Manual Version 1.7

Software Version 2.6

Doosan Robot

M0609 | M1509 | M1013 | M0617

Programming Guide

DOOSAN

Table of Contents

- **DRL Basic Syntax**

No.	Function	Description
1.1	**Indent**	This function is used to separate each code block.
1.2	**Comment**	This function is used to provide an additional description of the code. The comments do not affect the source code since they are excluded from code processing.
1.3	**Variable name**	This function is used to express the data value and can consist of letters, numbers, and underscores (_). (The first character cannot be a number.)
1.4	**Numeric value**	int, float, complex
1.5	**String**	String
1.6	**list**	This function lists the result values and recognizes the sequence.
1.7	tuple	This function is similar to a list but is faster at processing since it is read-only.
1.8	dictionary	This function specifies the keys and values and lists the values.
1.9	Function	This function is used to obtain a value by inputting the function name.
1.10	**Scoping** rule	If there is no value corresponding to the local variable name in a function, the name can be found based on the LGB rule.
1.11	**Parameter mode**	This function uses default parameter values, keyword parameters, and variable parameters.
1.12	pass	This function is used when an operation is not executed.

No.	Function	Description
1.13	**if**	This function is a conditional function that can use "elif" and "else" according to whether the condition of the "if" syntax is true or false.
1.14	while	This function is a conditional function that repeats an operation according to whether the condition is true or false.
1.15	**for**	This function repeats an operation within the specified repeating "range".
1.16	**break**	This function exits the internal block of a loop.
1.17	continue	This function stops further executing the internal block of a loop and returns to the beginning point of the loop.
1.18	**Else in a loop**	The "else" block is executed when the loop is executed until the end without being terminated by the "break" function in the middle of executing a loop.

- **Motion-related Commands**

No.	Function	Description
2.1	**posj**(q1=0, q2=0, q3=0, q4=0, q5=0, q6=0)	This function designates the joint space angle in coordinate values.
2.2	**posx**(x=0, y=0, z=0, w=0, p=0, r=0)	This function designates the task space in coordinate values.
2.3	trans(pos, delta, ref, ref_out)	This function is equivalent to "addto" in the task space and returns the value after homogeneous transformation as much as the delta of an object in the task space.
2.4	**posb**(seg_type, posx1, posx2=None, radius=0)	Input parameters for constant-velocity blending motion (moveb and amoveb) with the Posb coordinates of each waypoint and the data of the unit path type (line or arc) define the unit segment object of the trajectory to be blended.
2.5	**fkin**(pos, ref)	This function receives the input data of points or equivalent forms (float[6]) in joint space and returns the coordinates of the TCP (objects in the task space).

No.	Function	Description
2.6	**ikin**(pos, sol_space, ref)	This function returns to the joint location corresponding to sol_space, which is equivalent to the robot pose in the task space, among 8 joints.
2.7	**addto**(pos, add_val=None)	This function creates a new posj object by adding add_val to each joint value of posj.
2.8	**set_velj**(vel)	This function sets the global velocity in joint motion (movej, movejx, amovej, or amovejx) after using this command.
2.9	**set_accj**	This function sets the global velocity in joint motion (movej, movejx, amovej, or amovejx) after using this command.
2.10	**set_velx**	This function sets the velocity of the task space motion globally.
2.11	**set_velx**	This function sets the velocity of the task space motion globally.
2.12	**set_accx**(acc1, acc2)	This function sets the acceleration of the task space motion globally.
2.13	**set_accx**	This function calls the name of the TCP registered in the Teach Pendant and sets it as the current TCP.
2.14	**set_tcp**	This function calls the name of the TCP registered in the Teach Pendant and sets it as the current TCP.
2.15	**set_ref_coord**(coord)	This function sets the reference coordinate system.
2.16	**movej**	The robot moves to the target joint position (pos) from the current joint position.
2.17	**movel**	The robot moves along the straight line to the target position (pos) within the task space.
2.18	**movejx**	The robot moves to the target position (pos) within the joint space.
2.19	**movec**	The robot moves along an arc to the target pos (pos2) via a waypoint (pos1) or to a specified angle from the current position in the task space.
2.20	**movesj**	The robot moves along a spline curve path that connects the current position to the target position (the last waypoint in pos_list) via the waypoints of the joint space input in pos_list.
2.21	**movesx**	The robot moves along a spline curve path that connects the current position to the target position (the last waypoint in pos_list) via the waypoints of the task space input in pos_list.
2.22	**moveb**	This function takes a list that has one or more path segments (line or circle) as arguments and moves at a constant velocity by blending each segment into the specified radius.

<table>
<tr><th>No.</th><th>Function</th><th>Description</th></tr>
<tr><td>2.23</td><td>move_spiral</td><td>The radius increases in a radial direction and the robot moves in parallel with the rotating spiral motion in an axial direction.</td></tr>
<tr><td>2.24</td><td>move_periodic</td><td>This function performs the cyclic motion based on the sine function of each axis (parallel and rotation) of the reference coordinate (ref) input as a relative motion that begins at the current position.</td></tr>
<tr><td>2.25</td><td>move_home</td><td>Homing is performed by moving to the joint motion to the mechanical or user defined home position.</td></tr>
<tr><td>2.26</td><td><h2>1.1 move_home</h2>
Features
Homing is performed by moving to the joint motion to the mechanical or user defined home position. According to the input parameter [target], it moves to the mechanical home defined in the system or the home set by the user.
Parameters
<table><tr><th>Parameter Name</th></tr><tr><td>target</td></tr></table></td><td>The asynchronous movej motion operates in the same way as movej except that it does not have the radius parameter for blending.</td></tr>
</table>

No.	Function	Description			
					. DR_HOME_TARGET_MECHANIC :, Mechanical home, joint angle (0,0,0,0,0,0) . DR_HOME_TARGET_USER : user home.
	Note · Homing motion is divided into two steps and performed sequentially. step1) Move to the homing position at the speed specified in the system				

No.	Function	Description
	step2) Finding the home position precisely · Safety should be ensured so that there is no danger of collision in the vicinity of homing operation.. ▪ **Return**	

No.	Function	Description
	Negative value	Error
	▪ **Exception** E DR_Error (DR DR_Error (DR DR_Error (DR DR_Error (DR ▪ **Example** **move_ho** P0 = posj movej(P0 amovej**amovej**	
2.27	**amovel**	The asynchronous movel motion operates in the same way as movel except that it does not have the radius parameter for blending.
2.28	**amovejx**	The asynchronous movejx motion operates in the same way as movejx except that it does not have the radius parameter for blending.
2.29	**amovec**	The asynchronous movec motion operates in the same way as movec except that it does not have the radius parameter for blending.
2.30	**amovesj**	The asynchronous movesj motion operates in the same way as movesj() except for the asynchronous processing.
2.31	**amovesx**	The asynchronous movesx motion operates in the same way as movesx() except for the asynchronous processing.
2.32	**amoveb**	The asynchronous moveb motion operates in the same way as moveb() except for the asynchronous processing and executes the next line after the command is executed.
2.33	**amove_spiral**	The asynchronous move_spiral motion operates in the same way as move_spiral() except for the asynchronous processing and executes the next line after the command is executed.

No.	Function	Description
2.34	**amove_periodic**	The asynchronous move_periodic motion operates in the same way as move_periodic() except for the asynchronous processing and executes the next line after the command is executed.
2.35	**mwait**(time=0)	This function sets the waiting time between the previous motion command and the motion command in the next line.
2.36	**begin_blend**(radius=0)	This function begins the blending section.
2.37	**end_blend**()	This function ends the blending section.
2.38	**check_motion**()	This function checks the status of the currently active motion.
2.39	**stop**(st_mode)	This function stops the currently active motion. This function stops differently according to the st_mode received as an argument. All stop modes except Estop stop the motion in the currently active section.
2.40	**change_operation_speed**(speed)	This function adjusts the operation velocity.
2.41	**wait_manual_guide**	This function enables the user to perform hand during the execution of the program.
2.42	**wait_nudge**	This function enables users to resume the execution of the program through the user's nudge input (applying external force to the robot) when the execution of the program is paused.
2.43	**enable_alter_motion**	This function activates alter motion.
2.44	**alter_motion**	This function excutes alter motion as input pose.
2.45	**disable_alter_motion**	This function deactivates alter motion.

- **Auxiliary Control Commands**

No.	Function	Description
3.1	**get_control_mode**()	This function returns the current control mode.
3.2	**get_control_space**()	This function returns the current control space.
3.3	**get_current_posj**()	This function returns the current joint angle.
3.4	**get_current_velj**()	This function returns the current joint velocity.
3.5	**get_desired_posj**()	This function returns the current target joint angle.
3.6	**get_desired_velj**()	This function returns the current target joint velocity.

No.	Function	Description
3.7	**get_current_posx**(ref)	This function returns the pose and solution space of the current coordinate system.
3.8	**get_current_tool_flange_posx**(ref)	This function returns the pose of the current tool flange.
3.9	**get_current_velx**(ref)	This function returns the current tool velocity.
3.10	**get_desired_posx**(ref)	This function returns the target pose of the current tool.
3.11	**get_desired_velx**(ref)	This function returns the target velocity of the current tool.
3.12	**get_current_solution_space**()	This function returns the current solution space value.
3.13	**get_current_rotm**(ref)	This function returns the direction and matrix of the current tool.
3.14	**get_joint_torque**()	This function returns the sensor torque value of the current joint.
3.15	**get_external_torque**()	This function returns the torque value generated by the external force on each current joint.
3.16	**get_tool_force**(ref)	This function returns the external force applied to the current tool.
3.17	**get_solution_space**(pos)	This function obtains the solution space value.
3.18	**get_orientation_error**(xd, xc, axis)	This function returns the orientation error value between the arbitrary poses xd and xc of the axis.

- **Other Settings and Safety-related Commands**

4.1	**get_workpiece_weight**()	This function measures and returns the weight of the workpiece.
4.2	**reset_workpiece_weight**()	This function initializes the weight data of the material to initialize the algorithm before measuring the weight of the material.
4.3	**set_tool**(name)	This function activates the tool of the entered name among the tool information registered in the Teach Pendant.
4.4	set_tool(name)	This function activates the tool shape information of the entered name among the tool shape information registered in the Teach Pendant.
4.5	**set_singular_handling**	In case of path deviation due to the effect of singularity in task motion, user can select the response policy

• Force/Stiffness Control and Other User-Friendly Features

No.	Function	Description
5.1	**parallel_axis**(x1, x2, x3, axis, ref)	This function matches the axis received as the argument axis in the normal vector and tool frame obtained by get_normal (x1, x2, x3).
5.2	**parallel_axis**(vect, axis, ref)	This function matches the axis received as the argument axis in the tool frame in the given vect direction.
5.3	**align_axis**(x1, x2, x3, pos, axis, ref)	This function matches the axis received as the argument axis in the normal vector and tool frame obtained by get_normal (x1, x2, x3).
5.4	**align_axis**(vect, pos, axis, ref)	This function matches the axis received as the argument axis in the tool frame in the given vect direction.
5.5	**is_done_bolt_tightening**(m=0, timeout=0, axis=None)	This function monitors the tightening torque of the tool and returns True if the set torque (m) is reached within the given time and False if the given time has passed.
5.6	**release_compliance_ctrl**()	This function terminates compliance control and begins position control at the current position.
5.7	**task_compliance_ctrl**	This function begins task compliance control based on the preset reference coordinate system.
5.8	**set_stiffnessx**	This function sets the stiffness value.
5.9	**calc_coord**	The user can calculate the new cartesian coordinate system using up to 4 input poses (x1~x4), input mode (mod) and the reference coordinate system (ref).
5.10	**set_user_cart_coord**(pos, ref)	The user can set the new cartesian coordinate system using position (pos) and reference coordinate system (ref).
5.11	**set_user_cart_coord**(x1, x2, x3, pos, ref)	The user can set the new cartesian coordinate system using x1, x2, and x3.
5.12	**set_user_cart_coord**(u1, v1, pos, ref)	The user can set the new cartesian coordinate system using u1 and v1.
5.13	**overwrite_user_cart_coord**	This function changes the position (pos) and reference coordinate system (ref) of the preset cartesian coordinate system with the requested ID (id).
5.14	**get_user_cart_coord**	The user can get the position and reference coordinate system of the cartesian coordinate system with the requested ID (id).

No.	Function	Description
5.15	**set_desired_force**	This function sets the force control target value, force control direction, force target value, and variation time.
5.16	**release**_force(time=0)	This function reduces the force control target value to 0 through the time value and returns the task space to adaptive control.
5.17	**check_position_condition**	This function checks the status of the given position.
5.18	**check_force_condition**	This function checks the status of the given force. It disregards the force direction and only compares the sizes.
5.19	**check_orientation_condition**(axis, min, max, ref, mod)	This function checks the difference between the current pose and the specified pose of the robot end effector.
5.20	**check_orientation_condition**(axis, min, max, ref, mod, pos)	This function checks the difference between the current pose and the rotating angle range of the robot end effector.
5.21	**coord_transform**	This function transforms given task position expressed in reference coordinate.

- **System Commands**

No.	Function	Description
6.1.1	**set_digital_output**(index, val =None)	This function sends a signal at the digital contact point of the controller.
6.1.2	**set_digital_outputs**(bit_list)	This function sends a signal at multiple digital output contact points of the controller.
6.1.3	**set_digital**_outputs(bit_start, bit_end, val)	This function sends multiple signals at once from the digital output start contact point (bit_start) to the end contact point (bit_end) of the controller.
6.1.4	**get_digital_input**(index)	This function reads the signals from digital contact points of the controller and reads the digital input contact value.
6.1.5	**get_digital_inputs**(bit_list)	This function reads the signals from multiple digital contact points of the controller.
6.1.6	**get_digital**_inputs(bit_start, bit_end)	This function reads multiple signals at once from the digital input start contact point (start_index) to the end contact point (end_index) of the controller.
6.1.7	**wait_digital**_input(index, val, timeout=None)	This function waits until the signal value of the digital input register of the controller becomes val (ON or OFF).

No.	Function	Description
6.1.8	**set_tool_digital_output**(index, val=None)	This function sends the signal of the robot tool from the digital contact point.
6.1.9	**set_tool_digital_outputs**(bit_list)	This function sends the signal of the robot tool from the digital contact point. The digital signals of the contact points defined in bit_list are output at one.
6.1.10	**set_tool_digital_outputs**(bit_start, bit_end, val)	This function sends the signal of the robot tool from the digital contact point. The multiple signals from the first contact point (bit_start) to the last contact point (bit_end) are output at one.
6.1.11	**get_tool_digital_input**(index)	This function reads the signal of the robot tool from the digital contact point.
6.1.12	**get_tool_digital_inputs**(bit_list)	This function reads the signal of the robot tool from the digital contact point. The digital signals of the contact points defined in bit_list are input at one.
6.1.13	**get_tool_digital_inputs**(bit_start, bit_end)	This function reads the signal of the robot tool from the digital contact point. The multiple signals from the first contact point (start_index) to the last contact point (end_index) are input at one.
6.1.14	**wait_tool_digital_input**(index, val, timeout=None)	This function waits until the digital input signal value of the robot tool becomes val (ON or OFF).
6.1.15	**set_mode_analog_output**(ch, mod)	This function sets the channel mode of the controller analog output.
6.1.16	**set_mode_analog_input**(ch, mod)	This function sets the channel mode of the controller analog input.
6.1.17	**set_analog_output**(ch, val)	This function outputs the channel value corresponding to the controller analog output.
6.1.18	**get_analog_**input(ch)	This function reads the channel value corresponding to the controller analog input.
6.2.1	**tp_popup**(message, pm_type=DR_PM_MESSAGE, type=0)	This function provides a message to users through the Teach Pendant.
6.2.2	**tp_log**(message)	This function records the user-written log to the Teach Pendant.
6.2.3	**tp_progress**(cur_progress, total_progress)	This function provides a message to users through the Teach Pendant.

No.	Function	Description
6.2.4	**tp_get_user_input**(message, input_type)	This function receives the user input data through the Teach Pendant.
6.3.1	**thread_run**(th_func_name, loop=False)	This function creates and executes a thread. The features executed by the thread are determined by the functions specified in th_func_name.
6.3.2	**thread_stop**(th_id)	This function terminates a thread.
6.3.3	**thread**_pause(th_id)	This function temporarily suspends a thread.
6.3.4	**thread**_resume(th_id)	This function resumes a temporarily suspended thread.
6.3.5	**thread**_state(th_id)	This function checks the status of a thread.
6.3.6	**Integrated example**	This example explains how to use the thread.
6.4.1	**wait**(time)	This function waits for the specified time.
6.4.2	**exit**()	This function terminates the currently running program.
6.4.3	**sub_program_run**	It executes a subprogram saved as a separate file.
6.4.4	**drl_report_line**	This command is used to turn ON / OFF the execution line display function when the DRL script is running.
6.4.5	**set_fm**	This command is used when interworking is required for information on variables (global variables, system variables, etc.) created when the program is executed, in addition to the system information already defined and linked with KT Smart Factory.

- **Mathematical Function**

No.	Function	Description
7.1	**sin**(x)	This function returns the sine value of x radians.
7.2	**cos**(x)	This function returns the cosine value of x radians.
7.3	**tan**(x)	This function returns the tangent value of x radians.
7.4	**asin**(x)	This function returns the arc sine value of x radians.
7.5	**acos**(x)	This function returns the arc cosine value of x radians.

No.	Function	Description
7.6	**atan**(x)	This function returns the arc tangent value of x radians.
7.7	**atan2**(y, x)	This function returns the arc tangent value of y/x radians.
7.8	**ceil**(x)	This function returns the smallest integer value of integers larger than x.
7.9	**floor**(x)	This function returns the largest integer value of integers smaller than x.
7.10	**pow**(x, y)	Return x raised to the power of y.
7.11	**sqrt**(x)	This function returns the square root of x.
7.12	**log**(x, b)	This function returns the log of x with base b.
7.13	**d2r**(x)	This function returns the x radians value to degrees.
7.14	**r2d**(x)	This function returns the x radians value to degrees.
7.15	**norm**(x)	This function returns the L2 norm of x.
7.16	**random**()	This function returns a random number.
7.17	**rotx**(angle)	This function returns a rotation matrix that rotates by the angle value along the x-axis.
7.18	**roty**(angle)	This function returns a rotation matrix that rotates by the angle value along the y-axis.
7.19	**rotz**(angle)	This function returns a rotation matrix that rotates by the angle value along the z-axis.
7.20	**rotm2eul**(rotm)	This function receives a rotation matrix and returns the Euler angle (zyz order) to degrees.
7.21	**rotm2rotvec**(rotm)	This function receives a rotation matrix and returns the rotation vector (angle/axis representation).
7.22	**eul2rotm**([alpha,beta,gamma])	This function transforms a Euler angle (zyz order) to a rotation matrix.
7.23	**eul2rotvec**([alpha,beta,gamma])	This function transforms a Euler angle (zyz order) to a rotation vector.
7.24	**rotvec2eul**([rx,ry,rz])	This function transforms a rotation vector to a Euler angle (zyz).
7.25	**rotvec2rotm**([rx,ry,rz])	This function transforms a rotation vector to a rotation matrix.

No.	Function	Description
7.26	**htrans**(posx1,posx2)	This function returns the pose corresponding to T1*T2 assuming that the homogeneous transformation matrices obtained from posx1 and posx2 are T1 and T2, respectively.
7.27	**get_intermediate_pose**(posx1 ,posx2,alpha)	This function returns posx located at alpha of the linear transition from posx1 to posx2.
7.28	**get_distance**(posx1, posx2)	This function returns the distance between two pose positions in [mm].
7.29	**get_normal**(x1, x2, x3)	This function returns the normal vector of a surface consisting of three points (posx) in the task space. This direction is clockwise.
7.30	**add_pose**(posx1,posx2)	This function obtains the sum of two poses.
7.31	**subtract_pose**(posx1,posx2)	This function obtains the difference between two poses.
7.32	**inverse_pose**(posx1)	This function returns posx corresponding to the inverse of the posx.
7.33	**dot_pose**(posx1, posx2)	This function obtains the inner product of the translation component when two poses are given.
7.34	**cross_pose**(posx1, posx2)	This function obtains the outer product of the translation component when two poses are given.
7.35	**unit_pose**(posx1)	This function obtains the unit vector of the given posx translation component.

- **External Communication Commands**

No.	Function	Description
8.1.1	**serial_open**(port=None, baudrate=115200, bytesize=DR_EIGHTBITS, parity=DR_PARITY_NONE, stopbits=DR_STOPBITS_ONE)	This function opens a serial communication port.
8.1.2	**serial_close**(ser)	This function closes a serial communication port.
8.1.3	**serial_state**(ser)	This function returns the status of a serial communication port.
8.1.4	**serial_set_inter_byte_timeout**(se r, timeout=None)	This function sets the timeout between the bytes (inter-byte) when reading and writing to the port.
8.1.5	**serial_write**	This function writes the data (tx_data) to a serial port.

No.	Function	Description
8.1.6	**serial_read**(ser, length=-1, timeout=-1)	This function reads the data from a serial port.
8.1.7	**serial_get_count**	This function reads the number of devices connected to USB to Serial.
8.1.8	**serial_get_info**	This function reads the port information and device name of the connected USB to Serial.
8.1.9	**example**	This is an example for performing a self-loop-back test on RXD (#2 pin) and TXD (#3 pin) are connected with the serial port.
8.2.1	**client_socket_open**(ip, port)	This function creates a socket and attempts to connect it to a server (ip, port).
8.2.2	**client_socket**_close(sock)	This function terminates communication with the server.
8.2.3	**client_socket_state**(sock)	This function returns the socket status.
8.2.4	**client_socket_write**(sock, tx_data)	This function transmits data to the server.
8.2.5	**client_socket_read**(sock, length=-1, timeout=-1)	This function reads data from the server.
8.2.6	**exmaple**	Integrated example
8.3.1	**server_socket_open**(port)	This function creates a socket and waits for the connection to the client. This function returns the connected socket when the client is connected.
8.3.2	**server_socket_close**(sock)	This function terminates communication with the client.
8.3.3	**server_socket_state**(sock)	This function returns the socket status.
8.3.4	**server_socket_write**(sock, tx_data)	This function transmits data to the client.
8.3.5	**server_socket_read**(sock, length=-1, timeout=-1)	This function reads data from the client.
8.3.6	**exmaple**	Integrated example
8.4.1	오류! 참조 원본을 찾을 수 없습니다.	This function registers the Modbus signal.
8.4.2	**add_modbus_rtu_signal**	This function registers the ModbusRTU signal.

No.	Function	Description
8.4.3	**add_modbus_signal_multi**	This function registers the ModbusTCP FC15 & FC16 multiple signal.
8.4.4	**add_modbus_rtu_signal_multi**	This function registers the ModbusRTU FC15 & FC16 multiple signal.
8.4.5	오류! 참조 원본을 찾을 수 없습니다.	This function deletes the registered Modbus signal.
8.4.6	**del_modbus_signal_multi**	This function deletes the registered Modbus multiple signal.
8.4.7	오류! 참조 원본을 찾을 수 없습니다.	This function sends the signal to an external Modbus system.
8.4.8	오류! 참조 원본을 찾을 수 없습니다.	This function sends the multiple signals to the digital contact points of the external Modbus digital I/O unit.
8.4.9	**set_modbus_output_multi**	This function sends the signal to an external Modbus system.
8.4.10	오류! 참조 원본을 찾을 수 없습니다.	This function reads the signal from the Modbus system.
8.4.11	오류! 참조 원본을 찾을 수 없습니다.	This function reads multiple signals from the digital input contact points of the external Modbus digital I/O unit.
8.4.12	**get_modbus_inputs_list**	It is the command for reading multiple register type open signals from an external Modbus Slave unit.
8.4.13	**get_modbus_input_multi**	This function reads the signal from the Modbus Slave unit.
8.4.14	**wait_modbus_input**	This function waits until the specified signal contact point value of the Modbus digital I/O becomes val (ON or OFF).
8.4.15	**set_modbus_slave**	It is used to export values to the General Purpose Register area of the Modbus TCP Slave.
8.4.16	**get_modbus_slave**	It is used to import values by approaching the General Purpose Register area of the Modbus TCP Slave.
8.4.17	**modbus_crc16**	When using the Modbus protocol, this command reduces the load on Modbus CRC16 calculations.
8.4.18	**modbus_send_make**	When using the Modbus protocol, this command provides the result data including the Modbus CRC16 result for the send data.
8.4.19	**modbus_recv_check**	When using Modbus protocol, this command to check data integrity using CRC16 value for receive data.

No.	Function	Description
8.5.1	**set_output_register_bit**	It is used to export values to the Output Bit General Purpose Register area of the Industrial Ethernet(EtherNet/IP, PROFINET) Slave.
8.5.2	**set_output_register_int**	It is used to export values to the Output Int General Purpose Register area of the Industrial Ethernet(EtherNet/IP, PROFINET) Slave
8.5.3	**set_output_register_float**	It is used to export values to the Output Float General Purpose Register area of the Industrial Ethernet(EtherNet/IP, PROFINET) Slave.
8.5.4	**get_output_register_bit**	It is used to import values to the Output Bit General Purpose Register area of the Industrial Ethernet(EtherNet/IP, PROFINET) Slave.
8.5.5	**get_output_register_int**	It is used to import values to the Output Int General Purpose Register area of the Industrial Ethernet(EtherNet/IP, PROFINET) Slave.
8.5.6	**get_output_register_float**	It is used to import values to the Output Float General Purpose Register area of the Industrial Ethernet(EtherNet/IP, PROFINET) Slave.
8.5.7	**get_input_register_bit**	It is used to import values to the Input Bit General Purpose Register area of the Industrial Ethernet(EtherNet/IP, PROFINET) Slave.
8.5.8	**get_input_register_int**	It is used to import values to the Input Int General Purpose Register area of the Industrial Ethernet(EtherNet/IP, PROFINET) Slave.
8.5.9	**get_input_register_float**	It is used to import values to the Input Float General Purpose Register area of the Industrial Ethernet(EtherNet/IP, PROFINET) Slave.

- **External Vision Commands**

No.	Function	Description
9.1.1	**vs_set_info**	This function set the type of vision system to use.
9.1.2	**vs_connect**	This function establishes communication with the vision system.
9.1.3	**vs_disconnect**	This function terminates the connection to the vision system.

No.	Function	Description
9.1.4	**vs_get_job**	This function loaded the task name, currently loaded in the vision system.
9.1.5	**vs_set_job**	This function loaded the entered task into the vision system.
9.1.6	**vs_trigger**	This function transmits the measurement command to the vision system.
9.1.7	**vs_set_init_pos**	Enter the initial position information of the object to perform the vision guidance operation.
9.1.8	**vs_get_offset_pos**	The coordinate of the robot is calculated using the coordinate values, measured in the vision system.
9.1.9	**vs_request**	This function sets the feature for the vision system to request
9.1.10	**vs_result**	This function retrieves the processing result of the vision system.
9.1.11	**Integrated example 1**	example (DR_VS_COGNEX, DR_VS_SICK)
9.1.12	**Integrated example 2**	Example (DR_VS_CUSTOM)
9.2.1	**pick_connect**	This function establishes communication with the vision system.
9.2.2	**pick_disconnect**	This function terminates the connection to the vision system.
9.2.3	**pick_request_callibration**	This function requests a calibration once from the vision system.
9.2.4	**pick_change_configureation**	This function loads setup_id and product_id set in the vision system.
9.2.5	**pick_save_snapshot**	This function saves the snapshot to the server.
9.2.6	**pick_detection**	This function detects the input model and returns (pick_prepos, pick_pos).
9.2.7	**pick_next_object**	This function returns pick_prepos and pick_pos detected next to the input model.
9.2.8	**Integrated example**	pickit example

• Doosan Vision(SVM) Commands

No.	Function	Description
10.1	**svm_connect**	This function establishes communication with the SVM.

No.	Function	Description
10.2	**svm_disconnect**	This function terminates the connection to the SVM.
10.3	**svm_set_job**	This function loads the Vision task corresponding to the input id into the SVM.
10.4	**svm_get_robot_pose**	The robot pose information(joint coordinate system) set in the vision task is loaded.
10.5	**svm_get_vision_info**	Performs the measurement command corresponding to the input vision task.
10.6	**svm_get_variable**	If the object detection/measurement is successful(1) by executing svm_get_vision_info, the detection/measurement data is loaded.
10.7	**svm_get_offset_pos**	The robot task coordinate information reflecting the vision measurement.
10.8	**svm_set_init_pos_data**	Enter the initial id_list and posx_list information of the object to perform the vision guidance operation.
10.9	**svm_set_tp_popup**	This function selects whether to display tp_popup when a vision error occurs.
10.10	**svm_set_led_brightness**	Change the Vision LED value to the set value.
10.11	**svm_get_led_brihtness**	Vision LED The current value is loaded.
10.12	**svm_set_camera_exp_val**	Change the vision exposure value to the set value.
10.13	**svm_set_camera_gain_val**	Change the Vision gain value to the set value.
10.14	**svm_set_camera_load**	The LED / exp / gain / focus information stored in the vision is retrieved.
10.15	**example**	Intergrated example (SVM)

Application Commands

No.	Function	Description
11.2.1	**set_extenc_polarity**	It configures the polarity of phase A, B and Z and the trigger method of phase S of the corresponding channel encoder.
11.2.2	**set_extenc_mode**	It configures the operation mode of phase A, B, Z and S of the corresponding channel encoder.
11.2.3	**get_extenc_count**	Calculate the count of the corresponding channel encoder.

No.	Function	Description
11.2.4	**clear_extenc_count**	Reset the corresponding channel encoder counter value to 0.
11.1.1	**set_conveyor**	If conveyor information is configured in the UI, obtain the conveyor name as ID to start the Conveyor Tracking Application from the program and execute the command for workpiece monitoring.
11.1.2	**set_conveyor_ex**	Configures the conveyor and obtains Conveyor ID to allow the Conveyor Tracking Application to start.
11.1.3	**get_conveyor_obj**	It returns the workpiece coordinate ID available for the job from the corresponding conveyor.
11.1.4	**tracking_conveyor**	The robot starts Conveyor Tracking.
11.1.5	**untracking_conveyor**	The robot ends Conveyor Tracking.

Preface

This manual is composed of twelve chapters. Chapter 1 through 11 describe DRL commands common to M-series robot and A-series robot, chapter 12 describes DRL commands that apply only to A-series robot.

The contents of this manual are current as of the date this manual was written, and product-related information may be modified without prior notification to the user.

For more information on the revised manual, please visit our Robot LAB website.
(https://robotlab.doosanrobotics.com/)

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1. DRL Basic Syntax

⚠ **Caution**

The syntax of DRL is the same as the syntax of Python which means that DRL does not include all the syntax and features of Python.

DRL only supports the information described in this manual.

1.1 Indent

▪ Features

This function is used to separate each code block. An error occurs if the indentation is not complied.

- Indentation is used to separate each code block.
- For Indentation, 2 spaces, 4 space or tab character can be used.
- For a block, same type of indentation should be used.

▪ Example

```
Code block 1
[TAB] Code block 2

Example)
if x == 3:
        y += 1


# No Error
def fnSum(x,y):
[space4]sum = x + y
[space4]return sum


# No Error
def fnSubtract(x,y):
[TAB]diff = x - y
[TAB]return diff
```

```
# Indentation error
def fnProduct(x,y):
[space4]product = x * y
[TAB]return product
```

1.2 Comment

- **Features**

This function is used to provide an additional description of the code. The comments do not affect the source code since they are excluded from code processing.

A statement following "#" is recognized as a comment. A block that begins with ”’ and ends with ”’ is recognized as a comment.

- Comment is used to provide an additional description of the code. The comments do not affect the source code since they are excluded from code processing
- A statement following "#" is recognized as a comment.
- A block that begins with ”’ and ends with ”’ is recognized as a comment.

- **Example**

```
# Comment example 1
”’
    Comment example 2
”’
```

1.3 Variable name

▪ Features

- Variable is used to express the data value and can consist of letters, numbers, and underscores (_). The first character cannot be a number.
- Letters are case sensitive.
- An error occurs if the variable name is the same as a reserved word or interpreter internal function name.

To avoid this, use the function name as using the prefix "var _", if possible.

⚠ Caution

Never use the following reserved words as variable names or function names.

and	**assert**	**break**	**class**	**continue**
def	**del**	**elif**	**else**	**except**
exec	**finally**	**for**	**from**	**global**
if	**import**	**in**	**is**	**lambda**
list	**not**	**open**	**or**	**pass**
print	**raise**	**return**	**try**	**while**
with	**yield**	**select**		

▪ Example

```
friend = 10
Friend = 1
_myFriend = None

Pass = 10 # Syntax error
movej = 0 # movej is a DRL instruction name and should not be used as a variable.
```

1.4 Numeric value

- **Features**

DRL provides numeric types such as int, float, complex number and so on.

- **Example**

```
10, 0x10, 0o10, 0b10
3.14, 314e-2
x = 3-4j

int_value = 10
hexa_value = 0x10
octa_value = 0o10
binary_value = 0b10
double_value = 3.14
double value = 314e-2
complex_value = 3-4j
```

1.5 String

1.5.1 String

▪ Features

All character strings are in Unicode.

- Escape characters

  \n: New line
  \t: Tab
  \r: Carrage return
  \0: Null string
  \\: back slash(\) in string
  \': single quote mark in string
  \": double quote mark in string

- String concatenation: "py"+ "tyon" → "python"
- String repeatition: "py"* 3 → "pypypy"
- String indexing: "python" [0] → "p"
- String slicing: "python" [1:4] → "yth"

▪ Example

```
"string1"
'string2'


tp_log("st"+"ring")
        #expected result: string
tp_log("str"* 3)
        #expected result: strstrstr
tp_log("line1₩nline2")
        #expected result: line1
        # line2
tp_log("₩"string₩"")
        #expected result: "string"
tp_log("str"[0])
        #expected result: s
```

```
tp_log("string"[1:3])
        #expected result: tr
```

1.5.2 +, *

- **Example**

```
"Doosan"+ "Robotics" ➔ "DoosanRobotics"
"Doo"* 3 ➔ "DooDooDoo"
```

1.5.3 Indexing & slicing

- **Example**

```
" Doosan" [0] ➔ "D"
" Doosan" [1:4] ➔ "oos"
```

1.6 list

- **Features**
  - The items in a list can be changed and ordered.
  - A list can be indexed and sliced.
  - append, insert, extend, and + operators
  - count, remove, and sort operators
- **Example**

```
colors = ["red", "green", "blue"]
tp_log(colors[0]+","+colors[1]+","+colors[2])
        #expected print result: red,green,blue

numbers = [1, 3, 5, 7, 9]
sum = 0
for number in numbers:
    sum += number
tp_log( str(sum) )
        #expected result: 25
```

1.7 tuple

- **Features**

Tupule is similar to a list but is faster at processing since it is read-only.

- **Example**

```
colors = ("red", "green", "blue")
numbers = (1, 3, 5, 7, 9)

def fnMinMax(numbers):
    numbers.sort()
    return (numbers[0], numbers[-1])
minmax = fnMinMax([4,1,2,9,5,7])
tp_log("Min Value= " + str(minmax[0]))
      #expected result: Min Value = 1
tp_log("Max Value= "+ str(minmax[1]))
      #expected result: Max Value = 9
```

1.8 dictionary

- **Features**

Dictionary specifies the keys and values and lists the values.

```
d = dict(a = 1, b = 3, c = 5)

colors = dict()
colors["cherry"] = "red"

ages = {'Kim':35, 'Lee':38, 'Chang':37}
tp_log("Ages of Kim = " + str(ages['Kim']))
#expected print result: Ages of Kim = 35
```

1.9 Function

▪ Features

- Declaration: A function begins with def and ends with colon (:).
- The beginning and ending of a function is specified by an indentation of the code.
- The interface and implementation are not separated. However, they must have been defined before they are used.
- An error occurs if the function name is the same as a reserved word or interpreter internal function name.

To avoid this, use the function name as using the prefix "fn_", if possible.

⚠ Caution

Never use the following reserved words as variable names or function names.

and	**assert**	**break**	**class**	**continue**
def	**del**	**elif**	**else**	**except**
exec	**finally**	**for**	**from**	**global**
if	**import**	**in**	**is**	**lambda**
list	**not**	**open**	**or**	**pass**
print	**raise**	**return**	**try**	**while**
with	**yield**	**select**		

▪ sentence

def <function name> (parameter 1, parameter 2, ... parameter N):
<syntax> ...
return <return value>

```
# Example
def fn_Times(a, b):
  return a * b

fn_Times (10, 10)

def fn_Times(a, b):
    return a * b
```

```
tp_log(str(fn_Times(10, 5)))
#expected result: 50


def movej():
    return 0    # movej should not be used as a function name as interpreter
                # internal function name.
```

1.10 Scoping rule

- **Features**

- If there is no value corresponding to the local variable name in a function, the name can be found based on the LGB rule.
  - Namespace: An area that contains the variable name
  - Local scope: A namespace and local domain inside a function
  - Global scope: Global domain outside a function
  - Built-in scope: The domain related to the contents defined by Python and an internal domain
  - LGB rule: The order of finding a variable name. local → global → built-in

- **Example**

```
# Error: can't find simple_pi in circle_area
simple_pi = 3.14
def circle_area(r):
    return r*r*simple_pi

# simple_pi should be declared as global if it is used in circle_area_ok
def circle_area_ok(r):
    global simple_pi
    return r*r*simple_pi

tp_log(str(circle_area(3.0)))
#expected result: 28.26
```

1.11 Parameter mode

- **Features**

DRL provides 3 types of parameter modes: Default parameter values, Keyword parameters and Arbitary parameters

- **Example**

```
def fn_Times(a = 10, b = 20):
 return a * b

#Example - Default parameter value
tp_log(str(fn_Times(5)))
        #expected result: 100

#Example - Keyword parameter
tp_log(str(fn_Times(b=5)))
#expected result: 50
tp_log(str(fn_Times(a=5, b=5)))
#expected result: 25

#Example - arbitary parameter
def fn_myUnion(*args):
      for arg in args:
          tp_log(str(arg))
fn_myUnion("red", 1)
        #expected print result: red
        #                       1
```

- **Example - Default parameter value**

```
def fn_Times(a = 10, b = 20)
        return a * b

fn_Times(5)
```

- **Example - Keyword parameter**

```
def fn_Times(a = 10, b = 20)
        return a * b

fn_Times(a=5, b=5)
```

- **Example - Variable parameter**

```
def fn_myUnion(*ar)
        …….

fn_myUnion("red", "white", "black")
```

1.12 pass

- **Features**

The ‘pass’ is used when an operation is not executed.

- **Example**

```
while True:
    pass #pass means empty statement, so while statement continues to run.
tp_log("This line never reached")
```

1.13 if

- **Features**

'if' is a conditional statement. It can use "elif" and "else" according to whether the condition of the "if" syntax is true or false.

- **sentense**

if <conditional statement>:
<syntax>

if <conditional statement 1>:
<Syntax 1>
elif <conditional statement 2>:
<Syntax 2>
else:
<Syntax 3>

- **Example - if, elif, else**

```
numbers = [2,5,7]
for number in numbers:
    if number%2==0:
        tp_log(str(number) + " is even")
    else:
        tp_log (str(number) + " is odd")
#expected result:
#2 is even
#5 is odd
#7 is odd
```

1.14 while

- **Features**

'while' is a conditional statement that repeats an operation according to whether the condition is true or false.

- **syntax**

while <conditional statement>:

<syntax>

- **Example**

```
sum = 0
cnt = 1
while cnt < 10:
    sum = sum+cnt
    cnt = cnt+1
tp_log("sum = " + str(sum))
#expected result:
#sum = 45
```

1.15 for

- **Features**

'for' repeats an operation within the specified repeating range.

- **syntax**

for <item> in <sequential object S>:

<syntax>

- **Example**

```
x=0
for i in range(0, 3):    # i는  0 -> 1 -> 2
    x= x + 1

sum = 0
for i in range(0, 10):
     sum = sum + i
tp_log("sum = " + str(sum))
#expected result:
#sum = 45
```

1.16 break

- **Features**

'break' is used to exit the internal block of a loop.

- **Example**

```
x =0
while True:
        x = x + 1
        if x > 10:
                break

sum = 0;cnt = 0
while True:
      if cnt > 9:
            break
      sum = sum + cnt
      cnt = cnt+1
tp_log("sum = " + str(sum))
#expected print result:
#sum = 45
```

1.17 continue

- **Features**

If 'continue' is used in a loop block, the loop stops further executing and returns to the beginning point of the loop.

- **Example**

```
#<ex> 1
x=0
y=0
while True:
        x = x + 1
        if x > 10:
                continue
        y += 100

#<ex> 2
sum = 0
for i in range(0, 10):
      if i%2==0:
            continue
      sum = sum + i
tp_log("sum of odd numbers = " + str(sum))
#sum of odd numbers = 25
```

1.18 Else in a loop

- **Features**

The "else" block is executed when the loop is executed until the end without being terminated by the "break" function in the middle of executing a loop.

- **Example**

```
L = { 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 }

for i in L:
        if i % 2 == 0:
                continue
else:
        tp_log("exit without break")
```

2. Motion-related Commands

2.1 posj(q1=0, q2=0, q3=0, q4=0, q5=0, q6=0)

- **Features**

This function designates the joint space angle in coordinate values.

- **Parameters**

No.	Data Type	Default Value	Description
q1	float list posj	0	1-axis angle or angle list or posj
q2	float	0	2-axis angle
q3	float	0	3-axis angle
q4	float	0	4-axis angle
q5	float	0	5-axis angle
q6	float	0	6-axis angle

- **Return**

posj

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred

- **Example**

```
q1 = posj()                         # q1=posj(0,0,0,0,0,0)
q2 = posj(0, 0, 90, 0, 90, 0)
q3 = posj([0, 30, 60, 0, 90, 0])    # q3=posj(0,30,60,0,90,0)
```

- **Related commands**

movej()/amovej()/movesj()/amovesj()

2.2 posx(x=0, y=0, z=0, w=0, p=0, r=0)

- **Features**

This function designates the task space in coordinate values.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
x	float list posx	0	x position or position list or posx
y	float	0	y position
z	float	0	z position
w	float	0	w orientation (z-direction rotation of reference coordinate system)
p	float	0	p orientation (y-direction rotation of w rotated coordinate system)
r	float	0	r orientation (z-direction rotation of w and p rotated coordinate system)

- **Return**

posx

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred

- **Example**

```
movej([0,0,90,0,90,0], v=10, a=20)
x2 = posx(400, 300, 500, 0, 180, 0)
x3 = posx([350, 350, 450, 0, 180, 0])      #x3=posx(350, 350, 450, 0, 180, 0)
x4 = posx(x2)                              #x4=posx(400, 300, 500, 0, 180, 0)
movel(x2, v=100, a=200)
```

- **Related commands**

movel()/movec()/movejx()/amovel()/amovec()/amovejx()

2.3 trans(pos, delta, ref, ref_out)

▪ Features

- Input parameter(pos) based on the ref coordinate is translated/rotated as delta based on the same coordinate and this function returns the result that is converted to the value based on the ref_out coordinate.
- In case that the ref coordinate is the tool coordinate, this function retuns the value based on input parameter(pos)'s coordinate without ref_out coordinate.

▪ Parameters

Parameter Name	Data Type	Default Value	Description
pos	posx list (float[6])	-	posx or position list
delta	posx list (float[6])	-	posx or position list
ref	int	None	reference coordinate ・ DR_BASE : base coordinate ・ DR_WORLD : world coordinate ・ DR_TOOL : tool coordinate ・ user coordinate : user defined
ref_out	int	DR_BASE	reference coordinate ・ DR_BASE : base coordinate ・ DR_WORLD : world coordinate ・ user coordinate : user defined

▪ Return

Value	Description
posx list (float[6])	task space point

▪ Exception

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
p0 = posj(0,0,90,0,90,0)
movej(p0, v=30, a=30)

x1 = posx(200, 200, 200, 0, 180, 0)
delta = [100, 100, 100, 0, 0, 0]
x2 = trans(x1, delta, DR_BASE, DR_BASE)

x1_base = posx(500, 45, 700, 0, 180, 0)
x4 = trans(x1_base, [10, 0, 0, 0, 0, 0], DR_TOOL)
movel(x4, v=100, a=100, ref=DR_BASE)

uu1 = [1, 1, 0]
vv1 = [-1, 1, 0]
pos = posx(559, 34.5, 651.5, 0, 180.0, 0)
DR_userTC1 = set_user_cart_coord(uu1, vv1, pos) #user defined coordinate system
x1_userTC1 = posx(30, 20, 100, 0, 180, 0)            #posx on user coordinate system
x9 = trans(x1_userTC1, [0, 0, 50, 0, 0, 0], DR_userTC1, DR_BASE)
movel(x9, v=100, a=100, ref=DR_BASE)
```

- **Related commands**

posx()/addto()

2.4 posb(seg_type, posx1, posx2=None, radius=0)

▪ Features

- Input parameters for constant-velocity blending motion (moveb and amoveb) with the Posb coordinates of each waypoint and the data of the unit path type (line or arc) define the unit segment object of the trajectory to be blended.
- Only posx1 is inputted if seg_type is a line (DR_LINE), and posx2 is also inputted if seg_type is a circle (DR_CIRCLE). Radius sets the blending radius with the continued segment.

▪ Parameters

Parameter Name	Data Type	Default Value	Description
seg_type	Int	-	DR_LINE DR_CIRCLE
posx1	posx	-	1st task posx
posx2	posx	-	2nd task posx
radius	float	0	Blending radius [mm]

▪ Return

posb

▪ Exception

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred

▪ Example

```
q0 = posj(0, 0, 90, 0, 90, 0)
movej(q0,vel=30,acc=60)
x0 = posx(564,    34, 690, 0, 180, 0)
movel(x0, vel=200, acc=400)       # Moves to the start position.

x1 = posx(564, 200, 690, 0, 180, 0)
seg1 = posb(DR_LINE, x1, radius=40)
x2 = posx(564, 100, 590, 0, 180, 0)
x2c = posx(564, 200, 490, 0, 180, 0)
seg2 = posb(DR_CIRCLE, x2, x2c, radius=40)
x3 = posx(564, 300, 490, 0, 180, 0)
seg3 = posb(DR_LINE, x3, radius=40)
x4 = posx(564, 400, 590, 0, 180, 0)
```

```
x4c = posx(564, 300, 690, 0, 180, 0)
seg4 = posb(DR_CIRCLE, x4, x4c, radius=40)
x5 = posx(664, 300, 690, 0, 180, 0)
seg5 = posb(DR_LINE, x5, radius=40)
x6 = posx(564, 400, 690, 0, 180, 0)
x6c = posx(664, 500, 690, 0, 180, 0)
seg6 = posb(DR_CIRCLE, x6, x6c, radius=40)
x7 = posx(664, 400, 690, 0, 180, 0)
seg7 = posb(DR_LINE, x7, radius=40)
x8 = posx(664, 400, 590, 0, 180, 0)
x8c = posx(564, 400, 490, 0, 180, 0)
seg8 = posb(DR_CIRCLE, x8, x8c, radius=0)          # The last radius must be 0.
        # If not 0, it is processed as 0.

b_list = [seg1, seg2, seg3, seg4, seg5, seg6, seg7, seg8]

moveb(b_list, vel=200, acc=400)
```

- **Related commands**

posx()/moveb()/amoveb()

2.5 fkin(pos, ref)

- **Features**

This function receives the input data of joint angles or equivalent forms (float[6]) in the joint space and returns the TCP (objects in the task space) based on the ref coordinate.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
pos	posj list (float[6])	-	posj or position list
ref	int	DR_BASE	reference coordinate ・ DR_BASE : base coordinate ・ DR_WORLD : world coordinate

- **Return**

Value	Description
posx	Task space point

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred

Exception	Description
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred

- **Example**

```
q1 = posj(0, 0, 90, 0, 90, 0)
movej(q1,v=10,a=20)
q2 = posj(30, 0, 90, 0, 90, 0)
x2 = fkin(q2, DR_WORLD)
# x2: Space coordinate at the edge of the robot (TCP) corresponding to joint value q2
movel(x2,v=100,a=200,ref=DR_WORLD)          # Linear motion to x2
```

- **Related commands**

set_tcp() # The tcp data of the name registered in the teach pendant (TP) is reflected during an fkin operation.
posj()/posx()

2.6 ikin(pos, sol_space, ref)

▪ Features

This function returns the joint position corresponding to sol_space, which is equivalent to the robot pose in the operating space, among 8 joint shapes.

▪ Parameters

Parameter Name	Data Type	Default Value	Description
pos	posx list (float[6])	-	posx or position list
sol_space	int	-	solution space
ref	int	DR_BASE	reference coordinate · DR_BASE : base coordinate · DR_WORLD : world coordinate

▪ Robot configuration vs. solution space

Solution space	Binary	Shoulder	Elbow	Wrist
0	000	Lefty	Below	No Flip
1	001	Lefty	Below	Flip
2	010	Lefty	Above	No Flip
3	011	Lefty	Above	Flip
4	100	Righty	Below	No Flip
5	101	Righty	Below	Flip
6	110	Righty	Above	No Flip
7	111	Righty	Above	Flip

▪ Return

Value	Description
posj	Joint space point

▪ Exception

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred

Exception	Description
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
x1 = posx(370.9, 719.7, 651.5, 90, -180, 0)
q1 = ikin(x1, 2)     # Joint angle q1 where the coordinate of the robot edge is x1 (second of 8 cases)
                     # q1=posj(60.3, 81.0, -60.4, -0.0, 159.4, -29.7) (M1013, tcp=(0,0,0))
movej(q1,v=10,a=20)
```

- **Related commands**

set_tcp()/posj()/posx()

2.7 addto(pos, add_val=None)

- **Features**

This function creates a new posj object by adding add_val to each joint value of posj.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
pos	posj list (float[6])	-	posj or position list
add_val	list (float[6])	None	List of add values to be added to the position * No value is added if it is None or [].

