# Doosan Robot

M0609 | M0617 | M1013 | M1509

# ROS Programming Manual

# 1. Installation Doosan ROS package

## 1.1 Overview

- **Doosan robotics ROS package**

Doosan robotics ROS package is a metapackage for running Doosan cooperative robots on ROS URDF model is provided, simulation is possible through Rviz, Gazebo, and the real robot can be driven through moveIt or various examples.

## 1.2 Prerequisitese

- **System**

You must use an x86 system.

We recommend a workstation-class PC for the best simulation.

- **OS & Distro**

Ubuntu 16.04(32/64bit) + ROS kinetic or melodic

## 1.3 Installation

- **Install the source from github**

Download and build the source from Doosan robotics

Github : **https://github.com/doosan-robotics/doosan-robot**

- **How to Install**

```
### We recoomand the /home/<user>/catkin_ws/src
$ mkdir -p /home/<user>/catkin_ws/src
$ cd /home/<user>/catkin_ws/src
$ catkin_init_workspace
$ git clone https://github.com/doosan-robotics/doosan-robot
$ rosdep install --from-paths doosan-robot --ignore-src --rosdistro kinetic -r -y
$ catkin_make
$ source ./devel/setup.bash
# In this manual, workspace was used as '~/catkin_ws'
```

# 2. Operation mode

## 2.1 Virtual mode

- **Feature**

• If you are driving without a real robot, use virtual mode.

• Selecting virtual mode sets the mode argument to virtual when running the dsr_aluncher launch file. If you omit the argument, it defaults to virsual. .

ex> roslaunch dsr_launcher single_robot_gazebo.launch **mode:=virtual**

• When ROS launches in virtual mode, the emulator(DRCF) runs automatically.

- (DRCF) location: doosan-robot/common/bin/ DRCF

• One emulator is required for each robot.

• When controlling multiple robots, the emulator will automatically run as many as the number of robots and use different port.

## 2.2 Real mode

- **Feature**

• Use real mode to drive a real robot.

• In real mode operation, communication must be established with the real robot controller.

• The default IP of the robot controller is 192.168.127.100 and the port is 12345.

• Selecting arguments(**mode:=real host:=192.168.127.100 port:=12345**) to real mode when running the dsr_launcher launch file.

ex> roslaunch dsr_launcher single_robot_gazebo.launch **mode:=real host:=192.168.127.100 port:=12345**

- **Connect with Controller**

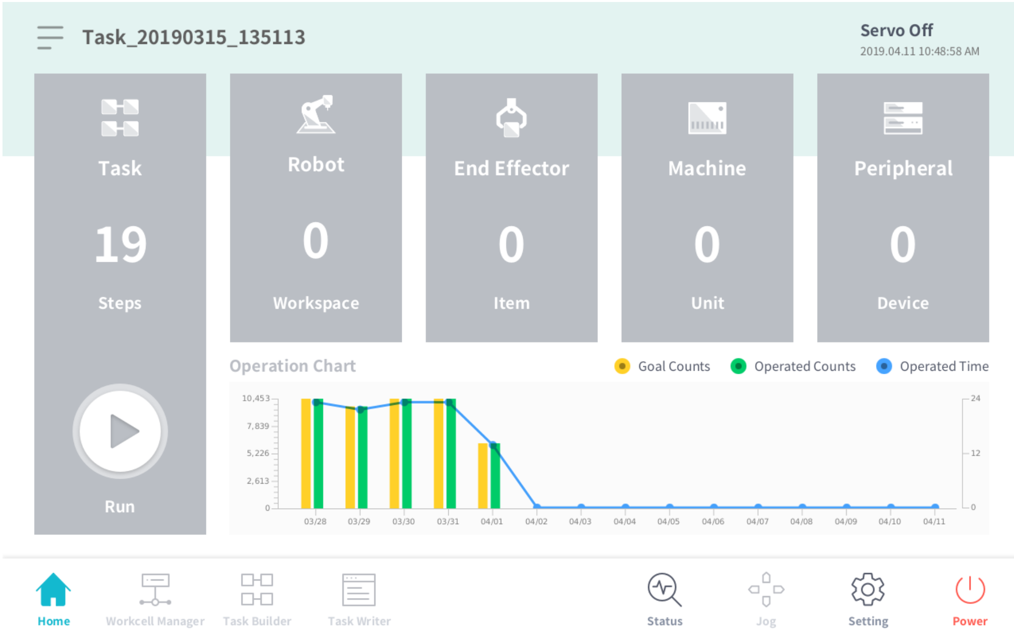



**Figure 2.2 Teach Pandaunt Screen**

- The user can set static IP in Setting -> Network of TP screen.

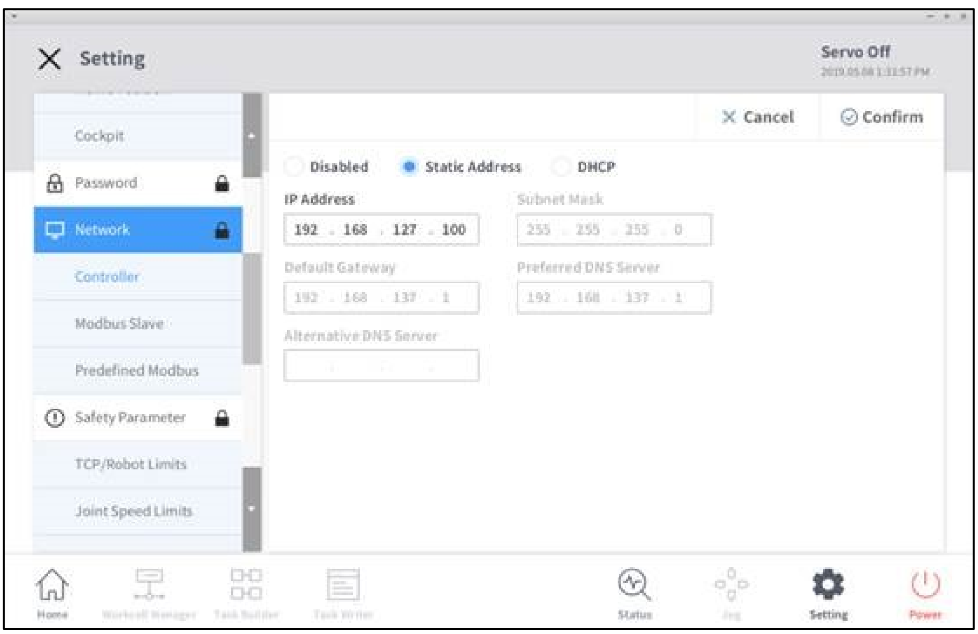



**Figure 2.3 Check robot controller IP on TP**

- Check the IP of the controller set in the Network tab, and set this IP in the ROS (host := ROBOT_IP)
- If the ROS control node is correctly executed, ROS has the robot control.
- If the TP transfer control, below pop-up message on the TP screen.

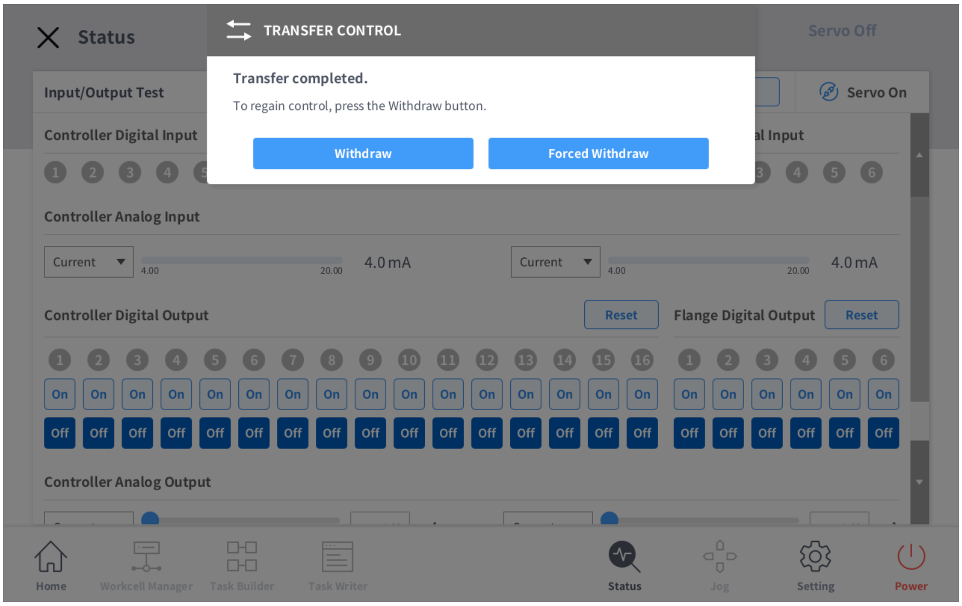



**Figure 2.4 Transfer Control pop-up message**

# 3. dsr_description

## 3.1 dsr_description <robot_model>.launch

### ▪ Feature

- Launch the robot model on Rviz simulator and load Joint_state_publisher.
- The robot can be moved by using Joint_state_publisher.

### ▪ Parameter

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| model | - | m1013 | M-Series Robot model<br>. m0609, m0617, m1013, m1509<br>A-Series Robot model<br>. a0509 |
| color | - | white | Robot Color<br>. white or blue |
| gripper | - | none | using gripper or not<br>. none : not use gripper<br>. robotiq_2f : use robotiq 2finger gripper |

### ▪ Example

```
$ roslaunch dsr_description m0609.launch
$ roslaunch dsr_description m1013.launch color:=blue # Change Color
$ roslaunch dsr_description m1509.launch gripper:=robotiq_2f # insert robotiq
gripper
$ roslaunch dsr_description m0617.launch color:=blue gripper:=robotiq_2f
$ roslaunch dsr_description a0509.launch # A-Series

Robot and Joint_state_publisher are loaded on Rviz simulator (Figure 3.1).
The robot can be moved by using Joint_state_publisher.
```

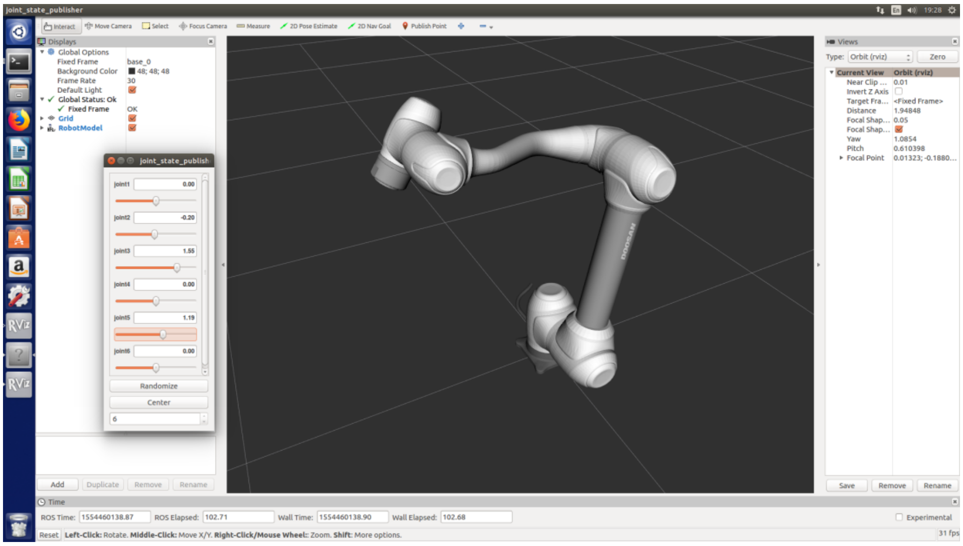



**Figure 3.1 Robot on the Rviz simulator**

# 4. dsr_moveit

## 4.1 dsr_moveit_config

### ▪ Feature

- Launch the robot model on Rviz simulator and operated by MoveIt.
- It only works in simulation mode.

### ▪ Parameter

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| color | - | white | Robot Color<br>. white or blue |

### ▪ Example

```
$ roslaunch moveit_config_m0609 m0609.launch
$ roslaunch moveit_config_m0617 m0617.launch
$ roslaunch moveit_config_m1013 m1013.launch color:=blue
$ roslaunch moveit_config_m1509 m1509.launch
$ roslaunch moveit_config_a0509 a0509.launch
```

Robot and Motion Planning Interface window are loaded on Rviz(Figure 4.1)
MotionPlanning allows the robot to run virtually.

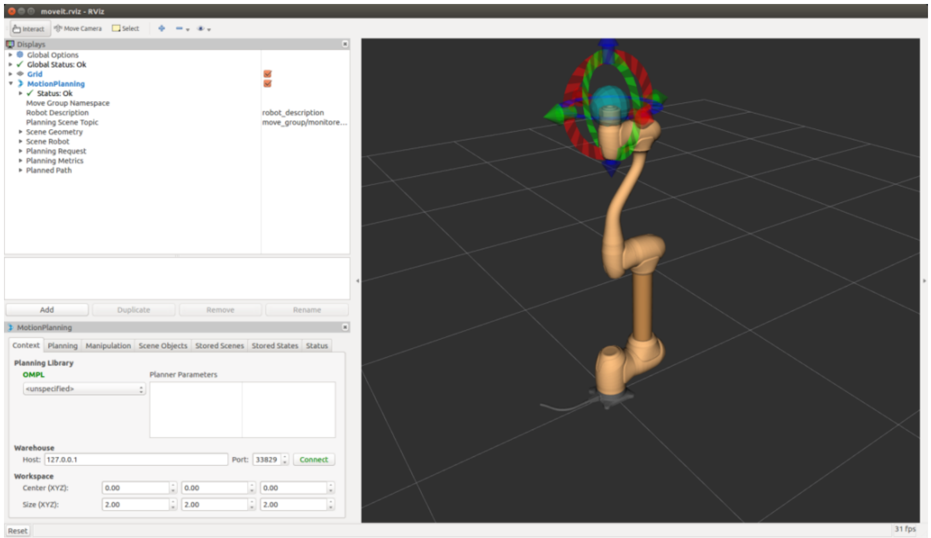



**Figure 4.1 Rviz + MoveIt**

## 4.2 dsr_control + moveit

### ▪ Feature

- Launch the robot model on Rviz simulator and operated by MoveIt.
- Working by connecting with emulator mode or real robot.
- The emulator mode only works in virtual mode.

### ▪ Parameter

| Paramater Name | Data Type | Default Value | Description |
|---|---|---|---|
| host | - | 127.0.0.1 | Robot Controller IP<br>. Emulator : 127.0.0.1<br>. Real robot controller : 192.168.127.100 |
| port | - | 12345 | port |
| mode | - | virtual | Robot operation mode<br>- virtual : virtual mode<br>- real : real mode |
| model | - | m1013 | M-Series Robot model<br>. m0609, m0617, m1013, m1509<br>A-Series Robot model<br>. a0509 |
| color | - | white | Robot color<br>. white or blue |
| gripper | - | none | using gripper or not<br>. none : not use gripper<br>. robotiq_2f : use robotiq 2finger gripper |

### ▪ Example

<virtual mode>

$ roslaunch dsr_control dsr_moveit.launch model:=m0609 **mode:=virtual**

$ roslaunch dsr_control dsr_moveit.launch model:=m0617

$ roslaunch dsr_control dsr_moveit.launch model:=m1013 **mode:=virtual** color:=blue

**<real mode>**

**Robot controller IP defalut = 192.168.127.100, port = 12345**

$ roslaunch dsr_control dsr_moveit.launch model:=m1509 host:=192.168.127.100 **mode:=real** color:=blue gripper:=robotiq_2f

$ roslaunch dsr_control dsr_moveit.launch model:=a0509 host:=192.168.127.10**0** **mode:=real**

The Robot and Motion Planning Interface window are loaded on Rviz(Figure 4.2). The MotionPlanning allows the robot to run in real environment.

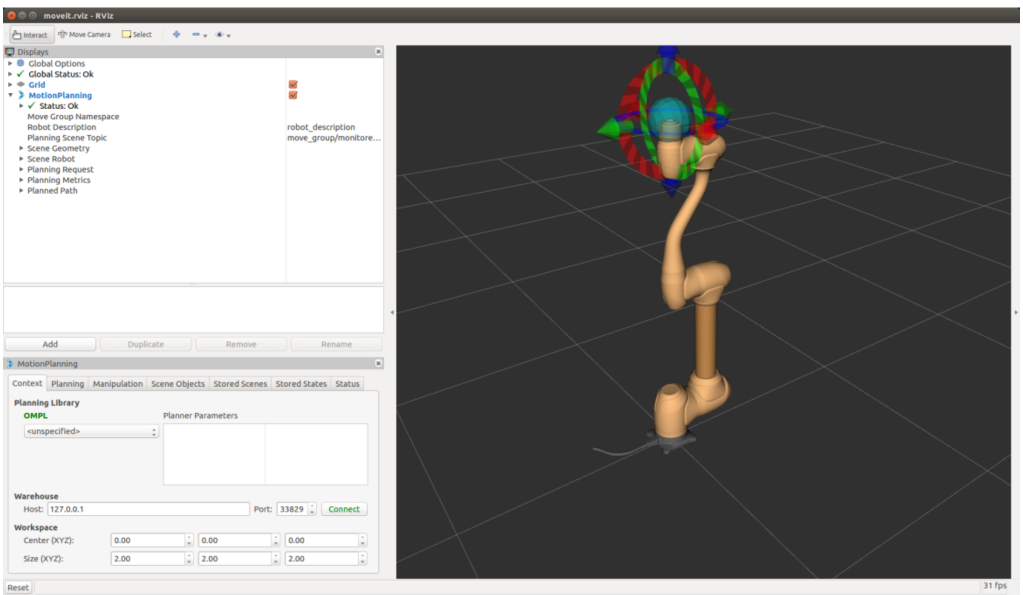



**Figure 4.2 Rviz + dsr_control**

## 4.3 MoveIt Commander

### ▪ Feature

- Control the robot through Moveit Commander..

### ▪ Install

- sudo apt-get insatll ros-kinetic-moveit-commander

### ▪ Example

```
<virtual mode>
$ roslaunch dsr_control dsr_moveit.launch model:=m1013 mode:=virtual

$ ROS_NAMESPACE=/dsr01m1013 rosrun moveit_commander
moveit_commander_cmdline.py robot_description:=/dsr01m1013/robot_description

> use arm
> goal0 = [0 0 0 0 0 0]         # save the home position to variable "goal0"
> goal1 = [0 0 1.57 0 1.57 0] # save the target position to varialbe "goal1" / radian
> go goal1              # plan & excute (the robot is going to move target position)
> go goal0              # paln & excute (the robot is going to move home position)


<real mode>
  Robot controller IP defalut = 192.168.127.100, port = 12345
$ roslaunch dsr_control dsr_moveit.launch model:=a0509 host:=192.168.127.100
mode:=real

$ ROS_NAMESPACE=/dsr01a0509 rosrun moveit_commander
moveit_commander_cmdline.py robot_description:=/dsr01a0509/robot_description

> use arm
> goal0 = [0 0 0 0 0 0]         # save the home position to variable "goal0"
> goal1 = [0 0 1.57 0 1.57 0] # save the target position to varialbe "goal1" / radian
```

# 5. dsr_launcher

## 5.1 dsr_launcher

### ▪ Feature

- Configure various robot environment through dsr_launcher.
- The user can build Single Robot, Multi Robot, Gripper, mobile environment according to Paramater.
- Multi Robot configuration is an extension of Single Robot configuration. This is an example of 2 robots of Multi Robot configuration basically provided in this package. Please modify the dsr_launcher / multi-robot * .launch files to the appropriate configuration for your environment. (ns, host, port, model, etc. should be corrected correctly.)
- After loading dsr_launcher, run dsr_example for each environment with rosrun.

  (For details, see Chapter 6, dsr_example.)

### ▪ Paramater

| Parameter Name | Datatype | Default Value | Description |
|---|---|---|---|
| ns | - | dsr01 | ROBOT name space<br>. single robot : dsr01<br>. multi robot: dsr01, dsr02, dsr03, dsr04 … |
| host | - | 127.0.0.1 | Robot controller IP<br>. Emulator : 127.0.0.1<br>. Real robot controller : 192.168.127.100 |
| port | - | 12345 | port |
| mode | - | virtual | Robot operation mode<br>- virtual : virtual mode<br>- real : real mode |
| model | - | m1013 | M-Series Robot model<br>. m0609, m0617, m1013, m1509<br>A-Series Robot model<br>. a0509 |

| Parameter Name | Datatype | Default Value | Description |
|---|---|---|---|
| color | - | white | Robot color<br>. white or blue |
| gripper | - | none | using gripper or not<br>. none : not use gripper<br>. robotiq_2f : use robotiq 2finger gripper |
| mobile | - | none | using mobile robot or not<br>. none : not use mobile robot<br>. husky : use husky mobile robot |

## Examples

**<single robot>**

**- rviz, virtual mode, m1013(white)**

$ roslaunch dsr_launcher single_robot_rviz.launch **mode:=virtual** model:=m1013

**- gazebo, real mode, m1013(blue)**

$ roslaunch dsr_launcher single_robot_gazebo.**launch host:=192.168.127.100 port:= 12345 mode:=real** color:=**bule**

**- rviz+gazebo, real mode, m1013(white)**

$ roslaunch dsr_launcher single_robot_rviz_gazebo.launch host:=192.168.127.100 port:= 12345 mode:=real

**- + gripper**

$ roslaunch dsr_launcher single_robot_rviz_gazebo.launch **gripper:=robotiq_2f**

**- + mobile**

$ roslaunch dsr_launcher single_robot_rviz_gazebo.launch gripper:=robotiq_2f **mobile:=husky**

**<multi robot>**

**- rviz, virtual mode, m1013 x 2**

$ roslaunch dsr_launcher multi_robot_rviz.launch

**- gazebo, virtual mode, m1013 x 2**

$ roslaunch dsr_launcher multi_robot_gazebo.launch

**- rviz + gazebo, virtual mode, m1013 x 2**

$ roslaunch dsr_launcher multi_robot_rviz_gazebo.launch

# 6. dsr_example

- **Feature**

- Provides an example of robot operation according to robot environment configured through dsr_launcher.

  (Please refer to Chapter 5, "dsr_launcher" for detailed robot environment configuration.)

- The example files was written by python.

  - Directory of .py files: ~/catkin_ws/src/doosan-robot/dsr_example/py/scripts

## 6.1 Single Robot

- **Feature**

- Provides an example of operating a Single Robot.

  (Please refer to Chapter 5, "dsr_launcher" for detailed robot environment configuration.)

- The example files was written in python

  - Directory of .py files: ~/catkin_ws/src/doosan-robot/dsr_example/py/scripts/simple

- **Paramaters of dsr_launcher**

| Parameter Name | Datatype | Default Value | Description |
|---|---|---|---|
| ns | - | dsr01 | ROBOT name space<br>. single robot : dsr01<br>. multi robot: dsr01, dsr02, dsr03, dsr04 … |
| host | - | 127.0.0.1 | Robot controller IP<br>. Emulator : 127.0.0.1<br>. Real robot controller : 192.168.127.100 |
| port | - | 12345 | port |
| mode | - | virtual | Robot operation mode<br>- virtual : virtual mode |

| Parameter Name | Datatype | Default Value | Description |
|---|---|---|---|
| | | | - real : real mode |
| model | - | m1013 | M-Series Robot model<br>. m0609, m0617, m1013, m1509<br>A-Series Robot model<br>. a0509 |
| color | - | white | Robot color<br>. white or blue |
| gripper | - | none | using gripper or not<br>. none : not use gripper<br>. robotiq_2f : use robotiq 2finger gripper |
| mobile | - | none | using mobile robot or not<br>. none : not use mobile robot<br>. husky : use husky mobile robot |

- **Example**

**1. Robot controller default IP/Port**

**- IP : 192.168.127.100 , port = 12345**

**2. launch**

**Run dsr_launher for your desired configuration.**

**- single robot in rviz, virtual mode, m1013(white)**

$ roslaunch dsr_launcher single_robot_rviz.launch mode:=virtual model:=m1013 color:=white

**- single robot in gazebo, real mode, m1013(blue)**

$ roslaunch dsr_launcher single_robot_gazebo.launch mode:=real host:=192.168.127.100 model:=m1013 color:=blue

**- single robot in rviz + gazebo, virtual mode, m1013(white)**

$ roslaunch dsr_launcher single_robot_rviz_gazebo.launch model:=m1013 color:=white

**3. run application node**

- Edit example files

. Open the example file you want to run and modify the ROBOT_ID and ROBOT_MODEL accordingly.

