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**AC DRIVES**

**OPTE9, OPTEA**  
**PLC FUNCTION BLOCKS FOR TIA PORTAL V13**  
**USER MANUAL**



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## 1 INTRODUCTION

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

This document also describes how to use the example function blocks for application parameter read/write operations. These function 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.

## 2 LIBRARY COMPATIBILITY

The library has been created with TIA Portal V13 SP1. Older versions of TIA Portal are not supported. If the library is used in a newer version of TIA Portal, check if the library is compatible with it. If it is not compatible, load the library in compatibility mode, or, if possible, convert it to a newer version.

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

## 2.1 TIA PORTAL LIBRARY FOR S7-300 PLCs

If you use an S7-300 PLC, use the library *VACON\_LIB\_S300.zal13*. The table below lists the PLCs and TIA Portal versions that the library has been tested with. If you use a PLC and/or TIA Portal version that is not in the table below, be aware that getting customer support for that combination might be limited.

Table 1.

PLC type	TIA Portal version
S7-300 CPU 317-2 PN/DP	TIA Portal V13 SP1 update 4

## 2.2 TIA PORTAL LIBRARY FOR S7-1500 PLCs

If you use an S7-1500 PLC, use the library *VACON\_LIB\_S1500.zal13*. The table below lists the PLCs and TIA Portal versions that the library has been tested with. If you use a PLC and/or TIA Portal version that is not in the table below, be aware that getting customer support for that combination might be limited.

Table 2.

PLC type	TIA Portal version
S7-1500 CPU 1516-F3 PN/DP	TIA Portal V13 SP1 update 4

## 3 HOW TO TAKE THE LIBRARY IN USE

The library is supplied as a TIA Portal library archive file named *VACON\_LIB\_S300.zal13* or *VACON\_LIB\_S1500.zal13*.

1. Retrieve the library file by clicking *Options -> Global libraries -> Retrieve library*. This will extract the archive file.
2. Go to the *Libraries* tab on the right.
3. Expand *Global libraries*.
4. Click on the *Open global library* icon.
5. Drag and drop function blocks from the global library to your project.

### NOTE!

Add the library blocks to the program blocks of your projects first. After that, create instances of the library blocks by dragging and dropping them to your work area. Do not drag and drop them directly from the library to your work area, as this will create a new function block and not a new instance.

## 4 PROFIdrive CONTROL BLOCK

### 4.1 FUNCTION BLOCK INTERFACE

When you use a standard telegram for communication, this function block can be used to control the AC drive.

#### NOTE!

The RUN input is not edge sensitive. This function block will always start the drive if RUN = 1, if it is possible (there are no faults present).

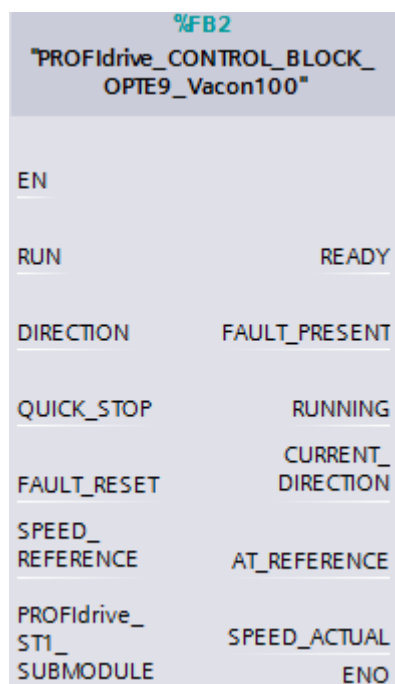


Figure 1. Function block interface for S7-1500 PLCs

The inputs are on the left side and the outputs on the right side of the function block.

Table 3. Description of the inputs and outputs

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

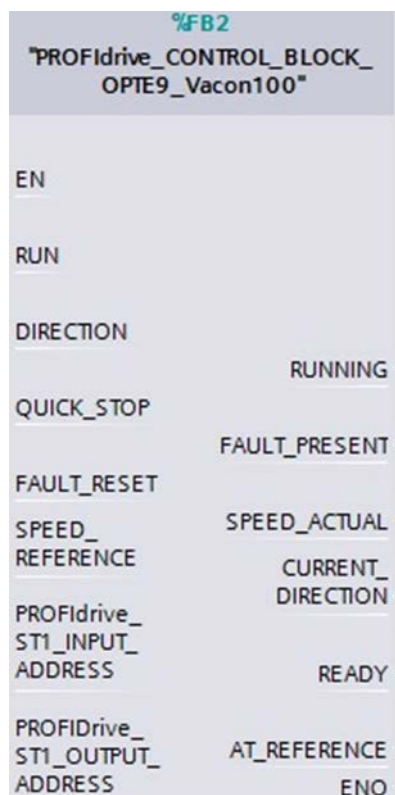


Figure 2. Function block interface for S7-300 PLCs

The difference between the S7-1500 PLCs and the S7-300 PLCs is that for S7-300 PLCs, you need to provide the actual input/output addresses to the function 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 drag and 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 function block.

