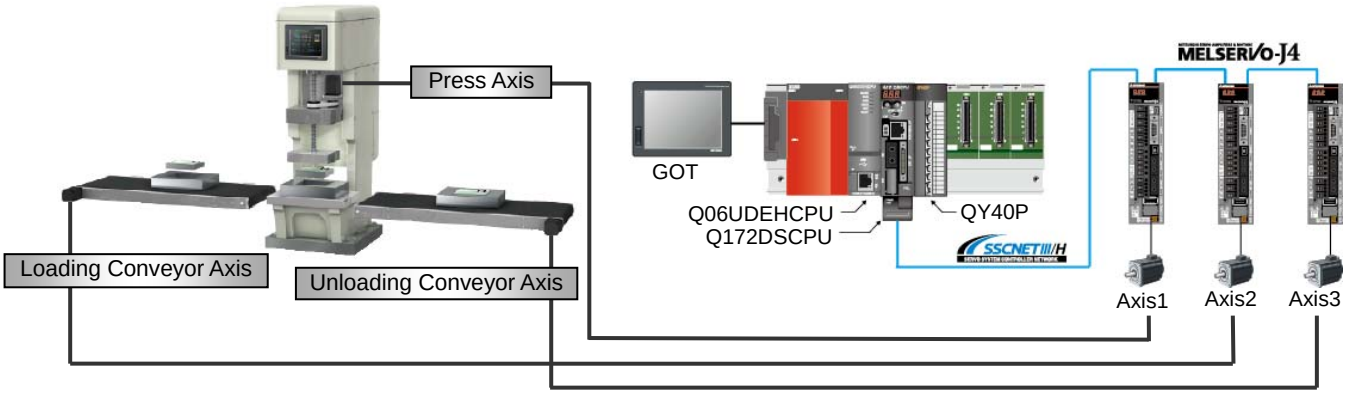
Press-fit Machine

[System Configuration]



[Mitsubishi solution]

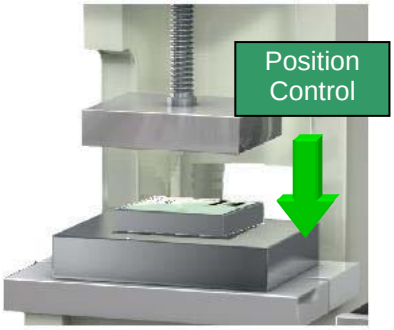
Motion CPU: Q172DSCPU
PLC CPU: Q06UDEHCPU
Main base: Q35DB
GOT: GT165*-V
Output module: QY40P
Servo amplifier: MR-J4-B
Servo motor: HG-SR(B)
(Press axis has magnetic brake)
Engineering environment: MELSOFT MT Works2 (Motion), MELSOFT GX Works2 (PLC), MELSOFT GT Works3 (GOT)
Motion CPU operating system software: SW8DNC-SV22QL

[Operation Description]

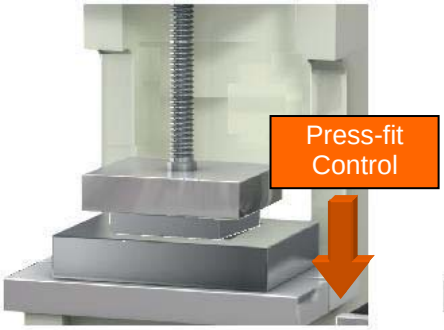
The work is fed by the loading conveyor then the work is pressed (Press-fit). The work that had press-fitted is outputted by the unloading conveyor.

[Control Points]

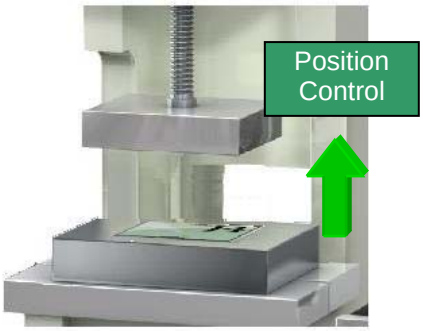
Point1: When the continuous operation to torque control mode is used, the mode can be switched to torque control smoothly without stopping even during positioning control.
Point2: Because position and torque is controlled simultaneously, it is possible to have pressure control in simple setups that doesn't use external sensors like linear scale or load cell.
Point3: It's possible to change command torque in real-time and the time constant up to the rated torque. Therefore, various press-fit patterns can be performed. And, by torque feedback gain setting, the collision load can be reduced during press-fitting.



Positioning is executed to the specified work approach position at high speed.



The press fitting is executed with the specified torque level and time in press-fit control.



Return to standby position at high speed.

