

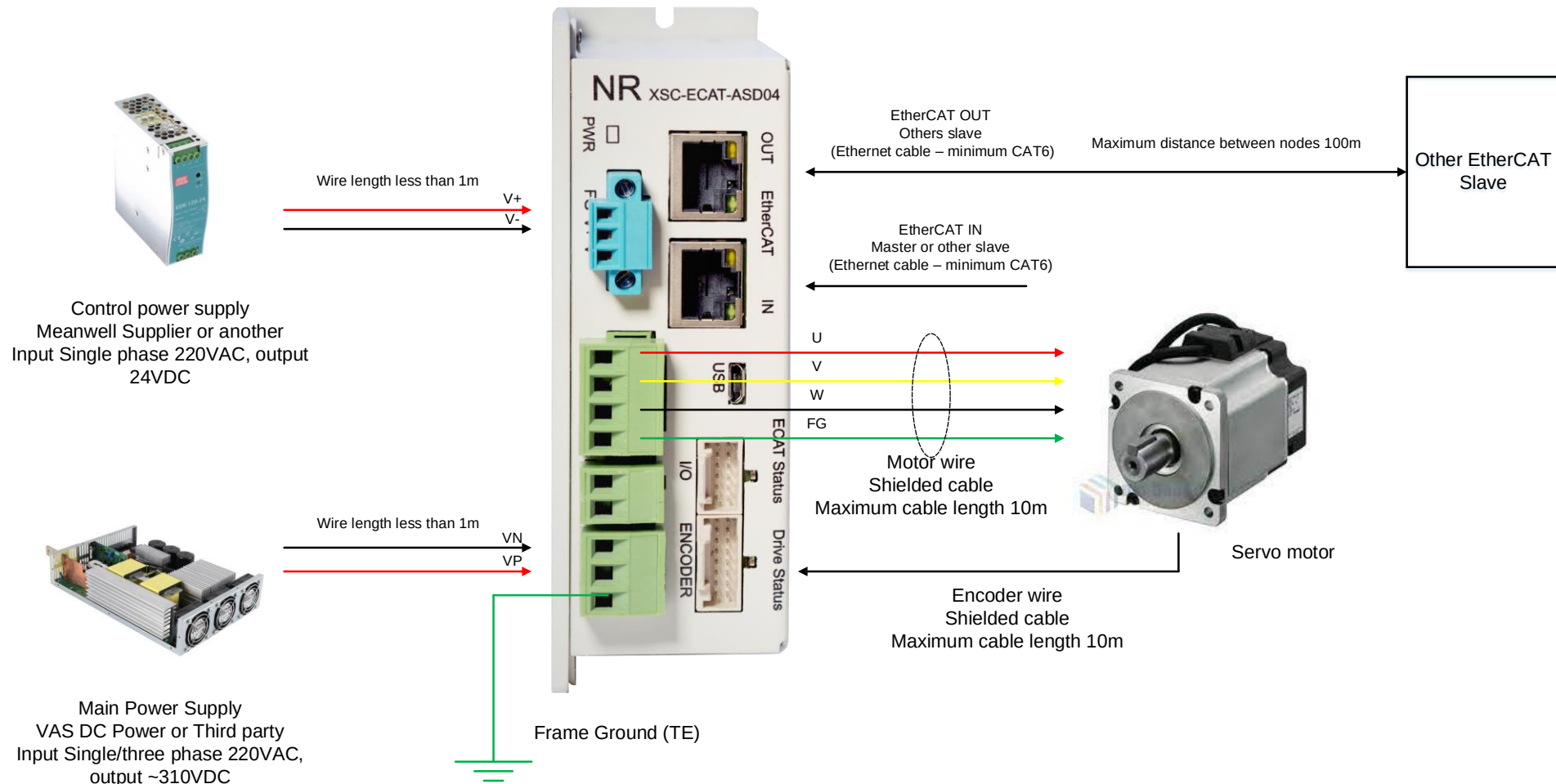
VAS CORPORATION

- EtherCAT AC Servo Driver Tuning

Contents

- Getting Started
- nEXT1 Configurator Basic
 - Monitors & Alarms
 - Digital Input/Output
 - Parameters
 - Trials Run
 - Data Trace
- Tuning
 - Motor Configuration
 - Tuning Speed, Position Loop
 - Tuning for low position error
 - Gain Switching
- Update Firmware

nEXT1 Servo Drive Configurator connection



Monitors

Monitor status of servo driver

NR Servo Drive Configurator

File Basic Functions Trial Run Trace Tuning Download Tools Help

Motor Power ON

Speed Reference

Motor Running

Motor base blocked (BB)

Motion Monitor

Show	Name	Value	Unit
☐	DC input voltage	-	Volt
☐	Temperature	-	Degree celsius
☐	Speed Reference	-	RPM
☐	Motor Speed	-	RPM
☐	Position Command	-	Reference units
☐	Actual Position	-	Reference units
☐	Position Error	-	Reference units
☐	Speed Error	-	RPM
☐	Torque reference	-	%
☐	Motor Power	-	Watt
☐	Total Operating Time	-	h:m:s.ms

Status Monitor

Show	Name	Value	Unit
☐	EtherCAT State Machine	-	
☐	Main Circuit	-	
☐	Motor Power ON	-	
☐	Dynamic Brake (DB)	-	
☐	Rotation Direction	-	
☐	InPosition	-	
☐	Alarm Code	-	-

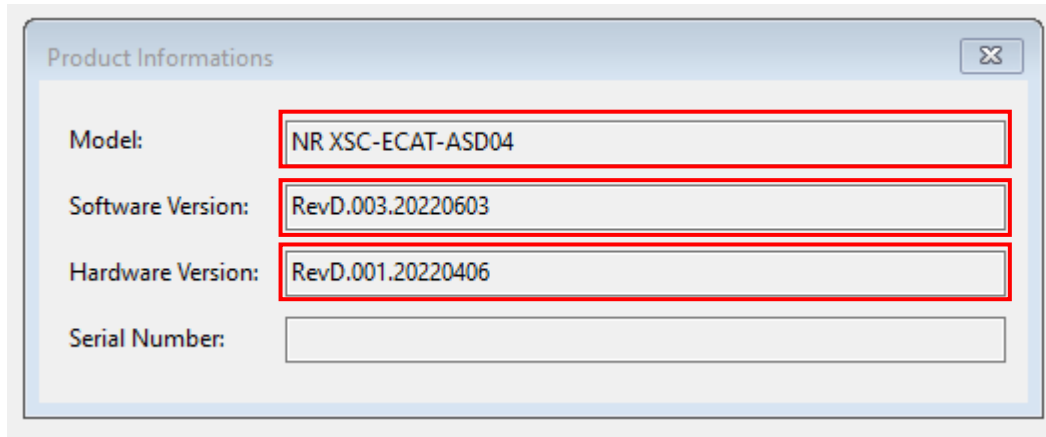
Status monitor

Motion monitor

Status monitor

Monitors

Monitor product informations: Click Basic functions → Product information



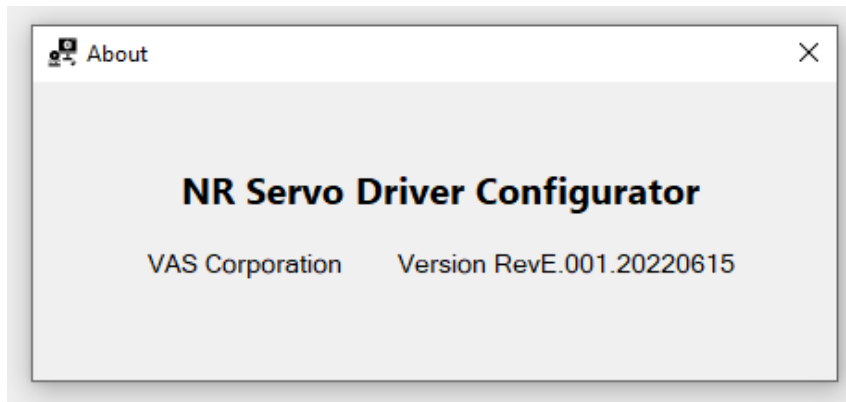
A screenshot of a 'Product Informations' dialog box. It contains four input fields: 'Model:' with the value 'NR XSC-ECAT-ASD04', 'Software Version:' with 'RevD.003.20220603', 'Hardware Version:' with 'RevD.001.20220406', and 'Serial Number:' which is empty. Each of the first three fields is highlighted with a red rectangular border.

The model of servo driver

Software version

Hardware version

Monitor software version: Click Help → About software



Alarm Display

When an alarm occurred, the Driver Status Led is Red
Open Alarm Display: Trace → Alarms

- (1) Alarm name and alarm code
- (2) The possible reason case the alarm
- (3) The investigate action to check the alarm
- (4) The Corrective action to fix the alarm
- (5) The monitor parameters when alarm occurs
- (6) Click to reset the Alarm

(1)

(2)

(3)

(4)

(5)

The screenshot shows the 'Alarm Display' window with the following components:

- Alarm Section:** Contains a table with columns 'Code' and 'Alarm'. The first row shows '0xFF08' and 'MAIN_UNDER_VOLTAGE'. A 'Reset Alarm' button is located to the right of this section.
- Alarm Diagnosis Section:** Includes a 'Cause' list (e.g., 'The power supply voltage went below the specified range'), 'Investigated actions' (e.g., 'Measure the power supply voltage'), and 'Corrective actions' (e.g., 'Set the power supply voltage within the specified range').
- Monitor at occurrence of alarm Section:** A table showing various parameters and their values at the time of the alarm.

