TEST REPORT

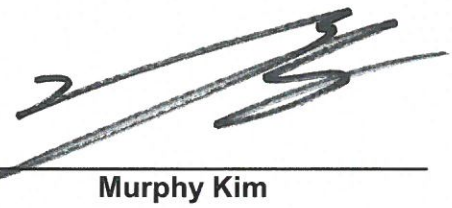
of

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

FCC ID: TQ8-IBU-4E07
IC Certification: 5074A-IBU4E07

Equipment Under Test	:	SMART KEY ECU
Model Name	:	IBU-4E07
Applicant	:	Hyundai Mobis Co., Ltd.
Manufacturer	:	Hyundai Mobis Co., Ltd.
Date of Receipt	:	2019.06.26
Date of Test(s)	:	2019.07.12 ~ 2019.08.09
Date of Issue	:	2019.08.09

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

Tested By:  **Date:** **2019.08.09**

Murphy Kim

Technical Manager:  **Date:** **2019.08.09**

Jungmin Yang

Table of Contents

1. General Information

1.1. Testing Laboratory

SGS Korea Co., Ltd. (Gunpo Laboratory)
- 10-2, LS-ro 182beon-gil, Gunpo-si, Gyeonggi-do, Korea, 15807
- 4, 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		IBU-4E07
Power Supply		DC 12.0 V
Frequency Range		Tx: 125.00 ㎑, Rx: 433.92 ㎒
Antenna Type	**Tx**	External Type (Coil Antenna)
	Rx	Internal Type

1.5. Declaration of Manufacturer

- The EUT has 7 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. 08, 2019	Annual	Mar. 08, 2020
Signal Generator	R&S	SMBV100A	259067	Jun. 10, 2019	Annual	Jun. 10, 2020
DC Power Supply	Agilent	U8002A	MY50060028	Mar. 12, 2019	Annual	Mar. 12, 2020
Test Receiver	R&S	ESU26	100109	Jan. 31, 2019	Annual	Jan. 31, 2020
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. 20, 2019	Semi-annual	Jan. 20, 2020
Coaxial Cable	SUCOFLEX	104 (10 m)	MY3145814	Jul. 20, 2019	Semi-annual	Jan. 20, 2020

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			
Section in FCC	**Section in IC**	**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

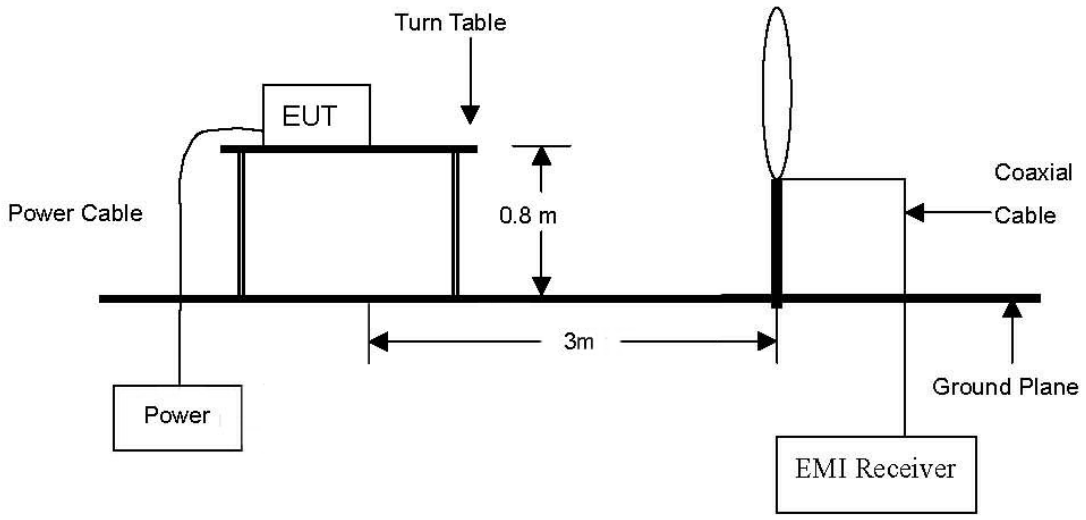
1.9. Test Report Revision

Revision	Report Number	Date of Issue	Description
0	F690501/RF-RTL014211	2019.08.09	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 1 000 ㎒. 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 ㎒

1. 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.
2. 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.
3. 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.
4. The test-receiver system was set to average or quasi peak detect function and Specified Bandwidth with Maximum Hold Mode.
5. 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.

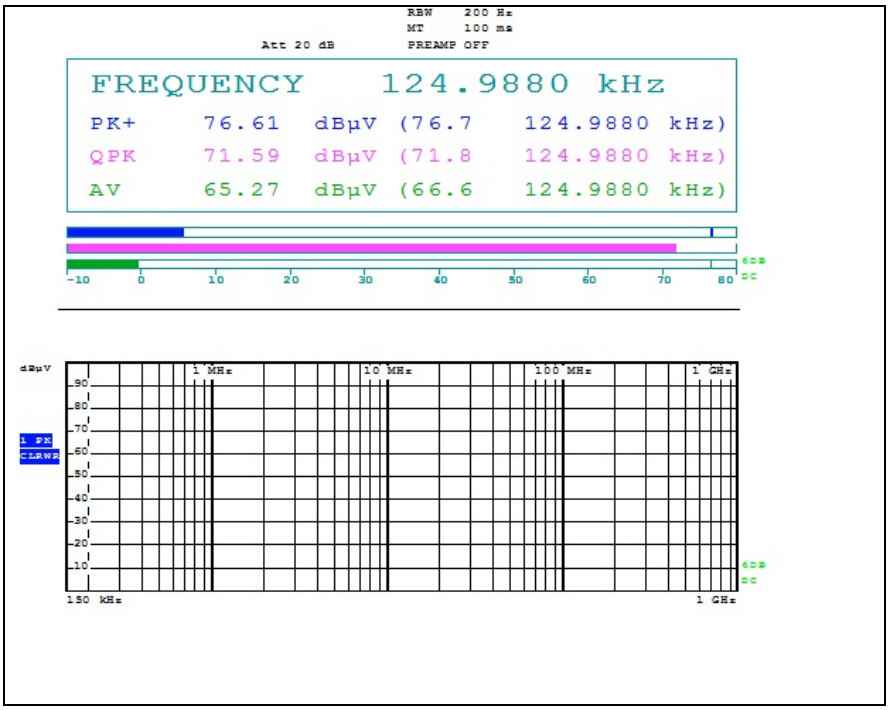
Radiated Emissions			Ant.	Correction Factors		Total		Limit	
Frequency (㎒)	Reading (dB㎶)	Detect Mode	Pol.	Ant. (dB/m)	Cable (dB)	Actual (dB㎶/m) at 3 m	Actual (dB㎶/m) at 300 m	Limit (dB㎶/m) at 300 m	Margin (dB)
DRV Antenna									
0.125	66.60	Average	H	19.69	0.07	86.36	6.36	25.67	19.31
AST Antenna									
0.125	65.80	Average	H	19.69	0.07	85.56	5.56	25.67	20.11
INT1 Antenna									
0.125	65.80	Average	H	19.69	0.07	85.56	5.56	25.67	20.11
INT2 Antenna									
0.125	64.10	Average	H	19.69	0.07	83.86	3.86	25.67	21.81
TRK Antenna									
0.125	66.30	Average	H	19.69	0.07	86.06	6.06	25.67	19.61
BUM Antenna									
0.125	65.00	Average	H	19.69	0.07	84.76	4.76	25.67	20.91
SSB Antenna									
0.125	68.90	Average	H	19.69	0.07	88.66	8.66	25.67	17.01

Remark;

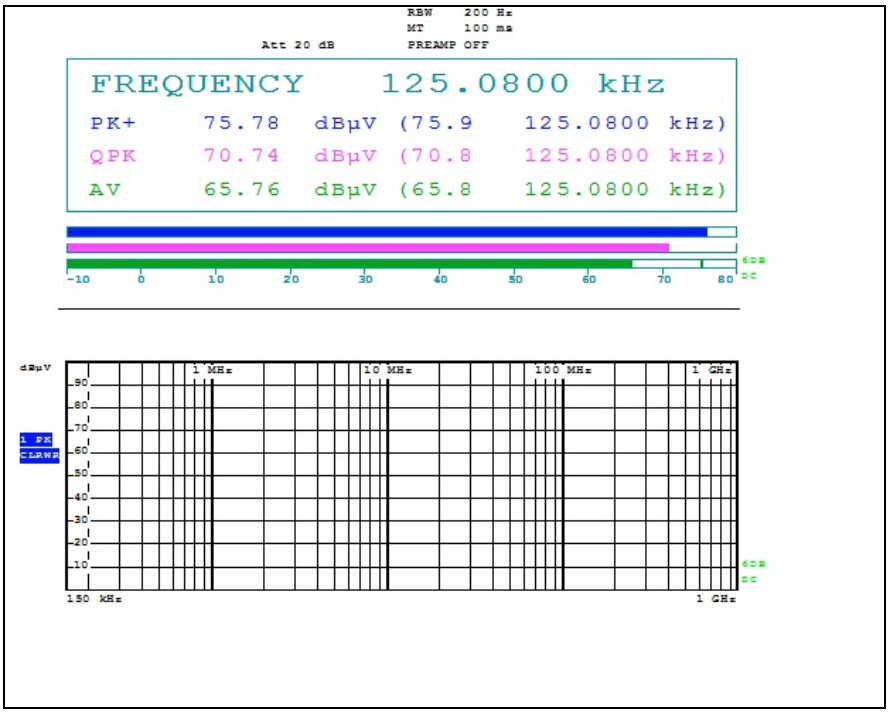
1. According to §15.31(f)(2) 300 m Result (dB㎶/m) = 3 m Result (dB㎶/m) - 40log (300/3) (dB㎶/m).
2. According to §15.209(d), the measurements were tested by using Quasi peak detector except for the frequency bands 9-90 ㎑, 110-490 ㎑ and above 1 ㎓ in these three bands on measurements employing an average 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