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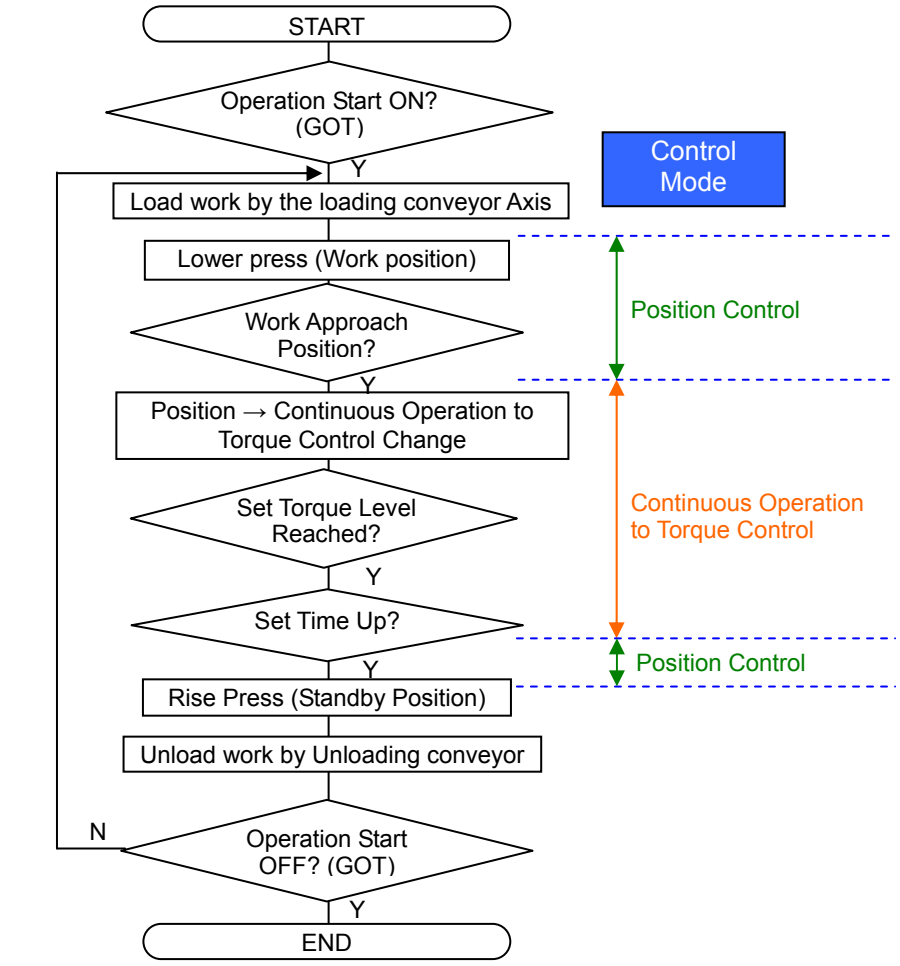
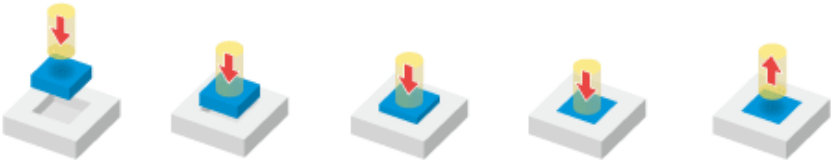
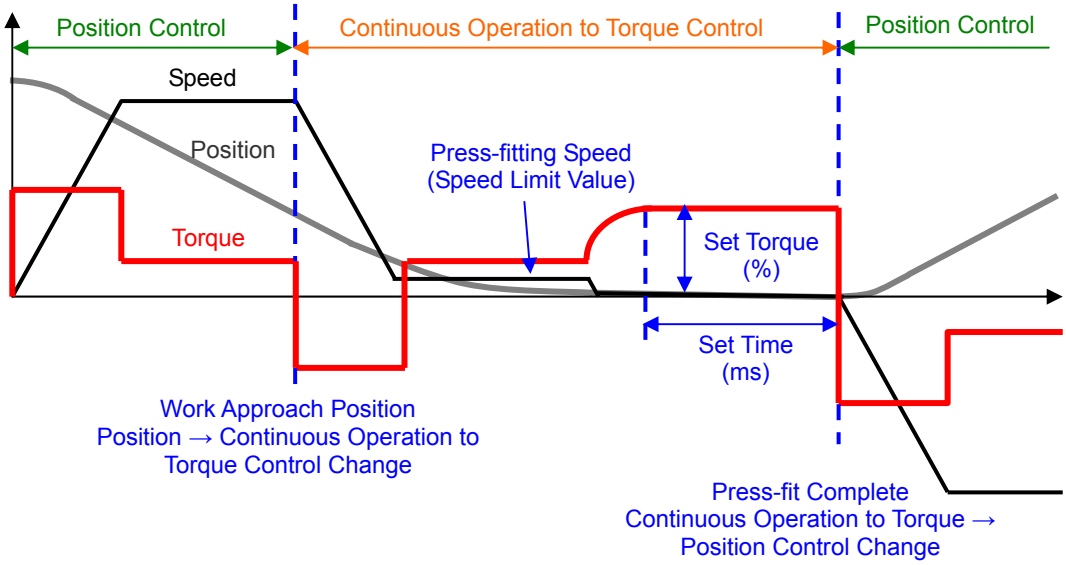
[Operation Flowchart]

