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-210015	KOSTEC Co., Ltd. http://www.kostec.org

1. Applicant

- Name : MANDO corp.
- Address : 21, Pangyo-ro 255beon-gil, Bundang-gu, Gyeonggi-do, Seongnam-si 463-400 Korea (Republic Of)

2. Test Item

- Product Name: Automotive Radar
- Model Name: LRR-25
- Brand: -
- FCC ID: 2ACDX-LRR25 • IC: 11988A-LRR25

3. Manufacturer

- Name : MANDO corp.
- Address : 21, Pangyo-ro 255beon-gil, Bundang-gu, Gyeonggi-do, Seongnam-si 463-400 Korea (Republic Of)

4. Date of Test : 2021. 05. 24. ~ 2021. 05. 25.

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: Class II Permissive Change

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)

2021. 05. 27.

KOSTEC Co., Ltd.

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1. GENERAL INFORMATION

1.1 Test Facility

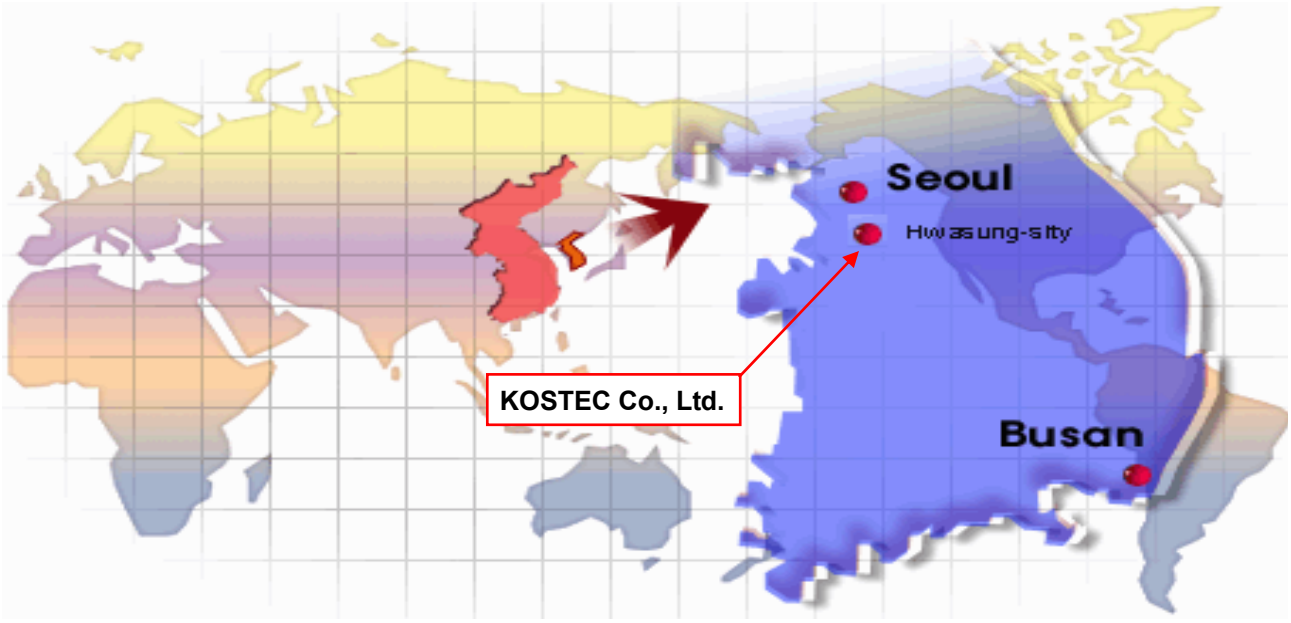
Test laboratory and address

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	2021. 05. 27.

2. EQUIPMENT DESCRIPTION

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

Equipment Name	Automotive Radar
Model No	LRR-25
Usage	Automotive Radar
Serial Number	Proto type
Modulation type	FMCW
Emission Type	831MF1N
Maximum output power(e.i.r.p)	20.4 dBm(PK), 19.3 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 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. 4.This report is prepared for FCC class II permissive change. This report is issued as a supplementary report to original report no. RF190502E01. The modification is concerned with following: 1) Kyocera CX3225SA20000D0PTWZ1 of 20 MHz Crystal change to NDK NX3225GA STD-CRA-1(Q601) 2) NXP TJA1046TK of CAN IC change to TI TCAN1046DMTRQ1(U302) Changed part is not the worst case of original test report, thus only Frequency and Radiated Spurious Emissions had been tested.
FCC ID	2ACDX-LRR25
IC	11988A-LRR25
PMN(Product Marketing Number)	Advanced Smart Cruise Control System
HVIN(Hardware Version Identification Number)	LRR-25
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 Automotive 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

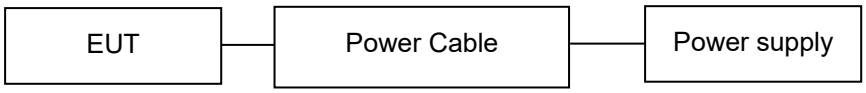
N/A

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. Software used to control the EUT for staying in continuous transmitting mode was programmed. The worst case data rate is determined as the data rate with highest output power.

