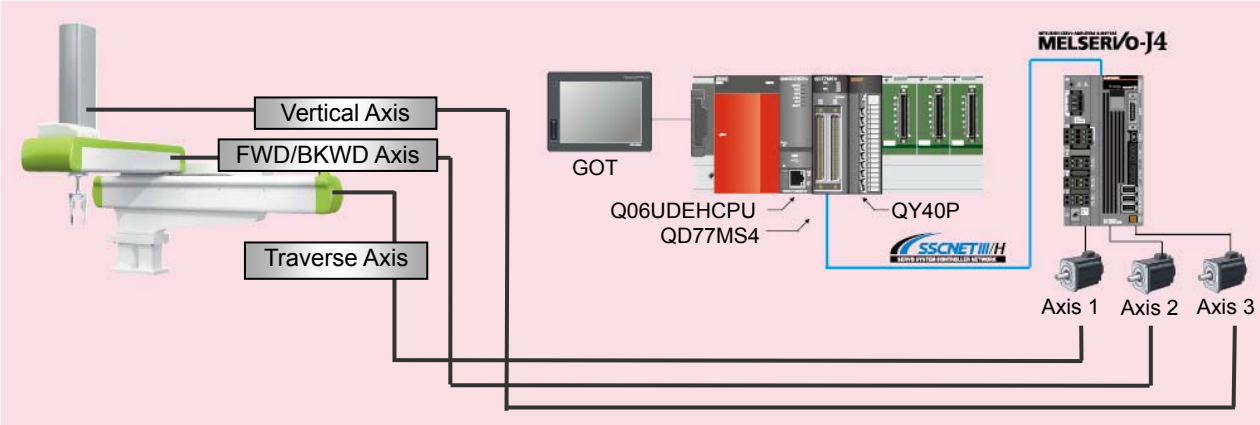
Take-out Robot

[System Configuration]



[Mitsubishi solution]

PLC CPU: Q06UDEHCPU **Simple Motion module: QD77MS4** **Servo amplifier: MR-J4W3-B**
Main base: Q35DB **Output Module: QY40P** **Servo motor: HG-KR**
GOT: GT165*-V
Engineering environment: MELSOFT GX Works2 (PLC), MELSOFT GT Works3 (GOT)

[Operation Description]

The product created with an injection molding machine is lifted, and then transported to the next work station.

[Control Points]

Point1: Reduction of the hand vibration through usage of the Advanced Vibration Suppression Control II.
Point2: Creation of a compact machine through usage of 3-axis servo amplifier.
Point3: Pick/Place and Transport positioning operations based on positioning control through positioning table created data in Simple Motion modules.

[Positioning Data Setting]

			Traverse Axis Positioning Address	Forward/Backward Axis Positioning Address	Vertical Axis Positioning Address
No.	Operation pattern	Control system	Positioning address 1	Positioning address 2	Positioning address 3
1	1:CONT	15h:ABS Linear 3	0.0 µm	0.0 µm	0.0 µm
	<Positioning Comment>Home Position (Extract Side)				
2	1:CONT	15h:ABS Linear 3	0.0 µm	0.0 µm	500000.0 µm
	<Positioning Comment>Down (Extract Side)				
3	1:CONT	15h:ABS Linear 3	0.0 µm	1000000.0 µm	500000.0 µm
	<Positioning Comment>Advance (Extract Side)				
4	1:CONT	15h:ABS Linear 3	0.0 µm	0.0 µm	500000.0 µm
	<Positioning Comment>Backward (Extract Side)				
5	1:CONT	15h:ABS Linear 3	0.0 µm	0.0 µm	0.0 µm
	<Positioning Comment>Up (Extract Side)				
6	1:CONT	15h:ABS Linear 3	1000000.0 µm	0.0 µm	0.0 µm
	<Positioning Comment>Traveling (Release Side)				
7	1:CONT	15h:ABS Linear 3	1000000.0 µm	0.0 µm	500000.0 µm
	<Positioning Comment>Down (Release Side)				
8	1:CONT	15h:ABS Linear 3	1000000.0 µm	0.0 µm	0.0 µm
	<Positioning Comment>Up (Release Side)				
9	0:END	15h:ABS Linear 3	0.0 µm	0.0 µm	0.0 µm
	<Positioning Comment>Traveling (Extract Side)				

