

## STM 429J – Scavenger Transmitter Module

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## STM 429J – Scavenger Transmitter Module



**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

## STM 429J – Scavenger Transmitter Module

**REVISION HISTORY**

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

No	Major Changes
1.0	Initial version
1.1	Added marking and STM 425J.
1.2	Editorial corrections.
1.3	Changed PCB / System Drawings – STM 425J and STM 429J. Added radio certificate.
1.31	Changed helical antenna picture
2.0	Update of revision with consolidation and small corrections.

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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.

STM 429J – Scavenger Transmitter Module

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**TABLE OF CONTENT**

1	GENERAL DESCRIPTION .....	4
1.1	Basic functionality .....	4
1.2	Technical data .....	4
1.3	Physical dimensions .....	5
1.4	References .....	7
1.5	Environmental conditions .....	7
1.6	Ordering Information .....	7
2	FUNCTIONAL DESCRIPTION .....	8
2.1	Block diagram .....	8
2.2	Radio telegram.....	8
2.3	Secure radio telegram.....	8
2.3.1	Switching between modes .....	8
2.3.2	Encrypted communication – enhanced security mode .....	9
2.3.3	Security Teach-In – enhanced security mode .....	9
2.3.3.1	PSK Security Teach-in - optional .....	10
2.4	Transmit timing.....	10
2.5	Energy consumption .....	11
3	APPLICATIONS INFORMATION.....	12
3.1	Antenna Details.....	12
3.2	Transmission range .....	13
3.3	Connecting an external backup battery .....	13
3.4	Mounting 429J into a housing.....	14
3.5	PSK Labelling .....	15
3.5.1	Included Information: .....	15
3.5.2	QR-Code Specification .....	15
4	AGENCY CERTIFICATIONS .....	16
5	Label Information .....	17

## STM 429J – Scavenger Transmitter Module

### 1 GENERAL DESCRIPTION

#### 1.1 Basic functionality

The radio transmitter modules and 429J from EnOcean enable 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.

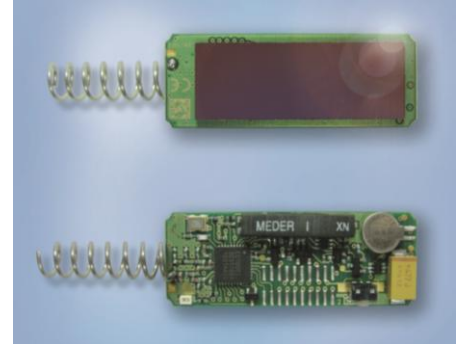
Key applications are window and door sensors.

STM 429J supervise an integrated reed contact and report every status change immediately (open <> closed). In addition a sign of life signal is transmitted every 20-30 minutes.

A LRN button and a TX indicator LED are pre-installed on the PCB. On STM 429J they are oriented upwards. When the LRN button is pressed then a special teach-in signal will be sent.

STM 429J operate at 928.35MHz using FSK modulation.

STM 429J in enhanced mode provides enhanced security features with encrypted communication.



#### Features with built-in firmware

- Pre-installed solar cell
- On-board energy storage and charging circuit
- On-board LRN button (operated from above on STM 429J)
- On-board TX indicator LED (pointing upwards on STM 429J)
- On-board reed contact

