Stepper Motor

AGDxxx / AGAxxx configuration with Open Loop Stepper Motor

Application Note

agito

www.agito-akribis.com

Member of Akribis Systems group

Revision History

Version	Description	Date
1.0	Initial Release	11 Aug 2022
2.0	Add Close Loop configuration	19 Oct 2022

Contact Information

Manufacturer	Agito Akribis Systems Ltd., Member of Akribis Systems Group
Address	6 Yad-Harutsim St., P.O.Box 7172, Kfar-Saba 4464103
Telephone	+972-9-8909797
Website	www.agito-akribis.com

Copyright Notice

Products Rights

AGDx, AGCx, AGMx, AGAx, AGIx, and AGLx are products designed by Agito Akribis Systems Ltd. in Israel. Sales of the products are licensed to Akribis Systems Pte Ltd. under intercompany license agreement.

Agito Akribis Systems Ltd. has full rights to distribute above products worldwide.

Disclaimer

This product documentation was accurate and reliable at the time of its release.

Agito Akribis Systems Ltd. reserves the right to change the specifications of the product described in this manual without notice at any time.

Trademarks

Agito PCSuite is a trademark of Agito Akribis Systems Ltd..

Warranty

This product is warranted to be free of defects in material and workmanship and conforms to the specifications listed in this manual, for a period of 12 months from the shipment date from factory.

Contents

1 Introduction

1.1 Background

In some application, customers want to use Agito controller to control stepper motor.

Agito controllers have built-in features that allow the user to control stepper motor in open loop.

1.2 Scope

This application note seeks to introduce how to do configuration and tunning in PCSuite software, and finally realize the open-loop control of stepper motor with Agito controller.

In this application note, AGM800 + AGA155-CI-2A10 are used. Other Central-I and integrated controllers also support this function.

2 Setup

2.1 Equipment and overview

The typical setup topology is presented in the following figure:

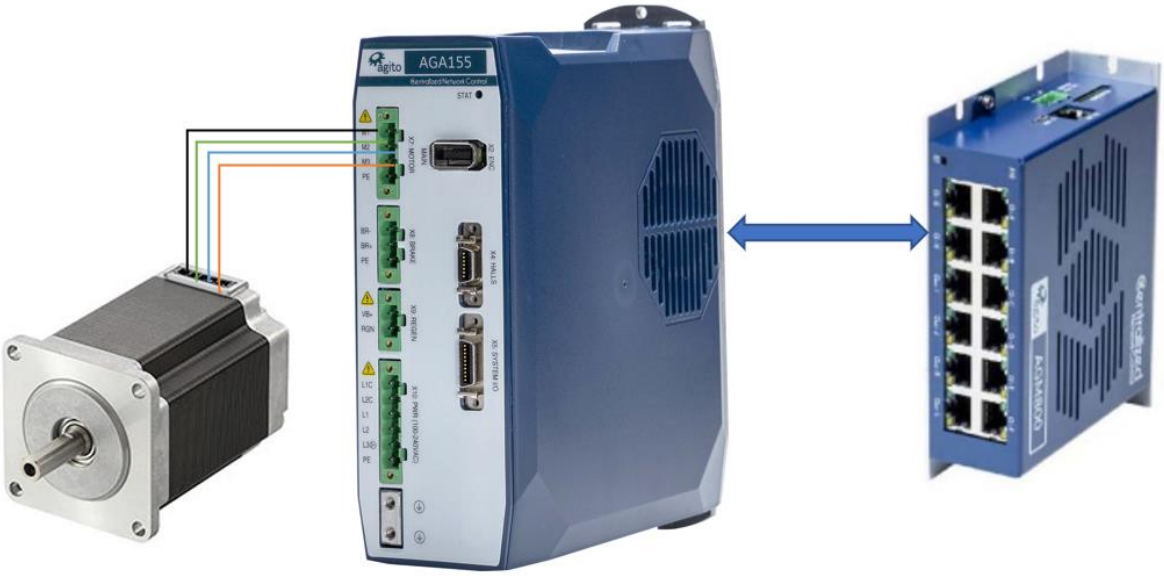


Figure 1. Setup topology

The example setup includes:

1. AGA155-CI-2A10 Central-i remote power amplifiers.
2. AGM800 Central-i master controller.
3. 2-Phase Bipolar Stepper Motor, Orientalmotor PKP268D28A2.

2.2 Setup Pictures

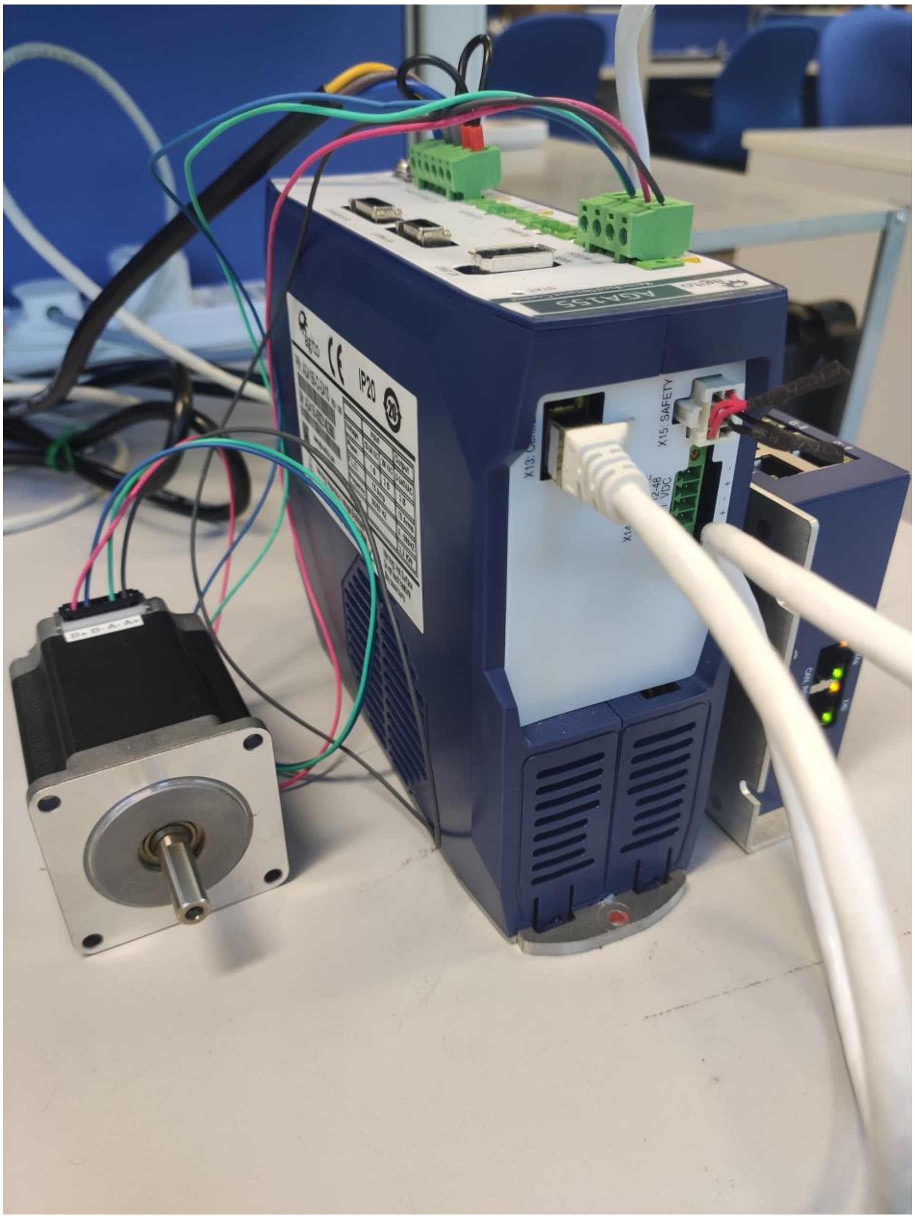


Figure 2. Setup picture 1 (Open loop)

