

TEST REPORT

OF

FCC Part 15 Subpart C §15.209

FCC ID: CQOEG00270

Equipment Under Test : Smart Key ECU
 Model Name : EG00270
 Applicant : DENSO KOREA ELECTRONICS CORPORATION
 Manufacturer : DENSO KOREA ELECTRONICS CORPORATION
 Date of Receipt : 2017.03.03
 Date of Test(s) : 2017.03.13 ~ 2017.03.20
 Date of Issue : 2017.03.20

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

Tested By:



Inho Park

Date:

2017.03.20

Technical Manager:



Alvin Kim

Date:

2017.03.20

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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, Chemdansaneop-ro, Masanhappo-gu, Chang-won-si, Gyeongsangnam-do, Korea

Contact Person : Kang, Sung-Won

Phone No. : +82 55 220 9346

1.3. Description of EUT

Kind of Product		Smart Key ECU
Model Name		EG00270
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

1.4. Declaration of manufacturer

- The EUT has 6 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	Feb. 17, 2017	Annual	Feb. 17, 2018
Loop Antenna	Schwarzbeck Mess-Elektronik	FMZB 1519	1519-039	Aug. 19, 2015	Biennial	Aug. 19, 2017
Bilog Antenna	Schwarzbeck Mess-Elektronik	VULB9163	396	Jun. 18, 2015	Biennial	Jun. 18, 2017
Preamplifier	H.P.	8447F	2944A03909	Aug. 11, 2016	Annual	Aug. 11, 2017
Controller	Innco systems GmbH	CONTROLLER CO3000-4P	CO3000/963/3 8330516/L	N.C.R.	N/A	N.C.R.
Antenna Mast	Innco systems GmbH	MA4640-XP-ET	MA4640/536/3 8330516/L	N.C.R.	N/A	N.C.R.
Turn Table	Innco systems GmbH	DS 1200 S	N/A	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.

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: FCC Part 15		
Section in FCC Part 15	Test Item	Result
15.209	Radiated emission, Spurious Emission and Field Strength of Fundamental	Complied
2.1049	20 dB Bandwidth	Complied

1.8. Test Report Revision

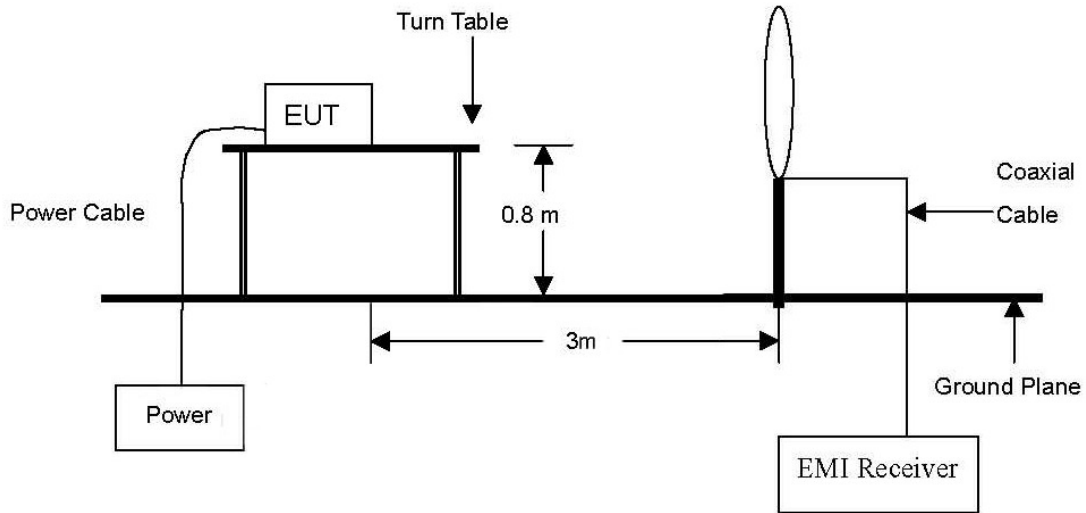
Revision	Report number	Date of Issue	Description
0	F690501/RF-RTL010929	2017.03.16	Initial
1	F690501/RF-RTL010929-1	2017.03.20	Retested Spurious Emissions item

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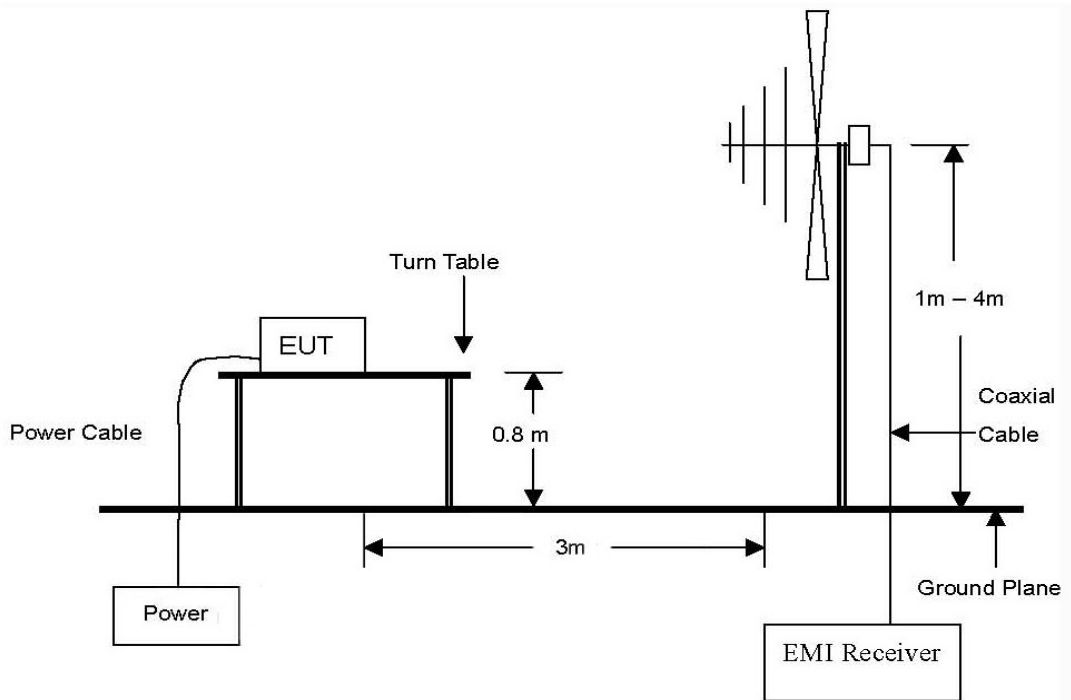
2. Field Strength of Fundamental and Spurious Emission

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.



The diagram below shows the test setup that is utilized to make the measurements for emission from 30 MHz to 1 GHz emissions.



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2.2. Limits

According to §15.209 Radiated emission limits; general requirements,

(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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2.3. 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 Y – 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.

2.3.2. Test Procedures for emission from above 30 MHz

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 below 1 GHz and 1.5 meters above the ground at a 3 meter anechoic chamber test site above 1 GHz. The table was rotated 360 degrees to determine the position of the highest radiation.
2. During performing radiated emission below 1 GHz, the EUT was set 3 meters away from the interference receiving antenna, which was mounted on the top of a variable-height antenna tower. During performing radiated emission above 1 GHz, the EUT was set 3 meter away from the interference-receiving antenna.
3. The antenna is a bi-log antenna, a horn antenna and its height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are set to make the measurement.
4. For each suspected emission, the EUT was arranged to its worst case and then the antenna was tuned to heights from 1 meter to 4 meters and the table was turned from 0 degrees to 360 degrees to find the maximum reading.
5. The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
6. If the emission level of the EUT in peak mode was 10 dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10 dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

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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 (Y-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)
LF ANT1									
0.134	76.91	Average	H	19.42	0.07	96.40	16.40	25.06	8.66
LF ANT2									
0.134	77.90	Average	H	19.42	0.07	97.39	17.39	25.06	7.67
LF ANT3									
0.134	76.84	Average	H	19.42	0.07	96.33	16.33	25.06	8.73
LF ANT4									
0.134	74.94	Average	H	19.42	0.07	94.43	14.43	25.06	10.63
LF ANT5									
0.134	75.25	Average	H	19.42	0.07	94.74	14.74	25.06	10.32
TP ANT									
0.134	63.80	Average	H	19.42	0.07	83.29	3.29	25.06	21.77

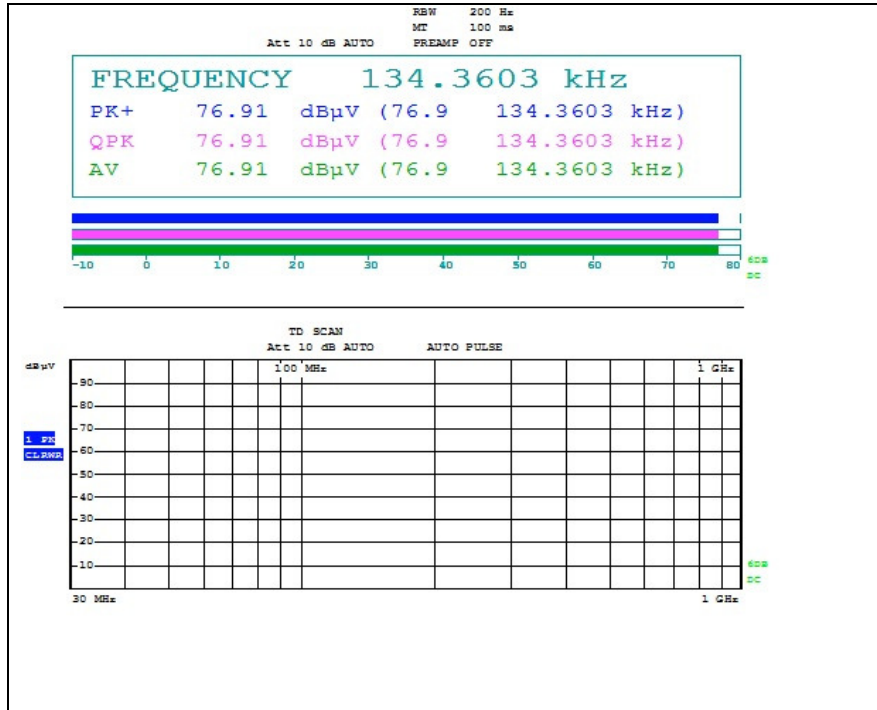
Note;

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),
 - 9 kHz to 490 kHz : 20log(2 400 / F (kHz)) at 300 m (dB μ V/m)

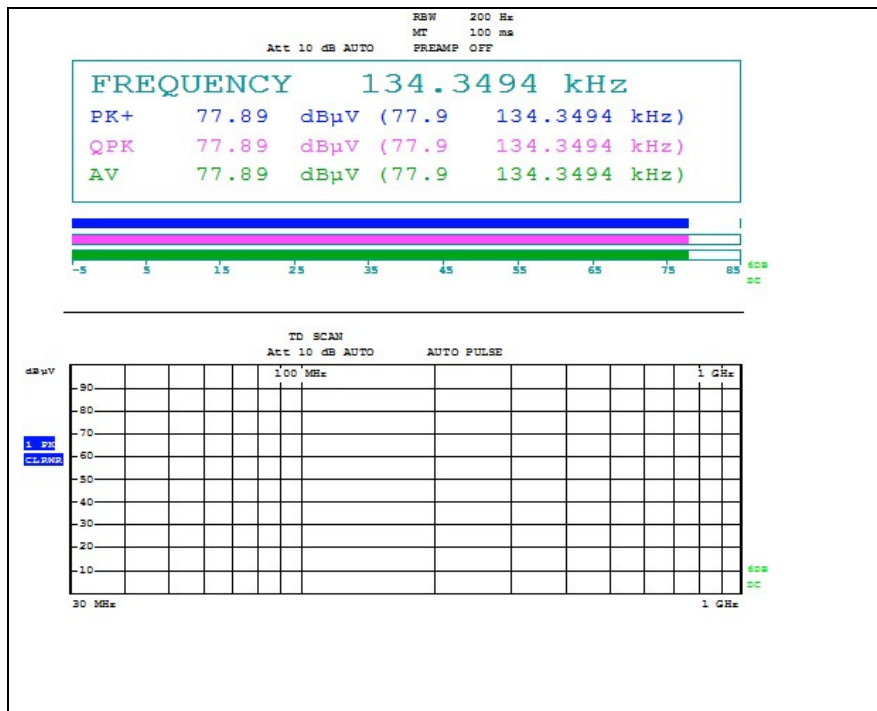
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Test plot