.. ex>

ROBOT_ID = "dsr01"

ROBOT_MODEL = "m1013"

$ rosrun dsr_example_py **single_robot_simple.py**

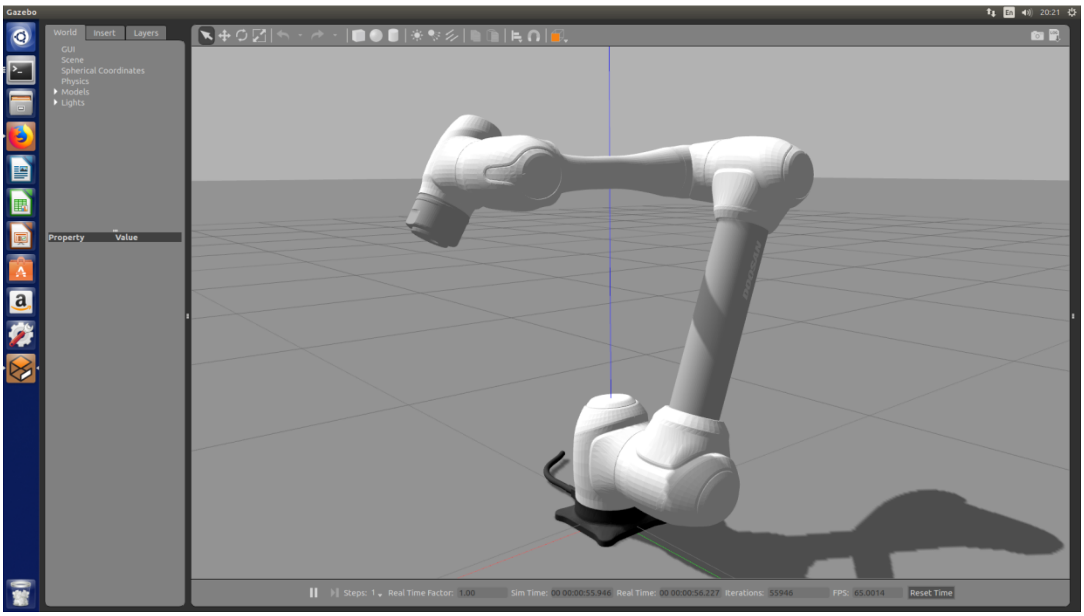


**Figure 6.2 single robot**

## 6.2 Multi Robot

### ▪ Feature

- Provides an example of driving Multi Robot.

  (Please refer to Chapter 5, "dsr_launcher" for detailed robot environment configuration.)

- The example files was written in python

  - Directory of .py files: ~/catkin_ws/src/doosan-robot/dsr_example/py/scripts/simple

### ▪ Paramaters of dsr_launcher

| Parameter Name | Datatype | Default Value | Description |
|---|---|---|---|
| ns | - | dsr01 | ROBOT name space<br>. single robot : dsr01<br>. multi robot: dsr01, dsr02, dsr03, dsr04 … |
| host | - | 127.0.0.1 | Robot controller IP<br>. Emulator : 127.0.0.1<br>. Real robot controller : 192.168.127.100 |
| port | - | 12345 | port |
| mode | - | virtual | Robot operation mode<br>- virtual : virtual mode<br>- real : real mode |
| model | - | m1013 | M-Series Robot model<br>. m0609, m0617, m1013, m1509<br>A-Series Robot model<br>. a0509 |
| color | - | white | Robot color<br>. white or blue |
| gripper | - | none | using gripper or not<br>. none : not use gripper<br>. robotiq_2f : use robotiq 2finger gripper |
| mobile | - | none | using mobile robot or not |

| Parameter Name | Datatype | Default Value | Description |
|---|---|---|---|
| | | | . none : not use mobile robot<br>. husky : use husky mobile robot |

- **Example**

1. Robot controller default IP/Port
   - IP : 192.168.127.100 , port = 12345
   - For multi robot, set the IP of each robot controller differently

1. launch
   - edit launch file
     . $ cd ~/catkin_ws/src/doosan-robot/dsr_launcher/launch
     . Modify the multi_robot_*.launch file for each situation.
       .. edit argument ns host port, model...
   - multi robot in rviz

$ roslaunch **dsr_launcher multi_robot_rviz.launch** model:=m1013

   - multi robot in gazebo

$ roslaunch **dsr_launcher multi_robot_gazebo.launch** color:=bule

   - multi robot in rviz + gazebo

$ roslaunch **dsr_launcher multi_robot_rviz_gazebo.launch**

2. run application node
   - Edit example files
     . Open the example file you want to run and modify the robot_id and robot_model accordingly.
       .. ex>

```
robot_id1 = "dsr01"; robot_model1 = "m1013"
robot_id2 = "dsr02"; robot_model2 = "m1013"
```

$ rosrun dsr_example_py **multi_robot_simple.py**

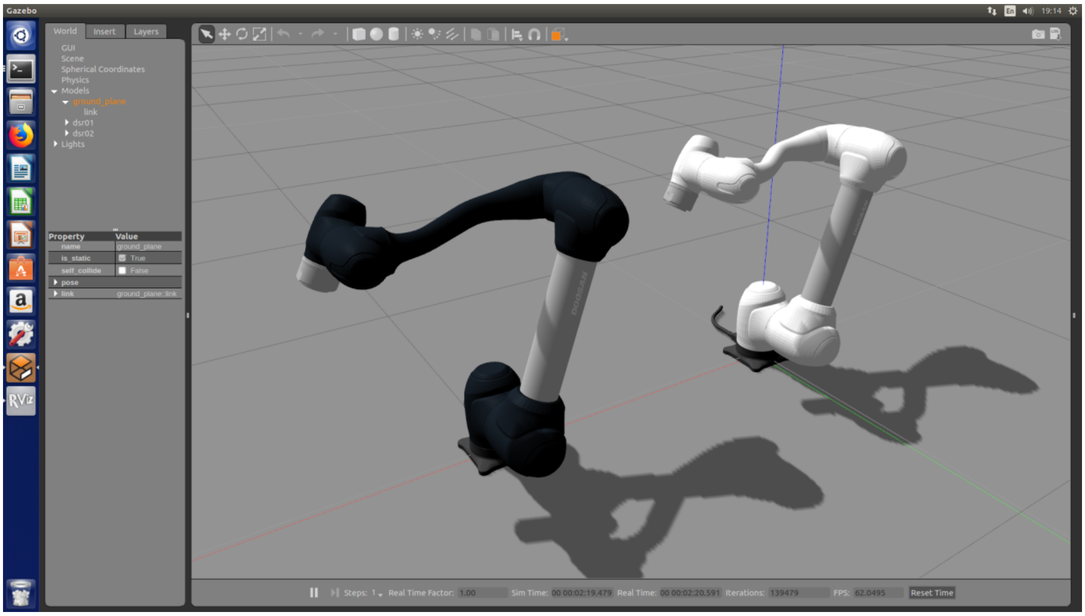



Figure 6.3 multi robot

## 6.3 Gripper

### ▪ Feature

- Provides an example of using gripper (robotiq_2f)

  (Please refer to Chapter 5, "dsr_launcher" for detailed robot environment configuration.)
- When running dsr_launcher, give argument (**gripper: = robotiq_2f)**.
- The example files was written in python

  - Directory of .py files: ~/catkin_ws/src/doosan-robot/dsr_example/py/scripts/gripper

### ▪ Praramaters of dsr_launcher

| Parameter Name | Datatype | Default Value | Description |
|---|---|---|---|
| ns | - | dsr01 | ROBOT name space<br>. single robot : dsr01<br>. multi robot: dsr01, dsr02, dsr03, dsr04 … |
| host | - | 127.0.0.1 | Robot controller IP<br>. Emulator : 127.0.0.1<br>. Real robot controller : 192.168.127.100 |
| port | - | 12345 | port |
| mode | - | virtual | Robot operation mode<br>- virtual : virtual mode<br>- real : real mode |
| model | - | m1013 | M-Series Robot model<br>. m0609, m0617, m1013, m1509<br>A-Series Robot model<br>. a0509 |
| color | - | white | Robot color<br>. white or blue |
| gripper | - | none | using gripper or not<br>. none : not use gripper<br>. robotiq_2f : use robotiq 2finger gripper |

| Parameter Name | Datatype | Default Value | Description |
|---|---|---|---|
| mobile | - | none | using mobile robot or not<br>. none : not use mobile robot<br>. husky : use husky mobile robot |

## ▪ Example

**1. Robot controller default IP/Port**

**- IP : 192.168.127.100 , port = 12345**

**2. launch : single robot + gripper**

**- single robot in rviz**

$ roslaunch dsr_launcher single_robot_rviz.launch model:=m1013 **gripper:=robotiq_2f**

**- single robot in gazebo**

$ roslaunch dsr_launcher single_robot_gazebo.launch model:=m1013 **gripper:=robotiq_2f**

**- single robot in rviz + gazebo**

$ roslaunch dsr_launcher single_robot_rviz_gazebo.launch model:=m1013 **gripper:=robotiq_2f**

**3. run application node**

**- Edit example files**

**. Open the example file you want to run and modify the ROBOT_ID and ROBOT_MODEL accordingly.**

**.. ex>**

**ROBOT_ID = "dsr01"**

**ROBOT_MODEL = "m1013"**

$ rosrun dsr_example_py **pick_and_place.py**

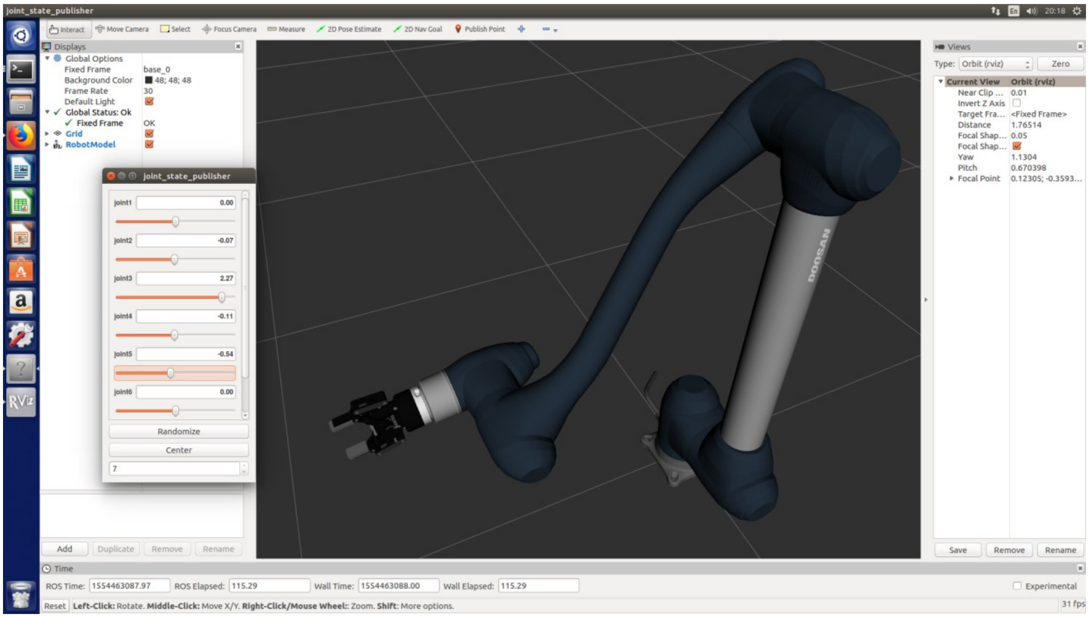


Figure 6.4 robot + gripper

## 6.4 Mobile robot

### ▪ Feature

- Provides mobile robot(huskey) examples.

  (Please refer to Chapter 5, "dsr_launcher" for detailed robot environment configuration.)

- When running dsr_launcher, give argument (**mobile:=husky**).
- The example files was written in python

  - Directory of .py files: ~/catkin_ws/src/doosan-robot/dsr_example/py/scripts/mobile

### ▪ Paramaters of dsr_launcher

| Parameter Name | Datatype | Default Value | Description |
|---|---|---|---|
| ns | - | dsr01 | ROBOT name space<br>. single robot : dsr01<br>. multi robot: dsr01, dsr02, dsr03, dsr04 … |
| host | - | 127.0.0.1 | Robot controller IP<br>. Emulator : 127.0.0.1<br>. Real robot controller : 192.168.127.100 |
| port | - | 12345 | port |
| mode | - | virtual | Robot operation mode<br>- virtual : virtual mode<br>- real : real mode |
| model | - | m1013 | M-Series Robot model<br>. m0609, m0617, m1013, m1509<br>A-Series Robot model<br>. a0509 |
| color | - | white | Robot color<br>. white or blue |
| gripper | - | none | using gripper or not<br>. none : not use gripper<br>. robotiq_2f : use robotiq 2finger gripper |

| Parameter Name | Datatype | Default Value | Description |
|---|---|---|---|
| mobile | - | none | using mobile robot or not<br>. none : not use mobile robot<br>. husky : use husky mobile robot |

- **Example**

1. Robot controller default IP/Port
  - IP : 192.168.127.100 , port = 12345

2. launch : single robot + mobile
  - single robot in rviz

$ roslaunch dsr_launcher single_robot_rviz.launch model:=m1013 **mobile:=husky**

  - single robot in gazebo

$ roslaunch dsr_launcher single_robot_gazebo.launch model:=m1013 **mobile:=husky**

  - single robot in rviz + gazebo

$ roslaunch dsr_launcher single_robot_rviz_gazebo.launch model:=m1013 **mobile:=husky**

3. run application node
  - Edit example files
    . Open the example file you want to run and modify the ROBOT_ID and ROBOT_MODEL accordingly.
      .. ex>
        ROBOT_ID = "dsr01"
        ROBOT_MODEL = "m1013"

$ rosrun dsr_example_py **single_robot_moblie.py**

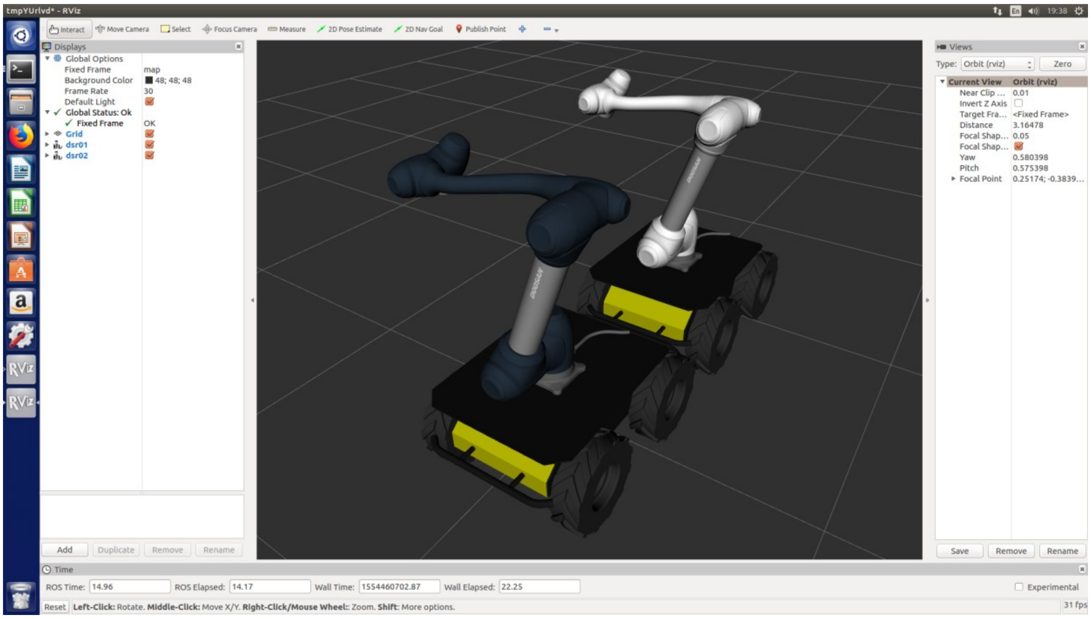


Figure 6.5 robot on mobile

# 7. dsr_msgs

## 7.1 Topic

### 7.1.1 RobotState.msg

- **Features**

Topic message of robot state.

- **Parameters**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| robot_state | int32 | | Robot State : enum.ROBOT_STATE |
| robot_state_str | string | | Output robot status as string |
| actual_mode | int8 | | Robot Control Mode: enum.CONTROL_MODE |
| actual_space | int8 | | Robot Control Space: enum.ROBOT_SPACE |
| current_posj | float64[6] | | 6 current joint angle |
| joint_abs | float64[6] | | 6 current joint angle(Absolute Encorder) |
| current_velj | float64[6] | | 6 current joint velocity |
| joint_err | float64[6] | | 6 current joint error |
| target_posj | float64[6] | | 6 target joint angle |
| target_velj | float64[6] | | 6 target joint velocity |
| current_posx | float64[6] | | 6 current task position |
| current_tool_posx | float64[6] | | 6 current flange position |
| current_velx | float64[6] | | 6 current task velocity |
| task_err | float64[6] | | 6 current task error |
| target_posx | float64[6] | | 6 target task position |
| target_velx | float64[6] | | 6 target task velocity |

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| solution_space | int8 | | solution space(0~7) |
| rotation_matrix | std_msgs/Float64MultiArray[] | | Rotation matrix: float[3][3] |
| dynamic_tor | float64[6] | | 6 dynamic torque |
| actual_jts | float64[6] | | 6 joint torque sensor data |
| actual_ejt | float64[6] | | 6 current joint axis external force |
| actual_ett | float64[6] | | 6 current Task-based external forces |
| actual_w2b | float64[6] | | Position deviation between 6 World and Base coordinate systems<br>**This argument is only available in M2.50 and higher versions.** |
| current_posw | std_msgs/Float64MultiArray[] | | 6 current task position based on world coordinate system<br>**This argument is only available in M2.50 and higher versions.** |
| current_velw | float64[6] | | 6 current task velocity based on world coordinate system<br>**This argument is only available in M2.50 and higher versions.** |
| world_ett | float64[6] | | 6 external force based on world coordinate system<br>**This argument is only available in M2.50 and higher versions.** |
| target_posw | float64[6] | | 6 target task position based on world coordinate system<br>**This argument is only available in M2.50 and higher versions.** |
| target_velw | float64[6] | | 6 target task velocity based on world coordinate system<br>**This argument is only available in M2.50 and higher versions.** |

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| rotation_matrix_world | std_msgs/Float64MultiArray[] | | Rotation matrix based on world coordinate system: float[3][3]<br>**This argument is only available in M2.50 and higher versions.** |
| actual_UCN | int8 | | User coordinate ID information(101 ~ 200)<br>**This argument is only available in M2.50 and higher versions.** |
| parent | int8 | | Parent coordinate of current user coordinate system<br>**This argument is only available in M2.50 and higher versions.** |
| current_posu | float64[6] | | 6 current task position based on user coordinate system<br>**This argument is only available in M2.50 and higher versions.** |
| current_velu | float64[6] | | 6 current task velocity based on user coordinate system<br>**This argument is only available in M2.50 and higher versions.** |
| user_ett | float64[6] | | 6 external force based on user coordinate system<br>**This argument is only available in M2.50 and higher versions.** |
| target_posu | float64[6] | | 6 target task position based on user coordinate system<br>**This argument is only available in M2.50 and higher versions.** |
| target_velu | float64[6] | | 6 target task velocity based on user coordinate system<br>**This argument is only available in M2.50 and higher versions.** |
| rotation_matrix_user | std_msgs/Float64MultiArray[] | | Rotation matrix based on user coordinate system: float[3][3]<br>**This argument is only available in M2.50 and higher versions.** |

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| sync_time | int8 | | Internal clock count |
| flange_digital_output | int8[6] | | 6 flange digital output |
| flange_digital_input | int8[6] | | 6 Flange Digital Input |
| actual_bk | int8[6] | | 6 break state |
| actual_bt | int8[5] | | 5 robot button information |
| actual_mc | float64[6] | | Current consumption of 6 motors |
| actual_mt | float64[6] | | 6 inverter temperature information |
| ctrlbox_digital_input | int8[6] | | 16 control boxes digital intput information |
| actual_ai | int8[2] | | 2 Analog Input numeric information |
| actual_sw | int8[3] | | 3 switch state |
| actual_si | int8[2] | | 2 safety input state |
| actual_at | int8[2] | | 2 analog input type information<br>**This argument is only available in M2.50 and higher versions.** |
| ctrlbox_digital_output | int8[16] | | 16 control box digital output information |
| target_ao | float64[2] | | 2 Analog Output numeric information |
| target_at | int8[2] | | 2 analog output type information<br>**This argument is only available in M2.50 and higher versions.** |
| actual_es | int8[2] | | 2 Encorder state information<br>**This argument is only available in M2.50 and higher versions.** |
| actual_ed | int8[2] | | 2 Encorder Raw data numerical information |
| actual_er | int8[2] | | 2 Encorder Reset status information<br>**This argument is only available in M2.50 and higher versions.** |
| modbus_state | ModbusState[] | | Modbus State : ModbusState.msg 참조 |

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| access_control | int32 | | Control state: enum.ACCESS_CONTROL 참조 |

**enum.ROBOT_STATE**

| Num | name | Description |
|---|---|---|
| 0 | STATE_INITIALIZING | It is an initialization state for setting various parameters by automatically entering by TP application. |
| 1 | STATE_STANDBY | Operable Standby state. |
| 2 | STATE_MOVING | It is a command operation state that is automatically switched when the command is received after receiving the command in the command wait state. When the operation is completed, it is switched to the auto command waiting state. |
| 3 | STATE_SAFE_OFF | Robot stop mode due to function and operation error, Servo off state (motor and brake power are cut off after control stop) |
| 4 | STATE_TEACHING | Direct teaching state |
| 5 | STATE_SAFE_STOP | Robot stop mode due to function and operation error. Safe stop status (status in which only the control is stopped, program suspended status in the automatic mode) |
| 6 | STATE_EMERGENCY_STOP: | Emergency stop state |
| 7 | STATE_HOMMING | Homing mode state (state in which robot is aligned in hardware). |
| 8 | STATE_RECOVERY | When the robot is stopped due to an error such as exceeding the robot driving range, it is in the recovery mode state to move within the driving range. |
| 9 | eSTATE_SAFE_STOP2 | Same as eSTATE_SAFE_STOP but a state that must be switched to recovery mode because the robot is out of range |

| Num | name | Description |
|---|---|---|
| 10 | STATE_SAFE_OFF2 | Same as eSTATE_SAFE_OFF state, but must be in recovery mode due to exceeding the robot drive range |
| 11 | STATE_RESERVED1 | reserved |
| 12 | STATE_RESERVED2 | reserved |

**enum.CONTROL_MODE**

| Num | name | Description |
|---|---|---|
| 0 | CONTROL_MODE_POSITION | Position control mode |
| 1 | CONTROL_MODE_TORQUE | Torque control mode |

**enum.ROBOT_STATE**

| Num | name | Description |
|---|---|---|
| 0 | ROBOT_SPACE_JOINT | Joint space |
| 1 | ROBOT_SPACE_TASK | Task Space |

**enum.ACCESS_CONTROL**

| Num | name | Description |
|---|---|---|
| 0 | MANAGE_ACCESS_CONTROL_FORCE_REQUEEST | Control forced release message transmission |
| 1 | MANAGE_ACCESS_CONTROL_REQUEST, | Send control request message |
| 2 | MANAGE_ACCESS_CONTROL_RESPONSE_YES | Send control authorization request acknowledge message |
| 3 | MANAGE_ACCESS_CONTROL_RESPONSE_NO | Send control permission request decline message |

### 7.1.2 RobotStop.msg

- **Features**

Topic message of robot stop.

