

## Scavenger Transmitter Module STM 320 / STM 320C / STM 320U

April 26, 2013



**Observe precautions! Electrostatic sensitive devices!**

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

## REVISION HISTORY

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

No	Major Changes
0.5	Initial version
0.90	New drawings added; new energy consumption data added; application note for connecting an external battery added; Agency certifications added; new charging circuitry added; editorial changes
0.95	Editorial changes
0.99	Pin for connection of backup battery changed; section 3.4 inserted; drawings updated
1.00	Drawing updated
1.02	Remark added in 3.4; additional remarks in 2.4; label information modified in chapter 5; Shelf life added in 1.4; Conducted output power replaced by radiated output power in 1.2; other editorial changes
1.03	Duration of a sub-telegram corrected to 0.9ms in 2.3;
1.04	Specification of shelf life improved. Chapter Related Documents added
1.05	STM 320U 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.

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## 1 RELATED DOCUMENTS

For mechanical integration please refer to our 3D drawings found at [http://www.enocean.com/en/enocean\\_modules/stm-320/](http://www.enocean.com/en/enocean_modules/stm-320/)

## 2 GENERAL DESCRIPTION

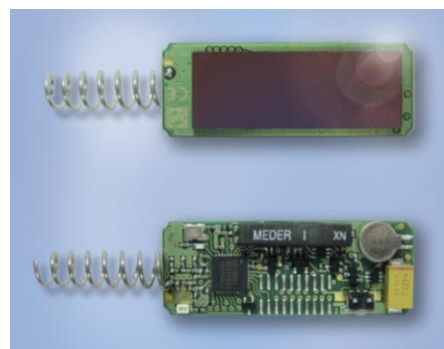
### 2.1 Basic functionality

The radio transmitter module STM 320 from EnOcean enables the implementation of a wireless magnet contact sensor. Powered by a solar cell, it works absolutely maintenance-free. An integrated energy store allows operation for several days even in total darkness. Key applications are window and door sensors.

The STM 320 supervises an integrated reed contact and reports every status change immediately (open <> closed). In addition a sign of life signal is transmitted every 20-30 minutes.

A LRN button is pre-installed on the PCB. When this button is pressed a special teach-in signal is sent.

There are three frequency variants – STM 320 in 868 MHz, STM 320C in 315 MHz, and STM 320U in 902MHz.



#### Features with built-in firmware

- Pre-installed solar cell
- On-board energy storage and charging circuit
- On-board LRN button
- On-board TX indicator LED
- On-board reed contact

### 2.2 Technical data

<b>Antenna</b>	Pre-installed helical antenna installed
<b>Frequency</b>	315.0 MHz (STM 320C) 868.3 MHz (STM 320) 902.875MHz (STM 320U)
<b>Radio Standard</b>	EnOcean 902MHz/868 MHz/315 MHz
<b>Data rate/Modulation type</b>	125 kbps/ASK(868MHz, 315MHz) FSK(902MHz)
<b>Radiated Output Power</b>	STM 320: +5 dBm <sup>1</sup> (EIRP) ± 2.5 dB <sup>2</sup> STM 320C: +92 dBµV/m <sup>1</sup> ± 2 dB <sup>2</sup> STM 320U: +99 dBµV/m <sup>1</sup> ± 2 dB <sup>2</sup>
<b>Power Supply</b>	Pre-installed solar cell Illumination 50-100000 lux
<b>Initial operation time in darkness @ 25°C</b>	typ. 6 days, min 90 hours if energy storage fully charged transmission of telegram every 25 min on average <sup>3</sup>

<sup>1</sup> Measured in test laboratory, measurement uncertainty 2.7 dB

<sup>2</sup> Tolerance of measurement in production at 50 Ω

STM 320 / STM 320C / STM 320U

**Operation start up time with empty energy store**

typ. 2.5 min @ 400 lux / 25°C  
incandescent or fluorescent light

**Reed contact**

1x internal, Meder MK23-90-BV14496 or MK01-I

**Radio Regulations**

R&TTE EN 300 220 (STM 320)  
FCC CFR-47 Part 15 (STM 320C, STM 320U)

