TEST REPORT

KOSTEC Co., Ltd. 28(175-20, Annyeong-dong) 406-gil sejaro, Hwaseong-si, Gyeonggi-do, Korea Tel:031-222-4251, Fax:031-222-4252	Report No.: KST-FCR-220010	KOSTEC Co., Ltd. http://www.kostec.org

1. Applicant

   • Name : HL Klemove Corp.

   • Address : 224, Harmony -ro, Yeonsu-gu, Incheon, Republic of Korea

2. Test Item

   • Product Name: Vehicle Radar

   • Model Name: MRR-35

   • Brand: -

   • FCC ID: 2A3OZ-MRR-35 • IC: 27992-MRR35

3. Manufacturer

   • Name : HL Klemove Corp.

   • Address : 224, Harmony -ro, Yeonsu-gu, Incheon, Republic of Korea

4. Date of Test : 2022. 09. 07. ~ 2022. 09. 08.

5. Test Method Used : FCC CFR 47, Part 95. Subpart M
   RSS-251 issue 2, RSS-GEN issue 5
   ANSI C 63.10-2013

6. Test Result : Compliance

7. Note: -

Supplementary Information

The device bearing the brand name and FCC ID specified above has been shown to comply with the applicable technical standards as indicated in the measurement report and was tested in accordance with measurement procedures specified in ANSI C 63.10-2013.

We attest to the accuracy of data and all measurements reported herein were performed by KOSTEC Co., Ltd. and were made under Chief Engineer's supervision. We assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.

The results shown in this test report refer only to the sample(s) tested unless otherwise stated.
This test report is not related to KOLAS accreditation.

Affirmation	Tested by Name : Choo, Kwang-Yeol (Signature)	Technical Manager Name : Park, Gyeong-Hyeon (Signature)

2022. 09. 13.

KOSTEC Co., Ltd.

Table of Contents

1. GENERAL INFORMATION

1.1 Test Facility

Test laboratory and address

KOSTEC Co., Ltd.
28(175-20,Annyeong-dong)406-gil sejaro, Hwaseong-si Gyeonggi-do, Korea
Telephone Number: 82-31-222-4251
Facsimile Number: 82-31-222-4252

Registration information

KOLAS No.: KT232
RRA (National Radio Research Agency): KR0041
FCC Designation No.: KR0041
IC Designation No.: KR0041
VCCI Membership No.: 2005

1.2 Location

1.3 Revision History of test report

Rev.	Revisions	Effect page	Reviewed	Date
-	Initial issue	All	Gyeong Hyeon, Park	2022. 09. 13.

2. EQUIPMENT DESCRIPTION

The product specification described herein was declared by manufacturer. And refer to user's manual for the details.

Equipment Name	Vehicle Radar
Model No	MRR-35
Usage	Vehicle Radar
Serial Number	Proto type
Modulation type	FMCW
Emission Type	733MF0N
Maximum output power(e.i.r.p)	31.499 dBm(PK), 29.82 dBm(AV)
Operated Frequency	76 GHz ~ 77 GHz
Channel Number	1
Operation temperature	-40 °C ~ 85 °C
Power Source	DC 12 V
Antenna Description	Patch Antenna(Fixed), gain : 21.2 dBi
Remark	1. The device was operating at its maximum output power for all measurements. 2. The radiation measurements are performed in X, Y, Z axis positioning. Only the worst case (Y) is shown in the report. 3. The above DUT's information was declared by manufacturer. Please refer to the specifications or user manual for more detailed description.
FCC ID	2A3OZ-MRR-35
IC	27992-MRR35
PMN(Product Marketing Number)	MRR-35
HVIN(Hardware Version Identification Number)	1.00
FVIN(Firmware Version Identification Number)	1.00
HMN(Host Marketing Name)	N/A

3. SYSTEM CONFIGURATION FOR TEST

3.1 Characteristics of equipment

The Equipment Under Test (EUT) contains the following capabilities: This equipment is Vehicle Radar. The detailed explanation is refer as user manual.

3.2 Used peripherals list

Description	Model No.	Serial No.	Manufacture	Remark
-	-	-	-	-

3.3 Product Modification

N/A

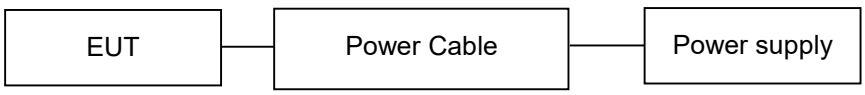
3.4 Operating Mode

The EUT was operated in the engineering mode to fix the TX frequency that was for the purpose of the measurements. The EUT operates in the following modes depending on the distance and speed of the lead vehicle.

Mode: LR, SR

3.5 Test Setup of EUT

The measurements were taken in continuous transmit mode using the test mode. The cables were provided by the applicant.



