# TEST REPORT



## CTK Co., Ltd.

(Ho-dong), 113, Yejik-ro, Cheoin-gu, Yongin-si, Gyeonggi-do, Korea Tel: +82-31-339-9970

Fax: +82-31-624-9501

Report No.: CTK-2022-00510 Page (1) / (25) Pages

#### 1. Client

• Name : SOLUM CO.,LTD.

 Address: 4,5,6th F, 357, Guseong-ro, Giheung-gu, Gyeonggi-do, Yongin-si, Republic of Korea

Date of Receipt: 2021-11-15

#### 2. Manufacturer

• Name #1 : SOLUM CO.,LTD.

 Address #1: 4,5,6th F, 357, Guseong-ro, Giheung-gu, Gyeonggi-do, Yongin-si, Republic of Korea

∘ Name #2 : SOLUM VINA CO., LTD

Address #2: Plot B3, Ba Thien 2 Industrial park, Thien Ke Ward, Binh Xuyen District,
 Vinh Phuc Province, 281200., People's Republic of Vietnam

3. Use of Report: For FCC Certification

4. Test Sample / Model : SoluM SmartTag+ / CS06FHB01

**5. Date of Test**: 2022-01-10 to 2022-01-28

6. Test Standard(method) used: FCC 47 CFR part 15 subpart F 15.519,

ANSI C63.10-2013

**7. Testing Environment :** Temp.:  $(23 \pm 1) \, ^{\circ}$ , Humidity:  $(51 \pm 3) \, ^{\circ}$  R.H.

8. Test Results: Compliance

The results shown in this test report refer only to the sample(s) tested unless otherwise stated. This Test Report cannot be reproduced, except in full.

	Tested by	Technical Manager
Affirmation	Bong-seok Kim: (Signature)	Young-taek Lee: (Signature)

2022-01-28

Republic of KOREA CTK Co., Ltd.



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### REPORT REVISION HISTORY

Date	Revision	Page No
2022-01-28	Issued (CTK-2022-00510)	all

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# 1. General Product Description

### 1.1 Client Information

Company	SOLUM CO.,LTD.
Contact Point	4,5,6th F, 357, Guseong-ro, Giheung-gu, Gyeonggi-do, Yongin-si, Republic of Korea
	Name : nammin.kim
Contact Person	E-mail : nammin.kim@solu-m.com
	Tel: +82-31-8006-0918

### 1.2 Product Information

FCC ID	2AFWN-CS06FHB01
Product Description	SoluM SmartTag+
Model name	CS06FHB01
Variant Model name	-
Operating Frequency	7737.6 - 8236.8 MHz
RF Output Power	Mean Power : -55.30 dBm/MHz Peak power : -9.38 dBm/50MHz
Antenna Specification	Antenna type : PCB Antenna Peak Gain : 3.36 dBi
Number of channels	1
Power Source	DC 3.0 V(Battery)
Device type	hand held

## 1.3 Peripheral Devices

### -For Conducted Measurement and Radiated Measurement

Device	Manufacturer	Model No.	Serial No.
Notebook	HP Inc.	HP Probook 455 G7	5CD0234DWW
AC Adapter	HP Inc.	TPN-LA16	PA-1650-20HL



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# 2. Facility and Accreditations

### 2.1 Test Facility

The measurement facility is located at (Ho-dong), 113, Yejik-ro, Cheoin-gu, Yong-in-si, Gyeonggi-do, Korea.

### 2.2 Laboratory Accreditations and Listings

Country	Agency	Registration Number
USA	FCC	805871
CANADA	ISED	8737A-2
KOREA	NRRA	KR0025

### 2.3 Calibration Details of Equipment Used for Measurement

Test equipment and test accessories are calibrated on regular basis. The maximum time between calibrations is one year or what is recommended by the manufacturer, whichever is less. All test equipment calibrations are traceable to the Korea Research Institute of Standards and Science (KRISS), therefore, all test data recorded in this report is traceable to KRISS.



