TEST REPORT

of

FCC Part 15 Subpart C §15.209
IC RSS-210 Issue 9, RSS-Gen Issue 5

FCC ID: TQ8-SMK-4E22
IC Certification: 5074A-SMK4E22

Equipment Under Test	:	SMART KEY ECU
Model Name	:	SMK-4E22
Applicant	:	Hyundai Mobis Co., Ltd.
Manufacturer	:	Hyundai Mobis Co., Ltd.
Date of Receipt	:	2018.11.09
Date of Test(s)	:	2018.11.24 ~ 2018.12.27
Date of Issue	:	2019.01.02

In the configuration tested, the EUT complied with the standards specified above.

Tested By: **Nancy Park** **Date:** **2019.01.02**

Technical Manager: **Harim Lee** **Date:** **2019.01.02**

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1. General information

1.1. Testing Laboratory

SGS Korea Co., Ltd. (Gunpo Laboratory)
- Wireless Div. 2FL, 10-2, LS-ro 182beon-gil, Gunpo-si, Gyeonggi-do, Korea, 15807
- Designation number: KR0150

All SGS services are rendered in accordance with the applicable SGS conditions of service available on request and accessible at http://www.sgs.com/en/Terms-and-Conditions.aspx.

Phone No. : +82 31 688 0901
Fax No. : +82 31 688 0921

1.2. Details of Applicant

Applicant : Hyundai Mobis Co., Ltd.
Address : 203, Teheran-ro, Gangnam-gu, Seoul, South Korea, 135-977
Contact Person : Choe, Seung-Hoon
Phone No. : +82 31 260 0098

1.3. Details of Manufacturer

Applicant : Same as applicant
Address : Same as applicant

1.4. Description of EUT

Kind of Product		SMART KEY ECU
Model Name		SMK-4E22
Power Supply		DC 12.0 V
Frequency Range		Tx: 125.00 ㎑, Rx: 433.92 ㎒
Antenna Type	**Tx**	External Type (Coil Antenna)
	Rx	Internal Type (Chip Antenna)

1.5. Declaration of manufacturer

- The EUT has 6 transmit antennas and one receive antenna.
- The transmit antennas can not operate at the same time.

1.6. Test Equipment List

Equipment	Manufacturer	Model	S/N	Cal. Date	Cal. Interval	Cal. Due
Spectrum Analyzer	R&S	FSV30	100768	Mar. 12, 2018	Annual	Mar. 12, 2019
Signal Generator	R&S	SMBV100A	255834	Jun. 15, 2018	Annual	Jun. 15, 2019
DC Power Supply	Agilent	U8002A	MY50060028	Mar. 15, 2018	Annual	Mar. 15, 2019
Test Receiver	R&S	ESU26	100109	Feb. 07, 2018	Annual	Feb. 07, 2019
Loop Antenna	Schwarzbeck Mess-Elektronik	FMZB 1519	1519-039	Aug. 23, 2017	Biennial	Aug. 23, 2019
Turn Table	Innco systems GmbH	DS 1200 S	N/A	N. C. R.	N/A	N. C. R.
Controller	Innco systems GmbH	CONTROLLER CO3000-4P	CO3000/963/38330516/L	N. C. R.	N/A	N. C. R.
Anechoic Chamber	SY Corporation	L × W × H (9.6 m × 6.4 m × 6.6 m)	N/A	N. C. R.	N/A	N. C. R.
Coaxial Cable	SUCOFLEX	104 (3 m)	MY3258414	Jul. 04, 2018	Semi-annual	Jan. 04, 2019
Coaxial Cable	SUCOFLEX	104 (10 m)	MY3145814	Jul. 04, 2018	Semi-annual	Jan. 04, 2019

1.7. Sample Calculation

Where relevant, the following sample calculation is provided:
Field strength level (dBμV/m) = Measured level (dBμV) + Antenna factor (dB) + Cable loss (dB)

1.8. Summary of Test Results

The EUT has been tested according to the following specifications:

Applied standard: FCC Part15 subpart C, IC RSS-210 Issue 9, RSS-Gen Issue 5			
FCC Section	**IC Section**	**Test Item**	**Result**
15.209	RSS-210 Issue 9, 4.4, RSS-Gen Issue 5, 8.9	Radiated emission, Spurious Emission and Field Strength of Fundamental	Complied
2.1049	-	20 dB Bandwidth	Complied
-	RSS-Gen Issue 5, 6.7	Occupied Bandwidth	Complied

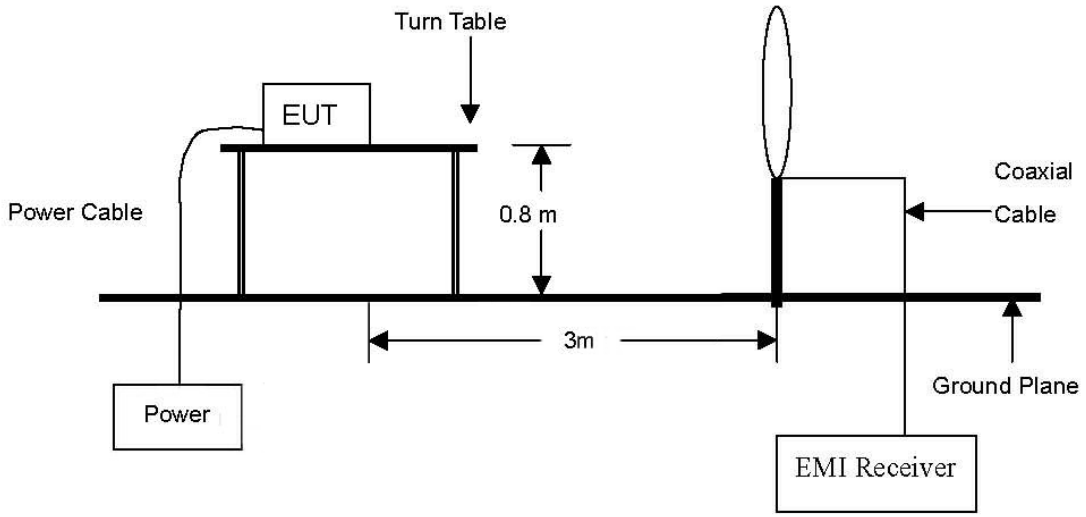
1.9. Test Report Revision

Revision	Report number	Date of Issue	Description
0	F690501/RF-RTL013359	2019.01.02	Initial

2. Field Strength of Fundamental and Spurious Emission

2.1. Test Setup

The diagram below shows the test setup that is utilized to make the measurements for emission below 30 ㎒.



2.2. Limits

2.2.1. FCC

According to §15.209(a), except as provided elsewhere in this Subpart, the emissions from an intentional radiator shall not exceed the field strength levels specified in the following table:

Frequency (㎒)	Field Strength (microvolts/meter)	Measurement Distance (meter)
0.009-0.490	2 400/F(㎑)	300
0.490-1.705	24 000/F(㎑)	30
1.705-30.0	30	30
30-88	100**	3
88-216	150**	3
216-960	200**	3
Above 960	500	3

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

According to §15.209 (d), The emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9-90 ㎑, 110-490 ㎑ and above 1000 ㎒. Radiated emission limits in these three bands are based on measurements employing an average detector.

2.2.2. IC

2.2.2.1. Transmitter emission limits

According to RSS-Gen Issue 5, 8.9.
Except where otherwise indicated in the applicable RSS, radiated emissions shall comply with the field strength limits shown in table 5 and table 6. Additionally, the level of any transmitter unwanted emission shall not exceed the level of the transmitter's fundamental emission.

Table 5 - General field strength limits at frequencies above 30 ㎒

Frequency (㎒)	Field Strength (㎶/m at 3 m)
30-88	100
88-216	150
216-960	200
Above 960	500

Table 6 - General field strength limits at frequencies below 30 ㎒

Frequency	Magnetic Field Strength (H-Field) (㎂/m)	Measurement Distance (m)
9-490 ㎑ [1]	6.37/F (F in ㎑)	300
490-1 705 ㎑	63.7/F (F in ㎑)	30
1.705-30 ㎒	0.08	30

Note 1: The emission limits for the ranges 9-90 ㎑ and 110-490 ㎑ are based on measurements employing a linear average detector.

2.3. Test Procedures

Radiated emissions from the EUT were measured according to the dictates of ANSI C63.10-2013.

2.3.1. Test Procedures for emission from 9 ㎑ to 30 ㎒

a. The EUT was placed on the top of a rotating table 0.8 meters above the ground at a 3 meter anechoic chamber test site. The table was rotated 360 degrees to determine the position of the highest radiation.
b. Then antenna is a loop antenna is fixed at one meter above the ground to determine the maximum value of the field strength. Both parallel and perpendicular of the antenna are set to make the measurement.
c. For each suspected emission, the EUT was arranged to its worst case and then the table was turned from 0 degrees to 360 degrees to find the maximum reading.
d. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
e. To get a maximum emission level from the EUT, the EUT is manipulated through three orthogonal planes (X, Y, Z). Worst orthogonal plan of EUT is **X – axis** during radiation test.

2.4. Field Strength of Fundamental Test Result

Ambient temperature : (23 ± 1) ℃
Relative humidity : 47 % R.H.

The following table shows the highest levels of radiated emissions on both polarizations of horizontal and vertical. The field strength of spurious emission was measured in one orthogonal EUT position (x-axis). Definition of DUT for a orthogonal plane was described in the test setup photo.

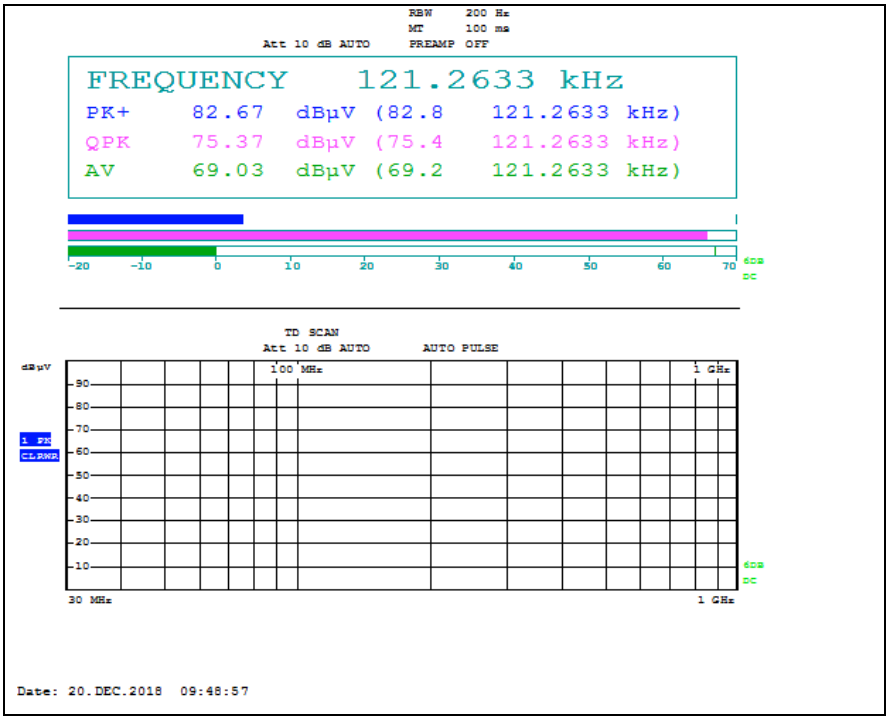
Radiated Emissions			Ant.	Correction Factors		Total		Limit	
Frequency (㎒)	Reading (dB㎶)	Detect Mode	Pol.	Ant. (dB/m)	Cable (dB)	Actual (dB㎶/m) at 3 m	Actual (dB㎶/m) at 300 m	Limit (dB㎶/m) at 300 m	Margin (dB)
DRV Antenna									
0.121	69.20	Average	H	19.69	0.06	88.95	8.95	25.95	17.00
AST Antenna									
0.121	68.40	Average	H	19.69	0.06	88.15	8.15	25.95	17.80
BUM Antenna									
0.121	69.60	Average	H	19.69	0.06	89.35	9.35	25.95	16.60
INT1 Antenna									
0.121	69.01	Average	H	19.69	0.06	88.76	8.76	25.95	17.19
INT2 Antenna									
0.121	69.70	Average	H	19.69	0.06	89.45	9.45	25.95	16.50
SSB Antenna									
0.125	61.90	Average	H	19.69	0.07	81.66	1.66	25.67	24.01

Remark;

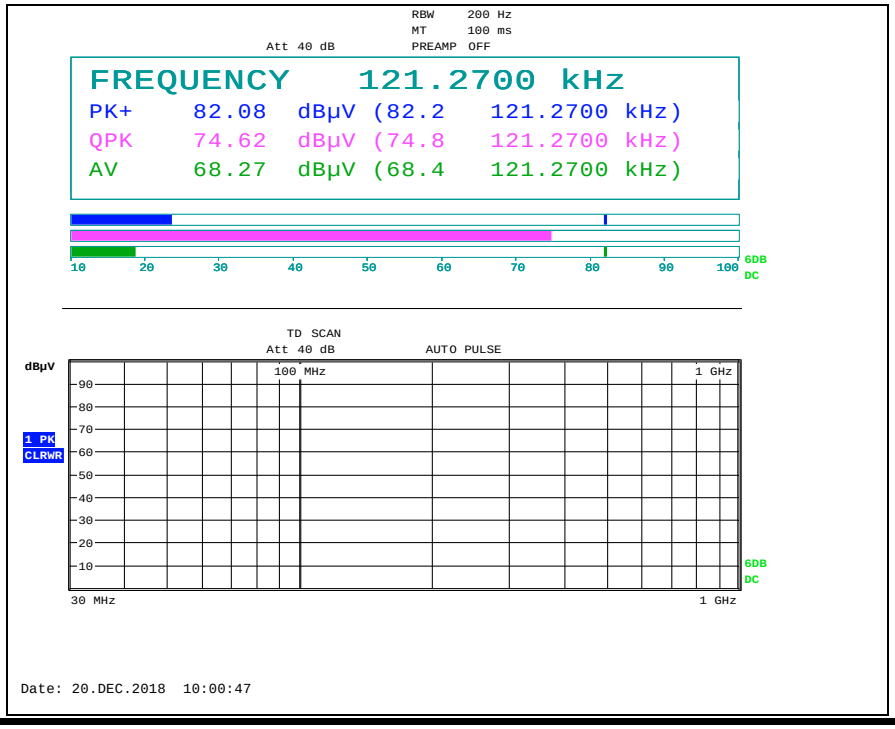
1. According to §15.31 (f)(2) 300 m Result (dB㎶/m) = 3 m Result (dB㎶/m) - 40log(300/3) (dB㎶/m).
2. According to §15.209 (d), the measurements were tested by using Quasi peak detector except for the frequency bands 9-90 ㎑, 110-490 ㎑ and above 1 ㎓ in these three bands on measurements employing an average detector.
3. The limit above was calculated based on table of §15.209 (a).
4. According to ANSI C63.10: 2013, For measurement below 30 ㎒.
   conversion factor from E-field to H-field is considered as free-space impedance [1 ㎂/m = (1/377 Ω) × 1 ㎂/m]
   The FCC limits are same to the IC limits.

