

RADIO PERFORMANCE TEST REPORT

Test Report No. : OT-237-RWD-069
Reception No. : 2305001469
Applicant : Geoplan Co., Ltd.
Address : 622, Geumjeong SKV1, 142, LS-ro, Dongan-gu, Anyang-si, Gyeonggi-do, South Korea
Manufacturer : GEOWORKS Co.,Ltd.
Address : Geumjeong SKV1 607, 142, LS-ro, Dongan-gu, Anyang-si, Gyeonggi-do, South Korea
Type of Equipment : UWB+BLE Combo Module
FCC ID. : 2ASPN-MNN2CSX0
Model Name : GMU-NN2CSx.0
Multiple Model Name : GMU-NN2Cxx.0
Serial number : N/A
Total page of Report : 27 pages (including this page)
Date of Incoming : March 17, 2023
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SUMMARY

The equipment complies with the regulation; **FCC PART 15 SUBPART C Section 15.247**

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

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

This report is not correlated with the "KS Q ISO/IEC 17025 and KOLAS accreditation" of Korean Laboratory Accreditation Scheme.





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※ Please refer to the Annex section for All test plots

Revision History

Rev. No.	Issue Report No.	Issued Date	Revisions	Section Affected
0	OT-237-RWD-069	July 28, 2023	Initial Release	All

1. VERIFICATION OF COMPLIANCE

Applicant : Geoplan Co., Ltd.

Address : 622, Geumjeong SKV1, 142, LS-ro, Dongan-gu, Anyang-si, Gyeonggi-do, South Korea

Contact Person : Arron, Kim / Principal Research Engineer

Telephone No. : +82-10-9580-1067

FCC ID : 2ASPN-MNN2CSX0

Model Name : GMU-NN2CSx.0

Brand Name : -

Serial Number : N/A

Date : July 28, 2023

EQUIPMENT CLASS	DTS – DIGITAL TRNSMISSION SYSTEM
E.U.T. DESCRIPTION	UWB+BLE Combo Module
THIS REPORT CONCERNS	Original Grant
MEASUREMENT PROCEDURES	ANSI C63.10: 2013
TYPE OF EQUIPMENT TESTED	Pre-Production
KIND OF EQUIPMENT AUTHORIZATION REQUESTED	Certification
EQUIPMENT WILL BE OPERATED UNDER FCC RULES PART(S)	FCC PART 15 SUBPART C Section 15.247 KDB 558074 D01 15.247 Meas Guidance v05r02
Modifications on the Equipment to Achieve Compliance	None
Final Test was Conducted On	3 m, Semi Anechoic Chamber

-. The above equipment was tested by ONETECH Corp. for compliance with the requirement set forth in the FCC Rules and Regulations. This said equipment in the configuration described in this report, shows the maximum emission levels emanating from equipment are within the compliance requirements.

2. TEST SUMMARY

2.1 Test items and results

SECTION	TEST ITEMS	RESULTS
15.247 (a) (2)	Minimum 6 dB Bandwidth	Met the Limit / PASS
15.247 (b) (3)	Maximum Conducted Output Power	Met the Limit / PASS
15.247 (d)	100 kHz Bandwidth Outside the Frequency Band	Met the Limit / PASS
15.247 (d)	Radiated Emission which fall in the Restricted Band	Met the Limit / PASS
15.247 (e)	Power Spectral Density	Met the Limit / PASS
15.209	Radiated Emission Limits	Met the Limit / PASS
15.207	Conducted Limits	Met the Limit / PASS
15.203	Antenna Requirement	Met requirement / PASS

2.2 Additions, deviations, exclusions from standards

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

2.3 Related Submittal(s) / Grant(s)

Original submittal only

2.4 Purpose of the test

To determine whether the equipment under test fulfills the requirements of the regulation stated in FCC PART 15 SUBPART C Section 15.247.

2.5 Test Methodology

Both conducted and radiated testing was performed according to the procedures in ANSI C63.10: 2013. Radiated testing was performed at a distance of 3 m from EUT to the antenna.

2.6 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 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea.

-. Site Filing:

VCCI (Voluntary Control Council for Interference) – Registration No. R-20122/ C-14617/ G-10666/ T-11842

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

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

FCC (Federal Communications Commission) - Accreditation No. KR0013

RRA (Radio Research Agency) – Designation No. KR0013

3. GENERAL INFORMATION

3.1 Product Description

The Geoplan Co., Ltd., Model GMU-NN2CSx.0 (referred to as the EUT in this report) is a UWB+BLE Combo Module. The product specification described herein was obtained from product data sheet or user's manual.

Device Type	UWB+BLE Combo Module	
Temperature Range	-20 °C ~ 75 °C	
OPERATING FREQUENCY	Bluetooth LE	2 402 MHz ~ 2 480 MHz
	UWB	6 489.60 MHz, 7 987.20 MHz
MODULATION TYPE	Bluetooth LE	GFSK
	UWB	BPSK
RF OUTPUT POWER	Bluetooth LE	1 Mbps: -1.89 dBm 2 Mbps: -0.94 dBm
	UWB	-41.30 dBm/MHz (Average) 0 dBm/50MHz (Peak)
ANTENNA TYPE	Bluetooth LE	PCB Antenna
	UWB	Chip Antenna
ANTENNA GAIN	Bluetooth LE	4.98 dBi
	UWB	2.20 dBi
List of each Osc. or crystal Freq.(Freq. >= 1 MHz)	32 MHz, 38.4 MHz	

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

-. The following lists consist of the added model and their differences.

Model Name	Differences	Tested
GMU-NN2CSx.0	Basic Model	☒
GMU-NN2Cxx.0	The model is identical to basic model except that the security IC has been removed.	☐

Note: 1. Applicant consigns only basic model to test. Therefore this test report just guarantees the units, which have been tested.

2. The Applicant/manufacture is responsible for the compliance of all variants.

4. EUT MODIFICATIONS

-. None

5. SYSTEM TEST CONFIGURATION

5.1 Justification

This device was configured for testing in a typical way as a normal customer is supposed to be used. During the test, the following components were installed inside of the EUT.