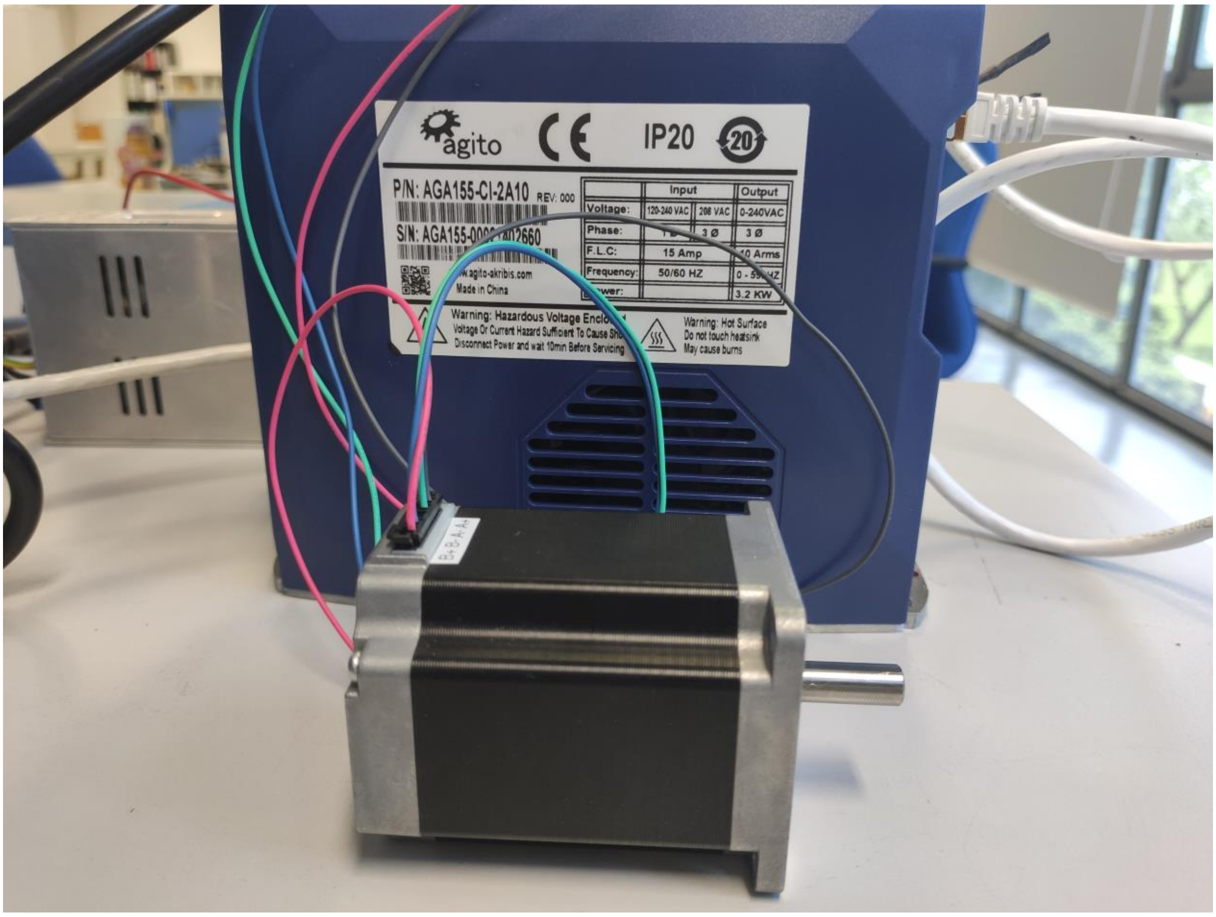


Figure 3. Setup picture 2 (Open loop)

