

ROBOTICS

# Application manual

# Externally Guided Motion



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# Application manual Externally Guided Motion RobotWare 7.18

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# **Overview of this manual**

About this manual	This manual contains information about the RobotWare option Externally Guided Motion [3124-1], often referred to as EGM.		
Usage			
	This manual can	be used to find out what Externally Guided	Motion is and how t
	use II. The manua	a also provides information about RAPID con ad to Externally Guided Motion, and example	nponents and syster
	parameters relate	ed to Externally Guided Motion, and example	s of now to use then
Who should read th	is manual?		
	This manual is m	ainly intended for robot programmers.	
Prerequisites			
	The reader shoul	d be familiar with:	
	<ul> <li>Industrial relation</li> </ul>	obots and their terminology	
	The RAPID	programming language	
	<ul> <li>System par</li> </ul>	rameters and how to configure them	
References			
	Reference		Document ID
	Application manua	al - Controller software OmniCore	3HAC066554-001
	Operating manual	- OmniCore	3HAC065036-001
	Operating manual	- RobotStudio	3HAC032104-001
	Technical reference	e manual - RAPID Overview	3HAC065040-001
	Technical referenc Data types	e manual - RAPID Instructions, Functions and	3HAC065038-001
	Technical reference	e manual - System parameters	3HAC065041-001
Revisions			
	Revision	Description	
	A	Released with RobotWare 7.0.	

Α	Released with RobotWare 7.0.
В	<ul> <li>Released with RobotWare 7.0.1.</li> <li>Changed default value for the parameter <i>Default Ramp Time on page 46</i>.</li> </ul>

### Continued

Revision	Description
С	<ul> <li>Released with RobotWare 7.1.</li> <li>Description of the <i>K factor</i> (Default proportional Position Gain) added in section <i>Input data on page 25</i>.</li> <li>Note regarding unpredictable movement added in section <i>Default Low Pass Filter Bandwidth on page 48</i>.</li> <li>Limitations undated for instructions <i>EGMPun Joint - Perform an</i></li> </ul>
	<ul> <li>EGM movement with a joint target on page 71 and EGMRunPose</li> <li>Perform an EGM movement with a pose target on page 74.</li> <li>Limitations updated in section Overview on page 13.</li> <li>Removed the argument LATR from instructions EGMSetupAI, EGMSetupAO, and EGMSetupGI. This is no longer available.</li> </ul>
	New set-up section added in <i>Introduction to EGM Position</i> <i>Guidance on page 17</i> .
D	<ul> <li>Released with RobotWare 7.2.</li> <li>Sections Introduction to EGM Position Guidance on page 17 and Configuring UdpUc devices on page 40 updated with information about the system parameter type UDP Unicast Device.</li> <li>Updated the section Building an EGM sensor communication</li> </ul>
	<ul> <li>endpoint on page 39.</li> <li>Section Overview on page 33 updated with information about the EGM sensor protocol data structure.</li> </ul>
E	<ul> <li>Released with RobotWare 7.6.</li> <li>Added moveIndex and CollisionIndex to EgmRobot on page 36.</li> </ul>
	<ul> <li>The pose mode in EGM Position Guidance now also supports YuMi and SCARA robots.</li> </ul>
F	<ul> <li>Released with RobotWare 7.7.</li> <li>EGM Position Guidance can now be used also for 4-axis palletizing robots.</li> <li>Updated information about sending RAPID data and I/O signals. Added RAPIDfromRobot and RAPIDfromSensor to EgmRobot on page 36. Added the data type EGM_MAX_RAPID_DNUM, and arguments to the instructions ECMAct L and ECMAct Doce</li> </ul>
	<ul> <li>Added information for proportional controller gain, see <i>Input data on page 25</i>.</li> </ul>
G	<ul> <li>Released with RobotWare 7.8.</li> <li>Path to EGM folder corrected in <i>The EGM sensor protocol on page 33</i>.</li> </ul>
н	Released with RobotWare 7.13. <ul> <li>Minor corrections.</li> </ul>
L	<ul> <li>Released with RobotWare 7.15.</li> <li>Updated section <i>Execution states and correction states on page 23</i>.</li> <li>Added section <i>egycorrectate - Defines the correction state for</i></li> </ul>
	EGM on page 103.
к	<ul> <li>Released with RobotWare 7.16.</li> <li>Added information about PTP support, see EGM sensor protocol description on page 35.</li> </ul>
	• Updated information about the argument RampInTime, see EGMRunJoint - Perform an EGM movement with a joint target on page 71 and EGMRunPose - Perform an EGM movement with a pose target on page 74.
L	<ul><li>Released with RobotWare 7.18.</li><li>Minor updates for <i>EGM Position Guidance</i>.</li></ul>

# **Product documentation**

#### Categories for user documentation from ABB Robotics

The user documentation from ABB Robotics is divided into a number of categories. This listing is based on the type of information in the documents, regardless of whether the products are standard or optional.



All documents can be found via myABB Business Portal, www.abb.com/myABB.

#### **Product manuals**

Manipulators, controllers, DressPack, and most other hardware is delivered with a **Product manual** that generally contains:

- Safety information.
- Installation and commissioning (descriptions of mechanical installation or electrical connections).
- Maintenance (descriptions of all required preventive maintenance procedures including intervals and expected life time of parts).
- Repair (descriptions of all recommended repair procedures including spare parts).
- Calibration.
- Troubleshooting.
- Decommissioning.
- Reference information (safety standards, unit conversions, screw joints, lists of tools).
- Spare parts list with corresponding figures (or references to separate spare parts lists).
- References to circuit diagrams.

#### **Technical reference manuals**

The technical reference manuals describe reference information for robotics products, for example lubrication, the RAPID language, and system parameters.

#### **Application manuals**

Specific applications (for example software or hardware options) are described in **Application manuals**. An application manual can describe one or several applications.

An application manual generally contains information about:

- The purpose of the application (what it does and when it is useful).
- What is included (for example cables, I/O boards, RAPID instructions, system parameters, software).
- How to install included or required hardware.
- How to use the application.

### Continued

• Examples of how to use the application.

#### **Operating manuals**

The operating manuals describe hands-on handling of the products. The manuals are aimed at those having first-hand operational contact with the product, that is production cell operators, programmers, and troubleshooters.

# Safety

### Safety of personnel

A robot is heavy and extremely powerful regardless of its speed. A pause or long stop in movement can be followed by a fast hazardous movement. Even if a pattern of movement is predicted, a change in operation can be triggered by an external signal resulting in an unexpected movement.

Therefore, it is important that all safety regulations are followed when entering safeguarded space.



Program changes should always be validated and tested before entering production, to protect humans and property. Ensure it is possible to stop the robot with a protective stop device.

#### Safety regulations

Before beginning work with the robot, make sure you are familiar with the safety regulations described in the manual *Safety manual for robot - Manipulator and IRC5 or OmniCore controller*.

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# **1** Introduction to Externally Guided Motion

# 1.1 Overview

Purpose	
	Externally Guided Motion (EGM) offers three different features:
	EGM Position Stream:
	The current and the planned positions of the mechanical units in a RAPID task are sent to an external equipment.
	EGM Position Guidance:
	The robot does not follow a programmed path in RAPID, but a path generated by an external device. This is intended as a motion/sensor interface with low latency, and does not offer the same path following performance as for normal RAPID movement instructions.
	EGM Path Correction:
	The programmed robot path is modified/corrected using measurements provided by an external device.
EGM Position Stream	n
	The purpose of EGM Position Stream is to provide external equipment with the current and planned positions of mechanical units that are controlled by the robot controller.
	Some example of applications are:
	<ul> <li>Laser Welding, where the Laser head is controlling the Laser beam dynamically.</li> </ul>
	<ul> <li>Any robot mounted equipment that controls the "robot"-TCP with an external controller.</li> </ul>
EGM Position Guida	nce
	The purpose of <i>EGM Position Guidance</i> is to use an external device to generate position data for one or several robots. The robots will be moved to that given position.
	Some examples of applications are:
	• Place an object (for example a car door or a window) at a location (for example a car body) that was given by an external sensor.
	<ul> <li>Bin picking. Pick objects from a bin using an external sensor to identify the object and its position.</li> </ul>
	<ul> <li>Visual Servoing. Control robot position with vision input.</li> </ul>
	It is possible to run complete paths from external device, but it will not have same path following performance as for normal RAPID movement instructions.

<sup>1.1</sup> Overview

#### 1.1 Overview Continued

#### EGM Path Correction

The purpose of *EGM Path Correction* is to use external robot mounted devices to generate path correction data for one or several robots. The robots will be moved along the corrected path, which is the programmed path with added measured corrections.

Some examples of applications are:

- Seam tracking.
- Tracking of objects moving near a known path.

#### What is included

The RobotWare option *Externally Guided Motion* gives you access to:

- Instructions to start and stop EGM Position Stream.
- Instructions to set up, activate, and reset EGM Position Guidance.
- Instructions to set up, activate, and reset EGM Path Correction.
- Instructions to initiate EGM Position Guidance movements, synchronized with RAPID execution or not, and to stop them.
- Instructions to perform EGM Path Correction movements.
- A function to retrieve the current EGM state.
- System parameters to configure EGM and set default values.

#### Limitations

EGM does not support coordinated MultiMove.

#### Limitations for EGM Position Stream

- EGM Position Stream is available with UdpUc communication only.
- Tool data and load data cannot be changed dynamically during an active position stream.
- It is not possible to stream positions of coordinated MultiMove systems.
- Absolute Accuracy is not supported if streaming is started using EGMStreamStart, but it is supported if it started using EGMActXXX\StreamStart.
- EGM Position Stream is not compatible with EGM Path Correction.
- It is not allowed to activate or deactivate mechanical units if EGM Position Stream is active.

Limitations for EGM Position Guidance

- Has to start and to end in a fine point.
- The first movement that is performed after a controller restart cannot be an EGM movement.
- Pose mode supports 6-axis robots, 4-axis palletizer robots, YuMi robots, and SCARA robots.
- It is not possible to perform linear movements using EGM Position Guidance, since EGM Position Guidance does not contain interpolator functionality. The actual path of the robot will depend on the robot configuration, the start position, and the generated position data.

- EGM Position Guidance does not support MultiMove coordinated.
- There is a limitation of one mechanical unit per motion task.
- It is not possible to use EGM Position Guidance to guide a mechanical unit in a moving work object.
- If the robot ends up near a singularity, i.e. when two robot axes are nearly parallel, the robot movement will be stopped with an error message. In that situation the only way is to jog the robot out of the singularity.
- When EGM is active, Motion Supervision can behave differently than during normal movements. The recommended action after a collision is to disable EGM and start the EGM sequence from the beginning.

Limitations for EGM Path Correction

- Supports only 6-axis robots.
- Has to start and to end in a fine point.
- The external device has to be robot mounted.
- · Corrections can only be applied in the path coordinate system.
- Only position correction in y and z can be performed. It is not possible to perform orientation corrections, nor corrections in x (which is the path direction/tangent).
- When EGM is active, Motion Supervision can behave differently than during normal movements. The recommended action after a collision is to disable EGM and start the EGM sequence from the beginning.

### 1.2 Introduction to EGM Position Stream

# **1.2 Introduction to EGM Position Stream**

#### What is EGM Position Stream

EGM Position Stream is available for UdpUc communication only. It provides the possibility to periodically send planned and actual mechanical unit (e.g. robot, positioner, track motion ...) position data from the robot controller. The message contents is specified by the Google Protobuf definition file *egm.proto*. The cyclic communication channel (UDP) can be executed in the high-priority network environment of the robot controller which ensures a stable data exchange up to 250 Hz. There has to be one communication channel for each motion task. EGM Position Stream may be used together with EGM Position Guidance.

1.3 Introduction to EGM Position Guidance

# **1.3 Introduction to EGM Position Guidance**

#### What is EGM Position Guidance

EGM Position Guidance is designed for advanced users and provides a low level interface to the robot controller, by by-passing the path planning that can be used when highly responsive robot movements are needed. EGM Position Guidance can be used to read positions from and write positions to the motion system at a high rate. This can be done every 4 ms with a control lag of 10–20 ms depending on the robot type. The references can either be specified using joint values or a pose. The pose can be defined in any work object that is not moved during the EGM Position Guidance movement.



In all further descriptions of EGM the actual sampling time is 4.032 ms on a real robot system and approximately 4 ms in a virtual robot system.

All necessary filtering, supervision of references, and state handling is handled by EGM Position Guidance. Examples of state handling are program start/stop, emergency stop, etc.

The main advantage of EGM Position Guidance is the high rate and low delay/latency compared to other means of external motion control. The time between writing a new position until that given position starts to affect the actual robot position, is usually around 20 ms.

EGM handles Absolute Accuracy.

EGM Position Guidance can be combined with Logical settings (setting I/O:s etc.) or enabling other control modes e.g. using Force Control assembly instructions. This can be achieved by using optional argument to not wait for EGM convergence (\NoWaitCond).

#### What EGM Position Guidance does not do

EGM goes directly into the motor reference generation, i.e. it does not provide any path planning. This means that you cannot order a movement to a pose target and expect a linear movement. It is not possible either to order a movement with a specified speed or order a movement that is supposed to take a specified time.

For ordering such movements path planning is needed and we refer you to the standard movement instructions in RAPID, i.e. <code>Movel, Movel, etc.</code>



Since the path planning is by-passed by EGM in the robot controller, the robot path is created directly from user input. It is therefore important to make sure that the stream of position references sent to the controller is as smooth as possible. The robot will react quickly to all position references sent to the controller, also faulty ones.

1.3 Introduction to EGM Position Guidance Continued

#### Setting up EGM Position Guidance

When EGM Position Guidance is set up correctly, the external device communicates with the controller via a protocol and thereby controls the movement of the robot. The following image displays a schematic overview of a possible set-up of an EGM application:



#### xx2000000152

For this to work, the following steps must be taken:

1 Set up your RobotWare system, including the RobotWare option Externally Guided Motion.



Note

See Limitations on page 14 for information regarding what types of robots and options can be included in the set-up.

2 Set up your UdpUc device with an EGM sensor protocol so that it can communicate with the robot controller. See The EGM sensor protocol on page 33 for basic instructions on how to build an EGM sensor communication endpoint.



Note

Code examples are available in the RobotWare distribution. See UdpUc code examples on page 119.

- 3 Set up the RAPID code defining the details of the EGM Position Guidance functionality. See Basic approach on page 21 for a description of the basic elements needed in the code, and Using EGM Position Guidance with an UdpUc device on page 108 for a complete example of RAPID code.
- 4 The device which provides the input data for EGM has to be configured as a UDP Unicast Device (UdpUc). This configuration is made in RobotStudio,

1.3 Introduction to EGM Position Guidance Continued

using the system parameters of type UDP Unicast Device in topic Communication. Define the name and the IP address of the device, and set the type to UDPUC. See Configuring UdpUc devices on page 40.



## Note

After this configuration change, the controller has to be restarted. After the restart, the device can be used by EGM to guide a robot.

#### 1.4 Introduction to EGM Path Correction

# 1.4 Introduction to EGM Path Correction

#### What is EGM Path Correction

EGM Path Correction gives the user the possibility to correct a programmed robot path. The device or sensor that is used to measure the actual path has to be mounted on the tool flange of the robot and it must be possible to calibrate the sensor frame.

The corrections are performed in the path coordinate system, which gets its x-axis from the tangent of the path, the y-axis is the cross product of the path tangent, and the z-direction of the active tool frame and the z-axis is the cross product of x-axis and y-axis.

EGM Path correction has to start and end in a fine point. The sensor measurements can be provided at multiples of about 48 ms.

# 2 Using Externally Guided Motion

# 2.1 Basic approach

#### **Basic approach for EGM Position Stream**

EGM Position Stream is available if UdpUc is used for communication with the external equipment. It is possible to start EGM Position Stream in two different ways. One is to use EGMStreamStart and the other EGMActJoint\StreamStart or EGMActPose\StreamStart. EGM Position Stream is automatically stopped by EGMStop, EGMReset and when an EGMRunJoint or EGMRunPose instruction is completed. There is also a specific instruction, EGMStreamStop, to stop the data stream.

Position streaming does not support dynamic change of tool or load. If EGMStreamStart is used to start the position stream, the active tool and load are passed to the controller. If EGMActJoint or EGMActPose is used, the active tool and load (or if specified, the specified tool and/or load) are passed to the controller. Those tool and load data are then used by EGM for calculation of positions until the position stream is stopped. For each motion task, a separate position stream has to be started.

	Action
1	Register an EGM client and get an EGM identity. This identity is then used to link setup, activation, movement, deactivation etc. to a certain EGM usage. The EGM state changes to EGM_STATE_CONNECTED.
2	Call the EGM setup instruction <code>EGMSetupUC</code> to set up the external equipment using UdpUc protocol connection.
3	Either: A Start the position stream with the instruction EGMStreamStart. B Start the position stream using EGMActJoint or EGMActPose with the optional argument \StreamStart. Now the EGM state is EGM_STATE_RUNNING.
4	EGM Position Stream will be active, sending actual and planned position, until it is stopped.
5	<ul> <li>A If started with EGMStreamStart: Stop the position stream with EGMStreamStop.</li> <li>B If started with EGMActJoint or EGMActPose: Stop the position stream with EGMStop or EGMReset.</li> <li>The EGM state changes back to EGM_STATE_CONNECTED.</li> </ul>
	5

#### **Basic approach for EGM Position Guidance**

This is the general approach to move/guide a robot using an external device (sensor) to give the target for the movement.

	Action
1	Move the robot to a fine point.
2	Register an EGM client and get an EGM identity. This identity is then used to link setup, activation, movement, deactivation etc. to a certain EGM usage. The EGM state changes to EGM_STATE_CONNECTED.

Continues on next page

# 2 Using Externally Guided Motion

# 2.1 Basic approach

Continued

	Action
3	Call an EGM setup instruction to set up the position data source using signals or UdpUc protocol connection.
4	Choose if the position is given as joint values or as a pose and give the position con- vergence criteria, i.e. when the position is considered to be reached.
5	If pose was chosen, define which frames are used to define the target position and in which frame the movement is to be applied.
6	Give the stop mode, an optional time-out and perform the movement itself. Now the EGM state is EGM_STATE_RUNNING. This is when the robot is moving.
7	The EGM movement will stop when the position is considered to be reached, i.e. the convergence criteria is fulfilled. Now the EGM state has changed back to <pre>EGM_STATE_CONNECTED.</pre>

# Basic approach for EGM Path Correction

This is the general approach to correct a programmed path with EGM Path Correction.

	Action
1	Move the robot to a fine point.
2	Register an EGM client and get an EGM identity. This identity is then used to link setup, activation, movement, deactivation etc. to a certain EGM usage. The EGM state changes to EGM_STATE_CONNECTED.
3	Call an EGM setup instruction to set up the position data source using signals or UdpUc protocol connection.
4	Define the sensor correction frame, which always is a tool frame.
5	Perform the movement itself. Now the EGM state is EGM_STATE_RUNNING.
	At the end point EGM will return to the state EGM_STATE_CONNECTED.
6	To free an EGM identity for use with another sensor you have to reset EGM, which returns EGM to the state EGM_STATE_DISCONNECTED.

2.2 Execution states and correction states

# 2.2 Execution states and correction states

#### **Execution states description**

These are the execution states of EGM on the robot controller:

Value	Description
EGM_STATE_DISCONNECTED	The EGM state of the specific process is undefined. No EGM correction is connected/active.
EGM_STATE_CONNECTED	Setup has been made, but no EGM movement is active.
EGM_STATE_RUNNING	The specified EGM process is running. The EGM movement is active, i.e. the robot is moved.

Transitions between the different states are according to the figure below.



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The RAPID instructions EGMRunJoint and EGMRunPose change the state from EGM\_STATE\_CONNECTED to EGM\_STATE\_RUNNING as long as the convergence criteria for the target position have not been met and the time-out time has not expired. When one of these conditions is met, the EGM state is changed to EGM\_STATE\_CONNECTED again and the instruction ends, i.e. RAPID execution continues to the next instruction.

If EGM has the state EGM\_STATE\_RUNNING and RAPID execution is stopped, EGM enters the state EGM\_STATE\_CONNECTED. At program restart, EGM returns to the state EGM\_STATE\_RUNNING.

If the program pointer is moved using PP to Main or PP to cursor, the EGM state is changed to EGM\_STATE\_CONNECTED, if the state was EGM\_STATE\_RUNNING.

# 2 Using Externally Guided Motion

# 2.2 Execution states and correction states *Continued*

#### **Correction states description**

These are the correction states of EGM on the robot controller:

Value	Description
EGM_CORR_UNDEFINED	The EGM correction state of the specific process is un- defined.
	EGMGetId has not yet been executed or EGM was reset.
EGM_CORR_STOPPED	This correction state is entered as soon as EGMGetId is executed, but no EGM movement is active yet.
EGM_CORR_RUNNING	The specified EGM process is running, i.e. the robot is moved.
EGM_CORR_ERROR	A position guidance or path correction error occurred when the EGM process was running.



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To identify that EGM streaming is started, you check, that the EGM state is EGM\_STATE\_RUNNING and the correction state EGM\_STATE\_STOPPED or EGM\_STATE\_RUNNING.

2.3 Input data

## 2.3 Input data

#### Input data for EGM Position Guidance

The source for input data is selected using the EGM setup instructions. The three first instructions select a signal interface and the last instruction a UdpUc interface (*User Datagram Protocol Unicast Communication*).

Instructions	Description	
EGMSetupAI	Setup analog input signals for EGM	
EGMSetupAO	Setup analog output signals for EGM	
EGMSetupGI	Setup group input signals for EGM	
EGMSetupUC	Setup the UdpUc protocol for EGM	

Input data for EGM contain mainly position data either as joints or as a pose, i.e. Cartesian position plus orientation.

The data flow for the signal interface is illustrated below:



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- 1 Motion control calls EGM.
- 2 EGM reads the position values from the signals.
- 3 EGM writes the position data to motion control.
- The sensor writes position data to the signals.

If signals are used as data source, the input is limited to 6 for the robot, i.e. 6 joint values or 3 Cartesian position values (x, y, z) plus 3 Euler angle values (rx, ry, rz), and up to 6 values for additional axes.

When using EGM joint mode with a 7-axis robot, then the first additional axis input provides the position for the additional robot axis.

The data flow for the UdpUc interface is illustrated below:

### 2.3 Input data Continued



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- 1 Motion control calls EGM.
- 2 EGM reads feedback data from motion control.
- 3 EGM sends feedback data to the sensor.
- 4 EGM checks the UDP queue for messages from the sensor.
- 5 If there is a message, EGM reads the next message and step 5 writes the position data to motion control. If no position data had been sent, motion control continues to use the latest position data previously written by EGM.
- The sensor sends position data to the controller (EGM). Our recommendation is to couple this to step 3. Then the sensor will be in phase with the controller.

