

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-210010	 KOSTEC Co., Ltd. http://www.kostec.org
1. Applicant • Name : IT TELECOM Co., Ltd. • Address : #517, TheOvalley, 555-9, Hogyedong,Dongan-gu, Gyeonggi-do, Anyang-si, South Korea 2. Test Item • Product Name: WAVE RSU • Model Name: ITT-V2X-RSU-N2 • Brand: None • FCC ID: ZO9ITT-V2X-RSU-N2 3. Manufacturer • Name : IT TELECOM Co., Ltd. • Address : #517, TheOvalley, 555-9, Hogyedong,Dongan-gu, Gyeonggi-do, Anyang-si, South Korea 4. Date of Test : 2021. 02. 25. ~ 2021. 02. 27. 5. Test Method Used : FCC CFR 47, Part 90. Subpart M 6. Test Result : Compliance 7. Note: None		
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 <u>ANSI/TIA-603-E-2016</u>. 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 : Lee, Mi-Young (Signature)	Technical Manager Name : Park, Gyeong-Hyeon (Signature)
2021. 03. 01.		
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

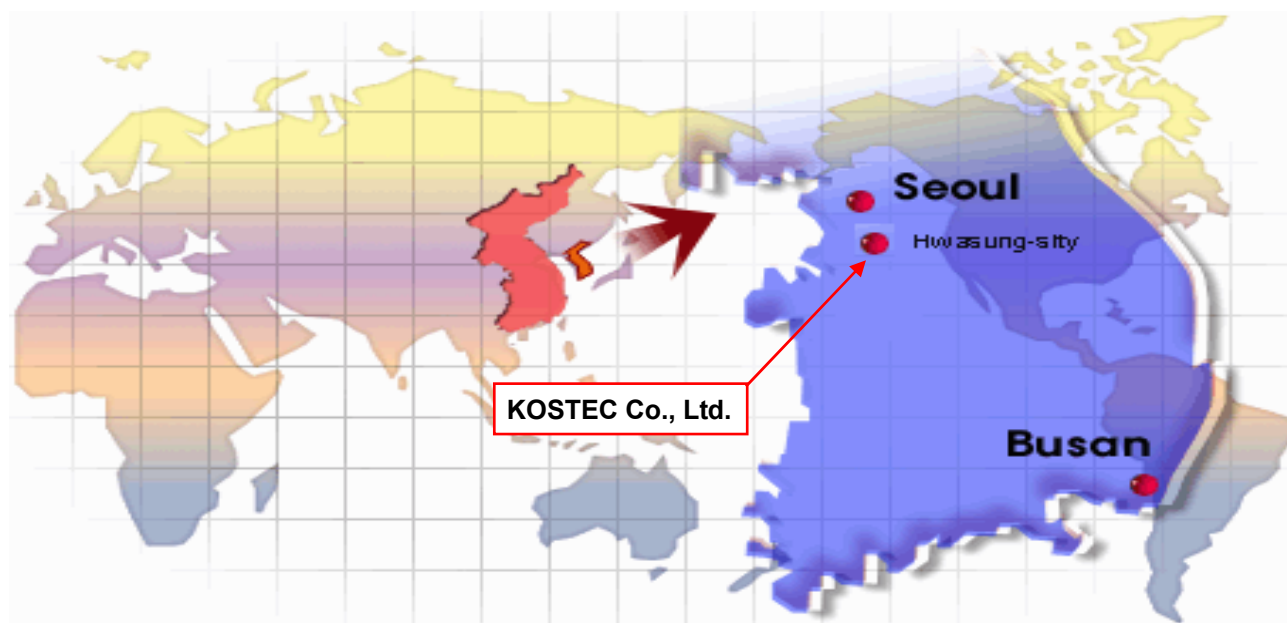
RRA (National Radio Research Agency): KR0041

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. 03. 01.

2. EQUIPMENT DESCRIPTION

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

Equipment Name	WAVE RSU
Model No	ITT-V2X-RSU-N2
Usage	Roadside Units
Serial Number	Proto type
Device class	C
Modulation type	802.11p: OFDM (BPSK / QPSK / 16QAM / 64QAM)
Emission Type	D1D
Maximum cond.output power	19.10 dBm
Operated Frequency	5 860 MHz ~ 5 920 MHz
Channel Number	7 ea
Operation temperature	-20 °C ~ 55 °C
Power Source	DC 48 V
Antenna Description	Dipole array antenna, Peak gain 5.8 dBi
Remark	1. The data rates used when evaluating the DUT was the lowest data rates. The device was operating at its maximum output power at the lowest data rate for all measurements. 2. Regarding to the operation frequency, the lowest, middle and highest frequency are selected to perform the test. 3. The radiation measurements are performed in X, Y, Z axis positioning. Only the worst case is shown in the report. 5. The above DUT's information was declared by manufacturer. Please refer to the specifications or user manual for more detailed description.
FCC ID	FCC ID: ZO9ITT-V2X-RSU-N2

3. SYSTEM CONFIGURATION FOR TEST

3.1 Characteristics of equipment

The Equipment Under Test (EUT) use for Dedicated Short-Range Communications Service.

DSRCS system is transmit status and instructional messages related to the units involved. This unit is Roadside Unit.

3.2 Used peripherals list

Description	Model No.	Serial No.	Manufacture	Remark

3.3 Product Modification

N/A

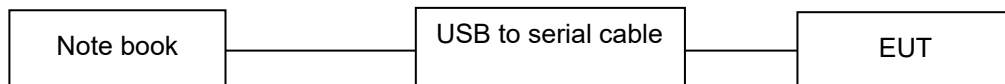
3.4 Operating Mode

Constantly transmitting with a modulated carrier at maximum power/widest bandwidth on the bottom, middle and top channels as required using the supported data rates/modulation types.

3.5 Test Setup of EUT

The measurements were taken in continuous transmit mode using the TEST MODE.

For controlling the EUT as typing the commands using tera-term, commands were provided by the applicant.



3.6 Parameters of Test Software Setting

During testing, Channel & Power Controlling Software provided by the customer was used to control the operating channel as well as the output power level. The RF output power selection is for the setting of RF output power expected by the customer and is going to be fixed on the firmware of the final end product.

Test software version	Type commands using terminal program									
Modulation Mode	Test Frequency (MHz)									
	5860		5890		5900		5910		5920	
802.11p-10M	Port 1	Port 2	Port 1	Port 2	Port 1	Port 2	Port 1	Port 2	Port 1	Port 2
	52	48	52	48	34	34	34	34	52	48

3.7 Table for Carrier Frequencies

Frequency Range: 5850 - 5925 MHz		
Frequency Range	Channel	BW: 5/10MHz
5855-5865	172	5860 MHz
5865-5875	174	5870 MHz
5875-5885	176	5880 MHz
5885-5895	178	5890 MHz
5895-5905	180	5900 MHz
5905-5915	182	5910 MHz
5915-5925	184	5920 MHz

3.8 Tested Data rate & Modulation

Emission Types(Modulation)	D1D(OFDM:BPSK, QPSK, 16QAM, 64QAM)
Modulation Standard	DSRC for IEEE 802.11p
Data rate	802.11p-10M : 3 - 27 Mbps / Worst case : 3 Mbps

3.9 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	2021.03.31	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	2021.02.26	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	2021.05.13	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	DELTAELEKTRONIKA	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	2021.05.13	1 year	☒
41	Attenuator	54A-10	74564	WEINSCHEL	2021.09.02	1 year	☒
42	Attenuator	56-10	66920	WEINSCHEL	2021.05.13	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	2021.05.13	1 year	☐
49	OSP	OSP120	101577	Rohde & Schwarz	2021.05.14	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	2021.05.13	1 year	☐
57	Band rejection filter	WRCJV12-5120-5150-5350-5380-40SS	4	Wainwright Instruments GmbH	2021.05.13	1 year	☐
58	Band rejection filter	WRCGV10-2360-2400-2500-2540-50SS	2	Wainwright Instruments GmbH	2021.05.13	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	2021.05.13	1 year	☐
65	Highpass Filter	WHNX6-2370-3000-26500-40CC	4	Wainwright Instruments GmbH	2021.05.13	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	2021.04.03	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	2021.01.20	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	☐

4. SUMMARY TEST RESULTS

Description of Test	FCC Rule	Reference Clause	Used	Test Result
Emission Bandwidth	2.1049/ 90.379	Clause 5.1	☒	Compliance
Maximum Transmitter Power (Effective Isotropic Radiated Power (EIRP))	90.379 / ASTM E2213-03 8.10.1	Clause 5.2	☒	Compliance
Transmit Spectrum Mask	90.379 / ASTM E2213-03 8.10.2	Clause 5.3	☒	Compliance
Transmitter Conducted Unwanted Emissions	2.1051/ 90.379 / ASTM E2213-03 8.10.2 & 8.10.3	Clause 5.4	☒	Compliance
Transmitter Radiated Unwanted Emissions	2.1053/ 90.379 / ASTM E2213-03 8.10.2 & 8.10.3	Clause 5.5	☒	Compliance
Frequency Stability	90.213 / ASTM E2213-03 8.10.4	Clause 5.6	☒	Compliance
Emission Types	ASTM E2213-03	Clause 5.7	☒	Compliance
Modulation Standard	ASTM E2213-03	Clause 5.8	☒	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 90M

ASTM E2213-03

ANSI/TIA-603-E-2016

ANSI C63.26-2015

ANSI C63.4-2014

5. MEASUREMENT RESULTS

5.1 Emission Bandwidth

5.1.1 Standard Applicable [FCC §2.1049, FCC 90.379]

5.1.2 Test Environment conditions

- Ambient temperature : (21 ~ 22) °C • Relative Humidity : (53 ~ 56) % R.H.

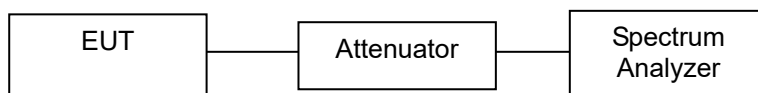
5.1.3 Measurement Procedure

1. The transmitter output (antenna port) was connected to the spectrum analyzer in peak hold mode.
2. Measure the maximum width of the emission that is 26 dB down from the peak of the emission. The 99 % occupied bandwidth is the frequency bandwidth of the signal power at the 99 % channel power of occupied bandwidth when resolution bandwidth should be approximately 1 % to 5 % of the occupied bandwidth.

The spectrum analyzer is set to the as follows :

- RBW : >1% of the emission bandwidth
- VBW : >3 x RBW
- Sweep : auto
- Detector function : peak
- Trace : max hold

5.1.4 Test setup



5.1.5 Measurement Result

TX port #1

CH	Freq [MHz]	Data Rate	26 dB Bandwidth [MHz]	99 % Bandwidth [MHz]	Limit [MHz]	Test Results
172	5 860	3	9.03	8.02	-	Compliance
		27	9.01	8.07		
178	5 890	3	8.95	8.02	-	Compliance
		27	8.89	8.07		
184	5 920	3	8.93	8.01	-	Compliance
		27	8.93	8.05		

TX port #2

CH	Freq [MHz]	Data Rate	26 dB Bandwidth [MHz]	99 % Bandwidth [MHz]	Limit [MHz]	Test Results
172	5 860	3	10.23	8.16	-	Compliance
		27	9.23	8.14		
178	5 890	3	10.03	8.14	-	Compliance
		27	9.11	8.12		
184	5 920	3	9.73	8.09	-	Compliance
		27	8.95	8.10		

5.1.6 Test Plot (26 dB band width)

TX port #1

Ch172 / 5 860 MHz / 3M data rate



Ch172 / 5 860 MHz / 27M data rate



Ch178 / 5 890 MHz / 3M data rate



Ch178 / 5 890 MHz / 27M data rate



Ch184 / 5 920 MHz / 3M data rate



Ch184 / 5 920 MHz / 27M data rate



TX port #2

Ch172 / 5 860 MHz / 3M data rate



Ch172 / 5 860 MHz / 27M data rate



Ch178 / 5 890 MHz / 3M data rate



Ch178 / 5 890 MHz / 27M data rate



Ch184 / 5 920 MHz / 3M data rate



Ch184 / 5 920 MHz / 27M data rate



Test Plot (99 % band width)

TX port #1

Ch172 / 5 860 MHz / 3M data rate



Ch172 / 5 860 MHz / 27M data rate



Ch178 / 5 890 MHz / 3M data rate



Ch178 / 5 890 MHz / 27M data rate



Ch184 / 5 920 MHz / 3M data rate



Ch184 / 5 920 MHz / 27M data rate



TX port #2

Ch172 / 5 860 MHz / 3M data rate



Ch172 / 5 860 MHz / 27M data rate



Ch178 / 5 890 MHz / 3M data rate



Ch178 / 5 890 MHz / 27M data rate



Ch184 / 5 920 MHz / 3M data rate



Ch184 / 5 920 MHz / 27M data rate



5.2 Maximum Transmitter Power

5.2.1 Standard Applicable [FCC §90.379 / ASTM E2213-03 8.10.1]

For the 5.850 - 5.925 GHz band, the maximum conducted output power shall not exceed the below table.

