

PLC Function Blocks for VACON PROFIBUS OPTE3 / OPTE5 TIA Portal V14

DRAFT Programming Guide

Date: 29.6.2020

Contents

Disclaimer	3
1. Introduction.....	3
2. Info on Library Compatibility.....	4
2.1. TIA Portal Library for S7-300 PLCs	4
2.2. TIA Portal Library for S7-1500 PLCs	4
3. How to Take the Library in Use	5
4. Description of the PROFIdrive Control Block.....	6
4.1. Function Block Interface Description	6
4.2. Using the PROFIdrive Control Block	7
4.3. Note on MIN/MAX frequency.....	7
4.4. PROFIdrive Control Block with 8 Process data items	7
5. Vacon Telegram Control Block	9
5.1. Function Block Interface Description	9
5.2. Using the Vacon Control Block	10
5.3. Vacon Control Block with 8 process data items	10
6. Description of the Application ID Write Block.....	11
6.1. Function Block Interface Description	11
6.2. List of Error codes	12
Using the Application ID Write Block	12
7. Description of the Application ID Read Block.....	13
7.1. Function Block Interface Description	13
7.2. List of Error codes	14
7.3. Using the Application ID Read Block	14
8. PLC Configuration Example	15
8.1. Install the GSD file	15
8.2. Hardware configuration	15
8.3. Adding the library	18
8.4. Using the function block.....	18

Disclaimer

This is free and unencumbered software released into the public domain. Anyone is free to copy, modify, publish, use, compile, sell, or distribute this software, either in source code form or as a compiled binary, for any purpose, commercial or noncommercial, and by any means.

In jurisdictions that recognize copyright laws, the author or authors of this software dedicate any and all copyright interest in the software to the public domain. We make this dedication for the benefit of the public at large and to the detriment of our heirs and successors. We intend this dedication to be an overt act of relinquishment in perpetuity of all present and future rights to this software under copyright law.

THE SOFTWARE IS PROVIDED "AS IS", WITHOUT WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE AND NONINFRINGEMENT. IN NO EVENT SHALL THE AUTHORS OR ANY LEGAL ENTITY PART OF DANFOSS GROUP BE LIABLE FOR ANY CLAIM, DAMAGES OR OTHER LIABILITY, WHETHER IN AN ACTION OF CONTRACT, TORT OR OTHERWISE, ARISING FROM, OUT OF OR IN CONNECTION WITH THE SOFTWARE OR THE USE OR OTHER DEALINGS IN THE SOFTWARE.

For more information, refer to <http://unlicense.org>.

1. Introduction

Danfoss Drives provides example function blocks that can be used to control Vacon drives connected to PROFIBUS fieldbus while using PROFIdrive profile via standard telegrams and Vacon specific profile via vendor telegram 1. These function blocks can handle basic functions like starting/stopping motor, resetting faults etc. This document describes how to take these blocks into use.

This document will also describe how to use the example blocks for application parameter read/write operations. These blocks are telegram independent, so they work with both PROFIdrive and Vacon telegrams.

Additionally, there is a detailed example on how to set up a project that controls a Vacon AC drive using PROFIdrive Control Block.

NOTE!

Provided function blocks are examples and are not meant to be used as-is by the end user. The function blocks can be modified at will and serve as an example to start the programming of VACON® AC drives. The code should not be used as or a part of a safety system.

2. Info on Library Compatibility

Library has been created with TIA PORTAL V14. This is the minimum required TIA PORTAL version that is supported. Library is incompatible with older version of TIA PORTAL.

There are currently two versions of the library available depending on the PLC type that is used. Libraries are not cross compatible.

2.1. TIA Portal Library for S7-300 PLCs

If you use a S7-300 PLC then use the library *VACON_LIB_S300_PROFIBUS_V1.1.za/14*. Following table lists the PLCs and TIA Portal versions that the library has been tested. If you use a PLC and/or TIA Portal version that is not in the table below, please be aware that getting customer support for that combination might be limited.

PLC type	TIA Portal version
S7-300 CPU 317-2 PN/DP	TIA Portal V14

2.2. TIA Portal Library for S7-1500 PLCs

If you use a S7-1500 PLC then use the library *VACON_LIB_S1500_PROFIBUS_V1.1.za/14*. Following table lists the PLCs and TIA Portal versions that the library has been tested. If you use a PLC and/or TIA Portal version that is not in the table below, please be aware that getting customer support for that combination might be limited.

PLC type	TIA Portal version
S7-1500 CPU 1516-F3 PN/DP	TIA Portal V14

3. How to Take the Library in Use

Library is supplied as a TIA PORTAL library archive file named *VACON_LIB_S300_PROFIBUS_V1.1.zal14* or *VACON_LIB_S1500_PROFIBUS_V1.1.zal14*. Retrieve it by clicking *Options->Global libraries->Open library*. This will extract the archive file and then you can load the library from the *libraries* tab on the right by expanding *Global libraries* and clicking *Open global library* icon. Once this is done you can drag and drop function blocks from the global library to your project.

NOTE:

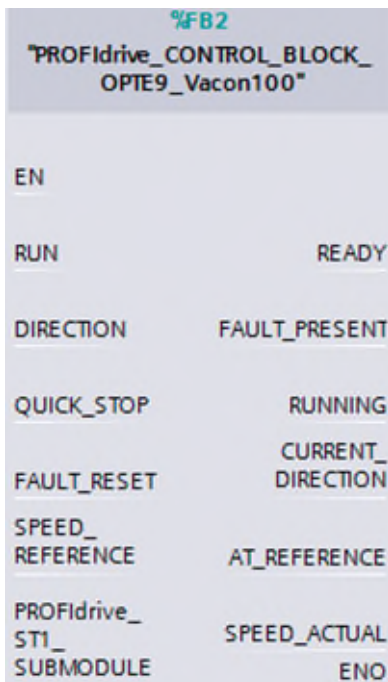
First add the library blocks to your projects program blocks and after that create instances of the blocks by dragging and dropping them to you work area. Do not drag and drop them directly from the library to your work area as this will always create a new function block and not a new instance.

