Servo / Motion

Date: January 2009

Application Examples for MR-MQ100

Contact: Oliver Giertz
+49/(0)2102/486-7750
oliver.giertz@meg.mee.com

Flying Saw application

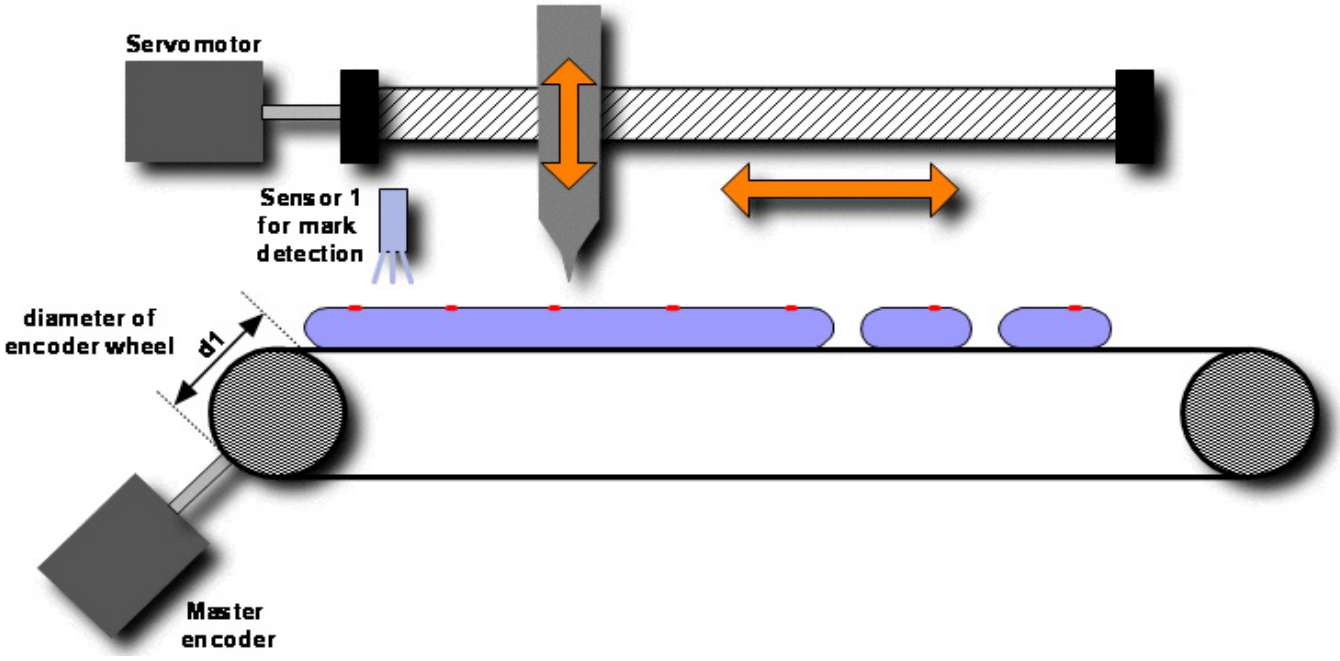
What is a Flying Saw ?

In a flying saw web-cut application, the material to be cut is fed on a continuous conveyor that is driven by an open-loop motor. The saw is mounted on a carriage under servo control that runs parallel to the conveyor. The saw accelerates to meet the velocity of the material to perform the cut at the correct location. When the cut is complete, the saw rapidly decelerates and moves back to the starting position to begin the next cutting cycle. This results in equal length pieces of material being fed to the next machine process.
Flying saw applications don't always involve a saw and they can be utilized in a variety of industries for: Steel / paper cutting, wood machining, drilling / embossing, filling / sorting…

There are 2 typical types for starting of the synchronisation possible:

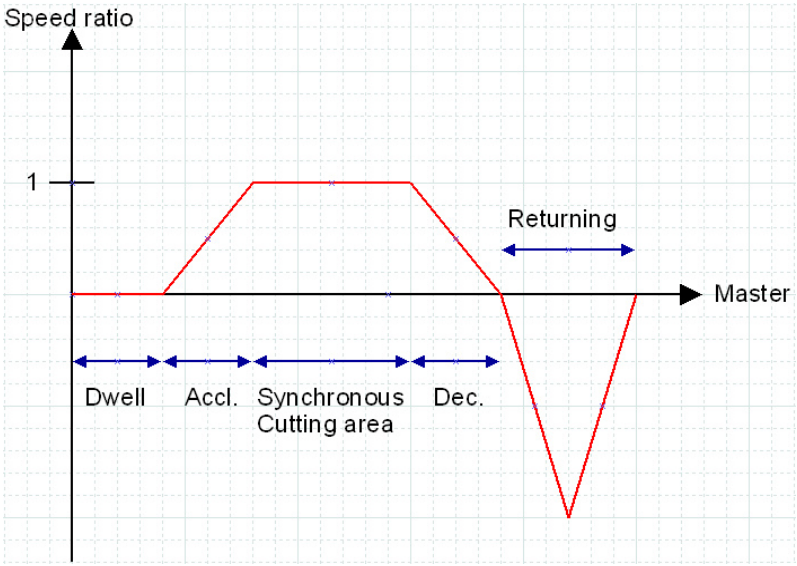
1. **Cutting length control**
   An encoder on the material registers the material speed and position of the production process. A length calculator calculates equidistant lengths in the controller and generates a start signal for the synchronising process. The advantage of cutting length control is that no cutting marks are required on the material.
2. **Cutting mark control**
   A sensor registers the cutting marks present on the material. This sensor signal is processed as an interrupt in the drive and starts the sawing process. This method is used if there are cutting marks on the material which have to be referred to, e.g. when using printed materials.

Typical construction of a flying saw :



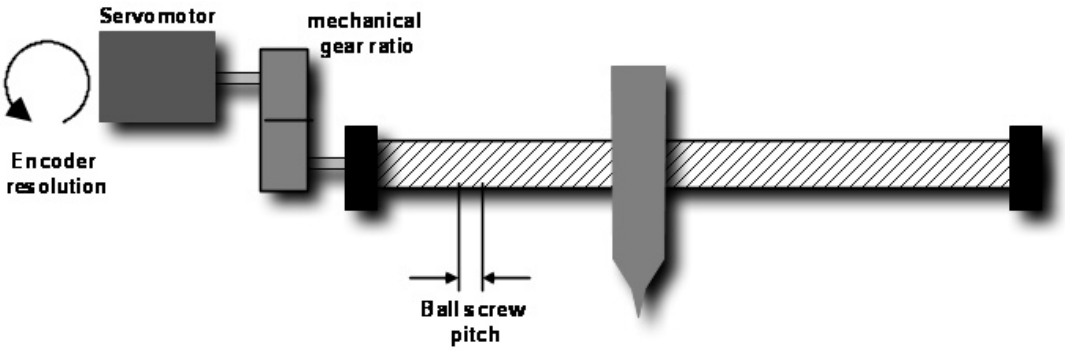
MITSUBISHI ELECTRIC FACTORY AUTOMATION
Mitsubishi Electric Europe B.V. /// FA-European Business Group /// Gothaer Strasse 8 /// D-40880 Ratingen /// Germany
Tel: (02102) 4860 /// Fax: (02102) 486112 /// Email:info@mitsubishi-automation.com /// Web: www.mitsubishi-automation.com

- **The figure below illustrates the relationship between the speed ratio of the Master axis and the slave axis:**



- **Machine parameters:**

  Mechanical construction of slave axis controlled by servo drive:

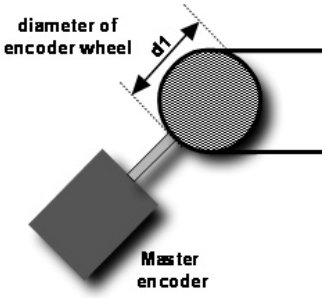


Encoder resolution: 262144 p/rev
Mechanical gear ratio: 5:1
Ball screw pitch: 5 mm

Fixed parameter setting :

Number of Pulses/Rev. :	262144 * 5	= 1310720 [PLS]	= 262144 [PLS]
Travel Value/Rev. :	5 mm	= 5000.0 [µm]	= 10000.0 [µm]

Mechanical construction master axis with external encoder:



Diameter of wheel: 50.93 mm
➔ Circumference : 50.93 mm * π = 160 mm

Encoder resolution: 2048 pulses/Rev.
➔ 2048 * 4 = 8192 edges/Rev.