PROFIdrive\_ST1\_SUBMODULE is the telegram identifier of the device that will be controlled by this function block.

The function block will internally write to the device output address that corresponds to the STW1 and NSOLL\_A fields in VACON® OPTE9/A Dual Port Ethernet Board Manual. These fields should not be written anywhere else in the program. Fields marked with PDIx are freely usable in your project.

## 4.3 NOTE ON MIN/MAX FREQUENCY

The function block assumes that the MIN/MAX frequencies of the drive are 0 Hz and 50 Hz respectively. If you have parameterized the drive differently, this function block will not function as described. For example, if MIN frequency is 10 Hz, a speed reference of 0-20% does not have an effect on the actual speed of the drive.

## 4.4 PROFIdRIVE CONTROL BLOCK WITH 8 PROCESS DATA ITEMS

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

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

*Table 4. Mapping of process data items in VACON® standard applications*

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 with the parameters. For example, in the multi-purpose application they are in Parameters -> Fieldbus -> FB Data Out



{1-8} Sel. Edit the value and set the application ID that must be followed in the given process data item.

## 5 VACON® TELEGRAM CONTROL BLOCK

### 5.1 FUNCTION BLOCK INTERFACE

If the drive communication is handled by Vendor Telegram 1 (all variants, but not Vendor Telegram 2 or 3), this function block can be used to control the AC drive.

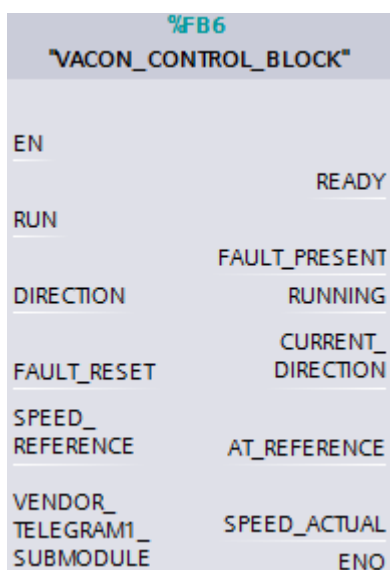


Figure 3. Function block interface for S7-1500 PLCs

Table 5. Description of the inputs and outputs

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

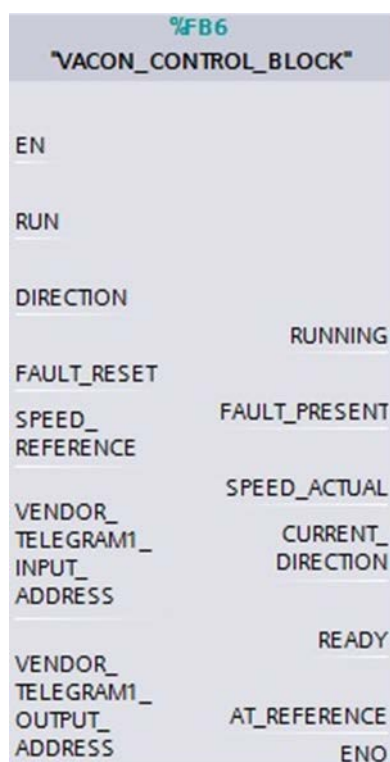


Figure 4. Function block interface for S7-300 PLCs

Again, the small difference is that you need to provide the actual input/output addresses to the function 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® TELEGRAM CONTROL BLOCK

Usage follows the same principle as with the PROFIdrive Control Block. The function block will also write directly to the fields marked as FB FIXED CW and FB SPEED REF in the VACON® OPTE9/A Dual Port Ethernet Board Manual. They should not be written to anywhere else in the project. PDIx fields are freely usable.

## 5.3 VACON® TELEGRAM CONTROL BLOCK WITH 8 PROCESS DATA ITEMS

This function block has 8 additional outputs for process data. For more information, see chapter 4.4 PROFIdrive control block with 8 process data items.

