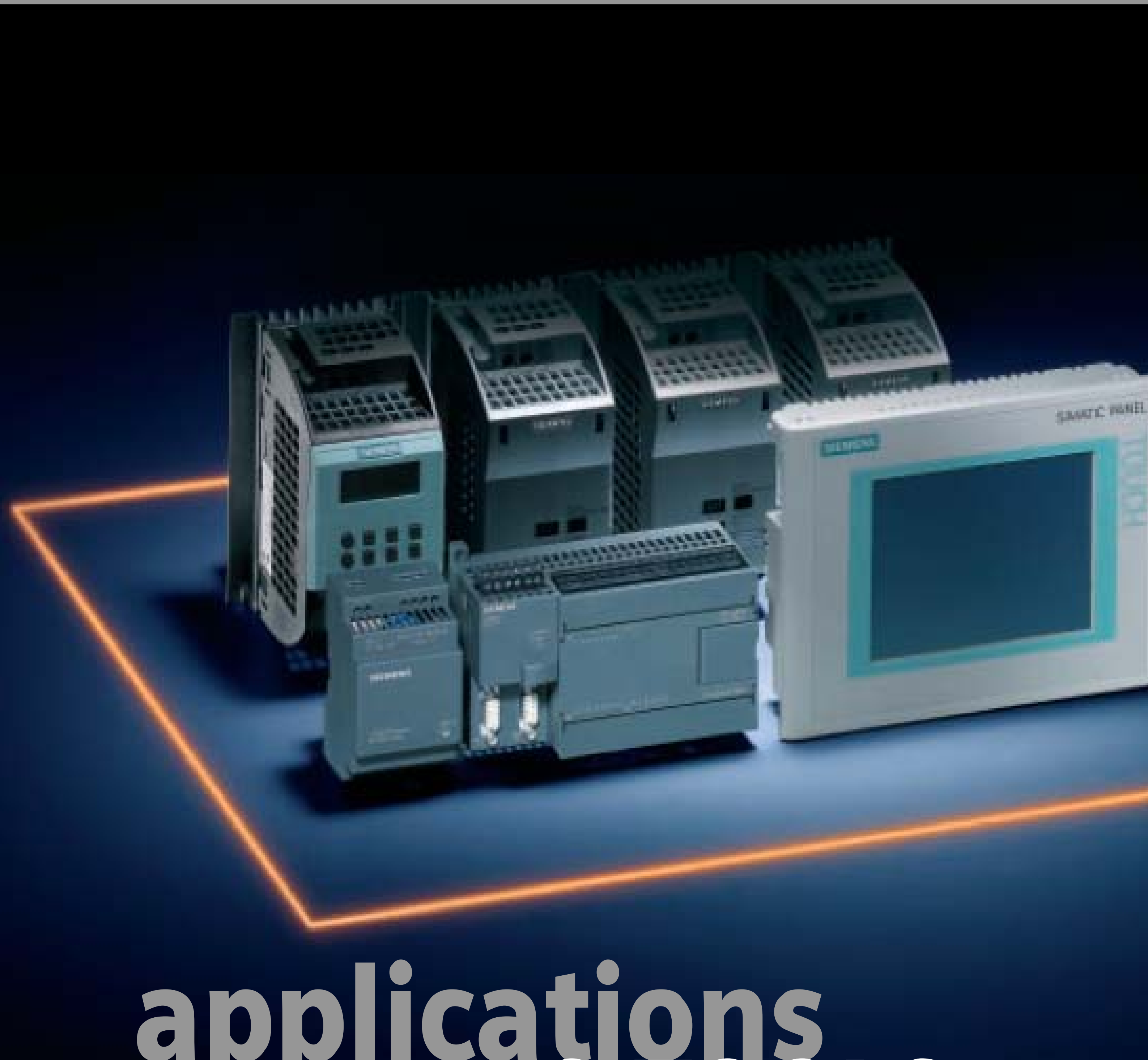
Micro Application Example



applications & TOOLS

Easy Cabling and Cascading of Drives

(with S7-224 XP, 4x SINAMICS G110 and TP 177micro)

SIEMENS

Micro Automation Set 26

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Preface

Micro Automation Sets are fully functional and tested automation configurations based on IA / DT standard products for simple, fast and inexpensive implementation of automation tasks for small-scale automation. Each of the available Micro Automatic Sets covers a frequently occurring subtask of a typical customer problem in the low-end performance level.

The sets help you to obtain answers with regard to required products and the question of how they function when combined.

However, depending on the system requirements, a variety of other components (e.g. other CPUs, power supplies, etc.) can be used to implement the functionality on which this set is based. For these components, please refer to the corresponding SIEMENS IA / DT catalogs.

The Micro Automation Sets are also available by clicking the following link:

http://www.siemens.de/microset

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1 Application Areas and Usage

Automation Task

A water user shall be supplied with water on demand via four pumps.

Four induction motors drive one pump each. Assuming an output of 100% for each pump, an output of 400% is to be generated by cascading all four pumps.

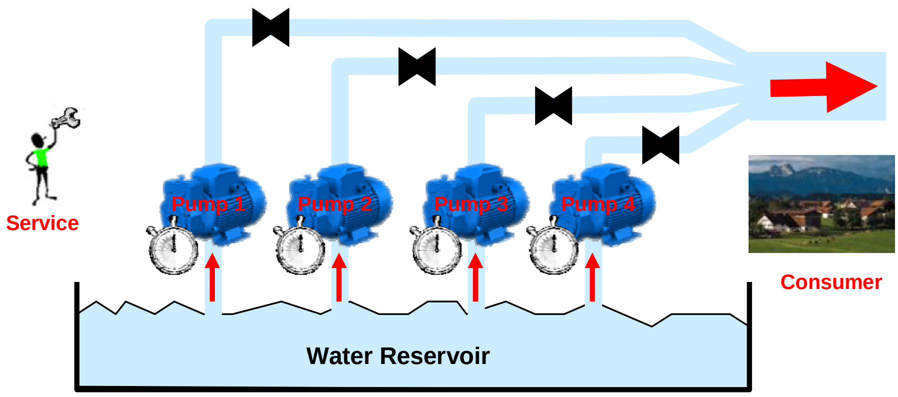
By switching pumps on an equal load for all pumps shall be ensured taking into consideration the operating times. The pumping output of a pump which has been released for maintenance shall be automatically taken over by a pump with free capacity.

Apart from the above described automatic operation, it shall also be possible to operate each pump manually.

In order to take into consideration the various pump types, it shall be possible to operate all pumps in positive and negative direction.

The plant shall be operated via a monochrome Touch-Panel

Figure 1-1



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Automation Solution – Set 26

Technical Features

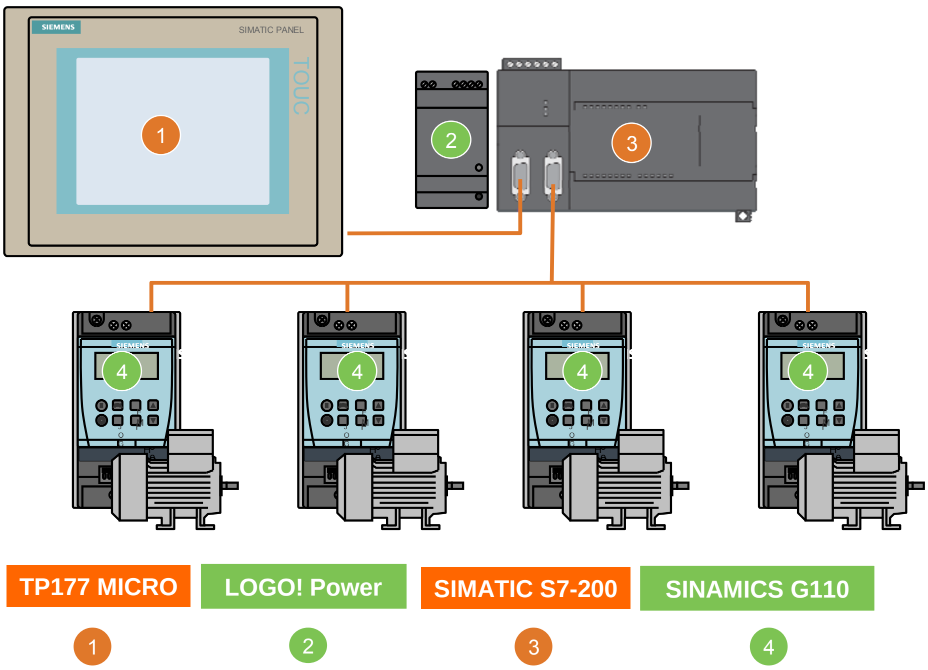
The 4 induction motors are controlled with one SINAMICS G110 type frequency converter each.