- Test plots

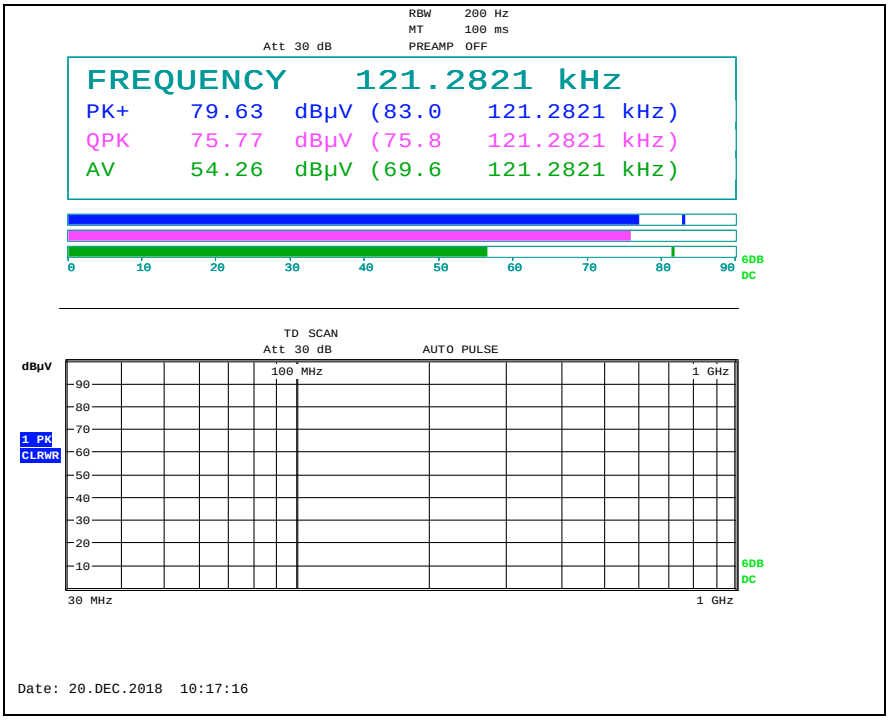
- DRV Antenna



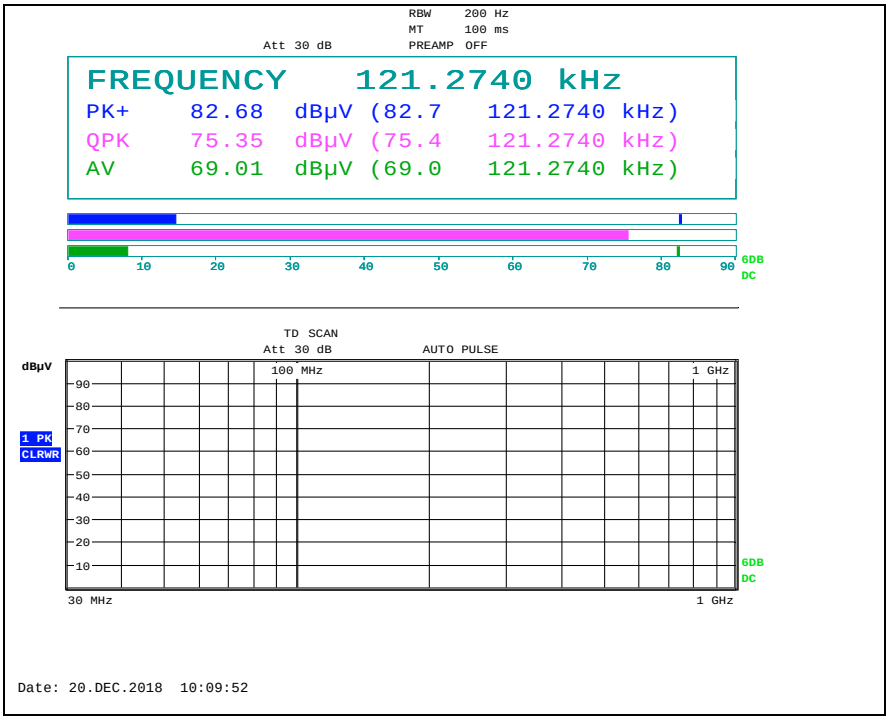
- AST Antenna



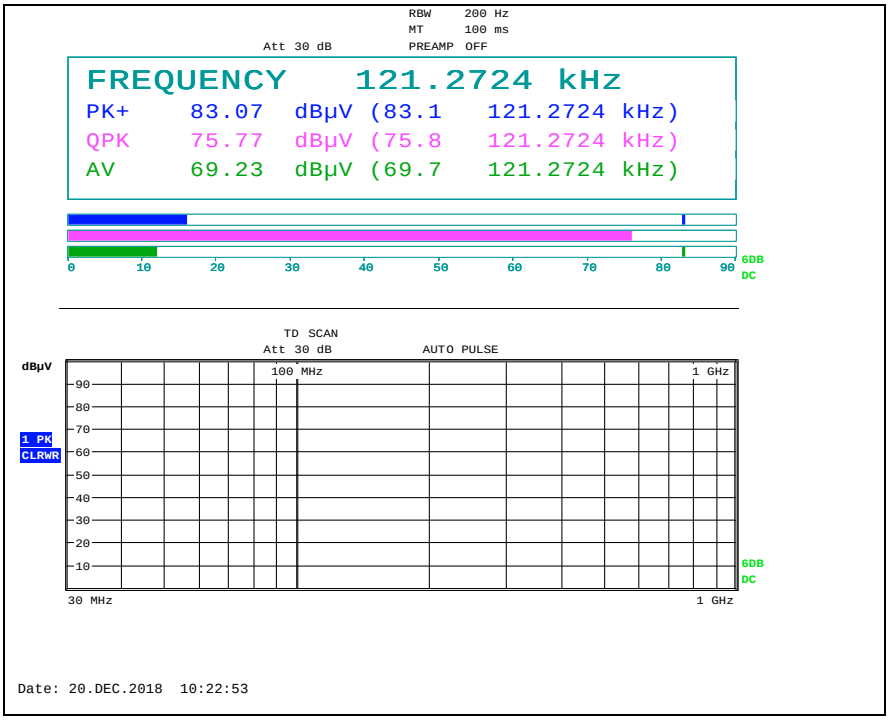
- BUM Antenna



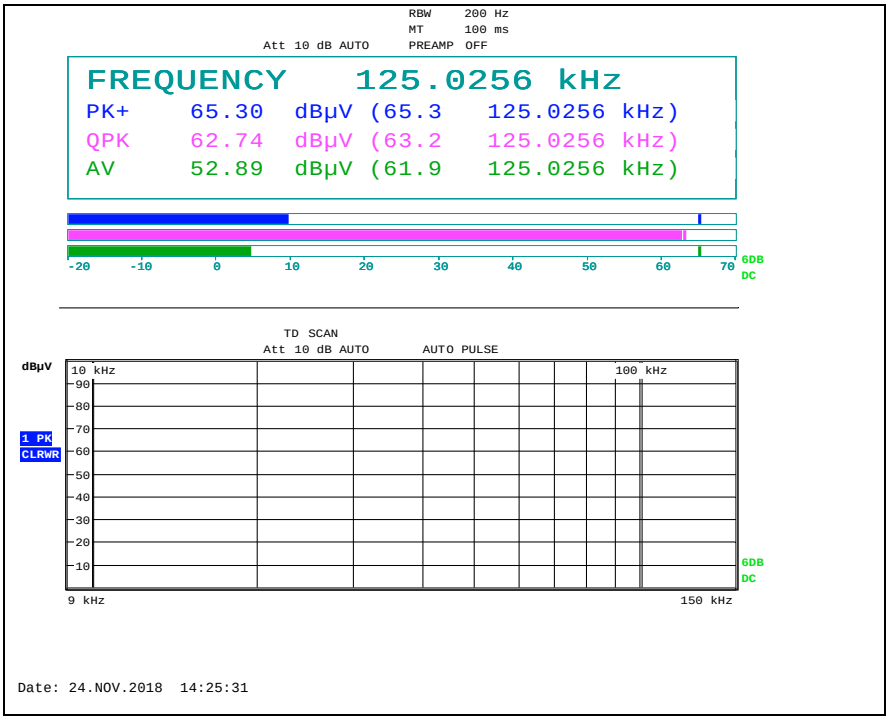
- INT1 Antenna



- INT2 Antenna



- SSB Antenna



2.5. Spurious Emission Test Result

Ambient temperature : (23 ± 1) ℃
Relative humidity : 47 % R.H.

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

Radiated Emissions			Ant.	Correction Factors		Total		Limit	
Frequency (㎒)	Reading (dB㎶)	Detect Mode	Pol.	Ant. (dB/m)	Cable (dB)	Actual (dB㎶/m) at 3 m	Actual (dB㎶/m) at 30 m or 300 m	Limit (dB㎶/m) at 30 m or 300 m	Margin (dB)
DRV Antenna									
0.020	22.10	Average	H	19.95	0.01	42.06	-37.94	41.58	79.52
0.098	33.20	Quasi-Peak	H	19.70	0.04	52.94	-27.06	27.78	54.84
2.526	10.30	Quasi-Peak	H	19.78	0.58	30.66	-9.34	30.00	39.34
Above 3.000	Not detected	-	-	-	-	-	-	-	-
AST Antenna									
0.019	24.80	Average	H	19.97	0.01	44.78	-35.22	42.03	77.25
0.082	20.40	Average	H	19.73	0.03	40.16	-39.84	29.33	69.17
2.519	10.00	Quasi-Peak	H	19.78	0.58	30.36	-9.64	30.00	39.64
Above 3.000	Not detected	-	-	-	-	-	-	-	-
BUM Antenna									
0.018	23.70	Average	H	19.98	0.01	43.69	-36.31	42.50	78.81
0.097	17.20	Quasi-Peak	H	19.70	0.04	36.94	-43.06	27.87	70.93
2.418	9.11	Quasi-Peak	H	19.77	0.59	29.47	-10.53	30.00	40.53
Above 3.000	Not detected	-	-	-	-	-	-	-	-
INT1 Antenna									
0.011	21.10	Average	H	20.09	0.01	41.20	-38.80	46.78	85.58
0.090	23.60	Average	H	19.71	0.04	43.35	-36.65	28.52	65.17
2.533	9.80	Quasi-Peak	H	19.78	0.58	30.16	-9.84	30.00	39.84
Above 3.000	Not detected	-	-	-	-	-	-	-	-

Radiated Emissions			Ant.	Correction Factors		Total		Limit	
Frequency (㎒)	Reading (dB㎶)	Detect Mode	Pol.	Ant. (dB/m)	Cable (dB)	Actual (dB㎶/m) at 3 m	Actual (dB㎶/m) at 30 m or 300 m	Limit (dB㎶/m) at 30 m or 300 m	Margin (dB)
INT2 Antenna									
0.019	27.80	Average	H	19.97	0.01	47.78	-32.22	42.03	74.25
0.074	7.10	Average	H	19.74	0.03	26.87	-53.13	30.22	83.35
2.542	9.60	Quasi-Peak	H	19.78	0.58	29.96	-10.04	30.00	40.04
Above 3.000	Not detected	-	-	-	-	-	-	-	-
SSB Antenna									
0.018	34.00	Average	H	19.98	0.01	53.99	-26.01	42.50	68.51
0.090	21.20	Average	H	19.71	0.04	40.95	-39.05	28.52	67.57
0.378	26.30	Average	H	19.60	0.29	46.19	-33.81	16.05	49.86
0.627	20.30	Quasi-Peak	H	19.63	0.49	40.42	0.42	31.66	31.24
2.635	13.10	Quasi-Peak	H	19.78	0.56	33.44	-6.56	30.00	36.56
Above 3.000	Not detected	-	-	-	-	-	-	-	-

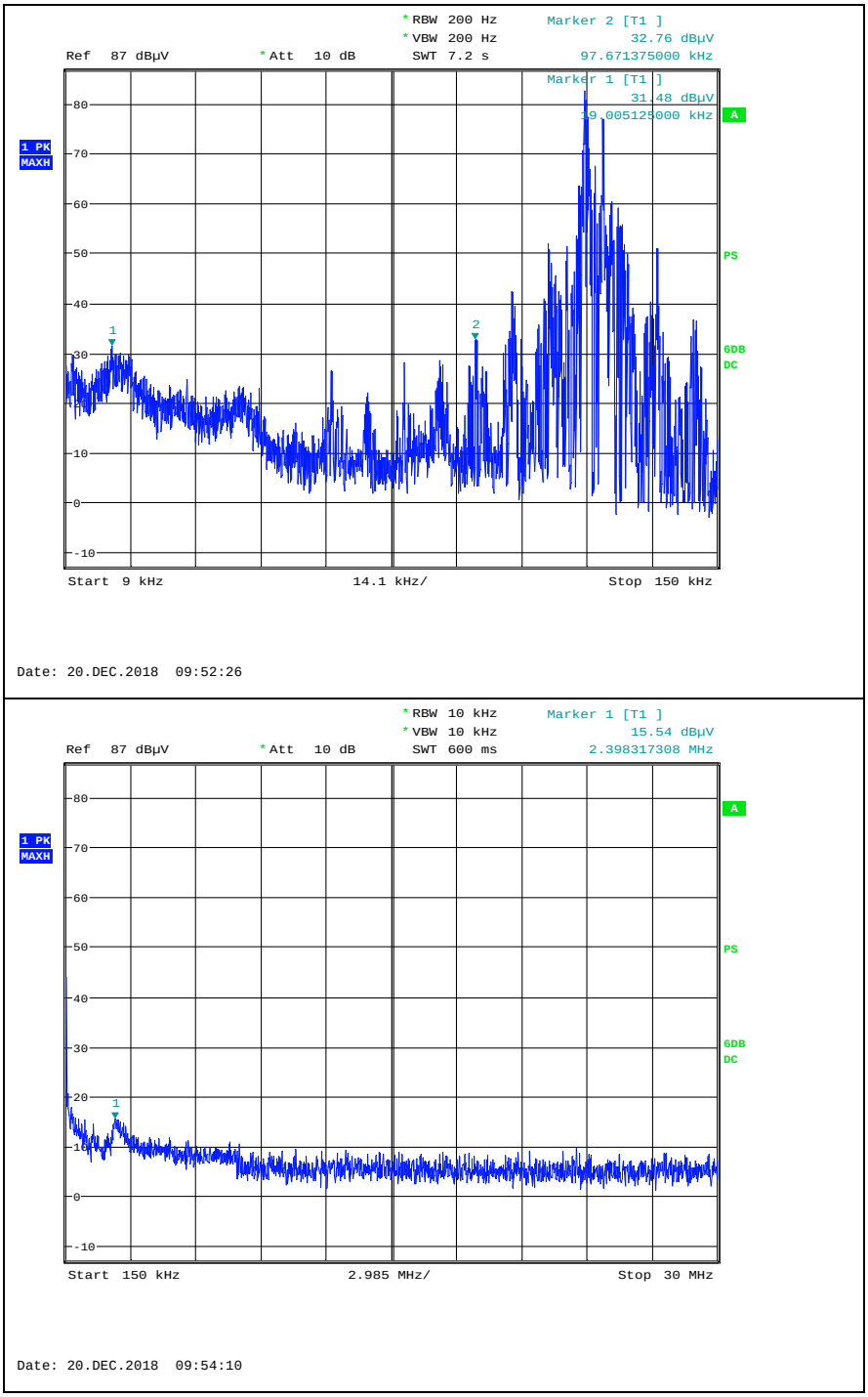
Remark;

1. According to §15.31 (f)(2)
   - 300 m Result (dB㎶/m) = 3 m Result (dB㎶/m) - 40log(300/3) (dB㎶/m)
   - 30 m Result (dB㎶/m) = 3 m Result (dB㎶/m) - 40log(30/3) (dB㎶/m)
2. According to field strength table of general requirement in §15.209 (a), field strength limits below 1.705 ㎒ were calculated as below.
   - 9 ㎑ to 490 ㎑: 20log(2 400 / F (㎑)) at 300 m (dB㎶/m)
   - 490 ㎑ to 1 705 ㎑: 20log(24 000 / F (㎑)) at 30 m (dB㎶/m)
3. According to §15.209 (d), the measurements were tested by using Quasi peak detector except for the frequency bands 9-90 ㎑, 110-490 ㎑ and above 1 ㎓ in these three bands on measurements employing an average detector.
4. According to ANSI C63.10: 2013, For measurement below 30 ㎒.
   conversion factor from E-field to H-field is considered as free-space impedance [1 ㎶/m = (1/377 Ω) × 1 ㎂/m]
   The FCC limits are same to the IC limits.