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

## 6 APPLICATION ID WRITE BLOCK

### 6.1 FUNCTION BLOCK INTERFACE

This function block can be used to write application parameter values to the drive using their IDs. The interface of the function block differs slightly between S7-300 and S7-1500 PLCs.

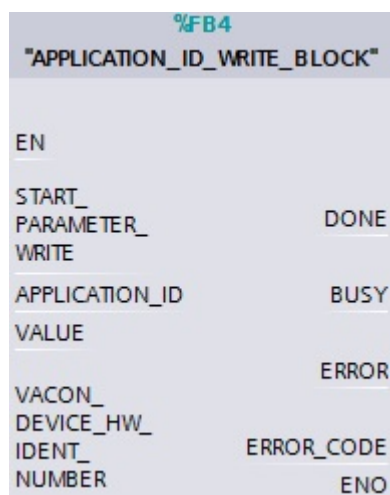


Figure 5. Function block interface for S7-1500 PLCs

Table 6. Description of the inputs and outputs

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

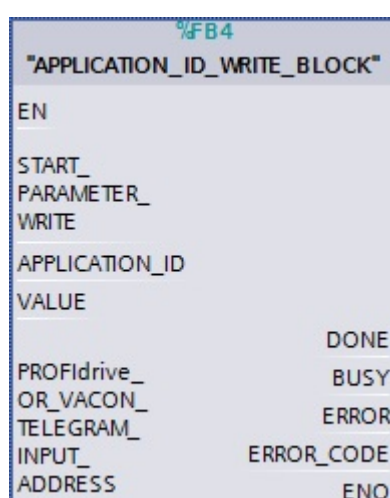


Figure 6. Function block interface for S7-300 PLCs

The only difference is the identifier that is 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 input data address of the module.

## 6.2 LIST OF ERROR CODES

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

Table 7. The most common error codes

Error code	Description
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

## 6.3 USING THE APPLICATION ID WRITE BLOCK

The function block works asynchronously, that is, it must be called cyclically for it to complete its task. If BUSY signal is high, the function block is currently processing the previous write process. Once DONE signal is high, the function block has finished its task and another write process can 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 function block cyclically until DONE signal goes high. When DONE signal is high, it means that the write operation was successful.

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

## 7 APPLICATION ID READ BLOCK

### 7.1 FUNCTION BLOCK INTERFACE

This function block can be used to read application parameter values using their IDs. This function block differs also slightly between S7-1500 and S7-300 PLCs.

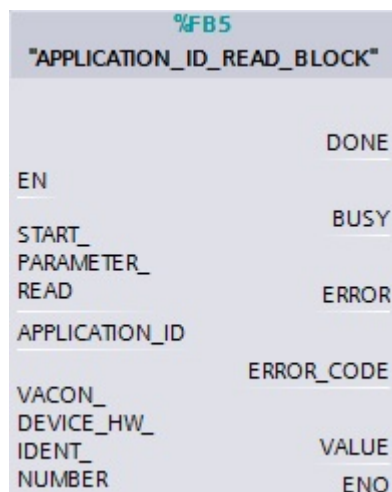


Figure 7. Function block interface for S7-1500 PLCs

Table 8. Description of the inputs and outputs

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

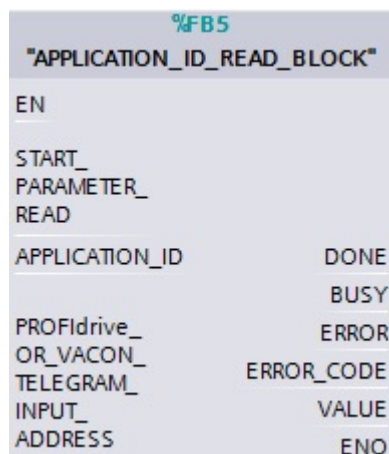


Figure 8. Function block interface for S7-300 PLCs

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 PLCs, it is the input data address of the module.

## 7.2 LIST OF ERROR CODES

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

Table 9. The most common error codes

Error code	Description
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

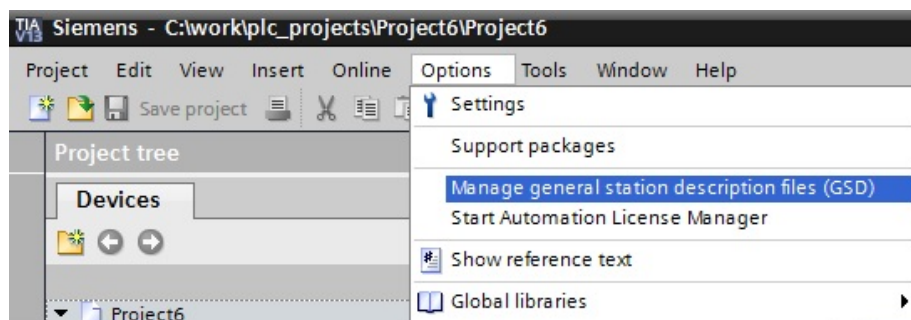
The function block operation follows the same principle as *APPLICATION\_ID\_WRITE\_BLOCK*. The only difference is that *VALUE* is output instead of input. Once DONE signal goes high, the value of application ID *APPLICATION\_ID* can be read from *VALUE*.