**2.3 Physical dimensions**

**PCB dimensions**

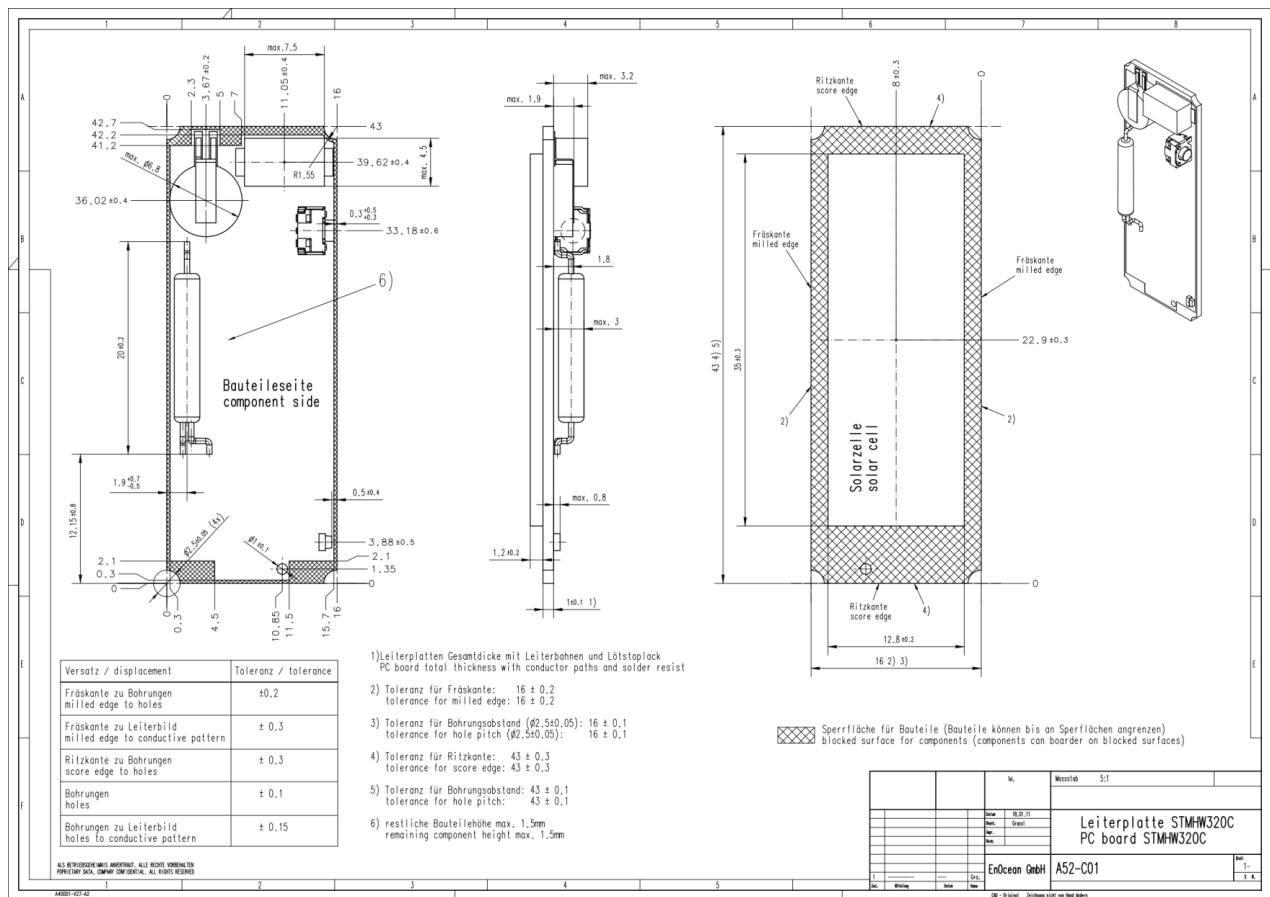
