INOVANCE

2022

Start up procedure

SV660N

INOVANCE TECHNOLOGY EUROPE

V1.4

TABLE OF CONTENTS

1 GENERAL DATA

Authors: RSR

Date: 26.08.2022

Hardware: SV660N

Software: InoDriverShop v3.2.1.1

Info: SV660N Start up procedure guide

2 PURPOSE OF THIS DOCUMENT

The purpose of this document is to facilitate the start-up and diagnosis of the SV660 servo drive. The SV660N series high-performance AC servo drive covers a power range from 50 W to 7.5 kW. It supports EtherCAT communication protocol to work with the host controller for a networked operation of multiple servo drives.

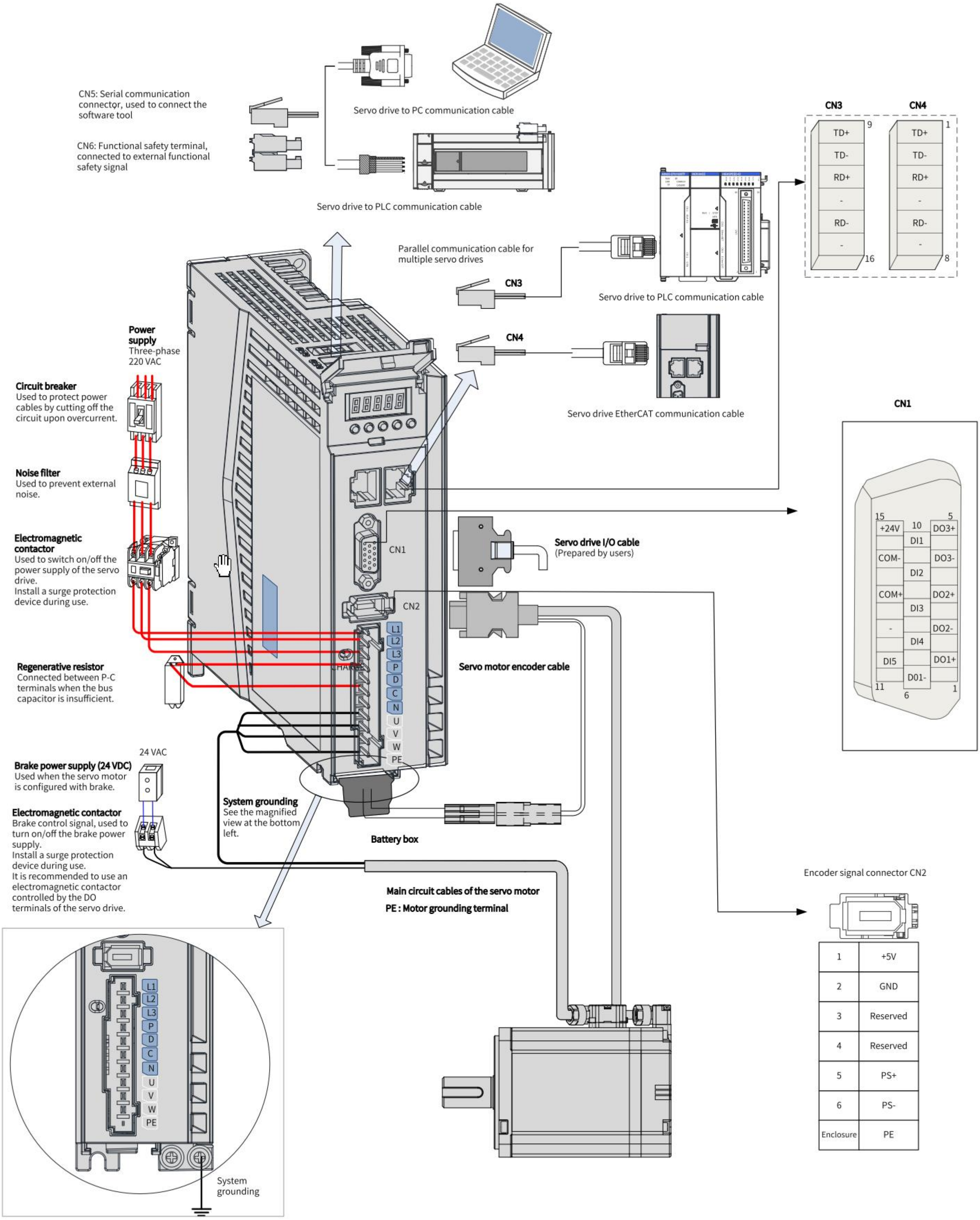
The document is divided into different sections to explain the basic wiring, communication with the diagnostic PC and the operation of the InoDriverShop program, which is used to perform the configuration and diagnostic functions of the servo drive.

In order to use the InoProShop software, you need the serial communication cable S6-L-T00-3.0, described in the section 5. Serial Communication cable.

3 REVISION HISTORY

Revision	Date	Author	Description
1.2	4 February 21	RSR	First release
1.3	5 March 21	RSR	The following sections have been added: 6.5.4 Comparison 6.8.1 EtherCAT position interpolation 7 Axis Scaling 8 Absolute encoder system 9.4 CiA402 Object Dictionary
1.4	26 August 21	RSR	The following sections have been added: 8.2 Data range in the absolute position linear mode 6.6.4 Inertia ratio calculation The following sections have been modified: 6.4.4 Motor parameters 6.6.2 STUNE

4 WIRING & COMMUNICATION



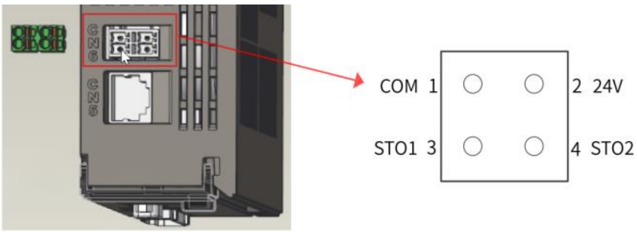
4.1 CONNECTION OF STO TERMINALS

This section describes the definition and functions of the I/O terminal (CN6) for the safe torque off (STO) functional safety function.

Two isolated inputs are configured to dual-channel inputs of STO function: STO1/STO2.

To make it more convenient and safe for installation, an additional pin with supply voltage (+24V) is integrated. The bridging of the 24 volts is needed in case the safety circuit is installed but no STO function is needed.

NOTE The servo drive can operate normally only if the input status of STO1 and STO2 are both "1" or "H". If the input status of either STO1 or STO2 (or both) is "0" or "L", the servo **drive cannot run**.



Terminal	Pin No.	Name	Value	Description
CN6	1	COM	0 V	STO reference ground
	2	24V	24 V	24 V power supply
	3	STO1	-	Control input for STO1
	4	STO2	-	Control input for STO2

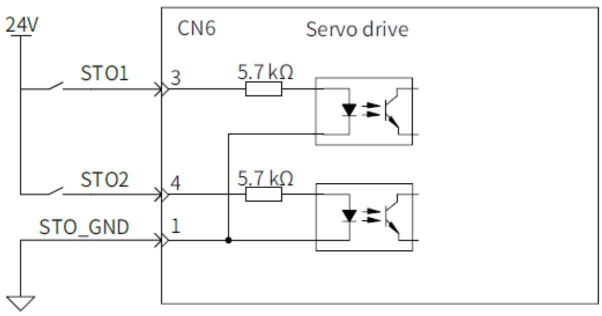


Figure 1. Example of external 24 V connection

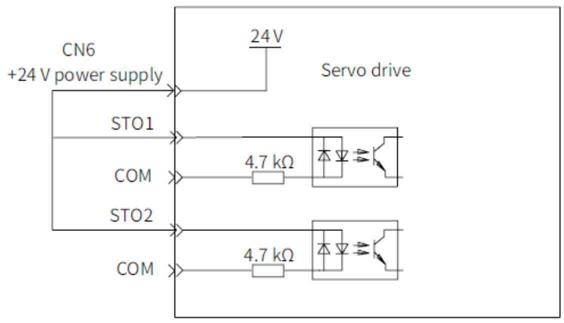


Figure 2. Example of internal 24 V connection

5 SERIAL COMMUNICATION CABLE

The cable used to connect the SV660N with the computer is S6-L-T00-3.0. It is a DB9 (PC side) to RJ45 (drive side) cable. The physical layer is according to RS232 communication.

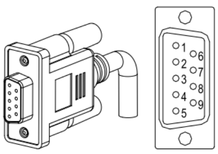
Model Number: S6-L-T00-3.0

Material Code: 15041243

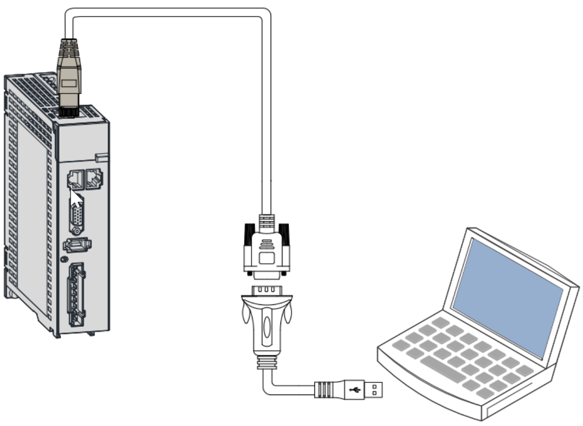
Figure 1. Connection relation between the servo drive and PC communication cable pins

RJ45 on Servo Drive Side (A)		DB9 on PC Side (B)	
Signal Name	Pin No.	Signal Name	Pin No.
RS232-TXD	6	PC-RXD	2
RS232-RXD	7	PC-TXD	3
GND	8	GND	5
PE (shield)	Enclosure	PE (shield)	Enclosure

Figure 2. Pin definition of DB9 ("B" in the preceding figure) on the PC side

Pin No.	Definition	Description	Terminal Pin Layout
2	PC-RXD	PC receiving end	
3	PC-TXD	PC transmitting end	
5	GND	Ground	
Enclosure	PE	Shield	

A female USB / RS232 converter will be needed if your computer is not equipped with a RS232 serial port.

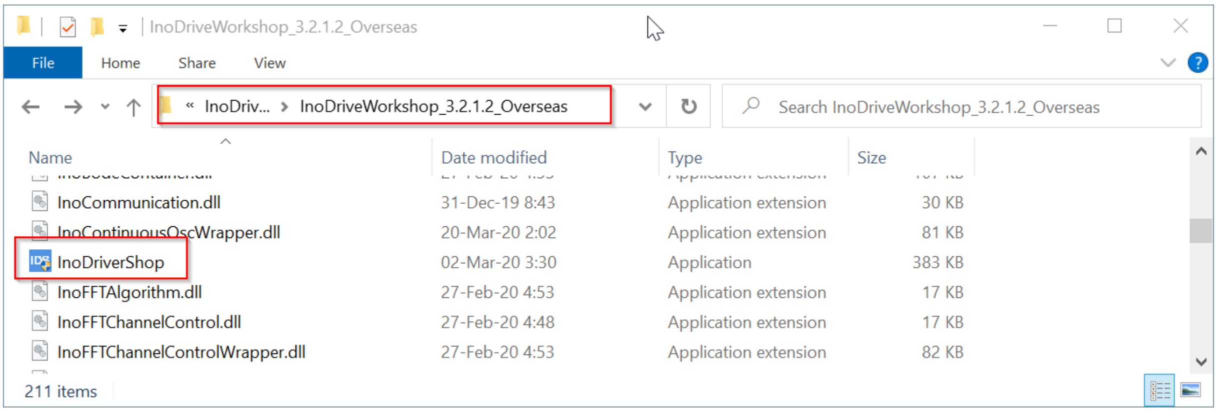


6 INODRIVERSHOP

InoDriverShop is the commissioning and diagnostic tool for SV660N drives series. This document explain the InoDriverShop version v3.2.1.1

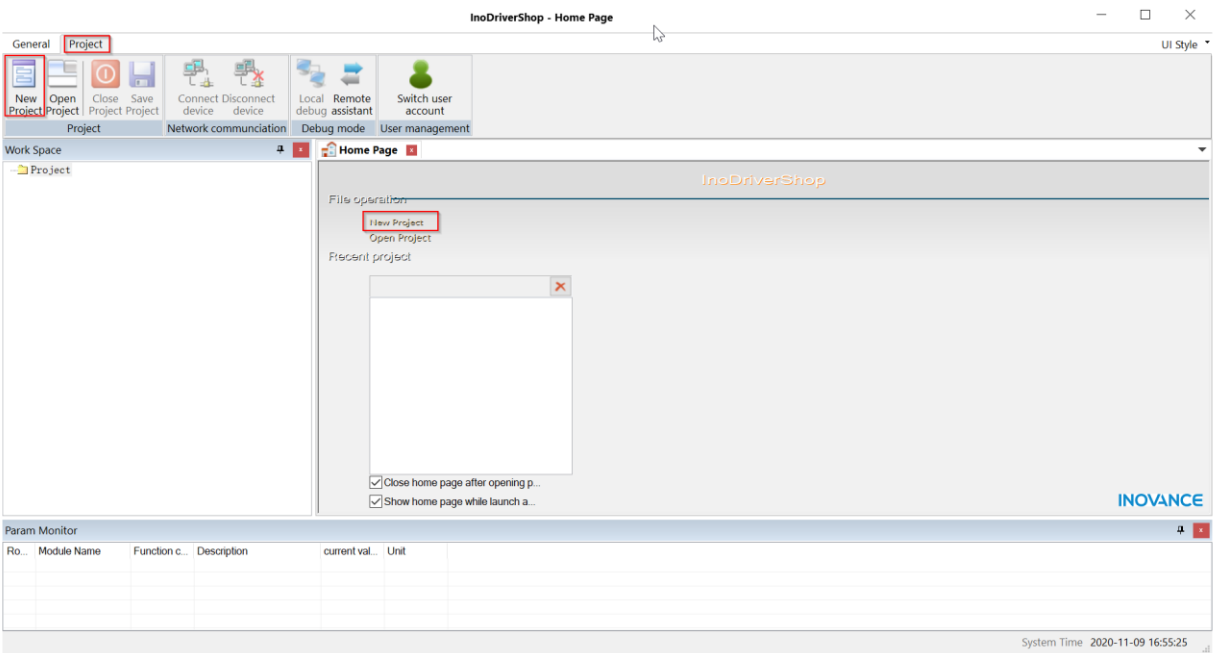
6.1 INSTALL AND EXECUTE INODRIVERSHOP

This program does not need to be installed. Unzipping the file in a folder on your computer is enough to run it. Once the file has been decompressed in the resulting folder, the executable InoDriveShop appears. Executing this file opens the user environment.



6.2 CREATE A NEW PROJECT

To create a new project, click on the new project icon or the command from the start screen:

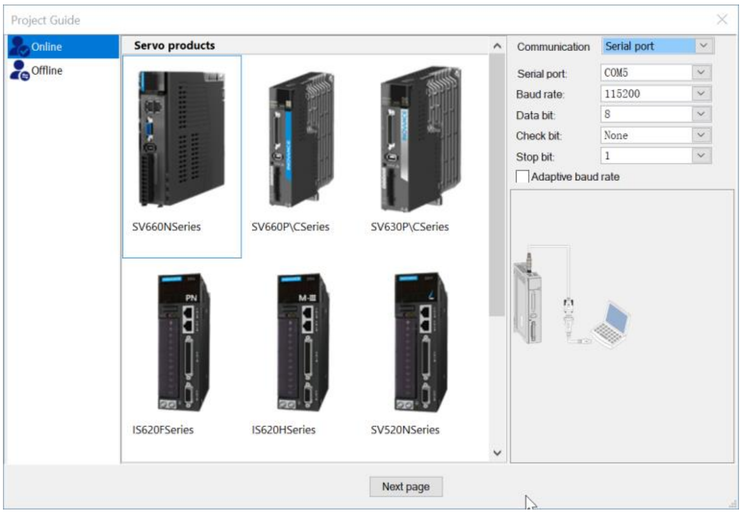


The corresponding dialog to select the type of drive is show. It is possible to create a new project online or offline. The offline project allows you to create a project without being connected to the computer.

If you connect with the drive, select the appropriate communication parameters. Connect the servo drive and the PC by using the PC communications cable.

The default parameters of the SV660N are:

- Communication: Serial port
- Baud Rate: 115200
- Data bit:8
- Check bit: none
- Stop bit: 1

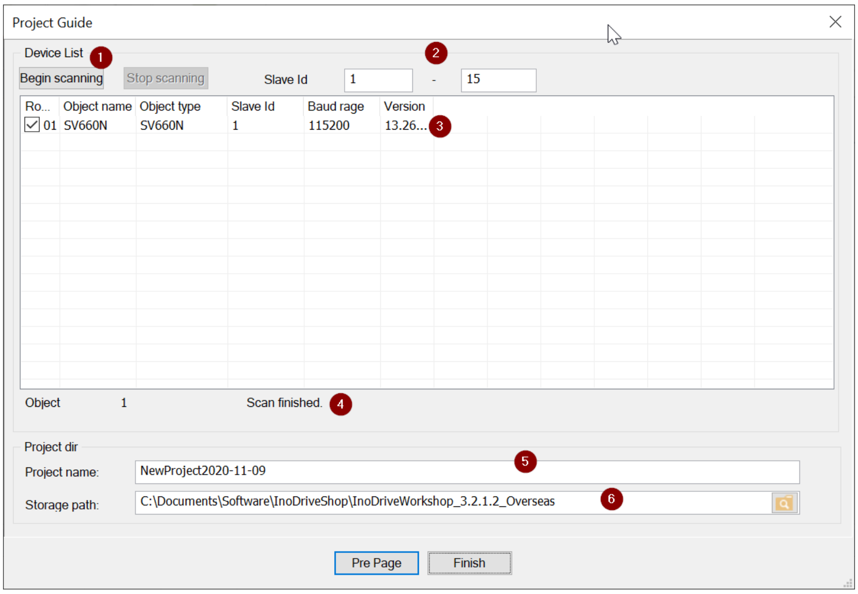


Select the corresponding drive model (in this case SV660N) and click “Next Page” button.

The next image shows the dialog for scanning drives:

1. When the dialog opens, the scan of the devices starts automatically. But using this buttons it is possible to start and stop the scanning procedure.
2. In this text box there is the range node Id to search devices. Usually the drive uses no Id 1
3. When a device is detected it is shown in this list.
4. This message shows when the search ends
5. Name of the project
6. Folder where project is stored

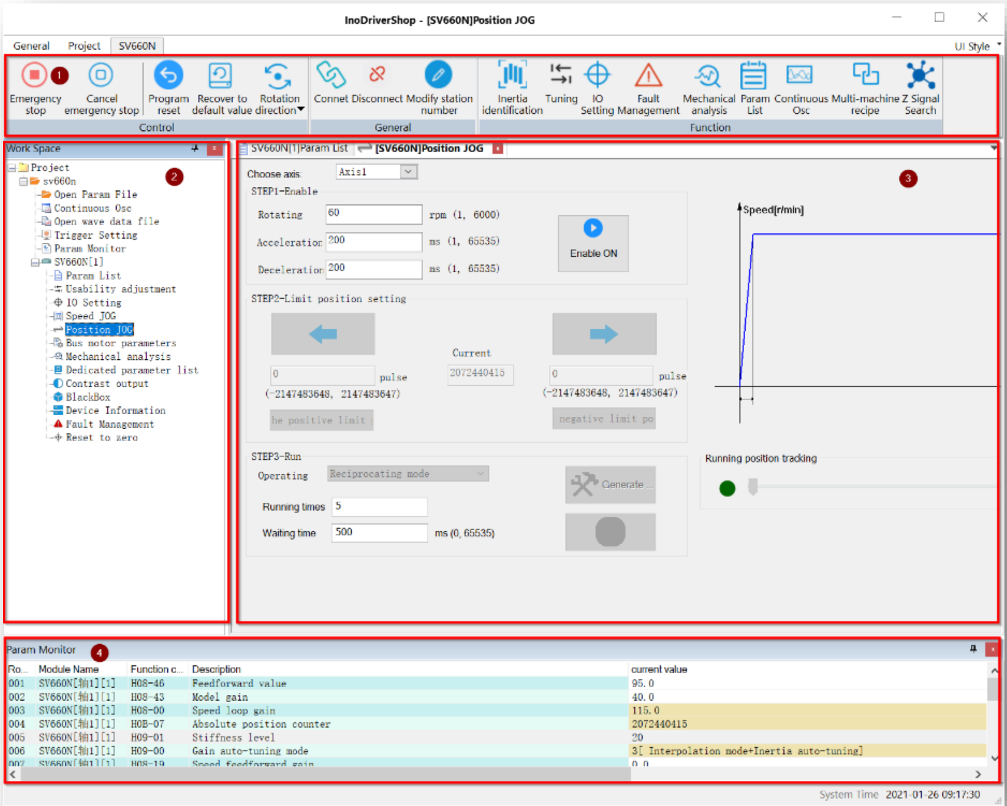
Select the SV660N Drive which connected on the serial port communication and define the project name then press the button “Finish”



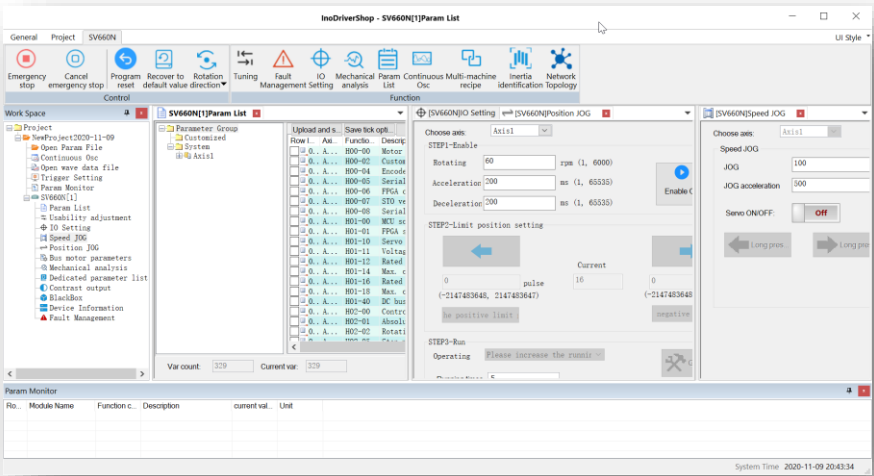
6.3 USER INTERFACE

The main screen is divided into three sections:

1. Buttons to access the most common functions
2. Project tree, where it is possible to access all the program options
3. This section shows the different screens of the program
4. Parameter monitor.

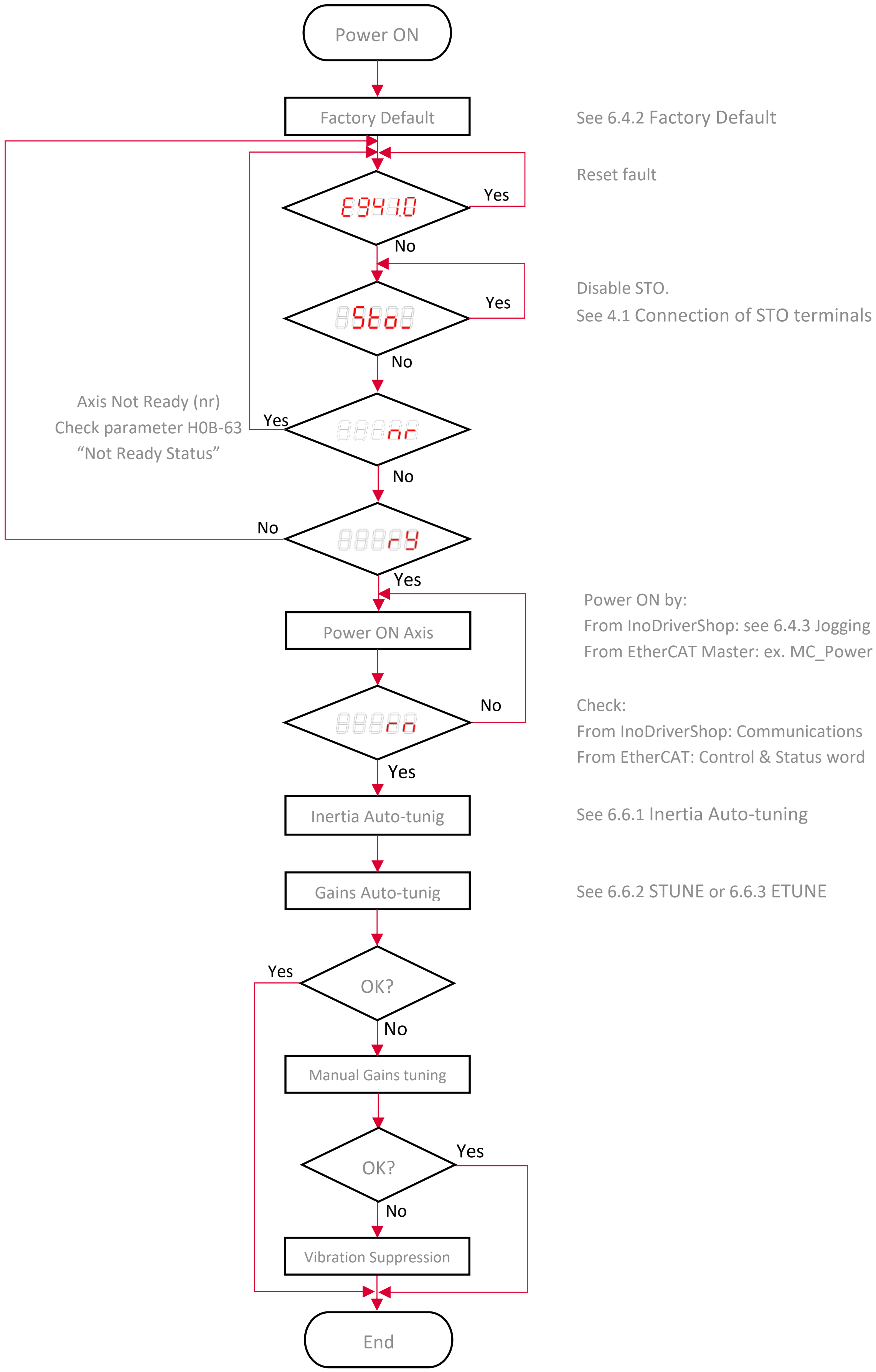


By dragging the tabs it is possible to organize the different windows or sections of the program as shown in the following image:



6.4 COMMISIONING AND OPERATION

The following figure shows the general procedure for axis commissioning:



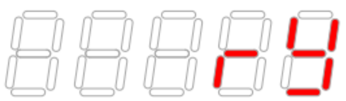
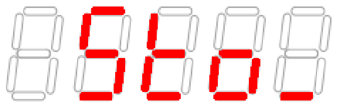
6.4.1 POWER SUPPLY

Switching on the input power supply

The input terminals for **single-phase 220 V** power supplies are L1 and L2.

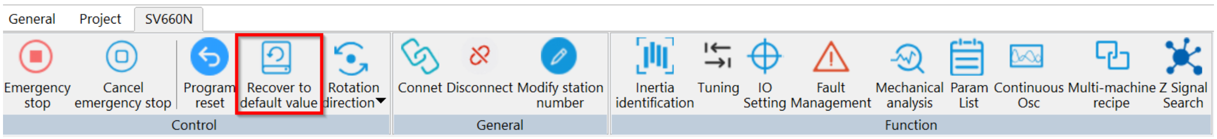
The input terminals for **three-phase power supplies** are L1C/L2C (control circuit power input terminals) and R/S/T (main circuit power input terminals)

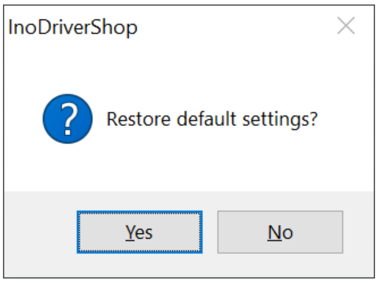
After switching on the input power supply, if the bus voltage indicator is in normal status and the keypad displays "reset" → "ry" in sequence, it indicates the servo drive is ready to run and waits for the S-ON signal to be sent from the host controller.

	First status after power up. After initialization or reset is done, the servo drive automatically switches to other status.
	The servo drive is ready to run and waits for the S-ON signal to be sent from the host controller.
	STO enabled. Connect the STO1 and STO2 to the 24 V input voltage signal to switch to “Ready” state

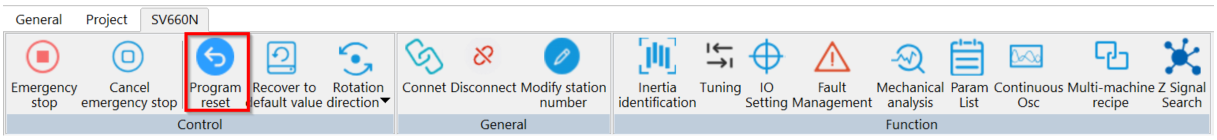
6.4.2 FACTORY DEFAULT

The factory default parameters of the drive can be restored through the software InoDriverShop or with parameter “H02-31 System parameter initialization” changing the value from 0 to 1.





Some parameters need to be effective after powered on again. The parameters can be validated by software reset. So, it is recommended to do a software reset after restore factory default parameters



6.4.3 JOGGING

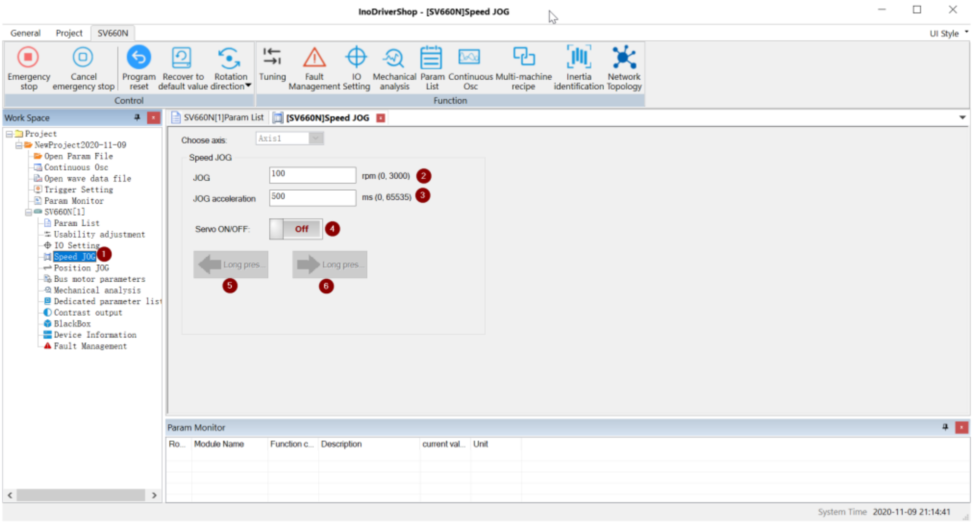
The jog function can be started using the keypad (jogging in the speed mode/jogging in the position mode) or Inovance software tool (jogging in the speed mode).

1. Open Jog screen

2,3. Change speed and acceleration values

4. Enable drive (S-ON signal)

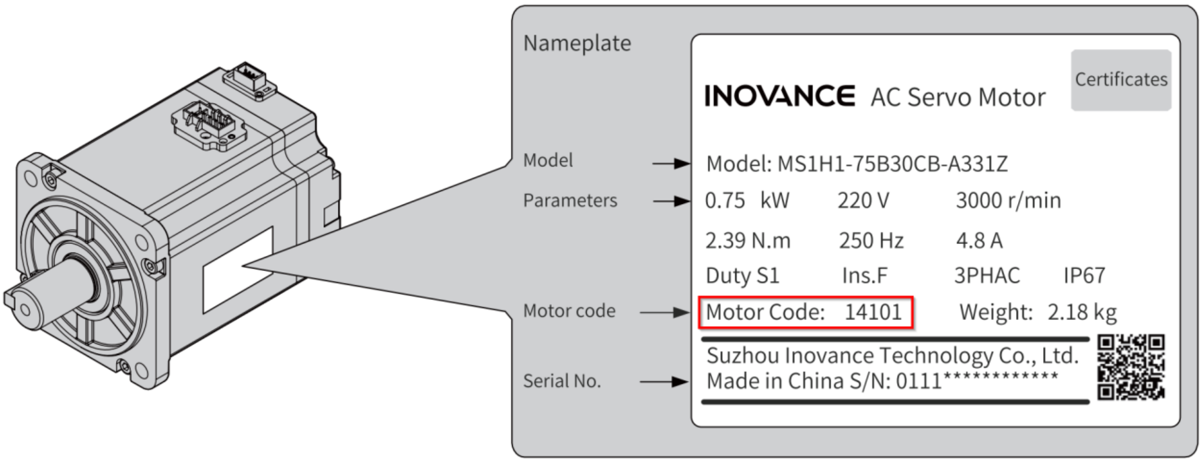
5,6. Move forward and reverse in jog mode



6.4.4 MOTOR PARAMETERS

If the motor belongs to INOVANCE MS1 Series Servo Motor, the parameters are stored in the encoder. Therefore, it is not necessary to configure the motor parameters, but it is important to verify that the parameter "H00-00 Motor Code" corresponds to the motor code indicated on the nameplate.