DEVICE TYPE	MANUFACTURER	MODEL/PART NUMBER	FCC ID
Main Board	GEOWORKS Co.,Ltd.	N/A	N/A

5.2 Peripheral equipment

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

Model	Manufacturer	Description	Connected to
GMU-NN2CSx.0	GEOWORKS Co.,Ltd.	UWB+BLE Combo Module (EUT)	-
Ideapad 320	Lenovo	Notebook PC	EUT

5.3 Mode of operation during the test

-. Channel List (Bluetooth LE)

Channel	Frequency[MHz]	Channel	Frequency[MHz]	Channel	Frequency[MHz]
0	2 402.00	14	2 430.00	28	2 458.00
1	2 404.00	15	2 432.00	29	2 460.00
2	2 406.00	16	2 434.00	30	2 462.00
3	2 408.00	17	2 436.00	31	2 464.00
4	2 410.00	18	2 438.00	32	2 466.00
5	2 412.00	19	2 440.00	33	2 468.00
6	2 414.00	20	2 442.00	34	2 470.00
7	2 416.00	21	2 444.00	35	2 472.00
8	2 418.00	22	2 446.00	36	2 474.00
9	2 420.00	23	2 448.00	37	2 476.00
10	2 422.00	24	2 450.00	38	2 478.00
11	2 424.00	25	2 452.00	39	2 480.00
12	2 426.00	26	2 454.00		
13	2 428.00	27	2 456.00		

-. Duty Cycle

Mode	Tx On Time [ms]	Tx Off Time [ms]	Duty Cycle [%]	Correction Factor [dB]
Bluetooth LE 1 Mbps	2.150	0.350	86.00	0.66
Bluetooth LE 2 Mbps	1.090	1.410	43.60	3.61

Note – Duty Cycle : (Tx On Time / (Tx On Time + Tx Off Time)) * 100

Correction Factor : 10 * Log(1 / (Duty Cycle / 100))

5.4 Configuration of Test System

- Line Conducted Test:** The EUT was connected to DC power supply and the power of DC power supply was connected to LISN. All supporting equipment 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.
- Radiated Emission Test:** Preliminary radiated emissions test were conducted using the procedure in ANSI C63.10: 2013 to determine the worse operating conditions. Final radiated emission tests were conducted at 3 meter Semi Anechoic Chamber. The turntable was rotated through 360 degrees and the EUT 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.

5.5 Antenna Requirement

For intentional device, according to section 15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device.

Antenna Construction:

The antenna of the EUT is a PCB Antenna and Chip Antenna on the main board in the EUT, so no consideration of replacement by the user.

6. PRELIMINARY TEST

6.1 AC Power line Conducted Emissions Tests

During Preliminary Test, the following operating mode was investigated.

Operation Mode	The Worse operating condition (Please check one only)
Transmitting Mode	X

6.2 General Radiated Emissions Tests

During Preliminary Test, the following operating mode was investigated.

Operation Mode	The Worse operating condition (Please check one only)
Transmitting Mode	X

7. MINIMUM 6 dB BANDWIDTH

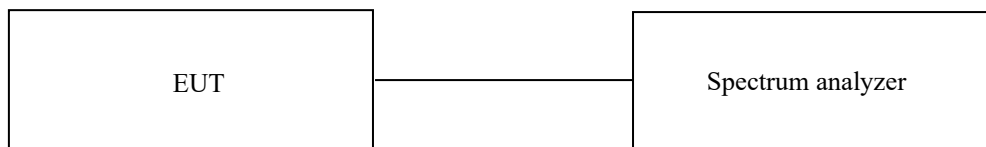
7.1 Operating environment

Temperature : 23 °C

Relative humidity : 45 % R.H.

7.2 Test set-up

The antenna output of the EUT was connected to the spectrum analyzer. The resolution bandwidth is set to 100 kHz, and peak detection was used. The 6 dB bandwidth is defined as the total spectrum over which the power is higher than the peak power minus 6 dB.



7.3 Measurement uncertainty

The uncertainty for Minimum 6 dB bandwidth is $\pm 8\,623.60$ Hz

7.4 Test date

April 11, 2023 ~ April 14, 2023

7.5 Test data for 1 Mbps

-. Test Result : Pass

CHANNEL	FREQUENCY (MHz)	6 dB Bandwidth (kHz)	LIMIT (kHz)	Margin (kHz)
Low	2 402.00	669.30	500.00	169.30
Middle	2 440.00	669.30	500.00	169.30
High	2 480.00	669.30	500.00	169.30

Remark. Margin = Measured Value – Limit

7.6 Test data for 2 Mbps

-. Test Result : Pass

CHANNEL	FREQUENCY (MHz)	6 dB Bandwidth (kHz)	LIMIT (kHz)	Margin (kHz)
Low	2 402.00	1 151.00	500.00	651.00
Middle	2 440.00	1 139.00	500.00	639.00
High	2 480.00	1 149.00	500.00	649.00

Remark. Margin = Measured Value – Limit

8. MAXIMUM CONDUCTED(PEAK) OUTPUT POWER

8.1 Operating environment

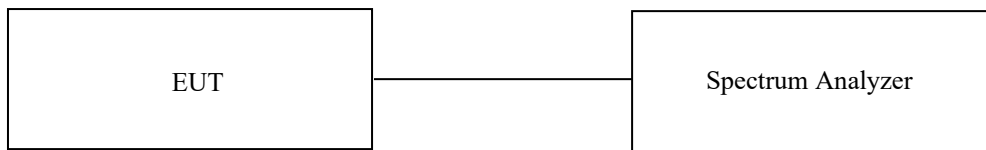
Temperature : 23 °C

Relative humidity : 45 % R.H.

8.2 Test set-up

The antenna output of the EUT was connected to the spectrum analyzer.

The resolution bandwidth is set to 1 MHz, the video bandwidth is set to 3 times the resolution bandwidth.