3.6 Used Test Equipment List

No.	Instrument	Model	S/N	Manufacturer	Next Cal Date	Cal interval	used
1	T & H Chamber	PL-3J	15003623	ESPEC CORP	2022.11.04	1 year	☐
2	T & H Chamber	SH-662	93000067	ESPEC CORP	2023.08.24	1 year	☐
3	T & H Chamber	SH-641	92006831	ESPEC CORP	2023.01.19	1 year	☒
4	Spectrum Analyzer	8563EC	3046A00527	Agilent Technology	2023.01.17	1 year	☐
5	Spectrum Analyzer	FSV30	104029	Rohde & Schwarz	2023.08.24	1 year	☐
6	Spectrum Analyzer	FSV30	20-353063	Rohde & Schwarz	2023.01.17	1 year	☐
7	Spectrum Analyzer	FSV40	101727	Rohde & Schwarz	2023.08.26	1 year	☒
8	Signal Analyzer	FSW43	101294	Rohde & Schwarz	2023.01.19	1 year	☐
9	Signal Analyzer	FSW85	101602	Rohde & Schwarz	2023.06.27	1 year	☒
10	EMI Test Receiver	ESCI7	100823	Rohde & Schwarz	2023.01.17	1 year	☐
11	EMI Test Receiver	ESPI	100488	Rohde & Schwarz	2023.01.17	1 year	☒
12	Vector Signal Analyzer	89441A	3416A02620	Agilent Technology	2023.01.19	1 year	☐
13	Network Analyzer	8753ES	US39170869	AGILENT	2023.08.24	1 year	☐
14	EPM Series Power meter	E4418B	GB39512547	Agilent Technology	2023.01.18	1 year	☐
15	RF Power Sensor	E9300A	MY41496631	Agilent Technology	2023.01.18	1 year	☐
16	Microwave Frequency Counter	5352B	2908A00480	Agilent Technology	2023.01.17	1 year	☐
17	Audio Analyzer	8903B	3514A16919	Agilent Technology	2023.01.18	1 year	☐
18	Audio Telephone Analyzer	DD-5601CID	520010281	CREDIX	2023.01.17	1 year	☐
19	Modulation Analyzer	8901A	3041A05716	H.P	2023.01.18	1 year	☐
20	Digital storage Oscilloscope	TDS3052	B015962	Tektronix	2023.08.25	1 year	☐
21	ESG-D Series Signal Generator	E4436B	US39260458	Agilent Technology	2023.01.18	1 year	☐
22	Vector Signal Generator	SMBV100A	257557	Rohde & Schwarz	2023.01.17	1 year	☐
23	GNSS Signal Generator	TC-2800A	2800A000494	TESCOM CO., LTD.	2023.01.18	1 year	☐
24	Signal Generator	SMB100A	179628	Rohde & Schwarz	2023.01.17	1 year	☒
25	Signal Generator	N5173B	MY57280148	KEYSIGHT	2023.06.14	1 year	☒
26	SLIDAC	None	0207-4	Myoung sung Ele.	2023.01.18	1 year	☐
27	DC Power supply	DRP-5030	9028029	Digital Electronic Co.,Ltd	2023.01.18	1 year	☐
28	DC Power supply	E3610A	KR24104505	Agilent Technology	2023.01.18	1 year	☐
29	DC Power supply	UP-3005T	68	Unicon Co.,Ltd	2023.01.18	1 year	☒
30	DC Power Supply	SM 3400-D	114701000117	DELTA ELEKTRONIKA	2023.01.18	1 year	☐
31	DC Power supply	6632B	MY43004005	Agilent Technology	2023.01.18	1 year	☐
32	DC Power Supply	6632B	MY43004137	Agilent Technology	2023.01.18	1 year	☐
33	Termination	1433-3	LM718	WEINSCHEL	2023.01.18	1 year	☐
34	Termination	1432-3	QR946	AEROFLEX/WEINSCHEL	2023.01.18	1 year	☐
35	Attenuator	24-30-34	BX5630	Aeroflex / Weinschel	2022.12.01	1 year	☐
36	Attenuator	8498A	3318A09485	HP	2023.01.19	1 year	☐
37	Step Attenuator	8494B	3308A32809	HP	2023.01.19	1 year	☐
38	RF Step Attenuator	RSP	100091	Rohde & Schwarz	2023.01.18	1 year	☐
39	Attenuator	18B50W-20F	64671	INMET	2023.01.19	1 year	☐
40	Attenuator	10 dB	1	Rohde & Schwarz	2023.01.18	1 year	☐
41	Attenuator	54A-10	74564	WEINSCHEL	2023.08.26	1 year	☐
42	Attenuator	56-10	66920	WEINSCHEL	2023.01.19	1 year	☐
43	Attenuator	48-30-33-LIM	BL5350	Weinschel Corp.	2023.01.18	1 year	☐
44	Power divider	11636B	51212	HP	2023.01.19	1 year	☐
45	3Way Power divider	KPDSU3W	00070365	KMW	2023.08.25	1 year	☐
46	4Way Power divider	70052651	173834	KRYTAR	2023.01.19	1 year	☐
47	3Way Power divider	1580	SQ361	WEINSCHEL	2023.01.19	1 year	☐
48	OSP	OSP120	101577	Rohde & Schwarz	2023.01.19	1 year	☐
49	White noise audio filter	ST31EQ	101902	SoundTech	2023.08.25	1 year	☐
50	Dual directional coupler	778D	17693	HEWLETT PACKARD	2023.01.18	1 year	☐
51	Dual directional coupler	772D	2839A00924	HEWLETT PACKARD	2023.01.18	1 year	☐

No.	Instrument	Model	S/N	Manufacturer	Next Cal Date	Cal interval	used
52	Band rejection filter	3TNF-0006	26	DOVER Tech	2023.01.18	1 year	☐
53	Band rejection filter	3TNF-0007	311	DOVER Tech	2023.01.18	1 year	☐
54	Band rejection filter	WTR-BRF2442-84NN	09020001	WAVE TECH Co.,LTD	2023.01.19	1 year	☐
55	Band rejection filter	WRCJV12-5695-5725-5825-5855-50SS	1	Wainwright Instruments GmbH	2023.01.19	1 year	☐
56	Band rejection filter	WRCJV12-5120-5150-5350-5380-40SS	4	Wainwright Instruments GmbH	2023.01.19	1 year	☐
57	Band rejection filter	WRCGV10-2360-2400-2500-2540-50SS	2	Wainwright Instruments GmbH	2023.01.18	1 year	☐
58	Band rejection filter	CTF-155M-S1	001	RF One Electronics	2023.08.24	1 year	☐
59	Band rejection filter	CTF-435M-S1	001	RF One Electronics	2023.08.24	1 year	☐
60	Band rejection filter	CTF-5890M-70MS1	1	RF One Electronics	2023.01.19	1 year	☐
61	Highpass Filter	WHJS1100-10EF	1	WAINWRIGHT	2023.01.19	1 year	☐
62	Highpass Filter	WHJS3000-10EF	1	WAINWRIGHT	2023.01.19	1 year	☐
63	Highpass Filter	WHNX6-5530-7000-26500-40CC	2	Wainwright Instruments GmbH	2023.01.19	1 year	☐
64	Highpass Filter	WHNX6-2370-3000-26500-40CC	4	Wainwright Instruments GmbH	2023.01.19	1 year	☐
65	WideBand Radio Communication Tester	CMW500	102276	Rohde & Schwarz	2023.01.18	1 year	☐
66	WideBand Radio Communication Tester	CMW500	117235	Rohde & Schwarz	2023.01.18	1 year	☐
67	WideBand Radio Communication Tester(with CMX500)	CMW500	167157	Rohde & Schwarz	2023.01.18	1 year	☐
68	Bluetooth Tester	TC-3000B	3000B6A0166	TESCOM CO., LTD.	2023.01.18	1 year	☐
69	Loop Antenna	6502	9203-0493	EMCO	2023.05.31	2 year	☐
70	Loop Antenna	FMZB1513	#374	Schwarzbeck	2023.02.26	2 year	☒
71	BiconiLog Antenna	3142B	1745	EMCO	2024.04.08	2 year	☐
72	Trilog-Broadband Antenna(R)	VULB 9168	9168-606	SCHWARZBECK	2022.09.21	2 year	☒
73	Biconical Antenna(T)	VUBA9117	9117-342	Schwarz beck	2024.01.24	2 year	☐
74	Horn Antenna	3115	9605-4834	EMCO	2023.03.02	1 year	☐
75	Horn Antenna	QMS-00208	21909	STEATITE ANTENNA	2022.12.04	1 year	☐
76	Horn Antenna(R)	3117	00135191	ETS-LINDGREN	2023.04.12	1 year	☐
77	Horn Antenna(T)	3115	2996	EMCO	2023.02.10	1 year	☒
78	Horn Antenna(R)	BBHA 9170	9170-722	SCHWARZBECK	2023.01.20	1 year	☒
79	Horn Antenna(T)	BBHA 9170	743	SCHWARZBECK	2023.01.21	1 year	☐
80	AMPLIFIER(A_10)	TK-PA01S	220109-L	TESTEK	2023.04.29	1 year	☐
81	AMPLIFIER(C_3)	TK-PA01S	200141-L	TESTEK	2023.08.24	1 year	☒
82	PREAMPLIFIER(C_3)	8449B	3008A02577	Agilent	2023.01.17	1 year	☒
83	RF PRE AMPLIFIER	SCU08F2	100762	Rohde & Schwarz	2022.12.01	1 year	☐
84	AMPLIFIER	TK-PA18	150003	TESTEK	2023.01.17	1 year	☐
85	AMPLIFIER	TK-PA1840H	160010-L	TESTEK	2023.01.18	1 year	☒
86	Horn Antenna	M19RH	T01	OML, Inc.	2023.04.19	1 year	☒
87	Horn Antenna	M12RH	T02	OML, Inc.	2023.04.18	1 year	☒
88	Horn Antenna	M08RH	T03	OML, Inc.	2023.04.19	1 year	☒
89	Horn Antenna	M05RH	T04	OML, Inc.	2023.04.19	1 year	☒
90	Horn Antenna	M03RH	T05	OML, Inc.	2023.04.19	1 year	☒
91	Harmonic Mixer	M12HWD	200529-1	OML, Inc.	2023.06.27	1 year	☒
92	Harmonic Mixer	M08HWD	200529-1	OML, Inc.	2023.06.27	1 year	☒
93	Harmonic Mixer	M05HWD	200529-1	OML, Inc.	2023.06.27	1 year	☒
94	Harmonic Mixer	M03HWD	200529-1	OML, Inc.	2023.06.27	1 year	☒
95	Source Module	S19MS-A	200529-1	OML, Inc.	2023.04.18	1 year	☒
96	Source Module	S12MS-A	200529-1	OML, Inc.	2023.04.18	1 year	☒
97	Source Module	S08MS-A	200529-1	OML, Inc.	2023.04.18	1 year	☒
98	Source Module	S05MS-A	200529-1	OML, Inc.	2023.04.18	1 year	☒
99	Source Module	S03MS-A	200529-1	OML, Inc.	2023.04.18	1 year	☒

