

RADIO PERFORMANCE TEST REPORT

Test Report No. : OT-234-RWD-017

Reception No. : 2303000827

Applicant : Nttworks Co., Ltd

Address : 5-10, Nttworks Bldg. Tongil-ro 89-gil, Eunpyeong-gu, Seoul, 03328, South Korea

Manufacturer : Nttworks Co., Ltd

Address : 5-10, Nttworks Bldg. Tongil-ro 89-gil, Eunpyeong-gu, Seoul, 03328, South Korea

Type of Equipment : Data transceiver

FCC ID : 2BAO4-SUD100H

Model No. : SUD-100H

Multiple Model Name : N/A

Serial number : N/A

Total page of Report : 23 pages (including this page)

Date of Incoming : March 22, 2023

Date of issuing : April 14, 2023

SUMMARY

The equipment complies with the regulation; **FCC PART 15 SUBPART C Section 15.209 and Section 15.231**

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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Revision History

Rev. No.	Issue Report No.	Issued Date	Revisions	Section Affected
0	OT-234-RWD-017	April 14, 2023	Initial Release	All

1. VERIFICATION OF COMPLIANCE

Applicant : Nttworks Co., Ltd
 Address : 5-10, Nttworks Bldg. Tongil-ro 89-gil, Eunpyeong-gu, Seoul, 03328, South Korea
 Contact Person : Jun Young, Kim / Engineer
 Telephone No. : +82-2-387-3790
 FCC ID : 2BAO4-SUD100H
 Model Name : SUD-100H
 Brand Name : Syscall / Nttworks Co., Ltd
 Serial Number : N/A
 Date : April 14, 2023

EQUIPMENT CLASS	DSC - Part 15, Security/Remote Control Transmitter
E.U.T. DESCRIPTION	Data transceiver
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 15.209 and Section 15.231
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
15.231(c)	Bandwidth Measurement	Met the Limit / PASS
15.231(a)	Transmission Time	Met the Limit / PASS
15.231(b) 15.209(a)	Field Strength of Fundamental and Spurious Emission	Met the Limit / PASS
15.205	Restricted Band	Met the Limit / PASS
15.207	AC Conducted Emissions	Met the Limit / 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 section 2.1.

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 Nttworks Co., Ltd, Model: SUD-100H (referred to as the EUT in this report) is a Transmitter that it controls locking and unlocking the door of a vehicle. Product specification information described herein was obtained from product data sheet or user's manual.

DEVICE TYPE	Data transceiver
TX FREQUENCY	433.42 MHz
RX FREQUENCY	433.42 MHz
MODULATION	FSK
LIST OF EACH OSC. OR CRY. FREQ.(FREQ.>= 1 MHz)	32 MHz
DUTY CYCLE FACTOR	21.09 dB (Duty Cycle: 8.82 %)
ANTENNA TYPE	SMA Antenna
ANTEENA GAIN	3.14 dBi
RATED SUPPLY VOLTAGE	DC 5.0 V

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

-. None

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	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
SUD-100H	Nttworks Co., Ltd	Data transceiver (EUT)	-
Ideapad 330	Lenovo	Notebook PC	EUT

5.3 Mode of operation during the test

Software was programmed into the EUT to maintain continuous transfer mode. The EUT was set at 433.42 MHz. To get a maximum radiated emission levels from the EUT, the EUT was moved throughout the XY, XZ, and YZ planes and the worst case is “XY” axis. So, the worst data was recorded in this test report.

