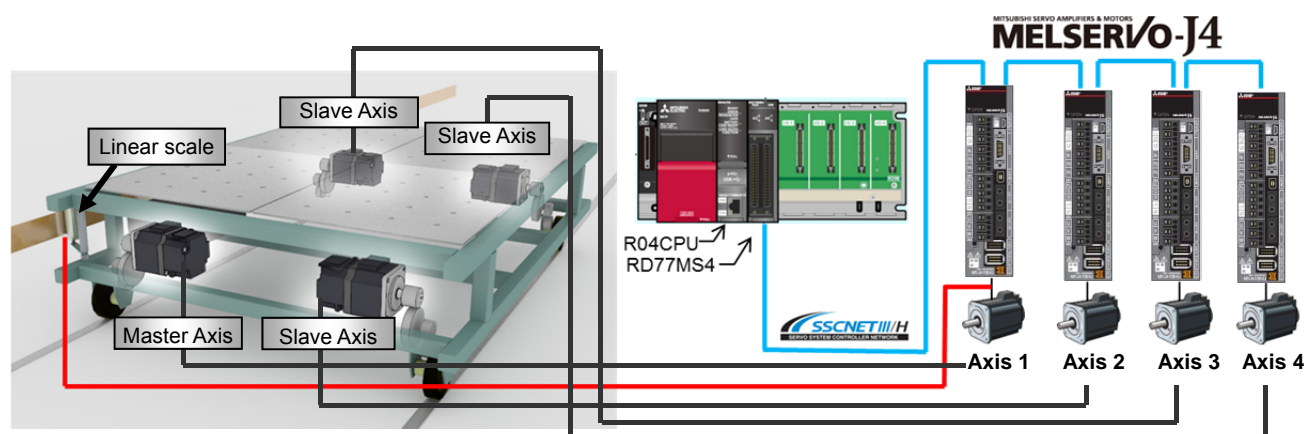


Automated Guided Vehicle

[System Configuration]



[Mitsubishi solution]

PLC CPU : R04CPU Simple Motion module : RD77MS4 Servo amplifier: MR-J4-B_KJ (Note-1)
Main base unit : R35B Servo motor: HG-SR
Engineering environment: MELSOFT GX Works3

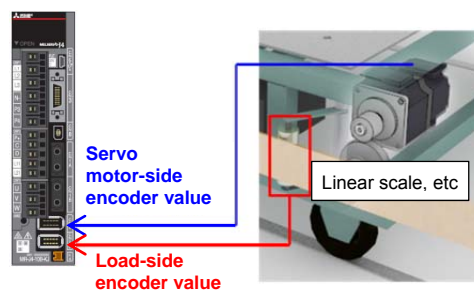
(Note-1): The MR-J4-B-RJ servo amplifier with DC input (Contact your local sales office for details.)

[Operation Description]

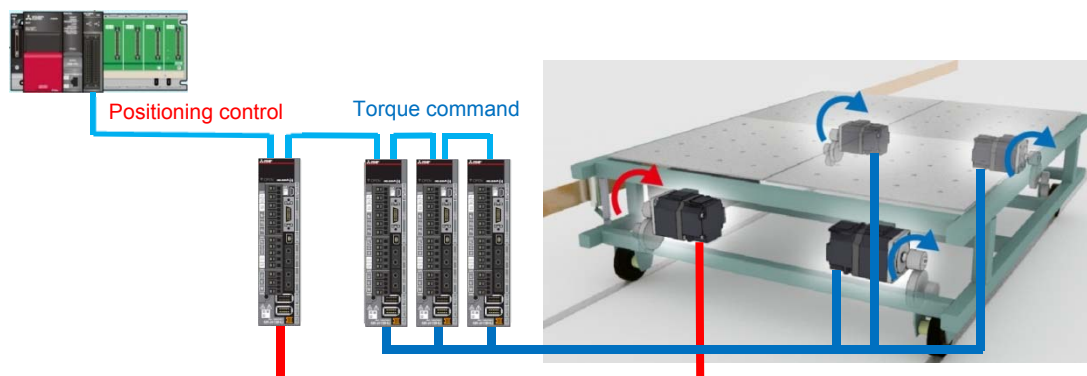
The AGV picks up a workpiece and carries it to the target position.

[Control Points]

Point1: Since control can be switched based on the information from the load-side encoder during stopping, and the servo motor encoder during operation, effects from wheel slippage can be eliminated while shortening the settling time.