4. Description of the PROFIdrive Control Block

4.1. Function Block Interface Description

When using standard telegram for communication this block can be used to control the AC drive. Below is a picture of the function blocks interface (S7-1500).

NOTE: RUN -input is not edge sensitive. This block will always start the drive if RUN=1, if it is possible (no faults present).

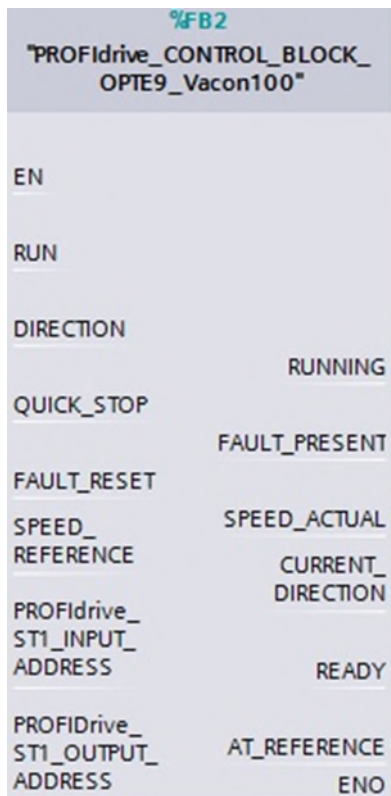


Inputs are on the left side and outputs are on the right side of the block. Detailed description of the inputs/outputs is in table below

INPUT/OUTPUT	Description
EN	Enable block call
RUN	RUN=1 Run motor; RUN=0 Stop motor (coast/ramp)
DIRECTION	DIRECTION=1 Reverse direction; Direction=0 Forward direction
QUICK_STOP	QUICK_STOP=1 Stop drive using quick stop ramp, overrides RUN state; QUICK_STOP=0 Quick stop inactive, RUN works normally
FAULT_RESET	FAULT_RESET 0->1 (rising edge) Reset faults
SPEED_REFERENCE	Speed reference in Vacon standard format, e.g. 10000=100% of max frequency, 5000=50% of max frequency
PROFIdrive_ST1_SUBMODULE	Submodule identifier of type HW_SUBMODULE
READY	If READY=1 drive can start operation, if READY=0 drive is not ready to start operation because of active faults etc.
RUNNING	RUNNING=0 motor is stopped, RUNNING=1 Motor is running (follows SPEED_REFERENCE)
FAULT_PRESENT	FAULT_PRESENT=1 Fault active in drive; FAULT_PRESENT=0 No faults active
CURRENT_DIRECTION	Current motor direction, 0=forward; 1=reverse
AT_REFERENCE	AT_REFERENCE=1 drive is at setpoint, AT_REFERENCE=0 drive is not at setpoint

SPEED_ACTUAL	Current speed in Vacon standard format, see SPEED_REFERENCE
ENO	If EN=1 ENO=1

Below is the interface for S7-300 PLCs



The difference is that for S7-300 PLCs you need to provide the actual input/output addresses to the block (PROFIdrive_ST1_INPUT_ADDRESS, PROFIdrive_ST1_OUTPUT_ADDRESS). Assign the starting address of the telegrams input/output address to these inputs.

4.2. Using the PROFIdrive Control Block

You can simply drag&drop the function block into your work area. This will create a new instance of it and then you can map the proper signals to the inputs and outputs of the block.

PROFIdrive_ST1_SUBMODULE is the telegram identifier of the device that is to be controlled by this block.

The block will internally write to the devices output address that are mapped to STW1 and Setpoint Value. These fields should not be written anywhere else in the program.

4.3. Note on MIN/MAX frequency

This block and all other drive control blocks assume that the drives MIN/MAX frequencies are 0Hz and 50Hz respectively. If you have parameterized the drive differently, this block will not function as described. For example, if MIN frequency is 10Hz, speed reference between 0-20% do not affect the actual speed of the drive.

4.4. PROFIdrive Control Block with 8 Process data items

This function block provides additional outputs which can be used to monitor different values from the AC drive. All the other inputs and outputs of the function block are the same, as is the behavior also.

To use this block, configure the drive to use “ST1 + 8 PD” as the telegram type.

In Vacon standard applications the process data items are mapped as follows:

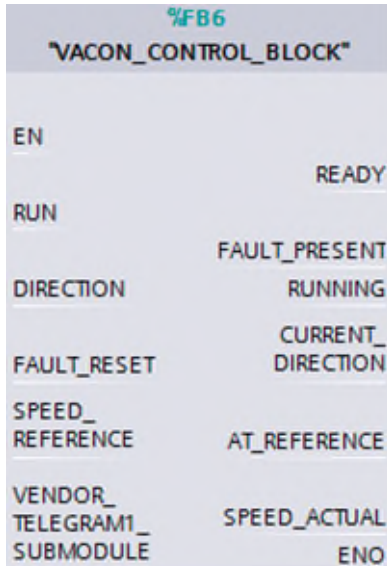
Process data item no.	Monitored value	Unit
PD1	Output frequency	Hz
PD2	Motor speed	rpm
PD3	Motor current	A
PD4	Shaft torque	% of max torque
PD5	Shaft power	% of max torque
PD6	Motor voltage	V
PD7	DC link voltage	V
PD8	Last active error code	

If you want to monitor different values, they can be changed via parameters. For example, in multi-purpose application they are in Parameters -> Fieldbus -> FB Data Out{1-8} Sel. Edit the value and set the application ID that is to be followed in the given process data item.