In order to minimize the wiring expenses between controller S7-200, CPU 224XP, and the frequency converter, the SINAMICS G110 with integrated bus interface (RS485 with USS protocol) was selected as a frequency converter. This enables controlling all 4 frequency converters via the internal interface of the S7 200 CPU.

The compact controller S7- 200, CPU 224 XP is configured via the programming user interface STEP7 MicroWIN V4.0 SP6, which enables including an USS library for simple controlling of the frequency converter.

Touch-panel TP 177micro represents the user interface for the operator. WinCC flexible 2007 is used as a configuration tool.

Figure 1-2



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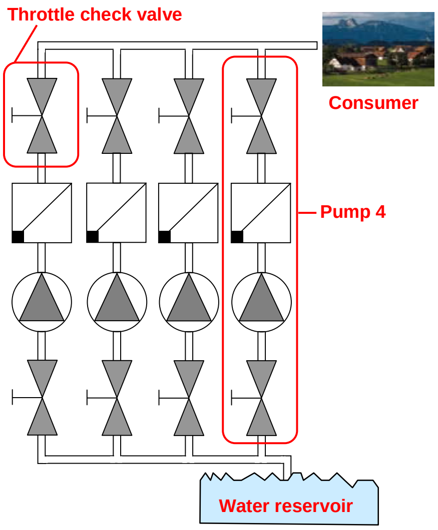
Technological Features

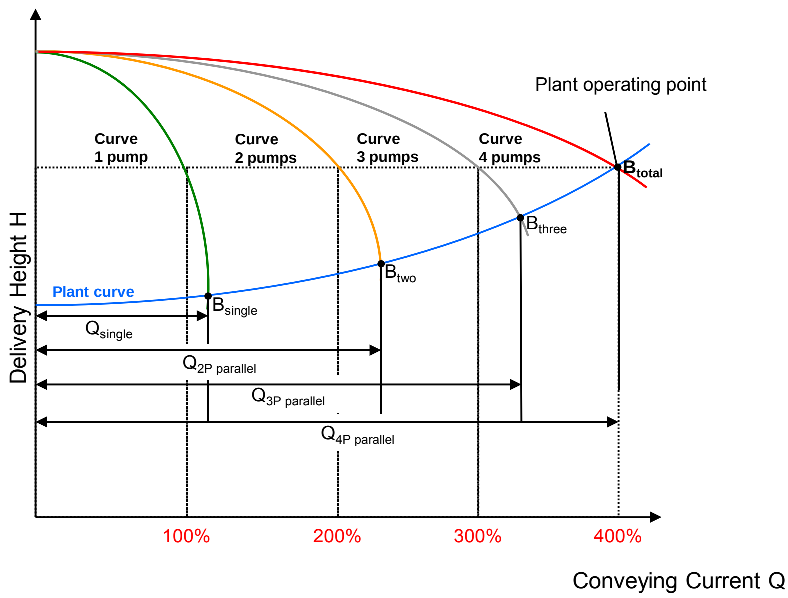
As mapped out in Figure 1-3, the control program takes into consideration that activated and cascaded pumps must have an identical flow rate. This prevents the throttle check valves from reducing the water flow rate.

Figure 1-3



The delivery height H of each pump depends on the conveying current Q. Figure 1-4 shows how the delivery height is increased for a quadrupled conveying current when cascading 4 pumps.

Figure 1-4



Fields of application

This configuration is mainly intended for applications with several interconnected drives. Requirements for a dynamic speed change or controllable/adjustable speed can easily be met.

This configuration is particularly suitable for:

- Fan groups
- Compressor cascades/groups
- Pump cascades/groups

Benefits

- Equalizing the operating hours of all pumps, i.e. no premature wearing of individual pumps. Maintenance needs only be performed once for all pumps, i.e. cost reduction during servicing.
- During pump failure or pump switch-off the conveying current is automatically replaced by one or several other pumps (as long as up to 300% are conveyed)
- All networked drives can be controlled by one central S7-200 CPU.
- Communication between frequency converters can be programmed using prefabricated function blocks, all control functions can be used via a library
- Energy is saved by specific adaptation of the motor output to the output needed
- Protective mechanisms for motors are integrated into SINAMICS G110
- Frequency converter design without a fan which eliminates the need for wearing parts (up to 750W, housing size FS A)
- Bus terminating resistor is integrated into the frequency converter and can be activated using a DIP switch
- Optional availability of the frequency converter with an integrated EMC filter
- A parameter set can be saved and downloaded using a basic operator panel. Only the bus address needs to be adapted afterwards.

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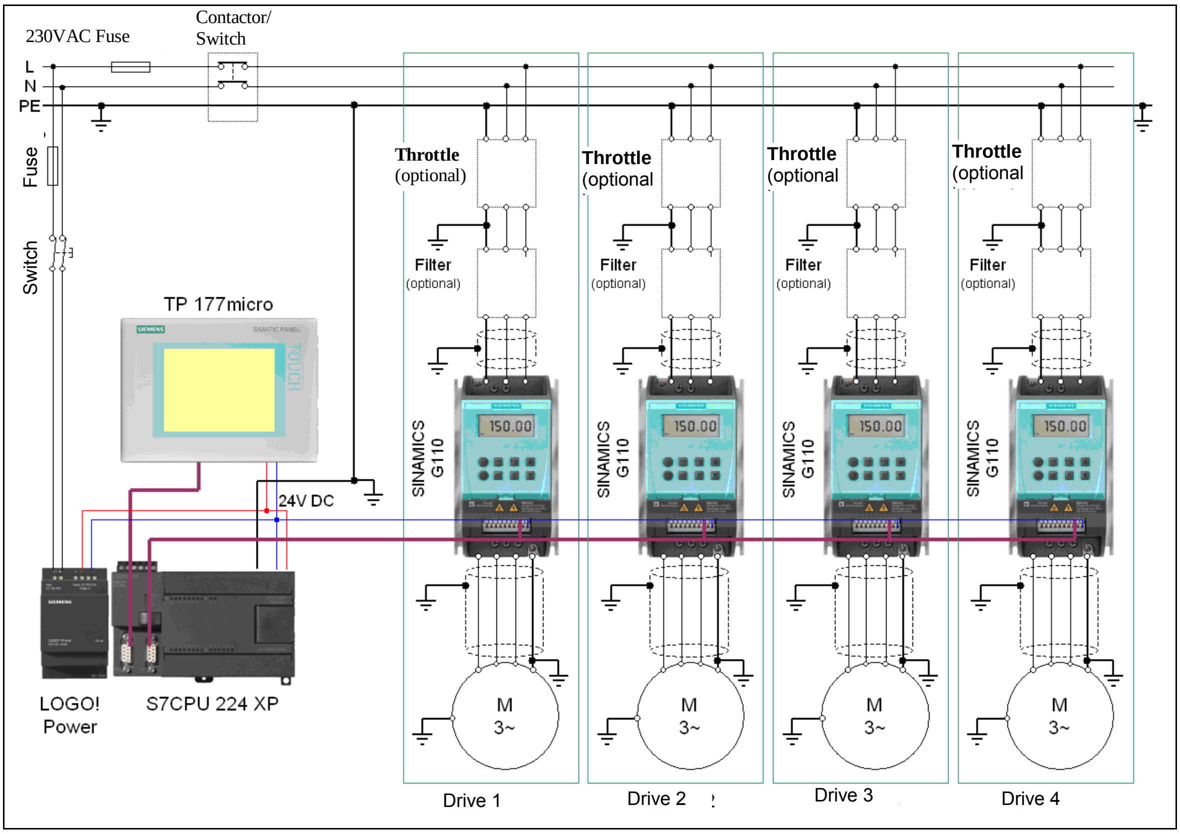
2 Setup

Figure 2-1 -- Wiring



Note

Enabling the frequency converters of pump P1 to P4 requires supplying the following digital inputs with a status “1”:

- Pump P1: I0.0
- Pump P2: I0.1
- Pump P3: I0.2
- Pump P4: I0.3

The 4-pole induction motors with 400V/230V star/delta winding have to be connected to the frequency converter in a delta connection (Δ 230V).