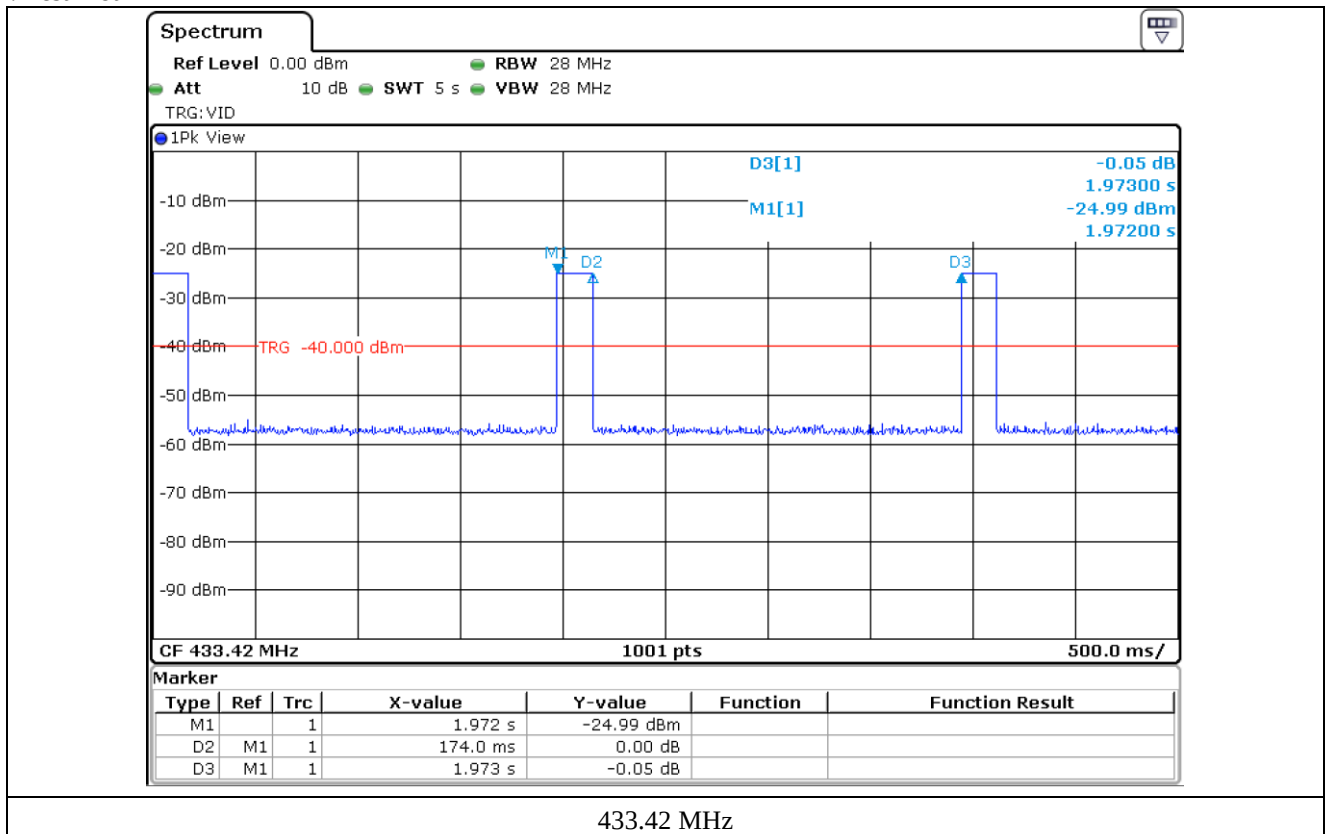
-. Duty Cycle

Frequency (MHz)	Tx On Time [ms]	Tx Off Time [ms]	Duty Cycle [%]	Duty Cycle Factor [dB]
433.42	174	1 973	8.82	21.09

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

Duty Cycle Factor : $20 * \log(1 / (\text{Duty Cycle} / 100))$

-. Test Plot



The average field strength may be found by measuring the peak pulse amplitude (in log equivalent units) and determining the duty cycle correction factor (in dB) associated with the pulse modulation as shown in Equation. (ANSI C63.10: 2013)

5.4 Configuration of Test System

- Line Conducted Test:** The EUT was connected to USB and the power of USB was connected to Notebook PC. 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.
- 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 m 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 SMA Antenna on the main board, 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. Bandwidth Measurement

7.1 Operating environment

Temperature : 21 °C

Relative humidity : 52 % 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 10 kHz, and peak detection was used. The bandwidth of fundamental frequency was measured and recorded.