MITSUBISHI ELECTRIC
FACTORY AUTOMATION
Mitsubishi Electric Europe B.V. /// FA-European Business Group /// Gothaer Strasse 8 /// D-40880 Ratingen /// Germany
Tel: (02102) 4860 /// Fax: (02102) 486112 /// Email:info@mitsubishi-automation.com /// Web: www.mitsubishi-automation.com

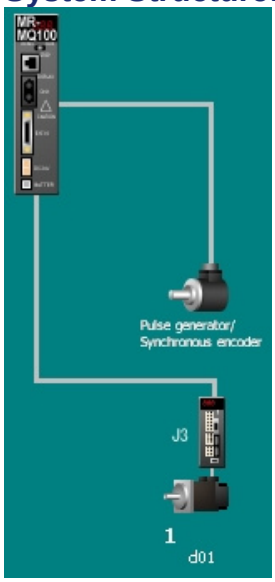
Configuration:

1* MR-MQ100
1* MR-J3-_B with MR-J3 Motor
1* External incremental Encoder (Open collector/Differential line driver)
1* External sensor 24V for mark detection

Software:

The powerful programming tool MT-Developer2-MQ and MR-Configurator helps you to setup, program, tune and easily monitor your system.

System Structure:



External encoder will be set active to follow the line speed.

One MR-J3-_B can connected. The axis no. rotary switch must be set to 0.

Servo Data:

		Axis 1
Fixed Parameter	Unit Setting	mm
	Number of Pulses/Rev.	262144[PLS]
	Travel Value/Rev.	10000,0[µm]
	Backlash Compensation	0,0[µm]
	Upper Stroke Limit	214748364,7[µm]
	Lower Stroke Limit	-214748364,8[µm]
	Command In-position	10,0[µm]
	Sp. Ctrl. 10x Mult. for Deg.	-
Home Position Return Data	HPR Direction	Reverse
	HPR Method	Dog Cradle Type
	Home Position Address	0,0[µm]
	HPR Speed	1000,00[mm/min]
	Creep Speed	100,00[mm/min]
	Travel After Dog	-
	Parameter Block Setting	1
	HPR Retry Function	Invalid
	Dwell Time At The HPR Retry	-
	Home Position Shift Amount	15000,0[µm]
	Speed Set at Home Pos. Shift	HPR Speed
	Torque Limit at Creep Speed	-
	Operation for HPR Incompletion	Exec.Sv.Prog.
JOG Operation Data	JOG Speed Limit Value	200,00[mm/min]
	Parameter Block Setting	1

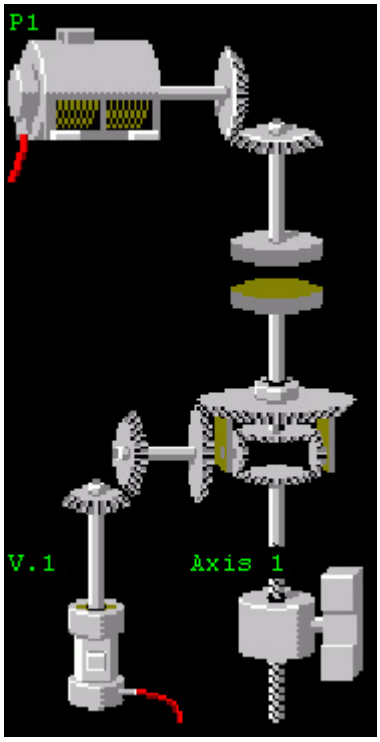
Electronic gear to adapt the mechanical construction to the servo system.

Home Position Return method can be set according to the type needed.

MITSUBISHI ELECTRIC FACTORY AUTOMATION
Mitsubishi Electric Europe B.V. /// FA-European Business Group /// Gothaer Strasse 8 /// D-40880 Ratingen /// Germany
Tel: (02102) 4860 /// Fax: (02102) 486112 /// Email:info@mitsubishi-automation.com /// Web: www.mitsubishi-automation.com

Mechanical System:

Synchronous encoder connected at the line shaft.



Spindle gear must be set corresponding to the encoder resolution and motor movement.

Smoothing clutch is set to have a smooth movement for the

Auxiliary spindle gear ratio must be set equal to main spindle gear ratio.

Virtual motor is used for the linear movement back to the start position.

Ball screw output module is used for the real servo motor.

