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Position control with MICROMASTER420 frequency converter and asynchronous motors with USS protocol (Tip 65)

Category: Motor Control

Special Hardware Requirements:

- SIMATIC S7-200 PLC
- MICROMASTER 420 frequency converter.

Project Example 1 (Micro/WIN)

Project Example 2 (ProTool Designer)

Project Example 3 (TP Designer)

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Overview

The following Tip & Trick shows a sample program for a position control system based on a SIMATIC S7-200 and a MICROMASTER 420. Target position and target window can be set as needed.

The completion of this task requires only a SIMATIC S7-200 PLC and a MICROMASTER 420 frequency converter. The SIMATIC S7-200 communicates with the MICROMASTER 420 frequency converter using the USS protocol integrated in the PLC.

Tip 28 describes the following configuring files:

S7-200 program: MicroWin 3.2 Tip065b.mwp

OP7 configuration: ProTool 5.2 Tip065b.pdb

TP070 configuration: TP Designer 1.0 Tip065b.tpf

Advantages :

- Exceptionally precise positioning
  (among other things, positioning accuracy is dependent on:

  -mechanical construction
  -dynamics of the relevant Micromasters
  -size of the S7-200 program)

- Variable positioning.Optimum path/time response.

- Insensitive to load changes during travel and during positioning when dimensioned accordingly.

- Response can always be adapted. The dynamic parameters are stored in the controller and can be changed e.g. prior to travel.

- Reduction in wiring overhead through the elimination of conventional drive circuits
- All S7-200 CPUs (independence on the other program functions) can be used.

Note:

- It is recommended that cycle times be kept to a minimum, as the cycle time influences the positioning accuracy.
- Approx. 4,200 bytes of program memory are required.
- PORT 0 on the CPU is reserved for the Micromaster. (Port 0 cannot be used simultaneously for USS protocol and HMI functions or as programming interface, which means that the OP7 or TP070 can be connected only via an EM277 (CPU222 or newer) or second PLC interface (CPU226 or newer).

2 Sample application

2.1 Hardware for the sample application

- CPU222-226XM possible
- MW V 3.2 or newer
- USS Protocol Library (Add-On Instruction Library 6ES7 830-2BC00-0YX0)
- EM277 expansion module for an OP7 or TP070 (Optional with CPU226 or CPU226XM)
- SIEMENS MICROMASTER 6SE6420-2AB11-2AA0 frequency converter (FC)
- 0.12 kW 1350 U/min asynchronous motor
- Heidenhain 24V- A/B Ref. 1000 I/U incremental encoder connected to the motor via a front shaft
- OP7 or TP070

2.2 Function in general

Controlled positioning based on actual-value acquisition and setpoint generation using a ramp generator.

In a state of rest, the drive opposes a mechanical load and attempts to hold the position in the position window.

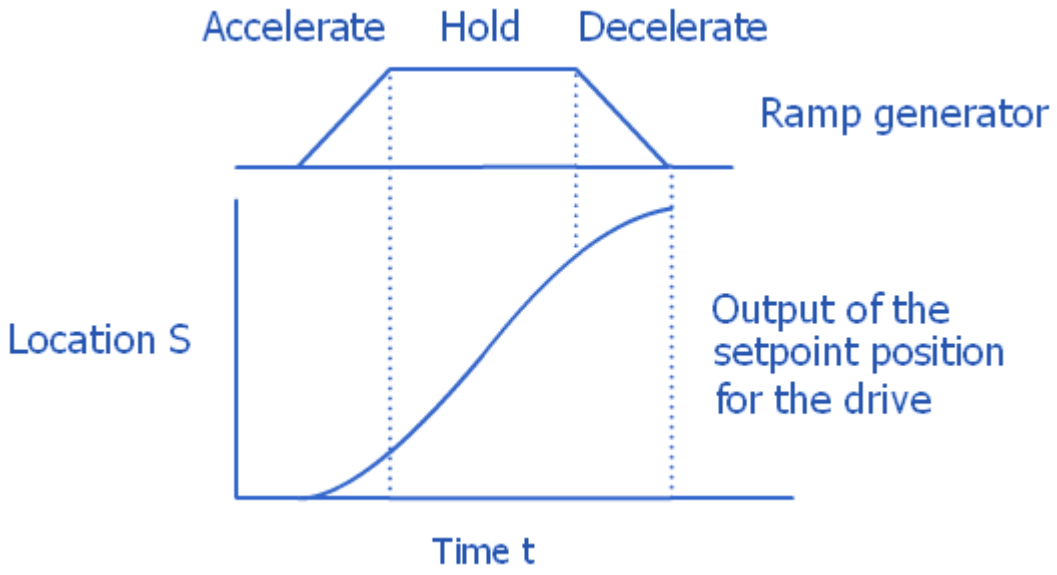
As the distance between setpoint and actual position increases, the manipulated variable increases proportionally (P controller), as does the analog value, which increases the frequency on the FC so that the counter-torque increases with maximum deviation and the drive moves back to the position window.

