MCST3601 – Encoder

Introduction

Even if a stepper motor is not originally designed to work in closed loop, an encoder might be used for redundancy or validation purposes. The encoder would not have a direct role in the motor control loop, but would act as a positioning error identifier. The MCST3601 controller offers all the features needed for such encoder usage, allowing effective step loss detection implementation.

Encoder interface operating principle

The MCST3601 controller includes a versatile encoder interface, that is compatible with a wide range of encoders. It includes dual inputs for A&B encoder signals, and a dedicated input for reference index signal. The inputs are configurable with optional pullup setup by software.
Relation between stepper and encoder position counters can be set through a programmable prescaler register. The reaction in case of deviation between both counters can be defined by software, using a dedicated interrupt vector.

Encoder parametrization

Three different parameters are used to configure the encoder:

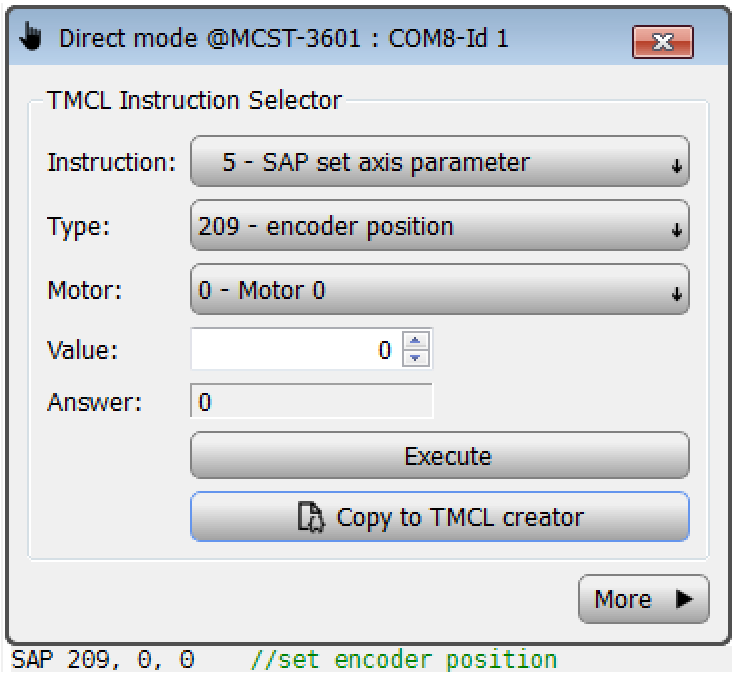
- Encoder position: Sets the absolute position of the encoder (to be compared with motor absolute position)
- Encoder prescaler: Sets the relation between motor and encoder steps
- Maximum encoder deviation: Sets the maximum allowed difference between motor and encoder position

The parameters usage and setup are described in the following points.

1. Encoder position configuration

Before using the encoder, its absolute position system has to be initialized. This operation is typically done after homing operation, when the motor is positioned at its origin position. In that case, the encoder position register can be simply reset by the user.

The encoder position can be modified or reset through a dedicated command. The latter can be either sent using Direct mode interface, or written in the processor code:


Direct mode @MCST-3601 : COM8-Id 1

TMCL Instruction Selector

Instruction: 5 - SAP set axis parameter

Type: 209 - encoder position

Motor: 0 - Motor 0

Value: 0

Answer: 0

```
SAP 209, 0, 0    //set encoder position
```

Figure 1: Encoder position modification command

2. Encoder prescaler configuration

The prescaler value depends on several parameters:

- Number of full step per motor rotation [FS]
- Number of usteps per full step [uS]
- Number of encoder lines per revolution [CPR]

The prescaler actually corresponds to the ratio between the number of micro-steps per motor revolution and the number of encoder line per revolution. It is calculated with the following formula:

PRESCALER = FS * uS / CPR

The prescaler has to be converted to integer value, that will be sent to the corresponding register. This operation is done with the following formula:

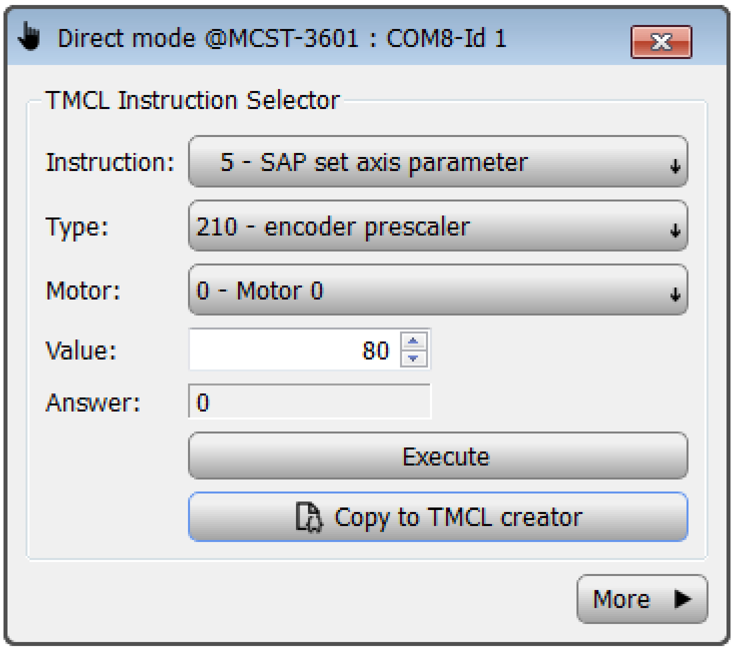
P = PRESCALER * 512

The following examples shows how to calculate the prescaler register value for a 20 steps per revolution motor that is connected to a 1024 lines per revolution encoder. The motor is commanded in 8 usteps per full step:

PRESCALER = 20*8/1024=0.15625
P=0.15625*512=80

The value “80” shall then be written to the prescaler register.

The prescaler register can be modified through a dedicated command. The latter can be either sent using Direct mode interface, or written in the processor code:


Direct mode @MCST-3601 : COM8-Id 1

TMCL Instruction Selector

Instruction: 5 - SAP set axis parameter

Type: 210 - encoder prescaler

Motor: 0 - Motor 0

Value: 80

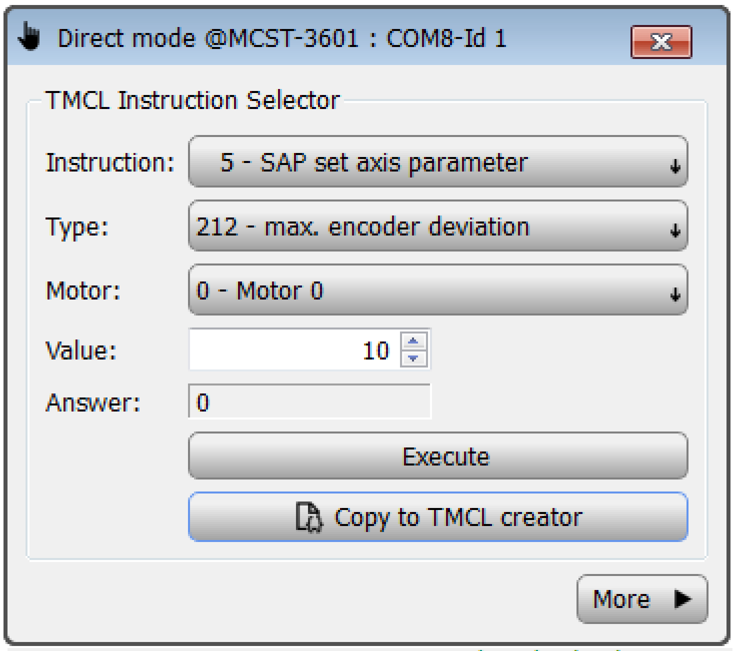
Answer: 0

```
SAP 210, 0, 80     //set encoder prescaler
```

Figure 2: Encoder prescaler modification command

3. Maximum deviation configuration

The user can define the maximum acceptable deviation between the step counter and the encoder counter. In case of step loss, the deviation between both counters can indeed increase from 0 to any higher value. The goal of the maximum deviation register is to define a deviation threshold above which a software reaction is wanted. This parameter can be modified the following way:


Direct mode @MCST-3601 : COM8-Id 1

TMCL Instruction Selector

Instruction: 5 - SAP set axis parameter

Type: 212 - max. encoder deviation

Motor: 0 - Motor 0

Value: 10

Answer: 0

```
SAP 212, 0, 10     //set max. encoder deviation
```

Figure 3: Max. encoder deviation modification command

When the actual position (parameter 1) and the encoder position (parameter 209) differ more than set in the max. encoder deviation register, the motor will be stopped. This function is switched off when the maximum deviation is set to zero.

Encoder usage

When the encoder is fully configured, it will automatically be used by the controller, until the maximum deviation threshold is reached. When this appears, the motor will be automatically stopped by the controller. However, the user may want to define some additional actions in case of max. deviation overshoot. For that reason, the controller offers the possibility to manage this case as interrupt vector.

If properly setup, the interrupt vector would be called if the deviation threshold is met. When this interrupt occurs, the normal TMCL™ program flow will be interrupted and the interrupt handling routine will be called. Before an interrupt handling routine gets called, the context of the normal program will be saved automatically (i.e. accumulator register, X register, TMCL™ flags).

The following code example shows how to activate and configure the interrupt, and how to manage the interrupt routine

```
// INTERRUPT ACTIVATION AND CONFIGURATION
VECT 21, DevIrq   // Define the interrupt vector for deviation
EI 21             // Enable this interrupt
EI 255            // Globally switch on interrupt processing

// INTERRUPT ROUTINE MANAGEMENT
DevIrq:
      SIO 0, 2, 1 // Activate error flag output 0 (example)
      …
      RETI        // Return from interrupt
```

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