BACnet MSTP communication card

Overview

As a BACnet slave, it can realize operations such as the reading and writing of VFD process data and function codes, reading of VFD status words, and writing of VFD control words. The application layer supports setting 32 analog value objects and supports host controllers such as Yet Another BACnet Explorer (YABE) and PLC controller.

Features

In market demand, BACnet MS/TP is a data communication protocol used primarily in the building automation and HVAC (heating, ventilation and air conditioning) industries. The protocol supports devices such as fans, pumps and ventilation units to establish communication with PLCs. This facilitates a high level of automation in buildings.

The physical transmission medium for the bus is twisted pair (RS485 compliant), two-wire cable or fiber optic cable. The baud rate ranges from 9.6 kbit/s to 115.2 kbit/s. The maximum length of the bus cable is in the range of 100 m to 1200 m, depending on the selected transmission rate. A maximum of 31 nodes can be connected to the same network segment when repeaters are not used, while the number of nodes connected to the network (including repeaters and master nodes) can be increased to 127 when repeaters are used.

Table 4-1 BACnet MSTP card technical specifications

Category		Specifications
Main functions	Feature	● Supports the BACnet protocol and BACnet MSTP devices. ● Provides one BACnet MSTP port and supports half-duplex operations of 115.2kbps. ● Supports the line, star, and daisy chain connection network topologies, with the number of slave nodes up to 31. ● Supports timeout detection.
	Service	● Single-property reading service ● Multi-property reading service ● Single-property writing service ● Multi-property writing service ● I-Am service ● I-Have service ● Device communication control service ● Device re-initialization service
	Function	● Supports the setting of 32 analog objects. ● Supports the reading and writing of VFD process data and function codes, reading of VFD status words, and writing of VFD control words.

Category		Specifications
		● Supports host controllers such as YABE and PLC.
Others	Input power	Power voltage of 24V, current of 200mA, and maximum power of 4.8W
	Installation method	HD2 option, inserted to the slot
	Running environment temperature	-10 – +50 °C
	Storage temperature	-20 – +60 °C
	Relative humidity	5%–95% (No condensation)
	Distance	Up to 100 m (cable of shielded twisted pair or with magnetic ring) from the controller

Electrical wiring

1. Node selection

A node address is the unique address of a device on the bus, and the address number of a node is set by the function code P15.01.

2. Bus terminator

Each segment has a bus terminator at the head and at the tail to ensure error-free operation. The switches on the PCB are used to switch on the bus terminators, which prevent signal reflection at the bus cable end. If the communication card is the last or first module in the network, the bus terminator must be set to ON. When a D-sub connector with a built-in terminator is used, the communication card terminator must be disconnected.

Table 4-2 RS485 hardware specifications

Item	Description
Number of ports	1
Isolation	1.5kV electrical isolation
Standard	TIA/EIA-485
Communication speed and duplex	0.96k–115.2k baud (protocol depended), half-duplex
Connector type	Swappable, 3-bits, screw-type wiring board
Cable type	Cable of shielded twisted pair or with magnetic ring
Cable length	100 m
Topology	Line, star, and daisy chain connection
Unit load	1/8

Terminal wiring

control terminal layout

Table 4-3 BACnet MSTP card terminal layout

485+	485-	PGND	PE

control terminal functions

Table 4-4 BACnet MSTP card terminal functions

Signal	Port	Terminal function description
485+	RS-485	Positive differential signal
485-		Negative differential signal
PGND	/	Signal ground
PE	/	Earth

Table 4-5 Indicator functions

Indicator	Definition	Function		
LED1	Status indicator	On: The expansion card is establishing a connection with the control board. Blinking periodically: The expansion card is properly connected to the control board (the period is 1s, on for 0.5s, and off for the other 0.5s). Off: The expansion card is disconnected from the control board.		
LED2	Run indicator (Green)	Off	Not powered or in fault state	Not powered or in fault state
		Blinking periodically (on-off at a 0.5s interval)	Online. Waiting to receive BACnet data frames	Waiting to receive data
		On	BACnet communication state	Received BACnet data frames
LED3	Fault indicator (Red)	Off	No fault	No fault
		Blinking periodically (on-off at a 0.5s interval for twice and 2s off)	Faulty	Duplicate address. The VFD keypad reports E-bAC.
		Blinking periodically (on-off	Faulty	No BACnet data frames received in specified time.

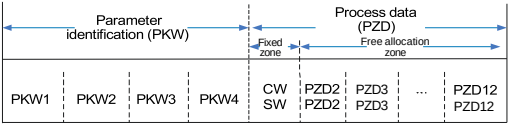
Indicator	Definition	Function		
		at a 0.5s interval for three times and 2s off)		(Timeout detection must be enabled, that is, the timeout time cannot be 0). The VFD keypad reports E-bAC.
LED4	Power indicator	It is on once the control board feeds power to the communication card.		
LED5	485TX indicator (Green)	Off	No transmission	The device does not transmit data on the RS485 network.
		Blinking	Transmitting	The device is transmitting data on the RS485 network.
		On	Transmitting	The device is transmitting data fast on the RS485 network.
LED6	485RX indicator (Green)	Off	No receiving	The device does not receive data on the RS485 network.
		Blinking	Receiving	The device is receiving data on the RS485 network.
		On	Receiving	The device is receiving data fast on the RS485 network.