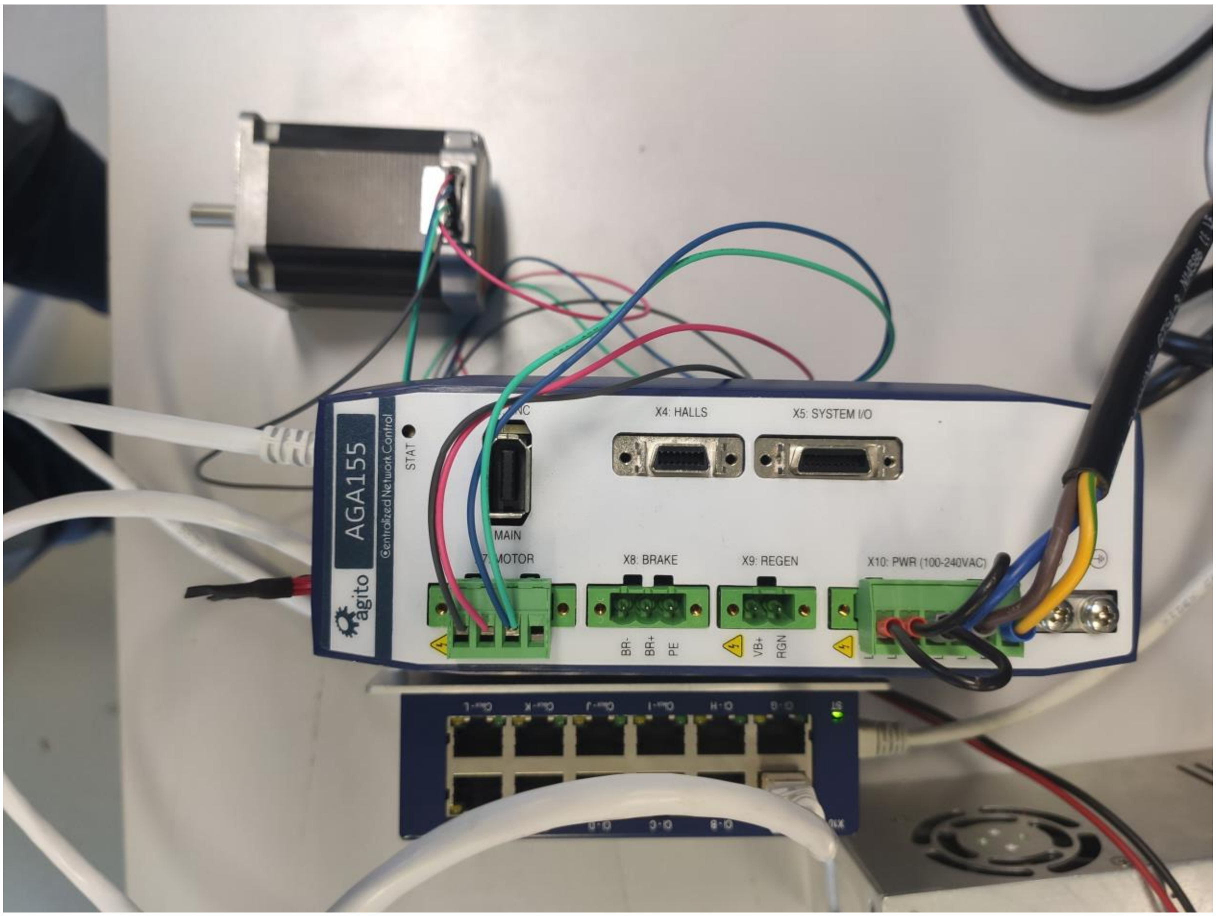
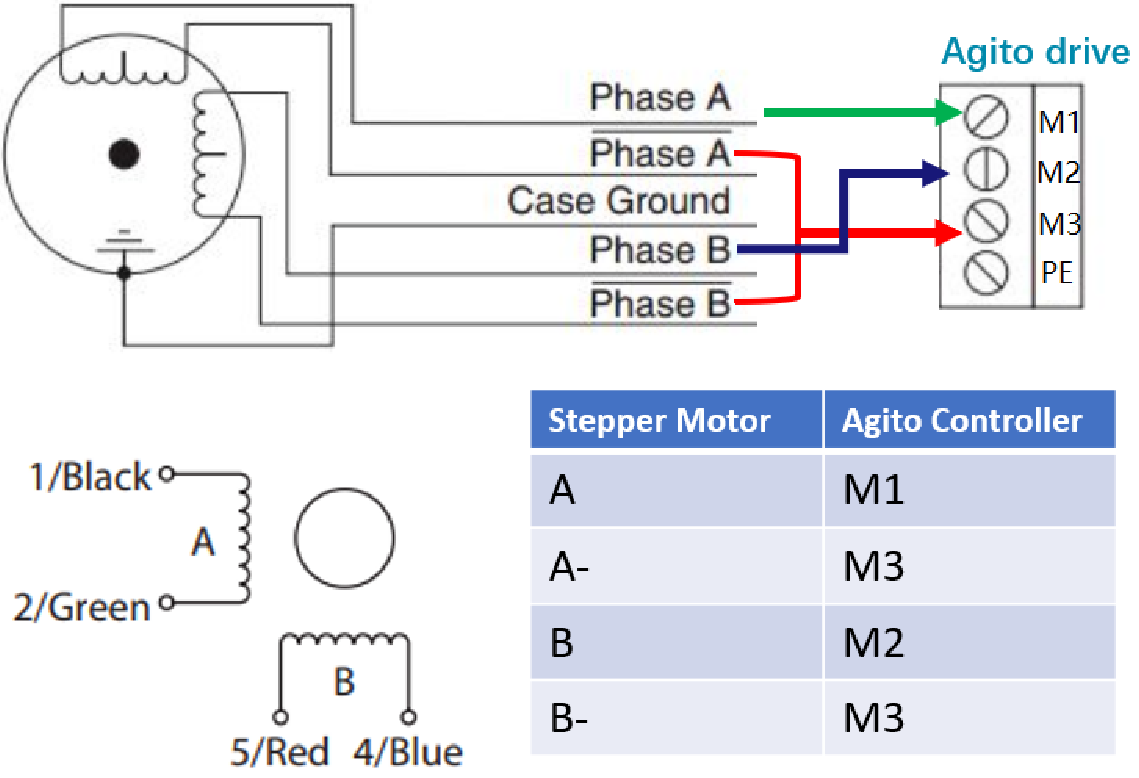


Figure 4. Setup picture 3 (Open loop)

2.3 Wiring

AGA155: X7 – Motor Power

Function	Pin Name	Pin #	Remarks
Motor Phase A	Phase A, M1	1	Motor Power
Motor Phase B	Phase B, M2	2	Motor Power
Motor Phase C	Phase C, M3	3	Motor Power, NC for voice coils
PE	PE	4	Motor PE



Stepper Motor	Agito Controller
A	M1
A-	M3
B	M2
B-	M3

Figure 5. Stepper Motor Connection

Note – Wiring for other controllers

This example uses Agito controller, AGA155 for the example. Wiring information for other controllers or encoder protocols can be found in their respective Product Manuals.

2.4 Configuration

In PCSuite, navigate to COFIG Tab CFG.

COFIG CFG / MOT MOT

Open loop configuration:

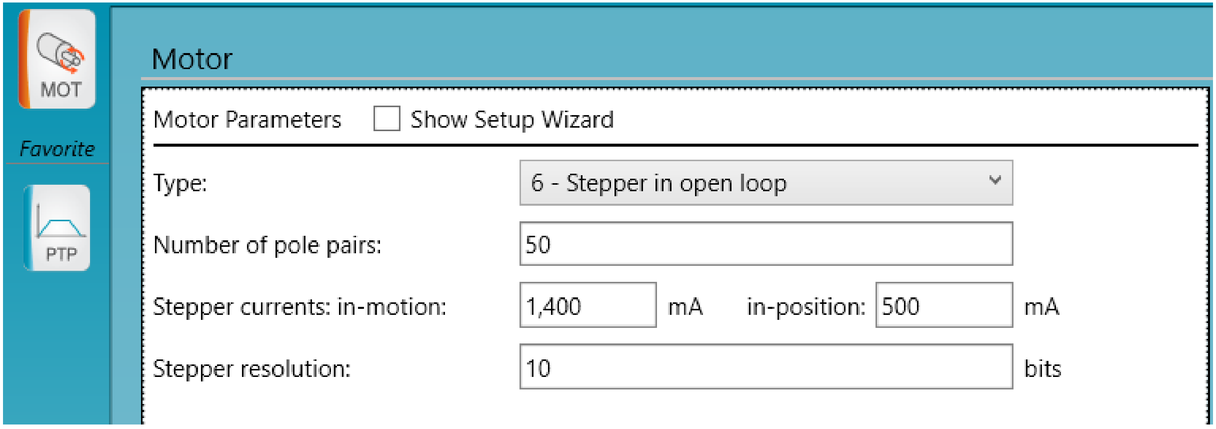
Set Type: Stepper in open loop.

Set Poles to 50 (or other number based on motor datasheet. Motors with step of 1.8°are 50 poles (most typical number of poles in steppers).

Set stepper current to rated current of stepper (according datasheet). In position current can be lower to save energy when motor is not moving (if hold position not needed).

Stepper resolution set to 10bits (1024 mico stepping), can set up to 16bits (65536 micro steps).

Resolution 10 bits means 51,200 counts in 1 rev (2^10 bits * 50 poles = 51200).



