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

SINAMICS V20, SIMATIC S7-1200

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

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1   Overview

1.1   Content

The present short documentation describes two blocks that you can use for the connection of a SINAMICS V20 to a SIMATIC S7-1200 via the USS[®] protocol in STEP 7 in the TIA portal.

This short documentation largely does not use explanations. It explains the block parameters and shows the main steps for the integration of the blocks in your own projects.

Table 1-1: Block functions

Block	Function	Explanation
V20_USS_Control_1 (FB1)	cyclic access to process data of up to 16 drives of a port	Controlling SINAMICS V20 via selected STW bits
		Specifying setpoint speed
		Condition monitoring of the SINAMICS V20 via selected ZSW bits
		Reading of the actual speed value
V20_USS_Param_1 (FB2)	acyclic access to parameters of up to 16 drives of a port	**ACTIVATE_USS** mode: Switching the operation of the cyclic process data access (BOP ⇔ USS)
		RW_PARAM mode: Reading/writing of any inverter parameter
		ACTUAL_STATE mode: Reading a set of selected status information from the inverter.
		SET_FUNCTIONS mode: **S**pecifying a set of selected modes.

1.2 Requirements

Hardware components

Table 1-2: Hardware components

Component		MLFB	Firmware
SIMATIC S7-1200		6ES721…	V2.2.0 and higher
CM 1241 (RS422/485)	optional	6ES7241-1CH32-0XB0	V2.0 and higher
CM 1241 (RS485)		6ES7241-1CH30-0XB0	V1.0 and higher
CB 1241 (RS485)		6ES7241-1CH30-1XB0	V1.0 and higher
SINAMICS V20		6SL3210-5B…	V3.5 and higher

Control software

STEP 7 BASIC

Libraries are available for TIA Portal V11, V12 and V13. The blocks have been tested in the following combination:

Table 1-3: test combination

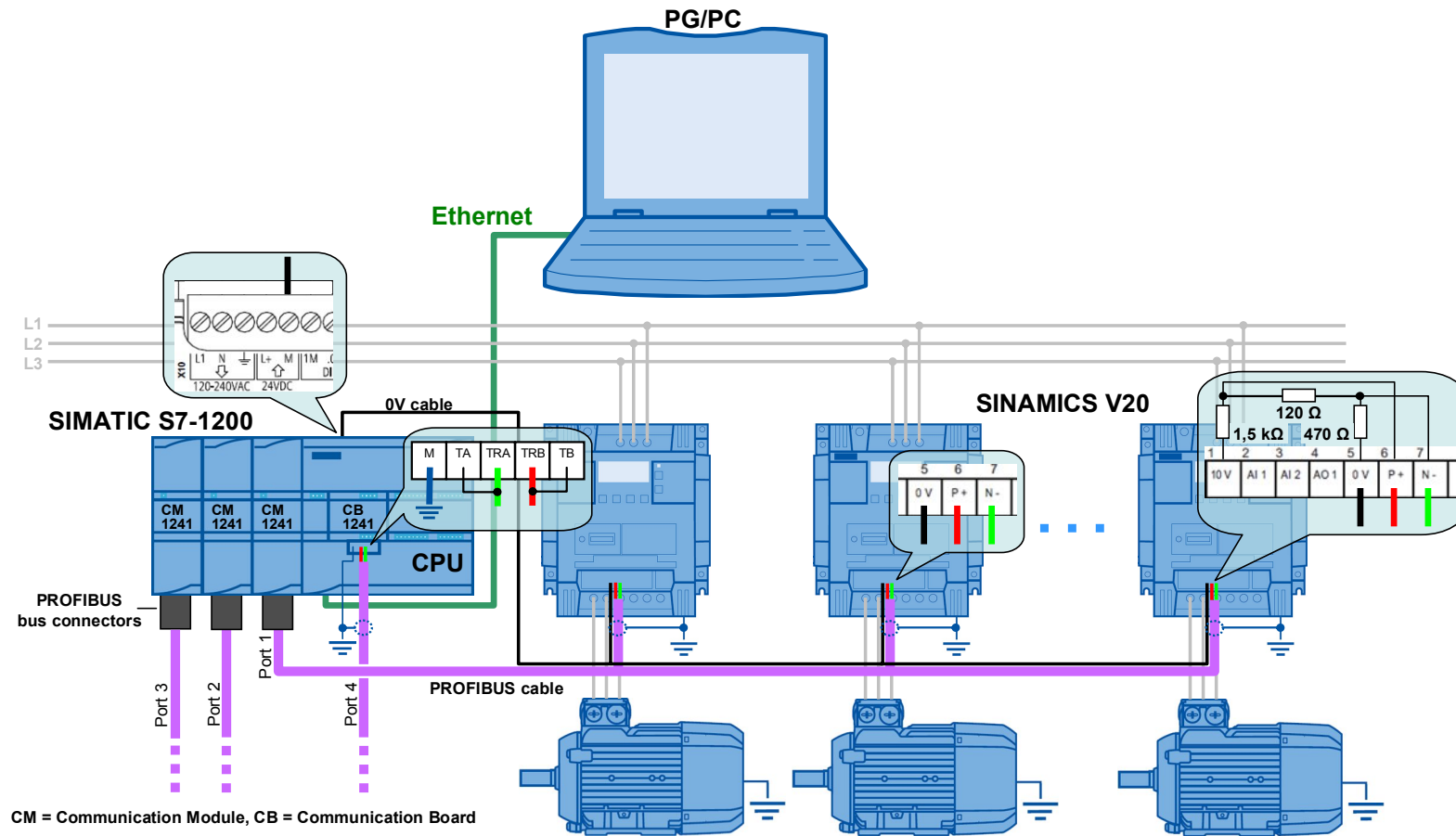| TIA Portal	USS library version	CPU firmware version
V13	V1.1	V4.0
V12	V1.1	V3.0
V11	V1.1	V2.2

