Radio sensor powered by a mini solar cell – the EnOcean STM 110 now functions with even less light

In this issue, we would like to present the EnOcean radio sensor module STM 110 in more detail. The module obtains its operating energy from a small solar cell. Like its predecessor, the STM 100, the STM 110 sensor module was designed as a maintenance-free (!) radio module to transmit various sensor information. It can be powered by the solar cell that comes with it and which measures just 13mm x 35mm. An integrated energy store enables the module to function fully, even after several days of total darkness.

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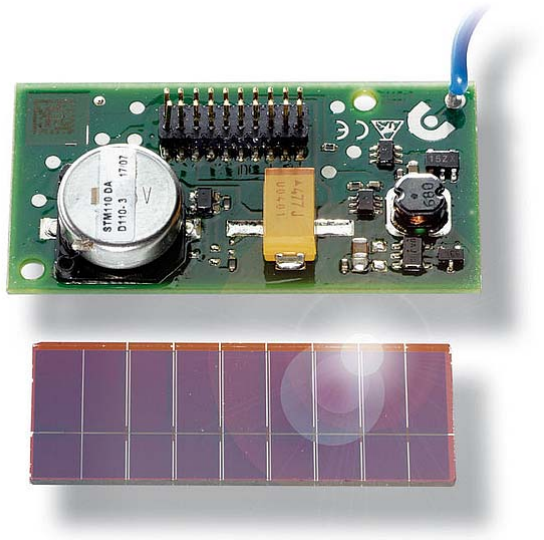

Figure 1: The core of the STM 110 is its nano-timer,
a wake-up timer with an operating energy consumption of around only 30 nA.

Radio sensors that can be implemented with the STM 110

As well as running without batteries, the STM 110 radio sensor module also offers great flexibility in terms of usage – another highlight. All key functions (AD converter, microcontroller, radio transmitter, antenna, and energy management) already exist in the module. This enables users to easily design maintenance-free radio sensors in the areas of temperature, brightness, humidity, vapor, gas, current, water, and pressure.

Examples:

- Temperature and humidity sensors for heating and climate control
- Brightness sensors for lighting control
- Window and door contacts for monitoring status and locking
- Industrial sensors for temperature and position

The energy balance determines the type of battery-free radio sensors that the STM 100 module is suited for. Energy equals power multiplied by time (E = P x t). EnOcean products are therefore suitable for all sensor elements that can only be operated for a short time. The typical value is a measurement period of 2.5ms with a measurement current of 1mA. This means that with a power supply of 3V, a total energy requirement of < 10µWs is needed per measurement. Around 110µWs are needed to send a radio telegram (typically 3 sub-telegrams, each with a length of 1.2ms x 10mA current x 3V voltage). Therefore, it is important to choose as small a ratio as possible between "telegram transmissions per time" and "number of measurements per time", in other words, not to transmit each measurement. The solar cell supplies around 20µW at 400lx. Over the course of a day, the average measurement cycles should rather be within the range of seconds than milliseconds. And the average transmission cycles should be rather in the range of minutes. Details on calculating the energy balance for the STM 110 are to be found in the product manual.

Differences between the new STM 110 and its predecessor STM 100

Compared to its predecessor, the STM 100, the new radio sensor module STM 110 functions with even less light. Until now, the lower operating limit lay at an illumination level of around 100lx. The new module can operate as of 50lx. 100lx is the typical lower limit for minimum daily lighting in occupied spaces, particularly during the critical wintertime. However, illumination levels are often at 50lx in corridors or hallways, even if there are windows letting in light. The increased performance is due to an improved solar cell and the operating range of the module – and thus the solar cell voltage – which has been extended to 2.2-5.0 volts. The main differences between the STM 110 and its predecessor model are as follows:

- Improved solar cell performance (operates as of 50 lx)
- Extended operating voltage range (2.2 V to 5.0 V)
- Faster wake-up timing (from 7 ms switching time)
- ADC inputs with configurable signal trigger thresholds
- Option of configurable device coding: telegram transmission of device profile and manufacturer information
- Frequency variants 868 MHz (Europe) and 315 MHz (North America)

Functional description of the STM 110 radio sensor module

Like its predecessor, the STM 110 module has three sensor inputs to which analog measurement sensors can be connected, for temperature, pressure, forces, etc. Four digital inputs are also available to identify switching statuses. The integrated timer wakes up the switch periodically (this can be set externally to every 1, 10, or 100 seconds by using wire bridges). Then all sensor inputs are exported and their values transmitted together with the 32-bit ID number of the sensor. However, this only takes place if the measurement values have actually changed or if a configurable time (every 1, 10, or 100 measurement intervals) has expired, or if an external wake-up signal orders immediate measurement and transmission.

