RADIO PERFORMANCE TEST REPORT

Test Report No.	**: OT-237-RWD-070**
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	**: 25 pages (including this page)**
Date of Incoming	**: March 17, 2023**
Date of issue	**: July 28, 2023**

SUMMARY

The equipment complies with the regulation; ***FCC PART 15 SUBPART F Section 15.521 & 15.517***

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.



Tested by	Reviewed by	Approved by
Myeong-Hwa, Jang / Sr. Engineer	Tae-Ho, Kim / Chief Engineer	Jae-Ho, Lee / Chief Engineer
ONETECH Corp.	ONETECH Corp.	ONETECH Corp.

It should not be reproduced except in full, without the written approval of ONETECH Corp.

ONETECH Corp.: 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)

CONTENTS

PAGE

It should not be reproduced except in full, without the written approval of ONETECH Corp.

ONETECH Corp.: 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)

※ Please refer to the Annex section for All test plots

It should not be reproduced except in full, without the written approval of ONETECH Corp.

ONETECH Corp.: 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)

Revision History

Rev. No.	Issue Report No.	Issued Date	Revisions	Section Affected
0	OT-237-RWD-070	July 28, 2023	Initial Release	All

It should not be reproduced except in full, without the written approval of ONETECH Corp.

ONETECH Corp.: 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)

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	UWB – ULTRA WIDEBAND TRANSMITTER
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 F Section 15.521 & 15.517.
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.

It should not be reproduced except in full, without the written approval of ONETECH Corp.

ONETECH Corp.: 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)

2. TEST SUMMARY

2.1 Test items and results

SECTION	TEST ITEMS	RESULTS
15.207 15.505(a)	Conducted Limits	Met the Limit / PASS
15.517(b)	UWB Bandwidth	Met the Limit / PASS
15.209 15.517(c)	Radiated Emissions	Met the Limit / PASS
15.517(d)	Radiated Emissions in GPS Bands	Met the Limit / PASS
15.517(e)	Peak Emissions within a 50MHz Bandwidth	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 F Section 15.521 & 15.517.

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

It should not be reproduced except in full, without the written approval of ONETECH Corp.

ONETECH Corp.: 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)

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/manufacturer is responsible for the compliance of all variants.

4. EUT MODIFICATIONS

-. None

It should not be reproduced except in full, without the written approval of ONETECH Corp.

ONETECH Corp.: 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)

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

The EUT was used for making continuous transmitting and receiving mode during the test.

-. Duty Cycle

Frequency [MHz]	Tx On Time [ms]	Tx Off Time [ms]	Duty Cycle [%]	Correction Factor [dB]
6 489.60	0.120	2.000	5.66	12.47
7 987.20	0.110	2.005	5.20	12.84

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

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

It should not be reproduced except in full, without the written approval of ONETECH Corp.

ONETECH Corp.: 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)

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

It should not be reproduced except in full, without the written approval of ONETECH Corp.

ONETECH Corp.: 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)

7. UWB Bandwidth Measurement

7.1 Operating environment

Temperature : 23 °C

Relative humidity : 45 % R.H.

7.2 Test set-up

1. The EUT was placed on the top of the turntable 0.8 meter above ground. The phase center of the receiving antenna mounted on the top of a height-variable antenna tower was placed 3 meters far away from the turntable.
2. The horn receiving antenna was varied between one meter and four meters above ground to find the maximum emissions field strength of both horizontal and vertical polarization.
3. For maximum emission amplitude, the antenna tower was scan (from 1 M to 4 M) and then the turntable was rotated (from 0 degree to 360 degrees) to find the maximum reading and was used to determine the frequency at which the highest radiated emission occurs, fM. Next, the points that are 10dB or more below the highest radiated emission were observed in a search from fM in both the lower and higher frequency direction in the measured frequency EIRP graph, they are denoted as fL and fH, respectively. The UWB bandwidth is the difference between fL and fH.
4. The individual UWB bandwidths were measured for each BAND_ID (nb) of the UWB spectrum. Both horizontal and vertical polarizations were taken into account to determine the full UWB BW on the maximized (in azimuth and elevation) signals.

7.3 Test date

April 11, 2023 ~ April 14, 2023

7.4 Test data

-. Test Result : Pass

Frequency (MHz)	FM (MHz)	FL (MHz)	FH(MHz)	10 dB Bandwidth (MHz)	Limit (MHz)
6 489.60	6 646.40	6 230.90	6 766.30	535.40	≥ 500 MHz
7 987.20	7 832.40	7 721.50	8 256.90	535.40	≥ 500 MHz

It should not be reproduced except in full, without the written approval of ONETECH Corp.

ONETECH Corp.: 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)

8. Radiated Emissions Measurement

8.1 Operating environment

Temperature : 23 °C

Relative humidity : 45 % R.H.