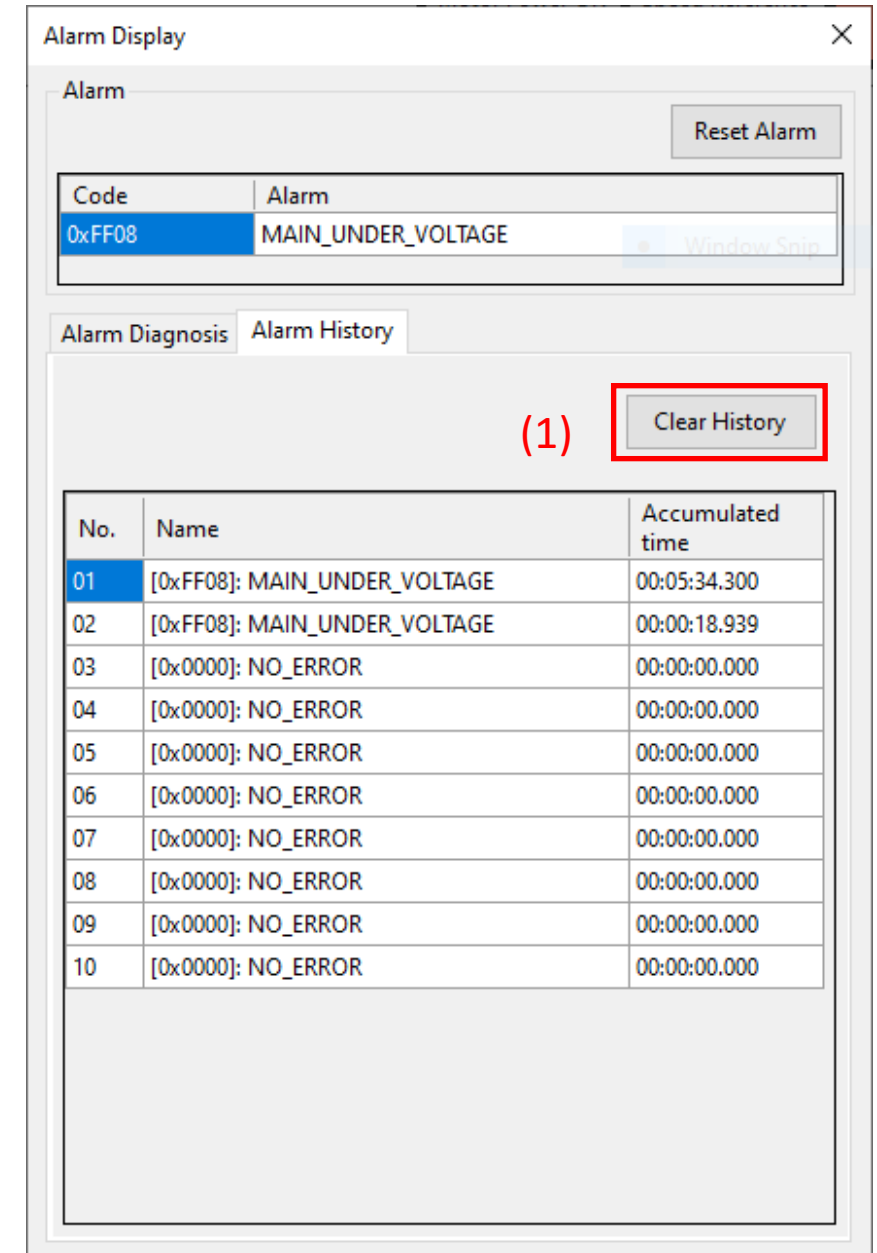
Name	Value	Unit
Accumulation time	04:07:11.617	h:m:s.ms
Torque reference	0	0.1%
Feedback speed	0	RPM
Position reference speed	0	RPM
Position deviation	0	Pulses
Motor position	0	Pulses

Alarm Display

Alarm History tab: Show the history of alarm and

Accumulated time when alarm occurs

(1) Click to clear the history alarm list



Monitors

Monitor status of Digital I/O signal:

- Basic functions → IO Signal Allocation
- Monitor digital input/output pin assignment
- Monitor Input level
- Force digital output

The screenshot shows a software window titled "IO Signal" with two tabs: "Digital I/O" and "Pin Assign". The "Digital I/O" tab is active and contains two sections: "Input" and "Output".

Input Section:

Input	Assignment	Status
Digital Input 1	[0] Inhibit	Low
Digital Input 2	[0] Inhibit	Low
Digital Input 3	[0] Inhibit	Low
Digital Input 4	[0] Inhibit	Low
Digital Input 5	[0] Inhibit	Low
Digital Input 6	[0] Inhibit	Low

Output Section:

Output	Assignment	Force Output
Digital Output 1	[7] Holding Brake Output Signal (HB)	Enabled
Digital Output 2	[0] Inhibit	Disabled
Digital Output 3	[0] Inhibit	Disabled
Digital Output 4	[0] Inhibit	Disabled

Digital Input/Output

Pin Assignment

Digital Input	Digital Output
• Inhibit • Forward Drive Prohibit (POT) • Reverse Drive prohibit (NOT) • Home Signal (HOME) • Touch Probe signal (TP1, TP2) • General Input (DI1, DI2)	• Inhibit • Servo Alarm (ALM) • Position Complete (COIN) • Rotation Detection Output (TGON) • Servo Ready (SRDY) • Torque Limit Detection (CLT) • Speed Limit Detection (VLT) • Holding brake output (HB) • General Outputs (DO1, DO2, DO3)

- Select Digital Input/Output assignment
- Select Digital Input level
- Click apply
- Click Save to save the assignment to Flash memory

The screenshot shows the 'IO Signal' window with the 'Pin Assign' tab selected. It contains two sections: 'Input' and 'Output'.

Input Section:

Digital Input	Signal	Level	Action
Digital Input 1	[7] General Input 2 (DI2)	High	Apply
Digital Input 2	[2] Reverse Drive Prohibit Input Signal (NOT)	High	Apply
Digital Input 3	[3] Home Signal (HOME)	High	Apply
Digital Input 4	[0] Inhibit	High	Apply
Digital Input 5	[0] Inhibit	High	Apply
Digital Input 6	[0] Inhibit	High	Apply

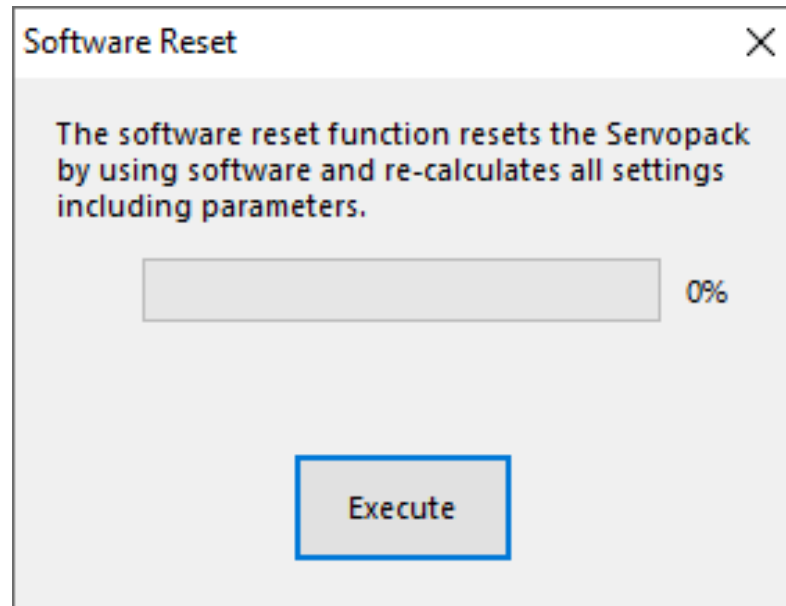
Output Section:

Digital Output	Signal	Action
Digital Output 1	[7] Holding Brake Output Signal (HB)	Apply
Digital Output 2	[8] General Output 1 (DO1)	Apply
Digital Output 3	[0] Inhibit	Apply
Digital Output 4	[0] Inhibit	Apply

At the bottom right, there are 'Save' and 'Close' buttons.