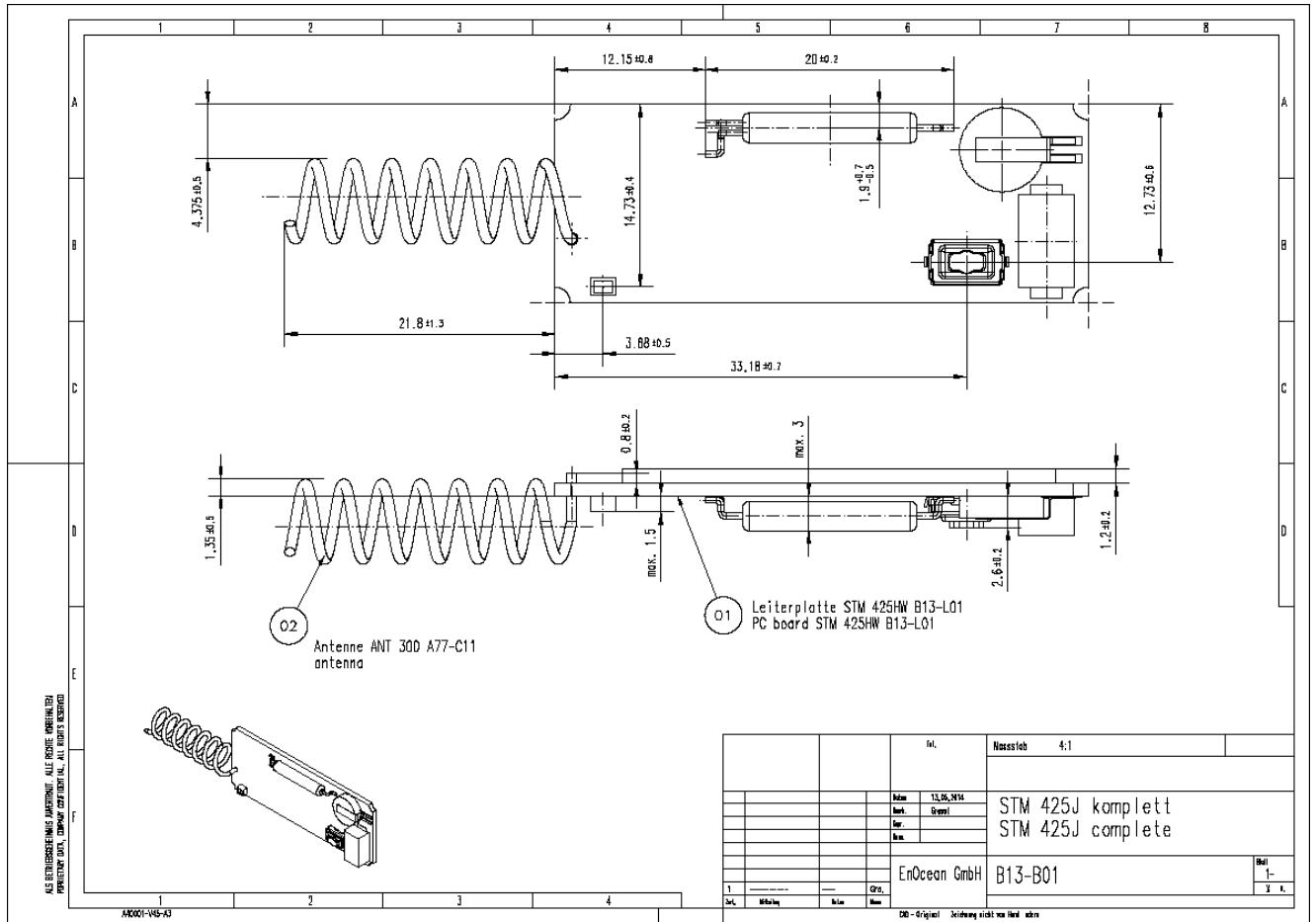
#### 1.2 Technical data

<b>Antenna</b>	Pre-installed helical antenna installed
<b>Frequency</b>	928.35MHz
<b>Data rate/Modulation type</b>	125 kbps / FSK
<b>Radiated Output Power</b>	Typ. 0dBm
<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>1</sup>
<b>Operation start up time with empty energy store</b>	typ. 2.5 min @ 400 lux / 25°C incandescent or fluorescent light
<b>Reed contact</b>	1x internal, Meder MK23-90-BV14496 or MK01-I
<b>Radio Regulations</b>	ARIB STD-T108
<b>Security Level Format</b>	24-bit RLC, No RLC tx, 4-byte CMAC, VAES encryption

<sup>1</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 429J – Scavenger Transmitter Module



System drawing STM 429J

## STM 429J – Scavenger Transmitter Module

## 1.4 References

- [1] Security of EnOcean Radio Networks - <http://www.enocean.com/en/security-specification/>
- [2] Dolphin V4 Core Description - <http://www.enocean.com/dolphin-v4-core-description/>
- [3] Dolphin V4 API - <http://www.enocean.com/en/enocean-software/>
- [4] AN509 Explanation of EnOcean security in applications - <http://www.enocean.com/en/application-notes/>
- [5] AN510 Adding Security to EnOcean Receivers - <http://www.enocean.com/en/application-notes/>
- [6] AN511 Advanced security in self-powered wireless applications - <http://www.enocean.com/en/application-notes/>
- [7] Microchip EEPROM Memory - [www.microchip.com/serialeeprom/](http://www.microchip.com/serialeeprom/)
- [8] EnOcean Equipment Profiles - <http://www.enocean-alliance.org/eep/>

## 1.5 Environmental conditions

<b>Operating temperature</b>	-20 °C ... +60 °C
<b>Storage temperature</b>	-20 °C ... +60 °C, recommended <sup>2</sup> : +10 °C...+30 °C, <60%r.h.
<b>Shelf life (in absolute darkness)</b>	36 months after delivery <sup>3</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>3</sup>. Even materials such as conductive foam (ESD protection) may have negative impact.