6.4.4.1 NAMEPLATE AND MODEL



MS1 H1 – 40B 30C B – A3 3 1 Z

Mark	Series
MS1	MS1 series servo motor

Mark	Type
H	1:Low inertia and small capacity
	2: Low inertia and medium capacity
	3:Medium inertia and medium capacity
	4: Medium inertia and small capacity

Mark	Rated Power (W)
One number and one letter	
B	x 10
C	x 100
Example: 40B: 400W	

Mark	Rated Speed (RPM)
One number and one letter	
B	x 10
C	x 100
Example: 30C: 3000 RPM	

Mark	Wiring Mode
Z	Terminal-type
Z-S	Lead wire-type

Mark	Brake, Reducer and Oil Seal
0	None
1	Oil seal
2	Brake
4	Oil seal and brake

Mark	Shaft Connection Mode
3	Solid, keyed, with threaded holes

Mark	Encoder Type
One letter and one digit	
A3	23-bit Multi-turn absolute encoder
T3	18-bit multi-turn encoder

Mark	Voltage Class
B	220 V
D	380 V

Parram.	Name	Range
H00-00	Motor code	**14000** Inovance motor with incremental encoder. Encoder resolution: 1048576 (2^{20}) **14101** Inovance motor with absolute encoder. Encoder resolution: 8388608 (2^{23})
H00-05	Serial-type motor code	The definition of H00-05 shown as below table. For example, 11408 means 750W MS1 H4 series motor with serial bus encoder without PTC. 11101 means 100W MS1 H1 series motor with serial bus encoder without PTC.

Ten thousands digit	Thousands digit	Hundreds digit	Tens digit	Units digit
Platform version	Encoder type	Motor series	Power rating (follow the rounding principle)	
1-first generation product 2-second generation product	1-serial bus without PTC 2-serial bus with PTC 5-non serial bus without PTC 6-non serial bus with PTC 7-resolver without PTC 8-resolver with PTC	1-H1 series 220V 2-H2 series 380V 3-H3 series 380V 4-H4 series 220V 8-H2 series 220V 9-H3 series 220V	Power rating digits = power (W)/100 For example, 100W is 01, 750W is 08	
		5-G1 series	power rating digits = power (kW)/1	
		6-G2 series	power rating digits = power (kW)/10 for example, 31 kW is 03	

6.4.4.2 MOTOR SAMPLE

Model	Frame Size (mm)	Rated Output (kW)[1]	Rated Torque (N·m)	Maximum Torque (N·m)	Rated Current (Arms)	Maximum Current (Arms)
MS1H1-40B30CB	60	0.4	1.27	4.46	2.8	10.10

Encoder Type A3: 23 bit Multi-turn absolute encoder

Rated Voltage H00-09 = 220 V

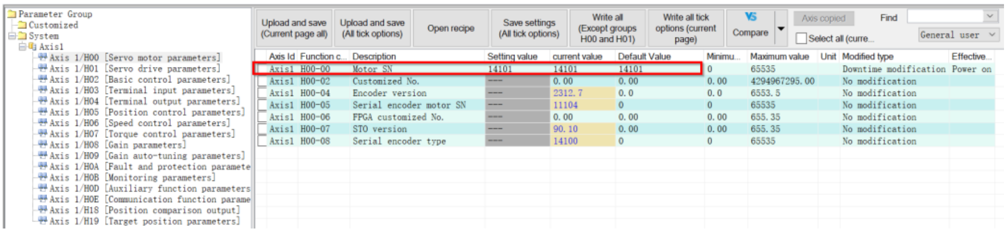
Rated Power H00-10 = 0.4 kW

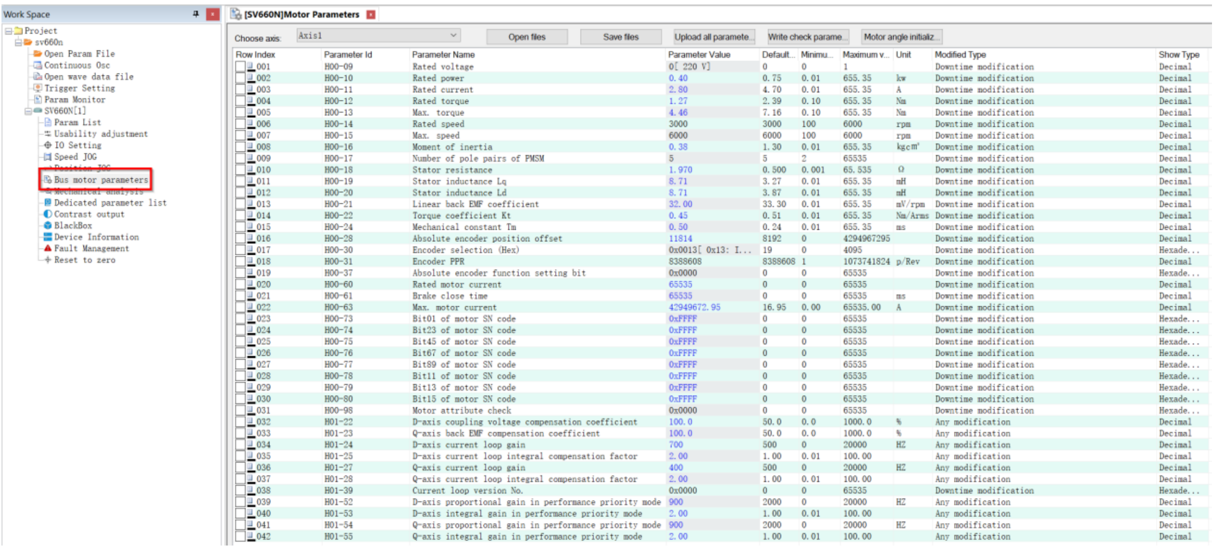
Rated Current H00-11 = 2.8 A

Rated Torque H00-12 = 1.27 Nm

Max. Torque H00-13 = 4.46 Nm

Motor Code H00-00 = 14101



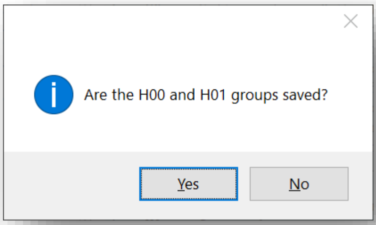


6.5 PARAMETER MANAGEMENT

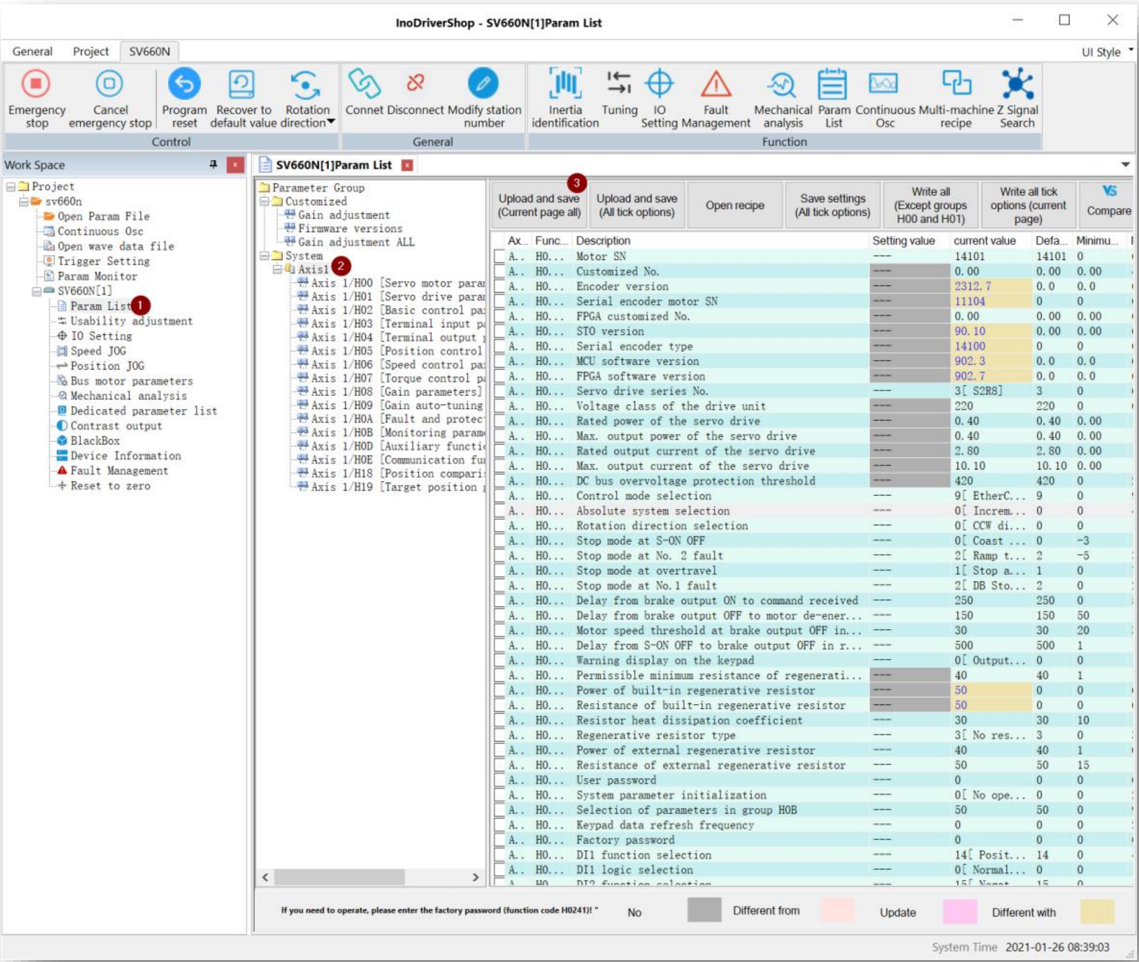
6.5.1 BACKUP

Following this procedure we can make a backup copy of the drive parameters.

1. Click on "Param List"
2. Select the axis group
3. Click on "Upload and save (Current page all)"
4. The following message appears. Select whether the parameters H00, H01 should be saved in the parameter file.



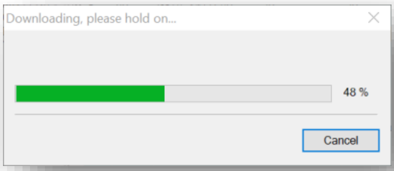
5. Select the file to save the parameters



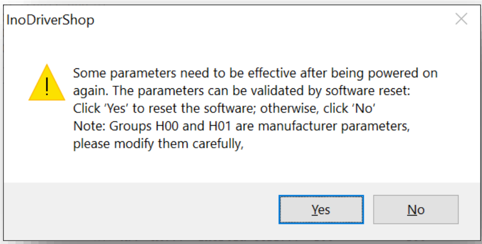
6.5.2 RESTORE

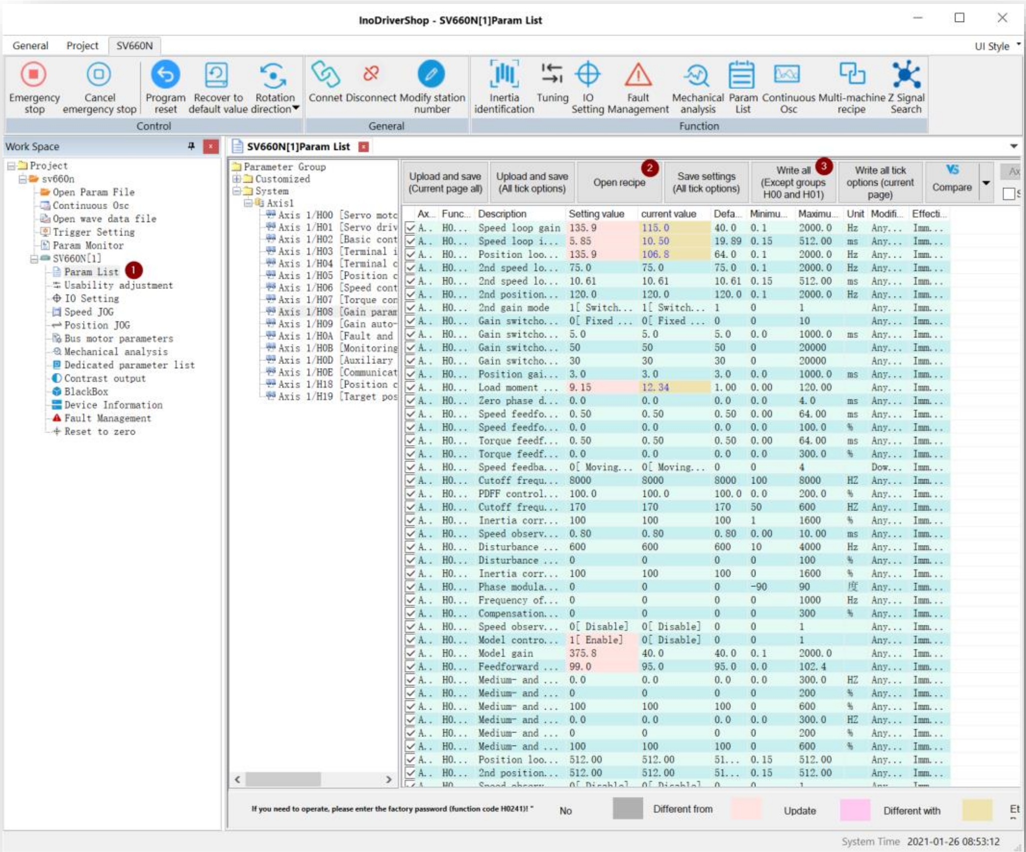
This procedure shows us the steps to restore the drive parameters from a backup file:

1. Click on “Param List”
2. Click on “Open recipe”. The parameter file values are showed in the “Setting value” field
3. Click on “Write all (Except groups H00 and H01)”. A progress bar show the downloading process status



The following message appears. It is recommended to reset the drive after downloading parameters. Click on Yes to reset the drive software.



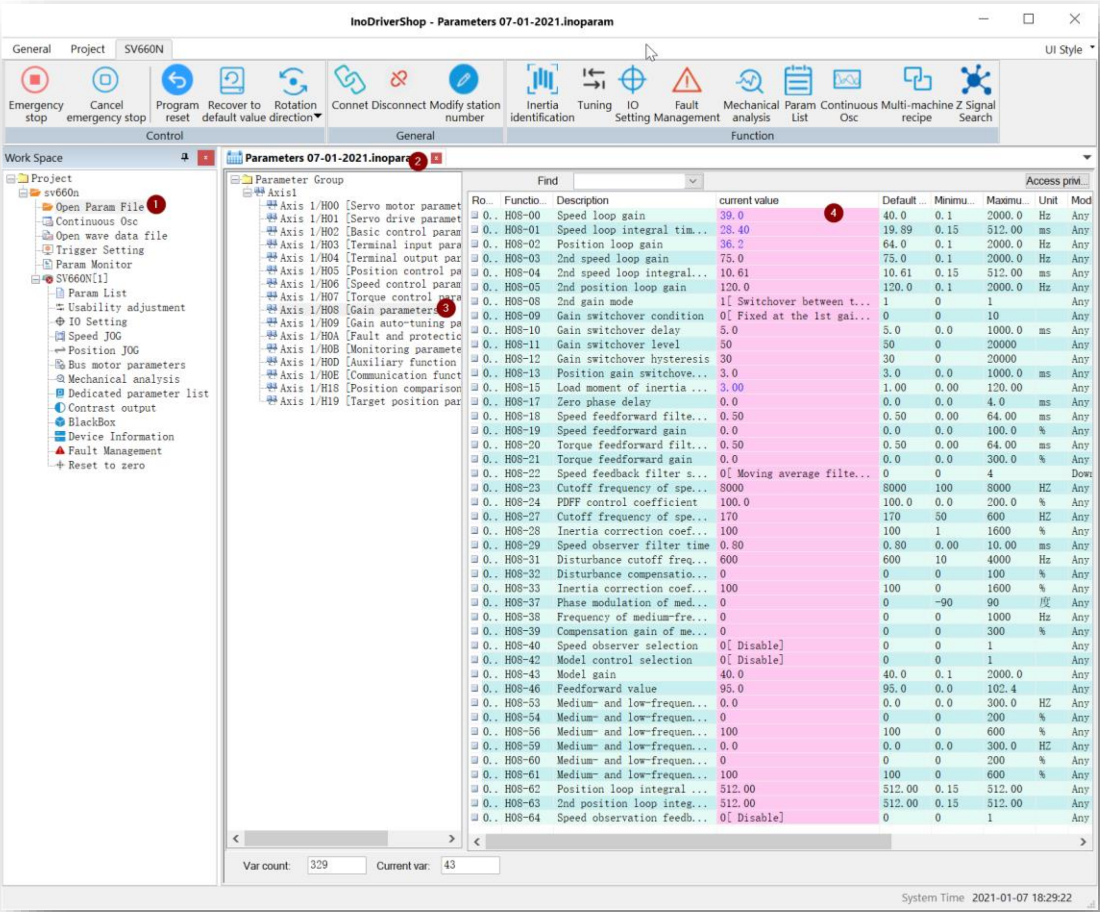


6.5.3 OFFLINE EDIT

To edit the values of a parameter file without being connected to the drive, follow these steps:

4. Click on "Open parameter file"
5. Select the corresponding parameter file in the open file dialog box
6. Select the corresponding parameter section
7. Edit the "current value" of the parameter

Changes made to the parameter values are automatically saved in the corresponding parameter file



6.5.4 COMPARISON

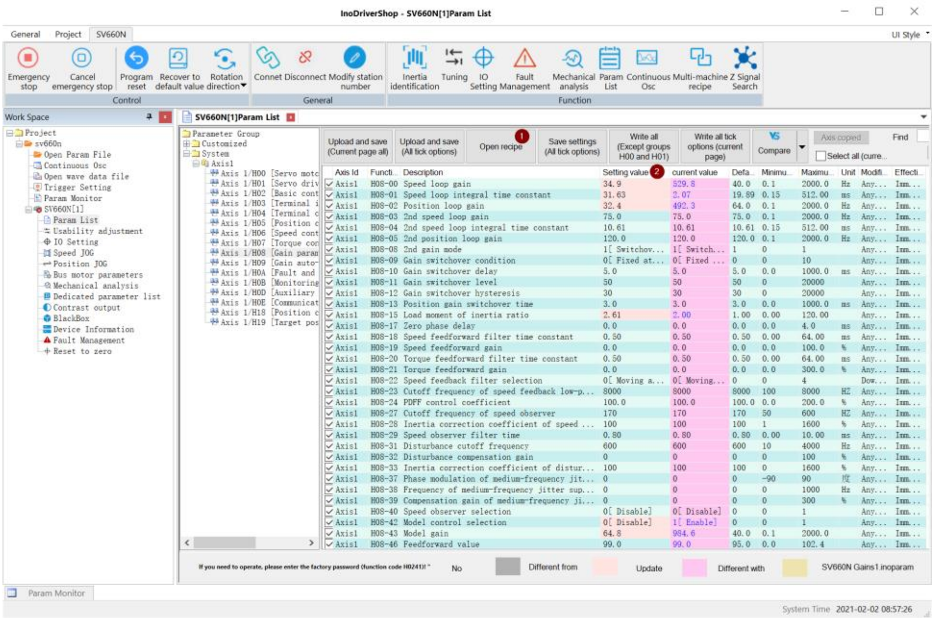
The InoDRiverShop software has two options for comparing the project parameters.

The first option allows you to compare the current values of the project with a parameter file. The second option allows you to compare the values of a file with the factory values.

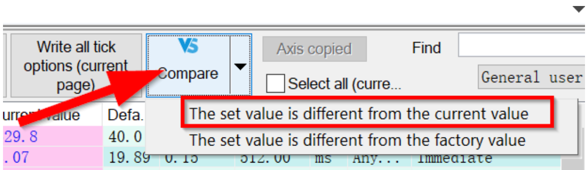
6.5.4.1 COMPARE WITH CURRENT VALUES

To **compare parameter file with actual values** follow the next procedure:

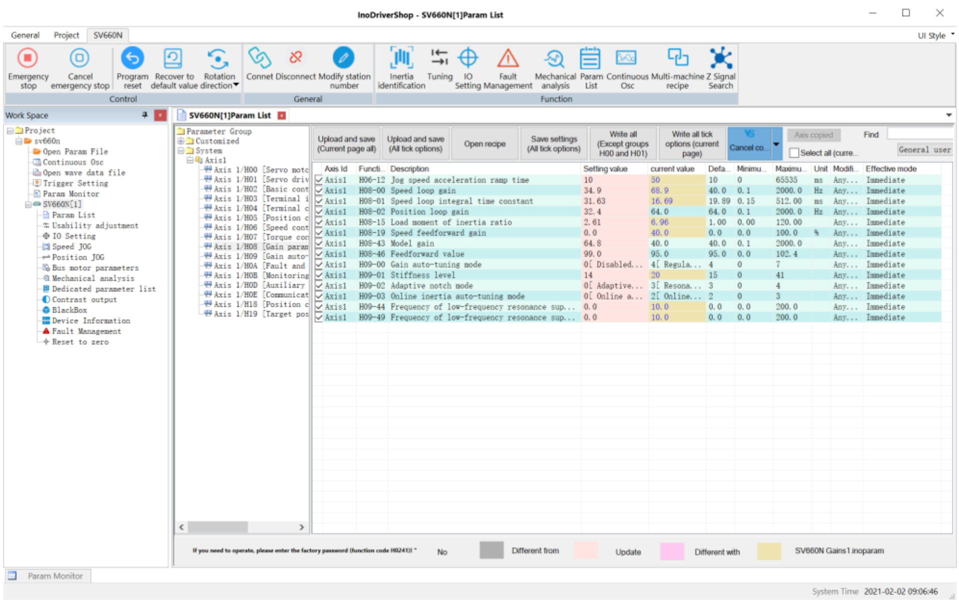
1. Open parameter file. Click on "Open Recipe" button and select the corresponding parameter file. After opening the parameter file the values of this file are loaded in the column "Setting value".



2. Click "Compare" button and select "The set value is different from the current value"



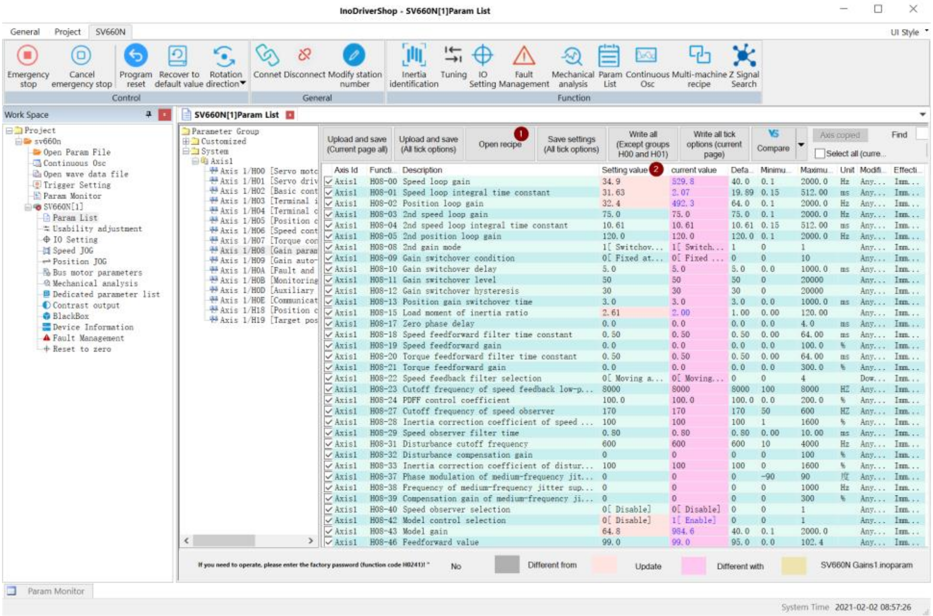
3. This is the comparison result:



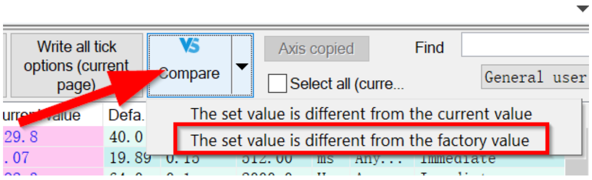
6.5.4.2 COMPARE WITH FACTORY VALUES

To **compare parameter file with factory values** follow the next procedure:

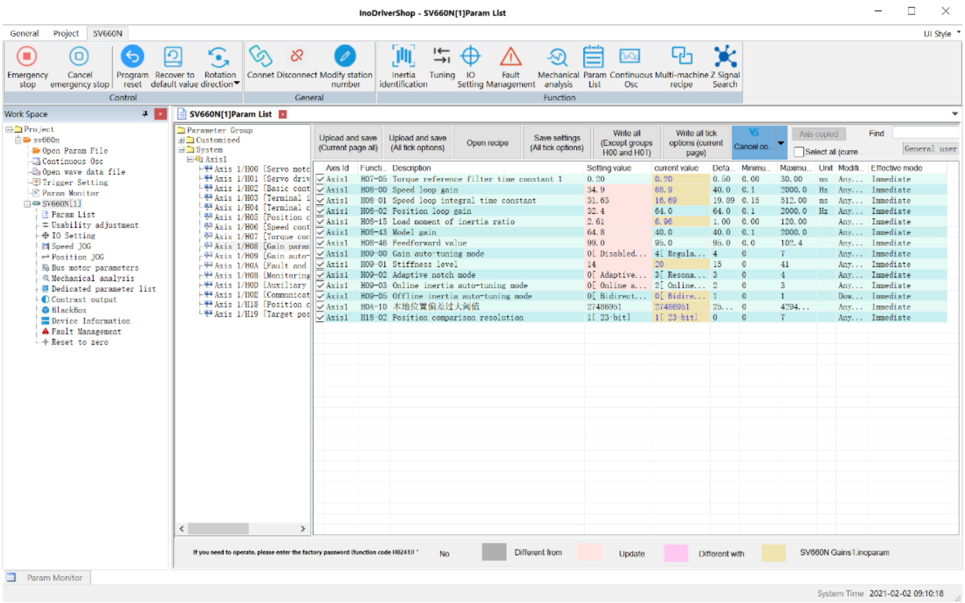
1. Open parameter file. Click on “Open Recipe” button and select the corresponding parameter file. After opening the parameter file the values of this file are loaded in the column "Setting value".



2. Click “Compare” button and select “The set value is different from the factory value”



3. This is the comparison result:



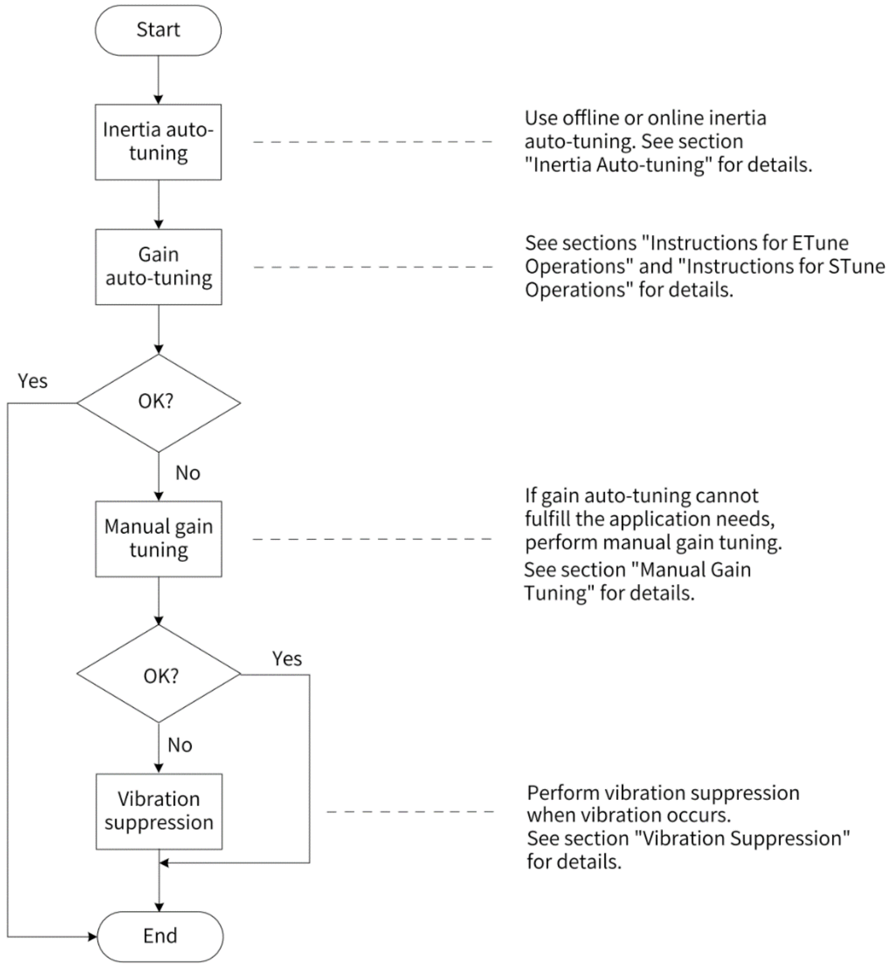
6.6 GAIN TUNING

Set the gain parameters of the servo drive to proper values so that the servo drive can drive the motor as fast and accurate as possible based on internal references or commands sent from the host controller.

The gain is defined by the combination of multiple mutually-affected parameters (including position loop gain, speed loop gain, filter and inertia ratio). Set these parameters to proper values to keep a balanced performance.

NOTE Before gain tuning, perform a trial run through jogging to ensure the motor operates properly.

The following figure shows the general procedure for gain tuning.

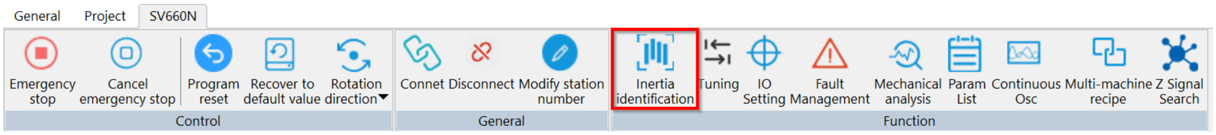


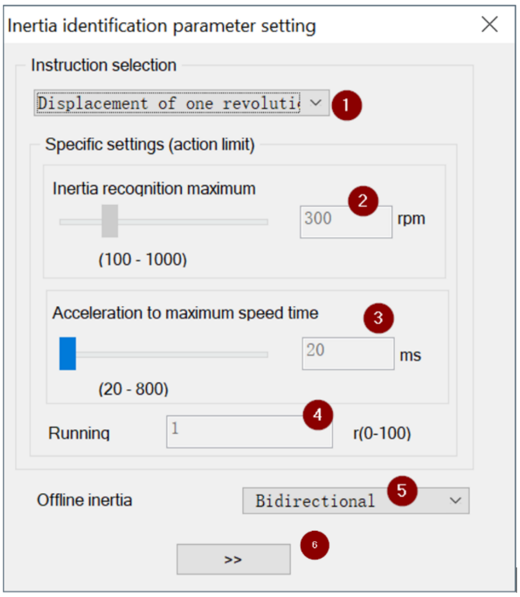
6.6.1 INERTIA AUTO-TUNING

The load inertia ratio (H08-15) is calculated by using the following formula.

