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doi:10.15199/48.2024.06.26

Using KNX Virtual applications to learn how to program the KNX system

Abstract. *The paper presents a method of learning how to program the KNX system using the KNX Virtual application. This application, together with the ETS one, provides an opportunity to learn how to program the KNX system without the need for dedicated modules. With its help, it is possible to practise the entire programming process, from device parametrisation through uploading applications to devices, as well as observing their operation.*

Streszczenie. *W pracy przedstawiono sposób nauki programowania systemu KNX z wykorzystaniem aplikacji KNX Virtual. Aplikacja ta wraz z aplikacją ETS daje możliwość nauki programowania sytemu KNX bez konieczności posiadania dedykowanych modułów. Za jej pomocą możliwe jest ćwiczenie całego procesu programowania począwszy od parametryzację urządzeń poprzez wgrywanie aplikacji do urządzeń poprzez możliwość obserwacji ich działania. (**Wykorzystanie aplikacji KNX Virtual do nauki programowania systemu KNX**)*

Keywords: KNX, programing, KNX Virtual
Słowa kluczowe: KNX, programowanie, KNX Virtual

Introduction

Building automation is currently the basic element of the technical infrastructure of a modern building [1]. Its task is to supervise the individual functions of the building and to control the operation of other installations. Moreover, it enables ongoing monitoring as well as archiving events and cooperation with other SCADA systems [2-4]. Despite the use of devices with a high energy class or specially designed device components [5], it is not possible to achieve a high energy efficiency class of the building [1, 6]. This is of particular importance in the light of the regulations [7]. Another argument in favour of the use of building automation is to ensure the appropriate microclimate in the building. In the case of such an installation, it is easier because the system has information from sensors and can adjust the operation of the HVAC (heating, ventilation, air conditioning) system accordingly. In addition, having building automation, you can program scenarios of events depending on a given situation, e.g. in emergency situations [8].

There are many solutions on the market offered as building automation. Each system differs in many factors. One of them is the transmission medium, there are wired and wireless systems. Another factor is how system data are made available to the user. Here we distinguish between open and closed systems. Whether the system is open or closed is evidenced by the fact that the system manufacturer provides information about a given system, e.g. in the form of a standard [9]. Another important issue that distinguishes the systems is the method of controlling the operation of a given installation. Here, we can distinguish decentralised systems and ones with a central unit. Systems with a central unit, despite being cheaper and easier to program, are being pushed out of the market. Currently, decentralised systems are used more and more often due to their lower failure rate.

One of the most popular building automation systems is the KNX system. This system was created in the late 1990s from the combination of Batibus, EIB and EHS [10]. As a standard, it was published in 2003 in the form of EN 50090 [11]. However, in 2006 it was presented as the international standard ISO/IEC 14543-3 [12]. KNX belongs to open systems, which means that the communication protocol and other technical parameters of data transfer are available in the form of a standard [4]. The openness of the system allows different manufacturers to produce components compatible with this system. According to the data available on the KNX website [13], currently under the KNX brand products from over 500 manufacturers are available, while there are over 8,000 of all types of devices with the KNX certificate on the market.

According to the authors in [14], by using KNX automation it is possible to save from 35% to 48% of energy, or even up to 50% as reported by the authors in [15].

To be able to program devices in the KNX standard, one must have the ETS (Engineering Tool Software) application. Currently, version 6.1 of the ETS application is available for download. In addition to the ETS application, the database of individual modules must be downloaded from the device manufacturer's website. These databases are free and available on the websites of device manufacturers. Having an application and a database, we can create a building structure or familiarise ourselves with the available functions of individual devices. However, by changing the settings without uploading them to the devices, we are not able to determine whether the device works in accordance with our vision. While one can download the demo version of the ETS application from the KNX Association website and become familiar with this application, learning how to program the KNX system without having the appropriate modules is not possible. Only in conjunction with the KNX Virtual application is it possible to learn how to program the system, from parameterisation of modules to observation of the operation of a given module.

The purpose of this study is to present the ways of configuring the ETS application with the KNX Virtual application and to present the possibilities of its application.

System KNX

The KNX system has a three-level structure. The smallest part of the system is the line, which can contain up to 64 devices, and in the case of using line amplifiers, up to 255 devices. If this number of devices is insufficient, 15 lines can be connected to create an area. Subsequently, 15 areas can be connected to form a system [16]. KNX standard modules can communicate using several transmission media. These are:

- twisted pair – TP,
- power line – PL,
- radio frequency – RF,
- Ethernet IP [17].

The most popular solution is Twisted Pair. At the same time, it should be remembered that this solution should be foreseen already at the building design stage, so as not to interfere with its construction later. In the case of a TP bus, the most popular topology is the tree topology. In addition to transmitting data, the bus is also used to power individual modules (Figure 1).

