# HOME AUTOMATION SYSTEMS OVERVIEW

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# 1 Table of Contents

# 2 INTRODUCTION

This guide provides an insight into a "smart house", that is a dwelling equipped with an „intelligent "system, able to control several equipment's and services, and is designed for all those who are planning a new building or renovating an old one, or for those who are simple curious and interested in what it means to have a "smart house".
Reading it you will learn which are the special features of a smart home system, which are the basic and advanced services a smart home can offer to you, what is the fundamental difference between a standard electric system and a smart home system, and a lot of other insider information that, as a simple customer, you will never be made aware.

## 2.1 WHAT EXACTLY IS A "Home Automation"

Traditionally, houses, apartments, business premises and buildings for various purposes consist of separate electrical devices and systems where each of them requires separate handling and work independently of each other.
Usually, in our homes, we cannot open the door from the TV remote or cannot change the radio station by the wall switches. This is because every system works on its own and does not communicate with the others.
A "smart house" is actually a dwelling where an organized home automation system connects all the electrical devices to manage lighting, heating, air conditioning, ventilation, security (burglar) alarm system, audio and video system, call devices, energy control equipment's, presence, automation (door, windows, blinds, gates), technical alarms (for example in case of unwanted water spillage) etcetera.
A smart home is thus created by connecting separate parts of household installations such as lighting, heating, cooling, blinds, sensors, etc. into a common system. This form of automation results in a reduced need for human interaction and in an increase of comfort and safety, the provision of additional benefits and improved energy efficiency.
First of all, we must be aware that neither the electrical system nor the house itself are smart or intelligent, as they have not programmed themselves, they do not learn on their own from their mistakes and do not correct them (except in the case they are equipped with an artificial intelligent system!). However, „smart home system "or „smart house ", as far as marketing is concerned, are well known terms that can be traced in all media.
Second, by increasing energy efficiency, i.e., reducing electricity consumption, we reduce our carbon imp, which is in line with current European and world policies.

