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SINAMICS V: Speed Control of a V20 with S7-1200 (TIA Portal) via MODBUS RTU, with HMI

SINAMICS V20, SIMATIC S7-1200

http://support.automation.siemens.com/WW/view/en/63696870

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1 Task

SINAMICS V20 drives are to exchange data via the RS485 interface and via Modbus RTU with a SIMATIC S7-1200 controller. A controller is to operate up to 32 drives via one of the provided ports. It requires the functionality described in the sections 1.1 to 1.3.

1.1 Cyclic process data exchange

All drives of the port are to be operated cyclically, one after the other.

Control data

- The complete control word (STW1) is to be transferred to the SINAMICS V20:

  Table 1-1: STW1

Bit	Signal name	Remark
00	ON/OFF1	
01	OFF2: Electr. stop	*Low* enabled
02	OFF3: Fast stop	*Low* enabled
03	Pulse enabled	
04	RFG enabled	
05	RFG start	
06	Enable setpoint	
07	Error acknowledgement	
08	JOG right	
09	JOG left	
10	Controller of AG	
11	Reversing	
12	-	
13	Motor potentiometer higher	
14	Motor potentiometer lower	
15	Manual/automatic mode	

- The main setpoint value (HSW) is to be transferred to the SINAMICS V20.

Status data

- The complete status word (ZSW1) of the SINAMICS V20 is to be transferred to the controller:

  Table 1-2: ZSW1

Bit	Signal name	Remark
00	Drive ready	
01	Drive ready to run	
02	Drive running	
03	Drive fault active	
04	OFF2 active	*Low* enabled

Bit	Signal name	Remark
05	OFF3 active	*Low* enabled
06	ON inhibit active	
07	Drive warning active	
08	Deviation setpoint / act. value	*Low* enabled
09	PZD control	
10	$\|f_{act}\| \geq$ P1082 (f_{max})	
11	Warning: Motor current limit	*Low* enabled
12	Motor holding brake active	
13	Motor overload	*Low* enabled
14	Motor runs right	
15	Inverter overload	*Low* enabled

- The main actual value (HIW) of the SINAMICS V20 is to be transferred to the controller.

1.2 Acyclic data accesses

Upon request (acyclically), all data that SINAMICS V20 provides for transfer with the Modbus RTU protocol is to be accessed as individual read and if required as write accesses. When writing, broadcast transmission should also be possible.

The respective data is listed in the mapping table in chap. 6.2 of the SINAMICS V20 operating instruction \7\.

Note The functions provided to you here, are to support you in configuring your user software and in commissioning your inverter application. The inverter configuration itself is not subject of this application example.

1.3 HMI for convenient operating and monitoring

The controller project is to include a KTP600 operator panel (touch panel) for operating and monitoring which can also run as simulation on the development system (PG/PC). This makes very fast commissioning and demonstrating of the application example possible. The user can furthermore accept the operator panel configuration either fully or partly in own projects.

2 Components and Structure

2.1 Hardware components used

The application was created with the following components and assumes a configuration with one SINAMICS V20. If there are more inverters, the number of the affected components has to be adjusted.

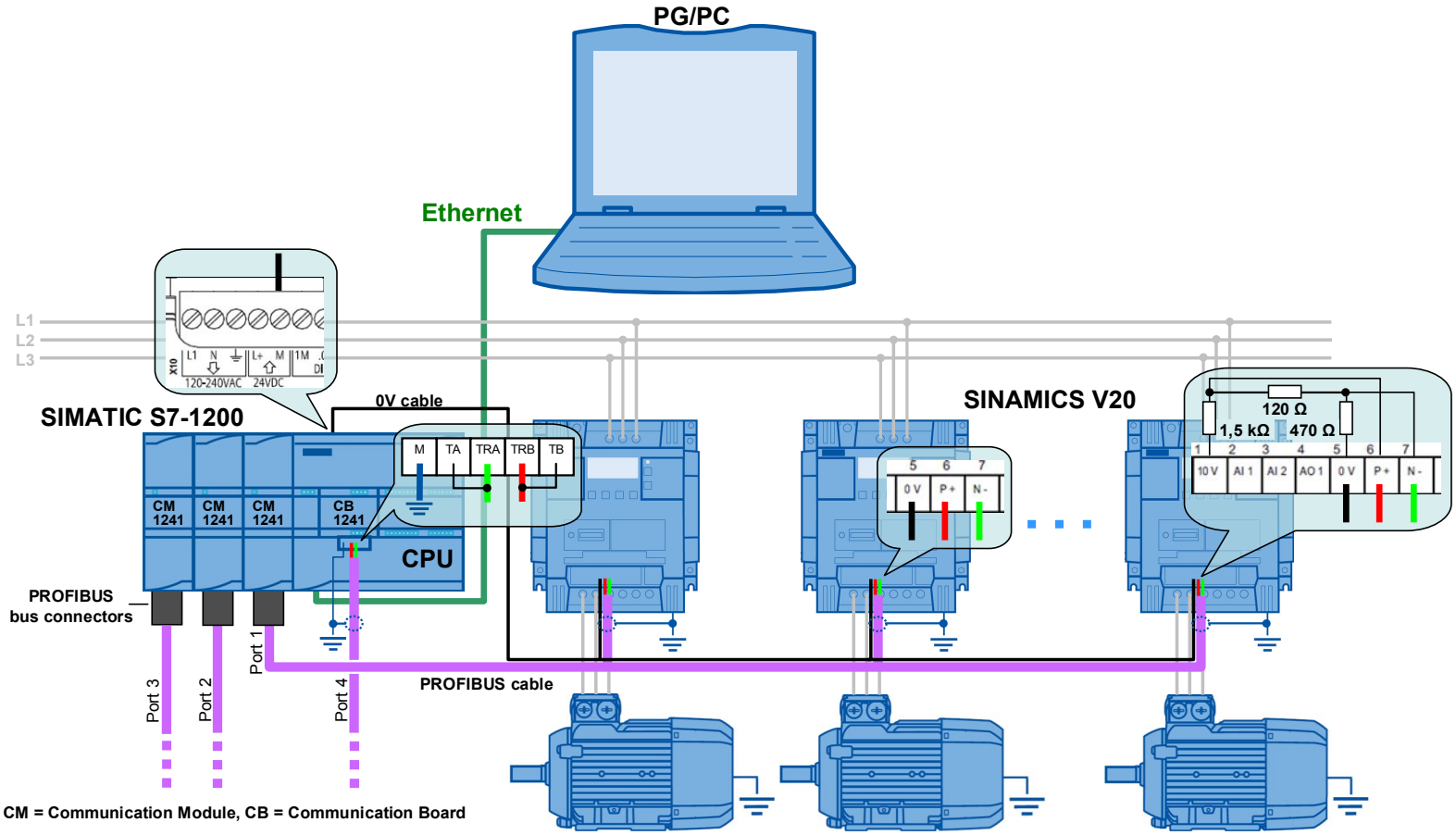
Table 2-1: Hardware components[1]

Component	Qty.	Order number	Note
SIMATIC S7-1200 CPU1212C AC/DC/Rly	1	6ES7212-1BE40-0XB0[2]	V 4.0 (projected with TIA V13)
		6ES7212-1BE31-0XB0[2]	V 3.0 (projected with TIA V12)
		6ES7212-1BD30-0XB0[2]	V 2.2 (projected with TIA V11)
CM 1241 (RS422/485)	1	6ES7241-1CH32-0XB0	V2.0 (projected with TIA V13)
CM 1241 (RS485)		6ES7241-1CH30-0XB0	V1.0 (projected with TIA V12 and TIA V11)
CB 1241 (RS485)		6ES7241-1CH30-1XB0	Communication board (not used in the sample project)
SINAMICS V20 (3AC400V, 0.75KW, FILTER C3)	1	6SL3210-5BE17-5CV0[3]	Firmware version as per Parameter r0964[0..6]: [0]: 42 [1]: 8001 [2]: 370 [3]: 2014 [4]: 306 [5]: 1 [6]: 600
RS485 Bus termination network	1	6SL3255-0VC00-0HA0	Package content: 50 pcs
RJ45 patch cable, shielded (S7-1200 ⇔ PG/PC)	1	-	...or S7-1200 ⇔ CSM1277, if optional KTP600
PROFIBUS connector plug	1	6ES7972-0BA52-0XA0	or …-0BB52-… (with PG socket)
PROFIBUS line		6XV1830-0EH10	
Motor	1	1LA7083-4AA60	Example
SIMATIC Panel KTP600 Basic color PN	1	6AV6647-0AD11-3AX0	If you simulate the operator panel only in the TIA portal on your PG/PC you do not require this component.
Compact switch module CSM1277	1	6GK7277-1AA10-0AA0	
RJ45 patch cable, shielded (KTP600 ⇔ CSM1277) (S7-1200 ⇔ CSM1277)	2	-	

[1] Small parts such as wire, resistors and other installation material are not included in this table.
[2] Any SIMATIC S7-1200 with corresponding firmware version applicable.
[3] Any SINAMICS V20 applicable. Always use the latest firmware version.