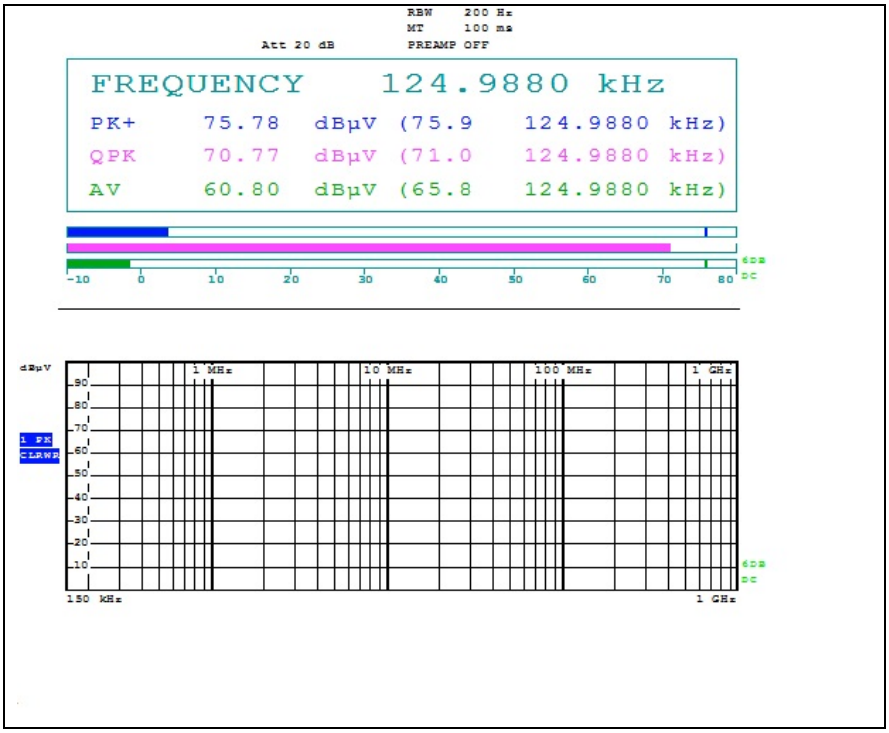
- DRV Antenna



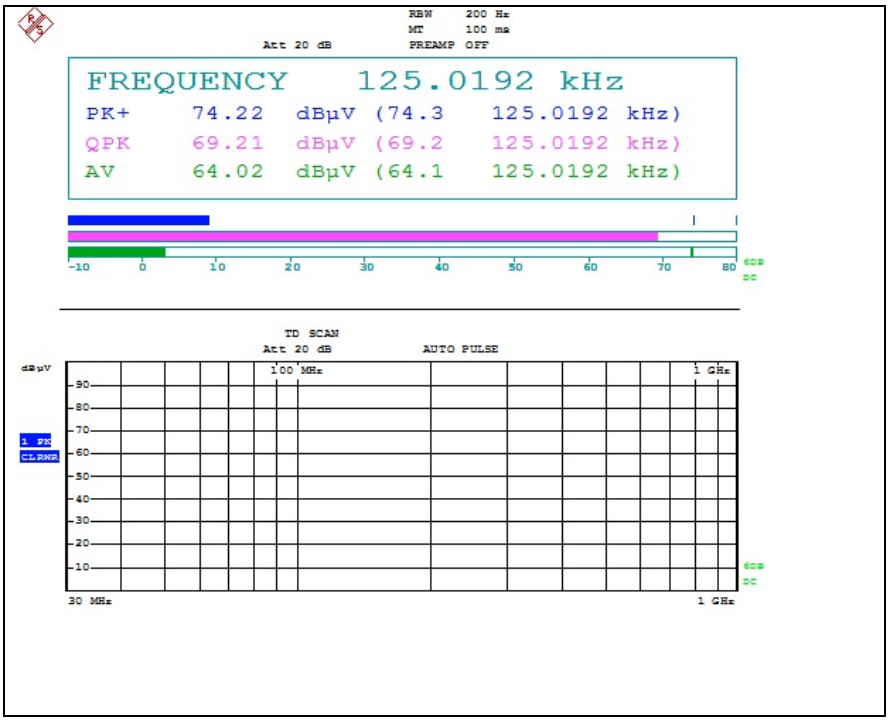
- AST Antenna



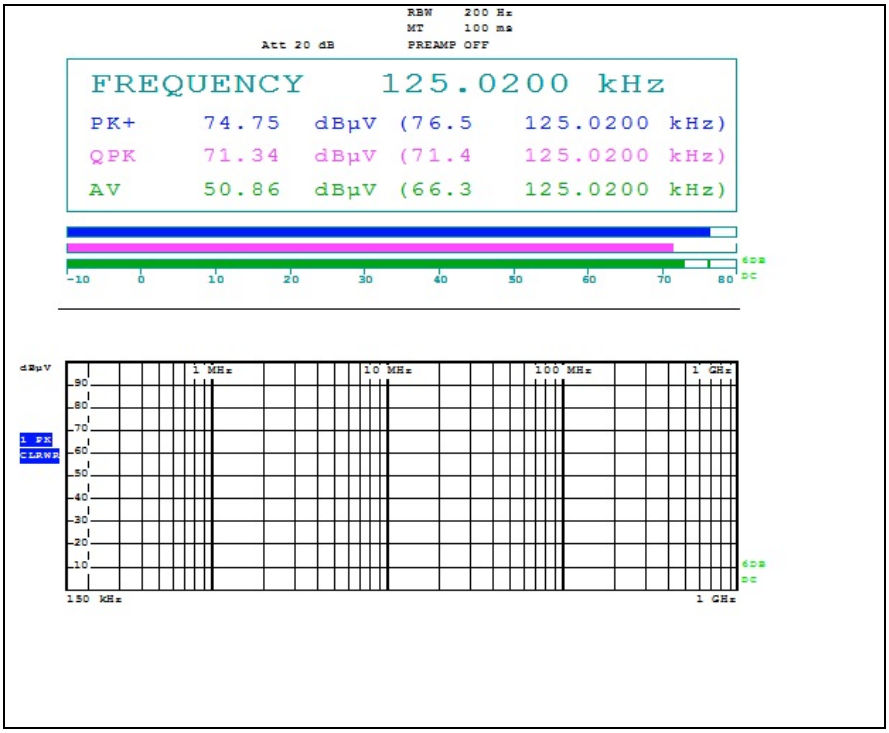
- INT1 Antenna



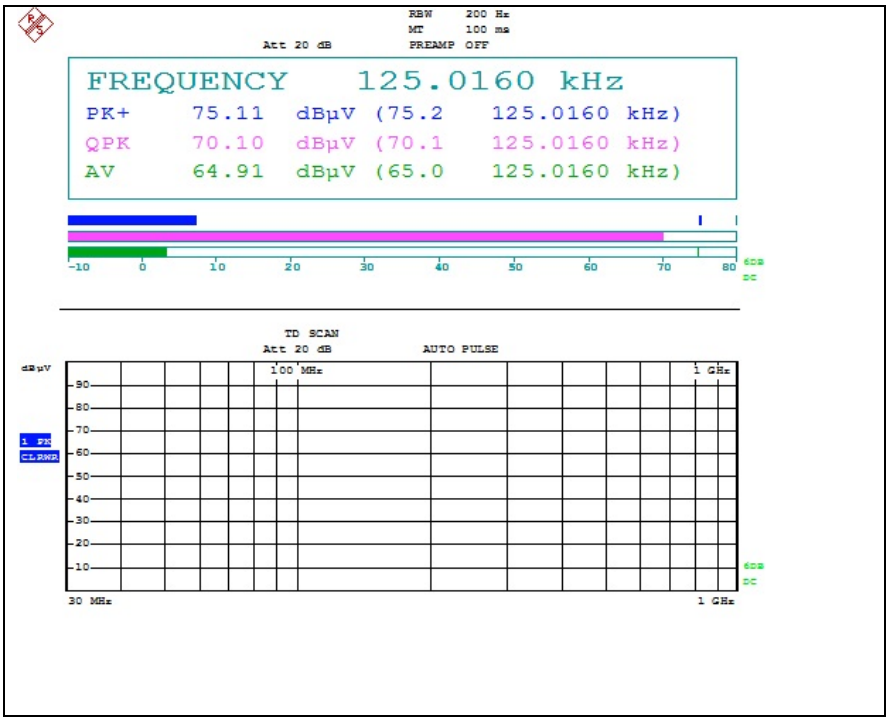
- INT2 Antenna



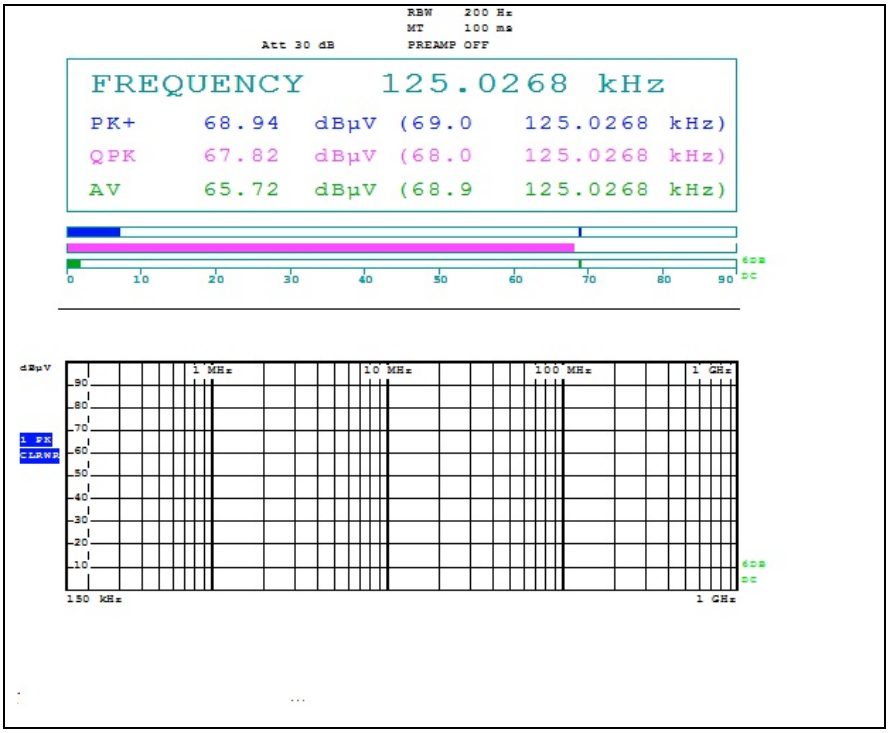
- TRK Antenna



- BUM Antenna



- SSB Antenna


RBW 200 Hz
MT 100 ms
Att 30 dB
PREAMP OFF
FREQUENCY 125.0268 kHz
PK+ 68.94 dBµV (69.0 125.0268 kHz)
QPK 67.82 dBµV (68.0 125.0268 kHz)
AV 65.72 dBµV (68.9 125.0268 kHz)
dBµV
1 MHz
10 MHz
100 MHz
1 GHz
150 kHz
1 GHz

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									
0.022	30.30	Average	H	19.92	0.01	50.23	-29.77	40.76	70.53
0.036	34.00	Average	H	19.79	0.02	53.81	-26.19	36.48	62.67
0.117	40.70	Average	H	19.69	0.06	60.45	-19.55	26.24	45.79
0.129	51.80	Average	H	19.69	0.07	71.56	-8.44	25.39	33.83
0.207	16.20	Average	H	19.65	0.15	36.00	-44.00	21.28	65.28
1.642	7.00	Quasi-Peak	H	19.73	0.57	27.30	-12.70	23.30	36.00
Above 2.000	Not detected	-	-	-	-	-	-	-	-
AST Antenna									
0.022	28.30	Average	H	19.92	0.01	48.23	-31.77	40.76	72.53
0.069	23.90	Average	H	19.74	0.03	43.67	-36.33	30.83	67.16
0.117	43.90	Average	H	19.69	0.06	63.65	-16.35	26.24	42.59
0.133	40.10	Average	H	19.68	0.08	59.86	-20.14	25.13	45.27
0.479	7.80	Average	H	19.60	0.30	27.70	-52.30	14.00	66.30
0.641	11.50	Quasi-Peak	H	19.63	0.39	31.52	-8.48	31.47	39.95
Above 1.000	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)
INT1 Antenna									
0.022	27.50	Average	H	19.92	0.01	47.43	-32.57	40.76	73.33
0.035	34.20	Average	H	19.79	0.02	54.01	-25.99	36.72	62.71
0.110	16.10	Average	H	19.70	0.05	35.85	-44.15	26.78	70.93
0.118	30.40	Average	H	19.69	0.06	50.15	-29.85	26.17	56.02
0.463	7.20	Average	H	19.60	0.29	27.09	-52.91	14.29	67.20
0.564	11.90	Quasi-Peak	H	19.61	0.35	31.86	-8.14	32.58	40.72
Above 1.000	Not detected	-	-	-	-	-	-	-	-
INT2 Antenna									
0.023	27.30	Average	H	19.91	0.01	47.22	-32.78	40.37	73.15
0.035	34.00	Average	H	19.79	0.02	53.81	-26.19	36.72	62.91
0.109	34.30	Quasi-Peak	H	19.70	0.05	54.05	-25.95	26.86	52.81
0.135	19.60	Average	H	19.68	0.08	39.36	-40.64	25.00	65.64
0.195	14.90	Average	H	19.65	0.14	34.69	-45.31	21.80	67.11
0.378	9.00	Average	H	19.60	0.25	28.85	-51.15	16.05	67.20
Above 1.000	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)
TRK Antenna									
0.035	33.80	Average	H	19.79	0.02	53.61	-26.39	36.72	63.11
0.069	22.00	Average	H	19.74	0.03	41.77	-38.23	30.83	69.06
0.117	42.90	Average	H	19.69	0.06	62.65	-17.35	26.24	43.59
0.137	23.60	Average	H	19.68	0.08	43.36	-36.64	24.87	61.51
0.229	14.00	Average	H	19.64	0.17	33.81	-46.19	20.41	66.60
0.580	11.30	Quasi-Peak	H	19.62	0.35	31.27	-8.73	32.34	41.07
Above 1.000	Not detected	-	-	-	-	-	-	-	-
BUM Antenna									
0.036	33.10	Average	H	19.79	0.02	52.91	-27.09	36.48	63.57
0.071	20.70	Average	H	19.74	0.03	40.47	-39.53	30.58	70.11
0.111	18.00	Average	H	19.69	0.05	37.74	-42.26	26.70	68.96
0.130	34.00	Average	H	19.69	0.07	53.76	-26.24	25.33	51.57
0.386	8.50	Average	H	19.60	0.25	28.35	-51.65	15.87	67.52
1.058	8.84	Quasi-Peak	H	19.70	0.58	29.12	-10.88	27.11	37.99
Above 2.000	Not detected	-	-	-	-	-	-	-	-

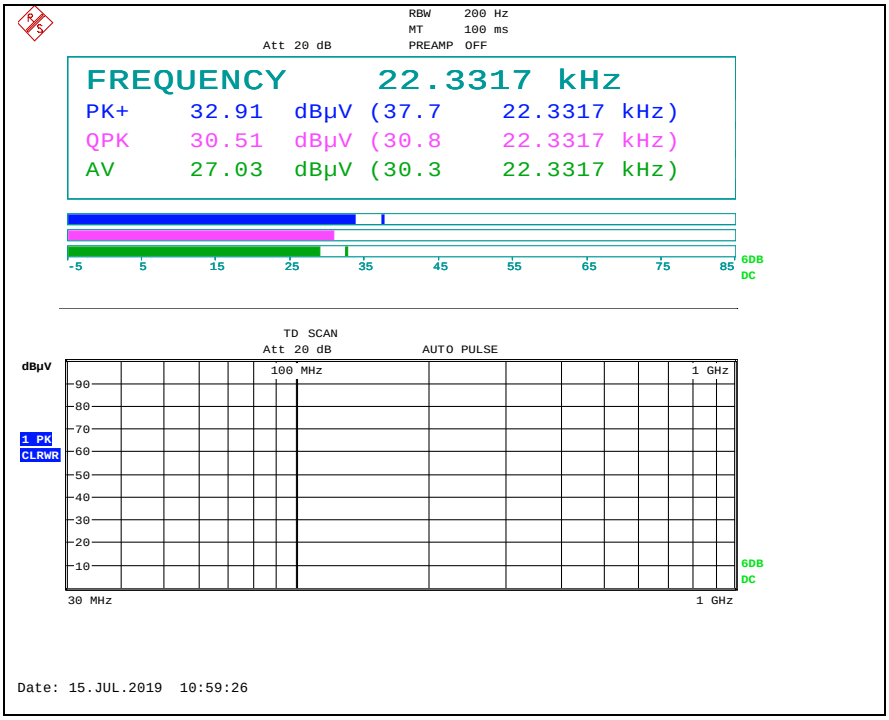
Radiated Emissions			Ant.	Correction Factors		Total		Limit	
Frequency (㎒)	Reading (dB㎶)	Detect Mode	Pol.	Ant. (dB/m)	Cable (dB)	Actual (dB㎶/m) at 3 m	Actual (dB㎶/m) at 30 m or 300 m	Limit (dB㎶/m) at 30 m or 300 m	Margin (dB)
SSB Antenna									
0.019	31.30	Average	H	19.97	0.01	51.28	-28.72	42.03	70.75
0.067	23.20	Average	H	19.75	0.03	42.98	-37.02	31.08	68.10
0.099	14.60	Quasi-Peak	H	19.70	0.04	34.34	-45.66	27.69	73.35
0.151	18.50	Average	H	19.67	0.10	38.27	-41.73	24.02	65.75
2.680	6.40	Quasi-Peak	H	19.78	0.55	26.73	-13.27	29.54	42.81
Above 3.000	Not detected	-	-	-	-	-	-	-	-

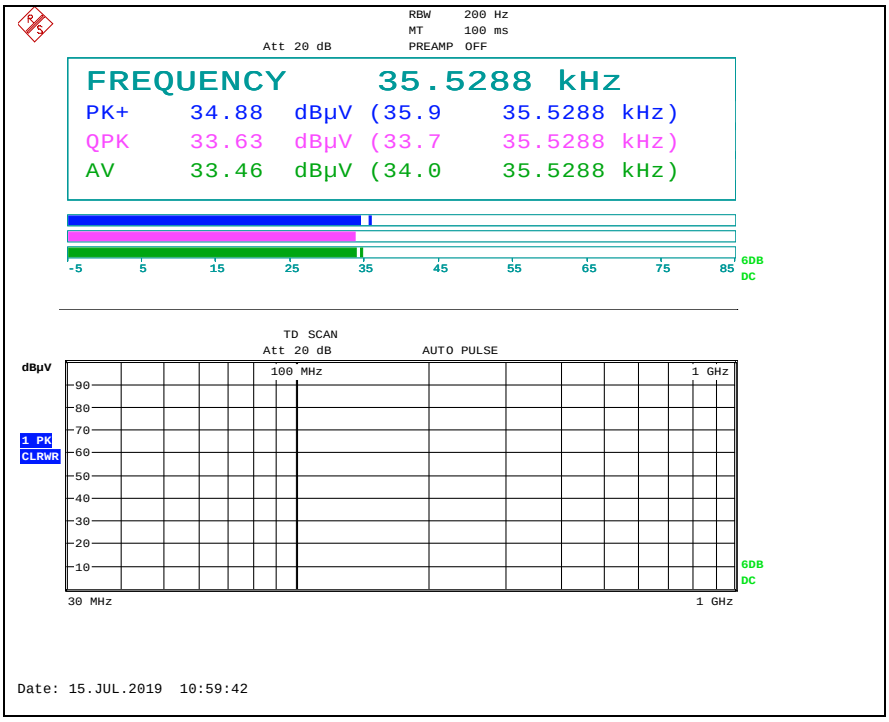
Remark;

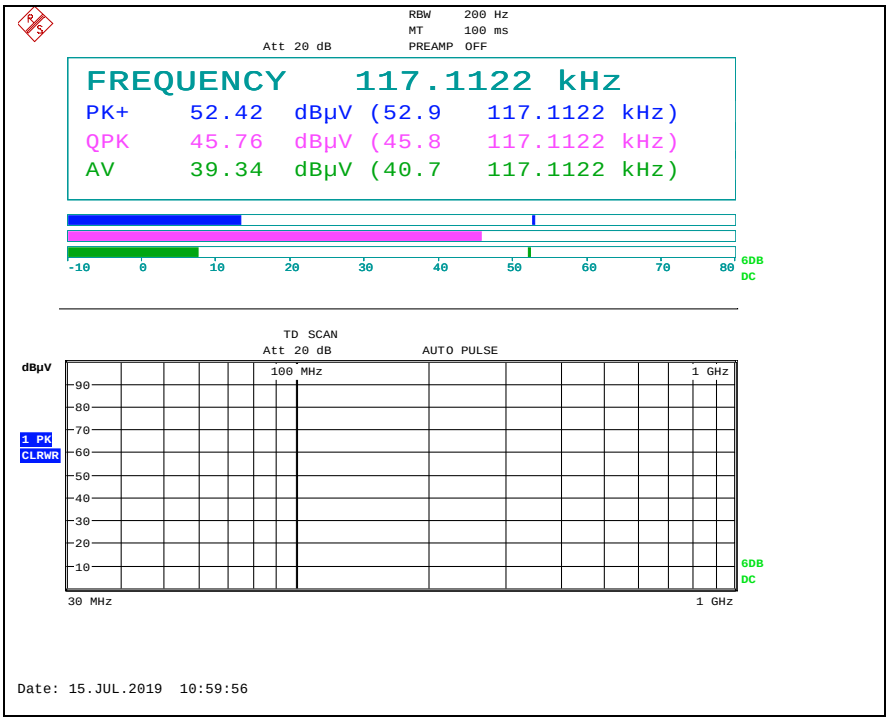
1. According to §15.31(f)(2)
   - 300 m Result (dB㎶/m) = 3 m Result (dB㎶/m) - 40log (300/3) (dB㎶/m)
   - 30 m Result (dB㎶/m) = 3 m Result (dB㎶/m) - 40log (30/3) (dB㎶/m)
2. According to field strength table of general requirement in §15.209(a), field strength limits below 1.705 ㎒ were calculated as below.
   - 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.