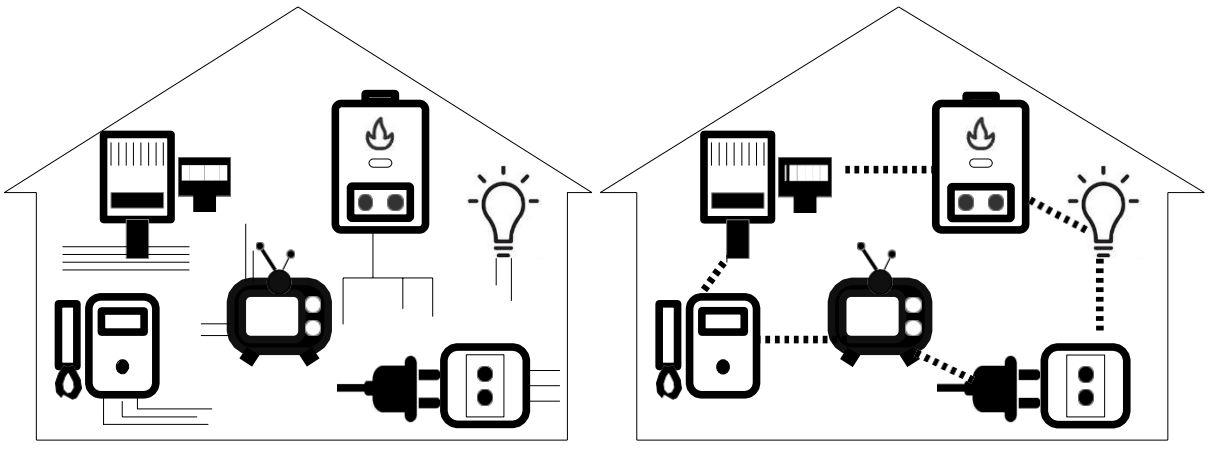

*Fig. 1: standard electrical systems versus home Automation system*

## 2.2 HOME AND BUILDING AUTOMATION

When we think of home automation, or smart home systems, or demotics as it is often called, we thus think of smart thermostats, motion sensor controlled lighting and automated heating and ventilation systems. It can be defined as the use of a set of devices that controls basic home functions and features automatically and sometimes remotely.
But if we consider a building, instead of a house, the offered services and the users' needs can be different. Most of the time, the rooms of a building are used especially during the day, there are dozens or hundreds or even thousands of devices to be controlled, there are equipment's thatusually we don't have at home (for example an elevator, fan coils, escalators) and a special attention to access control, energy saving, security (maybe the owner of an office building is less interested in entertainment and more interested in who can enter which space)
A common definition of Building Automation could be "An automation system that includes a comprehensive and coordinated control of one or more major system functions required in a facility."
Smart home systems (or home automation systems) and Building automation systems (offend abbreviated to BA systems) are therefore "brothers": they share the same technologies and the same aptitude for control, with a slightly different point of view regarding implemented functions and number of controlled devices.

## 2.3 FUNCTIONS YOU CAN DO WITH A SMART HOME SYSTEM

Let's take a look at some of the things a smart home system can do.

### 1. Lighting:

lighting is the most important and most commonly used electrical thing in your home. At the moment, our lifestyle is such that we spend most of our time at home in the evenings. Since there is not enough natural light at that time, we replace it with artificial light.

In some rooms at home, it is recommended to use lighting with the possibility of dimming or even changing the lighting temperature (light color).
Such rooms are not just living rooms and bedrooms where you would like to achieve different light scenes, but can also be a hallway between the bedroom and bathroom or children's room.
Think about having to visit the toilet at night. In order not to injure yourself or break something, or by accident step on that sharp toy that your baby forgot in the middle of the hallway, it's a good idea to light up your path. In order not to be blinded by too much light, it is more pleasant if the light in the hallway shines with reduced intensity at night. We also would not like to wake up others.
A similar situation can occur if your child wakes up in the middle of the night due to bad dreams and you try to calm him (her) down and put him (her) to sleep as quickly as possible. If you turn on the light when entering the child's room, the child may think it is already morning and will be all happy, as his (her) dad or mom came to play in his room.
On the other hand, many children find it difficult to fall asleep in pitch dark. The dim light in his (her) room can help you slowly put him (her) to sleep at lower and lower light intensities.
Smart homes usually have lighting outside as well. With different lamps, you can create different scenes and atmospheres in front of your home. If we are talking about the case that you are outside, it is advisable to use the option of remote switching on and of these lamps. This will allow you to operate the outdoor lamps with a remote control (or smartphone) in your pocket as needed, without having to go into the house each time.

*Fig. 2: outdoor lighting*

With a smart home system, you are able to control all kind of lamps, in on/off or dimming mode, choosing the best interface suitable for you (a simple pushbutton or a remote interface, for example using your smartphone or a remote controller). You can decide which lamp or group of lamps to turn on or off, you can set a certain time of the day when you want the lamp to turn on, you can decide some "scenes" (the first lamp at 100% of its intensity, the second at 50% and the third one at 20%) or also some lighting profiles (for 1 hour the lamp is at 70%, then for 25 minutes is at 40%, then for 5 minutes is at 15%...)

You can also use another feature for the same thing, as your home wireless network always knows where you are because you always have your smartphone with you. This way, the driveway to the house will light up as soon as you get close enough to your home without having to turn it on yourself over the phone.

At night, set the outdoor lighting to auto-off so it won't light up all night. It will turn on again if someone invited or uninvited comes to visit. Your smart house will inform you about his arrival by outdoor lighting.