5. Vacon Telegram Control Block

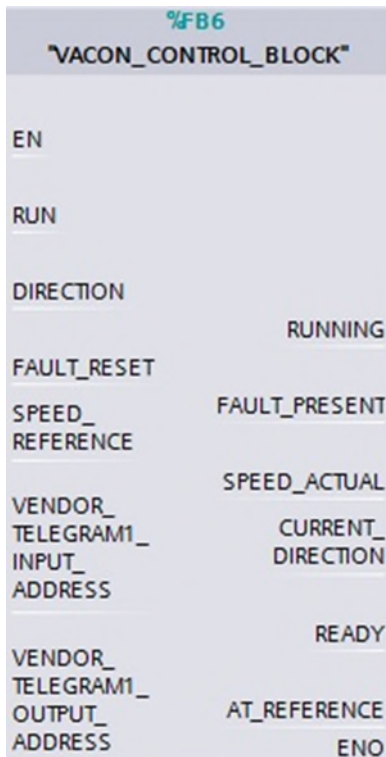
5.1. Function Block Interface Description

If drive communication is handled by Vendor Telegram 1 (all variants, but not Vendor Telegram 2&3) this block can be used to control the AC drive. Below is the picture of its interface (S7-1500).



INPUT/OUTPUT	Description
EN	Enable block call
RUN	RUN=1 Run motor; RUN=0 Stop motor (coast/ramp)
DIRECTION	DIRECTION=1 Reverse direction; Direction=0 Forward direction
FAULT_RESET	FAULT_RESET 0->1 (rising edge) Reset faults
SPEED_REFERENCE	Speed reference in Vacon standard format, e.g. 10000=100% of max frequency, 5000=50% of max frequency
VENDOR_TELEGRAM1_SUBMODULE	Submodule identifier of type HW_SUBMODULE
READY	READY=1 Drive ready for operation, READY=0 not ready (fault etc)
FAULT_PRESENT	FAULT_PRESENT=1 Fault active in drive; FAULT_PRESENT=0 No faults active
RUNNING	RUNNING=0 motor is stopped, RUNNING=1 Motor is running (follows SPEED_REFERENCE)
CURRENT_DIRECTION	Current motor direction, 0=forward; 1=reverse
AT_REFERENCE	AT_REFERENCE=1 drive is at setpoint, AT_REFERENCE=0 drive is not at setpoint
SPEED_ACTUAL	Current speed in Vacon standard format, see SPEED_REFERENCE
ENO	If EN=1 ENO=1

Below is the interface for S7-300 PLCs



Again, the small difference is that you need to provide the actual input/output addresses to the block (VENDOR_TELEGRAM1_INPUT_ADDRESS, VENDOR_TELEGRAM1_OUTPUT_ADDRESS). Assign the starting address of the telegrams input/output address to these inputs.

5.2. Using the Vacon Control Block

Usage follows the same principle as with the PROFIdrive Control Block. The block will also write directly to the fields “Bypass Control Word” and “Bypass Setpoint Value”. They should not be written to anywhere else in the project.

5.3. Vacon Control Block with 8 process data items

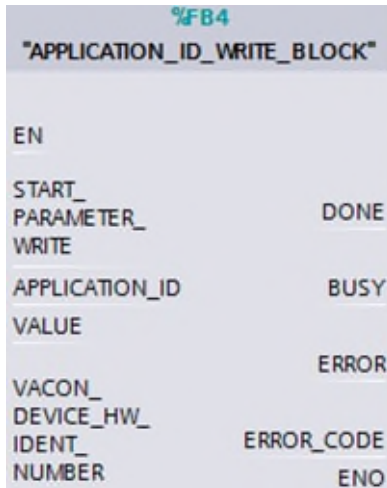
This block has 8 additional outputs for process data. See PROFIdrive Control Block with 8 process data items.

To use the block, configure the drive to use “Vendor 1 + 8 PD” as the telegram.

6. Description of the Application ID Write Block

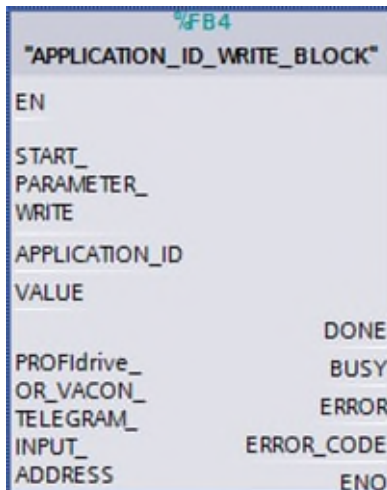
6.1. Function Block Interface Description

This block can be used to write application parameters to the drive using the associated IDs. The interface of the function block differs slightly between S7-300 and S7-1500 PLCs. Below is a picture of its interface for the S7-1500 PLCs.



INPUT/OUTPUT	Description
EN	Enable block call
START_PARAMETER_WRITE	0->1 (rising edge) Start writing value in input <i>value</i> to current <i>APPLICATION_ID</i>
APPLICATION_ID	Application ID of parameter, see application manual for complete list
VALUE	New value of parameter addressed with <i>APPLICATION_ID</i>
VACON_DEVICE_HW_IDENT_NUMBER (S7-1500)	Hardware identifier number, found in device properties of the Vacon device in device view
DONE	DONE=1 Write successful; DONE=0 no significance
BUSY	BUSY=1 Write ongoing; BUSY=0 No writes active or error.
ERROR	ERROR=1 Write failed; ERROR=0 no significance
ERROR_CODE	If ERROR=1 this shows the ERROR_CODE (double word)
ENO	If EN=1, ENO=1

And below is the picture of the interface for S7-300 PLCs



The only difference is the identifier used to differentiate between devices. In S7-1500 PLCs it is the HW identifier that TIA Portal assigns to each device automatically. In S7-300 it is the modules input data address.