7.3 Test date

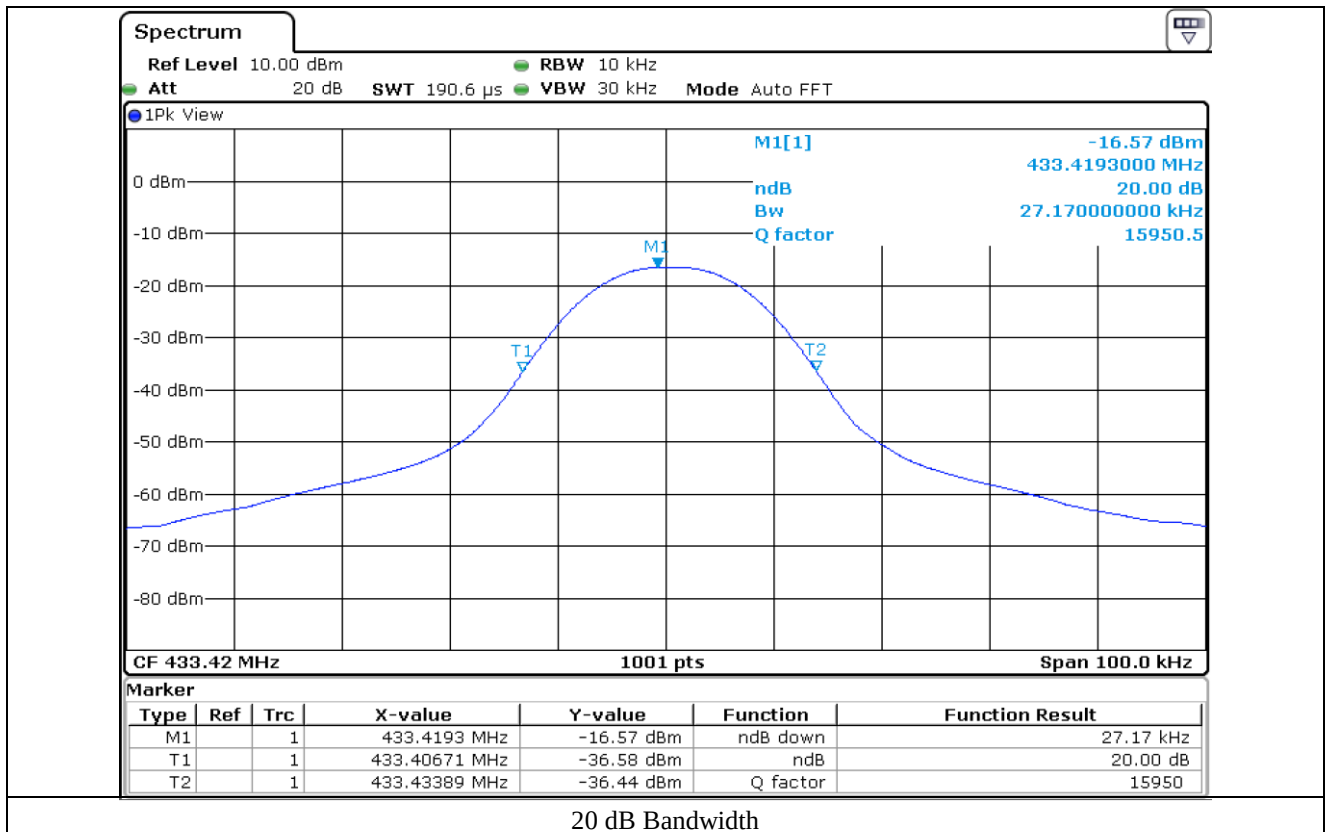
March 22, 2023 ~ April 12, 2023

7.4 Test data

-. Test Result : Pass

Frequency (MHz)	20 dB Bandwidth (MHz)	Limit (MHz)
433.42	0.027	1.085

Remark: See next page for measurement data.



8. Transmission Time

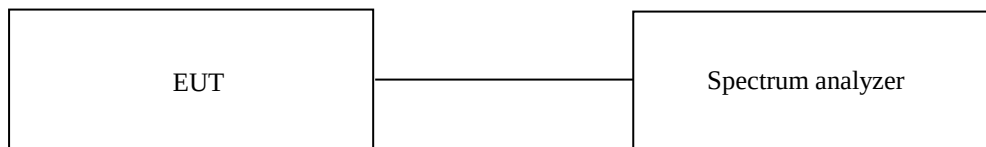
8.1 Operating environment

Temperature : 21 °C

Relative humidity : 52 % 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 100 kHz, and peak detection was used. The bandwidth of fundamental frequency was measured and recorded.