Connecting the BACnet MSTP card to the PLC

Bus communication networking

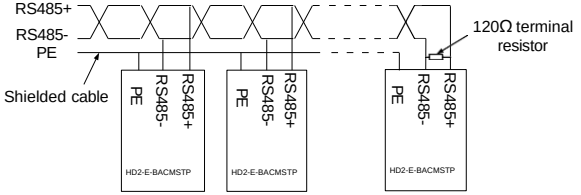
Communication packet structure

The communication data frame structure (PKW+PZD) of BACnet MSTP is similar to that of PROFINET. See the following figure.

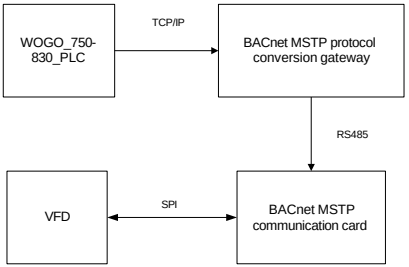


Networking topology

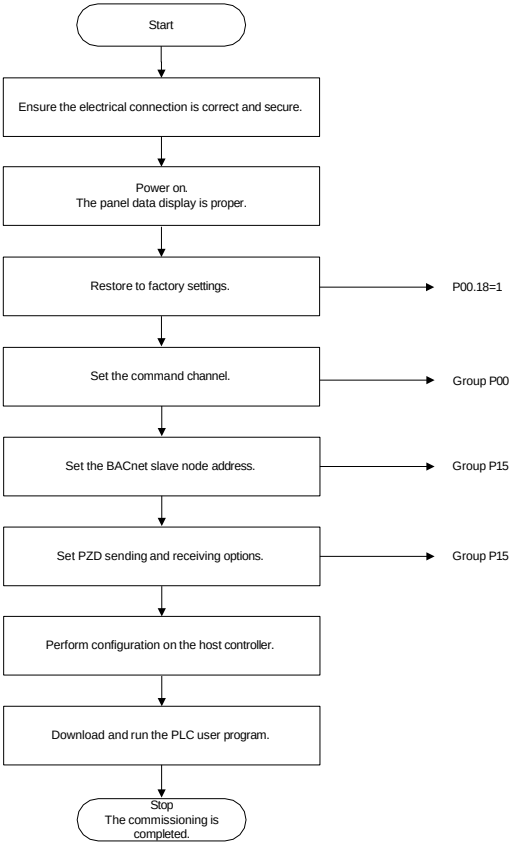
The BACnet MSTP communication card adopts standard 4-pin terminal interface, which can be used in line network topology, star network topology and daisy chain topology, and its electrical wiring diagram is shown in the following. BACnet MSTP cards form a communication network with the PLC by inserting a BACnet MSTP communication card into each unit.



Due to the constraints, the connection method currently used is to add the BACnet MSTP protocol conversion gateway between the PLC and the communication card. See the following figure.

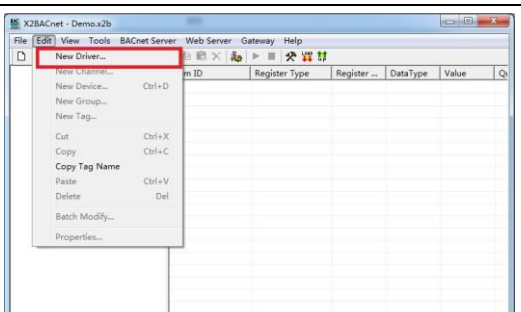


The BACnet MSTP networking commissioning flowchart is as follows.

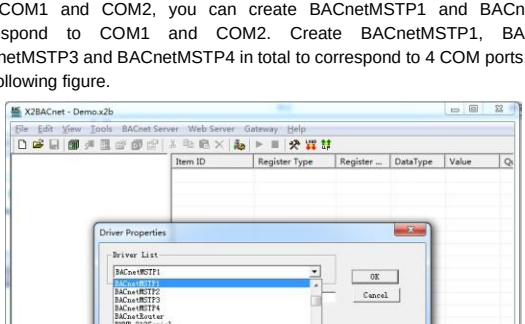


Configuring the BACnet MSTP protocol conversion gateway on the Sunfull PLC

1. Open X2BACnet, select the **New Driver** option in the menu bar of the host controller configuration interface, as shown below.

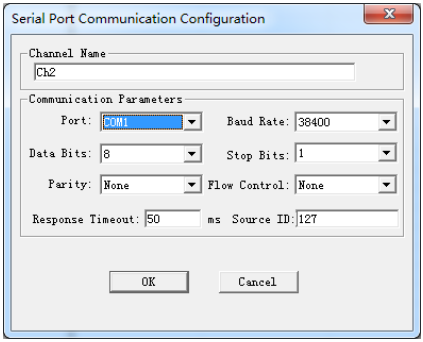


In the displayed window, select **BACnetMSTP1**. (For every COM port that is enabled to collect MSTP, an MSTP drive needs to be created. If two buses are used and there are COM1 and COM2, you can create BACnetMSTP1 and BACnetMSTP2 to correspond to COM1 and COM2. Create BACnetMSTP1, BACnetMSTP2, BACnetMSTP3 and BACnetMSTP4 in total to correspond to 4 COM ports, as shown in the following figure.

