

ELECTROMAGNETIC COMPATIBILITY TEST REPORT

Test Report No. : OT-206-RED-036

AGR No. : A204A-242

Applicant : SEONG JI INDUSTRIAL CO., LTD

Address : 54-33, Dongtanhana 1-gil, Gyeonggi-do, Hwaseong-si, South Korea

Manufacturer : SEONG JI INDUSTRIAL CO., LTD

Address : 54-33, Dongtanhana 1-gil, Gyeonggi-do, Hwaseong-si, South Korea

Type of Equipment : Asset Tracker

Model Name : IET10MO

Multiple Model Name : N/A

Serial number : N/A

Total page of Report : 33 pages (including this page)

Date of Incoming : May 13, 2020

Date of Issuing : June 03, 2020

SUMMARY


The equipment complies with the standard;

EN 301 489-1 V2.1.1, EN 301 489-3 V2.1.1, EN 301 489-17 V3.1.1, EN 301 489-19 V2.1.1

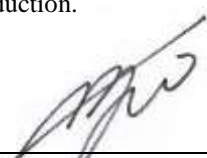
This test report contains only the results of a single test of the sample supplied for the examination.

It is not a general valid assessment of the features of the respective products of the mass-production.

Reviewed by:


Jae-Beom, Cho / General Manager
ONETECH Corp.

Approved by:


Eung-Chan, Kim / General Manager
ONETECH Corp.

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Revision History

Rev. No.	Issued Report No.	Issued Date	Revisions	Section Effected
0	OT-206-RED-036	June 03, 2020	Initial Issue	All

1. APPLICANT AND MANUFACTURER INFORMATION

-. Applicant : SEONG JI INDUSTRIAL CO., LTD
 -. Address : 54-33, Dongtanhana 1-gil, Gyeonggi-do, Hwaseong-si, South Korea
 -. Manufacturer : SEONG JI INDUSTRIAL CO., LTD
 -. Address : 54-33, Dongtanhana 1-gil, Gyeonggi-do, Hwaseong-si, South Korea

2. TEST SUMMARY

2.1 Test standards and results

Emission		RESULTS
EN 301 489-1 V2.1.1	Conducted Emission on AC mains Input/Output Port	N/A (See Note 1)
EN 301 489-3 V2.1.1	Conducted Emission on Telecommunication Port	N/A (See Note 2)
EN 301 489-17 V3.1.1 EN 301 489-19 V2.1.1	Radiated Emission	Met / PASS
EN 61000-3-2: 2014	Harmonic Current Emission on AC Mains Input Port	N/A (See Note 1)
EN 61000-3-3: 2013	Voltage Fluctuations and Flicker on AC Mains Input Port	N/A (See Note 1)
Immunity		RESULTS
EN 301 489-1 V2.1.1 EN 301 489-3 V2.1.1 EN 301 489-17 V3.1.1 EN 301 489-19 V2.1.1	Electrostatic Discharge Immunity	Met Criterion A / PASS
	RF Electromagnetic Field Immunity	Met Criterion A / PASS
	Electrical Fast Transient/Burst Immunity	N/A (See Note 1)
	Surge Immunity	N/A (See Note 1)
	Conducted Disturbance induced by RF fields Immunity	N/A (See Note 1)
	Power Frequency Magnetic Field Immunity	N/A (See Note 3)
	Voltage Dips, Short Interruptions and Voltage Variations	N/A (See Note 1)

Note 1: The test is not applicable because the EUT is portable product.

Note 2: The test is not applicable because the EUT is not have a telecommunication port.

Note 3: The equipment under test does not contain devices susceptible to magnetic fields, so the test was not performed.

2.2 Additions, deviations, exclusions from standards

No additions, deviations or exclusions have been made from standard.

2.3 Purpose of the test

To determine whether the equipment under test fulfills the EMC requirements of the standards stated in section 2.1.

2.4 Test Facility

The Onetech Corp. has been designated to perform equipment testing in compliance with ISO/IEC 17025.

The Electromagnetic compatibility measurement facilities are located at:

- 1) 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea
- 2) 12-5, Jinsaegol-gil 75 beon-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea

-. Site Filing:

VCCI (Voluntary Control Council for Interference) – Registration No. R-4112/ C-14617/ G-10666/ T-11842

ISED (Innovation, Science and Economic Development Canada) – Registration No. Site# 3736A-3

-. Site Accreditation:

KOLAS (Korea Laboratory Accreditation Scheme) - Accreditation NO. KT085

FCC (Federal Communications Commission) - Accreditation No. KR0013

RRA (Radio Research Agency) – Designation No. KR0013

3. EUT (Equipment Under Test)

3.1 Identification of EUT

-. Equipment	: Asset Tracker
-. Model Name	: IET10MO
-. Brand Name	: -
-. Serial number	: N/A
-. Manufacturer	: SEONG JI INDUSTRIAL CO., LTD

3.2 Additional information about the EUT

The SEONG JI INDUSTRIAL CO., LTD, Model IET10MO (referred to as the EUT in this report) is a Asset Tracker.

Product specification information described herein was obtained from product data sheet or user's manual.

CHASSIS TYPE	Plastic & Metal	
LIST OF EACH OSC. Or CRY. FREQ.(FREQ. >= 1 MHz)	50 MHz, 32 MHz, 26 MHz, 32.768 kHz	
RF Spec.	Sig Fox	868.034 MHz ~ 868.226 MHz (Tx) 869.429 MHz ~ 869.621 MHz (Rx)
	GPS	1 559 MHz ~ 1 610 MHz
	Bluetooth LE	2 402 MHz ~ 2 480 MHz
	WLAN 2.4 GHz	2 412 MHz ~ 2 472 MHz (802.11b/g/n(HT20))
P. C. BOARD NAME	IET10MO	
NUMBER OF LAYERS	2 Layers	
ELECTRICAL RATING	DC 3.6 V, 50 mA/5400 mAh	
EXTERNAL CONNECTOR	-	

3.3 Peripheral equipment

Defined as equipment needed for correct operation of the EUT, but not considered as tested:

Model	Manufacturer	Description	Connected to
IET10MO	SEONG JI INDUSTRIAL CO., LTD	Asset Tracker (EUT)	-
Ideapad 350	LENOVO	Notebook PC	BT JIG
N/A	N/A	BT JIG	Notebook PC
00001A1F	SIG FOX-	SDR Dongle	-
GSS7000	Spirent Communications Plc	Signal Generator	-
A604M	iptime	Router	-

3.4 Cable Description

Cable	Shielded	Ferrite Bead	Metal Shell	Length (m)	Connected to
-	-	-	-	-	-

3.5 Mode of operation during the test

The test conditions of the noted test mode(s) in this test report are;

- 1) Sig Fox & Bluetooth Mode: Checked the communication status with a notebook pc through Bluetooth.
 - 2) Wi-Fi 2.4 GHz & Bluetooth Mode: Checked the communication status with a notebook pc through Bluetooth.
 - 3) GPS & Bluetooth Mode: Checked the communication status with a notebook pc through Bluetooth.
- . Input power conditions during the measurements was DC 3.6 V Lithium Battery
- . Test Mode(s)

Operating Mode 1	Sig Fox
Operating Mode 2	Wi-Fi 2.4 GHz
Operating Mode 3	GPS

- . For emission test compliance, If the measurement result is below the limit by a margin less than the measurement uncertainty, it is not possible to define compliance at a level of confidence of 95 %. However, the measurement result indicates a higher probability that the product complies.

3.6 Criterion description

3.6.1 EN 301 489-1/17

Criteria	During test	After test
A	<p>Shall operate as intended. (see note 1).</p> <p>Shall be no loss of function.</p> <p>Shall be no unintentional transmissions.</p>	<p>Shall operate as intended.</p> <p>Shall be no degradation of performance (see note 3).</p> <p>Shall be no loss of function.</p> <p>Shall be no loss of stored data or user programmable functions.</p>
B	<p>May show loss of function (one or more).</p> <p>May show degradation of performance (see note 2).</p> <p>No unintentional transmissions.</p>	<p>Functions shall be self-recoverable.</p> <p>Shall operate as intended after recovering.</p> <p>Shall be no degradation of performance (see note 3).</p> <p>Shall be no loss of stored data or user programmable functions.</p>
C	<p>May be loss of function (one or more).</p>	<p>Functions shall be recoverable by the operator.</p> <p>Shall operate as intended after recovering.</p> <p>Shall be no degradation of performance (see note 3).</p>
<p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p> <p>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.</p>		

3.6.1.1 Performance criteria for Continuous phenomena applied to Transmitters (CT)

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.

3.6.1.2 Performance criteria for Transient phenomena applied to Transmitters (TT)

The performance criteria B shall apply, except for voltage dips of 100 ms and voltage interruptions of 5 000 ms duration, for which performance criteria C 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.

3.6.1.3 Performance criteria for Continuous phenomena applied to Receivers (CR)

The performance criteria A shall apply.

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.

3.6.1.4 Performance criteria for Transient phenomena applied to Receivers (TR)

The performance criteria B shall apply, except for voltage dips of 100 ms and voltage interruptions of 5 000 ms duration for which performance criteria C shall apply.

