

TEST REPORT

OF

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

FCC ID: CQOED00670
IC Certification: 1551E-ED00670

Equipment Under Test : Smart Key ECU
Model Name : ED00670
Applicant : DENSO KOREA ELECTRONICS CORPORATION
Manufacturer : DENSO KOREA ELECTRONICS CORPORATION
Date of Receipt : 2016.10.25
Date of Test(s) : 2016.11.10 ~ 2016.11.17
Date of Issue : 2016.11.21

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

Tested By:



Inho Park

Date:

2016.11.21

Technical
Manager:



Alvin Kim

Date:

2016.11.21

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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

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 : DENSO KOREA ELECTRONICS CORPORATION

Address : 3, Cheomdan Industry, Masanhappo-gu, Chang-won-si, Gyung-sangnam-do, Korea

Contact Person : Kang, Sung-Won

Phone No. : +82 55 600 9346

1.3. Description of EUT

Kind of Product		Smart Key ECU
Model Name		ED00670
Power Supply		DC 12.0 V (Used by Vehicle battery)
Frequency Range		Tx: 134.20 kHz, Rx: 433.92 MHz
Antenna Type	Tx	External Type (Coil Antenna)
	Rx	Internal Type
Operating Temperature		-30 °C ~ 80 °C
H/W Version		A002
S/W Version		a00

1.4. 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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1.5. Test Equipment List

Equipment	Manufacturer	Model	S/N	Cal. Date	Cal. Interval	Cal. Due
Spectrum Analyzer	R&S	FSV30	103100	Jun. 24, 2016	Annual	Jun. 24, 2017
Signal Generator	R&S	SMBV100A	255834	Jun. 20, 2016	Annual	Jun. 20, 2017
DC Power Supply	R&S	HMP2020	020089489	May 31, 2016	Annual	May 31, 2017
Test Receiver	R&S	ESU26	100109	Mar. 07, 2016	Annual	Mar. 07, 2017
Loop Antenna	Schwarzbeck Mess-Elektronik	FMZB 1519	1519-039	Aug. 19, 2015	Biennial	Aug. 19, 2017
Turn Table	INNCO systems	CONTROLLER CO3000	N/A	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.

1.6. 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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1.7. 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

1.8. Test Report Revision

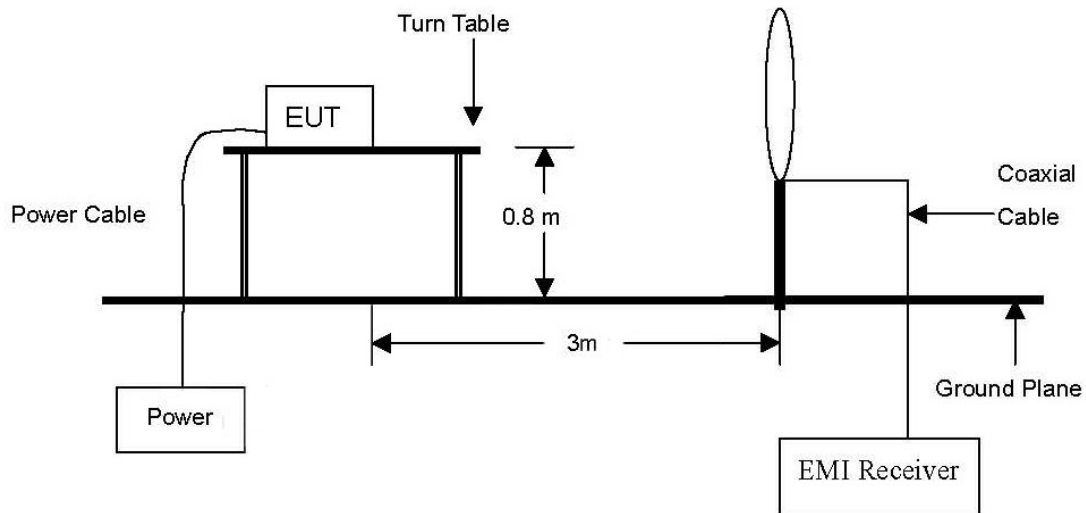
Revision	Report number	Date of Issue	Description
0	F690501/RF-RTL010558	2016.11.21	Initial

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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.



2.2. Limits

2.2.1. FCC Limits

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

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2.2.2. IC Limits

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 937606.

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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)
AST Antenna									
0.134	51.10	Average	H	19.42	0.07	70.59	-9.41	25.06	34.47
BUM Antenna									
0.134	53.30	Average	H	19.42	0.07	72.79	-7.21	25.06	32.27
DRV Antenna									
0.134	51.10	Average	H	19.42	0.07	70.59	-9.41	25.06	34.47
INT Antenna									
0.134	54.20	Average	H	19.42	0.07	73.69	-6.31	25.06	31.37
INT3 Antenna									
0.134	53.20	Average	H	19.42	0.07	72.69	-7.31	25.06	32.37
SSB Antenna									
0.134	41.40	Average	H	19.42	0.07	60.89	-19.11	25.06	44.17
TNK Antenna									
0.134	58.30	Average	H	19.42	0.07	77.79	-2.21	25.06	27.27

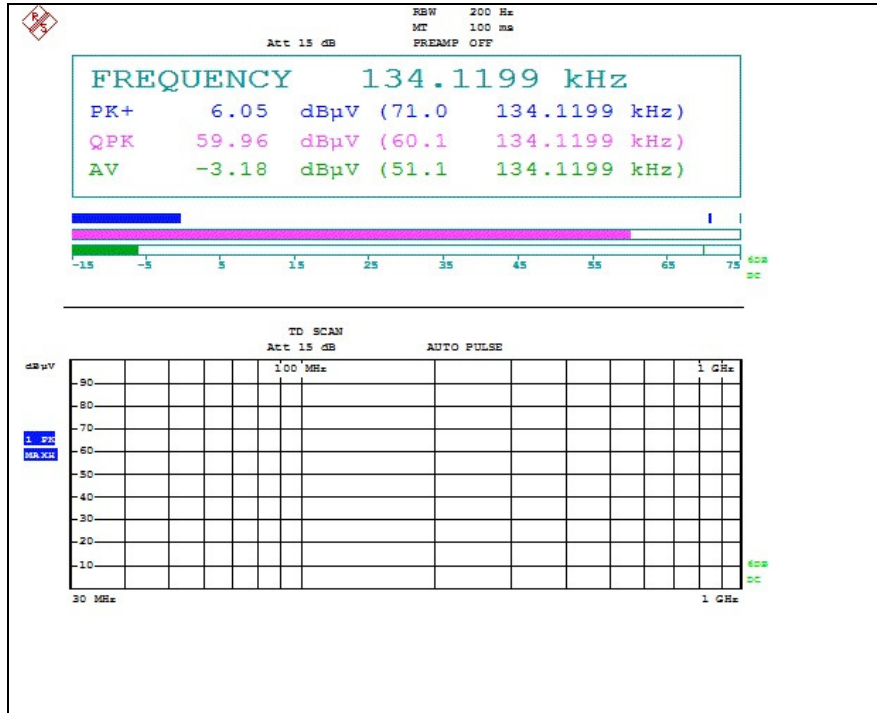
Note;

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).

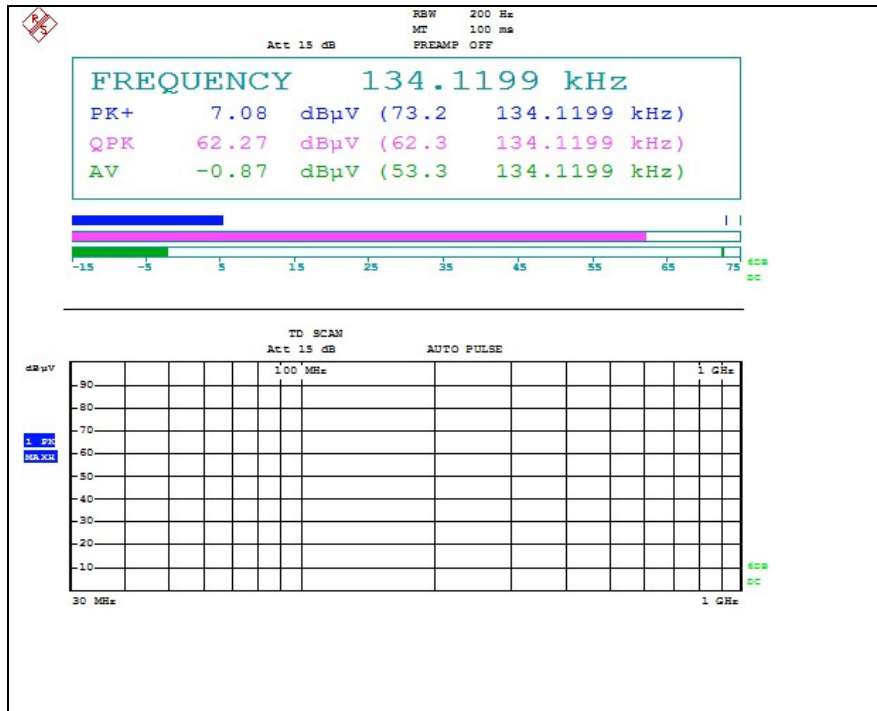
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Test plot