43±0.2 x 16±0.3 x 1±0.1 mm

**Module height**

6 mm

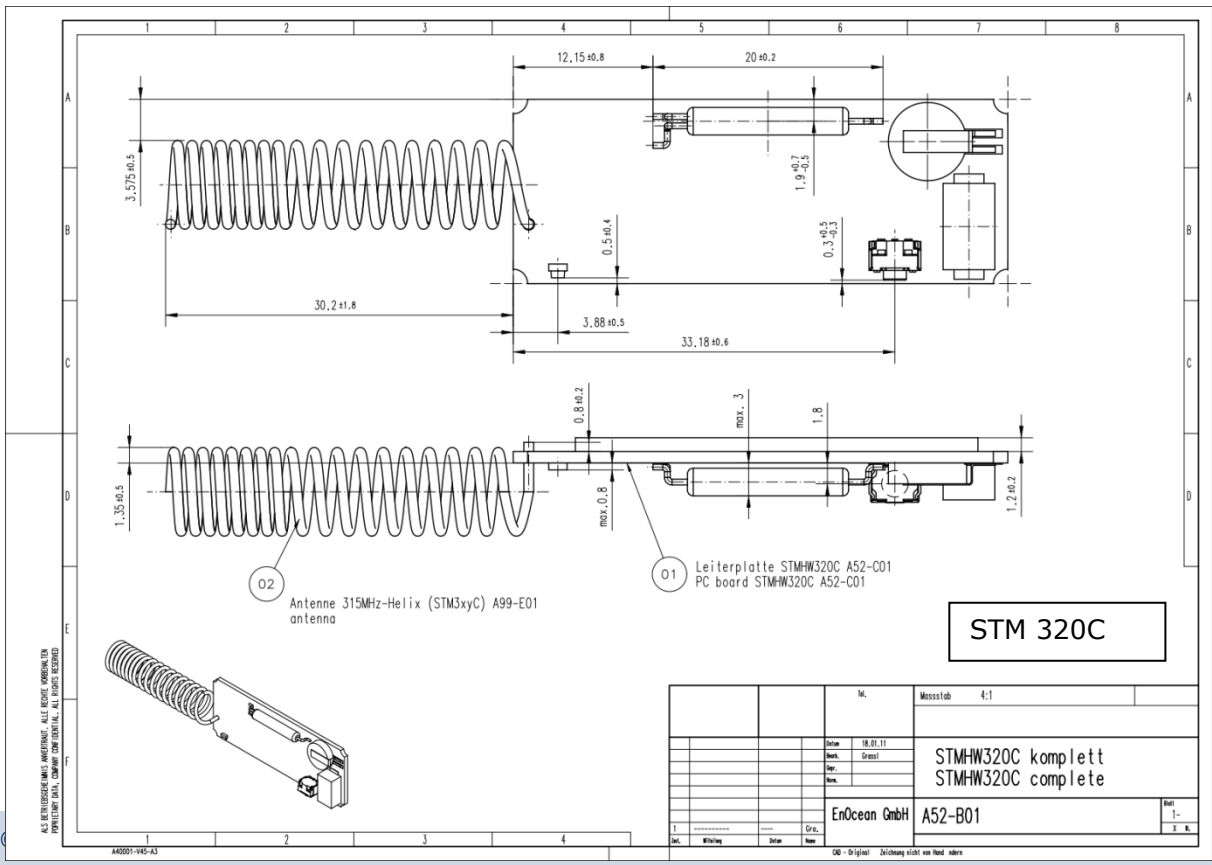
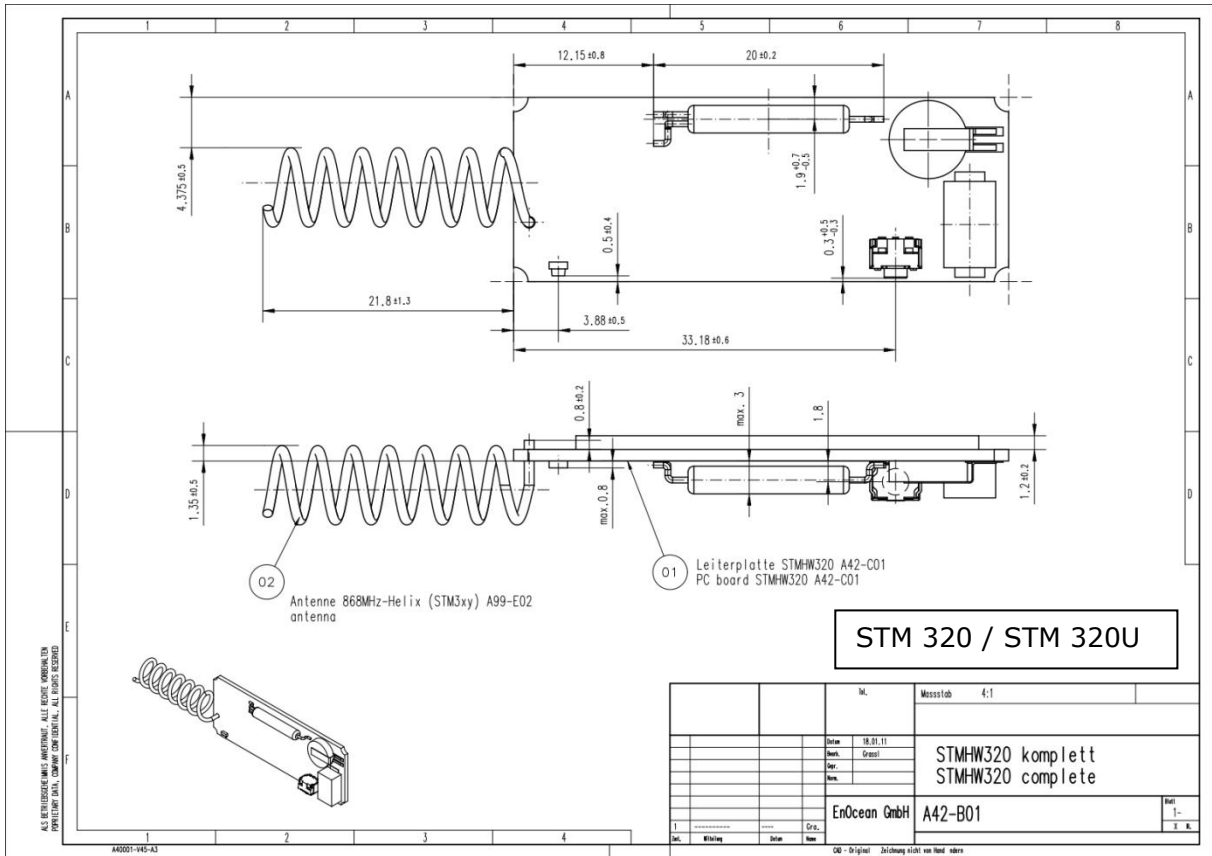
**Weight**

