EPSON

# Epson RC+ 8.0 Option
# Force Guide 8.0
# SPEL+ Language Reference

Original instructions

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# 1. FOREWORD

## 1.1 Introduction

Thank you for purchasing this Epson robot system. This manual provides the information necessary for correctly using the robot system.
Before using the system, please read this manual and related manuals to ensure correct use.
After reading this manual, store it in an easily accessible location for future reference.

Epson conducts rigorous testing and inspection to ensure that the performance of our robot systems meets our standards. Please note that if the Epson robot system is used outside the operating conditions described in the manual, the product will not perform up to its basic performance.

This manual describes potential hazards and problems that are foreseen. To use the Epson robot system safely and correctly, be sure to follow the safety information contained in this manual.

## 1.2 Trademarks

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## 1.3 Notation

Microsoft® Windows® 10 operating system
Microsoft® Windows® 11 operating system
In this manual, the above operating systems are referred to as Windows 10 and Windows 11, respectively. Windows 10 and Windows 11 are sometimes collectively referred to as Windows.

## 1.4 Terms of Use

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The information in this document is subject to change without notice.
Please contact us if you find any errors in this document or if you have any questions about the information in this document.

## 1.5 Manufacturer

**SEIKO EPSON CORPORATION**

## 1.6 Contact Information

Contact information details are listed in the "Supplier" section in the following manual.
Note that the contact information may vary depending on your region.
"Safety Manual - Contact Information"

The Safety Manual is also available at the following site.
URL: https://download.epson.biz/robots/

## 1.7 Disposal

When disposing of this product, please do so in accordance with the laws and regulations of your country.

# 2. Summary

This reference manual explains the Force Guide 8.0 object properties and status, as well as all of the Force Guide 8.0 SPEL+ commands.
Refer to the following manual for how to use Force Guide 8.0.
“Epson RC+ 8.0 Option Force Guide 8.0”

# 2.1 Explanation of Force Guide 8.0 Properties and Statuses Format

This manual explains all Force Guide 8.0 properties and statuses. The items explained on each reference page are as follows.

| | |
|---|---|
| **Application** | When Property or Status is used with Force Object, this indicates which respective properties are applied to which force object.<br>(Examples: Force Coordinate System Object FCS#,<br>Force Control Object FC#,<br>Force Trigger Object FT#,<br>Force Monitor Object FM#…) |
| Comments | Contains a simple explanation of each property or status. |
| Immediate Execution | When “Yes”:<br>Reflected in motion directly after execution in the FSet string<br>When “No”:<br>After the properties are set and the motion command is executed, the motion, reflecting the established properties, is executed |
| Usage | Explains the SPEL+ Language property, or the method to access the status SPEL |
| Values | Explains the range for values which can be set in properties, or explains the range of the status return value |
| Detailed Explanation | This gives greater detail than that which is contained in the comments.<br>Specific warnings and special instructions are given for each property. Be sure to read this prior to using that property. |
| Usage Example | This gives usage examples for properties, statuses, functions, statements and commands. |
| Reference | This lists related properties, statuses, force objects, and other related items. |

# 3. Force Guide 8.0 Command Table

## 3.1 Robot Control Related Commands

| | |
|---|---|
| FCKeep | Activates the force control function, and when the specified amount of time has elapsed, a stop is executed. |
| FCEnd | Stops the active force control function. |
| GetRobotFCOn | Returns the robot number of the robot executing the force control function. |
| FCOn | Determines if the specified robot is executing the force control function. |
| FCElapsedTime | Returns the duration after started the force control function of the specified robot. |
| Move | Activates force control and executes a linear interpolation motion. |
| TMove | Executes an offset linear interpolation motion in the current tool coordinate system with the force control function active. |
| BMove | This executes in the local selected coordinate system an offset linear interpolation motion with the force control active. |
| CVMove | Activates force control and executes a free curve CP motion. |
| Arc3 | Moves the robot in a circular interpolation motion in 3 dimensions with the force control active. |
| Arc | Moves the robot in a circular interpolation motion in the XY plane with the force control active. |
| FCSMove | Executes an offset linear interpolation motion in the specified force coordinate system. |
| F_CheckPos | Returns whether specified position is satisfied trigger condition set in FMR object. |

## 3.2 Force Object Related Commands

| | |
|---|---|
| FGet | This is used when acquiring the properties or status of a force object. |
| FSet | Used when setting the value of force object properties. |
| FLoad | Loads all force objects from the disc into the current project. |
| FSave | Saves all force objects from the current project to the disc. |
| FExport | Exports the project force files for the project currently selected. |
| FImport | Imports force files into the currently selected robot project. |
| FDef | Indicates whether the force object is defined or not. |
| FDel | Deletes the force object. |
| FList | Displays a list of objects. |
| FLabel$ | Returns the label for the force object and the force sensor object. |
| FNumber | Returns the number of the force object by type. |

## 3.3 Mass Property Object Related Commands

| | |
|---|---|
| MPGet | Used when obtaining the Mass Property Object value. |
| MPSet | Used when setting the Mass Property Object value. |

| | |
|---|---|
| MP | Sets or returns the number for the Mass Property Object to be used. |
| MPDef | Indicates whether the Mass Property Object is defined or not. |
| MPDel | Deletes the Mass Property Object. |
| MPList | Displays a list of Mass Property Objects. |
| MPNumber | Returns the number of the Mass Property Object. |
| MPLabel$ | Returns the Mass Property Object label. |

## 3.4 Coordinate Conversion Related Commands

| | |
|---|---|
| F_FlangeOffset | This sets or returns the force sensor position and orientation in the Tool 0 (TCP0, J6 flange) coordinate system. |
| F_GravityDirection | Sets or returns the direction of gravity for the robot. |
| F_DestPos | Returns the virtual destination position before correction by force control function. |
| F_RefPos | Returns the current virtual command position f before correction by force control function. |
| F_OffsetPos | Returns the position of relative movement from the reference point. |

## 3.5 Force Guidance Related Commands

| | |
|---|---|
| FGRun | Executes a force guide sequence. |
| FGGet | Acquires a result of a force guide sequence or a force guide object. |

# 4. Object

# 4.1 Force Object - Common

### Description

A force object is an object (collectively) used when using the force function. The following are the types of objects.

- Force Sensor Object (FS)
- Force Coordinate System (FCS)
- Robot Object
- Force Control Object (FC)
- Force Trigger Object (FT)
- Force Monitor Object (FM)
- Force Motion Restriction Object (FMR)
- Mass Property Object (MP)

| | |
|---|---|
| Label | Sets or returns the object label. |
| Number | Sets or returns the number of the object by type. |
| Description | Sets or returns an explanation for an object. |

## 4.2 FS (Force Sensor) Object

### Description

This is a force sensor related object (collectively). It is used to control the sensor and obtain data, etc.

### Range

FS1 to FS4

| | |
|---|---|
| Reset | Resets the force sensor. |
| Reboot | Reboots the force sensor. |
| Label | Returns the force sensor label. |
| Description | Displays an explanation of the force sensor. |
| Model | Returns the model name of the force sensor. |
| SerialCode | Returns the serial code for the force sensor. |

# 4.3 FCS (Force Coordinate System) Object

### Description

This object (collectively) is used to convert the coordinate system in the direction of the user set values for force and torque. FCS0 corresponds to the set leading point of the tool.

### Range

FCS0 to FCS63

However, FCS0 corresponds to the coordinate system of the selected tool and cannot be modified.

| | |
|---|---|
| Position | Sets or returns the force coordinate origin. |
| Orientation | Sets or returns the orientation of the force coordinate coordinate-axis. |

### See Also

"Epson RC+ User’s Guide - Coordinate Systems"
"Epson RC+ User’s Guide - Robot Motion Commands"

# 4.4 Robot Object

**Description**

This object (collectively) is used to establish the installation settings for the robot to which the force sensor is installed, or for the purpose of obtaining data when the robot is operating / moving.

| | |
|---|---|
| FlangeOffset | Sets the positional relationship between Tool 0 (TCP0, J6 Flange) and the force sensor position. |
| GravityDirection | Sets or returns the direction of gravity for the robot. |
| StepID | Sets or returns the robot object StepID. |
| RefPos | Returns the command position for the first variable, including the force control.<br>Returns only the command position for the second variable, disregarding the effect of the force control. |

# 4.5 FC (Force Control) Object

### Description
This object (collectively) is used to fix the movement properties when executing the force control function.

### Range
FC0 to FC999

| | |
|---|---|
| CoordinateSystem | Sets or returns the force coordinates. |
| Fx_Enabled, Fy_Enabled, Fz_Enabled | Independently activates/inactivates, or returns the force control function of the translational direction. |
| Tx_Enabled, Ty_Enabled, Tz_Enabled | Independently activates/inactivates, or returns the force control function of the rotational direction. |
| Enabled | Activates/inactivates, or returns the force control function for each axis collectively. |
| Fx_Mass | Sets or returns the virtual coefficient of inertia for the force control on the X axis in the direction of the translational force. |
| Fx_Damper | Sets or returns the virtual coefficient of viscosity for the force control on the X axis in the direction of the translational force. |
| Fx_Spring | Sets or returns the virtual coefficient of elasticity for the force control on the X axis in the direction of the translational force. |
| Fx, Fy, Fz, Tx, Ty, Tz | Sets or returns the virtual coefficient of elasticity, the virtual coefficient of viscosity, and the virtual coefficient of inertia for the force control on the specified axis of the force coordinates. |
| Fy_Mass | Sets or returns the virtual coefficient of inertia for the force control on the Y axis in the direction of the translational force. |
| Fy_Damper | Sets or returns the virtual coefficient of viscosity for the force control on the Y axis in the direction of the translational force. |
| Fy_Spring | Sets or returns the virtual coefficient of elasticity for the force control on the Y axis in the direction of the translational force. |
| Fz_Mass | Sets or returns the virtual coefficient of inertia for the force control on the Z axis in the direction of the translational force. |
| Fz_Damper | Sets or returns the virtual coefficient of viscosity for the force control on the Z axis in the direction of the translational force. |
| Fz_Spring | Sets or returns the virtual coefficient of elasticity for the force control on the Z axis in the direction of the translational force. |
| Tx_Mass | Sets or returns the virtual coefficient of inertia for the force control in the rotational direction around the X axis. |
| Tx_Damper | Sets or returns the virtual coefficient of viscosity for the force control in the rotational direction around the X axis. |
| Tx_Spring | Sets or returns the virtual coefficient of elasticity for the force control in the rotational direction around the X axis. |
| Ty_Mass | Sets or returns the virtual coefficient of inertia for the force control in the rotational direction around the Y axis. |
| Ty_Damper | Sets or returns the virtual coefficient of viscosity for the force control in the rotational direction around the Y axis. |

| | |
|---|---|
| Ty_Spring | Sets or returns the virtual coefficient of elasticity for the force control in the rotational direction around the Y axis. |
| Tz_Mass | Sets or returns the virtual coefficient of inertia for the force control in the rotational direction around the Z axis. |
| Tz_Damper | Sets or returns the virtual coefficient of viscosity for the force control in the rotational direction around the Z axis. |
| Tz_Spring | Sets or returns the virtual coefficient of elasticity for the force control in the rotational direction around the Z axis. |
| TargetForcePriorityMode | Activates/inactivates or returns the target force priority mode. |
| Fx_TargetForce | Sets or returns the target force on the X axis in the direction of the translational force. |
| Fy_TargetForce | Sets or returns the target force on the Y axis in the direction of the translational force. |
| Fz_TargetForce | Sets or returns the target force on the Z axis in the direction of the translational force. |
| Tx_TargetForce | Sets or returns the target torque in the rotational direction around the X axis. |
| Ty_TargetForce | Sets or returns the target torque in the rotational direction around the Y axis. |
| Tz_TargetForce | Sets or returns the target torque in the rotational direction around the Z axis. |
| TargetForces | Simultaneously sets or returns the target force and target torque for each of the six axes. |
| MotionLimited | Returns the velocity and acceleration limits during force control. |
| LimitSpeedS | Sets or returns the maximum velocity limit for tool position change during force control. |
| LimitSpeedR | Sets or returns the maximum velocity limit for tool orientation change during force control. |
| LimitSpeedJ | Sets or returns the maximum velocity limit for joint movement during force control. |
| LimitSpeedSRJ | Sets or returns the maximum velocity limit for tool position change, tool orientation change, and joint movement during force control. |
| LimitAccelS | Sets or returns the maximum acceleration limit for tool position change during force control. |
| LimitAccelR | Sets or returns the maximum acceleration limit for tool orientation change during force control. |
| LimitAccelJ | Sets or returns the maximum acceleration limit for joint movement during force control. |
| LimitAccelSRJ | This sets or returns the maximum values of acceleration for joint acceleration, tool position modification, and tool orientation modification during force control. |

# 4.6 FT (Force Trigger) Object

### Description

This object (collectively) is used for changing the movement path based on the value from the force sensor, and for use with conditional branches.

### Range

FT0 to FT999

| | |
|---|---|
| ForceSensor | Sets or returns the number of the force sensor in question. |
| CoordinateSystem | Sets or returns the force coordinates. |
| TriggerMode | Sets or returns the object of the force trigger monitor. |
| Operator | Sets or returns the trigger conditions. |
| TillStopMode | Sets or returns the stop method when trigger conditions are met. |
| Fmag_Axes | Sets or returns the subject axis for calculating the resultant force. |
| Tmag_Axes | Sets or returns the subject axis for calculating the resultant torque. |
| Fx_Enabled, Fy_Enabled, Fz_Enabled | Independently activates/inactivates, or returns the force trigger of the translational direction. |
| Tx_Enabled, Ty_Enabled, Tz_Enabled | Independently activates/inactivates, or returns the force trigger of the rotational direction. |
| Fmag_Enabled | Activates/inactivates or returns the force trigger based on Fmag resultant force. |
| Tmag_Enabled | Activates/inactivates or returns the force trigger based on Tmag resultant torque. |
| Enabled | Activates/inactivates, or returns the force trigger for each axis collectively. |
| Fx_Polarity | Sets or returns for Fx whether the force trigger is activated or inactivated when values correspond to or do not correspond with threshold values. |
| Fy_Polarity | Sets or returns for Fy whether the force trigger is activated or inactivated when values correspond to or do not correspond with threshold values. |
| Fz_Polarity | Sets or returns for Fz whether the force trigger is activated or inactivated when values correspond to or do not correspond with threshold values. |
| Tx_Polarity | Sets or returns for Tx whether the force trigger is activated or inactivated when values correspond to or do not correspond with threshold values. |
| Ty_Polarity | Sets or returns for Ty whether the force trigger is activated or inactivated when values correspond to or do not correspond with threshold values. |
| Tz_Polarity | Sets or returns for Tz whether the force trigger is activated or inactivated when values correspond to or do not correspond with threshold values. |
| Fmag_Polarity | Sets or returns for resultant force whether the force trigger is activated or inactivated when values correspond to or do not correspond with threshold values. |
| Tmag_Polarity | Sets or returns for resultant torque whether the force trigger is activated or inactivated when values correspond to or do not correspond with threshold values. |
| Polarities | Sets or returns for each axis whether the force trigger is activated or inactivated when values correspond to or do not correspond with threshold values. |
| Fx_Levels | Sets or returns the upper and lower threshold values for Fx force. |

| | |
|---|---|
| Fy_Levels | Sets or returns the upper and lower threshold values for Fy force. |
| Fz_Levels | Sets or returns the upper and lower threshold values for Fz force. |
| Tx_Levels | Sets or returns the upper and lower threshold values for Tx torque. |
| Ty_Levels | Sets or returns the upper and lower threshold values for Ty torque. |
| Tz_Levels | Sets or returns the upper and lower threshold values for Tz torque. |
| Fmag_Levels | Sets or returns the upper and lower threshold values for resultant force. |
| Tmag_Levels | Sets or returns the upper and lower threshold values for resultant torque. |
| UpperLevels | Sets or returns the upper threshold values for force and torque for each axis simultaneously. |
| LowerLevels | Sets or returns the lower threshold values for force and torque for each axis simultaneously. |
| Fx_LPF_Enabled | Activates/inactivates or returns the low-pass filter applied to the force in the X axis in the direction of translation. |
| Fy_LPF_Enabled | Activates/inactivates or returns the low-pass filter applied to the force in the Y axis in the direction of translation. |
| Fz_LPF_Enabled | Activates/inactivates or returns the low-pass filter applied to the force in the Z axis in the direction of translation. |
| Tx_LPF_Enabled | Activates/inactivates or returns the low-pass filter applied to the torque around the X axis. |
| Ty_LPF_Enabled | Activates/inactivates or returns the low-pass filter applied to the torque around the Y axis. |
| Tz_LPF_Enabled | Activates/inactivates or returns the low-pass filter applied to the torque around the Z axis. |
| Fmag_LPF_Enabled | Activates/inactivates or returns the resultant force low-pass filter. |
| Tmag_LPF_Enabled | Activates/inactivates or returns the resultant torque low-pass filter. |
| LPF_Enabled | Activates/inactivates or returns the low-pass filters applied to each axis simultaneously. |
| Fx_LPF_TimeConstant | Sets or returns the time constant for the low-pass filter applied to the force in the X axis in the direction of translation. |
| Fy_LPF_TimeConstant | Sets or returns the time constant for the low-pass filter applied to the force in the Y axis in the direction of translation. |
| Fz_LPF_TimeConstant | Sets or returns the time constant for the low-pass filter applied to the force in the Z axis in the direction of translation. |
| Tx_LPF_TimeConstant | Sets or returns the time constant for the low-pass filter applied to the torque around the X axis. |
| Ty_LPF_TimeConstant | Sets or returns the time constant for the low-pass filter applied to the torque around the Y axis. |
| Tz_LPF_TimeConstant | Sets or returns the time constant for the low-pass filter applied to the torque around the Z axis. |
| Fmag_LPF_TimeConstant | Sets or returns the time constant for the low-pass filter applied to the resultant force. |
| Tmag_LPF_TimeConstant | This sets or returns the value of the time constant for the low-pass filter applied to resultant torque. |
| LPF_TimeConstants | Sets or returns the time constant for the low-pass filter applied to each axis simultaneously. |
| Triggered | Returns the status/condition of the force trigger. |
| TriggeredAxes | Returns the forced/not forced status of force triggers by axis. |
| TriggeredPos | Returns the met position for the force trigger conditions. |

| | |
|---|---|
| TriggeredForces | Returns force and torque when end conditions of force trigger are achieved. |

# 4.7 FM (Force Monitor) Object

### Description

This object (collectively) is used to display the value from the force sensor and when recording that value.

### Range

FM0 to FM255

| | |
|---|---|
| ForceSensor | Sets or returns the number of the force sensor in question. |
| CoordinateSystem | Sets or returns the force coordinates. |
| RobotLocal | Sets or returns the local coordinate system that will serve as the basis for robot positions. |
| RobotTool | Sets or returns the tool coordinate system that will serve as the basis for robot positions. |
| Fmag_Axes | Sets or returns the subject axis for calculating the resultant force. |
| Tmag_Axes | Sets or returns the subject axis for calculating the resultant torque. |
| Fx_LPF_Enabled | Activates/inactivates or returns the low-pass filter applied to the force in the X axis in the direction of translation. |
| Fy_LPF_Enabled | Activates/inactivates or returns the low-pass filter applied to the force in the Y axis in the direction of translation. |
| Fz_LPF_Enabled | Activates/inactivates or returns the low-pass filter applied to the force in the Z axis in the direction of translation. |
| Tx_LPF_Enabled | Activates/inactivates or returns the low-pass filter applied to the rotational force around the X axis. |
| Ty_LPF_Enabled | Activates/inactivates or returns the low-pass filter applied to the rotational force around the Y axis. |
| Tz_LPF_Enabled | Activates/inactivates or returns the low-pass filter applied to the rotational force around the Z axis. |
| Fmag_LPF_Enabled | Activates/inactivates or returns the resultant force low-pass filter. |
| Tmag_LPF_Enabled | Activates/inactivates or returns the resultant torque low-pass filter. |
| LPF_Enabled | Activates/inactivates or returns the low-pass filters applied to each axis simultaneously. |
| Fx_LPF_TimeConstant | Sets or returns the time constant for the low-pass filter applied to the force in the X axis in the direction of translation. |
| Fy_LPF_TimeConstant | Sets or returns the time constant for the low-pass filter applied to the force in the Y axis in the direction of translation. |
| Fz_LPF_TimeConstant | Sets or returns the time constant for the low-pass filter applied to the force in the Z axis in the direction of translation. |
| Tx_LPF_TimeConstant | Sets or returns the time constant for the low-pass filter applied to the rotational force around the X axis. |
| Ty_LPF_TimeConstant | Sets or returns the time constant for the low-pass filter applied to the rotational force around the Y axis. |
| Tz_LPF_TimeConstant | Sets or returns the time constant for the low-pass filter applied to the rotational force around the Z axis. |
| Fmag_LPF_TimeConstant | Sets or returns the time constant for the low-pass filter applied to the resultant force. |

| | |
|---|---|
| Tmag_LPF_TimeConstant | Sets or returns the time constant for the low-pass filter applied to the resultant torque. |
| LPF_TimeConstants | Sets or returns the time constant for the low-pass filter applied to each axis simultaneously. |
| AvgForceClear | Activates/inactivates force and torque averaging simultaneously. |
| PeakForceClear | Activates/inactivates force and torque peak value calculations simultaneously. |
| RecordEnd | Ends recording of sensor values, robot position/orientation, and StepID that starts by RecordStart property. |
| RecordStart | Begins recording of sensor values, robot position/orientation, StepID, and the time of data acquisition. |
| Fx_Force | Returns X axis force. |
| Fy_Force | Returns Y axis force. |
| Fz_Force | Returns Z axis force. |
| Tx_Force | Returns X axis torque. |
| Ty_Force | Returns Y axis torque. |
| Tz_Force | Returns Z axis torque. |
| Fmag_Force | Returns the resultant force for the force monitor object. |
| Tmag_Force | Returns the resultant torque for the force monitor object. |
| Forces | Returns all force data, torque data, resultant force data, and resultant torque data on force monitor object. |
| Fx_AvgForce | Returns average Fx force. |
| Fy_AvgForce | Returns average Fy force. |
| Fz_AvgForce | Returns average Fz force. |
| Tx_AvgForce | Returns average Tx torque. |
| Ty_AvgForce | Returns average Ty torque. |
| Tz_AvgForce | Returns average Tz torque. |
| Fmag_AvgForce | Returns average resultant force. |
| Tmag_AvgForce | Returns average resultant torque. |
| AvgForces | Returns average force and torque simultaneously. |
| Fx_PeakForce | Returns the peak Fx force. |
| Fy_PeakForce | Returns the peak Fy force. |
| Fz_PeakForce | Returns the peak Fz force. |
| Tx_PeakForce | Returns the peak Tx torque. |
| Ty_PeakForce | Returns the peak Ty torque. |
| Tz_PeakForce | Returns the peak Tz torque. |
| Fmag_PeakForce | Returns the resultant force peak. |
| Tmag_PeakForce | Returns the resultant torque peak. |

| | |
|---|---|
| PeakForces | Returns the resultant force and torque peaks simultaneously. |

# 4.8 FMR (Force Motion Restriction) Object

### Description

Force motion restriction is an object (collectively) used for changing the movement path based on the position of the robot, and for use with conditional branches.

### Range

FMR0 to FMR63

| | |
|---|---|
| ForceSensor | Sets or returns the number of the force sensor in question. |
| HoldTimeThresh | Sets or returns the duration to determine that trigger conditions have been achieved. |
| CoordinateSystem | Sets or returns the force coordinates. |
| Operator | Sets or returns the trigger conditions when multiple triggers are set. |
| RobotLocal | Sets or returns the local coordinate system that will serve as the basis for robot positions. |
| RobotTool | Sets or returns the tool coordinate system that will serve as the basis for robot positions. |
| TriggerMode | Sets or returns the object of the force motion restriction monitor. |
| DatumPoint | Sets or returns the reference point when TriggerMode is set to FG_REL_POINT. |
| PosX_Enabled | Sets or returns the enable/disable switch for the force motion restriction function for the position on the X axis. |
| PosY_Enabled | Sets or returns the enable/disable switch for the force motion restriction function for the position on the Y axis. |
| PosZ_Enabled | Sets or returns the enable/disable switch for the force motion restriction function for the position on the Z axis. |
| PosEnabled | Collectively sets or returns the enable/disable switch for the force motion restriction function for the position on each axis. |
| Dist_Enabled | Sets or returns the enable/disable switch for the force motion restriction function for the distance of the specified axis. |
| Rot_Enabled | Sets or returns the enable/disable switch for the force motion restriction function for the rotation angle of the specified axis. |
| J1_Enabled | Sets or returns the enable/disable switch for the force motion restriction function for the J1 joint position. |
| J2_Enabled | Sets or returns the enable/disable switch for the force motion restriction function for the J2 joint position. |
| J3_Enabled | Sets or returns the enable/disable switch for the force motion restriction function for the J3 joint position. |
| J4_Enabled | Sets or returns the enable/disable switch for the force motion restriction function for the J4 joint position. |
| J5_Enabled | Sets or returns the enable/disable switch for the force motion restriction function for the J5 joint position. |
| J6_Enabled | Sets or returns the enable/disable switch for the force motion restriction function for the J6 joint position. |
| JointEnabled | Collectively sets or returns the enable/disable switch for the force motion restriction function for each joint position. |

| | |
|---|---|
| Dist_Axes | Sets or returns the target axis for finding the force motion restriction range in relation to distance. |
| Rot_Axes | Sets or returns the target axis for finding the force motion restriction range in relation to rotation angle. |
| PosX_Polarity | Sets or returns whether to activate force motion restriction when the X axis position falls within, or outside the threshold range. |
| PosY_Polarity | Sets or returns whether to activate force motion restriction when the Y axis position falls within, or outside the threshold range. |
| PosZ_Polarity | Sets or returns whether to activate force motion restriction when the Z axis position falls within, or outside the threshold range. |
| PosPolarities | Collectively sets or returns whether to activate force motion restriction when the positions on each axis fall within, or outside the threshold range. |
| Dist_Polarity | Sets or returns whether to activate force motion restriction when the robot position falls within, or outside the threshold range for distance. |
| Rot_Polarity | Sets or returns whether to activate force motion restriction when the robot position falls within, or outside the threshold range for the rotation angle. |
| J1_Polarity | Sets or returns whether to activate force motion restriction when the J1 joint position falls within, or outside the threshold range. |
| J2_Polarity | Sets or returns whether to activate force motion restriction when the J2 joint position falls within, or outside the threshold range. |
| J3_Polarity | Sets or returns whether to activate force motion restriction when the J3 joint position falls within, or outside the threshold range. |
| J4_Polarity | Sets or returns whether to activate force motion restriction when the J4 joint position falls within, or outside the threshold range. |
| J5_Polarity | Sets or returns whether to activate force motion restriction when the J5 joint position falls within, or outside the threshold range. |
| J6_Polarity | Sets or returns whether to activate force motion restriction when the J6 joint position falls within, or outside the threshold range. |
| JointPolarities | Collectively sets or returns whether to activate force motion restriction when the positions on each joint fall within, or outside the threshold range. |
| PosX_Levels | Sets or returns the lower and upper threshold limits for the position in the direction of the X axis. |
| PosY_Levels | Sets or returns the lower and upper threshold limits for the position in the direction of the Y axis. |
| PosZ_Levels | Sets or returns the lower and upper threshold limits for the position in the direction of the Z axis. |
| PosUpperLevels | Collectively sets or returns the upper threshold limit for the positions in the direction of each axis. |
| PosLowerLevels | Collectively sets or returns the lower threshold limit for the positions in the direction of each axis. |
| Dist_Levels | Sets or returns the lower and upper threshold limits for robot travel distance. |
| Rot_Levels | Sets or returns the lower and upper threshold limits for the angle of movement of the robot. |
| J1_Levels | Sets or returns the lower and upper threshold limits for the J1 joint position. |
| J2_Levels | Sets or returns the lower and upper threshold limits for the J2 joint position. |
| J3_Levels | Sets or returns the lower and upper threshold limits for the J3 joint position. |
| J4_Levels | Sets or returns the lower and upper threshold limits for the J4 joint position. |

| | |
|---|---|
| J5_Levels | Sets or returns the lower and upper threshold limits for the J5 joint position. |
| J6_Levels | Sets or returns the lower and upper threshold limits for the J6 joint position. |
| JointUpperLevels | Collectively sets or returns the upper threshold limit for each joint position. |
| JointLowerLevels | Collectively sets or returns the lower threshold limit for each joint position. |
| Triggered | Returns the status of the force motion restriction. |
| TriggeredAxes | Returns the achievement status for force motion restriction by axis when the object monitored is in position. |
| TriggeredJoints | Returns the achievement status for force motion restriction by axis when the object monitored is in the joint position. |
| TriggeredPos | Returns position when end conditions of force motion restriction are achieved. |
| TriggeredForces | Returns force and torque when end conditions of force motion restriction are achieved. |

## 4.9 MP (Mass Properties) Object

### Description

This object (collectively) deals with the Mass Property for gravity compensation.

### Range

MP0 to MP15
However, MP0 is fixed when the values are such that gravity compensation inactivated. Modification is not possible.

| | |
|---|---|
| Label | Sets or returns the label. |
| Number | Returns the number. |
| Description | Establishes or returns the explanation. |
| Mass | This sets or returns the weight of the hand and workpiece/payload at the leading end side from the force sensor. |
| GravityCenter | This sets or returns the overall center of gravity of the hand and workpiece/payload at the leading end side from the force sensor. |

# 5. Result

# 5.1 General Purpose Sequence Result

### Description

Result of force guide sequence. There are the following types:

| | |
|---|---|
| EndStatus | Execution results of a force guide sequence. |
| EndStatusData | Additional information for EndStatus. |
| Time | Execution time for a force guide sequence. |
| LastExecObject | Name of the force guide object that was executed at the end. |
| EndForces | Force and torque at end of a force guide sequence. |
| PeakForces | Returns the peak values of force and torque during execution of a force guide sequence. |

## 5.2 Contact Object Result

**Description**

Result of Contact object. There are the following types:

| | |
|---|---|
| EndStatus | Execution results of the object. |
| ConditionStatus | Status of end condition achievement. |
| Time | Execution time for the object. |
| EndForces | Force and torque at end of the object. |
| EndPos | Robot position/orientation at end of the object. |
| AvgForces | Average value of force and torque during object execution. |
| PeakForces | Peak value of force and torque during object execution. |
| TriggeredForces | Force and torque when the end conditions of force are achieved. |
| TriggeredPos | Robot position/orientation when the end conditions of force are achieved. |

# 5.3 Relax Object Result

### Description

Result of Relax object. There are the following types:

| | |
|---|---|
| EndStatus | Execution results of the object. |
| ConditionStatus | Status of end condition achievement. |
| Time | Execution time for the object. |
| EndForces | Force and torque at end of the object. |
| EndPos | Robot position/orientation at end of the object. |
| AvgForces | Average value of force and torque during object execution. |
| PeakForces | Peak value of force and torque during object execution. |
| TriggeredForces | Force and torque when the end conditions of force are achieved. |
| TriggeredPos | Robot position/orientation when the end conditions of force are achieved. |

## 5.4 FollowMove Object Result

### Description

Result of FollowMove object. There are the following types:

| | |
|---|---|
| EndStatus | Execution results of the object. |
| ConditionStatus | Status of end condition achievement. |
| Time | Execution time for the object. |
| EndForces | Force and torque at end of the object. |
| EndPos | Robot position/orientation at end of the object. |
| AvgForces | Average value of force and torque during object execution. |
| PeakForces | Peak value of force and torque during object execution. |

## 5.5 SurfaceAlign Object Result

**Description**

Result of SurfaceAlign object. There are the following types:

| | |
|---|---|
| EndStatus | Execution results of the object. |
| ConditionStatus | Status of end condition achievement. |
| Time | Execution time for the object. |
| EndForces | Force and torque at end of the object. |
| EndPos | Robot position/orientation at end of the object. |
| AvgForces | Average value of force and torque during object execution. |
| PeakForces | Peak value of force and torque during object execution. |
| TriggeredForces | Force and torque when the end conditions of force are achieved. |
| TriggeredPos | Robot position/orientation when the end conditions of force are achieved. |

# 5.6 PressProbe Object Result

**Description**

Result of PressProbe object. There are the following types:

| | |
|---|---|
| EndStatus | Execution results of the object. |
| ConditionStatus | Status of end condition achievement. |
| Time | Execution time for the object. |
| EndForces | Force and torque at end of the object. |
| EndPos | Robot position/orientation at end of the object. |
| AvgForces | Average value of force and torque during object execution. |
| PeakForces | Peak value of force and torque during object execution. |
| TriggeredForces | Force and torque when the end conditions of force are achieved. |
| TriggeredPos | Robot position/orientation when the end conditions of force are achieved. |

# 5.7 ContactProbe Object Result

### Description

Result of ContactProbe object. There are the following types:

| | |
|---|---|
| EndStatus | Execution results of the object. |
| ConditionStatus | Status of end condition achievement. |
| Time | Execution time for the object. |
| EndForces | Force and torque at end of the object. |
| EndPos | Robot position/orientation at end of the object. |
| AvgForces | Average value of force and torque during object execution. |
| PeakForces | Peak value of force and torque during object execution. |
| TriggeredForces | Force and torque when the end conditions of force are achieved. |
| TriggeredPos | Robot position/orientation when the end conditions of force are achieved. |

# 5.8 Press Object Result

**Description**

Result of Press object. There are the following types:

| | |
|---|---|
| EndStatus | Execution results of the object. |
| ConditionStatus | Status of end condition achievement. |
| Time | Execution time for the object. |
| EndForces | Force and torque at end of the object. |
| EndPos | Robot position/orientation at end of the object. |
| AvgForces | Average value of force and torque during object execution. |
| PeakForces | Peak value of force and torque during object execution. |
| TriggeredForces | Force and torque when the end conditions of force are achieved. |
| TriggeredPos | Robot position/orientation when the end conditions of force are achieved. |

# 5.9 PressMove Object Result

### Description

Result of PressMove object. There are the following types:

| | |
|---|---|
| EndStatus | Execution results of the object. |
| ConditionStatus | Status of end condition achievement. |
| Time | Execution time for the object. |
| EndForces | Force and torque at end of the object. |
| EndPos | Robot position/orientation at end of the object. |
| AvgForces | Average value of force and torque during object execution. |
| PeakForces | Peak value of force and torque during object execution. |
| TriggeredForces | Force and torque when the end conditions of force are achieved. |
| TriggeredPos | Robot position/orientation when the end conditions of force are achieved. |

# 5.10 SPELFunc Object Result

**Description**

Result of SPELFunc object. There are the following types:

| | |
|---|---|
| EndStatus | Execution results of the object. |
| Time | Execution time for the object. |

# 5.11 Paste Sequene Result

**Description**

Result of Paste sequence. There are the following types:

| | |
|---|---|
| EndStatus | Execution results of a force guide sequence. |
| FailedStatus | Failed reasons of a force guide sequence. |
| Time | Execution time for a force guide sequence. |
| LastExecObject | Name of the force guide object that was executed at the end. |
| EndForces | Force and torque at end of a force guide sequence. |
| PeakForces | Returns the peak values of force and torque during execution of a force guide sequence. |

## 5.12 Paste Object Result

**Description**

Result of Paste object. There are the following types:

| | |
|---|---|
| EndStatus | Execution results of the object. |
| ConditionStatus | Status of end condition achievement. |
| LimitedStatus | Limited status of limited condition. |
| Time | Execution time for the object. |
| EndForces | Force and torque at end of the object. |
| EndPos | Robot position/orientation at end of the object. |
| AvgForces | Average value of force and torque during object execution. |
| PeakForces | Peak value of force and torque during object execution. |
| TriggeredForces | Force and torque when the end conditions of force are achieved. |
| TriggeredPos | Robot position/orientation when the end conditions of force are achieved. |

# 5.13 ScrewTighten Sequence Result

### Description

Result of ScrewTighten sequence. There are the following types:

| | |
|---|---|
| EndStatus | Execution results of a force guide sequence. |
| FailedStatus | Failed reasons of a force guide sequence. |
| Time | Execution time for a force guide sequence. |
| LastExecObject | Name of the force guide object that was executed at the end. |
| EndForces | Force and torque at end of a force guide sequence. |
| PeakForces | Returns the peak values of force and torque during execution of a force guide sequence. |

# 5.14 ScrewRetighten Object Result

**Description**

Result of ScrewRetighten object. There are the following types:

| | |
|---|---|
| EndStatus | Execution results of the object. |
| ConditionStatus | Status of end condition achievement. |
| LimitedStatus | Limited status of limited condition. |
| Time | Execution time for the object. |
| EndForces | Force and torque at end of the object. |
| EndPos | Robot position/orientation at end of the object. |
| AvgForces | Average value of force and torque during object execution. |
| PeakForces | Peak value of force and torque during object execution. |
| TriggeredForces | Force and torque when the end conditions of force are achieved. |
| TriggeredPos | Robot position/orientation when the end conditions of force are achieved. |

# 5.15 ScrewTighten Object Result

**Description**

Result of ScrewTighten object. There are the following types:

| | |
|---|---|
| EndStatus | Execution results of the object. |
| Time | Execution time for the object. |
| ConditionStatus | Status of end condition achievement. |
| LimitedStatus | Limited status of limited condition. |
| EndForces | Force and torque at end of the object. |
| EndPos | Robot position/orientation at end of the object. |
| AvgForces | Average value of force and torque during object execution. |
| PeakForces | Peak value of force and torque during object execution. |

# 5.16 HeightInspect Sequence Result

**Description**

Result of HeightInspect sequence. There are the following types:

| | |
|---|---|
| EndStatus | Execution results of a force guide sequence. |
| FailedStatus | Failed reasons of a force guide sequence. |
| Time | Execution time for a force guide sequence. |
| LastExecObject | Name of the force guide object that was executed at the end. |
| EndForces | Force and torque at end of a force guide sequence. |
| PeakForces | Returns the peak values of force and torque during execution of a force guide sequence. |
| MeasuredHeight | Height measured by force guide sequence. |

## 5.17 HeightInspect Object Result

**Description**

Result of HeightInspect object. There are the following types:

| | |
|---|---|
| EndStatus | Execution results of the object. |
| ConditionStatus | Status of end condition achievement. |
| LimitedStatus | Limited status of limited condition. |
| Time | Execution time for the object. |
| EndForces | Force and torque at end of the object. |
| EndPos | Robot position/orientation at end of the object. |
| AvgForces | Average value of force and torque during object execution. |
| PeakForces | Peak value of force and torque during object execution. |
| TriggeredForces | Force and torque when the end conditions of force are achieved. |
| TriggeredPos | Robot position/orientation when the end conditions of force are achieved. |

# 5.18 Insert Sequence Result

**Description**

Result of Insert sequence. There are the following types:

| | |
|---|---|
| EndStatus | Execution results of a force guide sequence. |
| FailedStatus | Failed reasons of a force guide sequence. |
| Time | Execution time for a force guide sequence. |
| LastExecObject | Name of the force guide object that was executed at the end. |
| EndForces | Force and torque at end of a force guide sequence. |
| PeakForces | Returns the peak values of force and torque during execution of a force guide sequence. |

# 5.19 Insert Object Result

### Description

Result of Insert object. There are the following types:

| | |
|---|---|
| EndStatus | Execution results of the object. |
| ConditionStatus | Status of end condition achievement. |
| LimitedStatus | Limited status of limited condition. |
| Time | Execution time for the object. |
| EndForces | Force and torque at end of the object. |
| EndPos | Robot position/orientation at end of the object. |
| AvgForces | Average value of force and torque during object execution. |
| PeakForces | Peak value of force and torque during object execution. |
| TriggeredForces | Force and torque when the end conditions of force are achieved. |
| TriggeredPos | Robot position/orientation when the end conditions of force are achieved. |

## 5.20 TensileTest Object Result

### Description

Result of TensileTest. There are the following types:

| | |
|---|---|
| EndStatus | Execution results of the object. |
| ConditionStatus | Status of end condition achievement. |
| LimitedStatus | Limited status of limited condition. |
| Time | Execution time for the object. |
| EndForces | Force and torque at end of the object. |
| EndPos | Robot position/orientation at end of the object. |
| AvgForces | Average value of force and torque during object execution. |
| PeakForces | Peak value of force and torque during object execution. |
| TriggeredForces | Force and torque when the end conditions of force are achieved. |
| TriggeredPos | Robot position/orientation when the end conditions of force are achieved. |

# 6. Object Designation

# 6.1 Object Designation

### Application

Force Control Object FC, Force Coordinate System Object FCS,
Force Trigger Object FT, Force Monitor Object FM,
Force Motion Restriction Object (FMR), Force Sensor Object FS,
Mass Property Object MP, Robot Object Robot

### Description

This is a formula specifying the object by a statement or function.

### Usage

| | | | | |
|---|---|---|---|---|
| Force Control Object | FC # | FC(#) | FC(Label) | FC((Var)) |
| Force Coordinate System Object: | FCS # | FCS(#) | FCS(Label) | FCS((Var)) |
| Force Trigger Object | FT # | FT(#) | FT(Label) | FT((Var)) |
| Force Monitor Object | FM # | FM(#) | FM(Label) | FM((Var)) |
| Force Motion Restriction Object | FMR # | FMR(#) | FMR(Label) | FMR((Var)) |
| Force Sensor Object | FS # | FS(#) | - | FS((Var)) |
| Mass Property Object | MP # | MP(#) | MP(Label) | MP((Var)) |
| Robot Object | Robot | | | |

| | |
|---|---|
| # | An integer 0 or greater |
| Label | The label assigned to the object |
| Var | A variable expressed as an integer or real number 0 or greater |

### Detailed Explanation

In the statement or function, the respective Number #, object label Label, and variable Var value are specified for the object.
The real number is specified by truncating the decimal places to the nearest whole integer.

### Usage Example

Program example which specifies an object.

```
Function Test
  Integer Var
  String Var1$, Var2$
  Var = 1
  FSet FC1.Label, "Label1"            ' Establishes object FC1 label.
  FSet FC(1).Description, "comment 1" ' Establishes object FC1 comments.
  FGet FC(Label1).Description, Var1$  ' Refers to object FC1 by its label.
  Print Var1$                         ' Prints "comment 1".
  FGet FC((Var)).Description, Var2$   ' Refers to object FC1 by the variable.
  Print Var2$                         ' Prints "comment 1" in the same manner.
Fend
```

# 7. Force Guide 8.0 Constant

## 7.1 Force Guide 8.0 Constant

The following constants are established for Force Guide 8.0.
The constants can be used as needed when writing a program.

**Tips**
In place of the name of the constant, a value can be inserted directly, but it is recommended that the name of the constants be used throughout the program.

| Name of Constants | Values | Application |
|---|---|---|
| FG_FX | 0 | All force objects |
| FG_FY | 1 | |
| FG_FZ | 2 | |
| FG_TX | 3 | |
| FG_TY | 4 | |
| FG_TZ | 5 | |
| FG_FMAG | 6 | |
| FG_TMAG | 7 | |
| FG_X | 0 | [FlangeOffset \| GravityDirection \| GravityCenter \| Position \| Orientation] Property |
| FG_Y | 1 | |
| FG_Z | 2 | |
| FG_U | 3 | |
| FG_V | 4 | |
| FG_W | 5 | |
| FG_SPRING | 0 | FC#.(Axis) Property |
| FG_DAMPER | 1 | |
| FG_MASS | 2 | |
| FG_LIMIT_S | 0 | FC#.Limit[Accel \| Speed]SRJ Property |
| FG_LIMIT_R | 1 | |
| FG_LIMIT_J | 2 | |
| FG_XYZ | 0 | FT#.Fmag_Axes, Tmag_Axes Property<br>FM#.Fmag_Axes, Tmag_Axes Property<br>FMR#.Dist_Axes Property |
| FG_XY | 1 | |
| FG_YZ | 2 | |
| FG_ZX | 3 | |
| FG_ROT_X | 0 | FMR#.ROT_Axes Property |
| FG_ROT_Y | 1 | |
| FG_ROT_Z | 2 | |

| Name of Constants | Values | Application |
|---|---|---|
| FG_ROT_ALL | 3 | |
| FG_FORCE | 0 | FT#.TriggerMode Property |
| FG_DIFF | 1 | |
| FG_OR | 0 | FT#.Operator Property<br>FMR#.Operator Property |
| FG_AND | 1 | |
| FG_BASE | 0 | FCS#.Orientation Property |
| FG_LOCAL | 1 | |
| FG_TOOL | 2 | |
| FG_CUSTOM | 3 | |
| FG_OUT | 0 | FT#.(Axis)_Polarity Property<br>FMR#.[PosX \| PosY \| PosZ \| Dist \| Rot \| (Joint)]_Polarity Property |
| FG_IN | 1 | |
| FG_LOWERLEVEL | 0 | FT#.[Fx \| Fy \| Fz \| Tx \| Ty \| Tz \| Fmag \| Tmag]_Levels Property<br>FMR#.[PosX \| PosY \| PosZ \| Dist \| Rot \| (Joint)]_Levels Property |
| FG_UPPERLEVEL | 1 | |
| FG_CRD_SYS | 0 | FCS#.Orientation Property |
| FG_LOCAL_NO | 1 | |
| FG_CURRENT_TOOL | -1 | FM#.RobotTool Property |
| FG_RESET_FINE | 0 | FS#.Reset Property |
| FG_RESET_WAIT_VIBRATION | 1 | |
| FG_STANDARD_STOP | 0 | FT#.TillStopMode Property |
| FG_SOFT_STOP | 1 | |
| FG_ABS_COORD_SYS | 0 | FMR#.TriggerMode Property |
| FG_REL_COORD_SYS | 1 | |
| FG_REL_TOOL | 2 | |
| FG_REL_POINT | 3 | |
| FG_FRC_CORRECTION | 4 | |
| FG_ABS_JOINT | 5 | |
| FG_REL_JOINT | 6 | |
| FG_PASSED | 0 | Sequence.EndStatus Result<br>Sequence.Object.EndStatus Result |
| FG_FAILED | 1 | |
| FG_NOEXEC | 2 | |
| FG_ABORTED | 3 | |

# 8. A

# 8.1 Arc, Arc3 Statement

### Description

Arc moves the robot in a circular interpolation motion in the XY plane with force control active.
Arc3 moves the robot in a circular interpolation motion in 3 dimensions with the force control active.

### Usage

**Arc** Point1, Point2 [FC#] [ROT] [ CP ] [CF] [Till | Find] [!parallel processing!] [SYNC]

**Arc** Point2, radius, way, direction [FC#] [ROT] [ CP ] [CF] [Till | Find] [!parallel processing!] [SYNC] *

**Arc** Point2, angle [FC#] [ROT] [ CP ] [CF] [Till | Find] [!parallel processing!] [SYNC] *

**Arc** Point2, Point3, way [FC#] [ROT] [ CP ] [CF] [Till | Find] [!parallel processing!] [SYNC] *

**Arc3** Point1, Point2 [FC#] [ROT] [ CP ] [CF] [Till | Find] [!parallel processing!] [SYNC]

**Arc3** Point2, Point3, way [FC#] [ROT] [ CP ] [CF] [Till | Find] [!parallel processing!] [SYNC] *

- Point1
  Specifies the point data defining the through position of the motion.
- Point2
  Specified the point data defining the target position of the motion.
- Point3*
  Specifies the point data defining the center position of the motion.
- radius*
  Specifies the radius of a circular motion as a real number or an expression (unit: mm).
- way*
  Specifies whether the circle will take the short path or the long path from the current position to the target coordinates.
- direction*
  Specifies the rotation direction for the circular motion.
- angle*
  Specifies the rotational angle of a circular motion as a real number or an expression (unit: degrees).
- FC#
  Specifies the force control object.
- CF
  Continues the force control function. Can be omitted.

* Supported only on the RC800 series

### Values

way

| Constant name | Values | Description |
|---|---|---|
| ARC_SHORT | 0 | Takes the short path |
| ARC_LONG | 1 | Takes the long path |

direction

| Constant name | Values | Description |
|---|---|---|
| ARC_PLUS | 1 | Rotates counterclockwise in the Z axis direction relative to the XY plane of the base coordinate system |

| Constant name | Values | Description |
|---|---|---|
| ARC_MINUS | -1 | Rotates clockwise in the Z axis direction relative to the XY plane of the base coordinate system |

### Detailed Explanation

By adding a force control object as a parameter to a normal Arc or Arc3, an Arc or Arc3 motion is carried out with the force control function active.

For Arc and Arc3 motion details, refer to the following manual.
"Epson RC+ 8.0 SPEL+ Language Reference" Arc, Arc3

For details on the force control function, see below.
**Move Statement**

### Usage Example

This is an example of a simple program which executes an Arc motion with the force control function active.
In this example, the Arc is executed in the X axis direction of the tool coordinate system with the force control function active.

```
Function ForceArcTest
  FSet FCS1.Orientation, FG_TOOL    ' Sets the force coordinate data
  FSet FC1.CoordinateSystem, FCS1   ' Specifies the force coordinate data
  FSet FC1.Fx_Spring, 0             ' Sets the virtual Fx coefficient of elasticity
  FSet FC1.Fx_Damper, 1             ' Sets the virtual Fx coefficient of viscosity
  FSet FC1.Fx_Mass, 10              ' Sets the virtual Fx coefficient of inertia
  FSet FC1.Fx_Enabled, True         ' Sets the Fx force control function to active
  Arc P0,P1 FC1                     ' Executes an Arc motion with the force control
' function active
Fend
```

### See Also

**Arc, Arc3 Statement**, **Move Statement**, **FC (Force Control) Object**

# 8.2 AvgForceClear Property

### Application
Force Monitor Object FM#

### Description
Activates/inactivates force and torque averaging simultaneously.

### Immediate Execution
Yes

### Usage
FSet Object. AvgForceClear, bValueFx, bValueFy, bValueFz, bValueTx, bValueTy, bValueTz [, bValueFmag, bValueTmag]

- Object
  Object name
  The object is specified as either of FM (numerical value) or FM (label).
- bValueFx
  A Boolean value or formula defining the new value of the property
- bValueFy
  A Boolean value or formula defining the new value of the property
- bValueFz
  A Boolean value or formula defining the new value of the property
- bValueTx
  A Boolean value or formula defining the new value of the property
- bValueTy
  A Boolean value or formula defining the new value of the property
- bValueTz
  A Boolean value or formula defining the new value of the property
- bValueFmag
  A Boolean value or formula defining the new value of the property
- bValueTmag
  A Boolean value or formula defining the new value of the property

### Values
bValueFx, bValueFy, bValueFz, bValueTx, bValueTy, bValueTz, bValueFmag, bValueTmag

| Name of Constants | Values | Description |
|---|---|---|
| False | 0 | Inactivates the subject axis. (default) |
| True | -1 | Activates the subject axis. |

### Detailed Explanation
AvgForceClear activates/inactivates force and torque averaging simultaneously.
Be sure to execute AvgForceClear prior to executing AvgForces and XX_AvgForce.
Without executing AvgForceClear, “0” is returned.

