ADEPT Robot Control using a SIMATIC S7-300 Controller

"ADEPT_RobotControl" Function Block

Application Description • August 2013

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SIMATIC
FB "ADEPT_RobotControl"

SIMATIC S7-300

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Preface

Objective of this application

It is the purpose of the application to describe how an ADEPT robot can be controlled via a SIMATIC S7-300 controller in a convenient and easy way using a preprogrammed function block.

In this application, the description of the robot control is restricted to the use of the preprogrammed function block for influencing the robot functions on the robot controller. For robot-specific features and functions please refer to the documentation by the robot manufacturer.

This application was developed in cooperation with the following robot manufacturer:

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Main contents of this application

The following main points will be discussed in this application:

- Connecting an ADEPT robot to a SIMATIC controller
- Controlling the ADEPT robot via a preprogrammed function block through a SIMATIC controller

Validity

This application can only be used together with the ADEPT data interface for the ADEPT SmartController EX with the following version:

- ADEPT ePLC V3.1B Preliminary or higher

Security notice

This application is limited to controlling the ADEPT Robot via a SIMATIC S7-300 Controller. Secure operation of the ADEPT robot is not possible this way.

Particularly in case of a communication failure between the SIMATIC Controller and the robot controller the robot behavior can no longer be influenced through the SIMATIC Controller.

DANGER

In case of danger, take additional measures for stopping the robot if the robot movements can no longer be influenced by the SIMATIC Controller.

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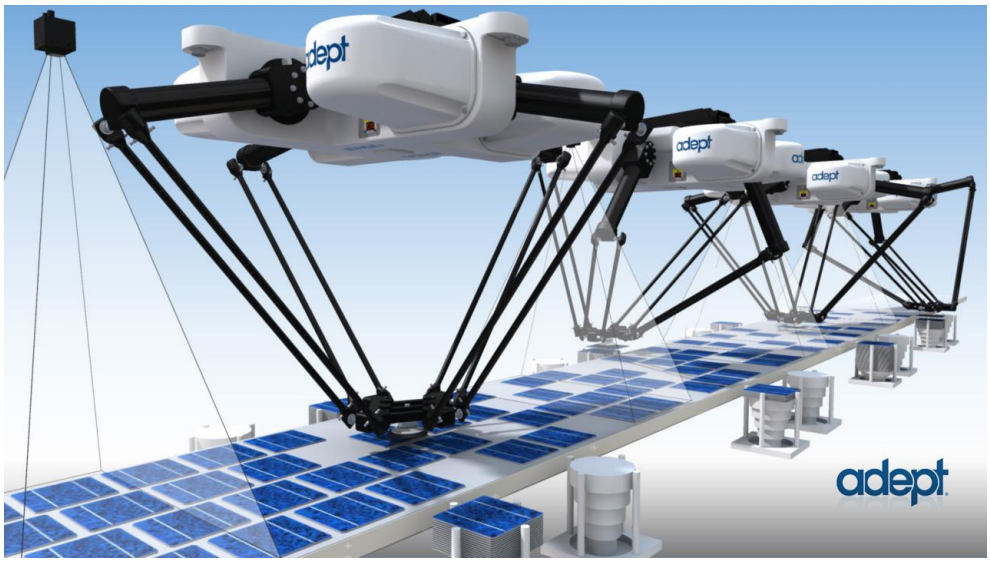
1 Task

1.1 Introduction

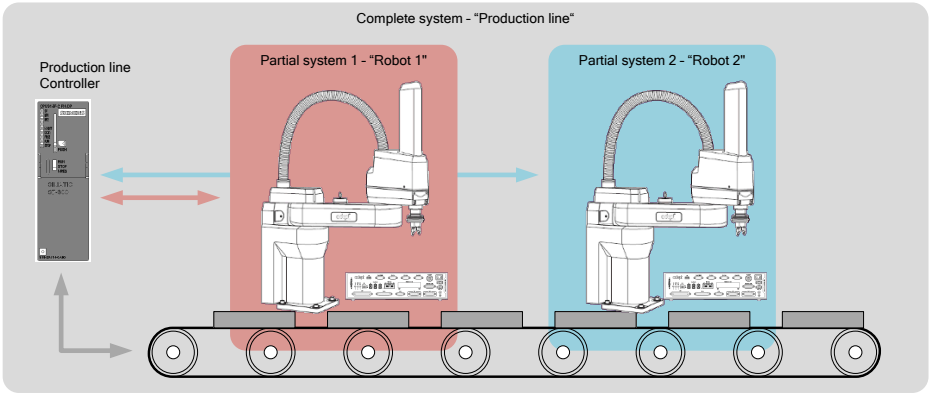
Robot applications in industry are very frequently integrated into production lines that are controlled by programmable logic controllers.

Figure 1-1 Industrial robot applications



Usually the robot application is a separate unit acting independently from the production line controller and needs to be supplied with data required for operating the robot by this controller.

Figure 1-2 Basic diagram of a production line

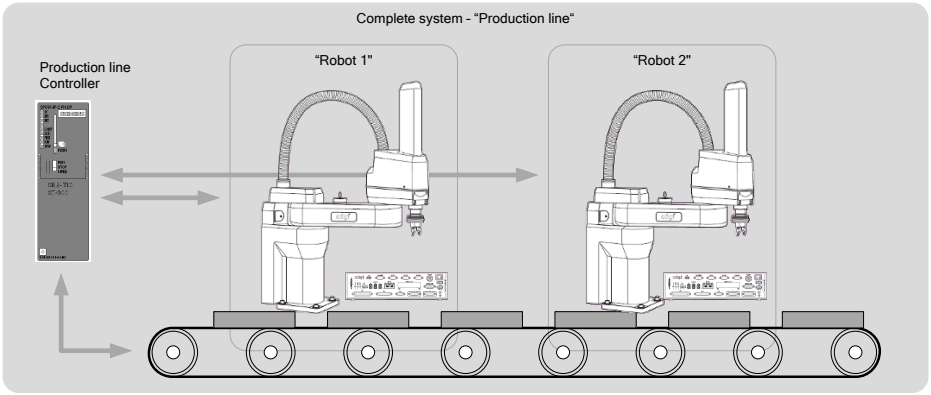


Commissioning a production line requires both the knowledge for commissioning the PLC and the knowledge of the robot system. The same applies to maintaining this production line and to changing production to a different product.

1.2 Automation Task

In order to control the robot in a production line in a convenient way it should be possible to fully integrate the robot into the production line controller and to define and influence the robot movements directly from this controller.

Figure 1-3 Basic diagram of the automation task



Through this it will be possible to commission the production line even without any knowledge of the robot system and to carry out maintenance works or production changes directly via the production line controller.

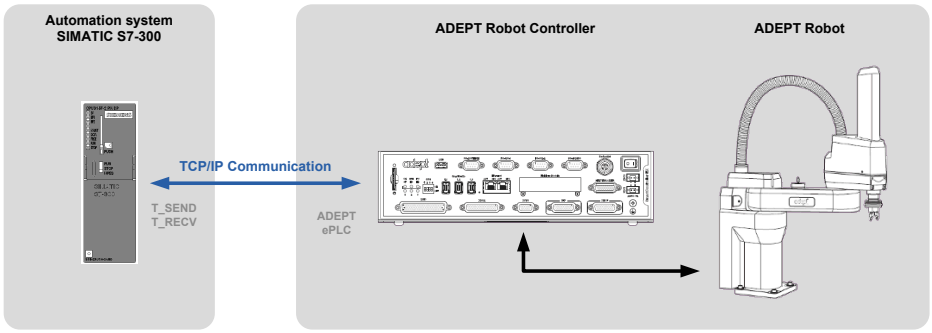
2 Solution

2.1 Overview

To solve the automation task, this application will introduce a function block for the SIMATIC S7-300 PLC, through which an ADEPT robot can be controlled directly from the automation system.

For this purpose, the ADEPT robot provides a data interface through which commands for the robot and status data from the robot can be exchanged with the automation system.

Figure 2-1 Overview of the solution of the automation task



2.1.1 Advantages of the automation solution

The automation solution presented in this document offers the following advantages:

- **No robot controller knowledge required**
  The robot system is usually delivered by the manufacturer with a preinstalled ePLC data interface and is immediately ready for operation.
  Adapting the IP address of the robot controller might be required.
- **Easy robot control via the SIMATIC S7-300 Controller**
  The robot is fully controlled via the SIMATIC S7-300 Controller, which allows for addressing and programming the robot functions via the automation system. STEP-7 knowledge is sufficient for that.

2.1.2 Delimitation

This application does not include any information on ...

- ... the basic usage and handling of a robot.
- ... the specific geometric characteristics of different robot kinematics for programming the robot movements.
- ... the internal functional principle of the ADEPT ePLC data interface.

Basic knowledge of these topics is assumed.

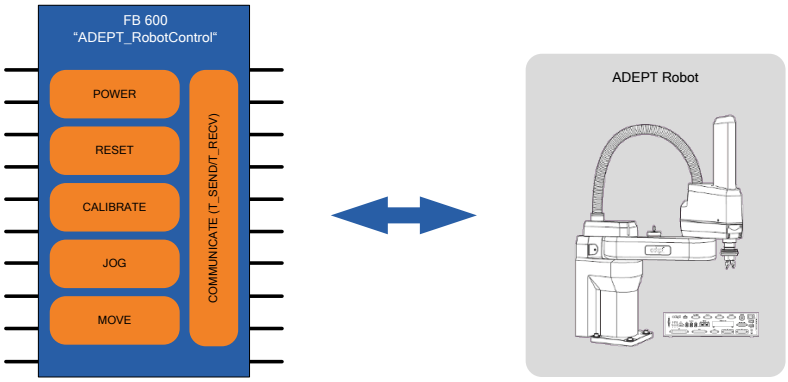
2.2 Core functionality

The focus of this application example is a function block for the SIMATIC S7-300 automation system, through which an ADEPT robot with ePLC data interface can be fully controlled and monitored.

The function block includes the following functionalities:

- Setting up the communication connection between the SIMATIC S7-300 automation system and the robot controller with ePLC data interface
- Switching the robot power on and off
- Acknowledging and resetting error events in the robot controller
- Triggering a homing operation (Calibration) at the robot
- Moving the robot axes in jog mode (JOG)
- Perform travel movements at the robot by defining the required target position
- Chaining individual movements to one sequence of movements that can be performed by the robot without interruption with a smooth travel movement.

Figure 2-2 Overview of the core functionality of the function block



2.3 Required hardware and software components

The hardware and software components described in the following chapters were used for creating the application example.

2.3.1 Hardware components

Table 2-1 SIEMENS hardware components

SIEMENS Component	Qty.	Order number	Note
CPU 315-2 PN/DP	1	6ES7 315-2EH14-0AB0 Firmware: V3.1 or higher	

SIEMENS Component	Qty.	Order number	Note
SM 323 DI8/DO8x24V	1	6ES7 323-1BH01-0AA0	Optional component for additional hardware wiring of the robot. Currently not used in the Application Example.

Table 2-2 ADEPT hardware components

ADEPT Component	Qty.	Order number	Note
Robot	1	Please inquire order number from ADEPT.	Models “Viper” and “Cobra” were used for testing with the application example.
Power unit robot	1	Please inquire order number from ADEPT.	If not already integrated in the robot.
Robot controller: • SmartController EX	1	Please inquire order number from ADEPT.	The ePLC data interface is compatible with this controller.

2.3.2 Software components

Table 2-3 SIEMENS software components

SIEMENS Component	Qty.	Order number	Note
STEP 7	1	6ES7 810-4CC10-0YA5 Version: V5.5 SP3	
STEP 7 option “S7-SCL”	1	6ES7 811-1CC05-0YA5 Version: V5.3 SP6	Only required if the function block is to be opened, changed or recompiled.
WinCC flexible	1	6AV6 613-0AA51-3CA5 Version: 2008 SP3 Upd3	Engineering system of the HMI user interface, in case this is to be adapted or extended.
WinCC flexible Runtime	1	6AV6 613-4BD01-3AD0 Version: 2008 SP3 Upd3	In case the HMI user interface is to be operated on a PC without engineering system.

Table 2-4 ADEPT software components

ADEPT Component	Qty.	Order number	Note
ADEPT ePLC	1	Please inquire order number from ADEPT. Version: V3.1 (Siemens)	Data interface as a software solution in the robot controller.
ADEPT ACE 3.3.3.1	1	Please inquire order number from ADEPT.	Automation Control Environment Software. Required only if the robot controller IP address needs to be changed.

2.3.3 Sample files and projects

The following list includes all files and projects associated with this application example.

Table 2-5 Example files and projects

Component	Note
79100154_ADEPT_RobotControlFB_DOKU_en.pdf	This documentation
79100154_ADEPT_RobotControlFB_CODE_EXP.zip	STEP 7 archive of the application example as a full STEP 7 project with HMI user interface
79100154_ADEPT_RobotControlFB_CODE.zip	STEP 7 archive of the function block with all required blocks for integration into own STEP 7 projects.

3 Basics

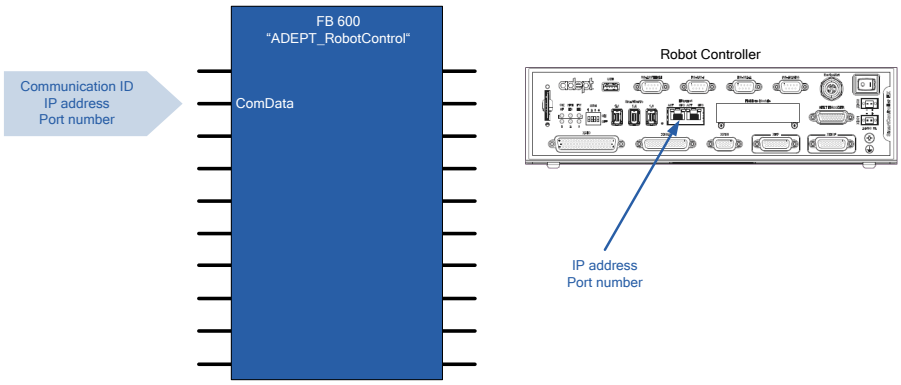
3.1 Communication connection to the robot

Data is exchanged between robot and SIMATIC automation system through “programmed communication” via a TCP/IP connection, which is executed via functional blocks FB 65 “TCON”, FB 66 “TDISCON” for setting up and clearing the connection and FB 63 “TSEND”, FB 64 “TRCV” for sending and receiving the data.