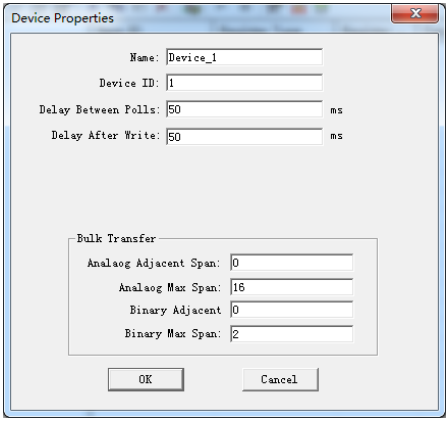


2. After drives are added, choose to create channels. As serial communication, the default BACnet MSTP channel serial port is COM1, and the other default communication parameters are as follows: 38400bps baud rate, 8 data bits, 1 stop bit,

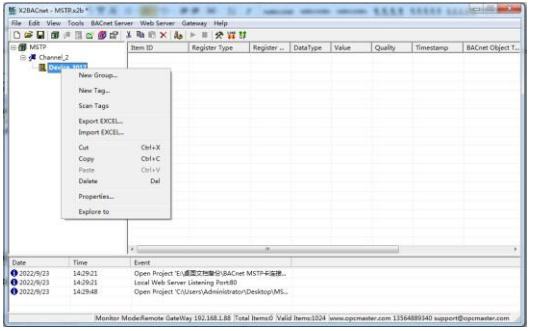
no parity bit, 50ms timeout time (the timeout time does not need to be modified in most cases), and master node MAC address of 127, which is not recommended to modify. See the following figure.



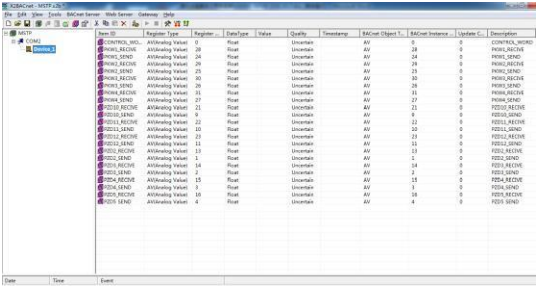
After the channel is created, choose **New Device**, set the device properties in the pop-up dialog box, including the device ID. You can query which devices are online on the bus through BACnetScan automatic scanning. The request frame interval (**Delay Between Polls**) is 50 milliseconds. See following figure.



3. Choose **Scan Tags** to scan the device for all tags. See the following figure.

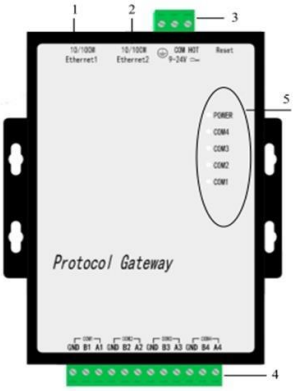


X2BACnet connects to the BACnet MSTP card through RS485. Add all scanned records, and save the project. See the following figure.

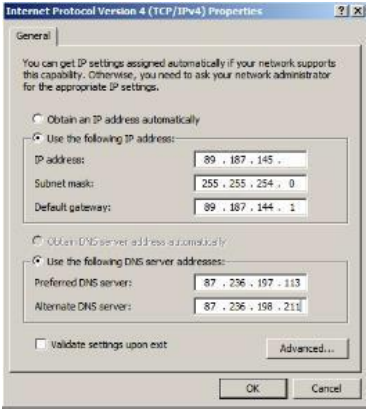


4. The PC port connects to port 2 of the protocol gateway 192.168.1.88. COM2 connects to the RS485 port of the BACnet MSTP card. Set the PC port properties. See the following figure.

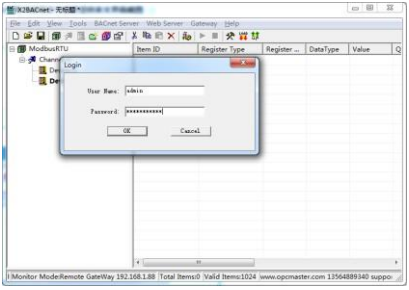
Open the X2BACnet host controller and import the saved project.



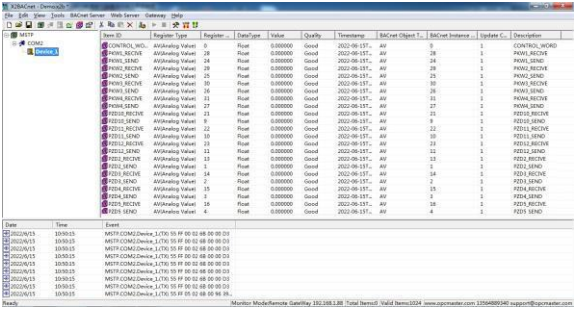
1. Port 1
2. Port 2
3. AC/DC power 24V
4. Fully electrical isolated 4-channel RS485 port
5. LED communication indicators



Click to upload the project to the gateway. Enter the user name and password in the pop-up dialog box. The user name is fixed to **admin**, and the password is fixed to **admin123456**. Then you can set the system parameters related to the gateway. See the following figure.



You can choose the monitoring mode under **Monitor Mode** in the toolbar, or double click **Monitor Mode** in the bottom status bar to switch the mode. To use gateway monitoring, you need to switch the monitoring mode to gateway mode. Configure the project in X2BACnet and upload it to the hardware gateway to realize the protocol conversion function through the hardware gateway. Click ▶ to start monitoring on the X2BACnet software to monitor the communication status of the hardware gateway simultaneously. See the following figure.