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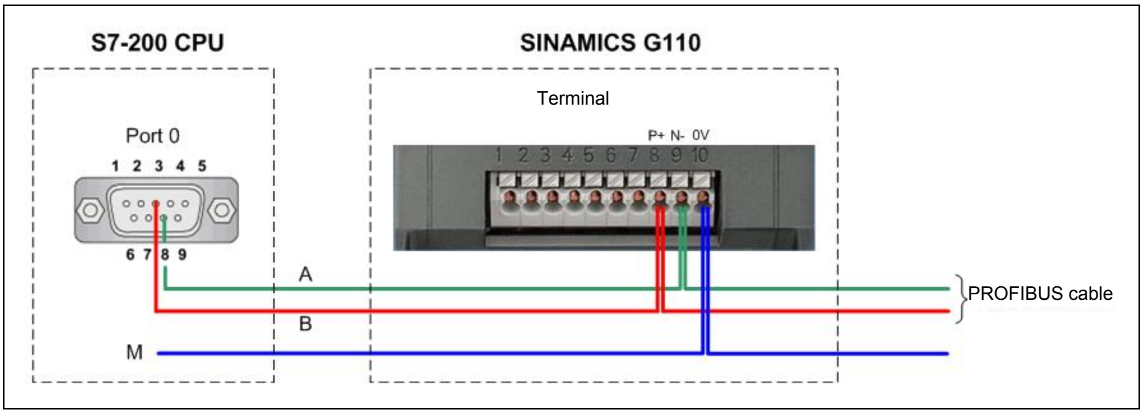
Figure 2-2 – Wiring detail for bus connection



Attention

What should be done to prevent electromagnetic interference:

- Make sure a good conductive connection between the frequency converter and the (grounded) metal mounting plate is provided.
- Ensure all devices in the cabinet are earthed using short earthing lines with a large diameter and are connected to a common earthing point or earthing bar.
- Ensure that the S7-200 CPU connected to the frequency converter is connected to the same earthing or earthing point as the frequency converter using a short line with a large diameter.
- Please use shielded control lines, e.g. a SIEMENS Profibus cable for setting up the RS485 bus. Ground the shield on the converter side with shield connections.
- Control lines must be installed separately from power cables in separate installation channels, if possible. Crossings between power and control lines should be at 90° angle.
- Connect the protective conductor of the motor to the earth connection (PE) of the respective frequency converter.
- The line ends should be properly terminated and unshielded lines kept as short as possible.

Use shielded lines for motor connections, earth the shielding both on the converter and the motor side using cable clamps.

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3 Hardware and Software Components

Products

Table 3-1

Component	Qty.	MLFB / Order number	Note
S7-CPU 224 XP DC	1	6ES7 214-2AD23-0XB0	
TP 177micro	1	6AV6640-0CA11-0AX0	
LOGO! Power 24V/1,3A	1	6EP1331-1SH02	
SINAMICS G110 120W without filter; USS version, FS A,	4	6SL3211-0AB11-2UB1	
BOP	min. 1	6SL3255-0AA00-4BA1	
4-pole, aluminum frame, 120W	4	1LA7060-4AB10	
SIMULATOR MODULE SIM274 for 14 inputs	1	6ES7274-1XH00-0XA0	Optional

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Accessories

Table 3-2

Component	Qty.	MLFB / Order number	Note
PROFIBUS cable PB FC standard, 2-wire bus line, shielded, delivery packaging: Max. 1000m, minimum quantity: 20m (sold by the meter)	Length [m]	6XV1830-0EH10	
Profibus connector with PG port	1	6ES7972-0BB12-0XA0	
Adapter for attachment of the SINAMICS converter FS A to the top hat rail	4 (optional)	6SL3261-1BA00-0AA0	
Filter for low leakage currents	4 (optional)	6SE6400-2FL01-0AB0	
Commutation inductor	4 (optional)	6SE6400-3CC00-4AB3	
Prepared connection cable between TP177micro and S7-CPU 224 XP	1	6XV1830-1CH30	Connecting cable 839-1T for PROFIBUS
PC/PPI cable (COM connection)	1	6ES7901-3CB30-0XA0	
USB/PPI cable (COM connection)		6ES7901-3DB30-0XA0	

Note

The configuration, as it is, is intended for industrial application. For energy supply, industrial networks are usually implemented. It is therefore not necessary to use special filters/inductors with low leakage currents.
If the configuration is used in sensible electricity networks (e.g. PCs on the same network), filters or inductors should be used.

Configuration software/tools

Table 3-3

Component	Qty.	MLFB / Order number	Note
STEP 7Micro/WIN V4.0 SP6	1	6ES7810-2CC03-0YX0	
S7-200 Instruction Library	1	6ES7830-2BC00-0YX0	
WinCC flexible 2007	1	6AV6612-0AA51-2CA5	

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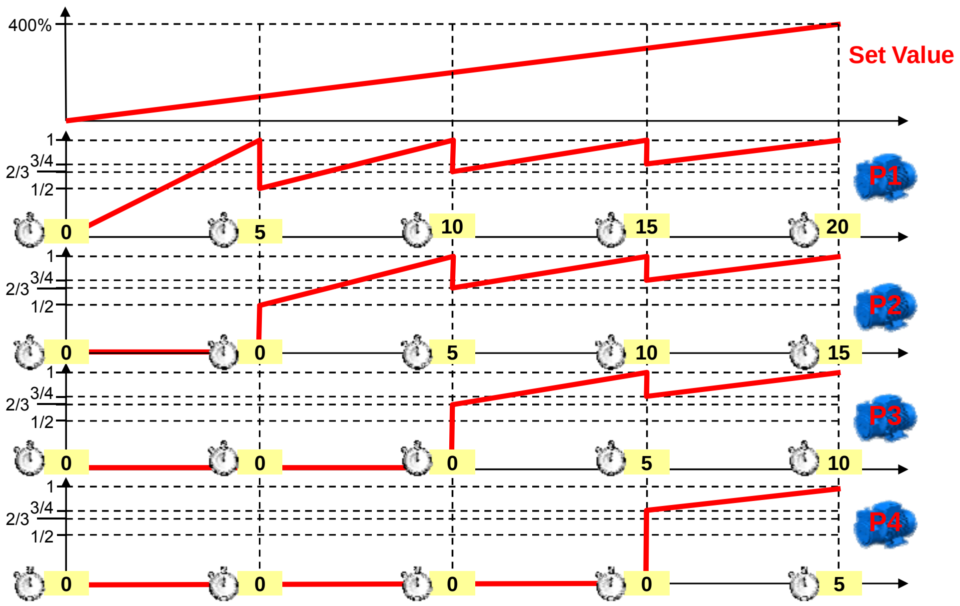
4 Functionality

4.1 Controlling the pumped amount

The control algorithm shall be explained using the following graphic.

- The algorithm controls pump P1 when demand <100%
- If the demand increases to >100% and remains below 200%, the load is distributed between pump P1 and P2. For a load of 200% both pumps are used at 100% load each.
- If the demand increases to >200% and remains below 300%, the load is distributed between pump P1, P2 and P3. For a load of 300% all three pumps are used at 100% load each.
- If the demand increases to >300% and remains below 400%, the load is distributed between pump P1, P2, P3 and P4. For a load of 400% all 4 pumps are used at 100% load each.

Figure 4-1



Note The used algorithm assumes that all used pumps have the same characteristics!

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4.2 Balancing of operating hours

Recording the pump operating hours

The control program records the operating hours of each pump. As soon as a pump is running (even if only slowly) it is considered as switched on.

The speed of the pumps does not enter the calculation of the operating hours. Only the effective runtimes are calculated.

Switch-on priorities of the frequency converters

Each pump is assigned a priority, which controls which pump will be switched on next when required. The pump with the lowest operating time receives the highest priority. This means that this pump is the next to be switched on if required.

The control algorithm shall be explained using the following graphic Figure 4-2.

- The algorithm controls pump P4 if the demand is <100%, since with 5 hours it has the lowest amount of operating hours.
- If the demand increases to >100% and remains below 200%, the load is distributed between pump P4 and P3. Pump P3 is selected as with 10 hours it has the lowest number of operating hours. For a load of 200% both pumps are used at 100% load each.
- If the demand increases to >200% and remains below 300%, the load is distributed between pump P4, P3 and P2. Pump P2 is selected as with 15 hours it has the lowest number of operating hours. For a load of 300% all 3 pumps are used at 100% load each.
- If the demand increases to >300% and remains below 400%, the load is distributed between pump P4, P3, P2 and P1. For a load of 400% all 4 pumps are used at 100% load each.