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	2021.11.04	1 year	☐
2	T & H Chamber	SH-662	93000067	ESPEC CORP	2021.09.02	1 year	☐
3	T & H Chamber	SH-641	92006831	ESPEC CORP	2022.03.29	1 year	☒
4	Spectrum Analyzer	8563EC	3046A00527	Agilent Technology	2022.01.19	1 year	☐
5	Spectrum Analyzer	FSV30	104029	Rohde & Schwarz	2021.09.01	1 year	☐
6	Spectrum Analyzer	FSV30	20-353063	Rohde & Schwarz	2022.01.19	1 year	☐
7	Spectrum Analyzer	FSV40	101727	Rohde & Schwarz	2021.07.22	1 year	☐
8	Signal Analyzer	FSW43	101294	Rohde & Schwarz	2022.02.18	1 year	☐
9	Signal Analyzer	FSW85	101602	Rohde & Schwarz	2021.06.21	1 year	☒
10	EMI Test Receiver	ESCI7	100823	Rohde & Schwarz	2022.01.20	1 year	☐
11	EMI Test Receiver	ESI	837514/004	Rohde & Schwarz	2021.08.31	1 year	☒
12	Vector Signal Analyzer	89441A	3416A02620	Agilent Technology	2022.01.20	1 year	☐
13	Network Analyzer	8753ES	US39172348	AGILENT	2021.09.01	1 year	☐
14	EPM Series Power meter	E4418B	GB39512547	Agilent Technology	2022.01.19	1 year	☐
15	RF Power Sensor	E9300A	MY41496631	Agilent Technology	2022.01.19	1 year	☐
16	Microwave Frequency Counter	5352B	2908A00480	Agilent Technology	2022.01.19	1 year	☐
17	Audio Analyzer	8903B	3514A16919	Agilent Technology	2022.01.19	1 year	☐
18	Audio Telephone Analyzer	DD-5601CID	520010281	CREDIX	2022.01.18	1 year	☐
19	Modulation Analyzer	8901A	3041A05716	H.P	2022.01.18	1 year	☐
20	Digital storage Oscilloscope	TDS3052	B015962	Tektronix	2021.08.31	1 year	☐
21	ESG-D Series Signal Generator	E4436B	US39260458	Agilent Technology	2022.01.18	1 year	☐
22	Vector Signal Generator	SMBV100A	257557	Rohde & Schwarz	2022.01.18	1 year	☐
23	GNSS Signal Generator	TC-2800A	2800A000494	TESCOM CO., LTD.	2022.01.19	1 year	☐
24	Signal Generator	SMB100A	179628	Rohde & Schwarz	2022.05.04	1 year	☒
25	Signal Generator	N5173B	MY57280148	KEYSIGHT	2021.06.11	1 year	☒
26	SLIDAC	None	0207-4	Myoung sung Ele.	2022.01.20	1 year	☐
27	DC Power supply	DRP-5030	9028029	Digital Electronic Co.,Ltd	2022.01.20	1 year	☐
28	DC Power supply	E3610A	KR24104505	Agilent Technology	2022.01.19	1 year	☐
29	DC Power supply	UP-3005T	68	Unicon Co.,Ltd	2022.01.20	1 year	☒
30	DC Power Supply	SM 3004-D	114701000117	DELTA ELEKTRONIKA	2022.01.19	1 year	☐
31	DC Power supply	6632B	MY43004005	Agilent Technology	2022.01.20	1 year	☐
32	DC Power Supply	6632B	MY43004137	Agilent Technology	2022.01.20	1 year	☐
33	Termination	1433-3	LM718	WEINSCHEL	2021.07.17	1 year	☐
34	Termination	1432-3	QR946	AEROFLEX/WEINSCHEL	2021.07.17	1 year	☐
35	Attenuator	24-30-34	BX5630	Aeroflex / Weinschel	2021.12.04	1 year	☐
36	Attenuator	8498A	3318A09485	HP	2022.01.19	1 year	☐
37	Step Attenuator	8494B	3308A32809	HP	2022.01.19	1 year	☐
38	RF Step Attenuator	RSP	100091	Rohde & Schwarz	2022.01.19	1 year	☐
39	Attenuator	18B50W-20F	64671	INMET	2022.01.19	1 year	☐
40	Attenuator	10 dB	1	Rohde & Schwarz	2022.05.04	1 year	☐
41	Attenuator	54A-10	74564	WEINSCHEL	2021.09.02	1 year	☐
42	Attenuator	56-10	66920	WEINSCHEL	2022.05.04	1 year	☐
43	Attenuator	48-20-11	BV2658	Aeroflex/Weinschel	2021.07.17	1 year	☐
44	Attenuator	48-30-33-LIM	BL5350	Weinschel Corp.	2021.07.17	1 year	☐
45	Power divider	11636B	51212	HP	2022.01.21	1 year	☐
46	3Way Power divider	KPDSU3W	00070365	KMW	2021.08.31	1 year	☐
47	4Way Power divider	70052651	173834	KRYTAR	2022.01.19	1 year	☐
48	3Way Power divider	1580	SQ361	WEINSCHEL	2022.05.04	1 year	☐
49	OSP	OSP120	101577	Rohde & Schwarz	2021.06.02	1 year	☐
50	White noise audio filter	ST31EQ	101902	SoundTech	2021.08.31	1 year	☐