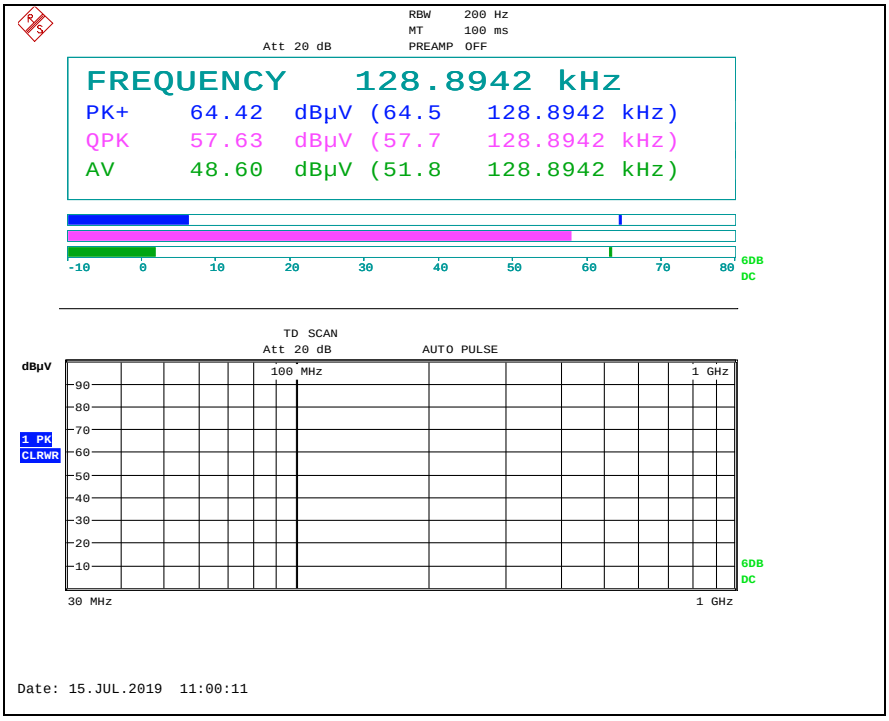
- Test plots

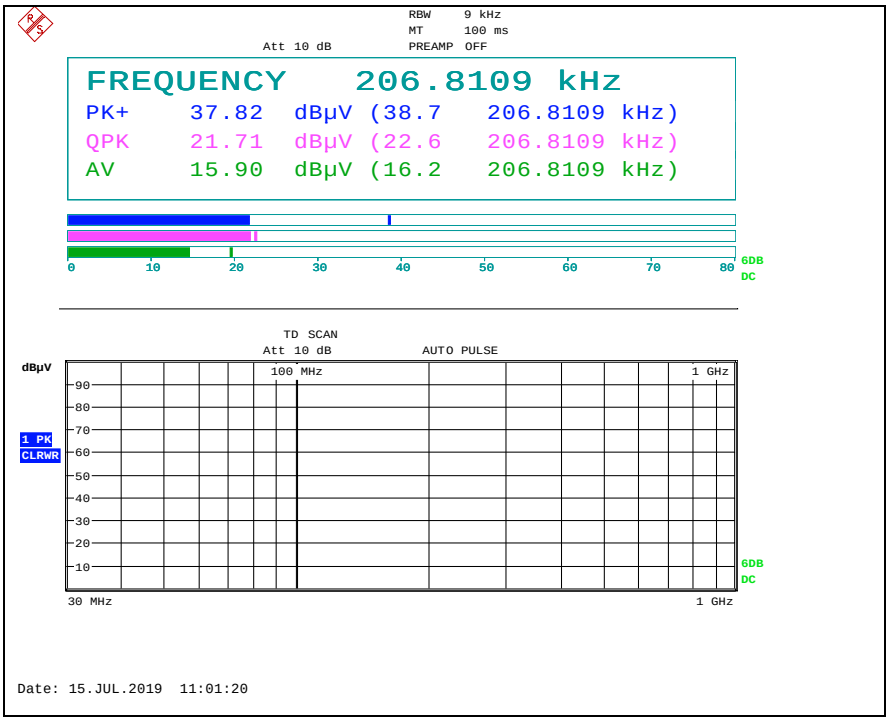
- DRV Antenna

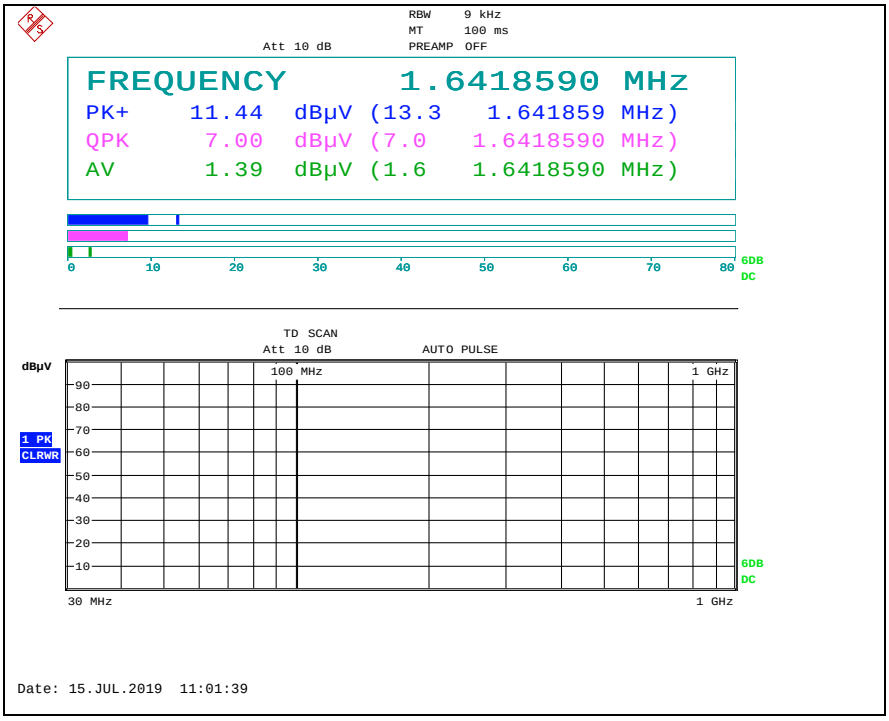




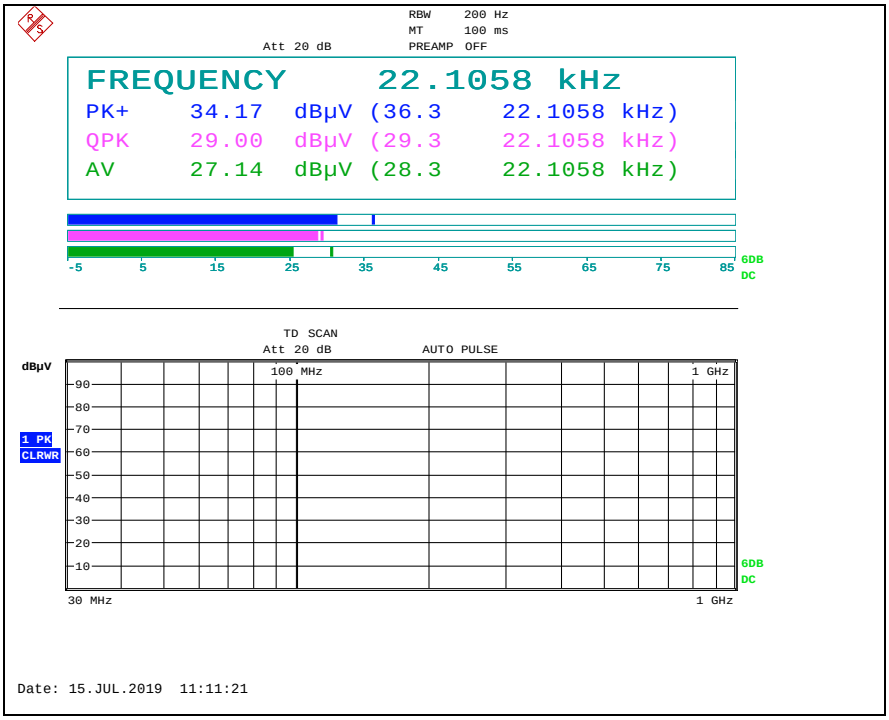


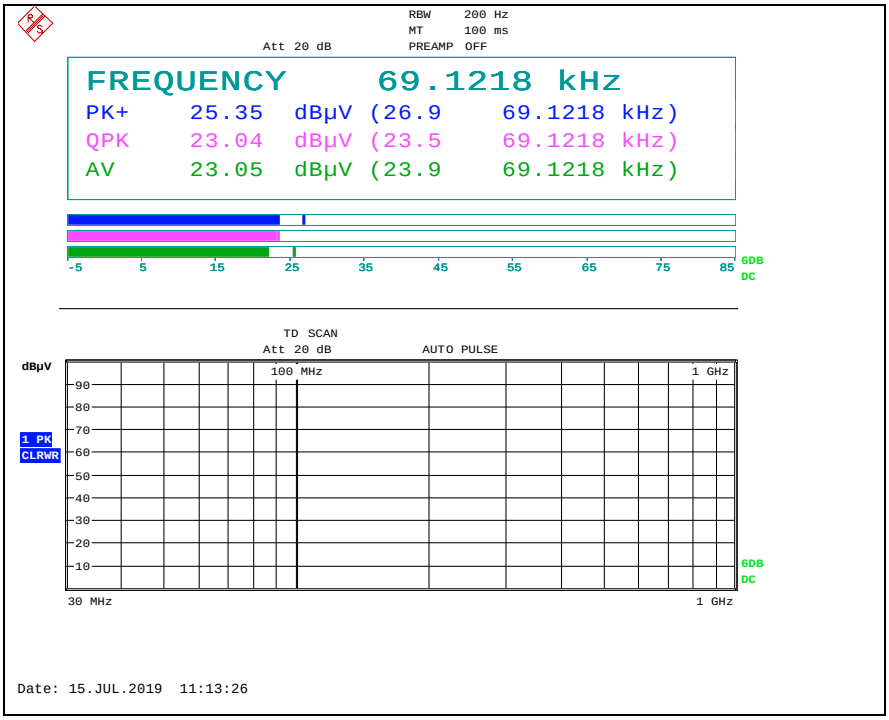


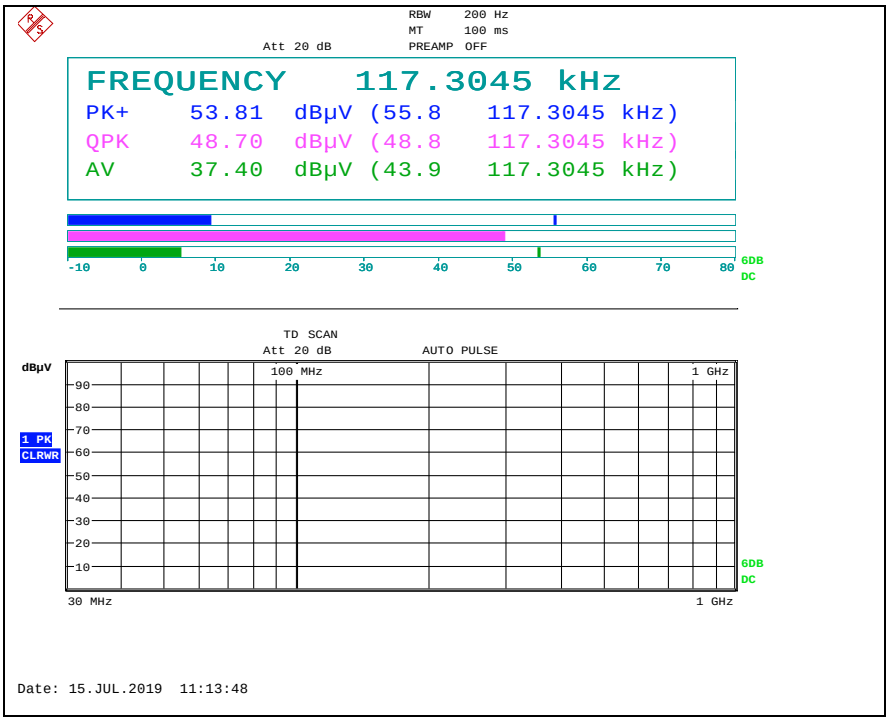


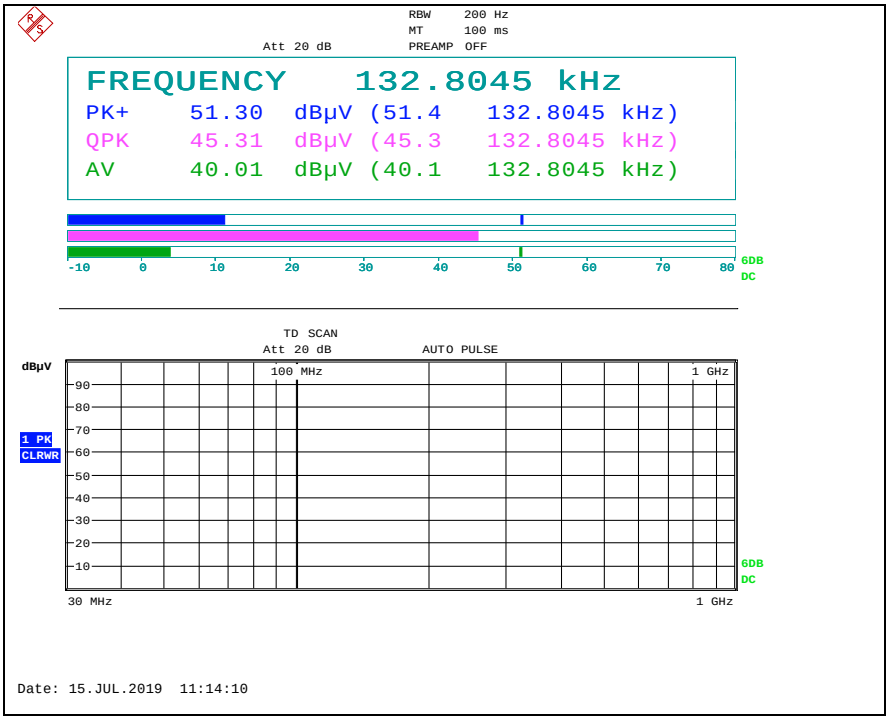


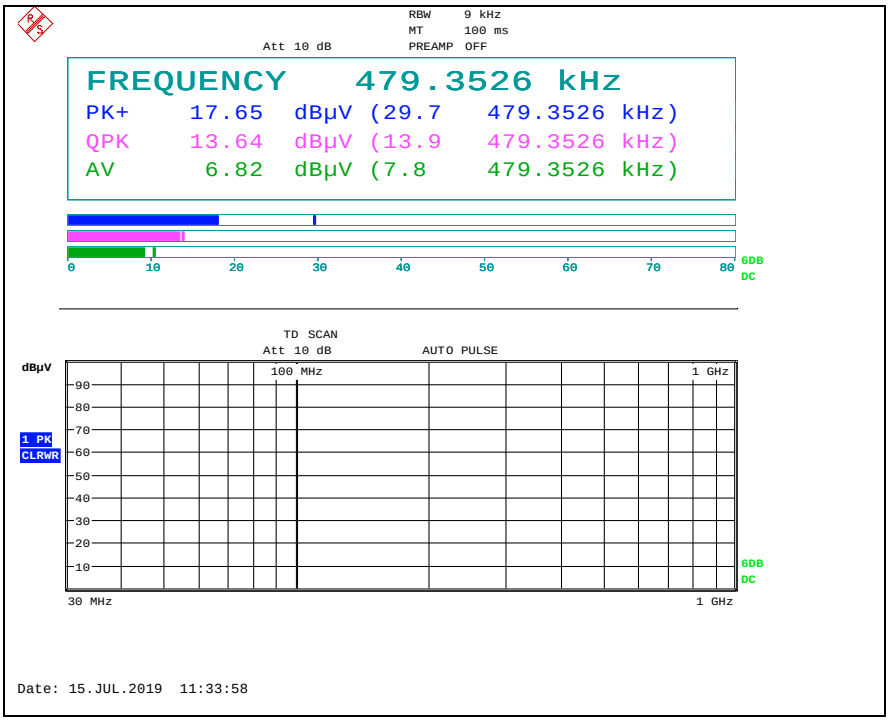
- AST Antenna

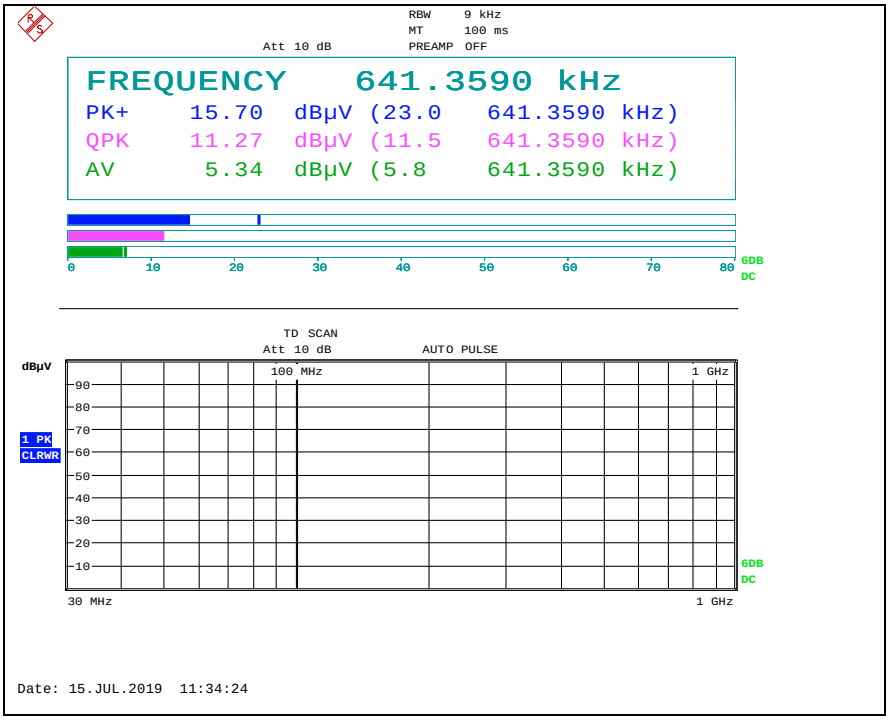




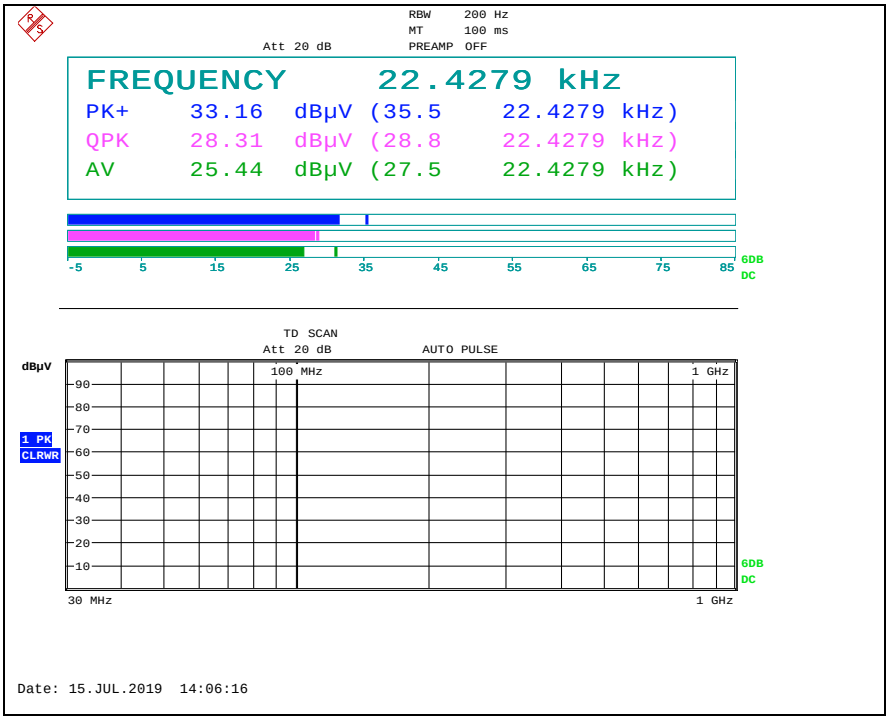


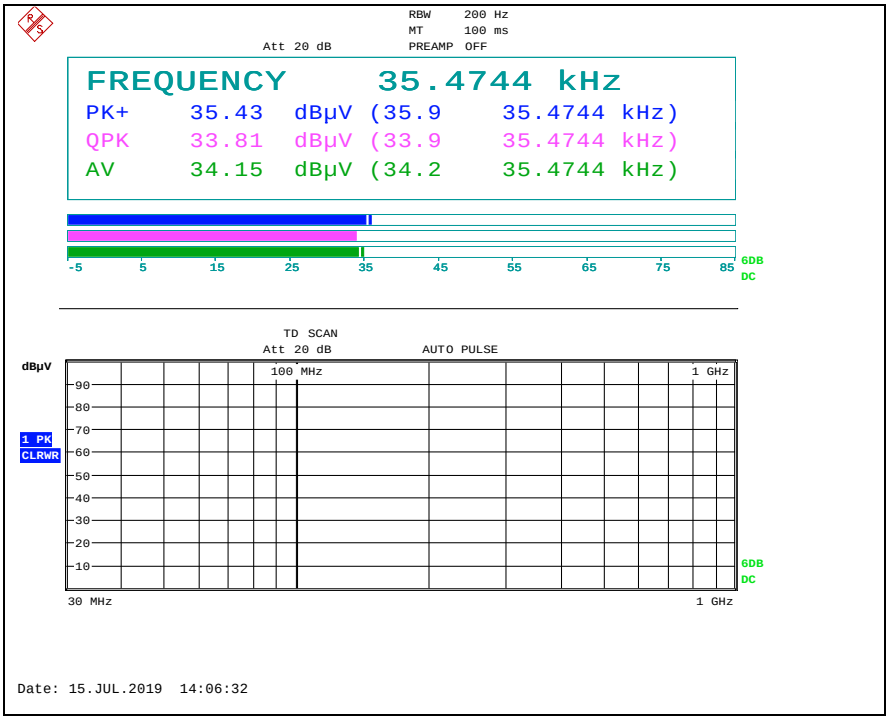


