ROBOSTAR ROBOT

N1 Series

GAIN SETUP MANUAL

- □ INSTRUCTION MANUAL
- □ OPERATION MANUAL
- □ PROGRAMMING MANUAL
- □ UNI-HOST MANUAL
- ☑ GAIN SETUP MANUAL
- □ ALARM CODE MANUAL

Robostar

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Constitution of User Manual

The user manual for this product is constituted as follows. When using this product first, please fully read all the manuals before use.

- **Instruction Manual**

  A controller is generally explained. Overview of the controller, installation, and interfacing to peripherals are explained.

- **Manipulation & Operation Manual**

  As well as general use of the controller, parameter setup, Job program editing, robot operation, etc. are explained.

- **Programming Manual**

  RRL (Robostar Robot Language) which is the robot program of Robostar and how to write a robot program by using RRL are explained.

- **Unihost Manual**

  'Unihost' which is the on-line PC program of Robostar is explained.

- **Gain Setup Manual**

  How to set up the gain necessary for trial run, and the motor response performance according to change in the gain value are explained.

- **Alarm Code Manual**

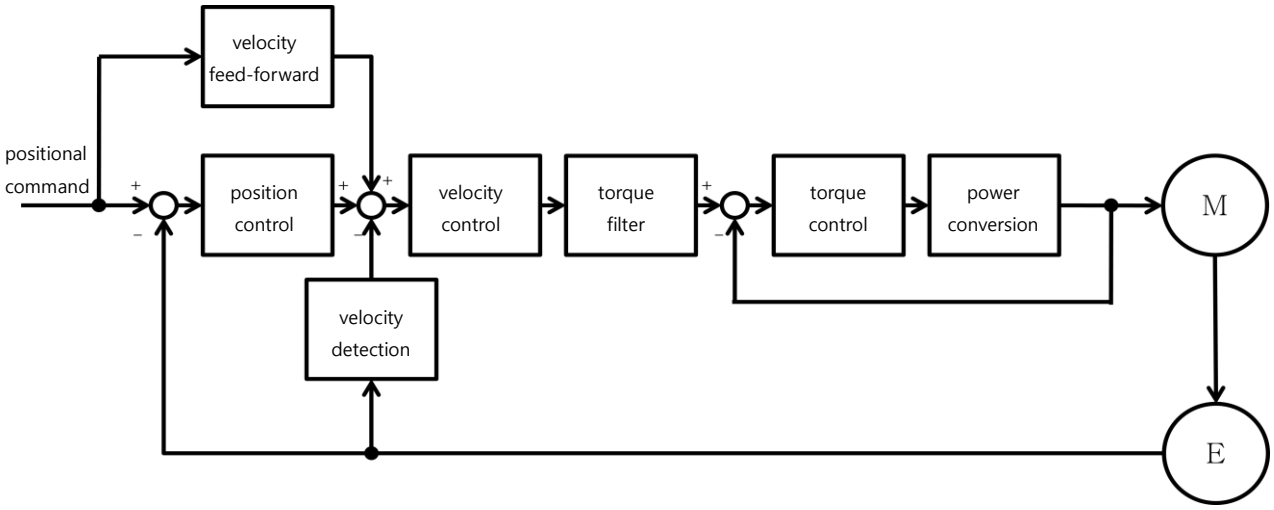
  Reasons for Reasons for and countermeasures against the alarms which can occur while operating the controller are explained.

CONTENTS

Chapter 1 How to Set up Gain

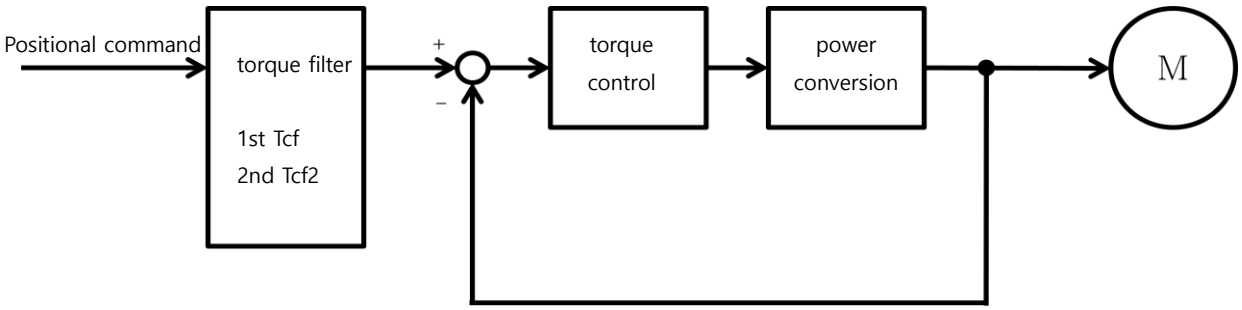
	Abbr.	Name	Setup range [Unit]	Initial value
1. PVG_1st	Kpp	1st position-proportional gain	1-2000 [1/S]	70
	Kpf	velocity feed-forward gain	0-2000 [0.1%]	300
	Kvf	Reserved		
	Kvi	1st velocity integral time constant	1-1000 [ms]	16
	Kvp	1st velocity-proportional gain	1-2000 [Hz]	40
	IR	inertia ratio	0-2000 [0.01배]	300
	Tcf	1st torque command filter time constant	50-3000 [Hz]	300
	Vft	velocity feed-forward filter time constant	50-2000 [Hz]	200
2. PVG_2nd	Kpp2	2nd position-proportional gain	1-2000 [1/S]	80
	Kvp2	2nd velocity-proportional gain	1-2000 [Hz]	40
	Kvi2	2nd velocity integral time constant	1-1000 [ms]	300
	Tcf2	2nd torque command filter time constant	50-3000 [Hz]	300
	Act	gain switching action setup	0, 1	0
	Mode	gain switching mode setup	0	0
	Dtime	2nd-1st gain switching time	0-10000 [160us]	10
	Level	gain switching level	0-10000 [pulse]	3200
	Hyst	gain switching hysteresis	0-10000 [pulse]	300
	Time	1st-2nd gain switching time	0-10000 [320us]	10

[Table 1-1 Descriptions of gain variables and initial values]



[Fig. 1-1 Overall control block diagram]

1.1 Torque Control



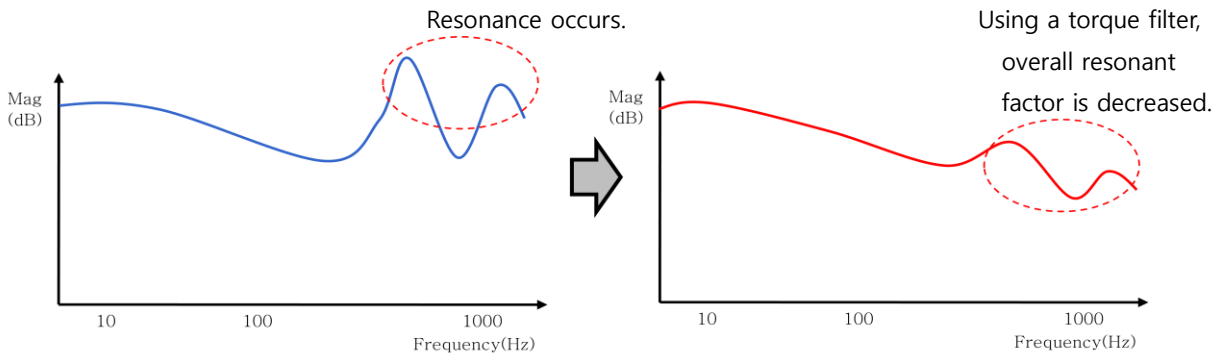
[Fig. 1-2 Torque control block diagram]

As in the above block diagram, the torque control is composed of a 1st torque filter (Tcf) and a 2nd torque filter (Tcf2). Setting up the torque filter parameter helps suppressing the oscillation causing the resonance.