No.	Instrument	Model	S/N	Manufacturer	Next Cal Date	Cal interval	used
51	Dual directional coupler	778D	17693	HEWLETT PACKARD	2022.01.19	1 year	☐
52	Dual directional coupler	772D	2839A00924	HEWLETT PACKARD	2022.01.19	1 year	☐
53	Band rejection filter	3TNF-0006	26	DOVER Tech	2022.01.19	1 year	☐
54	Band rejection filter	3TNF-0007	311	DOVER Tech	2022.01.19	1 year	☐
55	Band rejection filter	WTR-BRF2442-84NN	09020001	WAVE TECH Co.,LTD	2022.01.19	1 year	☐
56	Band rejection filter	WRCJV12-5695-5725-5825-5855-50SS	1	Wainwright Instruments GmbH	2022.05.04	1 year	☐
57	Band rejection filter	WRCJV12-5120-5150-5350-5380-40SS	4	Wainwright Instruments GmbH	2022.05.04	1 year	☐
58	Band rejection filter	WRCGV10-2360-2400-2500-2540-50SS	2	Wainwright Instruments GmbH	2022.05.04	1 year	☐
59	Band rejection filter	CTF-155M-S1	001	RF One Electronics	2021.08.31	1 year	☐
60	Band rejection filter	CTF-435M-S1	001	RF One Electronics	2021.08.31	1 year	☐
61	Band rejection filter	CTF-5890M-70MS1	1	RF One Electronics	2022.01.19	1 year	☐
62	Highpass Filter	WHJS1100-10EF	1	WAINWRIGHT	2022.01.19	1 year	☐
63	Highpass Filter	WHJS3000-10EF	1	WAINWRIGHT	2022.01.19	1 year	☐
64	Highpass Filter	WHNX6-5530-7000-26500-40CC	2	Wainwright Instruments GmbH	2022.05.04	1 year	☐
65	Highpass Filter	WHNX6-2370-3000-26500-40CC	4	Wainwright Instruments GmbH	2022.05.04	1 year	☐
66	WideBand Radio Communication Tester	CMW500	102276	Rohde & Schwarz	2022.01.19	1 year	☐
67	WideBand Radio Communication Tester	CMW500	117235	Rohde & Schwarz	2022.01.19	1 year	☐
68	WideBand Radio Communication Tester(with CMX500)	CMW500	167157	Rohde & Schwarz	2022.04.09	1 year	☐
69	Bluetooth Tester	TC-3000B	3000B6A0166	TESCOM CO., LTD.	2022.01.18	1 year	☐
70	Loop Antenna	6502	9203-0493	EMCO	2021.05.27	2 year	☒
71	BiconiLog Antenna	3142B	1745	EMCO	2022.04.24	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	2022.03.24	2 year	☐
74	Horn Antenna	3115	9605-4834	EMCO	2022.03.06	2 year	☐
75	Horn Antenna	QMS-00208	21909	STEATITE ANTENNA	2022.12.04	2 year	☐
76	Horn Antenna(R)	3117	00135191	ETS-LINDGREN	2022.04.29	2 year	☐
77	Horn Antenna(T)	3115	2996	EMCO	2022.02.14	2 year	☒
