Guideline

enocean alliance
Building Smarter Connectivity

EnOcean Alliance Certification
Radio Performance Best Practices

V 0.2

Approved for release TBD

San Ramon, CA, USA, 2022

EXECUTIVE SUMMARY

This document defines best practices for the radio performance certification tests.

This document is owned by the Technical Working Group (TWG) of the EnOcean Alliance. It is maintained and will be progressed within the authority of the chairman of the TWG.

Following approval this guideline is now in the status PRELIMINARY.

Changes to this document have to be proposed to the TWG for decision. The EnOcean Certification Task Group will then act up on request by the TWG.

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REVISION HISTORY

Ver.	Editor	Change	Date
0.2	AP	Draft Document for TWG review	March 17, 2022

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These errata may not have been subjected to an Intellectual Property review, and as such, may contain undeclared Necessary Claims.

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1. Introduction

1.1. Objectives of this document

A sufficient and proper radio performance – mainly reflected in the range – is among the most important parameters of any wireless products, also for EnOcean-based products.

The tests defined in the Radio performance certification specification [1] are designed to validate the RF-performance of EnOcean-based wireless products.

This document shall support the tester to create a proper test setup to perform the tests in the best way possible to receive the highest benefit.

1.2. Definitions & References

1.2.1. Definitions

Antenna: A component, typically metallic, which either radiates (as used for a transmitter) or collects (as used for a receiver) electromagnetic waves.

Antenna Efficiency: The ability of an *antenna* to convert transmission line power to electromagnetic field intensity (transmitter) and vice-versa (receiver). It is used to account for losses at the terminals of an antenna. Losses are due to: 1) impedance mismatch between the antenna and the electronics connected to the terminals of the antenna and 2) conduction and dielectric losses. When an antenna is improperly positioned, such as when it is too close to metal objects, it can be "de-tuned", which affects the impedance of the antenna, creating an impedance mismatch, which degrades the efficiency of the antenna.

Antenna Gain: Similar to *directive gain*, but accounts for *antenna efficiency*.

Directivity: The value of the *directive gain* in the direction of its maximum value.

Directive Gain: The ratio of the radiation intensity in a given direction to the radiation intensity of a reference antenna (usually an isotropic radiator). An antenna positioned improperly can affect the *radiation pattern* of the antenna, creating *radiation lobes* and *radiation nulls*.

Dolphin View: A SW tool provided from EnOcean GmbH to visualize EnOcean telegrams. It is also possible to send out EnOcean telegrams and to decode other SW protocols defined by the EnOcean GmbH, like EEPs, RECOM, etc.

DUT: Device under Test

EMI: Electromagnetic Interference

Fresnel Zone: An ellipsoid-shaped volume between two *antenna*s, which should be free of obstructions for best results.

Isotropic radiator: A hypothetical *antenna* which has a *radiation pattern* that is equal in all directions. That is, its radiation pattern forms a sphere in 3D space. The radiation pattern is omnidirectional - the same in all directions.

MER: Message Error Rate, a receiver related parameter that is calculated as the number of EnOcean Messages not decoded correctly by a receiver in relationship to the number of EnOcean Messages sent by a corresponding transmitter. The EnOcean Messages used to determine the MER shall be either the addressed Remote Management Ping message or any other standardized EnOcean Message of the same message length. Such messages shall be sent using three EnOcean sub-telegrams.

PTM: Push button transmitter module. This is a product from EnOcean GmbH usually used for building light switches. It has a mechanical energy harvester generating the energy by a button press to be used to send out a radio telegram.

Radiation lobe: A portion of the *radiation pattern* of an *antenna* which is surrounded by regions of less radiation intensity. A radiation lobe (both radiating and receiving) focuses in one direction. In some cases, radiation lobes are bounded by radiation nulls. In the case of point-to-point communication, radiation lobes are desirable. Radiation lobes are undesirable when a device must communicate with other devices that may be located anywhere (i.e. in any direction) around this device. In most applications using EnOcean devices, radiation lobes are not wanted.

Radiation null: A portion of the *radiation pattern* of an antenna where the radiation intensity is substantially weak and, under certain conditions, might be close to zero measurable signal strength.

Radiation pattern: A graphical representation of the radiation properties of an *antenna* as a function of spatial coordinates. A radiation pattern graph shows how well an antenna radiates/receives in all directions. Radiation patterns are measured by rotating the antenna (or the whole device, including the antenna) around a full 360 degrees with respect to a separate antenna. Signals are transmitted between the reference antenna and the antenna under test and the signal strength is measured. The result is a graph that shows the radiation characteristics in the plane formed by the 360 degree rotation.

