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Enable/disable torque limiting by means of _enable- /_disableTorqueLimiting

Contents

1   Description

With the function _**enableTorqueLimiting**, the torque active on the drive can be limited. The limit value is specified in the command.

The function can be used with a speed-controlled axis, a positioning axis or a synchronous axis. The accuracy depends on the drive used.

When this function is active, following error monitoring and position monitoring are disabled. Positioning itself may take as much time as required. When a specified target position has been reached, standstill monitoring is activated as in any normal positioning process, and an alarm is triggered when the standstill window is exited.

Active motion commands and synchronous relationships are continued.

The limits can be activated before or in parallel with a motion and can be changed by issuing a new command.

The command _**disableTorqueLimiting** cancels torque limiting.

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2 Start-up procedure

2.1 Requirements and description of interface

The function can only be used with PROFIBUS axes that are connected via a PROFIBUS telegram, which includes torque reduction. These are drives that support the PROFIBUS telegrams 101, 102, 103, 104, 105 and 106. The function cannot be used with analog axes.
Example: Structure of telegram 105. The data relevant for torque limiting are indicated in bold.

Transmit data of telegram 105
1   Control word 1 (STW_1)
2   Speed setpoint B (NSOLL_B)
3   Speed setpoint B (NSOLL_B)
4   Control word 2 (STW_2)
5   Torque reduction (MomRed)
6   Encoder 1 Control word (G1_STW)
7   System deviation DSC (XERR)
8   System deviation DSC (XERR)
9   Position controller gain factor DSC (KPC)
10 Position controller gain factor DSC (KPC)

Receive data of telegram 105
1   Status word 1 (ZSW_1)
2   Actual speed value B (NIST_B)
3   Actual speed value B (NIST_B)
4   Status word 2 (ZSW_2)
5   Status word MeldW (Meld_W)   → Bit 1: |M| < M$_x$
6   Encoder 1 Status word (G1_ZSW)
7   Encoder 1 Actual position value 1 (G1_XIST1)
8   Encoder 1 Actual position value 1 (G1_XIST1)
9   Encoder 1 Actual position value 2 (G1_XIST2)
10 Encoder 1 Actual position value 2 (G1_XIST2)

Explanation:
|M| Absolute value of torque resulting in the drive
M$_x$ Set torque (→ possibly limited)

In SIMOTION, you specify the **desired torque** (possible for rotary and linear axes) or the **desired force** (only possible for linear axis!) when **calling the function** by providing the relevant unit or the % value related to a reference value (userDefaultTorqueLimiting.torqueLimit). In this context, 0% represents **no** torque on the drive, while 100% represents **full** torque on the drive. → In SIMOTION you specify a torque limit value (→ torque limiting).

Via the **PROFIBUS interface,** a value of 0–100% is transmitted to the drive in integer increments. In this context, 0% represents **full** torque on the drive, while 100% represents **no** torque on the drive. → A torque reduction is transmitted to the drive.

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In SIMOTION, the desired torque or the desired force is converted to a torque reduction for the drive using the preset data. Example: In SIMOTION, the torque reduction is specified with 80%. Resulting from this, a value of 20 (%) is calculated in SIMOTION as the torque reduction and is transmitted to the drive.

This start-up procedure describes the drive settings for a SIMODRIVE 611U connected via telegram 105.

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2.2 Torque/force conversion

For **speed-controlled axes** and **rotary axes**, programming of the '_enableTorqueLimiting' function always defines a torque in Nm, kNm or MNm.
When the function is called and the setting TORQUE is indicated in the 'torqueLimitUnit' function parameter, the specified torque is related to the motor. The gear ratio is not taken into account.
If the setting DEFAULT_UNIT is selected in the function parameter, the torque is related to the load side and the gear ratio is taken into account. The following conversion formula applies:

$$M_{load} = M_{motor} \cdot \frac{Motor\ revolution\ {}_{(Gear.numFactor)}}{Load\ revolution\ {}_{(Gear.denFactor)}}$$

Example: $M_{load} = 14\ \text{Nm} \cdot \dfrac{1}{5} = 2.8\ \text{Nm}$

For **linear axes with standard motor**, either a torque in Nm, kNm or MNm related to the motor, or a force in N, kN or MN related to the load side can be specified for the '_enableTorqueLimiting' function.
When the function is called and the setting TORQUE is indicated in the 'torqueLimitUnit' function parameter, the programmed value is interpreted as a torque related to the motor. The gear ratio, the leadscrew pitch and the efficiency of the spindle are not taken into account.
If the setting DEFAULT_UNIT is selected in the function parameter, the programmed value will be interpreted as a force related to the load side. With this setting, the gear ratio, the leadscrew pitch and the efficiency of the spindle are taken into account. The following conversion formula applies:

$$F = M_{motor} \cdot 2 \cdot \pi \cdot \frac{\eta\ _{Spindle\ (leadscrew.efficiency)}}{S\ _{(leadscrew.pitchval)}} \cdot \frac{Motor\ revolution\ {}_{(Gear.numFactor)}}{Load\ revolution\ {}_{(Gear.denFactor)}}$$

Example:

$$F = 14\ \text{Nm} \cdot 2 \cdot \pi \cdot \frac{1}{10\ \text{mm}} \cdot \frac{1}{5} = 14\ \text{Nm} \cdot 2 \cdot \pi \cdot \frac{1}{0.01\ \text{m}} \cdot \frac{1}{5} = 1759.3\ \text{N}$$

F = Force
M = Torque
S = Leadscrew pitch (leadscrew.pitchVal)
η = Leadscrew efficiency (leadScrew.efficiency)

For **linear axes with linear motor**, programming always specifies a force in N, kN or MN.