Note: The measuring equipment, which was utilized in performing the tests documented herein, has been calibrated in accordance with the manufacturer's recommendations for utilizing calibration equipment's, which is traceable to recognized national standards.
Especially, all antenna(Up to 40 GHz) for measurement is calibrated in accordance with the requirements of C 63.5.

3.7 Measurement uncertainty

The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI C63.10-2013. All measurement uncertainty values are shown with a coverage factor of k = 2 to indicate a 95% level of confidence. The measurement uncertainty shown below meets or exceeds the UCISPR measurement uncertainty values specified in CISPR 16-4-2 and, thus, can be compared directly to specified limits to determine compliance.

Parameter	Measurement uncertainty
Radiated Disturbance(Below 1 GHz)	3.62 dB (CL: Approx 95 %, k=2)
Radiated Disturbance(1 GHz ~ 40 GHz)	4.18 dB (CL: Approx 95 %, k=2)
Radiated Disturbance(Above 40 GHz)	5.38 dB (CL: Approx 95 %, k=2)

4. SUMMARY TEST RESULTS

Description of Test	FCC Rule	ISED	Reference Clause	Used	Test Result
Equivalent Isotropically Radiated Power(EIRP)	95.3367(a)(b)	RSS-251, Section 8.1, 9.1	Clause 5.1	☒	Compliance
Unwanted emissions	95.3379(a)	RSS-GEN Section 6.13, RSS-251 Section 10	Clause 5.2	☒	Compliance
Frequency stability	95.3379(b)	RSS-GEN Section 8.11, RSS-251 Section 11	Clause 5.3	☒	Compliance
Occupied Bandwidth	2.1049	RSS-GEN Section 6.7, RSS-251 Section 7	Clause 5.4	☒	Compliance
Modulation characteristics	2.1047	RSS-251 Section 6	Clause 5.5	☒	Compliance
Antenna requirements	15.203	RSS-GEN	Clause 5.6	☒	Compliance
Compliance/pass : The EUT complies with the essential requirements in the standard. Not Compliance : The EUT does not comply with the essential requirements in the standard. N/A : The test was not applicable in the standard.					

Procedure Reference

FCC CFR 47, Part 95. Subpart M

RSS-GEN Issue 5, RSS-251 Issue 2

KDB 653005 D01 76-81 GHz Radars v01r01

ANSI C 63.10-2013

5. MEASUREMENT RESULTS

5.1 Equivalent Isotropically Radiated Power(EIRP)

5.1.1 Standard Applicable [FCC §95.3367(a)(b), RSS-251, Section 8.1, 9.1]

FCC

The fundamental radiated emission limits within the 76-81 GHz band are expressed in terms of Equivalent Isotropically Radiated Power (EIRP) and are as follows:

(a) The maximum power (EIRP) within the 76-81 GHz band shall not exceed 50 dBm based on measurements employing a power averaging detector with a 1 MHz Resolution Bandwidth (RBW).

(b) The maximum peak power (EIRP) within the 76-81 GHz band shall not exceed 55 dBm based on measurements employing a peak detector with a 1 MHz RBW.

ISED

Average equivalent isotropically radiated power (e.i.r.p.)

The radar device's total average e.i.r.p. shall not exceed 50 dBm over the occupied bandwidth.

Peak e.i.r.p. spectral density

The radar device's peak e.i.r.p. spectral density shall not exceed 55 dBm/MHz.

5.1.2 Test Environment conditions

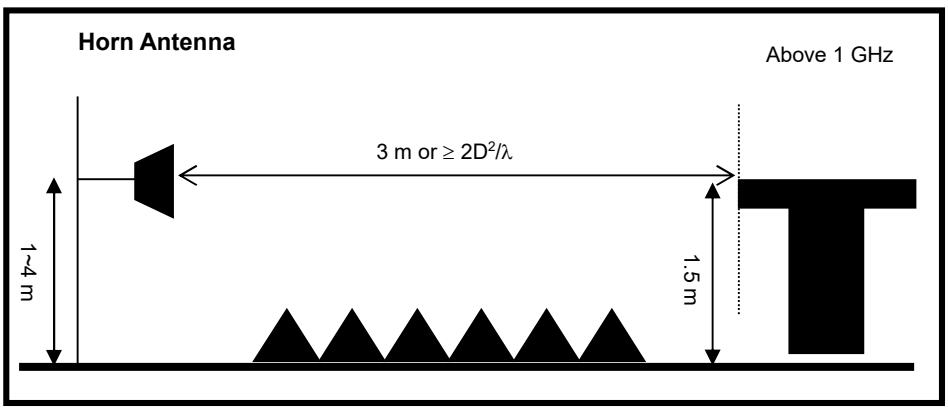
• Ambient temperature : (21 ~ 22) ℃ • Relative Humidity : (53 ~ 55) % R.H.

5.1.3 Measurement Procedure

The measurements procedure of the Equivalent Isotropically Radiated Power is as following describe method.

1. The EUT is placed on a turntable, which is 1.5 m above ground plane.
2. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
3. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
4. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
5. Repeat above procedures until the measurements for all frequencies are complete.

5.1.4 Test setup



5.1.5 Measurement Result

▣ Mode: LR

Average EIRP

Freq. (GHz)	Reading (dBm)	Pol. (H/V)	Factor(dB)	Duty Factor(dB)	Meas Result (dBm)	Limit (dBm)	Margin. (dB)	Result
76.356	-50.95	H	77.30	3.47	29.82	50	20.18	Compliance

Peak EIRP

Freq. (GHz)	Reading (dBm)	Pol. (H/V)	Factor(dB)	FMCW desensitization factor(dB)	Meas Result (dBm/MHz)	Limit (dBm/MHz)	Margin. (dB)	Result
76.199	-45.70	H	77.19	0.009	31.499	55	23.501	Compliance

※Note

Wavelength = Speed of light / Measurement frequency = 30 / 7 700 = 0.0038

$R_{(Far\ Field)}$ = (2 * (Max antenna length of EUT)^2) / Wavelength = (2 * (0.0435)^2 / 0.0038 = 0.97 m

Our measurement is performed at a minimum distance of 1 m > $R_{(Far\ field)}$

Calculation of test results

•Factor (dB): Mixer Loss(dB) + Cable Loss(dB) + FSPL(dB) - Antenna Gain(dBi)