The control loop is based on the following relation between speed and position:

speed - $k^*$ (nos ref - nos) , speed ref	<i>k</i> - factor (Default proportional Position Gain) <i>pos_ref</i> - reference position
speed = k (pos_rer – pos) + speed_rer	<i>pos</i> - desired position <i>speed_ref</i> - reference speed

For instructions on how to implement the UdpUc protocol for an external device, see *The EGM sensor protocol on page 33*. There you will also find a description of input data.

#### Proportional controller gain k

The proportional controller gain k is used to calculate a velocity correction, used to drive the robot position towards the reference position *pos\_ref*.

The input *speed\_ref* is intended to be used as feedforward of a desired velocity, for instance when tracking a moving target or time-varying reference position. In such cases, input *speed\_ref* should correspond to the desired current velocity of the moving target or time-varying reference position.

The resulting value speed is the resulting velocity, used internally by the robot controller to calculate joint references sent to the low-level servo control.

2.3 Input data Continued

#### Input data for EGM Path Correction

The source for input data is selected using the EGM setup instructions. The three first instructions select a signal interface and the last instruction a UdpUc interface (User Datagram Protocol Unicast Communication).

Instructions	Description
EGMSetupAI	Setup analog input signals for EGM
EGMSetupAO	Setup analog output signals for EGM
EGMSetupGI	Setup group input signals for EGM
EGMSetupUC	Setup the UdpUc protocol for EGM

Input data for EGM contain mainly position data.

The data flow for the signal interface is illustrated below:



xx1400002016

- 1 Motion control calls EGM.
- 2 The measurement data (y- and z-values) are read from the signals or fetched from the sensor at multiples of about 48 ms.
- 3 EGM calculates the position correction and writes it to motion control. If the UdpUc protocol is used, feedback is sent to the sensor.

### 2.4 Output data

# 2.4 Output data

#### Description

Output data is only available for the UdpUc interface.

For instructions on how to implement the UdpUc protocol for an external device, see *The EGM sensor protocol on page 33*. There you will also find a description of output data.

2.5 Configuration

# 2.5 Configuration

#### **Configuration for EGM Position Stream**

The default configuration, which is predefined in RobotWare, works for any position streaming. It will also work with the same configuration as for EGM Position Guidance.

#### **Configuration for EGM Position Guidance**

EGM behavior can be influenced using the system parameters of type *External Motion Interface Data* topic *Motion*. For a description of all available EGM parameters, see *System parameters on page 41*.

Here follows a closer description of the two parameters that influence the EGM control loop. The figure shows a simplified view of the EGM control system.



#### xx1400001083

Default proportional Position Gain	The parameter <i>Position gain</i> in the figure influences the responsiveness moving to the target position, given by the sensor, in relation to the current robot position. The higher the value, the faster the response.
Default Low Pass Filter Bandwith Time	The parameter <i>LP Filter</i> in the figure is the default value used to filter the speed contribution from EGM.

#### **Configuration for EGM Path Correction**

The configuration for EGM Path Correction has to have *Level* set to *Path*. None of the other values are used.

#### 2.6 Frames

### 2.6 Frames

#### Frames for EGM Position Stream

Position streaming does not support dynamic change of tool or load. If EGMStreamStart is used to start the position stream, the active tool and load are passed to the controller. If EGMActJoint or EGMActPose is used, the active tool and load (or if specified, the specified tool and/or load) are passed to the controller. Those tool and load data are then used by EGM for calculation of positions until the position stream is stopped.

#### Frames for EGM Position Guidance

EGM can be run in two different modes, joint mode and pose mode. The following section applies to the EGM pose mode only.

For the joint mode there is no need for reference frames, because both sensor values and position values are axis angles given in degrees relative to the calibration position of each axis. But for the pose mode reference frames are necessary. Measurements from the sensor and directions for position change can only be given relative to reference frames.

The RAPID instruction EGMActPose defines all frames that are available in EGM:

Frame	Description
ΤοοΙ	The tool data to be used for the EGM process is defined with the optional $\tabla Tool$ argument.
Work object	The work object data used for the EGM process is defined with the optional $\mbox{wobj}$ argument.
Correction	The frame to be used to give the final movement direction is defined by the mandatory CorrFrame argument.
Sensor	The frame to be used to interpret the sensor data is defined by the mandatory SensorFrame argument.

#### Tools and work objects

The tool and the work object may be defined in two combinations only:

- 1 If the tool is attached to the robot, the work object has to be fixed.
- 2 If the tool is fixed, the work object has to be attached to the robot.



It is not possible to use a work object or tool that is attached to any other mechanical unit than the EGM robot.

#### Predefined frame types

For the frames CorrFrame and SensorFrame it is also necessary to know what they are related to. This information is specified using the predefined frame types in the data type egmframetype:

Value	Description
EGM_FRAME_BASE	The frame is defined relative to the base frame (pose mode).
EGM_FRAME_TOOL	The frame is defined relative to tool0 (pose mode).

#### 2.6 Frames Continued

Value	Description
EGM_FRAME_WOBJ	The frame is defined relative to the active work object (pose mode).
EGM_FRAME_WORLD	The frame is defined relative to the world frame (pose mode).
EGM_FRAME_JOINT	The values are joint values (joint mode).

#### Frames for EGM Path Correction

EGM Path Correction can only be run in pose mode.

The RAPID instruction EGMActMove defines the only frame that is needed for EGM Path Correction. Tool and Work object are specified in EGMMoveL or EGMMoveC.

#### Tools and work objects

The tool has to be attached to the robot and the work object may be fixed or moved by another mechanical unit.

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3.1.1 EGM sensor protocol overview

# 3 The EGM sensor protocol

### 3.1 Overview

### 3.1.1 EGM sensor protocol overview

#### **Communication and transport protocol**

The EGM sensor protocol is designed for high speed communication between a robot controller and a communication endpoint with minimum overhead.

The communication endpoint is typically a sensor, so *sensor* will be used from now on instead of communication endpoint. Sometimes the sensor is connected to a PC, and the PC then transfers the sensor data to the robot. The purpose of the sensor protocol is to communicate sensor data frequently between the robot controller and sensors. The EGM sensor protocol is using Google Protocol Buffers for encoding and UDP as a transport protocol. Google Protocol Buffers has been selected due to its speed and its language-neutrality. UDP has been chosen as a transport protocol since the data sent is *real-time* data sent with high frequency and if packets get lost it is useless to re-send the data.

#### Data structures and system parameters

The EGM sensor protocol data structures are defined by the EGM proto file. Sensor name, IP-address and port number of sensors are configured in the system parameters. A maximum of eight sensors can be configured.

#### Messages and queue handling

The sensor is acting as a server and it cannot send anything to the robot before it has received a first message from the robot controller. Messages can be sent independently of each other in both directions after that first message. Applications using the protocol may put restrictions on its usage but the protocol itself has no built-in synchronization of request responses or supervision of lost messages. There are no special connect or disconnect messages, only data which can flow in both directions independently of each other. The first message from the robot is a data message. One has also to keep in mind, that a sender of an UDP message continues to send even though the receiver's queue may be full. The receiver has to make sure, that its queue is emptied.

By default, the robot will send and read data from the sensor every 4 milliseconds, independently of when data is sent from the sensor. This cycle time can be changed to a multiple of 4 ms using the optional argument \SampleRate of the RAPID instructions EGMStreamStart, EGMActJoint or EGMActPose.

Each motion task requires its own UDP channel.

3.1.2 Google Protocol Buffers

# 3.1.2 Google Protocol Buffers

Protobuf overview		
	Google Protocol Buffers or <i>Protobuf</i> , are a way to serialize/de-serialize data in a very efficient way. Protobuf is in general 10-100 times faster than XML. There is plenty of information on the Internet about Protobuf and the <i>Google overview</i> is a good start.	
	In short, message structures are described in a <i>.proto</i> file. The <i>.proto</i> file is then compiled. The compiler generates serialized/de-serialized code which is then used by the application. The application reads a message from the network, runs the de-serialization, creates a message, calls serialization method, and then sends the message.	
	It is possible to use Protobuf in most programming languages since Protobuf is language neutral. There are many different implementations depending on the language.	
	The main disadvantage with Protobuf is that Protobuf messages are serialized into a binary format which makes it more difficult to debug packages using a network analyzer.	
Third party tools		
	Except for the <i>Google C++</i> tool, we have also verified the following third party tools and code:	
	<ul> <li>Nanopb, generates C-code and it does not require any dynamic memory allocations.</li> </ul>	
	Protobuf-net, a Google Protobuf .NET library.	
	<ul> <li>Protobuf-csharp, a Google Protobuf .NET library, the C# API is similar to the Google C++ API.</li> </ul>	



Note that the code mentioned above is open source, which means that you have to check the license that the code is allowed to be used in your product.

3.1.3 EGM sensor protocol description

### 3.1.3 EGM sensor protocol description

#### Data structure

The EGM sensor protocol is not a request/response protocol, the sensor can send data at any frequency after the sensor gets the first message from the robot.

The EGM sensor protocol has two main data structures, *EgmRobot* and *EgmSensor*. *EgmRobot* is sent from the robot and *EgmSensor* is sent from the sensor. All message fields in both data structures are defined as optional which means that a field may or may not be present in a message. Applications using *Google Protocol Buffers* must check if optional fields are present or not.

The Google protobul data structure can include the *repeated* element, that is, a list of elements of the same type. The *repeated* element count is a maximum of six elements in the EGM sensor protocol, except for EGMRAPIDdata which has a maximum of 40.

#### PTP support



Note

The implementation of the IEEE1588 timestamp currently has beta status. To activate the IEEE1588 timestamp functionality, the ICI I/O Driver option must be included in the controller. Note that this option can be used without any ICI-specific hardware.

#### Sensor protocol messages

This section describes some of the sensor protocol messages. Note that new optional fields that are not described in this manual can exist.

#### EgmHeader

The EgmHeader is common for both EgmRobot and EgmSensor.

```
message EgmHeader
```

```
{
    optional uint32 seqno = 1; // sequence number (to be able to find
        lost messages)
    optional uint32 tm = 2; // time stamp in milliseconds
    enum MessageType {
        MSGTYPE_UNDEFINED = 0;
        MSGTYPE_COMMAND = 1; // for future use
        MSGTYPE_DATA = 2; // sent by robot controller
        MSGTYPE_DATA = 2; // sent by robot controller
        MSGTYPE_CORRECTION = 3; // sent by sensor for position guidance
        MSGTYPE_PATH_CORRECTION = 4; // sent by sensor for path
        correction
    }
    optional MessageType mtype = 3 [default = MSGTYPE_UNDEFINED];
}
```

# **3** The EGM sensor protocol

# 3.1.3 EGM sensor protocol description *Continued*

Variable	Description
seqno	Sequence number. Applications shall increase the sequence number by one for each message they send. It makes it possible to check for lost mes- sages in a series of messages.
tm	Timestamp in milliseconds. (Can be used for monitoring of delays).
mtype	Message type. Shall be set to MSGTYPE_CORRECTION by the sensor, and is set to MSGTYPE_DATA by the robot controller.

### EgmRobot

message EgmRobot

{			
	optional	EgmHeader	header = 1;
	optional	EgmFeedBack	feedBack = 2;
	optional	EgmPlanned	planned = 3;
	optional	EgmMotorState	motorState = 4;
	optional	EgmMCIState	mciState = 5;
	optional	bool	<pre>mciConvergenceMet = 6;</pre>
	optional	EgmTestSignals	testSignals = 7;
	optional	EgmRapidCtrlExecState	<pre>rapidExecState = 8;</pre>
	optional	EgmMeasuredForce	<pre>measuredForce = 9;</pre>
	optional	double	utilizationRate=10;
	optional	uint32	moveIndex=11;
	optional	EgmCollisionInfo	CollisionInfo = 12;
	optional	EgmRAPIDdata	RAPIDfromRobot = 13;
	optional	EgmJoints	torqueRef = 14;
}			

Variable	Description
header	Reference to EgmHeader.
feedback	Feedback position, that is, measured position for robot and additional axes. See the description of EgmFeedBack for more details.
planned	Reference position for robot and additional axes. See the description of EgmPlanned for more details.
motorState	Motors On state (On, Off).
mciState <sup>i</sup>	Internal EGM state (Running, Stopped, Error).
mciConvergenceMet	Boolean that shows if the convergence criteria defined in the EGM instruction is fulfilled
testSignals	For internal use only.
rapidExecState	RAPID program execution state (Running, Stopped).
measuredForce	Measured contact force. Will show raw sensor force when force control is not active.
#### 3.1.3 EGM sensor protocol description Continued

Description	
This value shows a percentage value of how much of the available robot performance is needed to perform the movement according to the latest sent EgmSensor package. If this value is over 100% then the controller will not be able to perform the full movement and EGM will modify the refer- ence so that the robot will only perform a partial movement in the desired direction. If EgmSensor packages are missing or delayed the last sent EcmPackage will be used and this can also cause the	
utilizationRate temporarily to be very high.	
Simple index counter that will indicate start of movement and change of target.	
Shows an indication of collision for an axis.	
I/O signal and array of dnum that are sent from the robot to the sensor. This data can be used in various ways and adds flexibility to the use of EGM.	
Torque reference for each robot joint. The torque reference output will only be set when path references or path correc- tions are sent to the controller via EGM and the External Motion Interface Level is set to 0, that is, in raw mode.	

The acronym MCI refers to the Motion Correction Interface which is the internal controller interface that EGM uses.

#### EgmSensor

message EgmSensor

{			
	optional	EgmHeader	header = 1;
	optional	EgmPlanned	planned = 2;
	optional	EgmSpeedRef	<pre>speedRef = 3;</pre>
	optional	EgmRAPIDdata	<pre>RAPIDtoRobot = 4;</pre>
}			

Variable	Description	
header	Reference to EgmHeader.	
planned	Reference position for robot and additional axes.	
speedRef	Reference speed for robot and additional axes. The unit is mm/s or degrees/s depending on the type of joint.	
RAPIDfromSensor	I/O signal and array of dnum that are sent from the sensor to the robot. This data can be used in various ways and adds flexibility to the use of EGM.	

#### EgmPlanned

message EgmPlanned

{		
optional	EgmJoints	joints = 1;
optional	EgmPose	cartesian = 2;
optional	EgmJoints external	Joints = 3;
optional	EgmClock	time = $4;$
optional	EgmTimestamp	timeStamp = 5;
}		

## 3 The EGM sensor protocol

# 3.1.3 EGM sensor protocol description *Continued*

Description	
Planned joint position for Robot.	
Planned Cartesian position for Robot.	
Planned position for external axes (6 values).	
Timestamp for when the Robot and external axes will be in the planned position.	
IEEE1588 timestamp for when the robot and external axes will be in the planned position.	
1 Note	
This feature requires the option ICI I/O Driver.	

#### EgmFeedBack

message	EgmFeedBack	
{		
optional	EgmJoints	joints = 1;
optional	EgmPose	cartesian = 2;
optional	EgmJoints external	Joints = 3;
optional	EgmClock	time = $4;$
optional	EgmTimestamp	timeStamp = $5;$
}		

Variable	Description	
joints	Measured joint position for Robot.	
cartesian	Measured Cartesian position for Robot.	
externalJoints	Measured position for external axes (6 values).	
time	Timestamp for when the Robot and external axes was in the measured position.	
timeStamp	IEEE1588 timestamp for when the robot and external axes will be in the planned position.	
	Note	
	This feature requires the option ICI I/O Driver.	

## 3.2 Building an EGM sensor communication endpoint

#### How to build an EGM sensor communication endpoint using .Net

This guide assumes that you build and compile using Visual Studio and are familiar with its operation.

Here is a short description on how to install and create a simple test application using *protobuf-csharp-port*.

	Action		
1	In Visual Studio, create a C# application.		
2	Select Tools and then NuGet Package Manager, and install Google.Protobuf.		
3	In the NuGet Package Manager, also install Google.Protobuf.Tools.		
4	Navigate to Solution package\packages\Google.Protobuf.Tools.3.xx.x\tools\win- dows_x64.		
5	Copy the EGM folder from C:\ProgramData\ABB\DistributionPackages\ABB.RobotWare- 7.yy\RobotPackages\RobotControl_7.zz\utility\Template" to "\packages\Google.Proto- buf.Tools.3.xx.x\tools\windows_x64.		
6	Open a cmd line and run " .\protoc .\egm\egm.protocsharp_out=.\egm ". => Egm.cs file is built Note The egm.proto syntax is proto2.		
7	Add the generated file earn as to the Visual Studio project (add existing item)		
1	Add the generated me egin.cs to the visual Studio project (add existing item).		
8	Copy the example code into the Visual Studio Windows Console application file ( <i>egm-sensor.cs</i> ) and then compile, link and run.		

## 3 The EGM sensor protocol

#### 3.3 Configuring UdpUc devices

### 3.3 Configuring UdpUc devices

#### How to configure UdpUc devices

UdpUc communicates with a maximum of eight devices over Udp. The devices act as servers, and the robot controller acts as a client. It is the robot controller that initiates the connection to the sensor.

Each UDP channel is defined as a device, i.e. you need to set up one device for each motion task where you want to use EGM.

#### System parameters

This is a brief description of the parameters used when configuring a device. For more information about the parameters, see *Technical reference manual - System parameters*.

These parameters belong to the type UDP Unicast Device in topic Communication.

Parameter	Description	
Name	The name of the UDP Unicast Device instance. For example <i>EGMsensor</i> .	
Туре	The type of UDP Unicast Device protocol to be used. The only available UDP Unicast Device type is <i>UDPUC</i> .	
Remote Address	The IP address of the external device, for example, sensor.	
Remote Port Number	The the port number on the network node identified by <i>Re-mote Address</i> .	
Local Port Number	The port number on which the controller will listen for broadcast messages.	

#### Configuration example

The device which provides the input data for EGM, has to be configured as an UdpUc device in the following way:

Name	Туре	Remote Address	Remote Port Number
UCdevice	UDPUC	192.168.10.20	6510

4.1.1 The External Motion Interface Data type

# **4** System parameters

## 4.1 Type External Motion Interface Data

## 4.1.1 The External Motion Interface Data type

#### Overview

This section describes the type *External Motion Interface Data*, which belongs to the topic *Motion*. Each parameter of the type is described in a separate information topic in this section.

#### Type description

The *External Motion Interface Data* type contains a number of parameters that defines the characteristics for an *External Motion Interface Data*.

## 4 System parameters

4.1.2 Name

## 4.1.2 Name

Parent	
	Name belongs to the type External Motion Interface Data, in the topic Motion.
Description	
	The name of the External Motion Interface Data.
Usage	
	This is the public identity of the External Motion Interface Data.
	The parameter does not require a restart of the controller when modified.
Allowed values	
	A string with maximum 32 characters.

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4.1.3 Level

## 4.1.3 Level

Parent			
	Level belongs to the type External Motion Interface Data, in the topic Motion.		
Description			
	<i>External Motion Interface Level</i> determines the system level at which the corrections are applied.		
Usage			
	Level can	have the follow	wing values:
	Value:	Name	Description:
	0	Raw	Corresponds to raw corrections, added just before the servo controllers
	1	Filtering	Applies extra filtering on the correction, but also introduces some extra delays and latency
	2	Path	Applies path corrections.
	The para	neter does not	require a restart of the controller when modified.
Limitation			
	When usi	ng <i>Level 0</i> , low-	pass filtering is necessary to avoid vibrations in the robot.
Allowed values			
	Allowed v	values are level	<i>0</i> , <i>1</i> or <i>2</i>
	The defau	ult value is 1.	

## 4.1.4 Do Not Restart after Motors Off

## 4.1.4 Do Not Restart after Motors Off

Parent	
	Do Not Restart after Motors Off belongs to the type External Motion Interface Data, in the topic Motion.
Description	
	<i>Do Not Restart after Motors Off</i> determines if the <i>External Motion Interface</i> execution should automatically restart after the controller has been in motors off state, for example after an emergency stop.
Usage	
	If <i>False</i> (default), execution of the corrections will continue in the same state as when the system entered the Motors Off state.
	If <i>True</i> , execution will continue with all corrections in the STANDBY state.
Allowed values	
	True or False.

4.1.5 Return to Program Position when Stopped

Parent	
	Return to Program Position when Stopped belongs to the type External Motion
	Interface Data, in the topic Motion.
Description	
	Return to Program Position when Stopped determines if axes currently running
	<i>External Motion Interface</i> should return to the programmed position, when program execution is stopped.
Usage	
	If False (default), axes will stop in their current position.
	If <i>True</i> , axes will move to the programmed start position.
Limitation	
	The motion returning the axes to the programmed position will be defined in joint space. If the axes are far from the programmed position when <i>Return to Programmed Position when Stopped</i> is defined as <i>False</i> , unexpected trajectories may result. Therefore, it is recommended only to set this value to <i>False</i> , if the distance from the programmed position to the corrected position is known to be small.
Allowed values	
	True or False.

## 4.1.5 Return to Program Position when Stopped

## 4 System parameters

## 4.1.6 Default Ramp Time

## 4.1.6 Default Ramp Time

Parent	
	<i>Default Ramp Time</i> belongs to the type <i>External Motion Interface Data</i> , in the topic <i>Motion</i> .
Description	
-	Default Ramp Time defines the default total time for stopping External Motion Interface movements when External Motion Interface execution is stopped.
Usage	
C C	The value will be used to determine how fast the speed contribution from <i>External</i> <i>Motion Interface</i> should be ramped to zero when program execution is stopped, and how fast axes return to the programmed position if the <i>Return to Programmed</i> <i>Position when Stopped</i> is <i>True</i> .
	This value can normally be lower than 1. The value should be tuned and checked during application. A big robot with heavy payload that runs at high speed will need a higher value, while a small robot with small payload that runs at low speed can have a low value to stop quickly.
	Note
	Since movement during ramping will be a joint movement, the robot will deviate from its current position and guidance position during the stop.
Limitation	
	The value only affects the part of the motion that is generated by the <i>External Motion Interface</i> execution. It does not affect any simultaneous movements that have, for instance, been programmed in RAPID.
Allowed values	
	A value between 0.005 and 10.0 seconds.
	The default value is 0.5 seconds.

4.1.7 Default Proportional Position Gain

## 4.1.7 Default Proportional Position Gain

Parent	
	Default Proportional Position Gain belongs to the type External Motion Interface
	Data, in the topic Motion.
Description	
	Default Proportional Position Gain defines the default proportional gain of the
	External Motion Interface position feedback control.
Allowed values	
	A value between 0.0 and 20.0.
	The default value is 5.0.

## 4 System parameters

### 4.1.8 Default Low Pass Filter Bandwidth

## 4.1.8 Default Low Pass Filter Bandwidth

Parent	
	Default Low Pass Filter Bandwidth belongs to the type External Motion Interface
	Data, in the topic <i>Motion</i> .
Description	
	Default Low Pass Filter Bandwidth Time defines the default bandwidth of the
	low-pass filter used to filter the speed contribution from the External Motion Interface
	execution.
Allowed values	
	A value between 0.0 and 100.0 Hz.
	The default value is 20.0 Hz.
	<b>Note</b>
	Too low or too high values can result in unpredictable movement.

