may cause corner path failure, stopping the movement of the robot for a short time, which may be fatal for the process (for example, arc welding).
- CAP does not support error recovery with long jump.

This page is intentionally left blank

3 Programming examples

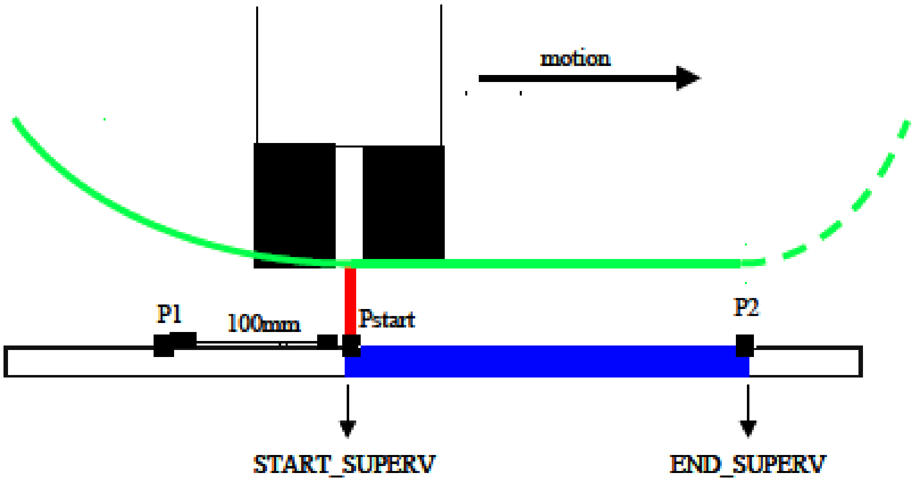
3.1 Laser cutting example

Requirements

- a slot is to be cut into a number of metal sheets with a laser
- accuracy *is not* critical at the starting point of the slot
- accuracy *is* critical at the finishing point of the slot
- the application is time critical, i.e. it should be as fast as possible

CAP setup to meet the requirements

- *flying start*: the robot can move with speed past the start point (P1) and start the process on the fly between point P1 and Pstart.
- *normal end*: the robot must cut all the way to the end point (P2) and stop before turning off the laser and moving on to next cycle.
- In order to assure the quality of the cuts the process needs to be started at the latest one second after passing Pstart. Three seconds are given for ending the process.



xx1200000172

3.2 Step by step

Set up CAP events

First you need to set up the necessary CAP events. For this application a minimum of two events are needed:

- start the application process: `SUPERV_START_MAIN` generated at position `Pstart`
- stop the application process: `SUPERV_END_MAIN` generated at the end position `P2`

```
VAR intnum start_intno:=0;
VAR intnum end_intno:=1;

TRAP start_trap
  SetDo doLaserOn, high;
ENDTRAP

TRAP end_trap
  SetDo doLaserOn, low;
ENDTRAP

IDelete start_intno;
IDelete end_intno;
CONNECT start_intno WITH start_trap;
CONNECT end_intno WITH end_trap;
ICap start_intno, START_MAIN;
ICap end_intno, END_MAIN;
```

Set up supervision

In this case only one signal, *diLaserOn*, needs to be supervised, but in three different process phases:

1. *diLaserOn* needs to go high (ACT) in the START_MAIN phase.
2. *diLaserOn* needs to stay high (i.e. supervision shall trigger on change from ACT to PAS) during the MAIN phase.
3. *diLaserOn* needs to go low (PAS) in the END_MAIN phase.

That means that we need to setup the handshake supervisions with time-out timers for the phases START_MAIN and END_MAIN. We nee also a status supervision during MAIN.

```
CapSetupSupervision diLaserOn, ACT, SUPERV_START_MAIN;
CapSetupSupervision diLaserOn, ACT, SUPERV_MAIN;
CapSetupSupervision diLaserOn, PAS, SUPERV_END_MAIN;

capdata.start_fly_point.process_dist := 0;
capdata.start_fly_point.distance := 100;
capdata.sup_timeouts.start_cond := 1;
capdata.end_fly_point.process_dist := 0;
capdata.end_fly_point.distance := 0;
capdata.sup_timeouts.end_main_cond := 3;
```

Continues on next page

The main program

The user might use an encapsulation of `CapL`, we call it `CutL` in the following way:

```
PROC CUTL (...)
  MoveL p1, v100, z10,...
  CapL p2, v100, cdata, startweave, weave, fine, tool0, ...
  MoveL px, ...
ENDPROC
```

This page is intentionally left blank

4 RAPID references

4.1 Instructions

4.1.1 CapAPTrSetupAI - Setup an At-Point-Tracker controlled by analog input signals

Usage

`CapAPTrSetupAI` is used to setup an At-Point-Tracker controlled by analog input signals.

Basic examples

The following example illustrates the instruction `CapAPTrSetupAI`.

Example 1

```
TASK PERS capdata cData:=[.....];
TASK PERS weavestartdata wsData:=[.....];
TASK PERS capweavedata wData:=[.....];
TASK PERS captrackdata trackData:=["ANALOG_TRACKER",.....];

VAR capaptrreferencedata referenceData:=[2,2,1,1,0.1,0.1];
VAR signalai ai_y;
VAR signalai ai_z;

AliasIO realsignal_y, ai_y;
AliasIO realsignal_z, ai_z;
CapAPTrSetupAI ai_y, ai_z, referenceData;

CapL p1, v200, cData, wsData, wData , fine, tWeldGun
     \Track:=trackData;
```

Arguments

```
CapAPTrSetupAO ai_y, ai_z, ReferenceData [\MaxIncrCorr]
     [\WarnMaxCorr] [\Filter] [\SampleTime] [\Logfile] [\LogSize]
     [\LatestCorr] [\AccCorr]
```

`ai_y`

Data type: `signalai`

Analog input signal used as process position for the y-direction.

`ai_z`

Data type: `signalai`

Analog input signal used as process position for the z-direction.

`ReferenceData`

Data type: `capaptrreferencedata`

Setup data used for the correction regulator loop.

`MaxIncCorr`

Data type: `num`

Continues on next page

Maximum incremental correction allowed (in mm).

If the incremental TCP correction is larger than `\MaxIncCorr` and `\WarnMaxCorr`, the robot will continue its path but the applied incremental correction will not exceed `\MaxIncCorr`. If `\WarnMaxCorr` is not specified, a track error is reported and the program execution is stopped.

`WarnMaxCorr`

Data type: `switch`

If this switch is present the program execution is not interrupted when the limit for maximum correction is exceeded, specified in `\MaxIncCorr`. Only a warning is sent.

`Filter`

Data type: `num`

Size of the reference sample data filter. A value between 1 and 15 is allowed, the default value is 1.

`SampleTime`

Data type: `num`

Sample time in milliseconds for the correction loop. The value is rounded to a multiple of 24. The minimum value allowed is 24, and the default value is 24.

`LogFile`

Data type: `string`

The name of the tracklog log file. The log file is placed in the HOME directory of the system.

`LogSize`

Data type: `num`

The size of the tracklog ring buffer that is the number of sensor measurements that can be buffered during tracking.

Default value: 1000.

`LatestCorr`

Data type: `pos`

Size of the latest added correction (in mm).

`AccCorr`

Data type: `pos`

Size of the total accumulated correction added (in mm).

Syntax

```
CapAPTrSetupAI
  [aoi_y ':='] <expression (IN) of signalai> ','
  [ai_z ':='] <expression (IN) of signalai> ','
  [ReferenceData ':='] <expression (IN) of capaptrreferencedata>
       ','
  [\MaxIncrCorr ':='] <expression (IN) of num> ','
  [\WarnMaxCorr ':='] <expression (IN) of switch> ','
```

Continues on next page

```
[\Filter ':='] <expression (IN) of num> ','
[\SampleTime ':='] <expression (IN) of num> ','
[\LogFile ':='] <expression (IN) of string> ','
[\LogSize ':='] <expression (IN) of num> ','
[\LatestCorr ':='] <expression (PERS) of pos> ','
[\AccCorr ':='] <expression (PERS) of pos> ';'
```

Related information

For information about	See
Instruction `CapAPTrSetupAO`	*CapAPTrSetupAO - Setup an At-Point-Tracker controlled by analog output signals on page 44*
Instruction `CapAPTrSetupPERS`	*CapAPTrSetupPERS - Setup an At-Point-Tracker controlled by persistent variables on page 47*
Data type `capaptrreferencedata`	*capaptrreferencedata - Variable setup data for At-Point-Tracker on page 97*
Sensor Interface	*Application manual - Controller software Omni-Core*

4.1.2 CapAPTrSetupAO - Setup an At-Point-Tracker controlled by analog output signals

Usage

`CapAPTrSetupAO` is used to setup an At-Point-Tracker controlled by analog output signals.

Basic examples

The following example illustrates the instruction `CapAPTrSetupAO`.

Example 1

```
TASK PERS capdata cData:=[.....];
TASK PERS weavestartdata wsData:=[.....];
TASK PERS capweavedata wData:=[.....];
TASK PERS captrackdata trackData:=["ANALOG_TRACKER",.....];

VAR capaptrreferencedata referenceData:=[2,2,1,1,0.1,0.1];
VAR signalao ao_y;
VAR signalao ao_z;

AliasIO realsignal_y, ao_y;
AliasIO realsignal_z, ao_z;
CapAPTrSetupAO ao_y, ao_z, referenceData;

CapL p1, v200, cData, wsData, wData , fine, tWeldGun
     \Track:=trackData;
```

Arguments

```
CapAPTrSetupAO ao_y, ao_z, ReferenceData [\MaxIncrCorr]
     [\WarnMaxCorr] [\Filter] [\SampleTime] [\Logfile] [\LogSize]
     [\LatestCorr] [\AccCorr]
```

`ao_y`

Data type: `signalao`

Analog output signal used as process position for the y-direction.

`ao_z`

Data type: `signalao`

Analog output signal used as process position for the z-direction.

`ReferenceData`

Data type: `capaptrreferencedata`

Setup data used for the correction regulator loop.

`MaxIncCorr`

Data type: `num`

Maximum incremental correction allowed (in mm).

If the incremental TCP correction is larger than `\MaxIncCorr` and `\WarnMaxCorr`, the robot will continue its path but the applied incremental correction will not exceed

Continues on next page

`\MaxIncCorr`. If `\WarnMaxCorr` is not specified, a track error is reported and the program execution is stopped.

`WarnMaxCorr`

Data type: `switch`

If this switch is present the program execution is not interrupted when the limit for maximum correction is exceeded, specified in `\MaxIncCorr`. Only a warning is sent.

`Filter`

Data type: `num`

Size of the reference sample data filter. A value between 1 and 15 is allowed, the default value is 1.

`SampleTime`

Data type: `num`

Sample time in milliseconds for the correction loop. The value is rounded to a multiple of 24. The minimum value allowed is 24, and the default value is 24.

`LogFile`

Data type: `string`

The name of the tracklog log file. The log file is placed in the HOME directory of the system.

`LogSize`

Data type: `num`

The size of the tracklog ring buffer that is the number of sensor measurements that can be buffered during tracking.

Default value: 1000.

`LatestCorr`

Data type: `pos`

Size of the latest added correction (in mm).

`AccCorr`

Data type: `pos`

Size of the total accumulated correction added (in mm).

Syntax

```
CapAPTrSetupAO
  [ao_y ':='] <expression (IN) of signalao> ','
  [ao_z ':='] <expression (IN) of signalao> ','
  [ReferenceData ':='] <expression (IN) of capaptrreferencedata>
       ','
  [\MaxIncrCorr ':='] <expression (IN) of num> ','
  [\WarnMaxCorr ':='] <expression (IN) of switch> ','
  [\Filter ':='] <expression (IN) of num> ','
  [\SampleTime ':='] <expression (IN) of num> ','
  [\LogFile ':='] <expression (IN) of string> ','
```

Continues on next page

```
[\LogSize ':='] <expression (IN) of num> ','
[\LatestCorr ':='] <expression (PERS) of pos> ','
[\AccCorr ':='] <expression (PERS) of pos> ';'
```

Related information

For information about	See
Instruction `CapAPTrSetupAI`	*CapAPTrSetupAI - Setup an At-Point-Tracker controlled by analog input signals on page 41*
Instruction `CapAPTrSetupPERS`	*CapAPTrSetupPERS - Setup an At-Point-Tracker controlled by persistent variables on page 47*
Data type `capaptrreferencedata`	*capaptrreferencedata - Variable setup data for At-Point-Tracker on page 97*
Sensor Interface	*Application manual - Controller software OmniCore*

4.1.3 CapAPTrSetupPERS - Setup an At-Point-Tracker controlled by persistent variables

Usage

`CapAPTrSetupPERS` is used to setup an At-Point-Tracker controlled by persistent variables.

Basic examples

The following example illustrates the instruction `CapAPTrSetupPERS`.

Example 1

```
TASK PERS capdata cData:=[.....];
TASK PERS weavestartdata wsData:=[.....];
TASK PERS capweavedata wData:=[.....];
TASK PERS captrackdata trackData:=["ANALOG_TRACKER",.....];
PERS pos corr:=[0,-0.05,-0.025];

VAR capaptrreferencedata referenceData:=[2,2,1,1,0.1,0.1];

main()
IDelete intno1;
CONNECT intno1 WITH trOffset;
CapAPTRSetupPERS corr.y, corr.z, referenceData;

ITimer 1,intno1;
CapL p1, v200, cData, wsData, wData , fine,
     tWeldGun\Track:=trackData;
ENDPROC

TRAP trOffset
  corr.y := referenceData.reference_y +- .....;
  corr.z := referenceData.reference_z +- .....;
ENDTRAP
```

Arguments

```
CapAPTrSetupPERS var_y, var_z, ReferenceData [\ResetToReference]
     [\MaxIncrCorr] [\WarnMaxCorr] [\Filter] [\SampleTime]
     [\Logfile] [\LogSize] [\LatestCorr] [\AccCorr]
```

`var_y`

Data type: `num`

Persistent data used as process position for the y-direction.

`var_z`

Data type: `signalai`

Persistent data used as process position for the z-direction.