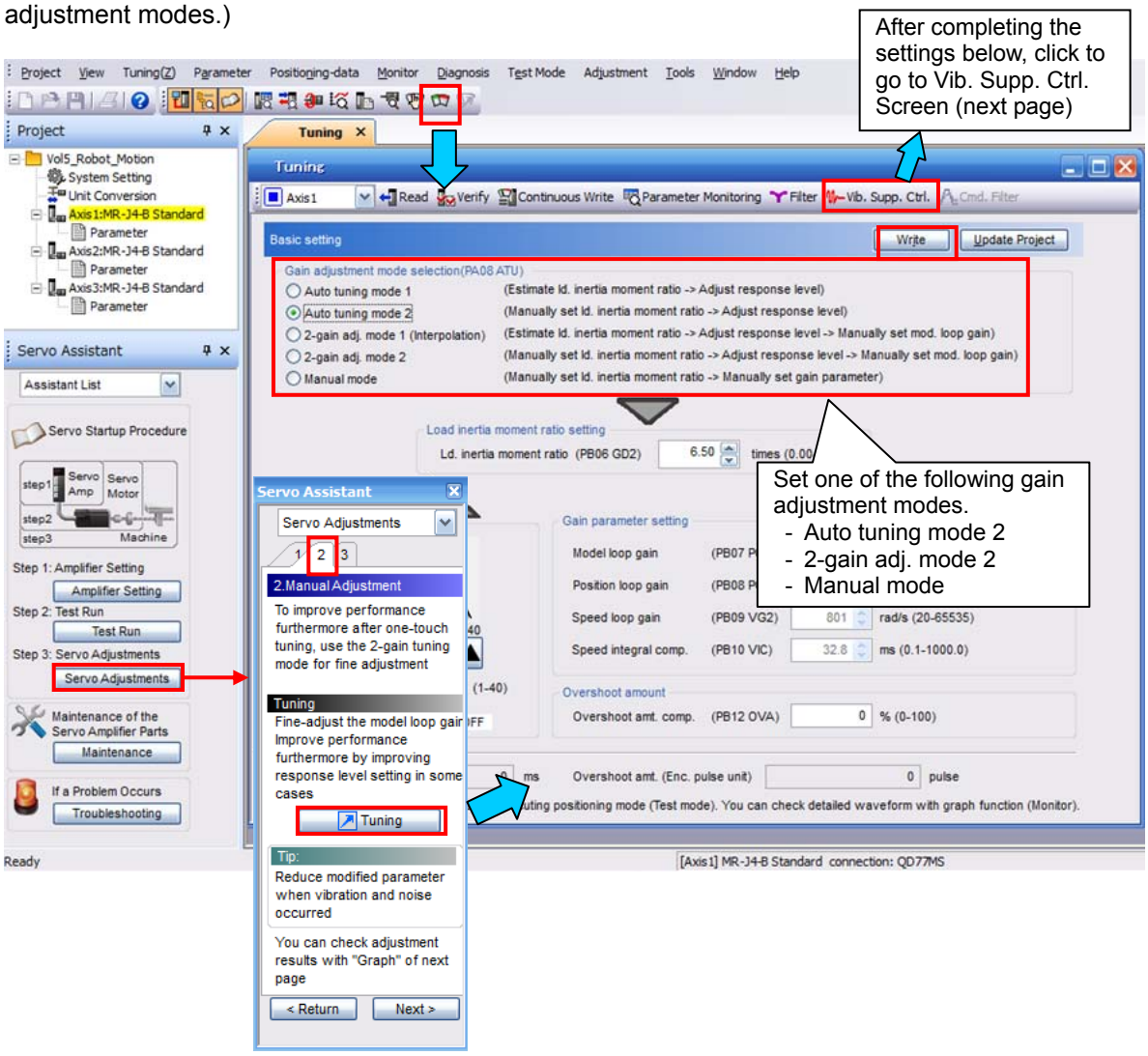
BCN-B62005-683-A

[Advanced Suppression Control II Setting Procedure]

Based on the suppression algorithms supporting “3 inertia system” machines, the machine end's (hand end) vibration frequency is automatically measured, and two machine end vibration points are able to be suppressed.

(1) Gain adjustment mode selection

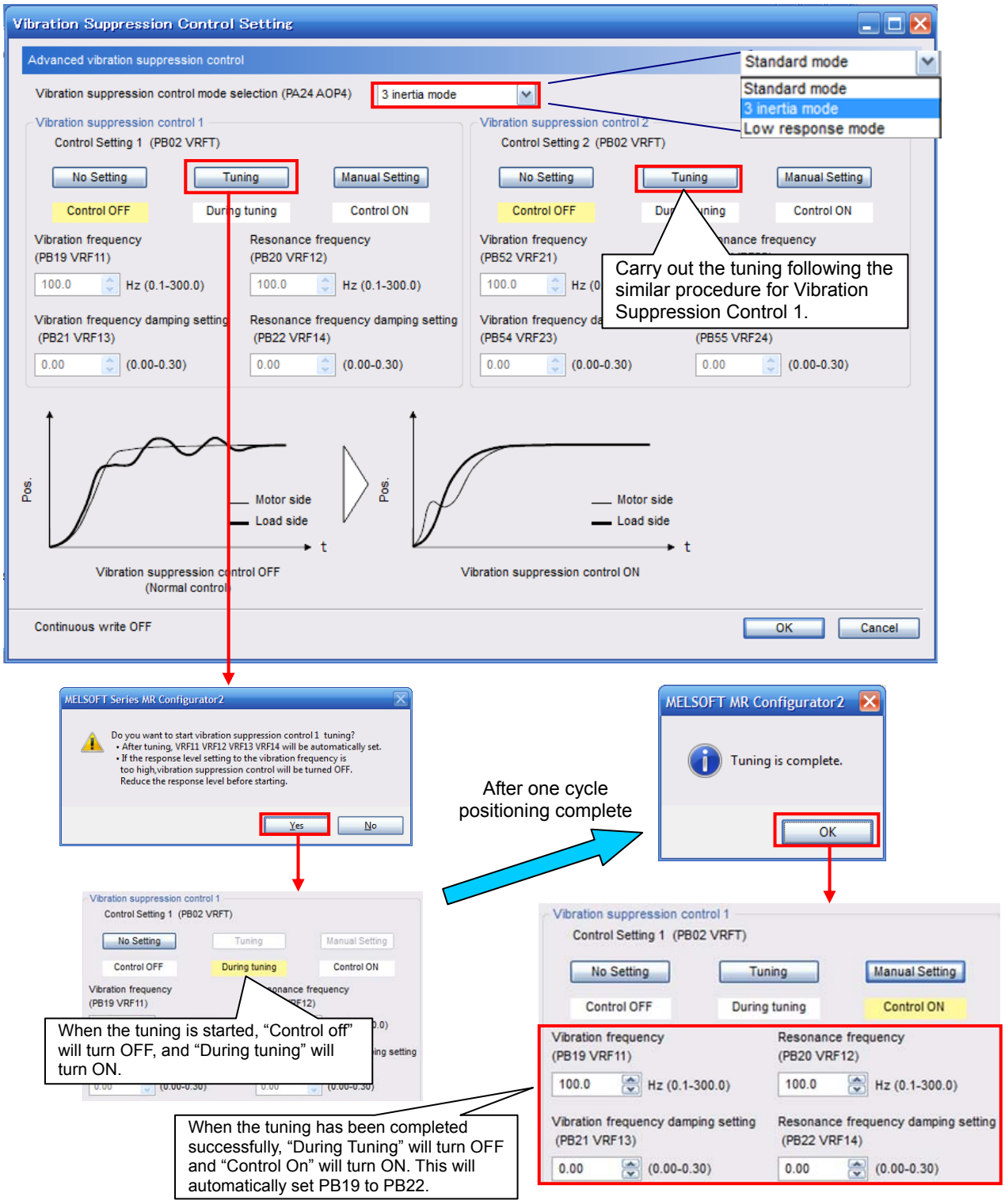
1) From the Simple Motion Setting Tool, click on the “Servo Parameter” to start MR Configurator2 for amplifier tuning. From the Servo Assistant Menu, go to “Servo Adjustments” → Tab “2” → “Tuning”. Or click on the tuning icon which is shown below.
2) From the “Gain Adjustment Mode Selection”, select “Auto tuning mode 2”, “2-gain adj. mode 2”, or “Manual mode”, and click the “Write” button. (Vibration suppression is only available via these gain adjustment modes.)



3) Click on the “Vib. Supp. Ctrl.” (Vibration Suppression Control) icon to bring up the Advanced Vibration Suppression Control screen.