Software reset

- Basic functions → Software Reset
- Reset all setting parameters
- Reset alarms



Parameters

Basic informations → Parameters

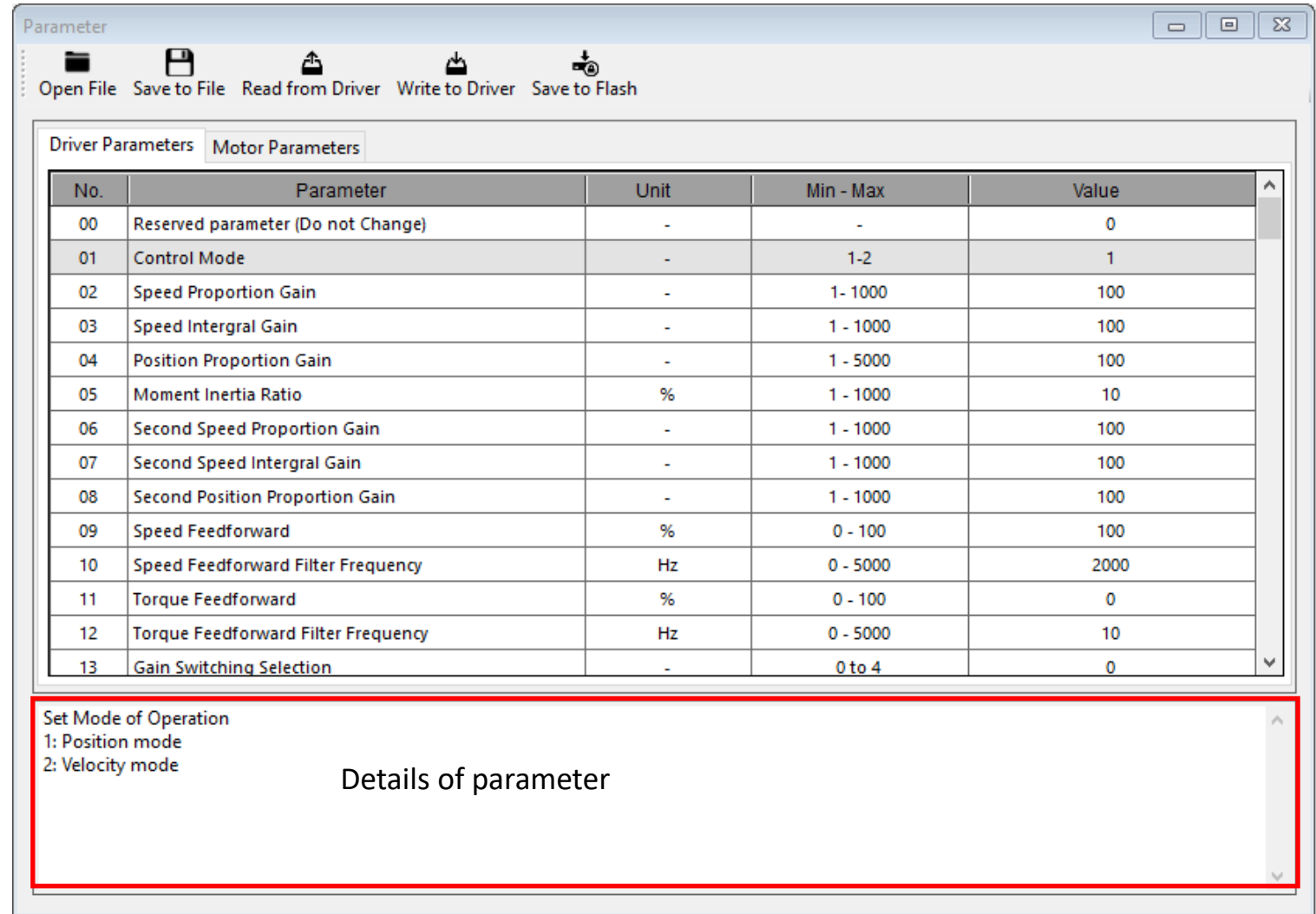
Function:

- Read/Wrire data to driver
- Back up to file
- Save data to servo driver Flash

Memory

Parameters:

- Driver Parameter: *.txt file
- Motor Parameter: *.sys file



The screenshot shows a software window titled "Parameter" with a menu bar containing "Open File", "Save to File", "Read from Driver", "Write to Driver", and "Save to Flash". Below the menu bar are two tabs: "Driver Parameters" (selected) and "Motor Parameters". The main area displays a table of parameters with columns: No., Parameter, Unit, Min - Max, and Value. The table lists 13 parameters, including reserved parameters, control modes, and various gain and feedforward settings. Below the table, a red-bordered box contains the text "Set Mode of Operation" followed by "1: Position mode" and "2: Velocity mode". To the right of this box, the text "Details of parameter" is visible.

No.	Parameter	Unit	Min - Max	Value
00	Reserved parameter (Do not Change)	-	-	0
01	Control Mode	-	1-2	1
02	Speed Proportion Gain	-	1 - 1000	100
03	Speed Intergral Gain	-	1 - 1000	100
04	Position Proportion Gain	-	1 - 5000	100
05	Moment Inertia Ratio	%	1 - 1000	10
06	Second Speed Proportion Gain	-	1 - 1000	100
07	Second Speed Intergral Gain	-	1 - 1000	100
08	Second Position Proportion Gain	-	1 - 1000	100
09	Speed Feedforward	%	0 - 100	100
10	Speed Feedforward Filter Frequency	Hz	0 - 5000	2000
11	Torque Feedforward	%	0 - 100	0
12	Torque Feedforward Filter Frequency	Hz	0 - 5000	10
13	Gain Switching Selection	-	0 to 4	0

Set Mode of Operation
1: Position mode
2: Velocity mode

Details of parameter

Trials Run

Control the servo motor without master controller

- Jog Operation
- Program JOG Operation

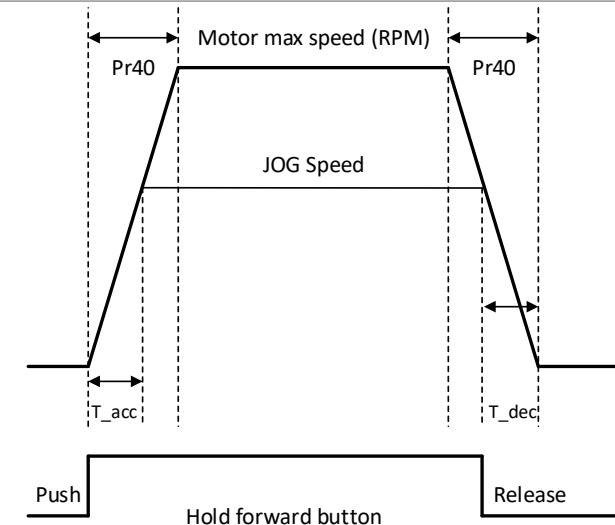
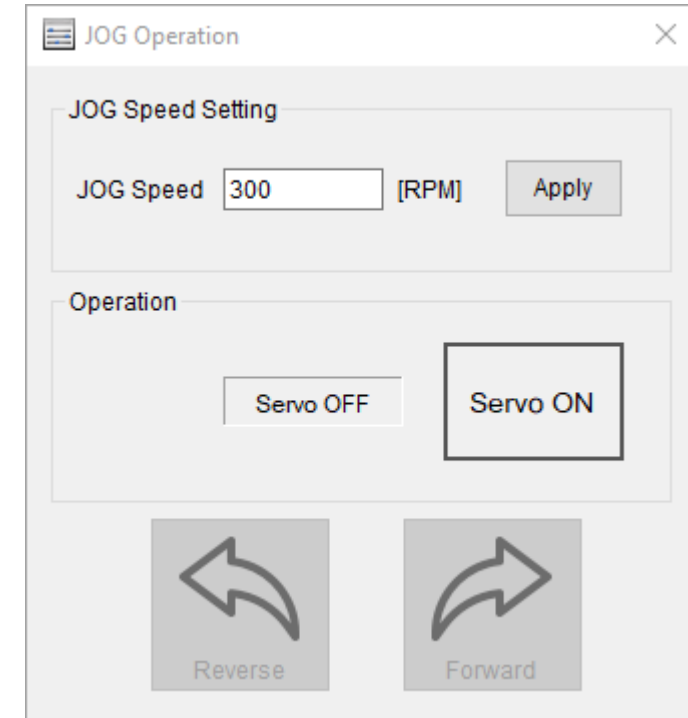
Trials Run

JOG Operation:

- Trial Run → JOG Manual
- Enter Speed → Apply
- Servo ON
- Hold Forward/Reverse Button

Parameter setting

- Pr40: Soft start acceleration/deceleration time (ms)
- Motor maximum speed (RPM)



Trials Run

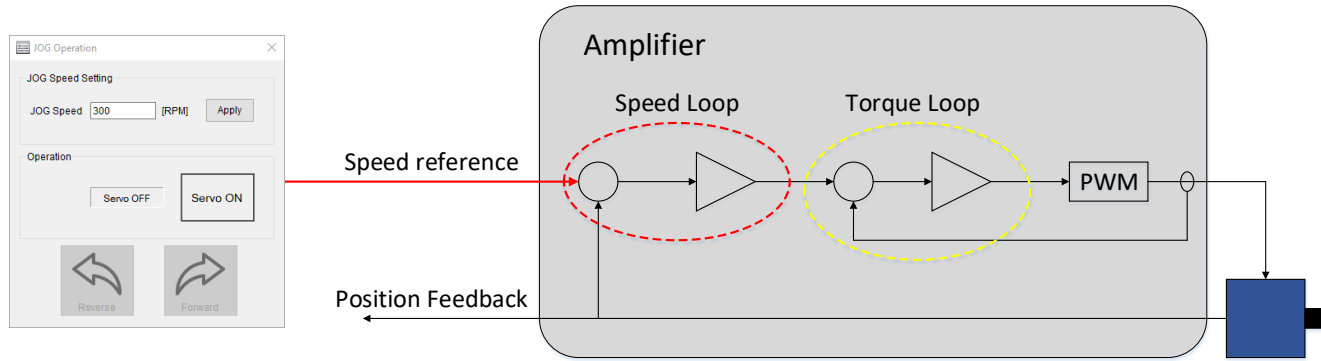
Program JOG Operation:

- Trial Run → Program JOG Operation
- Apply Parameters
- Run
- Servo ON
- Execute

