TMC4671+TMC6100-BOB Setup & Tuning Guide
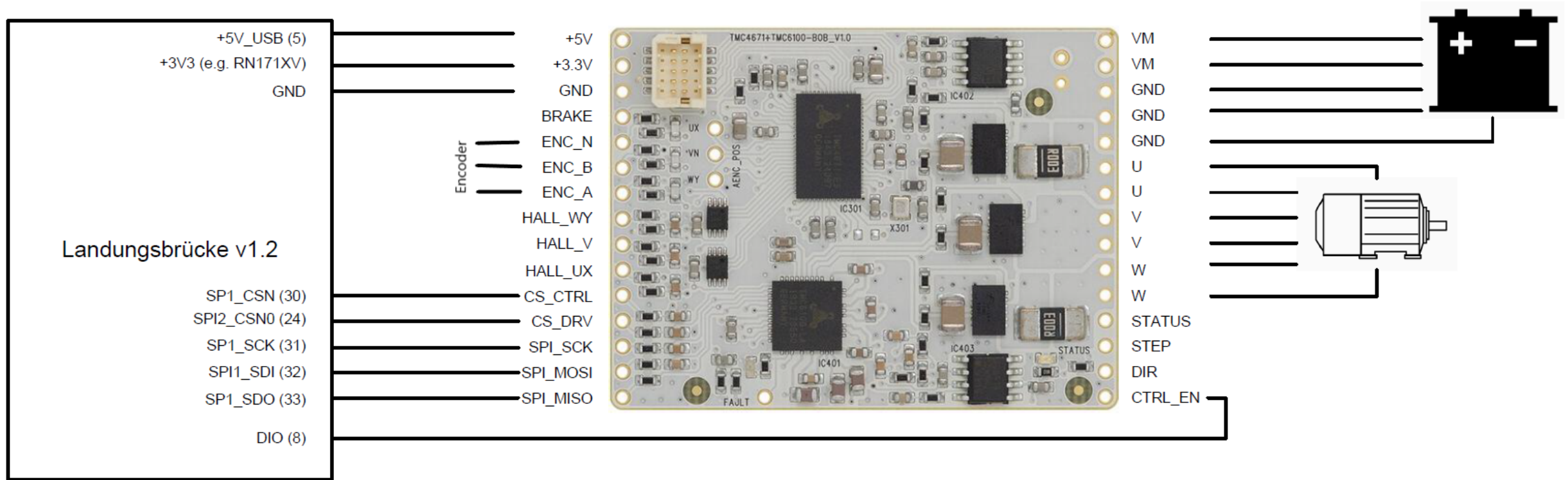
TS – 22.08.2023

What is needed?

- ► Newest TMCL-IDE
  https://github.com/trinamic/TMCL-IDE-Nightly

- ► TMC4671+TMC6100-BOB V1.0

- ► Landungsbruecke with special firmware

- ► USB cable & wiring

- ► BLDC motor with encoder
  - This guide uses an 8-pole motor with ABN-encoder, resolution: 4096cpr (16384ppr)

How to wire things up?

Landungsbrücke v1.2

Landungsbrücke v1.2	BOB
+5V_USB (5)	+5V
+3V3 (e.g. RN171XV)	+3.3V
GND	GND
	BRAKE
	ENC_N
	ENC_B
	ENC_A
	HALL_WY
	HALL_V
	HALL_UX
SP1_CSN (30)	CS_CTRL
SPI2_CSN0 (24)	CS_DRV
SP1_SCK (31)	SPI_SCK
SPI1_SDI (32)	SPI_MOSI
SP1_SDO (33)	SPI_MISO
DIO (8)	

Encoder

BOB side signals: VM, VM, GND, GND, GND, U, U, V, V, W, W, STATUS, STEP, DIR, CTRL_EN

TMC4671+TMC6100-BOB_V1.0
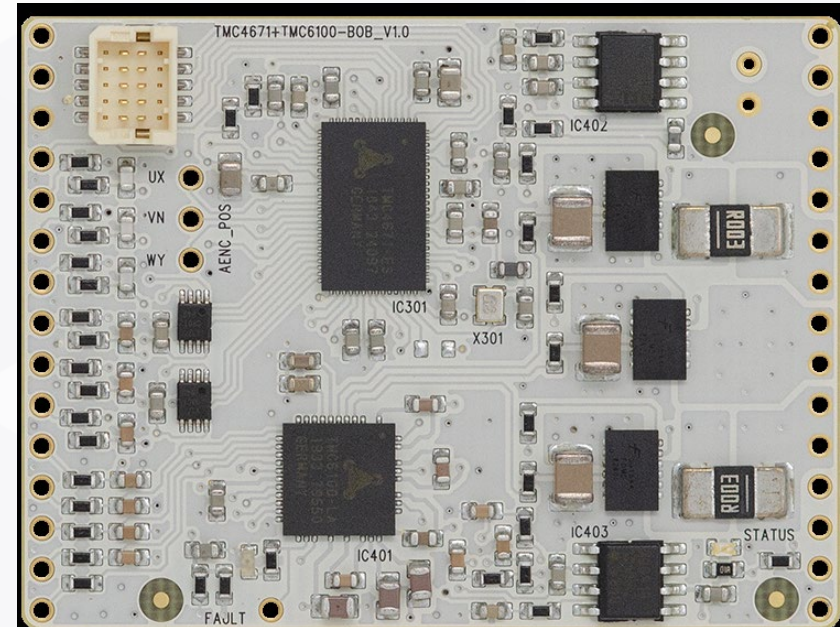
Start the Software