## 2. Heating:

heating is one of the sub systems always present in a dwelling. Some users maybe live in a building and have a central heating with radiators. In this case you can install thermostatic valves, connected to the smart home system, and control them room by room, setting different temperatures. Others maybe live in a townhouse or in a villa. In this case you can have an underfloor heating with a hydraulic manifold, and can install more zone valves with actuators connected to the smart home system.


*Fig. 3: thermostatic valves*

With these devices you have control over the heating at home even via a smartphone. An added value is that it even can save on your heating bill, by heating only when and where you need.

## 3. Scenarios:

a „scene “is used for setting a group of commands that acts on their actuators with different values. Typical examples are lighting scenes for different occasions (party, romantic dinner, TV watching etc.).
If you have a house with two or three floors the task of closing or opening all the windows can take a certain amount of time. But if you have a smart home system, at the front door you can

install a switch on the wall, with which you can turn off all the lights in the apartment at the moment you leave home with just one push of a button. If this example is not sufficient, try to imagine to have a small hotel or bed breakfast with 10 rooms. The possibility to send a command to several different actuators can be very useful.
A scene does not have to deal only with lighting. A „cinema scene “could for example involve a specific management of lights, the rolling shutters of the room all lowered, the video projector on and the motorized screen activated.

## 4. Anti-burglary system:

most of the smart home system producers sell devices that provide anti- theft functions, from the lowest level (just presence sensors and a siren) to the highest one (connection with the police or with a security service in case the anti-theft system fires).
If a burglar breaks into your home the smart home system can also trigger the rapid blinking of all the lights in the apartment (similar to a stroboscopic light) in order to confuse the burglar as much as possible. Hopefully, a loud alarm and crazy flashing lights will be enough to turn the burglar escaping into the night.

## 5. Presence simulation:

even the best anti-burglary system in the world will not distract a determined burglar. But there is something the smart home system might be able to do.

Do you remember the scene from the movie Alone at Home, starring Macauley Culkin, in which two burglars stopped a van in front of their house and saw that there is a party going on in the house? There was music playing in the background, a cardboard-cut figure of Michael Jordan riding around the room on a children's train. With the help of various strings and levers, Kevin managed to control some other puppets too, thus creating the impression that someone was at home.

A smart home system can provide a presence simulation feature that is much more advanced than the aforementioned movie story. It records your commands during any day, such as:

- when individual lights in the house were turned on and off,
- raised and lowered blinds in each room,
- changed light luminous in rooms,
- changed color of RGB LED lamps ...

When you leave home for a long time e.g., holiday, you can activate the presence simulation function by pressing a single key before leaving the house. This one will play all the saved commands so that on the outside it will look like you are still physically at home.

This way, you can record what’s going on for a day, a week, or even a month just to make the playback of the recording look as real as possible.

The described operation represents a great advantage in terms of safety compared to simple timers that turn the lighting on and off every day at the same time. A potential burglar can observe your home before the burglary and find that the blinds go up and down, the lights turn on and off at completely different times during the day or week. This can already make a difference whether he will break into your home or not.

## 6. Alarm clock and room control:

*if* you want to be sure to wake up at the right moment, for sure youwill use an alarm clock.
A smart home system can give you the possibility not only to set more alarm clocks, but also to be connected to the children's room (for example with a tablet or a smartphone) and at once turn on the lights in the room to the maximum and raise the blinds.
Of course, a teenager can get up and simply turn off the lights and lower the blinds back. With a simple push of a button, you can lock (block) the operation of the switches that operate the lights and blinds in the child's room, thus preventing it.

## 7. Weather control:

your smart home system can be equipped with a weather module, able to measure data such as rain intensity, humidity, wind speed and so on. In case you are not at home and suddenly it starts to rain, the system can close the windows, in order not to wet the floor, for example. Or in case of strong wind, it can raise the awning, in order not to damage it.

