

EMC TEST REPORT FOR CE CONFORMANCE

Client:

SJI Co.,Ltd

54-33, Dongtanhana 1-gil, Hwaseong-si, Gyeonggi-do,
Republic of Korea

Date of Issue: August 30, 2022

Test Report No.: HCT-EM-1907-CE002-R1

Test Site: HCT CO., LTD.

MODEL:

SFM20R1

Product Name : Sigfox Quad-mode module
Manufacturer : SJI Co.,Ltd
Test Standard : ETSI EN 301 489-1 V2.2.3
Draft ETSI EN 301 489-3 V2.3.0
ETSI EN 301 489-17 V3.2.4
Final draft ETSI EN 301 489-19 V2.2.1
Date of Test : May 15, 2017 - August 14, 2017
Test Result : Refer to the present document

The above equipment has been tested by HCT Co., Ltd and found compliance with the requirements set forth in the technical standards mentioned above. The results of testing in this report apply only to the product which was tested. Other similar equipment will not necessarily produce the same results due to production tolerance and measurement uncertainties.

Tested By



Wook Yi
Test Engineer
EMC Team
Certification Division

Reviewed By



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- Revision History

The revision history for this document is shown in table.

Report No.	Issue Date	Description
HCT-E-1708-C015	August 28, 2017	Initial Release
HCT-E-1708-C015-1	October 20, 2017	Revision of the frequency range (Wi-Fi)
HCT-E-1708-C015-2	October 27, 2017	Added the Test Standard (Final draft ETSI EN 301 489-3)
HCT-EM-1907-CE002	July 03, 2019	Revision Issuing; Changed the company name and address of client Before: WISOL CO., LTD. After: SEONG JI INDUSTRIAL CO., LTD.
HCT-EM-1907-CE002-R1	August 30, 2022	- Changed the company name and address of client Before: SEONG JI INDUSTRIAL CO., LTD. After: SJI Co.,Ltd - Updated the test standard and method



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1. INFORMATION OF THE EUT

1.1 General Information of the EUT

Model Name	SFM20R1
Product Name	Sigfox Quad-mode module
SW Version	SFM20R_V204
HW Version	1.0
Manufacturer	SJI Co.,Ltd

1.2 Product Specification

The SFM20R1 module is a quad mode module supporting Sigfox, BLE, WiFi and GPS.

This Module able to transmit and receive messages using the SIGFOX network.

Description		Specifications
Sigfox	Data Modulation	TX: DBPSK, RX: 2GFSK
	Frequency	TX: 868.055 MHz - 868.205 MHz, RX: 869.525 MHz
	Output Power and tolerance	13 ±0.9 dBm
BLE	Data Modulation	GFSK
	Frequency	2 402 to 2 480 MHz TX/RX
	Output Power and tolerance	1 ±4.0 dBm
WiFi	Data Modulation	DSSS:CCK,BPSK,QPSK for 802.11b OFDM:BPSK,QPSK,16QAM,64QAM for 802.11g,n (HT20)
	Frequency	2 412 MHz to 2 472 MHz
	Output Power and tolerance	12.5 ±2.5 dBm
GNSS (GPS, GLONASS)	Data Modulation	BPSK
	Frequency	1 559 MHz to 1 610 MHz



2. CONFIGURATION AND CONNECTIONS WITH THE EUT

2.1 Composition of the EUT and Peripheral Devices

Equipment	Model No.	Serial Number	Manufacturer
EUT	SFM20R1	-	SJI Co.,Ltd
USB to UART	-	-	SJI Co.,Ltd
JIG board	-	-	SJI Co.,Ltd
Antenna	-	-	-
SIGFOX antenna	-	-	-
GPS antenna	-	-	-
Notebook PC	ProBook 650 G1	5CG5520P9J	HP
Notebook PC adaptor	PPP009L-E	-	Lite-On Technology

2.2 Test Ports

WiFi / Bluetooth LE Mode

Start Connection		End Connection		Cable	
Equipment	I/O Port	Equipment	I/O Port	Length(m)	Shielding Condition
EUT	50 Pin	JIG Board	50 Pin	-	-
	SMA	Antenna	-	-	-
JIG Board	Micro USB	Notebook PC	USB	1.2	Shielded
	6 Pin	USB to UART	6 Pin	0.15	Unshielded
USB to UART	USB	Notebook PC	USB	-	-
Notebook PC	DC IN	Notebook PC adaptor	Power	1.8	Unshielded



SIGFOX Mode

Start Connection		End Connection		Cable	
Equipment	I/O Port	Equipment	I/O Port	Length(m)	Shielding Condition
EUT	50 Pin	JIG board	50 Pin	-	-
	SMA	SIGFOX antenna	-	-	-
JIG board	Micro USB	Notebook PC	USB	1.2	Shielded
USB to UART	USB	Notebook PC	USB	-	-
Notebook PC	DC IN	Notebook PC adaptor	Power	1.8	Unshielded

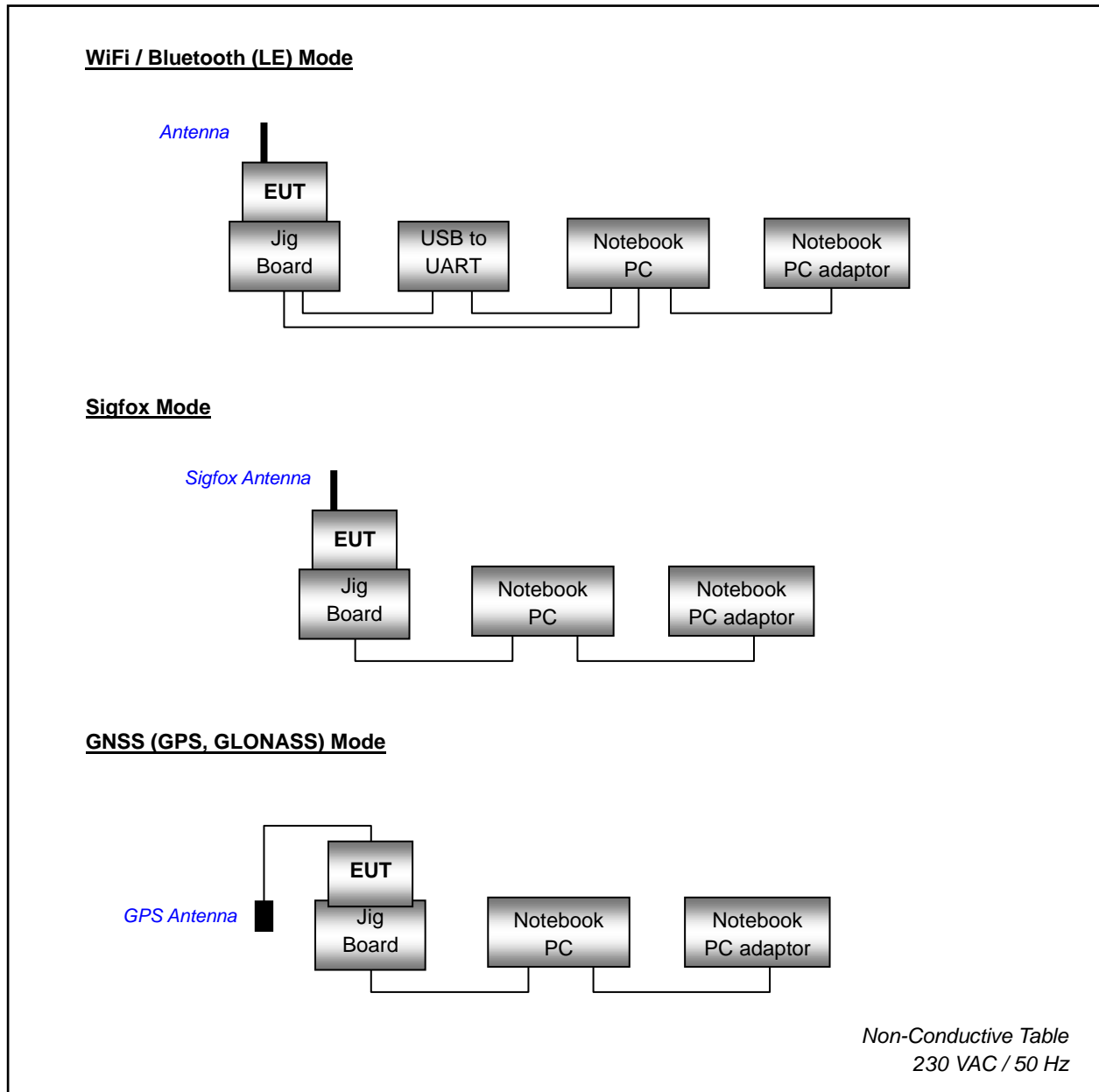
GNSS (GPS, GLONASS) Mode

Start Connection		End Connection		Cable	
Equipment	I/O Port	Equipment	I/O Port	Length(m)	Shielding Condition
EUT	50 Pin	JIG board	50 Pin	-	-
	SMA	GPS antenna	-	-	-
JIG board	Micro USB	Notebook PC	USB	1.2	Shielded
USB to UART	USB	Notebook PC	USB	-	-
Notebook PC	DC IN	Notebook PC adaptor	Power	1.8	Unshielded



2.3 Connection Diagram of the EUT and Peripheral Devices

The EUT was configured in the following manner.





2.4 Operation of the EUT

a. Operating Frequency

Sigfox: 868.055 MHz to 868.205 MHz for TX, 869.525 MHz for RX

Bluetooth: 2 402 MHz to 2 480 MHz for TX/RX

WiFi: 2 412 MHz to 2 472 MHz for TX/RX

GNSS (GPS, GLONASS): 1 559 to 1 610 MHz for RX

b. Operating Mode

WiFi Mode

It was monitored by ping test.

Bluetooth LE Mode

It was monitored by PER with Bluetooth base station.