▶ Power the board and connect the Landungsbruecke to the PC

▶ Start the TMCL-IDE & update the firmware

▶ Select TMC4671-EVAL as motion controller board & TMC6100-EVAL as the driver board
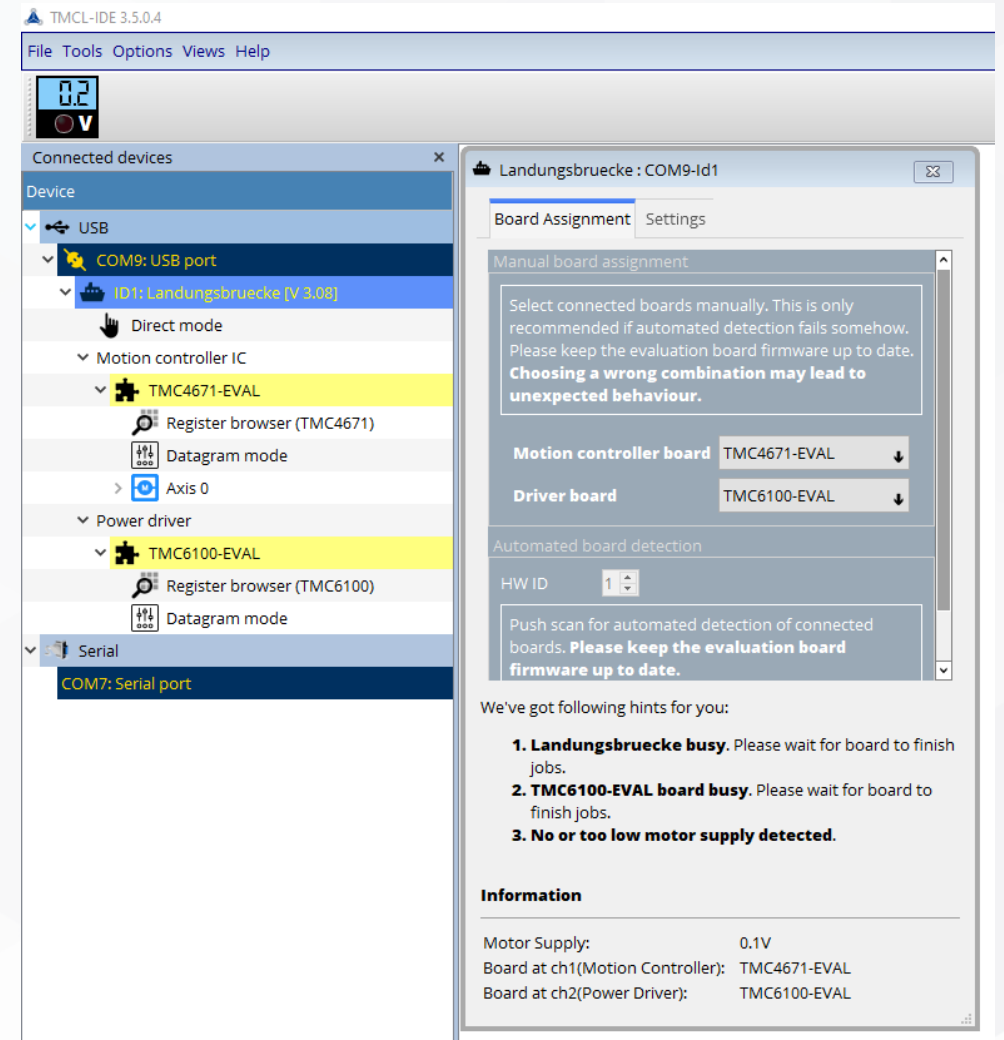
Configure the TMC6100

- ► Open the TMC6100 Register browser
- ► Make sure the following registers are set:
  - GCONF = 0x40
  - GSTAT = 0x00 (Write to clear)
  - DRV_CONF = 0x04
- ► *(Supply voltage is not connected to the Landungsbruecke and therefore showing 0V here)*

TMC4671 Basic wizard setup
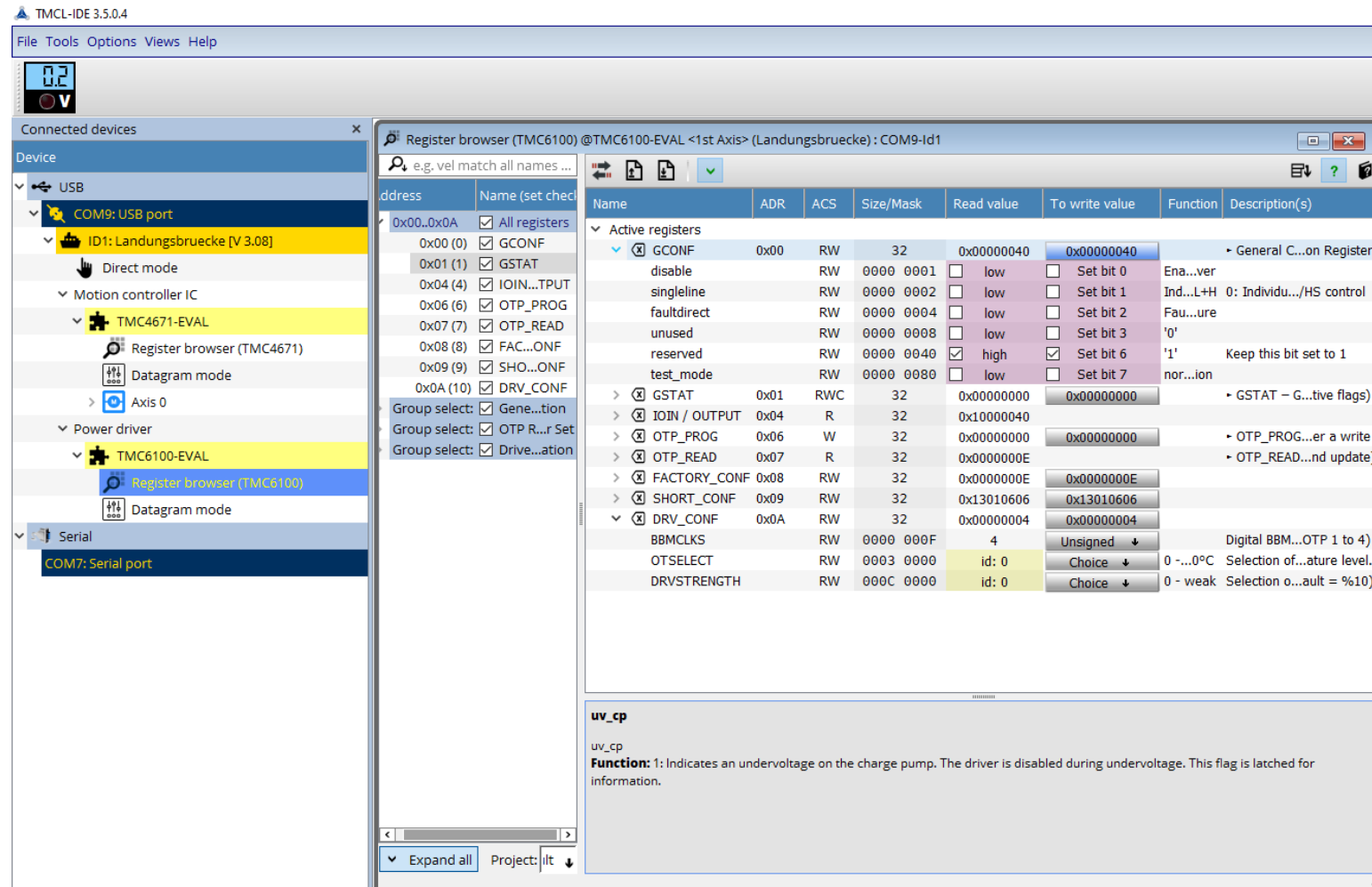
▶ Open the TMC4671 Wizard & go to Settings

