

TEST REPORT

of

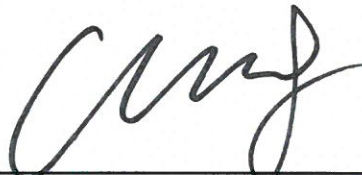
FCC Part 15 Subpart C §15.209 / IC RSS-210 Issue 9, RSS-Gen Issue 4

FCC ID: TQ8-IBU-4E02
IC Certification: 5074A-IBU4E02

Equipment Under Test : SMART KEY ECU
Model Name : IBU-4E02
Applicant : Hyundai Mobis Co., Ltd.
Manufacturer : AUTONICS Co., Ltd.
Date of Receipt : 2017.11.08
Date of Test(s) : 2017.12.11 ~ 2017.12.22
Date of Issue : 2017.12.26

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

Tested By:



Jaeha Chung

Date:

2017.12.26

Technical
Manager:



Hunchae You

Date:

2017.12.26

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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, 06141, Republic of Korea

Contact Person : Choi, Seung-Hoon

Phone No. : +82 31 260 0098

1.3. Details of Manufacturer

Applicant : AUTONICS Co., Ltd.

Address : 69-23, Hansam-ro, Deoksan-myeon, Jincheon-gun, Chugcheongbuk-do, Korea

1.4. Description of EUT

Kind of Product		SMART KEY ECU
Model Name		IBU-4E02
Power Supply		DC 12.0 V
Frequency Range		Tx: 125.00 kHz, Rx: 433.92 MHz
Antenna Type	Tx	External Type (Coil Antenna)
	Rx	External Type (Helical Antenna)

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.

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1.6. Test Equipment List

Equipment	Manufacturer	Model	S/N	Cal. Date	Cal. Interval	Cal. Due
Spectrum Analyzer	R&S	FSV30	100768	Mar. 20, 2017	Annual	Mar. 20, 2018
Signal Generator	R&S	SMBV100A	255834	Jun. 15, 2017	Annual	Jun. 15, 2018
DC Power Supply	R&S	HMP2020	019922876	Apr. 26, 2017	Annual	Apr. 26, 2018
Test Receiver	R&S	ESU26	100109	Feb. 17, 2017	Annual	Feb. 17, 2018
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	CO3000/963/3 8330516/L	N. C. R.	N/A	N. C. R.
Anechoic Chamber	SY Corporation	L x W x H (9.6 m x 6.4 m x 6.6 m)	N/A	N. C. R.	N/A	N. C. R.
Coaxial Cable	SUCOFLEX	104 (3 m)	MY3258414	Jul. 15, 2017	Semi-annual	Jan. 15, 2018
Coaxial Cable	SUCOFLEX	104 (10 m)	MY3145814	Jul. 15, 2017	Semi-annual	Jan. 15, 2018

1.7. Sample calculation

Where relevant, the following sample calculation is provided:

Field strength level (dB μ V/m) = Measured level (dB μ V) + Antenna factor (dB) + Cable loss (dB)

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1.8. Summary of Test Results

The EUT has been tested according to the following specifications:

APPLIED STANDARD			
Section in FCC Part 15	Section in RSS-210, RSS-Gen	Test Item	Result
15.209	RSS-210 Issue 9, 4.4, RSS-Gen Issue 4, 8.9	Radiated emission, Spurious Emission and Field Strength of Fundamental	Complied
2.1049	-	20 dB Bandwidth	Complied
-	RSS-Gen Issue 4, 6.6	Occupied Bandwidth	Complied

1.9. Test Report Revision

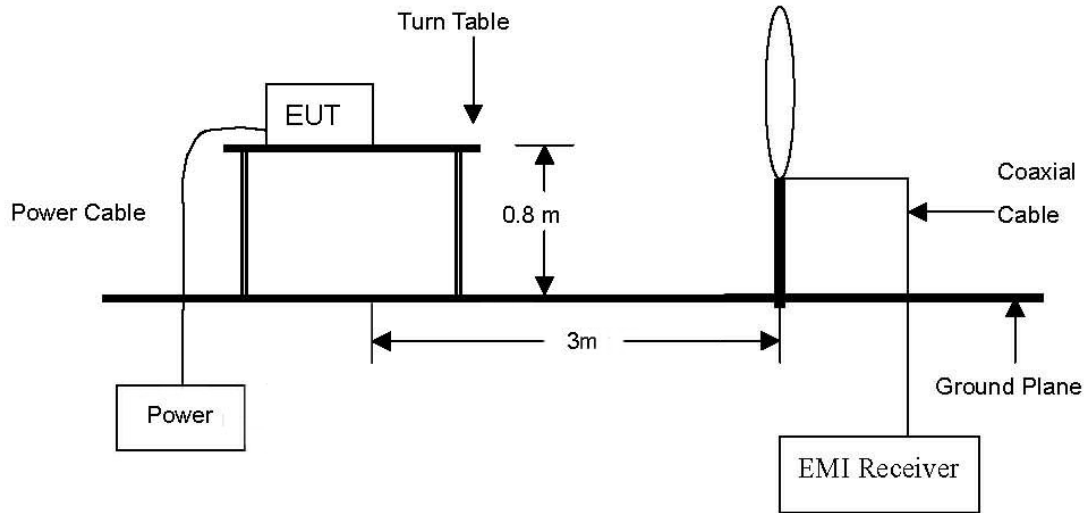
Revision	Report number	Date of Issue	Description
0	F690501/RF-RTL012202	2017.12.26	Initial

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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 from 9 kHz to 30 MHz Emissions.



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2.2. Limits

2.2.1. FCC

2.2.1.1. Radiated emission limits, general requirements

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

** 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 MHz, 76-88 MHz, 174-216 MHz or 470-806 MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g., Sections §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 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector.

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2.2.2. IC

2.2.2.1. Transmitter Emission Limits for Licence-Exempt Radio Apparatus

According to RSS-Gen Issue 4, Section 8.9, except when the requirements applicable to a given device state otherwise, the emissions from licence-exempt transmitters shall comply with the field strength limits shown in Table 4 or Table 5 below. Additionally, the level of any transmitter emission shall not exceed the level of the transmitter's fundamental emission.

Table 4 - General Field Strength Limits for Licence-Exempt Transmitters at Frequencies Above 30 MHz

Frequency (MHz)	Field Strength ($\mu\text{V}/\text{m}$ at 3 metres)
30-88	100
88-216	150
216-960	200
Above 960*	500

* Unless otherwise specified, for all frequencies greater than 1 GHz, the radiated emission limits for licence-exempt radio apparatus stated in applicable RSSs (including RSS-Gen) are based on measurements using a linear average detector function having a minimum resolution bandwidth of 1 MHz. If an average limit is specified for the EUT, then the peak emission shall also be measured with instrumentation properly adjusted for such factors as pulse desensitization to ensure the peak emission is less than 20 dB above the average limit.

Note: Transmitting devices are not permitted in restricted frequency bands unless stated otherwise in the specific RSS.

Table 5 - General Field Strength Limits for Licence-Exempt Transmitters at Frequencies Below 30 MHz

Frequency	Electric Field Strength ($\mu\text{V}/\text{m}$)	Magnetic Field Strength (H-Field) ($\mu\text{A}/\text{m}$)	Measurement Distance (metres)
9-490 kHz	2,400/F (F in kHz)	2,400/377F (F in kHz)	300
490-1,705 kHz	24,000/F (F in kHz)	24,000/377F (F in kHz)	30
1.705-30 MHz	30	N/A	30

Note: The emission limits for the bands 9-90 kHz and 110-490 kHz are based on measurements employing a linear average detector. Transmitting devices are not permitted in restricted frequency bands unless stated otherwise in the relevant RSS.

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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 kHz to 30 MHz

- 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.

Note;

Although these tests were performed other than open field test site, adequate comparison measurements were confirmed against 30 meter open field test site. Therefore sufficient tests were made to demonstrate that the alternative site produces results that correlate with the ones of tests made in an open field based on KDB 414788 D01 Radiated Test Site v01.

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2.4. Field Strength of Fundamental Test Result

Ambient temperature : (23 ± 1) °C
 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 (MHz)	Reading (dB μ V)	Detect Mode	Pol.	Ant. (dB/m)	Cable (dB)	Actual (dB μ V/m) at 3 m	Actual (dB μ V/m) at 300 m	Limit (dB μ V/m) at 300 m	Margin (dB)
DRV Antenna									
0.125	62.30	Average	H	19.69	0.05	82.04	2.04	25.67	23.63
AST Antenna									
0.125	57.90	Average	H	19.69	0.05	77.64	-2.36	25.67	28.03
BUM Antenna									
0.125	59.72	Average	H	19.69	0.05	79.46	-0.54	25.67	26.21
INT1 Antenna									
0.125	57.50	Average	H	19.69	0.05	77.24	-2.76	25.67	28.43
INT2 Antenna									
0.125	59.30	Average	H	19.69	0.05	79.04	-0.96	25.67	26.63
TNK Antenna									
0.125	54.40	Average	H	19.69	0.05	74.14	-5.86	25.67	31.53
SSB Antenna									
0.125	65.50	Average	H	19.69	0.05	85.24	5.24	25.67	20.43

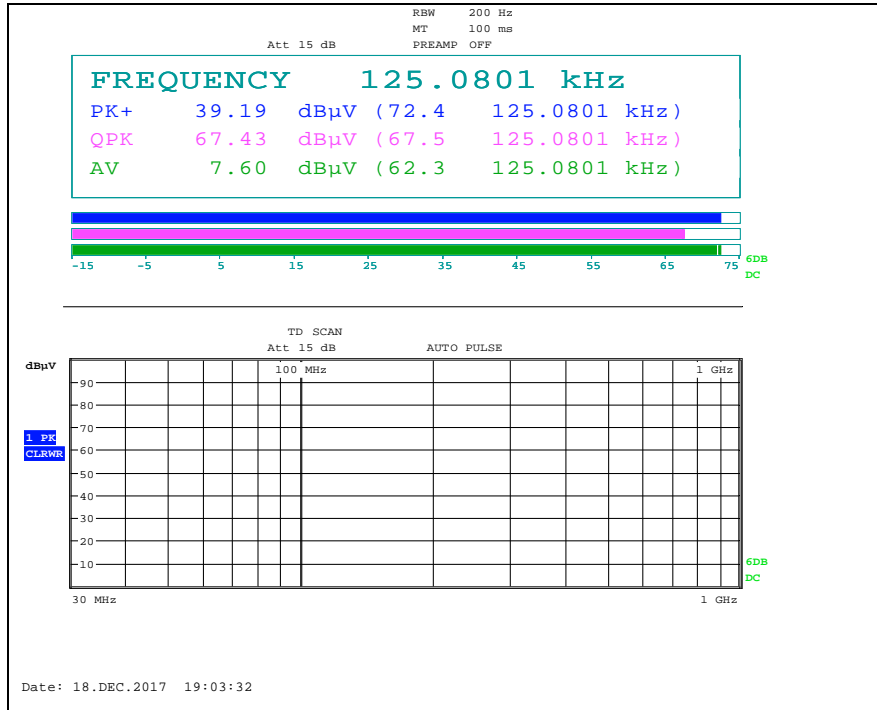
Note;

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

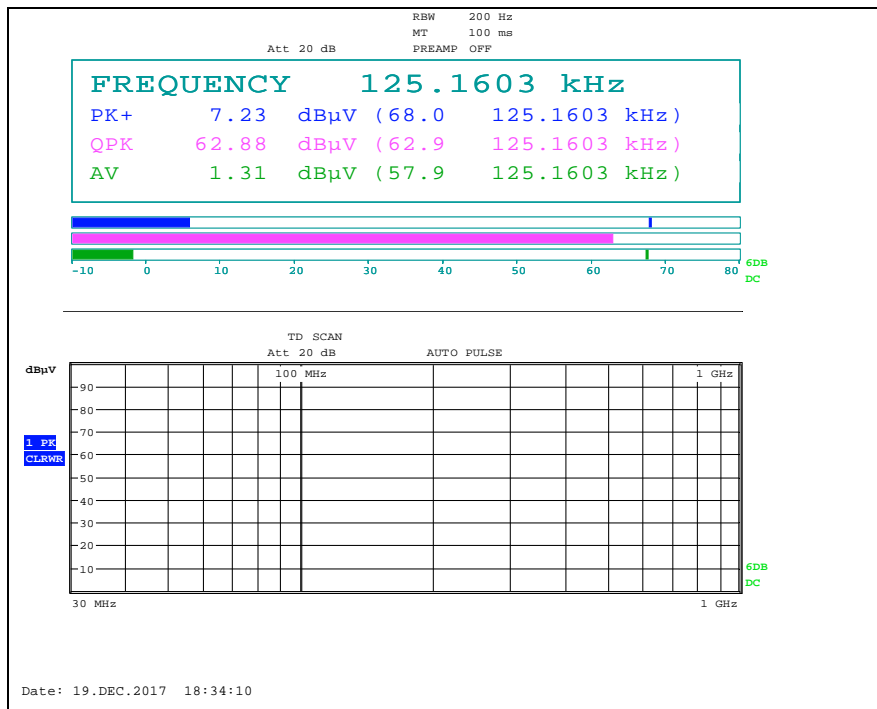
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Test plot