Because we are interested in how well an antenna works in all directions, it is necessary to measure the radiation pattern in at least several planes.

RTRX: Reference Transceiver; an EnOcean capable transceiver device used as a reference for comparison testing. The technical specifications of a RTRX have to be in line with the relevant definitions contained in this specification.

TTRX: Test Transceiver; an EnOcean capable transceiver device used as a communication counterpart for RTRX and DUT during testing. The technical specification of a TTRX has to be in line with the relevant definitions contained in this document.

1.2.2. References

[1] Radio performance certification specification
https://www.enocean-alliance.org/rpc/

[2] Radio Perf. Certif.Template
https://www.enocean-alliance.org/rpc/template/

2. Test setup

2.1. RTRX and TTRX common test setup

For RTRX and TTRX it is possible to use standard EnOcean technology transceiver modules (e.g. EnOcean GmbH TCM320/TCM300 in EOP350 set or similar). It is important to put the whole device into a shielded housing and use a coaxial connector instead of a wired antenna.

This is how a basic test setup could look like:

All possible holes and gaps have to be closed. The connector of the antenna needs to be an effective shielding to ensure not ‘leaking’ into the surrounding environment.

2.1.1. RTRX test setup

Based on the mutual setup described in chapter 2.1. the RTRX setup just needs a power supply by using a generic power bank to be able to close the housing with no extra cable exiting.

The antenna used in RTRX can be a usual omnidirectional whip antenna, best with no gain.

Use RTRX only with closed housing and be sure, that the bottom of the housing does completely fit and no gaps are visible.

With the Dolphin API of EnOcean GmbH radio modules the code example “REMAN device” is available. Except of the radio setting file depending on the radio module used, there is no further modification necessary. Best is to use the +4dBm radio settings because there is no +1dBm variant available which the Radio performance certification specification requires.

Anyhow, you need knowledge of the exact effective radiated transmitter power. This has once to be measured with a spectrum analyzer using a coaxial cable connection.

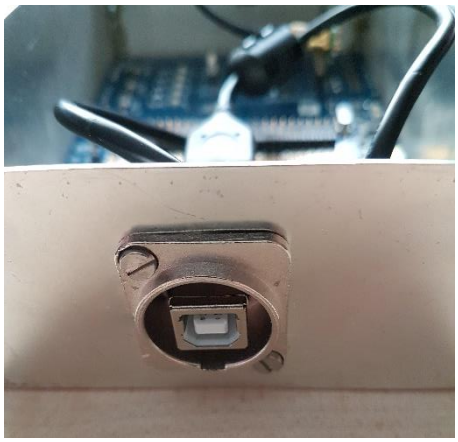
The difference between the required +1dBm and the real transmitted power can be considered in the template used for the test.

Don’t forget to note the EURID of the RTRX test setup, because this is needed later for the ping commands used.

2.1.2. TTRX test setup

Based on the mutual setup described in chapter 2.1. the TTRX setup needs a plug for the USB cable.

It is important to use a RF shielded USB connector.