## 5.1 Instructions

## 5.1.1 EGMActJoint - Prepare an EGM movement for a joint target

#### Usage

EGMActJoint activates a specific EGM process and defines static data for the sensor guided movement to a joint target, that is, data that is not changed frequently between different EGM movements.

Basic examples	
	VAR egmident egmID1;
	PERS pose pose1:=[[0,0,0], [1,0,0,0]];
	CONST egm_minmax egm_minmax1:=[-1,1];
	VAR signaldo RobotDO 1;
	<pre>PERS dnum RobotOut{10}:= [3.0, 6.0, 9.0, 12.0, 15.0, 18.0, 21.0, 24.0, 27.0, 30];</pre>
	VAR signaldi RobotDI 0;
	PERS dnum RobotIn{10}:= [33.0, 0, 0, 0, 0, 0, 0, 0, 0, 0];
	EGMGetId egmID1;
	EGMSetupAI ROB_1, egmID1, "default" \Pose \aiR1x:=ai_01 \aiR2y:=ai_02 \aiR3z:=ai_03 \aiR4rx:=ai_04 \aiR5ry:=ai_05 \aiR6rz:=ai_06;
	EGMActJoint egmID1 \D0toSensor:=RobotD0 \DataToSensor:=RobotOut \DIfromSensor:=RobotDI \DataFromSensor:=RobotIn \J1:=egm_minmax1 \J3:=egm_minmax1 \J4:=egm_minmax1;
Arguments	
	EGMActJoint EGMid [\StreamStart] [\Tool] [\WObj] [\TLoad] [\DOtoSensor] [\DataToSensor] [\DIfromSensor] [\DataFromSensor] [\J1] [\J2] [\J3] [\J4] [\J5] [\J6] [\J7] [\LpFilter] [\SampleRate] [\MaxPosDeviation] [\MaxSpeedDeviation]
EGMid	
	Data type: eqmident
	EGM identity.
[\StreamStart]	
	Data type: switch
	StreamStart starts streaming position data to external equipment. The data is sent at the cyclicity defined with \SampleRate and the content is according to the protocol specification in the Google Protobuf definition file <i>egm.proto</i> .
	StreamStart is only available if EGM is set up using EGMSetupUC, i.e. the protocol UdpUc is used for communication with the external equipment.

#### 5.1.1 EGMActJoint - Prepare an EGM movement for a joint target *Externally Guided Motion Continued*

## [\Tool] Data type: tooldata The tool in use for movements performed with the instruction EGMRunJoint. The argument $[\Tool]$ is optional. The default value when the argument is omitted is tool0. [\Wobj] The work object in use for movements performed with the instruction EGMRunJoint. 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. [\TLoad] The load in use for movements performed with the instruction EGMRunJoint. 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.

[\DOToSensor]

Data type: signaldo

#### 5.1.1 EGMActJoint - Prepare an EGM movement for a joint target Externally Guided Motion Continued

I/O signal sent from the robot controller to an external interface such as a sensor. The data is sent at the cyclicity defined with \SampleRate and the content is according to the protocol specification in the Google Protobuf definition file egm.proto. The option is only available if EGM is set up using *EGMSetupUC*, that is, the protocol UdpUc is used for communication with the external equipment.

#### [\DataToSensor]

#### Data type: dnum

An array of up to 40 dnum values sent from the robot controller to an external interface such as a sensor. The data is sent at the cyclicity defined with \SampleRate and the content is according to the protocol specification in the Google Protobuf definition file egm.proto. The option is only available if EGM is set up using *EGMSetupUC*, that is, the protocol UdpUc is used for communication with the external equipment.

#### [\DIFromSensor]

#### Data type: signaldi

I/O signal sent from an external interface such as a sensor to the robot controller. The data is sent at the cyclicity defined with \SampleRate and the content is according to the protocol specification in the Google Protobuf definition file egm.proto. The option is only available if EGM is set up using *EGMSetupUC*, that is, the protocol UdpUc is used for communication with the external equipment.

#### [\DataFromSensor]

#### Data type: dnum

An array of up to 40 dnum values sent from an external interface such as a sensor to the robot controller. The data is sent at the cyclicity defined with \SampleRate and the content is according to the protocol specification in the Google Protobuf definition file egm.proto. The option is only available if EGM is set up using *EGMSetupUC*, that is, the protocol UdpUc is used for communication with the external equipment.

#### [J1] [J2] [J3] [J4] [J5] [J6] [J7]

#### Data type: egm\_minmax

Convergence criteria for joint 1 to 6 in degrees for 6-axis robots, and joint 1 to 7 in degrees for 7-axis robots. The default value is  $\pm 0.5$  degrees.

The convergence criteria data is used to decide if the robot has reached the ordered joint positions. If the difference between the ordered joint position and the actual joint position is within the range of egm\_minmax.min and egm\_minmax.max, the joint is regarded to have reached its ordered position. If no convergence criteria is specified for a joint, that was selected in EGMRunJoint, the default value is used.

As soon as all joints that were specified in EGMRunJoint have reached their ordered positions, the robot itself has reached its ordered position and RAPID execution continues with the next RAPID instruction.

[\LpFilter]

Data type: num

#### 5.1.1 EGMActJoint - Prepare an EGM movement for a joint target

# Externally Guided Motion

## Continued

Low pass filter bandwidth, in Hertz (Hz), used to filter sensor noise.

[\SampleRate]

Data type: num

Input data reading sample rate in multiples of 4 milliseconds. Valid values are 4, 8, 12, 16, etc.

The default value is 4 milliseconds.

#### [\MaxPosDeviation]

#### Data type: num

Maximum joint deviation from the programmed position in degrees, i.e. the fine point the EGM movement started at. The same value is used for all joints. The default value is 1000 degrees.

#### [\MaxSpeedDeviation]

Data type: num

Maximum admitted joint speed change in degrees/second. All joints will be reduced with the same ratio if one joint is limited.

The default value is 1.0 degrees/second.

The recommended max value is 50 degrees/s.

#### Limitations

- If EGMActJoint is executed several times with the same EGMid, the latest activation data is used for EGMRunJoint instructions that follow until a new EGMActJoint is run.
- EGMActJoint can only be used in RAPID motion tasks.

#### Syntax

#### EGMActJoint

```
[EGMid ':='] <variable (VAR) of egmident>
['\'Tool ':=' <persistent (PERS) of tooldata>]
['\'Wobj ':=' <persistent (PERS) of wobjdata>
['\'TLoad ':=' <persistent (PERS) of loaddata>]
['\'DOToSensor ':=' <variable> (VAR) of signaldo]
['\'DataToSensor ':=' <persistent> (PERS) of dnum]
['\'DIFromSensor ':=' <variable> (VAR) of signaldi]
['\'DataFromSensor ':=' <persistent> (PERS) of dnum]
['\'J1 ':=' <expression (IN) of egm_minmax>]
['\'J2 ':=' <expression (IN) of eqm_minmax>]
['\'J3 ':=' <expression (IN) of egm_minmax>]
['\'J4 ':=' <expression (IN) of egm_minmax>]
['\'J5 ':=' <expression (IN) of egm_minmax>]
['\'J6 ':=' <expression (IN) of egm_minmax>]
['\'J7 ':=' <expression (IN) of egm_minmax>]
['\'LpFilter ':=' <expression (IN) of num>]
['\'SampleRate ':=' <expression (IN) of num>]
['\'MaxPosDeviation ':=' <expression (IN) of num>]
['\'MaxSpeedDeviation ':=' <expression (IN) of num>] ';'
```

Continues on next page

## 5.1.1 EGMActJoint - Prepare an EGM movement for a joint target Externally Guided Motion Continued

### **Related information**

For information about	See
Instruction EGMRunJoint	EGMRunJoint - Perform an EGM movement with a joint target on page 71
Instruction EGMStreamStart	EGMStreamStart - start EGM position streaming on page 93
Data type egm_minmax	egm_minmax - Convergence criteria for EGM on page 101
MoveJ	Technical reference manual - RAPID Instructions, Functions and Data types

# 5.1.2 EGMActMove - Prepare an EGM movement with path correction *Externally Guided Motion*

## 5.1.2 EGMActMove - Prepare an EGM movement with path correction

Usage	
5	EGMActMove is used to activate a specific EGM process and defines static data for the movement with path correction, i.e. data that is not changed frequently between different EGM path correction movements.
Basic examples	The following example illustrates the instruction EGMActMove.
Example 1	VAR eqmident EGMid1;
	<pre>PERS tooldata tLaser := [TRUE, [[148,50,326], [0.3902618,-0.589657,-0.589656,0.3902630]], [1,[-0.92,0,-0.39], [1,0,0,0], 0,0,0]]; EGMGetId EGMid1;</pre>
	EGMSetupLTAPP ROB_1, EGMid1, "pathCorr", "OptSim", 1\LATR; EGMActMove EGMid1, tLaser.tframe\SampleRate:=48;
	This program registers an EGM process, and sets up a sensor that uses the communication protocol LTAPP and is of the type <i>look-ahead</i> as data source (sensor). The sensor shall use the joint type definition number 1 for the tracking. The rate at which the controller will access the device and the sensor frame of the device are also setup.
Arguments	EGMActMove EGMid, SensorFrame [\SampleRate]
EGMid	
	Data type: egmident EGM identity.
SensorFrame	
	Data type: pose Sensor frame.
[\SampleRate]	
	Data type: num Input data reading sample rate in multiples of 24 ms. Valid values: 24, 48, 72, etcetera.
Program execution	The sensor frame and the sensor sampling rate are connected to an EGM identity until they are either reset with EGMReset or changed by another EGMActMove instruction.
Syntax	EGMActMove [EGMid ':='] <variable (var)="" egmident="" of=""> ',' [SensorFrame ':='] &lt; expression (IN) of pose&gt;</variable>
Continues on next p	age
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## 5.1.2 EGMActMove - Prepare an EGM movement with path correction Externally Guided Motion Continued

['\'SampleRate ':=' <expression (IN) of num>] ';'

#### **Related information**

For information about	See
EGMReset	EGMReset - Reset an EGM process on page 70

# 5.1.3 EGMActPose - Prepare an EGM movement for a pose target *Externally Guided Motion*

## 5.1.3 EGMActPose - Prepare an EGM movement for a pose target

Usage	
	EGMActPose activates a specific EGM process and defines static data for the sensor guided movement to a pose target, that is, data that is not changed frequently between different EGM movements.
Basic examples	
	VAR egmident egmID1;
	PERS pose pose1:=[[0,0,0], [1,0,0,0]];
	CONST egm_minmax egm_minmax_rot:= $[-0, 1, 0, 2]$ ;
	CONST pose posecor:=[[1200 400 900] [0 0 1 0]];
	CONST pose posesens:= $[[12, 3313, -0, 108707, 416, 142]$ .
	[0.903899,-0.00320735,0.427666,0.00765917]];
	VAR signaldo RobotDO 1;
	<pre>PERS dnum RobotOut{10}:= [3.0, 6.0, 9.0, 12.0, 15.0, 18.0, 21.0, 24.0, 27.0, 30];</pre>
	VAR signaldi RobotDI 0;
	PERS dnum RobotIn{10}:= [33.0, 0, 0, 0, 0, 0, 0, 0, 0, 0];
	EGMGetId egmID1;
	EGMSetupAI ROB_1, egmID1, "default" \Pose \aiR1x:=ai_01
	\aiR2y:=ai_02 \aiR3z:=ai_03 \aiR4rx:=ai_04 \aiR5ry:=ai_05 \aiR6rz:=ai_06;
	EGMActPose egmID1 \Tool:=tool0 \WObj:=wobj0, \DOtoSensor:=RobotD0 \DataToSensor:=RobotOut \DIfromSensor:=RobotDI
	<pre>\DataFromSensor:=RobotInposecor, EGM_FRAME_WOBJ, posesens, EGM_FRAME_TOOL \x:=egm_minmax_lin \y:=egm_minmax_lin \z:=egm_minmax_lin \rx:=egm_minmax_rot \ry:=egm_minmax_rot \rz:=egm_minmax_rot \LpFilter:=20;</pre>
Argumonto	
Arguments	EGMActPose EGMid [\StreamStart] [\Tool] [\WObi] [\TLoad]
	[\DOtoSensor] [\DataToSensor] [\DIfromSensor] [\DataFromSensor] CorrFrame CorrFrType SensorFrame SensorFrType [\x] [\y] [\z] [\rx] [\ry] [\rz] [\LpFilter] [\SampleRate] [\MaxPosDeviation] [\MaxSpeedDeviation]
EGMid	
	Data type: equident
	EGM identity.
[\StreamStart]	
	Data type: switch
	StreamStart starts streaming position data to external equipment. The data is sent at the cyclicity defined with \SampleRate and the content is according to the protocol specification in the Google Protobul definition file <i>egm.proto</i> .
	StreamStart is only available if EGM is set up using EGMSetupUC, i.e. the protocol UdpUc is used for communication with the external equipment.
Continues on next p	age

5.1.3 EGMActPose - Prepare an EGM movement for a pose target Externally Guided Motion Continued

[\Tool]	
	Data type: tooldata
	The tool in use for movements performed with the instruction EGMRunPose.
	The argument [ $\Tool$ ] is optional. The default value when the argument is omitted is tool0.
[\Wobj]	
	The work object in use for movements performed with the instruction EGMRunPose. 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.
[\TLoad]	
	The load in use for movements performed with the instruction EGMRunPose.
	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.
	<b>Note</b>
	Therefore the default value of the system parameter ModalPayLoadMode is 1.

[\DOToSensor]

Data type: signaldo

# 5.1.3 EGMActPose - Prepare an EGM movement for a pose target *Externally Guided Motion*

Continued

I/O signal sent from the robot controller to an external interface such as a sensor. The data is sent at the cyclicity defined with \SampleRate and the content is according to the protocol specification in the Google Protobuf definition file egm.proto. The option is only available if EGM is set up using *EGMSetupUC*, that is, the protocol UdpUc is used for communication with the external equipment.

#### [\DataToSensor]

#### Data type: dnum

An array of up to 40 dnum values sent from the robot controller to an external interface such as a sensor. The data is sent at the cyclicity defined with \SampleRate and the content is according to the protocol specification in the Google Protobuf definition file egm.proto. The option is only available if EGM is set up using *EGMSetupUC*, that is, the protocol UdpUc is used for communication with the external equipment.

#### [\DIFromSensor]

Data type: signaldi

I/O signal sent from an external interface such as a sensor to the robot controller. The data is sent at the cyclicity defined with \SampleRate and the content is according to the protocol specification in the Google Protobuf definition file egm.proto. The option is only available if EGM is set up using *EGMSetupUC*, that is, the protocol UdpUc is used for communication with the external equipment.

## [\DataFromSensor]

#### Data type: dnum

An array of up to 40 dnum values sent from an external interface such as a sensor to the robot controller. The data is sent at the cyclicity defined with \SampleRate and the content is according to the protocol specification in the Google Protobuf definition file egm.proto. The option is only available if EGM is set up using *EGMSetupUC*, that is, the protocol UdpUc is used for communication with the external equipment.

CorrFrame	
	Data type: pose
	Correction frame.
CorrFrType	
	Data type: egmframetype
	Frame type of the correction frame
SensorFrame	
	Data type: pose
	Sensor frame.
SensFrType	
	Data type: egmframetype
	Frame type of the sensor frame.

#### 5.1.3 EGMActPose - Prepare an EGM movement for a pose target Externally Guided Motion Continued

## [\x] [\y] [\z]

Data type: egm\_minmax

Convergence criteria for x, y, and z in millimeters. The default value is  $\pm 1.0$  millimeters.

The convergence criteria data is used to decide if the robot has reached the ordered position in the specified axis direction. If the difference between the ordered position and the actual position is within the range of <code>egm\_minmax.min</code> and <code>egm\_minmax.max</code>, the robot is regarded to have reached its ordered position. If no convergence criteria is specified for an axis direction, that was selected in <code>EGMRunPose</code>, the default value is used.

As soon as all axes that were specified in EGMRunPose have reached their ordered positions, the robot itself has reached its ordered position and RAPID execution continues with the next RAPID instruction.

## [\rx] [\ry] [\rz]

Data type: egm\_minmax

Convergence criteria for rotation x, y, and z in degrees. The default value is  $\pm 0.5$  degrees.

The convergence criteria data is used to decide if the robot has reached the ordered orientation along the specified axis. If the difference between the ordered orientation and the actual orientation is within the range of egm\_minmax.min and egm\_minmax.max, the robot is regarded to have reached its ordered orientation. If no convergence criteria is specified for an axis orientation, that was selected in EGMRunPose, the default value is used.

As soon as all axes orientations that were specified in EGMRunPose have reached their ordered orientation, the robot itself has reached its ordered position and RAPID execution continues with the next RAPID instruction.

## [\LpFilter]

## Data type: num

Low pass filter bandwidth, in Hertz (Hz), used to filter sensor noise. The default value is taken from the configuration of the EGMSetupXX instruction.

## [\SampleRate]

## Data type: num

Input data reading sample rate in multiples of 4 milliseconds. Valid values are 4, 8, 12, 16, etc.

The default value is 4 milliseconds.

## [\MaxPosDeviation]

## Data type: num

Maximum joint deviation from the programmed position in degrees, i.e. the fine point the EGM movement started at. The same value is used for all joints. The default value is 1000 degrees.

## 5.1.3 EGMActPose - Prepare an EGM movement for a pose target

#### Externally Guided Motion Continued

[\MaxSpeedDeviation]

Data type: num

Maximum admitted joint speed change in degrees/second. All joints will be reduced with the same ratio if one joint is limited.

The default value is 1.0 degrees/second.

The recommended max value is 50 degrees/s.

#### Limitations

- If EGMActPose is executed several times with the same EGMid, the latest activation data is used for EGMRunPose instructions that follow until a new EGMActPose is run.
- EGMActPose can only be used in RAPID motion tasks.

#### Syntax

EGMActPose
[EGMid ':='] <variable (<b="">VAR) of egmident&gt;</variable>
['\'Tool ':=' <persistent (<b="">PERS) of tooldata&gt;]</persistent>
['\'Wobj ':=' <persistent (<b="">PERS) of wobjdata&gt;]</persistent>
['\'TLoad ':=' <persistent (<b="">PERS) of loaddata&gt;] ','</persistent>
['\'DOToSensor ':=' <variable> (VAR) of signaldo]</variable>
['\'DataToSensor ':=' <persistent> (PERS) of dnum]</persistent>
['\'DIFromSensor ':=' <variable> (VAR) of signaldi]</variable>
['\'DataFromSensor ':=' <persistent> (PERS) of dnum]</persistent>
[CorrFrame ':='] < expression (IN) of pose> ','
[CorrFrType ':='] < expression ( <b>IN</b> ) of egmframetype> ','
[SensorFrame ':='] < expression (IN) of pose> ','
[SensorFrType ':='] < expression (IN) of egmframetype>
$[' \ x ':=' < expression (IN) of egm_minmax>]$
['\'y ':=' <expression (<b="">IN) of egm_minmax&gt;]</expression>
$[' 'z ':=' < expression (IN) of egm_minmax>]$
['\'rx ':=' <expression (in)="" egm_minmax="" of="">]</expression>
['\'ry ':=' <expression (in)="" egm_minmax="" of="">]</expression>
['\'rz ':=' <expression (in)="" egm_minmax="" of="">]</expression>
['\'LpFilter ':=' <expression (in)="" num="" of="">]</expression>
['\'SampleRate ':=' <expression (<b="">IN) of num&gt;]</expression>
$[' \ MaxPosDeviation ':=' < expression (IN) of num>]$
['\'MaxSpeedDeviation ':=' <expression (in)="" num="" of="">] ';'</expression>

#### **Related information**

For information about	See
Instruction EGMRunPose	EGMRunPose - Perform an EGM movement with a pose target on page 74
Instruction EGMStreamStart	EGMStreamStart - start EGM position streaming on page 93
<b>Data type</b> egm_minmax	egm_minmax - Convergence criteria for EGM on page 101

5.1.4 EGMGetId - Gets an EGM identity Externally Guided Motion

## 5.1.4 EGMGetId - Gets an EGM identity

Usage		
	EGMGetId is used to reserve in all other EGM RAPID instru connected to the RAPID mot	e an EGM identity (EGMid). That identity is then used ctions and functions to identify a certain EGM process ion task from which it is used.
	An egmident is identified by with the same egmident wil content.	v its name, that is, a second or third call of EGMGetId I neither reserve a new EGM process nor change its
	To release an egmident for EGMReset has to be used.	use by other EGM processes, the RAPID instruction
	It is possible to use maximu	m 4 different EGM identities at the same time.
Basic examples		
	VAR egmident egmID1;	
	EGMGetId egmID1;	
Arguments		
	EGMGetId EGMid	
EGMid		
	Data type: egmident	
	EGM identity.	
Limitations		
	• EGMGetId can only be	used in RAPID motion tasks.
Syntax		
	EGMGetId	
	[EGMid ':='] <varia< td=""><td>able (<b>VAR</b>) of egmident&gt; ';'</td></varia<>	able ( <b>VAR</b> ) of egmident> ';'
Related information		

For information about	See
EGMReset	EGMReset - Reset an EGM process on page 70

# 5.1.5 EGMMoveC - Circular EGM movement with path correction *Externally Guided Motion*

## 5.1.5 EGMMoveC - Circular EGM movement with path correction

Usage	
	EGMMoveC is used to move the tool center point (TCP) circularly to a given destination with path correction. During the movement the orientation normally remains unchanged relative to the circle.
Basic examples	
	The following example illustrates the instruction EGMMoveC.
Example 1	
	VAR egmident EGMid1;
	PERS tooldata tReg := [TRUE, [[148,0,326], [0.8339007,0,0.551914,0]], [1,[0,0,100], [1,0,0,0], 0,0,0]];
	<pre>PERS tooldata tLaser := [TRUE, [[148,50,326],       [0.3902618,-0.589657,-0.589656,0.3902630]],</pre>
	[1, [-0.92, 0, -0.39], [1, 0, 0, 0], 0, 0, 0]];
	EGMGetId EGMid1;
	EGMSetupLTAPP ROB_1, EGMid1, "pathCorr", "OptSim", 1\LATR;
	EGMActMove EGMid1, tLaser.tframe\SampleRate:=48;
	MoveL p6, v10, fine, tReg\WObj:=wobj0;
	EGMMoveL EGMid1, p12, v10, z5, tReg\WObj:=wobj0;
	EGMMoveL EGMidl, p7, v10, z5, tReg\WObj:=wobj0;
	EGMMoveC EGMidl, p13, p14, v10, z5, tReg\WObj:=wobj0;
	EGMMOVEL EGMIAI, p15, VIU, fine, tReg\WODj:=woDjU;
	MoveL p8, vluuu, zlu, tReg\WObj:=wobju;
	EGMRESET EGMIAI;
	communication protocol LTAPP and is of the type <i>look-ahead</i> as data source (sensor). The sensor shall use the joint type definition number 1 for the tracking. The rate at which the controller will access the device and the sensor frame of the device are also setup.
	The robot is moved to the start point of the tracking path with a MoveL instruction. The EGMMove instructions perform the robot movement with corrections from the sensor.
	Finally the robot is moved to a departure position, and the EGM identity is released.
Arguments	
-	EGMMoveC EGMid, CirPoint, ToPoint, Speed, Zone, Tool, [\Wobj] [\TLoad] [\NoCorr]
EGMid	
	Data type: egmident
	EGM identity.
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
Continues on next	page
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	5.1.5 EGMMoveC - Circular EGM movement with path correction Externally Guided Motion Continued
	placed about halfway between the start and destination points. If it is placed too close to the start or destination point, the robot may give a warning. The circle point is defined as a named position or stored directly in the instruction (marked with an * in the instruction). The position of the external axes are not used.
ToPoint	
	Data type:robtarget
	The destination point of the robot and external axes. It is defined as a named position or stored directly in the instruction (marked with an * in the instruction).
Speed	
	Data type: speeddata
	The speed data that applies to movements. Speed data defines the velocity of the TCP, the tool reorientation, and external axes.
Zone	
	Data type:zonedata
	Zone data for the movement. Zone data describes the size of the generated corner path.
Tool	
	Data type: tooldata
	The tool in use when the robot moves. The tool 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.
[\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 <b>\TLoad</b> argument is set to load0, then the <b>\TLoad</b> 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.