Motor

Motor Parameters ☐ Show Setup Wizard

Type: 6 - Stepper in open loop

Number of pole pairs: 50

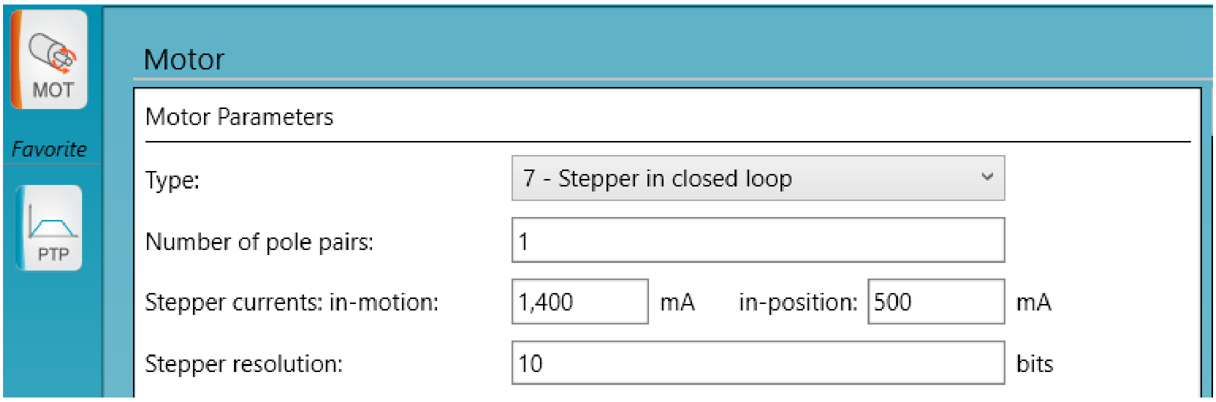
Stepper currents: in-motion: 1,400 mA in-position: 500 mA

Stepper resolution: 10 bits

Figure 6. Screen capture of MOT configuration in open loop.

Close loop configuration:

Set Type: Stepper in close loop.



Motor

Motor Parameters

Type: 7 - Stepper in closed loop

Number of pole pairs: 1

Stepper currents: in-motion: 1,400 mA in-position: 500 mA

Stepper resolution: 10 bits

Figure 7. Screen capture of MOT configuration in close loop.

Set Poles to 1.

Stepper resolution set to 10bits.

COFIG CFG /FDBK FDBK

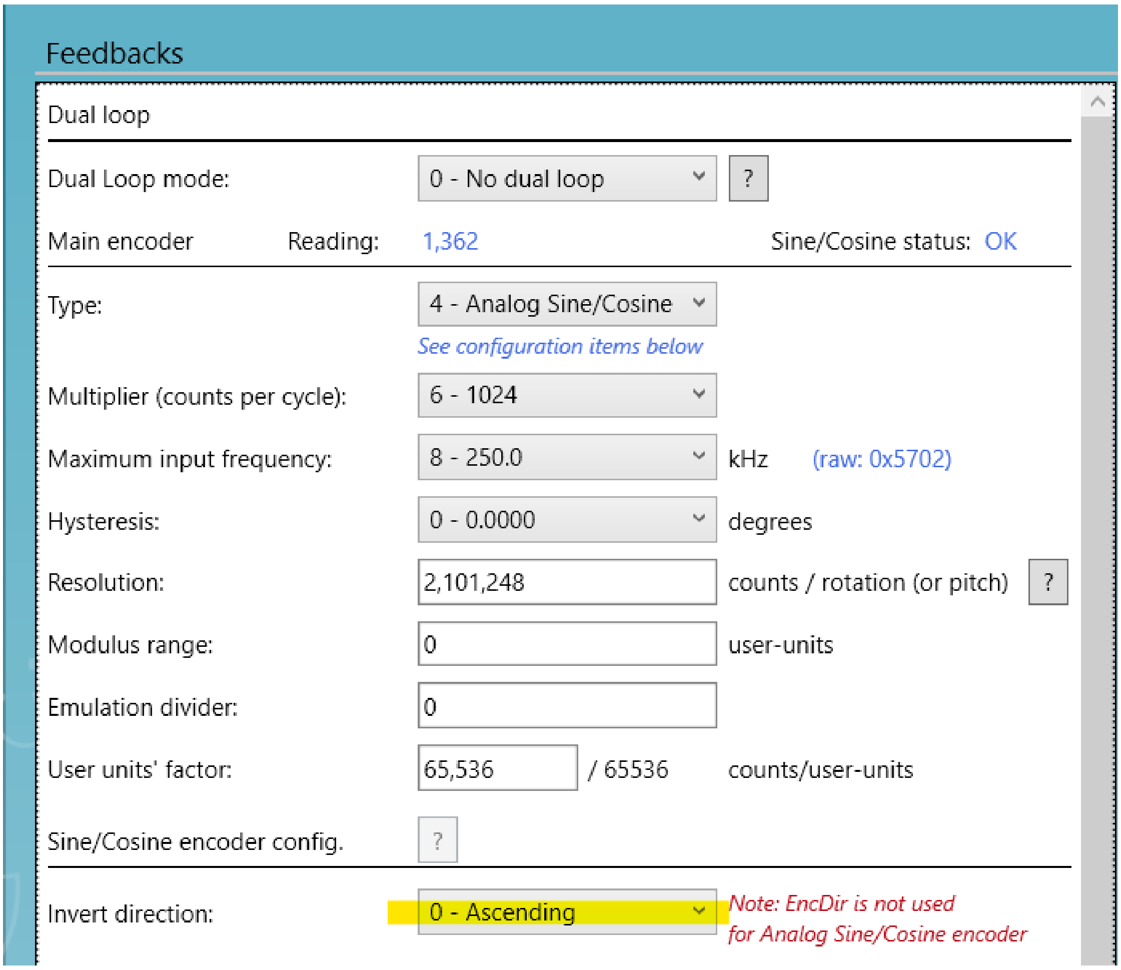
Open loop configuration:

Not relevant, since we don’t have feedback.

Close loop configuration:

Set the encoder type and resolution based on the encoder in use.

Please make sure the "Invert direction" is correct.



Feedbacks

Dual loop

Dual Loop mode: 0 - No dual loop

Main encoder Reading: 1,362 Sine/Cosine status: OK

Type: 4 - Analog Sine/Cosine

See configuration items below

Multiplier (counts per cycle): 6 - 1024

Maximum input frequency: 8 - 250.0 kHz (raw: 0x5702)

Hysteresis: 0 - 0.0000 degrees

Resolution: 2,101,248 counts / rotation (or pitch)

Modulus range: 0 user-units

Emulation divider: 0

User units' factor: 65,536 / 65536 counts/user-units

Sine/Cosine encoder config.

Invert direction: 0 - Ascending

Note: EncDir is not used for Analog Sine/Cosine encoder

Figure 8. Screen capture of FDBK configuration in close loop.

COFIG CFG/POS POS

Tick "Mask main encoder errors", if work in open loop.