8.2 Test set-up

1. Configure the EUT according to ANSI C63.10:2013. The EUT was placed on the top of the turntable 0.8 meter above ground. The phase center of the receiving antenna mounted on the top of a height-variable antenna tower was placed 3 meters far away from the turntable for measured the frequency range below 960 MHz and antenna tower was placed below 1 meters far away from the turntable for measured the frequency range above 960 MHz.
2. Power on the EUT and all the supporting units. The turntable was rotated by 360 degrees to determine the position of the highest radiation.
3. The height of the broadband receiving antenna was varied between one meter and four meters above ground to find the maximum emissions field strength of both horizontal and vertical polarization.
4. For each suspected emissions, the antenna tower was scan (from 1 M to 4 M) and then the turntable was rotated (from 0 degree to 360 degrees) to find the maximum reading.
5. The measurements made over the frequency range from 9 kHz to 960 MHz were maximized using an EMI receiver with peak detector capabilities. Measurements of the radiated field from 9 kHz to 960 MHz were made with the measurement antenna located a distance of 3 meters from the EUT. If the emissions level of the EUT in peak mode was 3 dB lower than the limit specified, then testing will be stopped and peak values of EUT will be reported, otherwise, the emissions which do not have 3 dB margin will be repeated one by one using the quasi-peak method for below 1GHz.
6. Measurements above 960 MHz were maximized using a spectrum analyzer with RMS detector capabilities. A spectrum analyzer was used for the final measurements utilizing an RMS detector at the frequencies with the largest amplitudes. The prescribed RBW of 1 MHz and VBW of 3 MHz, and a1 msec averaging time were used for these measurements. Measurements of the radiated field at frequencies above 960 MHz were made with the measurement antenna located a distance of below 1 meter from the EUT.
7. The spectrum between 9 kHz and 960 MHz contained no intentional radiation and lies below the limits. The spectrum from 960MHz to18GHz contained intentional UWB signals between 3100 MHz and 10600 MHz and lie below the limits. No other emissions above 10600 MHz were detected. The maximum frequency tested was 40 GHz.
8. Per 47 CFR, Part 15, Subpart F, §15.517© (§15.209) all digital emissions from the transmitter not intended to be radiated from the antenna port meet the 15.209 subpart C limits.
9. Additional measurements in the 960 MHz to 40 GHz range were performed to determine the nature of all unintentional emissions in this span. Conducted antenna port measurement and terminated antenna port measurement were done in the 960 MHz to 8 GHz range show that all noise peaks have the same frequency and polarization and are determined to be emission from the digital circuit and are not radiated from the antenna.

8.3 Test date

April 11, 2023 ~ April 14, 2023

It should not be reproduced except in full, without the written approval of ONETECH Corp.

ONETECH Corp.: 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)