- DRV Antenna

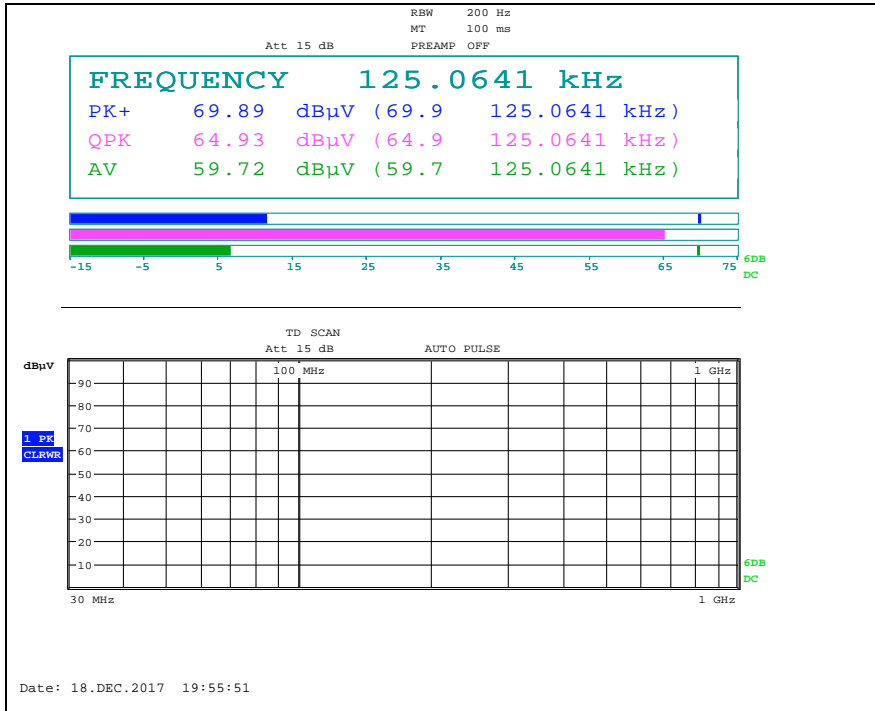


- AST Antenna

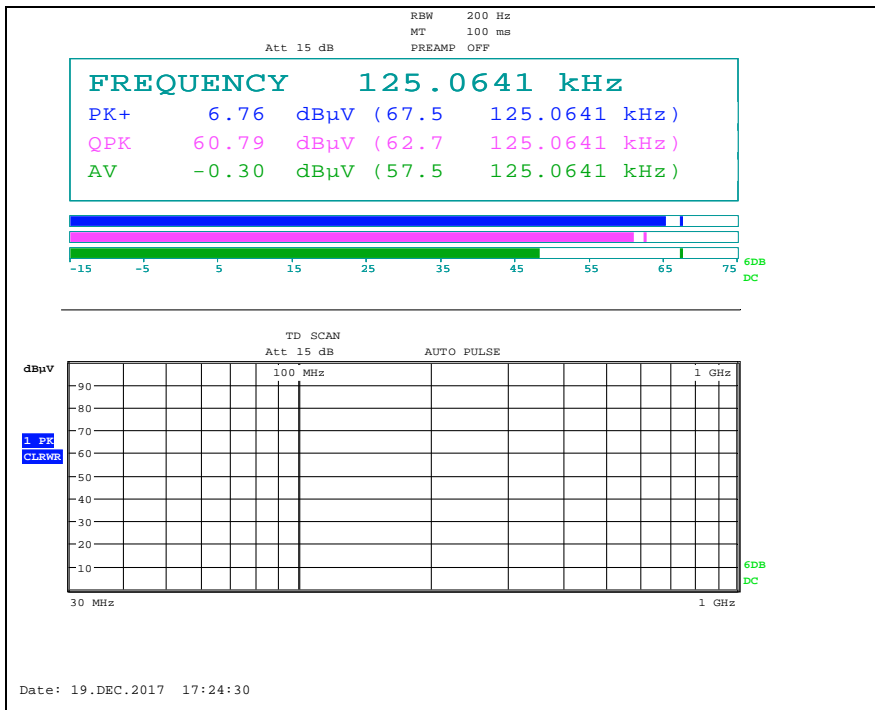


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- BUM Antenna

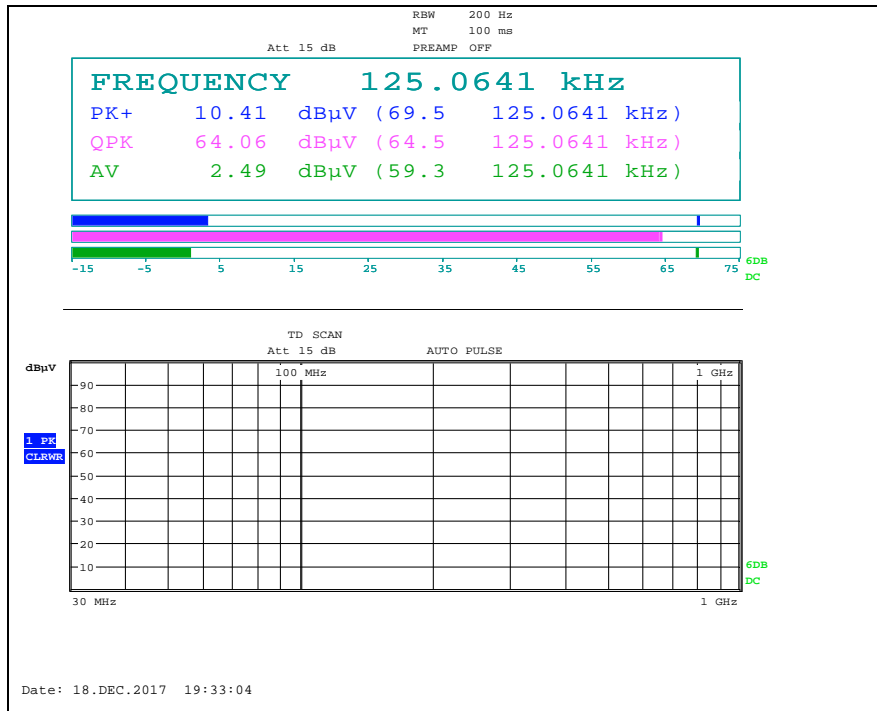


- INT1 Antenna

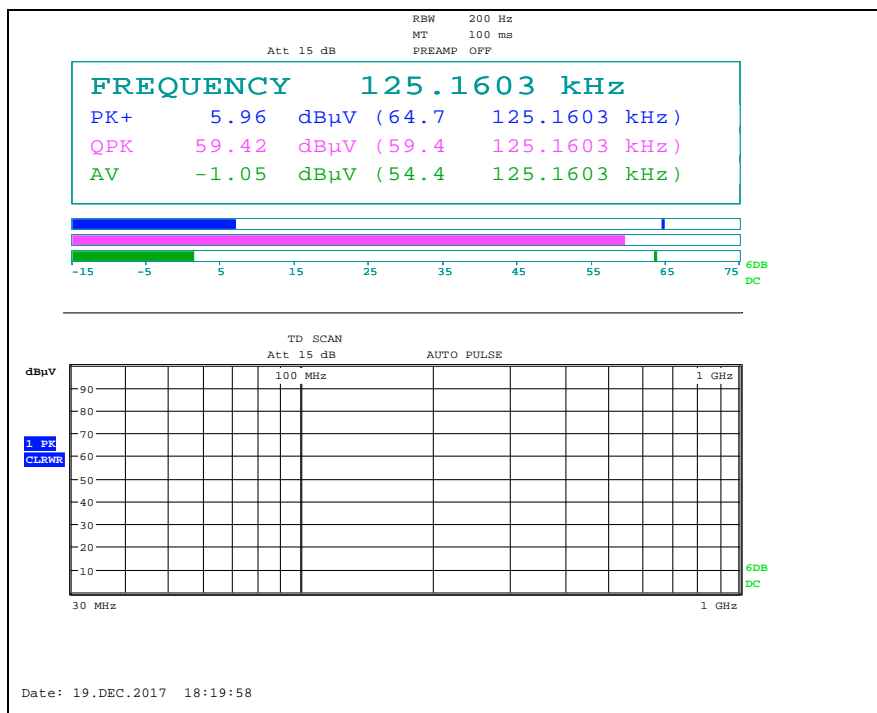


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- INT2 Antenna

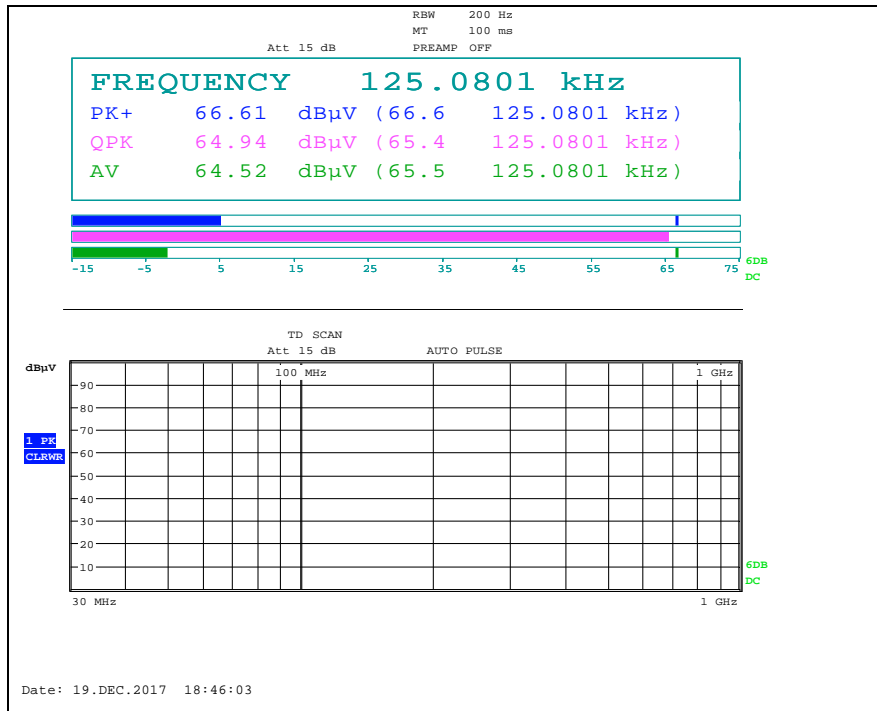


- TNK Antenna



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- SSB Antenna



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2.5. Spurious Emission Test Result

Ambient temperature : (23 ± 1) °C
 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 (MHz)	Reading (dB μ V)	Detect Mode	Pol.	Ant. (dB/m)	Cable (dB)	Actual (dB μ V/m) at 3 m	Actual (dB μ V/m) at 30 m or 300 m	Limit (dB μ V/m) at 30 m or 300 m	Margin (dB)
DRV Antenna									
0.048	24.90	Average	H	19.77	0.02	44.69	-35.31	33.98	69.29
0.069	28.90	Average	H	19.74	0.02	48.66	-31.34	30.83	62.17
0.106	22.80	Quasi-Peak	H	19.70	0.03	42.53	-37.47	27.10	64.57
0.246	14.80	Average	H	19.63	0.10	34.53	-45.47	19.79	65.26
1.495	9.90	Quasi-Peak	H	19.72	0.11	29.73	-10.27	24.11	34.38
Above 2.000	Not detected	-	-	-	-	-	-	-	-
AST Antenna									
0.035	28.80	Average	H	19.79	0.02	48.61	-31.39	36.72	68.11
0.067	21.10	Average	H	19.75	0.02	40.87	-39.13	31.08	70.21
0.098	21.10	Quasi-Peak	H	19.70	0.03	40.83	-39.17	27.78	66.95
1.233	9.30	Quasi-Peak	H	19.71	0.10	29.11	-10.89	25.78	36.67
2.431	13.30	Quasi-Peak	H	19.77	0.13	33.20	-6.80	29.54	36.34
Above 3.000	Not detected	-	-	-	-	-	-	-	-

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Radiated Emissions			Ant.	Correction Factors		Total		Limit	
Frequency (MHz)	Reading (dB μ V)	Detect Mode	Pol.	Ant. (dB/m)	Cable (dB)	Actual (dB μ V/m) at 3 m	Actual (dB μ V/m) at 30 m or 300 m	Limit (dB μ V/m) at 30 m or 300 m	Margin (dB)
BUM Antenna									
0.046	27.90	Average	H	19.78	0.02	47.70	-32.30	34.35	66.65
0.069	31.00	Average	H	19.74	0.02	50.76	-29.24	30.83	60.07
0.105	27.50	Quasi-Peak	H	19.70	0.03	47.23	-32.77	27.18	59.95
1.429	7.70	Quasi-Peak	H	19.72	0.11	27.53	-12.47	24.50	36.97
Above 2.000	Not detected	-	-	-	-	-	-	-	-
INT1 Antenna									
0.035	27.60	Average	H	19.79	0.02	47.41	-32.59	36.72	69.31
0.067	19.90	Average	H	19.75	0.02	39.67	-40.33	31.08	71.41
0.098	17.10	Quasi-Peak	H	19.70	0.03	36.83	-43.17	27.78	70.95
0.679	13.50	Quasi-Peak	H	19.64	0.10	33.24	-6.76	30.97	37.73
2.400	13.50	Quasi-Peak	H	19.77	0.12	33.39	-6.61	29.54	36.15
Above 3.000	Not detected	-	-	-	-	-	-	-	-
INT2 Antenna									
0.047	26.80	Average	H	19.78	0.02	46.60	-33.40	34.16	67.56
0.069	29.90	Average	H	19.74	0.02	49.66	-30.34	30.83	61.17
0.106	27.50	Quasi-Peak	H	19.70	0.03	47.23	-32.77	27.10	59.87
0.610	12.90	Quasi-Peak	H	19.62	0.10	32.62	-7.38	31.90	39.28
Above 1.000	Not detected	-	-	-	-	-	-	-	-

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Radiated Emissions			Ant.	Correction Factors		Total		Limit	
Frequency (MHz)	Reading (dB μ V)	Detect Mode	Pol.	Ant. (dB/m)	Cable (dB)	Actual (dB μ V/m) at 3 m	Actual (dB μ V/m) at 30 m or 300 m	Limit (dB μ V/m) at 30 m or 300 m	Margin (dB)
TNK Antenna									
0.035	26.80	Average	H	19.79	0.02	46.61	-33.39	36.72	70.11
0.067	20.20	Average	H	19.75	0.02	39.97	-40.03	31.08	71.11
0.106	28.00	Quasi-Peak	H	19.70	0.03	47.73	-32.27	27.10	59.37
0.417	7.30	Average	H	19.60	0.10	27.00	-53.00	15.20	68.20
2.482	11.90	Quasi-Peak	H	19.77	0.13	31.80	-8.20	29.54	37.74
Above 3.000	Not detected	-	-	-	-	-	-	-	-
SSB Antenna									
0.035	24.30	Average	H	19.79	0.02	44.11	-35.89	36.72	72.61
0.067	18.20	Average	H	19.75	0.02	37.97	-42.03	31.08	73.11
0.100	18.40	Quasi-Peak	H	19.70	0.03	38.13	-41.87	27.60	69.47
0.374	30.20	Average	H	19.60	0.10	49.90	-30.10	16.15	46.25
0.625	22.00	Quasi-Peak	H	19.63	0.10	41.73	1.73	31.69	29.96
2.427	12.30	Quasi-Peak	H	19.77	0.12	32.19	-7.81	29.54	37.35
Above 3.000	Not detected	-	-	-	-	-	-	-	-

Note;

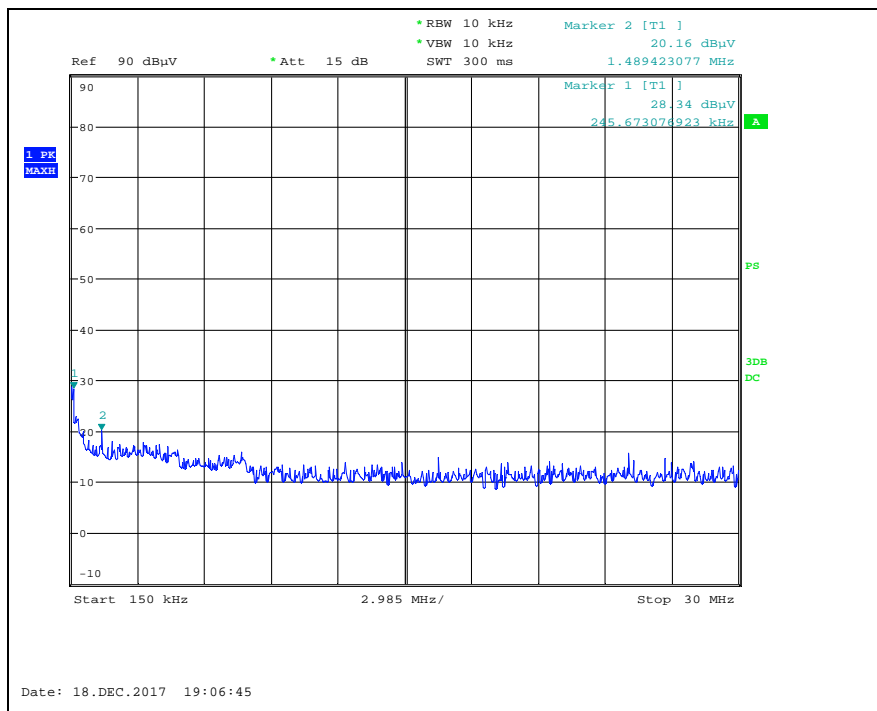
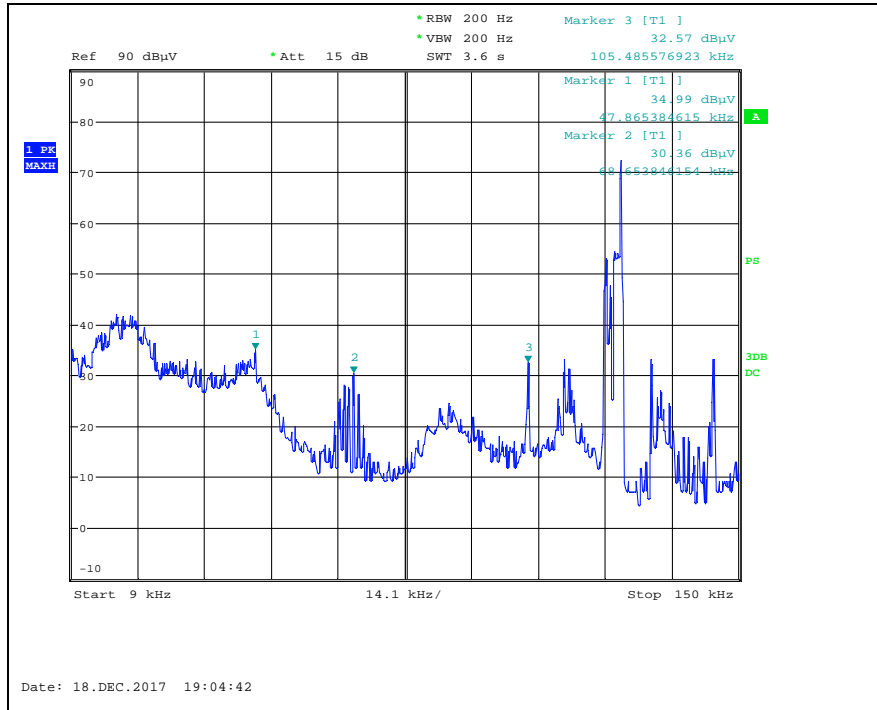
- According to §15.31 (f)(2)
 - 300 m Result (dB μ V/m) = 3 m Result (dB μ V/m) - 40log(300/3) (dB μ V/m)
 - 30 m Result (dB μ V/m) = 3 m Result (dB μ V/m) - 40log(30/3) (dB μ V/m)
- According to field strength table of general requirement in §15.209 (a), field strength limits below 1.705 MHz were calculated as below.
 - 9 kHz to 490 kHz: 20log(2 400 / F (kHz)) at 300 m (dB μ V/m)
 - 490 kHz to 1 705 kHz: 20log(24 000 / F (kHz)) at 30 m (dB μ V/m)
- According to §15.209 (d), the measurements were tested by using Quasi peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1 GHz in these three bands on measurements employing an average detector.

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Test plots

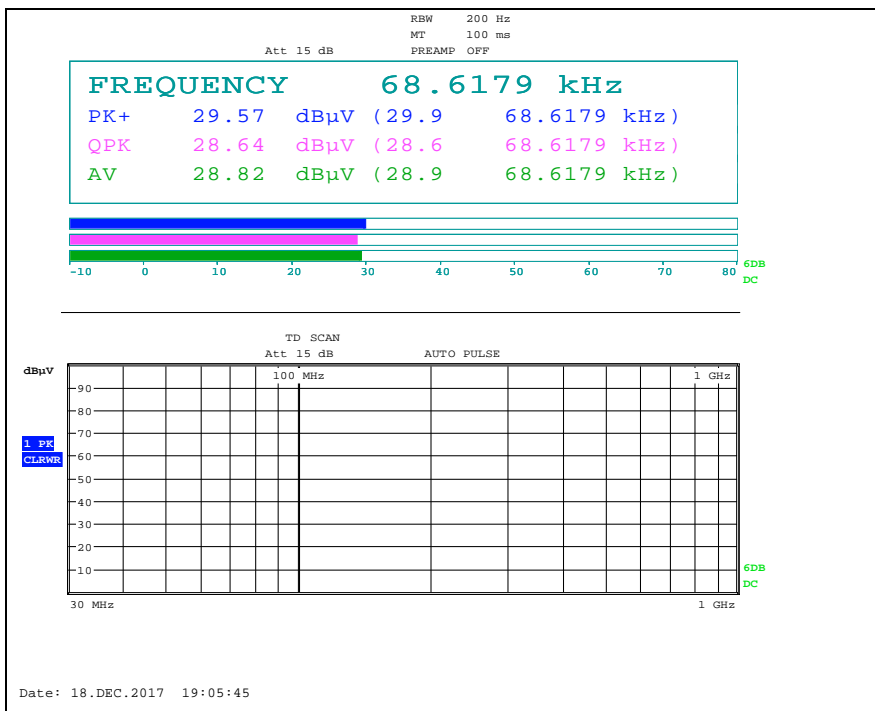
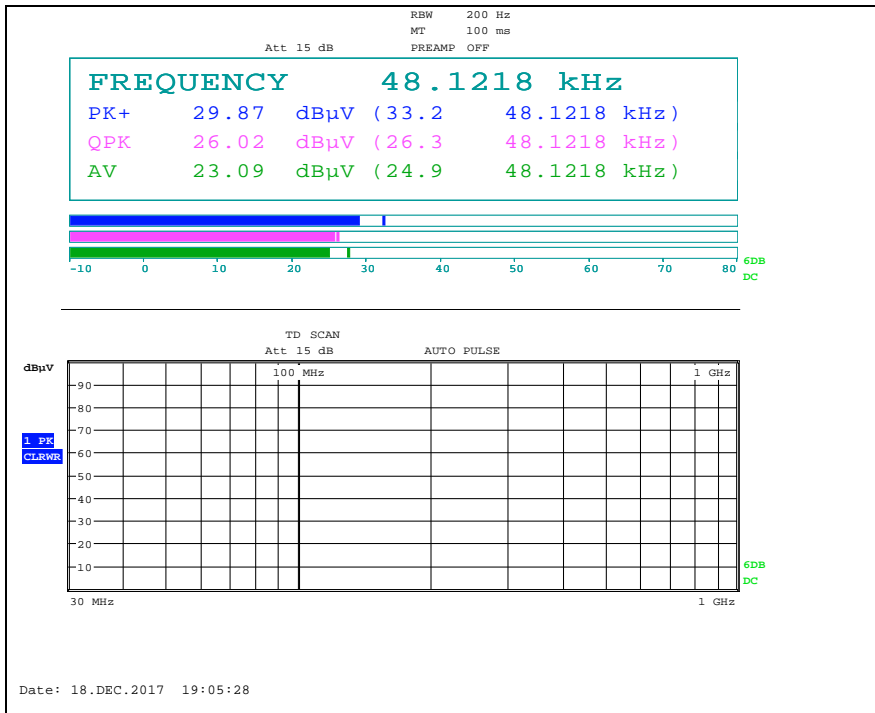
- DRV Antenna