- AST Antenna

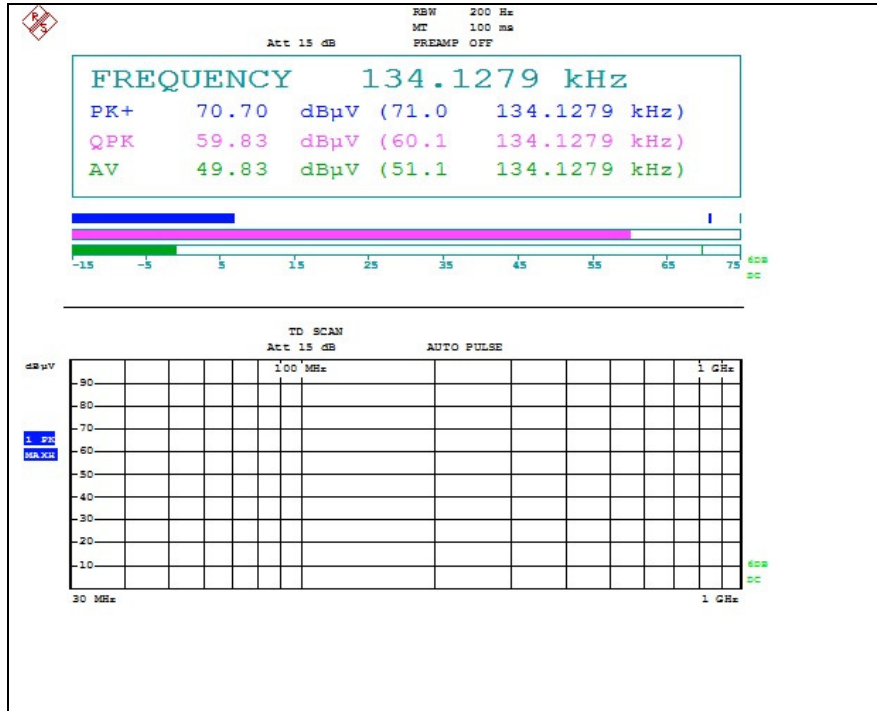


- BUM Antenna

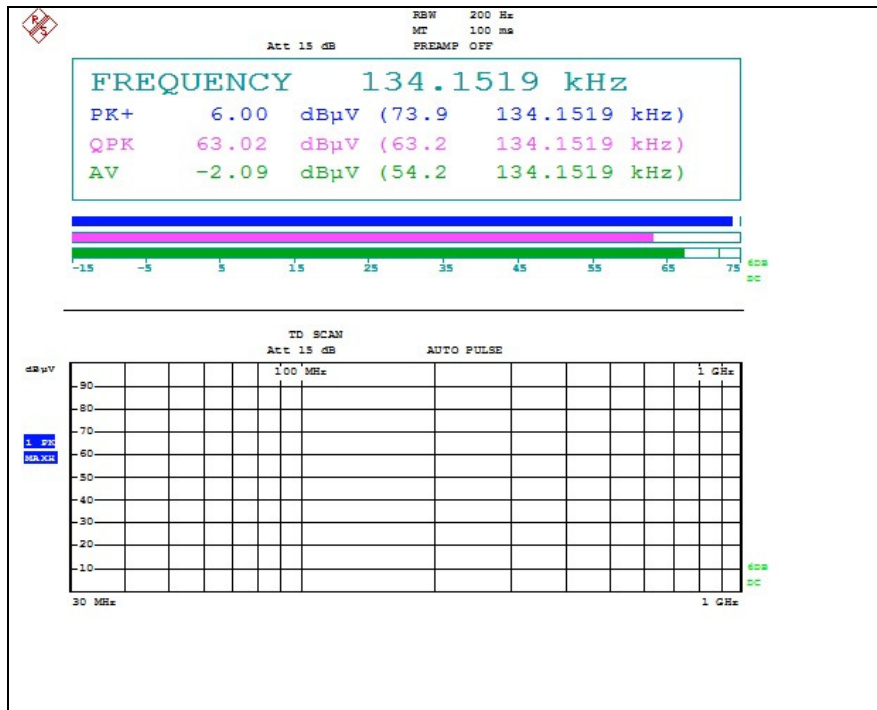


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- DRV Antenna

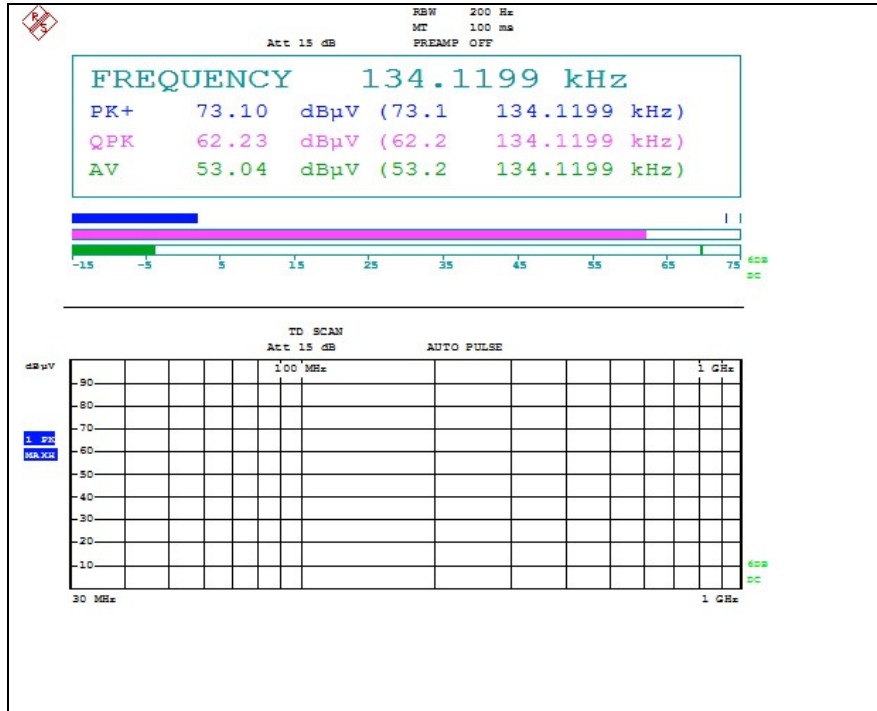


- INT Antenna

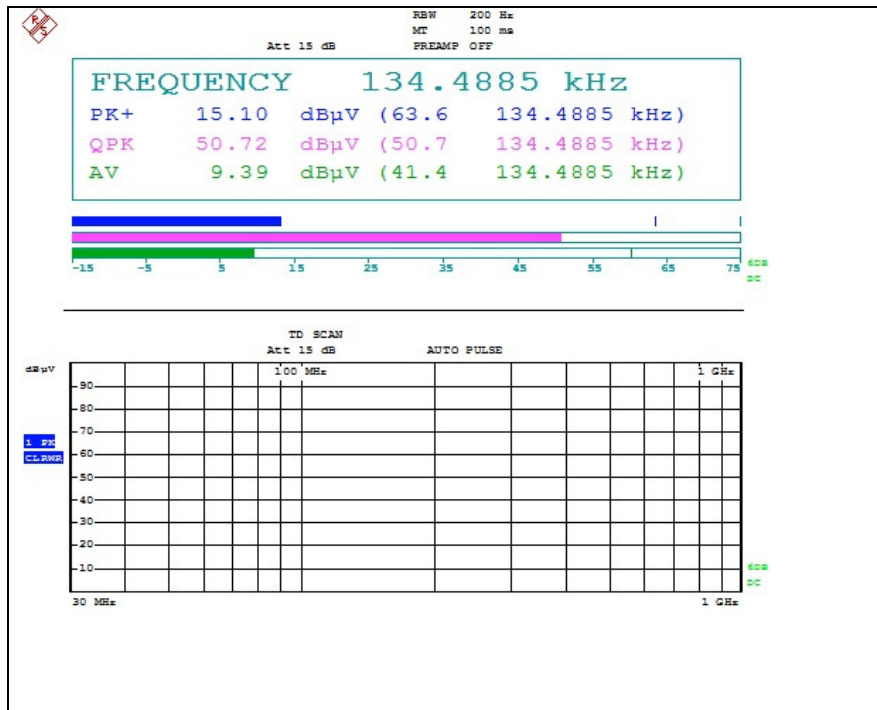


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- INT3 Antenna

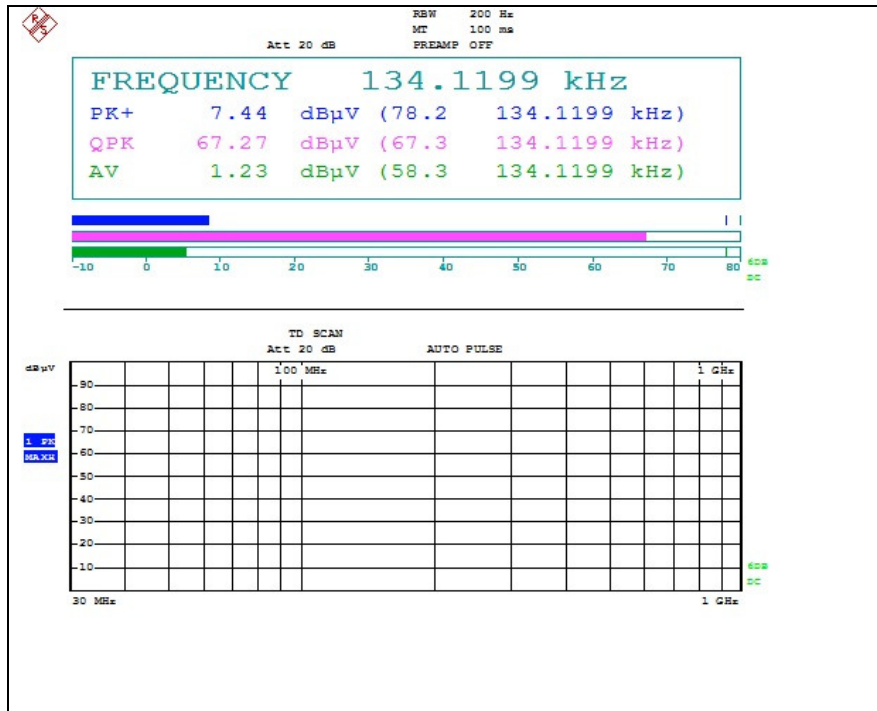


- SSB Antenna



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- TNK 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 300 m	Limit (dB μ V/m) at 300 m	Margin (dB)
AST Antenna									
0.019	36.80	Average	H	19.52	0.02	56.34	-23.66	42.03	65.69
0.046	25.40	Average	H	19.30	0.03	44.73	-35.27	34.35	69.62
0.069	27.80	Average	H	19.38	0.03	47.21	-32.79	30.83	63.62
Above 1.000	Not detected	-	-	-	-	-	-	-	-
BUM Antenna									
0.019	34.20	Average	H	19.52	0.02	53.74	-26.26	42.03	68.29
0.046	25.30	Average	H	19.30	0.03	44.63	-35.37	34.35	69.72
0.069	27.51	Average	H	19.38	0.03	46.92	-33.08	30.83	63.91
Above 1.000	Not detected	-	-	-	-	-	-	-	-
DRV Antenna									
0.019	36.70	Average	H	19.52	0.02	56.24	-23.76	42.03	65.79
0.046	25.90	Average	H	19.30	0.03	45.23	-34.77	34.35	69.12
0.069	27.80	Average	H	19.38	0.03	47.21	-32.79	30.83	63.62
Above 1.000	Not detected	-	-	-	-	-	-	-	-
INT Antenna									
0.022	33.40	Average	H	19.46	0.02	52.88	-27.12	40.76	67.88
0.046	25.00	Average	H	19.30	0.03	44.33	-35.67	34.35	70.02
0.069	27.70	Average	H	19.38	0.03	47.11	-32.89	30.83	63.72
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 300 m	Limit (dB μ V/m) at 300 m	Margin (dB)
INT3 Antenna									
0.019	33.10	Average	H	19.52	0.02	52.64	-27.36	42.03	69.39
0.046	25.00	Average	H	19.30	0.03	44.33	-35.67	34.35	70.02
0.069	27.50	Average	H	19.38	0.03	46.91	-33.09	30.83	63.92
Above 1.000	Not detected	-	-	-	-	-	-	-	-
SSB Antenna									
0.022	32.40	Average	H	19.46	0.02	51.88	-28.12	40.76	68.88
0.045	24.40	Average	H	19.30	0.03	43.73	-36.27	34.54	70.81
0.069	27.60	Average	H	19.38	0.03	47.01	-32.99	30.83	63.82
Above 1.000	Not detected	-	-	-	-	-	-	-	-
TNK Antenna									
0.023	32.90	Average	H	19.44	0.02	52.36	-27.64	40.37	68.01
0.045	24.80	Average	H	19.30	0.03	44.13	-35.87	34.54	70.41
0.069	27.30	Average	H	19.38	0.03	46.71	-33.29	30.83	64.12
Above 1.000	Not detected	-	-	-	-	-	-	-	-

Note;

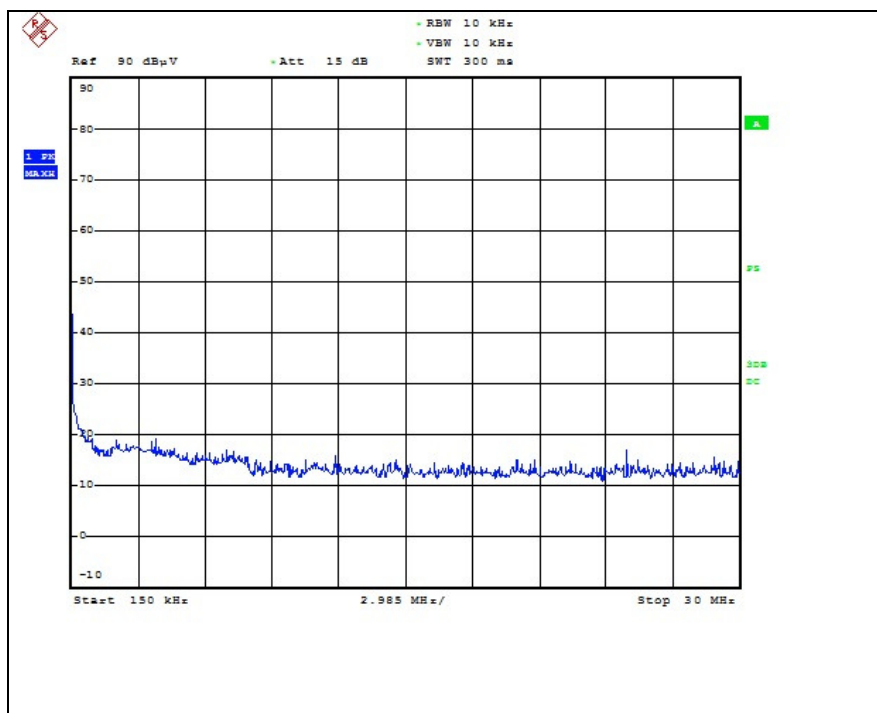
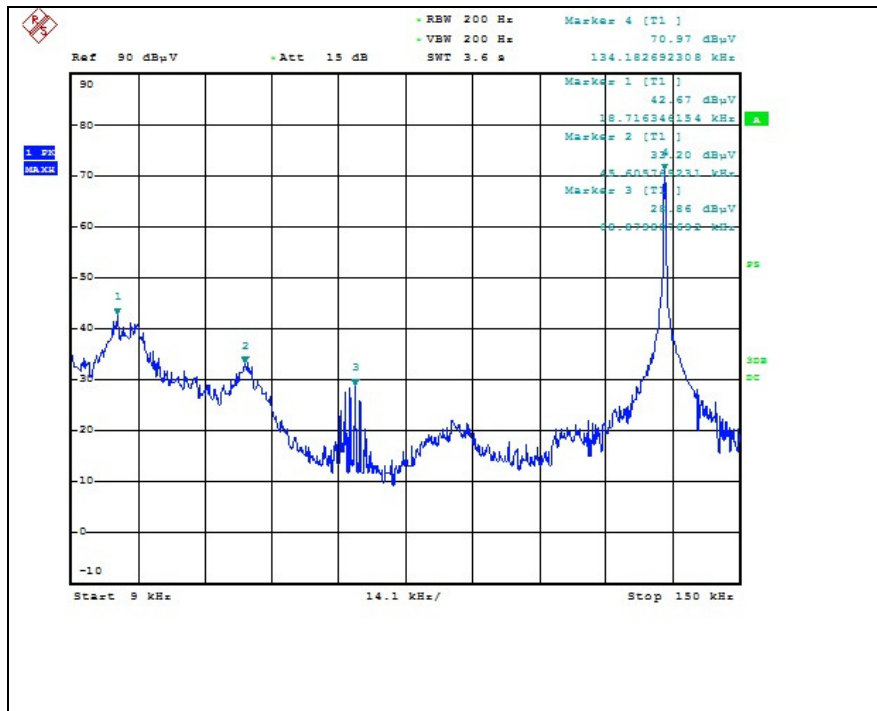
- According to §15.31 (f)(2)
 $- 300 \text{ m Result (dB}\mu\text{V/m)} = 3 \text{ m Result (dB}\mu\text{V/m)} - 40\log(300/3) \text{ (dB}\mu\text{V/m)}$
- According to field strength table of general requirement in §15.209 (a), field strength limits below 1.705 MHz were calculated as below.
 $- 9 \text{ kHz to } 490 \text{ kHz} : 20\log(2400 / F \text{ (kHz)}) \text{ at } 300 \text{ m (dB}\mu\text{V/m)}$
- 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

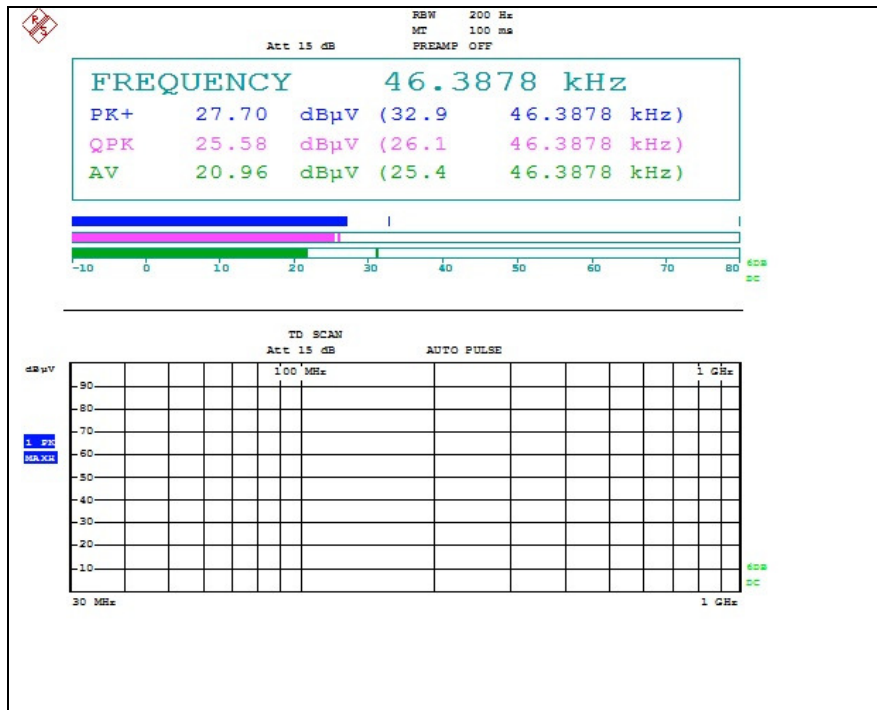
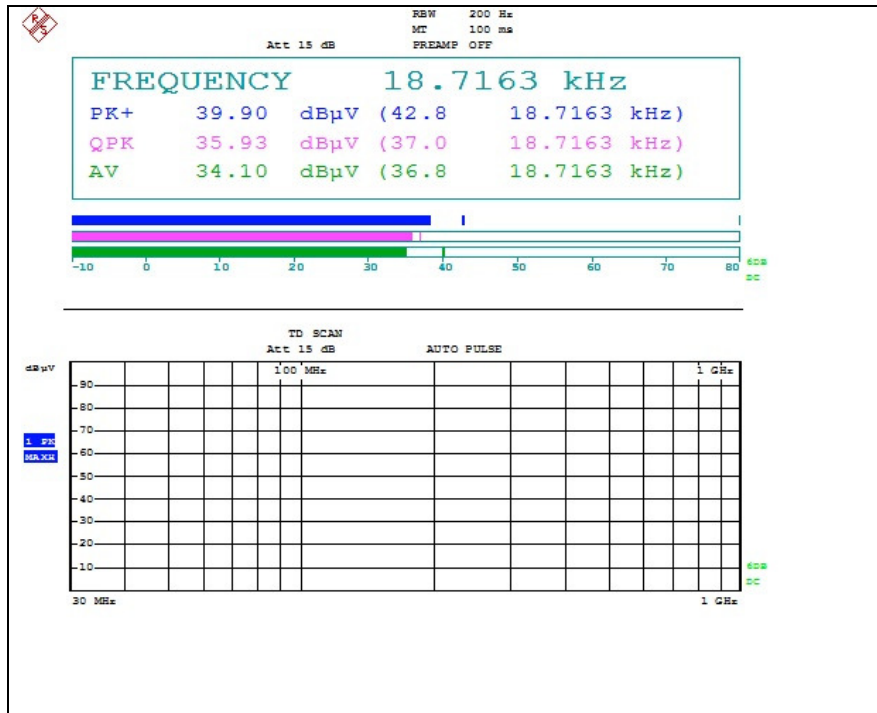
- AST Antenna