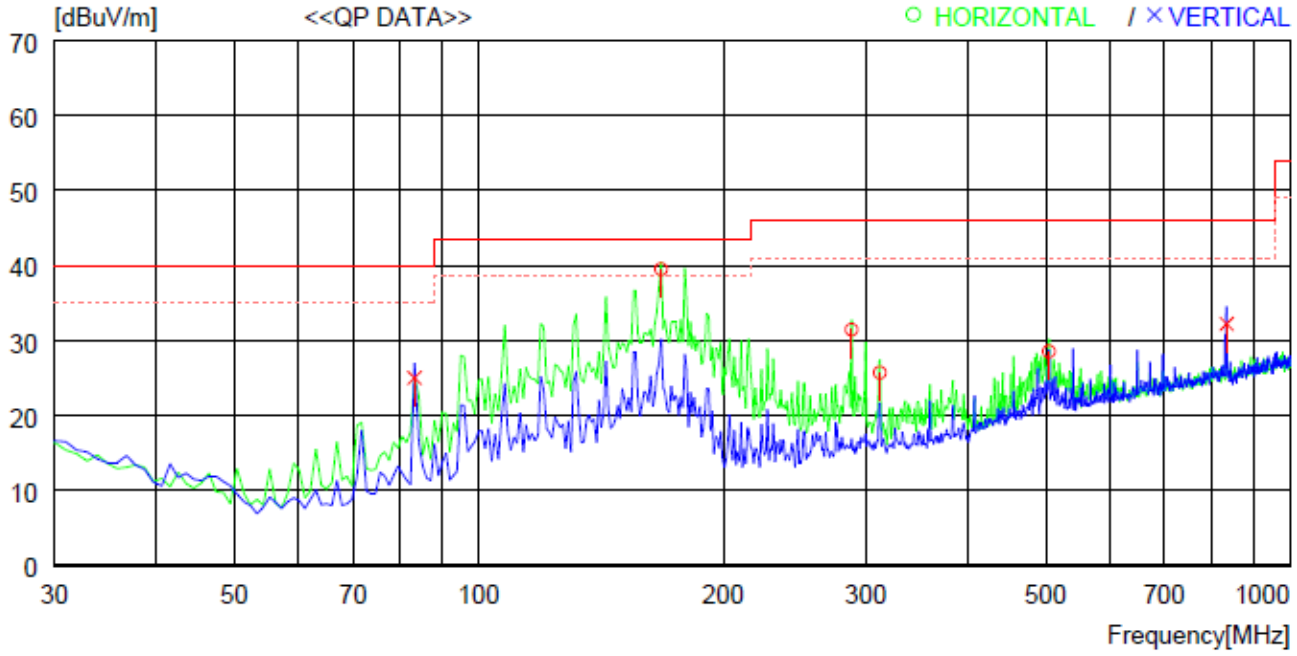
8.4 Test data for 30 MHz ~ 960 MHz

Measurement distance : 3 m

Result : PASSED

EUT : UWB+BLE Combo Module

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



No.	FREQ [MHz]	READING QP [dBuV]	ANT FACTOR [dB]	LOSS [dB]	GAIN [dB]	RESULT [dBuV/m]	LIMIT [dBuV/m]	MARGIN [dB]	ANTENNA [cm]	TABLE [DEG]
----- Horizontal ------										
1	167.740	52.1	17.3	3.2	33.1	39.5	43.5	4.0	200	359
2	288.020	41.7	18.7	4.2	33.2	31.4	46.0	14.6	200	222
3	312.270	35.2	19.3	4.4	33.2	25.7	46.0	20.3	100	0
4	504.331	32.8	23.2	5.6	33.1	28.5	46.0	17.5	200	301
----- Vertical ------										
5	83.350	42.6	13.2	2.3	33.1	25.0	40.0	15.0	200	0
6	835.091	31.2	27.0	7.2	33.2	32.2	46.0	13.8	200	328

It should not be reproduced except in full, without the written approval of ONETECH Corp.

ONETECH Corp.: 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)

8.5 Test data for 960 MHz ~ 40 GHz

8.5.1 Test data for 6 489.60 MHz

-. Resolution bandwidth : 1 MHz for Average Mode

-. Video bandwidth : 1 MHz for Average Mode

-. Measurement distance : 1 m

-. Operating Condition : Highest Output Power Transmitting Mode

Frequency (MHz)	Reading (dBuV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor (dB/m)	Cable Loss (dB)	AMP Gain (dB)	Distance	Total (dBuV/m)	Limits (dBuV/m)	Margin (dB)
960 MHz ~ 1 610 MHz										
1 073.430	50.44	Peak	H	24.90	3.68	45.40	9.54	24.08	39.90	15.82
1 052.710	41.03	Average	H	24.90	3.68	45.40	9.54	14.67	19.90	5.23
1 378.130	50.45	Peak	V	26.00	3.97	45.10	9.54	25.78	39.90	14.12
1 072.210	39.54	Average	V	24.90	3.68	45.40	9.54	13.18	19.90	6.72
1 610 MHz ~ 1 990 MHz										
1 783.680	50.83	Peak	H	25.30	4.83	45.10	9.54	26.32	61.90	35.58
1 804.560	38.90	Average	H	25.30	4.83	45.10	9.54	14.39	41.90	27.51
1 739.640	49.85	Peak	V	25.00	4.83	45.10	9.54	25.04	61.90	36.86
1 949.950	38.87	Average	V	25.90	5.11	45.10	9.54	15.24	41.90	26.66
1 990 MHz ~ 3 100 MHz										
2 041.560	49.33	Peak	H	26.00	5.11	45.10	9.54	25.80	63.90	38.10
1 996.100	38.54	Average	H	26.00	5.11	45.10	9.54	15.01	43.90	28.89
2 460.720	50.17	Peak	V	27.50	5.64	44.90	9.54	28.87	63.90	35.03
1 996.100	38.95	Average	V	26.00	5.11	45.10	9.54	15.42	43.90	28.48
3 100 MHz ~ 10 600 MHz										
6 647.700	65.15	Peak	H	34.20	9.42	44.40	9.54	54.83	73.90	19.07
6 722.630	42.90	Average	H	34.30	9.42	44.40	9.54	32.68	53.90	21.22
6 647.700	68.66	Peak	V	34.20	9.42	44.40	9.54	58.34	73.90	15.56
6 707.640	45.40	Average	V	34.30	9.42	44.40	9.54	35.18	53.90	18.72
10 600 MHz ~ 40 000 MHz										
15 874.630	48.83	Peak	H	37.90	15.26	44.40	9.54	48.05	63.90	15.85
11 002.900	36.89	Average	H	40.30	12.76	45.30	9.54	35.11	43.90	8.79
17 360.540	48.68	Peak	V	42.20	16.10	43.90	9.54	53.54	63.90	10.36
11 002.900	37.06	Average	V	40.30	12.76	45.30	9.54	35.28	43.90	8.62

Remark. -Total = Reading + Antenna Factor + Cable loss - Amp Gain + Dist.Correct

- Dcf = 20 log (1/3) = -9.54 (measurement distance is 1 meter)

It should not be reproduced except in full, without the written approval of ONETECH Corp.