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.

3.6.2 EN 301 489-3

Performance Requirements		
Criteria	During test	After test
A	Operate as intended No loss of function No unintentional responses	Operate as intended No loss of function No degradation of performance No loss of stored data or user programmable functions
B	May show loss of function No unintentional responses	Operate as intended Lost function(s) shall be self-recoverable No degradation of performance No loss of stored data or user programmable functions

3.6.3 EN 301 489-19

3.6.3.1 General performance criteria

If the EUT is of a non specialized nature or the EUT is combined with an ancillary equipment, the test modulation, test arrangements, etc. as required in clause 4 shall apply.

The EUT, for all immunity tests according to the present document, except the spot frequency test of the immunity test with radiated RF electromagnetic fields (see ETSI EN 301 489-1 [1], clause 9.2), shall be assessed for:

- the storage of messages in the memory of the EUT at the start of the test;
- unintentional responses of the EUT during the test;
- the maintenance of the EUT memory assessed at the conclusion of the test;
- the ability to receive and store messages at the conclusion of the test.

For the spot frequency test of the immunity test with radiated RF electromagnetic fields (see ETSI EN 301 489-1 [1], clause 9.2) the EUT shall be assessed by monitoring the accuracy of the call received alert signal.

3.6.3.2 Performance criteria for Continuous phenomena applied to ROMES and ROGNSS receivers (CR)

For the EUT, excluding spot frequency tests as part of the immunity test with radiated RF electromagnetic fields (see ETSI EN 301 489-1 [1], clause 9.2):

- the general performance criteria set out in clause 6.1;
- during the test no false calls shall occur;
- at the conclusion of the test comprising the series of individual exposures the EUT shall operate as intended with no loss of functions or stored data (messages), as declared by the manufacturer.

For the spot frequency test as part of the immunity test with radiated RF electromagnetic fields (see ETSI EN 301 489-1 [1], clause 9.2) the EUT shall be assessed by monitoring the accuracy of the call received alert signal.

3.6.3.3 Performance criteria for Transient phenomena applied to ROMES and ROGNSS receivers (TR)

For the EUT:

- the general performance criteria set out in clause 6.1;
- during the test no false calls shall occur;
- at the conclusion of the test comprising the series of individual exposures, the EUT shall operate as intended with no loss of function and/or stored data (messages), as declared by the manufacturer.

3.6.3.4 Performance criteria for equipment which does not provide a continuous communication link

The provision of ETSI EN 301 489-1 [1], clause 6.3 shall apply with the following modifications.

For EUTs of a specialized nature and/or ancillary equipment tested on a stand alone basis the manufacturer shall define the method of test to determine the acceptable level of performance or degradation of performance during and/or after the test. Under these circumstances the manufacturer will also provide the following information:

- the primary functions of the equipment to be tested during and after EMC stress;
- the intended functions of the EUT which shall be in accordance with the documentation accompanying the equipment;
- the pass/failure criteria for the equipment;
- the method of observing a degradation of performance of the equipment.

The assessment of the performance or the degradation of performance which shall be carried out during and/or at the conclusion of the tests, shall be simple, but at the same time give adequate proof that the primary functions of the equipment are operational.

3.7 Alternative type(s)/model(s); also covered by this test report

-. None

4. EUT MODIFICATIONS

-. None

5. EMISSION TESTS

5.1 RADIATED EMISSION

5.1.1 Operating environment

Temperature : (23.3 ~ 24.8) °C
Relative humidity : (49.3 ~ 51.2) % R.H.

5.1.2 Test set-up

The radiated emissions measurements were on the 10 m, semi anechoic chamber. The EUT and all local support equipment were placed on a non-conductive turntable approximately 0.8 m above the ground plane.

The frequency spectrum from 30 MHz to 6 000 MHz was scanned and maximum emission levels maximized at each frequency recorded. The system was rotated 360°, and the antenna was varied in the height between 1.0 m and 4.0 m (below 1 000 MHz) in order to determine the maximum emission levels. This procedure was performed for both horizontal and vertical polarization of the receiving antenna.

Reading value was measured on manual as changing at the height of antenna and the angle of table.

The test set-up photos are included in appendix I.

5.1.3 Measurement uncertainty

Radiated emission electric field intensity, 30 MHz ~ 1 000 MHz : ± 4.4 dB

Radiated emission electric field intensity, 1 GHz ~ 6 GHz : ± 5.3 dB

Measurement uncertainty is calculated in accordance with CISPR 16-4-2. The measurement uncertainty is given with a confidence of 95 % with the coverage factor, $k = 2$.

5.1.4 Test equipment used

	Model Number	Manufacturer	Description	Serial Number	Last Cal. (Interval)
■ -	ESR	Rohde & Schwarz	Test Receiver	101470	Oct. 22, 2019 (1Y)
■ -	VULB9163	Schwarzbeck	Trilog Broadband Antenna	9163-419	Mar. 20, 2020 (2Y)
■ -	BBHA9120D	Schwarzbeck	Horn Antenna	2895	Jan. 28, 2020 (2Y)
■ -	310N	Sonoma Instrument	Amplifier	312544	Mar. 16, 2020 (1Y)
■ -	BBV9718B	Schwarzbeck	Amplifier	009	Mar. 16, 2020 (1Y)
■ -	CO3000	Innco Systems GmbH	Controller	N/A	N/A
■ -	DT3000	Innco Systems GmbH	Turn Table	N/A	N/A

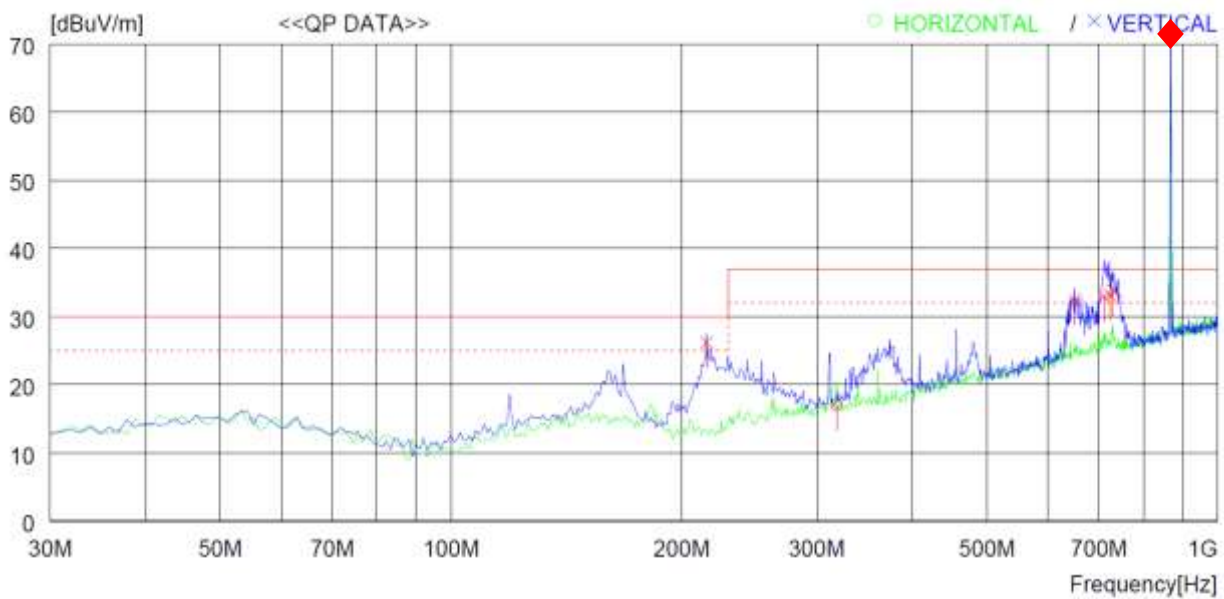
All test equipment used is calibrated on a regular basis.