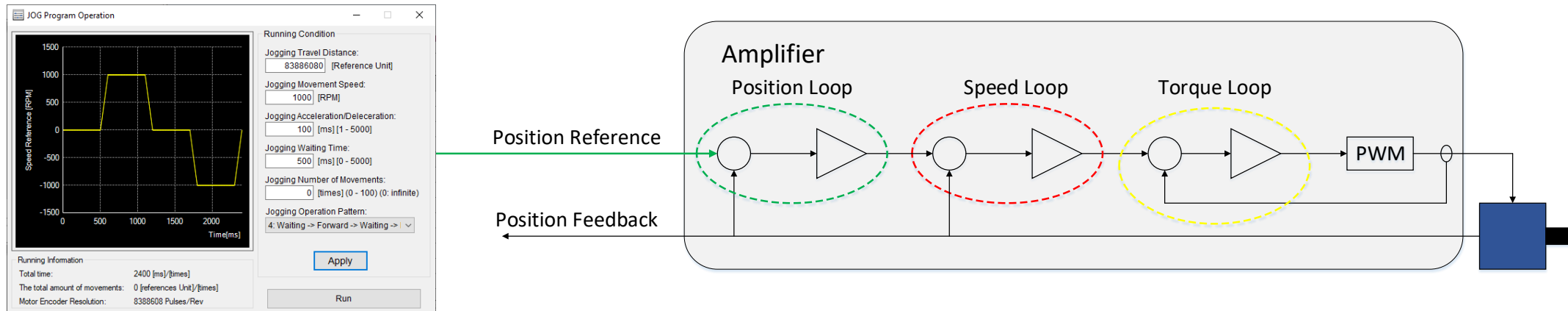


Trials Run

Jog Theory of Operation

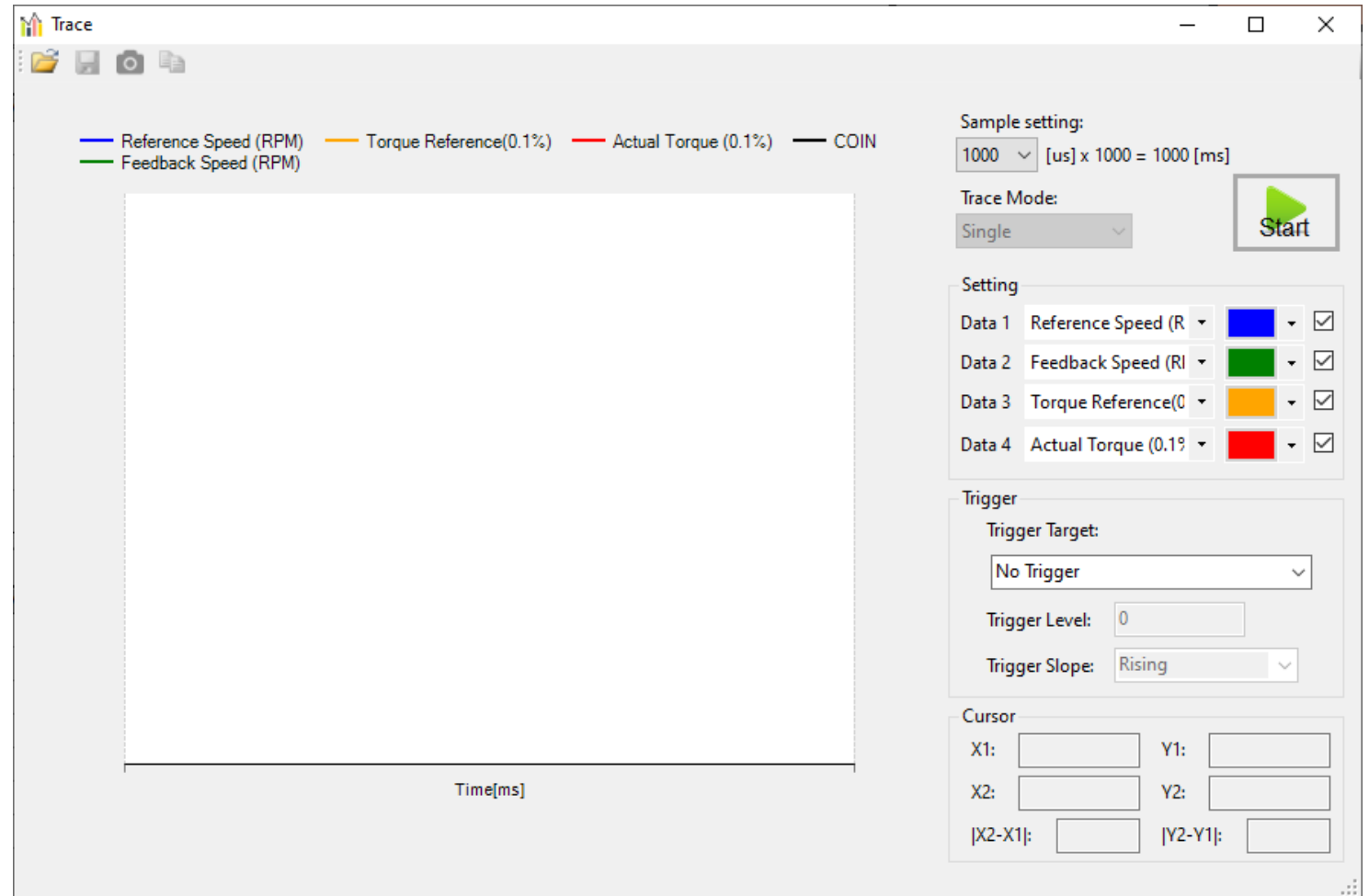


Program Jog Theory of Operation



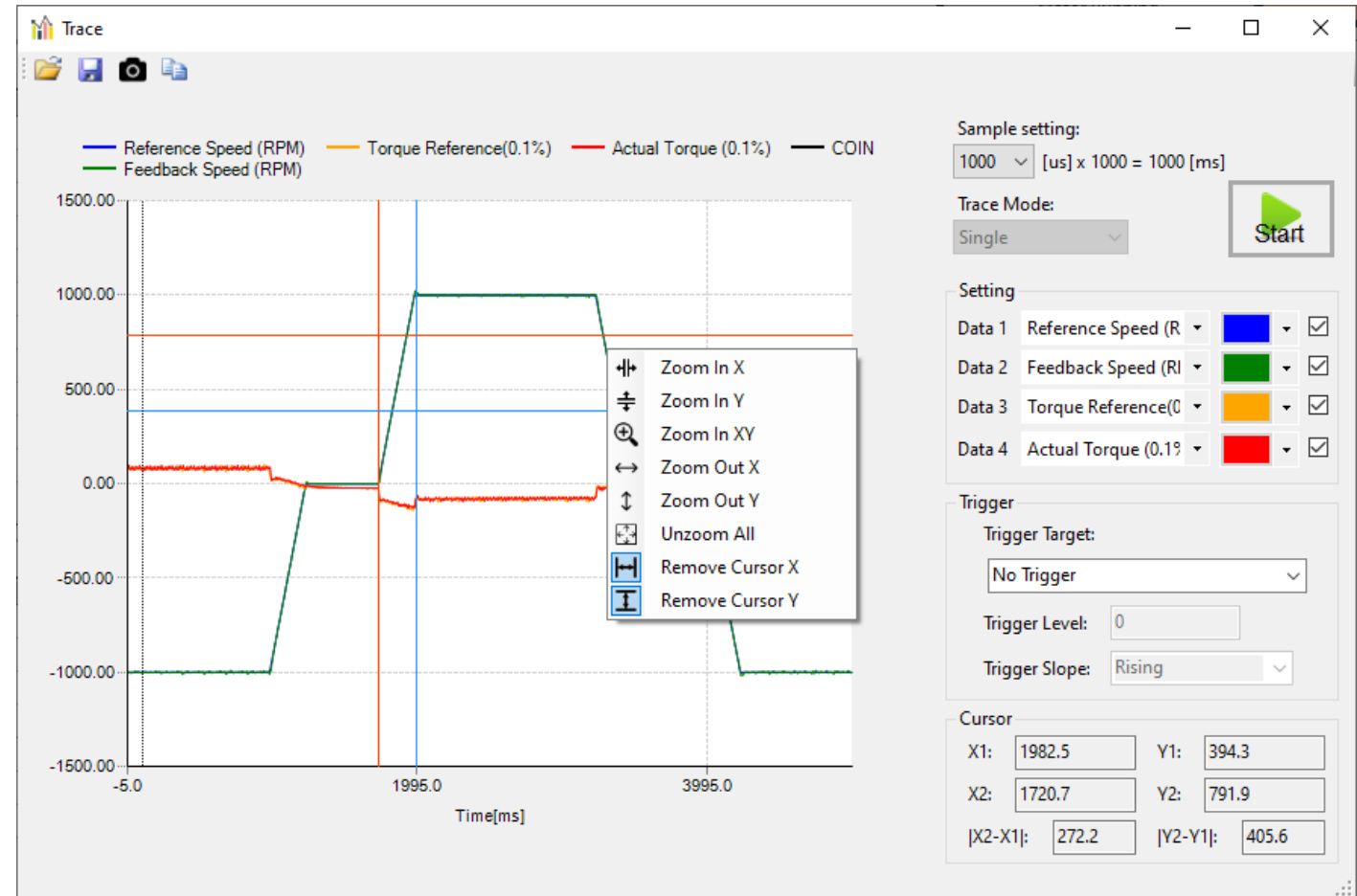
Data Trace

- Trace → Data Trace
- Setting:
 - Sample time: 125ms → 16s
 - Trace mode: Single/ continuous
 - Data Trace: 4 data
 - Trigger option
- Start trace data



Data Trace

- Right Click to the graph
- Option:
 - Zoom In/zoom out X, Y
 - Cursor X, Y: measure difference
- Button:
 - Open, save graph
 - Capture
 - Copy to clipboard
- Trigger:
 - Option to choose the target trigger
 - Rising/ falling edge trigger



Tuning

What is tuning ?