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# 3. Test Specifications

### 3.1 Standards

Section in FCC	Requirement(s)	Status (Note 1)	Test Condition	
15.503, 15.519(b)	10 dB Bandwidth	С		
15.519(a)(1)	Cessation Time	С		
15.519(e)	Maximum peak Power	С		
15.519(c)	Maximum Average emission in the range of 3100- 10600 MHz	С	Radiated	
15.519(c)	Radiate emission Above 960 MHz	С		
15.519(d)	Radiate emission in the 1164 -1240 MHz and 1559- 1610 MHz	С		
15.519(c), (a)	Radiate Emissions Below 960 MHz	С		
15.207(a)	AC Conducted Emission	NA(Note 3)	Line Conducted	
Note 1: C=Complies NC=Not Complies NT=Not Tested NA=Not Applicable				
Note 2: The data in this test report are traceable to the national or international standards.				
Note 3: The equipment is operated on battery power only.				
Note 4: The sample was tested according to the following specification: FCC Part 15.519, ANSI C63.10-2013				
<u>Note 5</u> : The tests were performed according to the method of measurements prescribed in KDB 393764.				

### 3.2 Mode of operation during the test

The EUT is operated in a manner representative of the typical of the equipments. During at testing, system components were manipulated within the confines of typical usage to maximize each emission. All modulation modes were tests. The results are only attached worst cases.

**Test Frequency** 

Operating channel
7 987.2 MHz

### 3.3 Maximum Measurement Uncertainty

The value of the measurement uncertainty for the measurement of each parameter. Coverage factor k = 2, Confidence levels of 95 %

Description	Uncertainty
Conducted RF Output Power	1.5 dB (C.L. : Approx. 95%, <i>k</i> =2)
Occupied Bandwidth	0.1 MHz (C.L. : Approx. 95%, <i>k</i> =2)
Unwanted Emission(conducted)	3.0 dB (C.L. : Approx. 95%, <i>k</i> =2)
Radiated Emissions ( $f \le 1 \text{ GHz}$ )	4.0 dB (C.L. : Approx. 95%, <i>k</i> =2)
Radiated Emissions (f > 1 GHz)	5.0 dB (C.L. : Approx. 95%, <i>k</i> =2)



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### 4. Technical Characteristic Test

#### 4.1 10dB Bandwidth

Test Procedures (15.503(a), 15.519(b), ANSI C63.10-2013 10.1)

UWB bandwidth. For the purpose of this subpart, the UWB bandwidth is the frequency band bounded by the points that are 10 dB below the highest radiated emission, as based on the complete transmission system including the antenna. The upper boundary is designated  $f_H$  and the lower boundary is designated  $f_L$ . The frequency at which the highest radiated emission occurs is designated  $f_M$ .

The UWB bandwidth of a device operating under the provisions of this section must be contained between 3100 MHz and 10,600 MHz.

#### **Test Settings:**

Center frequency = the operating channel

a) RBW = 1 MHz

b) VBW  $\geq$  3 x RBW

c) Detector = Peak

d) Trace mode = Max hold

- e) Sweep = auto
- f) Trace mode: max hold
- g) Span was set wide enough to capture the 10dB points of the signal
- h) Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 10 dB relative to the maximum level measured in the fundamental emission.

#### Limit:

10 dB Bandwidth ≥ 500 MHz



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### Test Data:

F <sub>M</sub>	F∟	F <sub>H</sub>	10 dB Bandwidth
(MHz)	(MHz)	(MHz)	(MHz)
7 872	7 718	8 242	524

See next pages for actual measured spectrum plots.





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#### 4.2 Cessation Time

### **Test Procedures (15.519(a)(1))**

A UWB device operating under the provisions of this section shall transmit only when it is sending information to an associated receiver. The UWB intentional radiator shall cease transmission within 10 seconds unless it receives an acknowledgement from the associated receiver that its transmission is being received. An acknowledgment of reception must continue to be received by the UWB intentional radiator at least every 10 seconds or the UWB device must cease transmitting.

### Test Settings:

Center frequency = the operating channel

a) RBW ≥ 1 MHz

b) VBW  $\geq$  3 x RBW

c) span  $\geq 0$ 

d) Detector = peak

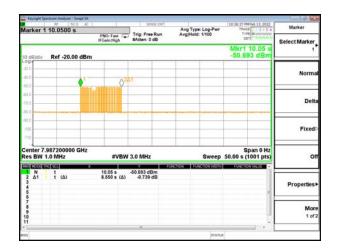
#### Limit:

Transmission shall cease in less than 10 s

#### Test Data:

Cessation Time	Result
8.55 s	Complies

See next pages for actual measured spectrum plots.