▶ Select TMC6100-BOB as Power driver

▶ Click "Set defaults for BLDC/PMSM motor"

▶ Put in correct pole pair count for the motor

▶ Set both BBM times = 40

General settings

Which basic parameters must be checked?

Before starting up the motor with open loop control, the PWM has to be adjusted to your power module/inverter. If you are using a standard evaluation board from Trinamic, you can set Default values with the following buttons. First select a universal Power Evaluation.

1.   Select a Power driver: [TMC6100-BOB ▼]

    [Set defaults for DC motor] [Set defaults for stepper motor] [Set defaults for BLDC/PMSM motor] [PWM off]

2.   Choose Motor_Type according to your motor and power stage. The TMC467X supports DC motors, two phase stepper motors (FOC2) and BLDC/PMSM motors (FOC3).

    Motor type: [3 - Three phase BLDC ▼]

3.   Set number of pole pairs according to your motor. If you don't know the number of pole pairs of your motor, we can determine the number of pole pairs in the next steps. You can also determine this value from your motor's nameplate data using the formula below. Stepper Motors usually have 50 pole pairs (1.8°).

    $p_{servo} = (60 * f\_nom [Hz])/n\_nom [rpm]$ e.g. n_nom = 3000 rpm, f_nom = 200 Hz, p = 4

    $p_{stepper} = 360 / (step\_angle * 4)$ e.g. step_angle = 1.8°, p = 50

    Pole pairs: [4 ▲▼]

4.   Set PWM_MAXCNT (0x18) to change switching frequency.
    Calculation: PWM_MAXCNT = 1/(f [Hz] * 10 ns) -1

    PWM frequency: [25 kHz ▼]
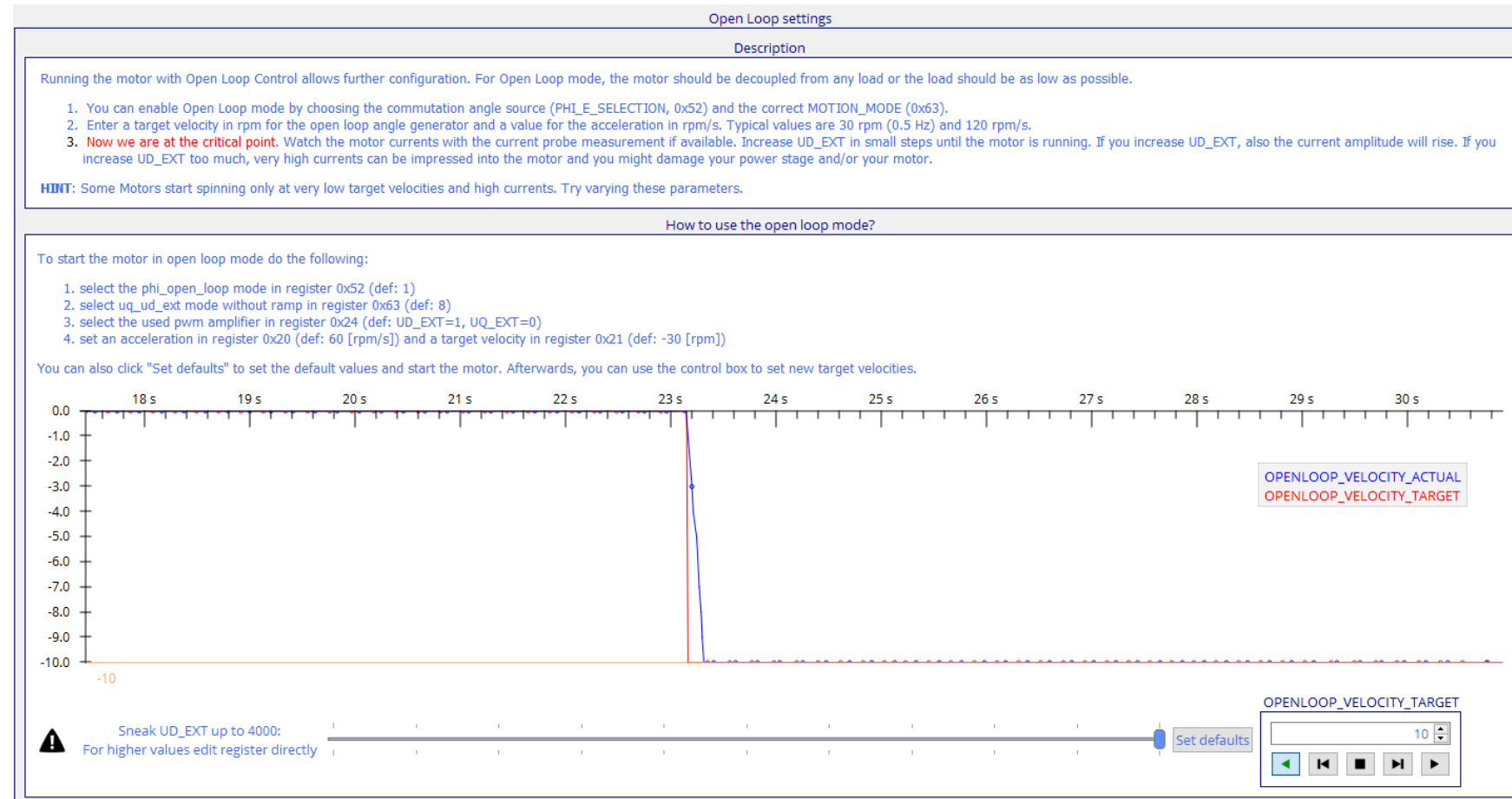
5.   Set Brake Before Make (BBM) times according to your power stage. These values can be defined separately for high side and low side switches.