2.2 Bus connection

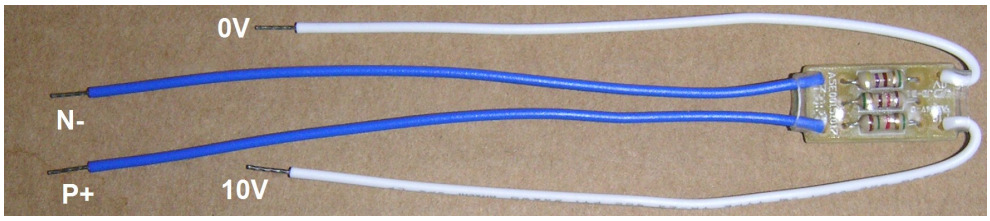
Figure 2-1: Wiring example



Bus wiring

According to Figure 2-1, the bus can be realized with a PROFIBUS cable. The connection to the communication module is via a PROFIBUS plug that provides a reversible basic network on the side of the controller and the bus termination [4] and the shielded contact. Switch the basic network on the PROFIBUS plug to “On”, provided the communication module – as is the case in Figure 2-1 – is the first or last bus node. At the other end of the bus (the last SINAMICS V20) you have to provide the basic network and the bus termination yourself and connect the cable shield to earth. However a bus termination network is offered as an accessory (Order number see Table 2-1).

Figure 2-2: Bus termination network



For the potential equalization the bus voltage reference points (0V) of all bus nodes have to be connected with each other.[5]

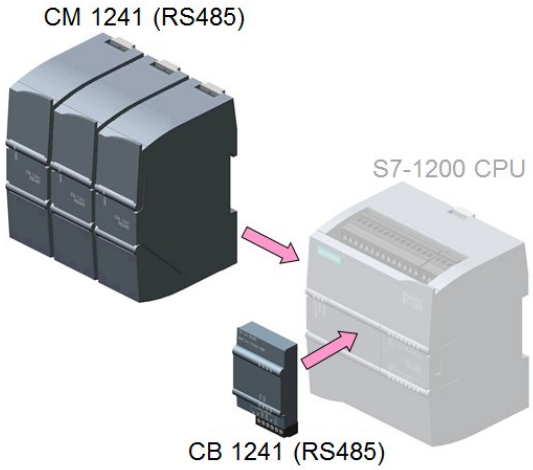
When establishing the bus connection, also note chap. 6.1 of the SINAMICS V20 operating instruction (\7\).

[4] If you are using a different 9 pole D sub plug, you have to provide the bus termination yourself. In this case, you have to use a terminator of 120 Ω between pins 3 and 8.
[5] Instead of the PROFIBUS cable (2 pole) you can also use a three-pole shielded cable that includes the potential equalization cable. However, it then has to be guided from the controller side away from the PROFIBUS plug to the 0V terminal of the CPU.

Communication modules

For the USS communication, the S7-1200 requires RS485 communication modules CM 1241 or a RS485 communication board CB 1241. Up to three communication modules and one communication board can be connected to a S7-1200. Each can operate up to 32[6] drives (addresses 1…32). The application example is configured for one communication module with one SINAMICS V20. In chapter 5 you can find out how you can expand the configuration to several SINAMICS V20 per port, and several ports.

Figure 2-3: Communication modules



Note The communication board has no sub D connection but only screw-type terminals. When using the communication board, PROFIBUS plugs can therefore not be used. However, the communication board offers internal resistors for the network termination. To enable the basic network, connect terminal TRA (bus line A) with terminal TA and terminal TRB (bus line B) with terminal TB on the communication board. See chap. 12.2 in \3\.

[6] With repeaters up to 247.

2.3 Controller software

Standard software components

Table 2-2: Standard software components

Component	Order number	Note
SIMATIC STEP 7 Basic V13 Floating Licence	6ES7822-0AA03-0YA5	
Update 6 for STEP 7 V13 and WinCC V13	Download[7] for free	see \5\
The engineering software SIMATIC STEP 7 V12 and V11 for the still provided TIA V12/V11 sample projects in this application are no longer available		

User software and documentation

Table 2-3: Projects, libraries and documentation

Component	Note
63696870_V20_at_S7-1200_MB_proj_V13_V1d2.zip (Archive file) V20_at_S7-1200_MB_proj_V13 (Project folder)	STEP 7 V13 project
63696870_V20_at_S7-1200_MB_lib_V13_V1d2.zip (Archive file) V20_at_S7-1200_MB_lib_V13 (Project folder)	STEP 7 V13 library
63696870_V20_at_S7-1200_MB_proj_V12_V1d1.zip (Archive file) V20_at_S7-1200_MB_proj_V12 (Project folder)	STEP 7 V12 project
63696870_V20_at_S7-1200_MB_lib_V12_V1d1.zip (Archive file) V20_at_S7-1200_MB_lib_V12 (Project folder)	STEP 7 V12 library
63696870_V20_at_S7-1200_MB_proj_V11_V1d1.zip (Archive file) V20_at_S7-1200_MB_proj_V11 (Project folder)	STEP 7 V11 project
63696870_V20_at_S7-1200_MB_lib_V11_V1d1.zip (Archive file) V20_at_S7-1200_MB_lib_V11 (Project folder)	STEP 7 V11 library
63696870_V20_at_S7-1200_MB_V1d2_en.pdf	This document
63696870_V20_at_S7-1200_MB_V1d2_SHORT-DOCU_en.pdf	Short Documentation

The V20_Modbus [FB1] function block is the core of this application example and the STEP 7 project. It is stored in Table 2-3 in the listed global STEP 7 library to be used separately by the user. If you are working with the project, you do not require the library.

[7] Always use the latest update

3 Commissioning

3.1 Requirements

1. The application example uses the hardware components according to Table 2-1.
2. The structure and the wiring follows Figure 2-1. Note the “bus wiring section” in chap. 2.2. The sample configuration includes one SINAMICS V20 and one communication module CM1241 that is added to the CPU. For expansion see chap. 5.
3. For the example you do not necessarily need a motor. However, if you do connect one, you have to set the correct motor parameters in the inverter according to chap. 5.5.1.2 of the SINAMICS V20 operating instructions \7\.
4. Use the TIA portal software from Table 2-2 or newer.
5. Make sure that the firmware of your hardware components used is not older than the one that is specified in the footer of the MLFBs in Table 2-1.
6. The instructions below assume that the inverter is in delivery state or was reset to factory settings.
7. You should have sufficient basic knowledge on SINAMICS inverters, SIMATIC S7-1200 controllers and TIA portal.

CAUTION	**Note the setup guidelines, commissioning instructions and operating instructions of the SINAMICS V20 in \7\ and for the SIMATIC S7-1200 controller in \3\.** **If the inverter configuration and the data of a connected motor do not match, inverter and/or motor could be damaged or destroyed.**

3.2 Instruction

How to generally modify drive parameters via the BOP

To modify parameters in “Table 3-2: Instruction to implement the application example”, proceed as generally described in the following table:

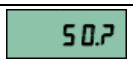
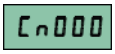
Table 3-1: Modifying drive parameters via the BOP (in general)

	Schritt
1.	With the appropriate step in Table 3-2 you already got into the setup or parameter menu.
2.	Select the parameter number with the arrow keys ▲ ▼ and press OK.
3.	If parameter is indexed: Select index with the arrow keys ▲ ▼ and press OK.
4.	Select the parameter value with the arrow keys ▲ ▼ and press OK.