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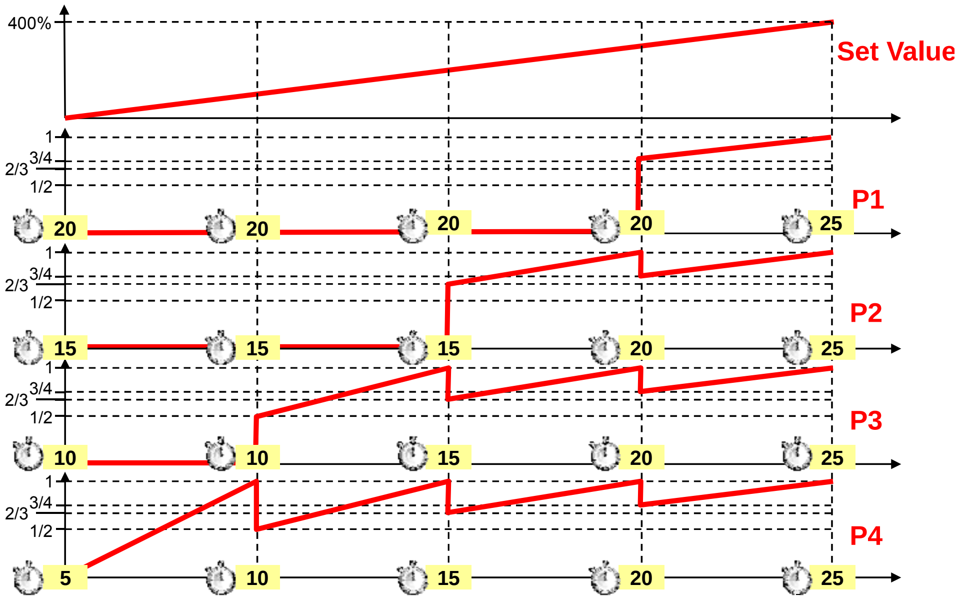
Figure 4-2



4.3 Maintenance

The plant also offers the possibility of excluding individual pumps from the process, e.g. during failure or if a pump needs to be serviced (as shown in Figure 4-3).

As long as the requested water consumption is lower or equal 300%, and an active pump is taken out of the group for servicing, its task is taken over by a pump which is inactive at that time.

The control algorithm shall be explained using the following graphic.

- The algorithm controls pump P1 when demand <100%
- If the demand increases to >100% and remains below 200%, the load is distributed between pump P1 and P2. For a load of 200% both pumps are used at 100% load each.
- If the demand increases to >200% and remains below 300%, the load is distributed between pump P1, P2 and P4. Since pump P3 is not available due to maintenance works, the task is taken on by pump P4. For a load of 300% all 3 pumps are used at 100% load each.

After terminating the maintenance works and enabling the maintained pump, it is reintegrated into the process according to the above rules.

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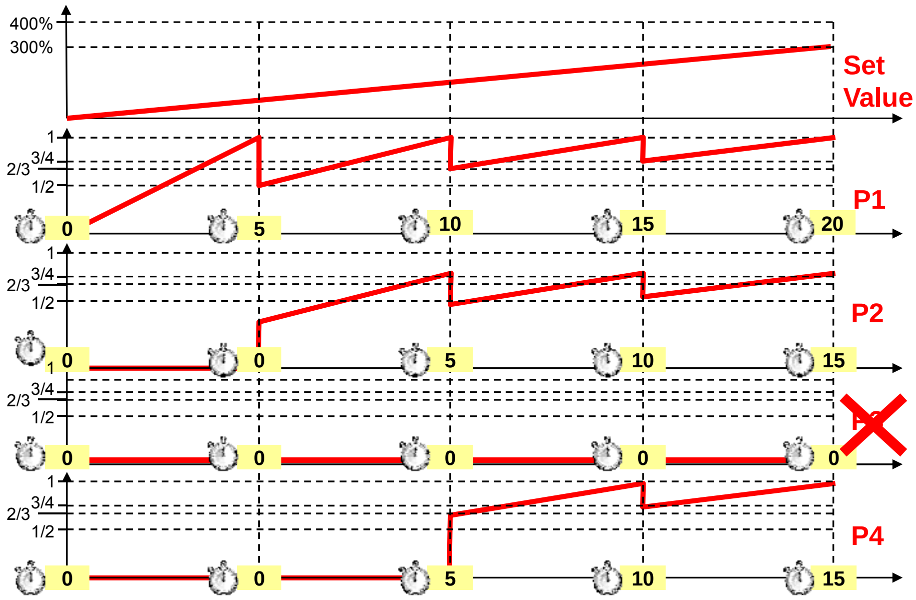
Figure 4-3



4.4 Addressing of bus stations and terminating a RS485 bus with USS protocol

An RS485 bus transmitting data using the USS protocol via a 2-wire connection between a master (e.g. CPU 224XP) and up to 32 slaves (e.g. SINAMICS G110). It is necessary here to identify each slave via a unique address between 0 and 31.

The USS protocol allows only one master which does not require an assigned address.

In order to avoid reflections at the bus start or end, which may cause a falsified data signal, the bus must be closed off with terminating resistors as illustrated in Figure 4-4.

As illustrated in Figure 4-5, in this example it is done on the control side via the PROFIBUS connector and at SINAMICS G110 of pump 4 by switching on both assigned DIP switches below the BOP.

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Figure 4-4

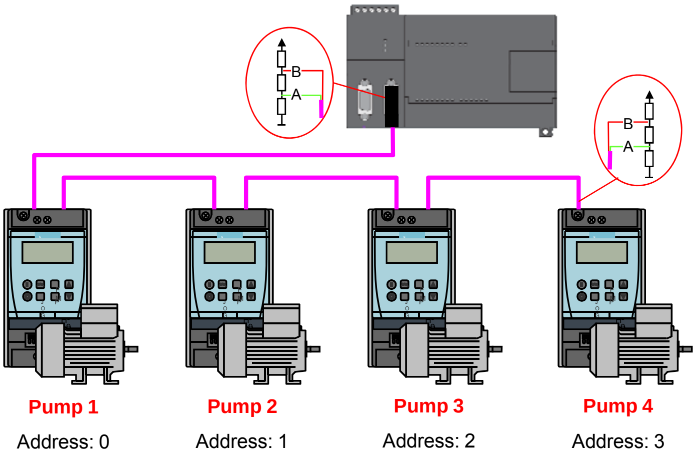
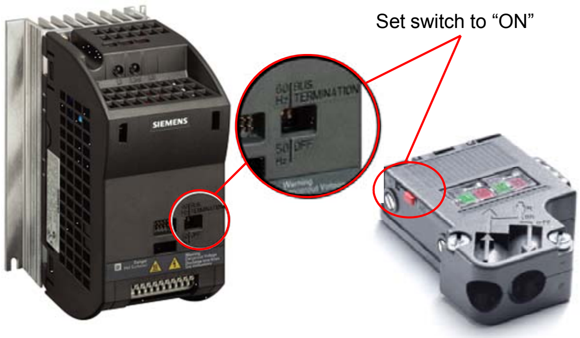


Figure 4-5



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4.5 Control speed via RS 485 bus

USS protocol

The USS protocol was developed in order to exchange process data between a central controller and bus stations on a RS485 bus. Each bus station is identified here via a unique bus address.

Even if PROFIBUS uses the same physical RS485 technology, PROFIBUS and USS protocol differ considerably.

Communication of the S7-200 controller via port 0 or 1 with the bus stations occurs by including a library into STEP7 Micro/WIN.

Initialize interface

Before a command can be sent from the controller to the bus station, the interface of the S7-200 controller must be initialized first. This is achieved using the USS_INIT block, which among other things fixes the baud rate (see Figure 4-6).

The “Mode” parameter selects the communication protocol (Figure 4-6):

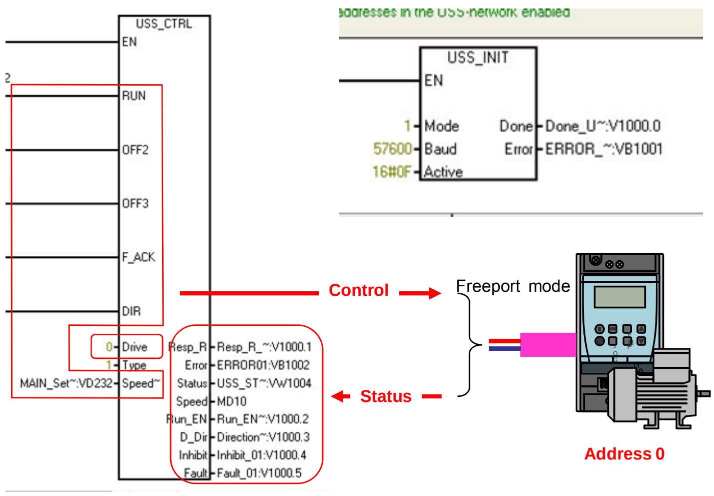
- Value “1” assigns the USS protocol to an interface 0 and activates the protocol.
- Value “0” assigns the PPI protocol to interface 0 and deactivates the USS protocol.

Controlling the speed

Using the parameters on the left side of block USS_CTRL the switch-on signal (RUN), for example, or the desired speed is sent to the assigned frequency converter.

The status signals of the frequency converter are provided by block USS_CTRL on the right block side. The current speed of the frequency converter is indicated by the parameter “Speed”.

Figure 4-6



4.6 Selecting the suitable frequency converter

For the application on hand, frequency converter SINAMICS G110 with USS interface or Micromaster MM4x can be employed.