Calculation of spindle gear ratio based on pls/mm:

Motor: Fixed parameter: Number of Pulses/Rev. : 262144 [PLS]
Travel Value/Rev. : 10000.0 [µm]

Encoder: Wheel circumference: 160 mm
Encoder resolution: 2048 pls/rev * 4 = 8192 pls/rev

→ $\frac{\text{Motor}}{\text{Encoder}} = \frac{262144\,[\text{pls}] / 10\,[\text{mm}]}{8192\,[\text{pls}] / 160\,[\text{mm}]} = \frac{512}{1}$

MITSUBISHI ELECTRIC FACTORY AUTOMATION
Mitsubishi Electric Europe B.V. /// FA-European Business Group /// Gothaer Strasse 8 /// D-40880 Ratingen /// Germany
Tel: (02102) 4860 /// Fax: (02102) 486112 /// Email:info@mitsubishi-automation.com /// Web: www.mitsubishi-automation.com

Variable definition:

PX0	Mark sensor
PX1	Cutting Cmd
PY0	Home position return complete
PY1	Cutting
M0	Clutch ON/OFF Cmd
M1	Clutch ON/OFF Status
M2	Clutch Smoothing Status
M3	Phase compensation Cmd
M10	True = Sensor Control False = Length Control
D6000	Clutch Mode
D6006	Phase compensation advance time
D6008	Phase compensation time constant
D6010	Phase compensation amount monitor
D6020	Clutch Slippage Dev.
D6022	Clutch Slippage Range
D6030	Speed of Virtual motor V1
D4000	Wheel circumference
D4002	Encoder resolution
D4004	Synchronous moving distance [mm]
D4006	Distance sensor to start [mm]
D4008	Cutting length [mm], PY01 ON
D4010	Cutting On distance [mm], PY01 OFF
D4100	Line speed [mm/s]
#0	Encoder pulses per mm [pls/mm]
#2	Moving distance [pls]
#4	Distance sensor to start [pls]
#6	Cutting length [pls]
#8	Cutting on distance [pls]
#10	Temp. value calculation of line speed
#12	Temp. value calculation of line speed
#14	CAM switch ON addr.PY01
#16	CAM switch OFF addr.PY01
#20	Mark detection counter
#22	Backup actual encoder value

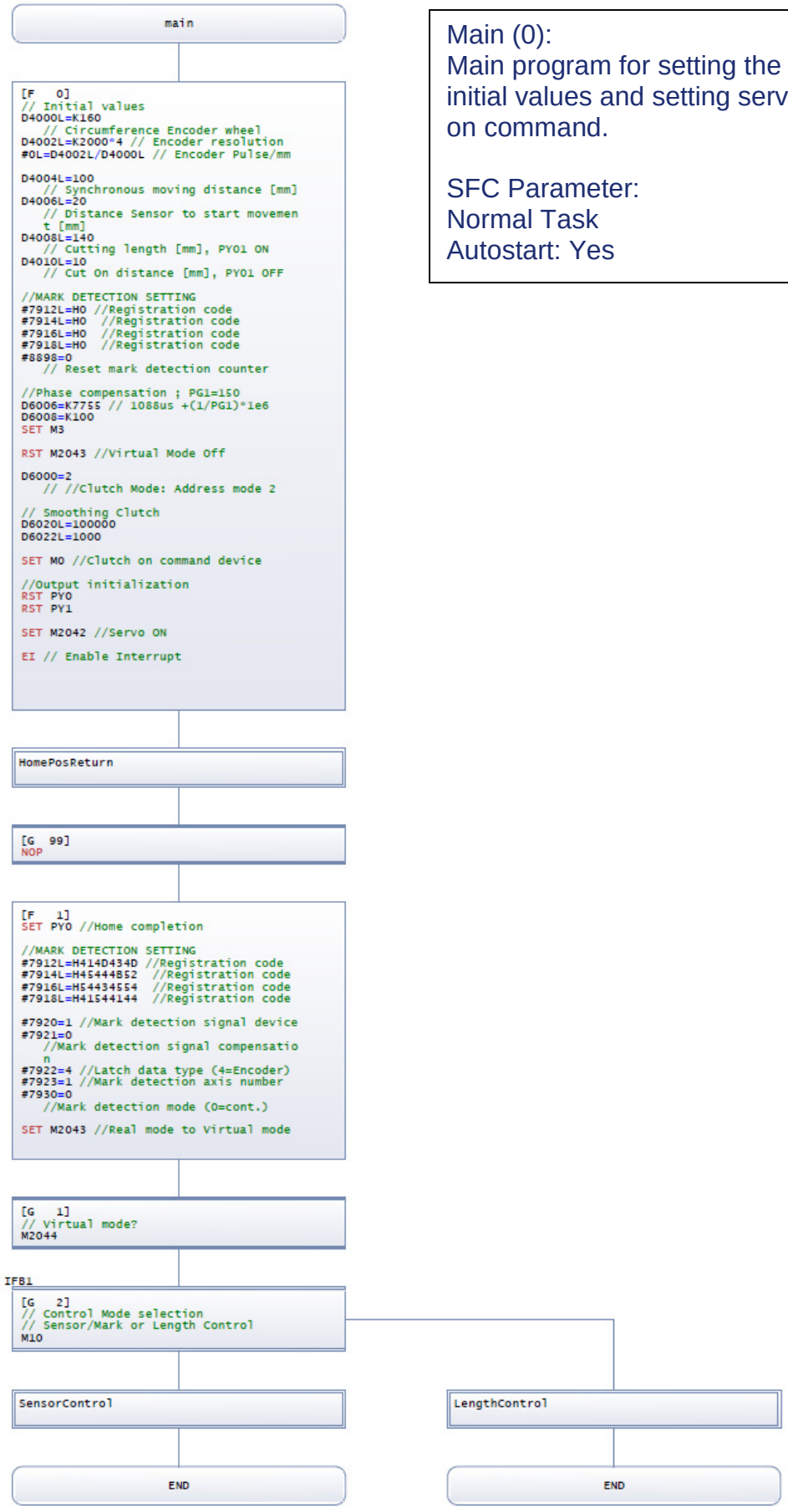
Phase compensation:

The phase compensation advance time (D6006) is set according the formula below:

Advance time =	System delay time	+ 1/PG1 (Model gain of Servo amplifier)		
D6006 =	1088 [µs]	+ 1/150 [s]		
D6006 =	1088 [µs]	+ 6667 [µs]	=	7755 [µs]

MITSUBISHI ELECTRIC FACTORY AUTOMATION
Mitsubishi Electric Europe B.V. /// FA-European Business Group /// Gothaer Strasse 8 /// D-40880 Ratingen /// Germany
Tel: (02102) 4860 /// Fax: (02102) 486112 /// Email:info@mitsubishi-automation.com /// Web: www.mitsubishi-automation.com

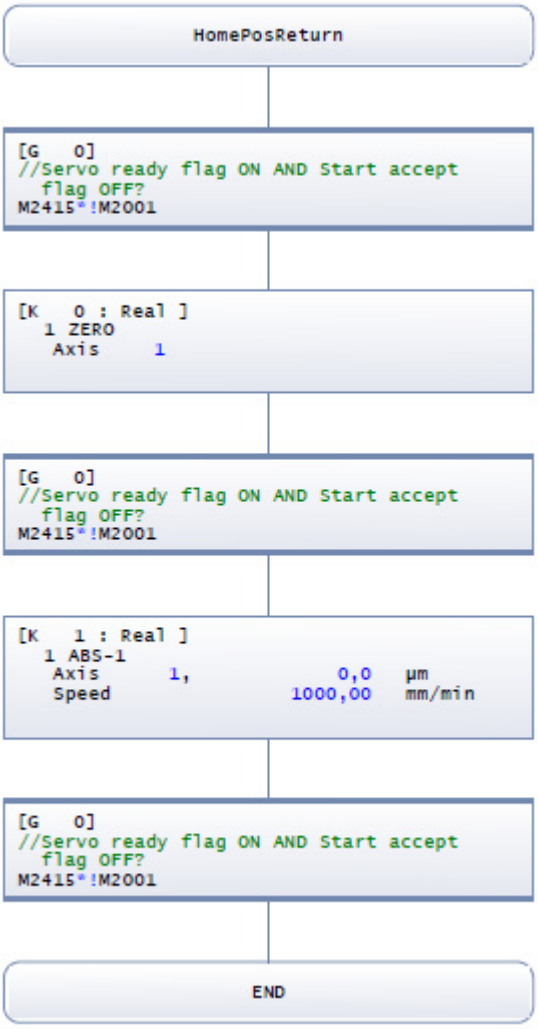
SFC Program:



Main (0):
Main program for setting the initial values and setting servo on command.