Sigfox Mode

It was monitored by software provided by manufacturer.

GNSS (GPS, GLONASS) Mode

It was monitored by software provided by manufacturer.



3. TEST FACILITIES AND ACCREDITATIONS

3.1 Test Laboratory

Company Name	HCT Co., Ltd.
Address	74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si, Gyeonggi-do, 17383. Rep. of KOREA
Telephone	+82 31 645 6300
FAX	+82 31 645 6401

3.2 Test Facilities

Our laboratories are accredited and approved by the following approval agencies according to ISO/IEC 17025.

KOREA	National Radio Research Agency	Designation No. KR0032
	KOLAS	Testing No. KT197



4. REFERENCES OF TEST

4.1 Test Standard

ETSI EN 301 489-1 V2.2.3 (2019-11)
Draft ETSI EN 301 489-3 V2.3.0 (2022-07)
ETSI EN 301 489-17 V3.2.4 (2020-09)
Final draft ETSI EN 301 489-19 V2.2.1 (2022-07)

4.2 Test Method

Emission Test

EN 55032:2015+A11:2020

Immunity Test

EN 61000-4-2:2009
EN 61000-4-3:2006+A1:2008+A2:2010



5. TEST RATIONALE

5.1 Exclusion Band

Testing shall be calculated as follows:

a. Sigfox Band

Exclusion bands for emissions testing:

Transmitters

Where this is not so specified the exclusions bands shall be as below:

- For transmitters operating, or intended to operate, in a channelized frequency band, the exclusion band is five times (i.e. $\pm 250\%$) the maximum operating channel width (OCW) allowed for that service, centred around the operating frequency.
- For wide band transmitters, i.e. transmitters in a non-channelized frequency band, the exclusion band is twice the intended operating frequency band centred around the centre frequency of the intended operating frequency band.

The exclusion band shall only apply when the EUT is in transmit mode of operation.

Receivers

No exclusion band applies.

Exclusion bands for immunity testing:

Transmitters

The exclusion band be as specified for emissions testing.

Receivers

The exclusion band is based on an extension value.

The lower limit of the exclusion band is the lower edge of the Operating Channel (OC) minus the extension value, or zero, whichever is the greater.

The upper limit is the upper edge of the OC plus the extension value.

The extension value is given in table. The OC is defined in the relevant radio standard.

Receiver operating frequency f_0	Extension value
< 300 kHz	300 kHz
300 kHz to < 30 MHz	3 MHz
30 MHz to < 1 GHz	15 MHz, or $5\% \times f_0$, whichever is greater
1 GHz to < 6 GHz	100 MHz
≥ 6 GHz	$5\% \times f_0$

NOTE. The receiver exclusion band frequency range aligns as far as possible with the blocking test frequency range defined in ETSI EN 300 220-1 [2].



b. WiFi Band

Immunity testing of equipment operating in the 2,4 GHz band shall be:

- lower limit of exclusion band = lowest allocated band edge frequency -120 MHz
- upper limit of exclusion band = highest allocated band edge frequency +120 MHz

c. GNSS (GPS, GLONASS) Band

The receiver exclusion band is the band of frequencies over which no tests of radiated immunity of a receiver are made.

- The lower frequency of the receiver exclusion band is the lower frequency of the complete receive band of the EUT minus 5 % of that lower frequency.
- The upper frequency of the receiver exclusion band is the upper frequency of the complete receive band of the EUT plus 5 % of that upper frequency.

5.2 Performance Criteria

a. General performance criteria

The performance criteria are:

performance criteria A for immunity tests with phenomena of a continuous nature;

performance criteria B for immunity tests with phenomena of a transient nature;

The equipment shall meet the minimum performance criteria as specified in the following clauses.

Criteria	During Test	After Test
A	Shall operate as intended May show degradation of performance (See note 1) Shall be no loss of function Shall be no unintentional transmissions	Shall operate as intended. Shall be no degradation of performance (see note 3). Shall be no loss of function. Shall be no loss of stored data or user programmable functions.
B	May show loss of function (one or more). May show degradation of performance (see note 2). Shall be no unintentional transmissions.	Functions shall be self-recoverable. Shall operate as intended after recovering. Shall be no degradation of performance (see note 3). Shall be no loss of stored data or user programmable functions.
NOTE 1: Operate as intended during the test allows a level of degradation not below a minimum performance level specified by the manufacturer for the use of the apparatus as intended. In some cases the specified minimum performance level may be replaced by a permissible degradation of performance. If the minimum performance level or the permissible performance degradation is not specified by the manufacturer then either of these may be derived from the product description and documentation (including leaflets and advertising) and what the user may reasonably expect from the apparatus if used as intended.		



NOTE 2: Degradation of performance during the test is understood as a degradation to a level not below a minimum performance level specified by the manufacturer for the use of the apparatus as intended. In some cases the specified minimum performance level may be replaced by a permissible degradation of performance.

If the minimum performance level or the permissible performance degradation is not specified by the manufacturer then either of these may be derived from the product description and documentation (including leaflets and advertising) and what the user may reasonably expect from the apparatus if used as intended.

NOTE 3: No degradation of performance after the test is understood as no degradation below a minimum performance level specified by the manufacturer for the use of the apparatus as intended. In some cases the specified minimum performance level may be replaced by a permissible degradation of performance. After the test no change of actual operating data or user retrievable data is allowed. If the minimum performance level or the permissible performance degradation is not specified by the manufacturer then either of these may be derived from the product description and documentation (including leaflets and advertising) and what the user may reasonably expect from the apparatus if used as intended.

b. Continuous phenomena applied to Transmitters (CT) / Receivers (CR)

The performance criteria A shall apply.

Tests shall be repeated with the EUT in standby mode (if applicable) to ensure that unintentional transmission does not occur. In systems using acknowledgement signals, it is recognized that an ACKnowledgement (ACK) or Not ACKnowledgement (NACK) transmission may occur, and steps should be taken to ensure that any transmission resulting from the application of the test is correctly interpreted.

c. Transient phenomena applied to Transmitters (TT) / Receivers (TR)

The performance criteria B shall apply.

Tests shall be repeated with the EUT in standby mode (if applicable) to ensure that unintentional transmission does not occur. In systems using acknowledgement signals, it is recognized that an acknowledgement (ACK) or not-acknowledgement (NACK) transmission may occur, and steps should be taken to ensure that any transmission resulting from the application of the test is correctly interpreted.

Where the EUT is a transceiver, under no circumstances, shall the transmitter operate unintentionally during the test. In systems using acknowledgement signals, it is recognized that an ACK or NACK transmission may occur, and steps should be taken to ensure that any transmission resulting from the application of the test is correctly interpreted.



6. TEST SUMMARY

The results in this report apply only to sample tested:

Test Date	Phenomena	Application	Limit Value/ Performance Criteria	Test Result	Test Method
05.15.2017 08.08.2017	Conducted Emission	AC power port	See test data	Pass	EN 55032
N/A	Radiated Emission ¹⁾	-	-	-	-
05.22.2017 08.10.2017 08.14.2017	Electro-Static Discharge	Enclosure port	TT/TR	Pass	EN 61000-4-2
06.12.2017 06.13.2017 06.14.2017 08.11.2017 08.14.2017	RF Electromagnetic Field	Enclosure port	CT/CR	Pass	EN 61000-4-3

***NOTE.**

1. CT/CR: Continuous phenomena (Transmitter/Receiver)
2. TT/TR: Transient phenomena (Transmitter/Receiver)
3. Radiated emission is that it was not tested on the basis of Section 8.2 of EN 301 489-1.
4. Immunity doesn't test based on reference Section 7.2 of EN 301 489-1.
(Fast transients, RF common mode, Voltage dips and interruptions, Surge)



7. TEST EQUIPMENT

<u>Type</u>	<u>Model Name</u>	<u>Manufacturer</u>	<u>Serial Number</u>	<u>Calibration Period</u>	<u>Next CAL Date</u>
<u>Conducted Emission</u>					
<input checked="" type="checkbox"/> EMI Test Receiver	ESCI	Rohde & Schwarz	100584	1 year	06.20.2018
<input checked="" type="checkbox"/> LISN	ENV216	Rohde & Schwarz	100073	1 year	12.23.2017
<input type="checkbox"/> Antenna	USLP9142	Rohde&Schwarz	9142-247	-	-
<u>Electro-Static Discharge (ESD)</u>					
<input checked="" type="checkbox"/> ESD SIMULATOR	ESS-2000	NOISETTEK	ESS0230746	1 year	09.22.2017
<input type="checkbox"/> Antenna	USLP9142	Rohde&Schwarz	9142-247	-	-
<u>RF Electro-Magnetic Field (RS-01)</u>					
<input checked="" type="checkbox"/> SW controller	RSM-02	TDK	208234	-	-
<input checked="" type="checkbox"/> Field Probe monitor	SI-300	TDK	41665	-	-
<input checked="" type="checkbox"/> Power Meter	NRVD	Rohde & Schwarz	832840/009	1 year	03.31.2018
<input checked="" type="checkbox"/> Power Sensor	NRV-Z51	Rohde & Schwarz	831808/021	1 year	03.31.2018
<input checked="" type="checkbox"/> Power Amplifier	30S1G6	AR	0345460	-	-
<input checked="" type="checkbox"/> Power Amplifier	250W1000AM3	AR	306169	-	-
<input checked="" type="checkbox"/> System Controller PC	E7400	-	-	-	-
<input checked="" type="checkbox"/> Log periodic antenna	LPDA-0803	TDK	130345	-	-
<input checked="" type="checkbox"/> Signal Generator	N5182A	Agilnet	MY47071067	1 year	03.30.2018
<input checked="" type="checkbox"/> Horn Antenna	BBHA 9120D	SCHWARZBECK	1407	-	-
<input checked="" type="checkbox"/> 60 dB dual directional coupler	DC6180	AR	0331309	1 year	11.22.2017
<input checked="" type="checkbox"/> 42 dB dual directional coupler	DC7205A	AR	0344986	1 year	08.25.2017
<input type="checkbox"/> Dynamic Signal Analyzer	35670A	HP	3340A00604	1 year	04.25.2018
<input type="checkbox"/> Wave Filter	DSP599zx	Time Wave	36829	-	-
<input type="checkbox"/> Wave Filter	DSP599zx	Time Wave	36840	-	-
<input type="checkbox"/> Microphone preamplifier	Type 2669	BRUEL&KJAER	2397254	1 year	12.16.2017
<input type="checkbox"/> Microphone	4188	BRUEL&KJAER	2380041	1 year	12.16.2017
<input type="checkbox"/> Dual Microphone Supply	5935L	BRUEL&KJAER	2116116	-	-
<input type="checkbox"/> Telephone Test Head	4602B	BRUEL&KJAER	2391518	-	-
<input checked="" type="checkbox"/> Bluetooth Base station	TC-3000C	TESCOM	3000C000276	1 year	03.31.2018
<input type="checkbox"/> Base station	MT8820C	Anritsu	6201041638	1 year	03.24.2018
<input type="checkbox"/> Universal Radio Communication Tester	CMU200	Rohde & Schwarz	1100000802	1 year	03.05.2018
<input type="checkbox"/> Antenna	USLP9142	Rohde&Schwarz	9142-247	-	-