Frequency Range(MHz)	Channel	BW: 5/10MHz	Cond. Power	EIRP Power
5855-5865	172	5860 MHz	28.8 dBm	33 dBm
5865-5875	174	5870 MHz	28.8 dBm	33 dBm
5875-5885	176	5880 MHz	28.8 dBm	33 dBm
5885-5895	178	5890 MHz	28.8 dBm	33 dBm or 44.8 dBm
5895-5905	180	5900 MHz	10 dBm	23 dBm
5905-5915	182	5910 MHz	10 dBm	23 dBm
5915-5925	184	5920 MHz	28.8 dBm	33 dBm or 40 dBm

Note 1: Conducted power could overcome limits but EIRP power shall under limits
Note 2: Refer as ASTM E2213-03 Clause 8.10.1

DSRC Device Classes and Transmit Power Levels (5850–5925 MHz Band)	
Device Class	Maximum Device Output Power (dBm)
A	0
B	10
C	20
D	28.8 or more

5.2.2 Test Environment conditions

- Ambient temperature : (21 ~ 22) °C • Relative Humidity : (53 ~ 56) % R.H.

5.2.3 Measurement Procedure

The transmitter output was connected to the power meter with an attenuator. The maximum output power was measured and recorded with the power meter. EUT was programmed to be in continuously transmitting mode. Method PM is used to perform output power measurement, trigger and gating function of wide band power meter is enabled to measure max output power of TX on burst. Duty factor is not added to measured value.(in case, duty cycle=1)

Test method:

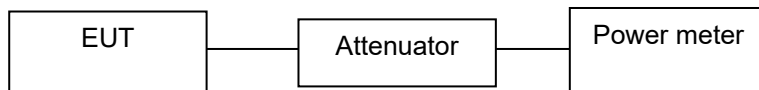
- 1) Maximum transmitter power :

ANSI/TIA-603-E, clause 3.2.1 for power meter measurement.

- 2) Effective Isotropic Radiated Power (EIRP)

KDB 412172, clause 1.3.2 following as power approach. e.i.r.p.= $P_T + G_T$.

5.2.4 Test setup



5.2.5 Measurement Result

CH	Freq [MHz]	Rate (Mbps)	Cond. Power [dBm]		Cond.EIRP Power* [dBm]		Limit [dBm]		Test Results
			TX port #1	TX port #2	TX port #1	TX port #2	Cond. Power	EIRP Power	
172	5 860	3	18.87	18.22	24.67	24.02	20	33	Compliance
		4.5	18.27	17.71	24.07	23.51			
		6	17.92	17.50	23.72	23.30			
		9	16.95	16.80	22.75	22.60			
		12	16.31	16.39	22.11	22.19			
		18	15.67	15.40	21.47	21.20			
		24	15.69	15.32	21.49	21.12			
178	5 890	27	15.92	14.84	21.72	20.64	20	33	Compliance
		3	19.10	18.03	24.90	23.83			
		4.5	18.61	17.51	24.41	23.31			
		6	17.74	16.73	23.54	22.53			
		9	16.83	16.61	22.63	22.41			
		12	16.27	15.48	22.07	21.28			
		18	16.01	15.28	21.81	21.08			
180	5 900	24	15.52	15.14	21.32	20.94	10	23	Compliance
		27	15.63	14.65	21.43	20.45			
		3	9.27	9.97	15.07	15.77			
		4.5	8.83	9.75	14.63	15.55			
		6	8.35	9.20	14.15	15.00			
		9	7.77	8.51	13.57	14.31			
		12	7.58	8.27	13.38	14.07			
182	5 910	18	6.64	7.59	12.44	13.39	10	23	Compliance
		24	6.35	6.83	12.15	12.63			
		27	6.25	6.67	12.05	12.47			
		3	9.55	9.91	15.35	15.71			
		4.5	9.22	9.57	15.02	15.37			
		6	8.87	9.13	14.67	14.93			
		9	8.22	8.77	14.02	14.57			
184	5 920	12	7.66	7.96	13.46	13.76	20	33	Compliance
		18	7.07	7.48	12.87	13.28			
		24	6.79	6.57	12.59	12.37			
		27	6.21	6.66	12.01	12.46			
		3	18.52	17.71	24.32	23.51			
		4.5	18.24	17.40	24.04	23.20			
		6	17.51	16.84	23.31	22.64			
		9	16.63	16.33	22.43	22.13			
		12	16.60	15.15	22.40	20.95			
		18	15.54	15.22	21.34	21.02			
		24	15.23	14.77	21.03	20.57			
		27	15.24	14.83	21.04	20.63			

*Conducted EIRP Power= Conducted output Power+Antenna gain(5.8 dBi)

5.2.6 Limit

- Please refer 5.2.1

5.3 Transmit Spectrum Mask

5.3.1 Standard Applicable [FCC §90.379 / ASTM E2213-03 8.10.2]

For the 5.850 - 5.925 GHz band, the Transmit Spectrum Mask shall not exceed the below table.

The 0 dBr level is the maximum power spectral density measured in the channel. The measurements of transmit spectral density are made using 100 kHz resolution bandwidth and 30 kHz video bandwidth.

5850 – 5925 MHz Band					
Device Class	Maximum STA transmit power(dBm)			Maximum permitted EIRP (dBm)	
A	0			23	
B	10			23	
C	20			33	
D	28.8 or more			33 for non-government / 44.8 for government	
CFR § 90.379 / ASTM – 8.10.2 Table 10 DSRC Spectrum Mask					
Device Class	± 4.5 MHz offset (±f1)	± 5.0 MHz offset (±f2)	± 5.5 MHz offset (±f3)	± 10 MHz offset (±f4)	± 15 MHz offset (±f5)
A	0	-10	-20	-28	-40
B	0	-16	-20	-28	-40
C	0	-26	-32	-40	-50
D	0	-35	-45	-55	-65

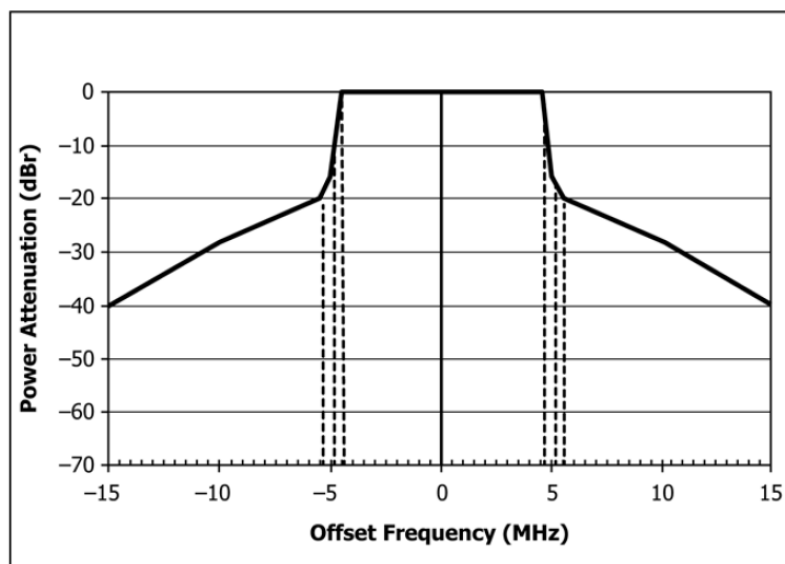


FIG. 13 Class B Transmit Spectrum Mask

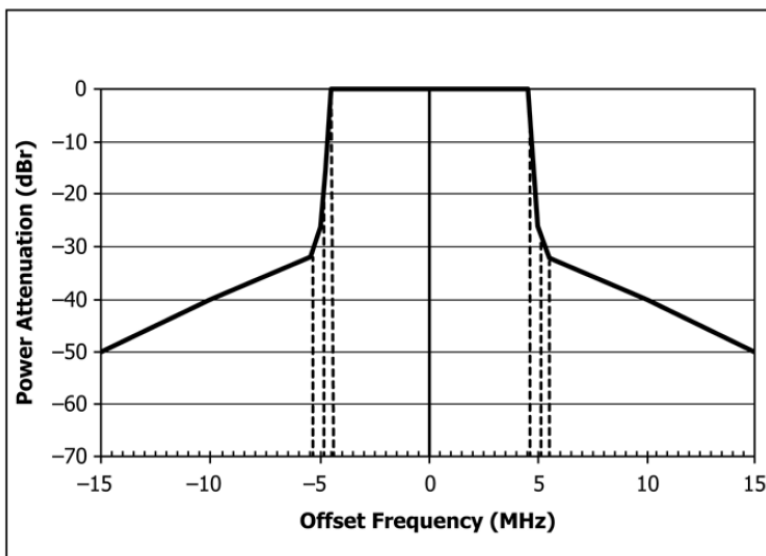


FIG. 14 Class C Transmit Spectrum Mask

5.3.2 Test Environment conditions

- Ambient temperature : (21 ~ 22) °C • Relative Humidity : (53 ~ 56) % R.H.