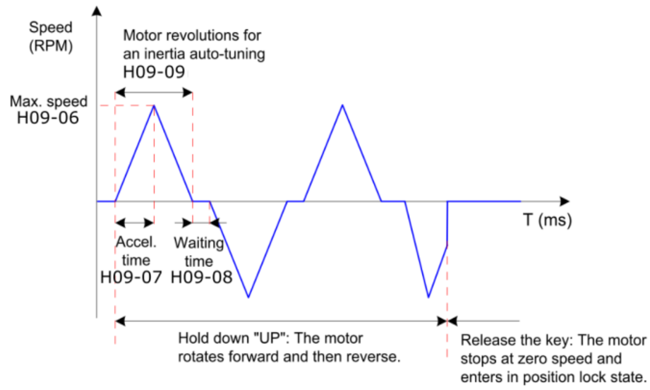
$$\text{load inertia ratio (H08} - \text{15)} = \frac{Total\ moment\ of\ inertia\ of\ the\ mechanical\ load}{Moment\ of\ inertia\ of\ the\ motor\ (H00-16)}$$

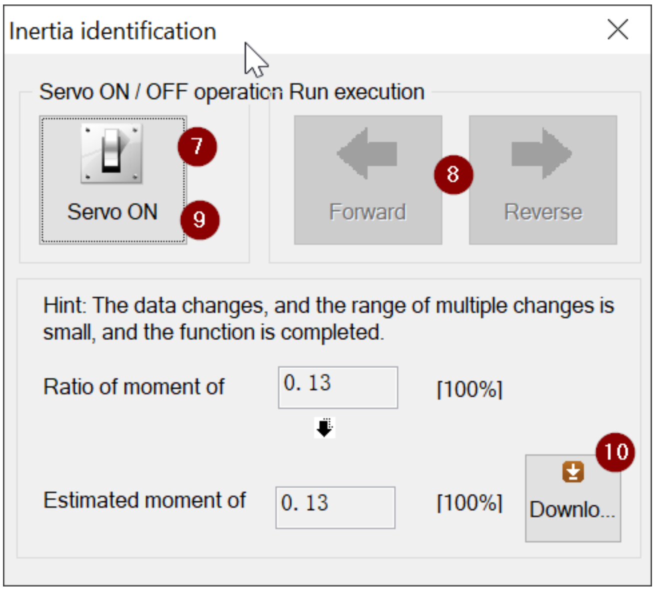
Click on “Inertia Identification” icon to access to the inertia identification dialog.





1. Parameter H09-09 - Number of motor revolutions per inertia auto-tuning
    a. Displacement of one revolution
    b. Displacement of five revolution
    c. Customized
2. Parameter H09-06 - Max. speed of inertia auto-tuning
3. Parameter H09-07- Time constant for accelerating to the maximum speed during inertia auto-tuning
4. Parameter H09-09 - Customized number of motor revolutions per inertia auto-tuning
5. Parameter H09-05 - Offline inertia auto-tuning mode
    a. Unidireccional
    b. Bidireccional
6. Button to go to the next step. Click this button when the inertia settings are ok.





7. Enable drive
8. Start Inertia autotuning. When either of these two buttons is pressed the inertia auto tune starts. The motor moves as configured in the previous screen. The calculated inertia value appears in the "estimated moment of inertia" box. Continue with the test until this value is stable.
9. Disable the drive
10. Save the inertia value in the parameter H08-15

6.6.1.1 ONLINE AUTO-TUNING

This method automatically calculates the inertia from the movements sent by the host controller. The servo drive calculates the inertia ratio in real time and stores the result to H08-15 every 30 minutes

Different H09-03h values indicating different updating speeds of the inertia ratio in H08-15

- H09-03h = 1: Applicable to the scenario where the actual inertia ratio rarely changes, such as machine tool and wood carving machine.
- H09-03h = 2: Applicable to the scenario where the inertia ratio changes slowly.
- H09-03h = 3: Applicable to the scenario where the actual inertia ratio changes rapidly, such as transportation manipulator.

NOTE Do not use online inertia auto-tuning in applications involving hitting against limit switches and press fitting.

6.6.2 STUNE

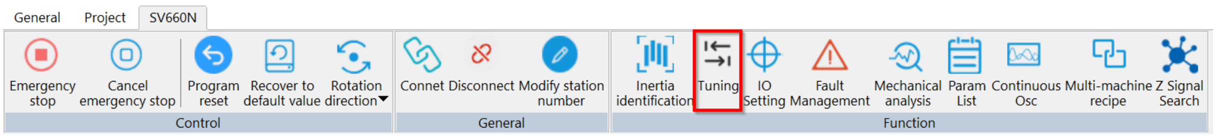
The servo tuning requirements are completed through a single parameter setting, the load inertia ratio is adaptively identified, and the resonance suppression parameters are automatically set, which greatly reduces the difficulty of debugging and improves the tuning

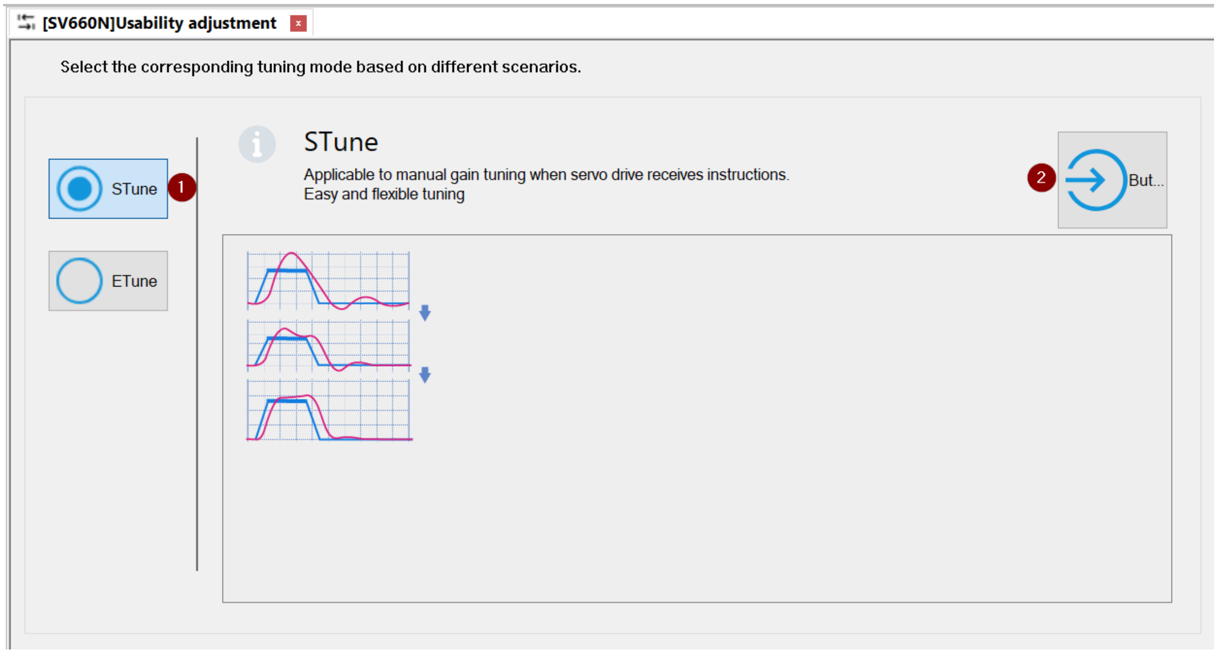
STune performs gain auto-tuning based on the set stiffness level H09-01. It aims to fulfill the requirements of rapidity and stability.

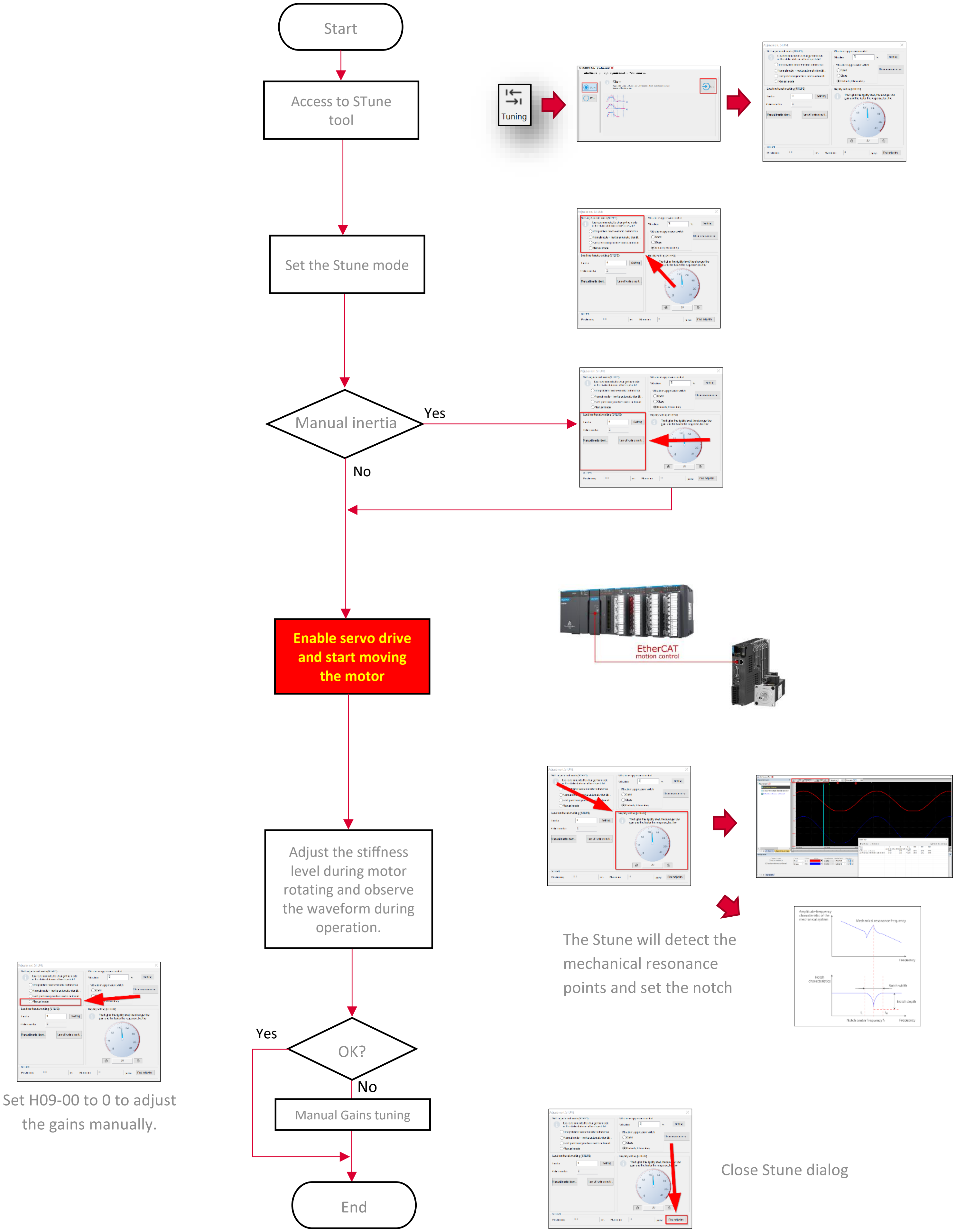
The servo tuning requirements are completed through a single parameter setting, the load inertia ratio is adaptively identified, and the resonance suppression parameters are automatically set, which greatly reduces the difficulty of debugging and improves the tuning

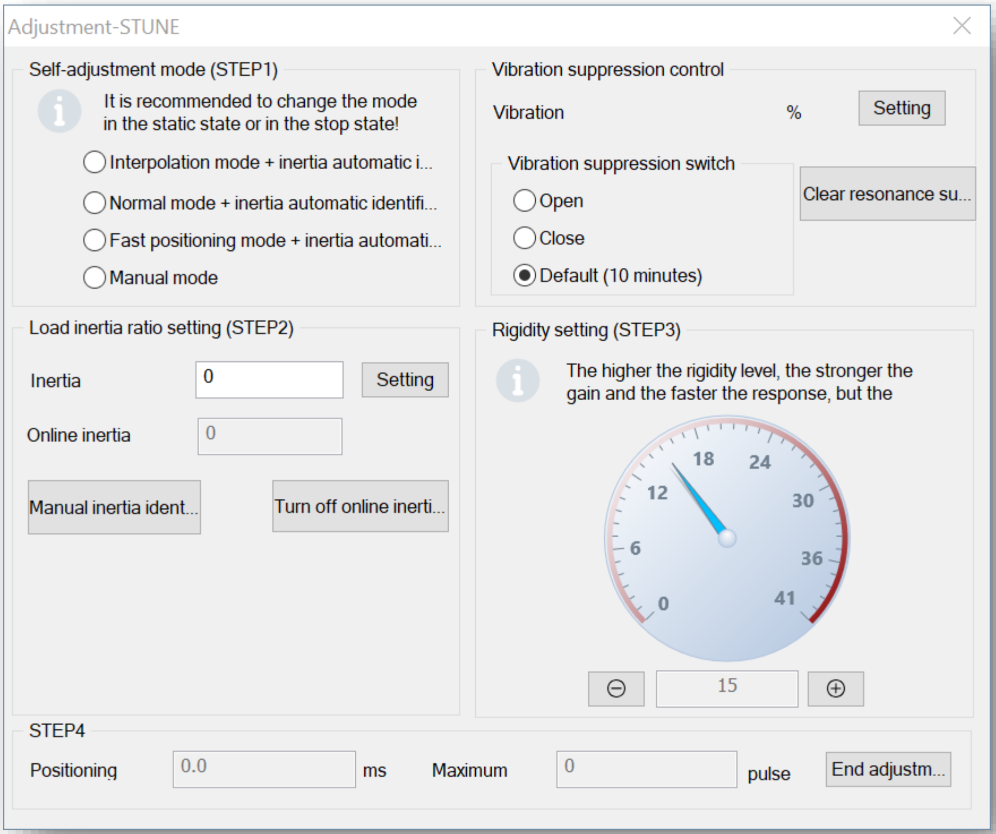
The STune function is enabled by default with H09-00 (Gain auto-tuning mode) being set to 4 (Normal mode+Inertia auto-tuning). The servo drive is turned off automatically 10 min after command input.

The STune function is intended to be used in applications featuring slight load inertia changes. For applications featuring dramatic inertia changes or where inertia auto-tuning is unavailable (due to operating speed too low or acceleration rate too small), disable the STune function after initial power-on.






Start
Access to STune tool
Tuning
Set the Stune mode
Manual inertia
Yes
No
EtherCAT
motion control
Enable servo drive and start moving the motor
Adjust the stiffness level during motor rotating and observe the waveform during operation.
The Stune will detect the mechanical resonance points and set the notch
Set H09-00 to 0 to adjust the gains manually.
Yes
OK?
No
Manual Gains tuning
End
Close Stune dialog


Adjustment-STUNE
Self-adjustment mode (STEP1)
It is recommended to change the mode in the static state or in the stop state!
Interpolation mode + inertia automatic i...
Normal mode + inertia automatic identifi...
Fast positioning mode + inertia automati...
Manual mode
Vibration suppression control
Vibration
%
Setting
Vibration suppression switch
Open
Close
Default (10 minutes)
Clear resonance su...
Load inertia ratio setting (STEP2)
Inertia
0
Setting
Online inertia
0
Manual inertia ident...
Turn off online inerti...
Rigidity setting (STEP3)
The higher the rigidity level, the stronger the gain and the faster the response, but the
0
6
12
18
24
30
36
41
15
STEP4
Positioning
0.0
ms
Maximum
0
pulse
End adjustm...

STEP 1 - Self-Adjustment mode (Firmware version H01-00<903.0 H02-00=0):

H09-00		Application	Affected parameters	Speed Feedforward	Gain switchover	Inertia auto-tuning	Resonance suppression	Model Tracking Function	Disturbance Observer	Notch Filter	PDFF
0	**Manual mode**	Manual gain tuning is needed.	**None**	**Can be configured**	**NO**		**NO**	**NO**	**NO**	**NO**	**NO**
1	Standard stiffness level mode	Gain auto-tuning is performed based on the set stiffness level. Allows the feedforward gains manual modification.	**H07-05 H08-00 H08-01 H08-02**	**Can be configured**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
2	Positioning mode	Gain auto-tuning is performed based on the set stiffness level. This mode is applicable to occasions requiring quick positioning. Allows the feedforward gains manual modification.	**H07-05 H07-06 H08-00 H08-01 H08-02 H08-03 H08-04 H08-05**	**Can be configured**	**YES H08-10**	**NO**	**NO**	**NO**	**NO**	**NO**	**NO**
3	**Interpolation mode**	Applied in trajectory control, such as CNC, gantry synchronization, electronic cam / gear. • high stability requirements • medium response requirements • low overshoot		**Can be configured**	**NO**	**YES (10 min.) H09-03 = 2**	**YES (10 min.) H09-11 H09-37**	**NO**	**NO**	**YES H09-02=3**	**NO**
4	**Normal mode**	General positioning (**default value**). Applied to general positioning control, automatic identification of load inertia. • high stability requirements • low response requirements • no overshoot		**Can be configured**	**NO**	**YES (10 min.) H09-03 = 2**	**YES (10 min.) H09-11 H09-37**	**NO**	**NO**	**YES H09-02=3**	**NO**
6	**Fast positioning mode**	Applied to short travel and high speed positioning control. Model-Tracking algorithm is added to realize positioning within 10ms, with small inertia adaptation range. • medium stability requirements • fast response requirements • some overshoot	**H07-05 H08-00 H08-01 H08-02 H08-43 H08-46**	**CANNOT be configured**	**NO**	**YES (10 min.) H09-03 = 2**	**YES (10 min.) H09-11 H09-37**	**YES H08-42=1**	**NO**	**YES H09-02=3**	**NO**

STEP 1 - Self-Adjustment mode (Firmware version H01-00>903.0 or H02-00>118.00):

H09-00		Application	Affected parameters	Speed Feedforward	Gain switch over	Inertia auto-tuning	Resonance suppression	Model Tracking Function	Disturbance Observer	Notch Filter	PDFF
0	**Manual mode**	Manual gain tuning is needed.	None	Can be configured	NO		NO	NO	NO	NO	NO
1	Standard stiffness level mode	Gain auto-tuning is performed based on the set stiffness level.	H07-05 H08-00 H08-01 H08-02	Can be configured	NO	NO	NO	NO	NO	NO	NO
2	Positioning mode	Gain auto-tuning is performed based on the set stiffness level. This mode is applicable to occasions requiring quick positioning.	H07-05 H07-06 H08-00 H08-01 H08-02 H08-03 H08-04 H08-05	Can be configured	YES H08-10	NO	NO	NO	NO	NO	NO
3	**Interpolation mode**	Applied in trajectory control, such as CNC, gantry synchronization, electronic cam / gear. • high stability requirements • medium response requirements low overshoot		H08-19 18.1% Cannot be configured	NO	YES (10 min.) H09-03 = 2	YES	NO	NO	YES H09-02=3	H08-24 81.9% Cannot be configured
4	**Normal mode**	General positioning (**default value**). Applied to general positioning control, automatic identification of load inertia. • high stability requirements • low response requirements • no overshoot		Cannot be configured	NO	YES (10 min.) H09-03 = 2	YES	NO	NO	YES H09-02=3	NO
6	**Fast positioning mode**	Applied to short travel and high speed positioning control. Model-Tracking algorithm is added to realize positioning within 10ms, with small inertia adaptation range. • medium stability requirements • fast response requirements • some overshoot	H07-05 H08-00 H08-01 H08-02 H08-43 H08-46	Cannot be configured	NO	YES (10 min.) H09-03 = 2	YES	YES H08-42=1	YES H08-31 H08-32	YES H09-02=3	NO

STEP 2 - Load inertia ratio setting

Please, refer to the section 6.6.1 Inertia Auto-tuning

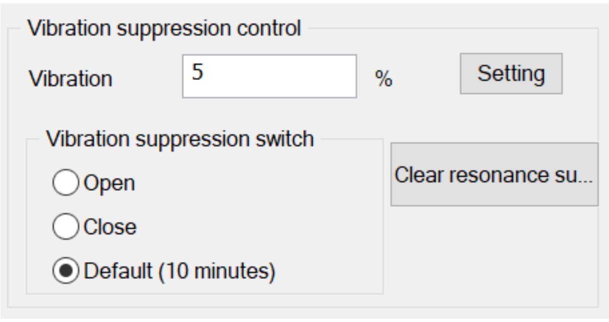
STEP 3 - Rigidity Setting

The value range of H09-01 (Stiffness level selection) is 0 to 41. The level 0 indicates the weakest stiffness and lowest gain and level 41 indicates the strongest stiffness and highest gain.

Please, refer to the section 6.6.5 Rigidity level calculation

Recommended Stiffness Level	Type of Load Mechanism
Level 4 to level 8	Large-scale machineries
Level 8 to level 15	Applications with low stiffness such as a conveyor
Level 15 to level 20	Applications with high stiffness such as a ball screw and direct-coupled motor

Vibration suppression control



Vibration: Parameter H09-11-Vibration threshold. When the torque ripple detected by the servo drive exceeds the setpoint of H09-11 and becomes uncontrollable, the stiffness level will be reduced automatically until reaching level 10 where ER661 is reported.

Vibration suppression switch:

Parameter H09-37 - Vibration monitoring time

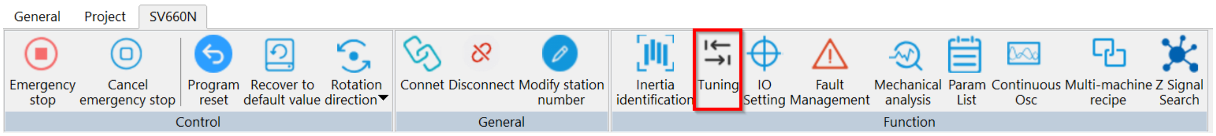
- Open →H09-37 = 65536
- Close →H09-37 = 0
- Default (10 minutes) →H09-37 = 600

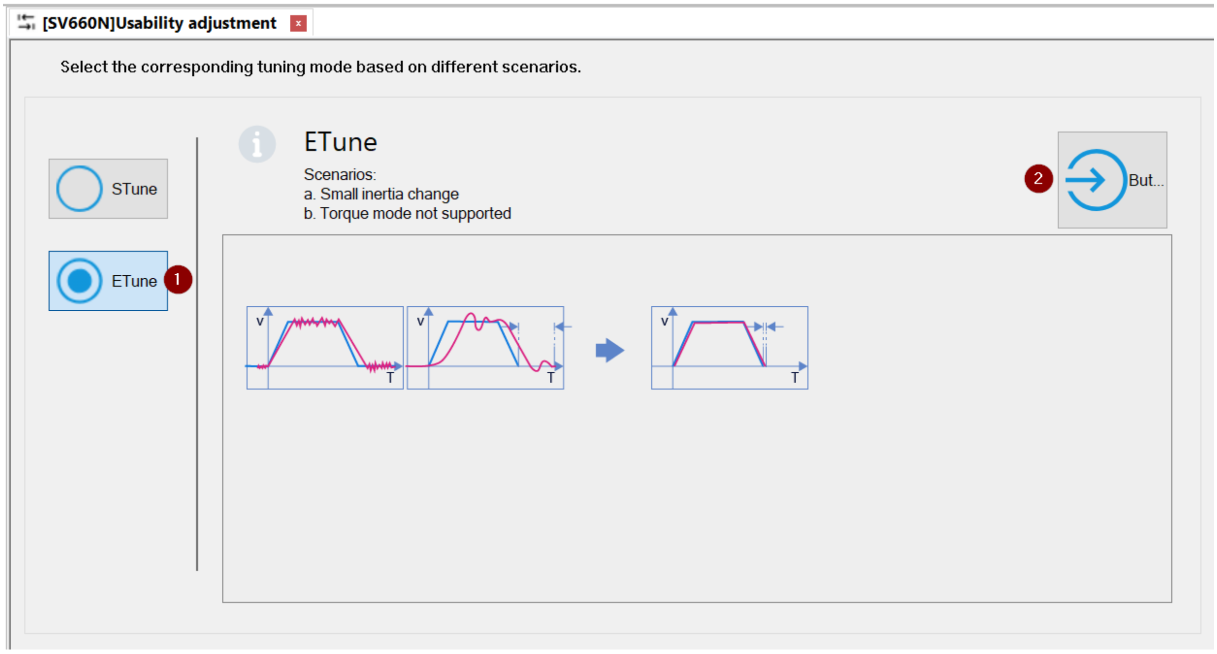
If H09-00 (Gain auto-tuning mode) is set to 3, 4, or 6, the servo drive suppresses vibration by performing inertia auto-tuning automatically within 10 min (or other time interval defined by H09-37) after power-on or stiffness level setting, and then it exits from inertia auto-tuning. The inertia auto-tuning function, once deactivated, cannot be activated again by setting H09-09 to 3, 4, or 6.

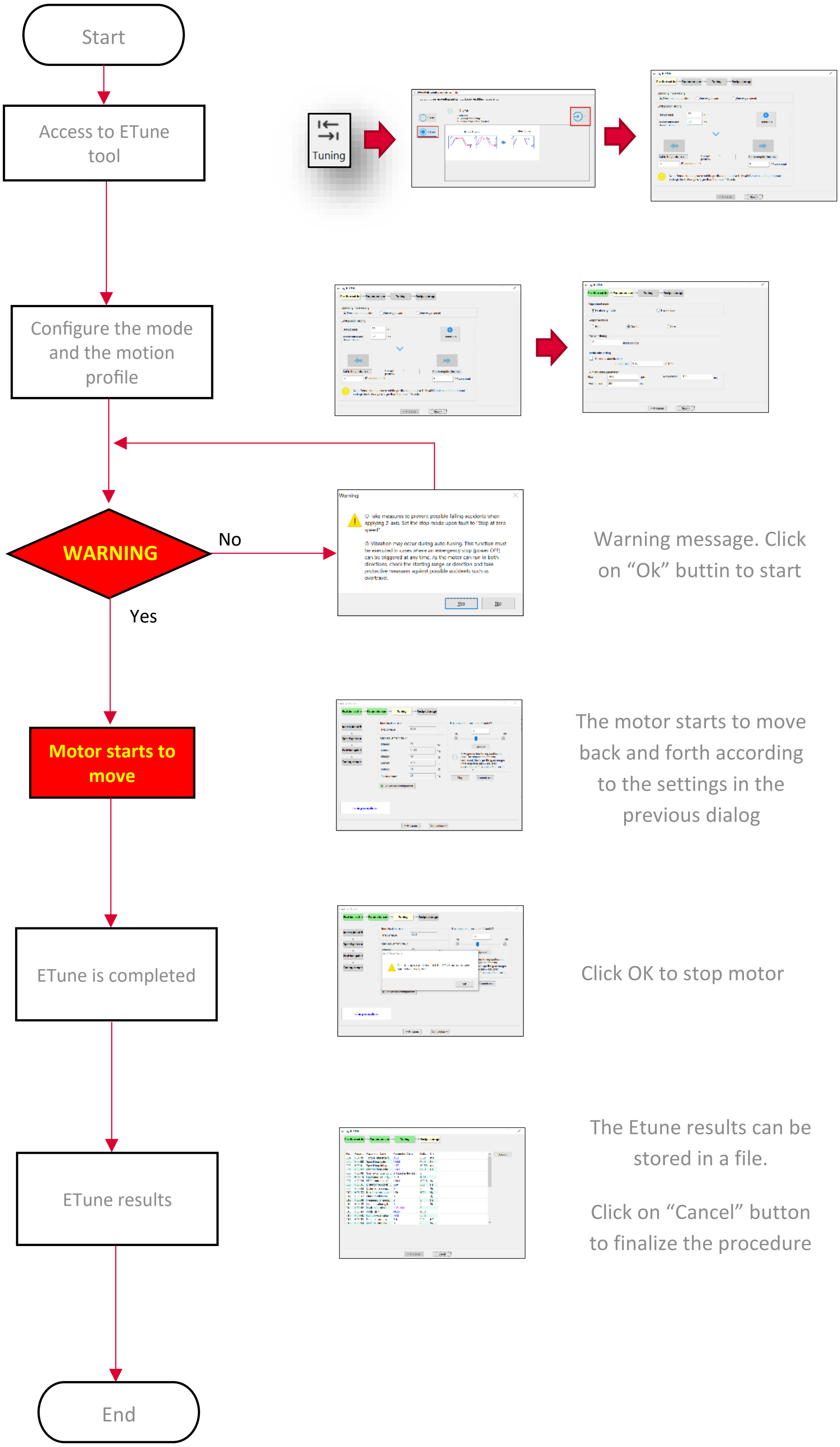
6.6.3 ETUNE

ETune is a wizard-type function designed to guide users to perform auto-tuning by setting the motion profile and the desired response level. After the motion profile and the response level are set, the servo drive will perform the auto-tuning to obtain the optimal gain parameters. The auto-tuned parameters can be saved and exported as a recipe for use in other devices of the same model.

The ETune function is intended to be used in applications featuring slight load inertia changes.






Start
Access to ETune tool
Tuning
Configure the mode and the motion profile
WARNING
No
Yes
Warning
Warning message. Click on "Ok" buttin to start
Motor starts to move
The motor starts to move back and forth according to the settings in the previous dialog
ETune is completed
Click OK to stop motor
ETune results
The Etune results can be stored in a file.
Click on "Cancel" button to finalize the procedure
End

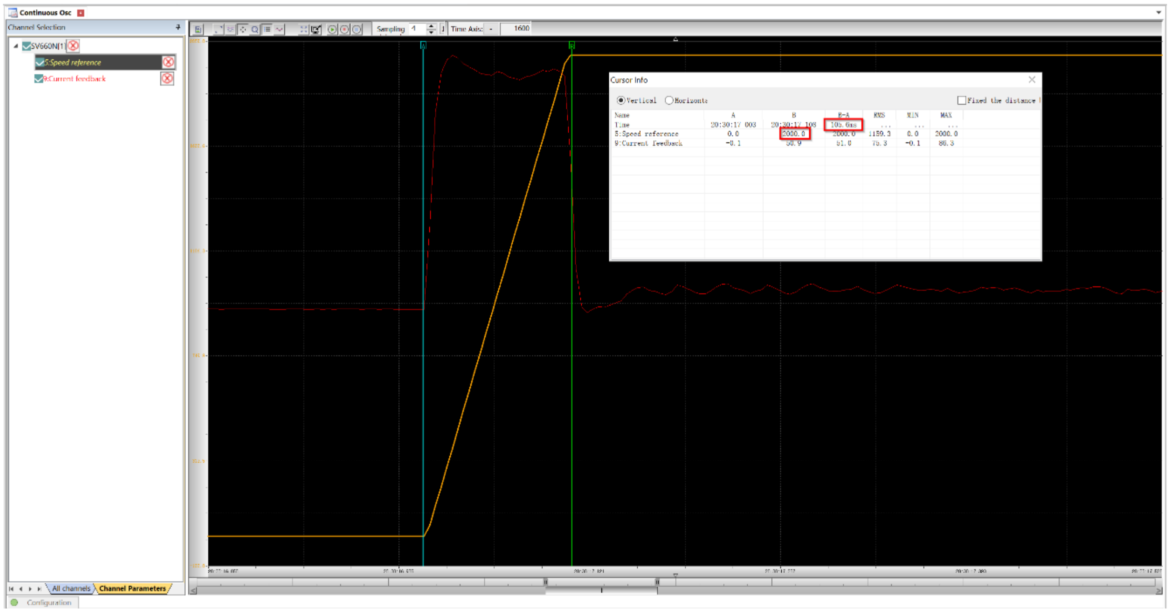
6.6.4 INERTIA RATIO CALCULATION

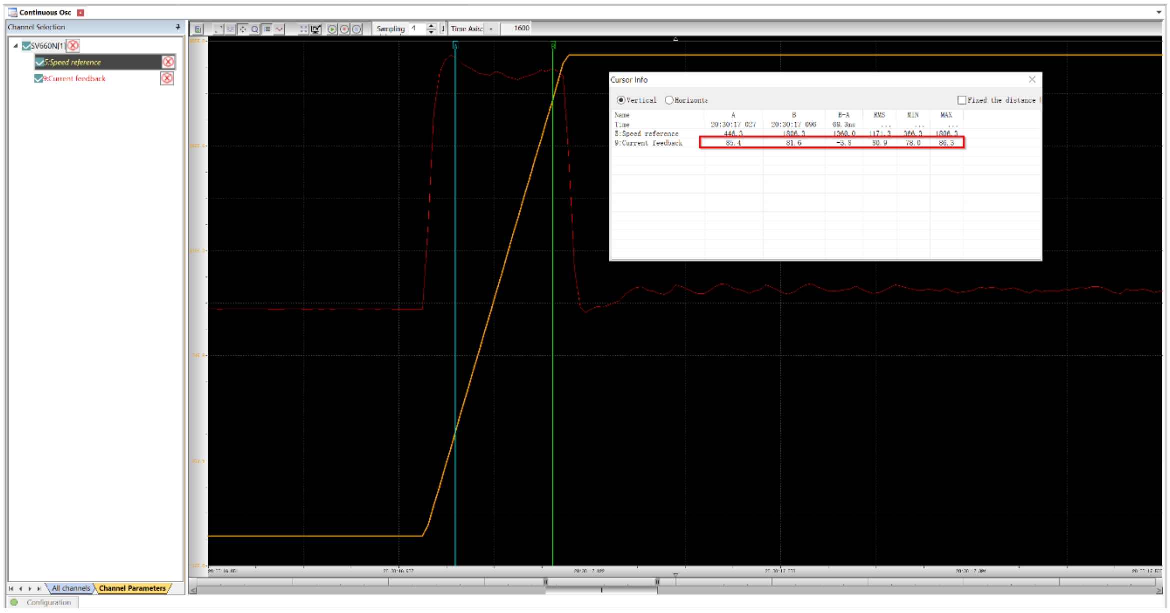
In some systems it is not possible to calculate the system inertia ratio with the InoDriverShop tool because the axis cannot be moved manually or the axis is coupled to another axis.