The configuration tool SINAMICS MICROMASTER SIZER (order no. 6SL3070-0AA00-0AG0), which is available to you free of charge, supports you in selecting the frequency converter and induction motor suitable for your application.

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5 Configuring the Software

5.1 Preliminary Remarks

We offer you software examples with test code and test parameters as a download. The software examples support you during the first steps and tests with your Micro Automation Sets. They enable quick testing of hardware and software interfaces between the products described in the Micro Automation Sets.

The software examples are always assigned to the components used in the set and show their basic interaction. However, they are not real applications in the sense of technological problem solving with definable properties.

5.2 Download

The software examples are available on the HTML page from which you downloaded this document.

The download is a ZIP file which can be unzipped with any unzip program. The zip.-file contains the following files:

Table 5-1

File name	Contents
Set26_S7-200_V2d0_en.zip	STEP 7 Micro/WIN configuration for the S7-200 CPU 224 XP.
Set26_WinCCflex_V2d0_en.zip	Archived WinCC flexible configuration for TP 177micro.

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5.3 Configuring the components

5.3.1 Installing and wiring the hardware

The exact wiring plan is available to you in Figure 2-1 and Figure 2-2.

Note

For simulating the enable of all frequency converters (status I0.0 to I0.3 = “1”) we recommend using the simulator module SIM274.

It is assumed here that the necessary software has been installed on your computer and that you are familiar with handling the software.

Furthermore it is assumed, that STEP7 Micro/Win has been installed on the standard Windows PC for operator control.

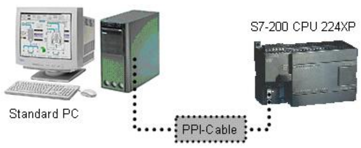
WARNING	**Please carefully read all safety and warning notices given in the operating instructions on the frequency converter and all warning labels attached to the device before doing any installation and commissioning procedures. Please maintain warning labels in a legible condition and do not remove them from the device.**

5.3.2 Configuring S7-200 with Micro/Win Project

Table 5-2

<table>
<tr><th>No.</th><th>Function</th><th>Comment</th></tr>
<tr><td>1.</td><td>Connect all components with to the power supply and wire the frequency converters with the controller as illustrated in the layout diagram. Do not connect Touch Panel TP 177micro to port 1 of the CPU as yet.</td><td></td></tr>
<tr><td>2.</td><td>

Connect your development system (PG/PC) to the S7-200 CPU, port 1, via the connection cable according to the interface available. When using the PC/PPI or the USB/PPI cable the respective local connection (COMx, USB) must be selected in STEP7 Micro/WIN.
DIP-Switches of the PC/PPI cable must be set as follows:

<table>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td></tr>
</table>
</td><td>

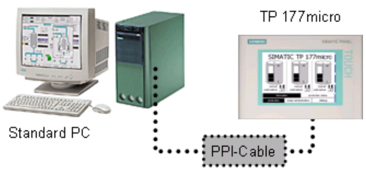
Select local connection at “Set PG/PC Interface > Properties > Local connection”</td></tr>
<tr><td>3.</td><td>Open the included S7-200 project (*.mwp file) using STEP7 Micro/WIN</td><td></td></tr>
<tr><td>4.</td><td>Load the program to the S7-200 CPU and restart it.</td><td></td></tr>
</table>

5.3.3 Configuring SIMATIC TP177micro panel with WinCC flexible

Table 5-3

<table>
<tr><th>No.</th><th>Instruction</th><th>Comment</th></tr>
<tr><td>1</td><td>

Connect TP 177micro with a DC 24V power supply
Connect the serial port COM1 of the PC with the TP 177micro via the RS232/PPI cable. When using a different COM interface, this has to be considered accordingly in the transfer properties of the WinCC flexible project.
DIP-Switches of the PC/PPI cable must be set as follows:

<table>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
</table>
</td><td>
</td></tr>
</table>

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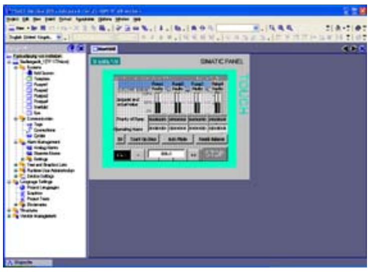
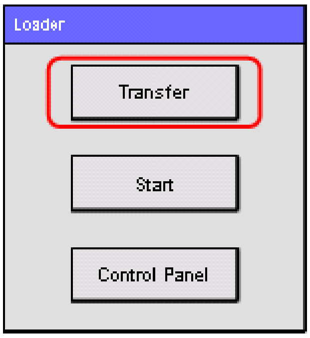
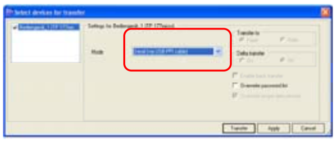
No.	Instruction	Comment
2	Extract the **WinCC flexible** project to the hard disk.	
3	Open the extracted **WinCC flexible** project.	
4	Turn on the power supply of TP 177micro and after the “bootloader” sequence you press the “Transfer” button. The download of the **WinCC flexible** project can start if a dialog box called “Transfer….” is displayed on the panel.	
5	In **WinCC flexible**, now start the transfer of the configuration to the **TP 177micro**.	
6	Close the **WinCC flexible** project.	

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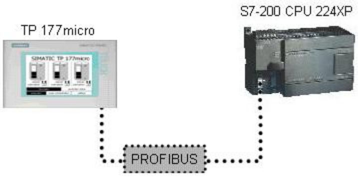
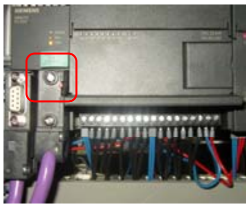
5.3.4 Connect SIMATIC Panel TP177micro and S7-200 CPU 224XP

Table 5-4

No.	Function	Comment
1	After the **S7-200** project and the **WinCC flexible** configuration have been loaded successfully, please connect the **S7-200** CPU (Port 1) and the **TP 177micro** via a PROFIBUS cable (e.g. via the 830-1T connecting cable)	

5.3.5 Close off RS 485 bus with terminating resistors

Table 5-5

No.	Function	Comment
1.	• Remove the BOP of the frequency converter (last bus station) of pump P4 • For activating the terminating resistor you change the DIP switch as follows: - 50Hz: 1=ON, 2=ON, 3=ON - 60Hz: 1=ON, 2=ON, 3=ON • Snatch the BOP back to the frequency converter	
2.	• In order to activate the terminating resistor at the controller (first bus station) please bring the switch to position “ON”	

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5.3.6 Parameterization of frequency converters

Parameterizing the frequency converter of pump P1 (address 0)

Table 5-6

Step	Instruction	Comment
1.	Set the BOP to the SINAMICS G110 frequency converter to whom address 0 is to be assigned	
2.	In order to change a parameter proceed as follows: • Switch to parameterization mode: P • Select parameter with cursor: ▲ / ▲ • Select parameter: P • Select value with cursor: ▲ / ▲ • Accept value: P	

Step	Instruction	Comment
3.	To set the traversing parameter proceed as follows:	

Function	Parameter	Value
Resetting the frequency converter to delivery status	P0010	30
	P0970	1
Start the quick startup	P0010	1
Check the parameter setting to suit the DIP switch: Europe 50Hz, power in kW[1]	P0100	0
Rated motor voltage	P0304	230 V
Rated motor output	P0307	0.12 kW
Rated motor frequency	P0310	50 Hz
Rated motor speed	P0311	1350 U/min
Command source (USS)	P0700	5
Frequency setpoint	P1000	5
Minimum motor frequency	P1080	0.0 Hz
Maximum motor frequency	P1082	50.0 Hz
Startup ramp	P1120	10.0 s
Delay ramp	P1121	10.0 s
End of the quick start	P3900	1
Activate Expert mode	P0003	3
Reference frequency	P2000	50.0 Hz
Data transmission speed 57,600 images/s	P2010	0
Address (Slave)	P2011	0
USS PZD length	P2012	2
USS PKW length	P2013	127
Communication monitoring: Value 0 without monitoring	P2014	0
Save data in E²PROM	P0971	1

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[1] These values are preset depending on the position of the DIP switch at the front of the SINAMICS G110 (except for parameter value 2). Details on interaction of P0100 and position of the DIP switch are given in the parameter list of SINAMICS G110. **Parameter value and position of the DIP switch must be related to parameter value 0 and 1!**