5.3.3 Measurement Procedure

The spectrum analyzer is set to the as follows

- RBW : 100 kHz
- VBW : 30 kHz
- Sweep : auto
- Detector function : RMS
- Trace : AVG 100

5.3.4 Test setup

Please refer 5.1.4

5.3.5 Measurement Result

Compliance: please refer 5.3.7 for details

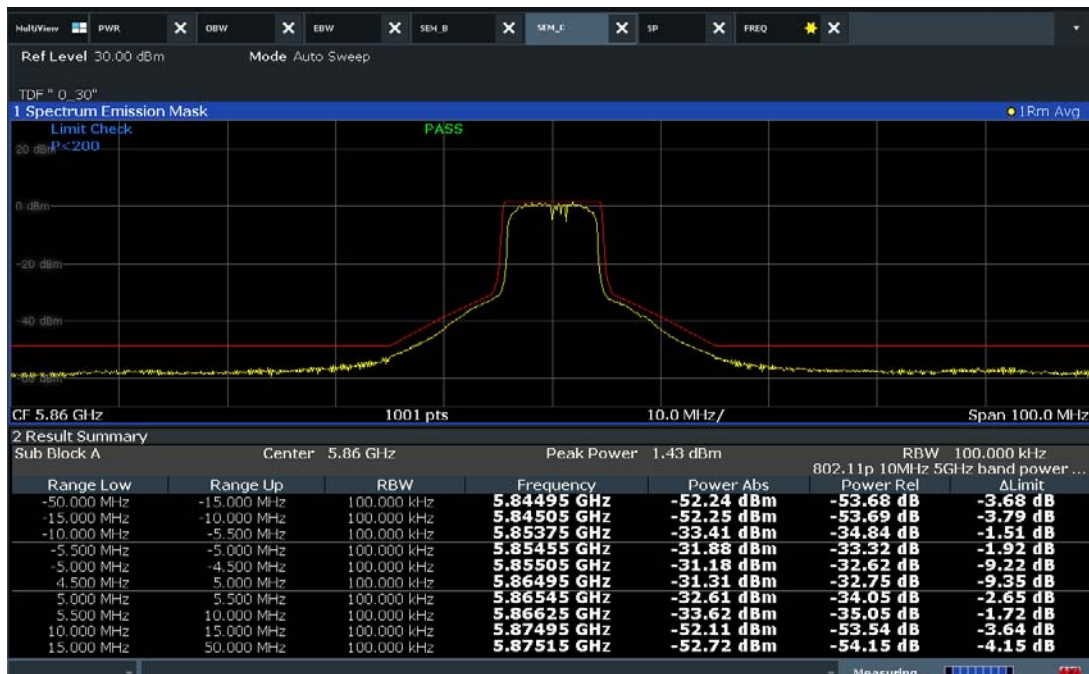
5.3.6 Limit

- Please refer 5.3.1

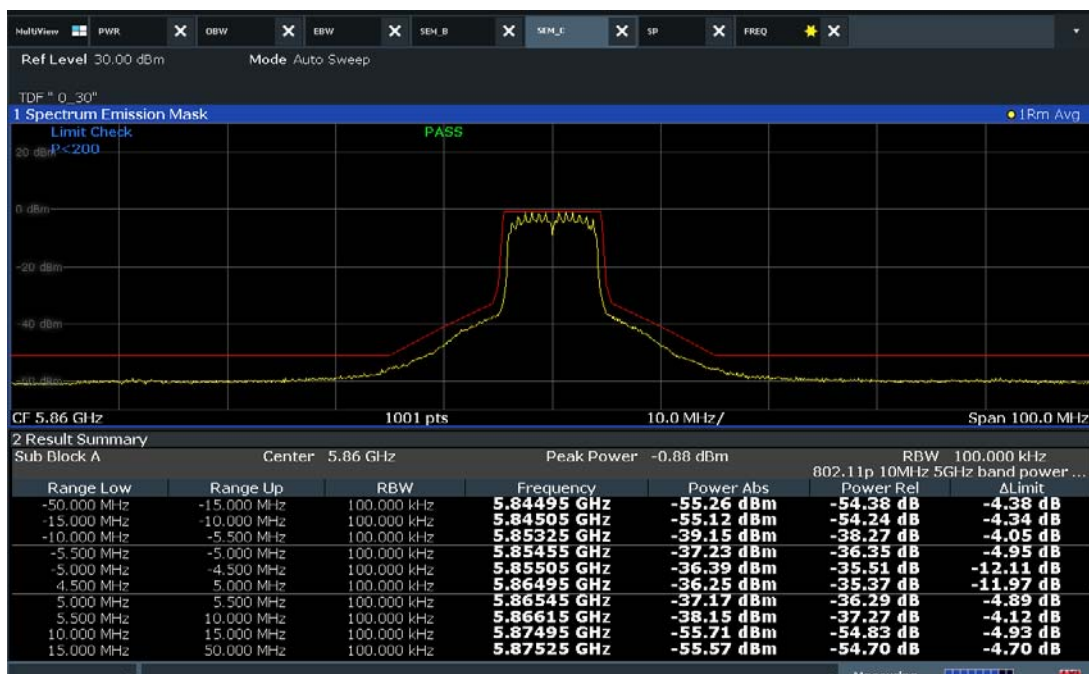
5.3.7 Test Plot

TX port #1

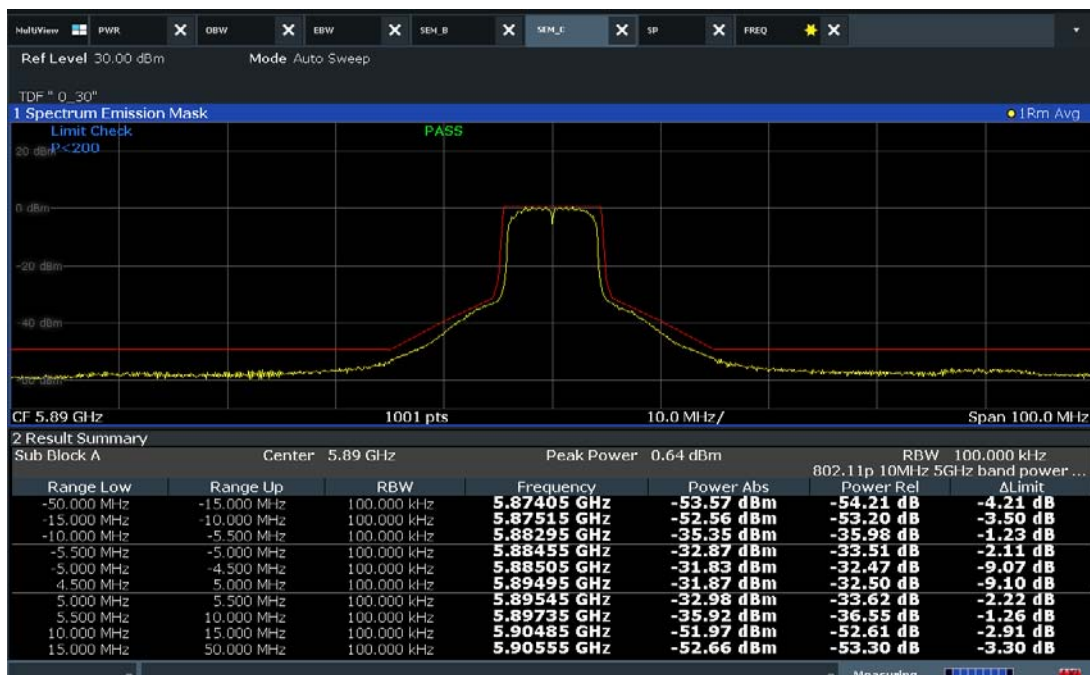
Ch172 / 5 860 MHz / 3M data rate



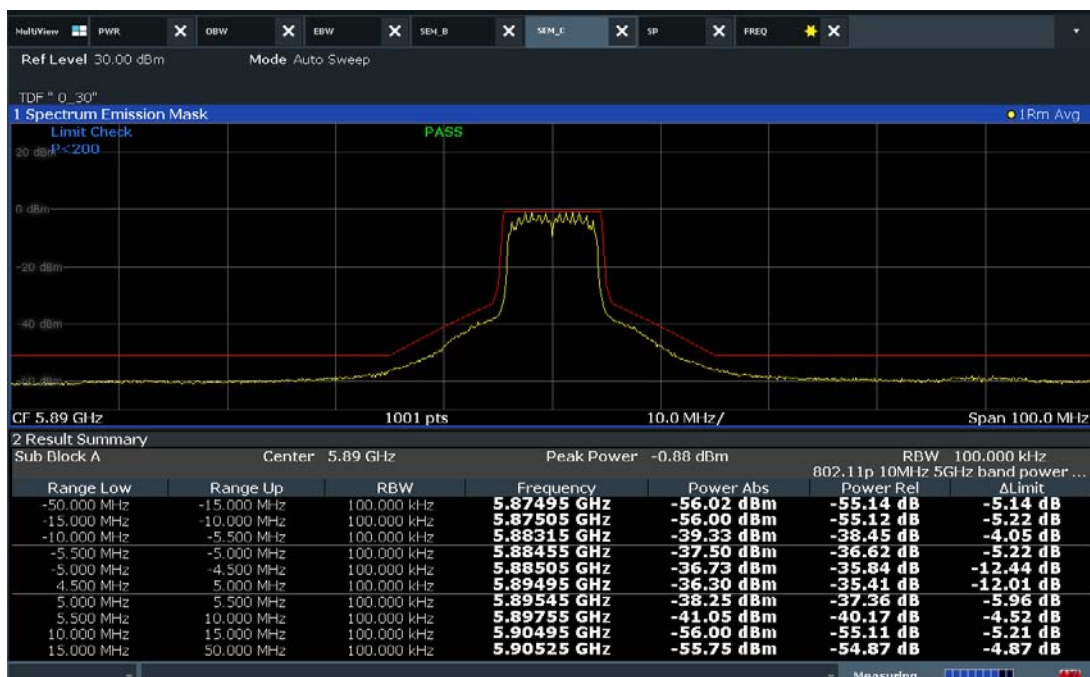
Ch172 / 5 860 MHz / 27M data rate