## 1.6 Ordering Information

Type	Ordering Code
STM 429J	S3061-D429

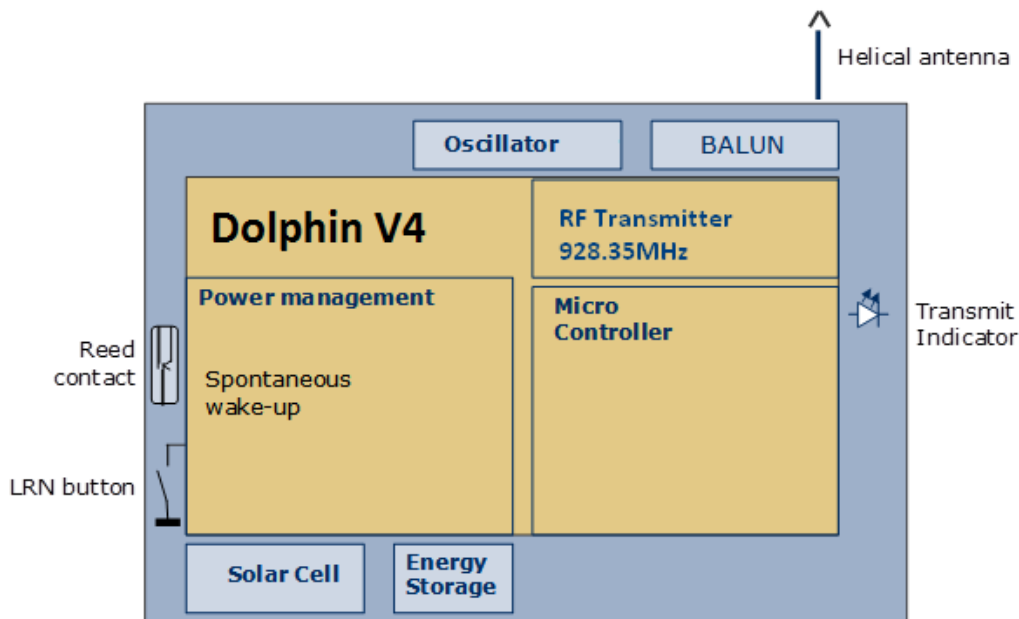
<sup>2</sup> Recommended for maximum life of energy storage capacitor

<sup>3</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.

## STM 429J – Scavenger Transmitter Module

## 2 FUNCTIONAL DESCRIPTION

### 2.1 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 (at profile teach-in 48 bit 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.

### 2.2 Radio telegram

429J transmits a radio telegram according to EnOcean Equipment Profile EEP D5-00-01 as defined in the EnOcean Equipment Profiles specification.

### 2.3 Secure radio telegram

The STM 429J can be operated in:

- Standard mode – no enhanced security is used. This is the common operation mode, originally available. This is also the default factory mode.
- Security mode – communication is protected by enhanced security features. This mode was added later in module evolution.

#### 2.3.1 Switching between modes

STM 429J can be switched from normal mode to secure mode and vice versa by long press of the LRN Button (Wake 1).

The behaviour of the LRN button is following:



## STM 429J – Scavenger Transmitter Module

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1. Button is pressed – LED flashes briefly Teach-in is performed according to the actual mode.
2. Button is hold
  - a. If released in period < 10 seconds then actual mode is kept. No further action.
  - b. If hold for at least 10 seconds then the actual mode is changed (standard -> secure or secure -> standard). LED flashes briefly. Teach-in is performed according to the actual (new) mode.
3. Button is released – no action.

Upon entry into secure mode, a secure teach-in telegram is sent by STM 429J.



Mode change features can be suppressed by configuration flag. If flag set module will not enter secure mode after long press, but stay in standard mode. By default mode change feature is enabled.