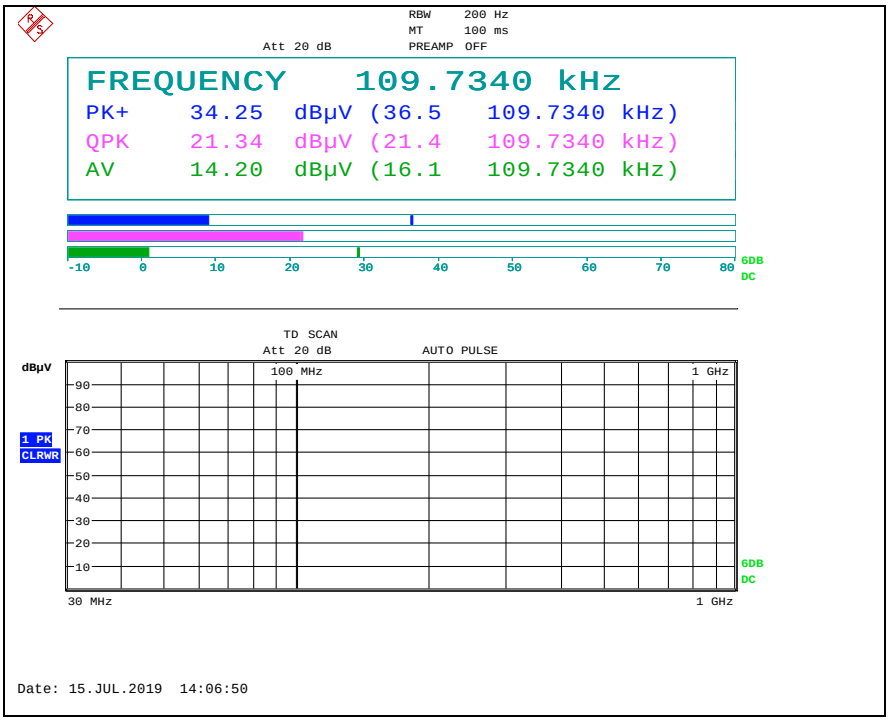


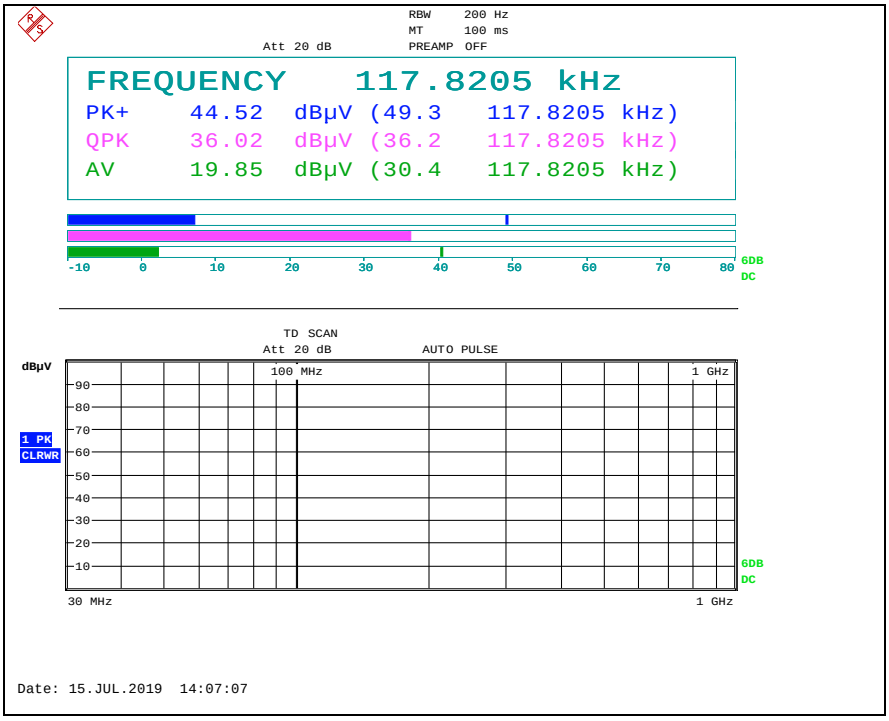


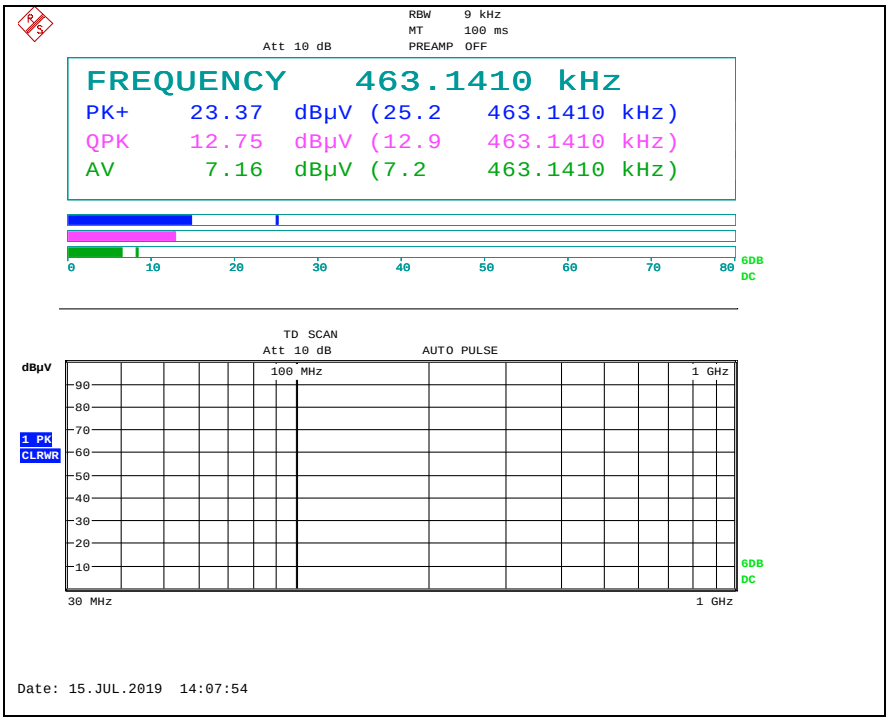
- INT1 Antenna

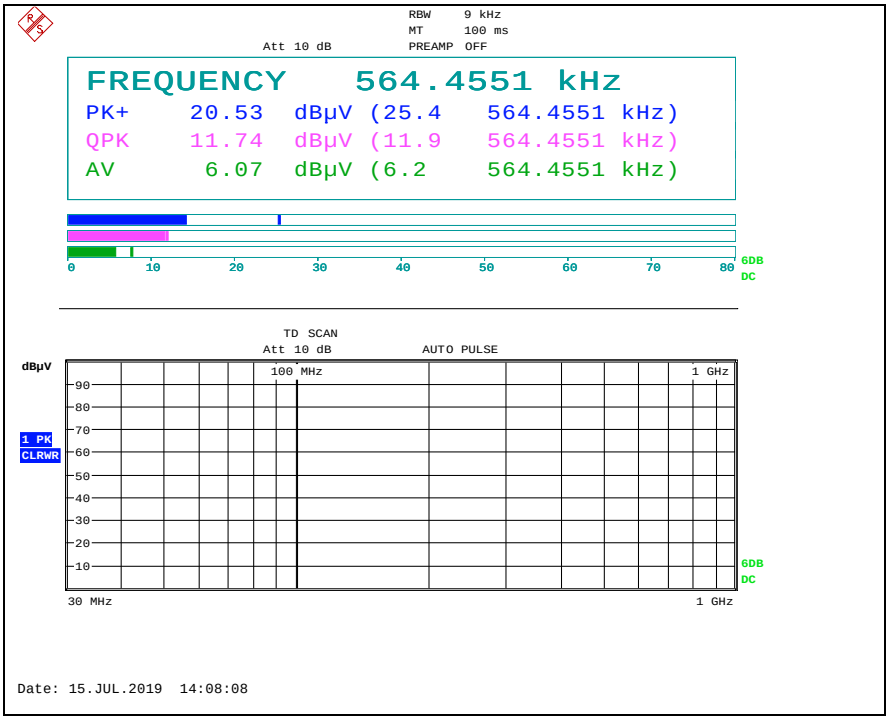




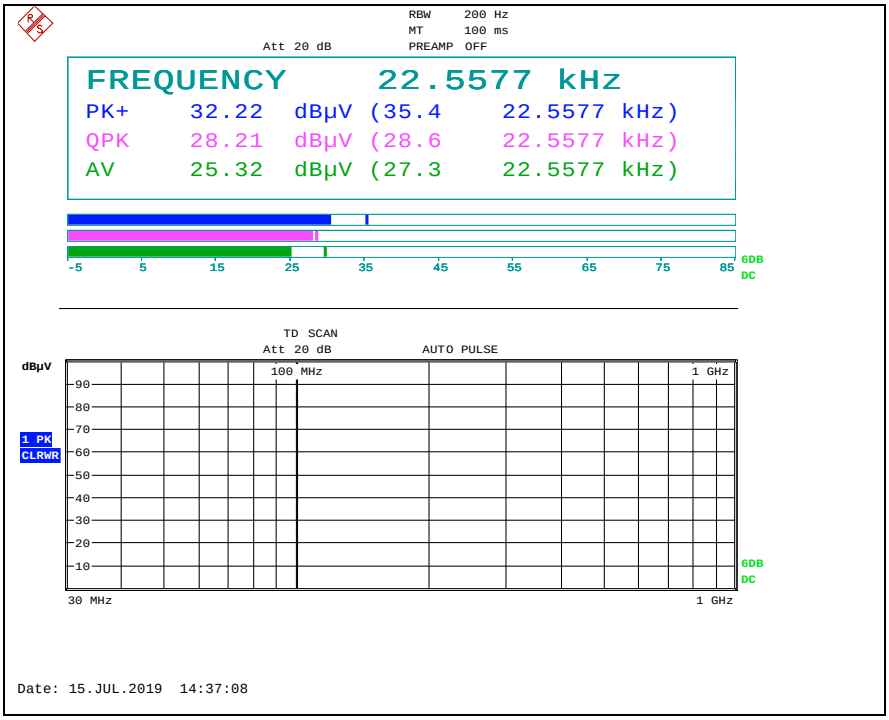


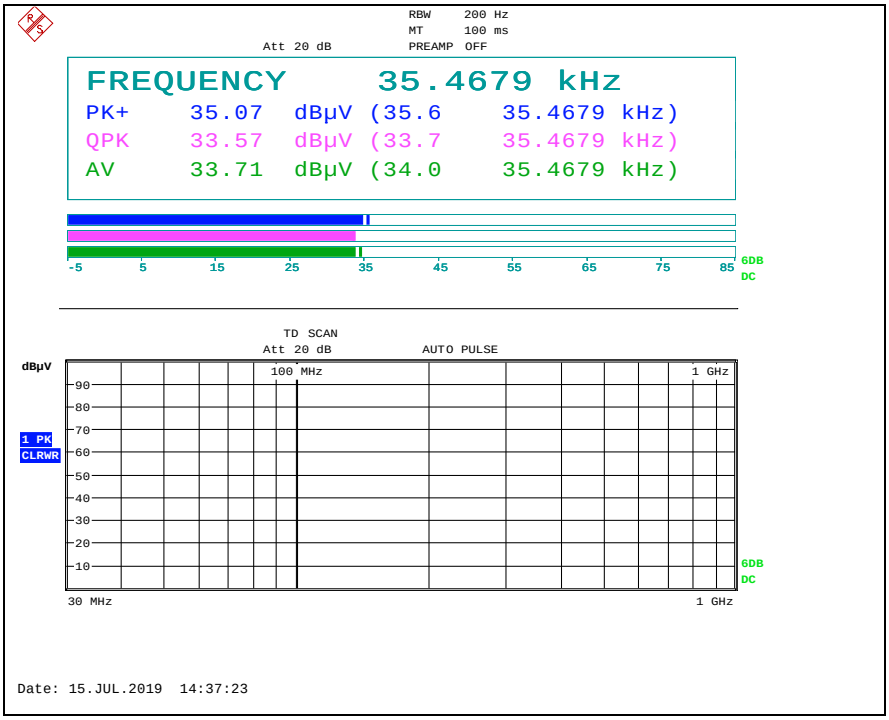


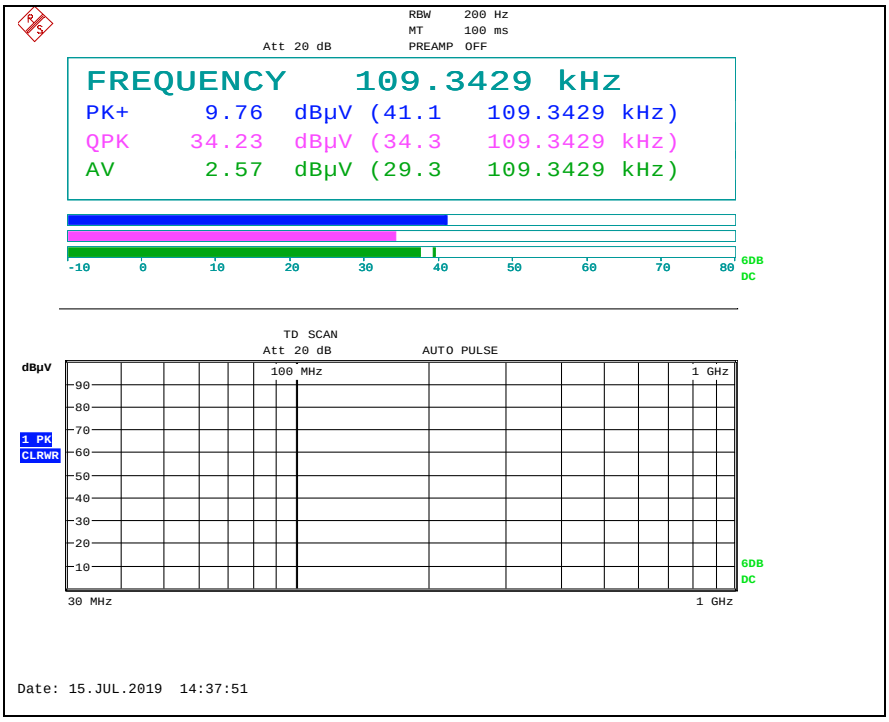


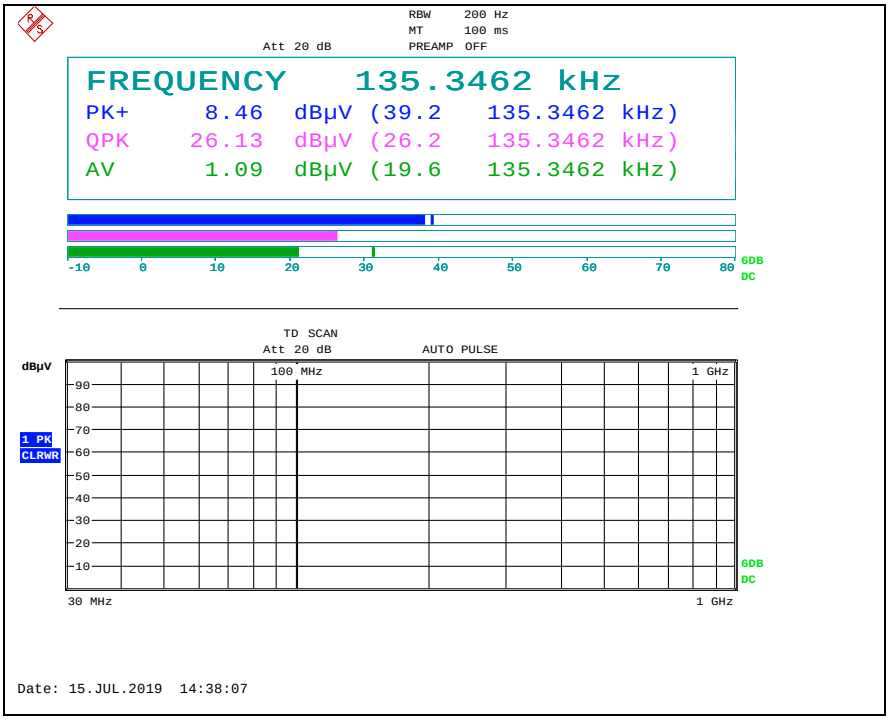


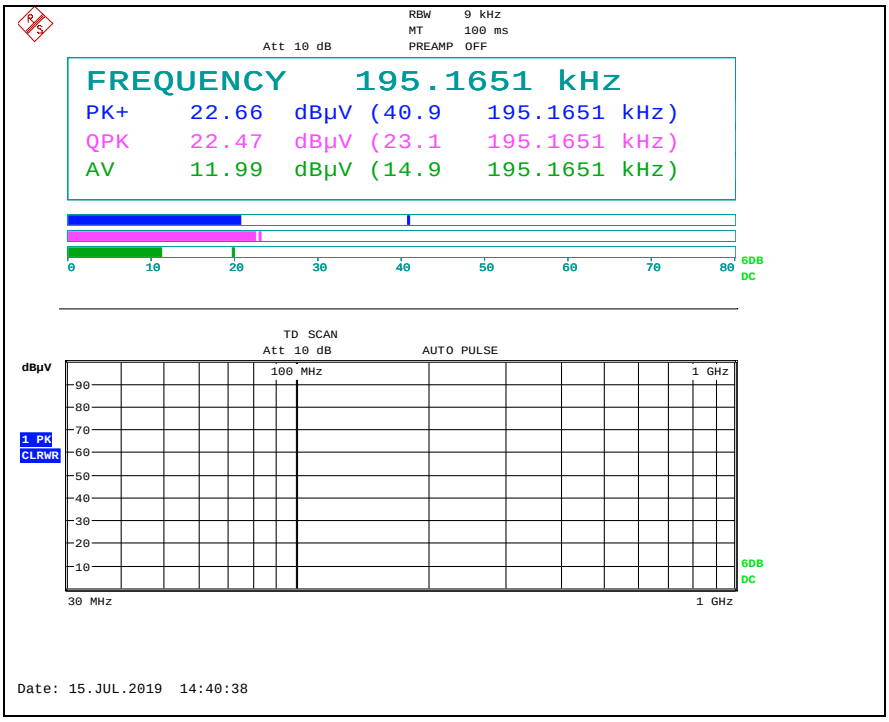
- INT2 Antenna

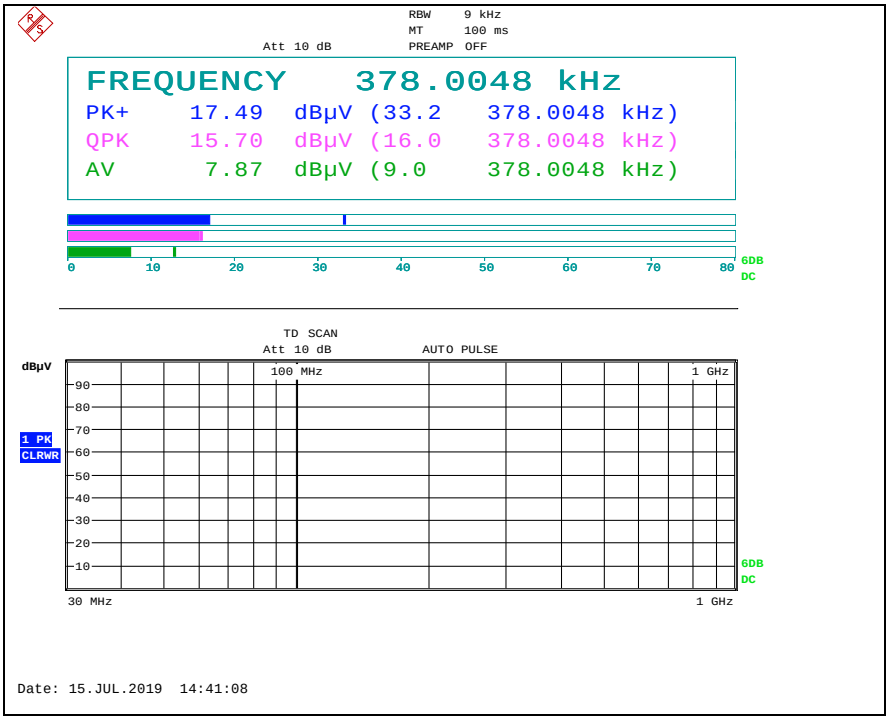




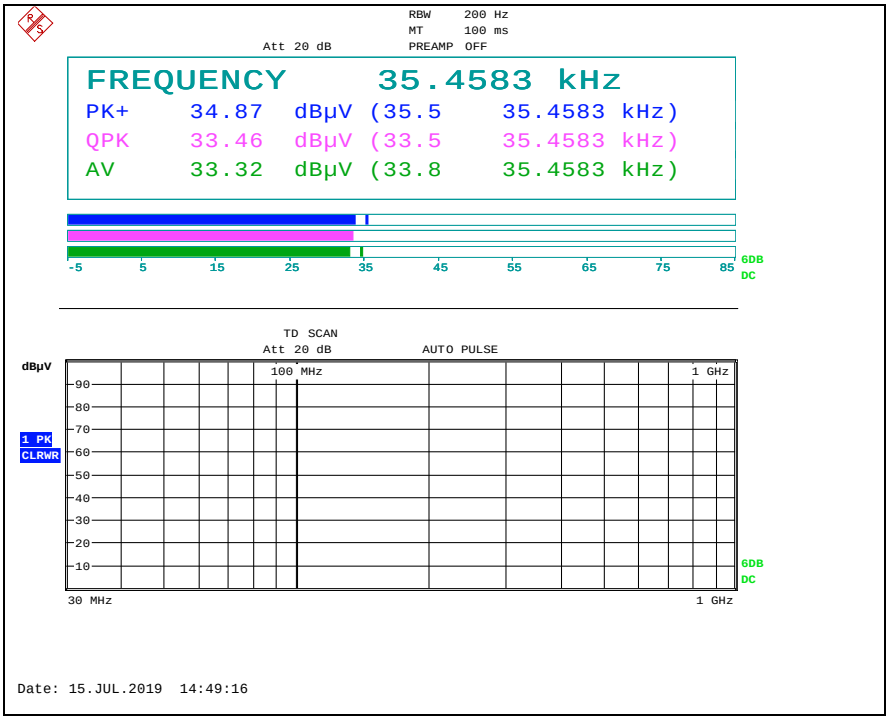