Storing the IP address of the robot in the SIMATIC Controller for the “programmed communication“, as well as defining a freely selectable communication ID (which must be unique for every connection, meaning for every addressed robot) is sufficient for establishing the communication connection to the robot. In addition, the communication port must be defined for the robot controller.

For this purpose, the function block for controlling the robot includes a specific port for transmitting the required connection data such as communication ID, IP address and port.

Figure 3-1 Port for transmitting the required connection data



Note Usually the port number of the robot controller has been defined to be **46555** by the manufacturer and cannot be changed!

3.2 ADEPT ePLC setup

3.2.1 General

The robot can receive commands and the robot status can be determined via the ADEPT ePLC data interface which has two messages that are exchanged between the SIMATIC Controller and the robot controller via a TCP/IP connection:

- **Command data**
  Command bits and parameters for controlling the required robot function in the robot controller.

- **Status data**
  Status bits and parameters transmitting the current status of the robot as well as execution status of the commanded robot function to the SIMATIC Controller.

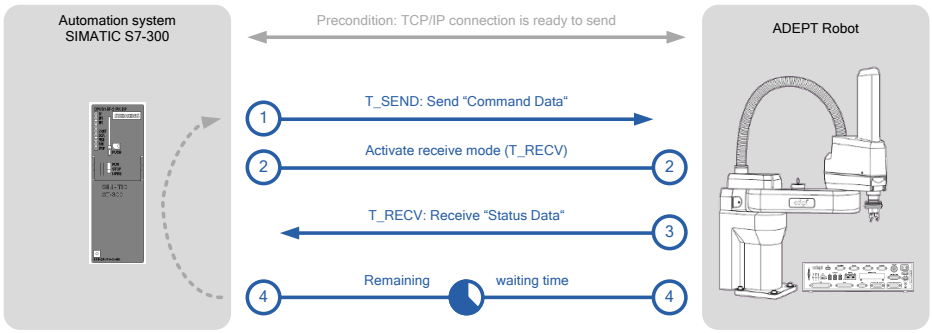
3.2.2 Communication principle

The robot controller and the SIMATIC Controller communicate via a TCP/IP connection using two messages.

Data is exchanged as follows, in a fixed time frame, under the presumption that the SIMATIC Controller has already set up a TCP/IP connection to the robot controller:

1. The SIMATIC Controller will send the “command data” message to the robot controller via the TCP/IP connection.
2. Then the SIMATIC Controller will switch to receiving mode.
3. The robot controller will answer with the “status data” message, which will also be transmitted to the SIMATIC Controller via the TCP/IP connection.
4. The SIMATIC Controller will wait for the end of the communication cycle before the communication cycle will start again with step 1.

Figure 3-2 Communication principle



3.2.3 Command data

The command data message has the following structure:

Table 3-1 Command data

Addr.	Name/Identifier	Type	Description
	system_commands	**STRUCT**	
0.0	cmd_high_power	BOOL	Switch on the robot power
0.1	cmd_reset	BOOL	Reset all pending errors
0.2	cmd_calibrate	BOOL	Reference (calibrate) the robot axes
0.3	cmd_tool_invoke	BOOL	Store specified position value as the coordinate displacement in the tool coordinate system and activate.
0.4	cmd_read_latch	BOOL	Read out registered print-mark position.

Addr.	Name/Identifier	Type	Description
0.5	reserve_0_5	BOOL	
0.6	reserve_0_6	BOOL	
0.7	reserve_0_7	BOOL	
1.0	reserve_1_0	BOOL	
1.1	reserve_1_1	BOOL	
1.2	reserve_1_2	BOOL	
1.3	reserve_1_3	BOOL	
1.4	reserve_1_4	BOOL	
1.5	reserve_1_5	BOOL	
1.6	reserve_1_6	BOOL	
1.7	reserve_1_7	BOOL	
		END_STRUCT	
	motion_commands	**STRUCT**	
2.0	cmd_brake	BOOL	Immediate stopping of the current travel movement
2.1	cmd_jog	BOOL	Manual movement of individual robot axes. Axes are selected via additional bits.
2.2	cmd_move	BOOL	Execute a positioning movement to a specified position.
2.3	cmd_jump	BOOL	Execute a pick & place movement to a specified position.
2.4	cmd_align	BOOL	Align Z-axis of the robot to the next coordinate axis of the WORLD coordinate system.
2.5	cmd_stop_on_input	BOOL	Stop the current travel movement if a preconfigured port responds.
2.6	cmd_arc	BOOL	[currently not supported]
2.7	cmd_circle	BOOL	[currently not supported]
3.0	reserve_3_0	BOOL	
3.1	reserve_3_1	BOOL	
3.2	reserve_3_2	BOOL	
3.3	reserve_3_3	BOOL	
3.4	reserve_3_4	BOOL	
3.5	reserve_3_5	BOOL	
3.6	reserve_3_6	BOOL	
3.7	reserve_3_7	BOOL	
		END_STRUCT	

Addr.	Name/Identifier	Type	Description
	motion_qualifiers	**STRUCT**	
4.0	relative_move	BOOL	0 = Interpretation of the specified position as absolute target position 1 = Interpretation of the specified position as relative target position
4.1	joint_coordinates	BOOL	0 = movement in the WORLD coordinate system 1 = movement in the JOINT coordinate system
4.2	straightline_move	BOOL	0 = movement axis-interpolated 1 = movement on a straight line
4.3	approach_at_absolute	BOOL	0 = Interpretation of the specified retraction height as a relative value. 1 = Interpretation of the specified retraction height as the absolute height.
4.4	nonull	BOOL	0 = Exact approach of the end points of the specified movement 1 = Blending of two movements
4.5	coarse_nulling	BOOL	0 = Positioning in the approximate range 1 = Positioning in the precise range
4.6	single_turn	BOOL	0 = Allow multiple turns of the axis of revolution 1 = Allow only one single turn of the axis of revolution
4.7	reserve_4_7	BOOL	
5.0	righty_configuration	BOOL	0 =Arm alignment to the left 1 =Arm alignment to the right
5.1	below_configuration	BOOL	0 =Arm alignment at the top 1 =Arm alignment at the bottom
5.2	flip_configuration	BOOL	0 =Arm alignment not flipped 1 =Arm alignment flipped
5.3	relative_to_pallet_frame	BOOL	0 = No application of settings for pallet/frame 1 = Application of settings for pallet/frame
5.4	reserve_5_4	BOOL	
5.5	reserve_5_5	BOOL	
5.6	reserve_5_6	BOOL	
5.7	reserve_5_7	BOOL	
		END_STRUCT	
	jog_mode_qualifiers	**STRUCT**	
6.0	jog_world_mode	BOOL	Manual travel movement in WORLD coordinate system

Addr.	Name/Identifier	Type	Description
6.1	jog_tool_mode	BOOL	Manual travel movement in TOOL coordinate system
6.2	jog_joint_mode	BOOL	Manual travel movement in JOINT coordinate system
6.3	jog_free_mode	BOOL	Remove axis for manual travel movement from the controller
6.4	reserve_6_4	BOOL	
6.5	reserve_6_5	BOOL	
6.6	reserve_6_6	BOOL	
6.7	reserve_6_7	BOOL	
7.0	reserve_7_0	BOOL	
7.1	reserve_7_1	BOOL	
7.2	reserve_7_2	BOOL	
7.3	reserve_7_3	BOOL	
7.4	reserve_7_4	BOOL	
7.5	reserve_7_5	BOOL	
7.6	reserve_7_6	BOOL	
7.7	reserve_7_7	BOOL	
8.0	jog_joint_1_or_x_PLUS	BOOL	Manually moving axis 1/X in plus direction
8.1	jog_joint_2_or_y_PLUS	BOOL	Manually moving axis 2/Y in plus direction
8.2	jog_joint_3_or_z_PLUS	BOOL	Manually moving axis 3/Z in plus direction
8.3	jog_joint_4_or_yaw_PLUS	BOOL	Manually moving axis 4/YAW in plus direction
8.4	jog_joint_5_or_pitch_PLUS	BOOL	Manually moving axis 5/PITCH in plus direction
8.5	jog_joint_6_or_roll_PLUS	BOOL	Manually moving axis 6/ROLL in plus direction
8.6	reserve_8_6	BOOL	
8.7	reserve_8_7	BOOL	
9.0	jog_joint_1_or_x_MINUS	BOOL	Manually moving axis 1/X in minus direction
9.1	jog_joint_2_or_y_ MINUS	BOOL	Manually moving axis 2/Y in minus direction
9.2	jog_joint_3_or_z_ MINUS	BOOL	Manually moving axis 3/Z in minus direction
9.3	jog_joint_4_or_yaw_ MINUS	BOOL	Manually moving axis 4/YAW in minus direction
9.4	jog_joint_5_or_pitch_ MINUS	BOOL	Manually moving axis 5/PITCH in minus direction
9.5	jog_joint_6_or_roll_ MINUS	BOOL	Manually moving axis 6/ROLL in minus direction
9.6	reserve_9_6	BOOL	
9.7	reserve_9_7	BOOL	
		END_STRUCT	

Addr.	Name/Identifier	Type	Description
	motion_parameters	**STRUCT**	
10	speed	INT	Absolute value of the speed of movement
12	acceleration	INT	Absolute value of the acceleration of movement
14	deceleration	INT	Absolute value of the deceleration of movement
16	acceleration_profile	INT	0 = Trapezoidal movement profile 1 = S-shaped moving profile
18	speed_limit	INT	
20	pallet_index	INT	Number of the required “pallet index” as the target position
22	approach_height	REAL	Retraction height for the pick-and-place movement
26	reserve_26	REAL	
		END_STRUCT	
	location_data	**STRUCT**	
30	X	REAL	X position
34	Y	REAL	Y position
38	Z	REAL	Z position
42	Yaw	REAL	Yaw angle
46	Pitch	REAL	Pitch angle
50	Roll	REAL	Roll angle
		END_STRUCT	
	location_2_data	**STRUCT**	
54	X	REAL	X position
58	Y	REAL	Y position
62	Z	REAL	Z position
66	Yaw	REAL	Yaw angle
70	Pitch	REAL	Pitch angle
74	Roll	REAL	Roll angle
		END_STRUCT	
	pallet	**STRUCT**	
	pallet_origin	**STRUCT**	
78	X	REAL	X position
82	Y	REAL	Y position
86	Z	REAL	Z position
90	Yaw	REAL	Yaw angle
94	Pitch	REAL	Pitch angle
98	Roll	REAL	Roll angle
		END_STRUCT	
	pallet_1st_row_location	**STRUCT**	
102	X	REAL	X position
106	Y	REAL	Y position

Addr.	Name/Identifier	Type	Description
110	Z	REAL	Z position
114	Yaw	REAL	Yaw angle
118	Pitch	REAL	Pitch angle
122	Roll	REAL	Roll angle
		END_STRUCT	
	pallet_last_row_location	**STRUCT**	
126	X	REAL	X position
130	Y	REAL	Y position
134	Z	REAL	Z position
138	Yaw	REAL	Yaw angle
142	Pitch	REAL	Pitch angle
146	Roll	REAL	Roll angle
		END_STRUCT	
150	pallet_positions_1st_row	INT	Number of positions in the first row of the pallet
152	pallet_number_of_rows	INT	Number of rows on the pallet
154	pallet_configuration	INT	Configuration of positions on the pallet (0...4)
156	pallet_s_traversal	INT	0 = Position configuration always starting from one side 1 = S-Shaped configuration of positions
		END_STRUCT	
	output_signals	**STRUCT**	
158.0	out_signal_1	BOOL	XDIO output
158.1	out_signal_2	BOOL	XDIO output
158.2	out_signal_3	BOOL	XDIO output
158.3	out_signal_4	BOOL	XDIO output
158.4	out_signal_5	BOOL	XDIO output
158.5	out_signal_6	BOOL	XDIO output
158.6	out_signal_7	BOOL	XDIO output
158.7	out_signal_8	BOOL	XDIO output
158.0	out_signal_3001	BOOL	Solenoid output
159.1	out_signal_3002	BOOL	Solenoid output
159.2	out_signal_3003	BOOL	Solenoid output
159.3	out_signal_3004	BOOL	Solenoid output
159.4	reserve_159_4	BOOL	
159.5	reserve_159_5	BOOL	
159.6	reserve_159_6	BOOL	
159.7	reserve_159_7	BOOL	
		END_STRUCT	
	vision	**STRUCT**	
	commands	**STRUCT**	
160.0	vis_sequence_start	BOOL	Start vision sequence

Addr.	Name/Identifier	Type	Description
160.1	vis_queue_clear	BOOL	Reset vision sequence
160.2	vis_queue_pop	BOOL	Read out vision sequence
160.3	reserve_160_3	BOOL	
160.4	reserve_160_4	BOOL	
160.5	reserve_160_5	BOOL	
160.6	reserve_160_6	BOOL	
160.7	reserve_160_7	BOOL	
161.0	reserve_161_0	BOOL	
161.1	reserve_161_1	BOOL	
161.2	reserve_161_2	BOOL	
161.3	reserve_161_3	BOOL	
161.4	reserve_161_4	BOOL	
161.5	reserve_161_5	BOOL	
161.6	reserve_161_6	BOOL	
161.7	reserve_161_7	BOOL	
		END_STRUCT	
	parameters	**STRUCT**	
162	vis_sequence_number	INT	Vision sequence number
164	vis_queue_number	BYTE	Vision queue number
165	reserve_165	BYTE	
166	reserve_166	BYTE	
167	reserve_167	BYTE	
168	reserve_168	BYTE	
169	reserve_169	BYTE	
		END_STRUCT	
		END_STRUCT	
170	**Total length of the message in bytes**		

3.2.4 Status data

The status data message has the following structure:

Table 3-2 Status data

Addr.	Name/Identifier	Type	Description
	system_state	**STRUCT**	
0.0	system_heartbeat	BOOL	Toggle bit that is inverted with every robot position update.
0.1	power_state	BOOL	0 = Robot power off 1 = Robot power on
0.2	power_ready_state	BOOL	Robot is ready for switch-on (key on the Adept panel is flashing)
0.3	system_initalized_state	BOOL	Robot controller re-initialized
0.4	emergency_stop_state	BOOL	The robot is in emergency stop status
0.5	fault_state	BOOL	The robot is in fault status
0.6	calibrated_state	BOOL	Referencing of robot axes is completed
0.7	command_execution_state	BOOL	Command detected and being processed - reset with undoing command
1.0	read_latch_state	BOOL	Print-mark position was read. Configured port has released.
1.1	ace_control_mode	BOOL	The robot is currently controlled via the Adept engineering software.
1.2	reserve_1_2	BOOL	
1.3	reserve_1_3	BOOL	
1.4	reserve_1_4	BOOL	
1.5	reserve_1_5	BOOL	
1.6	reserve_1_6	BOOL	
1.7	reserve_1_7	BOOL	
2	state_robot_overall	INT	Robot status STATE(1) For more information please refer to the manufacturer's documentation.
4	state_robot_motion	INT	Robot status STATE(2) For more information please refer to the manufacturer's documentation.
6	state_manual_control_mode	INT	Robot status STATE(3) For more information please refer to the manufacturer's documentation.
8	state_hardware	INT	Robot status STATE(4) For more information please refer to the manufacturer's documentation.