Before changing the operating mode please make sure to clear the device from all receivers which have been taught to work with this device before. Otherwise the receiver will ignore the telegrams and the application will not work.



The flag for actual mode itself is stored in non-volatile memory. After power down reset the previous selected mode is active. Therefore mode change is limited to 50 times. In normal application scenario only very few are required.

The factory delivery mode of the STM 429J is standard – not encrypted. This mode is common mode originally available. Secure mode was added in later product upgrades.

The mode change feature can be suppressed by a configuration parameter. By default mode change is enabled.

### 2.3.2 Encrypted communication – enhanced security mode

In Enhanced mode the data link (DL) content is always protected with advanced security features. Normal operation DL and also Teach-in DL are protected in the same way. The security features used are configured by the Security Level format - SLF. This parameter is set by default to the highest possible level:

- 24-bit RLC,
- No RLC tx,
- 4-byte CMAC,
- VAES encryption

To add security features to the communication the Normal operation DL and Teach-in DL are encapsulated into a secured telegram. The data content of the telegram is not changed. Please refer to the EnOcean Security Specification for details.

### 2.3.3 Security Teach-In – enhanced security mode

To enable security communication the STM 429J has to send a security teach-in telegram to the other communication partner and so inform him about the used security profile, keys and initial RLC. The security teach-in has to take place before any other communication can be executed (profile teach-in included). To trigger the transmission of the teach-in telegram LRN button is pressed. The security teach-in telegram is transmitted before the profile

## STM 429J – Scavenger Transmitter Module

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teach-in. The following profile teach-in telegram is already protected by advanced security features.

The process of sending security teach-in telegram and profile teach-in telegram is triggered by once pressing the LRN button.

The behaviour of the LRN button in enhanced mode is following:

1. Button is pressed
2. Security teach-in is send.
3. Profile teach-in is send.

### **2.3.3.1 PSK Security Teach-in - optional**

The Security Teach-in telegram carries the information of KEY and RLC. This information is either sent as plain text (as is) or it is protected by the pre-shared key - PSK. The PSK must be in printed on the transmitting device. To use PSK teach-in, the PSK must be read by the end-user and entered into the other communication partner. For this purpose the EnOcean radio interface cannot be used. The PSK can be entered trough a user interface or semi-automated by a code reader.

For details on the PSK Teach-in please refer to the EnOcean Security Speification.

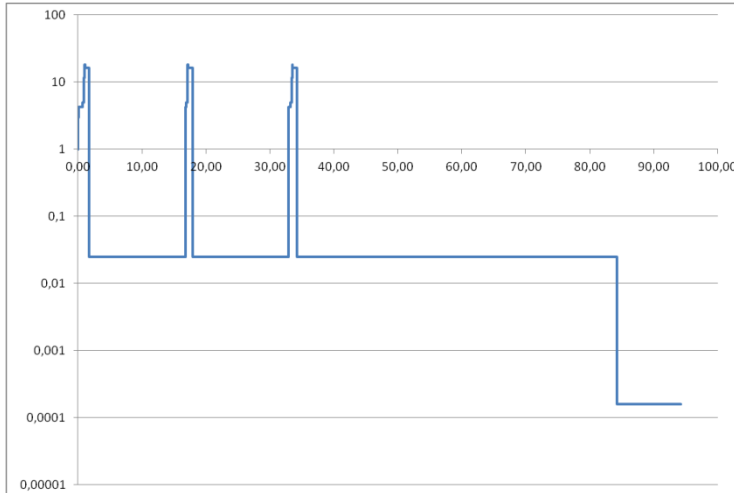
PSK feature is disabled by default. To enable PSK feature the execute configuration in Dolphin Suite.

## **2.4 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 25 ms. The transmission of a subtelegram lasts approximately 1 ms. The delay between the three transmission bursts is affected at random.