8.3 Measurement uncertainty

The uncertainty for Maximum conducted(Peak) output power is ± 1.51 dBm

8.4 Test date

April 11, 2023 ~ April 14, 2023

8.5 Test data for 1 Mbps

-. Test Result : Pass

-. Duty Cycle : 86.0 %

CHANNEL	FREQUENCY (MHz)	MEASURED VALUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 402.00	-1.95	30.00	31.95
MIDDLE	2 440.00	-1.89	30.00	31.89
HIGH	2 480.00	-2.16	30.00	32.16

Remark. Margin = Limit – Measured Value

8.6 Test data for 2 Mbps

-. Test Result : Pass

-. Duty Cycle : 43.6 %

CHANNEL	FREQUENCY (MHz)	MEASURED VALUE (dBm)	LIMIT (dBm)	MARGIN (dB)
LOW	2 402.00	-0.98	30.00	30.98
MIDDLE	2 440.00	-0.98	30.00	30.98
HIGH	2 480.00	-0.94	30.00	30.94

Remark. Margin = Limit – Measured Value

9. 100 kHz BANDWIDTH OUTSIDE THE FREQUENCY BAND

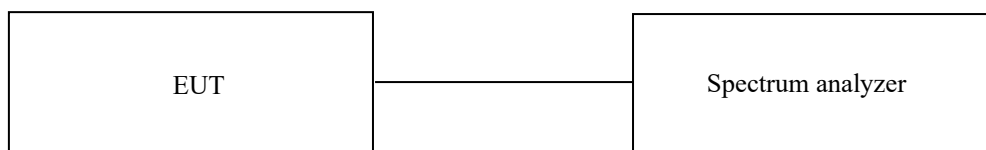
9.1 Operating environment

Temperature : 23 °C

Relative humidity : 45 % R.H.

9.2 Test set-up for conducted measurement

The antenna output of the EUT was connected to the spectrum analyzer. The resolution bandwidth is set to 100 kHz and video bandwidth is set to 300 kHz, and peak detection was used.



9.3 Test set-up for radiated measurement

The radiated emissions measurements were performed on the 3 m semi anechoic chamber. The EUT was placed on turntable approximately 1.5 m above the ground plane.

The frequency spectrum from 30 MHz to 26.5 GHz was scanned and maximum emission levels 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 in order to determine the maximum emission levels. This procedure was performed for horizontal and vertical polarization of the receiving antenna.

9.4 Measurement uncertainty

The uncertainty for 100 kHz bandwidth outside the frequency band is ± 1.56 dBm

9.5 Test date

April 11, 2023 ~ April 14, 2023

9.6 Test data for conducted emission

Please refer to the Annex

9.7 Test data for radiated emission

9.7.1 Radiated Emission which fall in the Restricted Band

9.7.1.1 Test data for 1 Mbps

- Resolution bandwidth : 1 MHz and Peak Detector for Peak Mode
1 MHz and RMS Detector for Average Mode
- Video bandwidth : 3 MHz for Peak and Average Mode
- Measurement distance : 3 m
- Duty Cycle : 86.0 %
- Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor (dB/m)	Cable Loss (dB)	AMP Gain (dB)	ATT (dB)	Duty Factor (dB)	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel											
2 390.000	65.25	Peak	H	27.90	5.68	45.14	-	-	53.69	74.00	20.31
2 390.000	42.39	Average	H	27.90	5.68	45.14	-	0.66	31.49	54.00	22.51
2 390.000	65.46	Peak	V	27.90	5.68	45.14	-	-	53.90	74.00	20.10
2 389.730	42.50	Average	V	27.90	5.68	45.14	-	0.66	31.60	54.00	22.40
Test Data for High Channel											
2483.75	74.53	Peak	H	27.40	5.82	44.90	-	-	62.85	74.00	11.15
2483.89	52.79	Average	H	27.40	5.82	44.90	-	0.66	41.77	54.00	12.23
2483.79	74.48	Peak	V	27.40	5.82	44.90	-	-	62.80	74.00	11.20
2484.13	52.83	Average	V	27.40	5.82	44.90	-	0.66	41.81	54.00	12.19

Remark: "H": Horizontal, "V": Vertical

Margin (dB) = Limits (dBμV/m) - Total Level (dBμV/m)

Total Level = Reading + Antenna Factor + Cable Loss + ATT + Duty Factor - AMP Gain

9.7.1.1 Test data for 2 Mbps

- Resolution bandwidth : 1 MHz and Peak Detector for Peak Mode
1 MHz and RMS Detector for Average Mode
- Video bandwidth : 3 MHz for Peak and Average Mode
- Measurement distance : 3 m
- Duty Cycle : 43.6 %
- Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor (dB/m)	Cable Loss (dB)	AMP Gain (dB)	ATT (dB)	Duty Factor (dB)	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel											
2 390.000	64.88	Peak	H	27.90	5.68	45.14	-	-	53.32	74.00	20.68
2 389.730	42.89	Average	H	27.90	5.68	45.14	-	3.61	34.94	54.00	19.06
2 390.000	64.94	Peak	V	27.90	5.68	45.14	-	-	53.38	74.00	20.62
2 389.914	43.39	Average	V	27.90	5.68	45.14	-	3.61	35.44	54.00	18.56
Test Data for High Channel											
2 483.946	74.49	Peak	H	27.40	5.82	44.90	-	-	58.03	74.00	15.97
2 483.826	52.52	Average	H	27.40	5.82	44.90	-	3.61	50.96	54.00	3.05
2 483.886	75.01	Peak	V	27.40	5.82	44.90	-	-	58.12	74.00	15.88
2 483.826	53.22	Average	V	27.40	5.82	44.90	-	3.61	50.67	54.00	3.34

Remark: "H": Horizontal, "V": Vertical

Margin (dB) = Limits (dBμV/m) - Total Level (dBμV/m)

Total Level = Reading + Antenna Factor + Cable Loss + ATT + Duty Factor - AMP Gain