Point 2: With master-slave operation, the master axis can transmit its torque command to slave axes and the 4 wheels are controlled by the equivalent torque, while the Simple Motion module is required to perform only positioning control to the master axis.



[Using the sample program]

[Sample program configuration]

File name	Description	Model	Programming tool
Vol11_Cart_PLC.gx3	Ladder program	R04CPU	MELSOFT GX Works3
	Simple Motion setting	RD77MS4	
	Servo amplifier setting	MR-J4(W)-B(-RJ) (Fully closed)	

[Start-up]

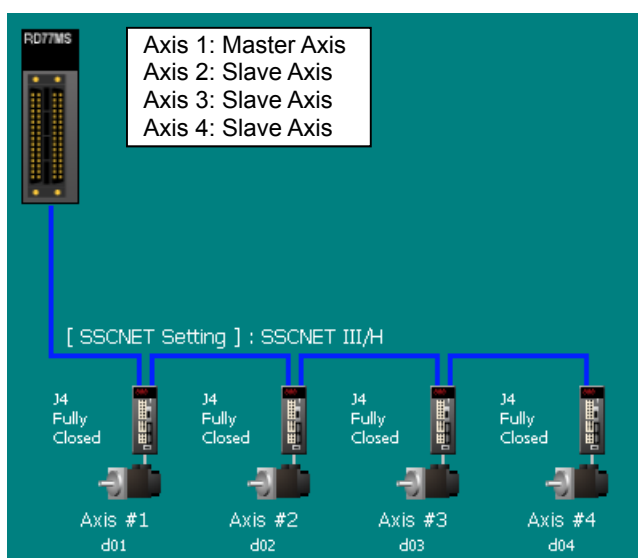
1. Decompress the downloaded files to any folder in your PC.
2. Double click the decompressed files to open the corresponding engineering tool.
3. Ladder programs as default are set for English environment. When switching to Japanese, select [View]→ [Multiple Comments Display Setting], and check boxes of [Target] and [Available] columns for English row instead of Japanese row on GX Works3 at startup.
4. Change the model settings according to models to be used.
5. Write the sample program data to PLC CPU and Simple Motion.
6. After writing all the programs, reset the PLC CPU.

[Operating method]

This sample program is created as an incremental system.

After the AGV is moved to the origin position by JOG operation and the home position return is executed, the AGV can pick up and carry the workpiece to the target position.

[System Settings]



[Servo Data Settings]

Item	Axis #1	Axis #2	Axis #3	Axis #4
Basic parameters 1	Set according to the machine and applicable motor when system is started up (It will be valid according to PLC READY signal).			
Pr.1:Unit setting	0:mm	0:mm	0:mm	0:mm
Pr.2:No. of pulses per rotation	5000000 pulse	5000000 pulse	5000000 pulse	5000000 pulse
Pr.3:Movement amount per rotation	50000.0 μm	50000.0 μm	50000.0 μm	50000.0 μm
Pr.4:Unit magnification	1x1 Times	1x1 Times	1x1 Times	1x1 Times
Pr.7:Bias speed at start	0.00 mm/min	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.10:Deceleration time 0	10 ms	10 ms	10 ms	10 ms
Detailed parameters 1	Set according to the system configuration when the system is started up.(It will be valid according to PLC READY signal)			
Detailed parameters 2	Set according to the system configuration when the system is started up.(Set as required).			
HPR basic parameters	Set the values required for carrying out HPR control (This parameter become valid when the PLC READY signal [Y0] turns from OFF to ON).			
Pr.43:HPR method	6:Data Set Method	6:Data Set Method	6:Data Set Method	6:Data Set Method
Pr.44:HPR direction	0:Forward Direction (Address Increase Direction)	0:Forward Direction (Address Increase Direction)	0:Forward Direction (Address Increase Direction)	0:Forward Direction (Address Increase Direction)
Pr.45:HPR address	0.0 μm	0.0 μm	0.0 μm	0.0 μm
Pr.46:HPR speed	0.01 mm/min	0.01 mm/min	0.01 mm/min	0.01 mm/min
Pr.47:Creep speed	0.01 mm/min	0.01 mm/min	0.01 mm/min	0.01 mm/min
Pr.48:HPR retry	0:Do Not Retry HPR with Limit Switch	0:Do Not Retry HPR with Limit Switch	0:Do Not Retry HPR with Limit Switch	0:Do Not Retry HPR with Limit Switch

Electronic gear setting (Note-1)

After home position return, the AGV current position becomes 0[μm].