•Meas Result (dBm): Reading(dBm) + Factor(dB)+Duty Factor(dB) or FMCW desensitization factor(dB)

•Duty factor = 10 * log(1/x) = 10 * log(1/0.45) = 3.47

FSPL measurement

•FSPL = TxPower - RxPower;

•RxPower = S.A Measured Level - Rx Ant Gain + Mixer Conversion Loss + Cable Loss;

•TxPower = OML Source Output + Tx Ant Gain;

FMCW desensitization factor

The derivation of the FMCW desensitization factor is given in Keysight Application Note 5952-1039 Appendix B.

$$\alpha = \frac{1}{\sqrt[4]{1+\left(\frac{2\ln(2)}{\pi}\right)^2\left(\frac{F_s}{T_s B^2}\right)^2}}$$

and

FMCW desensitization factor = 20 Log(α)

Where

F_S = FMCW Sweep Width or Chirp Width

T_S = FMCW Sweep Time

B = 3-dB bandwidth of Gaussian RBW Filter

FMCW Sweep Width (MHz)	FMCW Sweep Time (us)	3-dB bandwidth of Gaussian RBW Filter(MHz)	FMCW desensitization factor(dB)
380.29	3 680	1	0.009

▣ Mode: SR

Average EIRP

Freq. (GHz)	Reading (dBm)	Pol. (H/V)	Factor(dB)	Duty Factor(dB)	Meas Result (dBm)	Limit (dBm)	Margin. (dB)	Result
76.493	-61.06	H	77.40	3.47	19.81	50	30.90	Compliance

Peak EIRP

Freq. (GHz)	Reading (dBm)	Pol. (H/V)	Factor(dB)	FMCW desensitization factor(dB)	Meas Result (dBm/MHz)	Limit (dBm/MHz)	Margin. (dB)	Result
76.198	-56.52	H	77.19	0.668	21.338	55	33.662	Compliance

※Note

Wavelength = Speed of light / Measurement frequency = 30 / 7 700 = 0.0038

$R_{(Far\ Field)}$ = (2 * (Max antenna length of EUT)^2) / Wavelength = (2 * (0.0435)^2 / 0.0038 = 0.97 m

Our measurement is performed at a minimum distance of 1 m > $R_{(Far\ field)}$

Calculation of test results

•Factor (dB): Mixer Loss(dB) + Cable Loss(dB) + FSPL(dB) - Antenna Gain(dBi)

•Meas Result (dBm): Reading(dBm) + Factor(dB)+Duty Factor(dB) or FMCW desensitization factor(dB)

•Duty factor = 10 * log(1/x) = 10 * log(1/0.45) = 3.47

FSPL measurement

•FSPL = TxPower - RxPower;

•RxPower = S.A Measured Level - Rx Ant Gain + Mixer Conversion Loss + Cable Loss;

•TxPower = OML Source Output + Tx Ant Gain;

FMCW desensitization factor

The derivation of the FMCW desensitization factor is given in Keysight Application Note 5952-1039 Appendix B.

$$\alpha = \frac{1}{\sqrt[4]{1+\left(\frac{2\ln(2)}{\pi}\right)^2\left(\frac{F_s}{T_s B^2}\right)^2}}$$

and

FMCW desensitization factor = 20 Log(α)

Where

F_S = FMCW Sweep Width or Chirp Width

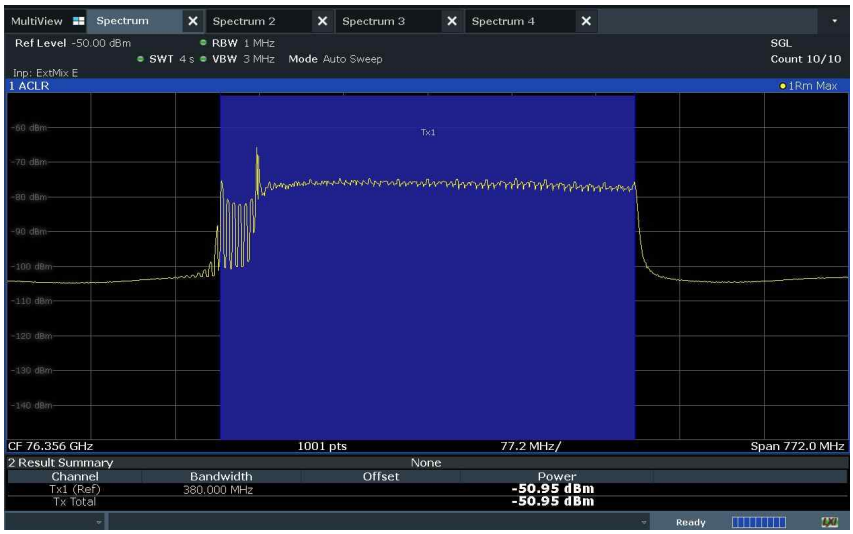
T_S = FMCW Sweep Time

B = 3-dB bandwidth of Gaussian RBW Filter

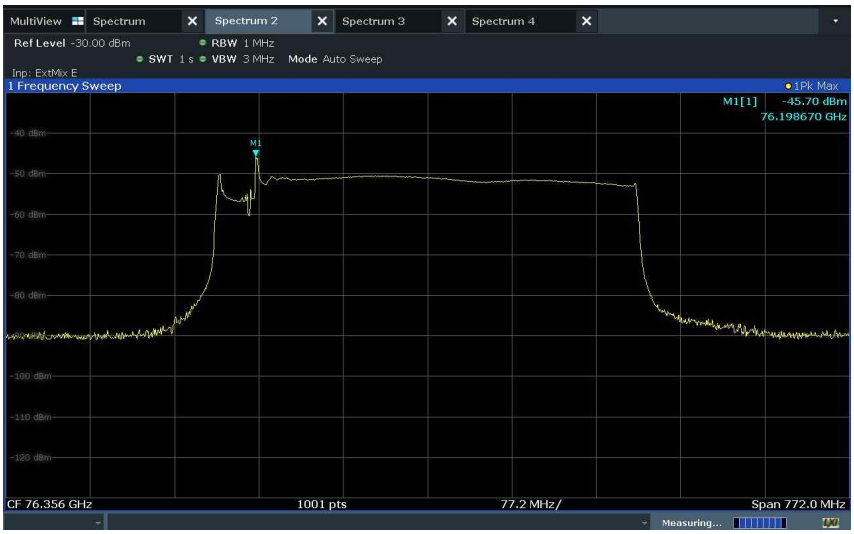
FMCW Sweep Width (MHz)	FMCW Sweep Time (us)	3-dB bandwidth of Gaussian RBW Filter(MHz)	FMCW desensitization factor(dB)
732.69	540	1	0.668