8.3 Test date

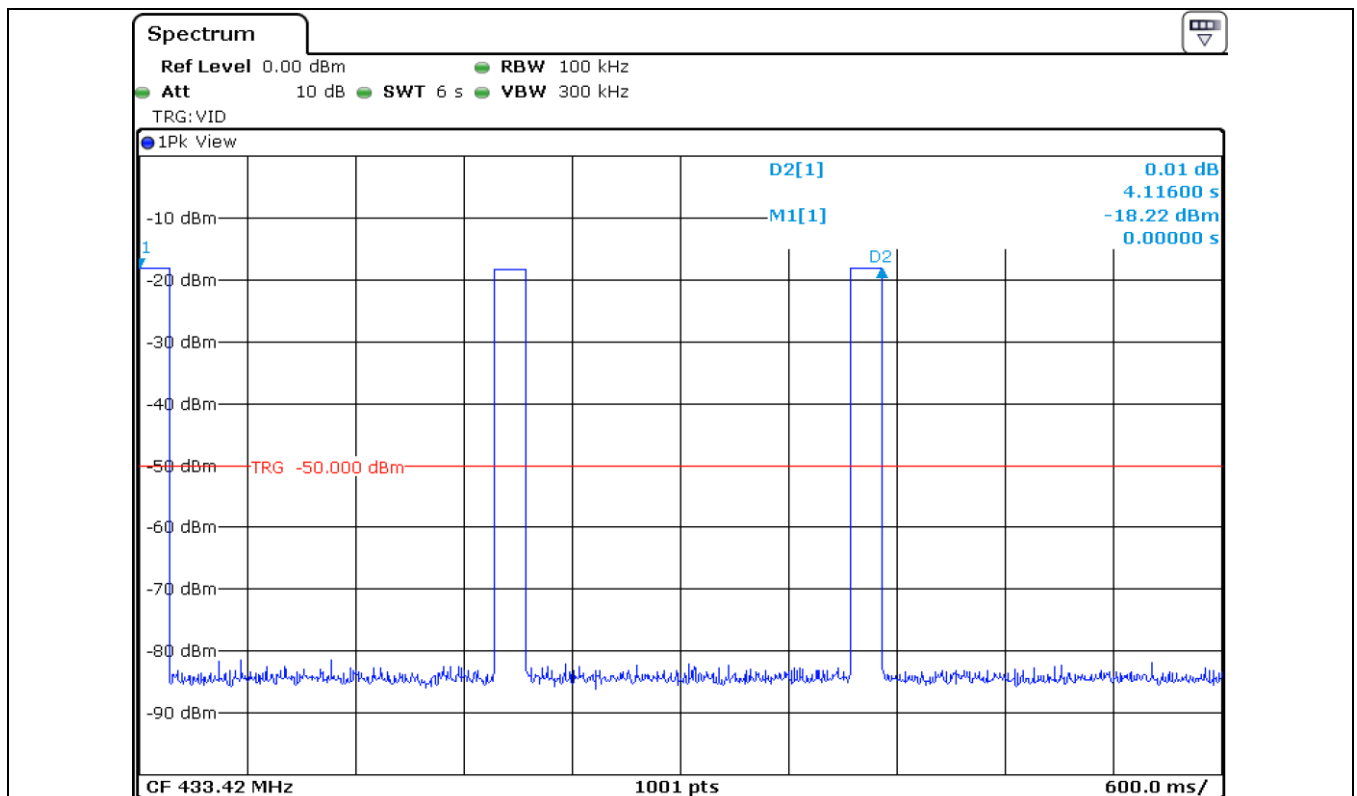
March 22, 2023 ~ April 12, 2023

8.4 Test data

-. Test Result : Pass

-. Test Applies : 15.231 (a) (1)

Frequency (MHz)	Transmission Time (s)	Limit (s)	Result
433.42	4.116	5.000	Pass



9. Radiated Emission Test

9.1 Regulation

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 [μ V/m]	Field strength [dBμ V/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	29.50	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

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

According to §15.231(b), 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 of Fundamental [μ V/m]	Field strength of Spurious Emissions [μ V/m]
40.66 ~ 40.70	2 250	225
70 ~ 130	1 250	125
130 ~ 174	1 250 ~ 3 750 **	125 ~ 375 **
174 ~ 260	3 750	375
260 ~ 470	3 750 ~ 12 500 **	375 ~ 1 250 **
Above 470	12 500	1 250

** Linear interpolations

9.2 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 kHz to 1 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.

9.3 Test date

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9.4 Test data

9.4.1 Field Strength of Fundamental

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

Humidity Level : 52 % R.H. Temperature: 21 °C
Limits apply to : FCC CFG 47, PART 15, SUBPART C, SECTION 15.231(b)
Result : PASSED

EUT : Data transceiver

Operating Condition : TX mode

Distance : 3 m

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	Amp Gain	Duty Factor	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
433.42	106.18	Peak	H	22.40	4.00	32.89	-	99.69	100.83	1.14
	-	Average	H	22.40	4.00	32.89	21.09	78.60	80.83	2.23
	101.23	Peak	V	22.40	4.00	32.89	-	94.74	100.83	6.09
	-	Average	V	22.40	4.00	32.89	21.09	73.65	80.83	7.18

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

Total (dBμV/m) = Reading (dBμV) + Ant Factor (dB) + Cable Loss (dB) – Amp Gain (dB) – Duty Factor (dB)

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

9.4.2 Spurious Emission Test & Restricted Band Test

9.4.2.1 Test data for 9 kHz to 30 MHz

-. Resolution bandwidth : 200 Hz (from 9 kHz to 0.15 MHz), 9 kHz (from 0.15 MHz to 30 MHz)

