Vertical packaging machine

[System configuration]

The film feed roller axis supplies the packaging film material. The film from the film feed roller axis is bonded in the vertical direction and formed into a bag while the film index axes feeds enough film to match the bag size. The sealing & cutting axis seals the top of the bag which is then transported by conveyor.

[Control points]

Point 1: By using the speed change gear module of advanced synchronous control, the speed of film feed roller axis is controlled to ensure that speed is constant even when outer diameter changes.
(Note): The control to detect outer diameter is not included in this sample program.
Point 2: Both film index axes can be synchronized based on the virtual position command that the virtual servo amplifier generates.
Point 3: The use of cam control makes film index axis feed/stop operations smoother.

---

[Operation description]

The film feed roller axis supplies the packaging film material. The film from the film feed roller axis is bonded in the vertical direction and formed into a bag while the film index axes feeds enough film to match the bag size. The sealing & cutting axis seals the top of the bag which is then transported by conveyor.

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Point 2: Both film index axes can be synchronized based on the virtual position command that the virtual servo amplifier generates.
Point 3: The use of cam control makes film index axis feed/stop operations smoother.
[Operation flow]

(Film Feed Roller Axis) Pull the film from the stock
(Dancer roll)Constant tension
(Vertical Thermal Heat Sealer) Form the film to cylindrical shape (bag)
(Film Index Axis) The feed sizing the film
(Sealing & Cutting Axis) Sealing, cutting the top (bottom) of the pillow
(Conveyor Axis) The packed food is sent to the next process

(Note): Film tension control with the dancer roll, the temperature adjustment function on the vertical thermal heat sealer and sealing & cutting axis, and the open/close control of food supply valve are not included in this sample program.

[Operation time chart]

1 cycle time (ms) is calculated from the number of productivity (bag/min). Time for seal operation (time set from GOT) is deducted.

- Pulling bag with cam curve
- Seal time: set from GOT screen

1 cycle (1st) 1 cycle (2nd or later)
[Using the sample program]

[Sample program configuration]

<table>
<thead>
<tr>
<th>File name</th>
<th>Description</th>
<th>Model</th>
<th>Programming tool</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vol1_VFFS_PLC.gxw</td>
<td>Ladder program</td>
<td>Q06UDEHCPU</td>
<td>MELSOFT GX Works2</td>
</tr>
<tr>
<td>Vol1_VFFS_Motion.pcw</td>
<td>Motion setting file</td>
<td>QD77MS16</td>
<td></td>
</tr>
<tr>
<td>Vol1_VFFS_GOT.GTW</td>
<td>GOT monitoring data</td>
<td>GT165*-V (640x480)</td>
<td>MELSOFT GT Works3</td>
</tr>
</tbody>
</table>

(Note): Equipment other than the servo amplifiers and servo motor 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 8).

[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 Designer 3 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. When writing all programs was completed, reset the PLC program.

[Operating method]
Start operation by using the GOT touch button. When you do not have GOT, operate the device with the appropriate touch button in GX Works3’s simulator function (Note) or GX Works2’s device test function.
(Note): When using GX 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, on the GOT screen press “Reset system” button 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.
3. Each axis can be operated independently by using the JOG touch buttons.

<table>
<thead>
<tr>
<th>Operation</th>
<th>GOT touch key</th>
<th>Device No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Home position return start</td>
<td>[Main] Reset System</td>
<td>B1</td>
</tr>
<tr>
<td>Automatic operation start/stop</td>
<td>[Main] Start Automatic</td>
<td>B0</td>
</tr>
<tr>
<td>2 Automatic operation setting</td>
<td>[Setting] Pieces</td>
<td>W10</td>
</tr>
<tr>
<td></td>
<td>[Setting] Bag Length</td>
<td>W12</td>
</tr>
<tr>
<td></td>
<td>[Setting] Sealing Stroke</td>
<td>W14</td>
</tr>
<tr>
<td></td>
<td>[Setting] Sealing Time</td>
<td>W16</td>
</tr>
<tr>
<td>3 Film feed roller axis JOG forward</td>
<td>[Main] FWD</td>
<td>B11</td>
</tr>
<tr>
<td>Film feed roller axis JOG reverse</td>
<td>[Main] REV</td>
<td>B12</td>
</tr>
<tr>
<td>Film index axis JOG forward</td>
<td>[Main] ▲</td>
<td>B21</td>
</tr>
<tr>
<td>Film index axis JOG reverse</td>
<td>[Main] ▼</td>
<td>B22</td>
</tr>
<tr>
<td>Sealing &amp; cutting axis JOG forward</td>
<td>[Main]</td>
<td>B41</td>
</tr>
<tr>
<td>Sealing &amp; cutting axis JOG reverse</td>
<td>[Main]</td>
<td>B42</td>
</tr>
<tr>
<td>Conveyor axis JOG forward</td>
<td>[Main] FWD</td>
<td>B51</td>
</tr>
<tr>
<td>Conveyor axis JOG reverse</td>
<td>[Main] REV</td>
<td>B52</td>
</tr>
</tbody>
</table>
[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.