- **Parameters**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| stop_mode | int32 | | robot stop mode :<br>Refer to enum.STOP _MODE. |

**enum.STOP_MODE**

| Num | name | Description |
|---|---|---|
| 0 | STOP_TYPE_QUICK_STO, | reserved |
| 1 | STOP_TYPE_QUICK | quick stop (motion trajectory maintenance) |
| 2 | STOP_TYPE_SLOW | slow stop (motion trajectory maintenance) |
| 3 | STOP_TYPE_HOLD | Emergency stop |
| | STOP_TYPE_EMERGENCY | Emergency stop |

### 7.1.3 RobotError.msg

- **Features**

Topic message of robot error.

- **Parameters**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| Level | int32 | - | Log level : enum.LOG _LEVEL |
| Group | int32 | - | Log group : enum.LOG _GROUP |
| Code | int32 | - | error code |
| msg1 | string | - | error msg 1 |
| msg2 | string | - | error msg 2 |
| msg3 | string | - | error msg 3 |

**enum.LOG_LEVEL**

| Num | name | Description |
|---|---|---|
| 0 | LOG_LEVEL_RESERVED | reserved |
| 1 | LOG_LEVEL_SYSINFO | Informational messages about simple functions and operational errors |
| 2 | LOG_LEVEL_SYSWARN | Robot is stopped due to simple function and operation error. |
| 3 | LOG_LEVEL_SYSERROR | Robot is stopped due to safety issue or device error. |

**enum.LOG_GROUP**

| Num | name | Description |
|---|---|---|
| 0 | LOG_GROUP_RESERVED | reserved |
| 1 | LOG_GROUP_SYSTEMFMK | Robot Controller (framework) |
| 2 | eLOG_GROUP_MOTIONLIB, | Robot Controller (motion) |

| Num | name | Description |
|---|---|---|
| 3 | LOG_GROUP_SMARTTP | TP application (GUI) |
| 4 | LOG_GROUP_INVERTER | Inverter board |
| 5 | LOG_GROUP_SAFETYCONTROLLER | Safety board (Safety Controller) |

### 7.1.4 LogAlarm.msg

- **Features**

Topic message of log alarm

- **Parameters**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| level | int32 | - | Log level : enum.LOG _LEVEL |
| group | int32 | - | Log group : enum.LOG _GROUP |
| index | int32 | - | error code |
| param | string | - | messages[3] |

**enum.LOG_LEVEL**

| Num | name | Description |
|---|---|---|
| 0 | LOG_LEVEL_RESERVED | reserved |
| 1 | LOG_LEVEL_SYSINFO | Informational messages about simple functions and operational errors |
| 2 | LOG_LEVEL_SYSWARN | Robot is stopped due to simple function and operation error. |
| 3 | LOG_LEVEL_SYSERROR | Robot is stopped due to safety issue or device error. |

**enum.LOG_GROUP**

| Num | name | Description |
|---|---|---|
| 0 | LOG_GROUP_RESERVED | reserved |
| 1 | LOG_GROUP_SYSTEMFMK | Robot Controller (framework) |
| 2 | eLOG_GROUP_MOTIONLIB, | Robot Controller (motion) |
| 3 | LOG_GROUP_SMARTTP | TP application (GUI) |
| 4 | LOG_GROUP_INVERTER | Inverter board |

| Num | name | Description |
|---|---|---|
| 5 | LOG_GROUP_SAFETYCONTROLLER | Safety board (Safety Controller) |

### 7.1.5 ModbusState.msg

- **Features**

Topic message of Modbus State

- **Parameters**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| level | string | - | Modbus Signal Name. |
| group | int32 | - | Modbus Register Value<br>(Unsigned : 0 ~ 65535) |

### 7.1.6 JogMultiAxis.msg

**Features**

Topic message for multi-axis jog control

Multi-axis jog speed = (250mm/s)/√3 x [Unit vector] x speed[%]

**Caution**

**This message is available with robot controller software version 2.50 or later.**

- **Parameters**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| jog_axis | float64[6] | - | Unit vector orientation of task space [Tx, Ty, Tz, Rx, Ry, Rz] (-1.0 ~ 1.0) |
| move_reference | int8 | - | 0: MOVE_REFERENCE_BASE<br>1: MOVE_REFERENCE_TOOL:<br>2: MOVE_REFERENCE_WORLD |
| speed | float64 | | jog speed [%] (1~100) |

## 7.2 Service/motion

### 7.2.1 Trans.srv

- **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 | float64[6] | - | position list |
| delta | float64[6] | - | position list |
| ref | int8 | None | • MOVE_REFERENCE_BASE =0<br>• MOVE_REFERENCE_TOOL=1<br>• MOVE_REFERENCE_WORLD=2<br>• MOVE_REFERENCE_USER=101~120 |
| ref_out | int8 | DR_BASE | • MOVE_REFERENCE_BASE =0<br>• MOVE_REFERENCE_WORLD=2<br>• MOVE_REFERENCE_USER=101~120 |

**Note**

- The ref argument DR_WORLD is only available in M2.40 or later versions.
- The ref_out argument is only available in M2.40 or later versions.

- **Return**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| trans_pos | float64[6] | - | Task space point |
| success | bool | - | True or False |

### 7.2.2 Fkin.srv

#### ▪ Features

This service 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 | float64[6] | - | Joint Space position list |
| ref | int8 | 0 | · MOVE_REFERENCE_BASE =0<br>· MOVE_REFERENCE_WORLD=2 |

**Note**

- The ref argument is only available in M2.40 or later versions.

#### ▪ Return

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| conv_posx | float64[6] | - | Task space point |
| success | bool | - | True or False |

### 7.2.3 Ikin.srv

- **Features**

This service 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 | float64[6] | - | position list |
| sol_space | int | - | solution space |
| ref | int | 0 | • MOVE_REFERENCE_BASE =0<br>• MOVE_REFERENCE_WORLD=2 |

**Note**

- The ref argument is only available in M2.40 or later versions.

- **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 |

- **Return**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| conv_posj | float64[6] | - | joint angle list |
| success | bool | - | True or False |

### 7.2.4 SetRefCoord.srv

- **Features**

This service sets the reference coordinate system.

- **Parameters**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| coord | int | - | · MOVE_REFERENCE_BASE =0<br>· MOVE_REFERENCE_TOOL=1<br>· MOVE_REFERENCE_WORLD=2<br>· MOVE_REFERENCE_USER=101~120 |

**Note**

- The MOVE_REFERENCE_WORLDargument of ref is only available in M2.40 or later versions.

- **Return**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| success | bool | - | True or False |

### 7.2.5 MoveJoint.srv

- **Features**

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

- **Parameters**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| pos | float64[6] | - | joint angle list |
| vel | float64 | - | velocity |
| acc | float64 | - | acceleration |
| time | float64 | 0.0 | Reach time [sec] |
| radius | float64 | 0.0 | Radius for blending |
| mode | int8 | 0 | Movement basis<br>• MOVE_MODE_ABSOLUTE =0<br>• MOVE_MODE_RELATIVE =1 |
| blendType | int8 | 0 | Reactive motion mode<br>• BLENDING_SPEED_TYPE_DUPLICATE =0<br>• BLENDING_SPEED_TYPE_OVERRIDE =1 |
| syncType | int8 | 0 | • SYNC = 0<br>• ASYNC = 1 |

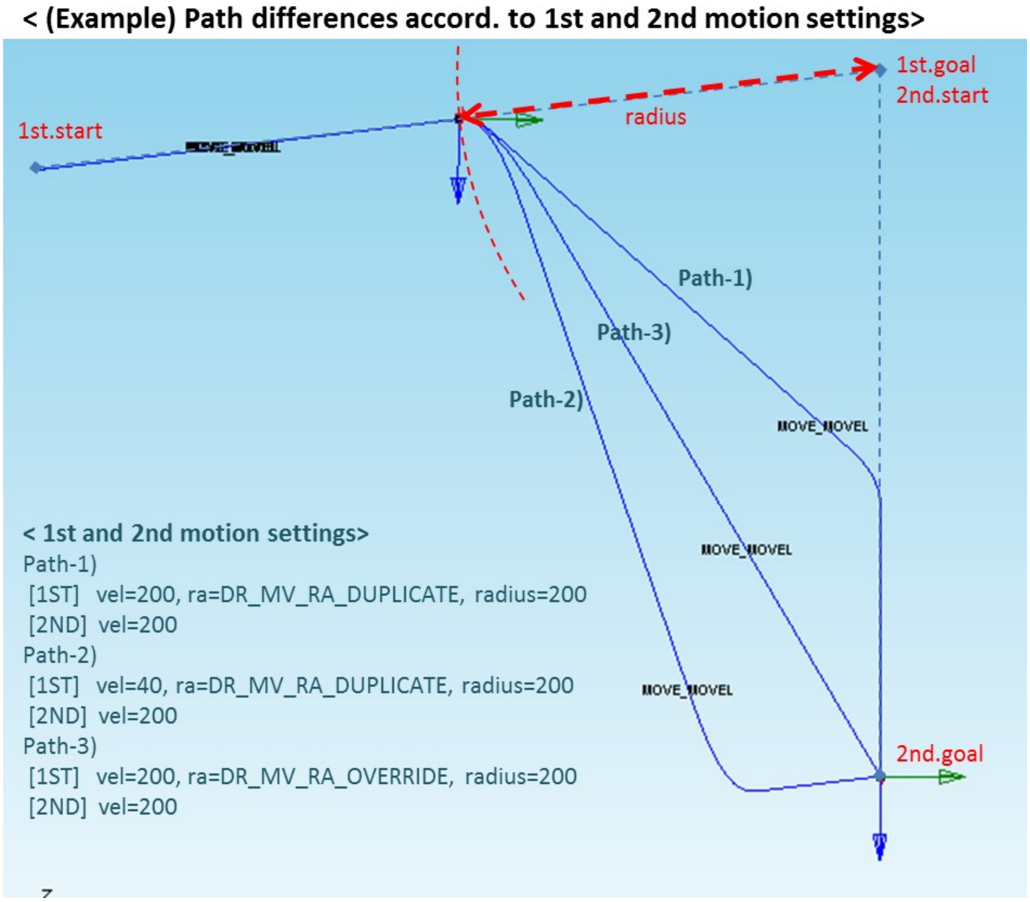
**Note**

- If the time is specified, values are processed based on time, ignoring vel and acc.

**Caution**

If the following motion is blended with the conditions of blendType

=BLENDING_SPEED_TYPE_BUPLICATE 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.




## Return

| Return Name | Data Type | Default Value | Description |
|---|---|---|---|
| success | bool | - | True or False |

### 7.2.6 MoveLine.srv

- **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 | float64[6] | - | position list |
| vel | float64[2] | - | linear velocity, angular velocity |
| acc | float64[2] | - | linear acceleration, angular acceleration |
| time | float64 | 0.0 | Reach time [sec]<br>* If the time is specified, values are processed based on time, ignoring vel and acc. |
| radius | float64 | 0.0 | Radius for blending |
| ref | int8 | 0 | reference coordinate<br>• MOVE_REFERENCE_BASE =0<br>• MOVE_REFERENCE_TOOL=1<br>• MOVE_REFERENCE_WORLD=2 |
| mode | int8 | 0 | Movement basis<br>• MOVE_MODE_ABSOLUTE =0<br>• MOVE_MODE_RELATIVE =1 |
| blendType | int8 | 0 | Reactive motion mode<br>• BLENDING_SPEED_TYPE_DUPLICATE =0<br>• BLENDING_SPEED_TYPE_OVERRIDE =1 |
| syncType | int8 | 0 | • SYNC = 0<br>• ASYNC = 1 |

**Note**

- 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.

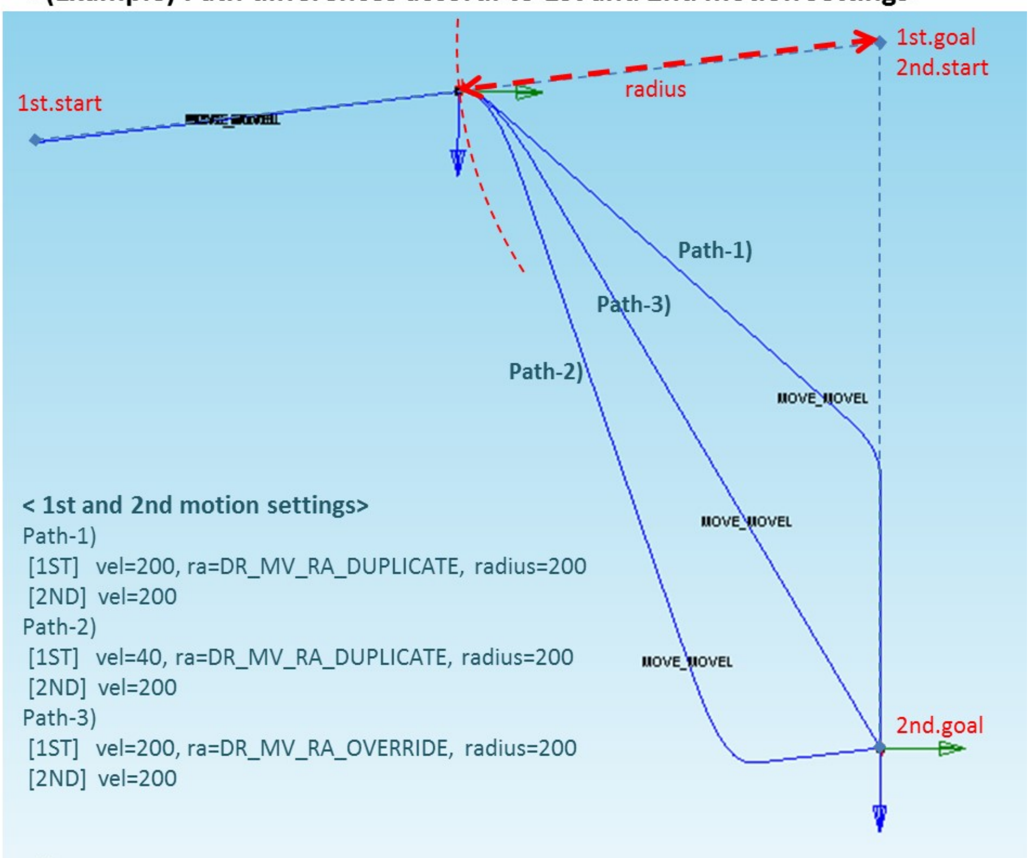
- If an argument is inputted to acc (e.g., acc=60), the input argument corresponds to the linear acceleration of the motion while the angular acceleration is determined proportionally to the linear acceleration.
- If the time is specified, values are processed based on time, ignoring vel and acc
- The MOVE_REFERENCE_WORLD argument of ref is only available in M2.40 or later versions.

### ⚠ Caution

If the following motion is blended with the conditions of blendType =

BLENDING_SPEED_TYPE_DUPLICATEE 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**

| Return Name | Data Type | Default Value | Description |
|---|---|---|---|
| success | bool | - | True or False |

### 7.2.7 MoveJointx.srv

- **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 | float64[6] | - | position list |
| vel | float64 | - | velocity |
| acc | float64 | - | acceleration |
| time | float64 | 0.0 | Reach time [sec] |
| radius | float64 | 0.0 | Radius for blending |
| ref | int8 | 0 | reference coordinate<br>• MOVE_REFERENCE_BASE =0<br>• MOVE_REFERENCE_TOOL=1<br>• MOVE_REFERENCE_WORLD=2 |
| mode | int8 | 0 | Movement basis<br>• MOVE_MODE_ABSOLUTE =0<br>• MOVE_MODE_RELATIVE =1 |
| blendType | int8 | 0 | Reactive motion mode<br>• BLENDING_SPEED_TYPE_DUPLICATE =0<br>• BLENDING_SPEED_TYPE_OVERRIDE =1 |
| sol | int8 | 0 | Solution space |
| syncType | int8 | 0 | • SYNC = 0<br>• ASYNC = 1 |

**Note**

- If the time is specified, values are processed based on time, ignoring vel and acc.
- Using the blending in the preceding motion generates an error in the case of input with relative motion (eMoveMode = MOVE_MODE_ RELATIVE), and it is recommended to blend using MoveJoint or MoveLine
- The MOVE_REFERENCE_WORLD argument of ref is only available in M2.40 or later versions.
- Refer to the description of MoveJoint.srv and MoveLine.srv 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

| Return Name | Data Type | Default Value | Description |
|---|---|---|---|
| success | bool | - | True or False |

## 7.2.8 MoveCircle.srv

### ▪ 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 | std_msgs/Float64MultiArray[] | - | target[2][6]<br>• position list |
| vel | float64[2] | - | linear velocity, angular velocity |
| acc | float64[2] | - | linear acceleration, angular acceleration |
| time | float64 | 0.0 | Reach time [sec] |
| radius | float64 | 0.0 | Radius for blending |
| ref | int8 | 0 | reference coordinate<br>• MOVE_REFERENCE_BASE =0<br>• MOVE_REFERENCE_TOOL=1<br>• MOVE_REFERENCE_WORLD=2 |
| mode | int8 | 0 | Movement basis<br>• MOVE_MODE_ABSOLUTE =0<br>• MOVE_MODE_RELATIVE =1 |
| angle1 | float64 | 0.0 | angle1 |
| angle2 | float64 | 0.0 | angle2 |
| blendType | int8 | 0 | Reactive motion mode<br>• BLENDING_SPEED_TYPE_DUPLICATE =0<br>• BLENDING_SPEED_TYPE_OVERRIDE =1 |
| syncType | int8 | 0 | • SYNC = 0<br>• ASYNC = 1 |

**Note**

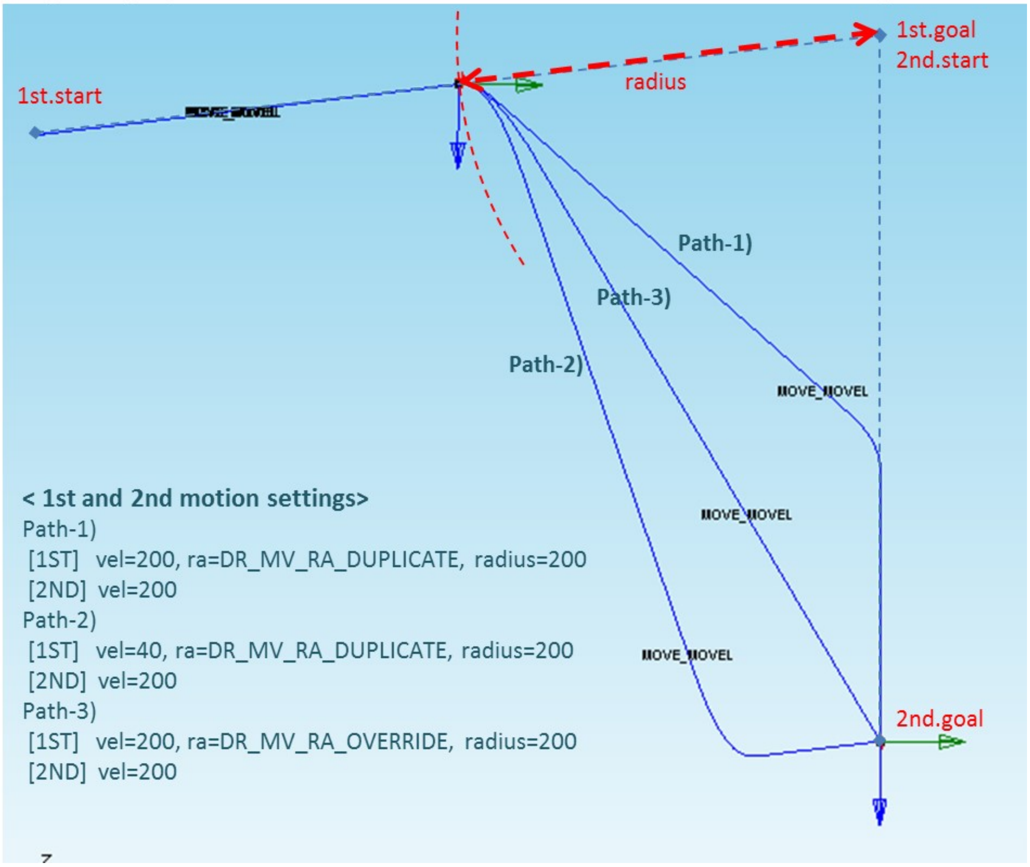
- If an argument is inputted to vel (e.g., vel=[30, 0]), the input argument corresponds to the linear velocity of the motion while the angular velocity is determined proportionally to the linear velocity.
- If an argument is inputted to acc (e.g., acc=[60, 0]), the input argument corresponds to the linear 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.
- The MOVE_REFERENCE_WORLD argument of ref is only available in M2.40 or later versions.
- If the mod is MOVE_MODE_RELATIVE L, pos[0] and pos[1] are defined in the relative coordinate system of the previous pos. (pos[0] is the relative coordinate from the starting point while pos[1] is the relative coordinate from pos[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.

### ⚠ Caution

If the following motion is blended with the conditions of blendType=

BLENDING_SPEED_TYPE_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

| Return Name | Data Type | Default Value | Description |
|---|---|---|---|
| success | bool | - | True or False |

### 7.2.9 MoveSplineJoint.srv

- **Features**

The robot moves along a spline curve path that connects the current position to the target position (the last waypoint in position list) via the waypoints of the joint space input in position 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 | std_msgs/Float64MultiArray[] | - | target pos [100][6]<br>max = 100 |
| posCnt | int8 | - | Count of target pos |
| vel | float64 | - | velocity |
| acc | float64 | - | acceleration |
| time | float64 | 0.0 | Reach time [sec] |
| mode | int8 | 0 | Movement basis<br>• MOVE_MODE_ABSOLUTE =0<br>• MOVE_MODE_RELATIVE =1 |
| syncType | int8 | 0 | • SYNC = 0<br>• ASYNC = 1 |

**Note**

- If the time is specified, values are processed based on time, ignoring vel and acc.
- If the mod is MOVE_MODE_RELATIVE, 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 service does not support online blending of previous and subsequent motions.