ONETECH Corp.: 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)

8.5.2 Test data for 7 987.20 MHz

-. Resolution bandwidth : 1 MHz for Average Mode

-. Video bandwidth : 1 MHz for Average Mode

-. Measurement distance : 1 m

-. Operating Condition : Highest Output Power Transmitting Mode

Frequency (MHz)	Reading (dBuV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor (dB/m)	Cable Loss (dB)	AMP Gain (dB)	Distance	Total (dBuV/m)	Limits (dBuV/m)	Margin (dB)
960 MHz ~ 1 610 MHz										
1 128.280	50.22	Peak	H	24.90	3.68	45.40	9.54	23.86	39.90	16.04
1 061.240	39.51	Average	H	24.90	3.68	45.40	9.54	13.15	19.90	6.75
1 149.380	47.94	Peak	V	24.90	3.68	45.40	9.54	21.58	39.90	18.32
1 108.780	42.37	Average	V	24.90	3.68	45.40	9.54	16.01	19.90	3.89
1 610 MHz ~ 1 990 MHz										
1 941.980	49.57	Peak	H	25.90	5.11	45.10	9.54	25.94	61.90	35.96
1 872.890	38.67	Average	H	25.30	4.83	45.10	9.54	14.16	41.90	27.74
1 621.960	50.14	Peak	V	25.20	4.80	45.10	9.54	25.50	61.90	36.40
1 950.710	38.86	Average	V	25.90	5.11	45.10	9.54	15.23	41.90	26.67
1 990 MHz ~ 3 100 MHz										
2 126.950	52.87	Peak	H	27.20	5.16	45.10	9.54	30.59	63.90	33.31
2 085.920	38.58	Average	H	26.00	5.11	45.10	9.54	15.05	43.90	28.85
2 177.960	49.77	Peak	V	27.20	5.16	45.10	9.54	27.49	63.90	36.41
1 996.100	38.85	Average	V	26.00	5.11	45.10	9.54	15.32	43.90	28.58
3 100 MHz ~ 10 600 MHz										
7 831.520	64.80	Peak	H	36.50	10.49	44.70	9.54	57.55	73.90	16.35
7 966.380	41.95	Average	H	36.90	10.49	44.70	9.54	35.10	53.90	18.80
7 831.520	68.05	Peak	V	36.50	10.49	44.70	9.54	60.80	73.90	13.10
7 764.090	45.42	Average	V	36.30	10.49	44.70	9.54	37.97	53.90	15.93
10 600 MHz ~ 40 000 MHz										
11 668.230	47.90	Peak	H	39.60	12.76	45.30	9.54	45.42	63.90	18.48
11 002.900	36.98	Average	H	40.30	12.76	45.30	9.54	35.20	43.90	8.70
14 965.330	48.33	Peak	V	40.60	15.26	44.40	9.54	50.25	63.90	13.65
11 002.900	37.01	Average	V	40.30	12.76	45.30	9.54	35.23	43.90	8.67

Remark. -Total = Reading + Antenna Factor + Cable loss - Amp Gain + Dist.Correct

- Dcf = 20 log (1/3) = -9.54 (measurement distance is 1 meter)

It should not be reproduced except in full, without the written approval of ONETECH Corp.

ONETECH Corp.: 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)

8.6 Limit

The radiated emissions at or below 960 MHz from a device shall not exceed the emission levels in section 15.209(a) limit below.

Frequencies (MHz)	Field Strength (micorvolts/meter)	Measurement Distance (meters)
0.009~0.490	2 400/F(KHz)	300
0.490~1.705	24 000/F(KHz)	30
1.705~30.0	30	30
30~88	100	3
88~216	150	3
216~960	200	3
Above 960	500	3

The radiated emissions above 960 MHz from a device shall not exceed the following average limits when measured using a resolution bandwidth of 1 MHz:

Freq. (MHz)	EIRP (dBm)	Field (dBμV/m) at 3m
960-1610	-75.3	19.90
1 610-1 990	-53.3	41.90
1 990-3 100	-51.3	43.90
3 100-10 600	-41.3	53.90
10 600 above	-51.3	43.90

Note 1: This may be converted to a peak field strength level at 3 meters using E(dBuV/m) = P(dBm EIRP) + 95.2 dB.

From 47 CFR Section 15.517(c): Emissions from digital circuitry used to enable the operation of the UWB transmitter shall comply with the limits in Section 15.209 of this chapter, rather than the limits specified in this subpart, provided it can be clearly demonstrated that those emissions from the UWB device are due solely to emissions from digital circuitry contained within the transmitter and that the emissions are not intended to be radiated from the transmitter's antenna. Emissions from associated digital devices, as defined in Section 15.3(k) of this chapter, e.g., emissions from digital circuitry used to control additional functions or capabilities other than the UWB transmission, are subject to the limits contained in Subpart B of Part 15 of this chapter.

The radiated emissions from a device operating under the provisions of this section shall not exceed the emission levels in Section 15.209.

Freq. (MHz)	E- Field (dBμV/m) at 3m	
	Quasi Peak	
30 ~ 88	40.00	
88 ~ 216	43.50	
216 ~ 960	46.00	
	Peak	Average
Above 960	74.00	54.00

It should not be reproduced except in full, without the written approval of ONETECH Corp.

ONETECH Corp.: 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)

9. Radiated Emissions in GPS Bands Measurement

9.1 Operating environment

Temperature : 23 °C

Relative humidity : 45 % R.H.

