January 2020

SIGFOX RADIATED PERFORMANCE SPECIFICATION

Public use

Revision History

Revision Number	Date	Author	Change description
0.1	August 15th, 2017	B.Ray	Initial spec
0.2	October 5th, 2017	B.Ray	Antenna Gain
0.3	November 5th, 2017	B.Ray	RC3a, RC3c, RC5
0.4	May 23th, 2018	B.Ray	RC6
0.5	September 17th, 2018	B.Ray	Adapt to new wording
0.6	November 2019	S.Barreiro	RC7
0.6.1	January 2020	S.Barreiro	Typo on RC7 corection

Content

1. Introduction

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I. Introduction

1. Acronyms and abbreviations

- CE: European Commission
- CW: Continuous wave
- DUT: Device Under Test
- EIRP: Effective Isotropic Radiated Power
- EIRS: Effective Isotropic Radiated Sensitivity
- ETSI: European Telecommunications Standards Institute
- ERP: Effective Radiated Power
- FCC: Federal Communications Commission
- GFSK: Gaussian Frequency Shift Keying
- PER: Packet Error Rate
- RC: Radio Configuration
- RF: Radio Frequency
- RX: Receive
- TX: Transmit

2. Scope

This document applies to Sigfox partners planning the radiated performance tests of the Sigfox Ready™ Certification for a device. Radiated performance tests will be performed by Sigfox accredited test houses. Filing is checked by Sigfox through the BUILD platform build.sigfox.com

This document intents to describe the **test specification** for each radiated test being performed for the Sigfox Ready™ certification.

Throughout this document, the Device under Test (DUT) refers to the product to be certified.

Important:
The Sigfox Ready™ certification does not substitute local regulatory requirements (CE marking, FCC, ETSI or other type approval) where the device is to be deployed.
It is the partner`s responsibility to comply with local country regulations.

3. Definitions

The **effective radiated power** (ERP) is the power radiated in the direction of maximum field strength under specified conditions of measurements.

ERP_{dBm}= $Conducted\_RF\_Power_{dBm}$ + $Antenna\_Gain_{dB}$

EIRP refers to an isotropic antenna whereas ERP refers to a perfect dipole antenna. The relation between ERP and EIRP is:

$EIRP_{dBm} = ERP_{dBm} + 2.15dB$

The **radiation pattern** is the variation of the power radiated by an antenna as a function of the direction away from the antenna. This power variation, as a function of the arrival angle, is observed in the antenna's far field.

Radiated receiver sensitivity is the minimum level of signal at the receiver input, produced by a carrier at the nominal frequency of the receiver, modulated with the normal test signal modulation.

EIRP and radiation pattern tests are mandatory for Sigfox Ready ™ filing.
The receiver sensitivity test is optional but highly recommended. It only applies to DUT operating in bidirectional communication way.

2. TX Test Specification

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II. TX Test Specification

1. ERP or EIRP

The DUT EIRP is measured to assess device transmitter's radiated performances

Test specification:
DUT EIRP must conform at least the high limit of the regulation in each RC.
Nevertheless, Sigfox will give a high limit recommendation to comply with its technology approach of:

- Low consumption
- Balanced budget link between uplink and downlink

It is highly recommended to achieve the Sigfox recommended limits.

DUT will be classified in each RC, based on the EIRP measurement value following the criteria declared in the tables below:

- Radio Configuration 1 (RC1)

RC1	Uplink class			
	Class 0u	Class 1u	Class 2u	Class 3u
EIRP (dBm)	**High limit**: device should comply with the normative limit of the target countries standard in the 868-868.6MHz frequency band for non-specific use applications **Sigfox high limit recommendation: 16dBm** **Low limit**: 12dBm	12dBm>EIRP≥7dBm	7dBm>EIRP≥2dBm	Below 2dBm

- Radio Configuration 2 (RC2)

RC2	Uplink class			
	Class 0u	Class 1u	Class 2u	Class 3u
EIRP (dBm)	**High limit**: device should comply with the limit of the target countries standard 902.1375-904.6625MHz frequency band. **Sigfox high limit recommendation: 24dBm** **Low limit**: 20dBm	20dBm>EIRP≥15dBm	15dBm>EIRP≥10dBm	Below 10dBm

- Radio Configuration 3 (RC3a, RC3c)

RC3a RC3c	Uplink class			
	Class 0u	Class 1u	Class 2u	Class 3u
EIRP (dBm)	**High limit**: device should comply with the normative limit of the ARIB STD - T108 standard in the 920.5-929.7MHz frequency band. **Sigfox high limit recommendation: 16dBm** **Low limit**: 12dBm	12dBm>EIRP≥7dBm	7dBm>EIRP≥2dBm	Below 2dBm