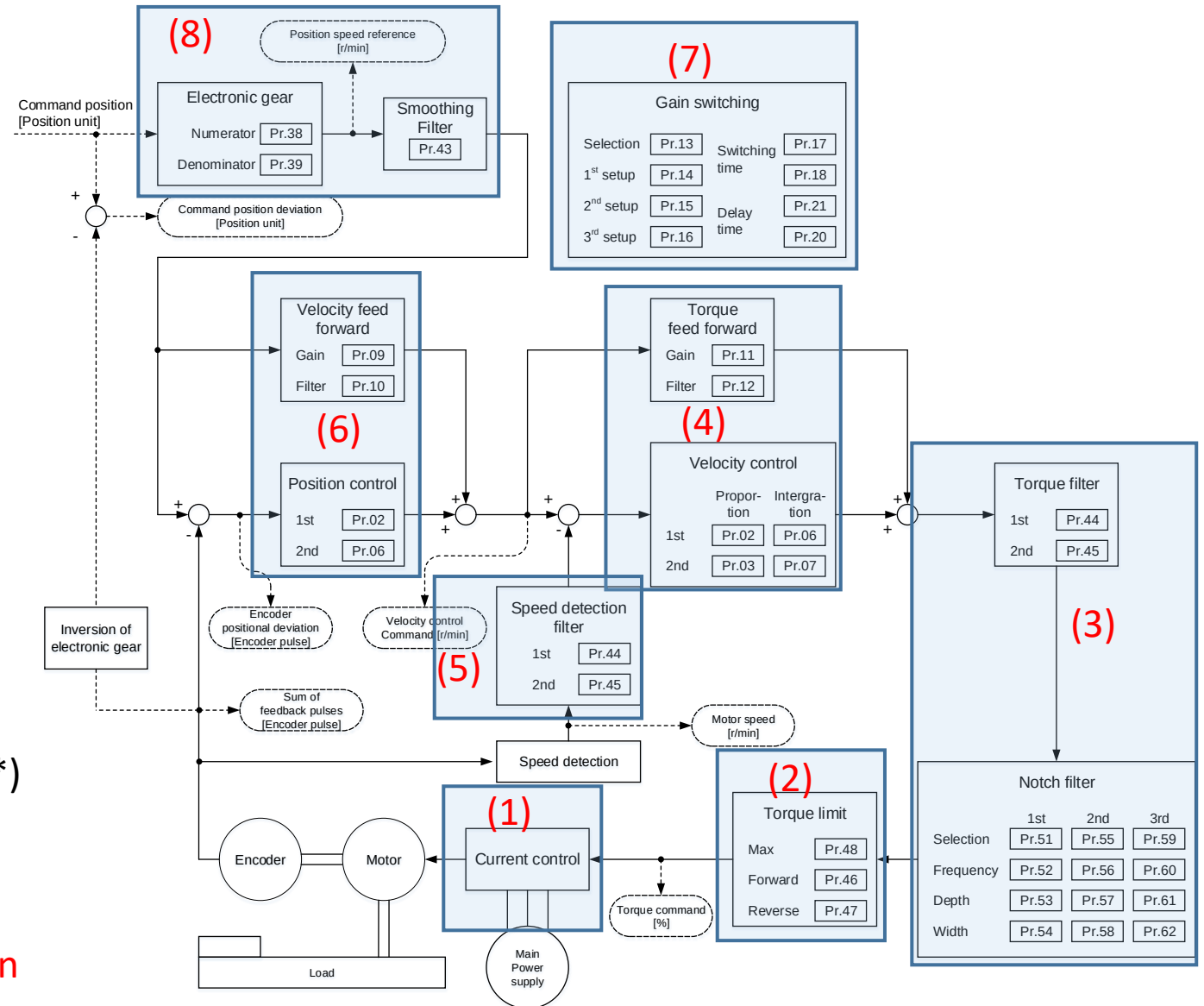
- Optimize how the amplifier responds to feedback
- Adjust the error compensation of the control loops
 - Torque (current)
 - Speed
 - Position

Tuning

NR Servo Driver Diagram

- (1) Torque (Current) control loop
- (2) Torque Limit
- (3) Torque filter (*)
- (4) Velocity control loop
- (5) Speed detection filter (*)
- (6) Position control loop
- (7) Gain switching (*)
- (8) Electronic gear and smoothing filter (*)

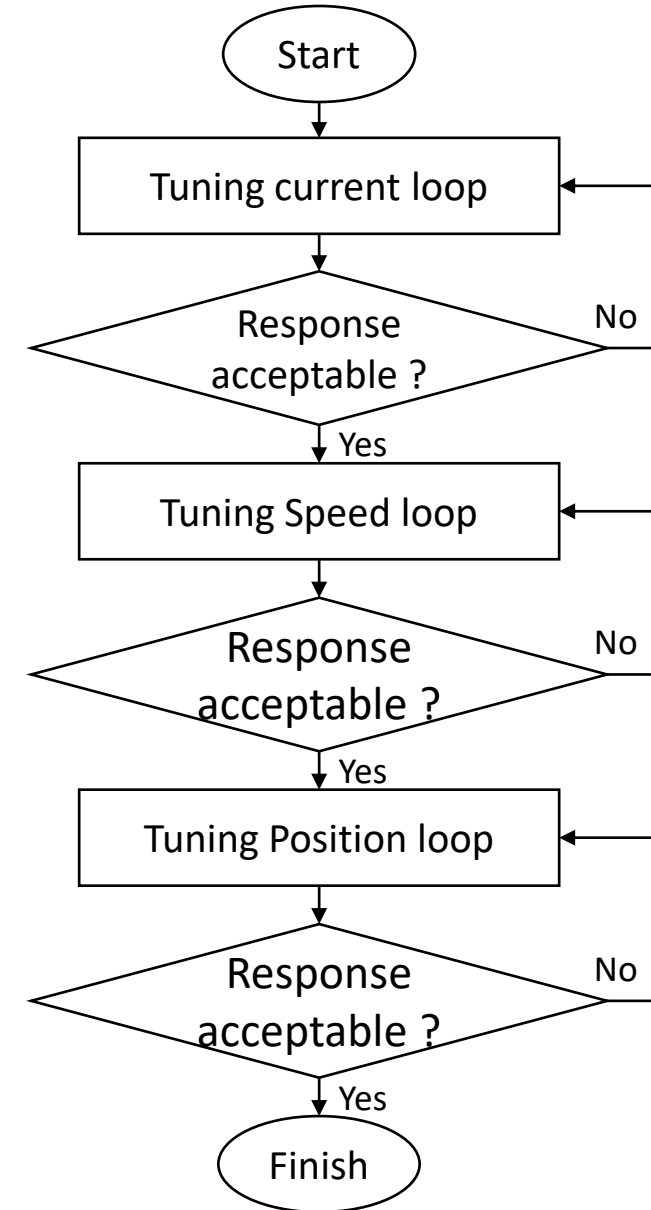
(*) Optional tuning depend on the application



Tuning

Basic manual tuning

- Tuning Current Loop: Adjust PI (K_p , K_i gain) controller
- Tuning Speed Loop: Adjust PI (K_p , K_i gain) controller
- Tuning Position Loop: adjust K_p , K_{ff} gain



Tuning

Current Loop tuning

When does need tuning current loop ?

- Set up new servo motor
- Adjust current loop bandwidth

Tuning

Tuning

Motor and Feedback | **Current Loop tuning** | Commutation

Rated Current [RMS Amps]	2.4	(*)
Peak Current [RMS Amps]:	4.8	(*)
Maximum motor speed [RPM]:	6500	(*)
Encoder Type:	04: Panasonic Minas A6 Serial Absolute	(*)
Encoder Resolution [Pulses]:	8388608	(*)
Pole Pairs per Revolution:	5	
Maximum Power (Watts):	100	
Maximum Voltage (Volts):	200	
Phase to Phase Resistance [Ohm]:	6.8	
Phase to Phase Inductance (mH):	10.7	
Rated Torque (N.m):	0.3	
Rotor Inertia (kg.m2):	0.0	

(*): Require Input

Encoder Setting

Apply

Load Form File | **Read from Driver** | << >>

Tuning

Motor Configuration

Motor and Feedback | **Current Loop tuning** | Commutation | Summary

— Current Command (A) — Actual Current (A)

Current (mA)

Time[ms]

