Korea Standard Testlab
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FCC TEST REPORT

Applicant Name	: SK telink Corporation
Brand Name	: N/A
Applicant Address	: Namdaemun-ro 5ga, 24, Toegye-ro, Gung-gu, Seoul, Republic of Korea
FCC ID	: 2AVZU-SKTL-400
Products Name	: RFID/USN Sensor Network
Model No.	: SKTL-400
Variant Model No.	: N/A
Products Manufacturer	: SK telink Corporation
Test Standard	: FCC CRF 47 PART 15 SUBPART C Section 15.225
Test Method	: ANSI C63.10:2013
Test Result	: PASS
Dates of Test	: MAR 16, 2020 to MAR 18, 2020
Date of Issue	: MAR 26, 2020
Test Laboratory	: Korea Standard Testlab FCC Registration No. : 829397

Tested by

Seungho Baek
Test Engineer

Approved by

Dongin Youn
Technical Manager

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1. Applicant Information

Applicant Name	SK telink Corporation
Address	Namdaemun-ro 5ga, 24, Toegye-ro, Gung-gu, Seoul, Republic of Korea
Manufacturer	SK telink Corporation
Addressant Name	Namdaemun-ro 5ga, 24, Toegye-ro, Gung-gu, Seoul, Republic of Korea
Country of Origin	Korea

2. E.U.T.(Equipment under test) Information

Porduct name	RFID/USN Sensor Network
Model name	SKTL-400
Power source	DC 12 V
Frequency range	13.56 MHz
Modulation Technique	ASK
Antenna specification	PCB Loop Antenna

3. Laboratory Information

Korea Standard Testlab

-107-27, Jangdeokdong-gil, Namyang-eup, Hwaseong-si, Gyeonggi-do, Korea.

Test site

-FCC Registration Number: 829397

-This test site is in compliance with ISO/IEC 17025 for general requirements for the competence of testing and calibration laboratories.

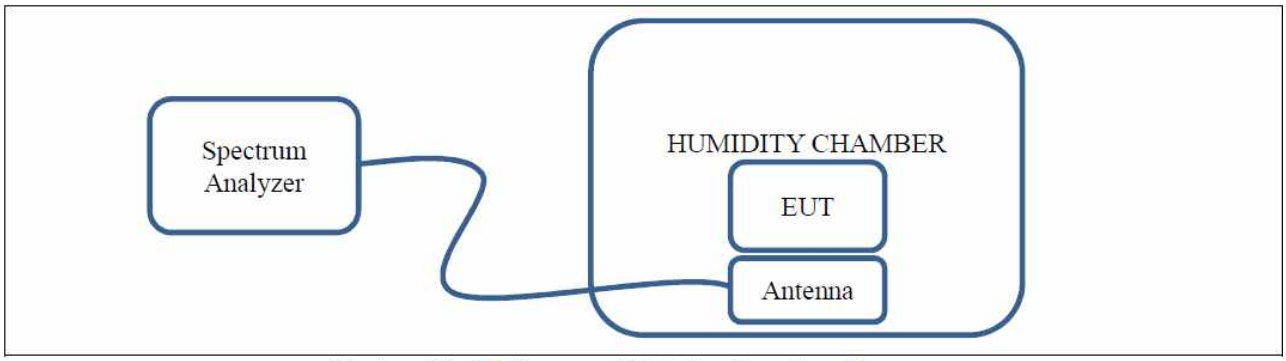
4. Test Configuration and Condition

4.1 E.U.T. operating condition

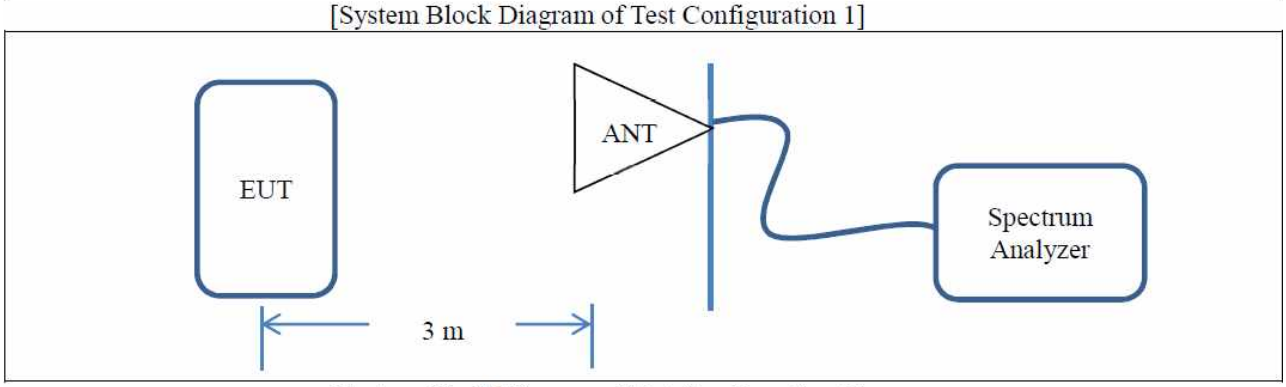
-The E.U.T had been tested under the operating condition.
-There are one channels have been tested as folloVing:

Channel	Frequency(MHz)
Fundamental	13.56

4.2 E.U.T. test configuration diagram



[System Block Diagram of Test Configuration 1]



[System Block Diagram of Test Configuration 2]

4.3 Peripheral equipments list for test

Equipment Name	Model	Serial Number	Manufacturer
RFID/USN Sensor Network	SKTL-400	-	SK telink Corporation
DC Power Supply	U8002A	MY5813082	KEYSIGHT
USB to 485/422 Convertor	-	-	Lightcom Co., Ltd.
RS-232/485 to Wiegand Convertor	NT-285W	-	LE Information Communication Co., Ltd.
USB Serial Convertor	-	-	GOODWAY TECHNOLOGY Co., Ltd.
Laptop	NT200B5C	JBRG91ED700063F	Samsung Electronics Co., Ltd.
Adapter	0455A1990	AD-9019S	Lysine Co., Ltd.