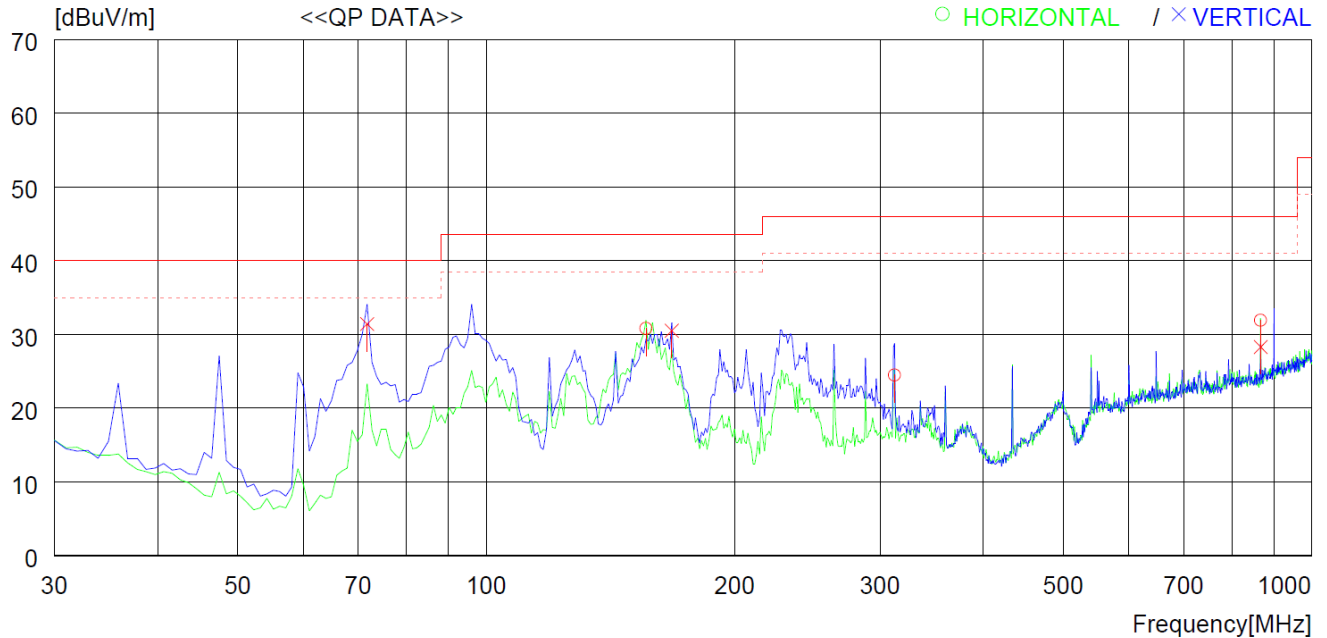
-. Frequency range : 9 kHz ~ 30 MHz

-. Measurement distance : 3 m

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)
All emissions observed were 20 dB below the limit.									

9.4.2.2 Test data for 30 MHz to 1 000 MHz

- . Resolution bandwidth : 120 kHz
- . Frequency range : 30 MHz ~ 1 000 MHz
- . Measurement distance : 3 m



Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	Amp Gain	Duty Factor	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
71.71	49.80	QP	V	13.00	1.70	33.10	-	31.40	40.00	8.60
156.10	43.10	QP	H	18.30	2.40	33.00	-	30.80	43.50	12.70
167.74	43.70	QP	V	17.30	2.50	33.00	-	30.50	43.50	13.00
312.27	34.60	QP	H	19.30	3.50	32.90	-	24.50	46.00	21.50
866.84 ¹⁾	31.90	Peak	H	27.20	5.90	32.80	-	32.20	80.83	48.63
866.84 ¹⁾		Average	H	27.20	5.90	32.80	21.09	11.11	60.83	49.72
866.84 ¹⁾	28.40	Peak	V	27.20	5.90	32.80	-	28.70	80.83	52.13
866.84 ¹⁾		Average	V	27.20	5.90	32.80	21.09	7.61	60.83	53.22

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

¹⁾ : Harmonic

Total (dBμV/m) = Reading (dBμV) + Ant Factor (dB) + Cable Loss (dB) – Amp Gain (dB) – Duty Factor (dB)

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

9.4.2.3 Test data for above 1 GHz

- Resolution bandwidth : 1 MHz for Peak and Average Mode
- Video bandwidth : 1 MHz for Peak and Average Mode
- Frequency range : 1 GHz ~ 5 GHz
- Measurement distance : 3 m
- Operating mode : Transmitting mode