- **Return**

| Return Name | Data Type | Default Value | Description |
|---|---|---|---|
| success | bool | - | True or False |

### 7.2.10 MoveSplineTask.srv

- **Features**

The robot moves along a spline curve path that connects the current position to the target position (the last waypoint in position 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 | std_msgs/Float64MultiArray[] | - | target pos [100][6]<br>max = 100 |
| posCnt | int8 | - | Count of target pos |
| vel | float64[2] | - | linear velocity, angular velocity |
| acc | float64[2] | - | linear acceleration, angular acceleration |
| time | float64 | 0.0 | Reach time [sec] |
| ref | int8 | 0 | reference coordinate<br>• MOVE_REFERENCE_BASE =0<br>• MOVE_REFERENCE_TOOL=1<br>• MOVE_REFERENCE_WORLD=2 |
| mode | int8 | 0 | Movement basis<br>• MOVE_MODE_ABSOLUTE =0<br>• MOVE_MODE_RELATIVE =1 |
| opt | int8 | 0 | Velocity option<br>• SPLINE_VELOCITY_OPTION_DEFAULT=0<br>• SPLINE_VELOCITY_OPTION_CONST=1 |
| syncType | int8 | 0 | • SYNC = 0<br>• ASYNC = 1 |

### Note

- If an argument is inputted to vel (e.g., vel=[30, 0]), 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, 0]), 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.
- The MOVE_REFERENCE_WORLD argument of ref is only available in M2.40 or later versions.
- If the mod is MOVE_MODE_RELATIVE, each pos in the pos_list is defined in the relative coordinate of the previous pos. (If positiolist=[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 service 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 "opt= SPLINE_VELOCITY_OPTION_CONST" option (constant velocity option) is selected, and the motion is automatically switched to the variable velocity motion (opt= SPLINE_VELOCITY_OPTION_DEFAULT) in that case.

## ▪ Return

| Return Name | Data Type | Default Value | Description |
|---|---|---|---|
| success | bool | - | True or False |

### 7.2.11 MoveBlending.srv

- **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 | std_msgs/Float64MultiArray[] | - | posb list<br>(pos1[6]:pos2[6]:type[1]:radius[1]) x 50(max) |
| posCnt | int8 | | Count of target pos |
| vel | float64[2] | - | linear velocity, angular velocity |
| acc | float64[2] | - | linear acceleration, angular acceleration |
| time | float64 | 0.0 | Reach time [sec] |
| ref | int8 | 0 | Reference coordinate<br>• MOVE_REFERENCE_BASE =0<br>• MOVE_REFERENCE_TOOL=1<br>• MOVE_REFERENCE_WORLD=2 |
| mode | int8 | 0 | Movement basis<br>• MOVE_MODE_ABSOLUTE =0<br>• MOVE_MODE_RELATIVE =1 |
| syncType | int8 | 0 | • SYNC = 0<br>• ASYNC = 1 |

**Note**

- If an argument is inputted to vel (e.g., vel=[30, 0]), 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, 0]), 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.
- The MOVE_REFERENCE_WORLD argument of ref is only available in M2.40 or later versions.

- If the mod is MOVE_MODE_RELATIVE, each pos in the posb_list is defined in the relative coordinate of the previous pos.

**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 service does not support online blending of previous and subsequent motions

## Return

| Return Name | Data Type | Default Value | Description |
|---|---|---|---|
| success | bool | - | True or False |

## 7.2.12 MoveSpiral.srv

### ▪ Features

The radius increases in a radial direction and the robot moves in parallel with the rotating spiral motion in an axial direction. It moves the robot along the spiral trajectory on the surface that is perpendicular to the axis on the coordinate specified as ref and the linear trajectory in the axis direction.

### ▪ Parameters

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| revolution | float64 | - | Total number of revolutions [revolution] |
| maxRadius | float64 | | Final spiral radius [mm] |
| maxLength | float64 | | Distance moved in the axis direction [mm] |
| vel | float64[2] | - | linear velocity, angular velocity |
| acc | float64[2] | - | linear acceleration, angular acceleration |
| time | float64 | 0.0 | Total execution time [sec] |
| taskAxis | int8 | 0 | axis<br>• TASK_AXIS_X = 0<br>• TASK_AXIS_Y = 1<br>• TASK_AXIS_Z = 2 |
| ref | int8 | 0 | reference coordinate<br>• MOVE_REFERENCE_BASE =0<br>• MOVE_REFERENCE_TOOL=1<br>• MOVE_REFERENCE_WORLD=2 |
| syncType | int8 | 0 | • SYNC = 0<br>• ASYNC = 1 |

**Note**

- Revolution refers to the maximum radius 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

- If the time is specified, values are processed based on time, ignoring vel and acc.
- The MOVE_REFERENCE_WORLD argument of ref is only available in M2.40 or later versions.
- 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 service 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

| Return Name | Data Type | Default Value | Description |
|---|---|---|---|
| success | bool | - | True or False |

### 7.2.13 MovePeriodic.srv

- **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 | Description |
| --- | --- | --- | --- |
| amp | float64[6] | - | Amplitude (motion between -amp and +amp) [mm] or [deg] |
| periodic | float64[6] | - | Period (time for 1 cycle) [sec] |
| acc | float64 | - | Acceleration |
| time | float64 | - | Acc-, dec- time [sec] |
| repeat | int8 | - | Repetition count |
| ref | int8 | 0 | reference coordinate<br>• MOVE_REFERENCE_BASE =0<br>• MOVE_REFERENCE_TOOL=1<br>• MOVE_REFERENCE_WORLD=2 |
| syncType | int8 | 0 | • SYNC = 0<br>• ASYNC = 1 |

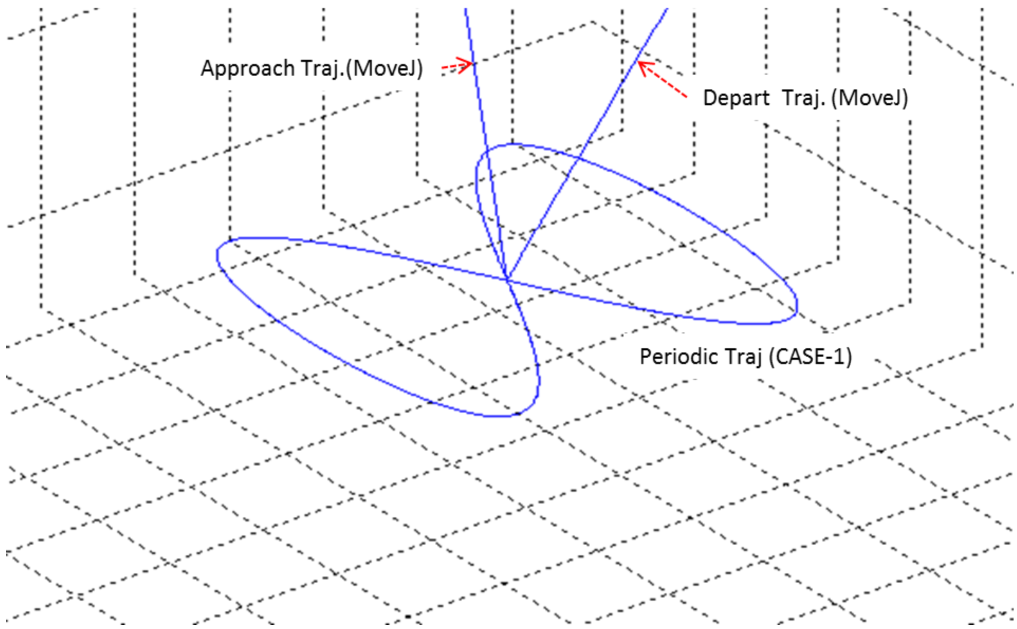
**Note**

- 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

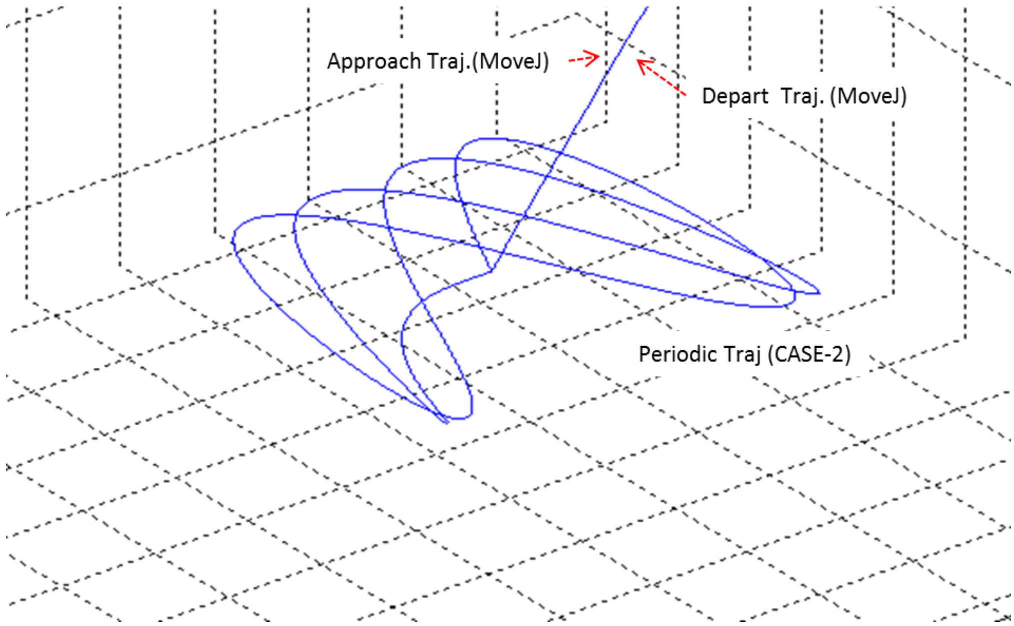
**CASE-1) All-axis motions end at the same time**

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.
- The MOVE_REFERENCE_WORLD argument of ref is only available in M2.40 or later versions.
- 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

| Return Name | Data Type | Default Value | Description |
|---|---|---|---|
| success | bool | - | True or False |

### 7.2.14 MoveWait.srv

- **Features**

This service sets the waiting time between the previous motion command and the motion command in the next line.

- **Parameters**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| N/A | - | - | - |

- **Return**

| Return Name | Data Type | Default Value | Description |
|---|---|---|---|
| success | bool | - | True or False |

## 7.2.15 MovePause.srv

- **Features**

It is a service to decelerate and pause the motion of the current robot.

If no robot motion is in progress, it is ignored.

- **Parameters**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| N/A | - | - | - |

- **Return**

| Return Name | Data Type | Default Value | Description |
|---|---|---|---|
| success | bool | - | True or False |

### 7.2.16 MoveResume.srv

- **Features**

Service to resume the motion of a suspended robot.

If no robot path motion is in progress, it is ignored.

- **Parameters**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| N/A | - | - | - |

- **Return**

| Return Name | Data Type | Default Value | Description |
|---|---|---|---|
| success | bool | - | True or False |

### 7.2.17 MoveStop.srv

- **Features**

Service to stop robot motion.

It stops differently depending on the input parameters.

- **Parameters**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| Stop_mode | int32 | - | 0 : reserved<br>1 : quick stop (keep motion trajectory)<br>2 : slow stop (keep motion trajectory) |

- **Return**

| Return Name | Data Type | Default Value | Description |
|---|---|---|---|
| success | bool | - | True or False |

### 7.2.18 Jog.srv

- **Features**

This service is for performing jog motion control for each axis of the robot.

- **Parameters**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| Jog_axis | int8 | - | 0 ~ 5 : JOINT 1 ~ 6<br>6 ~ 11: TASK 1 ~ 6 (X,Y,Z,rx,ry,rz) |
| move_reference | int8 | - | 0 : MOVE_REFERENCE_BASE<br>1 : MOVE_REFERENCE_TOOL |
| speed | float64 | - | jog speed [%] : + forward , 0=stop, - backward |

- **Return**

| Return Name | Data Type | Default Value | Description |
|---|---|---|---|
| success | bool | - | True or False |

### 7.2.19 JogMulti.srv

- **Features**

This is a service to perform jog control on multiple axes of robots in the robot controller.

Multi-axis jog speed = (250mm / s) / √3 x [unit vector] x speed [%]

⚠ **Caution**

**This service is available with robot controller software version 2.50 or later.**

- **Parameters**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| jog_axis | float64[6] | - | Unit vector direction of task space [Tx, Ty, Tz, Rx, Ry, Rz] (-1.0 ~ 1.0) |
| move_reference | int8 | - | 0: MOVE_REFERENCE_BASE<br>1: MOVE_REFERENCE_TOOL:<br>2: MOVE_REFERENCE_WORLD |
| speed | float64 | | jog speed [%] (1~100) |

- **Return**

| Return Name | Data Type | Default Value | Description |
|---|---|---|---|
| success | bool | - | True or False |

### 7.2.20 CheckMotion.srv

- **Features**

This service checks the status of the currently active motion..

- **Parameters**

Not applicable

- **Return**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| status | int8 | - | 0 : No motion in action<br>1 : nituib being calculated<br>2 : motion is operation |
| success | bool | - | True or False |

### 7.2.21 ChangeOperationSpeed.srv

- **Features**

This service 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 | int8 | - | operation speed(1~100) |

- **Return**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| success | bool | - | True or False |

### 7.2.22 EnableAlterMotion.srv

- **Features**

**This service is only available for M2.40 or later versions.**

enable_alter_motion() and alter_motion() services 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 | int32 | - | Cycle time number |
| mode | Int8 | - | • PATH_MODE_DPOS = 0<br>• PATH_MODE_DVEL = 1 |
| ref | int8 | - | • MOVE_REFERENCE_BASE =0<br>• MOVE_REFERENCE_TOOL=1<br>• MOVE_REFERENCE_WORLD=2<br>• MOVE_REFERENCE_USER=101~120 |
| limit_dPOS | float64[2] | - | First value : limitation of position[mm]<br>Second value : limitation of orientation[deg] |
| limit_dPOS_per | float64[2] | - | First value : limitation of position[mm]<br>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.

- **Return**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| success | bool | - | True or False |

### 7.2.23 AlterMotion.srv

#### ▪ Features

**This service is only available for M2.40 or later versions.**

This service 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 | float64[6] | - | position list |

#### ▪ Return

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| success | bool | - | True or False |

### 7.2.24 DisableAlterMotion.srv

- **Features**

**This service is only available for M2.40 or later versions.**

This service deactivates alter motion.

- **Parameters**

Not appicable

- **Return**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| success | bool | - | True or False |

# 7.3 Service/system

## 7.3.1 GetRobotMode.srv

- **Features**

It is a service input for checking the current operation mode of the robot controller. The auto mode is a mode for automatically performing a series of operations (programs), and the manual mode is for performing a single operation such as jogging.

- **Parameters**

None

- **Return**

| Return Name | Data Type | Default Value | Description |
|---|---|---|---|
| Robot_mode | int8 | - | refer to enum.ROBOT_MODE. |
| success | bool | - | True or False |

- **enum.ROBOT_MODE**

| Num | name | Description |
|---|---|---|
| 0 | ROBOT_MODE_MANUAL | Manual mode |
| 1 | ROBOT_MODE_AUTONOMOUS | Auto mode |
| 2 | ROBOT_MODE_MEASURE | Measure mode (Not currently supported) |

### 7.3.2 SetRobotMode.srv

- **Features**

This service is for setting the current operation mode of the robot controller.

- **Parameters**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| robot_mode | int8 | - | refer to enum.ROBOT_MODE |

- **Return**

| Return Name | Data Type | Default Value | Description |
|---|---|---|---|
| success | bool | - | True or False |

- **enum.ROBOT_MODE**

| Num | name | Description |
|---|---|---|
| 0 | ROBOT_MODE_MANUAL | Manual mode |
| 1 | ROBOT_MODE_AUTONOMOUS | Auto mode |
| 2 | ROBOT_MODE_MEASURE | Measure mode (Not currently supported) |

### 7.3.3 GetRobotSystem.srv

- **Features**

It is a service input for confirming the current operation mode (virtual robot, actual robot) of the robot controller.

- **Parameters**

None

- **Return**

| Return Name | Data Type | Default Value | Description |
|---|---|---|---|
| robot_system | int8 | - | refer to enum.ROBOT_SYSTEM |
| success | bool | - | True or False |

- **enum.ROBOT_SYSTEM**

| Num | name | Description |
|---|---|---|
| 0 | ROBOT_SYSTEM_REAL | Actual robot system |
| 1 | ROBOT_SYSTEM_VIRTUAL | virtual robot system |

### 7.3.4 SetRobotSystem.srv

- **Features**

This is a service for setting up the current robot system of the robot controller.

- **Parameters**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| robot_system | int8 | - | refer to enum.ROBOT_SYSTEM |

- **Return**

| Return Name | Data Type | Default Value | Description |
|---|---|---|---|
| success | bool | - | True or False |

- **enum.ROBOT_SYSTEM**

| Num | name | Description |
|---|---|---|
| 0 | ROBOT_SYSTEM_REAL | Actual robot system |
| 1 | ROBOT_SYSTEM_VIRTUAL | virtual robot system |

### 7.3.5 GetRobotSpeedMode.srv

- **Features**

This service is used to check the current speed mode (normal mode, deceleration mode) from the robot controller.

- **Parameters**

None

- **Return**

| Return Name | Data Type | Default Value | Description |
|---|---|---|---|
| Speed_mode | int8 | - | refer to enum.SPEED_MODE |
| success | bool | - | True or False |

- **enum.SPEED_MODE**

| Num | name | Description |
|---|---|---|
| 0 | SPEED_NORMAL_MODE | Normal speed mode |
| 1 | SPEED_REDUCED_MODE | deceleration speed mode |

### 7.3.6 SetRobotSpeedMode.srv

- **Features**

This service is used to set and change the currently operating speed mode of the robot controller.

- **Parameters**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| speed_mode | int8 | - | refer to enum.SPEED_MODE |

- **Return**

| Return Name | Data Type | Default Value | Description |
|---|---|---|---|
| success | bool | - | True or False |

- **enum.SPEED_MODE**

| Num | name | Description |
|---|---|---|
| 0 | SPEED_NORMAL_MODE | Normal speed mode |
| 1 | SPEED_REDUCED_MODE | deceleration speed mode |

### 7.3.7 SetSafeStopResetType.srv

- **Features**

This service is used to define a series of actions to be executed automatically after the state transition using the SetRobotMode service when the operation status information of the robot controller is SAFE_STOP.
If the robot operation mode is automatic, you can define and set whether to re-execute the program. In manual mode, this setting is ignored.

- **Parameters**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| reset_type | int8 | - | refer to enum.SAFE_STOP_RESET_TYPE |

- **Return**

| Return Name | Data Type | Default Value | Description |
|---|---|---|---|
| success | bool | - | True or False |

- **enum.SAFE_STOP_RESET_TYPE**

| Num | name | Description |
|---|---|---|
| 0 | SAFE_STOP_RESET_TYPE_DEFAULT | Simple state release (manual mode) |
| | SAFE_STOP_RESET_TYPE_PROGRAM_STOP | Stop program (autoc mode) |
| 1 | SAFE_STOP_RESET_TYPE_PROGRAM_RESUME | Restart the program (automatic mode) |

### 7.3.8 GetCurrentPose.srv

- **Features**

This service is used to check the current position information of each axis of the robot according to the coordinate system (joint space or task space) in the robot controller.

- **Parameters**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| space_type | int8 | - | refer to enum.ROBOT_SPACE |

- **Return**

| Return Name | Data Type | Default Value | Description |
|---|---|---|---|
| pos | float64[6] | - | Robot position information |
| success | bool | - | True or False |

- **enum.ROBOT_SPACE**

| Num | name | Description |
|---|---|---|
| 0 | ROBOT_SPACE_JOINT | Joint space |
| 1 | ROBOT_SPACE_TASK | task space |

### 7.3.9 GetLastAlarm.srv

- **Features**

This service is used to check the most recent log and alarm codes generated by the robot controller.

- **Parameters**

None

- **Return**

| Return Name | Data Type | Default Value | Description |
|---|---|---|---|
| log_alarm | LogAlarm.msg | - | refet to LogAlam.msg |
| success | bool | - | True or False |

- **LogAlam.msg**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| level | int32 | - | refet to enum.LOG _LEVEL |
| group | int32 | - | refet to enum.LOG _GROUP |
| index | int32 | - | error code |
| param | string[3] | - | param[3] |

**enum.LOG_LEVEL**

| Num | name | Description |
|---|---|---|
| 0 | LOG_LEVEL_RESERVED | reserved |
| 1 | LOG_LEVEL_SYSINFO | Informational messages about basic functions and operational errors |
| 2 | LOG_LEVEL_SYSWARN | Robot is stopped due to basic function and operation error |
| 3 | LOG_LEVEL_SYSERROR | Robot is stopped due to safety issue or device error |

**enum.LOG_GROUP**

| Num | name | Description |
|---|---|---|
| 0 | LOG_GROUP_RESERVED | reserved |
| 1 | LOG_GROUP_SYSTEMFMK | framework |
| 2 | eLOG_GROUP_MOTIONLIB, | Motion algorithm |
| 3 | LOG_GROUP_SMARTTP | TP program (GUI) |
| 4 | LOG_GROUP_INVERTER | Robot Inverter Board |
| 5 | LOG_GROUP_SAFETYCONTROLLER | Safety Controller |

The log and alarm messages are passed through the predefined contents through the number, and the relevant parameters are sent together if necessary.
Please refer to log and alarm definition section for details.

## 7.4 Service/aux_control

### 7.4.1 GetControlMode.srv

- **Features**

This service returns the current control mode.

- **Parameters**

Not applicable

- **Return**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| control_mode | int8 | - | Control mode<br>3 : Position Control Mode<br>4 : Torque Control mode |
| success | bool | - | True or False |

### 7.4.2 GetControlSpace.srv

- **Features**

This service returns the current control space.

- **Parameters**

Not applicable

- **Return**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| space | int8 | - | Control mode<br>1 : Joint space control<br>2 : Task space control |
| success | bool | - | True or False |

### 7.4.3 GetCurrentPosj.srv

- **Feature**

This service returns the current joint angle.

- **Parameters**

Not applicable

- **Return**

| Parameter Name | Data Type | Default value | Description |
|---|---|---|---|
| pos | float64[6] | - | Joint angle |
| success | bool | - | True or False |

### 7.4.4 GetCurrentVelj.srv

- **Features**

This service returns the current joint velocity.