Addr.	Name/Identifier	Type	Description
10	state_switch	INT	Robot status STATE(5) For more information please refer to the manufacturer's documentation.
12	state_current_motion	INT	Robot status STATE(10) For more information please refer to the manufacturer's documentation.
14	state_power_light	INT	Robot status STATE(30) For more information please refer to the manufacturer's documentation.
		END_STRUCT	
	motion_state	**STRUCT**	
16.0	in_position_state	BOOL	Positioning completed. Target position reached.
16.1	motion_state	BOOL	Robot movement active
16.2	brake_state	BOOL	Command detected and being processed - reset with finishing command execution
16.3	stop_on_input_state	BOOL	Command detected and being processed - reset with finishing command execution
16.4	tool_mode_state	BOOL	The current robot movement is executed in the TOOL coordinate system
16.5	reserve_16_5		
16.6	reserve_16_6		
16.7	reserve_16_7		
17.0	jog_mode_state	BOOL	The robot is currently moved in jog mode.
17.1	world_jog_mode_state	BOOL	The current robot movement is executed in the WORLD coordinate system
17.2	tool_ jog_mode_state	BOOL	The current robot movement is executed in the TOOL coordinate system
17.3	joint_ jog_mode_state	BOOL	The current robot movement is executed in the JOINT coordinate system
17.4	free_ jog_mode_state	BOOL	Robot axes were removed from the controller for manual movement.
17.5	reserve_17_5	BOOL	
17.6	reserve_17_6	BOOL	
17.7	reserve_17_7	BOOL	
18.0	righty_configuration	BOOL	0 =Arm alignment to the left 1 =Arm alignment to the right
18.1	below_configuration	BOOL	0 =Arm alignment at the top 1 =Arm alignment at the bottom

Addr.	Name/Identifier	Type	Description
18.2	flip_configuration	BOOL	0 =Arm alignment not flipped 1 =Arm alignment flipped
18.3	reserve_18_3	BOOL	
18.4	reserve_18_4	BOOL	
18.5	reserve_18_5	BOOL	
18.6	reserve_18_6	BOOL	
18.7	reserve_18_7	BOOL	
19.0	manual_control_mode_state	BOOL	0 = robot is in automatic mode 1 = robot is in setup mode (with restricted speed)
19.1	reserve_19_1	BOOL	
19.2	reserve_19_2	BOOL	
19.3	reserve_19_3	BOOL	
19.4	reserve_19_4	BOOL	
19.5	reserve_19_5	BOOL	
19.6	reserve_19_6	BOOL	
19.7	reserve_19_7	BOOL	
20	motion_counter	INT	Number of motion commands executed so far
22	reserve_22	INT	
		END_STRUCT	
	actual_position	**STRUCT**	
	world	**STRUCT**	
24	X	REAL	Current X position in the WORLD coordinate system.
28	Y	REAL	Current Y position in the WORLD coordinate system.
32	Z	REAL	Current Z position in the WORLD coordinate system.
36	Yaw	REAL	Current Yaw angle in the WORLD coordinate system.
40	Pitch	REAL	Current pitch angle in the WORLD coordinate system.
44	Roll	REAL	Current roll angle in the WORLD coordinate system.
		END_STRUCT	
	joint	**STRUCT**	
48	Joint_1	REAL	Current position of axis 1 in the JOINT coordinate system.
52	Joint_2	REAL	Current position of axis 2 in the JOINT coordinate system.
56	Joint_3	REAL	Current position of axis 3 in the JOINT coordinate system.
60	Joint_4	REAL	Current position of axis 4 in the JOINT coordinate system.
64	Joint_5	REAL	Current position of axis 5 in the JOINT coordinate system.

Addr.	Name/Identifier	Type	Description
68	Joint_6	REAL	Current position of axis 6 in the JOINT coordinate system.
		END_STRUCT	
		END_STRUCT	
	latch_position	**STRUCT**	
	world	**STRUCT**	
72	X	REAL	For more information please refer to ADEPT documentation.
76	Y	REAL	
80	Z	REAL	
84	Yaw	REAL	
88	Pitch	REAL	
92	Roll	REAL	
		END_STRUCT	
		END_STRUCT	
	pallet_relative_coordinates	**STRUCT**	
	world	**STRUCT**	
96	X	REAL	For more information please refer to ADEPT documentation.
100	Y	REAL	
104	Z	REAL	
108	Yaw	REAL	
112	Pitch	REAL	
116	Roll	REAL	
		END_STRUCT	
		END_STRUCT	
	input_singals	**STRUCT**	
120.0	input_1001	BOOL	XDIO Input 1001
120.1	input_1002	BOOL	XDIO Input 1002
120.2	input_1003	BOOL	XDIO Input 1003
120.3	input_1004	BOOL	XDIO Input 1004
120.4	input_1005	BOOL	XDIO Input 1005
120.5	input_1006	BOOL	XDIO Input 1006
120.6	input_1007	BOOL	XDIO Input 1007
120.7	input_1008	BOOL	XDIO Input 1008
121.0	input_1009	BOOL	XDIO Input 1009
121.1	input_1010	BOOL	XDIO Input 1010
121.2	input_1011	BOOL	XDIO Input 1011
121.3	input_1012	BOOL	XDIO Input 1012
121.4	soft_signal_2001	BOOL	eV+ soft signal 2001
121.5	soft_signal_2002	BOOL	eV+ soft signal 2002
121.6	soft_signal_2003	BOOL	eV+ soft signal 2003
121.7	soft_signal_2004	BOOL	eV+ soft signal 2004
		END_STRUCT	

Addr.	Name/Identifier	Type	Description
	error_message	**STRUCT**	
122	error_number	INT	Error number. Positive or negative values can be output here.
124	reserve_124	INT	
126	maximum_length	BYTE	In the SIMATIC, data can be interpreted as SIMATIC string and processed. SIMATIC String = 1 byte total length (here 80) / 1 byte number of characters / 80 bytes character.
127	actual_length	BYTE	
128	data	ARRAY [1..80] OF CHAR	
		END_STRUCT	
	vision	**STRUCT**	
	vis_state	**STRUCT**	
208.0	vis_sequence_started	BOOL	For more information please refer to ADEPT documentation.
208.1	vis_queue_cleared	BOOL	
208.2	vis_queue_popped	BOOL	
208.3	vis_results_valid	BOOL	
208.4	vis_system_online	BOOL	
208.5	reserve_208_5	BOOL	
208.6	reserve_208_6	BOOL	
208.7	reserve_208_7	BOOL	
209.0	reserve_209_0	BOOL	
209.1	reserve_209_1	BOOL	
209.2	reserve_209_2	BOOL	
209.3	reserve_209_3	BOOL	
209.4	reserve_209_4	BOOL	
209.5	reserve_209_5	BOOL	
209.6	reserve_209_6	BOOL	
209.7	reserve_209_7	BOOL	
210	vis_sequence_number	INT	For more information please refer to ADEPT documentation.
212	vis_sequence_state	BYTE	
213	vis_instances_found	BYTE	
214	vis_results_queue_number	BYTE	
215	reserve_215	BYTE	
		END_STRUCT	
	vis_queue_size	**STRUCT**	
216	Vision_queue_0	BYTE	For more information please refer to ADEPT documentation.
217	Vision_queue_1	BYTE	
218	Vision_queue_2	BYTE	
219	Vision_queue_3	BYTE	
220	Vision_queue_4	BYTE	
221	Vision_queue_5	BYTE	
222	Vision_queue_6	BYTE	

Addr.	Name/Identifier	Type	Description
223	Vision_queue_7	BYTE	
		END_STRUCT	
	vis_result	**STRUCT**	
224	X	REAL	For more information please refer to ADEPT documentation.
228	Y	REAL	
232	Z	REAL	
236	Yaw	REAL	
240	Pitch	REAL	
244	Roll	REAL	
		END_STRUCT	
		END_STRUCT	
248	**Total length of the message in bytes**		

4 Function Mechanisms

The functions described in the following chapters are stored in the function block for controlling the robot functions which is introduced in this application. They can easily be executed through the function block.

In the following, the controlling of these functions via the ADEPT ePLC data interface in the robot controller, which is executed by the function block in the SIMATIC controller, will be described briefly.

4.1 POWER - switching the power on/off

4.1.1 Functionality

Switching the power at the robot on and off to enable the movement of the robot axes.

4.1.2 ADEPT ePLC signals involved

The following signals of the ADEPT ePLC data interface will be used for realizing this function.

Table 4-1ADEPT ePLC signals involved

Addr.	Name/Identifier	Type
Command data		
0.0	system_commands.cmd_high_power	BOOL
0.1	system_commands.cmd_reset	BOOL
Status data		
0.1	system_state.power_state	BOOL
0.4	system_state.emergency_stop_state	BOOL
0.5	system_state.fault_state	BOOL
0.7	system_state.command_execution_state	BOOL

4.1.3 Signal sequence for function control

The function is controlled in the robot controller as follows:

Switch on power

Table 4-2 Signal sequence for function control

No.	Functionality	Note/Remark
1.	Check whether the robot is in emergency stop state.	If the robot is in emergency stop state, the function will branch into the error handling routine.
2.	Reset the robot in order to acknowledge any pending errors.	

No.	Functionality	Note/Remark
3.	Switch on the power at the robot.	If there is a robot error or if a robot error occurs when the power is switched on, the function will branch into the error handling routine.
4.		Power will stay on at the robot as long as the “cmd_high_power” command is set.

Switch off power

Table 4-3 Signal sequence for function control

No.	Functionality	Note/Remark
1.	Switch off the power at the robot.	If there is a robot error or if a robot error occurs when the power is switched off, the function will branch into the error handling routine.
2.		Power will stay off at the robot until the “cmd_high_power” command is set.

4.2 CALIBRATE - Reference the robot axes

4.2.1 Functionality

Calibrate or reference the robot axes. For this, the robot axes will perform a hardly noticeable movement around the current position.

4.2.2 ADEPT ePLC signals involved

The following signals of the ADEPT ePLC data interface will be used for realizing this function.

Table 4-4ADEPT ePLC signals involved

Addr.	Name/Identifier	Type
Command data		
0.2	system_commands.cmd_calibrate	BOOL
Status data		
0.5	system_state.fault_state	BOOL
0.6	system_state.calibrated_state	BOOL
0.7	system_state.command_execution_state	BOOL

4.2.3 Signal sequence for function control

The function is controlled in the robot controller as follows:

Table 4-5 Signal sequence for function control

No.	Functionality	Note/Remark
1.	Check whether the robot axes have already been calibrated.	If the robot axes have already been calibrated, the function will not be executed at the robot.
2.	Trigger the function for calibrating the robot axes.	If there is a robot error when the function is triggered, the function will branch into the error handling routine.

4.3 RESET - Reset errors at the robot

4.3.1 Functionality

Reset or acknowledge any error states pending at the robot or the robot controller.

4.3.2 ADEPT ePLC signals involved

The following signals of the ADEPT ePLC data interface will be used for realizing this function.

Table 4-6ADEPT ePLC signals involved

Addr.	Name/Identifier	Type
Command data		
0.1	system_commands.cmd_reset	BOOL
0.2	system_commands.cmd_calibrate	BOOL
0.3	system_commands.cmd_tool_invoke	BOOL
0.4	system_commands.cmd_read_latch	BOOL
2.0	motion_commands.cmd_brake	BOOL
2.1	motion_commands.cmd_jog	BOOL
2.2	motion_commands.cmd_move	BOOL
2.3	motion_commands.cmd_jump	BOOL
2.4	motion_commands.cmd_align	BOOL
2.5	motion_commands.cmd_stop_on_input	BOOL
2.6	motion_commands.cmd_arc	BOOL
2.7	motion_commands.cmd_circle	BOOL
Status data		
0.7	system_state.command_execution_state	BOOL
0.5	system_state.fault_state	BOOL

4.3.3 Signal sequence for function control

The function is controlled in the robot controller as follows:

Table 4-7 Signal sequence for function control

No.	Functionality	Note/Remark
1.	Reset any currently pending system commands and travel commands.	
2.	Trigger the function for acknowledging the pending error states at the robot.	

4.4 BRAKE - Immediately stop robot movement

4.4.1 Functionality

Stop a robot movement currently performed by the robot, or inhibit the triggering of a new robot movement.