The core of the STM 110 is an extremely energy-saving timer switch that was developed by EnOcean and requires a current of around just 30 nA. The amount of energy required by the timer is important as it is the only component that works continuously. It enables the module to work up to 60 hours, even in total darkness, using the energy from the reservoir capacitor, while measuring the signals at the inputs every 100 seconds and transmitting them every 18 minutes (if the measurement value changes or an external request is made by the touch of a button).

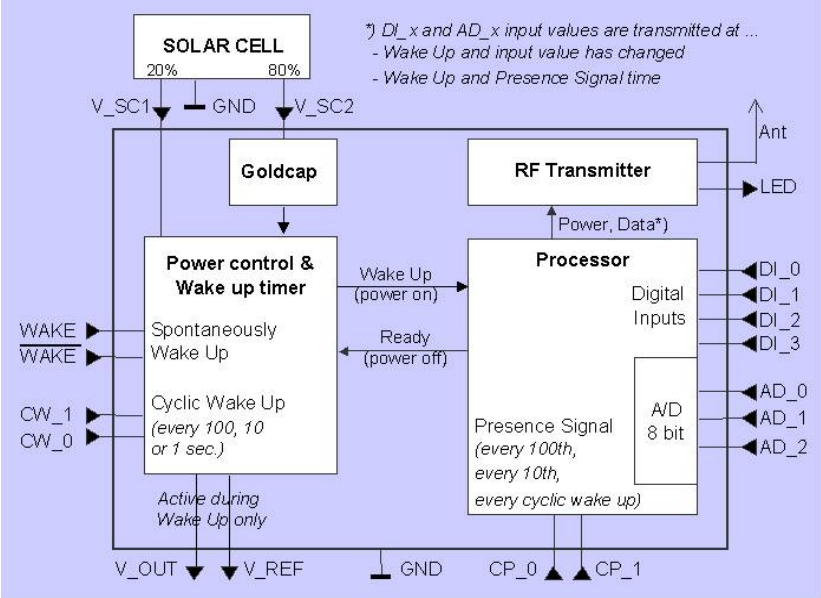

Figure 2: Block diagram showing the STM 110 radio sensor module

The radio signals generated by the STM 110 can, for example, be received by the receiver module RCM 120 and read out on the serial interface (9600 bps). After this, further processing can be carried out in an actuator or bus system, for example. Using the latter method, conventional, wire-based automation systems can be enhanced by maintenance-free components. This enables significant cost saving for the first installation and conversion, while increasing the flexibility of the whole system at the same time.

Device coding and profile standardization

On the basis of the STM 110, all sensors required for automation can be implemented using reliable radio transmission. If the radio sensors are integrated into the system automatically, however, the receiver needs information in the radio telegram about the sensor types utilized (device coding), at least for the learning process.

Each sensor can be clearly identified by its 32-bit transmitter ID, which is transmitted with every telegram transmission. To keep telegrams short, the device type information does not have to be transmitted with every telegram. A so-called “learning telegram” has been defined, which transmits the device and manufacturer code together with the transmitter ID instead of the current measurement data. The receiver can record this information during the assignment process, and call up the related device and manufacturer information later in its store at any time, according to the known ID.

Use of the code learning telegram is optional: The STM 110 offers the option of a programming routine for customers to be executed at start-up to enter the required device and manufacturer code into the module serially. If the module programming routine has been started, the programmed device and manufacturer code are then transmitted whenever a learning telegram is triggered (and a special bit is set for differentiation purposes).