- **Parameters**

Not applicable

- **Return**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| joint_speed | float64[6] | - | Joint Speed |
| success | bool | - | True or False |

### 7.4.5 GetDesiredPosj.srv

- **Features**

This service 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**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| pos | float64[6] | - | Joint angle |
| success | bool | - | True or False |

### 7.4.6 GetDesiredVelj.srv

- **Features**

This service 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**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| joint_vel | float64[6] | - | target joint velocity |
| success | bool | - | True or False |

## 7.4.7 GetCurrentPosx.srv

### ▪ Features

This service 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 | Int8 | 0 | · MOVE_REFERENCE_BASE =0<br>· MOVE_REFERENCE_WORLD=2<br>· MOVE_REFERENCE_USER=101~120 |

**Note**

- ref: MOVE_REFERENCE_BASE (base coordinate)/user coordinate (globally declared user coordinate)
- MOVE_REFERENCE_BASE is applied when ref is omitted.
- **The MOVE_REFERENCE_WORLD argument of ref is only available in M2.40 or later versions.**

### ▪ Return

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| task_pos_info | std_msgs/Float64MultiArray[] | - | posx list : task_pos_info[0][0:5]<br>solution space : task_pos_info[0][6] |
| success | bool | - | True or False |

### 7.4.8 GetCurrentToolFlangePosx.srv

- **Features**

This service 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 | Int8 | 0 | · MOVE_REFERENCE_BASE =0<br>· MOVE_REFERENCE_WORLD=2 |

**Note**

· **The ref argument is only available in M2.40 or later versions.**

- **Return**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| pos | float64[6] | - | Pose of tool flange |
| success | bool | - | True or False |

### 7.4.9 GetCurrentVelx.srv

- **Features**

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

- **Parameters**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| ref | Int8 | 0 | · MOVE_REFERENCE_BASE =0<br>· MOVE_REFERENCE_WORLD=2 |

**Note**

· **The ref argument is only available in M2.40 or later versions.**

- **Return**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| vel | float64[6] | - | tool velocity |
| | | | |

### 7.4.10 GetDesiredPosx.srv

- **Features**

This service 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 | Int8 | 0 | · MOVE_REFERENCE_BASE =0<br>· MOVE_REFERENCE_WORLD=2<br>· MOVE_REFERENCE_USER=101~120 |

**Note**

- ref: MOVE_REFERENCE_BASE (base coordinate)/user coordinate (globally declared user coordinate)
- MOVE_REFERENCE_BASE is applied when ref is omitted.
- **The MOVE_REFERENCE_WORLD argument of ref is only available in M2.40 or later versions.**

- **Return**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| pos | float64[6] | - | target tool position |
| success | bool | - | True or False |

### 7.4.11 GetDesiredVelx.srv

- **Features**

This service 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**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| ref | Int8 | 0 | · MOVE_REFERENCE_BASE =0<br>· MOVE_REFERENCE_WORLD=2 |

**Note**

- ref: MOVE_REFERENCE_BASE (base coordinate)/user coordinate (globally declared user coordinate)
- MOVE_REFERENCE_BASE is applied when ref is omitted.
- **The MOVE_REFERENCE_WORLD argument of ref is only available in M2.40 or later versions.**

- **Return**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| vel | float64[6] | - | tool velocity |
| success | bool | - | True or False |

### 7.4.12 GetCurrentSolutionSpace

- **Features**

It is a service to get the the current solution space value..

- **Parameters**

None

- **Return**

| Return Name | Data Type | Default Value | Description |
|---|---|---|---|
| solution_space | int8 | - | solution space (0~7) |
| success | bool | - | True or False |

- **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 |

### 7.4.13 GetCurrentRotm.srv

- **Features**

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

- **Parameters**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| ref | Int8 | 0 | · MOVE_REFERENCE_BASE =0<br>· MOVE_REFERENCE_WORLD=2 |

**Note**

· **The ref argument is only available in M2.40 or later versions.**

- **Return**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| rot_matrix | std_msgs/Float64MultiArray[] | - | Rotation Matrix |
| success | bool | - | True or False |

### 7.4.14 GetJointTorque.srv

- **Features**

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

- **Parameters**

None

- **Return**

| Return Name | Data Type | Default Value | Description |
|---|---|---|---|
| joint_torque | float64[6] | - | JTS torque value |
| success | bool | - | True or False |

### 7.4.15 GetExternalTorque.srv

- **Features**

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

- **Parameters**

Not applicable

- **Return**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| ext_torque | float64[6] | - | Torque value generated by and external force |
| success | bool | - | True or False |

### 7.4.16 GetToolForce.srv

- **Features**

This service returns the external force applied to the current tool based on the ref coordinate.

- **Parameters**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| ref | Int8 | 0 | · MOVE_REFERENCE_BASE =0<br>· MOVE_REFERENCE_WORLD=2 |

**Note**

- **The MOVE_REFERENCE_WORLD argument of ref is only available in M2.40 or later versions.**

- **Return**

| Return Name | Data Type | Default Value | Description |
|---|---|---|---|
| tool_force | float64[6] | - | External force applied to the tool |
| success | bool | - | True or False |

### 7.4.17 GetSolutionSpace.srv

- **Features**

This service obtains the solution space value.

- **Parameters**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| pos | float64[6] | - | position list |

- **Return**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| sol_space | int8 | - | solution space : 0 ~ 7 |
| success | bool | - | True or False |

### 7.4.18 GetOrientationError.srv

- **Features**

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

- **Parameters**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| xd | float64[6] | - | position list |
| xc | float64[6] | - | Position list |
| axis | int8 | - | axis<br>• TASK_AXIS_X : 0<br>• TASK_AXIS_Y : 1<br>• TASK_AXIS_Z : 2 |

- **Return**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| ori_error | float32 | - | Orientaion error value |
| success | bool | - | True or False |

# 7.5 Service/tcp

## 7.5.1 ConfigCreateTcp.srv

- **Features**

This service calls creating the name of the TCP information.

- **Parameters**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| name | string | - | Name of the TCP |
| pos | float64[6] | - | TCP infomation |

- **Return**

| Return Name | Data Type | Default Value | Description |
|---|---|---|---|
| success | bool | - | True or False |

### 7.5.2 ConfigDeleteTcp.srv

- **Features**

This service calls deleting the registered TCP information.

- **Parameters**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| name | string | - | Name of the TCP |

- **Return**

| Return Name | Data Type | Default Value | Description |
|---|---|---|---|
| success | bool | - | True or False |

### 7.5.3 GetCurrentTcp.srv

- **Features**

It is a service that fetches the currently set TCP information from the robot controller.

- **Parameters**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| None | - | - | - |

- **Return**

| Return Name | Data Type | Default Value | Description |
|---|---|---|---|
| info | string | - | Name of the TCP |
| success | bool | - | True or False |

### 7.5.4 SetCurrentTcp.srv

- **Features**

It is a service to set the information about the currently set the TCP information

- **Parameters**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| name | string | - | Name of the TCP |

- **Return**

| Return Name | Data Type | Default Value | Description |
|---|---|---|---|
| success | bool | - | True or False |

## 7.6 Service/tool

### 7.6.1 ConfigCreateTool.srv

- **Features**

It is a service to register tool information to be mounted on the robot end.

- **Parameters**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| name | string | - | Name of the TCP |
| weight | float | | Weight of tool |
| cog | float64[3] | | center of mass |
| inertia | float64[6] | | inertia information |

- **Return**

| Return Name | Data Type | Default Value | Description |
|---|---|---|---|
| success | bool | - | True or False |

### 7.6.2 ConfigDeleteTool.srv

- **Features**

This service calls deleting the registered TOOL information.

- **Parameters**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| name | string | - | Name of the TCP |

- **Return**

| Return Name | Data Type | Default Value | Description |
|---|---|---|---|
| success | bool | - | True or False |

### 7.6.3 GetCurrentTool.srv

- **Features**

It is a service that fetches the currently set TOOL information from the robot controller.

- **Parameters**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| None | - | - | - |

- **Return**

| Return Name | Data Type | Default Value | Description |
|---|---|---|---|
| info | string | - | Name of the TOOL |
| success | bool | - | True or False |

## 7.6.4 SetCurrentTool.srv

- **Features**

It is a service to set the information about the currently set the TOOL information

- **Parameters**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| name | string | - | Name of the TOOL |

- **Return**

| Return Name | Data Type | Default Value | Description |
|---|---|---|---|
| success | bool | - | True or False |

### 7.6.5 SetToolShape.srv

- **Features**

**This service is only available for M2.40 or later versions.**

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 | - | Name of the TOOL |

- **Return**

| Return Name | Data Type | Default Value | Description |
|---|---|---|---|
| success | bool | - | True or False |

## 7.7 Service/force

### 7.7.1 ParallelAxis1.srv

- **Features**

This service 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 | float64[6] | - | position list |
| x2 | float64[6] | - | position list |
| x3 | float64[6] | - | position list |
| axis | int8 | - | · TASK_AXIS_X = 0<br>· TASK_AXIS_Y = 1<br>· TASK_AXIS_Z = 2 |
| ref | int8 | 0 | · MOVE_REFERENCE_BASE =0<br>· MOVE_REFERENCE_WORLD=2<br>· MOVE_REFERENCE_USER=101~120 |

**Note**

- **The MOVE_REFERENCE_WORLD argument of ref is only available in M2.40 or later versions.**

- **Return**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| success | bool | - | True or False |

### 7.7.2 ParallelAxis2.srv

- **Features**

This service 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 | float64[3] | - | vector |
| axis | int8 | - | · TASK_AXIS_X = 0<br>· TASK_AXIS_Y = 1<br>· TASK_AXIS_Z = 2 |
| ref | int8 | 0 | · MOVE_REFERENCE_BASE =0<br>· MOVE_REFERENCE_WORLD=2<br>· MOVE_REFERENCE_USER=101~120 |

**Note**

- **The MOVE_REFERENCE_WORLD argument of ref is only available in M2.40 or later versions.**

- **Return**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| success | bool | - | True or False |

### 7.7.3 AlignAxis1.srv

- **Features**

This service 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 | float64[6] | - | position list |
| x2 | float64[6] | - | position list |
| x3 | float64[6] | - | position list |
| pos | float64[6] | - | position list |
| axis | int8 | - | • TASK_AXIS_X = 0<br>• TASK_AXIS_Y = 1<br>• TASK_AXIS_Z = 2 |
| ref | int8 | 0 | • MOVE_REFERENCE_BASE =0<br>• MOVE_REFERENCE_WORLD=2<br>• MOVE_REFERENCE_USER=101~120 |

**Note**

- **The MOVE_REFERENCE_WORLD argument of ref is only available in M2.40 or later versions.**

- **Return**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| success | bool | - | True or False |

### 7.7.4 AlignAxis2.srv

- **Features**

This serivce 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 | float64[3] | - | vector |
| pos | float64[6] | - | 6개의 Task Space 정보 |
| axis | int | - | · TASK_AXIS_X = 0<br>· TASK_AXIS_Y = 1<br>· TASK_AXIS_Z = 2 |
| ref | int | 0 | · MOVE_REFERENCE_BASE =0<br>· MOVE_REFERENCE_WORLD=2<br>· MOVE_REFERENCE_USER=101~120 |

**Note**

- **The MOVE_REFERENCE_WORLD argument of ref is only available in M2.40 or later versions.**

- **Return**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| success | bool | - | True or False |

### 7.7.5 IsDoneBoltTightening.srv

- **Features**

This service 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 | float64 | 0 | Target torque |
| timeout | float64 | 0 | Monitoring duration [sec] |
| axis | int8 | - | · TASK_AXIS_X = 0<br>· TASK_AXIS_Y = 1<br>· TASK_AXIS_Z = 2 |

- **Return**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| success | bool | - | True or False |

### 7.7.6 ReleaseComplianceCtrl.srv

- **Features**

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

- **Parameters**

Not applicable

- **Return**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| success | bool | - | True or False |

### 7.7.7 TaskComplianceCtrl.srv

- **Features**

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

- **Parameters(Stiffness TBD)**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| stx | float64[6] | [3000, 3000, 3000, 200, 200, 200] | Three translational stiffnesses<br>Three rotational stiffnesses |
| ref | int8 | 1 | · MOVE_REFERENCE_BASE =0<br>· MOVE_REFERENCE_TOOL=1<br>· MOVE_REFERENCE_WORLD=2<br>MOVE_REFERENCE_USER=101~120 |
| time | float | 0 | Stiffness varying time [sec]<br>Range: 0 - 1.0<br>* Linear transition during the specified time |

- **Return**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| success | bool | - | True or False |

### 7.7.8 SetStiffnessx.srv

- **Features**

This service 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 | float64[6] | [500, 500, 500, 100, 100, 100] | Three translational stiffnesses<br>Three rotational stiffnesses |
| ref | int8 | 1 | · MOVE_REFERENCE_BASE =0<br>· MOVE_REFERENCE_TOOL=1<br>· MOVE_REFERENCE_WORLD=2<br>MOVE_REFERENCE_USER=101~120 |
| time | float | 0 | Stiffness varying time [sec]<br>Range: 0 - 1.0<br>* Linear transition during the specified time |

- **Return**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| success | bool | - | True or False |

### 7.7.9 CalcCoord.srv

- **Features**

**This service is only available for M2.50 or later versions.**

This service 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 |
|---|---|---|---|
| input_pos_cnt | int8 | | Number of input positions |
| x1 | float64[6] | - | position list |
| x2 | float64[6] | - | position list |
| x3 | float64[6] | - | position list |
| x4 | float64[6] | - | position list |

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| ref | int8 | - | • MOVE_REFERENCE_BASE =0<br>• MOVE_REFERENCE_WORLD=2 |
| mod | int8 | - | input mode<br>(only valid when the number of input poses is 2)<br>• 0: defining z-axis based on the current Tool-z direction<br>• 1: defining z-axis based on the z direction of x1 |

- **Return**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| conv_posx | float64[6] | - | position list |
| success | bool | - | True or False |

### 7.7.10 SetUserCartCoord1.srv

- **Features**

This service 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 | float64[6] | - | coordinate information (position and orientation) |
| Ref | int8 | - | reference coordinate<br>· DR_BASE: base coordinate<br>· DR_WORLD: world coordinate |

**Note**

· **The ref argument is only available in M2.40 or later versions.**

- **Return**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| id | int8 | - | user coordinate ID(101~120) or fail(-1) |
| success | bool | - | True or False |

### 7.7.11 SetUserCartCoord2.srv

- **Features**

The user can set the new rectangular coordinate system using x1, x2, and x3 based on the ref coordinate. Creates a rectangular coordinate system with ux, uy, and uz as the vector for each axis and origin point is the pos based on the ref coordinate assuming that 1)ux is the unit vector of x1x2 and uy is the unit vector of the vector that represents the shortest distance between x1x2 and x3. A maximum of 20 can be used, and the most recent 20 values are used if there are more than 20.

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

- **Parameters**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| x1 | float64[6] | - | position list |
| x2 | float64[6] | - | position list |
| x3 | float64[6] | - | position list |
| pos | float64[6] | | position list |
| ref | int8 | 0 | · MOVE_REFERENCE_BASE =0<br>· MOVE_REFERENCE_WORLD=2 |

**Note**

· **The ref argument is only available in M2.40 or later versions.**

- **Return**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| id | int8 | - | user coordinate ID(101~120) or fail(-1) |
| success | bool | - | True or False |

## 7.7.12 SetUserCartCoord3.srv

### ▪ Features

The user can set the new rectangular coordinate system using u1 and v1 based on the ref coordinate. The origin point of the rectangular coordinate system is pos based on the ref coordinate while the x-axis and y-axis bases are given in the vectors u1 and v1, respectively. Other directions are determined by u1 x 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.

### ▪ Parameters

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| u1 | float64[3] | - | X-axis unit vector |
| v1 | float64[3] | - | Y-axis unit vector |
| pos | float64[6] | - | position list |
| ref | int8 | 0 | • MOVE_REFERENCE_BASE =0<br>• MOVE_REFERENCE_WORLD=2 |

**Note**

- **The ref argument is only available in M2.40 or later versions.**

### ▪ Return

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| id | int8 | - | user coordinate ID(101~120) or fail(-1) |
| success | bool | - | True or False |

### 7.7.13 OverwriteUserCartCoord.srv

- **Features**

**This service is only available for M2.50 or later versions.**

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

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| id | int8 | - | coordinate ID |
| pos | float64[6] | - | position list |
| ref | int8 | 0 | · MOVE_REFERENCE_BASE =0<br>· MOVE_REFERENCE_WORLD=2 |

- **Return**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| id | int8 | - | user coordinate ID(101~120) or fail(-1) |
| success | bool | - | True or False |

## 7.7.14 GetUserCartCoord.srv

- **Features**

**This service is only available for M2.50 or later versions.**

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

- **Parameters**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| id | int8 | - | coordinate ID |

- **Return**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| conv_posx | float64[6] | - | position list |
| ref | int8 | - | • MOVE_REFERENCE_BASE =0<br>• MOVE_REFERENCE_WORLD=2 |
| success | bool | - | • True or False |

## 7.7.15 SetDesiredForce.srv

### ▪ Features

This service 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 | float64[6] | [0, 0, 0, 0, 0, 0] | Three translational target forces<br>Three rotational target moments |
| dir | int8[6] | [0, 0, 0, 0, 0, 0] | Force control in the corresponding direction if 1<br>Compliance control in the corresponding direction if 0 |
| ref | int8 | 1 | · MOVE_REFERENCE_BASE =0<br>· MOVE_REFERENCE_TOOL=1<br>· MOVE_REFERENCE_WORLD=2<br>· MOVE_REFERENCE_USER=101~120 |
| time | float64 | 0.0 | Transition time of target force to take effect [sec]<br>Range: 0 - 1.0 |
| mod | int8 | 0 | FORCE_MODE_ABSOLUTE(0): Force control with absolute value<br>FORCE_MODE_RELATIVE(1): force control with relative value to initial state (the instance when this function is called) |

### ▪ Return

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| success | bool | - | True or False |

### 7.7.16 ReleaseForce.srv

- **Features**

This service 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 | float64 | 0.0 | Time needed to reduce the force<br>Range: 0 - 1.0 |

- **Return**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| success | bool | - | True or False |

### 7.7.17 CheckPositionCondition.srv

- **Features**

This service 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.Parameters

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| axis | int8 | - | · FORCE_AXIS_X = 0<br>· FORCE_AXIS_Y = 1<br>· FORCE_AXIS_Z = 2 |
| min | float64 | 0 | Minimum value |
| max | float64 | 0 | Maximum value |
| ref | int8 | 1 | · MOVE_REFERENCE_BASE =0<br>· MOVE_REFERENCE_TOOL=1<br>· MOVE_REFERENCE_WORLD=2<br>· MOVE_REFERENCE_USER=101~120 |
| mod | int8 | - | · MOVE_MODE_ABSOLUTE = 0<br>· MOVE_MODE_RELATIVE = 1 |
| pos | float64[6] | - | position list |

**알아두기**

- 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**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| success | bool | - | True or False |

## 7.7.18 CheckForceCondition.srv

### ▪ Features

This service 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 | int8 | - | • FORCE_AXIS_X = 0<br>• FORCE_AXIS_Y = 1<br>• FORCE_AXIS_Z = 2<br>• FORCE_AXIS_A = 10<br>• FORCE_AXIS_B = 11<br>• FORCE_AXIS_C = 12 |
| min | float64 | - | Minimum value (min ≥ 0) |
| max | float64 | - | Maximum value (max ≥ 0) |
| ref | int8 | None | • MOVE_REFERENCE_BASE =0<br>• MOVE_REFERENCE_TOOL=1<br>• MOVE_REFERENCE_WORLD=2<br>• MOVE_REFERENCE_USER=101~120 |

### ▪ Return

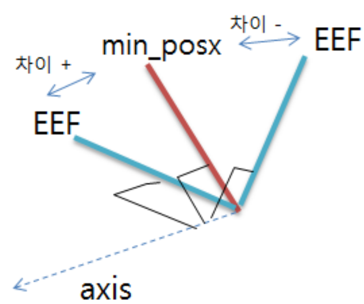
| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| success | bool | - | True or False |

### 7.7.19 CheckOrientationCondition1.srv

- **Features**

This service 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 | int8 | - | · FORCE_AXIS_A = 10<br>· FORCE_AXIS_B = 11<br>· FORCE_AXIS_C = 12 |
| min | float64[6] | - | position list |
| max | float64[6] | - | position list |
| ref | int8 | 1 | · MOVE_REFERENCE_BASE =0<br>· MOVE_REFERENCE_TOOL=1 |

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| | | | · MOVE_REFERENCE_WORLD=2<br>· MOVE_REFERENCE_USER=101~120 |
| mod | int8 | 0 | · MOVE_MODE_ABSOLUTE = 0<br>· MOVE_MODE_RELATIVE = 1 |

- **Return**

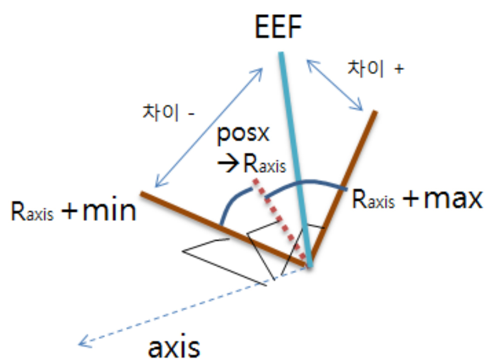
| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| success | bool | - | True or False |

### 7.7.20 CheckOrientationCondition2.srv

- **Features**

This service 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 | int8 | - | • FORCE_AXIS_X = 0<br>• FORCE_AXIS_Y = 1 |

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| | | | • FORCE_AXIS_Z = 2 |
| min | float64 | - | Minimum value |
| max | float64 | - | Maximum value |
| ref | int8 | 1 | • MOVE_REFERENCE_BASE =0<br>• MOVE_REFERENCE_TOOL=1<br>• MOVE_REFERENCE_WORLD=2<br>• MOVE_REFERENCE_USER=101~120 |
| mod | int8 | 0 | • MOVE_MODE_ABSOLUTE = 0<br>• MOVE_MODE_RELATIVE = 1 |
| pos | float64[6] | - | position list |

- **Return**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| success | bool | - | True or False |

### 7.7.21 CoordTransform.srv

- **Features**

This service 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 | float64[6] | - | position list |
| ref_in | int8 | DR_COND_NONE | · MOVE_REFERENCE_BASE =0<br>· MOVE_REFERENCE_TOOL=1<br>· MOVE_REFERENCE_WORLD=2<br>· MOVE_REFERENCE_USER=101~120 |
| ref_out | int8 | DR_COND_NONE | · MOVE_REFERENCE_BASE =0<br>· MOVE_REFERENCE_TOOL=1 |

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| | | | · MOVE_REFERENCE_WORLD=2<br>· MOVE_REFERENCE_USER=101~120 |

- **Return**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| conv_posx | float64[6] | - | position list |
| success | bool | - | True or False |

### 7.7.22 GetWorkpieceWeight.srv

- **Features**

This service measures and returns the weight of the workpiece.

- **Parameters**

Not applicable

- **Return**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| weight | float64 | - | positive value : measured weight<br>negative value : error |
| success | bool | - | True or False |

### 7.7.23 ResetWorkppieceWeight.srv

- **Features**

This service 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**

None

- **Return**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| success | bool | - | True or False |

# 7.8 Service/io

## 7.8.1 SetCtlBoxDigitalOutput.srv

- **Features**

This service sends a signal at the digital contact point of the controller..

- **Parameters**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| index | int8 | - | I/O contact number mounted on the controller<br>• Val argument existing: A number between 1 and 16 |
| value | int8 | | I/O value<br>• ON: 1<br>• OFF: 0 |

- **Return**

| Return Name | Data Type | Default Value | Description |
|---|---|---|---|
| success | bool | - | True or False |

### 7.8.2 GetCtlBoxDigitalOutput.srv

- **Features**

This service reads the current digital io output status .

- **Parameters**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| index | int8 | - | A number 1 - 16 which means the contact number of I/O mounted on the controller. |

- **Return**

| Return Name | Data Type | Default Value | Description |
|---|---|---|---|
| value | int8 | - | current stataus (OFF =0, ON =1) |
| success | bool | - | True or False |

### 7.8.3 GetCtlBoxDigitalInput.srv

- **Features**

This service reads the signals from digital contact points of the controller.

- **Parameters**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| index | int8 | - | A number 1 - 16 which means the contact number of I/O mounted on the controller. |

- **Return**

| Return Name | Data Type | Default Value | Description |
|---|---|---|---|
| value | int8 | - | OFF =0, ON =1 |
| success | bool | - | True or False |

### 7.8.4 SetToolDigitalOutput.srv

- **Features**

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

- **Parameters**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| index | int8 | - | I/O contact number mounted on the robot arm<br>• Val argument existing: A number between 1 and 6 |
| value | int8 | | I/O value<br>• ON: 1<br>• OFF: 0 |

- **Return**

| Return Name | Data Type | Default Value | Description |
|---|---|---|---|
| success | bool | - | True or False |

## 7.8.5 GetToolDigitalOutput.srv

- **Features**

This service reads the current tool digital io output status.

