SIEMENS

Enabling / disabling torque limiting with _enable/_disableTorqueLimiting

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1 Description

The effective torque at the drive can be limited with the function _**enableTorqueLimiting.** The limiting value is declared in the command.

This function can be used with drive, positioning and synchronous axes. The accuracy depends on the drive used.

When this function is active, the following error monitoring and position control systems are disabled. The positioning itself may have any duration. When a defined target position has been reached, the standstill monitoring is activated as with every regular positioning, and triggers an alarm when leaving the standstill window.

Active motion commands and synchronous relationships are continued.

The limitations can be activated before or simultaneously with a motion, and can be switched by removing the command again.

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

2 Start-up

2.1 Preconditions and interface description

This function can only be used on PROFIBUS axes linked by a PROFIBUS message frame containing the torque reduction. These are drives that understand PROFIBUS message frames 101, 102, 103, 104, 105 and 106. This function cannot be used on analog axes.
Example: Structure of message frame 105. Data relevant to torque limiting is shown bold.

Transmit data of message frame 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 message frame 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 resultant torque in drive
M_x	set (→ possibly limited) torque

By **calling the function** in SIMOTION, you define the **desired torque** (possible for rotary and linear axes) or the **desired force** (only possible for linear axes) in the corresponding unit or as a percentage value of a reference value (userDefaultTorqueLimiting.torqueLimit). 0% here means **no** torque on the drive; 100% means **full** torque on the drive. → One defines a torque limit (→ torque limiting) in SIMOTION.

A value between 0 and 100% is transferred in integral steps to the drive via the **PROFIBUS interface**. 0% means **full** torque on the drive; 100% means **no** torque on the drive. → A torque reduction is transferred to the drive.

In SIMOTION, the desired torque or force is converted to a torque reduction for the drive on the basis of the set data. Example: 80% is defined in SIMOTION as the torque limit. The value 20 (%) is calculated from this as the torque reduction in SIMOTION for the drive and transferred to the drive via the PROFIBUS interface.

This start-up description describes the drive settings for a SIMODRIVE 611D linked via message frame 105.

2.2 Conversion of torque / force

When programming the function '_enableTorqueLimiting', a torque is always defined in Nm, kNm or MNm for **drive axes** and **rotary axes**.
The declared torque refers to the motor when the setting TORQUE is declared in the functional parameter 'torqueLimitUnit' with the function call. The gear ratio is not taken into account.
When the DEFAULT_UNIT setting is selected in the functional parameter, the torque relates to the load side and the gear ratio is taken into account. The following conversion formula applies:

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

Example: $M_{Load} = 14Nm \cdot \frac{1}{5} = 2.8Nm$

In the case of **linear axes with a standard motor**, a torque can be defined optionally in Nm, kNm or MNm in relation to the motor or a force in N, kN or MN related to the load side in the function '_enableTorqueLimiting'.
When the setting TORQUE is declared in the function call to the functional parameter 'torqueLimitUnit', the programmed value is interpreted as a torque related to the motor. The gear ratio, leadscrew pitch and efficiency of the spindle are not taken into account.
When the setting DEFAULT_UNIT is selected in the functional parameter, the programmed value is interpreted as a force related to the load side. With this setting, the gear ratio, leadscrew pitch and efficiency of the spindle are taken into account. The following conversion formula applies:

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

Example:

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

F = force
M = torque
S = leadscrew pitch (leadscrew.pitchVal)
h = efficiency of the spindle (leadScrew.efficiency)

In the case of **linear axes with a linear motor**, the programming always defines a force in N, kN or MN.

2.3 Parameterization

SIMOTION configuration data	Meaning
TypeOfAxis.SetPointDriverInfo.DriveData.maxTorque	Standard motor: The maximum torque of the motor must be declared here (data on the motor rating plate). The maximum torque set here is the reference value for torque limiting. The value can be given in Nm, KNm or MNm. System default: 3.2Nm
TypeOfAxis.SetPointDriverInfo.LinearMotorDriveData.maxForce	Linear motor: Declaration of the maximum force in N, KN or MN. The force stated here is the reference value for the limitation. System default: 1000.0N
TypeofAxis.NumberOfDataSets.DataSet_x.Gear.numFactor	Declaration of the number of motor revolutions System default: 1
TypeofAxis.NumberOfDataSets.DataSet_x.Gear.denFactor	Declaration of the number of load revolutions System default: 1
LeadScrewInfo.efficiency	Efficiency of the spindle/nut combination. Is taken into account in the programming in force (F) on a linear axis with a standard motor (Setting in the command '_enableTorqueLimiting' → DEFAULT_UNIT). System default: 1.0
Leadscrew.pitchVal	Declaration of the leadscrew pitch per revolution of the spindle. (distance / spindle revolution). Is taken into account in the programming in force (F) on a linear axis with a standard motor (Setting in the command '_enableTorqueLimiting' → DEFAULT_UNIT). System default: 10.0mm

Note
The maximum values of DriveData.maxTorque or LinearMotorDriveData.MaxForce are the reference values for the torque reduction and must be entered correspondingly to the values of the motor in the drive and in SIMOTION. Otherwise incorrect limitations will become effective.

SIMOTION system data	Meaning
userDefaultTorqueLimiting.torqueLimit	The user presetting of the torque limit for the functional parameter torquelimit is declared here in the command _enableTorqueLimiting. This value is accessed in the command _enableToqueLimiting with the setting "USER-DEFAULT". System default: 10.0

Parameter drive 611U	Meaning
P881	Evaluation of the transferred PROFIBUS value for the torque reduction in the drive. The values from 0 to 100 (%) are transferred to the drive in integral steps. The parameter P881 in the 611U must therefore be left at the standard value16384 (4000H).

