Brake sequence control when using SINAMICS and MASTERDRIVES MC drives in conjunction with SIMOTION
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For example:

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AL: N
ECCN: N
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1 Question

When disabling the axis (command `_disableAxis` or in the case of alarms with the global reaction "Release disable"), SIMOTION sets the bits ON/OFF, OFF2, OFF3 and operation enable (pulse enable) simultaneously to zero. The axis may still rotate between the pulse inhibit and the closing of the brake because of the missing torque. This can result in a slight sagging of the vertical axes (Z axes).

- How can this be prevented?
- What is the sequence?
- How should the drive be parameterized?
- How should the enable be treated?
- How is it possible to recognize that "Release disable" has been triggered when an error occurs?
- The power must then also be switched off after approx. 200ms (brake closing time).
- Is the extended brake control of SINAMICS required?
- What must be observed when using the extended brake control, particularly for MASTERDRIVES MC?

1.1 Brake control / System-supported disabling from SIMOTION V4.4

From SIMOTION V4.4 the axis can be parameterized to execute disabling by means of OFF3 (quick stop) by default. Hence for the drive OFF2 (pulse inhibit) is set not before e.g. the brake is closed.

Thus the procedure described in the FAQ is not necessary anymore from SIMOTION V4.4.
2 Solution

2.1 Sequence

If the drive is to be disabled, this is performed first only with OFF1. At the same time the holding brake starts to close, however the pulse enable and therefore the torque remain active until the brake closing time has expired. The axis can no longer rotate during the brake closing time.

After the brake closing time has expired, the drive is shut down completely.

2.2 Parameterization

Brake control as expected can be achieved with the following adaptations in the parameters of the drive object and of the relevant axis.

Drive configuration

- Select the required PROFINET message frame (e.g. message frame 105).
- The quick stop ramp (OFF3) is set in parameter p1135.
- Set the value 1 in parameter p1215 in the respective drive object (motor holding brake as for sequence control; this parameter is automatically set to 1 when a connected brake is detected by the motor module).
- Enter the closing time of the brake in ms in parameter p1217 (if possible use the default value).
- The p9xxx parameters shown in the figure are only relevant when using safe standstill.
## Axis configuration

Set the configuration data

```plaintext
TypeOfAxis.DriveControlConfig.releaseDisableMode
```

of the respective axis object to 1 in the user program.

In the axis configuration you get via the button “Change” in the section “Functions” in a dialog where you can parameterize the axis also that way.

### Functions

<table>
<thead>
<tr>
<th>Technology data block</th>
<th>Response to alarm</th>
<th>SINAMICS Safety Integrated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remove drive enable individually for alarm reaction RELEASE_DISABLE</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Define specific enables to be removed**

- **Brake on ramp-function gen. (OFF 1)**
- **Coast to stop (OFF 2)**
- **Quick stop (OFF 3)**
- **Disable oper.**
- **Disable ramp-fct. gen.**
- **Freeze ramp-fct. gen.**
- **Disable setpoint**

For motor with holding brake, e.g. for hanging axis, only set OFF 2 when brake closed.

In the event of an error with “Release disable”, SIMOTION only automatically resets OFF1. This state of the axis can be polled cyclically in the user program and then reacted to accordingly through a controlled shutdown. The procedure described above is then used. The following expression is used for the polling:

```plaintext
Axis_Error := ActPosAxis.errorreaction = release_disable;
```
Alternative procedure with SS1 (Safe Stop 1)

If the SS1 functionality is to be used, it must be ensured that the signals of the two "safety channels" are simultaneously interconnected to the I/O area of the CU and to the respective drive module on the hardware side. If SINAMICS detects an opening of at least one of the two safety channels, the axes brake along the braking ramp settable in parameter p1135 and automatically shut down avoiding an uncontrolled sagging of the drive. Parameter p9652 (Safe Stop 1, control unit) and parameter p9852 (Safe Stop, motor module) must also be set to the required values not equal to zero (e.g. 1 s).

In this context note that with 1-channel selection greater than the set time of the monitoring for simultaneous operation p9650/p9850 and a delay time STOP F to STOP A p9650/p9850 set to less than delay time Safe Stop 1 p9652/p9852, the OFF3 ramp will be aborted after the delay time STOP F to STOP A. If the OFF3 ramp is be traversed to the end, the STOP F to STOP A time must correspond at least to the safe stop.