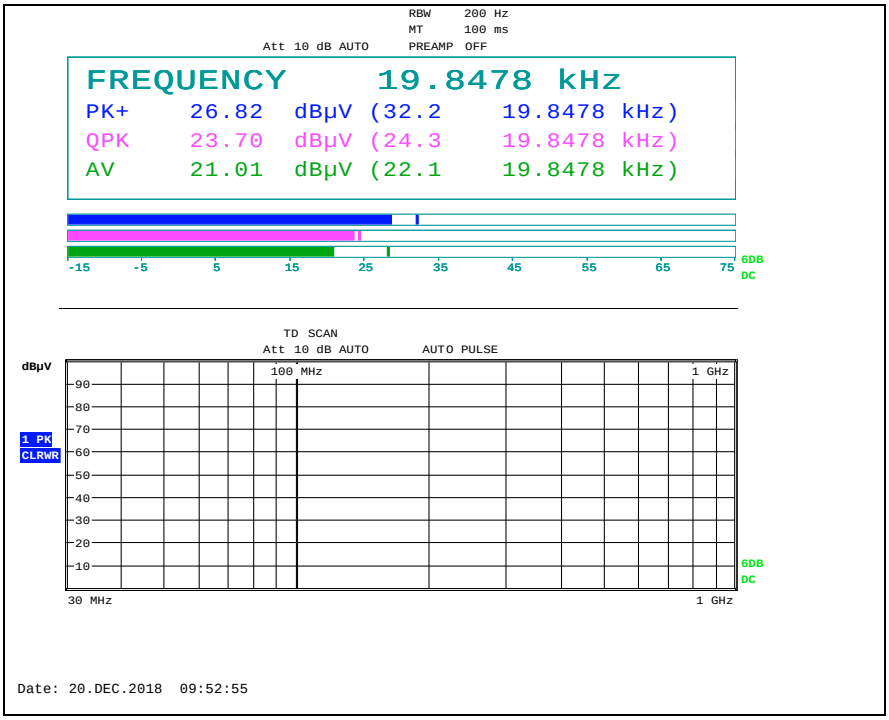
- Test plots

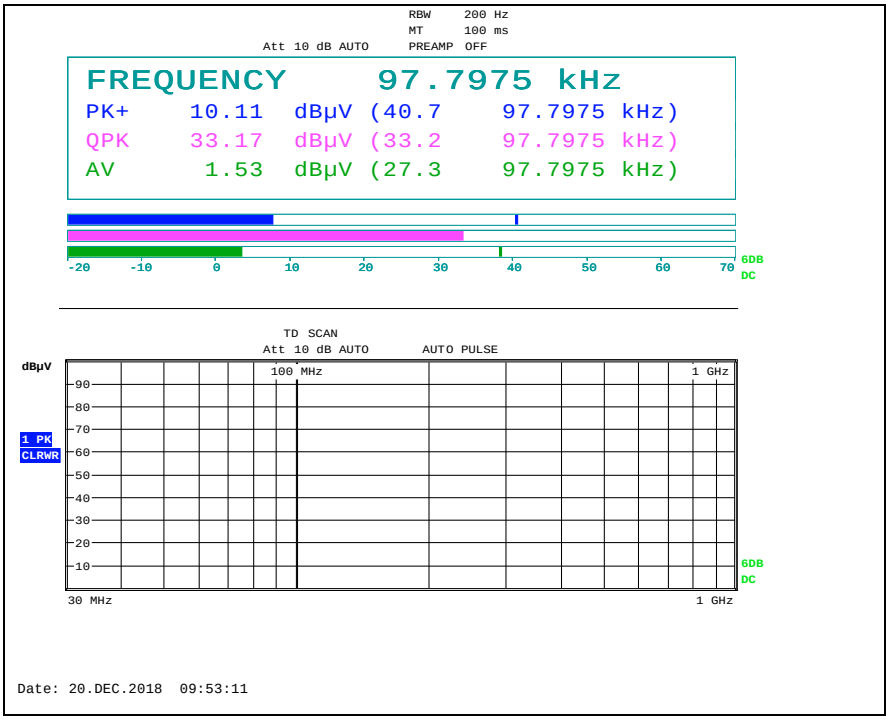
- DRV Antenna

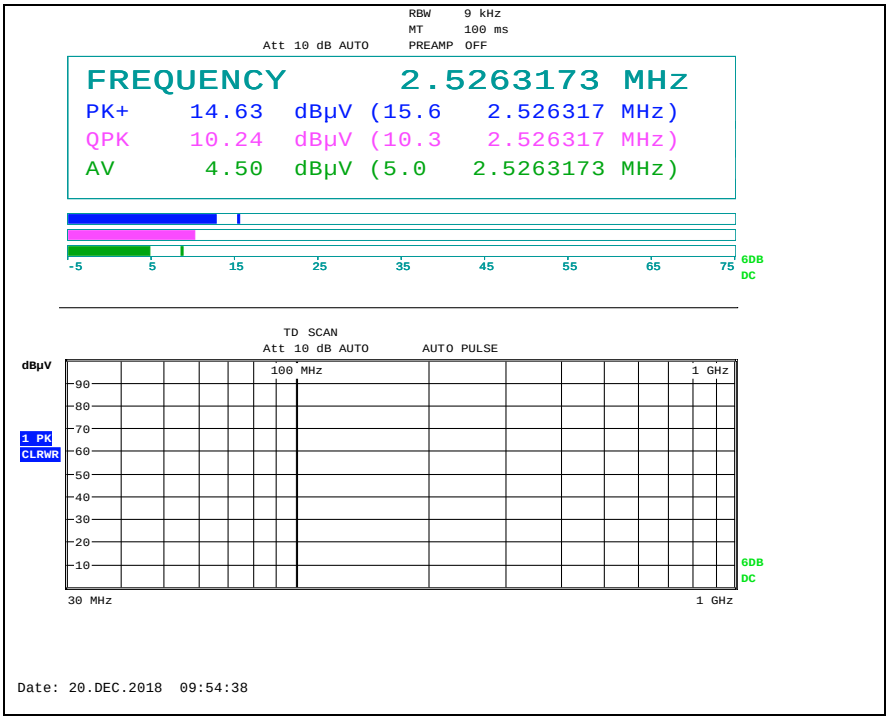
Scanning plots below 30 ㎒



Measured plots below 30 ㎒

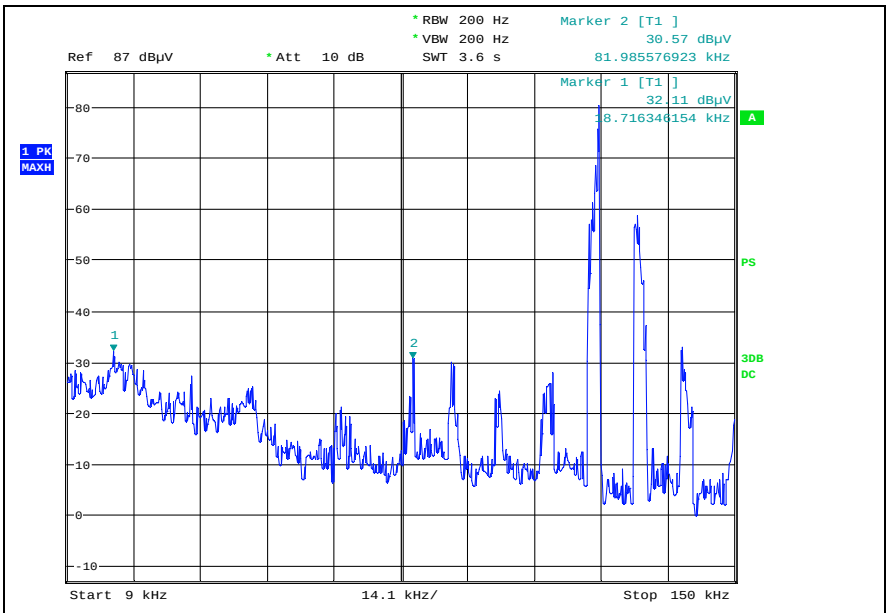


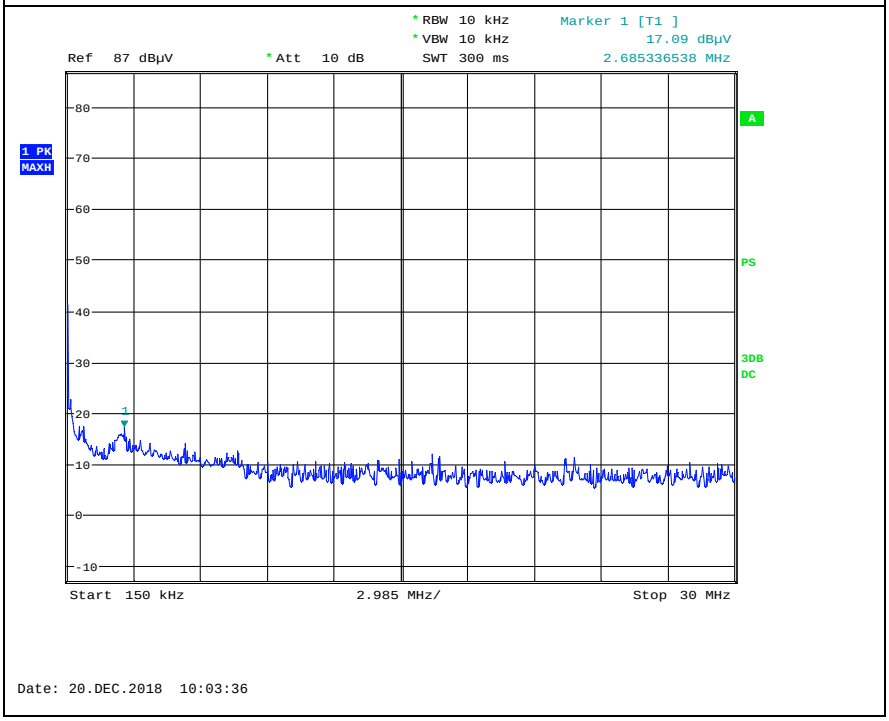




- AST Antenna

Scanning plots below 30 ㎒





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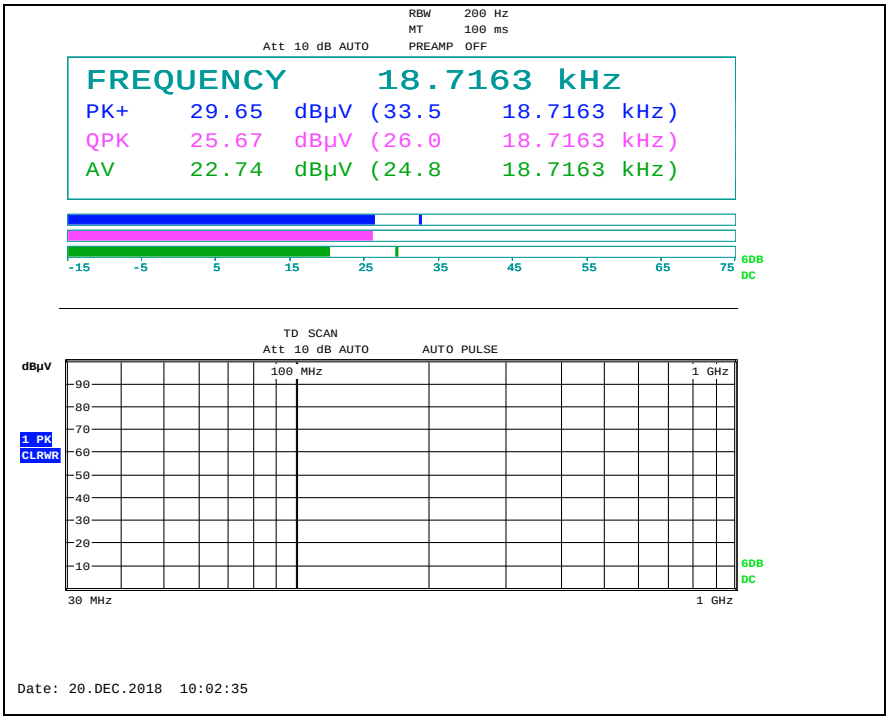
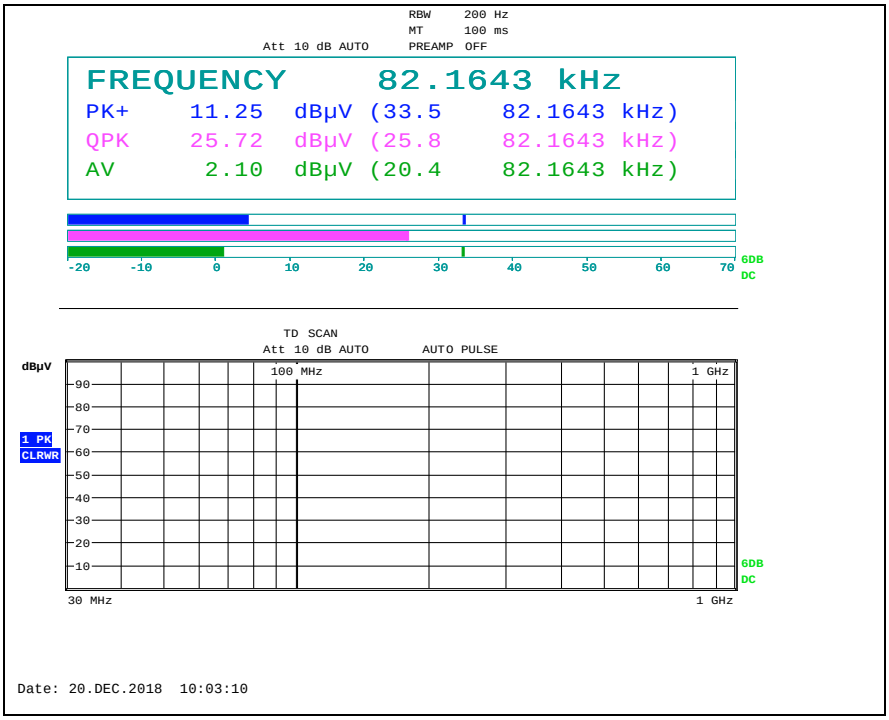
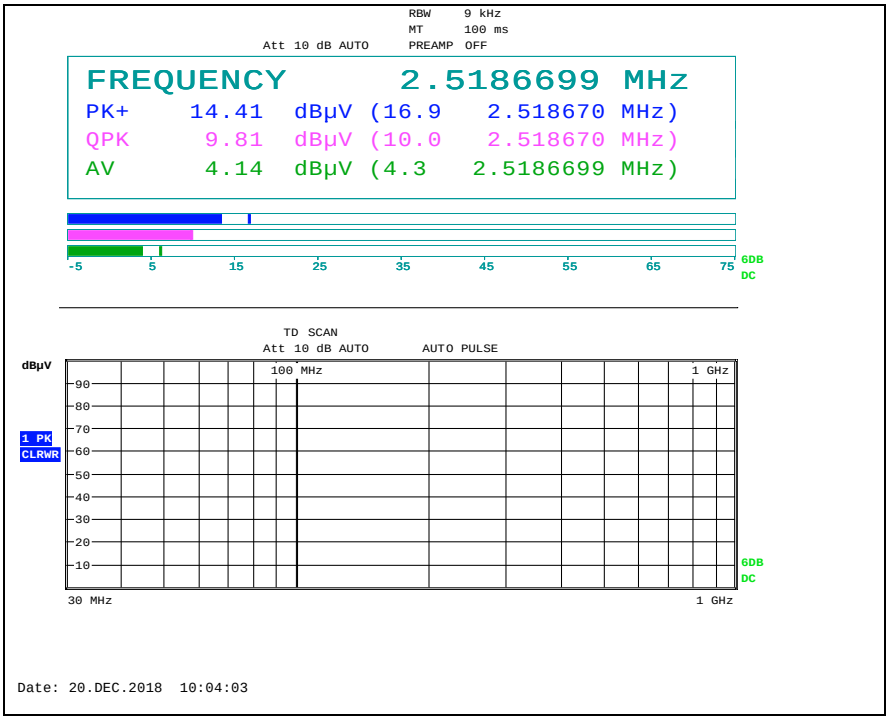
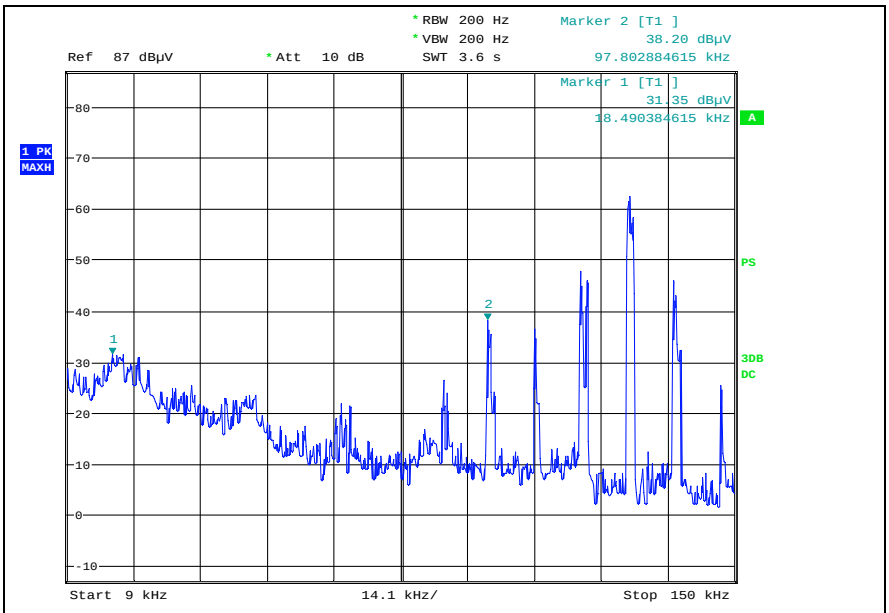