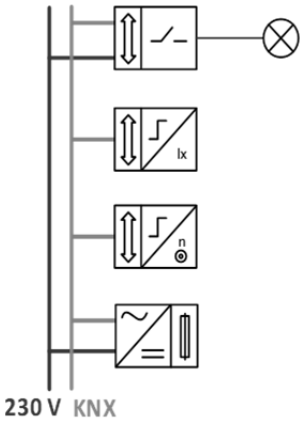

Fig. 1. KNX system scheme

In addition, some executive modules need a 230 V power supply. KNX system elements are divided into:

- Actors – executive elements,
- Sensors – elements collecting information from the environment,
- System components for proper system operation.

KNX Virtual

KNX Virtual is a free tool for registered users. This application is designed to work with the ETS application. To learn how to program the KNX system using this tool, one should download the KNX Association directory from the ETS application database, as shown in Figure 2.

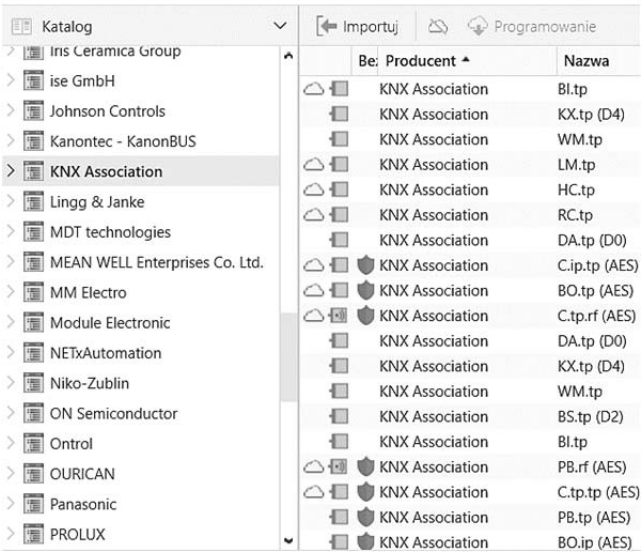

Fig. 2. ETS application database

In this catalogue we have 27 virtual modules from D0 to D26. Among the available modules we have basic sensors such as: schwitching or binary input, and on the side of actors, for example: blinds control or dimming. Virtual modules, like real modules, have the ability to configure individual parameters. The list of available modules is shown in Figure 3.

ID	OrderNr	Description	DevType
D0	DA.tp	Dimming Actuator	$2500
D1	PB.tp	Push Button Interface (AES)	$2501
D2	BS.tp	Blinds/Shutter Actuator	$2502
D3	BO.tp	Binary Output (AES)	$2503
D4	KX.tp	KliX	$2504
D5	C.tp.tp	TP/TP Coupler (AES)	$2505
D6	VA.tp	Valve Actuator	$2506
D7	SA.tp	Switching Actuator	$2507
D9	AM.tp	Alarm Module	$2509
D10	MP.tp	Movement/Presence Detector	$2510
D11	BI.tp	Binary Input Module	$2511
D12	WM.tp	Weather Module	$2512
D13	SC.tp	Scenario Controller	$2513
D14	LM.tp	Logic Module	$2514
D15	SP.tp	Setpoint Manager	$2515
D16	HC.tp	Heat Controller	$2516
D17	HE.tp	Heat Exchanger	$2517
D18	C.tp.rf	TP/RF Coupler (AES)	$2518
D19	C.ip.tp	IP/TP Coupler (AES)	$2519
D21	RC.tp	Room Controller	$2521
D22	RC.tp	Room Controller	$2521
D23	RC.tp	Room Controller	$2521
D24	RC.tp	Room Controller	$2521
D25	BO.ip	Binary Output (AES)	$2525
D26	PB.rf	Push Button Interface (AES)	$2526

Fig. 3. List of available modules in the Virtual KNX application

In the case of virtual modules, the process of programming the installation itself is no different from programming the actual installation. There are the same programming steps, such as:

- creating the building structure,
- adding appropriate modules to rooms,
- parameterisation of devices,
- creating address groups (Figure 4).