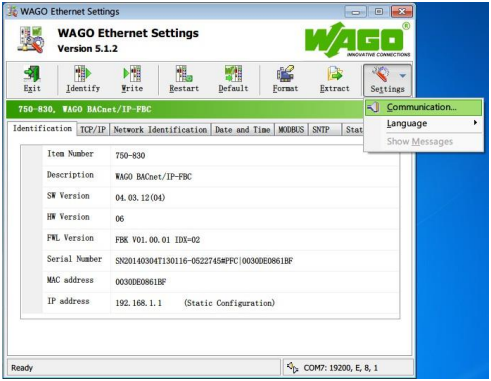
The configuration is completed.

Configuring WOGO 750-830 PLC

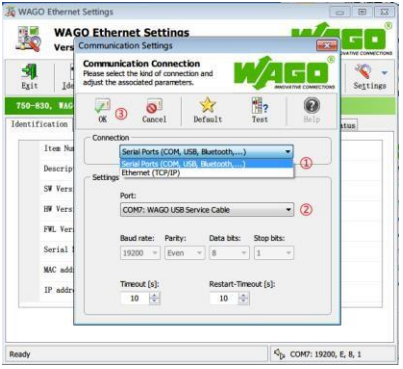
Connect the PLC to your PC with a network cable. Set your PC IP address (such as 192.168.1.250) on your network. Connect the PLC to the PC USB port with a burn-in cable for setting the PLC IP address (such as 192.168.1.1)

Configuring the PLC (750-830) IP address through the WAGO Ethernet Settings

1. Open the WAGO Ethernet Settings software, click on **Settings** in the upper right corner, and then choose **Communication**, as shown in the following figure.

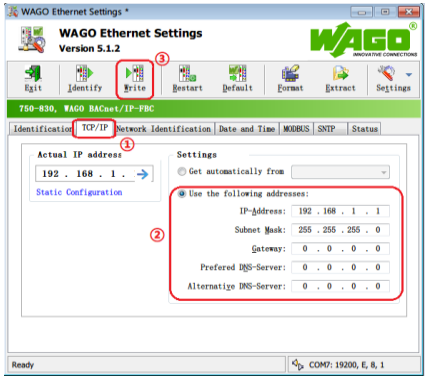


2. Select **Serial Ports** from the **Connection** drop-down list box, select the corresponding port number from the **Port** drop-down list box, and select the corresponding serial port number (which can be viewed in by choosing **Device Manager** > **Ports** on your PC), as shown in the following figure.



3. Click **Identify**, and wait for a while. If the PC and PLC are connected properly, the area in the red box as shown in the following figure will appear, showing information such as the PLC hardware and software versions, MAC address, and IP address. If the content in the red box area indicates that the connection has failed, check whether the connection between the PC and PLC is normal, as shown in the following figure.

4. Click **TCP/IP** and set the PLC IP address in red box ②, and ensure the PC IP address and the PLC IP address are in the same network segment. Then click **Write** to write the set IP address to the PLC. See the following figure.

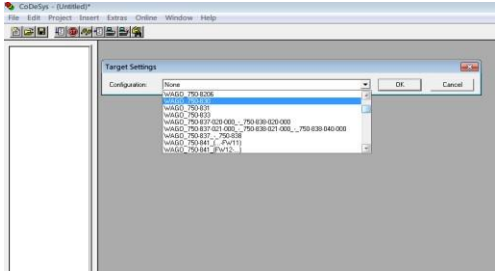


5. After the writing is successful, open CoDeSys V2.3.

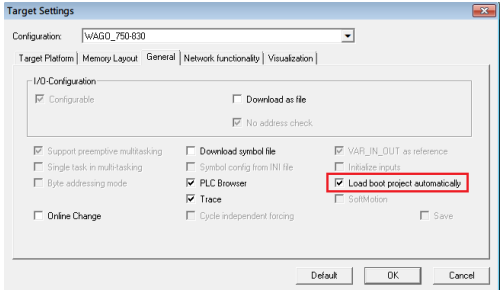
A. Use CoDeSys V2.3 to configure the PLC.

CoDeSys V2.3 has the same functions with WAGO-IO-PRO V2.3.

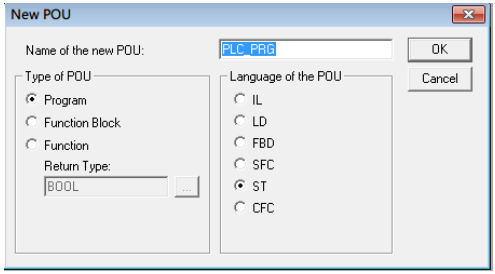
a) Open the CoDeSys software, click **File-New** to create a new document. The following window is displayed. Select the PLC model **WAGO_750-830** from the drop-down list box, and click **OK**. See the following figure.



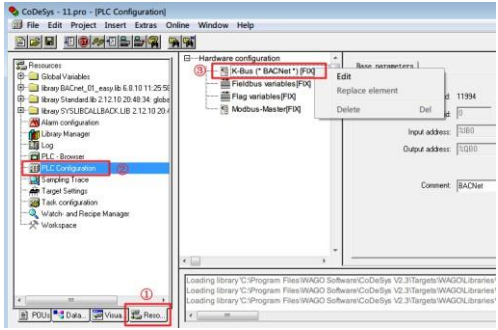
b) Click the **General** tab, choose **Load boot project automatically**, and click **OK**. See the following figure.