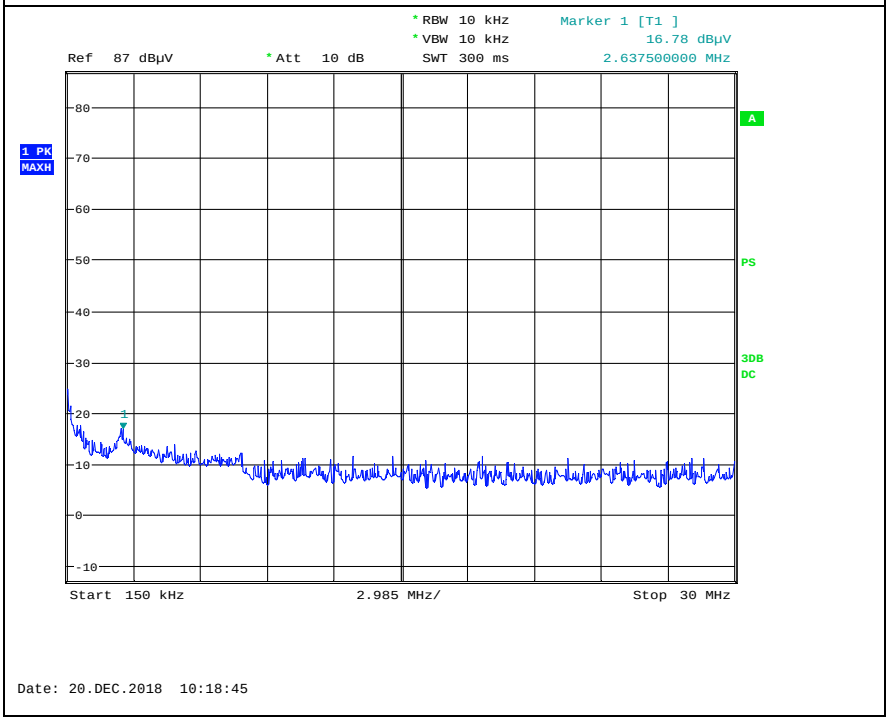




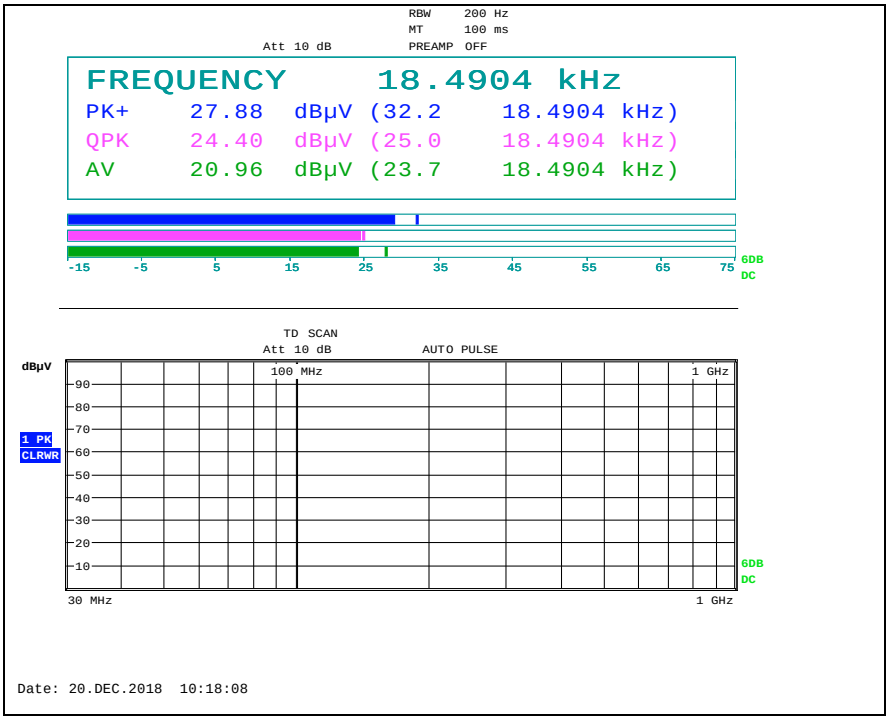
- BUM Antenna

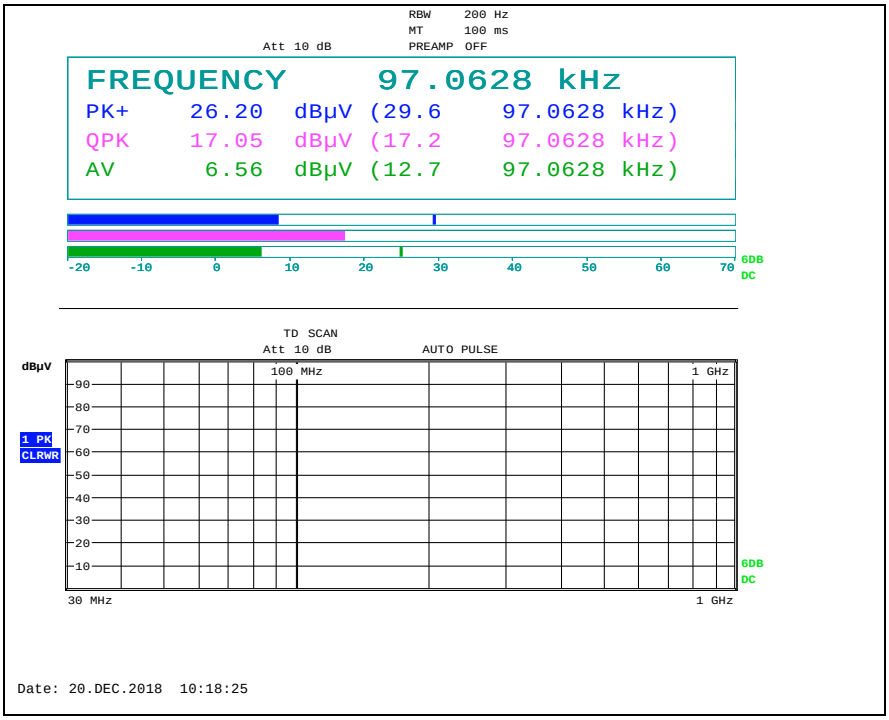
Scanning plots below 30 ㎒

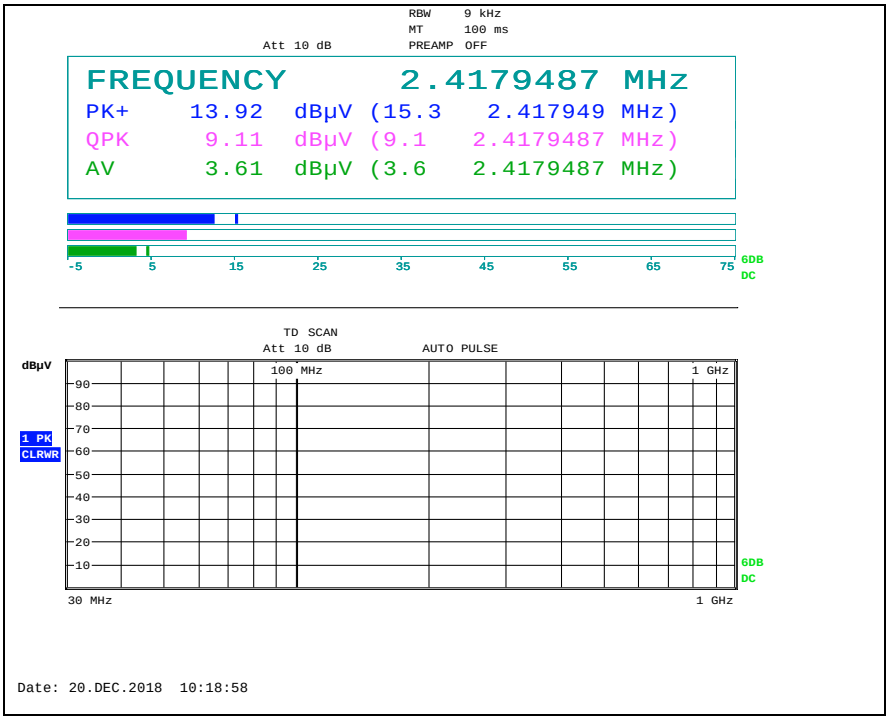




Measured plots below 30 ㎒

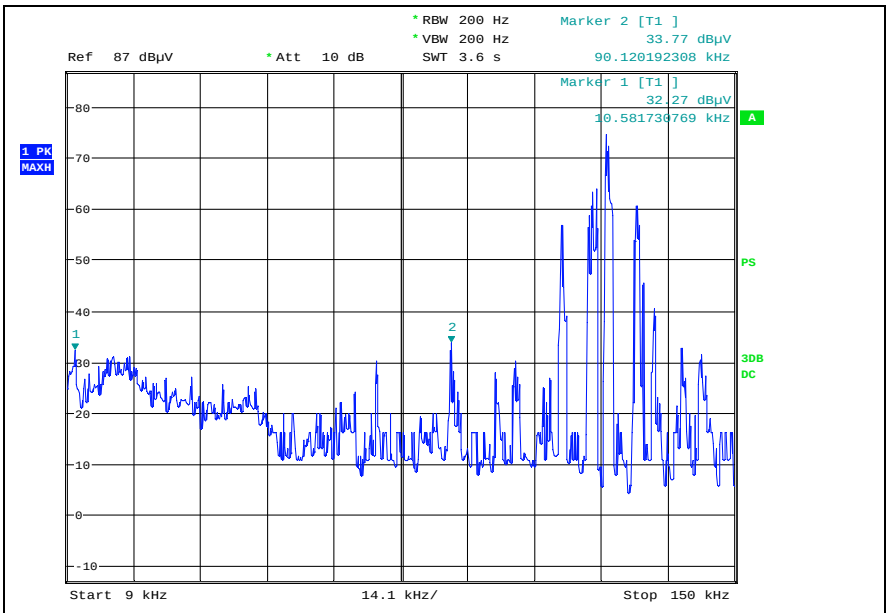


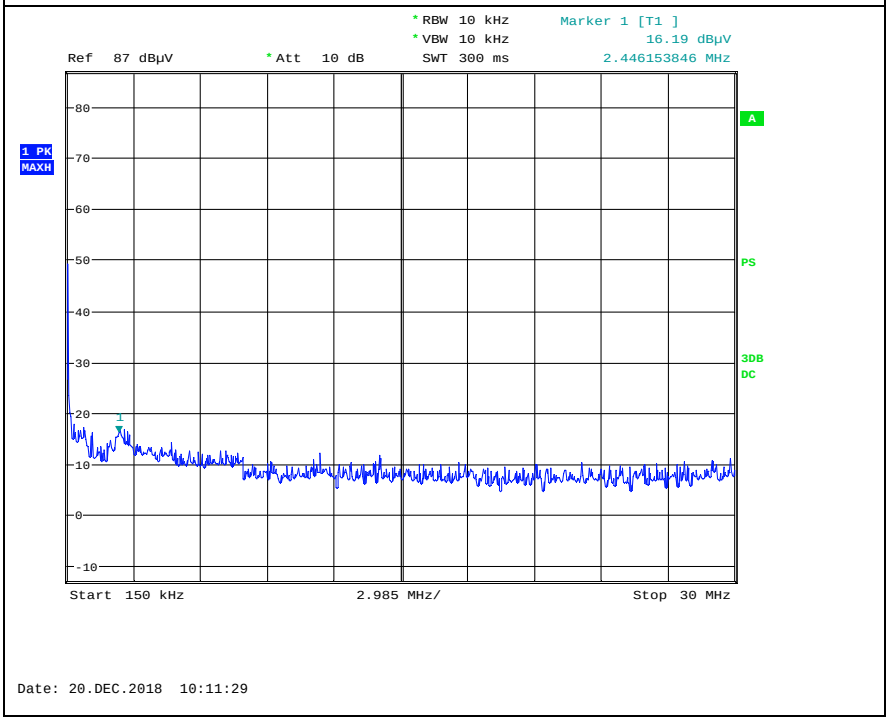




- INT1 Antenna

Scanning plots below 30 ㎒





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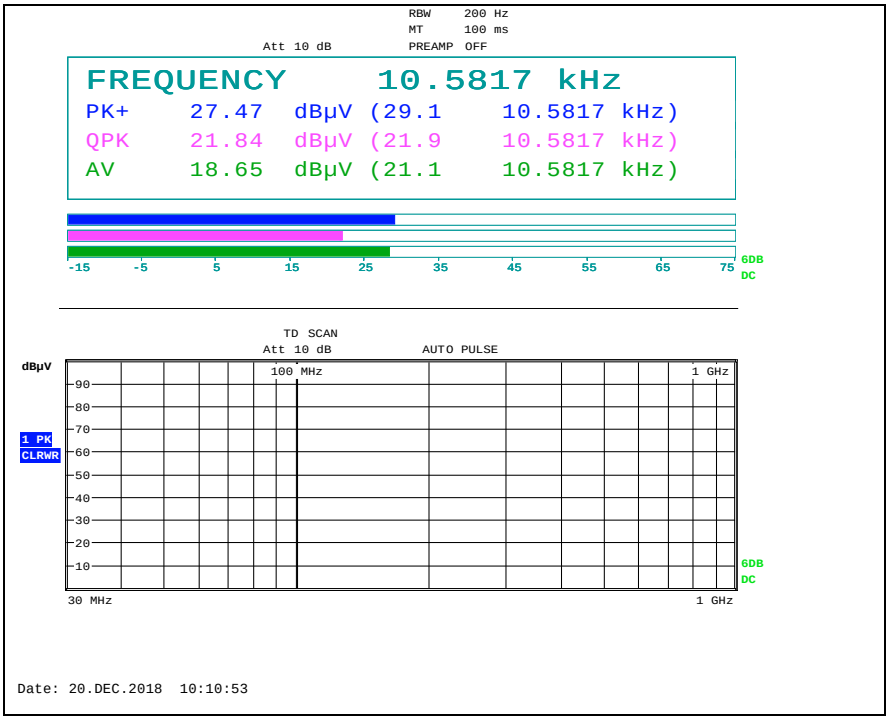
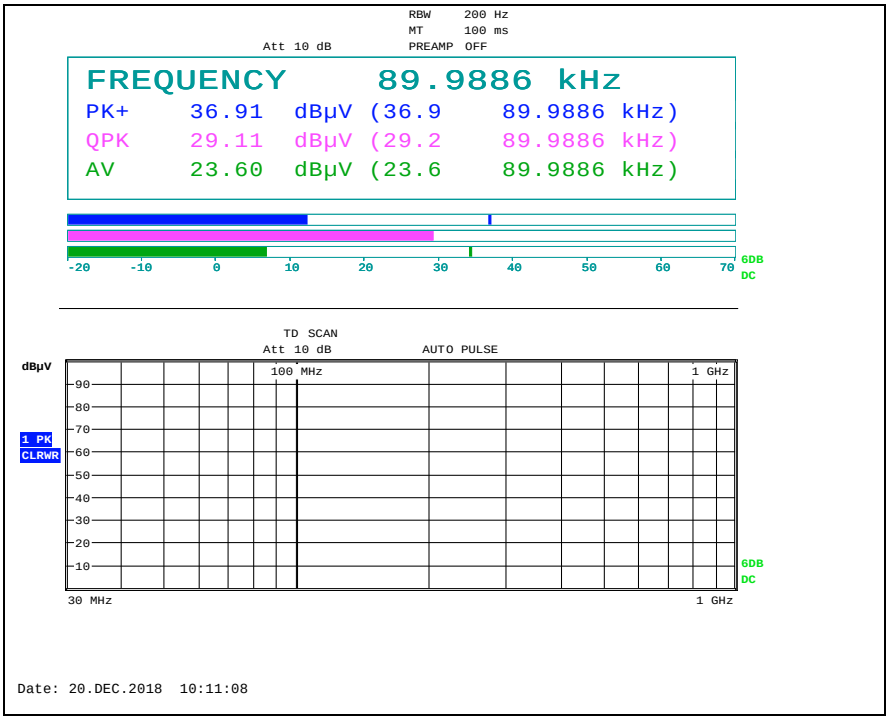
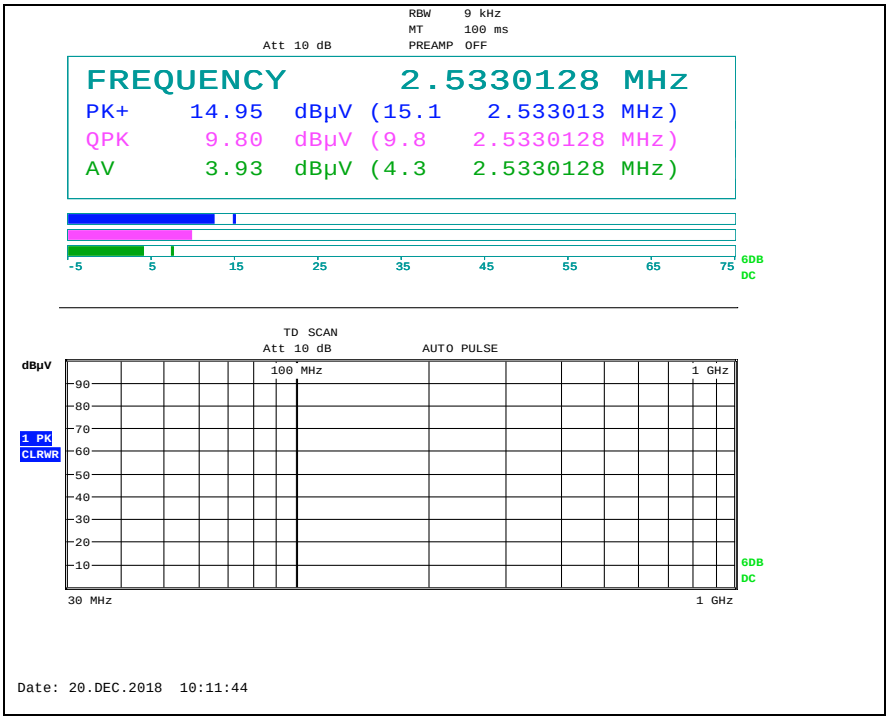
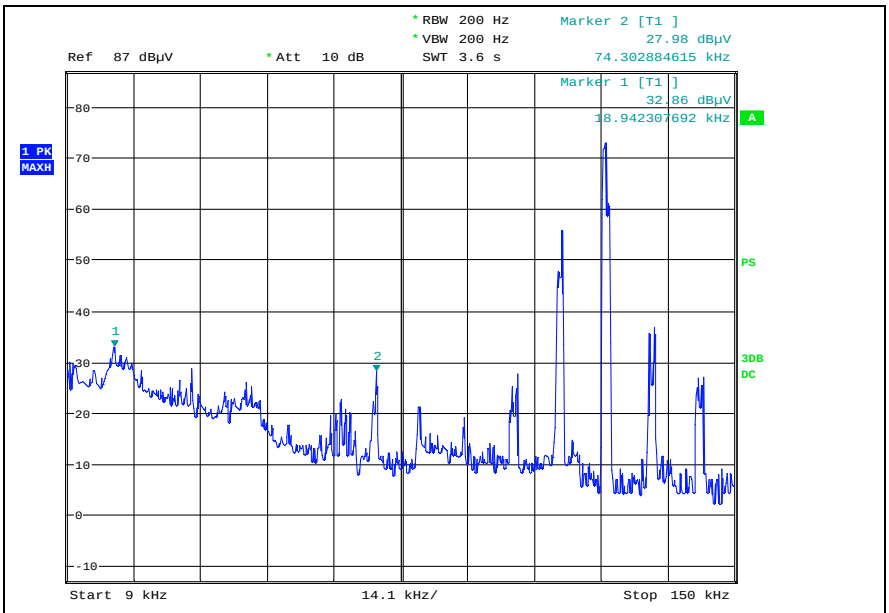