4.4.2 ADEPT ePLC signals involved

The following signals of the ADEPT ePLC data interface are used for realizing this function.

Table 4-8 ADEPT ePLC signals involved

Addr.	Name/Identifier	Type
Command data		
2.0	motion_commands.cmd_brake	BOOL
Status data		
16.2	motion_state.brake_state	BOOL

4.4.3 Signal sequence for function control

The function is controlled in the robot controller as follows:

Table 4-9 Signal sequence for function control

No.	Functionality	Note/Remark
1.	Trigger the function for stopping the current robot movement, or for inhibiting further robot movements.	The function will stay active as long as the input at the function block is set.
2.		Further robot movements will be inhibited as long as the order “cmd_brake” command is set.
3.	Complete the function by resetting the input at the function block.	Robot movements are now enabled again. Any error states occurred due to the stopping action might have to be acknowledged before the next robot movement.

4.5 JOG - Move axes in jog mode

4.5.1 Functionality

Move the individual robot axes in jog mode. The direction of travel and the required axis are defined by selecting the corresponding command.

4.5.2 ADEPT ePLC signals involved

The following signals of the ADEPT ePLC data interface will be used for realizing this function.

Table 4-10 ADEPT ePLC signals involved

Addr.	Name/Identifier	Type
Command data		
2.1	motion_commands.cmd_jog	BOOL
6.0	jog_mode_qualifiers.jog_world_mode	BOOL
6.1	jog_mode_qualifiers.jog_tool_mode	BOOL
6.2	jog_mode_qualifiers.jog_joint_mode	BOOL
6.3	jog_mode_qualifiers.jog_free_mode	BOOL
8.0	jog_mode_qualifiers.jog_joint_1_or_x_PLUS	BOOL
8.1	jog_mode_qualifiers.jog_joint_2_or_y_PLUS	BOOL
8.2	jog_mode_qualifiers.jog_joint_3_or_z_PLUS	BOOL
8.3	jog_mode_qualifiers.jog_joint_4_or_yaw_PLUS	BOOL
8.4	jog_mode_qualifiers.jog_joint_5_or_pit_PLUS	BOOL
8.5	jog_mode_qualifiers.jog_joint_6_or_rol_PLUS	BOOL
9.0	jog_mode_qualifiers.jog_joint_1_or_x_MINUS	BOOL
9.1	jog_mode_qualifiers.jog_joint_2_or_y_ MINUS	BOOL
9.2	jog_mode_qualifiers.jog_joint_3_or_z_ MINUS	BOOL
9.3	jog_mode_qualifiers.jog_joint_4_or_yaw_ MINUS	BOOL
9.4	jog_mode_qualifiers.jog_joint_5_or_pit_ MINUS	BOOL
9.5	jog_mode_qualifiers.jog_joint_6_or_rol_ MINUS	BOOL
10	motion_parameters.speed	INT
12	motion_parameters.acceleration	INT
14	motion_parameters.deceleration	INT
16	motion_parameters.acceleration_profile	INT
18	motion_parameters.speed_limit	INT
Status data		
17.0	motion_state.jog_mode_state	BOOL

4.5.3 Signal sequence for function control

The function is controlled in the robot controller as follows:

Table 4-11 Signal sequence for function control

No.	Functionality	Note/Remark
1.	Apply the coordinate system required for jog mode.	Usually jog mode (JOG) is carried out in the axis coordinate system (JOINT) or in the Cartesian coordinate system (WORLD).
2.	Apply the dynamic values required for jog mode.	For security reasons, individual dynamic values will be specified for jog mode (JOG).
3.	Triggering the jog mode (JOG) for the axes selected.	
4.		The axis movements will be performed as long as the jog mode is selected for each axis.
5.	Reset the jog mode (JOG).	

4.6 MOVE - Perform sequences of movements

4.6.1 Functionality

Perform a coordinated movement or a sequence of movements, which may involve all axes of the robot and which may be performed using the kinematic transformation of the robot controller.

4.6.2 ADEPT ePLC signals involved

The following signals of the ADEPT ePLC data interface will be used for realizing this function.

Table 4-12 ADEPT ePLC signals involved

Addr.	Name/Identifier	Type
Command data		
2.1	motion_commands.cmd_jog	BOOL
2.2	motion_commands.cmd_move	BOOL
2.3	motion_commands.cmd_jump	BOOL
2.4	motion_commands.cmd_align	BOOL
2.5	motion_commands.cmd_stop_on_input	BOOL
2.6	motion_commands.cmd_arc	BOOL
2.7	motion_commands.cmd_circle	BOOL
4.0	motion_qualifiers.relative_move	BOOL
4.1	motion_qualifiers.joint_coordinates	BOOL
4.2	motion_qualifiers.straightline_move	BOOL
4.3	motion_qualifiers.approach_at_absolute	BOOL
4.4	motion_qualifiers.nonull	BOOL
4.5	motion_qualifiers.coarse_nulling	BOOL
4.6	motion_qualifiers.single_turn	BOOL
5.0	motion_qualifiers.righty_configuration	BOOL

Addr.	Name/Identifier	Type
5.1	motion_qualifiers.below_configuration	BOOL
5.2	motion_qualifiers.flip_configuration	BOOL
5.3	motion_qualifiers.relative_to_pallet_frame	BOOL
10	motion_parameters.speed	INT
12	motion_parameters.acceleration	INT
14	motion_parameters.deceleration	INT
16	motion_parameters.acceleration_profile	INT
18	motion_parameters.speed_limit	INT
20	motion_parameters.pallet_index	INT
22	motion_parameters.approach_height	REAL
30	location_data.X	REAL
34	location_data.Y	REAL
38	location_data.Z	REAL
42	location_data.Yaw	REAL
46	location_data.Pitch	REAL
50	location_data.Roll	REAL
Status data		
0.7	system_state.command_execution_state	BOOL
16.0	motion_state.in_position_state	BOOL

4.6.3 Signal sequence for function control

The function is controlled in the robot controller as follows:

Table 4-13 Signal sequence for function control

No.	Functionality	Note/Remark
1.	Reset any currently pending travel commands.	
2.	Apply the movement criteria for performing the movement.	
3.	Apply the dynamic values required for the movement.	For security reasons, individual dynamic values will be specified for the coordinated movement of the robot.
4.	Apply the target position specified for the movement.	For security reasons, the target position is specified through different parameters in the axis coordinate system (JOINT) and in the Cartesian coordinate system (WORLD). Parameters are selected via the motion qualifier “motion_qualifiers.joint_coordinates”.
5.	Trigger the travel movement.	

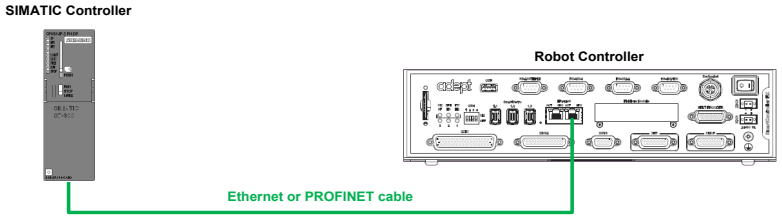
No.	Functionality	Note/Remark
6.		If, during an active travel movement, a new travel command is issued, this command will be added to the currently processed travel movement.
7.		If no new travel command is issued, the current movement will be completed and then the robot axes will be stopped.

5 Installation

5.1 Hardware installation

For commissioning the application example the SIMATIC automation system must be connected to the Ethernet interface of the robot controller via the PROFINET/Ethernet interface.

Figure 5-1 Hardware installation - wiring of the components



Note In case the interfaces of the SIMATIC Controller and the robot controller are directly connected, the use of an Ethernet cross cable might be required.

5.2 Integrating the application into a STEP 7 project

This section describes how to integrate the application into an existing or a newly established STEP 7 project.

5.2.1 Copying the required blocks and sources

Copy the blocks listed in the table into your existing or newly established STEP 7 project.

Table 5-1 Required blocks

Block	Symbolic name	Function
FB 63	TSEND	Function block working asynchronously, sending data through an existing communication connection.
FB 64	TRCV	Function block working asynchronously, receiving data through an existing communication connection.
FB 65	TCON	Function block working asynchronously, for setting up and establishing a communication connection.
FB 66	TDISCON	Function block working asynchronously, for clearing a communication connection.

Block	Symbolic name	Function
FB 600	ADEPT_RobotControl	Function block for exchanging data between a SIMATIC Controller and the ADEPT robot controller with ADEPT ePLC data interface.
FB 601	RobotErrorMessage	Function block for converting the robot messages issued via the ADEPT ePLC data interface into a STRING that can be displayed on the operating panel via the HMI user interface. **Note:** This block is only required if the robot messages are to be further processed as STRINGS. If not, there is no need to copy this block.
UDT 600	ADEPT_ePLC	Mapping of the ADEPT ePLC data interface including some parameters required for establishing the connection.
UDT 601	ADEPT_CommandData	Mapping of the command message of the ADEPT ePLC data interface.
UDT 602	ADEPT_StatusData	Mapping of the status message of the ADEPT ePLC data interface.
UDT 605	ADEPT_JogControl	Data interface for performing a JOG movement with the robot with selection of the jog mode, triggering of the JOG button for axis selection, and the dynamic parameters for the JOG movement.
UDT 606	ADEPT_Position	Data interface for the robot position in the WORLD and JOINT coordinate system for specifying a target position of the robot or for transferring the current robot position.
UDT 607	ADEPT_MoveControl	Data interface for performing a robot movement, specifying the movement qualifiers, the dynamic values, and the target position for the movement in the WORLD and the JOINT coordinate system.
UDT 608	ADEPT_ErrorMessage	Data interface of the robot messages transferred via the status message of the ADEPT ePLC data interface.
UDT 609	ADEPT_RobotState	Data interface of the robot status for displaying the system status and the movement status of the robot.
UDT 610	ADEPT_ComData	Parameter for setting up the communication connection between SIMATIC Controller and ADEPT robot controller.
SFB 4	TON	Creating a switch-on delay with specifiable delay time.
SFC 24	TEST_DB	Testing a data block with return of the number of data bytes in the DB and the write protection status.

5.2.2 Compiling the SCL source of the function block (optional)

The FB 600 “ADEPT_RobotControl“ function block is written in the “STEP 7 SCL” high-level language for easier handling of data structures. The compiled block is available in the block folder of the STEP 7 project.

In order to use the block in STEP 7 projects without the “SCL” option, it is sufficient to copy the compiled FB 600 “ADEPT_RobotControl” block from the block folder into the existing or newly created STEP 7 project.

In case the “SCL” option has been installed in the SIMATIC Manager, the FB 600 “ADEPT_RobotControl” block can easily be changed and re-compiled.

5.2.3 Integrating the function block into a cyclic OB

In order to use the application in your STEP 7 project, call function block FB 600 “ADEPT_RobotControl” in a cyclically processed organization block, OB1 for example.

If the robot messages from the status message of the ADEPT ePLC data interface are to be further processed as a STRING tags, by displaying them on a HMI user interface, for example, FB 601 “RobotErrorMessage” will also have to be called in a cyclically processed organization block, e.g. OB1. It is recommendable to call FB 601 “RobotErrorMessage” directly after FB 600 “ADEPT_RobotControl” and to transfer the data from port “RobotErrorMessage” of FB 600 “ADEPT_RobotControl” to port “RobotErrorMessage” of FB 601 “RobotErrorMessage”.

5.2.4 Using the HMI user interface

If the HMI user interface for FB 600 “ADEPT_RobotControl” is to be transferred to the STEP 7 project as well, the WinCC flexible project of the HMI user interface will also have to be transferred into your STEP 7 project and, if required, the tags of the HMI user interface will have to be reconnected with the instance block of FB 600 “ADEPT_RobotControl” via WinCC flexible project; in this example this would be DB 600 “idb_ADEPT_RobotControl”.

This is how to proceed:

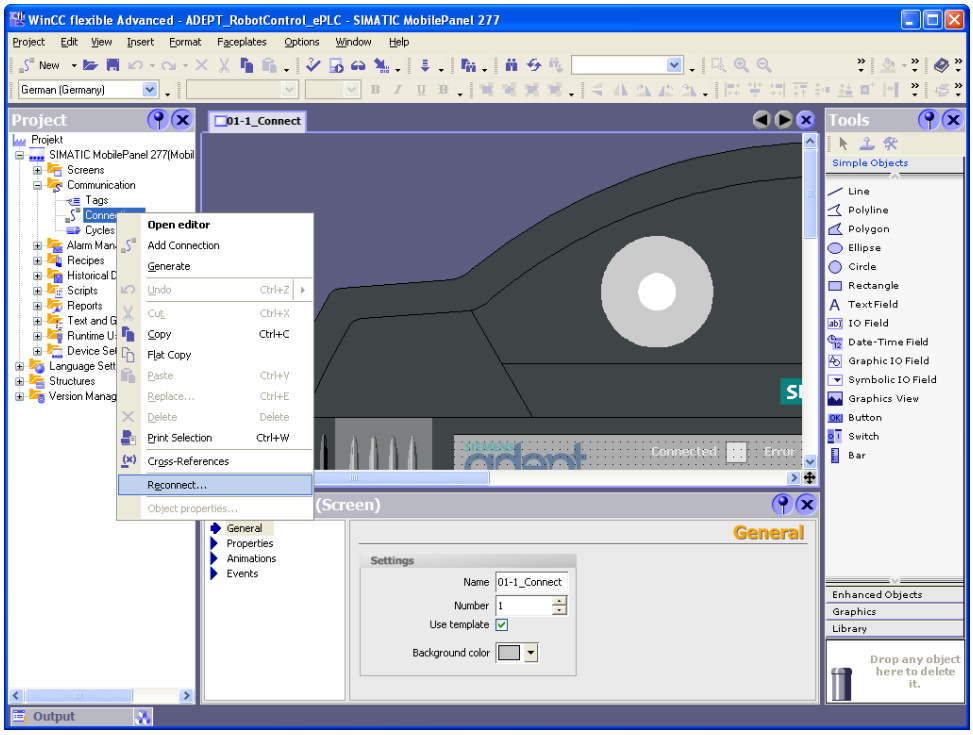
- In the SIMATIC Manager, copy HMI object “SIMATIC MobilePanel 277” from the application example into your STEP 7 project.
- Open the copied HMI object in your STEP 7 project in WinCC flexible and reconnect the tags of the HMI user interface to the instance block of FB 600 “ADEPT_RobotControl” in your STEP 7 project.