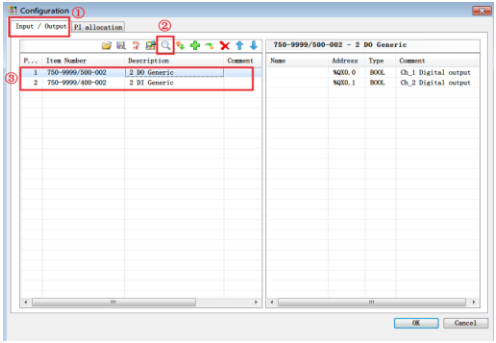
c) Create a POU program. Since the PLC must contain a PLC_PRG program, and keep the default settings and click **OK**. See the following figure.

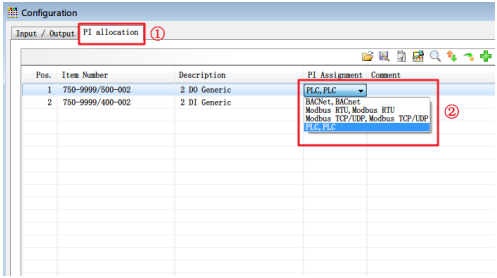


d) Configure the PLC hardware. Select **PLC Configuration** from the **Resource** drop-down list box. At the right, choose **Hardware configuration**, right-click **K-Bus**, and choose **Edit**. See the following figure.



e) Click the **Input/Output** tab in the **Configuration** dialog box. Click the icon in the toolbar to scan the devices on the PLC hardware bus. When the scan is completed, the devices in red box ③ will appear. Click on any device. The corresponding device address, data type and function description will appear in the right window. Select **PLC, PLC** from **PI Assignment** in the **PI allocation** tab, indicating the PLC controlled IO devices. If other types are selected, the IO devices are communication controlled. See the following figure.



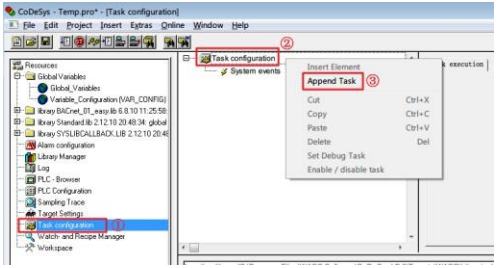


If no device is scanned, check the following:

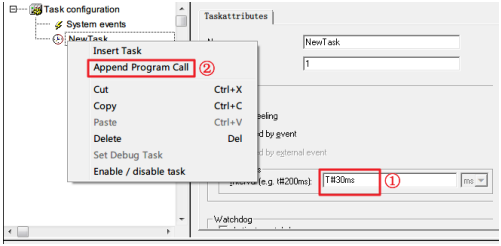
- Whether the PLC is properly powered.
- Whether the PLC and PC are connected properly and are in the same network segment.

f) Configure tasks.

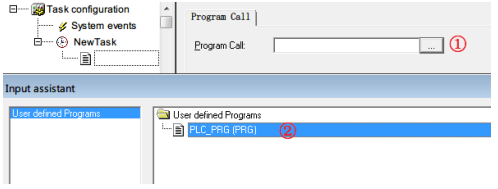
Create a task.



Set the circular interval to 30ms and append a program. See the following figure.



Select and add the program PLC_PRG. See the following figure.

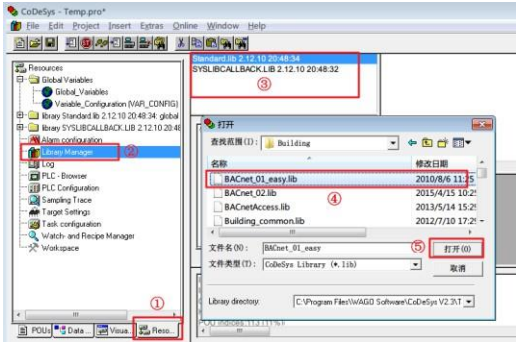


g) Import the BACnet library file.

Copy all files from **00_Libraries_BA** to the **Building** folder in the CoDeSys installation directory, for example, ***C:\Program Files\WAGO Software\CoDeSys V2.3\Targets\WAGO\Libraries\Building***.

After the copy is complete, choose **Library Manager** in the **Resource** tab in the CoDeSys main interface. Right-click on the blank area marked as ③, and choose Additional Library, choose **Building** > **BACnet_01_easy.lib**, and click **Open**. See

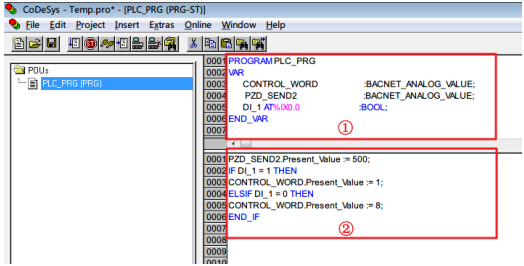
the following figure.



B. Create PLC programs.

This section describes how to write a simple application program, using the ST structured language for programming. The program achieves the following functions: If the VFD frequency is set to 5Hz, when the I0.0 terminal input of the digital input module 750–400 is high, the VFD runs forward; when the terminal input is low, the VFD decelerates to stop. (The VFD frequency is given by BACnet communication, the control mode is communication, and VFD received PZD2 is the set frequency.)

Variable declaration is in red box ①, and the main program is in red box ②. The format of data variable declaration is in the format of *Variable name*: *Data type of variable*.



Description of the content in red box ①:

CONTROL_WORD is VFD control word; **PZD_SEND2** is the given PZD of VFD, **DI_1** is the channel 0 of digital input module, and **%IX0.0** is the address of channel 0 of digital output module.

