

Application description • 11/2014

SINAMICS V: Speed Control of a V20 with S7-1200 (TIA Portal) via USS[®] Protocol, with HMI

SINAMICS V20, SIMATIC S7-1200

Warranty and liability

Note

The Application Examples are not binding and do not claim to be complete regarding the circuits shown, equipping and any eventuality. The Application Examples do not represent customer-specific solutions. They are only intended to provide support for typical applications. You are responsible for ensuring that the described products are used correctly. These application examples do not relieve you of the responsibility to use safe practices in application, installation, operation and maintenance. When using these Application Examples, you recognize that we cannot be made liable for any damage/claims beyond the liability clause described. We reserve the right to make changes to these Application Examples at any time without prior notice.

If there are any deviations between the recommendations provided in these application examples and other Siemens publications – e.g. Catalogs – the contents of the other documents have priority.

We do not accept any liability for the information contained in this document.

Any claims against us – based on whatever legal reason – resulting from the use of the examples, information, programs, engineering and performance data etc., described in this Application Example shall be excluded. Such an exclusion shall not apply in the case of mandatory liability, e.g. under the German Product Liability Act (“Produkthaftungsgesetz”), in case of intent, gross negligence, or injury of life, body or health, guarantee for the quality of a product, fraudulent concealment of a deficiency or breach of a condition which goes to the root of the contract (“wesentliche Vertragspflichten”). The damages for a breach of a substantial contractual obligation are, however, limited to the foreseeable damage, typical for the type of contract, except in the event of intent or gross negligence or injury to life, body or health. The above provisions do not imply a change of the burden of proof to your detriment.

Any form of duplication or distribution of these Application Examples or excerpts hereof is prohibited without the expressed consent of Siemens Industry Sector.

Security information

Siemens provides products and solutions with industrial security functions that support the secure operation of plants, solutions, machines, equipment and/or networks. They are important components in a holistic industrial security concept. With this in mind, Siemens' products and solutions undergo continuous development. Siemens recommends strongly that you regularly check for product updates.

For the secure operation of Siemens products and solutions, it is necessary to take suitable preventive action (e.g. cell protection concept) and integrate each component into a holistic, state-of-the-art industrial security concept. Third-party products that may be in use should also be considered. For more information about industrial security, visit <http://www.siemens.com/industrialsecurity>.

To stay informed about product updates as they occur, sign up for a product-specific newsletter. For more information, visit <http://support.automation.siemens.com>.

Table of contents

Warranty and liability.....	2
1 Task.....	5
1.1 Controlling a SINAMICS V20 (process data exchange)	5
1.2 Parameter accesses.....	6
1.3 HMI for convenient operating and monitoring	6
2 Components and Structure	7
2.1 Hardware components used	7
2.2 Bus connection	8
Bus wiring	9
Communication modules	10
2.3 Controller software	11
Standard software components	11
User software and documentation	11
3 Commissioning.....	12
3.1 Requirements	12
3.2 Instruction	12
How to generally modify drive parameters via the BOP	12
Instructions to commission the application example	13
4 Operation	16
4.1 Screen navigation.....	16
4.2 "Drive control" screen	17
Drive control	18
USS enabling	18
4.3 "RW parameter" screen.....	19
Reading parameters.....	19
Writing parameters	19
4.4 "Actual state" screen	20
Reading a set of current status parameters	20
4.5 "Set functions" screens.....	21
Reading out inverter functions	21
Writing inverter functions.....	21
Info buttons.....	22
4.6 "Error information (from USS_PORT/USS_DRV)" screen	22
Info buttons.....	23
4.7 "Error information (from USS_RPM/USS_WPM)" screen.....	23
Info buttons.....	23
5 Programming	24
5.1 Relevant code blocks	24
USS instructions	24
User function blocks	24
5.2 Program structure.....	25
Calling the V20_USS_Control_1 [FB1] in two OBs.....	25
Framework program (Main [OB1] and HMI_DB [DB10]).....	26
5.3 V20_USS_Control_1 [FB1] function block	27
5.3.1 Configuration	27
5.4 V20_USS_Param_1 [FB2] function block	29
5.4.1 Operating modes.....	29
ACTIVATE_USS	29
RW_PARAM.....	30
ACTUAL_STATE.....	31
SET_FUNCTIONS	31

Table of contents

5.4.2	Configuration	31
5.4.3	Start of a function	36
6	Expansion to Several Drives	37
6.1	Expansion to up to 16 drives	37
6.2	Expansion to up to 64 drives	37
7	Literature	41
8	History.....	41

1 Task

SINAMICS V20 drives are to exchange data via the RS485 interface and via USS[®] (Universelles Serielles Schnittstellenprotokoll – universal serial interface protocol) with a SIMATIC S7-1200 controller. One controller is to operate up to 64 drives. It requires the functionality described in the sections 1.1 to 1.2.

1.1 Controlling a SINAMICS V20 (process data exchange)

- A SINAMICS V20 is to be controlled via the following input signals:
 - RUN – start bit of SINAMICS V20 (STW1, bit 0)
If this parameter has the value TRUE, this input will enable the operation of the V20 at the preset speed.
 - OFF2 – coasting to a standstill (STW1, bit 1)
If this parameter has the value FALSE, this bit will cause the SINAMICS V20 to coast to a standstill, without braking.
 - OFF3 – fast stop bit (STW1, bit 2)
If this parameter has the value FALSE, this bit will cause a fast stop by braking the SINAMICS V20.
 - F_ACK – error acknowledgement bit (STW1, bit 7)
With this bit you reset the error bit of the SINAMICS V20 after having deleted the drive error. Thus, the V20 detects that the error no longer has to be reported.
 - DIR – direction control of the SINAMICS V20 (STW1, bit 11)¹
This bit is to be set if the V20 is to run in forward direction (if SPEED_SP is positive).
 - SPEED_SP – setpoint speed value
This is the speed in percentages of the SINAMICS V20 to the configured frequency. When entering a positive value, the V20 will run forward (if DIR has the value TRUE).
- A SINAMICS V20 is to continuously transfer the following data to the controller:
 - RUN_EN – enable operation (ZSW1, bit 2)
This bit reports whether the SINAMICS V20 is running.
 - RUN_EN – direction of drive (ZSW1, bit 14)
This bit reports whether the SINAMICS V20 is running forward.
 - INHIBIT – SINAMICS V20 blocked (ZSW1, bit 6)
This bit reports the status of the inhibit bit for the SINAMICS V20.
 - FAULT – drive error (ZSW1, bit 3)
This bit reports whether an error occurred in the SINAMICS V20. The user has to remove the fault and set the F_ACK bit in order to delete this bit.
 - SPEED – actual value drive speed (scaled value of ZSW2)
The data is the value of the current speed as a percentage to the configured speed.
- If there is a communication error, the error status is to be displayed.

¹ In STW1 the direction bit is entered negated.

1.2 Parameter accesses

The required parameter accesses are summarized in four selectable modes:

- **ACTIVATE_USS** – enabling the USS communication channel in order to control a SINAMICS V20 via the USS communication.
- **RW_PARAM** – reading and writing any inverter parameter by specifying the parameter number and the parameter indexes.
- **ACTUAL_STATE** – reading a set of selected status information from the inverter.
 - Actual value of the filtered output frequency [Hz] (r0024)
 - Actual value of the output voltage [V] (r0025)
 - Actual value of the smoothed link voltage [V] (r0026)
 - Actual value of the output current [A] (r0027)
 - Actual value of the total setpoint value [Hz] (r1078)
 - Actual value of the energy saving [kWh, currency, CO₂] (r0043[0..2])
 - Current connection macro (p0717)
 - Current application macro (p0717)
- **SET_FUNCTIONS** – specifying a set of selected operating modes.
 - Keep-running operation for DDS1...DDS3 (P0503[0..2])
 - Flying start (P1200)
 - Automatic restart (P1210)
 - Hibernation for DDS1...DDS3 (P2365[0..2])
 - Super torque for DDS1...DDS3 (P3350[0..2])

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 tested 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 components²

Component	Qty.	Order number	Note
SIMATIC S7-1200 CPU1212C AC/DC/Rly	1	6ES7212-1BE40-0XB0 ³	V 4.0 (projected with TIA V13)
		6ES7212-1BE31-0XB0 ³	V 3.0 (projected with TIA V12)
		6ES7212-1BD30-0XB0 ³	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 ⁴	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	-	

² Small parts such as wire, resistors and other installation material are not included in this table.

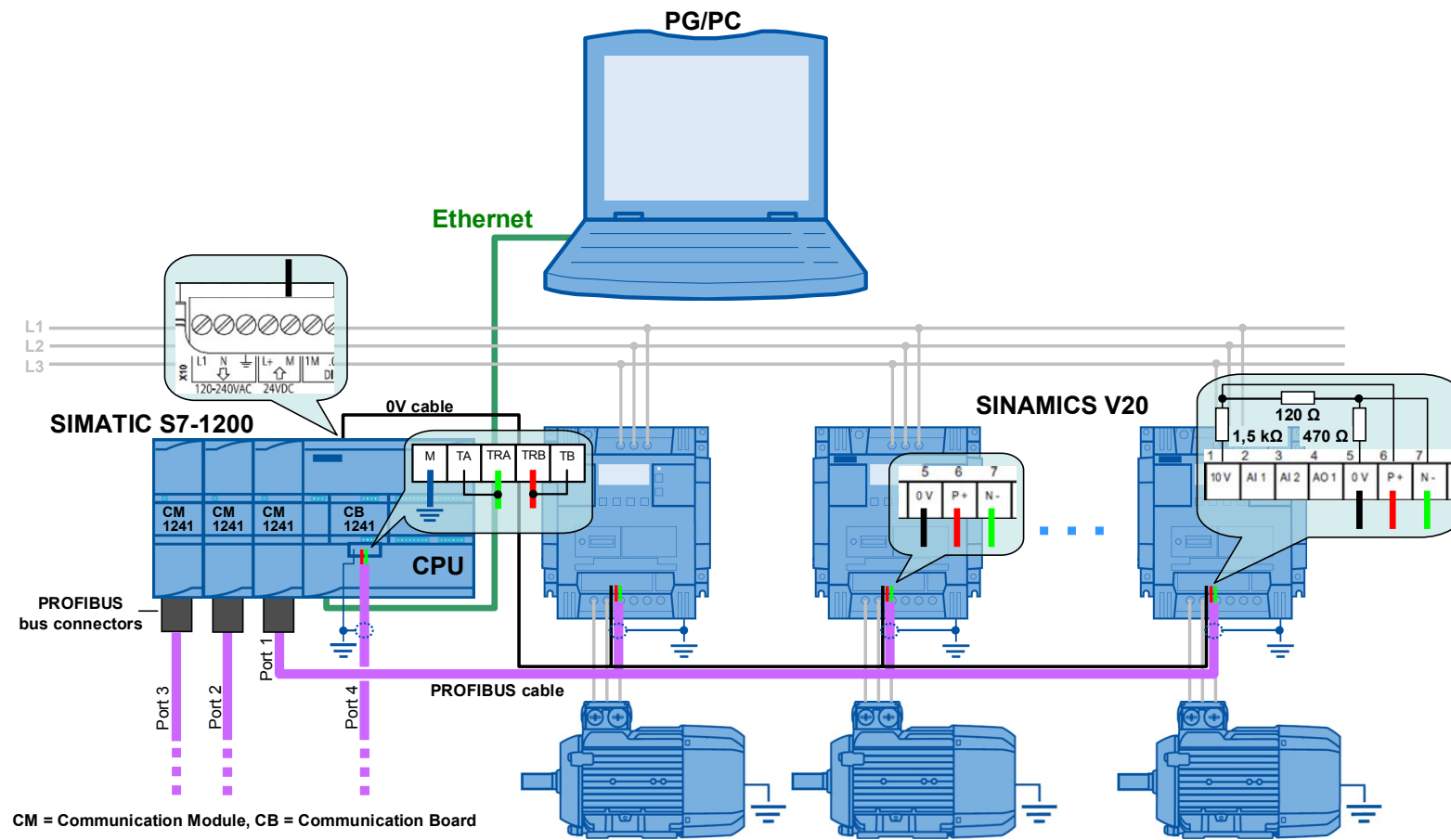
³ Any SIMATIC S7-1200 with corresponding firmware version applicable.