5.1.5 Test data

-. Test Result : Pass

Tested by: Sang-Hyun, Jeong / Manager

Operating Mode 1 (Sig Fox & Bluetooth)			
Frequency range	: 30 MHz ~ 1 000 MHz	Test Date	: May 14, 2020
Resolution bandwidth	: 120 kHz	Measurement distance	: 10 m
Detector Mode	: Quasi-Peak		



No.	FREQ	READING	ANT	LOSS	GAIN	RESULT	LIMIT	MARGIN	ANTENNA	TABLE
	[MHz]	[dBuV]	FACTOR	[dB]	[dB]	[dBuV/m]	[dBuV/m]	[dB]	[cm]	[DEG]
----- Horizontal -----										
1	318.090	26.3	19.8	3.9	33.0	17.0	37.0	20.0	400	48
----- Vertical -----										
2	215.270	40.2	15.7	3.2	32.9	26.2	30.0	3.8	100	0
3	650.796	33.9	26.2	5.7	33.3	32.5	37.0	4.5	400	346
4	709.965	33.5	26.9	5.9	33.3	33.0	37.0	4.0	100	188
5	722.574	33.4	27.1	6.0	33.3	33.2	37.0	3.8	100	188
6	731.304	33.9	27.2	6.0	33.3	33.8	37.0	3.2	300	0

Remark: Margin (dB) = Limit – Result and Result = Reading Quasi-Peak + Antenna Factor + Loss – Gain

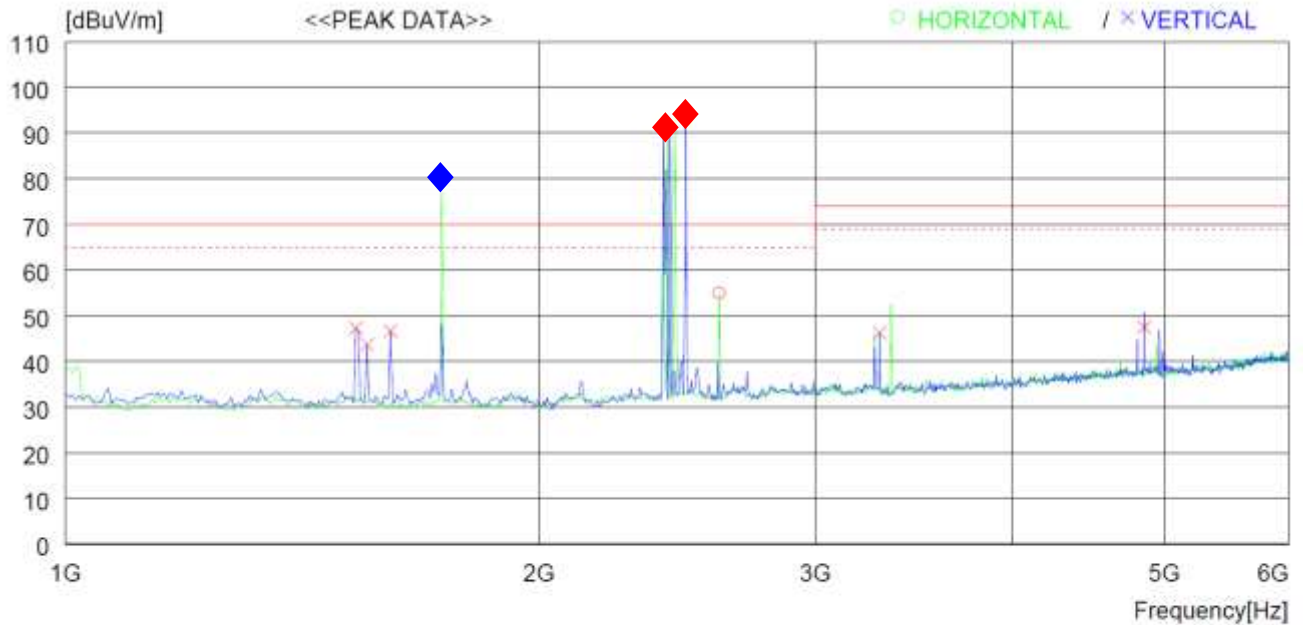
Loss and Gain in above table means Cable Loss and Pre-amplifier gain.

Remark 2: Radiated emissions (Tx/Rx frequencies) from the transceiver shall be ignored.

Sig Fox – (867.746 ~ 869.909) MHz

Remark 3: ◆ - Exclusion band Carrier Frequency, ◆ - Exclusion band Harmonic Frequency

Operating Mode 1 (Sig Fox & Bluetooth)			
Frequency range	: 1 000 MHz ~ 6 000 MHz	Test Date	: May 29, 2020
Resolution bandwidth	: 1 MHz	Measurement distance	: 3 m
Detector Mode	: Peak		



No.	FREQ	READING	ANT	LOSS	GAIN	RESULT	LIMIT	MARGIN	ANTENNA	TABLE
	[MHz]	PEAK	FACTOR							
		[dBuV]	[dB]	[dB]	[dB]	[dBuV/m]	[dBuV/m]	[dB]	[cm]	[DEG]
----- Horizontal -----										
1	2605.000	51.8	27.7	8.8	33.4	54.9	70.0	15.1	100	0
----- Vertical -----										
2	1530.000	48.1	25.2	6.9	32.9	47.3	70.0	22.7	100	359
3	1555.000	44.4	25.3	6.9	32.9	43.7	70.0	26.3	100	288
4	1610.000	47.2	25.3	7.0	32.9	46.6	70.0	23.4	100	125
5	3295.000	41.5	28.7	10.5	34.5	46.2	74.0	27.8	100	82
6	4855.000	40.4	31.1	10.6	34.6	47.5	74.0	26.5	100	359

Remark 1: Margin (dB) = Limit – Result and Result = Reading Peak + Antenna Factor + Loss – Gain

Loss and Gain in above table means Cable Loss and Pre-amplifier gain.

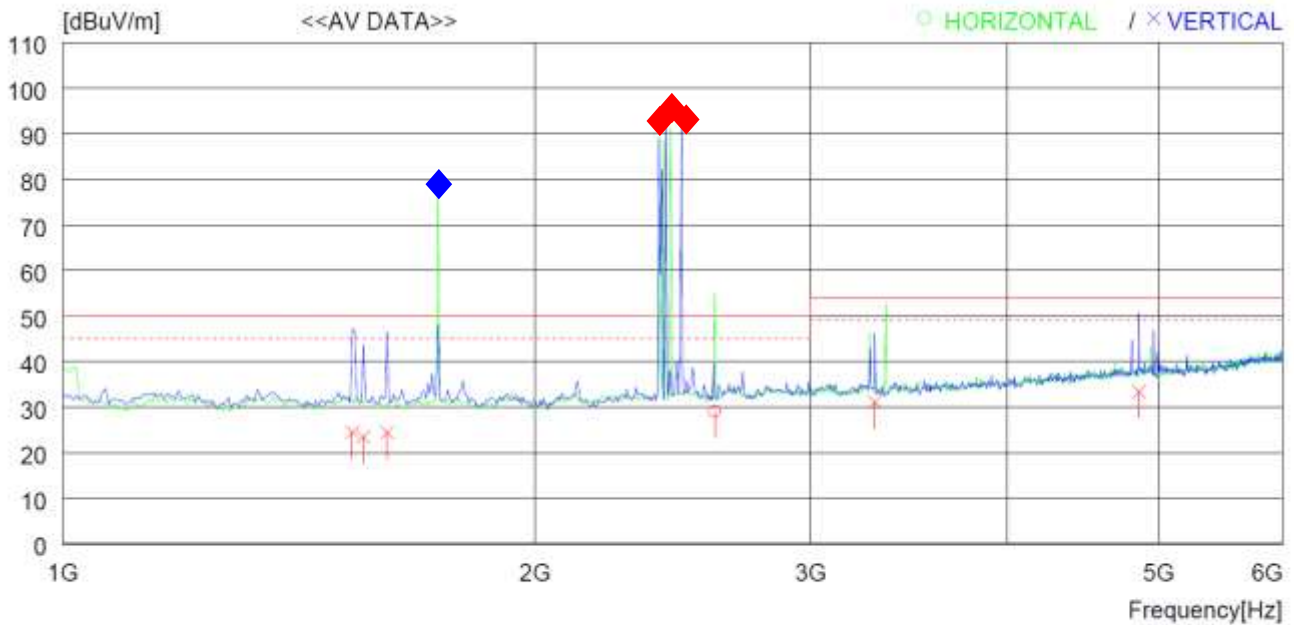
Remark 2: Radiated emissions (Tx/Rx frequencies) from the transceiver shall be ignored.

Sig Fox – (867.746 ~ 869.909) MHz

Bluetooth – (2 402 ~ 2 480) MHz

Remark 3: ◆ - Exclusion band Carrier Frequency, ◆ - Exclusion band Harmonic Frequency

Operating Mode 1 (Sig Fox & Bluetooth)			
Frequency range	: 1 000 MHz ~ 6 000 MHz	Test Date	: May 29, 2020
Resolution bandwidth	: 1 MHz	Measurement distance	: 3 m
Detector Mode	: CISPR-Average		



No.	FREQ	READING	ANT	LOSS	GAIN	RESULT	LIMIT	MARGIN	ANTENNA	TABLE
	[MHz]	[dBuV]	FACTOR	[dB]	[dB]	[dBuV/m]	[dBuV/m]	[dB]	[cm]	[DEG]
----- Horizontal -----										
1	2605.000	26.0	27.7	8.8	33.4	29.1	50.0	20.9	100	0
----- Vertical -----										
2	1530.000	25.3	25.2	6.9	32.9	24.5	50.0	25.5	100	359
3	1555.000	24.1	25.3	6.9	32.9	23.4	50.0	26.6	100	288
4	1610.000	25.0	25.3	7.0	32.9	24.4	50.0	25.6	100	125
5	3295.000	26.4	28.7	10.5	34.5	31.1	54.0	22.9	100	82
6	4855.000	23.0	31.1	13.4	34.1	33.4	54.0	20.6	100	359

Remark 1: Margin (dB) = Limit – Result and Result = Reading CISPR-Average + Antenna Factor + Loss – Gain

Loss and Gain in above table means Cable Loss and Pre-amplifier gain.