- **Parameters**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| index | int8 | - | I/O contact number (1-6) mounted on the robot tool |

- **Return**

| Return Name | Data Type | Default Value | Description |
|---|---|---|---|
| value | int8 | - | current status (OFF =0, ON =1) |
| success | bool | - | True or False |

### 7.8.6 GetToolDigitalIntput.srv

- **Features**

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

- **Parameters**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| index | int8 | - | I/O contact number (1-6) mounted on the robot tool |

- **Return**

| Return Name | Data Type | Default Value | Description |
|---|---|---|---|
| value | int8 | - | OFF =0, ON =1 |
| success | bool | - | True or False |

### 7.8.7 SetCtlBoxAnalogOutputType.srv

- **Features**

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

- **Parameters**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| channel | int8 | - | • 1 : channel 1<br>• 2 : channel 2 |
| mode | int8 | - | analog io mode<br>• current =0<br>• voltage =1 |

- **Return**

| Return Name | Data Type | Default Value | Description |
|---|---|---|---|
| success | bool | - | True or False |

### 7.8.8 SetCtlBoxAnalogInputType.srv

- **Features**

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

- **Parameters**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| channel | int8 | - | • 1 : channel 1<br>• 2 : channel 2 |
| mode | int8 | - | analog io mode<br>• current =0<br>• voltage =1 |

- **Return**

| Return Name | Data Type | Default Value | Description |
|---|---|---|---|
| success | bool | - | True or False |

### 7.8.9 SetCtlBoxAnalogOutput.srv

- **Features**

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

- **Parameters**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| channel | int8 | - | • 1 : channel 1<br>• 2 : channel 2 |
| value | float64 | - | analog output value<br>• Current mode: 4.0~20.0 [mA]<br>• Voltage mode: 0~10.0 [V] |

- **Return**

| Return Name | Data Type | Default Value | Description |
|---|---|---|---|
| success | bool | - | True or False |

## 7.8.10 GetCtlBoxAnalogInput.srv

### ▪ Features

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

### ▪ Parameters

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| channel | int8 | - | • 1 : channel 1<br>• 2 : channel 2 |

### ▪ Return

| Return Name | Data Type | Default Value | Description |
|---|---|---|---|
| value | float | - | The analog input value of the specified channel<br>• Current mode: 4.0~20.0 [mA]<br>• Voltage mode: 0~10.0 [V] |
| success | bool | - | True or False |

## 7.9 Service/modbus

### 7.9.1 ConfigCreateModbus.srv

- **Features**

This service registers the 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 | - | Modbus signal name |
| ip | string | - | IP address of the Modbus module |
| port | int8 | - | Port number of the Modbus module |
| reg_type | int8 | - | Modbus signal type<br>• MODBUS_REGISTER_TYPE_DISCRETE_INPUTS<br>• MODBUS_REGISTER_TYPE_COILS<br>• MODBUS_REGISTER_TYPE_INPUT_REGISTER<br>• MODBUS_REGISTER_TYPE_HOLDING_REGISTER |
| index | int8 | - | Modbus signal의 index |
| value | int8 | - | Output when the type is MODBUS_REGISTER_TYPE_COILS or MODBUS_REGISTER_TYPE_HOLDING_REGISTER (ignored otherwise) |

- **Return**

| Return Name | Data Type | Default Value | Description |
|---|---|---|---|
| success | bool | - | True or False |

### 7.9.2 ConfigDeleteModbus.srv

#### ▪ Features

This service 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

| Return Name | Data Type | Default Value | Description |
|---|---|---|---|
| success | bool | - | True or False |

### 7.9.3 SetModbusOutput.srv

- **Features**

This service sends the signal to an external Modbus system.

- **Parameters**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| name | string | - | Modbus name |
| value | int32 | - | Modbus digital I/O<br>• ON : 1<br>• OFF : 0 |
| | | | Value for Modbus analog I/O |

- **Return**

| Return Name | Data Type | Default Value | Description |
|---|---|---|---|
| success | bool | - | True or False |

### 7.9.4 GetModbuInput.srv

- **Features**

This service reads the signal from the Modbus system.

- **Parameters**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| name | string | - | Modbus name |

- **Return**

| Return Name | Data Type | Default Value | Description |
|---|---|---|---|
| value | int32 | - | ON or Off in the case of the Modbus digital I/O |
| | | | The register value in the case of the Modbus analog module |
| success | bool | - | True or False |

# 7.10 Service/drl

## 7.10.1 DrlStart.srv

- **Features**

This service is used to execute DRL script. (DRL is a Doosan robot language).

**Caution**
The drl service is only available in real mode.

- **Parameters**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| RobotSystem | int8 | - | |
| Code | string | - | DRL code string |

- **Return**

| Return Name | Data Type | Default Value | Description |
|---|---|---|---|
| success | bool | - | True or False |

**Note**

- Robot operation status should be in STANDBY state (STATE_STANDBY) and should be used when robot mode is in auto mode.
- DRL programming should be done by referring to the Programming Manual.
-

### 7.10.2 DrlStop.srv

- **Features**

This service is used to stop the DRL program (task) currently running on the robot controller. Stops differently according to the eStopType received as an argument, and stops the motion of the current section

**Caution**

The drl service is only available in real mode.

- **Parameters**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| stop_mode | int8 | - | drl stop mode<br>• STOP_TYPE_QUICK_STO = 0<br>• STOP_TYPE_QUICK = 1<br>• STOP_TYPE_SLOW = 2<br>• STOP_TYPE_HOLD = STOP_TYPE_EMERGENCY = 3 |

- **Return**

| Return Name | Data Type | Default Value | Description |
|---|---|---|---|
| Success | bool | - | True or False |

### 7.10.3 DrlPause.srv

- **Features**

This is a service to temporarily stop the DRL program (task) currently running on the robot controller.

⚠ **Caution**

The drl service is only available in real mode.

- **Parameters**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| None | - | - | - |

- **Return**

| Return Name | Data Type | Default Value | Description |
|---|---|---|---|
| success | bool | - | True or False |

### 7.10.4 DrlResume.srv

- **Features**

This is a service to resume the currently paused DRL program (task) from the robot controller.

⚠ **Caution**
The drl service is only available in real mode.

- **Parameters**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| None | - | - | - |

- **Return**

| Return Name | Data Type | Default Value | Description |
|---|---|---|---|
| success | bool | - | True or False |

## 7.10.5 GetDrlState.srv

- **Features**

This service reads the status of the DRL program

⚠ **Caution**

The drl service is only available in real mode.

- **Parameters**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| None | - | - | - |

- **Return**

| Return Name | Data Type | Default Value | Description |
|---|---|---|---|
| state | int8 | - | state of DRL program<br>. 0 : DRL_PROGRAM_STATE_PLAY<br>. 1 : DRL_PROGRAM_STATE_STOP<br>. 2 : DRL_PROGRAM_STATE_HOLD |
| success | bool | - | True or False |

# 7.11 Service/gripper

## 7.11.1 SerialSendData.srv

- **Features**

It controls the gripper through actual serial communication.

- **Parameters**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| data | string | - | String to send |

- **Return**

| Return Name | Data Type | Default Value | Description |
|---|---|---|---|
| success | bool | - | True or False |

### 7.11.2 RobotiqMove.srv

- **Features**

It is a service to control robotiq's gripper in simulator environment.

- **Parameters**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| width | float | - | Width of finger gripper : 0.0(close)~0.8(open) |

- **Return**

| Return Name | Data Type | Default Value | Description |
|---|---|---|---|
| success | bool | - | True or False |

# 8. Motion-related Functions

## 8.1 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<br>list<br>posj | 0 | 1-axis angle or<br>angle list or<br>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()**

## 8.2 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<br>list<br>posx | 0 | z position or<br>position list or<br>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()**

## 8.3 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 | - | posx or |
| | list (float[6]) | | position list |
| delta | posx | - | posx or |
| | list (float[6]) | | position list |
| ref | int | None | reference coordinate<br>· DR_BASE : base coordinate<br>· DR_WORLD : world coordinate<br>· DR_TOOL : tool coordinate<br>· user coordinate : user defined |
| ref_out | int | DR_BASE | reference coordinate<br>· DR_BASE : base coordinate<br>· DR_WORLD : world coordinate<br>· user coordinate : user defined |

**Note**

- The ref argument DR_WORLD is only available in M2.40 and later versions.
- The ref_out argument is only available in M2.40 and later versions.

### 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()**

## 8.4 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<br>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()**

## 8.5 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<br>list (float[6]) | - | posj or<br>position list |
| ref | int | DR_BASE | reference coordinate<br>• DR_BASE : base coordinate<br>• DR_WORLD : world coordinate |

**Note**

- **The ref argument is only available in M2.40 or later versions.**

### ▪ Return

| Value | Description |
|---|---|
| posx | 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 |

### ▪ 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()

## 8.6 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<br>list (float[6]) | - | posx or<br>position list |
| sol_space | int | - | solution space |
| ref | int | DR_BASE | reference coordinate<br>• DR_BASE : base coordinate<br>• DR_WORLD : world coordinate |

**Note**

- **The ref argument is only available in M2.40 or later versions.**

### ▪ 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 |

### ▪ 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 |
| 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()**

## 8.7 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/sec2). [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()**

## 8.8 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/sec2).
movej(Q2)          # The joint motion acceleration to Q2 is 60(deg/sec2) which is the global acceleration.
movej(Q1, vel=20, acc=40) # The joint motion acceleration to Q1 is 40(deg/sec2) 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()**

## 8.9 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()**

## 8.10 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()**

## 8.11 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()**

## 8.12 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/sec2). The global task angular acceleration is automatically determined.
movel(P2)           # The task motion linear acceleration to P2 is 60(mm/sec2) which is the global acceleration.
movel(P1, vel=20, acc=40)      # The task motion linear acceleration to P1 is 40(mm/sec2) which is the specified acceleration.
```

### ▪ Related commands

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

## 8.13 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()**

## 8.14 set_ref_coord(coord)

## 8.15 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<br>list (float[6]) | - | posj or<br>joint angle list |
| vel (v) | float<br>list (float[6]) | None<br>None | velocity (same to all axes) or<br>velocity (to an axis) |
| acc (a) | float<br>list (float[6]) | None<br>None | acceleration (same to all axes) or<br>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<br>• DR_MV_MOD_ABS: Absolute<br>• DR_MV_MOD_REL: Relative |
| Ra | int | DR_MV_RA_DUPLICATE | Reactive motion mode<br>• DR_MV_RA_DUPLICATE: duplicate<br>• DR_MV_RA_OVERRIDE: override |

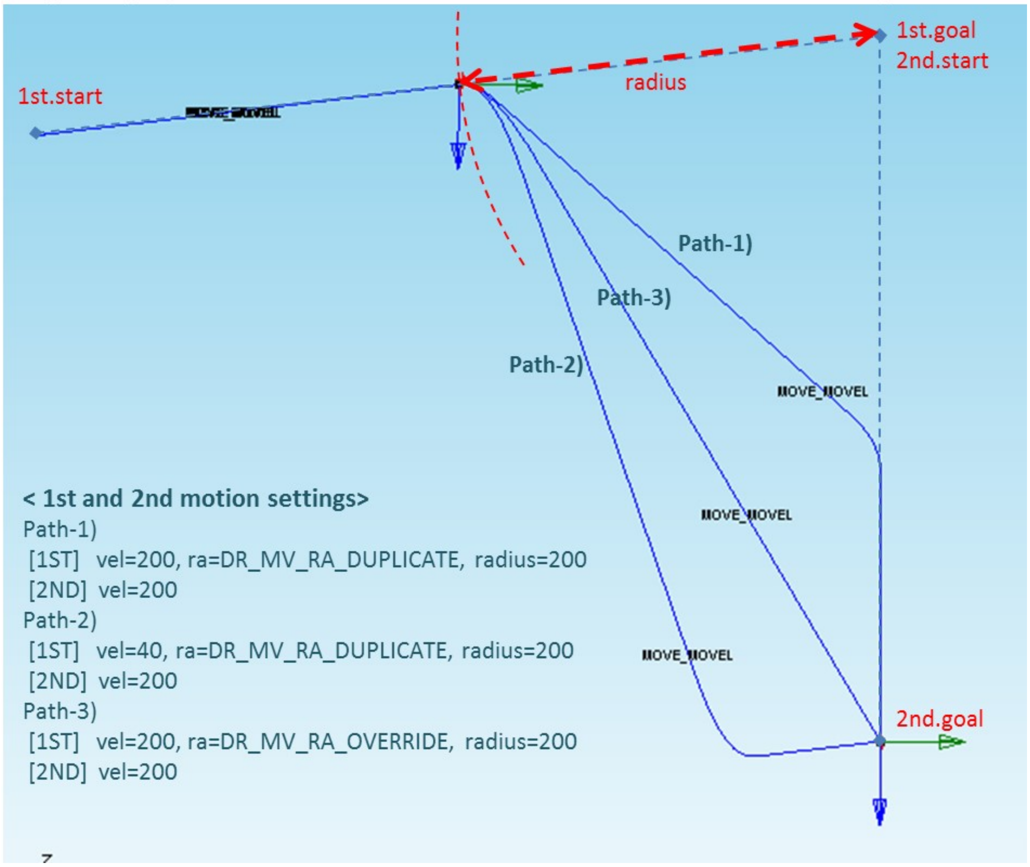
**Note**

- 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()**

## 8.16 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<br>list (float[6]) | - | posx or<br>position list |
| vel (v) | float<br>list (float[2]) | None<br>None | velocity or<br>velocity1, velocity2 |
| acc (a) | float<br>list (float[2]) | None<br>None | acceleration or<br>acceleration1, acceleration2 |
| time (t) | float | None | Reach time [sec]<br>* 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<br>• DR_BASE: base coordinate<br>• DR_WORLD: world coordinate<br>• DR_TOOL: tool coordinate<br>• user coordinate: User defined |
| mod | int | DR_MV_MOD_ABS | Movement basis<br>• DR_MV_MOD_ABS: Absolute<br>• DR_MV_MOD_REL: Relative |
| ra | int | DR_MV_RA_DUPLICATE | Reactive motion mode<br>• DR_MV_RA_DUPLICATE: duplicate<br>• DR_MV_RA_OVERRIDE: override |

**Note**

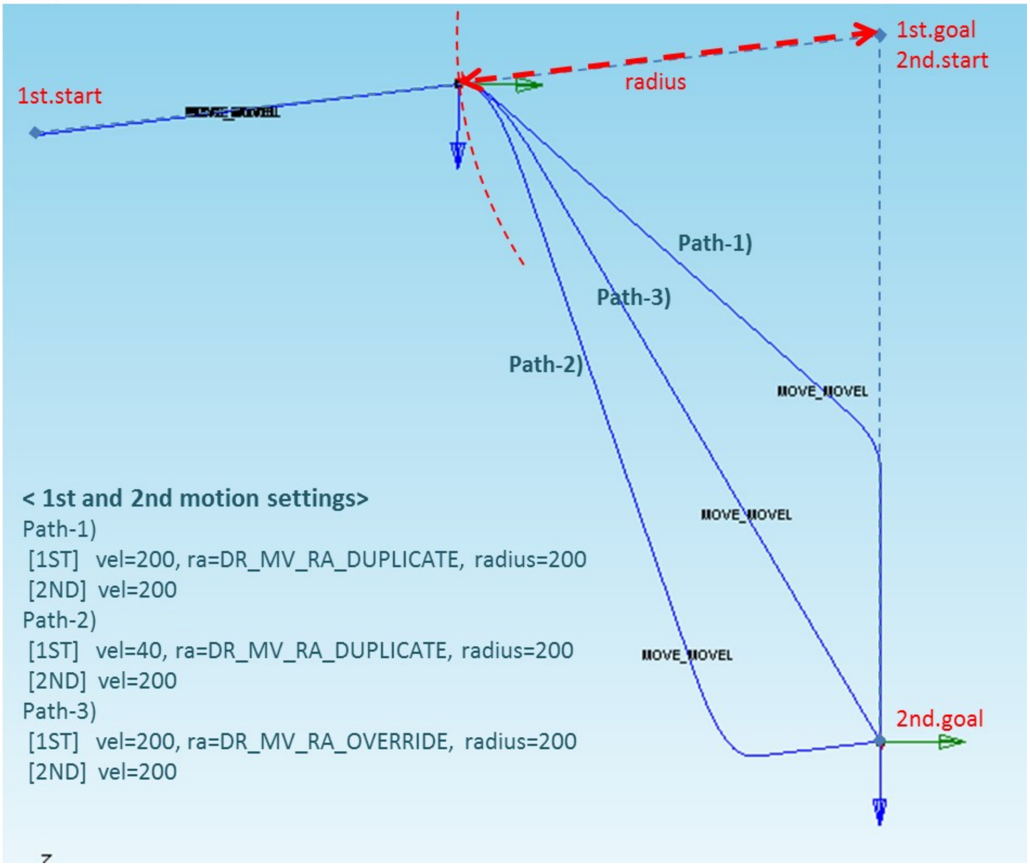
- Abbreviated parameter names are supported. (v:vel, a:acc, t:time, r:radius)
- _global_velx is applied if vel is None. (The initial value of _global_velx is 0.0 and can be set by set_velx.)

- _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.)
- **The DR_WORLD argument of ref is only available in M2.40 or later versions.**

**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()**

## 8.17 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<br>list (float[6]) | - | posx or<br>position list |
| vel (v) | float<br>list (float[6]) | None<br>None | velocity (same to all axes) or<br>velocity (to an axis) |
| acc (a) | float<br>list (float[6]) | None<br>None | acceleration (same to all axes) or<br>acceleration (acceleration to an axis) |
| time (t) | float | None | Reach time [sec] |
| radius (r) | float | None | Radius for blending |
| ref | int | None | reference coordinate<br>· DR_BASE: base coordinate<br>· DR_WORLD: world coordinate<br>· DR_TOOL: tool coordinate<br>· user coordinate: User defined |
| mod | int | DR_MV_MOD_ABS | Movement basis<br>· DR_MV_MOD_ABS: Absolute<br>· DR_MV_MOD_REL: Relative |
| ra | int | DR_MV_RA_DUPLICATE | Reactive motion mode<br>· DR_MV_RA_DUPLICATE: duplicate<br>· 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.)
- **The DR_WORLD argument of ref is only available in M2.40 or later versions.**
- 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/sec2), 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()**

# 8.18 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<br>list (float[6]) | - | posx or<br>position list |
| pos2 | posx<br>list (float[6] | | posx or<br>position list |
| vel (v) | float<br>list (float[2]) | None<br>None | velocity or<br>velocity1, velocity2 |
| acc (a) | float<br>list (float[2]) | None<br>None | acceleration or<br>acceleration1, acceleration2 |
| time (t) | float | None | Reach time [sec] |
| radius (r) | float | None | Radius for blending |
| ref | int | None | reference coordinate<br>・ DR_BASE: base coordinate<br>・ DR_WORLD: world coordinate<br>・ DR_TOOL: tool coordinate<br>・ user coordinate: User defined |
| mod | int | DR_MV_MOD_ABS | Movement basis<br>・ DR_MV_MOD_ABS: Absolute<br>・ DR_MV_MOD_REL: Relative |
| angle (an) | float<br>list (float[2]) | None | angle or<br>angle1, angle2 |
| ra | int | DR_MV_RA_DUPLICATE | Reactive motion mode<br>・ DR_MV_RA_DUPLICATE: duplicate<br>・ DR_MV_RA_OVERRIDE: override |

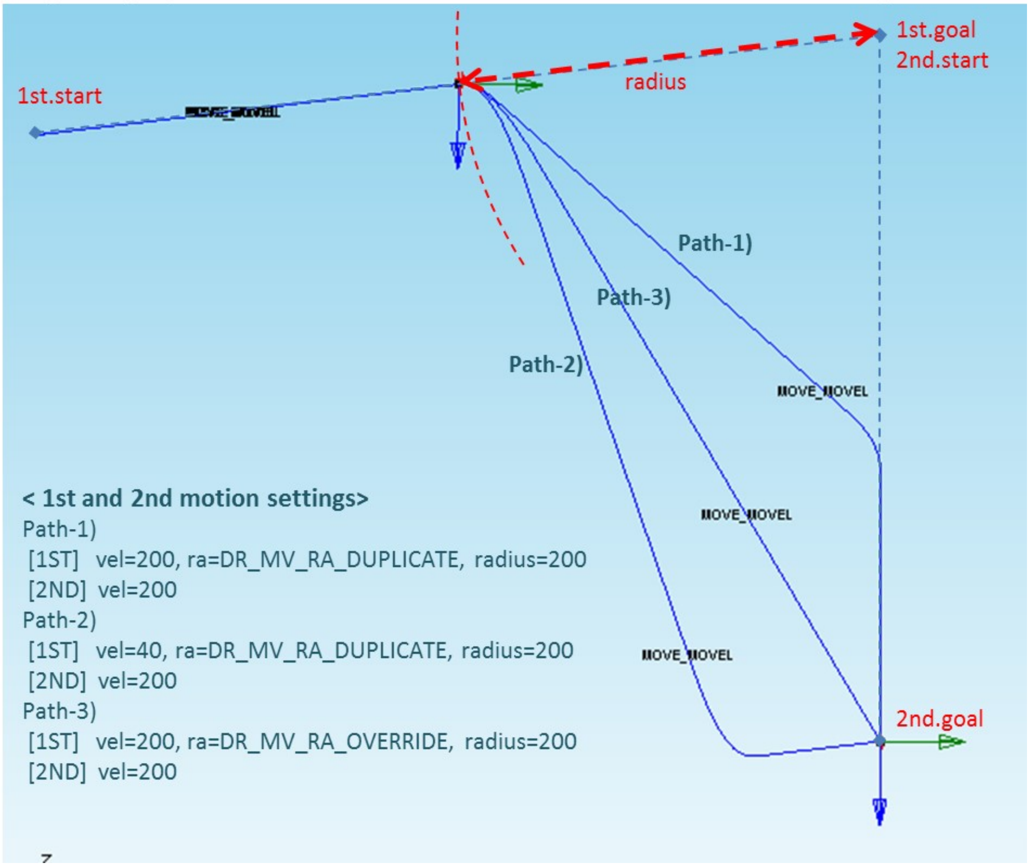
**Note**

- 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.)
- **The DR_WORLD argument of ref is only available in M2.40 or later versions.**
- 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.

**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/sec2) and 40(deg/sec2).

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/sec2)
# 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/sec2).
# 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/sec2).
# 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()**

## 8.19 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<br>list (float[6]) | None | velocity (same to all axes) or<br>velocity (to an axis) |
| acc (a) | float<br>list (float[6]) | None | acceleration (same to all axes) or<br>acceleration (acceleration to an axis) |
| time (t) | float | None | Reach time [sec] |
| mod | int | DR_MV_MOD_ABS | Movement basis<br>• DR_MV_MOD_ABS: Absolute<br>• 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/sec2)
```

```
#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/sec2) (same motion as CASE-1).
```