# 5.1.5 EGMMoveC - Circular EGM movement with path correction *Externally Guided Motion*

Continued

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.



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

[\NoCorr]

Data type: switch

Path correction is switched off.

#### **Program execution**

EGMMoveC moves the robot along a programmed circular path with superimposed corrections from a sensor. During the movement the instruction requests correction data from the sensor at the rate set up with EGMActMove. If the optional argument \NoCorr is present, no correction is added to the programmed path.

#### **Error handling**

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

Name	Cause of error
ERR_UDPUC_COMM	An error occurred in the communication with the UdpUc device.
	In synchronous mode ERR_UDPUC_COMM is always a recoverable error, which can be handled by an error handler.
	In asynchronous mode (EGMRunX\NoWait) ERR_UDPUC_COMM is always raised as fatal error if EGM is executed.

#### Limitations

- EGMMoveC can only be used in RAPID motion tasks.
- EGMMoveC cannot be executed in an UNDO handler or RAPID routine connected to any of the following special system events: PowerOn, Stop, QStop, Restart, Reset or Step.

#### Syntax

```
EGMMoveC
[GMid ':='] <variable (VAR) of egmident> ','
[CirPoint ':='] < expression (IN) of robtarget> ','
[ToPoint ':='] < expression (IN) of robtarget> ','
[Speed ':='] < expression (IN) of speeddata> ','
```

5.1.5 EGMMoveC - Circular EGM movement with path correction Externally Guided Motion Continued

```
[Zone ':='] < expression (IN) of zonedata> ','
[Tool ':='] < persistent (PERS) of tooldata>
['\'WObj ':=' < persistent (PERS) of wobjdata>]
['\'TLoad ':=' < persistent (PERS) of loaddata>]
['\'NoCorr] ';'
```

#### **Related information**

For information about	See
MoveC	Technical reference manual - RAPID Instructions, Functions and Data types

# 5.1.6 EGMMoveL - Linear EGM movement with path correction *Externally Guided Motion*

## 5.1.6 EGMMoveL - Linear EGM movement with path correction

Usage	
EGMMoveL is used to move the tool center point (TCP) linearly to a given desti with path correction. When the TCP is to remain stationary then this instruc can also be used to reorient the tool.	ination ction
Basic examples	
The following example illustrates the instruction EGMMoveL.	
Example 1	
VAR egmident EGMid1;	
PERS tooldata tReg := [TRUE, [[148,0,326], [0.8339007,0,0.551914,0]], [1,[0,0,100], [1,0,0,0], 0,0	),0]];
PERS tooldata tLaser := [TRUE, [[148,50,326], [0.3902618,-0.589657,-0.589656,0.3902630]],	
[1,[-0.92,0,-0.39], [1,0,0,0], 0,0,0]];	
EGMGetId EGMid1;	
EGMSetupLTAPP ROB_1, EGMid1, "pathCorr", "OptSim", 1\LATR;	
EGMActMove EGMid1, tLaser.tframe\SampleRate:=48;	
MoveL p6, v10, fine, tReg\WObj:=wobj0;	
EGMMoveL EGMid1, p12, v10, z5, tReg\WObj:=wobj0;	
EGMMoveL EGMid1, p7, v10, z5, tReg\WObj:=wobj0;	
EGMMoveC EGMid1, p13, p14, v10, z5, tReg\WObj:=wobj0;	
EGMMoveL EGMid1, p15, v10, fine, tReg\WObj:=wobj0;	
MoveL p8, v1000, z10, tReg\WObj:=wobj0;	
EGMRESET EGMIQI/	
communication protocol LTAPP and is of the type <i>look-ahead</i> as data source (sensor). The sensor shall use the joint type definition number 1 for the trace The rate at which the controller will access the device and the sensor frame device are also setup.	ce cking. of the
The robot is moved to the start point of the tracking path with a MoveL instru- The EGMMove instructions perform the robot movement with corrections from sensor.	uction. om the
Finally the robot is moved to a departure position, and the EGM identity is rele	eased.
Arguments	
EGMMoveL EGMid, ToPoint, Speed, Zone, Tool, [\Wobj] [\TLoad] [\NoCorr]	I
EGMid	
Data type: egmident	
EGM identity.	
ToPoint	
Data type:robtarget	
The destination point of the robot and external axes. It is defined as a name position or stored directly in the instruction (marked with an * in the instruction (marked with an * in the instruction)	ed tion).
Continues on next page	
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EGMMoveL - Linear EGM movement with path correction	5.1.6		
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Continuea			

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.
Zone	
	Data type:zonedata
	Zone data for the movement. Zone data describes the size of the generated corner path.
Tool	
	Data type: tooldata
	The tool in use when the robot moves. The tool 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.
[\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.

#### 5.1.6 EGMMoveL - Linear EGM movement with path correction **Externally Guided Motion** Continued

	1 Note	
	The default functiona	lity to handle payload is to use the instruction GripLoad.
	Therefore the default	value of the system parameter ModalPayLoadMode is 1.
[\NoCorr]		
[ (NOCOTT ]	Data type: switch	
	Path correction is swit	ched off
Program execution		
	$\texttt{EGMMoveL} \ \textbf{moves the}$	robot along a programmed linear path with superimposed
	corrections from a sense	sor. During the movement the instruction requests correction
	data from the sensor a	t the rate set up with EGMActMove. If the optional argument
	\NoCorr Is present, n	o correction is added to the programmed path.
Error handling		
5	The following recovera	able errors are generated and can be handled in an error
	handler. The system v	ariable ERRNO will be set to:
	Name	Cause of error
	ERR_UDPUC_COMM	An error occurred in the communication with the UdpUc device.
		In synchronous mode ERR_UDPUC_COMM is always a recoverable error, which can be handled by an error handler.
		In asynchronous mode (EGMRunX\NoWait) ERR_UDPUC_COMM is always raised as fatal error if EGM is executed.
Limitations		
		any he used in PARID motion tasks

## Limitations

- EGMMoveL can only be used in RAPID motion tasks.
- EGMMoveL cannot be executed in an UNDO handler or RAPID routine connected to any of the following special system events: PowerOn, Stop, QStop, Restart, Reset or Step.

#### **Syntax**

```
EGMMoveL
  [EGMid ':='] <variable (VAR) of egmident> ','
  [ToPoint ':='] < expression (IN) of robtarget> ','
  [Speed ':='] < expression (IN) of speeddata> ','
  [Zone ':='] < expression (IN) of zonedata> ','
  [Tool ':='] < persistent (PERS) of tooldata>
  ['\'WObj ':=' < persistent (PERS) of wobjdata>]
  ['\'TLoad ':=' < persistent (PERS) of loaddata>]
  ['\'NoCorr] ';'
```

## 5.1.6 EGMMoveL - Linear EGM movement with path correction Externally Guided Motion Continued

### **Related information**

For information about	See
MoveL	Technical reference manual - RAPID Instructions, Functions and Data types

5.1.7 EGMReset - Reset an EGM process Externally Guided Motion

## 5.1.7 EGMReset - Reset an EGM process

Usage	
	EGMReset resets a specific EGM process (EGMid), that is, the reservation is
	canceled.
Basic examples	
	VAR egmident egmID1;
	PERS pose pose1:=[[0,0,0], [1,0,0,0]];
	CONST egm_minmax egm_minmax_lin:=[-0.1,0.1];
	CONST egm_minmax egm_minmax_rot:=[-0.1,0.2];
	CONST pose posecor:=[[1200,400,900], [0,0,1,0]];
	CONST pose posesens:=[[12.3313,-0.108707,416.142],
	[0.903899,-0.00320735,0.427666,0.00765917]];
	EGMGetId egmID1;
	EGMSetupAI ROB_1, egmID1, "default" \Pose \aiR1x:=ai_01
	\aiR2y:=ai_02 \aiR3z:=ai_03 \aiR4rx:=ai_04 \aiR5ry:=ai_05 \aiR6rz:=ai_06;
	EGMActPose egmID1 \Tool:=tool0 \WObj:=wobj0, posecor,
	EGM_FRAME_WOBJ, posesens, EGM_FRAME_TOOL $\x:=egm_minmax_lin$
	\y:=egm_minmax_lin \z:=egm_minmax_lin \rx:=egm_minmax_rot \ry:=egm_minmax_rot \rz:=egm_minmax_rot \LpFilter:=20;
	EGMRunPose egmID1, EGM_STOP_HOLD $x y z rx ry rz$
	\RampInTime:=0.05;
	EGMReset egmID1;
Arguments	
	EGMReset EGMid
EGMid	
	Data type: egmident
	EGM identity.
Syntax	
	EGMReset

[EGMid ':='] <variable (VAR) of egmident>';'

5.1.8 EGMRunJoint - Perform an EGM movement with a joint target Externally Guided Motion

## 5.1.8 EGMRunJoint - Perform an EGM movement with a joint target

Usage	
	EGMRunJoint performs a sensor guided movement to a joint target from a fine
	point for a specific EGM process ( ${\tt EGMid}$ ) and defines which joints will be moved.
Basic examples	
·	VAR egmident egmID1;
	PERS pose pose1:=[[0,0,0],[1,0,0,0]];
	CONST egm_minmax egm_minmax1:=[-1,1];
	EGMGetId egmID1;
	EGMSetupAI ROB_1, egmID1, "default" \Joint \aiR1x:=ai_01 \aiR2y:=ai_02 \aiR3z:=ai_03 \aiR4rx:=ai_04 \aiR5ry:=ai_05 \aiR6rz:=ai_06;
	EGMActJoint egmID1, \J1:=egm_minmax1 \J3:=egm_minmax1 \J4:=egm_minmax1;
	EGMRunJoint egmID1, EGM_STOP_HOLD \J1 \J3 \RampInTime:=0.05;
Arguments	
A guillente	EGMRunJoint EGMid, Mode [\NoWaitCond] [\J1] [\J2] [\J3] [\J4] [\J5] [\J6] [\J7] [\CondTime] [\RampInTime] [\RampOutTime] [\PosCorrGain]
EGMid	
	Data type: egmident
	EGM identity.
Mode	
	Data type: egmstopmode
	Defines how the movement is ended (EGM_STOP_HOLD, EGM_STOP_RAMP_DOWN)
[\NoWaitCond]	
[ (nonarecona)	Data type: switch
	If this optional argument is used, EGMRunJoint will release the RAPID program pointer before the movement is completed. It is then mandatory to use the RAPID instruction EGMWaitCond to complete the EGM Position Guidance movement. Between EGMRunJoint and EGMWaitCond no other movement instruction is allowed.
[\J1] [\J2] [\J3	] [\J4] [\J5] [\J6] [\J7]
	Data type: switch
	Move joint 1 to 6 for 6-axis robots, and joint 1 to 7 for 7-axis robots.
[\CondTime]	
	Data type: num
	The time in seconds that the convergence criteria defined in EGMActJoint has to be fulfilled before the target point is considered to be reached and EGMRunJoint releases RAPID execution to continue to the next instruction.
	Continues on next page

5.1.8 EGMRunJoint Externally Guided M Continued	- Perform an EGM movement with a joint target otion
	The default value is 1 s.
[\RampInTime]	
	Data type: num
	Defines in seconds how fast EGM ramps in the movement after start, from the initial position to full tracking of the input position and speed. Defines in seconds how fast the movement is started.
[\RampOutTime]	
	Data type: num
	Defines in seconds how fast a ramp down of EGM to the EGM start position will be performed in case parameter Mode is set to EGM_STOP_RAMP_DOWN.
	This parameter has no meaning if the parameter Mode is set to EGM_STOP_HOLD.
	The default ramp time is if stop is set from other inputs than RAPID, for example, program stop or similar.
[\PosCorrGain]	
	Data type: num
	Position correction gain. A value between 0 and 1, default 1.

#### Error handling

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

Name	Cause of error
ERR_UDPUC_COMM	An error occurred in the communication with the UdpUc device.
	In synchronous mode ERR_UDPUC_COMM is always a recoverable error, which can be handled by an error handler.
	In asynchronous mode (EGMRunX\NoWait) ERR_UDPUC_COMM is always raised as fatal error if EGM is executed.

#### Limitations

- Before the first use of EGMRunJoint the robot must have been moved since the controller was started by the execution of a Move instruction from RAPID.
- The starting point for an EGMRunJoint movement has to be a fine point.
- EGMRunJoint can only be used in RAPID motion tasks.
- If the instruction EGMActPose was executed instead of EGMActJoint, the following fatal error will occur: 41826 EGM mode mismatch.
- If none of the switches \J1 to \J7 are specified, no movement is performed and RAPID execution continues to the next RAPID instruction.

#### Syntax

```
EGMRunJoint
```

```
[EGMid ':='] <variable (VAR) of egmident> ','
[Mode ':='] < expression (IN) of egmstopmode>
['\'NoWaitCond]
```
5.1.8 EGMRunJoint - Perform an EGM movement with a joint target Externally Guided Motion Continued

['\'J1] ['\'J2] ['\'J3] ['\'J4] ['\'J5] ['\'J6] ['\'GondTime ':=' <expression (IN) of num>] ['\'RampInTime ':=' <expression (IN) of num>] ['\'RampOutTime ':=' <expression (IN) of num>] ['\'PosCorrGain ':=' <expression (IN) of num>] ';'

For information about	See
egmstopmode	egmstopmode - Defines stop modes for EGM on page 104
MoveJ	Technical reference manual - RAPID Instructions, Functions and Data types

# 5.1.9 EGMRunPose - Perform an EGM movement with a pose target *Externally Guided Motion*

# 5.1.9 EGMRunPose - Perform an EGM movement with a pose target

Usuge	EGMRunPose performs a sensor guided movement to a pose target from a fine point for a specific EGM process (EGMid) and defines which directions and
	orientations may be changed.
Basic examples	
•	VAR egmident egmID1;
	PERS pose pose1:=[[0,0,0],[1,0,0,0]];
	CONST egm_minmax egm_minmax_lin:=[-0.1,0.1];
	CONST egm_minmax egm_minmax_rot:=[-0.1,0.2];
	CONST pose posecor:=[[1200,400,900],[0,0,1,0]];
	CONST pose posesens:=[[12.3313,-0.108707,416.142],
	[0.903899,-0.00320735,0.427666,0.00765917]];
	EGMGetId egmID1;
	EGMSetupAI ROB_1, egmID1, "default" \Pose \aiR1x:=ai_01
	\aiR2y:=ai_02 \aiR3z:=ai_03 \aiR4rx:=ai_04 \aiR5ry:=ai_05 \aiR6rz:=ai_06;
	EGMActPose egmID1 \Tool:=tool0 \WObj:=wobj0, posecor,
	EGM_FRAME_WOBJ, posesens, EGM_FRAME_TOOL \x:=egm_minmax_lin \y:=egm_minmax_lin \z:=egm_minmax_lin \rx:=egm_minmax_rot \ry:=egm_minmax_rot \rz:=egm_minmax_rot \LpFilter:=20;
	EGMRunPose emmID1. EGM STOP HOLD \x \v \z \rx \rv \rz
	\RampInTime:=0.05;
Arguments	
5	EGMRunPose EGMid, Mode [\NoWaitCond] [\x] [\y] [\z] [\rx] [\ry] [\rz] [\CondTime] [\RampInTime] [\RampOutTime] [\Offset] [\PosCorrGain]
EGMid	
	Data type: egmident
	EGM identity.
Mode	
	Data type: egmstopmode
	Defines how the movement is ended (EGM_STOP_HOLD, EGM_STOP_RAMP_DOWN)
[\NoWaitCond]	
	Data type: switch
	If this optional argument is used, EGMRunPose will release the RAPID program
	pointer before the movement is completed. It is then mandatory to use the RAPID instruction EGMWaitCond to complete the EGM Position Guidance movement. Between EGMRunPose and EGMWaitCond no other movement instruction is allowed.
[\x] [\y] [\z]	
	Data type: switch
	Movement in x, y, and z direction.
Continues on next r	bage

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## 5.1.9 EGMRunPose - Perform an EGM movement with a pose target Externally Guided Motion Continued

[\rx] [\ry] [\rz	z ]
	Data type: switch
	Reorientation around x, y, and z axes.
[\CondTime]	
	Data type: num
	The time in seconds that the convergence criteria defined in EGMActPose has to be fulfilled before the target point is considered to be reached and EGMRunPose releases RAPID execution to continue to the next instruction.
	The default value is 1 s.
[\RampInTime]	
	Data type: num
	Defines in seconds how fast EGM ramps in the movement after start, from the initial position to full tracking of the input position and speed. Defines in seconds how fast the movement is started.
[\RampOutTime]	
	Data type: num
	Defines in seconds how fast a ramp down of EGM to the EGM start position will be performed in case parameter Mode is set to EGM_STOP_RAMP_DOWN.
	This parameter has no meaning if the parameter Mode is set to EGM_STOP_HOLD.
	The default ramp time is if stop is set from other inputs than RAPID, for example, program stop or similar.
[\Offset]	
	Data type: pose
	Possibility to define a static offset on top of the value given by the sensor.
[\PosCorrGain]	
	Data type: num
	Position correction gain. A value between 0 and 1, default 1.

### **Error handling**

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

Name	Cause of error	
ERR_UDPUC_COMM	An error occurred in the communication with the UdpUc device.	
	In synchronous mode ERR_UDPUC_COMM is always a recoverable error, which can be handled by an error handler.	
	In asynchronous mode (EGMRunX\NoWait) ERR_UDPUC_COMM is always raised as fatal error if EGM is executed.	

#### 5.1.9 EGMRunPose - Perform an EGM movement with a pose target

['\'rz]

For information about

egmstopmode

Externally Guided Motion Continued

**Related information** 

Limitations	
	Before the first use of EGMRunPose the robot must have been moved since
	the controller was started by the execution of a ${\tt Move}$ instruction from RAPID.
	• The starting point for an EGMRunPose movement has to be a fine point.
	• EGMRunPose can only be used in RAPID motion tasks.
	• If the instruction EGMActJoint was executed instead of EGMActPose, the following fatal error will occur: 41826 EGM mode mismatch.
	<ul> <li>If none of the switches \x to \rz are specified, no movement is performed and RAPID execution continues to the next RAPID instruction.</li> </ul>
Syntax	
	EGMRunPose
	[EGMid ':='] <variable (var)="" egmident="" of="">','</variable>
	[Mode ':='] < expression (IN) of egmstopmode>
	['\'NoWaitCond]
	['\'x]
	['\'y]
	['\'z]
	['\'rx]
	['\'ry]

['\'CondTime ':=' <expression (IN) of num>]
['\'RampInTime ':=' <expression (IN) of num>]
['\'RampOutTime ':=' <expression (IN) of num>]
['\'Offset ':=' <expression (IN) of pose>]

['\'PosCorrGain ':=' <expression (IN) of num>] ';'

See

page 104

egmstopmode - Defines stop modes for EGM on

5.1.10 EGMSetupAI - Setup analog input signals for EGM *Externally Guided Motion* 

# 5.1.10 EGMSetupAI - Setup analog input signals for EGM

Usage	EGMSetupAT is used to set up analog input signals for a specific EGM process
	(EGMid), as the source for position destination values to which the robot, and up to 6 additional axis, is to be guided.
	EGM joint mode is the only EGM mode that supports 7-axis robots. For 7-axis robots, the first additional axis input provides the position for the additional robot axis.
Basic examples	VAR egmident egmID1;
	EGMGetid egmiD1;
	EGMSetupAI ROB_1, egmID1, "default" \Pose \aıR1x:=ai_01 \aiR2y:=ai_02 \aiR3z:=ai_03 \aiR4rx:=ai_04 \aiR5ry:=ai_05 \aiR6rz:=ai_06;
Arguments	
	EGMSetupAI MecUnit, EGMid, ExtConfigName [\Joint]   [\Pose]
	[\aiR3z] [\aiR4rx] [\aiR5ry] [\aiR6rz] [\aiE1] [\aiE2] [\aiE3] [\aiE4] [\aiE5] [\aiE6]
MecUnit	
	Data type: mecunit
	Mechanical unit name.
EGMid	
	Data type: egmident
	EGM identity.
ExtConfigName	
	Data type: string
	The name of the external motion interface data as defined in the system parameters.
	For more information see <i>Technical reference manual - System parameters</i> , type External Motion Interface Data, topic Motion.
[\Joint]	
	Data type: switch
	Selects joint movement for position guidance.
	At least one of the switches \Joint, \Pose, or \PathCorr has to be present.
[\Pose]	
	Data type: switch
	Selects pose movement for position guidance.
	At least one of the switches \Joint, \Pose, or \PathCorr has to be present.