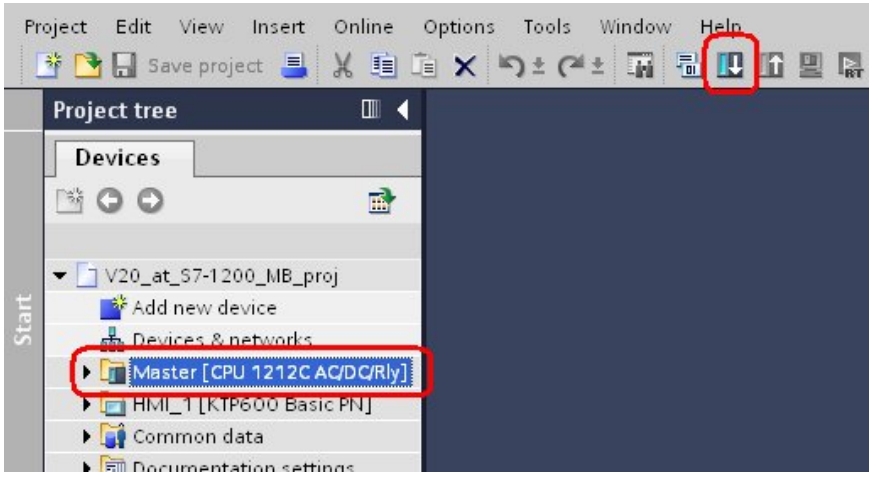
Instructions to commission the application example

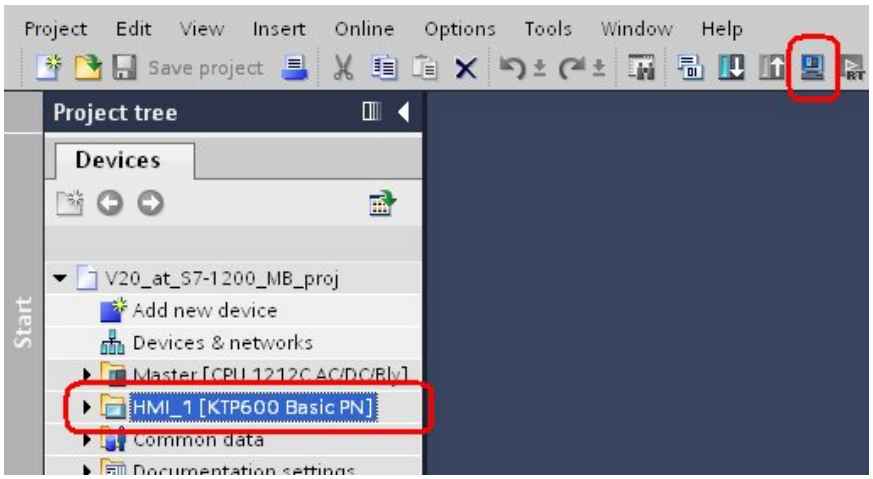
On the primary side, apply 400V~ (3 phase) on the inverter and supply the SIMATIC S7-1200 with 230V~. Subsequently, follow the steps in the following instruction:

Table 3-2: Instruction to implement the application example

	Implementing the application example
	BOP configuration of the SINAMICS V20
	General information: • In the following, fd means “factory defaults”. • Unless otherwise stated, keys [M] and [OK] have to be pressed <2s.
1.	Restore to defaults, if the SINAMICS V20 is no longer in the delivery status. Change from display to parameter menu with [M] and modify the following parameters: Access level P0003 ⇨ 1 (fd: 1) Commissioning parameter P0010 ⇨ 30 (fd: 0) Factory reset[8] P0970 ⇨ 21 (fd: 0)
2.	On the display  is displayed. Select the respective 50/60 or Hz/hp setting (chap.5.3 in \7\) that is appropriate for your region with the [▲] [▼] arrow buttons and exit the mask with [OK] .
3.	You are now in the setup menu and you can enter the motor parameters, starting with P0304, if you are executing the example with connected motor. Press [M], once you have finished entering the motor parameters or if you do not want to enter any motor parameters now.
4.	 is shown on the display. With the arrow buttons [▲] [▼] select the connection macro Cn011 for the Modbus RTU communication, confirm with [OK] and change to the display menu by pressing [M] (>2s).
5.	Go to the parameter menu with [M] .
6.	Check resp. modify the following parameters: Access level P0003 ⇨ 3 (fd: 1) Baudrate P2010[0] ⇨ 6 (fd: 8, bei Cn011: 6) Telegram off time (ms) P2014[0] ⇨ 130[9] (fd: 2000, bei Cn011: 100) Modbus address P2021 ⇨ 1[10] (fd: 1, bei Cn011: 1) RS485 protocol selection P2023 ⇨ 2 (fd: 1, bei Cn011: 2)
7.	Transfer data from RAM to EEPROM RAM to EEPROM P0971 ⇨ 21 (fd: 0) Access level P0003 ⇨ 1
8.	When the parameter entry is completed go back to the display menu by pressing [M] (>2s).

[8] With a factory reset, communication parameters P2010, P2021, P2023 used for Modbus are not reset automatically. But they are supplied in the table’s step 6.
[9] The telegram off time has to be greatly extended with the number of drives on the bus. If the time is too short the drive concerned displays error F72. For example, with three SINAMICS V20 at a SIMATIC CPU 1215C (FW=V4.0) each drive has to be parameterized with P2014[0]=4000ms.
[10] With more than one drive, they are to be numbered without gaps.

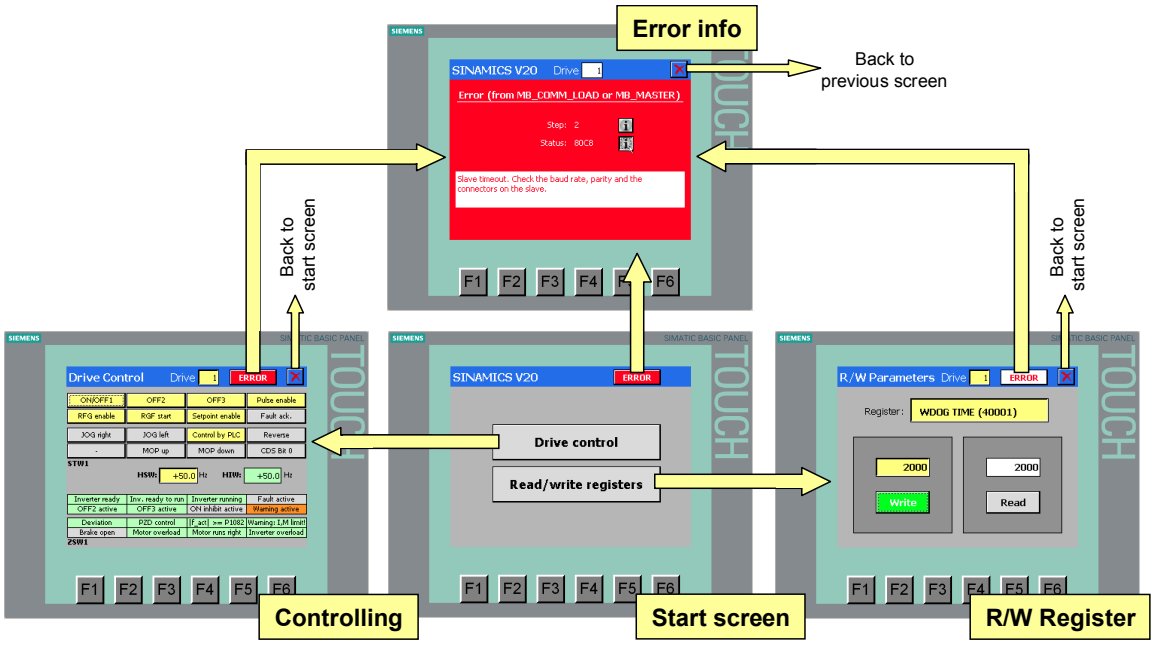
	Implementing the application example
9.	Switch the SINAMICS V20 off/on. After switching off wait until the LED or the display has lit off (can last some seconds), before you switch on the drive again.
	Loading the SIMATIC program
10.	Start the TIA Portal and open the **V20_at_S7-1200_MB_proj_Vxy (Vxy = TIA version)** project which you have downloaded and unzipped from the Siemens Industry Online Support pages.
11.	Load the controller project into the CPU.  If the window for further download appears, select … • Type of the PG/PC interface: ⇨ PN/IE • PG/PC interface: ⇨ select interface card • Connection to subnet: ⇨ (local) PN/IE Subsequently click “Load“. Monitor the download with the “Load preview” window (continue with the “Load” window) and “Load results” (continue with the “Finish” button).