    BBM low side: [40 ▲▼]   BBM high side: [40 ▲▼]

6.   Select the pwm chopper mode. For typical applications use "centered PWM for FOC" to enable the pwm and "PWM = OFF" for free running.

    PWM chopper mode: [7 - centered PWM for FOC ▼]

Start Motor in Open loop

▶ Go to open loop wizard page

▶ Click "Set defaults"

▶ Shift slider slowly to the right until the motor runs smoothly

Open Loop settings

Description

Running the motor with Open Loop Control allows further configuration. For Open Loop mode, the motor should be decoupled from any load or the load should be as low as possible.

1. You can enable Open Loop mode by choosing the commutation angle source (PHI_E_SELECTION, 0x52) and the correct MOTION_MODE (0x63).
2. Enter a target velocity in rpm for the open loop angle generator and a value for the acceleration in rpm/s. Typical values are 30 rpm (0.5 Hz) and 120 rpm/s.
3. Now we are at the critical point. Watch the motor currents with the current probe measurement if available. Increase UD_EXT in small steps until the motor is running. If you increase UD_EXT, also the current amplitude will rise. If you increase UD_EXT too much, very high currents can be impressed into the motor and you might damage your power stage and/or your motor.

HINT: Some Motors start spinning only at very low target velocities and high currents. Try varying these parameters.

How to use the open loop mode?

To start the motor in open loop mode do the following:

1. select the phi_open_loop mode in register 0x52 (def: 1)
2. select uq_ud_ext mode without ramp in register 0x63 (def: 8)
3. select the used pwm amplifier in register 0x24 (def: UD_EXT=1, UQ_EXT=0)
4. set an acceleration in register 0x20 (def: 60 [rpm/s]) and a target velocity in register 0x21 (def: -30 [rpm])

You can also click "Set defaults" to set the default values and start the motor. Afterwards, you can use the control box to set new target velocities.