## 8. Automation:

when you get home, you can use the remote control or smartphone to turn on the opening of the door before the entrance to the house and the opening of the garage door.
Using electrical motors, managed by smart actuators connected to the smart home system, you can automate almost everything: doors, windows, blinds, gates, screens, even armchairs and sofa.
In the same way you can control also third-party devices, that can be integrated in the smart home system control, like stairlift, equipment's for disabled and so on.

## 9. Safety:

undoubtedly, the safety of those close to us is more important to everyone than money and material goods. Protecting your home is absolutely necessary today, as it provides you with compensation in the event of a fire, burglary ... However, you must do everything you can to prevent such accidents.

Various events detected by sensors in the smart home as well as data on heating, room temperature, light status, ventilation and so on are processed in real time. This means that the system will notify the user of the event as soon as it occurs and not later. At the same time, all these events can be automatically stored in the event database, for the needs of possible later analysis. When you get home, you can watch these events or not, and you can receive the most important things on your smartphone even when you are not at home.

The smart home system provides a connection between various important functions about safety. With the alarm system you can connect the electrical installation as well as sensors of movement, smoke, $CO_2$, water spill, open windows and doors, energy consumption measurements. With their help, you can protect your home from damage and reduce side effects due to accidental events.
*Energy efficiency:* households use energy for various purposes: space and water heating, space cooling, cooking, lighting, electrical appliances and other end-uses. Most of the time a user is not aware of the energy consumption required by the used equipment, and in this case just only the opportunity to monitor it could reduce energy wastes.

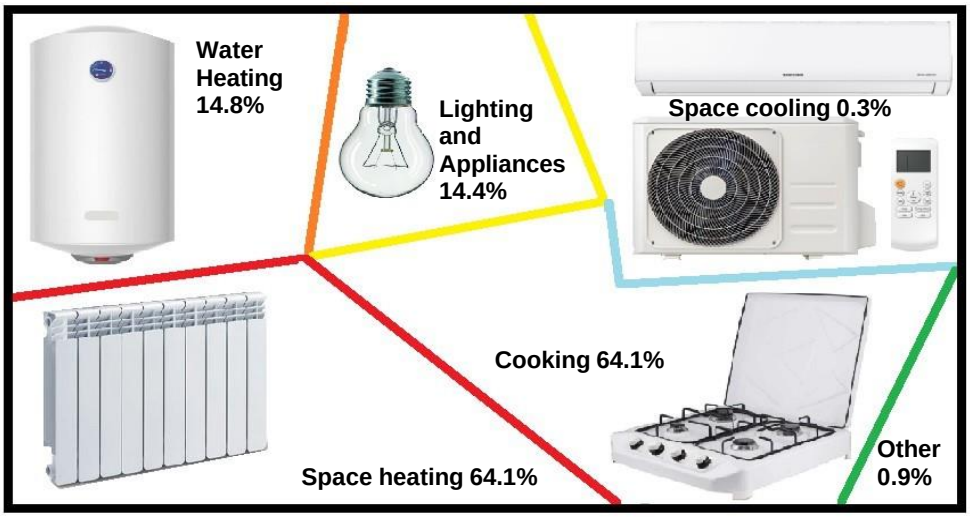


*Fig. 4: energy consumption in EU households*

A smart home system can measure and display the energy consumption of all the devices connected to the electrical system, can set a power threshold that must not be exceeded in order to prevent the general circuit breaker trigger, can activate an appliance when the energy tariff is more convenient, can turn off light and heating when nobody is in the room. Beside this, it can be interfaced with every kind of renewable energy production system.

Smart home systems, with their smart thermostats, presence sensors and energy monitoring devices are forging a path to a brighter, greener future – and saving us some cash along the way.

*Remote control of your house:* inside you house, to control all the devices and functions you can use switches, push buttons, touchscreens and even a voice control interface.

But if you are really in a hurry from home and you only remember later on the road or at work that you did not press the „Turn off all lights "button when you left, you can simply log in to your smart home system with your smartphone, tablet or computer and do so. The majority of the smart home system manufacturer gives you today the possibility to have a remote-control interface, and most of the time it consists in a web page where you can log in (with your name and password) and check the state of every equipment and every subsystem.