## 5.1.10 EGMSetupAI - Setup analog input signals for EGM *Externally Guided Motion Continued*

[\PathCorr]			
	Data type: switch		
	Selects path correction.		
	At least one of the switches	\Joint, \Pose, or \PathCorr has to be present.	
[\APTR]			
	Data type: switch		
	Setup an at-point-tracker type or AWC.	e of sensor for path correction. For example WeldGuide	
	\APTR has to be present if \	PathCorr <b>is used.</b>	
[\aiR1x] [\aiR2y	] [\aiR3z]		
	Data type: signalai		
	Specifies the signal that pro movement.	vides the x, y, and z value in millimeters for pose	
	Specifies the signal that pro movement.	vides the robot joint 1 to 3 angle in degrees for joint	
[\aiR4rx] [\aiR5	ory] [\aiR6rz]		
	Data type: signalai		
	Specifies the signal that pro degrees for pose movement	vides the rotation x, y, and z value of the robot in	
	Specifies the signal that pro movement.	vides the robot joint 4 to 6 angle in degrees for joint	
[\aiE1] [\aiE2]	[\aiE3] [\aiE4] [\aiE5	] [\aiE6]	
	Data type: signalai		
	Specifies the signal that provides the position of the additional axis joint 1 to 6.		
	When using EGM joint mode with a 7-axis robot, then $\aiE1$ provides the position for the additional robot axis.		
Error handling			
	The following recoverable e handler. The system variable	rrors are generated and can be handled in an error e ERRNO will be set to:	
	Name	Cause of error	
	ERR_NO_ALIASIO_DEF	The signal variable is a variable declared in RAPID. It has not been connected to an I/O signal defined in the I/O con- figuration with instruction AliasIO.	
	ERR_NORUNUNIT	There is no contact with the I/O device.	

# Limitations

• EGMSetupAI can only be used in RAPID motion tasks.

bus).

• The mechanical unit has to be a TCP robot.

ERR\_SIG\_NOT\_VALID

Continues on next page	

The I/O signal cannot be accessed (only valid for ICI field

5.1.10 EGMSetupAI - Setup analog input signals for EGM Externally Guided Motion Continued

At least one signal has to be specified, otherwise an error is sent and RAPID execution is stopped.

#### Syntax

#### EGMSetupAI

[MecUnit ':='] <variable (var)="" mecunit="" of=""> ','</variable>
[EGMid ':='] <variable (var)="" egmident="" of=""> ','</variable>
[ExtConfigName ':='] <expression (in)="" of="" string=""></expression>
[['\'Joint]   ['\'Pose]   ['\'PathCorr ]]
['\'APTR]
['\'aiRlx ':=' <variable (var)="" of="" signalai="">]</variable>
['\'aiR2y ':=' <variable (var)="" of="" signalai="">]</variable>
['\'aiR3z ':=' <variable (var)="" of="" signalai="">]</variable>
['\'aiR4rx ':=' <variable (<b="">VAR) of signalai&gt;]</variable>
['\'aiR5ry ':=' <variable (<b="">VAR) of signalai&gt;]</variable>
['\'aiR6rz ':=' <variable (<b="">VAR) of signalai&gt;]</variable>
['\'aiE1 ':=' <variable (var)="" of="" signalai="">]</variable>
['\'aiE2 ':=' <variable (var)="" of="" signalai="">]</variable>
['\'aiE3 ':=' <variable (var)="" of="" signalai="">]</variable>
['\'aiE4 ':=' <variable (var)="" of="" signalai="">]</variable>
['\'aiE5 ':=' <variable (var)="" of="" signalai="">]</variable>
['\'aiE6 ':=' <variable (var)="" of="" signalai="">] ';'</variable>

For information about	See
System parameters	System parameters on page 41

# 5.1.11 EGMSetupAO - Setup analog output signals for EGM *Externally Guided Motion*

# 5.1.11 EGMSetupAO - Setup analog output signals for EGM

Usage	
	EGMSetupAO is used to set up AO signals for a specific EGM process (EGMid) as the source for position destination values to which the robot, and up to 6 additional axis, is to be guided.
	EGM joint mode is the only EGM mode that supports 7-axis robots. For 7-axis robots, the first additional axis input provides the position for the additional robot axis.
Basic examples	VAD considert com TD1:
	VAR egnident egnidi;
	EGMGetId egmID1;
	EGMSetupAO ROB_1, egmID1, "default" \Pose \aoR1x:=ao_01 \aoR2y:=ao_02 \aoR3z:=ao_03 \aoR4rx:=ao_04 \aoR5ry:=ao_05 \aoR6rz:=ao_06;
Arguments	
	EGMSetupAO MecUnit, EGMid, ExtConfigName [\Joint]   [\Pose]   [\PathCorr] [\APTR] [\aoR1x] [\aoR2y] [\aoR3Z] [\aoR4rx] [\aoR5ry] [\aoR6rz] [\aoE1] [\aoE2] [\aoE3] [\aoE4] [\aoE5] [\aoE6]
MecUnit	
	Data type: mecunit
	Mechanical unit name.
EGMid	
	Data type: egmident
	EGM identity.
ExtConfigName	
_	Data type: string
	The name of the external motion interface data as defined in the system parameters.
	For more information see <i>Technical reference manual - System parameters</i> , type External Motion Interface Data, topic Motion.
[\Joint]	
	Data type: switch
	Selects joint movement.
	At least one of the switches \Joint or \Pose has to be present.
[\Pose]	
	Data type: switch
	Selects pose movement.
	At least one of the switches \Joint or \Pose has to be present.

# 5.1.11 EGMSetupAO - Setup analog output signals for EGM Externally Guided Motion Continued

[\PathCorr]			
	Data type: switch		
	Selects path correction.		
	At least one of the switches	\Joint, \Pose, or \PathCorr has to be present.	
[\APTR]			
	Data type: switch		
	Setup an at-point-tracker type or AWC.	e of sensor for path correction. For example WeldGuide	
	<b>\APTR</b> has to be present if $\$	PathCorr <b>is used.</b>	
[\aoR1x] [\aoR2y	] [\aoR3z] <b>Data type:</b> signalao		
	Specifies the signal that pro movement.	vides the x, y, and z value in millimeters for pose	
	Specifies the signal that pro movement.	vides the robot joint 1 to 3 angle in degrees for joint	
[\aoR4rx] [\aoR5	ry] [\aoR6rz]		
	<b>Data type:</b> signalao		
	Specifies the signal that pro degrees for pose movement	vides the rotation x, y, and z value of the robot in	
	Specifies the signal that pro movement.	vides the robot joint 4 to 6 angle in degrees for joint	
[\aoE1] [\aoE2]	aoE1] [\aoE2] [\aoE3] [\aoE4] [\aoE5] [\aoE6] <b>Data type:</b> signalao		
	Specifies the signal that provides the position of the additional axis joint 1 to 6.		
	When using EGM joint mode with a 7-axis robot, then $\ao E1$ provides the posit for the additional robot axis.		
Error handling	The following recoverable e	rrors are generated and can be handled in an error	
	nandier. The system variable ERRNO will be set to:		
	Name	Cause of error	
	ERR_NO_ALIASIO_DEF	The signal variable is a variable declared in RAPID. It has not been connected to an I/O signal defined in the I/O con- figuration with instruction AliasIO.	

# ERR\_SIG\_NOT\_VALID The I/O signal cannot be accessed (only valid for ICI field bus).

ERR\_NORUNUNIT

# Limitations

• EGMSetupAO can only be used in RAPID motion tasks.

There is no contact with the I/O device.

• The mechanical unit has to be a TCP robot.

#### 5.1.11 EGMSetupAO - Setup analog output signals for EGM *Externally Guided Motion Continued*

• At least one signal has to be specified, otherwise an error is sent and RAPID execution is stopped.

#### Syntax

#### EGMSetupAO

```
[MecUnit ':='] <variable (VAR) of mecunit> ','
[EGMid ':='] <variable (VAR) of eqmident> ','
[ExtConfigName ':='] <expression (IN) of string>
[['\'Joint] | ['\'Pose] | ['\'PathCorr]]
[' \setminus 'APTR]
['\'aoR1x ':=' <variable (VAR) of signalao>]
['\'aoR2y ':='] <variable (VAR) of signalao>]
['\'aoR3z ':='] <variable (VAR) of signalao>]
['\'aoR4rx ':='] <variable (VAR) of signalao>]
['\'aoR5ry ':='] <variable (VAR) of signalao>]
['\'aoR6rz ':='] <variable (VAR) of signalao>]
['\'aoE1 ':='] <variable (VAR) of signalao>]
['\'aoE2 ':='] <variable (VAR) of signalao>]
['\'aoE3 ':='] <variable (VAR) of signalao>]
['\'aoE4 ':='] <variable (VAR) of signalao>]
['\'aoE5 ':='] <variable (VAR) of signalao>]
['\'aoE6 ':='] <variable (VAR) of signalao>] ';'
```

For information about	See
System parameters	System parameters on page 41

5.1.12 EGMSetupGI - Setup group input signals for EGM Externally Guided Motion

# 5.1.12 EGMSetupGI - Setup group input signals for EGM

Usage	
	EGMSetupGI is used to set up group input signals for a specific EGM process
	(EGMid) as the source for position destination values to which the robot, and up
	ECM joint mode is the only ECM mode that supports 7 axis relate.
	robots, the first additional axis input provides the position for the additional robot
	axis.
Basic examples	
	VAR egmident egmID1;
	EGMGetId egmID1;
	EGMSetupGI ROB_1, egmID1, "default" \Pose \giRlx:=gi_01
	\giR2y:=gi_02 \giR3z:=gi_03 \giR4rx:=gi_04 \giR5ry:=gi_05 \giR6rz:=gi_06;
Arguments	
	EGMSetupGI MecUnit, EGMid, ExtConfigName [\Joint]   [\Pose]
	[\giR5z] [\giR6z] [\giE1] [\giE2] [\giE3] [\giE4] [\giE5] [\giE6]
MecUnit	
	Data type: mecunit
	Mechanical unit name.
EGMid	
	Data type: egmident
	EGM identity.
ExtConfigName	
	Data type: string
	The name of the external motion interface data as defined in the system parameters.
	For more information see <i>Technical reference manual - System parameters</i> , type <i>External Motion Interface Data</i> , topic <i>Motion</i> .
[\Joint]	
	Data type: switch
	Selects joint movement.
	At least one of the switches \Joint or \Pose has to be present.
[\Pose]	
	Data type: switch
	Selects pose movement.
	At least one of the switches $\forall doint or \forall Pose has to be present.$

#### 5.1.12 EGMSetupGI - Setup group input signals for EGM Externally Guided Motion Continued

[\PathCorr] Data type: switch Selects path correction. At least one of the switches \Joint, \Pose, or \PathCorr has to be present. [\APTR] Data type: switch Setup an at-point-tracker type of sensor for path correction. For example WeldGuide or AWC. \APTR has to be present if \PathCorr is used. [\giR1x] [\giR2y] [\giR3z] Data type: signalgi Specifies the signal that provides the x, y, and z value in millimeters for pose movement. Specifies the signal that provides the robot joint 1 to 3 angle in degrees for joint movement. [\giR4rx] [\giR5ry] [\giR6rz] Data type: signalgi Specifies the signal that provides the rotation x, y, and z value of the robot in degrees for pose movement. Specifies the signal that provides the robot joint 4 to 6 angle in degrees for joint movement. [\giE1] [\giE2] [\giE3] [\giE4] [\giE5] [\giE6] Data type: signalgi Specifies the signal that provides the position of the additional axis joint 1 to 6. When using EGM joint mode with a 7-axis robot, then \giEl provides the position for the additional robot axis. **Error handling** 

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

Name	Cause of error
ERR_NO_ALIASIO_DEF	The signal variable is a variable declared in RAPID. It has not been connected to an I/O signal defined in the I/O con- figuration with instruction AliasIO.
ERR_NORUNUNIT	There is no contact with the I/O device.
ERR_SIG_NOT_VALID	The I/O signal cannot be accessed (only valid for ICI field bus).

# Limitations

- EGMSetupGI can only be used in RAPID motion tasks.
- The mechanical unit has to be a TCP robot. ٠

Continues on next page	

5.1.12 EGMSetupGI - Setup group input signals for EGM Externally Guided Motion Continued

- Group signals can only handle positive values. Therefore their use in EGM is limited.
- At least one signal has to be specified, otherwise an error is sent and RAPID execution is stopped.

#### Syntax

```
EGMSetupGI
  [MecUnit ':='] <variable (VAR) of mecunit> ','
  [EGMid ':='] <variable (VAR) of egmident> ','
  [ExtConfigName ':='] <expression (IN) of string>
  [['\'Joint] | ['\'Pose] | ['\'PathCorr]]
  [' \setminus APTR]
  ['\'giR1x ':=' <variable (VAR) of signalgi>]
  ['\'giR2y ':=' <variable (VAR) of signalgi>]
  ['\'giR3z ':=' <variable (VAR) of signalgi>]
  ['\'giR4rx ':=' <variable (VAR) of signalgi>]
  ['\'giR5ry ':=' <variable (VAR) of signalgi>]
  ['\'giR6rz ':=' <variable (VAR) of signalgi>]
  ['\'giE1 ':=' <variable (VAR) of signalgi>]
  ['\'giE2 ':=' <variable (VAR) of signalgi>]
  ['\'giE3 ':=' <variable (VAR) of signalgi>]
  ['\'giE4 ':=' <variable (VAR) of signalgi>]
  ['\'giE5 ':=' <variable (VAR) of signalgi>]
  ['\'giE6 ':=' <variable (VAR) of signalgi>] ';'
```

For information about	See
System parameters	System parameters on page 41

# 5.1.13 EGMSetupLTAPP - Setup the LTAPP protocol for EGM *Externally Guided Motion*

# 5.1.13 EGMSetupLTAPP - Setup the LTAPP protocol for EGM

Usage	
	EGMSetupLTAPP is used to set up an <i>LTAPP</i> protocol for a specific EGM process (EGMid) as the source for path corrections.
Basic examples	
	The following example illustrates the instruction EGMSetupLTAPP.
Example 1	
	VAR egmident EGMid1; EGMGetId EGMid1; EGMSetupLTAPP ROB_1, EGMid1, "pathCorr", "OptSim", 1\LATR;
	This program registers an EGM process, and sets up the sensor OptSim that uses the communication protocol LTAPP and is of the type <i>look-ahead</i> as data source (sensor). The sensor shall use the joint type definition number 1 for the tracking.
Arguments	EGMActMove MecUnit, EGMid, ExtConfigName, Device, JointType [\APTR]   [\LATR]
MecUnit	
	Data type: mecunit
	Mechanical unit name.
EGMid	
	Data type: egmident
	EGM identity.
ExtConfigName	
	Data type: string
	The name of the external motion interface data as defined in the system parameters.
	For more information see <i>Technical reference manual - System parameters</i> , topic <i>Motion</i> , type <i>External Motion Interface Data</i> .
Device	
	Data type: string
	LTAPP device name.
JointType	
	Data type: num
	Defines the joint type, expressed as a number, that the sensor equipment shall use during path correction.
[\APTR]	
	Data type: switch
	Setup an at-point-tracker type of sensor for path correction. For example WeldGuide or AWC.

	5.1.13 EGMSetupLTAPP - Setup the LTAPP protocol for EGM Externally Guided Motion Continued
	Either \APTR or \LATR has to be present.
[\LATR]	
	Data type: switch
	Setup an Look-ahead-tracker type of sensor for path correction. For example Laser Tracker.
	Either \APTR or \LATR has to be present.
Program execution	
	EGMSetupLTAPP connects the characteristic data of the sensor that is used to an
	EGM identity. That EGM identity can then be used in different EGMActMove and
	EGMMove instructions.
Syntax	
-	EGMSetupLTAPP
	[MecUnit ':='] <variable (var)="" mecunit="" of=""> ','</variable>
	[EGMid ':='] <variable (<b="">VAR) of egmident&gt; ','</variable>
	[ExtConfigName ':='] < expression (IN) of string> ','

[Device ':='] < expression (IN) of string> ','
[JointType ':='] < expression (IN) of num>

[['\'APTR] | ['\'LATR]] ';'

# 5.1.14 EGMSetupUC - Setup the UdpUc protocol for EGM *Externally Guided Motion*

# 5.1.14 EGMSetupUC - Setup the UdpUc protocol for EGM

Usage	
	EGMSetupUC is used to set up a UdpUc protocol for a specific EGM process (EGMid) as the source for position destination values to which the robot, and up to 6
	additional axis, is to be guided.
	EGM joint mode is the only EGM mode that supports 7-axis robots. For 7-axis robots, the first additional axis input provides the position for the additional robot axis.
Basic examples	
	VAR egmident egmID1;
	VAR string egmSensor:="egmSensor:";
	EGMGetid egmiDi; EGMSetupUC ROB_1, egmID1, "default", egmSensor\Pose;
Arguments	
	EGMSetupUC MecUnit, EGMid, ExtConfigName, UCDevice [\Joint]   [\Pose]   [\PathCorr] [\APTR]   [\LATR] [\CommTimeout]
MecUnit	
	Data type: mecunit
	Mechanical unit name.
EGMid	
	Data type: egmident
	EGM identity.
ExtConfigName	
	Data type: string
	The name of the external motion interface data as defined in the system parameters.
	For more information see <i>Technical reference manual - System parameters</i> , type <i>External Motion Interface Data</i> , topic <i>Motion</i> .
UCDevice	
	Data type: string
	UdpUc device name.
[\Joint]	
	Data type: switch
	Selects joint movement for position guidance.
	At least one of the switches \Joint, \Pose, or \PathCorr has to be present.
[\Pose]	
	Data type: switch
	Selects pose movement for position guidance.
	At least one of the switches \Joint, \Pose, or \PathCorr has to be present.

### 5.1.14 EGMSetupUC - Setup the UdpUc protocol for EGM Externally Guided Motion Continued

Error handling	
	Time-out for communication with the external UdpUC device in seconds.
	Data type: num
[\CommTimeout]	
	Either \APTR or \LATR has to be present.
	Setup an Look-anead-tracker type of sensor for path correction. For example Laser Tracker.
	Setur on Lock chood tracker time of concertion not how we stight for a seture of the s
[\LATR]	Data type: and tak
	Either \APTR or \LATR has to be present.
	Setup an at-point-tracker type of sensor for path correction. For example WeldGuide or AWC.
	Data type: switch
[\APTR]	
	At least one of the switches \Joint, \Pose, or \PathCorr has to be present.
	Selects path correction.
	Data type: switch
[\PathCorr]	

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

Name	Cause of error
ERR_UDPUC_COMM	An error occurred in the communication with the UdpUc device.
	In synchronous mode ERR_UDPUC_COMM is always a recoverable error, which can be handled by an error handler.
	In asynchronous mode (EGMRunX\NoWait) ERR_UDPUC_COMM is always raised as fatal error if EGM is executed.

### Limitations

- EGMSetupUC can only be used in RAPID motion tasks.
- The mechanical unit has to be a TCP robot.

#### Syntax

#### EGMSetupUC

```
[MecUnit ':='] <variable (VAR) of mecunit> ','
[EGMid ':='] <variable (VAR) of egmident> ','
[ExtConfigName ':='] <expression (IN) of string> ','
[UCDevice ':='] <expression (IN) of string>
[['\'Joint] | ['\'Pose] | ['\'PathCorr]]
[['\'APTR] | ['\'LATR]]
['\'CommTimeout ':=' <expression (IN) of num>] ';'
```