`ReferenceData`

Data type: `capaptrreferencedata`

Setup data used for the correction regulator loop.

Continues on next page

`[\ResetToReference]`

Data type: `switch`

This switch enables resetting the value of the persistent correction data `var_y` and `var_z` to the reference value. If `var_y` and `var_z` are updated at low frequency, for example, using RAPID code, this switch is used to avoid drifting of the path correction.

`MaxIncCorr`

Data type: `num`

Maximum incremental correction allowed (in mm).

If the incremental TCP correction is larger than `\MaxIncCorr` and `\WarnMaxCorr`, the robot will continue its path but the applied incremental correction will not exceed `\MaxIncCorr`. If `\WarnMaxCorr` is not specified, a track error is reported and the program execution is stopped.

`WarnMaxCorr`

Data type: `switch`

If this switch is present the program execution is not interrupted when the limit for maximum correction is exceeded, specified in `\MaxIncCorr`. Only a warning is sent.

`Filter`

Data type: `num`

Size of the reference sample data filter. A value between 1 and 15 is allowed, the default value is 1.

`SampleTime`

Data type: `num`

Sample time in milliseconds for the correction loop. The value is rounded to a multiple of 24. The minimum value allowed is 24, and the default value is 24.

`LogFile`

Data type: `string`

The name of the tracklog log file. The log file is placed in the HOME directory of the system.

`LogSize`

Data type: `num`

The size of the tracklog ring buffer that is the number of sensor measurements that can be buffered during tracking.

Default value: 1000.

`LatestCorr`

Data type: `pos`

Size of the latest added correction (in mm).

`AccCorr`

Data type: `pos`

Continues on next page

Size of the total accumulated correction added (in mm).

Syntax

```
CapAPTrSetupPERS
  [var_y ':='] <expression (PERS) of num> ','
  [var_z ':='] <expression (PERS) of vnum> ','
  [ReferenceData ':='] <expression (IN) of capaptrreferencedata>
       ','
  [\ResetToReference ':='] <expression (IN) of switch>','
  [\MaxIncrCorr ':='] <expression (IN) of num> ','
  [\WarnMaxCorr ':='] <expression (IN) of switch> ','
  [\Filter ':='] <expression (IN) of num> ','
  [\SampleTime ':='] <expression (IN) of num> ','
  [\LogFile ':='] <expression (IN) of string> ','
  [\LogSize ':='] <expression (IN) of num> ','
  [\LatestCorr ':='] <expression (PERS) of pos> ','
  [\AccCorr ':='] <expression (PERS) of pos> ';'
```

Related information

For information about	See
Instruction `CapAPTrSetupAI`	*CapAPTrSetupAI - Setup an At-Point-Tracker controlled by analog input signals on page 41*
Instruction `CapAPTrSetupAO`	*CapAPTrSetupAO - Setup an At-Point-Tracker controlled by analog output signals on page 44*
Data type `capaptrreferencedata`	*capaptrreferencedata - Variable setup data for At-Point-Tracker on page 97*
Sensor Interface	*Application manual - Controller software OmniCore*

4.1.4 CapC - Circular CAP movement instruction

Usage

`CapC` is used to move the tool center point (TCP) along a circular path to a given destination and at the same time control a continuous process. Furthermore it is possible to connect up to eight events to `CapC`. The events are defined using the instructions `TriggRampAO`, `TriggIO`, `TriggEquip`, `TriggInt`, `TriggCheckIO`, or `TriggSpeed`.

Basic examples

Example 1

Circular movements with `CapC`.

```
CapC cirp, p1, v100, cdata, weavestart, weave, fine, gun1;
```

The TCP of the tool, `gun1`, is moved circularly to the fine point `p1` with speed defined in `cdata`.

Example 2

Circular movement with user event and CAP event.

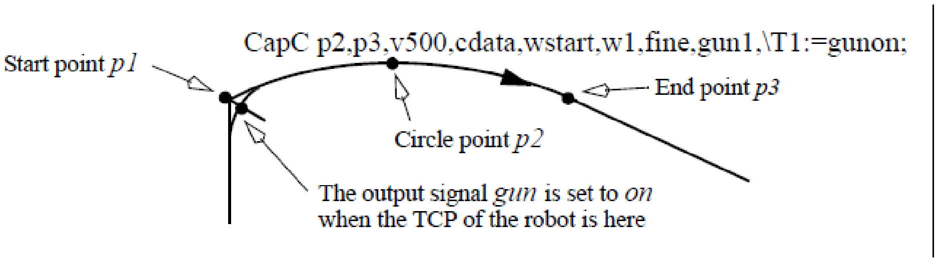
```
VAR intnum start_intno;
...
PROC main()
  VAR triggdata gunon;

  IDelete start_intno;
  CONNECT start_intno WITH start_trap;
  ICap start_intno, CAP_START;
  TriggIO gunon, 0 \Start \DOp:=gun, on;

  MoveJ p1, v500, z50, gun1;
  CapC p2,p3,v500,cdata,wstart,w1,fine,gun1,\T1:=gunon;
ENDPROC

TRAP start_trap
  ! This routine will be executed when the event CAP_START is
       reported
ENDTRAP
```

The digital output signal gun is set when the robot's TCP passes the midpoint of the corner path of the point `p1`. The trap routine start_trap is executed when the CAP process is starting.



xx1200000174

Continues on next page

Arguments

```
CapC Cirpoint ToPoint [\Id] Speed Cdata [\MoveStartTimer] Weavestart
     Weave Zone [\Inpos] Tool [\WObj] [\Corr] [\Time] [\T1]
     [\TriggArray] [\T2] [\T3] [\T4] [\T5] [\T6] [\T7] [\T8]
     [\TLoad]
```

`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).

`[ \ID ]`

Synchronization id

Data type: `identno`

The argument `[ \ID ]` is mandatory in MultiMove systems, if the movement is synchronized or coordinated synchronized. This argument is not allowed in any other case. The specified id number must be the same in all the cooperating program tasks. By using the id number the movements are not mixed up at the runtime.

`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.

`Cdata`

(CAP process Data)

Data type: capdata

CAP process data, see *capdata - CAP data on page 99* for a detailed description.

`[\Movestart_timer]`

(Time in s)

Data type: num

Upper limit for the time difference between the order of the process start and the actual start of the robot's TCP movement in a MultiMove system in synchronized mode.

`Weavestart`

(Weavestart Data)

Continues on next page

Data type: weavestartdata

Weave start data for the CAP process, see *weavestartdata - weave start data on page 117* for a detailed description.

`Weave`

(Weave Data)

Data type: capweavedata

Weaving data for the CAP process, see *capweavedata - Weavedata for CAP on page 103* for a detailed description.

`Zone`

Data type:`zonedata`

Zone data for the movement. Zone data describes the size of the generated corner path.

`[ \Inpos ]`

In position

Data type:`stoppoint data`

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 center 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 then 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.

The RobotWare option *Path Corrections* is required when using this argument.

`[\Time]`

Data type: num

Continues on next page

This argument is used to specify the total time in seconds during which the robot and additional axes move. It is then substituted for the corresponding speed data.

`[\T1]`

Trigg 1

Data type: `triggdata`

Variable that refers to trigger conditions and trigger activity defined earlier in the program using the instructions `TriggIO`, `TriggEquip`, `TriggInt`, `TriggCheckIO`, `TriggSpeed`, or `TriggRampAO`.

`TriggArray`

Trigg Data Array Parameter

Data type: `triggdata`

Array variable that refers to trigger conditions and trigger activity defined earlier in the program using the instructions `TriggIO`, `TriggEquip`, `TriggInt`, `TriggSpeed`, `TriggCheckIO`, or `TriggRampAO`.

The limitation is 25 elements in the array and 1 to 25 defined trigger conditions must be defined.

It is not possible to use the optional arguments `T2`, `T3`, `T4`, `T5`, `T6`, `T7`, or `T8` at the same time as the `TriggArray` argument is used.

`[ \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`, `TriggInt`, `TriggCheckIO`, `TriggSpeed`, or `TriggRampAO`.

`[ \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`, `TriggInt`, `TriggCheckIO`, `TriggSpeed`, or `TriggRampAO`.

`[ \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`, `TriggInt`, `TriggCheckIO`, `TriggSpeed`, or `TriggRampAO`.

`[ \T5 ]`

Trigg 5

Data type: `triggdata`

Continues on next page

Variable that refers to trigger conditions and trigger activity defined earlier in the program using the instructions `TriggIO`, `TriggEquip`, `TriggInt`, `TriggCheckIO`, `TriggSpeed`, or `TriggRampAO`.

`[ \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`, `TriggInt`, `TriggCheckIO`, `TriggSpeed`, or `TriggRampAO`.

`[ \T8 ]`

Trigg 8

Data type: `triggdata`

Variable that refers to trigger conditions and trigger activity defined earlier in the program using the instructions `TriggIO`, `TriggEquip`, `TriggInt`, `TriggCheckIO`, `TriggSpeed`, or `TriggRampAO`.

`[ \T8 ]`

Trigg 8

Data type: `triggdata`

Variable that refers to trigger conditions and trigger activity defined earlier in the program using the instructions `TriggIO`, `TriggEquip`, `TriggInt`, `TriggCheckIO`, `TriggSpeed`, or `TriggRampAO`.

`[ \TLoad ]`

Total load

Data type: `loaddata`

The `\TLoad` argument describes the total load used in the movement. The total load is the tool load together with the payload that the tool is carrying. If the `\TLoad` argument is used, then the `loaddata` in the current `tooldata` is not considered.

If the `\TLoad` argument is set to `load0`, then the `\TLoad` argument is not considered and the `loaddata` in the current `tooldata` is used instead.

To be able to use the `\TLoad` argument it is necessary to set the value of the system parameter `ModalPayLoadMode` to 0. If `ModalPayLoadMode` is set to 0, it is no longer possible to use the instruction `GripLoad`.

The total load can be identified with the service routine LoadIdentify. If the system parameter `ModalPayLoadMode` is set to 0, the operator has the possibility to copy the `loaddata` from the tool to an existing or new `loaddata` persistent variable when running the service routine.

It is possible to test run the program without any payload by using a digital input signal connected to the system input `SimMode` (Simulated Mode). If the digital

Continues on next page

input signal is set to 1, the `loaddata` in the optional argument `\TLoad` is not considered, and the `loaddata` in the current `tooldata` is used instead.

Note

The default functionality to handle payload is to use the instruction `GripLoad`. Therefore the default value of the system parameter `ModalPayLoadMode` is 1.

Program execution

See *Technical reference manual - RAPID Instructions, Functions and Data types* for information about the `MoveL` and `TriggL`.

Error handling

There are several different types of errors that can be handled in the error handler for the `CapC`/`CapL` instructions:

- supervision errors
- sensor specific errors
- errors specific to a MultiMove system
- errors inherited from `TriggX` functionality
- other CAP errors

If one of the signals that is supposed to be supervised does not have the correct value, or if it changes value during supervision, the system variable `ERRNO` is set.

If no values can be read from the track sensor, the system variable `ERRNO` is set.

For a MultiMove system running in synchronized mode the error handler must take care of two other errors. One is used to report that some other application has detected an recoverable error. This enables recoverable error handling in synchronized RAPID tasks. The other error, `CAP_MOV_WATCHDOG`, is reported if the time between the order of the process start and the actual start of the robot's TCP movement in a MultiMove system in synchronized mode expires. The time used is specified in the optional parameter `Movestart_timer` in the `CapC` instruction.

If anything abnormal is detected, program execution will stop. If, however, an error handler is programmed, the errors defined below can be remedied without stopping production. However, a recommendation is that some of the errors (the errors with `CAP_XX`) these errors should not be presented for the end user. Map those errors to a application specific error. For the supervision errors the instruction `CapGetFailSigs` can be used to get which specific signal that failed.

Supervision errors

The following recoverable errors are generated and can be handled in an error handler. The system variable `ERRNO` will be set to:

`CAP_START_PRE_ERR`	This error occurs when there is an error in the `START_PRE` supervision list, that is, when the conditions in the list are not met within the specified time frame (specified in `pre_cond` time-out).

Continues on next page

`CAP_PRE_ERR`	This error occurs when there is an error during the supervision of the `PRE` phase.
`CAP_END_PRE_ERR`	This event occurs when there is an error in the `END_PRE` supervision list, that is, when the conditions in the list are not met within the specified time frame (specified in `start_cond` time-out).
`CAP_START_MAIN_ERR`	This event occurs when there is an error in the `START_MAIN` supervision list, that is, when the conditions in the list are not met within the specified time frame (specified in `start_cond` time-out).
`CAP_MAIN_ERR`	This error occurs when there is an error during the supervision of the `MAIN` phase.
`CAP_END_MAIN_ERR`	This error occurs when there is an error in the `END_MAIN` supervision list, that is, when the conditions in the list are not met within the specified time frame (specified in `end_main_cond` time-out).
`CAP_START_POST1_ERR`	This event occurs when there is an error in the `START_POST1` supervision list, that is, when the conditions in the list are not met within the specified time frame (specified in `end_main_cond` time-out).
`CAP_POST1_ERR`	This error occurs when there is an error during the supervision of the `POST1` phase.
`CAP_END_POST1_ERR`	This error occurs when there is an error in the `END_POST1` supervision list, that is, when the conditions in the list are not met within the specified time frame (specified in `end_main_cond` time-out).
`CAP_START_POST2_ERR`	This event occurs when there is an error in the `START_POST1` supervision list, that is, when the conditions in the list are not met within the specified time frame (specified in `end_main_cond` time-out).
`CAP_POST2_ERR`	This error occurs when there is an error during the supervision of the `POST2` phase.
`CAP_END_POST2_ERR`	This error occurs when there is an error in the `END_POST2` supervision list, that is, when the conditions in the list are not met within the specified time frame (specified in `end_main_cond` time-out). If supervision is done on two different signals in the same phase, and both of them fails, the first one that is setup with is the one that generates the error. If supervision is done on two different signals in the same phase, and both of them fails, the first one that is setup with `CapSetupSupervision` is the one that generates the error.