- LF ANT1

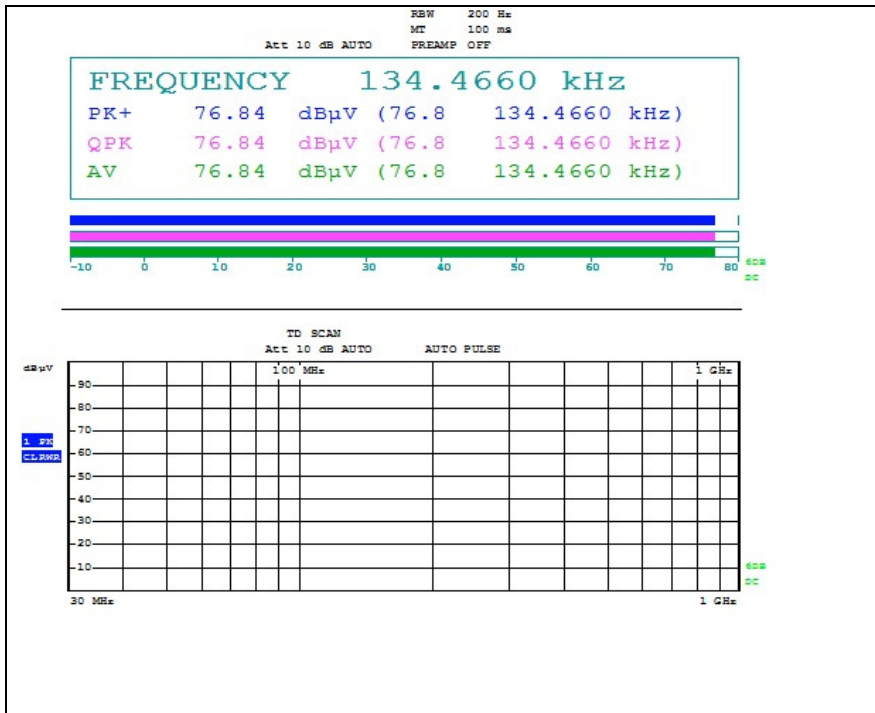


- LF ANT2

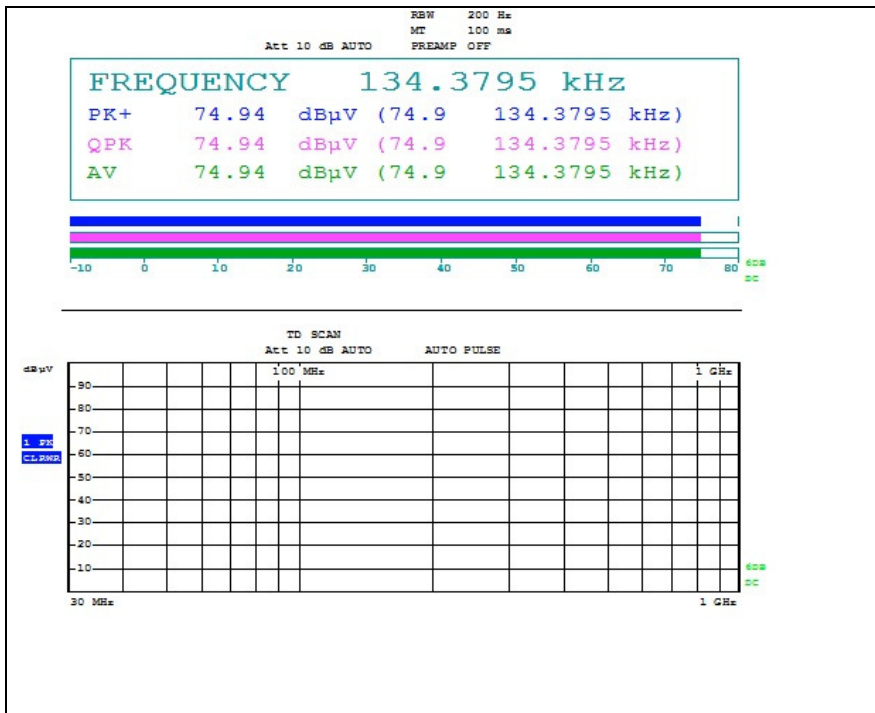


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- LF ANT3

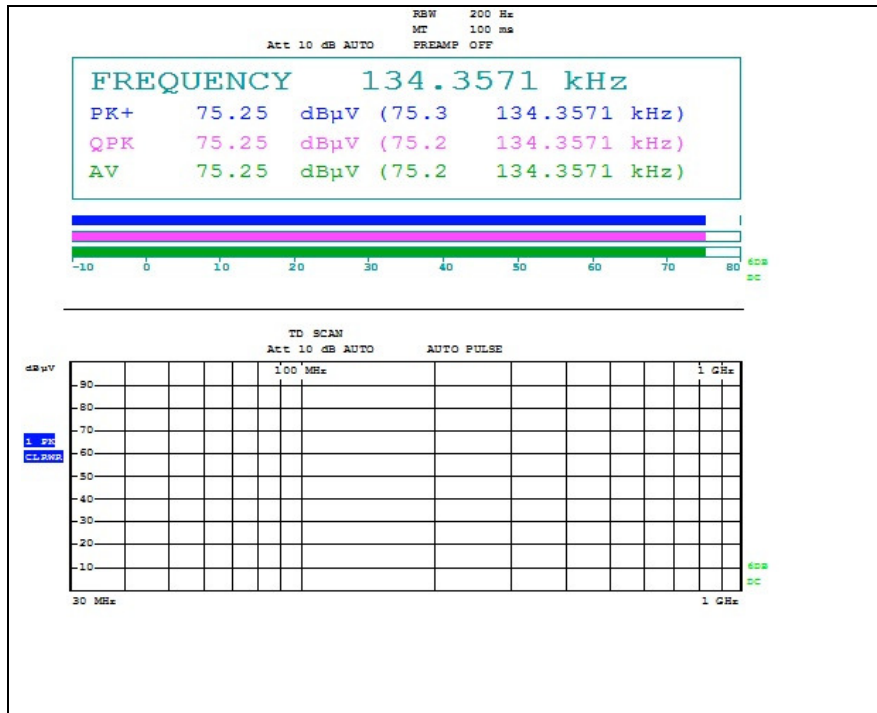


- LF ANT4

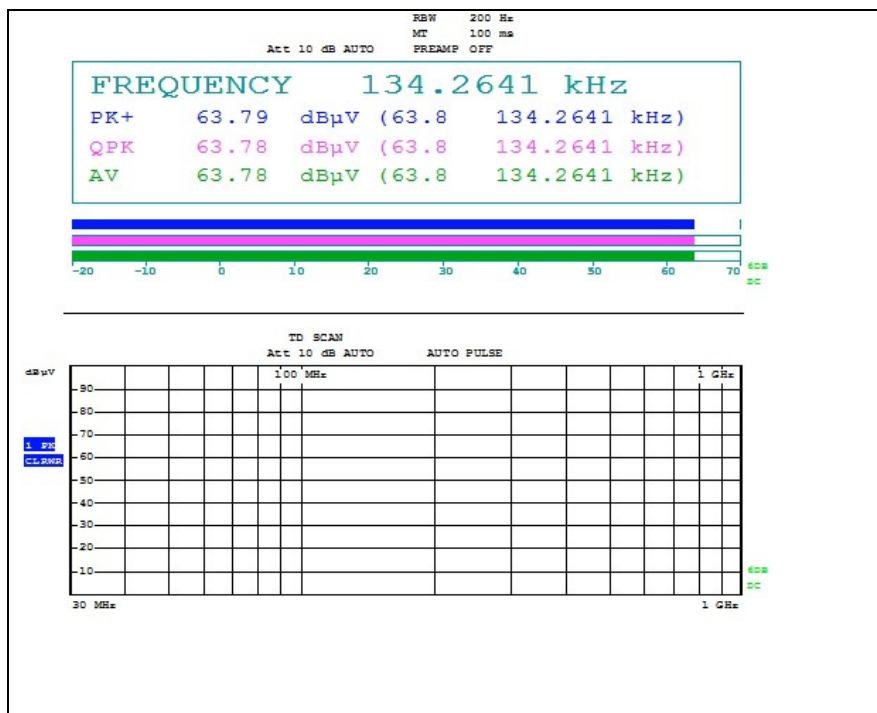


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- LF ANT5



- TP ANT



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2.5. Spurious Emission Test Results

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

2.5.1. Spurious Emission Below 30 MHz

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 30m or 300 m	Limit (dB μ V/m) at 30m or 300 m	Margin (dB)
LF ANT1									
0.022	29.30	Average	H	19.46	0.02	48.78	-31.22	40.76	71.98
0.131	41.10	Average	H	19.42	0.07	60.59	-19.41	25.26	44.67
0.137	41.40	Average	H	19.41	0.07	60.88	-19.12	24.87	43.99
2.516	12.00	Quasi peak	H	19.32	0.53	31.85	-8.15	29.54	37.69
Above 3.000	Not detected	-	-	-	-	-	-	-	-
LF ANT2									
0.022	28.60	Average	H	19.46	0.02	48.08	-31.92	40.76	72.68
0.035	24.80	Average	H	19.30	0.03	44.13	-35.87	36.72	72.59
0.069	23.20	Average	H	19.38	0.03	42.61	-37.39	30.83	68.22
2.486	12.50	Quasi peak	H	19.33	0.53	32.36	-7.64	29.54	37.18
Above 3.000	Not detected	-	-	-	-	-	-	-	-
LF ANT3									
0.022	28.20	Average	H	19.46	0.02	47.68	-32.32	40.76	73.08
0.035	23.30	Average	H	19.30	0.03	42.63	-37.37	36.72	74.09
0.069	22.00	Average	H	19.38	0.03	41.41	-38.59	30.83	69.42
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 30m or 300 m	Limit (dB μ V/m) at 30m or 300 m	Margin (dB)
LF ANT4									
0.022	28.80	Average	H	19.46	0.02	48.28	-31.72	40.76	72.48
0.131	39.10	Average	H	19.42	0.07	58.59	-21.41	25.26	46.67
0.138	39.80	Average	H	19.41	0.07	59.28	-20.72	24.81	45.53
Above 1.000	Not detected	-	-	-	-	-	-	-	-
LF ANT5									
0.022	28.40	Average	H	19.46	0.02	47.88	-32.12	40.76	72.88
0.131	39.92	Average	H	19.42	0.07	59.41	-20.59	25.26	45.85
0.138	39.20	Average	H	19.41	0.07	58.68	-21.32	24.81	46.13
Above 1.000	Not detected	-	-	-	-	-	-	-	-
TP ANT									
0.023	26.90	Average	H	19.44	0.02	46.36	-33.64	40.37	74.01
0.047	17.40	Average	H	19.30	0.03	36.73	-43.27	34.16	77.43
0.069	20.80	Average	H	19.38	0.03	40.21	-39.79	30.83	70.62
0.404	24.30	Average	H	19.05	0.30	43.65	-36.35	15.48	51.83
Above 1.000	Not detected	-	-	-	-	-	-	-	-

Note;

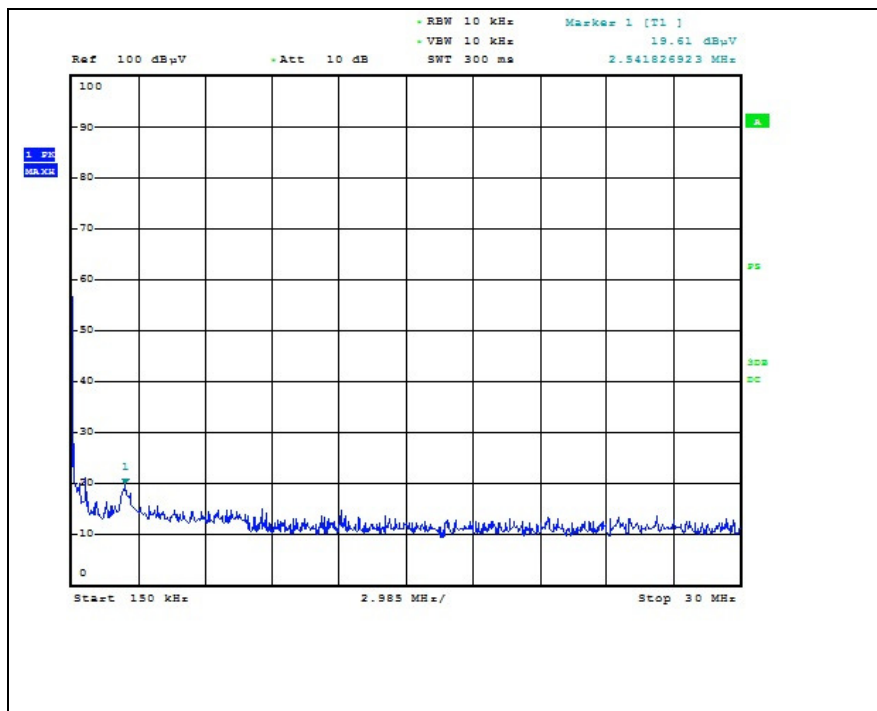
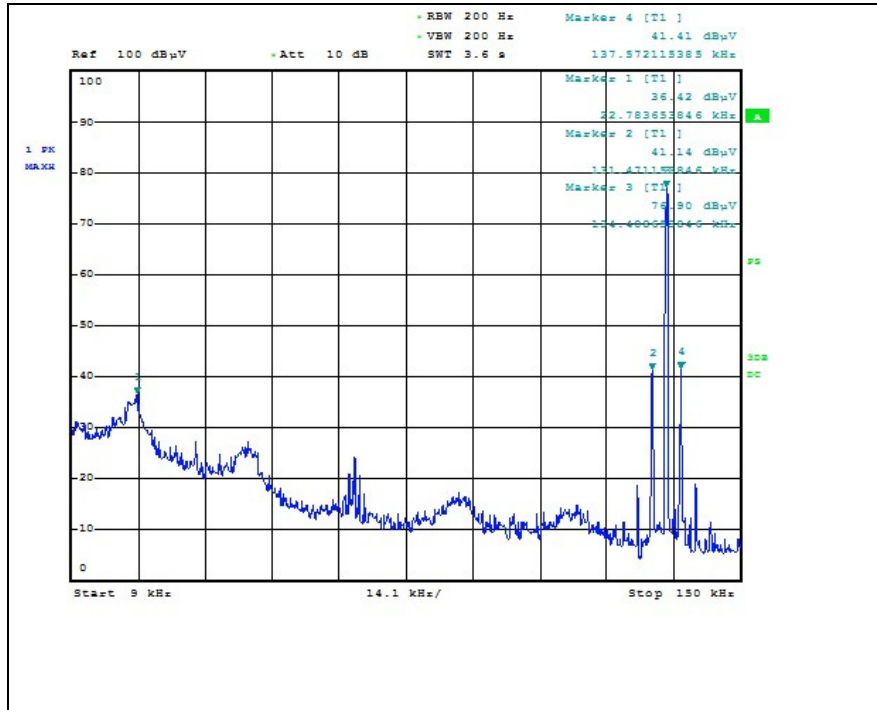
- According to §15.31 (f)(2)
 - 300 m Result(dB μ V/m) = 3 m Result(dB μ V/m) - 40log(300/3) (dB μ V/m)
 - 30 m Result(dB μ V/m) = 3 m Result(dB μ V/m) - 40log(30/3) (dB μ V/m)
- According to field strength table of general requirement in §15.209 (a), field strength limits below 30 MHz were calculated 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)
 - 1 705 kHz to 30 MHz : 20log(30) 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

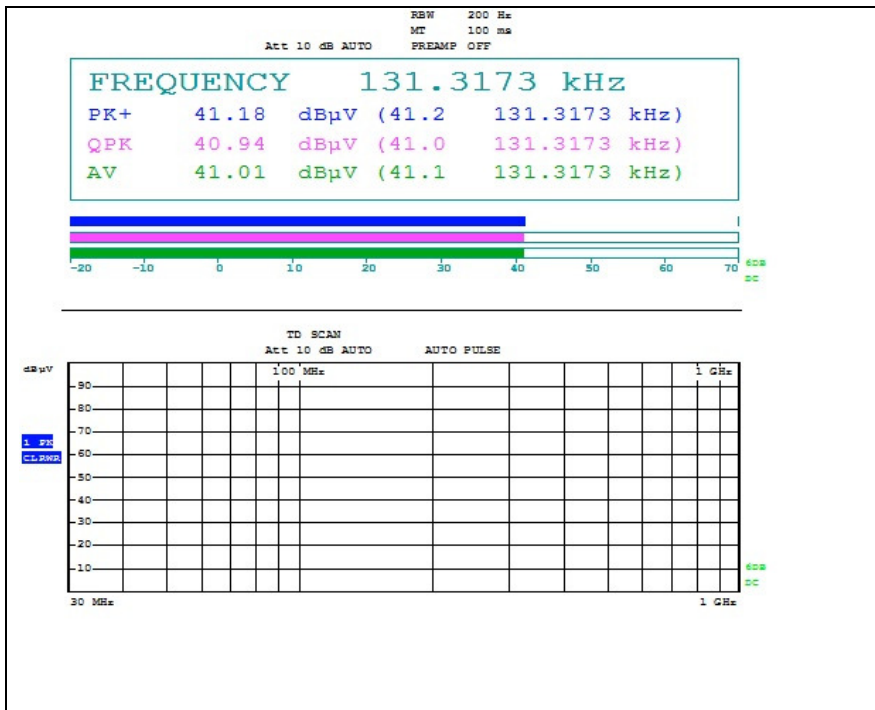
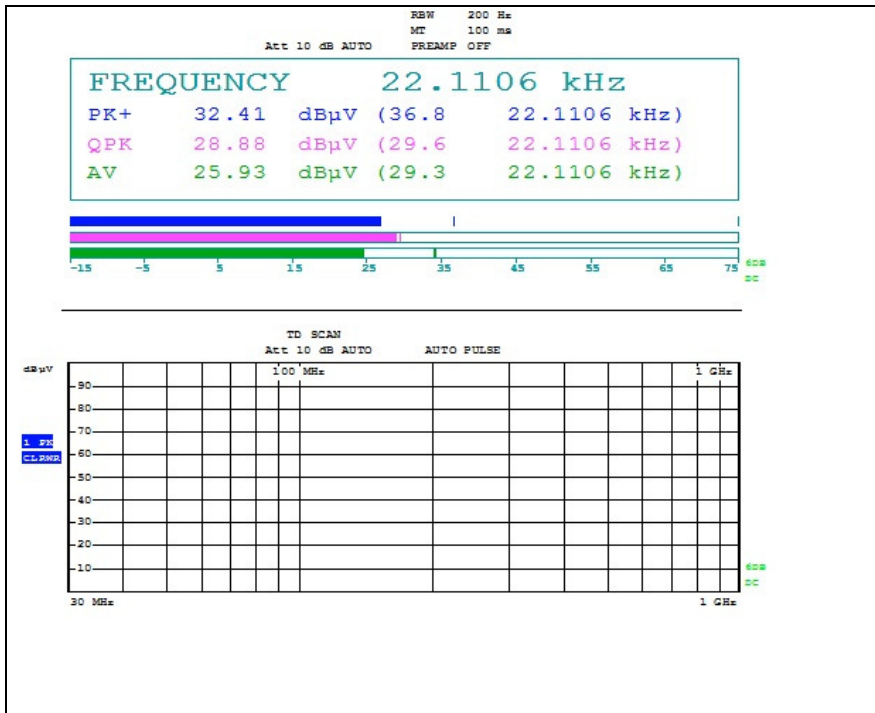
- LF ANT1