### Usage Example
This is an example of force averaging in the Fx axis.

```
Function CheckAverageForces
  Double AF(7)
  FSet FC1.Enabled, True, False, False, False, False, False
```

```
  FSet FC1.TargetForces, 10, 0, 0, 0, 0, 0
  FSet FS1.Reset
  FSet FM1.CoordinateSystem, FCS0
  FSet FM1.AvgForceClear, True, False, False, False, False, False, False, False
  FCKeep FC1, 10
  FGet FM1.AvgForces, AF()
  Print AF(FG_FX)
Fend
```

**See Also**

FM (Force Monitor) Object

# 8.3 AvgForces Status

### Application
Force Monitor Object FM#

### Description
Returns average force and torque simultaneously.

### Usage
FGet Object.AvgForces, rArray()

- Object
  Object name
  The object is specified as either of FM (numerical value) or FM (label).
- rArray()
  The number of elements, which define the property values, is an array of 8 or more real numbers.

### Values
rArray()

| Element number | Element number constant | Description |
|---|---|---|
| 0 | FG_FX | Acquires the average Fx force. |
| 1 | FG_FY | Acquires the average Fy force. |
| 2 | FG_FZ | Acquires the average Fz force. |
| 3 | FG_TX | Acquires the average Tx torque. |
| 4 | FG_TY | Acquires the average Ty torque. |
| 5 | FG_TZ | Acquires the average Tz torque. |
| 6 | FG_FMAG | Acquires the average resultant force Fmag. |
| 7 | FG_TMAG | Acquires the average resultant torque Tmag. |

Note: When the number of elements is an array of 6 or 7, the element numbers acquired are 0 to 5.

### Detailed Explanation
AvgForces returns force and torque averages simultaneously.
Execute AvgForceClear prior to executing AvgForces.
Without executing AvgForceClear, 0 is returned.
When the time from executing AvgForceClear to executing AvgForces is short, an error in the average force and torque is generated. Establish a low-pass filter with a time constant of about 5 times between the AvgForceClear and the AvgForces execution.
There is a time limit on AvgForces. Execute AvgForces within 600 seconds of executing AvgForceClear.
When AvgForces is executed after 600 seconds has passed, an error is generated.

### Usage Example
This is an example of force averaging in the Fx axis.

```
Function CheckAverageForces
  Double AF(7)
  FSet FC1.Enabled, True, False, False, False, False, False
  FSet FC1.TargetForces, 10, 0, 0, 0, 0, 0
  FSet FS1.Reset
  FSet FM1.CoordinateSystem, FCS0
```

```
  FSet FM1.AvgForceClear, True, False, False, False, False, False, False, False
  FCKeep FC1, 10
  FGet FM1.AvgForces, AF()
  Print AF(FG_FX)
Fend
```

**See Also**

**FM (Force Monitor) Object**

# 8.4 AvgForces Result

### Description

Returns average values of force and torque during execution of a force guide object.

### Usage

FGGet Sequence.Object.AvgForces, rArray()

- Sequence
  Force guide sequence name
- Object
  Force guide object name
- rArray
  Real array variable with six or more elements showing returned values

### Values

rArray()

| Element number | Element number constant | Description |
|---|---|---|
| 0 | FG_FX | Acquires average value of force in Fx direction during execution of a force guide object. |
| 1 | FG_FY | Acquires average value of force in Fy direction during execution of a force guide object. |
| 2 | FG_FZ | Acquires average value of force in Fz direction during execution of a force guide object. |
| 3 | FG_TX | Acquires average value of torque in Tx direction during execution of a force guide object. |
| 4 | FG_TY | Acquires average value of torque in Ty direction during execution of a force guide object. |
| 5 | FG_TZ | Acquires average value of torque in Tz direction during execution of a force guide object. |

### Detailed Explanation

Returns average values of force and torque during execution of a force guide object.
If the number of elements in a specified array variable is less than six, returns force and torque in each direction for the defined element numbers.
Also, if the number of elements in the array variable exceeds six, returns force and torque in each direction from element number 0 to 5, while making no change to element number 6 and above.

### Usage Example

The following is an example of a simple program that acquires a result with FGGet.

```
Function AvgForceTest
  Double dArray(6)
  Motor On
  FGRun Sequence1
  FGGet Sequence1.Contact01.AvgForces, dArray()   ' Acquisition of AvgForces
  Print dArray(FG_FX)
Fend
```

### See Also

**FGGet Statement**, **Contact Object Result**, **Relax Object Result**, **FollowMove Object Result**, **SurfaceAlign Object Result**,

**PressProbe Object Result**, **ContactProbe Object Result**, **Press Object Result**, **PressMove Object Result**, **Paste Object Result**, **ScrewRetighten Object Result**, **ScrewTighten Object Result**, **HeightInspect Object Result**, **Insert Object Result**, **TensileTest Object Result**

# 9. B

# 9.1 BMove Statement

### Description

This executes in the local selected coordinate system an offset linear interpolation motion with the force control active.

### Usage

BMove P# [FC#] [ROT] [CP] [CF] [Till | Find] [!parallel processing!] [SYNC]

- P#
  Specifies the point data to define the amount of movement.
- FC#
  Specifies the force control object.
- CF
  Continues the force control function. Can be omitted.

### Detailed Explanation

By adding a force control object as a parameter to a normal BMove command, a BMove motion is carried with the force control function active.
For BMove motion details, refer to the following manual.
"Epson RC+ 8.0 SPEL+ Language Reference "BMove
For details on the force control function, refer to Move Statement.
**Move Statement**

### Usage Example

This is a simple program example for executing a BMove motion with the force control function active.
In this example, the BMove motion is executed with the force control function active in the X axis direction of the tool coordinate system.

```
Function ForceBMoveTest
  FSet FCS1.Orientation, FG_TOOL    ' Sets the force coordinate data
  FSet FC1.CoordinateSystem, FCS1   ' Specifies the force coordinate data
  FSet FC1.Fx_Spring, 0             ' Sets the virtual Fx coefficient of elasticity
  FSet FC1.Fx_Damper, 1             ' Sets the virtual Fx coefficient of viscosity
  FSet FC1.Fx_Mass, 10              ' Sets the virtual Fx coefficient of inertia
  FSet FC1.Fx_Enabled, True         ' Sets the Fx force control function to active
  BMove XY(100,0,0,0) FC1           ' Executes the BMove motion with the force
control function active
Fend
```

### See Also

**BMove Statement**, **Move Statement**, **FC (Force Control) Object**

# 10. C

# 10.1 ConditionStatus Result

### Description
Returns status of end condition achievement for a force guide object.

### Usage
FGGet Sequence.Object.ConditionStatus, iVar

- Sequence
  Force guide sequence name
- Object
  Force guide sequence name
- iVar
  Integer variable that shows a returned value

### Values
**iVar**

| Bit | Results |
|---|---|
| 0 | Status of achievement of force-related end condition |
| 1 | Status of achievement of position-related end condition |
| 2 | Status of achievement of I/O-related end condition |

Bit values

- 0: Not achieved
- 1: Achieved

### Detailed Explanation
Returns status of end condition achievement for a force guide object.
Force guide objects can use some of force-related, position-related, and I/O-related end conditions. The ConditionStatus result sets the corresponding bit to “1” if a condition is achieved, or “0” if a condition is not achieved. This result is used to branch processing according to which conditions are achieved.

### Usage Example
The following is an example of a simple program that acquires a result with FGGet.

```
Function ConditionStatusTest
  Integer iVar

  Motor On
  FGRun Sequence1
  FGGet Sequence1.Press01.ConditionStatus, iVar  ' Acquisition of ConditionStatus
  If (iVar And &H01) <> 0 Then                   ' Processing when force-related
condition is achieved
    -
    -
    -
  ElseIf (iVar And &H02) <> 0 Then               ' Processing when position-related
condition is achieved
    -
    -
    -
  EndIf
Fend
```

**See Also**

**FGGet Statement**, **Contact Object Result**, **Relax Object Result**, **FollowMove Object Result**, **SurfaceAlign Object Result**, **PressProbe Object Result**, **ContactProbe Object Result**, **Press Object Result**, **PressMove Object Result**, **Paste Object Result**, **ScrewRetighten Object Result**, **ScrewTighten Object Result**, **HeightInspect Object Result**, **Insert Object Result**, **TensileTest Object Result**

# 10.2 CoordinateSystem Property

### Application
Force Control Object FC#, Force Trigger Object FT#,
Force Monitor Object FM#, Force Motion Restriction Object FMR#

### Description
Returns or sets the force coordinates.

### Immediate Execution
No

### Usage
FGet Object.CoordinateSystem, iVar
FSet Object.CoordinateSystem, FCS#

- Object
  Object name
  Object name or string variable defining object name The object is specified as FC (numerical value), FT (numerical value), FM (numerical value), FMR (numerical value), FC (label), FT (label), or FM (label), FMR (label).
- iVar
  An integer variable defining the value of the property
- FCS#
  Force Coordinate System Object Specified as whether FCS (numerical value) or FCS (label).

### Values
**iVar**

| | Value |
|---|---|
| Minimum | 0 (default) |
| Maximum | 63 |

### Detailed Explanation
Sets or returns the force coordinates used with the force control function, the force trigger function, the force monitor function, and the force motion restriction function.
The CoordinateSystem default is FCS0. It means the same since FCS0 matches to the leading point setting of the tool at the moment. (You cannot change FCS0 setting. This is a description to help understanding.)

FSet FCS0.Position, 0, 0, 0
FSet FCS0.Orientation, FG_TOOL

### Usage Example
This example sets the origin and coordinate axes for force coordinate 1, then sets force coordinate 1 as the Force Monitor Object, and acquires the force data.

```
Function GetForces
  Real myForces(8)
  FSet FCS1.Position, 0, 0, 100
  FSet FCS1.Orientation, FG_TOOL
  FSet FM1.CoordinateSystem, FCS1
  FGet FM1.Forces, myForces()
  Print myForces(FG_FX), myForces(FG_FY), myForces(FG_FZ)
Fend
```

**See Also**

**FCS (Force Coordinate System) Object**, **FC (Force Control) Object**, **FT (Force Trigger) Object**, **FM (Force Monitor) Object**, **FMR (Force Motion Restriction) Object**

# 10.3 CVMove Statement

### Description

This executes a free curve CP motion, defined by the Curve command, with the force control active.

### Usage

CVMove File name[FC#] [CP] [CF] [Till | Find] [SYNC]

- P#
  Specifies the point data defining the target position of the motion.
- FC#
  Specifies the force control object.
- CF
  Continues the force control function. Can be omitted.

### Detailed Explanation

By adding a force control object as a parameter to a CVMove command, a CVMove motion is executed with the force control function active.

For CVMove motion details, refer to the following manual.

"Epson RC+ 8.0 SPEL+ Language Reference" CVMove

For details on the force control function, see below.

**Move Statement**

### Usage Example

This is a simple program example to execute a CVMove motion with the force control function active.

In this example, a CVMove motion is executed with the force control function active in the X axis direction of the tool coordinate system.

```
Function ForceCVMoveTest
  FSet FCS1.Orientation, FG_TOOL    ' Sets the force coordinate data
  FSet FC1.CoordinateSystem, FCS1   ' Specifies the force coordinate data
  FSet FC1.Fx_Spring, 0             ' Sets the virtual Fx coefficient of elasticity
  FSet FC1.Fx_Damper, 1             ' Sets the virtual Fx coefficient of viscosity
  FSet FC1.Fx_Mass, 10              ' Sets the virtual Fx coefficient of inertia
  FSet FC1.Fx_Enabled, True         ' Sets the Fx force control function to active

  curve "mycurve",O,0,4,P(1:7)      ' Sets a free curve
  CVMove "mycurve" FC1              ' Executes a Move motion with the force control
active
Fend
```

### See Also

**CVMove Statement**, **Move Statement**, **FC (Force Control) Object**

# 11. D

## 11.1 DatumPoint Property

### Application
Force Motion Restriction Object FMR#

### Description
Sets or returns the reference point when TriggerMode is set to FG_REL_POINT.

### Immediate Execution
No

### Usage
FGet Object.Description, iVar
FSet Object.Description, P#

- Object
  Force object name
  The force object is specified as either FMR (numerical value) or FMR (label).
- iVar
  An integer variable defining the value of the property
- P#
  A variable defining the point data

### Detailed Explanation
This sets or returns the reference point data when the TriggerMode property is set to FG_REL_POINT.
This property is used to set or confirm the reference point for robot positions/orientations for determining set trigger met conditions. If a force motion restriction object with the TriggerMode property set to FG_REL_POINT is specified for Till, Wait, or other qualifier, monitoring will begin by applying point data from the time that monitoring starts. Note that any changes to the point data specified by this property will not be applied to monitoring if such changes are made after monitoring begins.
When using this property with FSet, specify point data such as P1. However, note that temporary point data acquired by Here and other similar functions cannot be specified. When using this property with FGet, specify an integer variable such as Integer to acquire the point number. For example, “1” will be acquired when specifying P1. Keep this in mind when different types of variables are used for FSet and FGet.

### Usage Example
This is an example of setting P1 as the reference point for the force motion restriction object.

```
Function DatumPointTest
  Integer iVar
  FSet FMR1.DatumPoint, P1    'Specify P1 as the reference point data
  FGet FMR1.DatumPoint, iVar  'iVar will be set to “1”

  Print iVar
Fend
```

### See Also
**FMR (Force Motion Restriction) Object**

# 11.2 Description Property

### Application
Force Control Object FC#, Force Sensor Object FS#, Force Trigger Object FT#, Force Monitor Object FM#, Force Motion Restriction Object FMR#, Force Coordinate System Object FCS#, Mass Property Object MP#

### Description
This refers to the explanation for each object, and provides an explanation for objects other than Force Sensor Objects.

### Immediate Execution
No

### Usage
FGet Object1.Description, sVar$
FSet Object2.Description, sValue$
MPGet MPbject.Description, sVar$
MPSet MPbject.Description, sValue$

- Object1
  Force object name
  The object is specified as FC (numerical value), FT (numerical value), FM (numerical value), FMR (numerical value), FCS (numerical value), FC (label), FT (label), FM (label), FMR (label), or FCS (label).
- Object2
  Force object name
  The object is specified as FC (numerical value), FT (numerical value), FM (numerical value), FMR (numerical value), FCS (numerical value), FC (label), FT (label), FM (label), FMR (label), or FCS (label).
- MPObject
  Mass Property Object name
  Mass Property Object is specified as either of MP (numerical value) or MP (label).
- sVar$
  String variable defining the property value
- sValue$
  String value or formula defining the property value

### Values
String

### Detailed Explanation
This allows one to refer to the explanation for each object in Descriptions Property as well as establish/modify the explanation. The Force Sensor Object explanation can be referred to, but cannot be established. The explanation can be freely written using up to 255 characters.

### Usage Example
This is an example of establishing an explanation for an object.

```
> FSet FC1.Description, “force 1”
```

### See Also
**FC (Force Control) Object**, **FS (Force Sensor) Object**, **FT (Force Trigger) Object**, **FM (Force Monitor) Object**, **FMR (Force Motion Restriction) Object**, **FCS (Force Coordinate System) Object**, **MP (Mass Properties) Object**

# 11.3 Dist_Axes Property

### Application
Force Motion Restriction Object FMR#

### Description
Sets or returns the subject axis for finding the force motion restriction range in relation to distance.

### Immediate Execution
No

### Usage
FGet Object.Dist_Axes, iVar
FSet Object.Dist _Axes, iValue

- Object
  Object name
  The object is specified as either of FMR (numerical value) or FMR (label).
- iVar
  An integer variable defining the value of the property
- iValue
  An integer value or formula defining the new value of the property

### Values
### iValue

| Constant name | Values | Description |
|---|---|---|
| FG_XYZ | 0 | The movement distance of X, Y, Z axis are combined. (default)<br>(Dist = sqrt($PosX^2$ + $PosY^2$ + $PosZ^2$) ) |
| FG_XY | 1 | The movement distance of X, Y axis are combined.<br>(Dist = sqrt($PosX^2$ + $PosY^2$) ) |
| FG_YZ | 2 | The movement distance of Y, Z axis are combined.<br>(Dist = sqrt($PosY^2$ + $PosZ^2$) ) |
| FG_ZX | 3 | The movement distance of Z, X axis are combined.<br>(Dist = sqrt($PosX^2$ + $PosZ^2$) ) |

### Detailed Explanation
Dist is a value that combined the movement distance of target axis from X, Y, Z.
This property is used when set or check the target axis to acquire the combined movement distance.

### Usage Example
This is an example of setting or checking the target axis to acquire the combined movement distance for force motion restriction object.

```
Function Test_Dist_Axes
  Integer iVar
  FSet FMR1.Dist_Axes, FG_ZX
  FGet FMR1.Dist _Axes, iVar
  Print iVar
Fend
```

### See Also

**FMR (Force Motion Restriction) Object**

# 11.4 Dist_Enabled Property

### Application
Force Motion Restriction Object FMR#

### Description
Sets or returns enable/disable of force motion restriction function of the movement distance.

### Immediate Execution
No

### Usage
FGet Object.Dist_Enabled, bVar
FSet Object.Dist_Enabled, bValue

- Object
  Object name
- bVar
  A Boolean variable defining the value of the property
- bValue
  A Boolean value or formula defining the new value of the property

### Values
**bValue**

| Constant name | Values | Description |
|---|---|---|
| False | 0 | Inactivates the subject axis. (default) |
| True | -1 | Activates the subject axis. |

### Detailed Explanation
Independently activates/inactivates or returns the force motion restriction function for the movement distance.

### Usage Example
This is an example of activating motion restriction function of the movement distance for the force motion restriction object.

```
> FSet FMR1.Dist_Enabled, True
```

### See Also
**FMR (Force Motion Restriction) Object**

# 11.5 Dist_Levels Property

### Application
Force Motion Restriction Object FMR#

### Description
Sets or returns the value of the lower threshold and upper threshold of movement distance.

### Immediate Execution
No

### Usage
FGet Object.Dist_Levels, rArray()
FSet Object.Dist _Levels, rValueL, rValueU

- Object
  Object name
  The object is specified as either of FMR (numerical value) or FMR (label).
- rArray()
  The number of elements defining the values of the property is an array of 2 or more real number variables
- rValueL
  A real number or formula defining the new value of the property.
- rValueU
  A real number or formula defining the new value of the property.

### Values
**rArray()**

| Element number | Element number constant |
|---|---|
| 0 | FG_ LOWERLEVEL |
| 1 | FG_ UPPERLEVEL |

**rValueL (Unit: [mm])**

| | Values |
|---|---|
| Minimum | 0 (default) |
| Maximum | 20000 |

**rValueU (Unit: [mm])**

| | Values |
|---|---|
| Minimum | 0 |
| Maximum | 20000 (default) |

### Detailed Explanation
Dist_Levels allow you to set or return the value of the lower threshold and upper threshold of movement distance.
rValueL is the lower threshold. rValueU is the upper threshold. Be sure that rValueL < rValueU.
This is used for error checking and task completion conditions.

### Usage Example

This is an example of stopping the robot due to an error from being below the lower threshold or above the upper threshold in the movement distance.

```
Function SettingLevels
  FSet FMR1.Dist_Enabled, True
  FSet FMR1.Dist_Polarity, FG_OUT
  FSet FMR1.Dist_Levels, 0, 100
  Trap 1, FMR1 Call ForceError
Fend

Function ForceError
  AbortMotion All
Fend
```

### See Also

**FMR (Force Motion Restriction) Object**

# 11.6 Dist_Polarity Property

### Application
Force Motion Restriction Object FMR#

### Description
This returns the status of or sets whether the force motion restriction is triggered by either being within the thresholds or being outside of the thresholds in the movement distance.

### Immediate Execution
No

### Usage
FGet Object.Dist_Polarity, iVar
FSet Object.Dist _Polarity, iValue

- Object
  Object name
  The object is specified as either of FMR (numerical value) or FMR (label).
- iVar
  An integer variable defining the value of the property
- iValue
  An integer value or formula defining the new value of the property

### Values
### iValue

| Constant name | Values | Description |
|---|---|---|
| FG_OUT | 0 | Activates when the value is outside of the thresholds. (default) |
| FG_IN | 1 | Activates when the value is within the thresholds. |

### Detailed Explanation
Dist_Polarity returns the status of or sets whether the force trigger is triggered by either being within the thresholds or being outside of the thresholds in the movement distance.

### Usage Example
This is an example of stopping the robot due to an error from being below the lower threshold or above the upper threshold in the movement distance.

```
Function SettingPolarity
  FSet FMR1.Dist_Enabled, True
  FSet FMR1.Dist_Polarity, FG_OUT
  FSet FMR1.Dist_Levels, 0, 100
  Trap 1, FMR1 Call ForceError
Fend

Function ForceError
  AbortMotion All
Fend
```

### See Also
**FMR (Force Motion Restriction) Object**

# 12. E

# 12.1 Enabled Property

### Application
Force Control Object FC#, Force Trigger Object FT#

### Description
Activates/inactivates the force control function or the force trigger function for each axis at the same time, or returns the status thereof.

### Immediate Execution
No

### Usage
FGet Object.Enabled, bArray()
FSet FC#.Enabled, bValueFx, bValueFy, bValueFz, bValueTx, bValueTy, bValueTz
FSet FT#.Enabled, bValueFx, bValueFy, bValueFz, bValueTx, bValueTy, bValueTz [,bValueFm, bValueTm]

- Object
  Object name
  The object is specified as either of FC (numerical value), FT (numerical value) or FT (label).

- bArray()
  The number of elements, which define the property values, is an array of 6 or 8 or more real number variables

- bValueFx
  A Boolean value or formula defining the new value of the property

- bValueFy
  A Boolean value or formula defining the new value of the property

- bValueFz
  A Boolean value or formula defining the new value of the property

- bValueTx
  A Boolean value or formula defining the new value of the property

- bValueTy
  A Boolean value or formula defining the new value of the property

- bValueTz
  A Boolean value or formula defining the new value of the property

- bValueFm
  A Boolean value or formula defining the new value of the property

- bValueTm
  A Boolean value or formula defining the new value of the property

### Values
bArray()

| Element number | Element number constant | Description |
|---|---|---|
| 0 | FG_FX | Activates/inactivates Fx. |
| 1 | FG_FY | Activates/inactivates Fy. |

| Element number | Element number constant | Description |
|---|---|---|
| 2 | FG_FZ | Activates/inactivates Fz. |
| 3 | FG_TX | Activates/inactivates Tx. |
| 4 | FG_TY | Activates/inactivates Ty. |
| 5 | FG_TZ | Activates/inactivates Tz. |
| 6 | FG_FMAG | Activates/inactivates Fmag resultant force. |
| 7 | FG_TMAG | Activates/inactivates Tmag resultant torque. |

**Note:** When the number of elements is an array of 6 or 7, or for a force control object, the element number returns 0 to 5.

bValueFx, bValueFy, bValueFz, bValueTx, bValueTy, bValueTz, bValueFm, bValueTm

| Name of Constants | Values | Description |
|---|---|---|
| False | 0 | Inactivates the subject axis. (default) |
| True | -1 | Activates the subject axis. |

### Detailed Explanation

Activates/inactivates the force control function or the force trigger function for each axis at the same time, or returns the status thereof.
For SCARA robots (including RS series), the force control cannot be executed with the FC object when Tx or Ty for the Enable property is “True”.

### See Also

**FC (Force Control) Object**, **FT (Force Trigger) Object**

# 12.2 EndForces Result

### Description

Returns force and torque at end of a force guide object or force guide sequence.

### Usage

FGGet Sequence.EndForces, rArray()
FGGet Sequence.Object.EndForces, rArray()

- Sequence
  Force guide sequence name

- Object
  Force guide object name
  Omitted when a result of a force guide sequence is acquired.

- rArray
  Real array variable with six or more elements showing returned values

### Values

rArray()

| Element number | Element number constant | Description |
|---|---|---|
| 0 | FG_FX | Acquires force in Fx direction at end of a force guide sequence or force guide object. |
| 1 | FG_FY | Acquires force in Fy direction at end of a force guide sequence or force guide object. |
| 2 | FG_FZ | Acquires force in Fz direction at end of a force guide sequence or force guide object. |
| 3 | FG_TX | Acquires torque in Tx direction at end of a force guide sequence or force guide object. |
| 4 | FG_TY | Acquires torque in Ty direction at end of a force guide sequence or force guide object. |
| 5 | FG_TZ | Acquires torque in Tz direction at end of a force guide sequence or force guide object. |

### Detailed Explanation

Returns force and torque at end of a force guide object or force guide sequence.
If the number of elements in a specified array variable is less than six, returns force and torque in each direction for the defined element numbers.
Also, if the number of elements in the array variable exceeds six, returns force and torque in each direction from element number 0 to 5, while making no change to element number 6 and above.

### Usage Example

The following is an example of a simple program that acquires a result with FGGet.

```
Function EndForceTest
  Double dArray(6)

  Motor On
```

```
  FGRun Sequence1
  FGGet Sequence1.Contact01.EndForces, dArray()  ' Acquisition of EndForces
  Print dArray(FG_FX)

Fend
```

**See Also**

**FGGet Statement**, **General Purpose Sequence Result**, **Contact Object Result**, **Relax Object Result**, **FollowMove Object Result**, **SurfaceAlign Object Result**, **PressProbe Object Result**, **ContactProbe Object Result**, **Press Object Result**, **PressMove Object Result**, **Paste Sequene Result**, **Paste Object Result**, **ScrewTighten Sequence Result**, **ScrewRetighten Object Result**, **ScrewTighten Object Result**, **HeightInspect Sequence Result**, **HeightInspect Object Result**, **Insert Sequence Result**, **Insert Object Result**, **TensileTest Object Result**

# 12.3 EndPos Result

### Description

Returns position at end of a force guide object.

### Usage

FGGet Sequence.Object.EndPos, P#

- Sequence
  Force guide sequence name
- Object
  Force guide object name
- P#
  Variable representing a point data

### Detailed Explanation

Returns position at end of a force guide object.

### Usage Example

The following is an example of a simple program that acquires a result with FGGet.

```
Function EndPosTest
  Motor On

  FGRun Sequence1
  FGGet Sequence1.Contact01.EndPos, P1  ' Acquisition of EndPos
  Print P1
Fend
```

### See Also

**FGGet Statement**, **Contact Object Result**, **Relax Object Result**, **FollowMove Object Result**, **SurfaceAlign Object Result**, **PressProbe Object Result**, **ContactProbe Object Result**, **Press Object Result**, **PressMove Object Result**, **Paste Object Result**, **ScrewRetighten Object Result**, **ScrewTighten Object Result**, **HeightInspect Object Result**, **Insert Object Result**, **TensileTest Object Result**

## 12.4 EndStatus Result

### Description
Returns end status for a force guide sequence or force guide object.

### Usage
FGGet Sequence.EndStatus, iVar
FGGet Sequence.Object.EndStatus, iVar

- Sequence
  Force guide sequence name

- Object
  Force guide object name
  Omitted when a result of a force guide sequence is acquired.

- iVar
  Integer variable that shows a returned value

### Values
iVar

| Constant name | Values | Description |
|---|---|---|
| FG_PASSED | 0 | Force guide sequence or force guide object succeeded. |
| FG_FAILED | 1 | Force guide sequence or force guide object failed. |
| FG_NOEXEC | 2 | Force guide sequence or force guide object has not been executed. |
| FG_ABORTED | 3 | Force guide sequence or force guide object stopped during execution. |

### Detailed Explanation
Returns end status for a force guide sequence or force guide object.
Success/fail criteria differ for each force guide sequence and force guide object. For details about the conditions, refer to the following manual:
"Epson RC+ 8.0 option Force Guide 8.0 - Software"

- Details on results of general sequence
- General force guide object

FG_NOEXEC is returned if a force guide sequence has not been executed. FG_NOEXEC is also returned if a force guide object is not executed depending on conditional branch or if a force guide sequence ends midway through because a preceding object failed. FG_ABORTED is returned if the emergency stop button or the [Stop] button on the [Run] window is pressed during execution, or if Stop input is received via remote input.

### Usage Example
The following is an example of a simple program that acquires a result with FGGet.

```
Function EndStatusTest
  Integer iVar

  Motor On

  FGRun Sequence1
  FGGet Sequence1.Contact01.EndStatus, iVar  ' Acquisition of EndStatus
  Print iVar
Fend
```

**See Also**

**FGGet Statement**, **General Purpose Sequence Result**, **Contact Object Result**, **Relax Object Result**, **FollowMove Object Result**, **SurfaceAlign Object Result**, **PressProbe Object Result**, **ContactProbe Object Result**, **Press Object Result**, **PressMove Object Result**, **SPELFunc Object Result**, **Paste Sequene Result**, **Paste Object Result**, **ScrewTighten Sequence Result**, **ScrewRetighten Object Result**, **ScrewTighten Object Result**, **HeightInspect Sequence Result**, **HeightInspect Object Result**, **Insert Sequence Result**, **Insert Object Result**, **TensileTest Object Result**

## 12.5 EndStatusData Result

### Description
Returns a reason for end status failure in a general purpose sequence.

### Usage
FGGet Sequence.EndStatusData, iVar

- Sequence
  General purpose sequence name or string variable representing general purpose sequence name

- iVar
  Integer variable that shows a returned value

### Values
iVar

| Bit | Results |
|---|---|
| 0 | Object whose AbortSeqOnFail is True failed. |
| 1 | Start position orientation (X, Y, Z, U, V, W) deviated from the specified range. |
| 2 | Starting arm orientation (Hand, Elbow, Wrist) differed from the specified arm orientation. |

### Detailed Explanation
Returns a reason for end status failure in a general purpose sequence.
AbortSeqOnFail is a property that specifies whether to end or continue a sequence after a force guide object has failed. If the force guide object whose AbortSeqOnFail is True fails, the general purpose sequence will also fail.
The start position/orientation (X, Y, Z, U, V, W) is checked when the PosCheckEnabled property is True.
The force guide sequence will fail if the sequence starting position/orientation deviates from the point specified by the StartCheckPoint property by an amount that exceeds the value specified by StartPntTolX in the X direction, exceeds the value specified by StartPntTolY in the Y direction, or exceeds the value specified by StartPntTolZ in the Z direction in the coordinate system specified by StartPntTolLocal, or exceeds the angle specified by StartPntTolRot in the direction of rotation. When a failure occurs, the general purpose object will not be executed.
The starting arm orientation (Hand, Elbow, Wrist) is checked when the OrientCheckEnabled property is True. The force guide sequence will fail if the sequence starting arm orientation differs from each arm orientation at a point specified by the StartCheckPoint property. In such a case, the general purpose object will not be executed.

### Usage Example
The following is an example of a simple program that acquires a result with FGGet.

```
Function EndStatuDataTest
  Integer iVar

  Motor On

  FGRun Sequence1
  FGGet Sequence1.EndStatusData, iVar   ' Acquisition of EndStatusData
  Print iVar
Fend
```

### See Also
**FGGet Statement**, **General Purpose Sequence Result**

# 13. F

## 13.1 FailedStatus Result

### Description
Returns the reason for failure regarding the dedicated sequence.

### Usage
FGGet Sequence.EndStatus, iVar

- Sequence
  Force guide sequence name

- iVar
  Integer variable that shows a returned value

### Values
iVar

| Name of constants | Values | Description |
|---|---|---|
| OK | 0 | Force guide sequence successful. |
| GeneralObjectFailed | 1 | General object failed. |
| ForceConditionFailed | 10 | Failure due to force outside the successful condition range. |
| ContactFailed | 12 | Failure due to position not reached. |
| PosConditionFailed | 20 | Failure due to position outside the successful condition range. |
| Overrun | 21 | Failure due to overrun. |
| Jammed | 22 | Failure due to position outside the successful condition range, even with the force within the successful condition range. |
| NoOKSignal | 31 | Failure due to not receiving the screw tightening complete signal from the screwdriver. |

### Detailed Explanation
Returns the reason for failure regarding the dedicated sequence.
The success/failure judgment conditions differ for each dedicated sequence. For more information about each condition, refer to the following manual.
"Epson RC+ 8.0 option Force Guide 8.0 Software"
- Details on the results of the Paste sequence
- Details on results of the screw tightening sequence
- Details on results of HeightInspect sequence
- Details on results of Insert sequence

This result will only return the failure reason for objects whose AbortSeqOnFail is True. Further, running this result without executing the specified sequence beforehand will result in error.

### Usage Example
The following is an example of a simple program that acquires a result with FGGet.

```
Function FailedStatusTest
  Integer iVar

  Motor On

  FGRun Sequence1
```

```
  FGGet Sequence1.FailedStatus, iVar  ' Acquire FailedStatus
  Print iVar

Fend
```

**See Also**

**FGGet Statement**, **Paste Sequene Result**, **ScrewTighten Sequence Result**, **HeightInspect Sequence Result**, **Insert Sequence Result**

## 13.2 FCElapsedTime Function

### Description

Returns the time elapsed since the force control function was activated for the specified robot.

### Usage

FCElapsedTime(RobotNo)

- RobotNo
  An integer value or formula which specifies the robot number.

### Return Values

Returns the time elapsed since the force control function was activated for the specified robot.

### Detailed Explanation

Returns the time elapsed since the force control function was activated for the specified robot. This function returns the elapsed duration only while the force control function is activated for the specified robot. Executing this function when the force control function is inactive will return a “0” value.   The RobotNo may be omitted. If omitted, the robot selected in the Robot statement will be specified.

### Usage Example

This example displays the elapsed time for the force control function.

```
Function FCElapsedTimeTest
  Print FCElapsedTime(1)
Fend
```

### See Also

**FCKeep Statement**, **FCEnd Statement**, **FC (Force Control) Object**

# 13.3 FCEnd Statement

### Description

Stops the active force control function.

### Usage

FCEnd

### Detailed Explanation

This inactivates the currently active force control function by adding a CF parameter to FCKeep or the motion command.

### See Also

**FCKeep Statement**, **FC (Force Control) Object**

# 13.4 FCKeep Statement

### Description
Activates the force control function, and when the specified amount of time has elapsed, a stop is executed.

### Usage
FCKeep FC# [CF] [Till | Find] [SYNC], rValue

- FC#
  Specifies the force control object.

- rValue
  Real number or formula

### Detailed Explanation
This does not execute a motion command, but is used when wanting to activate the force control function over a fixed period of time. When wanting to perform push-work using a fixed force over a fixed period of time, after moving the tool using position control to a point just prior to contact, specify the Force Control Object having had the target force set therein, and execute FCKeep.
In addition, when desiring to continue force control for a fixed period of time following the execution of a motion command, which includes force control, add a force control object and a CF parameter to the motion command and execute, then continue on with the execution of the FCKeep.

### Usage Example
This example continues activation of the force control function for a period of 30 seconds in accordance to the Force Control Object FC1.

```
> FCKeep FC1, 30
```

In this example, after moving to P1 with the force control active, in accordance with the Force Control Object FC1, the force control function is maintained for a period of 10 seconds.

```
Function main
  Move P1 FC1 CF
  FCKeep FC1, 10
FEnd
```

### See Also
Till, **FCEnd Statement**, **FCOn Function**, **FC (Force Control) Object**

# 13.5 FCOn Function

### Description
Determines if the specified robot is executing the force control function.

### Usage
FCOn(RobotNo)

- RobotNo
  An integer value or formula which specifies the robot number.

### Return Values

| Number | Constant | Description |
|---|---|---|
| 0 | Off | Force Control Function is inactive |
| 1 | On | Force Control Function is active |

### Detailed Explanation
This identifies whether the specified robot is executing the force control function or not.
“On” will be returned when the force control function is active due to a CF parameter following the completion of a motion command, or when the force control function is active due to FCKeep.

### Usage Example
The following displays the activation status of the force control function.

```
Function main
  If FCOn(1) = Off Then
    Print "Force Control is off"
  EndIf
Fend
```

### See Also
**FCKeep Statement**, **FCEnd Statement**, **FC (Force Control) Object**

# 13.6 FCSMove Statement

### Description
Executes an offset linear interpolation motion in the specified force coordinate system.

### Usage
FCSMove P# { FCS# | FC#} [ROT] [CF] [CP] [Till | Find] [!parallel processing!] [SYNC]

- P#
  Specifies the target position of the motion using point data.

- FCS#
  Specifies the force coordinate system object.

- FC#
  Specifies the force control object.

- CF
  Continues the force control function. Can be omitted.

- ROT
  Gives priority to the tool orientation modification and establishes the velocity and acceleration of the motion. Can be omitted.

- CP
  Specifies the path motion. Can be omitted.

- Till | Find
  Describes the Till or Find formulas. Can be omitted.

  Till | Find
  Till Sw(formula) = { On | Off }
  Find Sw(formula) = { On | Off }

- !parallel processing!
  A parallel processing statement can be added in order to execute I/O or other commands during the motion. Can be omitted.

### Detailed Explanation
This executes an offset linear interpolation motion in the specified force coordinate system.
Specify along with the target coordinates either a Force Coordinate System Object or Force Control Object.
If specifying a force coordinate system object, an offset linear interpolation motion will be executed in the specified force coordinate system.
If specifying a Force Control Object, an offset linear interpolation motion will be executed in force coordinate system specified by the Force Control Object. This motion will be executed with the force control active.
The point flag defined by the point data will be ignored, and the current point flag will be maintained. However, on vertical 6 axis robots (including N series), the point flag is automatically changed to decrease the amount of joint movement.
Each established value for SpeedS and AccelS will be used for the FCSMove velocity and acceleration. For the relationship between velocity and acceleration/deceleration, please see the **Note**: "Use FCSMove with CP." However, the velocity and acceleration/deceleration when using a qualified ROT parameter will be the established value for SpeedR and AccelR, respectively. In such instances, the values for SpeedS and AccelS are ignored.
If you attempt to change only the tool orientation with the position of the robot tool tip fixed to a certain coordinate or if the tool orientation modification is large relative to the movement distance of the tool tip, the tool orientation modification speed may become significantly faster. To prevent this, a function operates to automatically limit the operation speed when the tool orientation modification speed is large.

If you want to manually set the upper limit of the tool orientation modification speed during CP motion, set SpeedRLimitation to ON. When SpeedRLimitation is set to ON, the operation speed is limited so that the tool orientation modification speed becomes SpeedR in cases where the tool orientation modification speed exceeds the set SpeedR during CP motion. If the tool orientation modification speed does not exceed the set SpeedR, the system operates at the set SpeedS. Set the upper limit of the tool orientation modification speed in advance using SpeedR.
By using a Till qualifier, the robot can be decelerated and stopped mid-motion and the FCSMove completed when the Till conditions are met.
By using a Find qualifier, the point data will be stored in FindPos when the Find conditions are met during the motion.
\By using !parallel processing!, another process can be executed parallel to the motion.

### Note

Use FCSMove with CP
When using CP parameters, the motion control within the motion command moves to the next statement at the same time as deceleration begins. This is convenient when desiring to link multiple motion commands for a continuous motion at a fixed velocity. Without using CP, FCSMove will find without fail the arm decelerating and stopping at the specified target coordinates.

### Usage Example

This is an example of a movement 100 mm in the X axis direction in the force coordinate system 1.

```
> FCSMove XY(100, 0, 0, 0, 0, 0) FCS1
```

### See Also

**FCS (Force Coordinate System) Object**, **TMove Statement**, AccelS, AccelR, SpeedS, SpeedR

# 13.7 FDef Function

### Application
Force Control Object FC#, Force Trigger Object FT#, Force Monitor Object FM#, Force Coordinate System Object FCS#

### Description
Identifies whether the specified force object is defined or not.

### Usage
FDef(Object)

- Object
  Object name

### Return Values
“True” if the specified force object is defined, “False” if undefined.

### Detailed Explanation
Identifies whether the specified force object is defined or not.

### Usage Example
This is an example of when the object is defined.

```
Function main
  If FDef(FC9) Then
    Print "FC9 is defined"
  EndIf
Fend
```

### See Also
**FC (Force Control) Object**, **FT (Force Trigger) Object**, **FM (Force Monitor) Object**,
**FCS (Force Coordinate System) Object**

## 13.8 FDel Statement

### Application

Force Control Object FC#, Force Trigger Object FT#, Force Monitor Object FM#, Force Coordinate System Object FCS#

### Description

This deletes the specified force object.

### Usage

FDel Object1 [, Object2]

- Object1
  The object name at the beginning of the object data range to be deleted
- Object2
  The object name at the end of the object data range to be deleted

### Detailed Explanation

This is used to delete any type of specified force object while the program is running.
This deletes the object data starting with the start object and ending with the end object established in the parameters.
The start object and end object must be the same type of object.
In addition, please assign a smaller number to the start object than the end object. No error occurs when the object is not defined.

### Usage Example

This is an example of deleting an object.

```
> FDel FC1        ' Deletes Force Control Object1
> FDel FT2, FT10  ' Deletes Force Trigger Object2 through 10
```

### See Also

**FC (Force Control) Object**, **FT (Force Trigger) Object**, **FM (Force Monitor) Object**,
**FCS (Force Coordinate System) Object**

# 13.9 FExport Statement

### Description

This exports the force file to the specified path.

### Usage

FExport Filename_sValue$, DestPath_sValue$

- FileName_sValue$
  A string value defining the specific file you wish to export. The file extension is ".frc". You cannot specify the path.

- DestPath_sValue$
  A string value defining the destination path and file. The file extension is ".frc".

### Detailed Explanation

This makes a copy of the specified force file in the destination folder.
If a file with the same name exists in the folder, it will be overwritten.
The file name must be alphanumeric characters and the underscore character only, and can be up to 255 characters.

### Frequent Errors

Specified destination folder does not exist
    When the path of DestPath_sValue$ does not exist, an error is generated.
Specified file is not found
    When the path is included in FileName_sValue$, an error is generated.

### Usage Example

This is an example of exporting a project file to a separate folder.

```
> FExport "myforce.frc", "C:\temp\myforce.frc"
```

### See Also

**FImport Statement**, **FLoad Statement**, **FSave Statement**

## 13.10 FGet Statement

### Application

Force Object FC#, Force Trigger Object FT#, Force Monitor Object FM#, Force Coordinate System Object FCS#

### Description

This is used when acquiring the properties or status of a force object.

### Usage

FGet Object.Property, Var

- Object
  Object name

- Property
  The name of the property for which the value is to be acquired

- Var
  The variable that shows a returned value and format differ according to the property.

### Detailed Explanation

This is used when acquiring the properties or status of a force object.

### Usage Example

This is an example of acquiring from a force monitor object and displaying the axial value of force sensor 1 for each axis.

```
Function test

  Real myForces(8)

  FSet FS1.Reset

  FSet FM1.ForceSensor, 1
  FSet FM1.CoordinateSystem, FCS0
  Do
    FGet FM1.Forces, myForces()
    Print myForces(0), myForces(1), myForces(2)
    Wait 1
  Loop
Fend
```

### See Also

**FSet Statement**

## 13.11 FGGet Statement

### Description
Acquires a result of a force guide sequence or force guide object.

### Usage
FGGet Sequence.Result, Var
FGGet Sequence.Object.Result, Var

- Sequence
  Force guide sequence name

- Object
  Force guide object name
  Omitted when a result of a force guide sequence is acquired.

- Result
  Name of result to acquire a value

- Var
  The variable that shows a returned value and format differ according to the result.

### Detailed Explanation
Acquires a specified result.
If a result other than EndStatus is specified while the target force guide sequence or force guide object has not been executed by FGRun, an error will occur.

### Usage Example
The following is an example of a simple program that acquires a result with FGGet.

```
Function FGGetTest
  Integer iResult

  Motor On

  FGRun Sequence1                    ' Execution of a force guide sequence
  FGGet Sequence1.EndStatus, iResult ' Acquisition of results
  Print iResult

Fend
```

### See Also
**FGRun Statement**

# 13.12 FGRun Statement

### Description

Executes a force guide sequence.

### Usage

FGRun Sequence

- Sequence
  Sequence name or string value representing sequence name

### Detailed Explanation

Executes a specified force guide sequence. The force guide sequence starts from the position where the FGRun statement was executed. Execute after moving to the assumed start position by the Go statement, Move statement, or other motion commands.
When the specified force guide sequence ends, the program proceeds to the next statement.
To acquire the results of sequences executed by FGRun, use FGGet.
When path motion is enabled by the CP parameter or CP statement, the program waits until the robot stops and then executes a force guide sequence.
When any of the following conditions is fulfilled at the time of execution start, an error occurs.
The robot specified in the program differs from the robot specified by the RobotNumber property. Specify the correct robot by the Robot statement.
The robot type specified in the program differs from the robot type specified by the RobotType property. Specify the correct robot by the Robot statement.
The tool number specified in the program differs from the tool number specified by the RobotTool property. Specify the correct tool number by the Tool statement.
Motor is in OFF state. Switch to ON state by the Motor statement.
Force control function is currently being executed. Stop force control by the FCEnd statement.
Conveyor tracking is currently being executed. Stop conveyor tracking by the Cnv_AbortTrack statement.
Currently in the torque control mode. Disable the torque control mode by the TC statement.

FGRun, when executed, automatically overwrites the following properties; therefore, it cannot be used together with the following properties:
FM object
AvgForceClear property
PeakForceClear property

### Usage Example

The following is an example of a simple program that executes FGRun.
In this example, the results are acquired by FGGet after execution.

```
Function FGRunTest
  Integer iResult

  Motor On

  FGRun Sequence1                    ' Execution of a force guide sequence
  FGGet Sequence1.EndStatus, iResult ' Acquisition of results
  Print iResult
Fend
```

### See Also

**FGGet Statement**

# 13.13 FImport Statement

### Description
This imports a force file into the currently selected robot project.

### Usage
FImport SorcePath_sValue$, Filename_sValue$ [, RobotNo_iValue]

- SourcePath_sValue$
  A string value defining the file you wish to import into the current project. The extension is ".frc".

- FileName_sValue$
  A string value defining a specific file you wish to import into the current project for the current robot. The extension is ".frc". You cannot specify the path.

- RobotNo_iValue
  This is a real number expression specifying which robot is associated with the force file. Can be omitted. When the robot number is "0," the force file will be imported as a common force file. When omitted, the current robot number is used.

### Detailed Explanation
FImport imports a force file into the currently selected project and adds it to the currently selected robot file. The added file can be loaded with the FLoad statement. When a file with the same file name exists on the currently selected robot, it is overwritten.
The file name must be alphanumeric characters and the underscore character only, and can be up to 255 characters.

### Frequent Errors
Specified file does not exist When SourcePath_sValue$ does not exist, an error is generated.
Specified file is not found An error occurs when the path is included in FileName_sValue$.
Specified file is not on current robot When a force file from a different robot is specified in FileName_sValue$, an error occurs.

### Usage Example
This is an example of importing a force file to the currently selected project.

```
> Robot 1
> FImport "C:\temp\myforce.frc", "myforce.frc"
```

### See Also
**FExport Statement**, **FSave Statement**, Robot

# 13.14 FLabel$ Function

### Application
Force Control Object FC#, Force Trigger Object FT#, Force Monitor Object FM#, Force Coordinate System Object FCS#

### Description
Returns the label for all Force Objects and Force Sensor Objects.

### Usage
FLabel$(Object)

- Object
  Object name
  The object is specified as FC (numerical value), FT (numerical value), FM (numerical value), FMR (numerical value), FC (label), FT (label), or FM (label), FMR (label).

### Return Values
String

### Detailed Explanation
Returns the label for all force objects and force sensor objects.

### Usage Example
This is an example of establishing a label for a force object and displaying it.

```
> FSet FC1.Label, "Label1"
> Print FLabel$(FC1)
Label1
```

### See Also
**Label Property**, **FC (Force Control) Object**, **FCS (Force Coordinate System) Object**, **FT (Force Trigger) Object**, **FM (Force Monitor) Object**

# 13.15 FlangeOffset Property

### Application

Robot Object Robot

### Description

This sets or returns the force sensor position and orientation in the Tool 0 (TCP0, J6 flange) coordinate system.

### Usage

FGet Robot.FlangOffset, rArray()

FSet Robot.FlangOffset, rValueX, rValueY, rValueZ, rValueU, rValueV, rValueW

- rArray()
  The maximum number of elements to define the value of the property is an array of 6 or more real number variables
- rValueX
  A real number or formula defining the new value of the property.
- rValueY
  A real number or formula defining the new value of the property
- rValueZ
  A real number or formula defining the new value of the property.
- rValueU
  A real number or formula defining the new value of the property.
- rValueV
  A real number or formula defining the new value of the property.
- rValueW
  A real number or formula defining the new value of the property.

### Values

rArray()

| Element number | Element number constant | Description |
|---|---|---|
| 0 | FG_X | Positional X component |
| 1 | FG_Y | Positional Y component |
| 2 | FG_Z | Positional Z component |
| 3 | FG_U | Positional U component |
| 4 | FG_V | Positional V component |
| 5 | FG_W | Positional W component |

rValueX, rValueY, rValueZ

| Item | Values |
|---|---|
| Minimum | -2000 |
| Maximum | 2000 |

rValueU, rValueV, rValueW

| Item | Values |
|---|---|
| Minimum | -360 |

| Item | Values |
|---|---|
| Maximum | 360 |

(RC800 series Controller default)

| Model of Robot | Sensor type | Mount type | (rValueX, rValueY, rValueZ, rValueU, rValueV, rValueW) |
|---|---|---|---|
| GX4, GX8 series | S2503, S2506 | All | (0, 0, -22, 180, 0, 180) |
| GX10, GX20 series | S25010 | | (0, 0, -24, 180, 0, 180) |
| C8 series | S250L, S250P | Table Top mounting | (0, 0, 5, 0, 0, 0) |
| | | Ceiling mounting | (0, 0, 5, 180, 0, 0) |
| | | Wall mounting | (0, 0, 5, 0, 0, 0) |
| C12 series | S250L, S250P | Table Top mounting | (0, 0, 5, 0, 0, 0) |

(RC700 series Controller default)

| Model of Robot | Sensor type | Mount type | (rValueX, rValueY, rValueZ, rValueU, rValueV, rValueW) |
|---|---|---|---|
| C4 series | S250N | Table Top mounting | (0, 0, 5, 0, 0, 0) |
| | | Ceiling mounting | (0, 0, 5, 180, 0, 0) |
| C8 series | S250L, S250P | Table Top mounting | (0, 0, 5, 0, 0, 0) |
| | | Ceiling mounting | (0, 0, 5, 180, 0, 0) |
| | | Wall mounting | (0, 0, 5, 0, 0, 0) |
| C12 series | S250L | Table Top mounting | (0, 0, 5, 0, 0, 0) |
| N2 series | S250H | Table Top mounting | (0, 0, 5, 0, 0, 0) |
| | | Ceiling mounting | (0, 0, 5, 180, 0, 0) |
| N6 series | SH250LH | Table Top mounting | (0, 0, 0, 0, 0, 0) |
| | | Ceiling mounting | (0, 0, 0, 180, 0, 0) |
| G3, G6, GX4, GX8 series | S2503, S2506 | All | (0, 0, -22, 180, 0, 180) |
| G10, G20, GX10, GX20 series | S25010 | | (0, 0, -24, 180, 0, 180) |
| RS series | S2503 | | (0, 0, -22, 180, 0, 180) |

### Detailed Explanation

This sets or returns the position and orientation of the center of the force sensor base in the Tool 0 coordinate system.