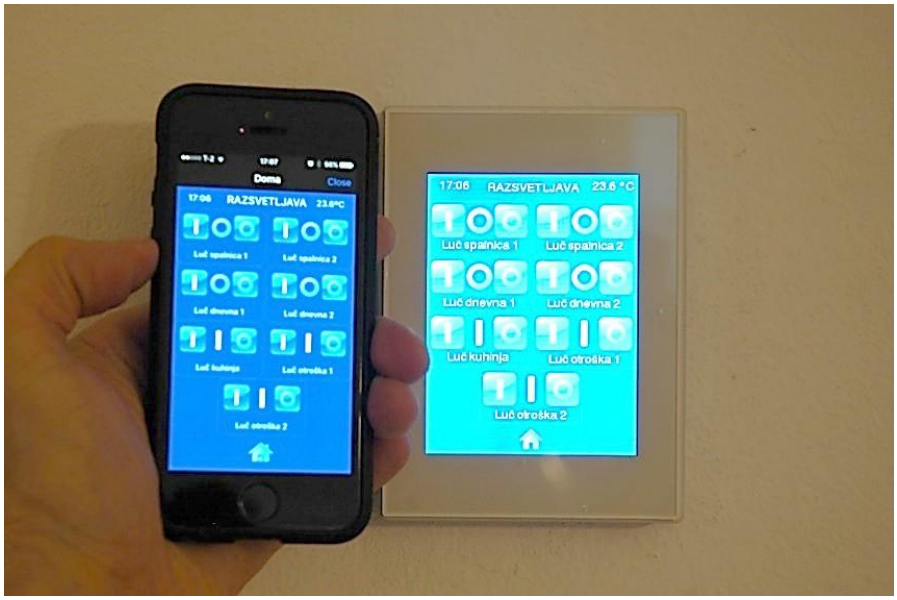


*Fig. 5: smartphone control of the house*

We have listed here the most common and used set of functions a smart home system can perform, but there are endless possibilities of usage. With such a system you can control the watering system, you can integrate smart appliances, telemedicine devices and every type of electrical equipment you may want to use.

# 3 STRUCTURE OF A SMART HOME SYSTEM

While in a standard electrical system the command and the power connection functions are performed by the same device (the switch), in a smart home system these two roles are separated: the command function is performed by a „smart switch “and the powerline connection function is performed by a „smart actuator “.
Both the commands and the actuators must be able to transmit and receive information, thus they are connected to a communication bus which is also the infrastructure that powers them. This bus runs through all the smart modules of the system, starting from a power supply device.

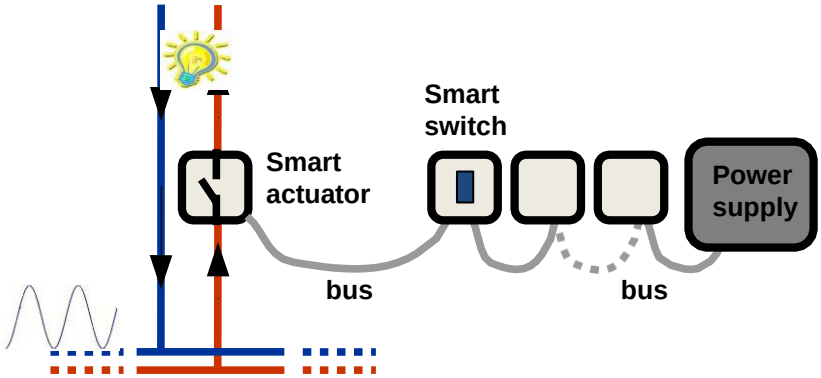


*Fig. 6: smart home system infrastructure*

A smart home system is a modern electrical installation of a building, i.e., a set of decentralized electrical output elements for the purpose of electricity distribution to terminal devices, decentralized communication and input elements for information collection, management and communication, wired to a common communication bus for interaction, automation operation of