Scanning plots below 30 MHz

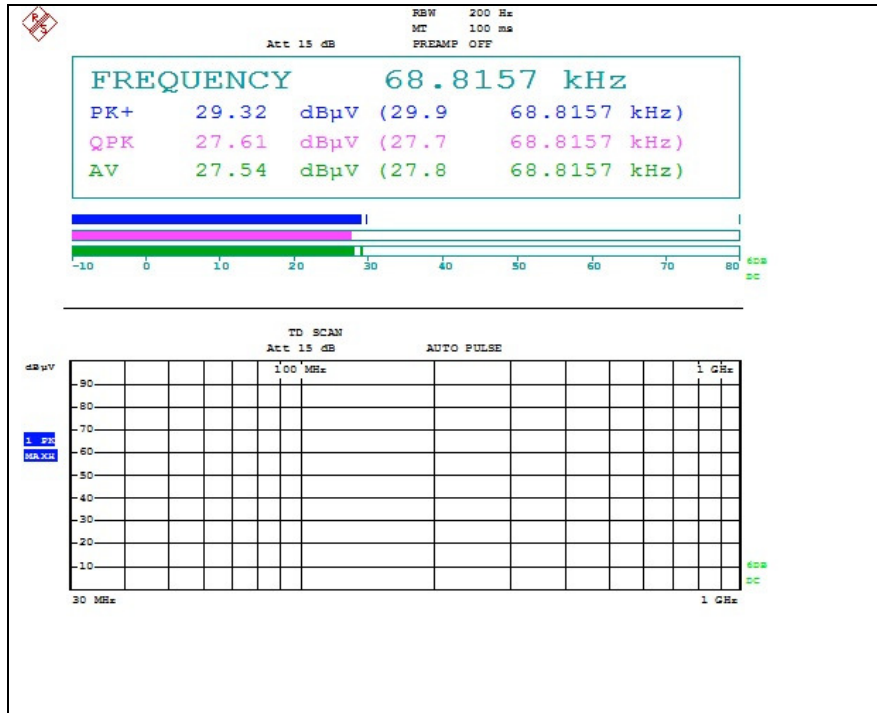


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Measured plots below 30 MHz



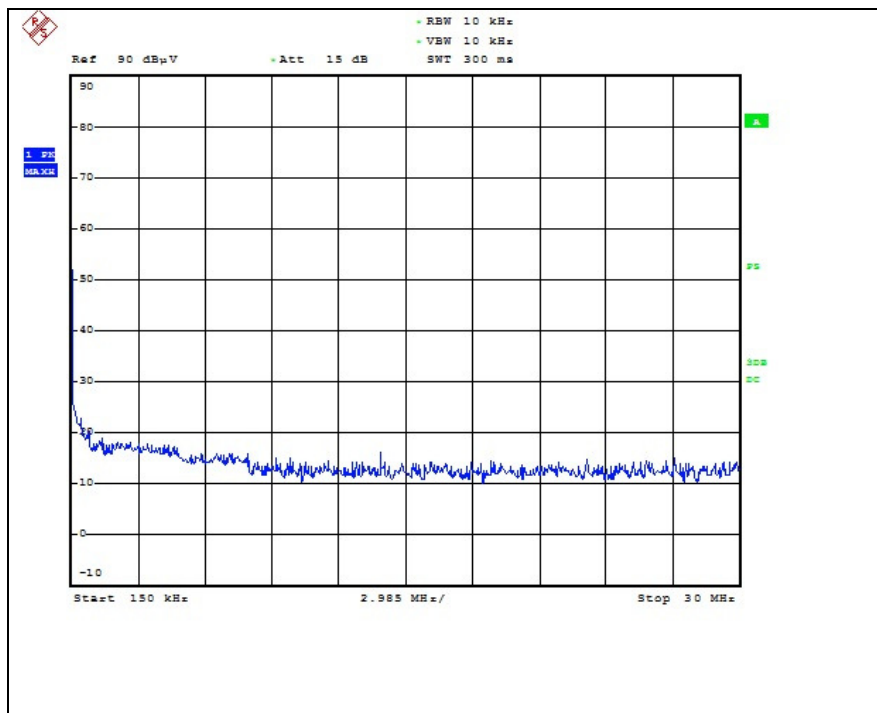
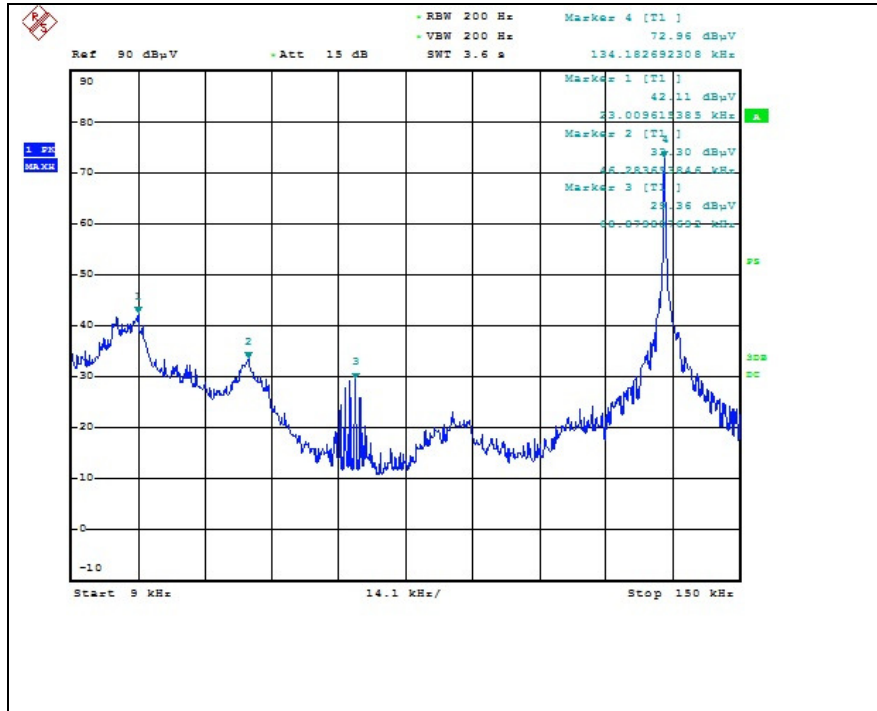
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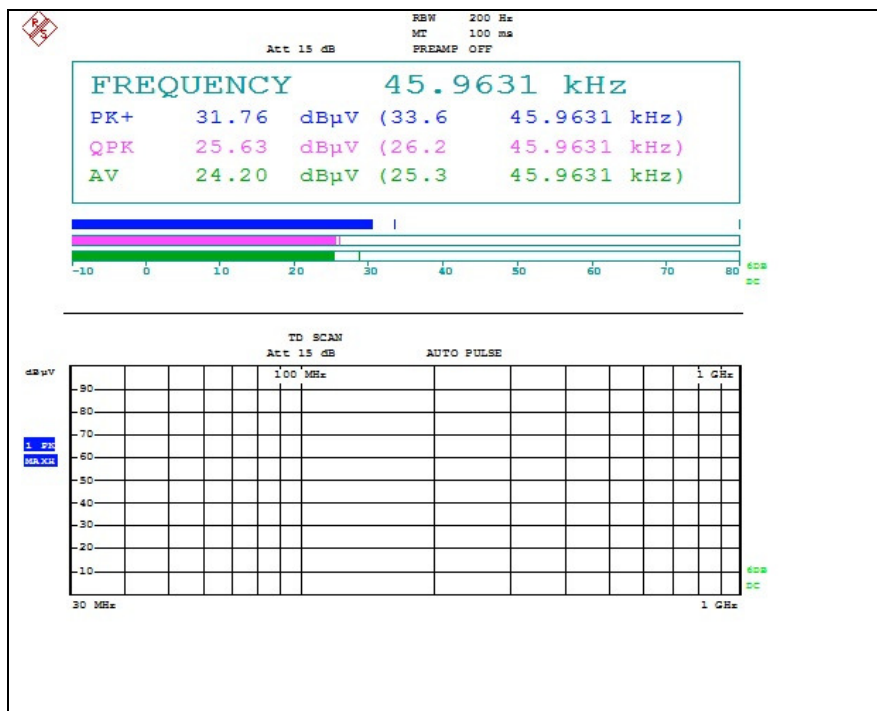
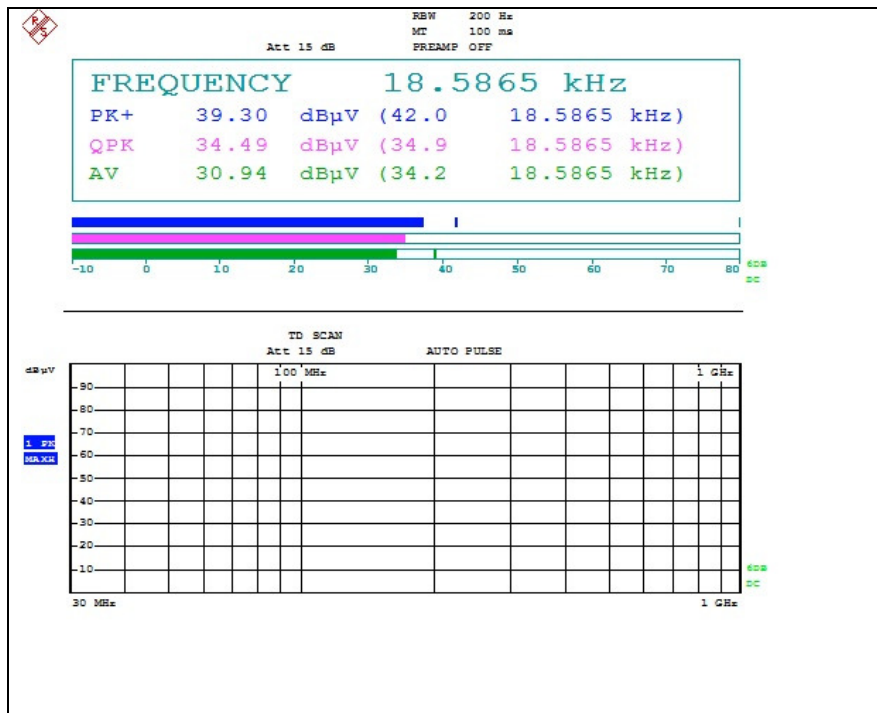
- BUM Antenna