To reconnect the tags of the HMI user interface in the STEP 7 project, proceed as follows:

After copying the HMI object into your STEP 7 project, open the HMI object via WinCC flexible. In the project tree, under “Communication > Tags”, you can see whether the connection of the tags to the controller, or the instance block of FB 600 “ADEPT_RobotControl”, is still active.

If it is not, first check the connection to the HMI user interface to the controller via “Communication > Connections”. Here, if required, select the controller from your STEP 7 project. You can then select the function “Reconnect” via the context menu of the “Communication > Tags” tree object.

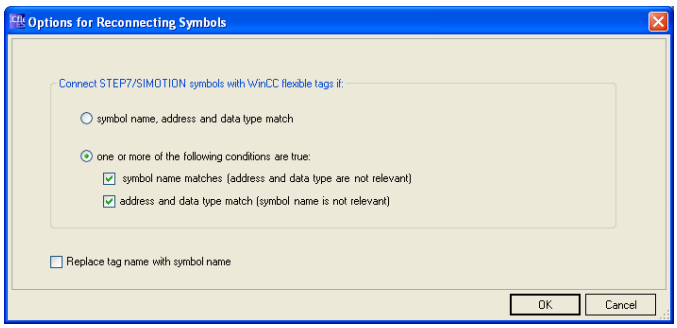
Figure 5-2 WinCC flexible – reconnecting tags



In the function dialog for reconnection, set the functions for reconnecting the tags as shown below.

Definitely make sure that the option “Replace tag name with symbol name” is deselected. Otherwise the tag table of the HMI project might be renamed.

Figure 5-3 Options for reconnecting symbols in WinCC flexible



Execute the function by clicking “OK”. After that, all tags should be reconnected with the controller.

6 Startup

6.1 Description of the function block interface

6.1.1 Block interface

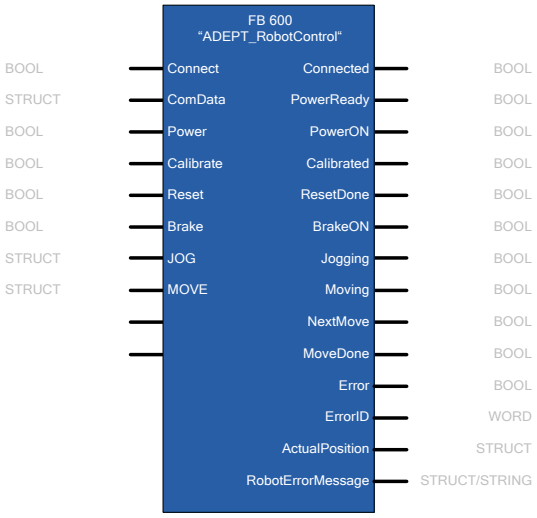


Table 6-1 Function block interface

Parameter	Data type	Initial value	Description
Input parameters			
Connect	BOOL	False	Communication with the robot controller is started through this parameter. The communication with the robot controller is active as long as the input is set.
ComData	STRUCT		Communication parameter for connection setup with the robot controller ⇨ see next chapter
Power	BOOL	False	Switching on the power at the robot. The robot power will stay on as long as the input is set. If necessary, due to fault conditions, the robot power may also be switched off by the robot controller.
Calibrate	BOOL	False	Triggering the homing operation of the robot axes (with minimum axis movement). The homing operation will only be performed if the axes of the robot have not yet been referenced, or calibrated.

Parameter	Data type	Initial value	Description
Reset	BOOL	False	Acknowledging any error messages pending at the robot controller and canceling any current commands within the function block.
Brake	BOOL	False	Immediately stopping any travel movements of the robot. Further travel movements of the robot axis will be prevented as long as the input is set.
JOG	STRUCT		Parameter for performing the jog mode of the robot axes ⇨ see next chapter
MOVE	STRUCT		Parameter for the performance of coordinated movements or a sequence of movements by the robot. ⇨ see next chapter
Output parameters			
Connected	BOOL	False	The communication connection with the robot controller is set up. The robot can be influenced via the function block.
PowerReady	BOOL	False	Robot is ready for switch-on. The robot power can be switched on by actuating the button at the robot operating panel.
PowerON	BOOL	False	The power at the robot is switched on. The robot axes can now be moved.
Calibrated	BOOL	False	The axes of the robot are referenced, or calibrated.
ResetDone	BOOL	False	Any error messages pending at the robot controller were acknowledged.
BrakeON	BOOL	False	All axes of the robot are stopped. No travel movements of the robot axis can be performed as long as the output is set.
Jogging	BOOL	False	The robot axes are moved in jog mode.
Moving	BOOL	False	The robot axes are moved through a coordinated movement.
NextMove	BOOL	False	Another movement command for performing a sequence of movements can be issued via the “MOVE” input.

Parameter	Data type	Initial value	Description
MoveDone	BOOL	False	The current coordinated movement or sequence of movements is completed.
Error	BOOL	False	Error at the function block.
ErrorID	WORD	W#16#0	Error number for more detailed specification of the error cause. ⇨ see next chapter
ActualPosition	STRUCT		Current position of the robot axes in the axis coordinate system (JOINT) and in the Cartesian coordinate system (WORLD) ⇨ see next chapter
RobotErrorMessage	STRUCT		Output of the robot controller messages ⇨ see next chapter

DANGER

In case of danger, take additional measures for stopping the robot if the robot movements can no longer be influenced by the SIMATIC Controller.

6.1.2 “ComData” data structure

Table 6-2 “ComData” data structure

Parameter	Data type	Initial value	Description
		STRUCT	
ID	WORD	W#16#5F	Freely selectable communication ID that must be uniquely specified for each robot.
IP_Address		**ARRAY[1..6] OF BYTE**	
IP_Address[1]	BYTE	B#16#0	IP address of the robot controller in IPv4 format for setting up the communication connection.
IP_Address[2]	BYTE	B#16#0	
IP_Address[3]	BYTE	B#16#0	
IP_Address[4]	BYTE	B#16#0	
IP_Address[5]	BYTE	B#16#0	Not used.
IP_Address[6]	BYTE	B#16#0	
		END_STRUCT	
LocalDevice_Type	BYTE	B#16#2	Identifier of the controller hardware from which the robot is controlled. The setting options for this parameter correspond to the “local_device_id” parameter according to the UDT 65 for the “CONNECT” input of the “T_CON” block for setting up the connection.

Parameter	Data type	Initial value	Description
Port	DINT	46555	Port number of the robot controller through which the communication with the SIMATIC Controller takes place.
BasicComTime	TIME	T#100ms	Cycle time for the communication with the robot. The data sending and receiving process between controller and robot must be completed within this period of time.
WatchDogComTime	TIME	T#40ms	Monitoring time for setting up the connection to the robot.
		END_STRUCT	

6.1.3 "JOG" data structure

Table 6-3 "JOG" data structure

Parameter	Data type	Initial value	Description
		STRUCT	
JOG_Mode		**STRUCT**	
jog_world_mode	BOOL	False	Jog mode along the axes of the Cartesian coordinate system (WORLD).
jog_tool_mode	BOOL	False	Jog mode along the axes of the tool coordinate system.
jog_joint_mode	BOOL	False	Jog mode along the axes of the axis coordinate system (JOINT).
jog_free_mode	BOOL	False	[currently not supported]
		END_STRUCT	
JOG_Buttons		**STRUCT**	
jog_joint_1_or_ x_PLUS	BOOL	False	Movement of robot axis 1 or along the x axis of the coordinate system in plus direction, as long as the button is pressed.
jog_joint_1_or_ x_MINUS	BOOL	False	Movement of robot axis 1 or along the x axis of the coordinate system in minus direction, as long as the button is pressed.
jog_joint_2_or_ y_PLUS	BOOL	False	Movement of robot axis 2 or along the Y axis of the coordinate system in plus direction, as long as the button is pressed.
jog_joint_2_or_ y_MINUS	BOOL	False	Movement of robot axis 2 or along the Y axis of the coordinate system in minus direction, as long as the button is pressed.
jog_joint_3_or_ z_PLUS	BOOL	False	Movement of robot axis 3 or along the Z axis of the coordinate system in plus direction, as long as the button is pressed.

Parameter	Data type	Initial value	Description
jog_joint_3_or_ z_MINUS	BOOL	False	Movement of robot axis 3 or along the Z axis of the coordinate system in minus direction, as long as the button is pressed.
jog_joint_4_or_ yaw_PLUS	BOOL	False	Movement of robot axis 4 or angular movement about the Z axis of the coordinate system in plus direction, as long as the button is pressed.
jog_joint_4_or_ yaw_MINUS	BOOL	False	Movement of robot axis 4 or angular movement about the X axis of the coordinate system in minus direction, as long as the button is pressed.
jog_joint_5_or_ pit_PLUS	BOOL	False	Movement of robot axis 5 or angular movement about the Y axis of the coordinate system in plus direction, as long as the button is pressed.
jog_joint_5_or_ pit_MINUS	BOOL	False	Movement of robot axis 5 or angular movement about the Y axis of the coordinate system in minus direction, as long as the button is pressed.
jog_joint_6_or_ rol_PLUS	BOOL	False	Movement of robot axis 6 or angular movement about the Z axis of the coordinate system in plus direction, as long as the button is pressed.
jog_joint_6_or_ rol_MINUS	BOOL	False	Movement of robot axis 6 or angular movement about the Z axis of the coordinate system in minus direction, as long as the button is pressed.
		END_STRUCT	
JOG_MotionParameters		**STRUCT**	
speed	INT	0	Absolute value of the speed of movement in jog mode.
acceleration	INT	0	Absolute value of the acceleration of movement in jog mode.
deceleration	INT	0	Absolute value of the deceleration of movement in jog mode.
acceleration_profile	INT	0	0 = Trapezoidal movement profile 1 = S-shaped moving profile
speed_limit	INT	0	[currently not supported]
		END_STRUCT	
		END_STRUCT	

6.1.4 "MOVE" data structure

Table 6-4 "MOVE" data structure

Parameter	Data type	Initial value	Description
		STRUCT	
Command		**STRUCT**	
Execute	BOOL	False	Via a rising edge at this input the movement command is started with the data specified here.
		END_STRUCT	
qualifiers		**STRUCT**	
relative_move	BOOL	False	0 = Interpretation of the specified position as absolute target position 1 = Interpretation of the specified position as relative target position
joint_coordinates	BOOL	False	0 = movement in the Cartesian coordinate system (WORLD) 1 = movement in the axis coordinate system (JOINT) **Notice:** For security reasons, depending on this parameter, the target position of the movement is taken over from the corresponding structure (WORLD or JOINT).
straightline_move	BOOL	False	0 = movement axis-interpolated 1 = movement on a straight line
nonull	BOOL	False	0 = Exact approach of the end points of the specified movement 1 = Blending of two movements
coarse_nulling	BOOL	False	0 = Positioning in the approximate range 1 = Positioning in the precise range
single_turn	BOOL	False	0 = Allow multiple turns of the axis of revolution 1 = Allow only one single turn of the axis of revolution
righty_configuration	BOOL	False	0 =Arm alignment to the left 1 =Arm alignment to the right
below_configuration	BOOL	False	0 =Arm alignment at the top 1 =Arm alignment at the bottom
flip_configuration	BOOL	False	0 =Arm alignment not flipped 1 =Arm alignment flipped
		END_STRUCT	
parameters		**STRUCT**	
speed	INT	0	Absolute value of the speed of movement.
acceleration	INT	0	Absolute value of the acceleration of movement.
deceleration	INT	0	Absolute value of the deceleration of movement.