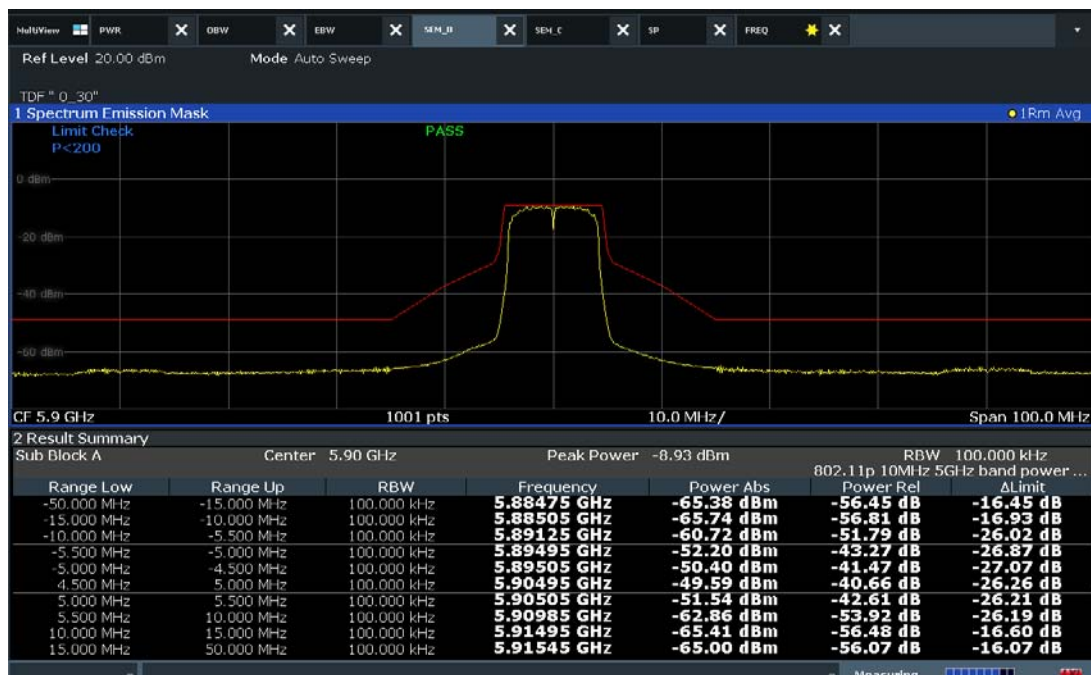
Ch178 / 5 890 MHz / 3M data rate



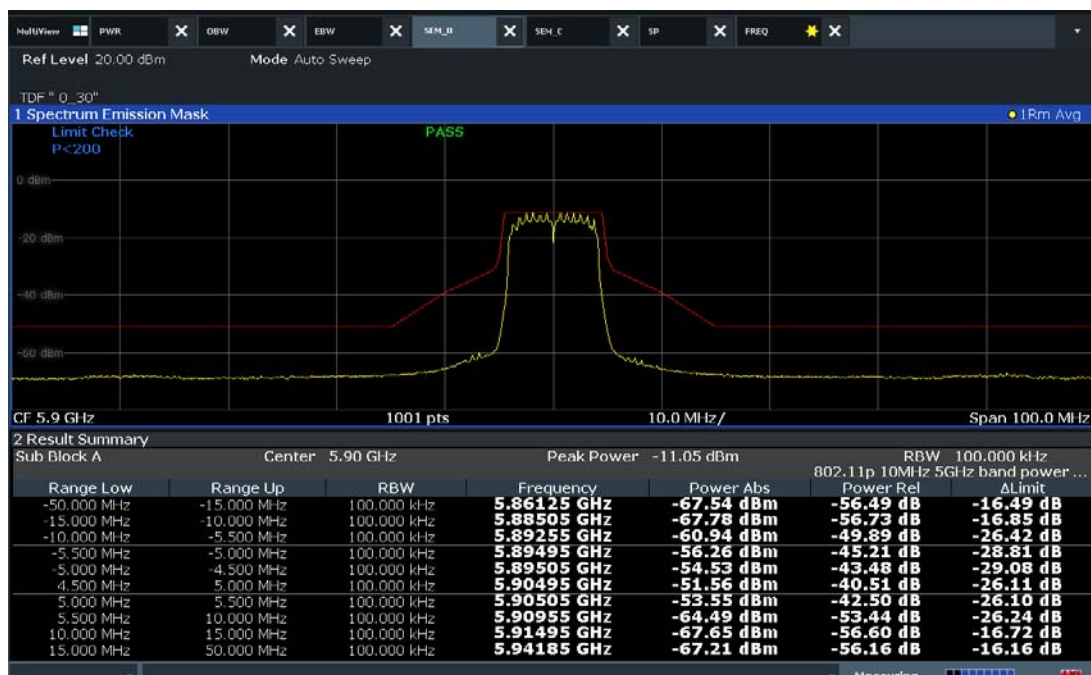
Ch178 / 5 890 MHz / 27M data rate



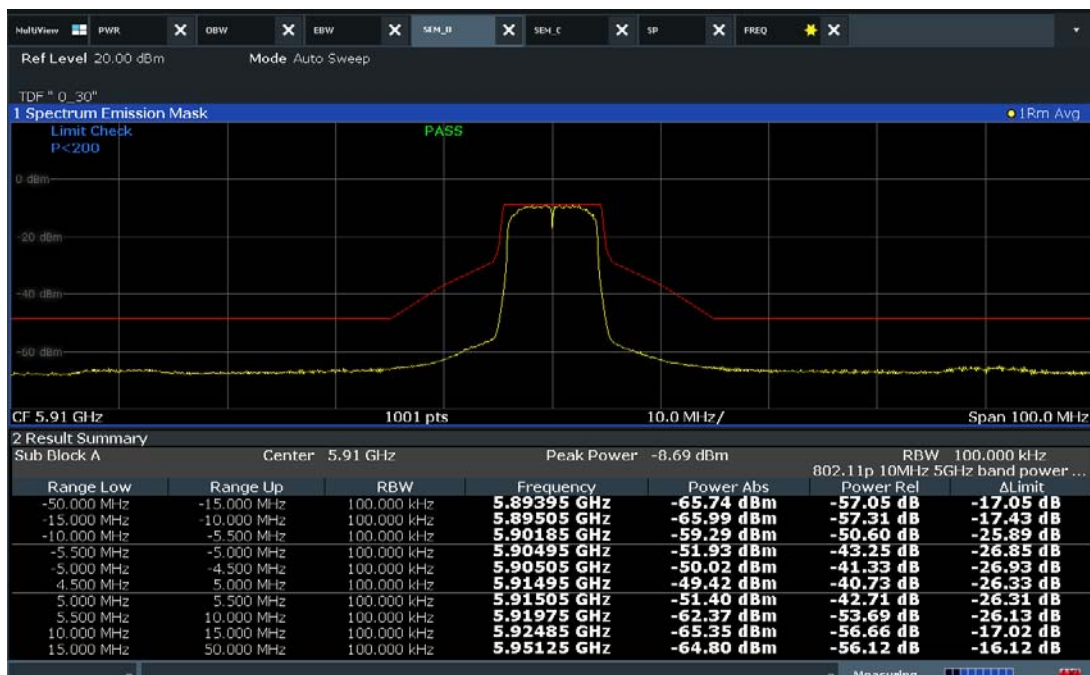
Ch180 / 5 900 MHz / 3M data rate



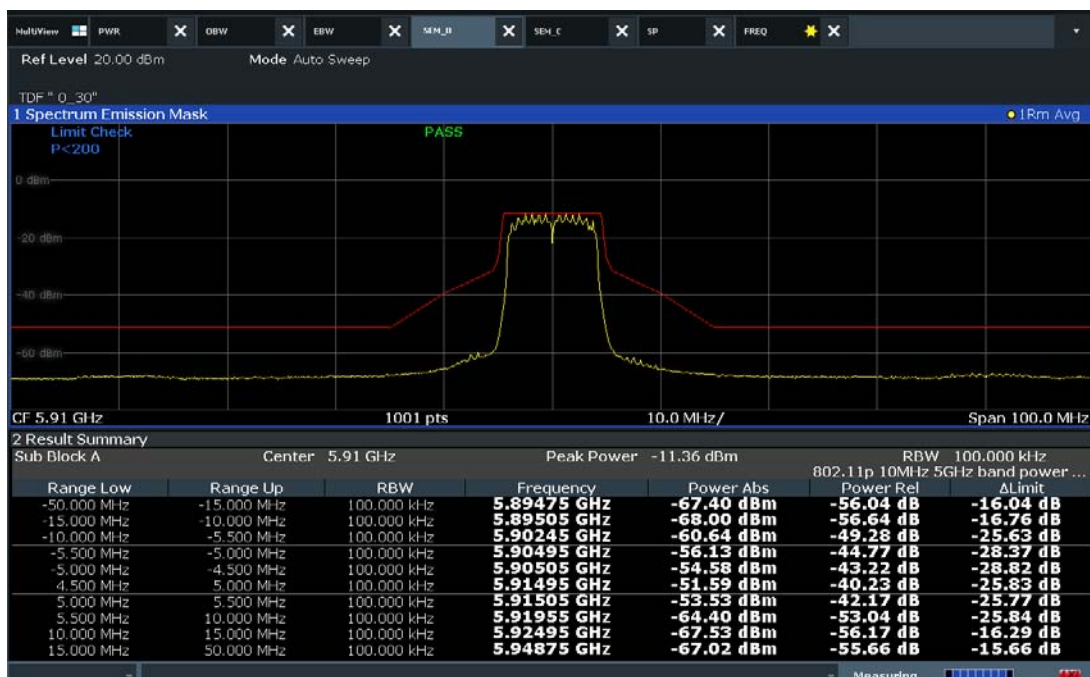
Ch180 / 5 900 MHz / 27M data rate



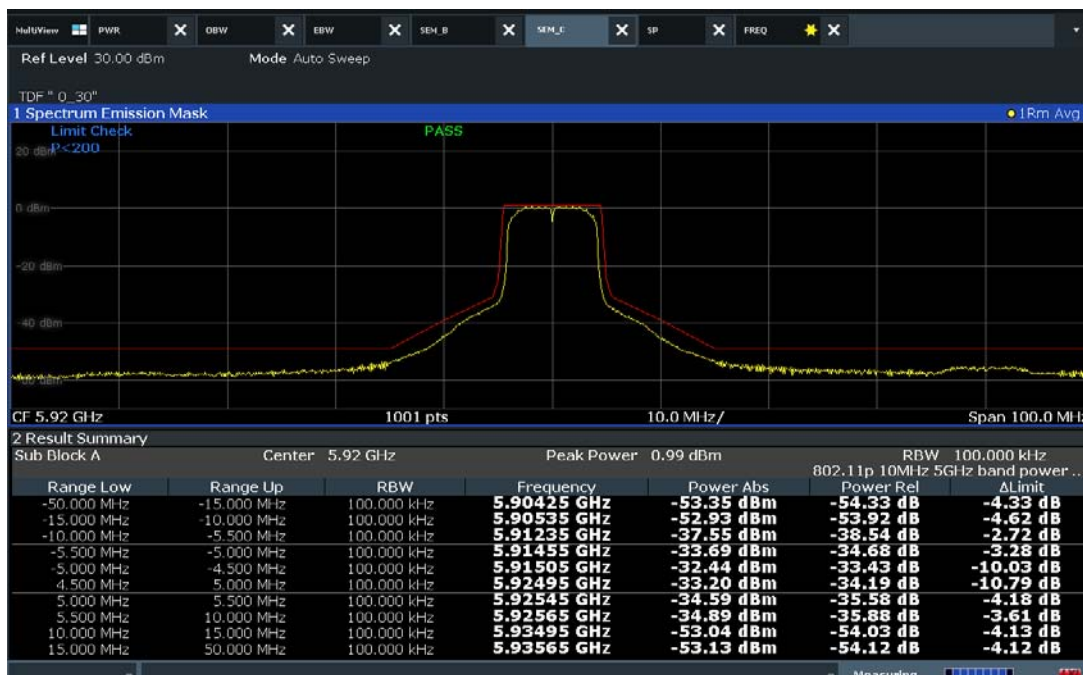
Ch182 / 5 910 MHz / 3M data rate



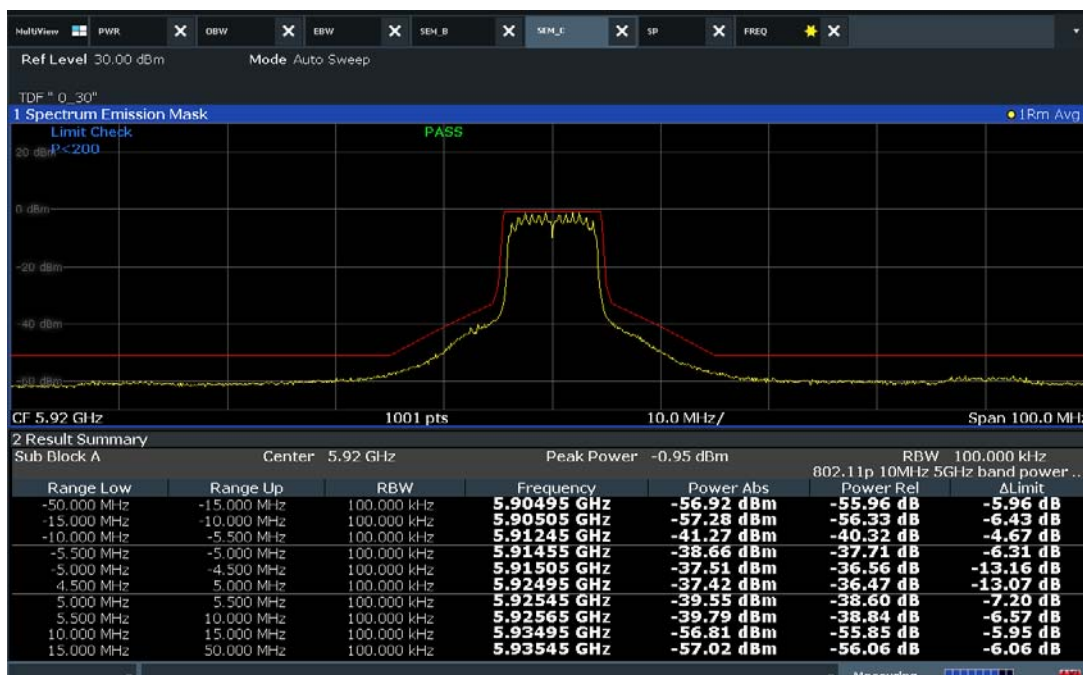
Ch182 / 5 910 MHz / 27M data rate



Ch184 / 5 920 MHz / 3M data rate

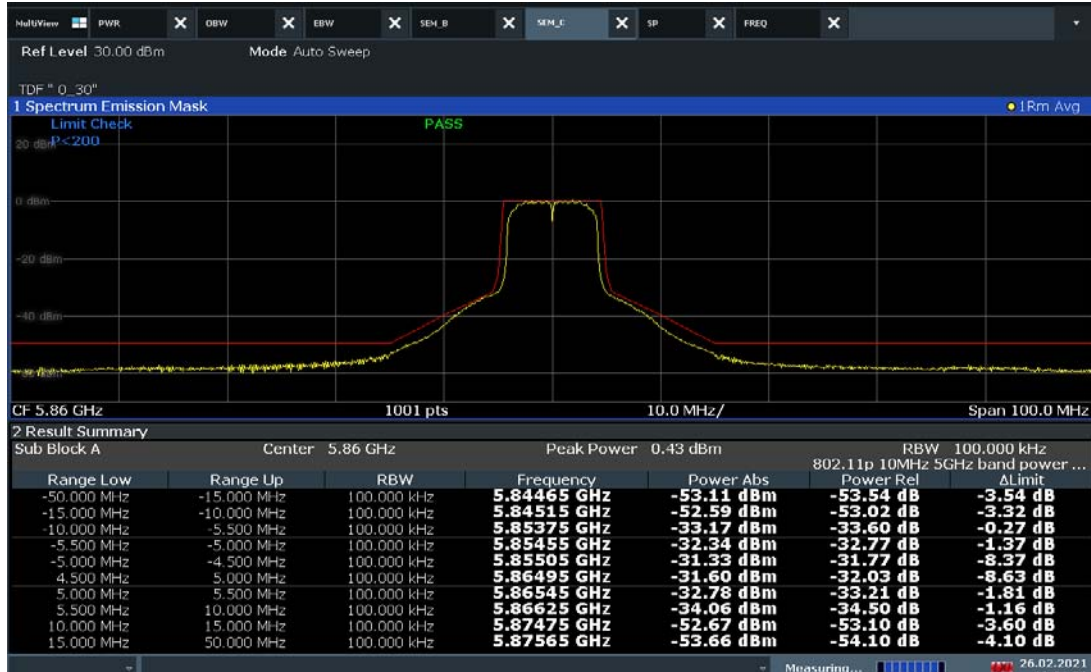


Ch184 / 5 920 MHz / 27M data rate