In this type of systems, the "Online Inertia identification" tool can be used or the inertia can be calculated manually with the following procedure.

In this example the inertia ratio of the Inovance's motor MS1H1-40B30CB and a 400g and 95mm diameter pulley is calculated. In this case we can know the inertia of the load, but normally this data is not known exactly. Therefore, we will calculate the inertial ratio without taking into account the pulley data.

To calculate the ratio of inertia we need to perform a step movement of the axis with load, and trace this movement using the InoDriverShop Oscilloscope:





From these graphs we can obtain the maximum speed of the movement at the end of the ramp, the acceleration time and the current feedback during the acceleration:

$$Max.Speed = 2000rpm = \frac{2000rpm \cdot 2 \cdot \pi}{60s} = 209.43\ rad/s$$

$$Acceleration\ time = 0.1s$$

$$Acceleration = \frac{209.43\ rad/s}{0.1s} = 2094.3\ rad/s^2$$

The current during the acceleration region is more or less 80% of nominal torque

$$Torque = 1.27Nm \cdot 0.8 = 1.016Nm$$

According the MS1 motor specifications the nominal torque is 1.27Nm and inertia of motor is $0.376Kg \cdot cm^2 = 0.376 \cdot 10^{-4}Kg \cdot m^2$

Torque of a body in an angular motion:

$$T = J_t \cdot \alpha \rightarrow \alpha = \frac{T}{J_t} = \frac{T}{J_l + J_m} \rightarrow J_l = \frac{1.016\text{Nm}}{2094.3\ rad/s^2} - 0.376 \cdot 10^{-4}Kg \cdot m^2 = 4.475 \cdot 10^{-4}Kg \cdot m^2$$

where

$\sum Inertia$=moment of inertia(Kgm^2)

α=angular acceleration (rad/s^2)

The inertia ratio is as follow:

$$\text{Inertia ratio (H08} - 15) = \frac{J_l}{J_m} = \frac{4.475 \cdot 10^{-4}Kg \cdot m^2}{0.376 \cdot 10^{-4}Kg \cdot m^2} = 11.9$$

where

J_l load inertia

J_m motor inertia

The theoretical calculation of the inertia of the pulley is:

$$\text{Disk Inertia } = \frac{m \cdot r^2}{2} = \frac{0.4Kg \cdot 0.0475^2m}{2} = 4.51 \cdot 10^{-4}Kg \cdot m^2$$

The theoretical result is almost the same as that calculated with the motor graphs.

6.6.5 RIGIDITY LEVEL CALCULATION

The value range of H09-01 (Stiffness level selection) is 0 to 41. The level 0 indicates the weakest stiffness and lowest gain and level 41 indicates the strongest stiffness and highest gain. The following table lists the stiffness levels for different load types.

Recommended Stiffness Level	Type of Load Mechanism
Level 4 to level 8	Large-scale machineries
Level 8 to level 15	Applications with low stiffness such as a conveyor
Level 15 to level 20	Applications with high stiffness such as a ball screw and direct-coupled motor

To get this Rigidity level value, there is some relation between different parameters:

- Motor Inertia $\mathbf{J_m}$
- Load inertia $\mathbf{J_l}$
- Motor torque $\mathbf{N_t}$
- Nominal current $\mathbf{I_n}$

In this example the following motor MS1H1-40B30CB-A331Z is used with the following data:

Drive Parameter	Description	Value
H00-11	Rated current I_n	2.8A
H00-12	Rated torque T_n	
H00-22	Torque Coefficient K_t	0.53 Nm/A_{rms}
H00-16	Moment of Inertia	$0.376 \cdot 10^{-4}$kgm^2

Inertia ratio H08-15=1
J_l = ratio*J_m

$$\text{Inertia ratio (H08} - 15) = \frac{J_l}{J_m} \rightarrow J_l = I_{ratio} \cdot J_l = 0.376 \cdot 10^{-4} Kg \cdot m^2$$

Torque of a body in angular motion:

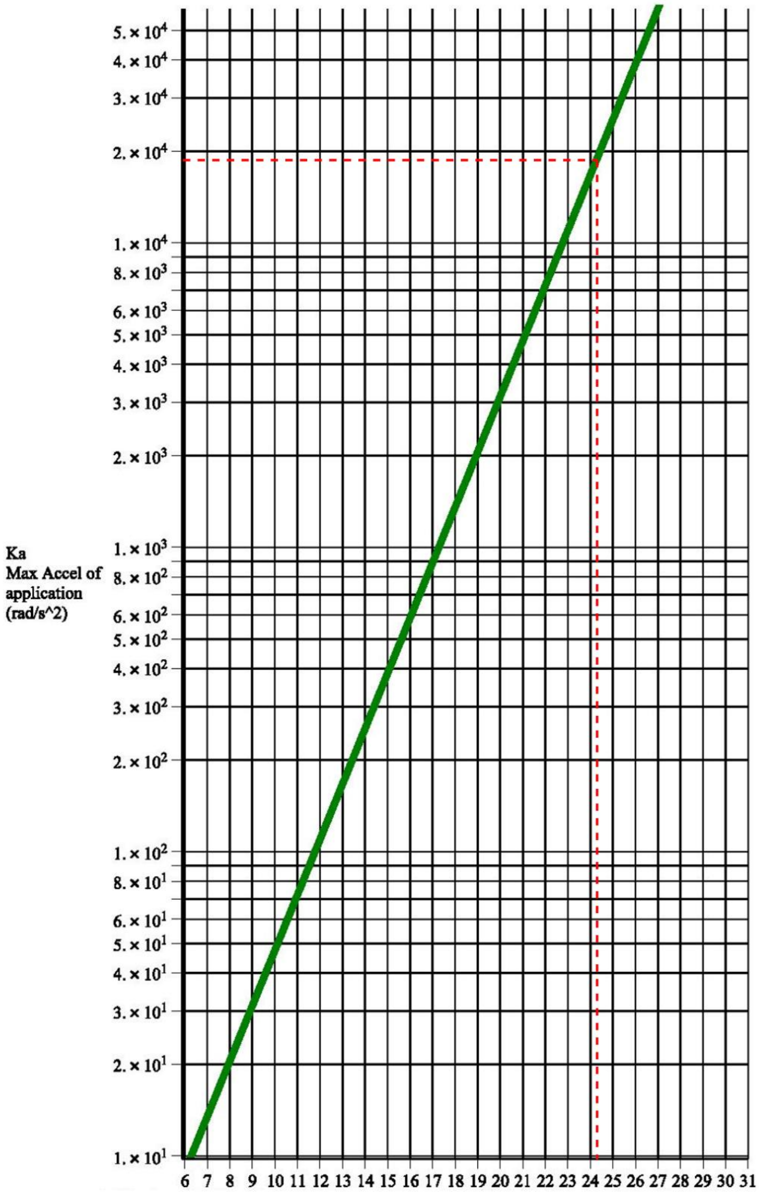
$$T = J_t \cdot \alpha \rightarrow \alpha = \frac{T}{J_t} = \frac{T}{J_l + J_m} = \frac{0.53 \frac{\text{Nm}}{A_{rms}} \cdot 2.8A}{0.376 \cdot 10^{-4} Kg \cdot m^2 + 0.376 \cdot 10^{-4} Kg \cdot m^2} = 19734 \frac{rad}{s^2}$$

where

$\sum Inertia$=moment of inertia(Kgm^2)

α=angular acceleration (rad/s^2)

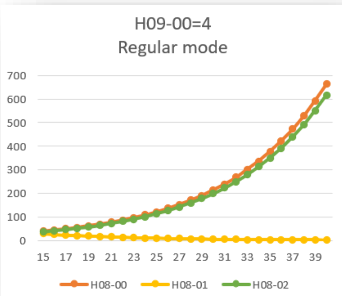
From the following table it can be calculated the rigidity level around 24. Then H09-01 = 24

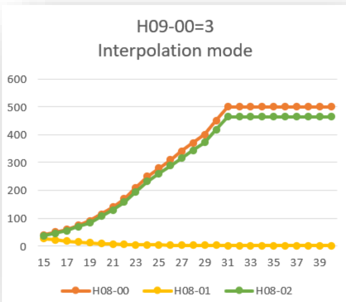

Ka
Max Accel of
application
(rad/s^2)
5. × 10^4
4. × 10^4
3. × 10^4
2. × 10^4
1. × 10^4
8. × 10^3
6. × 10^3
5. × 10^3
4. × 10^3
3. × 10^3
2. × 10^3
1. × 10^3
8. × 10^2
6. × 10^2
5. × 10^2
4. × 10^2
3. × 10^2
2. × 10^2
1. × 10^2
8. × 10^1
6. × 10^1
5. × 10^1
4. × 10^1
3. × 10^1
2. × 10^1
1. × 10^1
6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

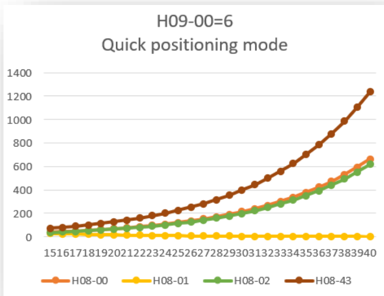
6.6.5.1 STIFFNESS LEVEL

This section shows the gain values depending on the value of stiffness level:
H09-00: Gain auto-tunning mode
H09-01: Stiffness level
H08-00: Speed loop proportional gain
H08-01: Speed loop integral gain
H08-02: Position loop proportional gain
H08-43: Tracking function model gain
H08-46: Tracking function feedforward gain
H07-05:Torque reference filter time constant

		H09-00=4					H09-00=3					H09-00=6					
H09-01 Stiffness level		H08-00	H08-01	H08-02	H07-05		H08-00	H08-01	H08-02	H07-05		H08-00	H08-01	H08-02	H08-43	H08-46	H07-05
15		39	28	36.2	0.2		40	27.43	37.1	0.2		39	28.13	36.2	72.4	99	0.2
16		43.7	25.11	40.6	0.2		50	21.95	46.4	0.2		43.7	25.11	40.6	81.2	99	0.2
17		49	22.38	45.5	0.2		60	18.28	55.7	0.2		49	22.38	45.5	91	99	0.2
18		54.9	19.98	51	0.2		75	14.62	69.7	0.2		54.9	19.98	51	102	99	0.2
19		61.5	17.83	57.1	0.2		90	12.18	83.6	0.2		61.5	17.83	57.1	114.2	99	0.2
20		68.9	15.92	64	0.2		115	9.53	106.8	0.2		68.9	15.92	64	128	99	0.2
21		77.1	14.22	71.6	0.2		140	7.83	130.1	0.2		77.1	14.22	71.6	143.2	99	0.2
22		86.4	12.69	80.2	0.2		170	6.44	157.9	0.2		86.4	12.69	80.2	160.4	99	0.2
23		96.8	11.33	89.9	0.2		210	5.22	195.1	0.18		96.4	11.33	89.9	179.8	99	0.2
24		108.4	10.11	100.7	0.2		250	4.38	232.3	0.15		108.4	10.11	100.7	201.4	99	0.2
25		121.4	9.03	112.8	0.2		280	3.91	260.2	0.14		121.4	9.03	112.8	225.6	99	0.2
26		136	8.06	126.3	0.2		310	3.53	288.1	0.12		136	8.06	126.3	252.6	99	0.2
27		152.3	7.2	141.5	0.2		340	3.22	315.9	0.11		152.3	7.2	141.5	283	99	0.2
28		170.5	6.43	158.4	0.2		370	2.95	343.8	0.1		170.5	6.43	158.4	316.8	99	0.2
29		191	5.74	177.5	0.2		400	2.74	371.7	0.09		191	5.74	177.5	355	99	0.2
30		213.9	5.13	198.7	0.18		450	2.43	418.2	0.08		213.9	5.13	198.7	397.4	99	0.18
31		239.6	4.57	222.6	0.16		500	2.19	464.6	0.07		239.6	4.57	222.6	445.2	99	0.16
32		268.4	4.08	249.4	0.14		500	2.19	464.6	0.07		268.4	4.08	249.4	498.8	99	0.14
33		300.6	3.64	279.3	0.13		500	2.19	464.6	0.07		300.6	3.64	279.3	558.6	99	0.13
34		336.7	3.25	312.9	0.11		500	2.19	464.6	0.07		336.7	3.25	312.9	625.8	99	0.11
35		377.1	2.9	350.4	0.1		500	2.19	464.6	0.07		377.1	2.9	350.4	700.8	99	0.1
36		422.3	2.59	392.4	0.09		500	2.19	464.6	0.07		422.3	2.59	392.4	784.8	99	0.09
37		473	2.31	439.5	0.08		500	2.19	464.6	0.07		473	2.31	439.5	879	99	0.08
38		529.8	2.07	492.3	0.07		500	2.19	464.6	0.07		529.8	2.07	492.3	984.6	99	0.07
39		593.4	1.84	551.4	0.06		500	2.19	464.6	0.07		593.4	1.84	551.4	1102.8	99	0.06
40		664.6	1.64	617.6	0.05		500	2.19	464.6	0.07		664.6	1.64	617.6	1235.2	99	0.05

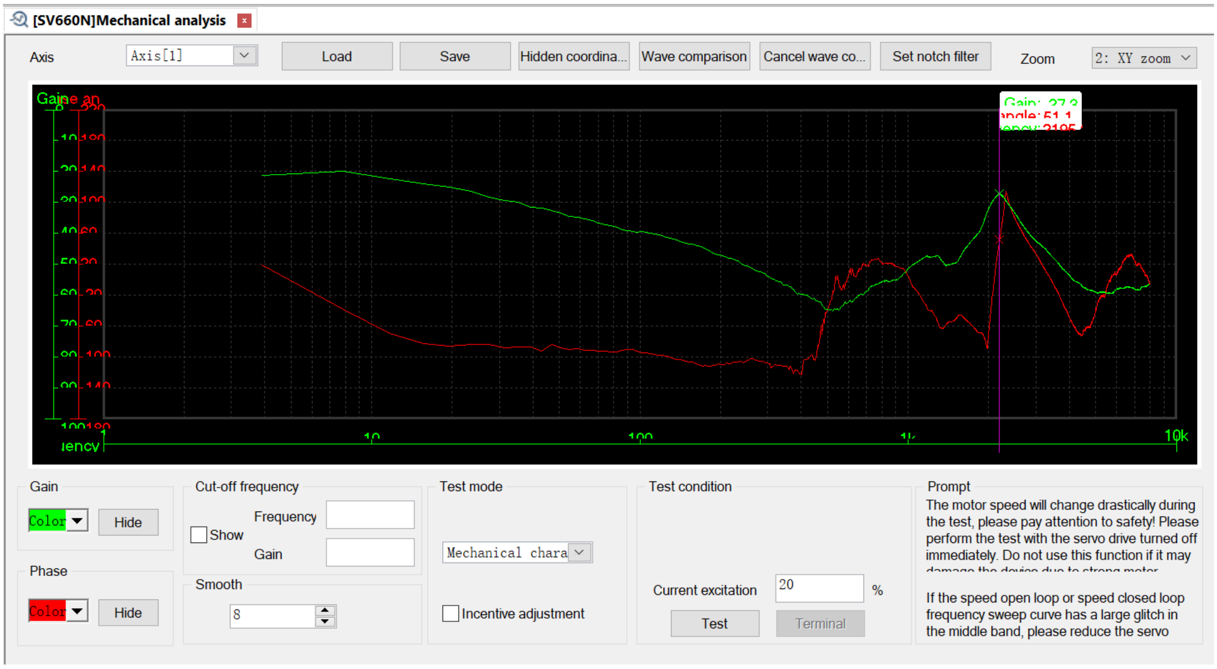






6.6.6 MECHANICAL ANALYSIS

As shown in the preceding figure, the mechanical analysis function tests the speed response of the entire system under different frequencies and generates the baud rate diagram, which helps you to find the resonance frequency and set notches. For example, the resonance frequency shown in the preceding figure is 2195 Hz.



- **Closed Loop** directly measures the closed loop frequency response of the servo. Used to determine the axis response bandwidth.
- **Mechanical Analysis** This trace shows the frequency response of the mechanics of the drive and motor. Directly measures the mechanical and electrical properties of the motor, drive and any mechanical bodies attached to the axis. Used to determine the mechanical resonance point.

The closed control loop is uses for the determination of the bandwidth, while the open control loop is regarded for calculating the amplitude response. The bandwidth is read where the phase response first crosses the -3 dB or the -90° line. The higher the bandwidth of a system, the more stable it is and the higher the control loop gain can be set. This result in high dynamics.

Incentive adjustment: when selecting this check box, if the vibration is excessive the current excitation will reduced automatically. If the current excitation set a reasonable value the ‘incentive adjustment’ function will not work. Usually this function is not used.

Smooth: Increasing the smoothing percentage, the Bode plot traces become cleaner and easier to read. Will not affect to test, but when there are a lot wave noise in the displayed wave, it can adjust the value to find the Resonance frequency.

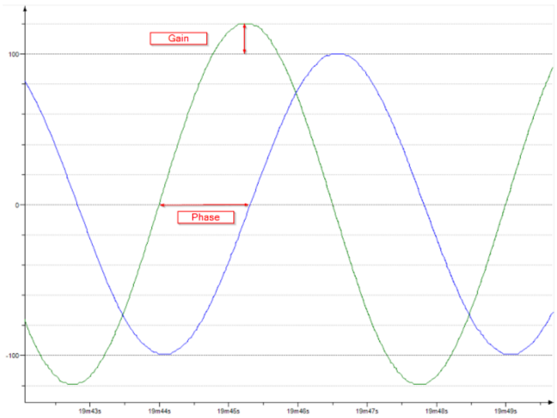
Current Excitation: Percentage of torque used to realize the test. To avoid strong vibration, the excitation level usually set as 10% at the beginning, it can adjust the value according to the wave feedback.

6.6.6.1 BODE PLOT

The Bode diagram is a representation of a system in the frequency range. The Bode diagram consists of a graph for the amplitude (gain response) and a graph for the phase shift (phase response). It describes the stationary reaction of the system to a harmonic excitation (sinus oscillation). The frequency is displayed logarithmically on the X-axes.

To determine the frequency response of a system, the following procedure is carried out. A sinusoidal signal of a certain amplitude and frequency is applied to the input of the system. As the frequency of the input signal is increased, it is compared with the output signal. At first the output is aligned in amplitude and frequency with the input, but when increasing the input frequency, without increasing the amplitude, the output signal has a different amplitude and phase.

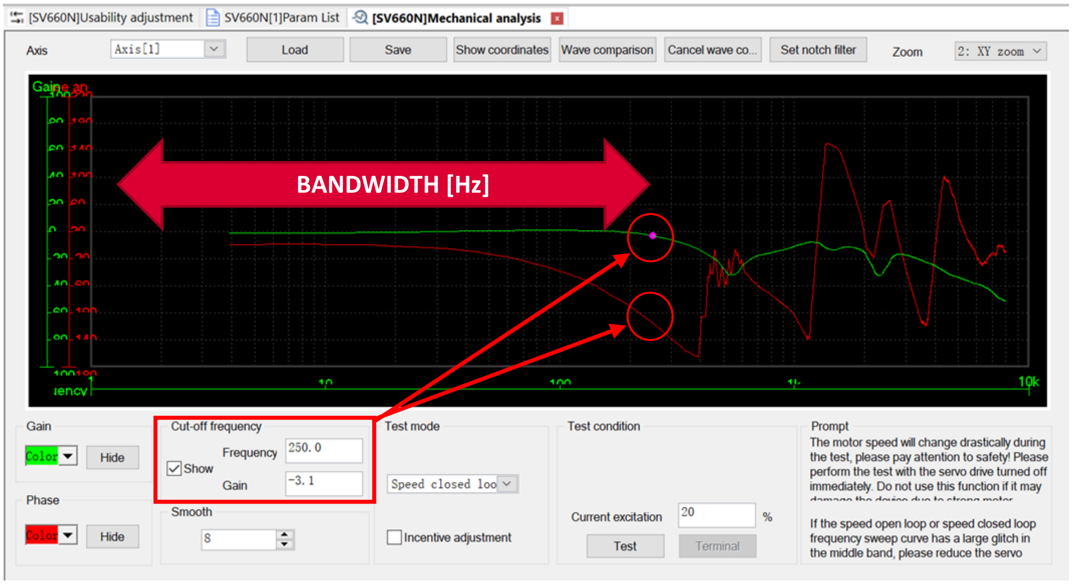
In an ideal system the output follows the input in amplitude and phase. In other words, the gain is 0dB and the phase is 0°. But in a real application there is a specific frequency where the output signal cannot follow the input signal and is increased by the amplitude and the phase shift.



6.6.6.2 AXIS BANDWIDTH

With the “Speed close loop” bode diagram you can determine the bandwidth of the system. Bandwidth is related to the response of the system. The higher the bandwidth, the better the response and the higher the control loop gain can be set. This result in high dynamics.

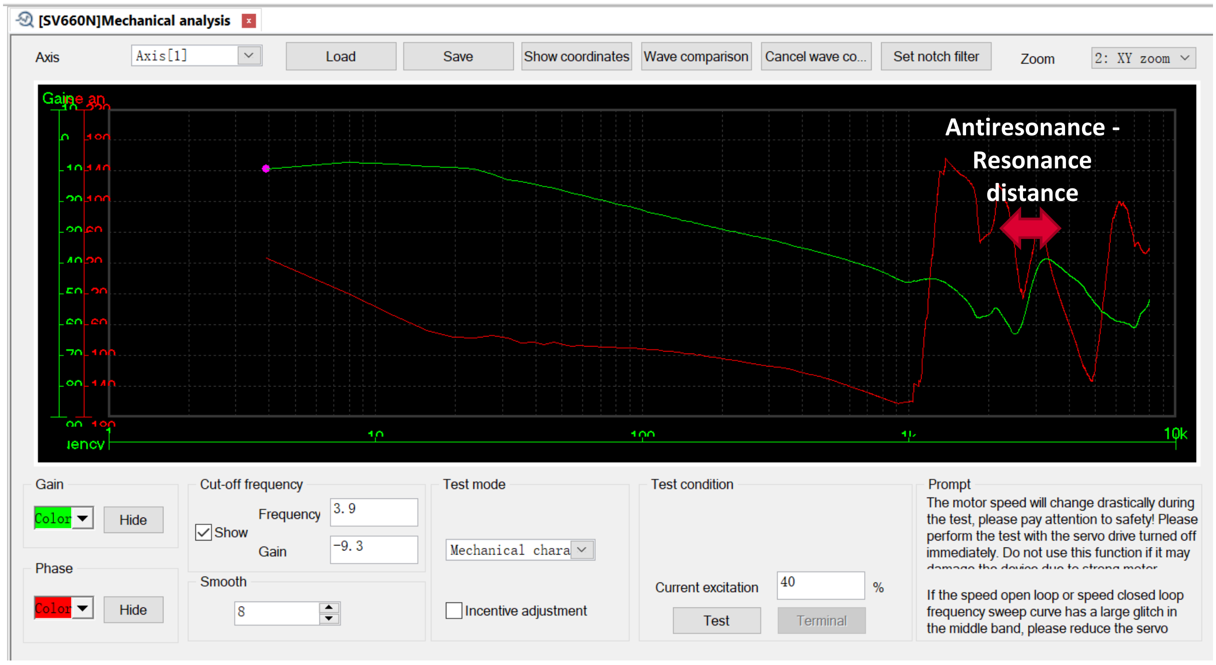
The bandwidth in the Bode plot is determined by the point at which the gain plot crosses -3dB or the phase reach -90 degrees.



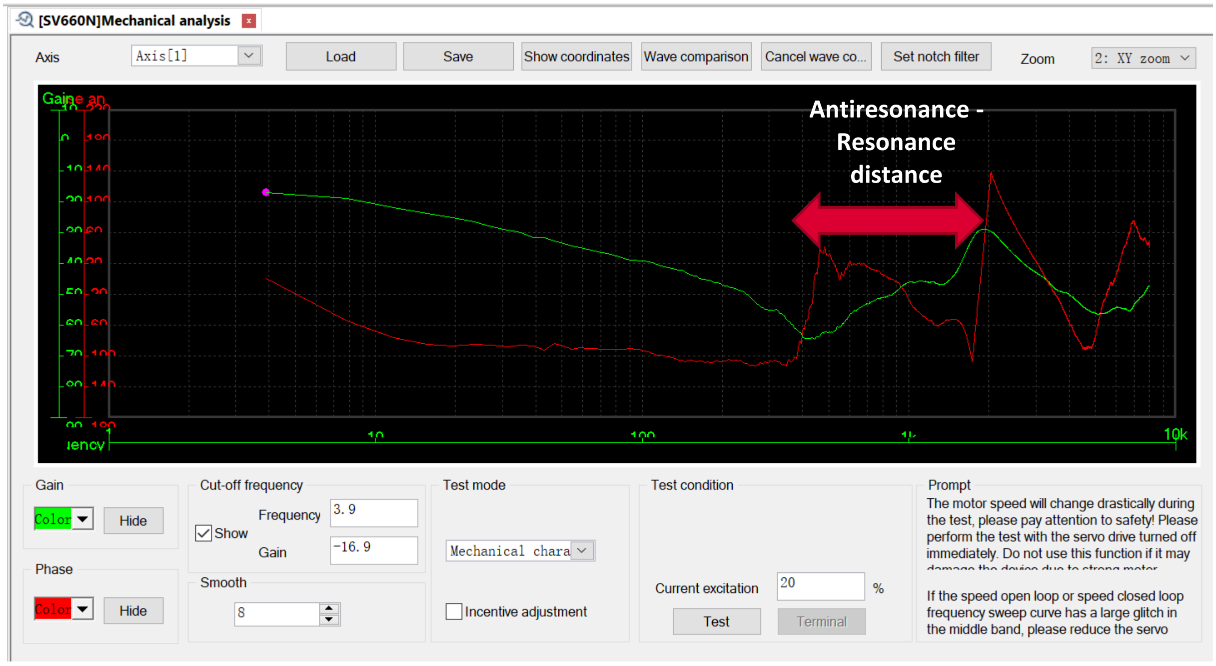
6.6.6.3 INERTIA RATIO

The Bode diagram also shows the inertia ratio of the system. The greater the distance between the antiresonance point and the resonance point, the greater the inertia ratio between the motor and the load.

Example 1: Pulley 32T 0.095 kg



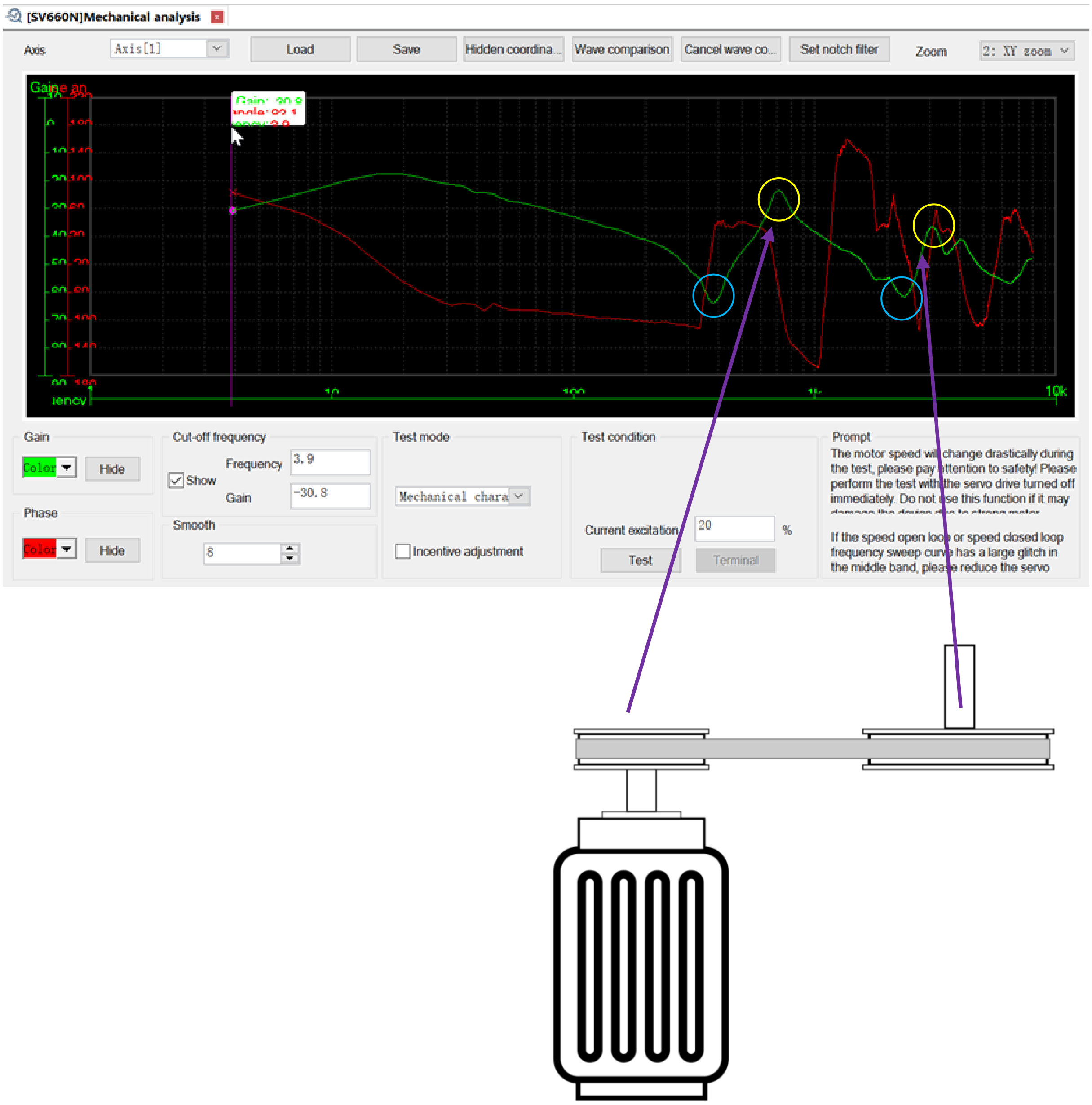
Example 2: Pulley 60T 0.480 kg


[SV660N]Mechanical analysis
Axis
Axis[1]
Load
Save
Show coordinates
Wave comparison
Cancel wave co...
Set notch filter
Zoom
2: XY zoom
Antiresonance -
Resonance
distance
10
100
10k
Gain
Color
Hide
Phase
Color
Hide
Cut-off frequency
Frequency
3.9
Show
Gain
-16.9
Smooth
8
Test mode
Mechanical chara
Incentive adjustment
Test condition
Current excitation
20
%
Test
Terminal
Prompt
The motor speed will change drastically during the test, please pay attention to safety! Please perform the test with the servo drive turned off immediately. Do not use this function if it may
If the speed open loop or speed closed loop frequency sweep curve has a large glitch in the middle band, please reduce the servo

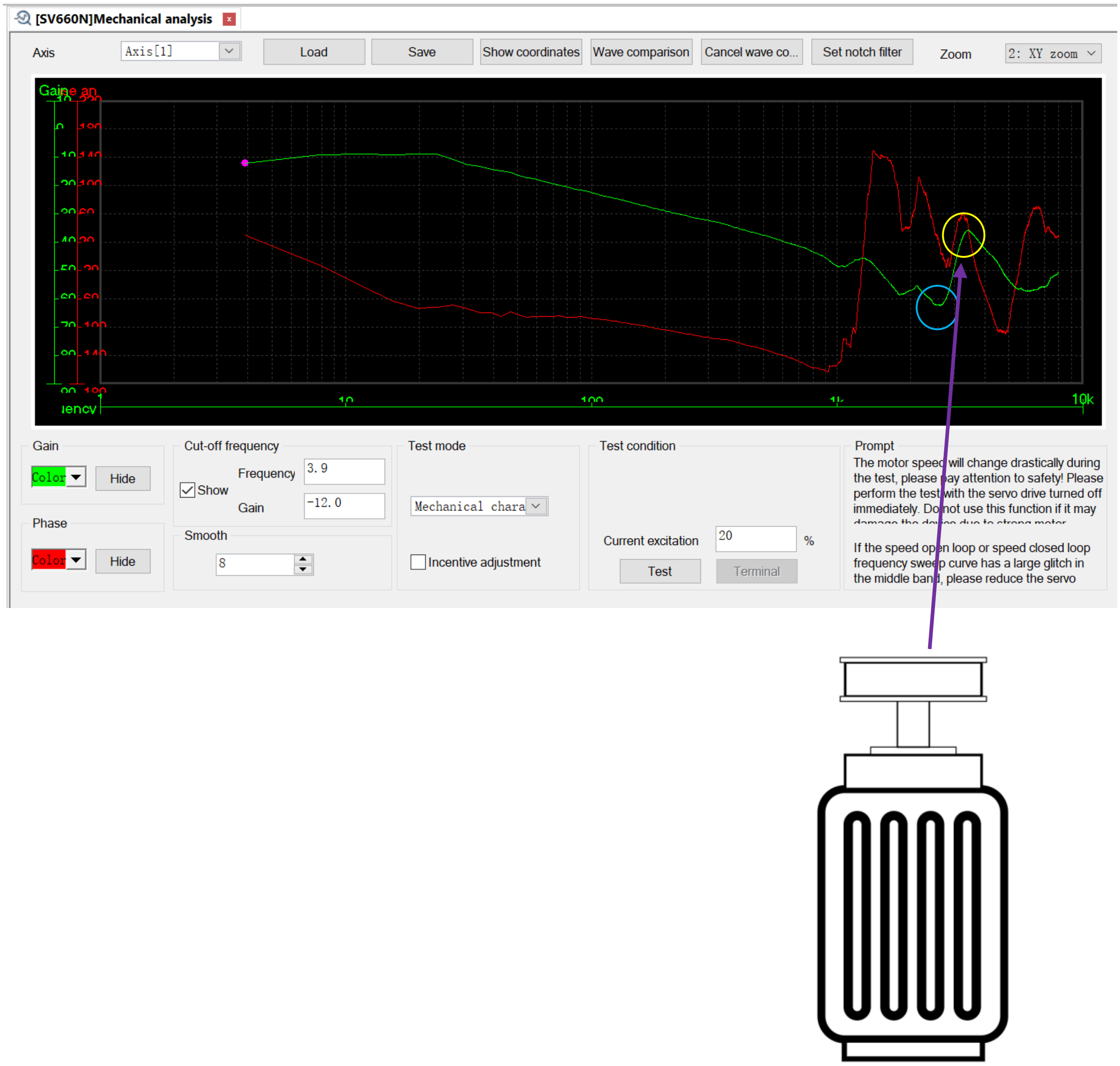
6.6.6.4 RESONANCE POINT

The elements of any mechanical system are what cause the different resonance frequencies. Each mechanical element in a system will have its own natural resonant frequency that shows both an antiresonance [ ] and a resonance [ ] point, where the mechanical element decouples from the system or is excited at its resonance point. Each pair of nodes is related to a coupled element in the system. While a system can have multiple resonant nodes, the first set of nodes (lowest frequency) is the most critical, as a bandwidth greater than the frequency of the first antiresonance node cannot be achieved.