1.1.1 Torque Command Filter

- Description : Parameter for Parameter for suppressing the resonance occurring at 200 Hz or higher
- Unit : Hz
- Setup range : 50 to 3000
- Setup unit : 50
- If Tcf value is increased : If there is no resonance and noise, the higher the value, the better the response-ability.
- If Tcf value is decreased : The resonance and the noise decrease, but the response-ability is also deteriorated.
- Standard value : 300

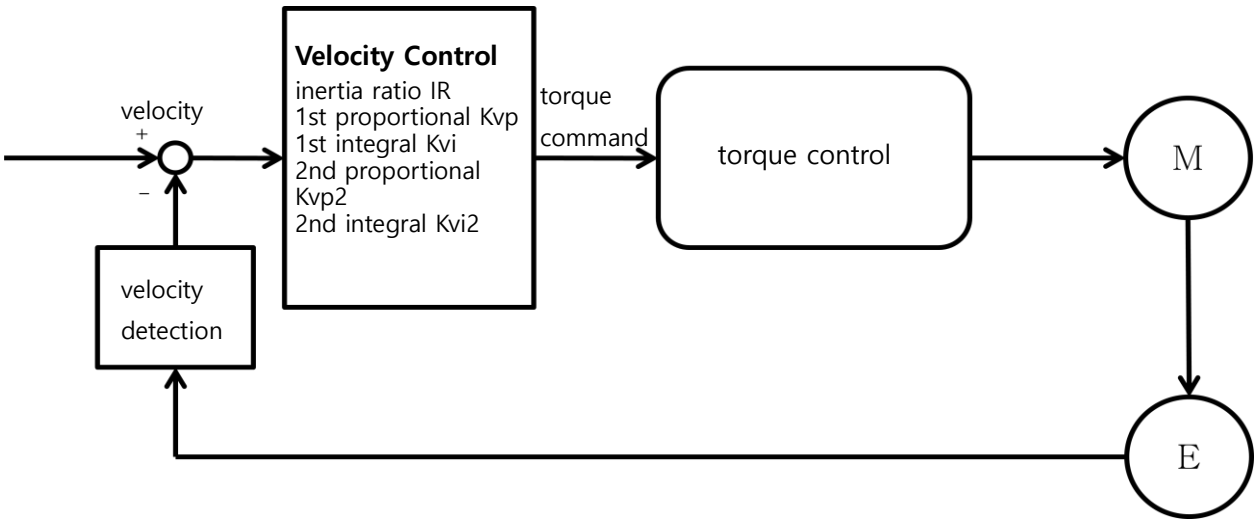
-> If Torque filter Parameter is entered as 3000, the filtering function disappears.



Before application After application

[Fig. 1-3 Application example of torque filter]

1.2 Velocity Control



[Fig. 1-4 Velocity control block diagram]

1.2.1 Setup of Load Inertia Ratio

- Description : Parameter for determining the ratio of load inertia to motor inertia
- Unit : **inertia ratio = (load inertia / motor inertia) X 100 [%]**
- E.g.) 1:1 load : 1/1 X 100 = 100, 1:2 load : 2/1 X 100 = 200
- Setup range : 0 to 2000
- Setup unit : 50 to 100
- If IR value is increased : The torque of a motor increases, but vibration and noise are generated.
- If IR value is decreased : The torque of a motor decreases.
- Standard value : 300

-> When the exact load inertia ratio is input, the velocity and the position gain are normally applied, but if the inertia ratio is greater, the higher velocity and gain are applied and if it is smaller, the lower velocity and gain are applied.

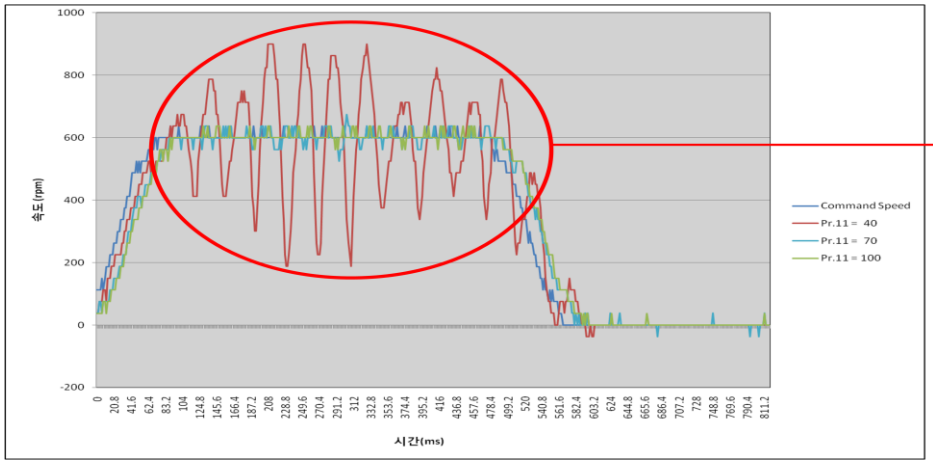
The inertia ratio is applied in proportional relationships to the whole velocity PI controller, as follow.

Velocity-proportional gain = Kvp X IR; Velocity integral gain = Kvi X IR

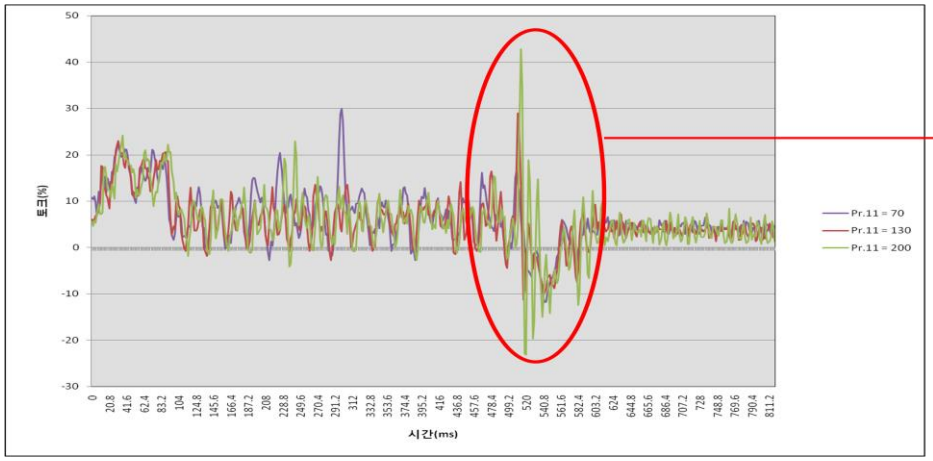
If the value of load inertia is unknown, it is to be set to be lower than about 10-20% than the inertia ratio, by which the vibration or noise generate during operation.

1.2.2 Setup of 1st Velocity Loop Gain (Velocity Proportional Gain)

- Description : Parameter for determining the velocity response-ability
- Unit : Hz
- Setup range : 1 to 2000
- Setup unit : 5
- If Kvp value is increased : The driving torque and the dynamic characteristic of a motor are improved, but the vibration and noise is generated.
- If Kvp value is decreased : The driving torque decreases, and the dynamic characteristic become slower (shaky)
- Standard value : 40 (at non-load)



If the velocity loop gain is too small, the following becomes slower and thus the velocity is shaky.



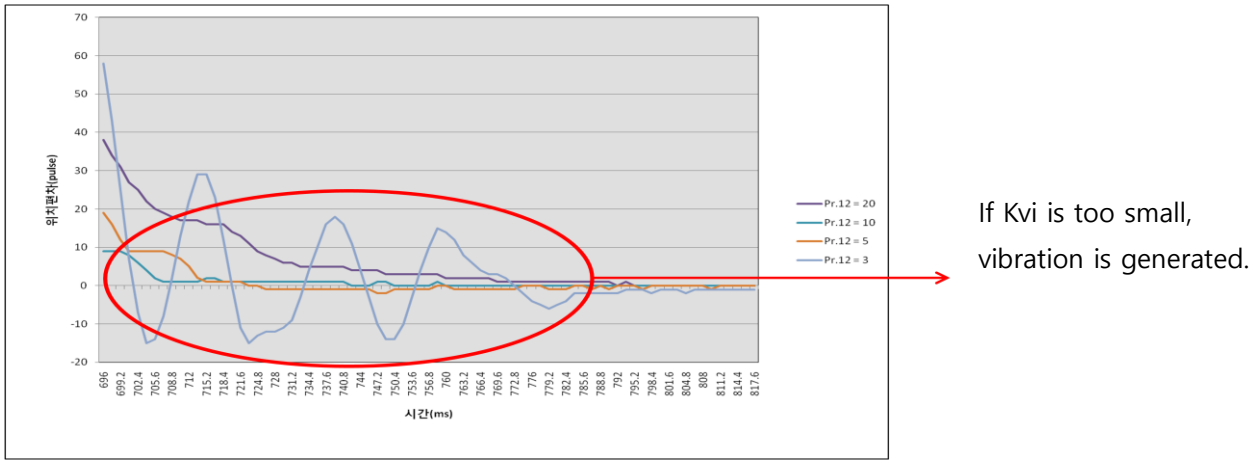
If the velocity loop gain is too large, the torque is shaky, noise or oscillation is generated.