Scanning plots below 30 MHz

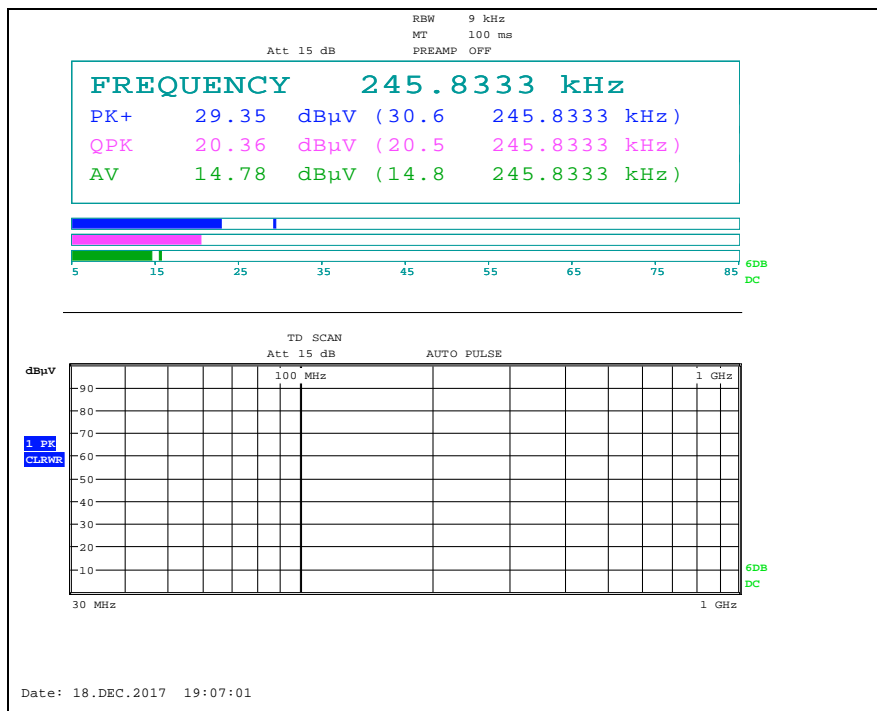
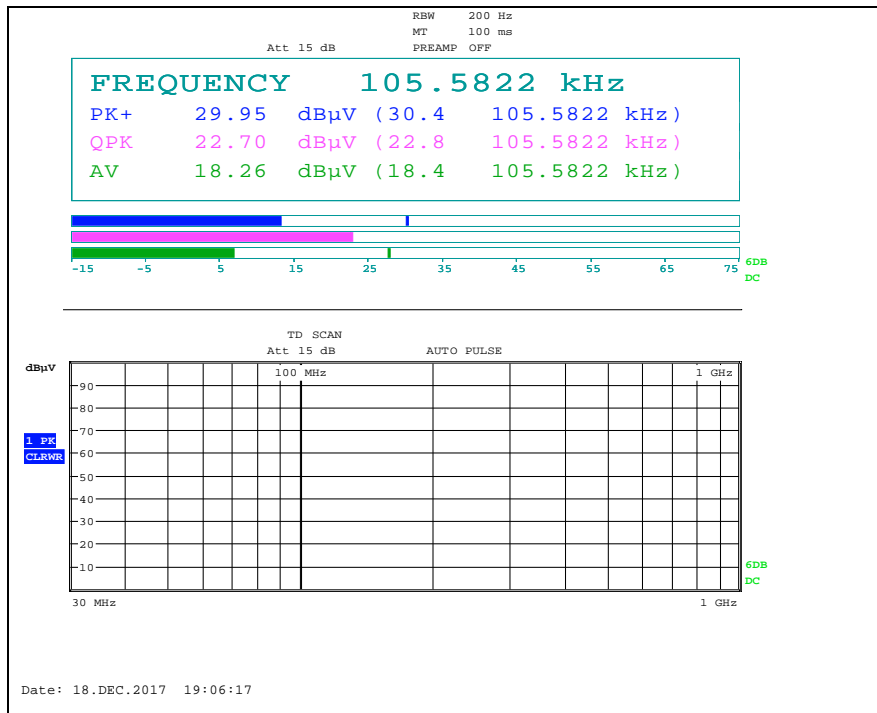


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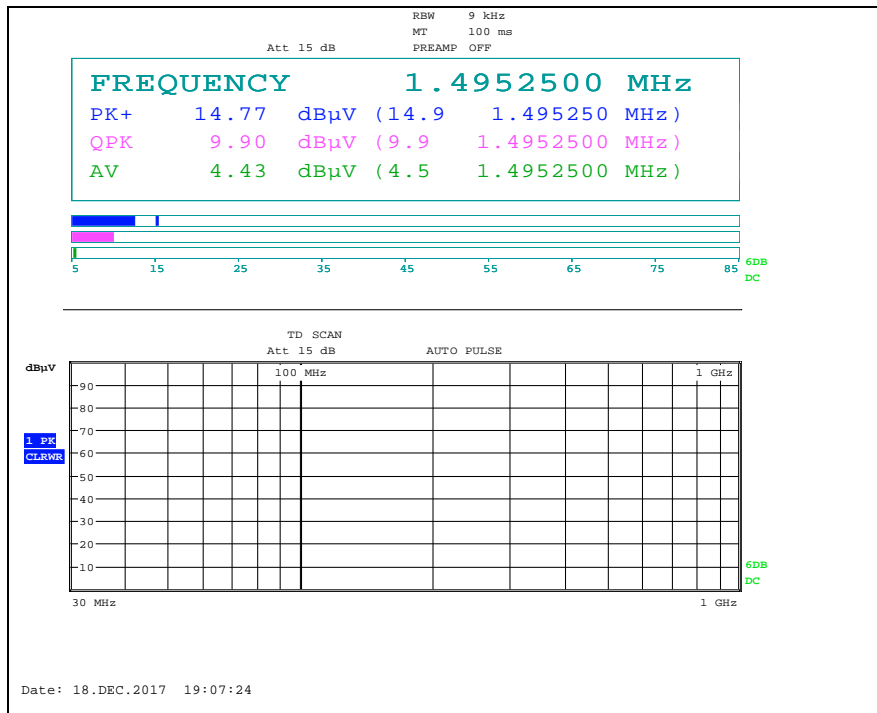
Measured plots below 30 MHz



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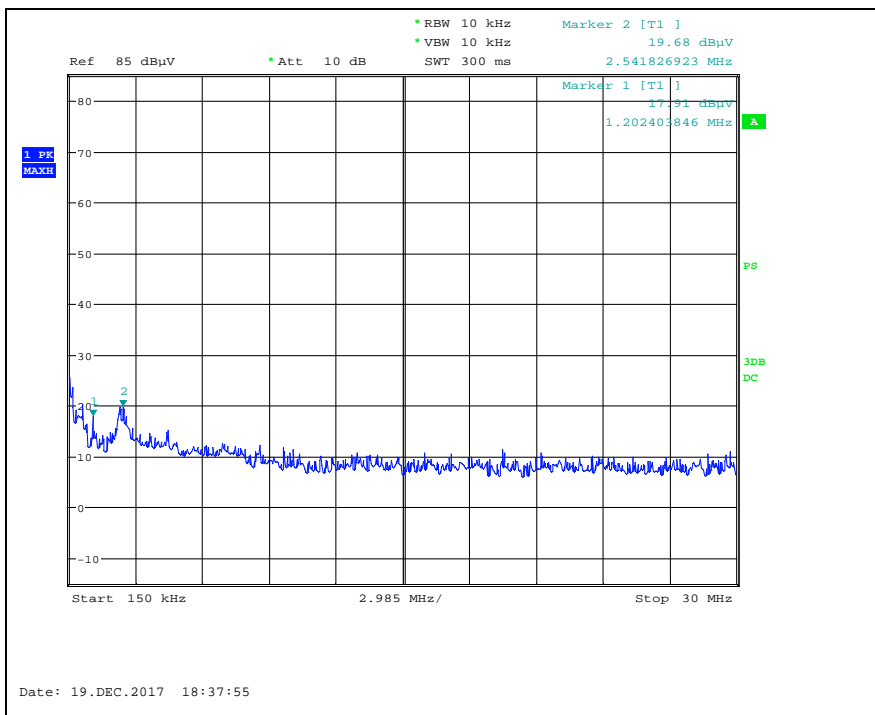
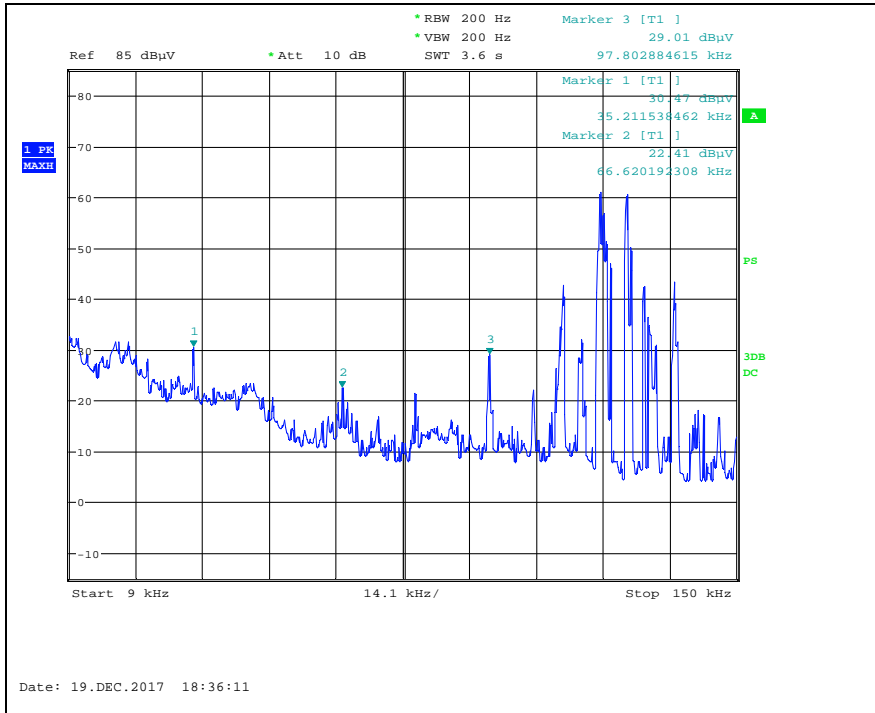
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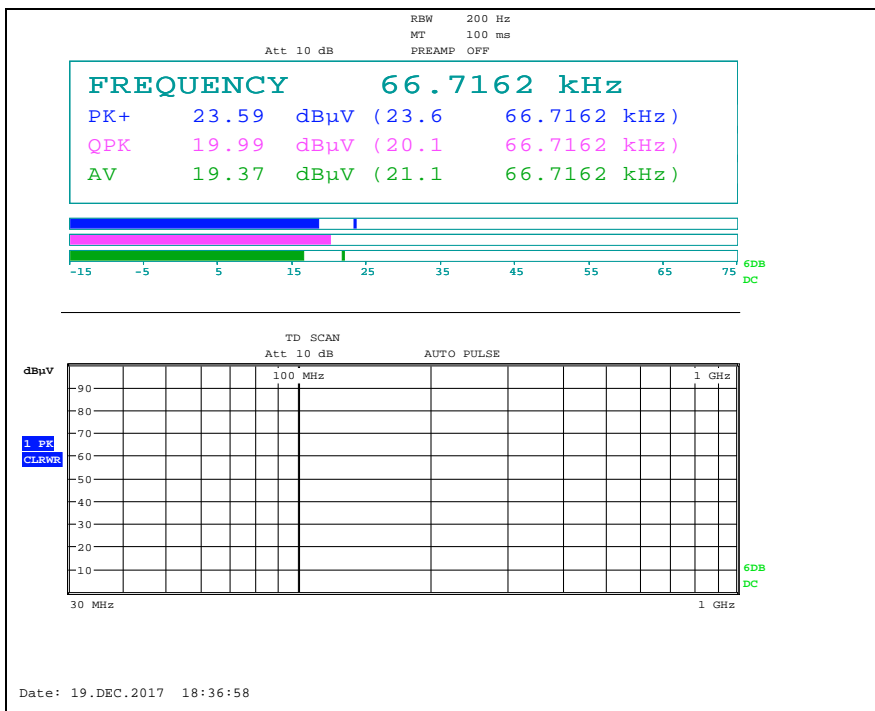
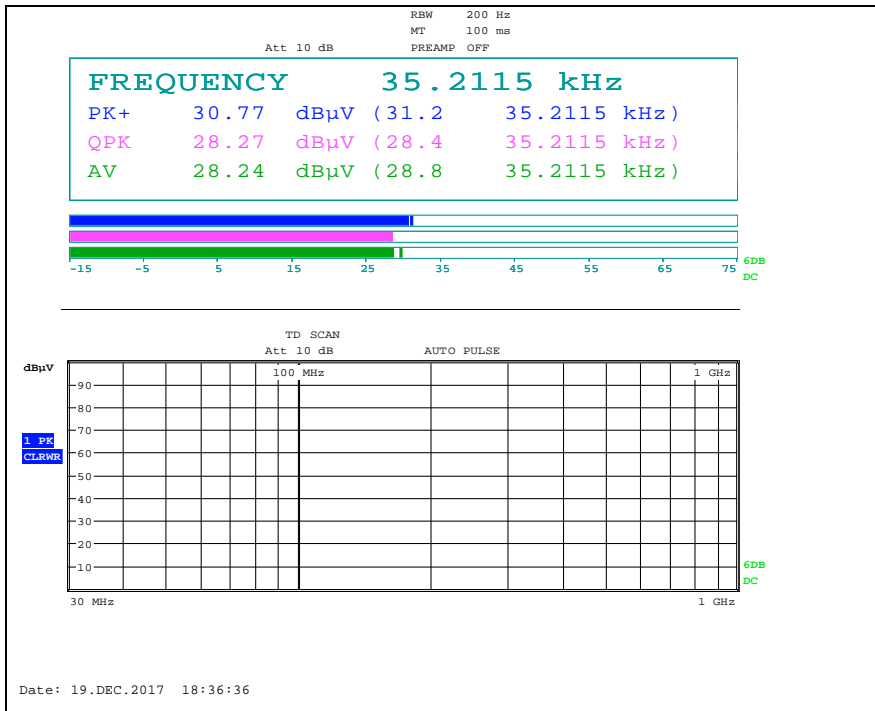
- AST Antenna

Scanning plots below 30 MHz

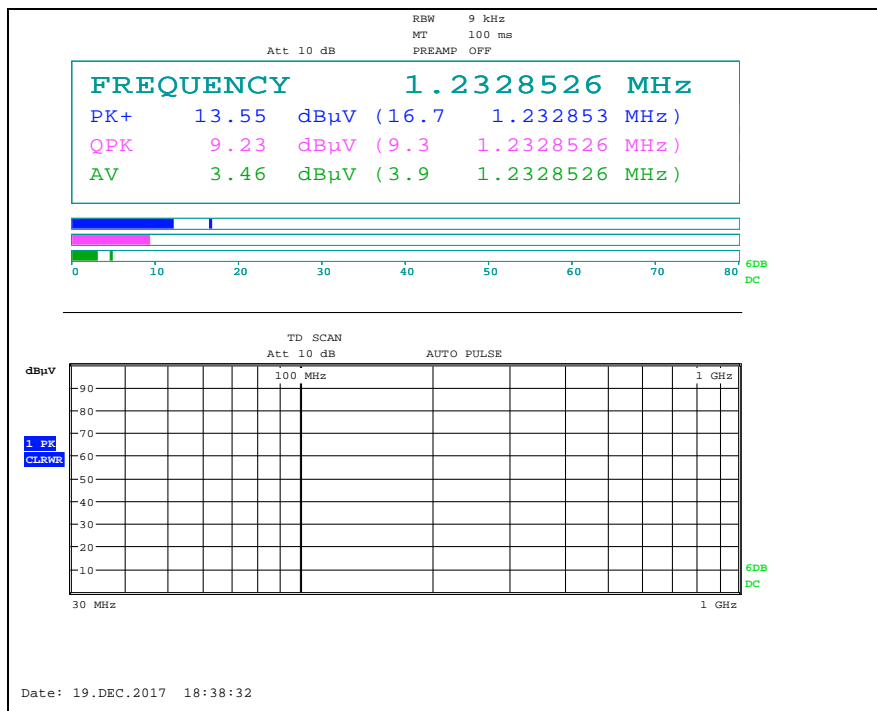
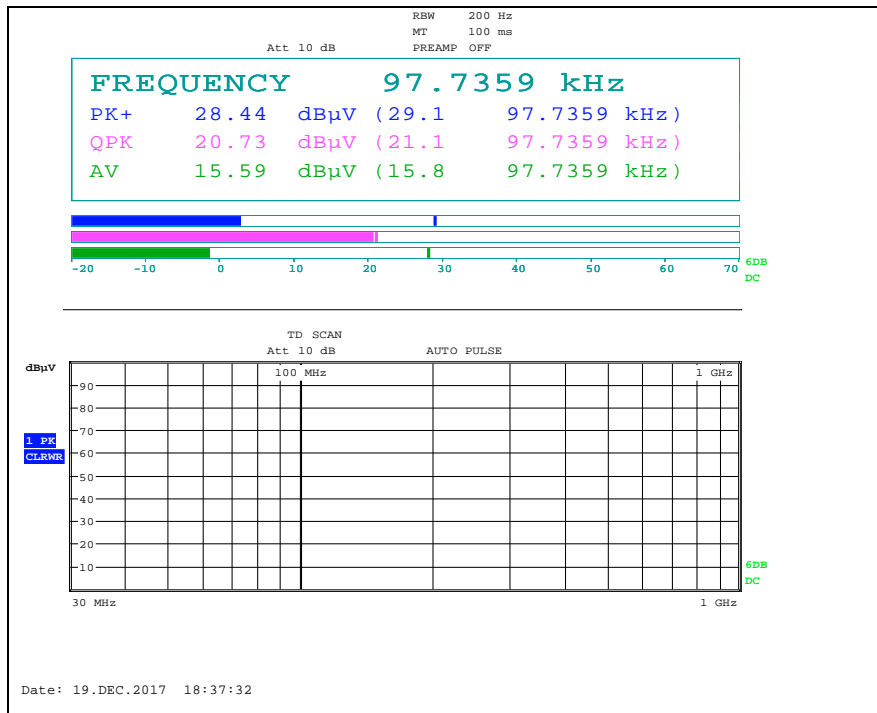


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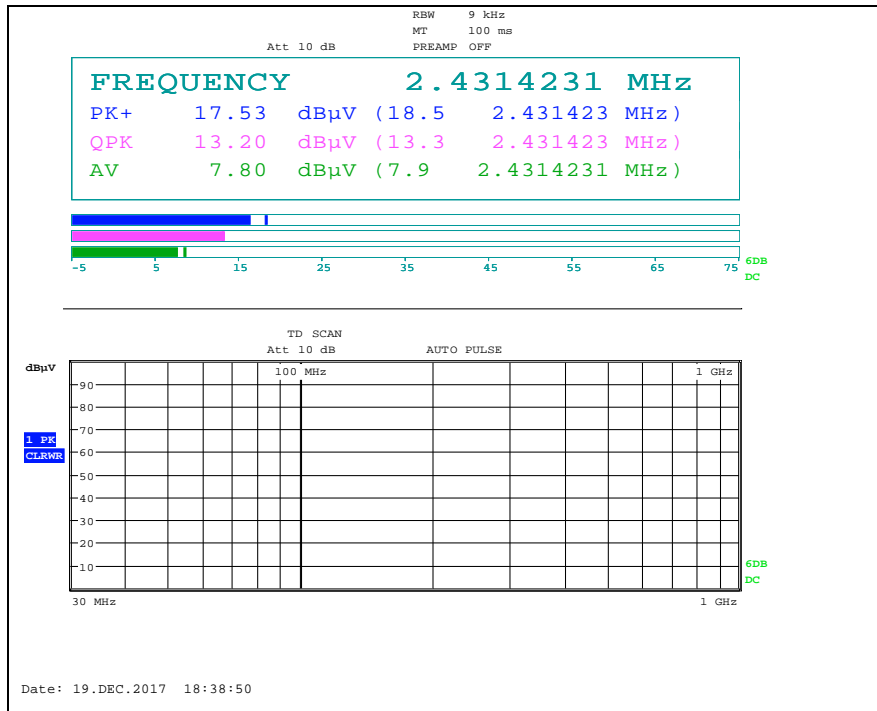
Measured plots below 30 MHz