Scanning plots below 30 MHz

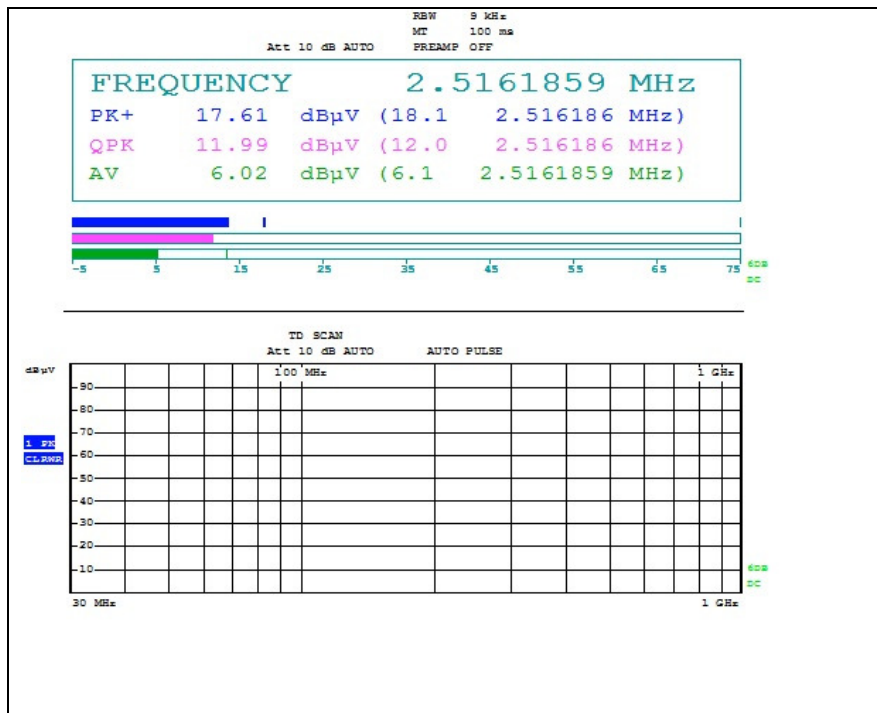
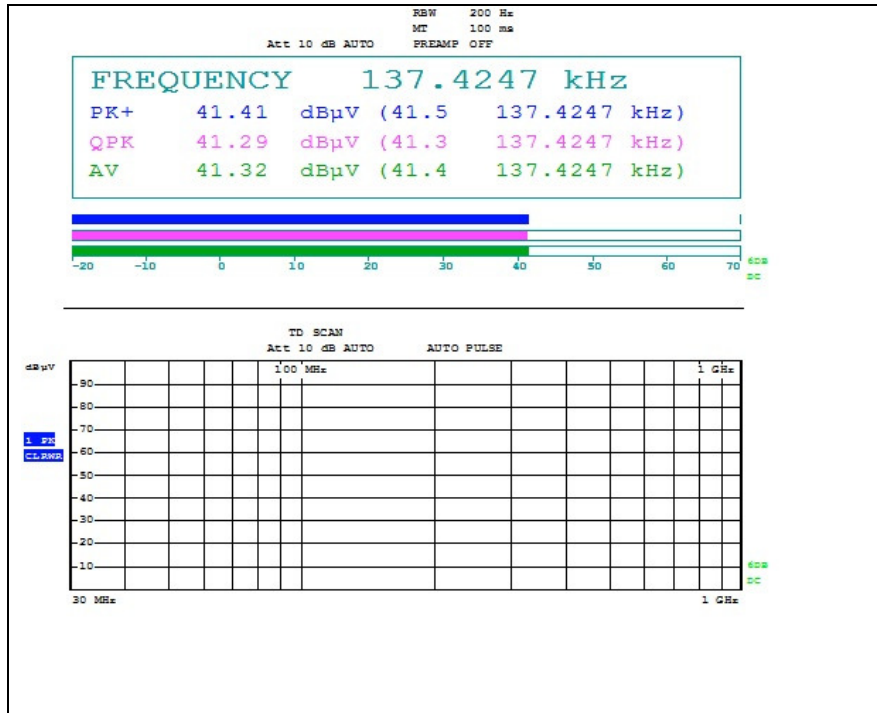


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Measured plots below 30 MHz



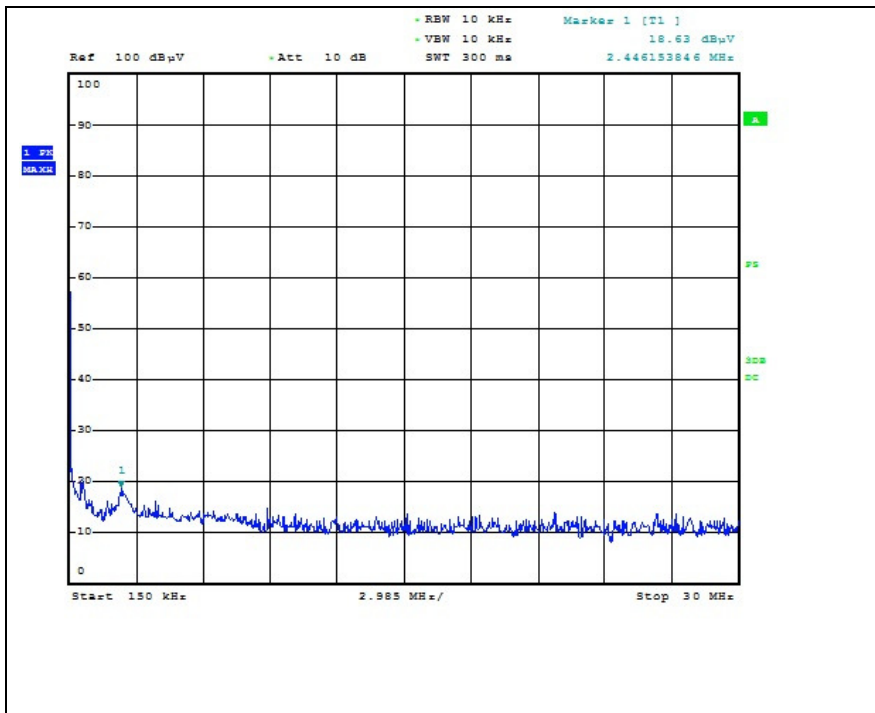
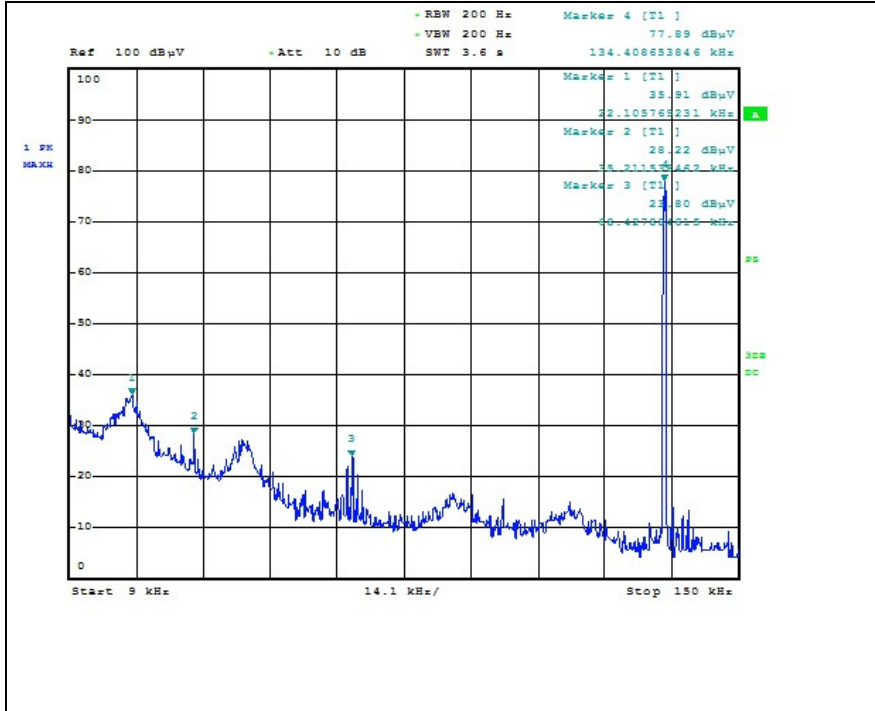
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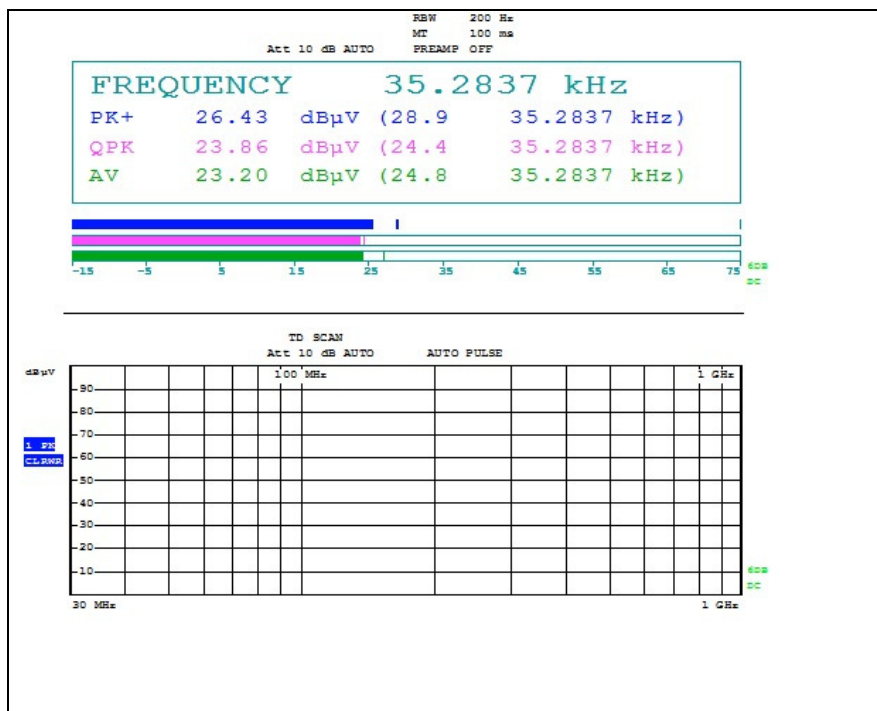
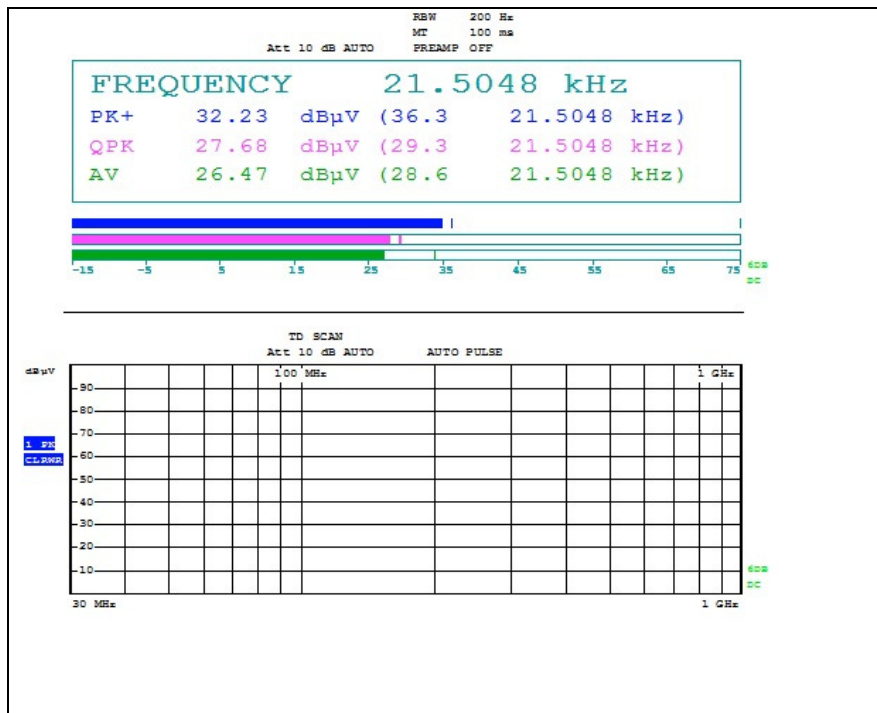
- LF ANT2