OPENLOOP_VELOCITY_ACTUAL
OPENLOOP_VELOCITY_TARGET

⚠ Sneak UD_EXT up to 4000:
For higher values edit register directly

Set defaults

OPENLOOP_VELOCITY_TARGET
10

Check ADC Settings

► Go to second ADC config page

► ADC RAW values should display sinusoidal waveforms

► Click "Set" for both ADC Offsets

► Scroll down and check phase voltages match the ADCs

Setup Encoder
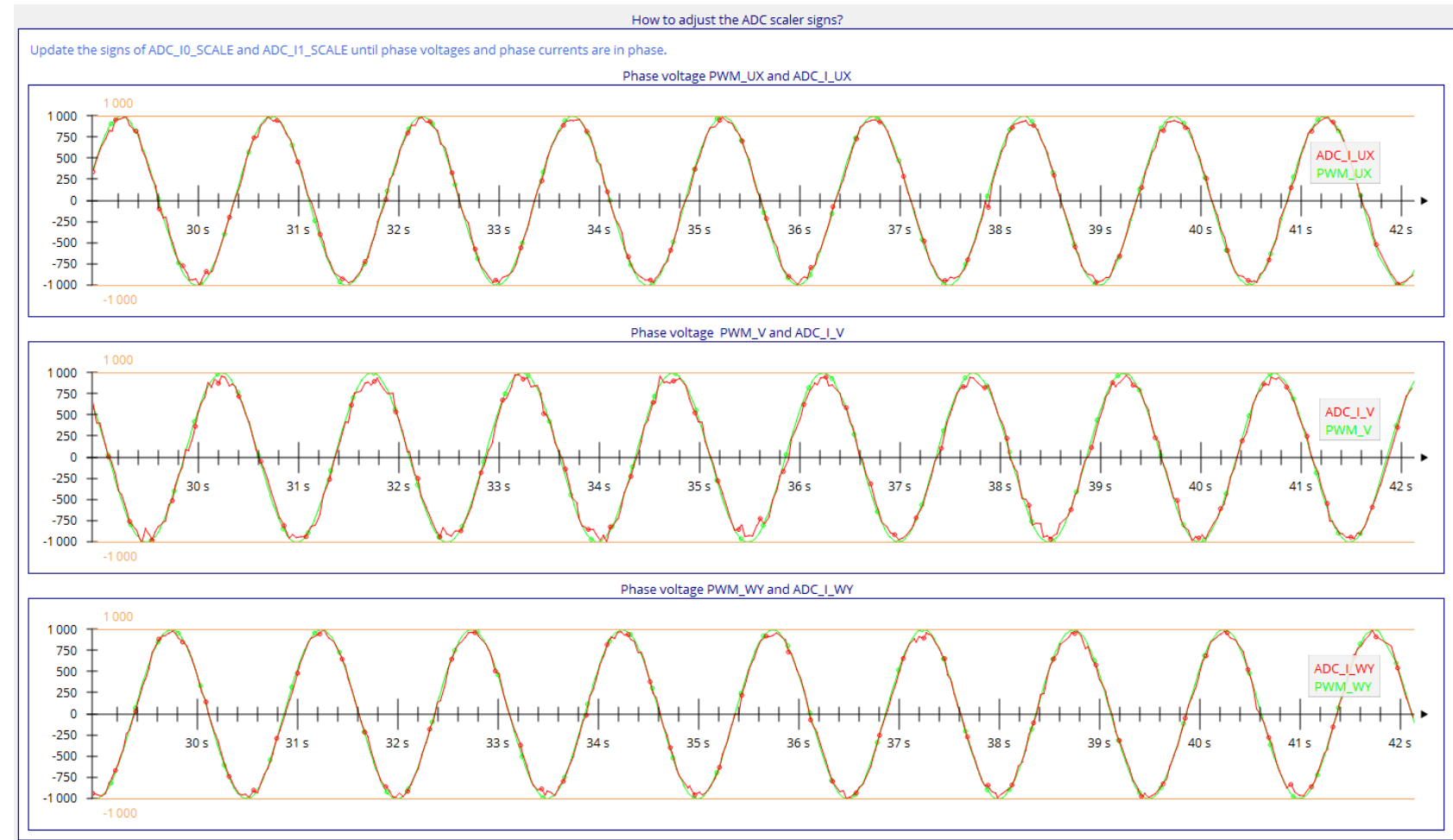
- ▶ Go to ABN encoder page

- ▶ Set ABN_DECODER_PPR according to the encoder resolution (PPR)

- ▶ If necessary, select direction

- ▶ Scroll down and click "Init with offset estimation (Firmware)"

First Test drive
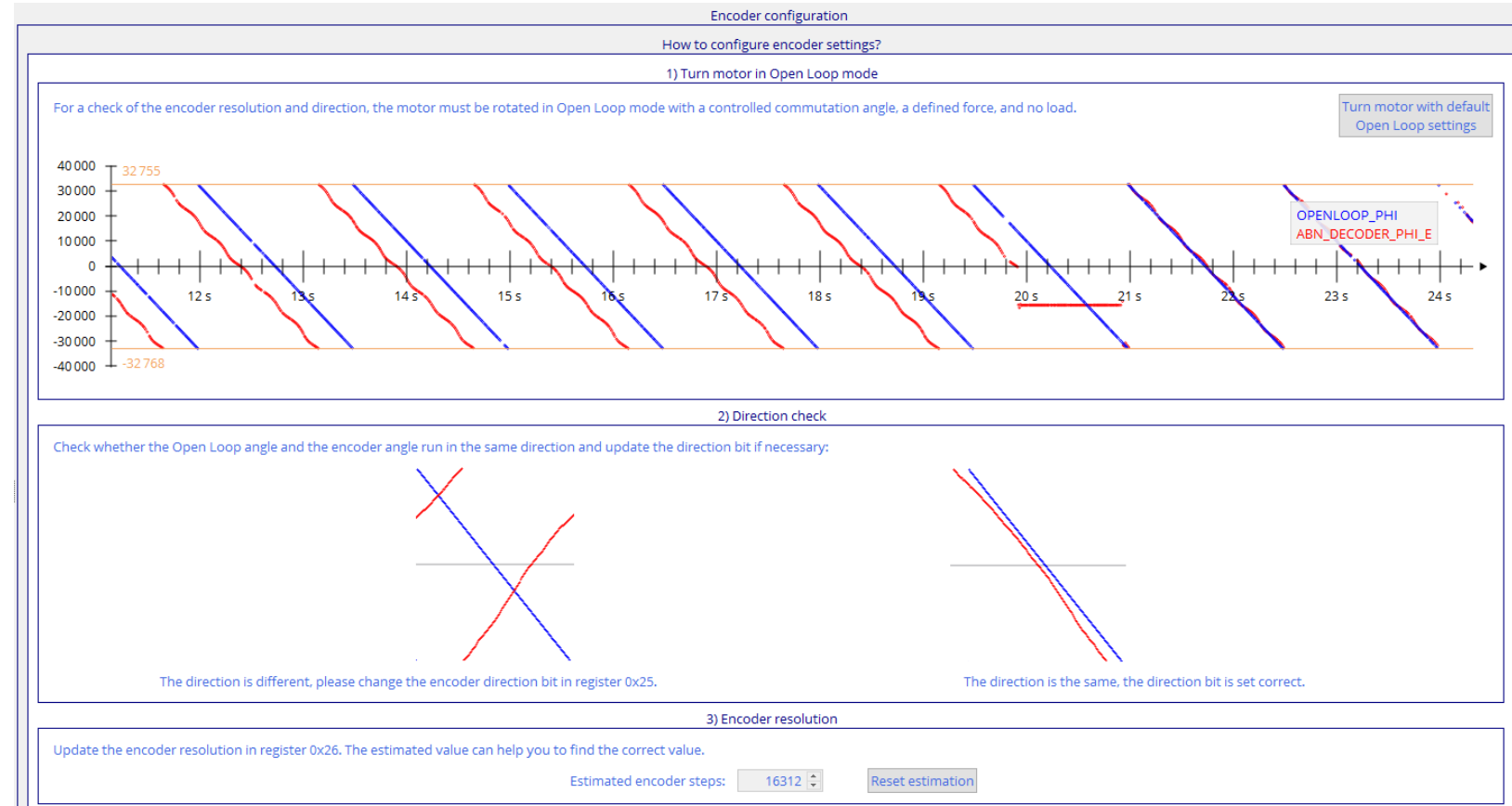
- ►Go to second ABN encoder page