The profiles are defined and standardized in a cross-user working group. This profile definition ensures the desired compatibility and interoperability of sensors and actuators from different manufacturers in the future, both easily and clearly

Development support with the EVA 120 evaluation kit

With the STM 110, EnOcean supplies a complete transmission module, including an energy generator (solar cell), energy management (ultra-low-power sleep timer and threshold value detector), microcontroller, radio transmitter, and detailed technical documentation, as well as a data sheet, manual, and instructions for use. The STM 110 sensor module has a fixed program to simplify start-up, but also has a large number of parameters that can be set: It is possible to set the measurement cycle time and presence signals, AD converter sensitivity thresholds for triggering telegrams, as well as the programming of device profile and manufacturer information as described above.

Using the EVA 120 evaluation kit, users can start up the STM 110 transmission module quickly. The kit contains an evaluation board with a PC interface and an STM 110 module. The evaluation board was developed to enable an easy and fast examination of the STM 110 product features, and to simplify the development of user-specific radio sensor products based on EnOcean technology. The main features of the evaluation kit are as follows:

- Simple power supply for the STM 110 using solar cells, batteries, or other external energy sources
- Pushbutton and optocoupler inputs for immediate wake-ups (WAKE inputs)
- Pushbutton to trigger a learning telegram
- Jumpers to set up the cyclic wake-up and transmission times, and to connect the digital inputs
- Potentiometers to simulate analog input values
- LED to indicate successful telegram transmission
- RS232 or USB interface to evaluate the measurement values directly using a PC and to configure the module in other ways
- Control inputs and measurement outputs for charge and discharge cycles

A plug connector allows users to connect the user-specific sensor circuitry with ease. This plug supplies the sensor switch with power. The additional circuitry shown in the diagram below allows temperature information from a PT-1000 resistor to be measured easily with the STM 110 via an analog input AD.
R2 serves to set the temperature offset. The measurement range can be set via the resistance ratio (amplification) R5/R4.

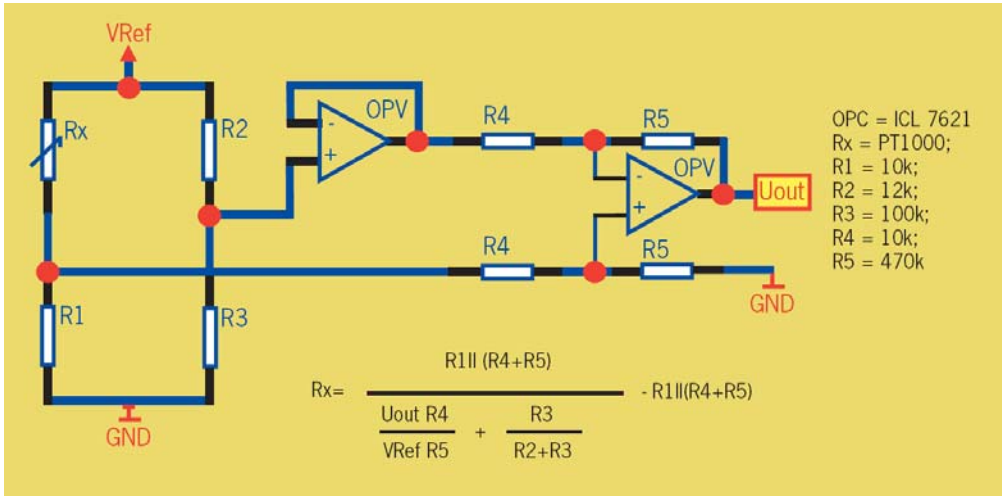

Figure 2: Additional external circuitry for implementing a solar-powered temperature sensor

To start up the receiver side quickly, the EVA 100 evaluation kit is used. This contains the EnOcean receiver module RCM 120 with an antenna, radio receiving unit, and microcontroller with a serial data interface. The EVA 100 evaluation kit also contains a board for the RCM receiver module with a current supply and PC interface

Conclusion

In conjunction with the EVA 120 evaluation kit, the STM 110 module enables battery-free radio sensors to be developed easily and quickly. With the STM 110, EnOcean again shows great progress in the continuous improvement of its technology – not just in terms of the efficiency of energy generation. The system architecture has also been enhanced in line with the users demand to ensure interoperability in end-device solutions.