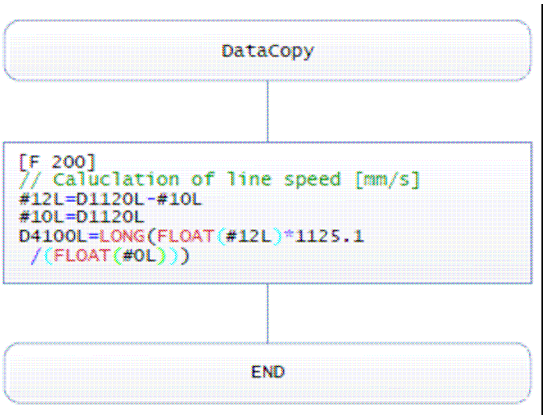
SFC Parameter:
Normal Task
Autostart: Yes

MITSUBISHI ELECTRIC FACTORY AUTOMATION
Mitsubishi Electric Europe B.V. /// FA-European Business Group /// Gothaer Strasse 8 /// D-40880 Ratingen /// Germany
Tel: (02102) 4860 /// Fax: (02102) 486112 /// Email:info@mitsubishi-automation.com /// Web: www.mitsubishi-automation.com



HomePosReturn (1):
Execution of the Home position return function.

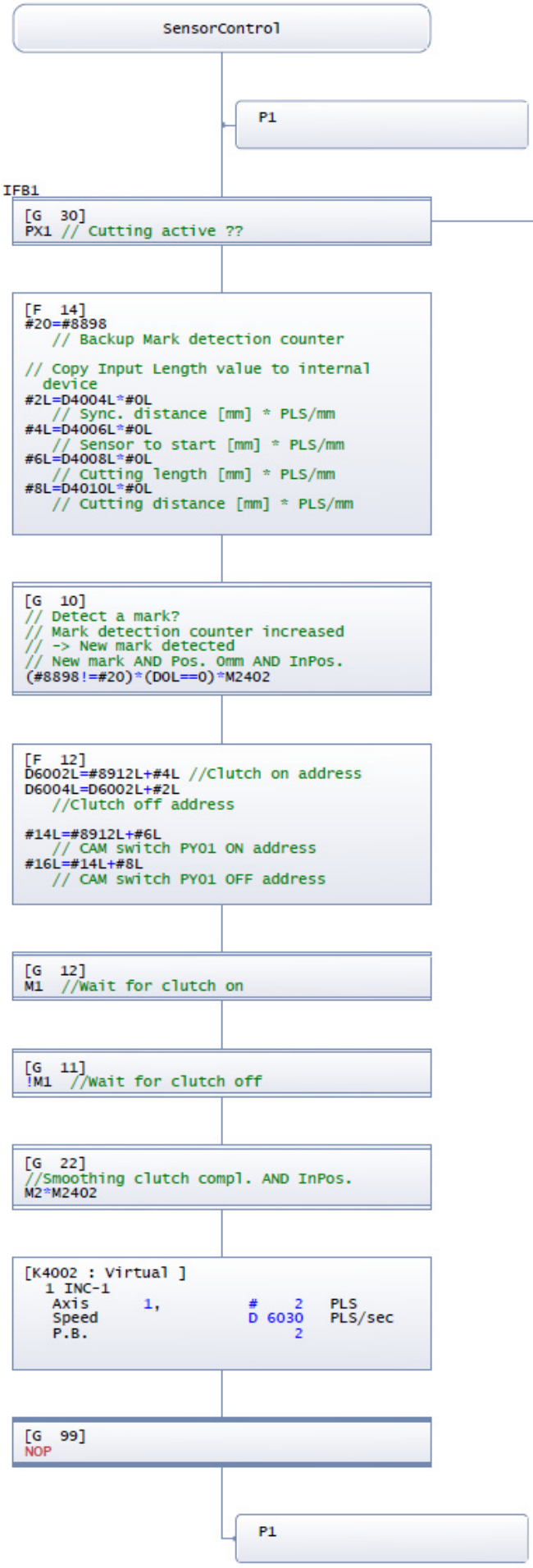
SFC Parameter:
Normal Task
Autostart: No



DataCopy (2):
Program for calculation the line speed of the material.