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### 4.3 Maximum Average Emissions

Test Procedures (15.519(c), ANSI C63.10-2013 10.3.7)

The radiated emissions above 960 MHz from a device operating under the provisions of this section shall not exceed the following average limits when measured using a resolution bandwidth of  $1\ \mathrm{MHz}$ 

#### Test Settings:

Center frequency =  $f_M$ 

a) RBW: 1 MHz

b) VBW  $\geq$  3 x RBW

c) Detector = Average(RMS)

d) Sweep time = auto couple

e) Trace mode= max hold

f) Allow trace to fully stabilize

#### Limit:

Maximum Peak Power < -41.3 dBm (EIRP)

#### Test Data:

Frequency Peak Power [MHz] [dBm] 8163.374 -55.30		Limit [dBm]	Result
8163.374	-55.30	-41.30	Complies

#### Note:

-EIRP= Reading - 95.2

See next pages for actual measured spectrum plots.



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#### 4.4 Maximum Peak Power

Test Procedures (15.519(e), ANSI C63.10-2013 10.3.5, 6)

There is a limit on the peak level of the emissions contained within a 50 MHz bandwidth centered on the frequency at which the highest radiated emission occurs,  $f_M$ . That limit is 0 dBm EIRP. It is acceptable to employ a different resolution bandwidth, and a correspondingly different peak emission limit, following the procedures described in § 15.521.

#### Test Settings:

Center frequency =  $f_M$ 

a) RBW: 1 MHz

b) VBW ≥ 3 x RBW

c) Detector = peak

d) Sweep time = auto couple

e) Trace mode= max hold

f) Allow trace to fully stabilize

#### Limit:

Maximum Peak Power < 0 dBm/50MHz(EIRP)

#### Test Data:

Frequency Peak Power [MHz] [dBm/50MHz] 7940.249 -9.38		Limit [dBm/50MHz]	Result
7940.249	-9.38	0.00	Complies

#### Note:

-EIRP= Reading - 95.2 + CorrdB

See next pages for actual measured spectrum plots.



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#### 4.5 Radiated Emission

Test	 

$\boxtimes$	10 m SAC	(test distance	: L	] 10	m,	$\boxtimes$	3	m)
$\boxtimes$	3 m SAC (	(test distance :	3 m	1)				

### Test Procedures (15.209, 15.519, ANSI C63.10-2013 10.2, 3)

- 1) In the frequency range of 9 kHz to 30 MHz, magnetic field is measured with Loop Antenna. The center of the Loop Test Antenna is 1m above the ground. During the measurement the Loop Test Antenna rotates about its vertical axis for maximum response at each azimuth about the EUT.
- 2) In the frequency rage above 30 MHz, Bi-Log Test Antenna(30 MHz to 1 GHz) and Horn Test Antenna(above 1 GHz) are used. Test Antenna is 3m away from the EUT. Test Antenna height is carried from 1m to 4m above the ground to determine the maximum value of the field strength. The emissions levels at both horizontal and vertical polarizations should be tested.

### Test Settings:

Frequency Range = 9 kHz ~ 40 GHz

- a) RBW = 1 MHz for  $f \ge 1$  GHz, 100 kHz for f < 1 GHz, 9 kHz for f < 30 MHz
- b) VBW ≥ RBW
- c) Sweep time = auto couple



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#### Limit:

The radiated emissions at or below 960 MHz from a device operating under the provisions of this section shall not exceed the emission levels in § 15.209. The radiated emissions above 960 MHz from a device operating under the provisions of this section shall not exceed the following average limits when measured using a resolution bandwidth of 1 MHz:

Table 1

Frequency in MHz	EIRP in dBm
960-1610	-75.3
1610-1990	-63.3
1990-3100	-61.3
3100-10600	-41.3
Above 10600	-61.3

In addition to the radiated emission limits specified in the table in paragraph 15.519(c) of this section, UWB transmitters operating under the provisions of this section shall not exceed the following average limits when measured using a resolution bandwidth of no less than 1 kHz:

Table 2

Frequency in MHz	EIRP in dBm
1164-1240	-85.3
1559-1610	-85.3



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FCC Part 15 § 15.209 (a) Except as provided elsewhere in this Subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table :

Except when the requirements applicable to a given device state otherwise, emissions from licence-exempt transmitters shall comply with the field strength limits shown in Table 2 Additionally, the level of any transmitter emission shall not exceed the level of the transmitter's fundamental emission.

