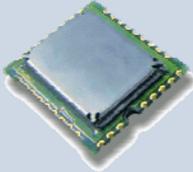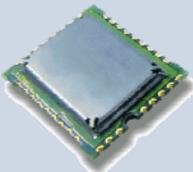Green.Smart.Wireless.
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The EnOcean Dolphin Platform:
An introduction to TCM 300/STM 300 wireless modules

When EnOcean brought the first generation of battery-less radio modules to the market most of their unique features – such as a 20nA wake-up timer – had to be realized in complex discrete analog electronic circuits. In recent years EnOcean has developed the revolutionary Dolphin chip integrating ultralow power radio with an energy harvester interface and a microcontroller. Based upon this brand new IC a new platform of maintenance free radio modules with superior performance, increased flexibility, and reduced cost is being introduced to the market.

Dr. Wolfgang Heller, Product Line Manager, EnOcean GmbH

Overview and key features

The new set of modules comprises the TCM 300 and TCM 320 module for use in line powered actuators, repeaters and gateways and the STM 300 which is designed for use in energy harvester driven sensors and actuators. An overview of the new module generation is given in the table below.

|	TCM 300 TCM 300C	TCM 320 TCM 320C	STM 300 STM 300C
Target Applications	Line powered actuators, repeaters, and gateways	Line powered actuators and repeaters	Energy harvester driven sensors and actuators
Firmware Features	■ Bidirectional serial communication ■ 1-channel / 4-channel relay mode ■ 1-channel dimming mode ■ 1- and 2-level repeater functionality		■ Cyclic reading of external sensors and uni-directional transmission of measured values ■ 3 analog and 4 digital inputs ■ User configurable wake-up and transmit cycles
Size	19 x 22 x 3 mm	36.5 x 19 x 5.5 mm	19 x 22 x 3 mm
Connector	34 SMD pads	16 pin connector	34 SMD pads
Antenna	External whip antenna or 50Ω antenna	Whip antenna or external 50Ω antenna	External whip antenna or 50Ω antenna
Variants	868 MHz: TCM 300 315 MHz: TCM 300C	868 MHz: TCM 320 315 MHz: TCM 320C	868 MHz: STM 300 315 MHz: STM 300C
# I/Os via API	14	11	16
Packaging	Tape&Reel	Tray	Tape&Reel

The transceiver modules TCM 3xx and TCM 3xxC enable the realization of line powered actuators, repeaters, and gateways. The module provides several built-in operating modes for serial communication, or switching and dimming of output loads. In addition repeater functionality (1 or 2 level) can be activated. TCM 300 and TCM 320 offer two different mounting options. TCM 300 can be mounted as a SMD component on a host PCB, TCM 320 is designed for vertical mounting using a pin connector. Depending on space and production requirements the optimal solution can be selected by the OEM.

The extremely power saving RF transmitter module STM 300 of EnOcean enables the realization of wireless and maintenance free sensors and actuators such as room operating panels, motion sensors or valve actuators for heating control. Power supply is provided by an external energy harvester, e.g. a small solar cell or a thermal harvester. An energy storage device can be connected externally to bridge periods with no supply from the energy harvester. A voltage limiter avoids damaging of the module when the supply from the energy harvester gets too high. The module provides a user configurable cyclic wake up. After wake up a radio telegram (input data, unique 32 bit sensor ID, checksum) will be transmitted in case of a change of any digital input value compared to the last sending or in case of a significant change of measured analogue values (different input sensitivities can be selected). In case of no relevant input change a redundant retransmission signal is sent after a user configurable number of wake-ups to announce all current values. In addition a wake up can be triggered externally.

Dolphin based modules enable new features...