Parameter	Data type	Initial value	Description
acceleration_profile	INT	0	0 = Trapezoidal movement profile 1 = S-shaped movement profile
		END_STRUCT	
location_data		**STRUCT**	
world		**STRUCT**	
X	REAL	0.0	Target position of the movement for movements in the Cartesian coordinate system (WORLD) **Notice:** For security reasons, depending on the “joint_coordinates” parameter, the target position of the movement is taken over from the corresponding structure (WORLD or JOINT).
Y	REAL	0.0	
Z	REAL	0.0	
Yaw	REAL	0.0	
Pitch	REAL	0.0	
Roll	REAL	0.0	
		END_STRUCT	
joint		**STRUCT**	
joint_1	REAL	0.0	Target position of the movement for movements in the axis coordinate system (JOINT) **Notice:** For security reasons, depending on the “joint_coordinates” parameter, the target position of the movement is taken over from the corresponding structure (WORLD or JOINT).
joint_2	REAL	0.0	
joint_3	REAL	0.0	
joint_4	REAL	0.0	
joint_5	REAL	0.0	
joint_6	REAL	0.0	
		END_STRUCT	
		END_STRUCT	

6.1.5 “ActualPosition” data structure

Table 6-5 “ActualPosition” data structure

Parameter	Data type	Initial value	Description
		STRUCT	
world		**STRUCT**	
X	REAL	0.0	Current position of the robot in the Cartesian coordinate system (WORLD)
Y	REAL	0.0	
Z	REAL	0.0	
Yaw	REAL	0.0	
Pitch	REAL	0.0	
Roll	REAL	0.0	
		END_STRUCT	

Parameter	Data type	Initial value	Description
joint		**STRUCT**	
joint_1	REAL	0.0	Current position of the robot in the axis coordinate system (JOINT)
joint_2	REAL	0.0	
joint_3	REAL	0.0	
joint_4	REAL	0.0	
joint_5	REAL	0.0	
joint_6	REAL	0.0	
		END_STRUCT	
		END_STRUCT	

6.1.6 "RobotErrorMessage" data structure

Table 6-6 "ComData" data structure

Parameter	Data type	Initial value	Description
		STRUCT	
error_message		**STRUCT**	
error_number	INT	0	Error number. Positive or negative values can be output here.
reserve_124	INT	0	[currently not supported]
maximum_length	BYTE	B#16#0	In the SIMATIC, data can be interpreted as SIMATIC string and processed. SIMATIC String = 1 byte total length (here 80) / 1 byte number of characters / 80 bytes character.
actual_length	BYTE	B#16#0	
data		**ARRAY[1..80] OF CHAR**	
data[1]	CHAR	" "	Character 1 of the message
…	…	…	…
data[80]	CHAR	" "	Character 80 of the message
		END_STRUCT	
		END_STRUCT	
		END_STRUCT	

6.2 Structure of the instance data block

The instance data block of FB 600 "ADEPT_RobotControl" has the following structure:

Table 6-7 Structure of the instance data block of FB 610 „ADEPT_RobotComm“

Address	Decl.	Name	Function
Block interface			
0.0	IN	Connect	Input for activating the connection setup and clearance
2.0 to 20.0	IN	ComData	Structure of the connecting parameters for setting up the communication connection.
24.0	IN	Power	Input for switching on the robot power.
24.1	IN	Calibrate	Input for activating the calibrating function of the robot.
24.2	IN	Reset	Input for resetting and acknowledging error events at the robot.
24.3	IN	Brake	Input for immediate stopping of travel movements at the robot.
26.0 to 38.0	IN	JOG	Structure for activating a jog movement with specification of JOG options and dynamic values.
40.0 to 96.0	IN	MOVE	Structure for specifying the options, dynamic values and target position for a moving command.
100.0 to 102.0	OUT	…	Outputs for displaying the current status of the function block.
104.0 to 148.0	OUT	ActualPosition	Structure for outputting the current position of the robot in WORLD and JOINT coordinates.
152.0 to 273.0	OUT	RobotErrorMessage	Structure for outputting the robot messages.
238.0 to 260.0	OUT	RobotState	Structure for displaying the current robot status.
Internal tags			
262.0 to 302.0	STAT	…	Internal tags of the function block.
304.0 to 758.0	STAT	RobotData	Structure of the ADEPT ePLC data interface for the communication between SIMATIC Controller and ADEPT robot controller.
762.0 to 824.0	STAT	ComConfiguration	Structure for the connection parameters of the communication connection (according to UDT 65).
826.0 to 830.0	STAT	…	Actually detected times of the sending and receiving process for diagnostic purposes.
834.0 to 950.0	STAT	…	Multi-instances of the blocks used in the function block.

NOTICE	**To ensure the correct function of the block, do not make any direct changes directly in the internal tags of the instance data block.**

6.3 Error and warning messages

The meaning of the error and warning messages issued at the “ErrorID” output is as follows:

Table 6-8 Error and warning messages

FB_ ErrorID	Error	Ref.	Remark
0000	No error	---	
Communication			
F001	Timeout during setup of the communication connection.	Connect	Check the connection between the SIMATIC Controller and the robot or, if required, increase the monitoring time “WatchDogComTime”.
F002	Timeout when sending command data	Connect	Check the connection between the SIMATIC Controller and the robot or, if required, increase the monitoring time “BasicComTime”.
F003	Timeout when receiving status data	Connect	Check the connection between the SIMATIC Controller and the robot or, if required, increase the monitoring time “BasicComTime”.
F004	The length of the “CommandData” structure could not be determined in the block.	Connect	
F005	The length of the “StatusData” structure could not be determined in the block.	Connect	
F006	The send-receive cycle could not be executed since there is no connection to the robot.	Connect	Check the connection between the SIMATIC Controller and the robot
Power: Switching the robot on/off.			
F101	Emergency stop at the ADEPT robot operator panel active	Power	Unlock the emergency stop of the ADEPT robot operator panel
F102	Error in resetting the robot controller	Power	
F103	Error in switching on the robot power	Power	

FB_ ErrorID	Error	Ref.	Remark
F104	Error in switching on the robot power	Power	
F105	Error in switching off the robot power	Power	
Calibrate: Referencing the robot axes			
F201	Error in starting the referencing function of the robot axes.	Calibrate	
F202	Error in performing the referencing function of the robot axes.	Calibrate	
F203	Error in completing the referencing function of the robot axes.	Calibrate	

6.4 Defining the communication parameters

Prior to setting up the communication connection between the SIMATIC Controller and the ADEPT robot controller, define the communication parameters via the structure of the “ComData” input.

Table 6-9 “ComData” data structure

Parameter	Data type	Initial value	Description
		STRUCT	
ID	WORD	W#16#5F	The communication ID needs to be changed only if connections with more than one robot controller exist within the project.
IP_Address		**ARRAY[1..6] OF BYTE**	
IP_Address[1]	BYTE	B#16#0	Enter the IP address of the robot controller here.
IP_Address[2]	BYTE	B#16#0	
IP_Address[3]	BYTE	B#16#0	
IP_Address[4]	BYTE	B#16#0	
IP_Address[5]	BYTE	B#16#0	Not used.
IP_Address[6]	BYTE	B#16#0	
		END_STRUCT	
LocalDevice_Type	BYTE	B#16#2	The default setting is suitable for the communication from SIMATIC CPUs 315-2 PN/DP and 317-2 PN/DP via the integrated interface. For further setting options please refer to the FB 65 “TCON” Online Help.

Parameter	Data type	Initial value	Description
Port	DINT	L46555	The port must be left at default setting for the communication with ADEPT robot controllers.
BasicComTime	TIME	T#2s	Usually the setting of the communication monitoring can be left at the default setting.
WatchDogComTime	TIME	T#10s	Usually the setting of the monitoring time of the connection setup can be left at the default setting.
		END_STRUCT	

6.5 Testing the block function

For testing the block functions, the application provides a tag table “VAT_STATES” and an HMI user interface “SIMATIC MobilePanel 277” that may also be operated on a PC via the WinCC flexible Runtime.

6.5.1 Using the tag table

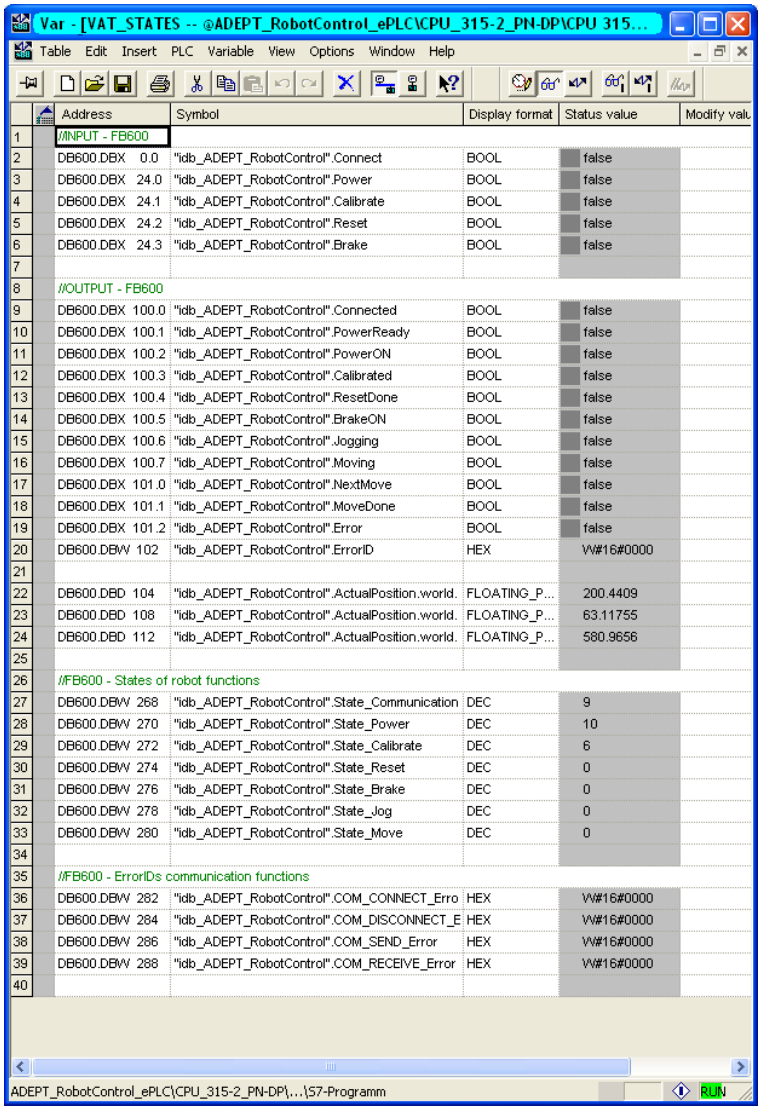
In the “VAT_STATES” tag table the required input bits of FB 600 “ADEPT_RobotControl” for controlling and the output bits and parameters for monitoring the block response have already been entered.

Note The parameters for setting up the communication are not listed in the tag table, but must be specified directly in the program via OB 1 or OB 100.

In addition, the tag table includes further information on the monitoring of the block response or the robot:

- Current positions of the robot axes in WORLD coordinates for the X, Y and Z axes of the world coordinate system.
- Currently active state of the state machine of the individual functions of function block F600 “ADEPT_RobotControl” for verifying the execution of the individual functions that can be triggered via the function block inputs.
- Internal error messages of the communication blocks “TCON”, “TDISCON”, “TSEND”, “TRECV”, that are responsible for setting or clearing the connection and for data transmission between SIMATIC Controller and ADEPT robot.

Figure 6-1 Tag table “VAT_STATES”



Var - [VAT_STATES -- @ADEPT_RobotControl_ePLC\CPU_315-2_PN-DP\CPU 315...

Table Edit Insert PLC Variable View Options Window Help

	Address	Symbol	Display format	Status value	Modify valu
1	//INPUT - FB600				
2	DB600.DBX 0.0	"idb_ADEPT_RobotControl".Connect	BOOL	false	
3	DB600.DBX 24.0	"idb_ADEPT_RobotControl".Power	BOOL	false	
4	DB600.DBX 24.1	"idb_ADEPT_RobotControl".Calibrate	BOOL	false	
5	DB600.DBX 24.2	"idb_ADEPT_RobotControl".Reset	BOOL	false	
6	DB600.DBX 24.3	"idb_ADEPT_RobotControl".Brake	BOOL	false	
7					
8	//OUTPUT - FB600				
9	DB600.DBX 100.0	"idb_ADEPT_RobotControl".Connected	BOOL	false	
10	DB600.DBX 100.1	"idb_ADEPT_RobotControl".PowerReady	BOOL	false	
11	DB600.DBX 100.2	"idb_ADEPT_RobotControl".PowerON	BOOL	false	
12	DB600.DBX 100.3	"idb_ADEPT_RobotControl".Calibrated	BOOL	false	
13	DB600.DBX 100.4	"idb_ADEPT_RobotControl".ResetDone	BOOL	false	
14	DB600.DBX 100.5	"idb_ADEPT_RobotControl".BrakeON	BOOL	false	
15	DB600.DBX 100.6	"idb_ADEPT_RobotControl".Jogging	BOOL	false	
16	DB600.DBX 100.7	"idb_ADEPT_RobotControl".Moving	BOOL	false	
17	DB600.DBX 101.0	"idb_ADEPT_RobotControl".NextMove	BOOL	false	
18	DB600.DBX 101.1	"idb_ADEPT_RobotControl".MoveDone	BOOL	false	
19	DB600.DBX 101.2	"idb_ADEPT_RobotControl".Error	BOOL	false	
20	DB600.DBW 102	"idb_ADEPT_RobotControl".ErrorID	HEX	W#16#0000	
21					
22	DB600.DBD 104	"idb_ADEPT_RobotControl".ActualPosition.world.	FLOATING_P...	200.4409	
23	DB600.DBD 108	"idb_ADEPT_RobotControl".ActualPosition.world.	FLOATING_P...	63.11755	
24	DB600.DBD 112	"idb_ADEPT_RobotControl".ActualPosition.world.	FLOATING_P...	580.9656	
25					
26	//FB600 - States of robot functions				
27	DB600.DBW 268	"idb_ADEPT_RobotControl".State_Communication	DEC	9	
28	DB600.DBW 270	"idb_ADEPT_RobotControl".State_Power	DEC	10	
29	DB600.DBW 272	"idb_ADEPT_RobotControl".State_Calibrate	DEC	6	
30	DB600.DBW 274	"idb_ADEPT_RobotControl".State_Reset	DEC	0	
31	DB600.DBW 276	"idb_ADEPT_RobotControl".State_Brake	DEC	0	
32	DB600.DBW 278	"idb_ADEPT_RobotControl".State_Jog	DEC	0	
33	DB600.DBW 280	"idb_ADEPT_RobotControl".State_Move	DEC	0	
34					
35	//FB600 - ErrorIDs communication functions				
36	DB600.DBW 282	"idb_ADEPT_RobotControl".COM_CONNECT_Erro	HEX	W#16#0000	
37	DB600.DBW 284	"idb_ADEPT_RobotControl".COM_DISCONNECT_E	HEX	W#16#0000	
38	DB600.DBW 286	"idb_ADEPT_RobotControl".COM_SEND_Error	HEX	W#16#0000	
39	DB600.DBW 288	"idb_ADEPT_RobotControl".COM_RECEIVE_Error	HEX	W#16#0000	
40					

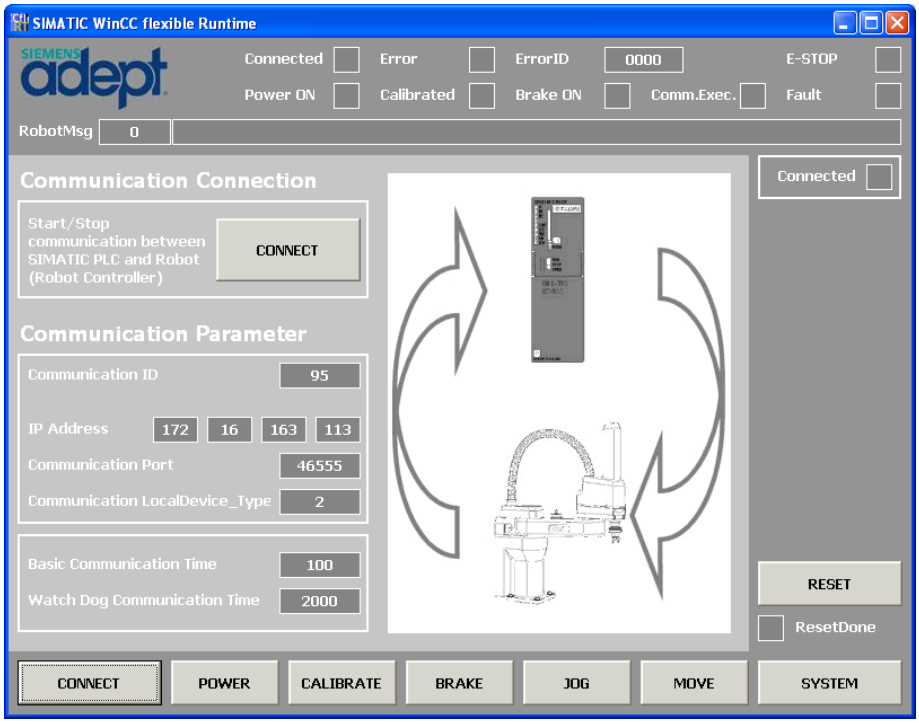
ADEPT_RobotControl_ePLC\CPU_315-2_PN-DP\...\S7-Programm RUN

6.5.2 Using the HMI user interface

If the HMI user interface is to be used for testing the block functions, it must be loaded to a SIMATIC MobilePanel 277 or the user interface must be started on a PC as WinCC flexible Runtime. For this purpose, however, the WinCC flexible Runtime software must be installed in this PC.