6.2. List of Error codes

Following table lists the most common error codes. It is not a complete list of all possible error codes.

Error code	Explanation
2	Value is outside permitted range of accessed ID (i.e. exceed min/max limits)
3	ID is not found or inaccessible
C0809300	HW ident number or telegram input address is wrong

Using the Application ID Write Block

The function block works asynchronously, I.E. it has to be called cyclically for it to complete its task. If **BUSY** –signal is high it is currently processing previous write operation. Once **DONE** –signal is high it has finished its task and another write –process may be started.

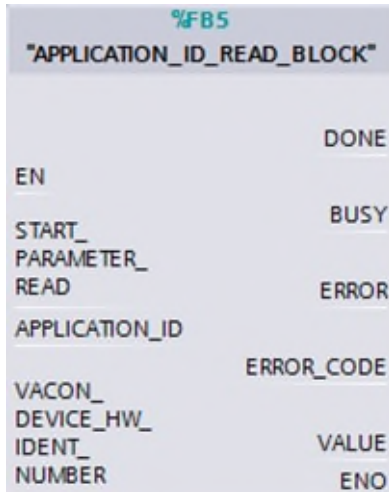
A new write –process is triggered by setting proper values to inputs *APPLICATION_ID*, *VALUE*, and *VACON_DEVICE_HW_IDENT_NUMBER* or *PROFIdrive_OR_VACON_TELEGRAM_INPUT_ADDRESS*. Once a rising edge is detected at *START_PARAMETER_WRITE* –input a new write process is started. You must then call the block cyclically until *DONE* –signal goes high. This marks a successful write operation.

If the write process encounters an error after calling the block, *ERROR* –signal is high and the error code can be read from *ERROR_CODE* –output. Error codes can be found from the TIA Portal documentation of RDREC and WRREC function blocks. Error code is directly mapped to their *STATUS* –output. A new write process can be triggered with a rising edge in *START_PARAMETER_WRITE* –input.

7. Description of the Application ID Read Block

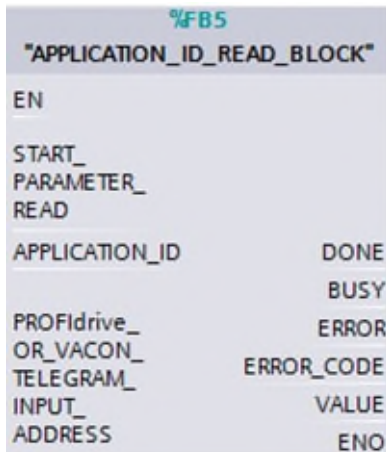
7.1. Function Block Interface Description

This block can be used to read application parameter values using their IDs. This block differs also slightly between S7-1500 and S7-300 PLCs. Below is picture of the blocks interface for the S7-1500 PLC



INPUT/OUTPUT	Description
EN	Enable block call
START_PARAMETER_READ	0->1 (rising edge) Start writing value in input <i>value</i> to current <i>APPLICATION_ID</i>
APPLICATION_ID	Application ID of parameter, see application manual for complete list
VACON_DEVICE_HW_IDENT_NUMBER (S7-1500)	Hardware identifier number, found in device properties of the Vacon device in device view
DONE	DONE=1 Write successful; DONE=0 no significance
BUSY	BUSY=1 Write ongoing; BUSY=0 No writes active or error.
ERROR	ERROR=1 Write failed; ERROR=0 no significance
ERROR_CODE	If ERROR=1 this shows the ERROR_CODE (double word)
VALUE	IF DONE==1 the respective value of parameter <i>APPLICATION_ID</i>
ENO	If EN=1, ENO=1

And below is the interface for the S7-300 PLC



Again the only difference is the input that is used to identify the device. In S7-1500 PLCs it is the HW identifier that TIA Portal assigns to each device automatically. In S7-300 it is the modules input data address.

7.2. List of Error codes

Following table lists the most common error codes. It is not a complete list of all possible error codes.

Error code	Explanation
3	ID is not found or inaccessible
C0809300	HW ident number or telegram input address is wrong

7.3. Using the Application ID Read Block

Function block operation follows the same principle as `APPLICATION_ID_WRITE_BLOCK`. The only difference is that `VALUE` is output instead of input. Once `DONE` –signal goes high the value of application ID `APPLICATION_ID` can be read from `VALUE`.