[Fig. 1-5 Example of application of] velocity loop gain (Kvp)]

1.2.3 Setup of 1st Velocity Integral Gain

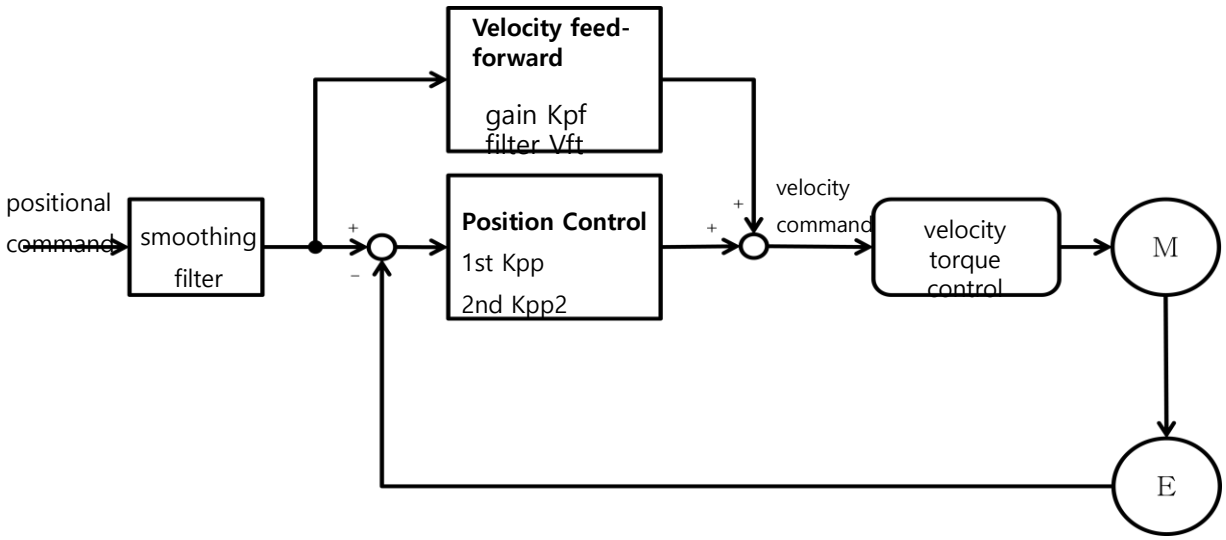
- Description : Parameter for determining the velocity which reduces the positional error at the time of stop.
- Unit : ms
- Setup range : 1 to 1000
- Setup unit : 5
- If Kvi value is decreased : The velocity, which reduces the positional error, becomes faster, but vibration is generated.
- If Kvi value is increased : The vibration is reduced, but the velocity which reduces the positional error becomes slower.
- Standard value : 16 (at non-load)

-> The smaller the integral gain, the better the response-ability. However, if it is 500 or more, the effect of integral disappears.



[Fig. 1-6 Example of application of] velocity integral gain (Kvi)]

1.3 Position Control



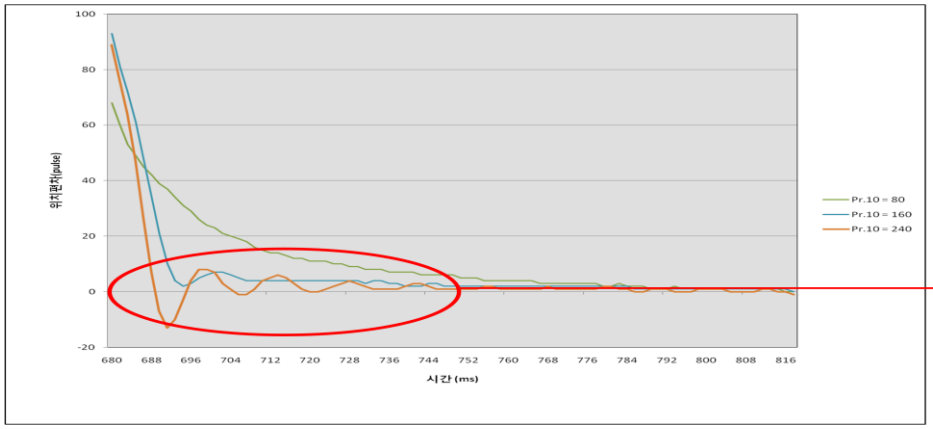
[Fig. 1-7 Block diagram of position control]

As in the above position control block diagram, a user can set up the parameters relating to a smoothing filter, a velocity feed-forward, and a position control.

1.3.1 Setup of 1st Position Loop Gain (Position Proportional Gain)

-Description : Parameter for determining the velocity which reduces the positional error

- Unit : 1/S
- Setup range : 1 to 2000
- Setup unit : 5
- If Kpp value is increased : The velocity which reduces the positional error becomes faster, but if it is overly great value, the vibration occurs.
- If Kpp value is decreased : The velocity which reduces the positional error becomes slower.
- Standard value : 70 (at non-load)

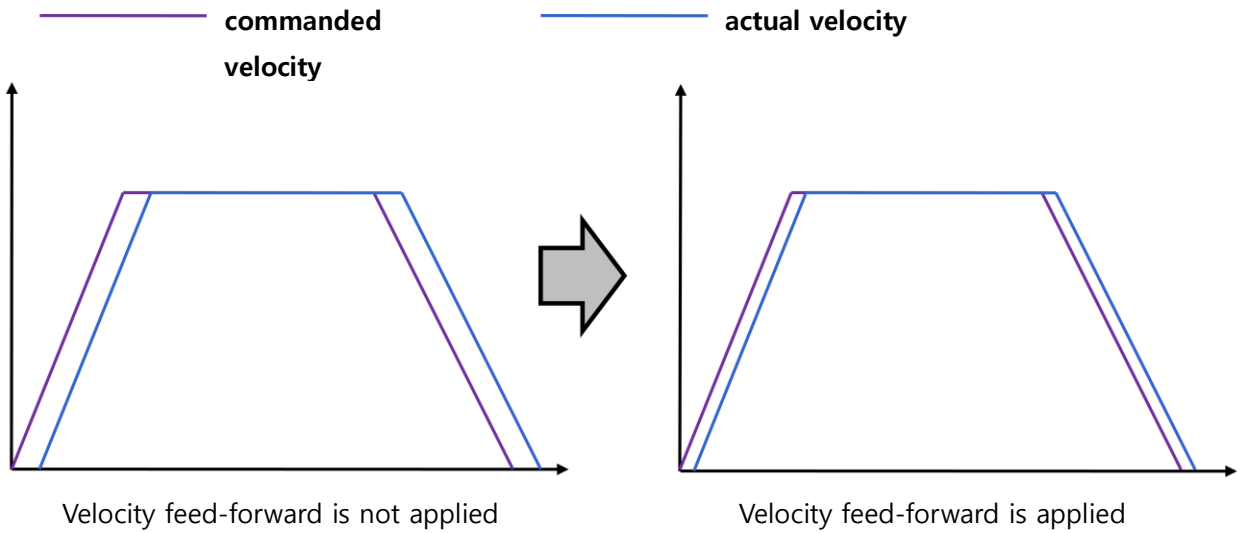


If too great, vibration occurs.