5.2 g (STM 320), 6.5 g (STM 320C), 5.2 g (STM 320U)



<sup>3</sup> Full performance of the PAS614L energy storage is achieved after several days of operation (up to two weeks) at good illumination level. Performance degrades over life time, especially if energy storage is exposed to higher temperatures. Each 10 K drop in temperature doubles the expected life span.

STM 320 / STM 320C / STM 320U



## 2.4 Environmental conditions

<b>Operating temperature</b>	-20 °C ... +60 °C
<b>Storage temperature</b>	-20 °C ... +60 °C, recommended <sup>4</sup> : +10 °C...+30 °C, <60%r.h.
<b>Shelf life (in absolute darkness)</b>	36 months after delivery <sup>5</sup>
<b>Humidity</b>	0% ... 93% r.h., non-condensing



The module shall not be placed on conductive materials, to prevent discharge of the internal energy storages<sup>5</sup>. Even materials such as conductive foam (ESD protection) may have negative impact.

## 2.5 Ordering Information

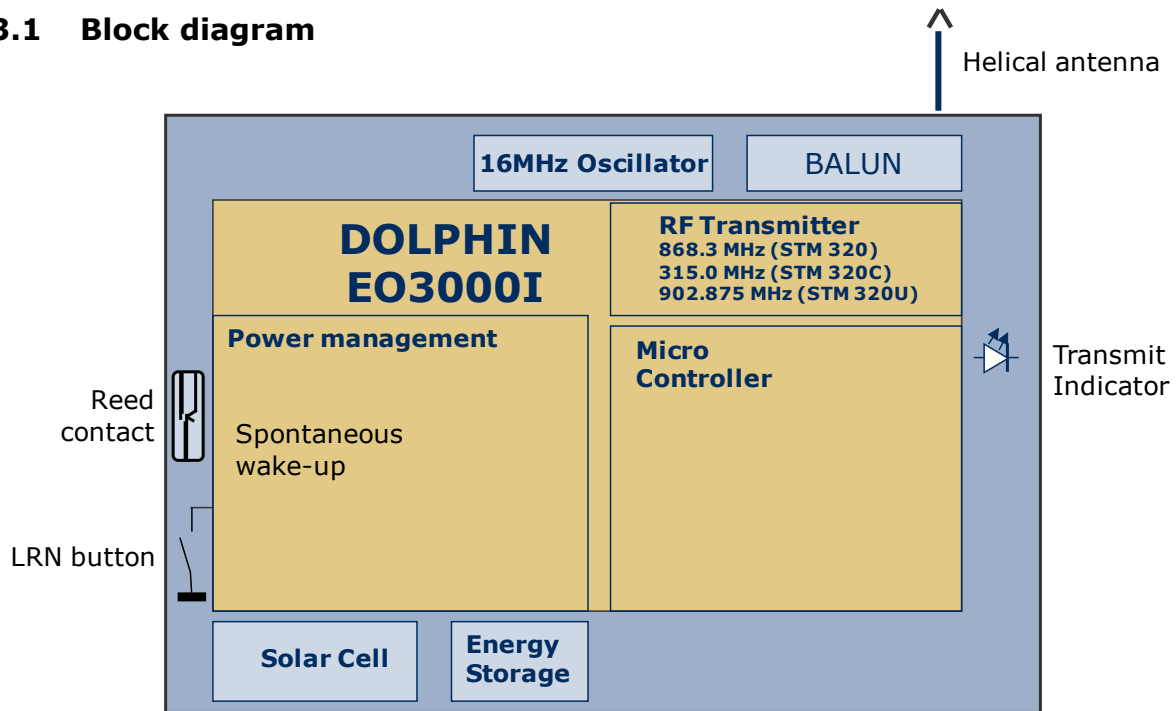
Type	Ordering Code	Frequency
<b>STM 320</b>	<b>S3001-D320</b>	<b>868.3 MHz</b>
<b>STM 320C</b>	<b>S3031-D320</b>	<b>315.0 MHz</b>
<b>STM 320U</b>	<b>S3051-D320</b>	<b>902.875 MHz</b>

<sup>4</sup> Recommended for maximum life of energy storage capacitor

<sup>5</sup> Deep discharge of the PAS614L energy storage leads to degradation of performance. Therefore products have to be taken into operation after 36 months. At least the PAS614L needs to be recharged to 2.1 V.

### 3 FUNCTIONAL DESCRIPTION

#### 3.1 Block diagram



A change of the reed contact status or pushing the LRN button will wake the transmitter unit to send a radio telegram immediately (reed contact position, LRN push button status, unique 32-bit sensor ID, checksum). In addition a redundant retransmission signal is sent to announce the contact status even in case of no input signal changes. This signal transmitted every 20-30 min, affected at random. The transmit indicator LED flashes briefly at every radio transmission.

Between the wake-up phases, the device is in sleep mode for minimum power consumption.

#### 3.2 Radio telegram

STM 320 transmits a radio telegram according to EnOcean Equipment Profile EEP D5-00-01 as defined in the EnOcean Equipment Profiles 2.1 specification.