⚠️ 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.
[Simple Motion settings]

[Parameters]
- Movement amount for 1 motor revolution
  - Film feed roller/conveyor axis: 20mm/rev (Circumference of film feed roller axis is 600[mm] (roll diameter 190.00[mm], gear ratio 1/30))
  - Film index axis/sealing & cutting axis: 40mm/rev

- Speed limit value
  - Film feed roller/conveyor axis: 20mm/rev × 3000r/min = 60000mm/min (if bag length is 400mm productivity is 150 bags/min)
  - Film index axis/sealing & cutting axis: 40mm/rev × 3000r/min = 120000mm/min (double the max line speed)

Virtual servo amplifier

Blue: Default value
Black: Set value
[Positioning data]

: Value that could be changed by PLC ladder program

Axis 4: Sealing & cutting axis
No.1 Home position return (position after homing)
No.2 Automatic operation

Axis 5: Conveyor automatic operation

Axis 9 Virtual servo amplifier: Film feed roller axis synchronous control

Axis 10 Virtual servo amplifier: Film index axes roller axis synchronous control

During automatic operation, positioning is executed using the open/close position (set value) alternatively.
Open: 0.0µm, Close: 200000.0µm

Line automatic operation speed setting (productivity (bag/min) x bag size (mm))

Acceleration/deceleration time is adjusted to currently executed cam pattern (virtual servo amplifier 10). That’s why acceleration/deceleration time is set to 1ms.

The one pitch feed time (one cam cycle time) for film index roller axis is calculated from the productivity setting during automatic operation and sealing & cutting axis operating time.
[Synchronous control parameters]

Axis 1: Film feed roller

Set main input axis to virtual servo axis 9. Productivity (bag/min) x bag size (mm) in speed control mode.

Gear ratio settings
- Roll size (190.99mm) x 100mm
- Film outer diameter (***.**mm) x 100mm

“Pr.437” should be updated according to measured value of film outer diameter to keep constant circumferential velocity.

Axis 2, Axis 3: Film index axes

Set main input axis for two film index axes (2, 3) to set the same virtual servo axis 10 for synchronization purpose.

Set Pr. 441 so that one cam cycle (360 degrees) is the stroke amount that achieves the bag size.

Cam pattern

Main input axis (virtual servo axis 10) for one cam revolution (360 degree) moves film index axes (axis 2,3) according to cam pattern (acceleration/deceleration) to achieve selected bag size.

Blue: stroke
Green: speed
[Sample ladder program configuration]

START
Setting initial data processing
QD77MS Simple Motion start processing
JOG operation processing
Home position return processing
Automatic operation processing 1: Data setting for operation
Automatic operation processing 2: Speed calculation for one cam revolution of film index axes
Automatic operation processing 3: Film index axis/sealing & cutting start data
Automatic operation processing 4: Stop processing
Synchronous control start processing
Positioning start signal processing
GOT monitor signals processing
Errors reset processing
END

[Devices used in this program]