<u>Type</u>	<u>Model Name</u>	<u>Manufacturer</u>	<u>Serial Number</u>	<u>Calibration Period</u>	<u>Next CAL Date</u>
<u>RF Electro-Magnetic Field (RS-02)</u>					
<input checked="" type="checkbox"/> System Controller PC	DM500T4Z	SAMSUNG	-	-	-
<input checked="" type="checkbox"/> Signal Generator	N5182A	Agilnet	MY50141919	1 year	04.19.2018
<input checked="" type="checkbox"/> EPM Series power meter	E4419B	AGILENT	MY40510553	1 year	08.07.2018
<input checked="" type="checkbox"/> Power Sensor	N8482A	Agilent	MY51330014	1 year	02.09.2018
<input checked="" type="checkbox"/> Field Probe monitor	SI-300	TDK	200215	-	-
<input checked="" type="checkbox"/> Power Amplifier	100S1G4	AR	0331066	-	-
<input checked="" type="checkbox"/> Power Amplifier	40S4G18	AR	0445051	-	-
<input checked="" type="checkbox"/> Power Amplifier	25W 1000M7	AR	13300	1 year	02.09.2018
<input checked="" type="checkbox"/> Directional Coupler	DC7435A	AR	0340283	1 year	08.07.2018
<input checked="" type="checkbox"/> Directional Coupler	DC7154A	AR	0343876	1 year	10.17.2017
<input checked="" type="checkbox"/> Directional Coupler	C5982	WERLATONE	11928	1 year	02.08.2018
<input checked="" type="checkbox"/> Log periodic Antenna	LPDA-0803	TDK	13112	-	-
<input checked="" type="checkbox"/> Horn Antenna	BBHA 9120D	SCHWARZBECK	1201	-	-



8. EMC TEST RESULT

8.1 Conducted Emission

8.1.1 Operating Environment

Temperature	23.7 / 23.4 °C	Relative Humidity	36.3 / 51.9 %
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8.1.2 Test Methods and Levels

The test method shall be in accordance with CENELEC EN 55032.

The equipment shall meet the class B limits given in CENELEC EN 55032.

8.1.3 Test Condition

a. The Operating Mode

WiFi Mode

Bluetooth LE Mode

Sigfox Mode

GNSS (GPS, GLONASS) Mode

b. Testing

The following requirements and evaluation of test results shall apply.

Power supply	230 VAC, 50 Hz
LISN impedance	50 Ω
Application port	AC mains input port
Measurement frequency range	150 kHz to 30 MHz
EMI receiver	IF BW: 9 kHz Detector: Quasi-Peak / CISPR-Average

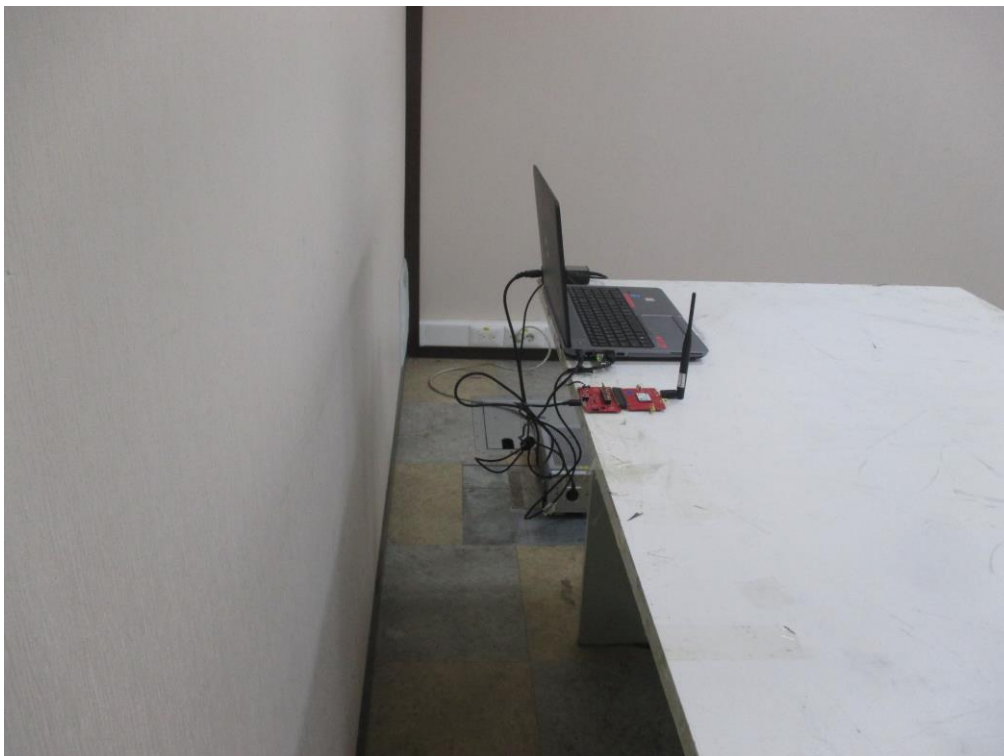
c. Test Site

Conducted emission testing was performed in shield room.



8.1.4 Test Setup

WiFi / Bluetooth LE Mode





Sigfox Mode





GNSS (GPS, GLONASS) Mode





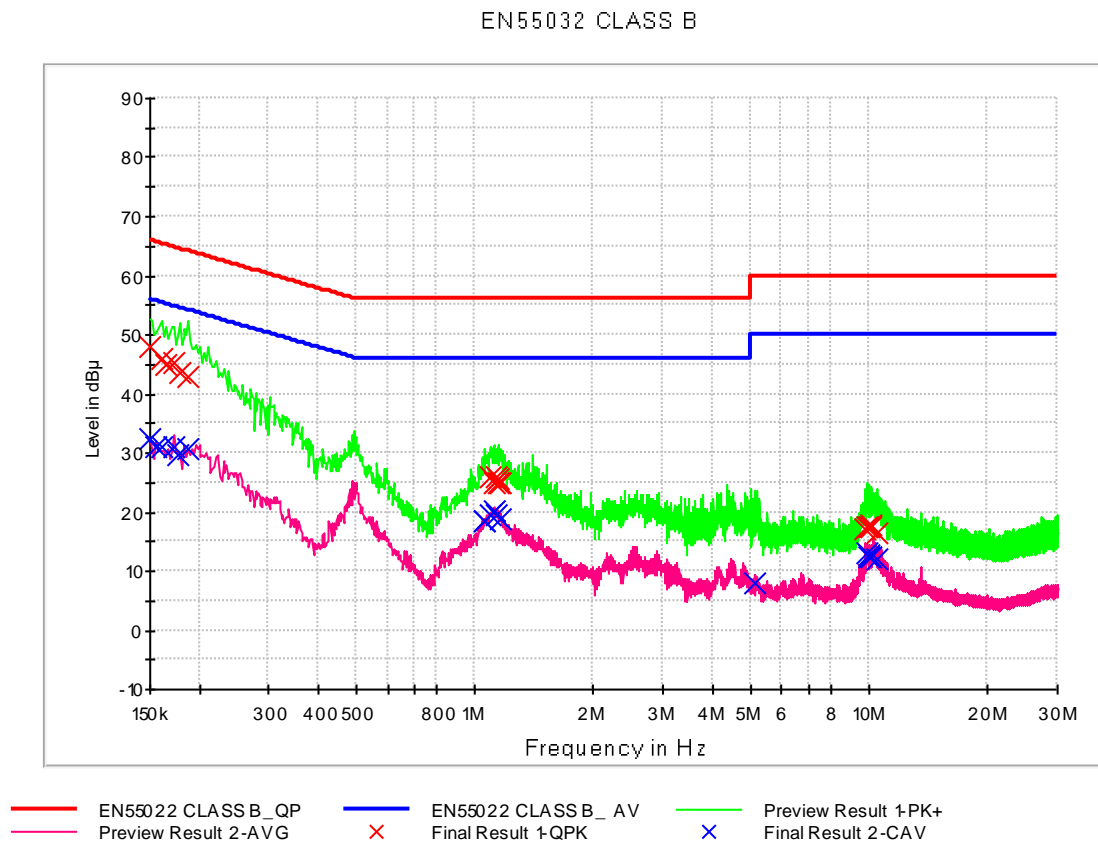
8.1.5 Test Limits

Frequency Range (MHz)	Quasi-Peak (dB μ V)	CISPR-Average (dB μ V)	Test Result
0.15 to 0.5	66 to 56	56 to 46	Pass
>0.5 to 5	56	46	Pass
>5 to 30	60	50	Pass