This is used when the positional relationship between Tool 0 and the force sensor has changed. Since the sensor reading cannot be acquired in the assumed coordinate system if a mistake is made in the setting operation, re-set it accurately and use the force function.

### Usage Example

This is an example of setting the positional relationship between Tool 0 of Robot 1 and the force sensor. (10 mm in the Z axis direction)

```
> Robot 1
> FSet Robot.FlangeOffset, 0, 0, 10, 0, 0, 0
```

### See Also

**Robot Object**

# 13.16 FList Statement

### Application
Force Control Object FC#, Force Trigger Object FT#, Force Monitor Object FM#, Force Coordinate System Object FCS#

### Description
Displays a list of objects.

### Usage
FList Object1 [, [Object2]]

- Object1
  Force Control Object, Force Trigger Object, Force Monitor Object, or Force Coordinate System Object with which the object data range to be listed starts

- Object2
  Force Control Object, Force Trigger Object, Force Monitor Object, or Force Coordinate System Object with which the object data range to be listed ends

### Detailed Explanation
The defined object data from the specified start object to the specified end object is displayed in the Command window or Run window. When "," and the end object are omitted, only the start object is displayed, and when "," is used and the end object is omitted, all objects from the start object on are displayed.

The output format for each line is the same format as for the FSet Statement.
*Object.Property, Values*

| | |
|---|---|
| Object | Object name |
| Property | Property name |
| Values | The number or format expressing the value depends on the property |

### Usage Example
This is an example of listing force object data.

```
> FList FC1
FC1.Label, "LabelFC1"
FC1.CoordinateSystem, FCS0
FC1.Enabled, False, False, False, False, False, False
FC1.Fx, 0, 10, 10
FC1.Fy, 0, 10, 10
FC1.Fz, 0, 10, 10
FC1.Tx, 0, 50, 5000
FC1.Ty, 0, 50, 5000
FC1.Tz, 0, 50, 5000
FC1.TargetForcePriorityMode, False
FC1.TargetForces, 0, 0, 0, 0, 0, 0
FC1.LimitSpeedSRJ, 50, 25, 50
FC1.LimitAccelSRJ, 200, 100, 100
FC1.Description, ""
```

### See Also
**FC (Force Control) Object**, **FT (Force Trigger) Object**, **FM (Force Monitor) Object**,
**FCS (Force Coordinate System) Object**

# 13.17 FLoad Statement

### Application
Force Control Object FC#, Force Trigger Object FT#, Force Monitor Object FM#, Force Coordinate System Object FCS#

### Description
This loads a force file into the robot's force memory area.

### Usage
FLoad FileName_sValue$ [,Merge]

- FileName_sValue$
  A character strings specifying the name of the file to be loaded into the robot's force memory area.

- Merge
  Character string to specify that the current force memory area is not to be cleared.

### Detailed Explanation
This loads a force file into the robot's force memory area. The file extension is fixed to ".frc". If the extension is omitted, ".frc" will be added. The specified file is limited to files within the project. You cannot specify the path.
When Merge is not specified, the object currently in the memory area is cleared prior to loading. When Merge is specified, a new force object is added to the current memory area. When the force object to be added already exists, it is overwritten.

### Frequent Errors
Cannot specify path
When FileName_sValue$ includes the path, an error is generated.
Cannot find specified file (file does not exist)
When FileName_sValue$ cannot be found, an error occurs.
Force file from different robot
When a force file from a different robot is specified in FileName_sValue$, an error occurs.
In such cases, either add the force file using the project editor, or execute either FSave or Fimport.

### Usage Example
This is an example of loading a force file.

```
> FLoad "myforce.frc"
```

### See Also
**FSave Statement**

# 13.18 Fmag_AvgForce Status

### Application
Force Monitor Object FM#

### Description
Returns average resultant force.

### Usage
FGet Object.Fmag_AvgForce, rVar

- Object
  Object name
  The object is specified as either of FM (numerical value) or FM (label).

- rVar
  A real number variable defining the value of the property

### Detailed Explanation
Fmag_AvgForce returns the average resultant force.
Execute AvgForceClear before executing Fmag_AvgForce.　Without executing AvgForceClear, “0” is returned.
If the time between executing AvgForceClear and executing Fmag_AvgForce is short, an error in the force and torque averages will occur. Establish a low-pass filter with a time constant of about 5 times between the AvgForceClear and the Fmag_AvgForce execution.
There is a time limit on Fmag_AvgForce. Execute Fmag_AvgForce within 600 seconds of executing AvgForceClear. When Fmag_AvgForce is executed after 600 seconds has passed, an error is generated.

### Usage Example
This is an example of acquiring the average resultant force.

```
Function CheckAverageForce
  Double AF
  FSet FC1.Enabled, True, False, False, False, False, False
  FSet FC1.TargetForces, 10, 0, 0, 0, 0, 0
  FSet FS1.Reset
  FSet FM1.CoordinateSystem, FCS0
  FSet FM1.AvgForceClear, False, False, False, False, False, False, True, False
  FCKeep FC1, 10
  FGet FM1.Fmag_AvgForce, AF
  Print AF
Fend
```

### See Also
**FM (Force Monitor) Object**

## 13.19 Fmag_Axes Property

### Application
Force Trigger Object FT#, Force Monitor Object FM#

### Description
Sets or returns the subject axis to acquire the resultant force.

### Immediate Execution
No

### Usage
FGet Object.Fmag_Axes, iVar
FSet Object.Fmag_Axes, iValue

- Object
  Object name
  The object is specified as either of FT (numerical value), FMR (numerical value), FT (label) or FMR (label).

- iVar
  An integer variable defining the value of the property

- iValue
  An integer value or formula defining the new value of the property

### Values
iValue

| Name of constants | Values | Description |
|---|---|---|
| FG_XYZ | 0 | The forces in the X, Y, and Z axes are combined. (default)<br>(Fmag = sqrt($Fx^2$ + $Fy^2$ + $Fz^2$) ) |
| FG_XY | 1 | The forces in the X and Y-axes are combined.<br>(Fmag = sqrt($Fx^2$ + $Fy^2$) ) |
| FG_YZ | 2 | The forces in the Y and Z-axes are combined.<br>(Fmag = sqrt($Fy^2$ + $Fz^2$) ) |
| FG_ZX | 3 | The forces in the Z and X-axes are combined.<br>(Fmag = sqrt($Fx^2$ + $Fz^2$) ) |

### Detailed Explanation
Fmag produces a value representing the combined force from the subject axes from the X, Y, and Z axes.
This property is used when setting or checking the subject axes to obtain the resultant force.

### Usage Example
This is an example of setting the subject axes to obtain the resultant force with respect to Force Monitor Object.

```
Function Test_Fmag_Axes
  Integer iVar
  FSet FM1.Fmag_Axes, FG_ZX
  FGet FM1.Fmag_Axes, iVar
  Print iVar
Fend
```

### See Also

**FT (Force Trigger) Object**, **FM (Force Monitor) Object**

# 13.20 Fmag_Enabled Property

### Application
Force Trigger Object FT#

### Description
Activates/inactivates the trigger based on Fmag resultant force, or returns the status thereof.

### Immediate Execution
No

### Usage
FGet Object.Fmag_Enabled, bVar
FSet Object.Fmag_Enabled, bValue

- Object
  Object name
  The object is specified as either of FT (numerical value) or FT (label).

- bVar
  A Boolean variable defining the value of the property

- bValue
  A Boolean value or formula defining the new value of the property

### Values
bValue

| Name of constants | Values | Description |
|---|---|---|
| False | 0 | Inactivates the subject axis. (default) |
| True | -1 | Activates the subject axis. |

### Detailed Explanation
This activates/inactivates or returns the trigger, which is tripped by the resultant force Fmag.

### See Also
**FT (Force Trigger) Object**

# 13.21 Fmag_Force Status

### Application
Force Monitor Object FM#

### Description
Returns the resultant force.

### Usage
FGet Object.Fmag_Force, rVar

- Object
  Object name
  The object is specified as either of FM (numerical value) or FM (label).

- rVar
  A real number variable defining the value of the property

### Detailed Explanation
Fmag_Force returns the resultant force of the subject axes specified by Fmag_Axes in the force coordinate system specified by CoordinateSystem.

### Usage Example
This example obtains the value of the resultant force in the X and Y axes in the specified force coordinate system.

```
Function Test_Fmag_Force
  Real rVar
  FSet FCS1.Position, 0, 0, 100
  FSet FCS1.Orientation, FG_TOOL
  FSet FM1.ForceSensor, 1
  FSet FM1.CoordinateSystem, FCS1
  FSet FM1.Fmag_Axes, FG_XY
  FGet FM1.Fmag_Force, rVar
  Print rVar
Fend
```

### See Also
**FM (Force Monitor) Object**

# 13.22 Fmag_Levels Property

### Application
Force Trigger Object FT#

### Description
Sets or returns the upper and lower threshold values for resultant force.

### Immediate Execution
No

### Usage
FGet Object.Fmag_Levels, rArray()
FSet Object.Fmag_Levels, rValueL, rValueU

- Object
  Object name
  The object is specified as either of FT (numerical value) or FT (label).

- rArray()
  The number of elements defining the values of the property is an array of 2 or more real number variables.

- rValueL
  A real number or formula defining the new value of the property.

- rValueU
  A real number or formula defining the new value of the property.

### Values
rArray()

| Element number | Element number constant |
|---|---|
| 0 | FG_ LOWERLEVEL |
| 1 | FG_ UPPERLEVEL |

rValueL (Unit: [N])

| | Values |
|---|---|
| Minimum | 0 (default) |
| Maximum | 1000 |

rValueU (Unit: [N])

| | Values |
|---|---|
| Minimum | 0 |
| Maximum | 1000 (default) |

### Detailed Explanation
Fmag_Levels sets or returns the upper and lower thresholds for resultant force.
rValueL is the lower threshold. rValueU is the upper threshold. Be sure that rValueL < rValueU.
This is used for error checking and task completion conditions.

### Usage Example

This is an example of stopping the robot due to an error from being below the lower threshold or above the upper threshold.

```
Function SettingLevels
  FSet FT1.Enabled, False, False, False, False, False, False, True, False
  FSet FT1.Fmag_Polarity, FG_OUT
  FSet FT1.Fmag_Levels, 0, 50
  Trap 1, FT1 Call ForceError
Fend

Function ForceError
  AbortMotion All
Fend
```

### See Also

**FT (Force Trigger) Object**

## 13.23 Fmag_LPF_Enabled Property

### Application
Force Trigger Object FT#, Force Monitor Object FM#

### Description
Activates/inactivates or returns the resultant force low-pass filter.

### Immediate Execution
No

### Usage
FGet Object.Fmag_LPF_Enabled, bVar
FSet Object.Fmag_LPF_Enabled, bValue

- Object
  Object name
  The object is specified as either of FT (numerical value), FMR (numerical value), FT (label) or FMR (label).

- bVar
  A Boolean variable defining the value of the property

- bValue
  A Boolean value or formula defining the new value of the property

### Values

| Name of Constants | Values | Description |
|---|---|---|
| False | 0 | Sets the low-pass filter to inactive. (default) |
| True | -1 | Sets the low-pass filter to active. |

### Detailed Explanation
Activates/inactivates or returns the resultant force low-pass filter.
When the low-pass filter is active, signal noise can be reduced, but the following performance for quick signal changes deteriorates.
The low-pass filter is used with AvgForces status, PeakForces status, the Force Trigger Function, and Force Monitor, but is not applied to Forces status.

### Usage Example
This example sets the low-pass filter for resultant force and acquires the force peak data.

```
Function GetPeakForceTest
  Real myPeakForce
  FSet FCS1.Orientation, FG_TOOL
  FSet FM1.CoordinateSystem, FCS1
  FSet FM1.Fmag_Axes, FG_XYZ
  FSet FM1.Fmag_LPF_Enabled, True
  FSet FM1.Fmag_LPF_TimeConstant, 0.02
  FSet FM1.PeakForceClear, True, True, True, True, True, True, True, True
  Wait 10
  FGet FM1.Fmag_PeakForce, myPeakForce
  Print myPeakForce
Fend
```

### See Also
**FT (Force Trigger) Object**, **FM (Force Monitor) Object**, **Fmag_LPF_TimeConstant Property**, **LPF_Enabled Property**

## 13.24 Fmag_LPF_TimeConstant Property

### Application
Force Trigger Object FT#, Force Monitor Object FM#

### Description
Sets or returns the time constant for the low-pass filter applied to the resultant force.

### Immediate Execution
No

### Usage
FGet Object.Fmag_LPF_TimeConstant, rVar
FSet Object.Fmag_LPF_TimeConstant, rValue

- Object
  Object name
  The object is specified as either of FT (numerical value), FMR (numerical value), FT (label) or FMR (label).

- rVar
  A real number variable defining the value of the property

- rValue
  A real number or formula defining the new value of the property.

### Values
rValue (Unit: [sec])

| | Values |
|---|---|
| Minimum | 0.002 |
| Maximum | 5 |

Default: 0.01

### Detailed Explanation
This specifies the time constant for the resultant force low-pass filter.

The low-pass filter time constant is the time it takes to arrive at an input value of $1\text{-}e^{-1}$ (approximately 63.2%) when giving step input.
The signal noise reduction can be enhanced when increasing the time constant, but the following performance for quick signal changes deteriorates.
The low-pass filter is used with AvgForces Status, PeakForces Status, the Force Trigger Function, and Force Monitor, but is not used with Forces Status.

### Usage Example
This example sets the low-pass filter for resultant force and acquires the force peak data.

```
Function GetPeakForceTest
  Real myPeakForce
  FSet FCS1.Orientation, FG_TOOL
  FSet FM1.CoordinateSystem, FCS1
  FSet FM1.Fmag_Axes, FG_XYZ
  FSet FM1.Fmag_LPF_Enabled, True
  FSet FM1.Fmag_LPF_TimeConstant, 0.02
  FSet FM1.PeakForceClear, True, True, True, True, True, True, True, True
  Wait 10
```

```
  FGet FM1.Fmag_PeakForce, myPeakForce
  Print myPeakForce
Fend
```

### See Also

**FT (Force Trigger) Object**, **FM (Force Monitor) Object**, **Fmag_LPF_Enabled Property**, **LPF_TimeConstants Property**

# 13.25 Fmag_PeakForce Status

### Application
Force Monitor Object FM#

### Description
Returns the resultant force peak.

### Usage
FGet Object.Fmag_PeakForce, rVar

- Object
  Object name
  The object is specified as either of FM (numerical value) or FM (label).

- rVar
  A real number variable defining the value of the property

### Detailed Explanation
Fmag_PeakForce returns the value of the resultant force peak.
Execute PeakForceClear before executing Fmag_PeakForce.

### Usage Example
This example measures the resultant force peak.

```
Function CheckPeakForce
  Double PF
  FSet FC1.Enabled, True, False, False, False, False, False
  FSet FC1.TargetForces, 10, 0, 0, 0, 0, 0
  FSet FS1.Reset
  FSet FM1.CoordinateSystem, FCS0
  FSet FM1.PeakForceClear, False, False, False, False, False, False, True, False
  FCKeep FC1, 10
  FGet FM1.Fmag_PeakForce, PF
  Print PF
Fend
```

### See Also
**FM (Force Monitor) Object**

## 13.26 Fmag_Polarity Property

### Application
Force Trigger Object FT#

### Description
Sets or returns for resultant force whether the force trigger is activated or inactivated when values correspond to or do not correspond with threshold values.

### Immediate Execution
No

### Usage
FGet Object.Fmag_Polarity, iVar
FSet Object.Fmag_Polarity, iValue

- Object
  Object name
  The object is specified as either of FT (numerical value) or FT (label).

- iVar
  An integer variable defining the value of the property

- iValue
  An integer value or formula defining the new value of the property

### Values
iValue

| Name of constants | Values | Description |
|---|---|---|
| FG_OUT | 0 | Activates when the value is outside of the thresholds. (default) |
| FG_IN | 1 | Activates when the value is within the thresholds. |

### Detailed Explanation
Fmag_Polarity returns the status of or sets whether the force trigger is triggered by either the resultant force being within the thresholds or the resultant force being outside of the thresholds.

### Usage Example
This example generates an error and stops the robot when the resultant force is above the upper threshold or below the lower threshold.

```
Function SettingPolarity
  FSet FT1.Enabled, False, False, False, False, False, False, True, False
  FSet FT1.Fmag_Polarity, FG_OUT
  FSet FT1.Fmag_Levels, 0, 50
  Trap 1, FT1 Call ForceError
Fend

Function ForceError
  AbortMotion All
Fend
```

### See Also
FT (Force Trigger) Object

# 13.27 FNumber Function

### Application
Force Control Object FC#, Force Trigger Object FT#, Force Monitor Object FM#, Force Coordinate System Object FCS#

### Description
This returns the force object number corresponding to the label of the specified force object.

### Usage
FNumber(Object)

- Object
  Object name
  The object is specified as FC (label), FCS (label), FT (label), or FM (label).

### Return Values
Integers

### Detailed Explanation
This returns the force object number corresponding to the label of the specified force object. An error occurs when there is no corresponding object.

### Usage Example
This is an example of establishing a label for a force object, acquiring the number from that label, then displaying it.

```
> FSet FM1.Label, "Label1"
> Print FNumber(FM(Label1))
 1
```

### See Also
**Number Property**, **Label Property**, **FC (Force Control) Object**, **FT (Force Trigger) Object**, **FM (Force Monitor) Object**, **FCS (Force Coordinate System) Object**

# 13.28 Forces Status

### Application
Force Monitor Object FM#

### Description
This returns data on the resultant force.

### Usage
FGet Object.Forces, rArray()

- Object
  Object name
  The object is specified as either of FM (numerical value) or FM (label).

- rArray
  The number of elements, which define the property values, is an array of 8 or more real numbers.

### Values
rArray()

| Element number | Element number constant |
|---|---|
| 0 | FG_FX |
| 1 | FG_FY |
| 2 | FG_FZ |
| 3 | FG_TX |
| 4 | FG_TY |
| 5 | FG_TZ |
| 6 | FG_FMAG |
| 7 | FG_TMAG |

### Detailed Explanation
Forces returns data on the specified force coordinate system specified by CoordinateSystem.
Since this command acquires the current value, it will acquire the value without the application of the low-pass filter. The data reflecting the application of the low-pass filter can be confirmed via Force Monitor or Force Log.

### Usage Example
This example establishes force coordinate systems 1 and 2, and acquires the respective resultant force data.

```
Function Test_Forces
  Real rArray1(8), rArray2(8)
  FSet FCS1.Position, 0, 0, 100
  FSet FCS1.Orientation, FG_TOOL
  FSet FCS2.Position, 0, 0, 5
  FSet FCS2.Orientation, FG_LOCAL, 1
  FSet FM1.ForceSensor, 1
  FSet FM1.CoordinateSystem, FCS1
  FGet FM1.Forces, rArray1()
  Print rArray1(FG_FX), rArray1(FG_FY), rArray1(FG_FZ), rArray1(FG_TX),
rArray1(FG_TY), rArray1(FG_TZ), rArray1(FG_FMAG), rArray1(FG_TMAG)
  FSet FM1.ForceSensor, 1
  FSet FM1.CoordinateSystem, FCS2
```

```
  FGet FM1.Forces, rArray2()
  Print rArray2(FG_FX), rArray2(FG_FY), rArray2(FG_FZ), rArray2(FG_TX),
rArray2(FG_TY), rArray2(FG_TZ), rArray2(FG_FMAG), rArray2(FG_TMAG)
Fend
```

### See Also

**FM (Force Monitor) Object**

# 13.29 ForceSensor Property

### Application
Force Trigger Object FT#, Force Monitor Object FM#,
Force Motion Restriction Object FMR#

### Description
Sets or returns the number of the force sensor in question.

### Usage
FGet Object.ForceSensor, iVar
FSet Object.ForceSensor, iValue

- Object
  Object name
  The object is specified as FT (numerical value), FM (numerical value), FMR (numerical value), FT (label), FM (label), or FMR (label).

- iVar
  An integer variable defining the value of the property

- iValue
  An integer value or formula defining the new value of the property

### Values
iValue (Unit: Number)

| | Values |
|---|---|
| Minimum | 1 (default) |
| Maximum | 4 |

### Detailed Explanation
This sets the number of the subject force sensor, or when confirming, uses the properties thereof.

### Usage Example
This example sets and acquires the number of the force sensor corresponding to FM1.

```
Function Test_ForceSensor
  Integer iVar
  FSet FM1.ForceSensor, 3
  FGet FM1.ForceSensor, iVar
  Print iVar
Fend
```

### See Also
**FT (Force Trigger) Object**, **FM (Force Monitor) Object**, Force Motion Restriction Object FMR#

# 13.30 FSave Statement

### Description
This saves the force data in the main memory in the current robot file.

### Usage
FSave FileName_sValue$

- FileName_sValue$
  The character string specifying the file name in the force data storage destination.

### Detailed Explanation
This saves the force data in the main memory in the current robot file. The extension is fixed to ".frc". If the extension is omitted, ".frc" will be added. The file name must be alphanumeric characters and the underscore character only, and can be up to 255 characters. You cannot specify the path. If the force data has not already been saved previously, it will be added to the current robot project.

### Frequent Errors
The specified file is not the current robot file
When a force file from a different robot is specified in FileName_sValue$, an error occurs.

The path is specified in the specified file name
When the path is included in FileName_sValue$, an error occurs. Be sure to specify the file name only.

File name error
An error is generated when a space or invalid character is contained in FileName_sValue$.

### Usage Example
This example saves the force file.

```
> FSave "myforce.frc"
```

### See Also
**FLoad Statement**

# 13.31 FSet Statement

### Application
Force Object FC#, Force Trigger Object FT#, Force Monitor Object FM#, Force Coordinate System Object FCS#

### Description
Used when setting the value of force object properties.

### Usage
FSet Object.Property, Values

- Object
  Object name defining the property value
- Property
  Property name defining the new value
- Values
  The parameter numbers and format differ according to the property.

### Detailed Explanation
This is used to set the force object properties and control the force sensor.
The property modifications made via FSet are only made in memory and are not saved to the file. Call up FSave to save the new settings to the file. In addition, when the Controller power is cycled and the unit reboots, or when a project is loaded, the values from the force file are loaded into memory and the modifications not saved to the file will revert to their original value.

### Usage Example
This example sets the properties for Force Monitor Object, and acquires and displays the value in each axis for force sensor 1.

```
Function test

  Real myForces(8)

  FSet FS1.Reset

  FSet FM1.ForceSensor, 1
  FSet FM1.CoordinateSystem, FCS0
  Do
    FGet FM1.Forces, myForces()
    Print myForces(0), myForces(1), myForces(2)
    Wait 1
  Loop
Fend
```

### See Also
**FGet Statement**, **FSave Statement**, **Force Object - Common**

# 13.32 Fx, Fy, Fz, Tx, Ty, Tz Property

### Application
Force Control Object FC#

### Description
Sets or returns the value of the following coefficients for force control in the specified axis of the force coordinates. Virtual coefficients of elasticity (Spring) Virtual coefficients of viscosity (Damper) Virtual coefficients of inertia (Mass)

### Immediate Execution
No

### Usage
FGet Object.XX, rArray()
FSet Object.XX, rValueS, rValueD, rValueM

- Object
  Object name
  The object is specified as either of FC (numerical value) or FC (label).

- XX
  A character string defining the name of the property

- rArray()
  The number of elements defining the value of the property is an array of 3 or more real numbers

- rValueS
  A real number or formula defining the new value of the property

- rValueD
  A real number or formula defining the new value of the property

- rValueM
  A real number or formula defining the new value of the property

### Values
XX

| Specified Axis | Description |
|---|---|
| Fx | Specifies translated force in the X axis. |
| Fy | Specifies translated force in the Y axis. |
| Fz | Specifies translated force in the Z axis. |
| Tx | Specifies rotational force in the X axis. |
| Ty | Specifies rotational force in the Y axis. |
| Tz | Specifies rotational force in the Z axis. |

rArray()

| Element number | Element number constant | Description |
|---|---|---|
| 0 | FG_ SPRING | Virtual coefficient of elasticity |

| Element number | Element number constant | Description |
|---|---|---|
| 1 | FG_ DAMPER | Virtual coefficient of viscosity |
| 2 | FG_ MASS | Virtual coefficient of inertia |

rValueS

| Fx, Fy, Fz | Value (Unit: N/mm) |
|---|---|
| Minimum | 0 (default) |
| Maximum | 100 |

| Tx, Ty, Tz | Value (Unit: N·mm/deg) |
|---|---|
| Minimum | 0 (default) |
| Maximum | 1000000 |

rValueD

| Fx, Fy, Fz | Value (Unit: N/(mm/sec)) |
|---|---|
| Minimum | 0.1 |
| Maximum | 200 |

Default: 10

| Tx, Ty, Tz | Value (Unit: N·mm/(deg/sec)) |
|---|---|
| Minimum | 10 |
| Maximum | 1000000 |

Default: 3000

rValueM

| Fx, Fy, Fz | Value (Unit: mN/(mm/ $sec^2$) = kg) |
|---|---|
| Minimum | 0.001 |
| Maximum | 1000 |

Default: 10

| Tx, Ty, Tz | Value (Unit: N·mm/(deg/ $sec^2$)) |
|---|---|
| Minimum | 1000 |
| Maximum | 10000000 |

Default: 30000

**Detailed Explanation**

This sets or returns the value of the virtual coefficients of elasticity, viscosity, and inertia for force control in the specified axes in the established force coordinate system.

The following properties can be set or retrieved with one command. (XX indicates either of Fx, Fy, Fz, Tx, Ty, or Tz)

XX_Spring property XX_Damper property XX_Mass property

rValueS, rValueD, and rValueM set the virtual coefficients of elasticity, viscosity, and inertia, respectively.
Refer to the following manual for details on coefficients.
"Epson RC+ 8.0 Option Force Guide 8.0"

### Usage Example

This example sets the virtual coefficients of elasticity, viscosity, and inertia for Fz, and carries out a motion with force control active.

```
Function ForceControlTest
  FSet FCS1.Orientation, FG_TOOL
  FSet FC1.CoordinateSystem, FCS1
  FSet FC1.Enabled, False, False, True, False, False, False
  FSet FC1.Fz, 0.01, 4, 5
  Move CurPos +Z(10) FC1
Fend
```

### See Also

**FC (Force Control) Object**

## 13.33 Fx_AvgForce, Fy_AvgForce, Fz_AvgForce Status

### Application
Force Monitor Object FM#

### Description
This returns the average translated force in the specified axes.

### Usage
FGet Object.XX_AvgForce, rVar

- Object
  Object name
  The object is specified as either of FM (numerical value) or FM (label).

- XX
  A character string defining the name of the property

- rVar
  A real number variable defining the value of the property

### Values
XX

| Specified Axis | Description |
|---|---|
| Fx | Specifies translated force in the X axis. |
| Fy | Specifies translated force in the Y axis. |
| Fz | Specifies translated force in the Z axis. |

### Detailed Explanation
XX_AvgForce returns the average translated force in the specified axis.
Before executing XX_AvgForce, execute AvgForceClear. “0” will be returned if AvgForceClear is not executed.
If the time between executing AvgForceClear and executing XX_AvgForce is short, an error in the force and torque averages will occur. Establish a low-pass filter with a time constant of about 5 times between the AvgForceClear and the XX_AvgForce execution.
There is a time limit on XX_AvgForce. Execute XX_AvgForces within 600 seconds of executing AvgForceClear. When XX_AvgForce is executed after 600 seconds has passed, an error is generated.

### Usage Example
This is an example of force averaging in the Fx axis.

```
Function CheckAverageForce
  Double AF
  FSet FC1.Enabled, True, False, False, False, False, False
  FSet FC1.TargetForces, 10, 0, 0, 0, 0, 0
  FSet FS1.Reset
  FSet FM1.CoordinateSystem, FCS0
  FSet FM1.AvgForceClear, True, False, False, False, False, False, False, False
  FCKeep FC1, 10
  FGet FM1.Fx_AvgForce, AF
  Print AF
Fend
```

### See Also
**FM (Force Monitor) Object**

# 13.34 Fx_Damper, Fy_Damper, Fz_Damper Property

### Application
Force Control Object FC#

### Description
This sets or returns the value of the virtual coefficient of viscosity for force control in the specified axis for the force in the direction of translation.

### Immediate Execution
No

### Usage
FGet Object.XX_Damper, rVar
FSet Object.XX_Damper, rValue

- Object
  Object name
  The object is specified as either of FC (numerical value) or FC (label).

- XX
  A character string defining the name of the property

- rVar
  A real number variable defining the value of the property

- rValue
  A real number or formula defining the new value of the property

### Values
XX

| Specified Axis | Description |
|---|---|
| Fx | Specifies translated force in the X axis. |
| Fy | Specifies translated force in the Y axis. |
| Fz | Specifies translated force in the Z axis. |

rValue (Unit: [N/(mm/sec)])

| | Values |
|---|---|
| Minimum | 0.1 |
| Maximum | 200 |

Default: 10

### Detailed Explanation
This sets or returns the value of the virtual coefficient of viscosity for force control in the specified axis of the established force coordinate system.
Refer to the following manual for details on coefficients.
“Epson RC+ 8.0 Option Force Guide 8.0”

### Usage Example

This example sets the virtual coefficients of elasticity, viscosity, and inertia in Fx and carries out a motion with force control active.

```
FSet FCS1.Orientation, FG_TOOL
FSet FC1.CoordinateSystem, FCS1
FSet FC1.Enabled, True, False, False, False, False, False
FSet FC1.Fx_Spring, 0.01
FSet FC1.Fx_Damper, 4
FSet FC1.Fx_Mass, 5
Move CurPos +X(10) FC1
```

### See Also

**FC (Force Control) Object**

# 13.35 Fx_Enabled, Fy_Enabled, Fz_Enabled Property

### Application
Force Control Object FC#, Force Trigger Object FT#

### Description
Independently activates/inactivates, or returns the force control function or force trigger function of the translational direction.

### Immediate Execution
No

### Usage
FGet Object.XX_Enabled, bVar
FSet Object.XX_Enabled, bValue

- Object
  Object name

- XX
  A character string defining the name of the property

- bVar
  A Boolean variable defining the value of the property

- bValue
  A Boolean value or formula defining the new value of the property

### Values
XX

| Specified Axis | Description |
|---|---|
| Fx | Specifies translated force in the X axis. |
| Fy | Specifies translated force in the Y axis. |
| Fz | Specifies translated force in the Z axis. |

bValue

| Name of constants | Values | Description |
|---|---|---|
| False | 0 | Inactivates the subject axis. (default) |
| True | -1 | Activates the subject axis. |

### Detailed Explanation
Independently activates/inactivates, or returns the force control function or force trigger function of the translational direction.

### Usage Example
This example activates the Force Control Object in the X axis.

```
> FSet FC1.Fx_Enabled, True
```

### See Also
**FC (Force Control) Object**, **FT (Force Trigger) Object**

# 13.36 Fx_Force, Fy_Force, Fz_Force Status

### Application
Force Monitor Object FM#

### Description
This returns force data for the specified axis.

### Usage
FGet Object.XX_Force, rVar

- Object
  Object name
  The object is specified as either of FM (numerical value) or FM (label).

- XX
  A character string defining the name of the property

- rVar
  A real number variable defining the value of the property

### Values
XX

| Specified Axis | Description |
|---|---|
| Fx | Specifies translated force in the X axis. |
| Fy | Specifies translated force in the Y axis. |
| Fz | Specifies translated force in the Z axis. |

### Detailed Explanation
Use this property to confirm the force data for the specified axis in the force coordinate system specified by CoordinateSystem.

### Usage Example
This example establishes the force coordinate system 1 for the Force Monitor Object, and acquires X axis force data.

```
Function Test_Fx_Force
  Real rVar
  FSet FCS1.Position, 0, 0, 100
  FSet FCS1.Orientation, FG_TOOL
  FSet FM1.ForceSensor, 1
  FSet FM1.CoordinateSystem, FCS1
  FGet FM1.Fx_Force, rVar
  Print rVar
Fend
```

### See Also
**FM (Force Monitor) Object**

# 13.37 Fx_Levels, Fy_Levels, Fz_Levels Property

### Application
Force Trigger Object FT#

### Description
This sets or returns the value of the lower force threshold and upper force threshold in the direction of translation in the specified axis.

### Immediate Execution
No

### Usage
FGet Object.XX_Levels, rArray()
FSet Object.XX_Levels, rValueL, rValueU

- Object
  Object name
  The object is specified as either of FT (numerical value) or FT (label).

- XX
  A character string defining the name of the property

- rArray()
  The number of elements defining the values of the property is an array of 2 or more real number variables

- rValueL
  A real number or formula defining the new value of the property.

- rValueU
  A real number or formula defining the new value of the property.

### Values
XX

| Specified Axis | Description |
|---|---|
| Fx | Specifies the X axis in the direction of translation. |
| Fy | Specifies the Y axis in the direction of translation. |
| Fz | Specifies the Z axis in the direction of translation. |

rArray()

| Element number | Element number constant |
|---|---|
| 0 | FG_ LOWERLEVEL |
| 1 | FG_ UPPERLEVEL |

rValueL (Unit: [N])

| | Values |
|---|---|
| Minimum | -1000 (default) |
| Maximum | 1000 |

rValueU (Unit: [N])

| | Values |
|---|---|
| Minimum | -1000 |
| Maximum | 1000 (default) |

### Detailed Explanation

XX_Levels sets or returns the lower and upper force threshold values for the specified axis in the direction of translation.
rValueL is the lower threshold. rValueU is the upper threshold. Be sure that rValueL < rValueU.
This is used for error checking and task completion conditions.

### Usage Example

This is an example of stopping the robot due to an error from being below the lower threshold or above the upper threshold in the Fx direction.

```
Function SettingLevels
  FSet FT1.Enabled, True, False, False, False, False, False, False, False
  FSet FT1.Fx_Polarity, FG_OUT
  FSet FT1.Fx_Levels, -50, 50
  Trap 1, FT1 Call ForceError
Fend

Function ForceError
  AbortMotion All
Fend
```

### See Also

**FT (Force Trigger) Object**

# 13.38 Fx_LPF_Enabled, Fy_LPF_Enabled, Fz_LPF_Enabled Property

### Application
Force Trigger Object FT#, Force Monitor Object FM#

### Description
This activates/inactivates or returns the status of the low-pass filter for the specified axis for the force in the direction of translation.

### Immediate Execution
No

### Usage
FGet Object.XX_LPF_Enabled, bVar
FSet Object.XX_LPF_Enabled, bValue

- Object
  Object name
  The object is specified as FT (numerical value), FT (label), FM (numerical value), or FM (label).

- XX
  A character string defining the name of the property

- bVar
  A Boolean variable defining the value of the property

- bValue
  A Boolean value or formula defining the new value of the property

### Values
XX

| Specified Axis | Description |
|---|---|
| Fx | Specifies the X axis in the direction of translation. |
| Fy | Specifies the Y axis in the direction of translation. |
| Fz | Specifies the Z axis in the direction of translation. |

bValue

| Name of constants | Values | Description |
|---|---|---|
| False | 0 | Sets the low-pass filter to inactive. (default) |
| True | -1 | Sets the low-pass filter to active. |

### Detailed Explanation
This activates/inactivates or returns the status of the low-pass filter for the specified axis for the force in the direction of translation.
When the low-pass filter is active, signal noise can be reduced, but the following performance for quick signal changes deteriorates.
The low-pass filter is used with AvgForces status, PeakForces status, the Force Trigger Function, and Force Monitor. It is not applied to Forces status.

### Usage Example

This example sets the low pass filter for Fx and acquires the force peak data.

```
Function GetPeakForceTest
  Real myPeakForce
  FSet FCS1.Orientation, FG_TOOL
  FSet FM1.CoordinateSystem, FCS1
  FSet FM1.Fx_LPF_Enabled, True
  FSet FM1.Fx_LPF_TimeConstant, 0.02
  FSet FM1.PeakForceClear, True, True, True, True, True, True
  Wait 10
  FGet FM1.Fx_PeakForce, myPeakForce
  Print myPeakForce
Fend
```

### See Also

**FT (Force Trigger) Object**, **FM (Force Monitor) Object**

# 13.39 Fx_LPF_TimeConstant, Fy_LPF_TimeConstant, Fz_LPF_TimeConstant Property

### Application
Force Trigger Object FT#, Force Monitor Object FM#

### Description
This sets the time constant or returns the value thereof for the force in the specified axis in the direction of translation.

### Immediate Execution
No

### Usage
FGet Object.XX_LPF_TimeConstant, rVar
FSet Object.XX_LPF_TimeConstant, rValue

- Object
  Object name
  The object is specified as FT (numerical value), FT (label), FM (numerical value), or FM (label).

- XX
  A character string defining the name of the property

- rVar
  A real number variable defining the value of the property

- rValue
  A real number or formula defining the new value of the property.

### Values
XX

| Specified Axis | Description |
|---|---|
| Fx | Specifies the X axis in the direction of translation. |
| Fy | Specifies the Y axis in the direction of translation. |
| Fz | Specifies the Z axis in the direction of translation. |

rValue (Unit: [sec])

| | Values |
|---|---|
| Minimum | 0.002 |
| Maximum | 5 |

' Default: 0.01

### Detailed Explanation
This sets the time constant for the low-pass filter or returns the status thereof for the specified axis in the direction of translation for the force trigger function or force monitor function.
The low-pass filter time constant is the time it takes to arrive at an input value of $1\text{-}e^{-1}$ (approximately 63.2%) when giving step input.
The signal noise reduction can be enhanced when increasing the time constant, but the following performance for quick signal changes deteriorates.

The low-pass filter is used with AvgForces Status, PeakForces Status, the Force Trigger Function, and Force Monitor. It is not used with Forces Status.

### Usage Example

This example sets the low pass filter for Fx and acquires the force peak data.

```
Function GetPeakForceTest
  Real myPeakForce
  FSet FCS1.Orientation, FG_TOOL
  FSet FM1.CoordinateSystem, FCS1
  FSet FM1.Fx_LPF_Enabled, True
  FSet FM1.Fx_LPF_TimeConstant, 0.02
  FSet FM1.PeakForceClear, True, True, True, True, True, True
  Wait 10
  FGet FM1.Fx_PeakForce, myPeakForce
  Print myPeakForce
Fend
```

### See Also

**FT (Force Trigger) Object**, **FM (Force Monitor) Object**

# 13.40 Fx_Mass, Fy_Mass, Fz_Mass Property

### Application
Force Control Object FC#

### Description
This sets or returns the value of the virtual coefficient of inertia for force control in the specified axis of the force in the translational direction.

### Immediate Execution
No

### Usage
FSet Object.XX_Mass, rValue
FGet Object.XX_Mass, rVar

- Object
  Object name
  The object is specified as either of FC (numerical value) or FC (label).

- XX
  A character string defining the name of the property

- rVar
  A real number variable defining the value of the property

- rValue
  A real number or formula defining the new value of the property.

### Values
XX

| Specified Axis | Description |
|---|---|
| Fx | Specifies the X axis in the direction of translation. |
| Fy | Specifies the Y axis in the direction of translation. |
| Fz | Specifies the Z axis in the direction of translation. |

rValue (Unit: [mN/(mm/sec$^2$) = kg])

| | Values |
|---|---|
| Minimum | 0.001 |
| Maximum | 1000 |

Default: 10

### Detailed Explanation
This sets or returns the value of the virtual coefficient of inertia for force control in the specified axis of the force in the direction of translation within the established force coordinate system.
Refer to the following manual for details on coefficients.
“Epson RC+ 8.0 Option Force Guide 8.0”

### Usage Example

This example sets the Fx virtual coefficients of elasticity, viscosity, and inertia, and carries out a motion with force control active.

```
Function Test_Mass
  FSet FCS1.Orientation, FG_TOOL
  FSet FC1.CoordinateSystem, FCS1
  FSet FC1.Enabled, True, False, False, False, False, False
  FSet FC1.Fx_Spring, 0.01
  FSet FC1.Fx_Damper, 4
  FSet FC1.Fx_Mass, 5
  Move CurPos +X(10) FC1
Fend
```

### See Also

FC (Force Control) Object

# 13.41 Fx_PeakForce, Fy_PeakForce, Fz_PeakForce Status

### Application
Force Monitor Object FM#

### Description
This returns the value of the peak force for the specified axis in the direction of translation.

### Usage
FGet Object.XX_PeakForce, rVar

- Object
  Object name
  The object is specified as either of FM (numerical value) or FM (label).

- XX
  A character string defining the name of the property

- rVar
  A real number variable defining the value of the property

### Values
XX

| Specified Axis | Description |
|---|---|
| Fx | Specifies the X axis in the direction of translation. |
| Fy | Specifies the Y axis in the direction of translation. |
| Fz | Specifies the Z axis in the direction of translation. |

### Detailed Explanation
XX_PeakForce returns the value of the force peak for the specified axis in the direction of translation.
Before executing XX_PeakForce, execute PeakForceClear.

### Usage Example
This example returns the value of the peak force in the Fx direction.

```
Function CheckPeakForce
  Double PF
  FSet FC1.Enabled, True, False, False, False, False, False
  FSet FC1.TargetForces, 10, 0, 0, 0, 0, 0
  FSet FS1.Reset
  FSet FM1.CoordinateSystem, FCS0
  FSet FM1.PeakForceClear, True, False, False, False, False,
                                  False, False, False
  FCKeep FC1, 10
  FGet FM1.Fx_PeakForce, PF
  Print PF
Fend
```

### See Also
**FM (Force Monitor) Object**

# 13.42 Fx_Polarity, Fy_Polarity, Fz_Polarity Property

### Application
Force Trigger Object FT#

### Description
This returns the status of or sets whether the force trigger is triggered by either being within the thresholds or being outside of the thresholds in the specified axis in the direction of translation.

### Immediate Execution
No

### Usage
FGet Object.XX_Polarity, iVar
FSet Object.XX_Polarity, iValue

- Object
  Object name
  The object is specified as either of FT (numerical value) or FT (label).

- XX
  A character string defining the name of the property

- iVar
  An integer variable defining the value of the property

- iValue
  An integer value or formula defining the new value of the property

### Values
XX

| Specified Axis | Description |
|---|---|
| Fx | Specifies the X axis in the direction of translation. |
| Fy | Specifies the Y axis in the direction of translation. |
| Fz | Specifies the Z axis in the direction of translation. |

iValue

| Name of constants | Values | Description |
|---|---|---|
| FG_OUT | 0 | Activates when the value is outside of the thresholds. (default) |
| FG_IN | 1 | Activates when the value is within the thresholds. |

### Detailed Explanation
XX_Polarity returns the status of or sets whether the force trigger is triggered by either being within the thresholds or being outside of the thresholds in the specified axis in the direction of translation.

### Usage Example
This example generates an error and stops the robot when the force in the Fx direction is above the upper the upper or below the lower threshold.

```
Function SettingPolarity
  FSet FT1.Enabled, True, False, False, False, False, False, False, False
```

```
  FSet FT1.Fx_Polarity, FG_OUT
  FSet FT1.Fx_Levels, -50, 50
  Trap 1, FT1 Call ForceError
Fend

Function ForceError
  AbortMotion All
Fend
```

**See Also**

FT (Force Trigger) Object

# 13.43 Fx_Spring, Fy_Spring, Fz_Spring Property

### Application
Force Control Object FC#

### Description
This sets or returns the value of the virtual coefficient of elasticity for force control in the specified axis for the force in the direction of translation.

### Immediate Execution
No

### Usage
FGet Object.XX_Spring, rVar
FSet Object.XX_Spring, rValue

- Object
  Object name
  The object is specified as either of FC (numerical value) or FC (label).

- XX
  A character string defining the name of the property

- rVar
  A real number variable defining the value of the property

- rValue
  A real number or formula defining the new value of the property.

### Values
XX

| Specified Axis | Description |
|---|---|
| Fx | Specifies the X axis in the direction of translation. |
| Fy | Specifies the Y axis in the direction of translation. |
| Fz | Specifies the Z axis in the direction of translation. |

rValue (Unit: [N/mm])

| | Values |
|---|---|
| Minimum | 0 (default) |
| Maximum | 100 |

### Detailed Explanation
This sets or returns the value of the virtual coefficient of elasticity for force control in the specified axis in the established force coordinate system.
Refer to the following manual for details on coefficients.
"Epson RC+ 8.0 Option Force Guide 8.0"

### Usage Example
This example sets the virtual coefficients of elasticity, viscosity, and inertia, and carries about a motion with the force control function active.

```
FSet FCS1.Orientation, FG_TOOL
FSet FC1.CoordinateSystem, FCS1
FSet FC1.Enabled, True, False, False, False, False, False
FSet FC1.Fx_Spring, 0.01
FSet FC1.Fx_Damper, 4
FSet FC1.Fx_Mass, 5
Move CurPos +X(10) FC1
```

### See Also

FC (Force Control) Object

# 13.44 Fx_TargetForce, Fy_TargetForce, Fz_TargetForce Property

### Application
Force Control Object FC#

### Description
This sets or returns the value of the target force in the specified axis in the direction of translation in the established force coordinate system.

### Immediate Execution
No

### Usage
FGet Object.XX_TargetForce, rVar
FSet Object.XX_TargetForce, rValue

- Object
  Object name
  The object is specified as either of FC (numerical value) or FC (label).
- XX
  A character string defining the name of the property
- rVar
  A real number variable defining the value of the property
- rValue
  A real number or formula defining the new value of the property.

### Values
XX

| Specified Axis | Description |
|---|---|
| Fx | Specifies the X axis in the direction of translation. |
| Fy | Specifies the Y axis in the direction of translation. |
| Fz | Specifies the Z axis in the direction of translation. |

rValue (Unit: [N])

| | Values |
|---|---|
| Minimum | The rated negative detection capability of the force sensor |
| Maximum | The rated positive detection capability of the force sensor |

Default: 0

### Detailed Explanation
This sets or returns the value of the target force in the specified axis in the direction of translation in the established force coordinate system.
When the force control function is executed with the target force being set to “0”, the robot can operate while following the external force since it moves so that the force becomes “0”.
When using the force control function having set the target force, there are times that the target force is not achieved even after sufficient time. In such instances, activate the TargetForcePriorityMode in order to accurately match the target force. However,

when the TargetForcePriorityMode is activated, operation of the robot will not be in accordance with the established values for the virtual coefficients of elasticity, viscosity, and inertia, and the movement may be slowed at times.

### Usage Example

This example sets the Fz virtual coefficients of elasticity, viscosity, and inertia, and carries out a motion with the force control function active.

```
FSet FCS1.Orientation, FG_TOOL
FSet FC1.CoordinateSystem, FCS1
FSet FC1.Enabled, False, False, True, False, False, False
FSet FC1.Fz, 0.01, 4, 5
FSet FC1.Fz_TargetForce, 10
FCKeep FC1, 5
```

### See Also

**FC (Force Control) Object**

# 13.45 F_CheckPos Function

### Description

Returns whether the specified position has met the trigger conditions set in the force motion restriction object.

### Usage

F_CheckPos(Object [, Point1[, Point2]])

- Object
  Object name
  The object is specified as either of FMR (numerical value) or FMR (label).

- Point1
  Point data/point designation to show reference position. Can be omitted.

- Point2
  Point data/point designation to show reference position. Can be omitted.

### Return Values

| Number | Constant | Description |
|---|---|---|
| 0 | False | Trigger conditions not met |
| -1 | True | Trigger conditions met |

Returns whether the specified position has met the trigger conditions set in the force motion restriction object.

### Detailed Explanation

Returns whether the specified position has met the trigger conditions set in the force motion restriction object. This function determines whether trigger conditions have been met with HoldTimeThresh set to “0”.
The usage of this function varies depending on the monitored object specified by the TriggerMode property.
When FG_REL_COORD_SYS, FG_REL_TOOL, or FG_REL_JOINT is specified by TriggerMode.
This evaluates the achievement status for force motion restriction for the position and orientation, or joint angle of Point2 relative to Point1. The point of reference, Point1, cannot be omitted. An error will occur if omitted. If the point being evaluated, Point2, is omitted, the achievement status for force motion restriction for the position and orientation, or joint angle of current position (CurPos) will be evaluated relative to Point1.

When FG_ABS_COORD_SYS, FG_REL_POINT, or FG_ABS_JOINT is specified by TriggerMode.
This evaluates the achievement status for force motion restriction for the position and orientation, or joint angle of Point1 in relation to the coordinate system set by the force motion restriction object. Point2 cannot be specified. An error will occur if this is specified. Point1, the point being evaluated, may be omitted. If Point1 is omitted, this will evaluate the achievement status for force motion restriction for the position and orientation, or joint angle of current position (CurPos) in relation to the coordinate system set by the force motion restriction function.

When FG_FRC_CORRECTION is specified by TriggerMode.
This evaluates the achievement status for force motion restriction for the correction amount set by the force control function. Point1 and Point2 do not need to be set. An error will occur if these are specified.

### Usage Example

This is an example for displaying whether the Z coordinate of the robot's current position (CurPos) in the base coordinate system is within the specified range (-10 to 10). If it is within the range, True(-1) will be displayed.

```
Function F_CheckPosTest
  Print F_CheckPos(FMR1)
Fend
```

```
Function F_CheckPosTest
  FSet FMR1.TriggerMode, FG_ABS_COORD_SYS
    ' Set to evaluate the position and orientation in the specified coordinate
system
  FSet FMR1.PosEnabled, False, False, True, False, False
    ' Set enable only in the Z direction
  FSet FMR1.PosZ_Levels, -10, 10
    ' Set the upper and lower thresholds of Z to -10 to 10 mm
  FSet FMR1.PosZ_Polarity, FG_IN
    ' Set the achievement condition when it is within the range of the upper and
lower thresholds
  FSet FMR1.RobotTool, FG_CURRENT_TOOL
    ' Set based on the currently selected tool
  FSet FMR1.RobotLocal, 0
    ' Set with reference to the base coordinate system

  Print F_CheckPos(FMR1)
Fend
```

**See Also**

**TriggerMode (FMR#) Property**, **FMR (Force Motion Restriction) Object**

# 13.46 F_DestPos Function

### Description
Returns the final virtual destination position for position control only, without the effects of force control function.

### Usage
F_DestPos

### Return Values
Returns the final virtual destination position for position control only, without the effects of force control function.