After the “Auto Operation Start” switch is pressed in the GOT the new work is fed by the loading conveyor. Then the work is pushed in the mold by the press-fit control and fitted. After fitting is completed the finished work is outputted by the unloading conveyor.







[GOT Sample Screen]

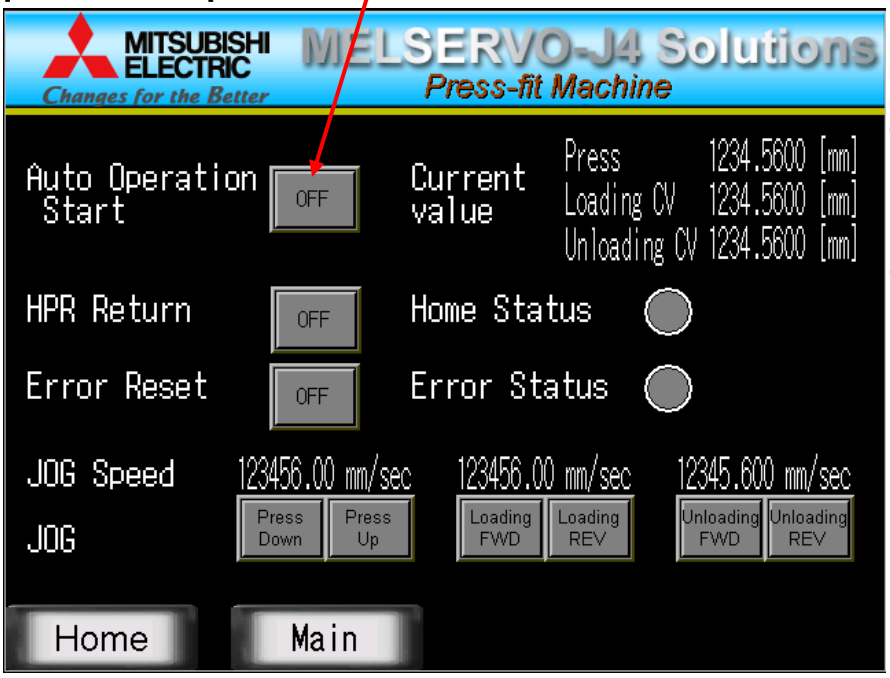
[GOT: Home Screen]

Language Selection

Screen Selection

Operation Start Switch
When this switch is ON, Press-fit operation is performed (Refer to P2.).

[GOT: Main Screen]

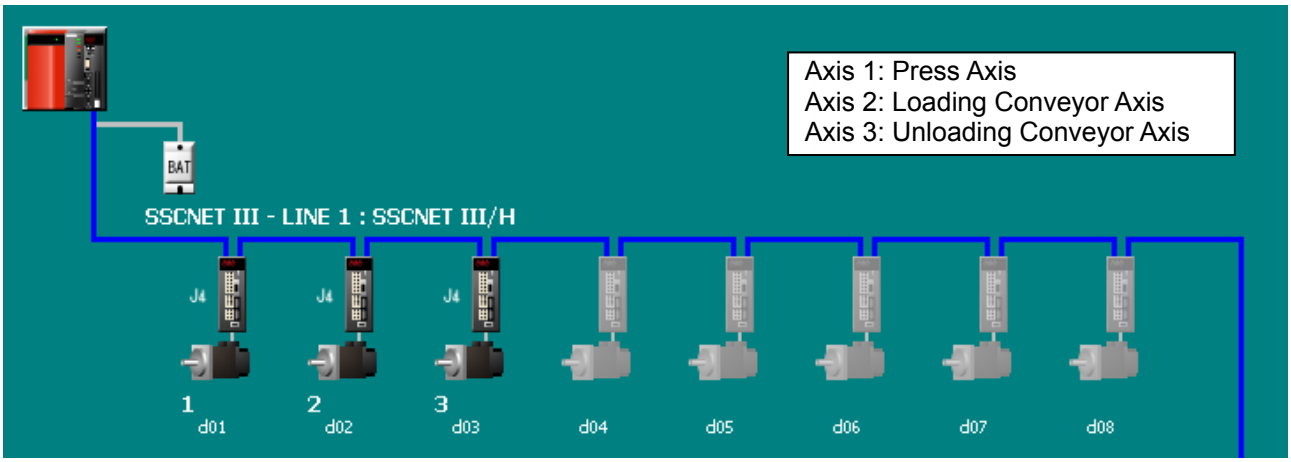


Current Position
Displays current value for each axis.