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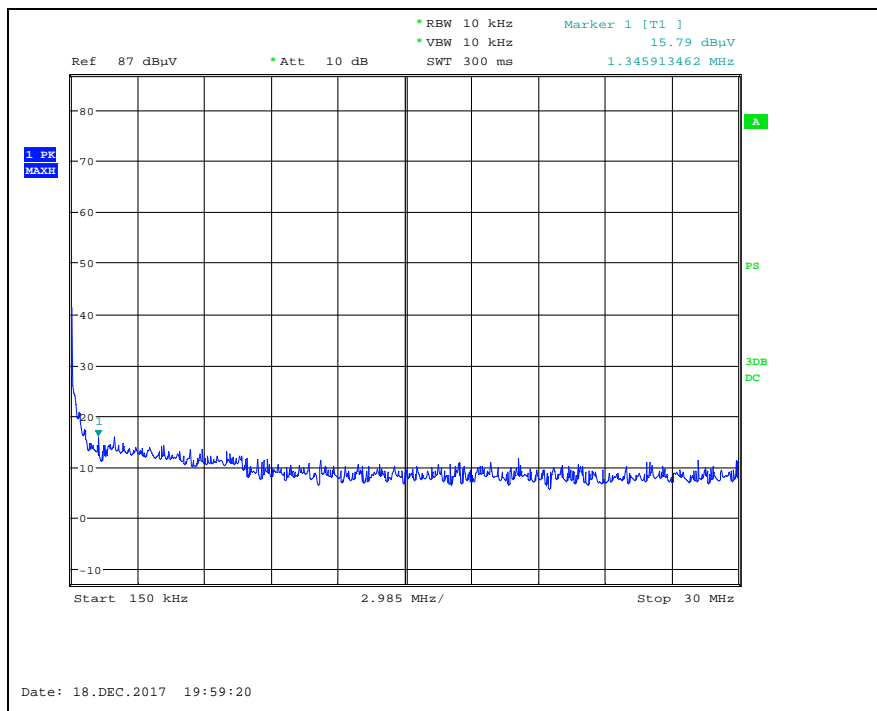
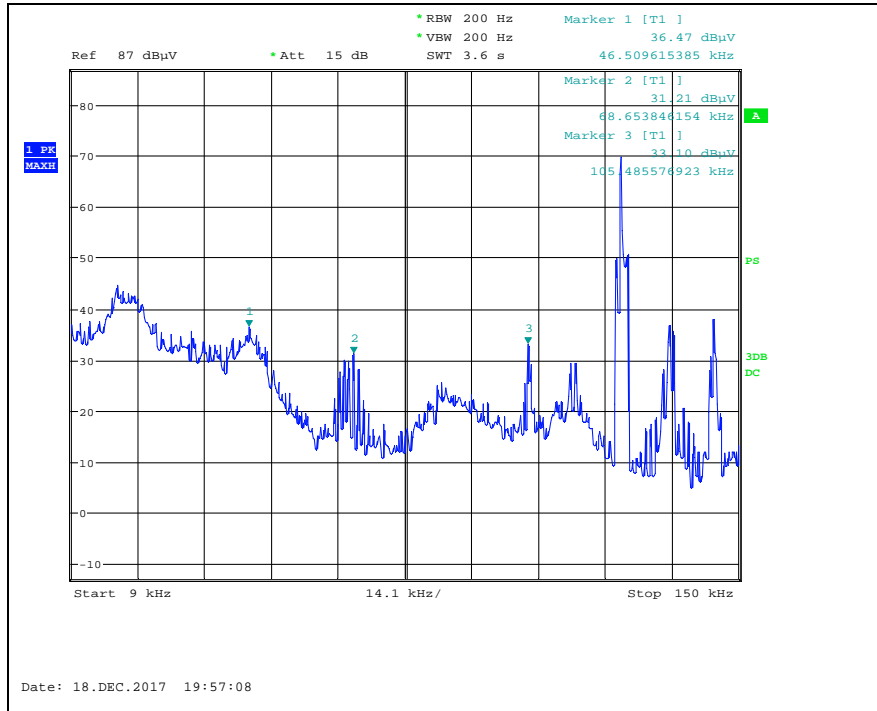
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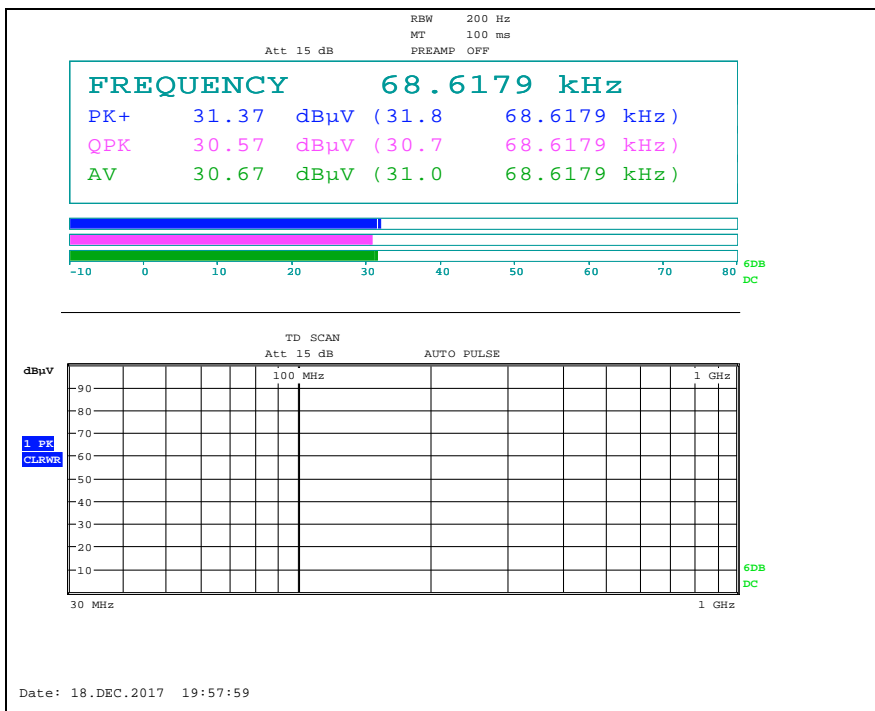
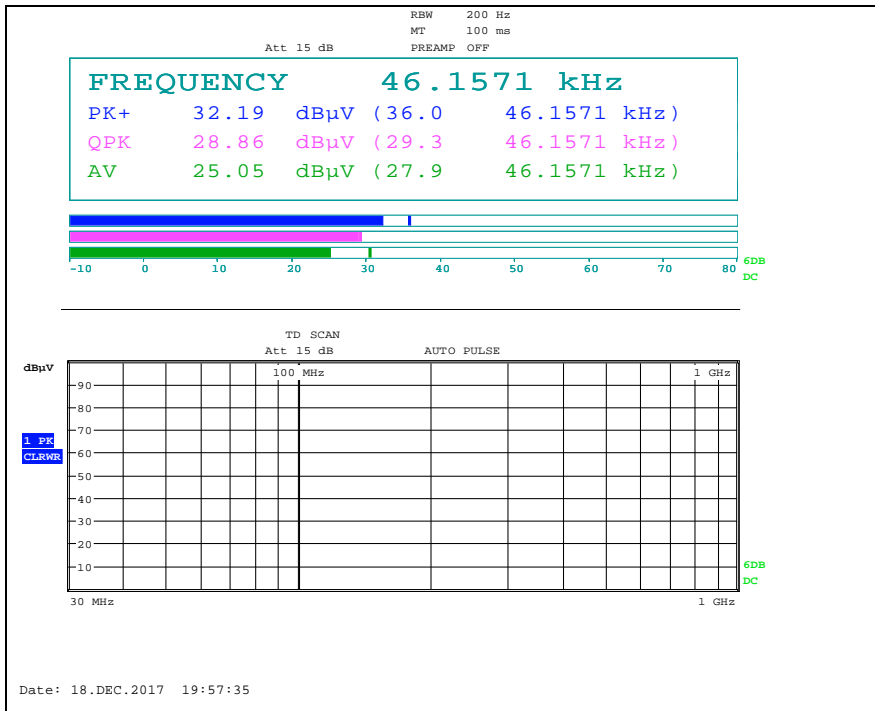
- BUM Antenna

Scanning plots below 30 MHz

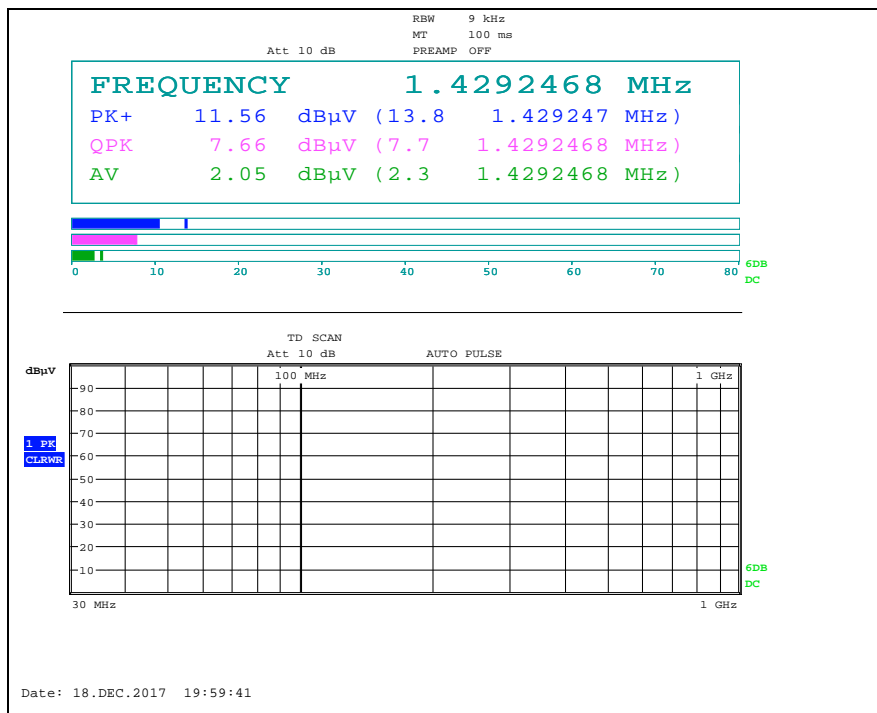
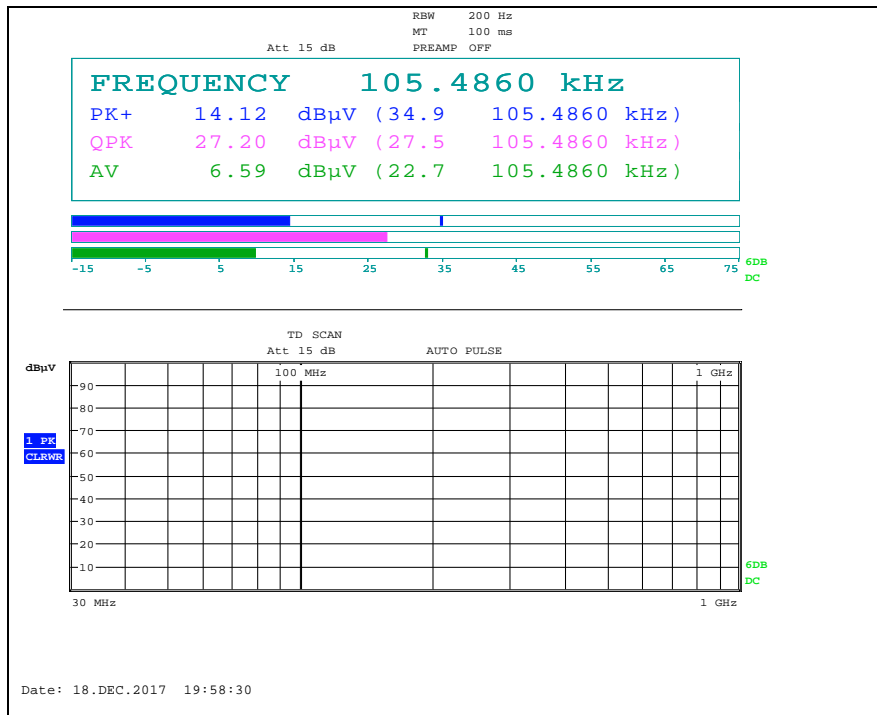


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Measured plots below 30 MHz



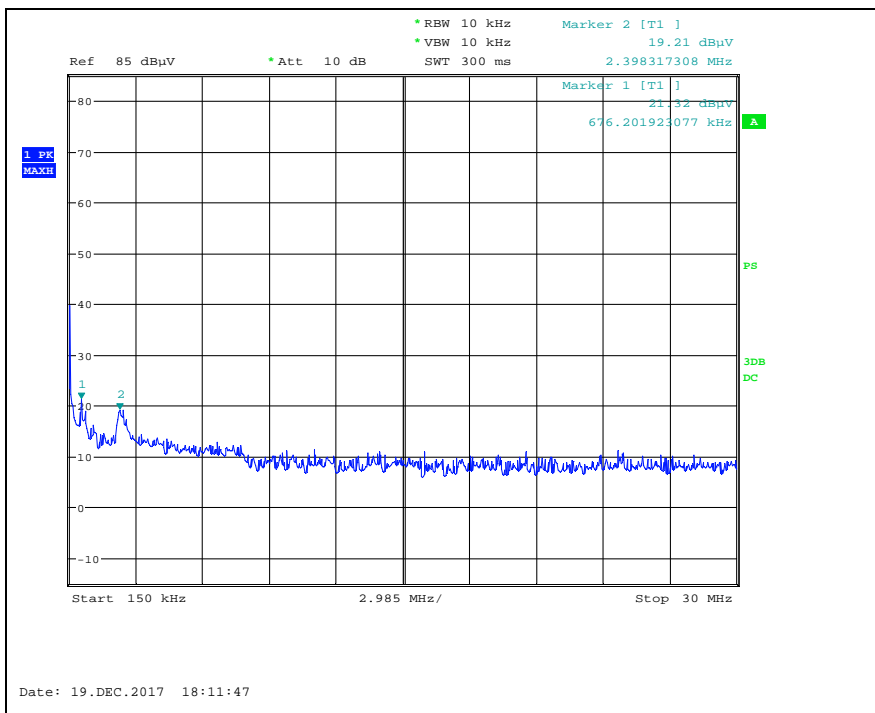
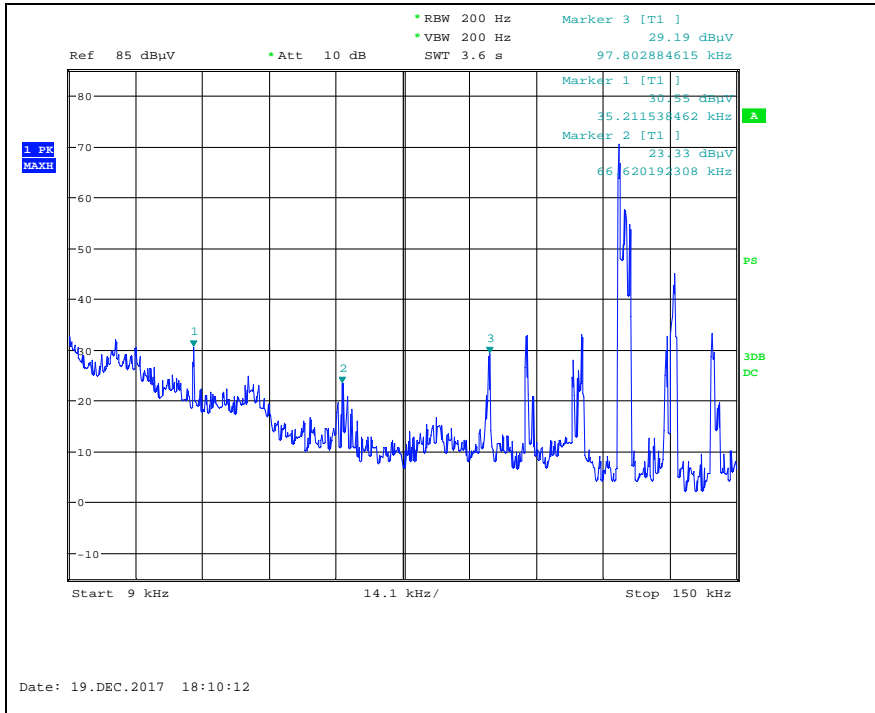
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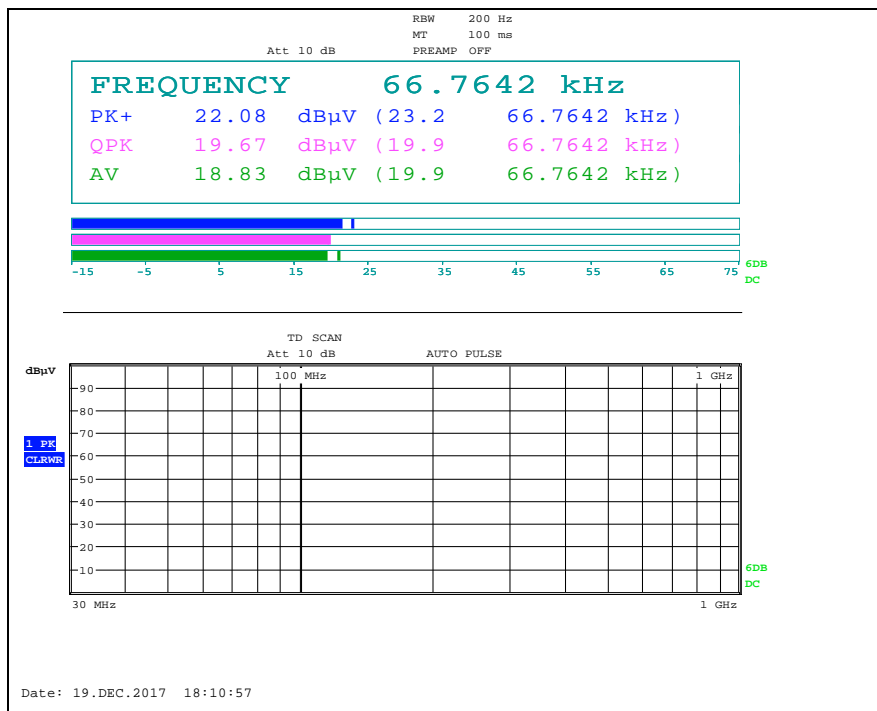
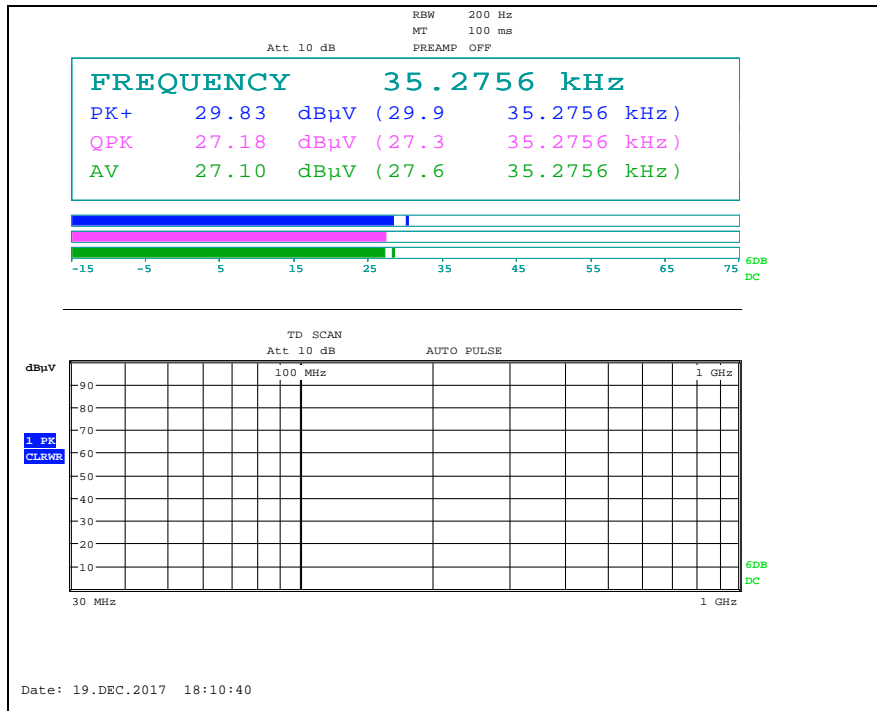
- INT1 Antenna