### Detailed Explanation
Returns the position control’s final virtual destination position.
The position control’s final virtual destination position is the virtual final destination position that the original motion command attempted to travel. When the force control function is used, corrections are made according to the force, so this destination position will not be reached. Also, be aware that this function returns the final destination position even immediately after the start of movement; therefore, the position will not be the robot’s current position. If, however, the robot is stopped, it will match the current position.

### Usage Example
The following is an example to display the position control’s command position.

```
Function F_DestPosTest
  Print F_DestPos
Fend
```

### See Also
**F_RefPos Function**

# 13.47 F_FlangeOffset Statement

### Application
Robot Object Robot

### Description
This sets or returns the force sensor position and orientation in the Tool 0 (TCP0, J6 flange) coordinate system.

### Usage
F_FlangeOffset
F_FlangeOffset x_rValue, y_rValue, z_rValue, u_rValue, v_rValue, w_rValue

- x_rValue, …
  A numerical value or formula defining the new value

### Detailed Explanation
This sets or returns the position and orientation of the center of the force sensor base in the Tool 0 coordinate system.
This is used when the positional relationship between Tool 0 and the force sensor has changed. Since the sensor reading cannot be acquired in the assumed coordinate system if a mistake is made in the setting operation, set it accurately and use the force function.

### Usage Example
This example sets the position of the force sensor flange (10, 10, 10, 5, 5, 10) and confirms the setting results.

```
> F_FlangeOffset 10, 10, 10, 5, 5, 10
> F_FlangeOffset
  10.000,    10.000,    10.000,     5.000,     5.000,    10.000
```

### See Also
**Robot Object**

# 13.48 F_GravityDirection Statement

### Application

Robot Object Robot

### Description

This returns the value of or sets, as a vector, the direction of gravity for the Robot Object.

### Usage

F_GravityDirection

F_GravityDirection x_rValue, y_rValue, z_rValue

- x_rValue, …
  A numerical value or formula defining the new value

### Detailed Explanation

This returns the value of or sets the orientation of the gravitational acceleration vector in the base coordinate system.

Set the direction of gravity only.

$rValueX^2 + rValueY^2 + rValueZ^2 = 1$

The settings described above are recommended.

Should the settings of (rValueX, rValueY, rValueZ) = (0, 0, 0), the direction of gravity will not be fixed, so an error will occur.

### Usage Example

This example sets the direction of gravity to (0, 0, 1), and confirms the results of the setting.

```
> F_GravityDirection 0, 0, 1
> F_GravityDirection
  0.000,     0.000,     1.000
```

### See Also

**Robot Object**

# 13.49 F_OffsetPos Function

### Description
Returns the position of relative movement from the reference point at a specified distance and angle.

### Usage
F_OffsetPos(Point1, Point2, iValue, iValueL)
F_OffsetPos(Point1, Point2, iValue)
F_OffsetPos(Point1, iValue, iValueL)
F_OffsetPos(Point1, iValue)

- Point1
  Point data/point designation to show amount of relative movement

- Point2
  Point data/point designation to show reference position. Can be omitted.

- iValue
  Integer or expression representing coordinate system to perform relative movement

- iValueL
  Integer or expression representing local coordinate system to perform relative movement. Specified only when local coordinate system is specified for iValue.

### Return Values
Returns the position of relative movement from the reference point at a specified distance and angle.

**Values** iValue

| Name of constants | Values | Description |
|---|---|---|
| FG_BASE | 0 | Causes relative movement in the base coordinate system. |
| FG_LOCAL | 1 | Causes relative movement in the local coordinate system.<br>Must also specify iValueL. |
| FG_TOOL | 2 | Causes relative movement in the tool coordinate system. |

iValueL

| | Values |
|---|---|
| Minimum | 0 |
| Maximum | 15 |

### Detailed Explanation
Returns the position of relative movement from the reference point at a specified distance and angle. Since this command is not a movement command, the robot will not move

When FG_BASE is specified for iValue, return a position that is moved the amount of relative movement specified in Point1 based on the direction of base coordinate system. When FG_LOCAL is specified, return a relative position based on direction of local coordinate system specified in iValueL. When FG_TOOL is specified, return a relative position based on direction of currently selected tool coordinate system.

Point 1 indicates the amount of relative movement. Only X, Y, Z, U, V, W, S, and T values are referenced, and other flag information such as Hand is not used.

Point 2 indicates the reference position for finding a relative movement position. If Point 2 is omitted, the position control's final virtual destination position which is acquirable with F_DestPos will be returned as the reference position.

An error will occur if the amount of movement is specified for Point 1 with respect to a value not defined for Point 2. For example, if Point 1 is specified as "XY(10,0,0,0,0,0) :ST(10, 10)" and Point 2 as "XY(10,0,0,0,0,0)", S and T values will not be defined for Point 2, but will be defined for Point 1, resulting in an error.

### Usage Example

The following is an example to display relative movement positions.

```
Function F_RefPosTest
  Print F_OffsetPos (P0, P1, FG_BASE)
  Print F_OffsetPos (XY(10,0,0,0,0,0), P1, FG_BASE)  'Position after moving 10 mm
from P1 to X direction of base coordinate system
  Print F_OffsetPos (XY(0,10,0,0,0,0), FG_LOCAL, 1)  'Position after moving 10 mm
from P1 to X direction of base coordinate system
  Print F_OffsetPos (P0, P1, FG_BASE)
Fend
```

### See Also

**F_DestPos Function**

# 13.50 F_RefPos Function

### Description
Returns the current virtual command position for position control only, without the effects of force control function.

### Usage
F_RefPos

### Return Values
Returns the current virtual command position for position control only, without the effects of force control function.

### Detailed Explanation
Returns the virtual command position for position control. The position is the same as the position that can be acquired by the second variable in the RefPos status.
The position control's virtual command position indicates the virtual trajectory that the original motion command attempted to travel. When the force control function is enabled, the robot will move toward a position that is corrected according to the actual force along the virtual trajectory.

### Usage Example
The following is an example to display the position control's command position.

```
Function F_RefPosTest
  Print F_RefPos
Fend
```

### See Also
**RefPos Status**

# 14. G

## 14.1 GetRobotFCOn Function

### Description
This identifies with which robot the force control function is active.

### Usage
GetRobotFCOn

### Values

| Bit | Results |
|---|---|
| 0 | Robot 1 status |
| 1 | Robot 2 status |
| 2 | Robot 3 status |
| 3 | Robot 4 status |
| 4 | Robot 5 status |
| 5 | Robot 6 status |
| 6 | Robot 7 status |
| 7 | Robot 8 status |
| 8 | Robot 9 status |
| 9 | Robot 10 status |
| 10 | Robot 11 status |
| 11 | Robot 12 status |
| 12 | Robot 13 status |
| 13 | Robot 14 status |
| 14 | Robot 15 status |
| 15 | Robot 16 status |

The value of each Bit
0: Force control function inactive
1: Force control function active

### Return Values
This returns the integer value obtained by setting the bits corresponding to the robot numbers for robots with the force control function active to “1”.
Bit 0 represents robot 1, and the subsequent numbers in order represent each of the other robots.
For example, when the force control function is active on robot 1 and robot 3, bit 0 and bit 2 are “On”, so “5” is returned.
The GetRobotFCOn function returns values from 0 to 65535 (hexadecimal FFFF). Because of this, the range of integers can be exceeded. When substituting a value for a variable, use Int32 or Int64 type variables.

### Usage Example
This example identifies the robots with the force control function active.

```
Function TestGetRobotFCOn
  Int32 iVar           'Use Int32 or Int64 types
```

```
  Robot 1
  FCKeep FC1 CF, 5     'Continue the force control function through the CF
parameter
  Print GetRobotFCOn   'This displays "1" because the force control function is
active for Robot 1

  iVar = GetRobotFCOn ' This saves the status as a variable

  FCKeep FC1, 5        'This stops the force control function when FCKeep
terminates
  Print GetRobotFCOn   'This displays "0" because the force control function is
stopped for Robot 1
Fend
```

**See Also**

**FCKeep Statement**, **FCEnd Statement**, **FC (Force Control) Object**

## 14.2 GravityCenter Property

### Application
Mass Property Object MP#

### Description
Sets or returns the value of the center of gravity for the overall robot hand and workpiece/payload at the leading end side from the force sensor.

### Usage
MPGet Object.GravityCenter, rArray()
MPSet Object.GravityCenter, rValueX, rValueY, rValueZ

- Object
  Object name
  The object is specified as either of MP (numerical value) or MP (label).

- rArray()
  The maximum element number defining the value of the property is an array of 3 or more real number variables

- rVvalueX
  A real number or formula defining the new value of the property.

- rValueY
  A real number or formula defining the new value of the property.

- rValueZ
  A real number or formula defining the new value of the property.

### Values
rArray()

| Element number | Element number constant | Description |
|---|---|---|
| 0 | FG_X | Center of gravity in X direction |
| 1 | FG_Y | Center of gravity in Y direction |
| 2 | FG_Z | Center of gravity in Z direction |

rVvalueX, rValueY, rValueZ (Unit: [mm])

| | Values |
|---|---|
| Minimum | -2000 |
| Maximum | 2000 |

Default: 0

### Detailed Explanation
Sets or returns the value of the center of gravity for the overall robot hand and workpiece/payload at the leading end side from the force sensor (not including the force sensor).

Set the position of the center of gravity for the Tool 0 coordinate system (robot hand center datum).
Mass Property Object is used to compensate for the effects of gravity on the force control function.

### Usage Example

This example carries out a motion using the force control function after setting the Mass Property Object.

```
> MPSet MP1.GravityCenter, 10, 10, 100
> MPSet MP1.Mass, 2
> MP 1
> Move CurPos +TLW(10) FC1 ROT
```

### See Also

**MP (Mass Properties) Object**

# 14.3 GravityDirection Property

### Application
Robot Object Robot

### Description
Sets or returns the direction of gravity for the robot.

### Usage
FGet Robot.GravityDirection, rArray()
FSet Robot.GravityDirection, rValueX, rValueY, rValueZ

- rArray()
  The maximum number of elements to define the value of the property is an array of 3 or more real number variables

- rValueX
  A real number or formula defining the new value of the property.

- rValueY
  A real number or formula defining the new value of the property.

- rValueZ
  A real number or formula defining the new value of the property.

### Values
rArray()

| Element number | Element number constant | Description |
|---|---|---|
| 0 | FG_X | X component of gravitational vector |
| 1 | FG_Y | Y component of gravitational vector |
| 2 | FG_Z | Z component of gravitational vector |

rValueX, rValueY, rValueZ

| | Values |
|---|---|
| Minimum | -1 |
| Maximum | 1 |

Default: (rValueX, rValueY, rValueZ) = (0, 0, -1)

NOTE: Should (rValueX, rValueY, rValueZ) = (0, 0, 0), an error will occur.

### Detailed Explanation
This sets or returns the orientation of the vector of gravitational acceleration in the base coordinate system.
Set the direction of gravity only.

$$rValueX^2 + rValueY^2 + rValueZ^2 = 1$$

The settings described above are recommended.
Should the settings of (rValueX, rValueY, rValueZ) = (0, 0, 0), the direction of gravity will not be fixed, so an error will occur.

### Usage Example
This example sets the direction of gravity and the Mass Property Object, and carries out a motion with the force control function active.

```
> FSet Robot.GravityDirection, 0, 0, -1
> MPSet MP1.GravityCenter, 10, 10, 100
> MPSet MP1.Mass, 2
> MP 1
> Move CurPos +TLW(10) FC1 ROT
```

### See Also

Robot Object

# 15. H

## 15.1 HoldTimeThresh Property

### Application
Force Trigger Object FT#, Force Motion Restriction Object FMR#

### Description
Sets or returns the duration used to determine that trigger conditions have been achieved for a force trigger or a force motion restriction object.

### Immediate Execution
No

### Usage
FGet Object.HoldTimeThresh, rVar
FSet Object.HoldTimeThresh, rValue

- Object
  Object name
  The object is specified as FT (numerical value), FT (label), FM (numerical value), or FM (label).

- rVar
  A real number variable defining the value of the property

- rValue
  A real number or formula defining the new value of the property.

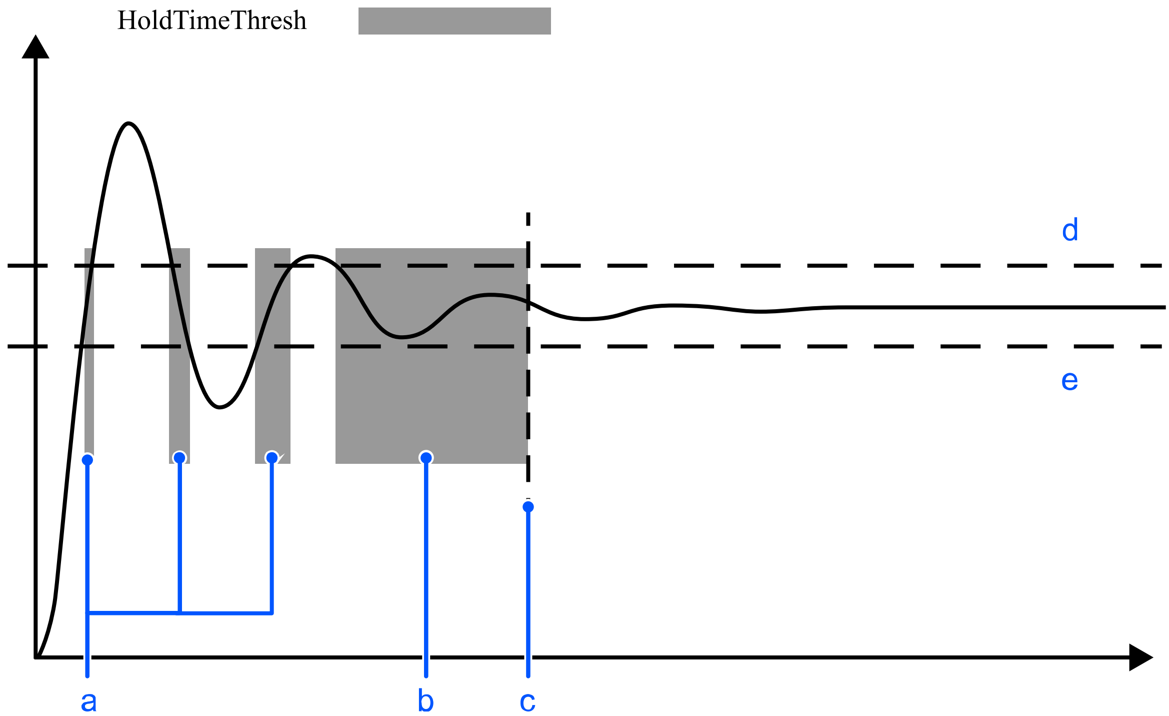
### Values
rValue (Unit: [sec])

| | Values |
|---|---|
| Minimum | 0 |
| Maximum | 10 |

Default: 0

### Detailed Explanation
This property is used when setting or checking the duration used to determine that trigger conditions have been achieved for a force trigger or a force motion restriction.
If the conditions specified for a force trigger or a force motion restriction object continued during the time specified by HoldTimeThresh, it’s judged as accomplished the trigger condition. If “0” is specified for HoldTimeThresh, it’s judged as accomplished the trigger condition when the conditions specified for the force trigger or a force motion restriction object are

achieved. Use this property, for instance, when you wish to detect when a force or position/orientation has stabilized or to eliminate the effects of noise and/or vibration.




| Symbol | Description |
| --- | --- |
| a | Duration not reached |
| b | Continuation for specified time |
| c | Timing when judged as accomplished the trigger condition |
| d | Upper limit threshold |
| e | Lower limit threshold |

### Usage Example

The following is an example of setting and acquiring HoldTimeThresh.

```
Function Test_HoldTimeThresh
  Integer rVar
  FSet FT1.HoldTimeThresh, 0.1
  FGet FT1.HoldTimeThresh, rVar
  Print rVar
Fend
```

### See Also

**FT (Force Trigger) Object**, **FMR (Force Motion Restriction) Object**

# 16. J

# 16.1 J1_Enabled, J2_Enabled, J3_Enabled, J4_Enabled, J5_Enabled, J6_Enabled Property

### Application
Force Motion Restriction Object FMR#

### Description
Independently activates/inactivates or returns the force motion restriction function of the axis position.

### Immediate Execution
No

### Usage
FGet Object.XX_Enabled, bVar
FSet Object.XX_Enabled, bValue

- Object
  Object name

- XX
  A character string defining the name of the property

- bVar
  A Boolean variable defining the value of the property

- bValue
  A Boolean value or formula defining the new value of the property

### Values
XX

| Specified Axis | Description |
|---|---|
| J1 | Specifies J1 as an axis position. |
| J2 | Specifies J2 as an axis position. |
| J3 | Specifies J3 as an axis position. |
| J4 | Specifies J4 as an axis position. |
| J5 | Specifies J5 as an axis position. |
| J6 | Specifies J6 as an axis position. |

bValue

| Constant name | Values | Description |
|---|---|---|
| False | 0 | Inactivates the subject axis. (default) |
| True | -1 | Activates the subject axis. |

### Detailed Explanation
Independently activates/inactivates, or returns the force motion restriction function for axis position.

### Usage Example

The following is an example of activate force motion restriction function of J1 axis position for the force motion restriction object.

```
> FSet FMR1.J1_Enabled, True
```

### See Also

**FMR (Force Motion Restriction) Object**

## 16.2 J1_Levels, J2_ Levels, J3_ Levels, J4_ Levels, J5_ Levels, J6_ Levels Property

### Application
Force Motion Restriction Object FMR#

### Description
Sets or returns the value of the lower threshold and upper threshold in axis position.

### Immediate Execution
No

### Usage
FGet Object.XX_Levels, rArray()
FSet Object.XX_Levels, rValueL, rValueU

- Object
  Object name
  The object is specified as either of FMR (numerical value) or FMR (label).
- XX
  A character string defining the name of the property
- rArray()
  The number of elements defining the values of the property is an array of 2 or more real number variables
- rValueL
  A real number or formula defining the new value of the property.
- rValueU
  A real number or formula defining the new value of the property.

### Values
XX

| Specified Axis | Description |
|---|---|
| J1 | Specifies J1 as an axis position. |
| J2 | Specifies J2 as an axis position. |
| J3 | Specifies J3 as an axis position. |
| J4 | Specifies J4 as an axis position. |
| J5 | Specifies J5 as an axis position. |
| J6 | Specifies J6 as an axis position. |

rArray()

| Element number | Element number constant |
|---|---|
| 0 | FG_ LOWERLEVEL |
| 1 | FG_ UPPERLEVEL |

rValueL (Unit: [Degree])

| | Axis | Values | |
|---|---|---|---|
| Minimum | J1, J2, J5, J6 | -360 | (default) |
| | J3, J4 | -1000 | |
| Maximum | J1, J2, J3, J5, J6 | 360 | |
| | J4 | 1000 | |

rValueU (Unit: [Degree])

| | Axis | Values | |
|---|---|---|---|
| Minimum | J1, J2, J5, J6 | -360 | |
| | J3, J4 | -1000 | |
| Maximum | J1, J2, J3, J5, J6 | 360 | (default) |
| | J4 | 1000 | |

### Detailed Explanation

XX_Levels set or return the value of the lower threshold and upper threshold in axis position.
rValueL is the lower threshold. rValueU is the upper threshold. Be sure that rValueL < rValueU.
This is used for error checking and task completion conditions.

### Usage Example

This example generates an error and stops the robot when the J1 axis position is above the upper or below the lower threshold.

```
Function SettingLevels
  FSet FMR1.JointEnabled, True, False, False, False, False, False
  FSet FMR1.J1_Polarity, FG_OUT
  FSet FMR1.J1_Levels, -90, 90
  Trap 1, FMR1 Call ForceError
Fend

Function ForceError
  AbortMotion All
Fend
```

### See Also

**FMR (Force Motion Restriction) Object**

# 16.3 J1_Polarity, J2_Polarity, J3_Polarity, J4_Polarity, J5_Polarity, J6_Polarity Property

### Application
Force Motion Restriction Object FMR#

### Description
This returns the status of or sets whether the force motion restriction is triggered by either being within the thresholds or being outside of the thresholds for the axis position.

### Immediate Execution
No

### Usage
FGet Object.XX_Polarity, iVar
FSet Object.XX_Polarity, iValue

- Object
  Object name
  The object is specified as either of FMR (numerical value) or FMR (label).

- XX
  A character string defining the name of the property

- iVar
  An integer variable defining the value of the property

- iValue
  An integer value or formula defining the new value of the property

### Values
XX

| Specified Axis | Description |
|---|---|
| J1 | Specifies J1 as an axis position. |
| J2 | Specifies J2 as an axis position. |
| J3 | Specifies J3 as an axis position. |
| J4 | Specifies J4 as an axis position. |
| J5 | Specifies J5 as an axis position. |
| J6 | Specifies J6 as an axis position. |

iValue

| Constant name | Values | Description |
|---|---|---|
| FG_OUT | 0 | Activates when the value is outside of the thresholds. (default) |
| FG_IN | 1 | Activates when the value is within the thresholds. |

### Detailed Explanation
XX_Polarity returns the status of or sets whether the force motion restriction is triggered by either being within the thresholds or being outside of the thresholds for the axis position.

### Usage Example

This example generates an error and stops the robot when the J1 axis position is above the upper or below the lower threshold.

```
Function SettingPolarity
  FSet FMR1.JointEnabled, True, False, False, False, False, False
  FSet FMR1.J1_Polarity, FG_OUT
  FSet FMR1.J1_Levels, -90, 90
  Trap 1, FMR1 Call ForceError
Fend

Function ForceError
  AbortMotion All
Fend
```

### See Also

**FMR (Force Motion Restriction) Object**

## 16.4 JointEnabled Property

### Application
Force Motion Restriction Object FMR#

### Description
Activates/inactivates, or returns the force motion restriction function for each axis collectively.

### Immediate Execution
No

### Usage
FGet Object.JointEnabled, bArray()
FSet Object.JointEnabled, bValueJ1, bValueJ2, bValueJ3, bValueJ4, bValueJ5, bValueJ6

- Object
  Object name
  The object is specified as either of FMR (numerical value) or FMR (label).

- bArray()
  The number of elements, which define the property values, is an array of 6 or more real number variables

- bValueJ1
  A Boolean value or formula defining the new value of the property

- bValueJ2
  A Boolean value or formula defining the new value of the property

- bValueJ3
  A Boolean value or formula defining the new value of the property

- bValueJ4
  A Boolean value or formula defining the new value of the property

- bValueJ5
  A Boolean value or formula defining the new value of the property

- bValueJ6
  A Boolean value or formula defining the new value of the property

### Values
bArray()

| Element number | Element number constant | Description |
|---|---|---|
| 0 | FG_J1 | Activates/inactivates J1. |
| 1 | FG_J2 | Activates/inactivates J2. |
| 2 | FG_J3 | Activates/inactivates J3. |
| 3 | FG_J4 | Activates/inactivates J4. |
| 4 | FG_J5 | Activates/inactivates J5. |
| 5 | FG_J6 | Activates/inactivates J6. |

bValueJ1, bValuej2, bValueJ3, bValueJ4, bValueJ5, bValueJ6

| Name of Constants | Values | Description |
|---|---|---|
| False | 0 | Inactivates the subject axis. (default) |
| True | -1 | Activates the subject axis. |

#### Detailed Explanation
Activates/inactivates, or returns the force motion restriction function for each axis collectively.

#### See Also
**FMR (Force Motion Restriction) Object**

# 16.5 JointLowerLevels Property

### Application
Force Motion Restriction Object FMR#

### Description
Sets or returns the value of the lower threshold for rotation angle on each axis at the same time.

### Immediate Execution
No

### Usage
FGet Object.JointLowerLevels, rArray()
FSet Object.JointLowerLevels, rValueJ1, rValueJ2, rValueJ3, rValueJ4, rValueJ5, rValueJ6

- Object
  Object name
  The object is specified as either of FMR (numerical value) or FMR (label).

- rArray()
  The number of elements defining the values of the property is an array of 6 or more real number variables

- rValueJ1
  A real number or formula defining the new value of the property

- rValuej2
  A real number or formula defining the new value of the property

- rValueJ3
  A real number or formula defining the new value of the property

- rValueJ4
  A real number or formula defining the new value of the property

- rValueJ5
  A real number or formula defining the new value of the property

- rValueJ6
  A real number or formula defining the new value of the property

**Values** rArray()

| Element number | Element number constant | Description |
|---|---|---|
| 0 | FG_J1 | Acquires the upper threshold for rotation angle of J1. |
| 1 | FG_J2 | Acquires the upper threshold for rotation angle of J2. |
| 2 | FG_J3 | Acquires the upper threshold for rotation angle of J3. |
| 3 | FG_J4 | Acquires the upper threshold for rotation angle of J4. |
| 4 | FG_J5 | Acquires the upper threshold for rotation angle of J5. |
| 5 | FG_J6 | Acquires the upper threshold for rotation angle of J6. |

rValueJ1, rValueJ2, rValueJ3, rValueJ4, rValueJ5, rValueJ6 (Unit: [Degree])

| | Values |
|---|---|
| Minimum | -360 (default) |
| Maximum | 360 |

### Detailed Explanation

JointLowerLevels sets or returns the value of the lower threshold for rotation angle of each axis at the same time.
Be sure that JointLowerLevels < JointUpperLevels.
Since all lower threshold values for each axis's rotation angle are set at one time, it can be done with fewer lines than setting them one axis at a time.
This is used for error checking and task completion conditions.

### Usage Example

This example generates an error and stops the robot when the rotation angle is below the lower threshold.

```
Function SettingLevels
  FSet FMR1.JointEnabled, True, True, True, True, True, True
  FSet FMR1.JointPolarities, FG_OUT, FG_OUT, FG_OUT, FG_OUT, FG_OUT, FG_OUT
  FSet FMR1.JointLowerLevels, 90, 90, 90, 90, 90, 90
  Trap 1, FMR1 Call ForceError
Fend

Function ForceError
  AbortMotion All
Fend
```

### See Also

**FMR (Force Motion Restriction) Object**

## 16.6 JointPolarities Property

### Application

Force Motion Restriction Object FMR#

### Description

Sets or returns for each axis whether the force motion restriction is activated or inactivated when values correspond to or do not correspond with threshold values.

### Immediate Execution

No

### Usage

FGet Object.JointPolarities, iArray()
FSet Object.JointPolarities, iValueJ1, iValueJ2, iValueJ3, iValueJ4, iValueJ5, iValueJ6

- Object
  Object name
  The object is specified as either of FMR (numerical value) or FMR (label).

- iArray()
  The number of elements defining the values of the property is an array of 6 or more real number variables

- iValueJ1
  An integer value or formula defining the new value of the property

- iValueJ2
  An integer value or formula defining the new value of the property

- iValueJ3
  An integer value or formula defining the new value of the property

- iValueJ4
  An integer value or formula defining the new value of the property

- iValueJ5
  An integer value or formula defining the new value of the property

- iValueJ6
  An integer value or formula defining the new value of the property

### Values

iArray()

| Element number | Element number constant | Description |
|---|---|---|
| 0 | FG_J1 | Returns whether the force motion restriction is activated by values within or outside of the threshold values in J1. |
| 1 | FG_J2 | Returns whether the force motion restriction is activated by values within or outside of the threshold values in J2. |
| 2 | FG_J3 | Returns whether the force motion restriction is activated by values within or outside of the threshold values in J3. |
| 3 | FG_J4 | Returns whether the force motion restriction is activated by values within or outside of the threshold values in J4. |

| Element number | Element number constant | Description |
|---|---|---|
| 4 | FG_J5 | Returns whether the force motion restriction is activated by values within or outside of the threshold values in J5. |
| 5 | FG_J6 | Returns whether the force motion restriction is activated by values within or outside of the threshold values in J6. |

iValueJ1, iValueJ2, iValueJ3, iValueJ4, iValueJ5, iValueJ6 (Unit: Number)

| Name of Constants | Values | Description |
|---|---|---|
| FG_OUT | 0 | Sets to active when over or under the upper and lower threshold values, respectively. (default) |
| FG_IN | 1 | Sets to active when within the upper threshold and lower threshold values. |

#### Detailed Explanation

JointPolarities return the status of or set whether the force motion restriction is triggered for each axis by the value being either within the thresholds or outside of the thresholds.
When setting the trigger for each axis at the same time, this allows one to set all of them with fewer lines than setting them 1 axis at a time.

#### Usage Example

This example will generate an error and stop the robot if each axis is above the upper threshold or below the lower threshold.

```
Function SettingPolarities
  FSet FMR1.JointEnabled, True, True, True, True, True, True
  FSet FMR1.JointPolarities, FG_OUT, FG_OUT, FG_OUT, FG_OUT, FG_OUT, FG_OUT
  FSet FMR1.JointLowerLevels, -90, -90, -90, -90, -90, -90
  FSet FMR1.JointUpperLevels, 90, 90, 90, 90, 90, 90
  Trap 1, FMR1 Call ForceError
Fend

Function ForceError
  AbortMotion All
Fend
```

#### See Also

**FMR (Force Motion Restriction) Object**

# 16.7 JointUpperLevels Property

### Application
Force Motion Restriction Object FMR#

### Description
This sets or returns the value of the upper threshold for rotation angle on each axis at the same time.

### Immediate Execution
No

### Usage
FGet Object.JointUpperLevels, rArray()
FSet Object.JointUpperLevels, rValueJ1, rValueJ2, rValueJ3, rValueJ4, rValueJ5, rValueJ6

- Object
  Object name
  The object is specified as either of FMR (numerical value) or FMR (label).

- rArray()
  The number of elements defining the value of the property is an array of 6 or more real number variables

- rValueJ1
  A real number or formula defining the new value of the property.

- rValueJ2
  A real number or formula defining the new value of the property.

- rValueJ3
  A real number or formula defining the new value of the property.

- rValueJ4
  A real number or formula defining the new value of the property.

- rValueJ5
  A real number or formula defining the new value of the property.

- rValueJ6
  A real number or formula defining the new value of the property.

### Values
rArray()

| Element number | Element number constant | Description |
|---|---|---|
| 0 | FG_J1 | Acquires the upper threshold for rotation angle of J1. |
| 1 | FG_J2 | Acquires the upper threshold for rotation angle of J2. |
| 2 | FG_J3 | Acquires the upper threshold for rotation angle of J3. |
| 3 | FG_J4 | Acquires the upper threshold for rotation angle of J4. |
| 4 | FG_J5 | Acquires the upper threshold for rotation angle of J5. |
| 5 | FG_J6 | Acquires the upper threshold for rotation angle of J6. |

rValueJ1, rValueJ2, rValueJ3, rValueJ4, rValueJ5, rValueJ6 (Unit: [Degree])

| | Values |
|---|---|
| Minimum | -360 |
| Maximum | 360 (default) |

### Detailed Explanation

JointUpperLevels sets or returns the value of the upper threshold for rotation angle of each axis at the same time.
Be sure that JointLowerLevels < JointUpperLevels
Since all upper threshold values for rotation angle of each axis are set at one time, it can be done with fewer lines than setting them one axis at a time.
This is used for error checking and task completion conditions.

### Usage Example

This example generates an error and stops the robot when the rotation angle is greater than the upper threshold.

```
Function SettingLevels
  FSet FMR1.JointEnabled, True, True, True, True, True, True
  FSet FMR1.JointPolarities, FG_OUT, FG_OUT, FG_OUT, FG_OUT, FG_OUT, FG_OUT
  FSet FMR1.JointUpperLevels, 90, 90, 90, 90, 90, 90
  Trap 1, FMR1 Call ForceError
Fend

Function ForceError
  AbortMotion All
Fend
```

### See Also

**FMR (Force Motion Restriction) Object**

# 17. L

# 17.1 Label Property

### Application
Force Control Object FC#, Force Coordinate System Object FCS#, Force Trigger Object FT#, Force Monitor Object FM#, Force Motion Restriction Object FMR#, Mass Property Object MP#,
Force Sensor Object FS#

### Description
Refer to each of the ForceObjects and Force Sensor Object labels, and set each of the ForceObject labels.

### Immediate Execution
No

### Usage
FGet Object1.Label, sVar$
FSet Object2.Label, sValue$
MPGet Object3.Label, sVar$
MPSet Object3.Label, sValue$

- Object1
  Object name
  The object is specified as FC (numerical value), FCS (numerical value), FT (numerical value), FM (numerical value) or FMR (numerical value).

- Object2
  Object name
  Specify the object as FC (numerical value), FC (label), FCS (numerical value), FCS (label), FT (numerical value), FT (label), FM (numerical value), or FM (label).

- Object3
  Object name
  The object is specified as MP (numerical value).

- sVar$
  A string variable defining the value of the property

- sValue$
  An string or formula defining the new value

### Values
String
32 single-byte, 16 double-byte alphanumeric characters, Japanese, and the underscore can be used. However, only English letters or Japanese can be used for the first character. Not case sensitive.

### Detailed Explanation
This allows one to refer to or set the Force Object Label. The Force Sensor Object label can be referenced. It cannot be set. The label value of force sensor object refers sensor name of the set force sensor.
There is a difference between this and the setting of other properties and objects. Other properties can be set using a number and label, but Label Property is for number specified objects only.

### See Also
**FC (Force Control) Object**, **FCS (Force Coordinate System) Object**, **FT (Force Trigger) Object**,
**FM (Force Monitor) Object**, Force Motion Restriction Object FMR#, Mass Property Object MP#, Force Sensor Object FS#

# 17.2 LastExecObject Result

### Description
Returns the name of the force guide object that was executed at the end for force guide sequence.

### Usage
FGGet Sequence.LastExecObject, sVar$

- Sequence
  Force guide sequence name or string variable representing force guide sequence name

- sVar$
  String variable defining the returned value

### Detailed Explanation
Returns the name of the force guide object that was executed at the end for force guide sequence. When the force guide sequence fails, you can acquire that the program had proceeded to which force guide object.

### Usage Example
The following is an example of a simple program that acquires a result with FGGet.

```
Function LastExecObjectTest
  String sVar$
  Motor On

  FGRun Sequence1
  FGGet Sequence1.LastExecObject, sVar$  ' Acquire LastExecObject
  Print sVar$

Fend
```

### See Also
**FGGet Statement**, **General Purpose Sequence Result**, **Paste Sequene Result**, **ScrewTighten Sequence Result**, **HeightInspect Sequence Result**, **Insert Sequence Result**

# 17.3 LimitAccelJ Property

### Application
Force Control Object FC#

### Description
Sets or returns the maximum value for joint acceleration during force control.

### Immediate Execution
No

### Usage
FGet Object.LimitAccelJ, rVar
FSet Object.LimitAccelJ, rValue

- Object
  Object name
  The object is specified as either of FC (numerical value) or FC (label).

- rVar
  A real number variable defining the value of the property

- rValue
  A real number or formula defining the new value of the property.

### Values
rValue (Unit: [%])

| | Values |
|---|---|
| Minimum | 0.1 |
| Maximum | 100 (default) |

### Detailed Explanation
This sets or returns the maximum value for joint acceleration during force control.
The value established for the LimitAccelJ property expresses a ratio with respect to the maximum acceleration.
When the robot, during force control, attempts to accelerate at a rate in excess of the established property value, the acceleration is automatically limited. The limitation is always active during force control.
In LowPower mode during force control, the motion is automatically corrected to the default Accel value when a value in excess of the default Accel value is established in the LimitAccelJ property.

### Usage Example
This is an example of a simple motion program using LimitAccelJ.
The Move motion is carried out at an acceleration of 2[mm/sec$^2$]; when in the course of the motion, a movement accelerating under force control attempts a motion exceeding 5% of the joint velocity, the acceleration is automatically limited by LimitAccelJ, and the motion is carried out at 5% of the established value of acceleration.

```
Function LimitAccelJTest

  FSet FCS1.Orientation, FG_TOOL   ' Sets the force coordinate data

  FSet FC1.CoordinateSystem, FCS1  ' Specifies the force coordinate data
  FSet FC1.Fx_Spring, 0            ' Sets the virtual Fx coefficient of elasticity
  FSet FC1.Fx_Damper, 1            ' Sets the virtual Fx coefficient of viscosity
  FSet FC1.Fx_Mass, 10             ' Sets the virtual Fx coefficient of inertia
  FSet FC1.Fx_Enabled, True        ' Sets the Fx force control to active
```

```
  FSet FC1.LimitAccelJ, 5           ' Sets the maximum joint acceleration to 5%
  AccelS 2                          ' Sets the maximum CP motion acceleration to
2[mm/sec^2]

  Move P0 FC1                       ' A Move motion with force control

Fend
```

**See Also**

**FC (Force Control) Object**, Accel

# 17.4 LimitAccelR Property

### Application
Force Control Object FC#

### Description
Sets or returns the maximum velocity limit for tool orientation change acceleration during force control.

### Immediate Execution
No

### Usage
FGet Object.LimitAccelR, rVar
FSet Object.LimitAccelR, rValue

- Object
  Object name
  The object is specified as either of FC (numerical value) or FC (label).

- rVar
  A real number variable defining the value of the property

- rValue
  A real number or formula defining the new value of the property.

### Values
rValue (Unit: [deg/sec $^2$])

| | Values |
|---|---|
| Minimum | 0.1 |
| Maximum | 5000 |

Default: 100

### Detailed Explanation
This sets or returns the value of the maximum tool orientation acceleration with force control active.
When the robot attempts to accelerate, with force control active, at a rate in excess of the value established in the LimitAcceIR properties, the acceleration is automatically limited. The limitation is always active during force control.
When executing force control in combination with motion commands that is added a qualified ROT parameter, the value must be greater than the acceleration value established for the robot via AccelR.
In LowPower mode, the motion is automatically corrected to the AccelR default value when force control is active and the value set in AccelR is greater than the AccelR default value.

### Usage Example
This is a simple example of a motion program using LimitAccelR.
The Move motion is carried out at an acceleration of 2[deg/sec$^2$], and if, during movement, the robot attempts a motion via force control with an acceleration in excess of 5[deg/sec$^2$], then the acceleration is automatically limited via LimitAccelR and carried out at 5[deg/sec$^2$].

```
Function LimitAccelRTest
  FSet FCS1.Orientation, FG_TOOL   ' Sets the force coordinate data

  FSet FC1.CoordinateSystem, FCS1  ' Specifies the force coordinate data
  FSet FC1.Fx_Spring, 0            ' Sets the virtual Fx coefficient of elasticity
```

```
  FSet FC1.Fx_Damper, 1             ' Sets the virtual Fx coefficient of viscosity
  FSet FC1.Fx_Mass, 10              ' Sets the virtual Fx coefficient of inertia
  FSet FC1.Fx_Enabled, True         ' Sets the Fx force control to active

  FSet FC1.LimitAccelR, 5           ' Sets the maximum tool orientation modification
velocity to 5[deg/sec^2]
  AccelR 2                          ' Sets the CP motion acceleration to
2[deg/sec^2]

  Move P0 FC1 ROT                   ' A Move motion with force control

Fend
```

**See Also**

**FC (Force Control) Object**, AccelR

# 17.5 LimitAccelS Property

### Application
Force Control Object FC#

### Description
This sets or returns the value of the maximum of the tool position modification acceleration during force control

### Immediate Execution
No

### Usage
FGet Object.LimitAccelS, rVar
FSet Object.LimitAccelS, rValue

- Object
  Object
  The object is specified as either of FC (numerical value) or FC (label).

- rVar
  A real number variable defining the value of the property

- rValue
  A real number or formula defining the new value of the property.

### Values
rValue (Unit: [mm/sec$^2$])

- For RC800 series Controllers

| Model of Robot | Maximum | Minimum | Default |
|---|---|---|---|
| GX series<br>C8, C12 series | 25,000 | 0.1 | 200 |

- For RC700 series Controllers

<table>
<tr><th>Model of Robot</th><th>Maximum</th><th>Minimum</th><th>Default</th></tr>
<tr><td>N2-A450**</td><td>5,000</td><td rowspan="3">0.1</td><td rowspan="3">200</td></tr>
<tr><td>C4-*901**</td><td>15,000</td></tr>
<tr><td>G3, G6, G10, G20,<br>GX series,<br>RS series,<br>C4-*601**, C8, C12,<br>N6</td><td>25,000</td></tr>
</table>

### Detailed Explanation
This sets or returns the value of the maximum of the tool position modification acceleration during force control.
When the robot attempts to accelerate, with force control active, at a rate in excess of the value established in the LimitAccelS properties, the acceleration is automatically limited. The limitation is always active during force control.
When executing force control in combination with motion commands that are not added a qualified ROT parameter except FCKeep, the value must be greater than the acceleration value established for the robot via AccelS.

In LowPower mode, the motion is automatically corrected to the AccelS default value when force control is active and the value set in the LimitAccelS property is greater than the AccelS default value.

### Usage Example

This is a simple example of a motion program using LimitAccelS.

The Move motion is carried out at an acceleration of 2[mm/sec$^2$], and if, during movement, the robot attempts a motion via force control with an acceleration in excess of 5[mm/sec$^2$], then the acceleration is automatically limited via LimitAccelS and carried out at 5[mm/sec$^2$].

```
Function LimitAccelSTest
  FSet FCS1.Orientation, FG_TOOL   ' Sets the force coordinate data

  FSet FC1.CoordinateSystem, FCS1  ' Specifies the force coordinate data
  FSet FC1.Fx_Spring, 0            ' Sets the virtual Fx coefficient of elasticity
  FSet FC1.Fx_Damper, 1            ' Sets the virtual Fx coefficient of viscosity
  FSet FC1.Fx_Mass, 10             ' Sets the virtual Fx coefficient of inertia
  FSet FC1.Fx_Enabled, True        ' Sets the Fx force control to active

  FSet FC1.LimitAccelS, 5          ' Sets the maximum tool position modification
velocity to 5[mm/sec^2]
  AccelS 2                         ' Sets the maximum CP motion acceleration to
2[mm/sec^2]

  Move P0 FC1                      ' A Move motion with force control

Fend
```

### See Also

**FC (Force Control) Object**, AccelS

# 17.6 LimitAccelSRJ Property

### Application
Force Control Object FC#

### Description
This sets or returns the maximum values of acceleration for joint acceleration, tool position modification, and tool orientation modification during force control.

### Immediate Execution
No

### Usage
FGet Object.LimitAccelSRJ, rArray()
FSet Object.LimitAccelSRJ, rValueS, rValueR, rValueJ

- Object
  Object name
  The object is specified as either of FC (numerical value) or FC (label).

- array()
  The maximum element number defining the value of the property is an array of 3 or more real number variables

- rValueS
  A real number or formula defining the new value of the property.

- rValueR
  A real number or formula defining the new value of the property.

- rValueJ
  A real number or formula defining the new value of the property.

### Values
rArray()

| Element number | Element number constant | Description |
|---|---|---|
| 0 | FG_LIMIT_S | Maximum tool position modification acceleration |
| 1 | FG_LIMIT_R | Maximum tool orientation modification acceleration |
| 2 | FG_LIMIT_J | Maximum joint acceleration |

rValueS (Unit: [mm/sec$^2$])

- For RC800 series Controllers

| Model of Robot | Maximum | Minimum | Default |
|---|---|---|---|
| GX series<br>C8, C12 series | 25,000 | 0.1 | 200 |

- For RC700 series Controllers

<table>
<tr><th>Model of Robot</th><th>Maximum</th><th>Minimum</th><th>Default</th></tr>
<tr><td>N2-A450**</td><td>5,000</td><td rowspan="3">0.1</td><td rowspan="3">200</td></tr>
<tr><td>C4-*901**</td><td>15,000</td></tr>
<tr><td>G3, G6, G10, G20,<br>GX series,<br>RS series,<br>C4-*601**, C8, C12,<br>N6</td><td>25,000</td></tr>
</table>

rValueR (Unit: [deg/sec$^2$])

| | Values |
|---|---|
| Minimum | 0.1 |
| Maximum | 5000 |

Default: 100

rValueJ (Unit: [%])

| | Values |
|---|---|
| Minimum | 0.1 |
| Maximum | 100 (default) |

### Detailed Explanation
This sets or returns the maximum values of acceleration for joint acceleration, tool position modification, and tool orientation modification during force control.
For details, refer to the following manual.**LimitAccelJ PropertyLimitAccelR PropertyLimitAccelS Property**

### See Also
**FC (Force Control) Object**, **LimitAccelJ Property**, **LimitAccelR Property**, **LimitAccelS Property**

## 17.7 LimitedStatus Result

### Description
Returns the limit result for the limit condition of dedicated object.

### Usage
FGGet Sequence.Object.LimitedStatus, iVar

- Sequence
  Force guide sequence name or string variable representing force guide sequence name

- Object
  Force guide sequence name or string variable representing force guide sequence name

- iVar
  Integer variable that shows a returned value

### Values
iVar

| Bit | Results |
|---|---|
| 0 | Achievement status of the force limit condition |
| 1 | Achievement status of the position limit condition |

The value of each Bit
0: Not met
1: Met

### Detailed Explanation
Returns the limit result for the limit condition of dedicated object.
Each dedicated object can use some of force limit conditions and position limit conditions. The LimitedStatus result sets the corresponding bit to “1” if a condition is achieved, or “0” if a condition is not achieved. If either bit becomes “1”, the robot will immediately cease operation, and executed objects will be terminated. This result is used for branch processing according to which conditions are achieved.

### Usage Example
The following is an example of a simple program that acquires a result with FGGet.

```
Function LimitedStatusTest
  Integer iVar

  Motor On
  FGRun Sequence1

  FGGet Sequence1.Paste01.LimitedStatus, iVar   ' Acquire LimitedStatus
  ElseIf (iVar And &H02) <> 0 Then              ' Processing when force-related
condition is achieved
    -
    -
    -
  EndIf

Fend
```

#### See Also

**FGGet Statement**, **Paste Object Result**, **ScrewRetighten Object Result**, **ScrewTighten Object Result**, **HeightInspect Object Result**, **Insert Object Result**, **TensileTest Object Result**

# 17.8 LimitSpeedJ Property

### Application
Force Control Object FC#

### Description
Sets or returns the maximum velocity limit for joint movement during force control.

### Immediate Execution
No

### Usage
FGet Object.LimitSpeedJ, rVar
FSet Object.LimitSpeedJ, rValue

- Object
  Object name
  The object is specified as either of FC (numerical value) or FC (label).

- rVar
  A real number variable defining the value of the property

- rValue
  A real number or formula defining the new value of the property

### Values
rValue (Unit: [%])

| | Values |
|---|---|
| Minimum | 0.1 |
| Maximum | 100 |

Default: 50

### Detailed Explanation
This sets or returns the maximum joint velocity during force control.
The value established in LimitSpeedJ Property expresses a ratio with respect to the maximum velocity.
When, during force control, the robot attempts to move at a velocity in excess of the value established in LimitSpeedJ Property, the velocity is automatically limited. The limitation is always active during force control.
In LowPower mode, with force control active, when the value established in LimitSpeedJ Property is in excess of the Speed Default value, the Speed is automatically adjusted to the Speed default value.

### Usage Example
This is an example of a simple motion program using LimitSpeedJ.
The Move motion is carried out at a velocity of 2[mm/sec], and when in motion, when the robot attempts via force control to move in excess of 5% of the joint velocity, the velocity is automatically limited to 5% via LimitSpeedJ.

```
Function LimitSpeedJTest
  FSet FCS1.Orientation, FG_TOOL   ' Sets the force coordinate data

  FSet FC1.CoordinateSystem, FCS1  ' Specifies the force coordinate data
  FSet FC1.Fx_Spring, 0            ' Sets the virtual Fx coefficient of elasticity
  FSet FC1.Fx_Damper, 1            ' Sets the virtual Fx coefficient of viscosity
  FSet FC1.Fx_Mass, 10             ' Sets the virtual Fx coefficient of inertia
  FSet FC1.Fx_Enabled, True        ' Sets the Fx force control to active
```

```
  FSet FC1.LimitSpeedJ, 5            ' Maximum joint velocity is set to 5%
  SpeedS 2                           ' Sets the CP motion velocity to 2[mm/sec]

  Move P0 FC1                        ' A Move motion with force control

Fend
```

**See Also**

**FC (Force Control) Object**, Speed

# 17.9 LimitSpeedR Property

### Application
Force Control Object FC#

### Description
Sets or returns the maximum velocity limit for tool orientation change during force control.

### Immediate Execution
No

### Usage
FGet Object.LimitSpeedR, rVar
FSet Object.LimitSpeedR, rValue

- Object
  Object name
  The object is specified as either of FC (numerical value) or FC (label).

- rVar
  A real number variable defining the value of the property

- rValue
  A real number or formula defining the new value of the property

### Values
rValue (Unit: [deg/sec])

| | Values |
|---|---|
| Minimum | 0.1 |
| Maximum | 1000 |

Default: 25

### Detailed Explanation
Sets or returns the maximum tool orientation modification velocity during force control.
When the robot, during force control, attempts to move at a velocity in excess of the value established in LimitSpeedR properties, the velocity is automatically limited. The limitation is always active during force control.
When executing force control in combination with motion commands that is added a qualified ROT parameter, the value must be greater than the robot speed set by SpeedR.
In LowPower mode, when the value set in LimitSpeedR is greater than the SpeedR default value the motion is automatically adjusted to the SpeedR default value when force control is active.

### Usage Example
This is an example of a simple movement program using LimitSpeedR.
The Move motion is carried out at a velocity of 2[deg/sec], and when in motion, the robot attempts to move via force control at a rate in excess of 5[deg/sec], the velocity is automatically limited via LimitSpeedR and carried out at 5[deg/sec].

```
Function LimitSpeedRTest
  FSet FCS1.Orientation, FG_TOOL    ' Sets the force coordinate data

  FSet FC1.CoordinateSystem, FCS1   ' Specifies the force coordinate data
  FSet FC1.Fx_Spring, 0             ' Sets the virtual Fx coefficient of elasticity
  FSet FC1.Fx_Damper, 1             ' Sets the virtual Fx coefficient of viscosity
  FSet FC1.Fx_Mass, 10              ' Sets the virtual Fx coefficient of inertia
```

```
  FSet FC1.Fx_Enabled, True           ' Sets the Fx force control to active
  FSet FC1.LimitSpeedR, 5             ' Sets the maximum tool orientation modification
velocity to 5[deg/sec]
  SpeedR 2                            ' Sets the CP motion velocity to 2[deg/sec]

  Move P0 FC1 ROT                     ' A Move motion with force control

Fend
```

**See Also**

**FC (Force Control) Object**, SpeedR

# 17.10 LimitSpeedS Property

### Application
Force Control Object FC#

### Description
This sets or returns the maximum tool position modification velocity during force control.

### Immediate Execution
No

### Usage
FGet Object.LimitSpeedS, rVar
FSet Object.LimitSpeedS, rValue

- Object
  Object name
  The object is specified as either of FC (numerical value) or FC (label).