During position control, an I controller is also enabled, causing a constant increase in the counter-torque in the event of deviation.

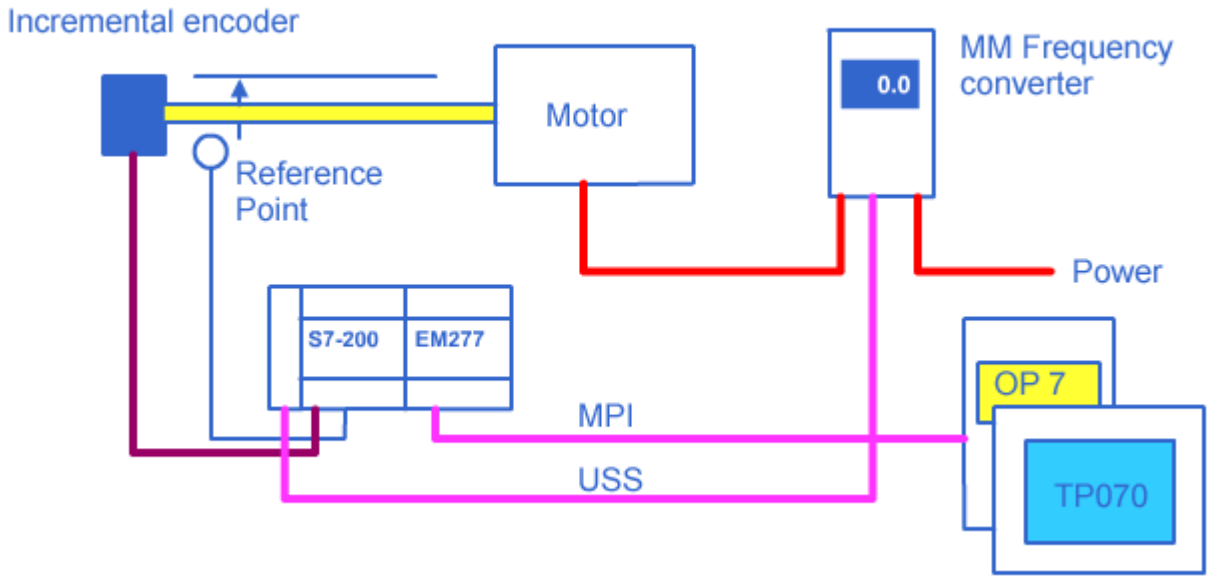
When a new setpoint position is specified, a ramp generator uses the specified data to calculate the ideal setpoint path for the drive to follow. During positioning, the I controller is disabled in order to keep

oscillation to a minimum.

The advantage of this positioning method is that the traversed path is controlled from beginning to end, with defined acceleration, maximum speed and delay joining to form an ideal path/time line.



2.3 Sample System



In this example, the encoder's reference point signal is not activated via an NO contact until the end of the path has been reached. This is necessary because the function of the high-speed counter cannot be changed while the controller is in RUN mode.