<table>
<tr><th>Step</th><th>Instruction</th><th>Comment</th></tr>
<tr><td>4.</td><td colspan="2">To secure the parameters in BOP proceed as follows:
<table>
<tr><th>Function</th><th>Parameter</th><th>Value</th></tr>
<tr><td>Activate Expert mode</td><td>P0003</td><td>3</td></tr>
<tr><td>Activate Parameterization mode</td><td>P0010</td><td>30</td></tr>
<tr><td>Transfer parameters from G110 to BOP</td><td>P0802</td><td>1</td></tr>
</table>
</td></tr>
<tr><td>5.</td><td>In order to depict the current frequency during runtime, select the parameter P0000 and press the P button</td><td></td></tr>
</table>

Parameterizing the frequency converter of pump P2 (address 1)

Table 5-7

<table>
<tr><th>Step</th><th>Instruction</th><th>Comment</th></tr>
<tr><td>1.</td><td>Unplug the BOP from the frequency converter of pump P1 and plug it to the second SINAMICS G110 (for pump 2).</td><td></td></tr>
<tr><td>2.</td><td colspan="2">In order to change a parameter proceed as follows:
• Switch to parameterization mode: P
• Select parameter with cursor: ▲ / ▲
• Select parameter: P
• Select value with cursor: ▲ / ▲
• Accept value: P</td></tr>
</table>

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<table>
<tr><th>Step</th><th>Instruction</th><th>Comment</th></tr>
<tr><td>3.</td><td colspan="2">To adopt the settings of the second frequency converter and adjust the address proceed as follows:
<table>
<tr><th>Function</th><th>Parameter</th><th>Value</th></tr>
<tr><td>Activate Expert mode</td><td>P0003</td><td>3</td></tr>
<tr><td>Activate Parameterization mode</td><td>P0010</td><td>30</td></tr>
<tr><td>Transfer parameters from BOP to G110</td><td>P0803</td><td>1</td></tr>
<tr><td>Change the address to 1</td><td>P2011</td><td>1</td></tr>
<tr><td>Save the data in the E²PROM</td><td>P0971</td><td>1</td></tr>
</table></td></tr>
<tr><td>4.</td><td>In order to depict the current frequency during runtime, select the parameter P0000 and press the P button</td><td></td></tr>
</table>

Parameterizing the frequency converter of pump P3 (address 2)

Table 5-8

<table>
<tr><th>Step</th><th>Instruction</th><th>Comment</th></tr>
<tr><td>1.</td><td>Unplug the BOP from the frequency converter of pump P2 and plug it to the third SINAMICS G110 (for pump 3).</td><td></td></tr>
<tr><td>2.</td><td colspan="2">In order to change a parameter proceed as follows:
• Switch to parameterization mode: P
• Select parameter with cursor: ▲ / ▲
• Select parameter: P
• Select value with cursor: ▲ / ▲
• Accept value: P</td></tr>
</table>

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<table>
<tr><th>Step</th><th>Instruction</th><th>Comment</th></tr>
<tr><td>3.</td><td colspan="2">To adopt the settings of the third frequency converter and adjust the address proceed as follows:
<table>
<tr><th>Function</th><th>Parameter</th><th>Value</th></tr>
<tr><td>Activate Expert mode</td><td>P0003</td><td>3</td></tr>
<tr><td>Activate Parameterization mode</td><td>P0010</td><td>30</td></tr>
<tr><td>Transfer parameters from BOP to G110</td><td>P0803</td><td>1</td></tr>
<tr><td>Change the address to 2</td><td>P2011</td><td>2</td></tr>
<tr><td>Save the data in the E²PROM</td><td>P0971</td><td>1</td></tr>
</table></td></tr>
<tr><td>4.</td><td>In order to depict the current frequency during runtime, select the parameter P0000 and press the P button</td><td></td></tr>
</table>

Parameterizing the frequency converter of pump P4 (address 3)

Table 5-9

<table>
<tr><th>Step</th><th>Instruction</th><th>Comment</th></tr>
<tr><td>1.</td><td>Unplug the BOP from the frequency converter of pump P3 and plug it to the fourth SINAMICS G110 (for pump 4).</td><td></td></tr>
<tr><td>2.</td><td colspan="2">In order to change a parameter proceed as follows:
• Switch to parameterization mode: P
• Select parameter with cursor: ▲ / ▲
• Select parameter: P
• Select value with cursor: ▲ / ▲
• Accept value: P</td></tr>
</table>

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Step	Instruction	Comment
3.	To adopt the settings of the fourth frequency converter and adjust the address proceed as follows:	

Function	Parameter	Value
Activate Expert mode	P0003	3
Activate Parameterization mode	P0010	30
Transfer parameters from BOP to G110	P0803	1
Change the address to 3	P2011	3
Save the data in the E²PROM	P0971	1

Step	Instruction	Comment
4.	In order to depict the current frequency during runtime, select the parameter P0000 and press the P button	

Note Ensure that a blinking light is visible at the SINAMICS G110. If this is not the case, it is in operation and a configuration is not possible.

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6 Live Demo

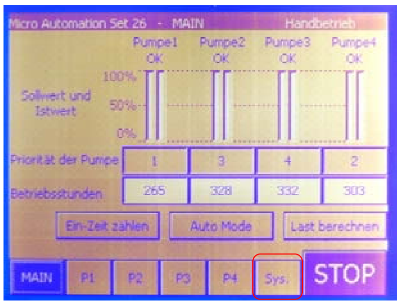
6.1 Enabling the pumps

Table 6-1

Step	Instruction	Figure/short note
1.	To enable pumps P1 to P4 you change the status of the following inputs “1”: • I0.0 • I0.1 • I0.2 • I0.3	

6.2 Change language settings

Table 6-2

Step	Instruction	Figure/short note
1.	Press the ”Sys” button in order to access the Control Panel.	
2.	• Press the “German” button in order to be able to control the plant in German language. • Press the “English” button in order to be able to control the plant in English language.	

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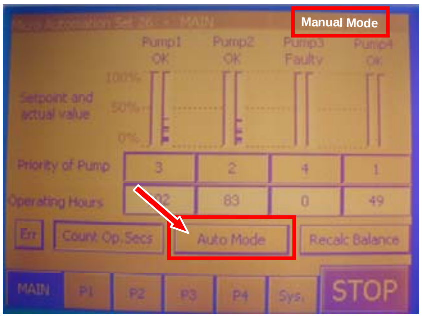
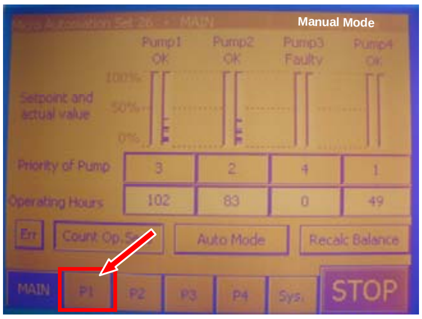
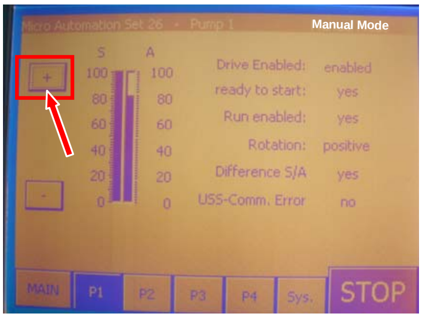
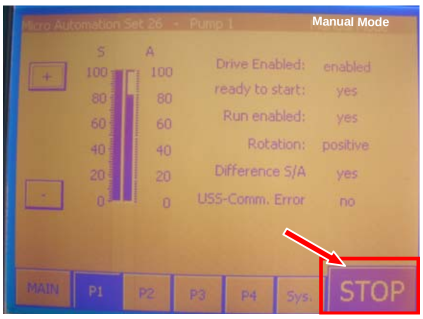
6.3 Moving pump P1 manually

In manual operation the setpoint speed value for each motor is given **individually**.

Table 6-3

Step	Instruction	Figure/short note
1.	• In order to select the manual mode press the “Manual Mode” button • The label of this button will subsequently display “Auto Mode”	
2.	Change to the operator screen of the pump P1, by pressing the ”P1” button.	
3.	• Press the selected button until the left bar shows a setpoint speed value of 100%. • Due to the ramp of 10 sec configured in the frequency converter the actual speed value is delayed. This ram causes a delayed rise of the speed list value in form of the right-hand bar.	
4.	Switch off pump P1 by pressing the STOP button.	