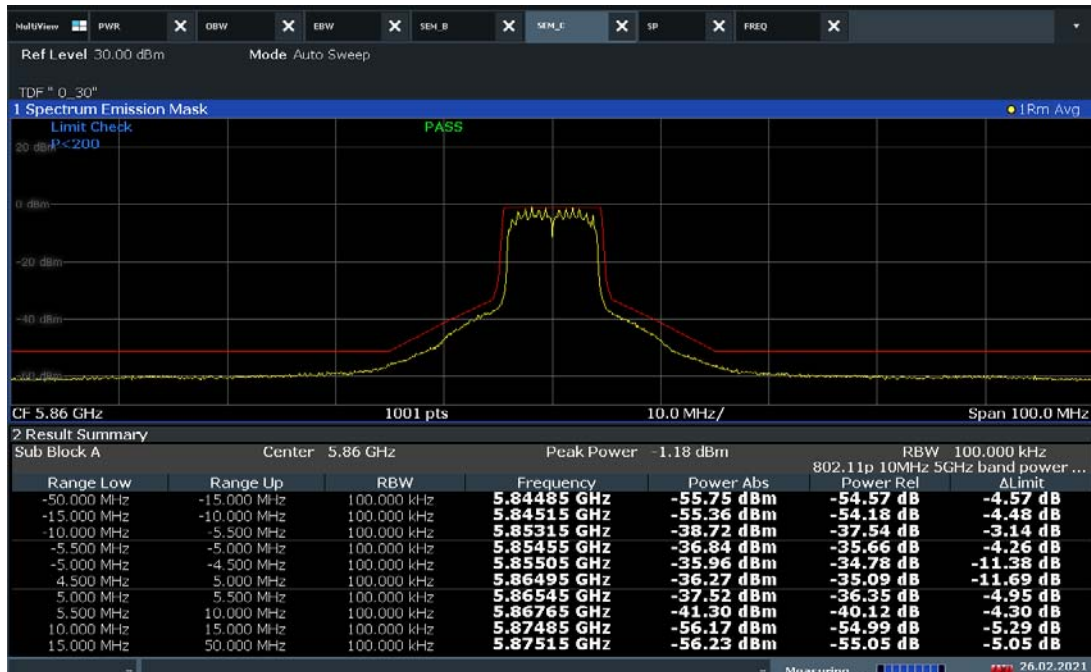


TX port #2

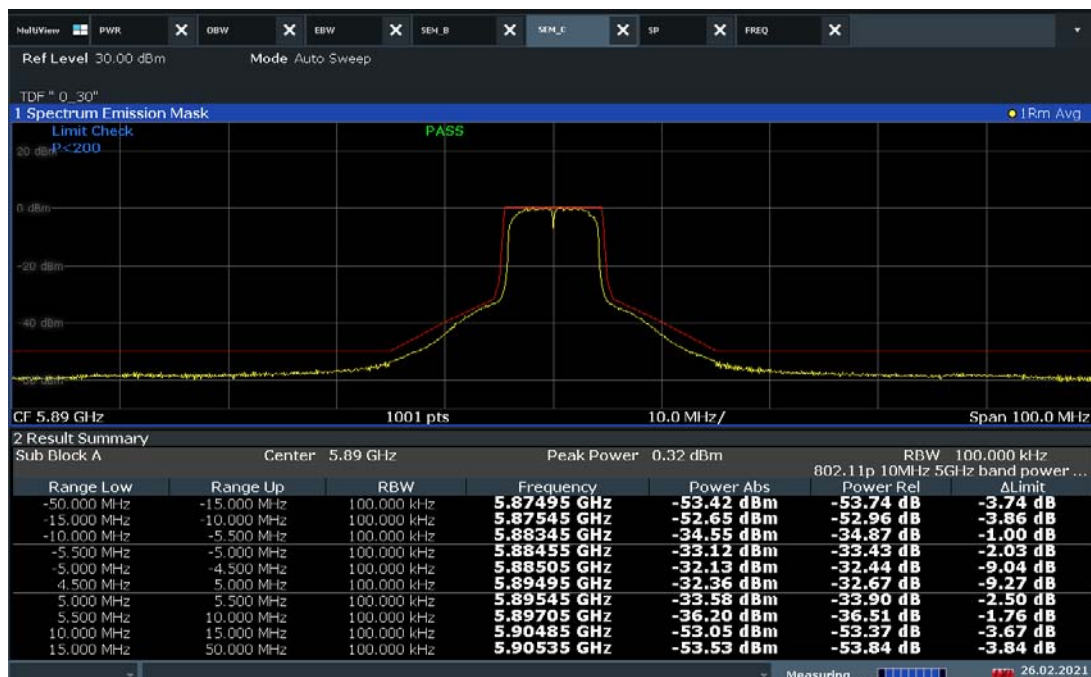
Ch172 / 5 860 MHz / 3M data rate



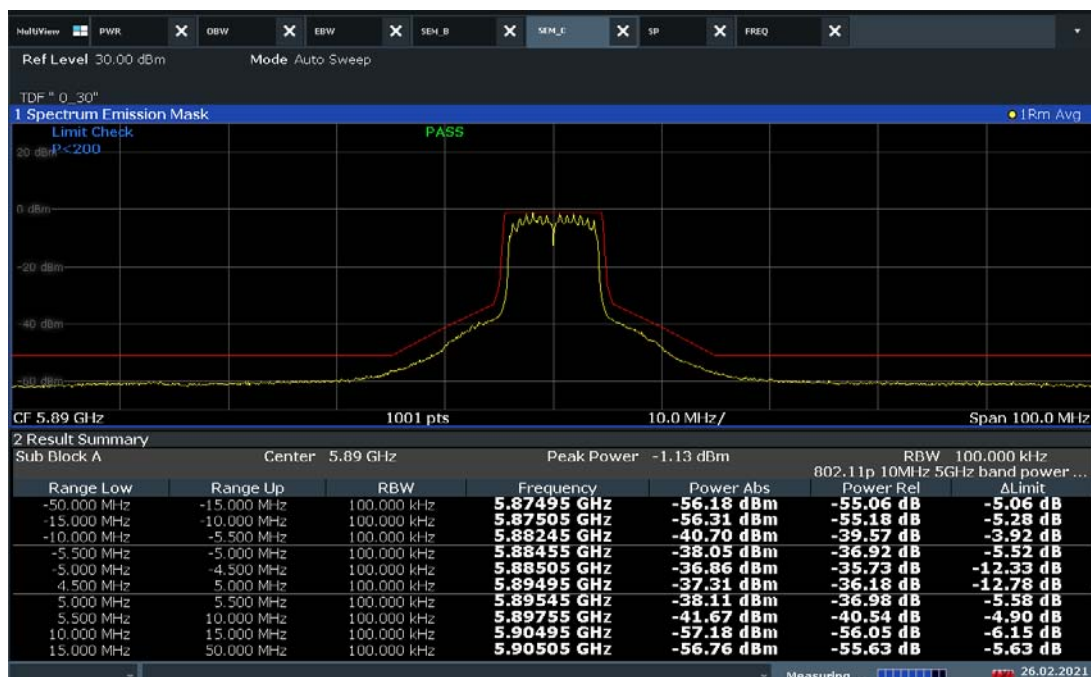
Ch172 / 5 860 MHz / 27M data rate



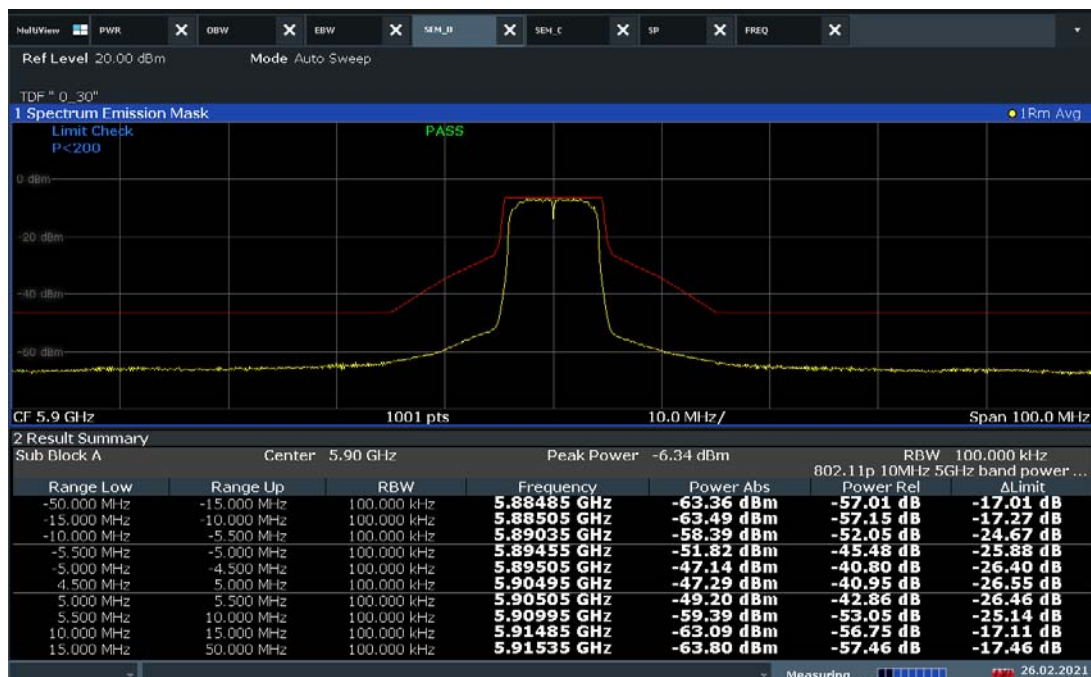
Ch178 / 5 890 MHz / 3M data rate



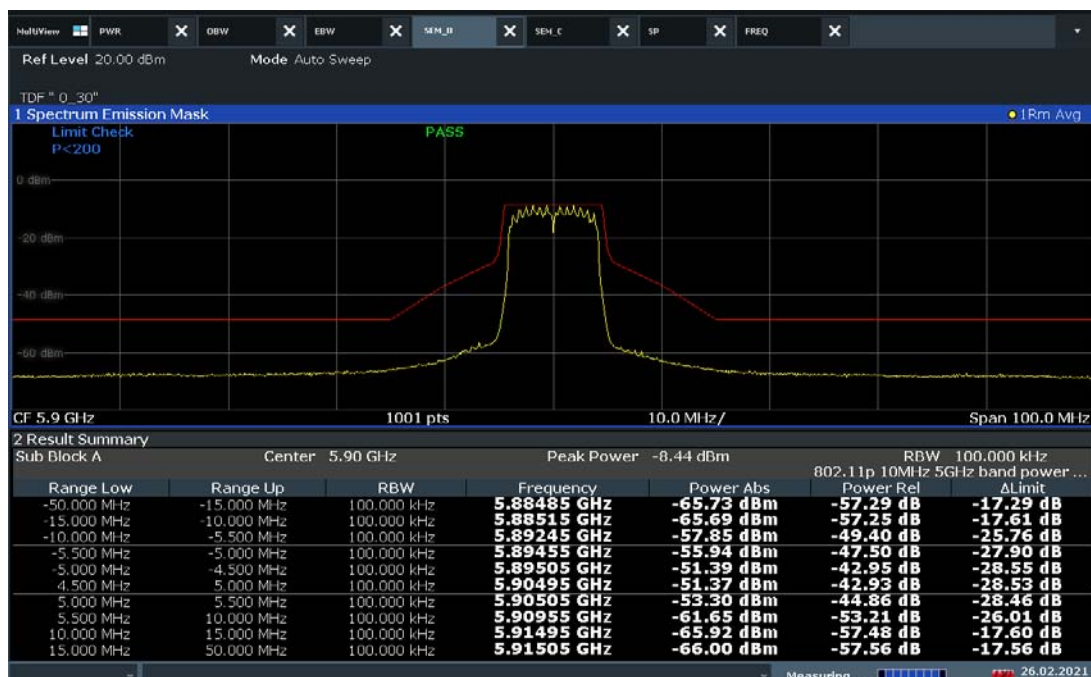
Ch178 / 5 890 MHz / 27M data rate



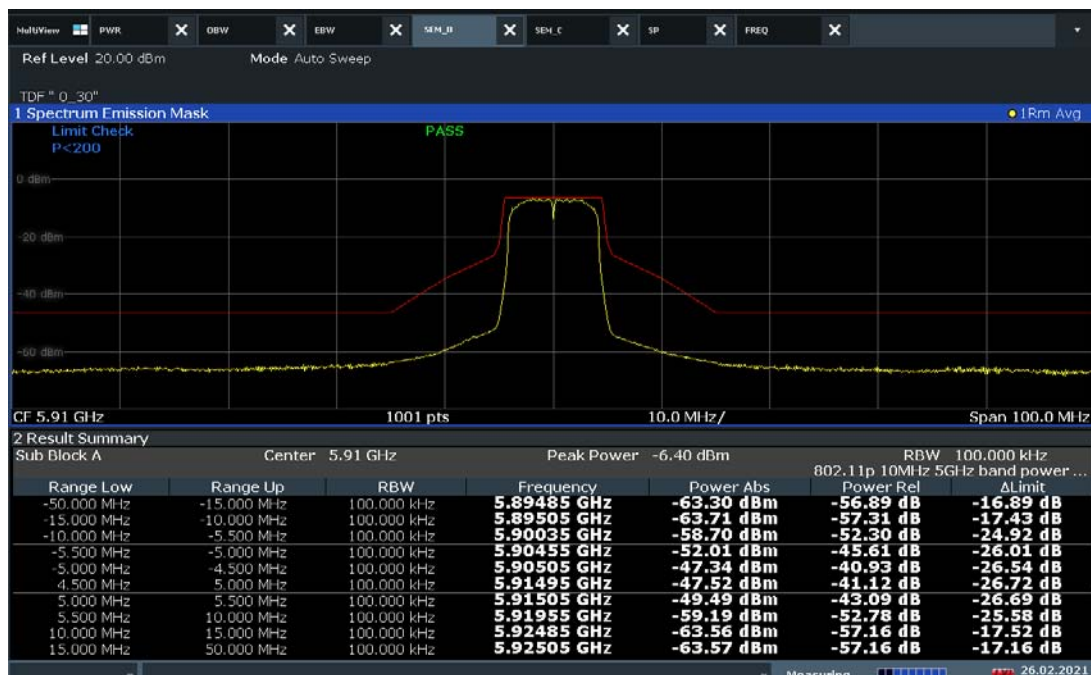
Ch180 / 5 900 MHz / 3M data rate



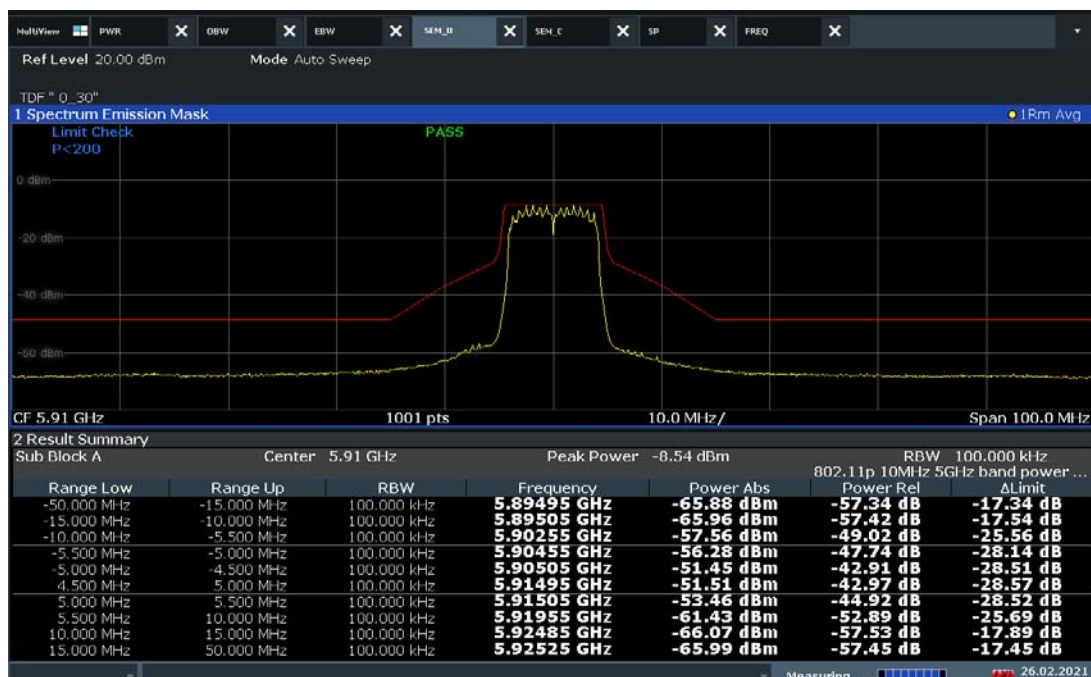
Ch180 / 5 900 MHz / 27M data rate



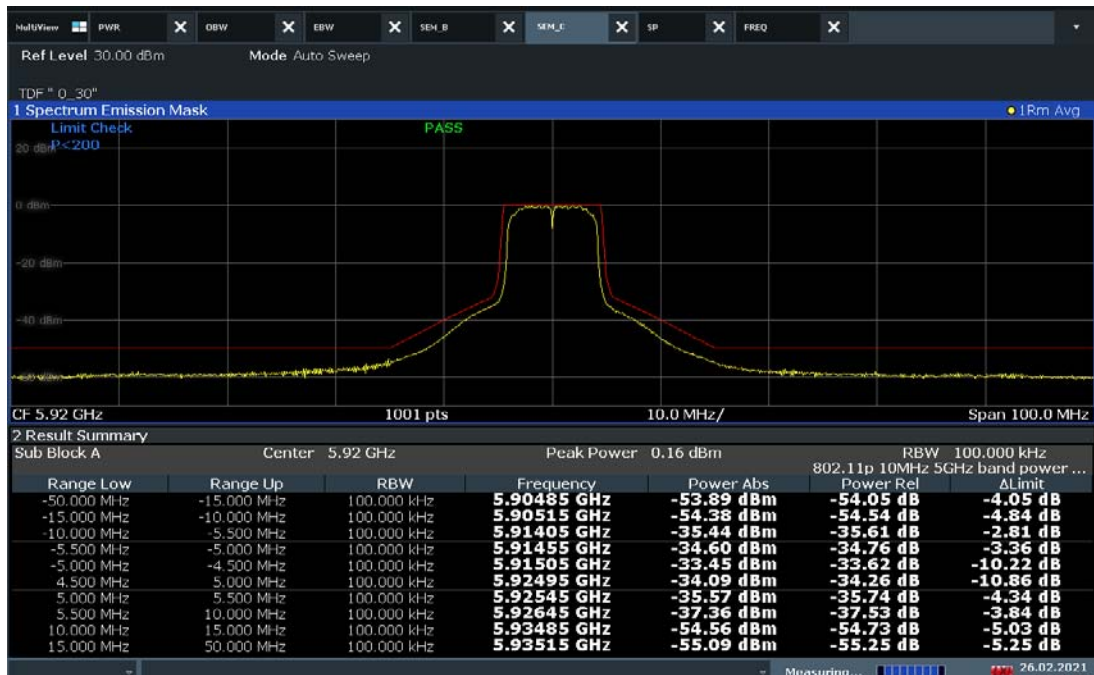