- ►Click "Set defaults and start"

- ►Motor should drive at constant speed

- ►When switching motor direction, the motor speed should have the same absolute value

Encoder test drive (torque mode)

How to drive a motor with an encoder?

To start the motor with digital hall sensor feedback in torque mode do the following:

1. select the torque mode in register 0x63 (def: 1)
2. select phi_e_hall in register 0x52 to select digital hall sensor
3. set P and I parameters for torque and flux control in register 0x54 and 0x56 (def: P=256, I=256)
4. set the maximum current limit in register 0x5E (def: 1000)
5. set a target current in register 0x64 (def: FLUX_TARGET= 0, TORQUE_TARGET=500)

You can also click "Set defaults and start" to start with default values.

Export Settings

- ▶ Open Wizard Summary page
- ▶ Select "ABN encoder"
- ▶ Click "Export to TMCL/PC host"
- ▶ Close Wizard
- ▶ Open TMCL/PC host & Save script

Set Limits

▶ Open "Limits" tool from device tree

▶ PIDOUT_UQ_UD_LIMIT sets the maximum utilized voltage
  - Set to 32767 for full supply voltage utilization

▶ PID_TORQUE_FLUX_LIMITS sets the maximum current
  - 1.27mA/LSB for the TMC4671+TMC6100-BOB

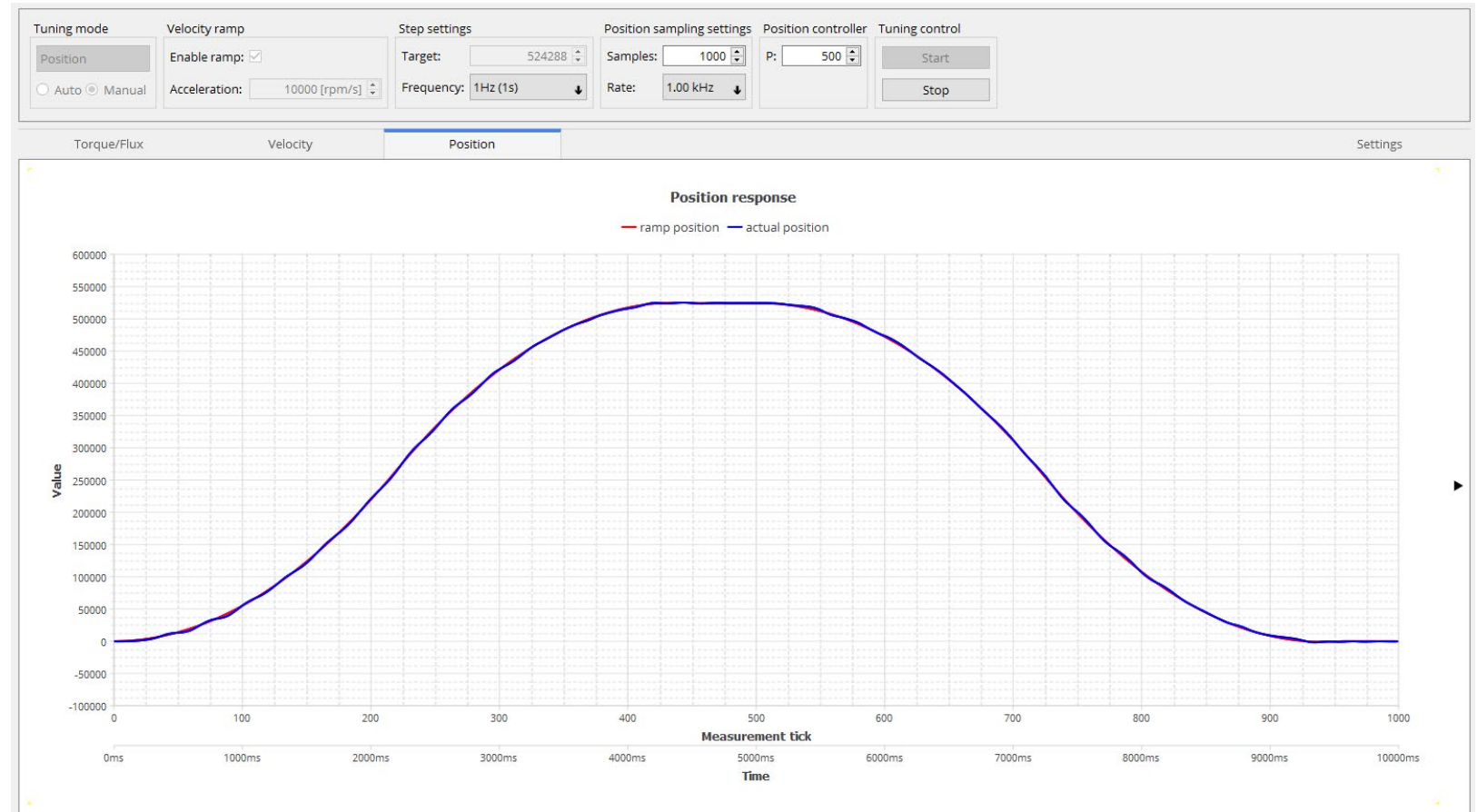▶ PID_VELOCITY_LIMIT sets the maximum velocity
  - Electrical velocity [rpm]