Scanning plots below 30 MHz

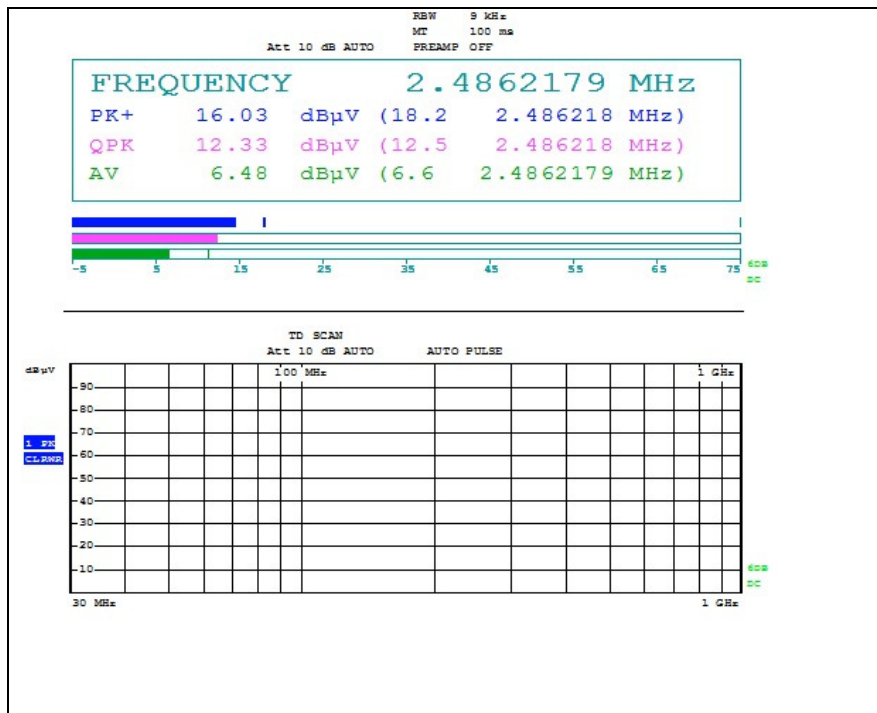
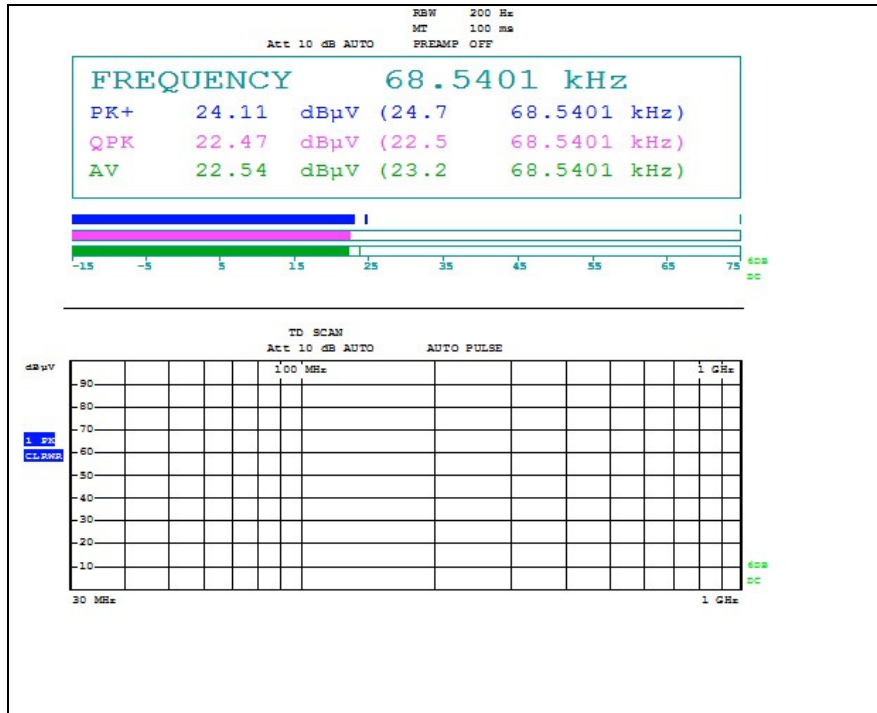


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Measured plots below 30 MHz



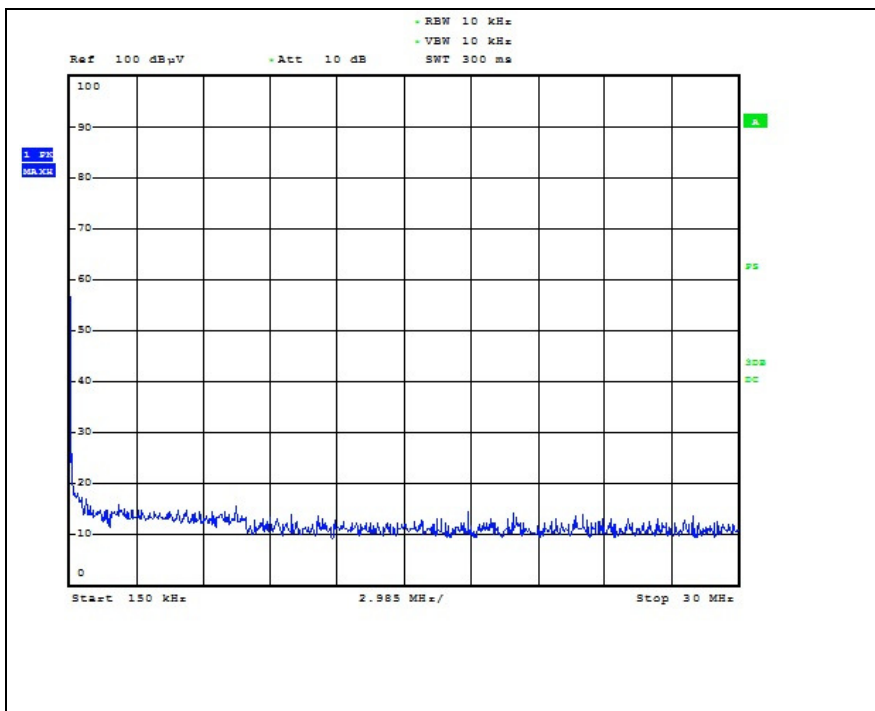
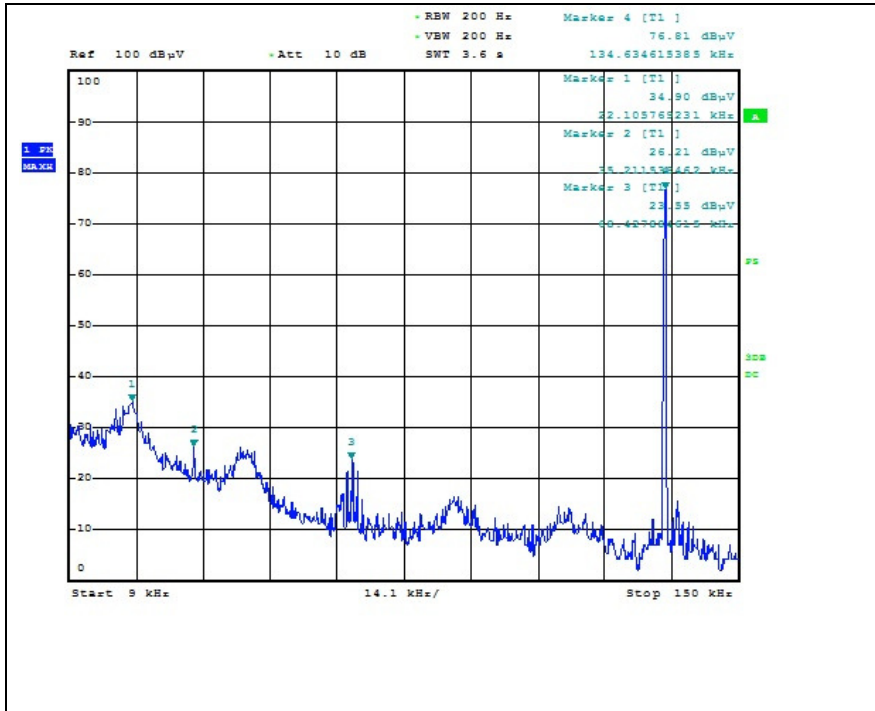
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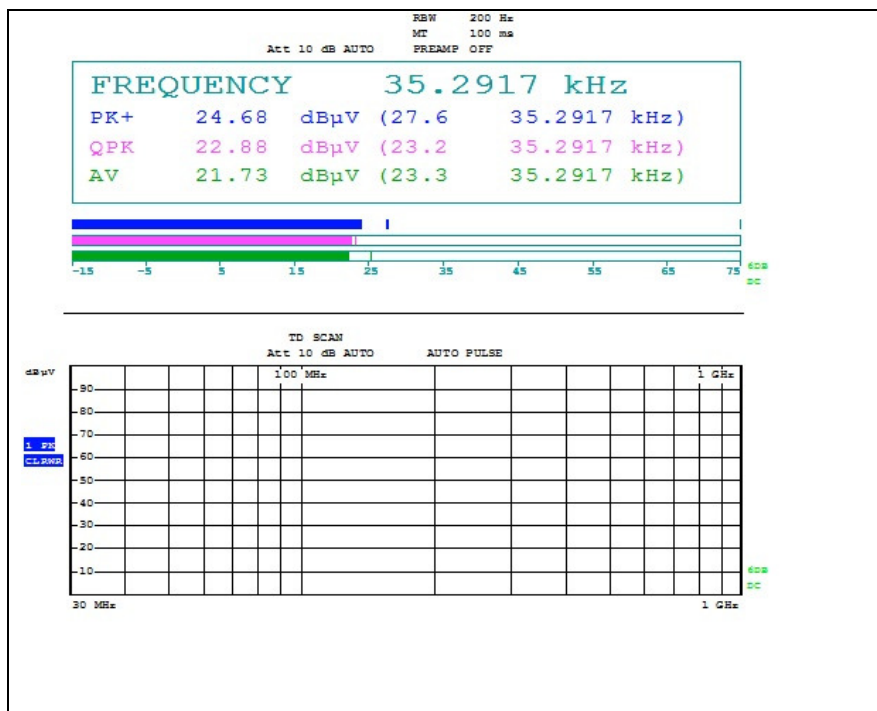
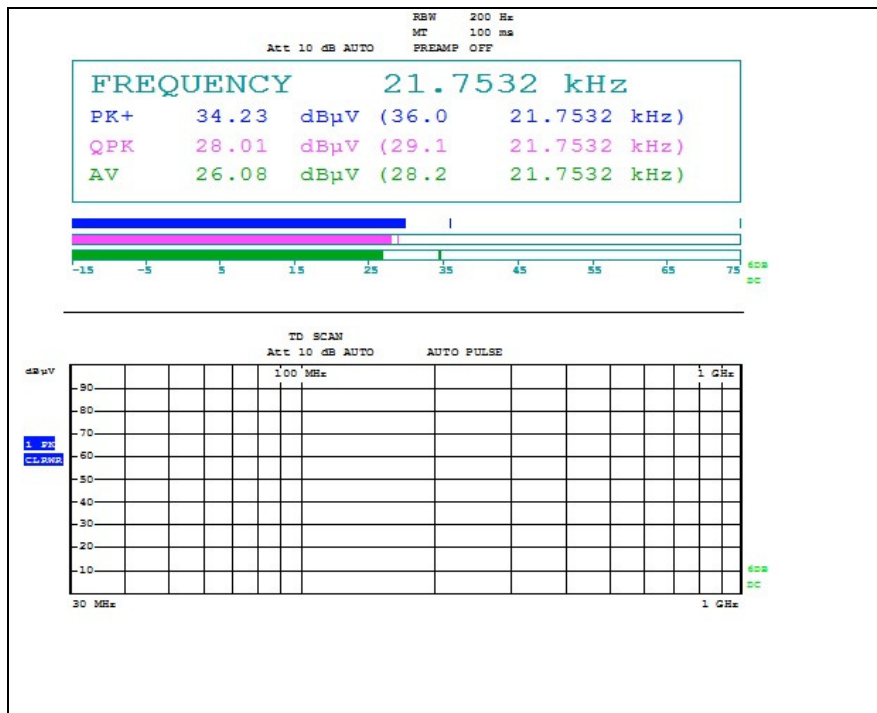
- LF ANT3