JOG Operation Switch
Perform JOG operation forward/reverse (up/down) for 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 Designer 3 Language change the preview column from [2] to [1].

[System Setting]



[Servo Data Setting]

Item	Axis1	Axis2	Axis3
Fixed Parameter	**Set the fixed parameters for each axis and their data is fixed...**		
Unit Setting	0:mm	0:mm	0:mm
Number of Pulses/Rev.	4194304[PLS]	4194304[PLS]	4194304[PLS]
Travel Value/Rev.	6000.0[µm]	10000.0[µm]	10000.0[µm]
Backlash Compensation	0.0[µm]	0.0[µm]	0.0[µm]
Upper Stroke Limit	500000.0[µm]	0.0[µm]	0.0[µm]
Lower Stroke Limit	-100000.0[µm]	0.0[µm]	0.0[µm]
Command In-position	10.0[µm]	10.0[µm]	10.0[µm]
Sp. Ctrl. 10x Mult. for Deg.	-	-	-
Home Position Return Data	**Set the data to execute the home position return.**		
OPR Direction	0:Reverse Direction	0:Reverse Direction	0:Reverse Direction
OPR Method	2:Data Set Type 1	2:Data Set Type 1	2:Data Set Type 1
Home Position Address	0.0[µm]	0.0[µm]	0.0[µm]
OPR Speed	-	-	-
JOG Operation Data	**Set the data to execute the JOG operation.**		
JOG Speed Limit Value	18000.00[mm/min]	30000.00[mm/min]	30000.00[mm/min]
Parameter Block Setting	1	2	2

Press Axis Motor Travel Value per Revolution: 6[mm]

Conveyor Axis Motor Travel Value per Revolution: 10[mm]

[Parameter Block]

Item	Block No.1	Block No.2
Parameter Block	**Set the data such as the acceleration/decelera**	
Interpolation Control Unit	0:mm	0:mm
Speed Limit Value	18000.00[mm/min]	30000.00[mm/min]
Acceleration Time	100[ms]	100[ms]
Deceleration Time	100[ms]	100[ms]
Rapid Stop Deceleration Time	100[ms]	100[ms]
S-curve Ratio	0[%]	0[%]
Torque Limit Value	300[%]	300[%]
Deceleration Process on STOP	0:Deceleration Stop	0:Deceleration Stop
Allowable Error Range for Circular Interpolation	10.0[µm]	10.0[µm]
Bias Speed at Start	0.00[mm/min]	0.00[mm/min]
Acceleration/Deceleration System	0:Trapezoid/S-curve	0:Trapezoid/S-curve

Block No.1: For Press Axis
Block No.2: For Conveyor Axis

[Servo Data Setting: Speed-Torque Control Data]

Item	Axis1	Axis2	Axis3
Speed-Torque Control Data	**Set the data only when the speed-torque control is executed.**		
Control Mode Switching Request Device	M1		
Control Mode Setting Device	D1000(1)		
Speed Limit Value in Speed-Torque Control	12000.00[mm/min]	2	
Torque Limit Value in Speed-Torque Control	100.0[%]	3	
Speed Command Device	D1002(2)		
Command Speed Acceleration Time	500[ms]	1000[ms]	1000[ms]
Command Speed Deceleration Time	500[ms]	1000[ms]	1000[ms]
Torque Command Device	D1004(1)		
Command Torque Time Constant (Positive Direction)	1000[ms]	1	
Command Torque Time Constant (Negative Direction)	1000[ms]	1	
Speed Initial Value Selection at Control Mode Switching	0:Command Speed	0:Command Speed	0:Command Speed
Torque Initial Value Selection at Control Mode Switching	0:Command Torque	0:Command Torque	0:Command Torque
Invalid Selection during Zero Speed at Control Mode Switching	0:Switching Condition at Switching Control Mode is Valid	0:Switching Condition at Switching Control Mode is Valid	0:Switching Condition at Switching Control Mode is Valid

Set the control mode in Mode Setting Device (D1000) and turn ON the change request bit (M1) to change the control mode.