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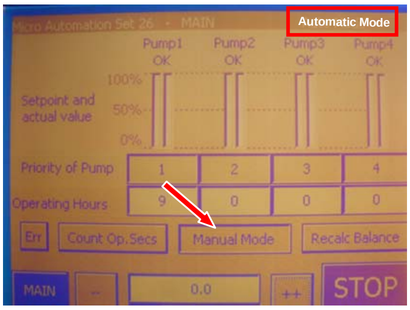
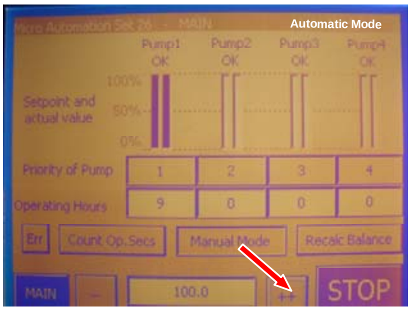
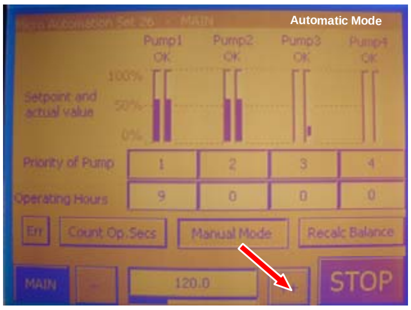
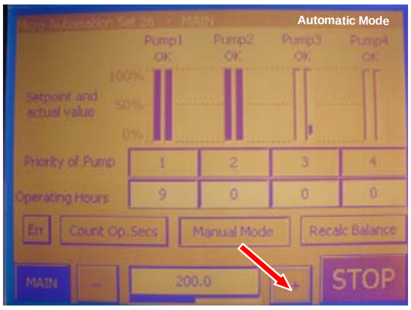
6.4 Move pump P1 to P4 automatically on demand

In automatic operation one setpoint value is assigned for **all** pumps. The startup program automatically calculates the setpoint value for the individual pumps.

Table 6-4

Step	Instruction	Figure/short note
1.	• In order to select the automatic mode press the “Auto Mode” button • The label of this button will subsequently display “Manual Mode”	
2.	• Increase the setpoint value to 100%. • The speed of pump P1 increases with a delay also to 100% of the maximum value • The BOP of the frequency converter of pump P1 shows 50 Hz	
3.	• Increase the setpoint value to 120%. • Since pump P1 cannot handle this load by itself, it is now distributed to pump P1 and P2. Both pumps P1 and P2 are now respectively operated with a speed of 60% of the maximum value • The BOP of the frequency converter of pump P1 and P2 now shows 30 Hz	
4.	• Increase the setpoint value to 200%. • The speed of pumps P1 and P2 increases with a delay to 100% of the maximum value respectively • The BOP of the frequency converter of pump P1 and P2 now shows 50 Hz	

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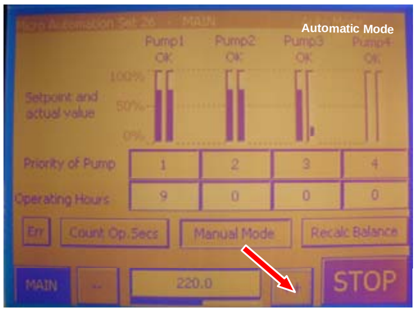
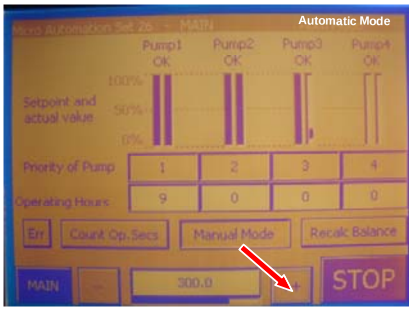
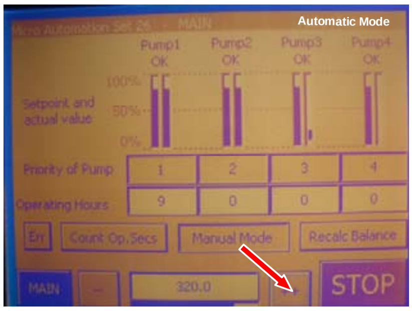
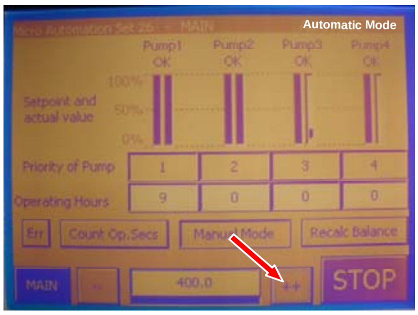
Step	Instruction	Figure/short note
5.	• Increase the setpoint value of the pumps to 220%. • Since the pumps P1 and P2 cannot handle this load alone, it is now distributed between pump P1, P2 and P2. All three pumps P1, P2 and P3 are now respectively operated with a speed of 73% of the maximum value • The BOP of the frequency converter of pump P1, P2 and P3 now shows 36.67 Hz	
6.	• Increase the setpoint value of the pumps to 300%. • The speed of pumps P1, P2 and P3 increases with a delay to 100% of the maximum value respectively • The BOP of the frequency converter of pump P1, P2 and P3 now shows 50 Hz	
7.	• Now increase the setpoint value of the pumps to 320%. • Since the pumps P1, P2 and P3 cannot handle this load alone, it is now distributed between pump P1, P2, P3 and P4. The four pumps P1, P2, P3 and P4 are now respectively operated with a speed of 80% of the maximum value • The BOP of the frequency converter of pump P1, P2, P3 and P4 now shows 40 Hz	
8.	• Increase the setpoint value of the pumps to 400%. • The speed of pumps P1, P2, P3 and P4 increases with a delay to 100% of the maximum value respectively • The BOP of the frequency converter of pump P1, P2, P3 and P4 now shows 50 Hz	

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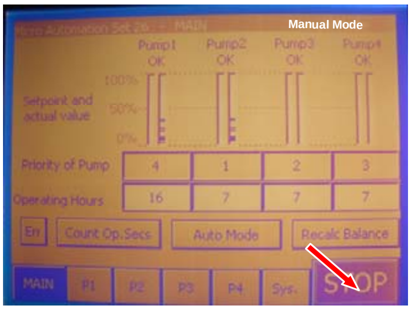
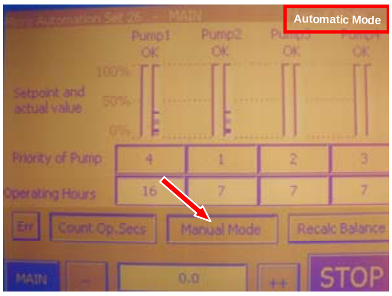
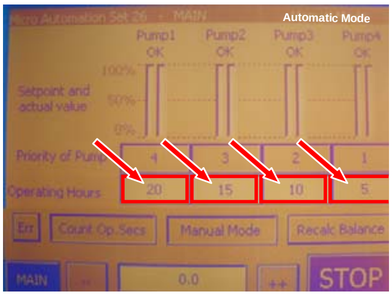
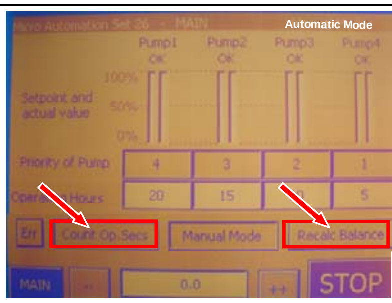
Step	Instruction	Figure/short note
9.	Stop the pumps by pressing the STOP button.	

6.5 Procedure with balancing of operating hours

Operating the plant with balancing of operating hours causes the pump with the least operating hours being added upon addition of a further pump.

Table 6-5

Step	Instruction	Figure/short note
1.	• In order to select the automatic mode press the “Auto Mode” button • The label of this button will subsequently display “Manual Mode”	
2.	• For the current operating hours of pump P1 to P4 you set the following values: - P1: 20 - P2: 15 - P3: 10 - P4: 05 • To do this you select the marked field, enter the desired value and acknowledge the input by pressing the Return key	
3.	• Press the selected buttons in order to recalculate the pump priority and to activate the counting of operating hours..	