Note: RC3 was renamed RC3a

- Radio Configuration 4 (RC4)

RC4	Uplink class			
	Class 0u	Class 1u	Class 2u	Class 3u
EIRP (dBm)	**High limit**: device should comply with the limit of the target countries standard in the 920.1375-922.6625MHz frequency band. **Sigfox high limit recommendation: 24dBm** **Low limit**: 20dBm	20dBm>EIRP≥15dBm	15dBm>EIRP≥10dBm	Below 10dBm

- Radio Configuration 5 (RC5)

RC5	Uplink class			
	Class 0u	Class 1u	Class 2u	Class 3u
EIRP (dBm)	**High limit**: device should comply with the limit of the target countries standard in the 920.8-923.4MHz frequency band. **Sigfox high limit recommendation: 14dBm** **Low limit**: 10dBm	10dBm>EIRP≥5dBm	5dBm>EIRP≥0dBm	Below 0dBm

- Radio Configuration 6 (RC6)

RC6	Uplink class			
	Class 0u	Class 1u	Class 2u	Class 3u
EIRP (dBm)	**High limit**: device should comply with the normative limit of the target countries standard in the 865-867MHz frequency band **Sigfox high limit recommendation: 16dBm** **Low limit**: 12dBm	12dBm>EIRP≥7dBm	7dBm>EIRP≥2dBm	Below 2dBm

- Radio Configuration 7 (RC7)

RC7	Uplink class			
	Class 0u	Class 1u	Class 2u	Class 3u
EIRP (dBm)	**High limit**: device should comply with the normative limit of the target countries standard in the 868.7-869.2 MHz frequency band for non-specific use applications **Sigfox high limit recommendation: 16dBm** **Low limit**: 12dBm	12dBm>EIRP≥7dBm	7dBm>EIRP≥2dBm	Below 2dBm

Important:
Integration of the antenna into the device is a critical part of the device design.
Severe degradation of performance may occur if antenna integration is not properly analyzed.
In this case, uplink class 0u may not be achieved.
The partner is responsible for adjusting device radio parameters (radiated power, harmonics…) in order to meet performances in the final application environment

2. Radiation pattern

An antenna radiates energy in most cases with some directional dependence. Radiation pattern measurement gives information of the radiation pattern shape and antenna polarization. Omni-directional antennas are the preferred option for most applications because of the star architecture of the Sigfox network.

Test specification:
DUT shall show an omni directional pattern to comply with the star Sigfox network topology. Directional antenna is allowed in case of dedicated end-user application (device mounted on a wall can radiate in the main direction opposite to the wall)

3. RX Test Specification (optional)

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II. RX Test Specification (optional)

1. RX radiated sensitivity GFSK 600bps

In the Sigfox RF & Protocol specification, the conducted sensitivity should be better or equal to -126dBm for all RCs with a PER at 10% on 1000 frames sent, assuming a 14dBm modulated conducted output power.
It means that the EIRS is -128dBm for a 0dBd antenna gain.

Test specification:
DUT EIRS Sigfox recommendation limit for a single link with a **PER at 10% on 30 frames sent** shall be as following depending on the targeted RC:

Radio Configuration	Sigfox recommended EIRS limit
RC1	≤ -128- (EIRP – 16) in dBm
RC2	≤ -128- (EIRP – 24) in dBm
RC3a, RC3c	≤ -128- (EIRP – 16) in dBm
RC4	≤ -128- (EIRP – 24) in dBm
RC5	≤ -128- (EIRP – 14) in dBm
RC6	≤ -128- (EIRP – 16) in dBm
RC7	≤ -128- (EIRP – 16) in dBm

where EIRP is the measured Equivalent Isotropic Radiated Power upon EIRP test.

Example: If we assume that a DUT is measured in RC1 at 9dBm EIRP, Sigfox recommendation is to have at least a measured EIRS better or equal to:

-128-(9-16)dBm = **-121dBm** in order to achieve a balanced budget link.

EIRS test result is not a pass/fail criteria and is only informative.

Important: It is the partner responsibility to implement during device integration the hardware achieving a balanced uplink/downlink budget and providing equivalent service map in both communication ways.

Device field radio environment can largely vary depending on the targeted application. An object located on a telecommunication tower needs higher protection from radio interference than an object set in a confined environment. Thus, the partner must pay attention to receive radio parameters (sensitivity, selectivity, blocking …).

Sigfox Verified™ modular design includes intrinsic radio characteristics that can be improved or altered during final product integration by adding components such as filters, LNA, switches…

Sigfox recommends partners to measure device global performance and radio parameters.

The antenna must be designed or selected to comply with transmit but also with receive nominal operation bandwidth.

Depending on the DUT final use-case, device uplink class and environment, Sigfox reserves the right to perform a field test in order to certify the DUT in its dedicated environment.