9.7.2 Spurious & Harmonic Radiated Emission

9.7.2.1 Test data for 1 Mbps

- Resolution bandwidth : 1 MHz and Peak Detector for Peak Mode for the emissions fall in restricted band,
1 MHz and RMS Detector for Average Mode for the emissions fall in restricted band
100 kHz for Peak Mode for the emissions outside restricted band
- Video bandwidth : 3 MHz for Peak and Average Mode
- Frequency range : 1 GHz ~ 26.5 GHz
- Measurement distance : 3 m
- Duty Cycle : 86.0 %
- Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor (dB/m)	Cable Loss (dB)	AMP Gain (dB)	Duty Factor (dB)	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel										
4 804.000	48.64	Peak	H	31.30	8.23	44.70	-	43.47	74.00	30.53
4 804.000	37.00	Average	H	31.30	8.23	44.70	0.66	32.49	54.00	21.51
4 804.000	48.59	Peak	V	31.30	8.23	44.70	-	43.42	74.00	30.58
4 804.000	37.03	Average	V	31.30	8.23	44.70	0.66	32.52	54.00	21.48
Test Data for Middle Channel										
4 880.000	48.38	Peak	H	31.20	8.25	44.70	-	43.13	74.00	30.87
4 880.000	37.11	Average	H	31.20	8.25	44.70	0.66	32.52	54.00	21.48
4 880.000	48.14	Peak	V	31.20	8.25	44.70	-	42.89	74.00	31.11
4 880.000	37.12	Average	V	31.20	8.25	44.70	0.66	32.53	54.00	21.47
Test Data for High Channel										
4 960.000	49.50	Peak	H	31.70	8.36	44.70	-	44.86	74.00	29.14
4 960.000	37.16	Average	H	31.70	8.36	44.70	0.66	33.18	54.00	20.82
4 960.000	50.85	Peak	V	31.70	8.36	44.70	-	46.21	74.00	27.79
4 960.000	37.59	Average	V	31.70	8.36	44.70	0.66	33.61	54.00	20.39

Remark: "H": Horizontal, "V": Vertical

$$\text{Margin (dB)} = \text{Limits (dBμV/m)} - \text{Total Level (dBμV/m)}$$

$$\text{Total Level} = \text{Reading} + \text{Antenna Factor} + \text{Cable Loss} + \text{Duty Factor} - \text{AMP Gain}$$

9.7.2.2 Test data for 2 Mbps

- Resolution bandwidth : 1 MHz and Peak Detector for Peak Mode for the emissions fall in restricted band,
1 MHz and RMS Detector for Average Mode for the emissions fall in restricted band
100 kHz for Peak Mode for the emissions outside restricted band
- Video bandwidth : 3 MHz for Peak and Average Mode
- Frequency range : 1 GHz ~ 26.5 GHz
- Measurement distance : 3 m
- Duty Cycle : 43.6 %
- Result : PASSED

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor (dB/m)	Cable Loss (dB)	AMP Gain (dB)	Duty Factor (dB)	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
Test Data for Low Channel										
4 804.000	48.55	Peak	H	31.30	8.23	44.70	-	43.38	74.00	30.62
4 804.000	37.43	Average	H	31.30	8.23	44.70	3.61	35.87	54.00	18.13
4 804.000	48.37	Peak	V	31.30	8.23	44.70	-	43.20	74.00	30.80
4 804.000	37.24	Average	V	31.30	8.23	44.70	3.61	35.68	54.00	18.32
Test Data for Middle Channel										
4 880.000	49.35	Peak	H	31.20	8.25	44.70	-	44.10	74.00	29.90
4 880.000	37.44	Average	H	31.20	8.25	44.70	3.61	35.80	54.00	18.20
4 880.000	48.97	Peak	V	31.20	8.25	44.70	-	43.72	74.00	30.28
4 880.000	37.28	Average	V	31.20	8.25	44.70	3.61	35.64	54.00	18.36
Test Data for High Channel										
4 960.000	48.45	Peak	H	31.70	8.36	44.70	-	43.81	74.00	30.19
4 960.000	37.11	Average	H	31.70	8.36	44.70	3.61	36.08	54.00	17.92
4 960.000	48.58	Peak	V	31.70	8.36	44.70	-	43.94	74.00	30.06
4 960.000	37.41	Average	V	31.70	8.36	44.70	3.61	36.38	54.00	17.62

Remark: "H": Horizontal, "V": Vertical

$$\text{Margin (dB)} = \text{Limits (dB}\mu\text{V/m)} - \text{Total Level (dB}\mu\text{V/m)}$$

$$\text{Total Level} = \text{Reading} + \text{Antenna Factor} + \text{Cable Loss} + \text{Duty Factor} - \text{AMP Gain}$$

10. POWER SPECTRAL DENSITY

10.1 Operating environment

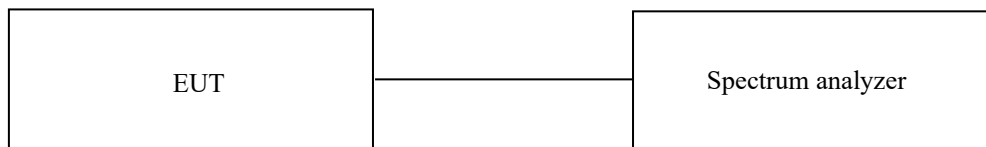
Temperature : 23 °C

Relative humidity : 45 % R.H.

10.2 Test set-up

The antenna output of the EUT was connected to the spectrum analyzer.

The resolution bandwidth is set to $3 \text{ kHz} \leq \text{RBW} \leq 100 \text{ kHz}$, the video bandwidth is set to 3 times the resolution bandwidth.



10.3 Measurement uncertainty

The uncertainty for Power spectral density is $\pm 1.51 \text{ dB}$

10.4 Test date

April 11, 2023 ~ April 14, 2023

10.5 Test data for 1 Mbps

-. Test Result : Pass

-. Duty Cycle : 86.0 %

CHANNEL	FREQUENCY (MHz)	MEASURED VALUE (dBm)	LIMIT (dBm / 3 kHz)	MARGIN (dB)
LOW	2 402.00	-21.95	8.00	29.95
MIDDLE	2 440.00	-22.12	8.00	30.12
HIGH	2 480.00	-22.52	8.00	30.52

Remark. Margin = Limit – Measured Value

10.6 Test data for 2 Mbps

-. Test Result : Pass

-. Duty Cycle : 43.6 %

CHANNEL	FREQUENCY (MHz)	MEASURED VALUE (dBm)	LIMIT (dBm / 3 kHz)	MARGIN (dB)
LOW	2 402.00	-23.60	8.00	31.60
MIDDLE	2 440.00	-23.25	8.00	31.25
HIGH	2 480.00	-23.80	8.00	31.80

Remark. Margin = Limit – Measured Value

11. RADIATED EMISSION TEST

11.1 Operating environment

Temperature : 23 °C

Relative humidity : 45 % R.H.