4.4 Cable connections

Start		End		Cable	
Name	I/O Port	Name	I/O Port	Length	Spec.
RFID/USN Sensor Network	-	USB to 485/422 Convertor	T+	0.1	Unshielded
			T-	0.1	Unshielded
		RS-232/485 to Wiegand Convertor	W10	0.1	Unshielded
			W11	0.1	Unshielded
			GND	0.1	Unshielded
			12V(+)	0.1	Unshielded
RS-232/485 to Wiegand Convertor	RS232	USB Serial Convertor	RS232	-	Unshielded
	GND	DC Power Supply	-	1.7	Unshielded
	12V(+)				
USB Serial Convertor	-	Laptop	USB	0.2	Unshielded
USB to 485/422 Convertor	-	Laptop	USB	0.2	Unshielded
Laptop	DC in	Adapter	DC out	1.6	Unshielded

4.5 E.U.T. modifications

-None

5. Summary of Test Results and Measurement Procedures

5.1 Summary of test results

Standard	Test Item	CFR 47 Section	Result
FCC CFR 47 PART 15 SUBPART C, Section 15.225	Radiated Electric Field Emissions	15.225(a) (b) (c)	PASS
	Radiated Electric Field Emissions	15.225(d)	PASS
	Frequency Stability	15.225(e)	PASS
	AC Power line Conducted Emissions	15.207	PASS
	20 dB Bandwidth	15.215(c)	PASS

5.2 AC power line conducted emissions

The E.U.T. was connected to DC Power Supply and the power of DC Power Supply was connected to LISN. All supporting equipments were connected to another LISN.
Preliminary Power line Conducted Emission test was performed by using the procedure in ANSI C63.10: 2013 to determine the worse operating conditions.

5.3 Radiated Spurious Emissions

Preliminary radiated emissions test were conducted using the procedure in ANSI C63.10:2013 to determine the worse operating conditions. The radiated emissions measurements were performed on the 3 m open area test site. The turntable was rotated through 360 degrees and the E.U.T. was tested by positioned three orthogonal planes to obtain the highest reading on the field strength meter. Once maximum reading was determined, the search antenna was raised and lowered in both vertical and horizontal polarization.

6. TEST Results

6.1 Radiated Electric Field Emissions

6.1.1 Regulation

According to §15.225(a), The field strength of any emissions within the band 13.553−3.567 MHz shall not exceed 15,848 microvolts/meter at 30 meters.
According to §15.225(b), Within the bands 13.410−3.553 MHz and 13.567−3.710 MHz, the field strength of any emissions shall not exceed 334 microvolts/meter at 30 meters.
According to §15.225(c) Within the bands 13.110−3.410 MHz and 13.710−4.010 MHz the field strength of any emissions shall not exceed 106 microvolts/meter at 30 meters.

6.1.2 Test Condition

- The EUT is placed on a turntable, which is 0.8m above ground plane.
- Three orientation for the EUT were tried to find out which orientation produces the worst emissions.
- The loop antenna was also moved around to find out worst position for the emissions.
- Set RBW of Spectrum analyzer to 9 kHz, VBW=10 kHz, Sweep=1s
- The field strength of any emissions within the band 13.553-13.567 MHz shall not exceed 15,848 uV/m at 30 meters.

6.1.3 Test Data

6.1.3.1 Operation Frequency Band:(13.553~13.567)MHz

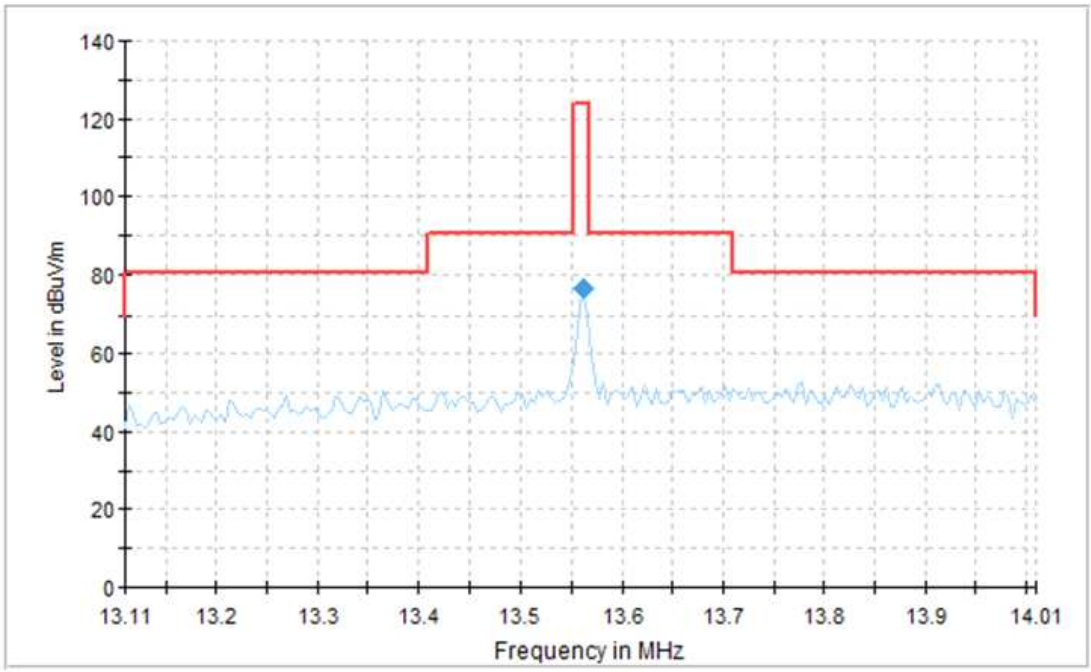
Radiated Emission		Ant	Correction Factors		Total	FCC	
Freq. [MHz]	Amplitud [dBμV]	Pol.	Antenna [dB/m]	Cable [dB]	Amplitude [dBμV/m]	Limit [dBμV/m]	Margin [dB]
13.56	57.58	H	14.50	1.50	73.58	124	-50.42
13.56	48.38	V	14.50	1.50	64.38	124	-59.62