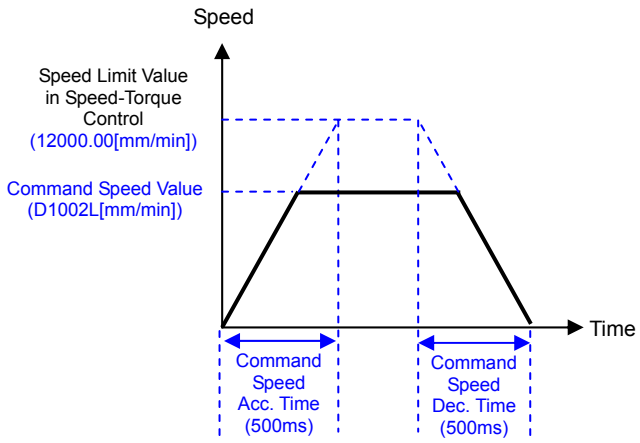
Set the operation pattern for Speed/Torque control with the fixed number or optional devices.

Control Mode	Control Mode Setting Device (D1000)	Servo Status 1 #8010+20n (n=Axis No.-1)		Servo Status 3 #8012+20n (n=Axis No.-1)
		bit3	bit2	bit14
Position Control	0	0	0	-
Speed Control	10	0	1	-
Torque Control	20	1	0	-
Continuous Operation to Toque Control	30	-	-	1

(Note): For the switching conditions at the switching time for all control modes (during motor stop, during positioning stop etc.), refer to the "Q173D(S)CPU/Q172D(S)CPU Motion Controller Programming Manual (SV13/SV22 Real Mode)".

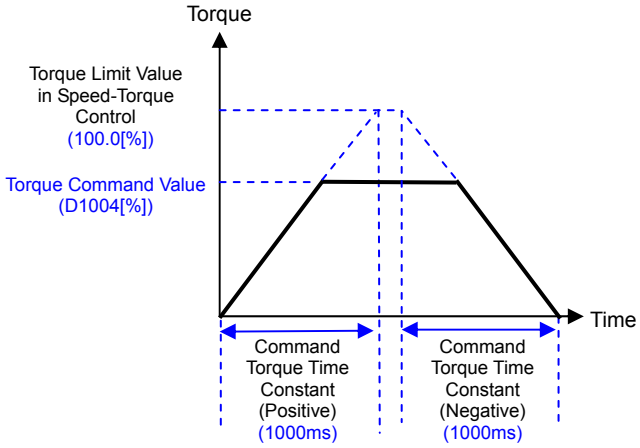
Speed Control

The speed control is made at the speed command device value. The torque control is made at the torque command device value.



Torque Control/Press-fit Control

The torque control is made at the torque command device value. The speed control is made at the speed command device value.



During press-fit control, speed limit value becomes limit for Acc./Dec. pattern.

<When Advance Synchronous Control is used>
During advanced synchronous control, the speed command to the output axis becomes the command speed during speed control, and the speed limit value during torque control/continuous operation to toque control. (Speed control cannot be done by speed command device.)

Control mode change is available only when linear cam (cam No.0) is used.

➡ The speed command during speed control

⚠ 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.
- When using simulation function in this sample program, since the torque change cannot be sensed, soft limit error (207) will be generated.

[Devices used in this program]

Device No.	Content	Device No.	Content
B0	Automatic Operation Start (GOT)	W0	Press Axis JOG Speed Setting (GOT): x0.01[mm/s]
B1	Home Position Return (GOT)	W1	
B2	Error Reset (GOT)	W2	Loading Conveyor Axis JOG Speed Setting (GOT): x0.01[mm/s]
B5	Home Position Return Complete Lamp (GOT)	W3	
B6	Error Lamp (GOT)	W4	Unloading Conveyor Axis JOG speed Setting (GOT): x0.01[mm/s]
B11	Press Axis JOG Up (GOT)	W5	
B12	Press Axis JOG Down (GOT)	M1	Press Axis Control Mode Change Request Device
B13	Loading Conveyor Axis JOG Forward (GOT)	D1000	Press Axis Control Mode Setting Device
B14	Loading Conveyor Axis JOG Reverse (GOT)	D1002	Press Axis Speed Command Device
B15	Unloading Conveyor Axis JOG Forward (GOT)	D1003	
B16	Unloading Conveyor Axis JOG Reverse (GOT)	D1004	Press Axis Torque Command Device