Sensor related errors

The following recoverable errors are generated and can be handled in an error handler. The system variable `ERRNO` will be set to:

`CAP_TRACK_ERR`	Track error occurs when reading data from sensor and after a time no valid data are received. One reason for this could be that the sensor cannot indicate the seam.
`CAP_TRACKSTA_ERR`	Track start error occurs when no valid data has been read from the laser track sensor.
`CAP_TRACKCOR_ERR`	Track correction error occurs when something goes wrong in the calculation of the offset.

Continues on next page

`CAP_TRACKCOM_ERR`	The communication between the robot controller and the sensor equipment is broken.
`CAP_TRACKPFR_ERR`	It is not possible to continue tracking, if a power failure occurred during tracking.
`CAP_SEN_NO_MEAS`	The controller did not get a valid measurement from sensor.
`CAP_SEN_NOREADY`	The sensor is not ready yet.
`CAP_SEN_GENERRO`	A general sensor error occurred.
`CAP_SEN_BUSY`	The sensor is busy and cannot answer the request.
`CAP_SEN_UNKNOWN`	The command sent to the sensor is unknown to sensor.
`CAP_SEN_ILLEGAL`	The variable or block number sent to the sensor is illegal.
`CAP_SEN_EXALARM`	An external alarm occurred in the sensor.
`CAP_SEN_CAALARM`	A camera alarm occurred in the sensor.
`CAP_SEN_TEMP`	The sensor temperature is out of range.
`CAP_SEN_VALUE`	The value sent to the sensor is out of range.
`CAP_SEN_CAMCHECK`	The camera check failed.
`CAP_SEN_TIMEOUT`	The sensor did not respond within the time out time.

Errors possible in MultiMove systems

The following recoverable errors are generated and can be handled in an error handler. The system variable `ERRNO` will be set to:

`ERR_PATH_STOP`	When using synchronized motion this error is reported when an application controlling one mechanical unit detects a recoverable error and notifies other applications that something went wrong. If this error code is received from a `CapC` instruction, the error is a reaction on another error. All tasks using movement instructions in synchronized mode in a MultiMove system should have this `ERRNO` value defined in the error handler.

Errors inherited from `TriggX`

The instruction `CapC` is based on the instruction `TriggC`. As a consequence you can get and handle the errors `ERR_AO_LIM` and `ERR_DIPLAG_LIM`, as in `TriggC`.

The system variable `ERRNO` will be set to:

`ERR_AO_LIM`	If the programmed `ScaleValue/SetValue` argument for the specified analog output signal `AOp/AOutput` in some of the connected `TriggSpeed/TriggRampAO` instructions, results are 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`.
`ERR_DIPLAG_LIM`	If the programmed `DipLag` argument in some of the connected `TriggSpeed` instructions, is too big in relation to the used system parameter *Event Preset Time*, the system variable `ERRNO` is set to `ERR_DIPLAG_LIM`.

Continues on next page

Other CAP errors

The following recoverable errors are generated and can be handled in an error handler. The system variable `ERRNO` will be set to:

`CAP_ATPROC_START`	This recoverable error is generated at the end of the first `CapC/L` instruction of a sequence if the optional argument `\PreProcessTracking` is used. It can be handled in the error handler to start the process.
`CAP_NOPROC_END`	This error occurs when the instruction `CapNoProcess` is used to run a certain distance without application process and the end of this distance is reached. This is not really an error, but it uses the mechanisms of error recovery.
`CAP_MOV_WATCHDOG`	This error occurs when the switch `\Movestart_timer` is specified and the time between the process start (`MAIN_STARTED`) and the start of the robot movement exceeds the time specified with the switch.

CAP process

During continuous execution in both Auto mode and Manual mode, the CAP process is running, unless it is blocked. That means, that all data controlling the CAP process (that is, `Cdata`, `Weavestart`, `Weave` and `Movestart_timer`), are used. In these modes all CAP trigger activities are carried out, see *ICap - connect CAP events to trap routines on page 88*.

In all other execution modes the CAP process is not running, and the `CapC` instruction behaves like a `MoveC` instruction.

Trigger conditions [\T1] to [\T8] and [\TriggArray]

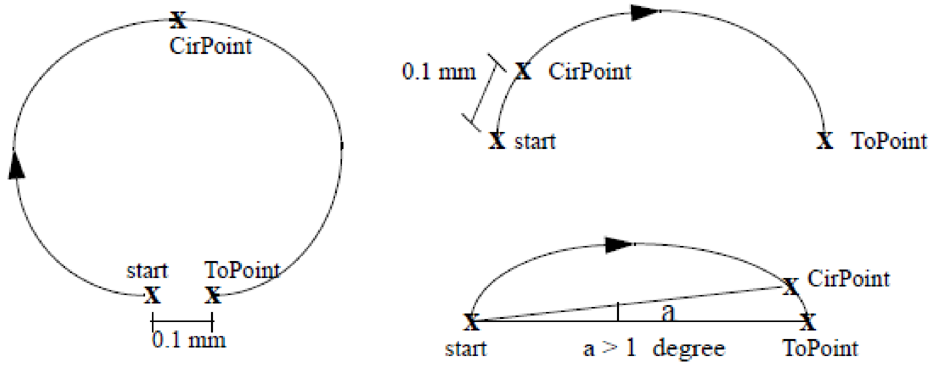
As the trigger conditions are fulfilled when the robot is positioned closer and closer to the end point, the defined trigger activities are carried out. The trigger conditions are fulfilled either at a certain distance before the end point of the instruction, or at a certain distance after the start 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.

Continues on next page

Limitations

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



xx1200000175

- 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, for example, 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 `CapC` (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.

If the current start point deviates from the usual, so that the total positioning length of the instruction `CapC` 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".

`CapC` cannot be executed in a RAPID routine connected to any of the following special system events: PowerOn, Stop, QStop, Restart, Reset or Step.

Syntax

```
CapC
  [CirPoint ':='] < expression (IN) of robtarget >
  [ToPoint ':='] < expression (IN) of robtarget >
  ['\' Id ':=' < expression (IN) of identno > ] ','
  [Speed ':='] < expression (IN) of speeddata >
```

Continues on next page

```
[Cdata ':='] < persistent (PERS) of capdata >
['\' Movestart_timer ':=' < expression (IN) of num > ] ','
[Weavestart ':='] <persistent (PERS) of weavestartdata >
[Weave ':='] < persistent (PERS) of capweavedata >
[Zone ':='] < expression (IN) of zonedata >
['\' Inpos ':=' < expression (IN) of stoppointdata >] ','
[Tool ':='] < persistent (PERS) of tooldata >
['\' WObj ':=' < persistent (PERS) of wobjdata > ]
|[ '\' Corr]
['\' Time ':=' < expression (IN) of num > ]
['\' T1 ':=' < variable (VAR) of triggdata > ]
['\' TriggArray ':=' < array 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 > ]
['\' T7 ':=' < variable (VAR) of triggdata > ]
['\' T8 ':=' < variable (VAR) of triggdata > ]
['\' TLoad ':=' < persistent (PERS) of loaddata > ] ';'
```

Related information

For information about	See
Definition of CAP data	*capdata - CAP data on page 99*
Definition of weave start data	*weavestartdata - weave start data on page 117*
Definition of weave data	*capweavedata - Weavedata for CAP on page 103*
Path Offset	*Application manual - Controller software OmniCore*
`MoveL`	*Technical reference manual - RAPID Instructions, Functions and Data types*

4.1.5 CapEquiDist - Generate equidistant event

Usage

`CapEquiDist` is used to tell CAP to generate an equidistant RAPID event (EQUIDIST) on the CAP path. The first event is generated at the startpoint of the first CAP instruction in a sequence of CAP instructions. From RAPID it is possible to subscribe this event using `ICap`.

Basic example

```
VAR intnum intno_equi;

PROC main()
  ......
  IDelete intno_equi;
  Connect intno_equi equi_trp;
  ICap intno_equi, EQUIDIST
  ......
  CapEquiDist\Distance:=5.0;
  MoveL p60, v1000, fine, tWeldGun;
  CapL p_fig3_l_1, v500, cd, wsd, cwd, z10, tWeldGun;
  CapL p_fig3_l_2, v500, cd, wsd, cwd, fine, tWeldGun;
  ......
  CapEquiDist\Reset;
  MoveL p70, v1000, fine, tWeldGun;
  CapL p_fig3_l_3, v500, cd, wsd, cwd, fine, tWeldGun;
  ......

  ERROR
    Retry;
ENDPROC

TRAP equi_trp
  ! do whatever you want, but it must not take too long time
ENDTRAP
```

In this example, the event `EQUIDIST` will be generated on the first CAP path. It will be sent every 5 mm on the path over several CAP instructions with zones.

Arguments

```
CapEquiDist [\Distance] [\Reset]
```

[\Distance]

Distance in mm

Data type: `num`

The data provided with this optional argument defines the distance in mm between two consecutive equidistant events.

[\Reset]

Reset event generation

Continues on next page

Data type: `switch`

If this switch is present, the event generation is reset, that is, the equidistant event will not be generated any longer on a `CapL`/`CapC` path. This switch has precedence before the `\Distance` switch.

Limitations

If the CAP path is long compared to the event distance, the system can run out of event resources, and the error message **50368 Too Short distance between equidistant events**.

Syntax

```
CapEquiDist
  ['\' Distance ':=' < expression (IN) of num >]
  ['\' Reset] ';'
```

4.1.6 CapInitSupervision - Reset all supervision for CAP

Usage

`CapInitSupervision` is used to initiate CAP supervision. This means that all supervision lists will be cleared and all I/O subscriptions will be removed.

Example

```
PROC main()
  CapInitSupervision;
  CapSetupSupervision diWR_EST, ACT,SUPERV_MAIN;
  CapSetupSupervision diGA_EST, ACT,SUPERV_MAIN;
  CapL p2, v100, cdata1, weavestart, weave,fine, tWeldGun;
ENDPROC
```

`CapInitSupervision` is used to clear all supervision lists before setting up new supervision.

Limitations

The `CapInitSupervision` instruction should be executed only once, for example, from the startup shelf.

Syntax

```
CapInitSupervision ';'
```

Related information

For information about	See
`CapSetupSupervision` instruction	*CapSetupSupervision - Setup conditions for signal supervision in CAP on page 82*
`CapRemoveSupervision` instruction	*CapRemoveSupervision - Remove condition for one signal on page 78*

4.1.7 CapL - Linear CAP movement instruction

Usage

`CapL` is used to move the tool center point (TCP) linearly to a given destination and at the same time control a continuous process. Furthermore it is possible to connect up to eight events to `CapL`. The events are defined using the instructions `TriggRampAO`, `TriggIO`, `TriggEquip`, `TriggInt`, `TriggCheckIO`, or `TriggSpeed`.

Basic examples

Example1

Linear movements with `CapL`.

```
CapL p1, v100, cdata, weavestart, weave, z50, gun1;
```

The TCP of the tool, gun1, is moved linearly to the position p1, with speed defined in `cdata`, and zone data z50.

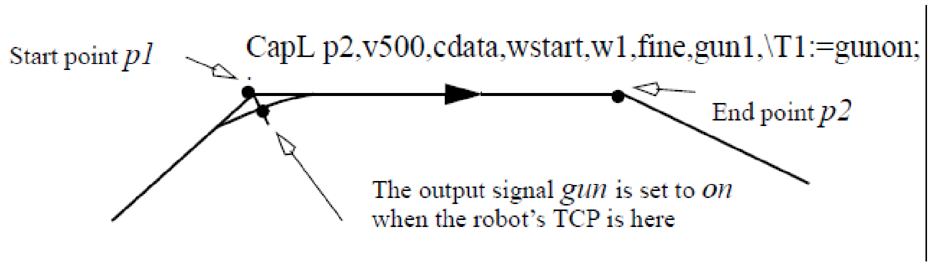
Example 2

Circular movement with user event and CAP event.

```
VAR intnum start_intno;
...
PROC main()
  VAR triggdata gunon;
  IDelete start_intno;
  CONNECT start_intno WITH start_trap;
  ICap start_intno, CAP_START;
  TriggIO gunon, 0 \Start \DOp:=gun, on;
  MoveJ p1, v500, z50, gun1;
  CapL p2, v500, cdata, wstart, w1, fine, gun1 \T1:=gunon;
ENDPROC

TRAP start_trap
  !This routine is executed when event CAP_START arrives
ENDTRAP
```

The digital output signal gun is set when the robot TCP passes the midpoint of the corner path of the point p1. The trap routine `start_trap` is executed when the CAP process is starting.



xx1200000173

Continues on next page

Arguments

```
CapL ToPoint [\Id] Speed Cdata [\MoveStartTimer] Weavestart Weave
     Zone [\Inpos] Tool [\WObj] [\Corr] [\Time] [\T1] [\TriggArray]
     [\T2] [\T3] [\T4] [\T5] [\T6] [\T7] [\T8] [\TLoad]
```

`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).

`[ \ID ]`

Synchronization id

Data type: `identno`

The argument `[ \ID ]` is mandatory in MultiMove systems, if the movement is synchronized or coordinated synchronized. This argument is not allowed in any other case. The specified id number must be the same in all the cooperating program tasks. By using the id number the movements are not mixed up at the runtime.

`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.

`Cdata`

(CAP process Data)

Data type: capdata

CAP process data, see *capdata - CAP data on page 99* for a detailed description.

`[ \Movestart_timer ]`

(Time in s)

Data type: num

Upper limit for the time difference between the order of the process start and the actual start of the robot's TCP movement in a MultiMove system in synchronized mode.

`Weavestart`

(Weavestart Data)

Data type: weavestartdata

Weave start data for the CAP process, see *weavestartdata - weave start data on page 117* for a detailed description.

`Weave`

(Weave Data)

Data type: capweavedata

Weaving data for the CAP process, see *capweavedata - Weavedata for CAP on page 103* for a detailed description.

Continues on next page

`Zone`

Data type:`zonedata`

Zone data for the movement. Zone data describes the size of the generated corner path.

`[ \Inpos ]`

In position

Data type:`stoppoint data`

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 center 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 then 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.