*Remark: The E.U.T. was tested at 3m, so converstation factor was included at above limit.

6.1.3.2 Operation frequency band:Below 13.553 MHz and above 13.567 MHz

-The following table shows the highest levels of radiated emissions on both polarizations of horizontal and vertical.

Full Spectrum



Final_Result

Frequency (MHz)	MaxPeak (dBuV/m)	Limit (dBuV/m)	Margin (dB)	Pol
13.562000	73.58	124.00	50.42	H

Acc. to above test data, the field strength level of 13. 56 MHz is 73.58 dBuV/m and the worst limit subject to 15.225 (b) and (c) is 80.5 dBuV/m, so the EUT meets the requirement.

6.2 Radiated Spurious Emissions

6.2.1 Regulation

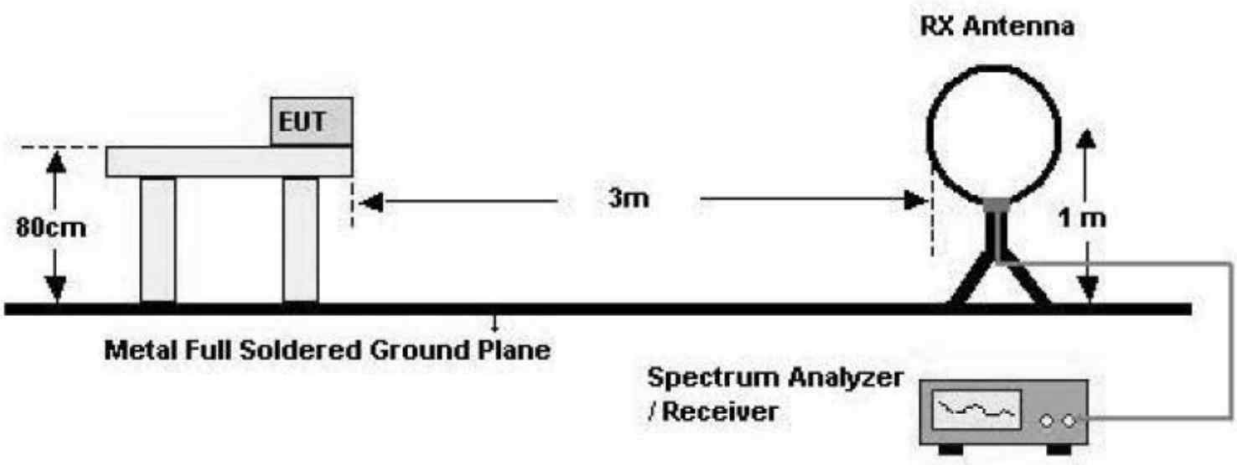
According to §15.225(d), The field strength of any emissions appearing outside of the 13.110–4.010 MHz band shall not exceed the general radiated emission limits in § 15.209.
According to §15.209(a), for an intentional device, the general requirement of field strength of radiated emissions from intentional radiators at a distance of 3 meters shall not exceed the following values:

Frequency [MHz]	Field strength [μV/m]	Field strength [dBμV/m]	Measurement distance [m]
0.009 ~ 0.490	2 400 / F (kHz)	-	300
0.490 ~ 1.705	24 000 / F (kHz)	-	30
1.705 ~ 30	30	29.54	30
30 ~ 88	100	40.00	3
88 ~ 216	150	43.52	3
216 ~ 960	200	46.02	3
Above 960	500	53.98	3

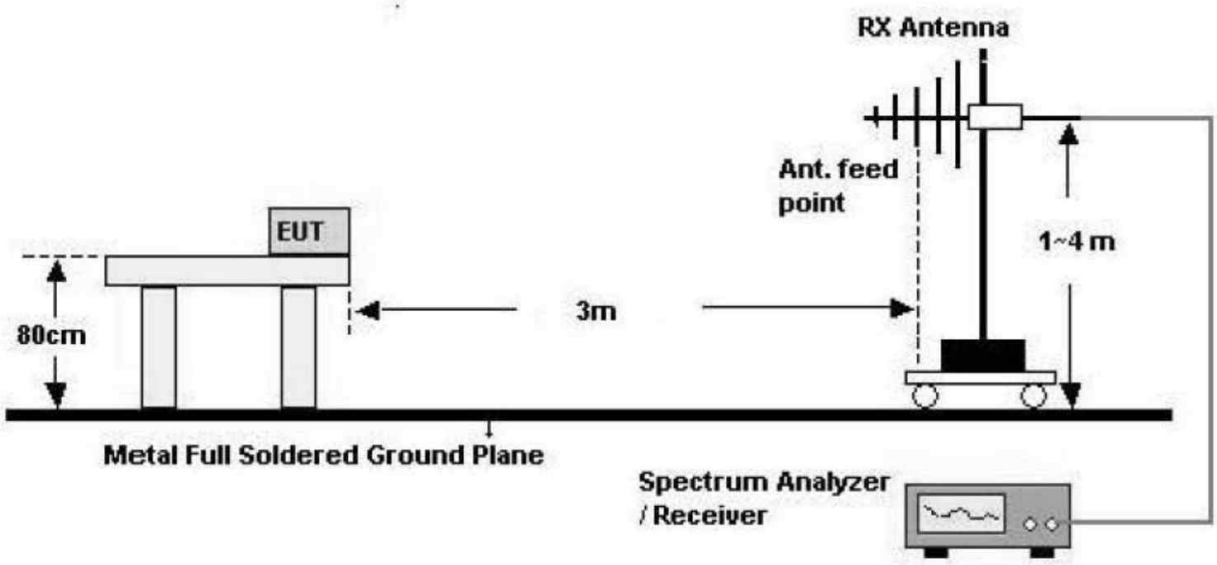
The emission limits shown in the above table are based on measurement instrumentation employing a CISPR quasi peak detector and above 1 000 MHz are based on the average value of measured emissions.