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2.3 Parameterization

SIMOTION configuration data	Meaning
TypeOfAxis.SetPointDriverInfo.DriveData.maxTorque	Standard motor: The maximum motor torque (indicated on the motor's rating plate) must be specified here. This maximum torque serves as the reference value for torque limiting. It can be indicated in Nm, KNm or MNm. System default: 3.2 Nm
TypeOfAxis.SetPointDriverInfo.Linear MotorDriveData.maxForce	Linear motor: Specification of the maximum force in N, KN or MN. This force serves as the reference value for the limitation. System default: 1000.0 N
TypeOfAxis.SetPointDriverInfo.DriveData.forceReductionGranularity (V4.0 and higher)	Specification of the torque reduction fine resolution. STANDARD: Resolution 1/16384 BASIC: Resolution 1/100 System default: STANDARD
TypeofAxis.NumberOfDataSets.DataSet_x.Gear.numFactor	Specification of the number of motor revolutions. System default: 1
TypeofAxis.NumberOfDataSets.DataSet_x.Gear.denFactor	Specification of the number of load revolutions. System default: 1
LeadScrewInfo.efficiency	Efficiency of the spindle/master combination. Is taken into account when force (F) on a linear axis with standard motor is programmed (setting in the command '_enableTorqueLimiting' → DEFAULT_UNIT). System default: 1.0
Leadscrew.pitchVal	Specification of the leadscrew pitch per spindle revolution (path / spindle revolution). Is taken into account when force (F) on a linear axis with standard motor is programmed (setting in the command '_enableTorqueLimiting' → DEFAULT_UNIT). System default: 10.0 mm

Note:
The maximum values DriveData.maxTorque or LinearMotorDriveData.MaxForce are the reference values for torque reduction and must be entered in the drive and in SIMOTION in accordance with the motor values. Otherwise incorrect limits will be activated.

SIMOTION system data	Meaning
userDefaultTorqueLimiting.torqueLimit	The user's default for the torque limit value for the 'torquelimit' function parameter is specified in command _enableTorqueLimiting. When setting USER-DEFAULT in command _enableToqueLimiting, this value will be used. System default: 10.0

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Parameter Drive: 611U	Meaning
P881	Evaluation of the transmitted PROFIBUS value for the torque reduction in the drive. Depending on the configuration data TypeOfAxis.SetPointDriverInfo.DriveData.forceReductionGranularity (V4.0 or higher): **Standard:** Via the PROFIBUS interface, the values 0 – 16384 (4000H) are transmitted to the drive in integer increments. Therefore, parameter P881 must be set to value 100 in the 611U (default = 16384) **Basic:** Via the PROFIBUS interface, the values 0 – 100 (%) are transmitted to the drive in integer increments. Therefore, parameter P881 must be maintained at the default of 16384 (4000H) in the 611U.

Parameter Drive: SINAMICS	Meaning
P1544	Evaluation of the transmitted PROFIBUS value for the torque reduction in the drive. Depending on the configuration data TypeOfAxis.SetPointDriverInfo.DriveData.forceReductionGranularity (V4.0 or higher): **Standard:** Via the PROFIBUS interface, the values 0 – 16384 (4000H) are transmitted to the drive in integer increments. Therefore, parameter P1544 must be set to value 100 in SINAMICS (default = 100) **Basic:** Via the PROFIBUS interface, the values 0 – 100 (%) are transmitted to the drive in integer increments. Therefore, parameter P1544 must be set to value 16384 (4000H) in SINAMICS (default = 100)

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3 Programming

3.1 Program sequence for travel with torque limiting

The limits can be activated before or in parallel with a motion and can be changed by issuing a new command.

Active motion commands and synchronous relationships are continued.

Execution of command _enableTorqueLimiting has the following results:
- the reduced maximum torque limit is activated immediately
- following error monitoring and position monitoring are disabled

The command _**disableTorqueLimiting** cancels torque limiting.

Special features

- The commands for torque limiting (_enableTorqueLimiting) and travel to fixed stop (_enableMovingToEndStop) cannot be active simultaneously. Transition from enableTorqueLimiting to _enableMovingToEndStop is permissible (but has a replacing effect). Transition from _enableMovingToEndStop to _enableTorqueLimiting is not permissible since the setpoint value must be frozen when the torque is retained in the fixed stop.