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	Amp Gain	Duty Factor	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
1 300.26 ^{1), 2)}	74.27	Peak	H	25.60	3.50	45.20	-	58.17	74.00	15.83
1 300.26 ^{1), 2)}	-	Average	H	25.60	3.50	45.20	21.09	37.08	54.00	16.92
1 300.26 ^{1), 2)}	71.35	Peak	V	25.60	3.50	45.20	-	55.25	74.00	18.75
1 300.26 ^{1), 2)}	-	Average	V	25.60	3.50	45.20	21.09	34.16	54.00	19.84
1 733.68 ¹⁾	56.36	Peak	H	24.90	4.10	45.10	-	40.26	80.83	40.57
1 733.68 ¹⁾	-	Average	H	24.90	4.10	45.10	21.09	19.17	60.83	41.66
1 733.68 ¹⁾	53.43	Peak	V	24.90	4.10	45.10	-	37.33	80.83	43.50
1 733.68 ¹⁾	-	Average	V	24.90	4.10	45.10	21.09	16.24	60.83	44.59
2 167.10 ¹⁾	53.68	Peak	H	27.30	4.50	45.00	-	40.48	80.83	40.35
2 167.10 ¹⁾	-	Average	H	27.30	4.50	45.00	21.09	19.39	60.83	41.44
2 167.10 ¹⁾	50.88	Peak	V	27.30	4.50	45.00	-	37.68	80.83	43.15
2 167.10 ¹⁾	-	Average	V	27.30	4.50	45.00	21.09	16.59	60.83	44.24
2 600.52 ¹⁾	52.77	Peak	H	27.40	4.90	44.80	-	40.27	80.83	40.56
2 600.52 ¹⁾	-	Average	H	27.40	4.90	44.80	21.09	19.18	60.83	41.65
2 600.52 ¹⁾	49.88	Peak	V	27.40	4.90	44.80	-	37.38	80.83	43.45
2 600.52 ¹⁾	-	Average	V	27.40	4.90	44.80	21.09	16.29	60.83	44.54
3 033.94 ¹⁾	56.65	Peak	H	28.70	5.30	44.70	-	45.95	80.83	34.88
3 033.94 ¹⁾	-	Average	H	28.70	5.30	44.70	21.09	24.86	60.83	35.97
3 033.94 ¹⁾	53.10	Peak	V	28.70	5.30	44.70	-	42.40	80.83	38.43
3 033.94 ¹⁾	-	Average	V	28.70	5.30	44.70	21.09	21.31	60.83	39.52
3 467.36 ¹⁾	52.75	Peak	H	28.40	5.70	44.70	-	42.15	80.83	38.68
3 467.36 ¹⁾	-	Average	H	28.40	5.70	44.70	21.09	21.06	60.83	39.77
3 467.36 ¹⁾	50.01	Peak	V	28.40	5.70	44.70	-	39.41	80.83	41.42
3 467.36 ¹⁾	-	Average	V	28.40	5.70	44.70	21.09	18.32	60.83	42.51

Frequency (MHz)	Reading (dBμV)	Detector Mode	Ant. Pol. (H/V)	Ant. Factor	Cable Loss	Amp Gain	Duty Factor	Total (dBμV/m)	Limits (dBμV/m)	Margin (dB)
4 334.20 ^{1), 2)}	52.05	Peak	H	30.30	6.60	44.60	-	44.35	74.00	29.65
4 334.20 ^{1), 2)}	-	Average	H	30.30	6.60	44.60	21.09	23.26	54.00	30.74
4 334.20 ^{1), 2)}	49.63	Peak	V	30.30	6.60	44.60	-	41.93	74.00	32.07
4 334.20 ^{1), 2)}	-	Average	V	30.30	6.60	44.60	21.09	20.84	54.00	33.16

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

¹⁾ : Harmonic

²⁾ : Restricted band

Total (dBμV/m) = Reading (dBμV) + Ant Factor (dB) + Cable Loss (dB) – Amp Gain (dB) – Duty Factor (dB)

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

10. CONDUCTED EMISSION TEST

10.1 Operating environment

Temperature : 21 °C

Relative humidity : 52 % R.H.

10.2 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 μ H + 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.