## 8 PLC CONFIGURATION EXAMPLE

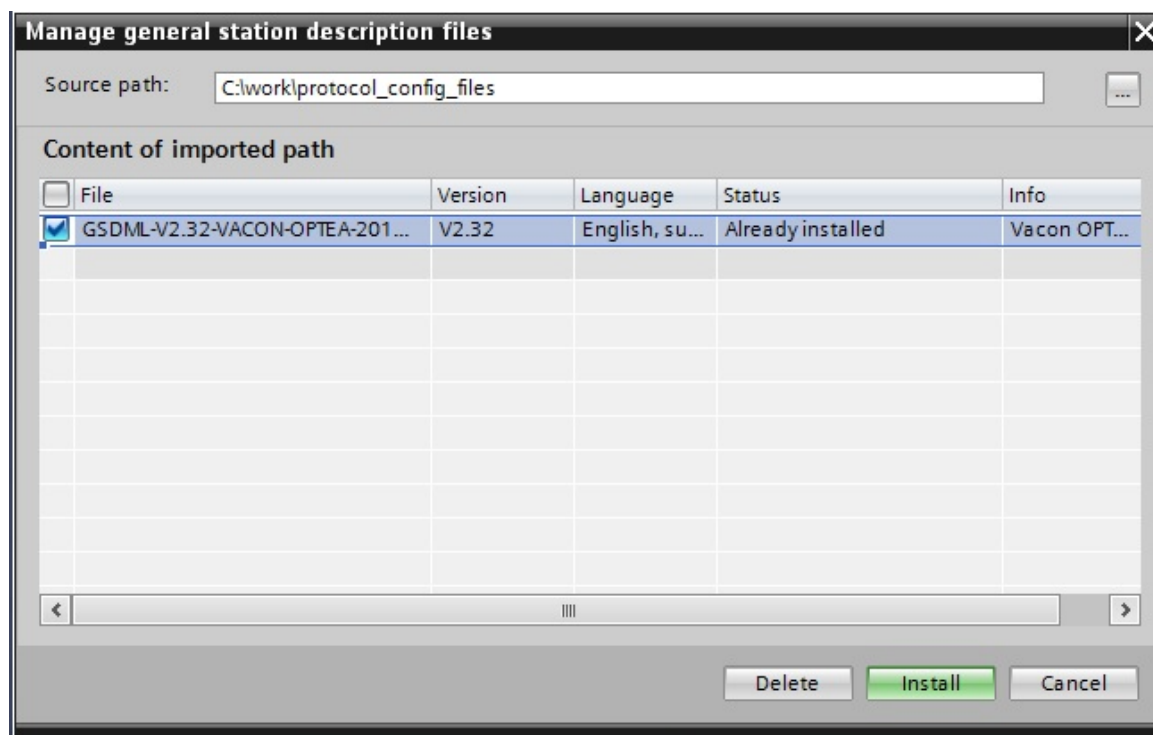
### 8.1 INSTALLING THE GSDML FILE

To add a VACON® device to the hardware catalog of TIA Portal, download the corresponding fieldbus configuration file for your AC Drive. They can be found on the Danfoss website: <http://drives.danfoss.com/downloads/fieldbus-configuration-files/#/>. For example, if you are using the OPTE9/A option board to connect to PROFINET, download the file “VACON® OPTE9/A Dual Port Ethernet PNIO GSDML”. If you are using the VACON® 100 internal Ethernet, download the file “VACON® 100 PROFINET IO GSDML”.

After this, click the highlighted menu item seen in the figure below.



The following menu opens.