78	Horn Antenna(R)	BBHA 9170	9170-722	SCHWARZBECK	2022.05.12	2 year	☒
79	Horn Antenna(T)	BBHA 9170	743	SCHWARZBECK	2023.01.21	2 year	☐
80	AMPLIFIER(A_10)	TK-PA6S	120009	TESTEK	2022.01.19	1 year	☐
81	AMPLIFIER(C_3)	TK-PA01S	200141-L	TESTEK	2021.09.23	1 year	☒
82	PREAMPLIFIER(C_3)	8449B	3008A02577	Agilent	2022.01.19	1 year	☒
83	RF PRE AMPLIFIER	SCU08F2	100762	Rohde & Schwarz	2021.12.04	1 year	☐
84	AMPLIFIER	TK-PA18	150003	TESTEK	2022.01.21	1 year	☐
85	AMPLIFIER	TK-PA1840H	160010-L	TESTEK	2022.01.21	1 year	☒
86	Horn Antenna	M19RH	T01	OML, Inc.	2022.05.29	2 year	☒
87	Horn Antenna	M19RH	R01	OML, Inc.	2022.05.29	2 year	☒
88	Horn Antenna	M12RH	T02	OML, Inc.	2022.05.29	2 year	☒
89	Horn Antenna	M12RH	R02	OML, Inc.	2022.05.29	2 year	☒
90	Horn Antenna	M08RH	T03	OML, Inc.	2022.05.29	2 year	☒
91	Horn Antenna	M08RH	R03	OML, Inc.	2022.05.29	2 year	☒
92	Horn Antenna	M05RH	T04	OML, Inc.	2022.05.29	2 year	☒
93	Horn Antenna	M05RH	R04	OML, Inc.	2022.05.29	2 year	☒
94	Horn Antenna	M03RH	T05	OML, Inc.	2022.05.29	2 year	☒
95	Horn Antenna	M03RH	R05	OML, Inc.	2022.05.29	2 year	☒
96	Harmonic Mixer	M12HWD	200529-1	OML, Inc.	2021.07.03	1 year	☒
97	Harmonic Mixer	M08HWD	200529-1	OML, Inc.	2021.07.03	1 year	☒
98	Harmonic Mixer	M05HWD	200529-1	OML, Inc.	2021.07.03	1 year	☒
99	Harmonic Mixer	M03HWD	200529-1	OML, Inc.	2021.07.03	1 year	☒
100	Source Module	S19MS-A	200529-1	OML, Inc.	2021.07.03	1 year	☒
101	Source Module	S12MS-A	200529-1	OML, Inc.	2021.07.03	1 year	☒
102	Source Module	S08MS-A	200529-1	OML, Inc.	2021.07.03	1 year	☒
103	Source Module	S05MS-A	200529-1	OML, Inc.	2021.07.03	1 year	☒
104	Source Module	S03MS-A	200529-1	OML, Inc.	2021.07.03	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	-	☐	N/A[Note1)]
Unwanted emissions	95.3379(a)	RSS-GEN Section 6.13, RSS-251 Section 10	Clause 5.1	☒	Compliance
Frequency stability	95.3379(b)	RSS-GEN Section 8.11, RSS-251 Section 11	Clause 5.2	☒	Compliance
Occupied Bandwidth	2.1049	RSS-GEN Section 6.7, RSS-251 Section 7	Clause 5.3	☒	Compliance
Modulation characteristics	2.1047	RSS-251 Section 6	Clause 5.4	☒	Compliance
Antenna requirements	15.203	RSS-GEN	Clause 5.5	☒	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.