9.2 Test set-up

1. Configure the EUT according to ANSI C63.10:2013. The EUT was placed on the top of the turntable 0.8 meter above ground. The phase center of the receiving antenna mounted on the top of a height-variable antenna tower was placed 1 meters far away from the turntable.
2. Power on the EUT and all the supporting units. The turntable was rotated by 360 degrees to determine the position of the highest radiation.
3. The height of the broadband receiving antenna was varied between one meter and four meters above ground to find the maximum emissions field strength of both horizontal and vertical polarization.
4. For each suspected emissions, the antenna tower was scan (from 1 M to 4 M) and then the turntable was rotated (from 0 degree to 360 degrees) to find the maximum reading.
5. Measurements frequencies were maximized using a spectrum analyzer with Average detector capabilities. A spectrum analyzer was used for the final measurements utilizing an Average detector at the frequencies with the largest amplitudes. The prescribed RBW of 1 kHz and VBW of 1 kHz, and a 1 msec averaging time were used for these measurements.
6. Per 47 CFR, Part 15, Subpart F, §15.517© (§15.209) all digital emissions from the transmitter not intended to be radiated from the antenna port meet the 15.209 subpart C limits.

9.3 Test date

April 11, 2023 ~ April 14, 2023

It should not be reproduced except in full, without the written approval of ONETECH Corp.

ONETECH Corp.: 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)

9.4 Test data for 6 489.60 MHz

-. Resolution bandwidth : 1 kHz for Average Mode

-. Video bandwidth : 1 kHz for Average Mode

-. Measurement distance : 1 m

-. Operating Condition : Highest Output Power Transmitting Mode

Frequency (MHz)	Reading (dBuV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor (dB/m)	Cable Loss (dB)	AMP Gain (dB)	Distance	Total (dBuV/m)	Limits (dBuV/m)	Margin (dB)
1 164 MHz ~ 1 240 MHz										
1 171.780	20.86	Peak	H	25.20	3.68	45.40	9.54	-5.20	9.90	15.10
1 207.160	8.92	average	H	25.40	3.97	45.40	9.54	-16.65	9.90	26.55
1 216.270	20.46	Peak	V	25.40	3.97	45.40	9.54	-5.11	9.90	15.01
1 207.540	8.96	average	V	25.40	3.97	45.40	9.54	-16.61	9.90	26.51
1 559 MHz ~ 1 610 MHz										
1 565.650	19.60	Peak	H	25.30	4.80	45.10	9.54	-4.94	9.90	14.84
1 579.150	8.48	average	H	25.30	4.80	45.10	9.54	-16.06	9.90	25.96
1 590.100	19.98	Peak	V	25.30	4.80	45.10	9.54	-4.56	9.90	14.46
1 577.930	8.49	average	V	25.30	4.80	45.10	9.54	-16.05	9.90	25.95

Remark. -Total = Reading + Antenna Factor + Cable loss - Amp Gain + Dist.Correct

- Dcf = 20 log (1/3) = -9.54 (measurement distance is 1 meter)

It should not be reproduced except in full, without the written approval of ONETECH Corp.

ONETECH Corp.: 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)

9.5 Test data for 7 987.20 MHz

-. Resolution bandwidth : 1 kHz for Average Mode

-. Video bandwidth : 1 kHz for Average Mode

-. Measurement distance : 1 m

-. Operating Condition : Highest Output Power Transmitting Mode

Frequency (MHz)	Reading (dBuV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor (dB/m)	Cable Loss (dB)	AMP Gain (dB)	Distance	Total (dBuV/m)	Limits (dBuV/m)	Margin (dB)
1 164 MHz ~ 1 240 MHz										
1 184.310	20.50	Peak	H	25.20	3.68	45.40	9.54	-5.56	9.90	15.46
1 207.690	8.86	average	H	25.40	3.97	45.40	9.54	-16.71	9.90	26.61
1 185.750	21.38	Peak	V	25.20	3.68	45.40	9.54	-4.68	9.90	14.58
1 207.770	8.92	average	V	25.40	3.68	45.40	9.54	-16.94	9.90	26.84
1 559 MHz ~ 1 610 MHz										
1 587.460	19.73	Peak	H	25.30	4.80	45.10	9.54	-4.81	9.90	14.71
1 578.590	8.46	average	H	25.30	4.80	45.10	9.54	-16.08	9.90	25.98
1 576.650	19.41	Peak	V	25.30	4.80	45.10	9.54	-5.13	9.90	15.03
1 579.050	8.52	average	V	25.30	4.80	45.10	9.54	-16.02	9.90	25.92

Remark. -Total = Reading + Antenna Factor + Cable loss - Amp Gain + Dist.Correct

- Dcf = 20 log (1/3) = -9.54 (measurement distance is 1 meter)

9.6 Limit

In addition to the radiated emission limits specified in the table in paragraph 4.5.1 of this report, 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.

Freq. (MHz)	EIRP (dBm)	E- Field (dBμV/m) at 3 m
1 164 ~ 1 240	-85.3	9.9
1 559 ~ 1 610	-85.3	9.9

Note 1: This may be converted to a peak field strength level at 3 meters using E(dBuV/m) = P(dBm EIRP) + 95.2 dB.

It should not be reproduced except in full, without the written approval of ONETECH Corp.