It is not necessary to activate the extended brake control for the procedure described here.
3 Special features of the brake control

3.1 Brake control with SINAMICS

3.1.1 Standard brake control with SINAMICS

Up to SINAMICS V2.5 SP1 HF4

If the standard brake control is used, the drive waits until the set brake opening time has expired before opening the brake. However, an "Operation enabled" is signaled from the drive via the status word ZSW[0] in bit 2 immediately after the enable by SIMOTION. This can result in following errors or unexpected, sudden movements of the axis if a motion command is triggered immediately after _enableAxis().

As of SINAMICS V2.5 SP1 HF4

The "Operation enabled" ready signal is sent to SIMOTION via the status word ZSW[0] bit 2 only after the brake opening time has expired and the setpoint enable from the brake control.

In this way, the step enabling condition after _enableAxis() is only satisfied when the brake has been opened.
3.1.2 Extended brake control with and without feedback signal

Note that with the extended brake control, the "Brake open" feedback signal or setpoint enable from the brake control is not included in ZSW[0] bit 2 (Operation enabled), but only the brake opening time is taken into account here.

If the "Brake opened" state must be taken into account in the application in SIMOTION, this can be done in two ways:

1. Evaluate parameter r899.15 after a _enableAxis() before a motion command is issued. The parameter can be read via _readDriveParameter() or evaluated via an appropriate I/O variable which is transferred to SIMOTION in the drive parameter on the cycle drive message frame via a BICO interconnection.

2. Modify the "Operation enabled" ready signal so that the "Brake opened" signal is integrated in the sequence control.

   Disadvantage: Message frame 999 is required (i.e. symbolic assignment can no longer be used on the axis).
   Advantage: A query is no longer required as to whether the brake is really open. The "Operation enabled" signal is cleared as soon as the "Brake open" signal is missing.

Procedure for the second method:

- Change the axis message frame to 999
- Replace status word1 p2051[0] bit 2 - > r899.2 with r2811.0 in the binector-connector converter
- Perform the AND interconnection:
  - p2810[0] Drive_x : r899.2
  - p2810[1] Drive_x : r899.15

Note: r2811.0 is the output of the AND logic link.
"Operation enabled" is now only signaled when the "Brake opened" signal is present.
3.2 **Extended brake control with MASTERDRIVES MC**

After issuing an `_enableAxis()` command, a used MASTERDRIVES MC immediately checks back to SIMOTION in ZSW1 bit 2 (operation enabled). This feedback signal is independent of a brake opening time parameterized in MASTERDRIVES MC. The feedback signal of the "Operation enabled" signal can result, for example, in a setpoint being sent to the drive by a Move() command, depending on the user program.

As the drive has not opened the brake yet due to the parameterized brake opening time, the motor cannot follow, which results in a following error. The brake is now opened on the motor after the brake opening time has expired, but before the following error monitoring is started. This has the result that the following error is traversed suddenly. The axis performs an unintentional jump.

3.2.1 **Work-around via "Wait for condition"**

After the `_enableAxis()` command, a check must be made in the user program of the SIMOTION, e.g. through "Wait for condition", when the drive signals ZSW1 bit 12 = FALSE (holding brake closed - FALSE = holding brake not activated). Only when this has occurred may a setpoint (Move() command) be issued.

3.2.2 **Work-around via "Wait for signal"**

In the MASTERDRIVES MC, wire parameter B277 (brake control setpoint enable) to an output, connect the output to an input to the SIMOTION and check this input with "Wait for signal" in the user program after issuing `_enableAxis()`.

Only issue a traversing command (setpoint) to the drive when this signal is connected.
4 Project data

4.1 Test project

A test project has been created for this FAQ (Brake_FW40.zip).

A D435 system with SINAMICS double motor module (SIMOTION training case) has been used. A motor of type 1-FK7022-5AK71-1UH0 with holding brake and SMI interface has been used as drive. The functionality can of course also be applied to similar drives.

Important: It is essential that a motor WITH holding brake is used to test the functionality described here. The usual drives of the test case do not have a holding brake.

In the project, the number of axes and their designations are entered in the StartupTask (Startup program). In addition, the parameter

\[
\text{ActPosAxis.setconfigdata.TypeOfAxis.DriveControlConfig.}
\text{releaseDisableMode} := 1;
\]

is written for all specified positioning axes.