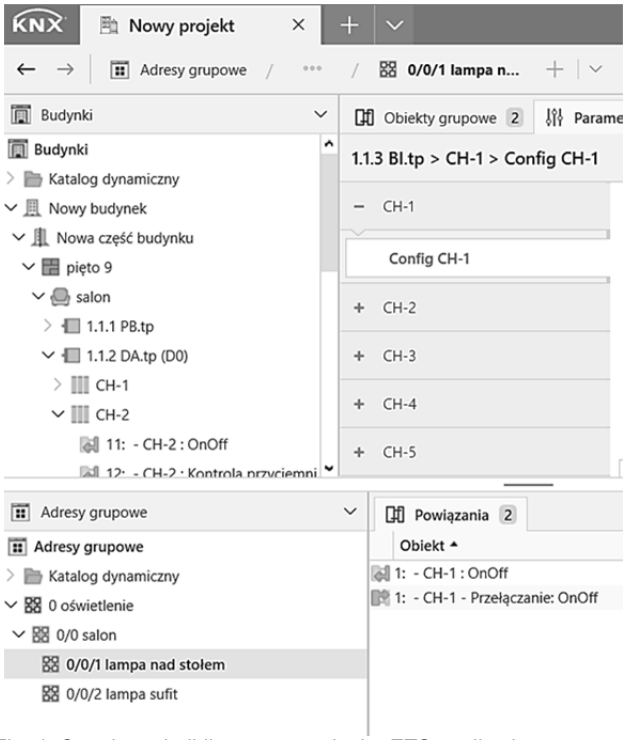

Fig. 4. Creating a building structure in the ETS application

The next step is to connect the ETS application to the KNX Virtual application. To do this, start the KNX Virtual application. The application's IP address and a port number will be displayed on the start page (Figure 5).

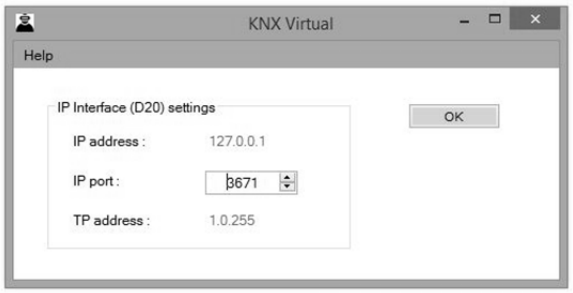

Fig. 5. Starting window of the KNX Virtual application

Then, a virtual KNX Virtual port will appear in the ETS application bus interface window, as in Figure 6.

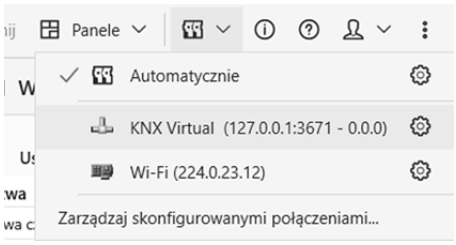

Fig. 6. KNX Virtual adress

Segment	ID	OrderNr	AES	Description
S1	D25	BO.ip	No	Binary Output
	D19^			Undefined: block/block
S2	D19_	C.ip.tp	No	IP/TP Coupler
	D0	DA.tp	-	Dimming Actuator
	D2	BS.tp	-	Blinds/Shutter Actuator
	D4	KX.tp	-	KliX
	D7	SA.tp	-	Switching Actuator
	D13	SC.tp	-	Scenario Controller
	D14	LM.tp	-	Logic Module
	D20	I.ip.tp	-	IP/TP Interface
	D5^			Undefined: block/block
S3	D5_	C.tp.tp	No	TP/TP Coupler
	D1	PB.tp	No	Push Button Interface
	D3	BO.tp	No	Binary Output
	D6	VA.tp	-	Valve Actuator
	D9	AM.tp	-	Alarm Module
	D10	MP.tp	-	Movement/Presence Detector
	D11	BI.tp	-	Binary Input Module
	D12	WM.tp	-	Weather Module
	D15	SP.tp	-	Setpoint Manager
	D16	HC.tp	-	Heat Controller
	D17	HE.tp	-	Heat Exchanger
	D21	RC.tp	-	Room Controller
	D22	RC.tp	-	Room Controller
	D23	RC.tp	-	Room Controller
	D24	RC.tp	-	Room Controller
	D18^			Undefined: block/block
S4	D18_	C.tp.rf	No	TP/RF Coupler
	D26	PB.rf	No	Push Button Interface

Fig. 7. Indicating a specific module in the KNX application

Select this port so that the ETS application is paired with the KNX Virtual application.

Then one can start programming the modules. To do this, select the module in the ETS application and select the "Download" command. The ETS application will wait until the module to which the setting is to be uploaded is indicated. Indicating the appropriate module is important because when programming the installation in a building, it may happen that a given switchboard may contain two or more modules with the same marking. But each of them has different components and circuits attached to it. In the case of the KNX Virtual application, the module to which the application is to be loaded is indicated by pressing the programming button (red cell, figure 7).