- **Return**

Value	Description
posj	Joint space point

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid

- **Example**

```
q1 = posj(10, 20, 30, 40, 50, 60)
movej (q1, v=10, a=20)
q2 = addto(q1, [0, 0, 0, 0, 45, 0])
movej (q2, v=10, a=20)  # The robot moves to the joint (10, 20, 30, 40, 95, 60).
q3 = addto(q2, [])
q4 = addto(q3)
```

- **Related commands**

posj()

2.8 set_velj(vel)

- **Features**

This function sets the global velocity in joint motion (movej, movejx, amovej, or amovejx) after using this command. The default velocity is applied to the globally set vel if movej() is called without the explicit input of the velocity argument.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
vel	float	-	velocity (same to all axes) or
	list (float[6])		velocity (to an axis)

- **Return**

Value	Description
0	Success

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred

- **Example**

```
#1
Q1 = posj(0,0,90,0,90,0)
Q2 = posj(0,0,0,0,90,0)
movej(Q1, vel=10, acc=20)
set_velj(30)        # The global joint velocity is set to 30 (deg/sec).
set_accj(60)        # The global joint acceleration is set to 60 (deg/sec^2). [See set_accj().]
movej(Q2)           # The joint motion velocity to Q2 is 30 (deg/sec) which is the global velocity.
movej(Q1, vel=20, acc=40)# The joint motion velocity to Q1 is 20 (deg/sec) which is the specified
velocity.
#2
set_velj(20.5)      # Decimal point input is possible.
set_velj([10, 10, 20, 20, 30, 10])        # The global velocity can be specified to each axis.
```

- **Related commands**

set_accx()/movej()/movejx()/movesj()amovej()/amovejx()/amovesj()

2.9 set_accj(acc)

- **Features**

This function sets the global velocity in joint motion (movej, movejx, amovej, or amovejx) after using this command. The globally set acceleration is applied as the default acceleration if movej() is called without the explicit input of the acceleration argument.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
acc	float	-	acceleration (same to all axes) or
	list (float[6])		acceleration (acceleration to an axis)

- **Return**

Value	Description
0	Success

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred

- **Example**

```
#1
Q1 = posj(0,0,90,0,90,0)
Q2 = posj(0,0,0,0,90,0)
movej(Q1, vel=10, acc=20)
set_velj(30)       # The global joint velocity is set to 30 (deg/sec). [See set_velj().]
set_accj(60)       # The global joint acceleration is set to 60 (deg/sec^2).
movej(Q2)          # The joint motion acceleration to Q2 is 60(deg/sec^2) which is the global acceleration.
movej(Q1, vel=20, acc=40) # The joint motion acceleration to Q1 is 40(deg/sec^2) which is the specified
acceleration.
#2
set_accj(30.55)
set_accj([30, 40, 30, 30, 30, 10])
```

- **Related commands**

set_velj()/movej()/movejx()/movesj()/amovej()/amovejx()amovesj()

2.10 set_velx(vel1, vel2)

- **Features**

This function sets the velocity of the task space motion globally. The globally set velocity velx is applied as the default velocity if the task motion such as movel(), amovel(), movec(), movesx() is called without the explicit input of the velocity value. In the set value, vel1 and vel2 define the linear velocity and rotating velocity, relatively, of TCP.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
vel1	float	-	velocity 1
vel2	float	-	velocity 2

- **Return**

Value	Description
0	Success

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred

- **Example**

```
<#1>
P0 = posj(0,0,90,0,90,0)
movej(P0)
P1 = posx(400,500,800,0,180,0)
P2 = posx(400,500,500,0,180,0)
movel(P1, vel=10, acc=20)
set_velx(30,20)      # The global task velocity is set to 30(mm/sec) and 20(deg/sec).
set_accx(60,40)      # The global task acceleration is set to 60(mm/sec2) and
40(deg/sec2).
movel(P2)                              # The task motion velocity to P2 is 30(mm/sec) and
20(deg/sec) which are the global velocity.
movel(P1, vel=20, acc=40)          # The task motion velocity to P1 is 20(mm/sec) and
20(deg/sec) which are the specified velocity.
<#2
set_velx(10.5, 19.4)       # Decimal point input is possible.
```

- **Related commands**

set_accx()/movel()/movec()/movesx()/moveb()/move_spiral()/amovel()/amovec()/ amovesx()/amoveb()/amove_spiral()

2.11 set_velx(vel)

- **Features**

This function sets the linear velocity of the task space motion globally. The globally set velocity vel is applied as the default velocity if the task motion such as movel(), amovel(), movec(), movesx() is called without the explicit input of the velocity value. The set value vel defines the linear velocity of the TCP while the rotating velocity of the TCP is determined proportionally to the linear velocity.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
vel	float	-	velocity

- **Return**

Value	Description
0	Success

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred

- **Example**

```
#1
p0 = posj(0,0,90,0,90,0)
movej(p0)

P1 = posx(400,500,800,0,180,0)
P2 = posx(400,500,500,0,180,0)
movel(P1, vel=10, acc=20)
set_velx(30)     # The global task velocity is set to 30 (mm/sec). The global task angular velocity is automatically determined.
set_accx(60)    # The global task acceleration is set to 60 (mm/sec2). The global task angular acceleration is automatically determined.
movel(P2)        # The task motion linear velocity to P2 is 30(mm/sec) which is the global velocity.
movel(P1, vel=20, acc=40)          # The task motion linear velocity to P1 is 20(mm/sec) which is the specified velocity.
#2
set_velx(10.5)  # Decimal point input is possible.
```

- **Related commands**

set_accx()/movel()/movec()/movesx()/moveb()/move_spiral()/amovel()/amovec()/amovesx()/amoveb()/amove_spiral()

2.12 set_accx(acc1, acc2)

- **Features**

This function sets the acceleration of the task space motion globally. The globally set acceleration accx is applied as the default acceleration if the task motion such as movel(), amovel(), movec(), movesx() is called without the explicit input of the acceleration value. In the set value, acc1 and acc2 define the linear acceleration and rotating acceleration, relatively, of the TCP.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
acc1	float	-	acceleration 1
acc2	float	-	acceleration 2

- **Return**

Value	Description
0	Success

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred

- **Example**

```
P0 = posj(0,0,90,0,90,0)
movej(P0)
P1 = posx(400,500,800,0,180,0)
P2 = posx(400,500,500,0,180,0)
movel(P1, vel=10, acc=20)
set_velx(30,20)    # The global task velocity is set to 30(mm/sec) and 20(deg/sec).
set_accx(60,40)              # The global task acceleration is set to 60(mm/sec2) and
40(deg/sec2).
movel(P2)        # The task motion acceleration to P2 is 60(mm/sec2) and 40(deg/sec2)
which is the global acceleration.
movel(P1, vel=20, acc=40)          # The task motion acceleration to P1 is 40(mm/sec)
and 40(deg/sec2) which is the specified acceleration.
```

- **Related commands**

set_velx()/movel()/movec()movesx()/moveb()/move_spiral()/amovel()/amovec()/amovesx()/amoveb()/amove_spiral()

2.13 set_accx(acc)

- **Features**

This function sets the linear acceleration of the task space motion globally. The globally set acceleration acc is applied as the default acceleration if the task motion such as movel(), amovel(), movec(), movesx() is called without the explicit input of the acceleration value. The set value acc defines the linear acceleration of the TCP while the rotating acceleration of the TCP is determined proportionally to the linear acceleration.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
acc	float	-	acceleration

- **Return**

Value	Description
0	Success

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred

- **Example**

```
P0 = posj(0,0,90,0,90,0)
movej(P0)
P1 = posx(400,500,800,0,180,0)
P2 = posx(400,500,500,0,180,0)
movej(P0, vel=10, acc=20)
movel(P1, vel=10, acc=20)
set_velx(30)          # The global task velocity is set to 30 (mm/sec). The global task angular velocity is automatically determined.
set_accx(60)          # The global task acceleration is set to 60 (mm/sec^2). The global task angular acceleration is automatically determined.
movel(P2)             # The task motion linear acceleration to P2 is 60(mm/sec^2) which is the global acceleration.
movel(P1, vel=20, acc=40)      # The task motion linear acceleration to P1 is 40(mm/sec^2) which is the specified acceleration.
```

- **Related commands**

set_velx()/movel()/movec()movesx()/moveb()/move_spiral()/amovel()/amovec()/amovesx()/amoveb()/amove_spiral()

2.14 set_tcp(name)

- **Features**

This function calls the name of the TCP registered in the Teach Pendant and sets it as the current TCP.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
name	string	-	Name of the TCP registered in the TP.

- **Return**

Value	Description
0	Success
Negative value	Failed

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
P0 = posj(0,0,90,0,90,0)
movej(P0)
set_tcp("tcp1") # The TCP data registered as tcp1 in the TP is called and set to the current TCP value.
P1 = posx(400,500,800,0,180,0)
movel(P1, vel=10, acc=20)          # Moves the recognized center of the tool to the P1 position.
```

- **Related commands**

fkin()/ikin()/movel()/movejx()/movec()/movesx()/moveb()/amovel()/amovejx()/ amovec()/amovesx()/amoveb()

2.15 set_ref_coord(coord)

- **Features**

This function sets the reference coordinate system.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
coord	int	-	Reference coordinate system · DR_BASE: Base Coordinate · DR_WORLD: World Coordinate · DR_TOOL: Tool Coordinate · user Coordinate: User defined

- **Return**

Value	Description
0	Success
Negative value	Failed

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
p0 = posj(0,0,90,0,90,0)
movej(p0, v=30, a=30)
x1 = posx(370.9, 419.7, 651.5, 90,-180,0)
movel(x1, v=100, a=100)    # Base Coordinate basis
uu1 = [-1, 1, 0] # x-axis vector of the user coordinate system (base coordinate basis)
vv1 = [1, 1, 0]   # y-axis vector of the user coordinate system (base coordinate basis)
pos = posx(370.9, -419.7, 651.5, 0, 0, 0)    # Origin point of the user coordinate system
DR_USER1 = set_user_cart_coord(uu1, vv1, pos)      # Sets the user coordinate
system.
set_ref_coord(DR_USER1)          # Sets DR_USER1 of the user coordinate system to
the global coordinate system.
movel([0,0,0,0,0,0],v=100,a=100)# The global coordinate system is used if the
```

```
reference coordinate system is not specified.
                                        # Moves to the origin point and direction of the
DR_USER1 coordinate system.
movel([0,200,0,0,0,0],v=100,a=100)    # Moves to the (0,200,0) point of the DR_USER1
coordinate system.
```

- **Related commands**

fkin()/ikin()/movel()/movejx()/movec()/movesx()/moveb()/amovel()/amovejx()/ amovec()/amovesx()/amoveb()

2.16 movej

▪ Features

The robot moves to the target joint position (pos) from the current joint position.

▪ Parameters

Parameter Name	Data Type	Default Value	Description
pos	posj	-	posj or
	list (float[6])		joint angle list
vel (v)	float	None	velocity (same to all axes) or
	list (float[6])	None	velocity (to an axis)
acc (a)	float	None	acceleration (same to all axes) or
	list (float[6])	None	acceleration (acceleration to an axis)
time (t)	float	None	Reach time [sec]
radius (r)	float	None	Radius for blending
mod	int	DR_MV_MOD_ABS	Movement basis · DR_MV_MOD_ABS: Absolute · DR_MV_MOD_REL: Relative
ra	int	DR_MV_RA_DUPLICATE	Reactive motion mode · DR_MV_RA_DUPLICATE: duplicate · DR_MV_RA_OVERRIDE: override

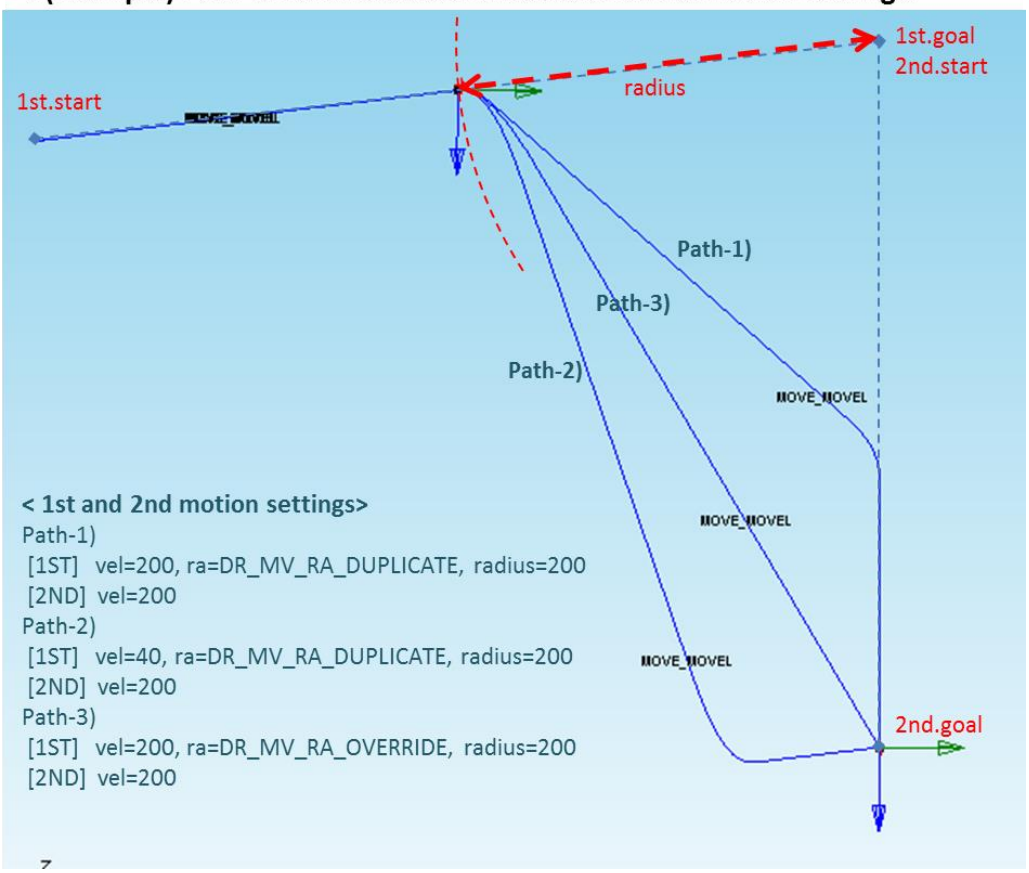
Note

- Abbreviated parameter names are supported. (v:vel, a:acc, t:time, r:radius)
- _global_velj is applied if vel is None. (The initial value of _global_velj is 0.0 and can be set by set_velj.)
- _global_accj is applied if acc is None. (The initial value of _global_accj is 0.0 and can be set by set_accj.)
- If the time is specified, values are processed based on time, ignoring vel and acc.
- If the time is None, it is set to 0.
- If the radius is None, it is set to the blending radius in the blending section and 0 otherwise.

Caution

If the following motion is blended with the conditions of ra=DR_MV_RA_DUPLICATE and radius>0, the preceding motion can be terminated when the following motion is terminated while the remaining motion time determined by the remaining distance, velocity, and acceleration of the preceding motion is greater than the motion time of the following motion. Refer to the following image for more information.

< (Example) Path differences accord. to 1st and 2nd motion settings>



- **Return**

Value	Description
0	Success
Negative value	Failed

Exception

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

Example

```
Q1 = posj(0,0,90,0,90,0)
Q2 = posj(0,0,0,0,90,0)
movej(Q1, vel=10, acc=20)
        # Moves to the Q1 joint angle at the velocity of 10(deg/sec) and acceleration of
        20(deg/sec2).
movej(Q2, time=5)
        # Moves to the Q2 joint angle with a reach time of 5 sec.
movej(Q1, v=30, a=60, r=200)
        # Moves to the Q1 joint angle and is set to execute the next motion
        # when the distance from the Q1 space position is 200mm.
movej(Q2, v=30, a=60, ra= DR_MV_RA_OVERRIDE)
        # Immediately terminates the last motion and blends it to move to the Q2 joint
        angle.
```

Related commands

posj()/set_velj()/set_accj()/amovej()

2.17 movel

- **Features**

The robot moves along the straight line to the target position (pos) within the task space.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
pos	posx list (float[6])	-	posx or position list
vel (v)	float list (float[2])	None None	velocity or velocity1, velocity2
acc (a)	float list (float[2])	None None	acceleration or acceleration1, acceleration2
time (t)	float	None	Reach time [sec] * If the time is specified, values are processed based on time, ignoring vel and acc.
radius (r)	float	None	Radius for blending
ref	int	None	reference coordinate ・ DR_BASE: base coordinate ・ DR_WORLD: world coordinate ・ DR_TOOL: tool coordinate ・ user coordinate: User defined
mod	int	DR_MV_MOD_ABS	Movement basis ・ DR_MV_MOD_ABS: Absolute ・ DR_MV_MOD_REL: Relative
ra	int	DR_MV_RA_DUPLICATE	Reactive motion mode ・ DR_MV_RA_DUPLICATE: duplicate ・ DR_MV_RA_OVERRIDE: override
app_type	int	DR_MV_APP_NONE	Application mode ・ DR_MV_APP_NONE: No application related ・ DR_MV_APP_WELD: Welding application related

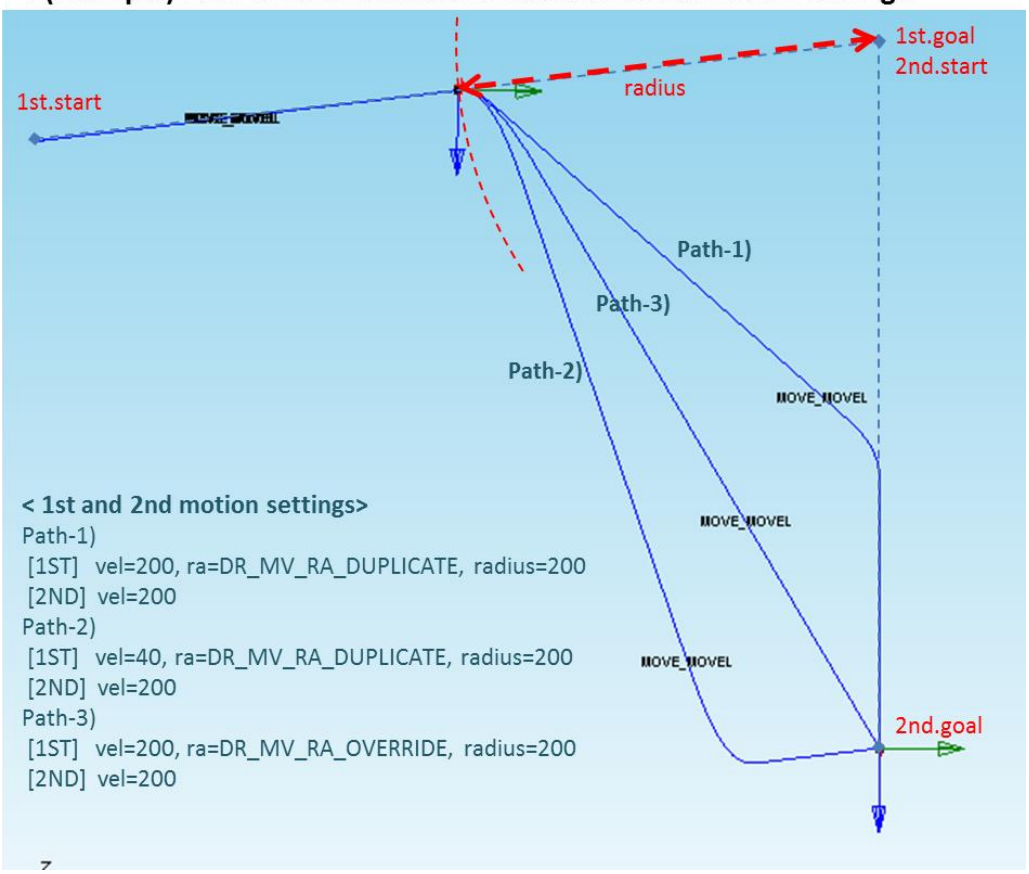
Note

- Abbreviated parameter names are supported. (v:vel, a:acc, t:time, r:radius)
- _global_velx is applied if vel is None. (The initial value of _global_velx is 0.0 and can be set by set_velx.)
- _global_accx is applied if acc is None. (The initial value of _global_accx is 0.0 and can be set by set_accx.)
- If an argument is inputted to vel (e.g., vel=30), the input argument corresponds to the linear velocity of the motion while the angular velocity is determined proportionally to the linear velocity.
- If an argument is inputted to acc (e.g., acc=60), the input argument corresponds to the linear acceleration of the motion while the angular acceleration is determined proportionally to the linear acceleration.
- If the time is specified, values are processed based on time, ignoring vel and acc.
- If the time is None, it is set to 0.
- If the radius is None, it is set to the blending radius in the blending section and 0 otherwise.
- _g_coord is applied if the ref is None. (The initial value of _g_coord is DR_BASE, and it can be set by the set_ref_coord command.)
- If 'app_type' is 'DR_MV_APP_WELD', parameter 'vel' is internally replaced by the speed setting entered in app_weld_set_weld_cond(), not the input value of 'vel'.

Caution

If the following motion is blended with the conditions of ra=DR_MV_RA_DUPLICATE and radius>0, the preceding motion can be terminated when the following motion is terminated while the remaining motion time determined by the remaining distance, velocity, and acceleration of the preceding motion is greater than the motion time of the following motion. Refer to the following image for more information.

< (Example) Path differences accord. to 1st and 2nd motion settings>



- **Return**

Value	Description
0	Success
Negative value	Failed

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
P0 = posj(0,0,90,0,90,0)
movej(P0, v=30, a=30)
P1 = posx(400,500,800,0,180,0)
P2 = posx(400,500,500,0,180,0)
P3 = posx(30,30,30,0,0,0)
movel(P1, vel=30, acc=100)
        # Moves to the P1 position with a velocity of 30(mm/sec) and acceleration of
        100(mm/sec2).
movel(P2, time=5)
        # Moves to the P2 position with a reach time of 5 sec.
movel(P3, time=5, ref=DR_TOOL, mod=DR_MV_MOD_REL)
        # Moves the robot from the start position to the relative position of P3 in the tool
        coordinate system
        # with a reach time of 5 sec.
movel(P2, time=5, r=10)
        # Moves the robot to the P2 position with a reach time of 5 seconds,
        # and the next motion is executed when the distance from the P2 position is
        10mm.
```

- **Related commands**

posx()/set_velx()/set_accx()/set_tcp()/set_ref_coord()/amovel()

2.18 movejx

▪ Features

The robot moves to the target position (pos) within the joint space.

Since the target position is inputted as a posx form in the task space, it moves in the same way as movel. However, since this robot motion is performed in the joint space, it does not guarantee a linear path to the target position. In addition, one of 8 types of joint combination (robot configurations) corresponding to the task space coordinate system (posx) must be specified in sol (solution space).

▪ Parameters

Parameter Name	Data Type	Default Value	Description
pos	posx list (float[6])	-	posx or position list
vel (v)	float list (float[6])	None None	velocity (same to all axes) or velocity (to an axis)
acc (a)	float list (float[6])	None None	acceleration (same to all axes) or acceleration (acceleration to an axis)
time (t)	float	None	Reach time [sec]
radius (r)	float	None	Radius for blending
ref	int	None	reference coordinate ・ DR_BASE: base coordinate ・ DR_WORLD: world coordinate ・ DR_TOOL: tool coordinate ・ user coordinate: User defined
mod	int	DR_MV_MOD_ABS	Movement basis ・ DR_MV_MOD_ABS: Absolute ・ DR_MV_MOD_REL: Relative
ra	int	DR_MV_RA_DUPLICATE	Reactive motion mode ・ DR_MV_RA_DUPLICATE: duplicate ・ DR_MV_RA_OVERRIDE: override
sol	int	0	Solution space

Note

- Abbreviated parameter names are supported. (v:vel, a:acc, t:time, r:radius)
- _global_velj is applied if vel is None. (The initial value of _global_velj is 0.0 and can be set by set_velj.)
- _global_accj is applied if acc is None. (The initial value of _global_accj is 0.0 and can be set by set_accj.)
- If the time is specified, values are processed based on time, ignoring vel and acc.
- If the time is None, it is set to 0.
- If the radius is None, it is set to the blending radius in the blending section and 0 otherwise.
- _g_coord is applied if the ref is None. (The initial value of _g_coord is DR_BASE, and it can be set by the set_ref_coord command.)
- Using the blending in the preceding motion generates an error in the case of input with relative motion (mod=DR_MV_MOD_REL), and it is recommended to blend using movej() or movel().
- Refer to the description of movej() and movel() for blending according to option ra and vel/acc.

Robot configuration (shape vs. solution space)

Solution space	Binary	Shoulder	Elbow	Wrist
0	000	Lefty	Below	No Flip
1	001	Lefty	Below	Flip
2	010	Lefty	Above	No Flip
3	011	Lefty	Above	Flip
4	100	Righty	Below	No Flip
5	101	Righty	Below	Flip
6	110	Righty	Above	No Flip
7	111	Righty	Above	Flip

Return

Value	Description
0	Success
Negative value	Error

Exception

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

Example

```
P0 = posj(0,0,90,0,90,0)
movej(P0, v=30, a=30)
P1 = posx(400,500,800,0,180,0)
P2 = posx(400,500,500,0,180,0)
movel(P2, vel=100, acc=200)            # Linear movement to P2
X_tmp, sol_init = get_current_posx()     # Obtains the current solution space from the P2 position
movejx(P1, vel=30, acc=60, sol=sol_init)
        # Moves to the joint angle with a velocity and acceleration of 30(deg/sec) and
        60(deg/sec^2), respectively,
        # when the TCP edge is the P1 position (maintaining the solution space in the last P2
        position)
movejx(P2, time=5, sol=2)
        # Moves to the joint angle with a reach time of 5 sec when the TCP edge is at the P2
        position
        # (forcefully sets a solution space to 2)
movejx(P1, vel=[10, 20, 30, 40, 50, 60], acc=[20, 20, 30, 30, 40, 40], radius=100, sol=2)
        # Moves the robot to the joint angle when the TCP edge is at the P1 position,
        # and the next motion is executed when the distance from the P2 position is 100mm.
movejx(P2, v=30, a=60, ra= DR_MV_RA_OVERRIDE, sol=2)
        # Immediately terminates the last motion and blends it to move to the joint angle
        # when the TCP edge is at the P2 position.
```

Related commands

posx()/set_velj()/set_accj()/get_current_posx()/amovejx()

2.19 movec

▪ Features

The robot moves along an arc to the target pos (pos2) via a waypoint (pos1) or to a specified angle from the current position in the task space.

▪ Parameters

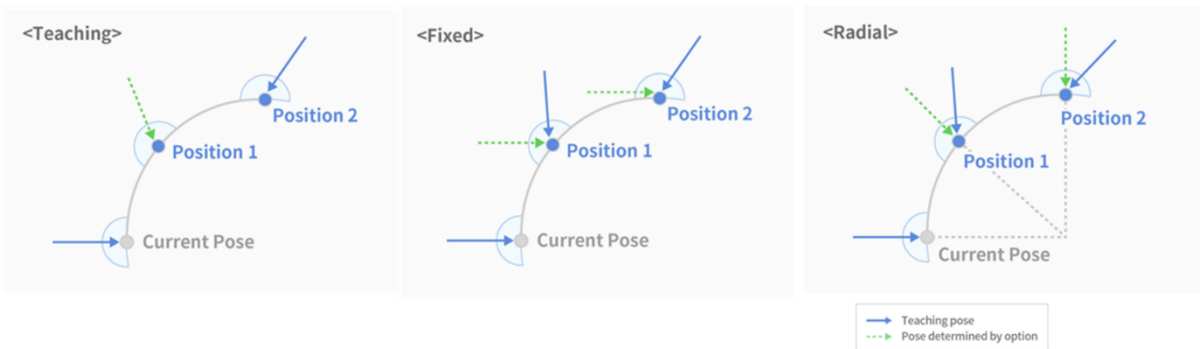
Parameter Name	Data Type	Default Value	Description
pos	posj list (float[6])	-	posx or position list
pos2	posx list (float[6]		posx or position list
vel (v)	float list (float[2])	None None	velocity or velocity1, velocity2
acc (a)	float list (float[2])	None None	acceleration or acceleration1, acceleration2
time (t)	float	None	Reach time [sec]
radius (r)	float	None	Radius for blending
ref	int	None	reference coordinate ・ DR_BASE: base coordinate ・ DR_WORLD: world coordinate ・ DR_TOOL: tool coordinate ・ user coordinate: User defined
mod	int	DR_MV_MOD_ABS	Movement basis ・ DR_MV_MOD_ABS: Absolute ・ DR_MV_MOD_REL: Relative
angle (an)	float list (float[2])	None	angle or angle1, angle2
ra	int	DR_MV_RA_DUPLICATE	Reactive motion mode ・ DR_MV_RA_DUPLICATE: duplicate ・ DR_MV_RA_OVERRIDE: override
ori	int	DR_MV_ORI_TEACH	Orientation mode

Parameter Name	Data Type	Default Value	Description
			• DR_MV_ORI_TEACH: orientation changes continuously from the initial to the final taught value • DR_MV_ORI_FIXED: orientation holds with the initial orientation • DR_MV_ORI_RADIAL: orientation changes radially from the initial.
app_type	int	DR_MV_APP_NONE	Application mode • DR_MV_APP_NONE: No application related • DR_MV_APP_WELD: Welding application related

Note

- Abbreviated parameter names are supported. (v:vel, a:acc, t:time, r:radius, angle:an)
- _global_velx is applied if vel is None. (The initial value of _global_velx is 0.0 and can be set by set_velx.)
- _global_accx is applied if acc is None. (The initial value of _global_accx is 0.0 and can be set by set_accx.)
- If an argument is inputted to vel (e.g., vel=30), the input argument corresponds to the linear velocity of the motion while the angular velocity is determined proportionally to the linear velocity.
- If an argument is inputted to acc (e.g., acc=60), the input argument corresponds to the linear acceleration of the motion while the angular acceleration is determined proportionally to the linear acceleration.
- If the time is specified, values are processed based on time, ignoring vel and acc.
- If the time is None, it is set to 0.
- If the radius is None, it is set to the blending radius in the blending section and 0 otherwise.
- _g_coord is applied if the ref is None. (The initial value of _g_coord is DR_BASE, and it can be set by the set_ref_coord command.)
- If the mod is DR_MV_MOD_REL, pos1 and pos2 are defined in the relative coordinate system of the previous pos. (pos1 is the relative coordinate from the starting point while pos2 is the relative coordinate from pos1.)
- If the angle is None, it is set to 0.
- If only one angle is inputted, the total rotated angle on the circular path is applied to the angle.
- If two angle values are inputted, angle1 refers to the total rotating angle moving at a constant velocity on the circular path while angle2 refers to the rotating angle in the rotating section for acceleration and deceleration. In that case, the total moving angle angle1 + 2 X angle2 moves along the circular path.
- If 'app_type' is 'DR_MV_APP_WELD', parameter 'vel' is internally replaced by the speed setting entered in app_weld_set_weld_cond(), not the input value of 'vel'.
- 'ori'(orientation mode) is defined as below.
  a) DR_MV_ORI_TEACH(orientation based on teaching) : From the inital pose to the taught pose, Pose 2, orientation changes to the distance of travel. The orientation of the taught pose, 'pose 1' is ignored.
  b) DR_MV_ORI_FIXED(fixed orientation) : Move along the path while maintaining the initial orientation up to the taught pose, 'pose2'.

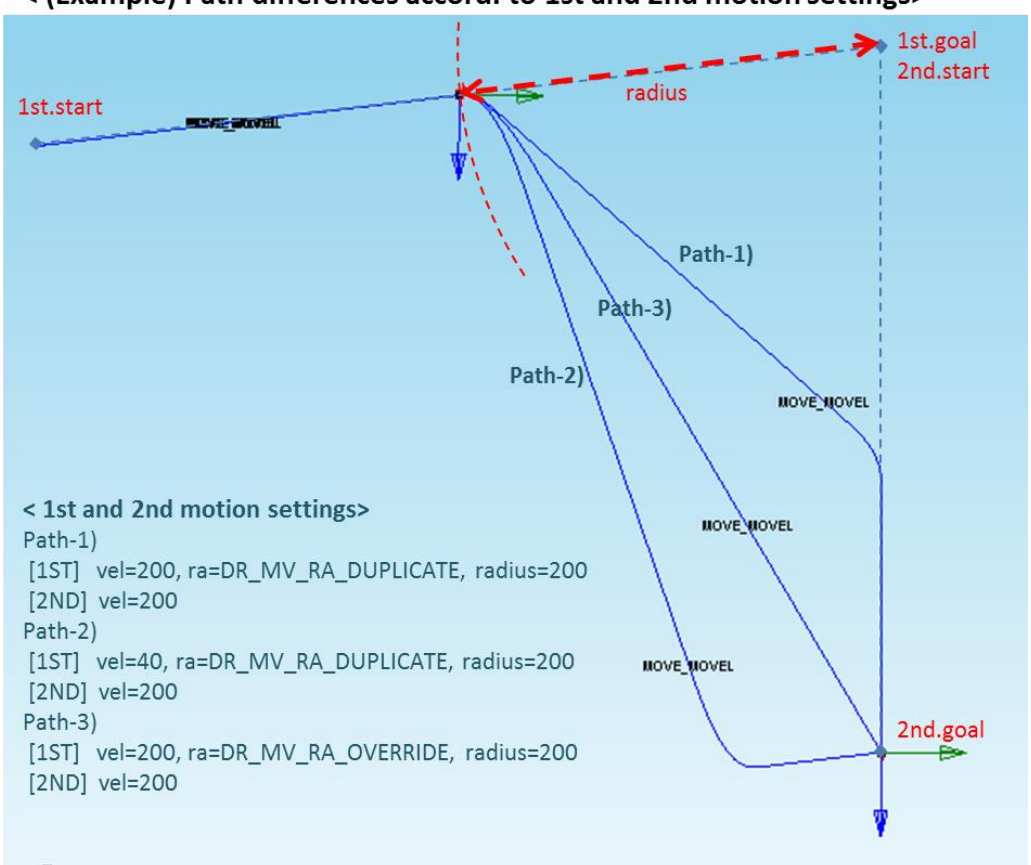
c) DR_MV_ORI_RADIAL(orientation constrained radially) : Move along the path while maintaining radial orientation at the initial pose to the 'pose 2'.



Caution

If the following motion is blended with the conditions of ra=DR_MV_RA_DUPLICATE and radius>0, the preceding motion can be terminated when the following motion is terminated while the remaining motion time determined by the remaining distance, velocity, and acceleration of the preceding motion is greater than the motion time of the following motion. Refer to the following image for more information.

< (Example) Path differences accord. to 1st and 2nd motion settings>



Return

Value	Description
0	Success
Negative value	Error

Exception

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

Example

```
#1
P0 = posj(0,0,90,0,90,0)
movej(P0)
set_velx(30,20)   # Set the global task velocity to 30(mm/sec) and 20(deg/sec).
set_accx(60,40)  # Set the global task acceleration to 60(mm/sec^2) and 40(deg/sec^2).

P1 = posx(400,500,800,0,180,0)
P2 = posx(400,500,500,0,180,0)
P3 = posx(100, 300, 700, 45, 0, 0)
P4 = posx(500, 400, 800, 45, 45, 0)

movec(P1, P2, vel=30)
# Moves to P2 with a velocity of 30(mm/sec) and global acceleration of 60(mm/sec^2)
# via P1 along the arc trajectory.
movej(P0)
movec(P3, P4, vel=30, acc=60)
# Moves to P4 with a velocity of 30(mm/sec) and acceleration of 60(mm/sec^2).
# via P3 along the arc trajectory
movej(P0).
movec(P2, P1, time=5)
# Moves with a global velocity of 30(mm/sec) and acceleration of 60(mm/sec^2).
# to P1 along the arc trajectory via P2 at the 5-second point.
movec(P3, P4, time=3, radius=100)
# Moves along the arc trajectory to P4 via P3 with a reach time of 3 seconds
# and then executes the next motion at a distance of 100mm from the P4 position.
movec(P2, P1, ra=DR_MV_RA_OVERRIDE)
# Immediately terminates the last motion and blends it to move to the P1 position.
```

Related commands

posx()/set_velx()/set_accx()/set_tcp()/set_ref_coord()/amovec()

2.20 movesj

▪ Features

The robot moves along a spline curve path that connects the current position to the target position (the last waypoint in pos_list) via the waypoints of the joint space input in pos_list.

The input velocity/acceleration means the maximum velocity/acceleration in the path, and the acceleration and deceleration during the motion are determined according to the position of the waypoint.

▪ Parameters

Parameter Name	Data Type	Default Value	Description
pos_list	list (posj)	-	posj list
vel (v)	float list (float[6])	None	velocity (same to all axes) or velocity (to an axis)
acc (a)	float list (float[6])	None	acceleration (same to all axes) or acceleration (acceleration to an axis)
time (t)	float	None	Reach time [sec]
mod	int	DR_MV_MOD_ABS	Movement basis · DR_MV_MOD_ABS: Absolute · DR_MV_MOD_REL: Relative

Note

- Abbreviated parameter names are supported. (v:vel, a:acc, t:time)
- _global_velj is applied if vel is None. (The initial value of _global_velj is 0.0 and can be set by set_velj.)
- _global_accj is applied if acc is None. (The initial value of _global_accj is 0.0 and can be set by set_accj.)
- If the time is specified, values are processed based on time, ignoring vel and acc.
- If the time is None, it is set to 0.
- If the mod is DR_MV_MOD_REL, each pos in the pos_list is defined in the relative coordinate of the previous pos. (If pos_list=[q1, q2, ...,q(n-1), q(n)], q1 is the relative angle of the starting point while q(n) is the relative coordinate of q(n-1).)
- This function does not support online blending of previous and subsequent motions.

- **Return**

Value	Description
0	Success
Negative value	Error

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
#CASE 1) Absolute angle input (mod= DR_MV_MOD_ABS)
q0 = posj(0,0,0,0,0,0)
movej(q0, vel=30, acc=60)          # Moves in joint motion to the initial position (q0).
q1 = posj(10, -10, 20, -30, 10, 20)          # Defines the posj variable (joint angle) q1.
q2 = posj(25, 0, 10, -50, 20, 40)
q3 = posj(50, 50, 50, 50, 50, 50)
q4 = posj(30, 10, 30, -20, 10, 60)
q5 = posj(20, 20, 40, 20, 0, 90)

qlist = [q1, q2, q3, q4, q5]          # Defines the list (qlist) which is a set of q1-q5 as the
waypoints.

movesj(qlist, vel=30, acc=100)
        # Moves the spline curve that connects the waypoints defined in the qlist.
        # with a maximum velocity of 30(mm/sec) and maximum acceleration of
        100(mm/sec^2)
```

```
#CASE 2) Relative angle input (mod= DR_MV_MOD_REL)
q0 = posj(0,0,0,0,0,0)
movej(q0, vel=30, acc=60)          # Moves in joint motion to the initial position (q0).
dq1 = posj(10, -10, 20, -30, 10, 20)          # Defines dq1 (q1=q0+dq1) as the relative
joint angle of q0
dq2 = posj(15, 10, -10, -20, 10, 20)          # Defines dq2 (q2=q1+dq2) as the relative
joint angle of q1
dq3 = posj(25, 50, 40, 100, 30, 10)          # Defines dq3 (q3=q2+dq3) as the relative
joint angle of q2
dq4 = posj(-20, -40, -20, -70, -40, 10)        # Defines dq4 (q4=q3+dq4) as the relative
joint angle of q3
```

```
dq5 = posj(-10, 10, 10, 40, -10, 30)          # Defines dq5 (q5=q4+dq5) as the relative
joint angle of q4

dqlist = [dq1, dq2, dq3, dq4, dq5]
        # Defines the list (dqlist) which is a set of q1-q5 as the relative waypoints.

movesj(dqlist, vel=30, acc=100, mod= DR_MV_MOD_REL )
        # Moves the spline curve that connects the relative waypoints defined in the
        dqlist
        # with a maximum velocity of 30(mm/sec) and maximum acceleration of
        100(mm/sec^2) (same motion as CASE-1).
```

- **Related commands**

posj()/set_velj()/set_accj()/amovesj()

2.21 movesx

▪ Features

The robot moves along a spline curve path that connects the current position to the target position (the last waypoint in pos_list) via the waypoints of the task space input in pos_list.

The input velocity/acceleration means the maximum velocity/acceleration in the path and the constant velocity motion is performed with the input velocity according to the condition if the option for the constant speed motion is selected.

▪ Parameters

Parameter Name	Data Type	Default Value	Description
pos_list	list (posx)	-	posx list
vel (v)	float list (float[2])	None	velocity or velocity1, velocity2
acc (a)	float list (float[2])	None	acceleration or acceleration1, acceleration2
time (t)	float	None	Reach time [sec]
ref	int	None	reference coordinate ・ DR_BASE: base coordinate ・ DR_WORLD: world coordinate ・ DR_TOOL: tool coordinate ・ user coordinate: User defined
mod	int	DR_MV_MOD_ABS	Movement basis ・ DR_MV_MOD_ABS: Absolute ・ DR_MV_MOD_REL: Relative
vel_opt	int	DR_MVS_VEL_NONE	Velocity option ・ DR_MVS_VEL_NONE: None ・ DR_MVS_VEL_CONST: Constant velocity

Note

- Abbreviated parameter names are supported. (v:vel, a:acc, t:time)
- _global_velx is applied if vel is None. (The initial value of _global_velx is 0.0 and can be set by set_velx.)
- _global_accx is applied if acc is None. (The initial value of _global_accx is 0.0 and can be set by set_accx.)
- If an argument is inputted to vel (e.g., vel=30), the input argument corresponds to the linear velocity of the motion while the angular velocity is determined proportionally to the linear velocity.
- If an argument is inputted to acc (e.g., acc=60), the input argument corresponds to the linear acceleration of the motion while the angular acceleration is determined proportionally to the linear acceleration.
- If the time is specified, values are processed based on time, ignoring vel and acc.
- If the time is None, it is set to 0.
- _g_coord is applied if the ref is None. (The initial value of _g_coord is DR_BASE, and it can be set by the set_ref_coord command.)
- If the mod is DR_MV_MOD_REL, each pos in the pos_list is defined in the relative coordinate of the previous pos. (If pos_list=[p1, p2, ...,p(n-1), p(n)], p1 is the relative angle of the starting point while p(n) is the relative coordinate of p(n-1).)
- This function does not support online blending of previous and subsequent motions.

Caution

The constant velocity motion according to the distance and velocity between the waypoints cannot be used if the "vel_opt= DR_MVS_VEL_CONST" option (constant velocity option) is selected, and the motion is automatically switched to the variable velocity motion (vel_opt= DR_MVS_VEL_NONE) in that case.