(2) Advanced suppression control

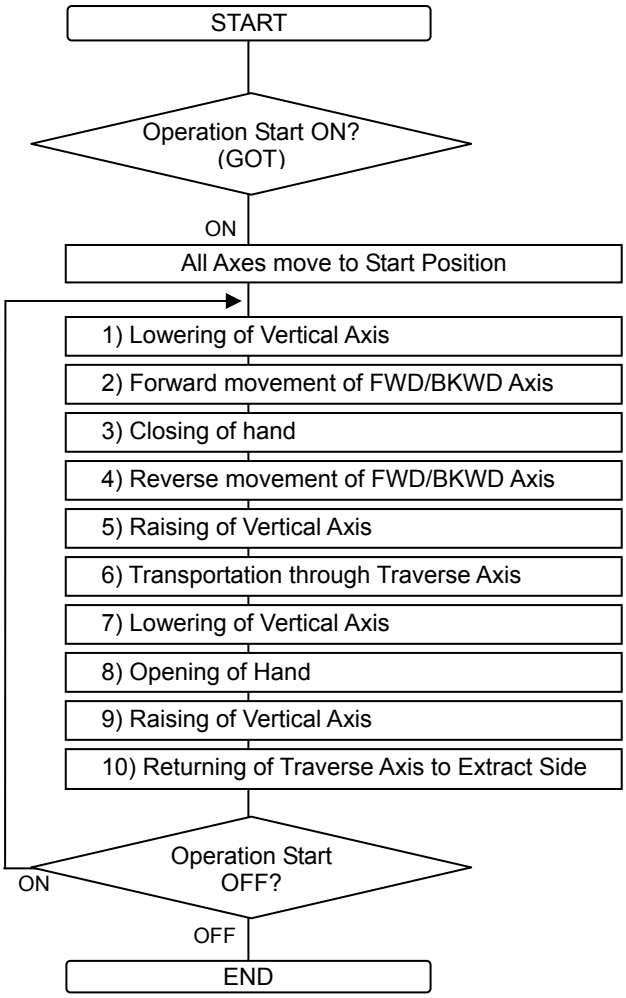
1) Select “3 inertia mode” from the Vibration suppression control mode selection.
2) Start the positioning mode (Pick/Place operation, refer to next page). Set the stopping time of the positioning operation of the hand end so the hand end vibration can slow and stop before the next positioning operation. (In the positioning data table, prepare the operation stopping time based on the dwell time, etc. of the FWD/BKWD axis and the horizontal axis.)
3) By pressing the “Tuning” button of the Vibration Suppression Control 1 and 2, the vibration suppression control tuning will start.

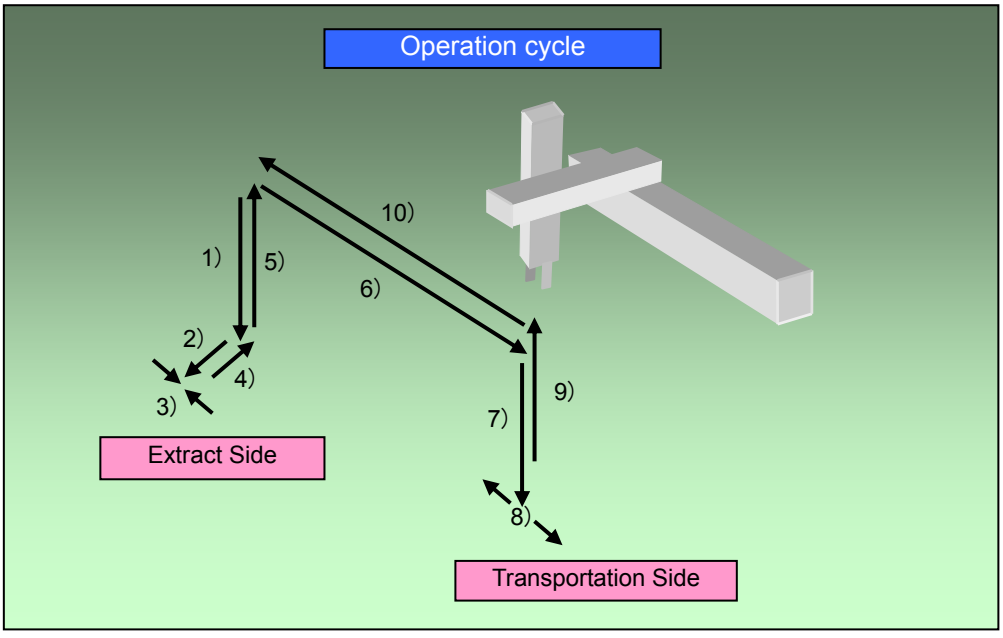


4) When the tuning is completed, the Vibration Suppression Control 1 parameters, PB19 to PB22, and the Vibration Suppression Control 2 parameters, PB52 to PB55 will automatically be set, thus suppressing vibrations during positioning.

[Operation Flowchart]

The product is grabbed after the machine moves to the starting point based on the GOT start switch. After, the product is transported and placed, and finally the machine returns back to the original grabbing point, where the entire operation is repeated again.





[Using the Sample Program]

[Sample program configuration]

File name	Description	Model	Engineering environment
Vol5_Robot_PLC.gxw	Ladder program	Q06UDEHCPU	MELSOFT GX Works2
Vol5_Robot_Motion.pcw	Motion setting file	QD77MS4	
Vol5_Robot_GOT.GTW	GOT monitoring data	GT165*-V (640x480)	MELSOFT GT Works3

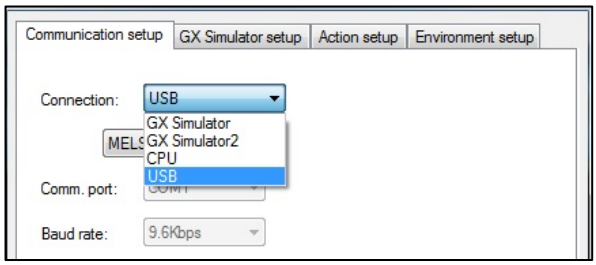
(Note): Equipment other than the servo amplifiers and servo motors in the system configuration (page 1) are required to operate sample program. Remove the circuit of amplifier-less operation function when connecting a servo amplifier to check the operation (page 10).

[Start-up]

1. Decompress the downloaded files to any folder in your PC.
2. Double clicking decompressed files to open the corresponding engineering tool.
3. Ladder program and GOT monitoring data as default are set for English environment. When using Japanese environment, it's possible to switch to Japanese for ladder program in GX Works2 [Tool] - > [Select Language] menu and for GOT monitoring data in GT Works3 Language change the preview column from [2] to [1].
4. Change the model settings according models to be used.
5. Write the sample program data to PLC CPU, Simple Motion and GOT.
6. After writing all the programs, reset the PLC CPU.

[Operating method]

Start operation by using the GOT touch button.
If you do not have GOT, operate the device with the appropriate touch button in GT Works3's simulator function (Note) or GX Works2's device test function.
(Note): When using GT Works3's simulator function, click on the "communication setup" tab of "Simulator setup" and select "USB" or "CPU(RS-232)" from the pull-down menu of "connection".



1. When you start-up the system, touch "Reset system" button on the GOT Main screen to perform home position return operation. Home position return complete lamp turns on when operation is completed.
2. After home position return operation is completed, press "Start Automatic" button, then automatic operation is started. Automatic operation is also stopped by pressing "Start Automatic" button again.
3. Each axis can be operated independently by using the JOG touch buttons.