6.2.2 Test setup layout

6.2.2.1 Radiated Spurious Emissions set-up, frequency below 30 MHz



6.2.2.2 Radiated Spurious Emissions set-up, frequency below 1 000 MHz



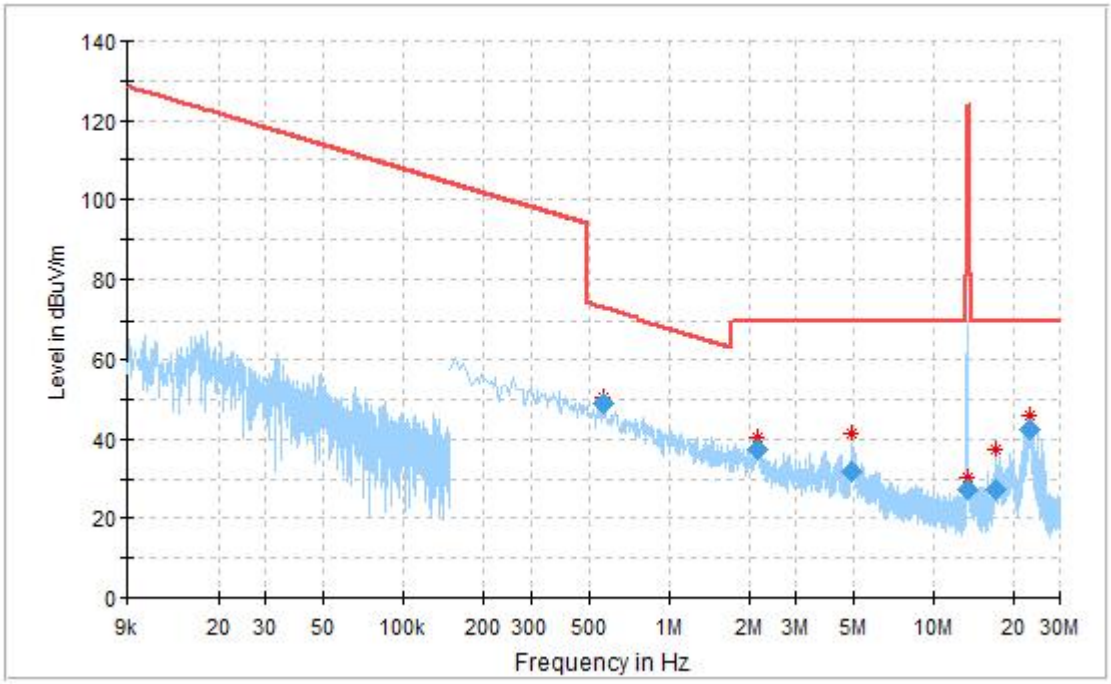
6.2.3 Test Data

Measured values of the Field strength of spurious emission					
Frequency [MHz]	Detect Mode	Polarization [V/H]	Emission Level [dB μ V/m]	Limit [dB μ V/m]	Margin [dB]
Average/Peak/Quasi-peak data, emissions below 30 MHz					
0.56	Qausi-peak	H	49.14	72.61	-23.47
0.56	Qausi-peak	V	63.55	72.61	-9.06
0.91	Qausi-peak	V	40.78	68.40	-27.62
2.09	Qausi-peak	V	35.23	69.50	-34.27
2.14	Qausi-peak	H	37.50	69.50	-32.00
4.87	Qausi-peak	H	31.75	69.50	-37.75
4.88	Qausi-peak	V	30.89	69.50	-38.61
17.25	Qausi-peak	H	27.13	69.50	-42.37
22.51	Qausi-peak	V	41.88	69.50	-27.62
22.91	Qausi-peak	H	42.28	69.50	-27.22
Quasi-peak data, emissions below 1 000 MHz					
31.94	Qausi-peak	V	36.40	40.00	-3.60
70.82	Qausi-peak	V	16.43	40.00	-23.57
168.02	Qausi-peak	H	31.02	43.50	-12.48
189.40	Qausi-peak	V	20.83	43.50	-22.67
243.83	Qausi-peak	H	14.77	46.00	-31.23
449.88	Qausi-peak	H	24.31	46.00	-21.69