Scanning plots below 30 MHz

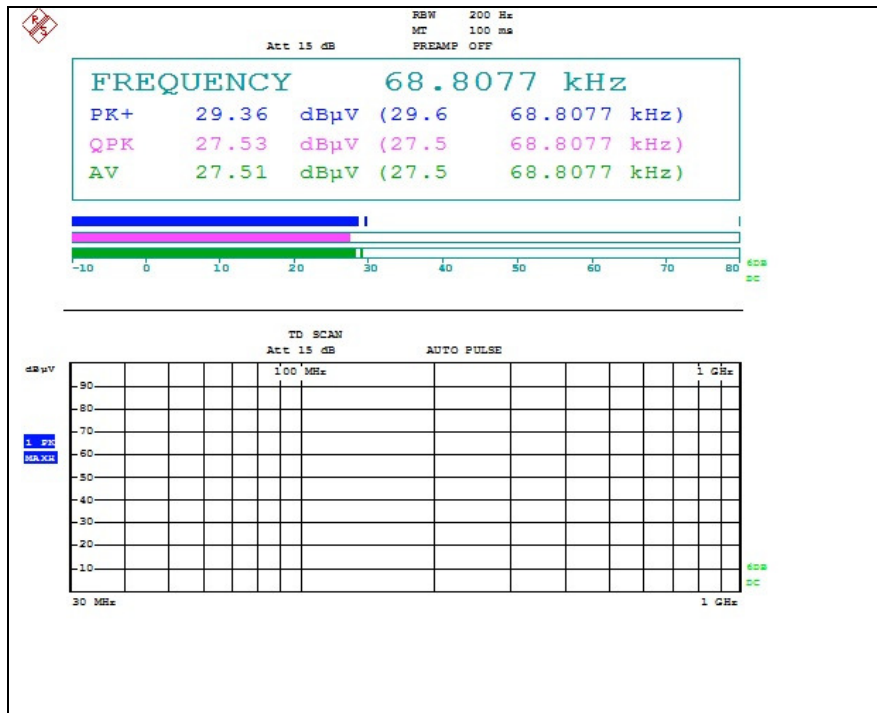


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Measured plots below 30 MHz



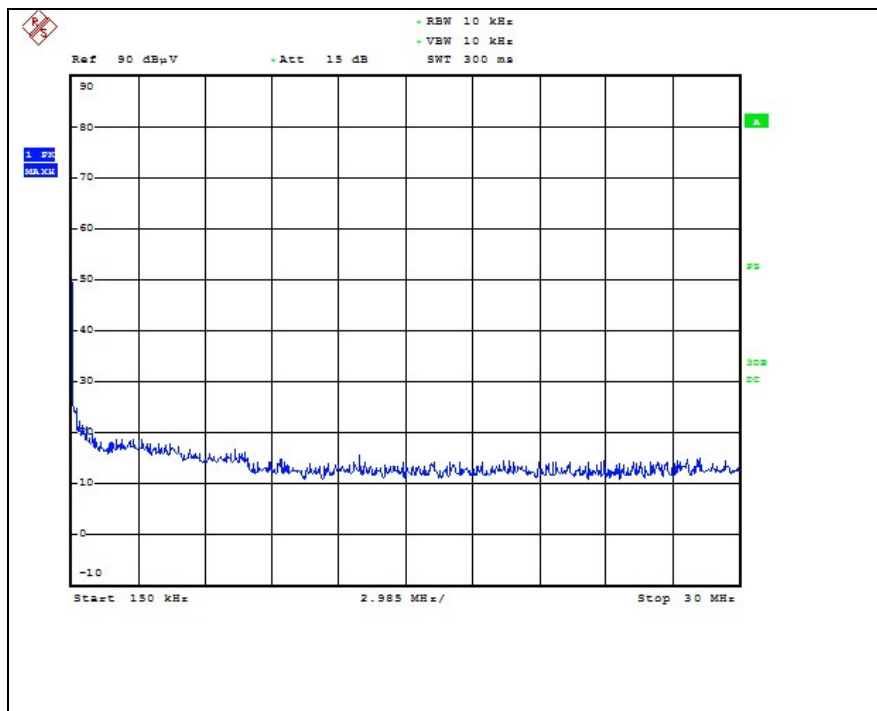
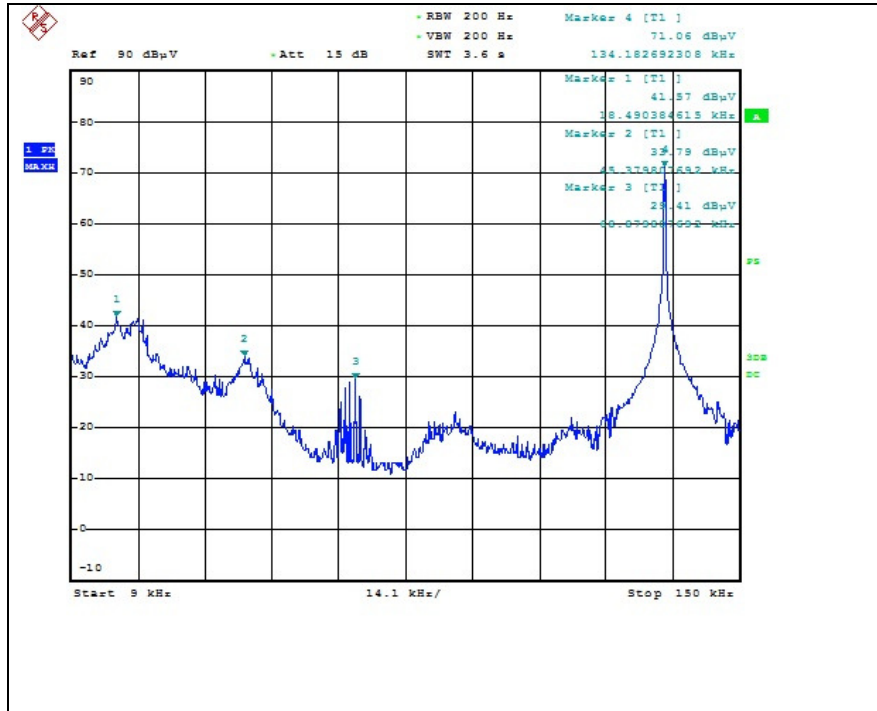
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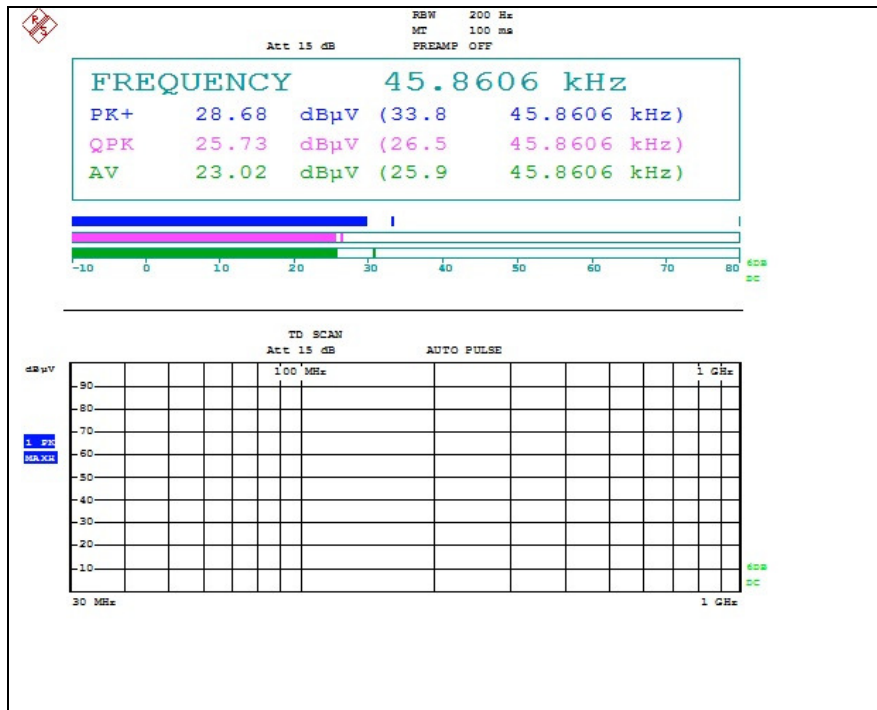
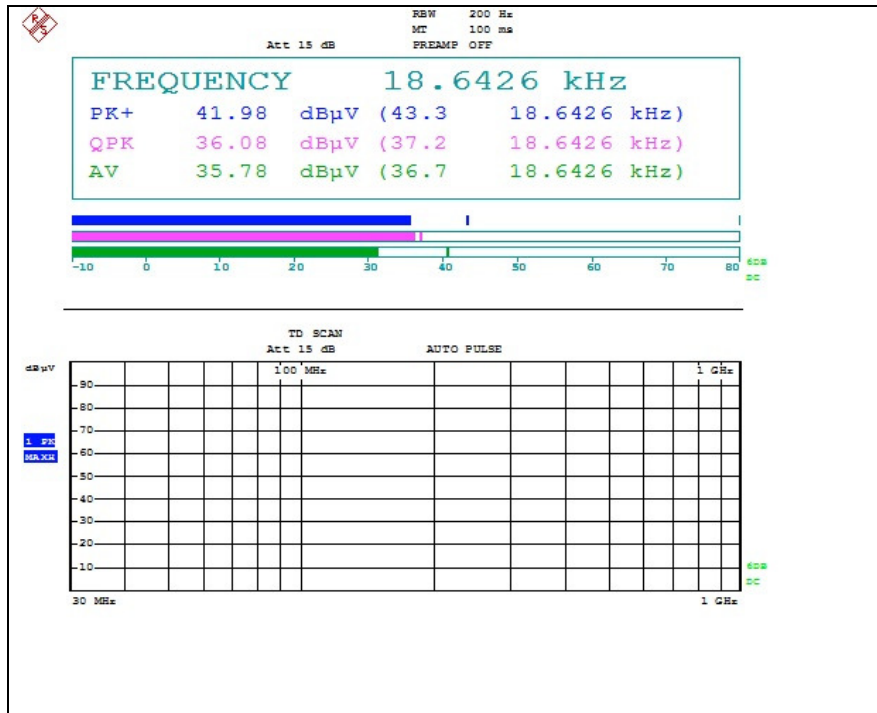
- DRV Antenna

Scanning plots below 30 MHz

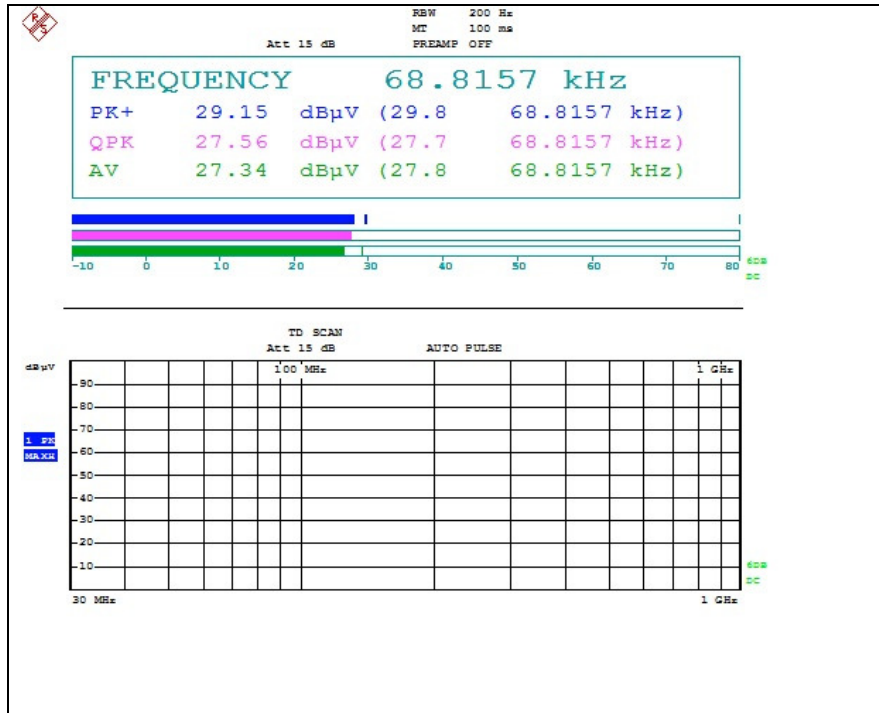


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Measured plots below 30 MHz



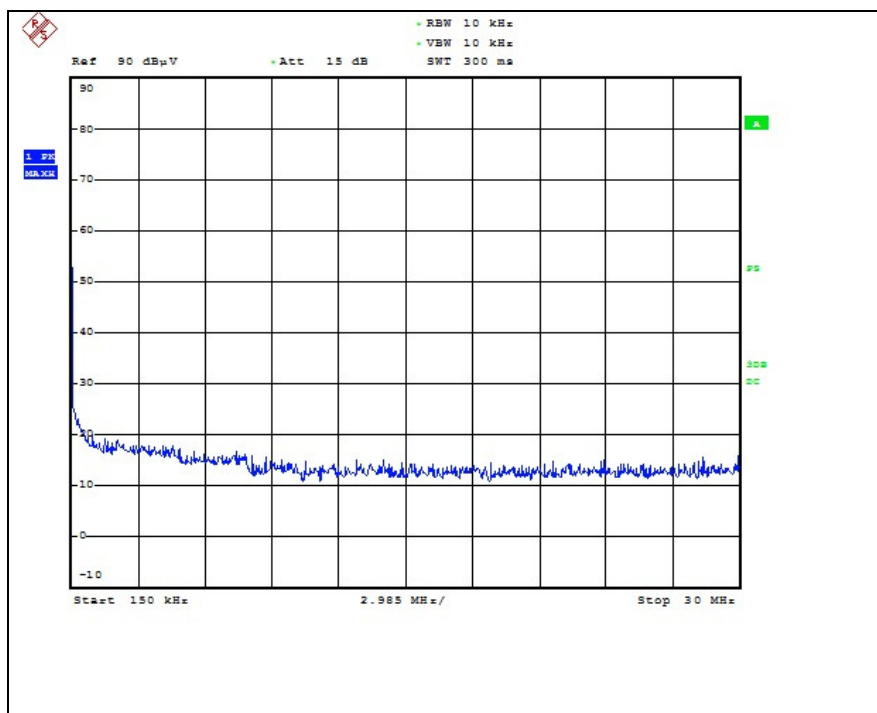
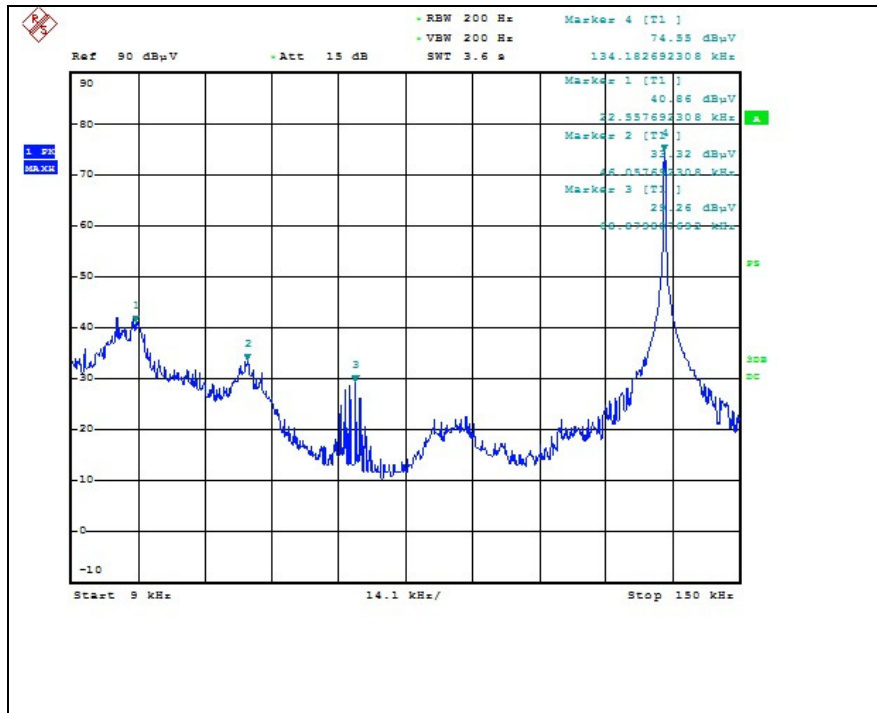
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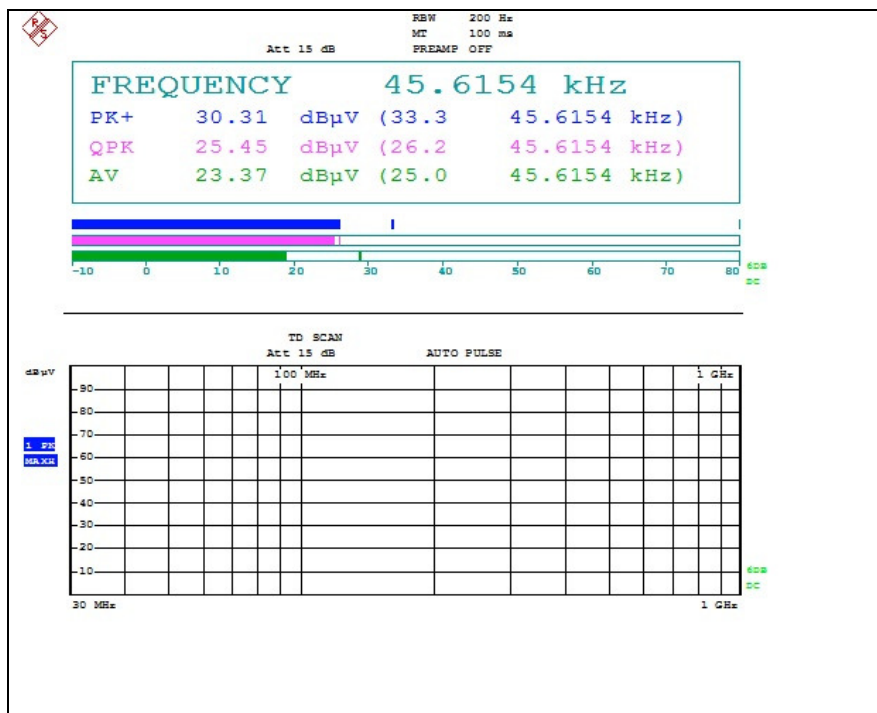
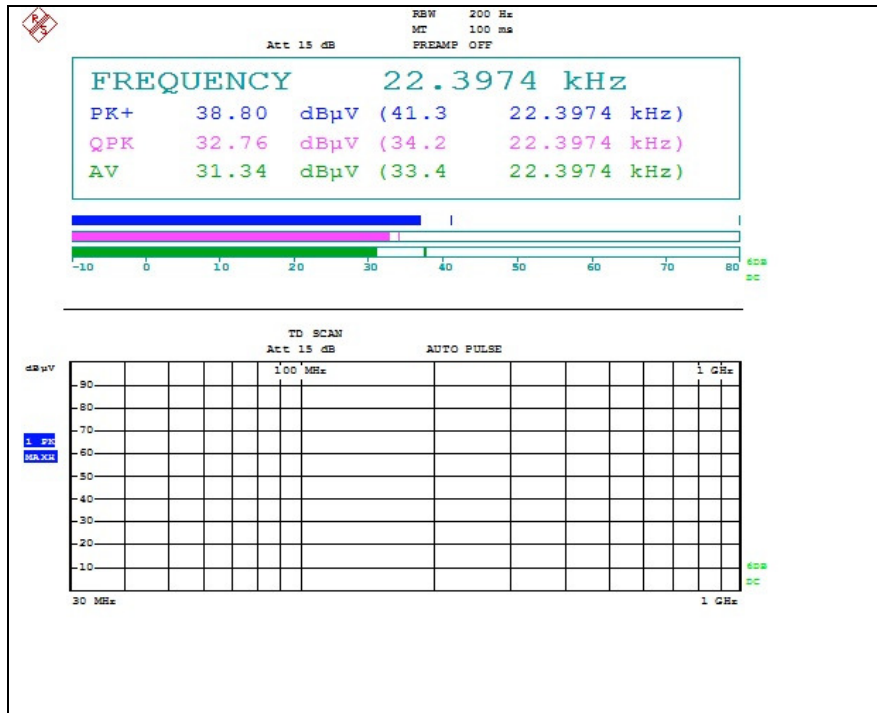
- INT Antenna