- rVar
  A real number variable defining the value of the property

- rValue
  A real number or formula defining the new value of the property

### Values
rValue (Unit: [mm/sec])

| | Values |
|---|---|
| Minimum | 0.1 |
| Maximum | 2000 |

Default: 50

### Detailed Explanation
This sets or returns the maximum tool position modification velocity during force control.
During force control, when the robot attempts to move at a velocity in excess of that set in LimitSpeedS property, the velocity is automatically limited. The limitation is always active during force control.
When executing force control in combination with motion commands that are not added a qualified ROT parameter except FCKeep, the value must be greater than the robot speed set by SpeedS.
In LowPower mode, when the value set in LimitSpeedS is greater than the SpeedS default value the movement is automatically adjusted to the SpeedS default value when force control is active.

### Usage Example
This is a simple example of a motion program using LimitSpeedS.
The Move motion is carried out at a velocity of 2[mm/sec], and when in motion, when the robot attempts via force control to move in excess of 5[mm/sec], the velocity is automatically limited to 5[mm/sec] via LimitSpeedS.

```
Function LimitSpeedSTest
  FSet FCS1.Orientation, FG_TOOL   ' Sets the force coordinate data

  FSet FC1.CoordinateSystem, FCS1  ' Specifies the force coordinate data
  FSet FC1.Fx_Spring, 0            ' Sets the virtual Fx coefficient of elasticity
  FSet FC1.Fx_Damper, 1            ' Sets the virtual Fx coefficient of viscosity
  FSet FC1.Fx_Mass, 10             ' Sets the virtual Fx coefficient of inertia
```

```
  FSet FC1.Fx_Enabled, True          ' Sets the Fx force control to active
  FSet FC1.LimitSpeedS, 5            ' Sets the maximum tool position modification
velocity to 5[mm/sec]
  SpeedS 2                           ' Sets the CP motion velocity to 2[mm/sec]

  Move P0 FC1                        ' A Move motion with force control

Fend
```

**See Also**

**FC (Force Control) Object**, SpeedS

# 17.11 LimitSpeedSRJ Property

### Application

Force Control Object FC#

### Description

Sets or returns the maximum values of joint velocity, tool position modification velocity, and tool orientation modification velocity with force control active.

### Immediate Execution

No

### Usage

FGet Object.LimitSpeedSRJ, rArray()
FSet Object.LimitSpeedSRJ, rValueS, rValueR, rValueJ

- Object
  Object name
  The object is specified as either of FC (numerical value) or FC (label).

- rArray()
  The maximum element number defining the value of the property is an array of 3 or more real number variables

- rValueS
  A real number or formula defining the new value of the property

- rValueR
  A real number or formula defining the new value of the property

- rValueJ
  A real number or formula defining the new value of the property

### Values

rArray()

| Element number | Element number constant | Description |
|---|---|---|
| 0 | FG_LIMIT_S | Maximum tool position modification velocity |
| 1 | FG_LIMIT_R | Maximum tool orientation modification velocity |
| 2 | FG_LIMIT_J | Maximum joint velocity |

rValueS (Unit: [mm/sec])

| | Values |
|---|---|
| Minimum | 0.1 |
| Maximum | 2000 |

Default: 50

rValueR (Unit: [deg/sec])

| | Values |
|---|---|
| Minimum | 0.1 |

| | Values |
|---|---|
| Maximum | 1000 |

Default: 25

rValueJ (Unit: [%])

| | Values |
|---|---|
| Minimum | 0.1 |
| Maximum | 100 |

Default: 50

### Detailed Explanation

Sets or returns the maximum values of joint velocity, tool position modification velocity, and tool orientation modification velocity with force control active.
For details, refer to the following manual.**LimitSpeedJ PropertyLimitSpeedR PropertyLimitSpeedS Property**

### See Also

**FC (Force Control) Object**, **LimitSpeedJ Property**, **LimitSpeedR Property**, **LimitSpeedS Property**

# 17.12 LowerLevels Property

### Application
Force Trigger Object FT#

### Description
This sets or returns the lower threshold value of force and torque in each axis at the same time.

### Immediate Execution
No

### Usage
FGet Object.LowerLevels, rArray()
FSet Object.LowerLevels, rValueFx, rValueFy, rValueFz, rValueTx, rValueTy, rValueTz [, rValueFmag, rValueTmag]

- Object
  Object name
  The object is specified as either of FT (numerical value) or FT (label).

- rArray()
  The maximum number of elements defining the value of the property is an array of 8 or more real number variable

- rValueFx
  A real number or formula defining the new value of the property.

- rValueFy
  A real number or formula defining the new value of the property.

- rValueFz
  A real number or formula defining the new value of the property.

- rValueTx
  A real number or formula defining the new value of the property.

- rValueTy
  A real number or formula defining the new value of the property.

- rValueTz
  A real number or formula defining the new value of the property.

- rValueFmag
  A real number or formula defining the new value of the property.

- rValueTmag
  A real number or formula defining the new value of the property.

### Values
rArray()

| Element number | Element number constant | Description |
|---|---|---|
| 0 | FG_FX | Acquires the lower threshold value for Fx force. |
| 1 | FG_FY | Acquires the lower threshold value for Fy force. |
| 2 | FG_FZ | Acquires the lower threshold value for Fz force. |

| Element number | Element number constant | Description |
|---|---|---|
| 3 | FG_TX | Acquires the lower threshold value for Tx torque. |
| 4 | FG_TY | Acquires the lower threshold value for Ty torque. |
| 5 | FG_TZ | Acquires the lower threshold value for Tz torque. |
| 6 | FG_FMAG | Acquires the lower threshold value for Fmag resultant force. |
| 7 | FG_TMAG | Acquires the lower threshold value for Tmag resultant torque. |

Note: When the number of elements is an array of 6 or 7, this will acquire element numbers 0 to 5.

rValueFx, rValueFy, rValueFz (Unit: [N])

| | Values |
|---|---|
| Minimum | -1000 (default) |
| Maximum | 1000 |

rValueTx, rValueTy, rValueTz (Unit: [N·mm])

| | Values |
|---|---|
| Minimum | -100000 (default) |
| Maximum | 100000 |

rValueFmag (Unit: [N])

| | Values |
|---|---|
| Minimum | 0 (default) |
| Maximum | 1000 |

rValueTmag (Unit: [N·mm])

| | Values |
|---|---|
| Minimum | 0 (default) |
| Maximum | 100000 |

### Detailed Explanation

LowerLevels sets or returns the lower threshold value for force and torque in each axis.
Be sure that LowerLevels < UpperLevels.
Since all force and torque lower threshold values for each axis are set at one time, it can be done with fewer lines than setting them one axis at a time.
This is used for error checking and task completion conditions.

### Usage Example

This example generates an error and stops the robot if force is less than the lower threshold value.

```
Function SettingLevels
  FSet FT1.Enabled, True, True, True, True, True, True, True, True
  FSet FT1.Polarities, FG_OUT, FG_OUT, FG_OUT, FG_OUT, FG_OUT, FG_OUT, FG_OUT,
FG_OUT
  FSet FT1.LowerLevels, -50, -50, -50, -3000, -3000, -3000, 0, 0
  Trap 1, FT1 Call ForceError
```

```
Fend

Function ForceError
  AbortMotion All
Fend
```

**See Also**

FT (Force Trigger) Object

# 17.13 LPF_Enabled Property

### Application
Force Trigger Object FT#, Force Monitor Object FM#

### Description
This activates/inactivates or returns the status of the low-pass filter in each axis of the force coordinate system.

### Immediate Execution
No

### Usage
FGet Object.LPF_Enabled, bArray()
FSet Object.LPF_Enabled, bValueFx, bValueFy, bValueFz, bValueTx, bValueTy, bValueTz [,bValueFmag, bValueTmag]

- Object
  Object name
  The object is specified as either of FT (numerical value), FT (label), FM (numerical value), or FM (label).

- bArray()
  The maximum number of elements defining the value of the property is an array of 6 or more Boolean variables

- bValueFx
  A Boolean value or formula defining the new value of the property

- bValueFy
  A Boolean value or formula defining the new value of the property

- bValueFz
  A Boolean value or formula defining the new value of the property

- bValueTx
  A Boolean value or formula defining the new value of the property

- bValueTy
  A Boolean value or formula defining the new value of the property

- bValueTz
  A Boolean value or formula defining the new value of the property

- bValueFmag
  A Boolean value or formula defining the new value of the property

- bValueFmag
  A Boolean value or formula defining the new value of the property

### Values
bArray()

| Element number | Element number constant | Description |
|---|---|---|
| 0 | FG_FX | Activates/inactivates the Fx low-pass filter. |
| 1 | FG_FY | Activates/inactivates the Fy low-pass filter. |
| 2 | FG_FZ | Activates/inactivates the Fz low-pass filter. |

| Element number | Element number constant | Description |
|---|---|---|
| 3 | FG_TX | Activates/inactivates the Tx low-pass filter. |
| 4 | FG_TY | Activates/inactivates the Ty low-pass filter. |
| 5 | FG_TZ | Activates/inactivates the Tz low-pass filter. |
| 6 | FG_FMAG | Activates/inactivates the Fmag resultant force low-pass filter. |
| 7 | FG_TMAG | Activates/inactivates the Tmag resultant torque low-pass filter. |

Note: When the number of elements is an array of 6 or 7 variables, only the element number settings 0 to 5 are acquired.

bValueFx, bValueFy, bValueFz, bValueTx, bValueTy, bValueTz, bValueFmag, bValueTmag

| Name of Constants | Values | Description |
|---|---|---|
| False | 0 | Sets the low-pass filter to inactive. (default) |
| True | -1 | Sets the low-pass filter to active. |

### Detailed Explanation

This activates/inactivates or returns the status of the low-pass filter in the specified axes of the force coordinate system.
It activate/inactivate the following settings.

| | | |
|---|---|---|
| bValueFx: Fx | bValueFy: Fy | bValueFz: Fz |
| bValueTx: Tx | bValueTy: Ty | bValueTz: Tz |
| bValueFmag: Fmag | bValueTmag :Tmag | |

The signal noise reduction can be enhanced when the low-pass filter is activated, but the following performance for quick signal changes deteriorates.
The low-pass filter is used with AvgForces Status, PeakForces Status, the Force Trigger Function, Force Monitor, and Force Control Monitor Function, but is not used with Forces Status.

### Usage Example

This example sets the low-pass filter and acquires the value when the maximum absolute value is attained for torque.

```
Function GetPeakForces
  Real myPeakForces(6)
  FSet FCS1.Orientation, FG_TOOL
  FSet FM1.CoordinateSystem, FCS1
  FSet FM1.LPF_Enabled, True, True, True, True, True, True
  FSet FM1.LPF_TimeConstants, 0.02, 0.02, 0.02, 0.02, 0.02, 0.02
  FSet FM1.PeakForceClear, True, True, True, True, True, True
  Wait 10
  FGet FM1.PeakForces, myPeakForces()
  Print myPeakForces (FG_TX), myPeakForces (FG_TY), myPeakForces (FG_TZ)
Fend
```

### See Also

**FT (Force Trigger) Object**, **FM (Force Monitor) Object**

# 17.14 LPF_TimeConstants Property

### Application
Force Trigger Object FT#, Force Monitor Object FM#

### Description
This sets or returns the value of the low-pass filter time constants applied to each axis in the force coordinate system at the same time.

### Immediate Execution
No

### Usage
FGet Object.LPF_TimeConstants, rArray()
FSet Object.LPF_TimeConstants, rValueFx, rValueFy, rValueFz, rValueTx, rValueTy, rValueTz [,rValueFmag, rValueTmag]

- Object Object name
  The object is specified as FT (numerical value), FT (label), FM (numerical value), or FM (label).
- rArray()
  The element numbers defining the value of the property is and array of 6 or more real number variable
- rValueFx
  A real number or formula defining the new value of the property
- rValueFy
  A real number or formula defining the new value of the property
- rValueFz
  A real number or formula defining the new value of the property
- rValueTx
  A real number or formula defining the new value of the property
- rValueTy
  A real number or formula defining the new value of the property
- rValueTz
  A real number or formula defining the new value of the property
- rValueFmag
  A real number or formula defining the new value of the property
- rValueTmag
  A real number or formula defining the new value of the property

### Values
rArray()

| Element number | Element number constant | Description |
|---|---|---|
| 0 | FG_FX | This is the Fx low-pass filter time constant. |
| 1 | FG_FY | This is the Fy low-pass filter time constant. |
| 2 | FG_FZ | This is the Fz low-pass filter time constant |
| 3 | FG_TX | This is the Tx low-pass filter time constant. |
| 4 | FG_TY | This is the Ty low-pass filter time constant. |
| 5 | FG_TZ | This is the Tz low-pass filter time constant. |
| 6 | FG_FMAG | This is the Fmag resultant force low-pass filter time constant. |

| Element number | Element number constant | Description |
|---|---|---|
| 7 | FG_TMAG | This is the Tmag resultant torque low-pass filter time constant. |

Note: When the number of elements is an array of 6 or 7 variables, only the element number settings 0 to 5 are acquired.

rValueFx, rValueFy, rValueFz, rValueTx, rValueTy, rValueTz, rValueFmag, rValueTmag
(Unit: [sec])

| | Values |
|---|---|
| Minimum | 0.002 |
| Maximum | 5 |

Default: 0.01

### Detailed Explanation

This sets or returns the value of the low-pass filter time constants applied to each axis in the force coordinate system at the same time.
It sets the following time constant settings.

| | | |
|---|---|---|
| rValueFx: Fx | rValueFy: Fy | rValueFz: Fz |
| rValueTx: Fx | rValueTy: Ty | rValueTz: Tz |
| rValueFmag: Fmag | rValueTmag: Tmag | |

The low-pass filter time constant is the time it takes to arrive at an input value of 1-$e^{-1}$ (approximately 63.2%) when giving step input.
The signal noise reduction can be enhanced when increasing the time constant, but the following performance for quick signal changes deteriorates.
The low-pass filter is used with AvgForces Status, PeakForces Status, the Force Trigger Function, and Force Monitor, and Force Control Monitor Function, but is not used with Forces Status.

### Usage Example

This example sets the low-pass filter and acquires the value when the maximum absolute value is attained for torque.

```
Function GetPeakForces
  Real myPeakForces(6)
  FSet FCS1.Orientation, FG_TOOL
  FSet FM1.CoordinateSystem, FCS1
  FSet FM1.LPF_Enabled, True, True, True, True, True, True
  FSet FM1.LPF_TimeConstants, 0.02, 0.02, 0.02, 0.02, 0.02, 0.02
  FSet FM1.PeakForceClear, True, True, True, True, True, True
  Wait 10
  FGet FM1.PeakForces, myPeakForces()
  Print myPeakForces (FG_TX), myPeakForces (FG_TY), myPeakForces (FG_TZ)
Fend
```

### See Also

FT (Force Trigger) Object, FM (Force Monitor) Object

# 18. M

# 18.1 Mass Property

### Application
Mass Property Object MP#

### Description
This sets or returns the value for the robot hand and workpiece/payload.

### Immediate Execution
No

### Usage
MPGet Object.Mass, rVar
MPSet Object.Mass, rValue

- Object
  Object name
  The object is specified as either of MP (numerical value) or MP (label).

- rVar
  A real number variable defining the value of the property

- rValue
  A real number or formula defining the new value of the property

### Values
rValue (Unit: [kg])

| | Values |
|---|---|
| Minimum | 0 |
| Maximum | Robot's maximum load capacity×1.5 |

Default: 0

### Detailed Explanation
Sets or returns the value of the overall weight of the robot hand and workpiece/payload at the leading end side from the force sensor (not including the force sensor).
Mass Property Object is used to compensate for the effects of gravity on the force function.

### Usage Example
This example carries out a motion using the force control function after setting the Mass Property Object.

```
Function GetPeakForces
  MPSet MP1.GravityCenter, 10, 10, 100
  MPSet MP1.Mass, 2
  MP 1
  Move CurPos +TLW(10) FC1 ROT
Fend
```

### See Also
**MP (Mass Properties) Object**

# 18.2 MeasuredHeight Result

### Description

Returns the distance traveled or the end point when executing the height detection sequence.

### Usage

FGGet Sequence.Object.EndPos, rVar

- Sequence
  Force guide sequence name or string variable representing force guide sequence name

- Object
  Force guide sequence name or string variable representing force guide sequence name

- rVar
  Real variable that shows a returned value

### Detailed Explanation

Returns the distance traveled or the end point when executing the height detection sequence. If the ForceOrient property is set to "Tool" for the height detection sequence, this returns the distance traveled in the direction of detection from the motion start position to the motion end position for the height detection object. If the ForceOrient property is set to "Base" or "Local" for the height detection sequence, this is the position in the direction of detection set by the ContactOrient property for the height detection object as viewed from the coordinate system set by the ForceOrient property.

### Usage Example

The following is an example of a simple program that acquires a result with FGGet.

```
Function MeasuredHeightTest

  Real rVar
  Motor On

  FGRun Sequence1
  FGGet Sequence1.MeasuredHeight, rVar   ' Acquire EndPos
  Print rVar

Fend
```

### See Also

**FGGet Statement**, **HeightInspect Sequence Result**

## 18.3 Model Property

### Application
Force Sensor Object FS#

### Description
Returns the model name of the force sensor.

### Immediate Execution
No

### Usage
FGet Object.Model, sVar$

- Object
  Object name
  The object is specified as FS (numerical value).

- sVar$
  A string variable defining the value of the property

### Detailed Explanation
This property is used when confirming the model name of the force sensor.

### Usage Example
This example confirms the model name for force sensor 1.

```
Function Test_Model
  String model$
  FGet FS1.Model, model$
  Print model$
Fend
```

### See Also
**FS (Force Sensor) Object**

## 18.4 MotionLimited Status

### Application
Force Control Object FC#

### Description
This returns which of the following velocity or acceleration limits limited the velocity or acceleration of the motion which was just carried out with force control active.

| | | |
|---|---|---|
| Maximum joint velocity | Maximum tool position modification velocity | Maximum tool orientation modification velocity |
| Maximum joint acceleration | Maximum tool position modification acceleration | Maximum tool orientation modification acceleration |

### Usage
FGet Object.MotionLimited, iVar

- Object
  Object name
  The object is specified as either of FC (numerical value) or FC (label).

- iVar
  A variable defining the value of the property of the Int32 or Int64 type

### Values

| Bit | Result |
|---|---|
| 0 | Maximum tool position modification velocity |
| 1 | Maximum tool position modification acceleration |
| 2 | Maximum tool orientation modification velocity |
| 3 | Maximum tool orientation modification acceleration |
| 4 | J1 Maximum joint velocity |
| 5 | J1 Maximum joint acceleration |
| 6 | J2 Maximum joint velocity |
| 7 | J2 Maximum joint acceleration |
| 8 | J3 Maximum joint velocity |
| 9 | J3 Maximum joint acceleration |
| 10 | J4 Maximum joint velocity |
| 11 | J4 Maximum joint acceleration |
| 12 | J5 Maximum joint velocity |
| 13 | J5 Maximum joint acceleration |
| 14 | J6 Maximum joint velocity |
| 15 | J6 Maximum joint acceleration |

The value of each Bit
0: No limitation
1: With limitation

### Detailed Explanation

This returns which of the following velocity or acceleration limits limited the velocity or acceleration of the motion which was just carried out with force control active.

| | | |
|---|---|---|
| Maximum joint velocity | Maximum tool position modification velocity | Maximum tool orientation modification velocity |
| Maximum joint acceleration | Maximum tool position modification acceleration | Maximum tool orientation modification acceleration |

Any item which limited the motion while force control was active even once will become a “1.”
This is used for processing or branching based on whether a motion was limited.
MotionLimited status returns a value of 0 to 65535 (hexadecimal FFFF). Because of this, the range that can be handled with an Integer type can be exceeded. Use Int32 or Int64 type variables.

### Usage Example

This is an example of branch-processing depending on whether the Move motion was limited or not.

```
Function motionLimitedTest
  Int64 Result
  FSet FCS1.Orientation, FG_TOOL   ' Sets the force coordinate data

  FSet FC1.CoordinateSystem, FCS1  ' Specifies the force coordinate data
  FSet FC1.Fx_Spring, 0            ' Sets the virtual Fx coefficient of elasticity
  FSet FC1.Fx_Damper, 1            ' Sets the virtual Fx coefficient of viscosity
  FSet FC1.Fx_Mass, 10             ' Sets the virtual Fx coefficient of inertia
  FSet FC1.Fx_Enabled, True        ' Sets the Fx force control to active
  FSet FC1.LimitAccelS, 5          ' Sets the maximum joint acceleration to
5[mm/sec^2]
  AccelS 2                         ' Sets the maximum CP motion acceleration to
2[mm/sec^2]

  Move P0 FC1                      ' A Move motion with force control active
  FGet FC1.MotionLimited, Result   ' Acquires limit result

  If Result <> 0 Then              ' When the motion is limited
    -
    -
    -
  EndIf
  -
  -
  -
Fend
```

### See Also

**FC (Force Control) Object**, **LimitSpeedSRJ Property**, **LimitAccelSRJ Property**

# 18.5 Move Statement

### Description
Carries out a linear interpolation motion with the force control function active.

### Usage
Move P# [FC#] [ROT] [CF] [CP] [Till | Find] [!parallel processing!] [SYNC]

- P#
  Specified the point data defining the target position of the motion.

- FC#
  Specifies the force control object.

- CF
  Continues the force control function. Can be omitted.

### Detailed Explanation
By adding, as a parameter, a force control object to an ordinary Move command, a Move motion is carried out with force control active. There are instances wherein the same path is not necessarily traced as a result of the exact same command due to the path changing according to the force during the motion, and the motion may stop at a position different than the target position

The Force Control Function operates in accordance with each of the properties for the Force Control Object. Execute after confirming each of the properties for the Force Control Object.

The velocity and acceleration of the Force Control Object is limited by the LimitSpeed and LimitAccel during the operation of the force control function. Refer to the appropriate item for the all property details.

By adding CF parameter, it is possible to continue the force control function up to the next motion. By doing this, the robot proceeds to the next statement at the point the Move motion is completed, as it would ordinarily do, but the robot continues with the force control function still active. In addition, when adding a CP parameter, you then must add a CF parameter. When a CP parameter is added, continued force control function accompanies the normal path motion.

Also, the continuation of the force control by virtue of the CF parameter brings with it the following limitations on the modification of the Force Control Object.

| Property name | Pre-motion parameter | Post-motion parameter | Modification advisable? |
|---|---|---|---|
| Enabled | False | True | OK |
| | True | False | NG |
| LimitAccel | Low | High | OK |
| | High | Low | NG |
| LimitSpeed | Low | High | OK |
| | High | Low | NG |
| TargetForcePriorityMode | False | True | NG |
| | True | False | NG |
| CoordinateSystem | FCSX | FCSX | OK |
| | FCSX | FCSY | NG |

Moreover, when a CF parameter is added, a normal motion cannot be executed immediately thereafter. When desiring to execute a normal motion command after the force control function has been activated, either do not add a CF parameter or execute an FCEnd statement to inactivate the force control function.
In the same manner as an ordinary motion, when adding a Till qualifier, the movement can be terminated by certain conditions. For details on a Till qualifier, refer to the following manual and Force Trigger Object sections.
“Epson RC+ 8.0 SPEL+ Language Reference” "Till
While force control is operating, Till will cause the force control function to decrease the velocity after the normal motion has been stopped. In addition, when a CF parameter is added, the motion command can be stopped, but the force control function continues. When desiring to stop the force control function as well, either do not add a CF parameter or execute an FCEnd statement.

When the motion is paused while force control is operating, the force control function cannot be re-started. Execute the next motion after the current motion has been completed.
The following commands cannot be used while the force command function is operating. Execute the following commands after executing an FCEnd statement and the force command function has ended.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Arm<br>ArmClr<br>ArmSet | Base<br>Brake<br>Calib<br>CP | ECP<br>ECPClr<br>ECPSet<br>Elbow<br>Encreset | Hand<br>Here<br>Home | J1Angle<br>J1Flag<br>J2Flag<br>J4Flag<br>J6Flag | Local<br>LocalClr<br>Mcal<br>Motor | Power<br>PTPTime<br>SFree | TLClr<br>TLSet<br>Tool | WaitPos<br>Where<br>Wrist |

For SCARA robots (including RS series), the force control function cannot be executed in the following cases regardless of the FCS object settings referred by the FC object.

- When the V or W parameter for the base coordinate system or the selected tool coordinate system is other than 0.
- When Tx_Enabled or Ty_Enabled property for the FC object is True.

The force control function cannot be executed in the following cases when the Local coordinate system is specified for the Orientation property of the FCS object which is referred by the FC object.

- When the V or W parameter for the local coordinate system with the number which is referred by the FCS object is other than 0.

The force control function cannot be executed in the following cases when the Custom coordinate system is specified for the Orientation property of the FCS object which is referred by the FC object.

- When the V or W parameter for the Orientation property is other than 0.

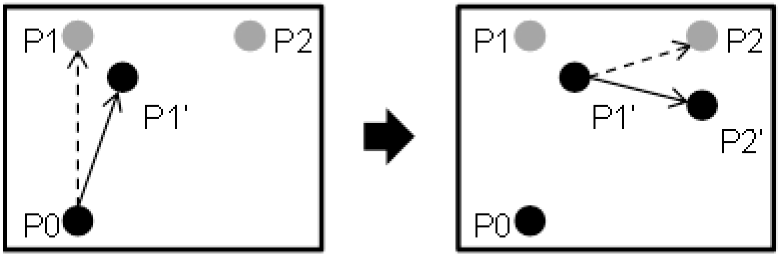
The force control function cannot be executed for other than SCARA (including RS series) and 6-axis robots (including N series).

### Force Control and trajectories

- Use Move with FC

  When a CF parameter and a CP parameter are not added, the robot is positioned each time the motion command is completed. In the subsequent command, a trajectory from the current position to the target position will be planned.
  The figure below shows the motion trajectories when the following program is executed.

  ```
  Move P1 FC1
  Move P2 FC1
  ```

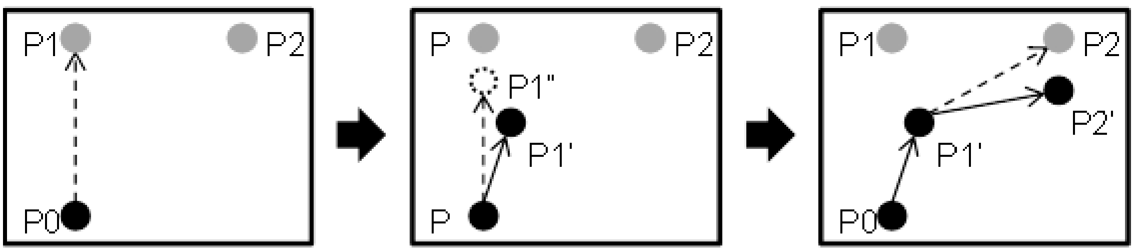



In the first Move, a trajectory from the initial position P0 to the target position P1 is planned (dashed line), and then the robot start motion.
At this point, the robot moves to P1’ because the path is corrected by the force control. (Solid line)
The robot is positioned at P1’ and then stops.
In the second Move, a trajectory from P1’ (where the robot is positioned) to P2 is planned (dotted line), but the robot moves to P2’ because the path is corrected by the force control like the first Move. (Solid line)

- Use Move with FC and Till

The robot is positioned at P1’ and then stops.

```
Move P1 FC1 Till
Move P2 FC1
```

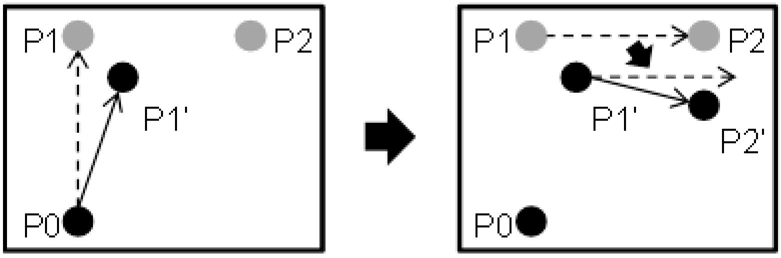



In the first Move, a trajectory from the initial position P0 to the target position P1 is planned (dashed line), and then the robot start motion.
At this point, the robot moves toward P1’ because the path is corrected by the force control. (Solid line)
If the Till conditions are met during the motion, the robot will be stopped and positioned at P1’ instead of P1’’ on the planned trajectory because of correction by the force control.
In the second Move, a trajectory from P1’ (where the robot is positioned) to P2 is planned (dotted line), but the robot moves to P2’ because the path is corrected by the force control like the first Move. (Solid line)
If the Till conditions are not met during the first Move motion, the robot moves in the same way as described in “Use Move with FC”.

- Use Move with FC and CF

When a CF parameter is added, the force control continues and the robot is not positioned even when a motion command is completed. In the subsequent command, a trajectory is planned based on the initially planned target position and the subsequent target position.
The figure below shows the motion trajectories when the following program is executed.

```
Move P1 FC1 CF
Move P2 FC1
```

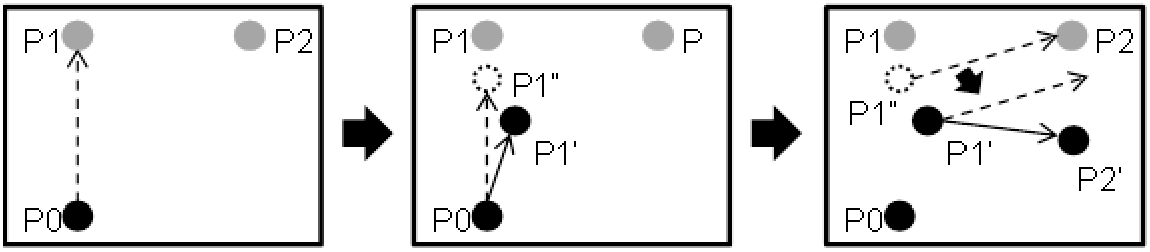



In the first Move, a trajectory from the initial position P0 to the target position P1 is planned (dashed line), and then the robot start motion. At this point, the robot moves to P1’ because the path is corrected by the force control. (Solid line) Since the CF parameter is added, the robot is not positioned and the force control continues.
In the second Move, a trajectory from the target position of the first Move, P1, to P2 is planned. (Dotted line) Then, the robot moves toward the position which considers the relative displacement amount from the current position P1’. (Dotted line) At this point, the robot moves to P2’ because the path is corrected by the force control function like the first Move. (Solid line)

- Use Move with FC, CF, and Till

The figure below shows the motion trajectories when the following program is executed.

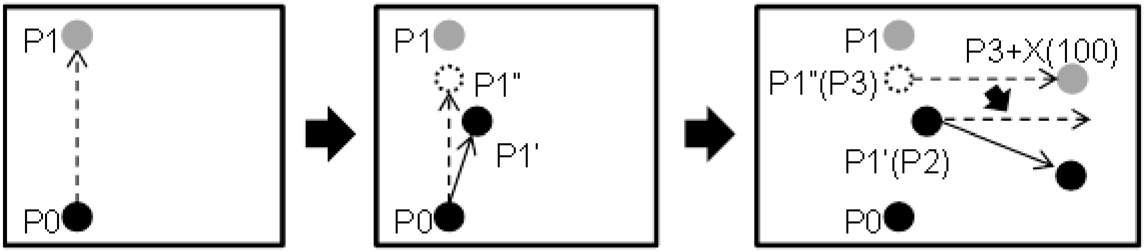
```
Move P1 FC1 CF Till
Move P2 FC1
```




In the first Move, a trajectory from the initial position P0 to the target position P1 is planned (dashed line), and then the robot start motion. At this point, the robot moves to P1’ because the path is corrected by the force control. (Solid line) If the Till conditions are met during the motion, the robot stops motion toward the planned trajectory. (P1”) Since the CF parameter is added, the robot is not positioned and the force control continues.
In the second Move, a trajectory from P1” (stop position on the trajectory planned for the first Move) to P2 is planned (dashed line). Then, the robot moves toward the position which considers the relative displacement amount from the current position P1’. (Dashed line) At this point, the robot moves to P2’ because the path is corrected by the force control function like the first Move. (Solid line)

By using the RefPos property, the current position on the planned trajectory and actual current position can be acquired. However, if the force control is continued by the CF parameter, the actual position keeps changing. By using this, the amount of relative displacement can be specified after motion stops by Till.
The figure below shows the motion trajectories when the following program is executed.

```
Move P1 FC1 CF Till
FGet Robot.RefPos, P2, P3
Move P3 +X(100) FC1
```

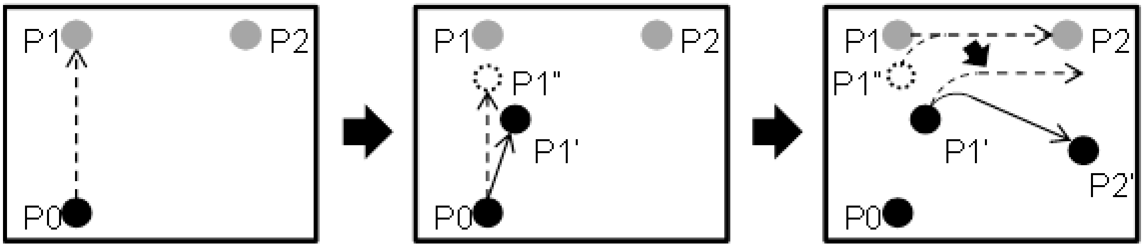



The stop position P1” on the planned trajectory at the time of motion stop by Till will be P3. The amount of relative displacement as position control can be specified based on P3.

- Use Move with FC, CF, and CP

When a CF parameter is added, the force control continues and the robot is not positioned even when a motion command is completed. In the subsequent command, a trajectory is planned based on the initially planned target position and the subsequent target position. Also, when a CP parameter is added, the control goes to next statement at the same time as deceleration for the motion command starts. By using this, several consecutive motions can be connected.
The figure below shows the motion trajectories when the following program is executed.

```
Move P1 FC1 CF CP
Move P2 FC1
```




In the first Move, a trajectory from the initial position P0 to the target position P1 is planned (dashed line), and then the robot start motion. At this point, the robot moves to P1’ because the path is corrected by the force control. (Solid line)
When deceleration starts in the planned trajectory (P1’’), the second Move plans a trajectory between P1 (the target position of the first Move) and P2, and then combine it to the planned trajectory of the first Move. (Curved dashed line) The robot starts motion toward the position which considers the relative displacement amount from the current position P1’. (Dashed line) At this time, the robot moves to P2’ because the path is corrected continuously by the force control. (Solid line)

- Use Move with FC, CF, CP, and Till

When the force control objects, CF parameter, CP parameter and Till qualifier are used together, the robot moves as below.

```
Move P1 FC1 CF CP Till
Move P2 FC1
```

If the Till conditions are met before the first Move starts deceleration, the robot moves in the same way as described in “Use Move with FC, CF, and Till”.
If the Till conditions are not met before the first Move starts deceleration, the robot moves in the same way as described in “Use Move with FC, CF, and CP”. Since the next motion command is executed at the same time as the start of deceleration, conditional judgement for Till is also completed simultaneously.

### Usage Example

This is a simple programming example of a executing a Move motion with force control active.
This example executes a Move motion with force control active in the X axis direction of the tool's coordinate system.

```
Function ForceMoveTest
  FSet FCS1.Orientation, FG_TOOL    ' Sets the force coordinate data

  FSet FC1.CoordinateSystem, FCS1   ' Sets the force coordinate data
  FSet FC1.Fx_Spring, 0             ' Sets the virtual Fx coefficient of elasticity
  FSet FC1.Fx_Damper, 1             ' Sets the virtual Fx coefficient of viscosity
  FSet FC1.Fx_Mass, 10              ' Sets the virtual Fx coefficient of inertia
  FSet FC1.Fx_Enabled, True         ' Sets the Fx force control function to active

  Move P0 FC1                       ' A Move motion with force control active
Fend
```

Next is an example of a program using a CF parameter.
In this example, Force Control Object FC1 is used to execute the force control function while moving from the current position to P0 and then to P1. The force control function will be terminated at the completion of the movement. After that, the movement will proceed to P2 and then to P3 using Force Control Object FC2 to execute the force control function. When the movement to P3 has been completed, the force control function will remain active due to the CF parameter, but the force control function will be terminated via that FCEnd statement. Following that, Force Control Object FC3 is used to continue the force control until 5 seconds have passed after arriving at P4. In order to maintain the active state of the force control function for a certain amount of time following a movement, use the FCKeep statement.

For details on FCKeep and FCend, please refer to the details for each statement.

```
Function ForceMoveCFTest
  Move P0 FC1 CF
  Move P1 FC1

  Move P2 FC2 CF
  Move P3 FC2 CF
  FCEnd

  Move P4 FC3 CF
  FCKeep FC3, 5
Fend
```

Next is an example of a program using a Till qualifier.
Establish Force Trigger Object FT1 for Till, and add a Till qualifier to the Move motion command with force control active. When Till becomes active during the movement to P1, the Move motion and the force control function are terminated and the robot stops. The same thing happens during the movement to P2. When Till becomes active on the way to P3, the Move motion is terminated due to the addition of the CF parameter, but the force control function remains active. For that reason the robot does not stop. After that, the movement progresses to P4 with the force control function remaining active.

```
Function ForceMoveTillTest
  Till FT1
  Move P1 FC1 Till     ' Both the motion and the force control function are
terminated
  Move P2 FC2 Till     ' Both the motion and the force control function are
terminated

  Move P3 FC3 CF Till  ' The motion is terminated, but the force control function
continues
  Move P4 FC3
Fend
```

### See Also

Move Statement, FC (Force Control) Object, FT (Force Trigger) Object, Till, FCKeep Statement, FCEnd Statement

# 18.6 MP Statement

### Application
Mass Property Object MP#

### Description
This sets or returns the value of the Mass Property used with gravity compensation.

### Immediate Execution
Yes

### Usage
MP [iValue]

- iValue
  A number defining the new Mass Property

### Detailed Explanation
This sets or returns the value of the Mass Property used with gravity compensation. With no argument, the current number will be displayed in the command window or run window. The argument can be set to 0 to 15. 0 is the setting to stop gravity compensation.
When the Mass Property is changed, execute the Reset Property.

### See Also
**MP (Mass Properties) Object**

# 18.7 MPDef Function

### Application

Mass Property Object MP#

### Description

This returns whether the Mass Property Object is defined or not.

### Usage

MPDef(Object)

- Object
  Mass Property Object name
  Mass Property Object is specified as either of MP (numerical value) or MP (label).

### Return Values

"True" if the specified force object is defined, "False" if undefined.

### Detailed Explanation

This returns whether the specified Mass Property Object is defined or not.

### Usage Example

This is an example of displaying that the Mass Property Object is defined.

```
Function main
  If MPDef(MP9) Then
    Print "MP9 is defined"
  EndIf
Fend
```

### See Also

**MP (Mass Properties) Object**

# 18.8 MPDel Statement

### Application
Mass Property Object MP#

### Description
This deletes the specified Mass Property Object.

### Immediate Execution
Yes

### Usage
MPDel Object1 [, Object2]

- Object1
  The Mass Property Object starting the object data range to be deleted or a string variable defining the Mass Property Object.

- Object2
  The Mass Property Object starting the object data range to be deleted or a string variable defining the Mass Property Object.

### Detailed Explanation
This is used to delete the specified Mass Property Object while the program is being executed. The object data from the start object parameter to the end object parameter is deleted. The start object and the end object must be a Mass Property Object. Moreover, make the number of the start object smaller than the number of the end object. No error occurs when the object is not defined.

### Usage Example
This is an example of deleting the Mass Property Object.

```
> MPDel MP1         ' Deletes Mass Property Object 1
> MPDel MP2, MP10   ' Deletes Mass Property Object 2 through 10
```

### See Also
**MP (Mass Properties) Object**

# 18.9 MPGet Statement

### Application
Mass Property Object MP#

### Description
This is used when obtaining the value of the properties of the Mass Property Object.

### Usage
MPGet Object.Property, Var

- Object
  Object name
  The object is specified as either of MP (numerical value) or MP (label).

- Property
  The name of the property for which the value is to be acquired

- Var
  The variable that shows a returned value and format differ according to the property.

### Detailed Explanation
This is used when obtaining the value of the properties of the Mass Property Object.

### Usage Example
This example sets the value of the Mass Property Object, then acquires that value and displays it.

```
Function MPTest

  Integer iVar
  String sVar$

  'Set each property
  MPSet MP1.Label, "MP1_Label"
  MPSet MP1.Description, "MP1_Description"
  MPSet MP1.Mass, 1
  MPSet MP1.GravityCenter, 0, 0, 100

  'Acquires the number
  MPGet MP(MP1_Label).Number, iVar
  Print iVar

  'Acquires the label
  MPGet MP((iVar)).Label, sVar$
  Print sVar$
Fend
```

### See Also
**FSet Statement**

# 18.10 MPLabel$ Function

### Application
Mass Property Object MP#

### Description
Returns the Mass Property Object label.

### Usage
MPLabel$(Object)

- Object
  Mass Property Object name
  Mass Property Object is specified as either of MP (numerical value) or MP (label).

### Return Values
String

### Detailed Explanation
Returns the Mass Property Object label.

### Usage Example
This example sets the Mass Property Object label and displays it.

```
> MPSet MP1.Label, "Label1"
> Print MPLabel$(MP1)
Label1
```

### See Also
**Label Property**, **MP (Mass Properties) Object**

## 18.11 MPList Statement

### Application
Mass Property Object MP#

### Description
Displays a list of Mass Property Objects.

### Immediate Execution
Yes

### Usage
MPList Object1 [, [Object2]]

- Object1
  The Mass Property Object name starting the object data range to be listed, or a string variable defining the Mass Property Object name.

- Object2
  The Mass Property Object name starting the object data range to be listed, or a string variable defining the Mass Property Object name.

### Detailed Explanation
The defined object data from the specified start object to the specified end object is displayed in the Command window or Run window.

When "," and the end object are omitted, only the start object is displayed, and when "," is used and the end object is omitted, all objects from the start object on are displayed.

The output format for each line is the same format as the parameter for the MPSet Statement.

*Object.Property, Values*

| | |
|---|---|
| Object | Object name |
| Property | Property name |
| Values | The number or format expressing the value depends on the property |

### Usage Example
This example lists the Mass Property Object data.

```
> MPList MP1
MP1.Label, "Label1"
MP1.Mass, 0
MP1.GravityCenter, 0, 0, 0
MP1.Inertia, 0
MP1.Description, ""
```

### See Also
**MP (Mass Properties) Object**

# 18.12 MPNumber Function

### Application
Mass Property Object MP#

### Description
Returns the Mass Property Object number matching the specified Mass Property Object label.

### Usage
MPNumber(Object)

- Object
  Mass Property Object name
  The Mass Property Object is specified as MP (label).

### Return Values
Integers

### Detailed Explanation
Returns the Mass Property Object number matching the specified Mass Property Object label. An error occurs when there is not matching object.

### Usage Example
This example specifies the label for the Mass Property Object, then acquires the number from the label.

```
> MPSet MP1.Label, "Label1"
> Print MPNumber(MP(Label1))
 1
```

### See Also
MP (Mass Properties) Object

# 18.13 MPSet Statement

### Application
Mass Property Object MP#

### Description
Used when setting the Mass Property Object value.

### Usage
MPSet Object.Property, Values

- Object
  Object name
  Mass Property Object is specified as either of MP (numerical value) or MP (label).

- Property
  Property name defining the new value

- Values
  The numbers and format differ according to the property.

### Detailed Explanation
This is used for setting the properties of Mass Property Objects.

### Usage Example
This example sets the value of the Mass Property Object, then acquires that value and displays it.

```
Function MPTest

  Integer iVar
  String sVar$

  'Set each property
  MPSet MP1.Label, "MP1_Label"
  MPSet MP1.Description, "MP1_Description"
  MPSet MP1.Mass, 1
  MPSet MP1.GravityCenter, 0, 0, 100

  'Acquires the number
  MPGet MP(MP1_Label).Number, iVar
  Print iVar

  'Acquires the label
  MPGet MP((iVar)).Label, sVar$
  Print sVar$
Fend
```

### See Also
**FGet Statement**, **FSave Statement**, **Force Object - Common**

# 19. N

# 19.1 Number Property

### Application
Force Control Object FC#, Force Coordinate System Object FCS#, Force Trigger Object FT#, Force Monitor Object FM#, Force Motion Restriction Object FMR#, Mass Property Object MP#

### Description
This references the number of the object by type.

### Immediate Execution
No

### Usage
FGet Object.Number, Var
MPGet MPObject.Number, Var

- Object
  Force object name
  The force object is specified as either of FC (label), FCS (label) FT (label), FM (label) or FMR (label).

- MPObject
  Mass Property Object　Name
  The Mass Property Object is specified as MP (label).

- Var
  A real number variable defining the value of the property

### Detailed Explanation
This references the number of the object by type. This cannot be set.
This differs from the specifying of other properties and objects. Other properties can be specified by number and label.
For Number Property, objects are specified by label only.

### See Also
**FC (Force Control) Object**, **FCS (Force Coordinate System) Object**, Force Control Object FC#, Force Coordinate System Object FCS#,
Force Trigger Object FT#, Force Monitor Object FM#,
Force Motion Restriction Object FMR#, Mass Property Object MP#

# 20. O

# 20.1 Operator Property

### Application
Force Trigger Object FT#, Force Motion Restriction Object FMR#

### Description
This sets or returns the trigger conditions for Force Trigger Objects or Force Motion Restriction objects.

### Immediate Execution
No

### Usage
FGet Object.Operator, iVar
FSet Object.Operator, iValue

- Object
  Object
  The object is specified as either of FT (numerical value), FMR (numerical value), FT (label) or FMR (label).

- iVar
  An integer variable defining the value of the property

- iValue
  An integer value or formula defining the new value of the property

### Values
iValue

| Name of Constants | Values | Description |
|---|---|---|
| FG_OR | 0 | OR condition (default) |
| FG_AND | 1 | AND condition |

### Detailed Explanation
When OR conditions are selected, the trigger is pulled when any one of the conditions active in the XX_Enabled Property is met.
When AND conditions are selected, the trigger is pulled when all of the conditions active in the XX_Enabled Property are met.

### Usage Example
This is an example of a program where the force trigger is pulled when the X axis and Y axis conditions are met.

```
Function Test_Operator
  Integer iVar
  FSet FT1.Fx_Enabled, True   ' Activates X axis
  FSet FT1.Fy_Enabled, True   ' Activates Y axis
  FSet FT1.Operator, FG_AND   ' Sets the trigger condition to an AND condition
  FGet FT1.Operator, iVar     ' Confirms the current trigger conditions
  Print iVar
Fend
```

### See Also
**FT (Force Trigger) Object**, **FMR (Force Motion Restriction) Object**

## 20.2 Orientation Property

### Application
Force Coordinate System Object FCS#

### Description
This sets or returns the orientation of the coordinate axis in the force coordinate system.
The local coordinate system number is only set when Local is selected for the coordinate axis.
u, v, and w can be set only when “Custom” is selected for the coordinate axis.

### Immediate Execution
No

### Usage
FGet Object.Orientation, rArray()
FSet Object.Orientation, iValue
FSet Object.Orientation, iValue, iValueL
FSet Object.Orientation, iValue, rValueU, rValueV, rValueW

- Object
  Object name
  The object is specified as either of FCS (numerical value) or FCS (label).
- rArray()
  The number of elements defining the values of the property is an array of 6 or more real number variables
- iValue
  An integer or formula defining the new value of the property
- iValueL
  An integer or formula defining the new value of the property
- rValueU
  An integer or formula defining the new value of the property
- rValueV
  An integer or formula defining the new value of the property
- rValueW
  An integer or formula defining the new value of the property

### Values
rArray

| Element number | Element number constant | Description |
|---|---|---|
| 0 | FG_CRD_SYS | Coordinate system |
| 1 | FG_LOCAL_NO | Local coordinate number |
| 2 | - | - |
| 3 | FG_U | The relative FG_CUSTOM orientation for the U axis rotation amount |
| 4 | FG_V | The relative FG_CUSTOM orientation for the V axis rotation amount |
| 5 | FG_W | The relative FG_CUSTOM orientation for the W axis rotation amount |

iValue

| Name of Constants | Values | Description |
|---|---|---|
| FG_BASE | 0 | Defines the direction of the base coordinate system |
| FG_LOCAL | 1 | Defines the direction of the local coordinate system |
| FG_TOOL | 2 (default) | Defines the direction of the tool coordinate system |
| FG_CUSTOM | 3 | Defines the direction of the custom coordinate system |

iValueL

| | Values |
|---|---|
| Minimum | 0 (default) |
| Maximum | 15 |

rValueU, rValueV, rValueW

| | Values |
|---|---|
| Minimum | -360 |
| Maximum | 360 |

Default: 0

### Detailed Explanation

Sets or returns the orientation of the force coordinate coordinate-axis.
The first argument, “iValue”, sets the coordinate system.

- FG_BASE
  The direction of the axis for the base coordinate system is set in the force coordinate system.
- FG_LOCAL
  The direction of the axis for the local coordinate system is set in the force coordinate system. In this case, the number for the local coordinate system is set as the second argument.
- FG_TOOL
  The direction of the axis for the tool coordinate system is set in the force coordinate system.
- FG_CUSTOM
  The direction of the axis for the coordinate system set off of the tool coordinate system as the datum is set in the force coordinate system.
  The relative orientation modification amount for U, V, and W axes from the tool coordinate system are set for the 2nd to 4th arguments.

FG_BASE and FG_LOCAL become the stationary coordinate systems for the direction of the axes during motions.
FG_TOOL and FG_CUSTOM become dynamic coordinate systems for robot orientation modification as well as for the direction of the axes during motion.

The datum for all coordinate system is the coordinate system used when using the force control function, the force trigger function, or force monitor function.
After setting the Orientation property, should the coordinate system serving as the datum for the Base, Local, and Tool statements be changed, the coordinate system established when setting the Orientation property is not used, but the coordinate system used when using the force function is applied.

### Usage Example

This example sets the origin and coordinate axes for force coordinate 1, then sets force coordinate 1 as the Force Monitor Object, and acquires the force data.

```
Function GetForces
  Real myForces(8)
  FSet FCS1.Position, 0, 0, 100
  FSet FCS1.Orientation, FG_TOOL
  FSet FM1.CoordinateSystem, FCS1
  FGet FM1.Forces, myForces()
  Print myForces(FG_TX), myForces(FG_TY), myForces(FG_TZ)
Fend
```

### See Also

**FCS (Force Coordinate System) Object**

# 21. P

# 21.1 PeakForceClear Property

### Application
Force Monitor Object FM#

### Description
This activates/inactivates the force and torque peak value calculations at the same time.

### Immediate Execution
Yes

### Usage
FSet Object.PeakForceClear, bValueFx, bValueFy, bValueFz, bValueTx, bValueTy, bValueTz [, bValueFmag, bValueTmag]

- Object
  Object name
  The object is specified as either of FM (numerical value) or FM (label).