The RobotWare option *Path Corrections* is required when using this argument.

`[ \Time ]`

Data type: num

This argument is used to specify the total time in seconds during which the robot and additional axes move. It is then substituted for the corresponding speed data.

`[\T1]`

Trigg 1

Data type: `triggdata`

Variable that refers to trigger conditions and trigger activity defined earlier in the program using the instructions `TriggIO`, `TriggEquip`, `TriggInt`, `TriggCheckIO`, `TriggSpeed`, or `TriggRampAO`.

Continues on next page

`TriggArray`

Trigg Data Array Parameter

Data type: `triggdata`

Array variable that refers to trigger conditions and trigger activity defined earlier in the program using the instructions `TriggIO`, `TriggEquip`, `TriggInt`, `TriggSpeed`, `TriggCheckIO`, or `TriggRampAO`.

The limitation is 25 elements in the array and 1 to 25 defined trigger conditions must be defined.

It is not possible to use the optional arguments `T2`, `T3`, `T4`, `T5`, `T6`, `T7`, or `T8` at the same time as the `TriggArray` argument is used.

`[ \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`, `TriggInt`, `TriggCheckIO`, `TriggSpeed`, or `TriggRampAO`.

`[ \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`, `TriggInt`, `TriggCheckIO`, `TriggSpeed`, or `TriggRampAO`.

`[ \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`, `TriggInt`, `TriggCheckIO`, `TriggSpeed`, or `TriggRampAO`.

`[ \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`, `TriggInt`, `TriggCheckIO`, `TriggSpeed`, or `TriggRampAO`.

`[ \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`, `TriggInt`, `TriggCheckIO`, `TriggSpeed`, or `TriggRampAO`.

Continues on next page

`[ \T8 ]`

Trigg 8

Data type: `triggdata`

Variable that refers to trigger conditions and trigger activity defined earlier in the program using the instructions `TriggIO`, `TriggEquip`, `TriggInt`, `TriggCheckIO`, `TriggSpeed`, or `TriggRampAO`.

`[ \T8 ]`

Trigg 8

Data type: `triggdata`

Variable that refers to trigger conditions and trigger activity defined earlier in the program using the instructions `TriggIO`, `TriggEquip`, `TriggInt`, `TriggCheckIO`, `TriggSpeed`, or `TriggRampAO`.

`[ \TLoad ]`

Total load

Data type: `loaddata`

The `\TLoad` argument describes the total load used in the movement. The total load is the tool load together with the payload that the tool is carrying. If the `\TLoad` argument is used, then the `loaddata` in the current `tooldata` is not considered.

If the `\TLoad` argument is set to `load0`, then the `\TLoad` argument is not considered and the `loaddata` in the current `tooldata` is used instead.

To be able to use the `\TLoad` argument it is necessary to set the value of the system parameter `ModalPayLoadMode` to 0. If `ModalPayLoadMode` is set to 0, it is no longer possible to use the instruction `GripLoad`.

The total load can be identified with the service routine LoadIdentify. If the system parameter `ModalPayLoadMode` is set to 0, the operator has the possibility to copy the `loaddata` from the tool to an existing or new `loaddata` persistent variable when running the service routine.

It is possible to test run the program without any payload by using a digital input signal connected to the system input `SimMode` (Simulated Mode). If the digital input signal is set to 1, the `loaddata` in the optional argument `\TLoad` is not considered, and the `loaddata` in the current `tooldata` is used instead.

Note

The default functionality to handle payload is to use the instruction `GripLoad`. Therefore the default value of the system parameter `ModalPayLoadMode` is 1.

Program execution

See *Technical reference manual - RAPID Instructions, Functions and Data types* for information about the `MoveL` and `TriggL`.

Continues on next page

Error handling

There are several different types of errors that can be handled in the error handler for the CapC/CapL instructions:

- supervision errors
- sensor specific errors
- errors specific to a MultiMove system
- errors inherited from TriggX functionality
- other CAP errors

If one of the signals that is supposed to be supervised does not have the correct value, or if it changes value during supervision, the system variable ERRNO is set.

If no values can be read from the track sensor, the system variable ERRNO is set.

For a MultiMove system running in synchronized mode the error handler must take care of two other errors. One is used to report that some other application has detected an recoverable error. This enables recoverable error handling in synchronized RAPID tasks. The other error, CAP_MOV_WATCHDOG, is reported if the time between the order of the process start and the actual start of the robot's TCP movement in a MultiMove system in synchronized mode expires. The time used is specified in the optional parameter Movestart_timer in the CapL instruction.

If anything abnormal is detected, program execution will stop. If, however, an error handler is programmed, the errors defined below can be remedied without stopping production. However, a recommendation is that some of the errors (the errors with CAP_XX) these errors should not be presented for the end user. Map those errors to a application specific error. For the supervision errors the instruction CapGetFailSigs can be used to get which specific signal that failed.

Supervision errors

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

CAP_START_PRE_ERR	This error occurs when there is an error in the START_PRE supervision list, that is, when the conditions in the list are not met within the specified time frame (specified in pre_cond time-out).
CAP_PRE_ERR	This error occurs when there is an error during the supervision of the PRE phase.
CAP_END_PRE_ERR	This event occurs when there is an error in the END_PRE supervision list, that is, when the conditions in the list are not met within the specified time frame (specified in start_cond time-out).
CAP_START_MAIN_ERR	This event occurs when there is an error in the START_MAIN supervision list, that is, when the conditions in the list are not met within the specified time frame (specified in start_cond time-out).
CAP_MAIN_ERR	This error occurs when there is an error during the supervision of the MAIN phase.

Continues on next page

`CAP_END_MAIN_ERR`	This error occurs when there is an error in the `END_MAIN` supervision list, that is, when the conditions in the list are not met within the specified time frame (specified in `end_main_cond` time-out).
`CAP_START_POST1_ERR`	This event occurs when there is an error in the `START_POST1` supervision list, that is, when the conditions in the list are not met within the specified time frame (specified in `end_main_cond` time-out).
`CAP_POST1_ERR`	This error occurs when there is an error during the supervision of the `POST1` phase.
`CAP_END_POST1_ERR`	This error occurs when there is an error in the `END_POST1` supervision list, that is, when the conditions in the list are not met within the specified time frame (specified in `end_main_cond` time-out).
`CAP_START_POST2_ERR`	This event occurs when there is an error in the `START_POST1` supervision list, that is, when the conditions in the list are not met within the specified time frame (specified in `end_main_cond` time-out).
`CAP_POST2_ERR`	This error occurs when there is an error during the supervision of the `POST2` phase.
`CAP_END_POST2_ERR`	This error occurs when there is an error in the `END_POST2` supervision list, that is, when the conditions in the list are not met within the specified time frame (specified in `end_main_cond` time-out). If supervision is done on two different signals in the same phase, and both of them fails, the first one that is setup with `CapSetupSupervision` is the one that generates the error.

Sensor related errors

The following recoverable errors are generated and can be handled in an error handler. The system variable `ERRNO` will be set to:

`CAP_TRACK_ERR`	Track error occurs when reading data from sensor and after a time no valid data are received. One reason for this could be that the sensor cannot indicate the seam.
`CAP_TRACKSTA_ERR`	Track start error occurs when no valid data has been read from the laser track sensor.
`CAP_TRACKCOR_ERR`	Track correction error occurs when something goes wrong in the calculation of the offset.
`CAP_TRACKCOM_ERR`	The communication between the robot controller and the sensor equipment is broken.
`CAP_TRACKPFR_ERR`	It is not possible to continue tracking, if a power failure occurred during tracking.
`CAP_SEN_NO_MEAS`	The controller did not get a valid measurement from sensor.
`CAP_SEN_NOREADY`	The sensor is not ready yet.
`CAP_SEN_GENERRO`	A general sensor error occurred.
`CAP_SEN_BUSY`	The sensor is busy and cannot answer the request.
`CAP_SEN_UNKNOWN`	The command sent to the sensor is unknown to sensor.
`CAP_SEN_ILLEGAL`	The variable or block number sent to the sensor is illegal.
`CAP_SEN_EXALARM`	An external alarm occurred in the sensor.
`CAP_SEN_CAALARM`	A camera alarm occurred in the sensor.

Continues on next page

CAP_SEN_TEMP	The sensor temperature is out of range.
CAP_SEN_VALUE	The value sent to the sensor is out of range.
CAP_SEN_CAMCHECK	The camera check failed.
CAP_SEN_TIMEOUT	The sensor did not respond within the time out time.

Errors possible in MultiMove systems

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

ERR_PATH_STOP	When using synchronized motion this error is reported when an application controlling one mechanical unit detects a recoverable error and notifies other applications that something went wrong. If this error code is received from a CapL instruction, the error is a reaction on another error. All tasks using movement instructions in synchronized mode in a MultiMove system should have this ERRNO value defined in the error handler.

Errors inherited from TriggX

The instruction CapL is based on the instruction TriggL. As a consequence you can get and handle the errors ERR_AO_LIM and ERR_DIPLAG_LIM, as in TriggL.

The system variable ERRNO will be set to:

ERR_AO_LIM	If the programmed ScaleValue/SetValue argument for the specified analog output signal AOp/AOutput in some of the connected TriggSpeed/TriggRampAO instructions, results are 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.
ERR_DIPLAG_LIM	If the programmed DipLag argument in some of the connected TriggSpeed instructions, is too big in relation to the used system parameter *Event Preset Time*, the system variable ERRNO is set to ERR_DIPLAG_LIM.

Other CAP errors

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

CAP_ATPROC_START	This recoverable error is generated at the end of the first CapC/L instruction of a sequence if the optional argument \PreProcessTracking is used. It can be handled in the error handler to start the process.
CAP_NOPROC_END	This error occurs when the instruction CapNoProcess is used to run a certain distance without application process and the end of this distance is reached. This is not really an error, but it uses the mechanisms of error recovery.
CAP_MOV_WATCHDOG	This error occurs when the switch \Movestart_timer is specified and the time between the process start (MAIN_STARTED) and the start of the robot movement exceeds the time specified with the switch.

Continues on next page

CAP process

During continuous execution in both Auto mode and Manual mode, the CAP process is running, unless it is blocked. That means, that all data controlling the CAP process (that is, `Cdata`, `Weavestart`, `Weave` and `Movestart_timer`), are used. In these modes all CAP trigger activities are carried out, see *ICap - connect CAP events to trap routines on page 88*.

In all other execution modes the CAP process is not running, and the `CapL` instruction behaves like a `MoveL` instruction.

Trigger conditions [\T1] to [\T8] and [\TriggArray]

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.

Limitations

If the current start point deviates from the usual, so that the total positioning length of the instruction `CapL` is shorter than usual (for example, at the start of `CapL` 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".

The behavior of the CAP process may be undefined if an error occurs during `CapL` or `CapC` instructions with extremely short TCP movements (< 1 mm).

`CapL` cannot be executed in a RAPID routine connected to any of the following special system events: PowerOn, Stop, QStop, Restart, Reset or Step.

Syntax

```
CapL
  [ToPoint ':='] < expression (IN) of robtarget >
  ['\' Id ':=' < expression (IN) of identno >] ','
  [Speed ':='] < expression (IN) of speeddata > ','
  [Cdata ':='] < persistent (PERS) of capdata >
  ['\' Movestart_timer ':=' < expression (IN) of num >] ','
  [Weavestart ':='] <persistent (PERS) of weavestartdata > ','
  [Weave ':='] < persistent (PERS) of capweavedata > ','
  [Zone ':='] < expression (IN) of zonedata >
  ['\' Inpos ':=' < expression (IN) of stoppointdata >] ','
  [Tool ':='] < persistent (PERS) of tooldata >
  ['\' WObj ':=' < persistent (PERS) of wobjdata >]
  |[ '\' Corr]
  ['\' Time ':=' < expression (IN) of num > ]
```

Continues on next page

```
['\' T1 ':=' < variable (VAR) of triggdata > ]
['\' TriggArray ':=' < array 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 >]
['\' T7 ':=' < variable (VAR) of triggdata >]
['\' T8 ':=' < variable (VAR) of triggdata >]
['\' TLoad':=' < persistent (PERS) of loaddata >] ';'
```

Related information

For information about	See
Definition of CAP data	*capdata - CAP data on page 99*
Definition of weave start data	*weavestartdata - weave start data on page 117*
Definition of weave data	*capweavedata - Weavedata for CAP on page 103*
Path Offset	*Application manual - Controller software OmniCore*
`MoveL` `TriggL`	*Technical reference manual - RAPID Instructions, Functions and Data types*

4.1.8 CapNoProcess - Run CAP without process

Usage

`CapNoProcess` is used to run CAP a certain distance without process.

With `CapNoProcess`, it is possible to tell CAP to execute a certain distance (in mm) without process. This is useful, if there was a recoverable process error, which in some way makes it impossible to restart the process at the error location.

In the beginning and at the end of the skip distance, backing on the path (`restart_dist` component in `capdata`) is suppressed.

At the end of the skip distance a error with errno `CAP_NOPROC_END` is generated.

Basic example

```
VAR num skip_dist := 0.0;
VAR bool cap_skip := FALSE;

PROC main()
  ......
  skip_dist := 25.0;
  CapL p_fig3_l_1, v500, cd, wsd, cwd, fine, tWeldGun;
  ......
  skip_dist := 15.0;
  CapL p_fig3_l_3, v500, cd, wsd, cwd, fine, tWeldGun;
  ......

  ERROR
    StorePath;
    TEST ERRNO
    CASE CAP_NOPROC_END:
      IF cap_skip THEN
        ! This is the end of the skip distance
        cap_skip := FALSE;
      ENDIF
    CASE CAP_MAIN_ERR:
      IF skip_dist > 0.0 THEN
        ! This is the start of the skip distance
        CapNoProcess skip_dist;
        cap_skip := TRUE;
      ENDIF
    DEFAULT:
    ENDTEST
    RestoPath;
    StartMoveRetry;
ENDPROC
ENDMODULE
```

In this example, the recoverable error `CAP_MAIN_ERR` is followed by 25 mm movement (at 10 mm/s) without process for the first `CapL` instruction and by 15

Continues on next page

mm for the second. At the end of that distance, `CAP_NOPROC_END` is generated and the process is restarted.