Example 1: Two pulleys with a belt. In this case it can be seen how the mechanical analysis shows two resonance points due to the two pulleys coupled by a belt.



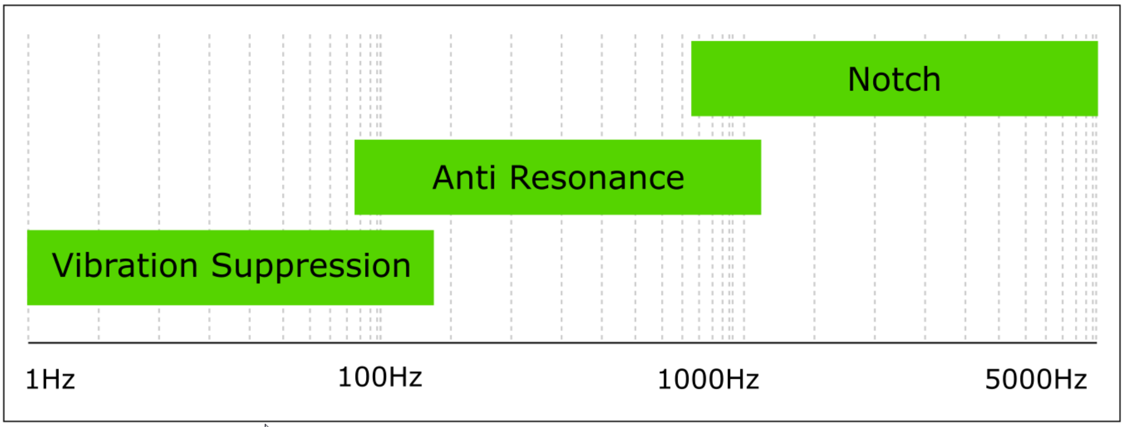
Example 2: One pulley. Mechanical analysis shows only one resonance point because the load coupled to the motor is made up of a single element.



6.6.7 FILTER ADJUSTMENT

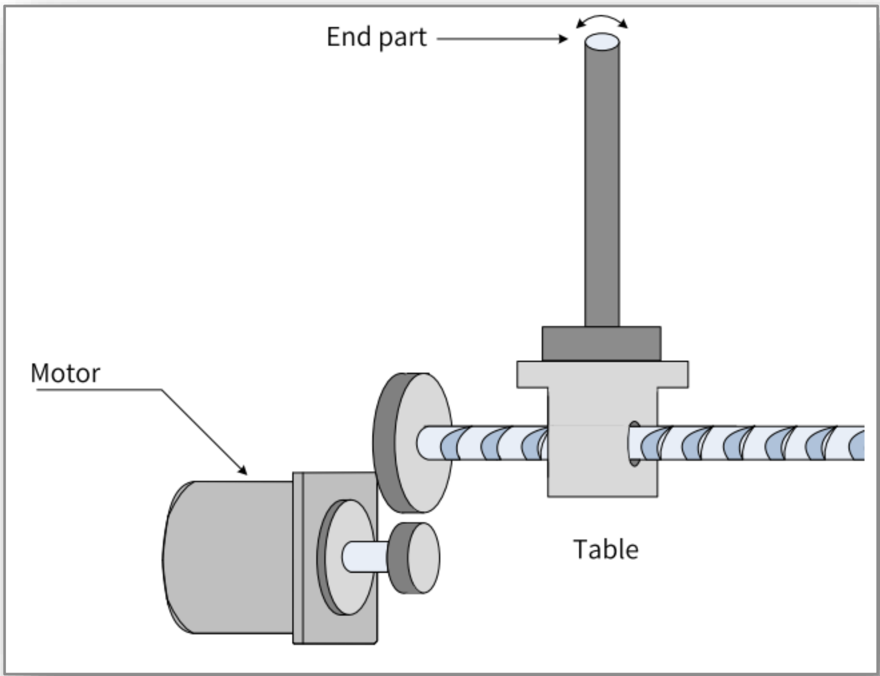
In all mechanical systems there are resonances that can be classified as high, medium or low frequency, depending on where they are within the bandwidth of the control loop.

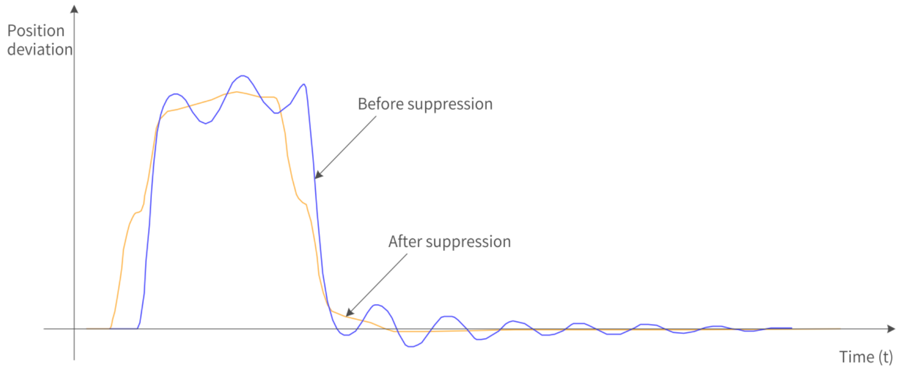
To eliminate these resonances, two types of filters are usually used, damping filters for low frequency alterations and notch filter for high frequency ones.



Low frequency – Vibration Suppression

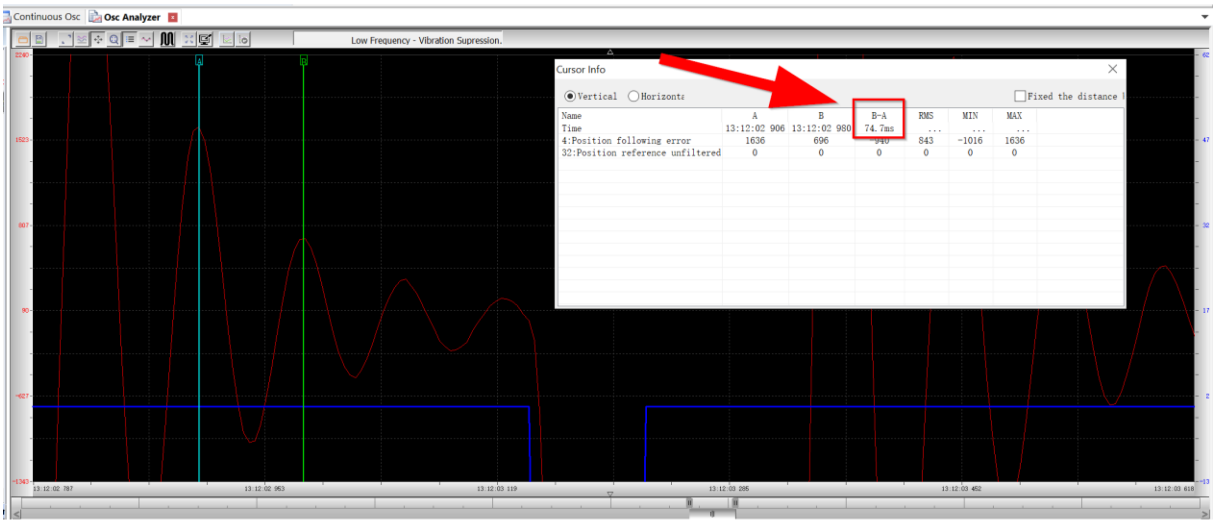
If the mechanical load end is long and heavy, vibration may easily occur on this part during fast ramps, affecting the settling time. Such vibration is called low frequency resonance as its frequency is generally within 100 Hz



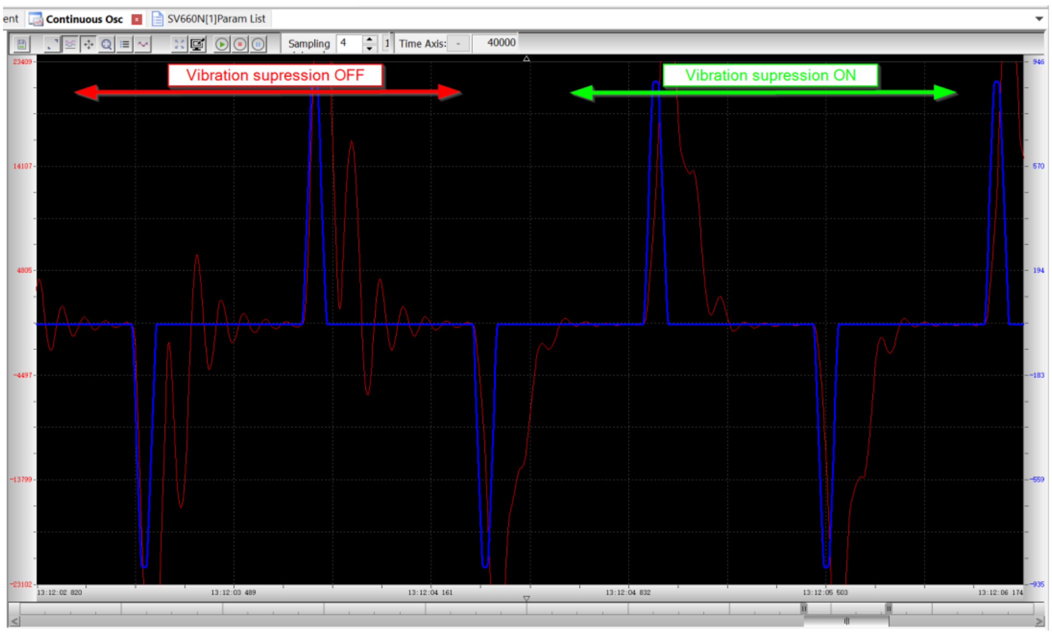


Use the low frequency resonance suppression function to suppress such vibration. Trace the position following error waveform using the oscilloscope function in INOVANCE software tool and calculate the position following error fluctuation frequency, which is the low-frequency resonance frequency. Next, input H09-38 (or H09-44) and H09-49 manually, and keep the values of other parameters to their default values. Observe the suppression effect after using the low frequency resonance suppression filter.

Example: position following error frequency 74.7ms = 13.38Hz



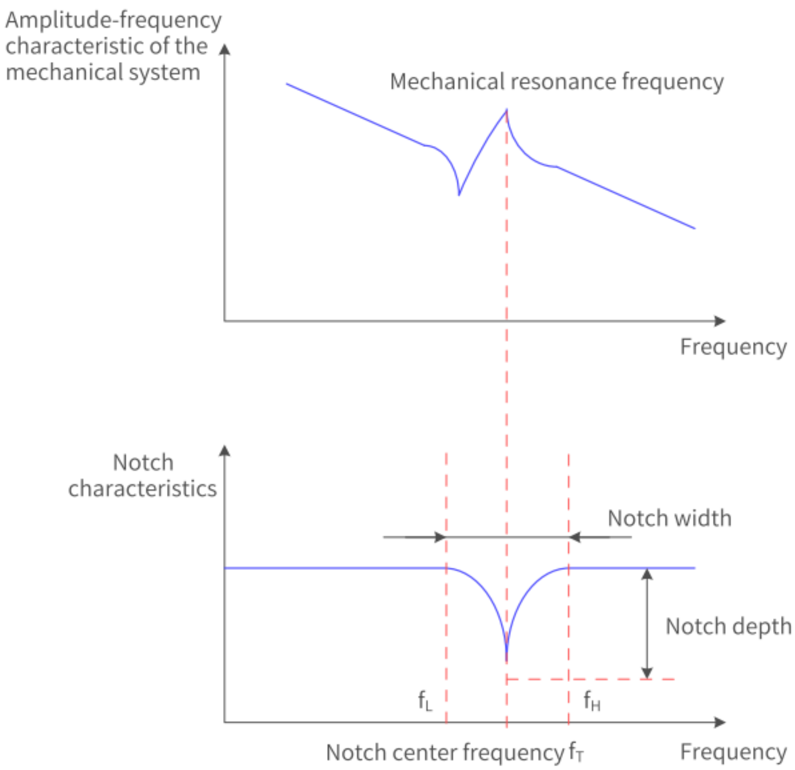
Vibration suppression ON → H09-38=13.4Hz and H09-49=13.4Hz



High Frequency – Notch filter

Notch filters attenuate the response of a narrow, specific range of frequencies around a center frequency (notch). Frequencies above or below the specified range pass unchanged. Signals close to the notch (center) frequency are heavily attenuated, but attenuation drops off at the ends of the specified range.

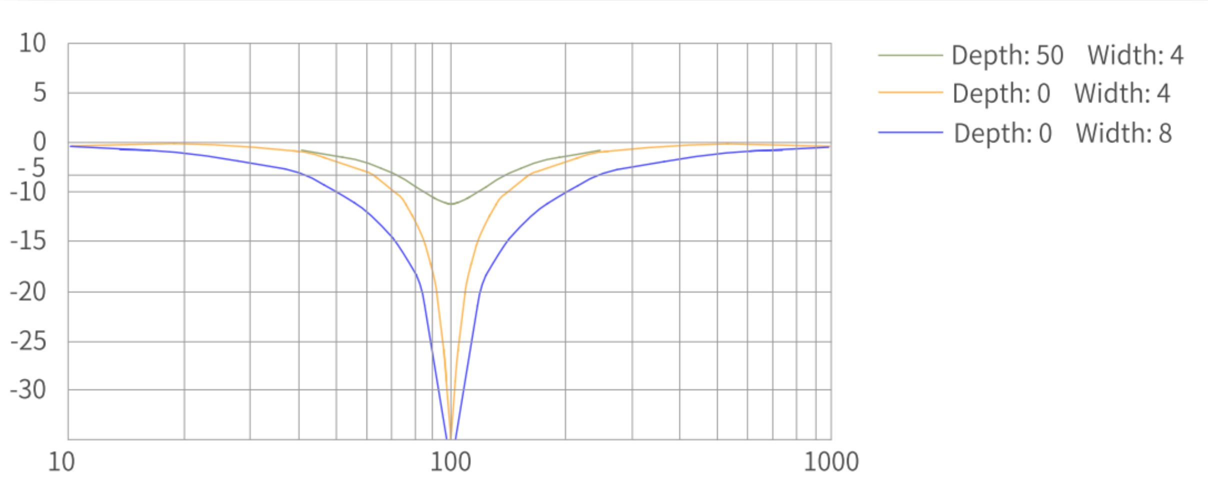
The notch reduces the gain at certain frequencies to suppress the mechanical resonance. After the vibration is suppressed by the notch, you can continue to increase the gain. The operating principle of the notch is shown in the following figure:



- **Width level** The width level indicates the ratio of the notch width to the center frequency of the notch.

  $$Width\ level = \frac{f_H - f_L}{f_T}$$

  In which:
  f_T : Center frequency of the notch, which is also the mechanical resonance frequency
  f_H-f_L : Notch width, indicating the frequency width whose amplitude attenuation rate is -3 dB in relative to the notch center frequency
  The default value 2 applies to general applications.
- **Depth Level**
  The notch depth level indicates the ratio of the input to the output at the center frequency.
  When the depth level is 0, the input is completely suppressed at the center frequency. When the depth level is 100, the input can be fully received at the center frequency. Therefore, the smaller the depth level is, the larger the notch depth is, and the stronger the suppression effect will be. Note that a too small depth level may lead to system oscillation.



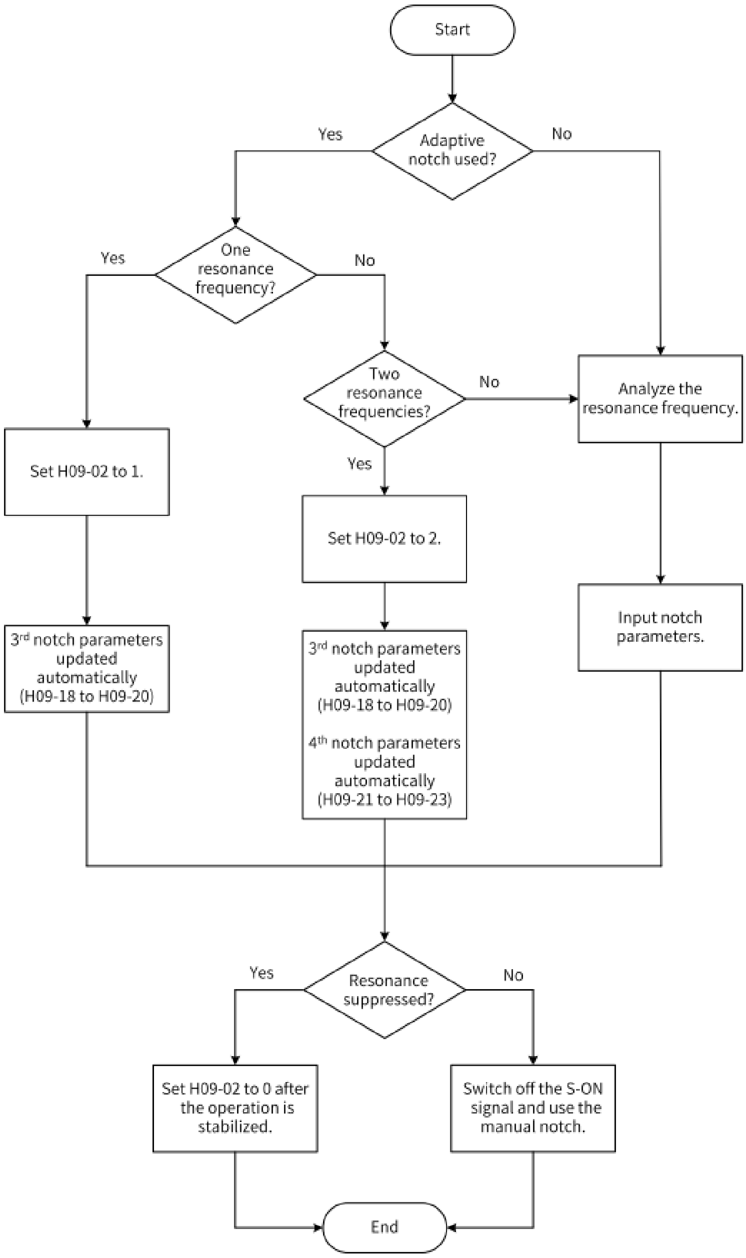
A total of four notches can be used, and each is defined by three parameters: frequency, width level, and depth level. Parameters of the 1st and 2nd manual notches are set manually by the user using 6.6.6 Mechanical analysis. Parameters of the 3rd and 4th notches can be either set manually or set automatically after being configured as an adaptive notch (H09-02 = 1 or 2).

	Manual Notch		Manual / Adaptative Notch	
	1st Notch	2nd Notch	3rd Notch	4th Notch
Frequency	H09-12	H09-15	H09-18	H09-21
Width level	H09-13	H09-16	H09-19	H09-22
Depth level	H09-14	H09-17	H09-20	H09-23

NOTE When the "frequency" is the default value (4000 Hz), the notch is disabled.

NOTE The adaptive notch (H09-02 = 1 or 2) is preferred for resonance suppression. The manual notch can be used in cases where the adaptive notch cannot deliver desired performance.

Procedure for using the adaptive notch:


Start
Adaptive notch used?
Yes
No
One resonance frequency?
Yes
No
Two resonance frequencies?
No
Analyze the resonance frequency.
Set H09-02 to 1.
Yes
Set H09-02 to 2.
Input notch parameters.
3rd notch parameters updated automatically (H09-18 to H09-20)
3rd notch parameters updated automatically (H09-18 to H09-20)
4th notch parameters updated automatically (H09-21 to H09-23)
Resonance suppressed?
Yes
No
Set H09-02 to 0 after the operation is stabilized.
Switch off the S-ON signal and use the manual notch.
End

6.6.8 MODEL TRACKING FUNCTION

The model tracking function, which is only available in the position control mode, can be used to improve the responsiveness and shorten the positioning time.

Parameters used by model tracking are normally set automatically through STune or ETune along with the gain parameters.

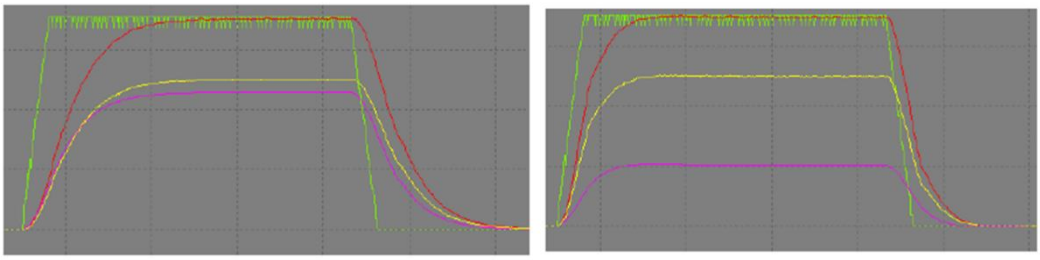
However, manual tuning could be needed. Model tracking function is based on system ideal mathematical model, it is as a “Feed-forward Controller+ Filter”.

Normally, this function is applied to point-to-point quick positioning mode (H09-00=6).

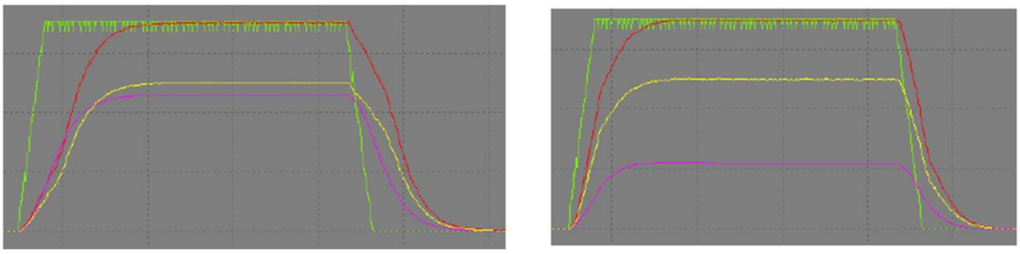
The effect of relevant parameters:

Reference speed Actual speed Position feedback Following error

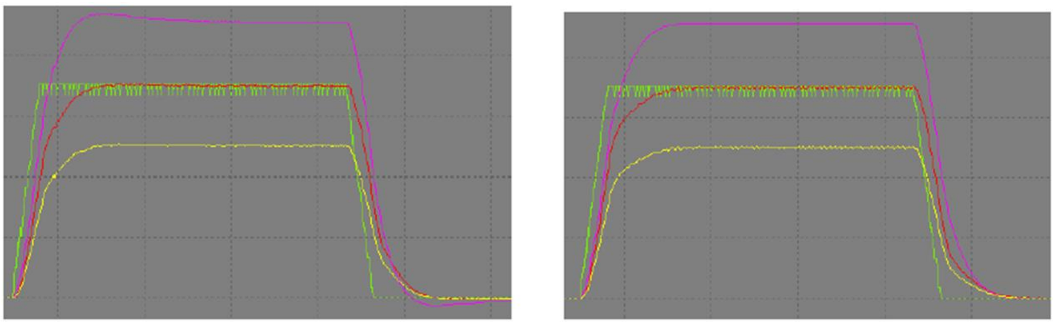
H08-43: Model Gain (as below curves, increasing H08-43 from 75 to 175, the speed response becomes more close to reference)



H08-46: Model feedforward (as below curves, increasing H08-46 from 1% to 90%, it can effectively shorten the positioning time)



H08-51: Model filter time 2 (as below curves, increasing H08-51 from 0 to 0.5ms, it can effectively reduce overshoot caused by too strong feedforward)



Drive Parameter	Description	Unit	Range	Default
H08-42	Model control selection		0 to 1	0
H08-43	Model Gain		0.1 to 2000	40
H08-46	Model feedforward	%	0 to 102.4	95

H08-51	Model filter time 2		0 to 2000	0

6.6.9 GAIN ADJUSTMENT PARAMETERS

This section collect all the parameters related with gains and filters adjustment of the different loops of the drive. The first section is a table with all the parameters. The second section is a diagram with the most important parameters of the drive loops.

MENU 8

	Function code ID	Description	Current var value	Unit	Minimum value	Maximum value	Default Value
Speed & position loop gains	H08-00	Speed loop gain	40	Hz	0.1	2000	40
	H08-01	Speed loop integral time constant	19.89	ms	0.15	512	19.89
	H08-02	Position loop gain	64	Hz	0.1	2000	64
	H08-03	2nd speed loop gain	75	Hz	0.1	2000	75
	H08-04	2nd speed loop integral time constant	10.61	ms	0.15	512	10.61
	H08-05	2nd position loop gain	120	Hz	0.1	2000	120
	H08-08	2nd gain mode	1		0	1	1
Gain Switchover	H08-09	Gain switchover condition	0		0	10	0
	H08-10	Gain switchover delay	5	ms	0	1000	5
	H08-11	Gain switchover level	50		0	20000	50
	H08-12	Gain switchover hysteresis	30		0	20000	30
	H08-13	Position gain switchover time	3	ms	0	1000	3
	H08-15	Load moment of inertia ratio	1		0	120	1
	H08-17	Zero phase delay	0	ms	0	4	0
	H08-18	Speed feedforward filter time constant	0.5	ms	0	64	0.5
	H08-19	Speed feedforward gain	0	%	0	100	0
	H08-20	Torque feedforward filter time constant	0.5	ms	0	64	0.5
	H08-21	Torque feedforward gain	0	%	0	300	0
	H08-22	Speed feedback filter selection	0		0	4	0
	H08-23	Cutoff frequency of speed feedback low-pass filter	8000	HZ	100	8000	8000
	H08-24	PDFF control coefficient	100	%	0	200	100
Speed Observer	H08-27	Cutoff frequency of speed observer	170	HZ	50	600	170
	H08-28	Inertia correction coefficient of speed observer	100	%	1	1600	100
	H08-29	Speed observer filter time	0.8	ms	0	10	0.8
Disturbance Observer	H08-31	Disturbance cutoff frequency	600	Hz	10	4000	600
	H08-32	Disturbance compensation gain	0	%	0	100	0
	H08-33	Inertia correction coefficient of disturbance observer	100	%	0	1600	100
Mechanical Resonance	H08-37	Phase modulation of medium-frequency jitter suppression 2	0	?	-90	90	0
	H08-38	Frequency of medium-frequency jitter suppression 2	0	Hz	0	1000	0

	Function code ID	Description	Current var value	Unit	Minimum value	Maximum value	Default Value
	H08-39	Compensation gain of medium-frequency jitter suppression 2	0	%	0	300	0
	H08-40	Speed observer selection	0		0	1	0
	H08-42	Model control selection	0		0	1	0
	H08-43	Model gain	40		0.1	2000	40
	H08-46	Feedforward value	95		0	102.4	95
Vibration Suppression	H08-53	Medium- and low-frequency jitter suppression frequency 3	0	HZ	0	300	0
	H08-54	Medium- and low-frequency jitter suppression compensation 3	0	%	0	200	0
	H08-56	Medium- and low-frequency jitter suppression phase modulation 3	100	%	0	600	100
	H08-59	Medium- and low-frequency jitter suppression frequency 4	0	HZ	0	300	0
	H08-60	Medium- and low-frequency jitter suppression compensation 4	0	%	0	200	0
	H08-61	Medium- and low-frequency jitter suppression phase modulation 4	100	%	0	600	100
	H08-62	Position loop integral time constant	512		0.15	512	512
	H08-63	2nd position loop integral time constant	512		0.15	512	512
	H08-64	Speed observation feedback source	0		0	1	0