Note1) The E.I.R.P tests of original report remain valid for this report. Please refers to original report.(Report No.: RF190502E01)

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 Unwanted Emissions

5.1.1 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.

5.1.2 Test Environment conditions

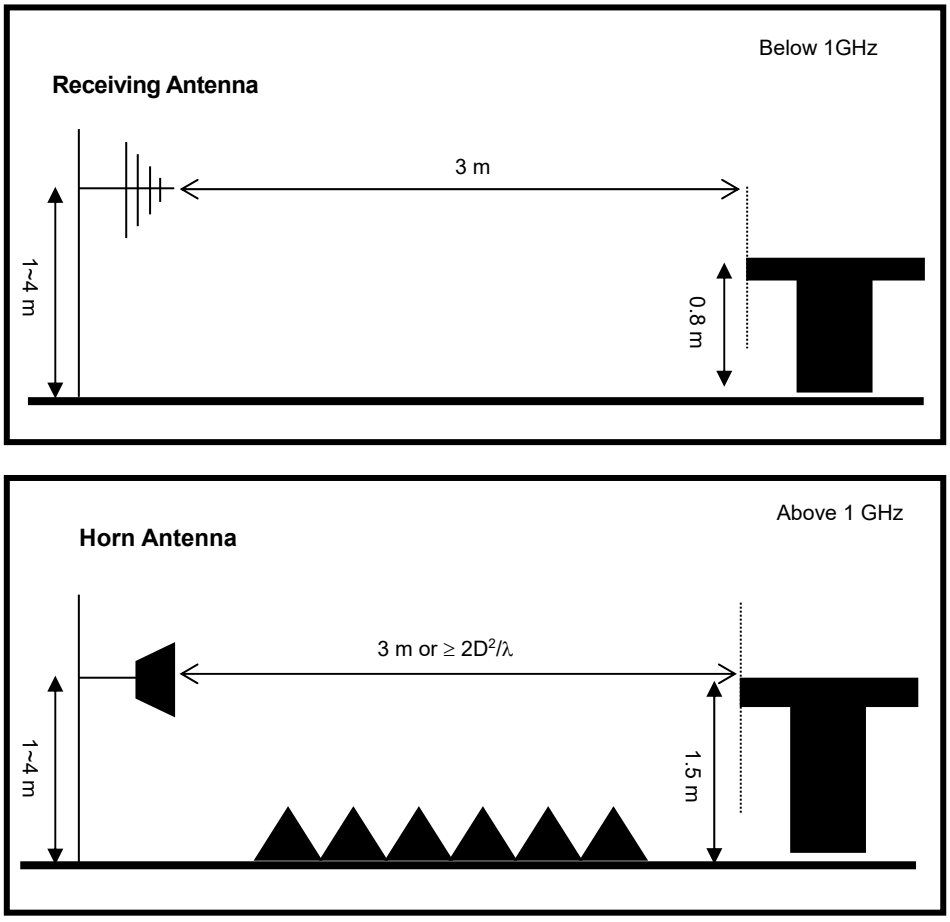
• Ambient temperature : (22 ~ 23) ℃ • Relative Humidity : (54 ~ 57) % R.H.

5.1.3 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.

5.1.4 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 * (0.037)^2 / 0.0038 = 0.703 m*

5.1.5 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)						
602.93	42.91	0	1.0	V	25.94	3.20	45.91	26.14	46.0	19.86	Compliance
620.12	42.99	0	1.0	H	26.15	3.28	45.88	26.54	46.0	19.46	Compliance
642.29	42.86	0	1.0	H	26.41	3.39	45.83	26.82	46.0	19.18	Compliance
938.71	42.20	0	1.0	H	30.20	4.02	45.29	31.13	46.0	14.87	Compliance
952.00	42.14	0	1.0	V	30.40	4.05	45.25	31.34	46.0	14.66	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.

▣ 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

Freq. (GHz)	Reading (dBm)	Pol. (H/V)	Factor (dB)	Meas Result (dBm)	Limit (dBm)		Margin. (dB)		Result
					FCC	IC	FCC	IC	
75.901 8	-104.24	V	77.44	-26.80	-1.7	0	28.50	26.80	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;

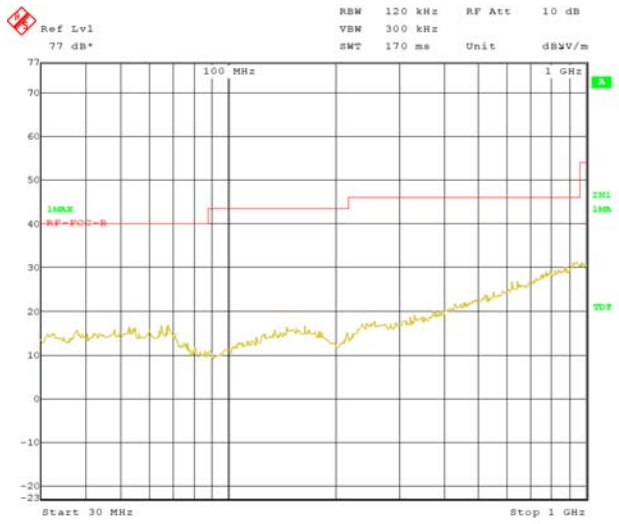
•RxPower = S.A Measured Level - Rx Ant Gain + Mixer Conversion Loss + Cable Loss;

