White Paper

KNX and EnOcean

New avenues in KNX building automation by integrating self-powered wireless sensors

Interaction between self-powered EnOcean sensors and a KNX solution unites the enhanced flexibility of wireless with the high performance of a bus. The result is a single consistent system of wireless, twisted pair and – if desired – IP (Ethernet) too. Expansion with KNXnet/IP means that the data of wireless sensors can also be used in very large-scale installations, and will present them on the Internet too.

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EnOcean technology was developed to detect sensor data without the need for batteries or an external supply of current, and to transmit them wirelessly. The wireless range is up to 30 meters in buildings, and up to 300 meters in the open. Minimal amounts of energy from the environment – some 50 microjoules per action – suffice to send a wireless telegram. Similar to the dynamo principle of generating energy for a bicycle light, a tiny electrodynamic transducer produces an electric voltage from finger pressure. The wireless telegram accompanying this is transmitted by the EnOcean wireless switch when the button is pressed or released. A KNX gateway receives the wireless signal and generates the appropriate KNX telegrams on the bus to switch something on and off, to dim or to adjust blinds.

Sensors intended to monitor their surroundings in cycles can be powered by a miniature solar cell. A small energy storage mechanism (Goldcap 0.1 F) charged during the day (minimum approx. 50 lx) serves to maintain functionality in the nighttime.

In a typical scenario the sensor is waked every 10 seconds for about 5 milliseconds to meter something. Any change in the metered value is transmitted. A socalled presence signal is sent after maximally 15 minutes. For 99.95 percent of the time a sensor is in a sleep state – with minimum current drain of its ultra-low-power timer, whose typical requirement of 100 nA dominates the energy balance.

But EnOcean also uses other energy sources from our surroundings – difference in heat for example – to generate voltage. Two degrees are sufficient for a thermal converter, currently being developed, to send a signal. That is less than the temperature difference between the air in a room and the surface of warm radiators or machine parts.

Secure wireless transmission – even in systems with hundreds of sensors

The principle of ultra-low-power wireless technology is simple: Energy is the product of power multiplied by time. The transmitting power (about 10 mW) determines the wireless range, so the technology must be extremely fast. EnOcean wireless telegrams are only about one thousandth of a second long (energy = 10 mW x 1 ms = approx. 10 microjoules), and are sent at a data transmission rate of 125 kilobits per second. The microprocessor and the RF transmitter of the wireless sensor are cut in for only a few milliseconds for each action, so they can be operated on the tiny amounts of ambient energy. The processor data come from connected sensor elements. The transmitted amount of data can be varied to match the requirement. A typical data transmission is 4 bytes. These data are given a 32-bit identification number and a checksum, and are sent by the RF transmitter as a digital data telegram. The EnOcean wireless signal is transmitted in the 868 MHz or 315 MHz frequency band, meaning it fits into solutions worldwide.

Little risk of collision through extremely short wireless telegrams

When a number of transmitters are operated on the same frequency there is, basically, a risk of two data telegrams being sent at the same time and their information thus colliding. The probability of EnOcean wireless telegrams colliding is nevertheless very slight because the signals are so short. Plus, the telegrams are transmitted consecutively three times with a random time offset in a matter of a few milliseconds. In this way a receiver can detect the signal intended for it even if there are hundreds of wireless sensors simultaneously working in its receiving radius. For further security each sensor sends its personal identification number as a 32-bit address. That makes it possible to differentiate more than 4,000,000,000 transmitters.

Ecological – no battery disposal and less radiation load than conventional light switches

In addition to the ecological aspect of constant battery consumption, the possible radiation load of a wireless system is often the focus of attention. The reputed ECOLOG Institute in Hannover examined low-power wireless light switches incorporating EnOcean technology. The results showed that the radiation produced by an EnOcean wireless switch is one hundred times less than that of a conventional wired switch. The reason is that with a conventional switch, during the actual switching, a broadband pulse is produced directly on the switch. This pulse virtually breaks down after a short gap, but nearly always strikes the person touching the switch.