Remark 2: Radiated emissions (Tx/Rx frequencies) from the transceiver shall be ignored.

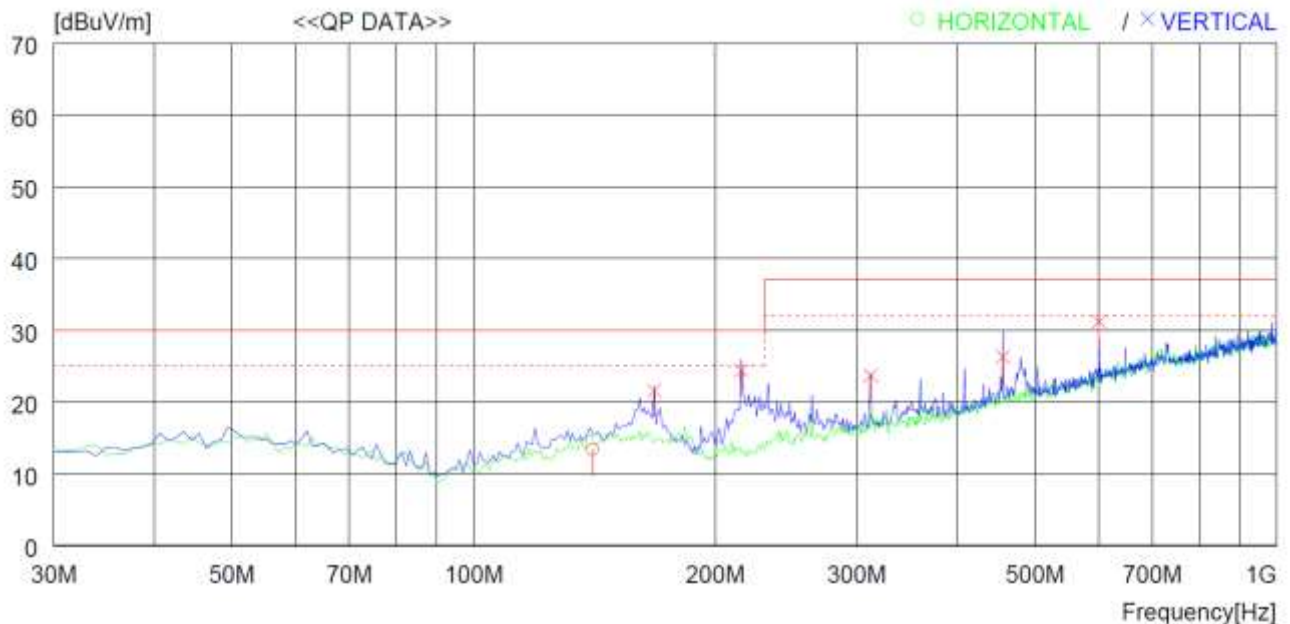
SIG FOX – (867.746 ~ 869.909) MHz

Bluetooth – (2 402 ~ 2 480) MHz

Remark 3: ◆ - Exclusion band Carrier Frequency, ◆ - Exclusion band Harmonic Frequency

* Reading value was measured on manual as changing at the height of antenna and the angle of table.

Operating Mode 2 (Wi-Fi 2.4 GHz & Bluetooth)			
Frequency range	: 30 MHz ~ 1 000 MHz	Test Date	: May 14, 2020
Resolution bandwidth	: 120 kHz	Measurement distance	: 10 m
Detector Mode	: Quasi-Peak		

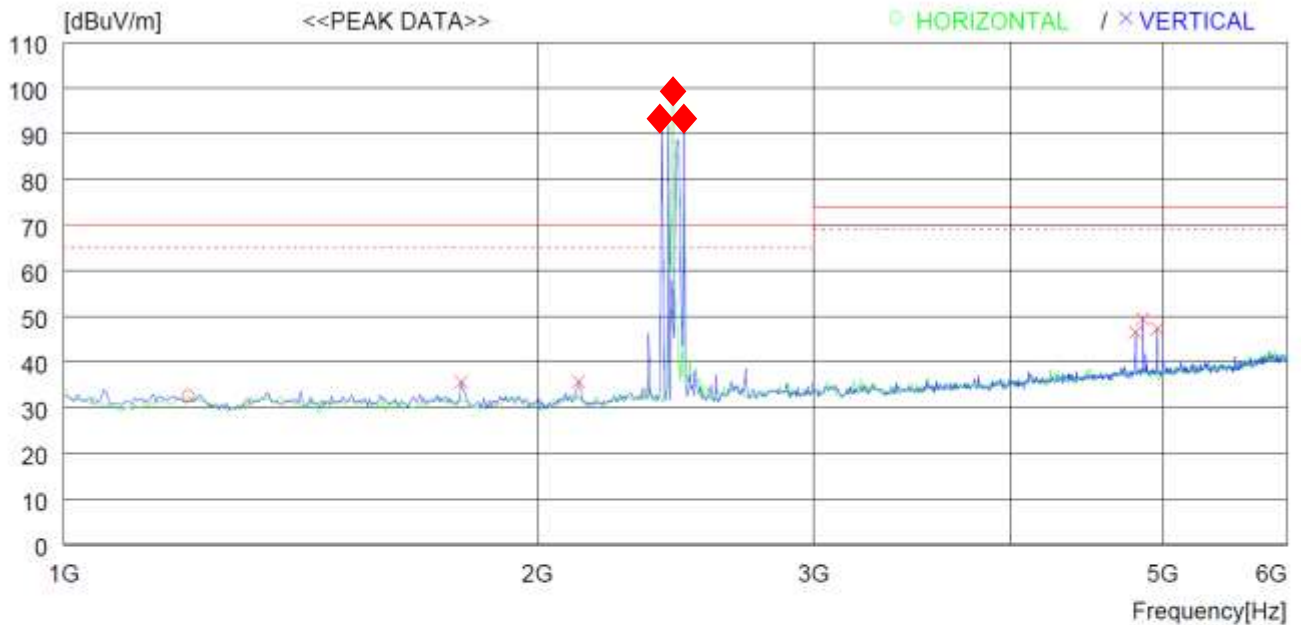


No.	FREQ	READING	ANT	LOSS	GAIN	RESULT	LIMIT	MARGIN	ANTENNA	TABLE
	[MHz]	QP	FACTOR							
		[dBuV]	[dB]	[dB]	[dB]	[dBuV/m]	[dBuV/m]	[dB]	[cm]	[DEG]
----- Horizontal -----										
1	140.580	25.4	18.4	2.6	33.0	13.4	30.0	16.6	400	359
----- Vertical -----										
2	167.740	33.0	18.8	2.8	33.0	21.6	30.0	8.4	100	359
3	215.270	38.4	15.7	3.2	32.9	24.4	30.0	5.6	100	341
4	312.270	33.1	19.7	3.9	33.0	23.7	37.0	13.3	400	0
5	455.831	31.5	23.1	4.7	33.0	26.3	37.0	10.7	100	359
6	600.358	33.6	25.6	5.4	33.4	31.2	37.0	5.8	300	287

Remark: Margin (dB) = Limit – Result and Result = Reading Quasi-Peak + Antenna Factor + Loss – Gain

Loss and Gain in above table means Cable Loss and Pre-amplifier gain.

Operating Mode 2 (Wi-Fi 2.4 GHz & Bluetooth)			
Frequency range	: 1 000 MHz ~ 6 000 MHz	Test Date	: May 29, 2020
Resolution bandwidth	: 1 MHz	Measurement distance	: 3 m
Detector Mode	: Peak		



No.	FREQ [MHz]	READING [dBuV]	ANT FACTOR [dB]	LOSS [dB]	GAIN [dB]	RESULT [dBuV/m]	LIMIT [dBuV/m]	MARGIN [dB]	ANTENNA [cm]	TABLE [DEG]
----- Horizontal -----										
1	1200.000	34.5	24.8	6.2	32.9	32.6	70.0	37.4	100	43
----- Vertical -----										
2	1790.000	35.4	25.5	7.6	32.9	35.6	70.0	34.4	100	359
3	2125.000	34.2	26.2	8.3	33.0	35.7	70.0	34.3	100	99
4	4805.000	36.2	31.0	13.4	34.1	46.5	74.0	27.5	100	359
5	4855.000	39.1	31.1	13.4	34.1	49.5	74.0	24.5	100	359
6	4960.000	36.8	31.2	13.5	34.2	47.3	74.0	26.7	100	359

Remark 1: Margin (dB) = Limit – Result and Result = Reading Peak + Antenna Factor + Loss – Gain

Loss and Gain in above table means Cable Loss and Pre-amplifier gain.

