Application Note

FESTO

Modulo Axis in Softmotion

How to use unlimited rotary axis in Softmotion V3.5

CMMP-AS-...M3/M0
CPX-CEC-M1-V3

100123

Title ..... Modulo Axis in Softmotion
Version 1.20
Document no. 100123
Original ..... en
Author ..... Festo

Last saved 23.01.2019

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1 Components/Software used

Type/Name	Version Software/Firmware	Date of manufacture
CODESYS	V3.5 SP7	--
CMMP-AS-...M3/M0	FW 4.0.1501.2.3	--
FCT CMMP-Plug-in	V2.7.0.154	--

Table 1.1: 1 Components/Software used

2 Issues with endless positioning axis

Endless rotary positioning axis are used for example in rotary tables or as drives for a conveyer belt. In many applications a certain position step – the feed motion - will be repeated again and again. If we have for example a rotary table with 6 index positions the feed motion is 60°. Often the axis will be operated as modulo axis with the feed motion or a multiple of the feed motion. A homing run after power up normally is not wished and thus motors with multi-turn encoders are used.

This application note especially addresses the effects of a CMMP-AS endless rotary axis controlled by a Softmotion master PLC. In this case there are certain issues which can have an effect:

- overflow of the position values of the multi-turn encoder of the motor
- overflow of the position values (set point and actual value) via fieldbus interface to the PLC

The multi-turn encoder of CMMP can count up to 4096 rev. If this value is not a integer multiple of the feed motion related to the motor shaft then there will be a residual value depending on the number of the overflows. This leads to a wrong position value after power on. To avoid this a storing of the position value before power down of the motorcontroller has to be done. This can be controlled via CI commands in FW 4.0.1501.**2.2** -› see Application Note 100004 **"**CMMP Function Activation of Multiturn Encoder for Endless Positioning**"** or via FCT settings in FCT Plug-in 2.7 and FW 4.0.1501.**2.3**.

The position values between the motor controller and the PLC are exchanged within 4 bytes, i.e. a double integer word. For Festo motor controllers like CMMP it was defined to have 16 bit to count the full revolutions and 16 bit as resolution of one revolution. So in case of an endless positioning there will be an overflow of this position value if 2^16 = 65536 full motor revolutions is reached.

In all cases where the feed-motion regarding to the motor shaft (i.e. the feed motion of the gear output multiplied with the overall gear ratio) is not a not an integer multiple of 65536 there will be problems because of the actual position depends on the number of overflows occurred. To handle this situation properly the number of overflows has to be stored in order to get a correct position after power off. This effect is the same like the one with multi-turn encoders – just that the overflow does not occur at 4096 but at 65536 revolutions of the motor shaft. Thus the position has to be stored in the PLC as well.

The application note describes how to configure this in the CMMP motorcontroller and the PLC.

3 Configuration of CMMP and Codesys

The example is done for an application with the following configuration:

- CMMP-AS plus EMMS-AS with multiturn encoder
- gearbox EMGA-...-P5 with gear ratio 5:1
- external gear with gear ratio 15:4
- Modulo settings: 180°

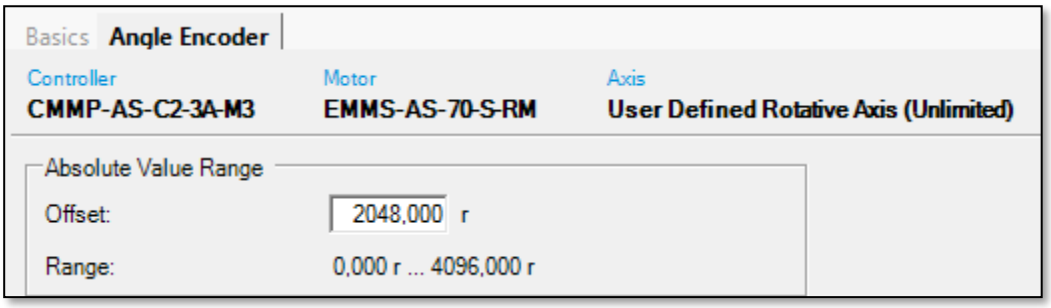
Overall gear ratio is 75:4 = 18,75

The feed move is always 180° of the gear output and thus Modulo will be set to this value.