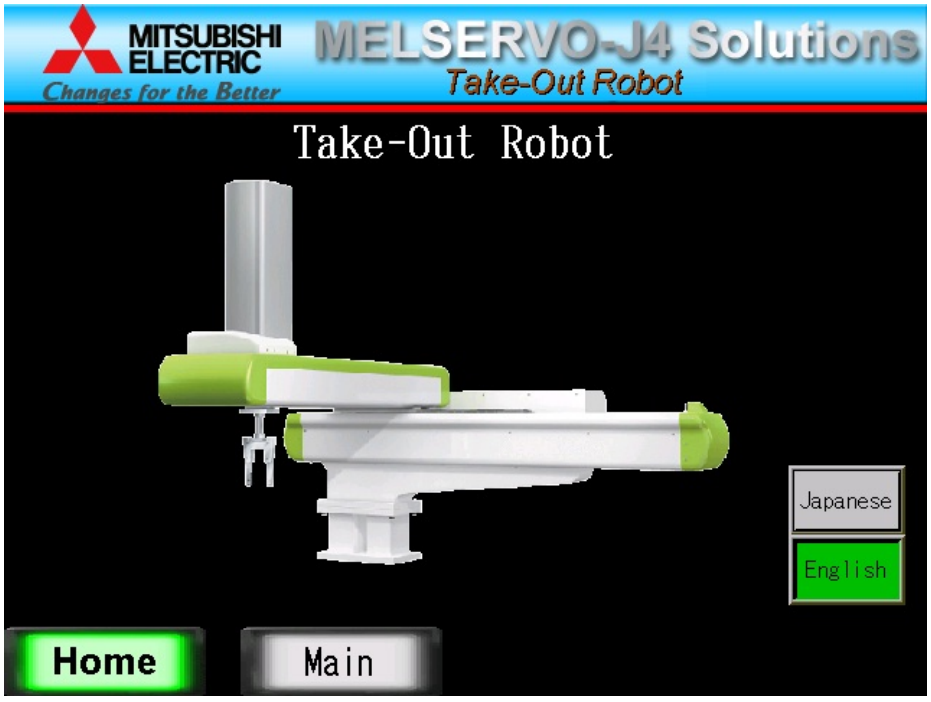
	Operation	GOT touch key	Device No.
1	Home Position Return	Reset System	B1
2	Pick/Place Operation	Automatic Start	B0
3	JOG Traverse Forward	Traverse FWD	B11
	JOG Traverse Reverse	Traverse REV	B12
	JOG Forward/Backward Forward	FWD/BKWD FWD	B13
	JOG Forward/Backward Reverse	FWD/BKWD REV	B14
	JOG Vertical Raise	Vertical DOWN	B15
	JOG Vertical Lower	Vertical UP	B16

[Operation check method]

1. Start the digital oscilloscope function of Simple Motion module setting tool.
2. A trigger condition is automatic operation start (B0). During automatic operation, speed waveform of each axis is registered.
3. Check collected waveforms with operation pattern.

[GOT Sample screen]

[GOT Home Screen]

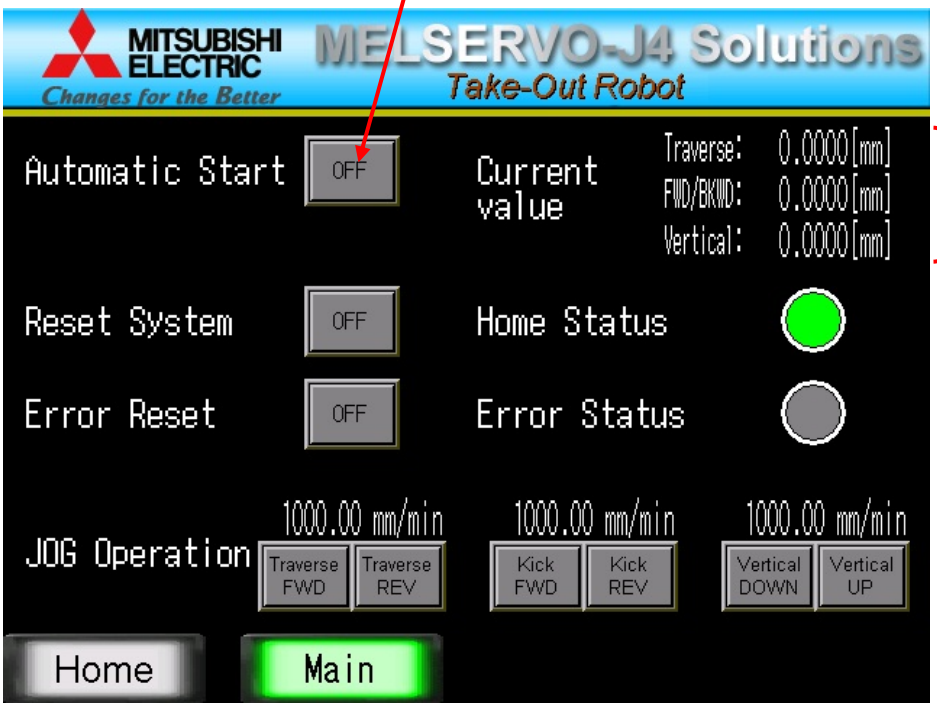


Language Selection

Screen Selection

Operation start button
The dispenser operation (Refer to page 4) is carried.

[GOT Main Screen]

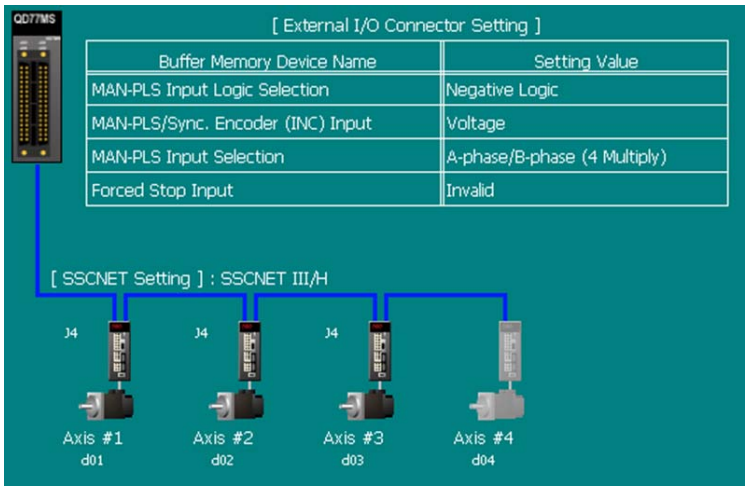


Current Value
Displays the current position of each axis.

JOG Operation Button
Displays the FWD/REV JOG status of each axis.

(Note): Sample screen as default are set for English environment. When using Japanese environment, it's possible to switch to Japanese for GOT monitoring data in GT Works3 Language change the preview column from [2] to [1].

