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TCM 120
Transceiver Module

User Manual V1.5
March 2006

Revision History

The following major modifications and improvements have been made to the initial version of the document (TCM 120 User Manual V1.0):

Version	Subject (major changes since last version)
0.93	Pin description changed (adapted to RCM 110/120)
0.94	Err_tx_status removed; connect inputs IN_0 to IN_3 to GND; changes in current consumption; new error message ERR_MODEM_DUP_ID
1.0	Serial speed set fix to 9600 baud, errors in INF_MODEM_STATUS and INF_SW_VER corrected
1.01	Several notes added in A1.2
1.02	Change in INF_INIT
1.03	Change in 3.4 Power supply requirements; section 2.3 added; note added in 3.2 and 3.5
1.04	Clarifications in section A.1.3
1.1	Application note (section 3.5) added
1.11	3.6 Approval requirements modified, minor corrections
1.15	Correction in 2.5.2 and A1.1 for MDA telegram; correction in 2.5.5
1.2	Correction in 2.5.3 and appendix. ERR_IDRANGE message added.
1.21	A1.1: Field BUTTONS defined for PTM200; 2.3.3. Telegram timing corrected
1.3	Declaration of Conformity added
1.4	FCC/IC Approval Requirements added (chapter 3.7)
1.5	Correction in current consumption

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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 components, not for applications, processes and circuits implemented within components or assemblies.

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

EnOcean GmbH does not recommend the use of its products in life support applications and will not knowingly sell its products for use in such applications unless it receives an adequate "products liability indemnification insurance agreement".

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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1. GENERAL DESCRIPTION

The transceiver module TCM 120 of EnOcean enables the implementation of bi-directional RF applications based on the innovative EnOcean radio technology.
Typical applications are bi-directional EnOcean compatible radio interfaces, e.g. to existing system solutions or bus systems.

The TCM 120 transceiver module serves the 868 MHz air interface protocol of EnOcean. It receives all signals of the EnOcean radio transmitters (based on e.g. modules PTM 100, STM 100) and makes them available at the serial port. Control signals can be sent to any EnOcean radio receiver (based on e.g. receiver modules RCM 110, RCM 120, TCM 120). The integrated modem functionality allows easy data transfer between several TCM 120s.

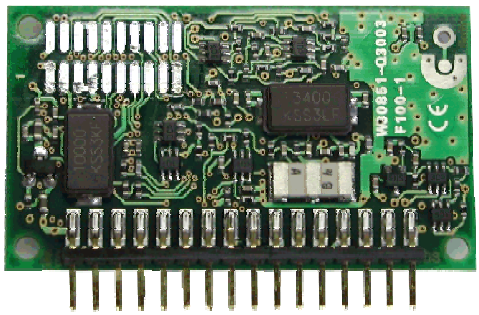

Figure 1: TCM 120 module

1.1 Basic Functionalities

- Receive radio telegrams from EnOcean radio transmitters.
  - Telegrams are provided via serial RS232 interface.
  - Functionality similar to RCM 120.
- Transmit EnOcean radio telegrams
  - All different kinds of telegrams (e.g. PTM 100 or STM 100) can be generated
  - The TCM 120 can send on 128 different IDs (derived from 1 base number)
- Simple modem functionality to distribute information between several TCM 120

1.2 Features Overview

Frequency / modulation type / transmission power: .868.3 MHz / ASK / max. 10 mW
Data rate (transmitter) / channel bandwidth (receiver):..... 120 kbps / 280 kHz
Transmission range: ..... 300 m free field
Power supply voltage: .....5V +10%/-5%
Power supply standby current: .....typ. 40 µA

Power supply operation current (receive): ..... typ. 33 mA, max. 40 mA
Power supply operation current (receive+transmit): ..... max. 55 mA
Bi-directional serial interface: ..... full-duplex, async., 9.6 kbps
Modem functionality (for easy data transfer): 6 bytes per telegram with acknowledge
Transmitting reliability feature: ..... carrier sense before transmit
Receiver features: ..... sensitivity can be reduced by SW command
Fast Tx power up from stand-by: ..... 2 µs
Tx/Rx changeover: ..... 0.5 µs
Transmitting indication output (LED): ..... 20 mA max., approx. 3 x 2 ms within 50 ms
RSSI Output: ..... indicates received peak signal strength

1.3 Physical Dimensions

Antenna: ..... No antenna installed, 9 cm whip antenna or external antenna mountable
only 1 antenna for transmit and receive
Dimensions of PCB: ..... 24.0 x 42.0 x 5 mm (without wiring pins)
Connector: ..... 16 pins, grid 2.0 mm (4.0 mm in length, ☐ 0.5 mm)

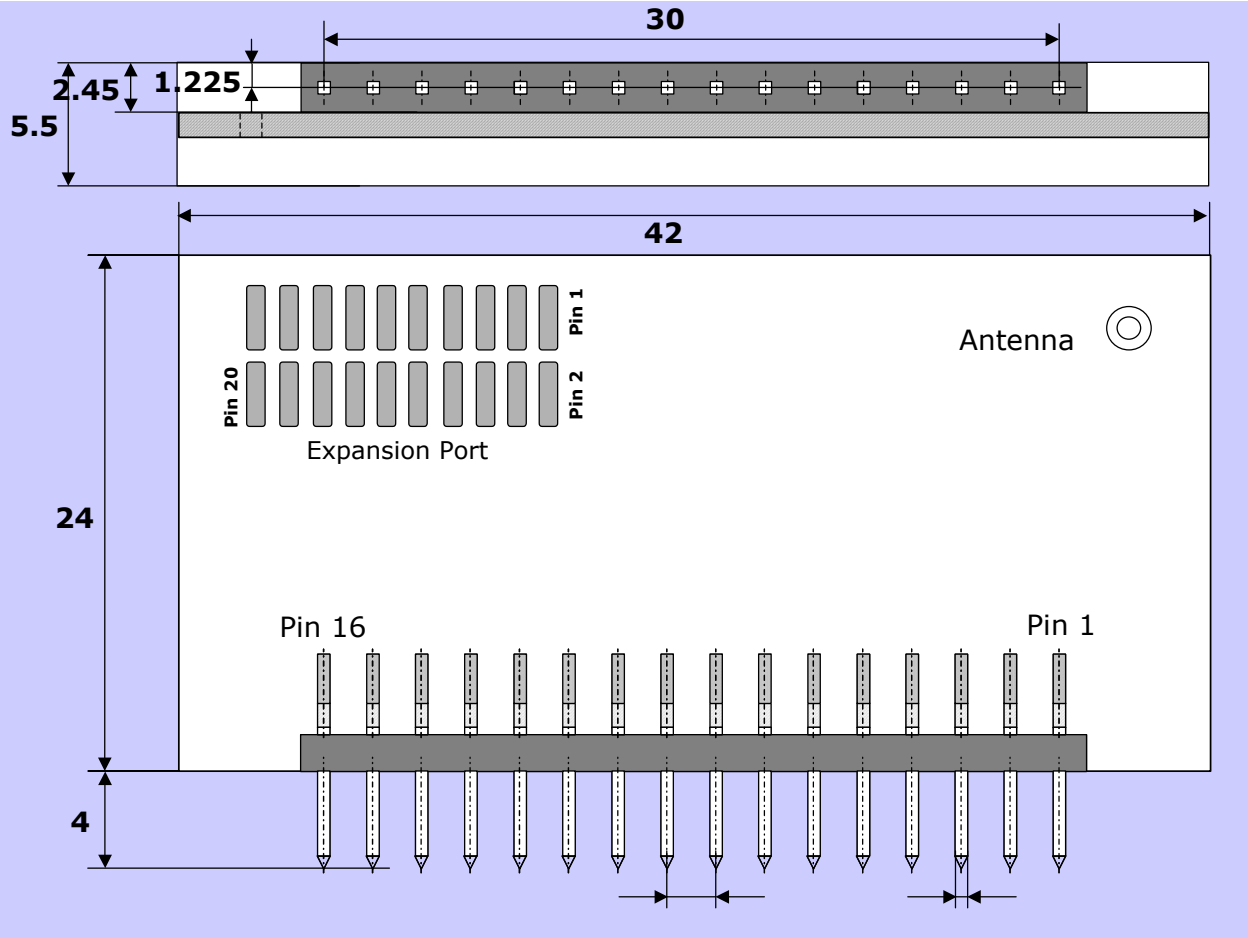

Figure 2: TCM 120 package outlines

1.4 Environmental Conditions

Operating temperature: ..... -25 up to +65 °C
Storage temperature: .....-40 up to +85 °C, +85 up to +100 °C for 1h max.
Humidity:.....0 % to 95 % r.h.

1.5 Ordering Information

Type	EnOcean Ordering Code
TCM 120	**S3003-K120**

2. FUNCTIONAL DESCRIPTION

2.1 Block Diagram

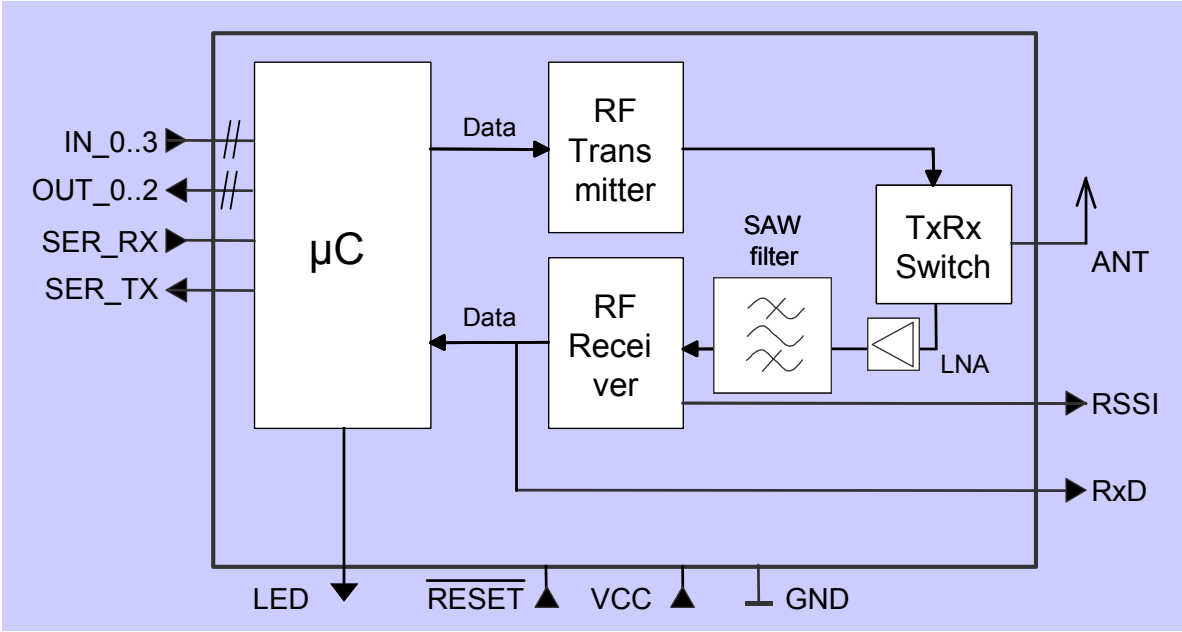

Figure 3: Block diagram of TCM 120

2.2 Pin Description

Pin No.	Symbol	Function	Operational characteristics
1, 16	**GND**	Ground connection	
2	**$\overline{\text{RESET}}$**	External reset signal	
3	**IN_0**	For future applications	Connect to GND[1]
4	**IN_1**	For future applications	Connect to GND[1]
5	**IN_2**	For future applications	Connect to GND[1]
6	**IN_3**	For future applications	Connect to GND[1]
7	**SER_RX**	Serial communications reception line	Viewed from TCM 5V CMOS input
8	**SER_TX**	Serial communications transmission line	Viewed from TCM 5V CMOS output, 20 mA max.
9	**OUT_0**	For future applications	Do not connect 5V CMOS output, 20 mA max.

[1] To reduce power consumption and for stable conditions

10	**OUT_1**	For future applications	Do not connect 5V CMOS output, 20 mA max.
11	**OUT_2**	For future applications	Do not connect 5V CMOS output, 20 mA max.
12	**LED**	Transmission indicator	5V CMOS output 20 mA max., approx. 3 x 2 ms within 50 ms
13	**RxD**	Raw base band data from receiver	5V TTL output, source impedance approx. 11 kΩ
14	**RSSI**	RSSI signal from receiver	Source impedance approx. 20 kΩ
15	**Vcc**	Supply voltage	5V +10%/-5% max. 55 mA (without LED current)
Expansion Port 1-20		For future applications	

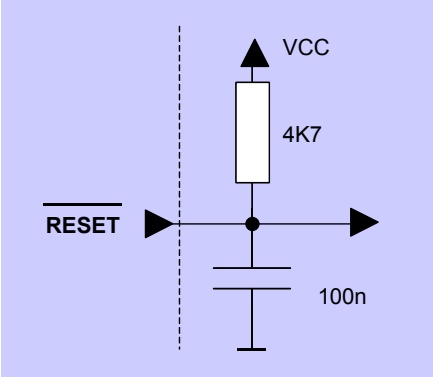

Figure 4: Equivalent schematics for /RESET input

2.3 TCM 120 Radio Telegram

For the transmission of the telemetric signals, EnOcean has defined a dynamic radio data telegram that is adapted to the individual application. It is optimized to the essential features of energy autarkic radio sensors:

- Minimal energy demand
- Minimal collision risk
- Maximum transmission reliability
- Wide transmission range
- Easy extensibility
- Suitable for uni- and bi-directional communication
- Flexibility for adaptation of different data structures and data quantities
- Data encryption option

2.3.1 Frequency range and duty cycle

The EnOcean technology operates the 868.3 MHz radio channel (868.0 – 868.6 MHz), which is exclusively released for short-time data transmission in Europe. Timing conditions can be found in chapter 3.6 of this paper.

Because of the very low radiated field strength on average, the 868.3 MHz EnOcean radio technology can be approved in the USA and in Canada. The approval requirements can be found in chapter 3.7 of this paper.

2.3.2 Modulation process

As modulation process, EnOcean uses incoherent amplitude modulation (ASK). Digital amplitude modulation enables the implementation of very efficient energy-saving transmitters because only the "1"-bits are transferred. At the same interference signal level, the transmission security of the alternative method (FSK) is identical to that of the ASK method (Ref: Pehl, Digitale und analoge Nachrichtenübertragung, Hüthig 2001).

2.3.3 Transmission timing

The setup of the transmission timing of the radio module TCM 120 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 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)

2.3.4 Reliable radio transmission within systems operating many sensors

The very short telegrams of EnOcean transmitters enable the operating of a large number of senders within the same radio cell; the error rate caused by collisions remains extremely low. Statistically viewed, the transmission reliability is still 99.99% in the case of 100 radio sensors that transmit once every minute. This means that even large office buildings and also huge industrial facilities can be equipped with a large number of sensors of this kind of radio technology.

2.4 TCM 120 Serial Interface

Via the serial interface, the TCM 120 transfers out data blocks of information from received radio telegrams and accepts commands. An asynchronous serial communication (9.6 kbps, 1 start bit, 8-bit data byte with LSB first, 1 stop bit) is used to establish communication.

At startup and after a reset of the module, an ASCII telegram (INF_INIT) containing information about the current settings is sent.

After sending the INF_INIT message, communication follows the structure described below.

For a complete message, a telegram of 14 data bytes is transferred. Since there is no minimum delay time between two messages, a verification of the two initial synchronization bytes and the final checksum byte is recommended for synchronizing the first message. It can happen that the data bytes have sync byte format. In this case, a checksum error will occur and the next correct sync byte sequence has to be awaited.

In TCM 120 there are 4 types of serial telegrams:

Acronym	Name	Direction	Radio emission / reception
TRT	Transmit Radio Telegram	Serial input	Yes
RRT	Received Radio Telegram	Serial output	Yes
TCT	Transmit Command Telegram	Serial input	No
RMT	Received Message Telegram	Serial output	No

2.4.1 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.

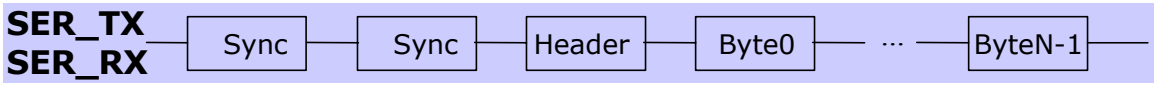

Figure 5: Message format for asynchronous serial communication

2.4.2 Octet signals and bit order

- 9.6 kbps, 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)

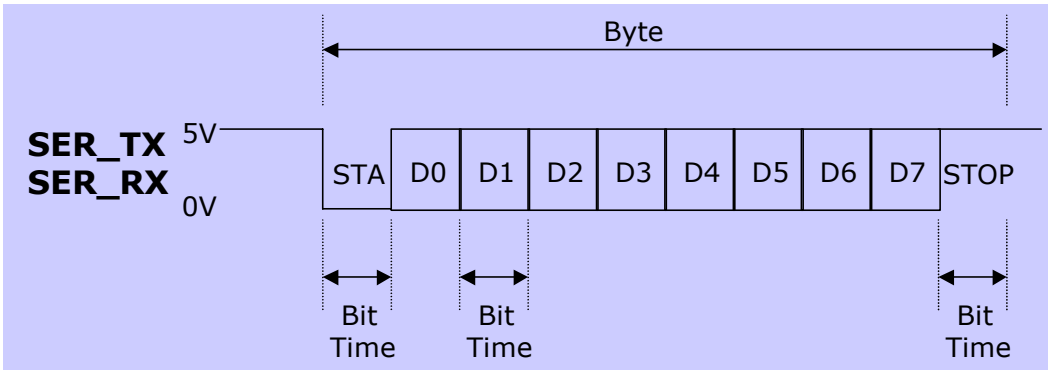

Figure 6: Signals and bit order sending a byte

2.4.3 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		

Field	Field length	Description
SYNC_BYTE 0..1	8 bit each	Synchronization Bytes (0xA5 0x5A)
H_SEQ	3 bit	Header identification: 0 : receive radio telegram (RRT) 1 : n.a. in TCM 120 2 : n.a. in TCM 120 3 : transmit radio telegram (TRT) 4 : receive message telegram (RMT) 5 : transmit command telegram (TCT)
LENGTH	5 bit	Number of octets following the header octet (always 11 dec)
ORG	8 bit	Type of telegram (see detailed description)
DATA_BYTE 0..3	8 bit each	Data bytes 0..3 (see detailed description)
ID_BYTE 0..3	8 bit each	32-bit transmitter ID
STATUS	8 bit	Status field (see detailed description)
CHECKSUM	8 bit	Checksum (Least Significant Byte from addition of all octets except sync bytes and checksum)

2.5 TCM 120 Commands

The following provides an overview of the built-in commands. A detailed description can be found in appendix A.

2.5.1 Radio Transmission/Reception commands

The following commands are used to transmit and receive radio telegrams.

Command	Response (RMT)
TX_TELEGRAM (TRT)	OK, ERR, ERR_TX_IDRANGE
RX_TELEGRAM (RRT)	

2.5.2 Modem commands

The TCM 120 provides a simple modem functionality that allows the transfer of 6-byte data packets from one TCM 120 to another.

Command (TCT)	Response (RMT)
MODEM_ON	OK, ERR
MODEM_OFF	OK, ERR
TX_TELEGRAM (TRT command)	OK, ERR, ERR_TX_IDRANGE, ERR_MODEM_NOTACK, ERR_MODEM_NOTWANTEDACK
RD_MODEM_STATUS	INF_MODEM_STATUS

Every TCM 120 has a 2-byte channel ID that is defined via the MODEM_ON command. In order to transmit a 6-byte message to another TCM 120, the transmitter has to specify the 6 data bytes and the 2-byte modem ID of the receiver in the TX_TELEGRAM command. The transmitting modem waits to receive an acknowledge telegram from the receiving modem. As soon as the acknowledge signal is received, the user gets an MDA telegram. If the acknowledge signal is not received within 100ms, there is a timeout and an error message is generated. If more than one acknowledge signal is received, an error message is also generated.
Within one hour it is possible (within the 1% duty cycle) to transmit 9000 x 6 bytes of user data. This corresponds to a data rate of about 120 bit/s.

2.5.3 ID Range commands

Every TCM 120 supports a range of 128 IDs. The ID length is 32bit. At production, every TCM 120 is programmed with a unique 32bit ID base.
The ID range base number can be read via the serial interface. In order to allow a replacement of one unit with another unit (without having to go through the learning procedure with every receiver), the ID range can be changed via the serial interface.
The allowed ID range is from 0xFF800000 to 0xFFFFFFFF.
In order to prevent misuse, this feature can only be used 10 times!

Command (TCT)	Response (RMT)
SET_IDBASE	OK, ERR, ERR_IDRANGE
RD_IDBASE	INF_IDBASE

2.5.4 Receiver sensitivity commands

The receiver sensitivity can be changed by the following commands. In LOW sensitivity mode, only transmitters in the vicinity of the TCM 120 are received.

Command (TCT)	Response (RMT)
SET_RX_SENSITIVITY	OK
RD_RX_SENSITIVITY	INF_RX_SENSITIVITY

2.5.5 Reset and Sleep Mode commands

Command (TCT)	Response (RMT)
RESET	INF_INIT
SLEEP	
WAKE	

The TCM wakes up from SLEEP mode as soon as a hardware reset is made or a WAKE telegram is sent via the serial interface.
Please note that after a WAKE telegram a delay of 20ms is necessary before another telegram may be sent via the serial interface. Otherwise several telegrams may be lost.

2.5.6 SW Version

Command (TCT)	Response (RMT)
RD_SW_VER	INF_SW_VER

2.5.7 Error messages

Error Messages (RMT)
ERR
ERR_MODEM_NOTWANTEDACK
ERR_MODEM_NOTACK
ERR_MODEM_DUP_ID
ERR_TX_IDRANGE
ERR_IDRANGE
ERR_SYNTAX

2.6 Received Signal Strength Indicator (RSSI)

The RSSI output of the RCM module is useful for transmission range tests. By indicating the strength of an incoming RF signal, this output allows the assessment of RF link quality and transmission range. The RSSI pin output voltage is typically 1.4 V with no RF signal, rising to typically 2.7 V at maximum signal. The external loading should be kept to a minimum since the RSSI output source impedance is around 20 kΩ. The following figure shows a typical RSSI characteristic:

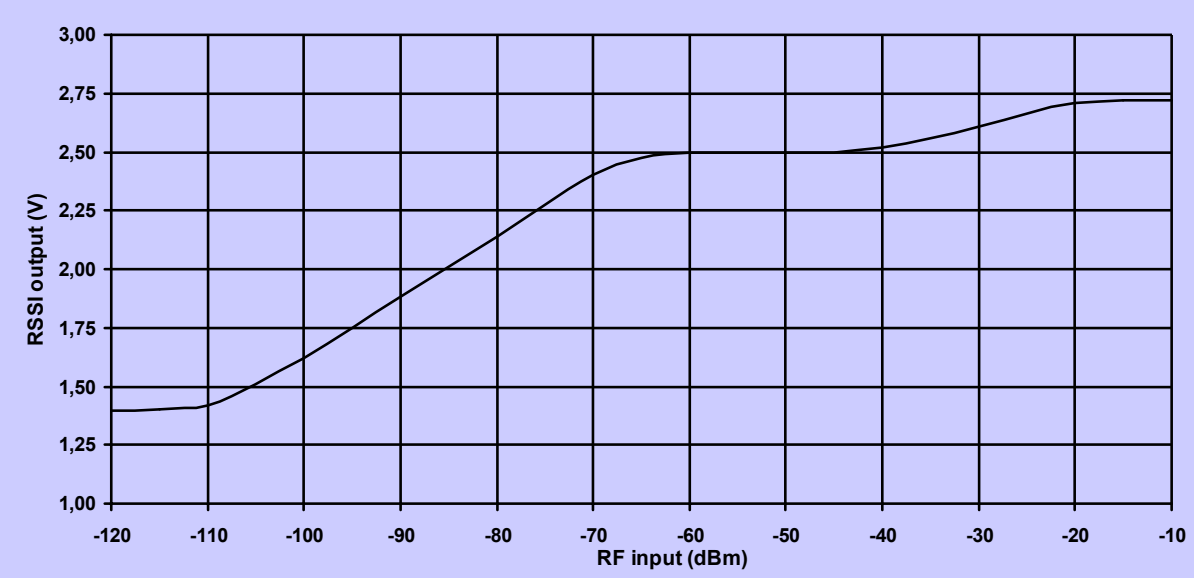

Figure 7: RSSI output characteristics

2.7 Demodulated Direct Signal Output (RxD)

TTL output of all received radio signals (120 KHz, physical layer 1).

3. APPLICATIONS INFORMATION

3.1 Module Mounting

The modules may be mounted in vertical or horizontal position to the motherboard of the application device (load module). In a vertical position, the module pins can be directly connected to the motherboard through suitable PCB holes. Optionally or for horizontal mounting, suitable female strip connectors for through-hole or SMD assembling are available and are supplied ready to the required contact number (e.g. type BLY from Fischer Elektronik). Additional module fixing may be necessary in rough environments.

The following features have to be available on the motherboard:

- Serial interface
- Power supply for the TCM 120 module
- External connectors

3.2 Antenna Mounting

Positioning and choice of receiver and transmitter antennas are the most important factors in determining system transmission range. The TCM 120 modules are supplied without antenna. For standard applications the use of a whip antenna is recommended (87 mm/ 0.14 mm^2 Cu-wire). This antenna enables very compact unit with good radio reception characteristics. For mounting the antenna, the following notes should be considered to optimize the system performance:

a) Mounting a 1/4-wave whip antenna:
For good receive/transmit 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. Primarily, the far end of the wire should be mounted as far away as possible from all metal parts, PCB strip lines and fast logic components (e.g. microprocessors). To avoid radio frequency hash from the motherboard, which desensitizes the unit, PCB strip lines on the motherboard should be designed as short as possible, and using PCB ground plane layer is also recommended.

Note that 868 MHz whip antennas do not show any directional effects under free-field radio-wave propagation conditions (spot-wise radiator).

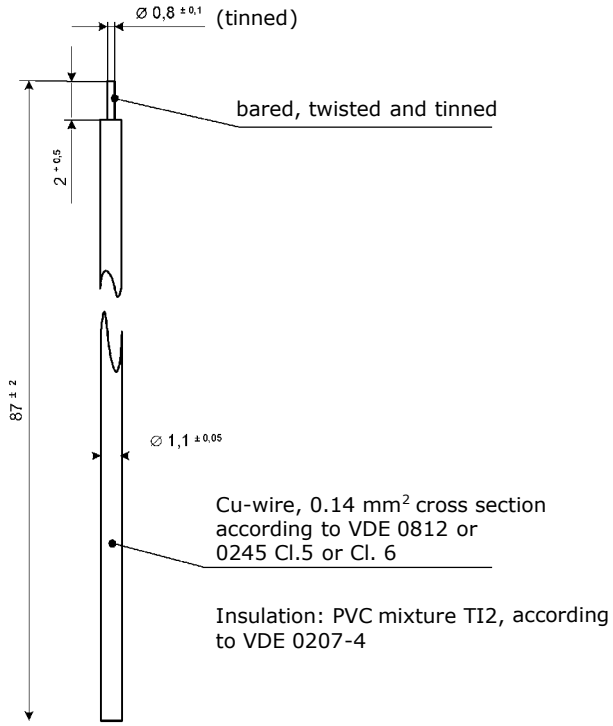

Figure 8: Specification of whip antenna

b) Mounting an external antenna:
For mounting the device at bad RF locations (e.g. within a metal cabinet), an external antenna has to be used. The external antenna can be connected to the equipment by a 50 Ω coax feeder.

Please note that a full approval is needed if the TCM 120 is used with an external antenna!

3.3 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 particular application.

The following figures for expected transmission range are considered by using a PTM, a STM or a TCM radio transmitter device and the RCM or 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
- ***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 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

Please note for use in the US and in Canada: In the US, 868 MHz frequency range is used by Trunk Radio. Since a reduction of transmission range is to be expected near a trunk radio station, range tests at the system's target location should categorically be performed before notification of a particular range in the US and in Canada!

3.4 Power Supply Requirements

The ripple-to-noise ratio on the supply rail should be below 10mVp-p to avoid problems. If the quality of the supply is in doubt, it is recommended that a 33µF low-ESR tantalum or similar capacitor be added between the module supply pin (Vcc) and ground, together with a 4.7 Ω series feed resistor between the Vcc pin and the supply rail.

3.5 Application Note

The following figure shows a basic application example for the TCM 120 module.

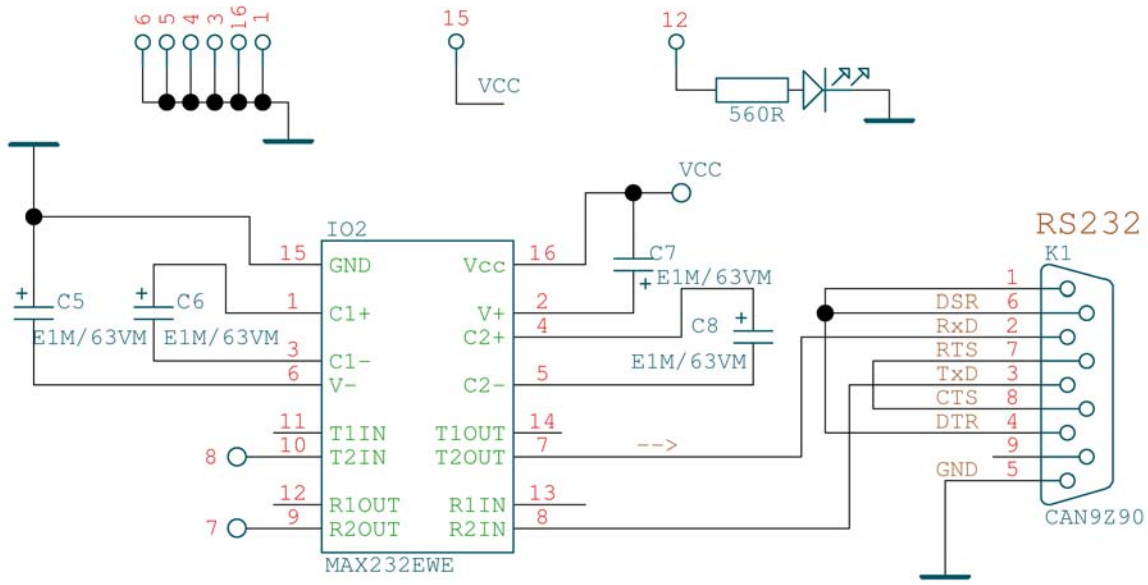

Figure 8: Application note

3.6 CE Approval Requirements

The modules bear the EC conformity marking CE and conforms to the R&TTE EU-directive on radio equipment. The assembly conforms to the European and national requirements of electromagnetic compatibility. The conformity has been proven and the according documentation has been deposited at EnOcean. The modules can be operated without notification and free of charge in the area of the European Union, in Switzerland, in Cyprus, in Czech, in Estonia, in Hungary, in Latvia, in Lithuania, in Malta, in Poland, in Romania and in Slovenia. The following provisos apply:

- EnOcean RF modules must not be modified or used outside their specification limits.
- EnOcean RF modules may only be used to transfer digital or digitized data. Analog speech and/or music are not permitted.
- The final product incorporating EnOcean RF modules must itself meet the essential requirement of the R&TTE Directive and a CE marking must be affixed on the final product and on the sales packaging each. Operating instructions containing a Declaration of Conformity has to be attached.
- If the STM 100 transmitter is used according to the regulations of the 868.3 MHz band, a so-called "Duty Cycle" of 1% per hour must not be exceeded. Permanent transmitters such as radio earphones are not allowed. For approval aspects, it must be ensured that **the TCM radio module does not transmit measuring data more than 9000 times per hour**. For this calculation the extraordinary short telegram length is considered including all subtelegrams (see Chapter 2.3). Also a tolerance of 5% in telegram length is included.

Please note that a full approval is needed if the TCM 120 is used with an external antenna!

3.7 FCC/IC Approval Requirements

Because of the very low radiated field strength on average, the 868.3 MHz EnOcean radio technology can be approved in the USA and in Canada. If the TCM is operated in compliance with the following requirements, a finished good containing this radio will comply with Part 15 of the FCC Rules and with RSS-210 of Industry Canada. **Please be aware of the possibility of reduced transmission range when using an EnOcean 868 MHz system near a US trunk radio station!**

Because dedicated timing limit conditions are claimed, no TCM module approval is possible in general. **The finished good has to be approved by a notified body for operating free of charge in the area of the United States of America ("FCC approval") and in Canada ("IC approval")**.

3.7.1 FCC Part 15 field strength limits

The limit for 868.3 MHz according to FCC15.231 is 82 dBuV/m at 3 m distance AVERAGE. The reduced limit for periodic transmissions according to FCC15.231e is 4 dB less. Considering the calculated peak to average factor of the EnOcean transmitters, there should be no problem with respect to FCC part 15 field strength limit values. The AVERAGE radiated output power of TCM 1xx with 1/4-wave whip antenna can be calculated as follows, considering the worst case telegram length (4BS of STM100):

- On pulse train is min. 24 ms, max 63.3 ms, depending on software. The length of one packet is 1.2 ms. Within a packet the duty cycle is ~50%, ~ 0.6 ms. So we have in worst case 4 pulse trains within 100 ms with together 12 packets with 0.6 ms TX-time.
- Added we have a TX-time 12*0.6 ms within 100ms, this is a duty cycle of 7.2%. So we calculate the average value 20*log(7.2/100) = -22.8 dB. The measured radiated output power of TCM1xx is 100.8 dBµV/m at 3m distance PEAK (Source: Test report by CeTeCom). The calculated **AVERAGE radiated output power is** 100.8 dBµV/m – 22.8 dB = 78.0 dBµV/m at 3m distance and **4 dB lower than the limit of 82 dBµV/m for 868.3 MHz according to FCC15.231**.
- A test report containing the TCM measurement details with 1/4-wave whip antenna is available from EnOcean on request.

3.7.2 FCC/IC operational and timing requirements

Because of the very low average to peak factor, the (corrected) field strengths of EnOcean transmitters meet the 15.231 conditions for manually operated transmitters and the lower field strength limit values for intentional radiators operated at a periodic rate. In addition to the field strength limits, the following timing conditions have to be met with respect to 15.231:

- **Intentional radiators operated at a periodic rate:**

  Periodic transmissions of EnOcean modules at regular predetermined intervals are allowed with respect to 15.231e, if the silent period between transmissions is in no case less than 10 seconds.

- **Manually operated transmitters, Presence signals:**
  - Periodic transmissions at regular predetermined intervals are permitted

under the conditions of 15.231e only. However, polling or supervision transmissions, including data, to determine system integrity of transmitters used in security or safety applications (e.g. presence signals of STM100 and STM250 based applications) are allowed if the total duration of transmissions does not exceed more than two seconds per hour for each transmitter. There is no limit on the number of individual transmissions, provided the **total transmission time does not exceed two seconds per hour**.

- This means that the following system conditions must be met to comply with Part 15 requirements under conditions of excessive data rates: **It must be ensured that the TCM radio module does not transmit data more than 1058 times per hour (manually operated telegrams and presence telegrams)**. For this timing calculation the worst case of STM100 packet length of 1.2 ms, a tolerance of 5% in packet length, a 50% on average packet Ton/Toff ratio and all 3 redundant packets are considered.

4. DECLARATION OF CONFORMITY

EnOcean GmbH
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D 82041 Oberhaching
www.enocean.com

Declaration of Conformity

CE

We: EnOcean GmbH
Kolpingring 18a
D 82041 Oberhaching
Germany

Declare: under our sole responsibility that the following labeled products:

Transmitter:	**PTM100, STM100, STM250, PTM200**
Receiver:	**RCM110, RCM120, RCM121**
Transceiver:	**TCM110, TCM120**

to which this declaration relates, are, when used according to specification, in conformity with the technical requirements of the standards and the provisions of the essential requirements of the Directives detailed below.

Directives: Electromagnetic Compatibility Directive 89/336/EC

Radio and Telecommunications Terminal Equipment Directive R&TTE 1999/5/EC

Standards: ETSI EN 301 489-1: 2001-09, ETSI EN 301 489-3: 2001-11 (class 2)

ETSI EN 61000-6-2: 2002-08

ETSI EN 300 220-3: 2000-09

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Date of issue: 13. May 2005
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Appendix A

A.1 Radio Telegrams

The TX_TELEGRAM and RX_TELEGRAM telegrams have the same structure. The only difference is that a TX_TELEGRAM is identified by "3" in H_SEQ instead of "0" for an RX_TELEGRAM.

A.1.1 Detailed description of ORG field

ORG	Description	RRT / TRT Acronym
0x05	Telegram from a PTM switch module received (original or repeated message)	RPS
0x06	1 byte data telegram from a STM sensor module received (original or repeated message)	1BS
0x07	4 byte data telegram from a STM sensor module received (original or repeated message)	4BS
0x08	Telegram from a CTM module received (original or repeated message)	HRC
0x0A	6byte Modem Telegram (original or repeated)	6DT
0x0B	Modem Acknowledge Telegram	MDA

Serial command encoding for RPS, 1BS, 4BS, HRC

Bit 7 Bit 0

0xA5
0x5A
0x0B (RX_TELEGRAM) 0x6B(TX_TELEGRAM)
ORG
DataBytes3
DataBytes2
DataBytes1
DataBytes0
IDBytes3
IDBytes2
IDBytes1
IDBytes0
Status
ChkSum

DataBytes2= DataBytes1= DataBytes0= 0x00

for RPS,1BS, HRC

Serial command encoding for 6DT

Bit 7 Bit 0

0xA5
0x5A
0x0B (RX_TELEGRAM) 0x6B(TX_TELEGRAM)
0x0A
DataBytes5
DataBytes4
DataBytes3
DataBytes2
DataBytes1
DataBytes0
Address1
Address0
Status
ChkSum

Serial command encoding for MDA

Bit 7 Bit 0

0xA5
0x5A
0x0B (RX_TELEGRAM) **0x6B(TX_TELEGRAM)**
0x0B
0xXX
0xXX
0xXX
0xXX
Address1
Address0
0xXX
0xXX
Status
ChkSum

A.1.2 Detailed description of STATUS field

If ORG = 0x05 (Telegram from a PTM switch module)

7			**0**
Reserved	**T21**	**NU**	**RP_COUNTER**

Reserved	(2 bit)	Do not care
T21	(1 bit)	T21=0 → PTM switch module of type 1, T21=1 → PTM switch module of type 2 Note: In transmission the TCM 120 always sets T21=1 → it is only possible to transmit PTM type 2 telegrams!
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: Within toggle switch applications using the RCM 120 or TCM 120 serial receiver mode in combination with the TCM 110 repeater module, please ensure that no serial command interpretation error may occur at the connected control unit. A toggle signal means that the same telegram (from e.g. PTM 100, PTM 200 or STM 100) is sent for switching something on and off. If e.g. the light is switched on by means of a RCM 120 receiving the I-button telegram from a PTM 100, the repeated telegram (delay <100ms) may switch off the light again. It is therefore mandatory to interpret the RP_COUNTER field as described in the RCM 120 User Manual. 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 1 (e.g. PTM 100) do not support interpretation of operating more than one rocker at the same time:

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

PTM switch modules of Type 2 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 100 piezo transmitters: Due to the mechanical hysteresis of the piezo 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 = 0x06, 0x07, 0x08 or 0x0A:

7							0
Reserved							**RP_COUNTER**

Reserved (4 bit) Do not care
RP_COUNTER (4 bit) Repeater level: 0 original message
1 repeated message

Please also consider IMPORTANT NOTE above!

A.1.3 Detailed description of DATA_BYTE 3..0 fields

If ORG = 0x05 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 = 0x05 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 follows:

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 = 0x06 (Telegram from a 1 Byte STM sensor):

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

If ORG = 0x07 (Telegram from a 4 Byte STM sensor):

DATA_BYTE3 Value of third sensor analog input
DATA_BYTE2 Value of second sensor analog input
DATA_BYTE1 Value of first sensor analog input
DATA_BYTE0 Sensor digital inputs as follows:

7				**0**
Reserved	**DI_3**	**DI_2**	**DI_1**	**DI_0**

If ORG = 0x08 (Telegram from a CTM module set into HRC operation):

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 SR bit is used only when the lower 3 bits from ID_BYTE0 = B'111' (scene switch), and RID ≠ 0 (indicates that the memory buttons M0-M6 are operated in the handheld remote control).

If ORG = 0x0A (Modem telegram):

Please note the different structure of modem telegrams with 6 data bytes and 2 address bytes for the ID of the receiving modem. See A.1.1.

A.2 Command Telegrams and Messages

INF_INIT

Bit 7 *Bit 0*

0xA5
0x5A
0x8B
0x89
X
X
X
X
X
X
X
X
X
ChkSum

After a power-on, a hardware reset or a RESET command the TCM informs the user through several of these telegrams about the current status.

The messages have the general syntax as shown on the left. The information contained by the bytes marked as X should be decoded according to ASCII code.

In total there are 15 telegrams:

0xA5 0x5A 0x8B 0x89 " "
0xA5 0x5A 0x8B 0x89 "EnOcean"
0xA5 0x5A 0x8B 0x89 "TCM120"
0xA5 0x5A 0x8B 0x89 "Version"
0xA5 0x5A 0x8B 0x89 Version number in ASCII
0xA5 0x5A 0x8B 0x89 "Bdrate"
0xA5 0x5A 0x8B 0x89 *"0x40" (9600 baud)*
0xA5 0x5A 0x8B 0x89 "Modem"
0xA5 0x5A 0x8B 0x89 "ON" or "OFF"
0xA5 0x5A 0x8B 0x89 "RxID"
0xA5 0x5A 0x8B 0x89 modem ID in ASCII
0xA5 0x5A 0x8B 0x89 "Mode"
0xA5 0x5A 0x8B 0x89 "Run"
0xA5 0x5A 0x8B 0x89 "PrgMem"
0xA5 0x5A 0x8B 0x89 "OK" or "CORRUPT"

OK

Bit 7 *Bit 0*

0xA5
0x5A
0x8B
0x58
X
X
X
X
X
X
X
X
X
ChkSum

Standard message used to confirm that an action was performed correctly by the TCM.

ERR

Bit 7	Bit 0
0xA5	
0x5A	
0x8B	
0x19	
X	
X	
X	
X	
X	
X	
X	
X	
X	
ChkSum	

Standard error message response if after a TCT command the operation could not be carried out successfully by the TCM.

SET_IDBASE

Bit 7	Bit 0
0xA5	
0x5A	
0xAB	
0x18	
IDBaseByte3	
IDBaseByte2	
IDBaseByte1	
IDBaseByte0	
X	
X	
X	
X	
X	
ChkSum	

With this command the user can rewrite its ID range base number. The most significant ID byte is IDBaseByte3**.** The information of the 25 most significant bits is stored in EEPROM. The allowed ID range is from 0xFF800000 to 0xFFFFFFFF.

32							**0**
25 most significant bits	**0**	**0**	**0**	**0**	**0**	**0**	**0**

ID range base

This command can only be used a maximum number of 10 times. After successfully ID range reprogramming, the TCM answers with an OK telegram. If reprogramming was not successful, the TCM answers sending an ERR telegram if the maximum number of 10 times is exceeded or an ERR_IDRANGE telegram if the ID range base is not within the allowed range.

RD_IDBASE

Bit 7	Bit 0
0xA5	
0x5A	
0xAB	
0x58	
X	
X	
X	
X	
X	
X	
X	
X	
X	
ChkSum	

When this command is sent to the TCM, the base ID range number is retrieved though an INF_IDBASE telegram.

INF_IDBASE

Bit 7 Bit 0

0xA5
0x5A
0x8B
0x98
IDBaseByte3
IDBaseByte2
IDBaseByte1
IDBaseByte0
X
X
X
X
X
ChkSum

This message informs the user about the ID range base number.

IDBaseByte3 is the most significant byte.

SET_RX_SENSITIVITY

Bit 7 Bit 0

0xA5
0x5A
0xAB
0x08
Sensitivity
X
X
X
X
X
X
X
X
ChkSum

This command is used to set the TCM radio sensitivity.
In LOW radio sensitivity, signals from remote transmitters are not detected by the TCM receiver. This feature is useful when only information from transmitters in the vicinity should be processed. An OK confirmation telegram is generated after TCM sensitivity has been changed.

Sensitivity=0x00 Low sensitivity
Sensitivity=0x01 High sensitivity

RD_RX_SENSITIVITY

Bit 7 Bit 0

0xA5
0x5A
0xAB
0x48
X
X
X
X
X
X
X
X
X
ChkSum

This command is sent to the TCM to retrieve the current radio sensitivity mode (HIGH or LOW).
This information is sent via a INF_RX_SENSITIVITY command.

INF_RX_SENSITIVITY

Bit 7	Bit 0
0xA5	
0x5A	
0x8B	
0x88	
Sensitivity	
X	
X	
X	
X	
X	
X	
X	
X	
ChkSum	

This message informs the user about the current TCM radio sensitivity.
Sensitivity= 0x00 Low sensitivity
Sensitivity= 0x01 High sensitivity

SLEEP

Bit 7	Bit 0
0xA5	
0x5A	
0xAB	
0x09	
X	
X	
X	
X	
X	
X	
X	
X	
X	
ChkSum	

If the TCM receives the SLEEP command, it works in an energy-saving mode. The TCM will not wake up before a hardware reset is made or a WAKE telegram is sent via the serial interface.

WAKE

Bit 7	Bit 0
0xAA	

If the TCM receives the WAKE command, it wakes up from sleep mode. In contrast to all other telegrams this telegram is only one byte long.

RESET

Bit 7	*Bit 0*
0xA5	
0x5A	
0xAB	
0x0A	
X	
X	
X	
X	
X	
X	
X	
X	
X	
ChkSum	

Performs a reset of the TCM microcontroller. When the TCM is ready to operate again, it sends an ASCII message (INF_INIT) containing the current settings.

MODEM_ON

Bit 7 Bit 0

0xA5
0x5A
0xAB
0x28
Modem ID (MSB)
Modem ID (LSB)
X
X
X
X
X
X
X
ChkSum

Activates TCM modem functionality and sets the modem ID. An OK confirmation telegram is generated. The modem ID is the ID at which the TCM receives messages of type 6DT.
The modem ID and modem status (ON/OFF) is stored in EEPROM. The modem ID range is from 0x0001 to 0xFFFF.
IF 0x0000 is provided as modem ID, the modem is activated with the ID previously stored in EEPROM.

MODEM_OFF

Bit 7 Bit 0

0xA5
0x5A
0xAB
0x2A
X
X
X
X
X
X
X
X
X
ChkSum

Deactivates TCM modem functionality. When this command has been sent, an OK command should be received, confirming that the modem status is OFF. The modem ID is not erased.

RD_MODEM_STATUS

Bit 7 Bit 0

0xA5
0x5A
0xAB
0x68
X
X
X
X
X
X
X
X
X
ChkSum

This command requests the TCM to send information about its current modem current status.
The requested information is reported to the user through an INF_MODEM_STATUS telegram.

INF_MODEM_STATUS

Bit 7 Bit 0

0xA5
0x5A
0x8B
0xA8
Modem status
Modem ID MSB
Modem ID LSB
X
X
X
X
X
X
ChkSum

Informs the user about the TCM current modem status. The information provided is the following: Modem status (ON or OFF) and modem ID stored.

Modem state=0x01, modem ON
Modem state=0x00, modem OFF

Modem ID MSB= most significant modem ID byte.
Modem ID LSB=least significant modem ID byte.

RD_SW_VER

Bit 7 Bit 0

0xA5
0x5A
0xAB
0x4B
X
X
X
X
X
X
X
X
X
ChkSum

This command requests the TCM to send its current software version number.
This information is provided via an INF_SW_VER telegram by the TCM.

INF_SW_VER

Bit 7 Bit 0

0xA5
0x5A
0x8B
0x8C
TCM SW Version Pos.1
TCM SW Version Pos.2
TCM SW Version Pos.3
TCM SW Version Pos.4
X
X
X
X
X
ChkSum

Informs the user about the current software version of the TCM.
Example: Version 1.0.1.16
TCM SW Version Pos.1 = 1
TCM SW Version Pos.2 = 0
TCM SW Version Pos.3 = 1
TCM SW Version Pos.4 =16

ERR_MODEM_NOTWANTEDACK

Bit 7	Bit 0
0xA5	
0x5A	
0x8B	
0x28	
X	
X	
X	
X	
X	
X	
X	
X	
X	
ChkSum	

When a 6DT modem telegram has been sent, the TCM waits for a modem acknowledge (MDA) telegram. This error message is generated if an MDA with the right modem ID is received after the timeout (100ms) or if there is more than one MDA received.

ERR_MODEM_NOTACK

Bit 7	Bit 0
0xA5	
0x5A	
0x8B	
0x29	
X	
X	
X	
X	
X	
X	
X	
X	
X	
ChkSum	

When a 6DT modem telegram has been sent, the TCM waits for a modem acknowledge (MDA) telegram. This error message is generated if no acknowledge was received before the timeout (100ms).

ERR_MODEM_DUP_ID

Bit 7	*Bit 0*
0xA5	
0x5A	
0x8B	
0x0C	
X	
X	
X	
X	
X	
X	
X	
X	
X	
ChkSum	

When the TCM receives an original (not repeated) MDA telegram with the same modem ID as its own, it sends this message through the serial port and informs that at least 2 TCMs have the same modem ID. This is not necessarily a problem and may even be intended. On the other hand it may also indicate that there is another installation/building in the vicinity where the same modem ID is in use.

ERR_SYNTAX

Bit 7	Bit 0
0xA5	
0x5A	
0x8B	
Field	
X	
X	
X	
X	
X	
X	
X	
X	
X	
ChkSum	

This telegram is sent automatically through the serial port after the TCM has detected a syntax error in a TCT telegram. Errors can occur in the H_SEQ, LENGTH, ORG or CHKSUM fields/bytes.

Field code:
H_SEQ=0x08 ORG=0x0B
LENGTH=0x09 CHKSUM=0x0A

ERR_TX_IDRANGE

Bit 7	Bit 0
0xA5	
0x5A	
0x8B	
0x22	
X	
X	
X	
X	
X	
X	
X	
X	
X	
ChkSum	

When a radio telegram intended to be sent has an ID number outside the ID range, this error message is generated. The radio telegram is not delivered.

ERR_ IDRANGE

Bit 7	Bit 0
0xA5	
0x5A	
0x8B	
0x1A	
X	
X	
X	
X	
X	
X	
X	
X	
X	
ChkSum	

This message is generated when the user tries to change the ID range base using the SET_IDBASE command to a value outside the allowed range from 0xFF800000 to 0xFFFFFFFF.