Ensure always to use the last service pack / update with the corresponding portal version.

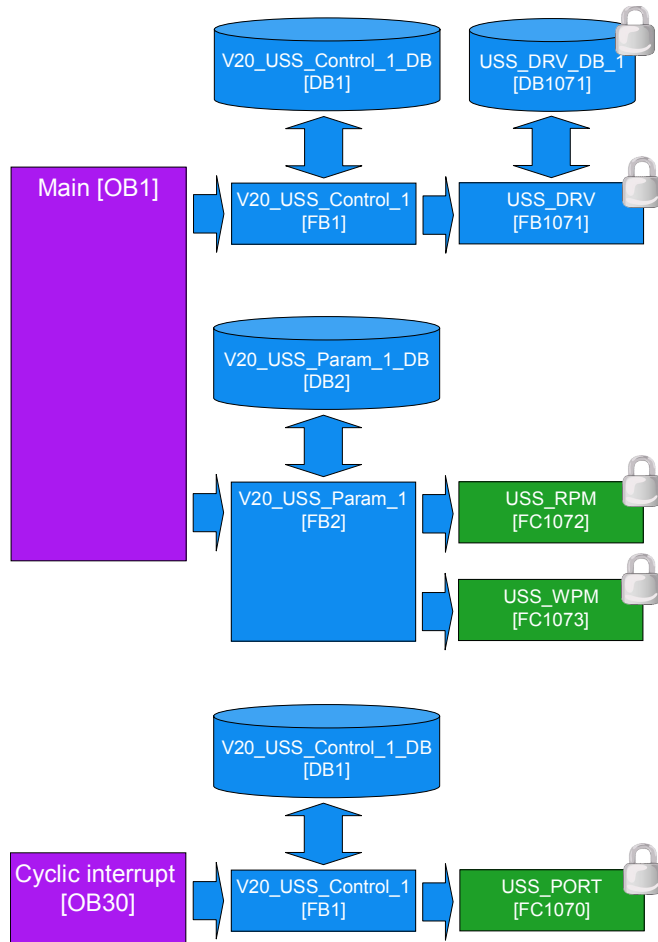## 1.2 Requirements

Bus wiring

Figure 1-1: Wiring example USS$^®$ Bus

Terminate the bus on the side of the controller with 120Ω, as long as you don't use a PROFIBUS plug with the CM1241.

2 Program Structure

Figure 2-1: Program structure

USS system instructions

In the screen above, the system blocks marked with a padlock, are created by STEP 7 itself when calling the instructions with the same name by the blocks V20_USS_Control_1 and V20_USS_Param_1.

Calling the V20_USS_Control_1 [FB1] in two OBs

As you can seen in Figure 2-1, the V20_USS_Control_1 [FB1] is to be called in the cyclic program part (OB1) as well as in an interrupt OB (OB30). You do not have to configure the time interval of the interrupt. This task is performed by V20_USS_Control_1.

Block relations

Due to the USS system blocks, it is always necessary to also call the V20_USS_Control_1 [FB1] in the program when using V20_USS_Param_1 [FB2].

3 V20_USS_Control_1 [FB1] block

Configuration

The block has the variable OB as the only parameter of the "Input" data segment. It now appears in the left formal parameter bar of the FB. The further configuration is performed in the statistic 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 3-1: Parameter of V20_USS_Control_1 [FB1]

Name	IN / OUT	Type	Explanation
OB *Only parameter of the "Input" data segment!*	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 /8/.
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.
PHASE	IN	UDInt	Phase shift of the interrupt interval. The value may be relevant if more than one port is configured. 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 (*Low enabled*) OFF2 Bit 01 (*Low enabled*) OFF3 Bit 02 (*Low enabled*) Ack_fault Bit 07 Direction_reversal Bit 11 (*True*=fwd) The remaining STW bits cannot be influenced by the FB1.