Scanning plots below 30 MHz

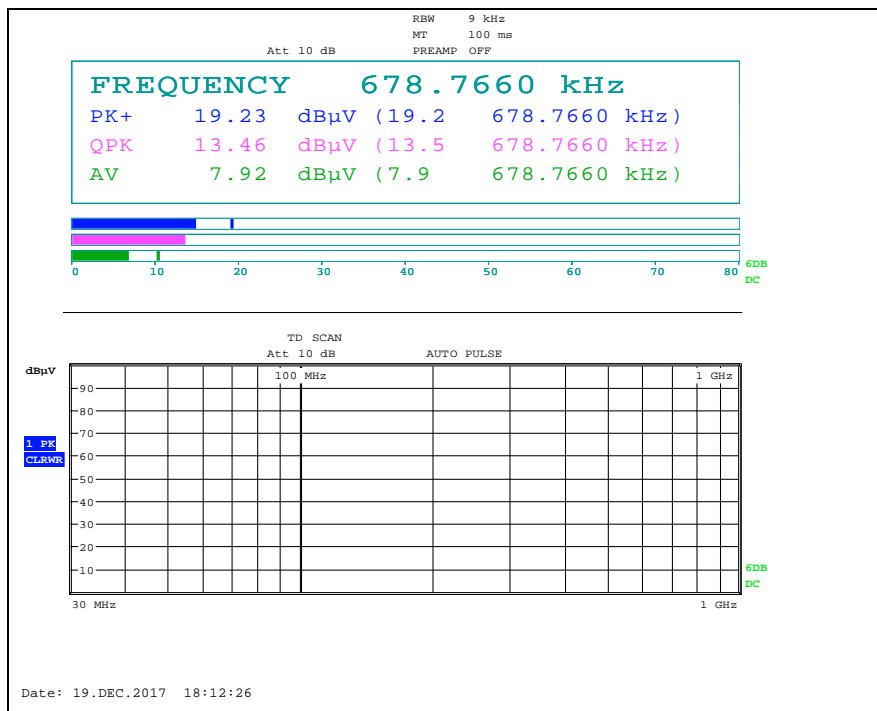
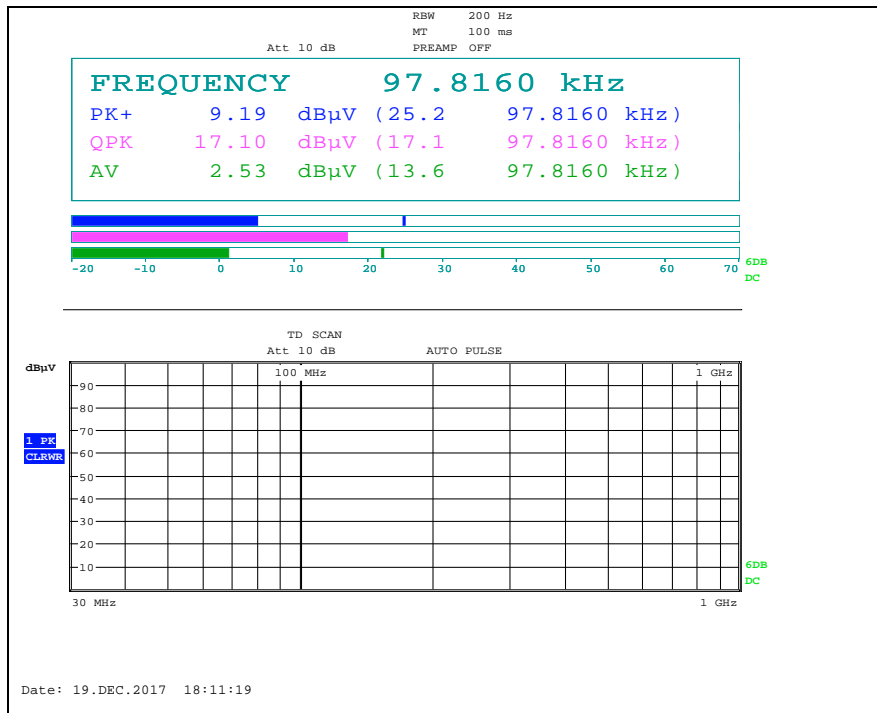


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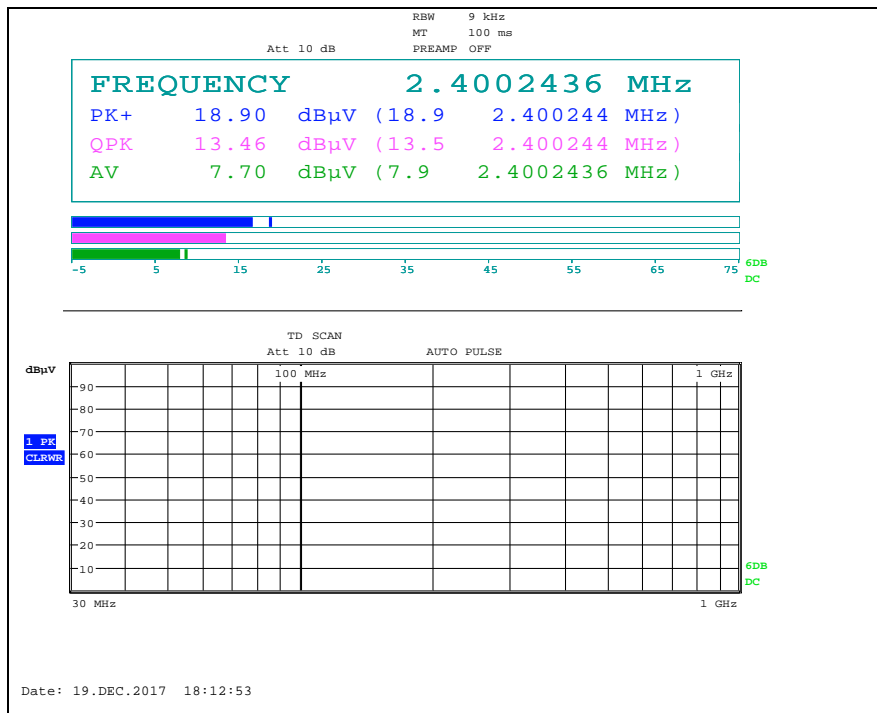
Measured plots below 30 MHz



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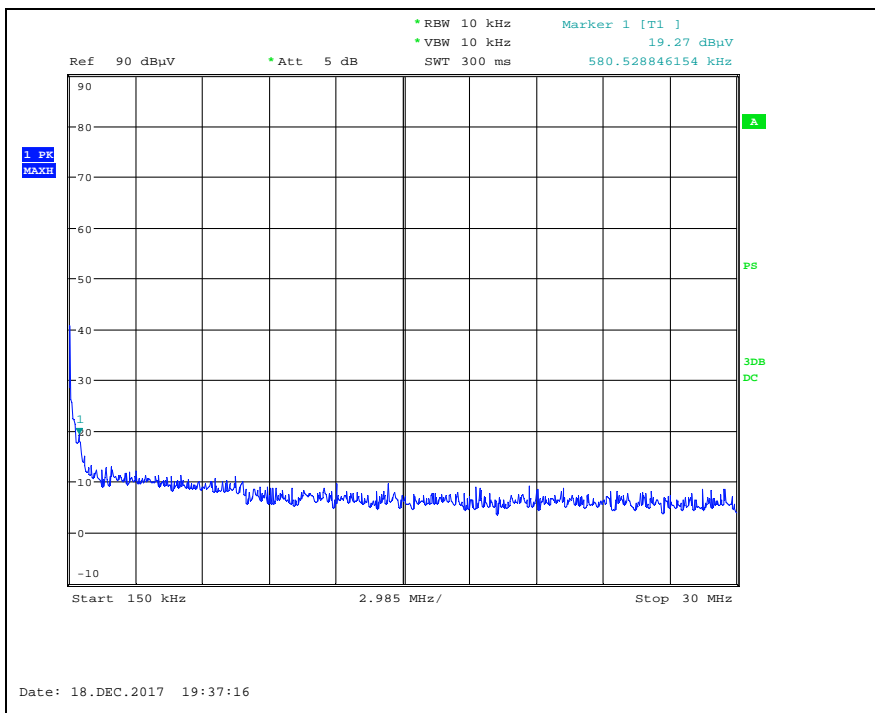
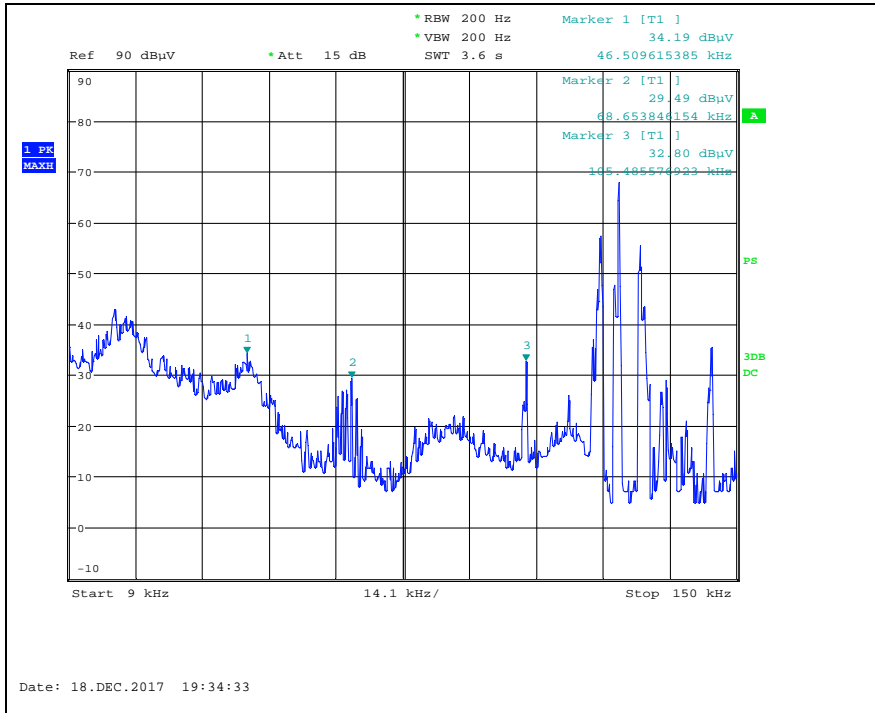
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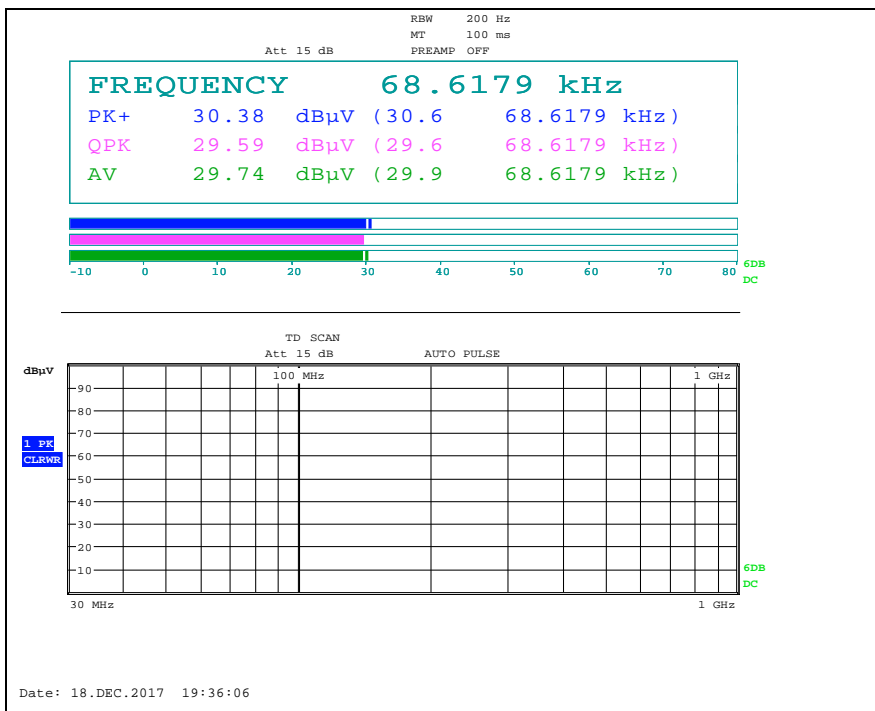
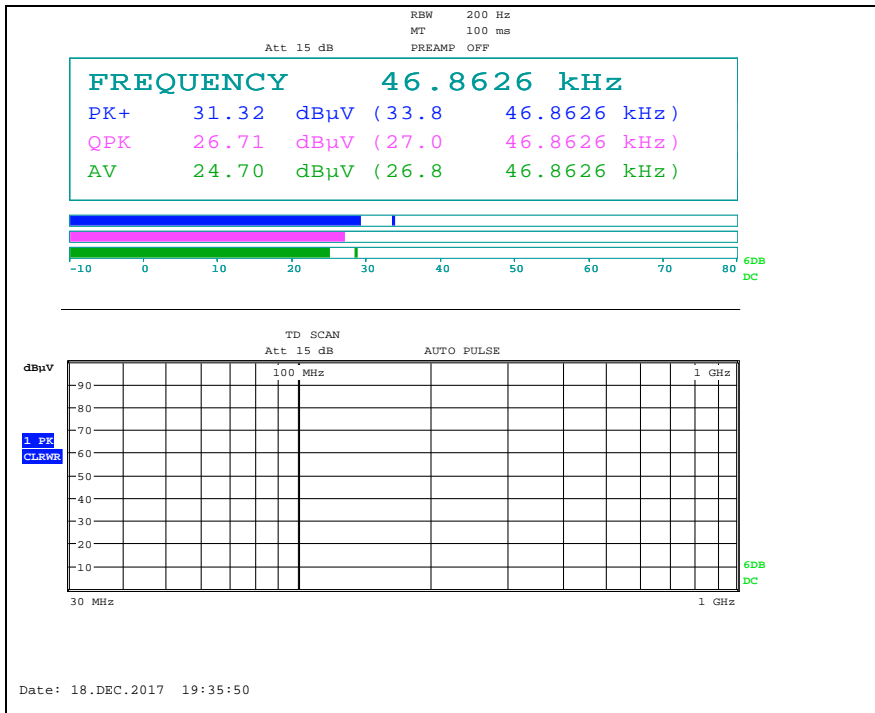
- INT2 Antenna

Scanning plots below 30 MHz

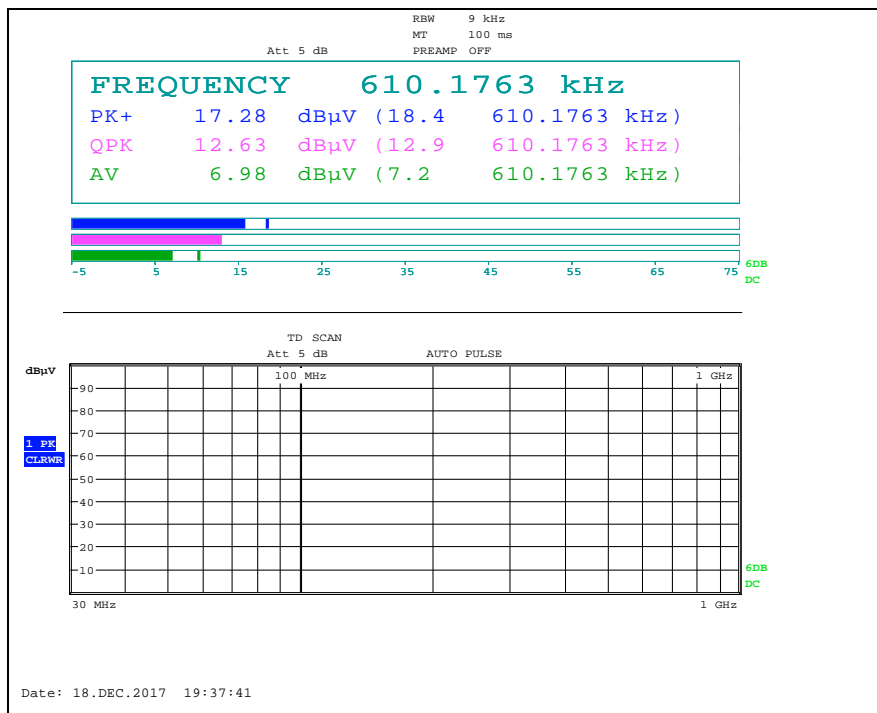
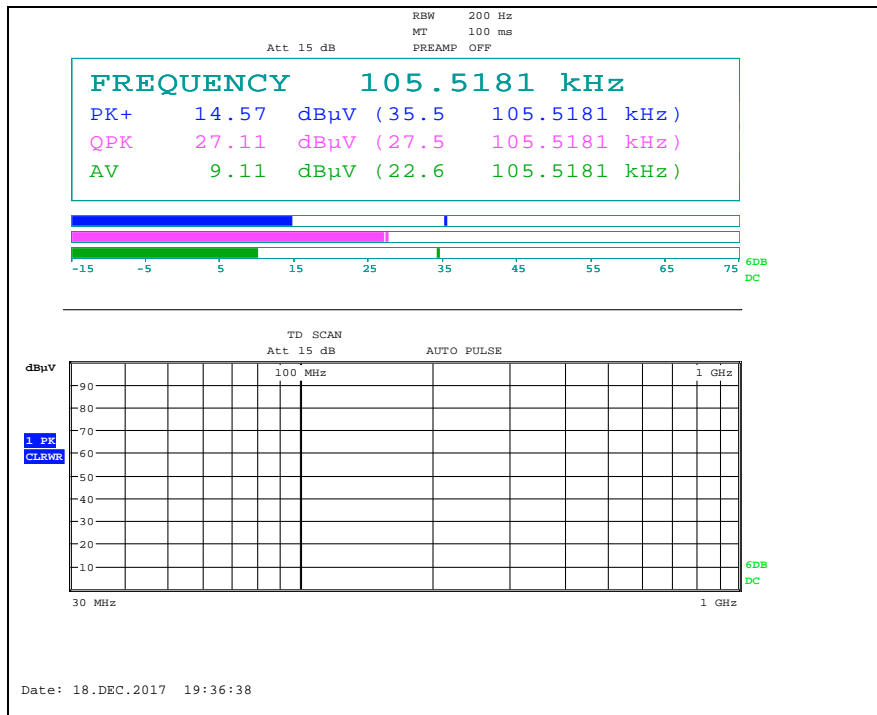