[System settings]



Axis 1: Traverse Axis
Axis 2: FWD/BKWD Axis
Axis 3: Vertical Axis

[Servo data settings]

Item	Axis #1	Axis #2	Axis #3
Basic parameters 1	**Set according to the machine and applicable motor when system is started up. (This parameter become valid when the PLC READY signal [Y0] turns from OFF to ON.)**		
Pr.1:Unit setting	0:mm	0:mm	0:mm
Pr.2:No. of pulses per rotation	4194304 PLS	4194304 PLS	4194304 PLS
Pr.3:Movement amount per rotation	50000.0 µm	50000.0 µm	50000.0 µm
Pr.4:Unit magnification	1:x1 Times	1:x1 Times	1:x1 Times
Pr.7:Bias speed at start	0.00 mm/min	0.00 mm/min	0.00 mm/min
Basic parameters 2	**Set according to the machine and applicable motor when system is started up.**		
Pr.8:Speed limit value	150000.00 mm/min	150000.00 mm/min	150000.00 mm/min
Pr.9:Acceleration time 0	100 ms	100 ms	100 ms
Pr.10:Deceleration time 0	100 ms	100 ms	100 ms
Detailed parameters 1	**Set according to the system configuration when the system is started up. (This parameter become valid when the PLC READY signal [Y0] turns from OFF to ON)**		
Pr.11:Backlash compensation amount	0.0 µm	0.0 µm	0.0 µm
Pr.12:Software stroke limit upper limit value	2000000.0 µm	1000000.0 µm	1000000.0 µm
Pr.13:Software stroke limit lower limit value	-200000.0 µm	-100000.0 µm	-100000.0 µm
Pr.18:M code ON signal output timing	1:AFTER Mode	1:AFTER Mode	1:AFTER Mode
Detailed parameters 2	**Set according to the system configuration when the system is started up. (Set as required.)**		
Pr.31:JOG speed limit value	150000.00 mm/min	150000.00 mm/min	150000.00 mm/min
OPR basic parameters	**Set the values required for carrying out OPR control. (This parameter become valid when the PLC READY signal [Y0] turns from OFF to ON)**		
Pr.43:OPR method	6:Data Set Method	6:Data Set Method	6:Data Set Method
Pr.44:OPR direction	0:Forward Direction (Address Increase Direction)	0:Forward Direction (Address Increase Direction)	0:Forward Direction (Address Increase Direction)
Pr.45:OP address	0.0 µm	0.0 µm	0.0 µm

Motor Movement amount per rotation: 50 [mm]

The opening and closing of the hand is controlled based on the M-code outputted after each axes' Position Complete signal.

[Positioning Data]

(1) Axis 1 Positioning data: Traverse Axis

No.	Operation pattern	Control system	Axis to be interpolated	Acceleration time No.	Deceleration time No.	Positioning address	Arc address	Command speed	Dwell time	M code
1	1:CONT	15h:ABS Linear 3	Axis#2,Axis#3	0:100	0:100	0.0 µm	0.0 µm	150000.00 mm/min	0 ms	10
	<Positioning Comment>Home Position (Extract Side)									
2	1:CONT	15h:ABS Linear 3	Axis#2,Axis#3	0:100	0:100	0.0 µm	0.0 µm	150000.00 mm/min	0 ms	0
	<Positioning Comment>Down (Extract Side)									
3	1:CONT	15h:ABS Linear 3	Axis#2,Axis#3	0:100	0:100	0.0 µm	0.0 µm	150000.00 mm/min	0 ms	11
	<Positioning Comment>Advance (Extract Side)									
4	1:CONT	15h:ABS Linear 3	Axis#2,Axis#3	0:100	0:100	0.0 µm	0.0 µm	150000.00 mm/min	0 ms	0
	<Positioning Comment>Backward (Extract Side)									
5	1:CONT	15h:ABS Linear 3	Axis#2,Axis#3	0:100	0:100				0 ms	0
	<Positioning Comment>Up (Extract Side)									
6	1:CONT	15h:ABS Linear 3	Axis#2,Axis#3	0:100	0:100	1000000.0 µm	0.0 µm	150000.00 mm/min	0 ms	0
	<Positioning Comment>Traveling (Release Side)									
7	1:CONT	15h:ABS Linear 3	Axis#2,Axis#3	0:100	0:100	1000000.0 µm	0.0 µm	150000.00 mm/min	0 ms	12
	<Positioning Comment>Down (Release Side)									
8	1:CONT	15h:ABS Linear 3	Axis#2,Axis#3	0:100	0:100	1000000.0 µm	0.0 µm	1		0
	<Positioning Comment>Up (Release Side)									
9	0:END	15h:ABS Linear 3	Axis#2,Axis#3	0:100	0:100	0.0 µm	0.0 µm	150000.00 mm/min	0 ms	0
	<Positioning Comment>Traveling (Extract Side)									

Hand Closing

Extract Side →Transport End

Hand Opening

Transport End → Extract Side

(2) Axis 2 Positioning data: FWD/BKWD Axis

No.	
1	0.0 µm
	<Positioning Comment>Home Position (Extract Side)
2	0.0 µm
	<Positioning Comment>Down (Extract Side)
3	100000.0 µm
	<Positioning Comment>Advance (Extract Side)
4	0.0 µm
	<Positioning Comment>Backward (Extract Side)
5	0.0 µm
	<Positioning Comment>Up (Extract Side)
6	0.0 µm
	<Positioning Comment>Traveling (Release Side)
7	0.0 µm
	<Positioning Comment>Down (Release Side)
8	0.0 µm
	<Positioning Comment>Up (Release Side)
9	0.0 µm
	<Positioning Comment>Traveling (Extract Side)

Forward

Reverse

(3) Axis 3 Positioning data: Vertical Axis

No.	Positi
1	0.0 µm
	<Positioning Comment>Home Position (Extract Side)
2	500000.0 µm
	<Positioning Comment>Down (Extract Side)
3	500000.0 µm
	<Positioning Comment>Advance (Extract Side)
4	500000.0 µm
	<Positioning Comment>Backward (Extract Side)
5	0.0 µm
	<Positioning Comment>Up (Extract Side)
6	0.0 µm
	<Positioning Comment>Traveling (Release Side)
7	500000.0 µm
	<Positioning Comment>Down (Release Side)
8	0.0 µm
	<Positioning Comment>Up (Release Side)
9	0.0 µm
	<Positioning Comment>Traveling (Extract Side)

Lowering

Rising

Lowering

Rising

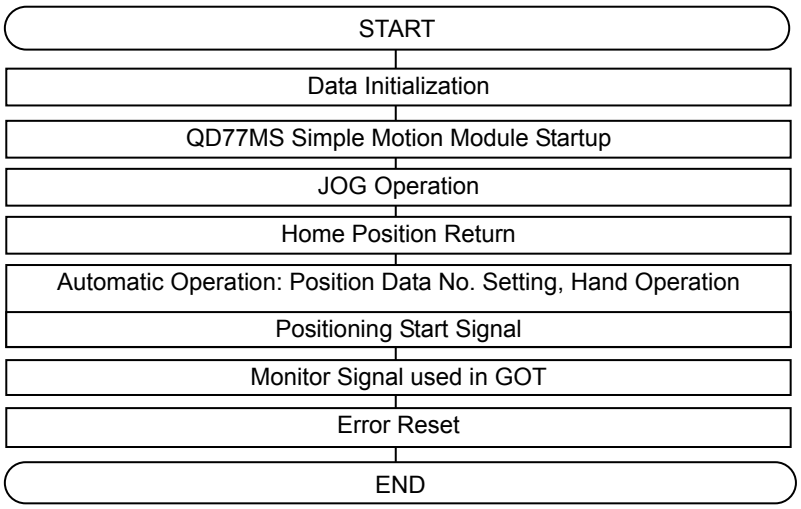
[Block start data]

Point No.	Shape	Start data No.	Special start instruction	Parameter	Condition data
1	1:Continue	1	05h:FOR Condition	1	30000(Buffer Memory) = 0(P1)
2	0:END	1	06h:NEXT Start	0	

When the Automatic Operation Start (B0) is ON, have the buffer memory (30000) bit 0 become ON. Until the Automatic Operation Start is turned OFF, the Positioning Table Operation (Pick/Place Operation) is repeated continuously.