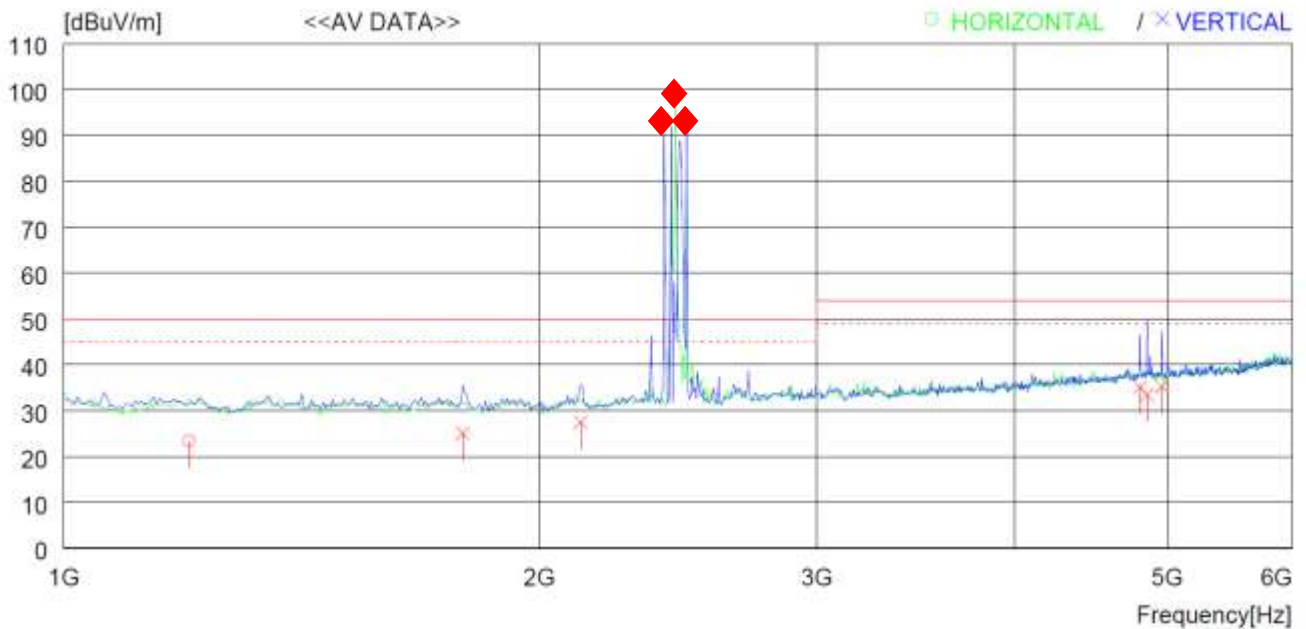
Remark 2: Radiated emissions (Tx/Rx frequencies) from the transceiver shall be ignored.

Wi-Fi 2.4 GHz – (2 412 ~ 2 472) MHz

Bluetooth – (2 402 ~ 2 480) MHz

Remark 3: ◆ - Exclusion band Carrier Frequency, ◆ - Exclusion band Harmonic Frequency

Operating Mode 2 (Wi-Fi 2.4 GHz & Bluetooth)			
Frequency range	: 1 000 MHz ~ 6 000 MHz	Test Date	: May 29, 2020
Resolution bandwidth	: 1 MHz	Measurement distance	: 3 m
Detector Mode	: CISPR-Average		



No.	FREQ	READING	ANT	LOSS	GAIN	RESULT	LIMIT	MARGIN	ANTENNA	TABLE
	[MHz]	AV	FACTOR	[dB]	[dB]	[dBuV/m]	[dBuV/m]	[dB]	[cm]	[DEG]
----- Horizontal -----										
1	1200.000	25.3	24.8	6.2	32.9	23.4	50.0	26.6	100	43
----- Vertical -----										
2	1790.000	24.8	25.5	7.6	32.9	25.0	50.0	25.0	100	359
3	2125.000	26.0	26.2	8.3	33.0	27.5	50.0	22.5	100	99
4	4805.000	24.8	31.0	13.4	34.1	35.1	54.0	18.9	100	359
5	4855.000	23.0	31.1	13.4	34.1	33.4	54.0	20.6	100	359
6	4960.000	24.7	31.2	13.5	34.2	35.2	54.0	18.8	100	359

Remark 1: Margin (dB) = Limit – Result and Result = Reading CISPR-Average + Antenna Factor + Loss – Gain

Loss and Gain in above table means Cable Loss and Pre-amplifier gain.

Remark 2: Radiated emissions (Tx/Rx frequencies) from the transceiver shall be ignored.

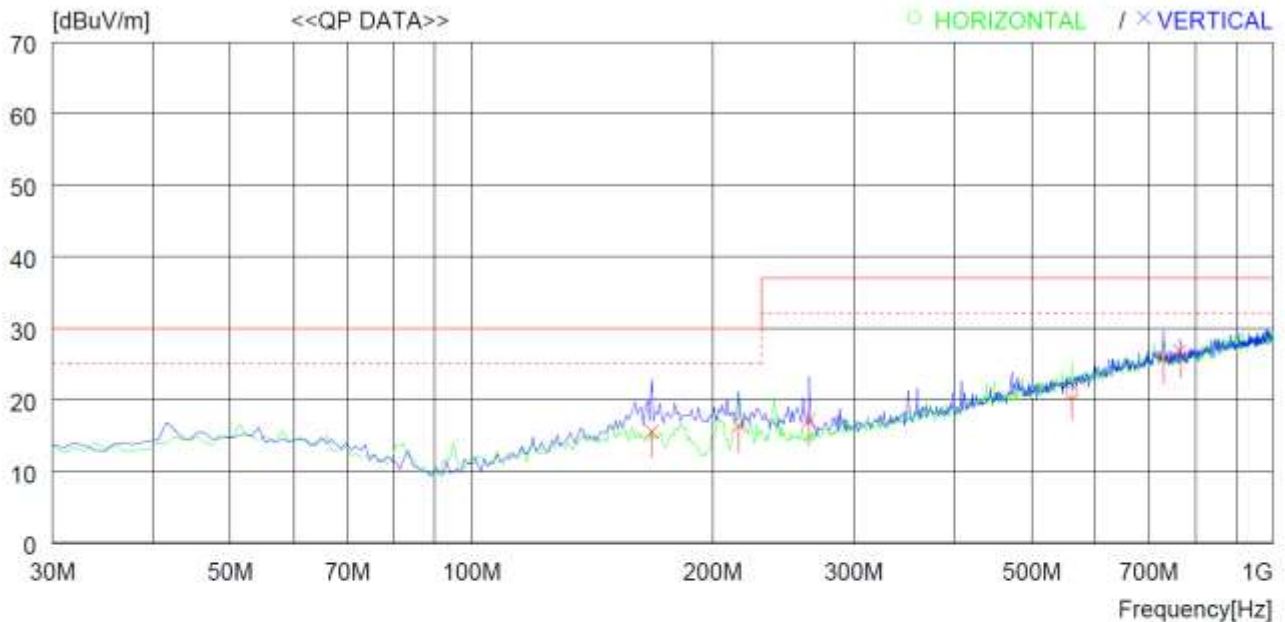
Wi-Fi 2.4 GHz – (2 412 ~ 2 472) MHz

Bluetooth – (2 402 ~ 2 480) MHz

Remark 3: ◆ - Exclusion band Carrier Frequency, ◆ - Exclusion band Harmonic Frequency

* Reading value was measured on manual as changing at the height of antenna and the angle of table.

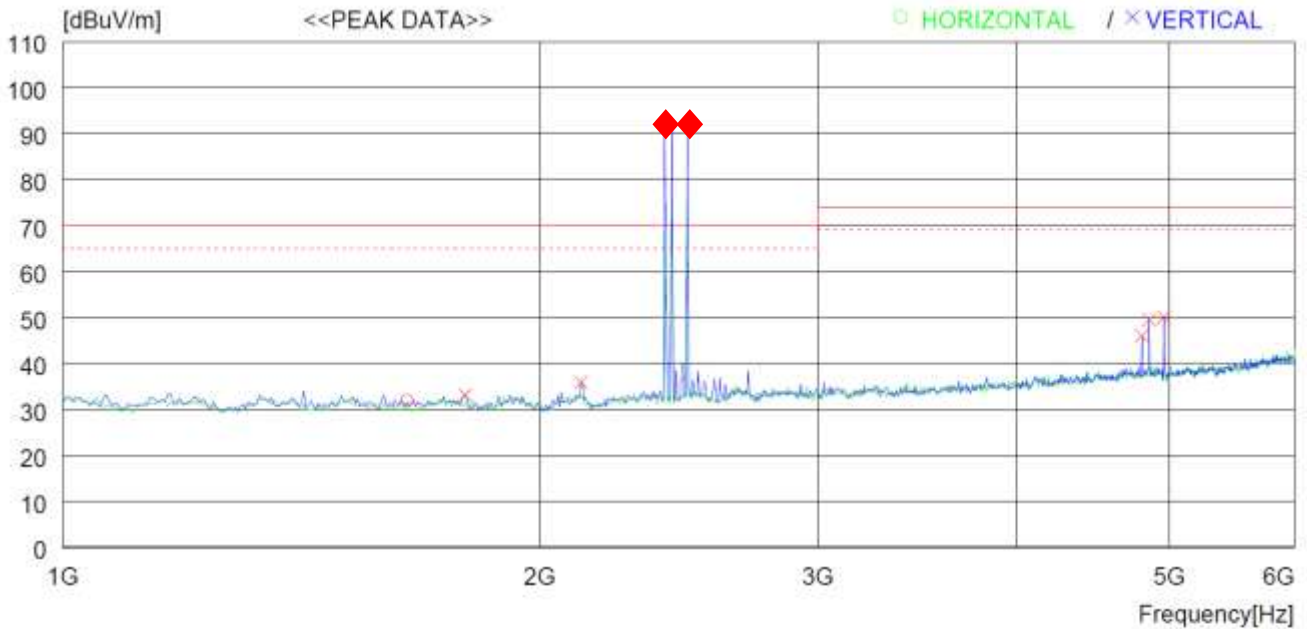
Operating Mode 3 (GPS & Bluetooth)			
Frequency range	: 30 MHz ~ 1 000 MHz	Test Date	: May 14, 2020
Resolution bandwidth	: 120 kHz	Measurement distance	: 10 m
Detector Mode	: Quasi-Peak		