Return

Value	Description
0	Success
Negative value	Error

Exception

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
#CASE 1) Absolute coordinate input (mod= DR_MV_MOD_ABS)
P0 = posj(0,0,90,0,90,0)
movej(P0, v=30, a=30)
x0 = posx(600, 43, 500, 0, 180, 0)          # Defines the posx variable (space
coordinate/pose) x0.
movel(x0, vel=100, acc=200)      # Linear movement to the initial position x0
x1 = posx(600, 600, 600, 0, 175, 0)          # Defines the posx variable (space
coordinate/pose) x1.
x2 = posx(600, 750, 600, 0, 175, 0)
x3 = posx(150, 600, 450, 0, 175, 0)
x4 = posx(-300, 300, 300, 0, 175, 0)
x5 = posx(-200, 700, 500, 0, 175, 0)
x6 = posx(600, 600, 400, 0, 175, 0)

xlist = [x1, x2, x3, x5, x6]             # Defines the list (xlist) which is a set of x1-x6 as the
waypoints.

movesx(xlist, vel=[100, 30], acc=[200, 60], vel_opt=DR_MVS_VEL_NONE)
        # Moves the spline curve that connects the waypoints defined in the xlist
        # with a maximum velocity of 100, 30(mm/sec, deg/sec) and maximum
acceleration of 200(mm/sec2) and
        # 60(deg/sec2).
movesx(xlist, vel=[100, 30], acc=[200, 60], time=5, vel_opt=DR_MVS_VEL_CONST)
        # Moves the spline curve that connects the waypoints defined in the xlist
        # with a constant velocity of 100, 30(mm/sec, deg/sec).
```

```
#CASE 2) Relative coordinate input (mod= DR_MV_MOD_REL)
P0 = posj(0,0,90,0,90,0)
movej(P0)
x0 = posx(600, 43, 500, 0, 180, 0)          # Defines the posx variable (space
coordinate/pose) x0.
movel(x0, vel=100, acc=200)      # Linear movement to the initial position x0
dx1 = posx(0, 557, 100, 0, -5, 0)
        # Definition of relative coordinate dx1 to x0 (Homogeneous transformation of
        dx1 based in x1= x0)
dx2 = posx(0, 150, 0, 0, 0, 0)
        # Definition of relative coordinate dx2 to x1 (Homogeneous transformation of dx2
        based in x2= x1)
dx3 = posx(-450, -150, -150, 0, 0, 0)
        # Definition of relative coordinate dx3 to x2 (Homogeneous transformation of dx3
based in x3= x2)
dx4 = posx(-450, -300, -150, 0, 0, 0)
        # Definition of relative coordinate dx4 to x3 (Homogeneous transformation of dx4
based in x4= x3)
dx5 = posx(100, 400, 200, 0, 0, 0)
        # Definition of relative coordinate dx5 to x4 (Homogeneous transformation of dx5
based in x5= x4)
dx6 = posx(800, -100, -100, 0, 0, 0)
        # Definition of relative coordinate dx6 to x5 (Homogeneous transformation of dx6
```

```
based in x6= x5)

dxlist = [dx1, dx2, dx3, dx4, dx5, dx6]
        # Defines the list (dxlist) which is a set of dx1-dx6 as the waypoints.

movesx(dxlist, vel=[100, 30], acc=[200, 60], mod= DR_MV_MOD_REL,
vel_opt=DR_MVS_VEL_NONE)
        # Moves the spline curve that connects the waypoints defined in the dxlist
        # with a maximum velocity of 100, 30 (mm/sec, deg/sec)
        # and maximum acceleration of 200(mm/sec^2), and 60(deg/sec^2) (same motion
        as CASE-1).
```

- **Related commands**

posx()/set_velx()/set_accx()/set_tcp()/set_ref_coord()/amovesx()

2.22 moveb

▪ Features

This function takes a list that has one or more path segments (line or circle) as arguments and moves at a constant velocity by blending each segment into the specified radius. Here, the radius can be set through posb.

▪ Parameters

Parameter Name	Data Type	Default Value	Description
pos_list	list (posb)	-	posb list
vel (v)	float list (float[2])	None	velocity or velocity1, velocity2
acc (a)	float list (float[2])	None	acceleration or acceleration1, acceleration2
time (t)	float	None	Reach time [sec] * If the time is specified, values are processed based on time, ignoring vel and acc.
ref	int	None	reference coordinate ・ DR_BASE: base coordinate ・ DR_WORLD: world coordinate ・ DR_TOOL: tool coordinate ・ user coordinate: User defined
mod	int	DR_MV_MOD_ABS	Movement basis ・ DR_MV_MOD_ABS: Absolute ・ DR_MV_MOD_REL: Relative
app_type	int	DR_MV_APP_NONE	Application mode ・ DR_MV_APP_NONE: No application related ・ DR_MV_APP_WELD: Welding application related

Note

- Abbreviated parameter names are supported. (v:vel, a:acc, t:time)
- Up to 50 arguments can be entered in posb_list.
- _global_velx is applied if vel is None. (The initial value of _global_velx is 0.0 and can be set by set_velx.)
- _global_accx is applied if acc is None. (The initial value of _global_accx is 0.0 and can be set by set_accx.)
- If an argument is inputted to vel (e.g., vel=30), the input argument corresponds to the linear velocity of the motion while the angular velocity is determined proportionally to the linear velocity.
- If an argument is inputted to acc (e.g., acc=60), the input argument corresponds to the linear acceleration of the motion while the angular acceleration is determined proportionally to the linear acceleration.
- If the time is specified, values are processed based on time, ignoring vel and acc.
- If the time is None, it is set to 0.
- _g_coord is applied if the ref is None. (The initial value of _g_coord is DR_BASE, and it can be set by the set_ref_coord command.)
- If the mod is DR_MV_MOD_REL, each pos in the posb_list is defined in the relative coordinate of the previous pos.
- If 'app_type' is 'DR_MV_APP_WELD', parameter 'vel' is internally replaced by the speed setting entered in app_weld_set_weld_cond(), not the input value of 'vel'.

Caution

- A user input error is generated if the blending radius in posb is 0.
- A user input error is generated due to the duplicated input of Line if contiguous Line-Line segments have the same direction.
- A user input error is generated to prevent a sudden acceleration if the blending condition causes a rapid change in direction.
- This function does not support online blending of previous and subsequent motions.

Return

Value	Description
0	Success
Negative value	Error

Exception

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid

Exception	Description
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

Example

```
# Init Pose @ Jx1
Jx1 = posj(45,0,90,0,90,45)                    # initial joint position
        X0 = posx(370, 420, 650, 0, 180, 0)    # initial task position
```

```
# CASE 1) ABSOLUTE
# Absolute Goal Poses
X1 =   posx(370, 670, 650, 0, 180, 0)
X1a = posx(370, 670, 400, 0, 180, 0)
X1a2= posx(370, 545, 400, 0, 180, 0)
X1b = posx(370, 595, 400, 0, 180, 0)
X1b2= posx(370, 670, 400, 0, 180, 0)
X1c = posx(370, 420, 150, 0, 180, 0)
X1c2= posx(370, 545, 150, 0, 180, 0)
X1d = posx(370, 670, 275, 0, 180, 0)
X1d2= posx(370, 795, 150, 0, 180, 0)

seg11 = posb(DR_LINE, X1, radius=20)
seg12 = posb(DR_CIRCLE, X1a, X1a2, radius=20)
seg14 = posb(DR_LINE, X1b2, radius=20)
seg15 = posb(DR_CIRCLE, X1c, X1c2, radius=20)
seg16 = posb(DR_CIRCLE, X1d, X1d2, radius=20)
b_list1 = [seg11, seg12, seg14, seg15, seg16]
        # The blending radius of the last waypoint (seg16) is ignored.

movej(Jx1, vel=30, acc=60, mod=DR_MV_MOD_ABS)
        # Joint motion to the initial angle (Jx1)
movel(X0, vel=150, acc=250, ref=DR_BASE, mod=DR_MV_MOD_ABS)
        # Line motion to the initial position (X0)
moveb(b_list1, vel=150, acc=250, ref=DR_BASE, mod=DR_MV_MOD_ABS)
        # Moves the robot from the current position through a trajectory consisting of
seg11(LINE), seg12(CIRCLE), seg14(LINE),
        # seg15(CIRCLE), and seg16(CIRCLE) with a constant velocity of 150(mm/sec)
with the exception of accelerating and decelerating sections.
        # (The final point is X1d2.) Blending to the next segment begins
        # when the distance of 20mm from the end point (X1, X1a2, X1b2, X1c2, and
X1d2) of each segment
        # is reached.
```

```
# CASE 2) RELATIVE
# Relative Goal Poses
dX1 =   posx(0, 250, 0, 0, 0, 0)
dX1a = posx(0, 0, -150, 0, 0, 0)
```

```
dX1a2= posx(0, -125, 0, 0, 0, 0)
dX1b = posx(0, 50, 0, 0, 0, 0)
dX1b2= posx(0, 75, 0, 0, 0, 0)
dX1c = posx(0, -250, -250, 0, 0, 0)
dX1c2= posx(0, 125, 0, 0, 0, 0)
dX1d = posx(0, 125, 125, 0, 0, 0)
dX1d2= posx(0, 125, -125, 0, 0, 0)

dseg11 = posb(DR_LINE, dX1, radius=20)
dseg12 = posb(DR_CIRCLE, dX1a, dX1a2, radius=20)
dseg14 = posb(DR_LINE, dX1b2, radius=20)
dseg15 = posb(DR_CIRCLE, dX1c, dX1c2, radius=20)
dseg16 = posb(DR_CIRCLE, dX1d, dX1d2, radius=20)
db_list1 = [dseg11, dseg12, dseg14, dseg15, dseg16]
        # The blending radius of the last waypoint (dseg16) is ignored.

movej(Jx1, vel=30, acc=60, mod=DR_MV_MOD_ABS)
        # Joint motion to the initial angle (Jx1)
movel(X0, vel=150, acc=250, ref=DR_BASE, mod=DR_MV_MOD_ABS)
         # Line motion to the initial position (X0)
moveb(b_list1, vel=150, acc=250, ref=DR_BASE, mod=DR_MV_MOD_ABS)
        # Moves the robot from the current position through a trajectory consisting of
dseg11(LINE), dseg12(CIRCLE), dseg14(LINE),
        # dseg15(CIRCLE), and dseg16(CIRCLE) with a constant velocity of
150(mm/sec) with the exception of accelerating and decelerating sections.
        # (The final point is X1d2.)
        # Blending to the next segment begins when the distance of 20mm from the end
point (X1, X1a2, X1b2, X1c2, and X1d2) of each segment is reached.
        # (The path is the same as CASE#1.)
```

- **Related commands**

posb()/set_velx()/set_accx()/set_tcp()/set_ref_coord()/amoveb()

2.23 move_spiral

▪ Features

Motion along a spiral trajectory on a plane which is perpendicular to the input 'axis' is performed on the specified coordinate system 'ref'. Additional input, travel distance 'lmax' can cause the robot to move around a cone, starting from the apex of it

▪ Parameters

Parameter Name	Data Type	Default Value	Range	Description
rev	float	10	rev > 0	Total number of revolutions
rmax	float	10	rmax > 0	Final spiral radius [mm]
lmax	float	0		Distance moved in the axis direction [mm]
vel (v)	float	None		velocity
acc (a)	float	None		acceleration
time (t)	float	None	time ≥ 0	Total execution time <sec>
axis	int	DR_AXIS_Z	-	axis ・ DR_AXIS_X: x-axis ・ DR_AXIS_Y: y-axis ・ DR_AXIS_Z: z-axis
ref	Int	DR_TOOL	-	reference coordinate ・ DR_BASE : base coordinate ・ DR_WORLD : world coordinate ・ DR_TOOL : tool coordinate ・ user coordinate: user defined

Note

- Abbreviated parameter names are supported. (v:vel, a:acc, t:time)
- rev refers to the total number of revolutions of the spiral motion.
- Rmax refers to the maximum radius of the spiral motion.
- Lmax refers to the parallel distance in the axis direction during the motion. A negative value means the parallel distance in the –axis direction.
- Vel refers to the moving velocity of the spiral motion.
- The first value of _global_velx (parallel velocity) is applied if vel is None. (The initial value of _global_velx is 0.0 and can be set by set_velx.)
- acc refers to the moving acceleration of the spiral motion.
- The first value of _global_accx (parallel acceleration) is applied if acc is None. (The initial value of _global_accx is 0.0 and can be set by set_accx.)
- If the time is specified, values are processed based on time, ignoring vel and acc.
- If the time is None, it is set to 0.
- The axis defines the axis that is perpendicular to the surface defined by the spiral motion.
- Ref refers to the reference coordinate system defined by the spiral motion.
- This function does not support online blending of previous and subsequent motions.

Caution

- An error can be generated to ensure safe motion if the rotating acceleration calculated by the spiral path is too great.
  In this case, reduce the vel, acc, or time value.

Return

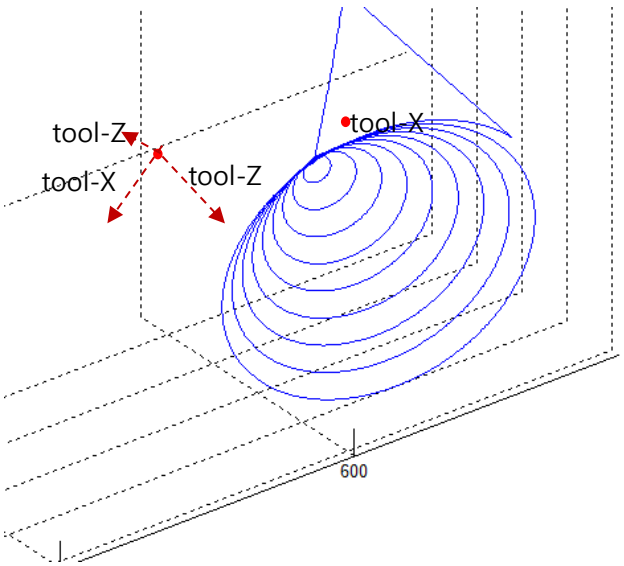
Value	Description
0	Success
Negative value	Error

Exception

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
# hole search
# (A motion that completes 9.5 revolutions (rev) to the 50 mm radius (rmax) from 0 on the Tool-X/Y surface as the center of the rotation in the Tool-Z direction and the spiral trajectory that moves 50 mm (lmax) in the Tool-Z direction at the same time in 10 seconds from the initial position)

J00 = posj(0,0,90,0,60,0)
movej(J00,vel=30,acc=30)          # Joint movement to the initial pose
move_spiral(rev=9.5,rmax=20.0,lmax=50.0,time=20.0,axis=DR_AXIS_Z,ref=DR_TOOL
)
```



- **Related commands**

set_velx()/set_accx()/set_tcp()/set_ref_coord()/amove_spiral()

2.24 move_periodic

▪ Features

This function performs the cyclic motion based on the sine function of each axis (parallel and rotation) of the reference coordinate (ref) input as a relative motion that begins at the current position. The attributes of the motion on each axis are determined by the amplitude and period, and the acceleration/deceleration time and the total motion time are set by the interval and repetition count.

▪ Parameters

Parameter Name	Data Type	Default Value	Range	Description
amp	list (float[6])	-	0≤amp	Amplitude (motion between -amp and +amp) [mm] or [deg]
period	float or list (float[6])		0≤period	Period (time for 1 cycle) [sec]
atime	float	0.0	0≤atime	Acc-, dec- time [sec]
repeat	int	1	> 0	Repetition count
ref	int	DR_TOOL	-	reference coordinate · DR_BASE : base coordinate · DR_WORLD : world coordinate · DR_TOOL : tool coordinate · user coordinate: user defined

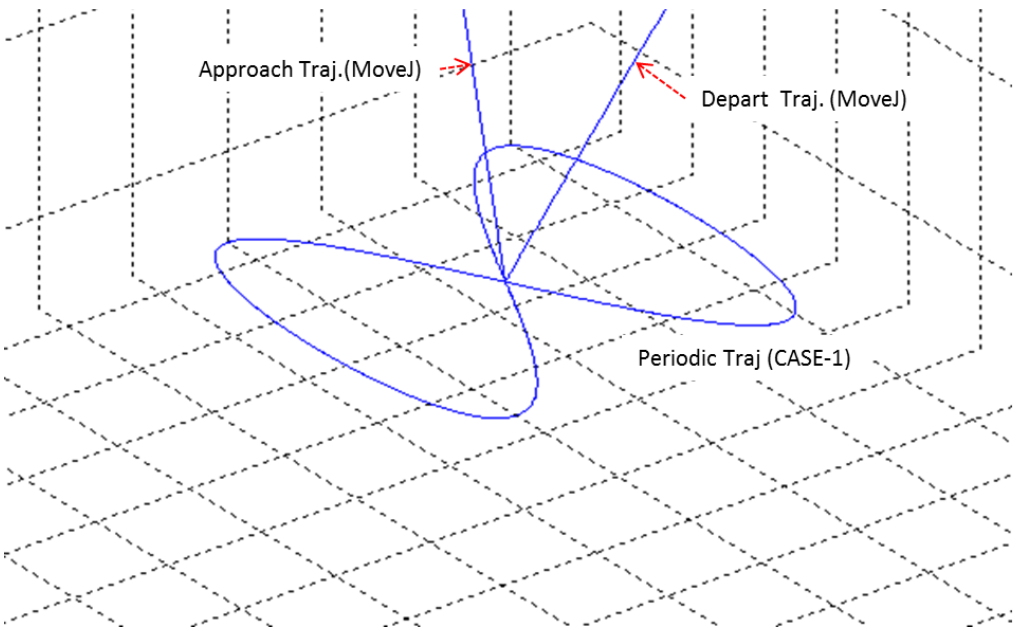
Note

- Amp refers to the amplitude. The input is a list of 6 elements which are the amp values for the axes (x, y, z, rx, ry, and rz). The amp input on the axis that does not have a motion must be 0.
- Period refers to the time needed to complete a motion in the direction, the amplitude. The input is a list of 6 elements which are the periods for the axes (x, y, z, rx, ry, and rz).
- Atime refers to the acceleration and deceleration time at the beginning and end of the periodic motion. The largest of the inputted acceleration/deceleration times and maximum period*1/4 is applied. An error is generated when the inputted acceleration/deceleration time exceeds 1/2 of the total motion time.
- Repeat refers to the number of repetitions of the axis (reference axis) that has the largest period value and determines the total motion time. The number of repetitions for each of the remaining axes is determined automatically according to the motion time.

- If the motion terminates normally, the motions for the remaining axes can be terminated before the reference axis's motion terminates so that the end position matches the starting position. The deceleration section will deviate from the previous path if the motions of all axes are not terminated at the same time. Refer to the following image for more information.

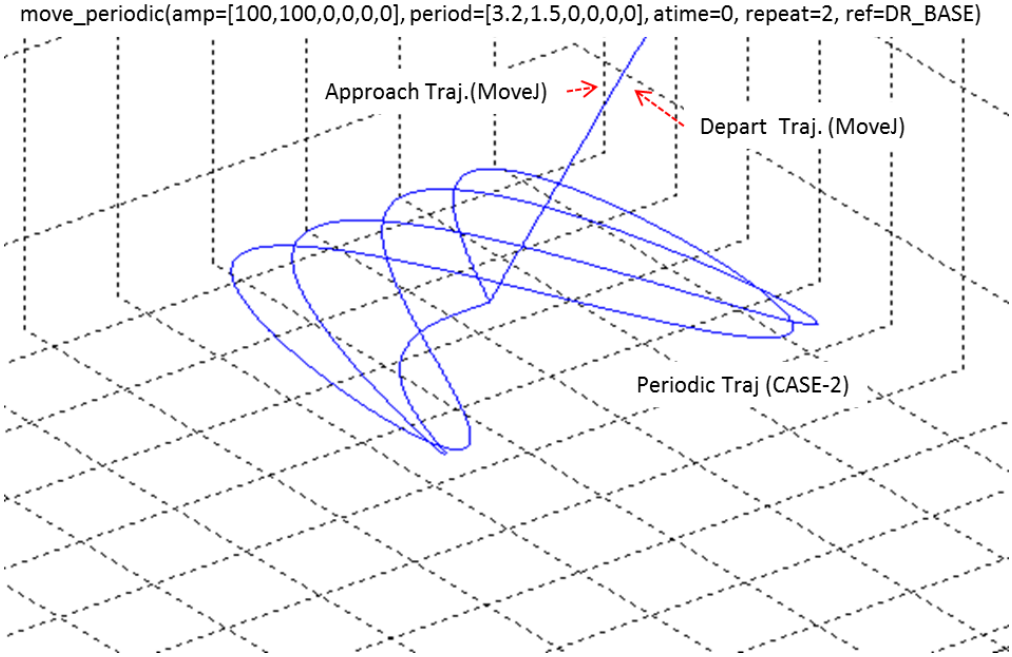
CASE-1) All-axis motions end at the same time

move_periodic(amp=[100,100,0,0,0,0], period=[3.2,1.6,0,0,0,0], atime=3.1, repeat=2, ref=DR_BASE)



CASE-2) Diff-axis motions end individually

move_periodic(amp=[100,100,0,0,0,0], period=[3.2,1.5,0,0,0,0], atime=0, repeat=2, ref=DR_BASE)



- Ref refers to the reference coordinate system of the repeated motion.
- If a maximum velocity error is generated during a motion, adjust the amplification and period using the following formula.
  Max. velocity = Amplification(amp)*2*pi(3.14)/Period(period) (i.e., Max. velocity=62.83mm/sec if amp=10mm and period=1 sec)
- This function does not support online blending of previous and subsequent motions.

Return

Value	Description
0	Success
Negative value	Error

Exception

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

Example

```
P0 = posj(0,0,90,0,90,0)
movej(P0)

#1
move_periodic(amp =[10,0,0,0,30,0], period=1.0, atime=0.2, repeat=5, ref=DR_TOOL)
        # Repeats the x-axis (10mm amp and 1 sec. period) motion and rotating y-axis
        (30deg amp and 1 sec. period) motion in the tool coordinate system
        # totally, repeat the motion 5 times.

#2
move_periodic(amp =[10,0,20,0,0.5,0], period=[1,0,1.5,0,0,0], atime=0.5, repeat=3,
ref=DR_BASE)
        # Repeats the x-axis (10mm amp and 1 sec. period) motion and z-axis (20mm
        amp and 1.5 sec. period) motion in the base coordinate system
        # 3 times. The rotating y-axis motion is not performed since its period is "0".
        # The total motion time is about 5.5 sec. (1.5 sec. * 3 times + 1 sec. for
        acceleration/deceleration) since the period of the x-axis motion is greater.
        # The x-axis motion is repeated 4.5 times.
```

Related commands

set_ref_coord()/amove_periodic()

2.25 move_home

▪ Features

Homing is performed by moving to the joint motion to the mechanical or user defined home position. According to the input parameter [target], it moves to the mechanical home defined in the system or the home set by the user.

▪ Parameters

Parameter Name	Data Type	Default Value	Range	Description
target	int	-	0 or 1	Tartget of home position . DR_HOME_TARGET_MECHANIC :, Mechanical home, joint angle (0,0,0,0,0,0) . DR_HOME_TARGET_USER : user home.

Note

- Homing motion is divided into two steps and performed sequentially.
  step1) Move to the homing position at the speed specified in the system
  step2) Finding the home position precisely
- Safety should be ensured so that there is no danger of collision in the vicinity of homing operation..

▪ Return

Value	Description
0	Success
Negative value	Error

▪ Exception

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
move_home(DR_HOME_TARGET_USER)        # Go to the user home

P0 = posj(0,0,90,0,90,0)
movej(P0)
```

2.26 amovej

▪ Features

The asynchronous movej motion operates in the same way as movej except that it does not have the radius parameter for blending. The command is the asynchronous motion command, and the next command is executed at the same time the motion begins.

Note)

- movej(pos): The next command is executed after the robot starts from the current position and reaches (stops at) pos.
- amovej(pos): The next command is executed regardless of whether the robot starts from the current position and reaches (stops at) pos.

▪ Parameters

Parameter Name	Data Type	Default Value	Description
pos	posj list (float[6])	-	posj or joint angle list
vel (v)	float list (float[6])	None	velocity (same to all axes) or velocity (to an axis)
acc (a)	float list (float[6])	None	acceleration (same to all axes) or acceleration (acceleration to an axis)
time (t)	float	None	Reach time [sec]
mod	int	DR_MV_MOD_ABS	Movement basis ・ DR_MV_MOD_ABS: Absolute ・ DR_MV_MOD_REL: Relative
ra	int	DR_MV_RA_DUPLICATE	Reactive motion mode ・ DR_MV_RA_DUPLICATE: duplicate ・ DR_MV_RA_OVERRIDE: override

Note

- Abbreviated parameter names are supported. (v:vel, a:acc, t:time)
- _global_velj is applied if vel is None. (The initial value of _global_velj is 0.0 and can be set by set_velj.)
- _global_accj is applied if acc is None. (The initial value of _global_accj is 0.0 and can be set by set_accj.)
- If the time is specified, values are processed based on time, ignoring vel and acc.
- If the time is None, it is set to 0.
- Refer to the description of the movej() motion for the path of blending according to option ra and vel/acc.

Return

Value	Description
0	Success
Negative value	Error

Exception

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
#Example 1. The robot moves to q1 and stops the motion 3 seconds after it begins the motion at q0 and then moves to q99
q0 = posj(0, 0, 90, 0, 90, 0)
amovej (q0, vel=10, acc=20)        # Moves to q0 and performs the next command immediately after
wait(3)            # Temporarily suspends the program execution for 3 seconds (while the motion continues).
q1 = posj(0, 0, 0, 0, 90, 0)
amovej (q1, vel=10, acc=20)
# Maintains the q0 motion (DUPLICATE blending if the ra argument is omitted) and iterates to q1.
# Performs the next command immediately after the blending motion.
mwait(0)          # Temporarily suspends the program execution until the motion is terminated.
q99 = posj(0, 0, 0, 0, 0, 0)
movej (q99, vel=10, acc=20)        # Joint motion to q99
```

- **Related commands**

posj()/set_velj()/set_accj()/mwait()/movej()

2.27 amovel

▪ Features

The asynchronous movel motion operates in the same way as movel except that it does not have the radius parameter for blending. The command is the asynchronous motion command, and the next command is executed without waiting for the motion to terminate.

Note)

- movel(pos): The next command is executed after the robot starts from the current position and reaches (stops at) pos.
- amovel(pos): The next command is executed regardless of whether the robot starts from the current position and reaches (stops at) pos.

▪ Parameters

Parameter Name	Data Type	Default Value	Description
pos	posx list (float[6])	-	posx or position list
vel (v)	float list (float[2])	None	velocity or velocity1, velocity2
acc (a)	float list (float[2])	None	acceleration or acceleration1, acceleration2
time (t)	float	None	Reach time [sec] * If the time is specified, values are processed based on time, ignoring vel and acc.
ref	int	None	reference coordinate ・ DR_BASE : base coordinate ・ DR_WORLD : world coordinate ・ DR_TOOL : tool coordinate ・ user coordinate: User defined
mod	int	DR_MV_MOD_ABS	Movement basis ・ DR_MV_MOD_ABS: Absolute ・ DR_MV_MOD_REL: Relative
ra	int	DR_MV_RA_DUPLICATE	Reactive motion mode ・ DR_MV_RA_DUPLICATE: duplicate ・ DR_MV_RA_OVERRIDE: override

Parameter Name	Data Type	Default Value	Description
app_type	int	DR_MV_APP_NONE	Application mode · DR_MV_APP_NONE: No application related · DR_MV_APP_WELD: Welding application related

Note

- Abbreviated parameter names supported (v:vel, a:acc, t:time).
- _global_velx is applied if vel is None. (The initial value of _global_velx is 0.0 and can be set by set_velx.)
- _global_accx is applied if acc is None. (The initial value of _global_accx is 0.0 and can be set by set_accx.)
- If an argument is inputted to vel (e.g., vel=30), the input argument corresponds to the linear velocity of the motion while the angular velocity is determined proportionally to the linear velocity.
- If an argument is inputted to acc (e.g., acc=60), the input argument corresponds to the linear acceleration of the motion while the angular acceleration is determined proportionally to the linear acceleration.
- If the time is specified, values are processed based on time, ignoring vel and acc.
- If the time is None, it is set to 0.
- _g_coord is applied if the ref is None. (The initial value of _g_coord is DR_BASE, and it can be set by the set_ref_coord command.)
- Refer to the description of the movej() motion for the path of the blending according to option ra and vel/acc.
- If 'app_type' is 'DR_MV_APP_WELD', parameter 'vel' is internally replaced by the speed setting entered in app_weld_set_weld_cond(), not the input value of 'vel'.

▪ Return

Value	Description
0	Success
Negative value	Error

▪ Exception

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid

Exception	Description
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
#Example 1. D-Out 2 seconds after the motion starts with x1
j0 = posj(-148,-33,-54,180,92,32)
movej(j0, v=30, a=30)
x1 = posx(784, 543, 570, 0, 180, 0)
amovel (x1, vel=100, acc=200)    # Performs the next motion immediately after
beginning a motion with x1.
wait(2)                          # Temporarily suspends the program execution for 2
seconds (while the motion continues).
set_digital_output(1, 1)         # D-Out (no. 1 channel) ON
mwait(0)                         # Temporarily suspends the program execution until
the motion is terminated.
```

- **Related commands**

posx()/set_velx()/set_accx()/set_tcp()/set_ref_coord()/mwait()movel()

2.28 amovejx

▪ Features

The asynchronous movejx motion operates in the same way as movejx except that it does not have the radius parameter for blending. The command is the asynchronous motion command, and the next command is executed without waiting for the motion to terminate.

Note)

- movejx(pos): The next command is executed after the robot starts from the current position and reaches (stops at) pos.
- amovejx(pos): The next command is executed regardless of whether the robot starts from the current position and reaches (stops at) pos.

▪ Parameters

Parameter Name	Data Type	Default Value	Description
pos	posx list (float[6])	-	posx or position list
vel (v)	float list (float[6])	None None	velocity (same to all axes) or velocity (to an axis)
acc (a)	float list (float[6])	None None	acceleration (same to all axes) or acceleration (acceleration to an axis)
time (t)	float	None	Reach time [sec]
ref	int	None	reference coordinate ・ DR_BASE: base coordinate ・ DR_WORLD : world coordinate ・ DR_TOOL: tool coordinate ・ user coordinate: User defined
mod	int	DR_MV_MOD_ABS	Movement basis ・ DR_MV_MOD_ABS: Absolute ・ DR_MV_MOD_REL: Relative
ra	int	DR_MV_RA_DUPLICATE	Reactive motion mode ・ DR_MV_RA_DUPLICATE: duplicate ・ DR_MV_RA_OVERRIDE: override
sol	int	0	Solution space

 **Note**

・ Abbreviated parameter names are supported. (v:vel, a:acc, t:time)

- _global_velj is applied if vel is None. (The initial value of _global_velj is 0.0 and can be set by set_velj.)
- _global_accj is applied if acc is None. (The initial value of _global_accj is 0.0 and can be set by set_accj.)
- If the time is specified, values are processed based on time, ignoring vel and acc.
- If the time is None, it is set to 0.
- If the time is specified, values are processed based on time, ignoring vel and acc.
- If the time is None, it is set to 0.
- _g_coord is applied if the ref is None. The initial value of _g_coord is DR_BASE, and it can be set by the set_ref_coord command.
- Refer to the description of the movej() motion for the path of the blending according to option ra and vel/acc.

⚠ Caution

The blending into current active motion is disabled in the case of input with relative motion (mod=DR_MV_MOD_REL), and it is recommended to blend using movej() or movel().

▪ Return

Value	Description
0	Success
Negative value	Error

▪ Exception

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
#Example 1. D-Out 2 seconds after the joint motion starts with x1
p0 = posj(-148,-33,-54,180,92,32)
movej(p0, v=30, a=30)
x1 = posx(784, 443, 770, 0, 180, 0)
amovejx (x1, vel=100, acc=200, sol=1)      # Performs the next motion immediately after beginning a joint motion with x1.
wait(2)                                    # Temporarily suspends the program execution for 2 seconds (while the motion continues).
set_digital_output(1, 1)                   # D-Out (no. 1 channel) ON
mwait(0)                                   # Temporarily suspends the program execution until the motion is terminated.
```

- **Related commands**

posx()/set_velj()/set_accj()/get_current_posx()/mwait()/movejx()

2.29 amovec

▪ Features

The asynchronous movec motion operates in the same way as movec except that it does not have the radius parameter for blending. The command is the asynchronous motion command, and the next command is executed without waiting for the motion to terminate.

Note)

- movec(pos1. pos2): The next command is executed after the robot starts from the current position and reaches (stops at) pos2.
- amovec(pos1. pos2): The next command is executed regardless of whether the robot starts from the current position and reaches (stops at) pos2.

▪ Parameters

Parameter Name	Data Type	Default Value	Description
pos	posx list (float[6])	-	posx or position list
pos2	posx list (float[6]	-	posx or position list
vel (v)	float list (float[2])	None	velocity or velocity1, velocity2
acc (a)	float list (float[2])	None	acceleration or acceleration1, acceleration2
time (t)	float	None	Reach time [sec]
ref	int	None	reference coordinate ・ DR_BASE: base coordinate ・ DR_WORLD: world coordinate ・ DR_TOOL: tool coordinate ・ user coordinate: User defined
mod	int	DR_MV_MOD_ABS	Movement basis ・ DR_MV_MOD_ABS: Absolute ・ DR_MV_MOD_REL: Relative
angle (an)	float list (float[2])	None	angle or angle1, angle2
ra	int	DR_MV_RA_DUPLICATE	Reactive motion mode ・ DR_MV_RA_DUPLICATE: duplicate

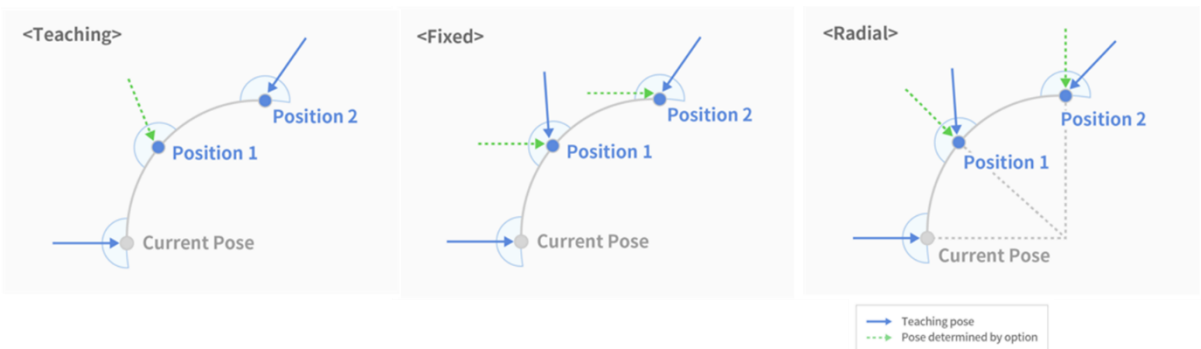
Parameter Name	Data Type	Default Value	Description
			• DR_MV_RA_OVERRIDE: override
ori	int	DR_MV_ORI_TEACH	Orientation mode • DR_MV_ORI_TEACH: orientation changes continuously from the initial to the final taught value • DR_MV_ORI_FIXED: orientation holds with the initial orientation • DR_MV_ORI_RADIAL: orientation changes radially from the initial.
app_type	int	DR_MV_APP_NONE	Application mode • DR_MV_APP_NONE: No application related • DR_MV_APP_WELD: Welding application related

Note

- Abbreviated parameter names are supported. (v:vel, a:acc, t:time, angle:an)
- _global_velx is applied if vel is None. (The initial value of _global_velx is 0.0 and can be set by set_velx.)
- _global_accx is applied if acc is None. (The initial value of _global_accx is 0.0 and can be set by set_accx.)
- If an argument is inputted to vel (e.g., vel=30), the input argument corresponds to the linear velocity of the motion while the angular velocity is determined proportionally to the linear velocity.
- If an argument is inputted to acc (e.g., acc=60), the input argument corresponds to the linear acceleration of the motion while the angular acceleration is determined proportionally to the linear acceleration.
- If the time is specified, values are processed based on time, ignoring vel and acc.
- If the time is None, it is set to 0.
- _g_coord is applied if the ref is None. (The initial value of _g_coord is DR_BASE, and it can be set by the set_ref_coord command.)
- If the mod is DR_MV_MOD_REL, pos1 and pos2 are defined in the relative coordinate system of the previous pos. (pos1 is the relative coordinate from the starting point while pos2 is the relative coordinate from pos1.)
- If the angle is None, it is set to 0.
- If only one angle is inputted, the total rotated angle on the circular path is applied to the angle.
- If two angle values are inputted, angle1 refers to the total rotating angle moving at a constant velocity on the circular path while angle2 refers to the rotating angle in the rotating section for

acceleration and deceleration. Here, the robot moves on the circular path at a total movement angle of angle1 + 2xangle2.

- Refer to the description of the movej() motion for the path of the blending according to option ra and vel/acc.
- If 'app_type' is 'DR_MV_APP_WELD', parameter 'vel' is internally replaced by the speed setting entered in app_weld_set_weld_cond(), not the input value of 'vel'.
- ori'(orientation mode) is defined as below.
  a) DR_MV_ORI_TEACH(orientation based on teaching) : From the inital pose to the taught pose, Pose 2, orientation changes to the distance of travel. The orientation of the taught pose, 'pose 1' is ignored.
  b) DR_MV_ORI_FIXED(fixed orientation) : Move along the path while maintaining the initial orientation up to the taught pose, 'pose2'.
  c) DR_MV_ORI_RADIAL(orientation constrained radially) : Move along the path while maintaining radial orientation at the initial pose to the 'pose 2'.



▪ Return

Value	Description
0	Success
Negative value	Error

▪ Exception

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

Example

```
#Example 1. D-Out 3 seconds after the arc motion through x1 and x2 begins
p0 = posj(-148,-33,-54,180,92,32)
movej(p0, v=30, a=30)
x1 = posx(784, 443, 770, 0, 180, 0)
amovejx (x1, vel=100, acc=200, sol=2) # Performs the next motion immediately after beginning a joint motion with x1.
wait(2)             # Temporarily suspends the program execution for 2 seconds (while the motion continues).
set_digital_output(1, 1)                # D-Out (no. 1 channel) ON
mwait(0)
```

Related commands

posx()/set_velx()/set_accx()/set_tcp()/set_ref_coord()/mwait()/movec()

2.30 amovesj

▪ Features

The asynchronous movesj motion operates in the same way as movesj() except for the asynchronous processing.

Generating a new command for the motion before the amovesj() motion results in an error for safety reasons. Therefore, the termination of the amovesj() motion must be confirmed using mwait() or check_motion() between amovesj() and the following motion command.

Note)

- movesj(pos_list): The next command is executed after the robot starts from the current position and reaches (stops at) the end point of pos_list.
- amovesj(pos_list): The next command is executed regardless of whether the robot starts from the current position and reaches (stops at) the end point of pos_list.

▪ Parameters

Parameter Name	Data Type	Default Value	Description
pos_list	list (posj)	-	posj list
vel (v)	float list (float[6])	None	velocity (same to all axes) or velocity (to an axis)
acc (a)	float list (float[6])	None	acceleration (same to all axes) or acceleration (acceleration to an axis)
time (t)	float	None	Reach time [sec]
mod	int	DR_MV_MOD_ABS	Movement basis ・ DR_MV_MOD_ABS: Absolute ・ DR_MV_MOD_REL: Relative

Note

- Abbreviated parameter names are supported. (v:vel, a:acc, t:time)
- _global_velj is applied if vel is None. (The initial value of _global_velj is 0.0 and can be set by set_velj.)
- _global_accj is applied if acc is None. (The initial value of _global_accj is 0.0 and can be set by set_accj.)
- If the time is specified, values are processed based on time, ignoring vel and acc.
- If the time is None, it is set to 0.
- If the mod is DR_MV_MOD_REL, each pos in the pos_list is defined in the relative coordinate of the previous pos. (If pos_list=[q1, q2, ...,q(n-1), q(n)], q1 is the relative angle of the starting point while q(n) is the relative coordinate of q(n-1).)
- This function does not support online blending of previous and subsequent motions.

- **Return**

Value	Description
0	Success
Negative value	Error

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
#Example 1. D-Out 3 seconds after the spline motion through q1 - q5 begins
q0 = posj(0,0,0,0,0,0)
movej(q0, vel=30, acc=60)     # Moves in joint motion to the initial position (q0).
q1 = posj(10, -10, 20, -30, 10, 20)              # Defines the posj variable (joint angle) q1.
q2 = posj(25, 0, 10, -50, 20, 40)
q3 = posj(50, 50, 50, 50, 50, 50)
q4 = posj(30, 10, 30, -20, 10, 60)
q5 = posj(20, 20, 40, 20, 0, 90)

qlist = [q1, q2, q3, q4, q5]
        # Defines the list (qlist) which is a set of waypoints q1-q5.

amovesj(qlist, vel=30, acc=100)
        # Moves the spline curve that connects the waypoints defined in the qlist.
        # with a maximum velocity of 30(mm/sec) and maximum acceleration of
100(mm/sec2).
        # Executes the next command.
wait(3)                                          # Temporarily suspends the program
execution for 3 seconds (while the motion continues).
set_digital_output(1, 1)              # D-Out (no. 1 channel) ON
mwait(0)                                         # Temporarily suspends the program execution until
the motion is terminated.
```

- **Related commands**

posj()/set_velj()/set_accj()/mwait()/amovesj()

2.31 amovesx

▪ Features

The asynchronous movesx motion operates in the same way as movesx() except for the asynchronous processing.

Generating a new command for the motion before the amovesj() motion results in an error for safety reasons. Therefore, the termination of the amovesx() motion must be confirmed using mwait() or check_motion() between amovesx() and the following motion command.

Note)

- movesx(pos_list): The next command is executed after the robot starts from the current position and reaches (stops at) the end point of pos_list.
- amovesx(pos_list): The next command is executed regardless of whether the robot starts from the current position and reaches (stops at) the end point of pos_list.

▪ Parameters

Parameter Name	Data Type	Default Value	Description
pos_list	list (posx)	-	posx list
vel (v)	float list (float[2])	None	velocity or velocity1, velocity2
acc (a)	float list (float[2])	None	acceleration or acceleration1, acceleration2
time (t)	float	None	Reach time [sec]
ref	int	None	reference coordinate ・ DR_BASE: base coordinate ・ DR_WORLD: world coordinate ・ DR_TOOL: tool coordinate ・ user coordinate: User defined
mod	int	DR_MV_MOD_ABS	Movement basis ・ DR_MV_MOD_ABS: Absolute ・ DR_MV_MOD_REL: Relative
vel_opt	int	DR_MVS_VEL_NONE	Velocity option ・ DR_MVS_VEL_NONE: None ・ DR_MVS_VEL_CONST: Constant velocity

Note

- Abbreviated parameter names are supported. (v:vel, a:acc, t:time)
- _global_velx is applied if vel is None. (The initial value of _global_velx is 0.0 and can be set by set_velx.)
- _global_accx is applied if acc is None. (The initial value of _global_accx is 0.0 and can be set by set_accx.)
- If an argument is inputted to vel (e.g., vel=30), the input argument corresponds to the linear velocity of the motion while the angular velocity is determined proportionally to the linear velocity.
- If an argument is inputted to acc (e.g., acc=60), the input argument corresponds to the linear acceleration of the motion while the angular acceleration is determined proportionally to the linear acceleration.
- If the time is specified, values are processed based on time, ignoring vel and acc.
- If the time is None, it is set to 0.
- _g_coord is applied if the ref is None. (The initial value of _g_coord is DR_BASE, and it can be set by the set_ref_coord command.)
- If the mod is DR_MV_MOD_REL, each pos in the pos_list is defined in the relative coordinate of the previous pos. (If pos_list=[p1, p2, ...,p(n-1), p(n)], p1 is the relative angle of the starting point while p(n) is the relative coordinate of p(n-1).)
- This function does not support online blending of previous and subsequent motions.

⚠ Caution

The constant velocity motion according to the distance and velocity between the waypoints cannot be used if the "vel_opt= DR_MVS_VEL_CONST" option (constant velocity option) is selected, and the motion is automatically switched to the variable velocity motion (vel_opt= DR_MVS_VEL_NONE) in that case.

Return

Value	Description
0	Success
Negative value	Error

Exception

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
#Example 1. D-Out 3 seconds after the spline motion through x1 - x6 begins
P0 = posj(0,0,90,0,90,0)
movej(P0)
x0 = posx(600, 43, 500, 0, 180, 0)          # Defines the posx variable (space coordinate/pose) x0.
movel(x0, vel=100, acc=200)      # Linear movement to the initial position x0
x1 = posx(600, 600, 600, 0, 175, 0)          # Defines the posx variable (space coordinate/pose) x1.
x2 = posx(600, 750, 600, 0, 175, 0)
x3 = posx(150, 600, 450, 0, 175, 0)
x4 = posx(-300, 300, 300, 0, 175, 0)
x5 = posx(-200, 700, 500, 0, 175, 0)
x6 = posx(600, 600, 400, 0, 175, 0)

xlist = [x1, x2, x3, x5, x6]            # Defines the list (xlist) which is a set of x1-x6 as the waypoints.

amovesx(xlist, vel=[100, 30], acc=[200, 60], vel_opt=DR_MVS_VEL_NONE)
        # Moves the spline curve that connects the waypoints defined in the xlist
        # with a maximum velocity of 100, 30(mm/sec, deg/sec) and maximum acceleration of 200(mm/sec^2) and
        # 60(deg/sec^2). The next command is executed immediately after the motion starts.
wait(3)          # Temporarily suspends the program execution for 3 seconds (while the motion continues).
set_digital_output(1, 1)              # D-Out (no. 1 channel) ON
mwait(0)                              # Temporarily suspends the program execution until the motion is terminated.
```

- **Related commands**

posx()set_velx()/set_accx()/set_tcp()/set_ref_coord()/mwait()/movesx()

2.32 amoveb

▪ Features

The asynchronous moveb motion operates in the same way as moveb() except for the asynchronous processing and executes the next line after the command is executed.

Generating a new command for the motion before the amoveb() motion results in an error for safety reasons. Therefore, the termination of the amoveb() motion must be confirmed using mwait() or check_motion() between amoveb() and the following motion command.

Note)

- moveb(seg_list): The next command is executed after the robot starts from the current position and reaches (stops at) the end point of seg_list.
- amoveb(seg_list): The next command is executed regardless of whether the robot starts from the current position and reaches (stops at) the end point of seg_list.

▪ Parameters

Parameter Name	Data Type	Default Value	Description
pos_list	list (posb)	-	posb list
vel (v)	float list (float[2])	None	velocity or velocity1, velocity2
acc (a)	float list (float[2])	None	acceleration or acceleration1, acceleration2
time (t)	float	None	Reach time [sec] * If the time is specified, values are processed based on time, ignoring vel and acc.
ref	int	None	reference coordinate ・ DR_BASE: base coordinate ・ DR_WORLD: world coordinate ・ DR_TOOL: tool coordinate ・ user coordinate: User defined
mod	int	DR_MV_MOD_ABS	Movement basis ・ DR_MV_MOD_ABS: Absolute ・ DR_MV_MOD_REL: Relative
app_type	int	DR_MV_APP_NONE	Application mode ・ DR_MV_APP_NONE: No application related

Parameter Name	Data Type	Default Value	Description
			• DR_MV_APP_WELD: Welding application related

Note

- Abbreviated parameter names are supported. (v:vel, a:acc, t:time)
- Up to 50 arguments can be entered in posb_list.
- _global_velx is applied if vel is None. (The initial value of _global_velx is 0.0 and can be set by set_velx.)
- _global_accj is applied if acc is None. (The initial value of _global_accx is 0.0 and can be set by set_accx.)
- If an argument is inputted to vel (e.g., vel=30), the input argument corresponds to the linear velocity of the motion while the angular velocity is determined proportionally to the linear velocity.
- If an argument is inputted to acc (e.g., acc=60), the input argument corresponds to the linear acceleration of the motion while the angular acceleration is determined proportionally to the linear acceleration.
- If the time is specified, values are processed based on time, ignoring vel and acc.
- If the time is None, it is set to 0.
- _g_coord is applied if the ref is None. (The initial value of _g_coord is DR_BASE, and it can be set by the set_ref_coord command.)
- If the mod is DR_MV_MOD_REL, each pos in the pos_list is defined in the relative coordinate of the previous pos.
- This function does not support online blending of previous and subsequent motions.
- If 'app_type' is 'DR_MV_APP_WELD', parameter 'vel' is internally replaced by the speed setting entered in app_weld_set_weld_cond(), not the input value of 'vel'.