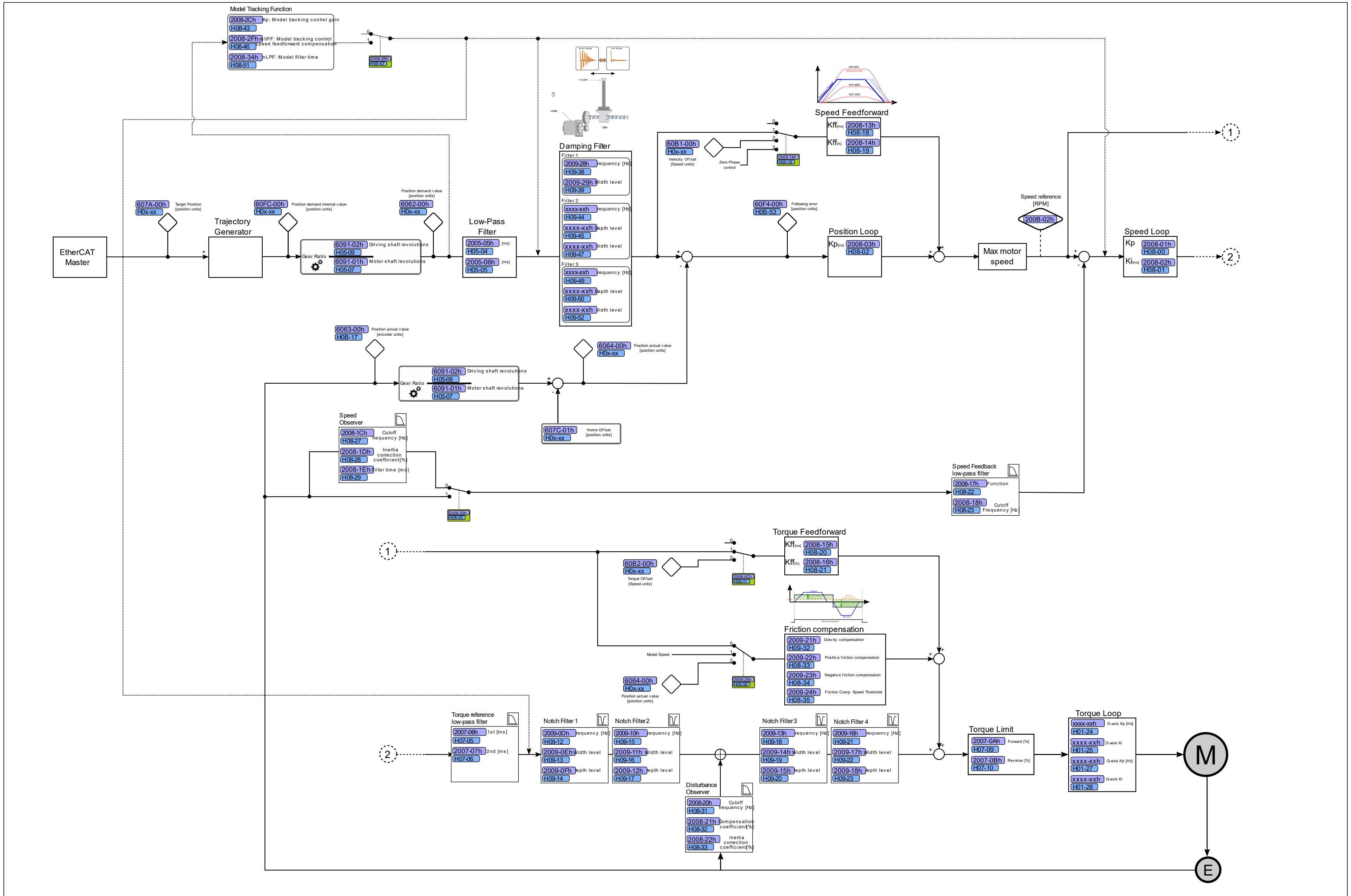
MENU 9

	Function code ID	Description	Current var value	Unit	Minimum value	Maximum value	Default Value
	H09-00	Gain auto-tuning mode	4		0	7	4
	H09-01	Stiffness level	15		0	41	15
	H09-02	Adaptive notch mode	3		0	4	3
Inertia	H09-03	Online inertia auto-tuning mode	2		0	3	2
	H09-05	Offline inertia auto-tuning mode	1		0	1	1
	H09-06	Max. speed of inertia auto-tuning	500	rpm	100	1000	500
	H09-07	Time constant for accelerating to the maximum speed during inertia auto-tuning	125	ms	20	800	125
	H09-08	Inertia auto-tuning interval	800	ms	50	10000	800
	H09-09	Number of motor revolutions per inertia auto-tuning	1		0	100	1
	H09-11	Vibration threshold	5	%	0	100	5
Mechanical Resonance	H09-12	Frequency of the 1st notch	8000	HZ	50	8000	8000
	H09-13	Width level of the 1st notch	2		0	20	2
	H09-14	Depth level of the 1st notch	0		0	99	0
	H09-15	Frequency of the 2nd notch	8000	HZ	50	8000	8000

	Function code ID	Description	Current var value	Unit	Minimum value	Maximum value	Default Value
	H09-16	Width level of the 2nd notch	2		0	20	2
	H09-17	Depth level of the 2nd notch	0		0	99	0
	H09-18	Frequency of the 3rd notch	8000	HZ	50	8000	8000
	H09-19	Width level of the 3rd notch	2		0	20	2
	H09-20	Depth level of the 3rd notch	0		0	99	0
	H09-21	Frequency of the 4th notch	8000	HZ	50	8000	8000
	H09-22	Width level of the 4th notch	2		0	20	2
	H09-23	Depth level of the 4th notch	0		0	99	0
	H09-24	Auto-tuned resonance frequency	0	HZ	0	5000	0
	H09-32	Gravity compensation value	0	%	0	100	0
	H09-33	Forward friction compensation value	0	%	0	100	0
	H09-34	Reverse friction compensation value	0	%	-100	0	0
	H09-35	Friction compensation speed	2		0	20	2
	H09-36	Friction compensation speed selection	0		0	19	0
	H09-37	Vibration monitoring time	600		0	65535	600
Mechanical low-frequency resonance	H09-38	Frequency of low-frequency resonance suppression 1 at the mechanical end	100	HZ	1	100	100
	H09-39	Setting of low-frequency resonance suppression 1 at the mechanical end	2		0	3	2
	H09-41	Frequency of the 5th notch	8000	HZ	50	8000	8000
	H09-42	Width level of the 5th notch	2		0	20	2
	H09-43	Depth level of the 5th notch	0		0	99	0
	H09-44	Frequency of low-frequency resonance suppression 2 at the mechanical end	0		0	200	0
	H09-45	Response of low-frequency resonance suppression 2 at the mechanical end	1		0.01	10	1
	H09-47	Width of low-frequency resonance suppression 2 at the mechanical end	1		0	2	1
	H09-49	Frequency of low-frequency resonance suppression 3 at the mechanical end	0		0	200	0
	H09-50	Response of low-frequency resonance suppression 3 at the mechanical end	1		0.01	10	1
	H09-52	Width of low-frequency resonance suppression 3 at the mechanical end	1		0	2	1

	Function code ID	Description	Current var value	Unit	Minimum value	Maximum value	Default Value
	H09-56	STune mode setting	4		0	4	4
	H09-57	STune resonance suppression switchover frequency	900	Hz	0	4000	900
	H09-58	STune resonance suppression reset selection	0		0	1	0

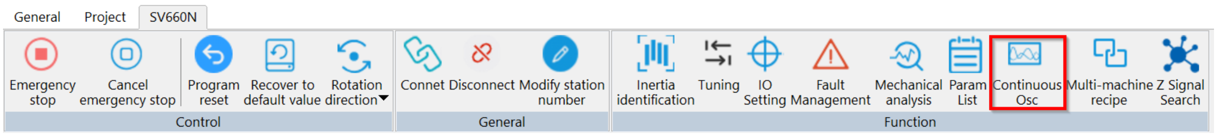
6.6.9.1 GAIN ADJUSTMENT PARAMETERS DIAGRAM

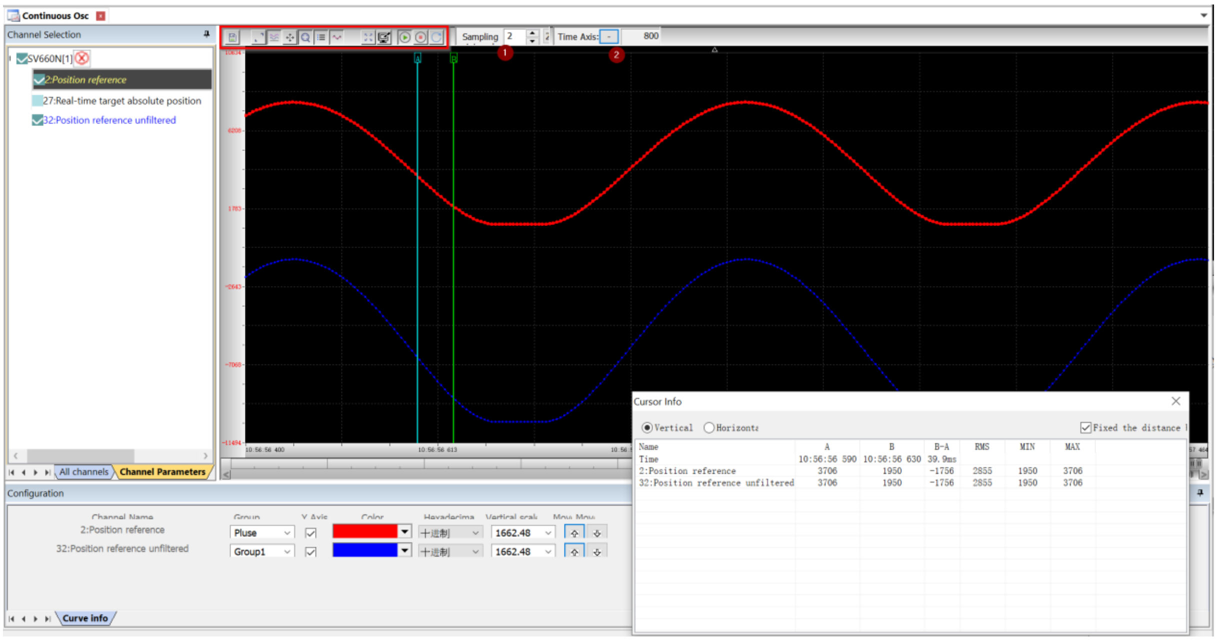


Author	Raúl Sampe	02. Nov. 20	SV660N	*Gain Adjustment*		INOVANCE	v1.0
Revised		02. Nov. 20	Parameters & CiA402 Objects	*Parameters*			1/1

6.7 CONTINUOS OSCILLOSCOPE

Continuous sampling supports long-term acquisition. During long-term acquisition, the waveform data will be automatically saved under the current project directory "WaveData". Therefore, if you need to sample continuously for a long time, you can run for a long time without data loss as long as you ensure enough hard disk space.





[1] Sample time. Minimum sample time is 3ms

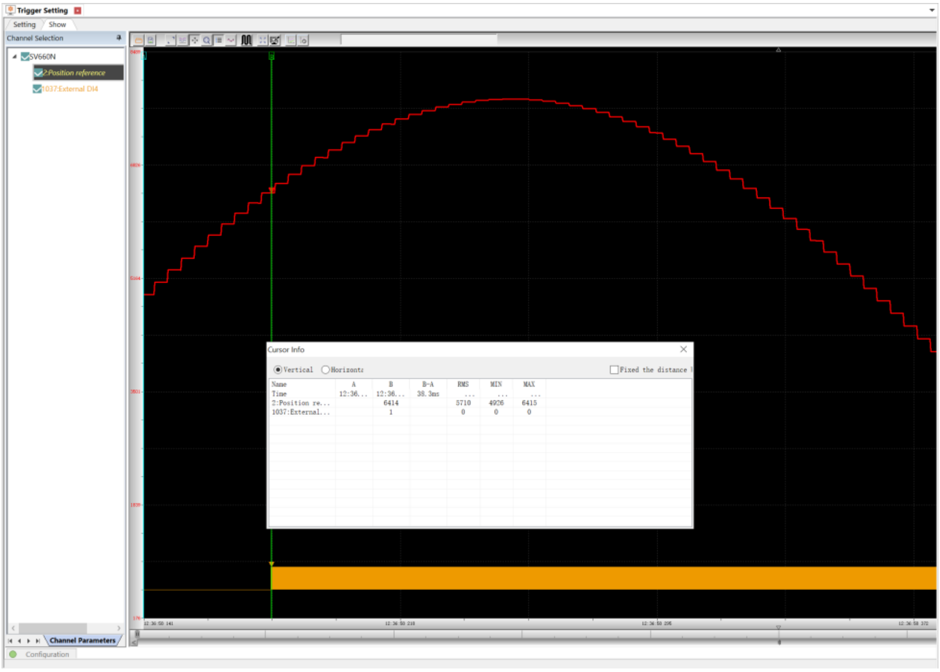
[2]Time Axis

	Save sampling data to a file
	Auto adjust the data to fit the screen
	Active the multi channel mode. If it is active, each channel is shown in a different graph. Otherwise all channels are shown on the same graph
	Enable pan mode. When hold the mouse right cursor over the graph the graph move along mouse movement
	Zoom in
	Enable cursors
	Displays sampling points
	Change to full screen mode
	It takes a screenshot of current data sampling
	Button to start sampling
	Button to stop sampling. After clicking the data is stored under the current project directory "WaveData"
	Button to pause sampling, and the button becomes .At this time, the data is still being collected, but the interface data is not refreshed. After clicking the , the sampling resumes, and the collected data can still be displayed normally during the pause

	sampling resumes

6.8 TRIGGER OSCILLOSCOPE

Trigger sampling supports event acquisition. The scope monitors the incoming signal and waits for the value to rise above (or fall below) a set threshold, then causes the scope to capture and display the waveform.



Ordinary Channel:

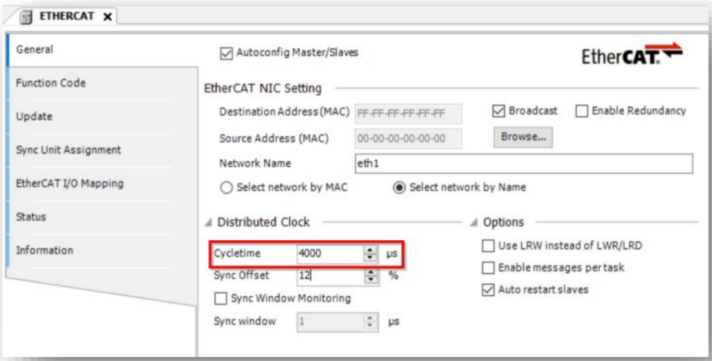
ID	Description	Parameter	Update Rate
17	Position reference absolute value	CiA402 position demand value 6062h (encoder unit)	250µs
27	Real-time target absolute position: CiA402 target position 607Ah + 60B0h	CiA402 target position 607Ah + 60B0h	EtherCAT cycle
28	Real-time target speed: CiA402 target speed 60FFh + 60B1h	CiA402 target speed 60FFh + 60B1h	EtherCAT cycle
29	Real-time target torque: CiA402 target torque 6071h + 60B2h	CiA402 target torque 6071h + 60B2h	EtherCAT cycle
30	Control Word: CiA402 Control Word 6040h	CiA402 Control Word 6040h	EtherCAT cycle
31	Status Word: CiA402 Control Word 6041h	CiA402 Status Word 6041h	1ms
2	Position reference: position increment		250µs
32	Position reference unfiltered: position increment		250µs
3	Position feedback: position increment		250µs
20	Position feedback absolute value: absolute position	CiA402 position actual value* 6063h (encoder unit) H0B-17	62.5µs
4	Position following error	H0B-15	62.5µs
25	Position following deviation-reference unit	H0B-53 Following Error Actual Value 60F4h	250µs
5	Speed reference (rpm)	H0B-01	62.5µs
6	Speed feedback (rpm)	606Ch (instruction unit/s)	62.5µs

7	Speed feedback filter	H0B-00	1ms
8	Torque reference	H0B-02	62.5µs
9	Current Feedback	6077h	62.5µs

6.8.1 ETHERCAT POSITION INTERPOLATION

In CSP mode, the servo drive operates as a position-follower with current/velocity/position loops closed in the drive. The EtherCAT master does all of the calculations to produce motion profiles that move the motor to desired positions.

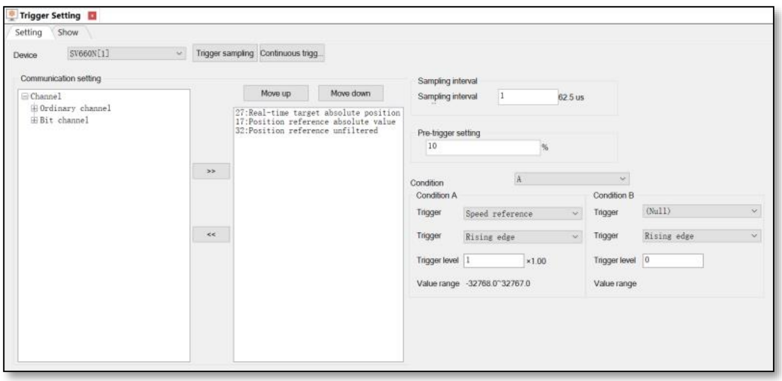
The servo drive only sees increments of position with every PDO (CiA402 object 607Ah) and has no knowledge of the final target position or velocities. And the rate at which the updates arrive depends on the time-base of the master (EtherCAT cycle time).



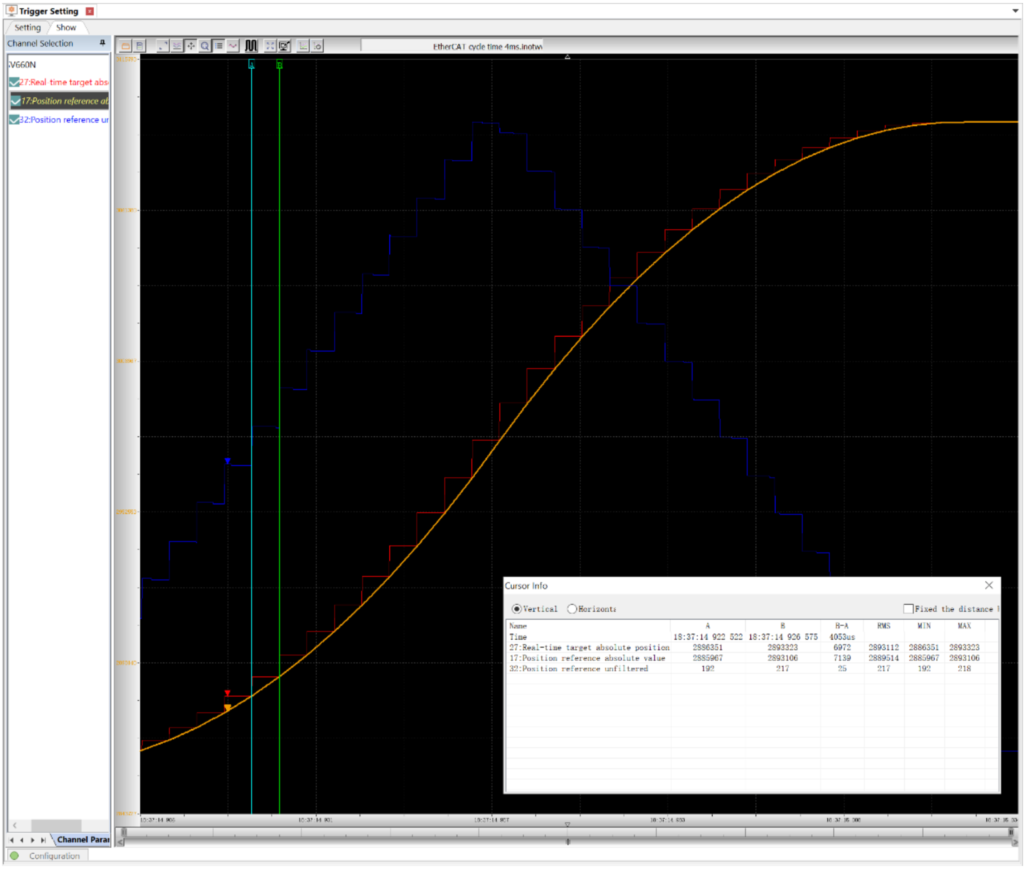
The next two graphs show the difference between a 4ms and an 8ms EtherCAT cycle. The waveform signal shows the position sent by the EtherCAT master each cycle and the orange waveform is the **position interpolated between two points** received each cycle from EtherCAT. The drive uses the value of the orange waveform to introduce it as a reference in the position loop.

ID	Description	Parameter	Update Rate
27	Real-time target absolute position	CiA402 target position 607Ah + 60B0h	EtherCAT cycle
17	Position reference absolute value	CiA402 position demand value 6062h (encoder unit)	250µs
32	Position reference unfiltered: position increment		250µs

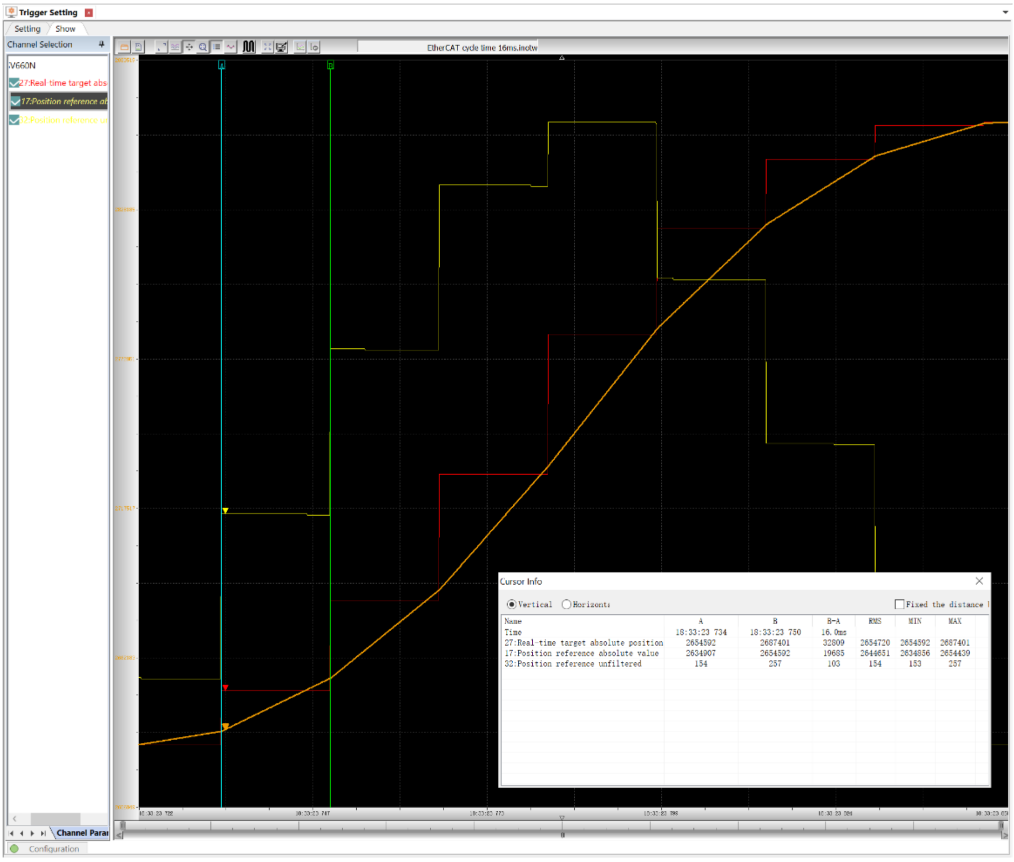
Trigger configuration:



Example 1: EtherCAT cycle time 4ms



Example 2: EtherCAT cycle time 8ms

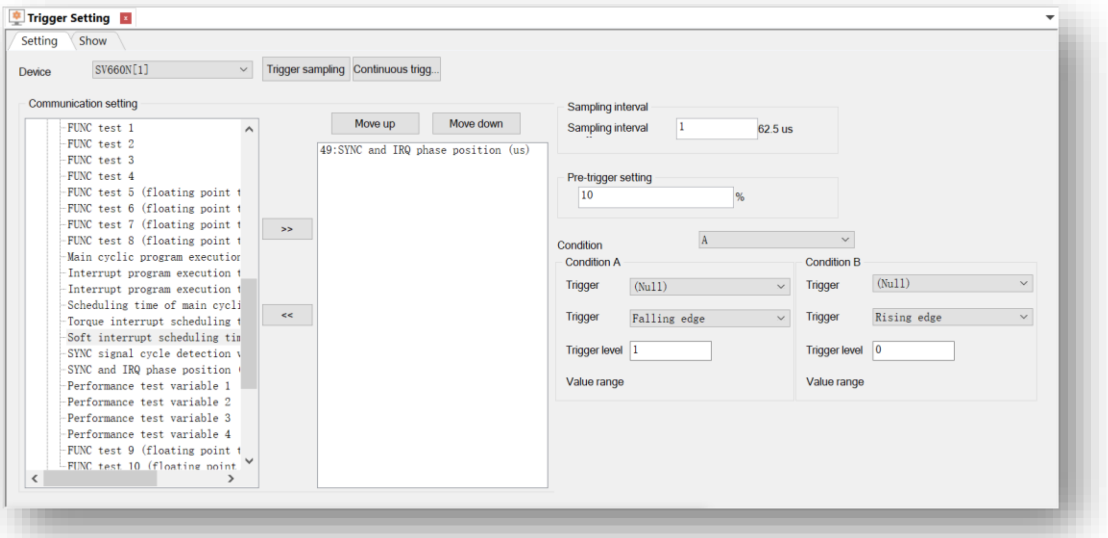


6.8.2 SYNC AND IRQ PHASE POSITION (µS) [49]

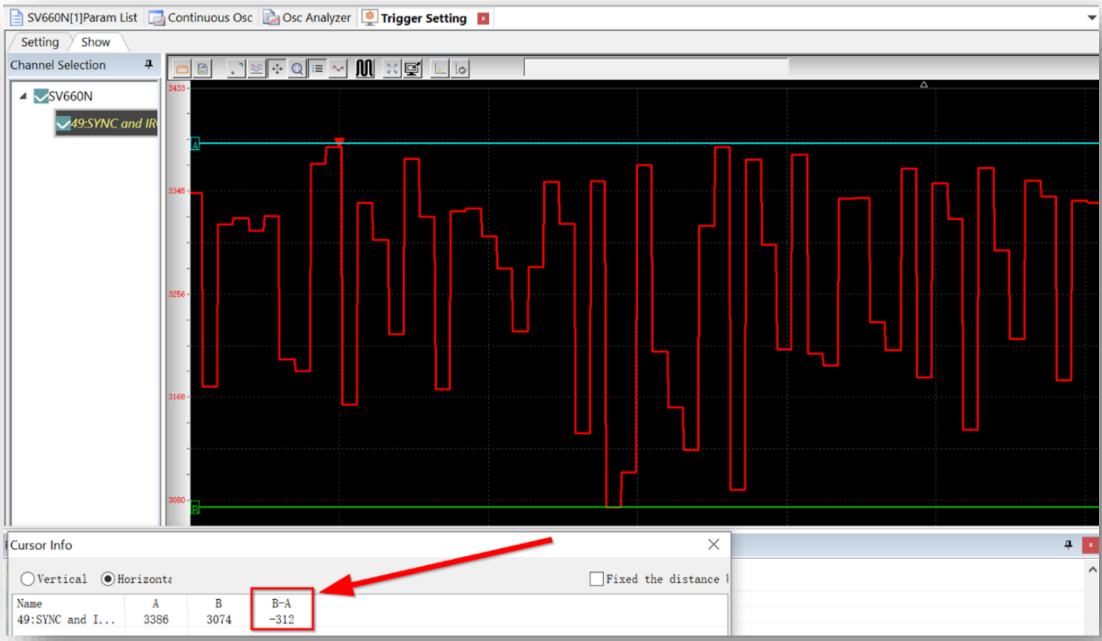
SV660N uses the Distributed Clock mode to maintain an exact synchronization with the master.

> *[Source EtherCAT.org]*
>
> *The method of Distributed Clocks provides highly precise time synchronization between slaves in an EtherCAT network. Since DC refers to the ESC-internal clocks, synchronization time between slaves can be guaranteed to much better than 1µs. The requirement of DC depends on the necessity of synchronization precision of the developing slave device. For instance, in machines in which multiple servo drives are functionally coupled, the axes need to be precisely synchronized to perform coherent movement. For this reason, many slaves for servo drive adopt DC in order to achieve high synchronization precision with other slaves. Thus the DC functionality should be implemented in cases of servo drive systems or I/O slaves being synchronized with servo drives.*

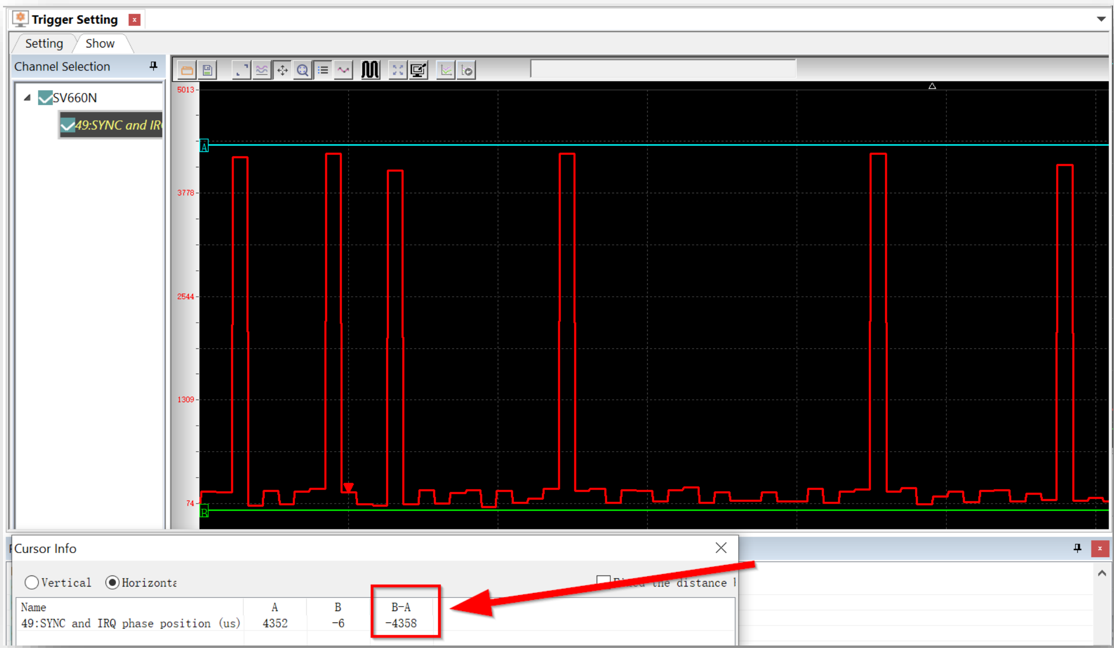
Using the trigger tool it is possible to see the synchronization between master and slave. The value of [49] “SYNC and IRQ phase position” shows the offset between slave microprocessor interrupt and SYNC signal interruption.



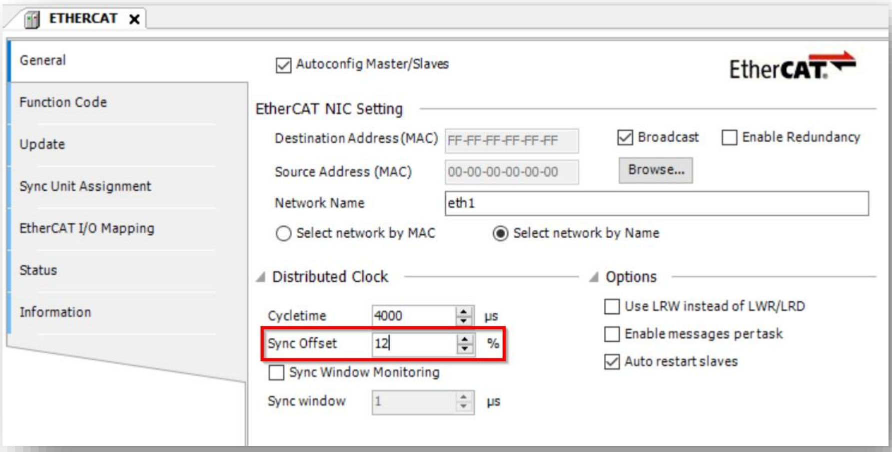
Example 1: This trace show the value of [49] “SYNC and IRQ phase position” when the jitter from EtherCAT master is acceptable. The EtherCAT master cycle time is 4 ms.



Example 2: This trace show the value of [49] “SYNC and IRQ phase position” when the jitter from EtherCAT master is NOT acceptable. The EtherCAT master cycle time is 4 ms. In this case it can observe that in some cycles the [49] value is too high. This is because EtherCAT SYNC signal is very close to Master IRQ interruption and these two signals are overlapping. In this example, the "Time Shift" parameter of the master has been modified from 12% to 30% to cause this effect



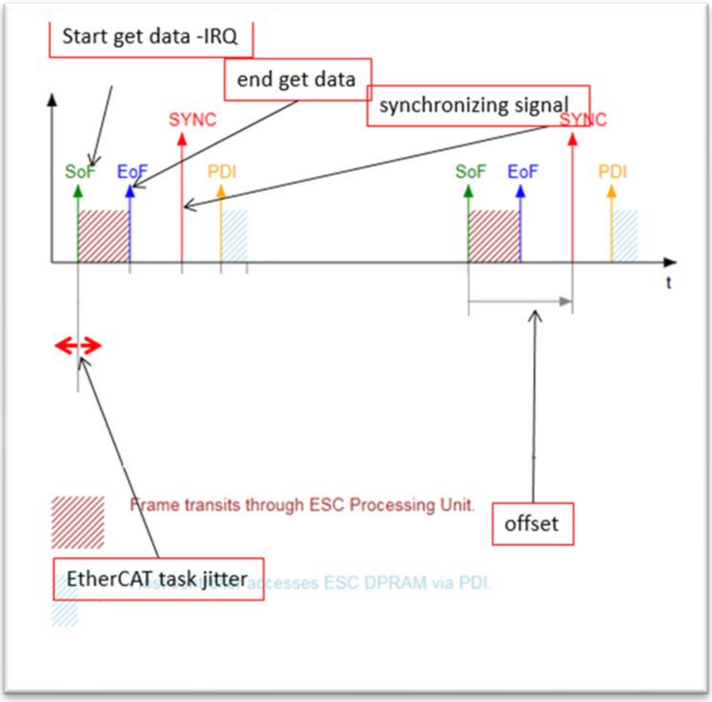
The following image shows the InoProShop EtherCAT Master configuration. The EtherCAT setting allows you to change the "Sync Offset" value to change the position of IRQ with respect to the SYNC signal.