	Implementing the application example
12.	Start the simulation of the operator panel.  After completed compilation, the start window of the simulated operator panel will open on the screen. 

4 Operation

4.1 Screen navigation

Figure 4-1: Screen navigation



Select the desired function from the start screen. You get back to the start screen via the  button in the respective function screen.

Selecting the drive

Select the desired drive by entering the drive address in the header of the appropriate function screen[11].

Calling the error information screen

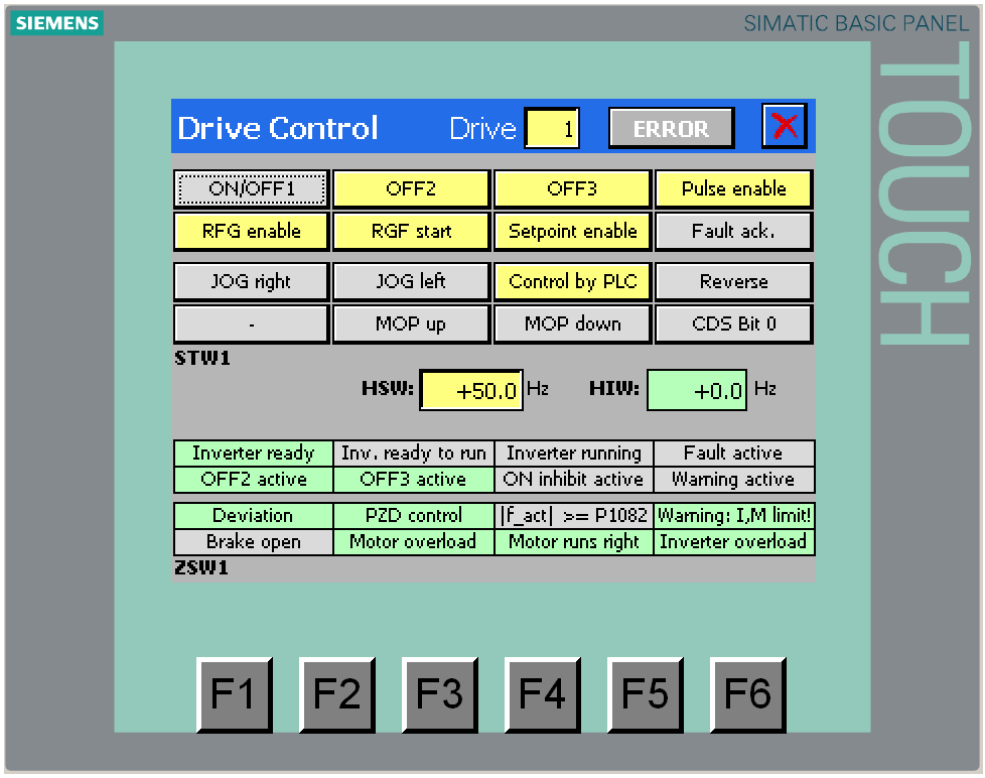
If there is a communication error, the  button in the header will flash red-white. By pressing the button you get to the screen of the error information. With the button in the error information screen, you get back to the previous screen.

If there is no current error and the  button does not flash red-white, you can get the error information of the last error back on the screen by clicking on it:

[11] The operator panel permits an entry of SINAMICS V20 devices up to the configured number.

4.2 “Drive Control” screen

Figure 4-2: “Drive Control” operator screen



STW1 buttons

The buttons in the top screen area correspond to the bits in control word 1 from table Table 1-1. A pressed button changes to yellow and supplies the signal status true. The buttons have the following properties:

Table 4-1: Property of the STW1 buttons

Button	Property
ON/ OFF	Locking-type button The unlocking (resetting of the bit) is performed by clicking again.
OFF2	
OFF3	
Pulse enable	
RFG enable	
RFG start	
Setpoint enable	
Control by PLC	
Reverse	
CDS Bit 0	
Fault ack.	Locking-type button The unlocking (resetting of the bit) is performed automatically after successful acknowledgment of the error.
JOG right	Non-locking button
JOG left	
MOP up	
MOP down	

If there are several drives on the bus, the STW1 read out from the newly addressed SINAMICS V20 is assigned to the buttons when changing the drive address in the header of the screen. This guarantees that the STW1 in the screen always matches the real STW1 of the addressed SINAMICS V20.

WARNING	**When switching the motor off via the control buttons in the screen above, it may slow down via the bus due to this signal delay.** **If there is a communication failure, a running motor cannot be switched off via the bus between the start of the fault and the end of the telegram downtime (P2014).**

HSW input field

Enter the speed setpoint in Hz here. Positive or negative values up to a maximum of the rated motor frequency can be entered.

HIW output field

Here, the actual speed value is output in Hz. When the value is positive, the motor is running forward if the “Reversing” control bit of STW1 has the value false.

ZSW1 display fields

The display fields in the bottom screen area of Figure 4-2 correspond to the bits in the control word 1 from table Table 1-2. If the signal status is “true” the respective text field will turn green (“Fault active” and “Warning active” fields become red or orange).

Motor ready for switched on

The motor starts when pressing the ON/OFF1 button, if the following conditions are met:

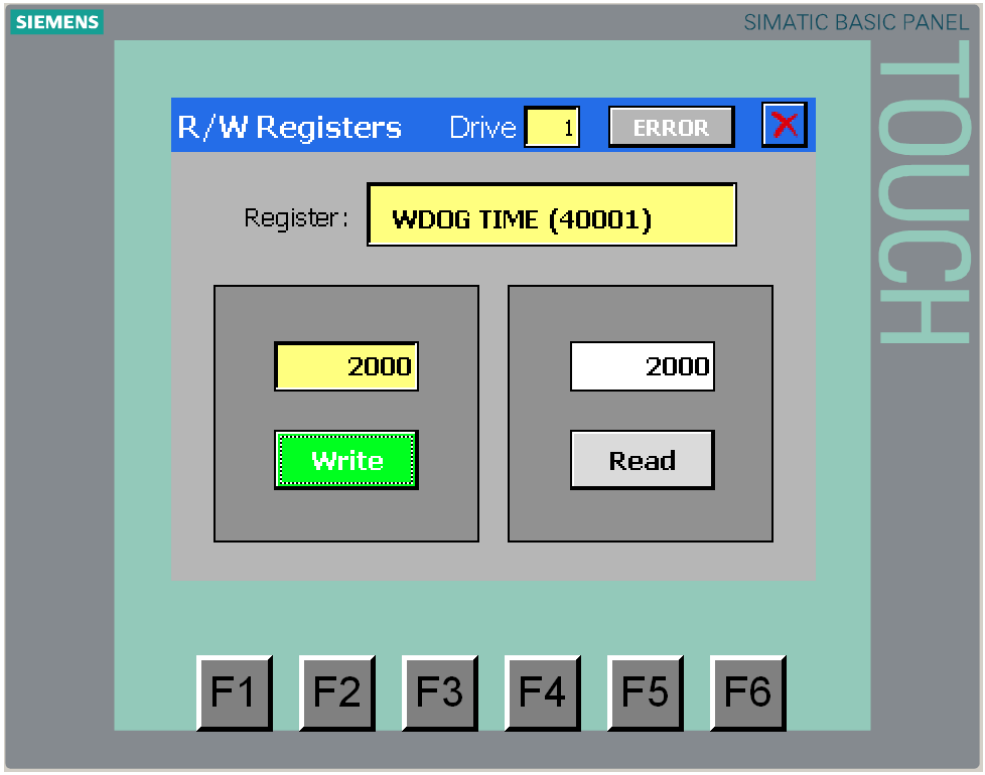
- You have set the control bits (STW1) according to Figure 4-2.
- You have entered a setpoint (HSW) >0 and <rated motor frequency.
- The status bits (ZSW) have been set as in Figure 4-2.