PI Tuning – Torque/Flux
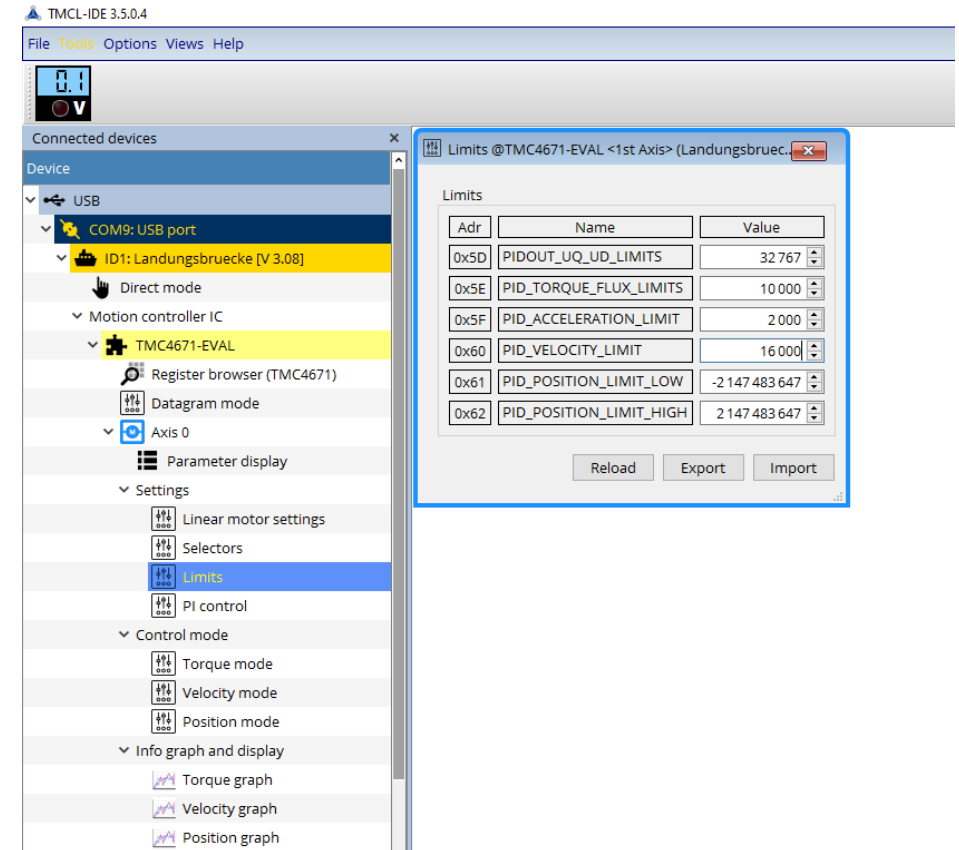
- ▶ Open PI tuning tool from TMC4671-EVAL device tree

- ▶ Set target current value according to motor

- ▶ Click "Start" & wait for procedure to finish
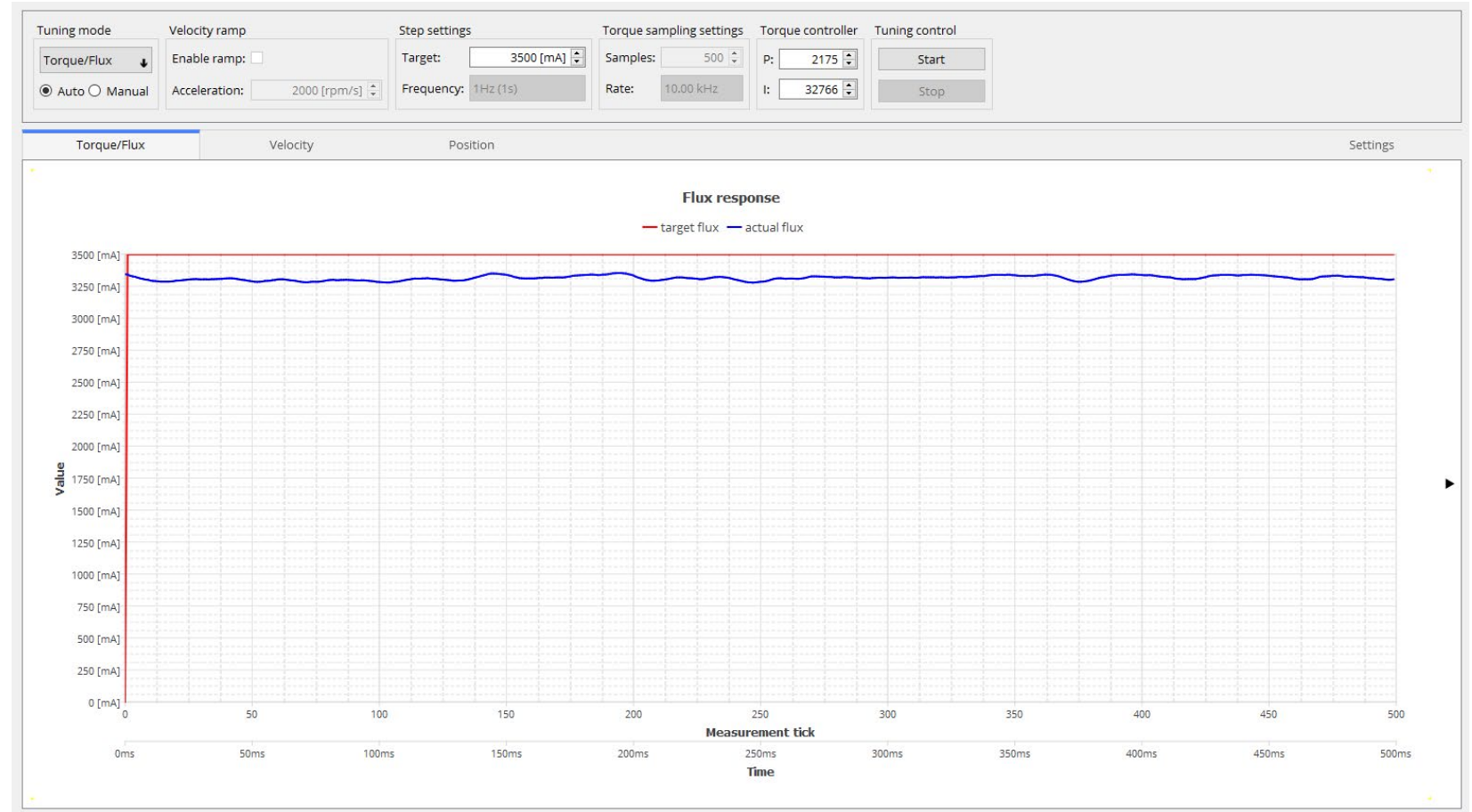
PI Tuning – Velocity