⁴ Any SINAMICS V20 applicable. Always use the latest firmware version.

2 Components and Structure

2.2 Bus connection

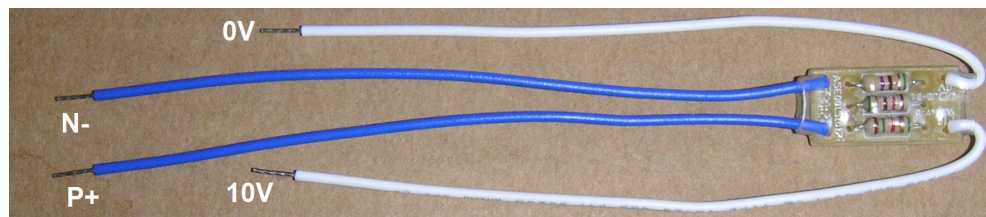
2.2 Bus connection

Figure 2-1: Wiring example USS[®] Bus

Bus wiring

According to Figure 2-1, the USS[®] Bus can be realized with a PROFIBUS line. The connection to the communication module is via a PROFIBUS plug that on the controller side, provides a switchable basic network with bus termination⁵ and the shielded contact. Switch the basic network on the PROFIBUS 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 **Fehler! Verweisquelle konnte nicht gefunden werden.**).

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.⁶

When establishing the bus connection, note the USS[®] specification ([\6\](#)) and chap. 6.1 of the operating instructions of the SINAMICS V20 ([\8\](#)).

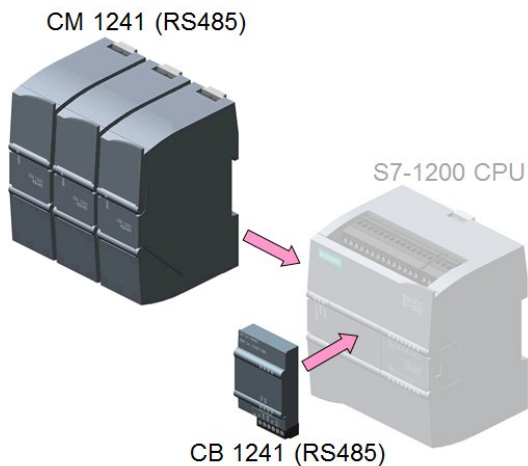
⁵ If you are using a different 9 pole D sub plug, you have to provide the bus termination yourself. In this case, you have to use a terminator of 120 Ω between pins 3 and 8.

⁶ Instead of the PROFIBUS cable (2 pole) you can also use a three-pole shielded cable that includes the potential equalization line. 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 16 drives (addresses 1...16). 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 [13](#).

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_USS_proj_V13_V1d2.zip (Archive file) V20_at_S7-1200_USS_proj_V13 (Project folder)	STEP 7 V13 project
63696870_V20_at_S7-1200_USS_lib_V13_V1d2.zip (Archive file) V20_at_S7-1200_USS_lib_V13 (Project folder)	STEP 7 V13 library
63696870_V20_at_S7-1200_USS_proj_V12_V1d1.zip (Archive file) V20_at_S7-1200_USS_proj_V12 (Project folder)	STEP 7 V12 project
63696870_V20_at_S7-1200_USS_lib_V12_V1d1.zip (Archive file) V20_at_S7-1200_USS_lib_V12 (Project folder)	STEP 7 V12 library
63696870_V20_at_S7-1200_USS_proj_V11_V1d1.zip (Archive file) V20_at_S7-1200_USS_proj_V11 (Project folder)	STEP 7 V11 project
63696870_V20_at_S7-1200_USS_lib_V11_V1d1.zip (Archive file) V20_at_S7-1200_USS_lib_V11 (Project folder)	STEP 7 V11 library
63696870_V20_at_S7-1200_USS_V1d2_en.pdf	This document
63696870_V20_at_S7-1200_USS_V1d2_SHORT-DOCU_en.pdf	Short Documentation

Two function blocks are the core of the application example or the STEP 7 project. They are 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 HW 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 [18](#).
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 to the order numbers 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 [18](#) and for the SIMATIC S7-1200 controller in [13](#).










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:




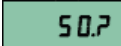






Table 3-1: Modifying drive parameters via the BOP (in general)

	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  .
3.	If parameter is indexed: Select index with the arrow keys   and press  .
4.	Select the parameter value with the arrow keys   and press  .

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:																					
<ul style="list-style-type: none">In the following, fd means “factory defaults” (delivery status).Unless otherwise stated, keys  and  have to be pressed <2s.																					
1.	<p>Restore to defaults, if the SINAMICS V20 is no longer in the delivery status.</p> <p>Change from display to parameter menu with  and modify the following parameters:</p> <table><tr><td>Access level</td><td>P0003</td><td>⇒</td><td>1 (fd: 1)</td></tr><tr><td>Commissioning parameter</td><td>P0010</td><td>⇒</td><td>30 (fd: 0)</td></tr><tr><td>Factory reset⁸</td><td>P0970</td><td>⇒</td><td>21 (fd: 0)</td></tr></table>	Access level	P0003	⇒	1 (fd: 1)	Commissioning parameter	P0010	⇒	30 (fd: 0)	Factory reset ⁸	P0970	⇒	21 (fd: 0)								
Access level	P0003	⇒	1 (fd: 1)																		
Commissioning parameter	P0010	⇒	30 (fd: 0)																		
Factory reset ⁸	P0970	⇒	21 (fd: 0)																		
2.	<p>On the display  is displayed.</p> <p>Select the respective 50/60 or Hz/hp setting (chap.5.3 in 18) that is appropriate for your region with the  arrow buttons and exit the mask with .</p>																				
3.	<p>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  (>2s), once you have finished entering the motor parameters or if you do not want to enter any motor parameters now. Now you are in the display menu again.</p>																				
4.	<p>Go to the parameter menu with .</p>																				
5.	<p>Check resp. modify the following parameters:⁹</p> <table><tr><td>Access level</td><td>P0003</td><td>⇒</td><td>3 (fd: 1)</td></tr><tr><td>Baudrate</td><td>P2010[0]</td><td>⇒</td><td>8¹⁰ (fd: 6)</td></tr><tr><td>USS address</td><td>P2011[0]</td><td>⇒</td><td>1¹¹ (fd: 0)</td></tr><tr><td>PKW length</td><td>P2013[0]</td><td>⇒</td><td>4 (fd: 127)</td></tr><tr><td>RS485 protocol selection</td><td>P2023</td><td>⇒</td><td>1 (fd: 1)</td></tr></table>	Access level	P0003	⇒	3 (fd: 1)	Baudrate	P2010[0]	⇒	8 ¹⁰ (fd: 6)	USS address	P2011[0]	⇒	1 ¹¹ (fd: 0)	PKW length	P2013[0]	⇒	4 (fd: 127)	RS485 protocol selection	P2023	⇒	1 (fd: 1)
Access level	P0003	⇒	3 (fd: 1)																		
Baudrate	P2010[0]	⇒	8 ¹⁰ (fd: 6)																		
USS address	P2011[0]	⇒	1 ¹¹ (fd: 0)																		
PKW length	P2013[0]	⇒	4 (fd: 127)																		
RS485 protocol selection	P2023	⇒	1 (fd: 1)																		
6.	<p>Transfer data from RAM to EEPROM</p> <table><tr><td>RAM nach EEPROM</td><td>P0971</td><td>⇒</td><td>21 (fd: 0)</td></tr><tr><td>Access level</td><td>P0003</td><td>⇒</td><td>1</td></tr></table>	RAM nach EEPROM	P0971	⇒	21 (fd: 0)	Access level	P0003	⇒	1												
RAM nach EEPROM	P0971	⇒	21 (fd: 0)																		
Access level	P0003	⇒	1																		
7.	<p>When the parameter entry is completed go back to the display menu by pressing  (>2s).</p>																				
8.	<p>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.</p>																				

⁸ With a factory reset, communication parameters P2010, P2011, P2023 used for USS[®] are not reset automatically. But they are supplied in the table's step 5.

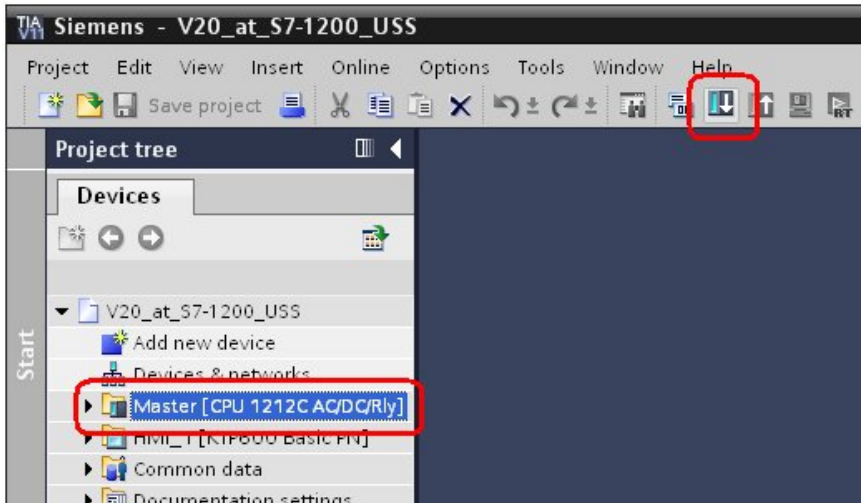
⁹ In the application example the SINAMICS V20 communication parameters are not set by means of the connection macro Cn010. They are set separately in the parameter menu.

