

Transceiver Module TCM200C / 220C

December 16, 2008



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WO98/36395, DE 100 25 561, DE 101 50 128,
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REVISION HISTORY

The following major modifications and improvements have been made to the first version of this document:

| No | Major Changes |
|------|---|
| 0.92 | Corrected: No internal pull-up on IN_5 |
| 0.93 | Agency Certification section added |
| 0.94 | FCC / IC Grants added; internal pull-ups specified in 2.2 |
| 0.95 | Flammability information for antenna wire added in 1.2 |
| 1.00 | Product released to serial production |
| 1.01 | IC numbers corrected in section 3.6 |
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| | |

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Important!

This information describes the type of component and shall not be considered as assured characteristics. No responsibility is assumed for possible omissions or inaccuracies. Circuitry and specifications are subject to change without notice. For the latest product specifications, refer to the EnOcean website: <http://www.enocean.com>.

As far as patents or other rights of third parties are concerned, liability is only assumed for modules, not for the described applications, processes and circuits.

EnOcean does not assume responsibility for use of modules described and limits its liability to the replacement of modules determined to be defective due to workmanship. Devices or systems containing RF components must meet the essential requirements of the local legal authorities.

The modules must not be used in any relation with equipment that supports, directly or indirectly, human health or life or with applications that can result in danger for people, animals or real value.

Components of the modules are considered and should be disposed of as hazardous waste. Local government regulations are to be observed.

Packing: Please use the recycling operators known to you. By agreement we will take packing material back if it is sorted. You must bear the costs of transport. For packing material that is returned to us unsorted or that we are not obliged to accept, we shall have to invoice you for any costs incurred.



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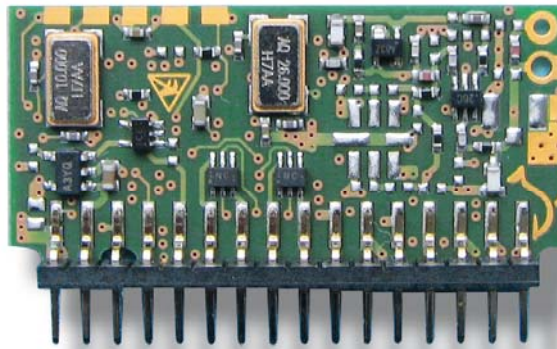
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1 GENERAL DESCRIPTION

1.1 Basic Functionality

The transceiver modules TCM 200C and TCM 220C of EnOcean enable the realization of highly efficient RF repeaters and transceivers for the EnOcean 315 MHz radio system. The module receives all signals of the EnOcean radio transmitters and makes them available at the serial port. In addition a repeater functionality can be activated. Using API200 it is possible to write custom software for the module.



TCM200C / TCM220C without antenna

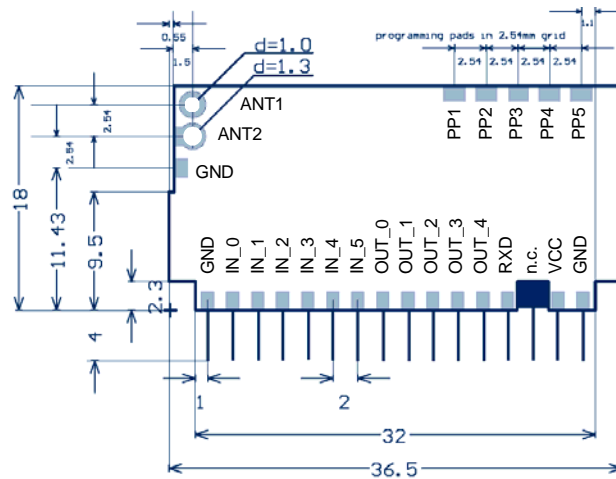
1.2 Technical Data

| | |
|------------------------------------|--|
| Antenna | 15cm whip antenna installed, flammability according to DIN VDE 0482 T265-2-1 external 50Ω antenna mountable |
| Frequency | 315.0 MHz |
| Data rate / Modulation type | 125 kbps / ASK |
| Conducted output power | typ. 5dBm |
| Receiver sensitivity | typ. -95 dBm |
| Power supply voltage | TCM200C: 5V ±5%, TCM220C 3V ±5% |
| Power supply current | Receive mode: typ. 29mA, max. 34mA (RX) Transmit mode: max. 40mA (TX) |
| Radio standards | approved according to FCC / IC for use in North America |



Observe precautions! Electrostatic sensitive devices!

1.3 Physical Dimensions



TCM200C/TCM220C Dimensions (mm)

| | |
|--|---|
| PCB dimensions (without pin connector) | 18.0 x 36.5 mm |
| Pin connector | 16 pins, grid 2.0 mm (4.0 mm in length, □ 0.5 mm) |

1.4 Environmental Conditions

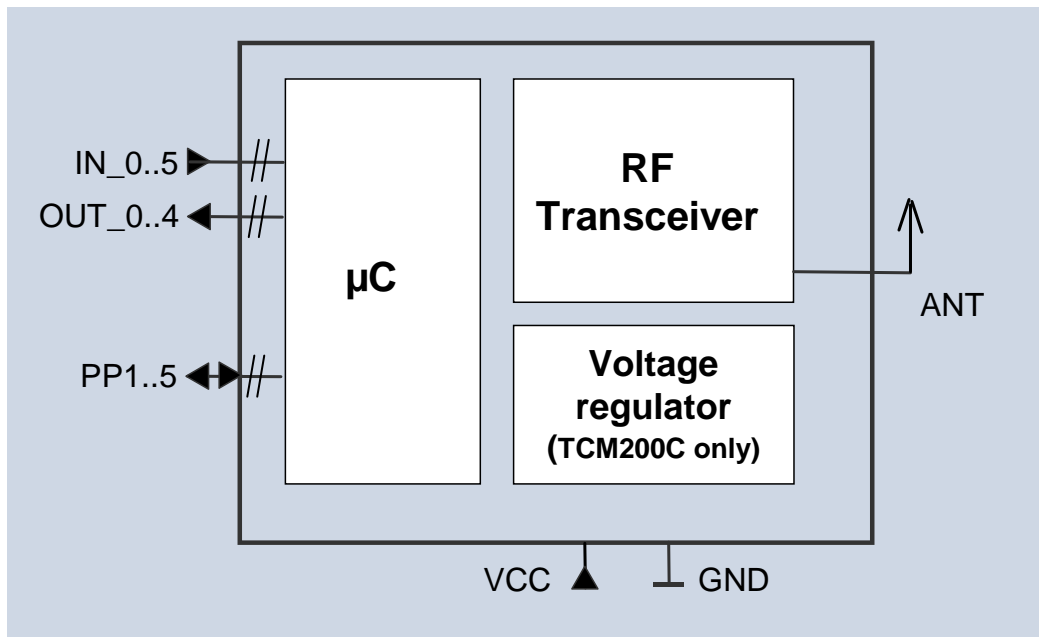
| | |
|-----------------------|---------------------|
| Operating temperature | -25°C ... +65 °C |
| Storage temperature | -40°C up ... +85 °C |
| Humidity | 0% ... 95% r.h. |

1.5 Ordering Information

| Type | Ordering Code |
|----------|---------------|
| TCM 200C | S3033-K200 |
| TCM 220C | S3033-K220 |

2 FUNCTIONAL DESCRIPTION

2.1 Block Diagram



2.2 Pin Description and operational characteristics

| Pin | Symbol | Function TCM200C | Function TCM220C |
|-----|-----------|--|--|
| 1 | GND | Ground connection | |
| 2 | IN_0 | Digital inputs 3V logic, 5V tolerant, internal weak pull-up (typ. 20-100k Ω) | Digital inputs, 3V logic or analog inputs 3V |
| 3 | IN_1 | | |
| 4 | IN_2 | | |
| 5 | IN_3 | | |
| 6 | IN_4 | | |
| 7 | IN_5 | Digital input, 3V logic, 5V tolerant | Digital input, 3V logic |
| 8 | OUT_0 | Open drain output, 35 V max., 100 mA max., 100 mW max. each. | Digital output, 3V logic, 20mA max. |
| 9 | OUT_1 | | |
| 10 | OUT_2 | | |
| 11 | OUT_3 | | |
| 12 | OUT_4 | Digital output, 5V logic, 20mA max. | Digital output, 3V logic, 20mA max. |
| 13 | RXD | For EnOcean internal use only | |
| 14 | n.c. | Not used | |
| 15 | VCC | Power supply 5V \pm 5% | Power supply 3V \pm 5% |
| 16 | GND | Ground connection | |
| | ANT1 | Foot point for whip antenna | |
| | ANT2 | Foot point for 50 Ω antenna | |
| PP1 | ICSP_VPP | Programming voltage or active low reset to controller | |
| PP2 | Vcc | 3V internal VCC for programming interface | |
| PP3 | GND | Ground connection for programming interface | |
| PP4 | ICSP_DATA | In-circuit debugger and ICSP programming data | |
| PP5 | ICSP_CLK | In-circuit debugger and ICSP programming clock | |

The module provides a basic firmware which is flashed at time of production.

It provides the following features:

- Serial output of received EnOcean radio telegrams at OUT_0 (see appendix A.1)
- Repeater activation if IN_2 LOW at startup
- The receiver sensitivity can be controlled via IN_3:
Reduced sensitivity if IN_3 LOW, high sensitivity if IN_3 HIGH



Please use external pull-ups at the IN_2 and IN_3 of TCM220C to assure defined input levels!

Please connect IN_0 and IN_1 to GND for compatibility with future products supporting multiple operating modes!

In addition EnOcean provides an API (please refer to API200 User Manual) which allows to write customer specific firmware for the microcontroller of the module.

2.3 Absolute maximum ratings

| Symbol | Description | Parameter | TCM200C | | TCM220C | | Units | |
|-----------|--------------------------------|--|-------------|------|---------|---------|-------|----|
| | | | min. | max. | min. | max. | | |
| VCC | Supply Voltage (Note 1) | VCC | -0.3 | 5.5 | -0.3 | 3.6 | V | |
| OUT_0 | Output 0 (Note 2) | Voltage | -0.3 | 60 | -0.3 | VCC+0.3 | V | |
| | | Current | | 200 | | ± 25 | mA | |
| OUT_1..3 | Output 1..3 (Note 2) | Voltage | -0.3 | 60 | -0.3 | 6 | V | |
| | | Output source or sink current | Current | | | | ± 25 | mA |
| | | Max. load current | Current | | 200 | | | mA |
| OUT_4 | Output 4 (Note 3) | Voltage | | | -0.3 | 6 | V | |
| | | Output diode current Vout < -0.5 V or Vout > VCC + 0.5 V | Current | | ± 20 | | | mA |
| | | Output source or sink current | Current | | ± 25 | | ± 25 | mA |
| IN_0..4 | Input 0..4 | Voltage | -0.3 | 6 | -0.3 | VCC+0.3 | V | |
| IN_5 | Input 5 (SER_RX) | Voltage | -0.3 | 6 | -0.3 | 6 | V | |
| RXD | For EnOcean internal use only! | this pin has to be left open for proper function of the device | | | | | | |
| VCCi | Internal Voltage (Note 1) | Voltage | not allowed | | see VCC | | V | |
| Vpp | Programming Voltage | Voltage | -0.3 | 6 | -0.3 | 6 | V | |
| ICSP_DATA | Programming Data | Voltage | -0.3 | 6 | -0.3 | 6 | V | |
| ICSP_CLK | Programming Clock | Voltage | -0.3 | 6 | -0.3 | 6 | V | |
| ANT2 | 50 Ohm Antenna (Note 4) | Voltage | | 0 | | 0 | V | |
| | | RF power | | -7 | | -7 | dBm | |
| ANT1 | Whip Antenna (Note 4) | Voltage | | 0 | | 0 | V | |

Note 1: on TCM200C VCCi is the internal stabilized voltage of 3V (should not be used for driving external circuitry)
on TCM220C VCCi is VCC

Note 2: on TCM200C OUT_0..3 are Open-Drain-Outputs, max. power dissipation 300mW for OUT_0/1 and OUT_2/3 each (dual transistor)

on TCM220C Output 0..3 are digital outputs at 3V (Low: max. 0.4V, High: min. 2.4V, see datasheet PIC18F65J11)

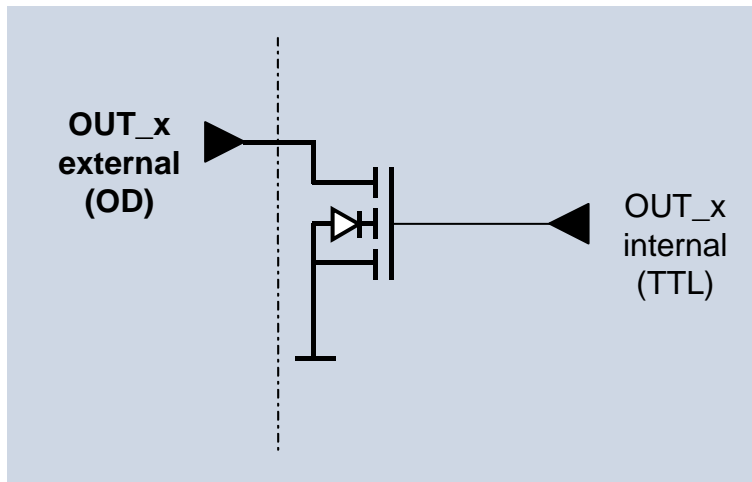
Note 3: on TCM200C OUT_4 is an digital driver output at 5V

on TCM220C OUT_4 is an digital output at 3V (Low: max. 0.4V, High: min. 2.4V, see datasheet PIC18F65J11)

Note 4: antenna connections are DC-shortened to ground, only for RF signal, no DC voltage should be applied

2.4 Equivalent schematics

2.4.1 Open drain outputs OUT_0..3 (TCM200C only)



2.5 Transmit timing (only in repeater mode)

The setup of the transmission timing allows avoiding possible collisions with data packages of other EnOcean transmitters as well as disturbances from the environment. With each transmission cycle, 3 identical subtelegrams are transmitted. The transmission of a subtelegram lasts approximately 1.2 ms. To optimize data security, each telegram is repeated twice within about 40 ms, whereas the delay between the three transmission bursts is effected at random.

Delay between received telegram and 1st subtelegram: $1 \text{ ms} + n \times 1 \text{ ms}$ (integer $n: 0 \leq n \leq 3$)

Delay between 1st and 2nd subtelegram: $6 \text{ ms} + n \times 1 \text{ ms}$ (integer $n: 0 \leq n \leq 3$)

Delay between 2nd and 3rd subtelegram: $18 \text{ ms} + n \times 1 \text{ ms}$ (integer $n: 0 \leq n \leq 11$)

3 APPLICATIONS INFORMATION

3.1 Transmission range

The main factors that influence the system transmission range are type and location of the antennas of the receiver and the transmitter, type of terrain and degree of obstruction of the link path, sources of interference affecting the receiver, and "Dead" spots caused by signal reflections from nearby conductive objects. Since the expected transmission range strongly depends on this system conditions, range tests should categorically be performed before notification of a particular range that will be attainable by a certain application.

The following figures for expected transmission range are considered by using a PTM, a STM or a TCM radio transmitter device and the TCM radio receiver device with preinstalled whip antenna and may be used as a rough guide only:

- Line-of-sight connections: Typically 30m range in corridors, up to 100m in halls
- Plasterboard walls / dry wood: Typically 30m range, through max. 5 walls
- Line-of-sight connections: Typically 30m range in corridors, up to 100m in halls
- Ferroconcrete walls / ceilings: Typically 10m range, through max. 1 ceiling
- Fire-safety walls, elevator shafts, staircases and supply areas should be considered as screening.

The angle at which the transmitted signal hits the wall is very important. The effective wall thickness – and with it the signal attenuation – varies according to this angle. Signals should be transmitted as directly as possible through the wall. Wall niches should be avoided. Other factors restricting transmission range:

- Switch mounted on metal surfaces (up to 30% loss of transmission range)
- Hollow lightweight walls filled with insulating wool on metal foil
- False ceilings with panels of metal or carbon fiber
- Lead glass or glass with metal coating, steel furniture

The distance between EnOcean receivers and other transmitting devices such as computers, audio and video equipment that also emit high-frequency signals should be at least 0.5m

A summarized application note to determine the transmission range within buildings is available as download from www.enocean.com.

3.2 Mounting the antenna

Positioning and choice of receiver and transmitter antennas are the most important factors in determining system transmission range.

TCM200C and TCM220C are providing two antenna outputs, ANT1 and ANT2:

- ANT1 is designed for use with a 15cm whip antenna
- ANT2 is designed for use with 50Ω antennas, e.g. helix antenna or external antenna

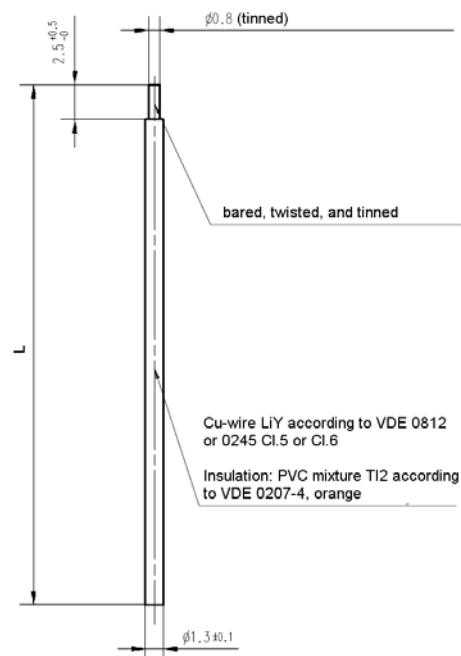
3.2.1 Mounting the 15cm whip antenna

For good receiver performance, great care must be taken about the space immediately around the antenna since this has a strong influence on screening and detuning the antenna. The antenna should be drawn out as far as possible and must never be cut off. Mainly the far end of the wire should be mounted as far away as possible (at least 15 mm) from all metal parts, ground planes, PCB strip lines and fast logic components (e.g. microprocessors).

Do not roll up or twist the whip antenna!

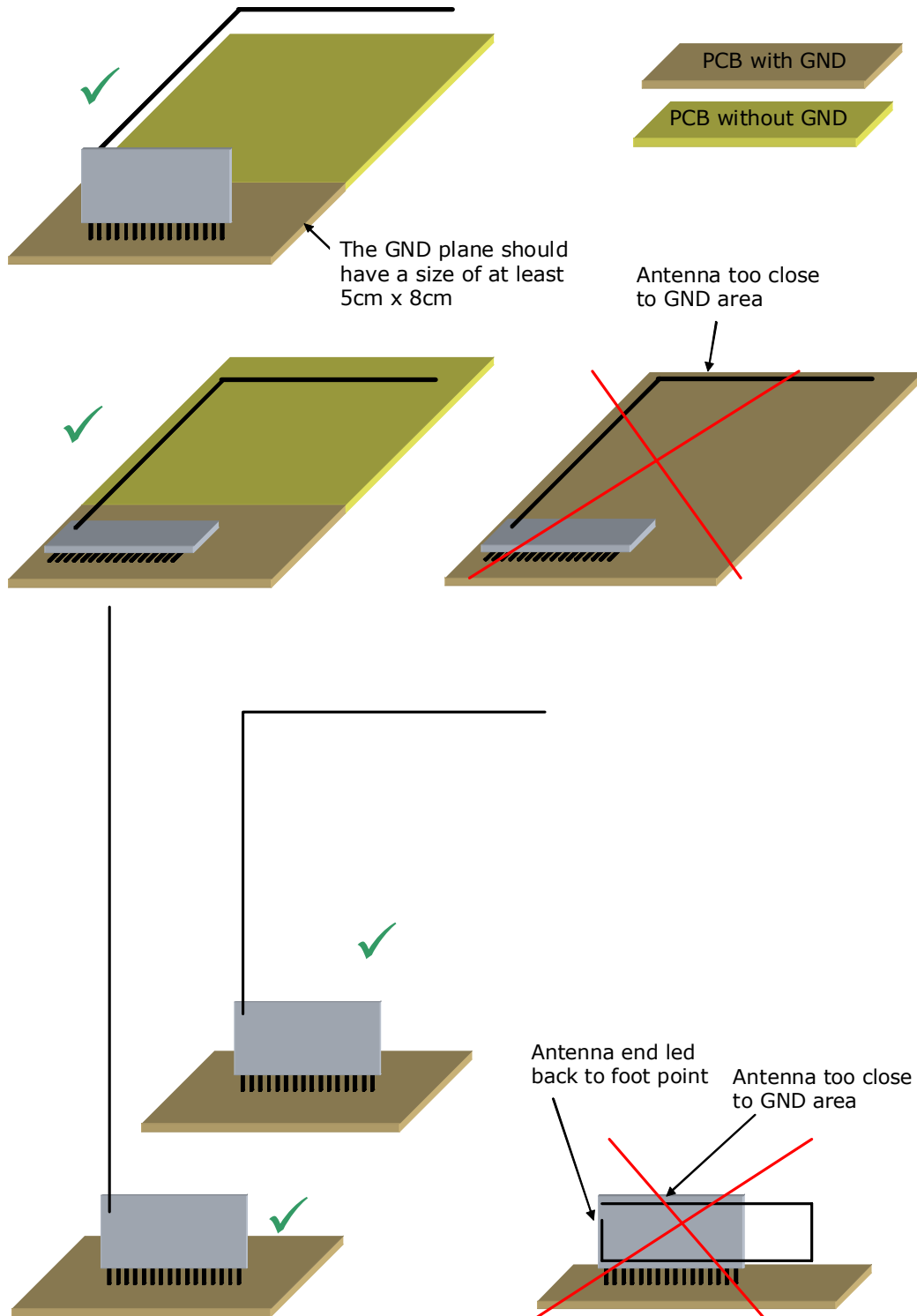
Radio frequency hash from the motherboard desensitizes the receiver. Therefore:

- PCB strip lines on the user board should be designed as short as possible
- A PCB ground plane layer with sufficient ground vias is strongly recommended
- See also section 3.3 for power supply requirements. Problems may especially occur with switching power supplies!



Specification of the TCM whip antenna; L=150mm

Recommendations for laying the antenna:



3.2.2 Mounting 50Ω antennas

For mounting the receiver at bad RF locations (e.g. within a metal cabinet), an external antenna has to be used.

- Unsolder the whip antenna (if already mounted)
- Connect external antenna to the module by 50Ω coax cable with Teflon insulation
 - ■ Connect the inner cable to the ANT2 antenna hole on the PCB
 - ■ Solder the shielding as short as possible to the antenna GND pad (length of insulation max. 4 mm)

It is also possible to mount other 50Ω antennas – such as off the shelf helix antennas – onto the module. In this case the GND pad is not used.

3.3 Power supply requirements

In order to provide a good radio performance, great attention must be paid to the power supply and a correct layout and shielding. A star-connected topology and at least a 22μF low-ESR tantalum or similar ceramic capacitor is recommended. This capacitor must be located as close as possible to the module, between the module supply pin VCC and GND. Furthermore, a low DC-resistance ($<1\Omega$) EMI-suppressor is needed in series between the board supply pin input and the output of the power supply rail. We recommend a ferrit bead e.g. multi layer suppressor type MLS0805-4S7-102 from Ferroxcube.

The ripple on the power supply rail must be below 10 mVpp.

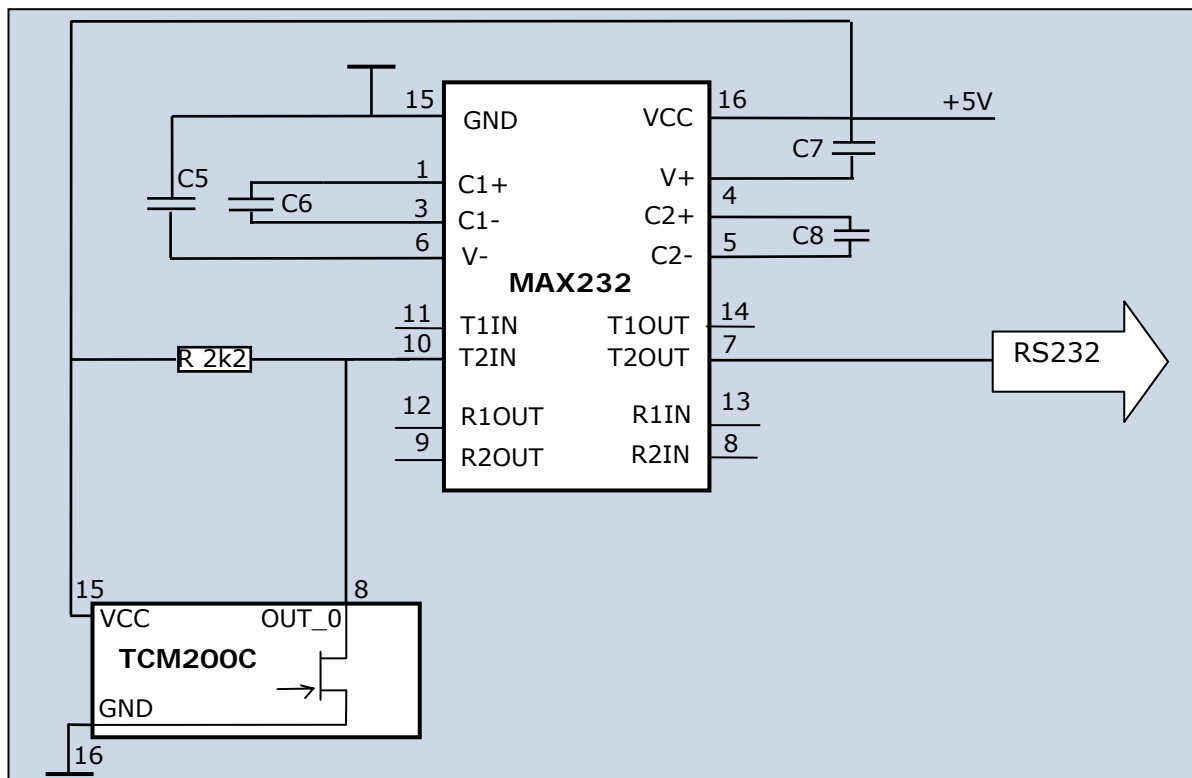
3.4 Connecting Open Collector or Open Drain Outputs

The term open-collector typically refers to a transistor output where the collector output (collector for bipolar transistors, drain for MOSFETs) of the transistor is not yet connected to a positive voltage internally. Since a transistor used in an output is typically a saturated switch, the collector needs to be connected to a positive voltage to complete the circuit. This positive voltage does not need to be any specific value as long as it is above the transistor saturation level. Therefore, an open collector/drain output offers more flexibility and can be connected to a broad range of voltages using an adequate pull-up/load resistor. This resistor is required for the output as it completes the transistor's circuit.

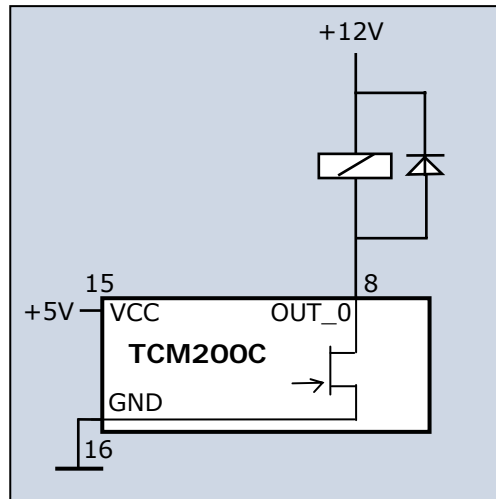
Applications of open-collector/drain devices:

One useful property is that the resistor does not need to be connected to the same supply voltage: a lower or higher voltage can be used instead. Open collector/drain circuits are therefore sometimes used to interface two devices that have different operating logic levels (voltages) or even to directly drive higher voltage external loads (e.g. relays).

Another advantage is that more than one open-collector/drain output can be attached to a single wire. If all outputs attached to the wire are in the high-impedance/logic 1 state, the pull-up resistor will hold the wire in a high voltage state. If at least one of the device outputs is in the ground/logic 0 state, it will sink current and bring the line voltage low.



Example for connection of an RS232 circuit to an open collector/drain output



Example for connection of a relay to an open collector/drain output

3.5 AGENCY CERTIFICATIONS

3.5.1 FCC (United States) Certification

TCM200C and TCM220C LIMITED MODULAR APPROVAL

This is an RF module approved for Limited Modular use operating as an intentional transmitting device with respect to 47 CFR 15.231(a-c) and is limited to OEM installation. The module is optimized to operate using small amounts of energy, and may be powered by a battery. The module transmits short radio packets comprised of control signals, (in some cases the control signal may be accompanied with data) such as those used with alarm systems, door openers, remote switches, and the like. The module does not support continuous streaming of voice, video, or any other forms of streaming data; it sends only short packets containing control signals and possibly data. The module is designed to comply with, has been tested according to 15.231(a-c), and has been found to comply with each requirement. Thus, a finished device containing the TCM200C/TCM220C radio module can be operated in the United States without additional Part 15 FCC approval (approval(s) for unintentional radiators may be required for the OEM's finished product), under EnOcean's FCC ID number. This greatly simplifies and shortens the design cycle and development costs for OEM integrators. The module can be triggered manually or automatically, which cases are described below.

Manual Activation

The radio module can be configured to transmit a short packetized control signal if triggered manually. The module can be triggered, by pressing a switch, for example. The packet contains one (or more) control signals that is(are) intended to control something at the receiving end. The packet may also contain data. Depending on how much energy is available from the energy source, subsequent manual triggers can initiate the transmission of additional control signals. This may be necessary if prior packet(s) was(were) lost to fading or interference. Subsequent triggers can also be initiated as a precaution if any doubt exists that the first packet didn't arrive at the receiver. Each packet

that is transmitted, regardless of whether it was the first one or a subsequent one, will only be transmitted if enough energy is available from the energy source.

Automatic Activation

The radio module also can be configured to transmit a short packetized control signal if triggered automatically, by a relevant change of its inputs or in response to receiving a signal from another transmitter, for example. Again, the packet contains a control signal that is intended to control something at the receiving end and may also contain data. As above, it is possible for the packet to get lost and never reach the receiver. However, if enough energy is available from the energy source, and the module has been configured to do so, then another packet or packets containing the control signal may be transmitted at a later time.

The device is designed to operate as a repeater, which can receive signals from the following list of FCC/IC approved transmitters, and retransmit the signals.

| | | |
|-----------|---------------------|-------------------|
| ■ PTM200C | FCC ID:SZV-PTM200C | IC:5713A-PTM-200C |
| ■ STM110C | FCC ID:SZV-STM110C | IC:5713A-STM-110C |
| ■ TCM200C | FCC ID:SZV-TCM-2XXC | IC:5713A-TCM-2XXC |
| ■ TCM200C | FCC ID:SZV-TCM-2XXC | IC:5713A-TCM-2XXC |

OEM Requirements

In order to use EnOcean's FCC ID number, the OEM must ensure that the following conditions are met:

- End users of products, which contain the module must not have the ability to alter the firmware that governs the operation of the module. The agency grant is valid only when the module is incorporated into a final product by OEM integrators.
- The end-user must not be provided with instructions to remove, adjust or install the module.
- The Original Equipment Manufacturer (OEM) must ensure that FCC labeling requirements are met. This includes a clearly visible label on the outside of the final product. Attaching a label to a removable portion of the final product, such as a battery cover, is not permitted. The label must include the following text:

Contains FCC ID: SZV-TCM2XXC

The enclosed device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (i.) this device may not cause harmful interference and (ii.) this device must accept any interference received, including interference that may cause undesired operation.

The user manual for the end product must also contain the text given above.

- Changes or modifications not expressly approved by EnOcean could void the user's authority to operate the equipment.
- The module must be used with only the following approved antenna(s).

| Part Number | Type | Gain |
|-------------|--------------------------|---------|
| N.A. | Integrated Wire/Monopole | 1.0 dBi |

- The OEM must sign the OEM Limited Modular Approval Agreement with EnOcean

TCB

**GRANT OF EQUIPMENT
AUTHORIZATION**
Certification
Issued Under the Authority of the
Federal Communications Commission
By:

TCB

American TCB, Inc.
6731 Whittier Avenue Suite C110
McLean, VA 22101

Date of Grant: 06/11/2008
Application Dated: 06/11/2008

EnOcean GmbH
Kolpingring 18a
Oberhaching, 82041
Germany

Attention: Armin Anders , Director Product Marketing

NOT TRANSFERABLE

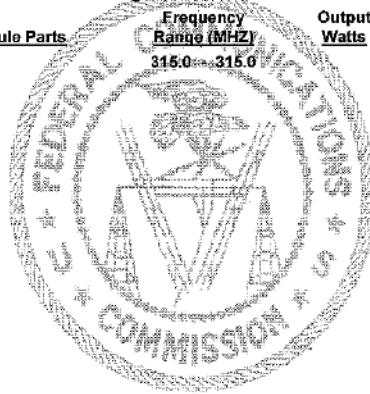
EQUIPMENT AUTHORIZATION is hereby issued to the named GRANTEE, and is VALID ONLY for the equipment identified hereon for use under the Commission's Rules and Regulations listed below.

FCC IDENTIFIER: SZV-TCM2XXC
Name of Grantee: EnOcean GmbH
Equipment Class: Part 15 Security/Remote Control Transmitter
Notes: 315 MHz Transceiver with optional Repeater capability
Modular Type: Limited Single Modular

Grant Notes

| FCC Rule Parts | Frequency Range (MHz) | Output Watts | Frequency Tolerance | Emission Designator |
|----------------|-----------------------|--------------|---------------------|---------------------|
| 15.231 | 315.0-315.0 | | | |

Limited Modular Approval.
Limited Single Modular



3.5.2 IC (Industry Canada) Certification

In order to use EnOcean’s IC number, the OEM must ensure that the following conditions are met:

- Labeling requirements for Industry Canada are similar to those required by the FCC. The Original Equipment Manufacturer (OEM) must ensure that IC labeling requirements are met. A clearly visible label on the outside of a non-removable part of the final product must include the following text:

Contains IC: 5713A-TCM2XXC

- The OEM must sign the OEM Limited Modular Approval Agreement with EnOcean



American Telecommunications Certification Body Inc.
6731 Whittier Ave, McLean, VA 22101

REF No. ► ATCB006398

**TECHNICAL ACCEPTANCE
CERTIFICATE**

**CERTIFICAT D'ACCEPTABILITÉ
TECHNIQUE**

| | | |
|--|--|---|
| <p>CERTIFICATION No. No. DE CERTIFICATION</p> <p>ISSUED TO DÉLIVRÉ À</p> <p>TYPE OF EQUIPMENT TYPE DE MATÉRIEL</p> <p>TRADE NAME AND MODEL MARQUE ET MODÈLE</p> <p>FREQUENCY RANGE BANDE DE FRÉQUENCES</p> <p>EMISSION DESIGNATION DESIGNATION D'ÉMISSION</p> <p>R.F. POWER RATING PUISSANCE NOMINALE H.F.</p> <p>ANTENNA ANTENNE</p> <p>TEST LABORATORY LABORATOIRE D'ESSAI</p> <p>CERTIFIED TO CERTIFIÉ SELON LE</p> | <p>► 5713A-TCM2XXC (New Family)</p> <p>► EnOcean GmbH Kolpingring 18a D-82041 Oberhaching Germany</p> <p>► Remote Control Device Modular Approval</p> <p>► TCM200C TCM220C</p> <p>► 315 MHz</p> <p>► 389KF1D</p> <p>► 93 dBuV/m Peak @ 3 Meters</p> <p>► Internal 1.0 dBi</p> <p>► Rhein Tech Laboratories, Inc. 360 Herndon Parkway, Suite 1400 Herndon, VA 20170</p> <p>► SPECIFICATION CAHIER DES CHARGES</p> | <p>SITE NUMBER ► 2956A-1 NUMÉRO DE SITE</p> <p>RSS 210</p> <p>ISSUE 7 ÉDITION</p> |
|--|--|---|

Certification of equipment means only that the equipment has met the requirements of the above noted specification. License applications, where applicable to use certified equipment, are acted on accordingly by the issuing office and will depend on the existing radio environment, service and location of operation.

This certificate is issued on condition that the holder complies and will continue to comply with the requirements of the radio standards specifications and procedures issued by Industry Canada.

La certification du matériel signifie seulement que le matériel a satisfait aux exigences de la norme indiquée ci-dessus. Les demandes de licences nécessaires pour l'utilisation du matériel certifié sont traitées en conséquence par le bureau de délivrance et dépendent des conditions radio ambiantes, du service et de l'emplacement d'exploitation.

Le présent certificat est délivré à condition que le titulaire satisfasse et continue de satisfaire aux exigences et aux procédures d'Industrie Canada.

DATE OF ISSUE: June 11, 2008

William H. Graff
President

051808-17b

4 DEVELOPMENT TOOLS

The EDK 100C is a complete set of tools and modules for the evaluation of EnOcean technology and the development and test of application specific end products based on EnOcean 315 MHz radio modules.

This comprehensive kit features everything needed to either evaluate and test functionality of self-powered STM110C sensor transmitter modules or to develop bidirectional application devices based on the TCM2xxC transceiver module.



The easy-to-use monitoring and control front-end software WinEtel runs under Windows and allows for real-time display and logging of any EnOcean radio telegram received. Telegrams may as well be composed and transmitted using a TCM2xxC module mounted on the transceiver interface board EVA100.

The EDK 100C comes with a software API and a programming adapter for the development of TCM2XXC transceiver application specific firmware. The Microchip MPLAB ICD 2 development platform that is needed for the software development process is not included in this kit and has to be purchased separately.

Also enclosed is the EPM100C range tester and a North-American style rocker switch with an integrated PTM200C self-powered transmitter module.

The EPM100C is a hand-held tool for measuring and indicating the received signal strength of EnOcean telegrams and disturbing radio activity at 315 MHz. This tool can be used for radio range testing together with any EnOcean transmitter. It also supports installers during the planning phase by enabling them to verify whether the placement of EnOcean transmitters and receivers is possible at the positions planned or if there are any objects obstructing the radio signal path.

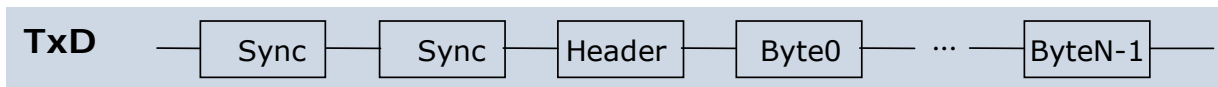
| Type | Ordering Code |
|----------|---------------|
| EDK 100C | S3034-X100 |

A APPENDIX

A.1 EnOcean serial protocol

A.1.1 Message format

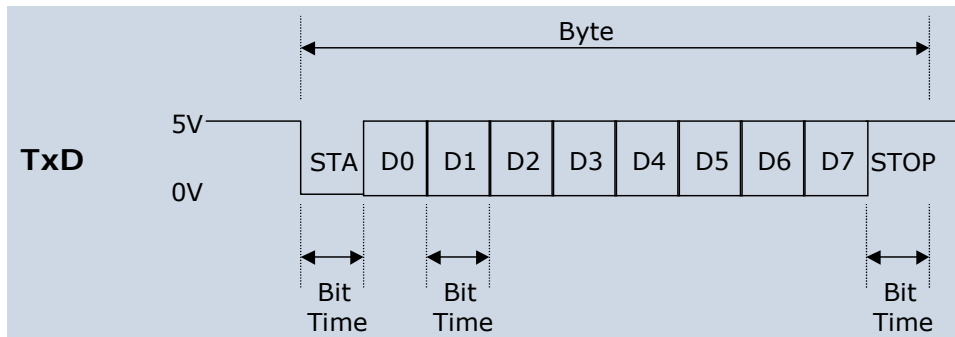
The following figure shows the message format. A data block of length n is composed of 2 synchronization bytes, 1 octet for the header and n-1 octets for the message data.



Message format for asynchronous serial communication

A.1.2 Octet signals and bit order

- 9600 bps; 8 data bits, no parity bit, one start bit, one stop bit
- Line idle is binary 1 (standard)
- Each character has one start bit (binary 0), 8 information bits (least significant bit first) and one stop bit (binary 1)



Signals and bit order sending a byte

A.1.3 Description of serial data structure

| Bit 7 | Bit 0 |
|---------------------|--------|
| SYNC_BYTE1 (A5 Hex) | |
| SYNC_BYTE0 (5A Hex) | |
| H_SEQ | LENGTH |
| ORG | |
| DATA_BYTE3 | |
| DATA_BYTE2 | |
| DATA_BYTE1 | |
| DATA_BYTE0 | |
| ID_BYTE3 | |
| ID_BYTE2 | |
| ID_BYTE1 | |
| ID_BYTE0 | |
| STATUS | |
| CHECKSUM | |

| | | |
|----------------|--------------|--|
| SYNC_BYTE 0..1 | (8 bit each) | Synchronization Bytes |
| H_SEQ | (3 bit) | Header identification: always 0 in TCM200C/220C |
| LENGTH | (5 bit) | Number of octets following the header octet (11 dec) |
| ORG | (8 bit) | Type of telegram (see detailed description below) |
| DATA_BYTE 0..3 | (8 bit each) | Data bytes 0..3 (see detailed description below) |
| ID_BYTE 0..3 | (8 bit each) | 32-bit transmitter ID |
| STATUS | (8 bit) | Status field (see detailed description below) |
| CHECKSUM | (8 bit) | Checksum (Last LSB from addition of all octets except sync bytes and checksum) |

A.1.4 Detailed description of ORG field

| ORG field (decimal) | Acronym | Description |
|---------------------|---------|--|
| 5 | RPS | Telegram from a PTM switch module received (e.g. PTM 100 or PTM 200) |
| 6 | 1BS | 1 byte data telegram from a STM sensor module (e.g. STM 250) |
| 7 | 4BS | 4 byte data telegram from a STM sensor module (e.g. STM 100) |
| 8 | HRC | Telegram from a CTM module received |
| 0-4, 9-255 | - | Reserved |

A.1.5 Detailed description of STATUS field

If ORG = 5 (Telegram from a PTM switch module):

| | | | |
|----------|-----|----|------------|
| 7 | | | 0 |
| Reserved | T21 | NU | RP_COUNTER |

| | | |
|------------|----------------|---|
| Reserved | (2 bit) | For future use |
| T21 | (1 bit) | T21=0 → PTM switch module of type 1, T21=1 → PTM switch module of type 2 |
| NU | (1 bit) | NU=1 → N-message, NU=0 → U-message. |
| RP_COUNTER | (4 bit) =0..15 | Repeater level: 0 is original message (not repeated) |



IMPORTANT NOTE FOR SYSTEMS USING AN ENOCEAN RADIO REPEATER:

Within toggle switch applications using the serial receiver mode in combination with a separate repeater, please ensure that no serial command interpretation error may occur at the connected control unit. A toggle signal means that the same telegram is sent for switching something on and off. If e.g. the light is switched on receiving the I-button telegram from a PTM 200C, the repeated telegram (delay <100ms) may switch off the light again. It is therefore mandatory to interpret the RP_COUNTER field. If a repeated telegram (RP_COUNTER>0) is received it has to be verified if the same telegram with a lower RP_COUNTER state has already been received in the previous 100 ms. In this case the repeated message has to be discarded.

PTM switch modules of Type 2 (e.g. PTM 200C) allow interpretation of operating two buttons simultaneously:

- N-message received → Only one or two pushbuttons have been pressed.
- U-message received → No pushbutton was pressed when activating the energy generator, or more than two pushbuttons have been pressed.

Note for telegrams from PTM transmitters: Due to the mechanical hysteresis of the energy bow, in most rocker switch device implementations, pressing the rocker sends an N-message and releasing the rocker sends a U-message!

If ORG = 6, 7 or 8 (all other telegrams):

| | | |
|----------|--|------------|
| 7 | | 0 |
| Reserved | | RP_COUNTER |

| | | |
|------------|---------|--|
| Reserved | (4 bit) | For future use |
| RP_COUNTER | (4 bit) | Repeater level: 0 is original message (not repeated) |

Please consider the "IMPORTANT NOTE" above!

A.1.6 Detailed description of DATA_BYTE 3..0 fields

If ORG = 5 and NU = 1 (N-message from a PTM switch module):

DATA_BYTE2..0 always = 0
 DATA_BYTE3 as follows:

| | |
|-----|-------------------|
| 7 | 0 |
| RID | UD PR SRID SUD SA |

| | | |
|------|---------|--|
| RID | (2 bit) | Rocker ID, from left (A) to right (D): 0, 1, 2 and 3 (decimal) |
| UD | (1 bit) | UD=1 → O-button, UD=0 → I-button |
| PR | (1 bit) | PR=1 → Energy bow pressed, PR=0 → Energy bow released |
| SRID | (2 bit) | Second Rocker ID, from left to right: 0, 1, 2 and 3 |
| SUD | (1 bit) | (Second) SUD=1 → O-button, SUD=0 → I-button |
| SA | (1 bit) | SA=1 → Second action (2 buttons pressed simultaneously), SA=0 → No second action |

If ORG = 5 and NU = 0 (U-message from a PTM switch module):

DATA_BYTE2..0 always = 0
 DATA_BYTE3 as follows:

| | |
|---------|-------------|
| 7 | 0 |
| BUTTONS | PR Reserved |

| | | | | | | | | | | | | | | | | | | | | |
|------------------|--------------------|---|------------------|-----------------|---------------|--------------|---------------|------------------|---------------|------------------|---------------|--------------------|---------------|------------------|---------------|------------------|---------------|------------------|---------------|------------------|
| BUTTONS | (3 bit) | Number of simultaneously pressed buttons, as following: | | | | | | | | | | | | | | | | | | |
| | | <table border="0"> <tr> <td>PTM 100 (Type1):</td> <td>PTM200 (Type2):</td> </tr> <tr> <td>0 = 0 Buttons</td> <td>0 = 0 Button</td> </tr> <tr> <td>1 = 2 Buttons</td> <td>1 = not possible</td> </tr> <tr> <td>2 = 3 Buttons</td> <td>2 = not possible</td> </tr> <tr> <td>3 = 4 Buttons</td> <td>3 = 3 or 4 buttons</td> </tr> <tr> <td>4 = 5 Buttons</td> <td>4 = not possible</td> </tr> <tr> <td>5 = 6 Buttons</td> <td>5 = not possible</td> </tr> <tr> <td>6 = 7 Buttons</td> <td>6 = not possible</td> </tr> <tr> <td>7 = 8 Buttons</td> <td>7 = not possible</td> </tr> </table> | PTM 100 (Type1): | PTM200 (Type2): | 0 = 0 Buttons | 0 = 0 Button | 1 = 2 Buttons | 1 = not possible | 2 = 3 Buttons | 2 = not possible | 3 = 4 Buttons | 3 = 3 or 4 buttons | 4 = 5 Buttons | 4 = not possible | 5 = 6 Buttons | 5 = not possible | 6 = 7 Buttons | 6 = not possible | 7 = 8 Buttons | 7 = not possible |
| PTM 100 (Type1): | PTM200 (Type2): | | | | | | | | | | | | | | | | | | | |
| 0 = 0 Buttons | 0 = 0 Button | | | | | | | | | | | | | | | | | | | |
| 1 = 2 Buttons | 1 = not possible | | | | | | | | | | | | | | | | | | | |
| 2 = 3 Buttons | 2 = not possible | | | | | | | | | | | | | | | | | | | |
| 3 = 4 Buttons | 3 = 3 or 4 buttons | | | | | | | | | | | | | | | | | | | |
| 4 = 5 Buttons | 4 = not possible | | | | | | | | | | | | | | | | | | | |
| 5 = 6 Buttons | 5 = not possible | | | | | | | | | | | | | | | | | | | |
| 6 = 7 Buttons | 6 = not possible | | | | | | | | | | | | | | | | | | | |
| 7 = 8 Buttons | 7 = not possible | | | | | | | | | | | | | | | | | | | |
| PR | (1 bit) | PR = 1 → Energy bow pressed, PR = 0 → Energy bow released | | | | | | | | | | | | | | | | | | |
| Reserved | (4 bit) | for future use | | | | | | | | | | | | | | | | | | |

If ORG = 6 (Telegram from a 1 Byte STM sensor):

DATA_BYTE2..0 always = 0
 DATA_BYTE3 Sensor data byte.

If ORG = 7 (Telegram from a 4 Byte STM sensor):

DATA_BYTE3 Value of third sensor analog input (AD_2)
 DATA_BYTE2 Value of second sensor analog input (AD_1)
 DATA_BYTE1 Value of first sensor analog input (AD_0)
 DATA_BYTE0 Sensor digital inputs as follows:

| | |
|----------|---------------------------|
| 7 | 0 |
| Reserved | DI_3 DI_2 DI_1 DI_0 |

If ORG = 8 (Telegram from a HRC transmitter):

DATA_BYTE2..0 always = 0
 DATA_BYTE3 as follows:

| | |
|-----|-------------------------|
| 7 | 0 |
| RID | UD PR SR Reserved |

| | | |
|----------|---------|--|
| RID | (2 bit) | Rocker ID, from left (A) to right (D): 0, 1, 2 and 3 |
| UD | (1 bit) | UD=1 → O-button, UD=0 → I-button |
| PR | (1 bit) | PR=1 → Button pushed, PR=0 → Button released |
| SR | (1 bit) | SR=1 → Store, SR=0 → Recall (see note) |
| Reserved | (3 bit) | for future use |

Note: The bit SR is used only when the lower 3 Bits from ID_BYTE0 = 0b111 (scene switch), and RID ≠ 0 (indicates that the memory buttons M0-M5 are operated in the hand-held remote control).