**Table 3. General Field Strength Limits for Licence-Exempt Transmitters** 

Frequency(MHz)	Field Strength (uA/m)	Field Strength (uV/m)	Field Strength (dBuV/m)	Measurement Distance (meters)
0.009-0.490	6.37/F (F in kHz)	2400/F(kHz)	48.5 - 13.8	300
0.490-1.705	0.490-1.705 63.7/F (F in kHz)		33.8 - 23	30
1.705-30	0.08	30	29.5	30
30-88	-	100**	40	3
88-216	88-216 - 216-960 -		43.5	3
216-960			46	3
Above 960	-	500	54	3

<sup>\*\*</sup> Except as provided in 15.209(g).fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54-72MHz, 76-88MHz, 174-216MHz, 470-806MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g.15.231 and 15.241.

#### Note:

- 1) For above 1 GHz, the emission limit in this paragraph is based on measurement instrumentation employing an average detector, measurement using instrumentation with a peak detector function, corresponding to 20 dB above the maximum permitted average limit.
- 2) For above 1 GHz, limit field strength of harmonics : 54 dBuV/m@3m (AV) and 74 dBuV/m@3m (PK)
- 3) For measurement above 1GHz, the resolution bandwidth is set to 1 MHz and video bandwidth is set to 3 MHz and detector is peak for peak measurement and detector RMS and Trace Averaging type for average measurement.

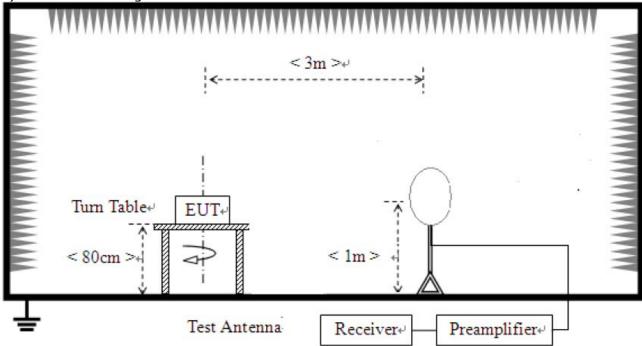


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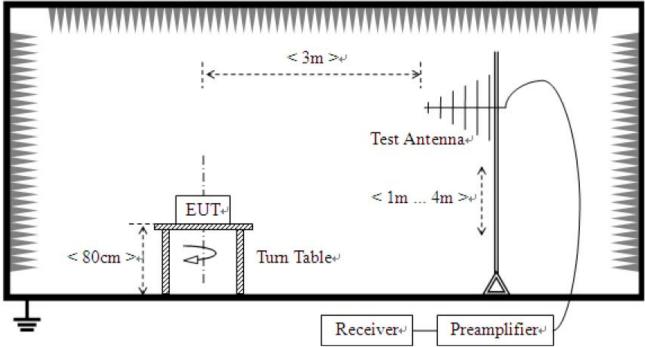
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### **Test Setup:**

For field strength of emissions from 9 kHz to 30 MHz



For field strength of emissions from 30 MHz to 1 GHz

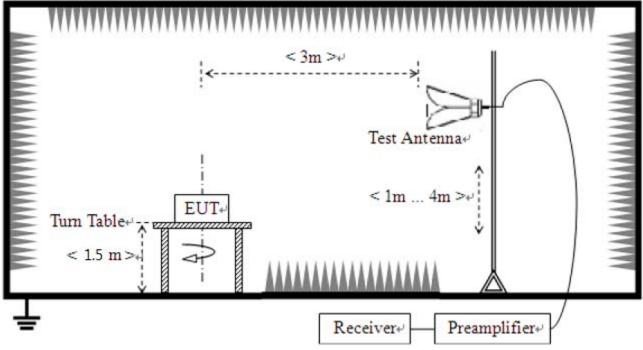




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3) For field strength of emissions above 1 GHz