Name	IN / OUT	Type	Explanation
IN_SPEED_SP[n]	IN	Real	Setpoint speed value [%] in relation to the configured frequency If the value is positive, the V20 is running forward (as long as the Direction_reversal bit is True).
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**[1] Drive address Address of the SINAMICS V20, where an error was signaled through OUT_ERROR.
STATUS	OUT	Word	Processing status Error code of USS_PORT or USS_DRV, if OUT_ERROR signals an error. The error codes can be found in the online help fort he 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.
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.

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[1] Always only the error information of the error that occurred last in the instance DB is saved.
A new error – signalized by the OUT_ERROR bit – overwrites the previous error information.

4 V20_USS_Param_1 [FB2] block

4.1 Operating modes

Select the mode via the MODE block parameter.

ACTIVATE_USS mode

Switch the command and frequency setpoint source for the SINAMICS V20 in this mode. You can select between…

- …via USS
  (P0700/P1000 ⇨ 5 inverter parameter)

- …via the incorporated BOP
  (P0700/P1000 ⇨ 1 inverter parameter)

Within the ACTIVATE USS mode, you can select between the following functions that can be selected with the ACTIVATE_USS.FUNCTION parameter:

- **Check**
  It is only checked what source has been selected. The result is output in the bool USS_selected parameter. The successful completion of the action is displayed by a DONE pulse.

- **Activate**
  It is switched to USS as command and frequency setpoint source. The result is output in the bool USS_selected parameter. The successful completion of the action is displayed by a DONE pulse.

- **Dectivate**
  It is switched to BOP as command and frequency setpoint source. The result is output in the bool USS_selected parameter. The successful completion of the action is displayed by a DONE pulse.

RW_PARAM mode

In this mode you can read or write any SINAMICS V20 parameter. Apart from specifying the data type of the desired parameter, you also have to indicate the parameter number and index. You can furthermore decide whether the value is to be stored in RAM or EEPROM when writing the value.

Within the mode, 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 in a structure variable (OUT parameter) in V20_USS_Param_1_DB that corresponds to its data type.

- **Write**
  The value of the inverter parameter is retrieved from a structure variable (IN parameter) in V20_USS_Param_1_DB that corresponds to its data type and written in the SINAMICS V20.

- **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.

ACTUAL_STATE mode

In this mode you read out a set of current inverter values from the SINAMICS V20 that are represented by parameters (see Parameter description in Table 4-1).

SET_FUNCTIONS mode

In this mode, you can select or switch the inverter functions, stored in the inverter parameters (see Parameter description in Table 4-1), on and off via the USS communication.

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 SINAMICS V20 into a structure variable (OUT parameter).

- **Write**
  A defined set of inverter functions is written from a structure variable (IN parameter) into the SINAMICS V20. A further FB input parameter specifies whether you want to write to the RAM or EEPROM of the SINAMICS V20.

- **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.

4.2 Configuration

Table 4-1: 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
START	IN	Bool	**Function start** The selected function is executed by START with a positive edge.
ACTIVATE_USS. NUMBER_OF_DRIVES	IN	Struct USInt	**Enabling USS** Number of drives that are connected to the respective port (1…16).
P2010		USInt	Baud rate The coding is identical with that of the V20 parameter P2010 (values: 6…12). See /8/.
FUNCTION		USInt	Function within the mode 0 = Deactivate 1 = Activate 2 = Check

4.2 Configuration

Name	IN / OUT	Type	Explanation
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		UInt	Parameter number The number can be found in the SINAMICS V20 operating instruction /8/.
INDEX		UInt	Parameter index The index can be found in the SINAMICS V20 operating instruction /8/.
EEPROM		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		USInt	Function within the mode 0 = read parameter 1 = write parameter 2 = read & write parameter
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		USInt	Function within the mode 0 = read parameter set 1 = write parameter set 2 = read & write parameter set

4.2 Configuration

Name	IN / OUT	Type	Explanation
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 /8/.
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.
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,€,CO_2] 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.