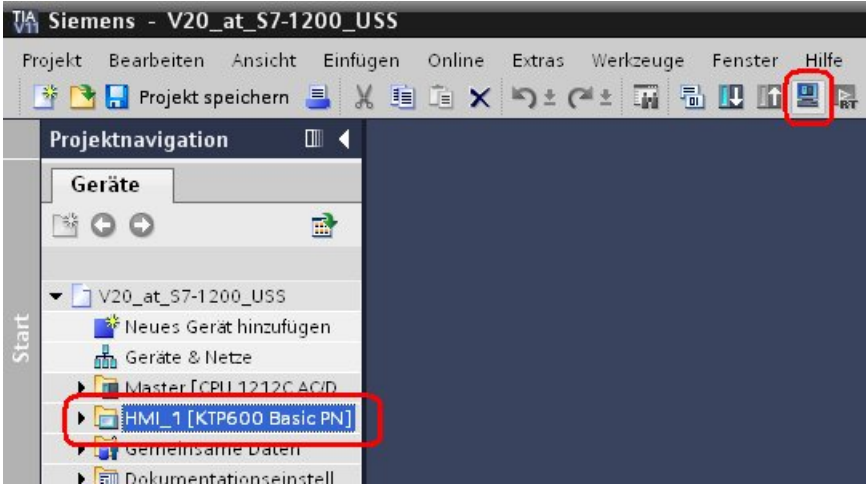
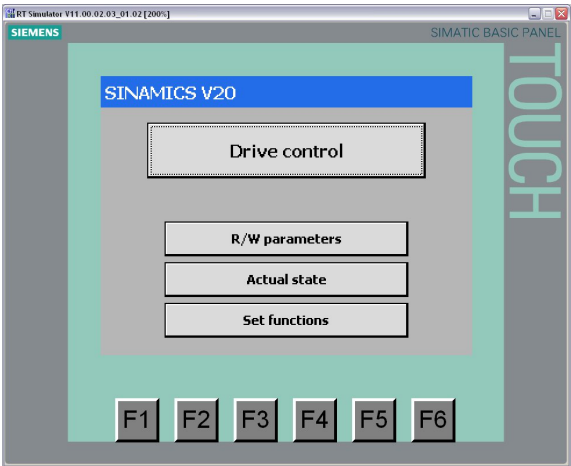
¹⁰ The application uses value 8 (38400 bps). If you want to modify it, you also have to modify the corresponding variable IN_P2010 in V20_USS_Control_1_DB.

¹¹ With more than one drive, they are to be numbered without gaps.

3 Commissioning

3.2 Instruction

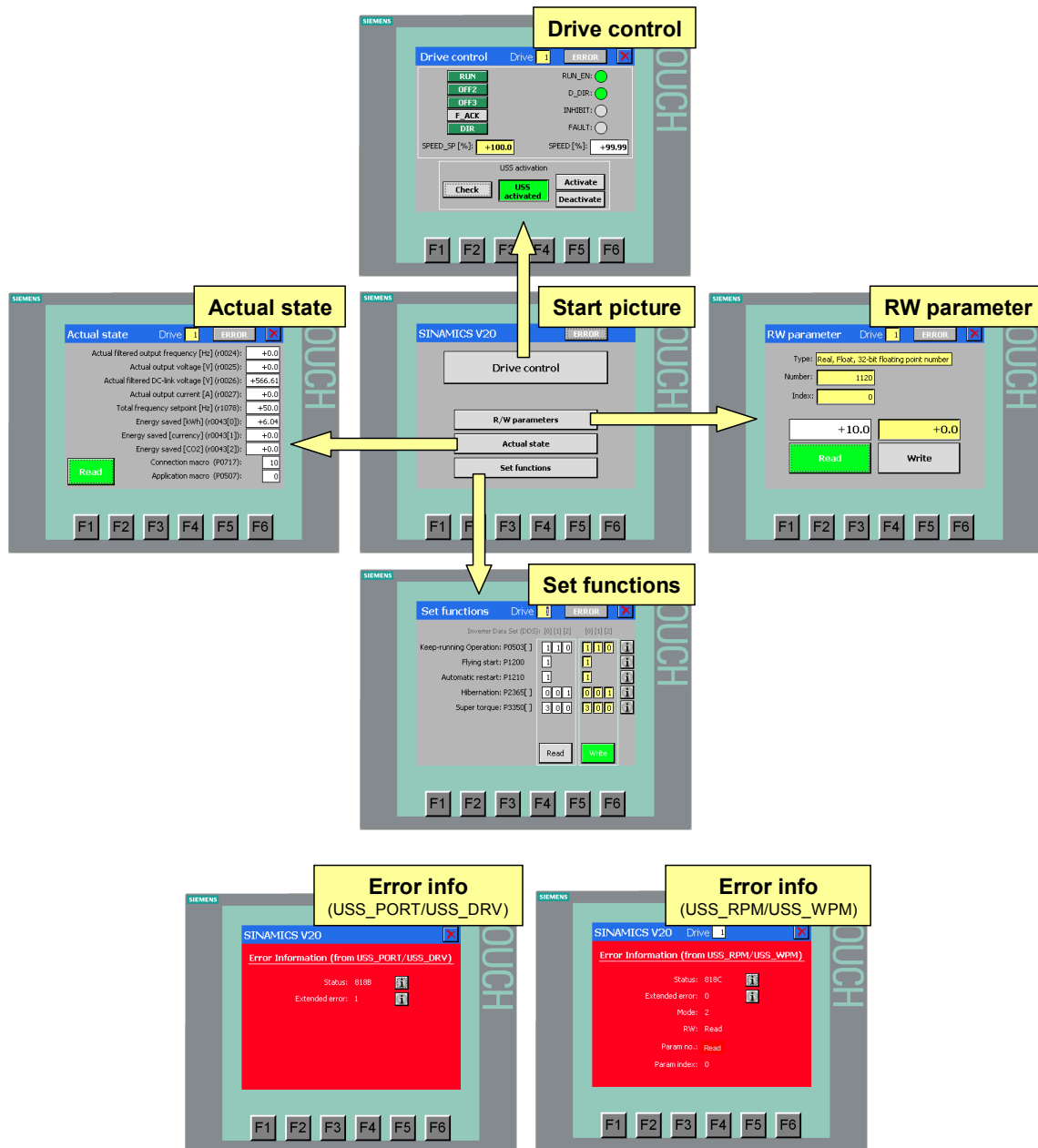
	Implementing the application example
	Loading the SIMATIC program
9.	Start the TIA Portal and open the V20_at_S7-1200_USS_proj_Vxy (Vxy = TIA version) project which you have downloaded and unzipped from the Siemens Industry Online Support pages.
10.	<p>Load the control project into the CPU.</p>  <p>If the window for further download appears, select ...</p> <ul style="list-style-type: none">• Type of the PG/PC interface: ⇒ PN/IE• PG/PC interface: ⇒ select interface card• Connection to subnet: ⇒ (local) PN/IE <p>Subsequently click "Load".</p> <p>Monitor the download with the "Load preview" window (continue with the "Load" window) and "Load results" (continue with the "Finish" button).</p>



Implementing the application example	
11.	<p>Start the simulation of the operator panel.</p>  <p>After completed compilation, the start window of the simulated operator panel will open on the screen.</p> 

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.

Select the desired drive by entering the drive address in the header of the appropriate function screen¹².

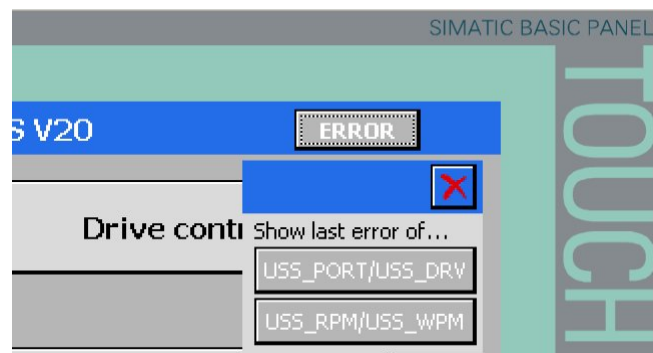
¹² If the application is configured in the V20_USS_Control_1_DB for IN_Number_of_drives = n drives (n=1..16), only the addresses 1 to n can be entered.



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

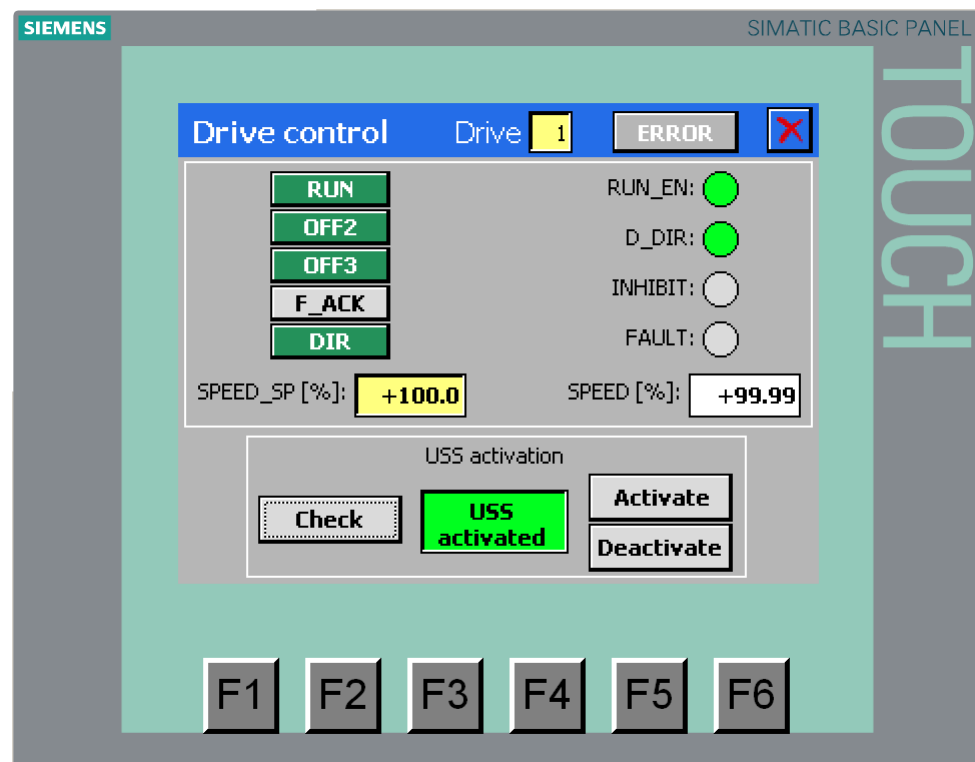
If there is no current error and the **ERROR** button does not flash red-white, you can get the error information of the last error back on the screen by clicking it from any screen:

Figure 4-2: calling last error information



4.2 "Drive control" screen

Figure 4-3: "Drive control" operator screen



Drive control

In the top part, the screen includes the following elements:

- **Buttons**
They correspond to the control bits listed in chap. 1.1. For the buttons RUN, OFF2, OFF3 and DIR, the logic status is inverted when clicking. F_ACK supplies "true", as long as the button is pressed. The green color of the button signifies the "true" signal state. If there is a restart of the controller, OFF2, OFF3 and DIR are set to "true" by default.
- **Entry field for speed**
It corresponds to the setpoint speed demanded in chap. 1.1 and is entered in %. Possible values are -100.0...+100.0.
- **Illuminated displays**
They correspond to the status bits listed in chap. 1.1. The green color of the respective display signifies the "true" signal state.
- **Output field for speed**
It corresponds to the actual speed value demanded in chap. 1.1 and is displayed in %.

USS enabling

Before the SINAMICS V20 can be controlled via the USS communication, the command and frequency setpoint source have to be changed to USS by changing the parameters (see chap. 5.4.1). In the bottom part of the screen, you can carry out the following three functions of the parameter operations of the ACTIVATE_USS mode at the touch of a button:

- **Check**
Query whether USS is enabled for the drive control.
- **Activate**
Enabling USS for the drive control.
- **Deactivate**
Disabling USS regarding the drive control. A re-parameterization to the command and frequency setpoint source that was previously set before changing to USS is carried out.

The execution of the according event is temporarily displayed in a display field with details regarding the event.

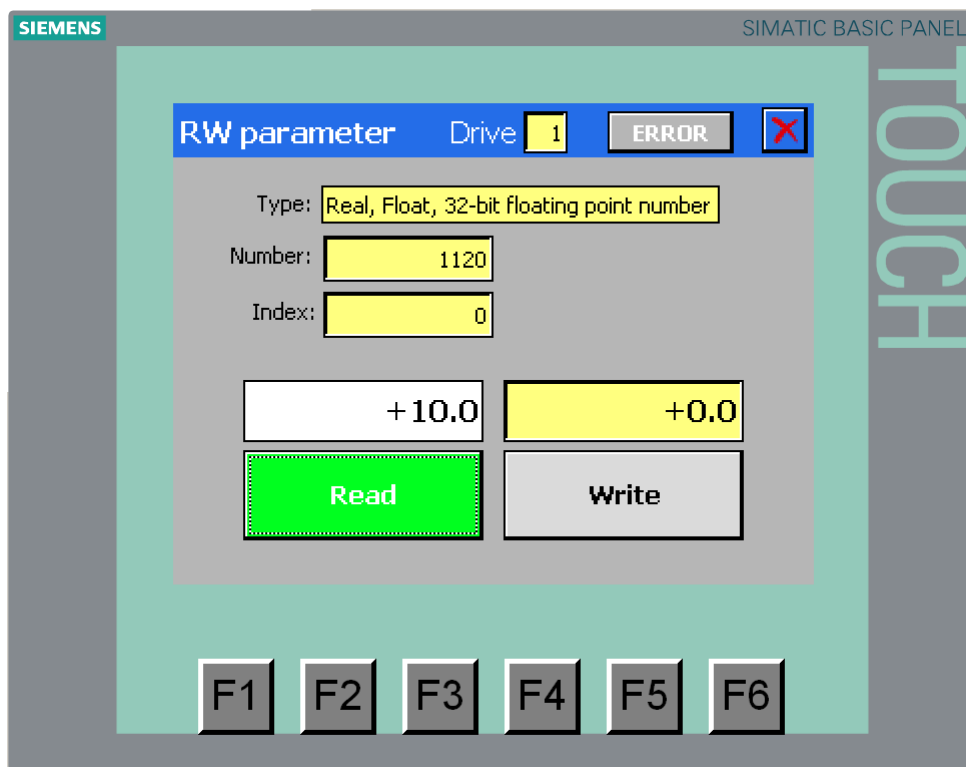


Note

If the SINAMICS V20 cannot be operated in the "Drive control" screen, get some information on the USS enabling status first by pressing the check button.

4.3 “RW parameter” screen

Figure 4-4: “RW parameter” operator screen



Reading parameters

In order to read any parameter, make the appropriate entries in the yellow input fields type, number and index. Afterwards, press the “Read” button. The parameter value read from the inverter is entered in the white output field above the read button. The execution of the event is displayed by a temporary green color of the read button.

Writing parameters

In order to write any parameter, make the appropriate entries in the yellow type, number and index input fields. Write the new parameter value in the yellow input field above the write button. Afterwards, press the “Write” button. This writes the new parameter in the RAM¹³ of the inverter, for control purposes it is read out straight away again¹⁴ and entered in the white output field of the read button. The execution of the event is displayed by a temporary green color of the write button.

NOTICE

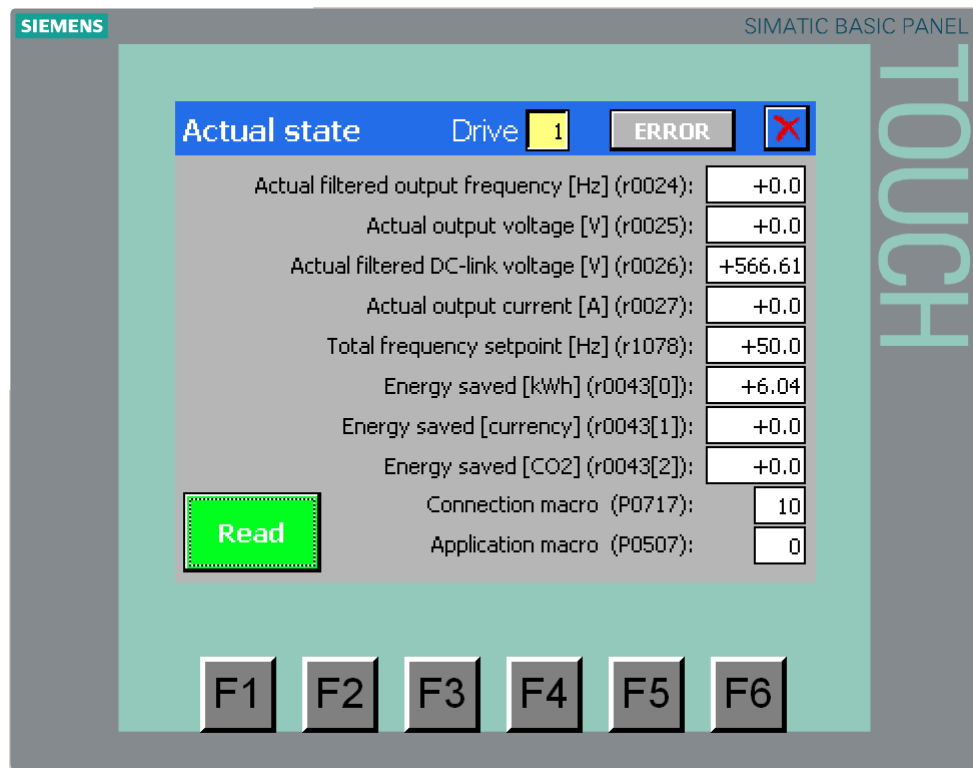
Entering an incorrect data format (type), does not necessarily cause an error message. An incorrect parameter value may be written or read.

¹³ In the application example the RW_PARAM.EEPROM FB parameter of V20_USS_Param_1 [FB2] is permanently assigned to “false”.

¹⁴ In the application example the RW_PARAM.FUNCTION FB parameter of V20_USS_Param_1 [FB2] is permanently assigned to “2”.

4.4 “Actual state” screen

Figure 4-5: “Actual state” operator screen



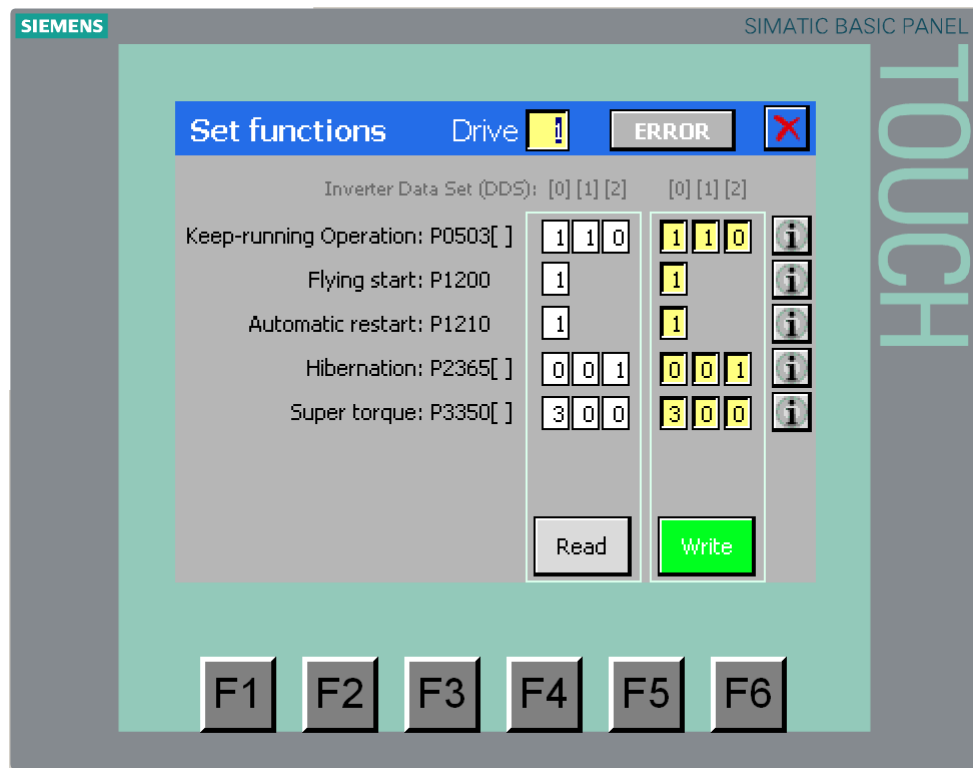
The parameters to be read correspond to the demands from chap. 1.2.