various building systems and devices, with the ability to optimize energy consumption in the building.
In order for devices to be able to exchange information with each other, they must be configured to understand the protocols that allow them to communicate with each other.
The fact that a smart home system is decentralized means that there is no central vital point (e.g., a central computer or controller) that would cause the system to suddenly shut down. Each communication element of the system is parameterized separately and in case of failure of one element, the others continue with normal operation.
In a smart home system, we distinguish between the energy distribution part of the installation (230 V) and the communication part of the installation (BUS) connected to low voltage (typically in the range 20 – 30 Vdc) as shown in Figure 20.

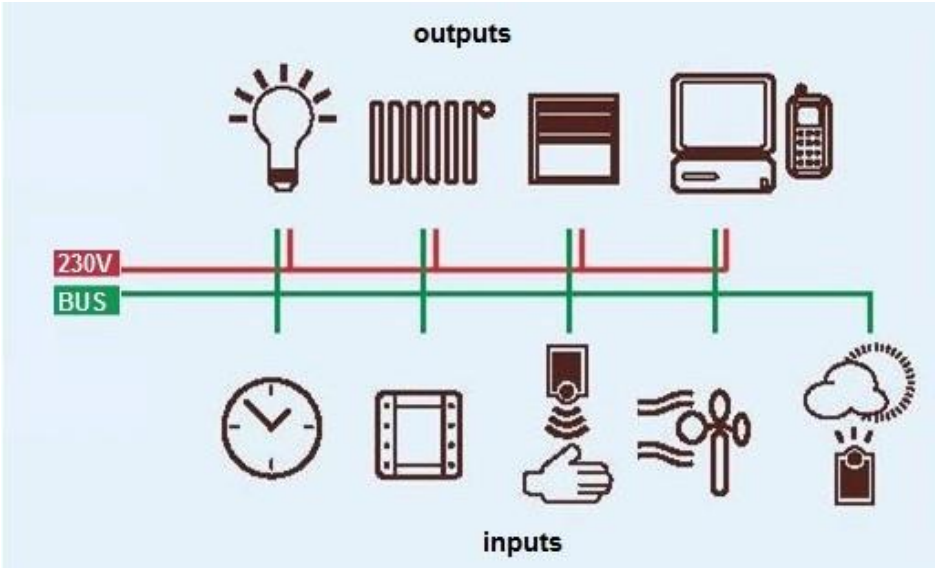


*Fig. 7: energy and bus distribution in a smart home system*

Each end device is connected to the energy part of the installation and to the communication bus via the appropriate actuator, while control devices (pushbuttons, switches, sensors, thermostats, etc.) are connected only to the communication bus.
Since all elements, input and output, are connected to the communication bus, interaction between different systems and devices is possible (e.g., information on current temperature, wind speed, glare, light intensity, space occupancy, measured by a sensor and can be used as input information for each device in the system).
Due to the possibility of interaction between different systems a higher level of regulation and management of the system is achieved, thus enabling greater energy savings in the building.
Once a smart home system is implemented, it has the ability to repurpose and change the functionality of executive functions (e.g., reorganize or repurpose space) by adding new controls to the existing communication bus or by replacing the actuator itself.

## 3.1 MODULES OF A SMART HOME SYSTEM

In functional terms, the components of a smart installation can be divided into:

- system elements
- input elements
- output elements (actuators)

## 3.2 Some examples of system elements are:

- Power supply unit: it generates a low DC voltage that powers all the smart modules of the system. Overlapped on this voltage there is also a digital small signal that allows data communication among all the input and output elements.

*Fig 8: power supply unit*

- Gateways or interfaces: allow the integration of other devices that use other communication protocols. For example, below we can see the DALI/KNX gateway used to add to the system some lighting features, equipped with the DALI control protocol, on the KNX communication bus.