[Sample Ladder Program Organization]

[MAIN: Scan Execution]



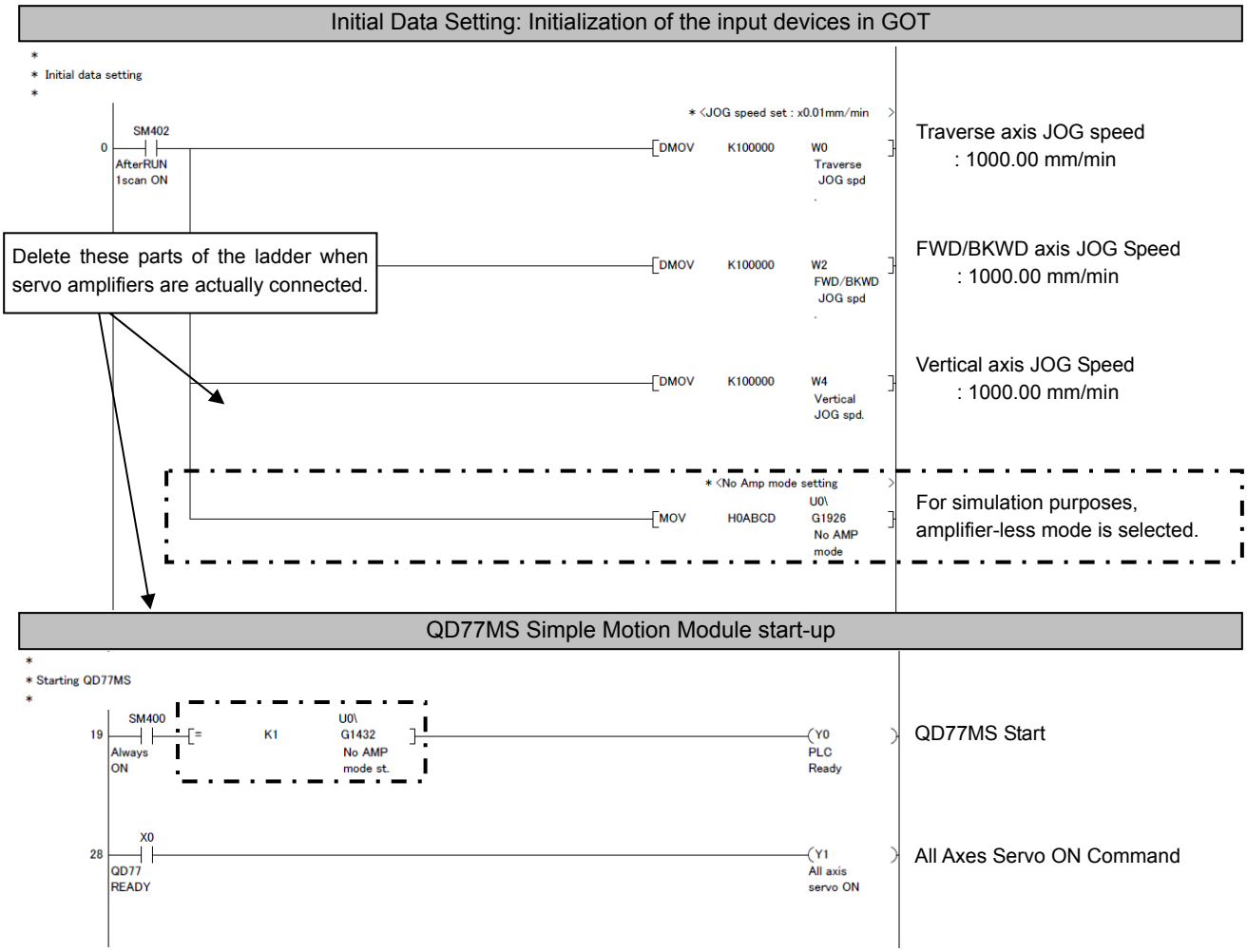
[Used Devices in this program]

Device No.	Content	Device No.	Content
B0	Automatic operation start (GOT)	W0	Traverse axis JOG Speed Setting (GOT): x 0.01[mm/sec]
B1	Home position return (GOT)	W1	
B2	Error reset (GOT)	W2	FWD/BKWD axis JOG Speed (GOT): x 0.01[mm/sec]
B5	Home position return complete lamp (GOT)	W3	
B6	Error lamp (GOT)	W4	Vertical axis JOG Speed Setting (GOT): x 0.01[mm/sec]
B11	Traverse axis JOG forward (GOT)	W5	
B12	Traverse axis JOG reverse (GOT)	U0\G30000.0	Automatic operation Start (B0) for Oscilloscope Sampling
B13	FWD/BKWD axis JOG forward (GOT)	U0\G30001.0	Hand Open/Close (Y20) for Oscilloscope Sampling
B14	FWD/BKWD axis JOG reverse (GOT)		
B15	Vertical axis JOG forward (GOT)		
B16	Vertical axis JOG reverse (GOT)		
M1	Traverse axis HPR start		
M2	FWD/BKWD axis HPR start		
M3	Vertical axis HPR start		
M4	Automatic operation start		
Y20	Hand Open/Close (ON: Close, OFF: Open)		