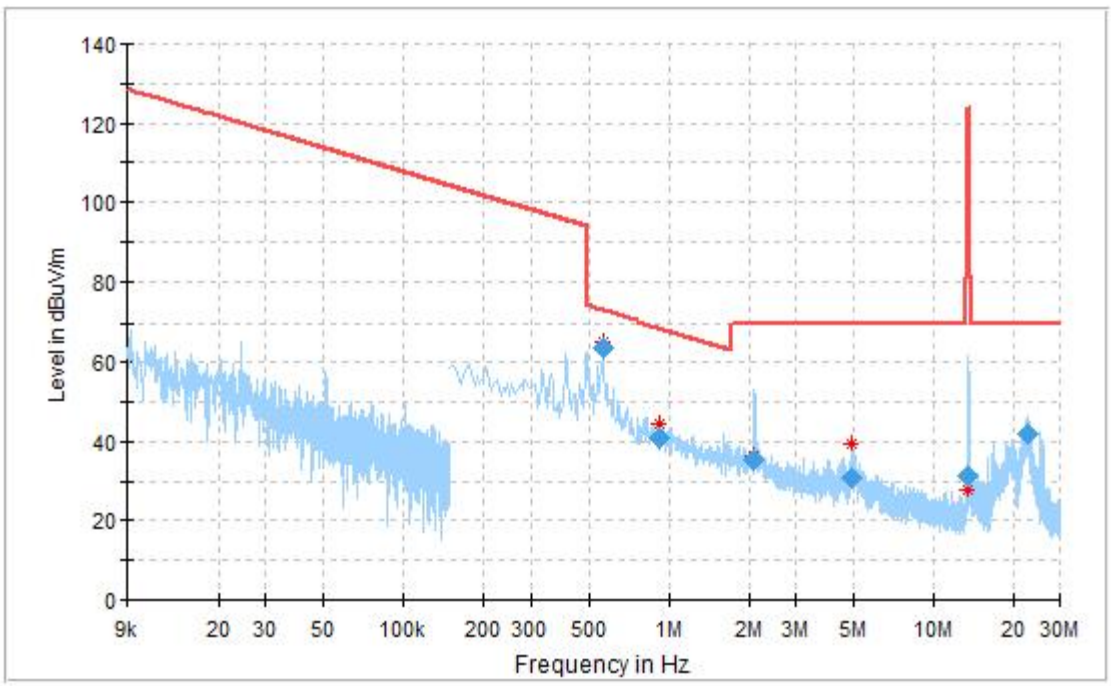
* Remark: “H”: Horizontal, “V”: Vertical
* Margin [dB] = Emission Level [dBμV/m] −Limit [dBμV/m]

6.2.4 Plot of the Radiated Spurious Emissions

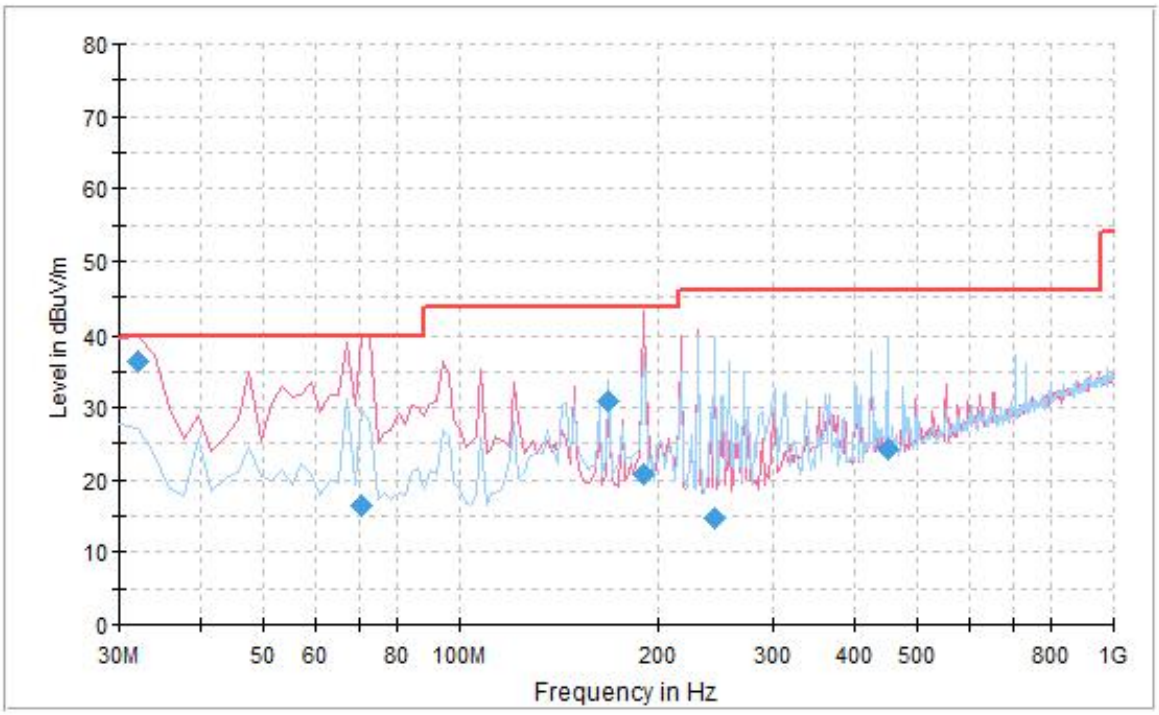
6.2.4.1 Plot of the Radiated Spurious Emissions Below 30 MHz Horizontal



6.2.4.2 Plot of the Radiated Spurious Emissions Below 30 MHz Vertical



6.2.4.3 Plot of the Radiated Spurious Emissions Below 1 GHz Horizontal and Vertical



6.3 Frequency Stability

6.3.1 Regulation

According to §15.225(e), The frequency tolerance of the carrier signal shall be maintained within ±0.01% of the operating frequency over a temperature variation of -20 degrees to +50 degrees C at normal supply voltage, and for a variation in the primary supply voltage from 85% to 115% of the rated supply voltage at a temperature of 20 degrees C. For battery operated equipment, the equipment tests shall be performed using a new battery.