- **Related commands**

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

## 8.20 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<br>list (float[2]) | None | velocity or<br>velocity1, velocity2 |
| acc (a) | float<br>list (float[2]) | None | acceleration or<br>acceleration1, acceleration2 |
| time (t) | float | None | Reach time [sec] |
| ref | int | None | reference coordinate<br>· DR_BASE: base coordinate<br>· DR_WORLD: world coordinate<br>· DR_TOOL: tool coordinate<br>· user coordinate: User defined |
| mod | int | DR_MV_MOD_ABS | Movement basis<br>· DR_MV_MOD_ABS: Absolute<br>· DR_MV_MOD_REL: Relative |
| vel_opt | int | DR_MVS_VEL_NONE | Velocity option<br>· DR_MVS_VEL_NONE: None<br>· 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.)
- **The DR_WORLD argument of ref is only available in M2.40 or later versions.**
- 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/sec2), and 60(deg/sec2) (same motion
        as CASE-1).
```

- **Related commands**

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

## 8.21 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<br>list (float[2]) | None | velocity or<br>velocity1, velocity2 |
| acc (a) | float<br>list (float[2]) | None | acceleration or<br>acceleration1, acceleration2 |
| time (t) | float | None | Reach time [sec]<br>* If the time is specified, values are processed based on time, ignoring vel and acc. |
| ref | int | None | reference coordinate<br>・ DR_BASE: base coordinate<br>・ DR_WORLD: world coordinate<br>・ DR_TOOL: tool coordinate<br>・ user coordinate: User defined |
| mod | int | DR_MV_MOD_ABS | Movement basis<br>・ DR_MV_MOD_ABS: Absolute<br>・ DR_MV_MOD_REL: Relative |

**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.)
- **The DR_WORLD argument of ref is only available in M2.40 or later versions.**
- If the mod is DR_MV_MOD_REL, each pos in the posb_list is defined in the relative coordinate of the previous pos.

**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 |
| DR_Error (DR_ERROR_RUNTIME) | C extension module error occurred |

| Exception | Description |
|---|---|
| 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()**

## 8.22 move_spiral

### ▪ Features

The radius increases in a radial direction and the robot moves in parallel with the rotating spiral motion in an axial direction. It moves the robot along the spiral trajectory on the surface that is perpendicular to the axis on the coordinate specified as ref and the linear trajectory in the axis direction.

### ▪ 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<br>• DR_AXIS_X: x-axis<br>• DR_AXIS_Y: y-axis<br>• DR_AXIS_Z: z-axis |
| ref | Int | DR_TOOL | - | reference coordinate<br>• DR_BASE : base coordinate<br>• DR_WORLD: world coordinate<br>• DR_TOOL : tool coordinate<br>• 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.
- **The DR_WORLD argument of ref is only available in M2.40 or later versions.**
- 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 |

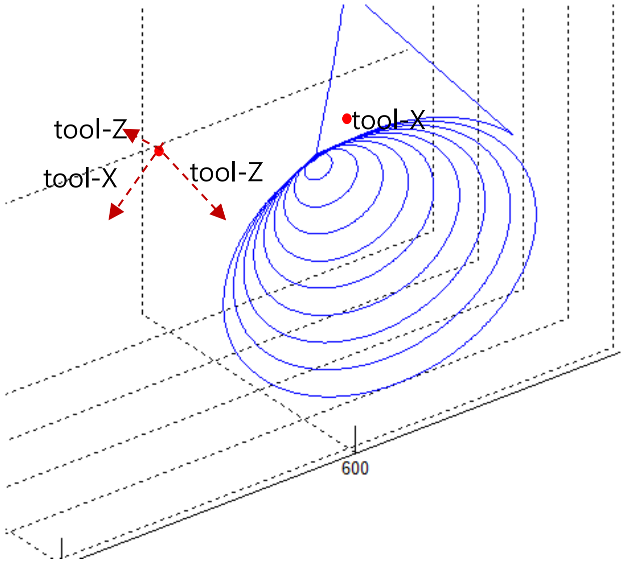
## Exception

| 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()

## 8.23 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<br>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<br>· DR_BASE : base coordinate<br>· DR_WORLD: world coordinate<br>· DR_TOOL : tool coordinate<br>· user coordinate: user defined |

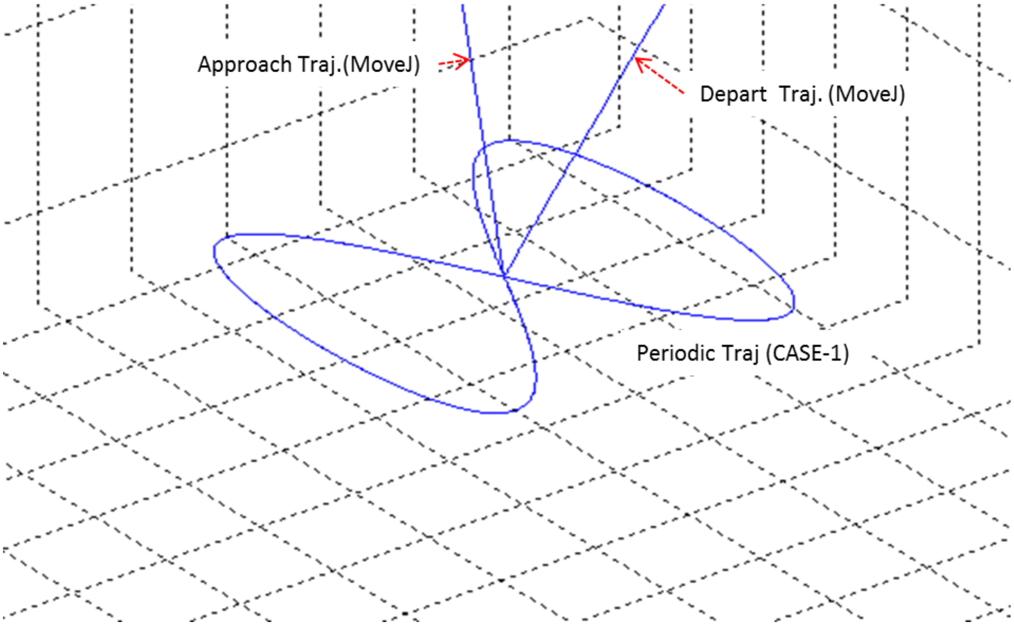
**Note**

- 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.

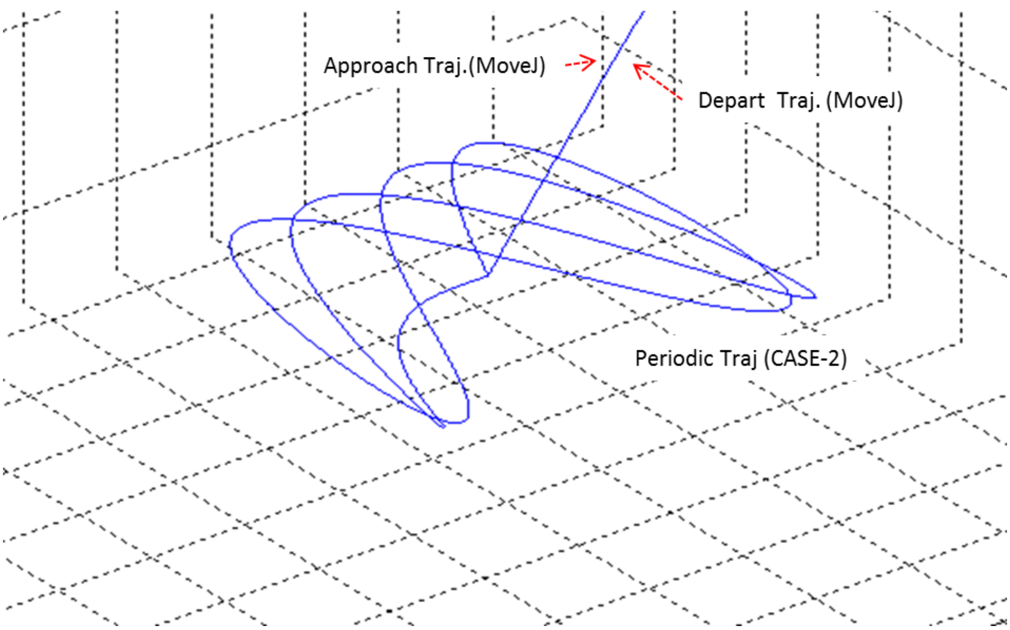
**CASE-1) All-axis motions end at the same time**

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.
- **The DR_WORLD argument of ref is only available in M2.40 or later versions.**
- 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()

# 8.24 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<br>list (float[6]) | - | posj or<br>joint angle list |
| vel (v) | float<br>list (float[6]) | None | velocity (same to all axes) or<br>velocity (to an axis) |
| acc (a) | float<br>list (float[6]) | None | acceleration (same to all axes) or<br>acceleration (acceleration to an axis) |
| time (t) | float | None | Reach time [sec] |
| mod | int | DR_MV_MOD_ABS | Movement basis<br>• DR_MV_MOD_ABS: Absolute<br>• DR_MV_MOD_REL: Relative |
| ra | int | DR_MV_RA_DUPLICATE | Reactive motion mode<br>• DR_MV_RA_DUPLICATE: duplicate<br>• 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()**

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

**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.)
- **The DR_WORLD argument of ref is only available in M2.40 or later versions.**
- Refer to the description of the movej() motion for the path of the 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. 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()**

## 8.26 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<br>list (float[6]) | - | posx or<br>position list |
| vel (v) | float<br>list (float[6]) | None<br>None | velocity (same to all axes) or<br>velocity (to an axis) |
| acc (a) | float<br>list (float[6]) | None<br>None | acceleration (same to all axes) or<br>acceleration (acceleration to an axis) |
| time (t) | float | None | Reach time [sec] |
| ref | int | None | reference coordinate<br>・ DR_BASE: base coordinate<br>・ DR_WORLD: world coordinate<br>・ DR_TOOL: tool coordinate<br>・ user coordinate: User defined |
| mod | int | DR_MV_MOD_ABS | Movement basis<br>・ DR_MV_MOD_ABS: Absolute<br>・ DR_MV_MOD_REL: Relative |
| ra | int | DR_MV_RA_DUPLICATE | Reactive motion mode<br>・ DR_MV_RA_DUPLICATE: duplicate<br>・ 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.
- **The DR_WORLD argument of ref is only available in M2.40 or later versions.**
- 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()**

## 8.27 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<br>list (float[6]) | - | posx or<br>position list |
| pos2 | posx<br>list (float[6] | - | posx or<br>position list |
| vel (v) | float<br>list (float[2]) | None | velocity or<br>velocity1, velocity2 |
| acc (a) | float<br>list (float[2]) | None | acceleration or<br>acceleration1, acceleration2 |
| time (t) | float | None | Reach time [sec] |
| ref | int | None | reference coordinate<br>· DR_BASE: base coordinate<br>· DR_WORLD: world coordinate<br>· DR_TOOL: tool coordinate<br>· user coordinate: User defined |
| mod | int | DR_MV_MOD_ABS | Movement basis<br>· DR_MV_MOD_ABS: Absolute<br>· DR_MV_MOD_REL: Relative |
| angle (an) | float<br>list (float[2]) | None | angle or<br>angle1, angle2 |
| ra | int | DR_MV_RA_DUPLICATE | Reactive motion mode<br>· DR_MV_RA_DUPLICATE: duplicate |

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| | | | • DR_MV_RA_OVERRIDE: override |

**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.)
- **The DR_WORLD argument of ref is only available in M2.40 or later versions.**
- 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.

## 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()**

## 8.28 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<br>list (float[6]) | None | velocity (same to all axes) or<br>velocity (to an axis) |
| acc (a) | float<br>list (float[6]) | None | acceleration (same to all axes) or<br>acceleration (acceleration to an axis) |
| time (t) | float | None | Reach time [sec] |
| mod | int | DR_MV_MOD_ABS | Movement basis<br>• DR_MV_MOD_ABS: Absolute<br>• 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()**

## 8.29 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<br>list (float[2]) | None | velocity or<br>velocity1, velocity2 |
| acc (a) | float<br>list (float[2]) | None | acceleration or<br>acceleration1, acceleration2 |
| time (t) | float | None | Reach time [sec] |
| ref | int | None | reference coordinate<br>· DR_BASE: base coordinate<br>· DR_WORLD: world coordinate<br>· DR_TOOL: tool coordinate<br>· user coordinate: User defined |
| mod | int | DR_MV_MOD_ABS | Movement basis<br>· DR_MV_MOD_ABS: Absolute<br>· DR_MV_MOD_REL: Relative |
| vel_opt | int | DR_MVS_VEL_NONE | Velocity option<br>· DR_MVS_VEL_NONE: None<br>· 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.)
- **The DR_WORLD argument of ref is only available in M2.40 or later versions.**
- 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/sec2) and
        # 60(deg/sec2). 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()**

## 8.30 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<br>list (float[2]) | None | velocity or<br>velocity1, velocity2 |
| acc (a) | float<br>list (float[2]) | None | acceleration or<br>acceleration1, acceleration2 |
| time (t) | float | None | Reach time [sec]<br>* If the time is specified, values are processed based on time, ignoring vel and acc. |
| ref | int | None | reference coordinate<br>· DR_BASE: base coordinate<br>· DR_WORLD: world coordinate<br>· DR_TOOL: tool coordinate<br>· user coordinate: User defined |
| mod | int | DR_MV_MOD_ABS | Movement basis<br>· DR_MV_MOD_ABS: Absolute<br>· DR_MV_MOD_REL: Relative |

**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.)
- **The DR_WORLD argument of ref is only available in M2.40 or later versions.**
- 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.

**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

```
#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()**

## 8.31 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.

The radius increases in a radial direction and the robot moves in parallel with the rotating spiral motion in an axial direction. It moves the robot along the spiral trajectory on the surface that is perpendicular to the axis on the coordinate specified as ref and the linear trajectory in the axis direction.

**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<br>・ DR_AXIS_X: x-axis<br>・ DR_AXIS_Y: y-axis<br>・ DR_AXIS_Z: z-axis |
| ref | Int | DR_TOOL | - | reference coordinate<br>・ DR_BASE : base coordinate<br>・ DR_WORLD: world coordinate<br>・ DR_TOOL : tool coordinate<br>・ 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.
- **The DR_WORLD argument of ref is only available in M2.40 or later versions.**
- 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

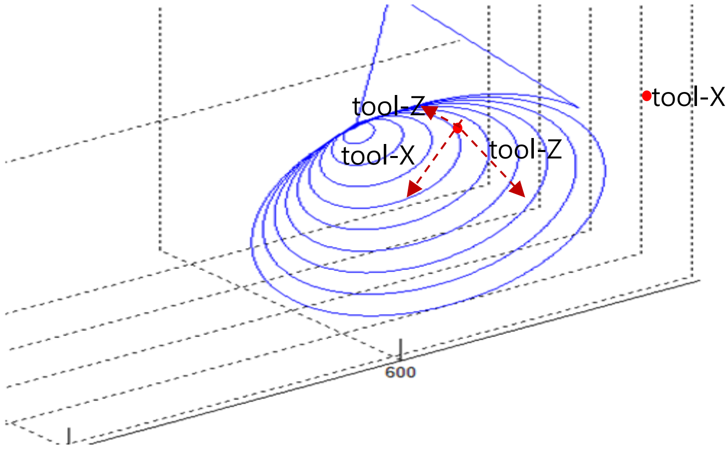
| Exception | Description |
|---|---|
| DR_Error (DR_ERROR_TYPE) | Parameter data type error occurred |
| DR_Error (DR_ERROR_VALUE) | Parameter value is invalid |
| DR_Error (DR_ERROR_RUNTIME) | C extension module error occurred |
| DR_Error (DR_ERROR_STOP) | Program terminated forcefully |

## 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_TOO
L)
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()**

## 8.32 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

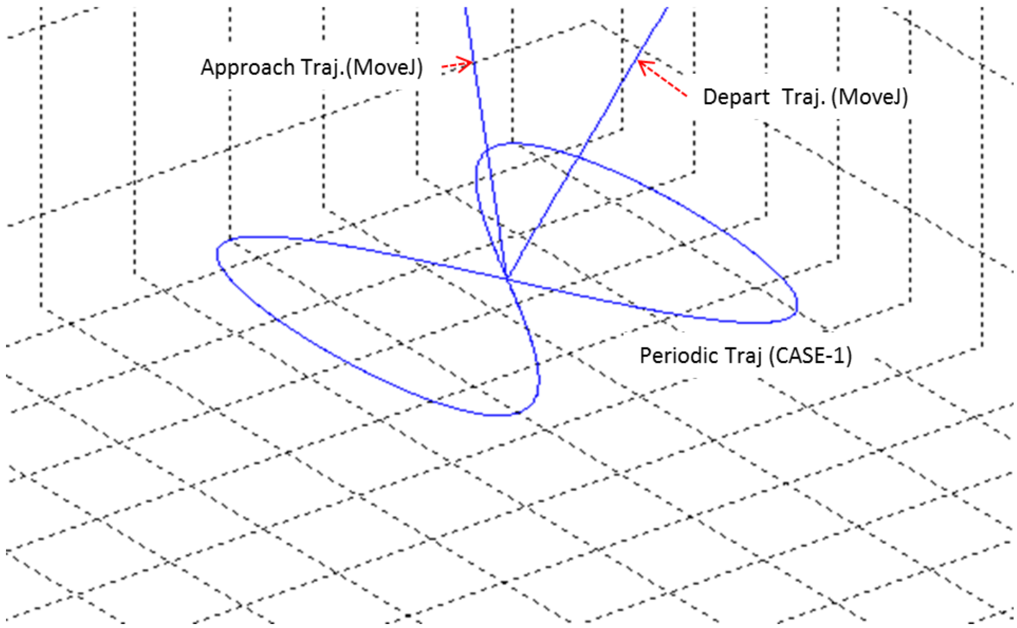
| Parameter Name | Data Type | Default Value | Range | Description |
|---|---|---|---|---|
| amp | list (float[6]) | - | 0≤amp | Amplitude (motion between -amp and +amp) [mm] or [deg] |
| period | float or<br>list (float[6]) | | 0≤period | Period (time for 1 cycle) [sec] |
| atime | float | 0.0 | 0≤atime | Acc-, dec- time [sec] |
| repeat | int | 1 | > 0 | Repetition count |
| ref | int | DR_TOOL | - | reference coordinate<br>· DR_BASE : base coordinate<br>· DR_WORLD: world coordinate<br>· DR_TOOL : tool coordinate<br>· 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.
- **The DR_WORLD argument of ref is only available in M2.40 or later versions.**
- 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()**

## 8.33 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()**

## 8.34 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()**

## 8.35 stop(st_mode)

### ▪ Features

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.

### ▪ Parameters

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| st_mode | int | - | stop mode<br>・ DR_QSTOP_STO: Stop Category 1<br>・ DR_QSTOP: Stop Category 2<br>・ DR_SSTO: Stop Category 2<br>・ DR_HOLD: emergency 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()**

## 8.36 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()**

## 8.37 enable_alter_motion(n, mode, ref, limit_dPOS, limit_dPOS_per)

- **Features**

**This functionis only available for M2.40 or later versions.**
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<br>• DR_DPOS : accumulation amount<br>• DR_VEL : increment amount |
| ref | int | None | reference coordinate<br>• DR_BASE : base coordinate<br>• DR_WORLD : world coordinate<br>• DR_TOOL : tool coordinate<br>user coordinate: user defined |
| limit_dPOS | list(float[2]) | None | First value : limitation of position[mm]<br>Second value : limitation of orientation[deg] |
| Limit_dPOS_per | list(float[2]) | None | Fist value : limitation of position[mm]<br>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.

## 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

```
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()**

## 8.38 Alter_motion([x,y,z,rx,ry,rz])

### Features

**This functionis only available for M2.40 or later versions.**
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 |

### 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

```
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()**

## 8.39 disalbe_alter_motion()

### ▪ Features

**This functionis only available for M2.40 or later versions.**
This function deactivates alter motion.

### ▪ 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

```
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)

# 9. Auxiliary Control Functions

## 9.1 get_control_mode()

### ▪ Features

This function returns the current control mode.

### ▪ Parameters

Not applicable

### ▪ Return

| Value | Description |
|---|---|
| int | Control mode<br>3 : Position control mode<br>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

## 9.2 get_control_space()

### ▪ Features

This function returns the current control space.

### ▪ Parameters

Not applicable

### ▪ Return

| Value | Description |
|---|---|
| int | Control mode<br>1 : Joint space control<br>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

## 9.3 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()
```

## 9.4 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()**

## 9.5 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()**

## 9.6 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()**

## 9.7 get_current_posx(ref)

### ▪ Features

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

### ▪ Parameters

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

**Note**

· **The ref argument is only available in M2.40 or later versions.**

### ▪ Return

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

### ▪ 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
```

## 9.8 get_current_tool_flange_posx()

- **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<br>• DR_BASE : base coordinate<br>• DR_WORLD : world coordinate |

**Note**

- **The ref argument is only available in M2.40 or later versions.**

- **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

## 9.9 get_current_velx()

- **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<br>• DR_BASE : base coordinate<br>• DR_WORLD : world coordinate |

**Note**

- **The ref argument is only available in M2.40 or later versions.**

- **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()**

## 9.10 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<br>・ DR_BASE : base coordinate<br>・ DR_WORLD : world coordinate<br>・ user coordinate: User defined |

**Note**

- ref: DR_BASE (base coordinate)/user coordinate (globally declared user coordinate)
- DR_BASE is applied when ref is omitted.
- **The DR_WORLD argument of ref is only available in M2.40 or later versions.**

### ▪ 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()

## 9.11 get_desired_velx()

- **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**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| ref | Int | DR_BASE | reference coordinate<br>• DR_BASE : base coordinate<br>• DR_WORLD : world coordinate |

**Note**

- **The ref argument is only available in M2.40 or later versions.**

- **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()**

## 9.12 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 |

## 9.13 get_current_rotm(ref)

### Features

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

### Parameters

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| ref | Int | DR_BASE | reference coordinate<br>· DR_BASE : base coordinate<br>· DR_WORLD : world coordinate |

**Note**

- **The ref argument is only available in M2.40 or later versions.**

### 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.
```

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

### Related commands

Not applicable

## 9.14 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()**

## 9.15 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()**

## 9.16 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<br>• DR_BASE : base coordinate<br>• DR_WORLD : world coordinate |

**Note**

- **The ref argument is only available in M2.40 or later versions.**

### ▪ 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()
```

### ▪ Related commands

**get_joint_torque()/get_external_torque()**

## 9.17 get_solution_space(pos)

### ▪ Features

This function obtains the solution space value.

### ▪ Parameters

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

# 10. Other Settings and Safety-related Functions

## 10.1 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()**

# 10.2 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()**

## 10.3 set_tool(name)

- **Features**

This function retrieves the tool data registered in the Teach Pendant by name.

- **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")    # Calls the "tool1" data registered in the TP and sets it as the tool.
```

- **Related commands**

set_tcp()

## 10.4 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()

## 10.5 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<br>DR_TASK_STOP : Deceleration/ Warning/ Task termination<br>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()

# 11. Force/Stiffness Control and Other User-Friendly Features

## 11.1 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<br>list (float[6]) | - | posx or<br>position list |
| x2 | posx<br>list (float[6]) | - | posx or<br>position list |
| x3 | posx<br>list (float[6]) | - | posx or<br>position list |
| axis | int | - | axis<br>· DR_AXIS_X: x-axis<br>· DR_AXIS_Y: y-axis<br>· DR_AXIS_Z: z-axis |
| ref | int | DR_BASE | reference coordinate<br>· DR_BASE: base coordinate<br>· DR_WORLD: world coordinate<br>· user coordinate : user difined |

**Note**

- **The ref argument is only available in M2.40 or later versions.**

- **Return**

| Value | Description |
|---|---|
| 0 | Success |

| Value | Description |
|---|---|
| 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)
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()**

## 11.2 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<br>· DR_AXIS_X: x-axis<br>· DR_AXIS_Y: y-axis<br>· DR_AXIS_Z: z-axis |
| ref | int | DR_BASE | reference coordinate<br>· DR_BASE: base coordinate<br>· DR_WORLD: world coordinate<br>· user coordinate: user defined |

**Note**

· **The ref argument is only available in M2.40 or later versions.**

▪ **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()**

## 11.3 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<br>list (float[6]) | - | posx or<br>position list |
| x2 | posx<br>list (float[6]) | - | posx or<br>position list |
| x3 | posx<br>list (float[6]) | - | posx or<br>position list |
| pos | posx<br>list (float[6]) | - | posx or<br>position list |
| axis | int | - | axis<br>• DR_AXIS_X: x-axis<br>• DR_AXIS_Y: y-axis<br>• DR_AXIS_Z: z-axis |
| ref | int | DR_BASE | reference coordinate<br>• DR_BASE: base coordinate<br>• DR_WORLD: world coordinate<br>• user coordinate: user defined |

**Note**

- **The ref argument is only available in M2.40 or later versions.**

### ▪ 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)

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()**

## 11.4 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<br>list (float[6]) | - | posx or<br>position list |
| axis | int | - | axis<br>· DR_AXIS_X: x-axis<br>· DR_AXIS_Y: y-axis<br>· DR_AXIS_Z: z-axis |
| ref | int | DR_BASE | reference coordinate<br>· DR_BASE: base coordinate<br>· DR_WORLD: world coordinate<br>user coordinate: user defined |

**Note**

- **The MOVE_REFERENCE_WORLD argument of ref is only available in M2.40 or later versions.**

### ▪ 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 |

| Exception | Description |
|---|---|
| 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()**

## 11.5 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<br>・ DR_AXIS_X: x-axis<br>・ DR_AXIS_Y: y-axis<br>・ 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()**

## 11.6 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()**

## 11.7 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<br>Three rotational stiffnesses |
| time | float | 0 | Stiffness varying time [sec]<br>Range: 0 - 1.0<br>* 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()**

## 11.8 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<br>Three rotational stiffnesses |
| time | float | 0 | Stiffness varying time [sec]<br>Range: 0 - 1.0<br>* 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()**

## 11.9 calc_coord(x1, x2, x3, x4, ref, mod)

### ▪ Features

**This functionis only available for M2.50 or later versions.**

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 | Posx<br>list (float[6]) | - | posx or<br>position list |
| x2 | Posx<br>list (float[6]) | - | posx or<br>position list |
| x3 | Posx<br>list (float[6]) | - | posx or<br>position list |
| x4 | Posx<br>list (float[6]) | - | posx or<br>position list |
| ref | int | DR_BASE | reference coordinate |

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| | | | · DR_BASE: base coordinate<br>· 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()

## 11.10 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<br>list (float[6])<br>list (float[6]) | - | coordinate information (position and orientation) |
| ref | int | DR_BASE | reference coordinate<br>· DR_BASE: base coordinate<br>· DR_WORLD: world coordinate |

### ▪ Return

| Value | Description |
|---|---|
| Positive integer | Successful coordinate setting<br>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()

# 11.11 set_user_cart_coord(x1, x2, x3, pos, ref)

## ▪ Features

The user can set the new rectangular coordinate system using x1, x2, and x3 based on the ref coordinate. Creates a rectangular coordinate system with ux, uy, and uz as the vector for each axis and origin point is the pos based on the ref coordinate assuming that [1)]ux is the unit vector of x1x2 and uy is the unit vector of the vector that represents the shortest distance between x1x2 and x3. A maximum of 20 can be used, and the most recent 20 values are used if there are more than 20.