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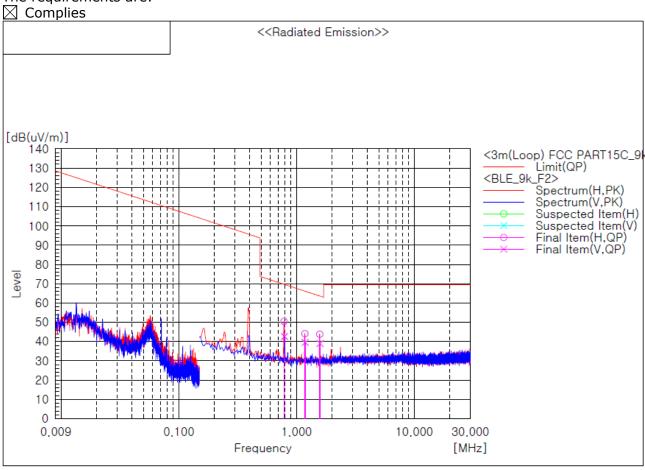
Test results

1) Spurious I

1. 9 kHz to 30 MHz

Test mode: Transmit, Middle Channel (Worst case)

The requirements are:



#### Final Result

No.	Frequency	(P)	Reading QP	c.f	Result QP	Limit QP	Margin QP	Height	Angle
	[MHz]		[dB(uV)]	[dB(1/m)]	[dB(uV/m)]	[dB(uV/m)]	[dB]	[cm]	[deg]
1	0.784	Н	25.5	25.0	50.5	69.7	19.2	101.0	299.0
2	0.792	V	17.6	25.0	42.6	69.6	27.0	100.0	299.0
3	1.180	Н	19.1	25.0	44.1	66.2	22.1	101.0	280.0
4	1.187	V	14.6	25.0	39.6	66.1	26.5	100.0	299.0
5	1.579	Н	18.8	25.0	43.8	63.6	19.8	101.0	316.0
6	1.587	V	14.0	25.0	39.0	63.6	24.6	100.0	279.0

#### Note:

- 1. The Unwanted emission was measured in the following position: EUT stand-up position(Z axis), lie-down position(X,Y axis). The worst emission was found in lie-down position(Z axis) and the worst case was recorded.
- 2. Result = Reading + c.f(correction factor)
- 3. Correction factor = Antenna factor + Cable loss + 6 dB attenuator
- 4. Tested during BLE & UWB operating operation.

<sup>\*</sup> Reading data is the peak value.



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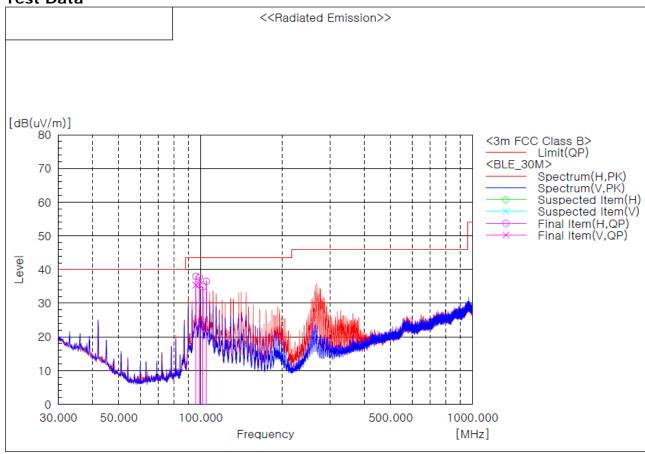
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#### 2. 30 MHz to 1 GHz

Test mode: Transmit, High Channel (Worst case)

The requirements are:

### **Test Data**



Final Result

No.	Frequency	(P)	Reading QP	c.f	Result OP	Limit QP	Margin QP	Height	Angle
	[MHz]		[dB(uV)]	[dB(1/m)]	[dB(uV/m)]	[dB(uV/m)]	[dB]	[cm]	[deg]
1	96.081	Н	52.8	-14.8	38.0	43.5	5.5	193.0	254.0
2	96.081	V	50.2	-14.8	35.4	43.5	8.1	101.0	306.0
3	99.113	Н	51.7	-14.0	37.7	43.5	5.8	193.0	251.0
4	99.113	V	49.5	-14.0	35.5	43.5	8.0	207.0	280.0
5	102.144	Н	48.5	-13.6	34.9	43.5	8.6	193.0	241.0
6	105.175	Н	49.5	-13.0	36.5	43.5	7.0	193.0	244.0

#### Remark:

- 1. The Unwanted emission was measured in the following position: EUT stand-up position(Z axis), lie-down position(X,Y axis). The worst emission was found in lie-down position(Z axis) and the worst case was recorded.
- 2. Result = Reading + c.f(Correction factor)
- 3. Correction factor = Antenna factor + Cable loss + 6 dB attenuator Amp Gain
- 4. Tested during BLE & UWB operating operation.