Reading a set of current status parameters

Press the “Read” button. The parameter set read from the inverter is entered in the white output fields. The execution of the event is displayed by a temporary green color of the read button.

4.5 “Set functions” screens

Figure 4-6: “Set functions” operator screen



The function parameters to be read/written correspond to the demands from chap. 1.2.

Reading out inverter functions

In order to read the function parameters, click the “Read” button. The parameter set read from the inverter is entered in the white output fields above the read button. The execution of the event is displayed by a temporary green color of the read button.

Writing inverter functions

To write a parameter set enter the respective values in the yellow input fields. Afterwards, press the “Write” button below the input fields. This writes the new function parameters in the RAM¹⁵ of the inverter, for control purposes they are read out straight away again¹⁶ and are entered in the white output fields above the read button. The execution of the event is displayed by a temporary green color of the write button.

¹⁵ In the application example the SET_FUNCTIONS.EEPROM FB parameter of V20_USS_Param_1 [FB2] is permanently assigned to “false”.

¹⁶ In the application example the SET_FUNCTIONS.FUNCTION FB parameter of V20_USS_Param_1 [FB2] is permanently assigned to “2”.

NOTICE

Always the entire parameter set is transferred. If you do not wish to change all parameters, you also have to re-assign those that are to keep their value. This is why you should perform a read process before writing, in order to get information on the previous parameter values.

Info buttons

Under the info buttons you can find explanations on the codes of the parameter values. As long as you hold the respective button down, the text is visible.

4.6 "Error information (from USS_PORT/USS_DRV)" screen

Figure 4-7: "Error information (from USS_PORT/USS_DRV)" operator screen



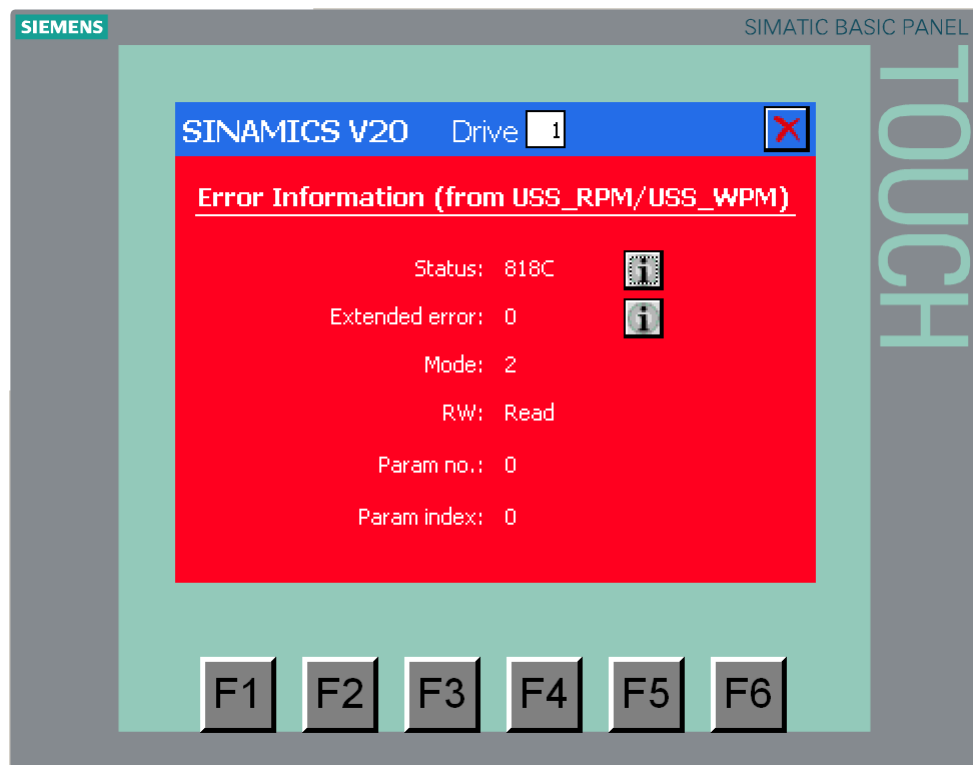
The error status and for some errors an expanded error information of the instruction creating the error is displayed which includes the address of the affected SINAMICS V20. The information always relates to the error that occurred last at the USS_PORT or USS_DRV. A new error overwrites the previous error information.

Info buttons

Under the info buttons you can find explanations on the error codes. As long as you hold the respective button down, the text is visible. The info button to the “Extended error” is only visible if respective error information is available.

4.7 “Error information (from USS_RPM/USS_WPM)” screen

Figure 4-8: “Error information (from USS_RPM/USS_WPM)” operator screen



The number of the SINAMICS V20 with the communication failure is written in the header of the error information screen (only output field). Apart from the error status and the expanded error information that is included for some errors, the mode, the data direction (RW, read or write) and the parameter address and index are displayed to be able to locate the error better. The screen always shows the error information of the error that occurred last in a parameter operation. A new error overwrites the previous error information.

Info buttons

Under the info buttons you can find explanations on the error codes. As long as you hold the respective button down, the text is visible. The info button to the “Extended error” is only visible if respective error information is available.

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 USS protocol.

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

5.1 Relevant code blocks

USS instructions

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

> Communication > Communication processor > USS

- **USS_PORT**
When inserting in the program, the instruction generates a FC1070 system function with the same name. USS_PORT processes the communication via the USS network.
- **USS_DRV**
When inserting it in the program, the instruction generates a FB1071 system block with the same name. USS_DRV exchanges data with the SINAMICS V20 by creating request messages and evaluating the reply messages of the V20.
- **USS_RPM**
When inserting it into the program, the instruction generates a FC1072 system function with the same name. USS_RPM reads a parameter from the SINAMICS V20.
- **USS_WPM**
When inserting it into the program, the instruction generates a FC1073 system function with the same name. USS_WPM changes a parameter in the SINAMICS V20.

Details on the instructions above can be found in the Online help in the TIA portal or chap. 12.4 of the S7-1200 system manual ([\[3\]](#)).

User function blocks

The USS communication is divided in a cyclic and an acyclic part.

Cyclic communication

Within the framework of the cyclic communication, data for drive control are 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 is realized in **V20_USS_Control_1 [FB1]**.

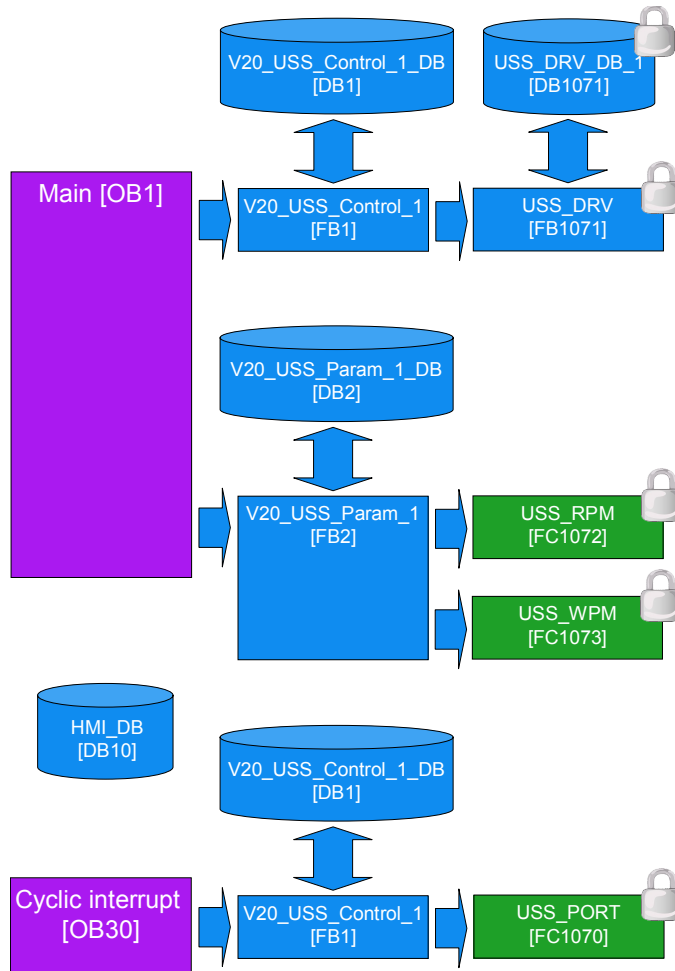
Acyclic communication

Within the framework of the acyclic communication, one or several inverter parameters of a selected SINAMICS V20 are read and/or written upon request once (not cyclically). The user selects one of four available modes, according to the specifications in chapter 1.2. The acyclic communication is realized in **V20_USS_Param_1 [FB2]**. Due to the USS system blocks, it is necessary to also

call the V20_USS_Control_1 [FB1] in the program when using V20_USS_Param_1 [FB2].

5.2 Program structure

Figure 5-1: Program structure



Calling the V20_USS_Control_1 [FB1] in two OBs

As you can see in Figure 5-1, the V20_USS_Control_1 [FB1] is called in the cyclic program part (OB1) as well as in an interrupt OB (OB30). The reason for this is the fact that the part of the FB1 that processes the communication via the USS network and calls the USS_PORT [FC1070] system function is to run in OB30 and the part that calls the USS_DRV system function block and exchanges data with the SINAMICS V20 is to be processed in OB1. The decision which program part of the FB1 is to be processed in which OB is specified by an input parameter of the FB1 (see chap. 5.3.1).

There is a minimum call interval for the USS_PORT [FC1070] that ensures that the respective port is available for every USS_PORT call. For this minimum call interval, guidelines are defined that depend on the selected baud rate. The FB1 retrieves the suitable value for the minimum call interval from a table in V20_USS_Control_1_DB and sets the OB30 interval in the first cycle after restarting

the PLC. Although a call of the USS_PORT [FC1070] in OB1 would not be harmful, it would burden its cycle unnecessarily.

More information on the USS_PORT call interval can be found in chap. 12.4.1 of the S7-1200 system manual ([3](#)) and in the application example “SINAMICS V: Speed Control of a V20 with S7-1500 and ET 200SP via USS® Protocol, with HMI Connection” ([7](#)).