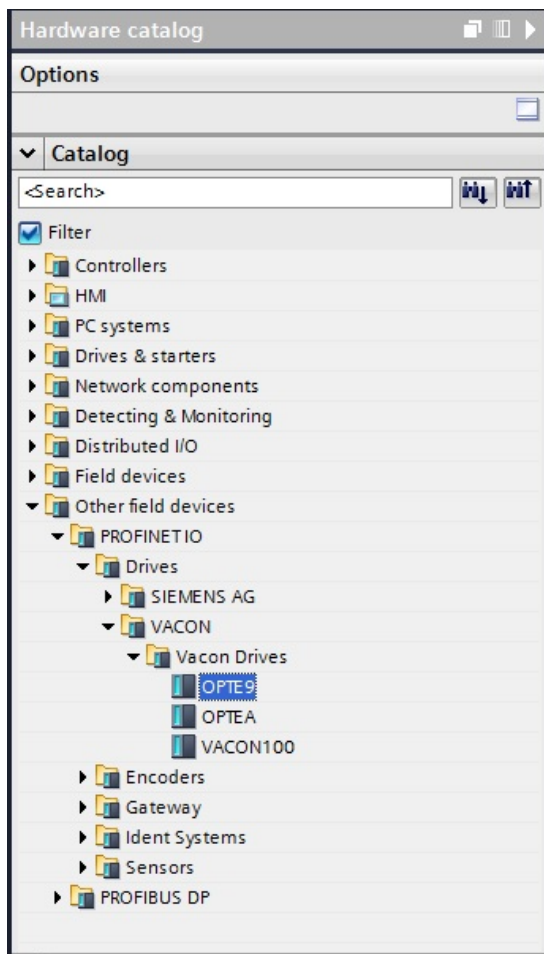


Find the folder where you stored the fieldbus configuration file. Then select the file you want to install and click “Install”.

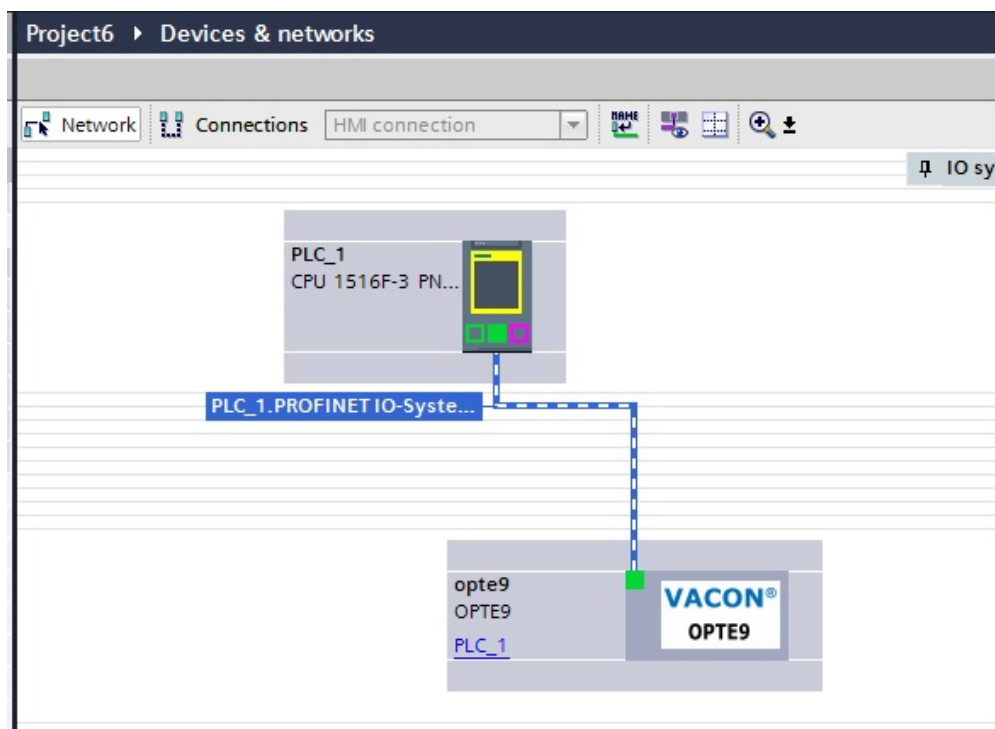
## 8.2 HARDWARE CONFIGURATION

Create an empty project. First add a PLC to your project from the hardware catalog by dragging and dropping. Then add a VACON® device from the hardware catalog. The following figure shows where you can find it.