*Fig. 9: KNX/DALI gateway*

- IP router: allows the smart home system of the building to be displayed on various devices (PC, tablet, smartphone) via a WEB browser. Also, with an IP "router" we can configure and manage smart home system remotely, from another location.

*Fig. 10: IP router*

- 230 VDC / 24 VDC rectifier: serves as a low voltage (24 VDC) power supply for some smart home system elements (e.g., meteorological stations)


*Fig. 11: 230 VDC / 24 VDC rectifier*

- Bus cable: used for wiring all elements of a smart home system and connecting them into a single control - monitoring system.

*Fig. 12: bus cable*

## 3.3 Some examples of input elements are:

- The outdoor weather station (meteorological station) is equipped with sensors to monitor and measure current outdoor conditions (wind, rain, temperature, daylight). It is placed on the front of the building.

*Fig. 13: weather station*

- The window contact is placed on the window to monitor the opening of the blind.

*Fig. 14: window contact*

- Input binary module: allows non-smart information from input elements (egg window contacts,switches, thermostats, hygrostats) to be integrated into a smart home system

*Fig. 15: input binary module*

- Room control unit: equipped with a temperature sensor that measures the temperature in the room. There is a screen on which it is possible to see the set and current values with programmable keys, for manual control of room devices and equipment (egg lighting, blinds, fan coils).


*Fig 16: room control unit*

- Multi-smart button: equipped with several programmable buttons, for the purpose of manual control of room devices and equipment (e.g., pumps, fans, valves).

*Fig. 17: multi-smart button*

- Digital clock: enables the function of real-time monitoring and switching on or off the elements of the smart system according to the annual time program. It has the ASTRO function (switching on / off the outdoor lighting depending on the geographical position of the building and the season of sunrise / sunset) and contains several program channels.


*Fig. 18: digital clock*

Multi-ceiling presence and lighting sensor: is a passive sensor for the presence of people andthe amount of daylight, designed for ceiling mounting, with a detection angle of 360°.

*Fig. 19: multi-ceiling presence and lighting sensor*

Some examples of output elements are:
- Switching actuator: is equipped with relay outputs and is used to turn on and off various electrical devices (lighting, motors ...).

*Fig. 20: switching actuator*

- Roller shutter actuator: is equipped with four 3-position switching outputs (opening, stop, closing), for connection of electric motor drives of window blinds.

*Fig. 21: roller shutter actuator*

- Fan coil actuator: designed to control the fan coil with variable ventilation speeds.

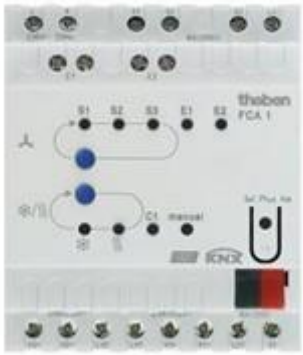

*Fig. 22: fan coil actuator*

# 4 CONCLUSION

We have now reached the end of this guide.
You have learnt a lot about smart home systems.
We have talked in general about net architectures, modules, topologies, communication media, addressing, software's, and then we have focused on Konnex, a very famous, robust and reliable smart home system standard.
You have now all the bases to draft a project, being able to consider every aspect that must be taken into account, from the first phase of designing and talking with the customers to the last part related to maintenance and further developments.
Every project is different, you have to be aware of that all the time. But they all contain steps that are the same for everyone. If you take the time at the beginning of the project to precisely define the task and produce accurate documentation, all further steps of the project will be easier and the project itself will be more manageable.
Of course, it is not mandatory for you to use Konnex: many other smart home system manufacturers exist all over the world, with good products and services offered.
The important thing is that you accurately study and know the technical details of the technology you have selected, with its advantages and disadvantages, and that you always offer a clear, honest and valuable service to your customers.

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