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Measured plots below 30 MHz



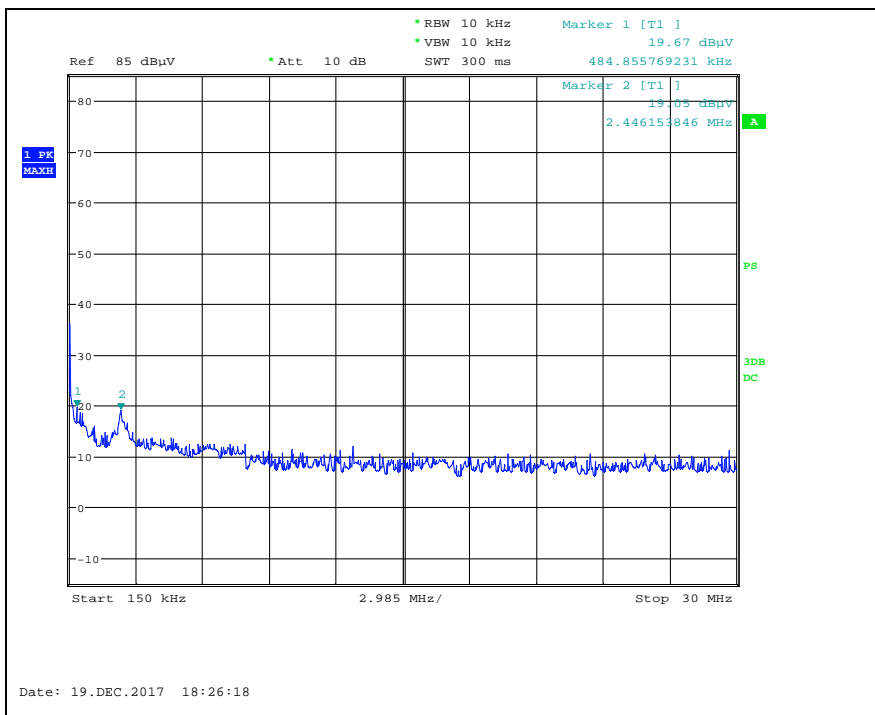
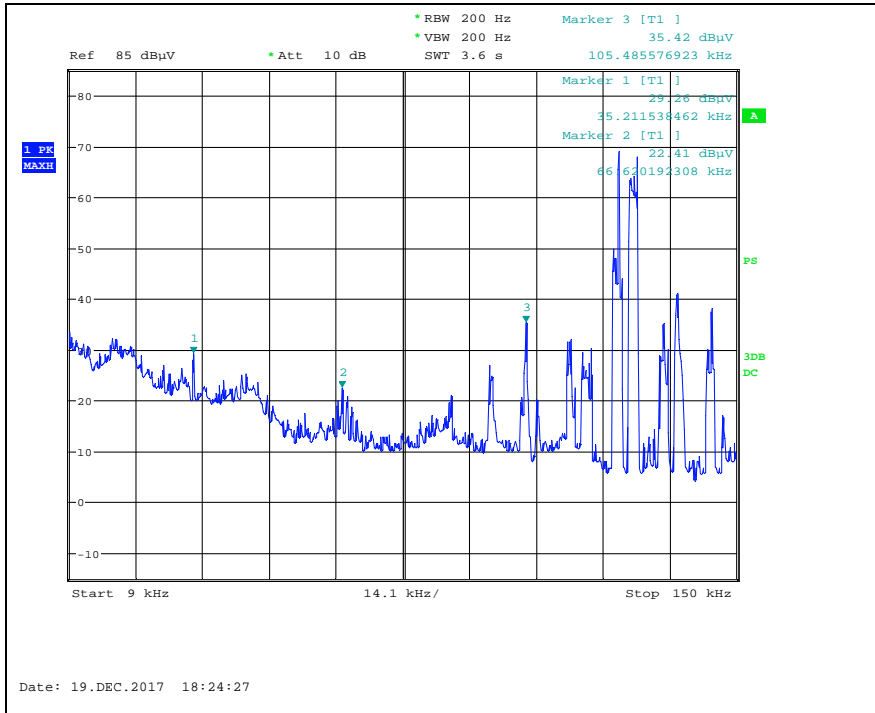
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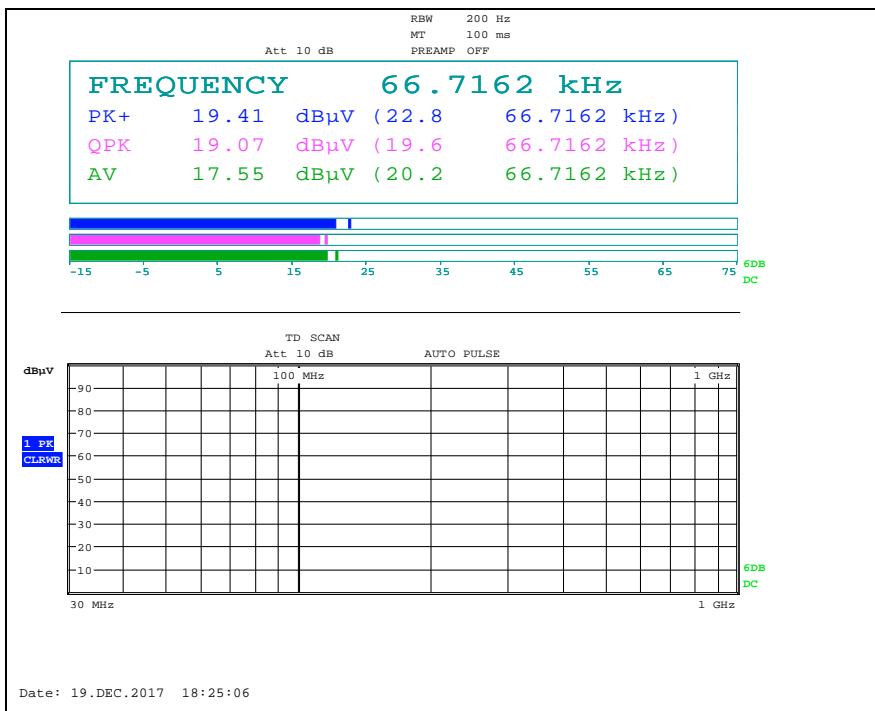
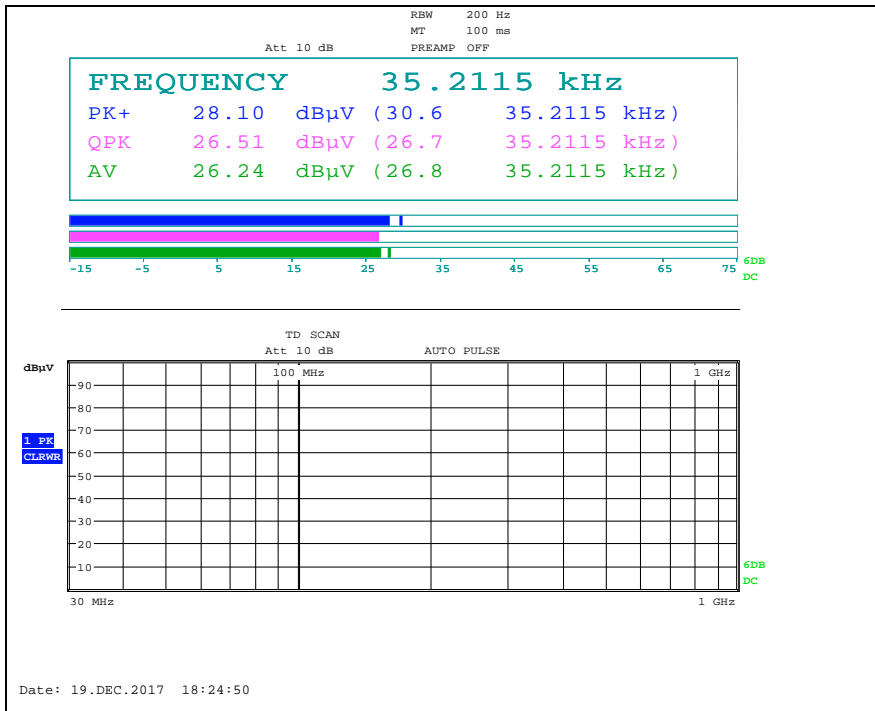
- TNK Antenna

Scanning plots below 30 MHz

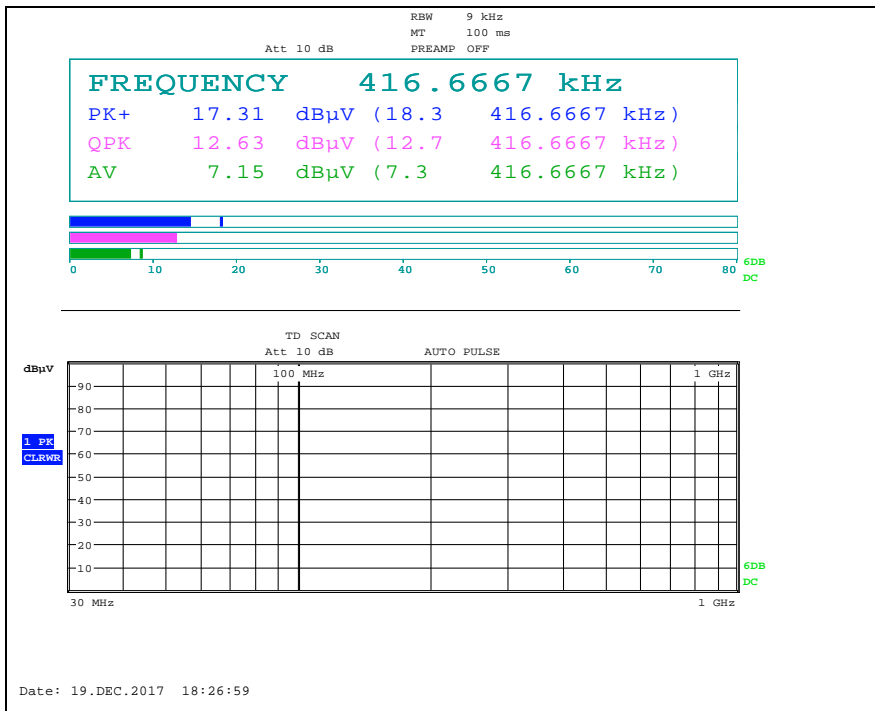
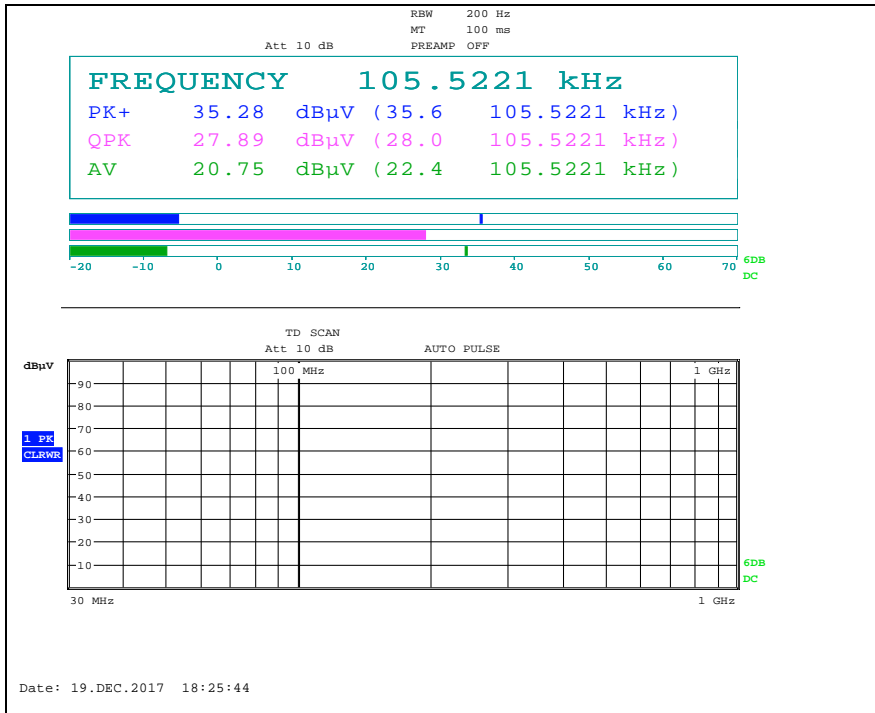


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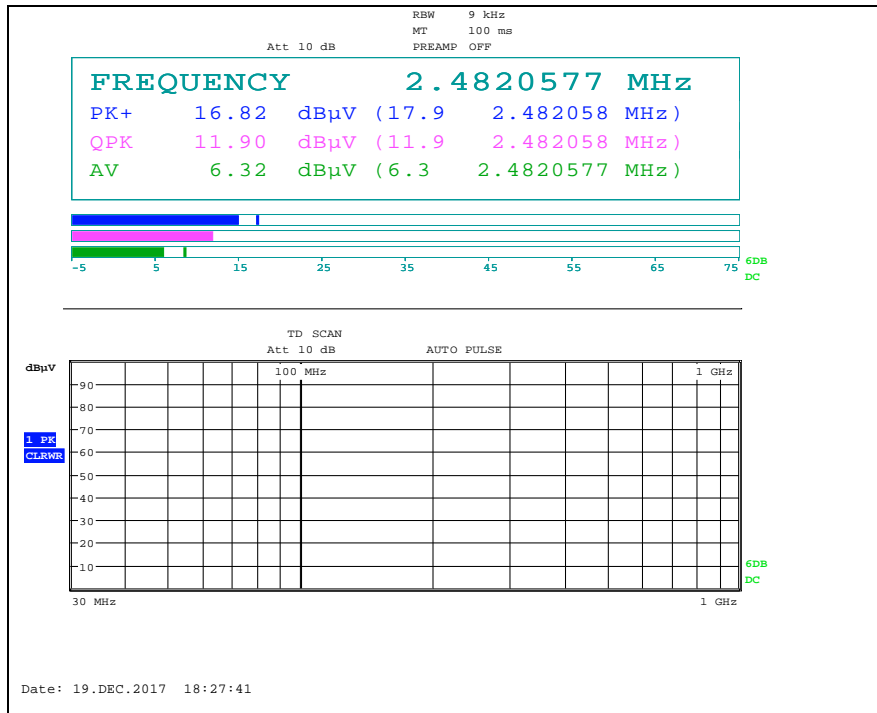
Measured plots below 30 MHz



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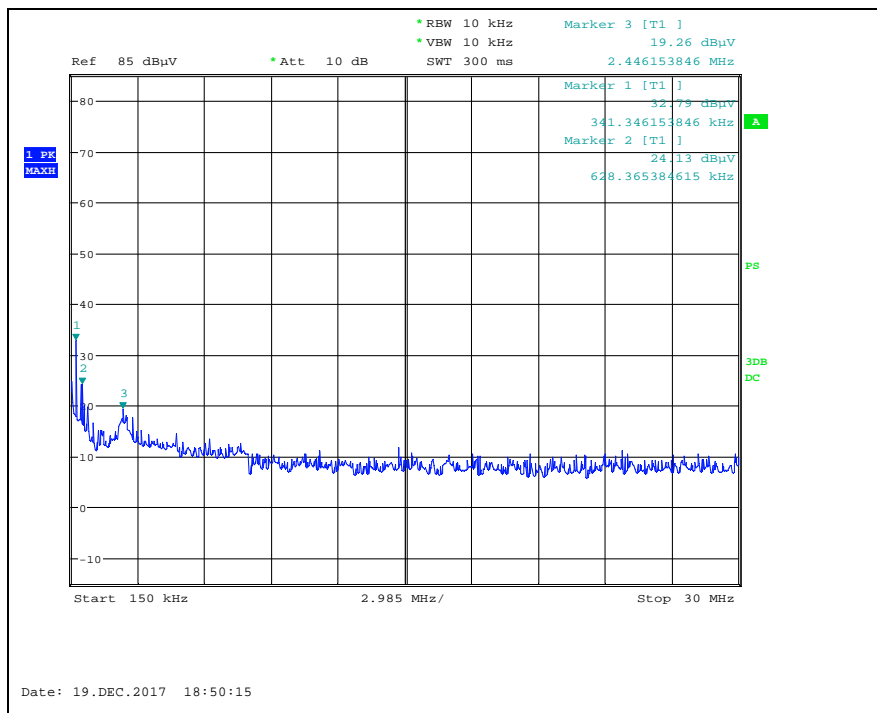
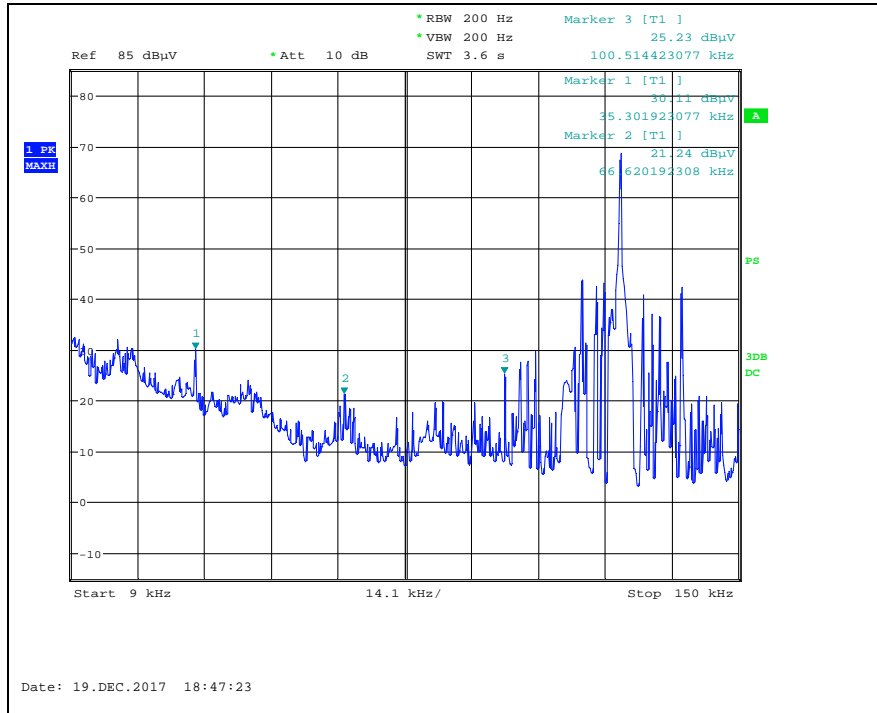
The results shown in this test report refer only to the sample(s) tested unless otherwise stated. This test report cannot be reproduced, except in full, without prior written permission of the Company. This test report does not assure KOLAS accreditation.



The results shown in this test report refer only to the sample(s) tested unless otherwise stated. This test report cannot be reproduced, except in full, without prior written permission of the Company. This test report does not assure KOLAS accreditation.