In the case of a low-power wireless switch on the other hand, there is no spark chopping at the moment of switching, but instead a wireless signal of minimal energy is sent to a receiver for a thousandth of a second. The current

is switched on the relay, which is usually a few meters away from the person however, so the electric smog is absorbed in the air.

EnOcean sensor profiles

For reasons of energy, EnOcean wireless telegrams need to be kept as short as possible. So the sensor only informs its receiver during the single teach-in phase of its properties and data decoding. For this purpose there is the socalled EnOcean Equipment Profile (EEP), a telegram profile number that points to an interpretation table in the receiver. To ensure interoperability between devices from different manufacturers, a standard was defined for the teach-in procedure, data exchange and the EEP profile. To date the specification was restricted to unidirectional sensor communication (about 50 EEPs), but is currently being expanded to bidirectional sensor communication and bidirectional communication of a gateway with EnOcean wireless actuators.

Byte#	Description
SYNC_BYTE 0	Synchronization Byte (0xA5)
SYNC_BYTE 0	Synchronization Byte (0x5A)
TYPE	Telegram info, e.g. length, Rx/Tx
ORG	Telegram info, e.g. PTM/STM
DB_3	Data byte 3
DB_2	Data byte 2
DB_1	Data byte 1
DB_0	Data byte 0
ID_3	Byte 3 of transmitter ID
ID_2	Byte 2 of transmitter ID
ID_1	Byte 1 of transmitter ID
ID_0	Byte 0 of transmitter ID
STATUS	Status info, e.g. repeater level
CHK	Checksum (LSB)

Fig. 1: Serial data protocol of EnOcean wireless transmitter at receiver output

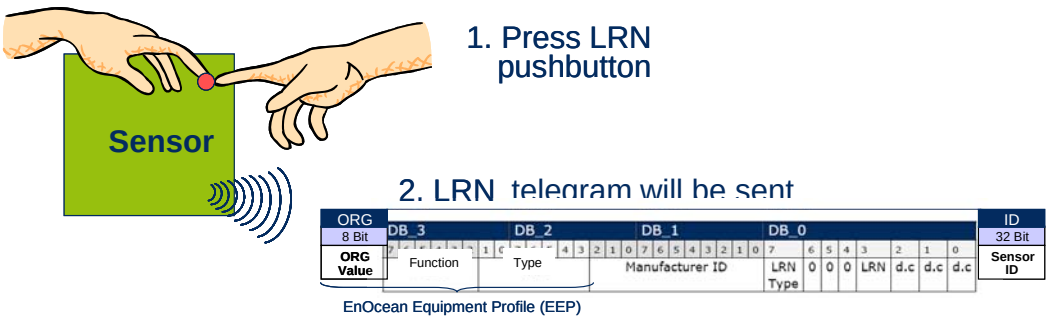

Fig. 2: Serial data protocol during teach-in phase (EEP profile)

The KNX standard

KNX has become the major communication system in building system automation, and was recognized as a worldwide standard for building management systems (ISO/IEC 14543-3-x). KNX is suitable, among other things, for controlling lighting, blinds or room climate.

The technical basis of the system is formed of the different communication media, guaranteed interworking with defined data types, plus scalable configuration methods for different applications and markets.

KNX media

KNX twisted pair is currently the most important medium for KNX products. This combines high quality of data transmission with the possibility of a voltage supply to the connected devices.

KNX power line (PL) uses the power network that is generally already installed in buildings for its data transmission, making it popular in particular in old buildings.

KNX RF is a bidirectional wireless solution enabling KNX features to be used wirelessly. KNX RF works with frequency shift keying (FSK) for data modulation on a center frequency of 868.30 MHz.

Internet protocol KNXnet/IP is specified as a separate medium in KNX, and shows the way to top-level communication in buildings, e.g. telecommunication or multimedia. The Internet protocol also allows access from the exterior to the KNX installation.

KNX configuration modes

The KNX standard includes powerful methods for network management that are termed configuration modes. Complex installations generally use what is called the system mode. Like all other modes this is non-proprietary and based on the ETS™ (Engineering Tool Software) PC program. For ETS each manufacturer creates a product database in which the properties of their devices are described. There is also a socalled easy mode allowing, as the name implies, configuration without a PC.