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

## ▪ Parameters

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

**Note**

- **The ref argument is only available in M2.40 or later versions.**

## ▪ Return

| Value | Description |
|---|---|
| Positive integer | Successful coordinate setting<br>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)
x4 = posx(300, 110, 510, 0, 0)
pos = posx(10, 20, 30, 0, 0, 0)
user_tc1 = set_user_cart_coord(x1, x2, x3, pos, DR_BASE)
user_tc2 = set_user_cart_coord(x2, x3, x4, pos, DR_WORLD)
```

## Related commands

set_ref_coord()

## 11.12 set_user_cart_coord(u1, v1, pos, ref)

### ▪ Features

The user can set the new rectangular coordinate system using u1 and v1 based on the ref coordinate. The origin point of the rectangular coordinate system is pos based on the ref coordinate while the x-axis and y-axis bases are given in the vectors u1 and v1, respectively. Other directions are determined by u1 x 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.

### ▪ Parameters

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

**Note**

- **The ref argument is only available in M2.40 or later versions.**

### ▪ Return

| Value | Description |
|---|---|
| Positive integer | Successful coordinate setting<br>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_tc1 = set_user_cart_coord(u1, v1, pos, DR_WORLD)
```

- **Related commands**

set_ref_coord()

# 11.13 overwrite_user_cart_coord(id, pos, ref)

## Features

**This functionis only available for M2.50 or later versions.**

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 | - | posx or position list |
| time | 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_coord(pose_user1, ref=DR_BASE)
pose_user2 = posx(100, 150, 200, 45, 180, 0)
overwrite_user_coord(id_user, pose_user2, ref=DR_BASE)
```

## Related commands

set_user_cart_coord

## 11.14 get_user_cart_coord(id)

- **Features**

This functionis only available for M2.50 or later versions.

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_coord(pose_user1, ref=DR_BASE)
pose, ref = get_user_cart_coord(id_user)
```

- **Related commands**

set_user_cart_coord()

## 11.15 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<br>Three rotational target moments |
| dir | int[6] | [0, 0, 0, 0, 0, 0] | Force control in the corresponding direction if 1<br>Compliance control in the corresponding direction if 0 |
| time | float | 0 | Transition time of target force to take effect [sec]<br>Range: 0 - 1.0 |
| mod | int | DR_FC_MOD_ABS | DR_FC_MOD_ABS: Force control with absolute value<br>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

```
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)
# 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
```

## Related commands

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

## 11.16 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<br>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()

## 11.17 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.

### ▪ Parameters

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

## 11.18 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<br>・ DR_AXIS_X: x-axis<br>・ DR_AXIS_Y: y-axis<br>・ DR_AXIS_Z: z-axis<br>・ DR_AXIS_A: x-axis rotation<br>・ DR_AXIS_B: y-axis rotation<br>・ 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<br>・ DR_BASE : base coordinate<br>・ DR_WORLD : world coordinate<br>・ DR_TOOL : tool coordinate<br>・ 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 |

| Exception | Description |
|---|---|
| DR_Error (DR_ERROR_RUNTIME) | C extension module error occurred |
| 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

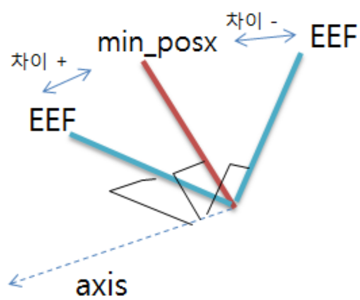
**check_position_condition()/check_orientation_condition()/set_ref_coord()**

## 11.19 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<br>· DR_AXIS_A: x-axis rotation<br>· DR_AXIS_B: y-axis rotation<br>· DR_AXIS_C: z-axis rotation |
| min | posx<br>list (float[6]) | - | posx or<br>position list |
| max | posx<br>list (float[6]) | - | posx or<br>position list |

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| ref | int | None | reference coordinate<br>· DR_BASE : base coordinate<br>· DR_WORLD : world coordinate<br>· DR_TOOL : tool coordinate<br>· user coordinate: User defined |
| mod | int | DR_MV_MOD_ABS | Movement basis<br>· 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()**

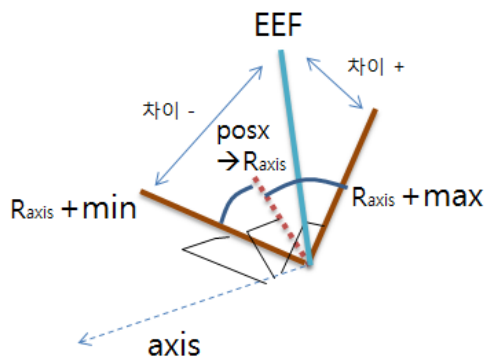
/set_ref_coord()

## 11.20 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<br>· DR_AXIS_X: x-axis rotation<br>· DR_AXIS_Y: y-axis rotation<br>· DR_AXIS_Z: z-axis rotation |
| min | float | DR_COND_NONE | Minimum value |

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| max | float | DR_COND_NONE | Maximum value |
| ref | int | None | reference coordinate<br>· DR_BASE : base coordinate<br>· DR_WORLD : world coordinate<br>· DR_TOOL : tool coordinate<br>· user coordinate: User defined |
| mod | int | DR_MV_MOD_ABS | Movement basis<br>· DR_MV_MOD_REL: Relative |
| pos | posx<br>list (float[6]) | - | posx or<br>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()

# 11.21 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<br>· DR_BASE : base coordinate<br>· DR_WORLD : world coordinate<br>· DR_TOOL : tool coordinate<br>· user coordinate: User defined |
| ref_out | float | DR_COND_NONE | reference coordinate after transformation<br>· DR_BASE : base coordinate |

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| | | | • DR_WORLD : world coordinate<br>• DR_TOOL : tool coordinate<br>• 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()**

# 12. System Functions

## 12.1 Robot Mode

### 12.1.1 set_robot_mode(robot_mode)

- **Features**

This function is to set the operation mode (manual / automatic) of the robot controller. Motion command is available in both modes, but manual handguiding is available in manual mode and operates in deceleration mode for safety.

In automatic mode, manual handguiding is not possible and operates in normal speed mode.

Manual mode: robot LED lights up blue

Auto mode: robot LED lights up in white

- **Parameters**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| Robot_mode | int | - | • ROBOT_MODE_MANUAL : 0<br>• ROBOT_MODE_AUTONOMOUS : 1 |

- **Return**

| Value | Description |
|---|---|
| 0 | Success |
| Negative value | Failed |

- **Example**

```
#...
set_robot_mode(ROBOT_MODE_MANUAL)
#...
#...
#...
set_robot_mode(ROBOT_MODE_AUTONOMOUS)
...
```

### 12.1.2 get_robot_mode()

- **Features**

This function reads the current operating mode of the robot controller.

- **Parameters**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| none | - | - | - |

- **Return**

| Value | Description |
|---|---|
| ROBOT_MODE_MANUAL (0) | Robot mode is manual. |
| ROBOT_MODE_AUTONOMOUS (1) | Robot mode is auto. |

- **Example**

```
#...
if get_robot_mode() != ROBOT_MODE_AUTONOMOUS:
    set_robot_mode(ROBOT_MODE_AUTONOMOUS)
#...
```

## 12.1.3 get_last_alarm()

- **Feature**

로봇 제어기의 최근 알람 로그를 읽어오는 함수입니다.

- **Parameters**

Not applicable

- **Return**

| Value | Description |
|---|---|
| level | 로그 메시지 레벨<br>0 : Info<br>1 : Warning<br>2 : Alarm |
| group | 로그 메시지 그룹 |
| index | 알람 로그 번호 |
| param | 알람 로그 파라미터 |

- **Example**

```
#...
index = get_last_alarm().index
print(str(index))
#...
```

### 12.1.4 set_safe_stop_reset_type(reset_type)

- **Feature**

When the operation status information of the robot controller is SAFE_STOP, it is a function to define a series of actions that are automatically executed after the change of status using the set_robot_control function. If the robot operation mode is automatic, the program can be defined and set again. In the manual mode, this setting is ignored.

- **Parameters**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| reset_type | int8 | 0 | Reset Type<br>STOP : 1<br>RESUME : 2 |

- **Return**

| Value | Description |
|---|---|
| 0 | Success |
| 1 | Failed |

- **Example**

```
#...
robot_state = get_robot_mode()
if robot_state == ROBOT_MODE_AUTONOMOUS:
   set_safe_reset_type(SAFE_STOP_PROGRAM_RESUME);
#...
```

## 12.1.5 set_robot_speed_mode(speed_mode)

- **Feature**

This is a function for setting and changing the speed mode currently being operated by the controller.

- **Parameters**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| speed_mode | int8 | - | Robot Speed mode<br>0 : normal mode<br>1 : reduced mode |

- **Return**

| Value | Description |
|---|---|
| 0 | Failed |
| 1 | Success |

- **Example**

```
if get_robot_speed_mode() == SPEED_REDUCED_MODE:
    #When in deceleration mode, change to constant speed mode
    set_robot_speed_mode(SPEED_NORMAL_MODE)
```

## 12.1.6 get_robot_speed_mode()

- **Feature**

This is a function to check the current speed mode (normal mode, deceleration mode) information from the robot controller.

- **Parameters**

Not applicable

- **Return**

| Value | Description |
| --- | --- |
| robot_speed | robot speed mode<br>0 : normal mode<br>1 : reduced mode |

- **Example**

```
if get_robot_speed_mode() == SPEED_REDUCED_MODE:
    # When in deceleration mode, change to constant speed mode
    set_robot_speed_mode(SPEED_NORMAL_MODE)
```

### 12.1.7 set_robot_system(robot_system)

- **Feature**

This is a function for setting and changing the current operating robot system in the robot controller.

- **Parameters**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| robot_system | int8 | - | robot system info<br>0 : Real<br>1 : Virtual |

- **Return**

| Value | Description |
|---|---|
| 0 | Failed |
| 1 | Success |

- **Example**

```
if(get_robot_system() != ROBOT_SYSTEM_REAL):
      #Automatic mode switching
      set_robot_system(ROBOT_SYSTEM_REAL)
else :
   #do somting …
```

### 12.1.8 get_robot_system()

- **Feature**

This function reads the current operating robot system from the robot controller.

- **Parameters**

Not applicable

- **Return**

| Value | Description |
| --- | --- |
| 0 | Real |
| 1 | Virtual |

- **Example**

```
if get_robot_system() != ROBOT_SYSTEM_REAL:
    # Automatic mode switching
    set_robot_system(ROBOT_SYSTEM_REAL)
else:
  #do somting …
```

### 12.1.9 get_robot_state()

- **Feature**

This is for checking the current operation status information of the robot controller.

- **Parameters**

Not applicable

- **Return**

| Value | Description |
|---|---|
| robot_state | Robot status<br>0 : Initializing<br>1 : Standby<br>2 : Moving<br>3 : SAFE OFF<br>4 : Teaching<br>5 : SAFE STOP<br>6 : Emergency Stop<br>7 : Homming<br>8 : Recovery |

- **Example**

```
if get_robot_state() == STATE_STANDBY:
    if get_robot_mode() == ROBOT_MODE_AUTONOMOUS:
        # Manual Mode
        # do something
```

## 12.2 IO

### 12.2.1 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<br>• Val argument existing: A number between 1 and 16<br>• No val argument: 1 ~ 16 , -1 ~ -16<br>(A positive number means ON while a negative number means OFF.) |
| val | int | - | I/O value<br>• ON: 1<br>• 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.)
```

## 12.2.2 get_digital_output(index)

- **Features**

This service reads the current digital IO output status

.

- **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**

```
out_state1 = get_digital_output(1)          #Read of current output status of contact 1
out_state8 = get_digital_output(8)          #Read of current output status of contact 8
```

## 12.2.3 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
```

## 12.2.4 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<br>• Val argument existing: A number between 1 and 6<br>• No val argument: 1 ~ 6 , -1 ~ -6<br>(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.)
```

## 12.2.5 get_tool_digital_output(index)

### ▪ Features

This service reads the current tool IO output status.

### ▪ 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

```
out_state1 = get_tool_digital_output(1)     # Read of current output status of contact 1
out_state6 = get_tool_digital_output(6)     # Read of current output status of contact 6
```

### 12.2.6 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
```

## 12.2.7 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<br>• 2 : channel 2 |
| mod | int | - | analog io mode<br>• DR_ANALOG_CURRENT: Current mode<br>• 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)
```

## 12.2.8 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<br>• 2 : channel 2 |
| mod | int | - | analog io mode<br>• DR_ANALOG_CURRENT: Current mode<br>• 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)
```

### 12.2.9 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<br>• 2 : channel 2 |
| val | float | - | analog output value<br>• Current mode: 4.0~20.0 [mA]<br>• 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
```

### 12.2.10 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<br>• 2 : channel 2 |

- **Return**

| Value | Description |
|---|---|
| float | The analog input value of the specified channel<br>• Current mode: 4.0~20.0 [mA]<br>• 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.
```

# 13. External Communication Functions

## 13.1 Modbus

### 13.1.1 add_modbus_signal (ip, port, name, reg_type, index, value=0)

- **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<br>• DR_MODBUS_DIG_INPUT<br>• DR_MODBUS_DIG_OUTPUT<br>• DR_MODBUS_REG_INPUT<br>• DR_MODBUS_REG_OUTPUT |
| index | int | - | Modbus signal index |
| value | int | 0 | Output when the type is DR_MODBUS_DIG_OUTPUT or DR_MODBUS_REG_OUTPUT (ignored otherwise) |
| slaveid | int | 255 | • Slave ID of the ModbusTCP module (0 or 1-247 or 255)<br>0 : Broadcase address<br>255 : Default value for ModbusTCP |

**Note**

- The slaveid argument is only available in M2.40 and later versions.

- **Return**

| Value | Description |
|---|---|
| 0 | Success |

| Value | Description |
| --- | --- |
| 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 192.168.127.254, 8 input points: “di1” - ”di8”, 8 output points: “do1” - "do8”
#Modbus IO 2: IP 192.168.127.253, 8 input points: “di9” - "di16”, 8 output points: “do9” - "do16”

# set <modbus 1> input : di1~di8
add_modbus_signal(ip="192.168.127.254",port=502, name="di1", reg_type=DR_MODBUS_REG_INPUT, index=0)
add_modbus_signal(ip="192.168.127.254",port=502, name="di2", reg_type=DR_MODBUS_REG_INPUT, index=1)
add_modbus_signal(ip="192.168.127.254",port=502, name="di3", reg_type=DR_MODBUS_REG_INPUT, index=2)
add_modbus_signal(ip="192.168.127.254",port=502, name="di4", reg_type=DR_MODBUS_REG_INPUT, index=3)
add_modbus_signal(ip="192.168.127.254",port=502, name="di5", reg_type=DR_MODBUS_REG_INPUT, index=4)
add_modbus_signal(ip="192.168.127.254",port=502, name="di6", reg_type=DR_MODBUS_REG_INPUT, index=5)
add_modbus_signal(ip="192.168.127.254",port=502, name="di7", reg_type=DR_MODBUS_REG_INPUT, index=6)
add_modbus_signal(ip="192.168.127.254",port=502, name="di8", reg_type=DR_MODBUS_REG_INPUT, index=7)

# set <modbus 1> output : do1~do8
add_modbus_signal(ip="192.168.127.254",port=502, name="do1", reg_type=DR_MODBUS_REG_OUTPUT, index=0, value=0)
add_modbus_signal(ip="192.168.127.254",port=502, name="do2", reg_type=DR_MODBUS_REG_OUTPUT, index=1, value=0)
add_modbus_signal(ip="192.168.127.254",port=502, name="do3", reg_type=DR_MODBUS_REG_OUTPUT, index=2, value=0)
add_modbus_signal(ip="192.168.127.254",port=502, name="do4", reg_type=DR_MODBUS_REG_OUTPUT, index=3, value=0)
add_modbus_signal(ip="192.168.127.254",port=502, name="do5", reg_type=DR_MODBUS_REG_OUTPUT, index=4, value=0)
```

```
add_modbus_signal(ip="192.168.127.254",port=502, name="do6",
reg_type=DR_MODBUS_REG_OUTPUT, index=5, value=0)
add_modbus_signal(ip="192.168.127.254",port=502, name="do7",
reg_type=DR_MODBUS_REG_OUTPUT, index=6, value=0)
add_modbus_signal(ip="192.168.127.254",port=502, name="do8",
reg_type=DR_MODBUS_REG_OUTPUT, index=7, value=0)

#=============================================================
# set <modbus 2> input : di9~di16
add_modbus_signal(ip="192.168.127.253",port=502, name="di9",
reg_type=DR_MODBUS_REG_INPUT, index=0)
add_modbus_signal(ip="192.168.127.253",port=502, name="di10",
reg_type=DR_MODBUS_REG_INPUT, index=1)
add_modbus_signal(ip="192.168.127.253",port=502, name="di11",
reg_type=DR_MODBUS_REG_INPUT, index=2)
add_modbus_signal(ip="192.168.127.253",port=502, name="di12",
reg_type=DR_MODBUS_REG_INPUT, index=3)
add_modbus_signal(ip="192.168.127.253",port=502, name="di13",
reg_type=DR_MODBUS_REG_INPUT, index=4)
add_modbus_signal(ip="192.168.127.253",port=502, name="di14",
reg_type=DR_MODBUS_REG_INPUT, index=5)
add_modbus_signal(ip="192.168.127.253",port=502, name="di15",
reg_type=DR_MODBUS_REG_INPUT, index=6)
add_modbus_signal(ip="192.168.127.253",port=502, name="di16",
reg_type=DR_MODBUS_REG_INPUT, index=7)

# set <modbus 2> output : do9~do16
add_modbus_signal(ip="192.168.127.253",port=502, name="do9",
reg_type=DR_MODBUS_REG_OUTPUT, index=0, value=0)
add_modbus_signal(ip="192.168.127.253",port=502, name="do10",
reg_type=DR_MODBUS_REG_OUTPUT, index=1, value=0)
add_modbus_signal(ip="192.168.127.253",port=502, name="do11",
reg_type=DR_MODBUS_REG_OUTPUT, index=2, value=0)
add_modbus_signal(ip="192.168.127.253",port=502, name="do12",
reg_type=DR_MODBUS_REG_OUTPUT, index=3, value=0)
add_modbus_signal(ip="192.168.127.253",port=502, name="do13",
reg_type=DR_MODBUS_REG_OUTPUT, index=4, value=0)
add_modbus_signal(ip="192.168.127.253",port=502, name="do14",
reg_type=DR_MODBUS_REG_OUTPUT, index=5, value=0)
add_modbus_signal(ip="192.168.127.253",port=502, name="do15",
reg_type=DR_MODBUS_REG_OUTPUT, index=6, value=0)
add_modbus_signal(ip="192.168.127.253",port=502, name="do16",
reg_type=DR_MODBUS_REG_OUTPUT, index=7, value=0)
```

## 13.1.2 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 “di1” and
"do1”
# and this signal registration is to be deleted. .
del_modbus_signal("di1")          # Deletes the registered “di1” contact
del_modbus_signal("do1")          # Deletes the registered “do1” contact
```

## 13.1.3 set_modbus_output(iobus, val)

### ▪ Features

This function sends the signal to an external Modbus system.

### ▪ Parameters

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| iobus | string | - | Modbus name (set in the TP) |
| value | int | - | Modbus digital I/O<br>• ON : 1<br>• OFF : 0 |
| | | | Value for Modbus analog I/O |

### ▪ 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 is connected, and the signals are registered as “do1” and “do2”.
set_modbus_output("do1", ON)
set_modbus_output("do2", OFF)

#Modbus analog I/O is connected, and the signals are registered as “reg1” and “reg2”.
set_modbus_output("reg1", 10)
set_modbus_output("reg2", 24)
```

### 13.1.4 get_modbus_input(iobus)

- **Features**

This function reads the signal from the Modbus system.

- **Parameters**

| Parameter Name | Data Type | Default Value | Description |
|---|---|---|---|
| iobus | string | - | Modbus name (set in the TP) |

- **Return**

| Value | Description |
|---|---|
| 0 or 1 | ON or Off in the case of the Modbus digital I/O |
| value | The register value in the case of<br>the Modbus analog module |

- **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")
```