

Energy for free – wireless technology without batteries

Wireless sensors will soon be appearing by the thousands. Not only in our homes where they will control lighting and temperature or supervise domestic appliances, but also in industry to control manufacturing processes, in automobiles to check tyre pressure, or outdoors monitoring the environment. To ensure the required system reliability, maintenance-free solutions are in many cases absolutely essential.

Dipl.-Ing. Armin Anders, Co-Founder and head of product marketing EnOcean GmbH

EnOcean wireless transmitters generate their energy from the environment. This energy harvesting enables wireless and batteryless switches and sensors for building, home and industrial automation. In addition to transmission reliability and long wireless range, applications of this kind require sensors that are miniaturised and cost-effective.

Batteryless wireless transmitter modules – 300 meters range and absolutely maintenance free

EnOcean has developed a wireless sensor technology that detects control commands or measurement data without any external power source or batteries in the sensor unit.

Embedded EnOcean radios transmit some 300 meters in a free field, the length of three soccer fields. A wireless sensor is operated by the smallest amount of ambient energy. About 50 microjoules per action are sufficient, comparable to lifting 1 gram by 5 mm. Pressing the button of a TV remote control takes a multiple of this. A tiny magnet and coil system produces an electric voltage from finger pressure, for example, similar to the way power is generated by a dynamo for a bicycle light.

Vibration can be converted into electric energy by using piezoelectric crystals. When the crystal is flexed, energy is generated. Small solar cells, like those in calculators, can also power a wireless sensor from EnOcean. A small energy accumulator (Goldcap), recharged during just one or two hours of light, sustains the operation overnight. A thermal converter, currently under development, makes use of temperature differences to generate voltage.

Three to four degrees are sufficient for transmission, less than the difference in temperature between the air in a room and the surface of warm radiators or machine parts. These are just a few examples of highly efficient, micro energy converters already marketed by EnOcean or in the process of development.

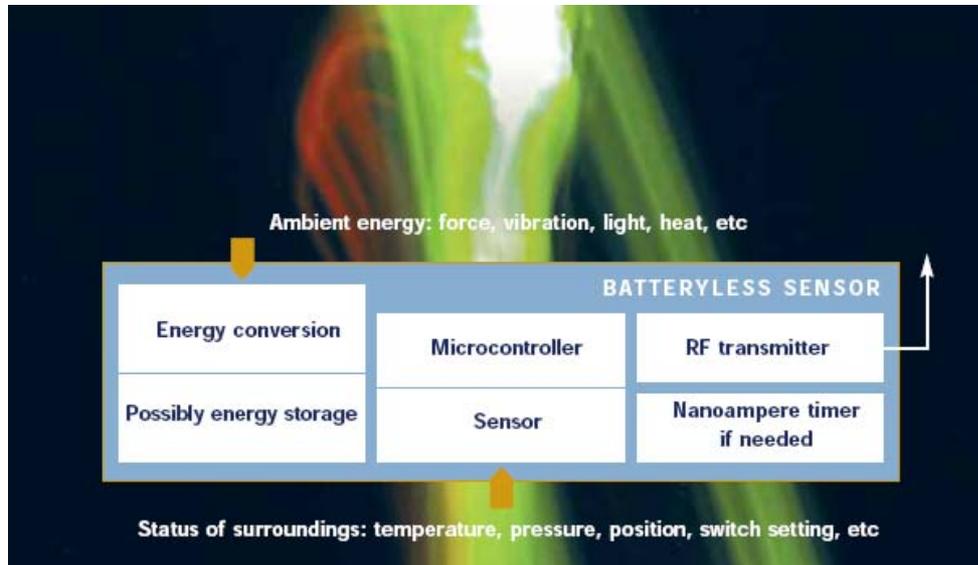
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Fig. left:
 Schematic of
 maintenancefree
 wireless
 sensors using
 ambient energy

Secure data transmission – even with hundreds of transmitters

EnOcean radios are low energy but not low power. Energy is the product of power multiplied by time. The transmitting power determines the wireless range, so there must be no savings here. EnOcean technology must consequently be extremely fast. The duration of a typical EnOcean radio telegram is less than one thousandth of a second. The microcontroller, the measurement circuitry and the RF transmitter of the wireless sensor are driven for just a few thousandths of a second per action. Sensor elements connected to the controller A/D converter deliver data that, provided with an identification number and a checksum, are sent by the RF transmitter as a digital data telegram. Energy store and sleep timer are parts of the wireless sensor that need continuous supply. These circuitry parts are effectively optimised for power consumption of some nanoamperes only, making it possible to operate them on tiny amounts of harvested ambient energy.