KNX interworking

A major asset of KNX technology is the strictly defined interworking, which guarantees the compatibility of products of different manufacturers and

different application domains. For this purpose there is a complete set of data types standardized in KNX for wide-ranging functionality.

KNX/EnOcean gateway from Weinzierl

The KNX/ENO 622 serves as a gateway between EnOcean wireless sensors and the KNX installation bus. It comes with 32 channels, each of which can be assigned one of the following functions:

- Button sensor of a switching module
  - Switch (on/off/changeover/value entry)
  - Switch and dim
  - Blind up/down
- Temperature sensor with selection of
  - Presence sensor/switch
  - Setpoint sensor
  - Stepping switch
  - Humidity sensor
- Window contact
- Window handle
- Binary input
- Light sensor
- Motion detector

The wireless telegrams from EnOcean sensors are interpreted, and the data mapped on KNX group objects – allowing for the KNX data point types.

Fig. 3: KNX/EnOcean gateway KNX/ENO 622 from Weinzierl

The function of each channel is set by parameters in the ETS software. Depending on the set function the EnOcean telegrams are mapped on up to six communication objects per channel. After programming of the device by ETS it is possible to teach in the wireless sensors. For this purpose the device has two buttons and a display to show channel numbers and their assignment.

Button sensors allow configuration for single button operation or as a rocker. As many as four buttons/rockers can be teached in on one channel. For the window contact function it is also possible to connect up to four sensors to a single channel. "Window open" is signaled on KNX if at least one window is opened, "Windows shut" only if all windows are closed. Only one sensor per channel can be teached in for the temperature, humidity and brightness functions.

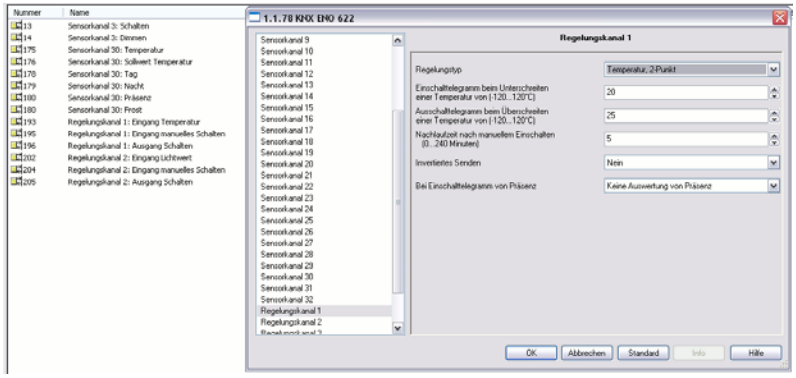

Fig. 4: How KNX/ENO 622 appears in ETS

The KNX/ENO 622 additionally offers six controller channels. Each of these channels can be assigned one of the following functions:

- Temperature controller, continuous
- Temperature controller, 2-level
- Light controller, continuous
- Light controller, 2-level

These controller channels use the data received from EnOcean sensors as their input to then control actuators on the KNX bus.

Application example – heating control

Fig. 5 illustrates heating control as an example. Both the actual temperature and the setpoint temperature are sent from a room control. From this the controller in the gateway calculates a manipulated variable and sends it on the KNX bus to the heating valve. If a presence detector or a window contact is integrated in the system, the controller can include their input to achieve optimal energy efficiency.