8.1.6 Test Data

Figure 1: Spectral Diagrams, WiFi Mode, Line (L1)





QuasiPeak Final Result, Line (L1)

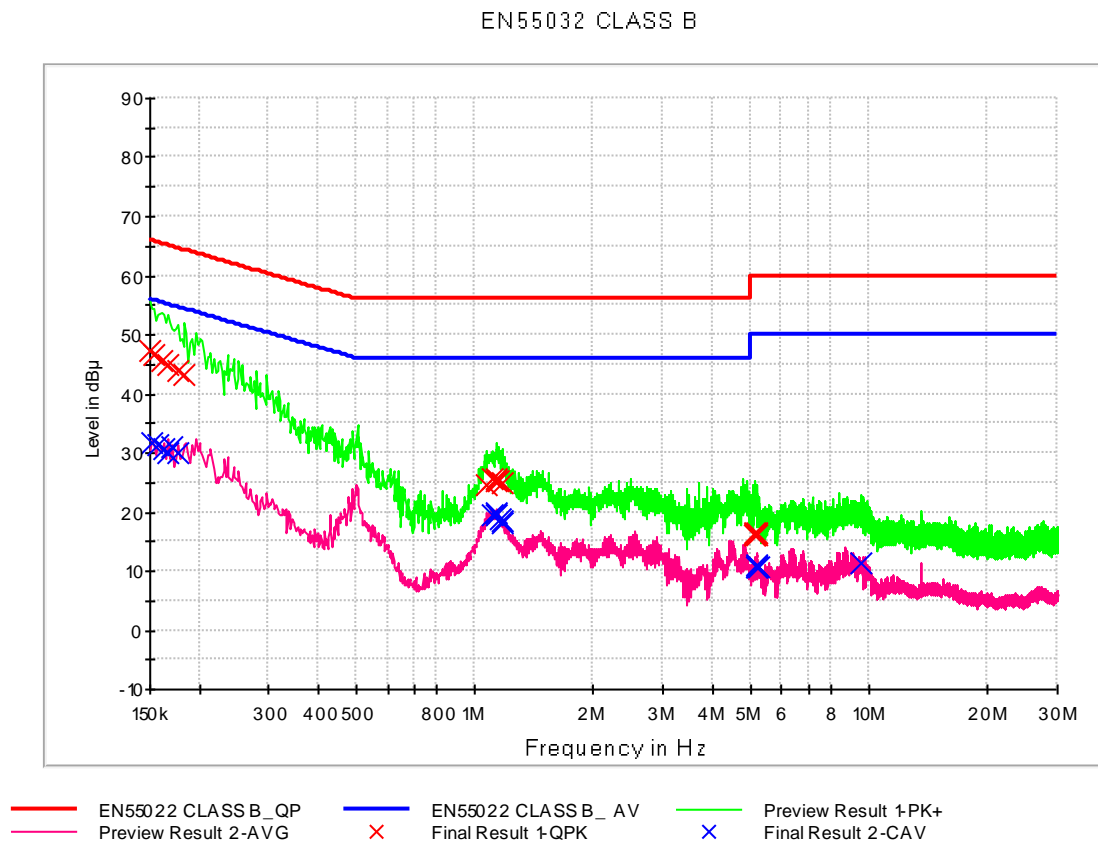
Frequency (MHz)	QuasiPeak (dBμV)	Bandwidth (kHz)	Corr. (dB)	Margin (dB)	Limit (dBμV)
0.150000	47.8	9.000	9.6	18.2	66.0
0.160000	45.8	9.000	9.6	19.7	65.5
0.164000	44.9	9.000	9.6	20.4	65.3
0.172000	45.4	9.000	9.6	19.5	64.9
0.178000	43.5	9.000	9.6	21.1	64.6
0.188000	42.9	9.000	9.6	21.3	64.1
1.092000	26.0	9.000	9.7	30.0	56.0
1.116000	25.1	9.000	9.7	30.9	56.0
1.130000	26.1	9.000	9.7	29.9	56.0
1.144000	25.0	9.000	9.7	31.0	56.0
1.152000	25.7	9.000	9.7	30.3	56.0
1.166000	24.8	9.000	9.7	31.2	56.0
9.810000	17.3	9.000	10.1	42.7	60.0
9.852000	17.6	9.000	10.1	42.4	60.0
9.974000	17.5	9.000	10.1	42.5	60.0
10.118000	17.3	9.000	10.1	42.7	60.0
10.154000	17.8	9.000	10.1	42.2	60.0
10.414000	16.4	9.000	10.1	43.6	60.0

CAverage Final Result, Line (L1)

Frequency (MHz)	CAverage (dBμV)	Bandwidth (kHz)	Corr. (dB)	Margin (dB)	Limit (dBμV)
0.150000	32.4	9.000	9.6	23.6	56.0
0.156000	30.9	9.000	9.6	24.8	55.7
0.160000	31.0	9.000	9.6	24.5	55.5
0.172000	30.9	9.000	9.6	23.9	54.9
0.176000	29.7	9.000	9.6	25.0	54.7
0.188000	30.8	9.000	9.6	23.3	54.1
1.054000	18.4	9.000	9.7	27.6	46.0
1.058000	18.3	9.000	9.7	27.7	46.0
1.092000	19.4	9.000	9.7	26.6	46.0
1.116000	20.0	9.000	9.7	26.0	46.0
1.132000	19.5	9.000	9.7	26.5	46.0
1.168000	18.9	9.000	9.7	27.1	46.0
5.130000	8.1	9.000	9.9	41.9	50.0
9.852000	13.1	9.000	10.1	36.9	50.0
9.998000	12.8	9.000	10.1	37.2	50.0
10.046000	12.4	9.000	10.1	37.6	50.0
10.086000	12.4	9.000	10.1	37.6	50.0
10.414000	12.1	9.000	10.1	37.9	50.0



Figure 2: Spectral Diagrams, WiFi Mode, Line (N)





QuasiPeak Final Result, Line (N)

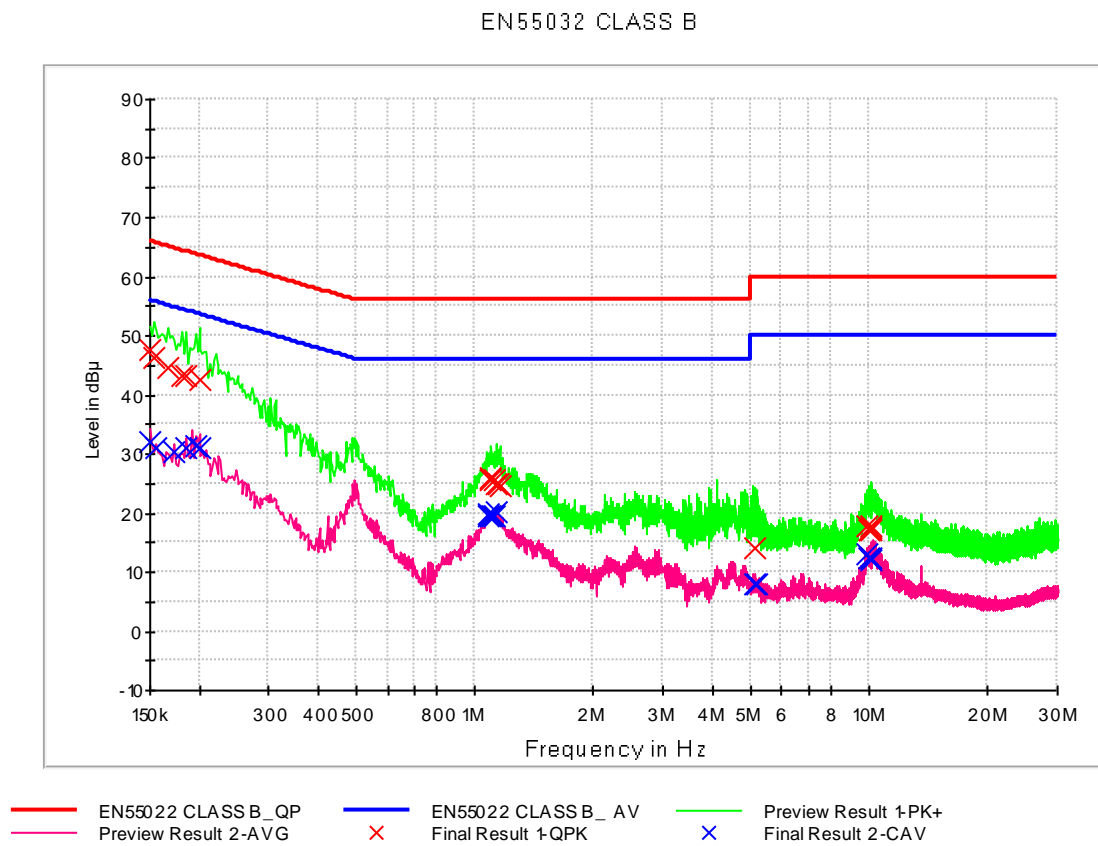
Frequency (MHz)	QuasiPeak (dBμV)	Bandwidth (kHz)	Corr. (dB)	Margin (dB)	Limit (dBμV)
0.150000	47.3	9.000	9.6	18.7	66.0
0.154000	46.5	9.000	9.6	19.3	65.8
0.160000	45.6	9.000	9.6	19.8	65.5
0.166000	44.9	9.000	9.6	20.2	65.2
0.176000	44.0	9.000	9.6	20.7	64.7
0.184000	43.2	9.000	9.6	21.1	64.3
1.070000	24.5	9.000	9.7	31.5	56.0
1.102000	25.5	9.000	9.7	30.5	56.0
1.136000	25.1	9.000	9.7	30.9	56.0
1.140000	25.7	9.000	9.7	30.3	56.0
1.146000	25.2	9.000	9.7	30.8	56.0
1.172000	25.0	9.000	9.7	31.0	56.0
5.134000	16.1	9.000	9.9	43.9	60.0
5.144000	16.2	9.000	9.9	43.8	60.0
5.148000	16.2	9.000	9.9	43.8	60.0
5.152000	16.4	9.000	9.9	43.6	60.0
5.166000	16.4	9.000	9.9	43.6	60.0
5.170000	16.2	9.000	9.9	43.8	60.0