Function 10 = A/B counter using I0.0 and I0.1 and Reset Counter using I0.2

Incremental encoder's zero track (one increment per revolution)

You can also set the reference point by means of an external switch. To do so, you need only execute the "SET 0" function, setting the counter to function 9. Function 9 = A/B counter using I0.0 and I0.1 and **no** Reset Counter using I0.2

2.4 Connections

I0.0 Incremental encoder track A (brown)

I0.1 Incremental encoder track B (gray) Signals from the incremental encoder
I0.2 Incremental encoder reference point (see above)

I0.3 Enable positioning

I0.4 Set zero point

I0.5 Manual V1 in positive direction

I0.6 Manual V2 in positive direction You can also execute these functions using the

I0.7 Manual V1 in negative direction OP7 or TP070

I1.0 Manual V2 in negative direction

I1.1 Start reference point approach

L+ 24V -	also on	blue + brown/green	Incremental encoders from Heidehain
M0	also on	white + white/green	Incremental encoders from Heidehain

Connection (USS protocol) from CPU PORT 0 to terminals 14 and 15 on the FC MICROMASTER MM420 (RS485 14->B red 15->A green) - with Profibus cable
The cable must have the proper termination and bias resistors. See the S7-200 System manual Edition 01/2002 Chapter 11 on using the USS Protocol Library.

2.5 Parameters and their settings

Parameters for the MICROMASTER 420

// +++ Parameters for the MicroMaster 420 ++++++++++++

//

// Enter the parameters in succession

//

//P0003=3

```
//P0010=30
//P0970=1
//P0003=3
//P2012=2            USS PZD length
//P2013=127          Variable USS PKW message length (default)
//P010=1             Enable quick commissioning mode
//P0304=Rated motor voltage (V)
//P0305=Rated motor current (A)
//P0307=Rated motor power (W)
//P0310=Rated motor frequency (Hz)
//P0311=Rated motor speed (RPM)
//P010=0             Disable quick commissioning mode
//P1080=0.20 Hz      Minimum frequency (depends on control response)
//P0700=5            Set local/remote control mode by setting
//P1000=5            Set local/remote control mode by setting
//P2010  Index 0 Value 7 (19200) Baud rate
//P2011  Index 0 Address 1 (0 to 31) Slave address
//P1120= 0.00        (0 to 650.00) Acceleration ramp
//P1121= 0.00        (0.00 to 650.00) Deceleration ramp
//
//          Set the serial link timeout by setting:
//P2014  Index 0     Value 300 (0 to 65535 ms)
//                   Value 0 is without monitoring
//                   When you change this value, the PLC must already carry out the
//                   USS protocol, as otherwise Error 72 is immediately reported.
//                   You must also change the value with the arrow pointing down,
//                   as the first value would be 1 ms if the arrow were pointing up, resulting
//                   in the immediate reporting of an error.
```

```
//
//P2000= 50.00 Hz (1 to 650 Hz)
//P2009  Index 0 Value 0 USS Normalization
//P0971= 1          0 Changes to parameter settings are lost when power is removed
//                  1 Changes to parameter settings are retained despite power outages
//                    (Automatically reset to 0 after the parameters are saved.)
```

2.5.2 Parameters for the demo system

In the CPU's data area.