The new hardware platform is capable of bidirectional communication. This is made possible by the integrated EnOcean transceiver chip EO3000I, which also comes with further improvements: reduced energy consumption down to 220nA (watch dog timer), programmable transmit power up to 6dBm, plus a digital state engine that ensures energy saving handling of transmit and receive operations while at the same time taking considerable load off the integrated 8051 controller. Of course there is full compatibility with existing wireless EnOcean products.
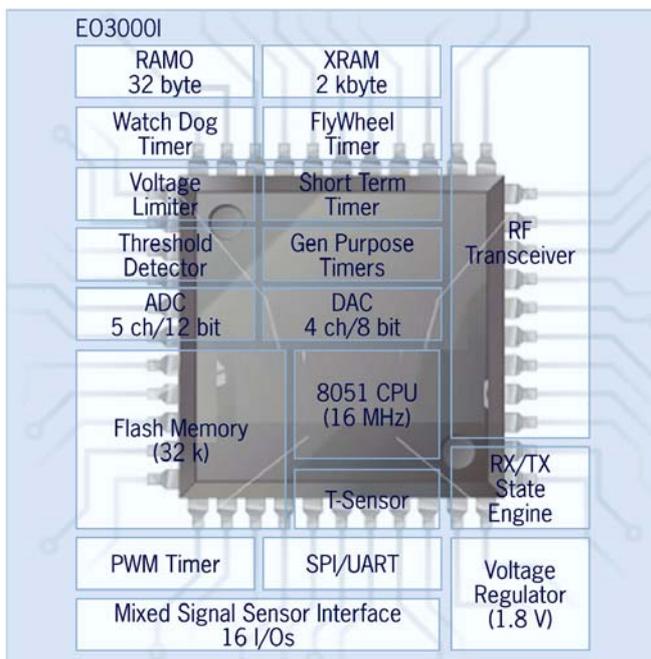
Block diagram of EnOcean ASIC EO3000I

While the current consumption of the receiver is in the same range as in previous products the supply voltage range now starts already at 2.5V. This allows a 50% reduction of receiver energy consumption!

The built-in firmware allows simple integration. In addition an application programming interface (API) allows the OEM to take full advantage of the capabilities of the modules.

The temperature range has been increased to -25°C / +85°C, leaving nothing to be desired for use in building automation applications.

... are easy to integrate ...

Through built-in application functions Dolphin modules enable straightforward start-up and system integration. The operating modes can be configured simply by a few external components (voltage dividers or 0Ω bridges). A development kit EDK 300 is available to support evaluation of all operating modes and configuration options and can be used as a starting point for the development of own firmware.

The modules include the complete RF circuitry and provide outputs for a whip antenna or an external 50Ω antenna, so there is no need for RF expertise on the OEM side. A radio certification for the modules is available for use with several antenna options. If these are used a radio approval for the end device is not required, saving the OEM a lot of effort and several thousand Euros of external approval cost.

New application notes for the connection of energy harvesters, dimensioning of energy storages and calculation of energy budgets are added to the already existing broad portfolio of application notes. This helps to quickly design a new application and ensures short time to market.

Compared to TCM 120/STM 110 the module size of TCM 300/STM 300 is reduced by about 50%. This strongly simplifies the mechanical integration and layout for the OEM.

### ... offer high flexibility ...

A lot of configuration options are available for the built-in firmware as given in the table above. These allow modules off-the-shelf to be used in a wide range of applications such as gateways, repeaters, actuators, or uni- and bidirectional sensors.

If this is not sufficient and more complex or completely different applications shall be realized an application programming interface (API) is available that allows application-specific software to be written in next to no time. Detailed microcontroller expertise is not required. Programming is in the high-level C language. All the resources of the integrated Dolphin chip are made available including up to 16 digital or analog I/Os, the RF transceiver, an 8051 microcontroller with 32kB Flash and 2kB RAM, several timers and ultra-low power management functions.

Based on the API it is for example possible to develop bidirectional self-powered sensors and actuators using the new SMART ACK technology. By switching its receiver on for only a few milliseconds after transmitting a telegram a self-powered sensor can receive an answer from a line-powered counter part which for example may contain data to show on its display.

The powerful development environment that comes with the API ensures fast development times. Dolphin Studio serves for configuring different API modules and makes laborious study of register settings obsolete. The resulting configuration file is simply included in the C program. The docu-

mented source code of TCM 3x0 and STM 300 is provided for training purposes and as a base for fast customer specific adaptation. Development of the application then uses the widely found development environment from Keil. A special version with some functional restrictions but much lower cost is available at EnOcean.
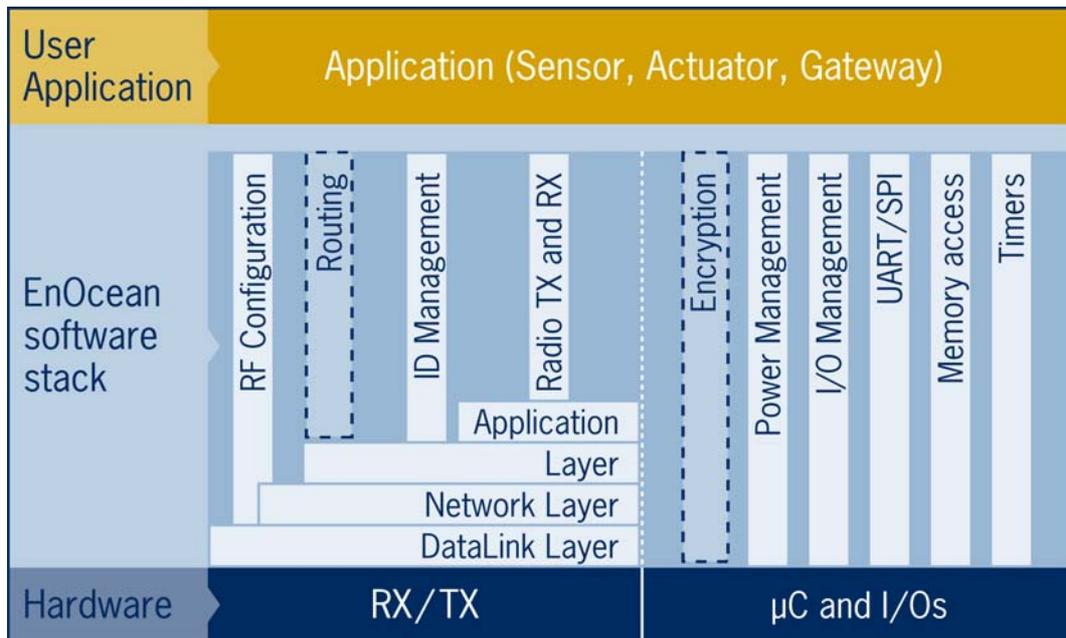
... reduce cost ...

Due to the high degree of integration the price of the new modules is reduced compared to the previous module generation while the functionality has been enhanced. For example a repeater functionality can now be activated on every actuator, as every node is bidirectional. In most cases this will save the cost for a dedicated repeater device in an installation. The microcontroller on board of the Dolphin modules can now also be used to perform application specific tasks. The cost for an additional external microcontroller – which has been used in many applications in the past – can be saved.

STM 300 and TCM 300 are now designed as SMD components and are delivered on Tape&Reel. They can be handled in production in the same way as any other SMD component, e.g. a microcontroller. This allows fully automated production whereas the previous module generation always required costly manual steps. This will strongly reduce the OEM´s production cost and enhance quality of the end device.

Summary

The new Dolphin modules are easy to integrate and provide a high level of flexibility for the realization of self-powered wireless sensors, and actuators and line-powered actuators, repeaters and gateways in building automation. Fast time to market and low development cost on the OEM side are supported by modular radio approval, and a comprehensive set of tools and application notes. The modules are designed for high-volume production and set the basis for attractive system cost.