Arguments

```
CapNoProcess skip_distance
```

skip_distance

Distance in mm

Data type: `num`

`CapNoProcess` has a `num` variable as input parameter, that defines the skip distance in mm.

Limitations

The speed of the TCP during skip is predefined with 10 mm/s. The shortest skip distance is predefined with 10 mm.

In synchronized MultiMove systems, the shortest distance of all skip distances defined for the different synchronized process robots will be the actual one.

If the skip distance is longer than the distance from the current TCP position to the end of the current sequence of CAP instructions, nothing special will happen: RAPID execution continues as usual, without stopping the robot.

Syntax

```
CapNoProcess
  [skip_dist ':='] < variable (IN) of num >';'
```

Related information

For information about	See
`CapInitSupervision` instruction	*CapInitSupervision - Reset all supervision for CAP on page 63*
`CapSetupSupervision` instruction	*CapSetupSupervision - Setup conditions for signal supervision in CAP on page 82*
`CapRemoveSupervision` instruction	*CapRemoveSupervision - Remove condition for one signal on page 78*

4.1.9 CapRefresh - Refresh CAP data

Usage

`CapRefresh` is used to tell the CAP process to refresh its process data. It can for example, be used to tune CAP process parameters during program execution.

Basic example

```
PROC PulseSpeed()
  ! Setup a 1 Hz timer interrupt
  CONNECT intno1 WITH TuneTrp;
  ITimer 1, intno1;
  CapL p1, v100, cdata, wstartdata, wdata, fine, gun1;
  IDelete intno1;
ENDPROC

TRAP TuneTrp
  ! Modify the main speed component of active cdata
  IF HighValueFlag = TRUE THEN
    cdata.speed_data.start := 10;
    HighValueFlag := FALSE;
  ELSE
    cdata.speed_data.start := 15;
    HighValueFlag := TRUE;
  ENDIF
  ! Order the process control to refresh process parameters
  CapRefresh;
ENDTRAP
```

In this example the speed will be switched between 10 and 15 mm/s at a rate of 1 Hz.

Arguments

```
CapRefresh [\MainSpeed] [\MainWeave] [\StartWeave] [\RestartDist]
```

Without optional argument the CAP data `capdata`, `capweavedata`, `weavestartdata`, `captrackdata`, and `movestarttimer` are - if present - re-read from the PERSISTENT RAPID variable specified in the currently active CAP instruction.

[\MainSpeed]

Data type: `switch`

If this switch is present, CAP will reread the component `capdata.speed_data.main` of the currently active CAP instruction.

[\MainWeave]

Data type: `switch`

If this switch is present, CAP will reread the components `capweavedata.width`, `capweavedata. length`, `capweavedata.bias`, and `capweavedata.active` of the currently active CAP instruction.

Continues on next page

[\StartWeave]

Data type: `bool`

If this switch is present, CAP will use its value instead of `weavestartdata.active` of the currently active CAP instruction. The data of the currently active CAP instruction remain untouched.

[\RestartDist]

Data type: `num`

If this switch is present, CAP will use its value instead of `capdata.restart_dist` of the currently active CAP instruction. The data of the currently active CAP instruction remain untouched.

Syntax

```
CapRefresh
  ['\' MainSpeed]
  ['\' MainWeave]
  ['\' Startweave ':=' < expression (IN) of bool >]
  ['\' RestartDist ':=' < expression (IN) of num >] ';'
```

4.1.10 CapRemoveSupervision - Remove condition for one signal

Usage

`CapRemoveSupervision` is used to remove conditions added by `CapSetupSuperv` from supervision.

Basic example

```
PROC main()
  CapInitSupervision;
  CapSetupSupervision diWR_EST, ACT, SUPERV_MAIN \ErrIndSig:=
       do_WR_Sup;
  CapSetupSupervision diGA_EST, ACT, SUPERV_MAIN;
  CapL p2, v100, cdata1, weavestart, weave,fine, tWeldGun;
  CapRemoveSupervision di_Arc_Sup, ACT, SUPERV_START_MAIN;
ENDPROC
```

Removes the signal *di_Arc_Sup* from the START list.

Arguments

```
CapRemoveSupervision Signal Condition Listtype [\Deactivate]
```

Signal

Data type: `signaldi`

Digital signal to remove from supervision list.

Condition

Data type: `num`

The name representing one of the following available conditions:

ACT:	Used for status supervision. Expected signal status during supervision: active. If the signal becomes passive, supervision triggers.
PAS:	Used for status supervision. Expected signal status during supervision: passive. If the signal becomes active, supervision triggers.
POS_EDGE:	Used for handshake supervision. Expected signal status at the end of supervision: active. If the signal does not become active within the chosen timeout, supervision triggers.
NEG_EDGE:	Used for handshake supervision. Expected signal status at the end of supervision: passive. If the signal does not become passive within the chosen timeout, supervision triggers.

Listtype

Data type: `num`

The name representing the number of the different lists (for example, phases in the process):

- SUPERV_START_PRE
- SUPERV_PRE
- SUPERV_END_PRE
- SUPERV_START_MAIN
- SUPERV_MAIN
- SUPERV_END_MAIN

Continues on next page

- SUPERV_START_POST1
- SUPERV_POST1
- SUPERV_END_POST1
- SUPERV_START_POST2
- SUPERV_POST2
- SUPERV_END_POST2

[\Deactivate]

Data type: `switch`

If this switch is present, CAP will not only remove the specified supervision, it will also deactivate it immediately, if active.

Syntax

```
CapRemoveSupervision
  [Signal ':='] < variable (VAR) of signaldi > ','
  [Condition ':='] < variable (IN) of num > ','
  [Listtype ':='] < variable (IN) of num >
  ['\' Deactivate] ';'
```

Related information

For information about	See
`CapInitSupervision` instruction	*CapInitSupervision - Reset all supervision for CAP on page 63*
`CapSetupSupervision` instruction	*CapSetupSupervision - Setup conditions for signal supervision in CAP on page 82*

4.1.11 CapSetDOAtStop - Set a digital output signal at TCP stop

Usage

`CapSetDOAtStop` is used to define a digital output signal and its value, which will be set when the TCP of the robot that runs CAP, stops moving during a CAP instruction (`CapL` or `CapC`) before the CAP sequence is finished.

An existing definition of such signals, is cleared with the CAP instruction `CapInitSupervision`.

Basic example

```
CapSetDOAtStop do15, 1;
```

The signal do15 is set to 1 when the TCP stops.

```
CapSetDOAtStop weld, off;
```

The signal weld is set to `off` when the TCP stops.

Arguments

```
CapSetDOAtStop Signal Value
```

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.

Specified Value	Set digital output to
0	0
Any value except 0	1

Limitations

The final value of the signal 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.

A maximum of 10 signals per RAPID task may be set up.

Syntax

```
CapSetDOAtStop
  [Signal ':='] < variable (VAR) of signaldo > ','
  [Value ':='] < expression (IN) of dionum > ';'
```

Related information

For information about	See
`CapInitSupervision` instruction	*CapInitSupervision - Reset all supervision for CAP on page 63*
`CapSetupSupervision` instruction	*CapSetupSupervision - Setup conditions for signal supervision in CAP on page 82*

Continues on next page

For information about	See
`CapRemoveSupervision` instruction	*CapRemoveSupervision - Remove condition for one signal on page 78*

4.1.12 CapSetupSupervision - Setup conditions for signal supervision in CAP

Usage

`CapSetupSupervision` is used to set up conditions for I/O signals to be supervised. The conditions are collected in different lists:

- START_PRE
- PRE
- END_PRE
- START_MAIN
- MAIN
- END_MAIN
- START_POST1
- POST1
- END_POST1
- START_POST2
- POST2
- END_POST2

For more information about supervision lists see *Application manual - Continuous Application Platform*.

As an optional parameter an out signal can be specified. This out signal is set to high, if the given condition fails.

Basic example

```
PROC main()
  CapInitSupervision;
  CapSetupSupervision diWR_EST, ACT, SUPERV_MAIN \ErrIndSig:=
       do_WR_Sup;
  CapSetupSupervision diGA_EST, ACT, SUPERV_MAIN;
  CapL p2, v100, cdata1, weavestart, weave, fine, tWeldGun;
ENDPROC
```

`CapSetupSupervision` is used to set up supervision on signals. If signal *diWR_EST* fails during SUPERV_MAIN phase, the digital output signal *do_WR_Sup* is set high.

The `CapSetupSupervision` instruction should be executed only if supervision data is changed. If the supervision data is never changed, it is a good idea to put it into a module, that is executed from the startup shelf.

Arguments

```
CapSetupSupervision Signal Condition Listtype [\ErrIndSig]
```

Signal

Data type: `signaldi`

Digital signal to be supervised.

Continues on next page

Condition

Data type: `num`

The name representing one of the following available conditions:

ACT:	Used for status supervision. Expected signal status during supervision: active. If the signal becomes passive, supervision triggers.
PAS:	Used for status supervision. Expected signal status during supervision: passive. If the signal becomes active, supervision triggers.
POS_EDGE:	Used for handshake supervision. Expected signal status at the end of supervision: active. If the signal does not become active within the chosen timeout, supervision triggers.
NEG_EDGE:	Used for handshake supervision. Expected signal status at the end of supervision: passive. If the signal does not become passive within the chosen timeout, supervision triggers.

Listtype

Data type: `num`

The name representing the number of the different lists (for example, phases in the process):

- SUPERV_START_PRE
- SUPERV_PRE
- SUPERV_END_PRE
- SUPERV_START_MAIN
- SUPERV_MAIN
- SUPERV_END_MAIN
- SUPERV_START_POST1
- SUPERV_POST1
- SUPERV_END_POST1
- SUPERV_START_POST2
- SUPERV_POST2
- SUPERV_END_POST2

[\ErrIndSig]

Data type: `signaldo`

Used to indicate which condition that failed if a failure has occurred. When the failure occurs the value on this signal is set to 1. This is an optional parameter.

Program execution

The given signal and its condition is added to the selected list. If a signal fails, the `CapL`/`CapC` instruction will report that a supervision error occurred during the specified phase and which signal(s) failed.

Errors

CAP_SPV_LIM

The maximum number of supervisions set up is exceeded.

Continues on next page

CAP_SPV_UNK_LST

The supervision list is unknown.

Limitations

Only digital input signals can be supervised.

Status supervision applies for a complete sequence of CAP instructions, see *Supervision and process phases on page 18*.

Syntax

```
CapSetupSupervision
  [Signal ':='] < variable (VAR) of signaldi > ','
  [Condition ':='] < variable (IN) of num > ','
  [Listtype ':='] < variable (IN) of num >
  [\ErrIndSig ':=' < variable (VAR) of signaldo >] ';'
```

Related information

For information about	See
`CapInitSupervision` instruction	*CapInitSupervision - Reset all supervision for CAP on page 63*
`CapRemoveSupervision` instruction	*CapRemoveSupervision - Remove condition for one signal on page 78*

4.1.13 CapWeaveSync - set up signals and levels for weave synchronization

Usage

`CapWeaveSync` is used to setup weaving synchronization signals without sensors. The I/O signals must be defined in EIO.cfg.

Basic example

RAPID program:

```
PROC main()
  ...
  CapWeaveSync \DoLeft:=do_sync_left \LevelLeft:=80
       \DoRight:=do_sync_right \LevelRight:=80;
  ...
ENDPROC
```

In this example the signals `do_sync_left and do_sync_right` are set up with weaving level 80%.

The `CapWeaveSync` instruction should be executed only once, for example, from the startup shelf.

Arguments

```
CapWeaveSync [\Reset] [\DoLeft] [\LevelLeft] [\DoRight]
     [\LevelRight]
```

[\Reset]

Data type: `switch`

Clear weave synchronization data.

[\DoLeft]

Data type: `signaldo`

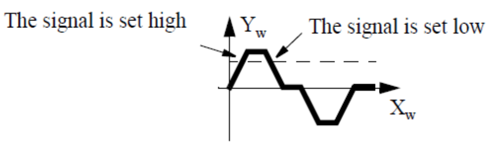
Digital output signal for weave synchronization on the left weave cycle.

[\LevelLeft]

Data type: `num`

The coordination position on the left side of the weaving pattern. The value specified is a percentage of the width on the left of the weaving centre. When weaving is carried out beyond this point, a digital output signal is automatically set high (if the signal is defined).

This type of coordination can be used for seam tracking using Through-the-Arc Tracker.



xx1200000176

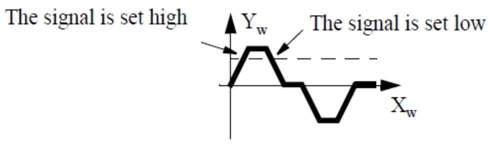
[\LevelLeft]

Data type: `num`

Continues on next page

The coordination position on the left side of the weaving pattern. The value specified is a percentage of the width on the left of the weaving centre. When weaving is carried out beyond this point, a digital output signal is automatically set high (if the signal is defined).

This type of coordination can be used for seam tracking using Through-the-Arc Tracker.



xx1200000176

[\DoRight]

Data type: `signaldo`

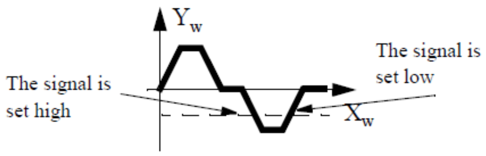
Digital output signal for weave synchronization on the right weave cycle.

[\LevelRight]

Data type: `num`

The coordination position on the right side of the weaving pattern. The value specified is a percentage of the width on the right of the weaving centre. When weaving is carried out beyond this point, a digital output signal is automatically set high (provided the signal is defined).

This type of coordination can be used for seam tracking using Through-the-Arc Tracker.



xx1200000177

Program execution

The defined signals are checked and set when running without a sensor.

Limitations

The signals must be defined in EIO.cfg.

It is not possible to use only either level or corresponding signal. It will not result in errors when loading the RAPID file, but it will result in RAPID run-time errors for the instruction `CapWeaveSynch`.