Feed move regarding to motor shaft is: 18,75 * 180°/360° = 9,375 rev

What happens now if the position is not stored in motorcontroller?

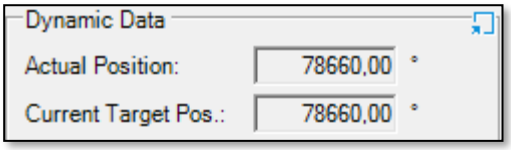
Assume the following settings of the AngleEncoder within FCT:



The first overflow of the multiturn encoder happens at 437 feed movements as then the actual position first time exceed the upper limit of the 12 bit multiturn counter.

Absolute position of motor shaft is 437 * 9,375 rev = 4096,875 rev

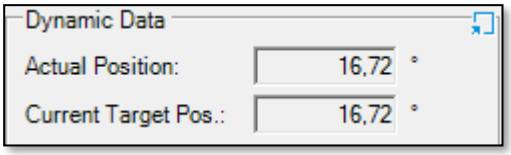
Absolute position of gear shaft is 437 * 180° = 218,5 rev = 78660°



FCT display before Power Off

After power on/off of the motorcontroller the absolute motor position jumps to 0,875 rev because of the overflow in the multiturn counter. For the gear-shaft the position is:

Absolute position of gear shaft is 0,875 rev / 18,75= 0,046666 rev =16,8 °



FCT display after Power On cycle

Now there is a wrong position of the output shaft ... actually it is 218,5 rev i.e a multiple of 180° but actual position shows around 16.8°.

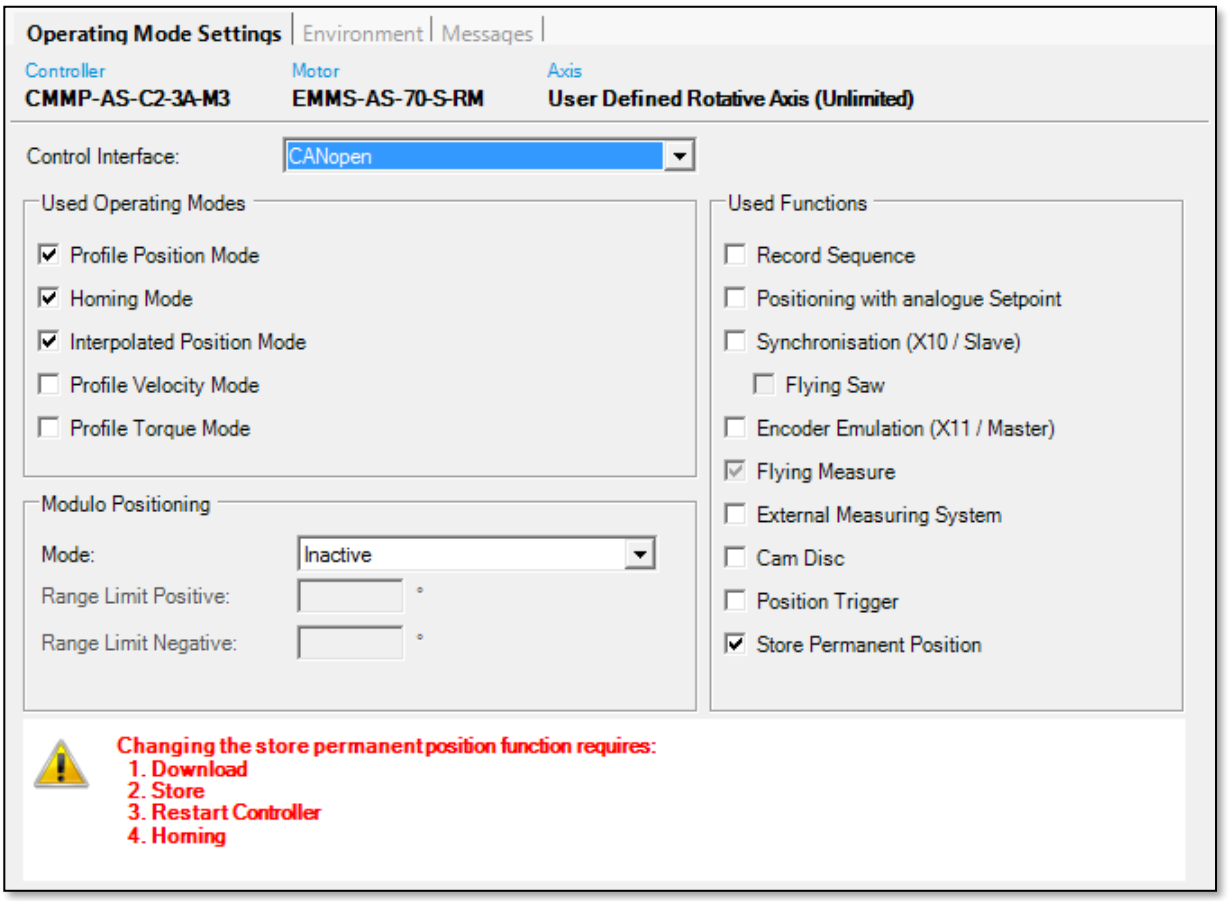
Thus storing the position permanently in the motor controller is necessary as the maximum value of the multi-turn encoder cannot divided by the feed movement without a reminder.