ONETECH Corp.: 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)

10. Peak Emissions within a 50 MHz Bandwidth Measurement

10.1 Operating environment

Temperature : 23 °C

Relative humidity : 45 % R.H.

10.2 Test set-up

1. The EUT was placed on the top of the turntable 1.5 meter above ground. The phase center of the receiving antenna mounted on the top of a height-variable antenna tower was placed 1 meters far away from the turntable.
2. The horn receiving antenna was varied between one meter and four meters above ground to find the maximum emissions field strength of both horizontal and vertical polarization.
3. For maximum peak emission amplitude, the antenna tower was scan (from 1 M to 4 M) and then the turntable was rotated (from 0 degree to 360 degrees) to find the maximum reading and was used to determine the frequency at which the highest radiated emission occurs, fM.
4. The individual UWB bandwidths were measured for each BAND_ID (nb) of the UWB spectrum. Both horizontal and vertical polarizations were taken into account to determine the full UWB BW on the maximized (in azimuth and elevation) signals.
5. A spectrum analyzer was used for the final measurement utilizing a peak detector at the frequency with the largest amplitude. The prescribed resolution bandwidth of 50 MHz was not supported by the spectrum analyzer. However, when a peak measurement is required, The resolution bandwidth for this measurement was set to 10 MHz, and the measurement was centered on the frequency at which the highest radiated emission occurred, fM. The video bandwidth was 10 MHz.

10.3 Test date

April 11, 2023 ~ April 14, 2023

It should not be reproduced except in full, without the written approval of ONETECH Corp.

ONETECH Corp.: 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)

10.4 Test data for 6 489.60 MHz

-. Resolution bandwidth : 10 MHz for Peak Mode

-. Video bandwidth : 10 MHz for Peak Mode

-. Measurement distance : 1 m

-. Operating Condition : Highest Output Power Transmitting Mode

Frequency (MHz)	Reading (dBuV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor (dB/m)	Cable Loss (dB)	AMP Gain (dB)	Distance	RBW (dB)	Duty (dB)	Total (dBuV/m)	EIRP at 3m Limits (dBuV/m)	Margin (dB)
Peak Field Strength of Fundamental												
6 489.600	81.69	Peak	H	34.20	9.42	44.40	-9.54	13.98	-	85.35	95.20	9.85
6 489.600	83.17	Peak	V	34.20	9.42	44.40	-9.54	13.98	-	86.83	95.20	8.37
Average Field Strength of Fundamental												
6 489.600	43.46	RMS	H	34.20	9.42	44.40	-9.54	-	12.47	45.61	53.90	8.29
6 489.600	46.50	RMS	V	34.20	9.42	44.40	-9.54	-	12.47	48.65	53.90	5.25

- Measurements were gathered with distance 1M and converted to 3M using the following formula:
  distance 1m→3m = 20log(1m/3m) = -9.54
- Measurements were gathered with a RBW of 10MHz and converted to 50MHz using the following formula:
  EIRP10 MHz = EIRP50 MHz - 20log(10MHz/50MHz) = 0dBm - (-13.98dBm) = 13.98dBm
- **Total = Reading + Ant. Factor + Cable Loss - AMP Gain + Distance + RBW + Duty**
  EIRP at 3m(dBuv/m)=EIRP Limit(dBm/50MHz)+95.2

It should not be reproduced except in full, without the written approval of ONETECH Corp. OTC-TRF-RF-001(0)

10.5 Test data for 7 987.20 MHz

-. Resolution bandwidth : 10 MHz for Peak Mode

-. Video bandwidth : 10 MHz for Peak Mode

-. Measurement distance : 1 m

-. Operating Condition : Highest Output Power Transmitting Mode

Frequency (MHz)	Reading (dBuV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor (dB/m)	Cable Loss (dB)	AMP Gain (dB)	Distance	RBW (dB)	Duty (dB)	Total (dBuV/m)	Limits (dBuV/m)	Margin (dB)
Peak Field Strength of Fundamental												
7 987.200	79.64	Peak	H	37.20	10.49	44.70	-9.54	13.98	-	87.07	95.20	8.13
7 987.200	83.16	Peak	V	37.20	10.49	44.70	-9.54	13.98	-	90.59	95.20	4.61
Average Field Strength of Fundamental												
7 987.200	43.18	RMS	H	37.20	10.49	44.70	-9.54	-	12.47	49.10	53.90	4.80
7 987.200	46.06	RMS	V	37.20	10.49	44.70	-9.54	-	12.47	51.98	53.90	1.92

- Measurements were gathered with distance 1M and converted to 3M using the following formula:
  distance 1m→3m = 20log(1m/3m) = -9.54
- Measurements were gathered with a RBW of 10MHz and converted to 50MHz using the following formula:
- EIRP10 MHz = EIRP50 MHz - 20log(10MHz/50MHz) = 0dBm - (-13.98dBm) = 13.98dBm
- **Total = Reading + Ant. Factor + Cable Loss - AMP Gain + Distance + RBW + Duty**
  EIRP at 3m(dBuv/m)=EIRP Limit(dBm/50MHz)+95.2

It should not be reproduced except in full, without the written approval of ONETECH Corp.