NOTICE	**Subsequent to the commissioning according to Table 3-2 due to the slave’s first response code, the MODBUS protocol generates the error message “data value error” and the ERROR button in the HMI screen’s headline flashes red-white.** **This is why the SINAMICS V20 neither accepts a STW1= 0000_{Hex}, nor a HSW=0.0. The error vanishes as soon as you supply STW1 and HSW correctly and acknowledge the error[12].**

[12] To acknowledge the error open and close the error screen

4.3 “R/W Registers” screen

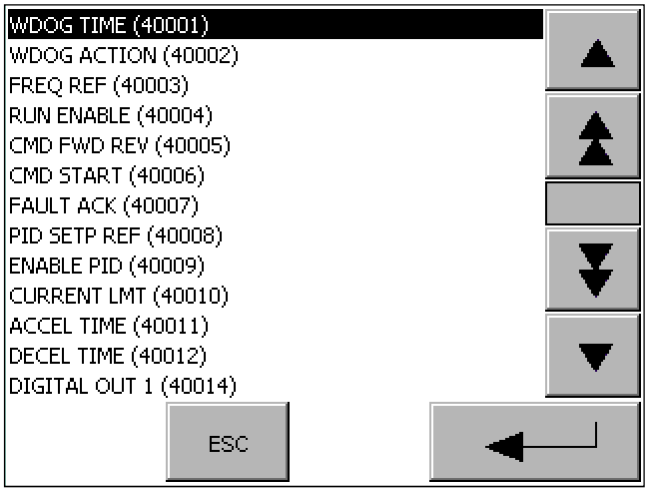
Figure 4-3: “R/W Registers” operator screen



Selecting register

Click into the symbolic “Register” input field and select the register that you want to read or write from the list.

Figure 4-4: List of registers



The list includes all registers that can be accessed at the SINAMICS V20 via the Modbus protocol. By selecting the register, the data format of the value to be read/written is also specified. If it is a “Read-only” parameter (rnnnn), the “Write button” is grayed out and any write attempt is stopped.

Reading register

Select the desired drive in the header and press the “Read” button. The register content read out from the SINAMICS V20 is written into the output field located above the button. The execution of the event is displayed by a temporary green color of the “read” button.

Writing register

Select the desired drive in the header. Enter the register content to be written in the SINAMICS V20 via the input field located above the “write” button and start the write process with the “write” button. The execution of the event is displayed by a temporary green color of the “write” button. For control purposes, the written date is read out straight away again via the “read” button located above the output field. The data written in the SINAMICS V20 via the Modbus is stored in the RAM of the inverter. To permanently save all parameters in EEPROM see \7\.

NOTICE	**Note their permitted value ranges when entering register values. They are included in the mapping table in chap. 6.2 of the SINAMICS V20 operating instruction \7\. Input error relating to this can have various effects:** • **No entries possible on the operator panel.** • **“Data value error” error message.** • **An incorrect value is transferred to the SINAMICS V20.**

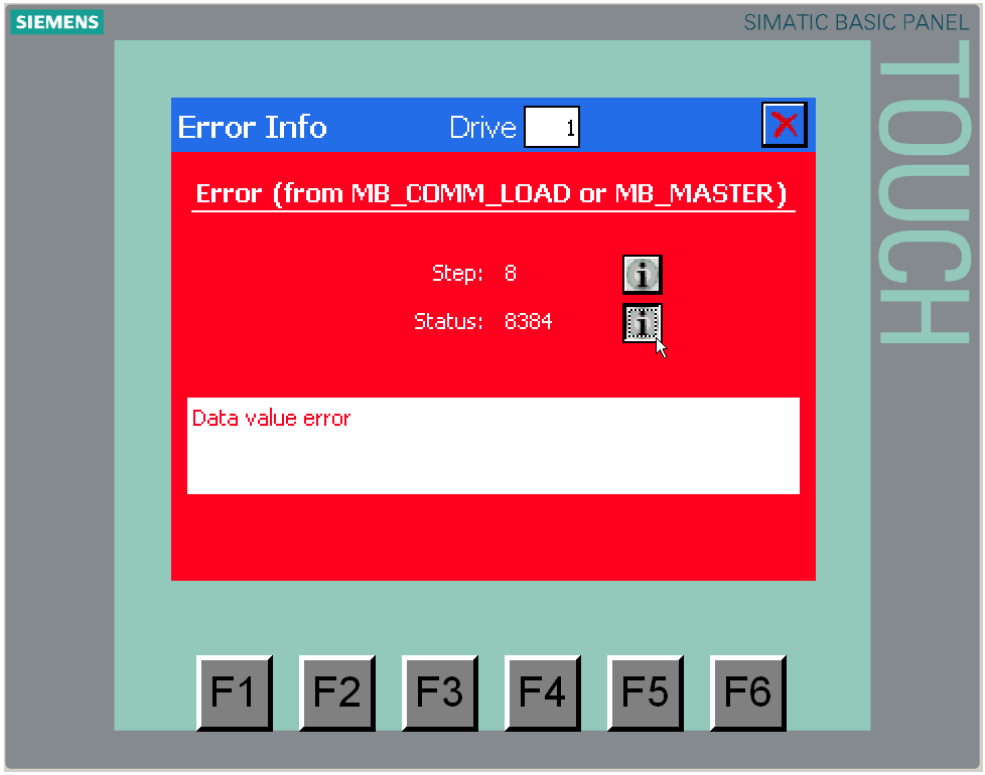
Broadcast transmission (writing to all SINAMICS V20 on the bus)

Select 0 as drive address in the header. Enter the register content to be written in the SINAMICS V20 via the input field located above the “write” button and start the write process with the “write” button. The execution of the event is displayed by a temporary green color of the “write” button. There is no read back of the date for the broadcast transmission. Furthermore no read accesses are permitted for drive address 0. This is why the “read” button and the output field are grayed out.

NOTICE	**The program has to interrupt the cyclic communication of the process data for the broadcast transmission via address 0. This has the effect that the SINAMICS V20 goes to fault once their telegram downtimes (see P2014) have lapsed, provided the times have not been configured with 0. However, also keep in mind that if the telegram downtime = 0 there will be no telegram downtime monitoring.**

4.4 “Error Info” screen

Figure 4-5: “Error Info” operator screen



The screen gives information on the communication error that occurred last and which was detected by the respective Modbus system instructions. A new error overwrites the previous error information. The drive number in the header of the screen signifies the address of the drive at which the communication was faulty last. With  you do not only exit the screen but you also acknowledge the error message. This changes the look of the error button in the header of the three other screens permanently back from

to

provided the respective error is no longer pending.

Step

The program is programmed as a sequencer. The step number gives information on the action at which the error occurred. You receive a clear text message via the respective info button  .[13]

Status

The error messages of the Modbus system instructions are displayed. You receive a clear text message via the respective info button  .[13]

[13] As long as you hold the info button down, the text is visible.

5 Programming

This chapter describes the structure of the STEP 7 program. Furthermore, the specific functions are explained in more detail in section 1. The chapter is to help you to deepen your knowledge on the functionality of the SINAMICS V20 ⇔ SIMATIC S7-1200 communication via the Modbus protocol.

The content of this section is not necessarily required for implementing and operating the application example.

5.1 Relevant code blocks

Modbus RTU - instructions

The functions specified in section 1 use the following two instructions provided by the TIA portal as a basis and which you can find in the “Instructions” task card under

> Communication > Communication processor > MODBUS

.**MB_COMM_LOAD**
When inserting it into the program the instruction generates a system function block FB1080 with the same name and a respective instance DB or instance data in the calling block. MB_COMM_LOAD configures a port for the communication via the Modbus RTU protocol. After restart, the block can only be called cyclically and processed by the user program until it reports the completion of the port configuration without error.

- **MB_Master**
  When inserting it into the program the instruction generates a system function block FB1081 with the same name and a respective instance DB or instance data in the calling block. MB_MASTER allows your user program the communication via the port of a communication module as Modbus master. You can access data in one or several SINAMICS V20 that act as Modbus slaves.

Details on the instructions above can be found in the Online help in the TIA portal or chap. 12.5.3 of the S7-1200 system manual (\3\).