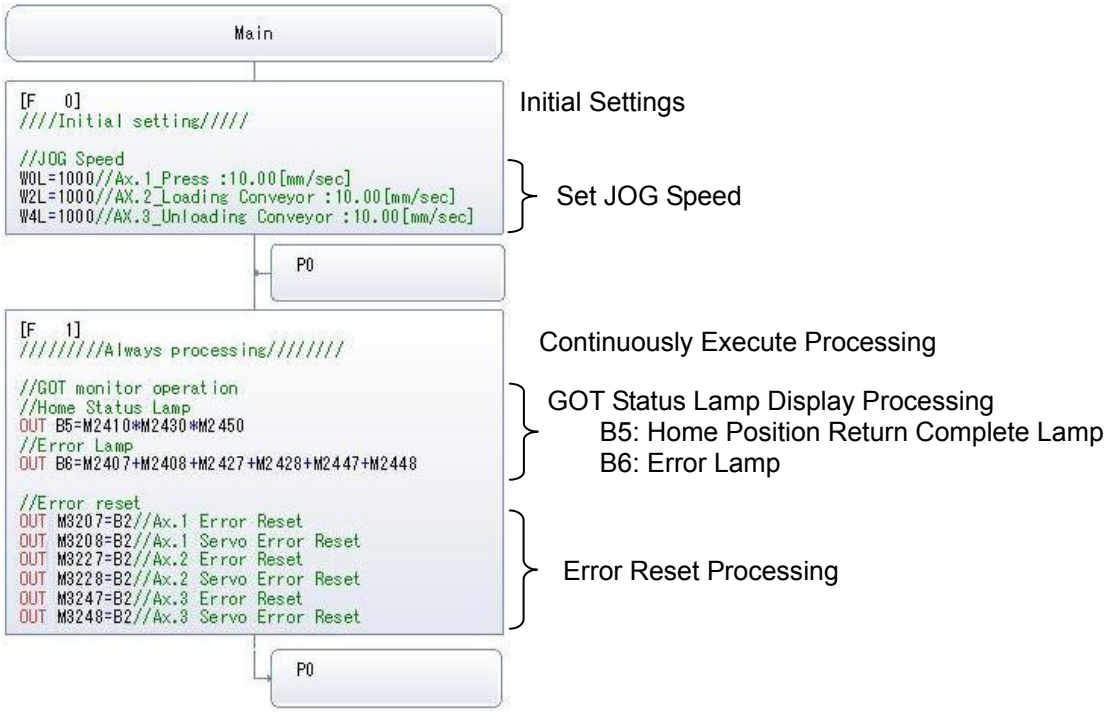
[Content of Motion SFC sample programs]

Program Structure

No.	Program Name	Automatic Start	Execution Task	Operation Summary
0	Main	Yes	Normal	Main Operation
1	Motion Control	Yes	Normal	Motion Control
2	Home Position	No	Normal	Home Position Return
3	JOG operation	No	Normal	JOG Operation
4	Auto Operation	No	Normal	Automatic Operation
5	Press-Fit	No	Normal	Press-fit Control

(1) No.0 Main: Main Operation Normal Task [Automatic Start]

This program continuously runs certain processes and initiates starting settings.

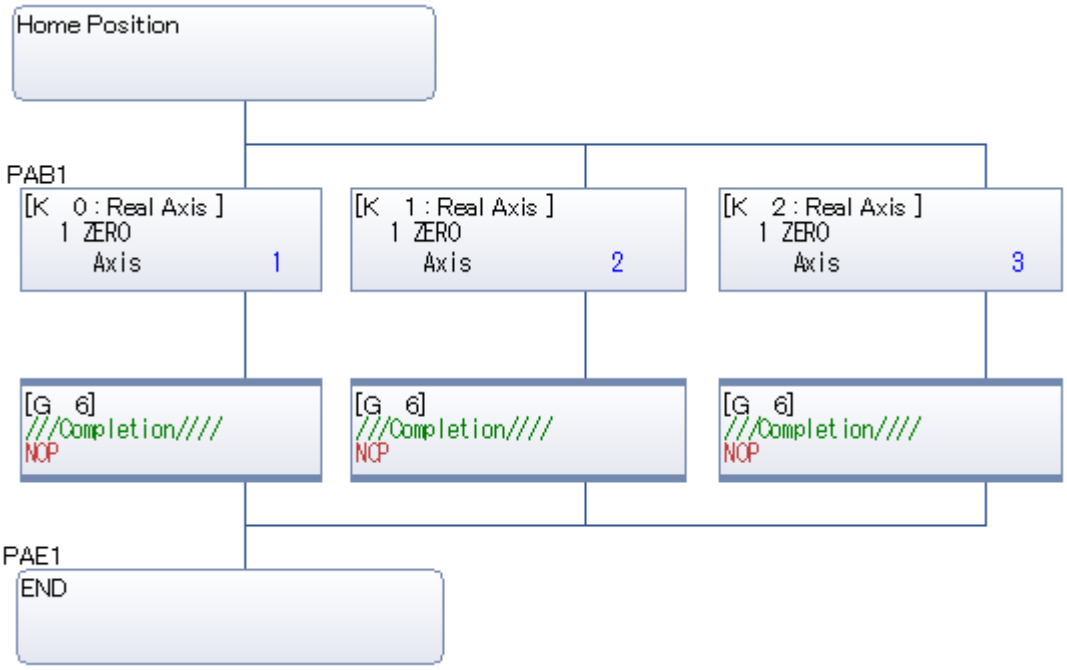


(2) No.1 Motion Control: Normal Task [Automatic Start]

Each Motion control task is initiated when started from the GOT screen.