An additional advantage of KNX Virtual is the ability to observe the reaction of individual modules to the signal from the sensor. This is done by animating the movement of roller shutters or interactive icons of light sources. This is especially important for beginners who do not fully understand the meaning of individual parameters (Figure 8a,8b).

a)

b)

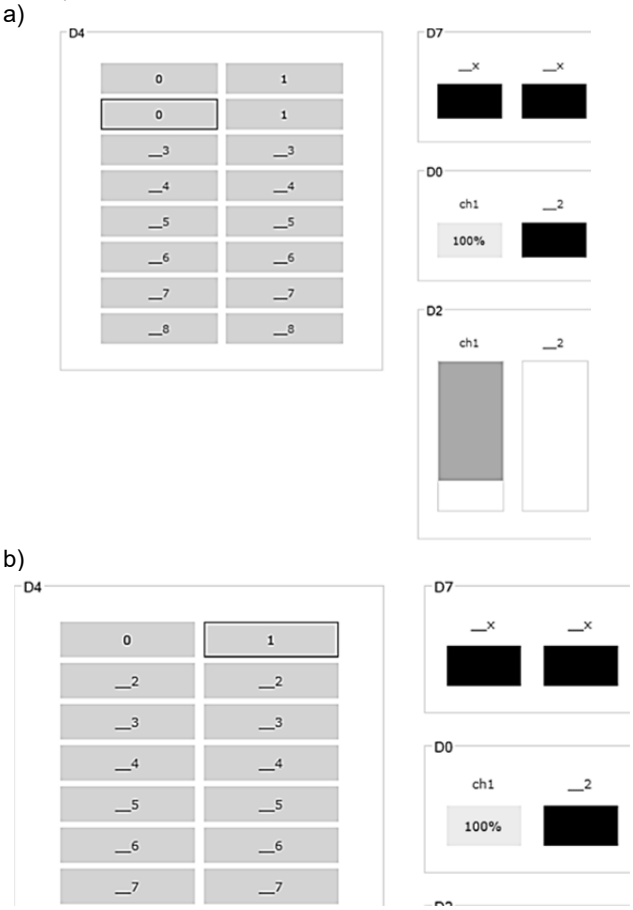

Fig. 8. Animation of the roller shutter (D2 module) and the light on (D0 module)

Similarly, in the case of other modules, it is possible to simulate the appropriate operating conditions. In the case of weather modules, it is possible to simulate changes in temperature, light intensity, wind speed or measure the amount of rainfall. The table with the above parameters is shown in Figure 9.

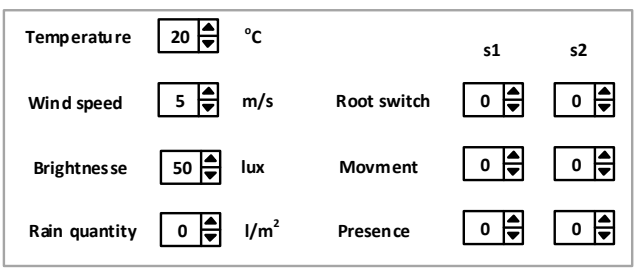

Fig. 9. Simulation of atmospheric parameters

KNX Virtual also offers diagnostic tools such as Telegram Tracer, which allows to monitor telegrams sent to the bus. An example window is shown in Figure 10.

Nr.	Device	HC	BUS	AES	GA
			start		
1	D4	6	AL: GroupWrite	-	0/0/1
2	D0	6	AL	-	0/0/1
3	D4	6	AL	-	0/0/1
4	D4	6	AL: GroupWrite	-	0/0/1
5	D0	6	AL	-	0/0/1
6	D4	6	AL	-	0/0/1

Fig. 8. Telegram tracer

Conclusion

The KNX Virtual tool is used to learn how to program building automation in the KNX standard. By using it it is possible to map individual stages of programming the entire installation without the need to have appropriate modules, and to check the operation of the created system in the initial phase. The disadvantage of this solution is the poor number of simulated modules and the low functionality of the models used to simulate the operation of individual modules connected in the system. An additional disadvantage is the inability to simulate real modules. In order to know the effect of parameterisation, especially for more complex modules, it is necessary to purchase a given module and observe its operation.

By using the KNX Virtual application it is possible to learn how to program building automation devices in the KNX standard. This application allows to perform all the activities carried out when programming real modules. By using various types of animations, it is possible to preview the work of individual modules. The disadvantage of this application is the need to upload virtual modules, the functionality of which differs from real modules.

The KNX Virtual application can be used in initial projects of simple building automation systems. Due to the discrepancies between the virtual modules and those offered by manufacturers, it is necessary to have KNX system modules in the final phase of the project.

Funding

Internal grant FD-20/EE-2/410.

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