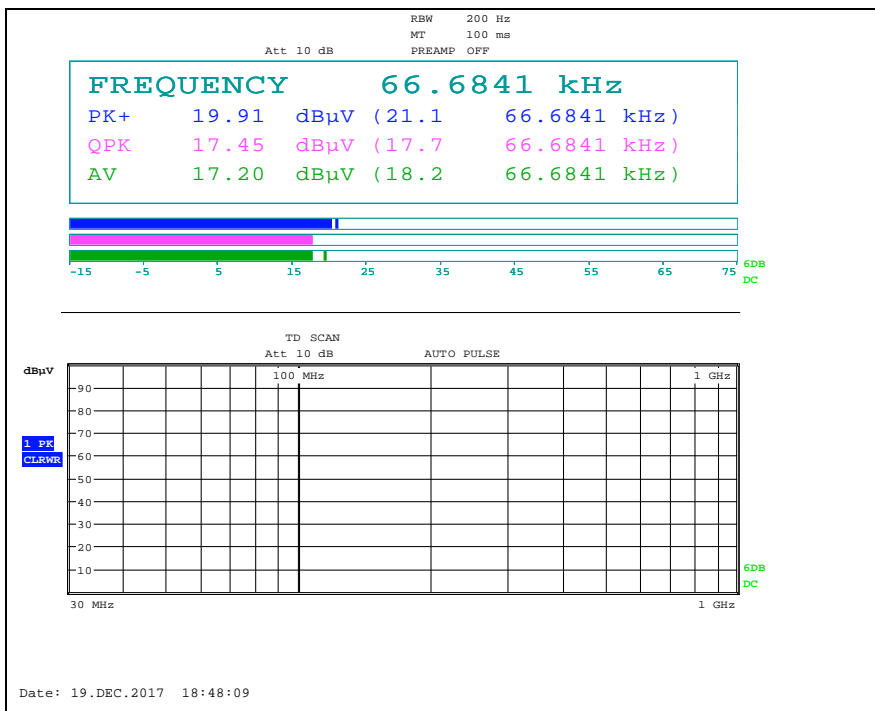
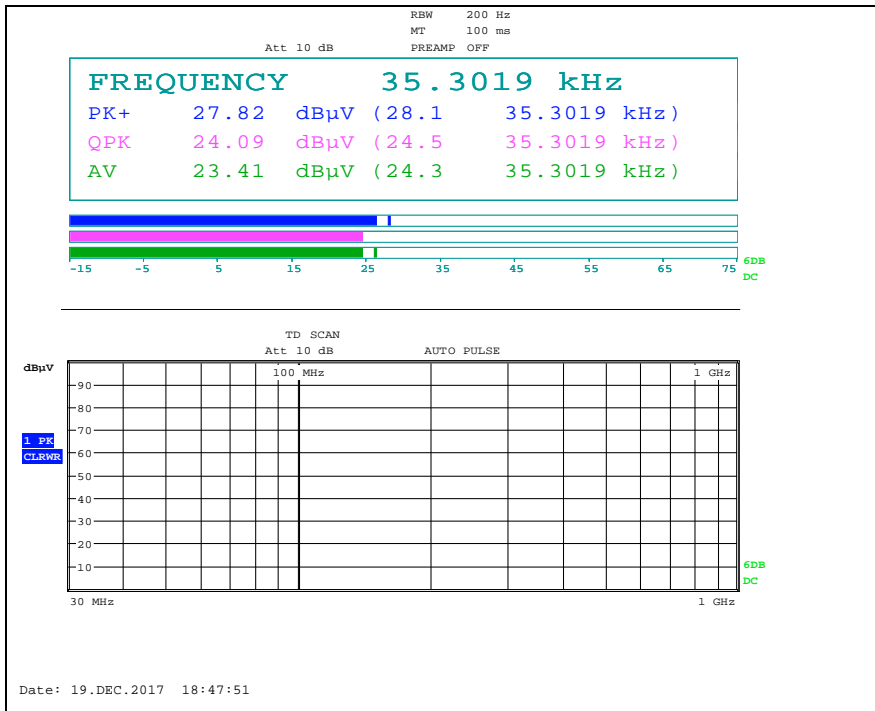
- SSB Antenna

Scanning plots below 30 MHz

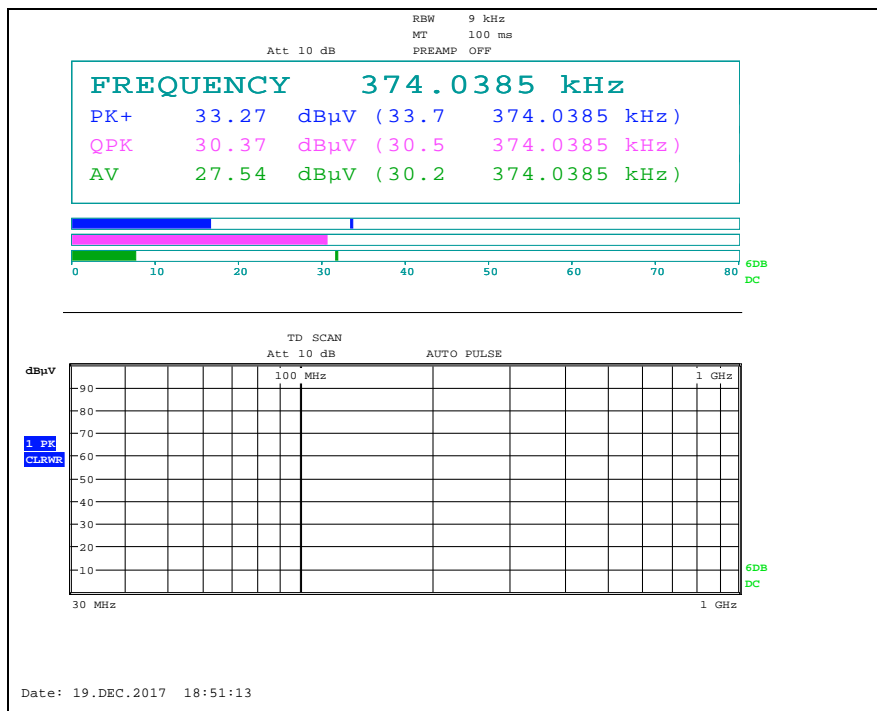
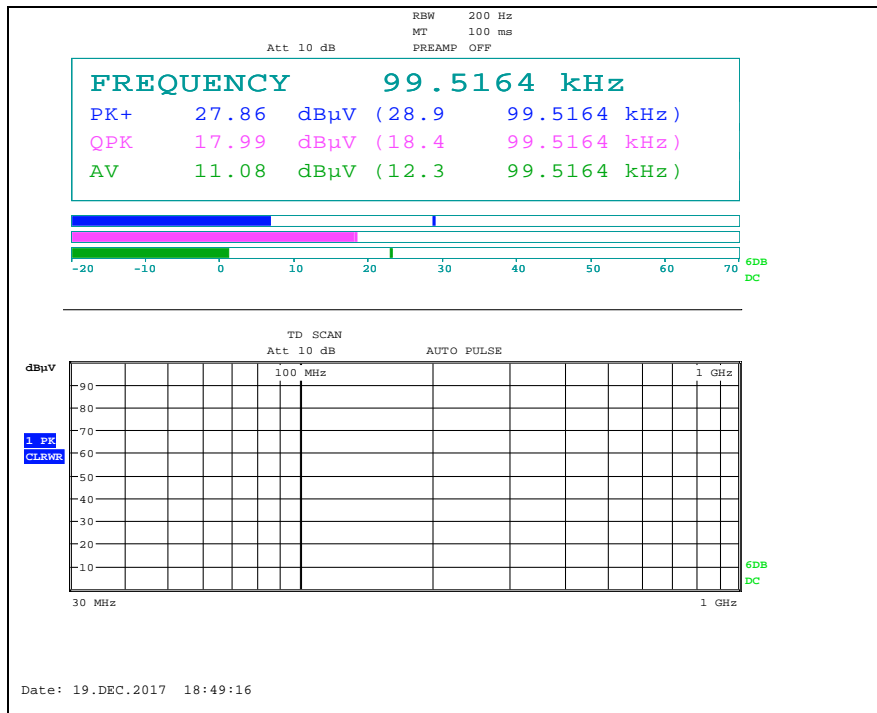


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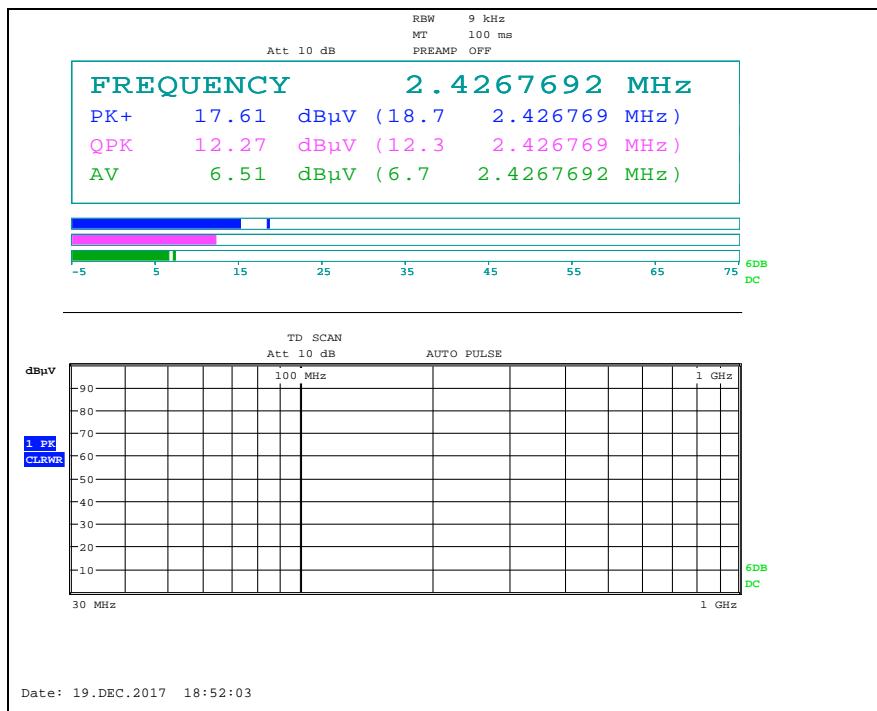
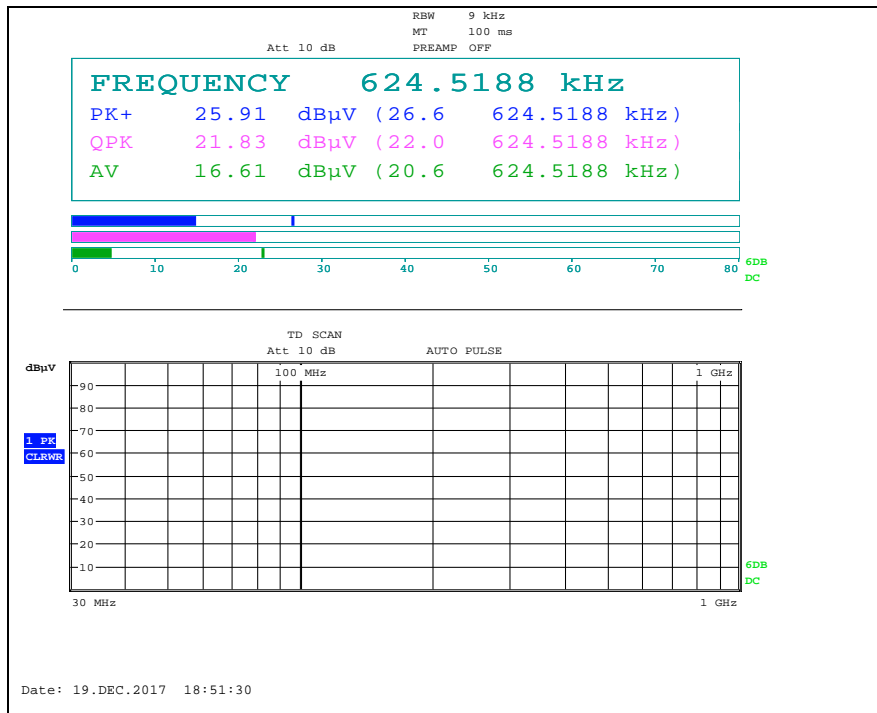
Measured plots below 30 MHz



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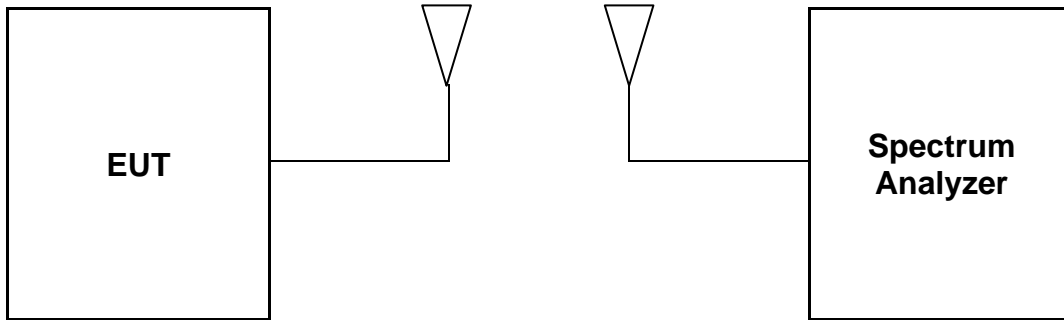
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3. 20 dB Bandwidth

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.

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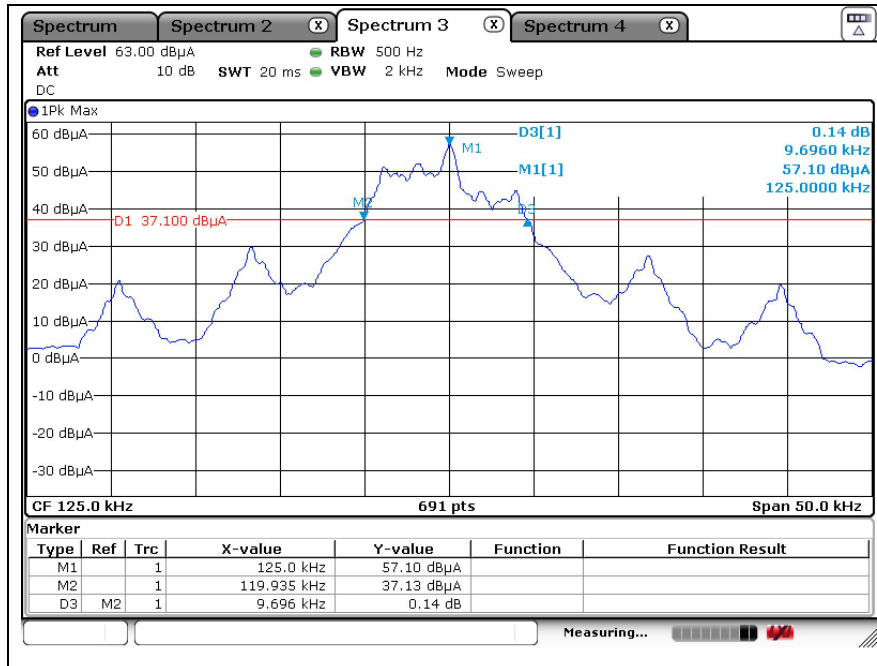
3.4. Test Result

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

Test Antenna	Carrier Frequency (kHz)	20 dB Bandwidth (kHz)	Limit
DRV Antenna	125.000	9.696	Reporting proposed only
AST Antenna	125.072	9.334	
BUM Antenna	125.000	11.143	
INT1 Antenna	125.000	10.999	
INT2 Antenna	125.000	10.564	
TNK Antenna	125.072	11.071	
SSB Antenna	125.000	15.485	