Low collision risk through extremely short radio telegrams

The transmission medium of wireless is of course the air, which has to be used by all wireless transmitters alike. When a number of transmitters is operating on the same frequency, there is always the risk that two data telegrams are transferred simultaneously, and that the information they carry is destroyed through collision. The collision probability of EnOcean radio telegrams is extremely slight because the signals are so short.

In addition, the telegrams are sent repeatedly within a few milliseconds and randomly offset from one another in time. So, hundreds of wireless sensors successfully coexist.

Each sensor is programmed with a unique 32 bit address that is transferred with each radio telegram. More than four billion transmitters can be distinguished from one another.

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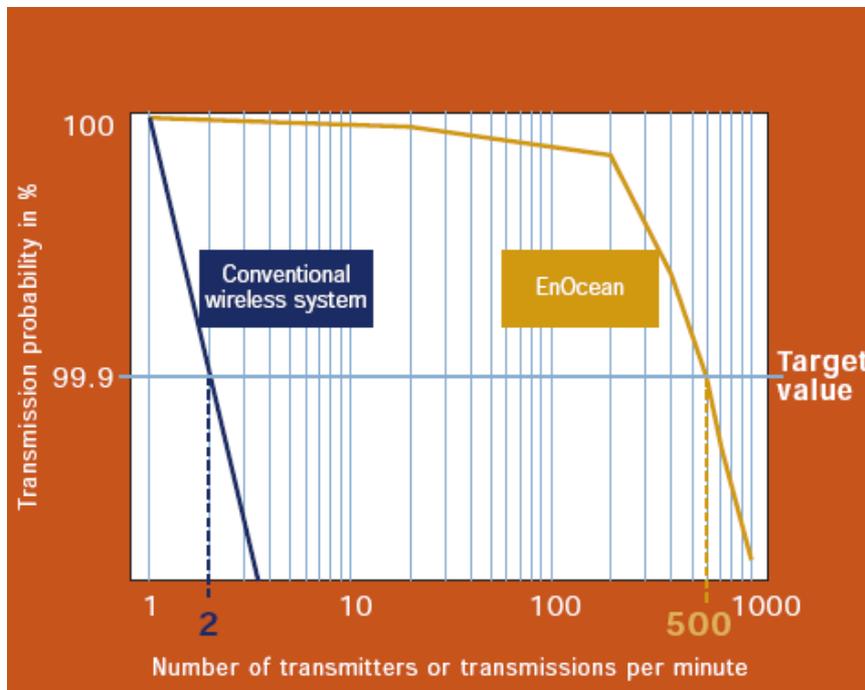


Fig. left: Low collision risk through extremely short telegrams allows hundreds of transmitters in a single radio cell

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

In addition to the ecological impacts of battery use, i.e. disposal, a frequent argument used against wireless technologies is the radiation they produce. This is where the extremely short transmission times of EnOcean radio present a further substantial advantage.

The prestigious ECOLOG Institute examined low-power wireless light switches using EnOcean technology. The result is surprising – the radiation given off by an EnOcean wireless switch is much less than that of a conventional wired switch. And why? The operation of a conventional switch produces a breakaway spark, in other words, a broadband radiation pulse directly on the switch. This disintegrates after traveling a short distance. However, it nearly always hits the person at the switch.

When a wireless switch with low-power electronic circuitry is operated, no breakaway spark is produced. Instead a relatively low-powered wireless signal is sent to a receiver for a thousandth of a second. The current is switched on at the receiver, which is nearly always a few metres away from the person, and the broadband radiation pulse (electrosmog) thus dissolves in the air. There is much less cabling in the wall, so lowfrequency 50/60 Hz radiation is also reduced. EnOcean wireless modules are all manufactured in line with the new European RoHS directive, forbidding the use of hazardous substances in electrical and electronic devices.

EnOcean wireless is proven on a large scale

With more than 150,000 wireless modules already sold, and primarily installed in buildings, the practical benefits of batteryless wireless EnOcean technology in building engineering are clearly demonstrated. Currently more than 50 industrial customers offer hundreds of end-products on the market with integrated EnOcean wireless modules. They are serving key applications like lighting, blinds and HVAC control. Numerous gateways allow integration into all common bus systems thus linking to automation engineering. Universal switch inserts are available to match the ranges of nearly all established producers of installation material, with more to follow soon for both European and US designs.