Ch182 / 5 910 MHz / 3M data rate



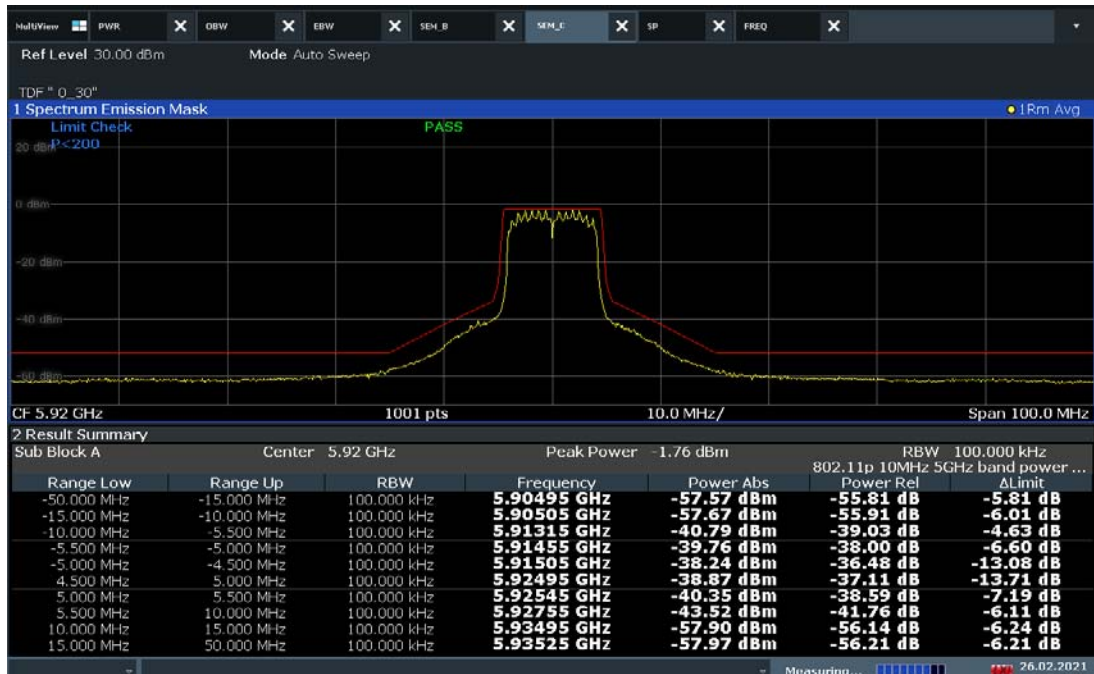
Ch182 / 5 910 MHz / 27M data rate



Ch184 / 5 920 MHz / 3M data rate



Ch184 / 5 920 MHz / 27M data rate



5.4 Transmitter Conducted Unwanted Emissions

5.4.1 Standard Applicable [FCC § 2.1051/ 90.379 / ASTM E2213-03 8.10.2 & 8.10.3]

For the 5.850 - 5.925 GHz band, The power of any emission outside a licensee's frequency band(s) of operation shall be attenuated below the transmitter power (P) within the licensed band(s) of operation, measured in watts, by at least $[55 + 10 \log (P)]$ (-25dBm).