**User devices**

<table>
<thead>
<tr>
<th>Device No.</th>
<th>Content</th>
<th>Device No.</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>B0</td>
<td>Automatic start (GOT)</td>
<td>M1</td>
<td>Film feed roller axis zero return start</td>
</tr>
<tr>
<td>B1</td>
<td>Home position return (GOT)</td>
<td>M2</td>
<td>Film index axis 1 zero return start</td>
</tr>
<tr>
<td>B2</td>
<td>Error reset (GOT)</td>
<td>M3</td>
<td>Film index axis 2 zero return start</td>
</tr>
<tr>
<td>B3</td>
<td>Forced stop</td>
<td>M4</td>
<td>Seal &amp; cut zero return start</td>
</tr>
<tr>
<td>B5</td>
<td>Zero return completion (GOT)</td>
<td>M5</td>
<td>Conveyor axis zero return start</td>
</tr>
<tr>
<td>B6</td>
<td>Error lamp (GOT)</td>
<td>M11</td>
<td>Film feed roller axis synchronous control</td>
</tr>
<tr>
<td>B11</td>
<td>Film feed roller axis JOG forward (GOT)</td>
<td>M12</td>
<td>Film index axis synchronous control</td>
</tr>
<tr>
<td>B12</td>
<td>Film feed roller axis JOG reverse (GOT)</td>
<td>M13</td>
<td>Film index axis 2 synchronous control</td>
</tr>
<tr>
<td>B21</td>
<td>Film index axis JOG forward (GOT)</td>
<td>M14</td>
<td>Film feed roller axis JOG synchronous control</td>
</tr>
<tr>
<td>B22</td>
<td>Film index axis JOG reverse (GOT)</td>
<td>M15</td>
<td>Film index axis JOG synchronous control</td>
</tr>
<tr>
<td>B41</td>
<td>Sealing &amp; cutting axis JOG forward (GOT)</td>
<td>M19</td>
<td>Automatic film index axis start</td>
</tr>
<tr>
<td>B42</td>
<td>Sealing &amp; cutting axis JOG reverse (GOT)</td>
<td>M20</td>
<td>Automatic film index axis and sealing &amp; cutting start</td>
</tr>
<tr>
<td>B51</td>
<td>Conveyor axis JOG forward (GOT)</td>
<td>M22</td>
<td>Automatic sealing &amp; cutting start</td>
</tr>
<tr>
<td>B52</td>
<td>Conveyor axis JOG reverse (GOT)</td>
<td>M23</td>
<td>Automatic sealing timer trigger</td>
</tr>
<tr>
<td>W0</td>
<td>Film feed roller axis JOG speed setting (GOT): x 0.01 [mm/min]</td>
<td>M30</td>
<td>Automatic film sending operation completion</td>
</tr>
<tr>
<td>W1</td>
<td>Film feed roller axis JOG speed settings (GOT): x 0.01 [mm/min]</td>
<td>M31</td>
<td>Sealing &amp; cutting closed in position</td>
</tr>
<tr>
<td>W3</td>
<td>Sealing &amp; cutting axis JOG speed setting (GOT): x 0.01 [mm/min]</td>
<td>M32</td>
<td>Sealing &amp; cutting open position</td>
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<tr>
<td>W4</td>
<td>Convoyer axis JOG speed setting (GOT): x 0.01 [mm/min]</td>
<td>D0</td>
<td>Sealing &amp; cutting closed position: [x 0.1μm]</td>
</tr>
<tr>
<td>W5</td>
<td>Convoyer axis JOG speed setting (GOT): x 0.01 [mm/min]</td>
<td>D1</td>
<td>Sealing &amp; cutting open position: [x 0.1μm]</td>
</tr>
<tr>
<td>W6</td>
<td>Convoyer axis JOG speed setting (GOT): x 0.01 [mm/min]</td>
<td>D2</td>
<td>Temporary calculation</td>
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<td>W7</td>
<td>Convoyer axis JOG speed setting (GOT): x 0.01 [mm/min]</td>
<td>D1050</td>
<td>Temporary calculation</td>
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<tr>
<td>WA</td>
<td>Current production monitor (GOT): [bag]</td>
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<tr>
<td>W10</td>
<td>Productivity monitor (GOT) [bag/min]</td>
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<tr>
<td>W12</td>
<td>Bag length (GOT): [mm]</td>
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<tr>
<td>W14</td>
<td>Sealing &amp; cutting stroke length setting (GOT): [mm]</td>
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<tr>
<td>W16</td>
<td>Seal time setting value (GOT): [ms]</td>
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</table>
## QD77MS dedicated devices