Parameter SINAMICS drive	Meaning
P1544	Evaluation of the transferred PROFIBUS value for the torque reduction in the drive. The values from 0 to 100 (%) are transferred via the PROFIBUS interface to the drive in integral steps. The parameter P1544 in SINAMICS must therefore be set to the standard value16384 (4000H). (Standard value = 100)

Programming

2.4 Program sequence when traversing with torque limit

The limitations can be activated before or simultaneously with a motion, and can be switched by transmitting the command again.

Active motion commands and synchronous relationships are continued.

The execution of the _enableTorqueLimiting command has the following effects:
- The reduced maximum torque limit becomes effective immediately
- The following error monitoring and position control systems are disabled

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

Specific features

- The torque limiting (_enableTorqueLimiting) and travel to fixed stop (_enableMovingToEndStop) commands cannot be active simultaneously. The transition of enableTorqueLimiting to _enableMovingToEndStop is permissible (then works as a take-over).
  The transition of _enableMovingToEndStop to _enableTorqueLimiting is not permissible as the setpoint must be clamped when stopping the torque in the fixed stop.

- _stopEmergency command:
  The _stopEmergency() command is not effective if a following error has built up with torque limiting active.
  An active torque reduction is retained (even when traveling to fixed stop).
  Exception
  The stopEmergency() command with stopDriveMode = STOP_WITH_COMMAND_VALUE_ZERO disables the torque reduction and the travel to fixed stop command is cancelled.

- _resetAxis command:
  The '_resetAxis' command cancels the torque limiting.

- _disableAxis command:
  The '_disableAxis' command cancels the torque limiting.

- The following error monitoring system is deactivated when torque limiting is active.
  A considerable distance-to-go can build up with position controlled axes as a result of, for example, torque limiting, which can lead to the axis continuing to accelerate (in order to reduce this difference) even when the velocity calculated by the interpolator may possibly have fallen again.
  If, for example, torque limiting is not desired during the acceleration phase, the function must not be activated until after the acceleration phase, or the acceleration must be reduced.

2.5 Commands (system functions)

2.5.1 Enable torque limiting (_enabletorquelimiting)

A torque limit, which is immediately effective, is activated at the same time as the motion with the function **_enabletorquelimiting**.

Call example: Enabling torque reduction

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

Description of the parameters

Parameter	Meaning
axis	Axis name
torqueLimitType (optional)	Type of declaration of the limiting value. **DIRECT**: The value in the 'torqueLimit' parameter is used as the programmed value. **EFFECTIVE**: The last programmed torque limit is taken over. **USER_DEFAULT**: The default setting of the torque limit defined in the system variable 'userDefaultTorqueLimiting.torqueLimit' is used. This default setting can be modified by inputting a value into the 'torqueLimit' parameter. The value of the parameter is interpreted as a percentage value. System default: USER_DEFAULT
torqueLimit (optional)	Desired torque limit on the axis. This parameter is evaluated as a function of the parameter 'torqueLimitType'. torqueLimitType → **DIRECT**: The value is declared as a torque or force; its evaluation is a function of the parameter 'torqueLimitUnit'. torqueLimitType → **USER_DEFAULT**: If this parameter is not declared, the default setting of the torque limit defined in the system variable 'userDefaultTorqueLimiting.torqueLimit' is used. If a value is declared, the input is interpreted as a percentage value of the torque reduction defined in the system variable 'userDefaultTorqueLimiting.torqueLimit'. torqueLimitType → **EFFECTIVE**: The parameter is not evaluated. System default: 100.0

nextCommand (optional)	Step enabling to the next command in the program execution. **IMMEDIATELY:** Immediate transfer to the next command. **WHEN_TORQUELIMIT_REACHED:** Transfer to the next command as soon as the torque is limited (the drive reaches the set torque limit). The status is derived from the PROFIBUS status word 'MeldW' (PZD 5), bit 1 (M < Mx) of the drive. **WHEN_TORQUELIMIT_GONE:** After the torque limit has been reached once, transfer to the next command after leaving the torque limit. The status is derived from the PROFIBUS status word 'MeldW' (PZD 5), bit 1 (M < Mx) of the drive. **WHEN_FUNCTION_DISABLED:** Transfer to the next command after reaching the end of the command. The command can be ended or cancelled by calling the '_disableTorqueLimiting' or '_resetAxis' function in another task. System default: IMMEDIATELY
commandId	System-wide unique 'commandId' to track the command status.
torqueLimitUnit (optional)	Reference of the limiting values in the programming. **DEFAULT_UNIT:** The force or torque relates to the load side. The gear ratio is always taken into account. See Section 2.2 for the conversion of the torque / force. **TORQUE**: The limiting value is interpreted as a torque related to the drive side. A gear ratio is not taken into account. System default: DEFAULT_UNIT

2.5.2 Disable torque limiting (_disabletorquelimiting)

The **_disabletorquelimiting** function disables a torque limit overlying the motion commands.

Call example: Disabling the torque reduction

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

Description of the parameters

Parameter	Meaning
axis	Axis name
nextCommand (optional)	Step enabling to the next command in the program execution. **IMMEDIATELY:** Immediate transfer to the next command. **WHEN_COMMAND_DONE:** Transfer to the next command after reaching the end of the command. System default: IMMEDIATELY
commandId	System-wide unique 'commandId' to track the command status.

2.6 Feedback messages (system variables)

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