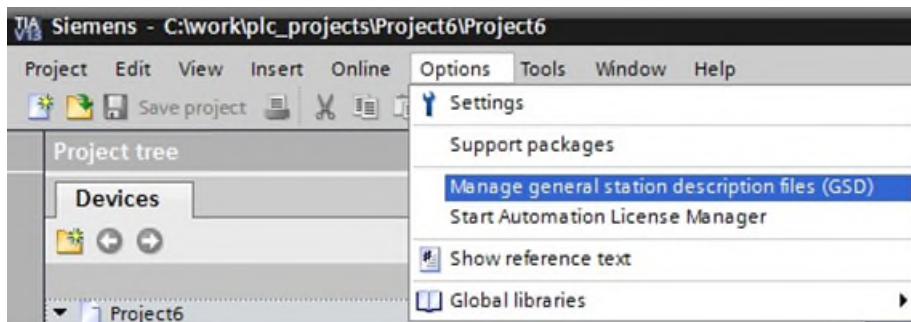
8. PLC Configuration Example

8.1. Install the GSD file

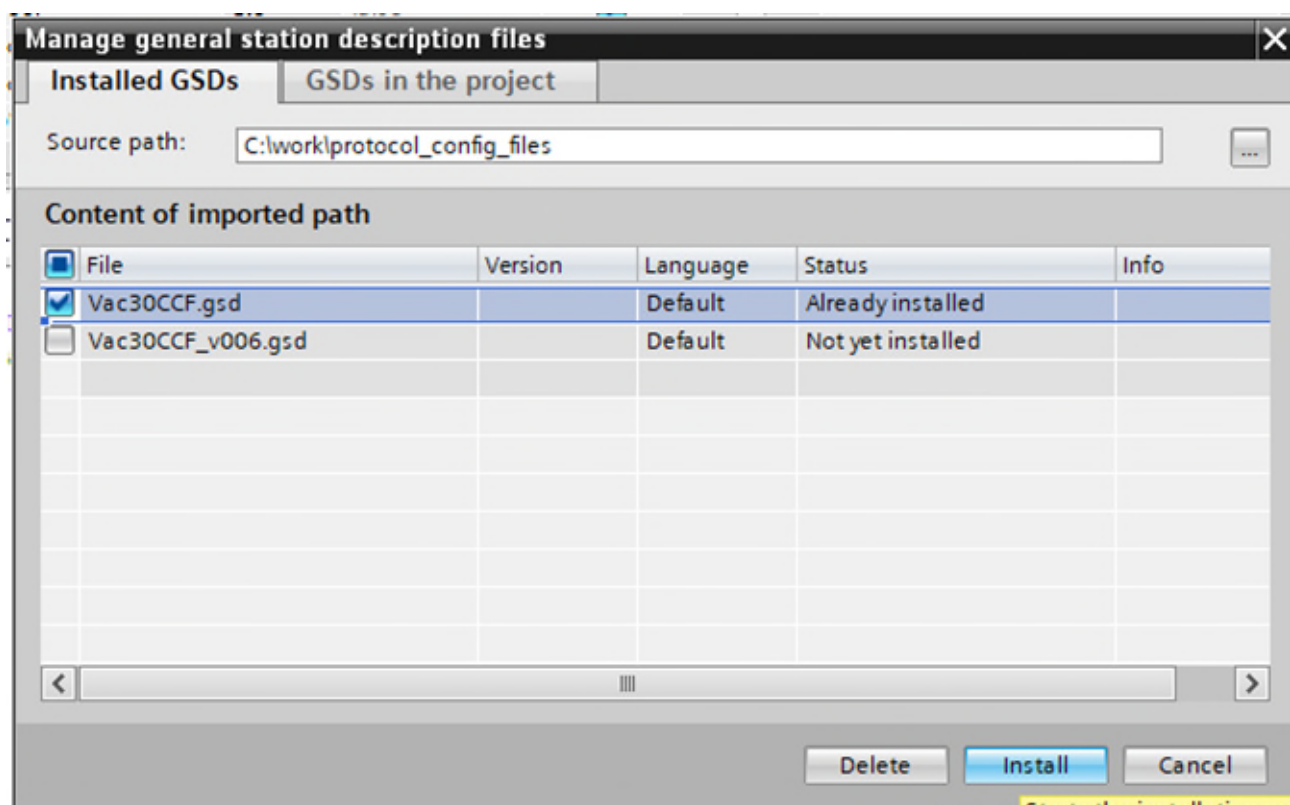
To add a Vacon device to the hardware catalog of TIA Portal, download the corresponding fieldbus configuration file for your AC Drive. They are found from the Danfoss website:

<http://drives.danfoss.com/downloads/fieldbus-configuration-files/#/>.

After this, click the highlighted item in the menu pictured below:



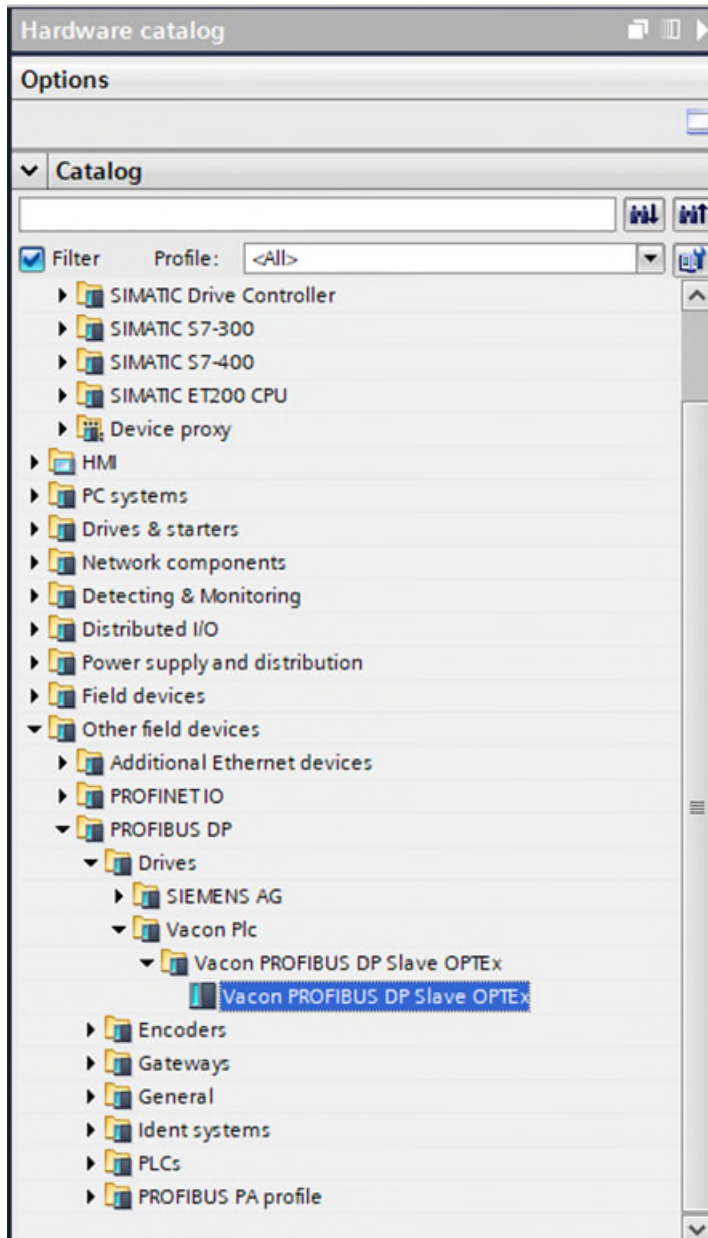
The following menu opens:



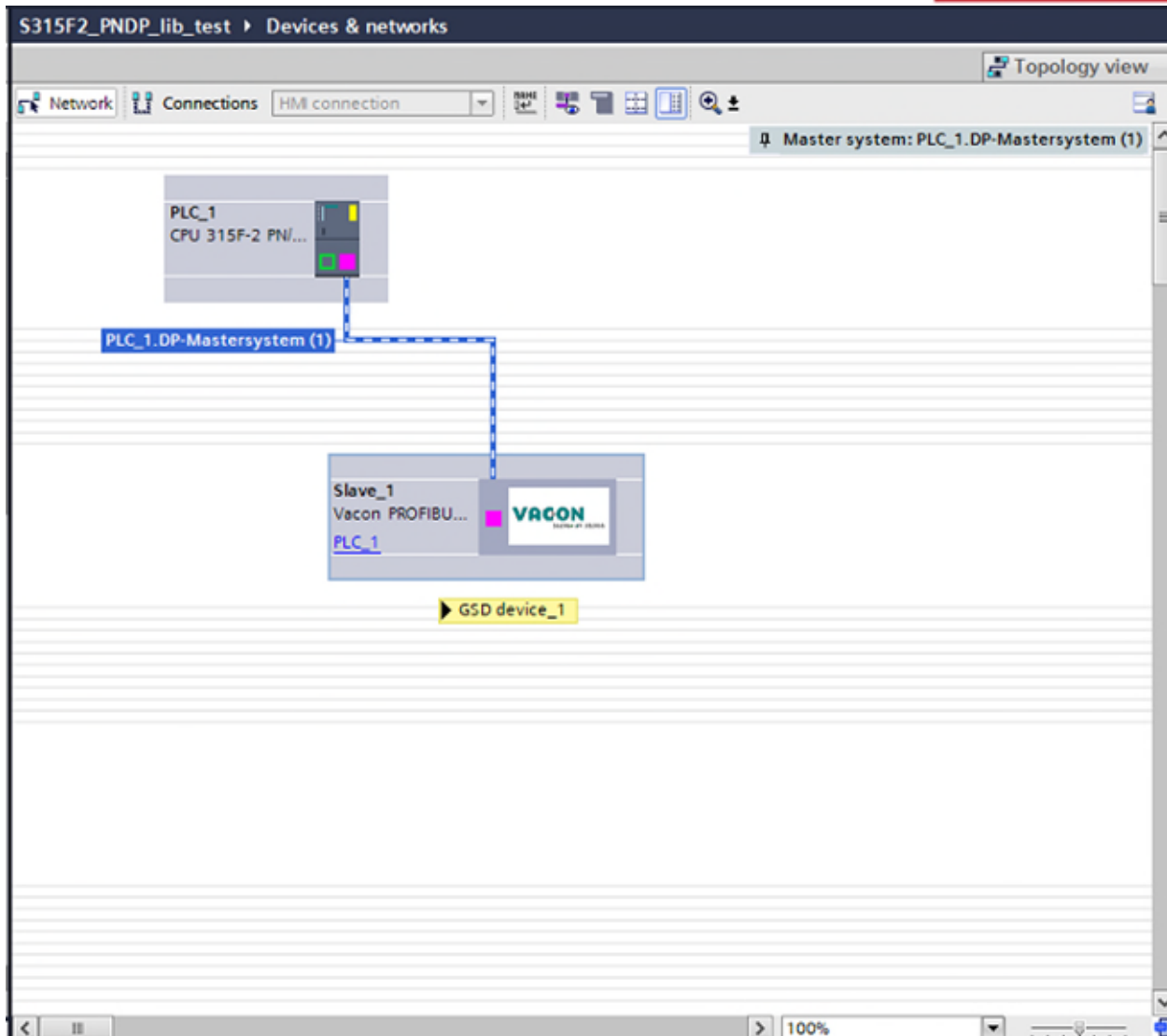
Find the folder where you stored the fieldbus configuration file. Then select the file you want to install and click "Install".