The distributed clock is used in applications that require very high synchronization between slaves. All slave clocks are aligned with the same time reference and generate synchronous events within each slave. The interruption

For good synchronization, the SYNC signal that triggers a process data update must always follow the receipt of the frame carrying new data values. However, the transmission time of the frame may fluctuate depending on the implementation of the master, and therefore the frame carrying new output data may overlap with the SYNC signal.

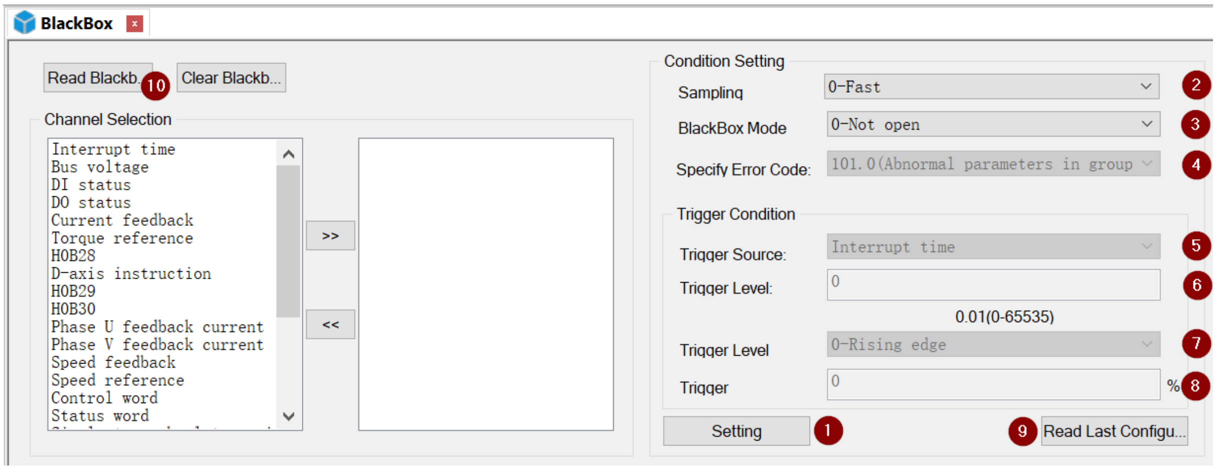
The following image show the EtherCAT slave timing:



- EoF: End of Frame
- SoF: Start of Frame. Ethernet SOF delimiter at the end of the preamble of Ethernet frames
- PDI: Process Data Interface or Physical Device Interface: an interface that allows access to ESC from the process side
- IRQ: Master application cycle time
- SYNC: Signal generated by the Distributed Clocks unit
- Offset [2]: value related with “Sync Offset” from the EtherCAT Master configuration

6.9 BLACKBOX

The black box is used for data collection when a fault occurs, which is convenient for analyzing the cause of the fault.



[01] Condition setting: enable the black box function, please set the condition parameters correctly, otherwise the data will not be captured normally

[02] Sampling frequency: 0-fast (sampling frequency: 16 kHz, sampling interval 62.5us), 1-medium (4 kHz, sampling interval 250us), 2-slow (1 kHz, sampling interval 1ms).

[03] Trigger mode: 0-not open, 1-arbitrary failure, 2-specified failure, 3-specified condition trigger; When the trigger mode is 2-specified fault, you can select the corresponding specified fault code through the drop-down menu [4]. At this time, you can also configure the trigger position. The trigger position refers to the data collected before and after the trigger condition

When the trigger mode is 3-specified condition trigger, the trigger source selects the corresponding observation channel variable through the drop-down menu [5], and sets the trigger level. When you want to view the value of the observation variable crossing the trigger level [6] from small to large, the trigger level selection [7] can select 0-rise Edge, if it crosses the trigger level from large to small, select 2-falling edge, etc.

Click the "Set" button [1] to send the black box trigger condition to the driver

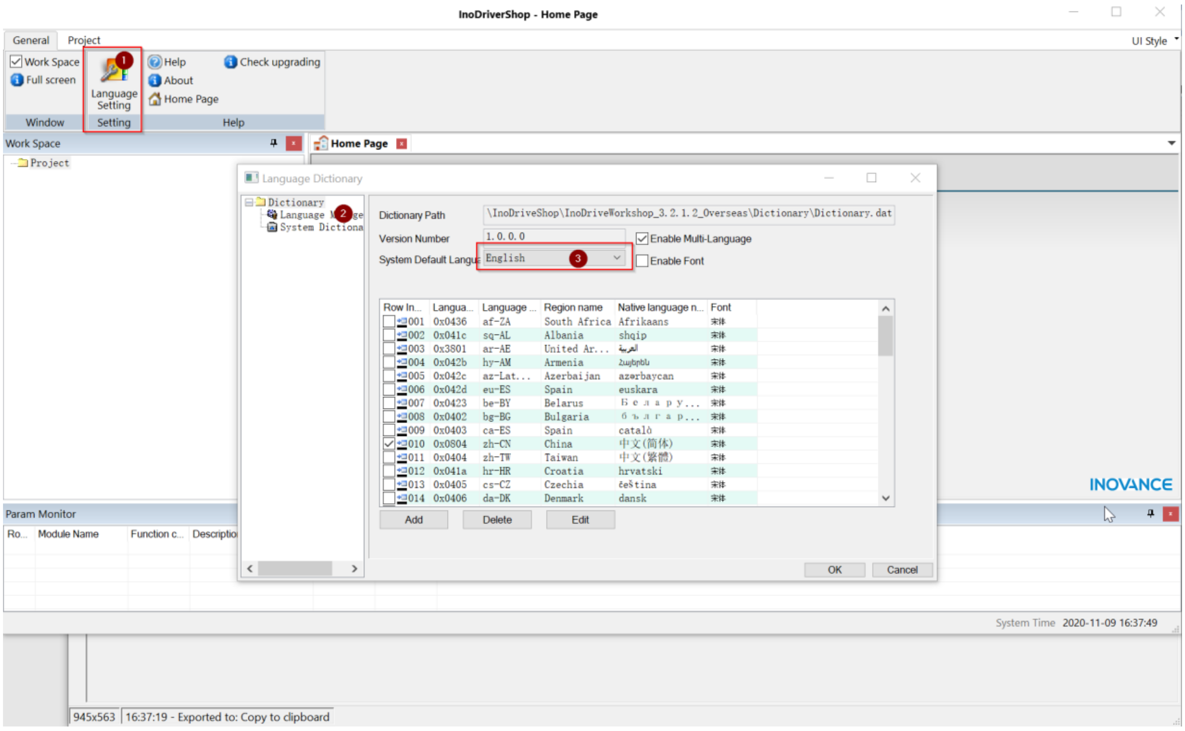
In addition, users can click "Read last configuration" [9] to get the trigger condition information set last time; 3. Black box data acquisition

Select the channels to be observed, up to 4 channels: click the button >> and << to delete the channels

Click "Read Black Box Data" [10] to start reading the black box data. After reading, it will jump to the oscilloscope interface to display the channel data

6.11 CHANGE INTERFACE LANGUAGE

To change the language of the user interface, access the main tab of the program and click on the button "Language Settings". Select the desired language on the dialog that appears.

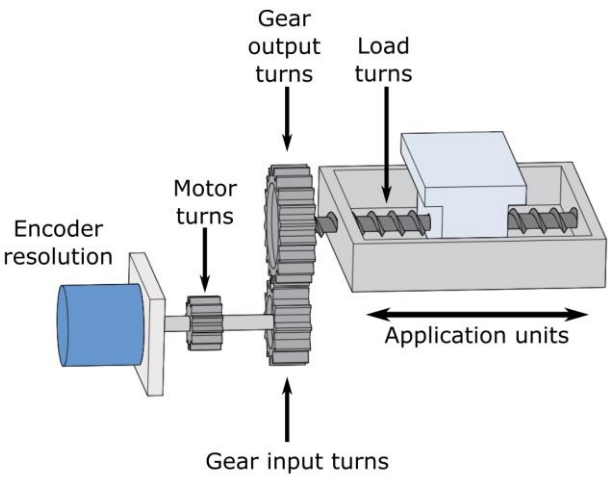


7 AXIS SCALING

There are two methods for modifying the axis scaling or application units: modify scaling on the SV660N or on the EtherCAT master. These two methods are described in the following sections.

7.1 SV660N SCALING CONFIGURATION

The following figure shows the relationship between the position reference (reference unit), load displacement, and electronic gear ratio.

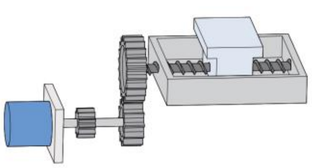
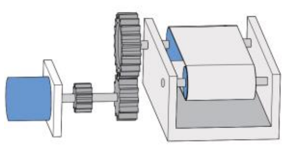
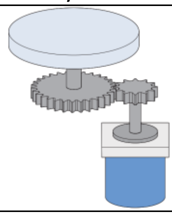


Encoder resolution ⇔ Motor turns

Gear input turns ⇔ Gear output turns

Load turns ⇔ Application units

$$Scaling\ factor = \frac{6091-1h}{6091-2h} = \frac{H05-07}{H05-09} = \frac{\text{Encoder resolution}}{\text{Motor turns}} \times \frac{\text{Gear input turns}}{\text{Gear output turns}} \times \frac{\text{Load turns}}{\text{Application units}}$$

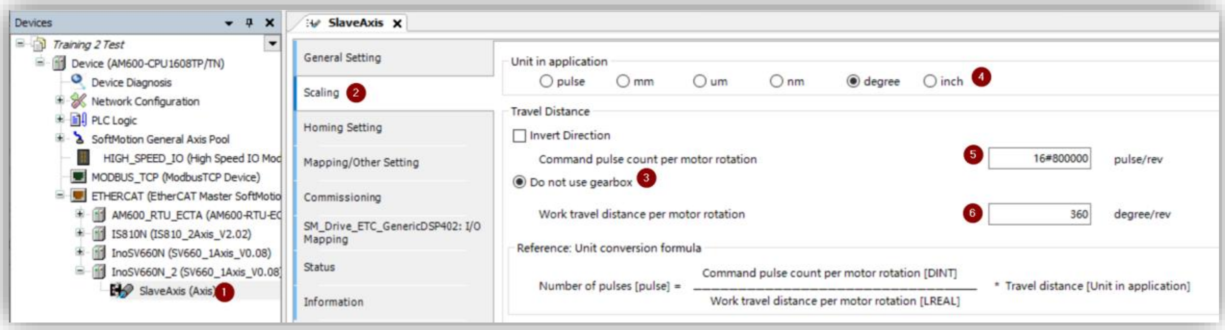
Step	Item	Mechanism		
		Ball Screw	Belt Pulley	Rotary actuator
				
1	Mechanical parameters	Reduction ratio R: 2/1 Lead: 0.01 m	Reduction ratio R: 5/1 Diameter of belt pulley: 0.2 m (circumference: 0.628 m)	Reduction ratio R: 10/1 Load rotating angle for one load shaft revolution: 360°
2	Encoder resolution	23 bit 8388608 pulses/revolution	23 bit 8388608 pulses/revolution	23 bit 8388608 pulses/rev.
3	Application units	1μm=0.00001 m	0.1mm=0.001m	0.01°
4	Calculation	$\frac{8388608}{1} \times \frac{2}{1} \times \frac{1}{0.01/0.00001}$	$\frac{8388608}{1} \times \frac{5}{1} \times \frac{1}{0.628/0.001}$	$\frac{8388608}{1} \times \frac{2}{1} \times \frac{1}{360/0.01}$
5	Setting	H05-07=16777216 H05-09=1000	H05-07=41943040 H05-09=628	H05-07=83886080 H05-09=36000

7.2 INOPROSHOP SCALING CONFIGURATION

The axis scaling can also be modified from the EtherCAT Master. This section describes the scaling configuration using the InoProShop software.

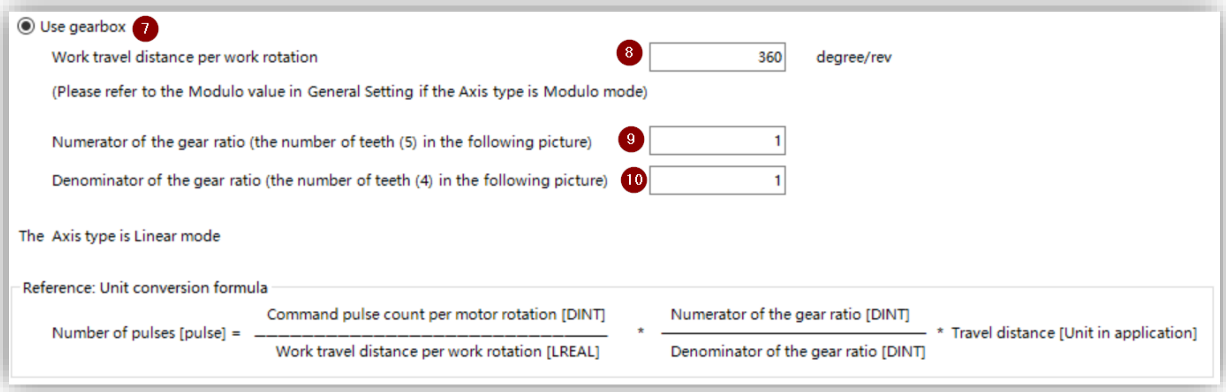
Follow this procedure to change the axis scaling:

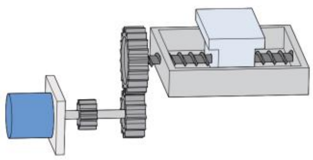
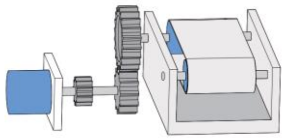
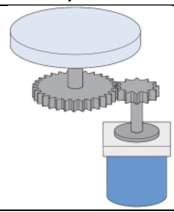
1. Open axis configuration
2. Select Scaling
3. Select “Do not use gearbox” if so is
4. Select the corresponding units. This does not affect to the axis behavior, it is only for information purpose.
5. Define the encoder pulse/revolution.
    a. 23 bit encoder: set 16#800000 or 8388608
    b. 20 bit encoder: set 16#100000 or 1048576
    c. Another kind of encoder set the corresponding value
6. Define travel distance for motor rotation



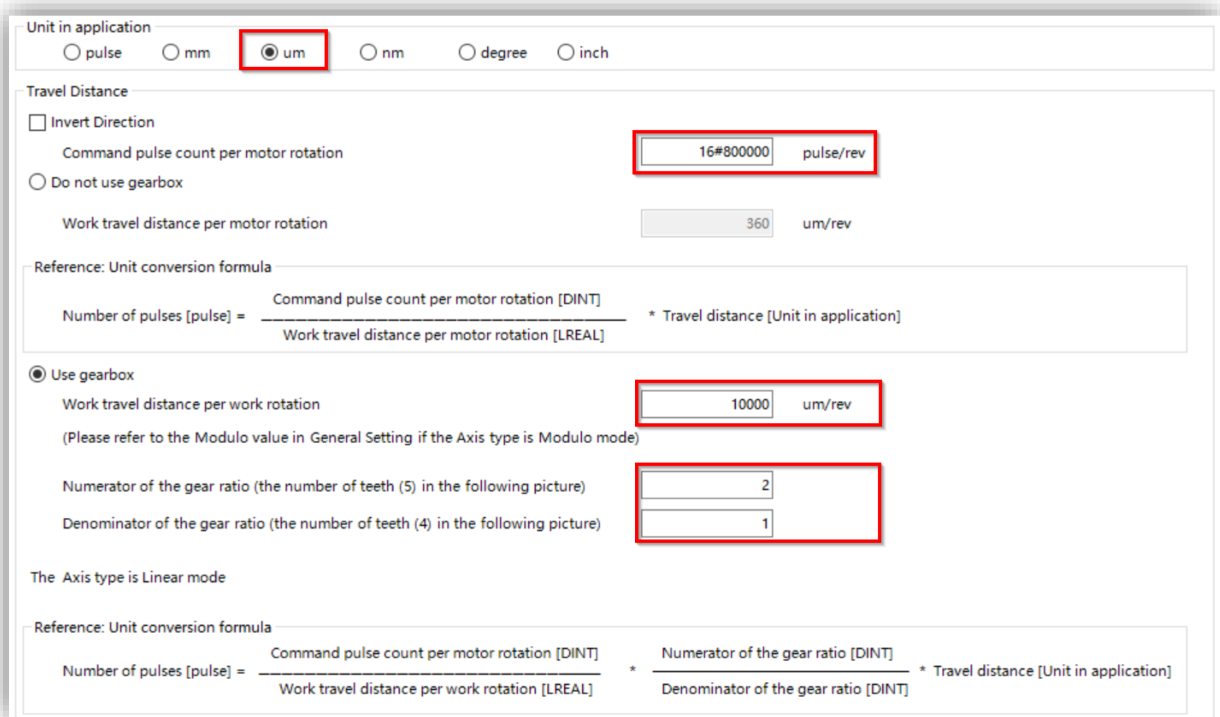
Follow the next procedure if there is a mechanical transmission ratio:

7. Enable gearbox option
8. Define travel distance for load rotation
9. Set numerator of the gear ratio
10. Set denominator of the gear ratio

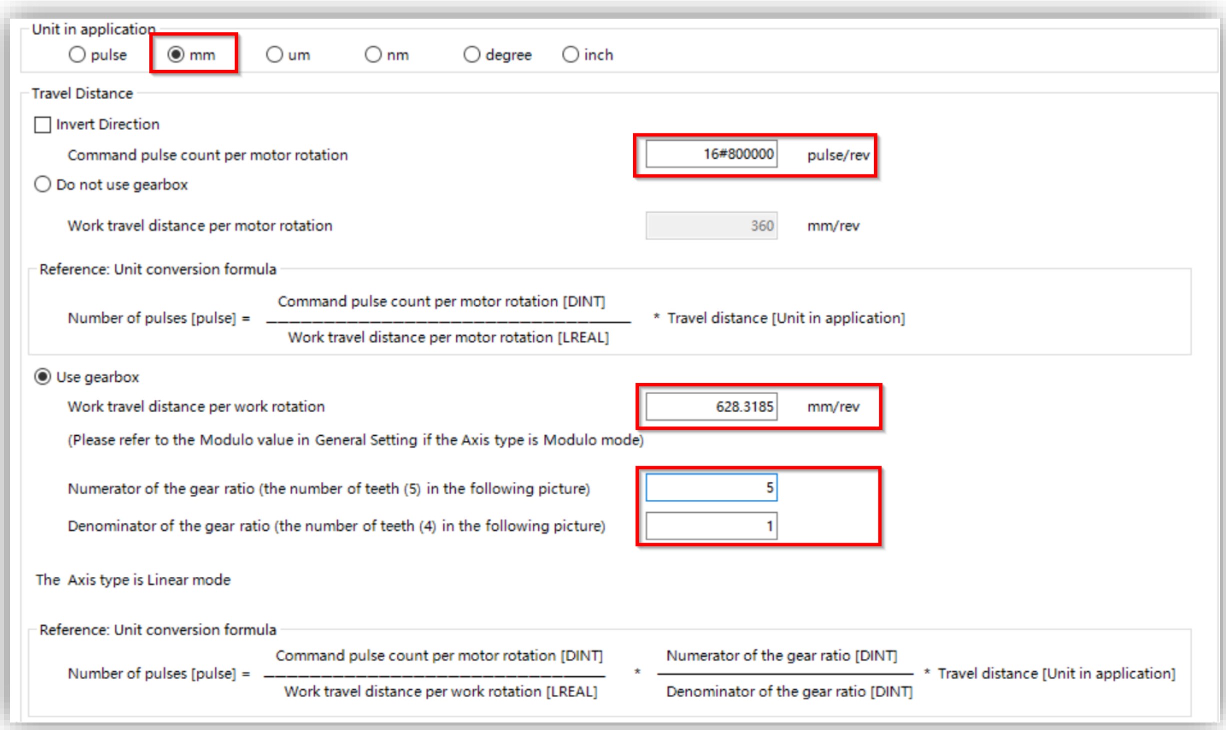


Item	Mechanism		
	Ball Screw	Belt Pulley	Rotary actuator
			
Mechanical parameters	Reduction ratio R: 2/1 Lead: 0.01 m	Reduction ratio R: 5/1 Diameter of belt pulley: 0.2 m (circumference: 0.6283185 m)	Reduction ratio R: 10/1 Load rotating angle for one load shaft revolution: 360°
Encoder resolution	23 bit 8388608 pulses/revolution	23 bit 8388608 pulses/revolution	23 bit 8388608 pulses/rev.
Application units	μm	millimetres	Degrees
Setting	•Encoder count/rev: 16#800000 •Enable Gear box •Load displacement: 0.01m=10000 μm •Gear numerator: 1 •Gear denominator: 2	•Encoder count/rev: 16#800000 •Enable Gear box •Load displacement: 628.3185 mm •Gear numerator: 1 •Gear denominator: 5	•Encoder count/rev: 16#800000 •Enable Gear box •Load displacement: 360º •Gear numerator: 1 •Gear denominator: 10

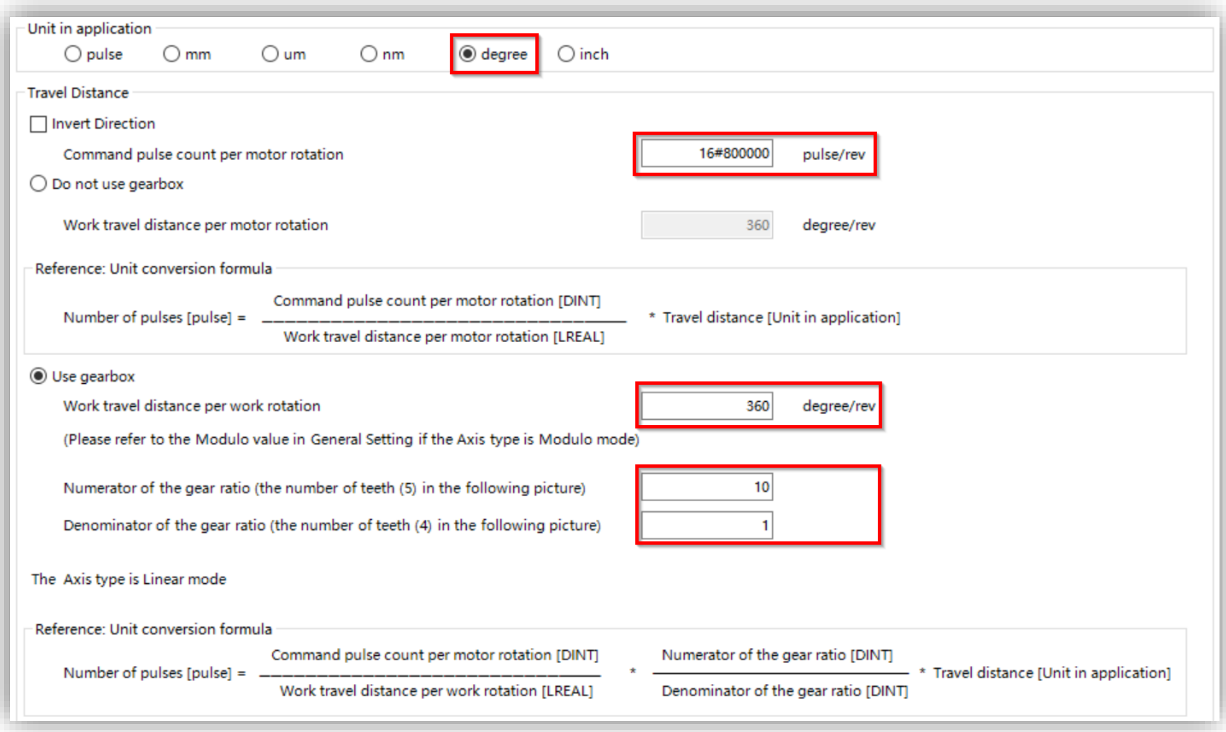
Ball screw:



Belt Pulley:



Rotary Actuator:



7.2.1 VELOCITY CALCULATION

The default speed of PLCOpen FBs is “application units / second”. The following formula is used to calculate the axis velocity from the motor revolutions per minute (RPM):

$$Axis\ velocity\ \left(\frac{application\ units}{s}\right) = \frac{(RPM)}{60\ s} \cdot Load\ displacement\ per\ rev. \cdot \frac{gear\ ratio\ numerator}{gear\ ratio\ denominator}$$

Ball screw:

Use this formula to fix the motor speed to 300 RPM

$$Axis\ velocity\ \left(\frac{application\ units}{s}\right) = \frac{300\ RPM}{60\ s} \cdot 10000\mathrm{\mu m} \cdot \frac{1}{2} = 1500000\,\frac{\mathrm{\mu m}}{\mathrm{s}}$$

Belt Pulley:

Use this formula to fix the motor speed to 200 RPM

$$Axis\ velocity\ \left(\frac{application\ units}{s}\right) = \frac{200\ RPM}{60\ s} \cdot 360^{o} \cdot \frac{1}{10} = 120\,\frac{\mathrm{degree}}{\mathrm{s}}$$

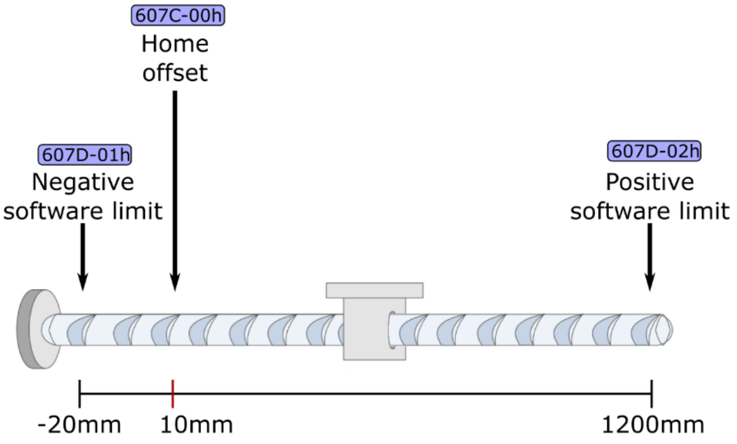
Rotary Actuator:

Use this formula to fix the motor speed to 200 RPM

$$Axis\ velocity\ \left(\frac{application\ units}{s}\right) = \frac{200\ RPM}{60\ s} \cdot 360^{o} \cdot \frac{1}{10} = 120\,\frac{\mathrm{degree}}{\mathrm{s}}$$

8 ABSOLUTE ENCODER SYSTEM

8.1 LINEAR MODE



To configure the absolute position with its limits of a linear axis it may be necessary to access the following objects of the CiA402. To access these objects, follow the steps in the section 9.4 CiA402 Object Dictionary

CiA402 Object	Description	Unit	Range	Default
607C-00h	Home offset	Application units	-2^{31} to $+(2^{31}-1)$	0
6098-00h	Homing method	-	1-35	26
60E6-00h	Actual position calculation method	-	0-Absolute position homing After homing is done, the following formula applies: 6064h (Position actual value) = 607Ch (Home offset) 1-Relative position homing After homing is done, the following formula applies: 6064h (Position actual value) = Present position feedback value + 607Ch (Home offset)	0
607D-01h	Negative software limit	Application units	-2^{31} to $+(2^{31}-1)$	-2^{31}
607D-02h	Positive software limit	Application units	-2^{31} to $+(2^{31}-1)$	$2^{31}-1$

Drive parameters:

Drive Parameter	Description	Unit	Range	Default
H02-01	Absolute system selection	-	0-Incremental position mode 1-Absolute position linear mode 2-Absolute position rotation mode 3-Absolute position linear mode 2 4-Single-turn absolute mode	0
H05-46 (2005-2Fh)	Position offset in absolute position linear mode (low 32 bits)	encoder counts	-2^{31} to $+(2^{31}-1)$	0
H05-48 (2005-31h)	Position offset in absolute position linear mode (high 32 bits)	encoder counts	-2^{31} to $+(2^{31}-1)$	0
H05-30 (2005-1Fh)	Local homing	-	0-No operation 6-Current position as home	0

H05-36 (2005-25h)	Local home offset	-	-2^{31} to $+(2^{31}-1)$	0

These two parameters (H05-46, H05-48) define the offset of the mechanical absolute position (H0B-58, H0B-60 encoder unit) relative to the motor absolute position (H0B-77, H0B-79 encoder unit) when the absolute encoder system works in the linear mode (H02-01 = 1).

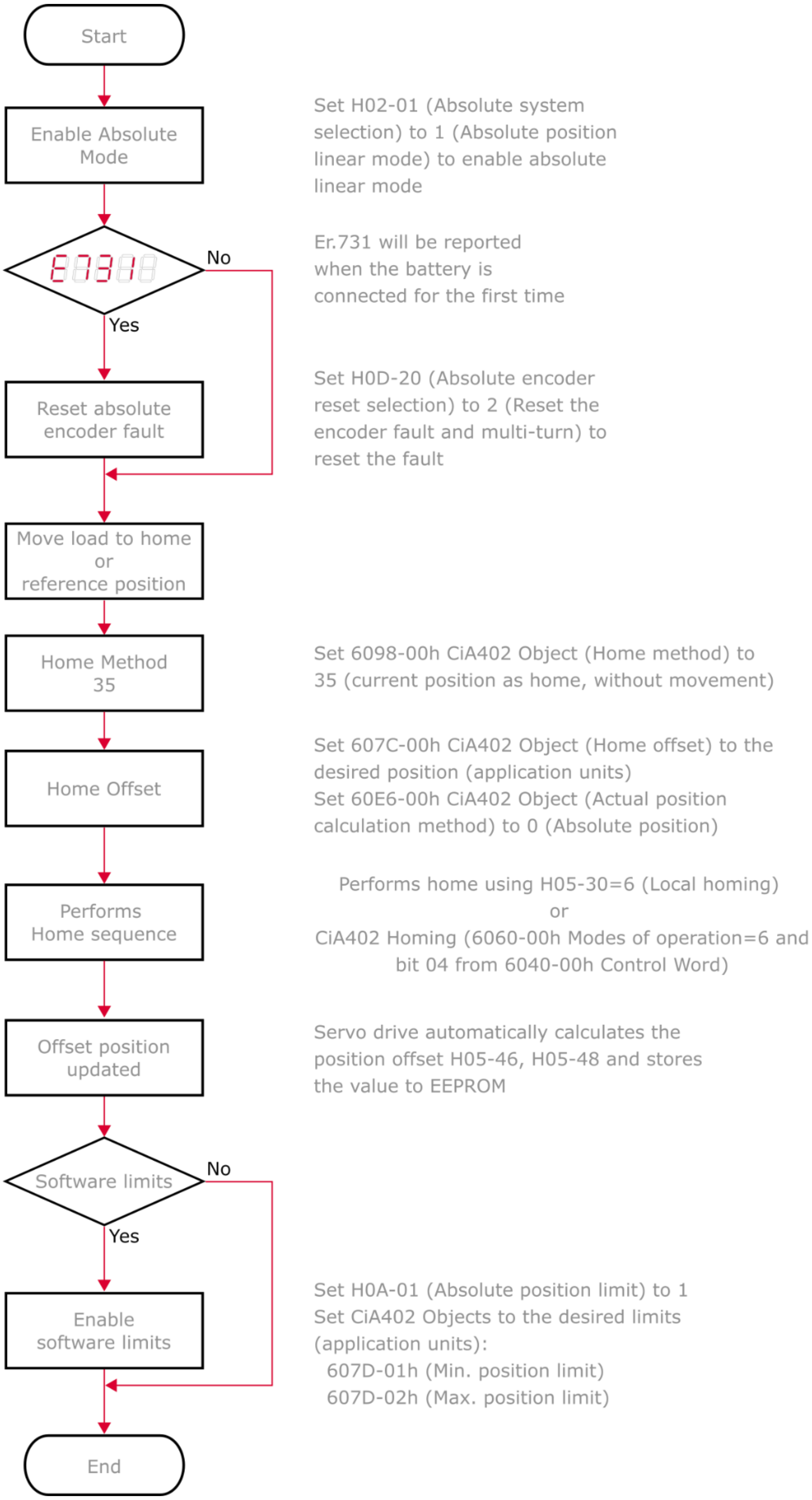
Position offset in the absolute position linear mode = Motor absolute position - Mechanical absolute position

(H05-46, H05-48) = (H0B-77, H0B-79) - (H0B-58, H0B-60)

NOTE Default values of these two parameters are 0 in the absolute position linear mode. After homing is done, the servo drive automatically calculates the deviation between the absolute position feedback by the encoder and the mechanical absolute position, assigns the deviation value to H05-46 and H05-48, and saves the deviation in EEPROM.