No.	FREQ	READING	ANT	LOSS	GAIN	RESULT	LIMIT	MARGIN	ANTENNA	TABLE
	[MHz]	QP	FACTOR							
		[dBuV]	[dB]	[dB]	[dB]	[dBuV/m]	[dBuV/m]	[dB]	[cm]	[DEG]
----- Horizontal -----										
1	560.589	24.3	24.8	5.2	33.3	21.0	37.0	16.0	400	288
----- Vertical -----										
2	167.740	27.0	18.8	2.8	33.0	15.6	30.0	14.4	100	63
3	215.270	30.4	15.7	3.2	32.9	16.4	30.0	13.6	100	359
4	263.770	28.4	18.1	3.5	32.8	17.2	37.0	19.8	200	0
5	730.334	26.0	27.2	6.0	33.3	25.9	37.0	11.1	100	359
6	765.253	26.3	27.7	6.1	33.3	26.8	37.0	10.2	100	6

Remark: Margin (dB) = Limit – Result and Result = Reading Quasi-Peak + Antenna Factor + Loss – Gain
Loss and Gain in above table means Cable Loss and Pre-amplifier gain.

Operating Mode 3 (GPS & Bluetooth)			
Frequency range	: 1 000 MHz ~ 6 000 MHz	Test Date	: May 29, 2020
Resolution bandwidth	: 1 MHz	Measurement distance	: 3 m
Detector Mode	: Peak		



No.	FREQ [MHz]	READING [dBuV]	ANT PEAK FACTOR [dB]	LOSS [dB]	GAIN [dB]	RESULT [dBuV/m]	LIMIT [dBuV/m]	MARGIN [dB]	ANTENNA [cm]	TABLE [DEG]
----- Horizontal -----										
1	1650.000	32.2	25.4	7.2	32.9	31.9	70.0	38.1	100	359
----- Vertical -----										
2	1795.000	32.8	25.6	7.6	32.9	33.1	70.0	36.9	100	339
3	2125.000	34.4	26.2	8.3	33.0	35.9	70.0	34.1	100	288
4	4805.000	35.7	31.0	13.4	34.1	46.0	74.0	28	100	330
5	4855.000	39.1	31.1	13.4	34.1	49.5	74.0	24.5	100	0
6	4960.000	39.5	31.2	13.5	34.2	50.0	74.0	24	100	0

Remark 1: Margin (dB) = Limit – Result and Result = Reading Peak + Antenna Factor + Loss – Gain

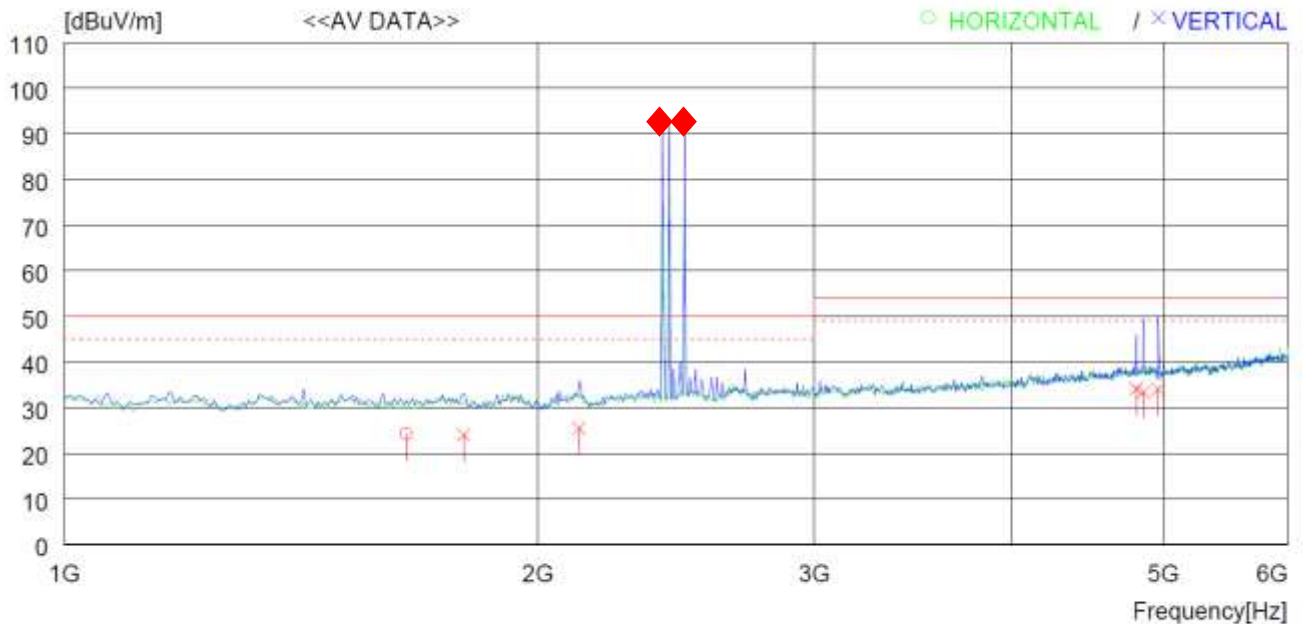
Loss and Gain in above table means Cable Loss and Pre-amplifier gain.

Remark 2: Radiated emissions (Tx/Rx frequencies) from the transceiver shall be ignored.

Bluetooth – (2 402 ~ 2 480) MHz

Remark 3: ◆ - Exclusion band Carrier Frequency, ◆ - Exclusion band Harmonic Frequency

Operating Mode 3 (GPS & Bluetooth)			
Frequency range	: 1 000 MHz ~ 6 000 MHz	Test Date	: May 29, 2020
Resolution bandwidth	: 1 MHz	Measurement distance	: 3 m
Detector Mode	: CISPR-Average		



No.	FREQ [MHz]	READING AV [dBuV]	ANT FACTOR [dB]	LOSS [dB]	GAIN [dB]	RESULT [dBuV/m]	LIMIT [dBuV/m]	MARGIN [dB]	ANTENNA [cm]	TABLE [DEG]
----- Horizontal -----										
1	1650.000	24.6	25.4	7.2	32.9	24.3	50.0	25.7	100	359
----- Vertical -----										
2	1795.000	23.7	25.6	7.6	32.9	24.0	50.0	26.0	100	339
3	2125.000	24.0	26.2	8.3	33.0	25.5	50.0	24.5	100	288
4	4805.000	23.8	31.0	13.4	34.1	34.1	54.0	19.9	100	330
5	4855.000	23.0	31.1	13.4	34.1	33.4	54.0	20.6	100	0
6	4960.000	23.5	31.2	13.5	34.2	34.0	54.0	20.0	100	0

Remark 1: Margin (dB) = Limit – Result and Result = Reading CISPR-Average + Antenna Factor + Loss – Gain

Loss and Gain in above table means Cable Loss and Pre-amplifier gain.

Remark 2: Radiated emissions (Tx/Rx frequencies) from the transceiver shall be ignored.

Bluetooth – (2 402 ~ 2 480) MHz

Remark 3: ◆ - Exclusion band Carrier Frequency, ◆ - Exclusion band Harmonic Frequency

* Reading value was measured on manual as changing at the height of antenna and the angle of table.

6. IMMUNITY TESTS

6.1 ELECTROSTATIC DISCHARGE IMMUNITY TEST

The measurement of the Immunity Against Electrostatic Discharge was performed in a shield room.2

Date: May 26, 2020

6.1.1 Operating environment

Ambient temperature	23.7 [°C]
Relative humidity	49.3 [% R.H.]
Atmospheric pressure	1 011.0 [hPa]

6.1.2 Test set-up

The EUT and all local support equipment were placed on non-conductive support 0.8 m above a reference ground plane (RGP) and were put into operation according to the specified operating mode.

The test set-up photo is included in appendix II.

6.1.3 Measurement uncertainty

It has been demonstrated that the ESD generator meets the specified requirements in the standard with at least a 95 % confidence.