Scanning plots below 30 MHz

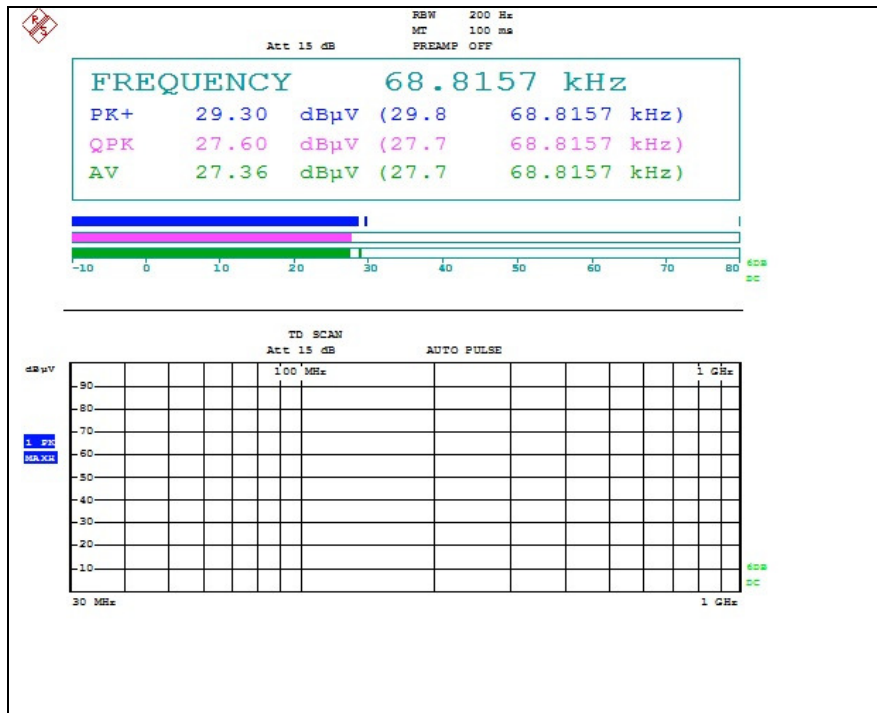


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Measured plots below 30 MHz



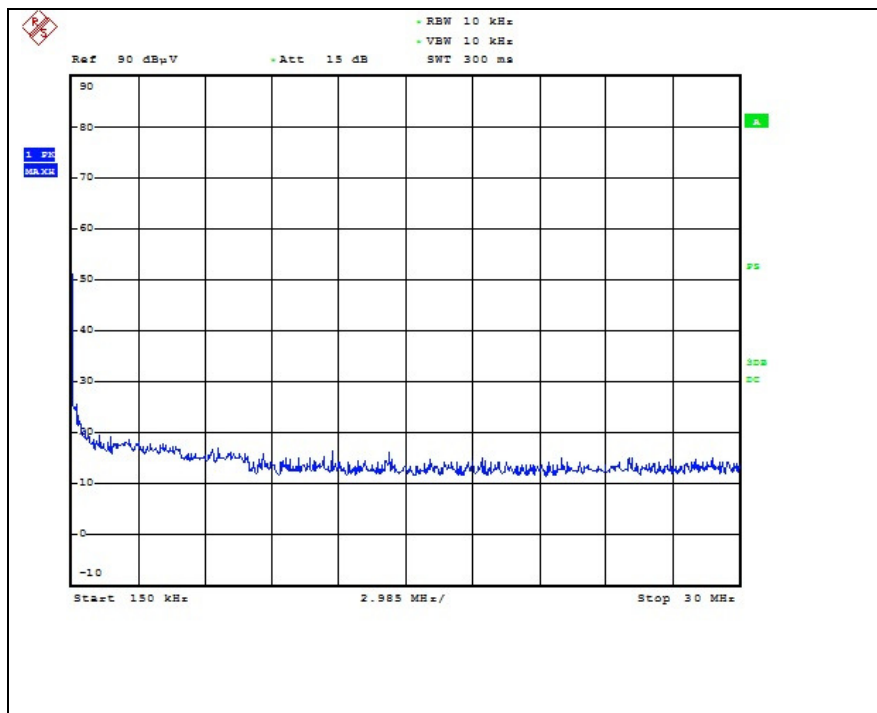
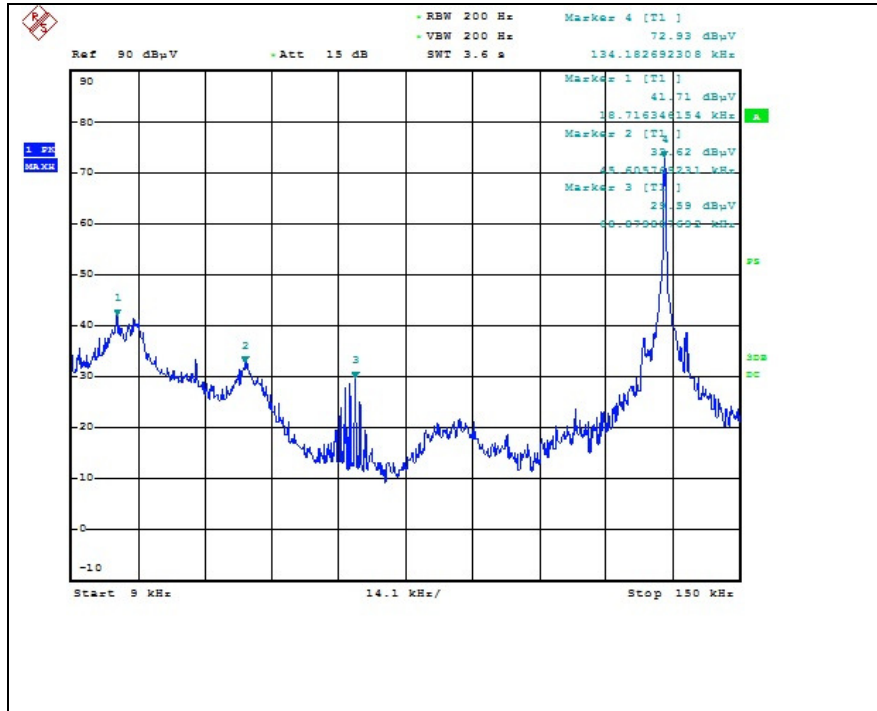
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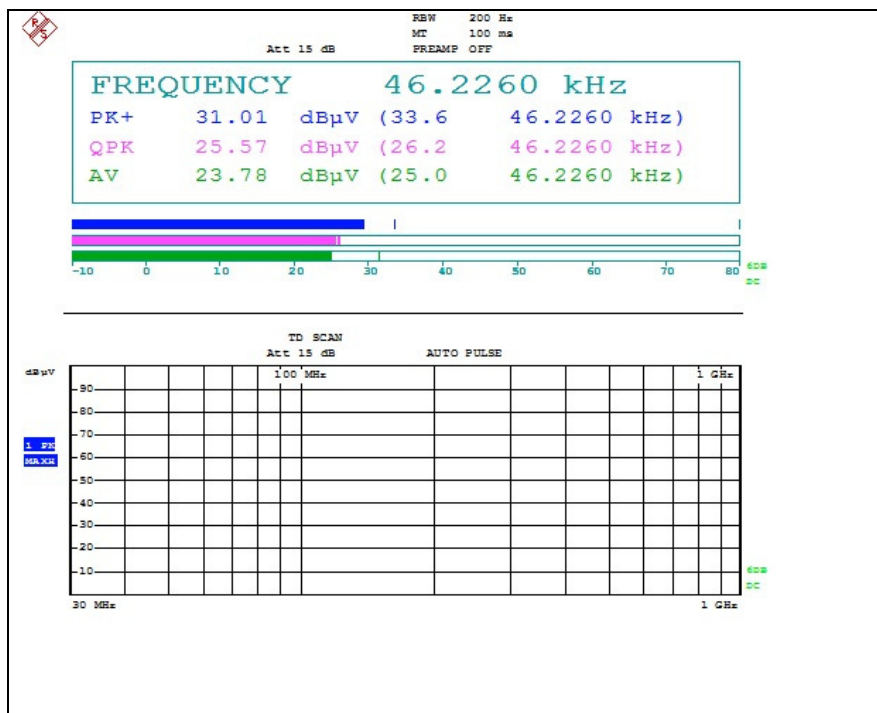
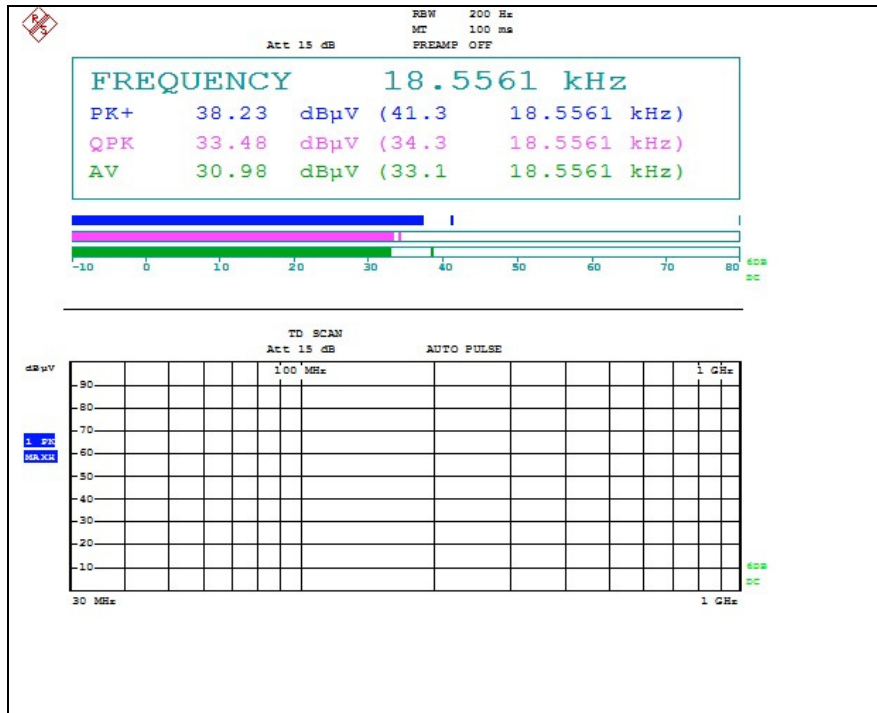
- INT3 Antenna

Scanning plots below 30 MHz

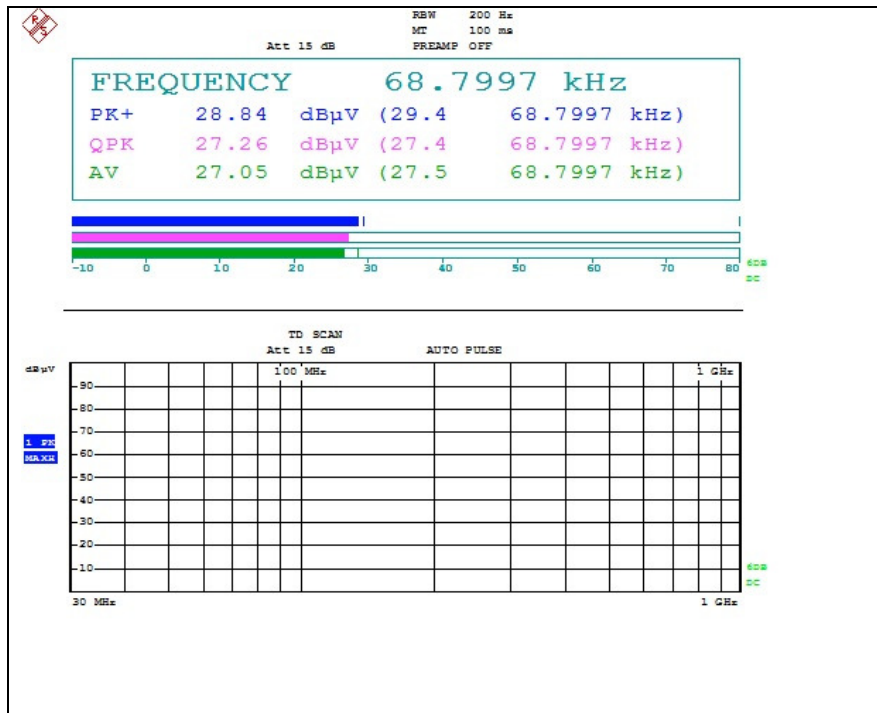


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Measured plots below 30 MHz



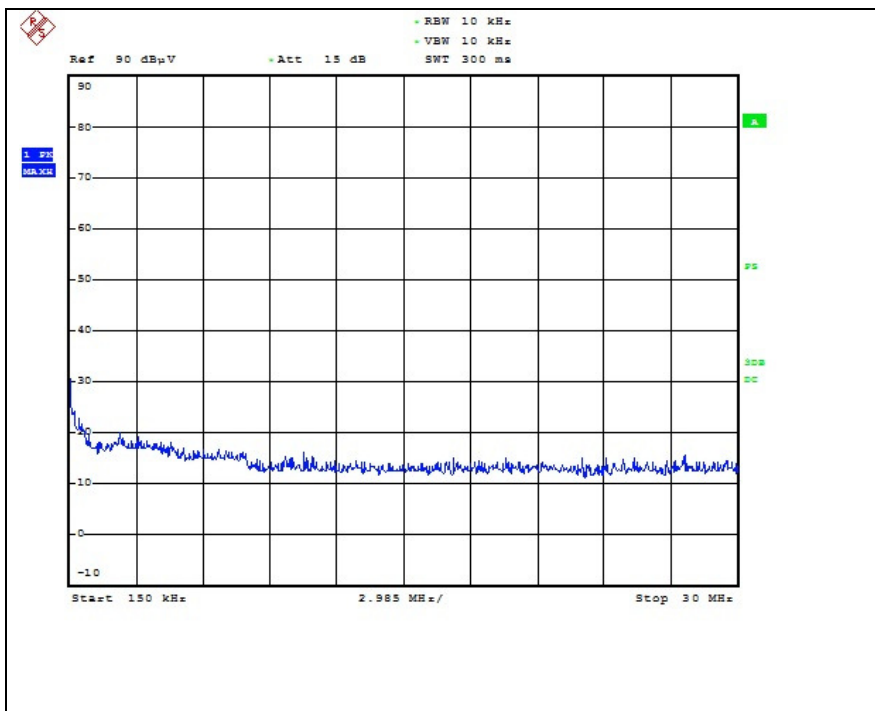
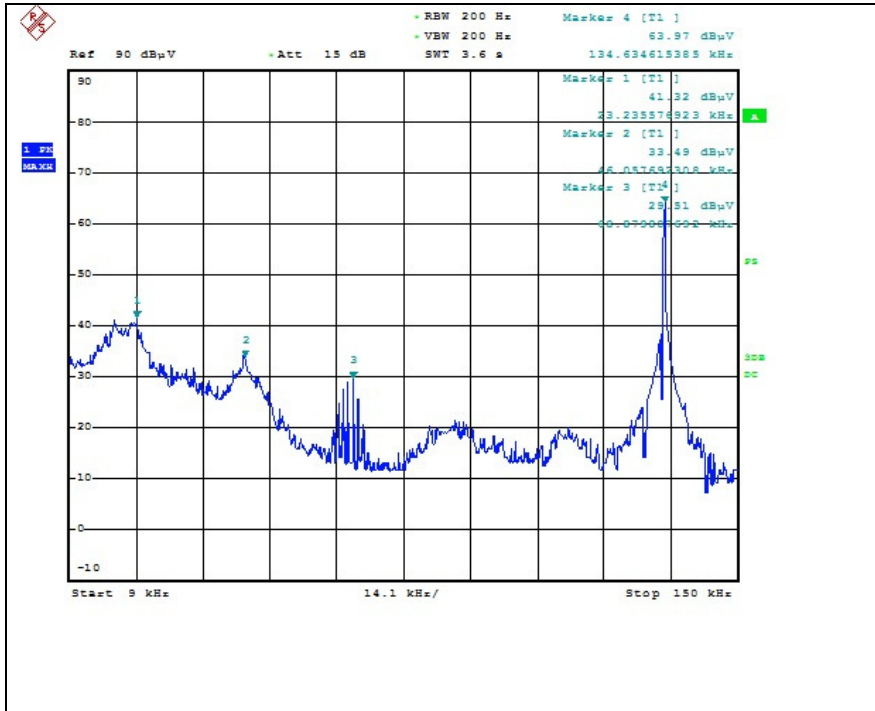
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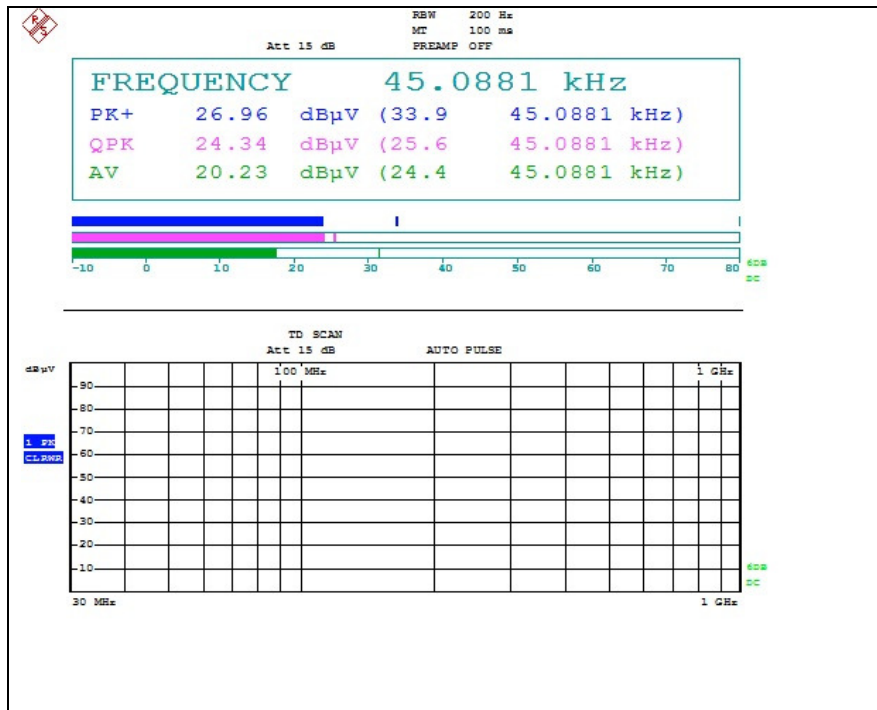
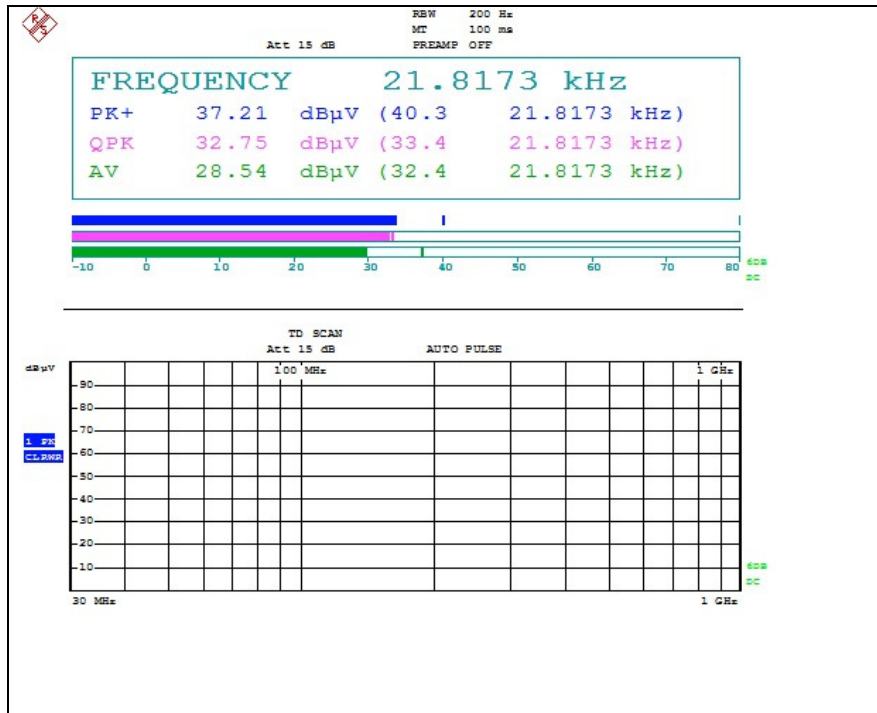
- SSB Antenna