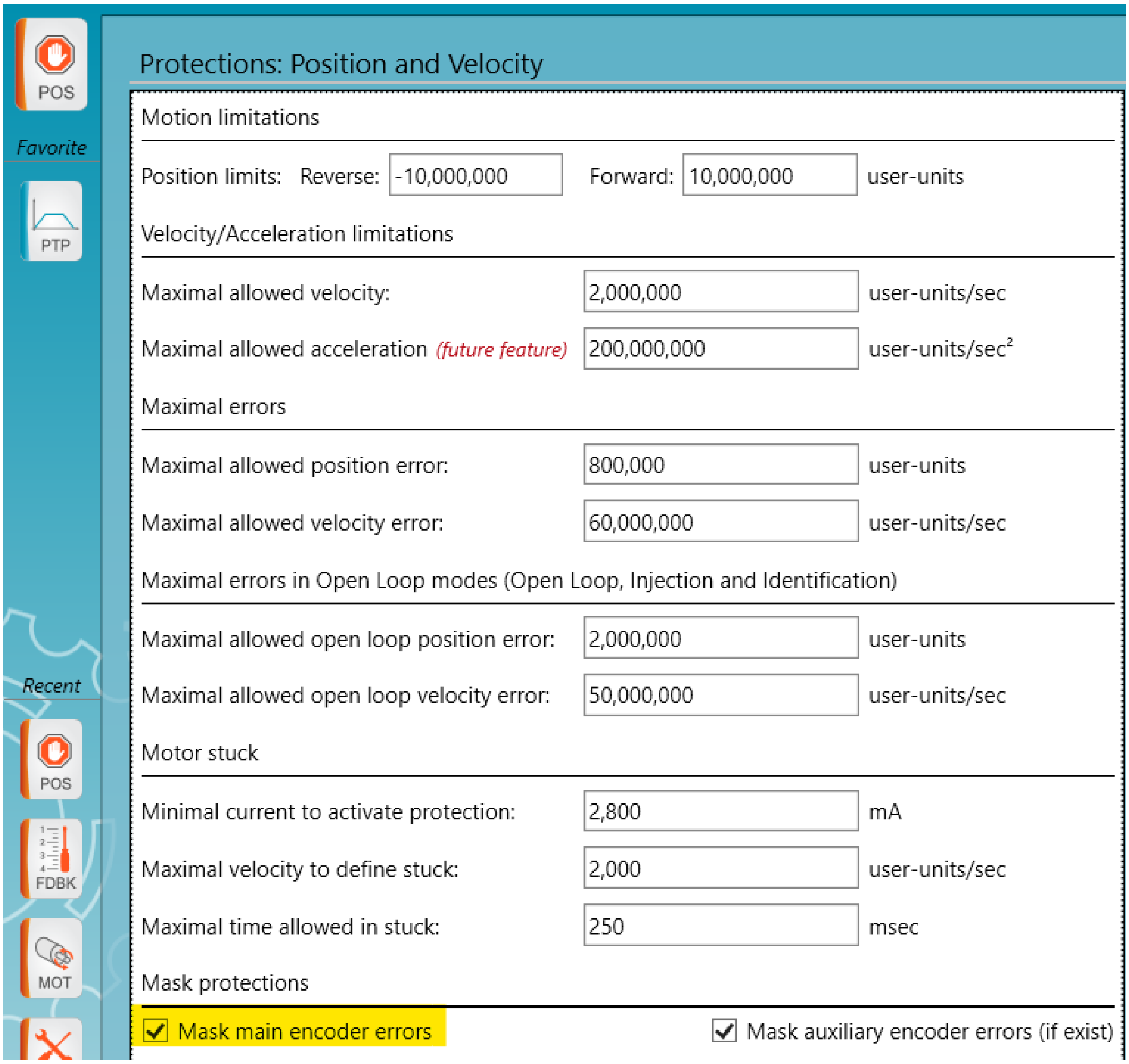
Do Not tick "Mask main encoder errors", if work in close loop.

Set position limits to +/-10,000,000.

Set allowed velocity to 2,000,000. ***Note****: stepper motors are slow, motor speed cannot reach more 200-300 RPM.*

Set allowed acceleration to 50,00,000

Motor stuck: current set to motor peak current. We don't have feedback, so need disable motor stuck protection.



Protections: Position and Velocity

Motion limitations

Position limits: Reverse: -10,000,000 Forward: 10,000,000 user-units

Velocity/Acceleration limitations

Maximal allowed velocity:	2,000,000	user-units/sec
Maximal allowed acceleration *(future feature)*	200,000,000	user-units/sec^2

Maximal errors

Maximal allowed position error:	800,000	user-units
Maximal allowed velocity error:	60,000,000	user-units/sec

Maximal errors in Open Loop modes (Open Loop, Injection and Identification)

Maximal allowed open loop position error:	2,000,000	user-units
Maximal allowed open loop velocity error:	50,000,000	user-units/sec

Motor stuck

Minimal current to activate protection:	2,800	mA
Maximal velocity to define stuck:	2,000	user-units/sec
Maximal time allowed in stuck:	250	msec

Mask protections

☑ Mask main encoder errors ☑ Mask auxiliary encoder errors (if exist)

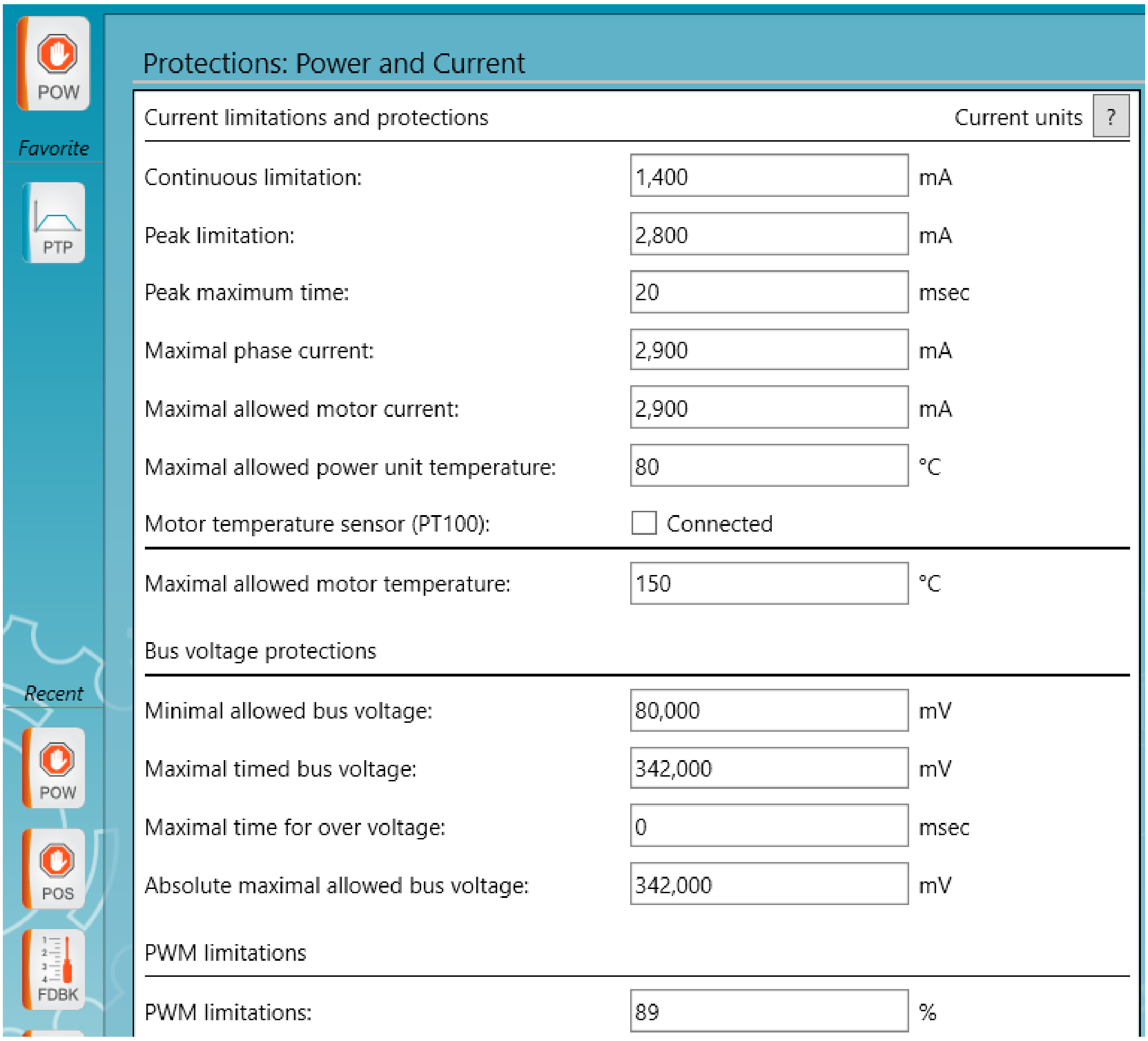
Figure 9. Screen capture of POS configuration.