6.1.4 Test equipment used

Model Number	Manufacturer	Description	Serial Number	Last Cal.(Interval)
■ - ESS-2000	NOISEKEN	ESD Simulator	ESS0170038	Apr. 20, 2020 (1Y)

All test equipment used is calibrated on a regular basis.

6.1.5 Test data

Test levels : Contact discharge 4 kV, Air discharge 2 / 4 / 8 kV

Number of discharges : 10 each pol. At each point for Contact Discharge
25 each pol. At each point for Air Discharge

Polarity : Positive / Negative

EUT Position : Table top

Required performance criterion : B


Test result : Met criterion A

Monitoring of the EUT : Monitored the normal operating state of the EUT at each operating mode.

The test points of EUT are each location on the surface touchable by hand (see test point in next page) and HCP / VCP - 0.1 m from the four side of the EUT.




The results of selected test points of EUT are listed in below table.

Point	Test level [\pm kV]	Pass/Fail	Description
Enclosure	2 / 4 / 8 (Air)	Pass	There was no deviation from normal operation condition during and after test. The EUT was not observed any unintentional transmission in standby mode.
HCP / VCP	4 (Indirect)	Pass	

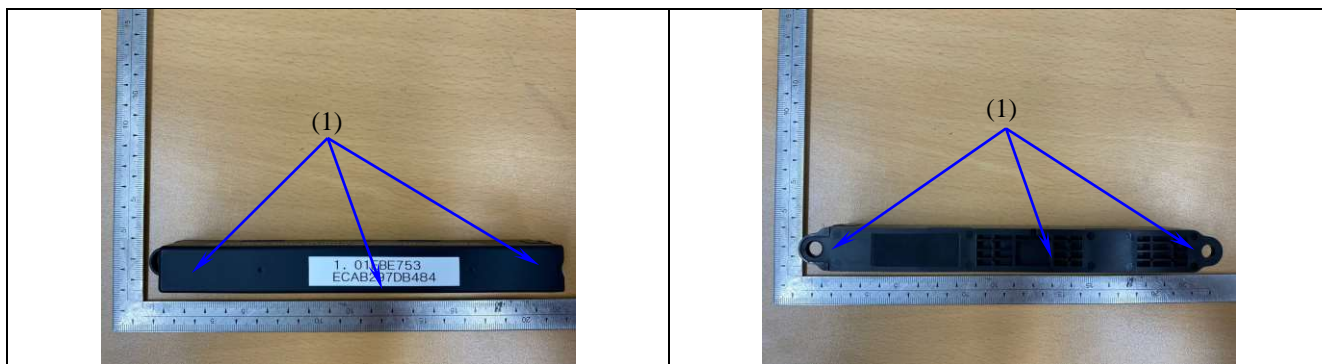


Tested by: Sang-Hyun, Jeong / Manager

6.1.6 ESD Test Point & Test Result

	Air
	Air / Contact
	Contact

ESD Point	Discharge voltage [\pm kV]	Results
(1) Enclosure	2 / 4 / 8 (Air)	Met criterion A
HCP / VCP	4 (Indirect)	Met criterion A



6.2 RADIATED RF-ELECTROMAGNETIC FIELD IMMUNITY TEST

The measurement of the Immunity Against Radiated RF-Electromagnetic Field was performed in an anechoic chamber.

Date: May 21, 2020

6.2.1 Operating environment

Ambient temperature	23.5 [°C]
Relative humidity	51.2 [% R.H.]
Atmospheric pressure	1 011.0 [hPa]

6.2.2 Test set-up

The EUT and all local support equipment were placed on a non-conductive support 0.8 m above a reference ground plane (RGP) and were put into operation according to the specified operating mode.

The test set-up photo is included in appendix III.

6.2.3 Measurement uncertainty

The measurement uncertainty is ± 1.2 dB.

Measurement uncertainty is calculated in accordance with UKAS Lab34. The measurement uncertainty is given with a confidence of 95 %. The measurement uncertainty is calculated as the uncertainty of the electric field intensity detected by the probe(s). The uncertainty calculations exclude influence of phenomena like inhomogeneity of the electric field intensity.

6.2.4 Test equipment used

	Model Number	Manufacturer	Description	Serial Number	Last Cal.(Interval)
■ -	SMT 06	Rohde & Schwarz	Signal Generator	100267	Oct. 21, 2019 (1Y)
■ -	NRVD	Rohde & Schwarz	Power Meter	101448	Mar. 18, 2020 (1Y)
■ -	AT1080	Rohde & Schwarz	Log Periodic Antenna	17611	N/A
■ -	500W1000A	Amplifier Research	Power Amplifier	332911	N/A
■ -	DC6180A	Amplifier Research	Directional Coupler	332598	Mar. 17, 2020 (1Y)
■ -	DC7420	Amplifier Research	Directional Coupler	347906	Mar. 09, 2020 (1Y)
■ -	30S1G6	Amplifier Research	Amplifier	345914	N/A
■ -	TA-EMS	Rohde & Schwarz	System Communication	11017	N/A
■ -	BBHA9120D	Schwarzbeck	Horn Antenna	1201	N/A

All test equipment used is calibrated on a regular basis.

6.2.5 Test data

Test level : 3 V/m (AM 80 %, 1 kHz sine wave)
 Frequency range : 80 MHz ~ 6 000 MHz
 Frequency step : 1 %
 Dwell time at each frequency : 3 s
 Exposed side : Front / Back / Left / Right
 Polarization of antenna : Horizontal / Vertical
 Distance of antenna – EUT : 3 m
 EUT Position : Table top
 Required performance criterion : A
 Test result : Met criterion A
 Monitoring of the EUT : Monitored the normal operating state of the EUT at each operating mode.

The results of test are listed in below table.

Freq. Range [MHz]	Pol. V/H	Exposed side	Pass/Fail	Description
80 ~ 6 000	H	Front / Back / Left / Right	Pass	There was no deviation from normal operation condition during and after test.
80 ~ 6 000	/V	Front / Back / Left / Right	Pass	The EUT was not observed any unintentional transmission in standby mode.

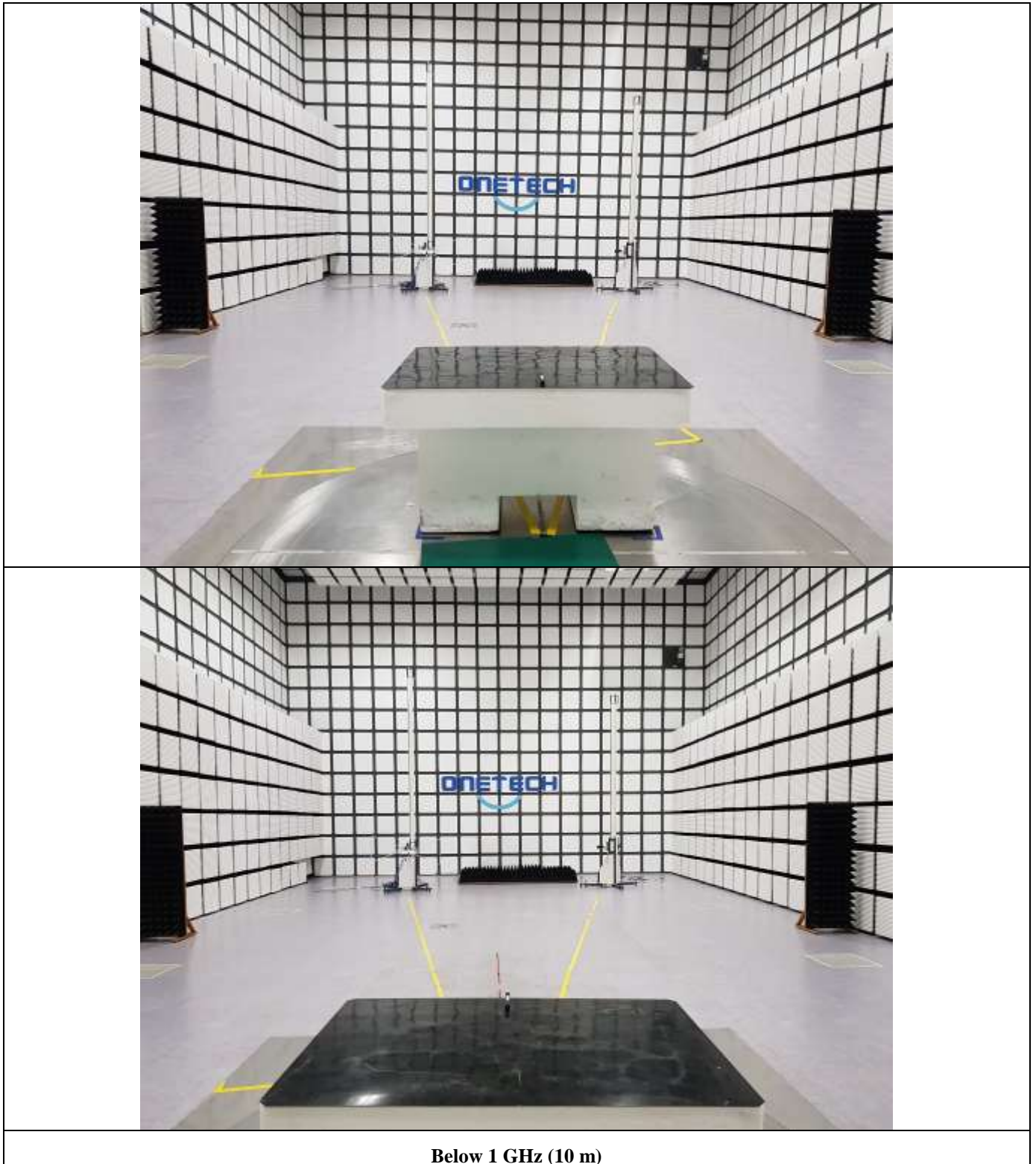
Remark 1: “H”: Horizontal, “V”: Vertical