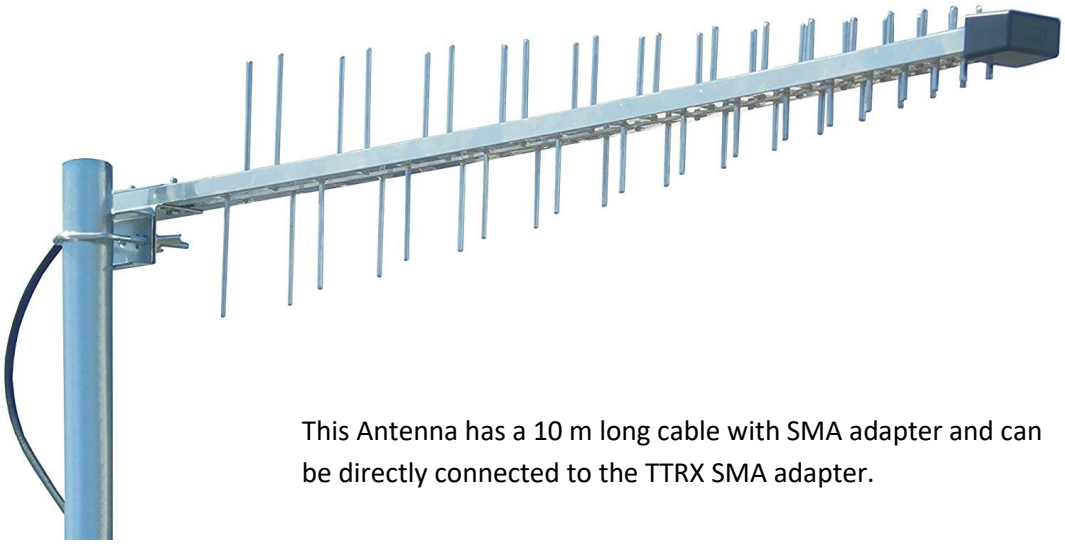


2.1.3. Validating the setup

Use a normal PTM switch to check, if the electromagnetic shielding of the setup exceeds 80 dB. Terminate the RF connector properly with 50 Ω. If you now click around the Housing and do only receive telegrams with RSSI < -80 DBm, then everything is setup correctly.

2.2. TTRX Antenna

It is recommended to use a directional antenna with low side lobes and a high front to back ratio.
A possible device is a Wittenberg K-102802-10 LAT 56 Universal antenna.



This Antenna has a 10 m long cable with SMA adapter and can be directly connected to the TTRX SMA adapter.

Of course you can use similar antennas from other manufacturers.

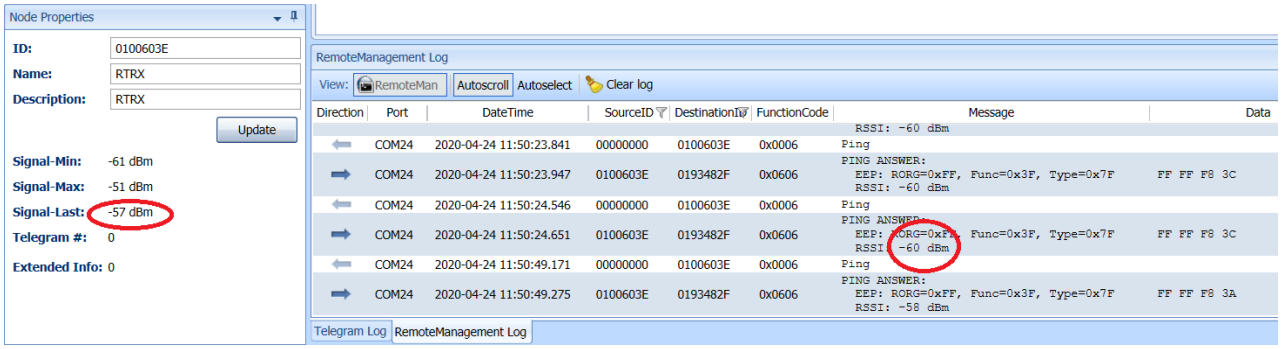
To mount the antenna in a height at least 1,2 m from the ground use a wooden or aluminum stand.

Those antennas usually have a gain and so it is needed to add attenuations to meet the requirement to have a RX signal strength detection ranging from -50dBm to -85dBm, and not going into saturation.

It is also possible to use mechanical or electronic adjustable attenuators.

2.3. Software

To execute the transmitter performance test it is necessary that RTRX/DUT send cyclic telegrams with maximum telegram length.
A possibility to trigger RTRX/DUT remotely by air to send a telegram with maximum telegram length is using the Remote Management ping command from TTRX. If TTRX is connected to Dolphin View the ping request can be sent, and the RTRX/DUT answers with ping response and the received RSSI-Value can be noted.



On the left side you see the signal strength how the TTRX received the ping answer. At the ping answer on the right side, you see the signal strength of the RTRX or DUT, how they saw the ping request.

For the receiver performance tests, the same test setup can be used. The ping response contains the RSSI-Level which was seen by DUT/RTRX and can be noted.

Be sure to use a proper firmware which supports Remote Management (e.g. EnOcean GmbH gateway controller or similar), offers all functionality necessary to perform the tests.

The MER-Test is performed by adding an additional sniffer to the test setup. This sniffer counts all telegrams it receives using the Dolphin View telegram counter. When comparing the telegrams received by the DUT the MER can be calculated.

2.4. Test site arrangement

In general, the test site

- **Strongly** suggested to be located outside, independent of the antenna used.
- Must be outside, when using omnidirectional antenna for TTRX.