Caution

- A user input error is generated if the blending radius in posb is 0.
- A user input error is generated due to the duplicated input of Line if contiguous Line-Line segments have the same direction.
- A user input error is generated to prevent a sudden acceleration if the blending condition causes a rapid change in direction.
- This function does not support online blending of previous and subsequent motions.

Return

Value	Description
0	Success
Negative value	Error

Exception

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred

Exception	Description
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
#Example 1. D-Out 3 seconds after the motion through the path of seg11 - seg16 begins
# Init Pose @ Jx1
Jx1 = posj(45,0,90,0,90,45)                # initial joint position
X0 = posx(370, 420, 650, 0, 180, 0)        # initial task position

# CASE#1) ABSOLUTE
# Absolute Goal Poses
X1 =    posx(370, 670, 650, 0, 180, 0)
X1a = posx(370, 670, 400, 0, 180, 0)
X1a2= posx(370, 545, 400, 0, 180, 0)
X1b = posx(370, 595, 400, 0, 180, 0)
X1b2= posx(370, 670, 400, 0, 180, 0)
X1c = posx(370, 420, 150, 0, 180, 0)
X1c2= posx(370, 545, 150, 0, 180, 0)
X1d = posx(370, 670, 275, 0, 180, 0)
X1d2= posx(370, 795, 150, 0, 180, 0)

seg11 = posb(DR_LINE, X1, radius=20)
seg12 = posb(DR_CIRCLE, X1a, X1a2, radius=20)
seg14 = posb(DR_LINE, X1b2, radius=20)
seg15 = posb(DR_CIRCLE, X1c, X1c2, radius=20)
seg16 = posb(DR_CIRCLE, X1d, X1d2, radius=20)
b_list1 = [seg11, seg12, seg14, seg15, seg16]
        # The blending radius of the last waypoint (seg16) is ignored.
movej(Jx1, vel=30, acc=60, mod=DR_MV_MOD_ABS)
        # Joint motion to the initial angle (Jx1)
movel(X0, vel=150, acc=250, ref=DR_BASE, mod=DR_MV_MOD_ABS)
        # Line motion to the initial position (X0)
amoveb(b_list1, vel=150, acc=250, ref=DR_BASE, mod=DR_MV_MOD_ABS)
        # Moves the robot from the current position through a trajectory consisting of seg11(LINE), seg12(CIRCLE), seg14(LINE),
        # seg15(CIRCLE), and seg16(CIRCLE) with a constant velocity of 150(mm/sec) with the exception of accelerating and decelerating sections.
        # (The final point is X1d2.)
        # Blending to the next segment begins when the distance of 20mm from the end point (X1, X1a2, X1b2, X1c2, and X1d2)
        # of each segment is reached.
wait(3)                                    # Temporarily suspends the program execution for 3 seconds (while the motion continues).
set_digital_output(1, 1)            # D-Out (no. 1 channel) ON
mwait(0)                                   # Temporarily suspends the program execution until the motion is terminated.
```

- **Related commands**

posb()/set_velx()/set_accx()/set_tcp()/set_ref_coord()/mwait()/moveb()

2.33 amove_spiral

▪ Features

The asynchronous move_spiral motion operates in the same way as move_spiral() except for the asynchronous processing and executes the next line after the command is executed.

Generating a new command for the motion before the amove_spiral() motion results in an error for safety reasons. Therefore, the termination of the amove_spiral() motion must be confirmed using mwait() or check_motion() between amove_spiral() and the following motion command.

Motion along a spiral trajectory on a plane which is perpendicular to the input 'axis' is performed on the specified coordinate system 'ref'. Additional input, travel distance 'lmax' can cause the robot to move around a cone, starting from the apex of it

Note)

- move_spiral: The next command is executed after the robot starts from the current position and reaches (stops at) the end point of the spiral trajectory.
- amove_spiral: The next command is executed after the robot starts from the current position and regardless of whether it reaches (stops at) the end point of the spiral trajectory.

▪ Parameters

Parameter Name	Data Type	Default Value	Range	Description
rev	float	10	rev > 0	Total number of revolutions
rmax	float	10	rmax > 0	Final spiral radius [mm]
lmax	float	0		Distance moved in the axis direction [mm]
vel (v)	float	None		velocity
acc (a)	float	None		acceleration
time (t)	float	None	time ≥ 0	Total execution time <sec>
axis	int	DR_AXIS_Z	-	axis ・ DR_AXIS_X: x-axis ・ DR_AXIS_Y: y-axis ・ DR_AXIS_Z: z-axis
ref	Int	DR_TOOL	-	reference coordinate ・ DR_BASE : base coordinate ・ DR_WORLD : world coordinate ・ DR_TOOL : tool coordinate ・ user coordinate: user defined

Note

・ Abbreviated parameter names are supported. (v:vel, a:acc, t:time)

- rev refers to the total number of revolutions of the spiral motion.
- Rmax refers to the maximum radius of the spiral motion.
- Lmax refers to the parallel distance in the axis direction during the motion. A negative value means the parallel distance in the –axis direction.
- Vel refers to the moving velocity of the spiral motion.
- The first value of _global_velx (parallel velocity) is applied if vel is None. (The initial value of _global_velx is 0.0 and can be set by set_velx.)
- Acc refers to the moving acceleration of the spiral motion.
- The first value of _global_accx (parallel acceleration) is applied if acc is None. (The initial value of _global_accx is 0.0 and can be set by set_accx.)
- If the time is specified, values are processed based on time, ignoring vel and acc.
- If the time is None, it is set to 0.
- The axis defines the axis that is perpendicular to the surface defined by the spiral motion.
- Ref refers to the reference coordinate system defined by the spiral motion.
- This function does not support online blending of previous and subsequent motions.

⚠ Caution

- An error can be generated to ensure safe motion if the rotating acceleration calculated by the spiral path is too great.
  In this case, reduce the vel, acc, or time value.

Return

Value	Description
0	Success
Negative value	Error

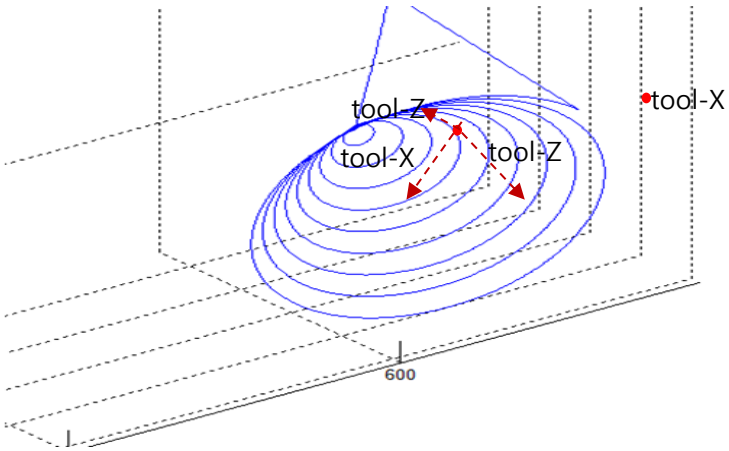
Exception

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

Example

```
## hole search
# (A motion that completes 9.5 revolutions (rev) to the 30 mm radius (rmax) from 0 on the Tool-X/Y surface as the center of the rotation in the Tool-Z direction
# and the spiral trajectory that moves 50 mm (lmax) in the Tool-Z direction at the same time in 20 seconds
```

```
# from the initial position.
# D-Out (no. 1 channel) 3 seconds after the motion begins.)

J00 = posj(0,0,90,0,60,0)
movel(J00, vel=30, acc=30)        # Joint moves to the beginning pose
amove_spiral(rev=9.5,rmax=50.0,lmax=50.0,time=10.0,axis=DR_AXIS_Z,ref=DR_TOOL)
wait(3)
set_digital_output(1, 1)          # D-Out (no. 1 channel) ON
mwait(0)                          # Waits until the motion stops.
```



- **Related commands**

set_velx()/set_accx()/set_tcp()/set_ref_coord()/mwait()/move_spiral()

2.34 amove_periodic

▪ Features

The asynchronous move_periodic motion operates in the same way as move_periodic() except for the asynchronous processing and executes the next line after the command is executed.

Generating a new command for the motion before the amove_periodic() motion results in an error for safety reasons. Therefore, the termination of the amove_periodic() motion must be confirmed using mwait() or check_motion() between amove_periodic() and the following motion command.

This command performs a cyclic motion based on the sine function of each axis (parallel and rotation) of the reference coordinate (ref) input as a relative motion that begins at the current position. The attributes of the motion on each axis are determined by amp (amplitude) and period, and the acceleration/deceleration time and the total motion time are set by the interval and repetition count.

Note)

- move_ periodic: The next command is executed after the robot starts from the current position and reaches (stops at) the end point of the periodic trajectory.
- amove_ periodic: The next command is executed after the robot starts from the current position and regardless of whether it reaches (stops at) the end point of the periodic trajectory.

▪ Parameters

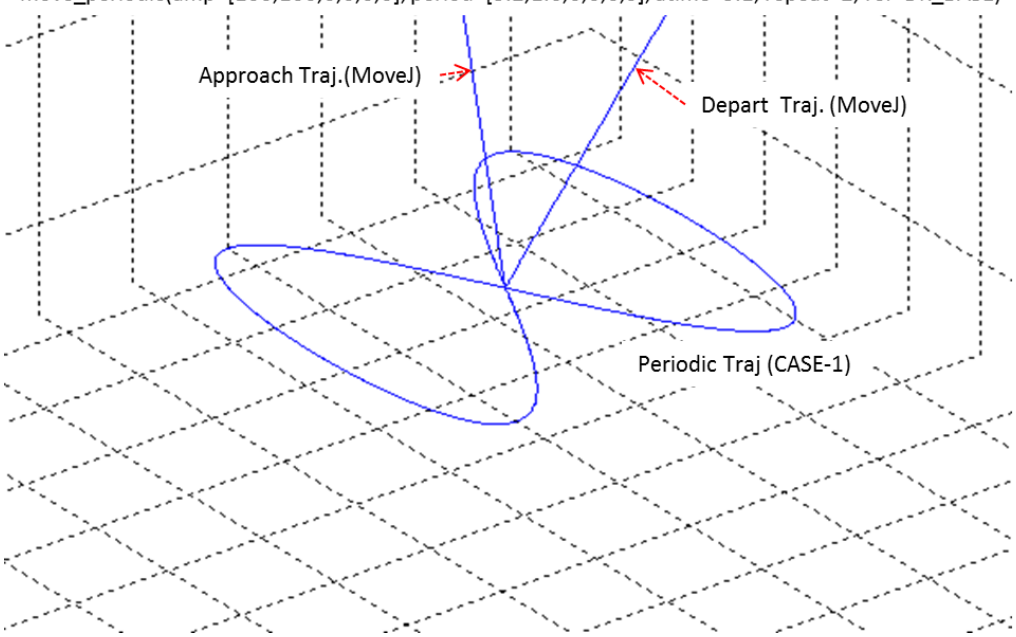
Parameter Name	Data Type	Default Value	Range	Description
amp	list (float[6])	-	0≤amp	Amplitude (motion between -amp and +amp) [mm] or [deg]
period	float or list (float[6])		0≤period	Period (time for 1 cycle) [sec]
atime	float	0.0	0≤atime	Acc-, dec- time [sec]
repeat	int	1	> 0	Repetition count
ref	int	DR_TOOL	-	reference coordinate ・ DR_BASE : base coordinate ・ DR_WORLD : world coordinate ・ DR_TOOL : tool coordinate ・ user coordinate: user defined

Note

- Amp refers to the amplitude. The input is a list of 6 elements which are the amp values for the axes (x, y, z, rx, ry, and rz). The amp input on the axis that does not have a motion must be 0.
- Period refers to the time needed to complete a motion in the direction, the amplitude. The input is a list of 6 elements which are the periods for the axes (x, y, z, rx, ry, and rz).
- Atime refers to the acceleration and deceleration time at the beginning and end of the periodic motion. The largest of the inputted acceleration/deceleration times and maximum period*1/4 is applied. An error is generated when the inputted acceleration/deceleration time exceeds 1/2 of the total motion time.
- Repeat refers to the number of repetitions of the axis (reference axis) that has the largest period value and determines the total motion time. The number of repetitions for each of the remaining axes is determined automatically according to the motion time.
- If the motion terminates normally, the motions for the remaining axes can be terminated before the reference axis's motion terminates so that the end position matches the starting position. The deceleration section will deviate from the previous path if the motions of all axes are not terminated at the same time. Refer to the following image for more information.

CASE-1) All-axis motions end at the same time

move_periodic(amp=[100,100,0,0,0,0], period=[3.2,1.6,0,0,0,0], atime=3.1, repeat=2, ref=DR_BASE)



- Ref refers to the reference coordinate system of the repeated motion.
- If a maximum velocity error is generated during a motion, adjust the amplification and period using the following formula.
  Max. velocity = Amplification(amp)*2*pi(3.14)/Period(period) (i.e., Max. velocity=62.83mm/sec if amp=10mm and period=1 sec)
- This function does not support online blending of previous and subsequent motions.

- **Return**

Value	Description
0	Success
Negative value	Error

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
P0 = posj(0,0,90,0,90,0)
movej(P0)
amove_periodic(amp =[10,0,0,0,0.5,0], period=1, atime=0.5, repeat=5, ref=DR_TOOL)
wait(1)
set_digital_output(1, 1)
mwait(0)
# Repeats the x-axis (10mm amp and 1 sec. period) motion and y rotating axis (0.5deg amp and 1 sec. period) motion in the tool coordinate system
# 5 times.
# SET(1) the Digital_Output channel no. 1, 1 second after the periodic motion begins.
```

- **Related commands**

set_ref_coord()/move_periodic()

2.35 mwait(time=0)

- **Features**

  This function sets the waiting time between the previous motion command and the motion command in the next line. The waiting time differs according to the time[sec] input.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
time	float	0	Waiting time after the motion ends [sec]

- **Return**

Value	Description
0	Success
Negative value	Error

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
#Example 1. The robot moves to q1 and stops the motion 3 seconds after it begins the
motion at q0 and then moves to q99
q0 = posj(0, 0, 90, 0, 90, 0)
amovej (q0, vel=10, acc=20)       # Moves to q0 and performs the next command
immediately after
wait(3)                                    # Temporarily suspends the program
execution for 3 seconds (while the motion continues).
q1 = posj(0, 0, 0, 0, 90, 0)
amovej (q1, vel=10, acc=20)
        # Maintains the q0 motion (DUPLICATE blending if the ra argument is omitted)
        and iterates to q1.
        # Performs the next command immediately after the blending motion.
mwait(0)                           # Temporarily suspends the program execution until
the motion is terminated.
q99 = posj(0, 0, 0, 0, 0, 0)
movej (q99, vel=10, acc=20)       # Joint motion to q99.
```

- **Related commands**

wait()amovej()/amovel()/amovejx()/amovec()/amovesj()/amovesx()/amoveb()/ amove_spiral()/amove_periodic()

2.36 begin_blend(radius=0)

- **Features**

  This function begins the blending section. The following sync motion commands (movej, movel, movec, and movejx) with the blending section argument radius are blended using the radius set as the default argument. There is no actual blending effect if the radius is 0. Moreover, if a blending radius that is different from the set radius is needed, the blending radius can be changed as an exception by specifying the blending radius to the motion argument.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
radius	float	0	Radius for blending

- **Return**

Value	Description
0	Success

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred

- **Example**

```
#1
begin_blend(radius=30)
        # The motion commands with the following radius option sets
        # the blending section to 30mm.
Q1 = posj(0,0,90,0,90,0)
Q2 = posj(0,0,0,0,90,0)
movej(Q1, vel=10, acc=20)
        # Moves to the Q1 joint angle and is set to execute the next motion
        # when the global distance from the Q1 space position is 30mm.
movej(Q2, time=5)
        # Moves to the Q2 joint angle after the blend while maintaining the last motion
        (motion iteration).
        # It is set to execute the next motion
        # when the global distance from the Q2 space position is 30mm.
movej(Q1, v=30, a=60, r=200)
        # Moves to the Q1 joint angle after the blending while maintaining the last motion
        (motion iteration).
        # It is set to execute the next motion
        # when the distance from the Q1 space position is 200mm (the global setting is
        not applied).
movej(Q2, v=30, a=60, ra= DR_MV_RA_OVERRIDE)
        # Immediately terminates the last motion and blends it to move to the Q2 joint
        angle.

end_blend()     # Ends the batch setting of the blending sections.
```

- **Related commands**

end_blend()/movej()/movel()/movejx()/movec()

2.37 end_blend()

- **Features**

This function ends the blending section. It means that the validity of the blending section that began with begin_blend() ends.

- **Parameters**

Not applicable

- **Return**

Value	Description
0	Success

- **Exception**

Not applicable

- **Example**

```
#1
begin_blend(radius=30)
    # The motion commands that have the following radius option set the blending
    section to 30mm.
Q1 = posj(0,0,90,0,90,0)
Q2 = posj(0,0,0,0,90,0)
movej(Q1, vel=10, acc=20)
    # Moves to the Q1 joint angle and is set to execute the next motion
    # when the global distance from the Q1 space position is 30mm.
movej(Q2, time=5)
    # Immediately terminates the last motion and blends it to move to the Q2 joint
    angle (motion iteration).
    # It is set to execute the next motion
    # when the global distance from the Q2 space position is 30mm.
movej(Q1, v=30, a=60, r=200)
    # Immediately terminates the last motion and blends it to move to the Q1 joint
    angle (motion iteration).
    # It is set to execute the next motion
    # when the distance from the Q1 space position is 200mm (the global setting is not
    applied).
movej(Q2, v=30, a=60, ra= DR_MV_RA_OVERRIDE)
    # Immediately terminates the last motion and blends it to move to the Q2 joint
    angle.
end_blend()    # Ends the batch setting of the blending sections.
```

- **Related commands**

begin_blend()/movej()/movel()/movejx()/movec()

2.38 check_motion()

- **Features**

  This function checks the status of the currently active motion.

- **Parameters**

  Not applicable

- **Return (TBD)**

Value	Description
0	DR_STATE_IDLE (no motion in action)
1	DR_STATE_INIT (motion being calculated)
2	DR_STATE_BUSY (motion in operation)

- **Exception**

Exception	Description
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
#1. The next motion (q99) is executed when an asynchronous motion to q0 begins
decelerating
q0 = posj(0, 0, 90, 0, 90, 0)
q99 = posj(0, 0, 0, 0, 0, 0)
amovej (q0, vel=10, acc=20)       # Executes the next command immediately after the
motion to q0.
while True:
  if check_motion()==0:           # A motion is completed.
      amovej (q99, vel=10, acc=20)   # Joint motion to q99.
      break
  if check_motion()==2:           # In motion
      pass
mwait(0)                          # Temporarily suspends the program execution until
the motion is terminated.
```

- **Related commands**

movej()/movel()/movejx()/movec()/movesj()/movesx()/moveb()/move_spiral()/move_periodic()/amovej()/amovel()/amovejx()/amovec()/amovesj()/amovesx()/amoveb()/amove_spiral()/amove_periodic()

2.39 stop(st_mode)

- **Features**

This function stops the currently active motion. stop time is determined by the ‘st_mode’ and robot position does not deviate from the in-progress path.
This command is only used to stop the robot from operating and will not cause stop the program. To stop a program from running, use additionally exit() function. Factor DR_QSTO_STO and DR_QSTOP correspond to Stop Category 1 (torque-off after maximum rate deceleration) and Stop Category 2 (maximum rate deceleration), respectively, as defined by Functional Safety, but Torque off after deceleration will not occur. For DR_SSTOP, deceleration time is about 1.5 times longer than the maximum rate deceleration time. In the case of DR_HOLD, stop immediately with no deceleration time.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
st_mode	int	-	stop mode ・ DR_QSTOP_STO: Quick stop (Stop Category 1 without STO(Safe Torque Off) ・ DR_QSTOP: Quick stop (Stop Category 2) ・ DR_SSTOP: Soft Stop ・ DR_HOLD: HOLE stop

- **Return**

Value	Description
0	Success
Negative value	Error

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

Example

```
#1. The motion is terminated with a soft stop 2 seconds after moving to x1
p0 = posj(-148,-33,-54,180,92,32)
movej(p0, v=30, a=30)
x1 = posx(784, 543, 570, 0, 180, 0)
amovel (x1, vel=100, acc=200)    # Executes the next command immediately after the motion with x1.
wait(2)                          # Temporarily suspends the program for 2 seconds.
stop(DR_SSTOP)                   # Stops the motion with a soft stop.
```

Related commands

movej()/movel()/movejx()/movec()/movesj()/movesx()/moveb()/move_spiral()/move_periodic()/amovej()/amovel()/amovejx()/amovec()/amovesj()/amovesx()/amoveb()/amove_spiral()/amove_periodic()

2.40 change_operation_speed(speed)

- **Features**

  This function adjusts the operation velocity. The argument is the relative velocity in a percentage of the currently set velocity and has a value from 1 to 100. Therefore, a value of 50 means that the velocity is reduced to 50% of the currently set velocity.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
speed	int	-	operation speed(1~100)

- **Return**

Value	Description
0	Success
Negative value	Error

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
change_operation_speed(10)
change_operation_speed(100)
#1. Motion with velocity specified to q0 and 20% of the specified velocity
q0 = posj(0, 0, 90, 0, 90, 0)
movej (q0, vel=10, acc=20)          # Moves to q0 at a velocity of 10mm/sec
change_operation_velocity(10)    # The velocities of all following motions executed are
10% of the specified velocity.
q1 = posj(0, 0, 0, 0, 90, 0)
movej (q1, vel=10, acc=20)          # Moves to q1 at a velocity of 10% of 10mm/sec.
change_operation_speed(100)    # The velocities of all following motions executed are
100% of the specified velocity.
movej (q0, vel=10, acc=20)          # Moves to q0 at a velocity 100% of 10mm/sec
```

- **Related commands**

movej()/movel()/movejx()/movec()/movesj()/movesx()/moveb()/move_spiral()/move_periodic()/amovej()/amovel()/amovejx()/amovec()/amovesj()/amovesx()/amoveb()/amove_spiral()/amove_periodic()

2.41 wait_manual_guide()

- **Features**

This function enables the user to perform hand guiding (changing the position of the robot by pressing the Direct Teach button in the cockpit or the TP) during the execution of the program. The user executes the next command in one of the following two ways after hand guiding is completed (unless the program is terminated, it will wait at the command until one of the following is executed after the user performs hand guiding).

1) The user presses the "OK" or "Finish" button on the "Hand Guiding Execution" popup window generated from the TP.

2) A signal is applied to the digital input channel specified for "Manual guide release" in the safety I/O settings.

The current TCP position and the TCP position of the hand guided robot must be in the collaborative workspace in order to execute this command properly. Run the command after specifying the hand guiding area as the collaborative workspace and enabling it. An error is generated, and the program is terminated to ensure worker safety if the current position or hand guiding deviates from the collaborative workspace.

- **Parameters**

Not applicable

- **Return**

Value	Description
0	Success
Negative value	Error

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
# Sets up the collaborative workspace before executing the program.
# Surface 1: Point-1(1000,1000), Point-2(0,0)
# Surface 2: Point-1(1000,-1000), Point-2(0,0)
# Activation of domain 1 - Point(1000,0)

j00 = posj(0,0,90,0,90,0)
movej(j00,vel=20,acc=40)    # Enters the collaborative workspace.
wait_manual_guide()    # Direct teaching until the "Finish" button on the popup window
```

```
generated by the TP is pressed.
pos1 = get_current_posx()    # Stores the directly taught point in pos1.
dposa = posx(0,0,-100,0,0,0)
movel(dposa, vel=300, acc=600, ref=DR_TOOL)
                              # Retract 100 mm in the tool-Z direction from the taught position.
```

- **Related commands**

movej()/movel()/movejx()/movec()/movesj()/movesx()/moveb()/move_spiral()/move_periodic()/amovej()/amovel()/amovejx()/amovec()/amovesj()/amovesx()/amoveb()/amove_spiral()/amove_periodic()

2.42 wait_nudge()

- **Features**

This function enables users to resume the execution of the program through the user's nudge input (applying external force to the robot) when the execution of the program is paused. When the external force greater than the force threshold, it will proceed to the following command after the resume time, where the force threshold and the resume time are set at the collaborative workspace setting menu. This command can be used as an interlock during the program.
However, if the robot's configuration is in the singularity area, or if the force is applied continuously after the nudge input, warning will be occurred for safety.
For this function is allowed to execute within the collaborative workspace, please set the collaborative workspace, activate it, and assure the TCP position is in this workspace when this command is performed in advance.

- **Parameters**

Not applicable

- **Return**

Value	Description
0	Success
Negative value	Error

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
# Sets up the collaborative workspace before executing the program.
# Surface 1: Point-1(1000,1000), Point-2(0,0)
# Surface 2: Point-1(1000,-1000), Point-2(0,0)
# Activation of domain 1 - Point(1000,0)

j00 = posj(0,0,90,0,90,0)
movej(j00,vel=20,acc=40)    # Enters the collaborative workspace.
wait_nudge()    # Wait for applying external force exceeding the threshold to the robot
dposa = posx(0,0,-100,0,0,0)
movel(dposa, vel=300, acc=600, ref=DR_TOOL)
                            # Retract 100 mm in the tool-Z direction from the taught position.
```

- **Related commands**

movej()/movel()/movejx()/movec()/movesj()/movesx()/moveb()/move_spiral()/move_periodic()/amovej()/amovel()/amovejx()/amovec()/amovesj()/amovesx()/amoveb()/amove_spiral()/amove_periodic()

2.43 enable_alter_motion(n,mode,ref,limit_dPOS,limit_dPOS_per)

▪ Features

enable_alter_motion() and alter_motion() functions enable to alter motion trajectory.
This function sets the configurations for altering function and allows the input quantity of alter_motion() to be applied to motion trajectory. The unit cycle time of generating alter motion is 100msec. Cycle time(n*100msec) can be changed through input parameter n. This function provide 2 modes(Accumulation mode, Increment mode). Input quantity of alter_motion() can be applied to motion trajectory in two ways as accumulated value or increment value. In accumulation mode, the input quantity means absolute altering amount(dX,dY,dZ,dRX,dRY,dRZ) from current motion trajectory. On the contrary in increment mode, the quantity means increment value from the previous absolute altering amount. The reference coordinate can be changed through input parameter ref. Limitations of accumulation amout and increment amount can be set through input paramet limit_dPOS (accumulated limit) and limit_dPOS_per(increment input limit during 1 cycle). The actual alter amount is limited to these limits.

▪ Parameters

Parameter Name	Data Type	Default Value	Description
n	int	None	Cycle time number
mode	Int	None	Mode · DR_DPOS : accumulation amount · DR_VEL : increment amount
ref	int	None	reference coordinate · DR_BASE : base coordinate · DR_WORLD : world coordinate · DR_TOOL : tool coordinate user coordinate: user defined
limit_dPOS	list(float[2])	None	First value : limitation of position[mm] Second value : limitation of orientation[deg]
Limit_dPOS_per	list(float[2])	None	Fist value : limitation of position[mm] Second value : limitation of orientation[deg]

Note

- _global_ref is applied if ref is None
- Accumulation amount or increment amout isn't be limited if limit_dPOS or limit_dPOS_per is None.

- alter_motion() can be executed only in user thread.

▪ Exception

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

▪ Example

```
def alter_thread():
        alter_motion(dX) #dX : amount of alter motion

dX = [10,0,0,10,0,0]

J00 = posj(0,0,90,0,90)
X1 = posx(559.0, 200, 651.5, 180, -180.0, 180)
X2 = posx(559.0, 200, 400, 180, -180.0, 180)

movej(J00,vel=50,acc=100)

enable_alter_motion(n=10,mode=DR_DPOS, ref=DR_BASE, limit_dPOS=[50,90],
limit_dPOS_per=[50,50])
# cycle time:(5*100)msec, mode:accumulate, reference coordination:base
coordination
# Lmitation of accumulation amount :50mm,50deg
# Limitation of increment amount :10mm, 10deg

th_id = thread_run(alter_thread, loop=True)

movel(X1,v=50,a=100,r=30)
movel(X2,v=50,a=100)

thread_stop(th_id)
```

```
disable_alter_motion() # deactivates alter motion
```

- **Related commands**

alter_motion(pos), disable_alter_motion()

2.44 alter_motion([x,y,z,rx,ry,rz])

▪ Features

This function applies altering amount of motion trajectory when the alter function is activated. The meaning of the input values is defined from enable_alter_motion().

Caution

- alter_motion() can be executed only in user thread.

Note

- alter_motion() can be executed only in user thread.
- Alter motion can be adjusted through setting value limit_dPOS or limit_dPOS_per in enable_alter_motion function.
- Orientation of Input pose follows fixed XYZ notation.

▪ Parameters

Parameter Name	Data Type	Default Value	Description
pos	list (float[6])	None	position list

▪ Exception

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

▪ Example

```
def alter_thread():
        alter_motion(dX) #dX : amount of alter motion

dX = [10,0,0,10,0,0]

J00 = posj(0,0,90,0,90)
```

```
X1 = posx(559.0, 200, 651.5, 180, -180.0, 180)
X2 = posx(559.0, 200, 400, 180, -180.0, 180)

movej(J00,vel=50,acc=100)

enable_alter_motion(n=5,mode=DR_DPOS, ref=DR_BASE, limit_dPOS=[50,90],
limit_dPOS_per=[10,10])
# cycle time:(5*100)msec, mode:accumulate, reference coordination:base
coordination
# Lmitation of accumulation amount :50mm,90deg
# Limitation of increment amount :10mm, 10deg

th_id = thread_run(alter_thread, loop=True)

movel(X1,v=50,a=100,r=30)
movel(X2,v=50,a=100)

thread_stop(th_id)
disable_alter_motion() # deactivates alter motion
```

- **Related commands**

enable_alter_motion(n,mode,ref,limit_dPOS,limit_dPOS_per), disable_alter_motion()

2.45 disable_alter_motion()

- **Features**

This function deactivates alter motion.

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
def alter_thread():
        alter_motion(dX) #dX : amount of alter motion

dX = [10,0,0,10,0,0]

J00 = posj(0,0,90,0,90)
X1 = posx(559.0, 200, 651.5, 180, -180.0, 180)
X2 = posx(559.0, 200, 400, 180, -180.0, 180)

movej(J00,vel=50,acc=100)

enable_alter_motion(n=10,mode=DR_DPOS, ref=DR_BASE, limit_dPOS=[50,90],
limit_dPOS_per=[50,50])
# cycle time:(5*100)msec, mode:accumulate, reference coordination:base
coordination
# Lmitation of accumulation amount :50mm,50deg
# Limitation of increment amount :10mm, 10deg

th_id = thread_run(alter_thread, loop=True)
```

```
movel(X1,v=50,a=100,r=30)
movel(X2,v=50,a=100)

thread_stop(th_id)
disable_alter_motion() # deactivates alter motion
```

- **Related commands**

enable_alter_motion(n,mode,ref,limit_dPOS,limit_dPOS_per), alter_motion(pos)

3. Auxiliary Control Commands

3.1 get_control_mode()

- **Features**

This function returns the current control mode.

- **Parameters**

Not applicable

- **Return**

Value	Description
int	Control mode 3 : Position control mode 4 : Torque control mode

- **Exception**

Exception	Description
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred

- **Example**

```
mode = get_control_mode()
```

- **Related commands**

Not applicable

3.2 get_control_space()

- **Features**

This function returns the current control space.

- **Parameters**

Not applicable

- **Return**

Value	Description
int	Control mode 1 : Joint space control 2 : Task space control

- **Exception**

Exception	Description
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred

- **Example**

```
x1 = get_control_space()
```

- **Related commands**

Not applicable

3.3 get_current_posj()

- **Features**

This function returns the current joint angle.

- **Parameters**

Not applicable

- **Return**

Value	Description
posj	Joint angle

- **Exception**

Exception	Description
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred

- **Example**

```
q1 = get_current_posj()
```

- **Related commands**

get_desired_posj()

3.4 get_current_velj()

- **Features**

This function returns the current joint velocity.

- **Parameters**

Not applicable

- **Return**

Value	Description
float[6]	Joint speed

- **Exception**

Exception	Description
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred

- **Example**

```
velj1 = get_current_velj()
```

- **Related commands**

get_desired_velj()

3.5 get_desired_posj()

- **Features**

  This function returns the current target joint angle. It cannot be used in the movel, movec, movesx, moveb, move_spiral, or move_periodic command.

- **Parameters**

  Not applicable

- **Return**

Value	Description
posj	Joint angle

- **Exception**

Exception	Description
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_INVALID)	Invalid command

- **Example**

```
jp1 = get_desired_posj()
```

- **Related commands**

get_current_posj()

3.6 get_desired_velj()

- **Features**

This function returns the current target joint velocity. It cannot be used in the movel, movec, movesx, moveb, move_spiral, or move_periodic command.

- **Parameters**

Not applicable

- **Return**

Value	Description
float[6]	Target joint velocity

- **Exception**

Exception	Description
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_INVALID)	Invalid command

- **Example**

```
velj1 = get_desired_velj()
```

- **Related commands**

get_current_velj()

3.7 get_current_posx(ref)

▪ Features

This function returns the pose and solution space of the current coordinate system. The pose is based on the ref coordinate.

▪ Parameters

Parameter Name	Data Type	Default Value	Description
ref	Int	DR_BASE	reference coordinate · DR_BASE : base coordinate · DR_WORLD : world coordinate · user coordinate: User defined

Note

- ref: DR_BASE (base coordinate)/user coordinate (globally declared user coordinate)
- DR_BASE is applied when ref is omitted.

▪ Return

Value	Description
Posx	Task space point
Int	Solution space (0 ~ 7)

▪ Robot configuration vs. solution space

Solution space	Binary	Shoulder	Elbow	Wrist
0	000	Lefty	Below	No Flip
1	001	Lefty	Below	Flip
2	010	Lefty	Above	No Flip
3	011	Lefty	Above	Flip
4	100	Righty	Below	No Flip
5	101	Righty	Below	Flip
6	110	Righty	Above	No Flip
7	111	Righty	Above	Flip

▪ Exception

Exception	Description
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred

- **Example**

```
x1, sol = get_current_posx()    #x1 w.r.t. DR_BASE

x1_wld, sol = get_current_posx(ref=DR_WORLD)    #x1 w.r.t. DR_WORLD

DR_USR1=set_user_cart_coord(x1, x2, x3, pos)
set_ref_coord(DR_USR1)

x1, sol = get_current_posx(DR_USR1)    #x1 w.r.t. DR_USR1
```

- **Related commands**

get_desired_posx()

3.8 get_current_tool_flange_posx(ref)

▪ Features

This function returns the pose of the current tool flange based on the ref coordinate. In other words, it means the return to tcp=(0,0,0,0,0,0).

▪ Parameters

Parameter Name	Data Type	Default Value	Description
ref	int	DR_BASE	reference coordinate · DR_BASE : base coordinate · DR_WORLD : world coordinate

▪ Return

Value	Description
posx	Pose of tool flange

▪ Exception

Exception	Description
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred

▪ Example

```
x1 = get_current_tool_flange_posx()
#x1 : Flange pose base on the base coordinate(default value)
x2 = get_current_tool_flange_posx(DR_BASE)
#x2 : Flange pose based on the base coordinate
x3 = get_current_tool_flange_posx(DR_WORLD)
#x3 : Flange pose based on the world coordinate
```

▪ Related commands

Not applicable

3.9 get_current_velx(ref)

▪ Features

This function returns the current tool velocity based on the ref coordinate.

▪ Parameters

Parameter Name	Data Type	Default Value	Description
ref	Int	DR_BASE	reference coordinate · DR_BASE : base coordinate · DR_WORLD : world coordinate

▪ Return

Value	Description
float[6]	Tool velocity

▪ Exception

Exception	Description
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred

▪ Example

```
velx1 = get_current_velx()
# velx1 : velocity based on the base coordinate(default value)
velx2 = get_current_velx(DR_BASE)
# velx2 (=velx1) : velocity based on the base coordinate
velx3 = get_current_velx(DR_WORLD)
#velx3 : velocity based on the world coordinate
```

▪ Related commands

get_desired_velx()

3.10 get_desired_posx(ref)

▪ Features

This function returns the target pose of the current tool. The pose is based on the ref coordinate.

▪ Parameters

Parameter Name	Data Type	Default Value	Description
ref	Int	DR_BASE	reference coordinate · DR_BASE : base coordinate · DR_WORLD : world coordinate · user coordinate: User defined

Note

- ref: DR_BASE (base coordinate)/user coordinate (globally declared user coordinate)
- DR_BASE is applied when ref is omitted.

▪ Return

Value	Description
float[6]	Tool velocity

▪ Exception

Exception	Description
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred

▪ Example

```
x1 = get_desired_posx()   #x1 w.r.t. DR_BASE
x2 = posx(100, 0, 0, 0, 0, 0)
x3 = posx(0, 0, 20, 20, 20, 20)
pos = x3
DR_USR1=set_user_cart_coord(x1, x2, x3, pos)
set_ref_coord(DR_USR1)

xa = get_desired_posx(DR_USR1)   #xa w.r.t. DR_USR1


xb = get_desired_posx(DR_WORLD)   #xb w.r.t. DR_WORLD
```

▪ Related commands

get_desired_posx()

3.11 get_desired_velx(ref)

- **Features**

This function returns the target velocity of the current tool based on the ref coordinate. It cannot be used in the movej, movejx, or movesj command.

- **Parameters**

인수명	자료형	기본값	설명
ref	Int	DR_BASE	reference coordinate · DR_BASE : base coordinate · DR_WORLD : world coordinate

- **Return**

Value	Description
float[6]	Tool velocity

- **Exception**

Exception	Description
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_INVALID)	Invalid command

- **Example**

```
vel_x1 = get_desired_velx()
#vel_x1 : desired velocity of the tool based on the base coordinate(default value)
vel_x2 = get_desired_velx(DR_BASE)
#vel_x2 : desired velocity of the tool based on the base coordinate
vel_x3 = get_desired_velx(DR_WORLD)
#vel_x3 : desired velocity of the tool based on the world
```

- **Related commands**

get_current_velx()

3.12 get_current_solution_space()

- **Features**

This function returns the current solution space value.

- **Parameters**

Not applicable

- **Return**

Value	Description
int	Solution space (0 ~ 7)

- **Exception**

Exception	Description
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred

- **Example**

```
sol = get_current_solution_space()
```

- **Related commands**

get_solution_space()

3.13 get_current_rotm(ref)

- **Features**

This function returns the direction and matrix of the current tool based on the ref coordinate.

- **Parameters**

인수명	자료형	기본값	설명
ref	Int	DR_BASE	reference coordinate · DR_BASE : base coordinate · DR_WORLD : world coordinate

- **Return**

Value	Description
float[3][3]	Rotation matrix

- **Exception**

Exception	Description
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred

- **Example**

```
rotm1 = get_current_rotm(DR_WORLD)
#rotm1 : rotation matrix(3x3) based on the world coordinate
        # The result value is stored in a 3x3 matrix.
```

$$rotm1=\begin{bmatrix} rotm1[0][0] & rotm1[0][1] & rotm1[0][2] \\ rotm1[1][0] & rotm1[1][1] & rotm1[1][2] \\ rotm1[2][0] & rotm1[2][1] & rotm1[2][2] \end{bmatrix}$$

- **Related commands**

Not applicable

3.14 get_joint_torque()

- **Features**

This function returns the sensor torque value of the current joint.

- **Parameters**

Not applicable

- **Return**

Value	Description
float[6]	JTS torque value

- **Exception**

Exception	Description
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred

- **Example**

```
j_trq1 = get_joint_torque()
```

- **Related commands**

get_external_torque()/get_tool_force()

3.15 get_external_torque()

- **Features**

This function returns the torque value generated by the external force on each current joint.

- **Parameters**

Not applicable

- **Return**

Value	Description
float[6]	Torque value generated by an external force

- **Exception**

Exception	Description
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred

- **Example**

```
trq_ext=get_external_torque()
```

- **Related commands**

get_joint_torque()/get_tool_force()

3.16 get_tool_force(ref)

▪ Features

This function returns the external force applied to the current tool based on the ref coordinate. The force is based on the base coordinate while the moment is based on the tool coordinate.

▪ Parameters

Parameter Name	Data Type	Default Value	Description
ref	Int	DR_BASE	reference coordinate · DR_BASE : base coordinate · DR_WORLD : world coordinate

▪ Return

Value	Description
float[6]	External force applied to the tool

▪ Exception

Exception	Description
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred

▪ Example

```
force_ext = get_tool_force(DR_WORLD)
# force_ext: external force of the tool based on the world coordinate
```

▪ Related commands

get_joint_torque()/get_external_torque()

3.17 get_solution_space(pos)

- **Features**

This function obtains the solution space value for the entered pos(posj).

- **Parameters**

Parameter Name	Data Type	Default Value	Description
pos	posj list (float[6])	-	posj or position list

- **Return**

Value	Description
0 ~ 7	Solution space

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
q1 = posj(0, 0, 0, 0, 0, 0)
sol1 = get_solution_space(q1)
sol2 = get_solution_space([10, 20, 30, 40, 50, 60])
```

- **Related commands**

get_current_solution_space()

3.18 get_orientation_error(xd, xc, axis)

- **Features**

This function returns the orientation error value between the arbitrary poses xd and xc of the axis.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
xd	posx list (float[6])	-	posx or position list
xc	posx list (float[6])	-	posx or position list
axis	int	-	axis · DR_AXIS_X: x-axis · DR_AXIS_Y: y-axis · DR_AXIS_Z: z-axis

- **Return**

Value	Description
float	Orientation error value

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
xd = posx(0, 0, 0, 0, 0, 0)
xc = posx(10, 20, 30, 40, 50, 60)
diff = get_orientation_error(xd, xc, DR_AXIS_X)
```

- **Related commands**

get_current_rotm()

4. Other Settings and Safety-related Commands

4.1 get_workpiece_weight()

- **Features**

This function measures and returns the weight of the workpiece.

- **Parameters**

Not applicable

- **Return**

Value	Description
Positive value	Measured weight
Negative value	Error

- **Exception**

Exception	Description
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
weight = get_workpiece_weight()
```

- **Related commands**

set_workpiece_weight()/reset_workpiece_weight()

4.2 reset_workpiece_weight()

- **Features**

This function initializes the weight data of the material to initialize the algorithm before measuring the weight of the material.

- **Parameters**

Not applicable

- **Return**

Value	Description
0	Success
Negative value	Error

- **Exception**

Exception	Description
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
reset_workpiece_weight()
```

- **Related commands**

set_workpiece_weight()/get_workpiece_weight()

4.3 set_tool(name)

- **Features**

  This function activates the tool of the entered name among the tool information registered in the Teach Pendant.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
name	string	-	Tool name registered in the Teach Pendant

- **Return**

Value	Description
0	Success
Negative value	Error

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
set_tool ("tool1")    # Activate the information of "tool1" registered in TP.
```

- **Related commands**

set_tcp()

4.4 set_tool_shape(name)

- **Features**

  This function activates the tool shape information of the entered name among the tool shape information registered in the Teach Pendant.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
name	string	-	Tool name registered in the Teach Pendant

- **Return**

Value	Description
0	Success
Negative value	Error

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
set_tool_shape("tool_shape1")  # Activate the geometry of "tool_shape1".
```

- **Related commands**

set_tcp()

4.5 set_singularity_handling(mode)

▪ Features

In case of path deviation due to the effect of singularity in task motion, user can select the response policy. The mode can be set as follows.

- Automatic avoidance mode(Default) : DR_AVOID
- Path first mode : DR_TASK_STOP
- Variable velocity mode : DR_VAR_VEL

The default setting is automatic avoidance mode, which reduces instability caused by singularity, but reduces path tracking accuracy. In case of path first setting, if there is possibility of instability due to singularity, a warning message is output after deceleration and then the corresponding task is terminated. In case of variable velocity mode setting, TCP velocity would be changed in singular region to reduce instability and maintain path tracking accuracy.