COFIG CFG /POW POW

Set Continues limitation to motor rated current.

Set Peak limitation to motor peak current.

Rest setting are standard as other motors.



Protections: Power and Current

Current limitations and protections — Current units ?

Continuous limitation:	1,400	mA
Peak limitation:	2,800	mA
Peak maximum time:	20	msec
Maximal phase current:	2,900	mA
Maximal allowed motor current:	2,900	mA
Maximal allowed power unit temperature:	80	°C
Motor temperature sensor (PT100):	□ Connected	
Maximal allowed motor temperature:	150	°C

Bus voltage protections

Minimal allowed bus voltage:	80,000	mV
Maximal timed bus voltage:	342,000	mV
Maximal time for over voltage:	0	msec
Absolute maximal allowed bus voltage:	342,000	mV

PWM limitations

PWM limitations:	89	%

Figure 10. Screen capture of POW configuration.

2.5 Tunning

In PCSuite, navigate to TUNE Tab TUNE .

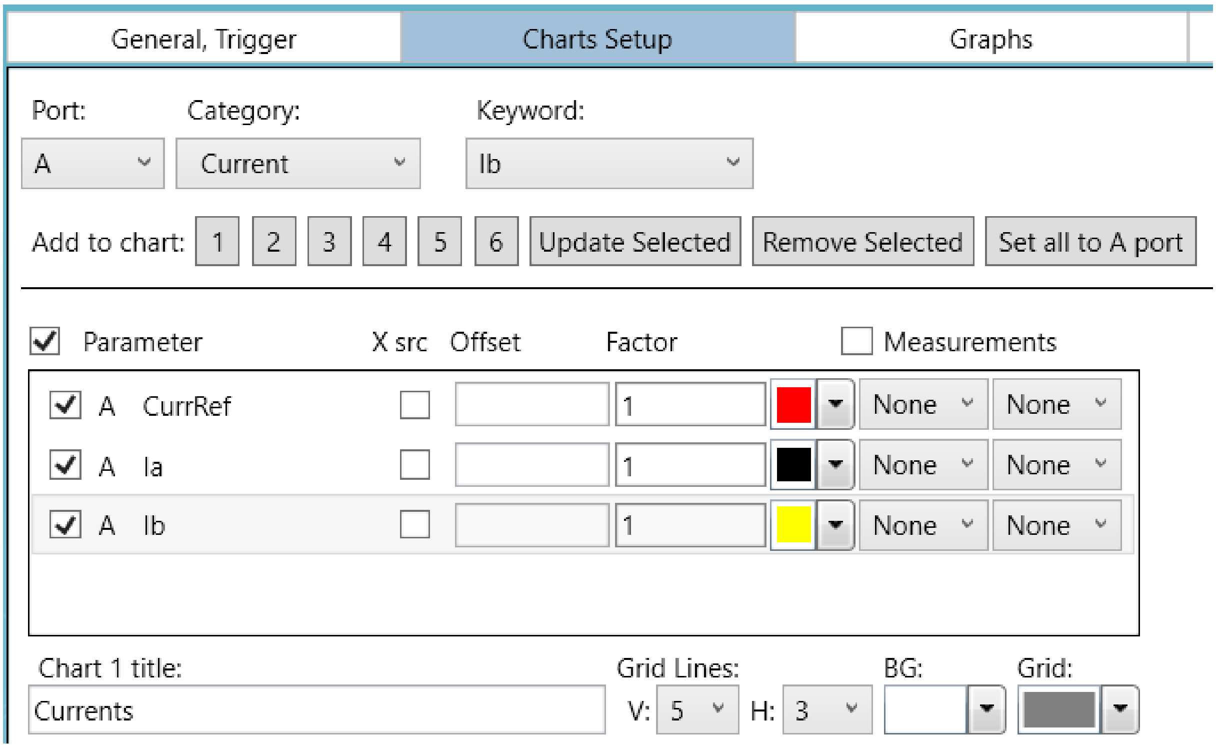
TUNE TUNE /PHAS PHAS

No need.

TUNE TUNE /CURR CURR

Perform tuning on step response of CurrRef, Ia and Ib, the highest amplitude. Use Proportional and Integral gains.

Note*: Inductance measurement in not available for steppers, please refer to data sheet of stepper motor and fill in the value in PCSuite.*