8.2. Hardware configuration

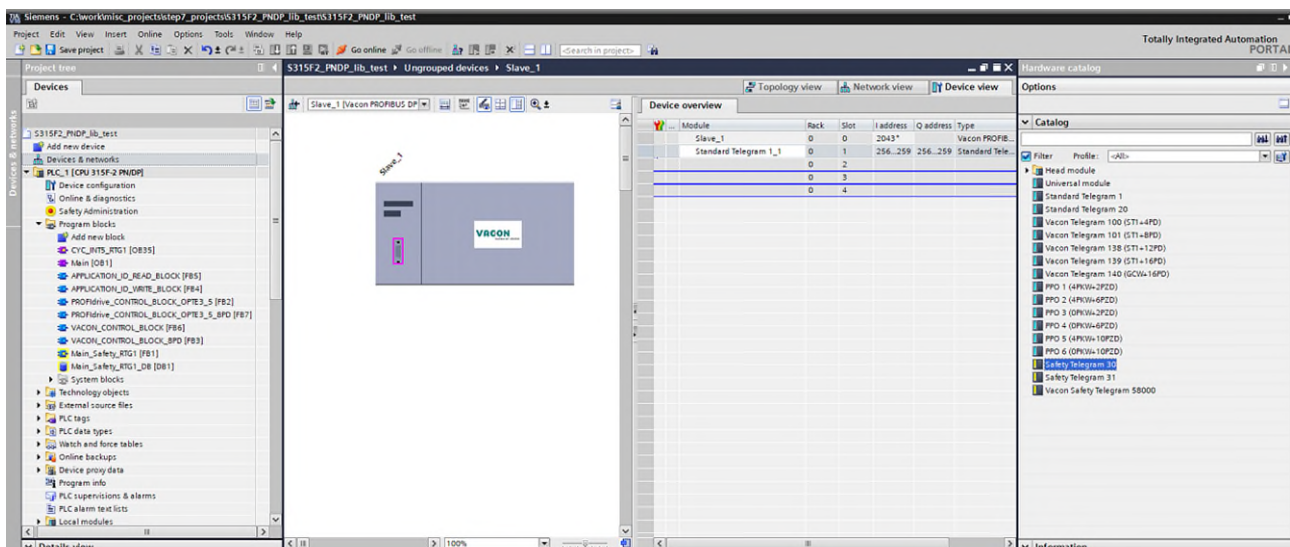
Create an empty project. First add a PLC to your project by dragging&dropping from the hardware catalog. Then add a Vacon device from the hardware catalog. Following picture shows the where you can find it:



Drag&drop it to your devices&networks view. Click the “Not assigned” -link in the Vacon device and attach it to your PLC. Then your HW configuration should look like in the following picture:



Double click on the Vacon device to configure the telegram. Insert the module “ST1” and drag&drop it to the slot number 1. The available modules can be seen by choosing the “Hardware catalog” tab on the right under “BYPASS” and “PROFIDRIVE”. The view will then look like this:

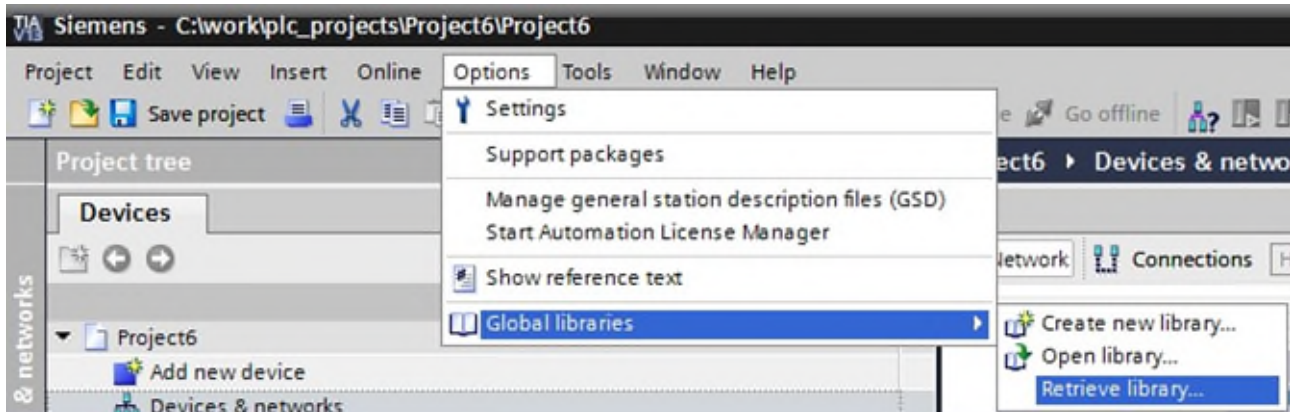


The values of fields named “I address” and “Q address” are used as inputs to the PROFIdrive control block and Vacon control block. They are assigned automatically but can be freely edited if needed.

The Vacon telegrams are under “BYPASS” and using them works the same as in this example.

8.3. Adding the library

To add a library to your project, click the following item in TIA Portal:



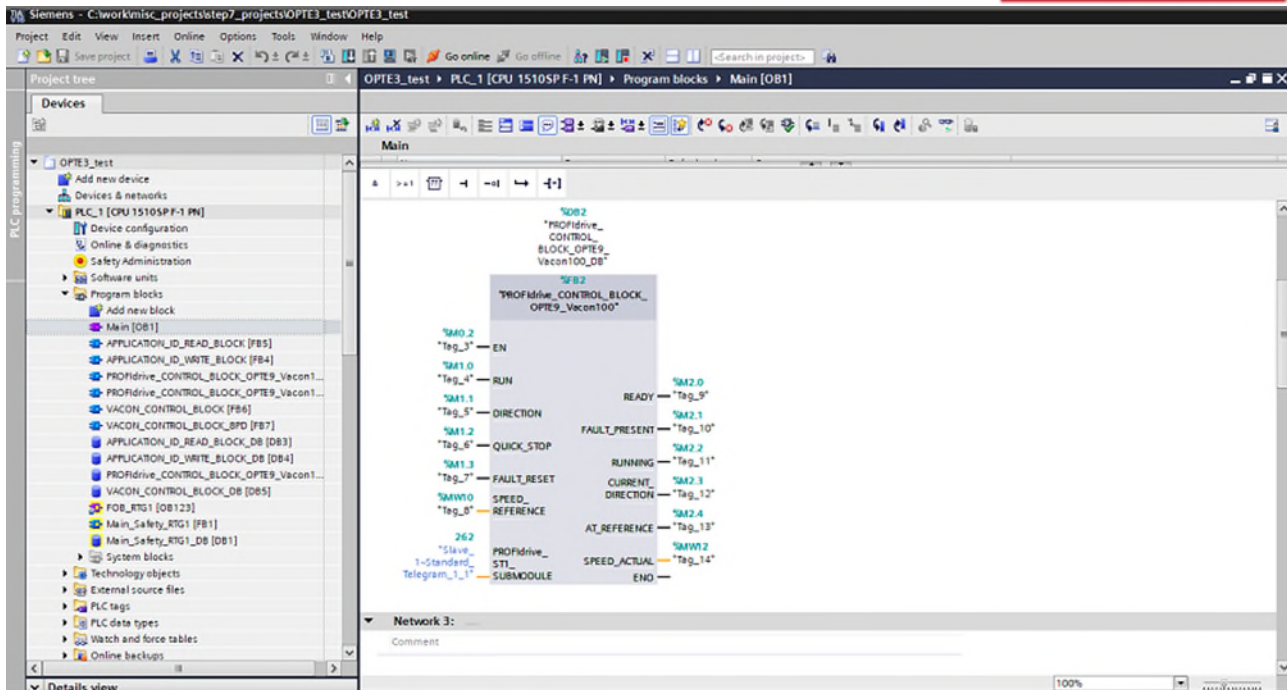
It opens a dialog. Find the library named “VACON_LIB_S300_PROFIBUS_V1.1.zal14” or “VACON_LIB_S1500_PROFIBUS_V1.1.zal14” from your computer. This retrieves the library and adds it to your Global Libraries. Libraries are located on the right side of the TIA Portal -window.

Open the “Master Copies” -folder inside the library and drag&drop the function blocks you need to your PLC’s program blocks on the left side of the TIA Portal window.

8.4. Using the function block

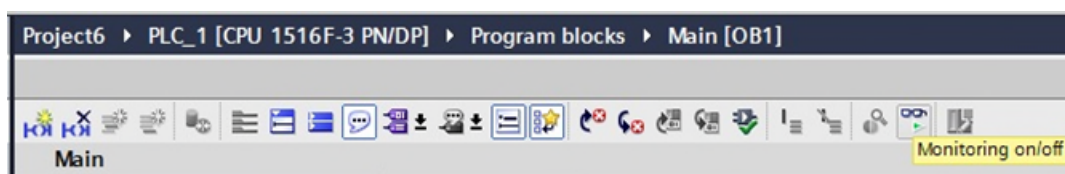
Double click the block named “Main [OB1]” to edit the program inside it. By right clicking it you can choose the programming language used. In this example FDB is used.

Inside the “Main [OB1]” are “Networks” that are executed whenever this block is executed. To insert a function block to a “Network” just drag&drop a function block from the PLC’s program blocks to the network. This will create an instance of the function block and create a DB block where it stores the blocks internal data. After this your view should look like this:

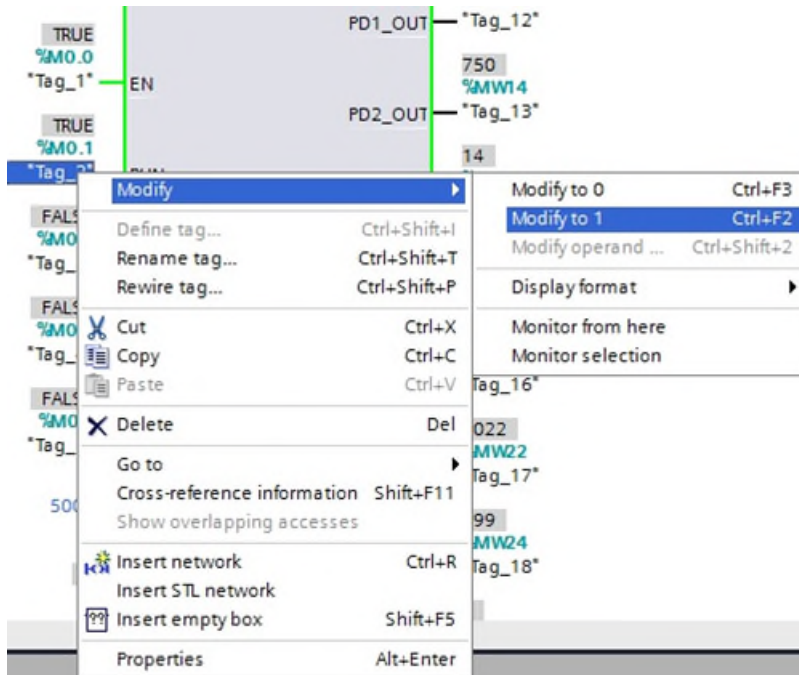


Now you can connect signals you want to the blocks inputs & outputs. To make a quick test, just map them to memory tags and then you can use the online mode to set the values of different inputs and see how the drive behaves. Example mapping can be seen in the picture.

Now you can compile the program and hardware configuration and download them to your PLC. It will then start executing the program. Go to online mode by clicking this icon in toolbar:



You will then see the current values of the function blocks interface. You can modify the input values by right clicking them. Below is an example:



Remember to set “EN” to 1, otherwise the function block is not executed.