Scanning plots below 30 MHz

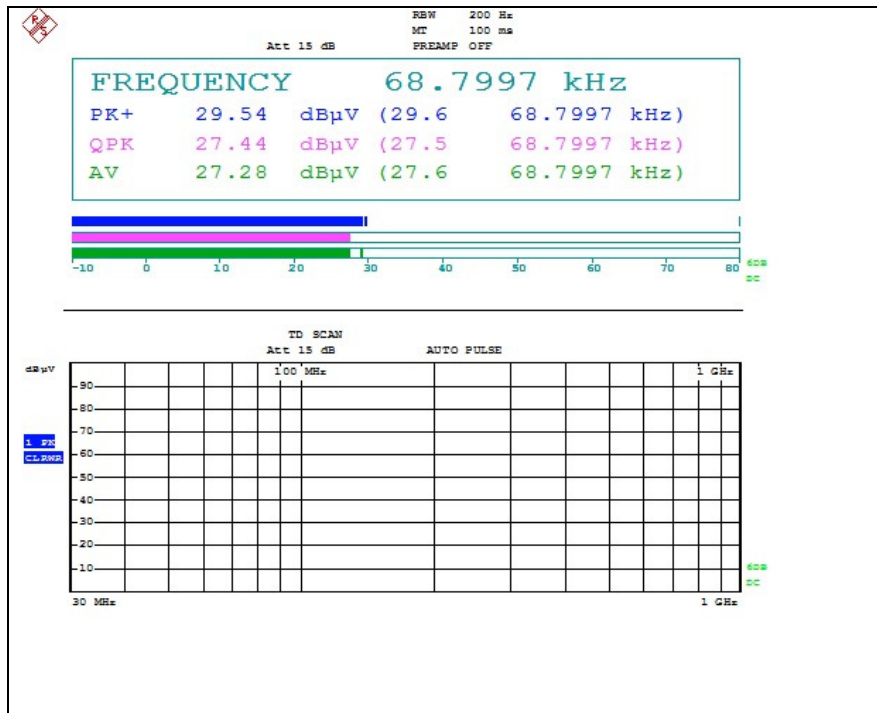


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Measured plots below 30 MHz



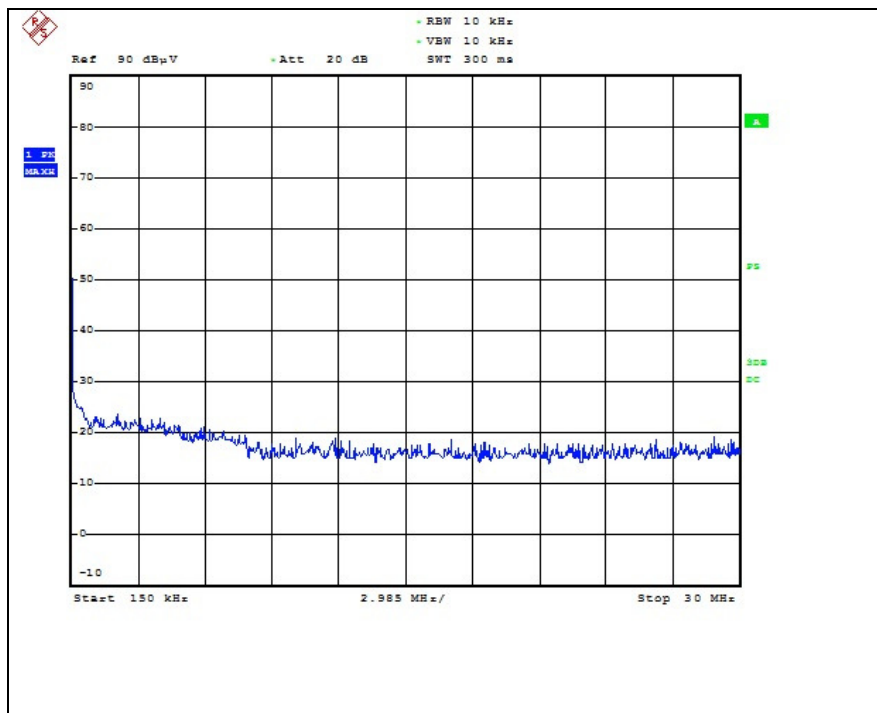
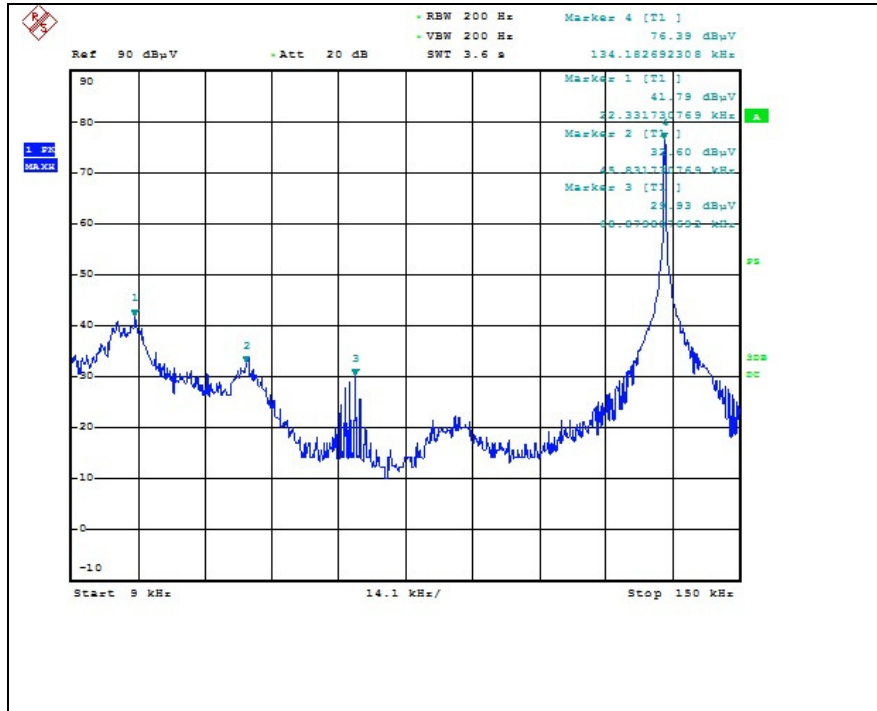
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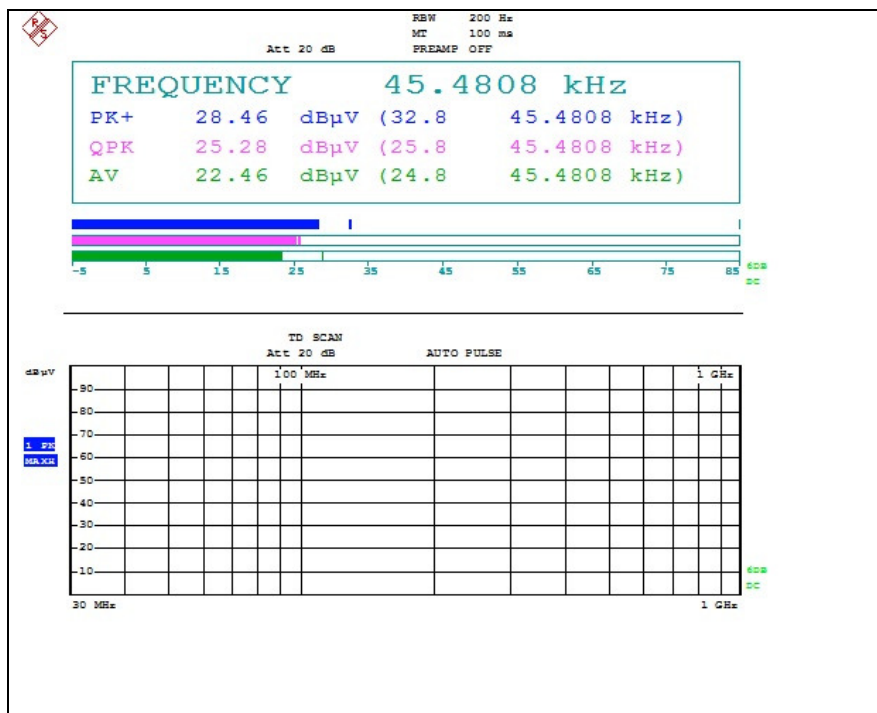
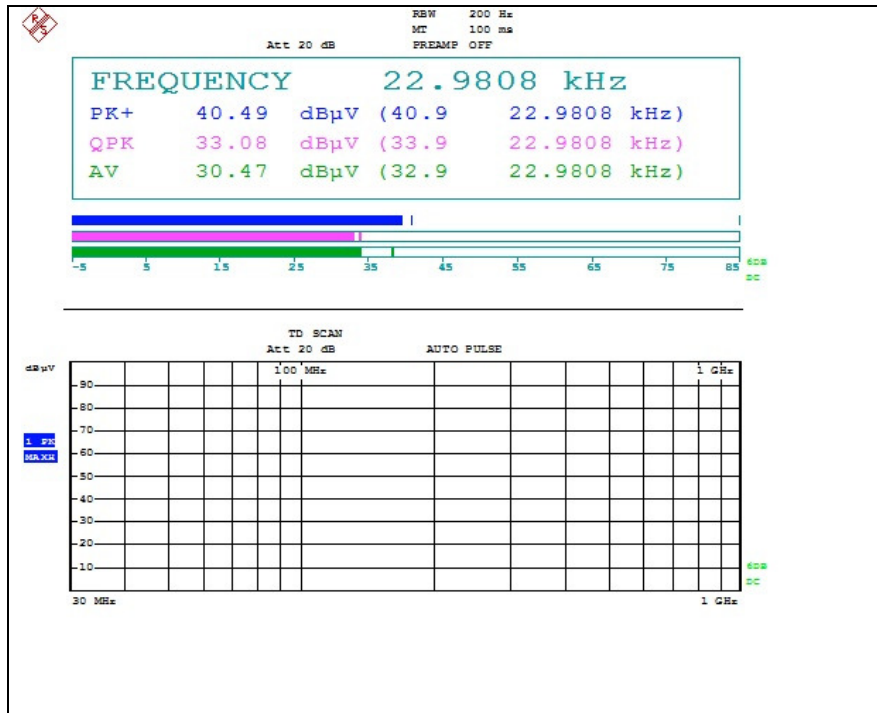
- TNK Antenna