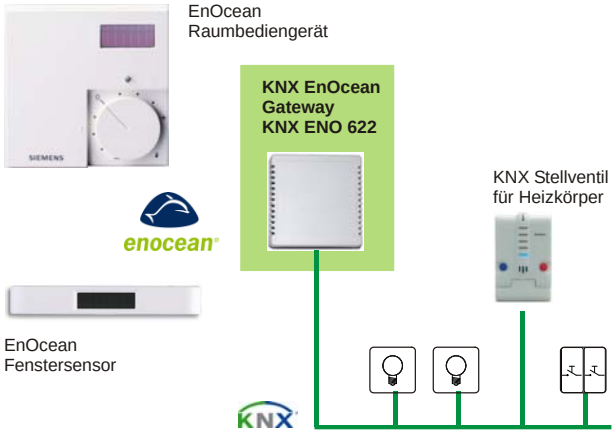

Fig. 5: Application example – heating control

Application example – lights control

Another means of energy saving is lights control with the KNX/ENO 622 as illustrated in Fig. 6. The device can be parameterized to implement an energy saving function where the user turns on the light when it is needed. The controller turns off the light when it is obviously no longer needed. Disturbance to the user by the automatic function is reduced to a minimum, and the occupant of a house or office can always decide for themselves when they want to turn the light on or off. It is also possible to parameterize automatic turning on of the light.

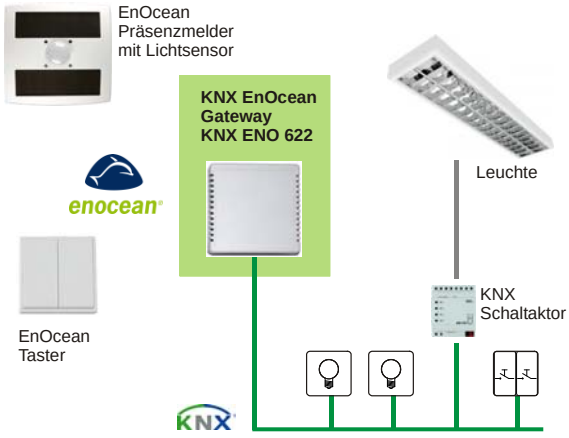

Fig. 6: Application example – lights control

Current KNX / EnOcean references

In the meantime there are numerous installations throughout Europe in which a KNX/EnOcean solution was implemented, for example the SAP corporate building in Walldorf. This building, with some 25,000 square meters floor space, uses 2000 self-powered lights and blinds switches in its automation.

In 2008 a 249-meter high-rise building in Madrid was completed, fitted entirely with wireless, the Torre Cristal. Light, shade and climate in the 52 storeys are controlled by a KNX automation system from Siemens. About 4000 self-powered wireless nodes are connected to the KNX system through gateways from Weinzierl.

About Weinzierl Engineering GmbH
Weinzierl Engineering GmbH develops software and hardware components for building systems engineering. The emphasis is communications technology based on the KNX standard. The strong focus on components and tools for KNX development means that all of KNX technology is covered, for example stack implementations for the various media and profiles of the KNX specification. Based on this, Weinzierl develops solutions for a variety of applications. A key product is the KNX/ENO 622, a gateway between EnOcean wireless and KNX twisted pair. Weinzierl Engineering GmbH is a member of the KNX Association and active in a number of its technical working groups.
For more information visit: www.weinzierl.de

About the KNX Association
The KNX Association is formed of a number of manufacturers, and emerged in 1999 from the following associations:

EIBA (European Installation Bus Association)
EHSA (European Home Systems Association)
BCI (BatiBUS Club International)

The association is the owner of the KNX standard, and also of the KNX trademark logo worldwide. The KNX Association is a profit-oriented organization coverned by Belgian law (cvba).
The aims of the KNX Association are the further development and promotion of KNX as a worldwide standard for home and building systems engineering.
For more information visit: www.knx.org

About the EnOcean Alliance
Leading companies worldwide from the building sector collected to form the EnOcean Alliance and establish innovative automation solutions for sustainable building projects – and so to make buildings more energy-efficient, more flexible and lower in cost. The core technology of the Alliance is self-powered wireless technology from EnOcean for flexibly positioned and service-free sensor solutions. The EnOcean Alliance aims to standardise and internationalise EnOcean wireless technology, and is dedicated to creating interoperability between the products of OEM partners. More than 120 companies currently belong to the EnOcean Alliance. The headquarters of the non-profit organisation is located in San Ramon, California.

For more information visit: www.enocean-alliance.org