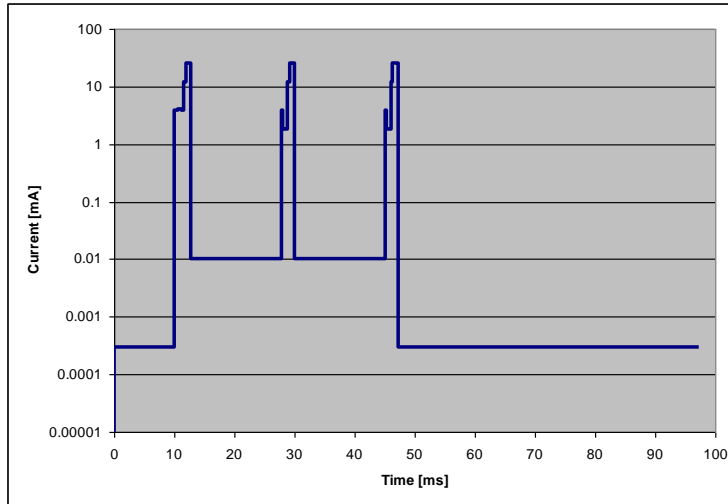
[http://www.enocean-alliance.org/fileadmin/redaktion/enocean\\_alliance/pdf/EnOcean\\_Equipment\\_Profiles\\_EEP2.1.pdf](http://www.enocean-alliance.org/fileadmin/redaktion/enocean_alliance/pdf/EnOcean_Equipment_Profiles_EEP2.1.pdf)

#### 3.3 Transmit timing

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 within 40 ms. The transmission of a subtelegram lasts approximately 0.9 ms. The delay between the three transmission bursts is affected at random.



### 3.4 Energy consumption



Charge needed for one measurement and transmit cycle:  $\sim 80 \mu\text{C}$

Charge needed for one measurement cycle without transmit:  $\sim 10 \mu\text{C}$

Calculations are performed on the basis of electric charges because of the internal linear voltage regulator of the module. Energy consumption varies with voltage of the energy storage while consumption of electric charge is constant.

From these values the following typical performance parameters at room temperature have been calculated:

Wake and transmit cycle [s]	Operation Time in darkness [h] when storage fully charged	Required reload time [h] at 200 lux within 24 h for continuous operation
1500	175	1.8

Assumptions:

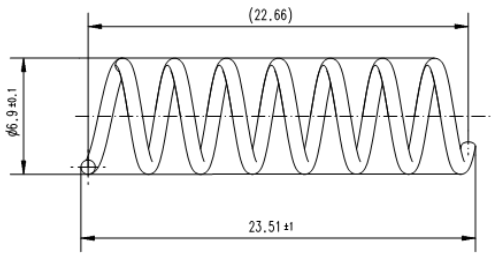
- Internal storage PAS614L-VL3 (after several days of operation at good illumination level) with 0.25 F,  $U_{\text{max}}=3.2 \text{ V}$ ,  $U_{\text{min}}=2.3 \text{ V}$ ,  $T=25 \text{ }^\circ\text{C}$
- Consumption: Transmit cycle  $80 \mu\text{C}$ , measurement cycle  $10 \mu\text{C}$
- Pre-installed solar cell ECS 300, operating values 3 V and  $5 \mu\text{A}$  @ 200 lux fluorescent light
- Current proportional to illumination level (not true at very low levels!)

These values are calculated, the accuracy is about  $\pm 20\%$ ! The performance varies over temperature and may be strongly reduced at extreme temperatures.