Conclusion:

Due to the above call structure and the USS_PORT minimum call interval table in V20_USS_Control_1_DB, the user does not have to worry about USS_PORT calls. The user only calls the V20_USS_Control_1 [FB1] in the two OBs.

When calling the V20_USS_Control_1 [FB1] in two places, its formal parameter bar also has to be provided with the same parameter values twice. To minimize the effort for the user and to avoid configuration errors, the FB1 only has one externally accessible formal parameter, namely the specification, whether it is called in OB1 or in OB30. The remaining configuration is performed once directly in the appropriate instance DB V20_USS_Control_1_DB1. The parameters to be provided or removed by the user are stored as static data. They are identified by name and in the comment as user parameter.

Framework program (Main [OB1] and HMI_DB [DB10])

Main [OB1]

The OB has the following tasks:

- Calling the V20_USS_Control_1 [FB1] (NW1)
- Providing the parameters of V20_USS_Param_1 [FB2] with the baud rate and the number of drives (NW2).
- Calling the V20_USS_Param_1 [FB2] (NW3)
- Preparing the feedback signals (done messages) of the V20_USS_Param_1 [FB2], to display them on the operator panel (NW4)
- HMI screen switching to error masks for communication errors (whilst using control jobs) (NW5)

HMI_DB [DB10]

The block includes the following data:

- All actual parameters (INPUT and OUTPUT) of V20_USS_Param_1 [FB2] that are pending at its formal parameter bar. DB10 is therefore used as interface for the operator panel of FB2.¹⁷
- Data that is required to display the feedback signals (done messages) of V20_USS_Param_1 [FB2] on the operator panel and that was generated in OB1.
- Control bits to coordinate the screen switch in the event of communication errors.
- Mailbox for control jobs for HMI screen switch in the event of communication errors.

¹⁷ Via the HMI, block parameters in the V20_USS_Param_1 [DB2] instance DB can be accessed directly – without detours via the DB10. In this case, the FB2 formal parameters would be unprovided if it is called in Main [OB1]. In view of a transparent display of the program code, especially since it is an application example, it was worked with DB10.

5.3 V20_USS_Control_1 [FB1] function block

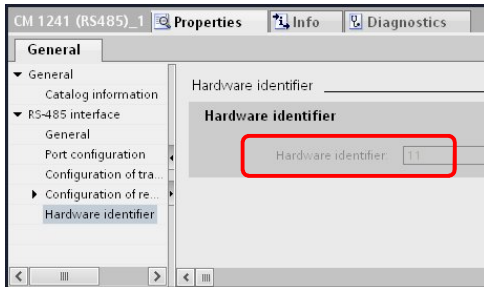
5.3.1 Configuration

Figure 5-2: Calling V20_USS_Control_1 [FB1]



The block has the variable OB as the only parameter of the “Input” data segment. It now appears on the left formal parameter bar of the FB. The further configuration is not performed by supplying the formal parameters when calling the block but in the static data of the appropriate instance DB. Each parameter that has to be provided or removed by the user has the IN_... or OUT_... prefix in the variable name or in one of its structural components. In addition, the line comment of an IN parameter starts with “?” and the line comment of an OUT parameter with “!”. Variables with higher address offset than those in the table below, meaning data that is further down in the DB, must not be changed by the user.

Table 5-1: Parameter of V20_USS_Control_1 [FB1]

Name	IN / OUT	Type	Explanation
OB <i>Only parameter of the “Input” data segment!</i>	IN	USInt	Call ID = 1, if the FB is called by Main [OB1]; ≠ 1, if the FB is called by the interrupt OB;
IN_P2010	IN	USInt	Baud rate The coding is identical with that of the V20 parameter P2010 (values: 6...12). See 18 .
IN_HW_Id	IN	PORT	Hardware ID of the communication module (board) You can find the value in the device configuration in the properties of the communication module. 
IN_CYCLIC_INTERRUPT. NUMBER	IN	Struct OB_CYCLIC	Interrupt OB Number of the interrupt OB, in which the FB V20_USS_Control_1 also has to be called.

Name	IN / OUT	Type	Explanation
PHASE	IN	UDInt	Phase shift of the interrupt interval. The value may be relevant if more than one port is configured. See Table 6-2, point 8. The default value is 0 and can be left as only one configured port.
IN_Number_of_drives	IN	USInt	Number of drives Number of drives that are connected to the respective port (1...16).
Drive. IN_STW[n]	IN	Struct Word	Control/status data of the SINAMICS V20 Drive control word [n] The V20_USS_Control_1 [FB1] sends the following STW bits to the inverter: ON_OFF Bit 00 OFF2 Bit 01 OFF3 Bit 02 Ack_fault Bit 07 Direction_reversal Bit 11 The remaining STW bits cannot be influenced by the FB1.
IN_SPEED_SP[n]	IN	Real	Setpoint speed value [%]
OUT_ZSW[n]	OUT	Word	Drive status word [n] The V20_USS_Control_1 [FB1] receives the following ZSW bits from the inverter: Operation_enabled Bit 02 Motor_rotates_fwd Bit 14 Closing_lockout_active Bit 06 Fault_present Bit 03 The remaining ZSW bits cannot be influenced by FB1.
OUT_SPEED[n]	OUT	Real	Actual speed value [%]
OUT_ERROR	OUT	Bool	Error The bit is set for a processing cycle of the FB if an error was detected by the system blocks USS_PORT or USS_DRV.
OUT_ERROR_INFO. DRIVE_ADDR	OUT	Struct USInt	Error information Drive address ¹⁸ Address of the SINAMICS V20, where an error was signaled through OUT_ERROR.
STATUS	OUT	Word	Processing status ¹⁸ Error code of USS_PORT or USS_DRV, if OUT_ERROR signals an error. The error codes can be found in the online help for the instructions USS_PORT and USS_DRV in the TIA portal or in chapter 12.4.6 of the S7-1200 system manual (3).
EXTENDED_ERROR_available	OUT	Bool	Extended error information available From the instance DB of the system USS_DRV FB extended error information can be called if OUT_ERROR signals an error.

¹⁸ Only the error information of the error that occurred last in the instance DB is saved. A new error – signaled by the OUT_ERROR bit – overwrites the previous error information.

Name	IN / OUT	Type	Explanation
EXTENDED_ERROR	OUT	UInt	Extended error information The address of the SINAMICS V20 where the communication error occurred can be found in the expanded error information.

5.4 V20_USS_Param_1 [FB2] function block

5.4.1 Operating modes

The parameter accesses carried out with FB2 are summarized in the four operating modes ACTIVATE_USS, RW_PARAM, ACTUAL_STATE and SET_FUNCTIONS in section 1.2. The desired operating mode is specified by the FB2 input parameter MODE (see Table 5-4) that you specify in the application example by selecting the HMI screen (Figure 4-1).

Table 5-2: Operating mode ⇔ HMI screen

Operating mode	HMI screen name
ACTIVATE_USS	Drive control
RW_PARAM	RW Parameter
ACTUAL_STATE	Actual state
SET_FUNCTIONS	Set functions

ACTIVATE_USS

In this mode you enable the USS communication channel in order to control a SINAMICS V20 via the USS communication. In the process the following parameters are changed:

Table 5-3: Inverter parameter for USS communication

Function	No.	Value	Dim.
Selecting the command source	P0700	⇒ 5	-
Selecting the frequency setpoint source	P1000	⇒ 5	-
USS telegram off time	P2014	⇒ Calculated value	ms

There are reference values for the telegram off time which depend on baud rate and the number of drives per port. There is a value table in the respective instance DB from which the relevant telegram off time can be calculated. More detail on the determination of the telegram off time can be found in the application example "SINAMICS V: Speed Control of a V20 with S7-1500 and ET 200SP via USS® Protocol, with HMI Connection" ([V7](#)).

You can select between the following functions that can be selected with the ACTIVATE_USS.FUNCTION parameter:

- **Check**

It is checked whether the USS communication has already been selected, meaning whether the three parameter values from the above table are already enabled in the inverter. For this purpose, the current parameters are read out from the inverter. If one of the parameters P0700 and P1000 does not have the value 5, the current inverter parameters P0700, P1000 and P2014 are saved in

5.4 V20_USS_Param_1 [FB2] function block

the instance DB and the FB sets the USS_selected bool parameter to false. If P0700 and P1000 both have the value 5, the FB USS_selected is set to true. If the current value of P2014 differs from the calculated value in this case, then the calculated value is written in the inverter. At the end the FB delivers a DONE pulse as done message.

- **Activate**
When enabling, it is checked first whether the USS communication has already been selected, meaning whether the three parameter values from the above table are already enabled in the inverter. For this purpose, the current parameters are read out from the inverter. The current inverter parameters P0700, P1000 and P2014 are saved in the instance DB if one of the parameters P0700 and P1000 does not have the value 5. Subsequently, all three parameters are written into the inverter according to Table 5-3. The FB sets the "USS_selected" bool parameter to true and delivers a DONE pulse as done message.
- **Deactivate**
When disabling, it is checked first whether the USS communication has already been selected, meaning whether the three parameter values from the above table are already enabled in the inverter. For this purpose, the current parameters are read out from the inverter. The current inverter parameters P0700, P1000 and P2014 are saved in the instance DB if one of the parameters P0700 and P1000 does not have the value 5. Subsequently the parameters P0700, P1000 and P2014, saved in the instance DB, are written into the inverter in order to re-establish the status before enabling the USS communication¹⁹. The FB delivers a DONE pulse as done message.

RW_PARAM

With this, you can read or write any SINAMICS V20 parameter. Access to parameter numbers >2047 through the usual entry of parameter numbers and index is also possible.

You can select between the following functions that can be selected with the RW_PARAM.FUNCTION FB parameter:

- **Read**
The value of the inverter parameter is read into a variable that corresponds to the RW_PARAM_VALUE_OUT (OUT parameter) structure in V20_USS_Param_1_DB. Enter the data type of the inverter parameter in the RW_PARAM.FORMAT FB input parameter.
- **Write**
The value of the inverter parameter is retrieved from a variable that corresponds to the RW_PARAM_VALUE_IN (INparameter) structure in V20_USS_Param_1_DB. Enter the data type of the inverter parameter in the RW_PARAM.FORMAT FB input parameter. A further FB input parameter specifies whether you want to write to the RAM or EEPROM of the inverter.
- **Write&read**
Combination of the above two functions. The inverter parameter is written into the SINAMICS V20 and subsequently read out straight away for control purposes.