ONETECH Corp.: 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)

11. CONDUCTED EMISSION TEST

11.1 Operating environment

Temperature : 23 °C

Relative humidity : 45 % R.H.

11.2 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 Ω / 50 μH + 5 Ω Artificial Mains Network (AMN). The ground plane was electrically bonded to the reference ground system and all power lines were filtered from ambient.

11.3 Measurement uncertainty

The uncertainty for Conducted emission test is ± 1.6 dB

11.4 Test date

April 11, 2023 ~ April 14, 2023

It should not be reproduced except in full, without the written approval of ONETECH Corp.

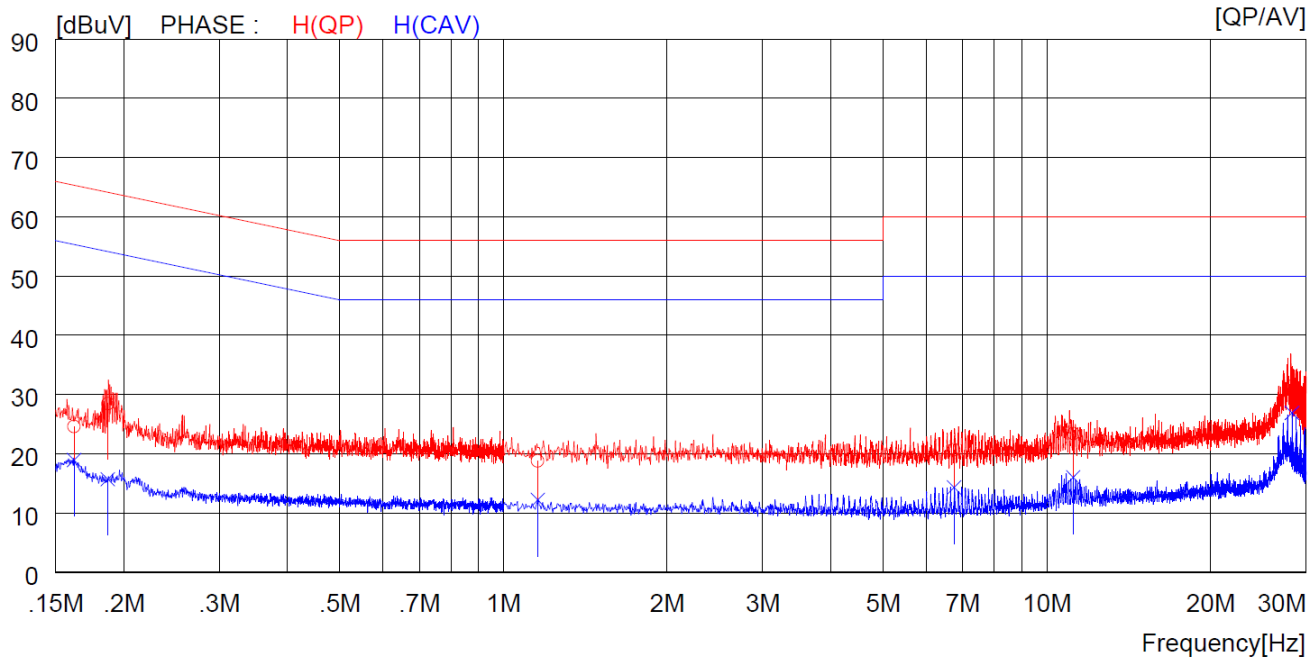
ONETECH Corp.: 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)