Syntax

```
CapWeaveSync
  ['\' Reset]
  [DoLeft ':=' < expression (IN) of signaldo >]
  [LevelLeft ':=' < expression (IN) of num >]
  [DoRight ':=' < expression (IN) of signaldo >]
  [LevelRight ':=' < expression (IN) of num >] ';'
```

Continues on next page

Related information

For information about	See
`capweavedata` **data type**	*capweavedata - Weavedata for CAP on page 103*

4.1.14 ICap - connect CAP events to trap routines

Usage

`ICap` is used to connect an interrupt number (which is already connected to a trap routine) with a specific CAP Event, see Arguments below for a listing of available Events. When using `ICap`, an association between a specific process event and a user defined Trap routine is created. In other words, the Trap routine in question is executed when the associated CAP event occurs.

We recommend placing the traps in a background task.

Basic example

Below is an example where the CAP Event CAP_START is associated with the trap routine `start_trap`.

```
VAR intnum start_intno:=0;
...

TRAP start_trap
  ! This routine will be executed when the event CAP_START is
       reported from the core
  ! Do what you want to do
ENDTRAP

PROC main()
  IDelete start_intno;
  CONNECT start_intno WITH start_trap;
  ICap start_intno, CAP_START;
  CapL p1, v100, cdata, weavestart, weave, z50, gun1;
ENDPROC
```

Arguments

```
ICap Interrupt Event
```

Interrupt

Data type: `intnum`

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

Event

Data type: `num`

The CAP event number to be associated with the interrupt. These events are predefined constants.

Continues on next page

Available CAP events

To see the events listed according to phases, see section *Coupling between phases and events on page 24*.

Events	Phase	Event number	Description
AT_ERRORPOINT	MAIN	28	This event occurs after restart, when the TCP reaches the position of the supervision error.
AT_POINT	MAIN	13	This event occurs at every robtarget on the process path except the start and finish point.
AT_RESTARTPOINT	MAIN	14	This event occurs when the robot has jogged back, the restart distance, on the process path after a stop.
CAP_PF_RESTART	MAIN	26	This event occurs when restart is ordered.
CAP_START		0	This event occurs as soon as the CAP process is started.
CAP_STOP		25	This event is a required event. If any other event is used, this event must be defined too. The event/trap is executed as soon as possible after the controller is stopped due to an error or a program stop. An error can be a recoverable error detected in CAP, a fatal error detected in CAP or an internal error stopping the controller. The code executed in this trap should take all external equipment to a safe state, for example, reset all external I/O-signals. Keep in mind that TRAP execution is stopped when RAPID execution of a NORMAL task is stopped. Therefore the TRAP connected to `CAP_STOP` has to be placed in a STATIC or SEMISTATIC task.
END_MAIN	END_MAIN	17	This event occurs at the point on the process path where supervision of the end sequence is started, that is, when the robot reaches the end point of the process.
END_POST1	END_POST1	21	This event occurs when it is time to end the POST1 phase, that is, when it is time to change from the POST1 to the POST2-phase. If using a *flying end* no event is distributed.
END_POST2	END_POST2	23	This event occurs when the POST2 phase is at an end, that is, when it is time to finally finish the process. If using a *flying end* no event is distributed.
END_PRE	PRE	32	This event occurs when the supervision of the PRE-phase, if present, is activated. If using a *flying start* no event is distributed, because there is a TCP movement already. At a restart this event is distributed.
EQUIDIST	MAIN	27	This event is sent, if it is ordered with the instruction `CapEquiDist`.

Continues on next page

Events	Phase	Event number	Description
FLY_END	MAIN	30	This event occurs when using *flying end*. This event is only available with *flying end*.
FLY_START	MAIN	29	This event occurs when using *flying start*. This event is only available with *flying start*.
LAST_INSTR_ENDED	MAIN	31	This event occurs when RAPID execution of the last CAP instruction is finished during *flying end*. This event is only available with *flying end*.
LAST_SEGMENT	MAIN	15	This event occurs at the starting point of the last segment.
MAIN_ENDED	END_MAIN	18	This event occurs when all conditions of the END_MAIN supervision list are fulfilled, that is, when the main process is considered ended.
MAIN_MOTION	MAIN	9	This event occurs when main motion is activated with the process running.
MAIN_STARTED	START	4	This event occurs when all conditions of the START Supervision list are fulfilled, that is, when the MAIN-phase is started.
MOTION_DELAY	MAIN	7	This event occurs after the delay, if any, of motion start. If using a *flying start* no event is distributed, because there is a TCP movement already. At a restart this event is distributed.
MOVE_STARTED	MAIN	10	This event occurs as soon as the robot starts moving along the process path. If using a *flying start* no event is distributed, because there is a TCP movement already. At a restart this event is distributed.
NEW_INSTR	MAIN	12	This event occurs when a new `CapL` or `CapC` instruction is fetched from the RAPID program.
PATH_END_POINT		19	This event occurs when the robot reaches the end point of the path, that is, the fine point or the middle of the zone (for *flying end*) in the last CAP instruction.
POST1_ENDED	END_POST1	22	This event occurs when all the conditions of the END_POST1 supervision list are fulfilled, that is, when the POST1 phase is successfully ended and the POST2 phase is started. If using a *flying end* no event is distributed.
POST1_STARTED	POST1	35	This event occurs when the supervision of the POST1-phase, if present, is activated. If using a *flying start* no event is distributed, because there is a TCP movement already. At a restart this event is distributed.

Continues on next page

Events	Phase	Event number	Description
POST2_ENDED	END_POST2	24	This event occurs when all the conditions of the END_POST2 supervision list are fulfilled, that is, when the POST2 phase, and thus the whole process, is successfully ended. If using a *flying end* no event is distributed.
POST2_STARTED	POST2	37	This event occurs when the supervision of the POST1-phase, if present, is activated. If using a *flying start* no event is distributed, because there is a TCP movement already. At a restart this event is distributed.
PRE_ENDED	PRE	33	This event occurs when the supervision of the PRE-phase, if present, is activated. If using a *flying start* no event is distributed, because there is a TCP movement already. At a restart this event is distributed.
PRE_STARTED	PRE	2	This event occurs when all the requirements of the PRE Supervision list are fulfilled, that is, when the PRE_START-phase is started. If using a *flying start* no event is distributed, because there is a TCP movement already. At a restart this event is distributed.
PROCESS_END_POINT	MAIN	16	This event occurs when the robot reaches the end point of the process, that is, where the process is supposed to be ended. If using a *flying end* no event is distributed.
PROCESS_ENDED		20	This event occurs only when both the process is ended at the fine point or the middle of the zone (for *flying end*) in the last CAP instruction.
RESTART	MAIN	11	This event occurs when restart is ordered.
START_MAIN	START	3	This event occurs when the PRE_START-phase is ended and the MAIN-phase is started.
START_POST1	POST1	34	This event occurs when the supervision of the POST1-phase, if present, is activated. If using a *flying start* no event is distributed, because there is a TCP movement already. At a restart this event is distributed.
START_POST2	POST2	36	This event occurs when the supervision of the POST1-phase, if present, is activated. If using a *flying start* no event is distributed, because there is a TCP movement already. At a restart this event is distributed.
START_PRE	PRE	1	This event occurs when the supervision of the PRE-phase, if present, is activated. If using a *flying start* no event is distributed, because there is a TCP movement already. At a restart this event is distributed.

Continues on next page

Events	Phase	Event number	Description
STARTSPEED_TIME	MAIN	8	This event occurs when the time to use *Start Speed* runs out and it is time to switch to main motion data.
STOP_WEAVESTART	MAIN	5	This event occurs, before each weave start - but only if weave start is ordered. If using a *flying start* no event is distributed, because there is a TCP movement already. At a restart this event is distributed.
WEAVESTART_REGAIN	MAIN	6	This event occurs when the robot has regained back to the path after a weave start. If using a *flying start* no event is distributed, because there is a TCP movement already. At a restart this event is distributed.

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 setup_events ()
  VAR intnum start_intno;
  IDelete start_intno;
  CONNECT start_intno WITH start_trap;
  ICap start_intno, CAP_START;
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. The `ICap` instruction should be executed only once, for example, from the startup system event routine. A recommendation is that the traps should be placed in a background task.

Syntax

```
ICap
  [Interrupt ':='] < variable (IN) of intnum > ','
  [Event ':='] < variable (IN) of num > ';'
```

Related information

For information about	See

`CONNECT`
`IDelete`
`intnum`
	Technical reference manual - RAPID Instructions, Functions and Data types

4.1.15 ICapPathPos - Get center line robtarget when weaving

Usage

`ICapPathPos` is used to retrieve the position of the center line during weaving with CAP.

This function is mainly used together with the tracking functionality. It is necessary to activate weaving and the synchronization signals on both the left side and the right side.

Basic example

```
connect intpt, TRP_ipathpos ICapPathPos p_robt, sen_pos, intpt;
```

When `p_robt` gets a new calculated value, the interrupt `intpt` will be sent, and the trap routine `TRP_ipathpos` will be executed.

Arguments

```
ICapPathPos p_robt, sen_pos, intpt [\NoDispl] [\EOffs]
```

p_robt

Data type: `robtarget`

`p_robt` keeps the latest value of the calculated `robtarget`.

sen_pos

Data type: `pos`

`sen_pos` is not used.

intpt

Data type: `intno`

`intpt` specifies the interrupt that will be received each time a new value is assigned to `p_robt`.

[\NoDispl]

Data type: `switch`

If `\NoDispl` is specified, the value returned in the `PERS p_robt` will not include any displacement that might be specified using the RAPID instructions `PDispSet` and `PDispOn`.

[\EOffs]

Data type: `switch`

If `[\EOffs]` is specified, the value returned in the `PERS p_robt` will include any offset specified using the RAPID instruction `EOffsSet`.

Limitations

It is necessary to activate weaving and weave synchronization (with or without tracking).

Syntax

```
ICapPathPos
  [p_robt ':='] < persistent (PERS) of robtarget > ','
```

Continues on next page

```
[sen_pos ':='] < persistent (PERS) of pos > ','
[Interrupt ':='] < variable (IN) of intnum >
['\' EOffs ]
['\' NoDispl ] ';'
```

Related information

For information about	See
`CapWeaveSync` instruction	*CapWeaveSync - set up signals and levels for weave synchronization on page 85*

4.2 Functions

4.2.1 CapGetFailSigs - Get failed I/O signals

Usage

`CapGetFailSigs` is used to return the names on the signal or signals that failed during supervision of `CapL` or `CapC`.

If supervision of one or several signals fails during the process a recoverable error will be returned from the `CapL`/`CapC` instruction. To determine which signal or signals that failed, `CapGetFailSigs` can be used in an error handler for all cases of supervision errors.

Basic example

```
Stringcopied := CapGetFailSigs(Failstring);
```

`Stringcopied` is assigned the value TRUE if the copy succeeds, and FALSE if it fails.

`Failstring` contains the signals that failed as text. If no string could be copied the string `EMPTY` is returned.

Return value

Data type: `bool`

TRUE or FALSE depending on if the fail string is modified.

Arguments

```
CapGetFailSigs (ErrorNames)
```

ErrorNames

Data type: `string`

`CapGetFailSigs` requires a string variable as input parameter.

Limitations

If many signals in a supervision list failed at the same time, only three of them are reported with `CapGetFailSigs`.

Syntax

```
CapGetFailSigs '('
[ErrorNames ':='] < variable (INOUT) of string >')'
```

A function with a return value of the data type `bool`.

Related information

For information about	See
`CapInitSupervision` instruction	*CapInitSupervision - Reset all supervision for CAP on page 63*
`CapSetupSupervision` instruction	*CapSetupSupervision - Setup conditions for signal supervision in CAP on page 82*

Continues on next page

For information about	See
`CapRemoveSupervision` instruction	*CapRemoveSupervision - Remove condition for one signal on page 78*

4.3 Data types

4.3.1 capaptrreferencedata - Variable setup data for At-Point-Tracker

Usage

`capaptrreferencedata` is used to setup the needed information for the At-Point-Tracker correction process setup by the `CapAPTrSetupAO`, `CapAPTrSetupAI`, and `CapAPTrSetupPERS` instructions.

Components

`reference_y`

Data type: `num`

Defines the reference for the Y position.

`reference_z`

Data type: `num`

Defines the reference for the Z position.

`threshold_y`

Data type: `num`

The difference between the input signal and the `reference_y` value must be greater than the `threshold_y` value for the regulator to react on the change.

`threshold_z`

Data type: `num`

The difference between the input signal and the `reference_z` value must be greater than the `threshold_z` value for the regulator to react on the change.

`gain_y`

Data type: `num`

The difference between the `reference_y` value and the input signal value is scaled with the `gain_y` value.

`gain_z`

Data type: `num`

The difference between the `reference_z` value and the input signal value is scaled with the `gain_z` value.

Structure

```
< data object of capaptrreferencedata >
  < reference_y of num >
  < reference_z of num >
  < threshold_y of num >
  < threshold_z of num >
  < gain_y of num >
  < gain_z of num >
```

Continues on next page

Related information

For information about	See
Instruction `CapAPTrSetupAI`	*CapAPTrSetupAI - Setup an At-Point-Tracker controlled by analog input signals on page 41*
Instruction `CapAPTrSetupAO`	*CapAPTrSetupAO - Setup an At-Point-Tracker controlled by analog output signals on page 44*
Instruction `CapAPTrSetupPERS`	*CapAPTrSetupPERS - Setup an At-Point-Tracker controlled by persistent variables on page 47*
Sensor Interface	*Application manual - Controller software OmniCore*

4.3.2 capdata - CAP data

Usage

`capdata` contains all data necessary for defining the behavior of the CAP process.