STM 429J – Scavenger Transmitter Module

## 2.5 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:

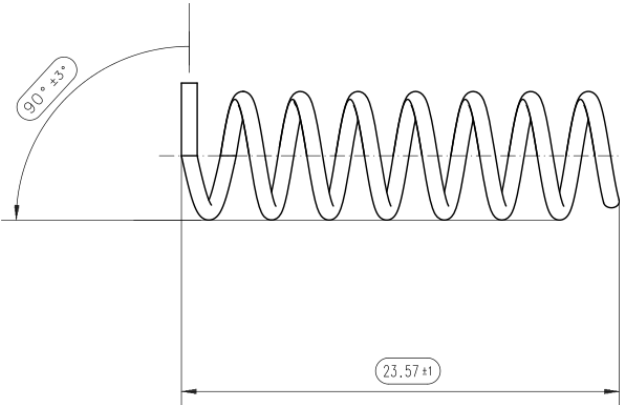
- Internal storage PAS614L-VL3 (after several days of operation at good illumination level) with 0.25 F,  $U_{\text{max}}=3.2 \text{ V}$ ,  $U_{\text{min}}=2.3 \text{ V}$ ,  $T=25 \text{ }^\circ\text{C}$
- Consumption: Transmit cycle  $80 \mu\text{C}$ , measurement cycle  $10 \mu\text{C}$
- Pre-installed 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.

STM 429J – Scavenger Transmitter Module

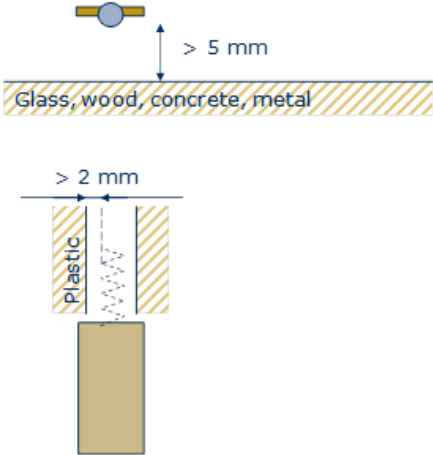
**3 APPLICATIONS INFORMATION**

**3.1 Antenna Details**

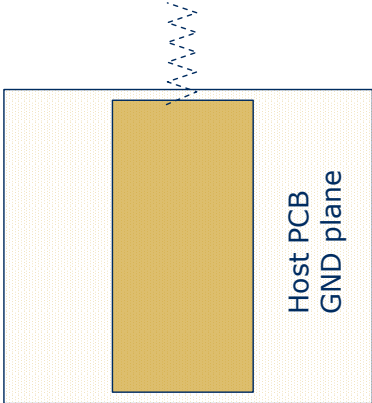


**Antenna location recommendation**

429J without host PCB



429J with host PCB



## STM 429J – Scavenger Transmitter Module

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### 3.2 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 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:

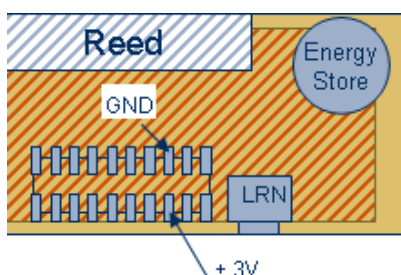
- Switch mounted on metal surfaces (up to 30% loss of transmission range)
- Hollow lightweight walls filled with insulating wool on metal foil
- False ceilings with panels of metal or carbon fiber
- Lead glass or glass with metal coating, steel furniture

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).

### 3.3 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:

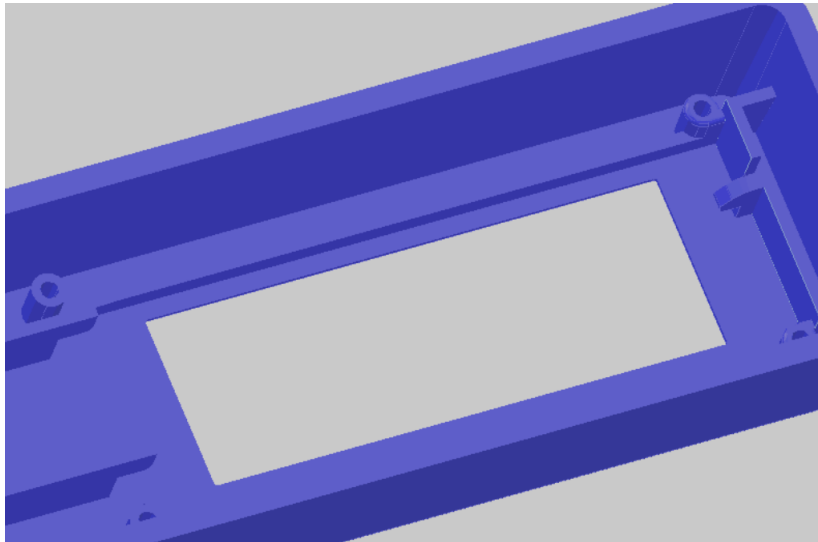


## STM 429J – Scavenger Transmitter Module

### 3.4 Mounting 429J 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.



To prevent damage, please make sure not to exert shear force (side force within the plane of the solar cell) onto the solar cell or the module itself!