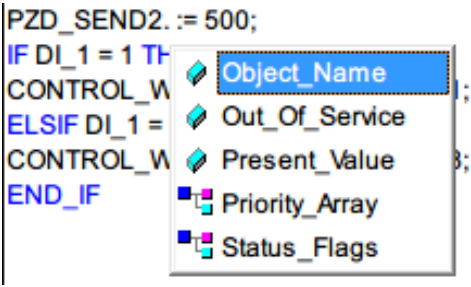
BACNET_ANALOG_VALUE is a data type of BACnet communication, which is defined in the library file **BACnet_01_easy.lib**.

```
PROGRAM PLC_PRG
VAR
  CONTROL_WORD                    :BACNET_ANALOG_VALUE;
   PZD_SEND2                      :BACNET_ANALOG_VALUE;
  DI_1 AT%IX0.0                                  :BOOL;
END_VAR
```

Description of the content in red box ②:

PZD_SEND2: Several properties of this object can follow at the right of the decimal point.

Present_Value indicates the current value.



The syntax ":=" is the assignment symbol.

```
PZD_SEND2.Present_Value := 500;
IF DI_1 = 1 THEN
CONTROL_WORD.Present_Value := 1;
ELSIF DI_1 = 0 THEN
CONTROL_WORD.Present_Value := 8;
```

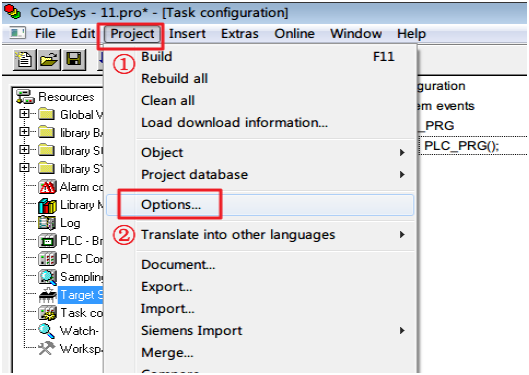
END_IF

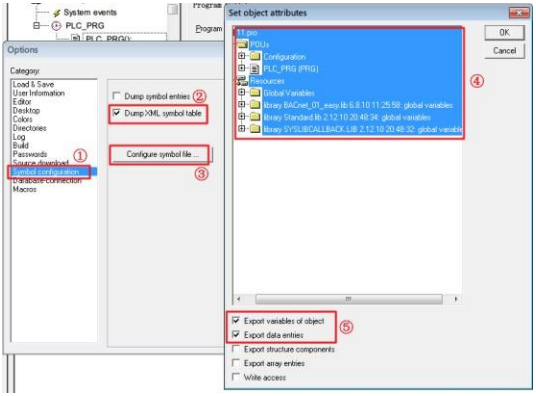
After the program is completed, press F11 to compile the project and proceed to the next step if there are no errors.

Note: After the program is completed, the PLC does not control the VFD directly, and you need to map the defined variables to the VFD variable table through **WAGO BACnet configurator**. Next, you need to generate the **SYM_XML variable** table and import it into the **WAGO BACnet configurator**.

C. Configure the symbol file.

In the main interface, choose **Project** > **Options** from the menu bar. In the pop-up **Options** dialog box, select **Dump XML Symbol table**, and click **Configura symbol file**. In the pop-up **Set object attributes** dialog box, select all, as shown in red box ④, and select the two items shown in red box ⑤. See the following figures.





After the setup, when the POU program is completed and the PLC is in login state, the file ***xxx*.sys_xml** (*xxx* is the project name) will be generated automatically and saved in the created project folder.

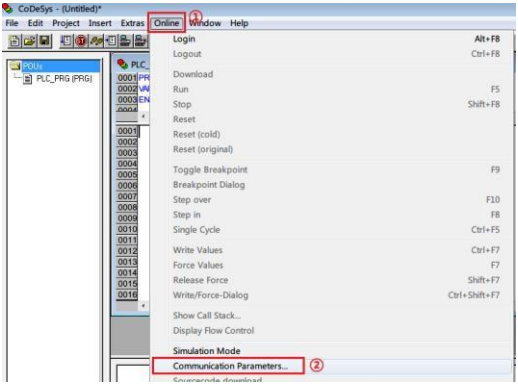
The **SYS_XML** file contains all variables in the project and can be imported directly into the **WAGO BACnet configurator** to configure the properties of each variable or object. This file is essential for the subsequent use of the PLC.

Note:

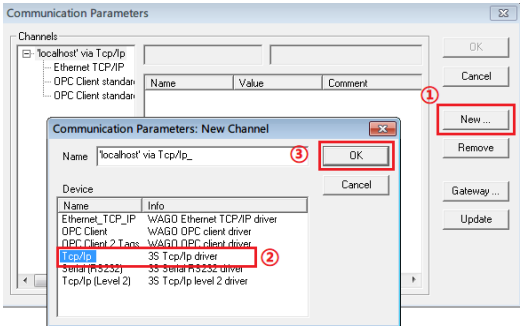
- If the system prompts that there is no relevant file locally during the generation process, you need to check whether the project built in CoDySys has been saved.
- If there are no variables declared in the POU program in the generated variable table, you need to check whether you have followed the steps in e) strictly.
- The XML file is generated only during the first PLC login. If the POU program has not changed, the XML file will not be regenerated subsequently, even if you log in again.