► Select "Velocity" from drop-down Tuning mode

► If positioning is required, enable velocity ramp

► Click "Start" & wait for procedure to finish
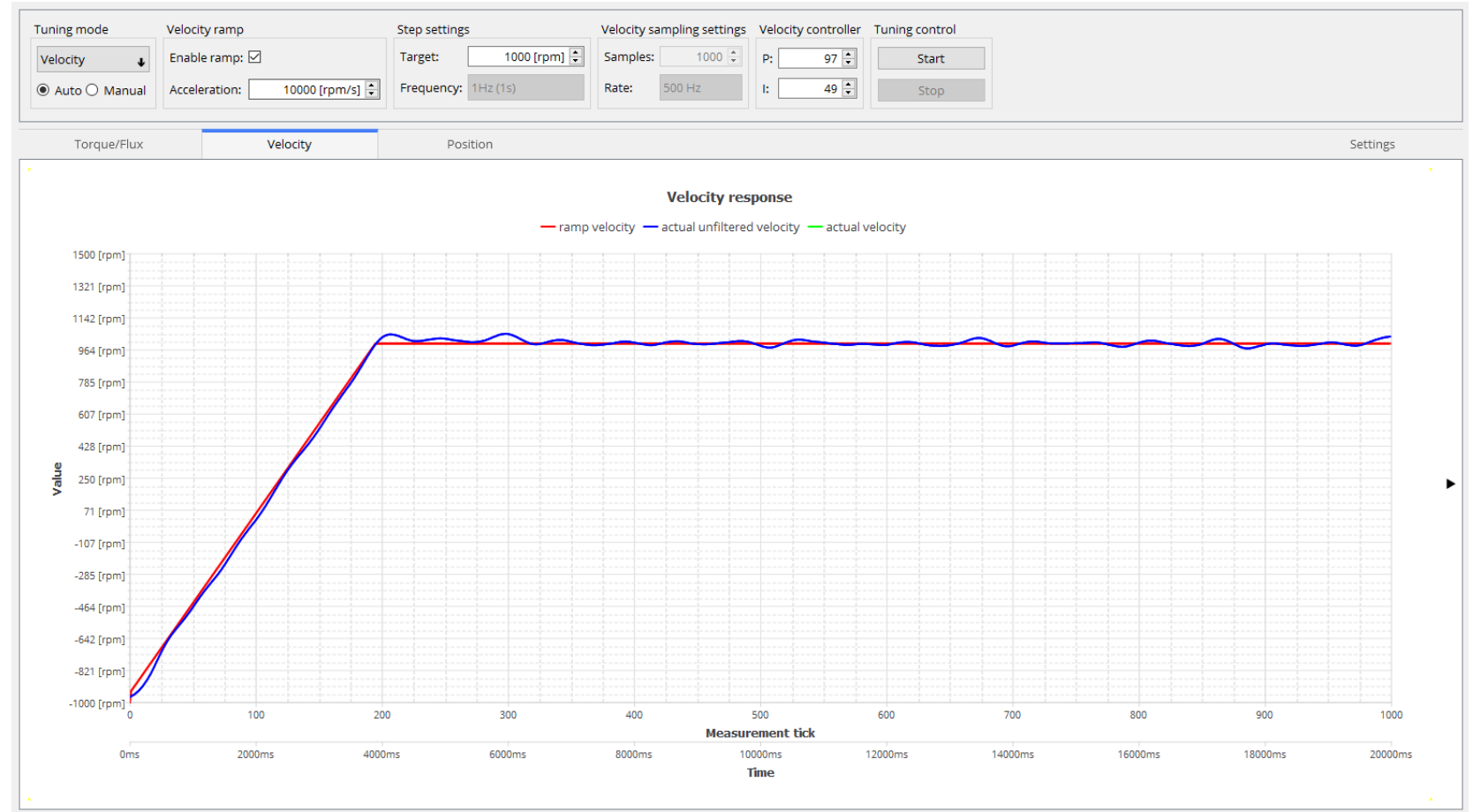
PI Tuning – Position

▶ Select "Velocity" from drop-down Tuning mode & choose "Manual"

▶ Set a target position in "Step settings"

▶ Click "Start"

▶ Increase the "Position controller" P-value until a smooth positioning is seen

Export PI Settings

► Open the TMC4671 Register browser

► Individually select register 0x56, 0x58, 0x5A and click "Send the highlighted register for writing to the Tool host PC

► Open TMCL/PC host, delete additional module assignment & save complete script