<table>
<thead>
<tr>
<th>Device No.</th>
<th>Content</th>
<th>Device No.</th>
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</tr>
</thead>
<tbody>
<tr>
<td>X0</td>
<td>QD77 READY</td>
<td>Y0</td>
<td>PLC READY</td>
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<tr>
<td>X10</td>
<td>Axis 1 BUSY</td>
<td>Y1</td>
<td>All axis servo ON</td>
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<td>X11</td>
<td>Axis 2 BUSY</td>
<td>Y10</td>
<td>Axis 1 Positioning start</td>
</tr>
<tr>
<td>X12</td>
<td>Axis 3 BUSY</td>
<td>Y11</td>
<td>Axis 2 Positioning start</td>
</tr>
<tr>
<td>X13</td>
<td>Axis 4 BUSY</td>
<td>Y12</td>
<td>Axis 3 Positioning start</td>
</tr>
<tr>
<td>X14</td>
<td>Axis 5 BUSY</td>
<td>Y13</td>
<td>Axis 4 Positioning start</td>
</tr>
<tr>
<td>X18</td>
<td>Axis 9 BUSY</td>
<td>Y14</td>
<td>Axis 5 Positioning start</td>
</tr>
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<td>X19</td>
<td>Axis 10 BUSY</td>
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<td>Axis 9 Positioning start</td>
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<tr>
<td>U0¥G5119</td>
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</tr>
</tbody>
</table>
[Ladder program]

Initial settings: Initialization of the input devices in GOT

* Initial data setting

** JOG speed setting: ** $0.1$ mm/min

- Film index axis JOG speed:
  - 600 mm/min (10 mm/s)
- Film feed roller axis JOG speed:
  - 600 mm/min (10 mm/s)
- Sealing & cutting axis JOG speed:
  - 600 mm/min (10 mm/s)
- Conveyor axis JOG speed:
  - 600 mm/min (10 mm/s)

** Production setting **

- Productivity:
  - 60 piece/min
- Bag size:
  - 200 mm
- Sealing & cutting axis stroke:
  - 200 mm
- Sealing time:
  - 50 ms
- Film roll diameter:
  - 191 mm (Roll diameter)

**QD77MS Simple Motion module start-up**

- QD77MS start
- All axes servo on command

Remove these lines to use real servo amplifier.
JOG operations

Film feed roller axis (synchronous control)

JOG speed setting

Synchronous control request ON

Virtual axis 9 forward JOG rotation ON

Virtual axis 9 reverses JOG rotation ON

Film index axis (synchronous control)

Axis 2: Cam No.0 (linear cam) specification

Axis 3: Cam No.0 (linear cam) specification

Axis 2: Cam stroke amount
Set the same value as the cam axis length per cycle to get the same movement amount as the command input value,

Axis 3: Cam stroke amount
Set the same value as the cam axis length per cycle to get the same movement amount as the command input value,

Synchronous control request ON

JOG speed setting

Virtual axis 10 forward JOG rotation ON

Virtual axis 10 reverses JOG rotation ON
Home Position Return

Film feed roller axis

Positioning No.9001 (HPR) is set.

Film feed roller axis HPR ON

Positioning start flag ON

Positioning start flag ON

Sealing & cutting axis

Positioning start flag ON

HPR is not completed
Positioning No.9001 (HPR) is set.

HPR is completed
Positioning No.1 (positioning to 0 mm) is set.

Sealing & cutting axis HPR start

Conveyor axis

Positioning No.9001 (HPR) is set.

Conveyor axis HPR ON
Automatic operation : Required data setting

- Positioning No. specification
  - Film feed roller axis (virtual axis 9) No.1: Speed control (forward)
  - Film index axis (virtual axis 10) No.1: INC 360deg Movement amount for one cam revolution
  - Sealing & cutting axis No.2: ABS stroke amount setting
  - Conveyor axis No.1: Speed control (forward)

- Speed setting for film feed roller and conveyor.
  - Speed setting [x0.01mm/min] = Productivity [bag/min] x bag size [mm] x 100

- Film feed roller axis speed
  - Calculated result set as speed value.

- Conveyor axis
  - Calculated result set as speed value.