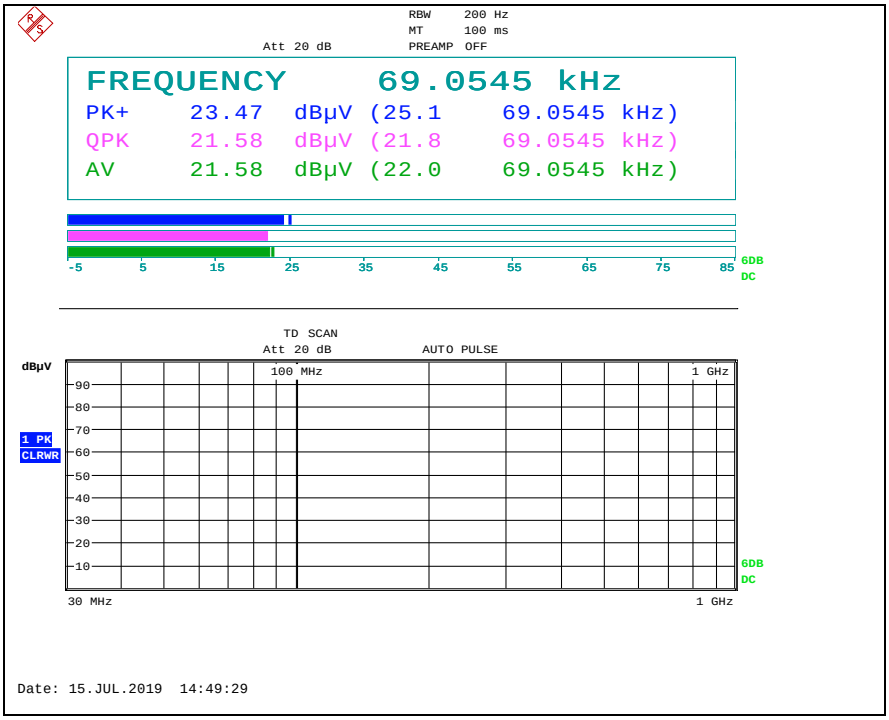


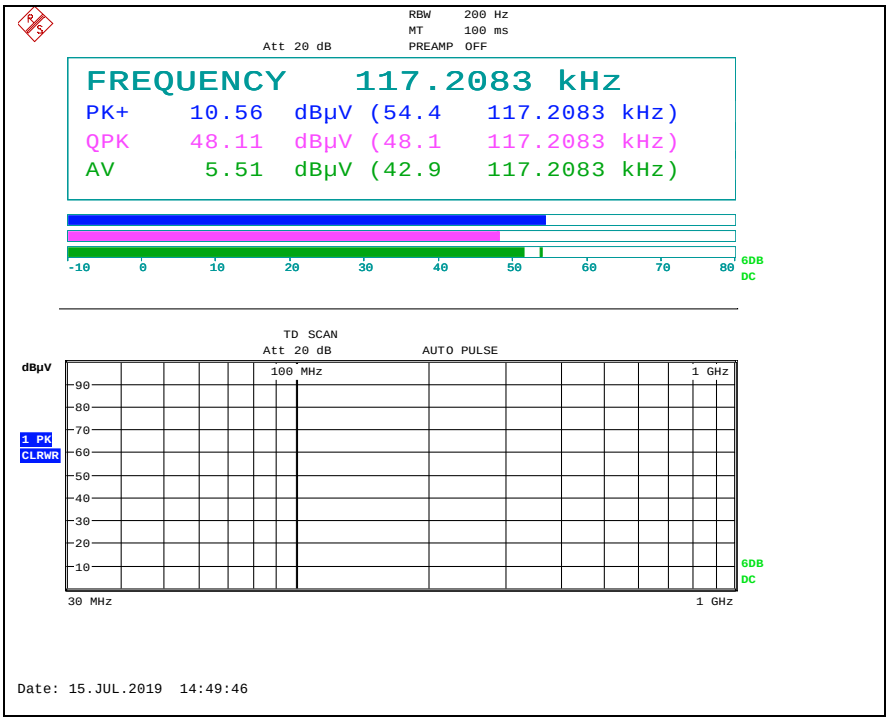


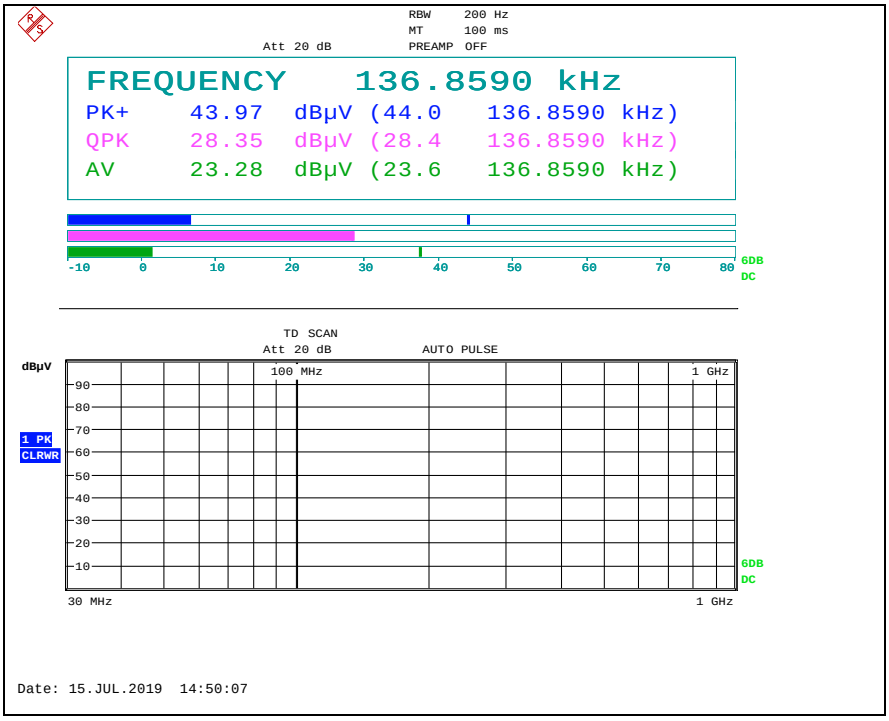


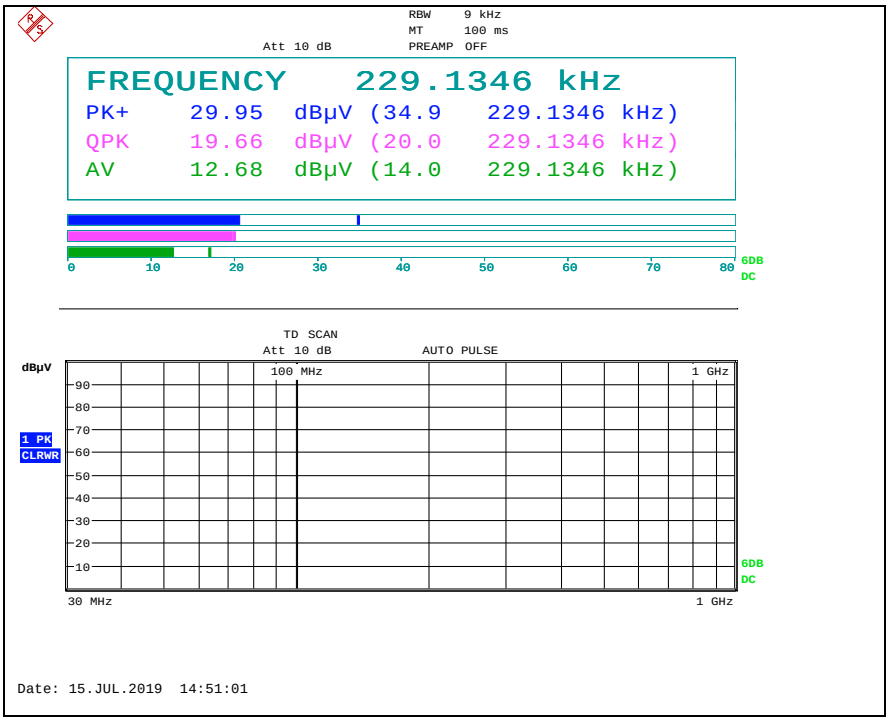
- TRK Antenna

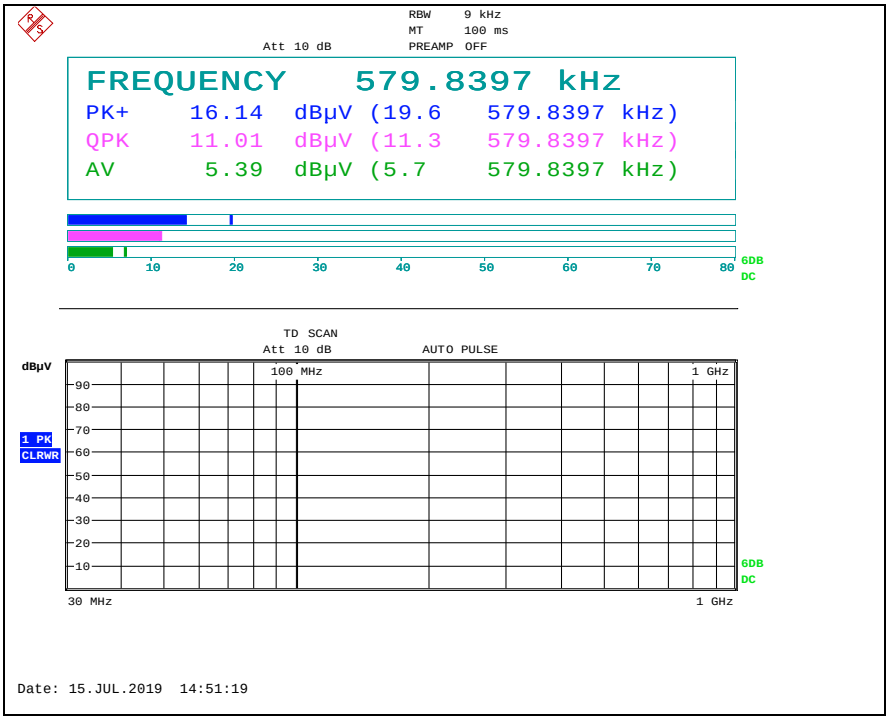




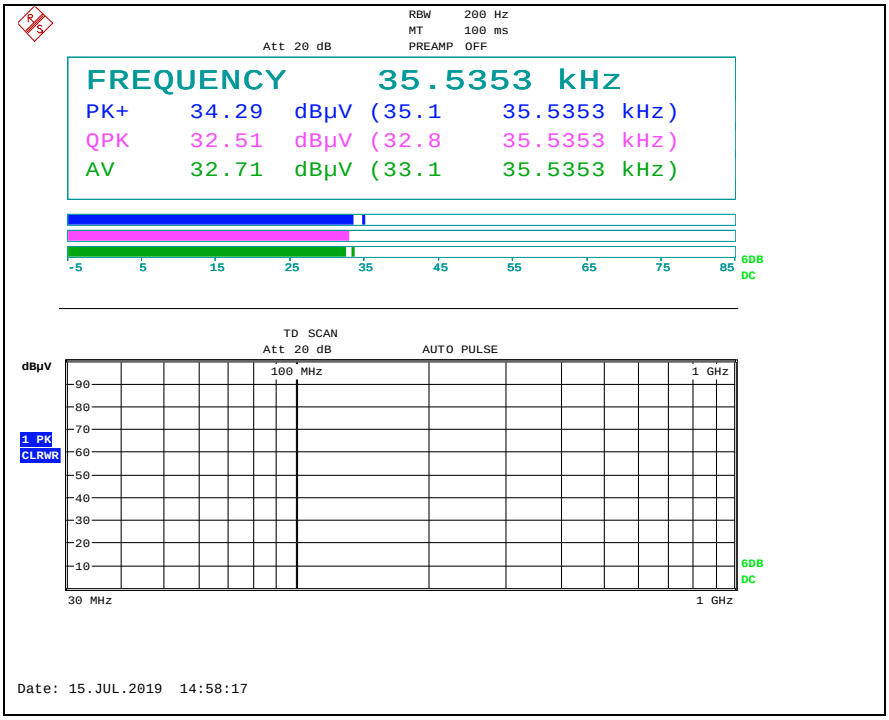


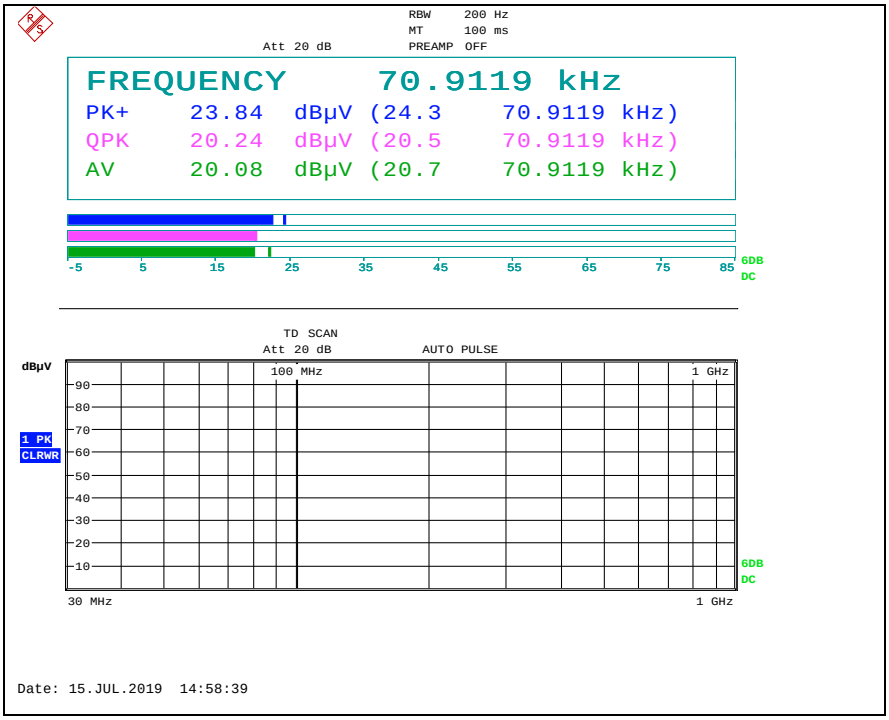


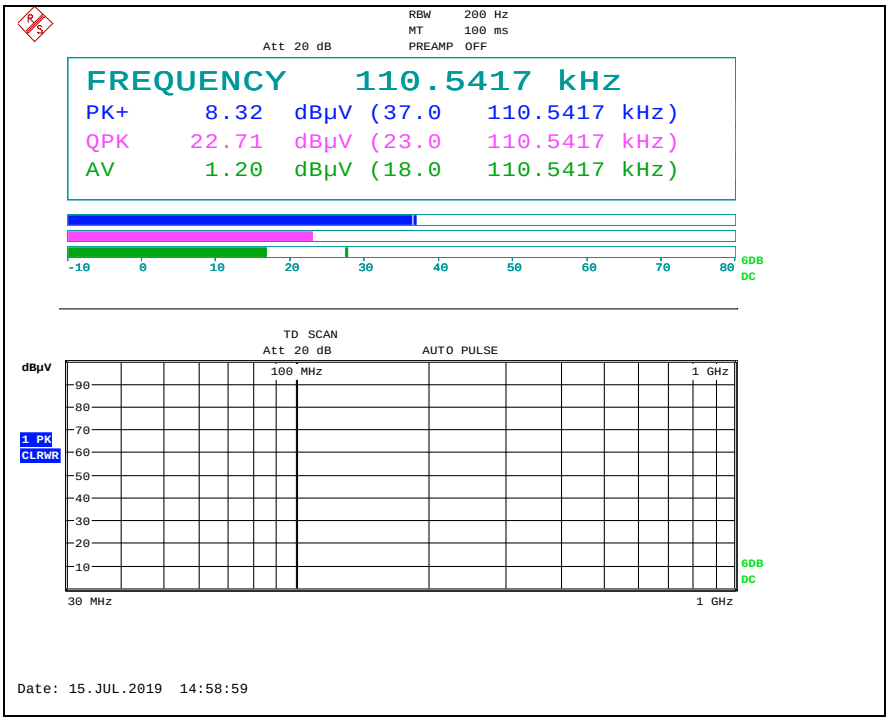


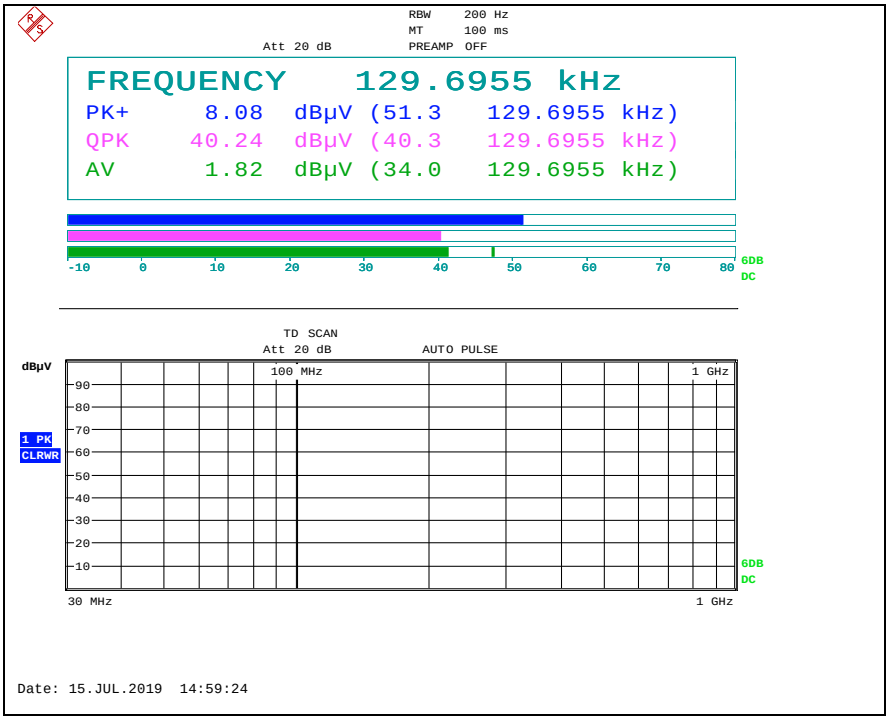


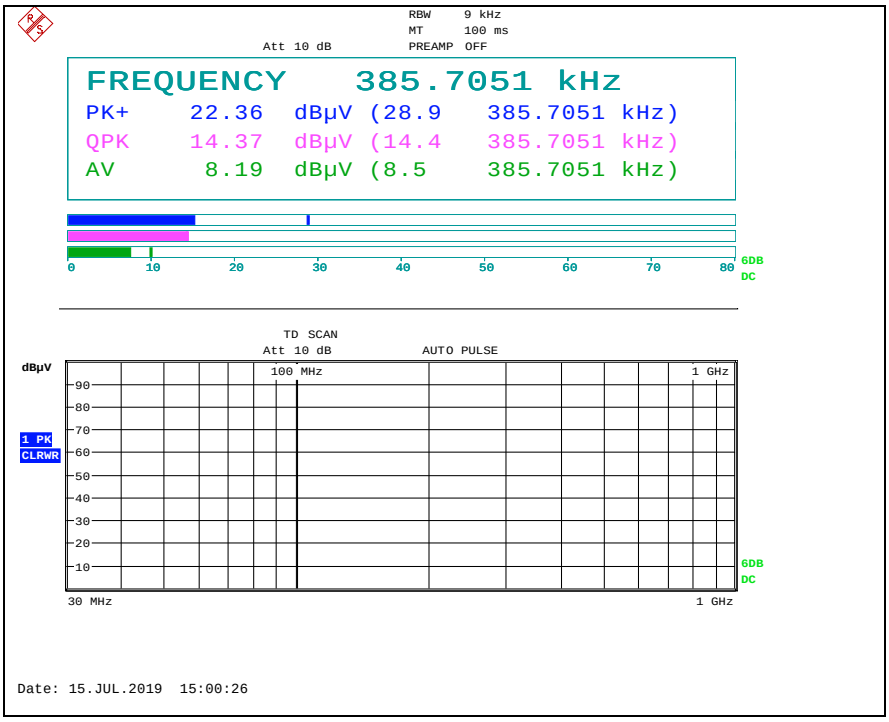
- BUM Antenna

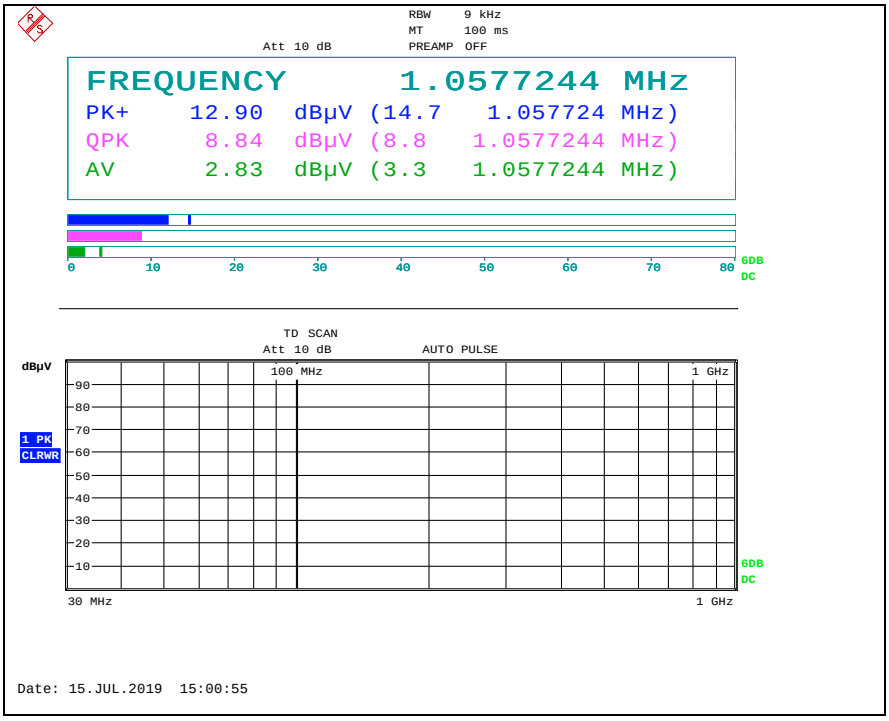