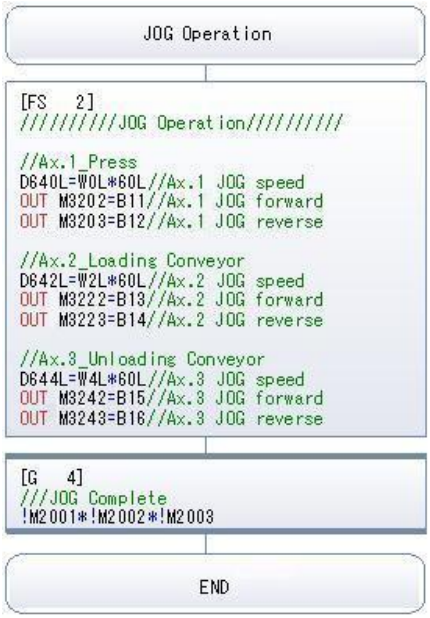
(3) No.2 Home Position: Home Position Return Normal Task

This program activates the home position return servo program for each axis.



(4) No.3 JOG Operation: Normal Task

Executes the JOG operation for each axis.



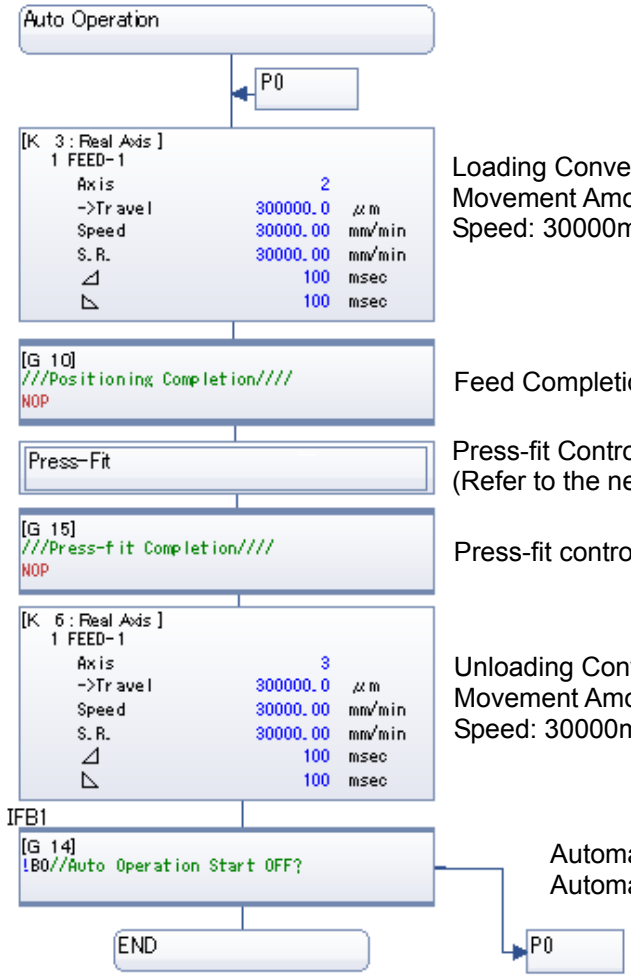
When GOT JOG switch is ON,
corresponding JOG command bit will turn ON.

<GOT>
W0L: Press Axis JOG speed setting
W2L: Loading Axis JOG speed setting
W4L: Unloading Axis JOG speed setting

B11: Press Axis JOG Down
B12: Press Axis JOG Up
B13: Loading Conveyor Axis JOG forward
B14: Loading Conveyor Axis JOG reverse
B15: Unloading Conveyor Axis JOG forward
B16: Unloading Conveyor Axis JOG reverse

(5) No.4 Auto Operation: Automatic Operation Normal Task

Executes the Loading new work → Press-fitting → Unloading finished work automatically.



Loading Conveyor Axis loading the new work.
Movement Amount: 300mm
Speed: 30000mm/min

Feed Completion

Press-fit Control Start
(Refer to the next page.)