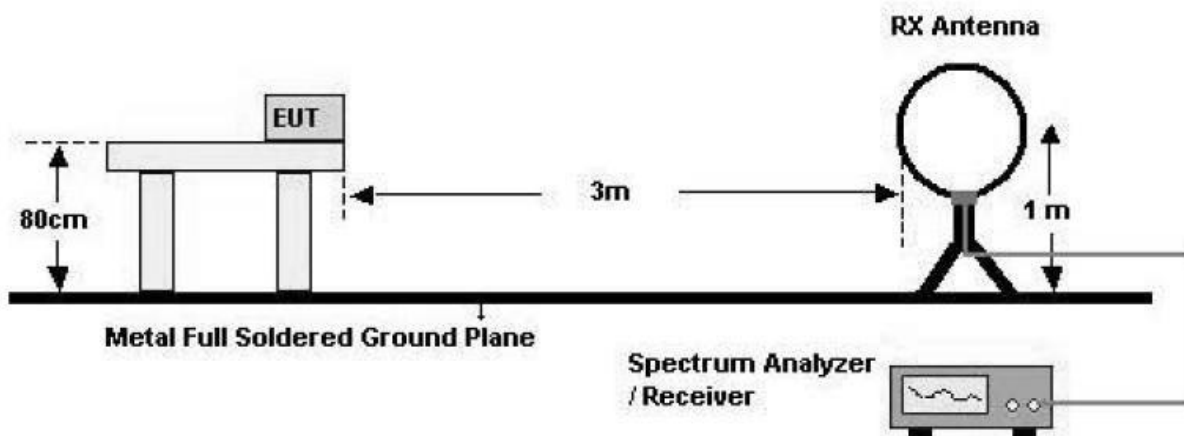
11.2 Test set-up

The radiated emissions measurements were on the 3 m semi anechoic chamber. The EUT and other support equipment were placed on a non-conductive turntable above the ground plane. The interconnecting cables from outside test site were inserted into ferrite clamps at the point where the cables reach the turntable.

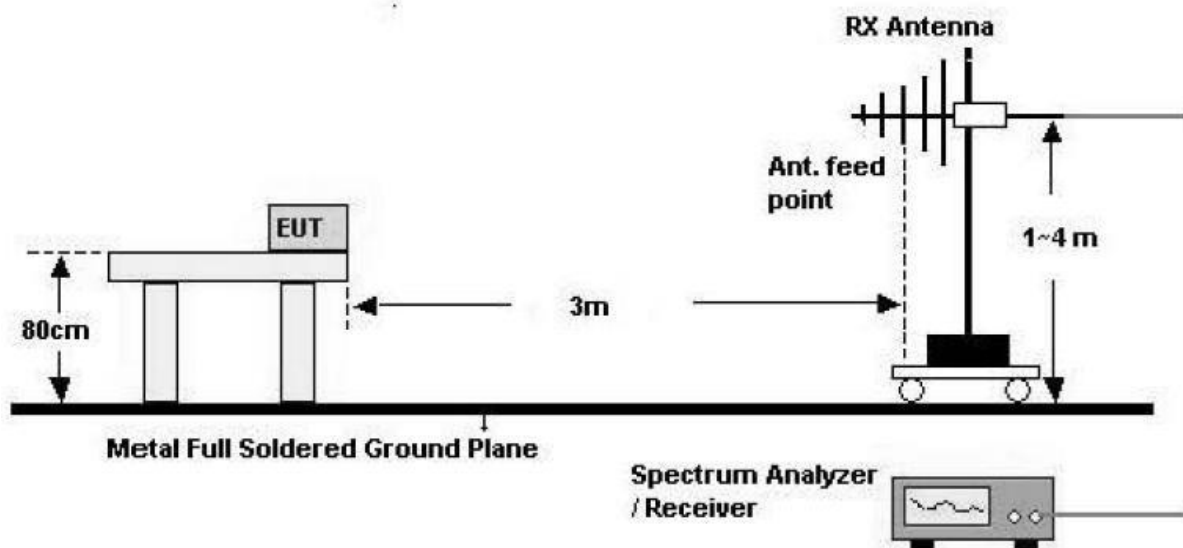
The frequency spectrum from 30 MHz to 26.5 GHz was scanned and emission levels maximized at each frequency recorded. The system was rotated 360°, and the antenna was varied in height between 1.0 m and 4.0 m in order to determine the maximum emission levels. This procedure was performed for both horizontal and vertical polarization of the receiving antenna.