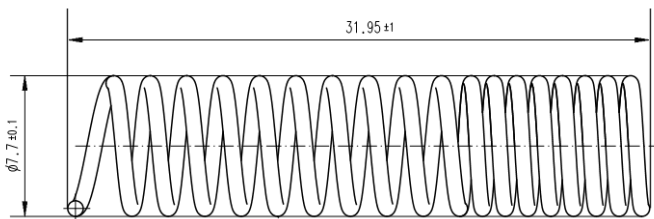
## 4 APPLICATIONS INFORMATION

### 4.1 Helical antenna

#### 868 MHz / 902 MHz

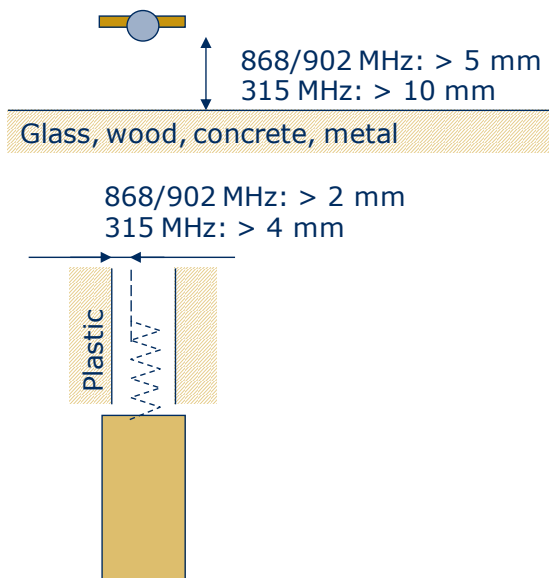


#### 315 MHz

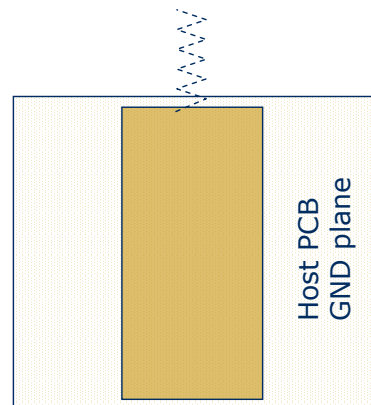


Antenna recommendation:

STM 320 without host PCB



STM 320 with host PCB



## 4.2 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 30 m range in corridors, up to 100 m in halls
- Plasterboard walls / dry wood: Typically 30 m range, through max. 5 walls
- Ferroconcrete walls / ceilings: Typically 10 m 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:

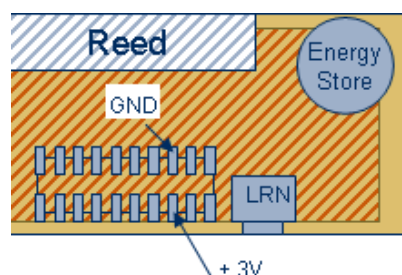
- Switch mounted on metal surfaces (up to 30% loss of transmission range)
- Hollow lightweight walls filled with insulating wool on metal foil
- False ceilings with panels of metal or carbon fiber
- Lead glass or glass with metal coating, steel furniture

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 0.5 m.

A summarized application note to determine the transmission range within buildings is available as download from [www.enocean.com](http://www.enocean.com).

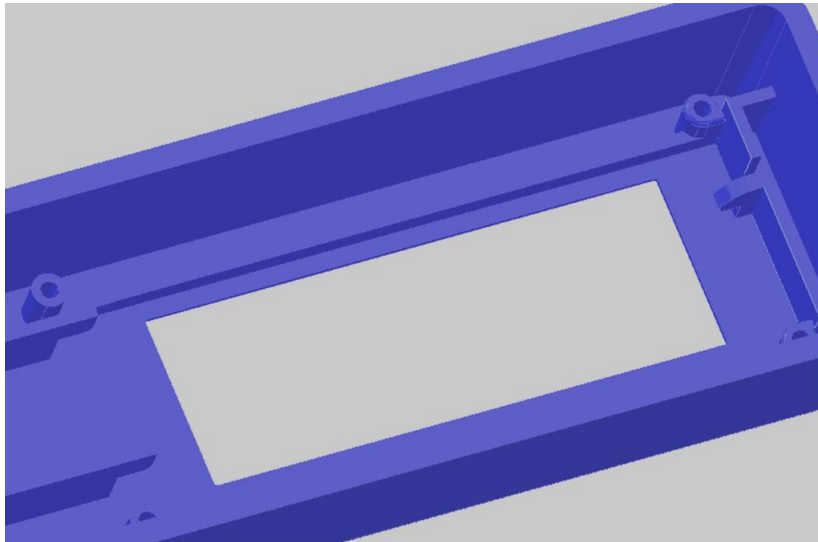
## 4.3 Connecting an external backup battery

In case there is not sufficient light available for operation with solar cell an external 3 V Lithium backup battery can be connected to the module at the soldering pads shown below:



#### 4.4 Mounting STM 320 into a housing

The figure below shows an example of a housing in which the module can be mounted (with antenna pointing to the left). Design data of the housing and the modules is available in .igs format.