6.3.2 Test Condition

1. Frequency stability vs. temperature measurement
   -The EUT was placed into the constant temperature chamber.
   -The spectrum analyzer was used to read the EUT operating frequency.
   -Set the constant temperature chamber temperature within the range of -20°C to +50°C
2. Frequency stability vs. input voltage measurement
   -The EUT was placed into the constant temperature chamber and set the temperature to 20°C.
   -The spectrum analyzer was used to read the EUT operating frequency.
   -The EUT is powered with the DC Power Supplied it with 85% and 115% voltage, and measured the EUT operating frequency.

6.3.3 Test Data

<table>
<tr><th colspan="7">Measured values of the Frequency Stability</th></tr>
<tr><th rowspan="2">Frequency [Hz]</th><th colspan="4">Test Data [Hz]</th><th rowspan="2">Limit [Hz]</th><th rowspan="2">Verdict</th></tr>
<tr><th>-20°C</th><th>-10°C</th><th>0°C</th><th>+10°C</th></tr>
<tr><td rowspan="8">13 560 000</td><td>13 561 549</td><td>13 561 599</td><td>13 561 621</td><td>13 561 642</td><td rowspan="8">± 1 356 Hz
(13 559 644
~
13 562 356)</td><td rowspan="8">PASS</td></tr>
<tr><td>+20°C</td><td>+30°C</td><td>+40°C</td><td>+50°C</td></tr>
<tr><td>135 616 57</td><td>13 561 679</td><td>13 561 712</td><td>13 561 740</td></tr>
<tr><td colspan="4">Test Voltage</td></tr>
<tr><td colspan="2">Power 85%</td><td colspan="2">Power 115%</td></tr>
<tr><td colspan="2">13 561 586</td><td colspan="2">13 561 735</td></tr>
</table>

*Note
- Limit : Operating frequency X (±) 0.0001 = (±) 1356 Hz
- Within the band : 13559644 Hz - 13562356 Hz

6.4 20 dB bandwidth

6.4.1 Regulation

15.215(c), Intentional radiators operating under the alternative provisions to the general emission limits, as contained in §§ 15.217 through 15.257 and in subpart E of this part, must be designed to ensure that the 20 dB bandwidth of the emission is contained within the frequency band designated in the rule section under which the equipment is operated. The requirement to contain the 20 dB bandwidth of the emission within the specified frequency band includes the effects from frequency sweeping, frequency hopping and other modulation techniques that may be employed as well as the frequency stability of the transmitter over expected variations in temperature and supply voltage. If a frequency stability is not specified in the regulations, it is recommended that the fundamental emission be kept within at least the central 80% of the permitted band in order to minimize the possibility of out-of-band operation.

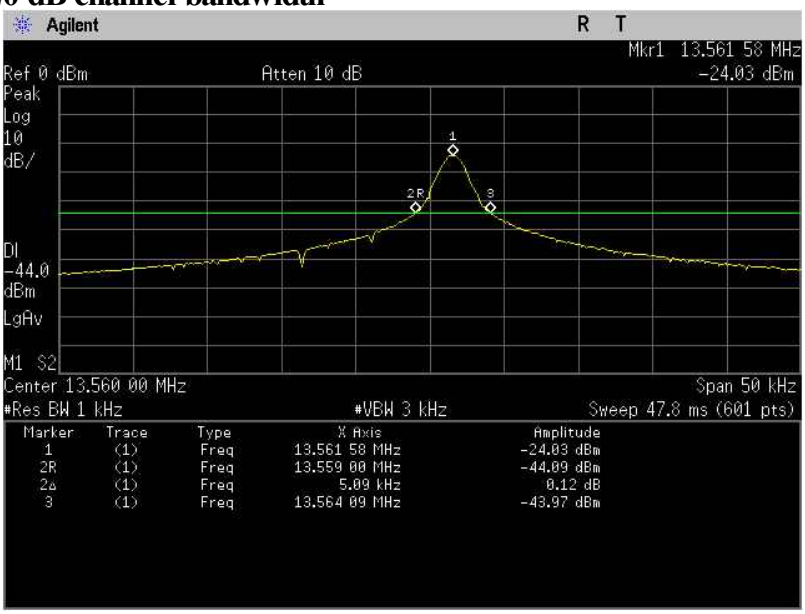
6.4.2 Test condition

The antenna output of the EUT was connected to the spectrum analyzer. The resolution bandwidth is set to 1 kHz, and peak detection was used. The 20 dB bandwidth is defined as the total spectrum over which the power is higher than the peak power minus 20 dB.

6.4.3 Test Data

Measured values of the 20 dB Bandwidth		
Operating Frequency [MHz]	**Measured Value [kHz]**	**Verdict**
13.56	5.09	PASS

6.4.4 Plot of the 20 dB channel bandwidth



6.5 AC power line conducted emissions

6.5.1 Regulation

According to §15.207(a), for an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any following table, as measured using a 50μH/50Ω line impedance stabilization network (LISN).
Compliance with the provisions of this paragraph shall be based on the measurement of the radio frequency voltage between each power line and ground at the power terminal. The lower limit applies at the boundary between the frequency ranges.

Frequency of emission [MHz]	Conducted limit [dBμV]	
	Qausi-peak	Average
0.15~0.5	66 to 56*	56 to 46*
0.5~5	56	46
5~30	60	50

* Decreases with the logarithm of the frequency.