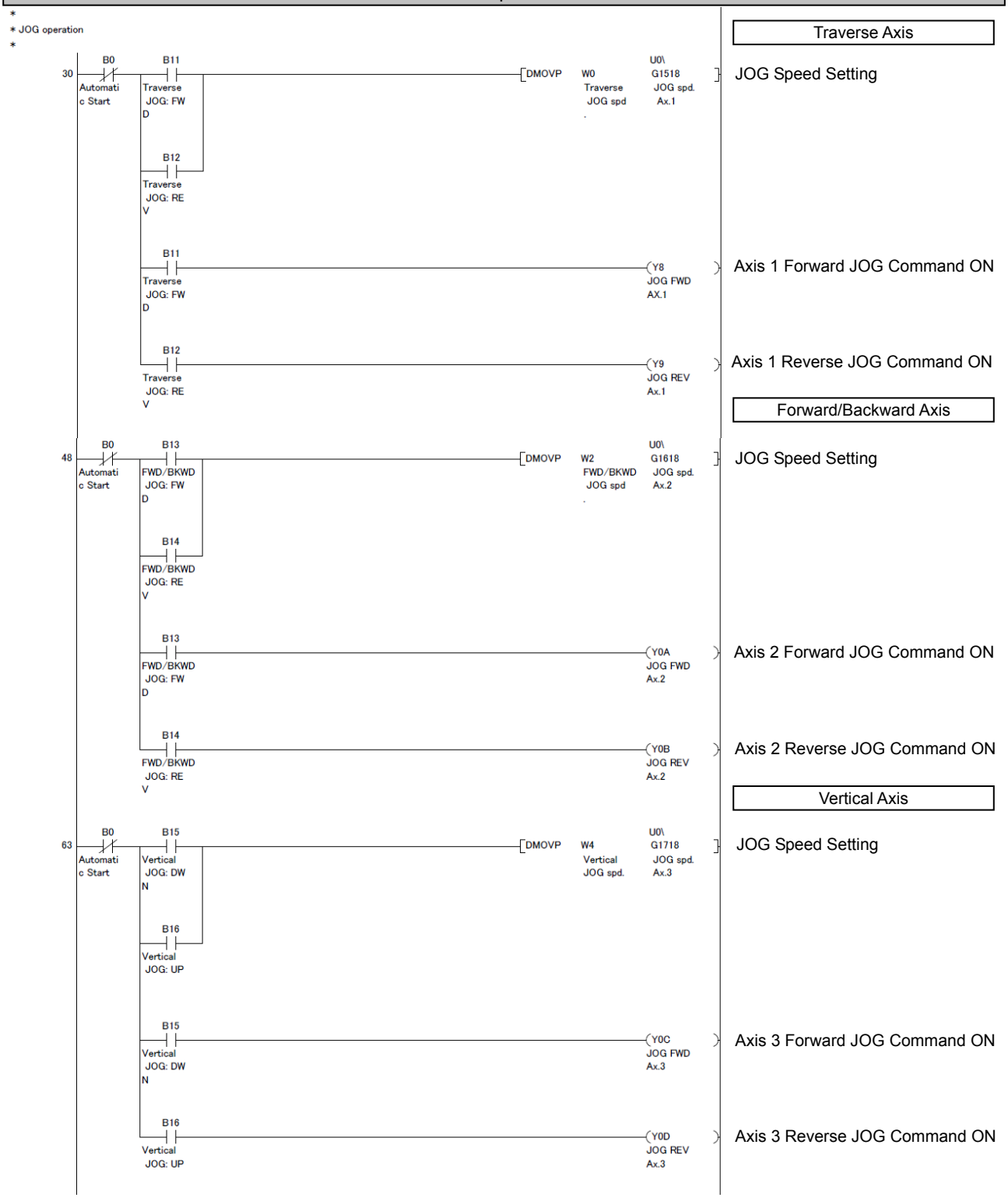
⚠ Cautions

- When diverting the sample program to the actual system, be sure to verify that there are no problems with control in the system.
- Add interlock conditions in the target system where considered necessary.

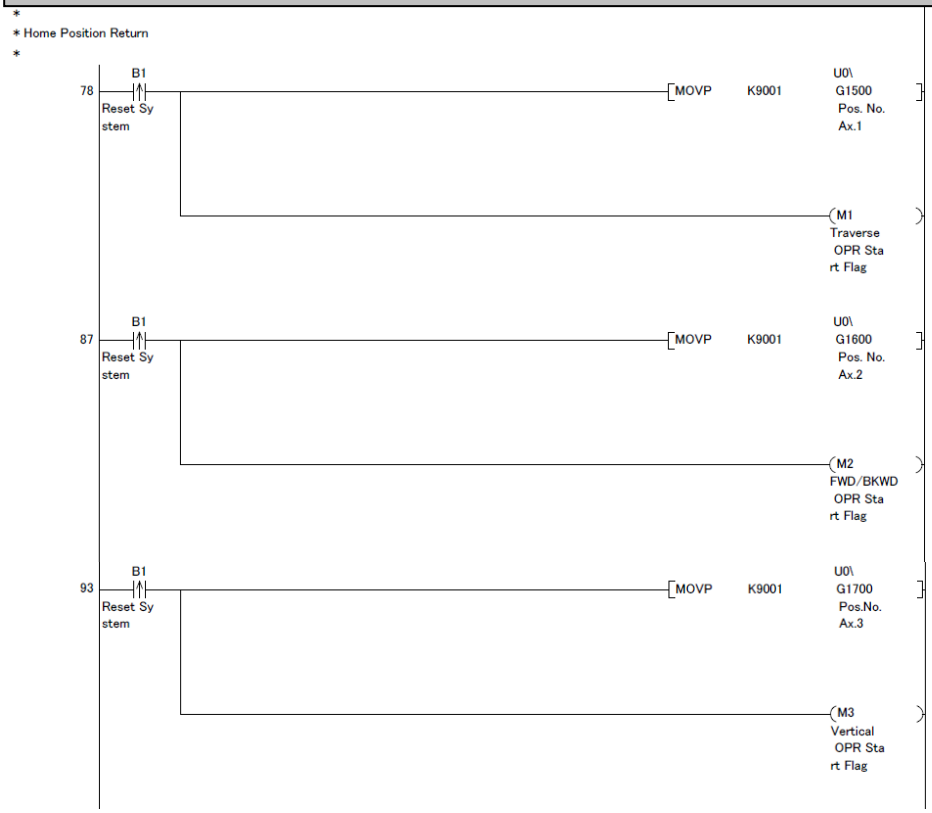
[Ladder program]



JOG Operation



Home Position Return



Traverse Axis

Positioning No.9001 (HPR) is set.

Positioning Start Flag ON

Forward/Backward Axis

Positioning No.9001 (HPR) is set.