- bValueFx
  A Boolean value or formula defining the new value of the property

- bValueFy
  A Boolean value or formula defining the new value of the property

- bValueFz
  A Boolean value or formula defining the new value of the property

- bValueTx
  A Boolean value or formula defining the new value of the property

- bValueTy
  A Boolean value or formula defining the new value of the property

- bValueTz
  A Boolean value or formula defining the new value of the property

- bValueFmag
  A Boolean value or formula defining the new value of the property

- bValueTmag
  A Boolean value or formula defining the new value of the property

### Values
bValueFx, bValueFy, bValueFz, bValueTx, bValueTy, bValueTz, bValueFmag, bValueTmag

| Name of Constants | Values | Description |
|---|---|---|
| False | 0 | Inactivates the subject axis. (default) |
| True | -1 | Activates the subject axis. |

### Detailed Explanation
PeakForces activates/inactivates the force and torque peak value calculations at the same time.
Be sure to execute PeakForceClear before executing PeakForces.

### Usage Example
This example returns the value of the peak force in the Fx direction.

```
Function CheckPeakForces
  Double PF(7)
  FSet FC1.Enabled, True, False, False, False, False, False
  FSet FC1.TargetForces, 10, 0, 0, 0, 0, 0
  FSet FS1.Reset
  FSet FM1.CoordinateSystem, FCS0
  FSet FM1.PeakForceClear, True, False, False, False, False,
                                  False, False, False
  FCKeep FC1, 10
  FGet FM1.PeakForces, PF()
  Print PF(FG_FX)
Fend
```

### See Also

**FM (Force Monitor) Object**

## 21.2 PeakForces Status

### Application

Force Monitor Object FM#

### Description

Returns the values of peak / minimum / maximum force and torque simultaneously. The minimum values and the maximum values can be omitted.

### Usage

FGet Object.PeakForces, rArrayPeak()
FGet Object.PeakForces, rArrayPeak(), rArrayMin(), rArrayMax()

- Object
  Object name
  The object is specified as either of FM (numerical value) or FM (label).

- rArrayPeak()
  The number of elements defining the values of the property is an array of 6 or more real number variables

- rArrayMin()
  The number of elements defining the values of the property is an array of 6 or more real number variables

- rArrayMax()
  The number of elements defining the values of the property is an array of 6 or more real number variables

### Values

rArrayPeak()

| Element number | Element number constant | Description |
|---|---|---|
| 0 | FG_FX | Acquires the value of peak Fx force. |
| 1 | FG_FY | Acquires the value of peak Fy force. |
| 2 | FG_FZ | Acquires the value of peak Fz force. |
| 3 | FG_TX | Acquires the value of peak Tx torque. |
| 4 | FG_TY | Acquires the value of peak Ty torque. |
| 5 | FG_TZ | Acquires the value of peak Tz torque. |
| 6 | FG_FMAG | Acquires the value of peak Fmag resultant force. |
| 7 | FG_TMAG | Acquires the value of peak Tmag resultant torque. |

rArrayMin()

| Element number | Element number constant | Description |
|---|---|---|
| 0 | FG_FX | Acquires the value of minimum Fx force. |
| 1 | FG_FY | Acquires the value of minimum Fy force. |
| 2 | FG_FZ | Acquires the value of minimum Fz force. |
| 3 | FG_TX | Acquires the value of minimum Tx torque. |
| 4 | FG_TY | Acquires the value of minimum Ty torque. |

| | | |
|---|---|---|
| 5 | FG_TZ | Acquires the value of minimum Tz torque. |
| 6 | FG_FMAG | Acquires the value of minimum Fmag resultant force. |
| 7 | FG_TMAG | Acquires the value of minimum Tmag resultant torque. |

rArrayMax()

| Element number | Element number constant | Description |
|---|---|---|
| 0 | FG_FX | Acquires the value of maximum Fx force. |
| 1 | FG_FY | Acquires the value of maximum Fy force. |
| 2 | FG_FZ | Acquires the value of maximum Fz force. |
| 3 | FG_TX | Acquires the value of maximum Tx torque. |
| 4 | FG_TY | Acquires the value of maximum Ty torque. |
| 5 | FG_TZ | Acquires the value of maximum Tz torque. |
| 6 | FG_FMAG | Acquires the value of maximum Fmag resultant force. |
| 7 | FG_TMAG | Acquires the value of maximum Tmag resultant torque. |

Note: When the number of elements is an array of 6 or 7, the element numbers acquired are 0 to 5.

### Detailed Explanation

PeakForces returns values of peak / minimum / maximum force and torque simultaneously while executing PeakForceClear and then PeakForces. The peak values are the maximum absolute value with a sign. The minimum values include a sign. The maximum values include a sign.
Be sure to execute PeakForceClear before executing PeakForces.

### Usage Example

This example returns the value of the peak force in the Fx direction.

```
Function CheckPeakForces
  Double PF(7)
  FSet FC1.Enabled, True, False, False, False, False, False
  FSet FC1.TargetForces, 10, 0, 0, 0, 0, 0
  FSet FS1.Reset
  FSet FM1.CoordinateSystem, FCS0
  FSet FM1.PeakForceClear, True, False, False, False, False,
                                  False, False, False
  FCKeep FC1, 10
  FGet FM1.PeakForces, PF()
  Print PF(FG_FX)
Fend
```

### See Also

**FM (Force Monitor) Object**

## 21.3 PeakForces Result

### Description

Returns the peak values of force and torque during execution of a force guide object or force guide sequence.

### Usage

FGGet Sequence.PeakForces, rArray()
FGGet Sequence.Object.PeakForces, rArray()

- Sequence
  Force guide sequence name or string variable representing force guide sequence name

- Object
  Force guide object name or string variable representing force guide object name. Omitted when a result of a force guide sequence is acquired.

- rArray
  Real array variable with six or more elements showing returned values

### Values

rArray()

| Element number | Element number constant | Description |
|---|---|---|
| 0 | FG_FX | Acquires the peak value of force in Fx direction during execution of a force guide sequence or force guide object. |
| 1 | FG_FY | Acquires the peak value of force in Fy direction during execution of a force guide sequence or force guide object. |
| 2 | FG_FZ | Acquires the peak value of force in Fz direction during execution of a force guide sequence or force guide object. |
| 3 | FG_TX | Acquires the peak value of torque in Tx direction during execution of a force guide sequence or force guide object. |
| 4 | FG_TY | Acquires the peak value of torque in Ty direction during execution of a force guide sequence or force guide object. |
| 5 | FG_TZ | Acquires the peak value of torque in Tz direction during execution of a force guide sequence or force guide object. |

### Detailed Explanation

Returns the peak values of force and torque during execution of a force guide object or force guide sequence.
Peak value is the largest absolute value of the force and torque during execution of a force guide object or a force guide sequence.
If the number of elements in a specified array variable is less than six, returns force and torque in each direction for the defined element numbers. Also, if the number of elements in the array variable exceeds six, returns force and torque in each direction from element number 0 to 5, while making no change to element number 6 and above.

### Usage Example

The following is an example of a simple program that acquires a result with FGGet.

```
Function PeakForceTest
  Double dArray(6)

  Motor On
```

```
  FGRun Sequence1
  FGGet Sequence1.Contact01.PeakForces, dArray()  ' Acquisition of PeakForces
  Print dArray(FG_FX)

Fend
```

### See Also

**FGGet Statement**, **General Purpose Sequence Result**, **Contact Object Result**, **Relax Object Result**, **FollowMove Object Result**, **SurfaceAlign Object Result**, **PressProbe Object Result**, **ContactProbe Object Result**, **Press Object Result**, **PressMove Object Result**, **Paste Sequene Result**, **Paste Object Result**, **ScrewTighten Sequence Result**, **ScrewRetighten Object Result**, **ScrewTighten Object Result**, **HeightInspect Sequence Result**, **HeightInspect Object Result**, **Insert Sequence Result**, **Insert Object Result**, **TensileTest Object Result**

# 21.4 Polarities Property

### Application
Force Trigger Object FT#

### Description
This returns the status of or sets whether the force trigger is triggered for each axis by the value being either within the thresholds or outside of the thresholds.

### Immediate Execution
No

### Usage
FGet Object.Polarities, iArray()
FSet Object.Polarities, iValueFx, iValueFy, iValueFz, iValueTx, iValueTy, iValueTz [, iValueFmag, iValueTmag]

- Object
  Object name
  The object is specified as either of FT (numerical value) or FT (label).

- iArray()
  The number of elements defining the values of the property is an array of 6 or more real number variables

- iValueFx
  An integer value or formula defining the new value of the property

- iValueFy
  An integer value or formula defining the new value of the property

- iValueFz
  An integer value or formula defining the new value of the property

- iValueTx
  An integer value or formula defining the new value of the property

- iValueTy
  An integer value or formula defining the new value of the property

- iValueTz
  An integer value or formula defining the new value of the property

- iValueFmag
  An integer value or formula defining the new value of the property

- iValueTmag
  An integer value or formula defining the new value of the property

### Values
iArray()

| Element number | Element number constant | Description |
|---|---|---|
| 0 | FG_FX | Returns whether the Fx force trigger is triggered by values within or outside of the threshold values. |

| Element number | Element number constant | Description |
|---|---|---|
| 1 | FG_FY | Returns whether the Fy force trigger is triggered by values within or outside of the threshold values. |
| 2 | FG_FZ | Returns whether the Fz force trigger is triggered by values within or outside of the threshold values. |
| 3 | FG_TX | Returns whether the Tx force trigger is triggered by values within or outside of the threshold values. |
| 4 | FG_TY | Returns whether the Ty force trigger is triggered by values within or outside of the threshold values. |
| 5 | FG_TZ | Returns whether the Tz force trigger is triggered by values within or outside of the threshold values. |
| 6 | FG_FMAG | Returns whether the Fmag resultant force trigger is triggered by values within or outside of the threshold values. |
| 7 | FG_TMAG | Returns whether the Tmag resultant torque trigger is triggered by values within or outside of the threshold values. |

Note: When the number of elements is an array of 6 or 7, the element numbers acquired are 0 to 5

iValueFx, iValueFy, iValueFz, iValueTx, iValueTy, iValueTz, iValueFmag, iValueTmag (Unit: Number)

| Name of Constants | Values | Description |
|---|---|---|
| FG_OUT | 0 | Sets to active when over or under the upper and lower threshold values, respectively. (default) |
| FG_IN | 1 | Sets to active when within the upper threshold and lower threshold values. |

### Detailed Explanation

Polarities returns the status of or sets whether the force trigger is triggered for each axis by the value being either within the thresholds or outside of the thresholds.
When setting the trigger for each axis at the same time, this allows one to set all of them with fewer lines than setting them 1 axis at a time.

### Usage Example

This example will generate an error and stop the robot if force, torque, resultant force or resultant torque is above the upper threshold or below the lower threshold.

```
Function SettingPolarities
  FSet FT1.Enabled, True, True, True, True, True, True, True, True
  FSet FT1.Polarities, FG_OUT, FG_OUT, FG_OUT, FG_OUT, FG_OUT, FG_OUT,FG_OUT,
FG_OUT
  FSet FT1.LowerLevels, -50, -50, -50, -3000, -3000, -3000, 0, 0
  FSet FT1.UpperLevels, 50, 50, 50, 3000, 3000, 3000, 50, 3000
  Trap 1, FT1 Call ForceError
Fend

Function ForceError
  AbortMotion All
Fend
```

### See Also

**FT (Force Trigger) Object**

# 21.5 PosEnabled Property

### Application
Force Motion Restriction Object FMR#

### Description
Activates/inactivates, or returns the force motion restriction function for each axis, movement distance and rotation angle collectively.

### Immediate Execution
No

### Usage
FGet Object.PosEnabled, bArray()
FSet Object.PosEnabled, bValuePosX, bValuePosY, bValuePosZ, bValueDist, bValueRot

- Object
  Object name
  The object is specified as either of FMR (numerical value) or FMR (label).
- bArray()
  The number of elements defining the values of the property is an array of 5 or more real number variables
- bValuePosX
  A Boolean value or formula defining the new value of the property
- bValuePosY
  A Boolean value or formula defining the new value of the property
- bValuePosZ
  A Boolean value or formula defining the new value of the property
- bValueDist
  A Boolean value or formula defining the new value of the property
- bValueRot
  A Boolean value or formula defining the new value of the property

### Values
bArray()

| Element number | Element number constant | Description |
|---|---|---|
| 0 | FG_X | Set activates/inactivates X axis. |
| 1 | FG_Y | Set activates/inactivates Y axis. |
| 2 | FG_Z | Set activates/inactivates Z axis. |
| 3 | FG_Dist | Set activates/inactivates distance. |
| 4 | FG_Rot | Set activates/inactivates rotation angle. |

bValuePosX, bValuePosY, bValuePosZ, bValueDist, bValueRot

| Name of Constants | Values | Description |
|---|---|---|
| False | 0 | Inactivates the subject axis. (default) |

| Name of Constants | Values | Description |
|---|---|---|
| True | -1 | Activates the subject axis. |

### Detailed Explanation

Activates/inactivates, or returns the force motion restriction function for each axis, movement distance and rotation angle collectively.

### See Also

**FMR (Force Motion Restriction) Object**

# 21.6 Position Property

### Application
Force Coordinate System Object FCS#

### Description
This sets the position of the origin in the force coordinate system for the selected tool coordinate system.

### Immediate Execution
No

### Usage
FGet Object.Position, rArray()
FSet Object.Position, rValueX, rValueY, rValueZ

- Object
  Object name
  The object is specified as either of FCS (numerical value) or FCS (label).

- rArray()
  The number of elements defining the values of the property is an array of 3 or more real number variables

- rValueX
  A real number or formula defining the new value of the property

- rValueY
  A real number or formula defining the new value of the property

- rValueZ
  A real number or formula defining the new value of the property

### Values
rArray()

| Element number | Element number constant | Description |
|---|---|---|
| 0 | FG_X | Acquires the position in the X direction of the force coordinate system for the selected tool coordinate system. |
| 1 | FG_Y | Acquires the position in the Y direction of the force coordinate system for the selected tool coordinate system. |
| 2 | FG_Z | Acquires the position in the Z direction of the force coordinate system for the selected tool coordinate system. |

rValueX, rValueY, rValueZ (Unit: [mm])

| | Values |
|---|---|
| Minimum | -2000 |
| Maximum | 2000 |

Default: 0

### Detailed Explanation
This sets the position of the force coordinate system in the tool coordinate system being used using the tool center point as the

datum.
When the datum coordinate system is changed via the Tool or TLSet statements after the Position property are set, the coordinate system established when setting the Position property is not used, but the coordinate system used when using the force function is applied.

### Usage Example

This is an example of a simple motion program using Position.

```
Function PositonTest
  Double ForceValue(8)
  FSet FCS1.Position, 100, 0, 0    ' Sets the position
  FSet FCS1.Orientation, FG_TOOL   ' Sets the direction

  FSet FM1.CoordinateSystem, FCS1  ' Specifies the force coordinate data
  FSet FM1.ForceSensor, FS1        ' Sets the number of the force sensor to be used

  Tool 1                           ' Selects Tool1
  FGet FM1.Forces, ForceValue()    ' Acquires sensor reading for the X:100 position
of Tool1

  Tool 2                           ' Selects Tool2
  FGet FM1.Forces, ForceValue()    ' Acquires sensor reading for the X:100 position
of Tool2
Fend
```

### See Also

**FCS (Force Coordinate System) Object**

## 21.7 PosLowerLevels Property

### Application
Force Motion Restriction Object FMR#

### Description
This sets or returns the lower threshold value of position of each axis, movement distance and rotation angle at the same time.

### Immediate Execution
No

### Usage
FGet Object.PosLowerLevels, rArray()
FSet Object.PosLowerLevels, rValuePosX, rValuePosY, rValuePosZ, rValueDist, rValueRot

- Object
  Object name
  The object is specified as either of FMR (numerical value) or FMR (label).

- rArray()
  The number of elements defining the values of the property is an array of 5 or more real number variables

- rValuePosX
  A real number or formula defining the new value of the property

- rValuePosY
  A real number or formula defining the new value of the property

- rValuePosZ
  A real number or formula defining the new value of the property

- rValueDist
  A real number or formula defining the new value of the property

- rValueRot
  A real number or formula defining the new value of the property

### Values
rArray()

| Element number | Element number constant | Description |
|---|---|---|
| 0 | FG_X | Acquires the lower threshold value for position of X axis. |
| 1 | FG_Y | Acquires the lower threshold value for position of Y axis. |
| 2 | FG_Z | Acquires the lower threshold value for position of Z axis. |
| 3 | FG_Dist | Acquires the lower threshold value for position of movement distance. |
| 4 | FG_Rot | Acquires the lower threshold value for position of rotation angle. |

rValuePosX, rValuePosY, rValuePosZ (Unit: [mm])

| | Values |
|---|---|
| Minimum | -20000 (default) |

| | Values |
|---|---|
| Maximum | 20000 |

rValueDist (Unit: [mm])

| | Values |
|---|---|
| Minimum | 0 (default) |
| Maximum | 20000 |

rValueRot (Unit: [Degree])

| | Values |
|---|---|
| Minimum | 0 (default) |
| Maximum | 180 |

### Detailed Explanation

PosLowerLevels set or return the lower threshold value of position of each axis, movement distance and rotation angle at the same time.
Be sure that PosLowerLevels < PosUpperLevels.
Since lower threshold values for position of each axis, movement distance and rotation angle are set at one time, it can be done with fewer lines than setting them one axis at a time.
This is used for error checking and task completion conditions.

### Usage Example

This example generates an error and stops the robot if position, movement distance and rotation angle is less than the lower threshold value.

```
Function SettingLevels
  FSet FMR1.PosEnabled, True, True, True, True, True
  FSet FMR1.PosPolarities, FG_OUT, FG_OUT, FG_OUT, FG_OUT, FG_OUT
  FSet FMR1.PosLowerLevels, -100, -100, -100, 0, 0
  Trap 1, FMR1 Call ForceError
Fend

Function ForceError
  AbortMotion All
Fend
```

### See Also

**FMR (Force Motion Restriction) Object**

# 21.8 PosPolarities Property

### Application

Force Motion Restriction Object FMR#

### Description

This returns the status of or sets whether the force motion restriction is activated for position of each axis, movement distance and rotation angle by the value being either within the thresholds or outside of the thresholds.

### Immediate Execution

No

### Usage

FGet Object.PosPolarities, iArray()
FSet Object.PosPolarities, iValuePosX, iValuePosY, iValuePosZ, iValueDist, iValueRot

- Object
  Object name
  The object is specified as either of FMR (numerical value) or FMR (label).

- iArray()
  The number of elements defining the values of the property is an array of 5 or more real number variables

- iValuePosX
  An integer value or formula defining the new value of the property

- iValuePosY
  An integer value or formula defining the new value of the property

- iValueposZ
  An integer value or formula defining the new value of the property

- iValueDist
  An integer value or formula defining the new value of the property

- iValueRot
  An integer value or formula defining the new value of the property

### Values

iArray()

| Element number | Element number constant | Description |
|---|---|---|
| 0 | FG_X | This returns the status of or sets whether the force motion restriction is activated for position of X axis by the value being either within the thresholds or outside of the thresholds. |
| 1 | FG_Y | This returns the status of or sets whether the force motion restriction is activated for position of X axis by the value being either within the thresholds or outside of the thresholds. |
| 2 | FG_Z | This returns the status of or sets whether the force motion restriction is activated for position of Z axis by the value being either within the thresholds or outside of the thresholds. |
| 3 | FG_Dist | This returns the status of or sets whether the force motion restriction is activated for position of movement distance by the value being either within the thresholds or outside of the thresholds. |

| Element number | Element number constant | Description |
|---|---|---|
| 4 | FG_Rot | This returns the status of or sets whether the force motion restriction is activated for position of rotation angel by the value being either within the thresholds or outside of the thresholds. |

iValuePosX, iValuePosY, iValuePosZ, iValueDist, iValueRot (Unit: Number)

| Name of Constants | Values | Description |
|---|---|---|
| FG_OUT | 0 | Sets to active when over or under the upper and lower threshold values, respectively. (default) |
| FG_IN | 1 | Sets to active when within the upper threshold and lower threshold values. |

### Detailed Explanation

PosPolarities return the status of or set whether the force motion restriction is activated for position of each axis, movement distance and rotation angle by the value being either within the thresholds or outside of the thresholds.
Since all force and torque lower threshold values for position of each axis, movement distance and rotation angel are set at one time, it can be done with fewer lines than setting them one axis at a time.

### Usage Example

This example generates an error and stops the robot if position, movement distance and rotation angle is more than the upper threshold value or less than the lower threshold value.

```
Function SettingPolarities
  FSet FMR1.PosEnabled, True, True, True, True, True
  FSet FMR1.PosPolarities, FG_OUT, FG_OUT, FG_OUT, FG_OUT, FG_OUT
  FSet FMR1.PosLowerLevels, -100, -100, -100, 0, 0
  FSet FMR1.PosUpperLevels, 100, 100, 100, 100, 100
  Trap 1, FMR1 Call ForceError
Fend

Function ForceError
  AbortMotion All
Fend
```

### See Also

**FMR (Force Motion Restriction) Object**

# 21.9 PosUpperLevels Property

### Application
Force Motion Restriction Object FMR#

### Description
This sets or returns the upper threshold value of position of each axis, movement distance and rotation angle at the same time.

### Immediate Execution
No

### Usage
FGet Object.PosUpperLevels, rArray()
FSet Object.PosUpperLevels, rValuePosX, rValuePosY, rValuePosZ, rValueDist, rValueRot

- Object
  Object name
  The object is specified as either of FMR (numerical value) or FMR (label).

- rArray()
  The number of elements defining the values of the property is an array of 5 or more real number variables

- rValuePosX
  A real number or formula defining the new value of the property

- rValuePosY
  A real number or formula defining the new value of the property

- rValuePosZ A real number or formula defining the new value of the property

- rValueDist
  A real number or formula defining the new value of the property

- rValueRot
  A real number or formula defining the new value of the property

### Values
rArray()

| Element number | Element number constant | Description |
|---|---|---|
| 0 | FG_X | Acquires the upper threshold value for position of X axis. |
| 1 | FG_Y | Acquires the upper threshold value for position of Y axis. |
| 2 | FG_Z | Acquires the upper threshold value for position of Z axis. |
| 3 | FG_Dist | Acquires the upper threshold value for movement distance. |
| 4 | FG_Rot | Acquires the upper threshold value for rotation angel. |

rValuePosX, rValuePosY, rValuePosZ (Unit: [mm])

| | Values |
|---|---|
| Minimum | -20000 |
| Maximum | 20000 (default) |

rValueDist (Unit: [mm])

| | Values |
|---|---|
| Minimum | 0 |
| Maximum | 20000 (default) |

rValueRot (Unit: [Degree])

| | Values |
|---|---|
| Minimum | 0 |
| Maximum | 180 (default) |

### Detailed Explanation

PosUpperLevels set or return the upper threshold value of position of each axis, movement distance and rotation angle at the same time.

Be sure that PosLowerLevels < PosUpperLevels.

Since all force and torque upper threshold values for position of each axis, movement distance and rotation angle are set at one time, it can be done with fewer lines than setting them one axis at a time.

This is used for error checking and task completion conditions.

### Usage Example

This example generates an error and stops the robot if position, movement distance and rotation angle is more than the upper threshold value.

```
Function SettingLevels
  FSet FMR1.PosEnabled, True, True, True, True, True
  FSet FMR1.PosPolarities, FG_OUT, FG_OUT, FG_OUT, FG_OUT, FG_OUT
  FSet FMR1.PosUpperLevels, 100, 100, 100, 100, 100
  Trap 1, FMR1 Call ForceError
Fend

Function ForceError
  AbortMotion All
Fend
```

### See Also

**FMR (Force Motion Restriction) Object**

# 21.10 PosX_Enabled, PosY_Enabled, PosZ_Enabled Property

### Application
Force Motion Restriction Object FMR#

### Description
Independently activates/inactivates, or returns the force motion restriction function for position.

### Immediate Execution
No

### Usage
FGet Object.XX_Enabled, bVar
FSet Object.XX_Enabled, bValue

- Object
  Object name

- XX
  A character string defining the name of the property

- bVar
  A Boolean variable defining the value of the property

- bValue
  A Boolean value or formula defining the new value of the property

### Values
XX

| Specified Axis | Description |
|---|---|
| PosX | Specifies X axis. |
| PosY | Specifies Y axis. |
| PosZ | Specifies Z axis. |

bValue

| Name of Constants | Values | Description |
|---|---|---|
| False | 0 | Inactivates the subject axis. (default) |
| True | -1 | Activates the subject axis. |

### Detailed Explanation
Independently activates/inactivates, or returns the force motion restriction function for position of specified axis.

### Usage Example
This example activates the force motion restriction function of X axis for the force motion restriction object.

```
> FSet FMR1.PosX_Enabled, True
```

### See Also
**FMR (Force Motion Restriction) Object**

# 21.11 PosX_Levels, PosY_Levels, PosZ_Levels Property

### Application
Force Motion Restriction Object FMR#

### Description
This sets or returns the lower threshold value and upper threshold value for position of specified axis.

### Immediate Execution
No

### Usage
FGet Object.XX_Levels, rArray()
FSet Object.XX_Levels, rValueL, rValueU

- Object
  Object name
  The object is specified as either of FMR (numerical value) or FMR (label).

- XX
  A character string defining the name of the property

- rArray()
  The number of elements defining the values of the property is an array of 2 or more real number variables

- rValueL
  A real number or formula defining the new value of the property

- rValueU
  A real number or formula defining the new value of the property

### Values
XX

| Specified Axis | Description |
|---|---|
| PosX | Specifies X axis. |
| PosY | Specifies Y axis. |
| PosZ | Specifies Z axis. |

rArray()

| Element number | Element number constant |
|---|---|
| 0 | FG_ LOWERLEVEL |
| 1 | FG_ UPPERLEVEL |

rValueL (Unit: [mm])

| | Values |
|---|---|
| Minimum | -20000 (default) |
| Maximum | 20000 |

rValueU (Unit: [mm])

| | Values |
|---|---|
| Minimum | -20000 |
| Maximum | 20000 (default) |

### Detailed Explanation

XX_Levels set or return the lower threshold value and upper threshold value for position of specified axis.
rValueL is the lower threshold. rValueU is the upper threshold. Be sure that rValueL < rValueU.
This is used for error checking and task completion conditions.

### Usage Example

This example generates an error and stops the robot if the position of X axis orientation is less than the lower threshold value or more than the upper threshold value.

```
Function SettingLevels
  FSet FMR1.PosEnabled, True, False, False, False, False
  FSet FMR1.PosX_Polarity, FG_OUT
  FSet FMR1.PosX_Levels, -500, 500
  Trap 1, FMR1 Call ForceError
Fend

Function ForceError
  AbortMotion All
Fend
```

### See Also

**FMR (Force Motion Restriction) Object**

# 21.12 PosX_Polarity, PosY_Polarity, PosZ_Polarity Property

### Application
Force Motion Restriction Object FMR#

### Description
This returns the status of or sets whether the force motion restriction is activated for position of specified axis by the value being either within the thresholds or outside of the thresholds.

### Immediate Execution
No

### Usage
FGet Object.XX_Polarity, iVar
FSet Object.XX_Polarity, iValue

- Object
  Object name
  The object is specified as either of FMR (numerical value) or FMR (label).

- XX
  A character string defining the name of the property

- iVar
  An integer variable defining the value of the property

- iValue
  An integer value or formula defining the new value of the property

### Values
XX

| Specified Axis | Description |
|---|---|
| PosX | Specifies X axis. |
| PosY | Specifies Y axis. |
| PosZ | Specifies Z axis. |

iValue

| Name of Constants | Values | Description |
|---|---|---|
| FG_OUT | 0 | Activates when the value is outside of the thresholds. (default) |
| FG_IN | 1 | Activates when the value is within the thresholds. |

### Detailed Explanation
XX_Polarity return the status of or set whether the force motion restriction is activated for position of specified axis by the value being either within the thresholds or outside of the thresholds.

### Usage Example
This example generates an error and stops the robot if the position of X axis orientation is less than the lower threshold value or more than the upper threshold value.

```
Function SettingPolarity
  FSet FMR1.PosEnabled, True, False, False, False, False
```

```
  FSet FMR1.PosX_Polarity, FG_OUT
  FSet FMR1.PosX_Levels, -500, 500
  Trap 1, FMR1 Call ForceError
Fend

Function ForceError
  AbortMotion All
Fend
```

### See Also

FMR (Force Motion Restriction) Object

# 22. R

# 22.1 Reboot Property

### Application
Force Sensor Object FS#

### Description
This reboots the force sensor.

### Immediate Execution
Yes

### Usage
FSet Object.Reboot

- Object
  Object name
  The object is specified as FS (numerical value).

### Detailed Explanation
This reboots the force sensor when Reboot Property is executed. It takes about 10 seconds to reboot the force sensor.

> ⚠ CAUTION
>
> Be sure to reset the Force Sensor with no external force applied to it.
>
> If it is reset with an external force applied to it, the state in which an external force applied is “0”. Therefore, if the force applied is removed, the Force Sensor detects a force even if no force is applied. If the force control function is performed in this state, the robot may move unintentionally. Caution is required in this regard.

### Usage Example
This example reboots the force sensor.

```
> FSet FS1.Reboot
```

### See Also
**FS (Force Sensor) Object**

# 22.2 RecordEnd Property

### Application
Force Monitor Object FM#

### Description
Ends recording of sensor values, robot position/orientation, and StepID that starts by RecordStart property.

### Immediate Execution
Yes

### Usage
FSet Object.RecordEnd

- Object
  Object name
  The object is specified as either of FM (numerical value) or FM (label).

### Detailed Explanation
Recording of the data is started by RecordStart property. This property is used to stop recording the data before the measurement time specified by RecordStart property elapses.

### Usage Example
This is an example to start and stop the data recording using RecordStart. The recording starts to acquire the data with intervals of 0.1 seconds for 60 seconds, and then stops after 10 seconds by the RecordEnd property. In this example, the Wait statement is used to halt the data recording, but it can be replaced by motion commands to record the force and robot position during the motion.

```
Function RecordEndTest
  FSet FM1.ForceSensor, 1
  FSet FM1.RecordStart, 60, 0.1
  Wait 10
  FSet FM1.FCMRecordEnd
Fend
```

### See Also
**FM (Force Monitor) Object**

# 22.3 RecordStart Property

### Application
Force Monitor Object FM#

### Description
Begins recording of sensor values, robot position/orientation, StepID, and the time of data acquisition.

### Immediate Execution
Yes

### Usage
FSet Object.RecordStart, rValueD, rValueI
FSet Object.RecordStart, rValueD, rValueI ,sValue$

- Object
  Object name
  The object is specified as either of FM (numerical value) or FM (label).

- rValueD
  A real number or formula defining the new value of the property

- rValueI
  A real number or formula defining the new value of the property

- sValue$
  A character string or formula defining the new value of the property

### Values
rValueD (measurement time unit: [sec])

| | Values |
|---|---|
| Minimum | 1* |
| Maximum | 600* |

rValueI (measurement interval unit: [sec])

| | Values |
|---|---|
| Minimum | 0.002* |
| Maximum | 10* |

* However, “measurement time / measurement interval” should be 30,000 or less.

sValue$
Up to 32 one-byte or 16 two-byte alphanumeric characters, Japanese characters, and the underscores can be used.

### Detailed Explanation
This property is used to start recording the sensor values, robot position and orientation, StepID, and measurement timing.

This property is available when the Controller is connected to RC+. If this property starts without connecting to RC+, any error will not be caused and the program proceeds to next statement. However, a file is not created.
The product of specified measurement time and interval “measurement time / measurement interval” cannot exceed 30,000.
This property can start the two data recording at the maximum in parallel. When starting the two data recording in parallel,

stop the execution of the force monitor or the force guide sequence.
Also, it is not possible to start the data recording by using the same robot and force monitor object in parallel. To start the two data recording in parallel, use different force monitor objects.
In addition, this property cannot be used together with the force control monitor.

This property stops recording when the task ends, the measurement time ends, or the RecordEnd property is executed.

You can specify a saving file by sValue$. Extension is added automatically. If omitting sValue$, file name is automatically set by the label of specified FM object and the start time.

### Format:

Label of FM object_time(yyyy/mm/dd)_time(hh:mm:ss:ms).csv

- Example: Label of FM object: MyFMLabel
  Start time: January 2nd, 2017 3 (h) 4(m) 5 (s) 006 (ms)
  MyFMLabel _170102_030405006.csv

### File format:

Save file is CSV format. The following information is recorded:

- 1st row: Item name of file's header information
- 2nd row: File's header information
- 3rd row: Item name of data
- After 4th row: Actual values
- A row before final row: Item name of footer information
- Final row: File's footer information

File used for saving the force monitor or executing force guide sequence is the same file format.

### Header information of file:

Start Time, File Type, File Version, Channel, Mode, Duration[sec], Interval[sec], Robot No, Robot Name, Sensor No, Sensor Serial, Sensor Label, FM No, FM Label, FCS No, FCS Label, Seq No, Seq Name, RobotLocal

### Data:

ElapsedTime[msec], Fx Force[N], Fy Force[N], Fz Force[N], Tx Force[N・mm], Ty Force[N・mm], Tz Force[N・mm], Fmag Force[N], Tmag Force[N・mm], CurPos(X)[mm], CurPos(Y)[mm], CurPos(Z)[mm], CurPos(U)[deg], CurPos(V)[deg], CurPos(W)[deg], RefPos(X)[mm], RefPos(Y)[mm], RefPos(Z)[mm], RefPos(U)[deg], RefPos(V)[deg], RefPos(W)[deg], Diff(X)[mm], Diff(Y)[mm], Diff(Z)[mm], TCPSpeed[mm/sec], TCPSpeed(X)[mm/sec], TCPSpeed(Y)[mm/sec], TCPSpeed(Z)[mm/sec], Joint(J1)[deg], Joint(J2)[deg], Joint(J3)[deg], Joint(J4)[deg], Joint(J5)[deg], Joint(J6)[deg], OLRate(J1), OLRate(J2), OLRate(J3), OLRate(J4), OLRate(J5), OLRate(J6), FCOn, StepID, Seq No, Object No, Time

### Footer information of file

EndTime, EndCondition, ErrorNo, ErrorMessage

| Item | Unit | Description |
|---|---|---|
| Start Time | - | Time when the measurement is started. Displayed in a format of "yyyy/mm/dd hh:mm:ss:ms". |
| File Type | - | File types. Described with Motion. |
| File Version | - | File version. |
| Channel | - | Channel number used for data output. It is record in either "1" or "2". |

| Item | Unit | Description |
|---|---|---|
| Mode | - | It is a mode of recording The following information is recorded:<br>0: Show force monitor records<br>1: Show records of RecordStart property<br>2: Show records of force guide sequence execution |
| Duration | sec | Measurement time specified at the measurement. |
| Interval | sec | Measurement interval specified at the measurement. |
| Robot No | - | Robot number to be measured. |
| Robot Name | - | Robot name to be measured. |
| Sensor No | - | Force sensor number to be measured. |
| Sensor Serial | - | Serial number of force sensor |
| Sensor Label | - | Label set to force sensor |
| FM No | - | Number of the specified force monitor object. |
| FM Label | - | Label of the specified force monitor object. |
| FCS No | - | Number of the specified force coordinate system object |
| FCS Label | - | Label of the specified force coordinate object. |
| Seq No | - | Number of a sequence executed by force guide sequence. |
| Seq Name | - | Name of the sequence executed by force guide sequence. |
| RobotLocal | - | RobotLocal property value of the specified force monitor object. |
| ElapsedTime | msec | Elapsed time from the start of the measurement. |
| Fx Force to<br>Fz Force<br>Tx Force to<br>Tz Force | N<br>N·mm | Sensor values of each axis in force coordinate system. |
| Fmag Force | N | Resultant force in force coordinate system. |
| Tmag Force | N·mm | Resultant torque in force coordinate system. |
| CurPos(X) to<br>CurPos(Z)<br>CurPos(U) to<br>CurPos(W) | mm<br>deg | Command position reflecting the position control-command position and the effects of force control. |
| RefPos(X) to<br>RefPos(Z)<br>RefPos(U) to<br>RefPos(W) | mm<br>deg | Command-position which reflects only the position control. |
| Diff(X) to<br>Diff(Z) | Mm | Difference between a direction of command reflecting the position control-command position and the effects of force control, and a direction of command which reflects only the position control. Express correction amount by force control function. |

<table>
<tr><th>Item</th><th>Unit</th><th colspan="2">Description</th></tr>
<tr><td>TCPSpeed</td><td>mm/sec</td><td colspan="2">Tool tip speed in base coordinate system of the robot.<br>For details, refer to the following manual.<br>"Epson RC+ 8.0 SPEL+ Language Reference"<br>TCPSpeed Function<br>Note: Differ from TCPSpeed function, it is measured during PTP motion.</td></tr>
<tr><td>TCPSpeed(X)<br>to<br>TCPSpeed(Z)</td><td>mm/sec</td><td colspan="2">Each axis component of tool tip speed in base coordinate system of the robot.</td></tr>
<tr><td>Joint(J1) to<br>Joint(J6)</td><td>deg</td><td colspan="2">Each joint angle of robot.<br>For SCARA robot, Joint # 5 and Joint # 6 are always “0”.</td></tr>
<tr><td>OLRate(J1)<br>to<br>OLRate(J6)</td><td>-</td><td colspan="2">Overload rate of each joint of robot.<br>For details, refer to the following manual<br>"Epson RC+ 8.0 SPEL+ Language Reference”<br>OLRate<br>For SCARA robot, Joint # 5 and Joint # 6 are always “0”.</td></tr>
<tr><td>FCOn</td><td>-</td><td colspan="2">Execution state of force control function of robot.<br>The following information is recorded:<br>1: When executing force control function<br>0: When the force control function is not executed</td></tr>
<tr><td>StepID</td><td>-</td><td colspan="2">Value specified to the StepID property.</td></tr>
<tr><td>Seq No</td><td>-</td><td colspan="2">Number of a sequence executed by force guide sequence.</td></tr>
<tr><td>Object No</td><td>-</td><td colspan="2">Number of an object executed by force guide sequence.</td></tr>
<tr><td>Time</td><td>-</td><td colspan="2">Time when the data is measured. Displayed in a format of “yyyy/mm/dd hh:mm:ss:ms”.</td></tr>
<tr><td>EndTime</td><td>-</td><td colspan="2">Time when the measurement ends. Displayed in a format of “yyyy/mm/dd hh:mm:ss:ms”.</td></tr>
<tr><td rowspan="7">EndCondition</td><td rowspan="7">-</td><td colspan="2">Reason for ending measurement.<br>Display as follows depending on each state:</td></tr>
<tr><td>Specified measurement time is elapsed<br>(In force monitor, when 600 seconds are elapsing.)</td><td>Duration elapsed</td></tr>
<tr><td>Stop command for recording was executed before the measurement time is elapsed.</td><td>End executed property</td></tr>
<tr><td>Stop force monitor before the measurement time is elapsed.</td><td>Stop requested</td></tr>
<tr><td>Build or rebuild the SPEL program during recording.</td><td>Build executed</td></tr>
<tr><td>Project ends without executing stop command for recording.</td><td>Task ended</td></tr>
<tr><td>An error occurs during recording.</td><td>Error occurred</td></tr>
<tr><td>ErrorNo</td><td>-</td><td colspan="2">Error number.<br>It is recorded when an error occurs and measurement ends.</td></tr>
<tr><td>ErrorMessage</td><td>-</td><td colspan="2">Error message.<br>It is recorded when an error occurs and measurement ends.</td></tr>
</table>

### Usage Example

This is an example of starting the logging of data for sensor 1 (at a frequency of 100 msec for 1 minute) and then ending the logging thereof.

```
Function Test_Record
  FSet FM1.ForceSensor, 1
  FSet FM1.RecordStart, 60, 0.1
  …
  FSet FM1.RecordEnd
Fend
```

Acquisition examples are as follows:

```
Start Time, File Type, File Version, Channel, Mode, Duration[sec], Interval[sec],
Robot No, Robot Name, Sensor No, Sensor Serial, Sensor Label, FM No., FM Label, FCS
No., FCS Label, Seq No, Seq Name, RobotLocal
2018/03/15 13:42:54:261, Motion, 1, 1, 1, 60, 0.1, 1, rb001, 1, AAAAA00001,
VirtualSensor1, 1, fm001, 1, fcs001, 0, (empty), 0
ElapsedTime[msec], Fx_Force[N], Fy_Force[N], Fz_Force[N], Tx_Force[N・mm],
Ty_Force[N・mm], Tz_Force[N・mm], Fmag_Force[N], Tmag_Force[N・mm], CurPos(X)[mm],
CurPos(Y)[mm], CurPos(Z)[mm], CurPos(U)[deg], CurPos(V)[deg], CurPos(W)[deg],
RefPos(X)[mm], RefPos(Y)[mm], RefPos(Z)[mm], RefPos(U)[deg], RefPos(V)[deg],
RefPos(W)[deg], Diff(X)[mm], Diff(Y)[mm], Diff(Z)[mm], TCPSpeed[mm/sec],
TCPSpeed(X)[mm/sec], TCPSpeed(Y)[mm/sec], TCPSpeed(Z)[mm/sec], Joint(J1)[deg],
Joint(J2)[deg], Joint(J3)[deg], Joint(J4)[deg], Joint(J5)[deg], Joint(J6)[deg],
OLRate(J1), OLRate(J2), OLRate(J3), OLRate(J4), OLRate(J5), OLRate(J6), FCOn,
StepID, Seq No, Object No, Time
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 565, 720, 0, -90, -90, 0, 565, 720, 0, -90, -90, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 2018/03/15
13:42:54:261
100, 0, 0, 0, 0, 0, 0, 0, 0, 0, 565, 720, 0, -90, -90, 0, 565, 720, 0, -90, -90, 0,
0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 2018/03/15
13:42:54:361
(After displaying the above, the actual values will be displayed subsequently.)
```

### See Also

**FM (Force Monitor) Object**

## 22.4 RefPos Status

### Application

Robot Object Robot

### Description

This returns the command-position, with force control, for the first variable. For the second variable, the command-position, which reflects only the position control without the effects of force control, is returned.

### Usage

FGet Robot.RefPos, Point1, Point2

- Point1
  Variable representing a point data

- Point2
  Variable representing a point data

### Detailed Explanation

This returns the command position reflecting the position control-command position and the effects of force control.
The position control command-position defines the virtual path that the original motion command tries to follow.
The force control command-position defines the actual robot path of movement, which is the calculated path reflecting the effect of force control on the position control command-position.
By looking at the amount of difference between the two command values, you see how much the movement is veered from the original path. This is effective when checking to see if the path differs from the original path more than was expected, or to analyze movement tendencies.

### Usage Example

This detects if, by force control, the movement has veered beyond a certain amount from the original path, and stops the robot.

```
Function RefPosTest

  FSet FCS1.Orientation, FG_TOOL   ' Sets the force coordinate data

  FSet FC1.CoordinateSystem, FCS1  ' Specifies the force coordinate data
  FSet FC1.Fx_Spring, 0            ' Sets the virtual Fx coefficient of elasticity
  FSet FC1.Fx_Damper, 1            ' Sets the virtual Fx coefficient of viscosity
  FSet FC1.Fx_Mass, 10             ' Sets the virtual Fx coefficient of inertia
  FSet FC1.Fx_Enabled, True        ' Sets the Fx force control to active
  Xqt RefPosCheck                  ' Launches a separate task to monitor
  Move P0 FC1                      ' A Move motion with force control
  Quit RefPosCheck                 ' Ends the separate monitored task

Fend

Function RefPosCheck
  Do
    FGet Robot.RefPos, P1, P2           ' Acquires RefPos
      If Abs(CX(P1) - CX(P2))  50 Then  ' Checks to see if the difference is 50 or
greater
        Print "Err"                     ' An error occurs if the difference is too
large
        AbortMotion All                 ' Stops motion
      EndIf
    Wait 0.1
  Loop
Fend
```

### See Also

**Robot Object**

## 22.5 Reset Property

### Application
Force Sensor Object FS#

### Description
Resets the force sensor.

### Immediate Execution
Yes

### Usage
FSet Object.Reset
FSet Object.Reset, iValue
FSet Object.Reset, iValue, rValueTime, rValueThreshF, rValueThreshT

- Object
  Object name
  The object is specified as FS (numerical value).

- iValue
  An integer value or formula defining the new value of the property

- rValueTime
  A real number or formula defining the new value of the property

- rValueThreshF
  A real number or formula defining the new value of the property

- rValueThreshT
  A real number or formula defining the new value of the property

### Values
iValue

| Name of Constants | Values | Description |
|---|---|---|
| FG_RESET_FINE | 0 (default) | Wait until the robot which the force sensor is connected satisfies Fine condition, and then reset the force sensor. |
| FG_RESET_WAIT_VIBRATION | 1 | Wait until the external vibration stops, and then reset the force sensor. |

rValueTime

| | Value |
|---|---|
| Minimum | 3 |
| Maximum | 20 |

Default: 2.5 (Only when rValueTime is omitted. When specifying the value, be sure to specify the value greater than 3)

rValueThreshF

| | Value |
|---|---|
| Minimum | 5 (default) |

| | Value |
|---|---|
| Maximum | 20 |

rValueThreshT

| | Value |
|---|---|
| Minimum | 50 (default) |
| Maximum | 200 |

### Detailed Explanation

When the Reset Property is executed, the force sensor is reset. Epson's force sensors have a drift characteristic. Reset the force sensor each time right before using the force function.
When iValue is omitted or FG_RESET_FINE is specified, the program waits up to 1.5 seconds until the robot which the force sensor is connected satisfies Fine condition, and then reset the force sensor. When an error occurs since FGRESETFINE is specified, specify FG_RESET_WAIT_VIBRATION for iValue. The error may be avoided.
Fine condition is a positioning condition for each joint when the motion ends. In this property, always use a robot 's specific number. The value specifeid by the Fine statement or FineDist statement is not be used for the determination.
When FG_RESET_WAIT_VIBRATION is specified for iValue, the program waits until the external vibration stops, and then reset the force sensor. It may take time to reset the force sensor depending on the state of external vibration.
Maximum wait time until the vibration stops is normally 2.5 seconds, however, it can be specified with rValueTime. You can specify the threshold used to determine that the vibrations have been stoped : the force (Fx,Fy,Fz) can specified by rValueThreshF and the torque (Tx,Ty,Tz) by rValueThreshT. rValueThreshF and rValueThreshT are peak to peak value. However, if making the threshold larger , zero point of the sensor changes and the accuracy may decrease. Adjust the threshold within the range which is allowable for your task.
rValueTime, rValueThreshF, and rValueThreshT are available only when FG_RESET_WAIT_VIBRATION is specified for iValue.

> ⚠ CAUTION
>
> Be sure to reset the Force Sensor with no external force applied to it.
>
> If it is reset with an external force applied to it, the state in which an external force applied is "0". Therefore, if the force applied is removed, the Force Sensor detects a force even if no force is applied. If the force control function is performed in this state, the robot may move unintentionally. Caution is required in this regard.

### Usage Example

This is an example of resetting the sensor.

```
> FSet FS1.Reset
> FSet FS1.Reset, FG_RESET_FINE
> FSet FS1.Reset, FG_RESET_WAIT_VIBRATION
```

### See Also

**FS (Force Sensor) Object**

## 22.6 RobotLocal Property

### Application
Force Monitor object FM#, Force Motion Restriction Object FMR#

### Description
Sets or returns the local coordinate system that will serve as the basis for robot position / orientation used for trigger accomplished condition of force motion restriction function recorded by the force monitor function.

### Immediate Execution
No

### Usage
FGet Object.RobotLocal, iVar
FSet Object.RobotLocal, iValue

- Object
  Object name
  The object is specified as either of FM (numerical value), FMR (numerical value), FM (label) or FMR (label).

- iVar
  An integer variable defining the value of the property

- iValue
  An integer value or formula defining the new value of the property

### Values
iValue

| | Values |
|---|---|
| Minimum | 0 (default) |
| Maximum | 15 |

### Detailed Explanation
When using this property for force monitor function:
This property is used when setting or checking the local coordinate system that will serve as the basis for robot position / orientation to be recorded.
This property changes the basis used to find robot positions/orientations that will be recorded by the RecordStart property.
When “0” is specified, the position/orientation in the Base coordinate system will be recorded.
The position/orientation of the robot recorded by the RecordStart property is recorded by the position/orientation of the tool specified by the RobotTool property in the local coordinate system specified by this property.
It is effective when, for instance, you wish to record positions/orientations based on a workpiece, or when the work reference plane is tilted.
If the coordinate system is changed by the Base, Local, or other statement after this property is set, the coordinate system used with the force function will apply rather than the coordinate system used when this property was set.

When using this property for force motion restriction function:
This property is used when setting or checking the local coordinate system that will serve as the basis for robot positions/orientations that judge the accomplishment condition of set trigger.
The position/orientation of the robot that judge the accomplishment condition of trigger is judged with tool positions/orientations specified by the RobotTool property in the local coordinate system specified by this property. When “0” is specified, the position/orientation in the Base coordinate system will be recorded.
It is effective when, for instance, you want to judge the accomplishment condition of trigger with positions/orientations based

on a workpiece, or when the work reference plane is tilted.
If the coordinate system is changed by the Base, Local, or other statement after this property is set, the coordinate system used with the force function will apply rather than the coordinate system used when this property was set.

### Usage Example

The following is an example of recording positions with Local 1 as the basis.

```
Function RobotLocalTest
  FSet FM1.ForceSensor, 1
  FSet FM1.RobotLocal, 1   ' Set Local 1 for RobotLocal.
  FSet FM1.FCMRecordEnd
  FSet FM1.RecordStart, 60, 0.01
  Wait 60
  FSet FM1.FCMRecordEnd
Fend
```

### See Also

**FM (Force Monitor) Object**, **FMR (Force Motion Restriction) Object**, **RecordStart Property**, **Result**

# 22.7 RobotTool Property

### Application
Force Monitor object FM#, Force Motion Restriction Object FMR#

### Description
Sets or returns the tool that will serve as the basis for robot position posture or position posture used for trigger accomplished condition of force motion restriction function recorded by the force monitor function.

### Immediate Execution
No

### Usage
FGet Object.RobotTool, iVar
FSet Object.RobotTool, iValue

- Object
  Object name
  The object is specified as either of FM (numerical value), FMR (numerical value), FM (label) or FMR (label).