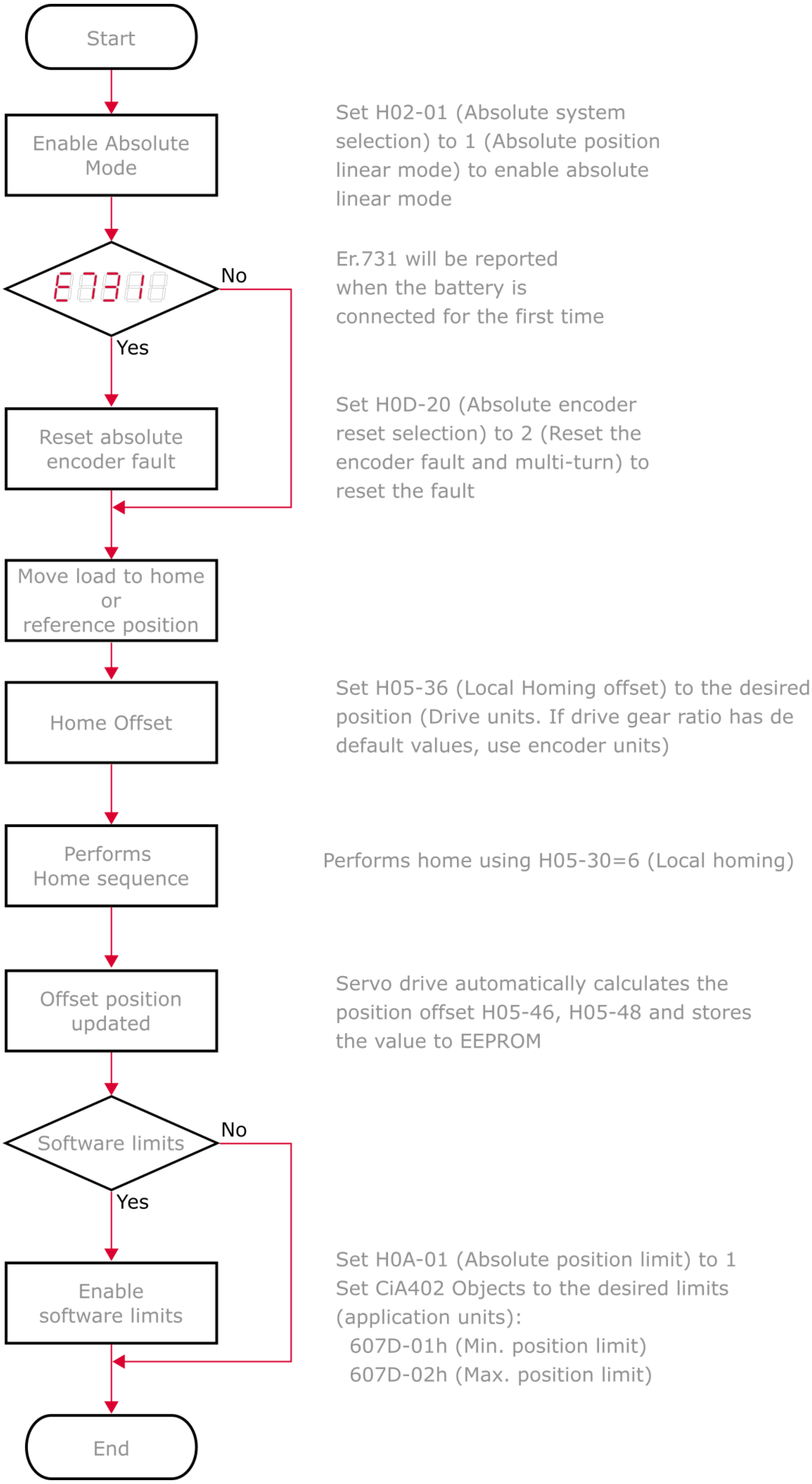
8.1.1 MASTER CONTROLLER HOME

The following figure shows the general procedure for absolute linear mode configuration using the PLCOpen FB MC_Home:



8.1.2 LOCAL HOME

The following figure shows the general procedure for absolute linear mode configuration using the drive local home:



8.2 DATA RANGE IN THE ABSOLUTE POSITION LINEAR MODE

The absolute encoder records the single-turn position (H0B-71) and the number of revolutions (H0B-70). With a single-turn resolution up to 8388608 (2^{23}) pulses, the encoder can record 16-bit multi-turn data.

The multi-turn data range in the absolute position linear mode is **–32768 to +32767**. If the number of forward revolutions is larger than 32767 or the number of reverse revolutions is smaller than –32768, E735.0 (Encoder multi-turn counting overflow) will occur. In this case, set H0D-20 (200D-15h - Absolute encoder reset selection) to 2 (Reset the encoder fault and multi-turn data) to reset the multi-turn data and perform homing again.

In special occasions, you can set H0A-36 (200A-25h - Multi-turn overflow fault of absolute encoder) to 1 (Hide) to hide E735.0 or use absolute position linear mode 2.

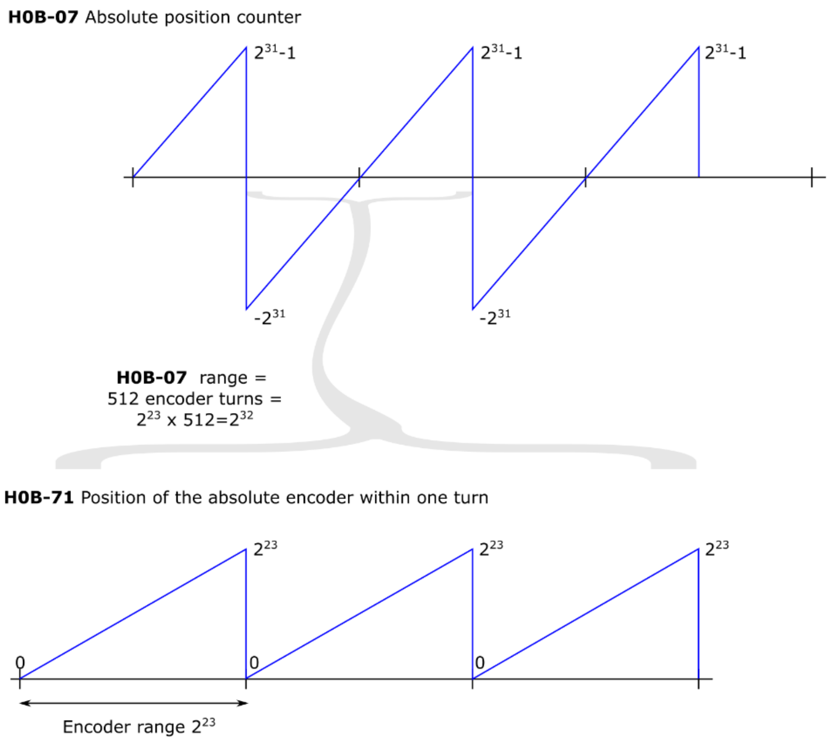
Parameter H0B-07 shows the absolute position of the axis. With the default values of the drive, this parameter has a range between 2 ^ 31 to 2 ^ 31. With this configuration the **axis range is 512 turns**. It can make 256 turns in the positive direction and 256 turns in the negative direction before exceeding the limit of the parameter.

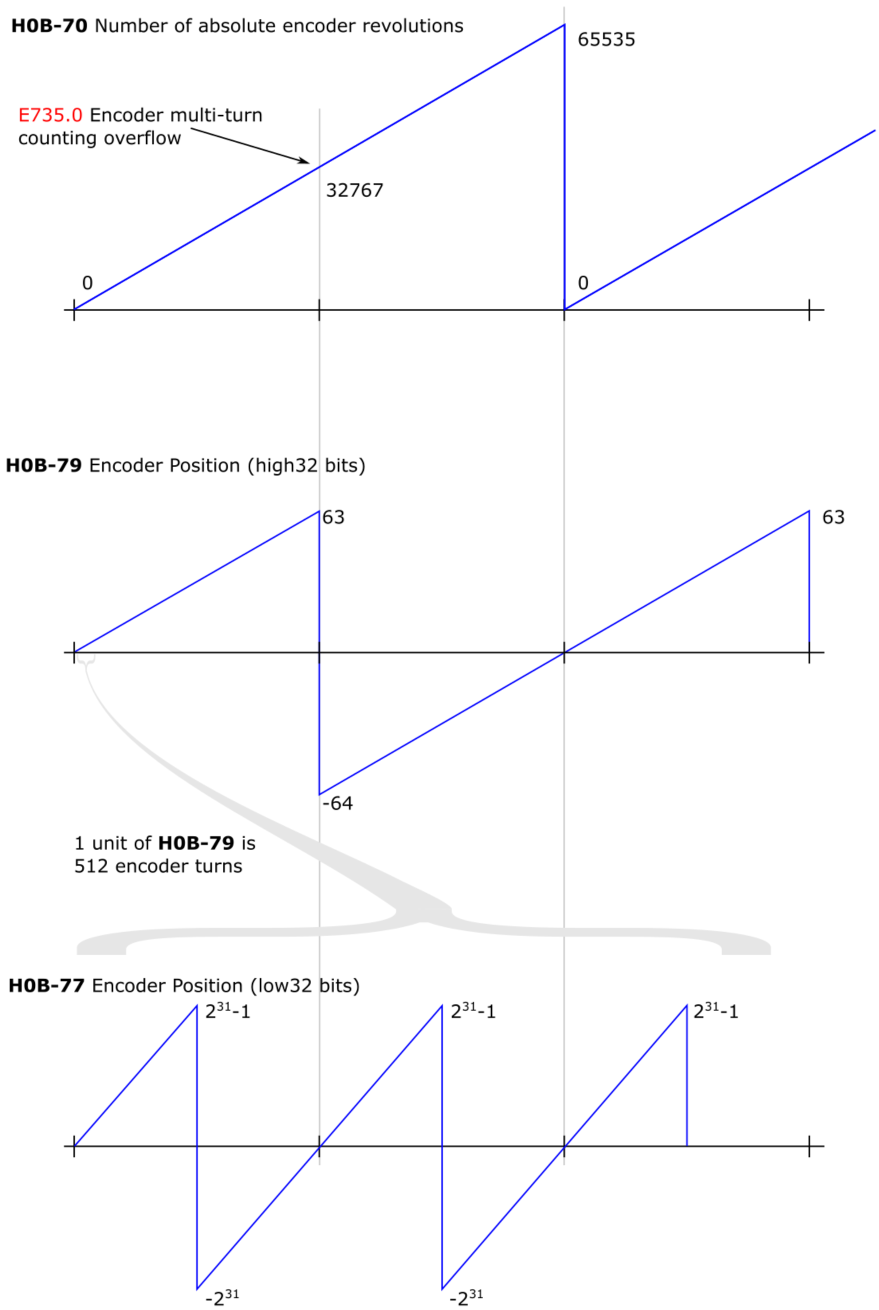
To increase the number of absolute encoder turns stored in parameter H0B-07, it is necessary to modify the scaling of the axis (H05-07 and H05-09). The absolute multi-turn information is stored in the parameters H0B-77 and H0B-79. The parameter H0B-07 is calculated from parameters H0B-77 and H0B-79. The multi-turn information for these parameters is in the range of –32768 to +32767. Therefore, by modifying the scaling of the axis, we can increase the multi-turn information stored in parameter H0B-07.

$$HB\_07 = \frac{H05\_09}{H05\_07} \times H0B\_79 \times 2^{32} + H0B\_77 - (H0B\_40 \times 2^{32} + H0B\_48)$$

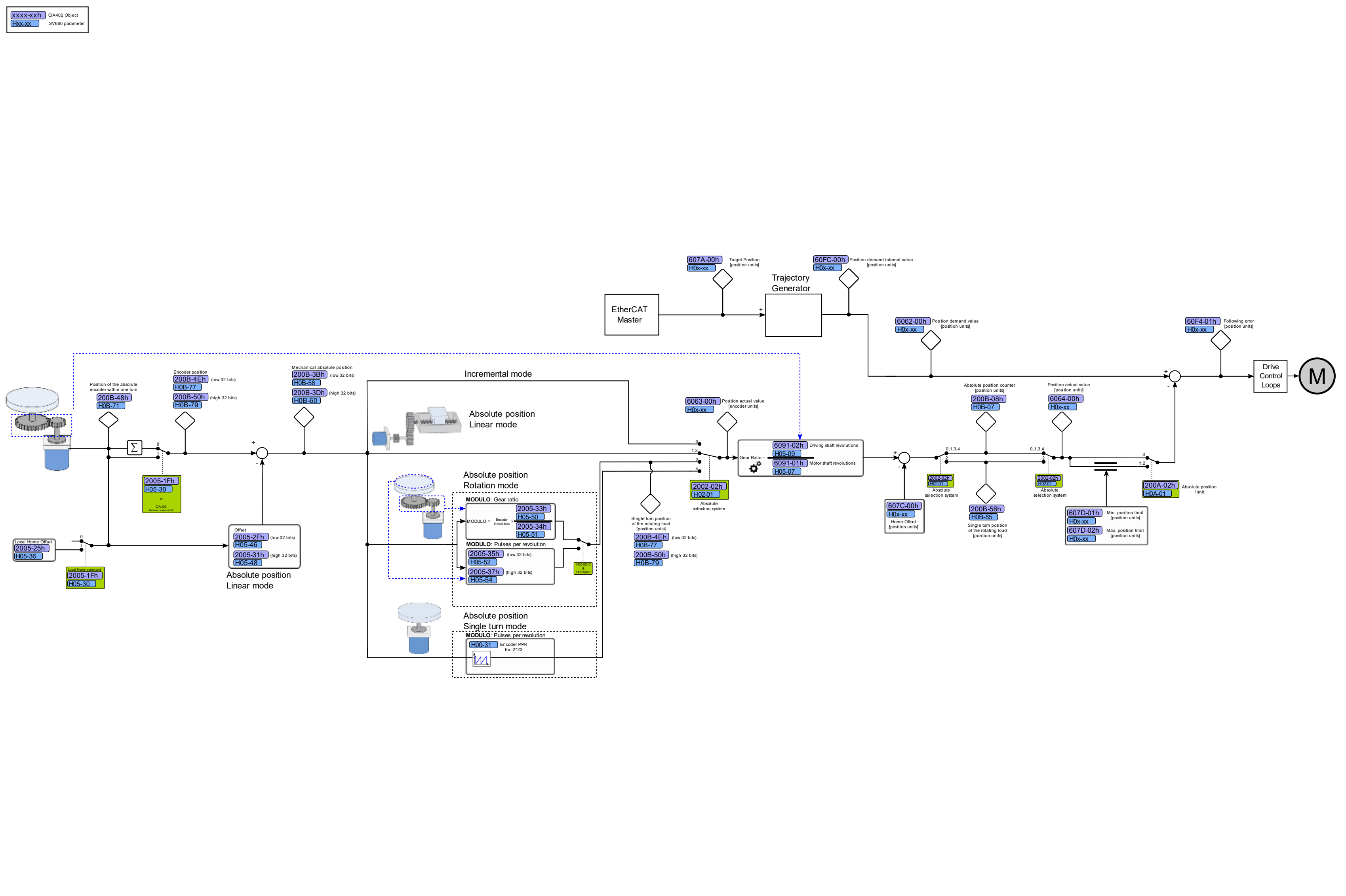
Absolute position **Gear Ratio** **Encoder Multi-turn position** **Home Offset**

The below image shows the absolute position parameters range.




H0B-70 Number of absolute encoder revolutions
65535
E735.0 Encoder multi-turn
counting overflow
32767
0
0
H0B-79 Encoder Position (high32 bits)
63
63
-64
1 unit of H0B-79 is
512 encoder turns
H0B-77 Encoder Position (low32 bits)
2^31-1
2^31-1
2^31-1
-2^31
-2^31

8.3 ABSOLUTE ENCODER SYSTEM PARAMETERS DIAGRAM



Author	Raúl Sampé	06. Feb. 21	SV660N	*Absolute position*		INOVANCE	v1.1
Revised		05. May. 21	Parameters & CiA402 Objects	*Parameters*			1/1

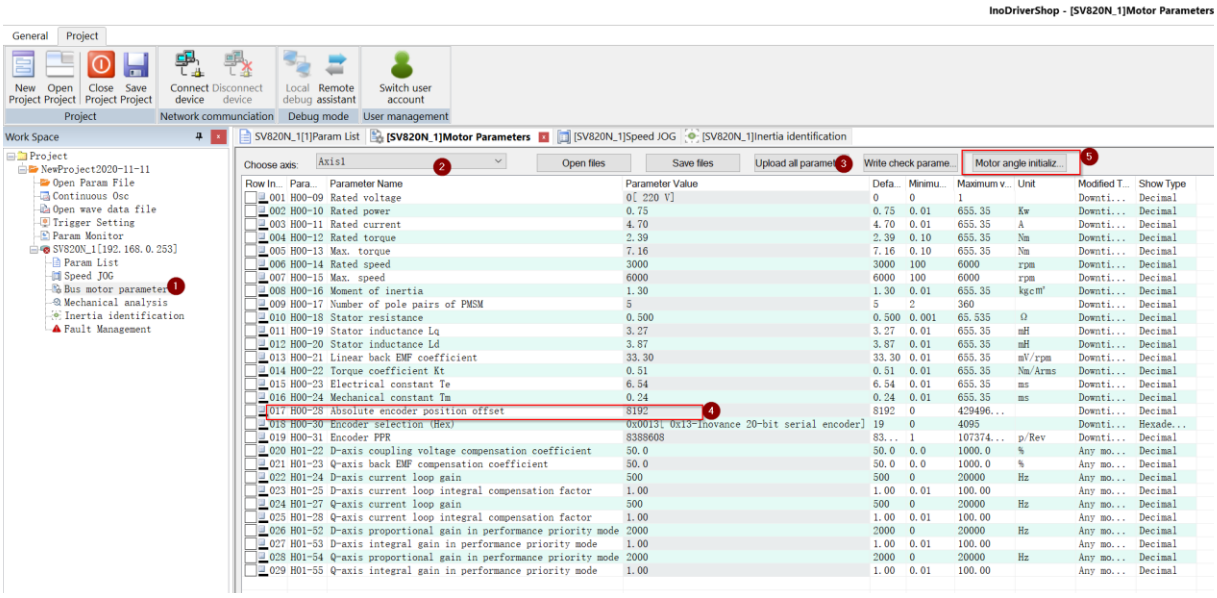
9 APPENDIX

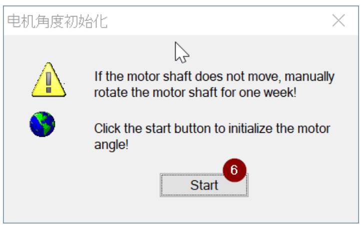
9.1 PHASE ANGLE TUNING

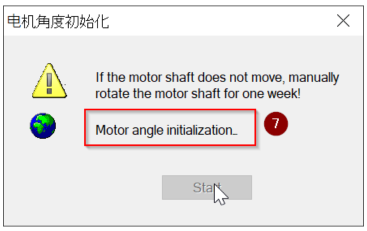
INOVANCE motors are already phased out of the box. The phase value is stored in the encoder parameter H00-28. If for some reason the value of the phase angle is not correct, a phase angle tune can be carried out with the following procedure:

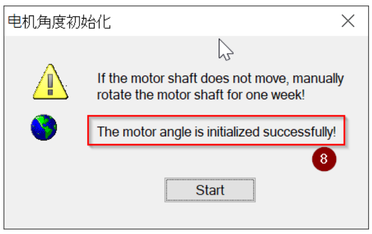
1. Open "Bus motor parameters“ screen
2. Select the corresponding axis
3. Upload all parameters from encoder
4. See the value of H00-28, it should be close to 0 (below 15000, the range is 0 2^32)
5. Open the angle initialization dialog
   WARNING When the angle initialization starts the motor will move around 60 degrees. It can be connected to the load, but better if it is free
6. Click the “Start” button, the motor move around 60 degrees and stops
7. Doing angle tune
8. Angle tune finish
9. Close the dialog.
10. Probably the parameter H00-28 has changed. Check if the value it is close to 0. If the procedure is repeated a few times the value should be similar
11. Restart the drive. Changes in the parameter H00-28 have no effect until the computer is restarted

NOTE During the angle initialization process could appears the error E941.0 “Parameter modifications activated at next power on. That is because the parameter H00-28 value has changed.









9.2 DRIVE LOOPS CYCLE TIME

By default the drive loops cycles are:

- Position command: refresh frequency of position command, related to the par H01-61 command scheduling frequency, 1 kHz/2 kHz /4 kHz /8 kHz, sample cycle up to 125µs, default 4 kHz, 250 µs.
- Position loop cycle: related to the par H01-60 FPGA scheduling frequency, 8KHz/16Khz, sample cycle up to 62.5µs, default 16 kHz, 62.5 µs.
- Velocity loop cycle: related to the par H01-60 FPGA scheduling frequency, 8 kHz /16 kHz, sample cycle up to 62.5µs, default 16 kHz, 62.5 µs.
- Current loop cycle: 1.6 µs, 625 kHz, cannot be modified.

To change the cycle of the position or speed loop, it is necessary to activate the super user mode with the password: "SuperAdmin" or H02-41 = 1430 (factory password)

Upload and save (Current page all) | Upload and save (All tick options) | Open recipe | Save settings (All tick options) | Write all (Except groups H00 and H01) | Write all tick options (current page) | VS Compare | Axis copied | Select all (curre... | Find | Super adminis | 1

Ax...	Function co...	Description	Setting value	current value	Defa...	Minimu...	Maximu...	Unit	Modifi...	Effecti...
A..	H01-00	MCU software version	---	902. 3	0. 0	0. 0	6553. 5		No ...	
A..	H01-01	FPGA software version	---	902. 9	0. 0	0. 0	6553. 5		No ...	
A..	H01-07	Software test version	---	0. 00	0. 00	0. 00	655. 35		No ...	
A..	H01-08	Model parameter version	---	2. 00	0. 00	0. 00	655. 35		No ...	
A..	H01-10	Servo drive series No.	3[S2R8]	3[S2R8]	3	0	65535		Dow...	Pow...
A..	H01-11	Voltage class of the drive unit	---	220	220	0	65535	V	No ...	
A..	H01-12	Rated power of the servo drive	---	0. 40	0. 40	0. 00	1073...	kw	No ...	
A..	H01-14	Max. output power of the servo drive	---	0. 40	0. 40	0. 00	1073...	kw	No ...	
A..	H01-16	Rated output current of the servo drive	---	2. 80	2. 80	0. 00	1073...	A	No ...	
A..	H01-18	Max. output current of the servo drive	---	10. 10	10. 10	0. 00	1073...	A	No ...	
A..	H01-20	Carrier frequency	---	8000	8000	4000	20000	HZ	Dow...	Pow...
A..	H01-21	Dead zone time	---	2. 00	2. 00	0. 01	20. 00	us	Dow...	Pow...
A..	H01-22	D-axis coupling voltage compensation coefficient	---	100. 0	50. 0	0. 0	1000. 0	%	Any...	Imm...
A..	H01-23	Q-axis back EMF compensation coefficient	---	100. 0	50. 0	0. 0	1000. 0	%	Any...	Imm...
A..	H01-24	D-axis current loop gain	---	700	500	0	20000	HZ	Any...	Imm...
A..	H01-25	D-axis current loop integral compensation factor	---	2. 00	1. 00	0. 01	100. 00		Any...	Imm...
A..	H01-26	Current sampling Sinc3 filter data extraction rate	---	0[Extraction rate 32]	0	0	3		Dow...	Pow...
A..	H01-27	Q-axis current loop gain	---	400	500	0	20000	HZ	Any...	Imm...
A..	H01-28	Q-axis current loop integral compensation factor	---	2. 00	1. 00	0. 01	100. 00		Any...	Imm...
A..	H01-29	Q-axis coupling voltage compensation coefficient	---	6553. 5	50. 0	0. 0	1000. 0	%	Any...	Imm...
A..	H01-30	Bus voltage gain adjustment	---	101. 7	100. 0	50. 0	150. 0	%	Dow...	Pow...
A..	H01-32	Relative gain of UV sampling	---	32768	32768	1	65535		Dow...	Pow...
A..	H01-34	Servo drive over-temperature threshold	---	90	90	0	150	℃	Any...	Pow...
A..	H01-36	Current sensor range	---	20. 83	62. 50	0. 00	9999. 99	A	Dow...	Pow...
A..	H01-38	FPGA phase current protection threshold	---	90. 0	90. 0	0. 0	100. 0	%	Dow...	Pow...
A..	H01-39	Current loop version No.	---	0x0000	0x0	0x0	0xFFFF		Dow...	Pow...
A..	H01-40	DC bus overvoltage protection threshold	---	420	420	0	2000	V	No ...	
A..	H01-41	DC bus voltage discharge threshold	---	380	380	0	2000	V	Dow...	Imm...
A..	H01-42	DC bus undervoltage threshold	---	200	200	0	2000	V	Any...	Imm...
A..	H01-52	D-axis proportional gain in performance priority mode	---	900	2000	0	20000	HZ	Any...	Imm...
A..	H01-53	D-axis integral gain in performance priority mode	---	2. 00	1. 00	0. 01	100. 00		Any...	Imm...
A..	H01-54	Q-axis proportional gain in performance priority mode	---	900	2000	0	20000	HZ	Any...	Imm...
A..	H01-55	Q-axis integral gain in performance priority mode	---	2. 00	1. 00	0. 01	100. 00		Any...	Imm...
A..	H01-56	Current loop low-pass cutoff frequency	---	11000	11000	0	65535	HZ	Dow...	Pow...
A..	H01-59	Serial encoder data transmission compensation time	---	0. 000	0. 000	0. 000	2. 000	us	Dow...	Pow...
A..	H01-60	FPGA scheduling frequency selection	---	1[16 kHz] 2	1	1	2		Dow...	Pow...
A..	H01-61	Command scheduling frequency selection	---	0[4 kHz]	3	0	3		Dow...	Pow...
A..	H01-62	Auto-tuning of servo drive model	---	3	0	0	65535		No ...	
A..	H01-66	Current loop configuration	---	12	12	0	31	KHZ	Any...	Imm...
A..	H01-67	Dead zone compensation coefficient	---	1. 00	1. 00	0. 00	2. 00		Any...	Imm...
A..	H01-68	Current observer cutoff frequency	---	2000	2000	200	5000		Any...	Imm...
A..	H01-69	Current observer correction coefficient	---	1. 00	1. 00	0. 00	9. 00		Any...	Imm...
A..	H01-72	Servo drive model auto-tuning selection	---	0[Not hide]	0	0	1		Any...	Pow...
A..	H01-73	电流采样延迟时间	---	1	1	0	7		Any...	Pow...

9.3 POSITION REFERENCE FILTER

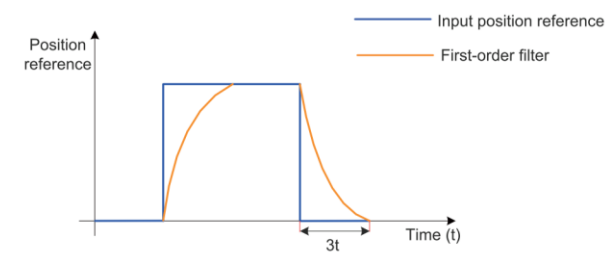
This function filters the position references divided or multiplied by the electronic gear ratio. It involves the first-order filter and moving average filter.

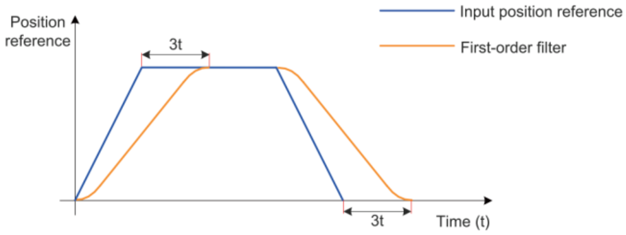
The next two parameters explain the reference position filter:

H05-04 First-order low-past filter time constant

It sets the time constant of first-order low-pass filter for position reference (encoder unit).

If position reference P is rectangular wave or trapezoidal wave, the position reference after first-order low-pass filter is as follows:





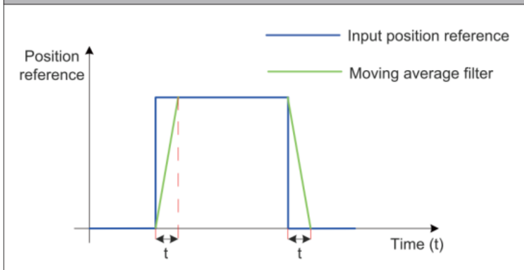
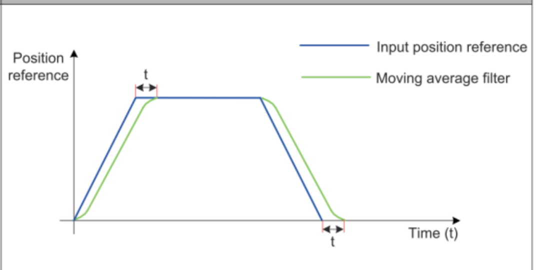
This function has no effect on displacement (position reference sum).

Too large setting of this parameter will cause an increase in response delay. Set this parameter correctly according to actual condition.

H05-05 Moving average filter time constant 1

It sets the time constant of moving average filter for position references (encoder unit). If position reference

P is rectangular wave or trapezoidal wave, the position reference after filter of average value is as follows:

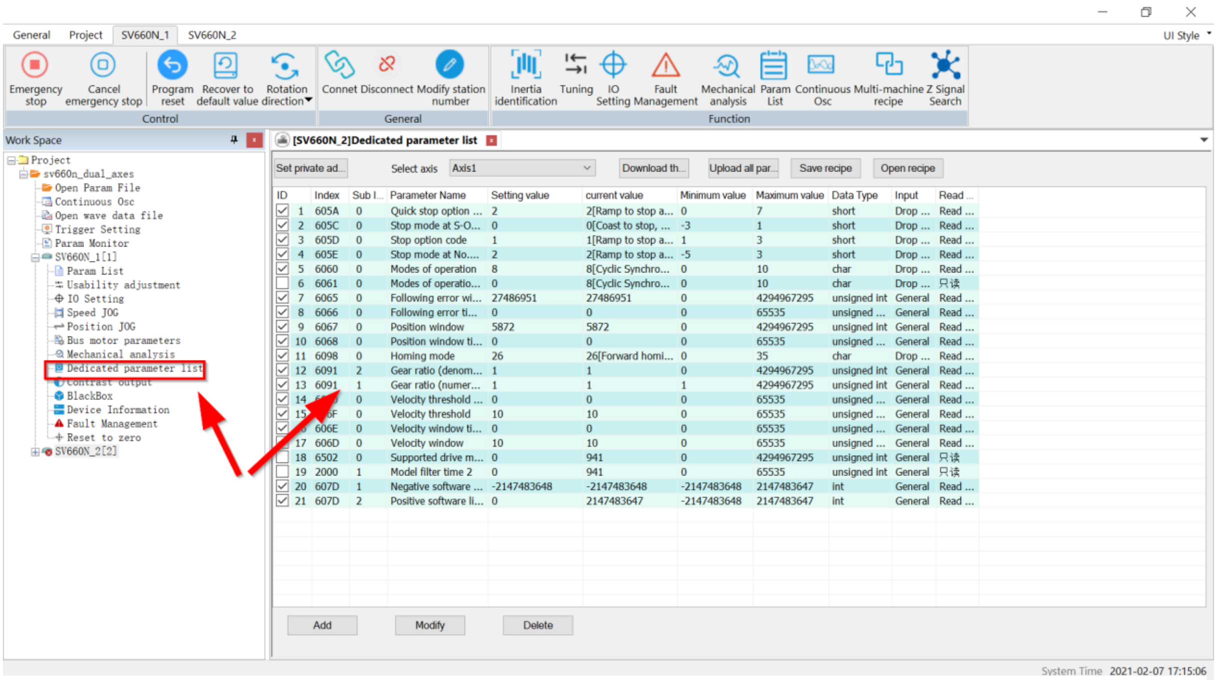
Position Reference Is Rectangular Wave	Position Reference Is Trapezoidal Wave
	

This function has no effect on displacement (position reference sum). Too large setting of this parameter will

cause an increase in response delay. Set this parameter correctly according to actual conditions.

9.4 CIA402 OBJECT DICTIONARY

Using the InoProShop software it is possible to access the CiA402 object dictionary list. Access to these objects is through the "Dedicated parameter list" option. This option shows us a list with some of the objects already configured:



Through the "Add" and "Modify" buttons we can modify this list to access the different objects of the CiA402 object dictionary. The next image shows dialog box with values to add the CiA402 object 607D-01h “Negative software limit”: