Appendix K: Manual

Please see the following pages.

USER MANUAL V0.92

Transceiver Module
TCM200C / 220C

June 5, 2008

PRELIMINARY

Patent protected:
WO98/36395, DE 100 25 561, DE 101 50 128,
WO 2004/051591, DE 103 01 678 A1, DE 10309334,
WO 04/109236, WO 05/096482, WO 02/095707,
US 6,747,573, US 7,019,241

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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

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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.

TABLE OF CONTENT

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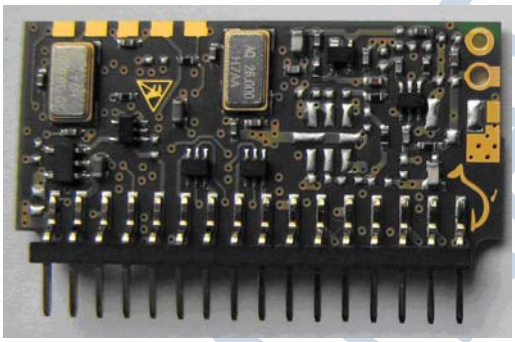
1 GENERAL DESCRIPTION

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.



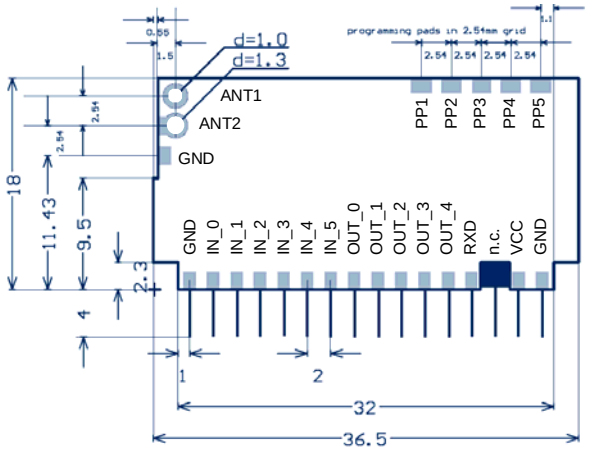
TCM200C / TCM220C without antenna

1.2 Technical Data

Antenna	15cm whip antenna installed, 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	approvable 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

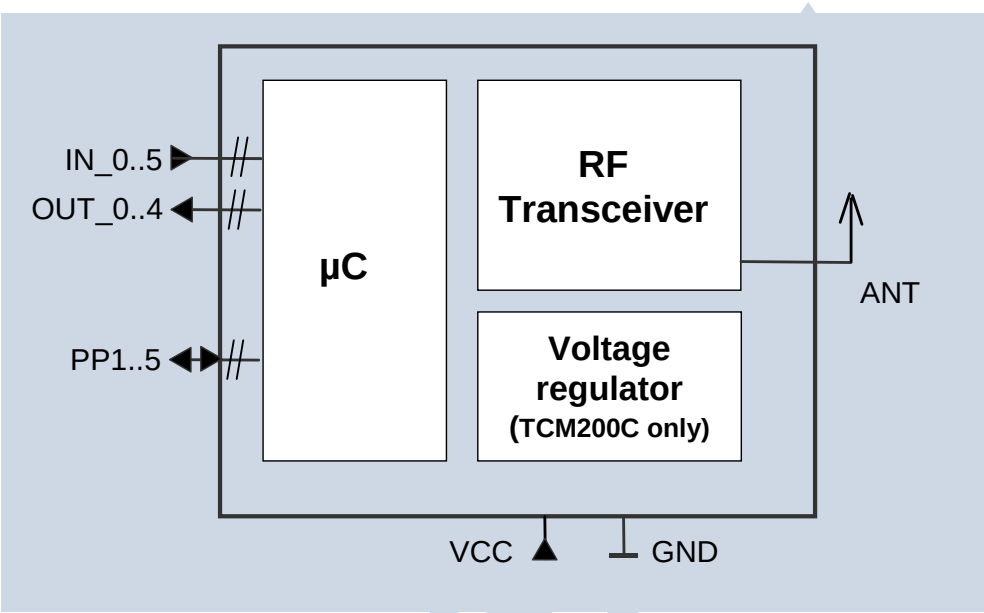
Operating temperature	-25°C … +65 °C
Storage temperature	-40°C up … +85 °C
Humidity	0% … 95% r.h.

1.5 Ordering Information

Type	Ordering Code
TCM200C	**S3033-K200**
TCM220C	**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 3 4 5 6	IN_0 IN_1 IN_2 IN_3 IN_4	Digital inputs 3V logic, 5V tolerant, internal pull-up (3V)	Digital inputs, 3V logic or analog inputs 3V
7	IN_5	Digital input, 3V logic, 5V tolerant	Digital input, 3V logic
8 9 10 11	OUT_0 OUT_1 OUT_2 OUT_3	Open drain output, 35 V max., 100 mA max., 100 mW max. each.	Digital output, 3V logic, 20mA max.
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 ± 5%	Power supply 3V ± 5%
16	GND	Ground connection	
	ANT1	Foot point for whip antenna	
	ANT2	Foot point for 50Ω 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!

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

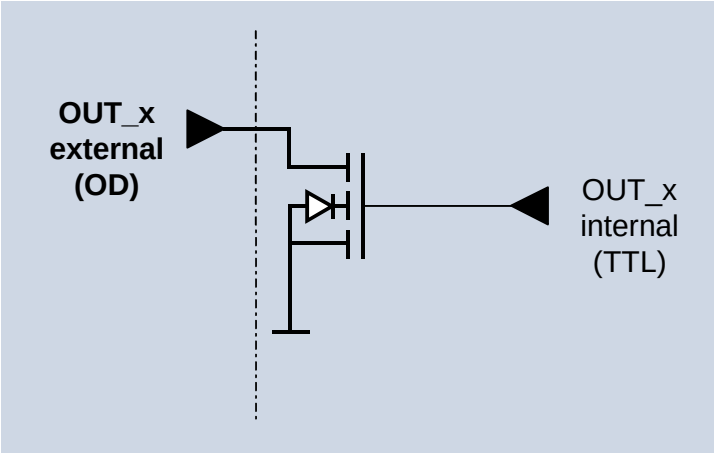
Note 2: on TCM200C OUT_0..3 are Open-Drain-Outputs, max. power dissipation 300mW for OUT_0/1 and OUT_2/3 each (dual transistor)
on TCM220C Output 0..3 are digital outputs at 3V (Low: max. 0.4V, High: min. 2.4V, see datasheet PIC18F65J11)

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-shorted 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 sub-telegram 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 telegam and 1st subtelegram: 1 ms + n x 1 ms (integer n: 0≤n≤3)
Delay between 1st and 2nd subtelegram: 6 ms + n x 1 ms (integer n: 0≤n≤3)
Delay between 2nd and 3rd subtelegram: 18 ms + n x 1 ms (integer n: 0≤n≤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

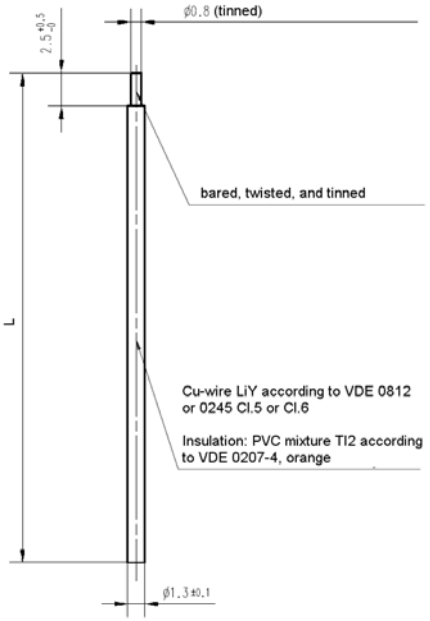
Positioning and choice of receiver and transmitter antennas are the most important factors in determining system transmission range.

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

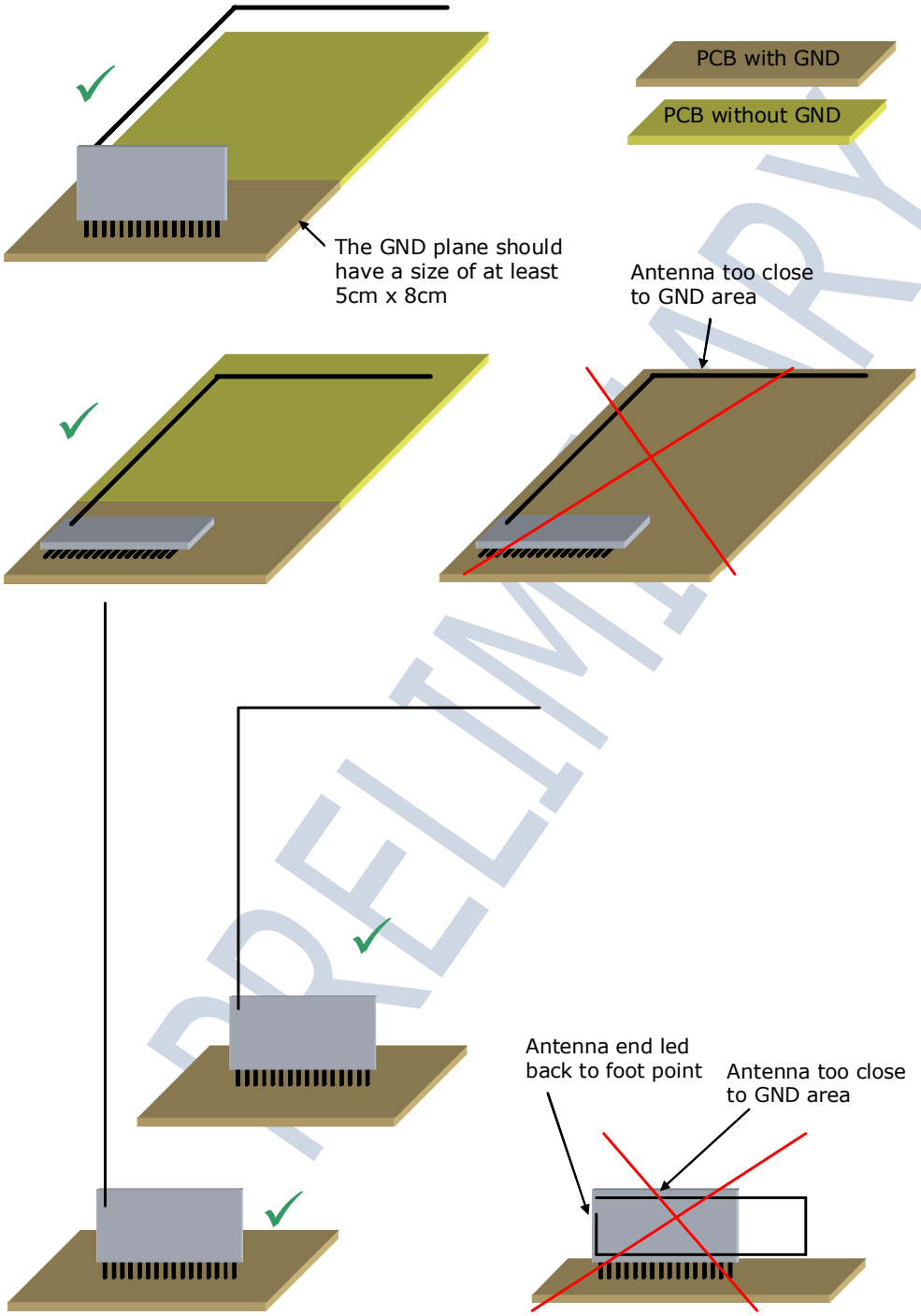
For good receiver performance, great care must be taken about the space immediately around the antenna since this has a strong influence on screening and detuning the antenna. The antenna should be drawn out as far as possible and must never be cut off. Mainly the far end of the wire should be mounted 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 22uF 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 (<1Ω) 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.

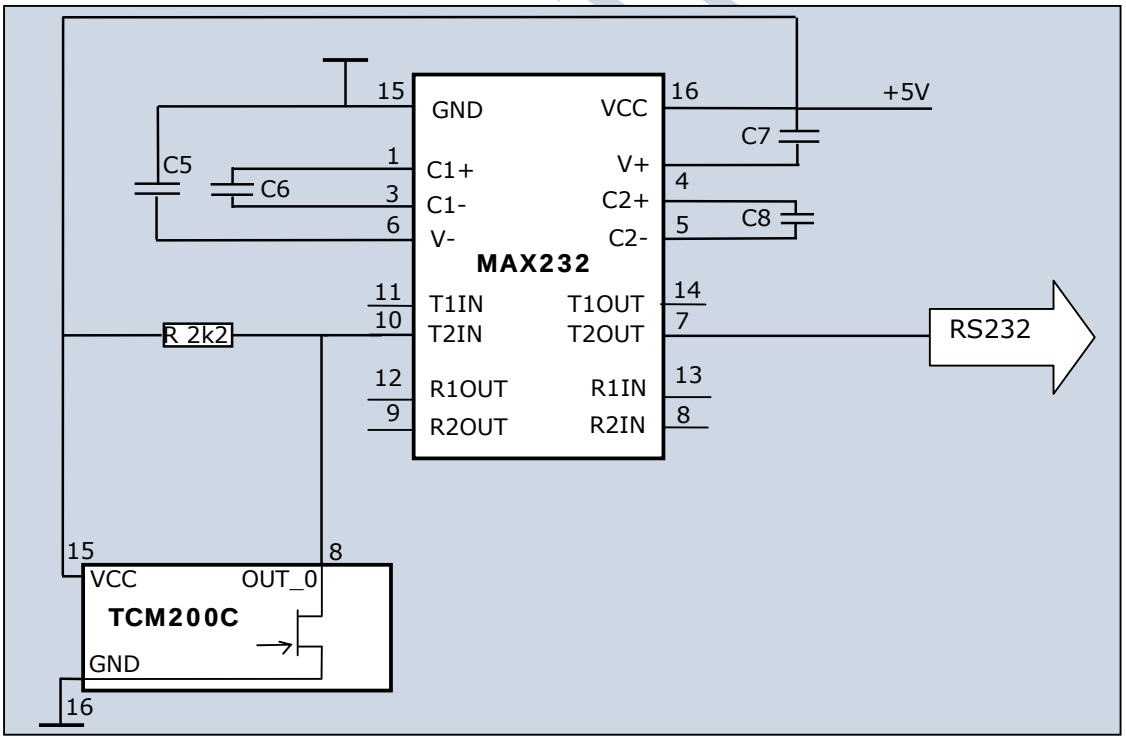
3.4 Connecting Open Collector or Open Drain Outputs

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.

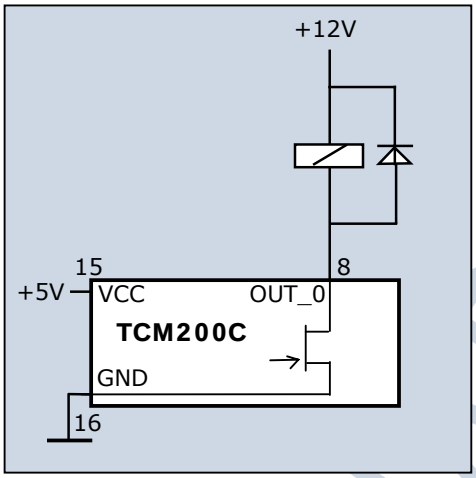
Applications of open-collector/drain devices:

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 Transmission range

The main factors that influence the system transmission range are:

- Type and location of the antennas of receiver and transmitter
- Type of terrain and degree of obstruction of the link path
- Sources of interference affecting the receiver
- "Dead" spots caused by signal reflections from nearby conductive objects

Since the expected transmission range strongly depends on these system conditions, range tests should categorically be performed in early project phases!

The following figures for expected transmission range are considered by using a PTM, or STM transmitter device and the TCM radio transceiver 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
- Brick walls / aerated concrete: Typically 20m range, through max. 3 walls
- 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 60% 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 1m.

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

3.6 AGENCY CERTIFICATIONS

3.6.1 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:5731A-PTM-200C
- STM110C FCC ID:SZV-STM110C, IC:5731A-STM-110C
- TCM200C FCC ID:SZV-TCM-2XXC, IC:5731A-TCM-2XXC
- TCM200C FCC ID:SZV-TCM-2XXC, IC:5731A-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

3.6.2 IC (Industry Canada) Certification
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: 5731A-TCM2XXC

4 DEVELOPMENT TOOLS

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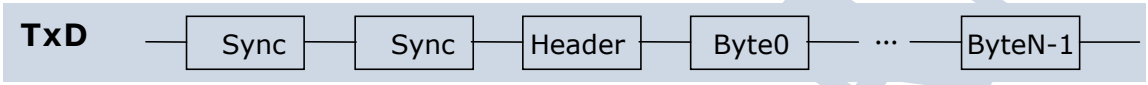
APPENDIX

A.1 EnOcean serial protocol

A.1.1 Message format

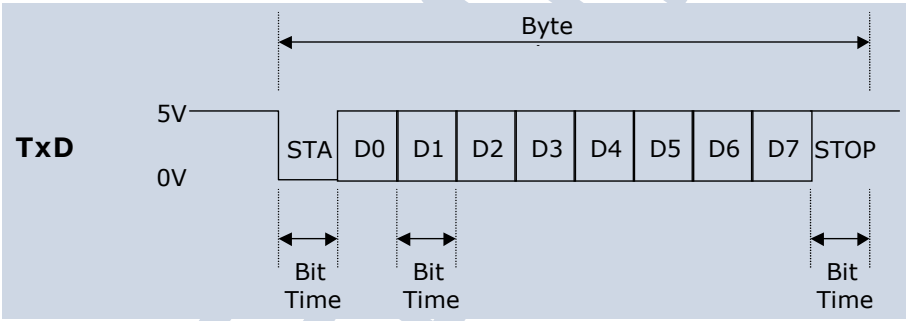
The following figure shows the message format. A data block of length n is composed of 2 synchronization bytes, 1 octet for the header and n-1 octets for the message data.



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:

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 = 0b*111* (scene switch), and RID ≠ 0 (indicates that the memory buttons M0-M5 are operated in the hand-held remote control).