Components

start_fly

Flying start

Data type: `bool`

Defines whether or not flying start is used:

Value	Consequence
TRUE	flying start is used
FALSE	flying start is NOT used

Flying start means that the robot movement is started before the process is started. The process is then started on the run (see *flypointdata - Data for flying start/end on page 109*).

first_instr

First instruction

Data type: `bool`

Defines whether or not a `CapL`/`CapC` instruction is the first instruction in a sequence of `CapL`/`CapC` instructions:

Value	Consequence
TRUE	this is the first instruction in a sequence of `CapL`/`CapC` instructions
FALSE	this is not the first instruction in a sequence of `CapL`/`CapC` instructions

last_instr

Last instruction

Data type: `bool`

Defines whether or not a `CapL`/`CapC` instruction is the last instruction in a sequence of `CapL`/`CapC` instructions:

Value	Consequence
TRUE	this is the last instruction in a sequence of `CapL`/`CapC` instructions
FALSE	this is not the last instruction in a sequence of `CapL`/`CapC` instructions

restart_dist

Restart distance, unit: mm

Data type: `num`

Defines the distance the robot has to back along the path, when it is restarted after having encountered a stop when a CAP process was active.

In MultiMove systems all synchronized robots must use the same restart distance.

Continues on next page

speed_data

Speed data for CAP

Data type: `capspeeddata`

Defines all CAP data concerning speed (see *capspeeddata - Speed data for CAP on page 102*).

start_fly_point

Data type: `flypointdata`

These data are only taken into account when `start_fly` is `TRUE`.

Defines flying start information for the CAP process (see *flypointdata - Data for flying start/end on page 109*.)

end_fly_point

Data type: `flypointdata`

These data are only taken into account when `end_fly` is `TRUE`.

Defines flying end information for the CAP process (see *flypointdata - Data for flying start/end on page 109*.)

sup_timeouts

Data type: `supervtimeouts`

Defines the timeouts used for all handshake supervision phases (see *supervtimeouts - Handshake supervision time outs on page 115* and section *Supervision* in *Application manual - Continuous Application Platform*).

proc_times

Data type: `processtimes`

Defines the timeouts used for the status supervision phases PRE, POST1, and POST2 (see *processtimes - process times on page 112* and section *Supervision and process phases* in *Application manual - Continuous Application Platform*).

block_at_restart

Data type: `restartblkdata`

Defines the behavior of the CAP process during a restart (see *restartblkdata - blockdata for restart on page 113*).

Structure

```
< data object of capdata >
  < start_fly of bool >
  < first_instr of bool >
  < last_instr of bool >
  < restart_dist of num >
  < speed_data of capspeeddata >
    < fly_start of num >
    < start of num >
    < startspeed_time of num >
    < startmove_delay of num >
    < main of num >
    < fly_end of num >
```

Continues on next page

```
< start_fly_point of flypointdata >
  < time_before of num >
  < distance of num >
< end_fly_point of flypointdata >
  < time_before of num >
  < distance of num >
< sup_timeouts of supervtimeouts >
  < pre_cond of num >
  < start_cond of num >
  < end_main_cond of num >
  < end_post1_cond of num >
  < end_post2_cond of num >
< proc_times of processtimes >
  < pre of num >
  < post1 of num >
  < post2 of num >
< block_at_restart of restartblkdata >
  < weave_start of bool >
  < motion_delay of bool >
  < pre_phase of bool >
  < startspeed_phase of bool >
  < post1_phase of bool >
  < post2_phase of bool >
```

Related information

	Described in:
`capspeeddata` **data type**	*capspeeddata - Speed data for CAP on page 102*
`flypointdata` **data type**	*flypointdata - Data for flying start/end on page 109*
`supervtimeouts` **data type**	*supervtimeouts - Handshake supervision time outs on page 115*
`processtimes` **data type**	*processtimes - process times on page 112*
`block_at_restart` **data type**	*restartblkdata - blockdata for restart on page 113*
`CapL` **instruction**	*CapL - Linear CAP movement instruction on page 64*
`CapC` **instruction**	*CapC - Circular CAP movement instruction on page 50*

4.3.3 capspeeddata - Speed data for CAP

Usage

`capspeeddata` is used to define all data concerning velocity for a CAP process - it is part of `capdata` and defines all velocity data and process times needed for a CAP process:

- velocity and how long this velocity shall be used at the start of the CAP process,
- delay for the movement of the robot relative the start of the CAP process,
- velocity for the CAP process,

The velocity is restricted by the performance of the robot. This differs, depending on the type of robot and the path of movement.

Components

start

Data type: `num`

Velocity (in mm/s) used at the start of the CAP process.

startspeed_time

Data type: `num`

The time (in seconds) to run at `start` velocity.

startmove_delay

Data type: `num`

The time (in seconds) that the robot movement is delayed relative the start of the CAP process.

main

Data type: `num`

The main CAP process velocity (mm/s).

Structure

```
< data object of capspeeddata >
  < start of num >
  < startspeed_time of num >
  < startmove_delay of num >
  < main of num >
```

Related information

	Described in:
`capdata` data type	*capdata - CAP data on page 99*

4.3.4 capweavedata - Weavedata for CAP

Usage

`capweavedata` is used to define weaving for a CAP process during its MAIN phase (see *Application manual - Continuous Application Platform*).

Description of weaving

Weaving is superimposed on the basic path of the process. That means, that the process speed (defined in `capspeeddata`) is kept as defined, but the TCP speed is increased unless the physical robot limitations are reached.

Available weaving types:

- geometric weaving: most accurate shape
- wrist weaving: only robot axis 6 is used for weaving
- rapid weaving: geometric weaving but specifying weaving frequency instead of length

Available weaving shapes:

- Zig-zag weaving
- V-shaped weaving
- Triangular weaving
- Circular weaving

All `capweavedata` components apply to the MAIN phase.

Components

The path coordinate system is defined by:

- X: path/movement direction
- Z: tool z-direction
- Y: perpendicular to both X and Z as to build a right-handed coordinate system

active

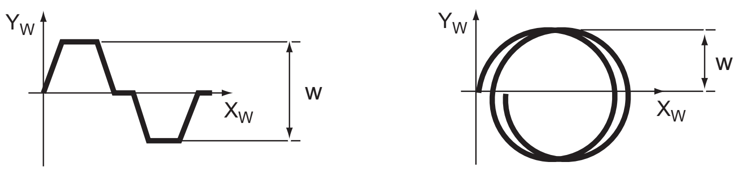
Data type: `bool`

Value	Description
TRUE	Perform weaving during the MAIN phase of the CAP process
FALSE	Do NOT perform weaving during the MAIN phase of the CAP process

width

Data type: `num`

For circular weaving, width is the radius of the circle (W in the following figure). For all other weaving shapes, width is the total amplitude of the weaving pattern.



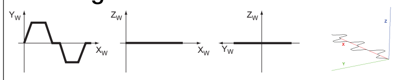
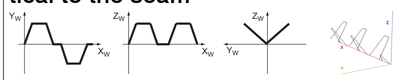
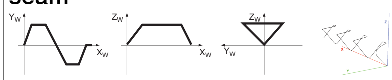
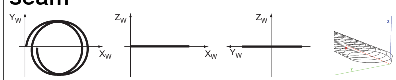
xx1200000721

Continues on next page

shape

Data type: `num`

The shape of the weaving pattern in the main phase.

Value	Shape geometry	Result
0	No weaving	
1	Zig-zag weaving	Weaving horizontal to the seam  xx1200000714
2	V-shaped weaving	Weaving in the shape of a "V", vertical to the seam  xx1200000715
3	Triangular weaving	A triangular shape, vertical to the seam  xx1200000716
4	Circular weaving (Only available with geometric weaving, weaving type 0)	A circular shape, vertical to the seam  xx1200000717

type

Data type: `num`

Defines what axes are used for weaving during the MAIN phase

Specified value	Weaving type
0	Geometric weaving. All axes are used during weaving.
1	Wrist weaving. Mainly axis 4, 5 and 6 are used during weaving.
2	Rapid weaving. Mainly axis 4, 5 and 6 are used during weaving, but weaving frequency is specified instead of weaving length.

length

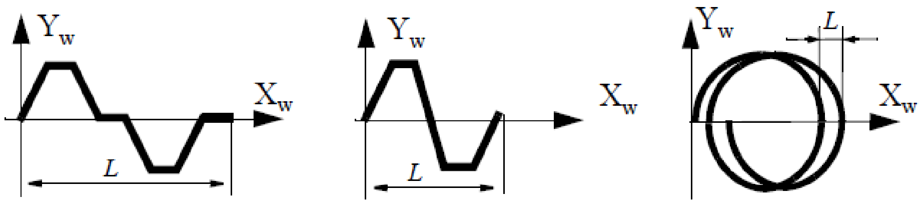
Data type: `num`

Defines the length of the weaving cycle in the MAIN phase for geometric weaving (type = 0) and wrist weaving (type = 1). The length argument is not used for the other weaving types.

For circular weaving the `length` component defines the distance between two successive circles (L) if the `cycle_time` argument is set to 0. The TCP rotates

Continues on next page

left with a positive length value, and right with a negative length value. If `cycle_time` has a value then `length` is not used.



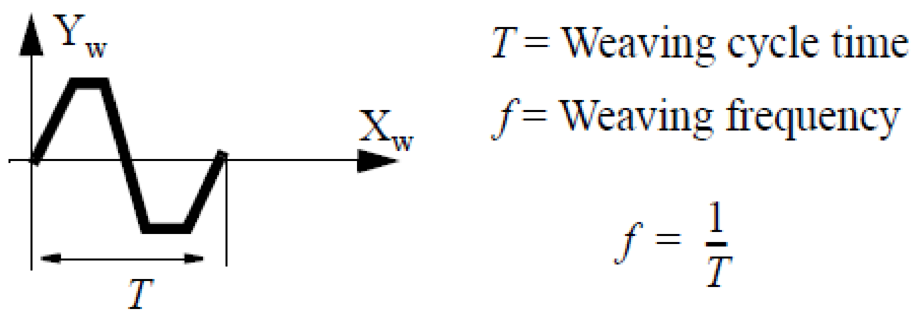
xx1200000187

cycle_time

Data type: `num`

Defines the weaving frequency (in Hz) in the MAIN phase for of Rapid weaving types and for circular weaving. The `cycle_time` argument is not used for the other weaving types.

For circular weaving the `cycle_time` argument defines the number of circles per second. The TCP rotates left with a positive `cycle_time` value, and right with a negative `cycle_time` value. If `cycle_time` has a value then `length` is not used.



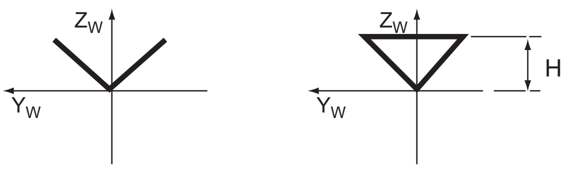
xx1200000188

height

Data type: `num`

Defines the height of the weaving pattern (in mm) during V-shaped and triangular weaving.

Not available for circular weaving.



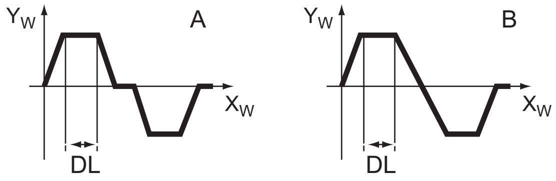
xx1200000722

Continues on next page

dwell_left

Data type: `num`

The length of the dwell (DL) used to force the TCP to move only in the direction of the seam at the left turning point of the weave. Not available for circular weaving.



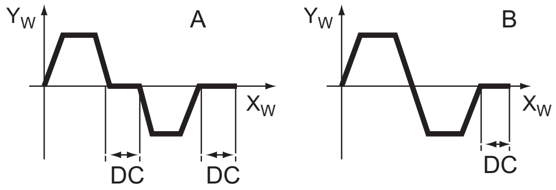
xx1200000723

A	Zigzag and V-shaped weaving
B	Triangular weaving

dwell_center

Data type: `num`

The length of the dwell (DC) used to force the TCP to move only in the direction of the seam at the center point of the weave. Not available for circular weaving.



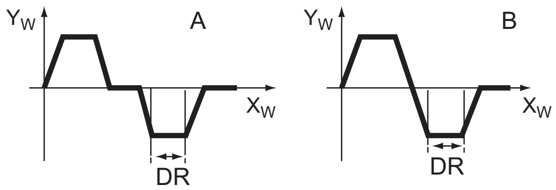
xx1200000724

A	Zigzag and V-shaped weaving
B	Triangular weaving

dwell_right

Data type: `num`

The length of the dwell (DR) used to force the TCP to move only in the direction of the seam at the right turning point of the weave. Not available for circular weaving.



xx1200000725

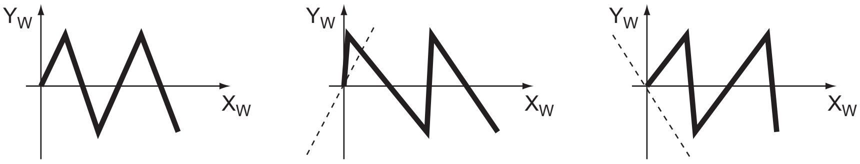
A	Zigzag and V-shaped weaving
B	Triangular weaving

Continues on next page

dir

Data type: `num`

The weave direction angle horizontal to the seam. An angle of zero degrees results in a weave vertical to the seam.

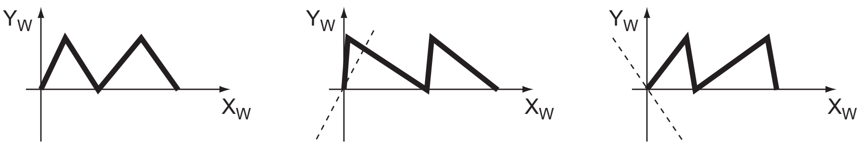


xx1200000726

tilt

Data type: `num`

The weave tilt angle, vertical to the seam. An angle of zero degrees results in a weave which is vertical to the seam.

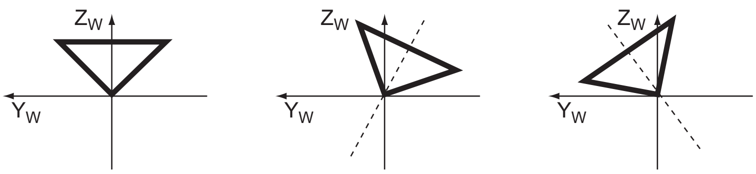


xx1200000727

rot

Data type: `num`

The weave orientation angle, horizontal-vertical to the seam. An angle of zero degrees results in symmetrical weaving.