Scanning plots below 30 MHz

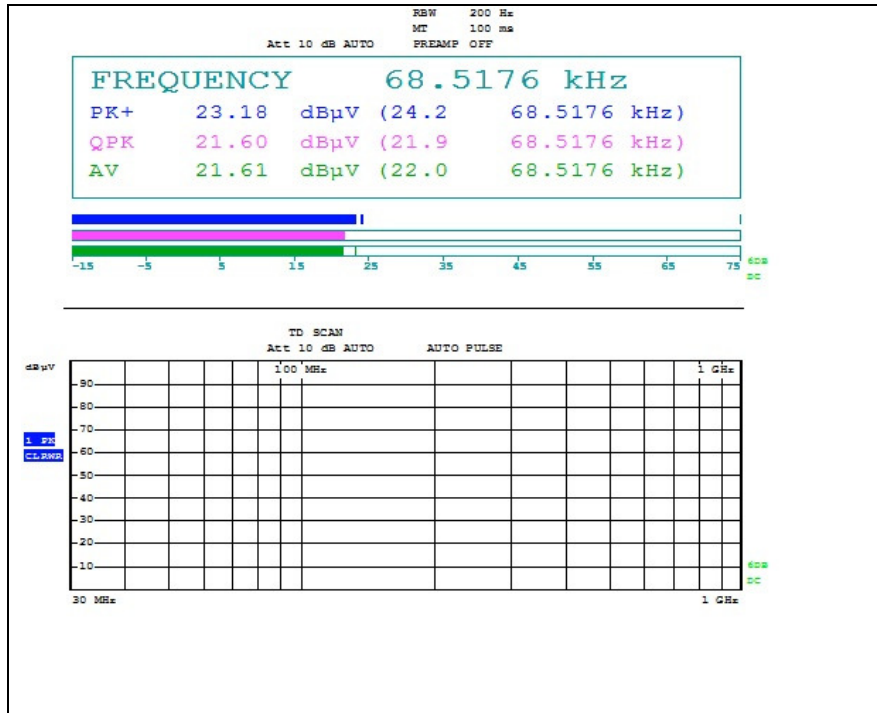


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Measured plots below 30 MHz



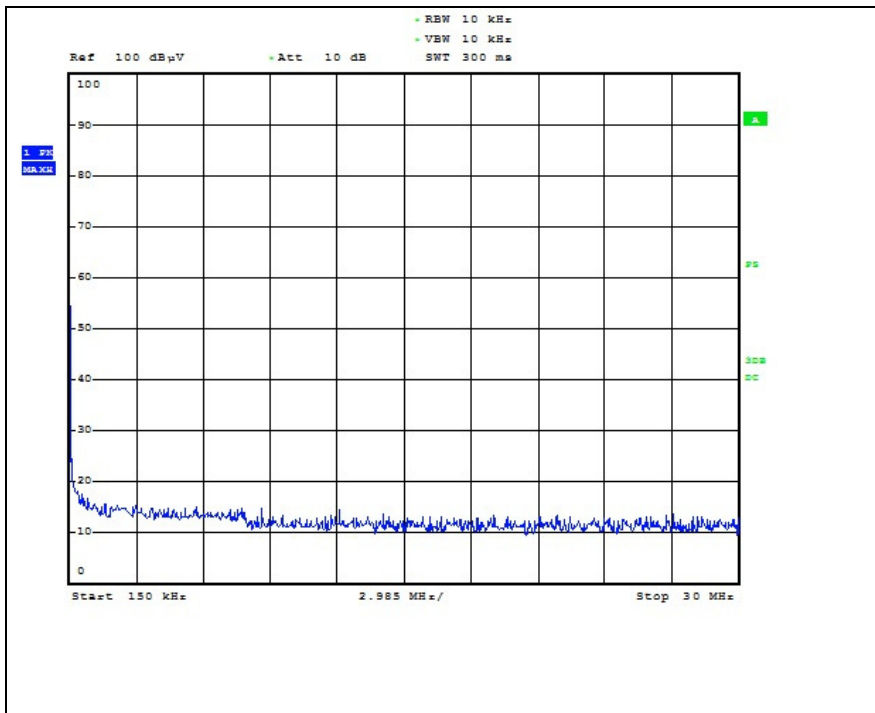
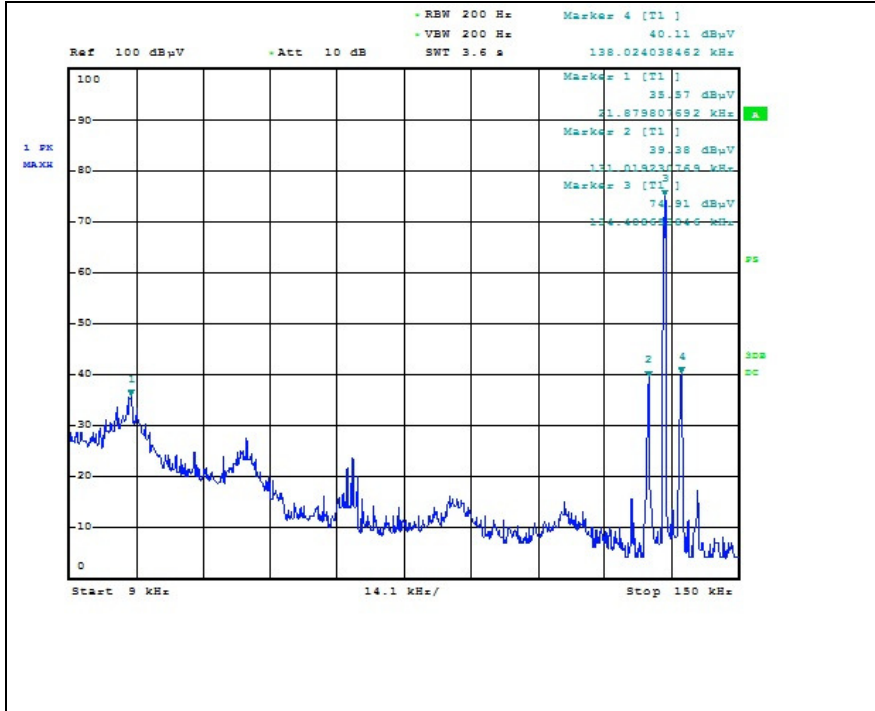
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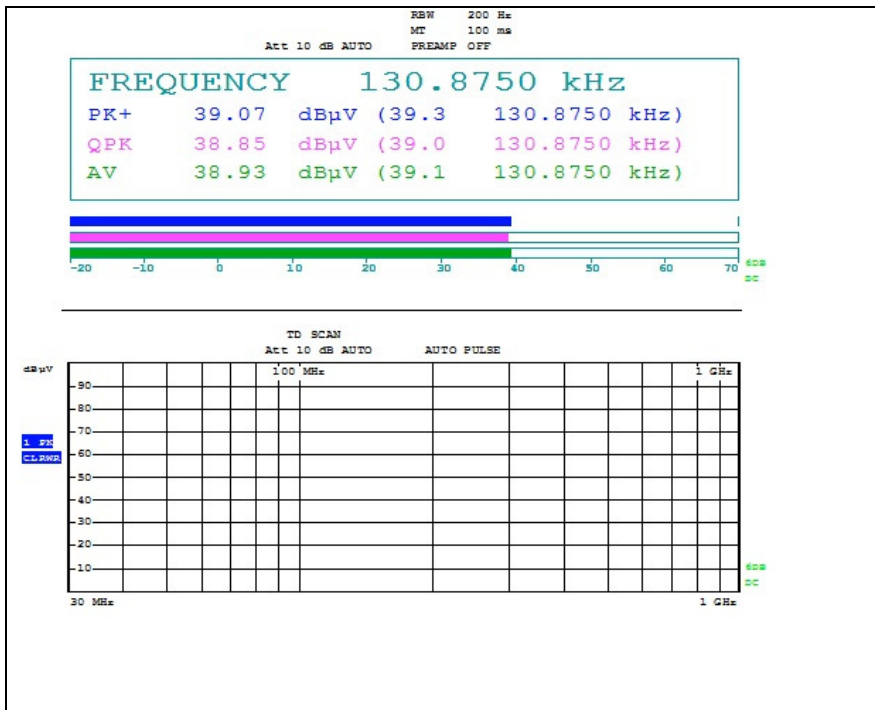
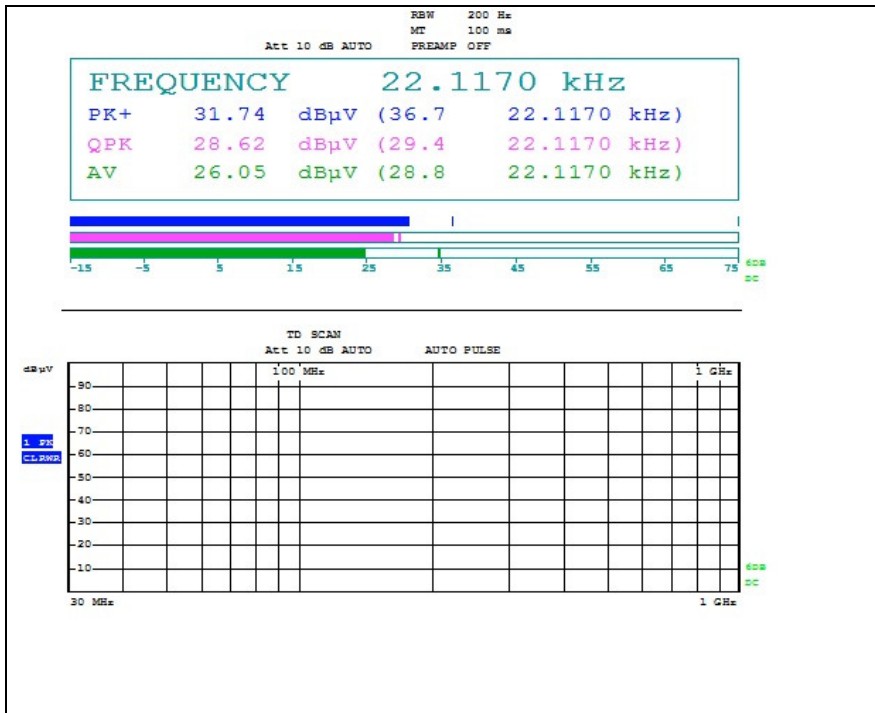
- LF ANT4

Scanning plots below 30 MHz

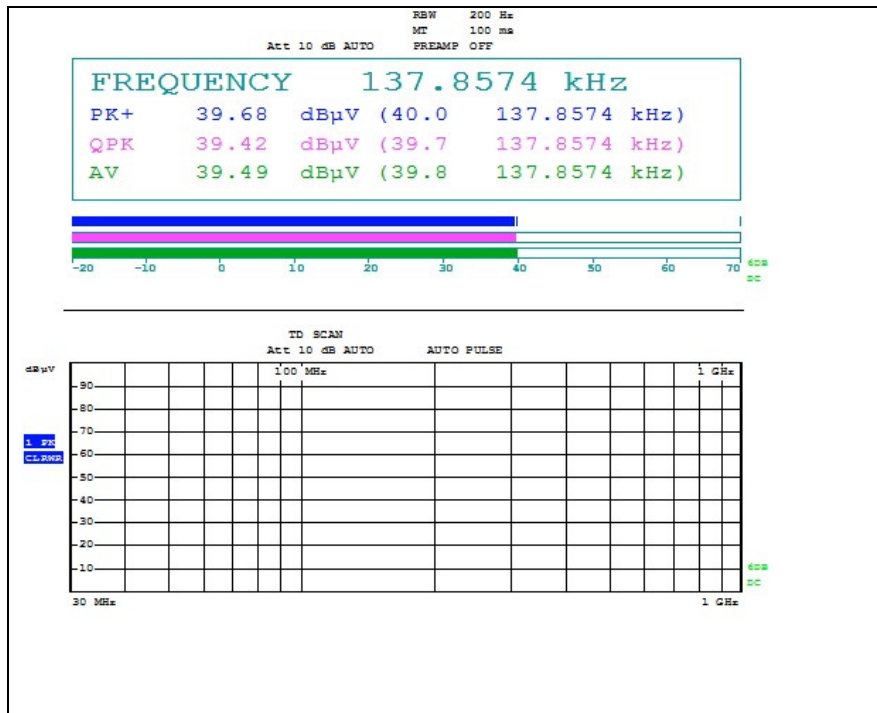


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Measured plots below 30 MHz



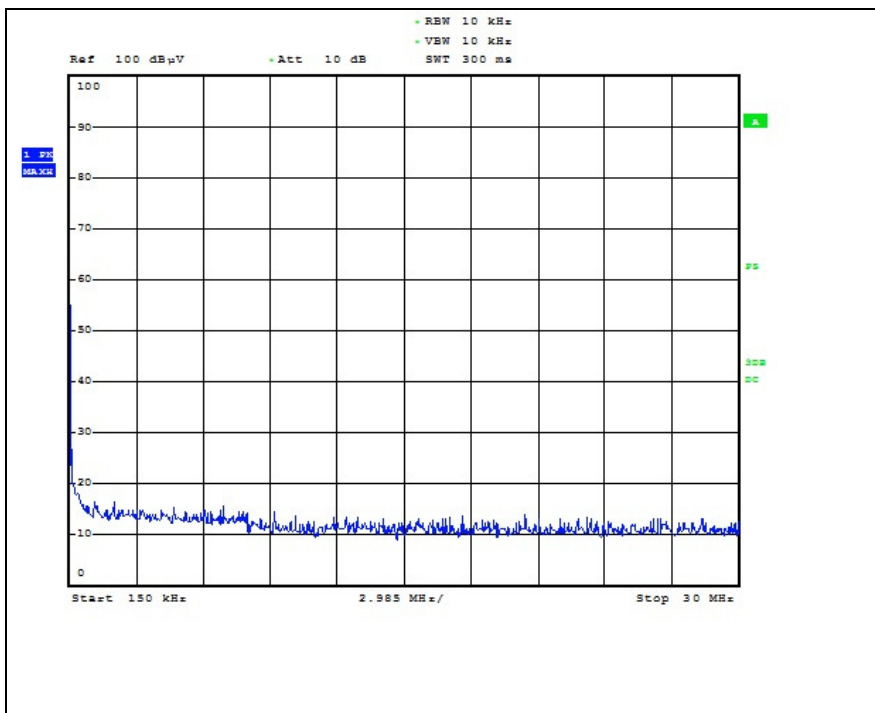
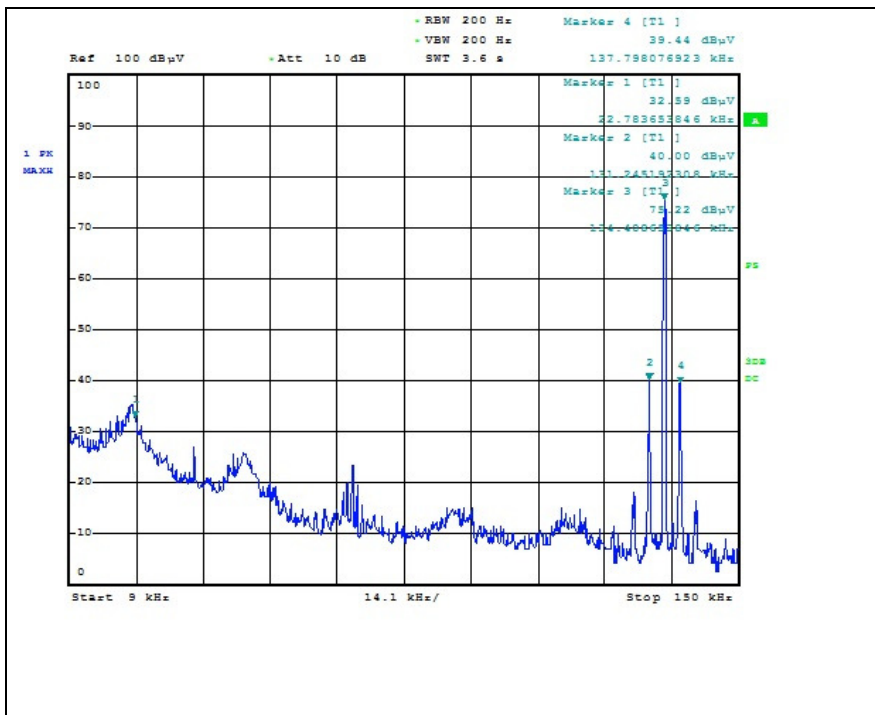
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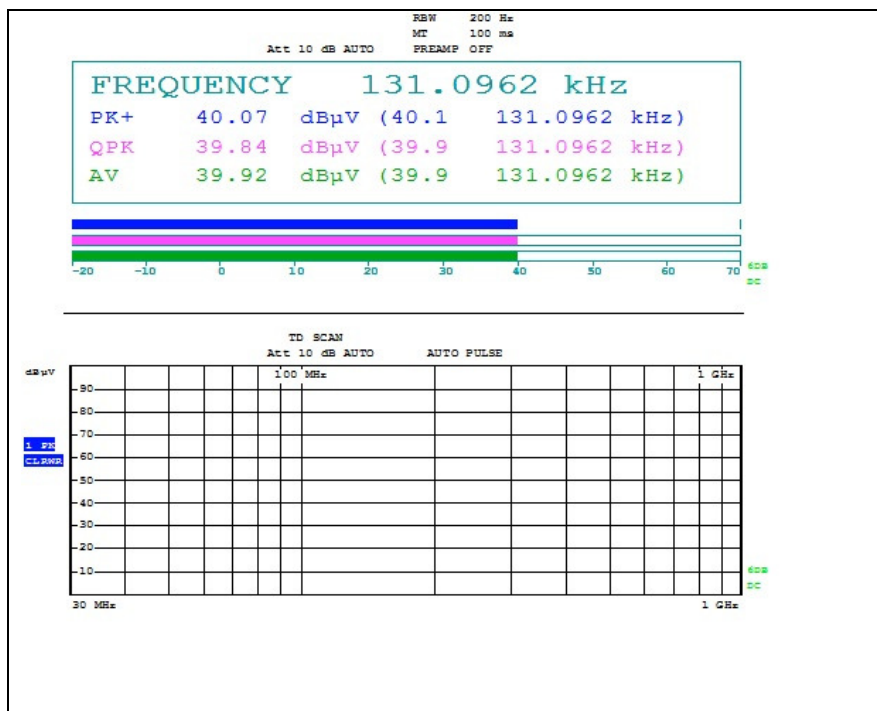
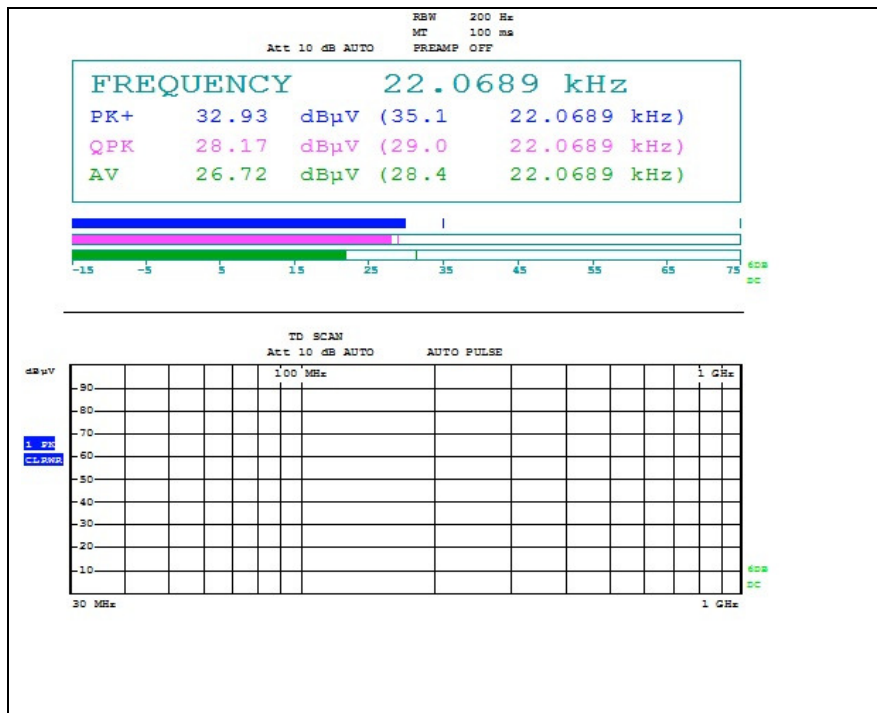
- LF ANT5