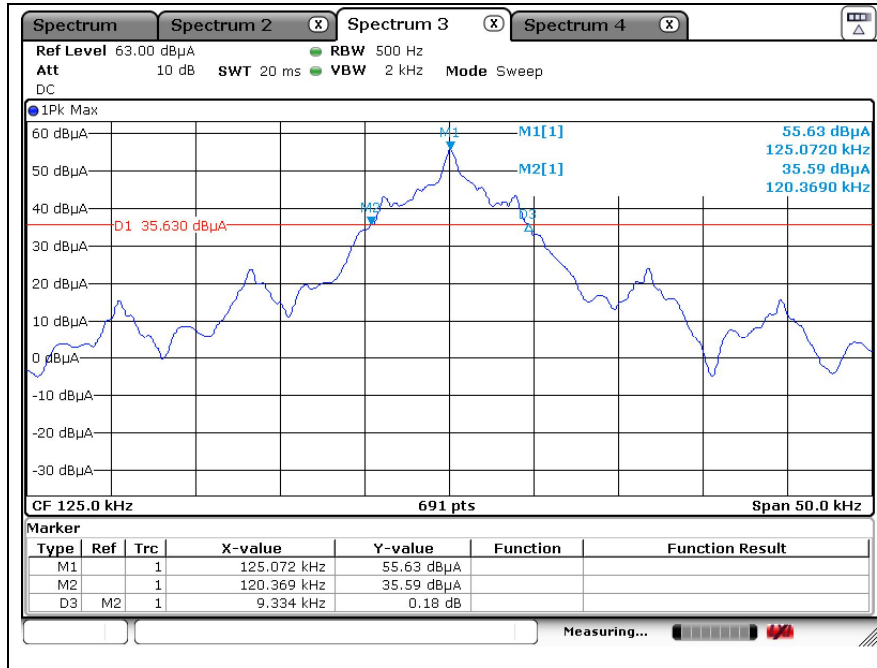
Test plots

- DRV Antenna

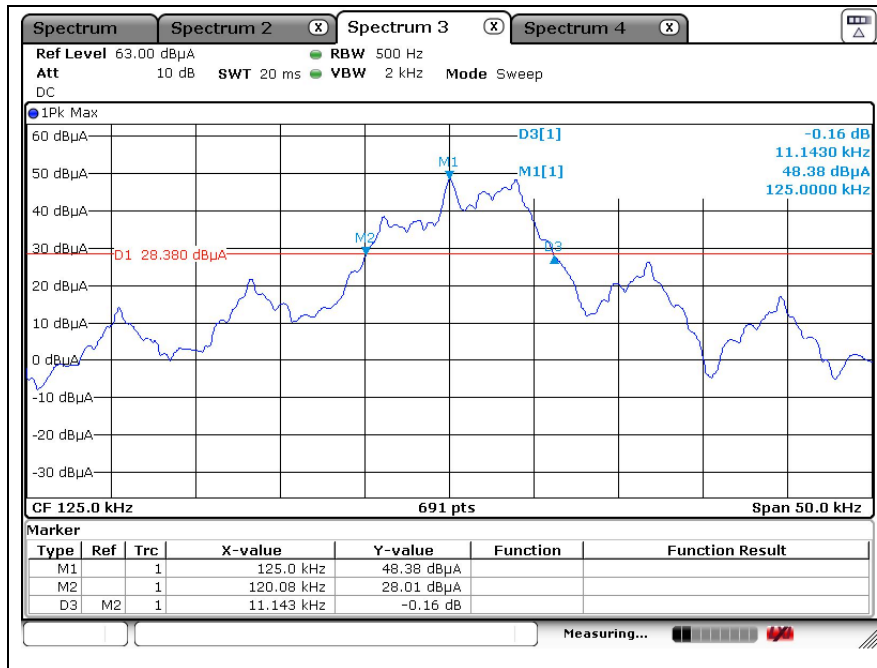


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- AST Antenna

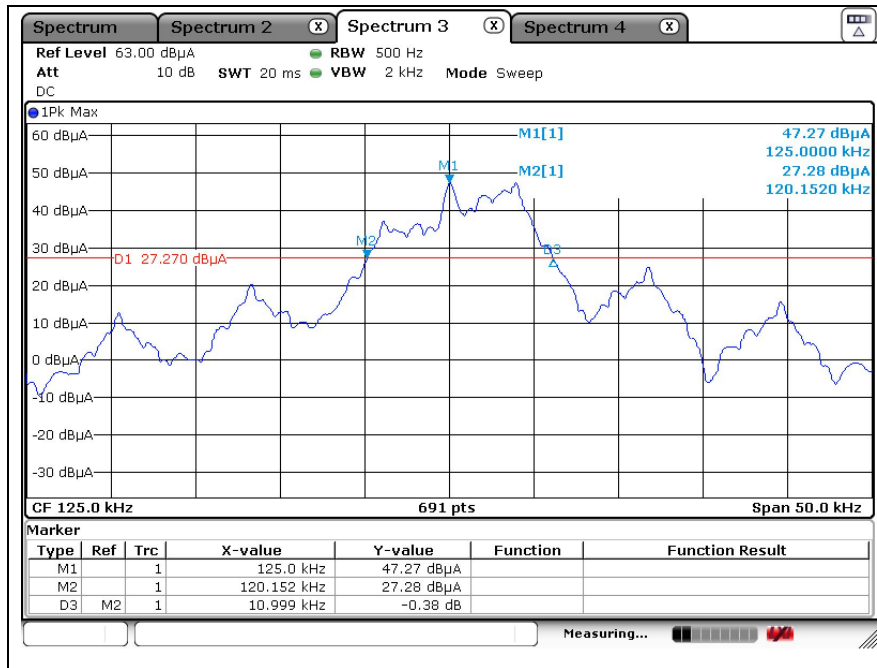


- BUM Antenna

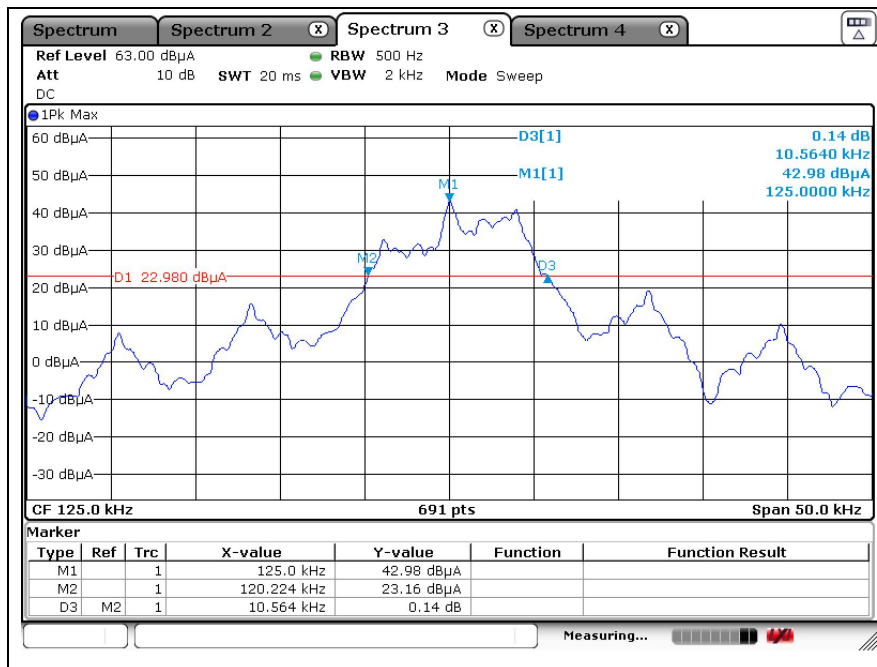


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- INT1 Antenna

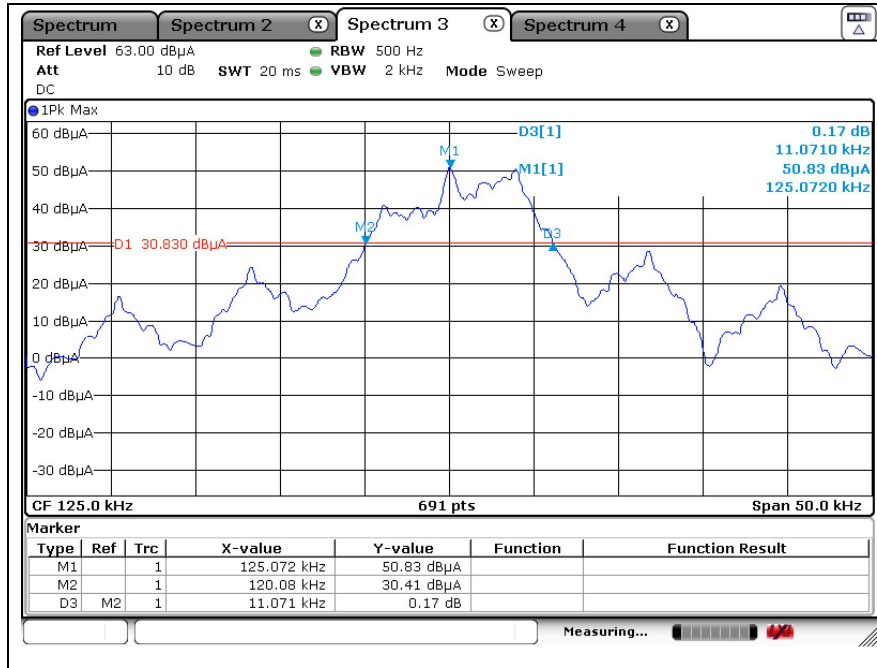


- INT2 Antenna

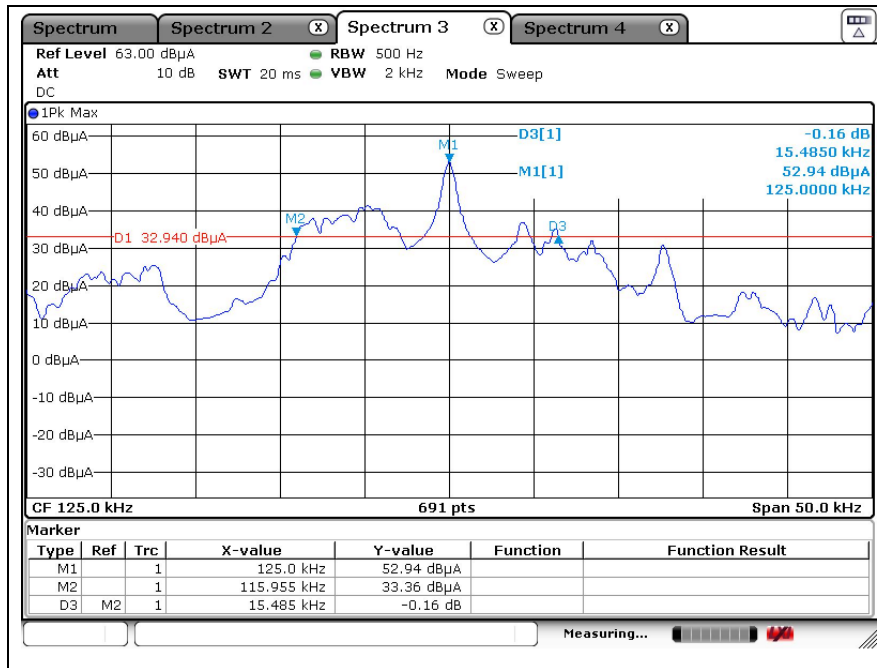


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- TNK Antenna



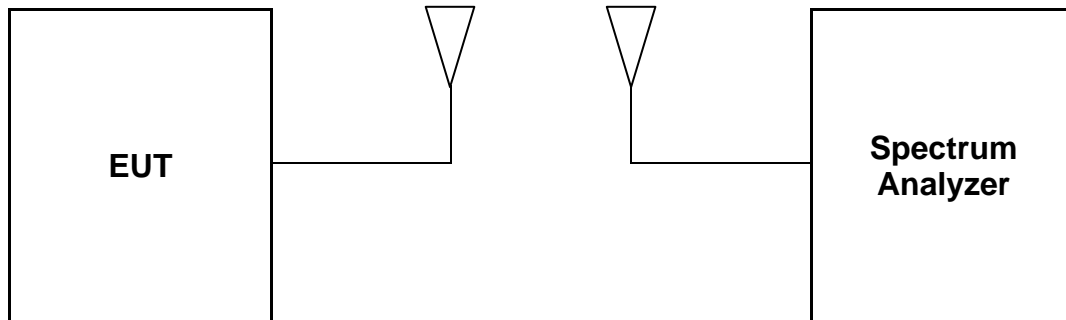
- SSB Antenna



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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 Hz, 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.

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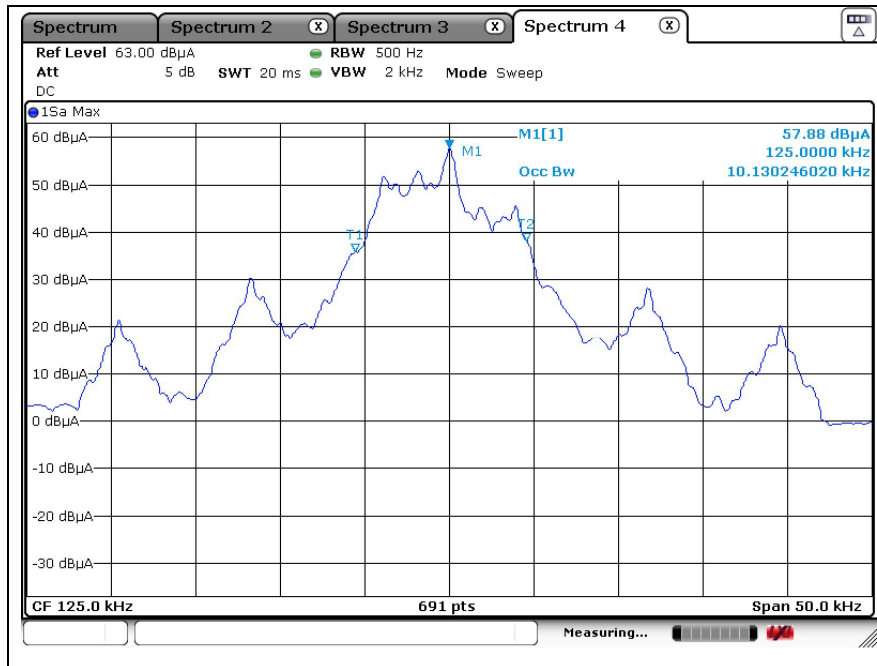
4.4. Test Result

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

Test Antenna	Carrier Frequency (MHz)	Occupied Bandwidth (kHz)	Limit
DRV Antenna	125.000	10.130	Reporting proposed only
AST Antenna	125.000	10.058	
BUM Antenna	125.000	11.216	
INT1 Antenna	125.000	10.781	
INT2 Antenna	125.000	10.709	
TNK Antenna	125.000	11.143	
SSB Antenna	125.000	28.944	

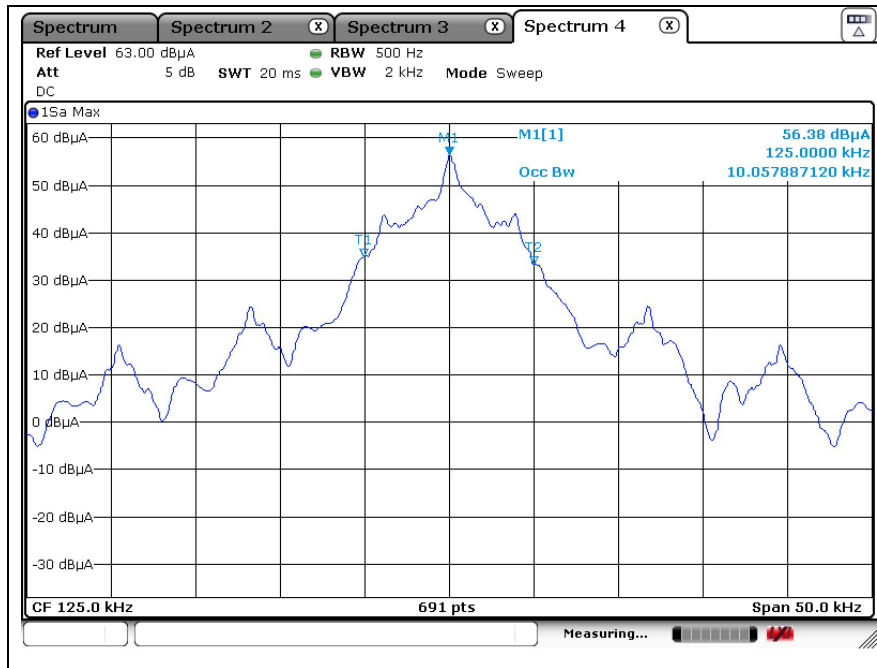
Test plots

- DRV Antenna

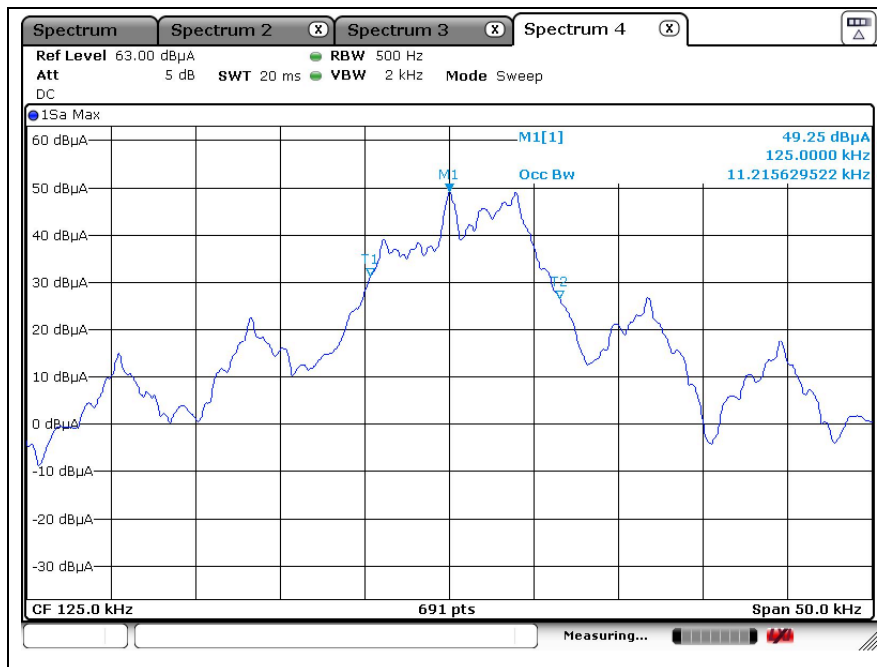


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- AST Antenna

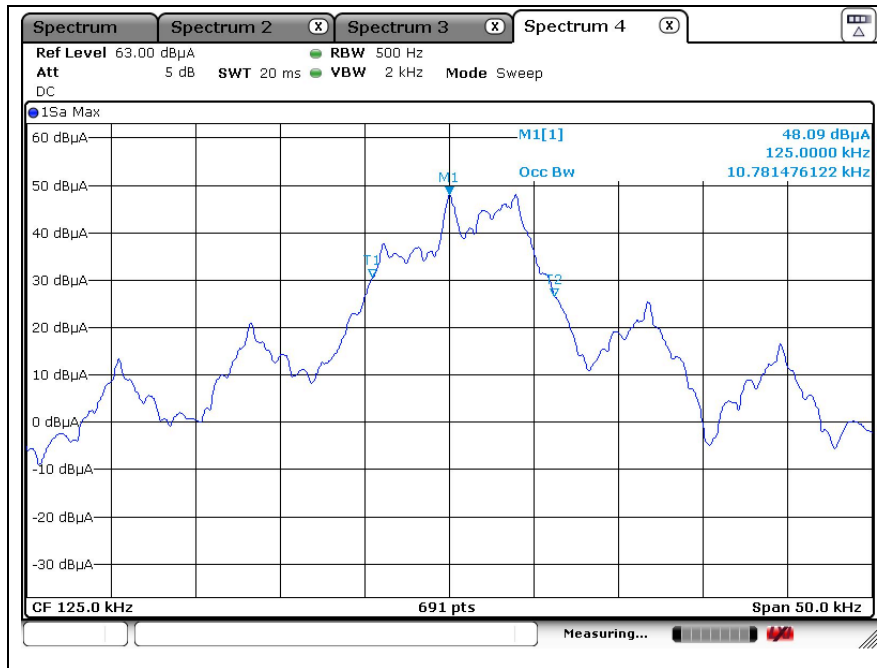


- BUM Antenna

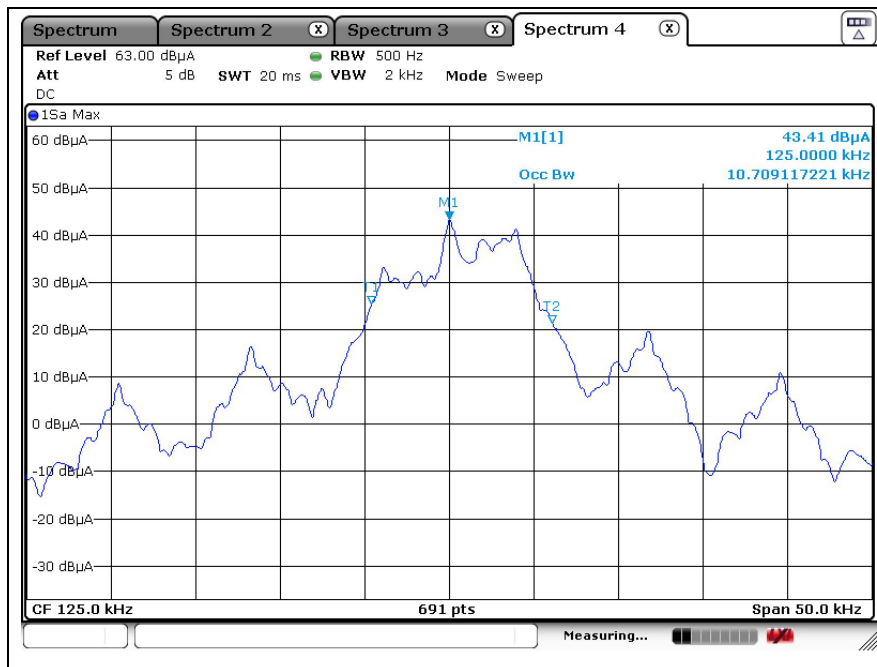


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- INT1 Antenna

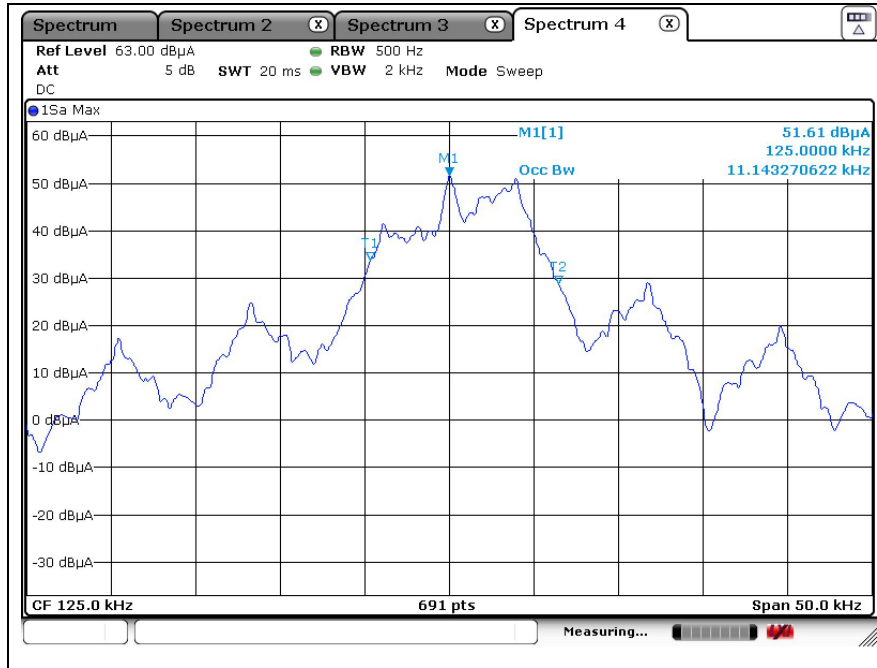


- INT2 Antenna

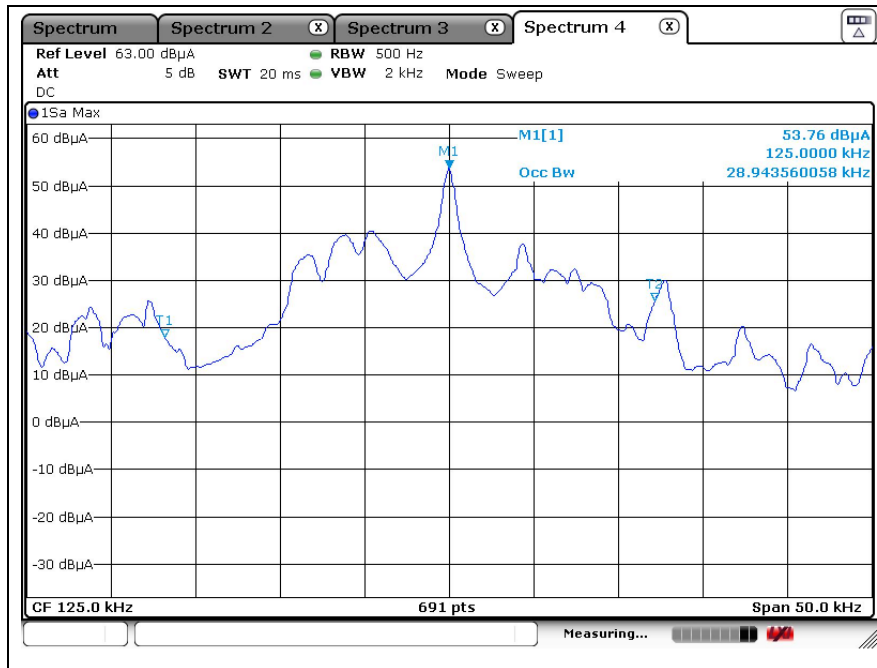


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- TNK Antenna



- SSB Antenna



- End of the Test Report -

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