(Note-1): For details of the electronic gear settings, refer to "4. Electronic gear settings on the Simple Motion module side" in page 4.

[Positioning Table Point Data]

No.	Operation pattern	Control method	Axis to be interpolated	Acceleration time No.	Deceleration time No.	Positioning address	Arc address	Command speed	Dwell time	M-code
1	0:END	01h:ABS Linear 1	-	0:250	0:250	5000000.0 μm	0.0 μm	50000.00 mm/min	0 ms	0
	<Positioning Comment>Product 1 Extract Position									
2	0:END	01h:ABS Linear 1	-	0:250	0:250	10000000.0 μm	0.0 μm	50000.00 mm/min	0 ms	0
	<Positioning Comment>Product 1 Placement Position									

Operation pattern data where the AGV moves to the target position

Operation pattern data where the AGV moves to the pickup position

[Master-slave Operation Settings]

- 1) Set the PA14 "Rotation direction selection/travel direction selection" for the torque generation direction by referring to the following table.

Setting value	Servo motor rotation direction/Linear servo motor travel direction	
	Positioning address increase	Positioning address decrease
0	CCW or positive direction	CW or negative direction
1	CW or negative direction	CCW or positive direction

This sample program is set as follows.

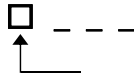
Parameter	Description	Axis 1	Axis 2	Axis 3	Axis 4
PA14	Rotation direction selection/travel direction selection	1	0	1	0

- 2) The following shows the settings for the master-slave operation in this sample program.

Parameters	Setting details	Master Axis	Slave Axis	Slave Axis	Slave Axis
		Axis 1	Axis 2	Axis 3	Axis 4
PD15	Selection of the master/slave axes	0001	0010	0010	0010
PD16	Torque command data transmitted from the master axis to slave axes	0038	0000	0000	0000
PD17	Speed limit command data transmitted from the master axis to slave axes	003A	0000	0000	0000
PD20	Master axis No. which transmits the data	0	1	1	1
PD30	Torque command ratio transmitted from the master axis to slave axes	0	100	100	100
PD31	Speed limit ratio from the master axis to slave axes	0	100	100	100
PD32	The lowest speed limit value transmitted from the master axis to slave axes	0	0	0	0

[Fully Closed Loop Control Settings] *The target axis is the first axis.

1. Change the PC04 setting according to the wiring method of the load-side encoder cable.



Load-side encoder cable communication method selection

0 : Two-wire type

1 : Four-wire type

When using an encoder of A/B/Z-phase differential output method, set "0".

Incorrect setting will trigger [AL. 70] and [AL. 71]. Setting "1" while using a servo amplifier other than MR-J4-_B_-RJ will trigger [AL. 37].

2. Change the "PC17 home position setting condition selection" according to the load-side encoder to be used. "0000: Need to pass servo motor Z-phase after power on" is selected in this program.

Load-side linear encoder type	PC17 setting value	Home position setting condition selection
Incremental type	___ 0	Need to pass servo motor Z-phase after power on
Absolute position type	___ 1	Not need to pass servo motor Z-phase after power on

(Note): For details of the linear encoder, refer to LINEAR ENCODER INSTRUCTION MANUAL.

3. For this sample program, the following conditions are set to the parameters for the movement amount per pulse on the Simple Motion side, servo motor-side electronic gear ratio settings, and load-side electronic gear ratio.

- Servo motor resolution : 4194304 [pulses/rev]
- Circumference of the wheels : 500 [mm]
- Reduction ratio between servo motor and wheels : 1/10
- Resolution of the linear encoder : 0.01[μm]

4. Electronic gear settings on the Simple Motion module side

For fully closed loop control, set the pulse of the linear scale (load-side encoder) with "Pr.2 Number of pulses per rotation".