▣ Mode: LR

Average EIRP

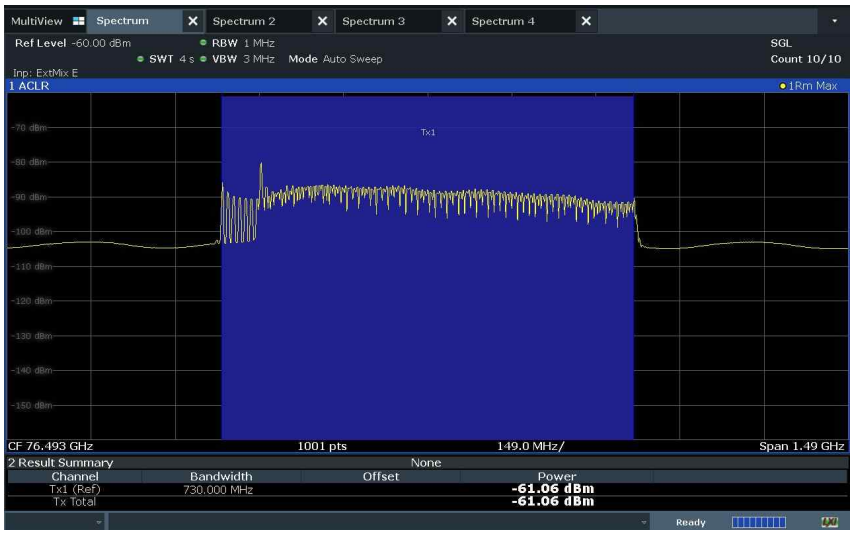


Peak EIRP

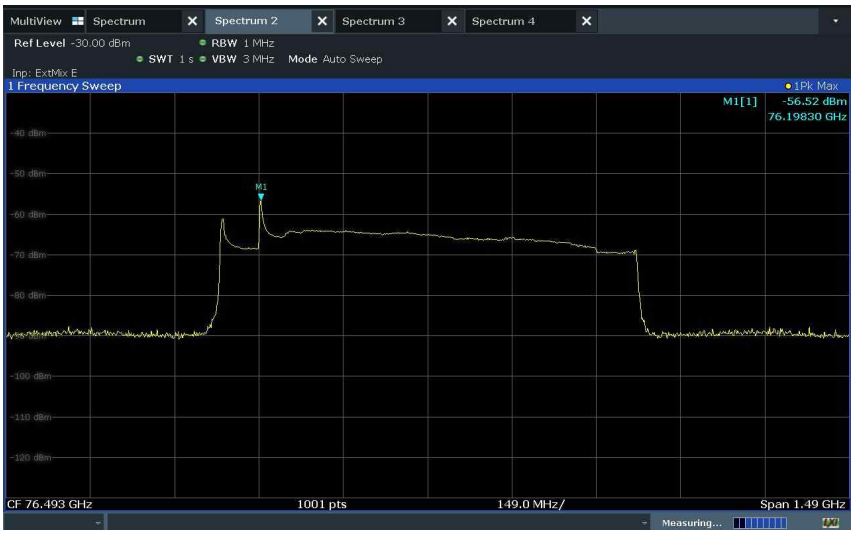


▣ Mode: SR

Average EIRP



Peak EIRP



5.2 Unwanted Emissions

5.2.1 Standard Applicable [FCC §95.3379(b), RSS-251 10, RSS-GEN 6.13, 7]

FCC

(a) The power density of any emissions outside the 76-81 GHz band shall consist solely of spurious emissions and shall not exceed the following:

(1) Radiated emissions below 40 GHz shall not exceed the field strength as shown in the following emissions table.

Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/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

(i) In the emissions table in paragraph (a)(1) of this section, the tighter limit applies at the band edges.

(ii) The limits in the table in paragraph (a)(1) of this section are based on the frequency of the unwanted emissions and not the fundamental frequency. However, the level of any unwanted emissions shall not exceed the level of the fundamental frequency.

(iii) The emissions limits shown in the table in paragraph (a)(1) of this section are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9.0-90.0 kHz, 110.0-490.0 kHz, and above 1000 MHz. Radiated emissions limits in these three bands are based on measurements employing an average detector with a 1 MHz RBW.

(2) The power density of radiated emissions outside the 76-81 GHz band above 40.0 GHz shall not exceed the following, based on measurements employing an average detector with a 1 MHz RBW:

(i) For radiated emissions outside the 76-81 GHz band between 40 GHz and 200 GHz from field disturbance sensors and radar systems operating in the 76-81 GHz band: 600 pW/cm 2 at a distance of 3 meters from the exterior surface of the radiating structure.

(ii) For radiated emissions above 200 GHz from field disturbance sensors and radar systems operating in the 76-81 GHz band: 1000 pW/cm 2 at a distance of 3 meters from the exterior surface of the radiating structure.

(3) For field disturbance sensors and radar systems operating in the 76-81 GHz band, the spectrum shall be investigated up to 231.0 GHz.

ISED

RSS-251, 10 Unwanted emissions

Emission frequency range	Limit	Applicable detector
Below 40 GHz	RSS-Gen general field strength limits for licence-exempt radio apparatus	RSS-Gen requirements
40-162 GHz *	-30 dBm/MHz (e.i.r.p.)	RMS detector

Note:

* For radar devices that operate solely in the 76-77 GHz band (i.e. the occupied bandwidth is entirely contained in the 76-77 GHz band), an unwanted emissions limit of 0 dBm/MHz shall apply for the unwanted emission that fall in the 73.5-76 GHz band. Outside of the 73.5-76 GHz band, the unwanted emission limits prescribed in table 1 shall apply.

RSS GEN 7.3 Receiver radiated emission limits

Radiated emission measurements shall be performed with the receiver antenna connected to the receiver antenna ports. The search for spurious emissions shall be from the lowest frequency internally generated or used in the receiver (e.g. local oscillator, intermediate or carrier frequency), or 30 MHz, whichever is higher, to at least five times the highest tunable or local oscillator frequency, whichever is higher, without exceeding 40 GHz.

Spurious emissions from receivers shall not exceed the radiated emissions limits shown in table 3.

Table 3 – Receiver radiated emissions limits	
Frequency (MHz)	Field strength (μV/m at 3 metres)[Note 1]
30-88	100
88-216	150
216-960	200
Above 960	500

Note 1: Measurements for compliance with the limits in table 3 may be performed at distances other than 3 metres, in accordance with section 6.6.

5.2.2 Test Environment conditions

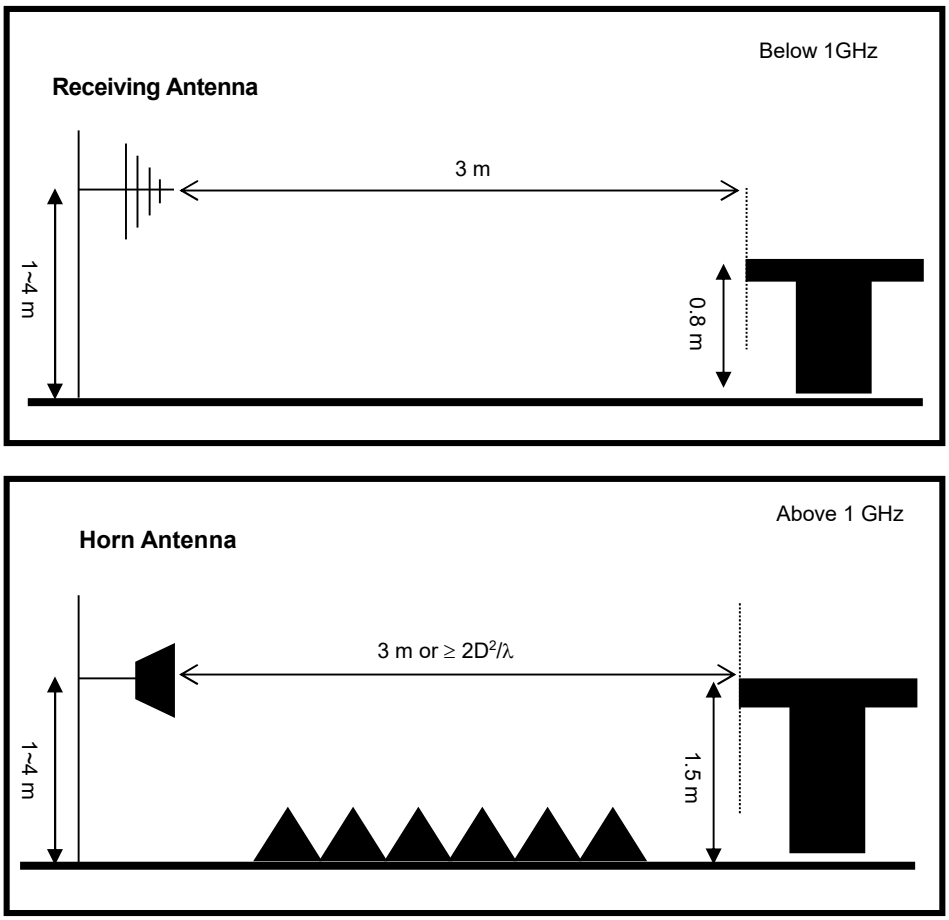
• Ambient temperature : (21 ~ 22) ℃ • Relative Humidity : (53 ~ 55) % R.H.