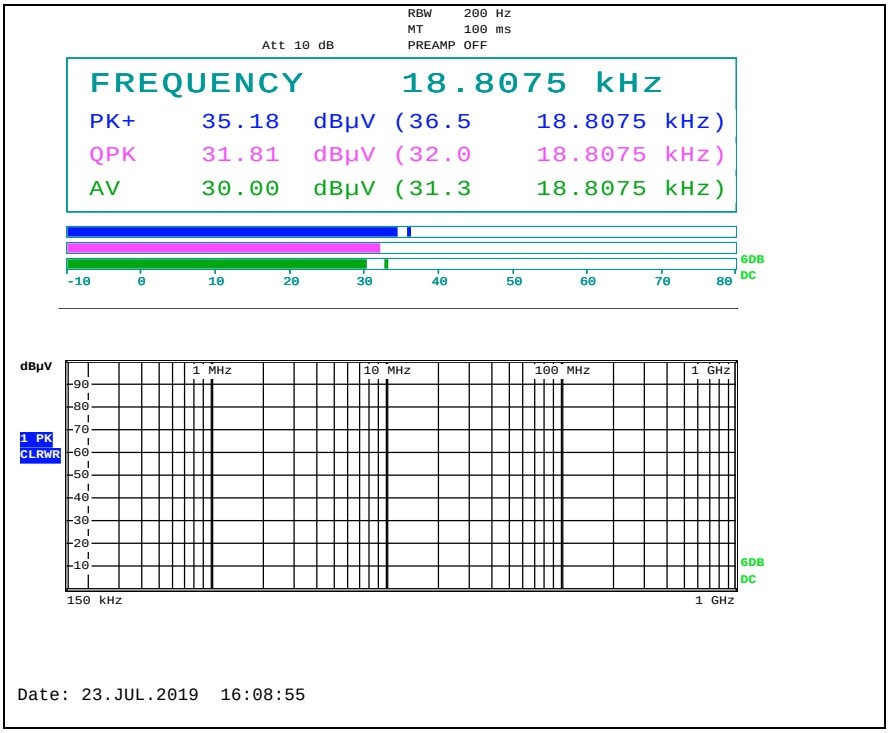


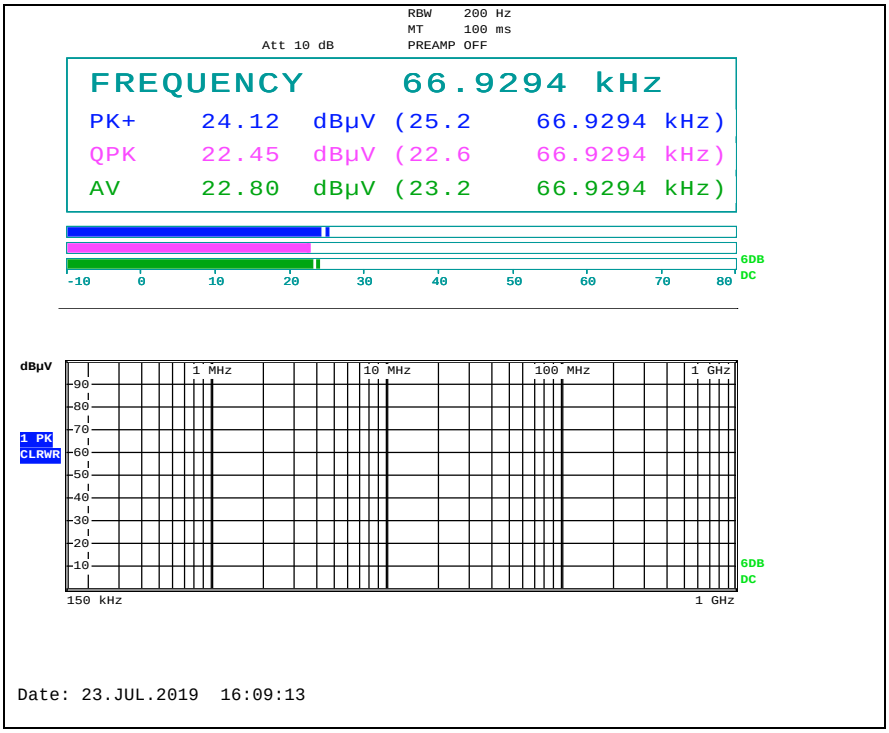


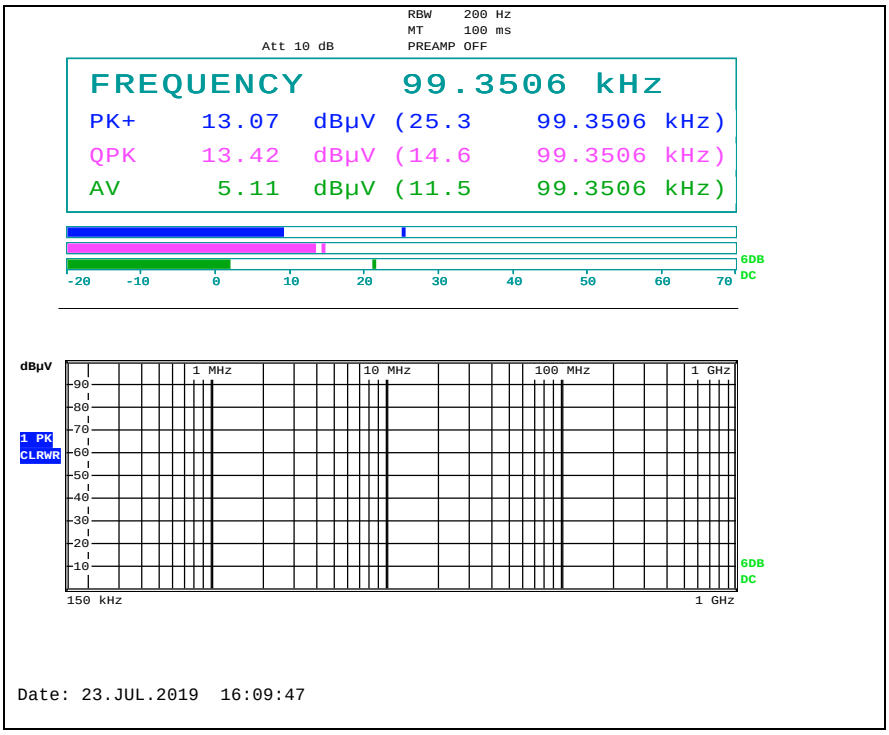


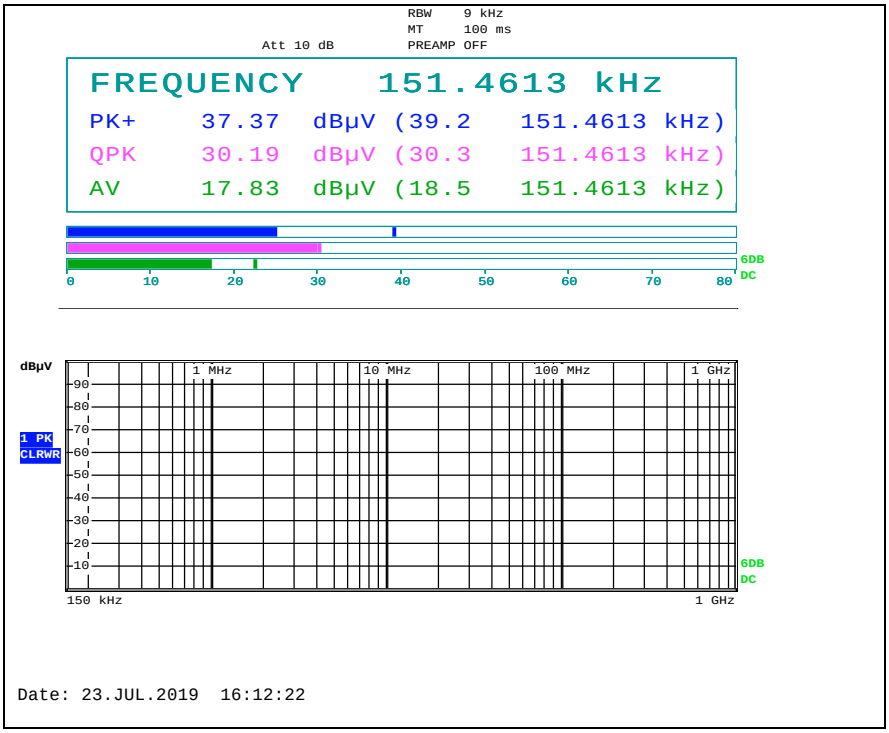


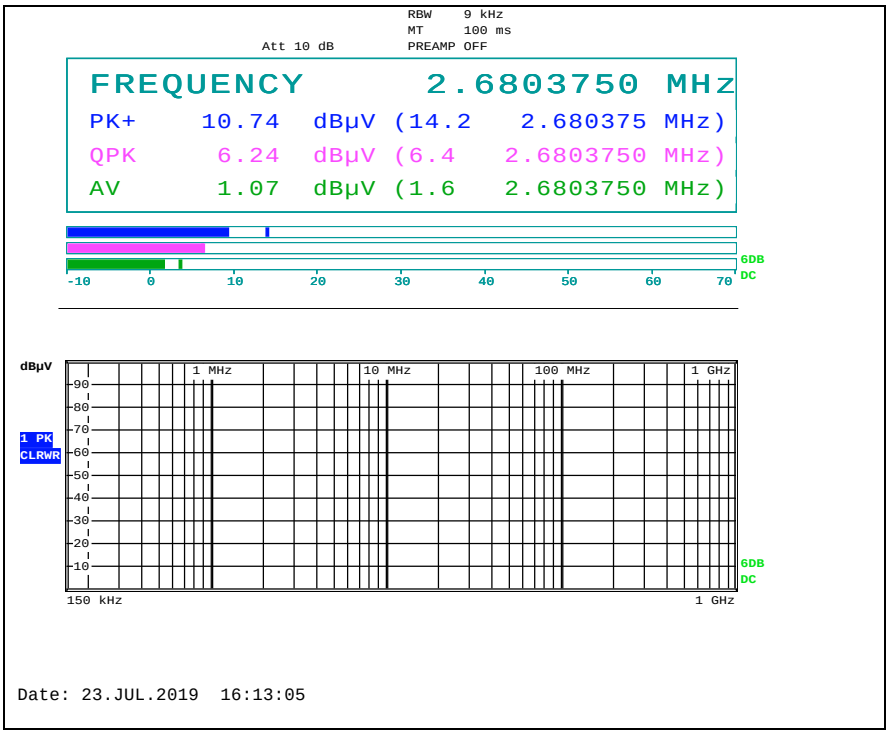
- SSB Antenna





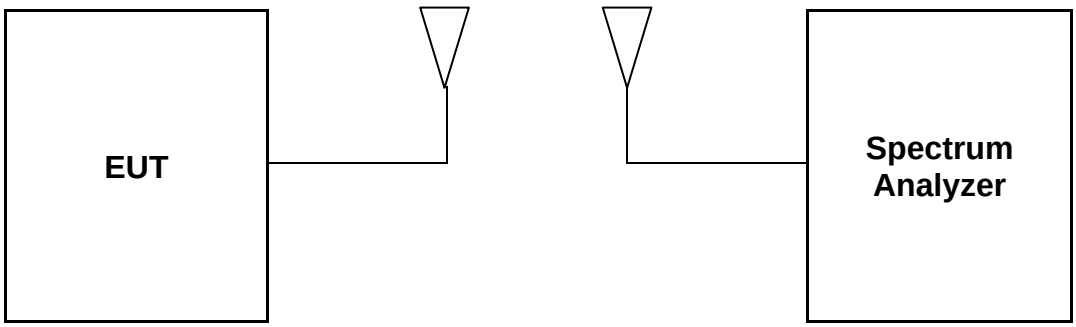






3. 20 dB Bandwidth

3.1. Test Setup



3.2. Limit

None; for reporting purposed only

3.3. Test Procedure

1. Span = the spectrum analyzer shall be between two times and five times the OBW, RBW = 1% to 5% of the OBW, VBW = set approximately 3 x RBW, Sweep = auto, Detector = peak, Trace = max hold.