Click Apply to change parameter setting

Adjust PI Controller gain

Setting current command profile

Click to start tuning

Enable cursor to measure

Current Kp Gain: 4000

Current Ki Gain: 5000

Excitation Type: ☒ Step ☐ Sine

Frequency (Hz): 100

Current Ref 1 (-1 - 1A): 0.5

Current Ref 2 (-1 - 1A): 0.1

Apply Verify

Cursor

☐ Cursor X ☐ Cursor Y

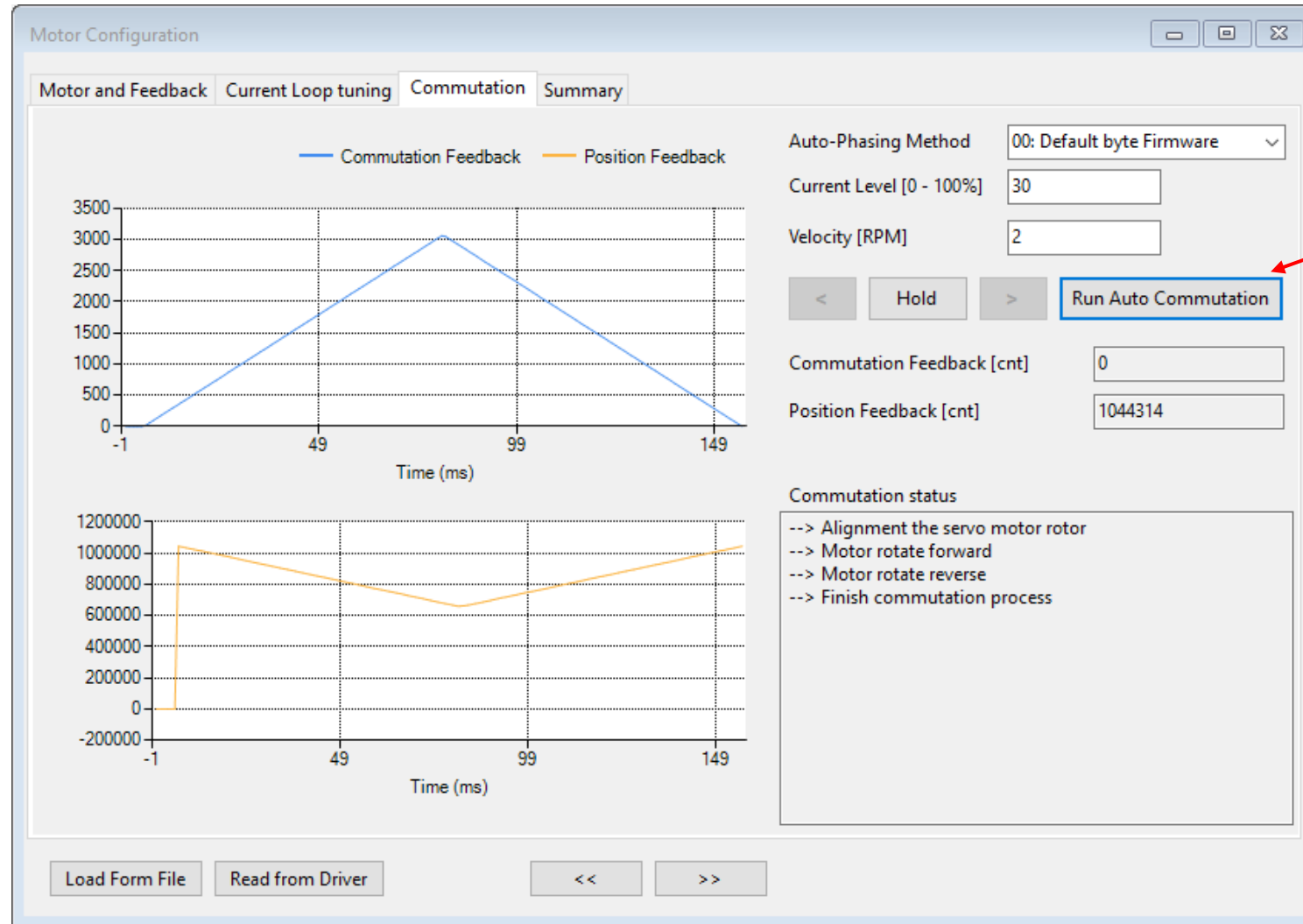
X1: Y1:

X2: Y2:

|X1-X2|: |Y1-Y2|:

Load Form File Read from Driver << >>

Tuning



Click to start
the auto
Commutation
process

Tuning

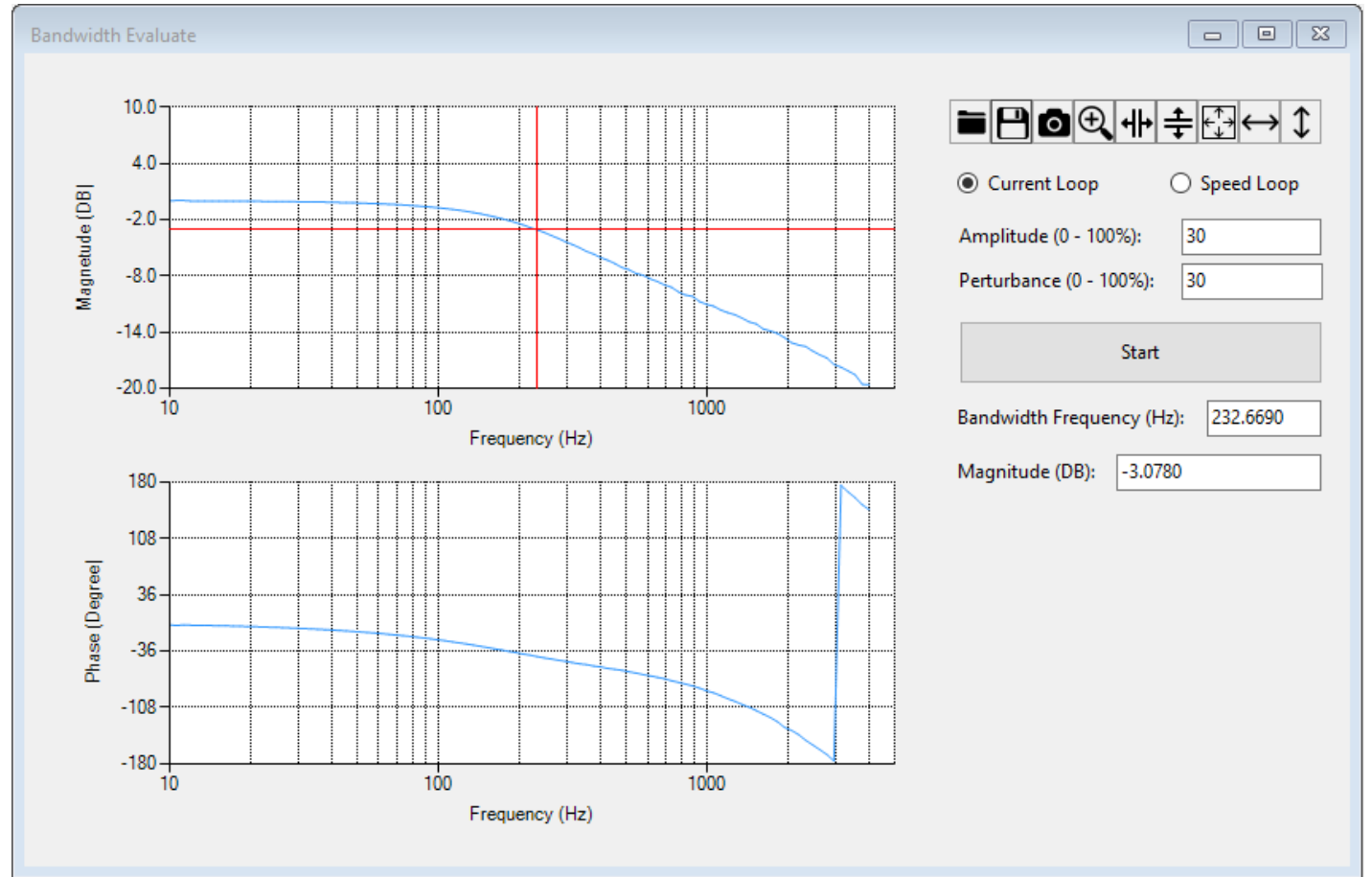
- Save Motor Parameters to Servo Driver
- Back up tuning parameter to file
- Close Program

The screenshot shows a software window titled "Motor Configuration" with four tabs: "Motor and Feedback", "Current Loop tuning", "Commutation", and "Summary". The "Summary" tab is active. The main area of the window contains the heading "Recommended Action Before Leaving The Tuner" followed by two unchecked checkboxes: "Save Parameters to Drive" and "Save Motor Parameters to File". Below these checkboxes is a text input field and a small button with three dots. At the bottom right of the main area are "Save" and "Close" buttons. At the bottom of the window are four buttons: "Load Form File", "Read from Driver", "<<", and ">>".

Tuning

Use Bandwidth evaluate tool to evaluate the control loop response

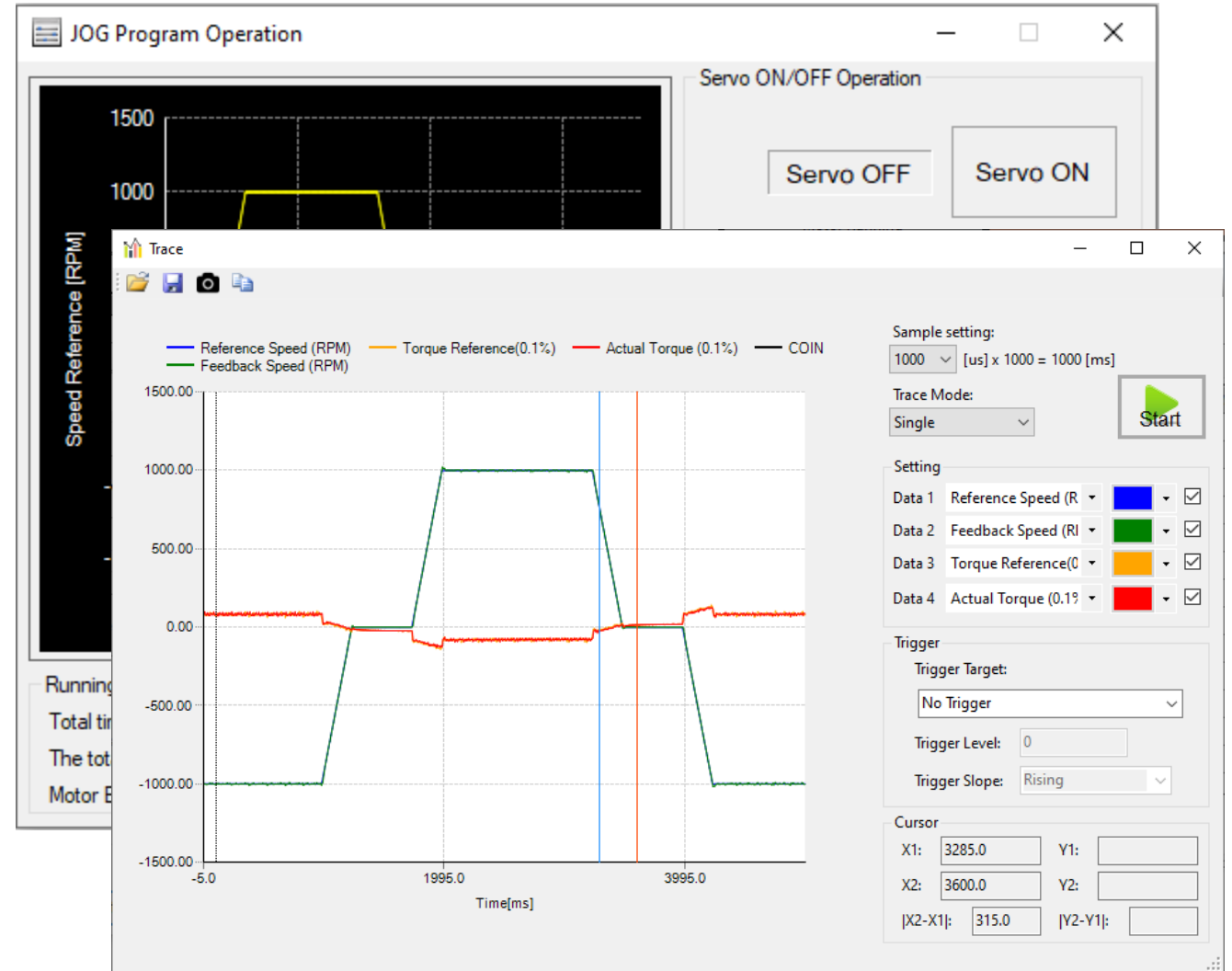
- Tuning → Evaluate Bandwidth
- Click start
- Get Current/ Speed Loop bandwidth