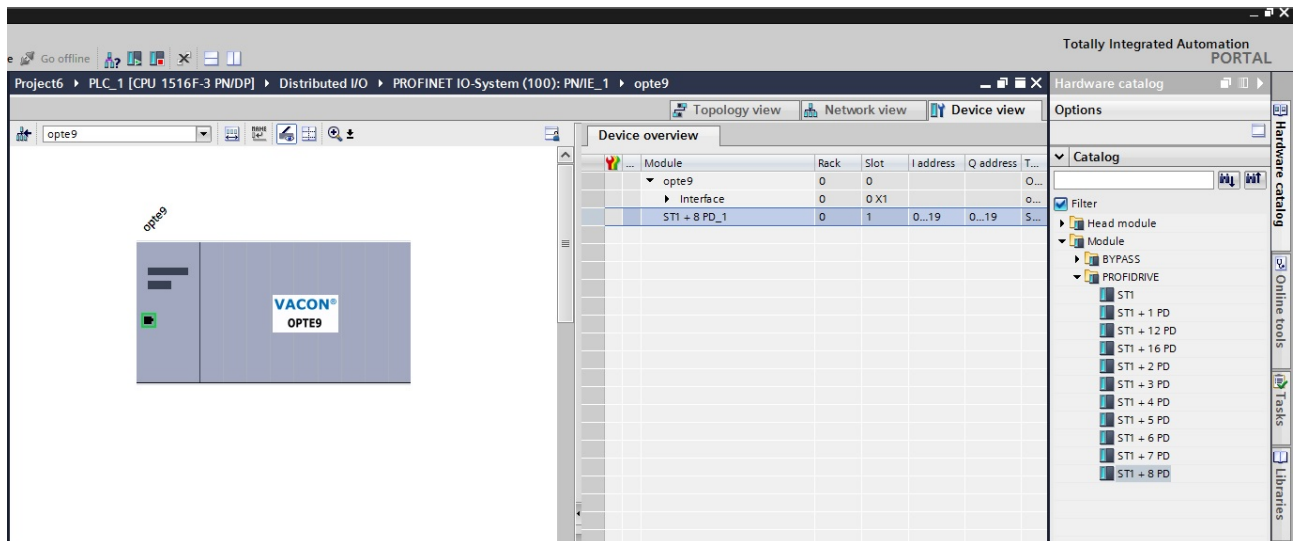




Drag and drop it to your Devices & networks view. Click the “Not assigned” link in the VACON® device and attach it to your PLC. Then your hardware configuration should look like in the following figure.



Double click on the VACON® device to configure the telegram. Insert the module “ST1 + 8PD” and drag and 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 in the figure below.

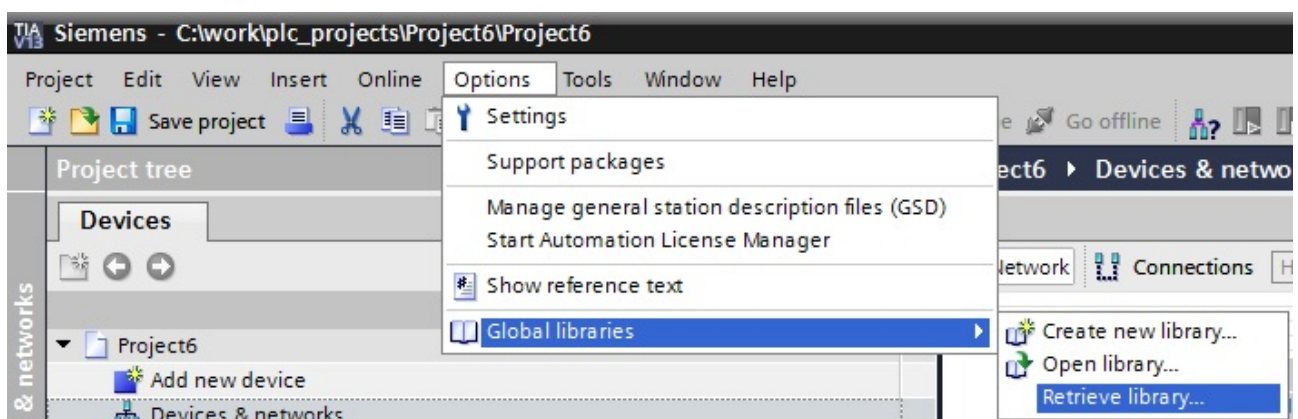


The values of fields named “I address” and “Q address” are used as inputs to the PROFIdrive control block and the VACON® control block. They are assigned automatically but can be freely edited if needed.

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 Options/Global libraries in the TIA Portal.