5.2.3 Measurement Procedure

The measurements procedure of the Spurious RF Radiated emissions is as following describe method.

1. The EUT is placed on a turntable, which is 1.5 m above ground plane.
2. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
3. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
4. And also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
5. Repeat above procedures until the measurements for all frequencies are complete.

5.2.4 Test setup



All tests is performed by radiated measurement and applied below conditions.(EIRP, OBW)

Wavelength = Speed of light / Measurement frequency = 30 / 7 700 = 0.0038

*(2 * (Max antenna length of EUT)^2) / Wavelength = (2 * (0.0435)^2 / 0.0038 = 0.97 m*

5.2.5 Measurement Result

▣ Below 1 GHz

Freq. (MHz)	Reading (dBμV/m)	Table (Deg)	Antenna			CL (dB)	AMP (dB)	Meas Result (dBμV/m)	Limit (dBμV/m)	Mgn (dB)	Result
			Height (m)	Pol. (H/V)	Fctr. (dB/m)						
32.86	44.05	160	1.0	H	18.62	1.14	46.33	17.48	40.00	22.52	Compliance
33.33	50.65	100	1.5	V	18.64	1.14	46.33	24.10	40.00	15.90	Compliance
155.91	41.73	160	1.0	H	18.82	2.10	46.44	16.21	43.50	27.29	Compliance
164.91	43.10	100	1.5	V	18.57	2.15	46.43	17.39	43.50	26.11	Compliance

Freq.(㎒) : Measurement frequency, Reading(dBμV/m) : Indicated value for test receiver, Table (Deg) : Directional degree of Turn table
Antenna (Height, Pol, Fctr) : Antenna Height, Polarization and Factor, Cbl(dB) : Cable loss, Pre AMP(dB) : Preamplifier gain(dB)
Meas Result (dBμV/m) :Reading(dBμV/m)+ Antenna factor.(dB/m)+ CL(dB) - Pre AMP(dB)
Limit(dBμV/m): Limit value specified with FCC Rule, Mgn(dB) : FCC Limit (dBμV/m) − Meas Result(dBμV/m)

- The transmitter radiated spectrum was investigated from 9 kHz to 1 GHz.
- The spurious signals detected do not depend on the operating mode.

▣ 1 GHz – 40 GHz

Freq. (GHz)	Reading (dBμV/m)		Table (Deg)	Antenna			CL (dB)	AMP (dB)	Meas Result (dBμV/m)		Limit (dBμV/m)		Mgn. (dB)		Result
	PK	AV		Height (m)	Pol. (H/V)	Fctr. (dB/m)			PK	AV	PK	AV	PK	AV	
No critical peaks found															

※Note
- Above 1 GHz is measured average and peak detector mode on Spectrum analyzer in accordance with FCC Rule15.35
- Limit: 54 dBμV/m(Average), 74 dBμV /m(Peak), Attenuated more than 20 dB below the permissible value.
- It is not recorded on the report that the reading of emissions are attenuated more than 20 dB below the permissible limits or the field strength is too small to measured.
- The transmitter radiated spectrum was investigated from 1 GHz to 40 GHz.

▣ 40 GHz – 243 GHz

Measurement distance: 3 m

Mode	Freq. (GHz)	Reading (dBm)	Pol. (H/V)	Factor (dB)	Meas. Result (dBm)	Limit (dBm)		Margin. (dB)		Result
						FCC	IC	FCC	IC	
LR	75.891 6	-103.27	H	85.06	-18.21	-1.7	0	-16.51	-18.21	Compliance
SR	75.895 6	-103.27	H	85.07	-18.20	-1.7	0	-16.50	-18.20	Compliance

※Note

Calculation of test results

•Factor (dB): Mixer Loss(dB) + Cable Loss(dB) + FSPL(dB) - Antenna Gain(dBi)

•Meas Result (dBm): Reading(dBm) + Factor(dB)

FSPL measurement

•FSPL = TxPower - RxPower;

•RxPower = S.A Measured Level - Rx Ant Gain + Mixer Conversion Loss + Cable Loss;

•TxPower = OML Source Output + Tx Ant Gain;

FCC Limit

•For radiated emissions outside the 76-81 GHz band between 40 GHz and 200 GHz from field disturbance sensors and radar systems operating in the 76-81 GHz band: 600 pW/cm 2 at a distance of 3 meters from the exterior surface of the radiating structure.

•For radiated emissions above 200 GHz from field disturbance sensors and radar systems operating in the 76-81 GHz band: 1000 pW/cm 2 at a distance of 3 meters from the exterior surface of the radiating structure.

Notes:

$P(mW) = \text{Power density } (mW/m^2) * 4\pi(r)^2$

$600\ pW/cm^2 = -1.7$ dBm @ 3 m = 7.84 dBm @ 1 m

$1000\ pW/cm^2 = 0.5$ dBm @ 3 m = 10.04 dBm @ 1 m

P: Power

r: Measurement distance(m)

ISED Limit

•For radar devices that operate solely in the 76-77 GHz band (i.e. the occupied bandwidth is entirely contained in the 76-77 GHz band), an unwanted emissions limit of 0 dBm/MHz shall apply for the unwanted emission that fall in the 73.5-76 GHz band. Outside of the 73.5-76 GHz band, the unwanted emission limits prescribed in table 1 shall apply.