CAverage Final Result, Line (N)

Frequency (MHz)	CAverage (dBμV)	Bandwidth (kHz)	Corr. (dB)	Margin (dB)	Limit (dBμV)
0.152000	31.7	9.000	9.6	24.1	55.9
0.158000	31.3	9.000	9.6	24.2	55.6
0.162000	30.6	9.000	9.6	24.8	55.4
0.166000	30.1	9.000	9.6	25.1	55.2
0.170000	30.9	9.000	9.6	24.0	55.0
0.176000	30.0	9.000	9.6	24.7	54.7
1.112000	19.7	9.000	9.7	26.3	46.0
1.134000	19.4	9.000	9.7	26.6	46.0
1.140000	19.8	9.000	9.7	26.2	46.0
1.160000	18.9	9.000	9.7	27.1	46.0
1.172000	18.3	9.000	9.7	27.7	46.0
1.180000	18.2	9.000	9.7	27.8	46.0
5.162000	10.6	9.000	9.9	39.4	50.0
5.166000	10.6	9.000	9.9	39.4	50.0
5.170000	10.6	9.000	9.9	39.4	50.0
5.204000	10.9	9.000	9.9	39.1	50.0
5.230000	10.7	9.000	9.9	39.4	50.0
9.518000	11.3	9.000	10.1	38.7	50.0



Figure 3: Spectral Diagrams, Bluetooth LE Mode, Line (L1)





QuasiPeak Final Result, Line (L1)

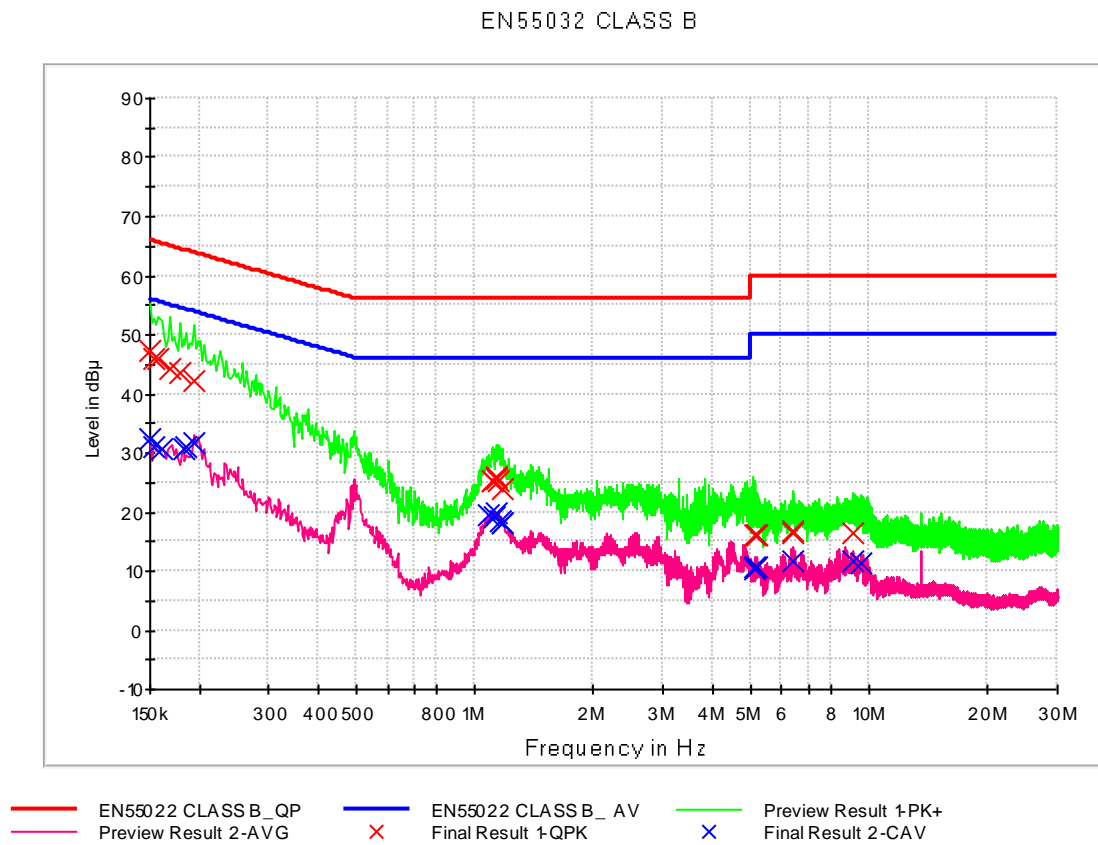
Frequency (MHz)	QuasiPeak (dBμV)	Bandwidth (kHz)	Corr. (dB)	Margin (dB)	Limit (dBμV)
0.150000	47.6	9.000	9.6	18.4	66.0
0.154000	46.1	9.000	9.6	19.7	65.8
0.166000	44.6	9.000	9.6	20.6	65.2
0.180000	43.1	9.000	9.6	21.4	64.5
0.186000	43.3	9.000	9.6	21.0	64.2
0.200000	42.4	9.000	9.6	21.2	63.6
1.092000	26.0	9.000	9.7	30.0	56.0
1.100000	25.5	9.000	9.7	30.5	56.0
1.122000	25.5	9.000	9.7	30.5	56.0
1.134000	25.0	9.000	9.7	31.0	56.0
1.148000	25.1	9.000	9.7	30.9	56.0
1.156000	24.6	9.000	9.7	31.4	56.0
5.158000	14.1	9.000	9.9	45.9	60.0
9.918000	17.8	9.000	10.1	42.2	60.0
10.008000	17.1	9.000	10.1	42.9	60.0
10.062000	17.3	9.000	10.1	42.7	60.0
10.104000	17.4	9.000	10.1	42.6	60.0
10.158000	17.9	9.000	10.1	42.1	60.0

CAverage Final Result, Line (L1)

Frequency (MHz)	CAverage (dBμV)	Bandwidth (kHz)	Corr. (dB)	Margin (dB)	Limit (dBμV)
0.150000	32.1	9.000	9.6	23.9	56.0
0.156000	31.1	9.000	9.6	24.6	55.7
0.172000	30.2	9.000	9.6	24.7	54.9
0.186000	30.9	9.000	9.6	23.3	54.2
0.196000	31.5	9.000	9.6	22.3	53.8
0.200000	31.1	9.000	9.6	22.5	53.6
1.078000	19.7	9.000	9.7	26.3	46.0
1.086000	19.5	9.000	9.7	26.5	46.0
1.092000	19.5	9.000	9.7	26.5	46.0
1.110000	19.6	9.000	9.7	26.4	46.0
1.122000	19.6	9.000	9.7	26.4	46.0
1.140000	20.1	9.000	9.7	25.9	46.0
5.158000	8.0	9.000	9.9	42.0	50.0
5.162000	7.8	9.000	9.9	42.2	50.0
9.918000	13.1	9.000	10.1	36.9	50.0
10.008000	12.5	9.000	10.1	37.5	50.0
10.062000	12.2	9.000	10.1	37.8	50.0
10.104000	12.4	9.000	10.1	37.6	50.0



Figure 4: Spectral Diagrams, Bluetooth LE Mode, Line (N)





QuasiPeak Final Result, Line (N)