Modbus user function block

The Modbus communication is divided between a cyclic and an acyclic part both of which are realized in **V20_Modbus [FB1]**. The application example uses the following Modbus communication mechanisms:

- Function code 03 – n read holding register[14]
- Function code 06 – 1 write holding register

Cyclic communication
Within the framework of the cyclic communication, data for drive control is exchanged between the PLC and SINAMICS V20. All drives of a port are operated one after the other. After the last drive, follows the first one again. The data, specified in chapter 1.1 is exchanged. The cyclic communication can be switched off via a parameter in order to save cycle time. This may be useful if you want to execute certain parameter changes via the Modbus registers via program but would like to use a different command source – e.g. the terminals.

[14] Though function code 03 supports reading multiple registers at a time, the user programm accesses only to one register.

Acyclic communication
Within the framework of the acyclic communication any register of a selected SINAMICS V20 once (not cyclically)

- reads on request,
- writes on request or
- writes on request and is read back for control purposes.

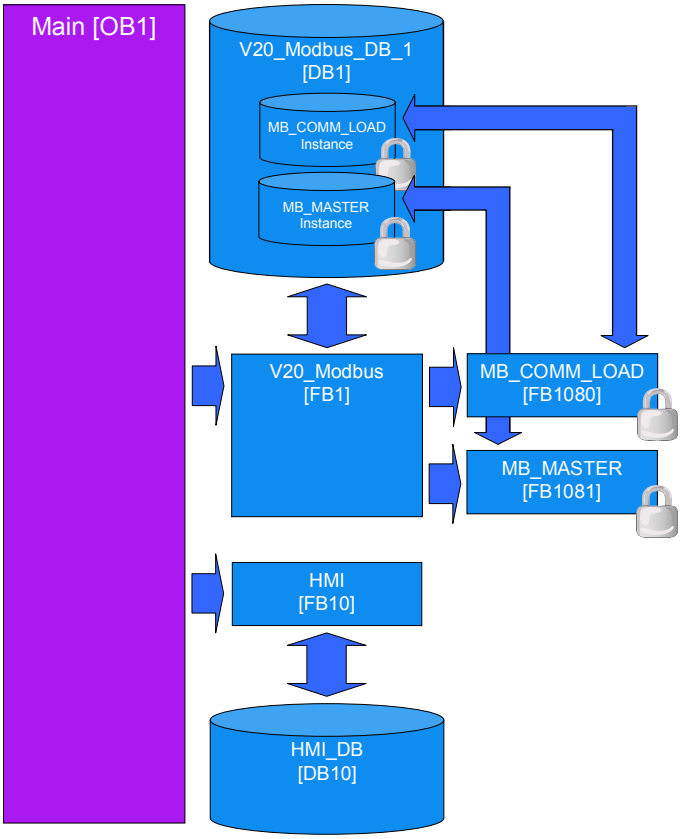
Furthermore, registers can be transmitted simultaneously to all SINAMICS V20 on the bus (broadcast).

HMI interface block

For convenient operating and monitoring via the KTP600 operator panel, the input and output data provided on the V20_Modbus [FB1] parameter interface, has to be prepared. For this purpose, the **HMI [FB10]** block without parameters is used. As a core, its instance DB includes the data relevant for operating & monitoring[15] from the mapping table in chap. 6.2 of the SINAMICS V20 operating instruction \7\.

5.2 Program structure

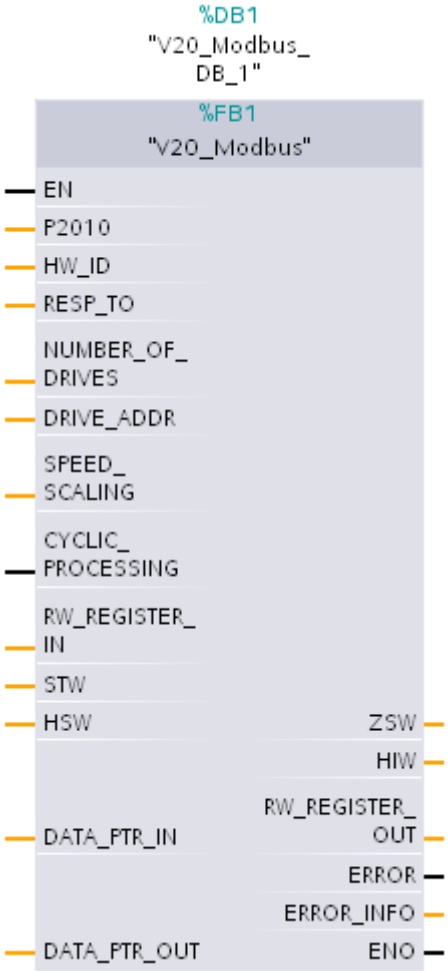
Figure 5-1: Program structure



[15] Register address, type of access (RW or R), scaling factor, data type

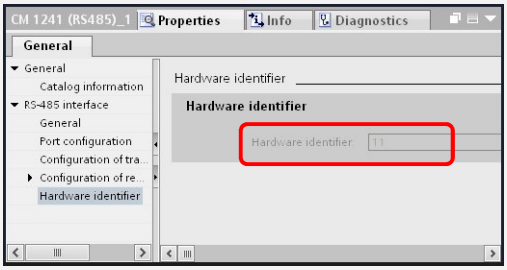
5.3 V20_Modbus [FB1] function block

Figure 5-2: V20_Modbus [FB1] call



5.3.1 Configuration

Table 5-1: Parameters of the V20_Modbus [FB1]

Name	IN / OUT	Type	Explanation
P2010	IN	USInt	**Baud rate** The coding is identical with that of the V20 parameter P2010 (values: 6…12). See \7\.
HW_ID	IN	PORT	**Hardware identifier of the communication module (board)** You can find the value in the device configuration in the properties of the communication module. 
RESP_TO	IN	UInt	**Timeout of reply** Time in milliseconds for which the MB_MASTER system FB waits for the reply by the slave. If the slave does not replay within this time, "MB_MASTER" repeats the request or finishes it with an error, provided the indicated number of repeats[16] has been sent. 5 ms to 65535 ms (default value = 1000 ms).
NUMBER_OF_DRIVES	IN	USInt	**Number of drives** Number of SINAMICS V20 that are connected to the respective port (1…32). With repeaters, the number can be increased to up to 247.
DRIVE_ADDR	IN	USInt	**Current drive address** Address of the drive that you want to monitor, control or configure.
SPEED_SCALING	IN	Real	**Reference frequency** Enter the motor frequency: Internally it is standardized to 16384. With this scaling HSW and HIW are transferred via the Modbus register.

[16] The number of request repetitions is stored in the RETRIES variable in the “Static” data segment of the instance data of the MB_COMM_LOAD and can be changed by you if required.

Name	IN / OUT	Type	Explanation
CYCLIC_PROCESSING	IN	Bool	**Cyclic PZD transfer on/off** false = switched off (no transfer by STW, HSW, ZSW, HIW; only acyclic register transfer) true = switched on
RW_REGISTER_IN.	IN	Struct	**acyclic register transfer (IN)**
START		Bool	Start of the operation with positive edge
FUNCTION		USInt	0 = read 1 = write 2 = read&write
REG_NUMBER		UDInt	Register number (see mapping table in \7\, chap. 6.2)
DATA_LEN		UInt	Number of registers (words) to be read/written
ZSW	OUT	Word	**Status word** ZSW1 of the SINAMICS V20 with the DRIVE_ADDR address
HIW	OUT	Real	**Main actual value** HIW [Hz] of the SINAMICS V20 with the DRIVE_ADDR address
RW_REGISTER_OUT.	OUT	Struct	**acyclic register transfer (OUT)**
DONE		Bool	Done message (pending at cycle 1); The action specified in RW_REGISTER_IN.FUNCTION has been fully completed. A register value read into the PLC by SINAMICS V20 can be removed or further processed. A register value written in the SINAMICS V20 will have an effect there.
BUSY		Bool	= True, as long as the action specified in RW_REGISTER_IN.FUNCTION is enabled.
ERROR	OUT	Bool	**Communication error** True = An error has occurred in the Modbus communication. The bit is pending for 1 cycle.
ERROR_INFO.	OUT	Struct	**extended error information**
drive_number		USInt	Number of the drive at which the communication error occurred.
step		USInt	Step within the sequencer of the V20_Modbus [FB1] at which the communication error occurred.
STATUS		Word	Error status information of the blocks MB_COMM_LOAD or MB_MASTER (see Online help or \3\, chap. 12.5.3).
STW	IN / OUT	Word	**Control word** STW1 of the SINAMICS V20 with the DRIVE_ADDR address. The control word is not only continuously transferred to the drive but is also continuously read back.