The program OFF is called cyclically in the BackgroundTask. The signals are evaluated there for the step-by-step disabling of the axes. If axis errors occur, they are detected and the automatic shutdown of the axes is also started.
4.2 Source texts

ST source file "Startup" (is executed once when the central unit is powered up):

INTERFACE
USEPACKAGE CAM;
PROGRAM Startup;
VAR_GLOBAL CONSTANT
MaxNumberOfAxes : INT := 2; //Machine with 2 axes
END_VAR
VAR_GLOBAL
AchsArray       : ARRAY[0..MaxNumberOfAxes-1] OF PosAxis;
AchsIndex       : INT;
ActPosAxis      : PosAxis;
my_TON          : ton;
my_TRIG_FLP_ON  : r_trig;
my_TRIG_FLN_ON  : f_trig;
enable_finished : BOOL;
enable_active   : BOOL;
disable_active  : BOOL;
disable_step_1  : BOOL;
disable_step_2  : BOOL;
END_VAR
END_INTERFACE
IMPLEMENTATION
PROGRAM Startup
AchsArray[0]    :=  Axis_brake    ;
AchsArray[1]    :=  Axis_blue     ;
//Execution for ALL positioning axes of machine
FOR AchsIndex := 0  TO  MaxNumberOfAxes-1 DO
  ActPosAxis  :=  AchsArray[AchsIndex];
  IF  ActPosAxis  <>  TO#NIL THEN
    //In case of "release disable" reset only OFF1 (bit 0 => 2^0 = 1) automatically
    ActPosAxis.setconfigdata.TypeOfAxis.DriveControlConfig.releaseDisableMode:=1;
  END_IF;
END_FOR;
END_PROGRAM
END_IMPLEMENTATION
ST source file "OFF" (is executed cyclically in the BackgroundTask):

INTERFACE
  USEPACKAGE CAM;
  USES Startup;
  PROGRAM OFF;
END_INTERFACE
IMPLEMENTATION
PROGRAM OFF
VAR
  RetDINT : DINT;
END_VAR
VAR_TEMP
  Error_active : BOOL := 0;
END_VAR

//Get negative flank of clamp X123.0
my_TRIG_FLN_ON(clk:=clamp_x123_0);

//Execution for ALL positioning axes of machine
FOR AchsIndex := 0 TO MaxNumberOfAxes-1 DO
  ActPosAxis := AchsArray[Achsindex];
  IF ActPosAxis <> TO#NIL THEN
    //Read, if there is a release disable
    Error_active := ActPosAxis.errorreaction = release_disable OR Error_active;
  END_IF;
END_FOR;

//Start disabling at negative flank of clamp X123.0 or active error
IF my_TRIG_FLN_ON.q OR Error_active THEN
  enable_active := 0;
  enable_finished := 0;
  disable_active := 1;
  disable_step_1 := 0;
  disable_step_2 := 0;
END_IF;

//Disable step 1
IF disable_active AND NOT disable_step_1 THEN
  //Execution for ALL positioning axes of machine
  FOR AchsIndex := 0 TO MaxNumberOfAxes-1 DO
    ActPosAxis := AchsArray[Achsindex];
    IF ActPosAxis <> TO#NIL THEN
      //Reset signal OFF1
      RetDINT := _disableAxis(axis:=ActPosAxis,
       disableMode:=BY_STW_BIT,
       stwbitset:=1,
       servoControlMode:=INACTIVE,
       servoCommandToActualMode:=ACTIVE,
       nextCommand:=IMMEDIATELY,
       commandId:=getCommandId(),
       forcecontrolMode:=INACTIVE);
    END_IF;
  END_FOR;
  disable_step_1 := 1;
END_IF;

//Wait time until complete disable
my_TON(in:=disable_active,
  pt:=T#200ms);

//Disable step 2
IF disable_active AND my_TON.q AND NOT disable_step_2 THEN
  //Execution for ALL positioning axes of machine
  FOR AchsIndex := 0 TO MaxNumberOfAxes-1 DO
    ActPosAxis := AchsArray[Achsindex];
    IF ActPosAxis <> TO#NIL THEN
      //Complete disable axis
      RetDINT := _disableAxis(axis:=ActPosAxis,
       disableMode:=ALL,
       servoControlMode:=INACTIVE,
       servoCommandToActualMode:=ACTIVE,
       nextCommand:=IMMEDIATELY,
       commandId:=getCommandId(),
       forcecontrolMode:=INACTIVE);
    END_IF;
  END_FOR;
  disable_step_2 := 1;
END_IF;

//Acknowledge TO alarms
RetDINT := _resetTechnologicalErrors();

END_IF;
END_PROGRAM
END_IMPLEMENTATION
5  Changes

Table 5-1: Changes/authors

<table>
<thead>
<tr>
<th>Version</th>
<th>Date/change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Version V1.0</td>
<td>31.01.2007</td>
</tr>
<tr>
<td>Version V1.1</td>
<td>22.08.2008</td>
</tr>
<tr>
<td>Version V1.2</td>
<td>20.10.2011</td>
</tr>
<tr>
<td>Version V1.3</td>
<td>12.07.2014</td>
</tr>
</tbody>
</table>
6 Contact

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