- Command _stopEmergency:
  Command _stopEmergency() will not be activated, if a following error has built up with torque limiting active.
  An active torque reduction (even with travelling to fixed stop) will be maintained.
  Exception
  Command stopEmergency() with stopDriveMode = STOP_WITH_COMMAND_VALUE_ZERO deactivates the torque reduction, and the command for travel to fixed stop will be cancelled.

- Command _resetAxis:
  This command cancels torque limiting.

- Command _disableAxis:
  This command cancels torque limiting.

- When torque limiting is active, following error monitoring is deactivated.
  As a result of torque limiting, it is possible that a larger distance-to-go on position-controlled axes may build which may cause the axis to still accelerate (to reduce this difference) even though the speed calculated by the interpolator may already be smaller again.
  If torque limiting is not desired during the acceleration phase, the function must not be enabled until the acceleration phase has ended or the acceleration must be reduced.

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3.2 Commands (system functions)

3.2.1 Enable torque limiting (_enabletorquelimiting)

The **_enabletorquelimiting** function enables and immediately activates torque limiting in parallel with the motion.

Sample call: Torque reduction enable

```
_MccRetDINT :=
_enabletorquelimiting(
  axis:=Achse_1,
  torquelimittype:=USER_DEFAULT,
  torquelimit:=100.0,
  nextcommand:=IMMEDIATELY,
  commandid:=getCommandId(),
  torquelimitunit:=DEFAULT_UNIT );
```

Description of parameters

Parameter	Meaning
axis	Axis name
torqueLimitType (optional)	Type of specifying the limit value. **DIRECT**: The value in the 'torqueLimit' parameter is used as the programmed value. **EFFECTIVE**: The last torque limit value programmed is used. **USER_DEFAULT**: The default torque limit value defined in system variable 'userDefaultTorqueLimiting.torqueLimit' is used. This default can be modified by entering a value in parameter 'torqueLimit'. The parameter value is interpreted as a percentage value. System default: USER_DEFAULT
torqueLimit (optional)	Torque limit value desired for the axis. This parameter is evaluated depending on parameter 'torqueLimitType': torqueLimitType → **DIRECT**: The value is indicated as torque or force; evaluation depends on the 'torqueLimitUnit' parameter. torqueLimitType → **USER_DEFAULT**: If this parameter is not specified, the default torque limit value defined in system variable 'userDefaultTorqueLimiting.torqueLimit' will be used. If a value is entered, it will be interpreted as % value related to the torque reduction defined in system variable 'userDefaultTorqueLimiting.torqueLimit'. torqueLimitType → **EFFECTIVE**: The parameter is not evaluated. System default: 100.0

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Parameter	Meaning
nextCommand (optional)	Step enabling condition for the next command in program execution. **IMMEDIATELY:** The next command is processed immediately. **WHEN_TORQUELIMIT_REACHED:** The next command is processed as soon as the torque is limited (i.e. the set torque limit is reached in the drive). The status is derived from the PROFIBUS status word 'MeldW' (PZD 5), bit 1 (M < Mx) of the drive. **WHEN_TORQUELIMIT_GONE:** The next command is processed when the torque limit has been reached once and is then gone. The status is derived from the PROFIBUS status word 'MeldW' (PZD 5), bit 1 (M < Mx) of the drive. **WHEN_FUNCTION_DISABLED:** The next command is processed at the end of the present command. The command can be terminated or cancelled by calling the function '_disableTorqueLimiting' or '_resetAxis' in another task. System default: IMMEDIATELY
commandId	System-wide unique 'commandId' for command status tracking.
torqueLimitUnit (optional)	Reference of the limit values during programming. **DEFAULT_UNIT:** The force or the torque refers to the load side. The gear ratio is always taken into account. See section 2.2 for torque/force conversion. **TORQUE**: The limit value is interpreted as torque referring to the drive side. The gear ratio is not taken into account. System default: DEFAULT_UNIT

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3.2.2   Disable torque limiting (_disabletorquelimiting)

With **_disabletorquelimiting**, the torque limiting function that overrides the motion commands is disabled.

Sample call: Torque reduction disable

```
_MccRetDINT :=
_disabletorquelimiting(
  axis:=Achse_1,
  nextcommand:=IMMEDIATELY,
  commandid:=getCommandId());
```

Description of parameters

Parameter	Meaning
axis	Axis name
nextCommand (optional)	Step enabling condition for the next command in program execution. **IMMEDIATELY:** The next command is processed immediately. **WHEN_COMMAND_DONE:** The next command is processed at the end of the present command. System default: IMMEDIATELY
commandId	System-wide unique 'commandId' for command status tracking.

3.3   Check back (system variables)

Variable	Meaning
TorqueLimitingCommand. State	Displays the torque limiting status. **ACTIVE:** Torque limiting enabled **INACTIVE:** Torque limiting disabled
TorqueLimitingCommand. torqueLimitingState	Indicates whether the drive works on the torque limit. Note: This status is derived from the PROFIBUS status word 'MeldW' (PZD 5), bit 1 (M < Mx) of the drive.