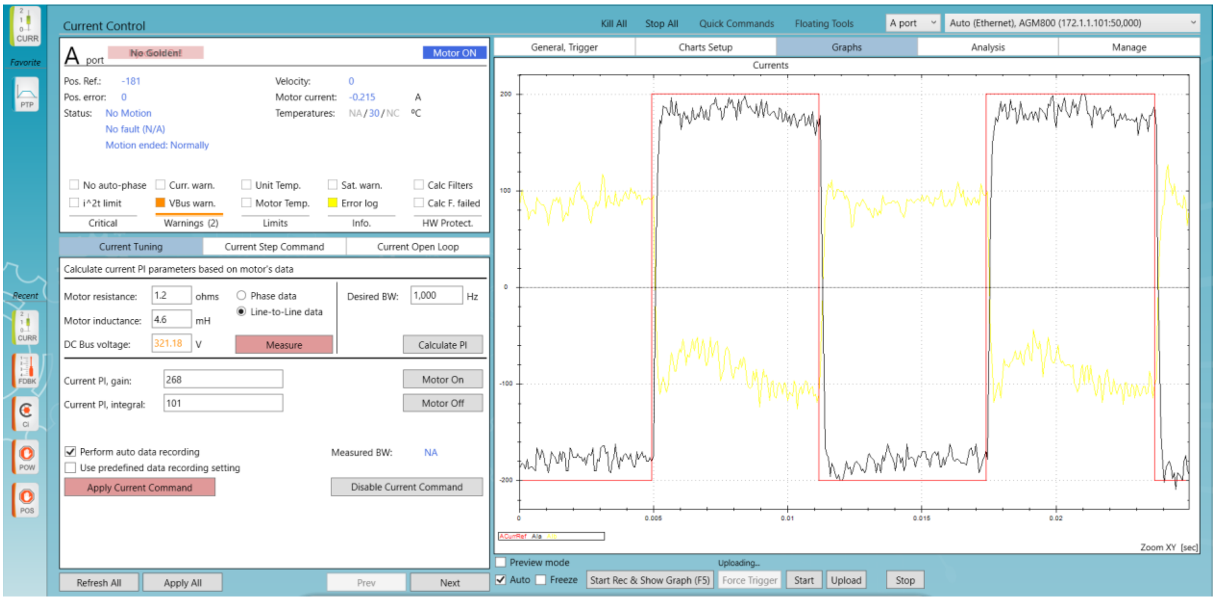


Port: A
Category: Current
Keyword: Ib

☑ Parameter		X src	Offset	Factor		☐ Measurements	
☑ A	CurrRef	☐		1	🟥	None	None
☑ A	Ia	☐		1	⬛	None	None
☑ A	Ib	☐		1	🟨	None	None

Chart 1 title: Currents
Grid Lines: V: 5 H: 3
BG:
Grid:

Figure 11. Screen capture of Data Recording Setup.



Current Control

A port: A port
Auto (Ethernet), AGM800 (172.1.1.101:50,000)

A port No Golden! Motor ON

Pos. Ref.: -181
Pos. error: 0
Status: No Motion
No fault (N/A)
Motion ended: Normally

Velocity: 0
Motor current: -0.215 A
Temperatures: NA / 30 / NC ºC

☐ No auto-phase ☐ Curr. warn. ☐ Unit Temp. ☐ Sat. warn. ☐ Calc Filters
☐ i^2t limit 🟧 VBus warn. ☐ Motor Temp. 🟨 Error log ☐ Calc F. failed

Calculate current PI parameters based on motor's data

Motor resistance: 1.2 ohms
Motor inductance: 4.6 mH
DC Bus voltage: 321.18 V
○ Phase data
● Line-to-Line data
Desired BW: 1,000 Hz

Current PI, gain: 268
Current PI, integral: 101

☑ Perform auto data recording
☐ Use predefined data recording setting
Measured BW: NA

☐ Preview mode
Uploading...
☑ Auto ☐ Freeze

Figure 12. Screen capture of Current Tunning.

TUNE /PIV

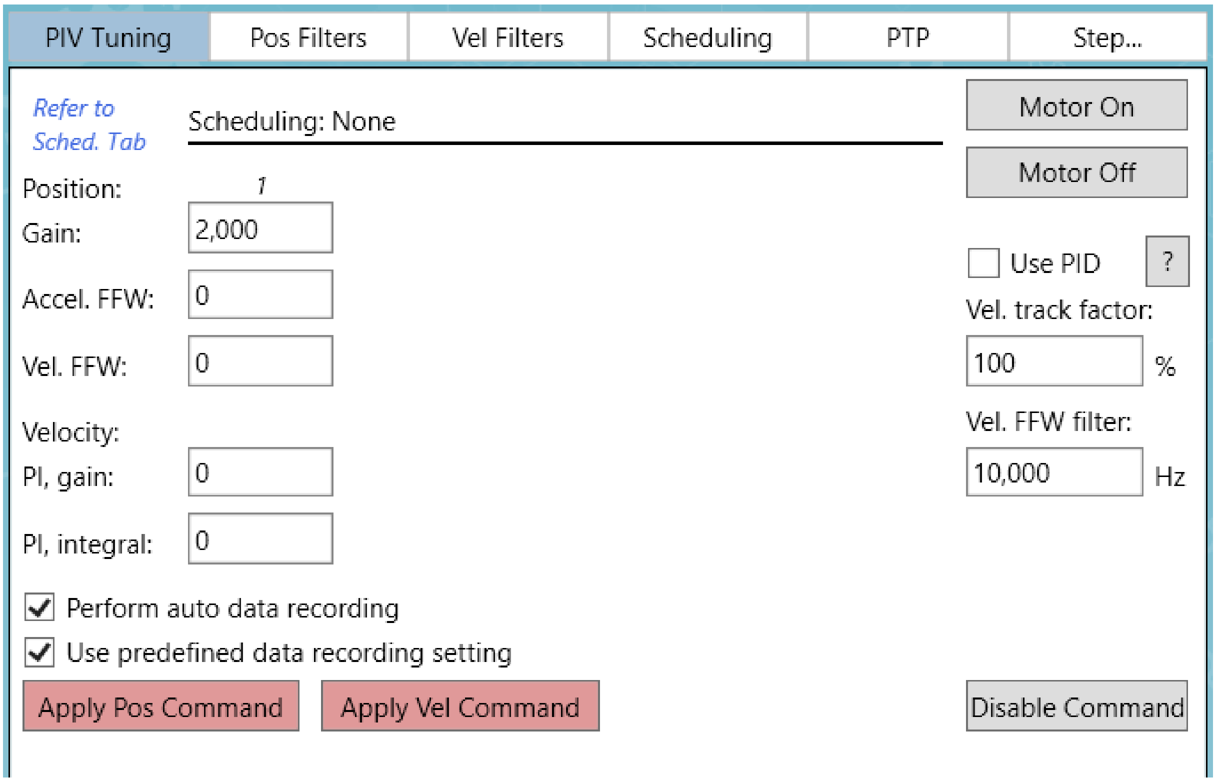
Open loop tuning:

No need, we work in open loop.

Close loop tuning:

Adjust the Position gain, until the motion performance meets the requirement.

Accel. FFW, Vel. FFW, Velocity gain and Velocity integral will not affect the performance of stepper motor.



Scheduling: None

Position: 1

Gain: 2,000

Accel. FFW: 0

Vel. FFW: 0

Velocity:

PI, gain: 0

PI, integral: 0

□ Use PID

Vel. track factor: 100 %

Vel. FFW filter: 10,000 Hz

☑ Perform auto data recording

☑ Use predefined data recording setting

Figure 13. Screen capture of PIV Tunning.

3 Motion

In PCSuite, navigate to MOTION Tab MOTION .