D. Download the program to the PLC to generate the **SYM_XML** file.

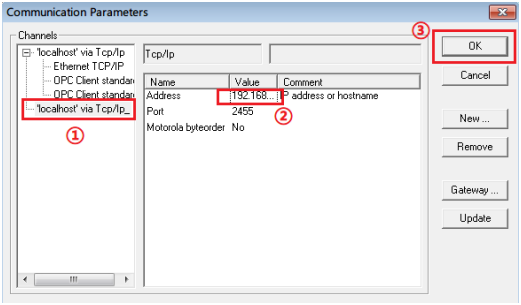
a) Choose **Online** > **Communication Parameters**. See the following figure.



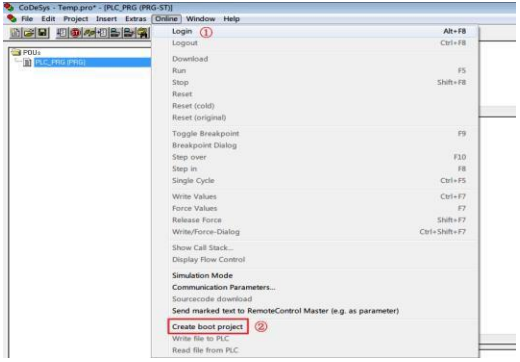
b) In the **Communication Parameters** window, click the **NEW** button. Select **Tcp/Ip (3S Tcp/Ip driver)** in the new pop-up window, and then click **OK**. See the following figure.



c) Select the newly created channel in the **Communication Parameters** window, and then fill in the PLC IP address in the **Value** column next to **Address**, and click **OK**. See the following figure.



d) Choose **Online** > **Login** on the menu bar. The software will compile the project and generate the **SYM_XML** file, which is located in the root directory of the project. After that, choose **Create boot project** to import the program file into the PLC, so that the PLC can run independently even if the PLC is disconnected from the PC. See the following figure.

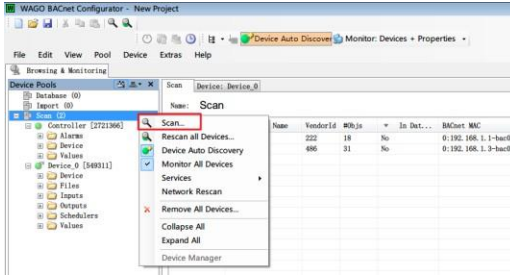


E. Configure the PLC through the WAGO BACnet configurator.

a) Set the IP addresses of the PLC, PC, VFD and other slave stations, which are required to be in the same network segment, and connect each node through the network cable.

b) Open the WAGO BACnet configurator and it will automatically scan the devices on the bus. Alternatively, scan manually by right-clicking on **Device Pools-Scan**

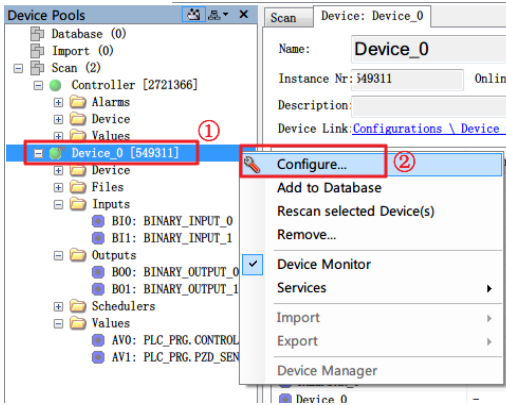
and choosing **Scan**. See the following figure.



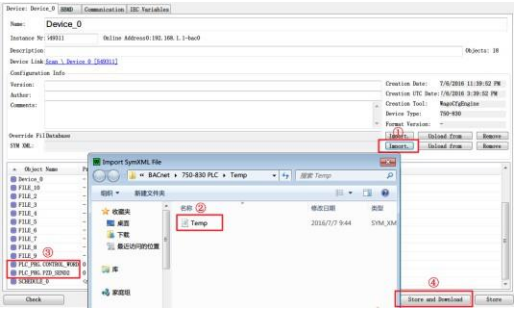
In the preceding figure, **Controller [2721366]** is the VFD node in the bus and **Device_0 [549311]** is the PLC node. The numeric part in [] is the decimal number converted from this node MAC address.

c) Import the **SYM_XML** file.

Right click on **Device_0** (PLC device), and choose **Configure**. See the following figure.



Import the previously generated **SYM_XML** file. After successful import, the objects (CONTROL_WORD, PZD_SEND2) declared in the previous project will appear in area ③. See the following figure.



Note:

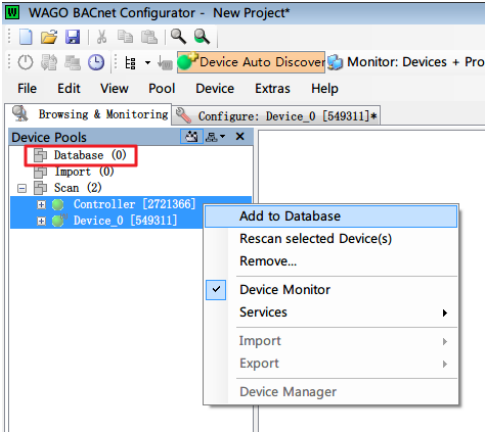
- After the import is completed, check the I/O indicator of the PLC. If the import is correct, the indicator is steady on in green. If it is blinking in red periodically, you need to follow the instructions to perform troubleshooting.
- You can check the PLC status through the **Status** window of WAGO Ethernet Settings.
- For details about PLC panel indicators, see WAGO 750-830 description document.

d) Map PLC variables to VFD variables.