•TxPower = OML Source Output + Tx Ant Gain;

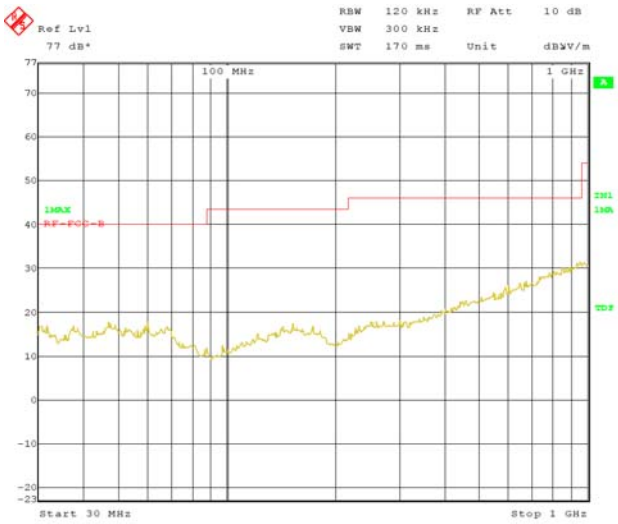
5.1.6 Plots
*The worst case only.

▪ Below 1 GHz

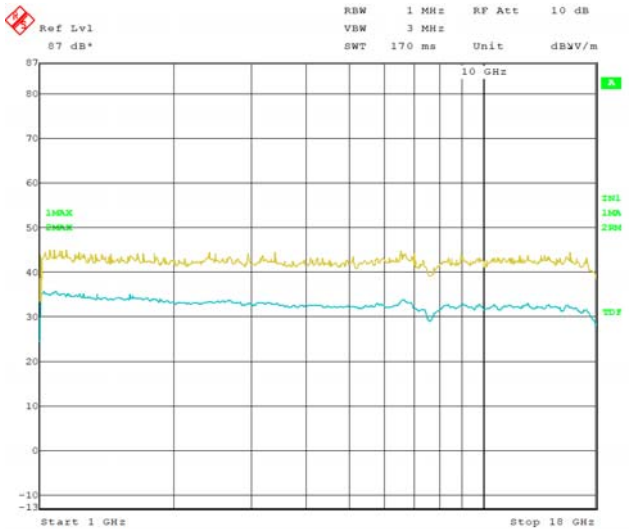
Horizontal

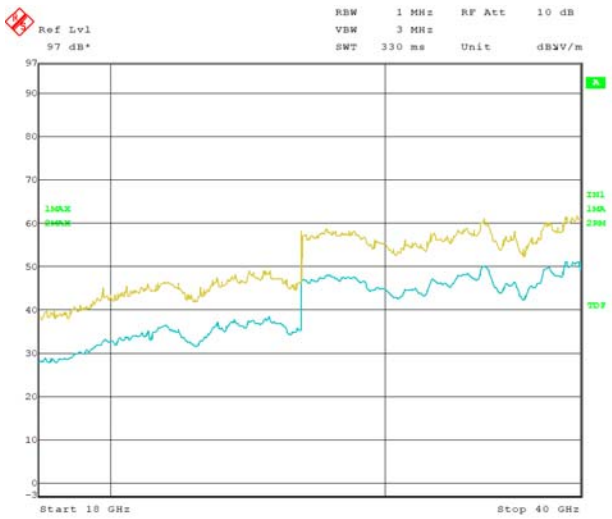


Vertical



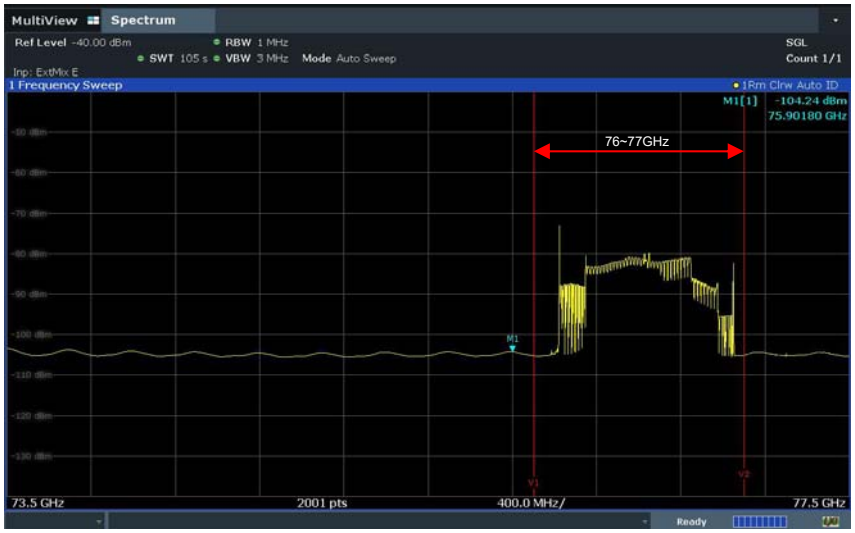
▪ Above 1 GHz



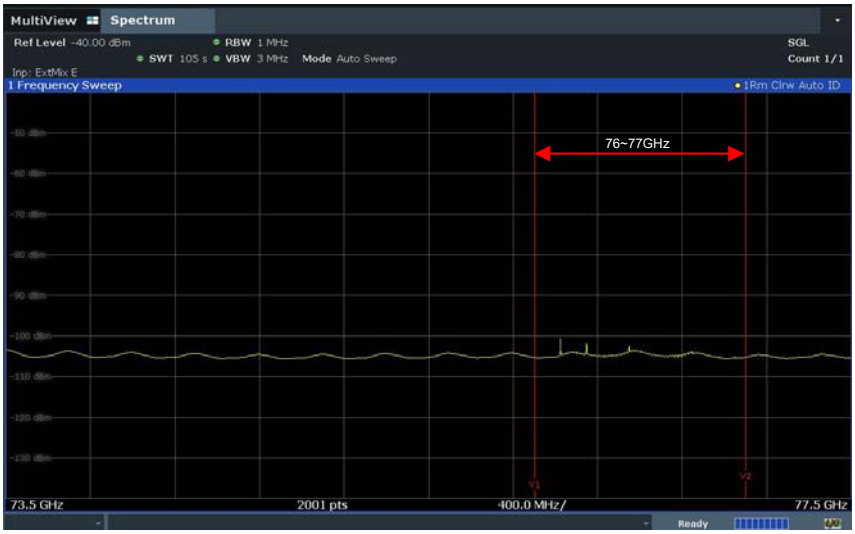


▪ Above 40 GHz

Band Edge_V



Band Edge_H



5.2 Frequency Stability

5.2.1 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.

5.2.2 Test Environment conditions

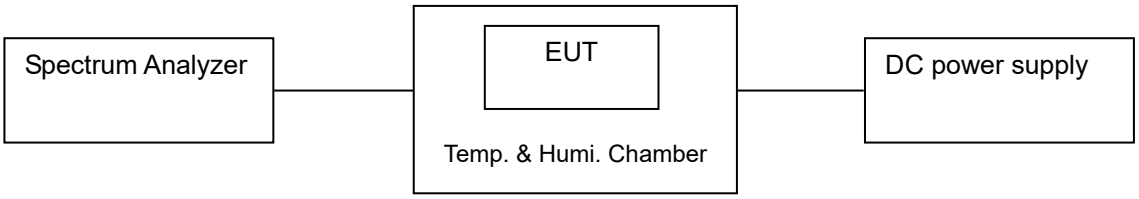
• Ambient temperature : (22 ~ 23) ℃ • Relative Humidity : (54 ~ 57) % R.H.

5.2.3 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.

5.2.4 Test setup



5.2.5 Measurement Result

Temp(℃)	Power Supply	Frequency Range(GHz)	Limit(GHz)	Result
85	DC 12 (Vnom)	76.145 ~ 76.984	76~81	Compliance
80		76.141 ~ 76.979		Compliance
70		76.138 ~ 76.976		Compliance
60		76.134 ~ 76.972		Compliance
50		76.131 ~ 76.968		Compliance
40		76.128 ~ 76.963		Compliance
30		76.123 ~ 76.959		Compliance
20(Ref.)		76.119 ~ 76.955		Compliance
10		76.114 ~ 76.951		Compliance
0		76.109 ~ 76.947		Compliance
-10		76.105 ~ 76.944		Compliance
-20		76.101 ~ 76.940		Compliance
-30		76.097 ~ 76.936		Compliance
-40		76.093 ~ 76.932		Compliance
Nom Temperature	DC 9 (Vmin)	76.117 ~ 76.955		Compliance
Nom Temperature	DC 16 (Vmax)	76.119 ~ 76.954		Compliance

5.3 Occupied Bandwidth

5.3.1 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.