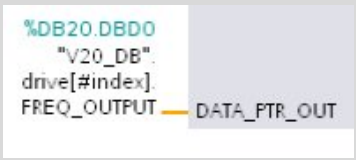
Name	IN / OUT	Type	Explanation
HSW	IN / OUT	Real	**Main setpoint** HSW of the SINAMICS V20 with the DRIVE_ADDR address. The setpoint is not only continuously transferred to the drive but is also continuously read back.
DATA_PTR_IN	IN / OUT	Variant	**Write pointer** Pointer to the data to be written (data source) into the SINAMICS V20 for the acyclic register transfer.
DATA_PTR_OUT	IN / OUT	Variant	**Read pointer** Pointer to the data to be read for the acyclic register transfer from the SINAMICS V20 to the S7-1200 (data destination).

Tip: Transfer only one word at a time for the acyclic register transfer (RW_REGISTER_IN.DATA_LEN =1). This makes it possible to symbolically provide the formal parameters DATA_PTR_IN or DATA_PTR_OUT with the variable name of the data word that corresponds to the register to be transferred to the S7-1200. Flexible, symbolic access to field elements and also to loop processing is possible, since this data word can also be an array element with an index which in turn can be indicated symbolically.

Example: Pointer addressing options

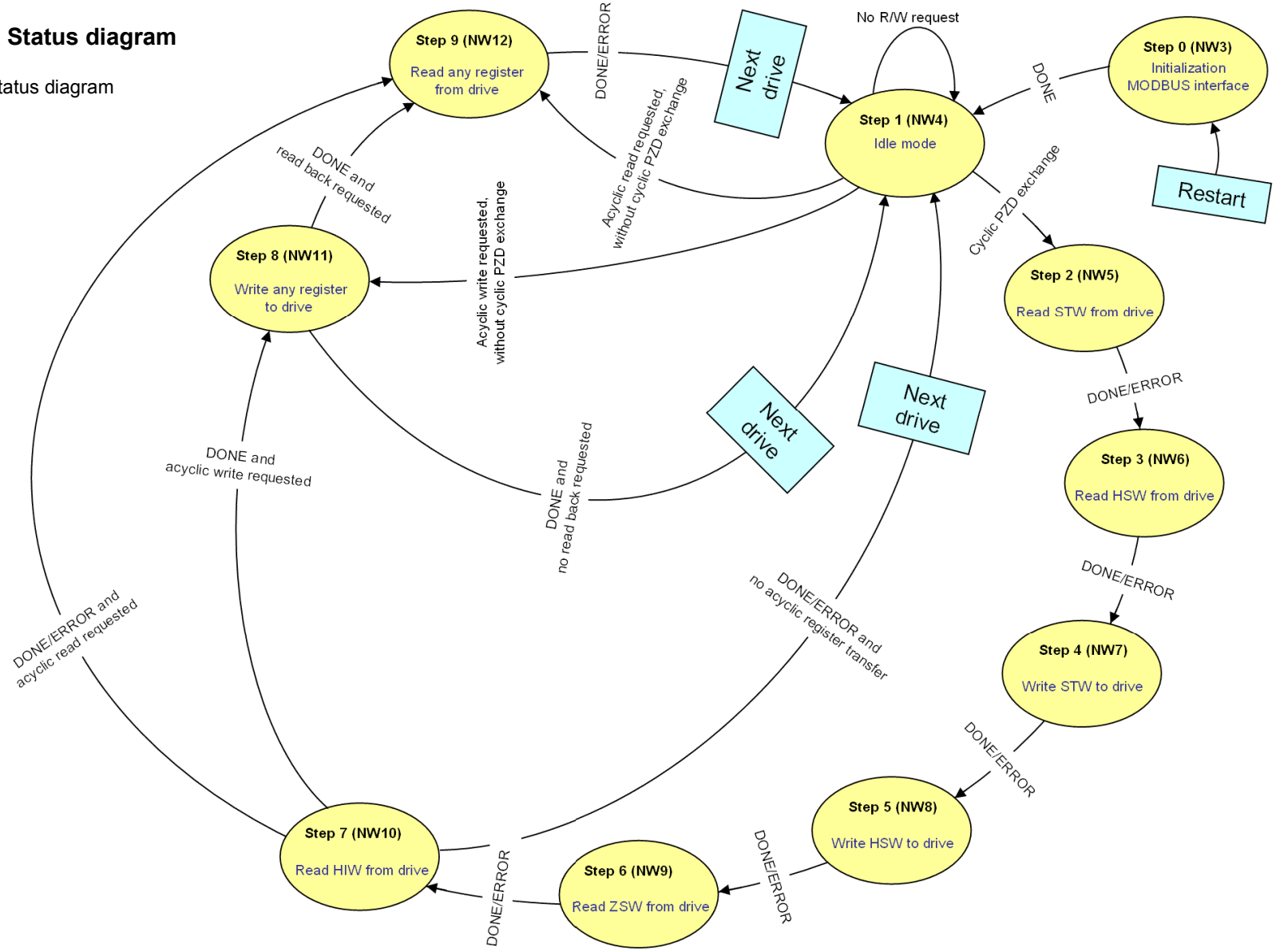
Addressing absolute
(no indexing possible)

Addressing symbolic
(indexing possible)



5.3.2 Status diagram

Figure 5-3: Status diagram



The MODBUS initialization is only carried out once at the restart of the S7-1200 in step 0.

If the cyclic process data exchange is switched on (IN parameter CYCLIC_PROCESSING = true), steps 1 to 7 are executed and subsequently the SINAMICS V20 is selected with the next address and it is restarted at step 1.

If an acyclic parameter transfer was requested via parameter RW_REGISTER_IN.START, the steps 8 (write), 9 (read) or both steps (write and subsequent read back) are each performed following step 7 – depending on the selected function, before the cyclic PZD transfer is continued with the next drive whose turn it is.

If the cyclic process data exchange is turned off (IN parameter CYCLIC_PROCESSING = false), the sequencer in step 1 will wait for the request of an acyclic register transfer which will directly branch off after step 8 or 9.

Switching condition in all states are the done messages DONE or ERROR of the system instructions MB_COMM_LOAD and MB_MASTER (exception: step 1 which does not contain any of these system instructions).

Once all SINAMICS V20 have been operated for the cyclic PZD exchange, it will be started at drive address 1 again.

6 Expansion to Several Drives

6.1 Expansion to up to 32 drives per port

The application example operates one SINAMICS V20. However, via a port up to 32 drives can be operated without a repeater. This has already been taken into account in the application example and especially in FB V20_Modbus [FB1]. To increase the number of drives, proceed as follows:

Table 6-1: Expansion to up to 32 drives

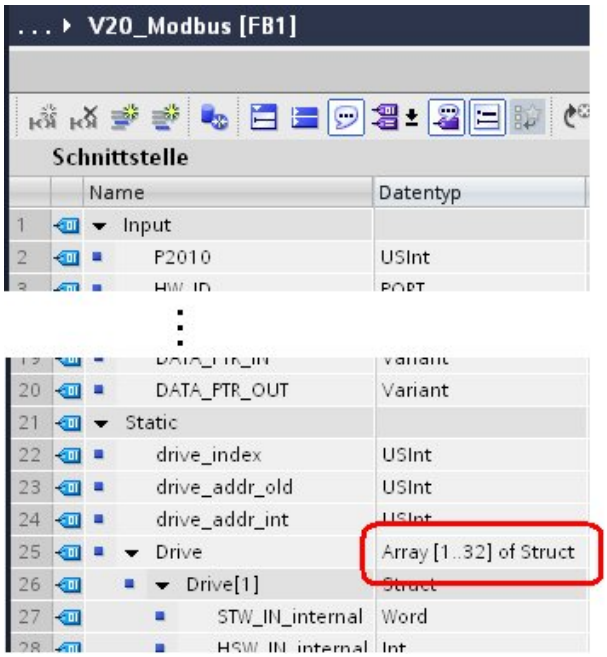
	Instruction
1.	Supplement your configuration by the number of the desired drives according to Figure 2-1.
2.	Configure the added inverter via the incorporated BOP according to point 0 to 0 of Table 3-2. From “2” onward the drive addresses have to be assigned continuously.
3.	Change the NUMBER_OF_DRIVES IN_Parameter of the V20_Modbus FB to the desired number of drives and load the V20_Modbus FB calling code block again into the S7-1200.