10.3 Measurement uncertainty

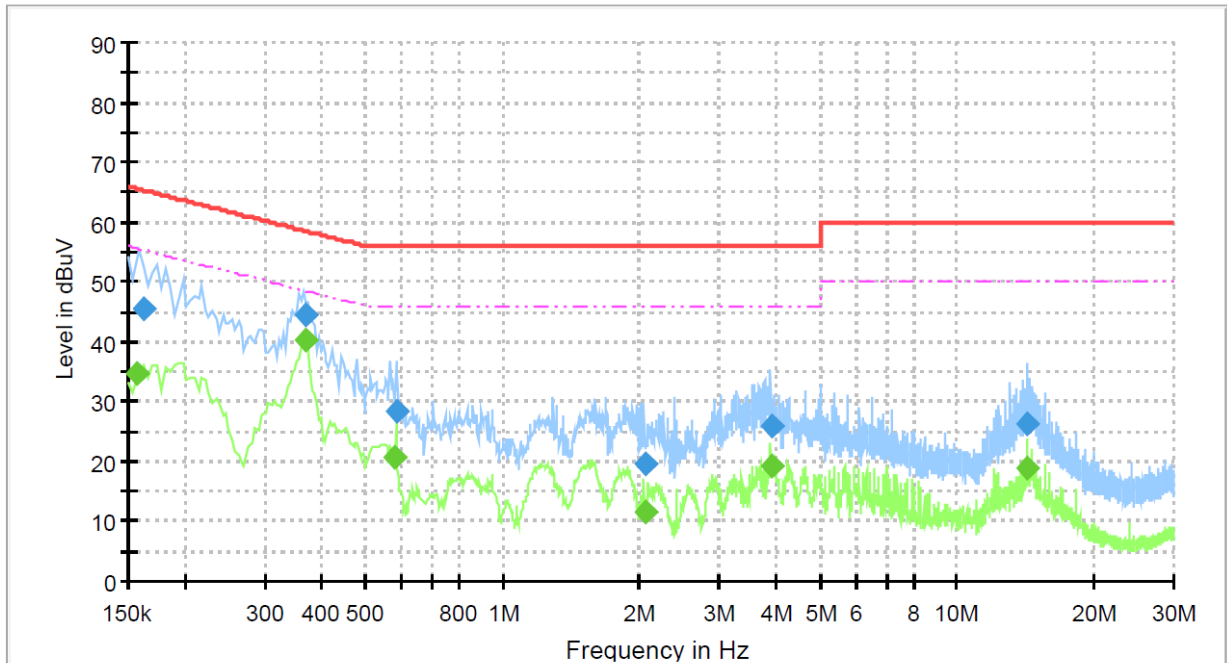
The uncertainty for Conducted emission test is ± 1.6 dB

10.4 Test date

March 22, 2023 ~ April 12, 2023

10.4 Test data

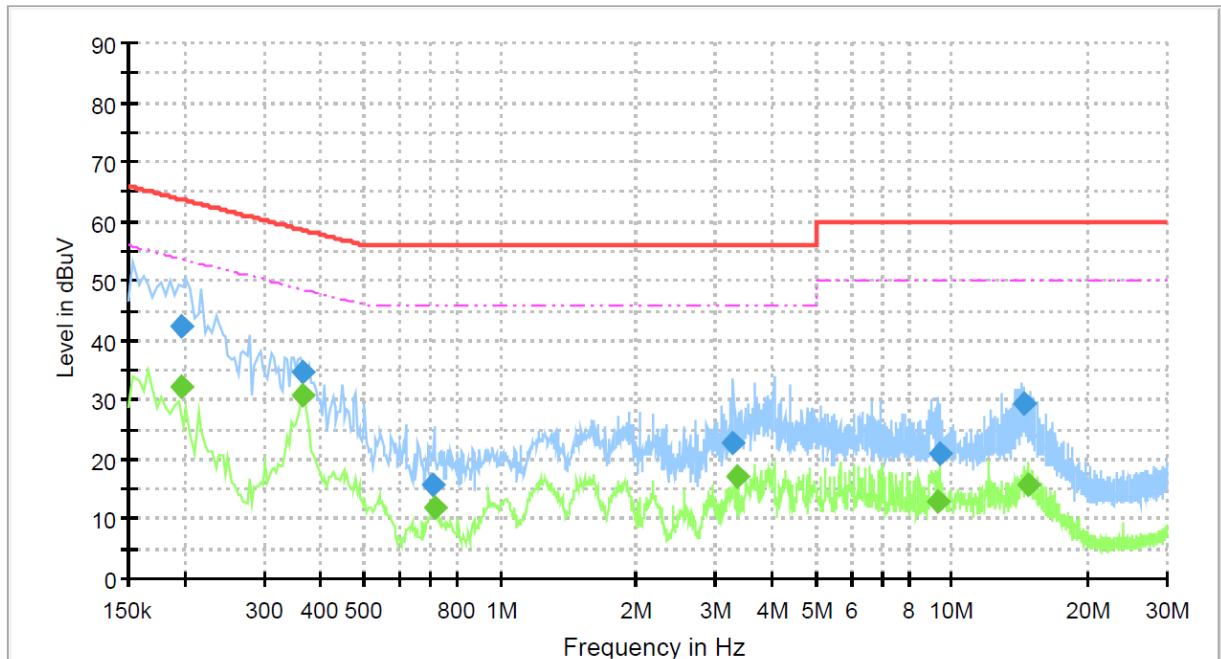
- . Resolution bandwidth : 9 kHz
- . Frequency range : 0.15 MHz ~ 30 MHz
- . Tested Line : HOT LINE