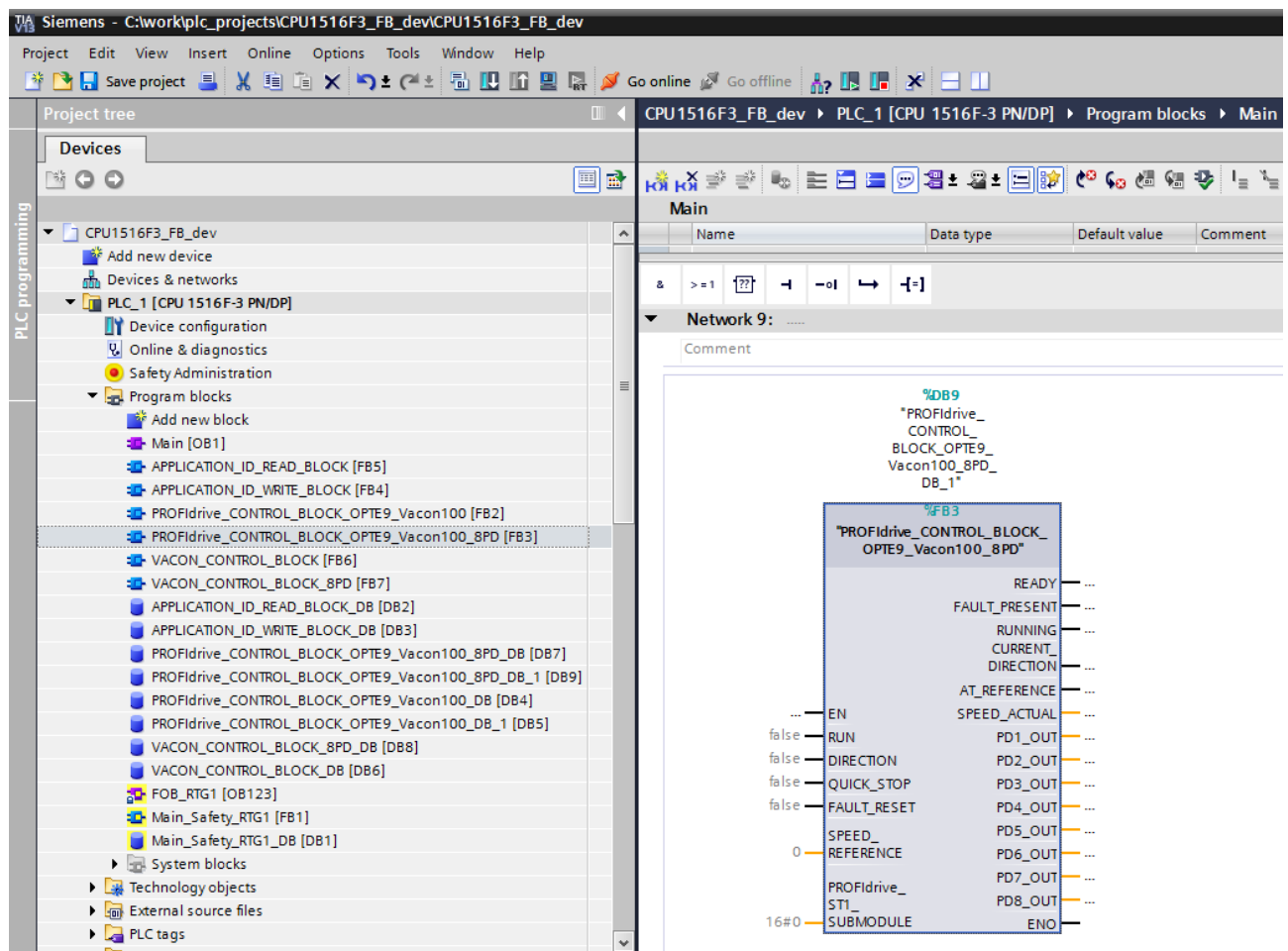
A dialog opens. Find the library named “VACON\_LIB\_S300.zal13” or “VACON\_LIB\_S1500.zal13” from your computer. This retrieves the library and adds it to your Global Libraries. Libraries are located on the right side of the TIA Portal window.