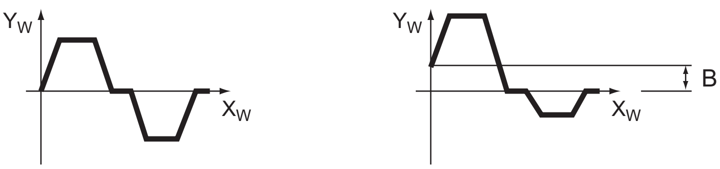
xx1200000728

bias

Data type: `num`

The bias horizontal to the weaving pattern. The bias can only be specified for zig-zag weaving and may not be greater than half the width of the weave. Not available for circular weaving.

The following figure shows zigzag weaving with and without bias (B).



xx1200000729

Continues on next page

ptrn_sync_on

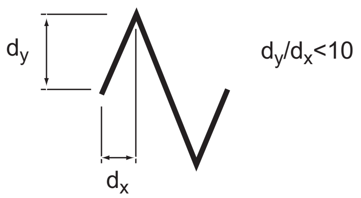
Data type: `bool`

Value	Description
TRUE	Send synchronization pulses at the right and left turning points of the weave pattern
FALSE	Do NOT send synchronization pulses at the right and left turning points of the weave pattern

Limitations

The maximum weaving frequency is 2 Hz.

The inclination of the weaving pattern must not exceed the ratio 1:10 (84 degrees). See the following figure.



xx1200000730

Change of `weave_type` in `weavedata` is not possible in zone points, only in fine points.

Syntax

```
< data object of capweavedata >
  < active of bool>
  < width of num >
  < shape of num >
  < type of num >
  < length of num >
  < cycle_time of num >
  < height of num >
  < dwell_left of num >
  < dwell_center of num >
  < dwell_right of num >
  < dir of num >
  < tilt of num >
  < rot of num >
  < bias of num >
  < ptrn_sync_on of bool >
```

Related information

	Described in:
`capdata` data type	*capdata - CAP data on page 99*

4.3.5 flypointdata - Data for flying start/end

Usage

`flypointdata` is used to define all data of flying start or flying end for a CAP process - it is part of `capdata` for both flying start and flying end.

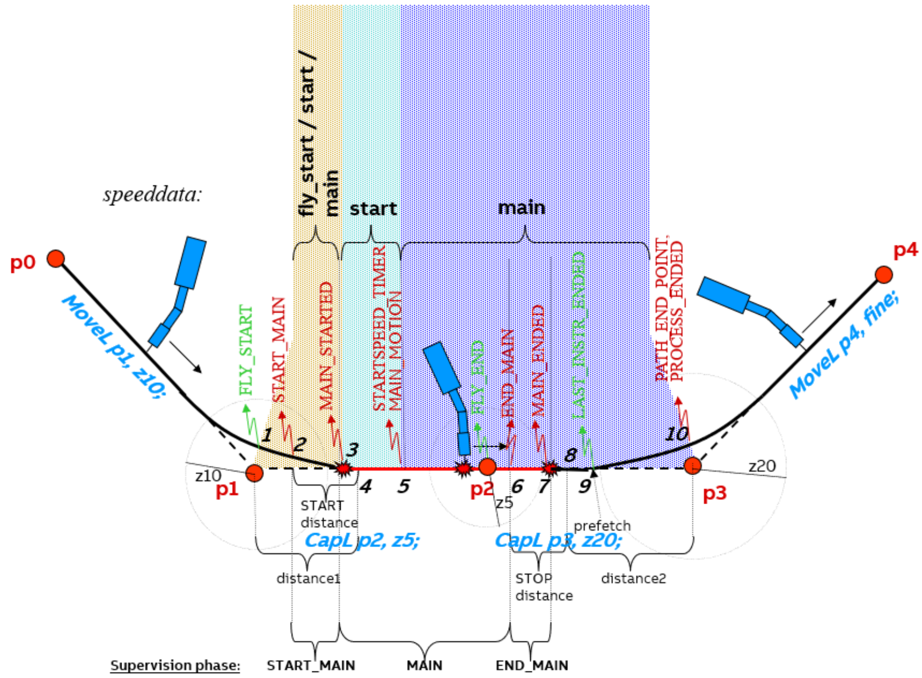
Definitions

`flypointdata` defines data for both flying start and flying end:

- This functionality is only available for CAP.
- Flying start is triggered by the combination of *first instruction = TRUE* and zone point.
- Flying end is triggered by the combination of *last_instr = TRUE* and zone point.
- Weavestart will be ignored.
- If the starting point is a fine point, no flying start will be performed.
- If the end point is a fine point, no flying end will be performed.
- Motion delay will be ignored.
- Restart after an error will work in the same way as usual: there are no specific features for flying start, scrape start is available, if the application process was active, when the error occurred.
- If weaving is activated, the transition in the zone is made by ramping in the weaving pattern starting at the entrance to the zone until the full pattern is reached when the TCP leaves the zone.
- Supervision is active during START phase (with moving TCP), MAIN phase and END_MAIN phase (with moving TCP).
- Backing on the path will be limited to backing to position 4 (see the following figure).
- The user has to adapt distance and the approach and leaving angle to the application process: for example, for arc welding at the point where the arc shall be established (point 4 in the figure) has to be selected in such a way, that it is possible to ignite.
- The distance between position 4 and 6 must not be = 0.
- The `START process_dist` must be equal to or shorter than `START distance`.
- If program execution is stopped and the application process is active (between positions 3 and 6), CAP will behave as usual, that is, backing on path (only if pos. 4 had been passed), weave start, motion delay and movement start timeout are available.
- If program execution is stopped between positions 1 and 3 or between positions 7 and 10, the `CapX` instruction will behave like a `TrigX` instruction.
- The first CAP segment with flying start is recommended to be at least `START distance` long.

Continues on next page

- If the first segment is shorter than `START distance`, but longer than `START process_dist`, the positions 2 and 4 will be moved towards position 1.
- If the first segment is shorter than or equal `START process_dist`, positions 1 and 2 will coincide and position 4 will be at the end of the segment.
- The last CAP segment with flying end is recommended to be at least `END distance + END process_dist` long.
- If the last segment is shorter than `END distance + END process_dist`, but longer than `END process_dist`, the positions 7 and 9 will be moved towards position 10.
- If the last segment is shorter than or equal `END process_dist`, positions 8 and 10 will coincide and position 6 will be at the start of the segment.
- The START phase timeout specified in `capdata` will only be used at restart of the application process.
- If a process error occurs after the prefetch request from motion has arrived at the last CAP instruction (after position 9), that is, PGM is released from the CAP instruction and may continue with the next instruction, an error log message is sent, the process is stopped, *but* the robot movement continues.



xx2300000233

Components

process_dist

Data type: `num`

The distance (in mm) within which the process is started (for *flying start*) or ended (for *flying end*).

distance

Data type: `num`

Continues on next page

Sets the start/end of the supervision of the CAP process as a distance (in mm) from the start/end point.

Structure

```
< databases of flypointdata >
  < process_dist of num >
  < distance of num >
```

Related information

	Described in:
`capdata` data type	*capdata - CAP data on page 99*

4.3.6 processtimes - process times

Usage

`processtimes` is used to define the duration times for all status supervision phases in CAP, except phase MAIN, which is defined by the robot movement (see section *Supervision* in *Application manual - Continuous Application Platform*).

`processtimes` is a component of `capdata` and defines the timeout times for the following status supervision phases in CAP:

- PRE
- POST1
- POST2

The specified timeout time has to be larger than zero, if supervision should be used during the corresponding status supervision phase in CAP (see section *Supervision and process phases* in *Application manual - Continuous Application Platform*).

Components

pre

Data type: `num`

Defines the duration of the phase PRE in seconds. During that time all conditions defined for that phase have to be fulfilled.

post1

Data type: `num`

Defines the duration of the phase POST1 in seconds. During that time all conditions defined for that phase have to be fulfilled.

post2

Data type: `num`

Defines the duration of the phase POST2 in seconds. During that time all conditions defined for that phase have to be fulfilled.

Syntax

```
< data object of processtimes >
  < pre of num >
  < post1 of num >
  < post2 of num >
```

Related information

	Described in:
`capdata` data type	*capdata - CAP data on page 99*

4.3.7 restartblkdata - blockdata for restart

Usage

`restartblkdata` is used to define the behavior of a CAP process at restart.

`restartblkdata` is a component of `capdata` and defines the following for a CAP process at restart, if:

- The robot should execute/block weaving stationary during process restart (`weave_start`).
- Robot movement restart should be delayed or not relative process restart (`motion_delay`).
- The phases PRE, PRE_START and END_PRE should be executed/blocked (`pre_phase`).
- A velocity different from main velocity should be used or not during start of the process (`startspeed_phase`).
- The phases START_POST1, POST1 and END_POST1should be executed/blocked (`post1_phase`).
- The phases START_POST2, POST2 and END_POST2should be executed/blocked (`post2_phase`).

Components

weave_start

Data type: `bool`

Value	Description
FALSE	Stationary weaving at restart until the process has started
TRUE	No stationary weaving at restart until the process has started

motion_delay

Data type: `bool`

Value	Description
FALSE	Delay of robot movement at restart after the process has started
TRUE	No delay of robot movement at restart after the process has started

pre_phase

Data type: `bool`

Value	Description
FALSE	Execute the phases START_PRE, PRE and END_PRE phase at restart
TRUE	Do NOT execute the phases START_PRE, PRE and END_PRE phase at restart

Continues on next page

startspeed_phase

Data type: `bool`

Value	Description
FALSE	Move the robot with start speed in the beginning of a restart
TRUE	Do NOT move the robot with start speed in the beginning of a restart, use main speed directly

post1_phase

Data type: `bool`

Value	Description
FALSE	Execute the phases START_POST1, POST1 and END_POST1 at restart
TRUE	Do NOT execute the phases START_POST1, POST1 and END_POST1 at restart

post2_phase

Data type: `bool`

Value	Description
FALSE	Execute the phases START_POST2, POST2 and END_POST2 at restart
TRUE	Do NOT execute the phases START_POST2, POST2 and END_POST2 at restart

Syntax

```
< data object of restartblkdata >
  < weave_start of bool >
  < motion_delay of bool >
  < pre_phase of bool >
  < startspeed_phase of bool >
  < post1_phase of bool >
  < post2_phase of bool >
```

Related information

	Described in:
`capdata` data type	*capdata - CAP data on page 99*

4.3.8 supervtimeouts - Handshake supervision time outs

Usage

`supervtimeouts` is used to define timeout times for handshake supervision in CAP.

`supervtimeouts` is a component of `capdata` and defines the timeout times for the following handshake supervision phases in CAP:

- START_PRE
- END_PRE and START_MAIN
- END MAIN and START_POST1
- END_POST1 and START_POST2
- END_POST2

If the parameter is set to 0, there is no timeout.

Components

pre_cond

Data type: `num`

Timeout time (in seconds) for the START_PRE phase conditions to be fulfilled.

start_cond

Data type: `num`

Timeout time (in seconds) for the END_PRE and START_MAIN phase conditions to be fulfilled.

end_main_cond

Data type: `num`

Timeout time (in seconds) for the END_MAIN and START_POST1 phase conditions to be fulfilled.

end_post1_cond

Data type: `num`

Timeout time (in seconds) for the END_POST1 and START_POST2 phase conditions to be fulfilled.

end_post2_cond

Data type: `num`

Timeout time (in seconds) for the END_POST2 phase conditions to be fulfilled.

Syntax

```
< data object of supervtimeouts >
  < pre_cond of num >
  < start_cond of num >
  < end_main_cond of num >
  < end_post1_cond of num >
  < end_post2_cond of num >
```

Continues on next page

Related information

	Described in:
`capdata` data type	*capdata - CAP data on page 99*

4.3.9 weavestartdata - weave start data

Usage

`weavestartdata` is used to control stationary weaving during start and restart of a process in CAP.

`weavestartdata` is a component of `capdata` and defines the properties of stationary weaving at start or restart of a CAP process:

- if there shall be stationary weaving at start (`active`)
- width of stationary weaving (`width`)
- direction relative path direction (`dir`)
- frequency of stationary weaving (`cycle_time`)

Stationary weaving uses always geometric weaving with zig-zag pattern, see *capweavedata - Weavedata for CAP on page 103*.

Components

active

Data type: `bool`

Value	Description
TRUE	Perform stationary weaving at start of a CAP process
FALSE	Do NOT perform stationary weaving at start of a CAP process

width

Data type: `num`

Defines the amplitude of stationary weaving (mm).

dir

Data type: `num`

Defines the direction of stationary weaving relative to the path direction (degrees). Zero degrees means weaving perpendicular to both the path and the z-coordinate of the tool.

cycle_time

Data type: `num`

Defines the total time (in seconds) for a complete cycle of stationary weaving, that is, it defines the weaving frequency. The stationary weaving will last until the process has started, that is, the supervision criteria of the START_MAIN phase are fulfilled.

Syntax

```
< data object of weavestartdata >
  < active of bool >
  < width of num >
  < dir of num >
  < cycle_time of num >
```

Continues on next page

Related information

	Described in:
`capdata` data type	*capdata - CAP data on page 99*

Index

ABB AB
Robotics & Discrete Automation
S-721 68 VÄSTERÅS, Sweden
Telephone +46 10-732 50 00

ABB AS
Robotics & Discrete Automation
Nordlysvegen 7, N-4340 BRYNE, Norway
Box 265, N-4349 BRYNE, Norway
Telephone: +47 22 87 2000

ABB Engineering (Shanghai) Ltd.
Robotics & Discrete Automation
No. 4528 Kangxin Highway
PuDong New District
SHANGHAI 201319, China
Telephone: +86 21 6105 6666

ABB Inc.
Robotics & Discrete Automation
1250 Brown Road
Auburn Hills, MI 48326
USA
Telephone: +1 248 391 9000

abb.com/robotics

3HAC083246-001, Rev C, en