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.

STM 429J – Scavenger Transmitter Module

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**3.5 PSK Labelling**

For the PSK information a specific QR code is placed on the module itself.

Information of the QR code:

**3.5.1 Included Information:**

[ID:XXXXXXXX KY:YYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYYY]

ID:	3 CHARS
XX	8 CHARS
FREESPACE	1 CHARS
KY:	3 CHARS
YY	32 CHARS

= 47 CHARS

**3.5.2 QR-Code Specification**

QR-Code Version:	3 (29x29 pixel)
Error Correction Level:	Q (25% error correction)
Mode:	Alphanumeric Mode
Character Capacity:	47

Keep off area around the code:	2 Pixel (Up, Down, Left and Right)
Pixel Size:	min. 4x4 points per Pixel

600dpi x 600dpi Resolution:

1 Print Point:	0.0423mm x 0.0423mm
1 Pixel:	0.1693mm x 0.1693mm

STM 429J – Scavenger Transmitter Module

## 4 AGENCY CERTIFICATIONS

STM 429J have been designed and tested to fulfil the approval requirements for ARIB STD-T108 based on the built-in firmware.

When the product is placed on the Japanese market, it must carry the Specified Radio Equipment marking as shown below:




### 認 証 書

認証を受けた者	ローム株式会社
特定無線設備の種類	第2条第1項第8号に掲げる無線設備 特定小電力機器 13GHz未満
電波の形式、周波数及び空中線電力	F1D 928.35MHz 0.001W
型式又は名称	STM429J 又は STM425J
販売業者	ローム株式会社
認証番号	003-130160
認証をした年月日	2014年7月4日
備考	No.14-1087 920MHz / テレコントロール、テレメーター、データ伝送用 P131169

上記のとおり、電波法第38条の24第1項の規定に基づく認証を行ったものであることを証する。

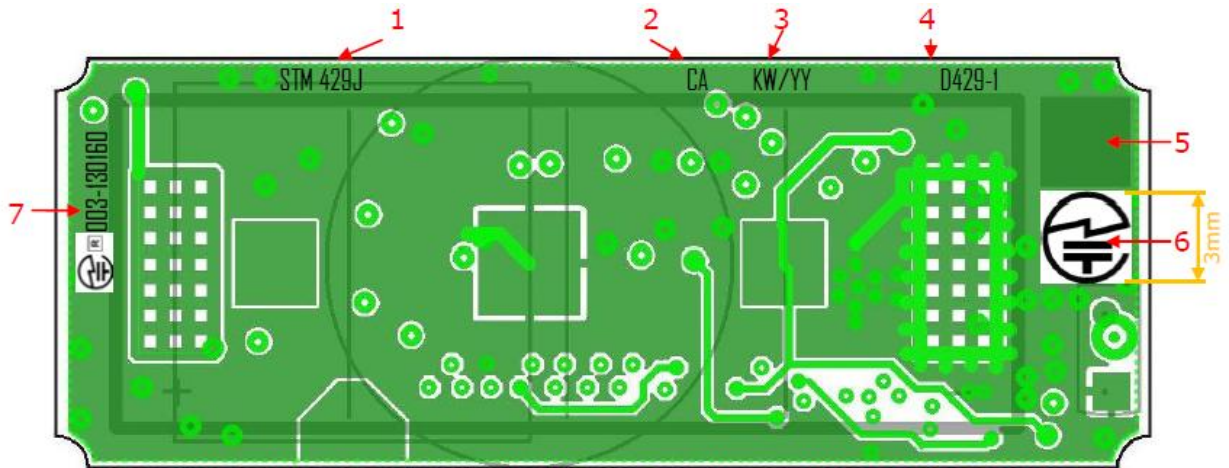
2014年7月4日

株式会社ディーエスピーリサーチ 



STM 429J – Scavenger Transmitter Module

## 5 Label Information



1. Product name - „STM 429J“
2. Step Code „xy“
3. Date Code “KW/YY”: e.g. 15/13
4. Status „D431-z”: e.g 1
5. DMC
6. ARIB Marking, radius 3mm
7. ARIB Marking with number (003-130160)