Can be set using OP7, TP070 or MicroWIN 3.2

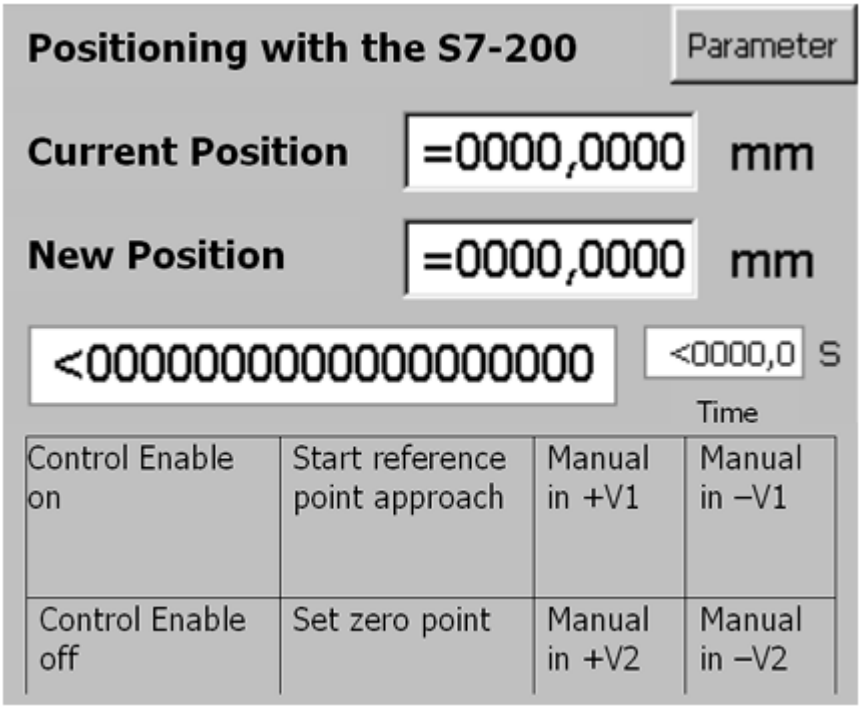
```
// values marked with //* may be modified
//
VD1000 0.0        //  New position m
VD1004 0.0        //  Current position m
VD1008 0.03       //* Controller I factor
VD1012 0.01       //  Position window m
VD1016 10.0       //* Speed 1 Manual %
VD1020 80.0       //* Speed 2 Manual %
VD1024 0.0        //  Setpoint position from setpoint generator m
VD1028 0.0        //  Manipulated variable m
VD1032 0.0        //  Traverse path m
VD1036 0.0        //  Old position m
VD1040 0.0        //  Time value in increments of 0.1 seconds
VD1044 0.01       //  Acceleration m/s³
VD1048 0.01       //  Deceleration m/s³
VD1052 0.03       //  Maximum speed m/s
```

```
VD1056 0.0          //  V setpoint from generator m/s
VD1060 0.0          //  Auxiliary memory 1 generator
VD1064 0.0          //  Auxiliary memory 2 generator
VD1068 0.0          //  Auxiliary memory 3 generator
VD1072 3.0          //* Controller / P factor
VD1076 100.0        //* Upper limit of manipulated variable +- 100.0 %
VD1080 6250.0       //* System coefficient
VD1084 0.1015       //  Reference point shift m
VW1088 0            //  Memory f. manual acceleration
VW1090 0            //  Memory f. manual deceleration
VD1092 0.0015       //  Travel per revolution m
VD1096 0.0          //  Ramp f. I component
VD1100 0.0          //  Speed output manual
VD1104 0.0          //  Intermediate memory manual travel
VD1108 0.001        //* Factor display versus meter
//                    1.0 = Display and specifications in meters
//                    0.01 = Display and specifications in centimeters
//                    0.001 = Display and specifications in millimeters
//                   0.000001 = Display and specifications in micrometers
VW1112 0            //  Memory f. time following reference point approach
//
// General specifications
// Values marked with //* may be modified
//
VD1120 0.0          //* New position mm
VD1124 0.0          //* Current position mm
VD1128 0.01         //* Position window mm
VD1132 30.0         //* Acceleration mm/s³
```

```
VD1136 30.0          //* Delay mm/s³
VD1140 30.0          //* Maximum speed mm/s
VD1144 102.1         //* Reference point shift mm
VD1148 1000.0        //* Increments per revolution
VD1152 1.5           //* Travel per revolution in mm
VW1156 +500          //* Manual acceleration and ref. in ms
VW1158 +500          //* Manual deceleration and ref. in ms
//
// General specifications
// Values marked with //* may be modified
//
// Values and status USS protocol
//
VD1160 0.0           // Manipulated variable + -100.0% to USS
//
VB1164 16#00         // Status bits USS Control
VB1165 0             // Error USS Control
VW1166 0             // Drive status
VD1168 0.0           // Drive speed
VB1172 0             // Error USS unit
```

2.6 Functions of the TP070

2.6.1 Starting display and general remarks



- The basic display appears when the controller is switched on:
- The display shows the current position.
- The axis begins to traverse when a new position is specified.
- When you want to change or enter a value, press the field showing the value you want to change. A system keyboard appears. Use it to enter your new values, including sign and decimal point.
- The lower keys are for axis control. The control keys for manual operation are switches, that is to say,
- "flipping" a switch (i.e. pressing a button) starts the relevant action. The switch must be "flipped back again" (the button re-pressed) to stop the action.

The text field shows the current status.