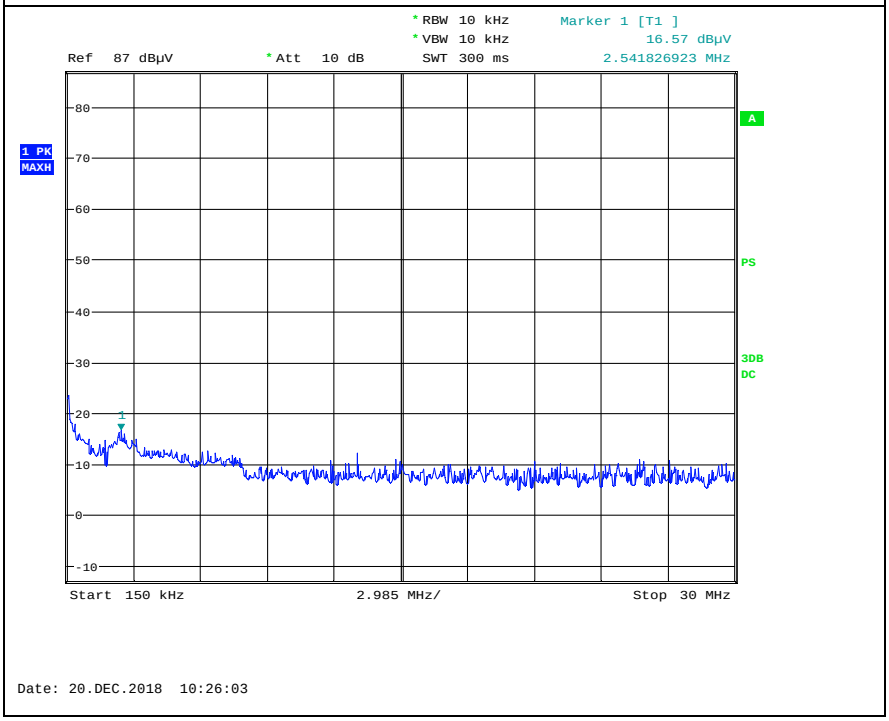




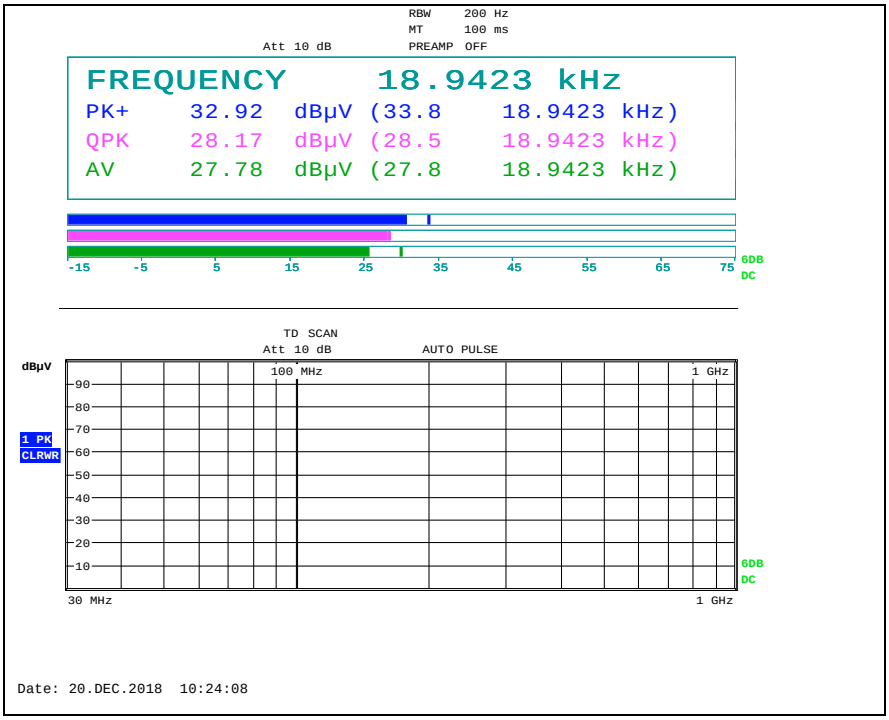
- INT2 Antenna

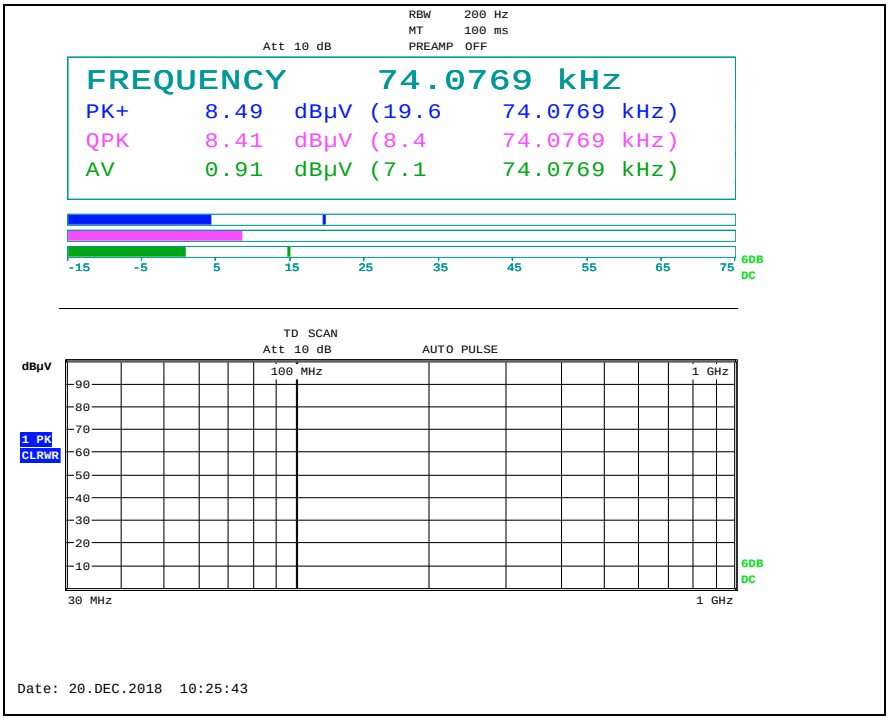
Scanning plots below 30 ㎒

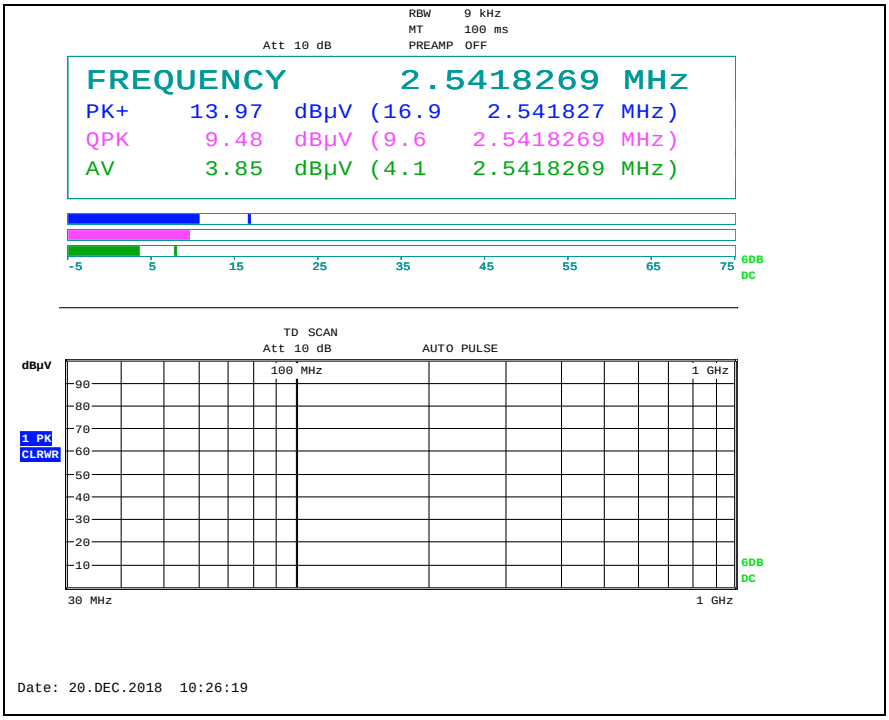




Measured plots below 30 ㎒

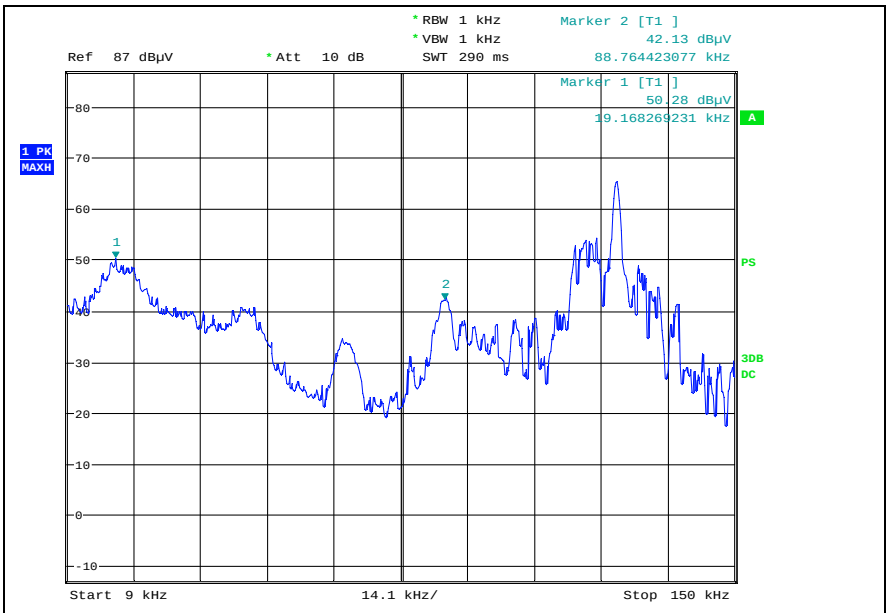


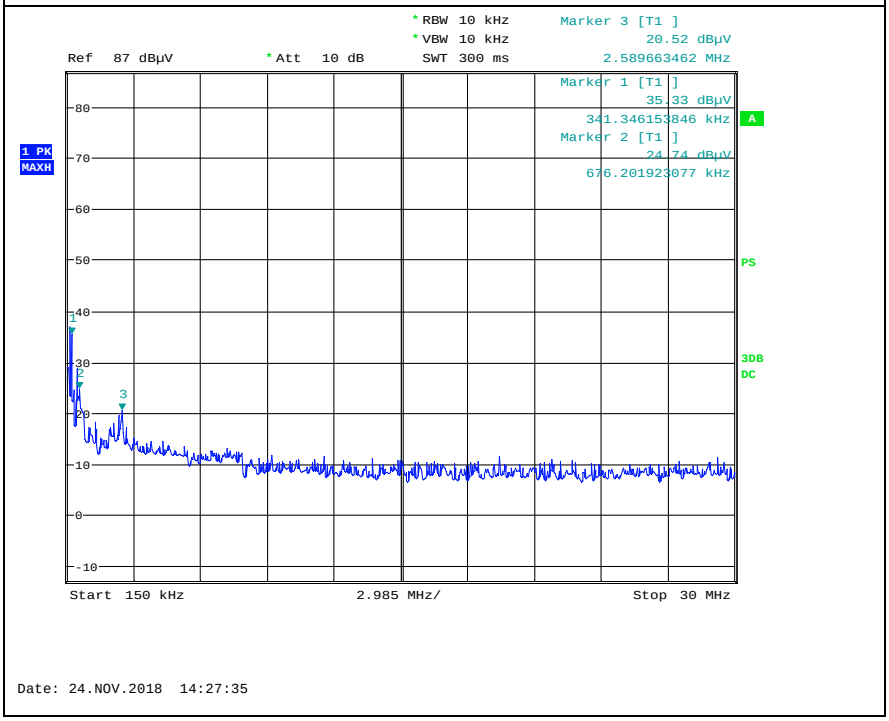




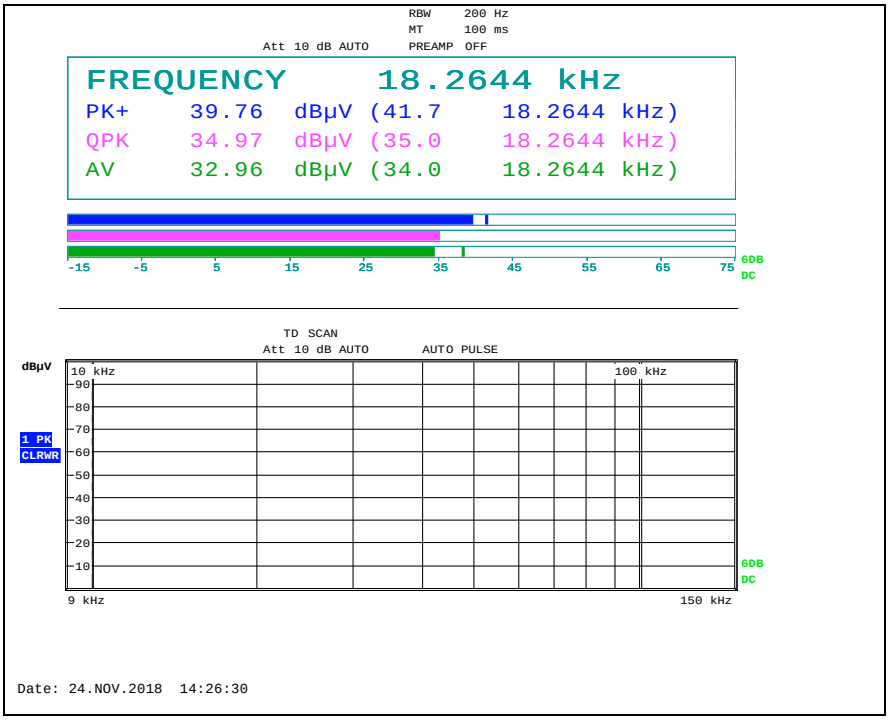
- SSB Antenna

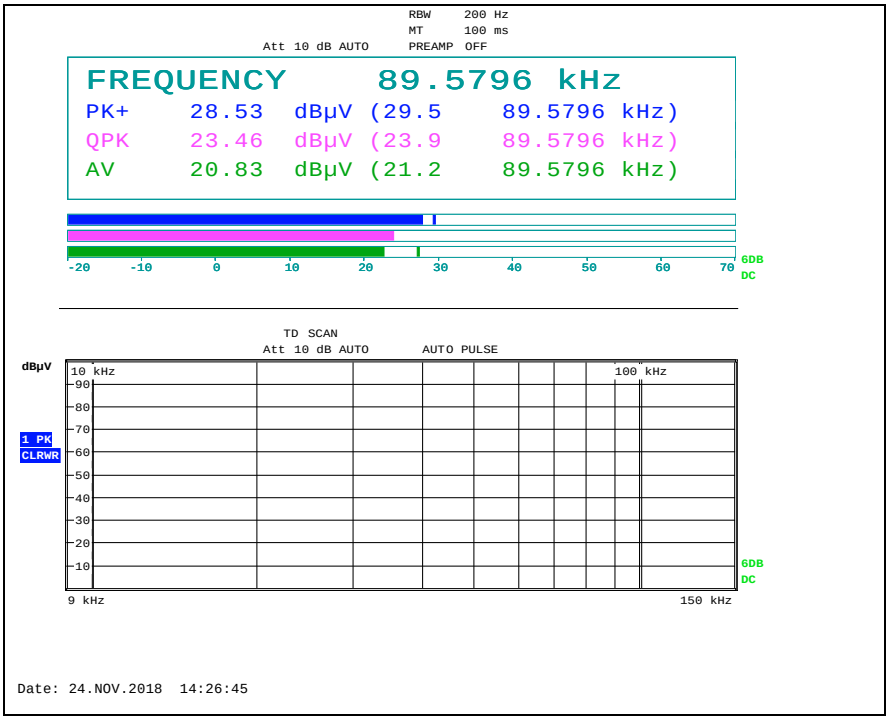
Scanning plots below 30 ㎒

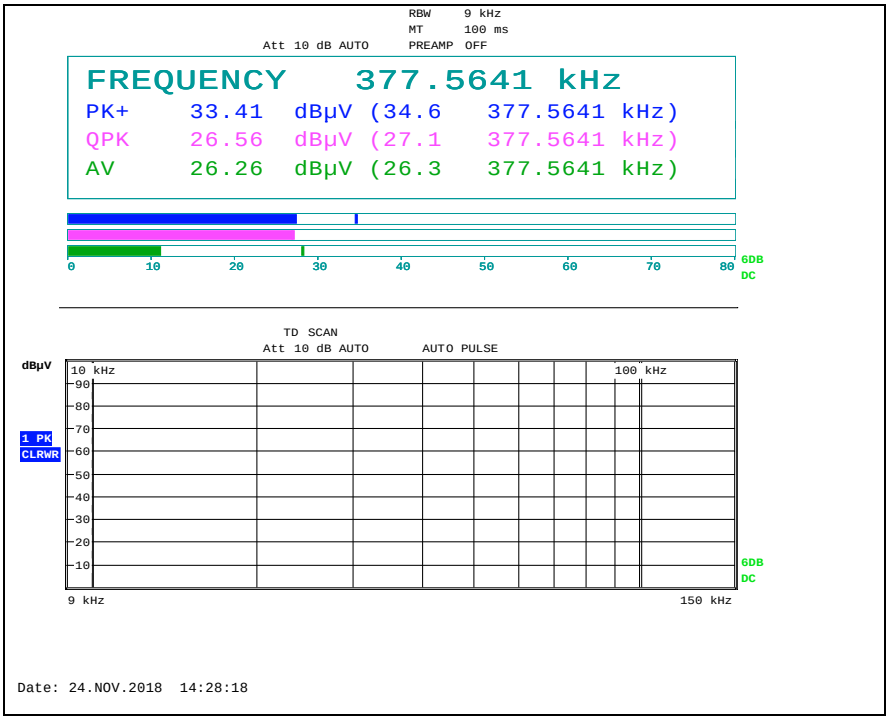


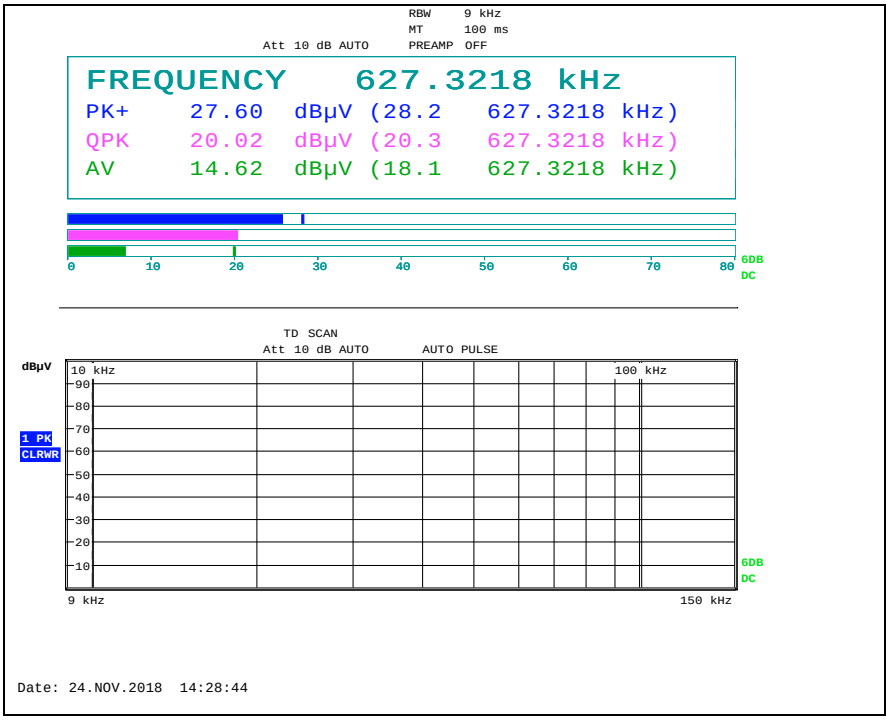


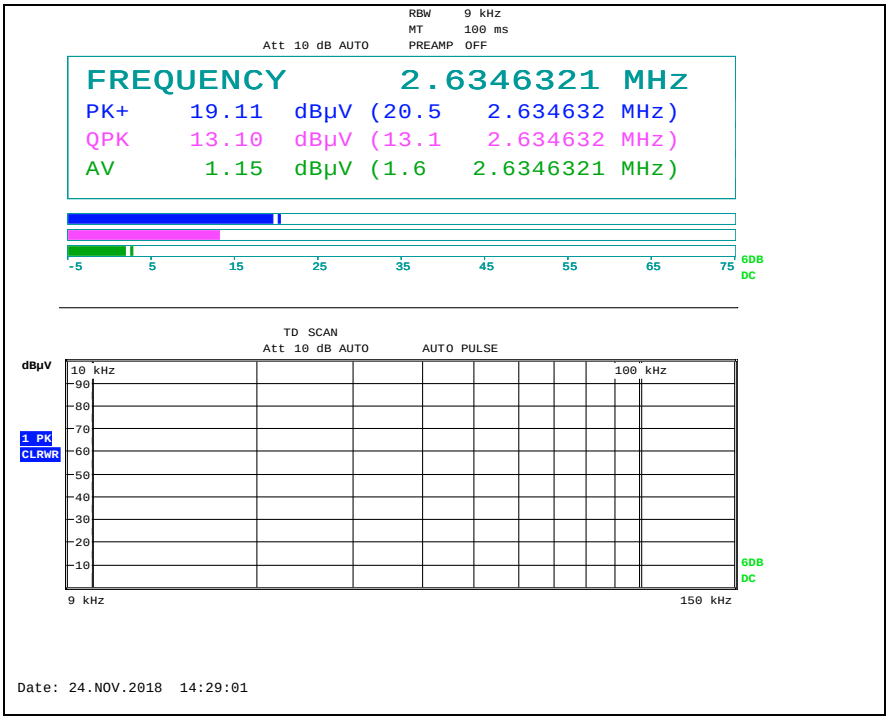
Measured plots below 30 ㎒





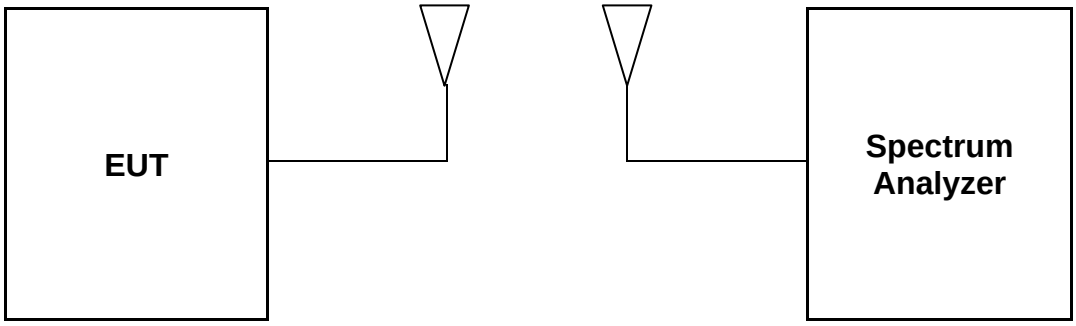






3. 20 dB Bandwidth

3.1. Test Setup



3.2. Limits

None; for reporting purposed only

3.3. Test Procedure