4.2 Configuration

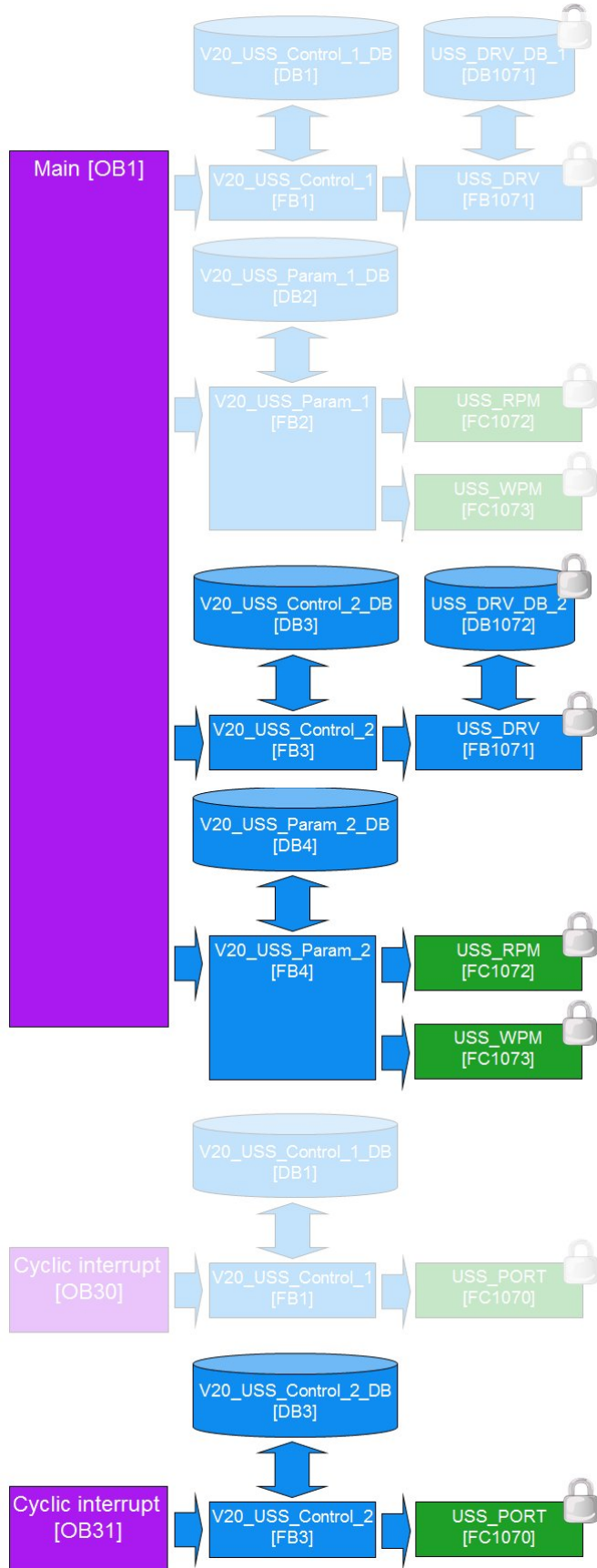| Name	IN / OUT	Type	Explanation
DONE	OUT	Bool	**Done message** If the processing of the block was completed without errors after its start (with START=true), a done message in the form of a DONE pulse is generated that last one cycle. Afterwards, the parameter read by the converter may be removed and 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 that 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 is ready again for a new start command.
ERROR_INFO. DRIVE_ADDR	OUT	Struct USInt	**Error information** Address of the SINAMICS V20 where the error occurred.
STATUS		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 (/3/).
EXTENDED_ERROR_available		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 that 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		UInt	For .EXTENDED_ERROR_available =true available additional error information. Error code can be found in chap. 6.1 of the SINAMICS V20 operating instruction /8/ (table: Error numbers in response ID 7 (request cannot be processed).
MODE		USInt	Block mode in 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 Expansion to Several Ports

You can provide the CPU with a maximum of three communication modules and one communication board. However, another port requires the creation of a complete other program structure according to Table 5-1. Proceed, for example, as follows:

Table 5-1: Port expansion instruction

No.	Instruction
1.	Copy the following blocks and change the indices in the block names and the block numbers. V20_USS_Control_1 [FB1] ⇨ V20_USS_Control_2 [FB3] V20_USS_Param_1 [FB2] ⇨ V20_USS_Param_2 [FB4] Cyclic_interrupt_1 [OB30] ⇨ Cyclic_interrupt_2 [OB31] USS_DRV_DB_1 [DB1071] ⇨ USS_DRV_DB_2 [DB1072]
2.	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].
3.	Adjust the following parameters in the V20_USS_Control_2 [FB3]: • IN_P2010 (baud rate according to your requirements) • IN_HW_Id (value from the device configuration of the CM1241/CB1241) • IN_CYCLIC_INTERRUPT.NUMBER (new interrupt OB no 31) • 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.)
4.	(V20_USS_Control_2_DB [DB3] and V20_USS_Param_2_DB [DB4] are automatically created if you are calling V20_USS_Control_2 [FB3] and V20_USS_Param_2 [FB4] in Main [OB1].
5.	Replace the old FB call in the new cyclic interrupt_2 [OB31] by calling V20_USS_Control_2 [FB3] with the instance DB V20_USS_Control_2_DB [DB3].

Figure 5-1: Program structure – 2nd port

6 Literature

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

Table 6-1: 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

7 History

Table 7-1: 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