Scanning plots below 30 MHz

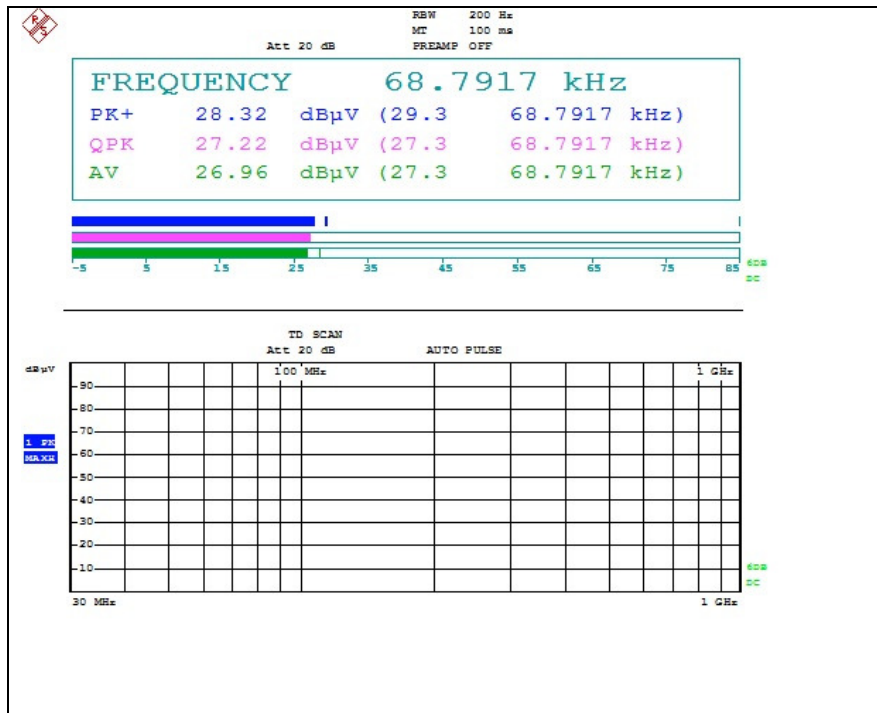


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Measured plots below 30 MHz



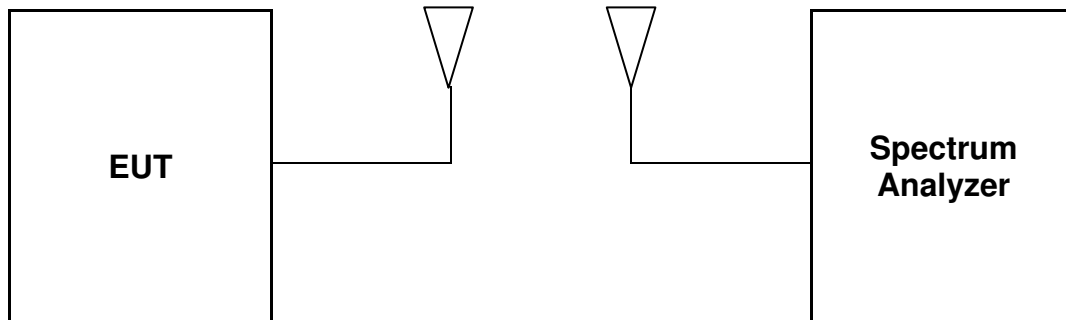
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3. 20 dB Bandwidth

3.1. Test Setup



3.2. Limits

None; for reporting purposed only

3.3. Test Procedure

20 dB Bandwidth

- a. Span = approximately 2 to 3 times the 20 dB bandwidth, RBW = greater than 1 % of the 20 dB bandwidth, VBW = 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

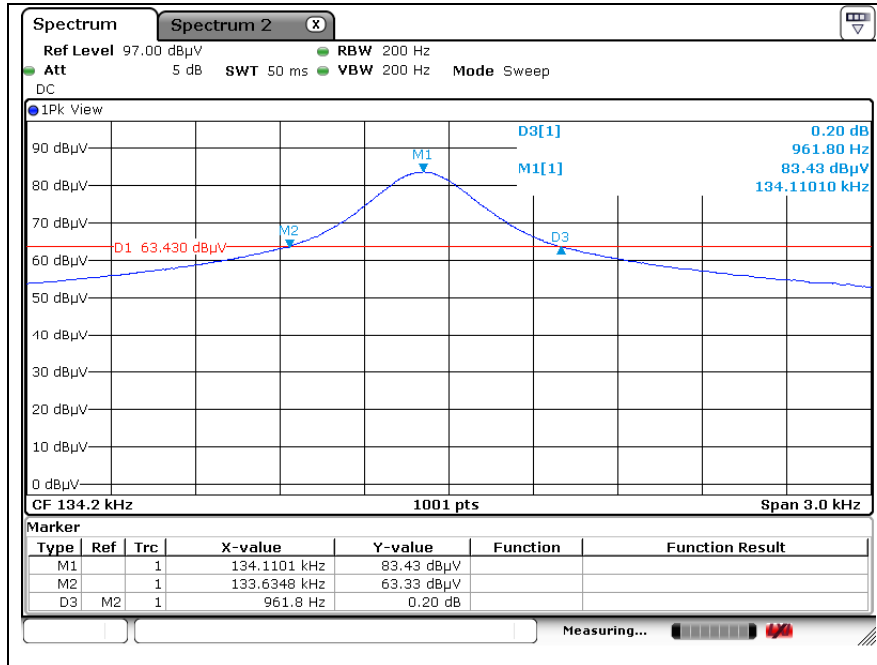
Ambient temperature : (23 ± 1) °C
 Relative humidity : 47 % R.H.

Test Antenna	Carrier Frequency (kHz)	20 dB Bandwidth (kHz)	Limit
AST Antenna	134.110	0.962	Reporting proposed only
BUM Antenna	134.110	0.986	
DRV Antenna	134.107	0.986	
INT Antenna	134.104	1.001	
INT3 Antenna	134.110	0.983	
SSB Antenna	134.479	0.989	
TNK Antenna	134.110	1.010	

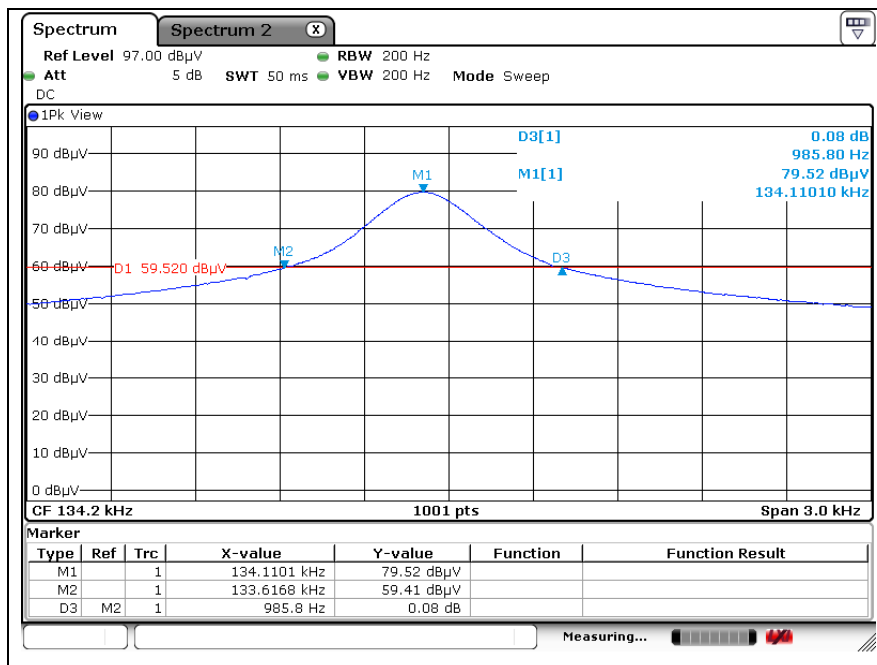
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Test plots

- AST Antenna

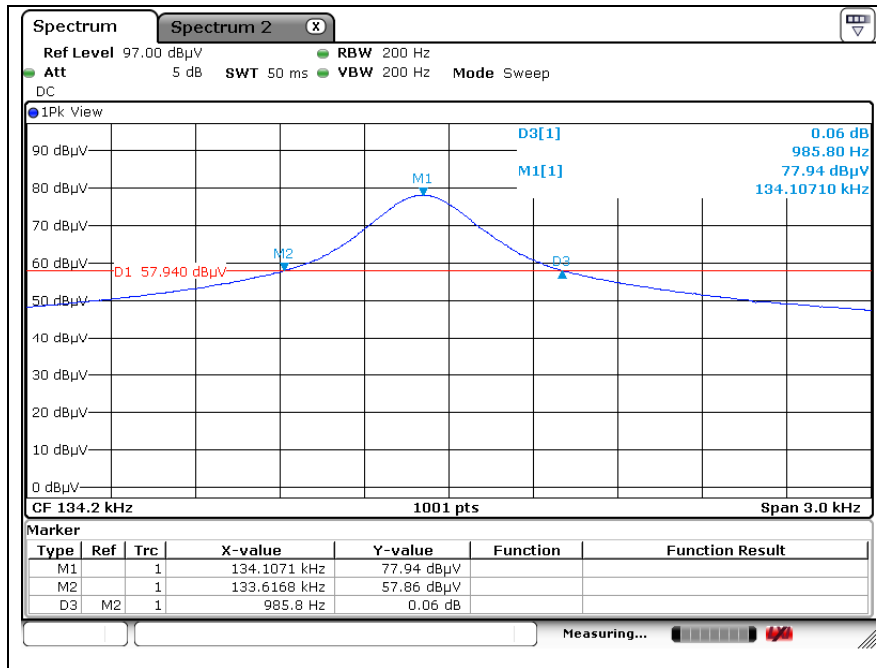


- BUM Antenna

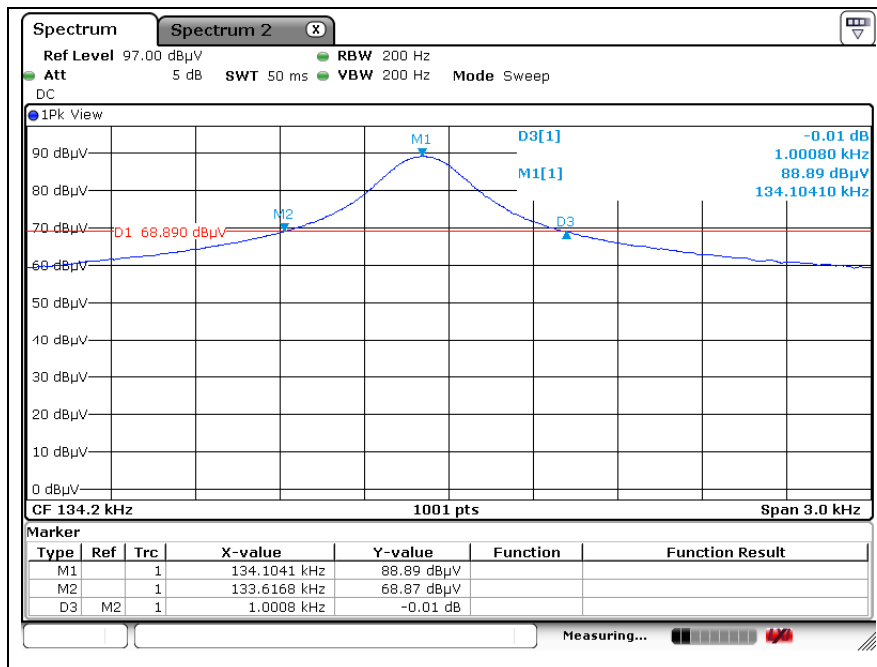


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- DRV Antenna

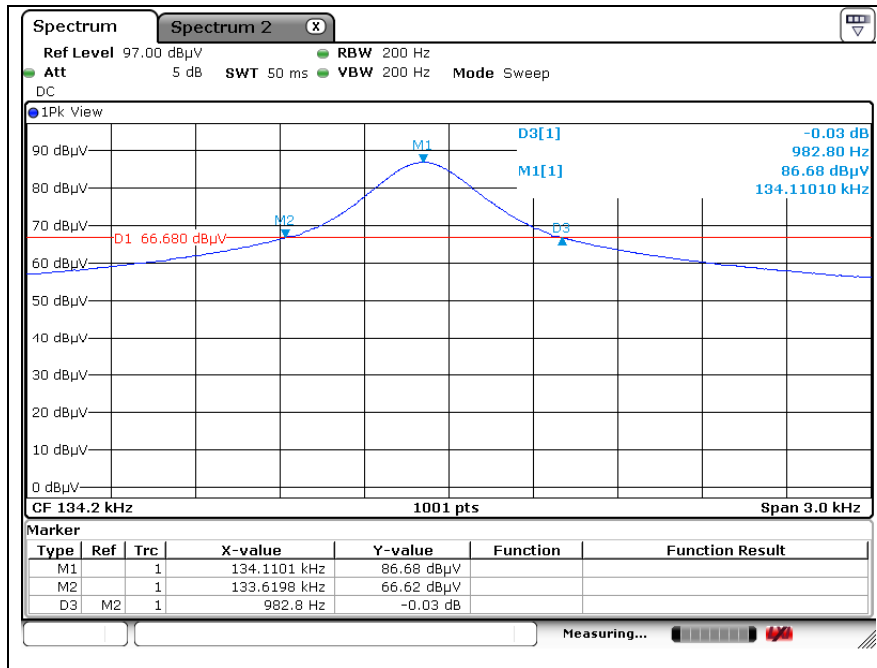


- INT Antenna

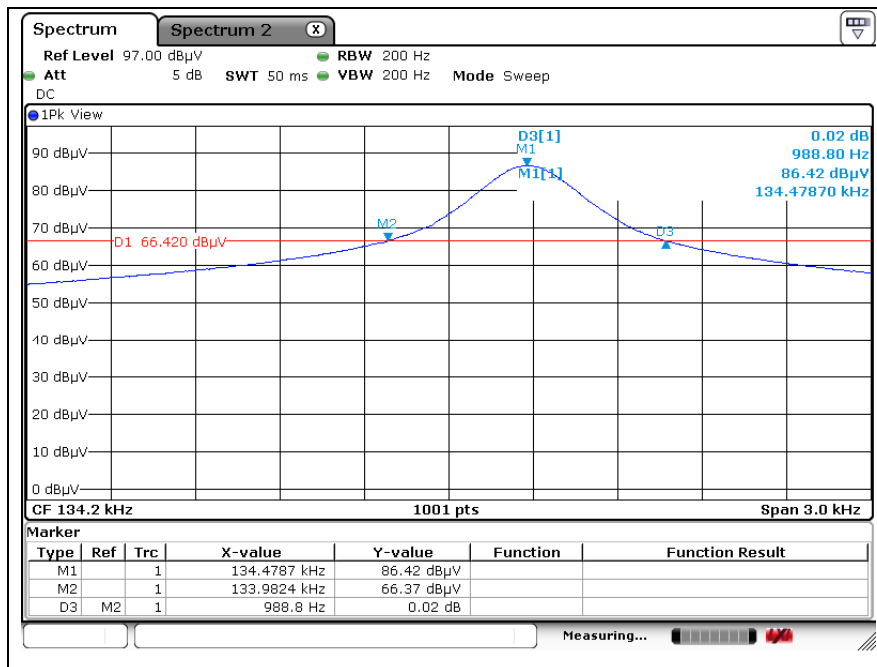


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- INT3 Antenna

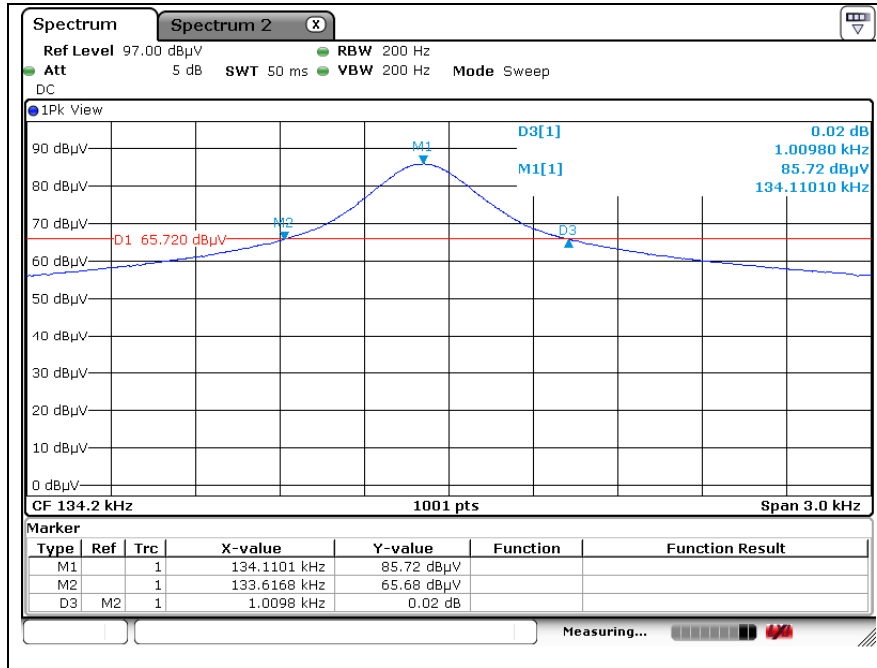


- SSB Antenna



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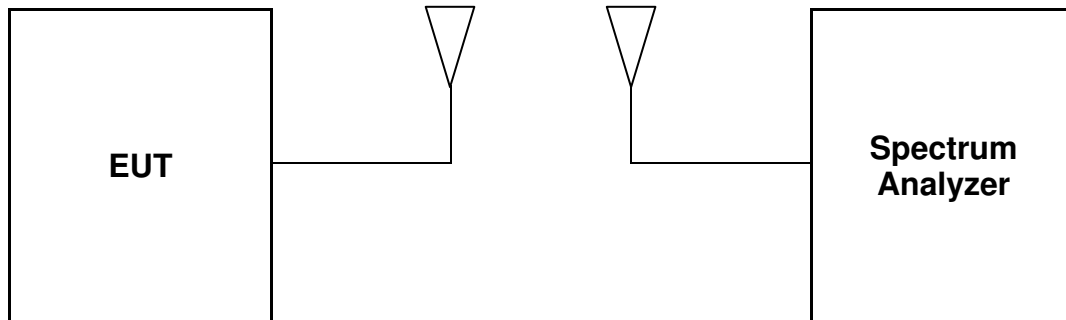
- TNK Antenna