a. Span = set to capture all products of the modulation process, including the emission skirts, RBW = 500 Hz, VBW = set approximately 3 x RBW, Sweep = auto, Detector = peak, Trace = max hold.
b. The marker-to-peak function to set the mark to the peak of the emission. Use the marker-delta function to measure 20 dB down one side of the emission. Reset the function, and move the marker to the other side of the emission, until it is (as close as possible to) even with the reference marker level. The marker-delta reading at this point is 20 dB bandwidth of the emission.

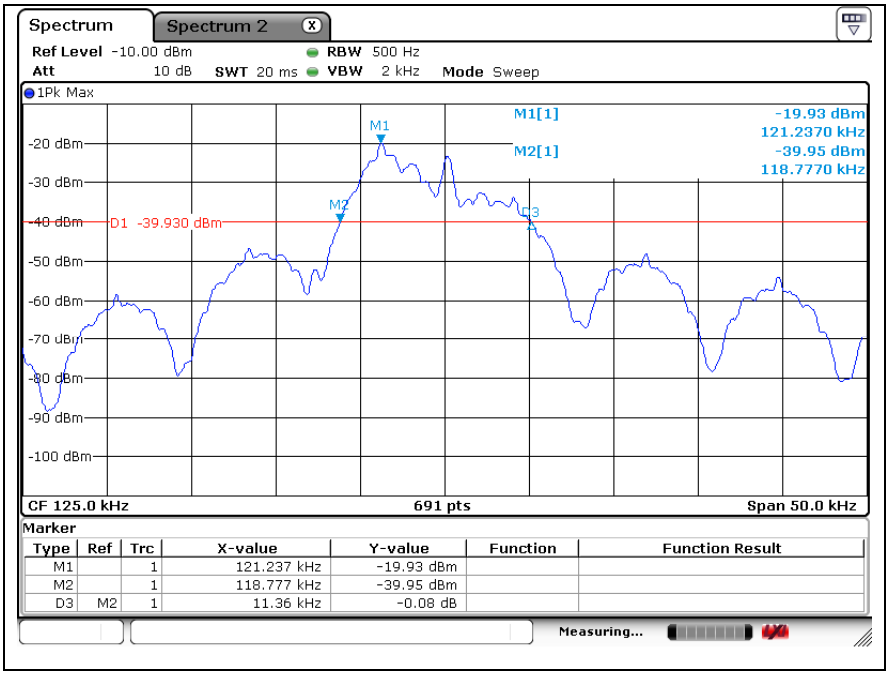
3.4. Test Result

Ambient temperature : (23 ± 1) ℃
Relative humidity : 47 % R.H.

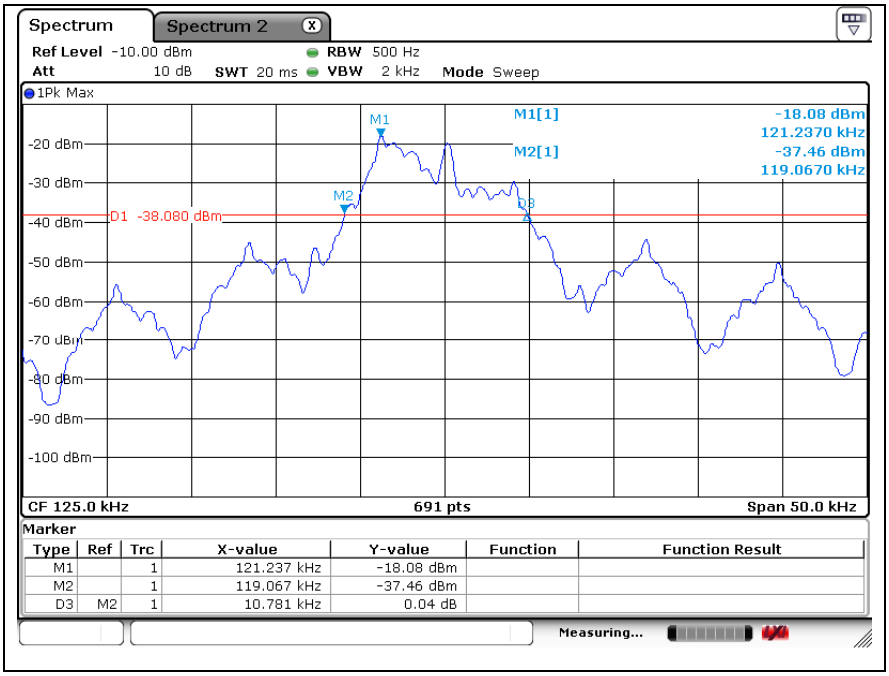
Test Antenna	20 dB Bandwidth (㎑)	Limit
DRV Antenna	11.360	Reporting proposed only
AST Antenna	10.781	
BUM Antenna	11.071	
INT1 Antenna	10.854	
INT2 Antenna	11.071	
SSB Antenna	13.893	