# 5.1.14 EGMSetupUC - Setup the UdpUc protocol for EGM Externally Guided Motion Continued

For information about	See
System parameters	System parameters on page 41

5.1.15 EGMStop - Stop an EGM movement Externally Guided Motion

# 5.1.15 EGMStop - Stop an EGM movement

EGMStop stops a specific EGM process (EGMid).  Basic examples In the RAPID motion task: VAR egmident egmID1? PERS pose posel:=[[0,0], [1,0,0,0]]; CONST egm_minmax egm_minmax_in:=[-0.1,0.1]; CONST egm_minmax egm_minmax_in:=[-0.1,0.1]; CONST pose posecor:=[[12,3313,-0.108707,416.142],	Usage	
Basic examples         In the RAPID motion task:         VAR egmident egmiD1;         PERS pose posel:=[(0,0,0), [1,0,0,0]];         CONST egm_minmax egm_minmax_not:=[-0.1,0.1];         CONST pose posecor:=[[120,0400,900], [0,0,1.0]];         CONST pose posecor:=[[120,0400,900], [0,0,1.0]];         CONST pose posecor:=[[120,0400,900], [0,0,1.0]];         CONST pose posecor:=[[120,0400,900], [0,0,1.0]];         CONST pose posecor:=[[120,0400,900], [0,0,0.10]];         CONST pose posecor:=[[120,0400,900], [0,001,01];         CONST pose posecor:=[[120,0400,900], [0,001,01];         CONST pose posecor:=[[120,0400,900,07416.142],         [0,903899,-0.00320735,0.427666,0.00765917]];         EXMBCLPAR, Dool, posecors, RCMMEXTER, DOOL posecor,         RIMPARMENDAL, posecens, RCMM_PRAME_TOOL [10, alr847:=ai_04 \alr877:=ai_06;         EXMACLPOSE egmID1;         EXMARCEPOSE, posecens, RCMM_PRAME_TOOL [1, reseqm_minmax_rot         Visegm_minmax_rot tria:=egm_minmax_rot         \text{Visegm_minmax_rot tria:=ai_minmax_rot         \text{Visegm_minmax_rot tria:=ai_minmax_rot         \text{Visegm_minmax_rot tria:=ai_minmax_rot         \text{Visegm_minmax_rot tria:=ai_minmax_rot         \text{Visegm_minmax_rot tria:=ai_0.05;         In a TRAP routine:         EGMId0         Data type: egmident         EG		EGMStop stops a specific EGM process (EGMid).
In the RAPID motion task: VAR egmident egmID1; FFERS pose pose1:=[[0,0,0], [1,0,0,0]]; CONST egm_minmax egm_minmax_rot:=[-0.1,0.1]; CONST egm_minmax egm_minmax_rot:=[-0.1,0.2]; CONST pose posecor:=[[12.3313,-0.108707,416.142], [0.903899,-0.00320735,0.427666,0.00765917]]; EGMGetId egmID1; EGMGetId egmID1; EGMGetId egmID1; EGMACtPose egmID1 VPOse \aiR1x:=ai_01 \aiR2y:=ai_02 \aiR3::=ai_03 \aiR4rx:=ai_04 \aiR5ry:=ai_05 \aiR6rz::=ai_06; EGMActPose egmID1 \trool:=tool0 \Wobj:=wobj0, posecor, EGM_FRAME_WOBJ, posesens, EGM_FRAME_TOOL \x:=egm_minmax_rot \y:=egm_minmax_rot \r:=egm_minmax_rot \LpF1lter:=20; EGMRunpOse egmID1, EGM_STOP_HOLD \x \y \z \rx \ry \rz \RampInTime:=0.05; In a TRAP routine: EGMStop EGMid, Mode [\RampOutTime] EGMid Data type: egmident EGM identity. Mode Defines how the movement is ended (EGM_STOP_HOLD, EGM_STOP_RAMP_DOWN) [\RampOutTime] Data type: num Defines in seconds how fast a ramp down of EGM will be performed. This parameter has no meaning if the parameter Mode is set to EGM_STOP_HOLD. Limitations • EGMStop can only be used in RAPID motion tasks. Syntax	Basic examples	
VAR egnident egmID1; PERS pose posel:=[[0,0,0], [1,0,0,0]]; CONST gem_minmax egm_minmax_lin:=[-0.1,0.1]; CONST pose posecor:=[[1200,400,900], [0,0,1,01]; CONST pose posesons:=[12.3]3]0.108707,146.142], [0.903899,-0.00320735,0.427666,0.00765917]]; EGMGetId egmID1; EGMSetUpAI ROB_1, egmID1 \Pose \aiR1x:=ai_01 \aiR2y:=ai_02 \aiR2x:=ai_00 \aiR4xx:=ai_04 \aiR5xy:=ai_05 \aiR6xz:=ai_06; EGMActPose egmID1 \Tool:=tool0 \WObj:=wobj0, posecor, EGM_FRAME_WOB7, posesens, EGM_FRAME_TOOL \v:=egm_minmax_lin \v:=egm_minmax_rot \vz:=egm_minmax_rot \LpFilter:=20; EGMActPose egmID1, EGM_STOP_HOLD \v \y \z \vx \vy \vz \kampinTime:=0.05; In a TRAP routine: EGMStop egmID1, EGM_STOP_HOLD; Arguments EGMStop EGMid, Mode [\kampOutTime] EGMid Data type: egmident EGM identity. Mode Defines how the movement is ended (EGM_STOP_HOLD, EGM_STOP_RAMP_DOWN) [\kampOutTime] Data type: num Defines in seconds how fast a ramp down of EGM will be performed. This parameter has no meaning if the parameter Mode is set to EGM_STOP_HOLD. Limitations • EGMStop can only be used in RAPID motion tasks. Syntax		In the RAPID motion task:
PERS pose posel:=[(0,0,0], [1,0,0,0]);         CONST egm_minmax egm_minmax_lin:=[-0.1,0.1];         CONST pose posecor:=[[120,400,900], [0,0,1,0]];         CONST pose posesens:=[[12,331,-0.108707,416.142],         [0,93899,-0.00320735,0.427666,0.00765917]];         EGMGetId egmID1;         EGMSetupAT ROB_1, egmID1 \Pose \aiR1x:=ai_01 \aiR2y:=ai_02 \aiR3z:=ai_06;         MARTPOSE egmID1 \TOO1:=tool0 \WDD3:=wobj0, posecor,         EGMARTPOSE egmID1 \TOO1:=tool0 \WDD3:=wobj0, posecor,         EGMRenPose egmID1 \Too1:=tool0 \WDD3:=wobj0, posecor,         V:=egm_minmax_lin \z:=egm_minmax_lin (x:=egm_minmax_lin \y:=egm_minmax_lin \y		VAR egmident egmID1;
CONST egm_minmax egm_minmax_lin:=[-0.1,0.2]; CONST pose posecor:=[[1200,400,900], [0,0,1,0]]; CONST pose posecor:=[[12,3313,-0.108707,416.142], [0.903899,-0.00320735,0.427666,0.00765917]]; EGMSetupAI ROB_1, egmID1 \Pose \aiR1x:=ai_01 \aiR2y:=ai_02 \aiR3z:=ai_03 \aiR4rx:=ai_04 \aiR5ry:=ai_05 \aiR6rz:=ai_06; EGMSetupAI ROB_1, egmID1 \Pose \aiR1x:=ai_01 \aiR2y:=ai_05; EGMACtPose egmID1 \Tool:=tool0 \WODj:=wobj0, posecor, EGM_FRAME_WOD4, posecans, EGM_FRAME_TOOL \x:=egm_minmax_lin \y:=egm_minmax_lin \z:=egm_minmax_rot \LpFilter:=20; EGMRunPose egmID1, EGM_STOP_HOLD \x \y \z \rx \ry \rz \RampInTime:=0.05; In a TRAP routine: EGMStop EGMid, Mode [\RampOutTime] EGMStop EGMid, Mode [\RampOutTime] EGMStop EGMid, Mode [\RampOutTime] EGMId Data type: egmident EGMStop EGMid, Mode [\CampOutTime] EGMid Data type: num Defines how the movement is ended (EGM_STOP_HOLD, EGM_STOP_RAMP_DOWN) [\RampOutTime] Data type: num Defines in seconds how fast a ramp down of EGM will be performed. This parameter has no meaning if the parameter Mode is set to EGM_STOP_HOLD. Limitations • EGMStop can only be used in RAPID motion tasks. Syntax		PERS pose pose1:=[[0,0,0], [1,0,0,0]];
CUNST egm_minmax egm_minmax_pot:=i-0.1,0.2/;         CONST pose posecer:=[1200,400,900], [0,0,1,0];         CONST pose posecens:=[12.3313,-0.108707,416.142],         [0.903899,-0.00320735,0.427666,0.00765917]];         EGMGetId egmID1;         EGMSetupAI ROB_1, egmID1 \Pose \aiRIx:=ai_01 \aiR2y:=ai_02 \aiRfx:=ai_06;         EGMActPose egmID1 \Tool:=tool0 \Wobj:=wobj0, posecor,         EGM_ERAME_WOB2, posesens, EGM_FRAME_TOOL \x:=egm_minmax_lin         \Y:=egm_minmax_rot \rz:=egm_minmax_rot \LpFilter:=20;         EGMEtunPose egmID1, EGM_STOP_HOLD \x \Y \Z \rx \ry \rz         \RampInTime:=0.05;         In a TRAP routine:         EGMStop EGMid, Mode [\RampOutTime]         EGMid         Data type: egmident         EGMid         Data type: egmstopmode         Defines how the movement is ended (EGM_STOP_HOLD, EGM_STOP_RAMP_DOWN)         [\RampOutTime]         Data type: num         Defines in seconds how fast a ramp down of EGM will be performed.         This parameter has no meaning if the parameter Mode is set to EGM_STOP_HOLD.         Limitations       • EGMStop can only be used in RAPID motion tasks.		CONST egm_minmax egm_minmax_lin:=[-0.1,0.1];
CONST pose poseedor = [[12,3], -0.108707, 416.142], [0.903899,-0.00320735,0.427666,0.00765917]]; EGMGetId egmID1; EGMGetUpAI ROB_1, egmID1 \Pose \aiRlx:=ai_01 \aiR2y:=ai_02 \aiR3z:=ai_03 \aiR4rx:=ai_04 \aiR5ry:=ai_05 \aiR6rr:=ai_06; EGMActPose egmID1 \Tool:=tool1 \WObj:=wobj0, posecor. EGM_FRAME_WOB7, posesens, EGM_FRAME_TOOL \x:=egm_minmax_lin \y:=egm_minmax_lin \x:=egm_minmax_rot \ry:=egm_minmax_rot \rz:=egm_minmax_rot \ry:=egm_minmax_rot \rz:=egm_minmax_rot \ry:=egm_minmax_rot \rz:=egm_minmax_rot \ry:=egm_minmax_rot \rz:=egm_minmax_rot \ry:=egm_minmax_rot \rz:=egm_minmax_rot \ry:=egm_minmax_rot PAOLD \x \y \z \rx \ry \rz \RampInTime:=0.05; In a TRAP routine: EGMStop egmID1, EGM_STOP_HOLD; Arguments EGMStop EGMid, Mode [\RampOutTime] EGMid Data type: egmident EGM identity. Mode Defines how the movement is ended (EGM_STOP_HOLD, EGM_STOP_RAMP_DOWN) [\RampOutTime] Data type: num Defines in seconds how fast a ramp down of EGM will be performed. This parameter has no meaning if the parameter Mode is set to EGM_STOP_HOLD. Limitations • EGMStop can only be used in RAPID motion tasks. Syntax		CONST egm_minmax egm_minmax_rot:=[-0.1,0.2];
<pre>converters of the process of th</pre>		CONST pose posecer:= $[[1200,400,900], [0,0,1,0]],$
EGMGetId egmID1;         EGMSetupAI ROB_1, egmID1 \Pose \aiR1x:=ai_01 \aiR2y:=ai_02 \aiR3::=ai_03 \aiR4rx:=ai_04 \aiR5ry:=ai_05 \aiR6r2:=ai_06;         EGMActPose egmID1 \Tool:=tool0 \W0bj:=wobj0, posecor, EGM_FRAME_W0BJ, posesens, EGM_FRAME_TOOL \x:=egm_minmax_Iin \y:=egm_minmax_Iot \rz:=egm_minmax_rot \ry:Tegm_minmax_rot \ry:=egm_minmax_rot \rz:=egm_minmax_rot \ry:Tegm_minmax_rot \ry:=egm_minmax_rot \ry:\rz:=egm_minmax_rot \ry:\rz: EGMENDOSe egmID1, EGM_STOP_HOLD \x \y \z \rx \ry \rz \RampInTime:=0.05;         In a TRAP routine: EGMStop egmID1, EGM_STOP_HOLD;         Arguments         EGMStop EGMid, Mode [\RampOutTime]         EGMid         Data type: egmident EGM identity.         Mode         Defines how the movement is ended (EGM_STOP_HOLD, EGM_STOP_RAMP_DOWN)         [\RampOutTime]         Data type: num         Defines in seconds how fast a ramp down of EGM will be performed. This parameter has no meaning if the parameter Mode is set to EGM_STOP_HOLD.         Limitations       • EGMStop can only be used in RAPID motion tasks.		[0.903899,-0.00320735,0.427666,0.00765917]];
EGMSetupAI ROB_1, egmID1 \Pose \aiRlx:=ai_01 \aiR2y:=ai_02 \aiR3z:=ai_03 \aiR4rx:=ai_04 \aiR5ry:=ai_05 \aiR6rz:=ai_06; EGMACFOSe egmID1 \Too1:=too10 \WObj:=wobj0, posecor, EGM_FRAME_WOBJ, posesens, EGM_FRAME_TOOL \x:=egm_minmax_lin \y:=egm_minmax_in \z:=egm_minmax_rot \ry:=egm_minmax_rot \rz:=egm_minmax_rot \ry:=egm_minmax_rot \rz:=egm_minmax_rot \ry:=cgm_minmax_rot \y \z \rx \ry \rz \RampInTime:=0.05; In a TRAP routine: EGMStop egmID1, EGM_STOP_HOLD \x \y \z \rx \ry \rz \RampInTime:=0.05; Arguments EGMStop EGMid, Mode [\RampOutTime] EGMid Data type: egmident EGM identity. Mode Data type: egmstopmode Defines how the movement is ended (EGM_STOP_HOLD, EGM_STOP_RAMP_DOWN) [\RampOutTime] Data type: num Defines in seconds how fast a ramp down of EGM will be performed. This parameter has no meaning if the parameter Mode is set to EGM_STOP_HOLD. Limitations • EGMStop can only be used in RAPID motion tasks.		EGMGetId egmID1;
EGMActPose egmIDl \Tool:=tool0 \W0bj:=wobj0, posecor, EGM_FRAME_W0BJ, posecens, EGM_FRAME_TOOL \x:=egm_minmax_lin \y:=egm_minmax_Iot \z:=egm_minmax_Iot \LpFilter:=20; EGMRunPose egmIDl, EGM_STOP_HOLD \x \y \z \rx \ry \rz \RampInTime:=0.05; In a TRAP routine: EGMStop egmIDl, EGM_STOP_HOLD; Arguments EGMStop egmIDl, EGM_STOP_HOLD; Arguments EGMStop EGMid, Mode [\RampOutTime] EGMid Data type: egmident EGM identity. Mode Data type: egmstopmode Defines how the movement is ended (EGM_STOP_HOLD, EGM_STOP_RAMP_DOWN) [\RampOutTime] Data type: num Defines in seconds how fast a ramp down of EGM will be performed. This parameter has no meaning if the parameter Mode is set to EGM_STOP_HOLD. Limitations • EGMStop can only be used in RAPID motion tasks.		EGMSetupAI ROB_1, egmID1 \Pose \aiR1x:=ai_01 \aiR2y:=ai_02 \aiR3z:=ai_03 \aiR4rx:=ai_04 \aiR5ry:=ai_05 \aiR6rz:=ai_06;
EGM_FRAME_WOBJ, posesens, EGM_FRAME_TOOL \x:=egm_minmax_lin \y:=egm_minmax_lin \z:=egm_minmax_rot \ry:=egm_minmax_rot \rz:=egm_minmax_rot \ry:=egm		EGMActPose egmID1 \Tool:=tool0 \WObj:=wobj0, posecor,
(y:=egm_minmax_lin /z:=egm_minmax_rot /ry:=egm_minmax_rot /ry:=egm_minmax_rot /LpFilter:=20;         EGMENDOSE egmID1, EGM_STOP_HOLD /x /y /z /rx /ry /rz         RampInTime:=0.05;         In a TRAP routine:         EGMStop egmID1, EGM_STOP_HOLD;         Arguments         EGMStop EGMid, Mode [\RampOutTime]         EGMid         Data type: egmident         EGM identity.         Mode         Defines how the movement is ended (EGM_STOP_HOLD, EGM_STOP_RAMP_DOWN)         [\RampOutTime]         Data type: num         Defines in seconds how fast a ramp down of EGM will be performed.         This parameter has no meaning if the parameter Mode is set to EGM_STOP_HOLD.         Limitations         • EGMStop can only be used in RAPID motion tasks.		EGM_FRAME_WOBJ, posesens, EGM_FRAME_TOOL \x:=egm_minmax_lin
(r) ** Oglicalization       (r) ** Oglicalization         EGMRunPose egmID1, EGM_STOP_HOLD \x \y \z \rx \ry \rz         \RampInTime:=0.05;         In a TRAP routine:         EGMStop egmID1, EGM_STOP_HOLD;         Arguments         EGMStop EGMid, Mode [\RampOutTime]         EGMid         Data type: egmident         EGM identity.         Mode         Data type: egmstopmode         Defines how the movement is ended (EGM_STOP_HOLD, EGM_STOP_RAMP_DOWN)         [\RampOutTime]         Data type: num         Defines in seconds how fast a ramp down of EGM will be performed.         This parameter has no meaning if the parameter Mode is set to EGM_STOP_HOLD.         Limitations         • EGMStop can only be used in RAPID motion tasks.		\y:=egm_minmax_lin \z:=egm_minmax_lin \rx:=egm_minmax_rot \ry:=egm_minmax_rot \rz:=egm_minmax_rot \LpEilter:=20:
\RampInTime:=0.05;         In a TRAP routine:         EGMStop egmID1, EGM_STOP_HOLD;         Arguments         EGMStop EGMid, Mode [\RampOutTime]         EGMid         Data type: egmident         EGM identity.         Mode         Defines how the movement is ended (EGM_STOP_HOLD, EGM_STOP_RAMP_DOWN)         [\RampOutTime]         Data type: num         Defines in seconds how fast a ramp down of EGM will be performed.         This parameter has no meaning if the parameter Mode is set to EGM_STOP_HOLD.         Limitations         • EGMStop can only be used in RAPID motion tasks.		EGMRunPose eqmID1. EGM STOP HOLD $x y z rx rv rz$
In a TRAP routine:       EGMStop egmID1, EGM_STOP_HOLD;         Arguments       EGMStop EGMid, Mode [\RampOutTime]         EGMid       Data type: egmident         EGM identity.       Mode         Data type: egmstopmode       Defines how the movement is ended (EGM_STOP_HOLD, EGM_STOP_RAMP_DOWN)         [\RampOutTime]       Data type: num         Defines in seconds how fast a ramp down of EGM will be performed.         This parameter has no meaning if the parameter Mode is set to EGM_STOP_HOLD.         Limitations       • EGMStop can only be used in RAPID motion tasks.		\RampInTime:=0.05;
EGMStop egmID1, EGM_STOP_HOLD;         Arguments         EGMStop EGMid, Mode [\RampOutTime]         EGMid         Data type: egmident         EGM identity.         Mode         Data type: egmstopmode         Defines how the movement is ended (EGM_STOP_HOLD, EGM_STOP_RAMP_DOWN)         [\RampOutTime]         Data type: num         Defines in seconds how fast a ramp down of EGM will be performed.         This parameter has no meaning if the parameter Mode is set to EGM_STOP_HOLD.         Limitations         • EGMStop can only be used in RAPID motion tasks.		In a TRAP routine:
Arguments       EGMStop EGMid, Mode [\RampOutTime]         EGMid       Data type: egmident         EGM identity.       Mode         Data type: egmstopmode       Defines how the movement is ended (EGM_STOP_HOLD, EGM_STOP_RAMP_DOWN)         [\RampOutTime]       Data type: num         Defines in seconds how fast a ramp down of EGM will be performed.         This parameter has no meaning if the parameter Mode is set to EGM_STOP_HOLD.         Limitations       • EGMStop can only be used in RAPID motion tasks.		EGMStop egmID1, EGM_STOP_HOLD;
Arguments       EGMStop EGMid, Mode [\RampOutTime]         EGMid       Data type: egmident         EGM identity.       EGM identity.         Mode       Data type: egmstopmode         Defines how the movement is ended (EGM_STOP_HOLD, EGM_STOP_RAMP_DOWN)         [\RampOutTime]       Data type: num         Defines in seconds how fast a ramp down of EGM will be performed.         This parameter has no meaning if the parameter Mode is set to EGM_STOP_HOLD.         Limitations       • EGMStop can only be used in RAPID motion tasks.		
EGMID	Arguments	
EGMid Data type: egmident EGM identity. Mode Data type: egmstopmode Defines how the movement is ended (EGM_STOP_HOLD, EGM_STOP_RAMP_DOWN) [\RampOutTime] Data type: num Defines in seconds how fast a ramp down of EGM will be performed. This parameter has no meaning if the parameter Mode is set to EGM_STOP_HOLD. Limitations • EGMStop can only be used in RAPID motion tasks. Syntax		EGMStop EGMId, Mode [\RampOutTime]
Data type: egmident         EGM identity.         Mode       Data type: egmstopmode         Defines how the movement is ended (EGM_STOP_HOLD, EGM_STOP_RAMP_DOWN)         [\RampOutTime]         Data type: num         Defines in seconds how fast a ramp down of EGM will be performed.         This parameter has no meaning if the parameter Mode is set to EGM_STOP_HOLD.         Limitations         • EGMStop can only be used in RAPID motion tasks.	EGMid	
EGM identity.         Mode       Data type: egmstopmode         Defines how the movement is ended (EGM_STOP_HOLD, EGM_STOP_RAMP_DOWN)         [\RampOutTime]       Data type: num         Defines in seconds how fast a ramp down of EGM will be performed.         This parameter has no meaning if the parameter Mode is set to EGM_STOP_HOLD.         Limitations       • EGMStop can only be used in RAPID motion tasks.		Data type: egmident
Mode Data type: egmstopmode Defines how the movement is ended (EGM_STOP_HOLD, EGM_STOP_RAMP_DOWN) [\RampOutTime] Data type: num Defines in seconds how fast a ramp down of EGM will be performed. This parameter has no meaning if the parameter Mode is set to EGM_STOP_HOLD. Limitations • EGMStop can only be used in RAPID motion tasks. Syntax		EGM identity.
Mode       Data type: egmstopmode         Defines how the movement is ended (EGM_STOP_HOLD, EGM_STOP_RAMP_DOWN)         [\RampOutTime]         Data type: num         Defines in seconds how fast a ramp down of EGM will be performed.         This parameter has no meaning if the parameter Mode is set to EGM_STOP_HOLD.         Limitations         • EGMStop can only be used in RAPID motion tasks.		
Data type: egmstopmode         Defines how the movement is ended (EGM_STOP_HOLD, EGM_STOP_RAMP_DOWN)         [\RampOutTime]         Data type: num         Defines in seconds how fast a ramp down of EGM will be performed.         This parameter has no meaning if the parameter Mode is set to EGM_STOP_HOLD.         Limitations         • EGMStop can only be used in RAPID motion tasks.	Mode	Data tumar
Defines how the movement is ended (EGM_STOP_HOLD, EGM_STOP_RAMP_DOWN)         [\RampOutTime]         Data type: num         Defines in seconds how fast a ramp down of EGM will be performed.         This parameter has no meaning if the parameter Mode is set to EGM_STOP_HOLD.         Limitations         • EGMStop can only be used in RAPID motion tasks.		Data type: egmstopmode
[\RampOutTime]         Data type: num         Defines in seconds how fast a ramp down of EGM will be performed.         This parameter has no meaning if the parameter Mode is set to EGM_STOP_HOLD.         Limitations         • EGMStop can only be used in RAPID motion tasks.         Syntax		Defines how the movement is ended (EGM_STOP_HOLD, EGM_STOP_RAMP_DOWN)
Data type: num         Defines in seconds how fast a ramp down of EGM will be performed.         This parameter has no meaning if the parameter Mode is set to EGM_STOP_HOLD.         Limitations         • EGMStop can only be used in RAPID motion tasks.    Syntax	[\RampOutTime]	
Defines in seconds how fast a ramp down of EGM will be performed.         This parameter has no meaning if the parameter Mode is set to EGM_STOP_HOLD.         Limitations         • EGMStop can only be used in RAPID motion tasks.         Syntax	[ (]	Data type: num
This parameter has no meaning if the parameter Mode is set to EGM_STOP_HOLD.         Limitations         • EGMStop can only be used in RAPID motion tasks.    Syntax		Defines in seconds how fast a ramp down of EGM will be performed
Limitations       EGMStop can only be used in RAPID motion tasks.         Syntax		This peremeter has a meaning if the peremeter we do is get to Edw (more used).
• EGMStop can only be used in RAPID motion tasks. Syntax		This parameter has no meaning if the parameter Mode is set to EGM_STOP_HOLD.
EGMStop can only be used in RAPID motion tasks.  Syntax	Limitations	
Syntax		• EGMStop can only be used in RAPID motion tasks.
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5.1.15 EGMStop - Stop an EGM movement Externally Guided Motion Continued

[EGMid ':='] <variable (VAR) of egmident>','
[Mode ':='] < expression (IN) of egmstopmode>
['\'RampOutTime ':=' <expression (IN) of num>] ';'

5.1.16 EGMStreamStart - start EGM position streaming *Externally Guided Motion* 

# 5.1.16 EGMStreamStart - start EGM position streaming

Usage	EGMStreamStart starts streaming position data for a specific EGM process		
	(EGMid).		
Basic example	The following example illustrates the instruction EGMStreamStart.		
Example 1			
	VAR egmident egmID1;		
	EGMGetId egmID1; EGMSetupUC ROB_1, egmID1, "default", "UCdevice"\Joint; EGMStreamStart egmID;		
	MoveAbsJ jpos20, v100, z20, Weldgun; MoveAbsJ jpos10\NoEOffs, v1000, fine, Weldgun;		
	EGMStreamStop egmID1; EGMReset egmID1;		
Arguments	EGMStreamStart EGMid [\SampleRate];		
EGMid			
	Data type: egmident		
	EGM identity.		
[\SampleRate]	Data type: num		
	Input data reading sample rate in multiples of 4 milliseconds. Valid values are 4, 8, 12, 16, etc.		
	The default value is 4 milliseconds.		
Program execution	Tayabar and the starte streaming position date to external equipment. The date		
	is sent at the cyclicity defined with \SampleRate and the content is according to the protocol specification in the Google Protobuf definition file <i>egm.proto</i> .		
Limitations			
	EGMStreamStart is only available if EGM is set up using EGMSetupUC, i.e. the protocol UdpUc is used for communication with the external equipment.		
Syntax	EGMStreamStart [EGMid ':='] <variable (var)="" egmident="" of="">';' ['\' SampleRate ':=' <expression (<b="">IN) of num&gt;]','</expression></variable>		