\* Reading data is the peak value.



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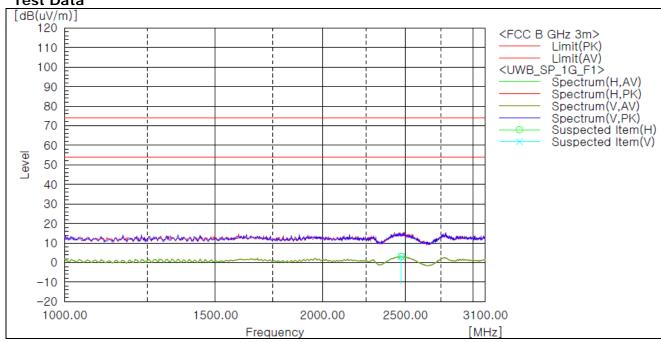
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#### 3. 1.0 GHz to 3.1 GHz

Test mode: Transmit, middle Channel (Worst case)

The requirements are:

**Test Data** 



Frequency [MHz]	Pol.	Reading [dBuV]	Space Loss [dB]	EIRP[dBuV]	Limit[dBuV]	Margin[dB]	Remark
			No p	eak found			

#### Remarks

- 1. The Unwanted emission was measured in the following position: EUT stand-up position(Z axis), lie-down position(X,Y axis). The worst emission was found in lie-down position(X axis) and the worst case was recorded.
- 2. Result = Reading + c.f(correction factor)
- 3. Correction factor = Antenna factor + Cable loss Amp Gain
- 4. Tested during BLE & UWB operating operation.



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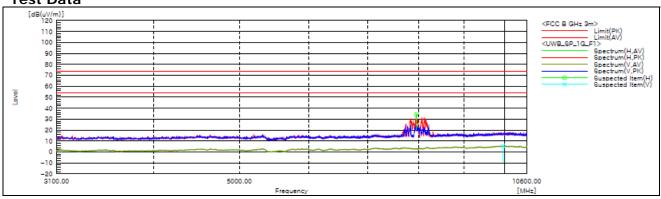
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#### 4. 3.1 GHz to 10.6 GHz

Test mode: Transmit, middle Channel (Worst case)

The requirements are:

#### **Test Data**



Frequency [MHz]	Pol.	Reading [dBuV]	Space Loss [dB]	EIRP[dBuV]	Limit[dBuV]	Margin[dB]	Remark		
No peak found									

#### Remarks

- 1. The Unwanted emission was measured in the following position: EUT stand-up position(Z axis), lie-down position(X,Y axis). The worst emission was found in lie-down position(X axis) and the worst case was recorded.
- Result = Reading + c.f(correction factor)
- 3. Correction factor = Antenna factor + Cable loss Amp Gain
- 4. The marker is a UWB operating signal.
- 5. Tested during BLE & UWB operating operation.



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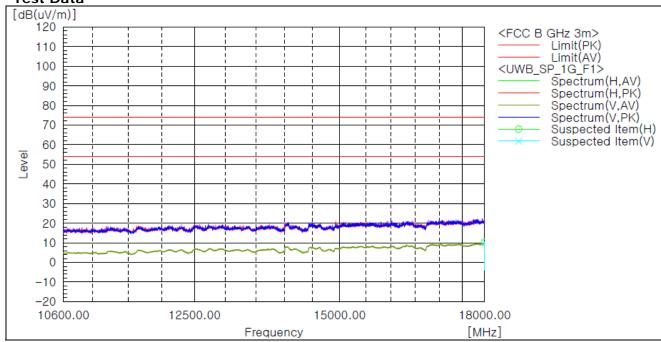
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#### 4. 10.6 GHz to 18.0 GHz

Test mode: Transmit, middle Channel (Worst case)

The requirements are:

#### **Test Data**



Frequency [MHz]	Pol.	Reading [dBuV]	Space Loss [dB]	EIRP[dBuV]	Limit[dBuV]	Margin[dB]	Remark		
No peak found									

#### Remarks

- 1. The Unwanted emission was measured in the following position: EUT stand-up position(Z axis), lie-down position(X,Y axis). The worst emission was found in lie-down position(X axis) and the worst case was recorded.
- 2. Result = Reading + c.f(correction factor)
- 3. Correction factor = Antenna factor + Cable loss Amp Gain
- 4. Tested during BLE & UWB operating operation.