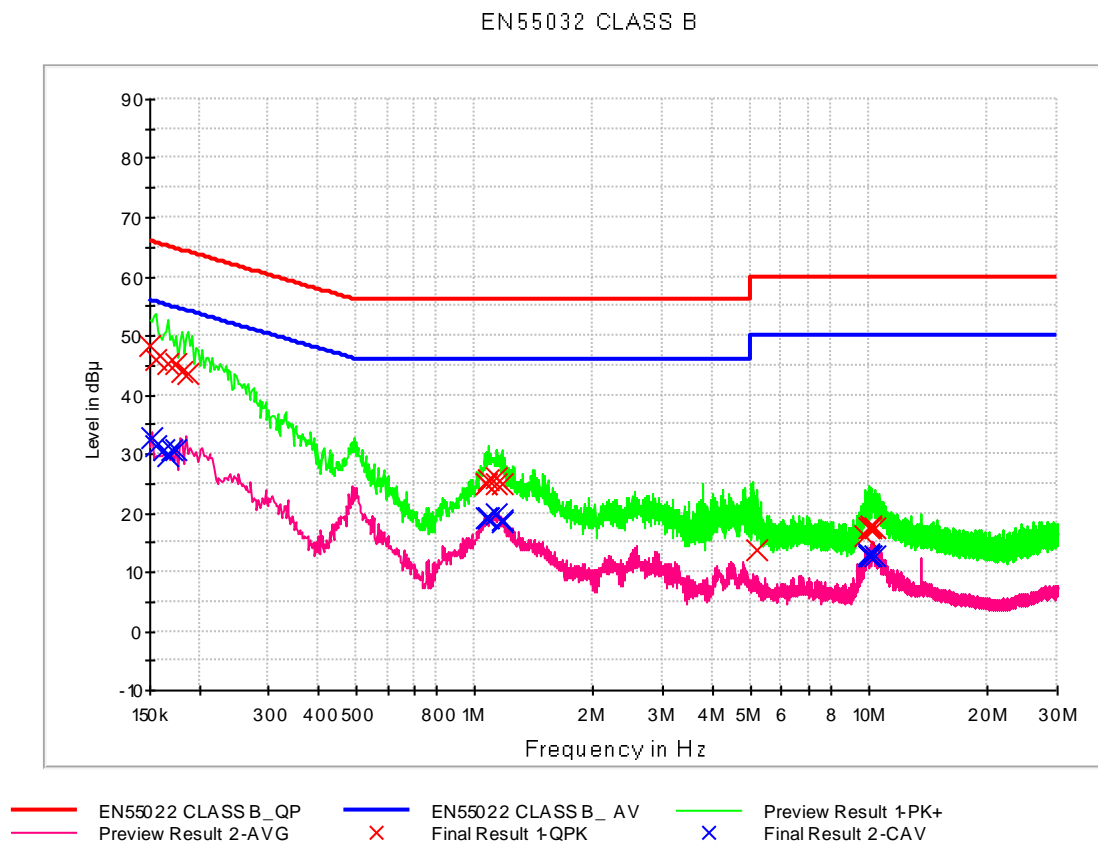
Frequency (MHz)	QuasiPeak (dBμV)	Bandwidth (kHz)	Corr. (dB)	Margin (dB)	Limit (dBμV)
0.150000	47.2	9.000	9.6	18.8	66.0
0.154000	46.1	9.000	9.6	19.7	65.8
0.158000	46.0	9.000	9.6	19.6	65.6
0.168000	44.3	9.000	9.6	20.8	65.1
0.178000	43.5	9.000	9.6	21.1	64.6
0.194000	42.4	9.000	9.6	21.5	63.9
1.102000	25.4	9.000	9.7	30.6	56.0
1.110000	25.2	9.000	9.7	30.8	56.0
1.130000	25.7	9.000	9.7	30.3	56.0
1.138000	25.8	9.000	9.7	30.2	56.0
1.154000	25.3	9.000	9.7	30.7	56.0
1.172000	23.9	9.000	9.7	32.1	56.0
5.150000	16.2	9.000	9.9	43.8	60.0
5.190000	16.2	9.000	9.9	43.8	60.0
5.198000	16.1	9.000	9.9	43.9	60.0
6.384000	16.7	9.000	10.0	43.3	60.0
6.430000	16.5	9.000	10.0	43.5	60.0
9.072000	16.5	9.000	10.1	43.5	60.0

CAverage Final Result, Line (N)

Frequency (MHz)	CAverage (dBμV)	Bandwidth (kHz)	Corr. (dB)	Margin (dB)	Limit (dBμV)
0.150000	32.5	9.000	9.6	23.5	56.0
0.154000	31.0	9.000	9.6	24.8	55.8
0.160000	30.7	9.000	9.6	24.7	55.5
0.182000	30.8	9.000	9.6	23.6	54.4
0.186000	31.1	9.000	9.6	23.1	54.2
0.194000	31.8	9.000	9.6	22.1	53.9
1.082000	19.6	9.000	9.7	26.4	46.0
1.116000	19.3	9.000	9.7	26.7	46.0
1.138000	19.8	9.000	9.7	26.2	46.0
1.158000	18.5	9.000	9.7	27.5	46.0
1.170000	18.3	9.000	9.7	27.7	46.0
1.180000	18.1	9.000	9.7	27.9	46.0
5.132000	10.6	9.000	9.9	39.4	50.0
5.150000	10.5	9.000	9.9	39.5	50.0
5.190000	10.8	9.000	9.9	39.2	50.0
6.430000	11.6	9.000	10.0	38.4	50.0
9.072000	11.7	9.000	10.1	38.3	50.0
9.506000	11.3	9.000	10.1	38.7	50.0



Figure 5: Spectral Diagrams, Sigfox Mode, Line (L1)





QuasiPeak Final Result, Line (L1)

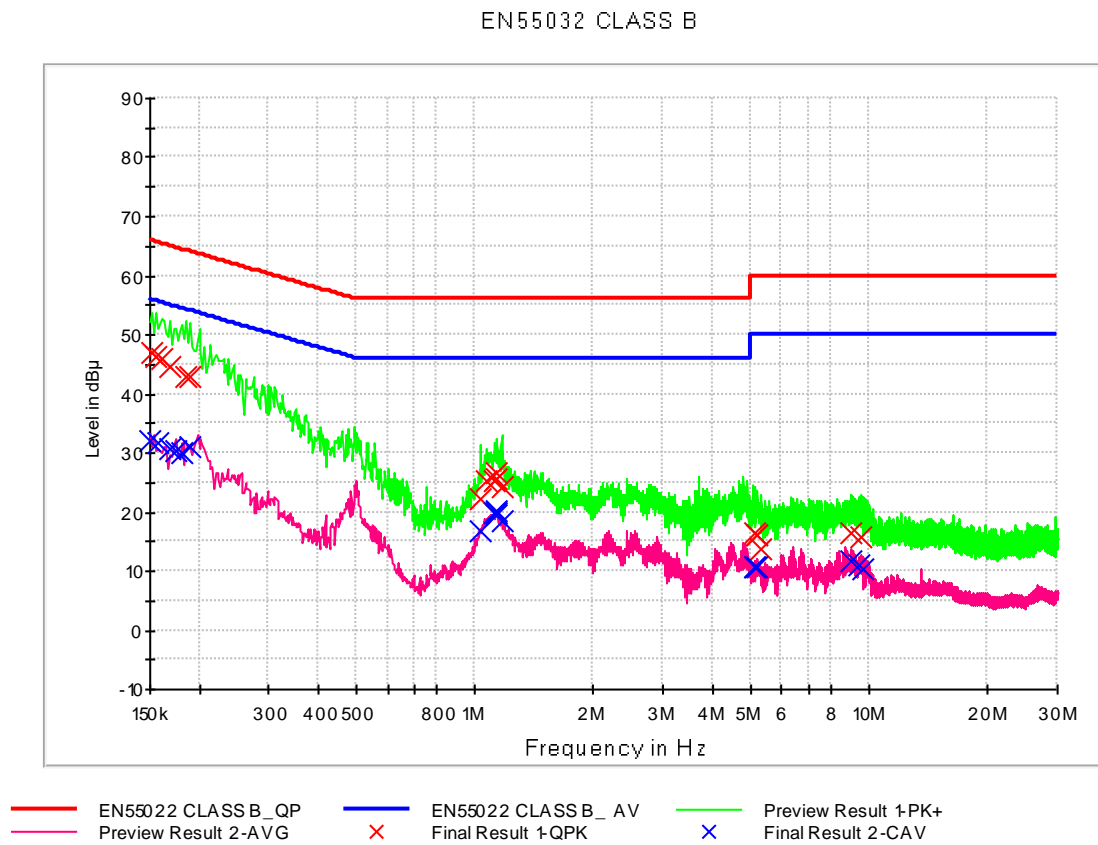
Frequency (MHz)	QuasiPeak (dBμV)	Bandwidth (kHz)	Corr. (dB)	Margin (dB)	Limit (dBμV)
0.150000	48.2	9.000	9.6	17.8	66.0
0.156000	46.1	9.000	9.6	19.6	65.7
0.166000	45.1	9.000	9.6	20.1	65.2
0.174000	45.2	9.000	9.6	19.5	64.8
0.180000	43.9	9.000	9.6	20.6	64.5
0.188000	43.7	9.000	9.6	20.5	64.1
1.064000	24.8	9.000	9.7	31.2	56.0
1.074000	24.9	9.000	9.7	31.1	56.0
1.084000	25.6	9.000	9.7	30.4	56.0
1.134000	24.9	9.000	9.7	31.1	56.0
1.140000	26.0	9.000	9.7	30.0	56.0
1.170000	24.8	9.000	9.7	31.2	56.0
5.190000	13.9	9.000	9.9	46.1	60.0
9.718000	16.0	9.000	10.1	44.0	60.0
10.042000	17.6	9.000	10.1	42.4	60.0
10.060000	17.9	9.000	10.1	42.1	60.0
10.064000	17.4	9.000	10.1	42.6	60.0
10.376000	17.3	9.000	10.1	42.7	60.0

CAverage Final Result, Line (L1)

Frequency (MHz)	CAverage (dBμV)	Bandwidth (kHz)	Corr. (dB)	Margin (dB)	Limit (dBμV)
0.152000	32.7	9.000	9.6	23.2	55.9
0.156000	31.2	9.000	9.6	24.5	55.7
0.162000	30.7	9.000	9.6	24.7	55.4
0.166000	29.6	9.000	9.6	25.5	55.2
0.170000	30.7	9.000	9.6	24.2	55.0
0.174000	30.6	9.000	9.6	24.2	54.8
1.064000	19.1	9.000	9.7	26.9	46.0
1.080000	19.3	9.000	9.7	26.7	46.0
1.084000	19.2	9.000	9.7	26.8	46.0
1.136000	19.7	9.000	9.7	26.3	46.0
1.170000	18.8	9.000	9.7	27.2	46.0
1.178000	18.5	9.000	9.7	27.5	46.0
9.936000	12.9	9.000	10.1	37.1	50.0
10.016000	12.7	9.000	10.1	37.3	50.0
10.050000	12.8	9.000	10.1	37.2	50.0
10.060000	12.7	9.000	10.1	37.3	50.0
10.064000	12.6	9.000	10.1	37.4	50.0
10.376000	12.6	9.000	10.1	37.4	50.0



Figure 6: Spectral Diagrams, Sigfox Mode, Line (N)





QuasiPeak Final Result, Line (N)