▪ Parameters

Parameter Name	Data Type	Default Value	Description
mode	int	DR_AVOID	DR_AVOID : Automatic avoidance mode DR_TASK_STOP : Deceleration/ Warning/ Task termination DR_VAR_VEL : Variable velocity mode

▪ Return

Value	Description
0	Success
Negative value	Error

▪ Exception

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

▪ Example

```
.P1 = posx(400,500,800,0,180,0)
P2 = posx(400,500,500,0,180,0)
P3 = posx(400,500,200,0,180,0)
set_singularity_handling (DR_AVOID) # Automatic avoidance mode for singularity
movel(P1, vel=10, acc=20)
set_velx(30)
```

```
set_accx(60)
set_singularity_handling(DR_TASK_STOP) # Task motion path first
movel(P2)
set_singularity_handling(DR_VAR_VEL) # Variable velocity mode for singularity
movel(P3)
```

- **Related commands**

movel()/movec()/movesx()/moveb()/move_spiral()/amovel()/amovec()/
amovesx()/amoveb()/amove_spiral()

5. Force/Stiffness Control and Other User-Friendly Features

5.1 parallel_axis(x1, x2, x3, axis, ref)

- **Features**

This function matches the normal vector of the plane consists of points(x1, x2, x3) based on the ref coordinate(refer to get_normal(x1, x2, x3)) and the designated axis of the tool frame. The current position is maintained as the TCP position of the robot.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
x1	posx list (float[6])	-	posx or position list
x2	posx list (float[6])	-	posx or position list
x3	posx list (float[6])	-	posx or position list
axis	int	-	axis ・ DR_AXIS_X: x-axis ・ DR_AXIS_Y: y-axis ・ DR_AXIS_Z: z-axis
ref	int	DR_BASE	reference coordinate ・ DR_BASE: base coordinate ・ DR_WORLD: world coordinate ・ user coordinate : user difined

- **Return**

Value	Description
0	Success
Negative value	Error

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred

Exception	Description
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
x0 = posx(0, 0, 90, 0, 90, 0)
movej(x0)
x1 = posx(0, 500, 700, 30, 0, 90)
x2 = posx(500, 0, 700, 0, 0, 45)
x3 = posx(300, 100, 500, 45, 0, 45)
parallel_axis(x1, x2, x3, DR_AXIS_X, DR_WORLD)
# match the tool x axis and the normal vector of the plane consists of points(x1,x2,x3)
# based on the world coordinate
```

- **Related commands**

get_normal()/parallel_axis()/align_axis()/align_axis()

5.2 parallel_axis(vect, axis, ref)

▪ Features

This function matches the given vect direction based on the ref coordinate and the designated axis of the tool frame. The current position is maintained as the TCP position of the robot.

▪ Parameters

Parameter Name	Data Type	Default Value	Description
vect	list (float[3])	-	vector
axis	int	-	axis · DR_AXIS_X: x-axis · DR_AXIS_Y: y-axis · DR_AXIS_Z: z-axis
ref	int	DR_BASE	reference coordinate · DR_BASE: base coordinate · DR_WORLD: world coordinate · user coordinate: user defined

▪ Return

Value	Description
0	Success
Negative value	Error

▪ Exception

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

▪ Example

```
x0 = posx(0, 0, 90, 0, 90, 0)
movej(x0)
parallel_axis([1000, 700, 300], DR_AXIS_X, DR_WORLD)
# match the tool x axis and the vector([1000,700,300]) based on the world coordinate
```

- **Related commands**

parallel_axis()/align_axis()/align_axis()

5.3 align_axis(x1, x2, x3, pos, axis, ref)

▪ Features

This function matches the normal vector of the plane consists of points(x1, x2, x3) based on the ref coordinate(refer to get_normal(x1, x2, x3)) and the designated axis of the tool frame. The robot TCP moves to the pos position.

▪ Parameters

Parameter Name	Data Type	Default Value	Description
x1	posx list (float[6])	-	posx or position list
x2	posx list (float[6])	-	posx or position list
x3	posx list (float[6])	-	posx or position list
pos	posx list (float[6])	-	posx or position list
axis	int	-	axis ・ DR_AXIS_X: x-axis ・ DR_AXIS_Y: y-axis ・ DR_AXIS_Z: z-axis
ref	int	DR_BASE	reference coordinate ・ DR_BASE: base coordinate ・ DR_WORLD: world coordinate ・ user coordinate: user defined

▪ Return

Value	Description
0	Success
Negative value	Error

▪ Exception

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred

Exception	Description
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
p0 = posj(0,0,45,0,90,0)
movej(p0, v=30, a=30)

x1 = posx(0, 500, 700, 30, 0, 0)
x2 = posx(500, 0, 700, 0, 0, 0)
x3 = posx(300, 100, 500, 0, 0, 0)
pos = posx(400, 400, 500, 0, 0, 0)
align_axis(x1, x2, x3, pos, DR_AXIS_X, DR_BASE)
# match the tool x axis and the normal vector in the plane consists of points(x1, x2,
# x3) based on the base coordinate
```

- **Related commands**

get_normal()/align_axis()/parallel_axis()/parallel_axis()

5.4 align_axis(vect, pos, axis, ref)

▪ Features

This function matches the given vect direction based on the ref coordinate and the designated axis of the tool frame. The robot TCP moves to the pos position.

▪ Parameters

Parameter Name	Data Type	Default Value	Description
vect	list (float[3])	-	vector
pos	posx list (float[6])	-	posx or position list
axis	int	-	axis ・ DR_AXIS_X: x-axis ・ DR_AXIS_Y: y-axis ・ DR_AXIS_Z: z-axis

▪ Return

Value	Description
0	Success
Negative value	Error

▪ Exception

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

▪ Example

```
p0 = posj(0,0,45,0,90,0)
movej(p0, v=30, a=30)

vect = [10, 20, 30]
pos = posx(100, 500, 700, 45, 0, 0)
align_axis(vect, pos, DR_AXIS_X)
```

▪ Related commands

align_axis()/parallel_axis()/parallel_axis()

5.5 is_done_bolt_tightening(m=0, timeout=0, axis=None)

Features

This function monitors the tightening torque of the tool and returns True if the set torque (m) is reached within the given time and False if the given time has passed.

Parameters

Parameter Name	Data Type	Default Value	Description
m	float	0	Target torque
timeout	float	0	Monitoring duration [sec]
axis	int	-	axis ・ DR_AXIS_X: x-axis ・ DR_AXIS_Y: y-axis ・ DR_AXIS_Z: z-axis

Return

Value	Description
0	Success
Negative value	Error

Exception

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
p0 = posj(0,0,90,0,90,0)
movej(p0, v=30, a=30)

task_compliance_ctrl()
xd = posx(559, 34.5, 651.5, 0, 180.0, 60)
amovel(xd, vel=50, acc=50) # Bolt tightening motion

res = is_done_bolt_tightening(10, 5, DR_AXIS_Z)
        # Returns True if the tightening torque of 10Nm is reached within 5 seconds.
        # Returns False otherwise.
if res==True:
   # some action comes here for the case that bolt tightening is done
   x=1
else:
   # some action comes here for the case that it fails
x=2
```

- **Related commands**

amovel()

5.6 release_compliance_ctrl()

- **Features**

This function terminates compliance control and begins position control at the current position.

- **Parameters**

Not applicable

- **Return**

Value	Description
0	Success
Negative value	Error

- **Exception**

Exception	Description
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
P0 = posj(0,0,90,0,90,0)
movej(P0)
task_compliance_ctrl()
set_stiffnessx([100, 100, 300, 100, 100, 100])
release_compliance_ctrl()
```

- **Related commands**

task_compliance_ctrl()/set_stiffnessx()

5.7 task_compliance_ctrl(stx, time)

- **Features**

This function begins task compliance control based on the preset reference coordinate system.

- **Parameters (Stiffness TBD)**

Parameter Name	Data Type	Default Value	Description
stx	float[6]	[3000, 3000, 3000, 200, 200, 200]	Three translational stiffnesses Three rotational stiffnesses
time	float	0	Stiffness varying time [sec] Range: 0 - 1.0 * Linear transition during the specified time

- **Return**

Value	Description
0	Success
Negative value	Error

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
P0 = posj(0,0,90,0,90,0)
movej(P0)
task_compliance_ctrl()              # Begins with the default stiffness
set_stiffnessx([500, 500, 500, 100, 100, 100], time=0.5)
# Switches to the user-defined stiffness for 0.5 sec.
release_compliance_ctrl()

task_compliance_ctrl([500, 500, 500, 100, 100, 100])
# Begins with the user-defined stiffness.
release_compliance_ctrl()
```

- **Related commands**

set_stiffnessx()/elease_compliance_ctrl()

5.8 set_stiffnessx(stx, time)

▪ Features

This function sets the stiffness value based on the global coordinate(refer to set_ref_coord()). The linear transition from the current or default stiffness is performed during the time given as STX. The user-defined ranges of the translational stiffness and rotational stiffness are 0-20000N/m and 0-400Nm/rad, respectively.

▪ Parameters

Parameter Name	Data Type	Default Value	Description
stx	float[6]	[500, 500, 500, 100, 100, 100]	Three translational stiffnesses Three rotational stiffnesses
time	float	0	Stiffness varying time [sec] Range: 0 - 1.0 * Linear transition during the specified time

▪ Return

Value	Description
0	Success
Negative value	Error

▪ Exception

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

▪ Example

```
set_ref_coord(DR_WORLD)       # Global coordinate is the world coordinate
x0 = posx(0, 0, 90, 0, 90, 0)
movej(x0)
task_compliance_ctrl()
stx = [1, 2, 3, 4, 5, 6]
set_stiffnessx(stx)    # Set the stiffness value based on the global coordinate(world coordinate)
release_compliance_ctrl()
```

▪ Related commands

task_compliance_ctrl()/release_compliance_ctrl()

5.9 calc_coord(x1, x2, x3, x4, ref, mod)

▪ Features

This function returns a new user cartesian coordinate system by using up to 4 input poses ([x1]~[x4]), input mode [mod] and the reference coordinate system [ref]. The input mode is only valid when the number of input robot poses is 2.
In the case that the number of input poses is 1, the coordinate system is calculated using the position and orientation of x1.
In the case that the number of input poses is 2 and the input mode is 0, X-axis is defined by the direction from x1 to x2, and Z-axis is defined by the projection of the current Tool-Z direction onto the plane orthogonal to the x-axis. The origin is the position of x1.
In the case that the number of input poses is 2 and the input mode is 1, X-axis is defined by the direction from x1 to x2, and Z-axis is defined by the projection of the z direction of x1 onto the plane orthogonal to the X-axis. The origin is the position of x1.
In the case that the number of input poses is 3, X-axis is defined by the direction from x1 to x2. If a vector v is the direction from x1 to x3, Z-axis is defined by the cross product of X-axis and v (X-axis cross v). The origin is the position of x1.
In the case that the number of input poses is 4, the definition of axes is identical to the case that the number of input poses is 3, but the origin is the position of x4.

▪ Parameters

Parameter Name	Data Type	Default Value	Description
x1, x2, x3, x4	Posx list (float[6])	-	Posx or position list
ref	int	-	reference coordinate ・ DR_BASE: base coordinate ・ DR_WORLD: world coordinate
mod	int	-	input mode (only valid when the number of input poses is 2) ・ 0: defining z-axis based on the current Tool-z direction ・ 1: defining z-axis based on the z direction of x1

▪ Return

Value	Description
posx	Successful coordinate calculation Position information of the calculated coordinate

Exception

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

Example

```
pos1 = posx(500, 30, 500, 0, 0, 0)
pos2 = posx(400, 30, 500, 0, 0, 0)
pos3 = posx(500, 30, 600, 45, 180, 45)
pos4 = posx(500, -30, 600, 0, 180, 0)
pose_user1 = calc_coord(pos1, ref=DR_BASE, mod=0)
pose_user21 = calc_coord(pos1, pos2, ref=DR_WORLD, mod=0)
%% Define z-axis based on the Tool-z direction.
pose_user22 = calc_coord(pos1, pos2, ref=DR_BASE, mod=1)
%% Define z-axis based on the z direction of pos1
pose_user3 = calc_coord(pos1, pos2, pos3, ref=DR_BASE, mod=0)
pose_user4 = calc_coord(pos1, pos2, pos3, pos4, ref=DR_WORLD, mod=0)
ucart1 = set_user_cart_coord(pose_user1, ref=DR_BASE)
ucart2 = set_user_cart_coord(pose_user21, ref=DR_WORLD)
```

Related commands

set_user_cart_coord()

5.10 set_user_cart_coord(pos, ref)

▪ Features

This function set a new user cartesian coordinate system using input pose [pos] and reference coordinate system[ref]. Up to 20 user coordinate systems can be set including the coordinate systems set within Workcell Item. Since the coordinate system set by this function is removed when the program is terminated, setting new coordinate systems within Workcell Item is recommended for maintaining the coordinate information.

▪ Parameters

Parameter Name	Data Type	Default Value	Description
pos	Posx list (float[6])	-	coordinate information (position and orientation)
ref	int	-	reference coordinate ・ DR_BASE: base coordinate ・ DR_WORLD: world coordinate

▪ Return

Value	Description
Positive integer	Successful coordinate setting Set coordinate ID (101 - 200)
-1	Failed coordinate setting

▪ Exception

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

▪ Example

```
pos1 = posx(10, 20, 30, 0, 0, 0)
pos2 = posx(30, 50, 70, 45, 180, 45)
user_id1 = set_user_cart_coord(pos1, ref=DR_BASE)
user_id2 = set_user_cart_coord(pos2, ref=DR_WORLD)
```

- **Related commands**

  set_ref_coord()

5.11 set_user_cart_coord(x1, x2, x3, pos, ref)

▪ Features

This function sets a new user cartesian coordinate system using [x1], [x2], and [x3] based on ref coordinate system[ref]. Creates a user coordinate system with ux, uy, and uz as the vector for each axis and origin position is the position of [pos] based on [ref]. [1)]ux is defined as the unit vector of x1x2 , uz is defined as the unit vector defined by the cross product of x1x2 and x1x3 (x1x2 cross x1x3). uy is can be determined by right hand rule (uz cross ux). Up to 20 user coordinate systems can be set including the coordinate systems set within Workcell Item. Since the coordinate system set by this function is removed when the program is terminated, setting new coordinate systems within Workcell Item is recommended for maintaining the coordinate information.

[1)]Before M2.0.2 software version, ux is the unit vector of x2x1

▪ Parameters

Parameter Name	Data Type	Default Value	Description
x1	Posx list (float[6])	-	posx or position list
x2	Posx list (float[6])	-	posx or position list
x3	Posx list (float[6])	-	posx or position list
pos	Posx list (float[6])	-	posx or position list
ref	int	DR_BASE	reference coordinate ・ DR_BASE: base coordinate ・ DR_WORLD: world coordinate

▪ Return

Value	Description
Positive integer	Successful coordinate setting Set coordinate ID (101 - 200)
-1	Failed coordinate setting

Exception

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

Example

```
x1 = posx(0, 500, 700, 0, 0, 0) # Ignores the Euler angle.
x2 = posx(500, 0, 700, 0, 0, 0)
x3 = posx(300, 100, 500, 0, 0, 0)
x4 = posx(300, 110, 510, 0, 0, 0)
pos = posx(10, 20, 30, 0, 0, 0)
user_tc1 = set_user_cart_coord(x1, x2, x3, pos, ref=DR_BASE)
user_tc2 = set_user_cart_coord(x2, x3, x4, pos, ref=DR_WORLD)
```

Related commands

set_ref_coord()

5.12 set_user_cart_coord(u1, v1, pos, ref)

▪ Features

This function sets a new user cartesian coordinate system using [u1] and [v1] based on [ref] coordinate system. The origin position the position of [pos] based on the [ref] coordinate while the direction of x-axis and y-axis bases are given in the vectors u1 and v1, respectively. Other directions are determined by u1 cross v1. If u1 and v1 are not orthogonal, v1', that is perpendicular to u1 on the surface spanned by u1 and v1, is set as the vector in the y-axis direction. Up to 20 user coordinate systems can be set including the coordinate systems set within Workcell Item. Since the coordinate system set by this function is removed when the program is terminated, setting new coordinate systems within Workcell Item is recommended for maintaining the coordinate information.

▪ Parameters

Parameter Name	Data Type	Default Value	Description
u1	float[3]	-	X-axis unit vector
v1	float[3]	-	Y-axis unit vector
pos	posx list (float[6])	-	posx or position list
ref	int	DR_BASE	reference coordinate ・ DR_BASE: base coordinate ・ DR_WORLD: world coordinate

▪ Return

Value	Description
Positive integer	Successful coordinate setting Set coordinate ID (101 - 200)
-1	Failed coordinate setting

▪ Exception

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
u1 = [1, 1, 0]
v1 = [-1, 1, 0]
pos = posx(10, 20, 30, 0, 0, 0)
user_tc1 = set_user_cart_coord(u1, v1, pos)
user_tc2 = set_user_cart_coord(u1, v1, pos, ref=DR_WORLD)
```

- **Related commands**

set_ref_coord()

5.13 overwrite_user_cart_coord(id, pos, ref)

▪ Features

This function changes the pose and reference coordinate system of the requested user coordinate system [id] with the [pos] and [ref], respectively.

▪ Parameters

Parameter Name	Data Type	Default Value	Description
id	int	-	coordinate ID
pos	posx list (float[6])	-	posx or position list
ref	int	DR_BASE	reference coordinate ・ DR_BASE: base coordinate ・ DR_WORLD: world coordinate

▪ Return

Value	Description
Positive integer	Successful coordinate setting Set coordinate ID (101 - 200)
-1	Failed coordinate setting

▪ Exception

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

▪ Example

```
pose_user1 = posx(30, 40, 50, 0, 0, 0)
id_user = set_user_cart_coord(pose_user1, ref=DR_BASE)
pose_user2 = posx(100, 150, 200, 45, 180, 0)
overwrite_user_cart_coord(id_user, pose_user2, ref=DR_BASE)
```

▪ Related commands

set_user_cart_coord()

5.14 get_user_cart_coord(id)

- **Features**

This function returns the pose and reference coordinate system of the requested user coordinate system [id].

- **Parameters**

Parameter Name	Data Type	Default Value	Description
id	int	-	coordinate ID

- **Return**

Value	Description
posx	Position and orientation information of the coordinate to get
ref	Reference coordinate of the coordinate to get

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
pose_user1 = posx(10, 20, 30, 0, 0, 0)
id_user = set_user_cart_coord(pose_user1, ref=DR_BASE)
pose, ref = get_user_cart_coord(id_user)
```

- **Related commands**

set_user_cart_coord()

5.15 set_desired_force(Fd, dir, time, mod)

- **Features**

This function defines the target force, direction, translation time, and mode for force control based on the global coordinate.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
fd	float[6]	[0, 0, 0, 0, 0, 0]	Three translational target forces Three rotational target moments
dir	int[6]	[0, 0, 0, 0, 0, 0]	Force control in the corresponding direction if 1 Compliance control in the corresponding direction if 0
time	float	0	Transition time of target force to take effect [sec] Range: 0 - 1.0
mod	int	DR_FC_MOD_ABS	DR_FC_MOD_ABS: Force control with absolute value DR_FC_MOD_REL: force control with relative value to initial state (the instance when this function is called)

- **Return**

Value	Description
0	Success
Negative value	Error

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

Note

- The value of external force refers to the sensor measurement at terminating the force control (control mode transition to compliance control) by the command release_force().
  Therefore, the variation in external force can occur if the option mod=DR_FC_MOD_REL is applied.
- Tool weight and external force value refer to the sensor measurement regardless of the setting for 'mod'

Caution

- To retain the accuracy in force control, it is recommended to start force control with setting mod=DR_FC_MOD_REL near the contact point.

Example

```
# Example # 1
# Executed in the global coordinate(tool coordinate)
# Zero force control in the z-axis direction of the tool, moment control in the z-axis direction of the tool, and compliance control in the other directions
# Force control with the relative value to the sensor measurement at starting the force control

set_ref_coord(DR_TOOL)
x0 = posx(0, 0, 90, 0, 90, 0)
movej(x0)
task_compliance_ctrl(stx=[500, 500, 500, 100, 100, 100])
fd = [0, 0, 0, 0, 0, 10]
fctrl_dir= [0, 0, 1, 0, 0, 1]
set_desired_force(fd, dir=fctrl_dir, mod=DR_FC_MOD_REL)

# Example #2
# 1. Move to initial posj: [J1, J2, J3, J4, J5, J6] = [0, 0, 90, 0, 90, 0]
# 2. Approach to the position to start force control: move -100mm along Base-z direction
# 3. Start force control : apply -20N force along Base–z direction
# 4. Force & compliance control after detecting external force : while maintaining -20N force along Base-z direction (force control), move 200mm along Base-y direction.
# 5. Retract 150mm in Base-z direction and move to initial posj

# 1. Move to initial posj
q0 = posj(0.0, 0.0, 90.0, 0.0, 90.0, 0.0)
set_velj(30.0)
set_accj(60.0)
movej(q0)

# 2. Approach to the position to start force control
set_velx(75.0)
set_accx(100.0)
delta_approach = [0.0, 0.0, -100.0, 0.0, 0.0, 0.0]
movel(delta_approach, mod=DR_MV_MOD_REL)
```

```
# 3. Start force control (apply -20N force along Base–z direction)
k_d = [3000.0, 3000.0, 3000.0, 200.0, 200.0, 200.0]
task_compliance_ctrl(k_d)
force_desired = 20.0
f_d = [0.0, 0.0, -force_desired, 0.0, 0.0, 0.0]
f_dir = [0, 0, 1, 0, 0, 0]
set_desired_force(f_d, f_dir)

# 4. Force & compliance control after detecting external force
force_check = 20.0
force_condition = check_force_condition(DR_AXIS_Z, max=force_check)
while (force_condition):
    force_condition = check_force_condition(DR_AXIS_Z, max=force_check)
    if force_condition == 0:
        break
delta_motion = [0.0, 200.0, 0.0, 0.0, 0.0, 0.0]
movel(delta_motion, mod=DR_MV_MOD_REL)

# 5. Retract 150mm in Base-z direction and move to initial posj
release_force()
wait(0.5)
delta_retract = [0.0, 0.0, 150.0, 0.0, 0.0, 0.0]
release_compliance_ctrl()
movel(delta_retract, mod=DR_MV_MOD_REL)
movej(q0)
```

- **Related commands**

release_force()/task_compliance_ctrl()/set_stiffnessx()/release_compliance_ctrl()

5.16 release_force(time=0)

- **Features**

This function reduces the force control target value to 0 through the time value and returns the task space to adaptive control.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
time	float	0	Time needed to reduce the force Range: 0 - 1.0

- **Return**

Value	Description
0	Success
Negative value	Error

- **Exception**

Exception	Description
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
j0 = posj(0, 0, 90, 0, 90, 0)
x0 = posx(0, 0, 0, 0, 0, 0)
x1 = posx(0, 500, 700, 0, 180, 0)
x2 = posx(300, 100, 700, 0, 180, 0)
x3 = posx(300, 100, 500, 0, 180, 0)
set_velx(100,20)
set_accx(100,20)
movej(j0, vel=10, acc=10)
movel(x2)
task_compliance_ctrl(stx = [500, 500, 500, 100, 100, 100])
fd = [0, 0, 0, 0, 0, 10]
fctrl_dir= [0, 0, 1, 0, 0, 1]
set_desired_force(fd, dir=fctrl_dir, time=1.0)
movel(x3, v=10)
release_force(0.5)
release_compliance_ctrl()
```

- **Related commands**

set_desired_force()/task_compliance_ctrl()/set_stiffnessx()/release_compliance_ctrl()

5.17 check_position_condition(axis, min, max, ref, mod, pos)

▪ Features

This function checks the status of the given position. This condition can be repeated with the while or if statement. Axis and pos of input paramets are based on the ref coordinate.

In case of ref=DR_TOOL, pos should be defined in BASE coordinate.

▪ Parameters

Parameter Name	Data Type	Default Value	Description
axis	int	-	axis · DR_AXIS_X: x-axis · DR_AXIS_Y: y-axis · DR_AXIS_Z: z-axis
min	float	DR_COND_NONE	Minimum value
max	float	DR_COND_NONE	Maximum value
ref	int	None	reference coordinate · DR_BASE : base coordinate · DR_WORLD : world coordinate · DR_TOOL : tool coordinate · user coordinate: User defined
mod	int	DR_MV_MOD_ABS	Movement basis · DR_MV_MOD_ABS: Absolute · DR_MV_MOD_REL: Relative
pos	posx list (float[6])	-	posx or position list

Note

- The absolution position is used if the mod is DR_MV_MOD_ABS.
- The pos position is used if the mod is DR_MV_MOD_REL.
- Pos is meaningful only if the mod is DR_MV_MOD_REL.

▪ Return

Value	Description
True	The condition is True.

Value	Description
False	The condition is False.

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
CON1= check_position_condition(DR_AXIS_X, min=-5, max=0, ref=DR_WORLD)
CON2= check_position_condition(DR_AXIS_Y, max=700)
CON3= check_position_condition(DR_AXIS_Z, min=-10, max=-5)      # −10 ≤ z ≤ −5
CON4= check_position_condition(DR_AXIS_Z, min=30)               # 30 ≤ z

CON5= check_position_condition(DR_AXIS_Z,min=-10,max=-5, ref=DR_BASE)
                                                                # −10 ≤ z ≤ −5

  CON6= check_position_condition(DR_AXIS_Z,min=-10,max=-5,
  mod=DR_MV_MOD_ABS)
      # −10 ≤ z ≤ −5

posx1 = posx(400, 500, 800, 0, 180,0)
CON7= check_position_condition(DR_AXIS_Z,min=-10,max=-5,mod =
DR_MV_MOD_REL, pos=posx1)                                       # posx1_(z) −
10 ≤ z ≤ posx1_(z) − 5
```

- **Related commands**

check_force_condition()/check_orientation_condition()/set_ref_coord()

5.18 check_force_condition(axis, min, max, ref)

▪ Features

This function checks the status of the given force. It disregards the force direction and only compares the sizes. This condition can be repeated with the while or if statement. Measuring the force, axis is based on the ref coordinate and measuring the moment, axis is based on the tool coordinate.

▪ Parameters

Parameter Name	Data Type	Default Value	Description
axis	int	-	axis · DR_AXIS_X: x-axis · DR_AXIS_Y: y-axis · DR_AXIS_Z: z-axis · DR_AXIS_A: x-axis rotation · DR_AXIS_B: y-axis rotation · DR_AXIS_C: z-axis rotation
min	float	DR_COND_NONE	Minimum value (min ≥ 0)
max	float	DR_COND_NONE	Maximum value (max ≥ 0)
ref	int	None	reference coordinate · DR_BASE : base coordinate · DR_WORLD : world coordinate · DR_TOOL : tool coordinate · user coordinate: User defined

▪ Return

Value	Description
True	The condition is True.
False	The condition is False.

▪ Exception

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred

Exception	Description
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
fcon1 = check_force_condition(DR_AXIS_Z, min=5, max=10, DR_WORLD)
# 5 ≤ f_z ≤ 10

while (fcon1):
    fcon2 = check_force_condition(DR_AXIS_C, min=30)                  #  30 ≤ m_z
    pcon1 = check_position_condition(DR_AXIS_X, min=0, max=0.1)   #  0 ≤ x ≤ 0.1

    if (fcon2 and pcon1):
        break
```

- **Related commands**

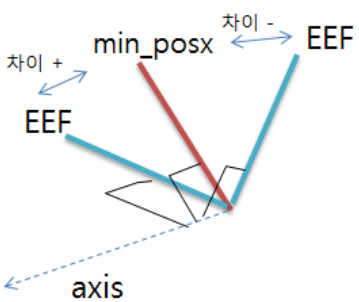
check_position_condition()/check_orientation_condition()/set_ref_coord()

5.19 check_orientation_condition(axis, min, max, ref, mod)

▪ Features

This function checks the difference between the current pose and the specified pose of the robot end effector. It returns the difference between the current pose and the specified pose in rad with the algorithm that transforms it to a rotation matrix using the "AngleAxis" technique. It returns True if the difference is positive (+) and False if the difference is negative (-). It is used to check if the difference between the current pose and the rotating angle range is + or -. For example, the function can use the direct teaching position to check if the difference from the current position is + or - and then create the condition for the orientation limit. This condition can be repeated with the while or if statement.

- Setting Min only: True if the difference is + and False if -
- Setting Min and Max: True if the difference from min is - while the difference from max is + and False otherwise
- Setting Max only: True if the maximum difference is + and False otherwise



▪ Parameters

Parameter Name	Data Type	Default Value	Description
axis	int	-	axis · DR_AXIS_A: x-axis rotation · DR_AXIS_B: y-axis rotation · DR_AXIS_C: z-axis rotation
min	posx list (float[6])	-	posx or position list
max	posx list (float[6])	-	posx or position list
ref	int	None	reference coordinate · DR_BASE : base coordinate · DR_WORLD : world coordinate

Parameter Name	Data Type	Default Value	Description
			・ DR_TOOL : tool coordinate ・ user coordinate: User defined
mod	int	DR_MV_MOD_ABS	Movement basis ・ DR_MV_MOD_ABS: Absolute

- **Return**

Value	Description
True	The condition is True.
False	The condition is False.

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
posx1 = posx(400,500,800,0,180,30)
posx2 = posx(400,500,500,0,180,60)

CON1= check_orientation_condition(DR_AXIS_C, min=posx1, max= posx2)
# If the current task coordinate posxc = posx(400, 500, 500, 0, 180, 40)
# CON1=True since posx1 Rz=30 < posxc Rz=40 < posx2 Rz=60

CON2= check_orientation_condition(DR_AXIS_C, min=posx1)
# If the current task coordinate posxc = posx(400, 500, 500, 0, 180, 15)
# CON2=False since posx1 Rz=30 > posxc Rz=15

CON3= check_orientation_condition(DR_AXIS_C, max= posx2)
# If the current task coordinate posxc = posx(400, 500, 500, 0, 180, 75)
# CON2=False since posx1 Rz=75 > posxc Rz=60
```

- **Related commands**

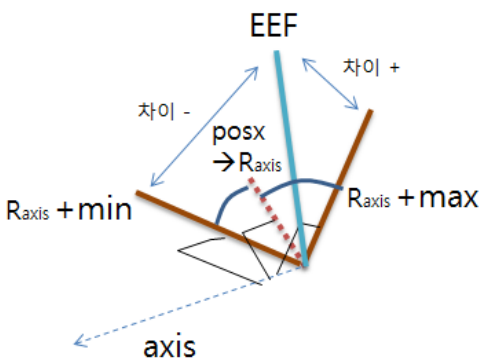
check_position_condition()/check_force_condition()/check_orientation_condition()
/set_ref_coord()

5.20 check_orientation_condition(axis, min, max, ref, mod, pos)

▪ Features

This function checks the difference between the current pose and the rotating angle range of the robot end effector. It returns the difference (in rad) between the current pose and the rotating angle range with the algorithm that transforms it to a rotation matrix using the "AngleAxis" technique. It returns True if the difference is positive (+) and False if the difference is negative (-). It is used to check if the difference between the current pose and the rotating angle range is + or -. For example, the function can be used to set the rotating angle range to min and max at any reference position, and then determine the orientation limit by checking if the difference from the current position is + or -. This condition can be repeated with the while or if statement.

- Setting Min only: True if the difference is + and False if -
- Setting Min and Max: True if the difference from min is - while the difference from max is + and False if the opposite.
- Setting Max only: True if the maximum difference is + and False otherwise



Note

Range of rotating angle: This means the relative angle range (min, max) based on the specified axis from a given position based on the ref coordinate.

▪ Parameters

Parameter Name	Data Type	Default Value	Description
axis	int	-	axis ・ DR_AXIS_X: x-axis rotation ・ DR_AXIS_Y: y-axis rotation ・ DR_AXIS_Z: z-axis rotation
min	float	DR_COND_NONE	Minimum value
max	float	DR_COND_NONE	Maximum value

Parameter Name	Data Type	Default Value	Description
ref	int	None	reference coordinate · DR_BASE : base coordinate · DR_WORLD : world coordinate · DR_TOOL : tool coordinate · user coordinate: User defined
mod	int	DR_MV_MOD_REL	Movement basis · DR_MV_MOD_REL: Relative
pos	posx list (float[6])	-	posx or position list

▪ Return

Value	Description
True	The condition is True.
False	The condition is False.

▪ Exception

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

▪ Example

```
posx1 = posx(400,500,800,0,180,15)
CON1= check_orientation_condition(DR_AXIS_C, min=-5, mod=DR_MV_MOD_REL, pos=posx1, DR_WORLD)
# If the current task coordinate posxc = posx(400, 500, 500, 0, 180, 40)
# CON1=True since posx1 Rz=15 – (min=5) < posxc Rz=40

CON1= check_orientation_condition(DR_AXIS_C, max=5, mod=DR_MV_MOD_REL, pos=posx1)
# If the current task coordinate posxc = posx(400, 500, 500, 0, 180, 40)
# CON1=False since posxc Rz=40 > posx1 Rz=15 + (max=5)
```

▪ Related commands

check_position_condition()/check_force_condition()/check_orientation_condition()

/set_ref_coord()

5.21 coord_transform(pose_in, ref_in, ref_out)

▪ Features

This function transforms given task position expressed in reference coordinate, ‘ref_in’ to task position expressed in reference coordinate, ‘ref_out’. It returns transformed task position. It supports calculation of coordinate transformation for the following cases.

- (ref_in) world reference coordinate → (ref_out) world reference coordinate
- (ref_in) world reference coordinate → (ref_out) base reference coordinate
- (ref_in) world reference coordinate → (ref_out) tool reference coordinate
- (ref_in) world reference coordinate → (ref_out) user reference coordinate
- (ref_in) base reference coordinate → (ref_out) base reference coordinate
- (ref_in) base reference coordinate → (ref_out) tool reference coordinate
- (ref_in) base reference coordinate → (ref_out) user reference coordinate
- (ref_in) tool reference coordinate → (ref_out) world reference coordinate
- (ref_in) tool reference coordinate → (ref_out) base reference coordinate
- (ref_in) tool reference coordinate → (ref_out) tool reference coordinate
- (ref_in) tool reference coordinate → (ref_out) user reference coordinate
- (ref_in) user reference coordinate → (ref_out) world reference coordinate
- (ref_in) user reference coordinate → (ref_out) base reference coordinate
- (ref_in) user reference coordinate → (ref_out) tool reference coordinate
- (ref_in) user reference coordinate → (ref_out) user reference coordinate

▪ Parameters

Parameter Name	Data Type	Default Value	Description
Pose_in	posx	-	posx
ref_in	float	DR_COND_NONE	reference coordinate before transformation ・ DR_BASE : base coordinate ・ DR_WORLD : world coordinate ・ DR_TOOL : tool coordinate ・ user coordinate: User defined
ref_out	float	DR_COND_NONE	reference coordinate after transformation ・ DR_BASE : base coordinate ・ DR_WORLD : world coordinate ・ DR_TOOL : tool coordinate ・ user coordinate: User defined

- **Return**

Value	Description
pos	posx

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
base_pos = posx(400,500,800,0,180,15)
# If task position based on base reference coordinate base_pos =
posx(400,500,800,0,180,15)

tool_pos = coord_transform(base_pos, DR_BASE, DR_TOOL)
# Transform task position(base_pos) expressed in base reference coordinate to task
position expressed in tool reference coordinate
# This command returns task position expressed in tool reference coordinate and the
result value is stored in tool_pos
```

- **Related commands**

set_user_cart_coord()/get_current_posx()/get_desired_posx()/set_ref_coord()

6. System Commands

6.1 IO Related

6.1.1 set_digital_output(index, val =None)

- **Features**

This function sends a signal at the digital contact point of the controller. A value saved in the digital output register is output as a digital signal.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
index	int	-	I/O contact number mounted on the controller • Val argument existing: A number between 1 and 16 • No val argument: 1 ~ 16 , -1 ~ -16 (A positive number means ON while a negative number means OFF.)
val	int	-	I/O value • ON: 1 • OFF: 0

Note

If val is omitted, the positive number becomes ON and the negative number OFF according to the sign of the argument index.

- **Return**

Value	Description
0	Success
Negative value	Failed

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
set_digital_output(1, ON)                    # No. 1 contact ON
set_digital_output(16, OFF)          # No. 16 contact OFF
set_digital_output(3)                        #No. 3 contact ON (A positive number means ON if
the argument val is omitted.)
set_digital_output(-3)                       #No. 3 contact OFF (A negative number means OFF
if the argument val is omitted.)
```

6.1.2 set_digital_outputs(bit_list)

- **Features**

This function sends a signal to multiple digital output contact points of the controller.
The digital signals of the contact points defined in bit_list are output at one.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
bit_list	list (int)	-	List of multiple output contacts • The positive contact number outputs ON: 1~16 • The negative contact number outputs OFF: -1~-16

- **Return**

Value	Description
0	Success
Negative value	Failed

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
set_digital_outputs(bit_list=[1,2,3,4,5,6,7,8])    # Contact number 1-8 ON
set_digital_outputs([-1,-2,-3,-4,-5,-6,-7,-8])      # Contact number 1-8 OFF
set_digital_outputs([1,-2,3])                       # Contact no. 1 ON, no. 2 OFF, and no. 3
ON
set_digital_outputs([4,-9,-12])                     # Contact no. 4 ON, no. 9 OFF, and no. 12
OFF
```

6.1.3 set_digital_outputs(bit_start, bit_end, val)

- **Features**

This function sends multiple signals at once from the digital output start contact point (bit_start) to the end contact point (bit_end) of the controller.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
bit_start	int	-	Beginning contact number for output signal (1~16)
bit_end	int	-	Ending contact number for output signal (1~16)
val	int	-	Output value

Note

- Bit_end must be a larger number than bit_start.
- Val is the value of the combination of bits where bit_start =LSB and bit_end=MSB.

  Ex) bit_start =1, bit_end=4, val=0b1010 # No. 4=ON, no. 3=OFF, no. 2=ON, and no. 1=OFF

- **Return**

Value	Description
0	Success
Negative value	Failed

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
# Outputs contact 1=ON, contact 2=ON, contact 3=OFF, and contact 4=OFF.
set_digital_outputs(bit_start=1, bit_end=4, val=0b0011) # 0b means a binary number.

# Outputs contact 3=ON and contact 4=OFF.
set_digital_outputs(bit_start=3, bit_end=4, val=0b01) # 0b means a binary number.

# Outputs the ON signal from contacts 1 through 8.
set_digital_outputs(1, 8, 0xff)                       # 0x means a hexadecimal
number.
```

6.1.4 get_digital_input(index)

- **Features**

This function reads the signals from digital contact points of the controller and reads the digital input contact value.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
index	int	-	A number 1 - 16 which means the contact number of I/O mounted on the controller.

- **Return**

Value	Description
1	ON
0	OFF
Negative value	Failed

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
in1 = get_digital_input(1)          # Reads the no. 1 contact
in8 = get_digital_input(8)          # Reads the no. 8 contact
```

6.1.5 get_digital_inputs(bit_list)

- **Features**

This function reads the signals from multiple digital contact points of the controller. The digital signals of the contact points defined in bit_list are input at one.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
index	list (int)	-	List of contact points to read A number 1–16 which means the I/O contact number mounted on the controller.

- **Return**

Value	Description
int (>=0)	Multiple contacts to be read at once (the value of the combination of the bit list where bit_start =LSB and bit_end=MSB)
Negative number	Failed

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
# input contacts: No. 1=OFF, No. 2=OFF, No. 3=ON, and No. 4=ON
res = get_digital_inputs(bit_list=[1,2,3,4])
#res expected value = 0b1100 (binary number), 12 (decimal number), or 0x0C (hexadecimal number)

# input contacts: No. 5=ON, No. 6=ON, No. 7=OFF, and No. 8=ON
res = get_digital_inputs([5,6,7,8])
      #res expected value = 0b1011 (binary number), 11 (decimal number), or 0x0B (hexadecimal number)
```

6.1.6 get_digital_inputs(bit_start, bit_end)

- **Features**

This function reads multiple signals at once from the digital input start contact point (start_index) to the end contact point (end_index) of the controller.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
bit_start	int	-	Beginning contact number for input signals (1~16)
bit_end	int	-	Ending contact number for input signals (1~16)

Note

Bit_end must be a larger number than bit_start.

- **Return**

Value	Description
int (>=0)	Multiple contacts to be read at once Value of the combination of bits where bit_start =LSB and bit_end=MSB.
Negative number	Failed

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
# input contacts: No. 1=OFF, No. 2=OFF, No. 3=ON, and No. 4=ON
res = get_digital_inputs(bit_start=1, bit_end=4)
#res expected value = 0b1100 (binary number), 12 (decimal number), or 0x0C
(hexadecimal number)
```

6.1.7 wait_digital_input(index, val, timeout=None)

- **Features**

This function waits until the signal value of the digital input register of the controller becomes val (ON or OFF). The waiting time can be changed with a timeout setting. The waiting time ends, and the result is returned if the waiting time has passed. This function waits indefinitely if the timeout is not set.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
index	int	-	A number 1 - 16 which means the I/O index mounted on the controller.
value	int	-	I/O value • ON : 1 • OFF : 0
timeout	float	-	Waiting time (sec) This function waits indefinitely if the timeout is not set.

- **Return**

Value	Description
0	Success
-1	Failed (time-out)

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
wait_digital_input(1, ON) # Indefinite wait until the no. 1 contact becomes ON
wait_digital_input(2, OFF) # Indefinite wait until the no. 2 contact becomes OFF
res = wait_digital_input(1, ON, 3) # Wait for up to 3 seconds until the no. 1 contact becomes ON
    # Waiting is terminated and res = 0 if the no. 1 contact becomes ON within 3 seconds.
    # Waiting is terminated and res = -1 if the no. 1 contact does not become ON within 3 seconds.
```

6.1.8 set_tool_digital_output(index, val=None)

- **Features**

This function sends the signal of the robot tool from the digital contact point.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
index	int	-	I/O contact number mounted on the robot arm • Val argument existing: A number between 1 and 6 • No val argument: 1 ~ 6 , -1 ~ -6 (A positive number means ON while a negative number means OFF.)
val	int	-	I/O value: The value to output

Note

If val is omitted, the positive number becomes ON and the negative number OFF according to the sign of the argument index.

- **Return**

Value	Description
0	Success
Negative value	Error

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
set_tool_digital_output(1, ON)      # Sets the no. 1 contact of the robot arm ON
set_tool_digital_output(6, OFF)     # Sets the no. 6 contact of the robot arm OFF
set_tool_digital_output(3                       #No. 3 contact ON (A positive number
means ON if the argument val is omitted.)
set_tool_digital_output(-3)                     #No. 3 contact OFF (A negative number
means OFF if the argument val is omitted.)
```

6.1.9 set_tool_digital_outputs(bit_list)

- **Features**

This function sends the signal of the robot tool from the digital contact point. The digital signals of the contact points defined in bit_list are output at one.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
bit_list	list (int)	-	List of multiple output contacts • The positive contact number outputs ON: 1~6 • The negative contact number outputs OFF: -1~-6

- **Return**

Value	Description
0	Success
Negative value	Error

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
set_tool_digital_outputs(bit_list=[1,2,3,4,5,6])     # Sets the contacts 1-6 ON
set_tool_digital_outputs([-1,-2,-3,-4,-5,-6]) # Sets the contacts 1-6 OFF
set_digital_outputs([1,-2,3])                        # Contact no. 1 ON, no. 2 OFF, and no. 3 ON
```

6.1.10 set_tool_digital_outputs(bit_start, bit_end, val)

- **Features**

This function sends the signal of the robot tool from the digital contact point. The multiple signals from the first contact point (bit_start) to the last contact point (bit_end) are output at one.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
bit_start	int	-	Beginning contact number for output signal (1~6)
bit_end	int	-	Ending contact number for output signal (1~6)
Val	int	-	Output value

Note

- Bit_end must be a larger number than bit_start.
- Val is the value of the combination of bits where bit_start =LSB and bit_end=MSB.

  Ex) bit_start =1, bit_end=4, val=0b1010 # No. 4=ON, no. 3=OFF, no. 2=ON, and no. 1=OFF

- **Return**

Value	Description
0	Success
Negative value	Error

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
# Outputs contact 1=ON, contact 2=ON, contact 3=OFF, and contact 4=OFF.
set_tool_digital_outputs(bit_start=1, bit_end=4, val=0b0011) # 0b means a binary
number.

# Outputs contact 3=ON and contact 4=OFF.
set_tool_digital_outputs(bit_start=3, bit_end=4, val=0b01) # 0b means a binary number.

# Outputs the ON signal from contacts 1 through 8.
set_tool_digital_outputs(1, 8, 0xff)                    # 0x means a hexadecimal
number.
```

6.1.11 get_tool_digital_input(index)

- **Features**

This function reads the signal of the robot tool from the digital contact point.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
index	int	-	I/O contact number (1-6) mounted on the robot tool

- **Return**

Value	Description
1	ON
0	OFF
Negative value	Failed

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
get_tool_digital_input(1)        # Reads the no. 1 contact of tool I/O
get_tool_digital_input(6)        # Reads the no. 6 contact of tool I/O
```

6.1.12 get_tool_digital_inputs(bit_list)

- **Features**

This function reads the signal of the robot tool from the digital contact point.
The digital signals of the contact points defined in bit_list are input at one.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
bit_list	list (int)	-	List of contact points to read • (I/O contact numbers (1-6) mounted on the robot arm)

- **Return**

Value	Description
int (>=0)	(the value of the combination of the bit list where bit_start =LSB and bit_end=MSB)
Negative number	Failed

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
# input contacts: No. 1=OFF, No. 2=OFF, and No. 3=ON
res = get_tool_digital_inputs(bit_list=[1,2,3]) # Reads the contacts 1, 2, and 3 at once.
#res expected value = 0b100 (binary number), 4 (decimal number), or 0x04 (hexadecimal number)

# input contacts: No. 4=ON, No. 5=ON, and No. 6=OFF
res = get_tool_digital_inputs([4,5,6])
#res expected value = 0b011 (binary number), 3 (decimal number), or 0x03 (hexadecimal number)
```

6.1.13 get_tool_digital_inputs(bit_start, bit_end)

- **Features**

This function reads the signal of the robot tool from the digital contact point. The multiple signals from the first contact point (start_index) to the last contact point (end_index) are input at one.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
bit_start	int	-	Beginning contact number for input signals (1~6)
bit_end	int	-	Ending contact number for input signals (1~6)

- **Return**

Value	Description
int (>=0)	Multiple contacts to be read at once Value of the combination of bits where bit_start =LSB and bit_end=MSB.
Negative number	Failed

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
# input contacts: No. 1=OFF, No. 2=OFF, and No. 3=ON
res = get_tool_digital_inputs(bit_start=1, bit_end=3)
#res expected value = 0b100 (binary number), 4 (decimal number), or 0x04
(hexadecimal number)

# input contacts: No. 4=ON, No. 5=ON, and No. 6=OFF
res = get_tool_digital_inputs(4, 6)
#res expected value = 0b011 (binary number), 3 (decimal number), or 0x03
(hexadecimal number)
```

6.1.14 wait_tool_digital_input(index, val, timeout=None)

- **Features**

This function waits until the digital input signal value of the robot tool becomes val (ON or OFF). The waiting time can be changed with a timeout setting. The waiting time ends, and the result is returned if the waiting time has passed. This function waits indefinitely if the timeout is not set.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
index	int	-	A number in 1 - 6 which means the I/O index mounted on the robot arm
value	int	-	I/O value • ON : 1 • OFF : 0
timeout	float	-	Waiting time (sec) This function waits indefinitely if the timeout is not set.

- **Return**

Value	Description
0	Success
-1	Failed (time-out)

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
wait_tool_digital_input(1, ON) # Indefinite wait until the no. 1 contact becomes ON
wait_tool_digital_input(2, OFF) # Indefinite wait until the no. 2 contact becomes OFF

res = wait_tool_digital_input(1, ON, 3) # Wait for up to 3 seconds until the no. 1 contact becomes ON
    # Waiting is terminated and res = 0 if the no. 1 contact becomes ON within 3 seconds.
    # Waiting is terminated and res = -1 if the no. 1 contact does not become ON within 3 seconds.
```

6.1.15 set_mode_analog_output(ch, mod)

- **Features**

This function sets the channel mode of the controller analog output.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
ch	int	-	• 1 : channel 1 • 2 : channel 2
mod	int	-	analog io mode • DR_ANALOG_CURRENT: Current mode • DR_ANALOG_VOLTAGE: Voltage mode

- **Return**

Value	Description
0	Success
Negative value	Failed

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
# Sets analog_output channel 1 to the current mode.
set_mode_analog_output(ch=1, mod=DR_ANALOG_CURRENT)

# Sets analog_output channel 2 to the voltage mode.
set_mode_analog_output(ch=2, mod=DR_ANALOG_VOLTAGE)
```

6.1.16 set_mode_analog_input(ch, mod)

- **Features**

This function sets the channel mode of the controller analog input.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
ch	int	-	• 1 : channel 1 • 2 : channel 2
mod	int	-	analog io mode • DR_ANALOG_CURRENT: Current mode • DR_ANALOG_VOLTAGE: Voltage mode

- **Return**

Value	Description
0	Success
Negative value	Failed

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
# Sets analog_input channel 1 to the current mode.
set_mode_analog_input(ch=1, mod=DR_ANALOG_CURRENT)

# Sets analog_input channel 2 to the voltage mode.
set_mode_analog_input(ch=2, mod=DR_ANALOG_VOLTAGE)
```

6.1.17 set_analog_output(ch, val)

- **Features**

This function outputs the channel value corresponding to the controller analog output.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
ch	int	-	• 1 : channel 1 • 2 : channel 2
val	float	-	analog output value • Current mode: 4.0~20.0 [mA] • Voltage mode: 0~10.0 [V]

- **Return**

Value	Description
0	Success
Negative value	Failed

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
set_mode_analog_output(ch=1, mod=DR_ANALOG_CURRENT) #out ch1=current mode
set_mode_analog_output(ch=2, mod=DR_ANALOG_VOLTAGE) #out ch1=voltage mode

set_analog_output(ch=1, val=5.2)     # Outputs 5.2 mA to channel 1
set_analog_output(ch=2, val=10.0)    #Outputs 10V to channel 2
```

6.1.18 get_analog_input(ch)

- **Features**

This function reads the channel value corresponding to the controller analog input.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
ch	int	-	• 1 : channel 1 • 2 : channel 2

- **Return**

Value	Description
float	The analog input value of the specified channel • Current mode: 4.0~20.0 [mA] • Voltage mode: 0~10.0 [V]

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
set_mode_analog_input(ch=1, mod=DR_ANALOG_CURRENT) #input ch1=current mode
set_mode_analog_input(ch=2, mod=DR_ANALOG_VOLTAGE)    #input ch2=voltage mode

Cur = get_analog_input(1)    # Reads the analog input current value of channel 1
Vol = get_analog_input(2)    # Reads the analog input voltage value of channel 2.
```

6.2 TP Interface

6.2.1 tp_popup(message, pm_type=DR_PM_MESSAGE, type=0)

▪ Features

This function provides a message to users through the Teach Pendant. The higher level controller receives the string and displays it in the popup window, and the window must be closed by a user's confirmation.