Press-fit control Completion

Unloading Conveyor Axis Unloading the finished work.
Movement Amount: 300mm
Speed: 30000mm/min

Automatic Start bit is ON: Operation Continues
Automatic Start bit is OFF: Operation Stops

(6) No.5 Press-Fit: Press-fit Control Normal Task

Executes the Press-fitting operation by the Press-fit control.

```
Press-Fit
```

```
[K  4 : Real Axis ]
   1 ABS-1
      Axis                    1
      ->Address          200000.0  μm
      Speed              12000.00  mm/min
```

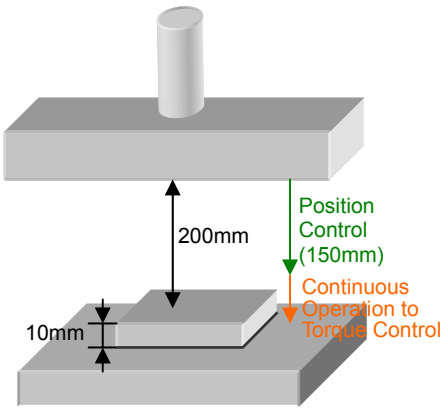
Positioning Start
[Work Position]
Position: 200mm
Speed: 12000mm/min
(200mm/s)

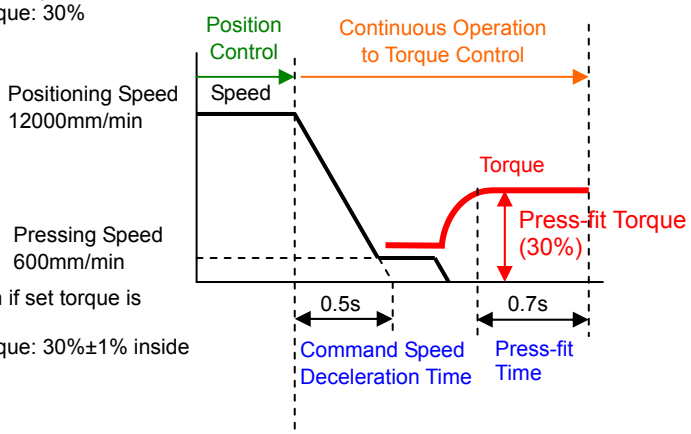
```
[G  8]:Positioning mode
///Position Detection Approach Workpice///

D2L>=1500000//50mm above the workpiece
```

Work Approach Position Detection
Current Value above 150mm
(Distance until work 50mm)

```
[G  9]:Positioning mode
//////////Switched to Press-fit Mode/////////
//[Continuous Operation to Torque Control Mode]

//Setting Parameter of Press-fit Mode
D1000=30
  //Control Mode     :[30] Press-fit mode
D1002L=60000 //Press-fit Speed  :600.00[mm/min]
D1004=300    //Press-fit Torque :30.0[%]

//Control Mode Switching Request
SET M1

//Confirmation Servo Status [Press-fit Mode]
(#8012&H4000)==H4000
//#8012 bit14(ON):[Press-fit Mode]
```

Change to Continuous Operation to Torque Control Mode
Speed: 600mm/min
(10mm/s)
Press-fit Torque: 30%






```
[G  12]:Press-fit Mode
//////Check Torque of Press-fit/////

//Reset Control Mode Switching Request
RST M1

//Check Torque of Press-fit
//Motor Torque within 1.0% of Set Value
ABS(#8001-D1004)<=10
```

Confirmation if set torque is reached.
Press-fit Torque: 30%±1% inside

```
[G  13]:Press-fit Mode
//Time of Press-fit [700ms]
TIME700
```

Press-fit time: 700ms

```
[G  18]
((#8011&H0008)==8)
//#8011 bit4(ON):[Zero Speed]
```

Switching condition: During motor stop

```
[G  17]:Press-fit Mode
////////Switched to Position Control Mode/////////

//Switched to Control Mode
D1000=0//Control Mode:[0] Position Control mode

//Control Mode Switching Request
SET M1

//Confirmation Servo Status [Position Control Mode]
((#8010&H000C)==0)*((#8012&H4000)==0)*!M2001

//#8010 bit2,3(OFF,OFF):[Position Control Mode]
//#8012 bit14(OFF):[Press-fit Mode OFF]
```

Switch to Positioning Control Mode

```
[F  3]:Positioning mode
//Reset Control Mode Switching Request
RST M1
```

Mode switching request flag OFF

```
[K  5 : Real Axis ]
   1 ABS-1
      Axis                    1
      ->Address             0.0  μm
      Speed              12000.00  mm/min
```

Return movement to the start position.
Machine standby position 0mm

```
[G  10]
///Positioning Completion////
NOP
```

```
END
```

END