- Pr.2: Number of pulses per rotation = $\frac{\text{Wheel circumference}}{\text{Linear encoder resolution}} = \frac{500000\mu\text{m}}{0.01\mu\text{m}} = 50000000$ pulses
- Pr.3: Movement amount per rotation = Wheel's circumference * Reduction ratio = $500000\mu\text{m} * \frac{1}{10} = 50000.0 \mu\text{m}$

5. Electronic gear settings on the servo amplifiers side

Set the pulse ratio between the servo motor-side encoder and the load-side encoder.

$$\frac{[\text{Pr. PE 04}] \times [\text{Pr. PE 34}]}{[\text{Pr. PE 05}] \times [\text{Pr. PE 35}]} = \frac{\text{Number of load-side encoder pulses per servo motor revolution (Note-1)}}{\text{Number of motor encoder pulses per servo motor revolution}}$$

(Note-1): "Number of load-side encoder pulses per servo motor revolution"

= Number of linear encoder pulses per wheel revolution

$$= \frac{\text{Wheel circumference}}{\text{Linear encoder resolution}} = \frac{500000\mu\text{m}}{0.01\mu\text{m}} = 50000000 \text{ pulses}$$

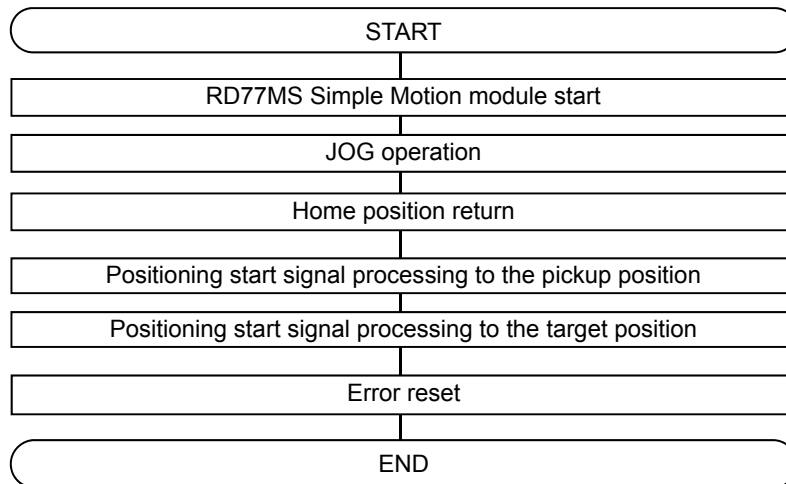
The following are set for the sample program based on the above calculation results.

$$\frac{[\text{Pr. PE 04}] \times [\text{Pr. PE 34}]}{[\text{Pr. PE 05}] \times [\text{Pr. PE 35}]} = \frac{50000000 \text{ pulses}}{4194304 \text{ pulses}} \times \frac{1}{10} = \frac{50000}{1280} \times \frac{1000}{32768}$$

No.	Abbr.	Name	Units	Setting range	Axis 1
PE04	**FBN	Fully closed loop ctrl. – F/B pls. elec. gear 1 numerator		1-65535	50000
PE05	**FBD	Fully closed loop ctrl. – F/B pls. elec. gear 1 denominator		1-65535	1280
PE34	**FBN2	Fully closed loop ctrl. – F/B pls. elec. gear 2 numerator		1-65535	1000
PE35	**FBD2	Fully closed loop ctrl. – F/B pls. elec. gear 2 denominator		1-65535	32768

[Sample Ladder Program Configuration]

<MAIN: Scan Execution>



[Used Devices in This Program]

Device No.	Content	Device No.	Content
M0	Execute JOG FB	D0	JOG Speed
M1	Forward JOG ON/OFF	D2	Inching Amount
M2	Reverse JOG ON/OFF	D4	JOG FB Error Code
M3	JOG FB Execution Status	D6	Home Position Return FB Error Code
M4	JOG FB Completed Normally	D10	Positioning 1 FB Error Code
M5	JOG FB Error Detected	D12	Axis Error Code
M6	Start Home Position Return FB	D14	Axis Warning Code
M7	Home Position Return FB Execution Status	D16	Stored Error Code
M8	Home Position Return FB Completed Normally	D20	Positioning 2 FB Error Code
M9	Home Position Return FB Error Detected	M1000	Error Reset FB
M10	Execute Positioning 1 FB	M1001	Axis Error Reset
M11	Positioning 1 FB Execution Status	M1002	Error Reset FB Execution Status
M12	Positioning 1 FB Movement Completed Normally	M1003	Error Reset FB Completed Normally
M13	Positioning 1 FB Movement Error Detected	M1004	Axis Error Detected
M20	Execute Positioning 2 FB	M1005	Axis Error Warning
M21	Positioning 2 FB Execution Status	M1006	Error Reset FB Problem Detected
M22	Positioning 2 FB Movement Completed Normally		
M23	Positioning 2 FB Movement Error Detected		

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]