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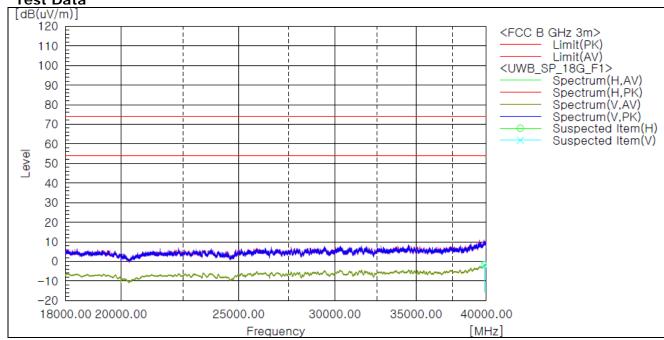
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#### 5. 18 GHz to 40 GHz

Test mode: Transmit, middle Channel (Worst case)

The requirements are:

**Test Data** 



Frequency [MHz]	Pol.	Reading [dBuV]	Space Loss [dB]	EIRP[dBuV]	Limit[dBuV]	Margin[dB]	Remark	
No peak found								

#### Remarks

- 1. The Unwanted emission was measured in the following position: EUT stand-up position(Z axis), lie-down position(X,Y axis). The worst emission was found in lie-down position(X axis) and the worst case was recorded.
- 2. Result = Reading + c.f(correction factor)
- 3. Correction factor = Antenna factor + Cable loss Amp Gain
- 4. Tested during BLE & UWB operating operation.



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### 2) Spurious II

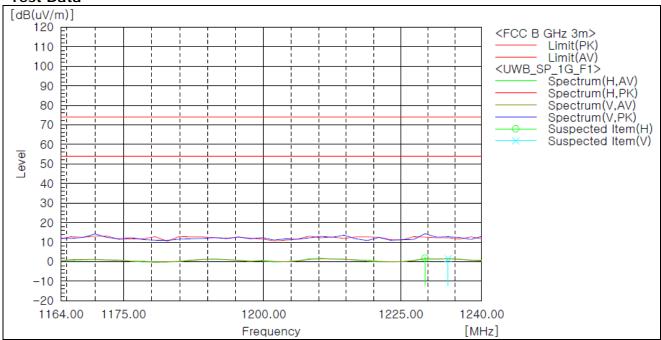
#### 1. 1164 MHz to 1240 MHz

Test mode: Transmit, Middle Channel (Worst case)

The requirements are:

□ Complies

### **Test Data**



Frequency [MHz]	Pol.	Reading [dBuV]	Space Loss [dB]	EIRP[dBuV]	Limit[dBuV]	Margin[dB]	Remark		
No peak found									

#### Remarks

- 1. The Unwanted emission was measured in the following position: EUT stand-up position(Z axis), lie-down position(X,Y axis). The worst emission was found in lie-down position(X axis) and the worst case was recorded.
- 2. Result = Reading + c.f(correction factor)
- 3. Correction factor = Antenna factor + Cable loss Amp Gain
- 4. Tested during BLE & UWB operating operation.