[Fig. 1-8 Example of application of position loop gain (Kpp)]

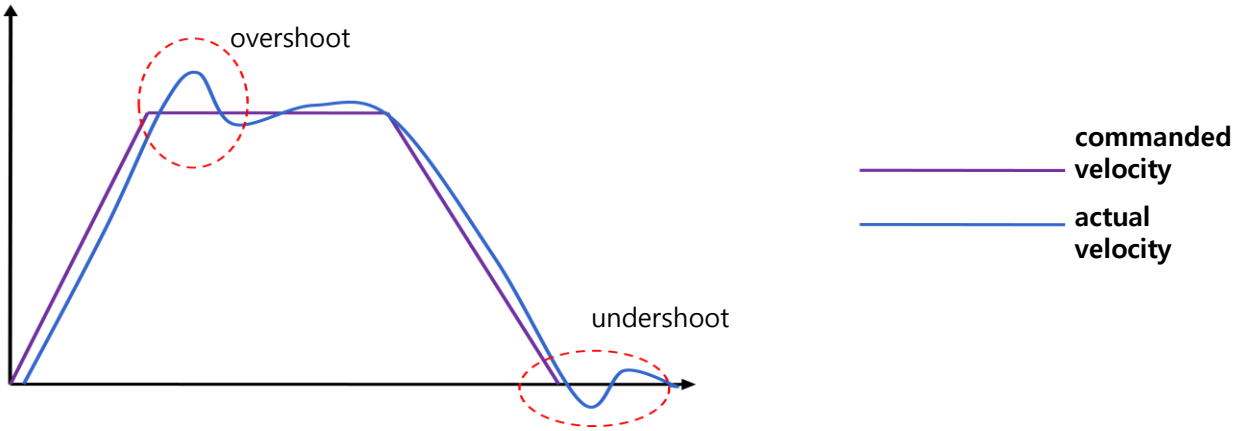
1.3.2 Setup of Velocity Feed-Forward (Feed-Forward Gain)

- Description : Parameter for performing prediction control to improve the response-ability
- Unit : 0.1%
- Setup range : 0 to 2000
- Setup unit : 100
- If Kpf value is increased : The positional error becomes smaller and the response-ability is improved, but if it is **excessively increased,** the overshoot/undershoot occur.
- Standard value : 300 (at non-load)



[Fig. 1-9 Example of application of velocity feed-forward (Kpf)]

If the velocity feed-forward is set up excessively large, the over/undershoot may occur. Therefore, increase the value up to a reasonable level.

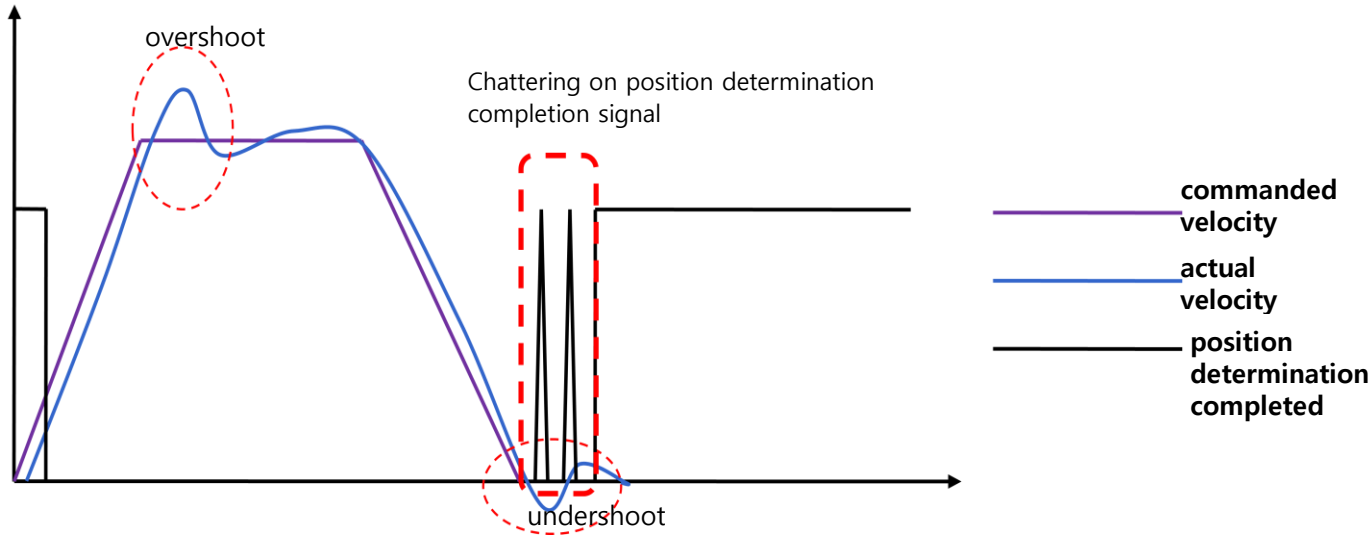


[Fig. 1-10 Case when the velocity feed-forward (Kpf) is too high]

1.3.3 Setup of Feed-Forward Filter Value

- Description : Parameter for setting up a filter when too large velocity feed-forward causes the over/undershoot
- Unit : Hz
- Setup range : 50 to 2000
- Setup unit : 50
- If Vft value is increased : Generation of over/undershoot is alleviated when the velocity feed-forward is set up.
- Standard value : 200 (at non-load)

-> If 1000 is input, the effect disappears. If too small value is input, the velocity feed-forward gain is not applied.



[Fig. 1-11 Example of application of Vft]

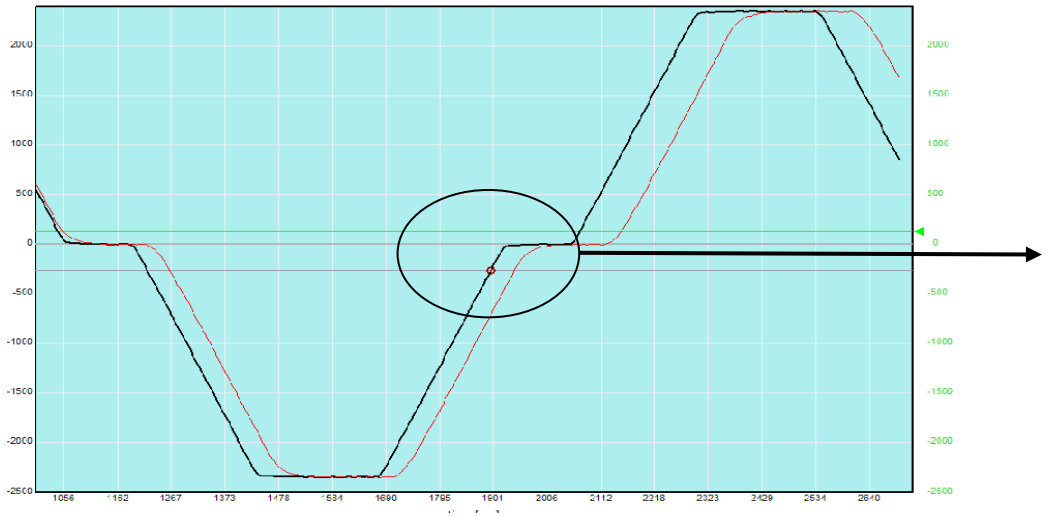
1.3.4 Setup of Smoothing Filter

- Description : This is a 1st command filter inserted to the positional command, which is used to prevent the velocity change from step-wise moving when the variations in acceleration and deceleration of the positional command are very large.

- Setup range : 0 to 7

- Setup unit : 1

->Up to 0 to 7 can be set. If this is set to 0, the filtering function is not applied.
In addition, the greater the setup value, the greater the filter's time constant value.



[Fig. 1-12 Example of application of Smoothing Filter]

Chapter 2 Function of 2nd Gain Switching

2.1 Setup Method

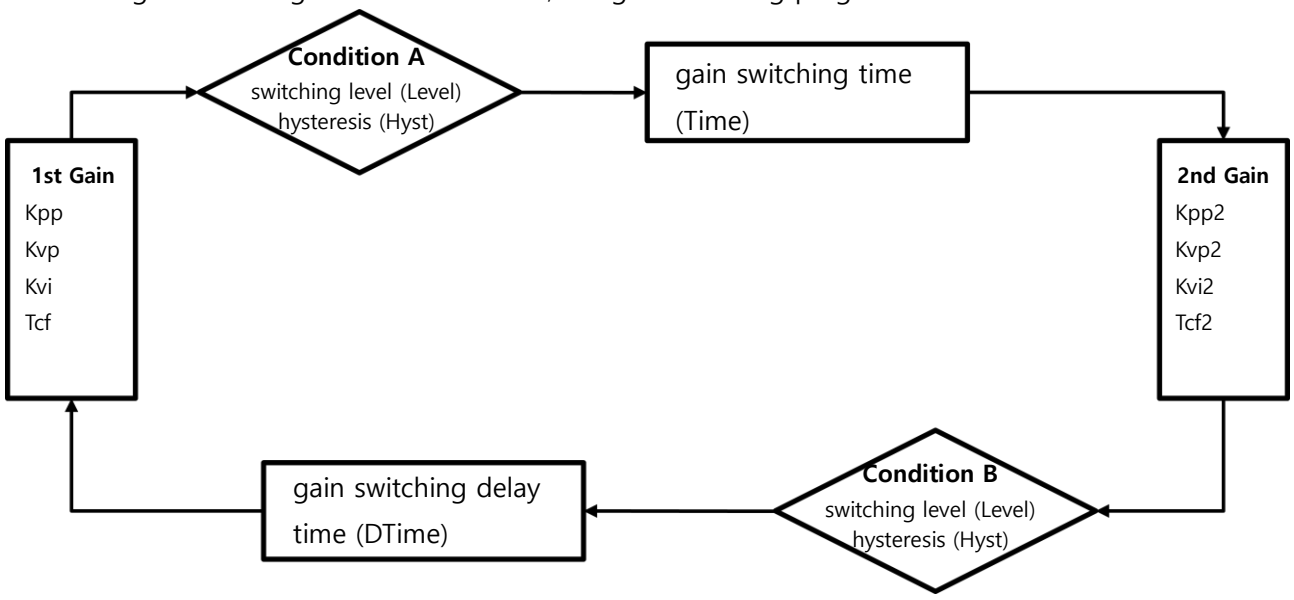
A servo module has two gains which can be switched according to the setup and conditions of the parameter.