Tuning

Velocity Loop Tuning

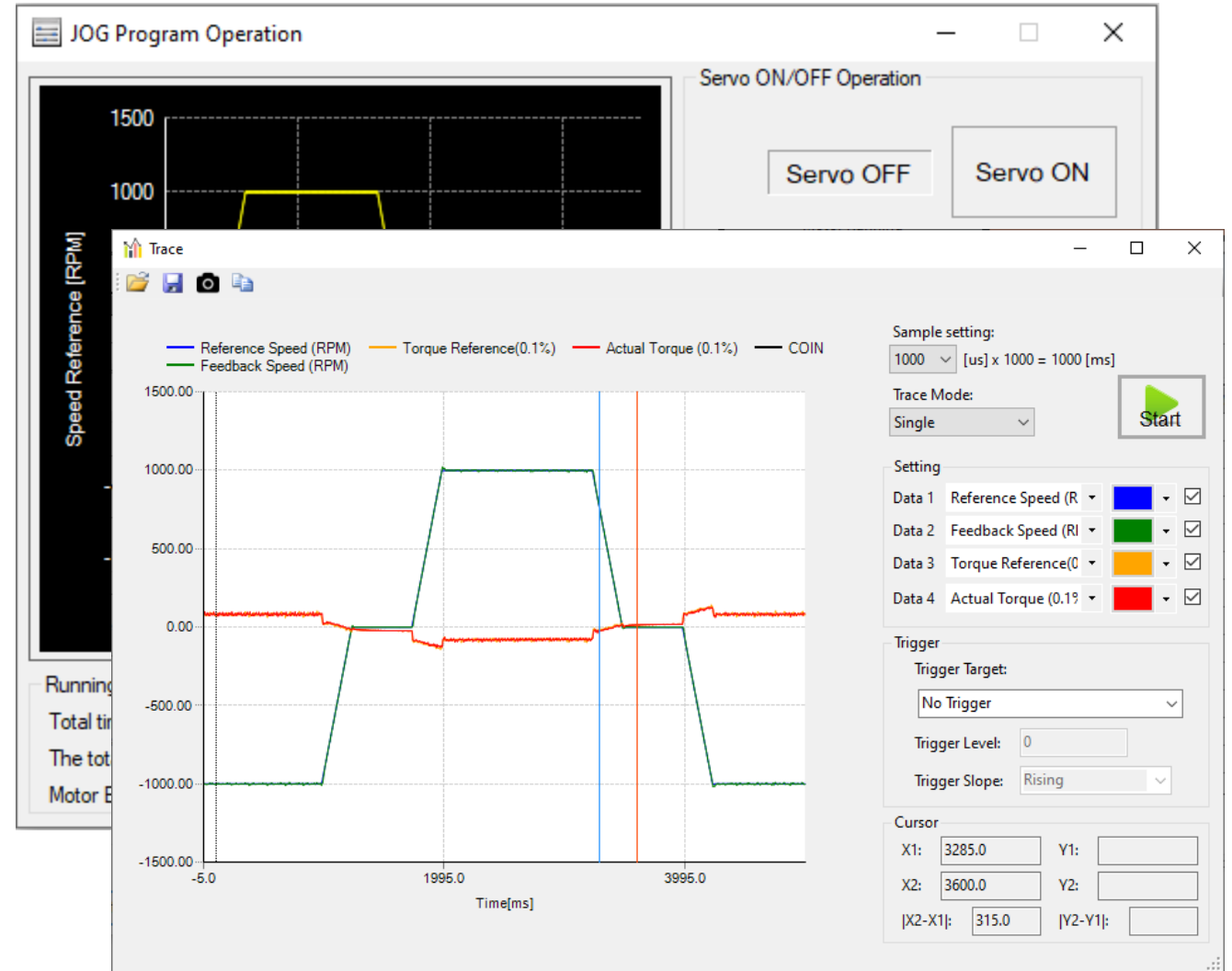
- Open **Edit Parameters**
- Setting Control mode to Velocity Mode
- Open **Program JOG Operation**
- Setting Trapezoidal profile
- Open **Data Trace**
- Execute JOG Program
- Start Trace Data
- Adjust Kp, Ki Speed gain



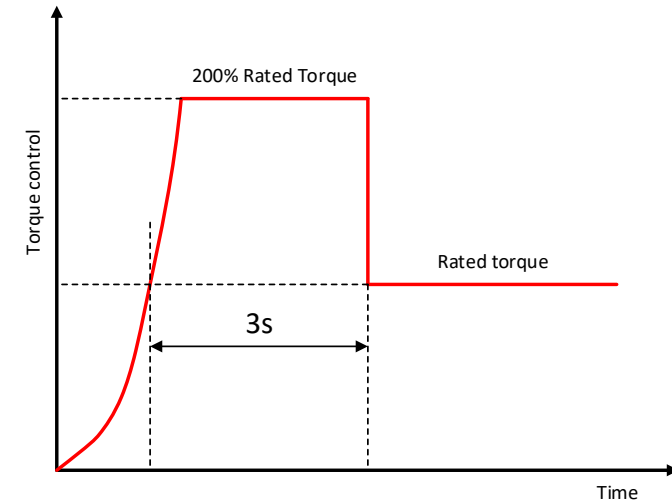
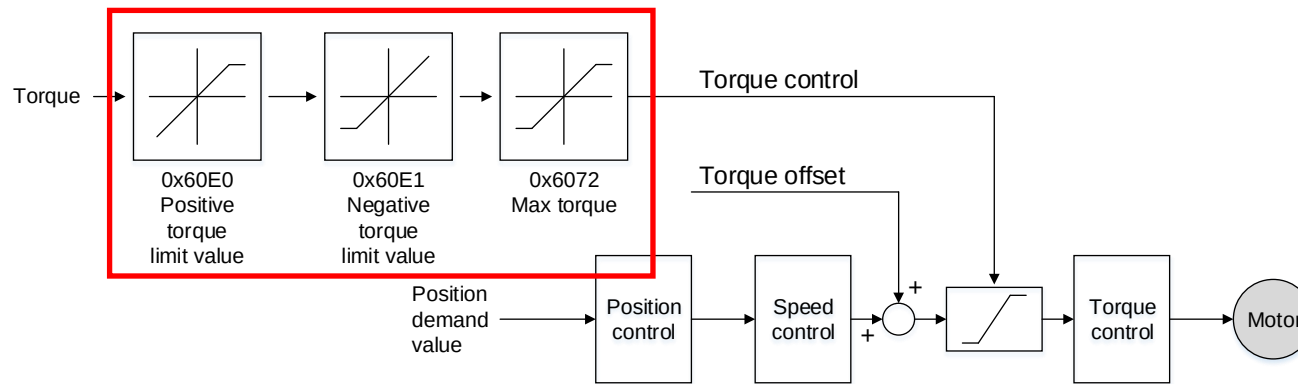
Tuning

Position Loop Tuning

- Turn off **JOG Program Operation**
- Open **Edit Parameters**
- Setting Control mode to Position Mode
- Open **Program JOG Operation** again
- Setting Trapezoidal profile
- Open **Data Trace**
- Execute JOG Program
- Start Trace Data
- Adjust Kp and feed forward gain