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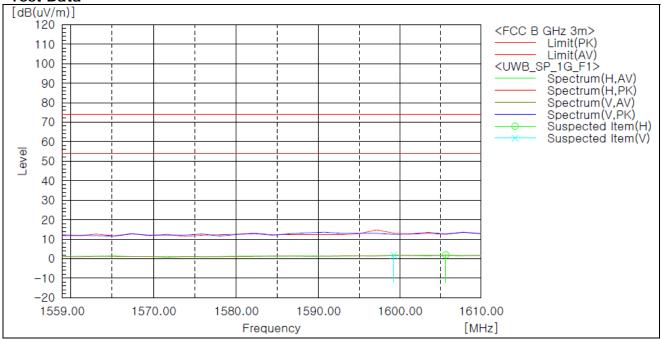
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#### 2. 1559 MHz to 1610 MHz

Test mode: Transmit, Middle Channel (Worst case)

The requirements are:

#### Test Data



Frequency [MHz]	Pol.	Reading [dBuV]	Space Loss [dB]	EIRP[dBuV]	Limit[dBuV]	Margin[dB]	Remark	
No peak found								

#### Remarks

- 1. The Unwanted emission was measured in the following position: EUT stand-up position(Z axis), lie-down position(X,Y axis). The worst emission was found in lie-down position(X axis) and the worst case was recorded.
- 2. Result = Reading + c.f(correction factor)
- 3. Correction factor = Antenna factor + Cable loss Amp Gain
- 4. Tested during BLE & UWB operating operation.



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# **APPENDIX A – Test Equipment Used For Tests**

No.	Name of Equipment	Manufacturer	Model No.	Serial No.	Cal Date	Due Date
1	Signal Analyzer	Agilent	N9020A	MY52090670	2021-10-21	2022-10-21
2	SPECTRUM ANALYZER	R&S	FSV40	101574	2021-01-18	2022-01-18
2	SPECTRUM ANALTZER				2022-01-12	2023-01-12
3	EMI Test Receiver	Rohde & Schwarz	ESCI7	100814	2021-10-20	2022-10-20
4	Active Loop Antenna	SCHWARZBECK	FMZB 1513	1513-126	2020-05-20	2022-05-20
5	Bilog Antenna	Schaffner	CBL6111C	2551	2021-03-22	2023-03-22
6	AMPLIFIER	SONOMA	310	291721	2021-01-22	2022-01-22
0	AMPLIFIER				2022-01-21	2023-01-21
7	6dB Attenuator	R&S	DNF	272.4110.50-2	2021-10-22	2022-10-22
8	EMI Test Receiver	Rohde & Schwarz	ESU40	100336	2021-01-12	2022-01-12
0	EMI Test Receiver				2022-01-11	2023-01-11
9	Double Ridged Guide Antenna	ETS-Lindgren	3117	00154525	2021-10-22	2022-10-21
10	Double Ridged Guide Antenna	ETS-Lindgren	3116	00062916	2021-04-14	2022-04-14
11	Preamplifier	Agilent	8449B	3008A02011	2021-10-24	2022-11-24
12	Band Reject Filter	Micro Tronics	BRM50702	G233	2022-01-07	2023-01-07
13	Signal Generator	R&S	SMB100A	175528	2021-04-12	2022-04-12
14	6dB Attenuator	BIRD	5W 6dB	1744	2021-11-18	2022-11-18
15	Dual-Tracking DC Power Supply	Topward Electric Instruments Co.,Ltd.	6303D	997931	2021-07-05	2022-07-05
16	System DC Power Supply	HP	6612C	US37462141	2022-01-05	2023-01-05

No.	Name of Equipment	Manufacturer	Model No.	Serial No.	Check Date
1	RF Cable (conducted)	Junkosha Inc.	MWX221	1510S087	2021-02-02
2	3m Loop Cable (Radiated)	HUBER+SUHNER	N/A	N/A	2021-10-25
3	3 m 1GHz Above RF Cable (Radiated)	HUBER+SUHNER	SUCOFLEX 104	MY27558/4	2021-01-28
4	3 m 1GHz Below RF Cable (Radiated)	HUBER+SUHNER	SUCOFLEX 104	N/A (below 1GHz)	2021-01-28
4	3 m 1GHz Above RF Cable (Radiated)	HUBER+SUHNER	SUCOFLEX 104	MY27573/4	2021-12-12
5	3 m 1GHz Above RF Cable (Radiated)	HUBER+SUHNER	SUCOFLEX 104	801924/4	2021-12-12
6	3 m 1GHz Above RF Cable (Radiated)	HUBER+SUHNER	SUCOFLEX 102	MY4728/2	2021-02-02
7	3 m 1GHz Above RF Cable (Radiated)	HUBER+SUHNER	SUCOFLEX 102	MY2374/2	2021-02-02