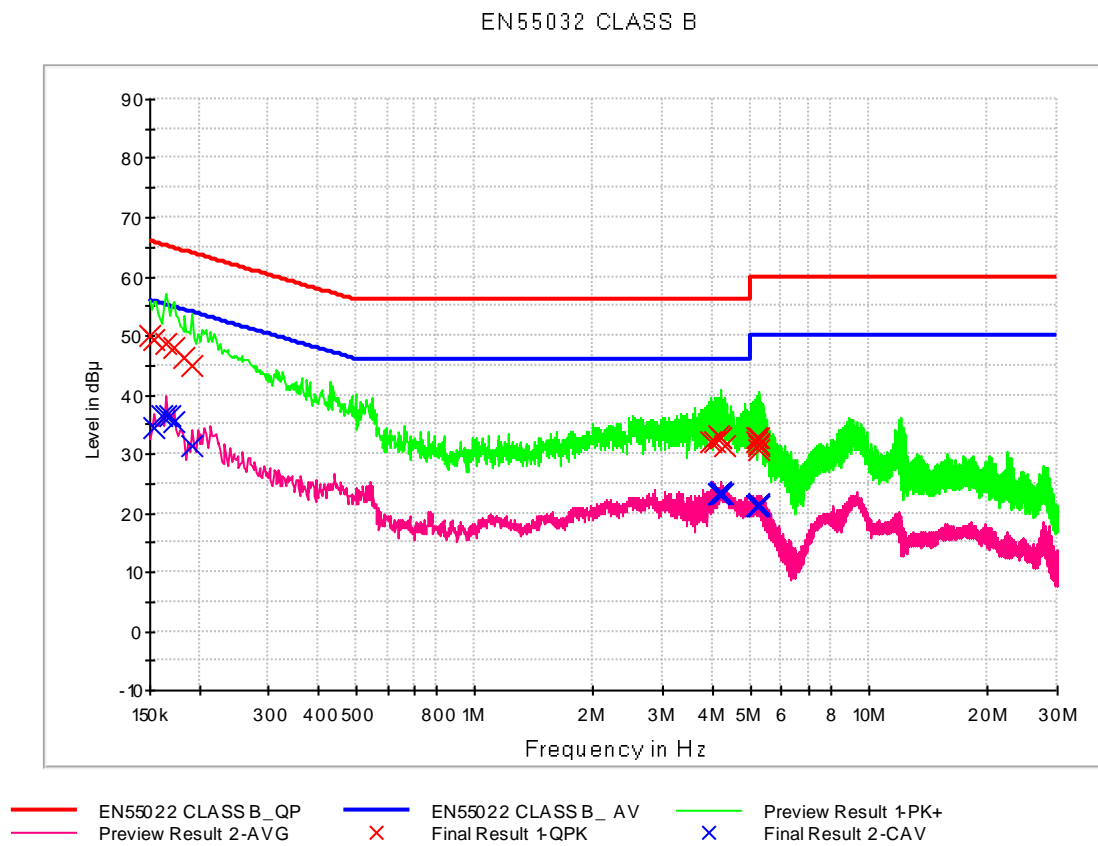
Frequency (MHz)	QuasiPeak (dBμV)	Bandwidth (kHz)	Corr. (dB)	Margin (dB)	Limit (dBμV)
0.152000	47.1	9.000	9.6	18.8	65.9
0.156000	46.3	9.000	9.6	19.4	65.7
0.160000	45.9	9.000	9.6	19.6	65.5
0.168000	44.7	9.000	9.6	20.4	65.1
0.186000	42.9	9.000	9.6	21.3	64.2
0.190000	42.8	9.000	9.6	21.2	64.0
1.030000	22.3	9.000	9.7	33.7	56.0
1.074000	25.1	9.000	9.7	30.9	56.0
1.118000	25.1	9.000	9.7	30.9	56.0
1.136000	25.6	9.000	9.7	30.4	56.0
1.140000	26.6	9.000	9.7	29.4	56.0
1.170000	24.2	9.000	9.7	31.8	56.0
5.154000	16.4	9.000	9.9	43.6	60.0
5.178000	16.2	9.000	9.9	43.8	60.0
5.188000	16.1	9.000	9.9	43.9	60.0
5.340000	13.9	9.000	9.9	46.1	60.0
9.016000	16.6	9.000	10.1	43.4	60.0
9.488000	15.9	9.000	10.1	44.1	60.0

CAverage Final Result, Line (N)

Frequency (MHz)	CAverage (dBμV)	Bandwidth (kHz)	Corr. (dB)	Margin (dB)	Limit (dBμV)
0.150000	32.1	9.000	9.6	23.9	56.0
0.158000	31.7	9.000	9.6	23.9	55.6
0.168000	30.8	9.000	9.6	24.3	55.1
0.174000	30.2	9.000	9.6	24.5	54.8
0.180000	30.1	9.000	9.6	24.4	54.5
0.190000	31.0	9.000	9.6	23.1	54.0
1.030000	16.8	9.000	9.7	29.2	46.0
1.118000	19.8	9.000	9.7	26.2	46.0
1.132000	19.8	9.000	9.7	26.2	46.0
1.136000	19.6	9.000	9.7	26.4	46.0
1.140000	20.2	9.000	9.7	25.8	46.0
1.170000	18.4	9.000	9.7	27.6	46.0
5.132000	10.6	9.000	9.9	39.4	50.0
5.148000	10.5	9.000	9.9	39.5	50.0
5.188000	10.8	9.000	9.9	39.2	50.0
9.016000	11.5	9.000	10.1	38.5	50.0
9.468000	11.1	9.000	10.1	38.9	50.0
9.632000	10.4	9.000	10.1	39.6	50.0



Figure 7: Spectral Diagrams, GNSS (GPS, GLONASS) Mode, Line (L1)





QuasiPeak Final Result, Line (L1)

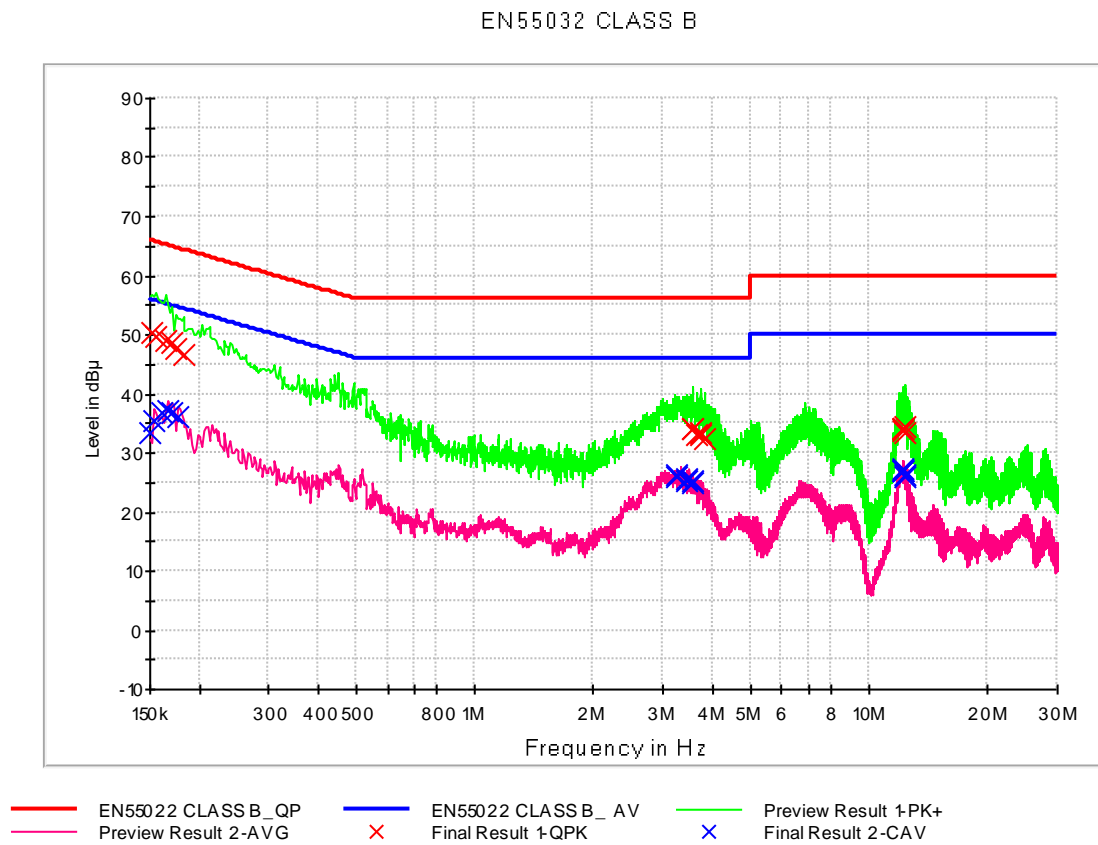
Frequency (MHz)	QuasiPeak (dBμV)	Bandwidth (kHz)	Corr. (dB)	Margin (dB)	Limit (dBμV)
0.150000	50.0	9.000	9.6	16.0	66.0
0.154000	49.3	9.000	9.6	16.4	65.8
0.164000	48.7	9.000	9.6	16.6	65.3
0.172000	48.0	9.000	9.6	16.8	64.9
0.184000	46.4	9.000	9.6	17.9	64.3
0.192000	45.0	9.000	9.6	19.0	63.9
3.956000	32.2	9.000	9.9	23.8	56.0
4.050000	32.0	9.000	9.9	24.0	56.0
4.140000	32.9	9.000	9.9	23.1	56.0
4.200000	32.9	9.000	9.9	23.1	56.0
4.216000	32.7	9.000	9.9	23.3	56.0
4.306000	31.5	9.000	9.9	24.5	56.0
5.190000	32.2	9.000	9.9	27.8	60.0
5.218000	32.7	9.000	9.9	27.3	60.0
5.228000	31.6	9.000	9.9	28.4	60.0
5.242000	30.7	9.000	9.9	29.3	60.0
5.252000	31.3	9.000	9.9	28.7	60.0
5.266000	32.8	9.000	9.9	27.2	60.0