Please make sure not to exert shear force (side force within the plane of the solar cell) onto the solar cell! The maximum vertical force onto the solar cell must not exceed 4 N and should be homogeneously distributed! Bending of the PCB must be avoided!



Please make sure that the housing covers 0.5 mm at the solar cell edges. Within 0.5 mm off the edge flaking is possible due to the cutting process.

## 5 AGENCY CERTIFICATIONS

The modules have been tested to fulfil the approval requirements for CE (STM 320) and FCC/IC (STM 320C / STM 320U) based on the built-in firmware.



When developing customer specific firmware based on the API for this module, special care must be taken not to exceed the specified regulatory limits, e.g. the duty cycle limitations!

### 5.1 CE Approval

The STM 320 module bears 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 and in Switzerland.



- 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.
- EnOcean RF modules must not be used with gain antennas, since this may result in allowed ERP or spurious emission levels being exceeded.
- 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 320 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.
- The module must be used with only the following approved antenna(s).

Model	Type
STM 320	Pre-installed helical antenna

## 5.2 FCC (United States) certification

### STM 320C 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 harvested energy from a small solar cell exposed to ambient light. 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 and is powered by a solar cell in ambient light. 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 STM 320C / STM 320U 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 button, 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, 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, unpredictable time.

## 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:

### STM 320C

*Contains FCC ID: SZV-STM311C*

*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.*

### STM 320U

*Contains FCC ID: SZV-STM320U*

*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.*

When the device is so small or for such use that it is not practicable to place the statement above on it, the information required by this paragraph shall be placed in a prominent location in the instruction manual or pamphlet supplied to the user or, alternatively, shall be placed on the container in which the device is marketed. However, the FCC identifier or the unique identifier, as appropriate, must be displayed on the device.

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 OEM must ensure that timing requirements according to 47 CFR 15.231(a-c) are met.
- The OEM must sign the OEM Limited Modular Approval Agreement with EnOcean
- The module must be used with only the following approved antenna(s).

Model	Type	Gain
STM 320C	Pre-installed helical antenna	-9 dBi
STM 320U	Pre-installed helical antenna	-2 dBi

### 5.3 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:

STM 320C:

*Contains IC: 5713A-STM311C*

STM 320U:

*Contains IC: 5713A-STM320U*

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

Pour utiliser le numéro IC EnOcean, le OEM doit s'assurer que les conditions suivantes sont remplies:

- Les exigences d'étiquetage pour Industrie Canada sont similaires à ceux exigés par la FCC. Le fabricant d'équipement d'origine (OEM) doit s'assurer que les exigences en matière d'étiquetage IC sont réunies. Une étiquette clairement visible à l'extérieur d'une partie non amovible du produit final doit contenir le texte suivant:

STM 320C:

*Contains IC: 5713A-STM311C*

*Contient le module d'émission IC: 5713A-STM311C*

STM 320U:

*Contains IC: 5713A-STM320U*

*Contient le module d'émission IC: 5713A-STM320U*

- L'OEM doit signer l'accord OEM limitée Approbation modulaire avec EnOcean



## 5.4 FCC Regulatory Statements

This device complies with part 15 of the FCC rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation. Any changes or modifications not expressly approved by manufacturer could void the user's authority to operate the equipment.

**IMPORTANT!** Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate this equipment.

**NOTE:** This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

Reorient or relocate the receiving antenna.

Increase the separation between the equipment and receiver.

Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

Consult the dealer or an experienced radio/ TV technician for help.

## 5.5 Industry Canada Regulatory Statements

This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence. L'exploitation est autorisée aux deux conditions suivantes: (1) l'appareil ne doit pas produire de brouillage, et (2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

**IMPORTANT!** Tous les changements ou modifications pas expressément approuvés par la partie responsable de la conformité ont pu vider l'autorité de l'utilisateur pour actionner cet équipement.

This Class B digital apparatus complies with Canadian ICES-003.

Cet appareil numérique de la classe B est conforme à la norme NMB-003 du Canada

## 6 Label Information