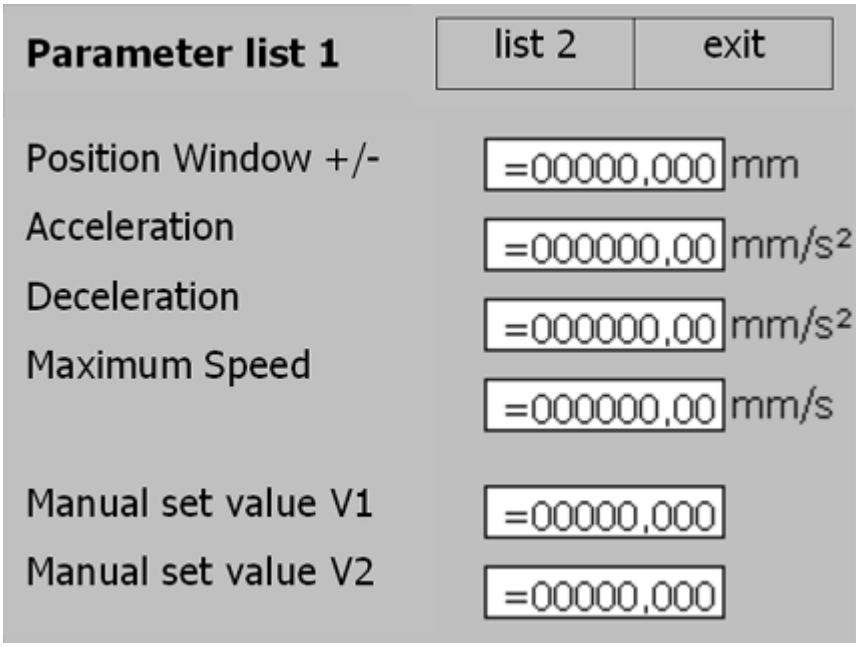
The following messages may appear:

- 'No Control Enable '
- 'Position control'
- 'In position'
- 'Acceleration phase'
- 'Holding phase'
- 'Deceleration phase'
- 'Reference point approach'

2.6.2 Functions of the TP070

2.6.2.1 Parameter List 1

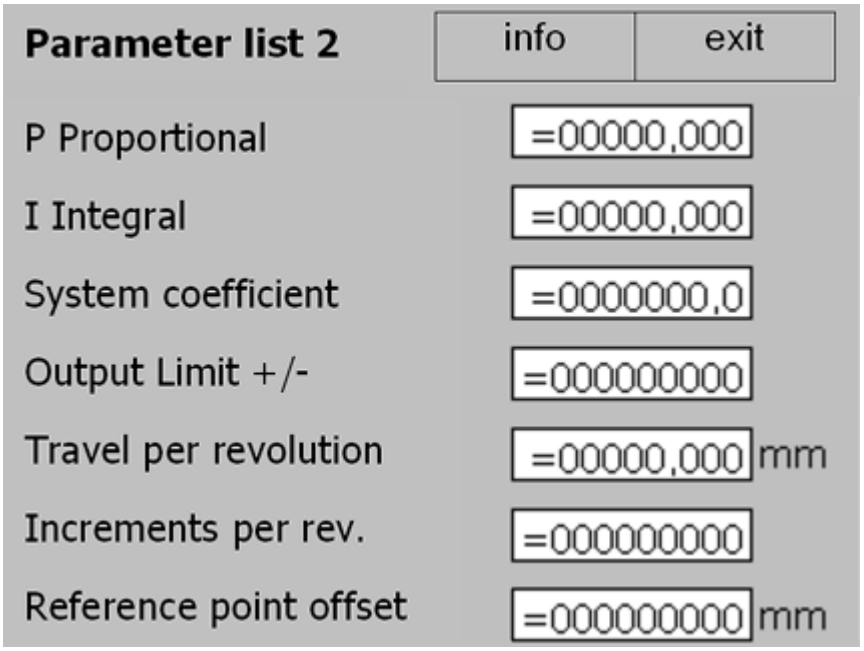
The following display shows you a list of all modifiable parameters



- The position window is the area in which the axis is seen as being in position. It will no longer be controlled.