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4. Occupied Bandwidth

4.1. Test Setup



4.2. Limit

None; for reporting purposed only

4.3. Test Procedure

Occupied Bandwidth

- a. Set the spectrum analyzer as SPAN = set to capture all products of the modulation process, including the emission skirts, RBW = set in the range of 1 % to 5 % of the occupied bandwidth (OBW), 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

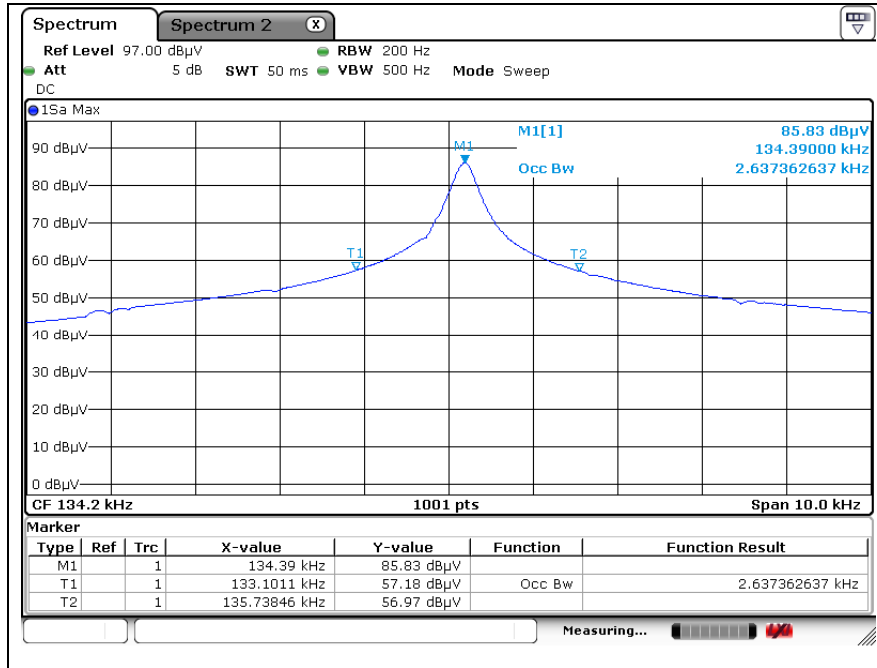
Ambient temperature : (23 ± 1) °C
 Relative humidity : 47 % R.H.

Test Antenna	Carrier Frequency (MHz)	Occupied Bandwidth (kHz)	Limit
AST Antenna	134.390	2.637	Reporting proposed only
BUM Antenna	134.390	2.817	
DRV Antenna	134.380	2.697	
INT Antenna	134.390	2.607	
INT3 Antenna	134.390	2.557	
SSB Antenna	134.550	2.577	
TNK Antenna	134.400	2.557	

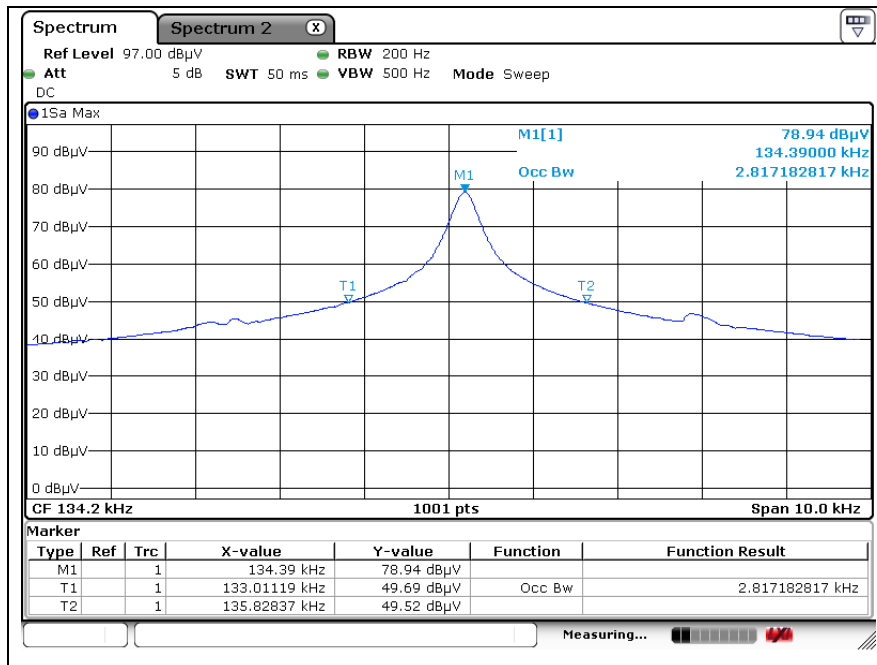
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Test plots

- AST Antenna

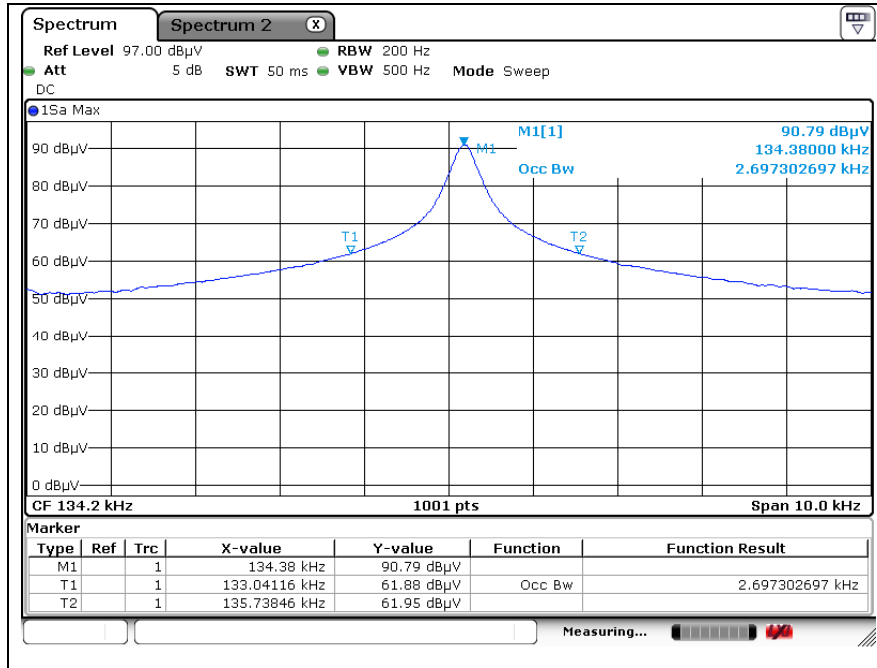


- BUM Antenna

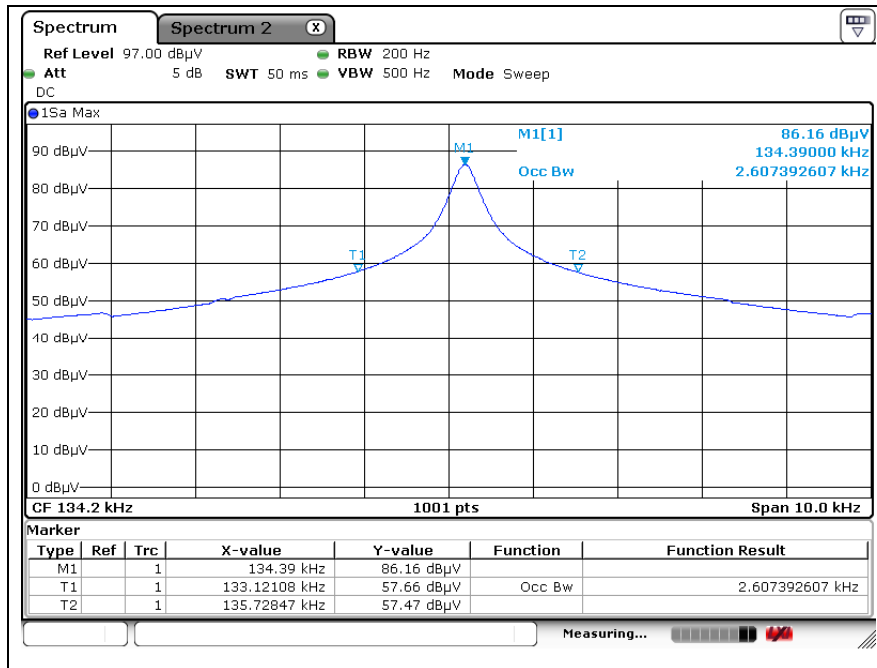


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- DRV Antenna

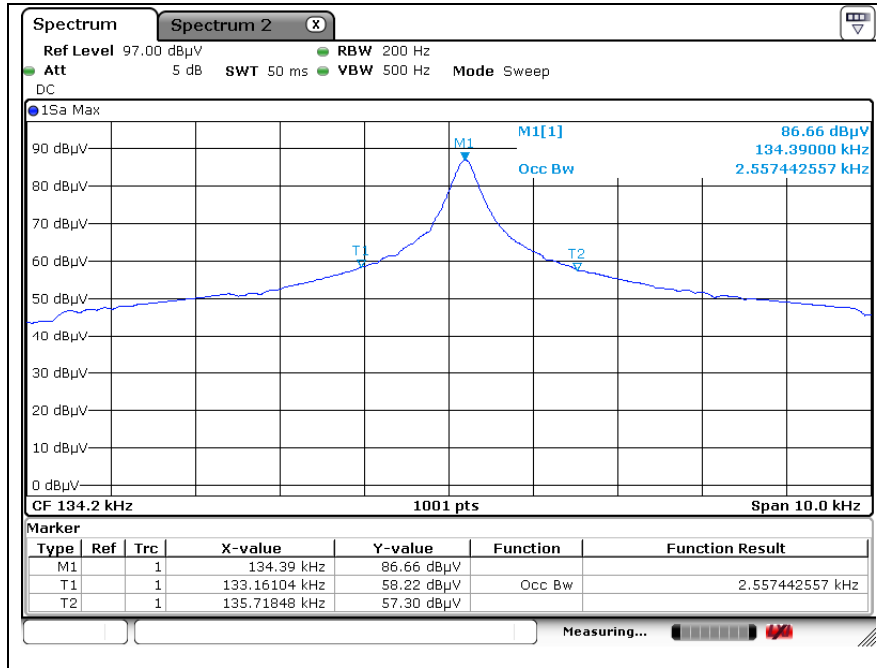


- INT Antenna

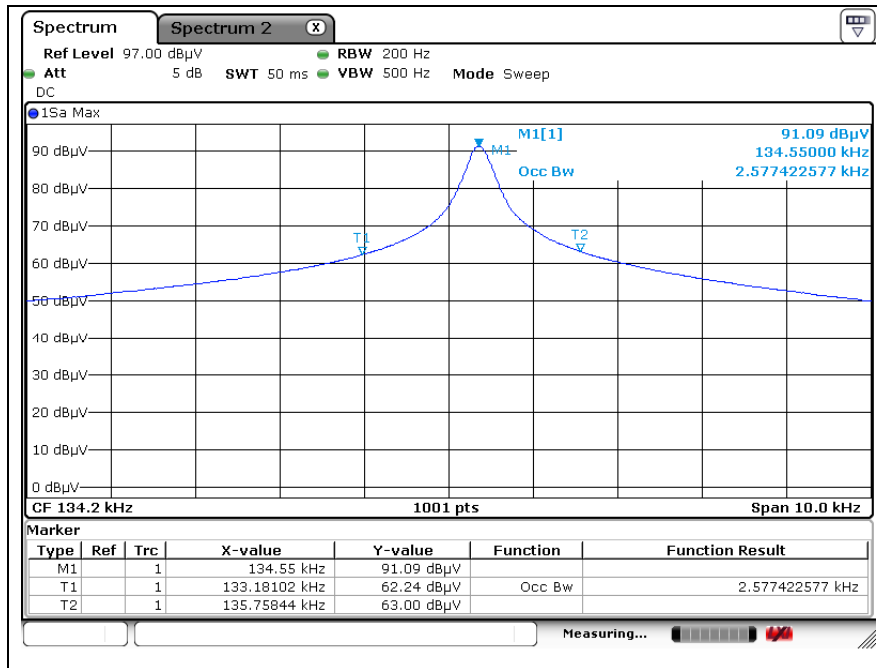


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- INT3 Antenna

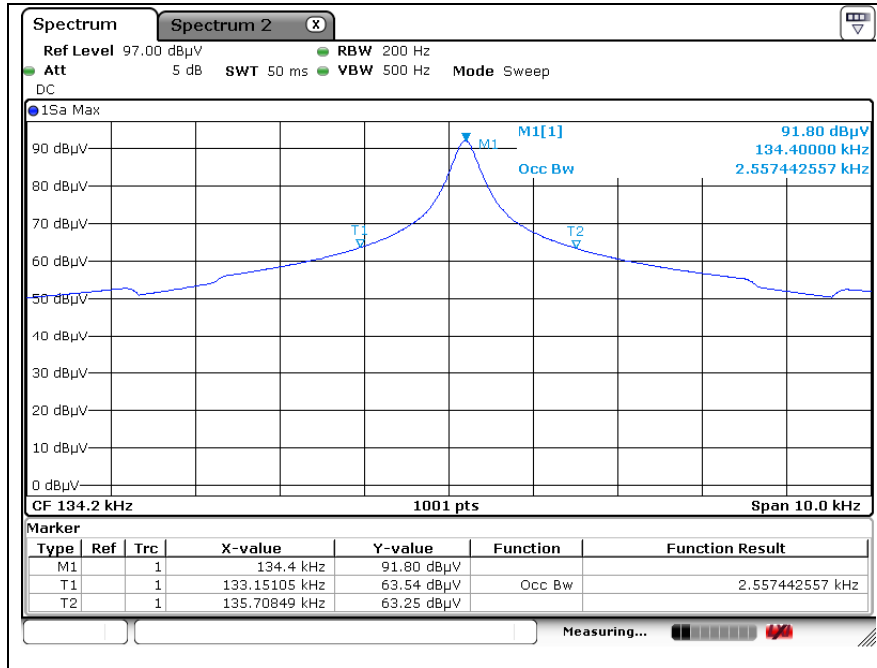


- SSB Antenna



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- TNK Antenna



- End of the Test Report -

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