- Test plots

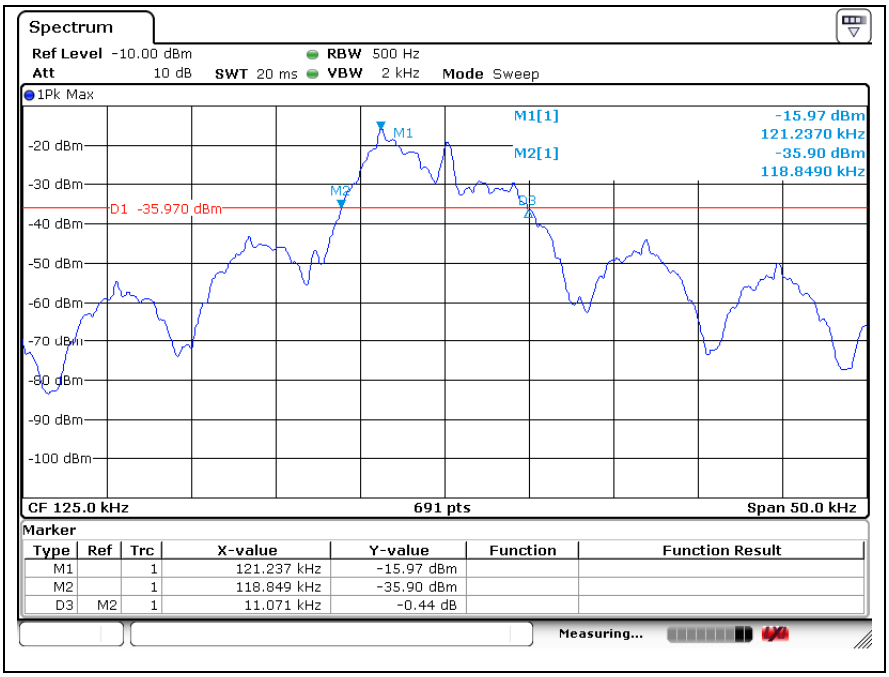
- DRV Antenna



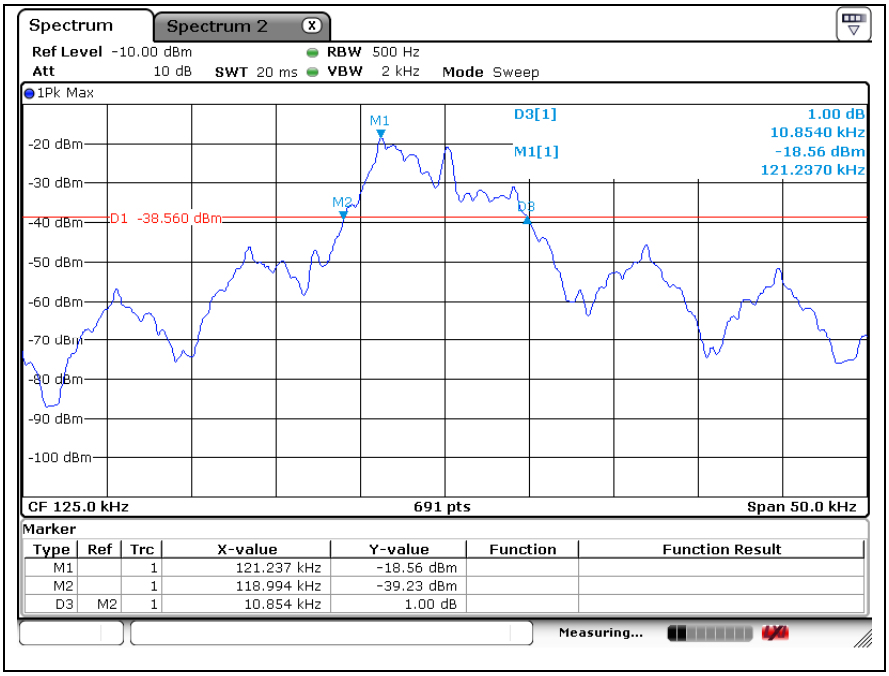
- AST Antenna



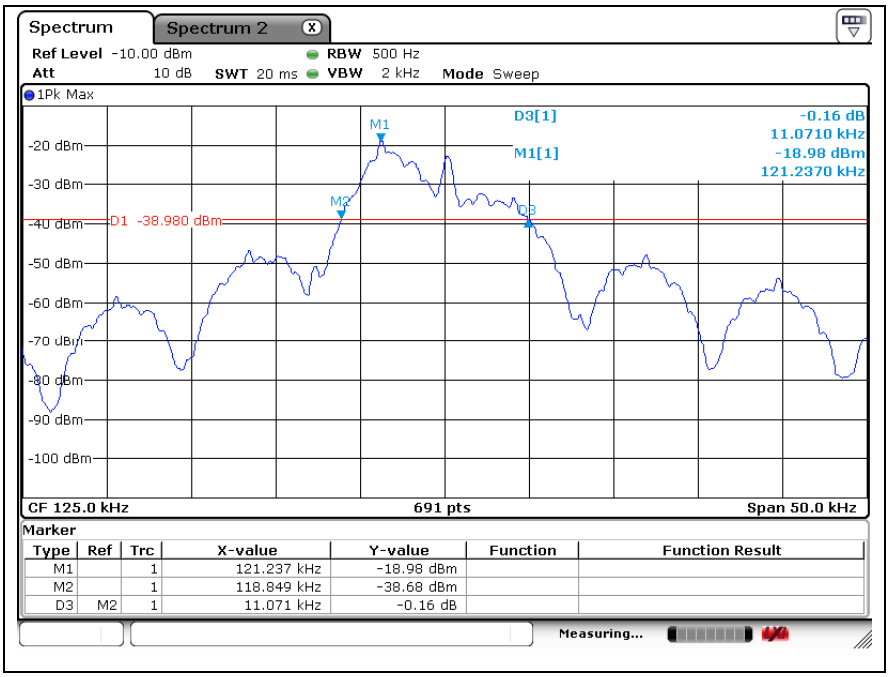
- BUM Antenna



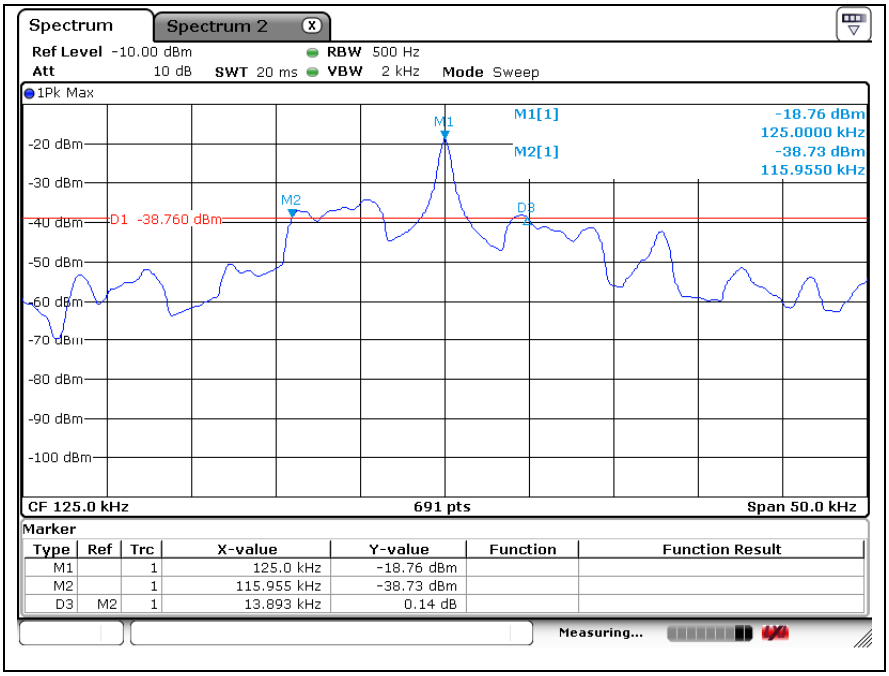
- INT1 Antenna



- INT2 Antenna

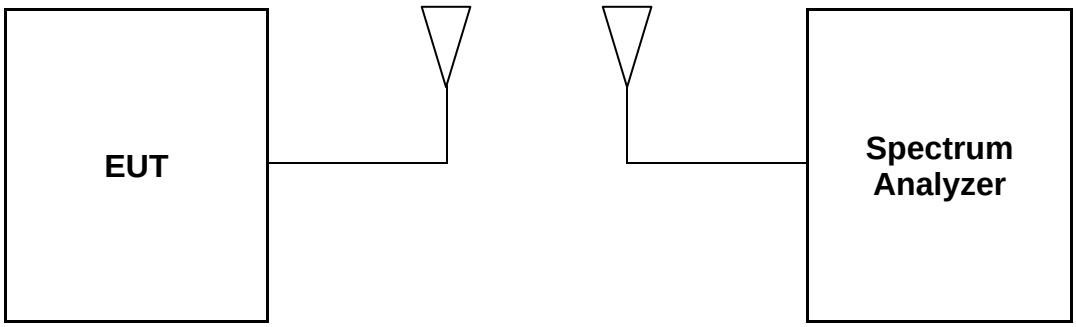


- SSB Antenna



4. Occupied Bandwidth

4.1. Test Setup



4.2. Limit

None; for reporting purposed only

4.3. Test Procedure

a. Set the spectrum analyzer as SPAN = set to capture all products of the modulation process, including the emission skirts, RBW = 500 ㎐, VBW = set approximately 3 x RBW, Detector = sampling, Trace mode = max hold.
b. Measure lowest and highest frequencies are placed in a running sum until 0.5 % and 99.5 % of the total is reached.