Torque Limit

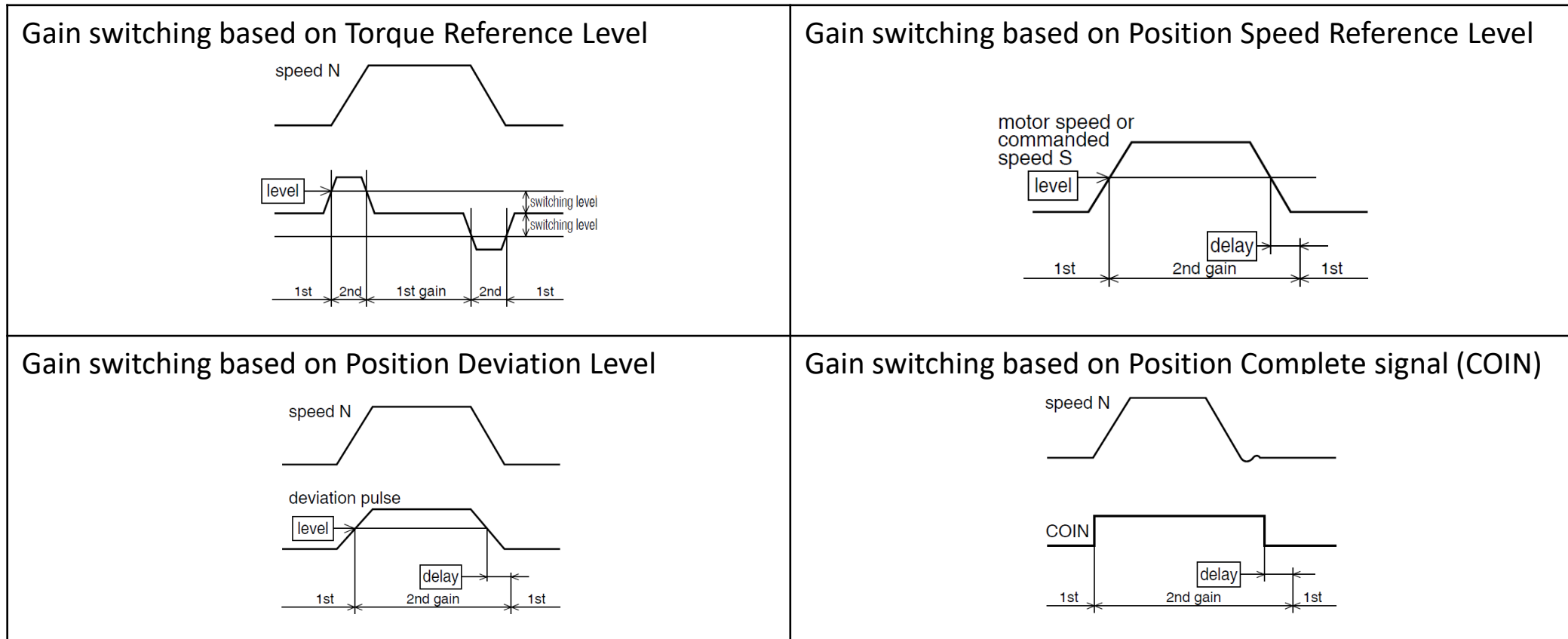


Parameter

- Forward torque limit Pr46 (maximum 200%)
- Reverse torque limit Pr47 (maximum 200%)
- Max torque Pr48 (maximum 200%)

Gain switching

- Decrease the gain at the time of stoppage (servo lock) to reduce vibration.
- Increase the gain at the time of stoppage (setting) to shorten the settling time.
- improve command compliance

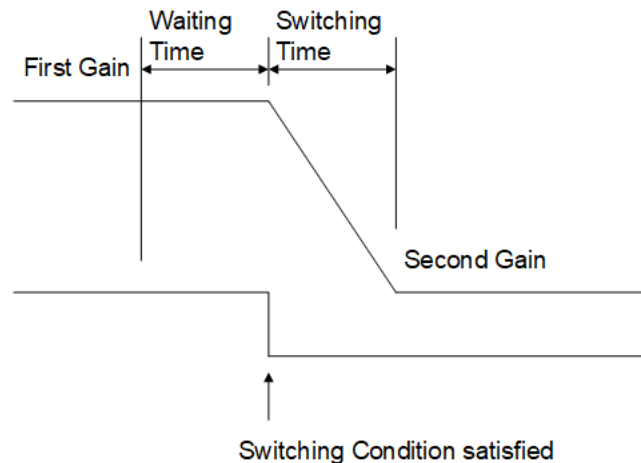


Gain switching

Gain switching combinations

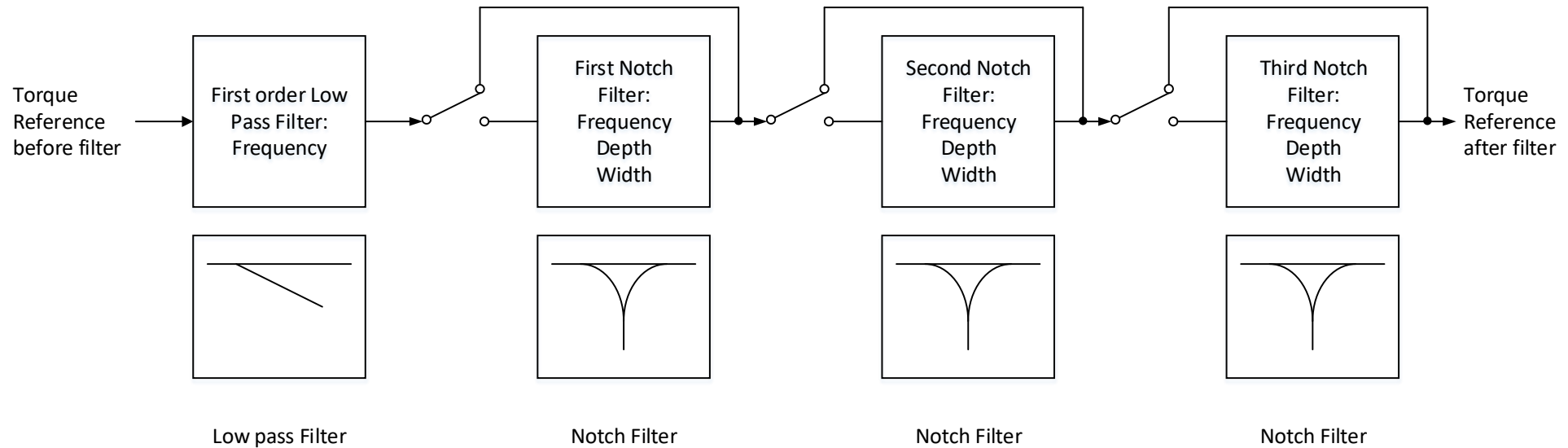
Select gain	Speed Loop Gain	Speed Intergral gain	Position Loop gain	Torque reference filter
Gain setting 1	1 st Kpv (Pr02)	1 st Kiv (Pr03)	1 st Kpp (Pr04)	1 st Torque filter (Pr44)
Gain setting 2	2 nd Kpv (Pr06)	2 nd Kiv (Pr07)	2 nd Kpp (Pr08)	2 nd Torque filter (Pr45)

Relationship between the Waiting Times and Switching Times for Gain Switching



Parameters	Range
Gain switching time 1 (Pr17)	0 to 65535ms
Gain switching time 2 (Pr18)	0 to 65535ms
Gain switching waiting time 1 (Pr19)	0 to 65535ms
Gain switching waiting time 2 (Pr20)	0 to 65535ms

Torque filter

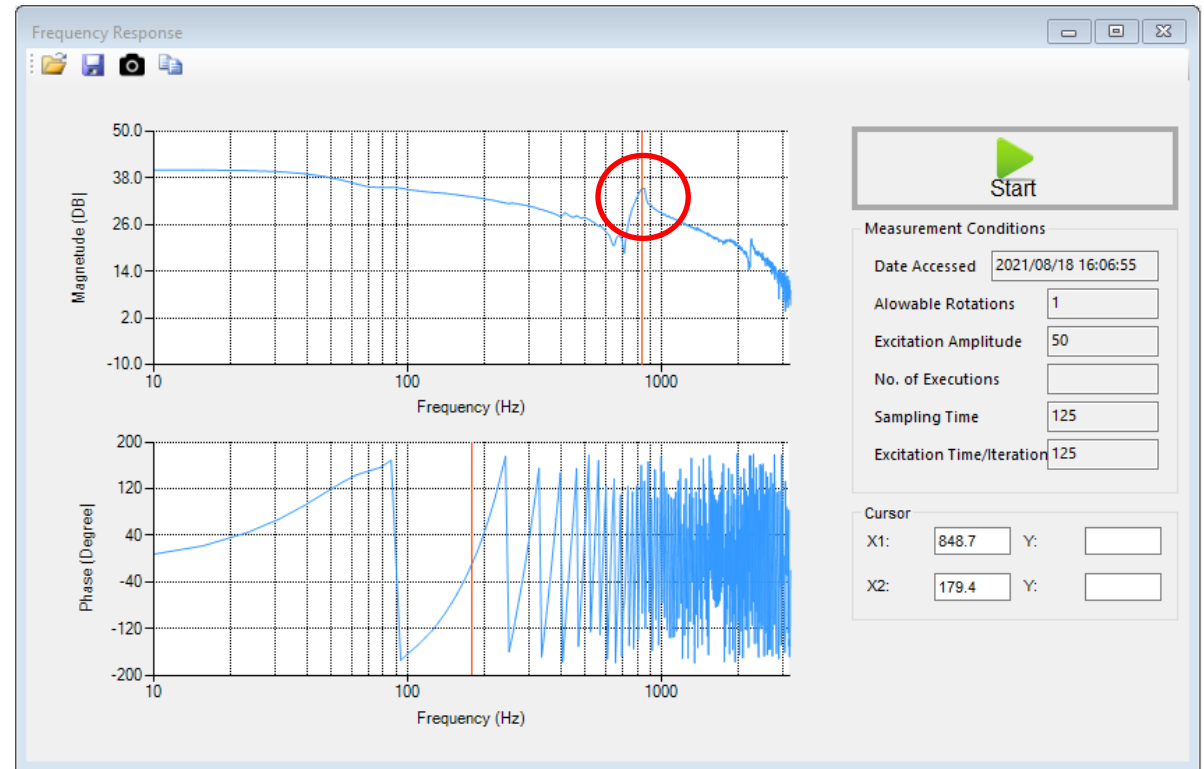


Low pass filter	Notch Filter (1 st , 2 nd , 3 rd)
Low pass filter frequency (Pr44, Pr45)	- Notch filter selection (Pr51, Pr55, Pr59) - Notch filter Frequency (Pr52, Pr56, Pr60) - Notch filter Width (Pr53, Pr57, Pr61) - Notch filter Depth (Pr54, Pr58, Pr62)

Torque filter

Use Mechanical Analysis to find notch frequency

- Tuning → Mechanical Analysis
- Click Start to start process
- Measure Notch frequency
- Design notch filter
- Verify



Update firmware

- Check current version firmware of servo Driver
- Load Firmware programming (*.spf) file
- Download to Servo Driver
- Reboot Device
- Check new firmware version