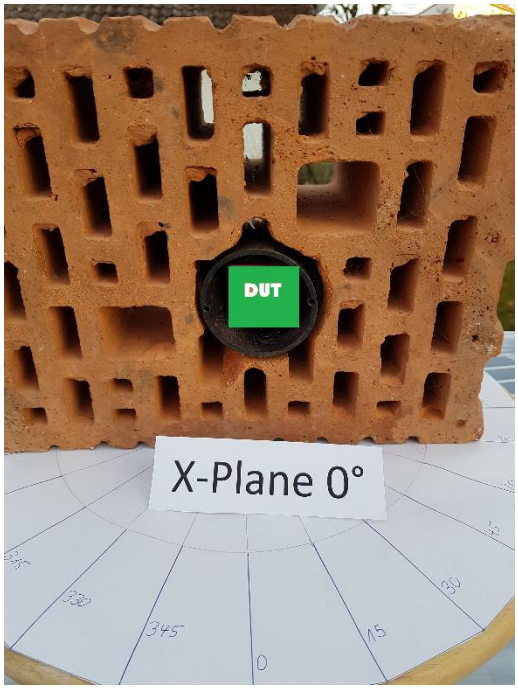
The test area has to be free from any obstacles!

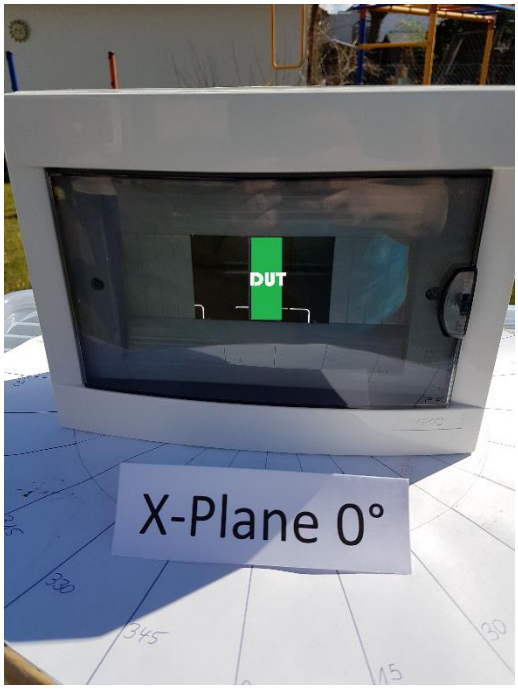
This means, that inside the test zone also no spectrum analyzers, power supplies or other devices are allowed!
It is recommended to put the TTRX device and the controlling PC device far away from the test zone and that no metal boards or devices are nearby.

The RTRX or the DUT has to be located in the same height as the TTRX antenna, at least 1.2 m above the ground. Use plastic, wooden or carton boxes without any metal to arrange the requested height.

2.5. DUT placement

The DUT has to be placed in an environment, where it is expected, that the device is used in major installations.





3. Test execution

3.1. Attenuation for radio pattern test

It is important to choose the proper attenuation to avoid coming into a saturation of the receiver. RX signal strengths < 50 dBm are not suitable for valid test results.

The attenuation has always to be connected between the TTRX device and the antenna and once chosen, is never changed between the measurements of the RTRX and the DUT, nor the 3 layers.

To find the correct attenuation, use the RTRX and monitor the received RX signal strength. Chose the attenuation that the RX signal strength is ideally ranging from -50dBm to -85dBm in all angles and layers.
When later using the DUT and the RX signal strength becomes outside of the receiver capabilities then this measurement can be marked as “no receiving” and is a valid measure.

3.2. Attenuation for MER test

The attenuation for the first test step has to be selected, that the connection is -83 dBm. Do not change the distance between the RTRX/DUT and the TTRX to reach the connection. Only change the attenuation between the TTRX and the antenna to reach the value.
To find out the correct attenuation send some telegrams and watch the RX signal strength of the RTRX/DUT till the value is -83 dBm.

3.3. Testing area

During the tests there are no persons allowed inside the testing area or behind the RTRX/DUT. Every disturbance has an influence on the testing results.

3.4. Testing documentation

Please only use the official EnOcean Alliance Template! The current version you find at the EnOcean Alliance homepage under “Technical Specifications”.

Please do always fill the Summary page to provide the general information's. Without this page completely filled no certification is possible.

It is important to provide images from the test setup (TTRX and RTRX devices, antennas, testing area) and the DUT.

The RX plot and TX plot images will be created by the data entered in the following tabs.

The row "TX Power [dBm]" has to be filled for:

- Reference Measurement
  - RTRX: TX power of the RTRX device once determined
  - TTRX: TX power of the TTRX defined in TTRX firmware
- X/Y/Z plane measurement
  - DUT: Usually not known, but can be entered informal
  - TTRX: TX power of the TTRX defined in TTRX firmware

The row "External Attenuation [dB]" has to be filled only for TTRX and must be the same for the reference measurement and the DUT measurement.
Due to the definition of the tests, there is no external attenuation for RTRX and DUT and so the value is 0 dB.