▪ Parameters

Parameter Name	Data Type	Default Value	Description
message	string	-	Message provided to the user (The message is limited to less than 256 bytes.)
pm_type	int	DR_PM_MESSAGE	Message type • DR_PM_MESSAGE • DR_PM_WARNING • DR_PM_ALARM
type	int	0	button type of TP pop message • 0 : show Stop & Resume button • 1 : show Stop button

▪ Return

Value	Description
0	Success
Negative value	Failed

▪ Exception

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

▪ Example

```
tp_popup("move done", DR_PM_MESSAGE)
tp_popup("Error!! ", DR_PM_ALARM)
a=1
b=2
c=3
```

```
tp_popup("a={0}, b={1}, c={2}".format(a,b,c) ,DR_PM_MESSAGE)
tp_popup("critical error!! ", DR_PM_ALARM, 1)
```

6.2.2 tp_log(message)

- **Features**

This function records the user-written log to the Teach Pendant.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
message	string	-	Log message (The message is limited to less than 256 bytes.)

- **Return**

Value	Description
0	Success
Negative value	Failed

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
tp_log("movej() is complete! ")
```

6.2.3 tp_progress(cur_progress, total_progress)

- **Features**

This function provides a message to users through the Teach Pendant. The higher level controller receives the runtime data when a patterned program is run and is displayed in the GUI.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
cur_progress	int	-	Value at the current step
total_ progress	int	-	Value at the final step

- **Return**

Value	Description
0	Success
Negative value	Failed

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
tp_progress(1, 100)
tp_progress(99, 100)
```

6.2.4 tp_get_user_input(message, input_type)

- **Features**

This function receives the user input data through the Teach Pendant.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
message	string	-	Character string message to be displayed on the TP user input window
input_type	int	-	TP user input message type • DR_VAR_INT: Integer type • DR_VAR_FLOAT: Real number type • DR_VAR_STR: Character string

- **Return**

Value	Description
User input data	User input data received from the TP

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
q1 = posj(10, 10, 10, 10, 10, 10)
q2 = posj(20, 20, 20, 20, 20, 20)
q3 = posj(30, 30, 30, 30, 30, 30)
q4 = posj(40, 40, 40, 40, 40, 40)
q5 = posj(50, 50, 50, 50, 50, 50)
q6 = posj(60, 60, 60, 60, 60, 60)

int_y= tp_get_user_input("message1", input_type= DR_VAR_INT)
if int_y==1:       # Moves to q1 if the TP user input is 1.
   movej(q1, vel=30, acc=30)
else:              # Moves to q2 if the TP user input is not 1.
   movej(q2, vel=30, acc=30)

float_y= tp_get_user_input("message2", input_type= DR_VAR_FLOAT)
if float_y==3.14:          # Moves to q3 if the TP user input is 3.14.
   movej(q3, vel=30, acc=30)
else:                      # Moves to q4 if the TP user input is not 3.14.
   movej(q4, vel=30, acc=30)

str_y= tp_get_user_input("message3", input_type= DR_VAR_STR)
if str_y=="a":             # Moves to q5 if the TP user input is "a".
   movej(q5, vel=30, acc=30)
else:                      # Moves to q6 if the TP user input is not "a".
   movej(q6, vel=30, acc=30)
```

6.3 Thread

6.3.1 thread_run(th_func_name, loop=False)

▪ Features

This function creates and executes a thread. The features executed by the thread are determined by the functions specified in th_func_name.

Note

The following constraints are applied when using the thread command.

- Up to 4 threads can be used.
- The following motion command cannot be used to move the robot in the thread.
  - movej, amovej, movejx, amovejx, movel, amovel, movec, amovec, movesj, amovesj,
  - movesx, amovesx, moveb, amoveb, move_spiral, amove_spiral,
  - move_periodic, amove_periodic, move_home
- The thread commands do not operate normally when the loop=Ture during thread_run and the block is an indefinite loop within the thread function. (The thread is normally stopped when the stop command is executed through the TP.)

▪ Parameters

Parameter Name	Data Type	Default Value	Description
th_func_name	callable	-	Name of the function run by the thread
loop	bool	False	Flag indicates whether the thread will be repeated • True: Repeated calling of th_func_name (interval 0.01second) • False: One-time calling of th_func_name

▪ Return

Value	Description
int	Registered thread ID
Negative value	Failed

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
#----- Thread ---------------------------------------
def fn_th_func():
        if check_motion()==0:        # No motion in action
                set_digital_output(1, OFF)
        else:
                set_digital_output(1, ON)

#----- Main routine ---------------------------------
th_id = thread_run(fn_th_func, loop=True) # Thread run

while 1:
        # do something…
        wait(0.1)
```

6.3.2 thread_stop(th_id)

- **Features**

This function terminates a thread.

The program is automatically terminated when the DRL program is terminated even if the thread_stop() command is not used.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
th_id	int	-	Thread ID to stop

- **Return**

Value	Description
0	Success
Negative value	Failed

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
def fn_th_func():
        if check_motion()==0:        # No motion in action
                set_digital_output(1, OFF)
        else:
                set_digital_output(1, ON)
#----- Main routine -------------------------------------
th_id = thread_run(fn_th_func, loop=True)

# do something…
thread_stop(th_id) # Stops the thread.
```

6.3.3 thread_pause(th_id)

- **Features**

This function temporarily suspends a thread.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
th_id	int	-	Thread ID to suspend

- **Return**

Value	Description
0	Success
Negative value	Failed

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
def fn_th_func():
        if check_motion()==0:        # No motion in action
                set_digital_output(1, OFF)
        else:
                set_digital_output(1, ON)
#----- Main routine ---------------------------------------
th_id = thread_run(fn_th_func, loop=True)

# do something…

thread_pause(th_id) # Suspends the thread.
```

6.3.4 thread_resume(th_id)

- **Features**

This function resumes a temporarily suspended thread.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
th_id	int	-	Suspended thread ID to be resumed

- **Return**

Value	Description
0	Success
Negative value	Failed

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
def fn_th_func():
        if check_motion()==0:           # No motion in action
                set_digital_output(1, OFF)
        else:
                set_digital_output(1, ON)

#----- Main routine ---------------------------------------
th_id = thread_run(fn_th_func, loop=True)

# do something…
thread_pause(th_id) # Suspends the thread.

# do something…
thread_resume(th_id) # Resumes the suspended thread.
```

6.3.5 thread_state(th_id)

- **Features**

This function checks the status of a thread.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
th_id	int	-	Thread ID to check the status

- **Return**

Value	Description
1	RUN (TH_STATE_RUN)
2	PAUSE (TH_STATE_PAUSE)
3	STOP (TH_STATE_STOP)

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid

- **Example**

```
def fn_th_func():
        if check_motion()==0:        # No motion in action
                set_digital_output(1, OFF)
        else:
                set_digital_output(1, ON)

th_id = thread_run(fn_th_func, loop=True)
state1 = thread_state(th_id)

thread_pause(th_id)
state2 = thread_state(th_id)
```

6.3.6 Integrated example

This example explains how to use the thread.

- **Example 1: Thread example**

```
#----- thread 1: client comm. ----------------------
def fn_th_client():
    global g_sock
    global g_cmd
    res, rx_data = client_socket_read(g_sock)
    if res > 0:
        g_cmd = rx_data.decode() #decode: Converts byte type into a string.
    else: # Communication error
        client_socket_close(g_sock)
        exit()    # Terminates the program.
    wait(0.1)
    return 0

#----- thread 2: check IO -------------------------
def fn_th_check_io():
    if get_digital_input(1) == ON:
        exit()    # Terminates the program.
    wait(0.1)
    return 0

#----- main ---------------------------------------
g_sock = client_socket_open("192.168.137.2", 20002) # Connects to the server.
g_cmd = ""

g_th_id1 = thread_run(th_client, loop=True)      # Runs the th_client thread.
g_th_id2 = thread_run(th_check_io, loop=True) # Runs the th_check_io thread.

p1 = posj(0, 0, 90, 0, 90, 0)
p2 = posj(10, 0, 90, 0, 90, 0)
p3 = posj(20, 0, 90, 0, 90, 0)

while 1:
    if g_cmd == "a":
        g_cmd = ""
        movej(p1,vel=100,acc=100)
        client_socket_write(g_sock, b"end")
    if g_cmd == "b":
        g_cmd = ""
        movej(p2,vel=100,acc=100)
        client_socket_write(g_sock, b"end")
    if g_cmd == "c":
        g_cmd = ""
        movej(p3,vel=100,acc=100)
        client_socket_write(g_sock, b"end")
    wait(0.1)
```

th_client thread: Converts the data received from the server into a string and saves it in g_cmd.
th_check_io thread: Checks the state of contact no. 1 and terminates the program if it is ON.
main: Connects to the server.
2 threads run: th_client and th_check_io
If "a" is received from the server, it moves to p1 and sends "end" to the servers.
If "b" is received from the server, it moves to p2 and sends "end" to the servers.
If "c" is received from the server, it moves to p3 and sends "end" to the servers.

6.4 Others

6.4.1 wait(time)

- **Features**

This function waits for the specified time.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
Time	Float	-	Time [sec]

- **Return**

Value	Description
0	Success
Negative value	Error

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
wait(1.3)    # Waits for 1.3 seconds.

while 1:    # Checks contact no. 1 every 0.1 second.
    if get_digital_input(1) == ON:
        set_digital_output(1, ON)
    wait(0.1)
```

6.4.2 exit()

- **Features**

This function terminates the currently running program.

- **Return**

Value	Description
0	Success

- **Exception**

Exception	Description
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred

- **Example**

```
exit()
```

6.4.3 sub_program_run(name)

- **Features**

It executes a subprogram saved as a separate file.

- **Parameter**

Parameter Name	Data Type	Default Value	Description
name	string	-	Name of subprogram

- **Return**

Value	Description
module	Module object of executed subprogram

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data error occurred occurred
DR_Error (DR_ERROR_VALUE)	Invalid parameter value occurred
DR_Error (DR_ERROR_RUNTIME)	C Extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

Note

- The first line of the subprogram must have the phrase "from DRCF import *".
- When programming with a teaching pendant, this phrase is automatically inserted.
- If the global variable names of the main program and subprograms are the same, they operate as different variables. That is, they are not variable references to each other.
- If you need to share variables between the main program and subprograms, use system variables.
- System variables are set through the teaching pendant. Please refer to the user manual for detailed usage.

- **Example**

```
# subprogramA and subprogramB must be created and saved in advance.

<subProgrmA.drl>
from DRCF import *
movej([0,0,90,0,90,0], vel=30, acc=30)

<subProgrmB.drl>
from DRCF import *
movej[(10,0,90,0,90,0), vel=30, acc=30)
```

```
<main program>
while True:
    var_select = tp_get_user_input("Select File", DR_VAR_INT)
    if var_select == 0:
      sub_program_run("subProgramA")   # execute subProgramA
    elif var_select == 1:
      sub_program_run("subProgramB")   # execute subProgramB
```

6.4.4 drl_report_line(option)

- **Features**

This command is used to turn ON / OFF the execution line display function when the DRL script is running. When the run line display function is turned OFF, the time required to execute the run line display function is reduced, which significantly speeds up the execution of the DRL.

Caution

The following features do not operate in the section where the execution line display function is turned OFF.

- Execution time display by line
- Variable monitoring
- System Variable Update
- Step by Step in Debug mode
- Brake Point in Debug mode

- **Parameter**

Parameter Name	Data Type	Default Value	Description
option	Int	-	Whether to display the DRL execution line ON(1) OFF(0)

- **Return**

Value	Description
None	None

- **Example**

```
x=0
y=0

drl_report_line(OFF)      # Execution line display function OFF
while x < 1000:           # Execution line not displayed (speed up execution)
   x += 1                 # Execution line not displayed (speed up execution)
drl_report_line(ON)       # Execution line display function ON
x=0                       # Execution line shown
y=0                       # Execution line shown
```

6.4.5 set_fm(key, value)

- **Features**

This command is used when interworking is required for information on variables (global variables, system variables, etc.) created when the program is executed, in addition to the system information already defined and linked with KT Smart Factory.

⚠ **Caution**

Please note that this function will not work if the linkage information is not set in the KT Smart Factory menu in the Setup menu.

The KT Smart Factory menu only appears when setting up KT-specific licenses.

- **Parameter**

Parameter Name	Data Type	Default Value	Description
key	string	-	Data Name
value	int float string	-	Interlocking Data Variable Possible data types .Integer data .Real data .string data

- **Return**

Value	Description
None	None

- **Example**

```
count = 0

movej(posj(0, 0, 90, 0,90,0), vel=30, acc=30)
while True:
    movej(posj(0, 0, -90, 0,90,0), vel=30, acc=30)
    movej(posj(0, 0, 90, 0,90,0), vel=30, acc=30)
    count = count + 1
    set_fm("TotalCount", count)
```

7. Mathematical Function

7.1 sin(x)

- **Features**

  This function returns the sine value of x radians.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
x	float	-	-

- **Return**

Value	Description
the sine of x	-

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred

7.2 cos(x)

- **Features**

  This function returns the cosine value of x radians.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
x	float	-	-

- **Return**

Value	Description
the cosine of x	

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred

7.3 tan(x)

- **Features**

  This function returns the tangent value of x radians.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
x	float	-	-

- **Return**

Value	Description
the tangent of x	-

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred

7.4 asin(x)

- **Features**

  This function returns the arc sine value of x radians.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
x	float	-	

- **Return**

Value	Description
the arc sine of x	-

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred

7.5 acos(x)

- **Features**

  This function returns the arc cosine value of x radians.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
x	float	-	

- **Return**

Value	Description
the arc cosine of x	-

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred

7.6 atan(x)

- **Features**

  This function returns the arc tangent value of x radians.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
x	float	-	-

- **Return**

Value	Description
the arc tangent of x	-

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred

7.7 atan2(y, x)

- **Features**

  This function returns the arc tangent value of y/x radians.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
y	float	-	-
x	float	-	-

- **Return**

Value	Description
the arc tangent of y/x	The result is between -pi and pi

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred

7.8 ceil(x)

- **Features**

  This function returns the smallest integer value of integers equal to or larger than x. It truncates up to the integer.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
x	float	-	-

- **Return**

Value	Description
rounded integer	-

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred

7.9 floor(x)

- **Features**

This function returns the largest integer value of integers equal to or smaller than x. It rounds down to the nearest one.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
x	float	-	-

- **Return**

Value	Description
rounded integer	-

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred

7.10 pow(x, y)

- **Features**

Return x raised to the power of y.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
x	float	-	
y	float	-	

- **Return**

Value	Description
x raised to the power y	-

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred

7.11 sqrt(x)

- **Features**

This function returns the square root of x.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
x	float	-	-

- **Return**

Value	Description
the square root of x	Success

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred

7.12 log(x, b)

- **Features**

This function returns the log of x with base b.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
x	float	-	-
b	float	-	base, e (natural logarithm)

- **Return**

Value	Description
the logarithm of f to the base of b.	-

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred

7.13 d2r(x)

- **Features**

  This function returns the x degrees value to radians.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
x	float	-	The angle in degrees

- **Return**

Value	Description
The angle in radians	-

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred

7.14 r2d(x)

- **Features**

  This function returns the x radians value to degrees.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
x	float		The angle in radians

- **Return**

Value	Description
The angle in degrees	-

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred

7.15 norm(x)

- **Features**

  This function returns the L2 norm of x.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
x	float[3]	-	Point coordinate (x, y, z)

- **Return**

Value	Description
float	Size of the point coordinate vector

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred

7.16 random()

- **Features**

  This function returns a random number between 0 and 1.

- **Return**

Value	Description
random number	Random number between 0 and 1 (float)

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred

7.17 rotx(angle)

- **Features**

  This function returns a rotation matrix that rotates by the angle value along the x-axis.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
angle	float	0	Rotating angle [deg]

- **Return**

Value	Description
float[3][3]	Rotation matrix

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred

- **Example**

```
rotm = rotx(30)
```

7.18 roty(angle)

- **Features**

This function returns a rotation matrix that rotates by the angle value along the y-axis.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
angle	float	0	Rotating angle [deg]

- **Return**

Value	Description
float[3][3]	Rotation matrix

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred

- **Example**

```
rotm = roty(30)
```

7.19 rotz(angle)

- **Features**

  This function returns a rotation matrix that rotates by the angle value along the z-axis.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
angle	float	0	Rotating angle [deg]

- **Return**

Value	Description
float[3][3]	Rotation matrix

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred

- **Example**

```
rotm = rotz(30)
```

7.20 rotm2eul(rotm)

- **Features**

This function receives a rotation matrix and returns the Euler angle (zyz order) to degrees. Of the Euler angle (rx, ry, rz) returned as a result, ry is always a positive number.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
rotm	Float[3][3]	-	Rotation matrix

- **Return**

Value	Description
float[3]	ZYZ Euler angle [deg]

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred

- **Example**

```
rotm = [[1,0,0],[0,0.87,-0.5],[0,0.5,0.87]]
eul = rotm2eul(rotm)
```

7.21 rotm2rotvec(rotm)

- **Features**

  This function receives a rotation matrix and returns the rotation vector (angle/axis representation).

- **Parameters**

Parameter Name	Data Type	Default Value	Description
rotm	float[3][3]	-	Rotation matrix

- **Return**

Value	Description
float[3]	rotation vector

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred

- **Example**

```
rotm = [[1,0,0],[0,0.87,-0.5],[0,0.5,0.87]]
eul = rotm2rotvec(rotm)
```

7.22 eul2rotm([alpha,beta,gamma])

- **Features**

This function transforms a Euler angle (zyz order) to a rotation matrix.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
eul	float[3]	[0 0 0]	Euler angle (zyz) [deg]

- **Return**

Value	Description
float[3][3]	Rotation matrix

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred

- **Example**

```
eul = [90, 90, 0]
rotm = eul2rotm (eul)
```

7.23 eul2rotvec([alpha,beta,gamma])

- **Features**

  This function transforms a Euler angle (zyz order) to a rotation vector.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
eul	float[3]	[0 0 0]	Euler angle (zyz) [deg]

- **Return**

Value	Description
float[3]	rotation vector

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred

- **Example**

```
eul = [90, 90, 0]
rotvec = eul2rotvec (eul)
```

7.24 rotvec2eul([rx,ry,rz])

- **Features**

This function transforms a rotation vector to a Euler angle (zyz).

- **Parameters**

Parameter Name	Data Type	Default Value	Description
rotvec	float[3]	-	rotation vector

- **Return**

Value	Description
float[3]	ZYZ Euler angle [deg]

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred

- **Example**

```
rotvec = [0.7854, 0, 0]
eul = rotvec2eul(rotvec)    # eul=[45,0,0]
```

7.25 rotvec2rotm([rx,ry,rz])

- **Features**

  This function transforms a rotation vector to a rotation matrix.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
rotvec	float[3]	-	rotation vector

- **Return**

Value	Description
float[3][3]	Rotation matrix

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred

- **Example**

```
rotm = rotvec2eul([0.7854,0,0])
```

7.26 htrans(posx1,posx2)

- **Features**

This function returns the pose corresponding to T1*T2 assuming that the homogeneous transformation matrices obtained from posx1 and posx2 are T1 and T2, respectively.

$$H_1H_2 = \begin{bmatrix} R_1 & r_1 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} R_2 & r_2 \\ 0 & 1 \end{bmatrix} = \begin{bmatrix} R_1R_2 & r_1 + R_1r_2 \\ 0 & 1 \end{bmatrix}$$

- **Parameters**

Parameter Name	Data Type	Default Value	Description
posx1	posx list (float[6])	-	posx or position list [mm, deg]
posx2	posx list (float[6])	-	posx or position list [mm, deg]

- **Return**

Value	Description
posx	[mm, deg]

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred

- **Example**

```
posx1 = [100, 20, 300, 90, 0, 180]
posx2 = [200, 50, 100, 90, 30, 150]
posx = htrans(posx1,posx2)
```

7.27 get_intermediate_pose(posx1,posx2,alpha)

- **Features**

This function returns posx located at alpha of the linear transition from posx1 to posx2. It returns posx1 if alpha is 0, the median value of two poses if alpha is 0.5, and posx2 if alpha is 1.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
posx1	posx list (float[6])	-	posx or position list [mm, deg]
posx2	posx list (float[6])	-	posx or position list [mm, deg]
alpha	float	-	0.0 ≤ alpha ≤ 1.0

- **Return**

Value	Description
posx	[mm, deg]

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred

- **Example**

```
posx1 = [100, 20, 300, 90, 0, 180]
posx2 = [200, 50, 100, 90, 30, 150]
alpha = 0.5
posx = get_intermediate_pose(posx1,posx2,alpha)
```

7.28 get_distance(posx1, posx2)

- **Features**

  This function returns the distance between two pose positions in [mm].

- **Parameters**

Parameter Name	Data Type	Default Value	Description
posx1	posx list (float[6])	-	posx or position list [mm]
posx2	posx list (float[6])	-	posx or position list [mm]

- **Return**

Value	Description
float	[mm]

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred

- **Example**

```
posx1 = [100, 20, 300, 90, 0, 180]
posx2 = [200, 50, 100, 90, 30, 150]
dis_posx = get_distance(posx1, posx2)
```

7.29 get_normal(x1, x2, x3)

- **Features**

This function returns the normal vector of a surface consisting of three points (posx) in the task space. This direction is clockwise.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
x1	posx list (float[6])	-	posx or position list
x2	posx list (float[6])	-	posx or position list
x3	posx list (float[6])	-	posx or position list

- **Return**

Value	Description
float[3]	normal vector

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
x1 = posx(0, 500, 700, 30, 0, 90)
x2 = posx(500, 0, 700, 0, 0, 45)
x3 = posx(300, 100, 500, 45, 0, 45)
vect = get_normal(x1, x2, x3)
```

7.30 add_pose(posx1,posx2)

- **Features**

This function obtains the sum of two poses.

add_pose($\begin{bmatrix} R_1 & r_1 \\ 0 & 1 \end{bmatrix}$,$\begin{bmatrix} R_2 & r_2 \\ 0 & 1 \end{bmatrix}$) $\Rightarrow \begin{bmatrix} R_1R_2 & r_1 + r_2 \\ 0 & 1 \end{bmatrix}$

- **Parameters**

Parameter Name	Data Type	Default Value	Description
posx1	posx list (float[6])	-	posx or position list [mm, deg]
posx2	posx list (float[6])	-	posx or position list [mm, deg]

- **Return**

Value	Description
posx	[mm, deg]

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred

- **Example**

```
posx1 = [100, 20, 300, 90, 0, 180]
posx2 = [200, 50, 100, 90, 30, 150]
add_posx = add_pose(posx1, posx2)
```

7.31 subtract_pose(posx1,posx2)

- **Features**

This function obtains the difference between two poses.

subtract_pose($\begin{bmatrix} R_1 & r_1 \\ 0 & 1 \end{bmatrix}$,$\begin{bmatrix} R_2 & r_2 \\ 0 & 1 \end{bmatrix}$) $\Rightarrow \begin{bmatrix} R_2^T R_1 & r_1 - r_2 \\ 0 & 1 \end{bmatrix}$

- **Parameters**

Parameter Name	Data Type	Default Value	Description
posx1	posx list (float[6])	-	posx or position list [mm, deg]
posx2	posx list (float[6])	-	posx or position list [mm, deg]

- **Return**

Value	Description
posx	[mm, deg]

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred

- **Example**

```
posx1 = [100, 20, 300, 90, 0, 180]
posx2 = [200, 50, 100, 90, 30, 150]
subtract_posx = subtract_pose(posx1, posx2)
```

7.32 inverse_pose(posx1)

- **Features**

This function returns the posx value that represents the inverse of posx.

inv_pose ($\begin{bmatrix} R_1 & r_1 \\ 0 & 1 \end{bmatrix}$)=$\begin{bmatrix} R_1 & r_1 \\ 0 & 1 \end{bmatrix}^{-1} = \begin{bmatrix} R_1^T & -R_1^T r_1 \\ 0 & 1 \end{bmatrix}$

- **Parameters**

Parameter Name	Data Type	Default Value	Description
posx1	posx list (float[6])	-	posx or position list [mm, deg]

- **Return**

Value	Description
posx	[mm, deg]

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred

- **Example**

```
posx1 = [100, 20, 300, 90, 0, 180]
inv_posx = inverse_pose(posx1)
```

7.33 dot_pose(posx1, posx2)

- **Features**

  This function obtains the inner product of the translation component when two poses are given.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
posx1	posx list (float[6])	-	posx or position list [mm, deg]
posx2	posx list (float[6])	-	posx or position list [mm, deg]

- **Return**

Value	Description
float	Inner product of two poses.

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred

- **Example**

```
posx1 = [100, 20, 300, 90, 0, 180]
posx2 = [200, 50, 100, 90, 30, 150]
res= dot_pose(posx1, posx2)
```

7.34 cross_pose(posx1, posx2)

- **Features**

This function obtains the outer product of the translation component when two poses are given.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
posx1	posx list (float[6])	-	posx or position list [mm, deg]
posx2	posx list (float[6])	-	posx or position list [mm, deg]

- **Return**

Value	Description
float[3]	Outer product of two poses.

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred

- **Example**

```
posx1 = [100, 20, 300, 90, 0, 180]
posx2 = [200, 50, 100, 90, 30, 150]
res= cross_pose(posx1, posx2)
```

7.35 unit_pose(posx1)

- **Features**

  This function obtains the unit vector of the given posx translation component.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
posx1	posx list (float[6])	-	posx or position list [mm, deg]

- **Return**

Value	Description
float[3]	Unit vector of the given posx

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred

- **Example**

```
posx1 = [100, 20, 300, 90, 0, 180]
res = unit_pose(posx1
```

8. External Communication Commands

8.1 Serial

8.1.1 serial_open(port=None, baudrate=115200, bytesize=DR_EIGHTBITS, parity=DR_PARITY_NONE, stopbits=DR_STOPBITS_ONE)

- **Features**

This function opens a serial communication port.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
port	string	None	E.g.) "COM1", "COM2"
baudrate	int	115200	Baud rate
bytesize	int	8	Number of data bits • DR_FIVEBITS: 5 • DR_SIXBITS: 6 • DR_SEVENBITS: 7 • DR_EIGHTBITS: 8
parity	str	"N"	Parity checking • DR_PARITY_NONE: "N" • DR_PARITY_EVEN: "E" • DR_PARITY_ODD: "O" • DR_PARITY_MARK: "M" • DR_PARITY_SPACE: "S"
stopbits	int	1	Number of stop bits • DR_STOPBITS_ONE =1 • DR_STOPBITS_ONE_POINT_FIVE = 1.5 • DR_STOPBITS_TWO = 2

- **Return**

Value	Description
serial.Serial instance	Successful connection

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid

Exception	Description
DR_Error (DR_ERROR_RUNTIME)	Serial.SerialException error occurred

- **Example**

```
ser = serial_open(port="COM2", baudrate=115200, bytesize=DR_EIGHTBITS,
parity=DR_PARITY_NONE, stopbits=DR_STOPBITS_ONE)

if type(ser) == serial.Serial:
  serial_write(ser, b"123456789")

serial_close(ser)
```

8.1.2 serial_close(ser)

- **Features**

This function closes a serial communication port.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
ser	serial.Serial	-	Serial instance

- **Return**

Value	Description
0	Successful closing of a serial port

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred

- **Example**

```
ser = serial_open(port="COM2", baudrate=115200, bytesize=DR_EIGHTBITS,
parity=DR_PARITY_NONE, stopbits=DR_STOPBITS_ONE)

if type(ser) == serial.Serial:
  serial_write(ser, b"123456789")

serial_close(ser)
```

8.1.3 serial_state(ser)

- **Features**

  This function returns the status of a serial communication port.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
ser	serial.Serial	-	Serial instance

- **Return**

Value	Description
1	Serial port opened
0	Serial port closed

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred

- **Example**

```
ser = serial_open(port="COM2", baudrate=115200, bytesize=DR_EIGHTBITS,
        parity=DR_PARITY_NONE, stopbits=DR_STOPBITS_ONE)

state = serial_state(ser)
serial_close(ser)
```

8.1.4 serial_set_inter_byte_timeout(ser, timeout=None)

- **Features**

This function sets the timeout between the bytes (inter-byte) when reading and writing to the port.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
ser	serial.Serial	-	Serial instance
timeout	float	None	Timeout between bytes during reading or writing • Continued processing of data that was processed before the timeout • None: inter-byte timeout not specified

- **Return**

Value	Description
0	Success

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred

- **Example**

```
ser = serial_open(port="COM2", baudrate=115200, bytesize=DR_EIGHTBITS,
        parity=DR_PARITY_NONE, stopbits=DR_STOPBITS_ONE)

state = serial_set_inter_byte_timeout(ser, 0.1)

serial_close(ser))
```

8.1.5 serial_write(ser, tx_data)

- **Features**

  This function writes the data (tx_data) to a serial port.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
ser	serial.Serial	-	Serial instance
tx_data	byte	-	Data to be transmitted • The data type must be a byte. • Refer to the example below.

- **Return**

Value	Description
0	Success
-1	The port is not open.
-2	serial.SerialException error occurred

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred

- **Example**

```
ser = serial_open(port="COM2", baudrate=115200, bytesize=DR_EIGHTBITS,
        parity=DR_PARITY_NONE, stopbits=DR_STOPBITS_ONE)

serial_write(ser, b"123456789") # b means the byte type.

serial_close(ser)
```

8.1.6 serial_read(ser, length=-1, timeout=-1)

- **Features**

This function reads the data from a serial port.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
ser	serial.Serial	-	Serial instance
length	int	-1	Number of bytes to read • -1: Not specified (The number of bytes to read is not specified.) • n(>=0): The specified number of bytes is read.
timeout	int float	-1	Read waiting time • -1: Indefinite wait • n(>0): n seconds

- **Return**

Value (res, rx_data)		Description
res	0	Number of bytes of the received data
	-1	The port is not open.
	-2	serial.SerialException error occurred
rx_data		Number of bytes read (byte type)

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid

- **Example**

```
ser = serial_open(port="COM2", baudrate=115200, bytesize=DR_EIGHTBITS,
        parity=DR_PARITY_NONE, stopbits=DR_STOPBITS_ONE)
serial_read(ser)
serial_read(ser, 100)
serial_read(ser, 100, 3)
serial_read(ser, -1, 3)
serial_close(ser)
```

8.1.7 serial_get_count()

- **Features**

  This function reads the number of devices connected to USB to Serial.

- **Parameter**

Parameter Name	Data Type	Default Value	Description
None	-	-	

- **Return**

Value (port_info, device_name)	Description
count	Number of connected serial ports

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data error occurred
DR_Error (DR_ERROR_VALUE)	Invalid parameter value occurred

- **Example**

```
count = serial_get_count()    # read number of connected serial ports

for i in range(count):
      port_info, device_name = serial_get_info(i+1)
      tp_popup("i={}, port ={}, dev ={}".format(i, port_info, device_name))
```

8.1.8 serial_get_info(id)

- **Features**

  This function reads the port information and device name of the connected USB to Serial.

- **Parameter**

Parameter Name	Data Type	Default Value	Description
id	int	1	ID of "USB to Serial" to read (1-10)

- **Return**

Value (port_info, device_name)	Description
port_info	Port information (NULL means no device is connected)
device_name	Device name (NULL means no device is connected)

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data error occurred
DR_Error (DR_ERROR_VALUE)	Invalid parameter value occurred

- **Example**

```
port_info, device_name = serial_get_info(1)    #1 connected device information
#port_info = "COM_USB"
ser = serial_open(port=port_info, baudrate=115200, bytesize=DR_EIGHTBITS,
        parity=DR_PARITY_NONE, stopbits=DR_STOPBITS_ONE)
```

8.1.9 Combined Example

This is an example for performing a self-loop-back test on RXD (#2 pin) and TXD (#3 pin) are connected with the serial port.

- **Example 1: Self-loop-back test example**

```
# serial port open
# if D-SUB (9pin) is connected                    : port="COM"
# if USB is connected with USB to Serial : port="COM_USB"
ser = serial_open(port="COM_USB", baudrate=115200, bytesize=DR_EIGHTBITS,
parity=DR_PARITY_NONE, stopbits=DR_STOPBITS_ONE)
wait(1)

# SEND DATA : "123ABC"
res = serial_write(ser, b"123ABC") # b means byte type
wait(1)

# READ DATA
res, rx_data = serial_read(ser)
# RXD and TXD are H/W connected res=6 (byte) rx_data = b"123ABC" are recevied

tp_popup("res ={0}, rx_data={1}".format(res, rx_data))

# close corresponding serial port
serial_close(ser)
```

Received data is collected as is and the result is outputted as a TP pop-up message.
If executed properly, it outputs a result of res=6 rx_data = b’123ABC’.

8.2 Tcp/Client

8.2.1 client_socket_open(ip, port)

- **Features**

This function creates a socket and attempts to connect it to a server (ip, port).
It returns the connected socket when the client is connected.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
ip	str	-	Server IP address: (E.g.) "192.168.137.200"
port	int	-	Server port number (e.g.) 20002

- **Return**

Value	Description
socket.socket instance	Successful connection

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	socket.error occurred during a connection

- **Example**

```
sock = client_socket_open("192.168.137.200", 20002)
# An indefinite connection is attempted to the server (ip="192.168.137.200",
port=20002).
# The connected socket is returned if the connection is successful.
# The data is read, written, and closed using the returned socket as shown below.

client_socket_write(sock, b"123abc")      # Sends data to the server (b represents the
byte type).
res, rx_data = client_socket_read(sock) # Receives the data from the server.
client_socket_close(sock)                  # Closes the connection to the server.
```

8.2.2 client_socket_close(sock)

- **Features**

This function terminates communication with the server. To reconnect to the server, the socket must be closed with client_socket_close(sock) and reopened.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
sock	socket.socket	-	Socket instance returned from client_socket_open()

- **Return**

Value	Description
0	Successful disconnection

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_RUNTIME)	socket.error occurred during disconnection

- **Example**

```
sock = client_socket_open("192.168.137.200", 20002)
# An indefinite connection is attempted to the server (ip="192.168.137.200",
port=20002).

# do something…

client_socket_close(sock)          # Closes the connection to the server.
```

8.2.3 client_socket_state(sock)

- **Features**

This function returns the socket connection status.To know the connection status with the server, check the return value of client_socket_read or client_socket_write (see Example 2).

- **Parameters**

Parameter Name	Data Type	Default Value	Description
sock	socket.socket	-	Socket instance returned from client_socket_open()

- **Return**

Value	Description
1	Socket normal state
0	Socket abnormal state

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred

- **Example**

```
sock = client_socket_open("192.168.137.200", 20002)

state = client_socket_state(sock)    # Reads the socket state.

client_socket_close(sock)
```

- **Example 2**

```
sock = client_socket_open("192.168.137.200", 20002)

res, rx_data =client_socket_read(sock)
tp_log("[RX] res={0}, rx_data ={1}".format(res, rx_data))
if (res < 0):
    tp_log("[RX] server disconnect")    #When the server connection is disconnected
    client_socket_close(sock)
    exit()

client_socket_close(sock)
```

8.2.4 client_socket_write(sock, tx_data)

- **Features**

This function transmits data to the server.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
sock	socket.socket	-	Socket instance returned from client_socket_open()
tx_data	byte	-	Data to be transmitted • The data type must be a byte. • Refer to the example below.

- **Return**

Value	Description
0	Success
-1	The server is not connected.
-2	server is disconnected, or socket.error occurred during a data transfer

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred

- **Example**

```
sock = client_socket_open("192.168.137.200", 20002)

client_socket_write(sock, b"1234abcd") # b means the byte type.

msg = "abcd" # msg is a string variable.
client_socket_write(sock, msg.decode()) # decode() converts a string type to a byte type.

client_socket_close(sock)
```

8.2.5 client_socket_read(sock, length=-1, timeout=-1)

- **Features**

This function receives data from the server.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
sock	socket.socket	-	Socket instance returned from client_socket_open()
length	int	-1	Number of bytes of the received data • -1: Not specified (The number of bytes to read is not specified.) • n(>=0): The specified number of bytes is read.
timeout	int float	-1	Waiting time for receipt • -1: Indefinite wait • n(>0): n seconds

- **Return**

Value (res, rx_data)		Description
res	>0	Number of bytes of the received data
	-1	The server is not connected.
	-2	socket.error occurred during data reception
	-3	Timeout during data reception
rx_data		Received data (byte type)

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid

- **Example**

```
sock = client_socket_open("192.168.137.200", 20002)

res, rx_data = client_socket_read(sock)       # Indefinite wait until the data is received
# Reads all received data since the length is omitted.
# Waits indefinitely until the data is received since timeout is omitted.
# (res = size of received data, rx_data=received data) is returned when the data is
received.

res, rx_data = client_socket_read(sock, timeout=3) # Waits for up to 3 seconds until the
data is received.
# (res = size of received data, rx_data=received data) is returned if the data is received
within 3 seconds.
# (res = -3, rx_data=None) is returned if the data is not received within 3 seconds.

res, rx_data = client_socket_read(sock, length=64)     # Reads 64 bytes of the received
data.

res, rx_data = client_socket_read(sock, length=64, timeout=3)
# Reads 64 bytes of the received data within the 3-second timeout.

rx_msg = rx_data.decode() # rx_data is a byte type and can be converted to a string
type
                                    # using decode().
                                    # For example, if rx_data = b"abcd",
                                    # rx_msg= "abcd".
client_socket_close(sock)
```

8.2.6 Integrated example

Assume that server IP = 192.168.137,200 and open port =20002
and that the received packets are sent to the client as they are (mirroring).

- **Example 1: Example of a default TCP client**

```
# Assume server IP = 192.168.137,200 and open port =20002.
g_sock = client_socket_open("192.168.137.200", 20002)

tp_popup("connect O.K!",DR_PM_MESSAGE)
while 1:
    client_socket_write(g_sock, b"abcd")    # The string "abcd" is sent in a byte type.
    wait(0.1)
    res, rx_data = client_socket_read(g_sock) # Waits for the data from the server.
    tp_popup("res={0}, rx_data ={1}".format(res, rx_data), DR_PM_MESSAGE)
    wait(0.1)
```

The example connects to the server and sends the string "abcd". (b converts the string to a byte type.)
The message received from the server is output to the TP.
res = 4 and rx_data=b"abcd" since the server transmits the received data as is.

- **Example 2: Examples of a packet transfer**

Transmission packet: “MEAS_START" +data1[4byte]+data2[4byte]
data1: Conversion of the integer to 4 byte. ex) 1 → 00000001
data2: Conversion of the integer to 4 byte. ex) 2 → 00000002
ex) data1=1 and data2=2: “MEAS_START"+00000001+00000002
Actual packet: 4D4541535F53544152540000000100000002
Received packet: res=18, rx_data=“MEAS_START"+00000001+00000002
rxd1 extraction: Conversion of 10th - 14th bytes to an integer
rxd2 extraction: Conversion of 14th - 18th bytes to an integer

```
g_sock = client_socket_open("192.168.137.100", 20002)
tp_popup("connect O.K!",DR_PM_MESSAGE)

send_data = b"MEAS_START"
data1 =1
data2 =2
send_data += (data1).to_bytes(4, byteorder='big')
send_data += (data2).to_bytes(4, byteorder='big')

client_socket_write(g_sock, send_data)

wait(0.1)

res, rx_data = client_socket_read(g_sock)
tp_popup("res={0}, rx_data ={1}".format(res, rx_data), DR_PM_MESSAGE)

rxd1 = int.from_bytes(rx_data[10:10+4], byteorder='big', signed=True)
rxd2 = int.from_bytes(rx_data[14:14+4], byteorder='big', signed=True)
```

```
tp_popup("res={0}, rxd1={1}, rxd2={2}".format(res, rxd1, rxd2), DR_PM_MESSAGE)

client_socket_close(g_sock)
```

The example connects to the server and sends a byte type send_data.
res = 18 and rx_data=send_data since the server transmits the received data as is.
rxd1 extraction: Conversion of 10th - 14th bytes to an integer
rxd2 extraction: Conversion of 14th - 18th bytes to an integer
The final result is res=18, rxd1=1, and rxd2=2.

- **Example 3: Reconnection**

```
def fn_reconnect():
    global g_sock
    client_socket_close(g_sock)
    g_sock = client_socket_open("192.168.137.200", 20002)
    return

g_sock = client_socket_open("192.168.137.200", 20002)
tp_popup("connect O.K!",DR_PM_MESSAGE)

client_socket_write(g_sock, b"abcd")
wait(0.1)

while 1:
    res, rx_data = client_socket_read(g_sock)
    if res < 0:
        fn_reconnect()
    else:
        tp_popup("res={0}, rx_data ={1}".format(res, rx_data), DR_PM_MESSAGE)
    wait(0.1)
```

The example checks the return value of the client_socket_read() command.
A negative value is returned if the connection to the server is terminated or there is a communication problem.
The function reconnect() is called to attempt a reconnection if a negative value is returned.
Note that the opened socket is closed when a reconnection is attempted.

8.3 Tcp/Server

8.3.1 server_socket_open(port)

- **Features**

  The robot controller creates a server socket and waits for the connection to the client. The connected socket is returned when the client is connected.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
port	int	-	Port number to open

- **Return**

Value	Description
socket.socket instance	Successful connection

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	socket.error occurred during a connection

- **Example**

```
sock = server_socket_open(20002)
# Opens the port 20002 and waits until the client connects.
# The connected socket is returned if the connection is successful.
# The data is read, written, and closed using the returned socket as shown below.

server_socket_write(sock, b"123abc") # Sends data to the client (b represents the byte type).
res, rx_data = server_socket_read(sock) # Receives the data from the client.

server_socket_close(sock)                    # Closes the connection to the client.
```

8.3.2 server_socket_close(sock)

- **Features**

This function terminates communication with the client. To reconnect to the client, the socket must be closed with server_socket_close(sock) and reopened.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
sock	socket.socket	-	Socket instance returned from server_socket_open() socket instance

- **Return**

Value	Description
0	Successful disconnection

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_RUNTIME)	socket.error occurred during disconnection

- **Example**

```
sock = server_socket_open(20002)
# Opens the port 20002 and waits until the client connects.