▣ Receiver Spurious Emissions Results

Freq. (GHz)	Reading (dBm)	Pol. (H/V)	Factor (dB)	Meas Result (dBm)	Limit (dBuV/m)	Margin. (dB)	Result
No critical peaks found							

※Note

Test method

•Below 1 GHz: RBW 120 kHz, VBW: 300 kHz(Quasi Peak)

•Above 1 GHz: RBW 1 MHz, VBW 1 MHz(Peak)

Calculation of test results

•Factor (dB): Mixer Loss(dB) + Cable Loss(dB) + FSPL(dB) - Antenna Gain(dBi)

•Meas Result (dBm): Reading(dBm) + Factor(dB)

FSPL measurement

•FSPL = TxPower - RxPower;

•RxPower = S.A Measured Level - Rx Ant Gain + Mixer Conversion Loss + Cable Loss;

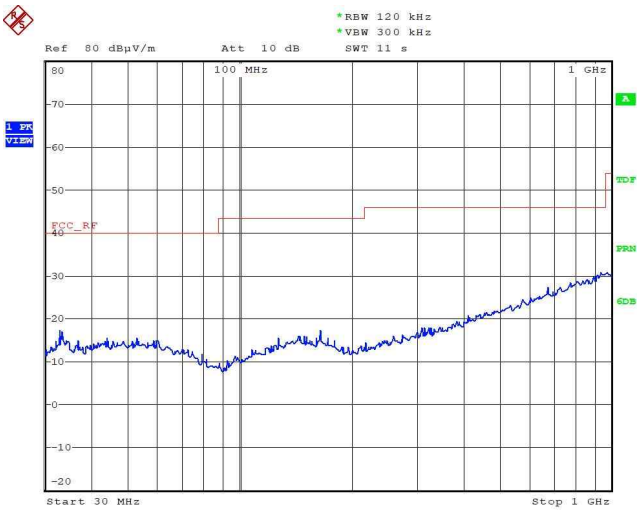
•TxPower = OML Source Output + Tx Ant Gain;

5.2.6 Plots

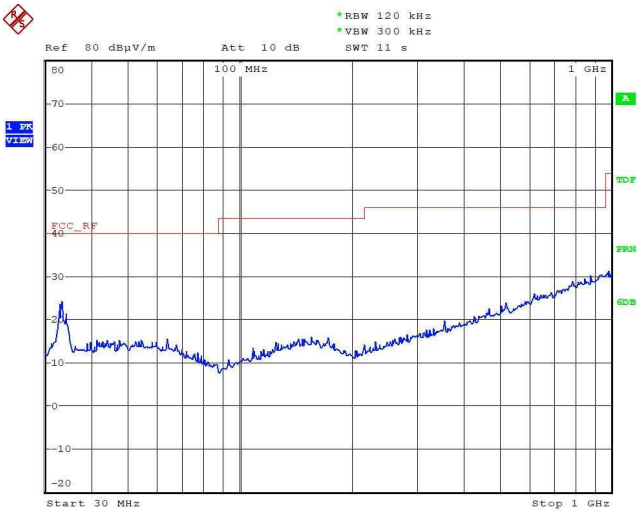
*The worst case only.

▪ Below 1 GHz

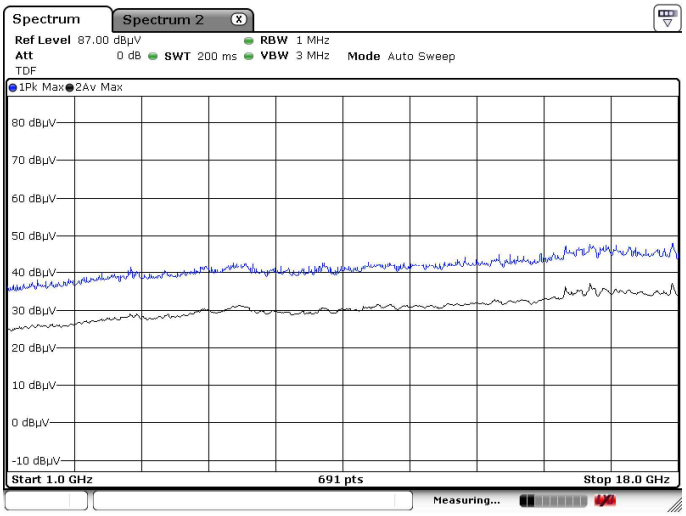
Horizontal

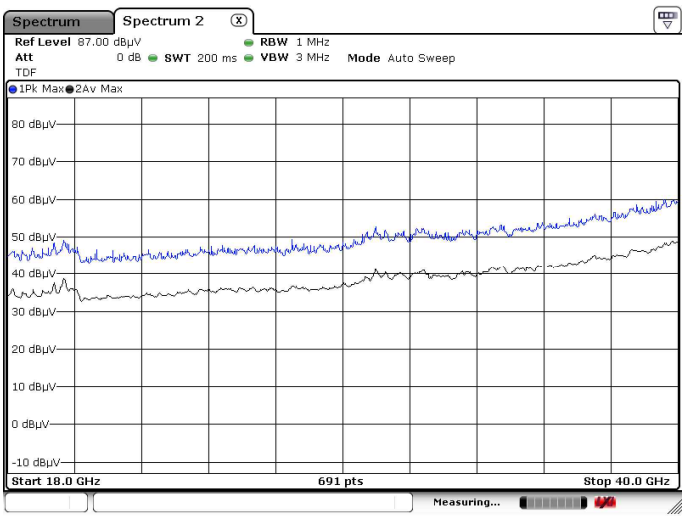


Vertical



▪ Above 1 GHz





- Above 40 GHz

▣ Mode: LR

Out of Band

▣ Mode: SR

Out of Band

5.3 Frequency Stability

5.3.1 Standard Applicable [FCC §95.3379(b), RSS-GEN 8.11]

FCC

(b) Fundamental emissions must be contained within the frequency bands specified in this section during all conditions of operation. Equipment is presumed to operate over the temperature range −20 to +50 degrees Celsius with an input voltage variation of 85% to 115% of rated input voltage, unless justification is presented to demonstrate otherwise.

ISED

If the frequency stability of the licence-exempt radio apparatus is not specified in the applicable RSS, the fundamental emissions of the radio apparatus should be kept within at least the central 80% of its permitted operating frequency band in order to minimize the possibility of out-of-band operation.

5.3.2 Test Environment conditions

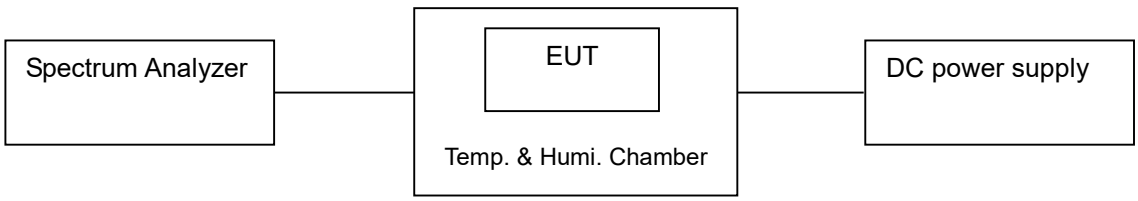
• Ambient temperature : (22 ~ 23) ℃ • Relative Humidity : (53 ~ 55) % R.H.

5.3.3 Measurement Procedure

The spectrum analyzer is set to the as follows :

• Set the RBW: 1 % to 3 % of the 99 % bandwidth.
• Set the VBW: ≥ 3 x RBW.
• Detector = Peak.
• Sweep time = auto couple.
• Trace mode = max hold.
• Allow trace to fully stabilize.
• The frequency drift was investigated for every 10 ℃ increment until the unit is stabilized then recorded the reading in tabular format with the temperature range of -40 ℃ to 85 ℃. (Manufacturer declaration)
• Voltage supplied to EUT is 12 V reference temperature was done at 20 ℃.
• The voltage was varied by ±15 % of nominal.