5.4.2 Test Environment conditions

- Ambient temperature : (21 ~ 22) °C • Relative Humidity : (53 ~ 56) % R.H.

5.4.3 Measurement Procedure

The DSRC transmitted spectrum mask is relative to the device class of operation. The power in the transmitted spectrum for all DSRC devices shall be -25 dBm or less within 100 kHz outside all channel and band edges. This will be accomplished by attenuating the transmitted signal 100 kHz outside the channel and band edges by $55 + 10\log(P)$ dB, where P is the total transmitted power in watts. The transmitted spectral density of the transmitted signal for all devices shall fall within the spectral mask, as detailed in Table 10.5 The measurements shall be made using a 100 kHz resolution bandwidth and a 30 kHz video bandwidth.

5.4.4 Test setup

Please refer 5.1.4

5.4.5 Measurement Result

Please refer 5.4.7 test plot

5.4.6 Limit

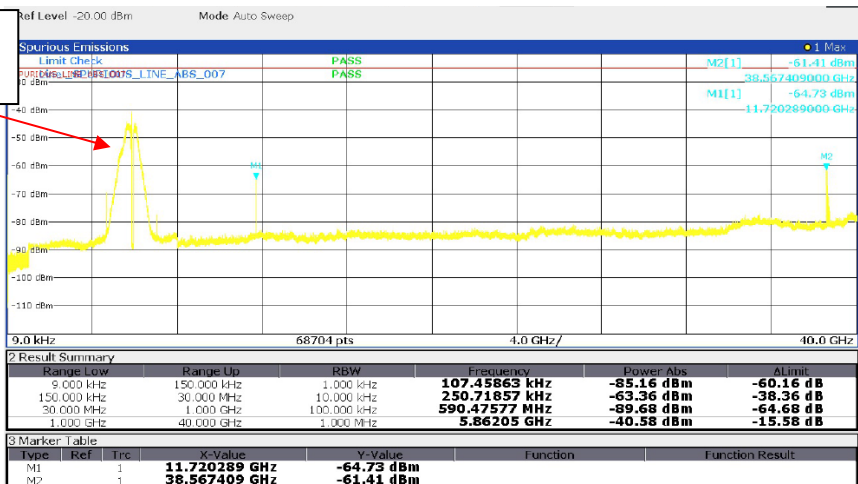
Attenuated at least -25 dBm

5.4.7 Test Plot

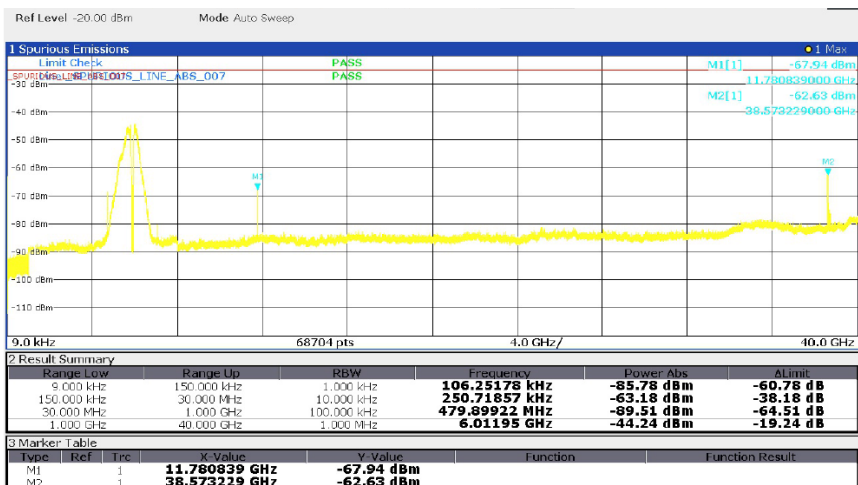
TX Port #1

Ch172 / 5 860 MHz / 3M data rate

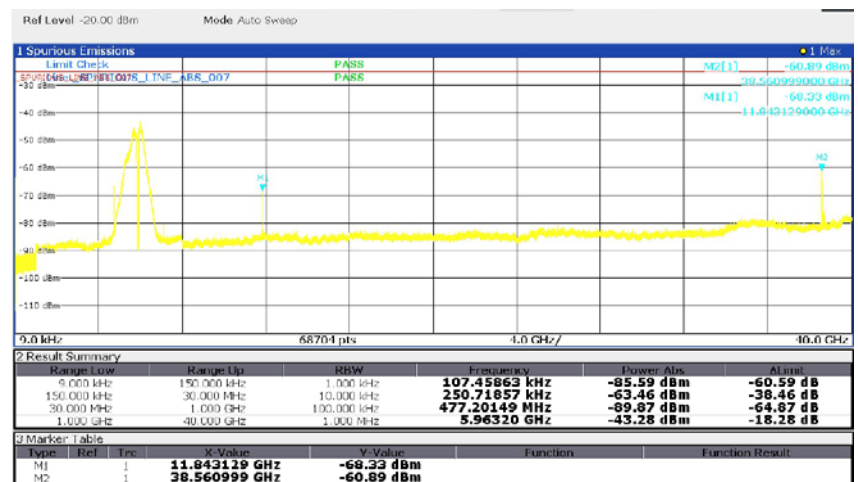
Fundamental signal
was removed by
band reject filter



Ch178 / 5 890 MHz / 3M data rate



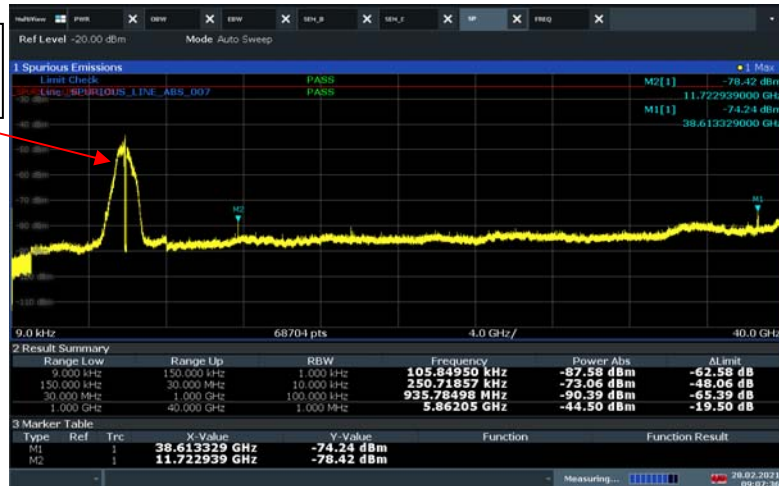
Ch184 / 5 920 MHz / 3M data rate



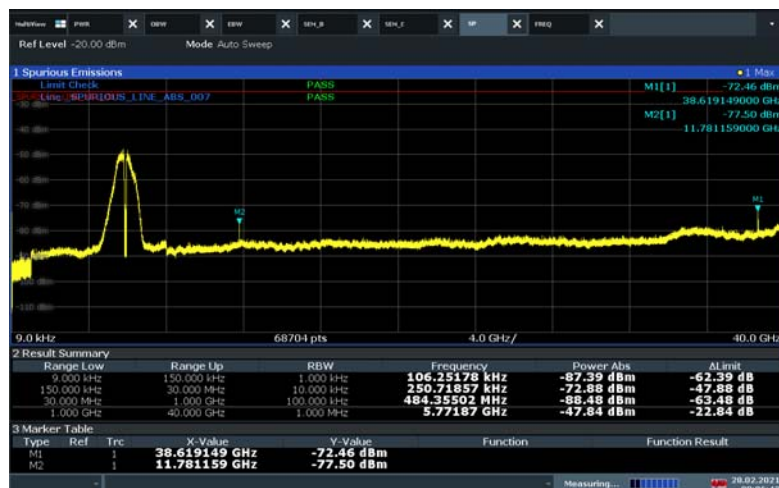
TX Port #2

Ch172 / 5 860 MHz / 3M data rate

Fundamental signal
was removed by
band reject filter



Ch178 / 5 890 MHz / 3M data rate



Ch184 / 5 920 MHz / 3M data rate



5.5 Transmitter Radiated Unwanted Emissions

5.5.1 Standard Applicable [FCC § 2.1053/ 90.379 / ASTM E2213-03 8.10.2 & 8.10.3]

The power of any emission outside a licensee's frequency band(s) of operation shall be attenuated below the transmitter power (P) within the licensed band(s) of operation, measured in watts, by at least $[55 + 10 \log (P)]$ (e.i.r.p. -25 dBm [70.2 dBuV/m at 3 m])

5.5.2 Test Environment conditions

- Ambient temperature : (21 ~ 22) °C • Relative Humidity : (53 ~ 56) % R.H.

5.5.3 Measurement Procedure

The EUT was setup according to ANSI/TIA 603E:2016 and tested according to test procedure of ASTM E2213-03 DSRC 8.10.2 & 8.10.3 for compliance to FCC 47CFR part 90 requirements.

1. The EUT was placed on the top of a rotating table (0.8 meters for below 1 GHz and 1.5 meters for above 1 GHz) above the ground at a 3 meter camber. The table was rotated 360 degree to determine the position of the highest radiation.
 2. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna master.
 3. The antenna height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both Horizontal and vertical polarizations of the antenna are set to make the measurement.
 4. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the rotating table was turned from 0 - 360 degrees to find the maximum reading.
 5. The measuring receiver was set to peak detector and specified bandwidth with max hold function.
 6. Low, Middle and high channels were measured, and radiation measurements are performed in X, Y, Z axis positioning. And found the worst axis position and only the test worst case mode is recorded in the report.
- The measurement results are obtained as described below:
Result(dBuV/m) = Reading(dBuV) + Antenna factor(dB/m) + CL(dB) + other applicable factor (dB)
 - The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 3 MHz for RMS Average (Duty cycle < 98 %) for Average detection (AV) at frequency above 1 GHz, then the measurement results was added to a correction factor ($10 \log(1/\text{duty cycle})$).
 - The resolution bandwidth of test receiver/spectrum analyzer is 1 MHz and the video bandwidth is 10 Hz (Duty cycle ≥ 98 %) for Average detection (AV) at frequency above 1 GHz.
 - According to §15.33 (a)(1), Frequency range of radiated measurement is performed the tenth harmonic.
 - Test Method : ANSI/TIA-603-E-2016, clause 3.2.12 for radiated measurement.