Scanning plots below 30 MHz

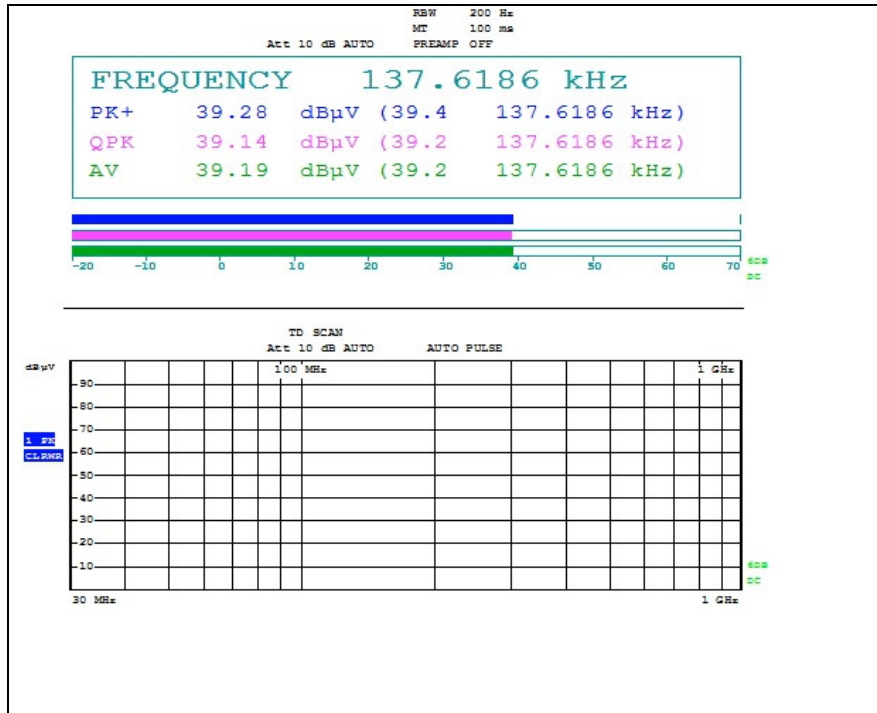


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Measured plots below 30 MHz



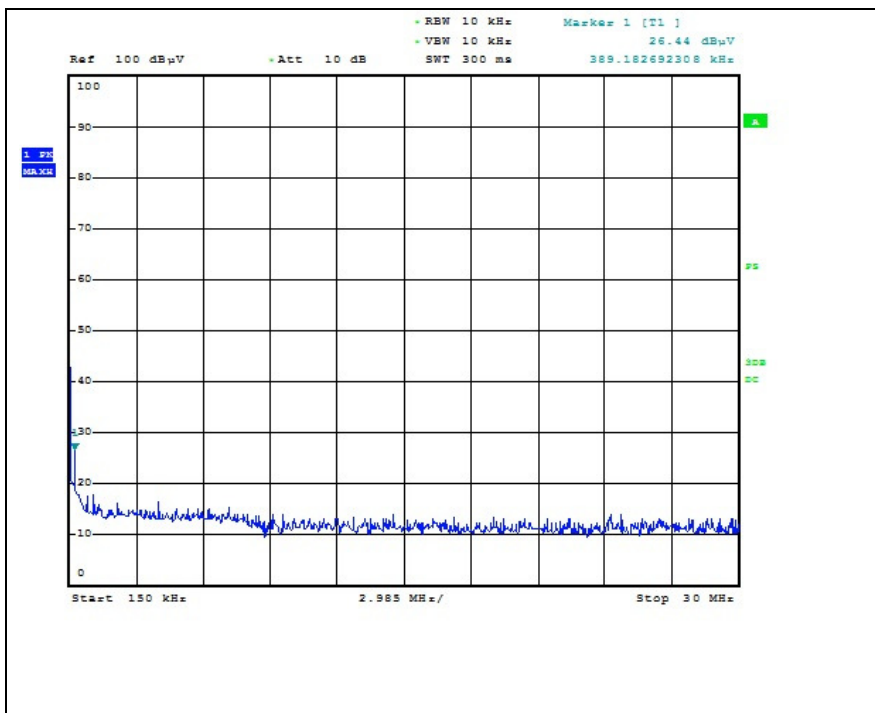
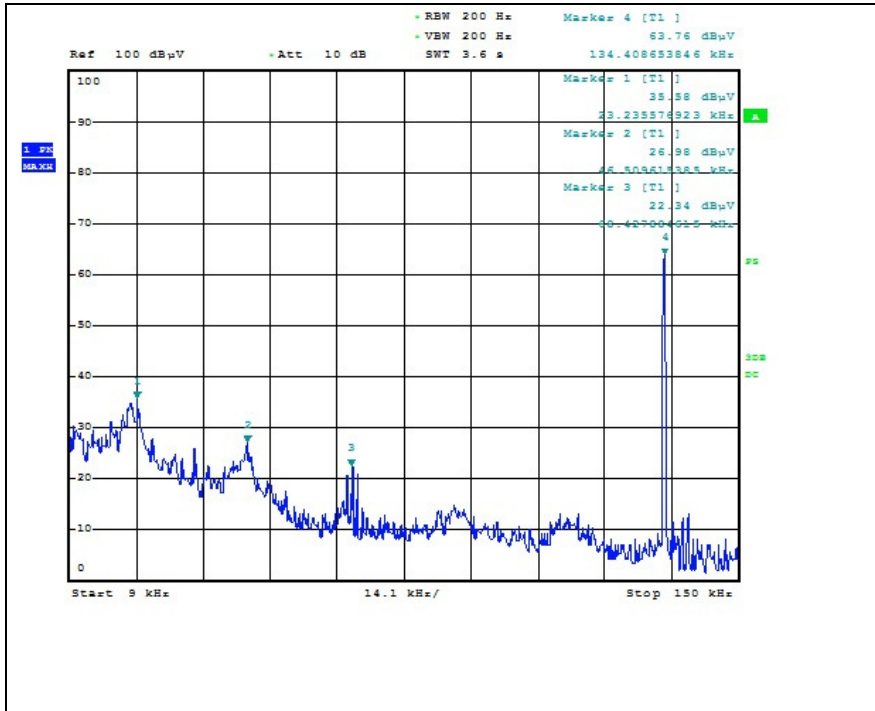
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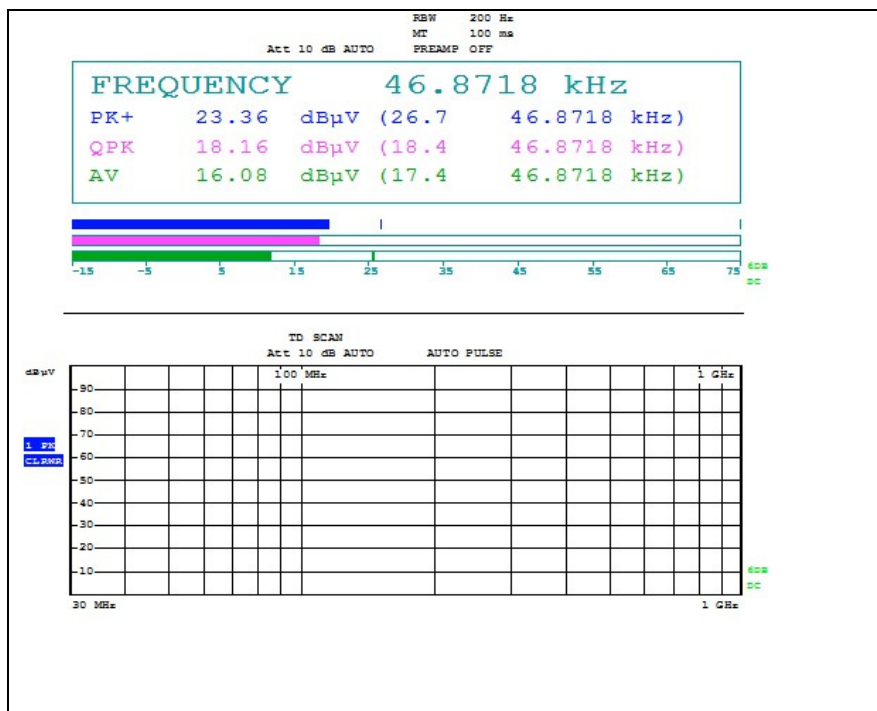
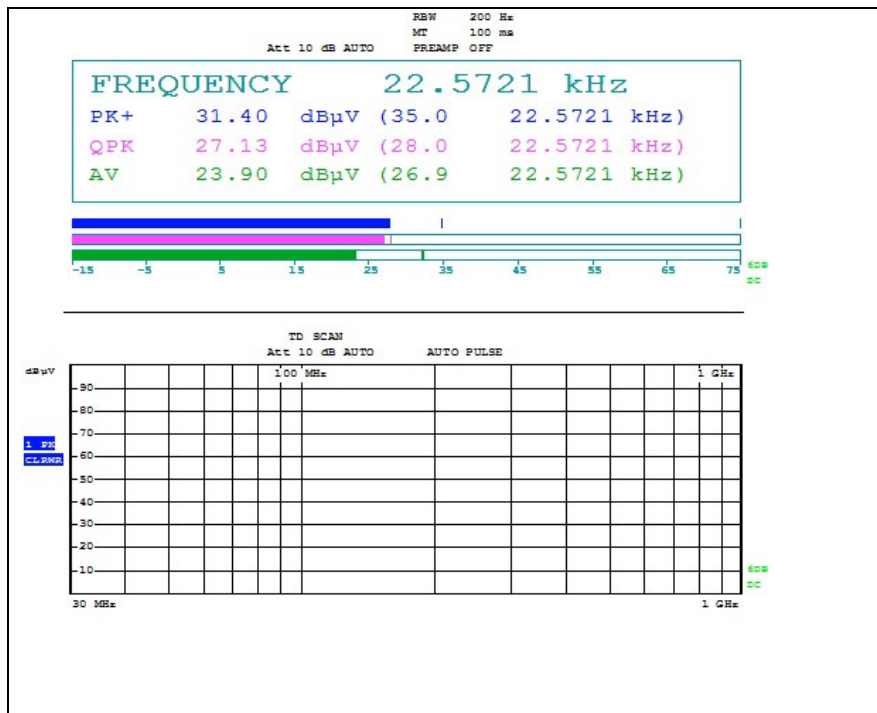
- TP ANT

Scanning plots below 30 MHz

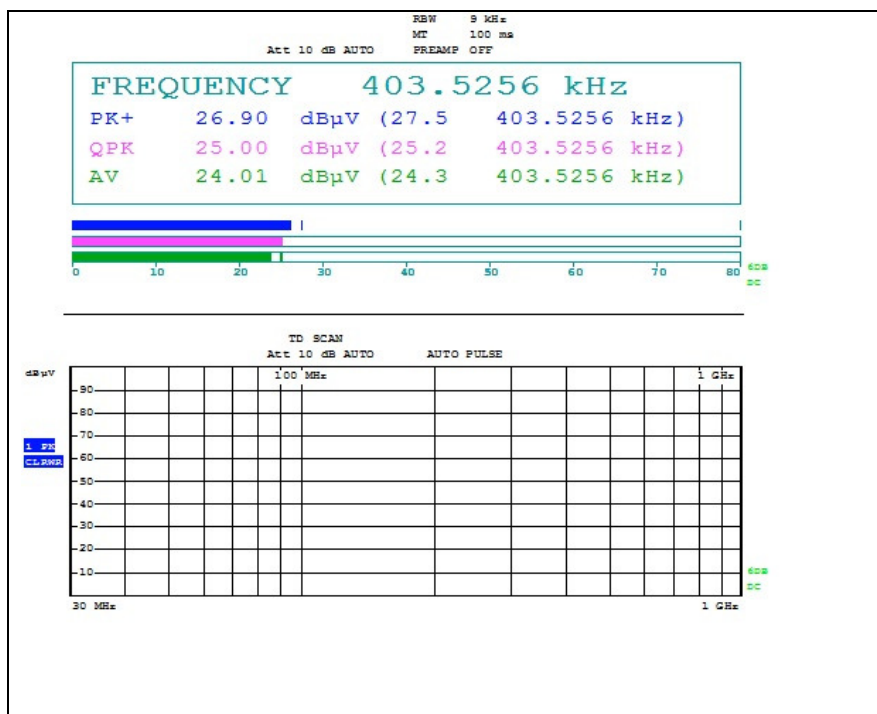
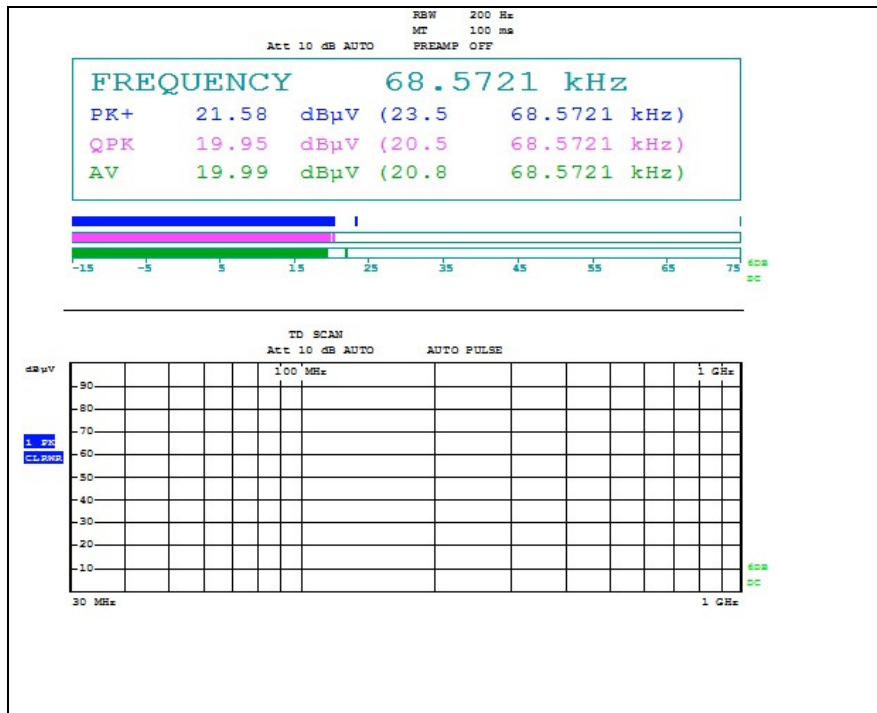


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Measured plots below 30 MHz



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2.5.2. Spurious Emission below 1 000 MHz

The frequency spectrum from 30 MHz to 1 000 MHz was investigated. All reading values are peak values.