5.3.2 Test Environment conditions

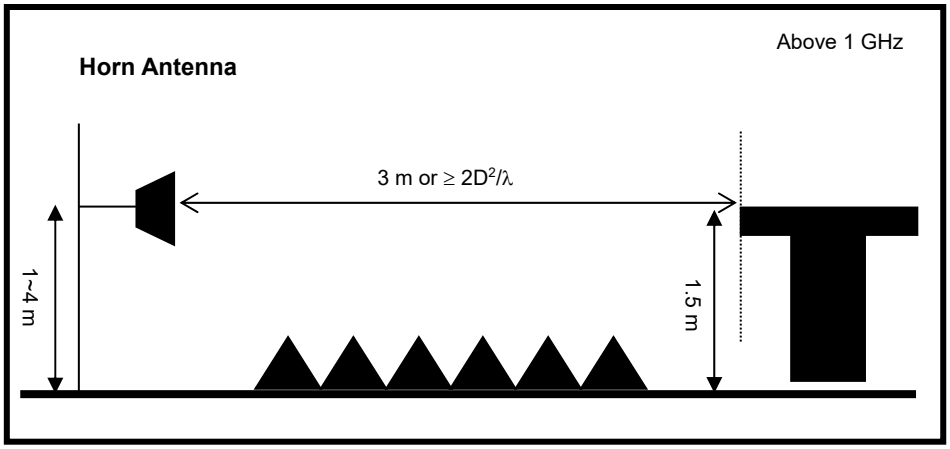
• Ambient temperature : (22 ~ 23) ℃ • Relative Humidity : (54 ~ 57) % R.H.

5.3.3 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

5.3.4 Test setup



5.3.5 Measurement Result

Channel	Frequency [GHz]	Occupied Bandwidth [MHz]	Limit [MHz]	Test Results
1	76.5	836.30	-	Compliance

Occupied Bandwidth

5.4 Modulation characteristics

5.4.1 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).

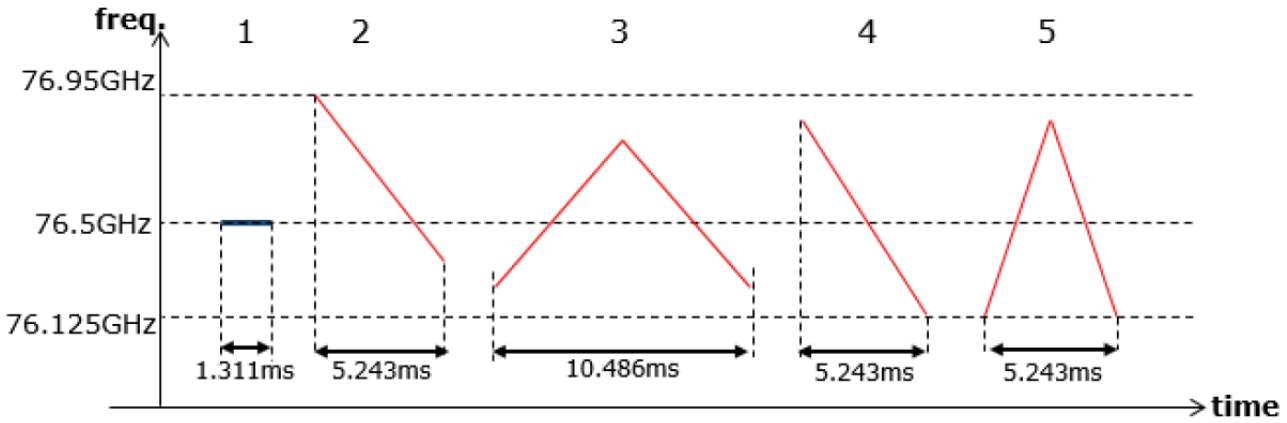
ISED

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).

5.4.2 Result



Chirp#	Modulation Type	Sweep Time	Sweep Bandwidth	Center Frequency
1	Unmodulated	1.311 ms	-	76.5 GHz
2	Negative sawtooth	5.243 ms	500 MHz	76.5 GHz
3	Triangle	10.486 ms	500 MHz	76.5 GHz
4	Negative sawtooth	5.243 ms	750 MHz	76.5 GHz
5	Triangle	5.243 ms	750 MHz	76.5 GHz

Average cycle time: 60 ms

RF on time: 27.53 ms

Duty cycle: 55.1 %

5.5 Antenna requirement

5.5.1 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.

5.5.2 Antenna details

Frequency Band	Antenna Type	Gain [dBi]	Results
76~77	Internal patch array antenna(Fixed)	21 dBi	Compliance

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