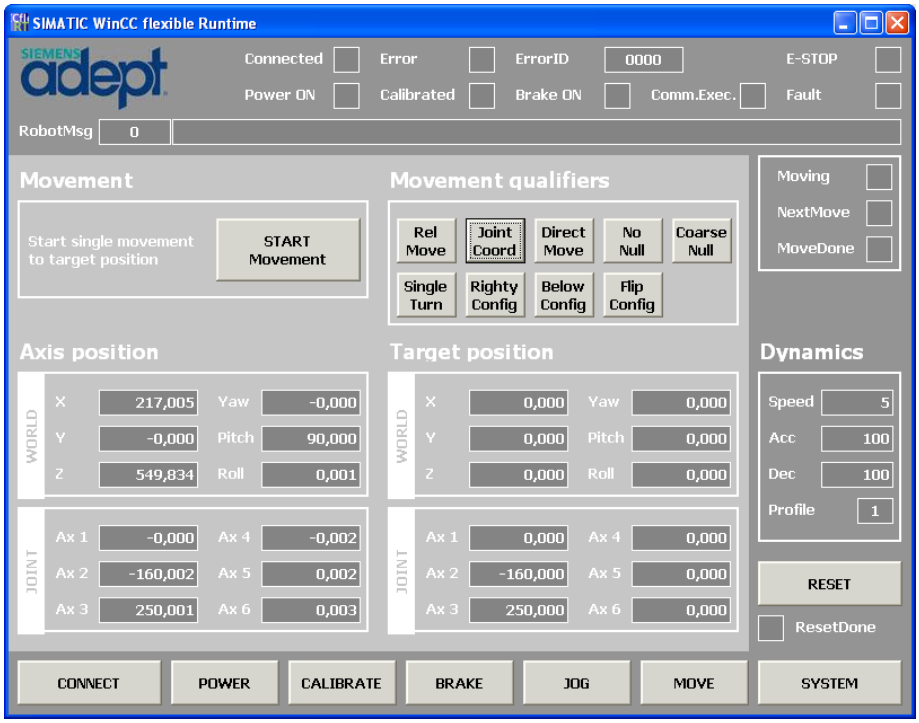
In order to start the HMI user interface as WinCC flexible Runtime, call the file “<STEP 7 project directory> > ADEPT_Ro > HmiEs > PROJECT_1 > PROJECT_1.SIMATIC MobilePanel 277.fwx“ directly from the Microsoft Windows Explorer. This way the WinCC flexible Runtime will only start the actual user interface on the PC.

Figure 6-2 HMI user interface - “Communication” function



Through the HMI user interface you can now easily control and monitor all inputs and outputs of FB 600 “ADEPT_RobotControl” on the corresponding pages.

Figure 6-3 HMI user interface - “Movement” function



7 Operation of the Application

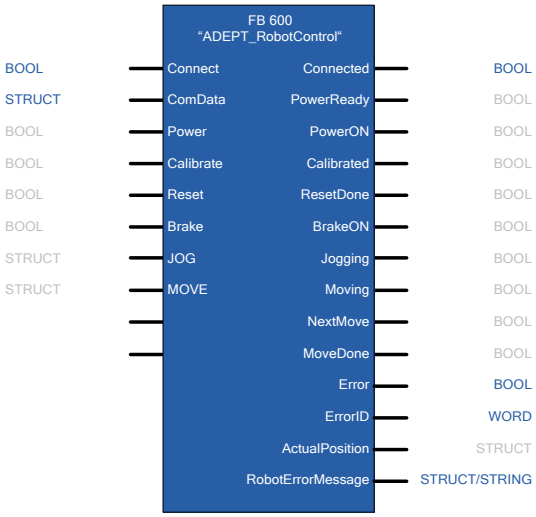
The application and thus the entire robot is operated through the function block of the application example. The proceeding for the individual functions of the function block will be described in the following chapters.

7.1 Starting the communication with the robot controller

Enter the connection parameters and the cycle and monitoring times for data exchange via the “ComData” input and then start the connection via the “Connect” input.

If the connection to the robot controller was successful, the “Connected” output will be set and the cyclic data exchange between SIMATIC Controller and robot controller will be executed within the specified time frame.
After successful connection setup, the robot controller will also issue a message that can be viewed via the “RobotErrorMessage” output.
In case an error occurred during connection setup, it can be identified and analyzed via the “Error” and “ErrorID” outputs.

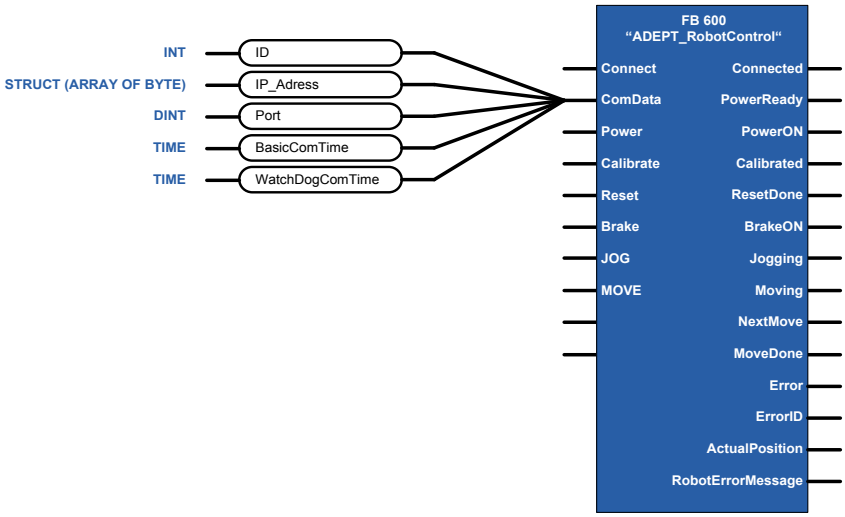
Figure 7-1 Communication with the robot controller



The connection parameters and the cycle and monitoring times for data exchange will be specified via the structure at the “ComData” input. Here, a unique but freely selectable (connection) ID, the IP address of the robot controller and the communication port of the robot controller through which data is exchanged must be defined for each robot.

In addition, the cycle time for data exchange between SIMATIC Controller and robot controller must be specified and the monitoring time for the communication connection setup must be defined.

Figure 7-2 Definition of connection parameters and the cycle / monitoring times



Note

Any other functions of the robot can only be controlled via the function block if the communication connection with the robot was set up successfully and the connection is currently active.

An active communication connection with the robot controller will be indicated through the “Connected” output of the function block.

DANGER

In case of danger, take additional measures for stopping the robot if the robot movements can no longer be influenced by the SIMATIC Controller.

7.2 Switching on the robot power

If the “Power” input at the function block is set, the command for switching on the robot power will be issued to the robot controller.

If the robot controller is ready for switching on the power at the robot, the “PowerReady” output at the function block will be set and the key for switching on the robot power at the robot front panel will be flashing. Pressing the key will switch on the power at the robot and the robot axes will go to controlled mode. This status will be displayed at the function block by setting the “PowerON” output.
In case any error occurs at the robot when the power is switched on, this will be indicated via the “Error” and “ErrorID” outputs of the function block. The robot controller can also send out a message concerning the error via the “RobotErrorMessage” output. The potential cause for such an error might be an active emergency stop function at the robot, e.g. if the emergency stop button at the front panel of the robot is pressed.

Figure 7-3 Switching on the robot power

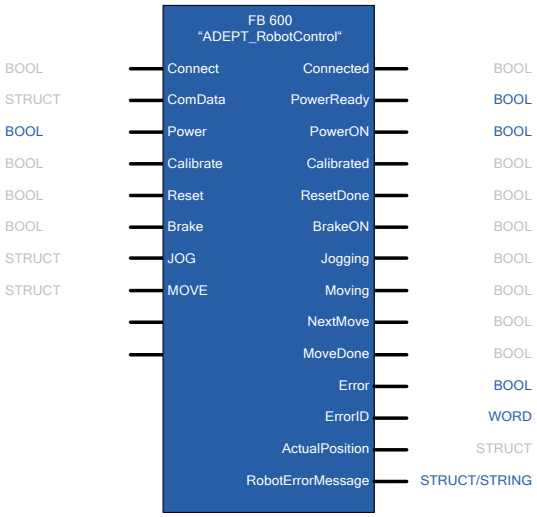
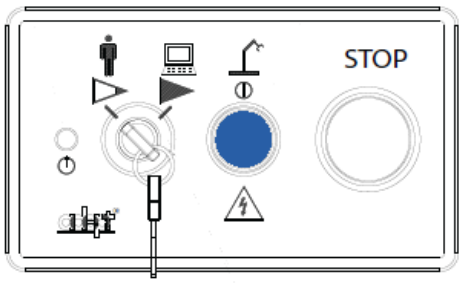


Figure 7-4 Switching on the robot power at the front panel of the robot

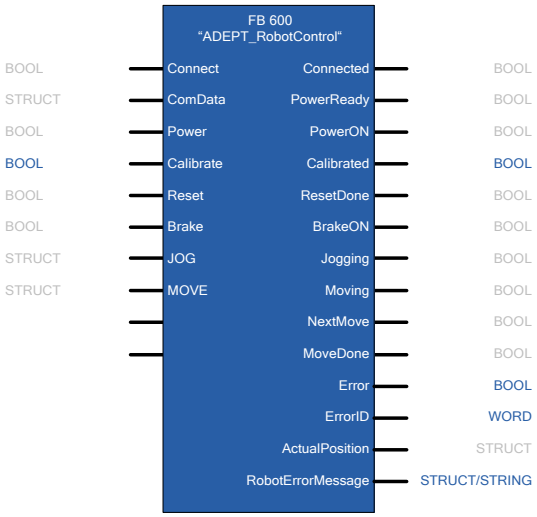


7.3 Referencing (calibrating) the robot axes

Prior to their first use, the robot axes must be calibrated or referenced via the "Calibrate" input. A rising edge at the input will trigger the function.

At the "Calibrated" output, the function blocks indicates that the robot axes are referenced or calibrated and can now be used for further movement functions. In case any error occurs at the robot when the power is switched on, this will be indicated via the "Error" and "ErrorID" outputs of the function block. In addition, the robot controller may also output further information on this function via the "RobotErrorMessage" output.

Figure 7-5 Referencing (calibrating) the robot axes



Note

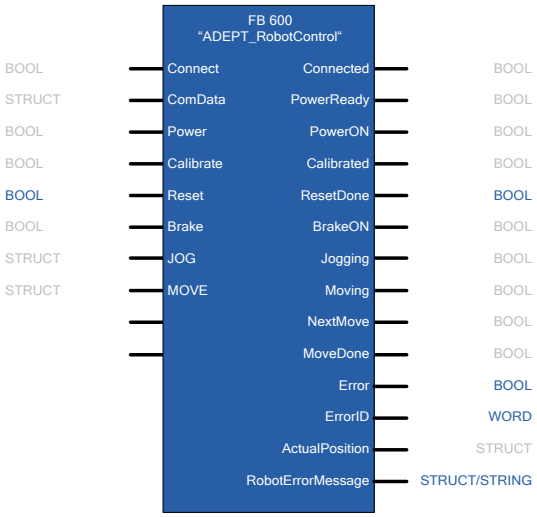
If the function is started via the "Calibrate" input even though the "Calibrated" output already indicates that the axes of the robot have already been calibrated or referenced, there will be no active referencing of the axes again. The execution of this function will be suppressed.

7.4 Acknowledging potentially pending errors

In case of any errors pending at the function block or at the robot or robot controller, these can be acknowledged or reset via the "Reset" input of the function block.

The successful execution of the function will be indicated via the "ResetDone" output, which will be set at least for one call cycle of the block, or will stay set until the "Reset" input is reset again.
In case any error occurs during the execution of this function, this will be indicated via the "Error" and "ErrorID" outputs. The currently pending error may possibly be indicated via these outputs even before the function is started. In addition, a message of the robot controller concerning a pending error may be output via the "RobotErrorMessage" output.