# do something…

server_socket_close(sock) ) # Closes the connection to the client.
```

8.3.3 server_socket_state(sock)

- **Features**

This function returns the socket status.
To know the connection status with the client, check the return value of server_socket_read or server_socket_write (see Example 2).

- **Parameters**

Parameter Name	Data Type	Default Value	Description
sock	socket.socket	-	Socket instance returned from server_socket_open() socket instance

- **Return**

Value	Description
1	Socket normal state
0	Socket abnormal state

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred

- **Example**

```
sock = server_socket_open(20002)

state = server_socket_state(sock)    # Reads the socket state.

server_socket_close(sock)
```

- **Example 2**

```
sock = server_socket_open(20002)

res, rx_data =server_socket_read(sock)
tp_log("[RX] res={0}, rx_data ={1}".format(res, rx_data))
if (res < 0):       #When the client connection is disconnected
      tp_log("[RX] client disconnect")
      server_socket_close(sock)
      exit()

server_socket_close(sock)
```

8.3.4 server_socket_write(sock, tx_data)

- **Features**

This function transmits data to the client.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
sock	socket.socket	-	Socket instance returned from server_socket_open() socket instance
tx_data	byte	-	Data to be transmitted • The data type must be a byte. • Refer to the example below.

- **Return**

Value	Description
0	Success
-1	The client is not connected.
-2	client is disconnected, or socket.error occurred during a data transfer

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred

- **Example**

```
sock = server_socket_open(20002)

server_socket_write(sock, b"1234abcd") # b means the byte type.

msg = "abcd"        # msg is a string variable.
server_socket_write(sock, msg.decode()) # decode() converts a string type to a byte
type.

server_socket_close(sock)
```

8.3.5 server_socket_read(sock, length=-1, timeout=-1)

- **Features**

  This function reads data from the client.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
sock	socket.socket	-	Socket instance returned from server_socket_open() socket instance
length	int	-1	Number of bytes of the received data • -1: Not specified (The number of bytes to read is not specified.) • n(>=0): The specified number of bytes is read.
timeout	int float	-1	Waiting time for receipt • -1: Indefinite wait • n(>0): n seconds

- **Return**

Value (res, rx_data)		Description
res	0	Number of bytes of the received data
	-1	The client is not connected.
	-2	socket.error occurred during data reception
	-3	Timeout during data reception
rx_data		Received data (byte type)

- **Example**

```
sock = server_socket_open(20002)

res, rx_data = server_socket_read(sock)       # Indefinite wait until the data is received
# Reads all received data since the length is omitted.
# Waits indefinitely until the data is received since timeout is omitted.
# (res = size of received data, rx_data=received data) is returned when the data is received.

res, rx_data = server_socket_read(sock, timeout=3) # Waits for up to 3 seconds until the data is received.
# (res = size of received data, rx_data=received data) is returned if the data is received within 3 seconds.
# (res = -3, rx_data=None) is returned if the data is not received within 3 seconds.
```

```
res, rx_data = server_socket_read(sock, length=64)      # Reads 64 bytes of the
received data.

res, rx_data = server_socket_read(sock, length=64, timeout=3)
# Reads 64 bytes of the received data within the 3-second timeout.

rx_msg = rx_data.decode() # rx_data is a byte type and can be converted to a string
type
                                    # using decode().
                                    # For example, if rx_data = b"abcd",
                                    # rx_msg= "abcd".

server_socket_close(sock)
```

8.3.6 Integrated example

The example assumes that the client connects to the controller with IP = 192,168,137.100 and port = 20002
and that the received packets are sent to the server as they are (mirroring).

- **Example 1: Default TCP server example**

```
g_sock = server_socket_open(20002)
tp_popup("connect O.K!",DR_PM_MESSAGE)

while 1:
    server_socket_write(g_sock, b"abcd")    # The string "abcd" is sent in a byte type.
    wait(0.1)
    res, rx_data = server_socket_read(g_sock) # Waits for the data from the server.
    tp_popup("res={0}, rx_data ={1}".format(res, rx_data), DR_PM_MESSAGE)
    wait(0.1)
```

The example opens the port 20002 and waits until the client connects.
It connects to the client and sends the string "abcd".
The message received from the client is output to the TP.
res = 4 and rx_data=b"abcd" since the client transmits the received data as is.

- **Example 2: Examples of a packet transfer**

Transmission packet: “MEAS_START" +data1[4byte]+data2[4byte]
data1: Conversion of the integer to 4 byte. ex) 1 → 00000001
data2: Conversion of the integer to 4 byte. ex) 2 → 00000002
ex) data1=1 and data2=2: “MEAS_START"+00000001+00000002
Actual packet: 4D4541535F535441525400000001000000002
Received packet: res=18, rx_data=“MEAS_START"+00000001+00000002
rxd1 extraction: Conversion of 10th - 14th bytes to an integer
rxd2 extraction: Conversion of 14th - 18th bytes to an integer

```
g_sock = server_socket_open(20002)
tp_popup("connect O.K!",DR_PM_MESSAGE)

send_data = b"MEAS_START"
data1 =1
data2 =2
send_data += (data1).to_bytes(4, byteorder='big')
send_data += (data2).to_bytes(4, byteorder='big')

server_socket_write(g_sock, send_data)

wait(0.1)

res, rx_data = server_socket_read(g_sock)
tp_popup("res={0}, rx_data ={1}".format(res, rx_data), DR_PM_MESSAGE)

rxd1 = int.from_bytes(rx_data[10:10+4], byteorder='big', signed=True)
rxd2 = int.from_bytes(rx_data[14:14+4], byteorder='big', signed=True)
```

```
tp_popup("res={0}, rxd1={1}, rxd2={2}".format(res, rxd1, rxd2), DR_PM_MESSAGE)

server_socket_close(g_sock)
```

The example sends the byte type send_data.
res = 18 and rx_data=send_data since the client transmits the received data as is.
rxd1 extraction: Conversion of 10th - 14th bytes to an integer
rxd2 extraction: Conversion of 14th - 18th bytes to an integer
The final result is res=18, rxd1=1, and rxd2=2.

- **Example 3: Reconnection**

```
def fn_reopen():
    global g_sock
    server_socket_close(g_sock)
    g_sock = server_socket_open(20002)
    return

g_sock = server_socket_open(20002)
tp_popup("connect O.K!",DR_PM_MESSAGE)

server_socket_write(g_sock, b"abcd")
wait(0.1)

while 1:
    res, rx_data = server_socket_read(g_sock)
    if res < 0:
        fn_reopen()
    else:
        tp_popup("res={0}, rx_data ={1}".format(res, rx_data), DR_PM_MESSAGE)
    wait(0.1)
```

The example checks the return value of the server_socket_read() command.
A negative value is returned if the connection to the client is terminated or there is a communication problem.
The function reopen() is called to wait for the client connection if a negative value is returned.
Note that the opened socket is closed when a reconnection is attempted.

8.4 Modbus

8.4.1 add_modbus_signal (ip, port, name, reg_type, index, value=0, slaveid=255)

- **Features**

This function registers the ModbusTCP signal. The Modbus I/O must be set in the Teach Pendant I/O set-up menu. Use this command only for testing if it is difficult to use the Teach Pendant. The Modbus menu is disabled in the Teach Pendant if it is set using this command.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
ip	string	-	IP address of the ModbusTCP module
port	int	-	Port number of the ModbusTCP module
name	string	-	Modbus signal name
reg_type	int	-	Modbus signal type • DR_DISCRETE_INPUT = DR_MODBUS_DIG_INPUT • DR_COIL = DR_MODBUS_DIG_OUTPUT • DR_INPUT_REGISTER = DR_MODBUS_REG_INPUT • DR_HOLDING_REGISTER = DR_MODBUS_REG_OUTPUT
index	int	-	Modbus signal index
value	int	0	Output when the type is DR_COIL or DR_HOLDING_REGISTER (ignored otherwise)
slaveid	int	255	• Slave ID of the ModbusTCP module (0 or 1-247 or 255) 0 : Broadcase address 255 : Default value for ModbusTCP

- **Return**

Value	Description
0	Success
Negative value	Failed

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
# An example of connecting two Modbus IO and allocating the contacts
# Modbus IO 1 : IP address 192.168.137.254, port 502
    Input Register Address 0 ~ 3, signal name “input1”~”input4”
    Holding Register Addreess 0 ~ 3, signal name “output1”~”output4”
# Modbus IO 2 : IP address 192.168.137.253, port 502
    Input Register Address 0 ~ 3, signal name “input1”~”input4”
    Holding Register Addreess 0 ~ 3, signal name “output1”~”output4”

# set < Modbus IO 1 > “input1”~”input4”, “output1”~”output4”
add_modbus_signal(ip="192.168.137.254",port=502, name="input1",
reg_type=DR_INPUT_REGISTER, index=0, slaveid=255)
add_modbus_signal(ip="192.168.137.254",port=502, name="input2",
reg_type=DR_INPUT_REGISTER, index=1, slaveid=255)
add_modbus_signal(ip="192.168.137.254",port=502, name="input3",
reg_type=DR_INPUT_REGISTER, index=2, slaveid=255)
add_modbus_signal(ip="192.168.137.254",port=502, name="input4",
reg_type=DR_INPUT_REGISTER, index=3, slaveid=255)

add_modbus_signal(ip="192.168.137.254",port=502, name="output1",
reg_type=DR_HOLDING_REGISTER, index=0, value=0, slaveid=255)
add_modbus_signal(ip="192.168.137.254",port=502, name=" output2",
reg_type=DR_HOLDING_REGISTER, index=1, value=0, slaveid=255)
add_modbus_signal(ip="192.168.137.254",port=502, name=" output3",
reg_type=DR_HOLDING_REGISTER, index=2, value=0, slaveid=255)
add_modbus_signal(ip="192.168.137.254",port=502, name=" output4",
reg_type=DR_HOLDING_REGISTER, index=3, value=0, slaveid=255)


# set < Modbus IO 1 > “input5”~”input8”, “output5”~”output8”
add_modbus_signal(ip="192.168.137.253",port=502, name="input5",
reg_type= DR_INPUT_REGISTER, index=0, slaveid=255)
add_modbus_signal(ip="192.168.137.253",port=502, name=" input6",
reg_type= DR_INPUT_REGISTER, index=1, slaveid=255)
add_modbus_signal(ip="192.168.137.253",port=502, name=" input7",
reg_type= DR_INPUT_REGISTER, index=2, slaveid=255)
add_modbus_signal(ip="192.168.137.253",port=502, name=" input8",
reg_type= DR_INPUT_REGISTER, index=3, slaveid=255)
```

```
add_modbus_signal(ip="192.168.137.253",port=502, name=" output5",
reg_type=DR_HOLDING_REGISTER, index=0, value=0, slaveid=255)
add_modbus_signal(ip="192.168.137.253",port=502, name=" output6",
reg_type=DR_HOLDING_REGISTER, index=1, value=0, slaveid=255)
add_modbus_signal(ip="192.168.137.253",port=502, name=" output7",
reg_type=DR_HOLDING_REGISTER, index=2, value=0, slaveid=255)
add_modbus_signal(ip="192.168.137.253",port=502, name=" output8",
reg_type=DR_HOLDING_REGISTER, index=3, value=0, slaveid=255)
```

8.4.2 add_modbus_rtu_signal (slaveid=1, port=None, baudrate=115200, bytesize=DR_EIGHTBITS, parity=DR_PARITY_NONE, stopbits=DR_STOPBITS_ONE, name, reg_type, index, value=0)

- **Features**

This function registers the ModbusRTU signal. The Modbus I/O must be set in the Teach Pendant I/O set-up menu. Use this command only for testing if it is difficult to use the Teach Pendant. The Modbus menu is disabled in the Teach Pendant if it is set using this command.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
slaveid	int	1	Slave ID of the ModbusRTU (0 or 1-247) 0 : Broadcase address
port	string	None	E.g.) “COM”, “COM_USB”, “/dev/ttyUSB0”
baudrate	int	115200	Baud rate 9600, 19200, 57600, 115200, etc
bytesize	int	8	Number of data bits • DR_FIVEBITES: 5 • DR_SIXBITS: 6 • DR_SEVENBITS: 7 • DR_EIGHTBITS: 8
parity	string	"N"	Parity checking • DR_PARITY_NONE: "N" • DR_PARITY_EVEN: "E" • DR_PARITY_ODD: "O"
stopbits	int	1	Number of stop bits • DR_STOPBITS_ONE =1 • DR_STOPBITS_TWO = 2
name	string	-	Modbus signal name
reg_type	int	-	Modbus signal type • DR_DISCRETE_INPUT = DR_MODBUS_DIG_INPUT • DR_COIL = DR_MODBUS_DIG_OUTPUT • DR_INPUT_REGISTER = DR_MODBUS_REG_INPUT • DR_HOLDING_REGISTER = DR_MODBUS_REG_OUTPUT
index	int	-	Modbus signal index

Parameter Name	Data Type	Default Value	Description
value	int	0	Output when the type is DR_COIL or DR_HOLDING_REGISTER (ignored otherwise)

- **Return**

Value	Description
0	Success
Negative value	Failed

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
add_modbus_rtu_signal(slaveid=1, port=port_info, baudrate=115200,
bytesize=DR_EIGHTBITS, parity=DR_PARITY_NONE, stopbits=DR_STOPBITS_ONE,
name='di1', reg_type=DR_INPUT_REGISTER, index=0)

add_modbus_rtu_signal(slaveid=1, port=port_info, baudrate=115200,
bytesize=DR_EIGHTBITS, parity=DR_PARITY_NONE, stopbits=DR_STOPBITS_ONE,
name='do1', reg_type=DR_HOLDING_REGISTER, index=0, value=12345)
```

8.4.3 add_modbus_signal_multi(ip, port, slaveid=255, name=None, reg_type=DR_HOLDING_REGISTER, start_address=0, cnt=1)

- **Features**

This function registers the ModbusTCP FC15 & FC16 multiple signal. The Modbus I/O must be set in the Teach Pendant I/O set-up menu. Use this command only for testing if it is difficult to use the Teach Pendant. The Modbus menu is disabled in the Teach Pendant if it is set using this command.

Note

- Initial value setting function is not supported.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
ip	string	-	IP address of the ModbusTCP module
port	int	-	Port number of the ModbusTCP module
slaveid	int	255	• Slave ID of the ModbusTCP module (0 or 1-247 or 255) 0 : Broadcase address 255 : Default value for ModbusTCP
name	string	-	Modbus signal name
reg_type	int	DR_HOLDING_REGISTER	Modbus signal type • DR_COIL = DR_MODBUS_DIG_OUTPUT • DR_HOLDING_REGISTER = DR_MODBUS_REG_OUTPUT
start_address	int	0	Start address of Modbus multiple signal
cnt	int	1	Count of Modbus multiple signal

- **Return**

Value	Description
0	Success
Negative value	Failed

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
add_modbus_signal_multi(ip="192.168.137.200", port=502, slaveid=255, name="multi",
reg_type=DR_HOLDING_REGISTER, start_address=0, cnt=5)
```

8.4.4 add_modbus_rtu_signal_multi (slaveid=1, port=None, baudrate=115200, bytesize=DR_EIGHTBITS, parity=DR_PARITY_NONE, stopbits=DR_STOPBITS_ONE, name=None, reg_type=DR_HOLDING_REGISTER, start_address=0, cnt=1)

- **Features**

This function registers the ModbusRTU FC15 & FC16 multiple signal. The Modbus I/O must be set in the Teach Pendant I/O set-up menu. Use this command only for testing if it is difficult to use the Teach Pendant. The Modbus menu is disabled in the Teach Pendant if it is set using this command.

Note

・ Initial value setting function is not supported.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
slaveid	int	1	Slave ID of the ModbusRTU (0 or 1-247) 0 : Broadcase address
port	string	None	E.g.) “COM”, “COM_USB”, “/dev/ttyUSB0”
baudrate	int	115200	Baud rate 9600, 19200, 57600, 115200, etc
bytesize	int	8	Number of data bits • DR_FIVEBITES: 5 • DR_SIXBITS: 6 • DR_SEVENBITS: 7 • DR_EIGHTBITS: 8
parity	string	"N"	Parity checking • DR_PARITY_NONE: "N" • DR_PARITY_EVEN: "E" • DR_PARITY_ODD: "O"
stopbits	int	1	Number of stop bits • DR_STOPBITS_ONE =1 • DR_STOPBITS_TWO = 2
name	string	-	Modbus signal name
reg_type	int	-	Modbus signal type • DR_COIL =

Parameter Name	Data Type	Default Value	Description
			DR_MODBUS_DIG_OUTPUT • DR_HOLDING_REGISTER = DR_MODBUS_REG_OUTPUT
start_address	int	0	Start address of Modbus multiple signal
cnt	int	1	Count of Modbus multiple signal

▪ Return

Value	Description
0	Success
Negative value	Failed

▪ Exception

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

▪ Example

```
add_modbus_rtu_signal_multi(slaveid=1, port=”COM”, baudrate=115200,
bytesize=DR_EIGHTBITS, parity=DR_PARITY_NONE, stopbits=DR_STOPBITS_ONE,
name=”multi”, reg_type=DR_HOLDING_REGISTER, start_address=0, cnt=5)
```

8.4.5 del_modbus_signal (name)

- **Features**

This function deletes the registered Modbus signal. The Modbus I/O must be set in the Teach Pendant I/O set-up menu. Use this command only for testing if it is difficult to use the Teach Pendant. The Modbus menu is disabled in the Teach Pendant if it is set using this command.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
name	string	-	Name of the registered Modbus signal

- **Return**

Value	Description
0	Success
Negative value	Failed

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
# Use the following command when the Modbus IO signals are registered as "input1"
and "output1"
# and this signal registration is to be deleted. .
del_modbus_signal("input1")       # Deletes the registered " input1" contact
del_modbus_signal("output1")      # Deletes the registered " output1" contact
```

8.4.6 del_modbus_signal_multi (name)

- **Features**

This function deletes the registered Modbus multiple signal. The Modbus I/O must be set in the Teach Pendant I/O set-up menu. Use this command only for testing if it is difficult to use the Teach Pendant. The Modbus menu is disabled in the Teach Pendant if it is set using this command.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
name	string	-	Name of the registered Modbus multiple signal

- **Return**

Value	Description
0	Success
Negative value	Failed

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
# Use the following command when the Modbus multiple signal is registered as
"multi1"(cnt=5)
# and this signal registration is to be deleted. .
del_modbus_signal_multi("multi1")          # Deletes the registered "multi1" contact
```

8.4.7 set_modbus_output(iobus, value)

- **Features**

This function sends the signal to an external Modbus system.
Function Code 05 Write Single Coil Register
Function Code 06 Write Signle Holding Register

- **Parameters**

Parameter Name	Data Type	Default Value	Description
iobus	string	-	Modbus name (set in the TP)
value	int	-	Value for Modbus coil register • ON : 1 • OFF : 0
			Value for Modbus holding register

Note

- When registered as a multiple signal, it is available by adding address value index to signal name.

- **Return**

Value	Description
0	Success
Negative value	Failed

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid

Exception	Description
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
#Modbus Coil Registers are registered as "do1" and "do2".
set_modbus_output("do1", ON)
set_modbus_output("do2", OFF)

#Modbus Holding Registers are registered as "reg1" and "reg2".
set_modbus_output("reg1", 10)
set_modbus_output("reg2", 24)

#Modbus multiple signal is registered as “multi”(start address=10, cnt=2).
#“multi_10” & “multi_11” abailable
set_modbus_output("multi_10", 24)
set_modbus_output("multi_11", 65535)
```

8.4.8 set_modbus_outputs(iobus_list, val_list)

- **Features**

This function sends multiple signals to the Modbus Slave unit.

The maximum number of outputs is 32.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
iobus	string	-	Modbus name (set in the TP)
value	int	-	I/O output value list

- **Return**

Value	Description
0	Success
Negative value	Failed

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
# Modbus digital I/O output contact "d1" OFF, "d2" ON, and "d3" ON
set_modbus_outputs(iobus_list=[ "d1", "d2", "d3",], val_list=[0,1,1])

# Modbus digital I/O output contact "d3" OFF and "d4" ON
set_modbus_outputs(["d3", "d4"], [0,1])
```

8.4.9 set_modbus_output_multi(iobus, val_list)

- **Features**

This function sends the signal to an external Modbus system.
Function Code 15 Write Multiple Coil Register
Function Code 16 Write Multiple Holding Register

- **Parameters**

Parameter Name	Data Type	Default Value	Description
iobus	string	-	Modbus multiple signal name (set in the TP)
val_list	list	-	Value list of modbus multiple signal

Note

- An error occurs if the number of singals registered in the multiple signal name does not match the number of elemensts in the output value list.

- **Return**

Value	Description
0	Success
Negative value	Failed

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
#Modbus Coil Registers are registered as "do1"(cnt=5), "do2"(cnt=3)
set_modbus_output_multi("do1", [ON, OFF, ON, ON, ON])
set_modbus_output_multi("do2", [ON, ON, ON])

#Modbus Holding Registers are registered as "reg1"(cnt=5), "reg2"(cnt=3)
set_modbus_output_multi("reg1", [10, 101, 12345, 777, 555])
set_modbus_output_multi("reg2", [24, 25, 26])
```

8.4.10 get_modbus_input(iobus)

- **Features**

This function reads the signal from the Modbus Slave unit. Parameters

- **Parameters**

Parameter Name	Data Type	Default Value	Description
iobus	string	-	Modbus name (set in the TP)

Note

- When registered as a multiple signal, it is available by adding address value index to signal name.

- **Return**

Value	Description
0 or 1 or value	Modbus Descrete / Coil Register: ON or OFF Modbus Input / Holding Register : Register value

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
#Modbus digital I/O is connected, and the signals are registered as "di1" and "di2".
get_modbus_input("di1")
get_modbus_input("di2")

#Modbus analog I/O is connected, and the signals are registered as "reg1" and "reg2".
get_modbus_input("reg1")
get_modbus_input("reg2")

#Modbus multiple signal is registered as “multi”(start address=10, cnt=2).
#“multi_10” & “multi_11” abailable
get_modbus_ input ("multi_10")
get_modbus_ input ("multi_11")
```

8.4.11 get_modbus_inputs(iobus_list)

- **Features**

This function reads multiple signals from the Modbus Slave unit.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
iobus_list	list(string)	-	Modbus input name list (set in the TP) signal type can be used only in the following cases • DR_MODBUS_DIG_INPUT • DR_MODBUS_DIG_OUTPUT

- **Return**

Value	Description
int (>=0)	Multiple signals to be read at once (the value of the combination of iobus_list where the first value is LSB and the last value is MSB)
Negative number	Failed

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
# Modbus digital I/O input signal "di1" =OFF, "di2"=ON, and "di3" =ON
res = get_modbus_inputs(iobus_list=[ "di1", "di2", "di3"])
        #res expected value = 0b110 (binary number), 6 (decimal number), or 0x06
(hexadecimal number)

# Modbus digital I I/O input signal "di4" OFF and "di5" ON
res = get_modbus_inputs(["di4", "di5"])
        #res expected value = 0b10 (binary number), 2 (decimal number), or 0x02
(hexadecimal number)
```

8.4.12 get_modbus_inputs_list(iobus_list)

- **Features**

It is the command for reading multiple register type open signals from an external Modbus Slave unit.

- **Parameter**

Parameter Name	Data Type	Default Value	Description
iobus_list	list(string)	-	Modbus input name list (configured at TP) Available only with the following signal types • DR_MODBUS_REG_INPUT • DR_MODBUS_REG_OUTPUT

- **Return**

Value	Description
res	Number values read
val_list	List of multiple signal values read simultaneously

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data error occurred
DR_Error (DR_ERROR_VALUE)	Invalid parameter value occurred
DR_Error (DR_ERROR_RUNTIME)	C Extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
# Modbus Register I/O "Holding1" is 1234, "Input1" is 567,
# and "Holding2" is 9876
res, val_list = get_modbus_inputs_list(iobus_list=[ "Holding1", "Input1", "Holding2"])
        #res expected value = 3
        #val_list expected value = [1234, 567, 9876]
```

8.4.13 get_modbus_input_multi(iobus)

- **Features**

This function reads the signal from the Modbus Slave unit.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
iobus	string	-	Modbus multi signal name (set in the TP)

- **Return**

Value	Description
list	List of values corresponding to the number of signals

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
#Modbus multiple signal is registered as “multi”(cnt=2).
get_modbus_input("multi")     # return = [10, 101]
```

8.4.14 wait_modbus_input(iobus, val, timeout=None)

- **Features**

This function waits until the specified signal value of the Modbus digital I/O becomes val (ON or OFF). The waiting time can be changed with a timeout setting. The waiting time ends, and the result is returned if the waiting time has passed. This function waits indefinitely if the timeout is not set.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
iobus	string	-	Modbus name (set in the TP)
value	int	-	Modbus digital I/O • ON : 1 • OFF : 0
			Value for Modbus analog I/O
timeout	float	-	Waiting time (sec) This function waits indefinitely if the timeout is not set.

Note

- When registered as a multiple signal, it is available by adding address value index to signal name.

- **Return**

Value	Description
0	Success
-1	Failed (time-out)

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data type error occurred
DR_Error (DR_ERROR_VALUE)	Parameter value is invalid
DR_Error (DR_ERROR_RUNTIME)	C extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
wait_modbus_input("CIN0", ON)    # Indefinite wait until the "CIN0" signal becomes ON
wait_modbus_input("CIN0", OFF)    # Indefinite wait until the "CIN0" signal becomes
OFF

res = wait_modbus_input("CIN0", ON, 3) # Wait for up to 3 seconds until the "CIN0"
signal becomes ON
      # res = 0 if the "CIN0" signal becomes ON within 3 seconds.
      # res = -1 if the "CIN0" signal does not become ON within 3 seconds.

#Modbus multiple signal is registered as “multi”(start address=10, cnt=2).
#“multi_10” & “multi_11” abailable
wait_modbus_input("multi_10")
wait_modbus_input("multi_11")
```

8.4.15 set_modbus_slave(address, val)

- **Features**

It is used to export values to the General Purpose Register area of the Modbus TCP Slave.

- **Parameter**

Parameter Name	Data Type	Default Value	Description
address	int	-	Address value of GPR area (128~255)
val	int	-	2byte value (0~65535)

- **Return**

Value	Description
0	Success
Negative value	Failure

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data error occurred occurred
DR_Error (DR_ERROR_VALUE)	Invalid parameter value occurred
DR_Error (DR_ERROR_RUNTIME)	C Extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
set_modbus_slave(128, 0)
set_modbus_slave(255, 65535)
```

8.4.16 get_modbus_slave(address)

- **Features**

It is used to import values by approaching the General Purpose Register area of the Modbus TCP Slave.

- **Parameter**

Parameter Name	Data Type	Default Value	Description
address	int	-	Address value of the GPR area to read (128~255)

- **Return**

Value	Description
value	Corresponding register value

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data error occurred occurred
DR_Error (DR_ERROR_VALUE)	Invalid parameter value occurred
DR_Error (DR_ERROR_RUNTIME)	C Extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
value1 = get_modbus_slave(128)
value2 = get_modbus_slave(255)
```

8.4.17 modbus_crc16(data)

- **Features**

When using the Modbus protocol, this command reduces the load on Modbus CRC16 calculations.

- **Parameter**

Parameter Name	Data Type	Default Value	Description
data	byte	-	Modbus data for CRC16 calculations

- **Return**

Value	Description
crchigh	High byte of CRC16 calculation result
crclow	Low byte of CRC16 calculation result

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data error occurred occurred
DR_Error (DR_ERROR_VALUE)	Invalid parameter value occurred
DR_Error (DR_ERROR_RUNTIME)	C Extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
data = b"₩x01₩x02₩x03₩x04₩x05₩x06"
crchigh, crclow = modbus_crc16(data)
#crchigh = 186(DEC), BA(HEX)
#crclow = 221(DEC), DD(HEX)
```

8.4.18 modbus_send_make(send_data)

- **Features**

When using the Modbus protocol, this command provides the result data including the Modbus CRC16 result for the send data.

- **Parameter**

Parameter Name	Data Type	Default Value	Description
send_data	byte	-	Transfer data requiring CRC calcuation

- **Return**

Value	Description
result_data	Data in which transmission data and CRC16 value are conbined

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data error occurred occurred
DR_Error (DR_ERROR_VALUE)	Invalid parameter value occurred
DR_Error (DR_ERROR_RUNTIME)	C Extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
senddata = b"₩x01₩x02₩x03₩x04₩x05₩x06"
resultdata = modbus_send_make(senddata)
#resultdata = b'₩x01₩x02₩x03₩x04₩x05₩x06₩xba₩xdd'
```

8.4.19 modbus_recv_check(recv_data)

- **Features**

When using Modbus protocol, this command to check data integrity using CRC16 value for receive data.

- **Parameter**

Parameter Name	Data Type	Default Value	Description
recv_data	byte	-	raw modbus data

- **Return**

Value	Description
res	True/False

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data error occurred occurred
DR_Error (DR_ERROR_VALUE)	Invalid parameter value occurred
DR_Error (DR_ERROR_RUNTIME)	C Extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
#recvdata = b"₩x01₩x02₩x03₩x04₩x05₩x06₩xba₩xdd"
res = modbus_recv_check(recvdata)
#recv = True
```

8.5 Industrial Ethernet (EtherNet/IP,PROFINET)

8.5.1 set_output_register_bit(address, val)

- **Features**

It is used to export values to the Output Bit General Purpose Register area of the Industrial Ethernet(EtherNet/IP, PROFINET) Slave.

- **Parameter**

Parameter Name	Data Type	Default Value	Description
address	unsigned short	-	Address value of Output Bit GPR area in Industrial Ethernet Slave(0-63)
val	int	-	ON : 1 OFF : 0

- **Return**

Value	Description
0	Success
Negative value	Failure

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data error occurred occurred
DR_Error (DR_ERROR_VALUE)	Invalid parameter value occurred
DR_Error (DR_ERROR_RUNTIME)	C Extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
set_output_register_bit (0, ON)
set_output_register_bit (63, OFF)
```

8.5.2 set_output_register_int(address, val)

- **Features**

It is used to export values to the Output Int General Purpose Register area of the Industrial Ethernet(EtherNet/IP, PROFINET) Slave.

- **Parameter**

Parameter Name	Data Type	Default Value	Description
address	unsigned short	-	Address value of Output Int GPR area in Industrial Ethernet Slave(0-23)
val	int	-	Int value(4bytes)

- **Return**

Value	Description
0	Success
Negative value	Failure

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data error occurred occurred
DR_Error (DR_ERROR_VALUE)	Invalid parameter value occurred
DR_Error (DR_ERROR_RUNTIME)	C Extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
set_output_register_int (0, 0x00FF00FF)
set_output_register_int (23, 65535)
```

8.5.3 set_output_register_float(address, val)

- **Features**

It is used to export values to the Output Float General Purpose Register area of the Industrial Ethernet(EtherNet/IP, PROFINET) Slave.

- **Parameter**

Parameter Name	Data Type	Default Value	Description
address	unsigned short	-	Address value of Output Float GPR area in Industrial Ethernet Slave(0-23)
val	int	-	float value(4bytes)

- **Return**

Value	Description
0	Success
Negative value	Failure

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data error occurred occurred
DR_Error (DR_ERROR_VALUE)	Invalid parameter value occurred
DR_Error (DR_ERROR_RUNTIME)	C Extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
set_output_register_float(0, 4.5)
set_output_register_float(23, 2.3)
```

8.5.4 get_output_register_bit(address)

- **Features**

It is used to import values to the Output Bit General Purpose Register area of the Industrial Ethernet(EtherNet/IP, PROFINET) Slave.

- **Parameter**

Parameter Name	Data Type	Default Value	Description
address	unsigned short	-	Address value of Output Bit GPR area in Industrial Ethernet Slave(0-63)

- **Return**

Value	Description
value	Corresponding register value

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data error occurred occurred
DR_Error (DR_ERROR_VALUE)	Invalid parameter value occurred
DR_Error (DR_ERROR_RUNTIME)	C Extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
a = get_output_register_bit(0)
b = get_output_register_bit(63)
```

8.5.5 get_output_register_int(address)

- **Features**

It is used to import values to the Output Int General Purpose Register area of the Industrial Ethernet(EtherNet/IP, PROFINET) Slave.

- **Parameter**

Parameter Name	Data Type	Default Value	Description
address	unsigned short	-	Address value of Output Int GPR area in Industrial Ethernet Slave(0-23)

- **Return**

Value	Description
value	Corresponding register value

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data error occurred occurred
DR_Error (DR_ERROR_VALUE)	Invalid parameter value occurred
DR_Error (DR_ERROR_RUNTIME)	C Extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
a = get_output_register_int(0)
b = get_output_register_int(23)
```

8.5.6 get_output_register_float(address)

- **Features**

It is used to import values to the Output Float General Purpose Register area of the Industrial Ethernet(EtherNet/IP, PROFINET) Slave.

- **Parameter**

Parameter Name	Data Type	Default Value	Description
address	unsigned short	-	Address value of Output Float GPR area in Industrial Ethernet Slave(0-23)

- **Return**

Value	Description
value	Corresponding register value

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data error occurred occurred
DR_Error (DR_ERROR_VALUE)	Invalid parameter value occurred
DR_Error (DR_ERROR_RUNTIME)	C Extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
a = get_output_register_float(0)
b = get_output_register_float(63)
```

8.5.7 get_input_register_bit(address)

- **Features**

It is used to import values to the Input Bit General Purpose Register area of the Industrial Ethernet(EtherNet/IP, PROFINET) Slave.

- **Parameter**

Parameter Name	Data Type	Default Value	Description
address	unsigned short	-	Address value of Input Bit GPR area in Industrial Ethernet Slave(0-63)

- **Return**

Value	Description
value	Corresponding register value

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data error occurred occurred
DR_Error (DR_ERROR_VALUE)	Invalid parameter value occurred
DR_Error (DR_ERROR_RUNTIME)	C Extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
a = get_input_register_bit(0)
b = get_input_register_bit(63)
```

8.5.8 get_input_register_int(address)

- **Features**

It is used to import values to the Input Int General Purpose Register area of the Industrial Ethernet(EtherNet/IP, PROFINET) Slave.

- **Parameter**

Parameter Name	Data Type	Default Value	Description
address	unsigned short	-	Address value of Input Int GPR area in Industrial Ethernet Slave(0-23)

- **Return**

Value	Description
value	Corresponding register value

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data error occurred occurred
DR_Error (DR_ERROR_VALUE)	Invalid parameter value occurred
DR_Error (DR_ERROR_RUNTIME)	C Extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
a = get_input_register_int(0)
b = get_input_register_int(23)
```

8.5.9 get_input_register_float(address)

- **Features**

It is used to import values to the Input Float General Purpose Register area of the Industrial Ethernet(EtherNet/IP, PROFINET) Slave.

- **Parameter**

Parameter Name	Data Type	Default Value	Description
address	unsigned short	-	Address value of Input Float GPR area in Industrial Ethernet Slave(0-23)

- **Return**

Value	Description
value	Corresponding register value

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data error occurred occurred
DR_Error (DR_ERROR_VALUE)	Invalid parameter value occurred
DR_Error (DR_ERROR_RUNTIME)	C Extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
a = get_input_register_float(0)
b = get_input_register_float(63)
```

9. External Vision Commands

Overview

Doosan Robotics provides the commands to guide robots with vision by connecting the robots to an external vision system. It enables connecting a robot to a 2D vision system which can measure the object position (Tx, Ty) data and the rotation (Rz) data (offset information) to guide the inputted robot task, and the commands can receive the measurement data inputs of multiple objects. The installation and tasks of the robot application using the 2D vision system need to calibrate the visual coordinate system of the vision system to the physical coordinate system of the robot system (coordinate system correction). When using an external vision system, the vision system must calibrate the coordinate system and transfer the corrected coordinate data to the robot.

The vision system can be installed in the Eye-in-hand mode connected to the robot or in-line mode separated from the robot. It must be fixed so that the relative position of the robot and vision system does not change during a task. The vision system and the robot controller communicate through the TCP/IP protocol, and communication is established when the cable of the vision system is connected to the wired hub port of the robot controller.

9.1 2D Vision(COGNEX, SICK)

9.1.1 vs_set_info(type)

- **Features**

  This function set the type of vision system to use.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
type	int	DR_VS_CUSTOM	DR_VS_CUSTOM(0) DR_VS_COGNEX(1) DR_VS_SICK(2)

- **Return**

Value	Description
ID of Type	ID of type to set

- **Example**

```
vs_set_info(DR_VS_COGNEX)   #Vision type information setting
vs_connect("192.168.137.10")   #Connect to vision - Vision IP, Default port
# Enter your task
vs_disconnect()                #Disconnect to vision
```

*** Supported Model**

Type	Model
DR_VS_COGNEX	COGNEX IS2000M-23M Series COGNEX IS5600/5705 Series COGNEX IS7000Series COGNEX IS8000Series
DR_VS_SICK	SICK Inspector PIM60 Series SICK Inspector PI50 Series
DR_VS_CUSTOM	

9.1.2 vs_connect(ip_addr, port_num=9999)

- **Features**

  This function establishes communication with the vision system.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
ip_addr	str	-	Server IP of vison module (ex. 192.168.137.200)
port_num	int	9999	Port Number (ex. 9999)

- **Return**

Value	Description
0	Connection success
-1	Connection failed

- **Example**

```
vs_set_info(DR_VS_COGNEX)    #Vision type information setting
vs_connect("192.168.137.10")    #Connect to vision - Vision IP, Default port
# Enter your task
vs_disconnect()                    #Disconnect to vision
```

9.1.5 vs_disconnect()

- **Features**

  This function terminates the connection to the vision system.

- **Return**

Value	Description
N/A	N/A

- **Example**

```
vs_set_info(DR_VS_COGNEX)   #Vision type information setting
vs_connect("192.168.137.10")   #Connect to vision - Vision IP, Default port
# Enter your task
vs_disconnect()                #Disconnect to vision
```

9.1.6 vs_get_job()

- **Feature**

This function loaded the task name, currently loaded in the vision system.(*VS_TYPE: DR_VS_COGNEX, DR_VS_SICK)

- **Return**

Value	Data Type	Description
job_name	string	Connection success
-1	int	Connection failed

- **Example**

```
vs_set_info(DR_VS_COGNEX)   #Vision type information setting
vs_connect("192.168.137.10")   #Connect to vision - Vision IP, Default port

vs_set_job("test.job")              # Set (load) the current vision job
job_name=vs_get_job()               # Get the current setting vision job
tp_popup("{0}".format(job_name))

vs_disconnect()                     # Disconnect to vision
```

9.1.7 vs_set_job(job_name)

- **Feature**

This function loaded the entered task into the vision system.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
job_name	string		Task name to be loaded

- **Return**

Value	Data Type	Description
0	int	Success
-1	int	Failed

- **Example**

```
vs_set_info(DR_VS_COGNEX)   #Vision type information setting
vs_connect("192.168.137.10")   #Connect to vision - Vision IP, Default port

vs_set_job("test.job")              # Set (load) the current vision job
job_name=vs_get_job()               # Get the current setting vision job
tp_popup("{0}".format(job_name))

vs_disconnect()                     # Disconnect to vision
```

9.1.8 vs_ trigger()

- **Features**

This function transmits the measurement command to the vision system. If the measurement is successful, the result is returned.(*VS_TYPE: DR_VS_COGNEX, DR_VS_SICK)

- **Return**

Value	Data Type	Description
pos	posx	pos: measuring position of an object (posx parameter type)
var_list	list[float]	var_list: Additional measurement results entered by Users ex) Check pass/fail, distance measurement, angle measurement, etc.
-1, []	int	failed

- **Example**

```
vs_set_info(DR_VS_COGNEX)                    # Select type of vision sensor
vs_connect("192.168.137.10")                 # Vision IP, Default port

vis_posx = posx (410,310,300,0,0,0)          # Define the initial posx data - vision
rob_posx = posx (400,300,300,0,180,0)        # Define the initial posx data - robot

vs_set_init_pos(vis_posx, rob_posx, VS_POS1) # Enter the initial posx data to Vision

for i in range(10):
    pos, var_list = vs_trigger()             # Execute the vision meausrement
    if var_list[0] == 1:                     # Check the inspection result
        robot_posx_meas = vs_get_offset_pos(pos, VS_POS1) # offset the robot pose
        movel(robot_posx_meas)               # move the robot pose
    else:
        tp_popup("Inspection Fail")

vs_disconnect()
```

9.1.9 vs_set_init_pos(vision_posx_init, robot_posx_init, vs_pos=1)

- **Features**

Enter the initial position information of the object to perform the vision guidance operation.
(*VS_TYPE: DR_VS_COGNEX, DR_VS_SICK)

- **Parameters**

Parameter Name	Data Type	Default Value	Description
vision_posx_init	posx	-	Vision measurement coordinate initial value
robot_posx_init	posx	-	Coordinate initial value for robot work
vs_pos	int	1	The pos number of the initial value entered

- **Return**

Value	Data Type	Description
vs_pos	int	Success – The entered pos number
-1	int	Failed

- **Example**

```
vs_set_info(DR_VS_COGNEX)                    # Select type of vision sensor
vs_connect("192.168.137.10")                 # Vision IP, Default port
vis_posx = posx (410,310,300,0,0,0)          # Define the initial posx data - vision
rob_posx = posx (400,300,300,0,180,0)        # Define the initial posx data - robot
vs_set_init_pos(vis_posx, rob_posx, VS_POS1) # Enter the initial posx data to Vision

for i in range(10):
    pos, var_list = vs_trigger()                    # Execute the vision meausrement
    if var_list[0] == 1:                            # Check the inspection result
        robot_posx_meas = vs_get_offset_pos(pos, VS_POS1) # offset the robot pose
        movel(robot_posx_meas)                      # move the robot pose
    else:
        tp_popup("Inspection Fail")

vs_disconnect()
```

9.1.1 vs_get_offset_pos(vision_posx _meas, vs_pos=1)

- **Features**

The coordinate of the robot is calculated using the coordinate values, measured in the vision system. The initial value should be entered in advance through vs_set_init_pos.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
vision_posx_meas	posx	-	Vision measurement coordinate values, caculated using vs_trigger
vs_pos	int	1	Pos number of the robot initial value to calculate offset coordinate

- **Return**

Value	Data Type	Description
robot_posx_meas	posx	Success
-1	int	Failed

- **Example**

```
vs_set_info(DR_VS_COGNEX)                    # Select type of vision sensor
vs_connect("192.168.137.10")                 # Vision IP, Default port

vis_posx = posx (410,310,300,0,0,0)          # Define the initial posx data - vision
rob_posx = posx (400,300,300,0,180,0)        # Define the initial posx data - robot

vs_set_init_pos(vis_posx, rob_posx, VS_POS1) # Enter the initial posx data to Vision

for i in range(10):
    pos, var_list = vs_trigger()                      # Execute the vision meausrement
    if var_list[0] == 1:                              # Check the inspection result
        robot_posx_meas = vs_get_offset_pos(pos, VS_POS1) # offset the robot pose
        movel(robot_posx_meas)                        # move the robot pose
    else:
        tp_popup("Inspection Fail")

vs_disconnect()
```

9.1.2 vs_request(cmd)

Features

This function sets the feature for the vision system to request
(*VS_TYPE: DR_VS_CUSTOM)

Parameters

Parameter Name	Data Type	Default Value	Description
cmd	int	-	The number of objects to be detected by the vision system

Return

Value	Description
0	Success
-1	Failed
-2	Communication timed out (3 sec.)

Example

```
vs_request(1)                    # request the vision measurement on the "1" job
```

9.1.12 vs_result()

Features

This function retrieves the processing result of the vision system.

(*VS_TYPE: DR_VS_CUSTOM)

Return

Value	Description
cnt (>=1)	Success The number of objects detected by the vision system
result	Position list as a result of the vision system (x coordinate, y coordinate, rotation value)
-	cnt =-2 and res = empty list if failed

Exmaple

```
vs_set_info(DR_VS_CUSTOM)
res = vs_connect("192.168.137.200", 9999)          #Vision and communication connection attempt
if res !=0:                                #Check the result of communication connection
   tp_popup("connection fail",DR_PM_MESSAGE)    #If connection fails, program ends
   exit()

ret = vs_request(1)                    #Request for object vision measurement information

cnt, result = vs_result()                          # Get object measurement result information

for i in range(cnt):
   x = result[i][0]
   y = result[i][1]
   t = result[i][2]
   tp_popup("x={0},y={1}, t={2}".format(result[i][0], result[i][1], result[i][2]),DR_PM_MESSAGE)
```

9.1.11 Integrated example 1

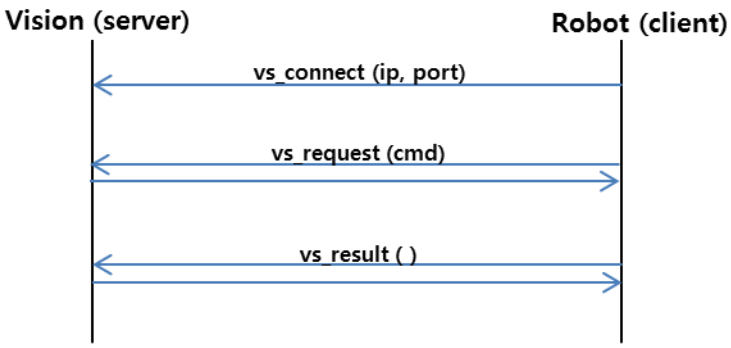
Example

```
vs_set_info(DR_VS_COGNEX)                          # Select type of vision sensor
if ( vs_connect("192.168.137.10") != 0 ):          # Vision IP, Default port
    tp_popup("connection fail",DR_PM_MESSAGE)
    exit()

vis_posx_init = posx (410,310,300,0,0,0)           # Define the initial posx data - vision
rob_posx_init1 = posx (400,300,300,0,180,0)        # Define the initial posx data - robot
rob_posx_init2 = posx (420,320,300,0,180,0)        # Define the initial posx data - robot

vs_set_init_pos(vis_posx_init, rob_posx_init1, VS_POS1) # Enter the initial posx data to Vision
vs_set_init_pos(vis_posx_init, rob_posx_init2, VS_POS2)

for i in range(10):
    pos_meas, var_list = vs_trigger()              # Execute the vision meausrement
    if pos_meas==-1:                               # Vision Fail to measure the object
        tp_popup("Vision measure fail")
        continue
    if var_list[0] == 1:                           # Check the inspection result
        # Get guided posx data
        rob_posx1_meas = vs_get_offset_pos(pos_meas, VS_POS1) # offset the robot pose
        rob_posx2_meas = vs_get_offset_pos(pos_meas, VS_POS2) # offset the robot pose
        movel(rob_posx1_meas)
        movel(rob_posx2_meas)
    else:
        tp_popup("Inspection Fail")
        continue

vs_disconnect()
```

9.1.12 Integrated example 2

Communication Protocol

The vision system must conform to the following protocol to ensure that vision commands run properly.



vs_request (cmd)

1) Robot controller → Vision system
"MEAS_START" +cmd[4byte]
- cmd refers to the number of detected objects: Conversion of the integer to 4 bytes. ex) cmd=1 → 00000001
ex) In case of **cmd= 1** : "MEAS_START"+**00000001**
Acutal packet : 4D4541535F5354415254**00000001**
2) Vision system → Robot controller
"MEAS_OK" is transmitted if the vision system is normal, and "**MEAS_NG"** is transmitted otherwise.