- Manual travel and reference point approach are not controlled variables. Instead, an analog value is output. These values are not physical quantities, as the latter would depend on the overall configuration.

2.6.2.2 Parameter List 2

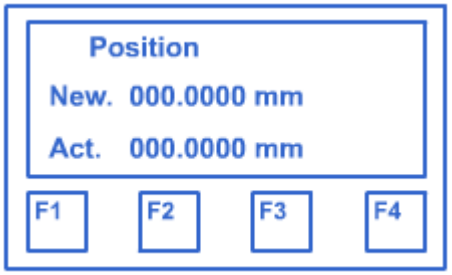


The system coefficient is a factor that depends on the overall configuration.

2.7 Functions of the OP7

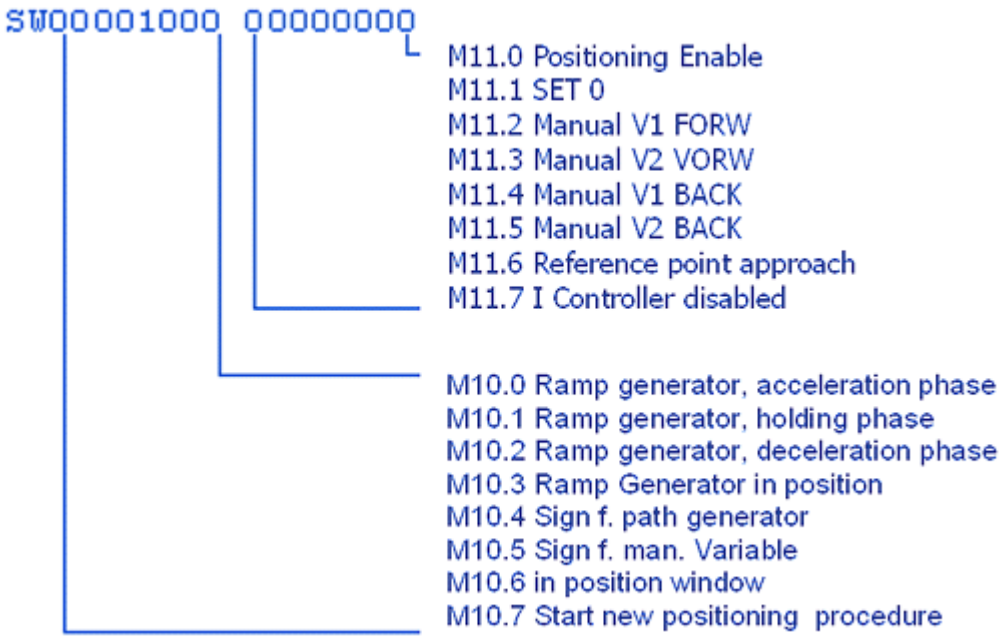
2.7.1 Starting display and general remarks

The basic display appears when the controller is switched on :



- The display shows you a line for entering a new position and a line showing the current position.
- A control word is also displayed.
- The control word is used to coordinate positioning, and this display allows you to follow the status at all times.

The bits are allocated as follows:



You can select all other displays using the arrow keys; the cursor will appear in the fields whose values you may modify.

When a new absolute position is entered, positioning begins automatically.
The parameters appear in the same succession as on the TP070.

2.7 Function Keys on the OP7

You can use either digital inputs or the OP7 for control purposes.

Function keys:

F1 Set Position Enable
F2 Reset Position Enable (use SHIFT to change to OP7. PW 100 mode)
F3 SET 0
F4 Start reference point approach

K1	As long as key is held down	FORW V1
K2	As long as key is held down	FORW V2
K3	As long as key is held down	BACK V1
K4	As long as key is held down	BACK V2

3 Program codes and parameter files

- To call a project file, click on the file when working with STEP 7-Micro/WIN 3.2 or a newer version.
- If you are using an earlier version of STEP 7-Micro/WIN, you must start Micro/WIN and then select menu command Project > Open in order to start the Tip project.

S7-200 project:	MicroWin 3.2	Tip065b.mwp
OP7 configuration:	ProTool 5.2	Tip065b.pdb
TP070 configuration	TP Designer 1.0	Tip065b.tpf