11.5 Test data

-. Resolution bandwidth : 9 kHz

-. Frequency range : 0.15 MHz ~ 30 MHz

-. Tested Line : HOT LINE

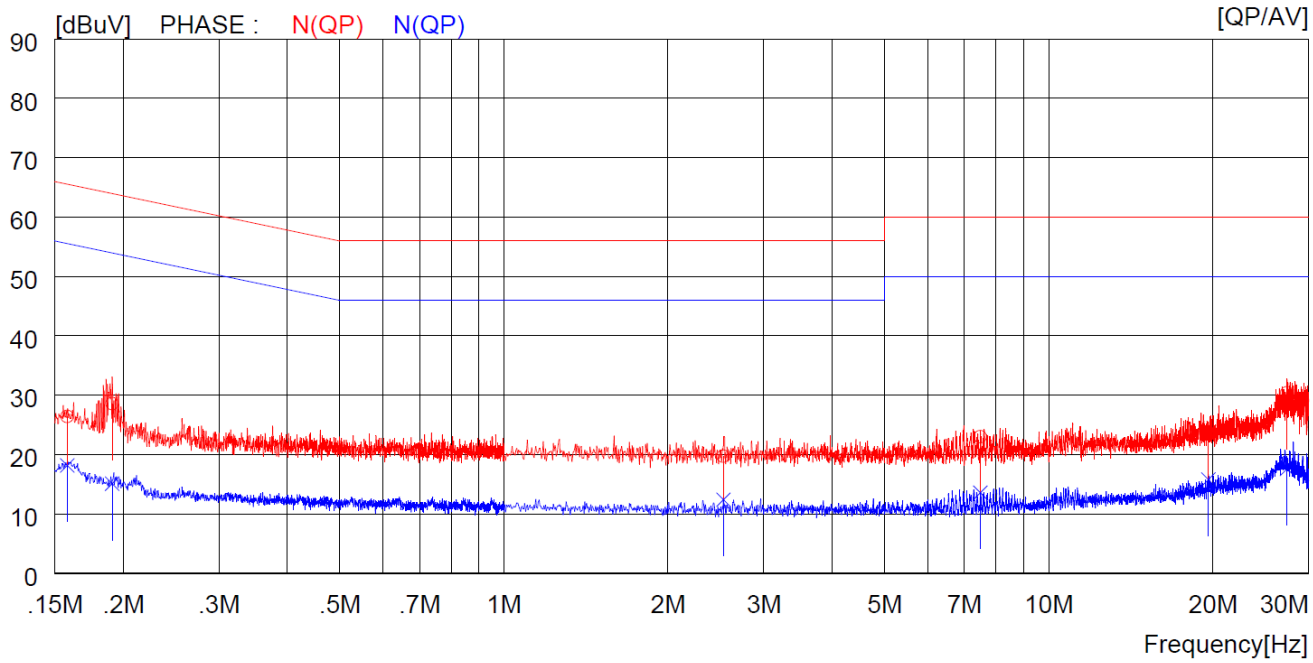


NO	FREQ [MHz]	READING QP [dBuV]	READING AV [dBuV]	C.FACTOR [dB]	RESULT QP [dBuV]	RESULT AV [dBuV]	LIMIT QP [dBuV]	LIMIT AV [dBuV]	MARGIN QP [dBuV]	MARGIN AV [dBuV]	PHASE
1	0.16200	14.6	----	10.0	24.6	----	65.4	----	40.8	----	H(QP)
2	0.18700	18.5	----	10.0	28.5	----	64.2	----	35.7	----	H(QP)
3	1.15600	8.7	----	10.1	18.8	----	56.0	----	37.2	----	H(QP)
4	6.75000	10.4	----	10.3	20.7	----	60.0	----	39.3	----	H(QP)
5	11.18000	12.8	----	10.6	23.4	----	60.0	----	36.6	----	H(QP)
6	28.25000	20.2	----	11.2	31.4	----	60.0	----	28.6	----	H(QP)
7	0.16200	----	9.0	10.0	----	19.0	----	55.4	----	36.4	H(CAV)
8	0.18700	----	5.7	10.0	----	15.7	----	54.2	----	38.5	H(CAV)
9	1.15600	----	2.1	10.1	----	12.2	----	46.0	----	33.8	H(CAV)
10	6.75000	----	4.0	10.3	----	14.3	----	50.0	----	35.7	H(CAV)
11	11.18000	----	5.4	10.6	----	16.0	----	50.0	----	34.0	H(CAV)
12	28.25000	----	15.7	11.2	----	26.9	----	50.0	----	23.1	H(CAV)

It should not be reproduced except in full, without the written approval of ONETECH Corp.

ONETECH Corp.: 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)

-. Tested Line : NEUTRAL LINE



NO	FREQ [MHz]	READING QP [dBuV]	READING AV [dBuV]	C.FACTOR [dB]	RESULT QP [dBuV]	RESULT AV [dBuV]	LIMIT QP [dBuV]	LIMIT AV [dBuV]	MARGIN QP [dBuV]	MARGIN AV [dBuV]	PHASE
1	0.15800	16.4	----	10.0	26.4	----	65.6	----	39.2	----	N(QP)
2	0.19100	18.6	----	10.0	28.6	----	64.0	----	35.4	----	N(QP)
3	2.52800	9.5	----	10.2	19.7	----	56.0	----	36.3	----	N(QP)
4	7.49000	12.7	----	10.3	23.0	----	60.0	----	37.0	----	N(QP)
5	19.62000	12.7	----	11.0	23.7	----	60.0	----	36.3	----	N(QP)
6	27.39000	19.2	----	11.2	30.4	----	60.0	----	29.6	----	N(QP)
7	0.15800	----	8.2	10.0	----	18.2	----	55.6	----	37.4	N(CAV)
8	0.19100	----	5.1	10.0	----	15.1	----	54.0	----	38.9	N(CAV)
9	2.52800	----	2.2	10.2	----	12.4	----	46.0	----	33.6	N(CAV)
10	7.49000	----	3.3	10.3	----	13.6	----	50.0	----	36.4	N(CAV)
11	19.62000	----	4.8	11.0	----	15.8	----	50.0	----	34.2	N(CAV)
12	27.39000	----	6.4	11.2	----	17.6	----	50.0	----	32.4	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.

It should not be reproduced except in full, without the written approval of ONETECH Corp.

ONETECH Corp.: 43-14, Jinsaegol-gil, Chowol-eup, Gwangju-si, Gyeonggi-do, 12735, Korea (TEL: 82-31-799-9500, FAX: 82-31-799-9599)

12. 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

It should not be reproduced except in full, without the written approval of ONETECH Corp. OTC-TRF-RF-001(0)