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

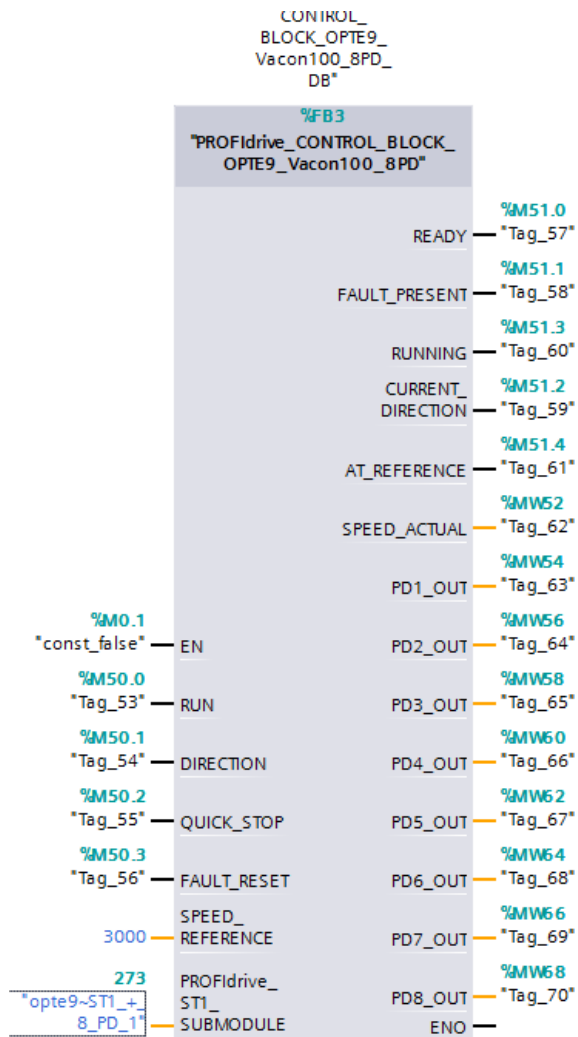
## 8.4 USING THE FUNCTION BLOCK

Double click the function 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.

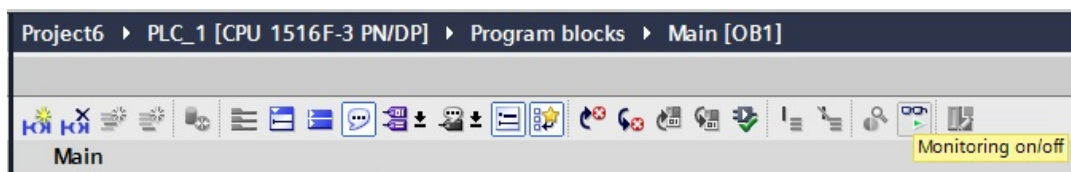
Inside the “Main [OB1]” are “Networks” that are executed whenever this function block is executed. To insert a function block to a “Network” just drag and drop a function block from the PLC’s program blocks to the network. This will create an instance of the function block and create a DB block where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



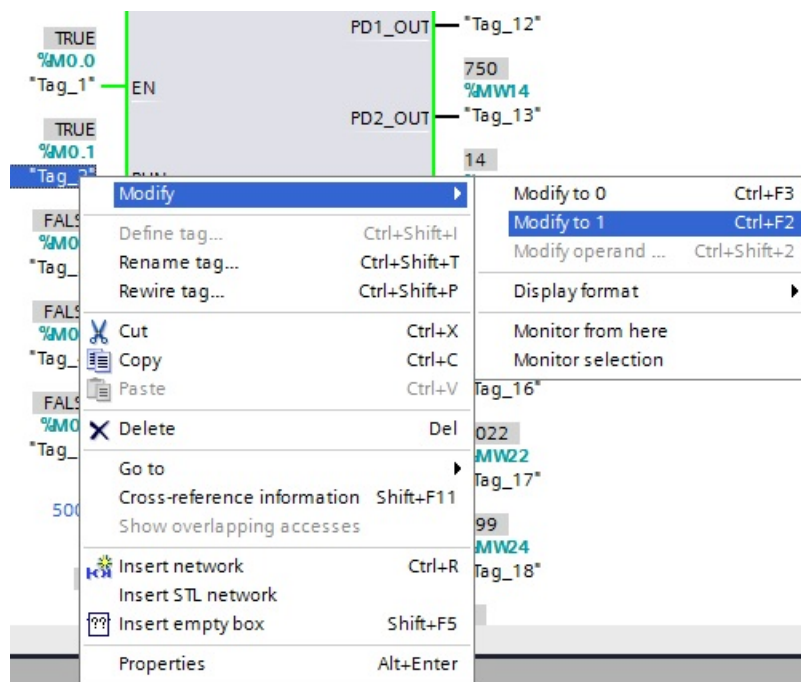
Now you can connect the signals you want to the function blocks inputs and outputs. To make a quick test, just map them to memory tags and then you can use the online mode to set the values of different inputs and see how the AC drive behaves. See an example mapping below.



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 the toolbar:



You will then see the current values of the function block interface. You can modify the input values by right clicking them. See an example below.



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

# VACON®

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