# 5.1.17 EGMStreamStop - stop EGM position streaming *Externally Guided Motion*

# 5.1.17 EGMStreamStop - stop EGM position streaming

Usage	ECMStroomStop stops streaming position data for a specific EGM process (ECMid
	EGMST Paulstop slops streaming position data for a specific Edit process (EGMTU
Basic example	
	The following example illustrates the instruction EGMStreamStop.
Example 1	
	VAR equident equilit:
	VAR Cymruche Cymru
	EGMGetId egmID1;
	EGMSetupUC ROB_1, egmID1, "default", "UCdevice"\Joint;
	EGMStreamStart egmID;
	MoveAbsJ jpos20, v100, z20, Weldgun;
	MoveAbsJ jpos10\NoEOffs, v1000, fine, Weldgun;
	EGMStreamStop egmID1;
	EGMReset egmID1;
Arguments	
	EGMStreamStop EGMid;
EGMid	
	Data type: egmident
	EGM identity.
Program execution	
-	EGMStreamStop stops streaming position data to external equipment.
Limitations	
	EGMStreamStop is only available if EGM is set up using EGMSetupUC, i.e. the protocol UdpUc is used for communication with the external equipment.
Syntax	
-	EGMStreamStop
	[EGMid ':='] <variable (var)="" egmident="" of="">';'</variable>

5.1.18 EGMWaitCond - wait for EGM process Externally Guided Motion

Usage	EGMWaitCond is used to wait for a specific EGM process (EGMid).
Basic example	
	The following example illustrates the instruction EGMWaitCond.
Example 1	
	VAR egmident egmiDI;
	PERS pose poset = $[[0,0,0],[1,0,0,0]]$ ,
	CONST cgm_minmax cgm_minmax_rot:= $[-0, 1, 0, 2];$
	CONST pose posecor:=[[1200 400 900] [0 0 1 0]];
	CONST pose posesens:= $[[12,3313,-0,108707,416,142]$ .
	[0.903899,-0.00320735,0.427666,0.00765917]];
	EGMGetId comID1;
	EGMSetupAI ROB 1. egmID1. "default" \Pose \aiR1x:=ai 01
	<pre>\aiR2y:=ai_02 \aiR3z:=ai_03 \aiR4rx:=ai_04 \aiR5ry:=ai_05 \aiR6rz:=ai_06;</pre>
	EGMActPose egmID1 \Tool:=tool0 \WObj:=wobj0, posecor,
	EGM_FRAME_WOBJ, posesens, EGM_FRAME_TOOL \x:=egm_minmax_lin \y:=egm_minmax_lin \z:=egm_minmax_lin \rx:=egm_minmax_rot \ry:=egm_minmax_rot \rz:=egm_minmax_rot \LpFilter:=20:
	EGMRunPose egmID1. EGM STOP HOLD $\times \sqrt{z}$ $rx \sqrt{r}$
	\rz\RampInTime:=0.05;
	SetDO doSignal1, 1;
	EGMWaitCond
Arguments	
5	EGMWaitCond EGMid;
EGMid	
	Data type: egmident
	EGM identity.
Program execution	
	EGMWaitCond will wait for an EGMRunJoint/Pose instruction to complete. If the
	movement has been completed before EGMWaitCond is run, program execution
	will continue with the next RAPID instruction at once.
Limitations	
	If EGMRunJoint or EGMRunPose are used with the optional argument \NoWaitCond, no movement instruction must be used before the EGM Position Guidance is completed by using EGMWaitCond.
	Continues on next name

# 5.1.18 EGMWaitCond - wait for EGM process

Continues on next page

5.1.18 EGMWaitCond - wait for EGM process Externally Guided Motion Continued

Syntax

EGMWaitCond
[EGMid ':='] <variable (VAR) of egmident>';'

5.2.1 EGMGetState - Gets the current EGM state Externally Guided Motion

# 5.2 Functions

# 5.2.1 EGMGetState - Gets the current EGM state

Usage		
	EGMGetState retrieves the state	of an EGM process (EGMid). It is also used to
	get the correction state.	
Basic examples		
	VAR egmident egmID1;	
	VAR egmstate egmState1:= :	EGM_STATE_DISCONNECTED;
	VAR egmcorrstate egmCorrS	tate1:= EGM_CORR_UNDEFINED;
	EGMGetId egmID1;	
	egmState1 := EGMGetState(	<pre>egmID1\CorrectionState:=egmCorrState1);</pre>
Return value		
	Data type: egmstate	
	The current state of the EGM proc	ess identified by the EGM identity specified in
	the argument.	
Arguments		
5	EGMGetState (EGMid [\Corr	ectionState])
EGMid		
	Data type: egmident	
	EGM identity.	
[\CorrectionStat	e]	
	Data type: egmcorrstate	
	The current correction state of the specified in the instruction.	EGM process identified by the EGM identity
Limitations	<u> </u>	
	• EGMGetState can only be u	sed in RAPID motion tasks.
	The mechanical unit has to I	be a TCP robot.
Syntax		
	EGMGetState '('	
	[EGMid ':='] < variable	(VAR) of egmident >
	['\'CorrectionState ':=	<pre>v <expression (var)="" egmcorrstate="" of="">] ')'</expression></pre>
Related information		
	For information about	See

For information about	See
egmstate	egmstate - Defines the state for EGM
egmcorrstate	egmcorrstate - Defines the correction state for EGM

5.3.1 egmframetype - Defines frame types for EGM *Externally Guided Motion* 

# 5.3 Data types

# 5.3.1 egmframetype - Defines frame types for EGM

egmframetype is used to define the frame types for corrections and sensor measurements in EGM.
egmframetype <b>is intended to be used in the instructions</b> EGMActJ <b>and</b>
EGMActPose.
CONST egm_minmax egm_minmax_lin1:=[-0.1,0.1];
CONST egm_minmax egm_minmax_rot1:=[-0.1,0.2];
<pre>EGMActPose egmID1\Tool:=tFroniusCMT\WObj:=wobj0, posecor, EGM_FRAME_WOBJ, posesens, EGM_FRAME_TOOL \x:=egm_minmax_lin \y:=egm_minmax_lin \z:=egm_minmax_lin \rx:=egm_minmax_rot \ry:=egm_minmax_rot \rz:=egm_minmax_rot \LpFilter:=20;</pre>

#### **Predefined values**

Value	Description
EGM_FRAME_BASE	The frame is defined relative to the base frame (pose mode).
EGM_FRAME_TOOL	The frame is defined relative to the used tool (pose mode).
EGM_FRAME_WOBJ	The frame is defined relative to the used work object (pose mode).
EGM_FRAME_WORLD	The frame is defined relative to the world frame (pose mode).
EGM_FRAME_JOINT	The values are joint values (joint mode).

#### Characteristics

egmframetype is an alias data type for num.

For information about	See
EGMActJ	EGMActJoint - Prepare an EGM movement for a joint target on page 49
EGMActPose	EGMActPose - Prepare an EGM movement for a pose target on page 56

5.3.2 egmident - Identifies a specific EGM process *Externally Guided Motion* 

Usage	egmident identifies a specific EGM process.
Description	
	An egmident is reserved using the instruction EGMGetId. It is then used to identify and link together the instructions EGMSetupXX, EGMActX, EGMRunX, and EGMReset to the same EGM operation.
	An egmident is identified by its name, i.e. a second or third call of EGMGetId with the same egmident will neither reserve a new process nor change its content. Only EGMReset releases an egmident.
Basic examples	
·	VAR egmident egmID1;
	VAR egmstate egmSt1;
	TASK PERS wobjdata wobj_EGM1:=[FALSE, TRUE, "", [[500,700,900], [1,0,0,0]], [[0,0,0], [1,0,0,0]];
	CONST pose posecor:=[[1200,400,900], [0,0,1,0]];
	CONST pose posesens:=[[12.3313,-0.108707,416.142], [0.903899,-0.00320735,0.427666,0.00765917]];
	CONST egm_minmax egm_minmax_lin1:=[-0.1,0.1];
	CONST egm_minmax egm_minmax_rot1:=[-0.1,0.2];
	CONST egm_minmax egm_minmax_joint1:=[-0.1,0.1];
	PROC testAI()
	EGMReset egmID1;
	EGMGetId egmID1;
	mvHome;
	<pre>mvHome_EGMLinear;</pre>
	<pre>egmSt1:=EGMGetState(egmID1);</pre>
	TPWrite "EGM state 1: " \Num:=egmSt1;
	IF eqmSt1<=EGM_STATE_CONNECTED THEN
	EGMSetupAI ROB_1, egmID1, "default" \Pose \aiR1x:=ai_MoveX \aiR2y:=ai_MoveY \aiR3z:=ai_MoveZ \aiR5ry:=ai_RotY \aiR6rz:=ai_RotZ;
	ENDIF
	EGMActPose egmID1 \Tool:=tFroniusCMT \WObj:=wobj0, posecor, EGM_FRAME_WOBJ, posesens, EGM_FRAME_TOOL \x:=egm_minmax_lin1 \y:=egm_minmax_lin1 \z:=egm_minmax_lin1 \rx:=egm_minmax_rot1 \ry:=egm_minmax_rot1 \rz:=egm_minmax_rot1 \LpFilter:=20;
	EGMRunPose egmID1, EGM_STOP_HOLD \x \y \z \rx \ry \rz \RampInTime:=0.05;
	<pre>egmSt1:=EGMGetState(egmID1);</pre>
	IF egmSt1=EGM_STATE_CONNECTED THEN TPWrite "Reset lin 1";

# 5.3.2 egmident - Identifies a specific EGM process

5.3.2 egmident - Identifies a specific EGM process *Externally Guided Motion Continued* 

> EGMReset egmID1; ENDIF ENDPROC

#### Limitations

There are up to 4 concurrent instances available for each RAPID task.

#### Characteristics

 $\texttt{egmident} \ is \ a \ \texttt{non-value} \ data \ type. \ It \ is \ set \ by \ \texttt{calling} \ \texttt{EGMGetId}.$ 

For information about	See
EGMGetId	EGMGetId - Gets an EGM identity on page 61

5.3.3 egm\_minmax - Convergence criteria for EGM Externally Guided Motion

Usage	egm_minmax is used to define the	e convergence criteria for EGM to finish.
Description	egm_minmax is intended to be use	ed in the instructions EGMActJ and EGMActPose.
Components		
Min		
	Data type: num	
	Minimum deviation	
	Defines the minimum value of the degrees.	position deviation. The default value is -0.5
Max		
	Data type: num	
	Maximum deviation	
	Defines the maximum value of the degrees.	e position deviation. The default value is 0.5
Basic examples		
	CONST egm_minmax egm_minm	nax_lin1:=[-0.1,0.1];
	CONST egm_minmax egm_minm	<pre>max_rot1:=[-0.1,0.2];</pre>
	EGMActPose egmID1\Tool:=t EGM_FRAME_WOBJ, pose \y:=egm_minmax_lin1 \ry:=egm_minmax_rot	EFroniusCMT\WObj:=wobj0, posecor, esens, EGM_FRAME_TOOL \x:=egm_minmax_lin1 \z:=egm_minmax_lin1 \rx:=egm_minmax_rot1 1 \rz:=egm_minmax_rot1 \LpFilter:=20;
Characteristics		
	Egm_minmax has the following ur	nits:
	• Millimeters for x, y and z in	linear movement.
	• Degrees for rx, ry, and rz in	linear movement and for joint movement.
Structure		
	< dataobject of egm_minma	ax >
	< min of num > < max of num >	
Related information	on	
	For information about	See

# 5.3.3 egm\_minmax - Convergence criteria for EGM

EGMActJ	EGMActJoint - Prepare an EGM movement for a joint target on page 49
EGMActPose	EGMActPose - Prepare an EGM movement for a pose target on page 56

5.3.4 egmstate - Defines the state for EGM *Externally Guided Motion* 

# 5.3.4 egmstate - Defines the state for EGM

# Usage

 ${\tt egmstate}$  is used to define the state for corrections and sensor measurements in EGM.

#### Description

egmstate is the return value of the function EGMGetState.

#### **Basic examples**

```
VAR egmstate egmStl;
VAR egmident egmID1;
EGMReset egmID1;
EGMGetId egmID1;
egmSt1:=EGMGetState(egmID1);
TPWrite "EGM state: "\Num:=egmSt1;
```

#### Predefined values

Value	Description
EGM_STATE_DISCONNECTED	The EGM state of the specific process is undefined. No setup is active.
EGM_STATE_CONNECTED	The specified EGM process is not activated. Setup has been made, but no EGM movement is active.
EGM_STATE_RUNNING	The specified EGM process is running. The EGM movement is active, i.e. the robot is moved.

#### Characteristics

egmstate is an alias data type for num.

For information about	See
EGMGetState	EGMGetState - Gets the current EGM state on page 97

5.3.5 egmcorrstate - Defines the correction state for EGM *Externally Guided Motion* 

# 5.3.5 egmcorrstate - Defines the correction state for EGM

Usage	egmcorrstate is used to define the state for corrections and sensor measurements in EGM.
Description	egmcorrstate is the return value from the optional argument \CorrectionState of the function EGMGetState.
Basic examples	VAR egmstate egmStl; VAR egmcorrstate egmCorrStl; VAR egmident egmID1;
	<pre>EGMReset egmID1; EGMGetId egmID1; egmSt1 := EGMGetState(egmID1\CorrectionState:=egmCorrSt1); TDWrite #EGM state: #\Nwr:=egmSt1;</pre>
	TPWrite "EGM correction state: "\Num:=egmCorrSt1;

#### **Predefined values**

Value	Description
EGM_CORR_UNDEFINED	The EGM correction state of the specific process is un- defined.
	${\tt EGMGetId}$ has not yet been executed or EGM was reset.
EGM_CORR_STOPPED	This correction state is entered as soon as EGMGetId is executed, but no EGM movement is active yet.
EGM_CORR_RUNNING	The specified EGM process is running, i.e. the robot is moved.
EGM_CORR_ERROR	A position guidance or path correction error occurred when the EGM process was running.

#### Characteristics

egmstate is an alias data type for num.

For information about	See
EGMGetState	EGMGetState - Gets the current EGM state on page 97

5.3.6 egmstopmode - Defines stop modes for EGM *Externally Guided Motion* 

# 5.3.6 egmstopmode - Defines stop modes for EGM

Usage		
	egmstopmode is used to define the stop modes for corrections and sensor measurements in EGM.	
Description		
	egmstopmode is intended to be used in the instructions EGMRunJoint, EGMRunPose	
	and EGMStop.	
Basic examples		
	From the RAPID motion task:	
	VAR egmstate egmSt1;	
	VAR egmident egmID1;	
	EGMReset egmID1;	
	EGMGetId egmID1;	
	CONST egm_minmax egm_minmax_lin1:=[-0.1,0.1];	
	CONST egm_minmax egm_minmax_rot1:=[-0.1,0.2];	
	<pre>EGMActPose egmID1 \Tool:=tFroniusCMT \WObj:=wobj0, posecor, EGM_FRAME_WOBJ, posesens, EGM_FRAME_TOOL \x:=egm_minmax_lin \y:=egm_minmax_lin \z:=egm_minmax_lin \rx:=egm_minmax_rot \ry:=egm_minmax_rot \rz:=egm_minmax_rot \LpFilter:=20; EGMRunPose egmID1, EGM_STOP_HOLD \x \y \z \rx \ry \rz \RampInTime:=0.05;</pre>	

EGMStop egmID1, EGM\_STOP\_RAMP\_DOWN\RampOutTime:=5.0;

#### **Predefined values**

Value	Description
EGM_STOP_HOLD	Keeps the EGM end position.
EGM_STOP_RAMP_DOWN	Returns from the EGM end position to the start position.

#### **Characteristics**

egmstopmode is an alias data type for num.

For information about	See
EGMRunJoint	EGMRunJoint - Perform an EGM movement with a joint target on page 71
EGMRunPose	EGMRunPose - Perform an EGM movement with a pose target on page 74
EGMStop	EGMStop - Stop an EGM movement on page 91

5.4.1 Using EGM Position Stream

# 5.4 Code examples

# 5.4.1 Using EGM Position Stream

#### Description

The device which provides the input data for EGM, first has to be configured as an UdpUc device. See *How to configure UdpUc devices on page 40*.

Now the device can be used by EGM to stream positions of mechanical units to an external equipment. Simple examples are shown below.

It is possible to stream positions from several motion tasks, but you have to use one communication channel for each motion task.

#### Examples

#### Using EGMStreamStart and EGMStreamStop for one mechanical unit

This method is the easiest way to use EGM Position Stream, but it is not accurate for robots with Absolute Accuracy or heavy load.

VAR egmident egmID1; EGMGetId egmID1; ! Set up the EGM data source: UdpUc server using device "UCdevice" and configuration "default" EGMSetupUC ROB\_1, egmID1, "default", "UCdevice"\Joint; ! Start the position stream for T\_ROB1 including active external axis. Cycle time is 16 ms. EGMStreamStart egmID1\SampleRate:=16; ! Run your program - streaming is active MoveAbsJ jpos20, v100, z20, Weldgun; ... MoveAbsJ jpos10\NoEOffs, v1000, fine, Weldgun; ! Stop the position stream - but it is not necessary if you want to stream until the controller shuts down EGMStreamStop egmID1; EGMReset egmID1;

#### Using EGMActXX \StreamStart for one mechanical unit

This method is preferred if you have a robot with Absolute Accuracy, because the RAPID instructions EGMActPose and EGMActJoint pass the data for tool and load to the controller.

VAR egmident egmID1; ! Used tool TASK PERS tooldata Weldgun:=[TRUE,[[12.3313,-0.108707,416.142], [0.903899,-0.00320735,0.427666,0.00765917]], [2.6,[-111.1,24.6,386.6],[1,0,0,0],0,0,0.072]]; ! limits for cartesian convergence: +-1 mm CONST egm\_minmax egm\_minmax\_lin1:=[-1,1]; ! limits for orientation convergence: +-2 degrees CONST egm\_minmax egm\_minmax\_rot1:=[-2,2]; ! Correction frame offset: none

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5.4.1 Using EGM Position Stream *Continued* 

```
VAR pose corr_frame_offs:=[[0,0,0],[1,0,0,0]];
EGMGetId egmID1;
! Set up the EGM data source: UdpUc server using device "UCdevice"
     and configuration "default"
EGMSetupUC ROB_1, egmID1, "default", "UCdevice"\Joint;
! Correction frame is the World coordinate system and the sensor
     measurements are relative to the tool frame of the used tool
     (Weldgun). Start the position stream for T_ROB1 including
     active external axis. Cycle time is 16 ms.
EGMActPose egmID1\StreamStart\Tool:= Weldgun, corr_frame_offs,
EGM_FRAME_WORLD, Weldgun.tframe, EGM_FRAME_TOOL
\x:=egm_minmax_lin1\y:=egm_minmax_lin1\z:=egm_minmax_lin1
\rx:=egm_minmax_rot1\ry:=egm_minmax_rot1\rz:=egm_minmax_rot1
\LpFilter:=20;
! Run your program - streaming is active
MoveAbsJ jpos20, v100, z20, Weldgun;
MoveAbsJ jpos10\NoEOffs, v1000, fine, Weldgun;
! Stop the position stream - but this is not necessary if you want
     to stream until the controller shuts down
EGMStreamStop eqmID1;
EGMReset egmID1;
```

#### Using EGMStreamStart and EGMStreamStop for multiple mechanical units

This example is for a MultiMove system with two robots, each mounted on a track motion.

#### RAPID task for robot 1:

```
VAR egmident egmID1;
! Activate the mechanical unit for the track motion
ActUnit TRACK1;
EGMReset eqmID1;
EGMGetId egmID1;
! Set up the EGM streaming destination for ROB1, including active
     additional axis, using device "UCdevice1" and configuration
     "default"
EGMSetupUC ROB_1, egmID1, "default", "UCdevice1"\Joint;
EGMStreamStart eqmID1;
! Start the position stream for ROB1 including active additional
     axis. Cycle time is 4 ms (default).
! Run your program - streaming is active
MoveJ p10, v1000, z50, Weldgun;
....
MoveAbsJ jpos10\NoEOffs, v1000, fine, Weldgun;
! Stop the position stream
EGMStreamStop egmID1;
! Deactivate the mechanical unit for the track motion
DeactUnit TRACK1;
```

#### RAPID task for robot 2:

VAR egmident egmID2;

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5.4.1 Using EGM Position Stream Continued

```
! Activate the mechanical unit for the track motion
ActUnit TRACK2;
EGMReset egmID2;
EGMGetId egmID2;
! Set up the EGM streaming destination for ROB2, including active
     additional axis, using device "UCdevice2" and configuration
     "default"
EGMSetupUC ROB_2, egmID2, "default", "UCdevice2"\Joint;
! Start the position stream for ROB2 including active additional
     axis. Cycle time is 4 ms (default).
EGMStreamStart egmID2;
! Run your program - streaming is active
MoveJ p10, v1000, z50, PKI_500;
•••
MoveAbsJ jpos10\NoEOffs, v1000, fine, PKI_500;
! Stop the position stream
EGMStreamStop egmID2;
! Deactivate the mechanical unit for the track motion
DeactUnit TRACK2;
```

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5.4.2 Using EGM Position Guidance with an UdpUc device

## 5.4.2 Using EGM Position Guidance with an UdpUc device

```
Description
                   The device which provides the input data for EGM, first has to be configured as
                   an UdpUc device. See How to configure UdpUc devices on page 40.
                   Now the device can be used by EGM to guide a robot. A simple example is the
                   following:
Example
                       MODULE EGM test
                         VAR eqmident eqmID1;
                         VAR egmstate egmSt1;
                         ! limits for cartesian convergence: +-1 mm
                         CONST egm_minmax egm_minmax_lin1:=[-1,1];
                         ! limits for orientation convergence: +-2 degrees
                         CONST egm_minmax egm_minmax_rot1:=[-2,2];
                         ! Start position
                         CONST jointtarget
                               jpos10:=[[0,0,0,0,40,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
                         ! Used tool
                         TASK PERS tooldata
                              tFroniusCMT:=[TRUE,[[12.3313,-0.108707,416.142],
                               [0.903899,-0.00320735,0.427666,0.00765917]],
                              [2.6,[-111.1,24.6,386.6],[1,0,0,0],0,0,0.072]];
                         ! corr-frame: wobj, sens-frame: wobj
                         TASK PERS wobjdata wobj_EGM1:=[FALSE,TRUE,"",
                               [[150, 1320, 1140], [1, 0, 0, 0]], [[0, 0, 0], [1, 0, 0, 0]]];
                         ! Correction frame offset: none
                         VAR pose corr_frame_offs:=[[0,0,0],[1,0,0,0]];
                           PROC main()
                             ! Move to start position. Fine point is demanded.
                             MoveAbsJ jpos10\NoEOffs, v1000, fine, tFroniusCMT;
                             testuc;
                           ENDPROC
                           PROC testuc()
                             EGMReset eqmID1;
                             EGMGetId egmID1;
                             egmSt1:=EGMGetState(egmID1);
                             TPWrite "EGM state: "\Num:=egmSt1;
                             IF egmSt1 <= EGM_STATE_CONNECTED THEN
                               ! Set up the EGM data source: UdpUc server using device
                                     "EGMsensor:" and configuration "default"
                               EGMSetupUC ROB_1, egmID1, "default", "EGMsensor:"\pose;
                             ENDIF
```
#### 5.4.2 Using EGM Position Guidance with an UdpUc device Continued

```
! Correction frame is the World coordinate system and the
          sensor measurements are relative to the tool frame of
          the used tool (tFroniusCMT)
     EGMActPose egmID1\Tool:=tFroniusCMT, corr_frame_offs,
          EGM_FRAME_WORLD, tFroniusCMT.tframe, EGM_FRAME_TOOL
           \x:=egm_minmax_lin1 \y:=egm_minmax_lin1
          \z:=egm_minmax_lin1 \rx:=egm_minmax_rot1
          \ry:=egm_minmax_rot1 \rz:=egm_minmax_rot1 \LpFilter:=20;
     ! Run: the convergence condition has to be fulfilled during
          2 seconds before RAPID execution continues to the next
          instruction
     EGMRunPose egmID1, EGM_STOP_HOLD x y z \
          \RampInTime:=0.05;
     egmSt1:=EGMGetState(egmID1);
     IF egmSt1 = EGM_STATE_CONNECTED THEN
       TPWrite "Reset EGM instance egmID1";
       EGMReset egmID1;
     ENDIF
   ENDPROC
ENDMODULE
```

#### **5 RAPID reference information**

5.4.3 Using EGM Position Guidance with signals as input

#### 5.4.3 Using EGM Position Guidance with signals as input

#### Description

All signals that are used together with EGM has to be defined in the I/O configuration of the system. I.e. the signals that are set up with EGMSetupAI, EGMSetupAO, or EGMSetupGI. After that, the signals can be used by EGM to guide a robot.