- Test Configuration

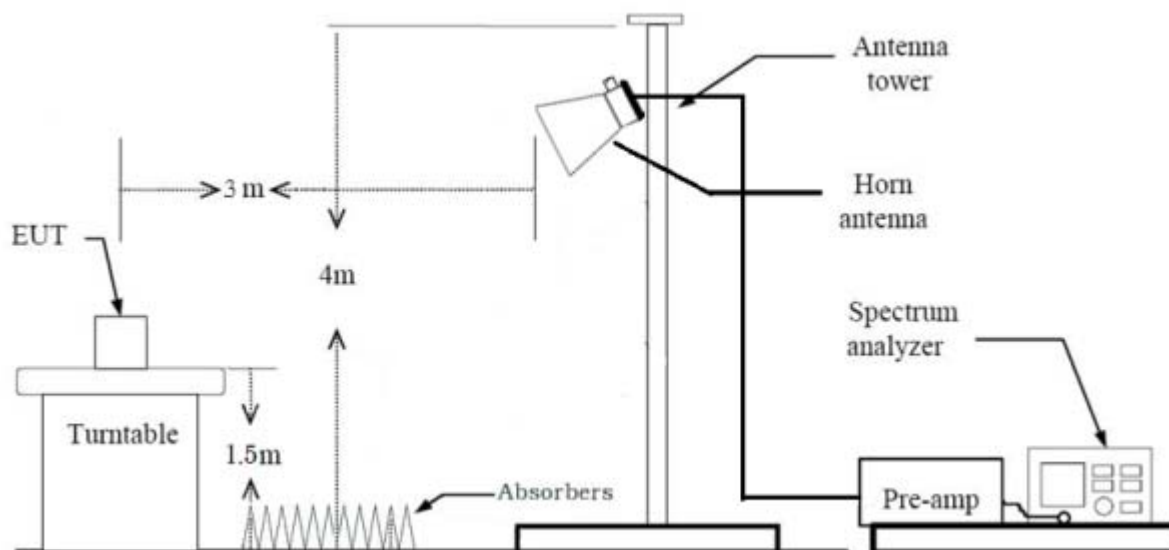
1. Below 30 MHz



2. 30 MHz - 1 GHz



3. Above 1 GHz



11.3 Measurement uncertainty

The uncertainty for Radiated emission test is ± 3.83 dB below 30 MHz

The uncertainty for Radiated emission test is ± 3.71 dB in 30 MHz ~ 1GHz

The uncertainty for Radiated emission test is ± 4.86 dB above 1 GHz

11.4 Test date

April 11, 2023 ~ April 14, 2023

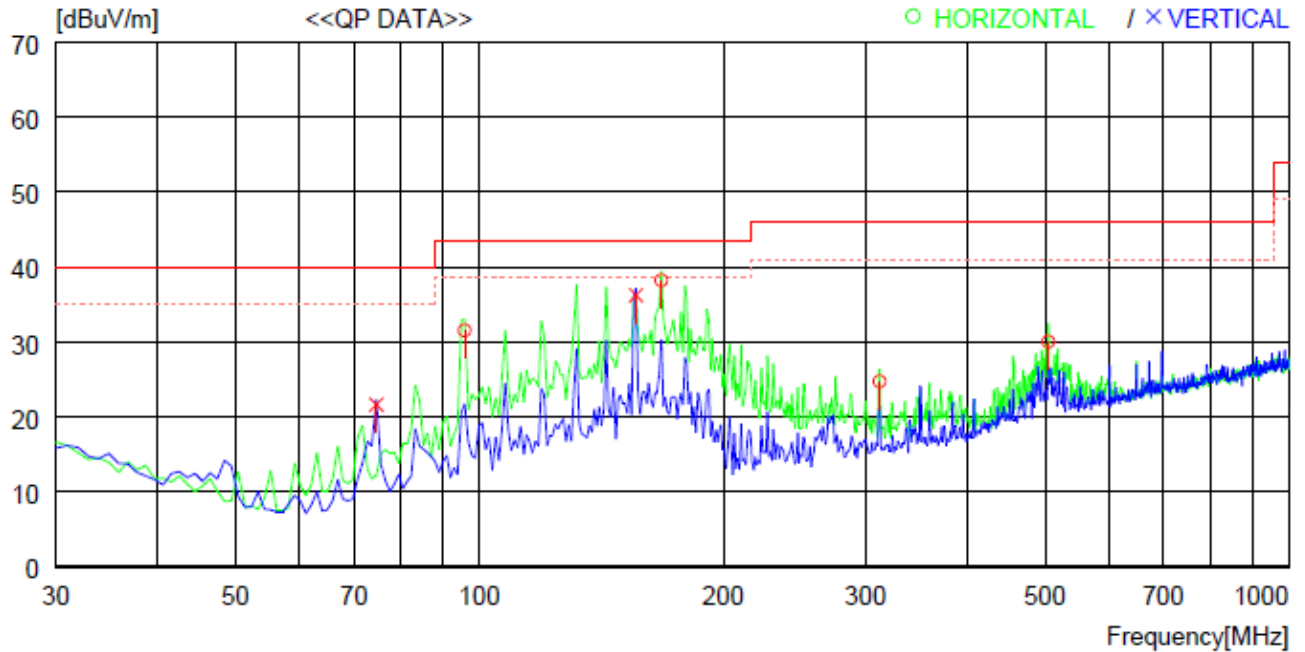
11.5 Test data for 30 MHz ~ 1 000 MHz

Limits apply to : FCC CFR 47, PART 15, SUBPART C, SECTION 15.247

Result : PASSED

EUT : UWB+BLE Combo Module

Detector : CISPR Quasi-Peak (6 dB Bandwidth: 120 kHz)



No.	FREQ	READING	ANT	LOSS	GAIN	RESULT	LIMIT	MARGIN	ANTENNA	TABLE
	[MHz]	QP	FACTOR	[dB]	[dB]	[dBuV/m]	[dBuV/m]	[dB]	[cm]	[DEG]
----- Horizontal -----										
1	95.960	47.6	14.6	2.4	33.1	31.5	43.5	12.0	400	0
2	167.740	50.8	17.3	3.2	33.1	38.2	43.5	5.3	200	0
3	312.270	34.2	19.3	4.4	33.2	24.7	46.0	21.3	100	359
4	504.331	34.3	23.2	5.6	33.1	30.0	46.0	16.0	200	312
----- Vertical -----										
5	74.620	39.5	13.0	2.2	33.1	21.6	40.0	18.4	300	0
6	156.100	47.9	18.3	3.1	33.1	36.2	43.5	7.3	400	359

11.6 Test data for Below 30 MHz

- Resolution bandwidth : 200 Hz (from 9 kHz to 0.15 MHz), 9 kHz (from 0.15 MHz to 30 MHz)
- Frequency range : 9 kHz ~ 30 MHz
- Measurement distance : 3 m
- Operating mode : Transmitting mode

Frequency (MHz)	Reading (dBμV)	Ant. Pol. (H/V)	Ant. Height (m)	Angle (°)	Ant. Factor (dB/m)	Cable Loss	Emission Level(dBμV/m)	Limits (dBμV/m)	Margin (dB)
Emission from the EUT more than 20 dB below the limit in each frequency range.									