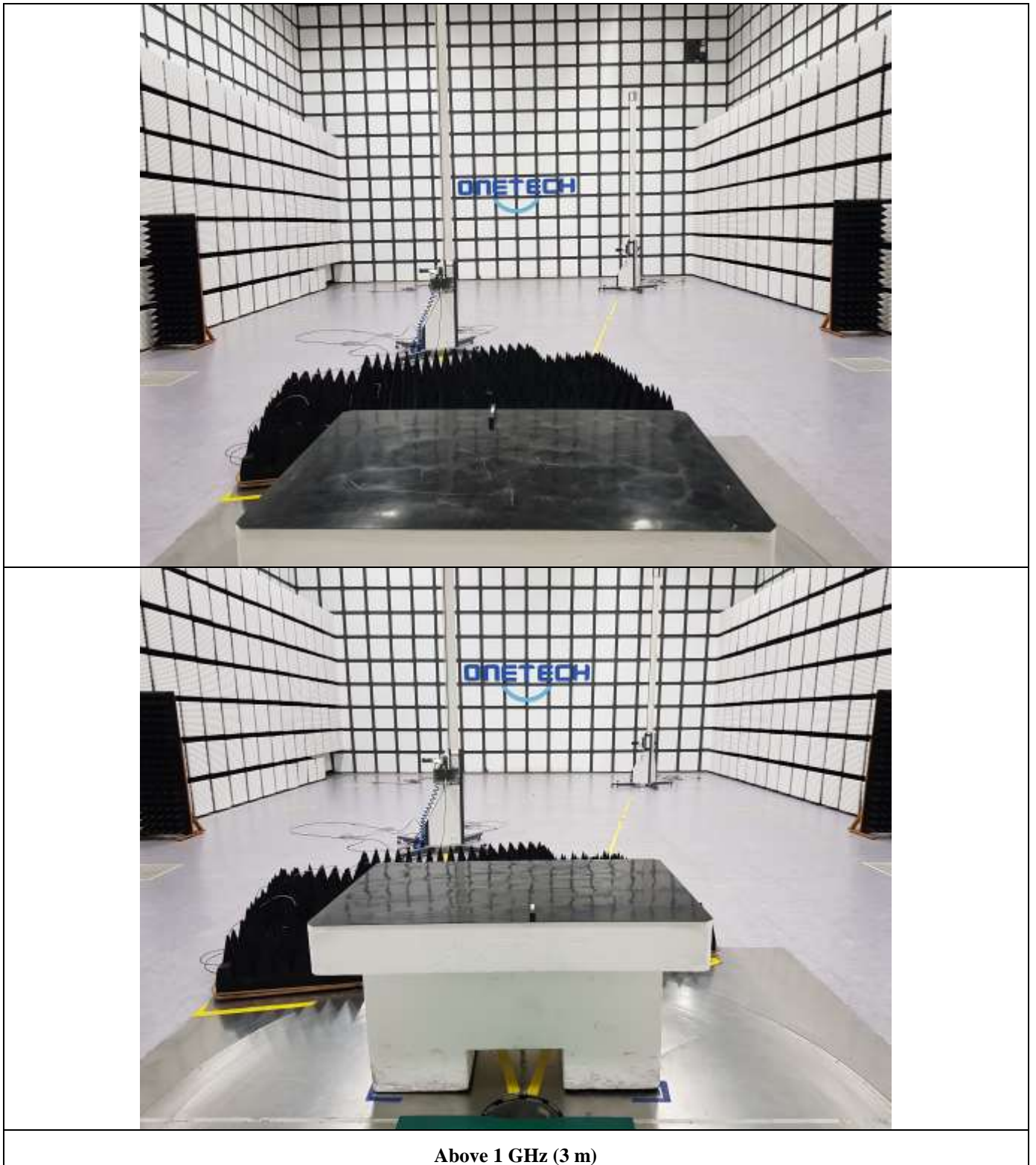
Remark 2: Sig Fox (867.746 ~ 869.909) MHz, Exclusion Band: lower limit – 824.359 MHz, upper limit – 913.404 MHz
 Wi-Fi 2.4 GHz (2 412 ~ 2 472) MHz, Exclusion Band: lower limit – 2 291.4 MHz, upper limit – 2 595.6 MHz
 Bluetooth (2 402 ~ 2 480) MHz, Exclusion Band: lower limit – 2 281.9 MHz, upper limit – 2 604.0 MHz



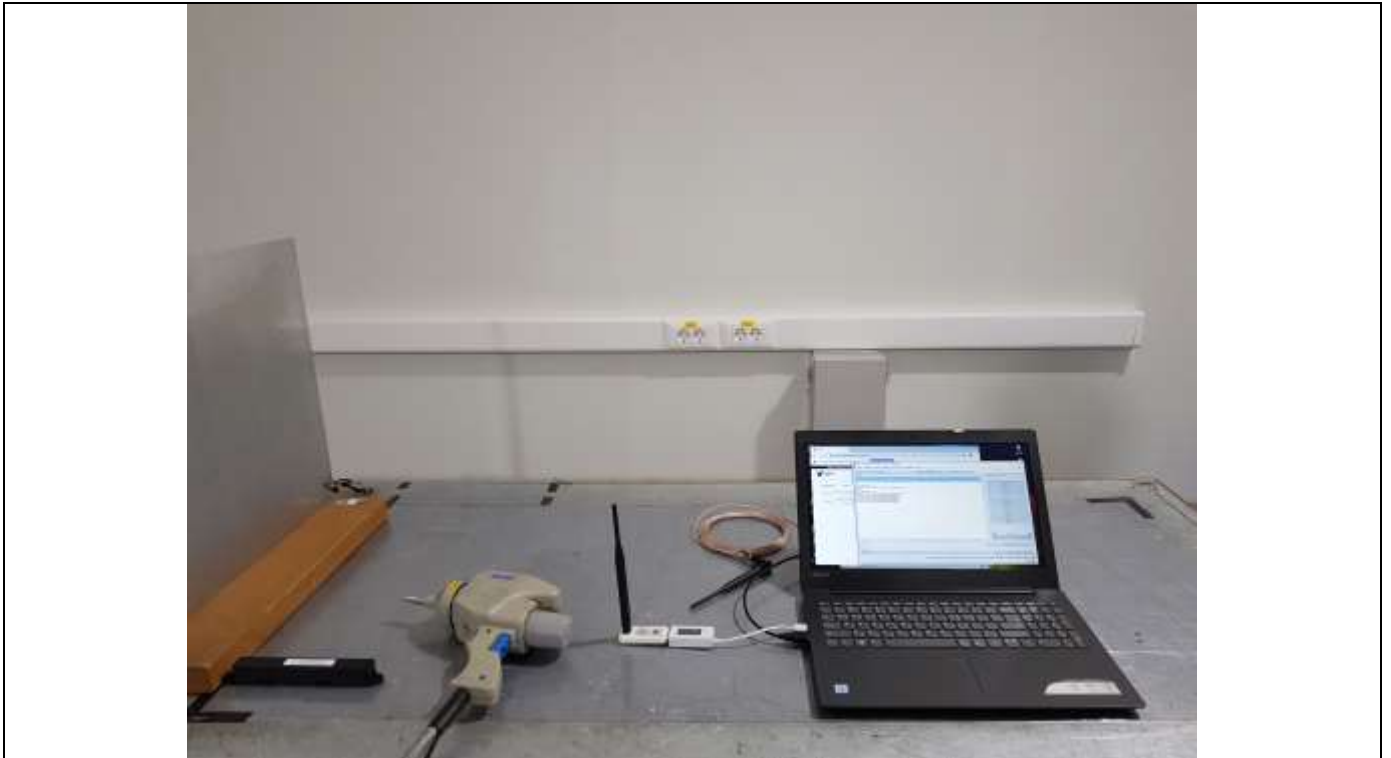
Tested by: Sang-Hyun, Jeong / Project Engineer

APPENDIX I - TEST SET-UP PHOTOS: RADIATED EMISSION





APPENDIX II - TEST SET-UP PHOTO: ESD



APPENDIX III - TEST SET-UP PHOTO: RF E- FIELD

APPENDIX IV - PHOTOGRAPHS OF THE PRODUCT