2. 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.

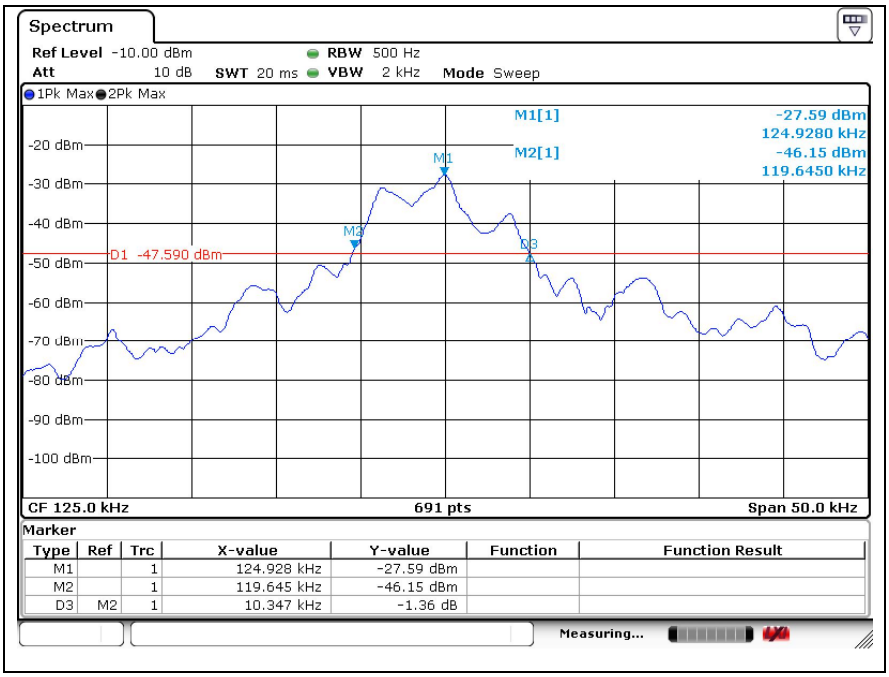
3.4. Test Result

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

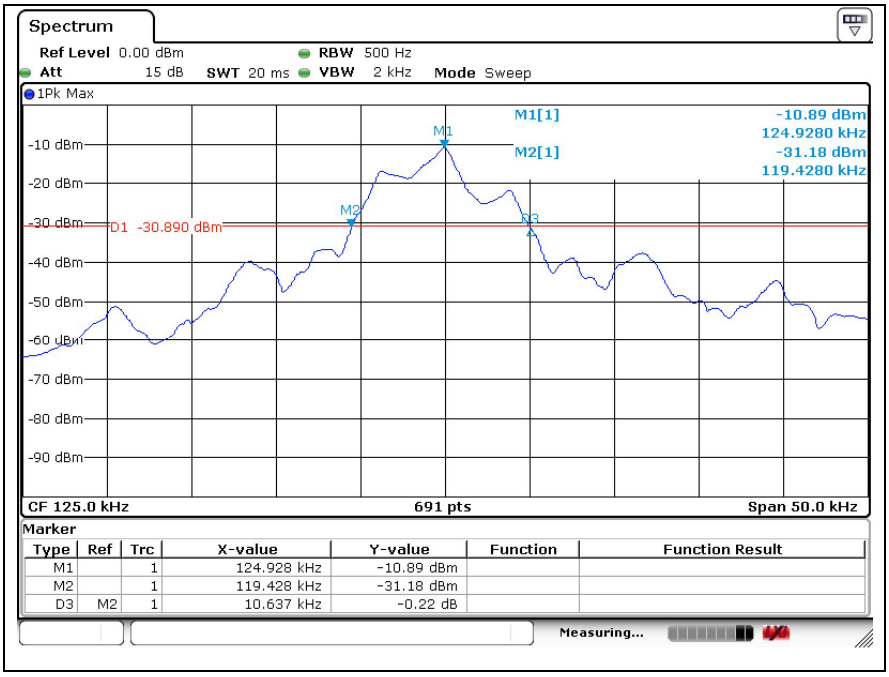
Test Antenna	Frequency (㎑)	20 ㏈ Bandwidth (㎑)	Limit
DRV Antenna	125	10.347	Reporting proposed only
AST Antenna	125	10.637	
INT1 Antenna	125	10.709	
INT2 Antenna	125	10.637	
TRK Antenna	125	10.058	
BUM Antenna	125	12.735	
SSB Antenna	125	10.029	