Effective Isotropic Radiated Power (EIRP) :

KDB 412172, clause 1.3.1 following as field strength approach. e.i.r.p.= $(E \times d)^2 / 30$.

$E = (1000000 \sqrt{30P}) / 3 \mu\text{V/m}$, Where P is the EIRP in Watts

For radiated measurement. :

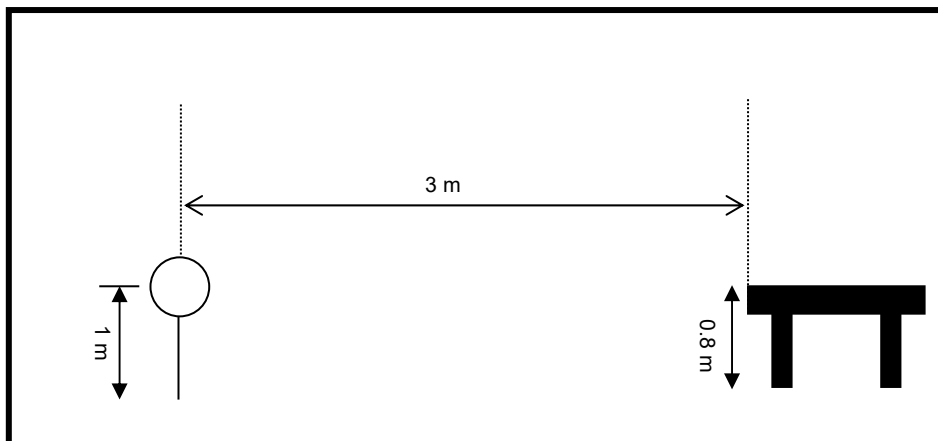
KDB 412172, clause 5 following eirp can be directly determined using the field strength.

5.5.4 Measurement Uncertainty

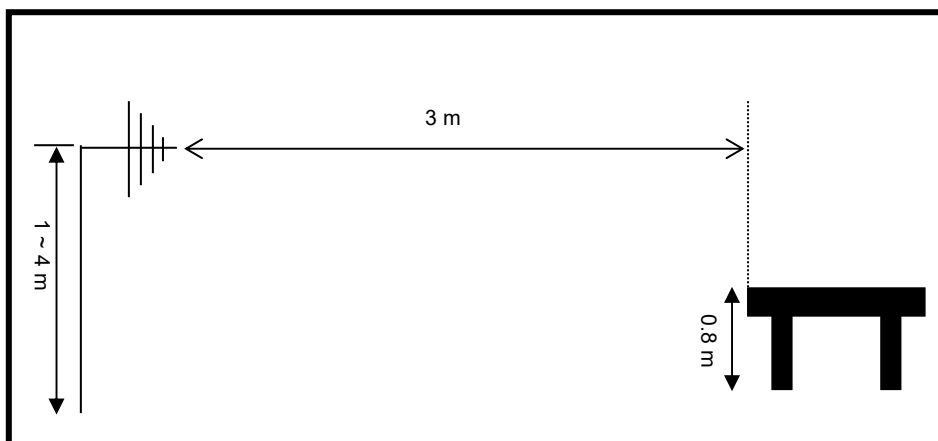
Radiated Emission measurement: Below 1 GHz: 3.62 dB (CL: Approx 95 %, k=2)
Above 1 GHz: 3.46 dB (CL: Approx 95 %, k=2)

5.5.5 Test Configuration

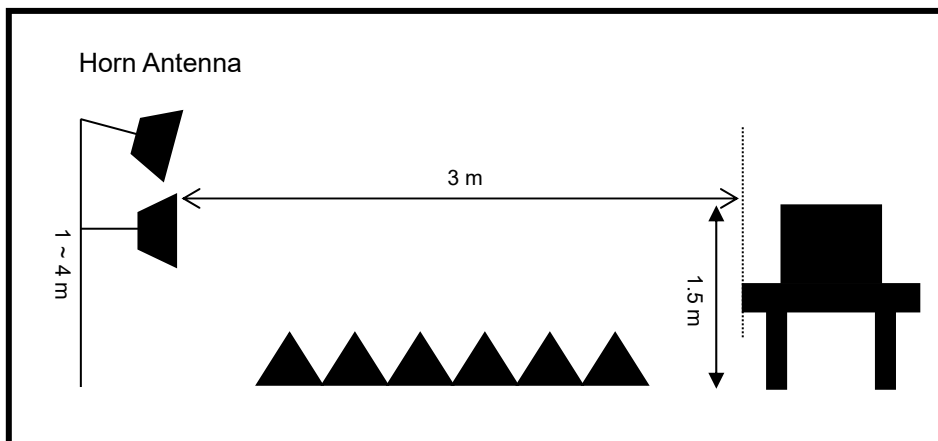
Radiated emission setup, below 30 MHz



Radiated emission setup, below 1 000 MHz



Radiated emission setup, above 1 GHz



5.5.5 Measurement Result

Pre-Scan has been conducted to determine the worst-case mode from all possible combinations between available modulations, data rates.

Following channel(s) was (were) selected for the final test as listed below.

Mode	Data rate	Measured CH
802.11p 5.9 G-10M	3 Mbps	172 (5 860 MHz)
		178 (5 890 MHz)
		184 (5 920 MHz)

■ Above 1 GHz

Ch172 / 5 860 MHz / 3M data rate

Freq. (GHz)	Reading (dB μ V/m)		Table (Deg)	Antenna			CL (dB)	AMP (dB)	Meas Result (dB μ V/m)		Limit (dB μ V/m)		Mgn. (dB)		Result
	PK	AV		Height (m)	Pol. (H/V)	Fctr. (dB/m)			PK	AV	PK	AV	PK	AV	
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Compliance

Ch178 / 5 890 MHz / 3M data rate

Freq. (GHz)	Reading (dB μ V/m)		Table (Deg)	Antenna			CL (dB)	AMP (dB)	Meas Result (dB μ V/m)		Limit (dB μ V/m)		Mgn. (dB)		Result
	PK	AV		Height (m)	Pol. (H/V)	Fctr. (dB/m)			PK	AV	PK	AV	PK	AV	
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Compliance

Ch184 / 5 920 MHz / 3M data rate

Freq. (GHz)	Reading (dB μ V/m)		Table (Deg)	Antenna			CL (dB)	AMP (dB)	Meas Result (dB μ V/m)		Limit (dB μ V/m)		Mgn. (dB)		Result
	PK	AV		Height (m)	Pol. (H/V)	Fctr. (dB/m)			PK	AV	PK	AV	PK	AV	
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Compliance

※Note

- 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.
- For above 1 GHz, any other signal is not detected on test receiver
- The transmitter radiated spectrum was investigated from 9 kHz to 40 GHz

■ Below 1 GHz

Freq. (MHz)	Reading (dB μ V/m)	Table (Deg)	Antenna			CL (dB)	AMP (dB)	Meas Result (dB μ V/m)	Limit (dB μ V/m)	Mgn (dB)	Result
			Height (m)	Pol. (H/V)	Fctr. (dB/m)						
64.20	59.22	180	1.1	V	18.30	1.07	46.48	32.11	70.2		Compliance
120.02	61.81	270	1.5	V	17.11	1.39	46.45	33.86	70.2		Compliance
250.10	62.05	250	1.5	V	17.70	2.07	46.32	35.50	70.2		Compliance

Freq.(MHz) : Measurement frequency

Reading(dB μ V/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 (dB μ V/m) : Reading(dB μ V/m)+ Antenna factor.(dB/m)+ CL(dB) - Pre AMP(dB)

Limit(dB μ V/m): Limit value specified with FCC Rule, Mgn(dB) : FCC Limit (dB μ V/m) – Meas Result(dB μ V/m)

5.6 Frequency Stability

5.6.1 Standard Applicable [FCC § 90.213 / ASTM E2213-03 8.10.4]

Per ASTM E2213-03 Clause 8.10.4, The transmitter center frequency stability shall be ± 10 ppm maximum for DSRC 5.9 GHz band.

5.6.2 Test Environment conditions

- Ambient temperature : (21 ~ 22) °C • Relative Humidity : (53 ~ 56) % R.H.

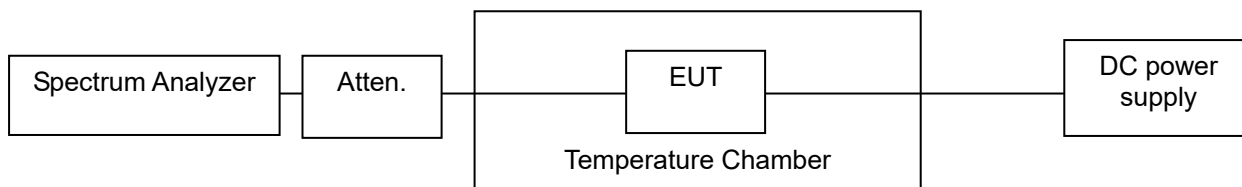
5.6.3 Measurement Procedure

EUT connect to Spectrum analyzer, test is performed in T&H chamber.

These measurements shall also be performed at normal and extreme test conditions.

- Test Method : ANSI/TIA-603-E-2016 for frequency stability tests
 - Frequency stability with respect to ambient temperature (-20 °C to 50 °C)
 - Frequency stability when varying supply voltage (85 % to 115 %)

5.6.4 Test setup



5.6.5 Measurement Result

TX Port #1

(Ch178: 5 890 MHz)

Temp(°C)	Power Supply	Measured Freq(MHz)	Freq Drift(ppm)	Limit
50	DC 48(Vnom)	5,889,985,210	-2.51	± 10
40	DC 48(Vnom)	5,889,987,200	-2.17	± 10
30	DC 48(Vnom)	5,890,009,700	1.65	± 10
20	DC 48(Vnom)	5,890,014,503	2.46	± 10
10	DC 48(Vnom)	5,890,013,300	2.26	± 10
0	DC 48(Vnom)	5,890,015,600	2.65	± 10
-10	DC 48(Vnom)	5,890,030,700	5.21	± 10
-20	DC 48(Vnom)	5,890,043,200	7.33	± 10
Nom Temperature	DC 43.2 (Vmin)	5,890,015,000	2.55	± 10
Nom Temperature	DC 52.8 (Vmax)	5,890,014,600	2.48	± 10
Test Results		Compliance		

TX Port #2

(Ch178: 5 890 MHz)

Temp(℃)	Power Supply	Measured Freq(MHz)	Freq Drift(ppm)	Limit
50	DC 48(Vnom)	5,889,985,205	-2.51	±10
40	DC 48(Vnom)	5,889,987,206	-2.17	±10
30	DC 48(Vnom)	5,890,009,699	1.65	±10
20	DC 48(Vnom)	5,890,014,505	2.46	±10
10	DC 48(Vnom)	5,890,013,299	2.26	±10
0	DC 48(Vnom)	5,890,015,606	2.65	±10
-10	DC 48(Vnom)	5,890,030,698	5.21	±10
-20	DC 48(Vnom)	5,890,043,203	7.33	±10
Nom Temperature	DC 43.2 (Vmin)	5,890,015,003	2.55	±10
Nom Temperature	DC 52.8 (Vmax)	5,890,014,597	2.48	±10
Test Results		Compliance		

5.7 Emission Types

5.7.1 Standard Applicable [ASTM E2213-03]

Emission Types	D1D
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5.8 Modulation Standard

5.8.1 Standard Applicable [ASTM E2213-03]

The carrier signal is OFDM. The sub-carriers have the following data rates and modulations:

Data rate	Modulation
3 MBit/s	BPSK
4.5 MBit/s	BPSK
6 MBit/s	QPSK
9 MBit/s	QPSK
12 MBit/s	16-QAM
18 MBit/s	16-QAM
24 MBit/s	64-QAM
27 MBit/s	64-QAM