¹⁹ If the controller cannot get the previous connection status from the inverter, in the event of an enabling or disabling action – e.g. after a restart – because it has already been configured for USS communication (P0700 = P1000 = 5), the next disabling is carried out with the default values P0700=1, P1000=1 and P2014=2000.

ACTUAL_STATE

With this, you read out a set of current inverter values from the SINAMICS V20 that are represented by parameters. The inverter values involved are specified in chapter 1.2. All data read out from the V20 is united in the ACTUAL_STATE_VALUES_OUT (Struct) FB output parameter.

SET_FUNCTIONS

With this, you can select or switch the inverter functions, stored in the inverter parameters, on and off via the USS communication. The inverter functions involved are explained in chapter 1.2.

You can select between the following functions that can be selected with the SET_FUNCTIONS.FUNCTION FB parameter:

- **Read**
A defined set of inverter functions is read out from the inverter in the SET_FUNCTIONS_VALUES_OUT FB output parameter in V20_USS_Param_1_DB.
- **Write**
A defined set of inverter functions is written from the SET_FUNCTIONS_VALUES_IN FB input parameter in V20_USS_Param_1_DB to the inverter. A further FB input parameter specifies whether you want to write to the RAM or EEPROM of the inverter.
- **Write&read**
Combination of the above two functions. The set of inverters parameter is written into the SINAMICS V20 and subsequently read out again straight away for control purposes.

5.4.2 Configuration

The configuration is either performed by supplying the formal parameters for the FB call or by directly accessing the parameters in the "Input" or "Output" data segments of the appropriate instance DB. The line comment of one of the IN parameters to be written by the user starts with "?" that of a OUT parameter to be read with "!". Variables with higher address offset than those in the table below, meaning variables in the data segment of the statistic data that are further down in the DB, must not be changed by the user.

5.4 V20_USS_Param_1 [FB2] function block

Figure 5-3: Calling V20_USS_Param_1 [FB2]

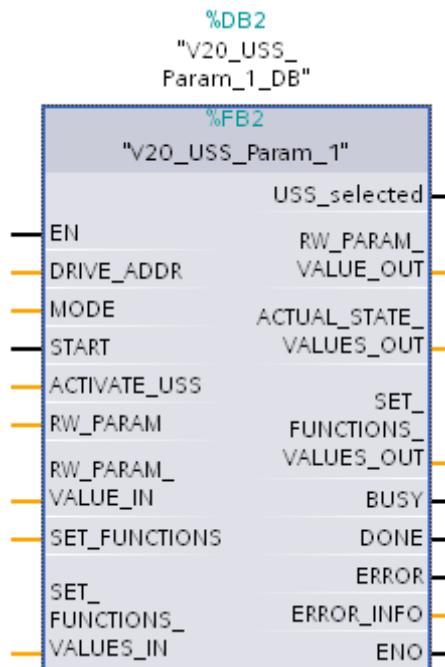


Table 5-4: Parameter of V20_USS_Param_1 [FB2]

Name	IN / OUT	Type	Explanation
DRIVE_ADDR	IN	USInt	Address of the SINAMICS V20 Possible values: 1...16
MODE	IN	USInt	Mode of the block 1 = ACTIVATE_USS 2 = RW_PARAM 3 = ACTUAL_STATE 4 = SET_FUNCTION Detailed contents of the various modes, see chapter 1.2.
START	IN	Bool	Function start The selected function is executed by START with a positive edge.

Name	IN / OUT	Type	Explanation
ACTIVATE_USS. NUMBER_OF_DRIVES	IN	Struct USInt	Enabling USS Number of drives that are connected to the respective port (1...16). The parameter is required for calculating the USS telegram off time. Specify a constant or use the IN_Number_of_drives variable from V20_USS_Control_1_DB.
P2010	IN	USInt	Baud rate The coding is identical with that of the V20 parameter P2010 (values: 6...12). See \8\ . The parameter is required for calculating the USS telegram off time. Specify a constant or use the IN_P2010 variable from V20_USS_Control_1_DB.
FUNCTION	IN	USInt	Function within the mode 0 = Deactivate 1 = Activate 2 = Check Details can be found in the description of the Mode in this chapter.
RW_PARAM. FORMAT	IN	Struct USInt	Reading/writing parameters Data type 3 = Int, I16, 16-bit integer 4 = DInt, I32, 32-bit integer 6 = UInt, U16, 16-bit unsigned 7 = UDInt, U32, 32-bit unsigned 8 = Real, Float, 32-bit floating point number Specifying a data type is required because PLC does not know what data format the inverter parameter to be read or written has.
PARAM	IN	UInt	Parameter number The number can be found in the SINAMICS V20 operating instruction \8\ .
INDEX	IN	UInt	Parameter index The index can be found in the SINAMICS V20 operating instruction \8\ .
EEPROM	IN	Bool	Writing to EEPROM false = The written value is only temporarily saved and gets lost the next time the SINAMICS V20 is switched on. true = The value written in the drive parameter is saved in the EEPROM of the SINAMICS V20.
FUNCTION	IN	USInt	Function within the mode 0 = read parameter 1 = write parameter 2 = read & write parameter Details can be found in the description of the Mode in this chapter.

Name	IN / OUT	Type	Explanation
RW_PARAM_VALUE_IN. Int DInt USInt UInt UDInt Real	IN	Struct Int DInt USInt UInt UDInt Real	Parameter value to be written The inverter parameter value to be written is to be stored in the FB formal parameter whose data format corresponds to the specification in the RW_PARAM.FORMAT FB input parameter.
SET_FUNCTIONS. EEPROM	IN	Struct Bool	Inverter functions Writing parameter set to EEPROM false = The written inverter parameter value is only temporarily saved and gets lost the next time the SINAMICS V20 is switched on. true = The drive parameter written in the drive parameter is saved in the EEPROM of the SINAMICS V20.
FUNCTION	IN	USInt	Function within the mode 0 = read parameter set 1 = write parameter set 2 = read & write parameter set Details can be found in the description of the Mode in this chapter.
SET_FUNCTIONS_VALUES_IN. Keep_running_Op[n] Flying_start Automatic_restart Hibernation[n] Super_torque[n]	IN	Struct UInt UInt UInt UInt UInt	Function values (IN) Keep-running Operation P0503[n] Flying start P1200 Automatic restart P1210 Hibernation P2365[n] Super torque P3350[n] n=0..2 indicates the drive data set Information on the meaning and on the value range of the functions can be found in the SINAMICS V20 operating instruction 18 .
USS_selected	OUT	Bool	Enabling USS – event bit false = USS communication not enabled true = USS communication enabled The bit is only valid in the cycle in which the DONE message is pending in a function started with MODE=1.
RW_PARAM_VALUE_OUT. Int DInt USInt UInt UDInt Real	OUT	Struct Int DInt USInt UInt UDInt Real	Read parameter value The read inverter parameter value is stored in the FB formal parameter whose data format corresponds to the specification in the RW_PARAM.FORMAT FB input parameter.

5 Programming

5.4 V20_USS_Param_1 [FB2] function block

Name	IN / OUT	Type	Explanation
ACTUAL_STATE_VALUES_OUT. FREQ_OUTPUT OUTPUT_VOLTS CURRENT DC_BUS_VOLTS TOTAL_FREQ_SP ENERGY_SAVED[n] CONNECTION_MACRO APPLICATION_MACRO	OUT	Struct Real Real Real Real Real Real UInt UInt	Actual values Act. filtered output frequency r0024 [Hz] Act. output voltage r0025 [V] Act. output current r0027 [A] Act. smoothed link voltage r0026 [V] Act. total setpoint r1078 [Hz] Act. energy saving r0043[0..2] [kWh,€,CO2] connection Macro last selected p0717 user Macro last selected p0507 Further information on the meaning and on the value range of the parameters can be found in the SINAMICS V20 operating instruction \8\ .
SET_FUNCTIONS_VALUES_OUT. Keep_running_Op Flying_start Automatic_restart Hibernation[n] Super_torque[n]	OUT	Struct UInt UInt UInt UInt UInt	Function values (OUT) Keep-running Operation P0503[n] Flying start P1200 Automatic restart P1210 Hibernation P2365[n] Super torque P3350[n] n=0..2 indicates the drive data set Information on the meaning and on the value range of the functions can be found in the SINAMICS V20 operating instruction \8\ .
BUSY	OUT	Bool	Block in process Processing the block requires several cycles. false = not in process true = in process As long as BUSY is pending, the pending parameters in the parameter bar to be transferred or the transferred parameters must not be changed.
DONE	OUT	Bool	Done message If the processing of the block was completed without errors after its start (with START=true), a done message in the form of a DONE pulse is generated which last one cycle. Afterwards, the parameter read by the inverter may be removed and the function can be restarted with a restart of the START edge.
ERROR	OUT	Bool	Error message If the processing of the block was completed with errors after its start (with START=true), an error message in the form of an ERROR pulse is generated which last one cycle. Afterwards the error information stored in the ERROR_INFO output parameter can be read out and a respective error response can be initiated. With the error pulse, the block is ready again for a new start command.

Name	IN / OUT	Type	Explanation
ERROR_INFO. DRIVE_ADDR	OUT	Struct USInt	Error information Address of the SINAMICS V20 where the error occurred.
STATUS	OUT	Word	Error information of the instructions USS_RPM and USS_WPM. Details on this, can be found in the Online help in the TIA portal or chap. 12.4.6 of the S7-1200 system manual (13).
EXTENDED_ERROR_available	OUT	Bool	For .STATUS=818C _{hex} the instructions USS_RPM and USS_WPM store an expanded error information in the USS_DRV_DB_1 system DB which in these cases, is provided to the user as EXTENDED_ERROR output parameter of the V20_USS_Param_1 FB FB. false = no .EXTENDED_ERROR available true = .EXTENDED_ERROR available The .EXTENDED_ERROR may only be evaluated by the user if .EXTENDED_ERROR_available is true.
EXTENDED_ERROR	OUT	UInt	For .EXTENDED_ERROR_available =true available additional error information. The error code can be found in chap. 6.1 of the SINAMICS V20 operating instruction 18 (table: Error numbers in response ID 7 (request cannot be processed)).
MODE		USInt	Mode of the block at which the error occurred.
RW		Bool	false = read error true = write error
PARAM		UInt	Number of the parameter at which the error occurred.
INDEX		UInt	Index of the parameter at which the error occurred.