The following RAPID program example uses analog output signals as input. The main reason for analog output signals is, that they are easier to simulate than analog input signals. In a real application group input signals and analog input signals might be more common.

In the examples below we also set the analog output signals to a constant value before the EGMRun instruction just for simplicity. Normally an external device will update the signal values to give the desired robot positions.

The second example below illustrates how a 7-axis robot can be used with EGM joint mode.

#### Example 1

```
MODULE EGM test
VAR egmident egmID1;
VAR egmident egmID2;
CONST egm_minmax egm_minmax_lin1:=[-1,1];
CONST egm_minmax egm_minmax_rot1:=[-2,2];
CONST egm_minmax egm_minmax_joint1:=[-0.1,0.1];
CONST robtarget p20:=[[150,1320,1140],
     [0.000494947,0.662278,-0.749217,-0.00783173], [0,0,-1,0],
     [9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
CONST robtarget p30:=[[114.50,1005.42,1410.38],
     [0.322151,-0.601023,0.672381,0.287914], [0,0,-1,0],
     [9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
CONST jointtarget
     jpos10:=[[0,0,0,0,35,0],[9E+09,9E+09,9E+09,9E+09,9E+09,9E+09]];
CONST pose posecor:=[[1200,400,900],[1,0,0,0]];
CONST pose posesens:=[[12.3313,-0.108707,416.142],
     [0.903899,-0.00320735,0.427666,0.00765917]];
! corr-frame: world, sens-frame: world
VAR pose posecor0:=[[0,0,0],[1,0,0,0]];
VAR pose posesen0:=[[0,0,0],[1,0,0,0]];
TASK PERS tooldata tFroniusCMT:=[TRUE,[[12.3313,-0.108707,416.142],
     [0.903899, -0.00320735, 0.427666, 0.00765917]],
     [2.6,[-111.1,24.6,386.6],[1,0,0,0],0,0,0.072]];
TASK PERS loaddata load1:=[5,[0,1,0],[1,0,0,0],0,0,0];
! corr-frame: wobj, sens-frame: wobj
```

```
TASK PERS wobjdata
     wobj_EGM1:=[FALSE,TRUE,"",[[150,1320,1140],[1,0,0,0]],
     [[0,0,0],[1,0,0,0]]];
VAR pose posecor1:=[[0,0,0],[1,0,0,0]];
VAR pose posesen1:=[[0,0,0],[1,0,0,0]];
TASK PERS wobjdata
     wobj_EGM2:=[FALSE,TRUE,"",[[0,1000,1000],[1,0,0,0]],
     [[0,0,0],[1,0,0,0]]];
VAR pose posecor2:=[[150,320,0],[1,0,0,0]];
VAR pose posesen2:=[[150,320,0],[1,0,0,0]];
PROC main()
MoveAbsJ jpos10\NoEOffs, v1000, fine, tFroniusCMT;
testA0;
ENDPROC
PROC testAO()
! Get two different EGM identities. They will be used for two
     different eGM setups.
EGMGetId egmID1;
EGMGetId egmID2;
! Set up the EGM data source: Analog output signals and
     configuration "default"
! One guidance using Pose mode and one using Joint mode
EGMSetupAO ROB_1,egmID1,"default" \Pose \aoR1x:=ao_MoveX
     \aoR2y:=ao_MoveY \aoR3z:=ao_MoveZ \aoR5ry:=ao_RotY
     \aoR6rz:=ao_RotZ;
EGMSetupAO ROB_1,egmID2, "default" \Joint \aoR1x:=ao_MoveX
     \aoR2y:=ao_MoveY \aoR3z:=ao_MoveZ \aoR4rx:=ao_RotX
     \aoR5ry:=ao_RotY \aoR6rz:=ao_RotZ;
! Move to the starting point - fine point is needed.
MoveJ p30, v1000, fine, tool0;
! Set the signals
SetAO ao_MoveX, 150;
SetAO ao_MoveY, 1320;
SetAO ao_MoveZ, 900;
! Correction frame is the World coordinate system and the sensor
     measurements are also relative to the world frame
! No offset is defined (posecor0 and posesen0)
EGMActPose egmID1 \Tool:=tFroniusCMT \WObj:=wobj0 \TLoad:=load1,
     posecor0, EGM_FRAME_WORLD, posesen0, EGM_FRAME_WORLD
     \x:=egm_minmax_lin1 \y:=egm_minmax_lin1 \z:=egm_minmax_lin1
     \rx:=egm_minmax_rot1 \ry:=egm_minmax_rot1 \rz:=egm_minmax_rot1
     \LpFilter:=20 \SampleRate:=16 \MaxPosDeviation:=1000;
! Run: keep the end position without returning to the start position
EGMRunPose eqmID1,
     EGM_STOP_HOLD\x\y\z\RampInTime:=0.05\PosCorrGain:=1;
! Move to the starting point - fine point is needed.
MoveJ p20, v1000, fine, tFroniusCMT;
```

```
! Set the signals
SetAO ao_MoveX, 150;
SetAO ao_MoveY, 1320;
SetAO ao_MoveZ, 1100;
! Run with the same frame definitions: ramp down to the start
     position after having reached the EGM end position
EGMRunPose eqmID1,
     EGM_STOP_RAMP_DOWN\x\y\z\RampInTime:=0.05\PosCorrGain:=1;
! Move to the starting point - fine point is needed.
MoveJ p30, v1000, fine, tool0;
! Set the signals
SetAO ao_MoveX, 50;
SetAO ao_MoveY, -20;
SetAO ao_MoveZ, -20;
! Correction frame is the Work object wobj_EGM1 and the sensor
     measurements are also relative to the same work object. No
     offset is defined (posecor1 and posesen1)
EGMActPose egmID1 \Tool:=tFroniusCMT \WObj:=wobj_EGM1 \TLoad:=load1,
     posecor1, EGM_FRAME_WOBJ, posesen1, EGM_FRAME_WOBJ
     \x:=egm_minmax_lin1 \y:=egm_minmax_lin1 \z:=egm_minmax_lin1
     \rx:=egm_minmax_rot1 \ry:=egm_minmax_rot1 \rz:=egm_minmax_rot1
     \LpFilter:=20;
! Run: keep the end position without returning to the start position
EGMRunPose eqmID1,
     EGM_STOP_HOLD\x\y\z\RampInTime:=0.05\PosCorrGain:=1;
! Move to the starting point - fine point is needed.
MoveJ p20, v1000, fine, tFroniusCMT;
! Set the signals
SetAO ao_MoveX, 0;
SetAO ao_MoveY, 0;
SetAO ao_MoveZ, 0;
! Correction frame is the Work object wobj_EGM2 and the sensor
     measurements are also relative to the same work object. This
     time an offset is defined for the correction frame (posecor2),
     and for the sensor frame (posesen2)
EGMActPose eqmID1 \Tool:=tFroniusCMT \WObj:=wobj_EGM2 \TLoad:=load1,
     posecor2, EGM_FRAME_WOBJ, posesen2, EGM_FRAME_WOBJ
     \x:=egm_minmax_lin1 \y:=egm_minmax_lin1 \z:=egm_minmax_lin1
     \rx:=egm_minmax_rot1 \ry:=egm_minmax_rot1 \rz:=egm_minmax_rot1
     \LpFilter:=20;
! Run: keep the end position without returning to the start position
EGMRunPose egmID1.
     EGM_STOP_HOLD\x\y\z\RampInTime:=0.05\PosCorrGain:=1;
! Move to the starting point - fine point is needed.
MoveJ p20, v1000, fine, tFroniusCMT;
! Set the signals
SetAO ao_MoveX, 0;
SetAO ao_MoveY, 0;
SetAO ao_MoveZ, 0;
```

```
! Correction frame is of tool type and the sensor measurements are
     relative to the work object wobj_EGM2. This time an offset
     is defined for the correction frame (posecor2), and for the
     sensor frame (posesen2)
EGMActPose egmID1 \Tool:=tFroniusCMT \WObj:=wobj_EGM2, posecor2,
     EGM_FRAME_TOOL, posesen2, EGM_FRAME_WOBJ \x:=egm_minmax_lin1
     \y:=egm_minmax_lin1 \z:=egm_minmax_lin1 \rx:=egm_minmax_rot1
     \ry:=egm_minmax_rot1 \rz:=egm_minmax_rot1 \LpFilter:=20;
EGMRunPose egmID1,
     EGM_STOP_HOLD\x\y\z\RampInTime:=0.05\PosCorrGain:=1;
! Move to the starting point - fine point is needed.
MoveJ p20, v1000, fine, tFroniusCMT\TLoad:=load1;
! Set the signals
SetAO ao_MoveX, 150;
SetAO ao_MoveY, 1320;
SetAO ao_MoveZ, 1100;
! Same as last, but with tool0 and wobj0
EGMActPose egmID1, posecor2, EGM_FRAME_TOOL, posesen2,
     EGM_FRAME_WOBJ \x:=egm_minmax_lin1 \y:=egm_minmax_lin1
     \z:=egm_minmax_lin1 \rx:=egm_minmax_rot1 \ry:=egm_minmax_rot1
     \rz:=egm_minmax_rot1 \LpFilter:=20;
! Run: keep the end position without returning to the start position
EGMRunPose egmID1,
     EGM_STOP_HOLD\x\y\z\RampInTime:=0.05\PosCorrGain:=1;
! Move to the starting point - fine point is needed.
MoveJ p20, v1000, fine, tFroniusCMT\TLoad:=load1;
! Set the signals
SetAO ao_MoveX, 70;
SetAO ao_MoveY, -5;
SetAO ao_MoveZ, 0;
SetAO ao_RotX, 0;
SetAO ao_RotY, 0;
SetAO ao_RotZ, 0;
! Joint guidance for joints 2-6
EGMActJoint egmID2 \J2:=egm_minmax_joint1 \J3:=egm_minmax_joint1
     \J4:=egm_minmax_joint1 \J5:=egm_minmax_joint1
     \J6:=egm_minmax_joint1 \LpFilter:=20;
! Run: keep the end position without returning to the start position
EGMRunJoint egmID2, EGM_STOP_HOLD \J2 \J3 \J4 \J5 \J6 \CondTime:=0.1
     \RampInTime:=0.05 \PosCorrGain:=1;
EGMReset eqmID1;
EGMReset egmID2;
ENDPROC
ENDMODULE
```

#### 5 RAPID reference information

```
Example 2
                      MODULE EGM_IRB14000_test
                      VAR egmident egmID;
                      CONST egm_minmax egm_minmax_joint1:=[-0.1,0.1];
                      ! For handling if the test is used with left or right arm.
                      VAR jointtarget jpos10;
                      CONST jointtarget jpos10_L:=[[0,-130,30,0,40,0],
                            [135,9E+09,9E+09,9E+09,9E+09,9E+09]];
                      CONST jointtarget jpos10_R:=[[0,-130,30,0,40,0],
                            [-135,9E+09,9E+09,9E+09,9E+09,9E+09]];
                      PROC main()
                        IF GetMecUnitName(ROB_ID) = "ROB_L" THEN
                          jpos10 := jpos10_L;
                          testA0;
                        ELSEIF GetMecUnitName(ROB_ID) = "ROB_R" THEN
                          jpos10 := jpos10_R;
                          testA0;
                        ENDIF
                      ENDPROC
                      PROC testAO()
                        ! Get an EGM idenity.
                        EGMGetId egmID;
                        ! Set up the EGM data source:
                        ! Analog output signals and configuration "default".
                        ! Only the EGM Joint mode support IRB14000.
                        ! Notice the joint mapping of the analog output signals.
                        EGMSetupAO ROB_ID, egmID, "default" \Joint \aoR1x:=ao_J1
                              \aoR2y:=ao_J2 \aoR3z:=ao_J4 \aoR4rx:=ao_J5 \aoR5ry:=ao_J6
                              \aoR6rz:=ao_J7 \AoE1:=ao_J3;
                        ! Move to the starting point - fine point is needed.
                        MoveAbsJ jpos10\NoEOffs, v50, fine, tool0;
                        ! Set the signals (using an incrementing offset from the initial
                             position).
                        ! Another set of analog signals should be created, if running
                              this code for both arms at the same time.
                        ! Notice the joint mapping from a jointtarget to the analog output
                              signals.
                        SetAO ao_J1, jpos10.robax.rax_1 + 1;
                        SetAO ao_J2, jpos10.robax.rax_2 + 2;
                        SetAO ao_J3, jpos10.extax.eax_a + 3;
                        SetAO ao_J4, jpos10.robax.rax_3 + 4;
                        SetAO ao_J5, jpos10.robax.rax_4 + 5;
                        SetAO ao_J6, jpos10.robax.rax_5 + 6;
                        SetAO ao_J7, jpos10.robax.rax_6 + 7;
                        ! Joint guidance for joints 1-7.
                        EGMActJoint egmID \J1:=egm_minmax_joint1 \J2:=egm_minmax_joint1
                              \J3:=egm_minmax_joint1 \J4:=egm_minmax_joint1
                              \J5:=egm_minmax_joint1 \J6:=egm_minmax_joint1
                              \J7:=egm_minmax_joint1 \LpFilter:=20;
                        ! Run: keep the end position without returning to the start
                              position.
```

EGMRunJoint egmID, EGM\_STOP\_HOLD \J1 \J2 \J3 \J4 \J5 \J6 \J7 \CondTime:=1 \RampInTime:=0.05 \PosCorrGain:=1; EGMReset egmID; ENDPROC ENDMODULE

#### **5 RAPID reference information**

5.4.4 Using EGM Path Correction with different protocol types

### 5.4.4 Using EGM Path Correction with different protocol types

Description	
	This example contains examples for different sensor and protocol types. The basic
	BAPID program structure is the same for all of them and they use the same external
	motion data configuration
	motion data configuration.
Example	
Example	MODILLE FOM DATHCORP
	$\frac{1}{100} = \frac{1}{100} = \frac{1}$
	$\begin{bmatrix} 1 & 333900724 & 0 & 551914471 & 0 \end{bmatrix} \begin{bmatrix} 1 & 0 & 100 \end{bmatrix}$
	[1,0,0,0],0,0,0];
	! Sensor tool, has to be calibrated
	PERS tooldata
	tLaser:=[TRUE,[[148.619609537,50.250017146,326.310337954],
	[0.390261856,-0.58965743,-0.58965629,0.390263064]],
	[1,[-0.920483747,-0.000000536,-0.390780849],
	[1,0,0,0],0,0,0]];
	! Displacement used
	VAR pose PP:=[[0,-3,2],[1,0,0,0]];
	VAR egmident egmId1;
	! Protocol: LTAPP
	! Example for a look ahead sensor, e.g. Laser Tracker
	PROC Part_2_EGM_OT_Pth_1()
	EGMGetId egmId1;
	! Set up the EGM data source: LTAPP server using device "Optsim", configuration "pathCorr", joint type 1 and look ahead sensor.
	EGMSetupLTAPP ROB 1. egmId1. "pathCorr". "OptSim". 1\LATR;
	! Activate EGM and define the sensor frame. Correction frame is
	always the path frame.
	EGMActMove eqmId1, tLaser.tframe\SampleRate:=48;
	! Move to a suitable approach position.
	MoveJ p100,v1000,z10,tEGM\WObj:=wobj0;
	MoveL p110,v1000,z100,tEGM\WObj:=wobj0;
	MoveL p120,v1000,z100,tEGM\WObj:=wobj0;
	! Activate displacement (not necessary but possible)
	PDispSet PP;
	! Move to the start point. Fine point is demanded.
	MoveL p130, v10, fine, tEGM\WObj:=wobj0;
	! movements with path corrections.
	EGMMoveL egmId1, p140, v10, z5, tEGM\WObj:=wobj0;
	EGMMoveL egmId1, p150, v10, z5, tEGM\WObj:=wobj0;
	EGMMoveC egmId1, p160, p165, v10, z5, tEGM\WObj:=wobj0;
	! Last path correction movement has to end with a fine point.
	EGMMoveL egmId1, p170, v10, fine, tEGM\WObi:=wobi0;
	! Move to a safe position after path correction.
	MoveL p180,v1000,z10,tEGM\WObi:=wobi0;
	! Release the EGM identity for reuse.
Continues on port no	-
Commues on next pa	yu araa ahaa ahaa ahaa ahaa ahaa ahaa aha

```
5.4.4 Using EGM Path Correction with different protocol types 
Continued
```

```
EGMReset eqmId1;
ENDPROC
! Protocol: LTAPP
! Example for an at point sensor, e.g. Weldguide
PROC Part_2_EGM_WG_Pth_1()
 EGMGetId eqmId1;
  ! Set up the EGM data source: LTAPP server using device "wglsim",
       configuration "pathCorr", joint type 1 and at point sensor.
 EGMSetupLTAPP ROB_1, egmId1, "pathCorr", "wg1sim", 1\APTR;
  ! Activate EGM and define the sensor frame, which is the tool
       frame for at point trackers.
  ! Correction frame is always the path frame.
 EGMActMove eqmId1, tEGM.tframe\SampleRate:=48;
  ! Move to a suitable approach position.
 MoveJ p100,v1000,z10,tEGM\WObj:=wobj0;
 MoveL p110,v1000,z100,tEGM\WObj:=wobj0;
 MoveL p120,v1000,fine,tEGM\WObj:=wobj0;
 ! Activate displacement (not necessary but possible)
 PDispSet PP;
 ! Move to the start point. Fine point is demanded.
 MoveL p130, v10, fine, tEGM\WObj:=wobj0;
  ! movements with path corrections.
 EGMMoveL eqmId1, p140, v10, z5, tEGM\WObj:=wobj0;
 EGMMoveL egmId1, p150, v10, z5, tEGM\WObj:=wobj0;
 EGMMoveC egmId1, p160, p165, v10, z5, tEGM\WObj:=wobj0;
  ! Last path correction movement has to end with a fine point.
 EGMMoveL egmId1, p170, v10, fine, tEGM\WObj:=wobj0;
 ! Move to a safe position after path correction.
 MoveL p180,v1000,z10,tEGM\WObj:=wobj0;
  ! Release the EGM identity for reuse.
 EGMReset eqmId1;
ENDPROC
! Protocol: UdpUc
! Example for an at point sensor, e.g. Weldguide
PROC Part_2_EGM_UDPUC_Pth_1()
 EGMGetId eqmId1;
 EGMSetupUC ROB_1, egmId1, "pathCorr", "UCdevice"\PathCorr\APTR;
 EGMActMove egmId1, tEGM.tframe\SampleRate:=48;
 ! Move to a suitable approach position.
 MoveJ p100,v1000,z10,tEGM\WObj:=wobj0;
 MoveL p110,v1000,z100,tEGM\WObj:=wobj0;
 MoveL p120,v1000,fine,tEGM\WObj:=wobj0;
 ! Activate displacement (not necessary but possible)
 PDispSet PP;
  ! Move to the start point. Fine point is demanded.
 MoveL p130, v10, fine, tEGM\WObj:=wobj0;
  ! movements with path corrections.
 EGMMoveL egmId1, p140, v10, z5, tEGM\WObj:=wobj0;
 EGMMoveL egmId1, p150, v10, z5, tEGM\WObj:=wobj0;
```

# 5.4.4 Using EGM Path Correction with different protocol types *Continued*

```
EGMMoveC egmId1, p160, p165, v10, z5, tEGM\WObj:=wobj0;
! Last path correction movement has to end with a fine point.
EGMMoveL egmId1, p170, v10, fine, tEGM\WObj:=wobj0;
! Move to a safe position after path correction.
MoveL p180,v1000,z10,tEGM\WObj:=wobj0;
! Release the EGM identity for reuse.
EGMReset egmId1;
ENDPROC
ENDMODULE
```

## 6 UdpUc code examples

#### **File locations**

The following code examples are available in the RobotWare distribution.

File	Description
egm-sensor.cs	Example using protobuf-csharp-port
egm-sensor.cpp	Example using Google protocol buffers C++
egm.proto	The <i>egm.proto</i> file defines the data contract between the robot and the sensor.

The files can be obtained from the PC or the robot controller.

- In the RobotWare installation folder in RobotStudio: ...\RobotPackages\RobotControl\_<version>\utility\Template\EGM\
- On the OmniCore Controller:

   SystemName>\PRODUCTS\RobotControl\_x.x.x-xxx\utility\Template\EGM\



#### Note

Navigate to the RobotWare installation folder from the RobotStudio Add-Ins tab, by right-clicking on the installed RobotWare version in the Add-Ins browser and selecting Open Package Folder.

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