6.5.2 Test procedure

1. The EUT was placed on a wooden table of size, 1 m by 1.5 m, raised 80 cm in which is located 40 cm away from the vertical wall and 1.5m away from the side wall of the shielded room.
2. Each current-carrying conductor of the EUT power cord was individually connected through a 50 Ω / 50 μH LISN, which is an input transducer to a Spectrum Analyzer or an EMI/Field Intensity Meter, to the input power source.
3. Exploratory measurements were made to identify the frequency of the emission that had the highest amplitude relative to the limit by operating the EUT in a range of typical modes of operation, cable position, and with a typical system equipment configuration and arrangement. Based on the exploratory tests of the EUT, the one EUT cable configuration and arrangement and mode of operation that had produced the emission with the highest amplitude relative to the limit was selected for the final measurement.
4. The final test on all current-carrying conductors of all of the power cords to the equipment that comprises the EUT (but not the cords associated with other non-EUT equipment is the system) was then performed over the frequency range of 0.15 MHz to 30 MHz.
5. The measurements were made with the detector set to PEAK amplitude within a bandwidth of 10 kHz or to QUASI-PEAK and AVERAGE within a bandwidth of 9 kHz. The EUT was in transmitting mode during the measurements.

6.5.3 Test Data

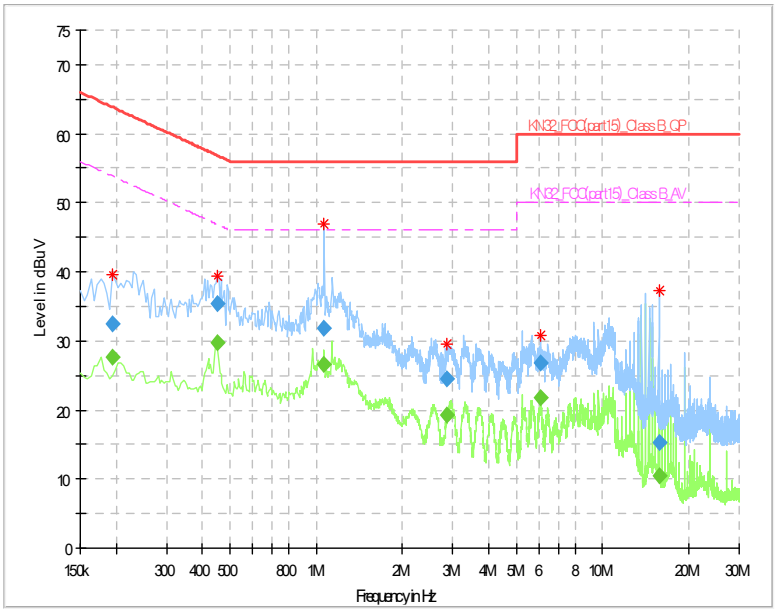
Table 8: Measured values of the AC Power Line Conducted Emissions

Frequency [MHz]	Factor		Line	Quasi-Peak			Average		
	LISN [dB]	Cable [dB]		Limit [dBμV]	Reading [dBμV]	Results [dBμV]	Limit [dBμV]	Reading [dBμV]	Results [dBμV]
0.20	9.85	0.09	H	63.82	22.54	32.48	53.82	17.77	27.71
0.22	9.88	0.09	N	62.74	21.19	31.16	52.74	16.11	26.08
0.45	9.87	0.12	H	56.85	25.39	35.38	46.85	19.82	29.81
0.45	9.89	0.12	N	56.93	26.06	36.07	46.93	18.16	28.17
1.07	9.74	0.18	H	56.00	21.90	31.82	46.00	16.63	26.55
1.14	9.73	0.18	N	56.00	24.61	34.52	46.00	19.85	29.76
2.60	9.68	0.24	N	56.00	14.93	24.85	46.00	9.96	19.88
2.86	9.66	0.25	H	56.00	14.66	24.57	46.00	9.43	19.34
5.65	9.69	0.37	N	60.00	14.94	25.00	50.00	9.63	19.69
6.05	9.68	0.35	H	60.00	16.81	26.84	50.00	11.78	21.81
9.09	9.72	0.40	N	60.00	12.69	22.81	50.00	7.58	17.7
15.72	9.75	0.57	H	60.00	4.91	15.23	50.00	0.14	10.46

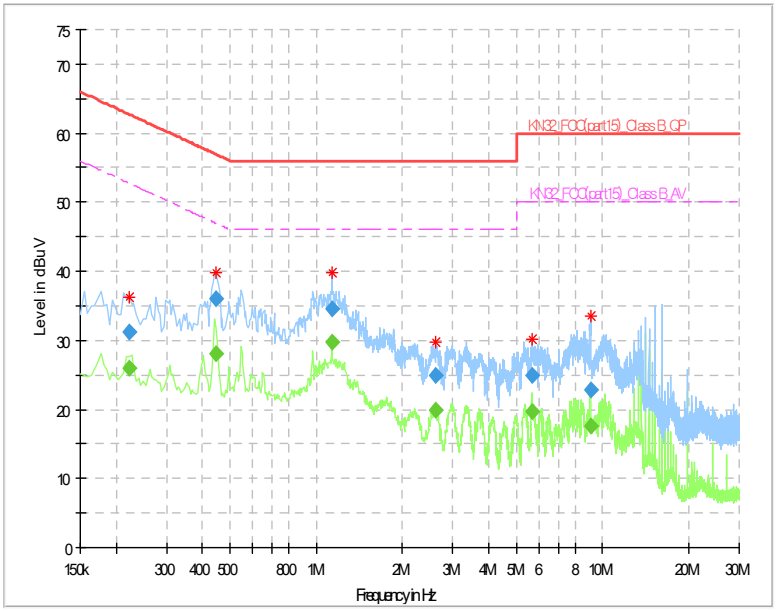
* Remark: “H”: Hot Line, “N”: Neutral Line