VS_result()

1) Robot controller → Vision system
"MEAS_REQUEST"
2) Vision system → Robot controller
"MEAS_INFO" +cnt[4byte] +[(x[4byte] + y[4byte] + t[4byte]) x cnt]
- cnt refers to the number of detected objects.
- The transmitted x (x coordinate), y (y coordinate), and t (rotation value) must be scaled up 100 times.
ex) **cnt = 1** , (x=1.1 , **y=2.2**, t=3.3)
"MEAS_INFO"+**1[4byte]** +110[4byte] +**220[4byte]** +330[4byte]
Actual packet: 4D4541535F494E464F**00000001**0000006E**000000DC**0000014A
ex) **cnt = 2** , (x=1.1 , **y=2.2**, t=3.3) (**x=1.1** , y=-2.2, **t=-3.3**)
"MEAS_ INFO"+**2[4byte]** +110[4byte] +**220[4byte]** +330[4byte]
+110[4byte] **-220[4byte]** -330[4byte]
Actual packet: 4D4541535F494E464F**00000002**0000006E**000000DC**0000014A
0000006E**FFFFFF24**FFFFFEB6

Example

```
vs_set_info(DR_VS_CUSTOM)
res = vs_connect("192.168.137.200", 9999)       #Vision and communication connection attempt
if res !=0:                                                  #Check the result of communication connection
   tp_popup("connection fail",DR_PM_MESSAGE)    #Upon connection failure, program termination
```

```
    exit()

ret = vs_request(1)                         #Request of Vision Measurement
Information for No. 1 Object

cnt, result = vs_result()                   #Get object measurement result information

for i in range(cnt):
    x = result[i][0]
    y = result[i][1]
    t = result[i][2]
    tp_popup("x={0},y={1}, t={2}".format(result[i][0], result[i][1],
result[i][2]),DR_PM_MESSAGE)
```

9.2 Pickit 3D

9.2.1 pickit_connect(ip)

- **Features**

This function establishes communication with the vision system.
The default IP of PickIt is 192.168.66.1, and the user uses PickIt IP in the same band as Robot IP. See the Pickit Support site for details on how to use it.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
ip_addr	str	-	Server IP of Pickit 3D (ex, 192.168.137.90)

- **Return**

Value	Description
0	Connection success
-1	Connection failed

- **Example**

```
pickit_connect("192.168.137.90") #Connect to vision - Vision IP
pickit_disconnect()              #Disconnect to vision
```

9.2.2 pickit_disconnect()

- **Features**

  This function terminates the connection to the vision system.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
N/A	-	-	N/A

- **Return**

Value	Description
N/A	

- **Example**

```
pickit_connect("192.168.137.90")#Connect to vision - Vision IP
pickit_disconnect()                #Disconnect to vision
```

9.2.3 pickit_request_calibration()

- **Features**

  This function requests a calibration once from the vision system

- **Parameters**

Parameter Name	Data Type	Default Value	Description
N/A	-	-	-

- **Return**

Value	Description
0	Connection success
-1	Connection failed

- **Example**

```
pickit_connect("192.168.137.90")
pickit_request_calibration()
pickit_disconnect()
```

9.2.4 pickit_change_configuration(setup_id, product_id))

- **Features**

  This function loads setup_id and product_id set in the vision system.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
Setup_id	int	-	The setup_id number stored in the Pickit server.
Product_id	int		The product_id number stored in the Pickit server

- **Return**

Value	Description
0	Connection success
-1	Connection failed

- **Example**

```
pickit_connect("192.168.137.90")
pickit_change_configuration(6, 8) # These numbers are defined in Pickit
pickit_disconnect()
```

9.2.5 pickit_save_snapshot()

- **Features**

  This function saves the snapshot to the server.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
N/A	-	-	N/A

- **Return**

Value	Description
0	Connection success
-1	Connection failed

- **Example**

```
pickit_connect("192.168.137.90")
pickit_save_snapshot()
pickit_disconnect()
```

9.2.6 pickit_detection(offset_z)

- **Features**

  This function detects the input model and returns (pick_prepos, pick_pos).

- **Parameters**

Parameter Name	Data Type	Default Value	Description
offset_z	int	-	The offset_z sets to 'pick_prepos' distance.

- **Return**

Value	Data type	Description
data_dictionary = {'pick_pos':pick_pos, 'pick_prepos':pick_prepos, 'object_age':data['object_age'], 'object_type':data['object_type'], 'object_dimensions':data['object_dimensions'], 'object_remaining':data['objects_remaining'], 'status':data['status']}	{'pick_pos': posx, 'pick_prepos': posx, 'object_age': int, 'object_type': int , 'object_dimensions': int , 'object_remaining': int , 'status': int}	**'pick_pos':** Model recognition position, **'pick_prepos':** Offset Value of model recognition position, **'object_age':** The amount of time that has passed between the capturing of the camera data and the moment the object information is sent to the robot. This value has to be divided by the **MULT** factor., **'object_type':** The type of object detected at object_pose , **'object_dimensions':** When reading array elements, each value has to be divided by the **MULT** factor. , **'object_remaining':** Only one object per pickit_to_robot_data message can be communicated. If this field is non-zero, it

Value	Data type	Description
		contains the number of remaining objects that can be sent in next messages to the robot. , **'status':** Contains the Pickit status or a response to previously received robot commands.

- **Example**

```
set_singular_handling(DR_AVOID)
set_velj(60.0)
set_accj(100.0)
set_velx(250.0, 80.625)
set_accx(1000.0, 322.5)

pickit_connect("192.168.137.90")
pickit_change_configuration( 7,10 ) # These numbers are defined in Pickit

data = pickit_detection(100)
if data['status'] == ResponseStatus.OBJECTS_FOUND:
        # Picking motion
    movel(data['pick_prepos'])
    movel(data['pick_pos'])
    movel(data['pick_prepos'])

pickit_disconnect()
```

9.2.7 pickit_next_object(offset_z)

- **Features**

  This function returns pick_prepos and pick_pos detected next to the input model.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
offset_z	int	-	The offset_z sets to 'pick_prepos' distance.

- **Return**

Value	Data Type	Description
data_dictionary = {'pick_pos':pick_pos, 'pick_prepos':pick_prepos, 'object_age':data['object_age'], 'object_type':data['object_type'], 'object_dimensions':data['object_dimensions'], 'object_remaining':data['objects_remaining'], 'status':data['status']}	{'pick_pos': posx, 'pick_prepos': posx, 'object_age': int, 'object_type': int , 'object_dimensions': int , 'object_remaining': int , 'status': int}	**'pick_pos':** Model recognition position, **'pick_prepos':** Offset value of model recognition position, **'object_age':** The amount of time that has passed between the capturing of the camera data and the moment the object information is sent to the robot. This value has to be divided by the **MULT** factor., **'object_type':** The type of object detected at object_pose , **'object_dimensions':** When reading array elements, each value has to be divided by the **MULT** factor. , **'object_remaining':** Only one object per pickit_to_robot_data message can be communicated. If this field is non-zero, it contains the number of remaining objects that can be sent in

Value	Data Type	Description
		next messages to the robot. , **'status':** Contains the Pickit status or a response to previously received robot commands.

- **Example**

```
pickit_connect("192.168.137.90")
pickit_change_configuration(7, 10) # These numbers are defined in Pickit

set_singular_handling(DR_AVOID)
set_velj(60.0)
set_accj(100.0)
set_velx(250.0, 80.625)
set_accx(1000.0, 322.5)
home_pos = posx(122.09, 35.28, 303.63, 140.45, 158.9, 134.39)
while True:
    # Detection
    data = pickit_detection(100)
    if data['status'] == ResponseStatus.OBJECTS_FOUND:
        # Picking motion
        movel(data['pick_prepos'])
        movel(data['pick_pos'])
        movel(data['pick_prepos'])

        remaining = data['object_remaining']
        while remaining > 0:
            data = pickit_next_object(100)
            remaining = data['object_remaining']

            # Picking motion
            movel(data['pick_prepos'])
            movel(data['pick_pos'])
            movel(data['pick_prepos'])

pickit_disconnect()
```

9.2.8 Integrated example

- **Example**

```
### For robot-camera calibration example ###

set_singular_handling(DR_AVOID)
set_velj(60.0)
set_accj(100.0)
set_velx(250.0, 80.625)
set_accx(1000.0, 322.5)
pickit_connect("192.168.137.90")

# Move to Pose #
pos1= posx(476.76, -151.68, 384.83, 33.36, 24.71, 95.44)
pos2= posx(495.86, -150.08, 435.69, 1.43, 8.21, 122.25)
pos3= posx(508.79, -83.06, 446.94, 82.88, -35.91, 39.23)
pos4= posx(521.66, -146.28, 431.8, 29.71, -33.73, 82.42)
pos5= posx(508.35, -147.45, 386.37, 101.03, 38.04, 42.68)
movel(pos1)
pickit_request_calibration()
movel(pos2)
pickit_request_calibration()
movel(pos3)
pickit_request_calibration()
movel(pos4)
pickit_request_calibration()
movel(pos5)
pickit_request_calibration()
```

- **Example**

```
### For simple picking example ###
pickit_connect("192.168.137.90")
pickit_change_configuration( 7,10 ) # These numbers are defined in Pickit

set_singular_handling(DR_AVOID)
set_velj(60.0)
set_accj(100.0)
set_velx(250.0, 80.625)
set_accx(1000.0, 322.5)
home_pos = posx(122.09, 35.28, 303.63, 140.45, 158.9, 134.39)
      #Move to home pose
movel(home_pos)

      # Detection
data = pickit_detection(100)
if data['status'] == ResponseStatus.OBJECTS_FOUND:
            # Picking motion
      movel(data['pick_prepos'])
      movel(data['pick_pos'])
      movel(data['pick_prepos'])

pickit_disconnect()
```

- **Example**

```
### For multiple parts picking example ###

pickit_connect("192.168.137.90")
pickit_change_configuration(7, 10) # These numbers are defined in Pickit

set_singular_handling(DR_AVOID)
set_velj(60.0)
set_accj(100.0)
set_velx(250.0, 80.625)
set_accx(1000.0, 322.5)
home_pos = posx(122.09, 35.28, 303.63, 140.45, 158.9, 134.39)
while True:
    # Move to home pose
    movel(home_pos)

    # Detection
    data = pickit_detection(100)
    if data['status'] == ResponseStatus.OBJECTS_FOUND:

        # Picking motion
        movel(data['pick_prepos'])
        movel(data['pick_pos'])
        movel(data['pick_prepos'])

        remaining = data['object_remaining']
        while remaining > 0:
            data = pickit_next_object(100)
            remaining = data['object_remaining']

            # Picking motion
            movel(data['pick_prepos'])
            movel(data['pick_pos'])
            movel(data['pick_prepos'])
```

10. Doosan Vision(SVM) Command

10.1 svm_connect (ip= "192.168.137.5", port=20)

- **Features**

  This function establishes communication with the SVM.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
ip	str	"192.168.137.5"	Server IP address of vision module
port	int	20	Port number

- **Return**

Value	Description
0	Connection success
-1	Connection failed

- **Example**

```
svm_connect()        #Connect to vision - Default IP address and port number
# Enter the vision task
svm_disconnect()     #Disconnect to vision
```

10.2 svm_disconnect ()

- **Features**

  This function terminates the connection to the SVM.

- **Return**

Value	Description
N/A	N/A

- **Example**

```
svm_connect()    #Connect to vision – Default IP address and port
# Enter the vision task
svm_disconnect()            #Disconnect to vision
```

10.3 svm_set_job (job_id)

- **Features**

  This function loads the Vision task corresponding to the input id into the SVM..

- **Parameters**

Parameter Name	Data Type	Default Value	Description
job_id	int	-	Vision Task id (ex. 1000, 2000, …)

- **Return**

Value	Description
0	Job Loading success
-1	Job Loading fail

- **Example**

```
svm_connect()                #Connect to vision - Vision IP, Default port
vision_test=1000             # Define vision job ID
svm_set_job(vision_test)      # Load the vision_test (1000)
svm_disconnect()               #Disconnect to vision
```

10.4 svm_get_robot_pose (job_id)

▪ Features

The robot pose information(joint coordinate system) set in the vision task is loaded. Robot pose information is used as shoot_pose for vision task.

▪ Parameters

Parameter Name	Data Type	Default Value	Description
job_id	int	-	Vision Task id (ex. 1000, 2000, …)

▪ Return

Value	Desciption
float [6]	Robot joint coordinate information (posj type)
-1	failed

▪ Example

```
svm_connect()                                    # Connect to vision
vision_test=1000                                 # Define vision job ID
svm_set_job(vision_test)                          # Load the vision_test (1000)
shoot_pos=svm_get_robot_pose (vision_test) # Load the robot pose of vision_test
tp_popup("{0}".format(shoot_pos))
svm_disconnect()                                  # Disconnect to vision
```

10.5 svm_get_vision_info (job_id)

- **Features**

  Performs the measurement command corresponding to the input vision task. The detailed information of the measurement command of the vision work should be entered in advance through the Workcell manager(WCM).

- **Parameters**

Parameter Name	Data Type	Default Value	Description
job_id	int	-	Vision Task id (ex. 1000, 2000, …)

- **Return**

Value	Data Type
1	Measurement success – One object was detected / measured successfully.
0	Measurement failed – Failed to detect the corresponding vision work object.
-1	Measurement failed – Communication error (timeout)

- **Example**

```
svm_connect()                                    # Connect to vision
vision_test=1000                                 # Define vision job ID
svm_set_job(vision_test)                         # Load the vision_test (1000)
shoot_pos=svm_get_robot_pose (vision_test) # Load the robot pose of vision_test
count=svm_get_vision_info(vision_test)           # Execute the vision measurement
tp_popup("{0}".format(count))                  # Check the result
svm_disconnect()                                   # Disconnect to vision
```

10.6 svm_get_variable (tool_id, var_type)

▪ Features

If the object detection/measurement is successful(1) by executing svm_get_vision_info, the detection/measurement data is loaded. Enter the tool id and variable type for the data to be loaded.

- Position tool: POSX_TYPE (Object location), VALUE_TYPE (Detection similarity)
- Presence tool: INSP_TYPE (Presence inspection result), VALUE_TYPE (Pixel count)
- Distance tool: INSP_TYPE (Distance inspection result), VALUE_TYPE (Distance measure)
- Angle tool: INSP _TYPE (Angle inspection result), VALUE_TYPE (Angle measure)
- Diameter tool: INSP _TYPE (Diameter inspection result), VALUE_TYPE (Diameter measure), POSX_TYPE (Circle center position)

▪ Parameters

Parameter Name	Data Type	Default Value	Description
tool_id	int	-	Vision tool id (ex. 1000, 1001, 1002, …)
var_type	int	-	POSX_TYPE: Vision measurement coordinate variable (posx) INSP_TYPE: Inspection result variable (int) VALEU_TYPE: Measurement result (int or float)

▪ Return

Value	Description
variable	POSX_TYPE – Coordinate information variable, ex. Posx(x,y,z,rx,ry,rz) INSP_TYPE: Inspection result variable - int (Returns 1 if successful) VALEU_TYPE: Measurement result variable (int of float)
-1	Failed – No measurement data or input variable error.

▪ Example

```
svm_connect()                                   # Connect to vision
vision_test=1000                                # Define vision job ID
print_insp=1001                                 # Define inspection tool ID
box_size=1002                                   # Define measurement tool ID
count=svm_get_vision_info(vision_test)          # Execute the vision measurement
if (count==1):                                  # Check the result
    # Get the position information (posx) of vision_test tool
    pos_result=svm_get_variable(vision_test, POSX_TYPE)
    tp_popup("{0}".format(pos_result))
```

```
    # Get the inspection information (PASS or Fail) of print_insp tool
    inspection_result=svm_get_variable(print_insp, INSP_TYPE)
    tp_popup("{0}".format(inspection_result))

    # Get the distance information (distance) of box_size tool
    measurement_result= svm_get_variable(box_size, VALUE_TYPE)
    tp_popup("{0}".format(measurement_result))

svm_disconnect()                                    # Disconnect to vision
```

10.7 svm_get_offset_pos (posx_robot_init, job_id, tool_id)

▪ Features

The robot task coordinate information reflecting the vision measurement result is loaded into the robot work coordinate input by the user.
*Procedure: Input posx_robot_init → Vision measurement→ Call svm_get_offset_pos
→ Changed robot work coordinates (posx_robot_offset) output

▪ Parameters

Parameter Name	Data Type	Default Value	Description
posx_robot_init	posx	-	Robot task coordinate information) (Input by direct teaching method.)
job_id	Int	-	Vision job id (ex. 1000, 2000, 3000, …)
tool_id	int	-	Vision tool id (ex. 1000, 1001, 1002, …)

▪ Return

Value	Description
posx	Robot work coordinate information reflecting vision measurement result
-1	Failed – No measurement data or input variable error.

▪ Example

```
svm_connect()                                   # Connect to vision
vision_test=1000                                # Define vision job ID
count=svm_get_vision_info(vision_test)          # Execute the vision measurement
if (count == 1):                                # Check the result
    # Get the position information (posx) of vision_test tool
    pos_result=svm_get_variable(vision_test, POSX_TYPE)
    tp_popup("{0}".format(pos_result))
    # Get the vision guided robot pose
    Id_list =[vision_test]
    pos_list =[pos_result]
    svm_set_init_pos_data(Id_list,pos_list)


    rob_posx=svm_get_offset_pos(posx(200,200,100,0,180,0), vision_test)
    tp_popup("{0}".format(rob_posx))
    # move to the rob_posx
    movel(rob_posx, vel=30, acc=100)
svm_disconnect()                                # Disconnect to vision
```

10.8 svm_set_init_pos_data(Id_list, Pos_list)

▪ Features

Enter the initial id_list and posx_list information of the object to perform the vision guidance operation.

⚠ Caution

* Be sure to set the settings before calling the function svm_get_offset_pos (posx_robot_init, job_id, tool_id).

* Note : id_list and pos_list should be matched with posx corresponding to each id.

▪ Parameters

Parameter Name	Data Type	Default Value	Description
Id_list	List(int)	-	Id list ([id, id, id, …])
Pos_list	List(Posx)	-	Posx list (ex.[posx, posx, posx, …])

▪ Return

Value	Description
None	-

▪ Example

```
svm_connect()                                          # Connect to vision
vision_test=1000                                       # Define vision job ID
count=svm_get_vision_info(vision_test)                 # Execute the vision measurement
if (count == 1):                                      # Check the result
    # Get the position information (posx) of vision_test tool
    pos_result=svm_get_variable(vision_test, POSX_TYPE)
    tp_popup("{0}".format(pos_result))
    # Get the vision guided robot pose
    Id_list =[vision_test]
    pos_list =[pos_result]
    svm_set_init_pos_data(Id_list,pos_list)
    rob_posx=svm_get_offset_pos(posx(200,200,100,0,180,0), vision_test)
    tp_popup("{0}".format(rob_posx))
    # move to the rob_posx
    movel(rob_posx, vel=30, acc=100)
svm_disconnect()                                       # Disconnect to vision
```

10.9 svm_set_tp_popup (svm_flag)

- **Features**

  Set whether (tp_popup) should be displayed when SVM error occurs.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
svm_flag	int	1	1(Activation), 0(Deactivation)

- **Return**

Parameter Name	Data Type	Default Value	Description
None	-	-	-

- **Example**

```
svm_set_tp_popup(0)                    # Hide tp_popup
svm_connect()                          # Connect to vision
svm_disconnect()                       # Disconnect to vision
```

10.10 svm_set_led_brightness(value)

- **Features**

  Set SVM LED brightness value.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
value	int	-	LED brightness value (0-1000).

- **Return**

Value	Data Type	Description
-1	int	Fail - No measurement data or input variable error.

Example

```
svm_connect()                          # Connect to vision
svm_set_led_brigtness(500)
svm_disconnect()                       # Disconnect to vision
```

10.11 svm_get_led_brightness()

- **Features**

  Return the LED brightness value set in the SVM.

- **Return**

Value	Description
int	SVM brightness value (0-1000)
-1	Fail - No measurement data or input variable error.

Example

```
svm_connect()                    # Connect to vision
svm_get_led_brigtness()
svm_disconnect()                 # Disconnect to vision
```

10.12 svm_set_camera_exp_val(value)

- **Features**

  Set exposure value of the SVM.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
value	int	-	SVM exposure value (2,660,000 – 29,260,000)

- **Return**

Value	Description
-1	Fail - No measurement data or input variable error.

Example

```
svm_connect()                                  # Connect to vision
svm_set_camera_exp_val(2,660,000)
svm_disconnect()                               # Disconnect to vision
```

10.13 svm_set_camera_gain_val(value)

- **Features**

  Set SVM gain value..

- **Parameters**

Parameter Name	Data Type	Default Value	Description
value	int	1	SVM gain value (0-1600).

- **Return**

Value	Description
-1	Fail - No measurement data or input variable error.

Example

```
svm_connect()                                  # Connect to vision
svm_set_camera_gain_val(500)
svm_disconnect()                               # Disconnect to vision
```

10.14 svm_set_camera_load(job_id)

- **Features**

  Load LED brightness, exp, gain and focus setting saved in the Job numbered job_id.

- **Parameters**

Parameter Name	Data Type	Default Value	Description
job_id	int		job id (ex - 1000, 2000, 3000)

- **Return**

Value	Description
-1	Fail - No measurement data or input variable error.

Example

```
svm_connect()                          # Connect to vision
svm_set_camera_load(job_id)
svm_disconnect()                       # Disconnect to vision
```

10.15 Intergrated example (SVM)

- **Example**

Vision Job setting status
- After deleting all the jobs saved in WCM, create vision task / tool as below.
- Create vision task : vision_test (position tool, 1000)
- Add vision tools: print_insp (presence tool, 1001)
  box_size (distance tool, 1002)
- Select the "vision_test" task in TW vision command set the variable information.
- Add the following example to your custom code to test.

```
svm_connect()                                    # Connect to vision
vision_test=1000                                 # Define vision job ID
print_insp=1001                                  # Define inspection tool ID
box_size=1002                                    # Define measurement tool ID
svm_set_job(vision_test)                         # Load the vision_test (1000)
movej(svm_get_robot_pose(vision_test), vel=10, acc=20) # Move to shoot pose (movej)

if (svm_get_vision_info(vision_test)== 1):    # Execute the vision measurement
    # Load the vision variables
    # Get the position information (posx) of vision_test tool
    pos_result=svm_get_variable(vision_test, POSX_TYPE)
    tp_popup("pos_result {0}".format(pos_result))

    # Get the inspection information (PASS or Fail) of print_insp tool
    inspection_result=svm_get_variable(print_insp, INSP_TYPE)
    tp_popup("inspection_result {0}".format(inspection_result))

    # Get the distance information (distance) of box_size tool
    measurement_result= svm_get_variable(box_size, VALUE_TYPE)
    tp_popup("measurement_result {0}".format(measurement_result))

    # Move to the vision guided robot pose
    # Get the vision guided robot pose
    Id_list =[vision_test]
    pos_list =[pos_result]
    svm_set_init_pos_data(Id_list,pos_list)
    rob_posx=svm_get_offset_pos(posx(200,200,100,0,180,0), vision_test)
    tp_popup("rob_posx {0}".format(rob_posx))

    # move to the rob_posx
    movel(rob_posx, vel=30, acc=100)

svm_disconnect()                                 # Disconnect to vision
```

11. Application Commands

11.1 External Encoder Setting Commands

11.1.1 set_extenc_polarity(channel, polarity_A, polarity_B, polarity_Z, polarity_S)

Features

It configures the polarity of phase A, B and the trigger method of phase S, Z of the corresponding encoder channel.

Parameter

Parameter Name	Data Type	Default Value	Description
channel	int	1	Encoder channel (1, 2) 1: Channel 1 2: Channel 2
polarity_A	int	0	Polarity of phase A (0: Phase A, 1: /Phase A)
polarity_B	int	0	Polarity of phase B (0: Phase B, 1: /Phase B)
polarity_Z	int	0	Trigger method of Phase Z (0: Falling edge, 1: Rising edge)
polarity_S	int	0	Trigger method of Phase S (0: Falling edge, 1: Rising edge)

Return

Value	Description
N/A	Not Used

Exception

Exception	Description
N/A	Not Used

Example

```
set_extenc_polarity(1, 0, 1, 0, 1)
# External Encoder channel 1 is set to phase A, /phase B, phase Z (falling edge), phase S (rising edge)
```

Related Commands

set_extenc_mode

11.1.2 set_extenc_mode(channel, mode_AB, pulse_AZ, mode_Z, mode_S, inverse_cnt)

Features

It configures the operation mode of phase A, B, Z and S of the corresponding encoder channel.

Parameter

Parameter Name	Data Type	Default Value	Description
channel	int	1	Encoder channel (1, 2) 1: Channel 1 2: Channel 2
mode_AB	int	0	Use of phase AB Mode (0 ~ 4) 0: Not Used 1: Phase A Quadrature use Phase B Quadrature use 2: Phase A Count Phase B Direction use 3: Phase A Up Count use Phase B Not Used 4: Phase A Down Count use Phase B Not Used
pulse_AZ	int	0	Pulse A Count per Pulse Z (0 ~ 100000)
mode_Z	int	0	Phase Z Use Mode (0 ~ 1) 0: Not Used 1: A/B Count Error Compensation 2: Encoder Count Clear
mode_S	int	0	Phase S Use Mode (0 ~ 1) 0: Not Used 1: Strobe Signal 2: Encoder Count Clear
inverse_cnt	int	0	Encoder Count Direction Reverse Status 0: Forward 1: Reverse

Return

Value	Description
N/A	Not Used

Exception

Exception	Description
N/A	Not Used

Example

```
set_extenc_mode(1, 2, 20000, 1, 1, 0)
# External Encoder channel 1 operation mode is set as follows
# Phase A Count, Phase B Direction Use
# Pulse A Count per Z Pulse is 20000
# Phase Z error count accumulate compensation mode use, phase S use
# Encoder Count direction is set to forward
```

Related Commands

set_extenc_polarity

11.1.3 get_extenc_count(channel)

Features

Get the count value of the corresponding encoder channel.

Parameter

Parameter Name	Data Type	Default Value	Description
channel	int	1	Encoder channel (1, 2) 1: Channel 1 2: Channel 2

Return

Value	Description
count	Current encoder count value of corresponding channel

Exception

Exception	Description
N/A	Not Used

Example

```
enc_cnt = get_extenc_count(1)
# External Encoder channel 1 current count value calculation
```

Related Commands

set_extenc_polarity

set_extenc_mode

clear_extenc_count

11.1.4 clear_extenc_count(channel)

Features

Reset counter value of the corresponding encoder channel to 0.

Parameter

Parameter Name	Data Type	Default Value	Description
channel	int	1	Encoder channel (1, 2) 1: Channel 1 2: Channel 2

Return

Value	Description
N/A	Not Used

Exception

Exception	Description
N/A	Not Used

Example

```
clear_extenc_count(1)
# External Encoder channel 1 count value reset to 0
```

Related Commands

get_extenc_count

11.2 Conveyor Tracking

11.2.1 set_conveyor(name)

- **Features**

  If conveyor information is configured in the UI, obtain ID with the conveyor name to start the Conveyor Tracking Application from the program and execute the command for workpiece monitoring. Workpiece monitoring is performed on workpieces triggered in the conveyor, and monitoring continues until the program ends.

- **Parameter**

Parameter Name	Data Type	Default Value	Description
name	string	-	Conveyor name

- **Return**

Value	Description
Conveyor ID	Returns Conveyor ID if conveyor setting is successful
None	Conveyor setting failure

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data error occurred occurred
DR_Error (DR_ERROR_VALUE)	Invalid parameter value occurred
DR_Error (DR_ERROR_RUNTIME)	C Extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
CONV1 = set_conveyor("conveyor1")
```

- **Related Commands**

  get_conveyor_obj(), tracking_conveyor(), untracking_conveyor()

11.2.2 set_conveyor_ex(name= "", conv_type=0, encoder_channel=1, triggering_mute_time=0.0, count_per_dist=5000, conv_coord=posx(0,0,0,0,0,0), ref=DR_BASE, conv_speed=100.0, speed_filter_size=500, min_dist=0.0, max_dist=1000.0, watch_window=100.0, out_tracking_dist=10.0)

- **Features**

Configures the conveyor and obtains Conveyor ID to allow the Conveyor Tracking Application to start. After the command is executed, it monitors workpieces triggered in the configured conveyor until the program ends. It can be used when you need to set parameters manually if is unavailable to configure conveyor information through UI.

[1] Added default value for all arguments compared to versions prior to M2.4.0

[2] Added 'ref' argument compared to versions prior to M2.4.0 (world coordinates available)

[3] Removed 'obj_offset_coord' argument compared to versions prior to M2.4.0, The 'obj_offset_coord' argument is changed to input only in **오류! 참조 원본을 찾을 수 없습니다.** get_conveyor_obj() function.

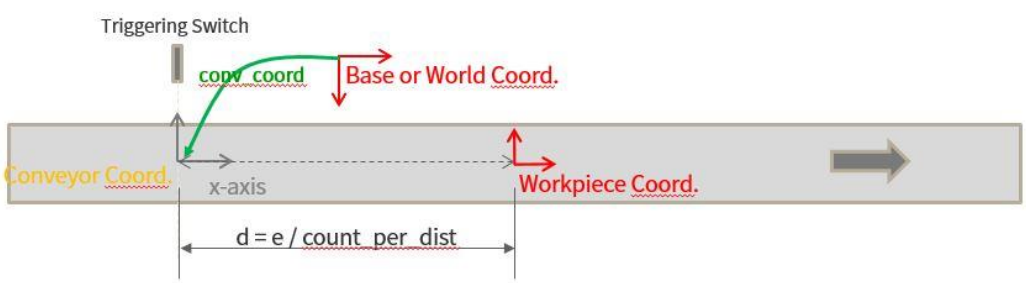
- **Parameter**

Parameter Name	Data Type	Default Value	Description
name	string	""	Conveyor name
conv_type	int	0	Conveyor type (0: Linear, 1: Circular)
encoder_channel	int	1	External encoder channel (1, 2)
triggering_mute_time	float	0.0	It is the time (s) triggering (encoder reset, start workpiece tracking) is not performed when a triggering signal is received immediately after triggering.
count_per_dist	int	5000	Encoder count converted value per length (Linear: count/m, Circular: count/rad)
conv_coord	posx list (float[6])	posx(0,0,0,0,0,0)	Fixed conveyor coordinates (based on Base/World coordinates, mm, ˚)
ref	int	DR_BASE	Reference coordinates of conveyor coordinates (DR_BASE: Base, DR_WORLD: World)
conv_speed	float	100.0	Conveyor nominal velocity (Linear: mm/s, Circular: ˚/s)
speed_filter_size	int	500	Moving Average Filter Size during conveyor velocity filtering

Parameter Name	Data Type	Default Value	Description
min_dist	float	0.0	Minimum conveyor work length (based on Triggering Switch, Linear: mm, Circular: ˚)
max_dist	float	1000.0	Maximum conveyor work length (based on Triggering Switch, Linear: mm, Circular: ˚)
watch_window	float	100.0	Conveyor work standby monitoring length (based on minimum work length, Linear: mm, Circular: ˚)
out_tracking_dist	float	10.0	Conveyor tracking release buffer section length (based on maximum work length, Linear: mm, Circular: ˚)

Note

- Currently conv_type argument does not support Circular Conveyors!
- All workpieces that pass the Triggering Switch are monitored until they reach max_dist after set_conveyor() or set_conveyor_ex() function execution and before the program ends.
- However, if triggering_mute_time is configured, and if the Triggering Switch activates during the corresponding time after the previous workpiece is detected, it is not included on the monitoring list. It is used when noise is present in the Triggering Switch or when the workpiece needs to be removed for a certain amount of time.
- conv_coord is a coordinate system fixed to the conveyor relative to the base or world coordinate system. **Here, the x-axis of conv_coord represents the direction the conveyor flows.** From the moment the conveyor workpiece activates the triggering switch, the increased encoder value can be converted to the length of the workpiece travel by using the count_per_dist argument, and extending this length in the x-axis direction of the conv_coord will position the workpiece relative to the reference coordinate system.

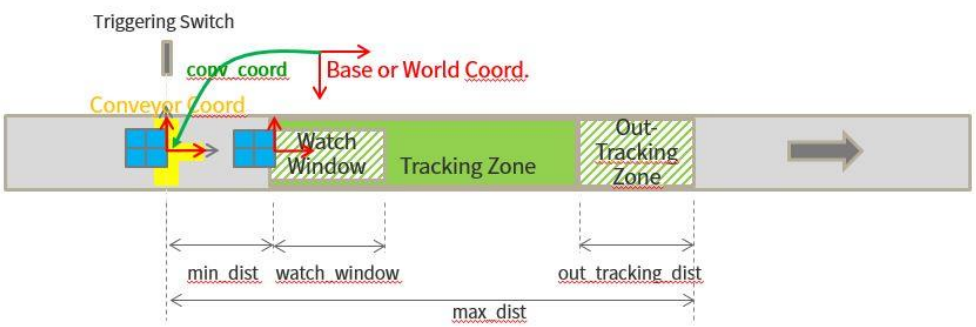


d: distance from conv_coord to workpiece
e: incremental encoder value after triggering switch activated

[Conveyor/Item Coordinate]

- conv_speed is the moving speed of the conveyor. It is used to give Info only if the conveyor speed sensed by the encoder exceeds 200% of this speed. Therefore, if the measurement is not possible through the TP UI, enter the approximate value.

- Speed_filter_size is the size of the moving-average filter used to estimate the conveyor speed from the encoder. The larger the size, the more the noise can be canceled, but the tracking accuracy may deteriorate during acceleration and deceleration.
- The area on top of the conveyor is categorized into Watch Window, Tracking Zone and Out-Tracking Zone.
- Watch Window is the area that determines whether workpieces within the area are available for the job when obtaining workpiece coordinates for tracking. When the get_conveyor_obj() function is loaded, if a workpiece is not present within this area, the function is not returned, and if a workpiece is present within this area, it returns workpiece coordinates according to get_conveyor_obj() function options (FIFO, LIFO).
- The Tracking Zone is the area that performs Conveyor Tracking.
- The Out-Tracking Zone is the area where the robot automatically ends tracking after it determines that the robot has exited the work space of the robot or the work space specified by the user during continuous tracking.
- These three areas are defined with the four lengths (min_dist, max_dist, watch_window, out_tracking_dist) as shown below.



[Conveyor Area and Length]

▪ Return

Value	Description
Conveyor ID	Returns Conveyor ID if conveyor setting is successful
None	Conveyor setting failure

▪ Exception

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data error occurred occurred
DR_Error (DR_ERROR_VALUE)	Invalid parameter value occurred
DR_Error (DR_ERROR_RUNTIME)	C Extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
CONV1 = set_conveyor_ex(name='conveyor_1',
                conv_type=0,                          # linear
                encoder_channel=1, triggering_mute_time=0.0,
                count_per_dist=5000,                  # 5000 count/mm)
                conv_coord=posx(500, 100, 500, 0, -90, 0), ref=DR_BASE,
                conv_speed=100.0,                     # conveyor speed: 100 mm/s,
                speed_filter_size=500,                # moving avg. filter size: 500 ms
                min_dist=100, max_dist=1000, watch_window=200, out_tracking_dist=10)
```

- **Related Commands**

get_conveyor_obj(), tracking_conveyor(), untracking_conveyor()

11.2.3 get_conveyor_obj(conv_id, timeout=None, container_type=DR_FIFO, obj_offset_coord=None)

▪ Features

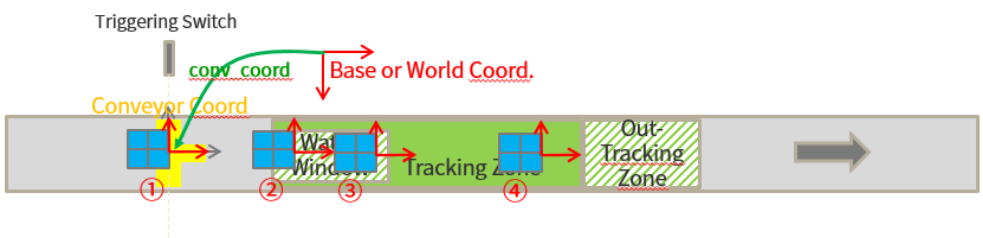
It returns the workpiece coordinate ID available for the job from the corresponding conveyor. When a function is called, it returns the workpiece present in the Watch Zone one by one according to the container rule.

▪ Parameter

Parameter Name	Data Type	Default Value	Description
conv_id	int	-	Conveyor ID
timeout	float	None	If no workpiece to return is present, it ends the standby and returns the function
container_type	int	DR_FIFO	Workpiece container type (DR_FIFO: first-in/first-out, DR_LIFO: last-in/last-out
obj_offset_coord	posx	None	Workpiece coordinates (mm, °) based on conveyor lock coordinates
	list (float[6])		

Note

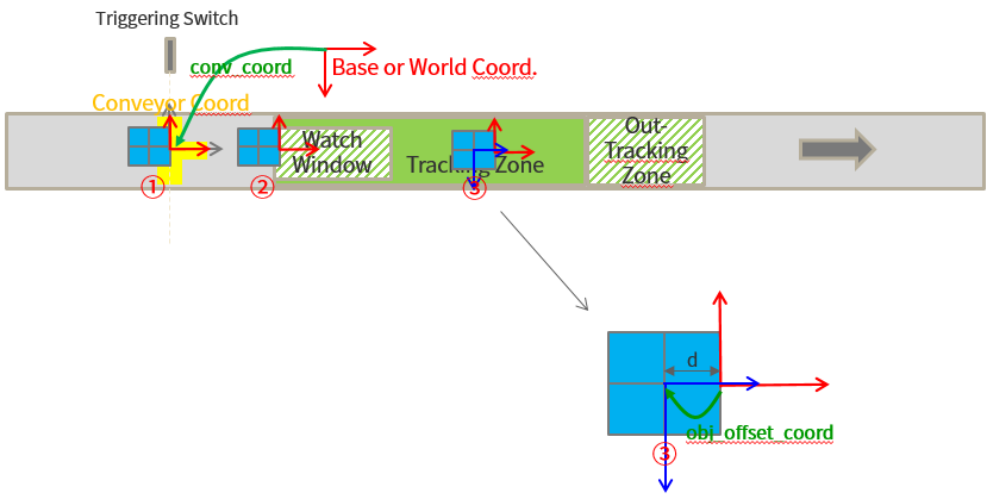
- When calling this function, it returns the coordinates ID of each workpiece in the Watch Window according to the container rule. For example, if you call get_conveyor_obj() function when the workpieces are places as shown below, the workpiece ② and ③ in the Watch Window will be candidates. At this time, if the container_type is set to DR_FIFO the corrdinates ID of ③ that entered the Watch Window first. If it is set to DR_LIFO, it returns the coordinates ID of ② that entered the Watch Window later. If there is no workpieces in the Watch Window at the time of the function call, it waits until the time set in the timeout parameter and return the id if the workpiece comes in.



[Workpiece Coordinate ID Return Rule Description]

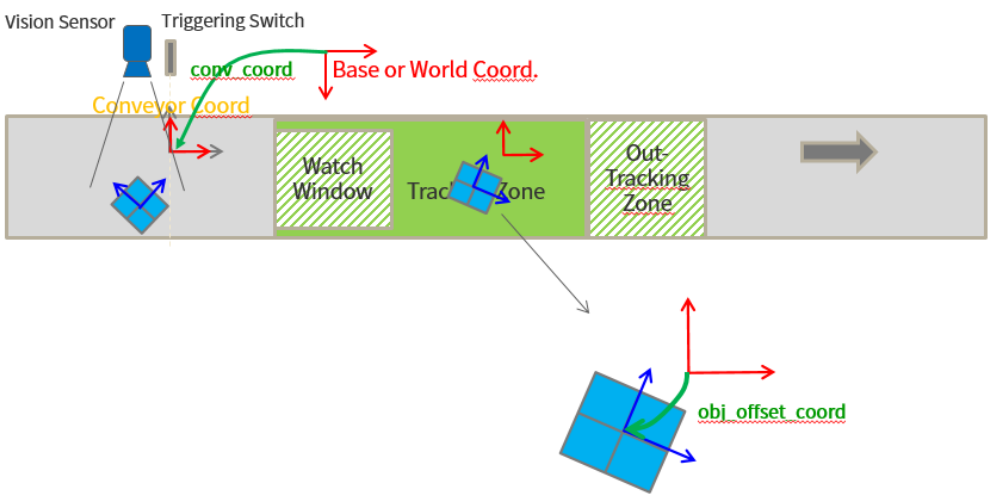
- obj_offset_coord is used when you want to apply offset to the workpiece coordinates. It is usually used for easy input of a teaching point or when you want to dynamically change the position and orientation of the workpiece coordinates in conjunction with an external sensor (ex. Vision sensor).

In the case shown below, the workpiece coordinates are created on the right side of the workpiece and the orientation is different from the base or world coord. At this time, if you want to position the workpiece coordinates at the center of workpiece and make the orientation to be same with the ones of base or world coordinates, you can apply it as obj_offset_coord = posx (-d, 0, 0, -90, 0, 0). It is not necessary to acquire a teaching point through this TP UI, but it could utilize this method if you need to use drl only or enter the teaching point directly.



[obj_offset_coord use case 1]

Next, if the workpiece changes its position in a direction that is independent of the conveying direction, or the orientation of the workpiece changes as shown below, the encoder signal alone cannot determine the position / orientation of the workpiece. In this case, you need to detect them using external vision sensor. After detecting this value, you can input the position/orientation change detected as obj_offset_coord dynamically and the workpiece coordinates are created accordingly.



[obj_offset_coord use case 2: using vision sensor]

Return

Value	Description
int	CONV_COORD. Conveyor user coordinate ID (121~150)
Negative integer	If no workpiece is present even after the timeout expires

Note

If no workpiece to return is present, no function is returned until the timeout time expires. If the timeout time expires but no workpiece is present, it returns -1. However, if a timeout time is not entered, it doesn't return continuously.

Exception

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data error occurred occurred
DR_Error (DR_ERROR_VALUE)	Invalid parameter value occurred
DR_Error (DR_ERROR_RUNTIME)	C Extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

Example

```
## One object in a cycle
CONV1 = set_conveyor('conveyor1')

movel(posx(100, 100, 50, 0, 0, 0), ref=DR_BASE) # waiting position
while True:
    CONV_COORD_1 = get_conveyor_obj(CONV1)
    tracking_conveyor(CONV1)

    # synched motion
    movel(posx(0,0, 50, 0, 0, 0), ref=CONV_COORD_1)
    movel(posx(0,0, 0, 0, 0, 0), ref=CONV_COORD_1)
    set_digital_output(DO_GRIPPER, 1)
    movel(posx(0,0, 50, 0, 0, 0), ref=CONV_COORD_1)

    untracking_conveyor(CONV1)

    movel(posx(100, 100, 50, 0, 0, 0), ref=DR_BASE) # waiting position

## Multi objects in a cycle
CONV1 = set_conveyor('conveyor1')

while True:
    CONV_COORD_1 = get_conveyor_obj(CONV1)
    tracking_conveyor(CONV1)
```

```
# fist object
movel(posx(0,0, 50, 0, 0, 0), ref=CONV_COORD_1)
movel(posx(0,0, 0, 0, 0, 0), ref=CONV_COORD_1)
set_digital_output(DO_GRIPPER, 1)
movel(posx(0,0, 50, 0, 0, 0), ref=CONV_COORD_1)

# second object
CONV_COORD_2 = get_conveyor_obj(CONV1, time_out=10)
if CONV_COORD_2 > 0:    # -1 if no objects available during time_out
        movel(posx(0,0, 50, 0, 0, 0), ref=CONV_COORD_2)
        movel(posx(0,0, 0, 0, 0, 0), ref=CONV_COORD_2)
        set_digital_output(DO_GRIPPER, 1)
        movel(posx(0,0, 50, 0, 0, 0), ref=CONV_COORD_2)

        # first object if you need
        movel(posx(0,0, 50, 0, 0, 0), ref=CONV_COORD_1)

untracking_conveyor(CONV1)

movel(posx(100, 100, 50, 0, 0, 0), ref=DR_BASE)
```

- **Related Commands**

  tracking_conveyor(), untracking_conveyor()

11.2.4 tracking_conveyor(conv_id)

- **Features**

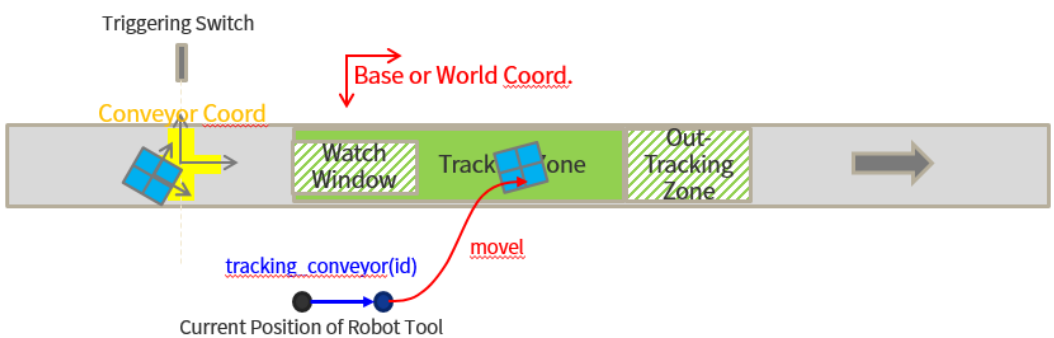
The robot starts Conveyor Tracking. It returns a function when it reaches conveyor velocity by accelerating from stop.

- **Parameter**

Parameter Name	Data Type	Default Value	Description
conv_id	int	-	Conveyor ID

Note

If the tracking_conveyor command is given, the conveyor starts tracking, and as it accelerates from stop and reaches the conveyor velocity, it returns a function. After a function is returned, it is possible to perform task motion.



[tracking sequence]

- **Return**

Value	Description
0	Velocity synchronization success
Negative integer	If the robot is expected to exit the robot work space during velocity synchronization

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data error occurred occurred
DR_Error (DR_ERROR_VALUE)	Invalid parameter value occurred
DR_Error (DR_ERROR_RUNTIME)	C Extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
CONV1 = set_conveyor('conveyor1')

while True:
    CONV_COORD_1 = get_conveyor_obj(CONV1)

    tracking_conveyor(CONV1)       # start moving to track conveyor

    # task on conveyor
    movel(posx(0,0, 50, 0, 0, 0), ref=CONV_COORD_1)
    movel(posx(0,0, 0, 0, 0, 0), ref=CONV_COORD_1)
    set_digital_output(DO_GRIPPER, 1)
    movel(posx(0,0, 50, 0, 0, 0), ref=CONV_COORD_1)

    untracking_conveyor(CONV1)
    obj_count = obj_count + 1
```

- **Related Commands**

  untracking_conveyor()

11.2.5 untracking_conveyor(conv_id, time=None)

- **Features**

The robot ends Conveyor Tracking. Return is made when end motion is complete and velocity reaches 0.

- **Parameter**

Parameter Name	Data Type	Default Value	Description
conv_id	int	-	Conveyor ID
time	float	None	Deceleration time (sec) to end Tracking

Note

- If the time is set to None, it decelerates with the velocity set to Default. If cycle time reduction is necessary, adjust the deceleration time. If a time value is shorter than the robot's maximum deceleration speed, the robot ignores the entered value and decelerates using the maximum deceleration speed.

- **Return**

Value	Description
0	End velocity synchronization success
Negative integer	If the robot is expected to exit the robot work space during end velocity synchronization

- **Exception**

Exception	Description
DR_Error (DR_ERROR_TYPE)	Parameter data error occurred
DR_Error (DR_ERROR_VALUE)	Invalid parameter value occurred
DR_Error (DR_ERROR_RUNTIME)	C Extension module error occurred
DR_Error (DR_ERROR_STOP)	Program terminated forcefully

- **Example**

```
CONV1 = set_conveyor('conveyor1')

while True:
    CONV_COORD_1 = get_conveyor_obj(CONV1)
    tracking_conveyor(CONV1)

    # task on conveyor
    movel(posx(0,0, 50, 0, 0, 0), ref=CONV_COORD_1)
```

```
movel(posx(0,0, 0, 0, 0, 0), ref=CONV_COORD_1)
set_digital_output(DO_GRIPPER, 1)
movel(posx(0,0, 50, 0, 0, 0), ref=CONV_COORD_1)

untracking_conveyor(CONV1, 0.1)
```

- **Related Commands**

  tracking_conveyor()

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