SFC Parameter:
Event Task: 0.8ms Cycle
Autostart: Yes

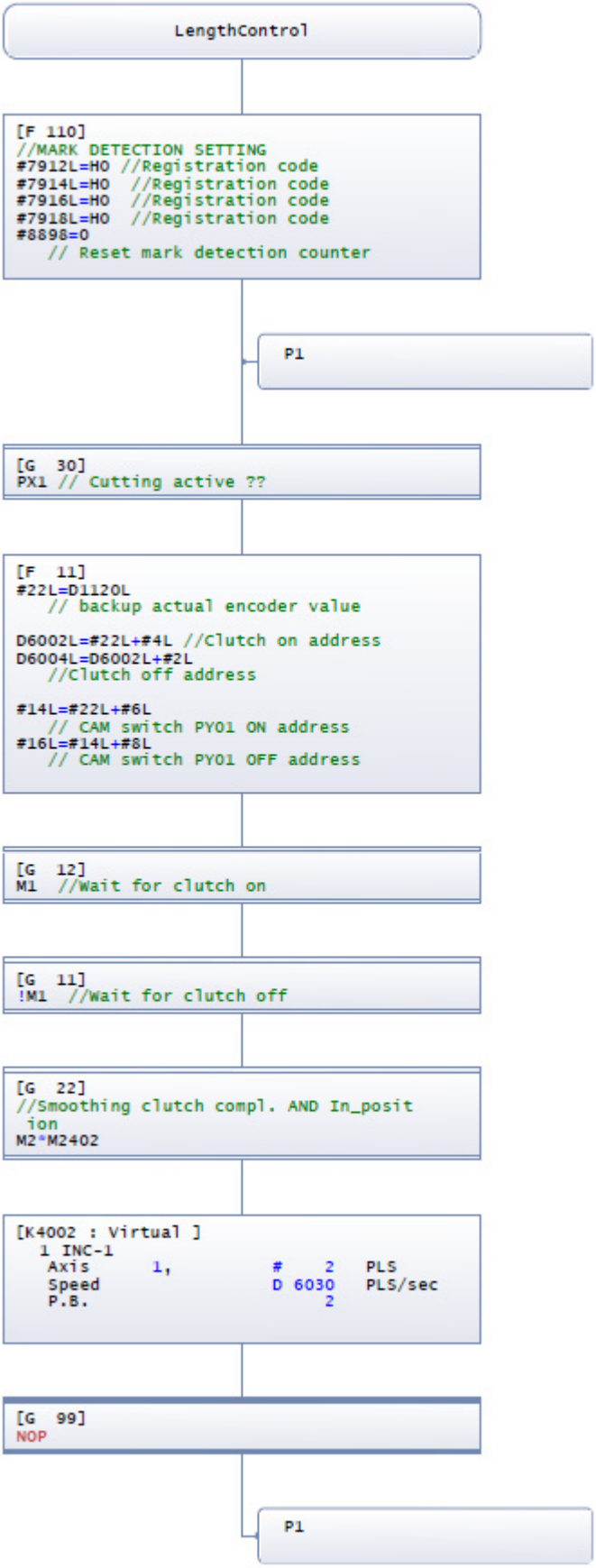
MITSUBISHI ELECTRIC FACTORY AUTOMATION
Mitsubishi Electric Europe B.V. /// FA-European Business Group /// Gothaer Strasse 8 /// D-40880 Ratingen /// Germany
Tel: (02102) 4860 /// Fax: (02102) 486112 /// Email:info@mitsubishi-automation.com /// Web: www.mitsubishi-automation.com



SensorControl (10):
Program for synchronisation of the servo to encoder using the mark detection function.

SFC Parameter:
Normal Task
Autostart: No

MITSUBISHI ELECTRIC FACTORY AUTOMATION
Mitsubishi Electric Europe B.V. /// FA-European Business Group /// Gothaer Strasse 8 /// D-40880 Ratingen /// Germany
Tel: (02102) 4860 /// Fax: (02102) 486112 /// Email:info@mitsubishi-automation.com /// Web: www.mitsubishi-automation.com



LengthControl (11):
Program for synchronisation of the servo to encoder fixed length without mark detection function.

SFC Parameter:
Normal Task
Autostart: No

MITSUBISHI ELECTRIC FACTORY AUTOMATION
Mitsubishi Electric Europe B.V. /// FA-European Business Group /// Gothaer Strasse 8 /// D-40880 Ratingen /// Germany
Tel: (02102) 4860 /// Fax: (02102) 486112 /// Email:info@mitsubishi-automation.com /// Web: www.mitsubishi-automation.com