Final Result

Frequency (MHz)	QuasiPeak (dBuV)	CAverage (dBuV)	Limit (dBuV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.157	---	34.54	55.60	21.06	1000.0	9.0	L1	9.99
0.162	45.47	---	65.39	19.91	1000.0	9.0	L1	9.99
0.371	---	40.16	48.49	8.33	1000.0	9.0	L1	9.97
0.371	44.53	---	58.49	13.96	1000.0	9.0	L1	9.97
0.576	---	20.68	46.00	25.32	1000.0	9.0	L1	9.99
0.588	28.48	---	56.00	27.52	1000.0	9.0	L1	9.99
2.054	19.77	---	56.00	36.23	1000.0	9.0	L1	10.07
2.066	---	11.58	46.00	34.42	1000.0	9.0	L1	10.07
3.903	---	19.19	46.00	26.81	1000.0	9.0	L1	10.12
3.927	25.76	---	56.00	30.24	1000.0	9.0	L1	10.12
14.211	---	18.84	50.00	31.16	1000.0	9.0	L1	10.72
14.279	26.29	---	60.00	33.71	1000.0	9.0	L1	10.72

-. Tested Line : NEUTRAL LINE



Final Result

Frequency (MHz)	QuasiPeak (dBuV)	CAverage (dBuV)	Limit (dBuV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Corr. (dB)
0.198	---	32.34	53.72	21.37	1000.0	9.0	N	10.01
0.198	42.30	---	63.72	21.42	1000.0	9.0	N	10.01
0.366	---	30.77	48.60	17.83	1000.0	9.0	N	9.98
0.367	34.68	---	58.58	23.90	1000.0	9.0	N	9.98
0.707	15.61	---	56.00	40.39	1000.0	9.0	N	10.00
0.715	---	12.00	46.00	34.00	1000.0	9.0	N	10.00
3.269	22.72	---	56.00	33.28	1000.0	9.0	N	10.10
3.360	---	17.18	46.00	28.82	1000.0	9.0	N	10.10
9.352	---	13.09	50.00	36.91	1000.0	9.0	N	10.52
9.376	21.07	---	60.00	38.93	1000.0	9.0	N	10.52
14.399	29.37	---	60.00	30.63	1000.0	9.0	N	10.76
14.835	---	15.74	50.00	34.26	1000.0	9.0	N	10.77

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.

11. LIST OF TEST EQUIPMENT

Model Number	Manufacturer	Description	Serial Number	Last Cal. (Interval)
FSV40-N	Rohde & Schwarz	Spectrum analyzer	101651	Apr. 03, 2023 (1Y)
ESR	Rohde & Schwarz	EMI Test Receiver	101470	Oct. 18, 2022 (1Y)
HLP-2008	TDK RF Solutions	TRILOG BROADBAND ANTENNA	131316	Mar. 07, 2022 (2Y)
310N	Sonoma Instrument	Pre-Amplifier	392756	Oct. 10, 2022 (1Y)
BBHA9120D	Schwarzbeck	Horn Antenna	9120D-1349	Jul. 08, 2022 (1Y)
N/A	PHELCOM.CO	Band Reject Filter	N/A	Jan. 17, 2023 (1Y)
F-20-1000-N	RLC Electronis	High Pass Filter (1 GHz)	0426	Jan. 17, 2023 (1Y)
HPF 3GHz	Rohde & Schwarz	High Pass Filter (3 GHz)	N/A	Jan. 17, 2023 (1Y)
SCU 18	R/S	SIGNAL CONDITIONING UNIT	18040081	Jul. 12, 2022 (1Y)
CO3000	Innco Systems GmbH	Controller	N/A	N/A
DT5000	Innco Systems GmbH	Turn Table	N/A	N/A
MA-4000XPET	Innco Systems GmbH	Antenna Master	MA4000/509/ 37211215/L	N/A
FMZB 1513	Schwarzbeck	Loop Antenna	1513-235	Mar 24, 2022 (2Y)