c. Record the SPAN between the lowest and the highest frequencies for the 99 % occupied bandwidth.

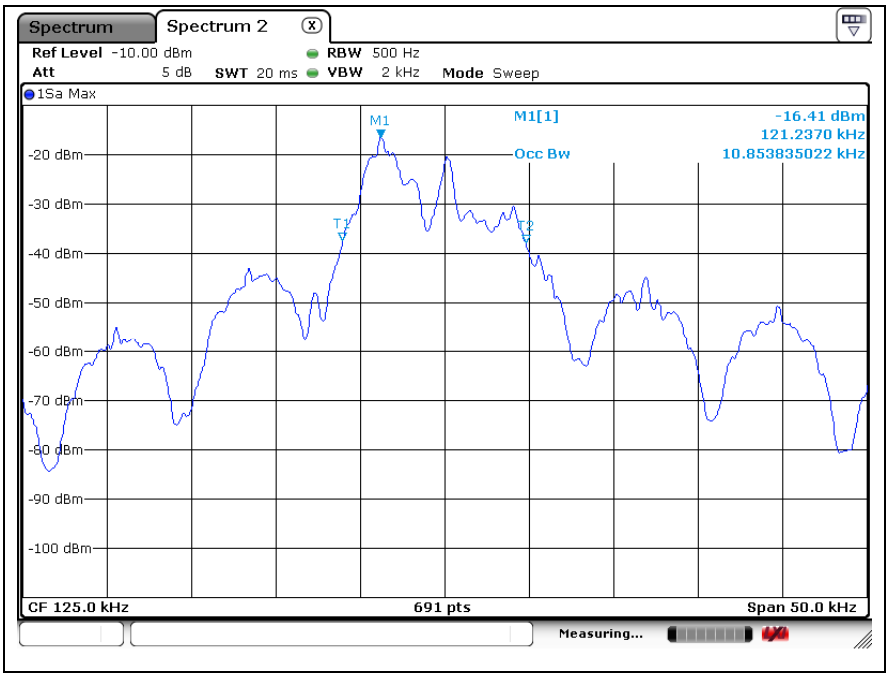
4.4. Test Result

Ambient temperature : (23 ± 1) ℃
Relative humidity : 47 % R.H.

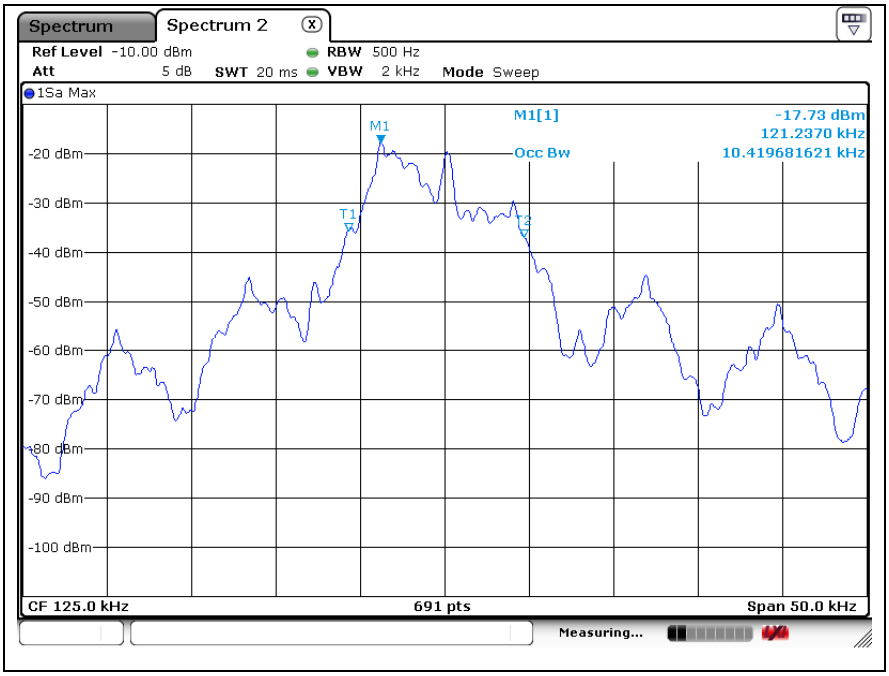
Test Antenna	Occupied Bandwidth (㎑)	Limit
DRV Antenna	10.854	Reporting proposed only
AST Antenna	10.420	
BUM Antenna	10.999	
INT1 Antenna	10.492	
INT2 Antenna	10.926	
SSB Antenna	22.142	

- Test plots

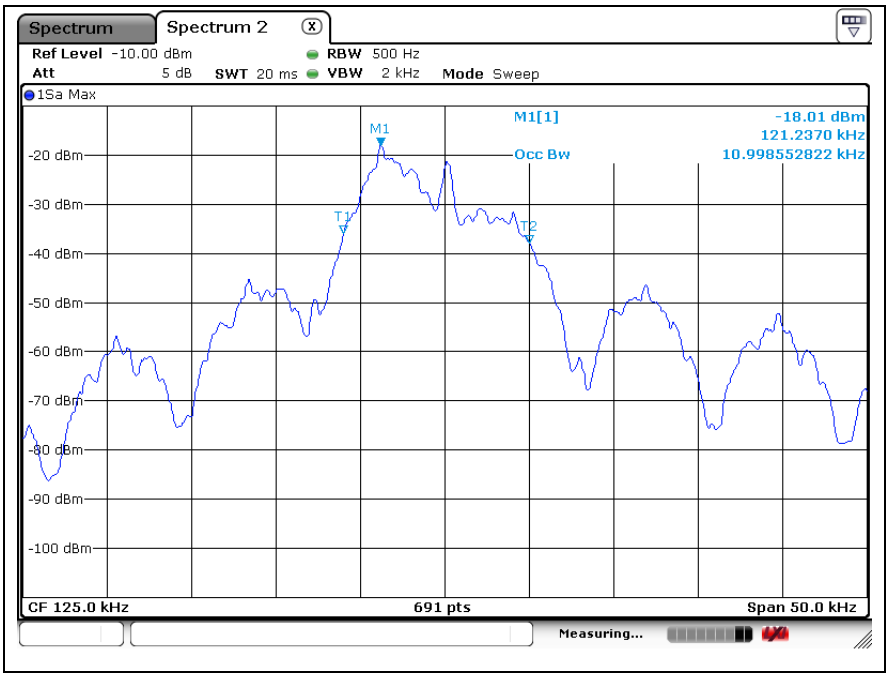
- DRV Antenna



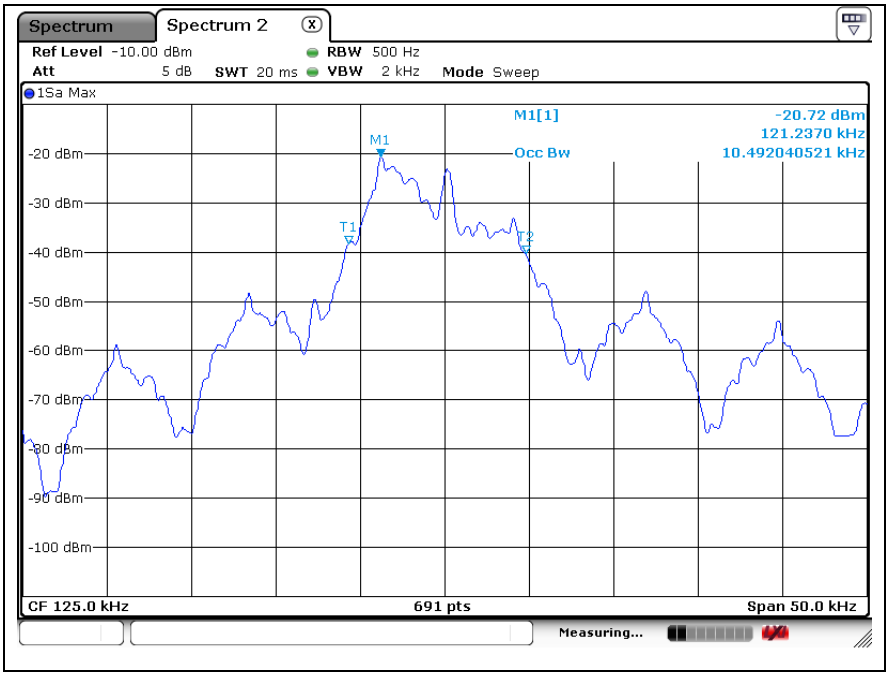
- AST Antenna



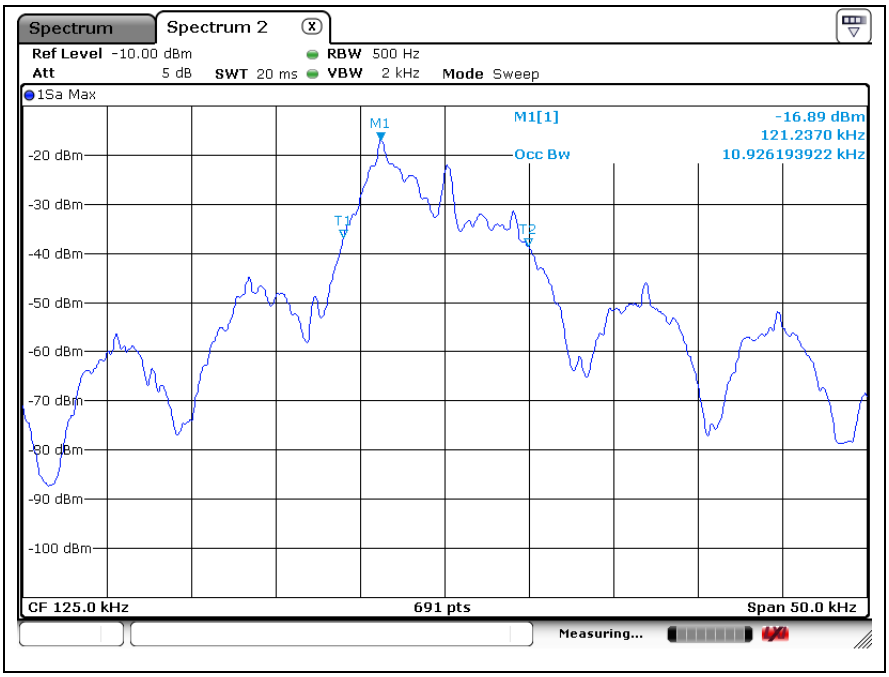
- BUM Antenna



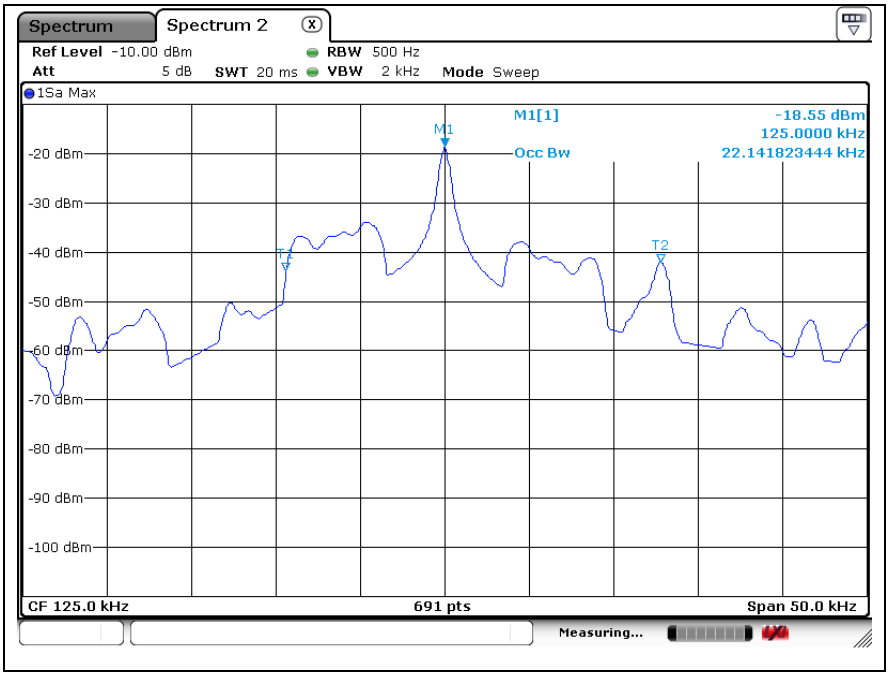
- INT1 Antenna



- INT2 Antenna



- SSB Antenna



- End of the Test Report -