- Sealing & cutting
  - Closed (forward) position address set from GOT is converted [mm] x 10000 → [x0.1μm]
  - Open (reverse) position address 0 → set position [x0.1μm]

- Various data set

- Auto operation

- Setting of positioning number:
  - U01
    - G5100 Pos. No. Ax.9(V)
  - U01
    - G5200 Pos. No. Ax.10(V)
  - U01
    - G4600 Pos. No. Ax.4
  - U01
    - G4700 Pos. No. Ax.5

- Speed of film roller & conveyor:
  - D1050 W10 W12 K100 D1050
    - calc. temp
  - D1050 G14004 Pos.No.1 Spd.Ax10
  - D1050 G10004 Pos.No.1 Spd.Ax5

- Positioning data setting
  - K10000 W14 D0 Seal str oka mm
  - D2 Sealer FWD pos.
  - DMOVP K0 Sealer REV pos.
A. Closing operation time [ms] = (stroke amount [mm] / 1.5 [mm/ms])
Acc/Dec time [ms] = (stroke amount / 1.5) + 75

B. Film index axis operation time (one cam cycle) [ms]
= 1 production cycle - closing time - seal time

C. Film index axis one cam cycle speed [x0.001 deg/min]
= (360 x 1000) / (cam cycle time / (60 x 1000))
= (360 x 1000 x 60 x 1000) / Cam one cycle time → overflow
Therefore the formula below is used.
= ((360 x 1000 x 60) / cam one cycle time) x 1000

Automatic operation : Film index axis cam speed calculation
Stroke length [x 0.1μm] = bag length setting [mm] x 10000

Film index axis
Cam stroke amount setting

W12  K10000
Bag L mm
U01
G367676
Cam stro
ke Ax2

W12  K10000
Bag L mm
U01
G36876
Cam stro
ke Ax3

* <Cam stroke value of V.Roller>
Automatic operation: Film index axis/sealing & cutting axis operation time

- Auto operation
- (3) Film index & sealing & cutting cycle operation timing

- Film index axis are started at raising edge (Initial process only)
- Film index axis feed operation is completed, then sealing & cutting axis starts (Initial process only)
- Automatic is ON

Film index axis feed operation is completed. Sealing & cutting axis open position. In the condition, sealing & cutting axis closing operation start.

Seal & cut closing operation starts sealing timer.

After the timer counts up, film index axis feed operation and sealing & cutting axis closing operation start.
Close: set stroke position
---Positioning data

Open: 0—positioning data

Close position confirmation
Current value = close position → ON

Open position confirmation
Current value = open position → ON

Sealing & cutting axis open/close position data switching
When forced stop is ON, automatic operation flag is clear.

Each axis stop command

- **Film feed roller axis**
  - When forced stop is ON or automatic operation is OFF, virtual axis 9 stop command is set.

- **Film index axis**
  - When forced stop is ON, virtual axis 10 stop command is set.

- **Sealing & cutting axis**
  - When forced stop is ON, axis 4 stop command is set.

- **Conveyor axis**
  - When forced stop is ON or automatic operation is OFF, axis 5 stop command is set.

Each axis busy signal is off then reset stop command

Automatic operation : Stop processing
Synchronous control start

[Film feed roller axis]
During JOG operation or automatic operation start, synchronous control request is ON.

[Film index axis 1]
During JOG operation or automatic operation start, synchronous control request is ON.

[Film index axis 2]
During JOG operation or automatic operation start, synchronous control request is ON.

[Film index axis 1]
Synchronous control status

[Film index axis 2]
Synchronous control status

[Film feed roller axis]
Synchronous control status

Synchronous control status
During HPR, axis 1 starts.

During HPR, axis 2 starts.

During HPR, virtual axis 9 starts.

During automatic feeding, operation virtual axis 10 starts.

During HPR and automatic operation start, axis 5 starts.

During HPR and automatic open/close operation on axis 4 starts.

During automatic operation start, virtual axis 9 starts.
GOT monitor signals

HPR complete lamp:
Turn ON when the HPR requests of all axes are turned OFF.

Error lamp:
Turn ON when an error of each axis is detected

Film roll diameter:
Data input from GOT screen for simulation is used.

Production counter:
The number of produced products is counted when automatic sealing & cutting operation is completed.

Error reset

* Error reset

END