11.7 Test data for above 1 GHz

- Resolution bandwidth : 1 MHz and Peak Detector for Peak Mode
1 MHz and RMS Detector for Average Mode
- Video bandwidth : 3 MHz for Peak and Average Mode
- Frequency range : 1 GHz ~ 26.5 GHz
- Measurement distance : 3 m
- Operating mode : Transmitting mode

Frequency (MHz)	Reading (dBμV)	Ant. Pol. (H/V)	Ant. Height (m)	Angle (°)	Ant. Factor (dB/m)	Cable Loss	Emission Level(dBμV/m)	Limits (dBμV/m)	Margin (dB)
Emission from the EUT more than 20 dB below the limit in each frequency range.									

12. CONDUCTED EMISSION TEST

12.1 Operating environment

Temperature : 23 °C

Relative humidity : 45 % R.H.

12.2 Test set-up

The EUT was placed on a wooden table, 0.8 m height above the floor. Power was fed to the EUT through a $50\ \Omega$ / $50\ \mu\text{H}$ + $5\ \Omega$ Artificial Mains Network (AMN). The ground plane was electrically bonded to the reference ground system and all power lines were filtered from ambient.

12.3 Measurement uncertainty

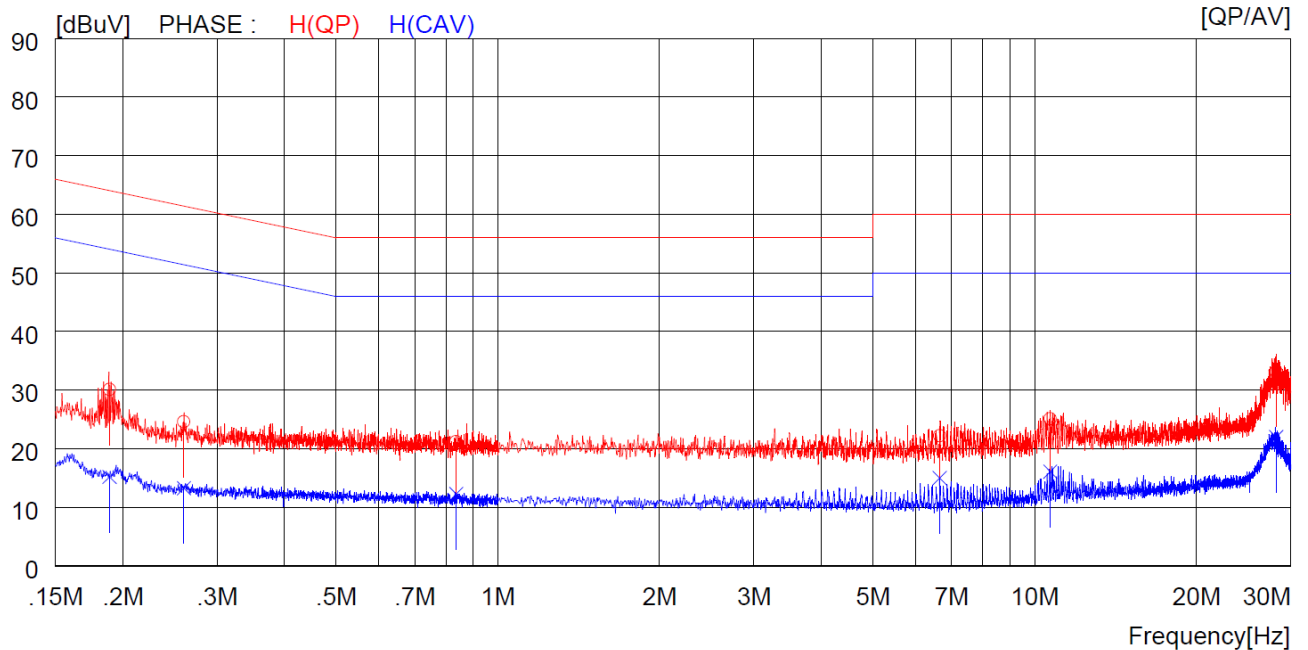
The uncertainty for Conducted emission test is $\pm 1.6\ \text{dB}$