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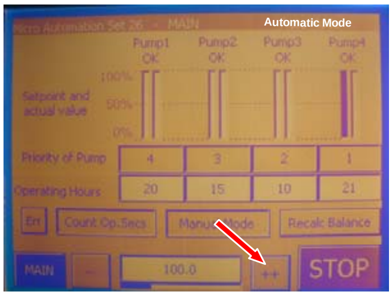
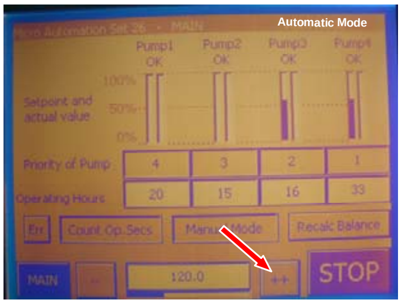
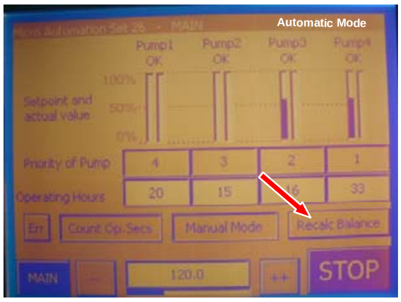
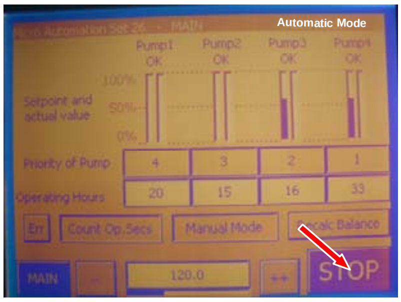
Step	Instruction	Figure/short note
4.	• Increase the setpoint value to 100%. • The speed of pump P4 increases with a delay also to 100% of the maximum value • The BOP of the frequency converter of pump P4 shows 50 Hz	
5.	• Increase the setpoint value to 120%. • Since pump P4 cannot handle this load by itself, it is now distributed to pump P4 and P3. Both pumps P4 and P3 are now respectively operated with a speed of 60% of the maximum value • The BOP of the frequency converter of pump P4 and P3 now shows 30 Hz	
6.	• Now press the “Recalc Balance” button. • The pump priorities are then recalculated. • If at this time the operating hours of pump P3 and P4 are higher than that of pump P1 and P2, pump P1 and P2 take on the tasks of pump P3 and P4. Both pumps P3 and P4 are then switched off.	
7.	In order to terminate this scenario you press the “STOP“ button.	

6.6 Procedure for excluding pump P3 due to servicing

In the case of servicing, it shall be possible to directly deactivate a pump for maintenance works, and its tasks shall be automatically taken on by another pump

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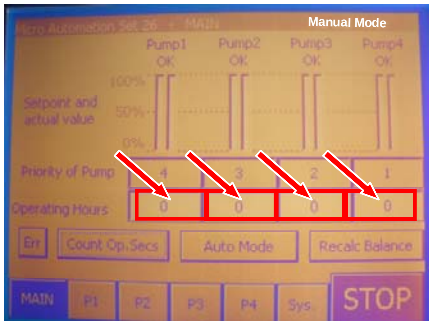
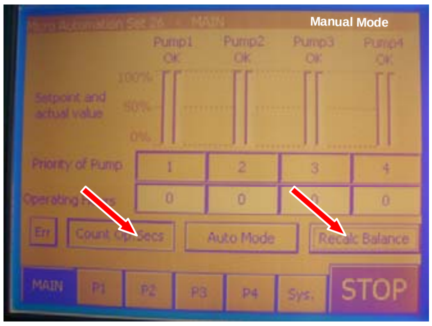
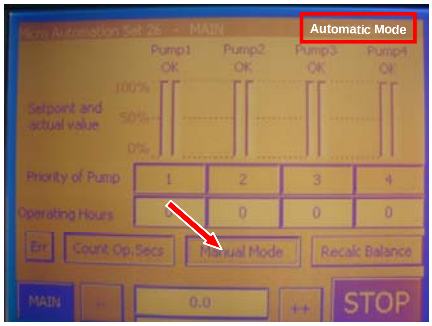
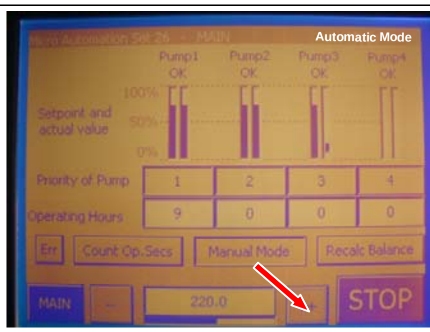
Table 6-6

Step	Instruction	Figure/short note
1.	• For the current operating hours of pump P1 to P4 you set the following values: - P1: 0 - P2: 0 - P3: 0 - P4: 0 • To do this you select the marked field, enter the desired value and acknowledge the input by pressing the Return key	
2.	• Activate the counting of operating hours by pressing the “Count Op. Secs“ button • Update the pump priority by pressing the “Recalc Balance” button.	
3.	Change into automatic operation of the plant by pressing the “Auto Mode” button.	
4.	• Increase the setpoint value of the pumps to 220%. • All three pumps P1, P2 and P3 are now respectively operated with a speed of 73% of the maximum value • The BOP of the frequency converter of pump P1, P2 and P3 now shows 36.67 Hz	

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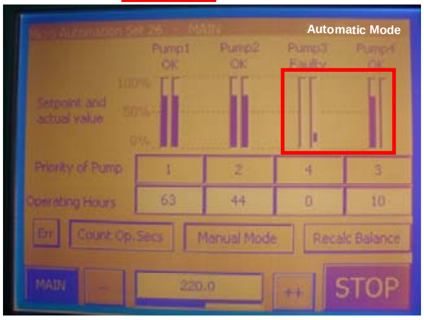
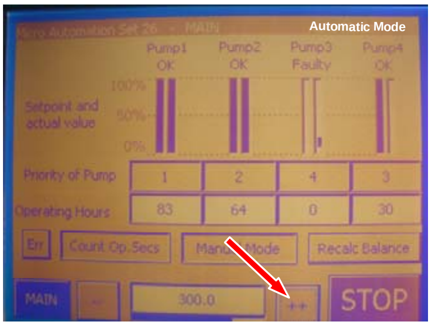
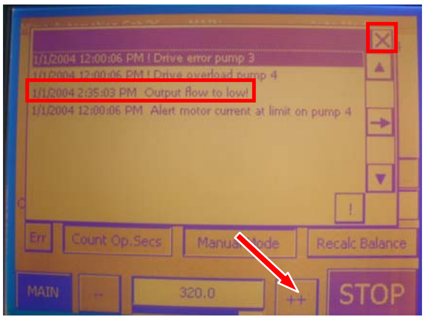
Step	Instruction	Figure/short note
5.	• Withdraw the enable for pump P3 by switching off input I0.2. • The right image shows how the load of pump P3 was taken over by pump P4.	 
6.	Increase the setpoint value of the pumps further to 300%.	
7.	• Increase the setpoint value to over 300%. • A demand of over 300%, however, cannot be managed, since only 3 pumps are available. A respective message informs of this condition. • Acknowledge the message box by pressing the “!” icon “. • Close the dialog box by pressing “x”	

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7 Basic Performance Data

LOGO! Power 24V 1.3A

Table 7-1

Criterion	Basic performance data	Additional note
Supply Voltage	AC 100-240V	
Output voltage	DC 24V	
Output current	1.3A	
Dimensions (W x H x D) in mm	54 (3 TE) × 90 × 55	

SIMATIC S7-CPU 224 XP

Table 7-2

Criterion	Basic performance data	Additional note
Supply Voltage	DC 20.4 to 28.8 V or AC 85 to 264 V	
Output current, expansion module	340 mA	
Interfaces	2x RS 485, communication interface, expansion bus for modules	
Inputs/outputs	14DI/10DO and 2AI/1AO	
Protection class	IP 20 according to IEC 529	

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SIMATIC Touch Panel TP 177micro

Table 7-3

Criterion	Basic performance data	Additional note
Memory	256kB	Flash/RAM
Supply Voltage	24V (rated current 0.24 A)	DC +18 up to +30 V
Clock	Software clock, not battery-backed	can be synchronized by the controller
Dimensions	W x H (mm) 212 x 156	Mounting cutout W x H (mm) 198 x 142
Weight	0.7 kg	

SINAMICS G110 frequency converter

Table 7-4

Criterion	Basic performance data	Additional note
Network	1 AC 200 V up to 240 V ±10 %	47 Hz up to 63 Hz
Output frequency	0 Hz up to 650 Hz	
Frequency converter efficiency		for devices <0.75kW 90% to 94% for devices >0.75 kW >95%
Overload capability	Overload current 1.5 x rated output current	(i.e. 150 % overload) for 60 s, afterwards 0.85 x rated output current for 240 s, cycle time 300 s
Digital inputs	3	
Digital output	1	electrically isolated optocoupler output (DC 24 V, 50 mA, Ohm-type, NPN-type)
Protection class	IP20	

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Motor 230V/400V D/Y 50Hz 0.12kW

Table 7-5

Criterion	Basic performance data	Additional note
Rated speed	1350min^{-1}	
Performance factor cos φ	0.75	
Rated current at 230V	0.73A	
Rated torque	0.85Nm	
Moment of inertia	Ca. 0.00029kgm²	
Weight	Ca. 4.0kg	Design B3

8 History

Table 8-1

Version	Date	Modification
V1.0	19.01.2006	First issue
V1.1	06.04.2006	Revision of current layout
V2.0	14.06.2007	• Algorithm of pump control adjusted. Pumps work with identical speed, i.e. using stop valves is now possible. • Operating hour counter added • Balancing of operating hours function added • Live Demo, 4 scenarios added

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