Similar overflow problem also happens within the PLC if there is an overflow over 2^16 motor revolutions because the variable for the motor position is limited to 16 bit. Thus storing the position in the PLC is necessary either.

The following chapters will show which settings are necessary for a CMMP motor controller and a PLC running Codesys 3.5.

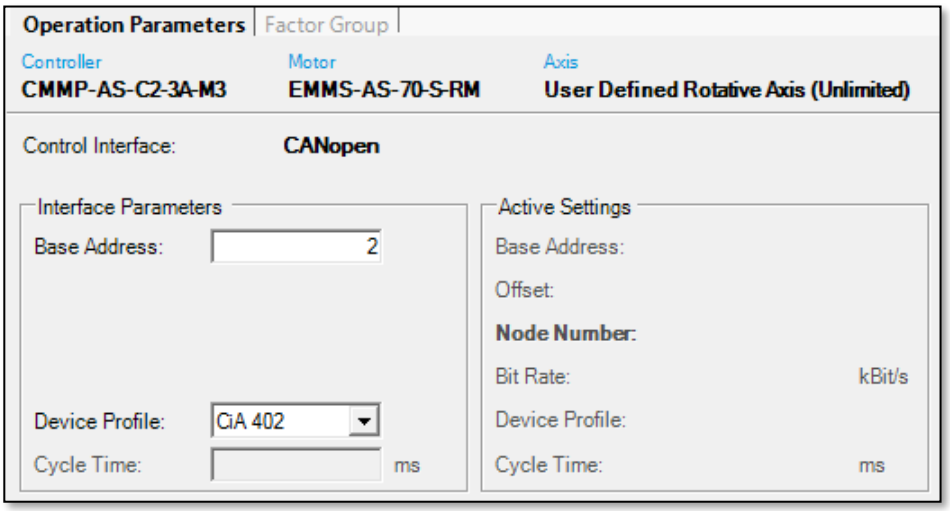
3.1 FCT settings of motor controller CMMP-AS

In tab ‘Operation Mode Settings’ select ‘Interpolated Positioning Mode’ as Softmotion works in interpolated mode. Activate the Function “Store Permanent Position” in order to handle the overflow of the multiturn counter properly.