Radiated Emissions			Ant	Correction Factors		Total	Limit	
Frequency (MHz)	Reading (dB μ V)	Detect Mode	Pol.	AF (dB/m)	AMP + CL (dB)	Actual (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)
LF ANT1								
239.16	38.00	Peak	V	13.50	-25.24	26.26	46.00	19.74
314.41	39.60	Peak	V	15.53	-24.95	30.18	46.00	15.82
339.83	42.00	Peak	V	16.16	-24.93	33.23	46.00	12.77
339.88	40.80	Peak	H	15.12	-24.93	30.99	46.00	15.01
Above 400.000	Not detected	-	-	-	-	-	-	-
LF ANT2								
188.76	39.50	Peak	V	10.13	-25.67	23.96	43.50	19.54
239.00	39.20	Peak	V	13.50	-25.24	27.46	46.00	18.54
314.41	39.90	Peak	V	15.53	-24.95	30.48	46.00	15.52
339.79	42.70	Peak	V	16.16	-24.93	33.93	46.00	12.07
339.92	40.20	Peak	H	15.12	-24.93	30.39	46.00	15.61
Above 400.000	Not detected	-	-	-	-	-	-	-
LF ANT3								
188.80	39.30	Peak	V	10.14	-25.67	23.77	43.50	19.73
239.04	38.40	Peak	V	13.50	-25.24	26.66	46.00	19.34
289.52	40.00	Peak	V	14.93	-24.98	29.95	46.00	16.05
339.67	42.70	Peak	V	16.16	-24.93	33.93	46.00	12.07
364.85	39.70	Peak	H	15.90	-25.08	30.52	46.00	15.48
Above 400.000	Not detected	-	-	-	-	-	-	-

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Radiated Emissions			Ant	Correction Factors		Total	Limit	
Frequency (MHz)	Reading (dB μ V)	Detect Mode	Pol.	AF (dB/m)	AMP + CL (dB)	Actual (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)
LF ANT4								
188.68	39.10	Peak	V	10.12	-25.68	23.54	43.50	19.96
313.60	38.90	Peak	V	15.51	-24.95	29.46	46.00	16.54
339.47	42.50	Peak	V	16.15	-24.94	33.71	46.00	12.29
377.42	36.80	Peak	H	16.31	-25.06	28.05	46.00	17.95
Above 400.000	Not detected	-	-	-	-	-	-	-
LF ANT5								
314.57	37.80	Peak	V	15.54	-24.95	28.39	46.00	17.61
339.75	41.30	Peak	V	16.16	-24.93	32.53	46.00	13.47
364.93	39.20	Peak	H	15.91	-25.08	30.03	46.00	15.97
Above 400.000	Not detected	-	-	-	-	-	-	-
TP ANT								
55.95	34.20	Peak	H	15.07	-26.92	22.35	40.00	17.65
289.56	40.40	Peak	V	14.93	-24.98	30.35	46.00	15.65
339.39	40.00	Peak	V	16.15	-24.94	31.21	46.00	14.79
364.97	39.00	Peak	H	15.91	-25.08	29.83	46.00	16.17
Above 400.000	Not detected	-	-	-	-	-	-	-

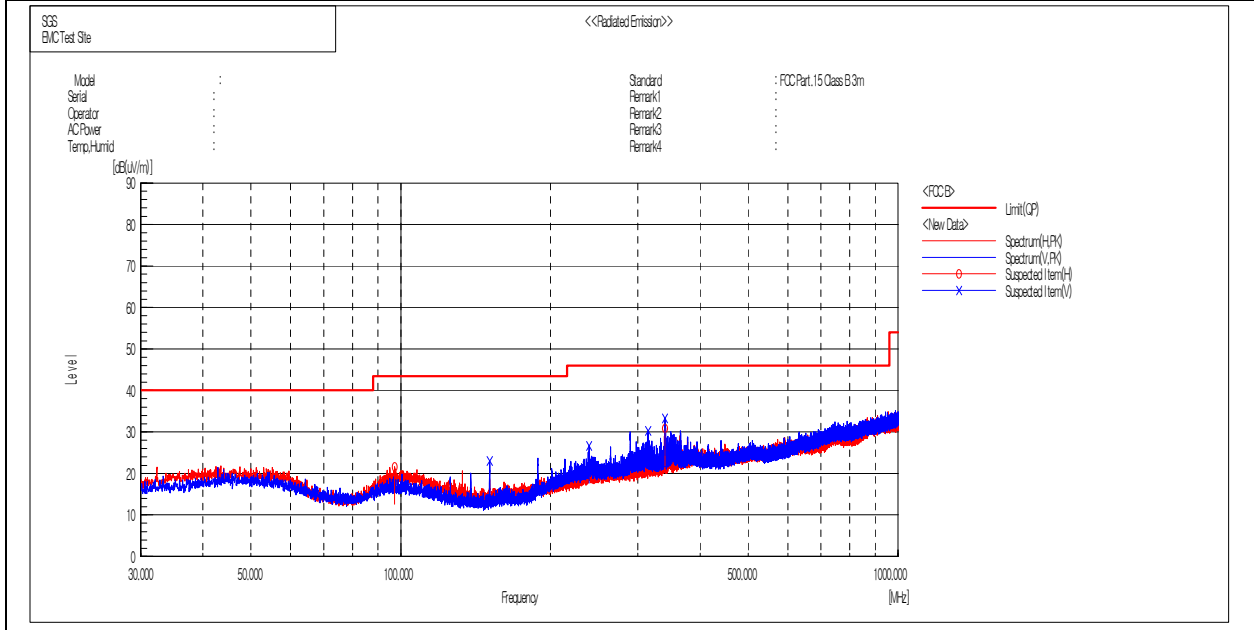
Remark:

1. Radiated spurious emission measurement as below.
(Actual = Reading + Antenna Factor + Amp + CL)
2. According to §15.31(o), emission levels are not report much lower than the limits by over 20 dB.

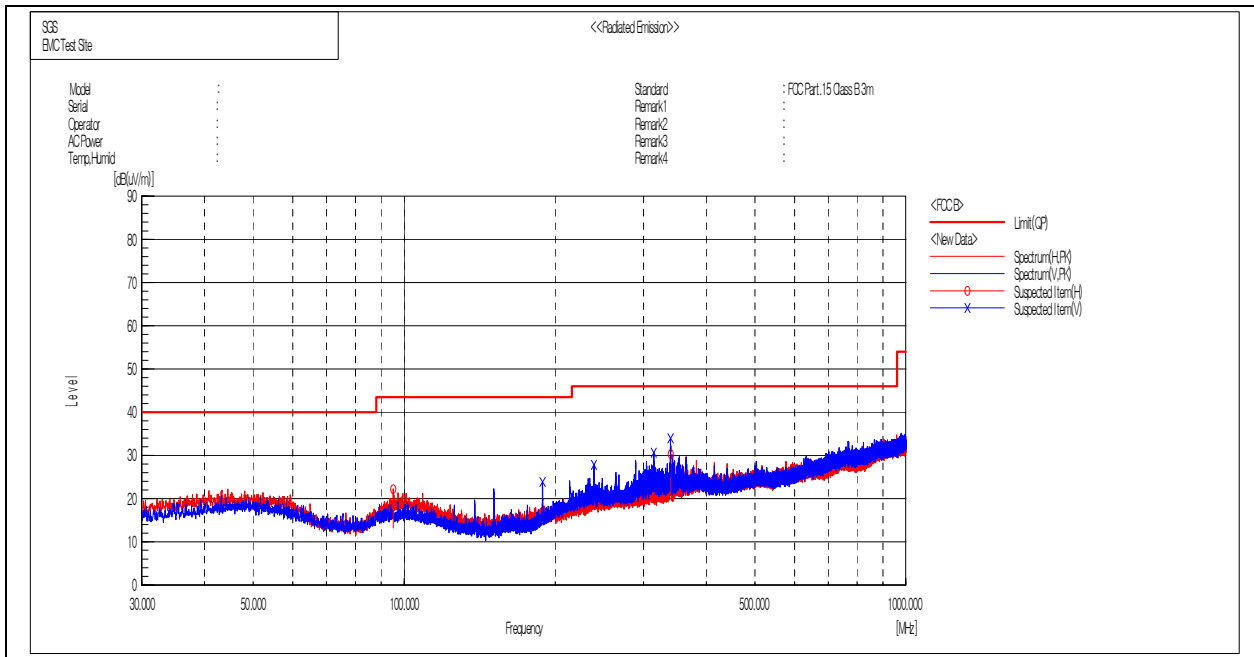
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Test plots