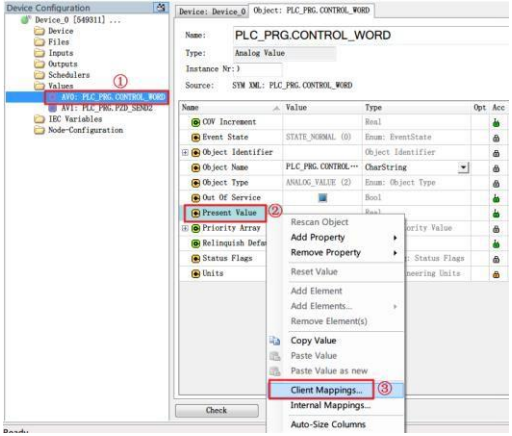
Since the WAGO 750-830 PLC can only be used as a slave, not as a master, when used in a BACnet network. In actual use, it is necessary to map the relevant variables of the VFD or other devices to the PLC so that the VFD can be controlled by only operating the mapped address in the PLC through the PLC program.

The following example associates the **CONTROL_WORD** control word in the PLC program with the **CONTROL_WORD** in the VFD to control VFD startup, stop, and reset. The associated operations of other variables are similar.

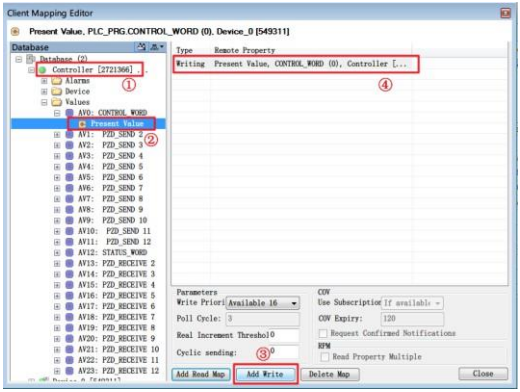
a) Select all devices that are scanned through the Scan menu. Right-click **Add to Database**. Choose **Device Pools** > **Database** to view the added devices. See the following figure.



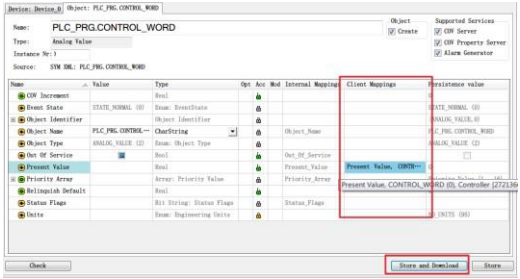
b) Access the **Configuration** interface of Device_0 (PLC device). Chose **Values** > **AV0: PLC_PRG.CONRTOL_WORD**. In the right area, choose **Present Value** > **Client Mappings**. See the following figure.



c) In the **Client Mapping Editor** window, select the VFD variable to be mapped with the PLC variable **AV0: PLC_PRG.CONRTOL_WORD**. Select **Controller – AV0: CONTROL_WORD-Present Value**, and click **Add Write**. See the following figure.



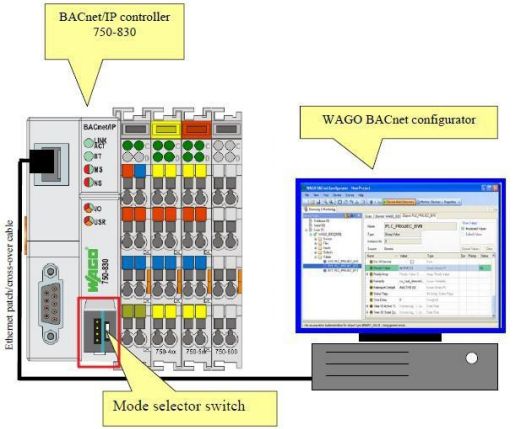
d) You can view the added variable in the **Client Mappings** column in the property window of the PLC variable **AV0: PLC_PRG.CONRTOL_WORD**. Map other variables with the same method. After mapping all variables, click **Store and Download** to download the property to the PLC. See the following figure.



F. Run the program.

Disconnect the PLC from the PC. Slide the PLC run switch to the top. The mode selection switch is in the red rectangular in the following figure. When the switch is

slid to the top, it is in the running state. See the following figure.

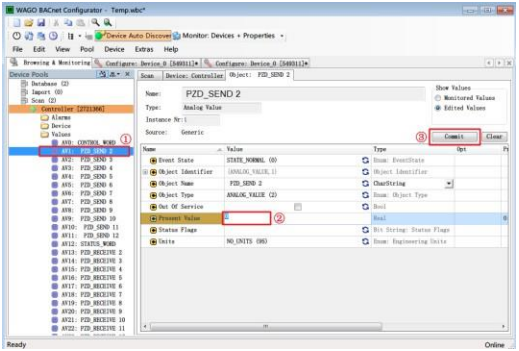


Controlling the VFD through WAGO BACnet configurator

If you only need to read and write VFD parameters and achieve basic control VFD functions, you can control the VFD directly through the WAGO BACnet configurator, without writing a PLC program.

1. Set the PZD related function codes of the VFD, and set the VFD control mode to communicate.

2. In the scanned devices, select the device (VFD) that needs to be controlled, and take **Controller [2721366]** as an example. Select the PZD functions or control words to be operated, taking **PZD_SEND2** as an example. Enter the required value in the **Present Value** field. Then click **Commit**.



Set other parameters in the same way.