By entering the drive address in the header of the respective operating screen, you can select the drive for your monitoring or operation.

6.2 Expansion to up to 247 drives per port

Regarding Modbus and the address space, up to 247 drives can be operated by one port when using repeaters. Additionally to the points from Table 6-1, in this case, you have to expand the “Drive” array in the “Static” data segment of the interface of the V20_Modbus_DB_1 FB to the desired number of drives.

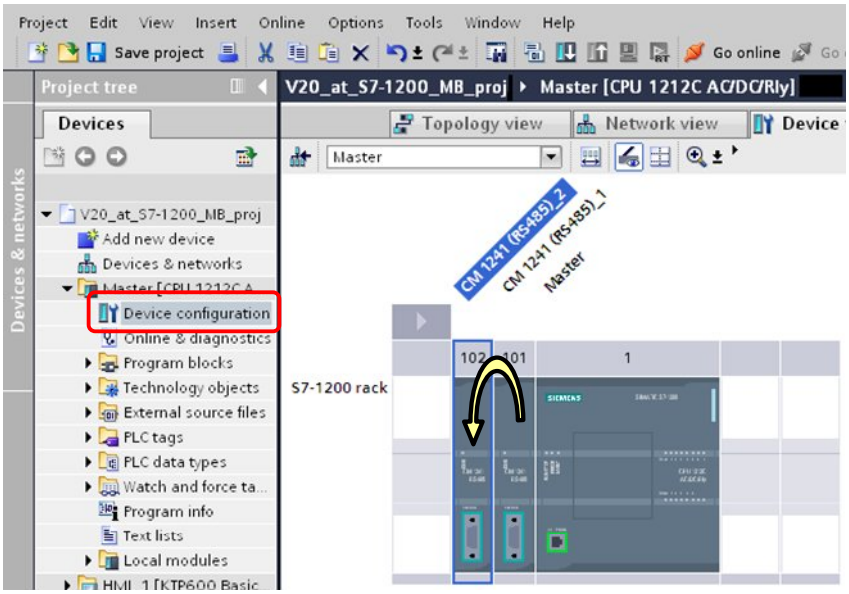
Figure 6-1: Expanding array in FB V20_Modbus

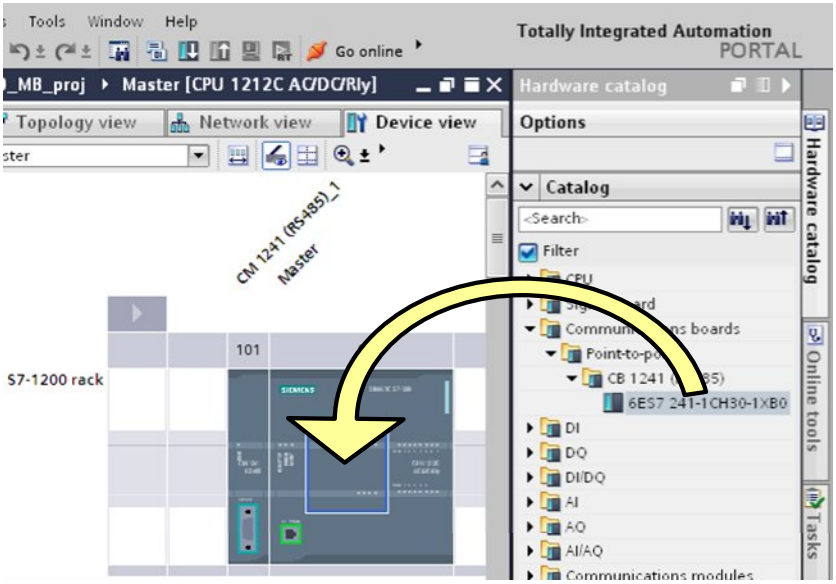
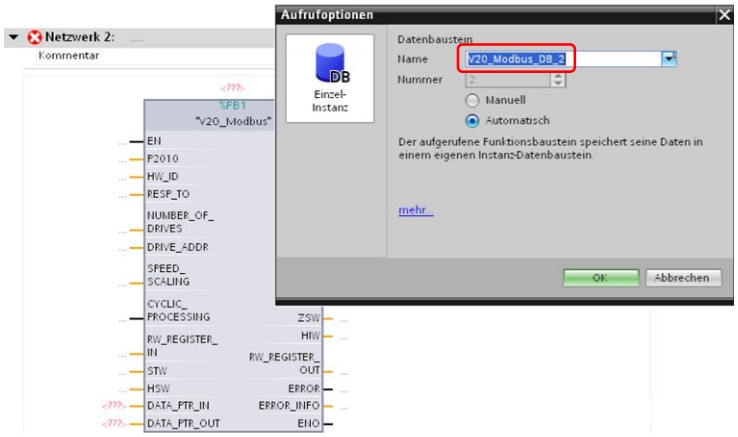
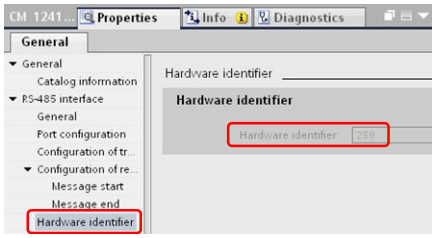


6.3 Expansion to up to 4 ports

You can provide the CPU with a maximum of three communication modules and one communication board (see Figure 2-3). Below, you find out how to expand the application by one port.

Table 6-2: Port expansion

	Instruction
Installing and wiring new hardware	
1.	Supplement your configuration by those drives according to Figure 2-1 that are to communicate with the controller via the new, additional port.
2.	Add a new CM1241 (RS485) communication module to SIMATIC S7-1200 and insert a CB1241 (RS485) communication board in the CPU.
3.	Establish the Modbus bus connection physically between the new drives and the new port – as explained in chap. 2.2.
Configuring new drives via the BOP	
4.	Configure the added inverter via the incorporated BOP according to point 0 to 0 of Table 3-2. From “1” onward, the drive addresses have to be assigned continuously.
Device configuration in TIA Portal	
5.	Copy the existing communication module in the device configuration via “drag and drop” with a held Ctrl button and insert it directly to the left of it into slot 102. 

	Instruction
	When using a different module type or communication board, drag it from the catalog and place it in the work area at the intended place. 
	Program expansion in TIA Portal
6.	Call the V20_Modbus FB for a second time in your user program. Name the respective instance DB which is newly created, e.g. V20_Modus_DB_2. 
7.	Configure the new block call according to your requirements. Specify the hardware identifier for the newly added communication module at the HW_ID IN parameter. You can find it in its device configuration. 

	Instruction
8.	Now expand your user program regarding the new port.
9.	Compile the entire STEP7 program.
10.	Expand the HMI by the new port.

7 Literature

The following list is by no means complete and only provides a selection of appropriate sources.

Table 7-1: Literature

	Topic	Title / link
\1\	Siemens Industry Online Support	http://support.automation.siemens.com
\2\	Download page of this entry	http://support.automation.siemens.com/WW/view/en/63696870
\3\	STEP7 SIMATIC S7-1200	SIMATIC S7-1200 Automation System - System Manual http://support.automation.siemens.com/WW/view/en /91696622
\4\		Update of the S7-1200 system manual http://support.automation.siemens.com/WW/view/en /89851659
\5\		Updates for STEP 7 V13 and WinCC V13 http://support.automation.siemens.com/WW/view/en /90466591
\6\	MODBUS-RTU	How do you establish a MODBUS-RTU communication with STEP 7 (TIA Portal) for the SIMATIC S7-1200? http://support.automation.siemens.com/WW/view/en /47755811
\7\	SINAMICS V20	SINAMICS V20 Inverter - Operating Instructions http://support.automation.siemens.com/WW/view/en /104426056

8 History

Table 8-1: History

Version	Date	Revisions
V1.0	11/2012	First issue
V1.1	07/2013	Extended to TIA V12
V1.2	11/2014	Extended to TIA V13