- iVar
  An integer variable defining the value of the property

- iValue
  An integer value or formula defining the new value of the property

### Values
iValue

| | Values |
|---|---|
| Minimum | -1 (Constant name: FG_CURRENT_TOOL) (default) |
| Maximum | 15 |

### Detailed Explanation
When using this property for force monitor function:
This property is used when setting or checking the tool that will serve as the basis for robot positions/orientations to be recorded.
This property changes the basis used to find robot positions/orientations that will be recorded by the RecordStart property. When “-1” is specified, the position/orientation is recorded with reference to the current tool. Therefore, when the tool number is changed by the Tool statement during recording, the position/orientation to be recorded will correspond to the changed tool. When a number from “0” to “15” is specified, the position/orientation will continue as per the tool specified.
The position/orientation of the robot recorded by the RecordStart property is recorded by the position/orientation of the tool specified by this property in the local coordinate system specified by the RobotLocal property.
This property is effective when you want to set the recording position as the specified tool position. When setting “-1”, position seems like shifting if changing the tool. Therefore, use each tool number to check continuity.
If the tool setting is changed by the TLSet statement after this property is set, the tool setting used with the force function will apply rather than the tool setting used when this property was set.
When using this property for force motion restriction function:
This property is used when setting or checking the local coordinate system that will serve as the basis for robot positions/orientations that judge the accomplishment condition of set trigger.
This property changes the basis used to judge robot positions/orientations that will judge the accomplishment condition of trigger. When “−1” is specified, the position/orientation is judged accomplishment condition of robot positions/orientations with reference to the current tool. Therefore, when the tool number is changed by the Tool statement during force controlling,

the position/orientation to be judged will correspond to the changed tool. When “0” to “15” is specified, positions / orientations will correspond to the specified tool.
This property is effective when you want to set the position of judging accomplishment condition of trigger as the specified tool position. When setting “−1”, position seems like shifting if changing the tool. Therefore, use each tool number to be sure continuity.
If the tool setting is changed by the TLSet statement after this property is set, the tool setting used with the force function will apply rather than the tool setting used when this property was set.

### Usage Example

The following is an example of recording positions/posture with Tool 1 as the basis.

```
Function RobotLocalTest
  FSet FM1.ForceSensor, 1
  FSet FM1.RobotTool, 1  ' Set Tool 1 for RobotTool.
  FSet FM1.FCMRecordEnd
  FSet FM1.RecordStart, 60, 0.01
  Wait 60
  FSet FM1.FCMRecordEnd
Fend
```

### See Also

**FM (Force Monitor) Object**, **RecordStart Property**

# 22.8 Rot_Axes Property

### Application
Force Motion Restriction Object FMR#

### Description
Sets or returns the subject axis for calculating the force motion restriction range for rotation angle.

### Immediate Execution
No

### Usage
FGet Object.Rot_Axes, iVar
FSet Object.Rot_Axes, iValue

- Object
  Object name
  The object is specified as either of FMR (numerical value) or FMR (label).

- iVar
  An integer variable defining the value of the property

- iValue
  An integer value or formula defining the new value of the property

### Values
iValue

| Name of Constants | Values | Description |
|---|---|---|
| FG_ROT_X | 0 | Specify the angle formed by the X-axis for the rotation angle (default) |
| FG_ROT_Y | 1 | Specify the angle formed by the Y-axis for the rotation angle |
| FG_ROT_Z | 2 | Specify the angle formed by the Z-axis for the rotation angle |
| FG_ROT _ALL | 3 | Specify the rotation amount with arbitrary axis rotation for the rotation angle |

### Detailed Explanation
Rot is X, Y, Z axis of when started force motion restriction and angle made by X, Y, Z axis in current or, rotation amount with arbitrary axis rotation.
Arbitrary axis rotation is an axis that movable with 1 rotation in around a virtual axis (one straight line) when there are two postures (U, V, W). This is used when set the condition of overall rotation angle with no limit for each axis.
This property is used to sets or confirm the subject axis to calculate the rotation angle.

### Usage Example
This is an example sets and acquires the subject axis to calculate the rotation angle for force motion restriction object.

```
Function Test_Rot_Axes
  Integer iVar
  FSet FMR1.Rot_Axes, FG_ROT_X
  FGet FMR1.Rot_Axes, iVar
  Print iVar
Fend
```

### See Also
**FMR (Force Motion Restriction) Object**

# 22.9 Rot_Enabled Property

### Application
Force Motion Restriction Object FMR#

### Description
Activates/inactivates, or returns the force motion restriction function for rotation angle.

### Immediate Execution
No

### Usage
FGet Object.Rot_Enabled, bVar
FSet Object.Rot_Enabled, bValue

- Object
  Object name

- bVar
  A Boolean variable defining the value of the property

- bValue
  A Boolean value or formula defining the new value of the property

### Values
bValue

| Name of Constants | Values | Description |
|---|---|---|
| False | 0 | Inactivates the subject axis. (default) |
| True | -1 | Activates the subject axis. |

### Detailed Explanation
Independently activates/inactivates, or returns the force motion restriction function for rotation angle.

### Usage Example
This is example to activate the force motion restriction of rotation angle to force motion restriction object.

```
> FSet FMR1.Rot_Enabled, True
```

### See Also
**FMR (Force Motion Restriction) Object**

# 22.10 Rot_Levels Property

### Application
Force Motion Restriction Object FMR#

### Description
Set or return the lower threshold value and upper threshold value for rotation angle.

### Immediate Execution
No

### Usage
FGet Object.Rot_Levels, rArray()
FSet Object.Rot _Levels, rValueL, rValueU

- Object
  Object name
  The object is specified as either of FMR (numerical value) or FMR (label).

- XX
  A character string defining the name of the property

- rArray()
  The number of elements defining the values of the property is an array of 2 or more real number variables

- rValueL
  A real number or formula defining the new value of the property

- rValueU
  A real number or formula defining the new value of the property

### Values
rArray()

| Element number | Element number constant |
|---|---|
| 0 | FG_ LOWERLEVEL |
| 1 | FG_ UPPERLEVEL |

rValueL (Unit: [Degree])

| | Value |
|---|---|
| Minimum | 0 (default) |
| Maximum | 180 |

rValueU (Unit: [Degree])

| | Value |
|---|---|
| Minimum | 0 |
| Maximum | 180 (default) |

### Detailed Explanation
Rot_Levels set or return the lower threshold value and upper threshold value for rotation angle.

rValueL is the lower threshold. rValueU is the upper threshold. Be sure that rValueL < rValueU.
This is used for error checking and task completion conditions.

### Usage Example

This example generates an error and stops the robot if the rotation angle is less than the lower threshold value or more than the upper threshold value.

```
Function SettingLevels
  FSet FMR1.Rot_Enabled, True
  FSet FMR1.Rot_Polarity, FG_OUT
  FSet FMR1.Rot_Levels, 0, 10
  Trap 1, FMR1 Call ForceError
Fend

Function ForceError
  AbortMotion All
Fend
```

### See Also

**FMR (Force Motion Restriction) Object**

# 22.11 Rot_Polarity Property

### Application
Force Motion Restriction Object FMR#

### Description
This returns the status of or sets whether the force motion restriction is activated for rotation angle by the value being either within the thresholds or outside of the thresholds.

### Immediate Execution
No

### Usage
FGet Object.Rot_Polarity, iVar
FSet Object.Rot _Polarity, iValue

- Object
  Object name
  The object is specified as either of FMR (numerical value) or FMR (label).

- iVar
  An integer variable defining the value of the property

- iValue
  An integer value or formula defining the new value of the property

### Values
iValue

| Name of Constants | Values | Description |
|---|---|---|
| FG_OUT | 0 | Activates when the value is outside of the thresholds. (default) |
| FG_IN | 1 | Activates when the value is within the thresholds. |

### Detailed Explanation
Rot_Polarity returns the status of or sets whether the force motion restriction is activated for rotation angle by the value being either within the thresholds or outside of the thresholds.

### Usage Example
This example generates an error and stops the robot if the rotation angle is less than the lower threshold value or more than the upper threshold value.

```
Function SettingPolarity
  FSet FMR1.Rot_Enabled, True
  FSet FMR1.Rot_Polarity, FG_OUT
  FSet FMR1.Rot_Levels, 0, 10
  Trap 1, FMR1 Call ForceError
Fend

Function ForceError
  AbortMotion All
Fend
```

### See Also
**FMR (Force Motion Restriction) Object**

# 23. S

## 23.1 SerialCode Property

### Application
Force Sensor Object FS#

### Description
Returns the serial code for the force sensor.

### Immediate Execution
No

### Usage
FGet Object.SerialCode, sVar$

- Object
  Object name
  The object is specified as FS (numerical value).

- sVar$
  A string variable defining the value of the property

### Detailed Explanation
This property is used to confirm the sensor's serial code

### Usage Example
This is an example of confirming the Force Sensor Object's serial code.

```
Function Test_SerialCode
  String serialcode$
  FGet FS1.SerialCode, serialcode$
  Print serialcode$
Fend
```

### See Also
**FS (Force Sensor) Object**

## 23.2 StepID Property

### Application
Robot Object Robot

### Description
This sets or returns the step number and step label so the user understands the task or job progression situation. The step label can be omitted and it is possible to set and return only the step number.

### Immediate Execution
No

### Usage
FGet Object.StepID, iVar
FGet Object.StepID, iVar, sVar$
FSet Object.StepID, iValue
FSet Object.StepID, iValue, sValue$

- Object
  Object name
- iVar
  An integer variable
- iValue
  An integer or formula defining the new value
- sVar$
  A string variable
- sValue$
  An string or formula defining the new value

### Value
iValue

| | Value |
|---|---|
| Minimum | 0 (default) |
| Maximum | 32767 |

sValue$
Up to 32 one-byte or 16 two-byte alphanumeric characters, Japanese characters, and the underscores can be used.

### Detailed Explanation
This property is used to set or confirm the StepID and step label the task or job progression situation is understood.

### Usage Example
This example sets and confirms the StepID in order to confirm the progress of the main process.
(Step label is omitted.)

```
Function Test_SetStepID(iStepID As Integer)   ' Process to set StepID
  FSet Robot.StepID, iStepID
Fend

Function Test_GetStepID  ' Process to acquire the StepID
```

```
  Integer iStepID
  FGet Robot.StepID, iStepID
  Print iStepID
Fend

Function Test_Main   ' Main process executing the force control function
  ...
  Move P0 FC1 CF
  Test_SetStepID(1)  ' Setting StepID=1
  ...
  Move P1 FC2 CF
  Test_SetStepID(2)  ' Setting StepID=2
   . . .
  FSet FS1.Reset
  Test_SetStepID(3)  ' Setting StepID=3
  ...
  Move P3 FC3 CF
  Test_SetStepID(4)  ' Setting StepID=4
   . . .
Fend

Function Test_Sub  ' Sub-process which monitors at 5 second intervals
  Do
    Test_GetStepID
    Wait(5)
  Loop
Fend
```

**See Also**

**Robot Object**

# 24. T

# 24.1 TargetForcePriorityMode Property

### Application
Force Control Object FC#

### Description
Activates/inactivates or returns the status thereof the target force priority mode.

### Immediate Execution
No

### Usage
FGet Object.TargetForcePriorityMode, bVar
FSet Object.TargetForcePriorityMode, bValue

- Object
  Object name
  The object is specified as either of FC (numerical value) or FC (label).

- bVar
  A Boolean variable defining the value of the property

- bValue
  A Boolean value or formula defining the new value of the property

**Values** bValue

| Name of Constants | Values | Description |
|---|---|---|
| False | 0 | Inactivates the target force priority mode. (default) |
| True | -1 | Activates the target force priority mode. |

### Detailed Explanation
There are times when the target force or target torque is set and the force control function is used that the target force is not achieved even after sufficient time. In such instances, activate the TargetForcePriorityMode when wanting to accurately match the target force. However, when the TargetForcePriorityMode is activated, operation of the robot will not be in accordance with the established values for the following coefficients, and the motion may be slowed at times.
Virtual coefficients of elasticity (Spring) Virtual coefficients of viscosity (Damper) Virtual coefficients of inertia (Mass)

### Usage Example
This example activates the target priority mode and uses the force control function.

```
Function ForceControlTest
  FSet FCS1.Orientation, FG_TOOL
  FSet FC1.CoordinateSystem, FCS1
  FSet FC1.Enabled, False, False, True, False, False, False
  FSet FC1.Fz, 0.01, 4, 5
  FSet FC1.Fz_TargetForce, 10
  FSet FC1.TargetForcePriorityMode, True
  FCKeep FC1, 5
Fend
```

### See Also
FC (Force Control) Object

## 24.2 TargetForces Property

**Application**

Force Control Object FC#

**Description**

This sets or returns the value of target force and torque for each of the 6 axes in the force coordinate system at the same time.

**Immediate Execution**

No

**Usage**

FGet Object.TargetForces, rArray()
FSet Object.TargetForces, rValueFx, rValueFy, rValueFz, rValueTx, rValueTy, rValueTz

- Object
  Object name
  The object is specified as either of FC (numerical value) or FC (label).

- rArray()
  The number of elements defining the values of the property is an array of 6 or more real number variables

- rValueFx
  A real number or formula defining the new value of the property

- rValueFy
  A real number or formula defining the new value of the property

- rValueFz
  A real number or formula defining the new value of the property

- rValueTx
  A real number or formula defining the new value of the property

- rValueTy
  A real number or formula defining the new value of the property

- rValueTz
  A real number or formula defining the new value of the property

**Values** rArray()

| Element number | Element number constant | Description |
|---|---|---|
| 0 | FG_FX | Fx target force |
| 1 | FG_FY | Fy target force |
| 2 | FG_FZ | Fz target force |
| 3 | FG_TX | Tx target torque |
| 4 | FG_TY | Ty target torque |
| 5 | FG_TZ | Tz target torque |

rValueFx, rValueFy, rValueFz (Unit: [N])

| | Values |
|---|---|
| Minimum | The rated negative detection capability of the force sensor |
| Maximum | The rated positive detection capability of the force sensor |

Default: 0

rValueTx, rValueTy, rValueTz (Unit: [N·mm])

| | Values |
|---|---|
| Minimum | The negative rated torque detection capability of the force sensor |
| Maximum | The positive rated torque detection capability of the force sensor |

Default: 0

### Detailed Explanation

This returns the value of or sets the target force and torque for the force control function for the 6 axes at the same time.
It sets the following target forces and torques.
rValueFx: Fx rValueFy: Fy rValueFz: Fz
rValueTx: Tx rValueTy: Ty rValueTz: Tz
When the force control function is executed with the target force or torque being set to “0”, the robot moves so that the force becomes “0” and operates while following the external force. Since the axes are independent each other, the robot can follow the force in Fx and Fy directions while pressing in the Fz direction.
When using the force control function having set the target force and torque, there are times that the target force is not achieved even after sufficient time. In such instances, activate the TargetForcePriorityMode when wanting to accurately match the target force.
However, when the TargetForcePriorityMode is activated, operation of the robot will not be in accordance with the established values for the virtual coefficients of elasticity, viscosity, and inertia, and the motion may be slowed at times.

### Usage Example

This example sets the target force and uses the force control function.

```
Function ForceControlTest
  FSet FCS1.Orientation, FG_TOOL
  FSet FC1.CoordinateSystem, FCS1
  FSet FC1.Enabled, False, True, True, False, False, False
  FSet FC1.Fy, 0.01, 4, 5
  FSet FC1.Fz, 0.01, 4, 5
  FSet FC1.TargetForces, 0, 10, -10, 0, 0, 0
  FCKeep FC1, 5
Fend
```

### See Also

**FC (Force Control) Object**,
Fx_TargetForce, Fy_TargetForce, Fz_TargetForce,
Tx_TargetForce, Ty_TargetForce, Tz_TargetForce Property

## 24.3 TillStopMode Property

### Application
Force Trigger Object FT#

### Description
Sets or returns the stop method when trigger conditions are met when the force trigger is used for Till.

### Immediate Execution
No

### Usage
FGet Object.TillStopMode, iVar
FSet Object.TillStopMode, iValue

- Object
  Object name
  The object is specified as either of FT (numerical value) or FT (label).

- iVar
  An integer variable defining the value of the property

- iValue
  An integer value or formula defining the new value of the property

### Values
iValue

| Name of Constants | Values | Description |
|---|---|---|
| FG_STANDARD_STOP | 0 | The standard stopping method. (default) |
| FG_SOFT_STOP | 1 | Stops the robot to reduce force overshoot upon contact. |

### Detailed Explanation
Sets or returns the stop method when trigger conditions are met when the force trigger is used for Till.
When using the force trigger to stop the robot upon detecting contact with an object, use FG_SOFT_STOP. FG_SOFT_STOP is more suited to reducing force overshoot upon contact compared to FG_STANDARD_STOP. Compared to FG_STANDARD_STOP, this makes it easier to stay within the tolerable range even when increasing the contact speed assuming that a tolerable contact force is applied.
Use FG_STANDARD_STOP when detecting the absence of force, such as when probing for holes.

### Usage Example
This is an example of detecting contact using FG_SOFT_STOP. Contact is detected and the robot is stopped when a force of 5 [N] or less, or 5 [N] or more is detected in the Fz direction when moving from the current position 100 mm in the -Z direction.

```
Function TillStopModeTest
  FSet FT1.Fz_Enabled, True
  FSet FT1.Fz_Levels, -5, 5
  FSet FT1.TillStopMode, FG_SOFT_STOP

  FSet FS1.Reset
  Till FT1
  Move Here -Z(100) Till
Fend
```

### See Also

**FT (Force Trigger) Object**

## 24.4 Time Result

### Description

Returns execution time for a force guide sequence or force guide object.

### Usage

FGGet Sequence.Time, rVar
FGGet Sequence.Object.Time, rVar

- Sequence
  Force guide sequence name

- Object
  Force guide object name
  Omitted when a result of a force guide sequence is acquired.

- rVar
  Real variable that shows a returned value

### Detailed Explanation

Returns execution time for a force guide sequence or force guide object.

### Usage Example

The following is an example of a simple program that acquires a result with FGGet.

```
Function TimeTest
  Real rVar
  Motor On

  FGRun Sequence1
  FGGet Sequence1.Contact01.Time, rVar  ' Acquisition of Time
  Print rVar

Fend
```

### See Also

**FGGet Statement**, **General Purpose Sequence Result**, **Contact Object Result**, **Relax Object Result**, **FollowMove Object Result**, **SurfaceAlign Object Result**, **PressProbe Object Result**, **ContactProbe Object Result**, **Press Object Result**, **PressMove Object Result**, **SPELFunc Object Result**, **Paste Sequene Result**, **Paste Object Result**, **ScrewTighten Sequence Result**, **ScrewRetighten Object Result**, **ScrewTighten Object Result**, **HeightInspect Sequence Result**, **HeightInspect Object Result**, **Insert Sequence Result**, **Insert Object Result**, **TensileTest Object Result**

# 24.5 Tmag_AvgForce Status

### Application
Force Monitor Object FM#

### Description
Returns average resultant torque.

### Usage
FGet Object.Tmag_AvgForce, rVar

- Object
  Object name
  The object is specified as either of FM (numerical value) or FM (label).

- rVar
  A real number variable defining the value of the property

### Detailed Explanation
Tmag_AvgForce returns the average value of the resultant torque.
Before executing Tmag_AvgForce, be sure to execute AvgForceClear. If AvgForceClear is not executed, "0" is returned.
When the time from executing AvgForceClear to executing Tmag_AvgForce is short, a deviation in the average force and torque is generated. When LowPassFilter is used, set the time about 5 times the LowPassFilter time constant between AvgForceClear and Tmag_AvgForce execution.
There is a time limit on Tmag_AvgForce. Execute Tmag_AvgForce within 600 seconds of executing AvgForceClear. When Tmag_AvgForce is executed after 600 seconds has passed, an error is generated.

### Usage Example
This example measures the average value of the resultant torque.

```
Function CheckAverageForce
  Double AF
  FSet FC1.Enabled, False, False, False, True, False, False
  FSet FC1.TargetForces, 0, 0, 0, 200, 0, 0
  FSet FS1.Reset
  FSet FM1.CoordinateSystem, FCS0
  FSet FM1.AvgForceClear, False, False, False, False, False, False, False, True
  FCKeep FC1, 10
  FGet FM1.Tmag_AvgForce, AF
  Print AF
Fend
```

### See Also
**FM (Force Monitor) Object**

# 24.6 Tmag_Axes Property

### Application
Force Trigger Object FT#, Force Monitor Object FM#

### Description
Sets or returns the subject axis for calculating the resultant torque.

### Immediate Execution
No

### Usage
FGet Object.Tmag_Axes, iVar
FSet Object.Tmag_Axes, iValue

- Object
  Object name
  The object is specified as FT (numerical value), FT (label), FM (numerical value), or FM (label).

- iVar
  An integer variable defining the value of the property

- iValue
  An integer value or formula defining the new value of the property

### Values
iValue (Unit: Number)

| Name of Constants | Values | Description |
|---|---|---|
| FG_XYZ | 0 | Defines as resultant torque for XYZ axes. (default)<br>(Tmag = sqrt($Tx^2$ + $Ty^2$ + $Tz^2$) ) |
| FG_XY | 1 | Defines as resultant torque for XY axes.<br>(Tmag = sqrt($Tx^2$ + $Ty^2$) ) |
| FG_YZ | 2 | Defines as resultant torque for YZ axes.<br>(Tmag = sqrt($Ty^2$ + $Tz^2$) ) |
| FG_ZX | 3 | Defines as resultant torque for ZX axes.<br>(Tmag = sqrt($Tx^2$ + $Tz^2$) ) |

### Detailed Explanation
Tmag is the resultant force from the subject axes selected from X, Y, and Z axes.
This property is used when setting or checking the subject axes to obtain the resultant torque with respect to the Force Trigger Object and Force Monitor Object.

### Usage Example
This example sets and acquires the axes wherein the resultant force will be applied for the Force Monitor Object.

```
Function Test_Tmag_Axes
  Integer iVar
  FSet FM1.Tmag_Axes, FG_ZX
  FGet FM1.Tmag_Axes, iVar
  Print iVar
Fend
```

### See Also

**FT (Force Trigger) Object**, **FM (Force Monitor) Object**

# 24.7 Tmag_Enabled Property

### Application
Force Trigger Object FT#

### Description
Activates/inactivates the trigger based on Tmag resultant torque.

### Immediate Execution
No

### Usage
FGet Object.Tmag_Enabled, bVar
FSet Object.Tmag_Enabled, bValue

- Object
  Object name
  The object is specified as either of FT (numerical value) or FT (label).

- bVar
  A Boolean variable defining the value of the property

- bValue
  A Boolean value or formula defining the new value of the property

**Values** bValue

| Name of Constants | Values | Description |
|---|---|---|
| False | 0 | Inactivates the subject axis. (default) |
| True | -1 | Activates the subject axis. |

### Detailed Explanation
Activates/inactivates the trigger based on Tmag resultant torque.

### Usage Example
This example activates the Tmag resultant torque trigger for the Force Trigger Object.

```
> FSet FT1.Tmag_Enabled, True
```

### See Also
**FT (Force Trigger) Object**

# 24.8 Tmag_Force Status

### Application
Force Monitor Object FM#

### Description
This returns the resultant torque.

### Usage
FGet Object.Tmag_Force, rVar

- Object
  Object name
  The object is specified as either of FM (numerical value) or FM (label).

- rVar
  A real number variable defining the value of the property

### Detailed Explanation
Tmag_Force returns the resultant torque for the subject axes specified in Tmag_Axes in the force coordinate system specified by the CoordinateSystem.

### Usage Example
This example acquires the resultant torque in the X and Y axes within the specified force coordinate system.

```
Function Test_Tmag_Force
  Real rVar
  FSet FCS1.Position, 0, 0, 100
  FCS1.Orientation, FG_TOOL
  FSet FM1.ForceSensor, 1
  FSet FM1.CoordinateSystem, FCS1
  FSet FM1.Tmag_Axes, FG_XY
  FGet FM1.Tmag_Force, rVar
  Print rVar
Fend
```

### See Also
**FM (Force Monitor) Object**

## 24.9 Tmag_Levels Property

### Application
Force Trigger Object FT#

### Description
Sets or returns the upper and lower threshold values for resultant torque.

### Immediate Execution
No

### Usage
FGet Object.Tmag_Levels, rArray()
FSet Object.Tmag_Levels, rValueL, rValueU

- Object
  Object name
  The object is specified as either of FT (numerical value) or FT (label).

- rArray
  The number of elements defining the values of the property is an array of 2 or more real number variables

- rValueL
  A real number or formula defining the new value of the property.

- rValueU
  A real number or formula defining the new value of the property.

### Values
rArray()

| Element number | Element number constant |
|---|---|
| 0 | FG_LOWERLEVEL |
| 1 | FG_UPPERLEVEL |

rValueL (Unit: [N·mm])

| | Values |
|---|---|
| Minimum | 0 (default) |
| Maximum | 100000 |

rValueU (Unit: [N·mm])

| | Values |
|---|---|
| Minimum | 0 |
| Maximum | 100000 (default) |

### Detailed Explanation
Tmag_Levels sets or returns the value of the lower and upper thresholds for resultant torque.
rValueL is the lower threshold. rValueU is the upper threshold. Be sure that rValueL < rValueU.
This is used for error checking and task completion conditions.

### Usage Example

This example generates an error and stops the robot if the resultant torque is lower than the lower threshold or higher than the upper threshold.

```
Function SettingLevels
  FSet FT1.Enabled, False, False, False, False, False, False, False, True
  FSet FT1.Tmag_Polarity, FG_OUT
  FSet FT1.Tmag_Levels, 0, 3000
  Trap 1, FT1 Call ForceError
Fend

Function ForceError
  AbortMotion All
Fend
```

### See Also

**FT (Force Trigger) Object**

# 24.10 Tmag_LPF_Enabled Property

### Application
Force Trigger Object FT#, Force Monitor Object FM#

### Description
Activates/inactivates or returns the resultant torque low-pass filter.

### Immediate Execution
No

### Usage
FGet Object.Tmag_LPF_Enabled, bVar
FSet Object. Tmag_LPF_Enabled, bValue

- Object
  Object name
  The object is specified as FT (numerical value), FT (label), FM (numerical value), or FM (label).

- bVar
  A Boolean variable defining the value of the property

- bValue
  A Boolean value or formula defining the new value of the property

### Values
bValue

| Name of Constants | Values | Description |
|---|---|---|
| False | 0 | Sets the low-pass filter to inactive. (default) |
| True | -1 | Sets the low-pass filter to active. |

### Detailed Explanation
Activates/inactivates or returns the resultant torque low-pass filter.
When the low-pass filter is active, signal noise can be reduced, but the following performance for quick signal changes deteriorates.
The low-pass filter is used with AvgForces Status, PeakForces Status, the Force Trigger Function, and Force Monitor, but is not used with Forces Status.

### Usage Example
This example sets the resultant torque low-pass filter, and acquires the absolute value of the peak resultant torque.

```
Function GetPeakForceTest
  Real myPeakForce
  FSet FCS1.Orientation, FG_TOOL
  FSet FM1.CoordinateSystem, FCS1
  FSet FM1.Tmag_Axes, FG_XYZ
  FSet FM1.Tmag_LPF_Enabled, True
  FSet FM1.Tmag_LPF_TimeConstant, 0.02
  FSet FM1.PeakForceClear, True, True, True, True, True, True, True, True
  Wait 10
  FGet FM1.Tmag_PeakForce, myPeakForce
  Print myPeakForce
Fend
```

### See Also

**FT (Force Trigger) Object**, **FM (Force Monitor) Object**

## 24.11 Tmag_LPF_TimeConstant Property

### Application
Force Trigger Object FT#, Force Monitor Object FM#

### Description
This sets or returns the value of the time constant for the low-pass filter applied to resultant torque.

### Immediate Execution
No

### Usage
FGet Object.Tmag_LPF_TimeConstant, rVar
FSet Object.Tmag_LPF_TimeConstant, rValue

- Object
  Object name
  The object is specified as FT (numerical value), FT (label), FM (numerical value), or FM (label).

- rVar
  A real number variable defining the value of the property

- rValue
  A real number or formula defining the new value of the property

### Values
rValue (Unit: [sec])

| | Values |
|---|---|
| Minimum | 0.002 |
| Maximum | 5 |

Default: 0.01

### Detailed Explanation
This sets the time constant for the resultant torque low-pass filter.

The low-pass filter time constant is the time it takes to arrive at an input value of $1\text{-}e^{-1}$ (approximately 63.2%) when giving step input.
The signal noise reduction can be enhanced when increasing the time constant, but the following performance for quick signal changes deteriorates.
The low-pass filter is used with AvgForces Status, PeakForces Status, the Force Trigger Function, and Force Monitor, but is not used with Forces Status.

### Usage Example
This example sets the resultant torque low-pass filter, and acquires the absolute value of the peak resultant torque.

```
Function GetPeakForceTest
  Real myPeakForce
  FSet FCS1.Orientation, FG_TOOL
  FSet FM1.CoordinateSystem, FCS1
  FSet FM1.Tmag_Axes, FG_XYZ
  FSet FM1.Tmag_LPF_Enabled, True
  FSet FM1.Tmag_LPF_TimeConstant, 0.02
  FSet FM1.PeakForceClear, True, True, True, True, True, True, True, True
  Wait 10
```

```
  FGet FM1.Tmag_PeakForce, myPeakForce
  Print myPeakForce
Fend
```

**See Also**

**FT (Force Trigger) Object**, **FM (Force Monitor) Object**

# 24.12 Tmag_PeakForce Status

### Application
Force Monitor Object FM#

### Description
Returns the resultant torque peak.

### Usage
FGet Object.Tmag_PeakForce, rVar

- Object
  Object name
  The object is specified as either of FM (numerical value) or FM (label).

- rVar
  A real number variable defining the value of the property

### Detailed Explanation
Tmag_PeakForce returns the value of peak resultant torque.
Before executing Tmag_PeakForce, execute PeakForceClear.

### Usage Example
This example measures the value of the peak resultant torque.

```
Function CheckPeakForce
  Double PF
  FSet FC1.Enabled, False, False, False, True, False, False
  FSet FC1.TargetForces, 0, 0, 0, 200, 0, 0
  FSet FS1.Reset
  FSet FM1.CoordinateSystem, FCS0
  FSet FM1.PeakForceClear, False, False, False, False, False, False, False, True
  FCKeep FC1, 10
  FGet FM1.Tmag_PeakForce, PF
  Print PF
Fend
```

### See Also
**FM (Force Monitor) Object**

# 24.13 Tmag_Polarity Property

### Application

Force Trigger Object FT#

### Description

Sets or returns for resultant torque whether the force trigger is activated or inactivated when values correspond to or do not correspond with threshold values.

### Immediate Execution

No

### Usage

FGet Object.Tmag_Polarity, iVar
FSet Object.Tmag_Polarity, iValue

- Object
  Object name
  The object is specified as either of FT (numerical value) or FT (label).

- iVar
  An integer variable defining the value of the property

- iValue
  An integer value or formula defining the new value of the property

### Values

iValue

| Name of Constants | Values | Description |
|---|---|---|
| FG_OUT | 0 | Triggered when value is not within upper and lower thresholds. (default) |
| FG_IN | 1 | Triggered when value is within upper and lower thresholds. |

### Detailed Explanation

Tmag_Polarity returns the status of or sets whether the force trigger is triggered by the value of the resultant torque being either within the thresholds or outside of the thresholds.

### Usage Example

This example generates an error and stops the robot when the resultant torque is greater than the upper threshold or lower than the lower threshold.

```
Function SettingPolarity
  FSet FT1.Enabled, False, False, False, False, False, False, False, True
  FSet FT1.Tmag_Polarity, FG_OUT
  FSet FT1.Tmag_Levels, 0, 3000
  Trap 1, FT1 Call ForceError
Fend

Function ForceError
  AbortMotion All
Fend
```

### See Also

FT (Force Trigger) Object

# 24.14 TMove Statement

### Description

Executes an offset linear interpolation motion in the current tool coordinate system with the force control function active.

### Usage

TMove P# [FC#] [ROT] [CP] [CF] [Till | Find] [!parallel processing!] [SYNC]

- P#
  Specifies the point data defining the target position of the motion.

- FC#
  Specifies the force control object.

- CF
  Continues the force control function. Can be omitted.

### Detailed Explanation

By adding a force control object as a parameter to an ordinary TMove command, a TMove motion is executed with the control force function active.
For TMove motion details, refer to the following manual.
"Epson RC+ 8.0 SPEL+ Language Reference" TMove
For details on the force control function, see below.
**Move Statement**

### Usage Example

This is a simple program example to execute a TMove motion with the force control active.
In this example, a TMove motion is executed with the force control function active in the X axis direction of the tool coordinate system.

```
Function ForceTMoveTest
  FSet FCS1.Orientation, FG_TOOL    ' Sets the force coordinate data

  FSet FC1.CoordinateSystem, FCS1   ' Specifies the force coordinate data
  FSet FC1.Fx_Spring, 0             ' Sets the virtual Fx coefficient of elasticity
  FSet FC1.Fx_Damper, 1             ' Sets the virtual Fx coefficient of viscosity
  FSet FC1.Fx_Mass, 10              ' Sets the virtual Fx coefficient of inertia
  FSet FC1.Fx_Enabled, True         ' Sets the Fx force control function to active

  TMove XY(100,0,0,0) FC1           ' Executes a TMove motion with the force control
function active
Fend
```

### See Also

**TMove Statement**, **Move Statement**, **FC (Force Control) Object**

# 24.15 Triggered Status

### Application
Force Trigger Object FT#, Force Motion Restriction Object FMR#

### Description
This returns the status/condition of the force trigger or force motion restriction.

### Immediate Execution
No

### Usage
FGet Object.Triggered, bVar

- Object
  Object name
  The object is specified as either of FT (numerical value), FMR (numerical value), FT (label) or FMR (label).

- bVar
  A Boolean variable defining the value of the property

### Detailed Explanation
This returns the status/condition just prior to the triggering of the force trigger or force motion restriction. When the force trigger or force motion restriction conditions are met, “True” is returned. “False” is returned when not met.
Force trigger is used for branch processing when force is used as a condition.
Force motion restriction is used for branch processing when position is used as a condition.

### Usage Example
This example branches the process due to meeting the force trigger conditions.

```
Function TriggeredTest
  Boolean bVar
  FCKeep FC1 Till FT1, 10
  FGet FT1.Triggered, bVar
  If bVar = True Then
    'The process when the trigger conditions are met
    -
  Else
    'The process when the trigger conditions are not met
    -
  EndIf
Fend
```

### See Also
**FT (Force Trigger) Object**, **FMR (Force Motion Restriction) Object**

# 24.16 TriggeredAxes Status

### Application
Force Trigger Object FT#, Force Motion Restriction Object FMR#

### Description
This returns the met/not met status of the force trigger or force motion restriction when position is subject by axis.

### Immediate Execution
No

### Usage
FGet Object.TriggeredAxes, iVar

- Object
  Object name
  The object is specified as either of FT (numerical value), FMR (numerical value), FT (label) or FMR (label).

- iVar
  An integer variable defining the value of the property

### Values
When using for force trigger object:

| Bit | Results |
|---|---|
| 0 | Met Fx LowerLevel conditions |
| 1 | Met Fy LowerLevel conditions |
| 2 | Met Fz LowerLevel conditions |
| 3 | Met Tx LowerLevel conditions |
| 4 | Met Ty LowerLevel conditions |
| 5 | Met Tz LowerLevel conditions |
| 6 | Met Fmag LowerLevel conditions |
| 7 | Met Tmag LowerLevel conditions |
| 8 | Met Fx UpperLevel conditions |
| 9 | Met Fy UpperLevel conditions |
| 10 | Met Fz UpperLevel conditions |
| 11 | Met Tx UpperLevel conditions |
| 12 | Met Ty UpperLevel conditions |
| 13 | Met Tz UpperLevel conditions |
| 14 | Met Fmag UpperLevel conditions |
| 15 | Met Tmag UpperLevel conditions |

The value of each Bit
0: Not met
1: Met

When using for force motion restriction object:

| Bit | Results |
|---|---|
| 0 | Met PosX LowerLevel conditions |
| 1 | Met PosY LowerLevel conditions |
| 2 | Met PosZ LowerLevel conditions |
| 3 | Met Dist LowerLevel conditions |
| 4 | Met Rot LowerLevel conditions |
| 5 | Met PosX UpperLevel conditions |
| 6 | Met PosY UpperLevel conditions |
| 7 | Met PosZ UpperLevel conditions |
| 8 | Met Dist UpperLevel conditions |
| 9 | Met Rot UpperLevel conditions |

The value of each Bit
0: Not met
1: Met

### Detailed Explanation

This returns the met/not met status by axis for the force trigger or force motion restriction just before triggering.
For each axis of the force trigger or force motion restriction the corresponding bit is "1" when the conditions are met. The bit is "0" when not met.
However, when under the Polarity Property FG_OUT is set, the UpperLevel and LowerLevel are set to "1" or "0".
When FG_IN is set, both the UpperLevel and LowerLevel are set to "1" when the conditions are met.
Force trigger function is used to accomplish branch processing based on the met/not met status of force in each axis.
Force motion restriction is used to accomplish branch processing based on the met/not met status of position in each axis.
When a value is acquired for an Integer variable, depending on the met/not met status, there are times when the value is negative. Int32 or Int64 type variables are recommended.

### Usage Example

This is an example of branch processing based on the met/not met status of each axis for the force trigger.

```
Function TriggeredAxesTest
  Int64 iVar
  FCKeep FC1 Till FT1, 10
  FGet FT1.TriggeredAxes, iVar
  If (iVar And &H01) <> 0 Then
    ' The process when Fx LowerLevel conditions are met
    -
  ElseIf (iVar And &H100) <> 0 Then
    ' The process when Fx UpperLevel conditions are met
    -
  EndIf
Fend
```

### See Also

FT (Force Trigger) Object, FMR (Force Motion Restriction) Object

## 24.17 TriggeredForces Status

### Application
Force Trigger Object FT#, Force Motion Restriction Object FMR#

### Description
Returns force and torque applied when force trigger or force motion restriction conditions are achieved.

### Usage
FGet Object.TriggeredForces, rArray()

- Object
  Object name
  The object is specified as either of FT (numerical value), FMR (numerical value), FT (label) or FMR (label).

- rArray()
  The number of elements defining the values of the property is an array of 6 or more real number variables

### Values
rArray()

| Element number | Element number constant | Description |
|---|---|---|
| 0 | FG_FX | Acquires force in Fx direction when force trigger conditions of force and position are achieved. |
| 1 | FG_FY | Acquires force in Fy direction when force trigger conditions of force and position are achieved. |
| 2 | FG_FZ | Acquires force in Fz direction when force trigger conditions of force and position are achieved. |
| 3 | FG_TX | Acquires torque in Tx direction when force trigger conditions of force and position are achieved. |
| 4 | FG_TY | Acquires torque in Ty direction when force trigger conditions of force and position are achieved. |
| 5 | FG_TZ | Acquires torque in Tz direction when force trigger conditions of force and position are achieved. |
| 6 | FG_FMAG | Acquires resultant force Fmag when force trigger conditions of force and position are achieved. |
| 7 | FG_TMAG | Acquires resultant torque Tmag when force trigger conditions of force and position are achieved. |

Note: When the number of elements is an array of 6 or 7, the element numbers acquired are 0 to 5.

### Detailed Explanation
Returns the force and torque applied when the force trigger or force motion restriction conditions are achieved.
Returns “0” for all values when the force trigger or force motion restriction conditions are not achieved.
When multiple force triggers or force motion restriction are combined as described below, each force trigger object or force motion restriction object will retain the force and torque that applied when the given force trigger object conditions were first achieved.

Till FT1 And FMR2

Therefore, when force trigger or force motion restriction objects having different conditions are combined and used, the TriggeredForces status of each object will differ.

### Usage Example

The following is an example of acquiring and displaying the force applied when the force trigger is achieved.

```
Function TriggeredForceTest
  Real rArray(7)
  FCKeep FC1 Till FT1, 10
  FGet FT1.TriggeredForces, rArray()
  Print rArray(FG_FX)
Fend
```

### See Also

**FT (Force Trigger) Object**, **FMR (Force Motion Restriction) Object**

# 24.18 TriggeredForces Result

### Description
Returns force and torque for a force guide object when force-related end conditions are achieved.

### Usage
FGGet Sequence.Object.TriggeredForces, rArray()

- Sequence
  Force guide sequence name
- Object
  Force guide object name
- rArray
  Real array variable with six or more elements showing returned values

### Values
rArray()

| Element number | Element number constant | Description |
|---|---|---|
| 0 | FG_FX | Acquires force in Fx direction when force-related end conditions are achieved. |
| 1 | FG_FY | Acquires force in Fy direction when force-related end conditions are achieved. |
| 2 | FG_FZ | Acquires force in Fz direction when force-related end conditions are achieved. |
| 3 | FG_TX | Acquires torque in Tx direction when force-related end conditions are achieved. |
| 4 | FG_TY | Acquires torque in Ty direction when force-related end conditions are achieved. |
| 5 | FG_TZ | Acquires torque in Tz direction when force-related end conditions are achieved. |

### Detailed Explanation
Returns force and torque for a force guide object when force-related end conditions are achieved.
Returns “0” for all values when force-related end conditions are not achieved or end conditions are invalid.
If the number of elements in a specified array variable is less than six, returns force and torque in each direction for the defined element numbers. Also, if the number of elements in the array variable exceeds six, returns force and torque in each direction from element number 0 to 5, while making no change to element number 6 and above.

### Usage Example
The following is an example of a simple program that acquires a result with FGGet.

```
Function TriggeredForcesTest
  Double dArray(6)

  Motor On

  FGRun Sequence1
  FGGet Sequence1.Contact01.TriggeredForces, dArray()
    ' Acquisition of TriggeredForces
  Print dArray(FG_FX)
```

```
Fend
```

**See Also**

**FGGet Statement**, **Contact Object Result**, **Relax Object Result**, **SurfaceAlign Object Result**, **PressProbe Object Result**, **ContactProbe Object Result**, **Press Object Result**, **PressMove Object Result**, **Paste Object Result**, **ScrewRetighten Object Result**, **HeightInspect Object Result**, **Insert Object Result**, **TensileTest Object Result**

## 24.19 TriggeredJoints Status

### Application

Force Motion Restriction Object FMR#

### Description

Returns the achievement status for force motion restriction by axis when the object monitored is in the joint position.

### Immediate Execution

No

### Usage

FGet Object.TriggeredAxes, iVar

- Object
  Object name
  The object is specified as either of FMR (numerical value) or FMR (label).

- iVar
  An integer variable defining the value of the property

### Values

| Bit | Results |
|---|---|
| 0 | Met J1 LowerLevel conditions |
| 1 | Met J2 LowerLevel conditions |
| 2 | Met J3 LowerLevel conditions |
| 3 | Met J4 LowerLevel conditions |
| 4 | Met J5 LowerLevel conditions |
| 5 | Met J6 LowerLevel conditions |
| 6 | Met J7 LowerLevel conditions |
| 7 | Met J8 LowerLevel conditions |
| 8 | Met J9 LowerLevel conditions |
| 9 | Met J1 UpperLevel conditions |
| 10 | Met J2 UpperLevel conditions |
| 11 | Met J3 UpperLevel conditions |
| 12 | Met J4 UpperLevel conditions |
| 13 | Met J5 UpperLevel conditions |
| 14 | Met J6 UpperLevel conditions |
| 15 | Met J7 UpperLevel conditions |
| 16 | Met J8 UpperLevel conditions |
| 17 | Met J9 UpperLevel conditions |

The value of each Bit
0: Not met
1: Met

### Detailed Explanation

Returns the achievement status for each axis when force motion restriction was last used when the object monitored was in the joint position.
This sets the corresponding bit for each force motion restriction axis to “1” when conditions are met. If conditions are not met, the corresponding bit is set to “0”.
However, when under the Polarity Property FG_OUT is set, the UpperLevel and LowerLevel are set to “1” or “0”.
When FG_IN is set, both the UpperLevel and LowerLevel are set to “1” when the conditions are met.
This is used to accomplish branch processing based on the met/not met status of position and orientation in each axis.
When a value is acquired for an Integer variable, depending on the met/not met status, there are times when the value is negative. Int32 or Int64 type variables are recommended.

### Usage Example

This is an example of branch processing based on the met/not met status of each axis for force motion restriction.

```
Function TriggeredAxesTest
  Int64 iVar
  FSet FMR1.TriggereMode, FG_ABS_JOINT
  FCKeep FC1 Till FMR1, 10
  FGet FMR1.TriggeredJoint, iVar
  If (iVar And &H01) <> 0 Then
    ' The process when J1 LowerLevel conditions are met
    -
  ElseIf (iVar And &H200) <> 0 Then
    ' The process when J1 UpperLevel conditions are met
    -
  EndIf
Fend
```

### See Also

**FMR (Force Motion Restriction) Object**

# 24.20 TriggeredPos Status

### Application
Force Trigger Object FT#, Force Motion Restriction Object FMR#

### Description
This returns the position when the force trigger or force motion restriction conditions are met.

### Immediate Execution
No

### Usage
FGet Object.TriggeredPos, P#

- Object
  Object name
  The object is specified as either of FT (numerical value), FMR (numerical value), FT (label) or FMR (label).

- P#
  Variable representing a point data

### Detailed Explanation
This returns the position just prior to the triggering of the force trigger or force motion restriction when the conditions are met.
When the force trigger or force motion restriction conditions are not met, a value of "0" is returned for all.
When, as below, multiple force triggers or force motion restrictions are combined, the position for when that object's conditions were first met is maintained for each force trigger or force motion restriction Object.

Till FT1 And FMR2

Therefore, when force trigger or force motion restriction objects with different conditions are used in combination, the TriggeredPos status is different for each object.

### Usage Example
This example acquires and displays the position when the force trigger conditions are met.

```
Function TriggeredPosTest
  FCKeep FC1 Till FT1, 10
  FGet FT1.TriggeredPos, P1
  Print P1
Fend
```

### See Also
**FT (Force Trigger) Object**, **FMR (Force Motion Restriction) Object**

# 24.21 TriggeredPos Result

### Description

Returns position for a force guide object when force-related end conditions are achieved.

### Usage

FGGet Sequence.Object.TriggeredPos, P#

- Sequence
  Force guide sequence name
- Object
  Force guide object name
- P#
  Variable representing a point data

### Detailed Explanation

Returns position for a force guide object when force-related end conditions are achieved.
Returns 0 for all values when force-related end conditions are not achieved or end conditions are invalid.

### Usage Example

The following is an example of a simple program that acquires a result with FGGet.

```
Function EndPosTest

  Motor On

  FGRun Sequence1
  FGGet Sequence1.Contact01.TriggeredPos, P1   ' Acquisition of TriggeredPos
  Print P1

Fend
```

### See Also

**FGGet Statement**, **Contact Object Result**, **Relax Object Result**, **SurfaceAlign Object Result**, **PressProbe Object Result**, **ContactProbe Object Result**, **Press Object Result**, **PressMove Object Result**, **Paste Object Result**, **ScrewRetighten Object Result**, **HeightInspect Object Result**, **Insert Object Result**, **TensileTest Object Result**

# 24.22 TriggerMode (FT#) Property

### Application
Force Trigger Object FT#

### Description
Sets or returns the object of the force trigger monitor.

### Immediate Execution
No

### Usage
FGet Object.TriggerMode, iVar
FSet Object.TriggerMode, iValue

- Object
  Object name
  The object is specified as either of FT (numerical value) or FT (label).

- iVar
  An integer variable defining the value of the property

- iValue
  An integer value or formula defining the new value of the property

### Values
iValue

| Name of Constants | Values | Description |
|---|---|---|
| FG_FORCE | 0 | Monitor force and torque. (default) |
| FG_DIFF | 1 | Monitor change in force and torque. |

### Detailed Explanation
This sets or returns whether the subject being monitored for the force trigger is force and torque or the change thereof.
When monitoring for force above or below a certain value, FC_FORCE is used. When monitoring for a change in force above or below a certain value, FG_DIFF is used.
Change in force is monitored in terms of [N/sec] and change in the torque is monitored in terms of [N·mm/sec].
When monitoring change, the use of a low-pass filter is recommended as the effects of noise is significant.

### Usage Example
This example monitors force. The force control function is activated for 10 seconds if force goes below 3[N] or above 3[N].

```
Function TriggerModeTest_FORCE
  FSet FT1.Fx_Enabled, True
  FSet FT1.Fx_Levels, -3, 3
  FSet FT1.TriggerMode, FG_FORCE

  Till FT1
  FCKeep FC1 Till, 10
Fend
```

This example monitors change in force. The force control function is activated for 10 second if the change goes below 50[N/sec] or above 50[N/sec].

```
Function TriggerModeTest_DIFF
  FSet FT1.Fx_Enabled, True
  FSet FT1.Fx_Levels, -50, 50
  FSet FT1.Fx_LPF_Enabled, True
  FSet FT1.Fx_LPF_TimeConstant, 0.1
  FSet FT1.TriggerMode, FG_DIFF

  Till FT1
  FCKeep FC1 Till, 10
  Print TillOn
Fend
```

### See Also

FT (Force Trigger) Object

# 24.23 TriggerMode (FMR#) Property

### Application
Force Motion Restriction Object FMR#

### Description
Sets or returns the object of the force motion restriction monitor.

### Immediate Execution
No

### Usage
FGet Object.TriggerMode, iVar
FSet Object.TriggerMode, iValue

- Object
  Object name
  The object is specified as either of FMR (numerical value) or FMR (label).

- iVar
  An integer variable defining the value of the property

- iValue
  An integer value or formula defining the new value of the property

### Values
iValue

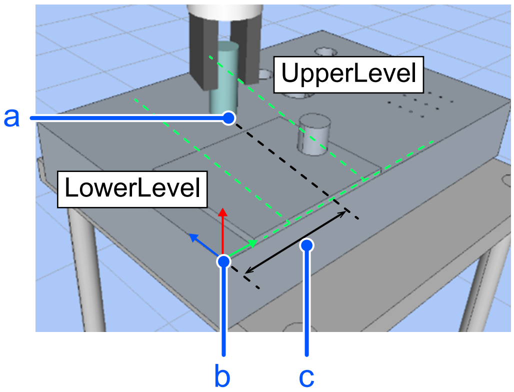
| Name of Constants | Values | Description |
|---|---|---|
| FG_ABS_COORD_SYS | 0 | Monitors the current position and orientation of the robot using the base or local coordinate system selected in the RobotLocal property as a reference. |
| FG_REL_COORD_SYS | 1 | Monitors the travel amount to the current position and orientation of the robot from the position and orientation at the start of monitoring using the base or local coordinate system selected in the RobotLocal property as a reference. |
| FG_REL_TOOL | 2 | Monitors the travel amount to the current position and orientation of the robot from the tool coordinate system at the start of monitoring. |
| FG_REL_POINT | 3 | Monitors the travel amount to the current position and orientation of the robot from the position specified in DatumPoint. |
| FG_FRC_CORRECTION | 4 | Monitors the amount of correction for the force control function. |
| FG_ABS_JOINT | 5 | Monitors the angle of each joint. |
| FG_REL_JOINT | 6 | Monitors the amount of rotation of each joint from the angle of each joint at the start of monitoring. |

### Detailed Explanation
Sets or returns the object of the force motion restriction monitor.

- FG_ABS_COORD_SYS

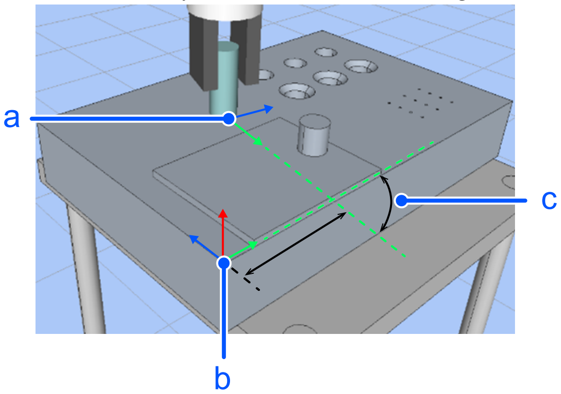
  Monitors the current position and orientation of the robot as seen from the base or local coordinate system selected in the RobotLocal property. As the LowerLevel and UpperLevel are fixed as values in the local coordinate system specified by RobotLocal, the restriction range as seen externally does not change depending on the position and orientation of the robot at the start of monitoring. This is used when setting the entry into and exit from a fixed range, regardless of the motion start position, as a condition.