- LF ANT1

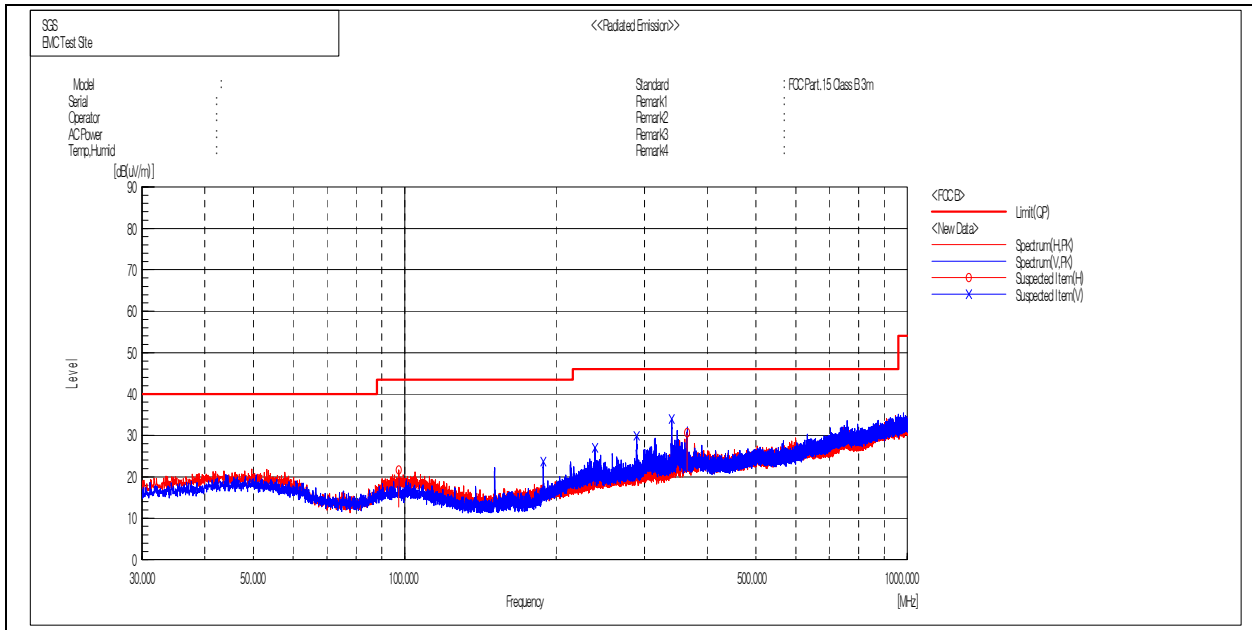


- LF ANT2

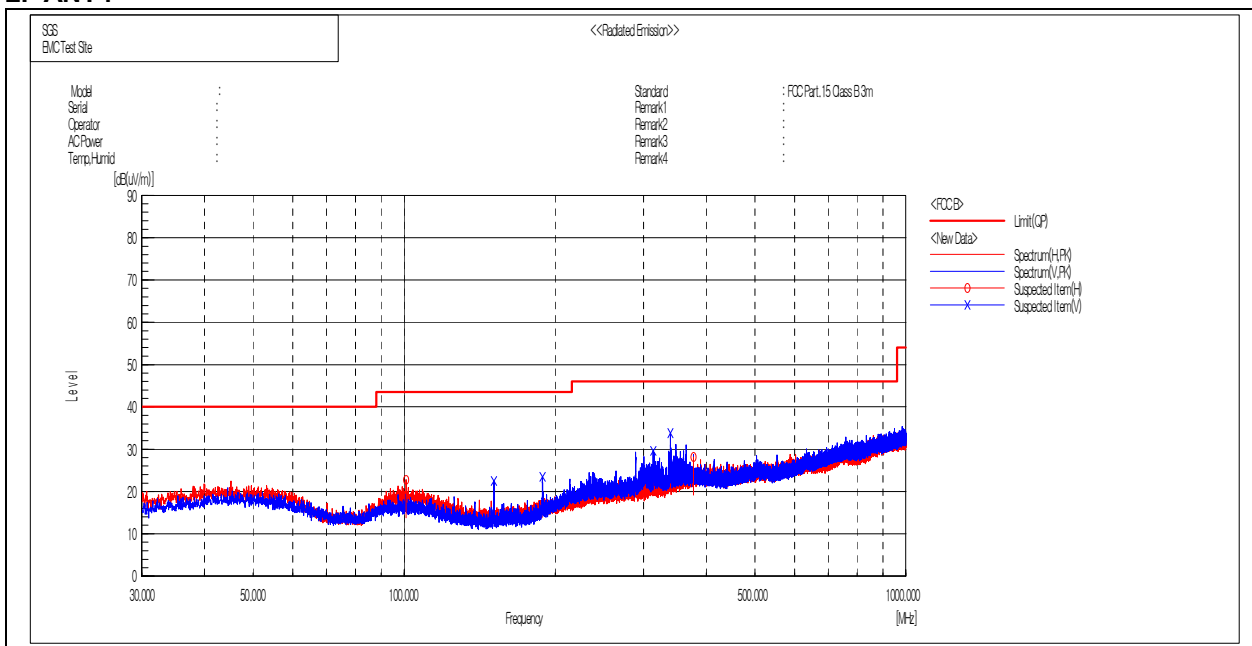


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- LF ANT3

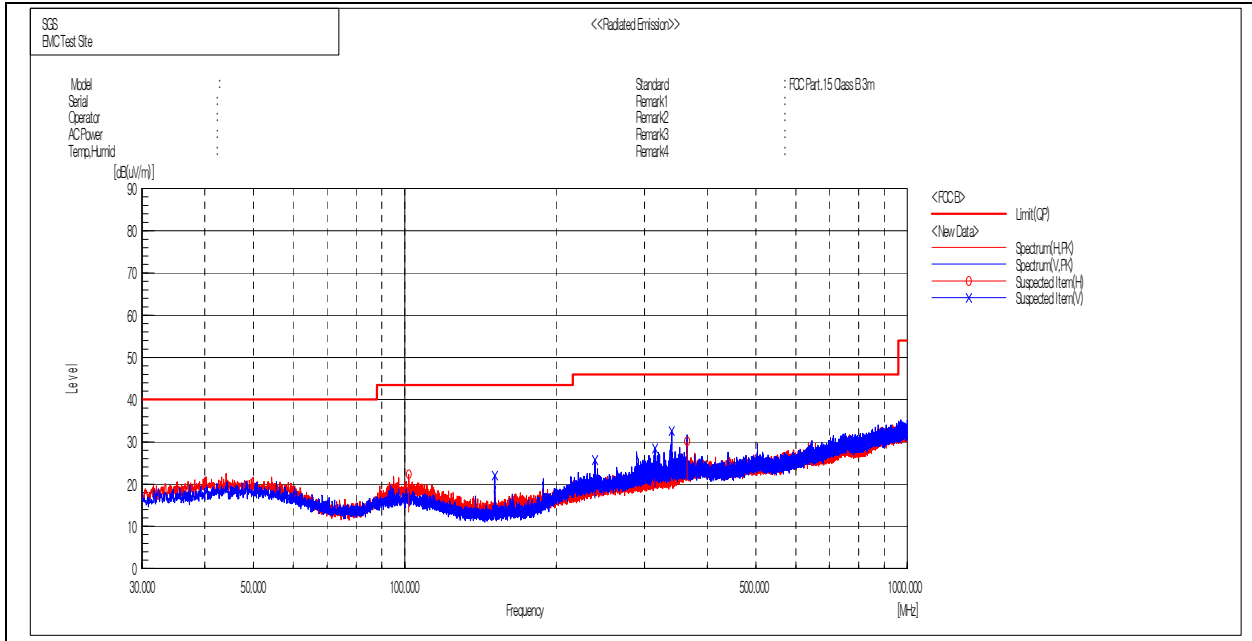


- LF ANT4

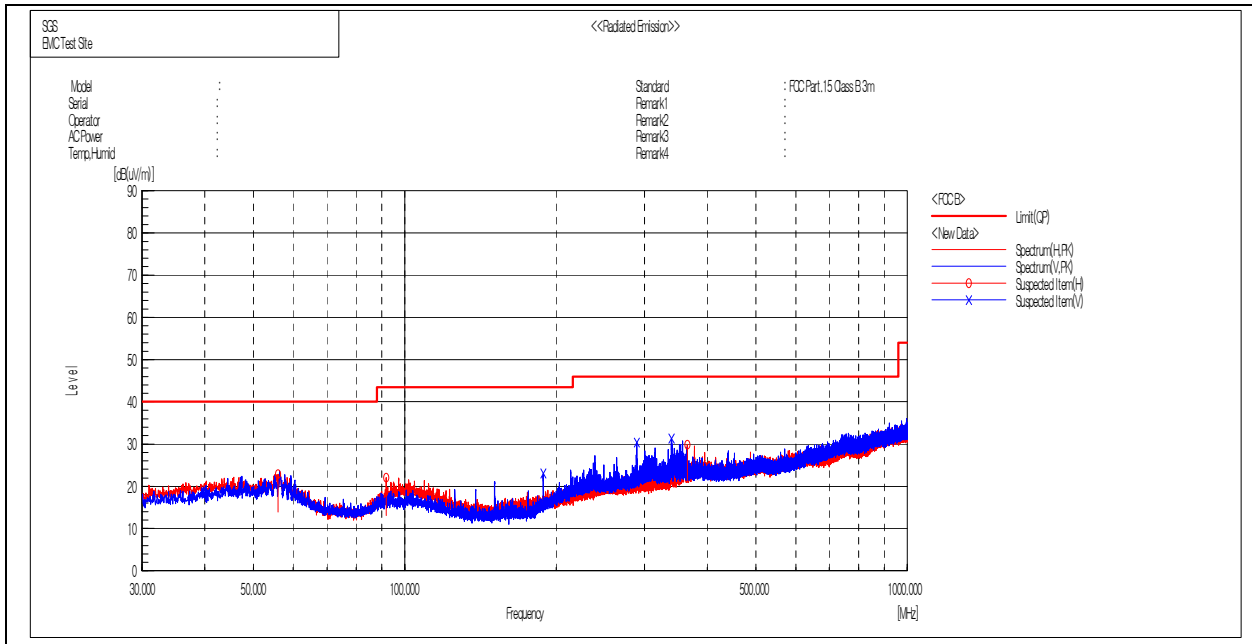


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- LF ANT5



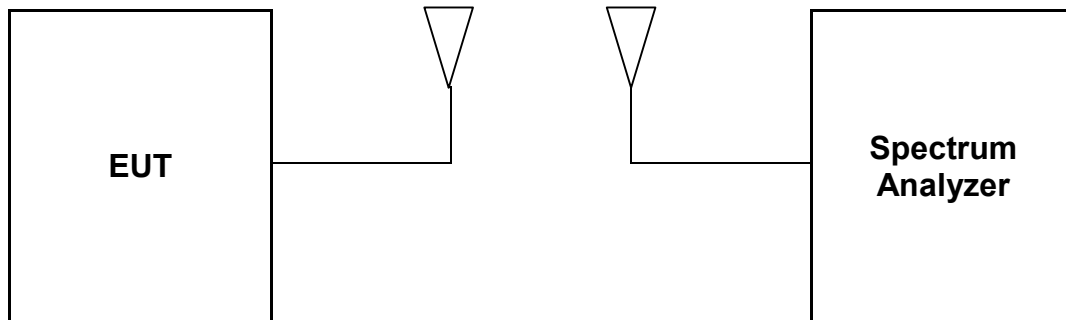
- TP ANT



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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

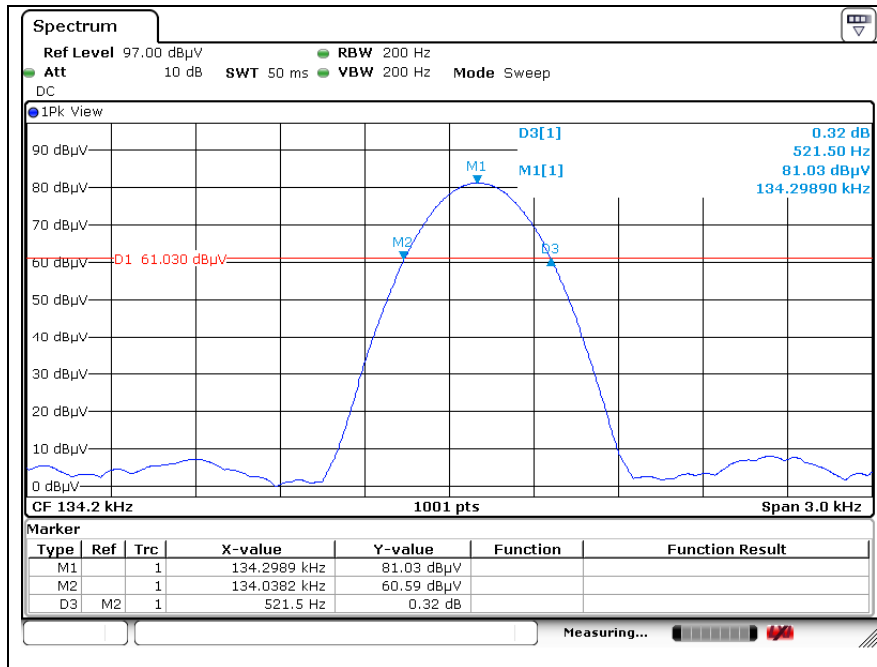
Ambient temperature : (23 ± 1) °C
 Relative humidity : 47 % R.H.

Test Antenna	Carrier Frequency (kHz)	20 dB Bandwidth (kHz)	Limit
LF ANT1	134.299	0.522	Reporting proposed only
LF ANT2	134.320	0.519	
LF ANT3	134.353	0.525	
LF ANT4	134.380	0.531	
LF ANT5	134.344	0.519	
TP ANT	134.269	0.522	

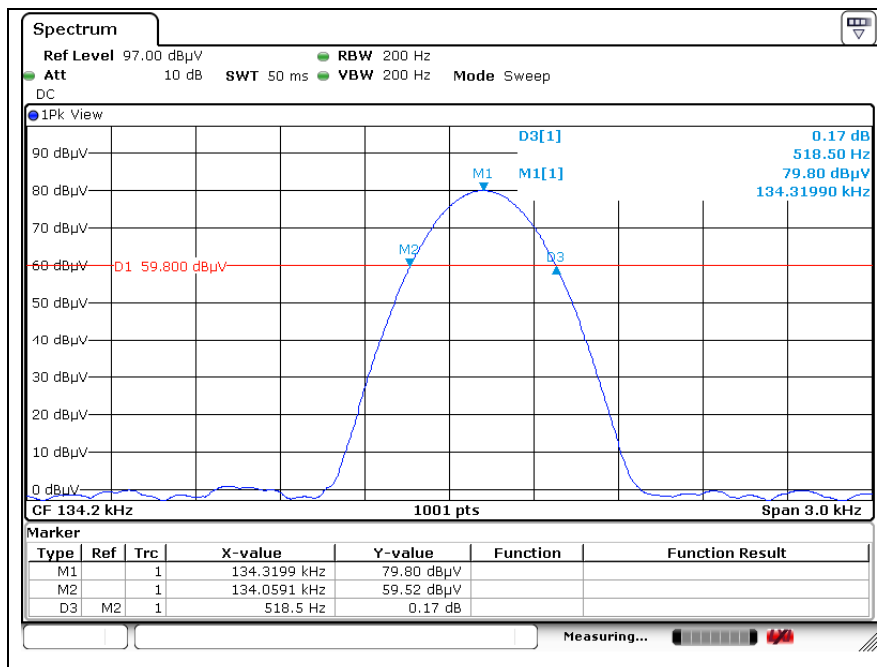
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Test plots

- LF ANT1

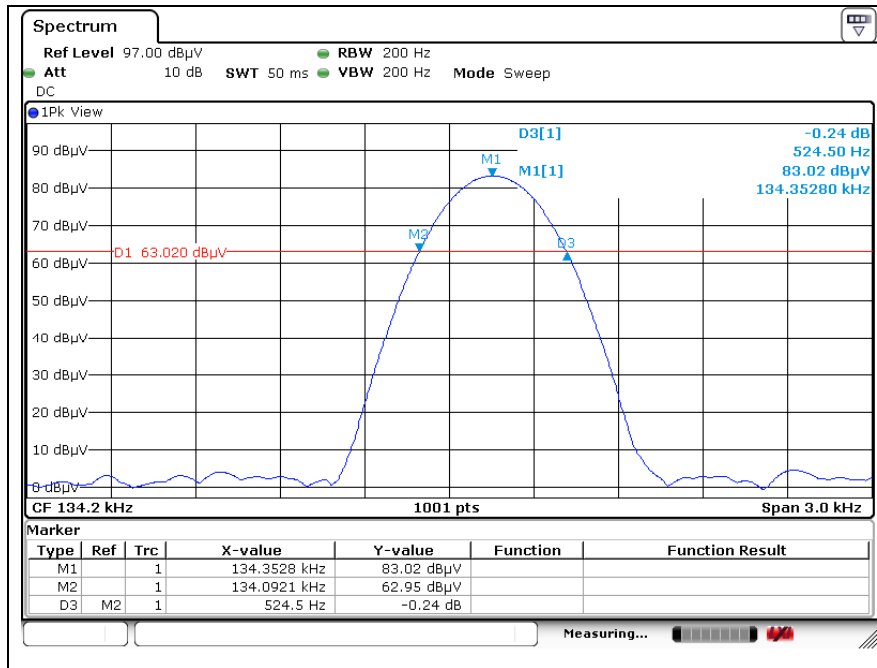


- LF ANT2

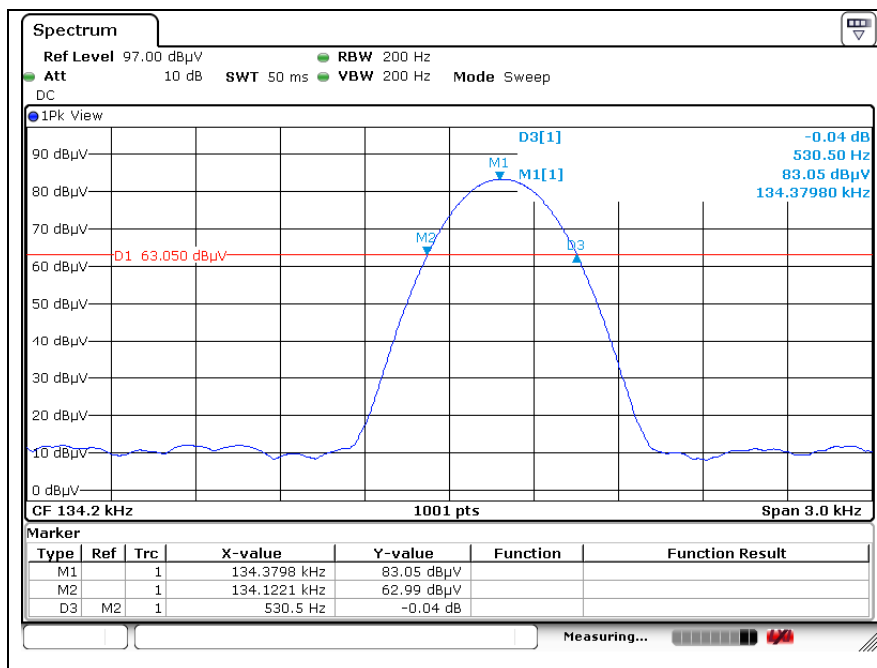


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- LF ANT3

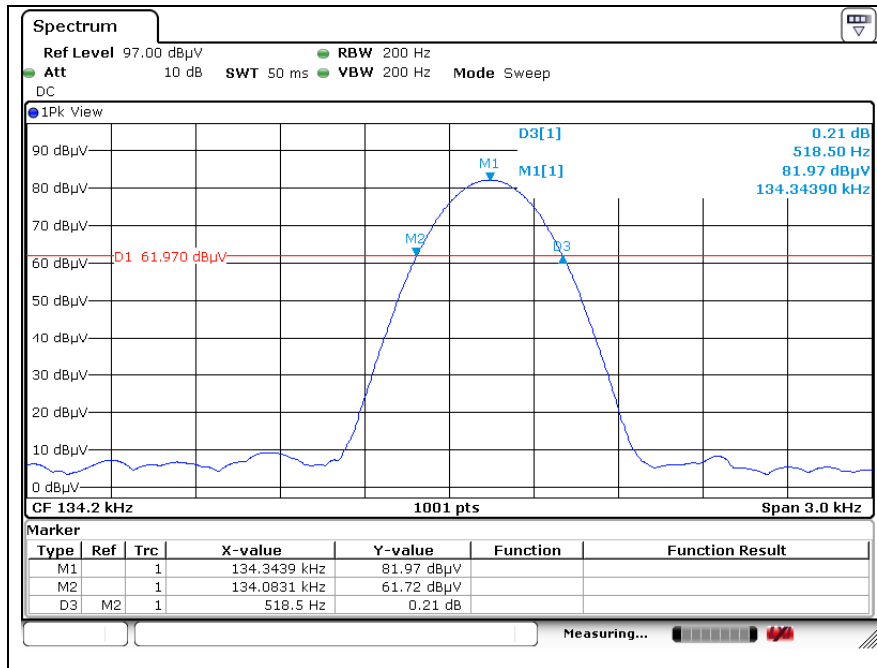


- LF ANT4

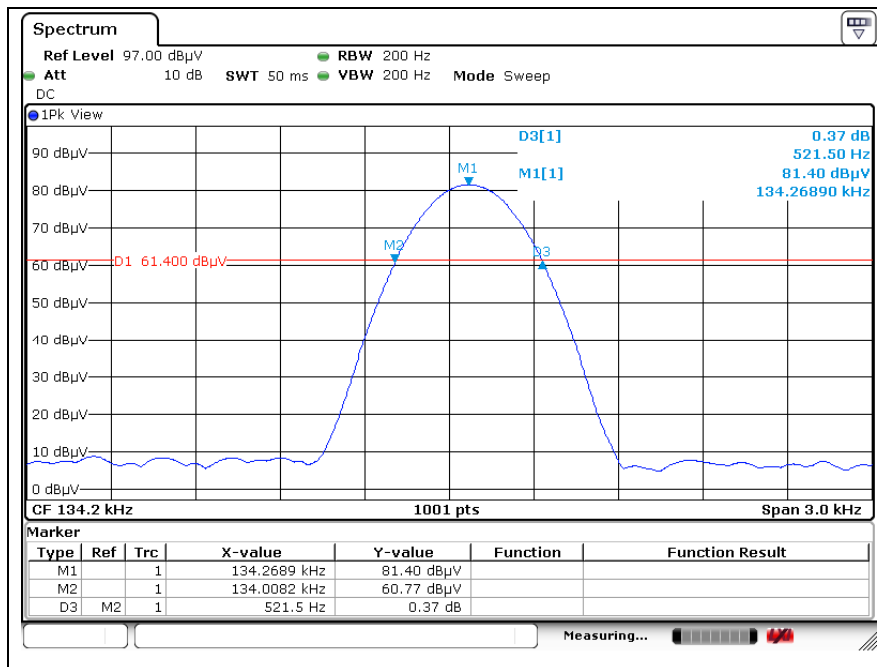


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- LF ANT5



- TP ANT



- End of the Test Report -

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