Figure 7-6 Acknowledging potentially pending errors

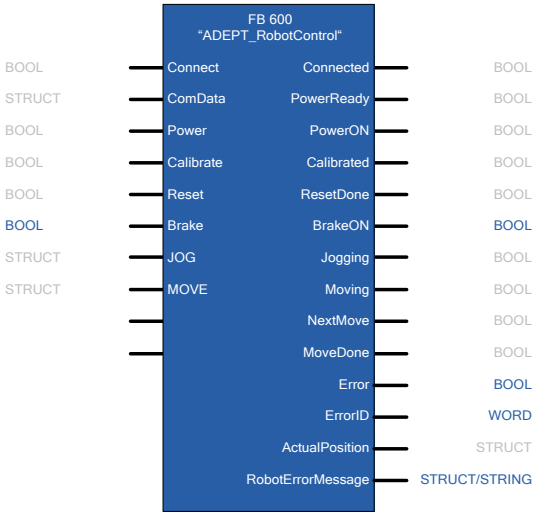


7.5 Immediately stopping a robot movement

If the robot axes are currently moving, this axis movement can immediately be stopped by setting the "Brake" input. The axes cannot be started again as long as the "Brake" input of the function block is set.

The "BrakeON" output of the function block indicates that the function for stopping the robot axes is active and that no further travel movement of the axes can be started.
In case any error occurs during the execution of this function, this will be indicated via the "Error" and "ErrorID" outputs. In addition, a message of the robot controller concerning this function may be output via the "RobotErrorMessage" output.

Figure 7-7 Immediately stopping a robot movement

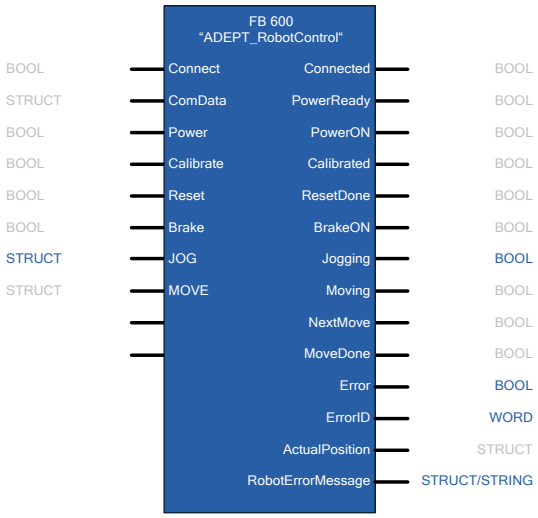


7.6 Moving the robot axes in jog mode

The robot axes can be moved in the different coordinate systems of the robot in jog mode via the “JOG” input.

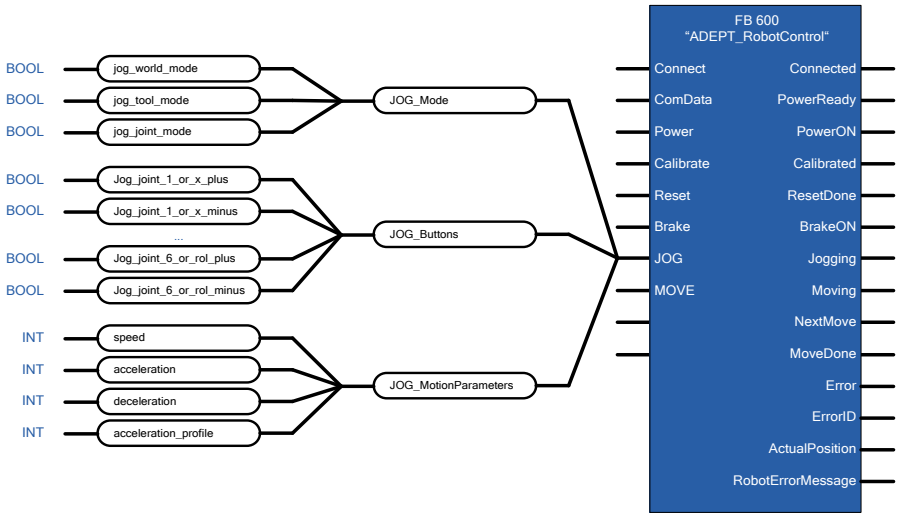
Active travel movement of the robot axes in jog mode will be indicated via the “Jogging” output.
In case any error occurs during the execution of this function, this will be indicated via the “Error” and “ErrorID” outputs. In addition, a message of the robot controller concerning this function may be output via the “RobotErrorMessage” output.

Figure 7-8 Moving the robot axes in jog mode



Jog mode is controlled through the structure of the “JOG” input. “JOG_Mode” enables switching between the Cartesian coordinate system (“jog_world_mode” input), the tool coordinate system (“jog_tool_mode” input), and the axis coordinate system (“jog_joint_mode” input).
The dynamic parameters for the jog mode of the axes, such as speed (“speed” input), acceleration (“acceleration” input), and deceleration (“deceleration” input) and the dynamic profile (“acceleration_profile” input) will be specified via the “JOG_MotionParameters”.
After that, through the “JOG_Buttons”, the respective axis can be moved, and several axes can be selected at the same time. The robot axes will keep moving as long as the corresponding jog buttons are pressed.

Figure 7-9 Controlling the jog mode

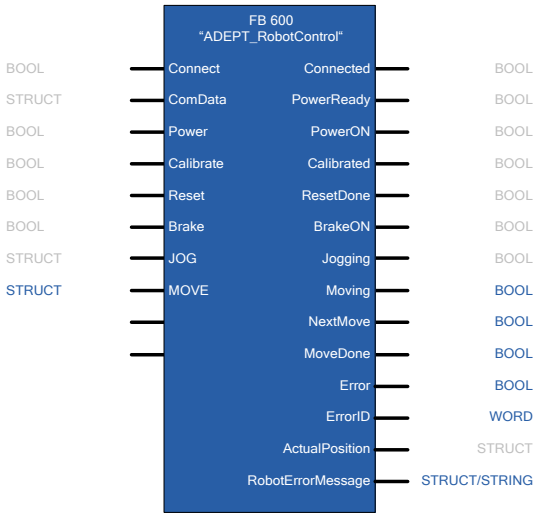


7.7 Executing coordinated movements

One or more coordinated and chained movements of the robot can be executed, with a target position specified, via the "MOVE" input.

Active travel movement of the robot axes will be indicated via the "Moving" output. The "NextMove" output indicates that a further moving command for a chained sequence of movements can be transferred to the function block, allowing orbital movements of the robot with several support points to be executed. The "MoveDone" ouput indicates that a single movement or a chained sequence of movements or orbital movement was fully executed and completed. This output will be displayed at least for one call cycle of the block, or until the "MOVE.command.Execute" input is reset.
In case any error occurs during the execution of this function, this will be indicated via the "Error" and "ErrorID" outputs. In addition, a message of the robot controller concerning this function may be output via the "RobotErrorMessage" output.

Figure 7-10 Executing coordinated movements



The moving functions of the robot will be controlled through the structure of the "MOVE" input.

The properties of the required movement are defined by means of the qualifiers. They allow the setting whether the target specification of the movement is an absolute or a relative position specification ("relative_mode" input), whether the position is specified in the Cartesian coordinate system or in the axis coordinate system ("joint_coordinates" input), whether the movement is to be executed on a straight line ("straightline_move" input), whether the command shall be chained to the next command ("nonull" input), and whether the specified target position is to be targeted precisely or only approximately ("coarse_nulling" input). The movement of the rotary axes can also be limited ("single_turn" input) or the arm positions of the robot can be defined ("righty_configuration", "below_configuration", and "flip_configuration" inputs).

The dynamic properties of the movement or the sequence of movements will be defined through the "parameters" structure.

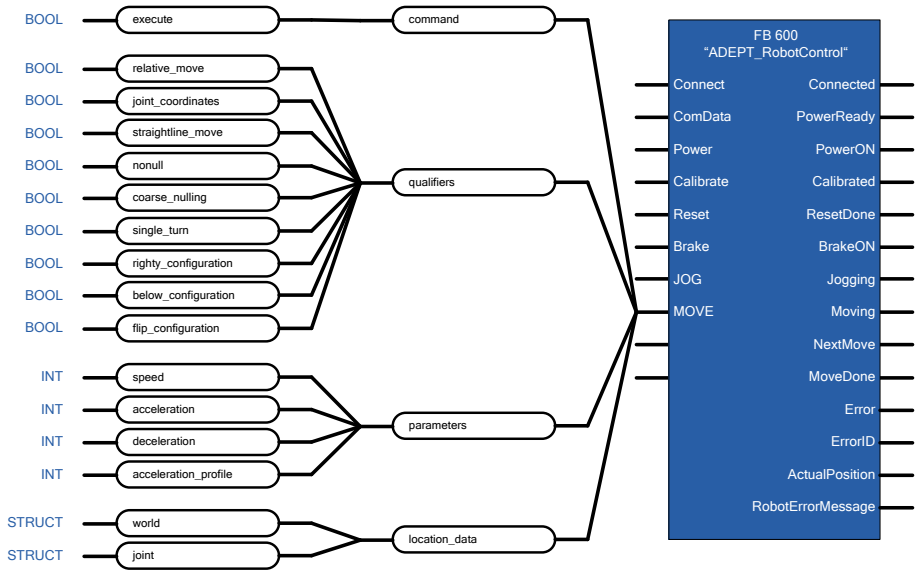
Finally the target position of the movement or the individual support point of a sequence of movements will be defined through the "location_data" structure. This structure also has the two sub-structures "world" and "joint" which, for security reasons, will be selected in dependence of the "qualifiers.joint_coordinates" input:

- If the "qualifiers.joint_coordinates" input is set, the target position will be taken from the "joint" structure. The movement will then be executed in the axis coordinate system.
- If the "qualifiers.joint_coordinates" input is not set, the target position will be taken from the "world" structure. The movement will then be executed in the Cartesian coordinate system.

The sub-structures each have six parameter inputs for the target position in the Cartesian coordinate system of the "world" structure (inputs "X", "Y", "Z", "Yaw", "Pitch", "Roll") or in the axis coordinate system of the "joint" structure (inputs "joint_1", "joint_2", "joint_3", "joint_4", "joint_5", "joint_6").

Finally the parameterized movement can be started via the "command.Execute" input.

Figure 7-11 Controlling the “MOVE” function



7.7.1 Executing a single movement

The properties of the movement will be defined through the structures “qualifiers” and “parameters” and the target position will be set through the “location_data” structure.

After that, a rising edge at the “MOVE.command.Execute” input will start the movement. The active movement will be indicated via the “Moving” output.

Once the “NextMove” output is set, the command for another movement for a sequence of movements could be given. However, this output is of no significance for executing a single movement.

After successful execution of the movement the “Moving” output will be reset and the “MoveDone” output will be set, which will stay active until the “MOVE.command.Execute” input is reset again.

Figure 7-12 Executing a single movement

7.7.2 Executing a sequence of movements

If a sequence of movements is to be executed, the properties of the movement must first be defined through the structures “qualifiers” and “parameters” and the target position of the first movement, i.e. the first support point of the movement, will be set through the “location_data” structure.

Then a rising edge at the “MOVE. command.Execute“ input will start the sequence of movements. The active movement will be indicated via the “Moving” output.

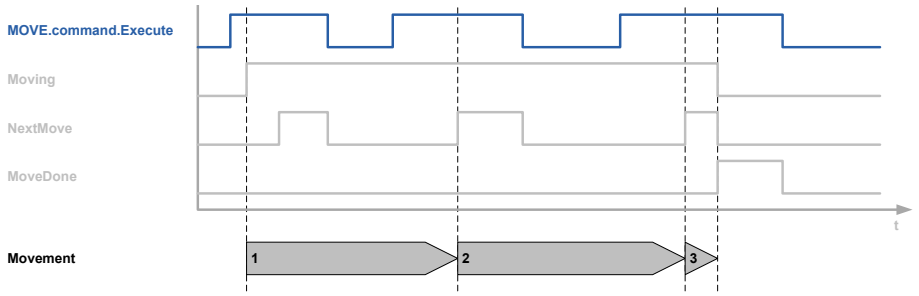
Once the “NextMove” output is set, the properties of the movement can be defined through the structures “qualifiers” and “parameters” and the target position of the next movement, i.e. the next support point of the movement, will be set through the “location_data” structure.

Then a rising edge at the “MOVE. command.Execute“ input will activate the next movement. This movement will be executed as soon as the previous movement has been completed with the defined properties.

Once the “NextMove” output is set again, the command for the next movement can be given. This process will repeat until the command for the last movement of the sequence of movements has been given.

After successful execution of the sequence of movements, or the last movement of the sequence, the “Moving” output will be reset and the “MoveDone” output will be set, which will stay active until the “MOVE.command.Execute” input is reset again.

Figure 7-13 Executing a sequence of movements



Note

If the individual movements in a sequence of movements are to be “blended”, i.e. executed without stopping the robot axis between the individual movements, the command for the follow-up movement must be given while the current movement is still being executed.

In addition, the “MOVE.Qualifiers.nonull” input must be set for each movement of the sequence.

8 Related Literature

8.1 Bibliography

This list is by no means complete and only represents a selection of relevant literature.

Table 8-1

	Subject	Title
/1/	STEP7 SIMATIC S7-300/400	Automating with STEP7 in STL and SCL Author: Hans Berger Publicis MCD Verlag ISBN: 978-3895784125
/2/	STEP7 SIMATIC S7-300/400	Automating with STEP7 in LAD and FBD Author: Hans Berger Publicis MCD Verlag ISBN: 978-3895784101
/3/	STEP7 SIMATIC S7-300	Automating with SIMATIC S7-300 inside TIA Portal Author: Hans Berger Publicis MCD Verlag ISBN: 978-3895783821

8.2 Internet Links

The following list is not complete and only represents a selection of relevant information.

Table 8-2

	Subject	Title
\1\	Reference to this entry	http://support.automation.siemens.com/WW/view/en/79100154
\2\	Siemens Industry Online Support	http://support.automation.siemens.com

9 History

Table 9-1

Version	Date	Modifications
V1.0	08/2013	First version