- Test plots

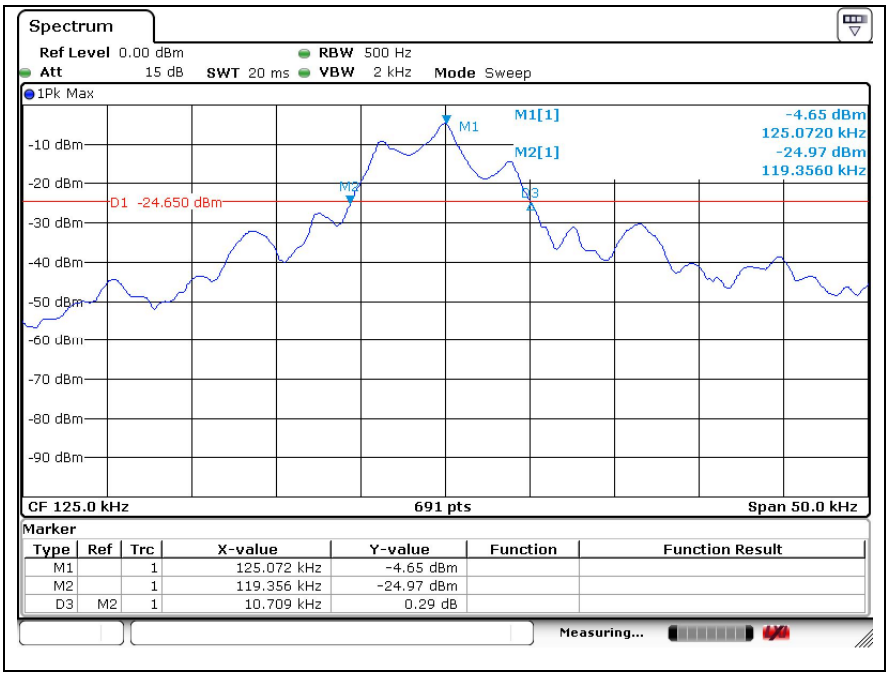
- DRV Antenna



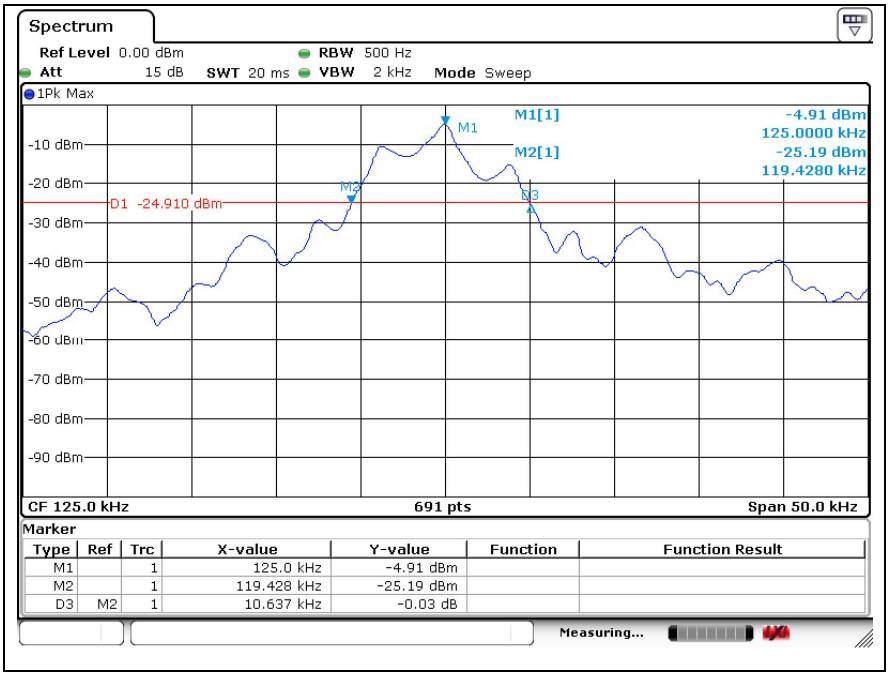
- AST Antenna



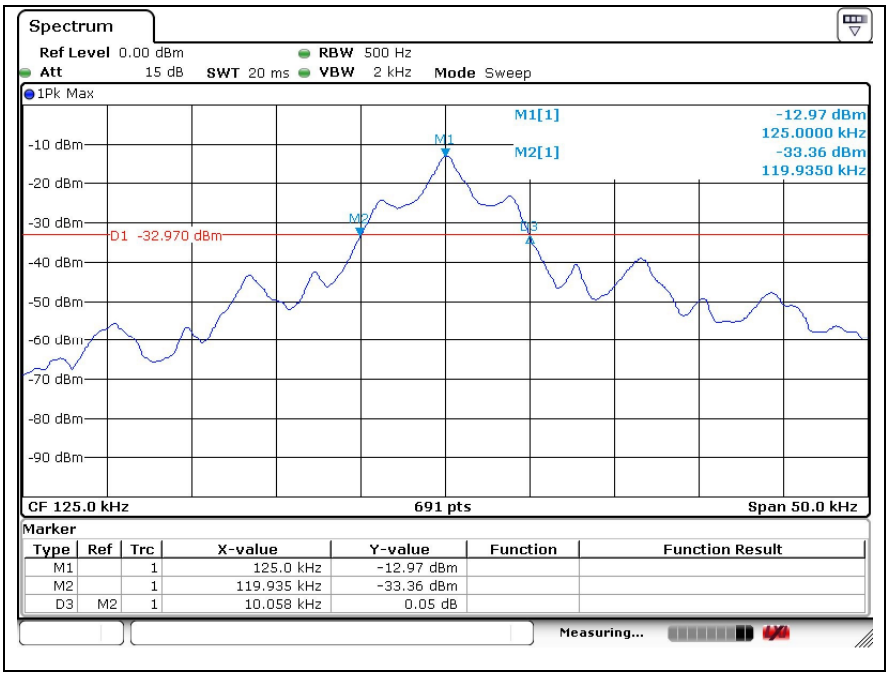
- INT1 Antenna



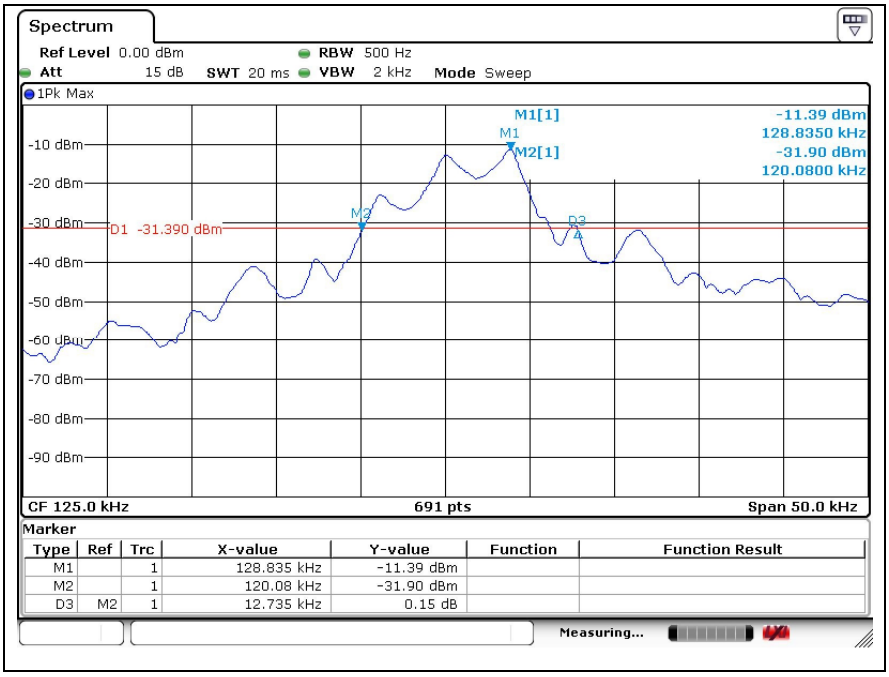
- INT2 Antenna



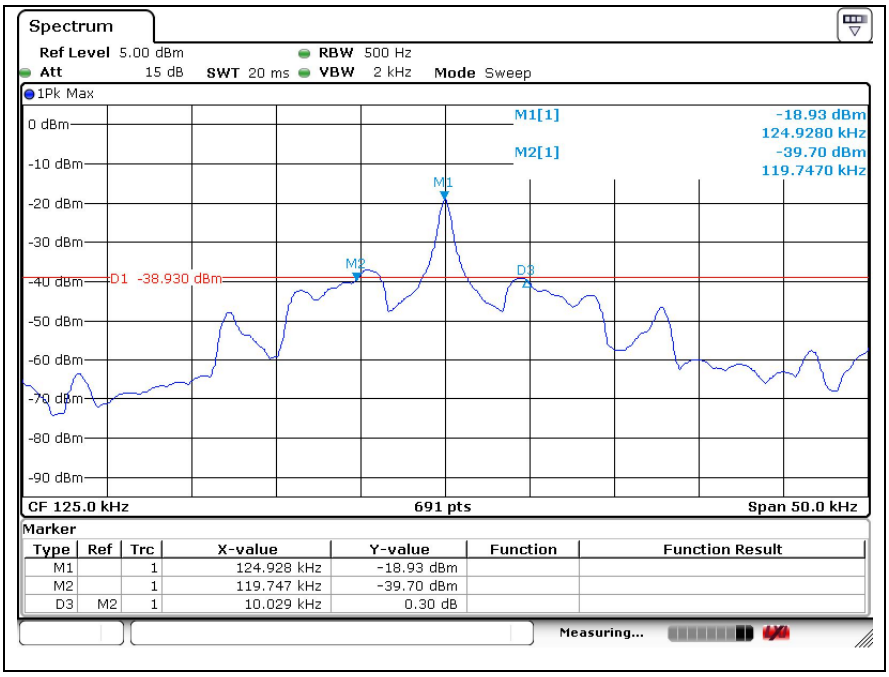
- TRK Antenna



- BUM Antenna

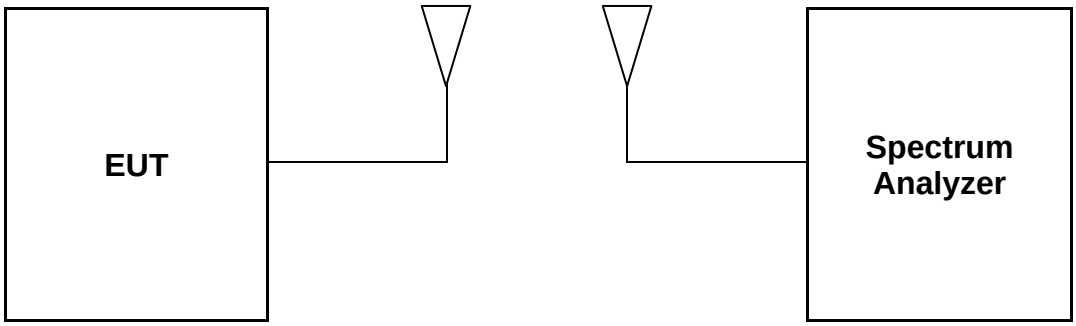


- SSB Antenna



4. Occupied Bandwidth

4.1. Test Setup



4.2. Limit

None; for reporting purposed only

4.3. Test Procedure

1. Set the spectrum analyzer as SPAN = shall be between 1.5 times and 5.0 times the OBW, RBW = 1% to 5% of the OBW, VBW = set approximately 3 x RBW, Detector = peak, Trace mode = max hold.
2. Measure lowest and highest frequencies are placed in a running sum until 0.5 % and 99.5 % of the total is reached.
3. Record the SPAN between the lowest and the highest frequencies for the 99 % occupied bandwidth.

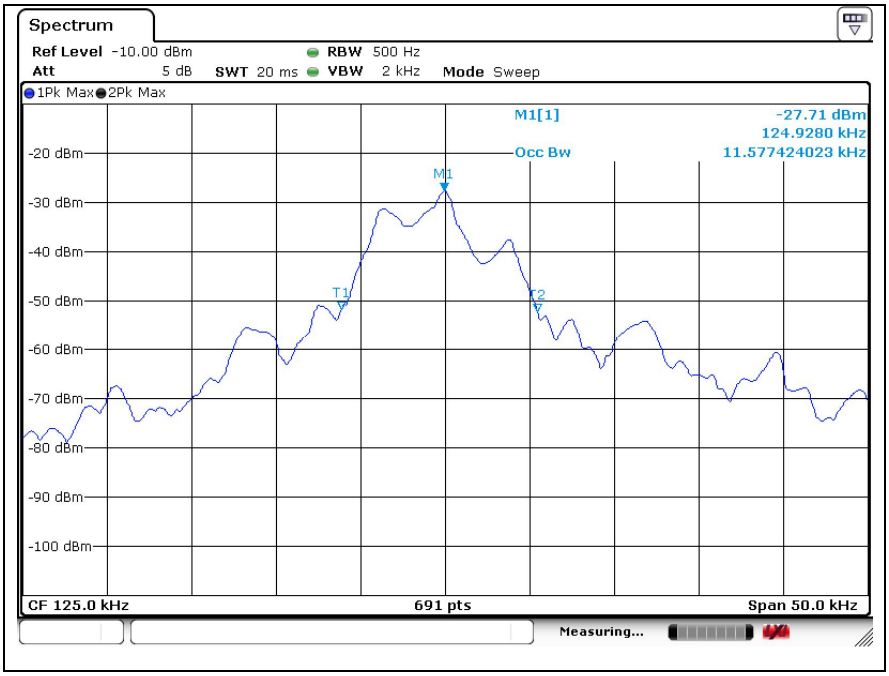
4.4. Test Result

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

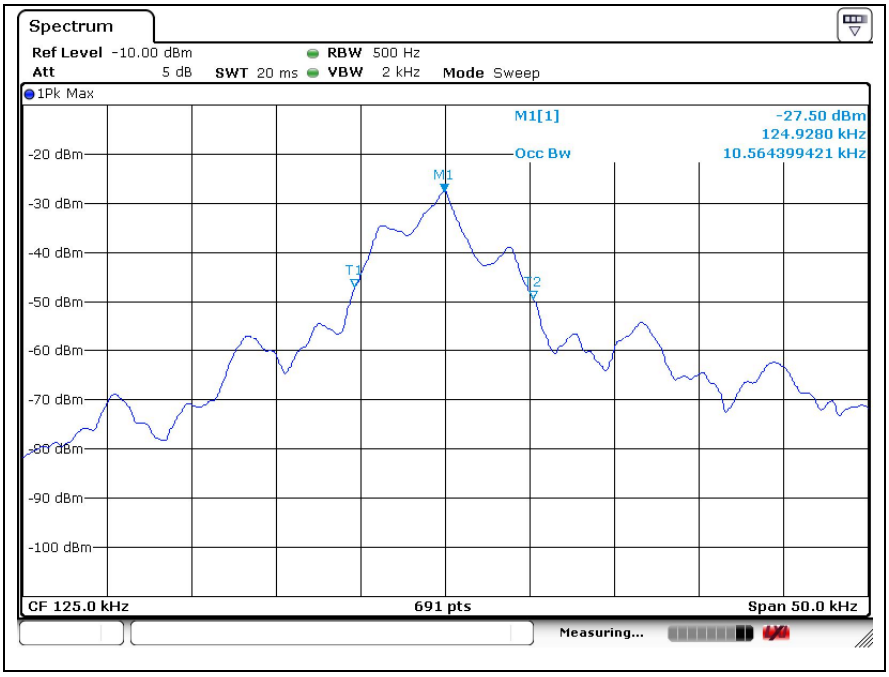
Test Antenna	Frequency (㎒)	Occupied Bandwidth (㎑)	Limit
DRV Antenna	125	11.577	Reporting proposed only
AST Antenna	125	10.564	
INT1 Antenna	125	12.084	
INT2 Antenna	125	11.143	
TRK Antenna	125	10.420	
BUM Antenna	125	15.630	
SSB Antenna	125	17.800	

- Test plots

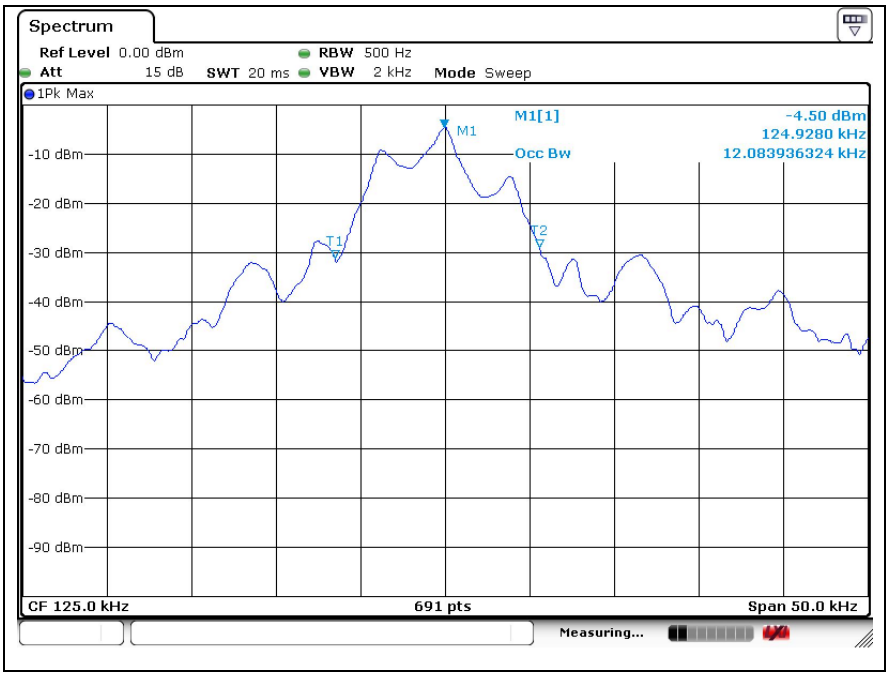
- DRV Antenna



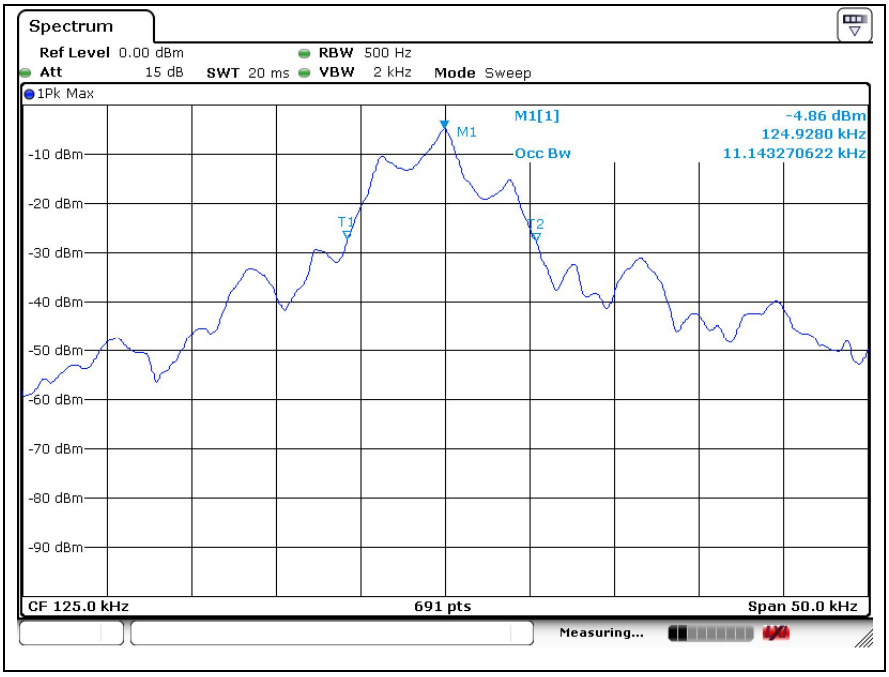
- AST Antenna



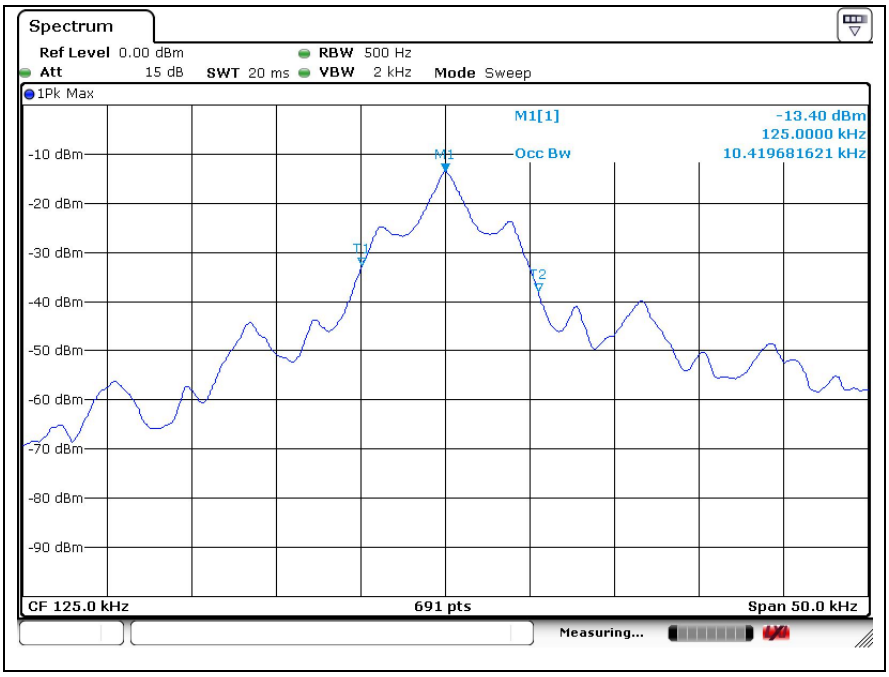
- INT1 Antenna



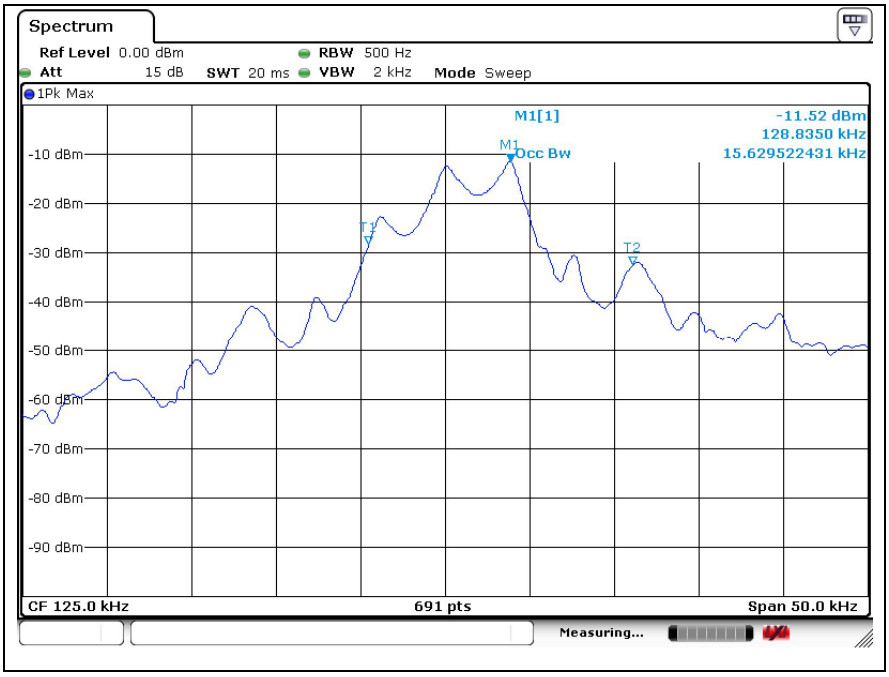
- INT2 Antenna



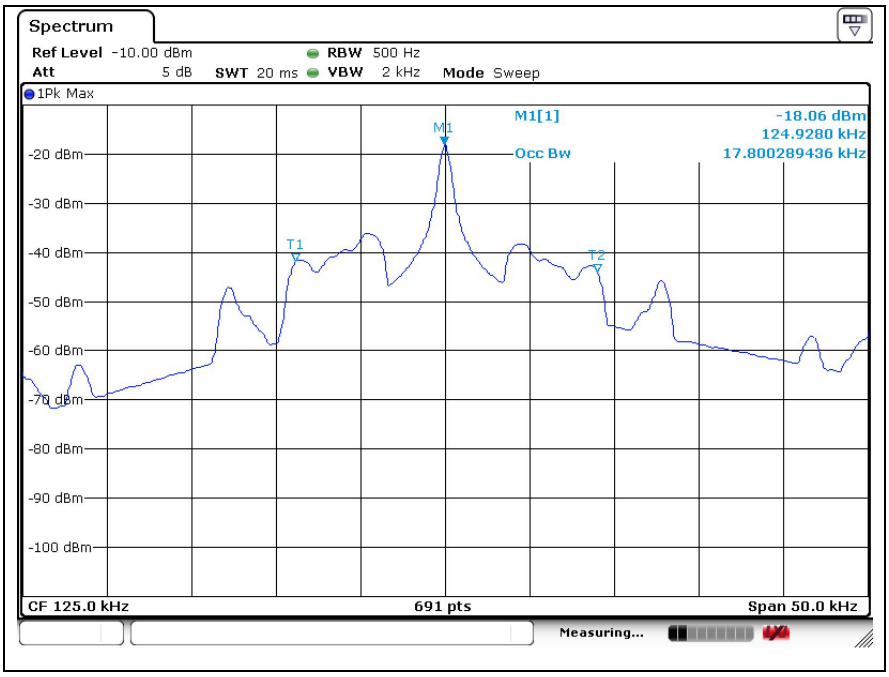
- TRK Antenna



- BUM Antenna



- SSB Antenna



- End of the Test Report -