As for the position loop gain and the velocity loop gain, the 2nd gain is set up to be greater than the 1st gain.
The 2nd velocity loop time constant is set to approximately 300 (ms).
As for the velocity detection filter and the torque filter, the 1st gain and the 2nd gain are identically set up.

Gain Switching	Position Loop Gain	Velocity Loop Gain	Velocity Loop Time Constant	Torque Filter
1st gain	Kpp	Kvp	Kvi	Tcf
2nd gain	Kpp2	Kvp2	Kvi2	Tcf2

[Table 2-1 Position Velocity Switching Gain]

When the gain switching function is enabled, the gain switching progresses as follows.



[Fig. 2-1 Procedure of 2nd gain switching]

2.2 Parameters for Effectively Setting up Gain Switching

2.2.1 Action Setup (Act)

- Description : Parameter for setting up the switching of the 1st gain and the 2nd gain
- Setup range : 0 to 1
- If Act value is 0 : Only the 1st gain is used.
- If Act value is 1 : The 1st/2nd gain can be switched.
- Standard value : 0

2.2.2 Gain Switching Mode (Mode)

- Description : Parameter for determining a gain switching mode on a basis of the amount of positional error
- Setup range : 0
- Standard value : 0

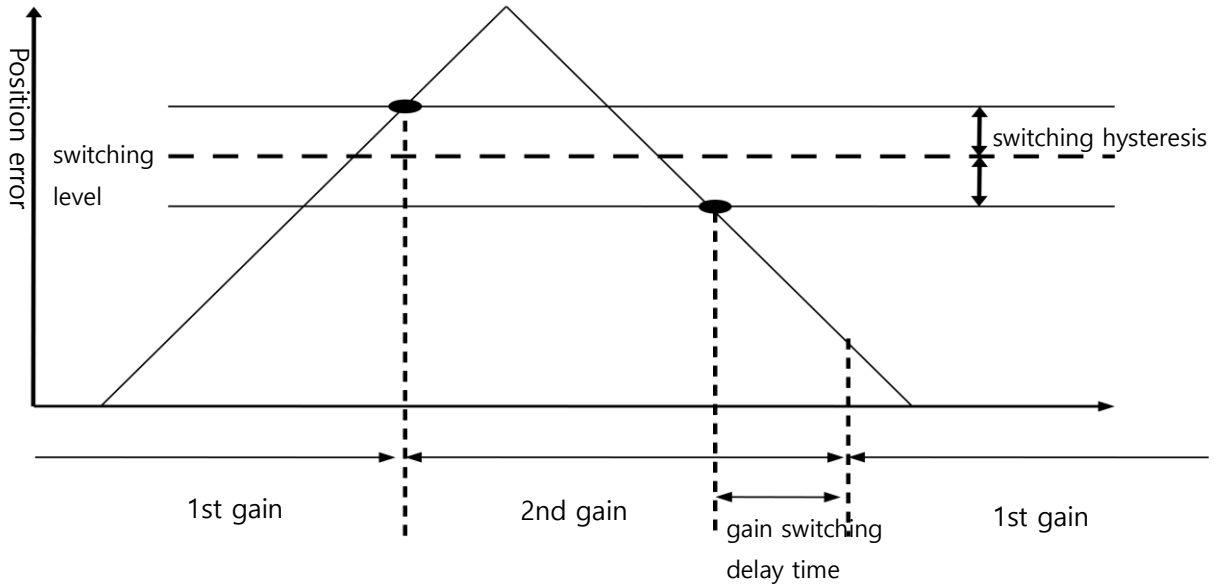
2.2.3 Gain Switching Level (Level)

- Description : Parameter for determining the switching level of the 1st gain and the 2nd gain
- Unit : -
- Setup range : 0 to 10000
- If Level value is increased : The gain switching level is raised.
- If Level value is decreased : The gain switching level is lowered.
- Standard value : 3000

2.2.4 Gain Switching Hysteresis (Hyst)

- Description : Parameter for setting the upper and lower width with regard to the switching level set up in the gain switching level parameter.

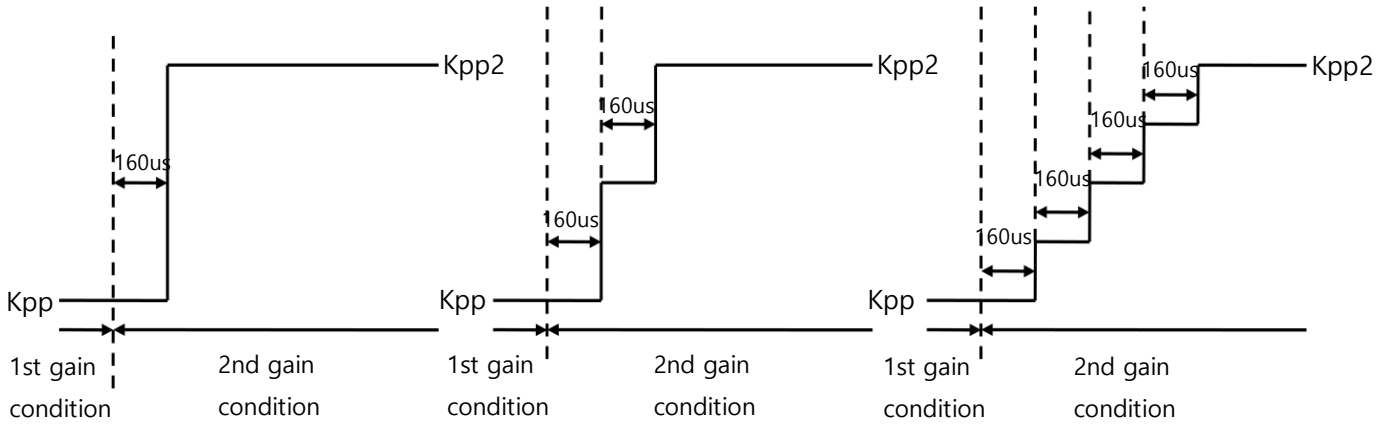
  To be switched from 1st gain to 2nd gain, the position error must be greater than Switch Level+ Hyst Switch. To the contrary, to be switched from 2nd gain to 1st gain, the position error must be less than Switch Level - Hyst Switch.
- Unit : -
- Setup range : 0 to 10000
- If Hyst value is increased : The hysteresis width increases with regard to a gain switching level.
- If Hyst value is decreased : The hysteresis width decreases with regard to a gain switching level.
- Standard value : 300



[Fig. 2-2 Gain switching conditions]

2.2.5 Gain Switching Time (Time)

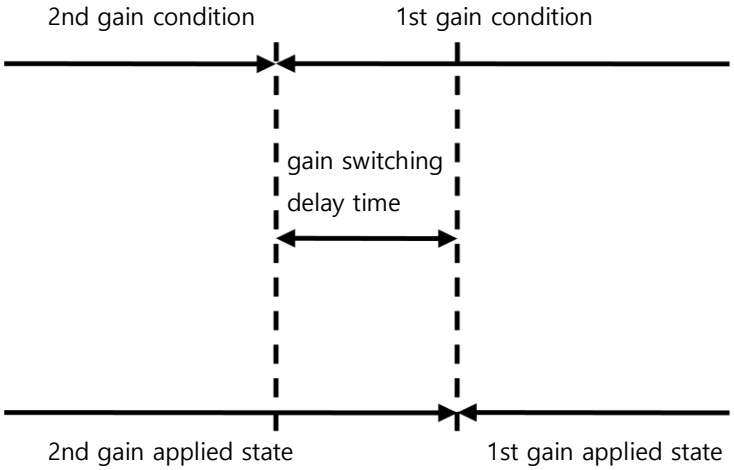
- Description : This is to alleviate the shock by gradually changing the gain when the 2nd gain switching function is used, since, if the position loop gain is changed at a time, the robot may be given the big shock.
- Unit : (Setup value + 1) * 160us (Switching time of minimum 160us is consumed.)
- Setup range : 0 to 10000
- If Time value is increased : Shock can be much alleviated because the step number of gain change increases, but gain switching is delayed.
- If Time value is decreased : Gain switching becomes faster because the number of gain change steps, but the extent of shock alleviation is reduced.
- Standard value : 10