12.4 Test date

April 11, 2023 ~ April 14, 2023

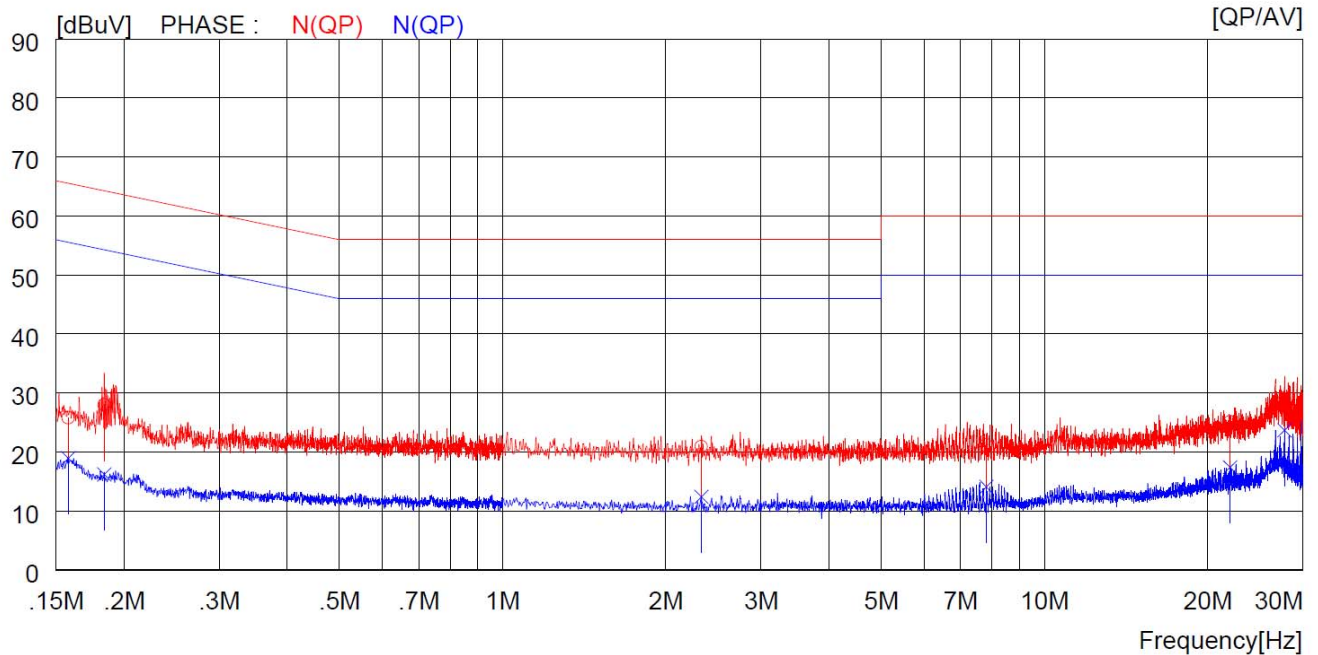
12.5 Test data

- Resolution bandwidth : 9 kHz
- Frequency range : 0.15 MHz ~ 30 MHz
- Tested Line : HOT LINE



NO	FREQ [MHz]	READING		C.FACTOR [dB]	RESULT		LIMIT		MARGIN		PHASE
		QP [dBuV]	AV [dBuV]		QP [dBuV]	AV [dBuV]	QP [dBuV]	AV [dBuV]	QP [dBuV]	AV [dBuV]	
1	0.18900	20.1	----	10.0	30.1	----	64.1	----	34.0	----	H (QP)
2	0.26000	14.6	----	10.0	24.6	----	61.4	----	36.8	----	H (QP)
3	0.83600	11.2	----	10.0	21.2	----	56.0	----	34.8	----	H (QP)
4	6.65000	11.9	----	10.3	22.2	----	60.0	----	37.8	----	H (QP)
5	10.69000	14.5	----	10.6	25.1	----	60.0	----	34.9	----	H (QP)
6	28.17000	22.0	----	11.2	33.2	----	60.0	----	26.8	----	H (QP)
7	0.18900	----	5.2	10.0	----	15.2	----	54.1	----	38.9	H (CAV)
8	0.26000	----	3.3	10.0	----	13.3	----	51.4	----	38.1	H (CAV)
9	0.83600	----	2.3	10.0	----	12.3	----	46.0	----	33.7	H (CAV)
10	6.65000	----	4.7	10.3	----	15.0	----	50.0	----	35.0	H (CAV)
11	10.69000	----	5.5	10.6	----	16.1	----	50.0	----	33.9	H (CAV)
12	28.17000	----	10.8	11.2	----	22.0	----	50.0	----	28.0	H (CAV)

-. Tested Line : NEUTRAL LINE



NO	FREQ [MHz]	READING		C.FACTOR [dB]	RESULT		LIMIT		MARGIN		PHASE
		QP [dBuV]	AV [dBuV]		QP [dBuV]	AV [dBuV]	QP [dBuV]	AV [dBuV]	QP [dBuV]	AV [dBuV]	
1	0.15800	15.8	----	10.0	25.8	----	65.6	----	39.8	----	N (QP)
2	0.18400	18.0	----	10.0	28.0	----	64.3	----	36.3	----	N (QP)
3	2.32800	10.7	----	10.2	20.9	----	56.0	----	35.1	----	N (QP)
4	7.81000	10.9	----	10.3	21.2	----	60.0	----	38.8	----	N (QP)
5	22.01000	14.1	----	11.0	25.1	----	60.0	----	34.9	----	N (QP)
6	27.73000	17.7	----	11.2	28.9	----	60.0	----	31.1	----	N (QP)
7	0.15800	----	9.0	10.0	----	19.0	----	55.6	----	36.6	N (CAV)
8	0.18400	----	6.2	10.0	----	16.2	----	54.3	----	38.1	N (CAV)
9	2.32800	----	2.2	10.2	----	12.4	----	46.0	----	33.6	N (CAV)
10	7.81000	----	3.8	10.3	----	14.1	----	50.0	----	35.9	N (CAV)
11	22.01000	----	6.4	11.0	----	17.4	----	50.0	----	32.6	N (CAV)
12	27.73000	----	12.5	11.2	----	23.7	----	50.0	----	26.3	N (CAV)

Remark: Margin (dB) = Limit – Level (Result)

The emission level in above table is included the transducer factor that means insertion loss (LISN), cable loss and attenuator.

13. LIST OF TEST EQUIPMENT

Model Number	Manufacturer	Description	Serial Number	Last Cal.(Interval)
FSVA40	Rohde & Schwarz	Signal Analyzer	101593	Apr. 03, 2023 (1Y)
ESR	Rohde & Schwarz	EMI Test Receiver	101470	Oct. 18, 2022 (1Y)
310N	Sonoma Instrument	Pre-Amplifier	312544	Mar. 14, 2023 (1Y)
SCU18	Rohde & Schwarz	Signal Conditioning unit	102266	Jul. 12, 2022 (1Y)
SCU40A	Rohde & Schwarz	Signal Conditioning unit	100436	Jan. 18, 2023 (1Y)
HPF 3GHz	Rohde & Schwarz	High Pass Filter (1-3 GHz)	N/A	Jan. 17, 2023 (1Y)
FMZB 1513	Schwarzbeck	Loop Antenna	1513-235	Mar. 24, 2022 (2Y)
HLP-2008	TDK	Hybrid Antenna	131314	Mar. 07, 2023 (2Y)
BBHA9120D	Schwarzbeck	Horn Antenna	9120D-1349	Jul. 08, 2022 (1Y)
BBHA9170	Schwarzbeck	Horn Antenna	BBHA9170179	Jan. 25, 2023 (1Y)
ESR 3	Rohde & Schwarz	EMI Test Receiver	102602	Mar. 15, 2023 (1Y)
ESH3Z2	Rohde & Schwarz	Pulse Limiter	357.8810.52	Mar. 14, 2023 (1Y)
NSLK8126	Schwarzbeck	LISN	8126404	Mar. 15, 2023 (1Y)
DT3000	Innco System	Turn Table	DT3000/093	N/A
MA4000-EP	Innco System	Antenna Master	MA4000/332	N/A
CO3000	Innco System	Controller	CO3000/904	N/A