6.5.4 Plot of the ac power line conducted emissions

6.5.4.1 Plot of the ac power line conducted emissions Hot line



6.5.4.2 Plot of the ac power line conducted emissions Neutral line



7. Test Equipment Used For Test

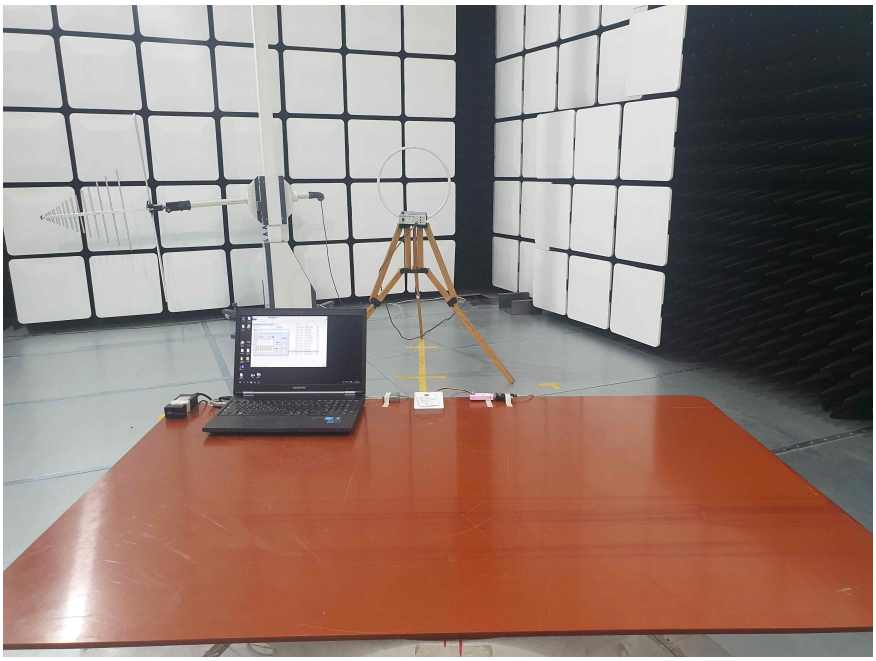
No.	Test Equipment	Manufacturer	Model No.	Serial No.	Next Cal. Data	Used equipment
1	Spectrum Analyzer	Agilent	E4440A	MY45304715	2020.10.01	■
2	DC Power Supply	KEYSIGHT	U8002A	MY5813082	2021.02.21	■
3	Temp & Humidity Chamber	Seoksan Tech	SE-CT-02	S7400JD5340618	2020.05.27	■
4	Loop ANT.	Com-Power	AL-130	121010	2021.06.10	■
5	Test Receiver	ROHDE&SCHWARZ	ESPI	101014	2021.02.21	■
6	EMI TEST Receiver	ESI	ROHD & SCHWARZ	838786	2021.02.21	■
7	LISN	HAMEG	HM6050-2	043810114	2021.02.21	■
8	LISN	ROHDE & SCHWARZ	ENV216	101732	2021.02.21	■
9	Bi-log Antenna	SCHWARZBECK	VULB9163	760	2021.04.09	■
10	Horn ANT.	SCHWARZBECK	BBHA 9120D	831	2020.07.23	■

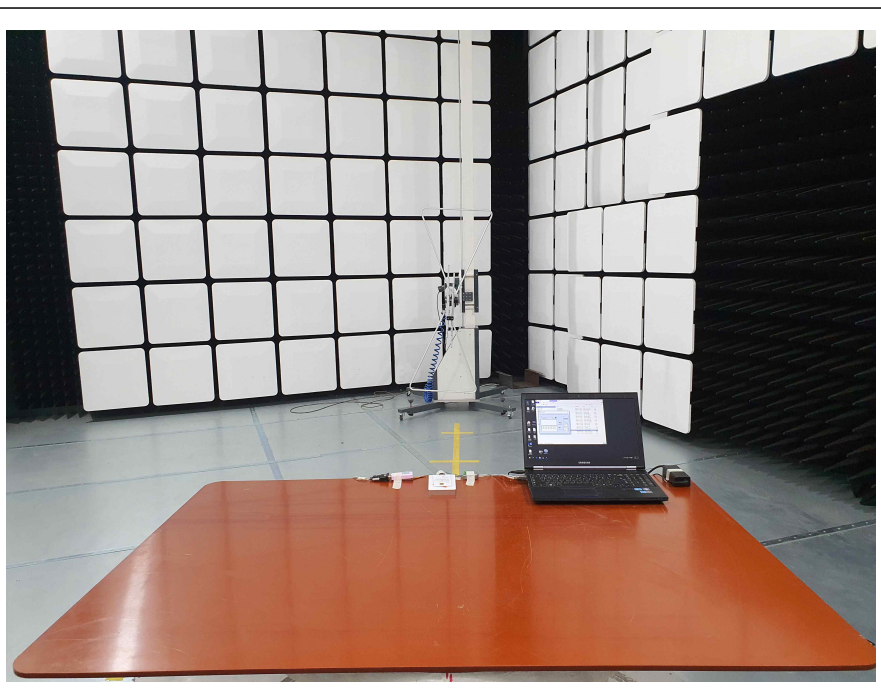
APPENDIX A : Photographs of E.U.T.

1. E.U.T. photo

APPENDIX B : Photographs of Test Setup

1. Radiated Spurious Emission





2. AC power line conducted emissions