[Fig. 2-3 Gain switching time]

2.2.6 Gain Switching Delay Time (Dtime)

- Description : Parameter for setting up the delay time when switching from the 2nd gain to the 1st gain.
- Unit : 160us
- Setup range : 0 to 10000
- If Dtime value is increased : The delay time when switching to the 1st gain increases.
- If Dtime value is decreased : The delay time when switching to the 1st gain decreases.
- Standard value : 10



[Fig. 2-4 Gain switching delay time]

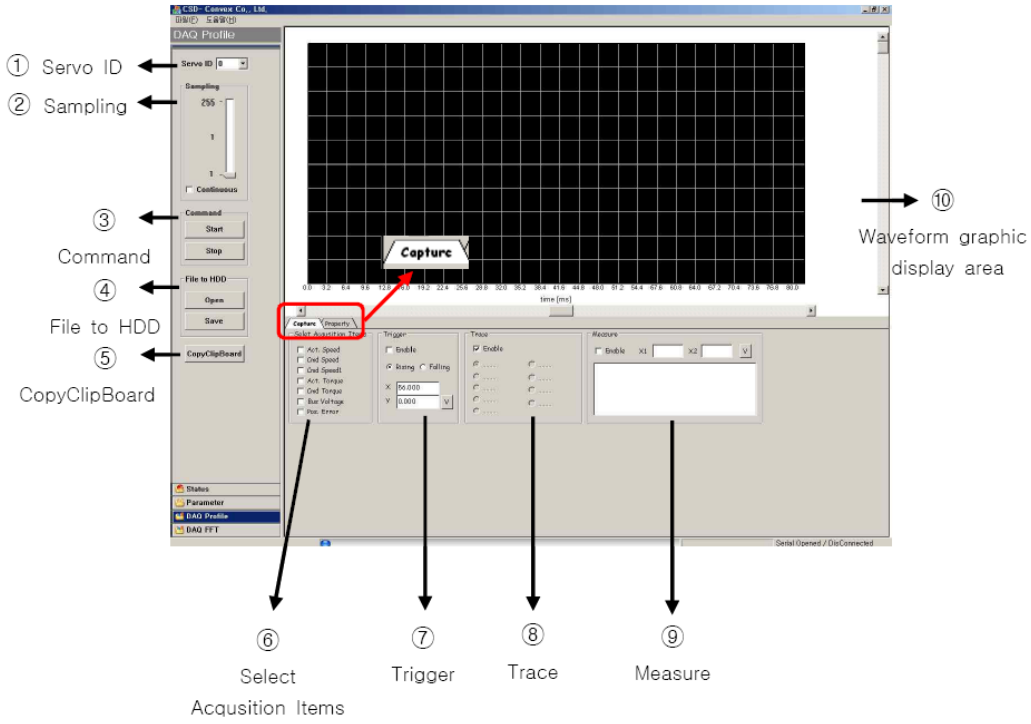
Chapter 3 How to Use Monitoring Program

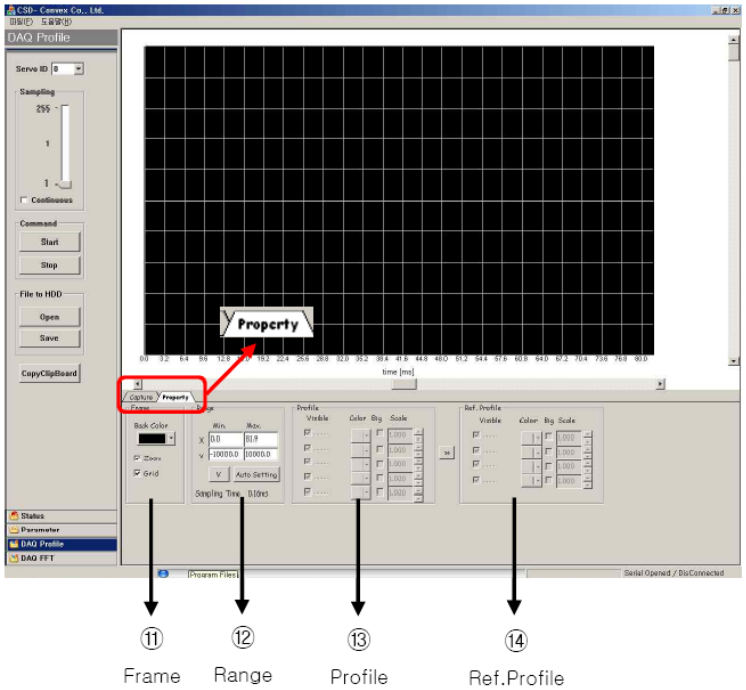
3.1 DAQ Profile

Data used in a servo module is graphically displayed.

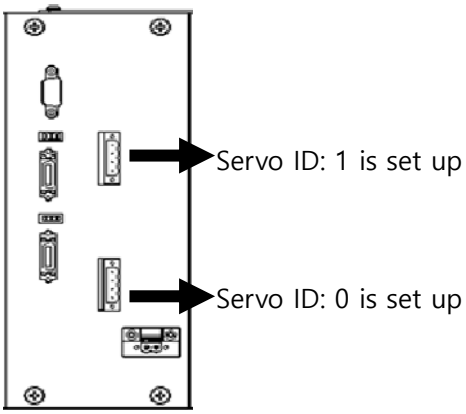
In Command bar, if 

is clicked, DAQ_Capture window is displayed.

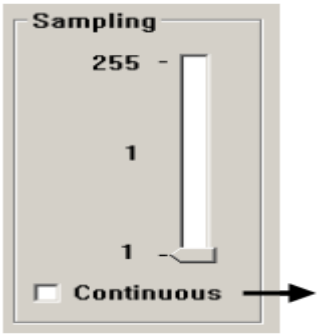




①. Servo ID : A servo module supports 2 axes, and selects the corresponding axis according to the setup value.



②. Sampling : Data sampling time is set up. The unit is 160 us. If 10 is set up, the data sampling interval is 1.6 ms.

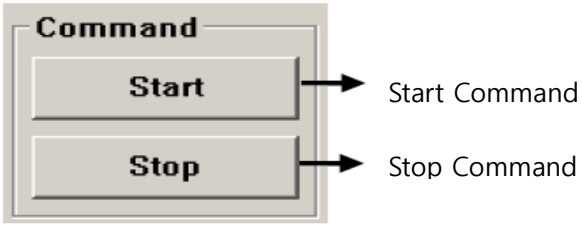


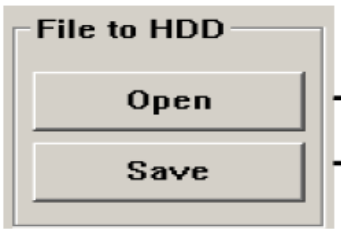
If Continuous is checked, data is continuously acquired by performing Command Start one time.

③. Command

Start : Data is acquired and the graph is drafted under the conditions of ②, ⑥, and ⑦. If Continuous (②) is checked, the data is continuously acquired and the graph is drafted till Stop. If it is not checked, the data acquisition is performed only one time, and stops.

Stop : Data acquisition is stopped.





Data saved as a file is displayed in the form of graph.