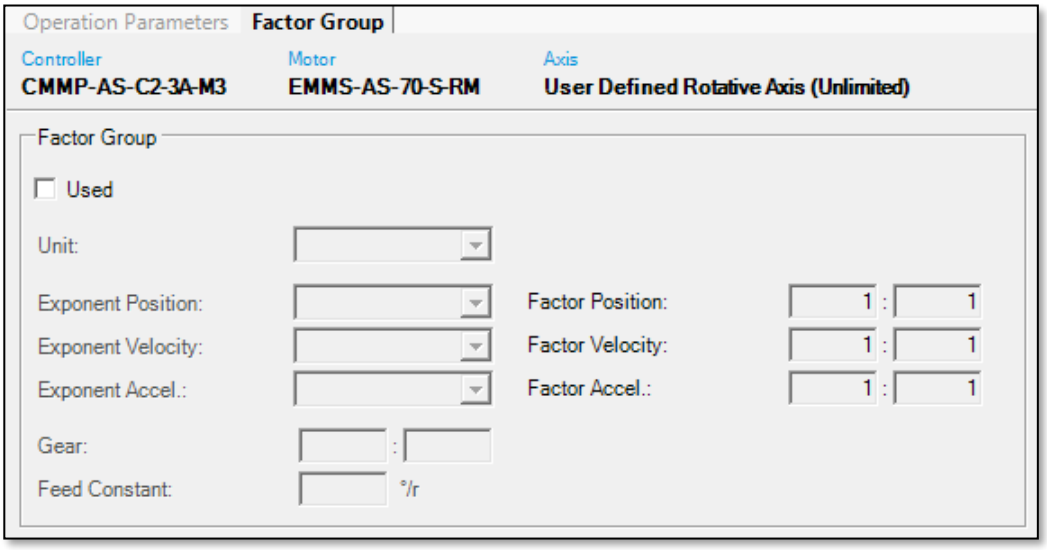


Do not select the modulo function on the motor controller side, i.e. keep “Modulo Positing” to Inactive. The activation of modulo calculations in the motor controller will change the position values sent to the PLC and leads to problems within Softmotion. For Softmotion we always should sent the unchanged position value via the fieldbus interface.

As usual for Softmotion applications in the Fieldbus settings of the motor controller choose “CiA 402” as Device profile:



Furthermore it is important not to activate the Factor group:

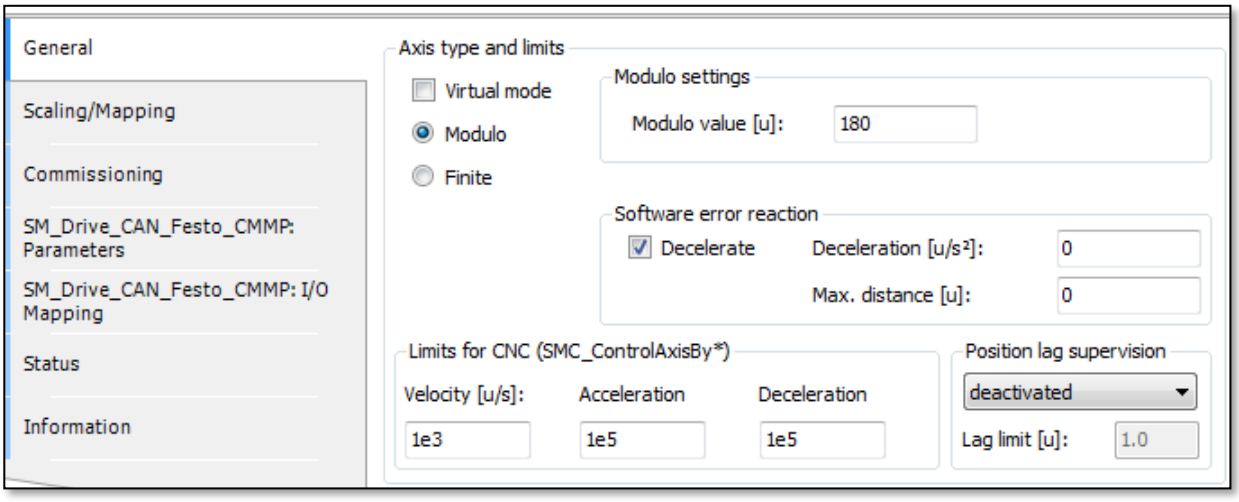


Not using the factor group means that the units of position values which are exchanged via the fieldbus are related to the motor shaft (1 rev = 2^16 inc) and all the scaling to user units will be done solely on the Softmotion side.

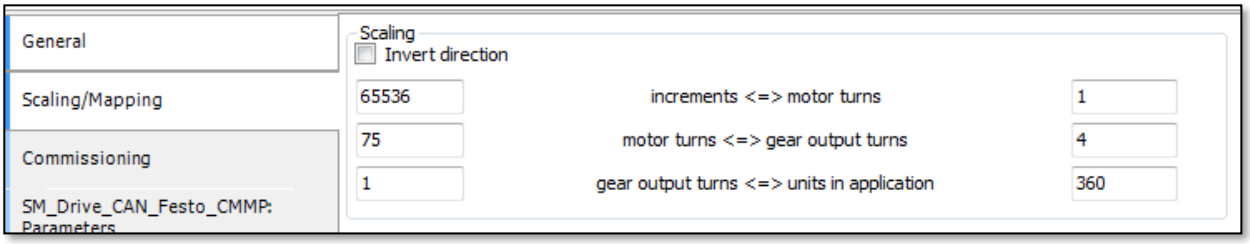
3.2 Application programming in Codesys 3.5

Selected user units is degrees of the gear output shaft and operation as modulo axis with 180°.

So in Configuration of SM_Drive_CAN_Festo_CMMP modulo is selected with the modulo value 180°:

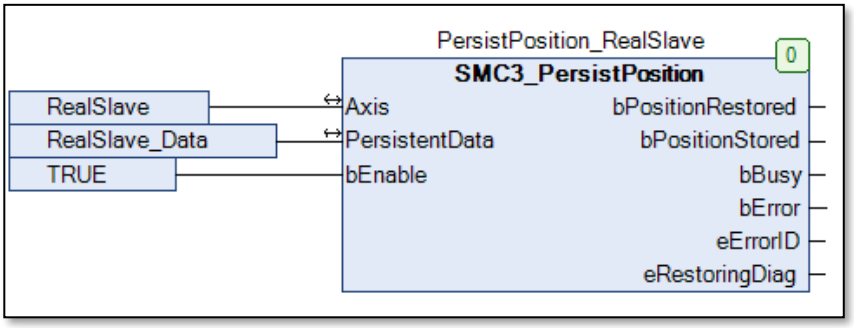


And in Scaling/Mapping configuration the scaling is done accordingly to the used gearboxes and the wished user unit in degrees:



In order to save the position of the drive persistently in the PLC we use the Codesys function block **SMC3_PersistPosition**. The block has to be called cyclically by the motion task. The SMC3_PersistPosition instance performs the restoring of the saved position during the start-up process. The function block controls that the actual position is stored in the associated data structure during normal operation.

In the Motion program (here shown in CFC) a call to an instance of SMC3_PersistPosition has to be added:



The necessary variable have to be declared as persistent:

```
VAR_GLOBAL PERSISTENT RETAIN
      PersistPosition_RealSlave: SMC3_PersistPosition;
      RealSlave_Data: SM3_BASIC.SMC3_PersistPosition_Data;
END_VAR
```

Please refer to the Softmotion help for further details.