The position is determined based on the current X, Y, or Z value in the base or local coordinate system used as the basis for robot positions. If X is the specified axis, the position in the X direction in the local coordinate system will be determined as shown in the diagram below.




| Symbol | Description |
|---|---|
| a | Current position |
| b | Local coordinate |
| c | Value to be monitored |

The orientation will be determined either by the angle between the base coordinate system or the local coordinate system used as the basis for robot positions and the axis (X, Y, or Z) specified by the Rot_Axes property in the tool coordinate system, or by the amount of rotation of arbitrary axis. If X is the specified axis, this will determine the angle between the X axis in the reference coordinate system and the X axis in the current tool coordinate system as shown in the diagram below.

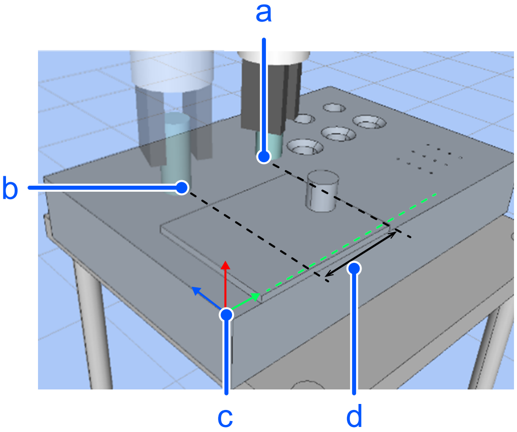



| Symbol | Description |
|---|---|
| a | Current position |
| b | Local coordinate |
| c | Value to be monitored |

- FG_REL_COORD_SYS

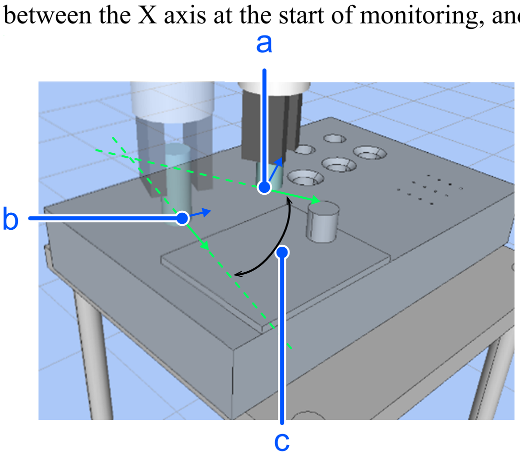
Monitors the relative travel amount in the base or local coordinate system specified by the RobotLocal property for tool position and orientation at the start of monitoring, and the current tool position and orientation. As the LowerLevel and UpperLevel are set based on the start position, the restriction range as seen externally will change depending on the position and orientation of the robot at the start of monitoring. This is used to detect movement exceeding a set distance in a specified direction in the local coordinate system when the motion or monitoring start position changes, such as when determining the start position using the vision system, or the force trigger function.

The position is determined based on the amount of movement - from the start of monitoring - towards the current position in the X, Y, or Z direction in the base or local coordinate system used as the basis for robot positions. If X is the specified axis, the amount of movement in the X direction in the local coordinate system will be determined as shown in the diagram below.




| Symbol | Description |
|---|---|
| a | Current position |
| b | Start position |
| c | Local coordinate |
| d | Value to be monitored |

The orientation will be determined either by the angle between the axis (X, Y, or Z) specified by the Rot_Axes property in the current tool coordinate system and the axis in the tool coordinate system at the start of monitoring, or by the amount of rotation of arbitrary axis. If X is the specified axis, this will determine the angle between the X axis at the start of monitoring, and the current X axis as shown in the diagram below.

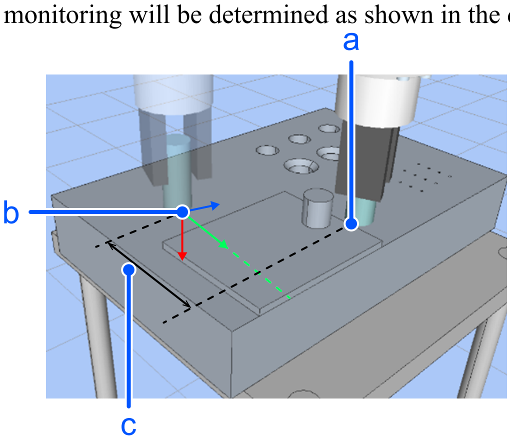



| Symbol | Description |
|---|---|
| a | Current orientation |
| b | Start orientation |
| c | Value to be monitored |

- FG_REL_TOOL

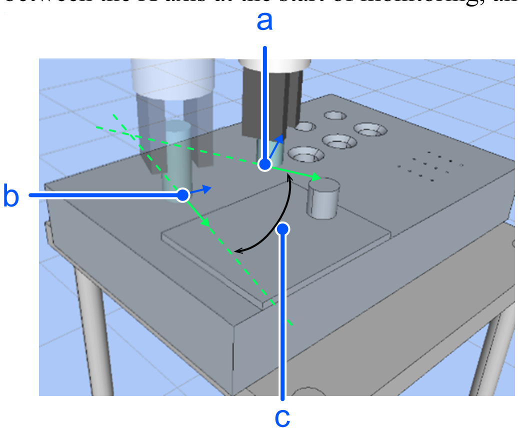
Monitors the relative travel amount to the current position of the robot from the tool coordinate system at the start of monitoring. As the LowerLevel and UpperLevel are set based on the start position, the restriction range as seen externally will change depending on the position and orientation of the robot at the start of monitoring. This is used to detect movement exceeding a set distance in a specified direction in the tool coordinate system at the start of monitoring when the motion or monitoring start position changes, such as when determining the start position using the vision system, or the force trigger function.

The position is determined based on the amount of movement - from the start of monitoring - towards the current position in the X, Y, or Z direction in the tool coordinate system at the start of monitoring. If X is the specified axis, the amount of movement in the X direction in the tool coordinate system at the start of monitoring will be determined as shown in the diagram below.




| Symbol | Description |
|---|---|
| a | Current position |
| b | Start tool coordinate |
| c | Value to be monitored |

The orientation will be determined either by the angle between the axis (X, Y, or Z) specified by the Rot_Axes property in the current tool coordinate system and the axis in the tool coordinate system at the start of monitoring, or by the amount of rotation of arbitrary axis. If X is the specified axis, this will determine the angle between the X axis at the start of monitoring, and the current X axis as shown in the diagram below.




| Symbol | Description |
|---|---|
| a | Current orientation |
| b | Start orientation |
| c | Value to be monitored |

- FG_REL_POINT

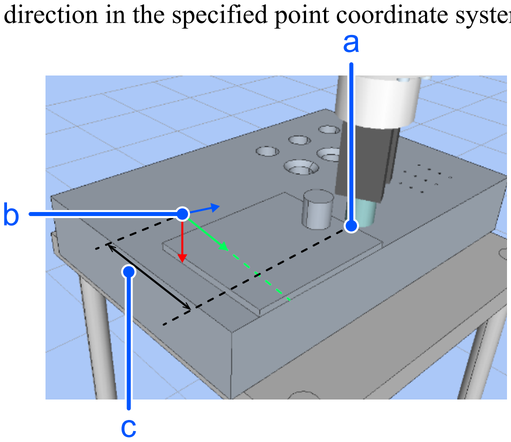
  Monitors the relative travel amount to the current position as seen from the point data specified by the DatumPoint property. As the LowerLevel and UpperLevel are set based on the specified point data, the restriction range as seen externally will not change depending on the position and orientation of the robot at the start of monitoring. However, you can refresh the point data before movement to monitor movement based on the motion start position. While the monitoring range can be changed according to the position of the robot at the start of movement using FG_REL_COORD_SYS and FG_REL_TOOL, the following program starts monitoring for each motion command when specifying the Till qualifier for monitoring multiple motion commands. As such, you cannot monitor positions using the first motion start position, for example, as a reference while executing multiple motion commands.

```
Move P1 FC1 Till FMR1
Move P2 FC1 Till FMR1
```

To do this, use FG_REL_POINT to save the motion start position as the point specified by the DatumPoint property before the first motion.

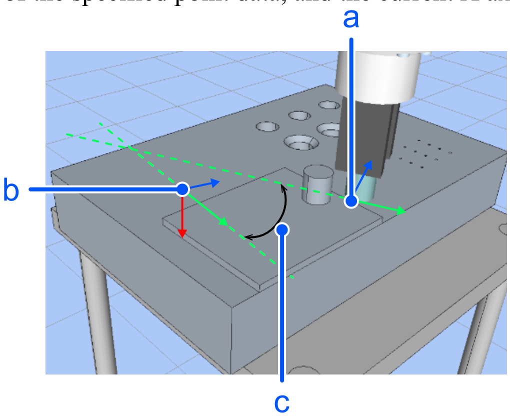
```
P1 = Here
Move P1 FC1 Till FMR1
Move P2 FC1 Till FMR1
```

This is used to monitor the travel amount from a point when executing multiple motion commands when the motion or monitoring start position changes, such as when determining the start position using the vision system, or the force trigger function. This can be used when monitoring a single motion command using the offset position from the start position as a reference.
The position is determined based on the amount of movement towards the current position in the X, Y, or Z direction from the point data set for the DatumPoint. If X is the specified axis, the amount of movement in the X direction in the specified point coordinate system will be determined as shown in the diagram below.




| Symbol | Description |
|---|---|
| a | Current position |
| b | Point data |
| c | Value to be monitored |

The orientation will be determined either by the angle between the axis (X, Y, or Z) specified by the Rot_Axes property in the current tool coordinate system and the axis in the point data set for the DatumPoint, or by the amount of rotation of arbitrary axis. If X is the specified axis, this will determine the angle between the X axis of the specified point data, and the current X axis as shown in the diagram below.

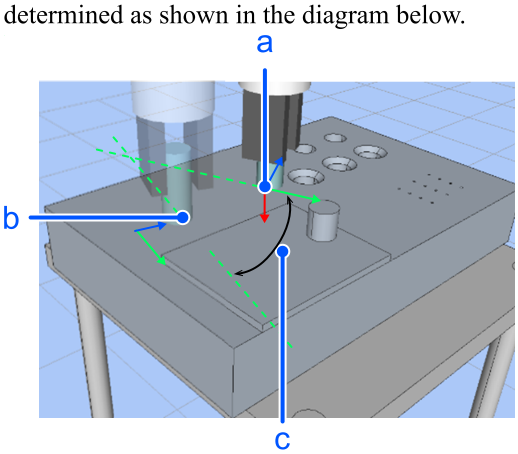


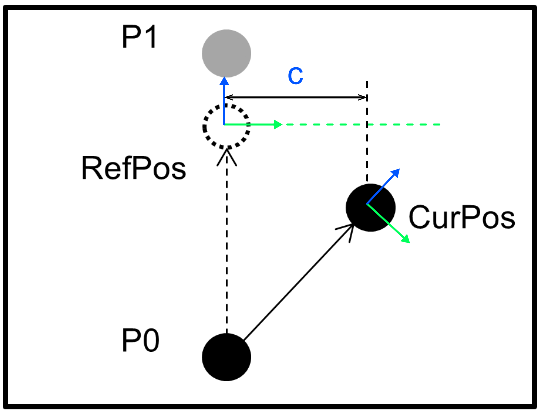

| Symbol | Description |
|---|---|
| a | Current orientation |
| b | Point data |
| c | Value to be monitored |

- FG_FRC_CORRECTION

Monitors the amount of correction applied by the force control function. The amount of correction is the difference between the virtual command position (RefPos) to which the robot attempted to move by original motion command and the command position including corrections applied by the force control function in the force coordinate system. Force coordinate system follows the force coordinate system object (FCS) specified by the CoordinateSystem property of the force control object (FC). You can detect deviations in the amount of correction applied by the force control function from the expected range.
The position is determined as X, Y, and Z according to the amount of correction in the Fx, Fy and Fz directions in the force coordinate system. If X is the specified axis, the amount of movement in the Fx direction will be

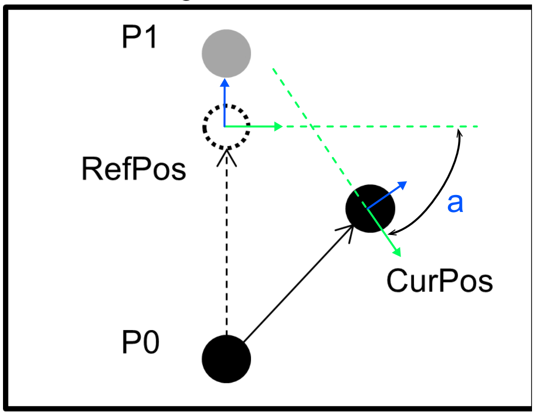
determined as shown in the diagram below.




| Symbol | Description |
|---|---|
| a | Current orientation |
| b | Start position |
| c | Value to be monitored |

The orientation will be determined either by the angle between the axes (X, Y, or Z) specified by the Rot_Axes property in RefPos and CurPos, or by the amount of rotation of arbitrary axis. If X is the specified axis, this will determine the angle between the X axis for RefPos and the X axis for CurPos as shown in the diagram below.




| Symbol | Description |
|---|---|
| a | Value to be monitored |

- FG_ABS_JOINT

Monitors the current joint position of each joint. As the LowerLevel and UpperLevel are fixed to robot joint positions, the restriction range as seen externally will not change depending on the position and orientation of the robot at the start of monitoring. This is used when setting the entry into and exit from a fixed range, regardless of the motion start position, as a condition.

- FG_REL_JOINT

  Monitors the amount of movement for each joint from the position at the start of monitoring to the current joint position. As the LowerLevel and UpperLevel are set based on the monitoring start position, the restriction range as seen externally will change depending on the position and orientation of the robot at the start of monitoring. This is used to detect movement of a specified joint exceeding a set angle from the start of movement when the motion or monitoring start position changes, such as when determining the start position using the vision system, or the force trigger function.

### Usage Example

This example outlines movement with the force control function activated until the Z position gets to 100 [mm] or less in the base coordinate system when specifying FG_ABS_COORD_SYS.

```
Function ABS_COORD_SYS_Test
  Motor On
  Go Here :Z(150)                    ' Go to Z = 150 [mm] as the initial position

  FSet FCS1.Orientation, FG_BASE     ' Sets the force coordinate data

  FSet FC1.CoordinateSystem, FCS1    ' Sets the force coordinate data
  FSet FC1.Fz_Spring, 0              ' Sets virtual Fz coefficient of elasticity
  FSet FC1.Fz_Damper, 1              ' Sets virtual Fz coefficient of viscosity
  FSet FC1.Fz_Mass, 10               ' Sets virtual Fz coefficient of inertia
  FSet FC1.Fz_Enabled, True          ' Activates Fz force control function

  FSet FMR1.CoordinateSystem, FCS1   ' Specifies the force coordinate data
  FSet FMR1.TriggerMode, FG_ABS_COORD_SYS
    ' Sets position monitoring in the specified coordinate system
  FSet FMR1.RobotLocal, 0            ' Sets the position coordinate system to 0
(base)
  FSet FMR1.PosZ_Enable, True        ' Activates monitoring in the Z direction
  FSet FMR1.PosZ_Levels, -100, 100   ' Sets the Z direction range to be from -100 to
100 [mm]
  FSet FMR1.PosZ_Polarity, FG_IN     ' Sets value within range as condition met

  Move Here -Z(100) FC1 Till FMR1
    ' Execute Move operation with the force control function activated while
monitoring end conditions using Till
Fend
```

In this example, the robot stops when there is ±100 [mm] of movement or more toward the Z position in the Local 1 coordinate system with the force control function activated when specifying FG_REL_COORD_SYS. While not expressly stated in this example, assume that the start position changes with each movement, such as for vision system detection.

```
Function REL_COORD_SYS_Test
  Motor On

  FSet FCS1.Orientation, FG_LOOCAL, 1   ' Sets the force coordinate data

  FSet FC1.CoordinateSystem, FCS1       ' Sets the force coordinate data
  FSet FC1.Fz_Spring, 0                 ' Sets virtual Fz coefficient of elasticity
  FSet FC1.Fz_Damper, 1                 ' Sets virtual Fz coefficient of viscosity
  FSet FC1.Fz_Mass, 10                  ' Sets virtual Fz coefficient of inertia
  FSet FC1.Fz_Enabled, True             ' Activates Fz force control function

  FSet FMR1.CoordinateSystem, FCS1      ' Sets the force coordinate data
  FSet FMR1.TriggerMode, FG_REL_COORD_SYS
    ' Sets movement amount monitoring in the specified coordinate system
  FSet FMR1.RobotLocal, 1               ' Sets Local 1 as the coordinate system of
```

```
the position
  FSet FMR1.PosZ_Enable, True          ' Activates monitoring in the Z direction
  FSet FMR1.PosZ_Levels, -100, 100     ' Sets the Z direction range to be from -100
to 100 [mm]
  FSet FMR1.PosZ_Polarity, FG_OUT      ' Sets value outside range as condition met

  Move P0 FC1 Till FMR1
    ' Execute Move operation with the force control function activated while
monitoring end conditions using Till
Fend
```

In this example, the robot stops when there is +100 [mm] of movement or more in the Z direction in the tool coordinate system at the start with the force control function activated when specifying FG_REL_TOOL. While not expressly stated in this example, assume that the start position changes with each movement, such as for vision system detection.

```
Function REL_TOOL_Test
  Motor On

  FSet FCS1.Orientation, FG_TOOL    ' Sets the force coordinate data

  FSet FC1.CoordinateSystem, FCS1   ' Sets the force coordinate data
  FSet FC1.Fz_Spring, 0             ' Sets virtual Fz coefficient of elasticity
  FSet FC1.Fz_Damper, 1             ' Sets virtual Fz coefficient of viscosity
  FSet FC1.Fz_Mass, 10              ' Sets virtual Fz coefficient of inertia
  FSet FC1.Fz_Enabled, True         ' Activates Fz force control function

  FSet FMR1.CoordinateSystem, FCS1  ' Specifies the force coordinate data
  FSet FMR1.TriggerMode, FG_REL_TOOL
    ' Sets movement amount monitoring in the tool coordinate system
  FSet FMR1.PosZ_Enable, True       ' Activates monitoring in the Z direction
  FSet FMR1.PosZ_Levels, 100, 200   ' Sets the Z direction range to be from 100 to
200 [mm]
  FSet FMR1.PosZ_Polarity, FG_IN    ' Sets value within range as condition met

  Move Here +TLZ(200) FC1 Till FMR1
    ' Execute Move operation with the force control function activated while
monitoring end conditions using Till
Fend
```

In this example, the robot stops when there is ±100 [mm] of movement or more in the Z direction in the tool coordinate system at the first start while executing multiple motion commands with the force control function activated using the start position as a reference when specifying FG_REL_POINT. While not expressly stated in this example, assume that each point changes with each movement, such as for vision system detection.

```
Function REL_POINT_Test
  Motor On
  Go P1                             ' Go to P1 as the initial position

  FSet FCS1.Orientation, FG_TOOL    ' Sets the force coordinate data

  FSet FC1.CoordinateSystem, FCS1   ' Sets the force coordinate data
  FSet FC1.Fz_Spring, 0             ' Sets virtual Fz coefficient of elasticity
  FSet FC1.Fz_Damper, 1             ' Sets virtual Fz coefficient of viscosity
  FSet FC1.Fz_Mass, 10              ' Sets virtual Fz coefficient of inertia
  FSet FC1.Fz_Enabled, True         ' Activates Fz force control function

  FSet FMR1.CoordinateSystem, FCS1  ' Specifies the force coordinate data
  FSet FMR1.TriggerMode, FG_REL_POINT
    ' Sets movement amount monitoring from point
  FSet FMR1.DatumPoint, P1          ' Sets P1 as the reference point
  FSet FMR1.PosZ_Enable, True       ' Activates monitoring in the Z direction
  FSet FMR1.PosZ_Levels, -100, 100  ' Sets the Z direction range to be from -100 to
100 [mm]
```

```
  FSet FMR1.PosZ_Polarity, FG_OUT   ' Sets value outside range as condition met

  Move P2 FC1 Till FMR1
  Move P3 FC1 Till FMR1
  Move P4 FC1 Till FMR1
    ' Execute Move operation with the force control function activated while
monitoring end conditions using Till
Fend
```

In this example, the robot stops when there is ±100 [mm] of movement or more in the Fz direction while executing multiple motion commands with the force control function activated when specifying FG_FRC_CORRECTION.

```
Function FRC_CORRECTION_Test
  Motor On
  Go P1                             ' Go to P1 as the initial position

  FSet FCS1.Orientation, FG_TOOL    ' Sets the force coordinate data

  FSet FC1.CoordinateSystem, FCS1   ' Sets the force coordinate data
  FSet FC1.Fz_Spring, 0             ' Sets virtual Fz coefficient of elasticity
  FSet FC1.Fz_Damper, 1             ' Sets virtual Fz coefficient of viscosity
  FSet FC1.Fz_Mass, 10              ' Sets virtual Fz coefficient of inertia
  FSet FC1.Fz_Enabled, True         ' Activates Fz force control function

  FSet FMR1.CoordinateSystem, FCS1  ' Specifies the force coordinate data
  FSet FMR1.TriggerMode, FG_FRC_CORRECTION
    ' Sets force control correction monitoring
  FSet FMR1.PosZ_Enable, True       ' Activates monitoring in the Z direction
  FSet FMR1.PosZ_Levels, -100, 100  ' Sets the Z direction range to be from -100 to
100 [mm]
  FSet FMR1.PosZ_Polarity, FG_OUT   ' Sets value outside range as condition met

  Move P2 FC1 Till FMR1
  Move P3 FC1 Till FMR1
  Move P4 FC1 Till FMR1
    ' Execute Move operation with the force control function activated while
monitoring end conditions using Till
Fend
```

In this example, the robot stops when J5 has moved -5 [deg] or more while executing multiple motion commands with the force control function activated when specifying FG_ABS_JOINT.

```
Function ABS_JOINT_Test
  Motor On
  Go JA(0, 0, 0, 0, -90, 0)            ' Move J5 to -90 [deg] as the initial
position

  FSet FCS1.Orientation, FG_TOOL       ' Sets the force coordinate data

  FSet FC1.CoordinateSystem, FCS1      ' Sets the force coordinate data
  FSet FC1.Fz_Spring, 0                ' Sets virtual Fz coefficient of elasticity
  FSet FC1.Fz_Damper, 1                ' Sets virtual Fz coefficient of viscosity
  FSet FC1.Fz_Mass, 10                 ' Sets virtual Fz coefficient of inertia
  FSet FC1.Fz_Enabled, True            ' Activates Fz force control function

  FSet FMR1.CoordinateSystem, FCS1     ' Sets the force coordinate data
  FSet FMR1.TriggerMode, FG_ABS_JOINT  ' Sets monitoring of joint positions
  FSet FMR1.J5_Enable, True            ' Activates monitoring of J5
  FSet FMR1.J5_Levels, -5, 100         ' Sets the J5 range to be from -5 to 100
[mm]
  FSet FMR1.J5_Polarity, FG_IN         ' Sets value within range as condition met

  Move P1 FC1 Till FMR1
    ' Execute Move operation with the force control function activated while
```

```
monitoring end conditions using Till
Fend
```

In this example, the robot stops when J5 has moved ±30 [deg] or more while executing multiple motion commands with the force control function activated when specifying FG_REL_JOINT. While not expressly stated in this example, assume that the start position changes with each movement, such as for vision system detection.

```
Function FG_REL_JOINT_Test
  Motor On

  FSet FCS1.Orientation, FG_TOOL       ' Sets the force coordinate data

  FSet FC1.CoordinateSystem, FCS1      ' Sets the force coordinate data
  FSet FC1.Fz_Spring, 0                ' Sets virtual Fz coefficient of elasticity
  FSet FC1.Fz_Damper, 1                ' Sets virtual Fz coefficient of viscosity
  FSet FC1.Fz_Mass, 10                 ' Sets virtual Fz coefficient of inertia
  FSet FC1.Fz_Enabled, True            ' Activates Fz force control function

  FSet FMR1.CoordinateSystem, FCS1     ' Sets the force coordinate data
  FSet FMR1.TriggerMode, FG_REL_JOINT  ' Sets monitoring of joint movement amount
  FSet FMR1.J5_Enable, True            ' Activates monitoring of J5
  FSet FMR1.J5_Levels, -30, 30         ' Sets the J5 range to be from -5 to 100
[mm]
  FSet FMR1.J5_Polarity, FG_IN         ' Sets value within range as condition met

  Move P2 FC1 Till FMR1
    ' Execute Move operation with the force control function activated while
monitoring end conditions using Till
Fend
```

**See Also**

**DatumPoint Property**, **RefPos Status**, **RobotLocal Property**, **FMR (Force Motion Restriction) Object**

# 24.24 Tx_AvgForce, Ty_AvgForce, Tz_AvgForce Status

### Application
Force Monitor Object FM#

### Description
This returns the average torque for the specified axis in the direction of rotation.

### Usage
FGet Object.XX_AvgForce, rVar

- Object
  Object name
  The object is specified as either of FM (numerical value) or FM (label).

- XX
  A character string defining the name of the property

- rVar
  A real number variable defining the value of the property

### Values
XX

| Specified Axis | Description |
|---|---|
| Tx | Specifies X axis in the direction of rotation. |
| Ty | Specifies Y axis in the direction of rotation. |
| Tz | Specifies Z axis in the direction of rotation. |

### Detailed Explanation
XX_AvgForce returns the value of the average torque in the specified axis in the direction of rotation.
Execute AvgForceClear before executing XX_AvgForce. Without executing AvgForceClear, “0” is returned.
If the time between executing AvgForceClear and executing XX_AvgForce is short, a deviation in the force and torque averages will occur. Establish a low-pass filter with a time constant of about 5 times between the AvgForceClear and the XX_AvgForce execution.
There is a time limit on XX_AvgForce. Execute XX_AvgForce within 600 seconds of executing AvgForceClear. When XX_AvgForce is executed after 600 seconds has passed, an error is generated.

### Usage Example
This example measures the value of the average torque in the Tx direction.

```
Function CheckAverageForce
  Double AF
  FSet FC1.Enabled, False, False, False, True, False, False
  FSet FC1.TargetForces, 0, 0, 0, 200, 0, 0
  FSet FS1.Reset
  FSet FM1.CoordinateSystem, FCS0
  FSet FM1.AvgForceClear, False, False, False, True, False,
                                   False, False, False
  FCKeep FC1, 10
  FGet FM1.Tx_AvgForce, AF
  Print AF
Fend
```

### See Also

**FM (Force Monitor) Object**

# 24.25 Tx_Damper, Ty_Damper, Tz_Damper Property

### Application
Force Control Object FC#

### Description
This sets or returns the value of the virtual coefficient of viscosity for force control in the specified axis of the force coordinate system.

### Immediate Execution
No

### Usage
FGet Object.XX_Damper, rVar
FSet Object.XX_Damper, rValue

- Object
  Object name
  The object is specified as either of FC (numerical value) or FC (label).
- XX
  A character string defining the name of the property
- rVar
  A real number variable defining the value of the property
- rValue
  A real number or formula defining the new value of the property

### Values
XX

| Specified Axis | Description |
|---|---|
| Tx | Specifies X axis in the direction of rotation. |
| Ty | Specifies Y axis in the direction of rotation. |
| Tz | Specifies Z axis in the direction of rotation. |

rValue (Unit: [ N·mm/(deg/sec)])

| | Values |
|---|---|
| Minimum | 10 |
| Maximum | 1000000 |

Default: 3000

### Detailed Explanation
This sets or returns the value of the virtual coefficient of viscosity for force control in the direction of rotation for the specified axis of the established force coordinate system.
Refer to the following manual for details on coefficients.
"Epson RC+ 8.0 Option Force Guide 8.0"

### Usage Example

This example sets the virtual Tx coefficients of elasticity, viscosity, and inertia, and carries out a motion with the force control function active.

```
Function ForceControlTest
  FSet FCS1.Orientation, FG_TOOL
  FSet FC1.CoordinateSystem, FCS1
  FSet FC1.Enabled, False, False, False, True, False, False
  FSet FC1.Tx_Spring, 20000
  FSet FC1.Tx_Damper, 8000
  FSet FC1.Tx_Mass, 10000
  Move CurPos +TLW(10) FC1 ROT
Fend
```

### See Also

**FC (Force Control) Object**

# 24.26 Tx_Enabled, Ty_Enabled, Tz_Enabled Property

### Application
Force Control Object FC#, Force Trigger Object FT#

### Description
This activates/inactivates, or returns the force control function of the rotational direction.

### Immediate Execution
No

### Usage
FGet Object.XX_Enabled, bVar
FSet Object. XX_Enabled, bValue

- Object
  Object name
- XX
  A character string defining the name of the property
- bVar
  A Boolean variable defining the value of the property
- bValue
  A Boolean value or formula defining the new value of the property

### Values
XX

| Specified Axis | Description |
|---|---|
| Tx | Specifies X axis in the direction of rotation. |
| Ty | Specifies Y axis in the direction of rotation. |
| Tz | Specifies Z axis in the direction of rotation. |

bValue

| Name of Constants | Values | Description |
|---|---|---|
| False | 0 | Inactivates the subject axis. (default) |
| True | -1 | Activates the subject axis. |

### Detailed Explanation
This activates/inactivates, or returns the force control function of the rotational direction.
For SCARA robots (including RS series), the force control cannot be executed with the FC object when the following properties are "True".
Tx_Enabled property
Ty_Enabled property

### Usage Example
This example activates the force control function for the torque in the Z axis for the Force Trigger Object.

```
> FSet FT1.Tz_Enabled, True
```

### See Also

**FC (Force Control) Object**, **FT (Force Trigger) Object**

## 24.27 Tx_Force, Ty_Force, Tz_Force Status

### Application

Force Monitor Object FM#

### Description

This returns torque data for the specified axis.

### Usage

FGet Object.XX_Force, rVar

- Object
  Object name
  The object is specified as either of FM (numerical value) or FM (label).

- XX
  A character string defining the name of the property

- rVar
  A real number variable defining the value of the property

### Values

XX

| Specified Axis | Description |
|---|---|
| Tx | Specifies X axis in the direction of rotation. |
| Ty | Specifies Y axis in the direction of rotation. |
| Tz | Specifies Z axis in the direction of rotation. |

### Detailed Explanation

This property is used to confirm the torque data for the specified axis of the force coordinate system specified by the CoordinateSystem.

### Usage Example

This example establishes the force coordinate system 1 for the Force Monitor Object, and acquires the X axis torque data.

```
Function Test_Tx_Force
  Real rVar
  FSet FCS1.Position, 0, 0, 100
  FSet FCS1.Orientation, FG_TOOL
  FM1.ForceSensor, 1
  FSet FM1.CoordinateSystem, FCS1
  FGet FM1.Tx_Force, rVar
  Print rVar
Fend
```

### See Also

**FM (Force Monitor) Object**

# 24.28 Tx_Levels, Ty_Levels, Tz_Levels Property

### Application
Force Trigger Object FT#

### Description
This sets or returns the values of the lower and upper thresholds for torque in the specified axis in the direction of rotation.

### Immediate Execution
No

### Usage
FGet Object.XX_Levels, rArray()
FSet Object.XX_Levels, rValueL, rValueU

- Object
  Object name
  The object is specified as either of FT (numerical value) or FT (label).

- XX
  A character string defining the name of the property

- rArray()
  The number of elements defining the values of the property is an array of 2 or more real number variables

- rValueL
  A real number or formula defining the new value of the property.

- rValueU
  A real number or formula defining the new value of the property.

### Values
XX

| Specified Axis | Description |
|---|---|
| Tx | Specifies X axis in the direction of rotation. |
| Ty | Specifies Y axis in the direction of rotation. |
| Tz | Specifies Z axis in the direction of rotation. |

rArray()

| Element number | Element number constant |
|---|---|
| 0 | FG_ LOWERLEVEL |
| 1 | FG_ UPPERLEVEL |

rValueL (Unit: [N·mm])

| | Values |
|---|---|
| Minimum | -100000 (default) |
| Maximum | 100000 |

rValueU (Unit: [N·mm])

| | Values |
|---|---|
| Minimum | -100000 |
| Maximum | 100000 (default) |

### Detailed Explanation

XX_Levels sets or returns the lower and upper torque threshold values for the specified axis in the direction of rotation.
rValueL is the lower threshold. rValueU is the upper threshold. Be sure that rValueL < rValueU.
This is used for error checking and task completion conditions.

### Usage Example

This example generates an error and stops the robot when the Tx torque is below or above the lower or upper thresholds, respectively.

```
Function SettingLevels
  Set FT1.Enabled, False, False, False, True, False, False, False, False
  FSet FT1.Tx_Polarity, FG_OUT
  FSet FT1.Tx_Levels, -5000, 5000
  Trap 1, FT1 Call ForceError
Fend

Function ForceError
  AbortMotion All
Fend
```

### See Also

**FT (Force Trigger) Object**

# 24.29 Tx_LPF_Enabled, Ty_LPF_Enabled, Tz_LPF_Enabled Property

### Application
Force Trigger Object FT#, Force Monitor Object FM#

### Description
This activates/inactivates or returns the status of the low-pass filter in the specified axis in the direction of rotation in the force coordinate system.

### Immediate Execution
No

### Usage
FGet Object.XX_LPF_Enabled, bVar
FSet Object.XX_LPF_Enabled, bValue

- Object
  Object name
  The object is specified as FT (numerical value), FT (label), FM (numerical value), or FM (label).

- XX
  A character string defining the name of the property

- bVar
  A Boolean variable defining the value of the property

- bValue
  A Boolean value or formula defining the new value of the property

### Values
XX

| Specified Axis | Description |
|---|---|
| Tx | Specifies X axis in the direction of rotation. |
| Ty | Specifies Y axis in the direction of rotation. |
| Tz | Specifies Z axis in the direction of rotation. |

bValue

| Name of Constants | Values | Description |
|---|---|---|
| False | 0 | Sets the low-pass filter to inactive. (default) |
| True | -1 | Sets the low-pass filter to active. |

### Detailed Explanation
This activates/inactivates or returns the status of the low-pass filter in the specified axis in the direction of rotation in the force coordinate system.
When the low-pass filter is active, signal noise can be reduced, but the following performance for quick signal changes deteriorates.
The low-pass filter is used with AvgForces Status, PeakForces Status, the Force Trigger Function, and Force Monitor, but is not used with Forces Status.

### Usage Example

This example sets the Tx low-pass filter, and acquires the force data.

```
Function GetPeakForceTest
  Real myPeakForce
  FSet FCS1.Orientation, FG_TOOL
  FSet FM1.CoordinateSystem, FCS1
  FSet FM1.Tx_LPF_Enabled, True
  FSet FM1.Tx_LPF_TimeConstant, 0.02
  FSet FM1.PeakForceClear, True, True, True, True, True, True
  Wait 10
  FGet FM1.Tx_PeakForce, myPeakForce
  Print myPeakForce
Fend
```

### See Also

**FT (Force Trigger) Object**, **FM (Force Monitor) Object**

# 24.30 Tx_LPF_TimeConstant, Ty_LPF_TimeConstant, Tz_LPF_TimeConstant Property

### Application

Force Trigger Object FT#, Force Monitor Object FM#

### Description

This sets or returns the value of the low-pass filter setting applied to the specified axis in the direction of rotation in the force coordinate system.

### Immediate Execution

No

### Usage

FGet Object.XX_LPF_TimeConstant, rVar
FSet Object.XX_LPF_TimeConstant, rValue

- Object
  Object name
  The object is specified as FT (numerical value), FT (label), FM (numerical value), or FM (label).
- XX
  A character string defining the name of the property
- rVar
  A real number variable defining the value of the property
- rValue
  A real number or formula defining the new value of the property

### Values

XX

| Specified Axis | Description |
|---|---|
| Tx | Specifies X axis in the direction of rotation. |
| Ty | Specifies Y axis in the direction of rotation. |
| Tz | Specifies Z axis in the direction of rotation. |

rValue (Unit: [sec])

| | Values |
|---|---|
| Minimum | 0.002 |
| Maximum | 5 |

Default: 0.01

### Detailed Explanation

This sets the time constant for the low-pass filter or returns the status thereof for the specified axis in the direction of rotation for the force trigger function or force monitor function.

The low-pass filter time constant is the time it takes to arrive at an input value of $1\text{-}e^{-1}$ (approximately 63.2%) when giving step input.

The signal noise reduction can be enhanced when increasing the time constant, but the following performance for quick signal changes deteriorates.

The low-pass filter is used with AvgForces Status, PeakForces Status, the Force Trigger Function, and Force Monitor, but is not used with Forces Status.

### Usage Example

This example sets the Tx low-pass filter, and acquires the force data.

```
Function GetPeakForceTest
  Real myPeakForce
  FSet FCS1.Orientation, FG_TOOL
  FSet FM1.CoordinateSystem, FCS1
  FSet FM1.Tx_LPF_Enabled, True
  FSet FM1.Tx_LPF_TimeConstant, 0.02
  FSet FM1.PeakForceClear, True, True, True, True, True, True
  Wait 10
  FGet FM1.Tx_PeakForce, myPeakForce
  Print myPeakForce
Fend
```

### See Also

**FT (Force Trigger) Object**, **FM (Force Monitor) Object**

# 24.31 Tx_Mass, Ty_Mass, Tz_Mass Property

### Application
Force Control Object FC#

### Description
This sets or returns the value of the virtual coefficient of inertia for force control in the specified axis in the direction of rotation in the force coordinate system.

### Immediate Execution
No

### Usage
FGet Object.XX_Mass, rVar
FSet Object.XX_Mass, rValue

- Object
  Object name
  The object is specified as either of FC (numerical value) or FC (label).
- XX
  A character string defining the name of the property
- rVar
  A real number variable defining the value of the property
- rValue
  A real number or formula defining the new value of the property.

### Values
XX

| Specified Axis | Description |
|---|---|
| Tx | Specifies X axis in the direction of rotation. |
| Ty | Specifies Y axis in the direction of rotation. |
| Tz | Specifies Z axis in the direction of rotation. |

rValue (Unit: [ mN·mm/(deg/sec$^2$)])

| | Values |
|---|---|
| Minimum | 1000 |
| Maximum | 10000000 |

Default: 30000

### Detailed Explanation
This sets or returns the value of the virtual coefficient of inertia for force control in the specified axis in the direction of rotation in the established force coordinate system.
Refer to the following manual for details on coefficients.
"Epson RC+ 8.0 Option Force Guide 8.0"

### Usage Example

This example sets the Tx virtual coefficients of elasticity, viscosity, and inertia, and carries out a motion with force control active.

```
Function ForceControlTest
  FSet FCS1.Orientation, FG_TOOL
  FSet FC1.CoordinateSystem, FCS1
  FSet FC1.Enabled, False, False, False, True, False, False
  FSet FC1.Tx_Spring, 20000
  FSet FC1.Tx_Damper, 8000
  FSet FC1.Tx_Mass, 10000
  Move CurPos +TLW(10) FC1 ROT
Fend
```

### See Also

**FC (Force Control) Object**

# 24.32 Tx_PeakForce, Ty_PeakForce, Tz_PeakForce Status

### Application

Force Monitor Object FM#

### Description

This returns the value of the peak torque in the specified axis in the direction of rotation.

### Usage

FGet Object.XX_PeakForce, rVar

- Object
  Object name
  The object is specified as either of FM (numerical value) or FM (label).

- XX
  A character string defining the name of the property

- rVar
  A real number variable defining the value of the property

### Values

XX

| Specified Axis | Description |
|---|---|
| Tx | Specifies X axis in the direction of rotation. |
| Ty | Specifies Y axis in the direction of rotation. |
| Tz | Specifies Z axis in the direction of rotation. |

### Detailed Explanation

XX_PeakForce returns the peak torque for the specified axis in the direction of rotation.
Before executing XX_PeakForce, execute PeakForceClear.

### Usage Example

This example measures the value of the peak torque in the Tx direction.

```
Function CheckPeakForce
  Double PF
  FSet FC1.Enabled, False, False, False, True, False, False
  FSet FC1.TargetForces, 0, 0, 0, 200, 0, 0
  FSet FS1.Reset
  FSet FM1.CoordinateSystem, FCS0
  FSet FM1.PeakForceClear, False, False, False, True, False, False, False, False
  FCKeep FC1, 10
  FGet FM1.Tx_PeakForce, PF
  Print PF
Fend
```

### See Also

**FM (Force Monitor) Object**

# 24.33 Tx_Polarity, Ty_Polarity, Tz_Polarity Property

### Application
Force Trigger Object FT#

### Description
This returns the status of or sets whether the force trigger is triggered when the value in the specified axis in the direction of rotation is within the thresholds or when the value in the specified axis in the direction of rotation is outside of the thresholds.

### Immediate Execution
No

### Usage
FGet Object.XX_Polarity, iVar
FSet Object.XX_Polarity, iValue

- Object
  Object name
  The object is specified as either of FT (numerical value) or FT (label).

- XX
  A character string defining the name of the property

- iVar
  An integer variable defining the value of the property

- iValue
  An integer value or formula defining the new value of the property

### Values
XX

| Specified Axis | Description |
|---|---|
| Tx | Specifies X axis in the direction of rotation. |
| Ty | Specifies Y axis in the direction of rotation. |
| Tz | Specifies Z axis in the direction of rotation. |

iValue

| Name of Constants | Values | Description |
|---|---|---|
| FG_OUT | 0 | Triggered when value is not within upper and lower thresholds. (default) |
| FG_IN | 1 | Triggered when value is within upper and lower thresholds. |

### Detailed Explanation
XX_Polarity returns the status of or sets whether the force trigger is triggered when the value in the specified axis in the direction of rotation is within the thresholds or when the value in the specified axis in the direction of rotation is outside of the thresholds.

### Usage Example
This example generates an error and stops the robot if the Tx torque is greater than the upper threshold or lower than the lower threshold.

```
Function SettingPolarity
  Set FT1.Enabled, False, False, False, True, False, False, False, False
  FSet FT1.Tx_Polarity, FG_OUT
  FSet FT1.Tx_Levels, -5000, 5000
  Trap 1, FT1 Call ForceError
Fend

Function ForceError
  AbortMotion All
Fend
```

### See Also

FT (Force Trigger) Object

# 24.34 Tx_Spring, Ty_Spring, Tz_Sprin Property

### Application
Force Control Object FC#

### Description
This sets or returns the value of the virtual coefficient of elasticity for force control in the specified axis in the direction of rotation in the force coordinate system.

### Immediate Execution
No

### Usage
FGet Object.XX_Spring, rVar
FSet Object.XX_Spring, rValue

- Object
  Object name
  The object is specified as either of FC (numerical value) or FC (label).

- XX
  A character string defining the name of the property

- rVar
  A real number variable defining the value of the property

- rValue
  A real number or formula defining the new value of the property

### Values
XX

| Specified Axis | Description |
|---|---|
| Tx | Specifies X axis in the direction of rotation. |
| Ty | Specifies Y axis in the direction of rotation. |
| Tz | Specifies Z axis in the direction of rotation. |

rValue (Unit: [N·mm/deg])

| | Values |
|---|---|
| Minimum | 0 (default) |
| Maximum | 1000000 |

### Detailed Explanation
This sets or returns the value of the virtual coefficient of elasticity for force control in the specified axis in the direction of rotation in the established force coordinate system.
Refer to the following manual for details on coefficients.
"Epson RC+ 8.0 Option Force Guide 8.0"

### Usage Example
This example sets the Tx virtual coefficients of elasticity, viscosity, and inertia, and carries out a motion with force control active.

```
Function ForceControlTest
  FSet FCS1.Orientation, FG_TOOL
  FSet FC1.CoordinateSystem, FCS1
  FSet FC1.Enabled, False, False, False, True, False, False
  FSet FC1.Tx_Spring, 20000
  FSet FC1.Tx_Damper, 8000
  FSet FC1.Tx_Mass, 10000
  Move CurPos +TLW(10) FC1 ROT
Fend
```

**See Also**

**FC (Force Control) Object**

# 24.35 Tx_TargetForce, Ty_TargetForce, Tz_TargetForce Property

### Application
Force Control Object FC#

### Description
This sets or returns the value of the target torque in the specified axis in the direction of rotation in the force coordinate system.

### Immediate Execution
No

### Usage
FGet Object.XX_TargetForce, rVar
FSet Object.XX_TargetForce, rValue

- Object
  Object name
  The object is specified as either of FC (numerical value) or FC (label).

- XX
  A character string defining the name of the property

- rVar
  A real number variable defining the value of the property

- rValue
  A real number or formula defining the new value of the property.

### Values
XX

| Specified Axis | Description |
|---|---|
| Tx | Specifies X axis in the direction of rotation. |
| Ty | Specifies Y axis in the direction of rotation. |
| Tz | Specifies Z axis in the direction of rotation. |

rValue (Unit: [N·mm])

| | Values |
|---|---|
| Minimum | The rated negative detection capability of the force sensor |
| Maximum | The rated positive detection capability of the force sensor |

Default: 0

### Detailed Explanation
This sets or returns the value of the target torque in the specified axis in the direction of rotation in the force coordinate system.
When the force control function is executed with the target torque being set to “0”, the robot operates while following the external force because it moves so that the force becomes “0”.
When using the force control function having set the target torque, there are times that the target force is not achieved even after sufficient time. In such instances, activate the TargetForcePriorityMode when wanting to accurately match the target force. However, when the TargetForcePriorityMode is activated, operation of the robot will not be in accordance with the established values for the virtual coefficients of elasticity, viscosity, and inertia, and the motion may be slowed at times.

### Usage Example

This example sets the Tx virtual coefficients of elasticity, viscosity, and inertia and the target torque, and carries out a motion with force control active.

```
FSet FCS1.Orientation, FG_TOOL
FSet FC1.CoordinateSystem, FCS1
FSet FC1.Enabled, False, False, False, True, False, False
FSet FC1.Tx_Spring, 20000
FSet FC1.Tx_Damper, 8000
FSet FC1.Tx_Mass, 10000
FSet FC1.Tx_TargetForce, 0.1
FCKeep FC1, 5
```

### See Also

**FC (Force Control) Object**

# 25. U

# 25.1 UpperLevels Property

### Application
Force Trigger Object FT#

### Description
This sets or returns the value of the upper threshold for force and torque on each axis at the same time.

### Immediate Execution
No

### Usage
FGet Object.UpperLevels, rArray()
FSet Object.UpperLevels, rValueFx, rValueFy, rValueFz, rValueTx, rValueTy, rValueTz [,rValueFmag ,rValueTmag]

- Object
  Object name
  The object is specified as either of FT (numerical value) or FT (label).

- rArray()
  The number of elements defining the values of the property is an array of 8 or more real number variables

- rValueFx
  A real number or formula defining the new value of the property.

- rValueFy
  A real number or formula defining the new value of the property.

- rValueFz
  A real number or formula defining the new value of the property.

- rValueTx
  A real number or formula defining the new value of the property.

- rValueTy
  A real number or formula defining the new value of the property.

- rValueTz
  A real number or formula defining the new value of the property.

- rValueFmag
  A real number or formula defining the new value of the property.

- rValueTmag
  A real number or formula defining the new value of the property.

### Values
rArray()

| Element number | Element number constant | Description |
|---|---|---|
| 0 | FG_FX | Acquires the upper threshold for Fx force. |
| 1 | FG_FY | Acquires the upper threshold for Fy force. |
| 2 | FG_FZ | Acquires the upper threshold for Fz force. |

| Element number | Element number constant | Description |
|---|---|---|
| 3 | FG_TX | Acquires the upper threshold for Tx torque. |
| 4 | FG_TY | Acquires the upper threshold for Ty torque. |
| 5 | FG_TZ | Acquires the upper threshold for Tz torque. |
| 6 | FG_FMAG | Acquires the upper threshold for Fmag resultant force. |
| 7 | FG_TMAG | Acquires the upper threshold for Tmag resultant torque. |

Note: When the number of elements is an array of 6 or 7, the element numbers acquired are 0 to 5.

rValueFx, rValueFy, rValueFz (Unit: [N])

| | Values |
|---|---|
| Minimum | -1000 |
| Maximum | 1000 (default) |

rValueTx, rValueTy, rValueTz (Unit: [N·mm])

| | Values |
|---|---|
| Minimum | -100000 |
| Maximum | 100000 (default) |

rValueFmag (Unit: [N])

| | Values |
|---|---|
| Minimum | 0 |
| Maximum | 1000 (default) |

rValueTmag (Unit: [N·mm])

| | Values |
|---|---|
| Minimum | 0 |
| Maximum | 100000 (default) |

### Detailed Explanation

UpperLevels sets or returns the value of the upper threshold for force and torque on each axis at the same time.
Be sure that LowerLevels < UpperLevels.
Since all force upper threshold values for each axis are set at one time, it can be done with fewer lines than setting them one axis at a time.
This is used for error checking and task completion conditions.

### Usage Example

This example generates an error and stops the robot when the force is greater than the upper threshold.

```
Function SettingLevels
  FSet FT1.Enabled, True, True, True, True, True, True, True, True
  FSet FT1.Polarities, FG_OUT, FG_OUT, FG_OUT, FG_OUT, FG_OUT, FG_OUT, FG_OUT,
FG_OUT
  FSet FT1.UpperLevels, 50, 50, 50, 3000, 3000, 3000, 50, 3000
  Trap 1, FT1 Call ForceError
```

```
Fend

Function ForceError
  AbortMotion All
Fend
```

**See Also**

**FT (Force Trigger) Object**

# 26. Appendix A:

## 26.1 List of Commands Added for Each Version

| Version of Epson RC+8.0 | New Commands |
|---|---|
| Ver.8.0.0 | - |