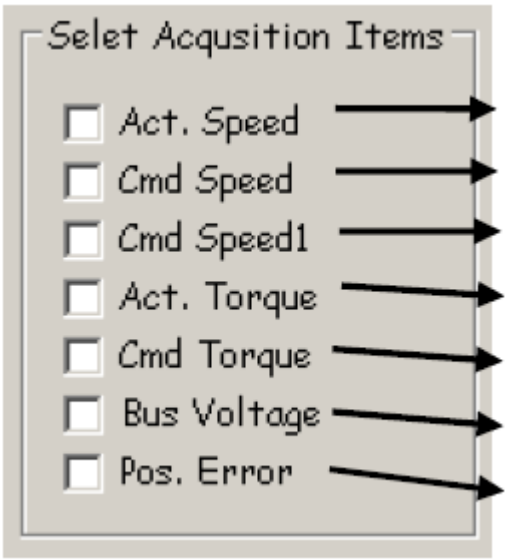
The acquired data is saved as a file (*.csp).

④. File to Hdd : Data can be saved or opened as a file.

⑤. Copy Clipboard : Copied into Clip Board of PC to be pasted in a text editor of Excel program or the like.

⑥. Select Acquisition Items : Data to be acquired is selected. Selectable up to 4 items. When at least one item has been selected, 

button becomes enabled.



Actual motor operation speed

Commanded speed : Speed or velocity commanded by the speed command of a higher level controller or the internal speed command

Commanded speed 1 : Commanded speed after the smoothing filter or FIR filter

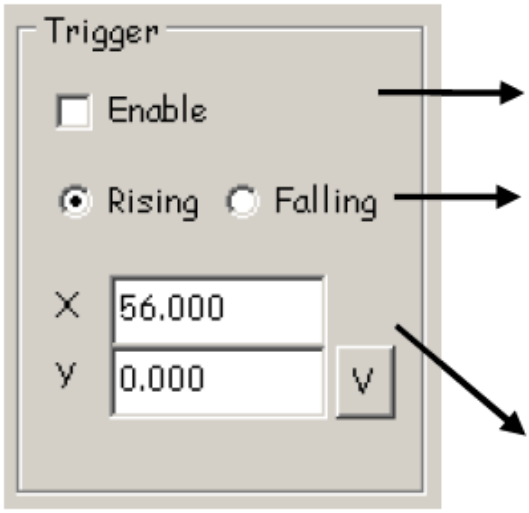
Actual torque : Actual motor torque (% ratio versus the rated motor torque)

Commanded torque : % ratio versus the rated motor torque

DC link voltage

Positional error: If this positional error is selected, In_Position is automatically displayed.

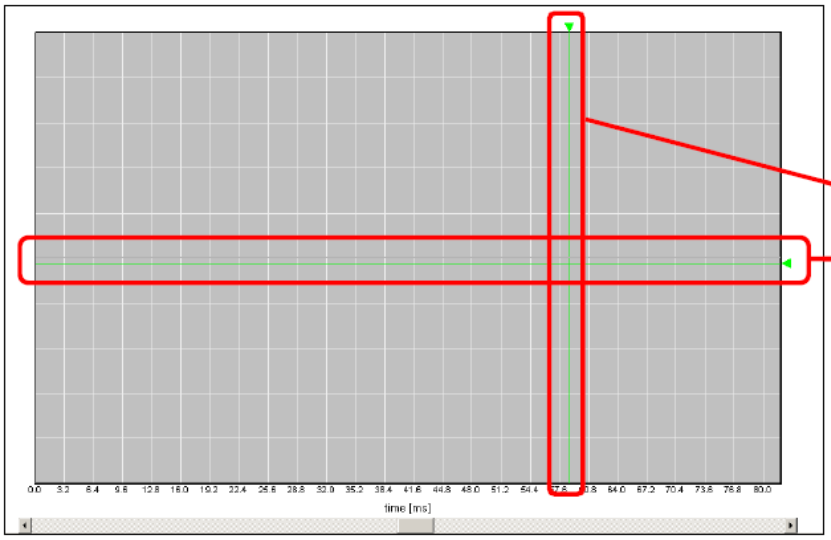
⑦. Trigger : Data being frequently changed is acquired in accordance with the user specified conditions (X-axis position, Y-axis level, etc.) and is displayed on a screen. A source for the trigger is Act. Speed.



If Enable is checked, the trigger function is available to acquire the data.

This selects the types of an edge triggered.
The rising edge is triggered when the speed increases, while the falling edge is triggered when the speed decreases.

Used to directly enter the triggering condition.
After X and Y values are entered, V must be clicked to apply the values.

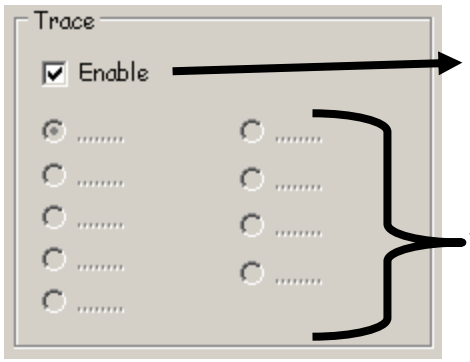


트리거 설정바
Trigger setting bar

Instead of direct entry, it can be set up as follows.
If Trigger Enable is checked, green X-axis and Y-axis cursor bars appear. Adjust the positions, using a mouse. X-axis and Y-axis can be simultaneously adjusted by moving the cursor bars while Ctrl key is being depressed.

To acquire the data as a changed value by changing the trigger condition, Start button must be clicked in ③ Command. If it has been already started, press Stop and then again press Start.

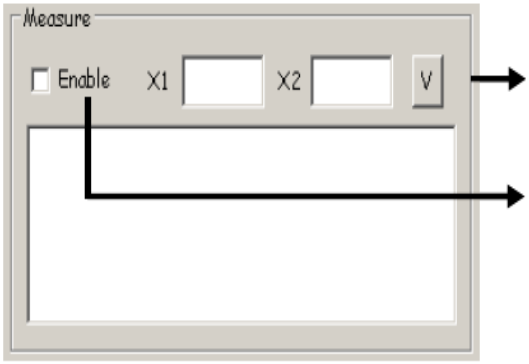
⑧. Trace : The acquired data values are displayed at the top center of a screen.



If Enable is selected, Trace function can be used.

Types of data to be traced are selectable.

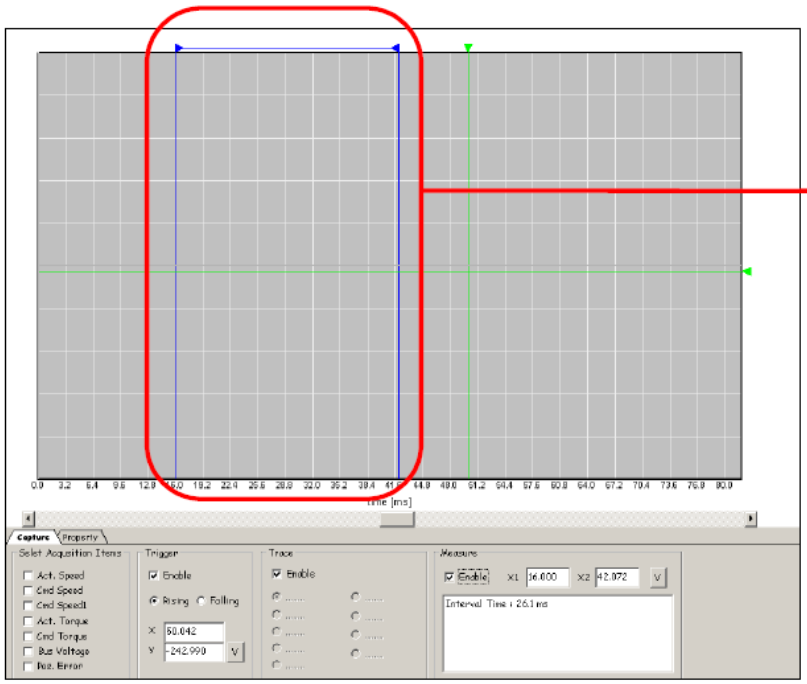
⑨. Measure : Data value acquired by using X1 and X2 cursors, or the difference between two cursors can be measured. If Enable is checked, a blue Y-axis cursor appears. Move this cursor by a mouse to move the position to be measured. Alternatively, by entering the values in X1 and X2 windows and pressing V, the position moves.



Write the range in X1 and X2, and press V to set up the range.