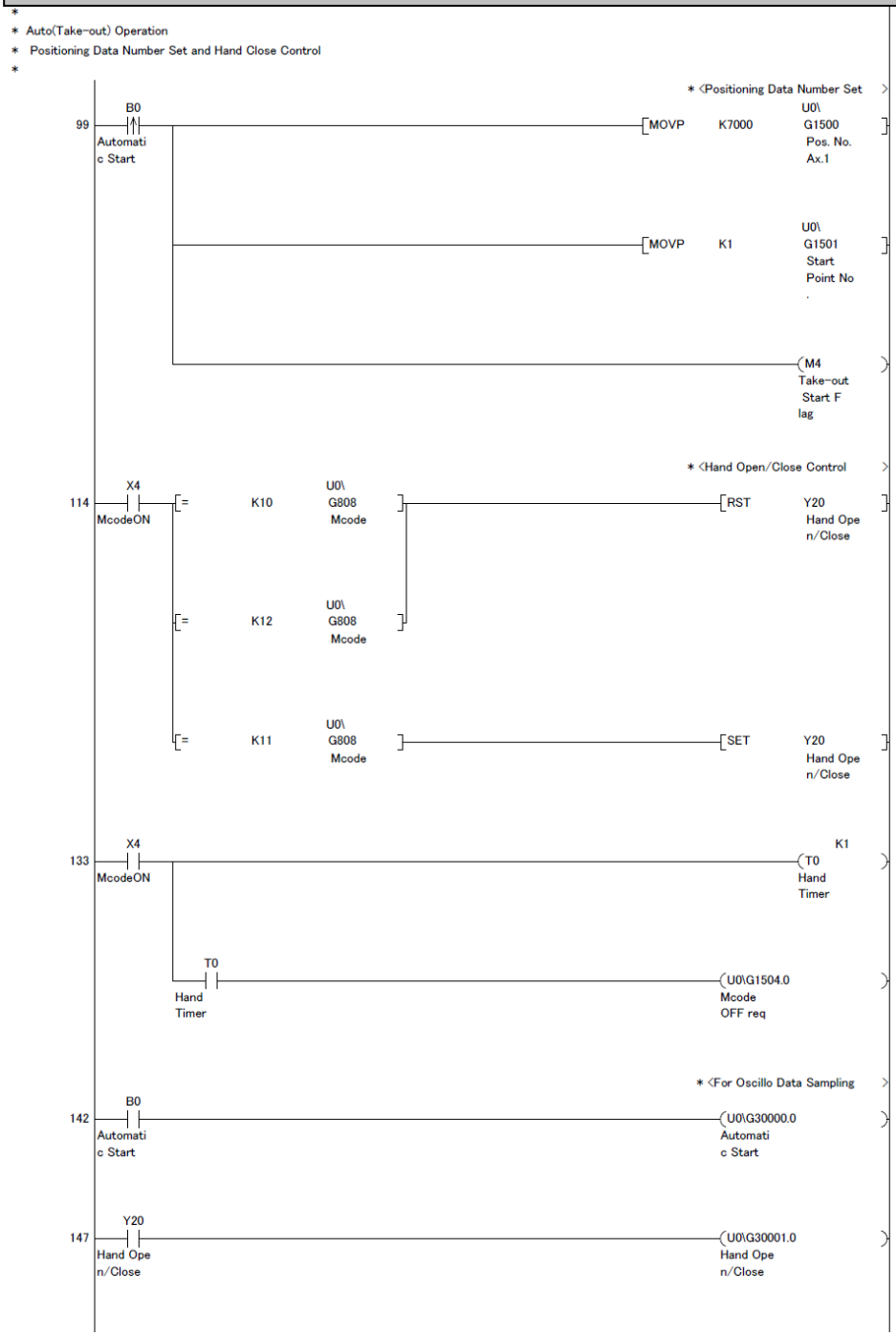
Positioning Start Flag ON

Vertical Axis

Positioning No.9001 (HPR) is set.

Positioning Start Flag ON

Automatic Operation Processing: Positioning Data No. Setting, Hand Opening/Closing Operation



Positioning No.7000 (Block Start Data) is set.

Start positioning point No. 1.

Positioning Start Flag ON

Hand Opening when M Code 10 and 12 is outputted
10: Positioning Complete to Start Position
12: Positioning Complete at Sending Destination Point

Hand Closing when M-Code 11 is outputted
11: After lowering at pick place position, forward movement completion

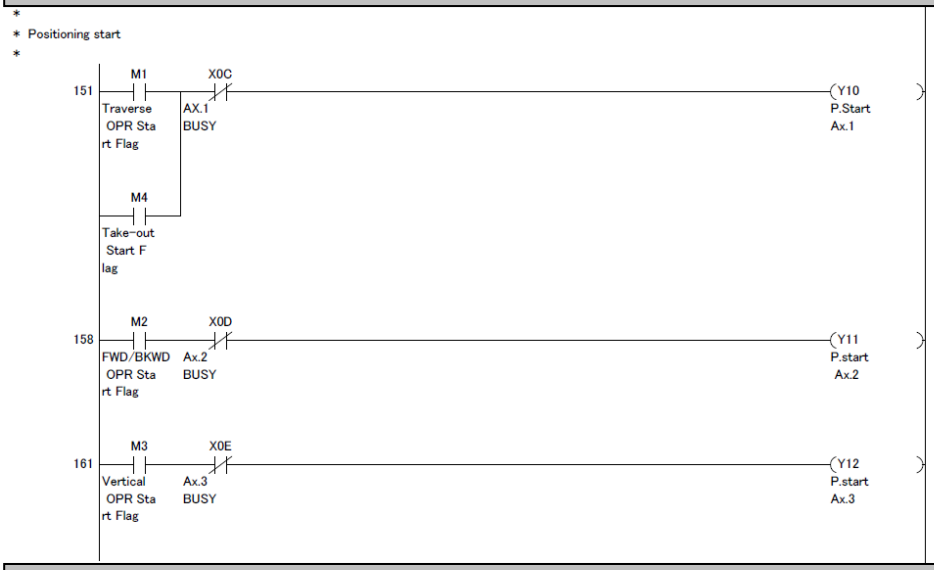
Hand Operation Time

After M code output ON, 100ms passed, M code OFF Request Flag goes ON, and next positioning starts

For Usage with Digital Oscilloscope Sampling (QD77MS PLC CPU Memory Area)
Automatic Operation Start Signal

Hand Open/Close Signal

Positioning Start Signals



Traverse Axis

When automatic start and the traverse OPR go on, Axis 1 Positioning starts.

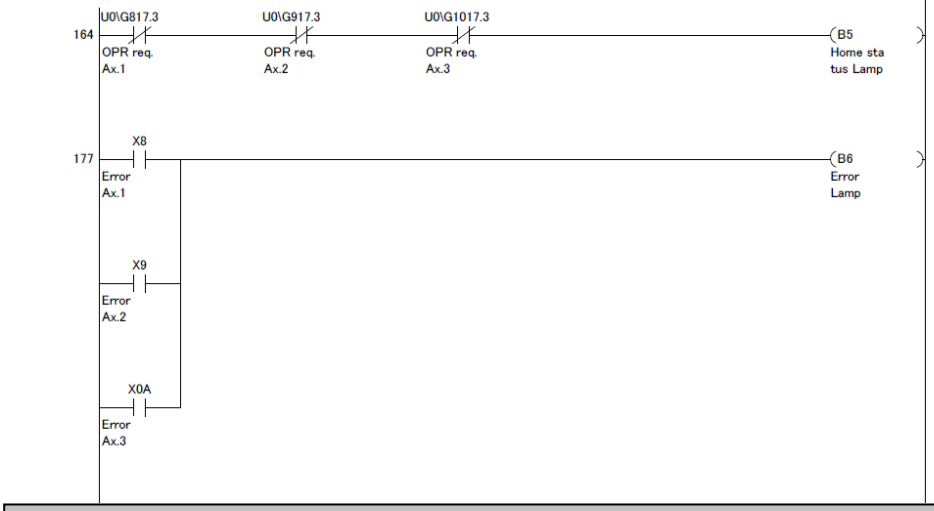
Forward/Backward Axis

During OPR, Axis 2 Positioning starts

Vertical Axis

During OPR, Axis 3 Positioning starts

GOT Monitoring Signals



OPR Completion Lamp
Turns on when all axes Home Position Return Request are OFF

Error Lamp
Turns ON if an error is detected on any axis

Error Reset

END