CAverage Final Result, Line (L1)

Frequency (MHz)	CAverage (dBμV)	Bandwidth (kHz)	Corr. (dB)	Margin (dB)	Limit (dBμV)
0.154000	34.4	9.000	9.6	21.4	55.8
0.160000	36.3	9.000	9.6	19.1	55.5
0.164000	36.5	9.000	9.6	18.8	55.3
0.168000	36.4	9.000	9.6	18.7	55.1
0.172000	35.4	9.000	9.6	19.5	54.9
0.192000	31.5	9.000	9.6	22.5	53.9
4.140000	23.4	9.000	9.9	22.6	46.0
4.150000	23.3	9.000	9.9	22.7	46.0
4.176000	23.1	9.000	9.9	22.9	46.0
4.200000	23.4	9.000	9.9	22.6	46.0
4.216000	23.2	9.000	9.9	22.8	46.0
4.276000	23.2	9.000	9.9	22.8	46.0
5.190000	21.3	9.000	9.9	28.7	50.0
5.218000	21.2	9.000	9.9	28.8	50.0
5.228000	21.3	9.000	9.9	28.7	50.0
5.242000	21.4	9.000	9.9	28.6	50.0
5.252000	21.6	9.000	9.9	28.4	50.0
5.266000	21.1	9.000	9.9	28.9	50.0



Figure 8: Spectral Diagrams, GNSS (GPS, GLONASS) Mode, Line (N)





QuasiPeak Final Result, Line (N)

Frequency (MHz)	QuasiPeak (dBμV)	Bandwidth (kHz)	Corr. (dB)	Margin (dB)	Limit (dBμV)
0.152000	50.2	9.000	9.6	15.7	65.9
0.156000	49.8	9.000	9.6	15.9	65.7
0.164000	48.8	9.000	9.6	16.4	65.3
0.170000	48.6	9.000	9.6	16.4	65.0
0.174000	47.7	9.000	9.6	17.1	64.8
0.182000	46.7	9.000	9.6	17.7	64.4
3.562000	34.2	9.000	9.8	21.8	56.0
3.568000	34.2	9.000	9.8	21.8	56.0
3.648000	33.0	9.000	9.8	23.0	56.0
3.720000	33.1	9.000	9.8	22.9	56.0
3.760000	33.5	9.000	9.8	22.5	56.0
3.812000	32.5	9.000	9.8	23.5	56.0
12.146000	34.2	9.000	10.2	25.8	60.0
12.164000	33.7	9.000	10.2	26.3	60.0
12.180000	34.2	9.000	10.2	25.8	60.0
12.192000	34.1	9.000	10.2	25.9	60.0
12.284000	34.4	9.000	10.2	25.6	60.0
12.334000	33.4	9.000	10.2	26.6	60.0

CAverage Final Result, Line (N)

Frequency (MHz)	CAverage (dBμV)	Bandwidth (kHz)	Corr. (dB)	Margin (dB)	Limit (dBμV)
0.150000	33.5	9.000	9.6	22.5	56.0
0.154000	35.3	9.000	9.6	20.5	55.8
0.160000	36.9	9.000	9.6	18.5	55.5
0.166000	37.1	9.000	9.6	18.1	55.2
0.170000	36.9	9.000	9.6	18.0	55.0
0.176000	36.1	9.000	9.6	18.6	54.7
3.244000	26.1	9.000	9.8	19.9	46.0
3.270000	26.2	9.000	9.8	19.8	46.0
3.460000	25.5	9.000	9.8	20.5	46.0
3.466000	25.4	9.000	9.8	20.6	46.0
3.562000	25.1	9.000	9.8	20.9	46.0
3.568000	25.2	9.000	9.8	20.8	46.0
12.146000	27.2	9.000	10.2	22.8	50.0
12.164000	27.1	9.000	10.2	22.9	50.0
12.180000	27.0	9.000	10.2	23.0	50.0
12.192000	26.9	9.000	10.2	23.1	50.0
12.306000	26.3	9.000	10.2	23.7	50.0
12.334000	26.1	9.000	10.2	23.9	50.0



8.2 Electro-Static Discharge

8.2.1 Operating Environment

Temperature	23.4 °C	Relative Humidity	38.2 %	Atmospheric Pressure	100.1 kPa
	23.6 °C		48.8 %		100.0 kPa
	23.5 °C		50.2 %		100.0 kPa

8.2.2 Test Methods and Levels

The test method shall be in accordance with CENELEC EN 61000-4-2.

8.2.3 Test Condition

a. The Operating Mode

WiFi / Bluetooth LE Mode

Sigfox Mode

GNSS (GPS, GLONASS) Mode

b. Testing

The following requirements and evaluation of test results shall apply.

Power supply	230 VAC, 50 Hz
Output voltage	Contact Discharge: ± 2 kV, ± 4 kV
Discharge impedance of ESD generator	330 Ω / 150 pF
Polarity of output voltage	Positive and Negative
Discharge mode of operation	Single discharges
Time interval of discharge	1 s
Number of Test Points	Contact Discharge: 25 at each test point

c. Test Point

This equipment is a module, thus indirect discharge was conducted.

d. Test Site

The test can be performed in normal laboratory environment:

Immunity testing was performed in RF shielded room.



8.2.4 Test Setup

WiFi / Bluetooth LE Mode

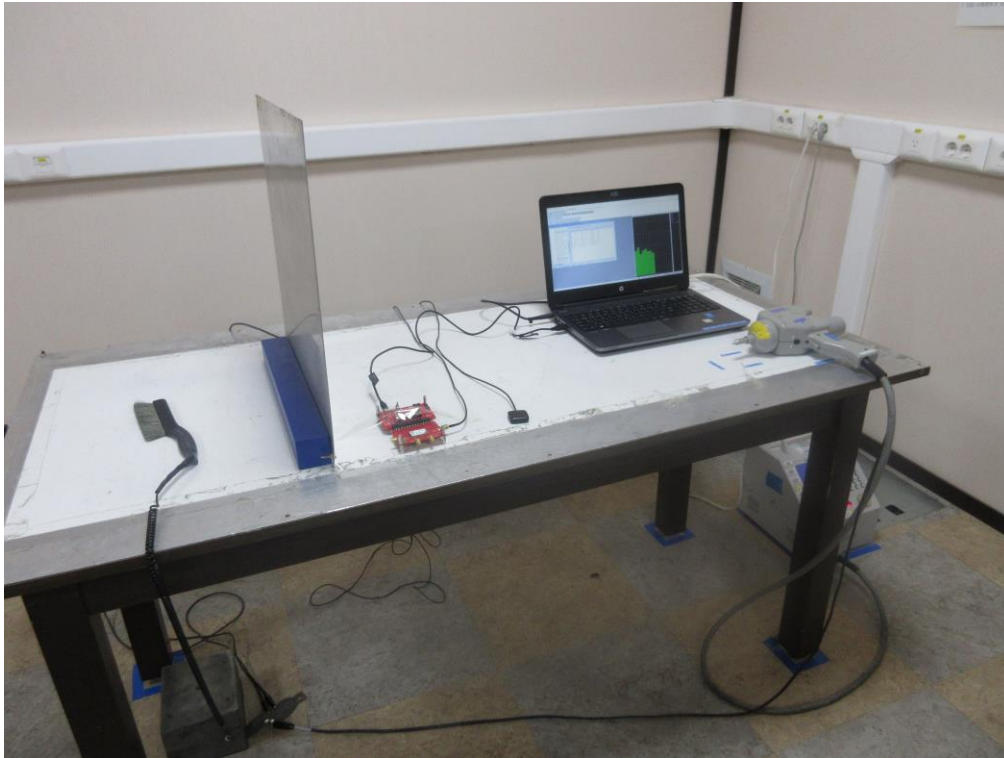


Sigfox Mode





GNSS (GPS, GLONASS) Mode



8.2.5 Test Results

Discharge Points	Type of Discharge	Performance Criterion	Test Result	
			±2 kV	±4 kV
HCP	Contact	Transient (B)	A	A
VCP	Contact	Transient (B)	A	A

NOTE “HCP” means Horizontal Coupling Plane / “VCP” means Vertical Coupling Plane



8.3 RF Electromagnetic Field

8.3.1 Operating Environment

RS-01	Temperature	22.8 / 23.3 / 23.7 °C	Relative Humidity	38.6 / 39.0 / 40.0 %
RS-02	Temperature	24.1 / 23.6 °C	Relative Humidity	60.2 / 60.9 %

8.3.2 Test Methods and Levels

The test method shall be in accordance with CENELEC EN 61000-4-3.

8.3.3 Test Condition

a. The Operating Mode

WiFi / Bluetooth LE Mode

Sigfox / GNSS (GPS, GLONASS) Mode

b. Testing

The following requirements and evaluation of test results shall apply.

Power supply	230 VAC, 50 Hz
Frequency range	80 MHz to 6 000 MHz
RF field strength	3 V/m
Modulation	AM, Depth of 80 % (1 kHz)
Modulation of test signal	1 kHz Audio sine wave
Frequency step	1 %
Dwell time	3 s
Sweep rate	$\leq 1.5 \times 10^{-3}$ decade /s
Polarization of antenna	Horizontal, Vertical
Field strength method	Substitution method

c. Test Site

Radiated Immunity testing was performed in Fully Anechoic Chamber Room (FACR).



8.3.4 Test Setup

WiFi / Bluetooth LE Mode



Sigfox Mode





GNSS (GPS, GLONASS) Mode



8.3.5 Test Results

Antenna Position	Performance Criterion	Test Result	
		Horizontal	Vertical
Front Side	Continuous (A)	A	A
Rear Side	Continuous (A)	A	A
Right Side	Continuous (A)	A	A
Left Side	Continuous (A)	A	A



9. PHOTOGRAPHS OF EUT

Front Side View



Rear Side View