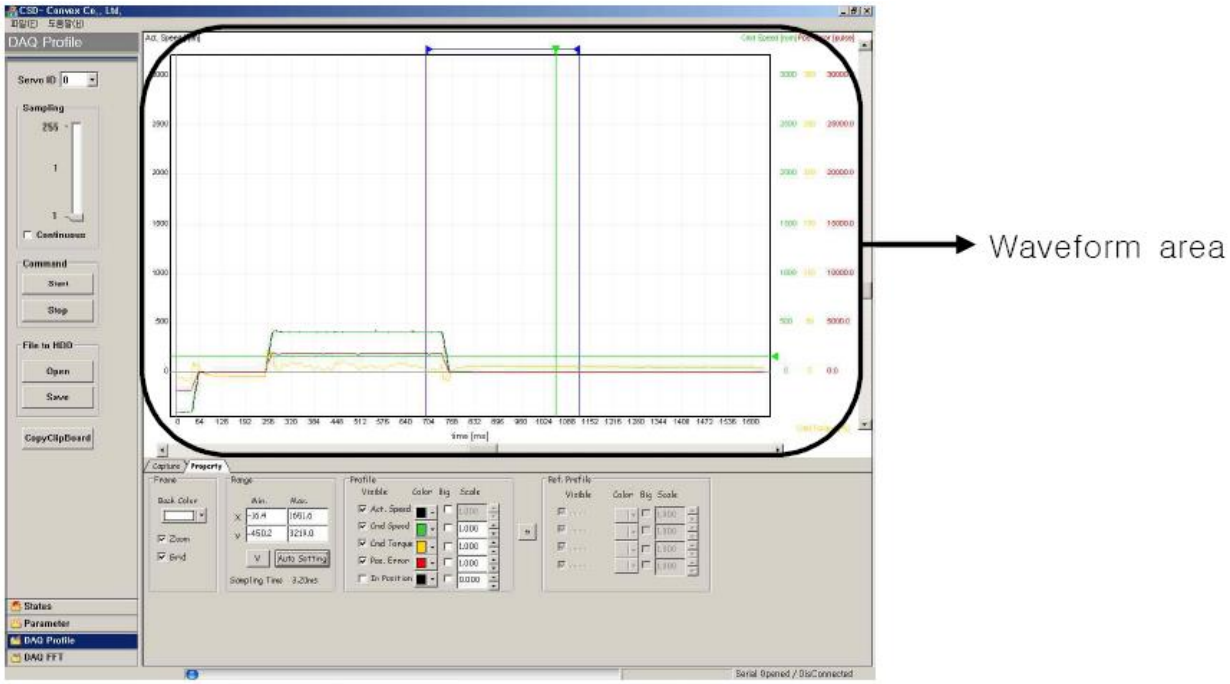
If Enable is checked, the range to be measured can be selected by a mouse.

In another way, Shift key and a mouse can be simultaneously used. By moving a mouse while Shift + mouse left button is being depressed, X1 cursor moves. By moving a mouse while Shift + mouse right button is being depressed, X2 cursor moves. When the cursor position is moved to the desired position, the measured data of the position, that the cursor directs to and the difference between X1 and X2, are displayed in a text window. This will be usefully used in measurement of Settling Time.

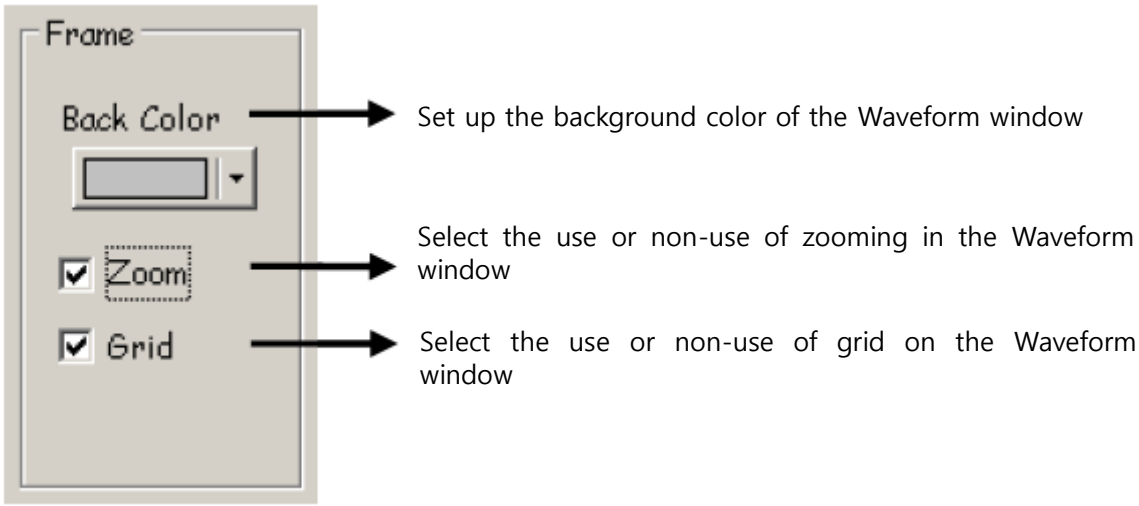

Range to be measured setting bar


Range to be measured
Measure
Enable
X1 128.000
X2 336.576
V
Interval Time : 208.6 ms
Act. Speed => 220.0 mm/s (77.5, 297.5)
Cmd Speed => 187.5 mm/s (112.5, 300.0)
Cmd Torque => 27.7 % (31.7, 3.9)
Pos. Error => 1624.0 pulse (1598.0, 3022.0)

⑩. Waveform graphic display area : The selected data is graphically displayed in the wave form.



⑪. Frame : For setup of use environment of the Waveform window.



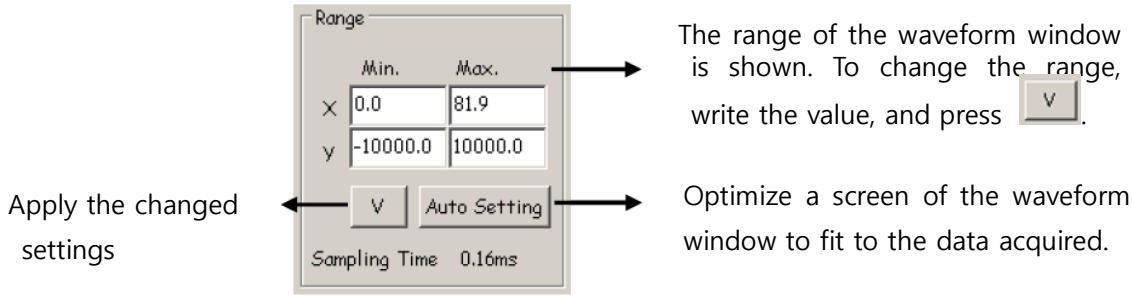
- How to use zooming

  If a mouse is moved right while its left button is being depressed, a square box is displayed.

  When selecting the area to be zoomed-in and releasing the mouse button, the square area is zoomed-in on a screen.

  If a mouse is moved left while its left button is being depressed, an object is zoomed-out.

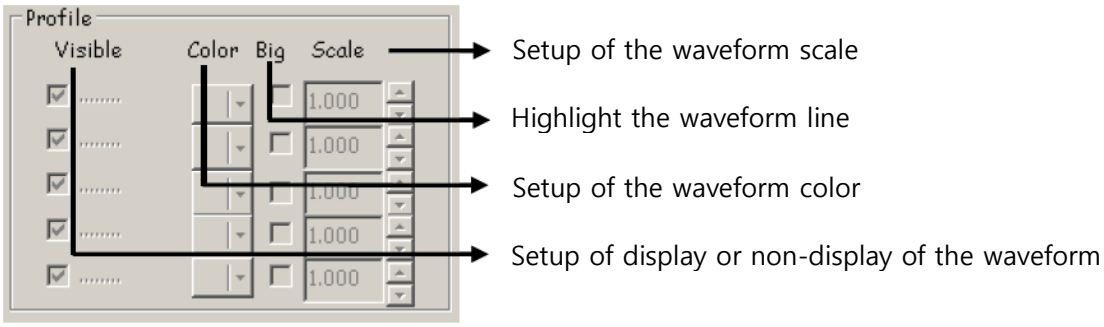
⑫. Range : Display range of the Waveform window is set up or shown.



⑬. Profile : Visible, Color, Scale, or the like can be set up for analysis of the captured waveform.

The reference waveform can be set to Ref.Profile by pressing ».

Ref.Profile waveform is retained so that it can be compared with the next updated waveform for analysis.



⑭. Ref.Profile : A waveform which will be a reference for analysis of the captured waveform is displayed. For this, Visible, Color, Scale, or the like is set up. How to set up this is identical to Profile setup.

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N1 ROBOT CONTROLLER

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