5.3.4 Test setup



5.3.5 Measurement Result

▣ Mode: LR

Temp(℃)	Power Supply	Frequency Range(GHz)	Limit(GHz)	Result
85	DC 12 (Vnom)	76.192 ~ 76.575	76~81	Compliance
80		76.188 ~ 76.571		Compliance
70		76.184 ~ 76.568		Compliance
60		76.180 ~ 76.564		Compliance
50		76.177 ~ 76.559		Compliance
40		76.174 ~ 76.555		Compliance
30		76.170 ~ 76.551		Compliance
20(Ref.)		76.167 ~ 76.547		Compliance
10		76.162 ~ 76.543		Compliance
0		76.158 ~ 76.539		Compliance
-10		76.153 ~ 76.536		Compliance
-20		76.150 ~ 76.532		Compliance
-30		76.147 ~ 76.527		Compliance
-40		76.143 ~ 76.524		Compliance
Nom Temperature	DC 9 (Vmin)	76.166 ~ 76.547		Compliance
Nom Temperature	DC 16 (Vmax)	76.167 ~ 76.547		Compliance

▣ Mode: SR

Temp(℃)	Power Supply	Frequency Range(GHz)	Limit(GHz)	Result
85	DC 12 (Vnom)	76.156 ~ 76.890	76~81	Compliance
80		76.151 ~ 76.887		Compliance
70		76.147 ~ 76.883		Compliance
60		76.144 ~ 76.879		Compliance
50		76.139 ~ 76.875		Compliance
40		76.135 ~ 76.870		Compliance
30		76.131 ~ 76.865		Compliance
20(Ref.)		76.128 ~ 76.861		Compliance
10		76.125 ~ 76.857		Compliance
0		76.121 ~ 76.852		Compliance
-10		76.117 ~ 76.849		Compliance
-20		76.112 ~ 76.846		Compliance
-30		76.109 ~ 76.842		Compliance
-40		76.104 ~ 76.839		Compliance
Nom Temperature	DC 9 (Vmin)	76.128 ~ 76.860		Compliance
Nom Temperature	DC 16 (Vmax)	76.127 ~ 76.861		Compliance

5.4 Occupied Bandwidth

5.4.1 Standard Applicable [FCC §2.1049, RSS-GEN 6.7]

FCC

The occupied bandwidth, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission shall be measured.

ISED

Occupied bandwidth (or 99% emission bandwidth) and x dB bandwidth

The occupied bandwidth or the “99% emission bandwidth” is defined as the frequency range between two points, one above and the other below the carrier frequency, within which 99% of the total transmitted power of the fundamental transmitted emission is contained. The occupied bandwidth shall be reported for all equipment in addition to the specified bandwidth required in the applicable RSSs.

5.4.2 Test Environment conditions

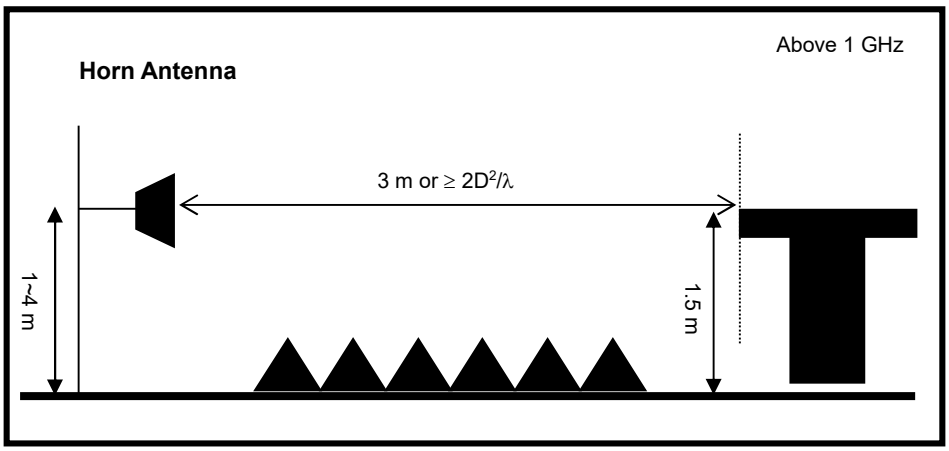
• Ambient temperature: (21 ~ 22) ℃ • Relative Humidity : (53 ~ 55) % R.H.

5.4.3 Measurement Procedure

The spectrum analyzer is set to the as follows:

• Set the RBW: 100 kHz.
• Set the VBW: ≥ 3 x RBW.
• Detector = Peak.
• Trace mode = max hold.
• Sweep = auto couple.
• Allow the trace to stabilize.
• Using the automatic bandwidth measurement capability of a spectrum analyzer

5.4.4 Test setup



5.4.5 Measurement Result

▣ Mode: LR

Channel	Frequency [GHz]	Occupied Bandwidth [MHz]	Limit [MHz]	Test Results
1	76.356	380.29	-	Compliance

Occupied Bandwidth

▣ Mode: SR

Channel	Frequency [GHz]	Occupied Bandwidth [MHz]	Limit [MHz]	Test Results
1	76.493	732.69	-	Compliance

Occupied Bandwidth

5.5 Modulation characteristics

5.5.1 Standard Applicable [FCC §2.1047, RSS-251 6]

FCC

Concerning the Section 2.1047 modulation characteristics requirement, the following information should be provided:

1) Pulsed radar: pulse width and pulse repetition frequency (if PRF is variable, then report maximum and minimum values).

2) Non-pulsed radar (e.g., FMCW): modulation type (i.e., sawtooth, sinusoid, triangle, or square wave) and sweep characteristics (sweep bandwidth, sweep rate, sweep time).

ISED

In addition to the reporting requirements of RSS-Gen, the following information shall be provided, as per the applicable modulation type:

a. Pulsed radar: pulse width and pulse repetition frequency (PRF). If the PRF is variable, the maximum and minimum values shall be reported.

b. Non-pulsed radar (e.g. frequency modulated continuous wave (FMCW)): modulation type (i.e. sawtooth, sinusoid, triangle, or square wave) and sweep characteristics (sweep bandwidth, sweep rate, sweep time).

5.5.2 Result

General Information

Waveform	Fast chirp FMCW
Modulation	Positive Sawtooth
Typical Cycle Time	55 ~ 80 ms
Duty Cycle	40~45 % [RF on time / Cycle time]

Ramp type sequence
I → II → III → VI (repeat)

Operation condition

Power on
(No extra configuration is necessary)

Ramp Type I	
Sweep Bandwidth	~352MHz
Sweep time	3.68 ms or 4.59 ms (72 ramps use)
Sweep rate	1008 ~ 1296 sweeps/second

Ramp Type II	
Sweep Bandwidth	~352MHz
Sweep time	14.25 ms or 16.50 ms (264 ramps use)
Sweep rate	3696 ~ 4752 sweeps/second

Ramp Type III	
Sweep Bandwidth	~671MHz
Sweep time	0.54 ms or 0.63 ms (16 ramps use)
Sweep rate	224 ~ 288 sweeps/second

Ramp Type IV	
Sweep Bandwidth	~671MHz
Sweep time	8.84 ms or 10.44 ms (264 ramps use)
Sweep rate	3696 ~ 4752 sweeps/second

5.6 Antenna requirement

5.6.1 Standard applicable [FCC §15.203, RSS-GEN]

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

The use of a permanently attached antenna or of an antenna that user a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section.

The manufacturer may design the unit so that broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited.

5.6.2 Antenna details

Frequency Band	Antenna Type	Gain [dBi]	Results
76~77	Internal patch array antenna(Fixed)	21.2 dBi(Max.)	Compliance

※ The antennas of this E.U.T permanently attached