MOTION MOTION /PTP PTP

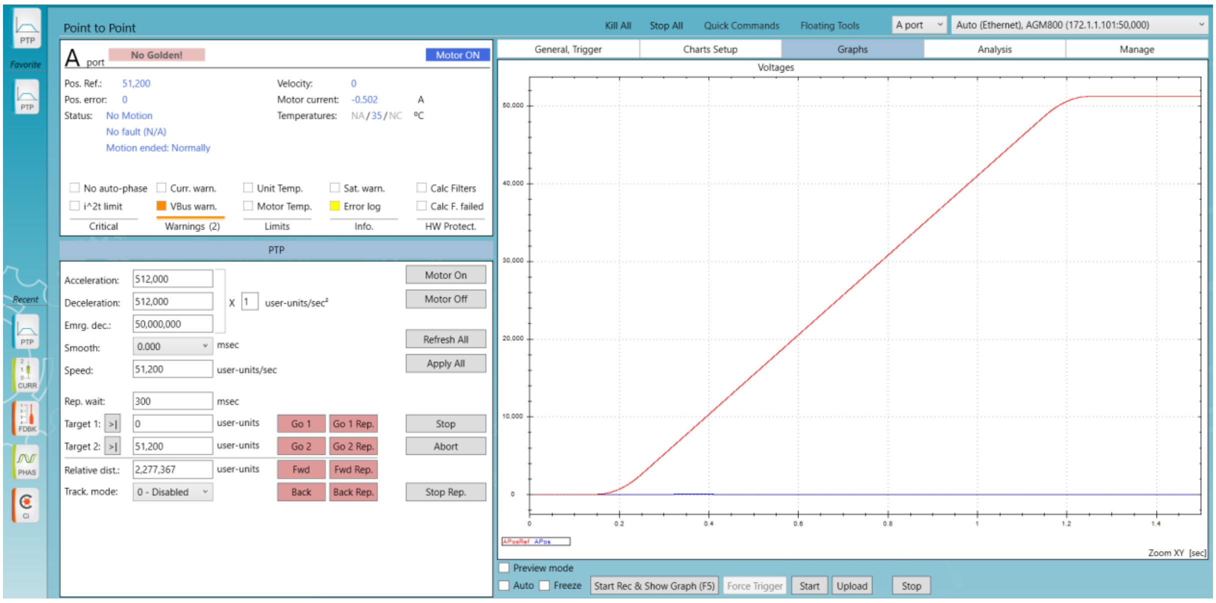
Speed up to 200 RPM (depend on motor

Current shall reflect the speed, best work at rated motor current.

Open loop motion:

POS (Actual position) is always 0 (we have no feedback)

POSREF (position reference) is available, use POSREF as feedback as well.



Point to Point

A port — No Golden! — Motor ON

Pos. Ref.: 51,200

Pos. error: 0

Status: No Motion

No fault (N/A)

Motion ended: Normally

Velocity: 0

Motor current: -0.502 A

Temperatures: NA / 35 / NC °C

Critical: □ No auto-phase, □ i^2t limit

Warnings (2): □ Curr. warn., ■ VBus warn.

Limits: □ Unit Temp., □ Motor Temp.

Info.: □ Sat. warn., ■ Error log

HW Protect.: □ Calc Filters, □ Calc F. failed

PTP

Acceleration: 512,000

Deceleration: 512,000 X 1 user-units/sec²

Emrg. dec.: 50,000,000

Smooth: 0.000 msec

Speed: 51,200 user-units/sec

Rep. wait: 300 msec

Target 1: 0 user-units

Target 2: 51,200 user-units

Relative dist.: 2,277,367 user-units

Track. mode: 0 - Disabled

A port — Auto (Ethernet), AGM800 (172.1.1.101:50,000)

□ Preview mode

□ Auto □ Freeze

Figure 14. Screen capture of Motion (Open loop).

Close loop motion:

POS (Actual position) will follow POSREF (position reference).

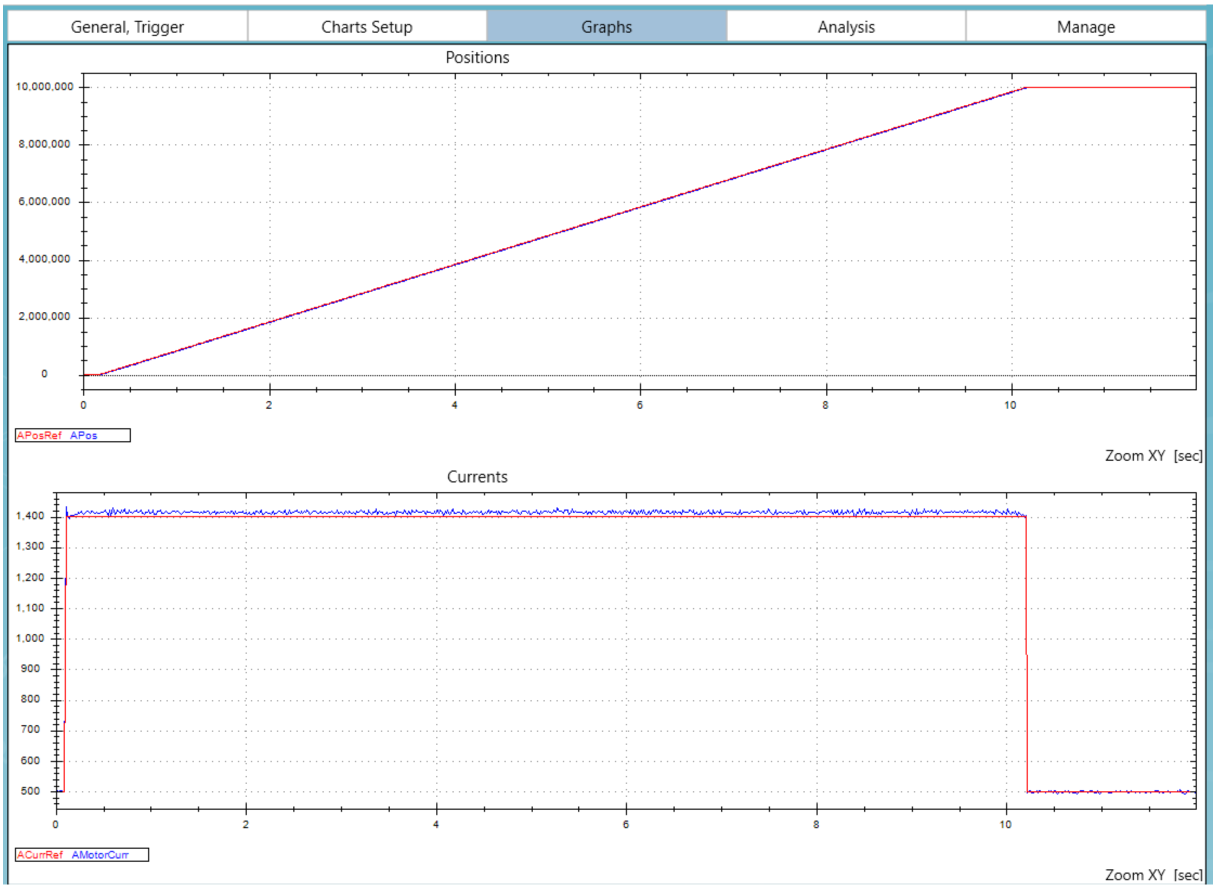


Figure 15. Screen capture of Motion (Open loop).