5.4.3 Start of a function

Table 5-5: Start of a function

	Instruction
1.	Setting the MODE FB parameter to desired value.
2.	Setting the FUNCTION FB parameter to the desired value in that structure that corresponds to the selected MODE.
3.	Depending on the MODE, if required, provide other FB input parameters that specify the function.
4.	Depending on MODE, if required, provide source data (parameter values) on the appropriate FB parameter.
5.	Create positive edge on the START FB parameter. (This can take place in the same cycle as the previous points.)
6.	For done message by DONE FB parameter: <ul style="list-style-type: none"> Depending on MODE, if required, remove target data (parameter values) on the respective FB parameter. Ready for other parameter operation

6 Expansion to Several Drives

6.1 Expansion to up to 16 drives

The application example operates one SINAMICS V20. However, via a port up to 16 drives can be operated. This has already been taken into consideration in the application example and especially in the FBs V20_USS_Control_1 [FB1] and V20_USS_Param [FB2]. To increase the number of drives, proceed as follows:

Table 6-1: Expansion to up to 16 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 1 to 8 of Table 3-2. From "2" onward the drive addresses have to be assigned continuously.
3.	Enter the new number of drives as start value in the IN_Number_of_drives variable in the static data of the V20_USS_Control_1_DB [DB1], load the DB into the CPU and restart it.

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

6.2 Expansion to up to 64 drives

You can provide the CPU with a maximum of three communication modules and one communication board (see Figure 2-3). On each module/board, up to 16 drives are possible. Below, you find out how to expand the application by one port.

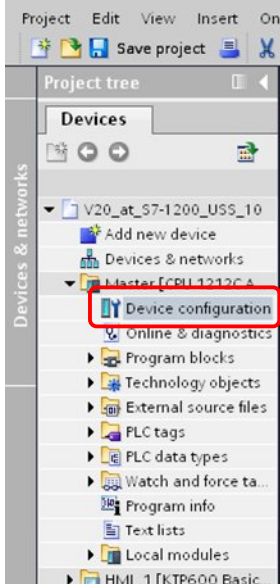
Table 6-2: Port expansion

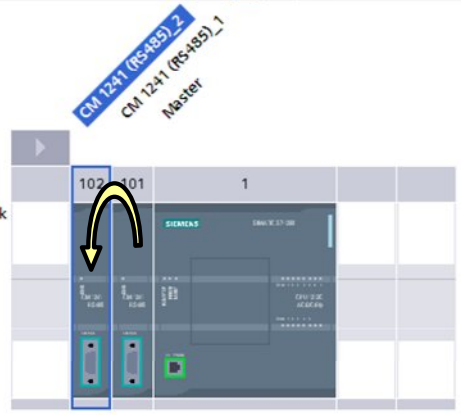
	Instruction
Installing and wiring new hardware	
1.	Supplement your configuration according to Figure 2-1, by those drives that are to communicate with the controller via the new, additional port.
2.	Add a new CM1241 (RS485) communication module to SIMATIC S7-1200 and insert a CB1241 (RS485) communication board in the CPU.
3.	Establish the USS 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 1 to 8 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.

6 Expansion to Several Drives

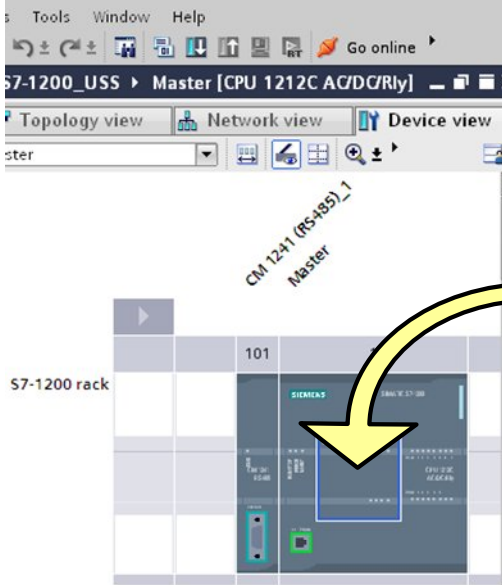
6.2 Expansion to up to 64 drives

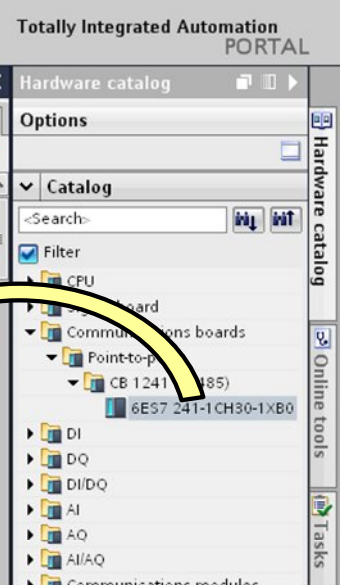
Instruction





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.

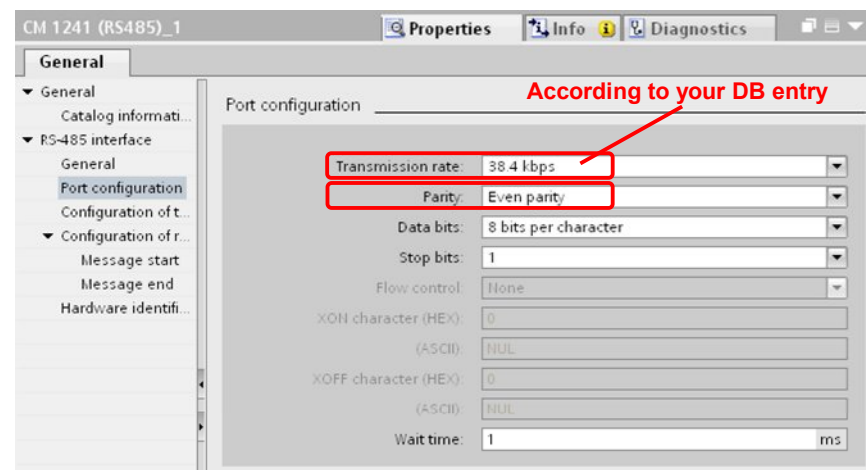
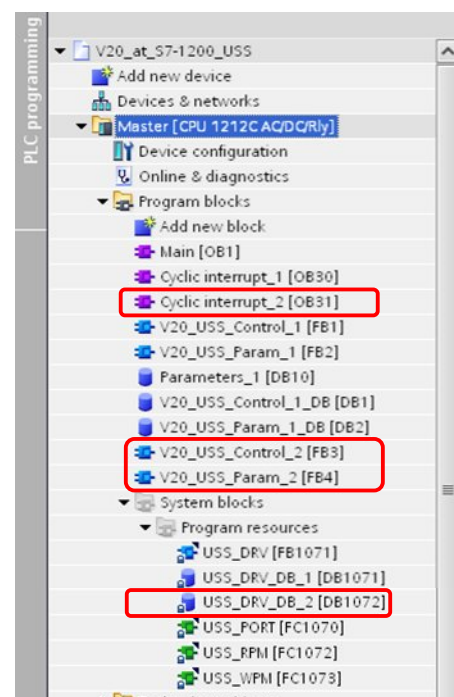




Configure the module/board inserted from the catalog. Change the transmission speed and parity according to the following screen. All other default values can remain as they are.

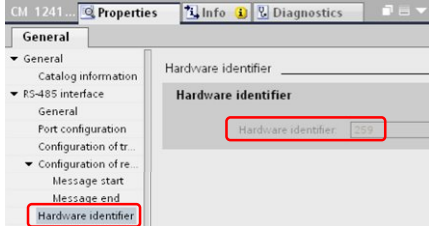
6 Expansion to Several Drives

6.2 Expansion to up to 64 drives

Instruction	
	
Program expansion in TIA Portal	
6.	<p>Copy the following code blocks (with Ctrl+C and Ctrl+V) in the project navigation...</p> <ul style="list-style-type: none">• Cyclic_interrupt_1 [OB30],• V20_USS_Control_1 [FB1],• V20_USS_Control_1 [FB2], <p>and the data block (under system blocks > program resources)...</p> <ul style="list-style-type: none">• USS_DRV_DB_1 [DB1071]. <p>The copies are automatically created with Index _2. Subsequently, go to the properties of each copied block via right click and change its block number, e.g. as follows:</p> <ul style="list-style-type: none">• Cyclic_interrupt_2 [OB31],• V20_USS_Control_2 [FB3],• V20_USS_Param_2 [FB4],• USS_DRV_DB_2 [DB1072] 

6 Expansion to Several Drives

6.2 Expansion to up to 64 drives

	Instruction
7.	<p>Replace all accesses to the USS_DRV_DB_1 [DB1071] system DB by accesses to USS_DRV_DB_2 [DB1072] in the blocks V20_USS_Control_2 [FB3] and V20_USS_Param_2 [FB4]. Proceed as follows:</p> <ol style="list-style-type: none"> 8. Open the code block by double clicking in the project navigation. 9. Open the "Tasks" task card. 10. Replace all system DB accesses with the "Find and replace" function.
8.	<p>Configure the V20_USS_Control_2 [FB3] in its interface. Adjust the following parameters:</p> <ul style="list-style-type: none"> • IN_P2010 ⇒ Baud rate according to your requirements • IN_HW_Id ⇒ Value from the device configuration of the CM1241/CB1241  <ul style="list-style-type: none"> • IN_CYCLIC_INTERRUPT.NUMBER ⇒ 31 (Number of the new interrupt OB) • IN_CYCLIC_INTERRUPT.PHASE ⇒ As long the two ports communicate with the same baud rate, a phase that corresponds to half an interrupt interval should be set, in order to equalize the polling of the ports in terms of time. The interrupt interval is indicated as millisecond value in the USS_PORT_param[IN_P2010].interval variable in V20_USS_Control_2 [FB3]. This means that for 38400 baud 22500 would have to be entered for .PHASE.
9.	<p>Now expand your user program regarding the new port and integrate the USS FBs V20_USS_Control_2 [FB3] and V20_USS_Param_2 [FB4] into it. When calling the new USS FBs their corresponding DBs V20_USS_Control_2_DB [DB3] and V20_USS_Param_2_DB [DB4] are created automatically.</p>
10.	<p>Replace the old FB call in NW1 of the new cyclic interrupt_2 [OB31] by calling V20_USS_Control_2 [FB3] with the instance DB V20_USS_Control_2_DB [DB3].</p>
11.	<p>Compile the entire STEP7 program.</p>
12.	<p>Expand the HMI by the new port.</p>

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 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\	USS®	Universal serial interface protocol USS® protocol http://support.automation.siemens.com/WW/view/en/24178253
\7\		Application example SINAMICS V: Speed Control of a V20 with S7-1500 and ET 200SP via USS® Protocol, with HMI Connection http://support.automation.siemens.com/WW/view/en/90468030
\8\	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