

TEST REPORT

of

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

FCC ID: TQ8-IBU-4E06
IC Certification: 5074A-IBU4E06

Equipment Under Test : SMART KEY ECU
Model Name : IBU-4E06
Applicant : Hyundai Mobis Co., Ltd.
Manufacturer : Hyundai Mobis Co., Ltd.
Date of Receipt : 2019.04.04
Date of Test(s) : 2019.04.12 ~ 2019.05.22
Date of Issue : 2019.05.27

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

Tested By:



Nancy Park

Date:

2019.05.27

Technical
Manager:



Jungmin Yang

Date:

2019.05.27

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RTT5041-19(2019.04.24)(1)

Tel. +82 31 428 5700 / Fax. +82 31 427 2370

A4(210 mm x 297 mm)

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1. General Information

1.1. Testing Laboratory

SGS Korea Co., Ltd. (Gunpo Laboratory)

- 10-2, LS-ro 182beon-gil, Gunpo-si, Gyeonggi-do, Korea, 15807
- 4, LS-ro 182beon-gil, Gunpo-si, Gyeonggi-do, Korea, 15807
- Designation number: KR0150

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Phone No. : +82 31 688 0901

Fax No. : +82 31 688 0921

1.2. Details of Applicant

Applicant : Hyundai Mobis Co., Ltd.

Address : 203, Teheran-ro, Gangnam-gu, Seoul, South Korea, 135-977

Contact Person : Choe, Seung-Hoon

Phone No. : +82 31 260 0098

1.3. Details of Manufacturer

Applicant : Same as applicant

Address : Same as applicant

1.4. Description of EUT

Kind of Product		SMART KEY ECU
Model Name		IBU-4E06
Power Supply		DC 12.0 V
Frequency Range		Tx: 125.00 kHz, Rx: 433.92 MHz
Antenna Type	Tx	External Type (Coil Antenna)
	Rx	Internal Type

1.5. Declaration of Manufacturer

- The EUT has 7 transmit antennas and one receive antenna.
- The transmit antennas can not operate at the same time.

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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. 08, 2019	Annual	Mar. 08, 2020
Signal Generator	R&S	SMBV100A	255834	Jun. 15, 2018	Annual	Jun. 15, 2019
DC Power Supply	Agilent	U8002A	MY50060028	Mar. 12, 2019	Annual	Mar. 12, 2020
Test Receiver	R&S	ESU26	100109	Jan. 31, 2019	Annual	Jan. 31, 2020
Loop Antenna	Schwarzbeck Mess-Elektronik	FMZB 1519	1519-039	Aug. 23, 2017	Biennial	Aug. 23, 2019
Turn Table	Innco systems GmbH	DS 1200 S	N/A	N. C. R.	N/A	N. C. R.
Controller	Innco systems GmbH	CONTROLLER CO3000-4P	CO3000/963/3 8330516/L	N. C. R.	N/A	N. C. R.
Anechoic Chamber	SY Corporation	L × W × H (9.6 m × 6.4 m × 6.6 m)	N/A	N. C. R.	N/A	N. C. R.
Coaxial Cable	SUCOFLEX	104 (3 m)	MY3258414	Jan. 04, 2019	Semi-annual	Jul. 04, 2019
Coaxial Cable	SUCOFLEX	104 (10 m)	MY3145814	Jan. 04, 2019	Semi-annual	Jul. 04, 2019

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

1.9. Test Report Revision

Revision	Report Number	Date of Issue	Description
0	F690501/RF-RTL013865	2019.05.27	Initial

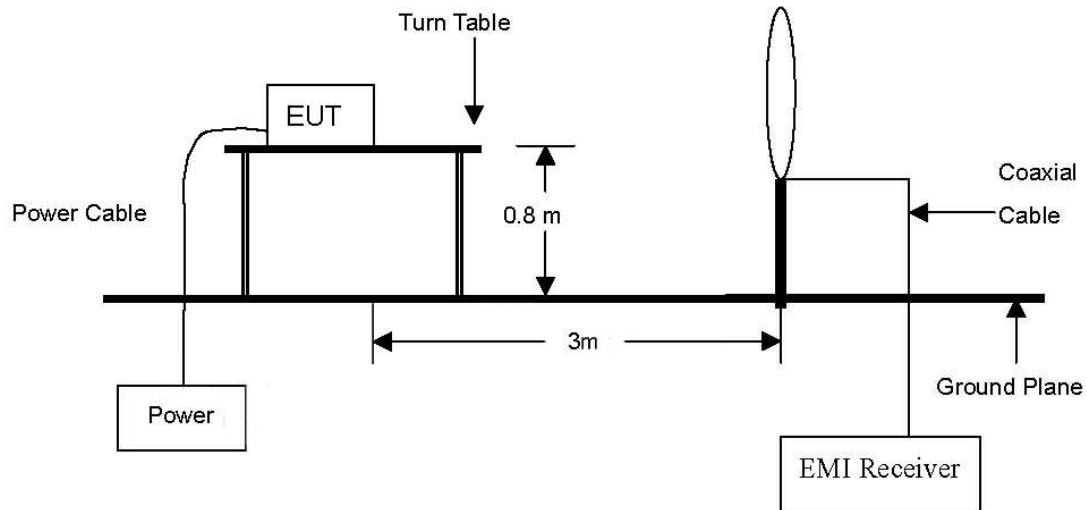
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2. Field Strength of Fundamental and Spurious Emission

2.1. Test Setup

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



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2.2. Limits

2.2.1. FCC

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

Frequency (MHz)	Field Strength (microvolts/meter)	Measurement Distance (meter)
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., §§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

According to RSS-Gen Issue 5, 8.9.

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

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

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

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

Frequency	Magnetic Field Strength (H-Field) ($\mu\text{A/m}$)	Measurement Distance (m)
9-490 kHz ¹	6.37/F (F in kHz)	300
490-1 705 kHz	63.7/F (F in kHz)	30
1.705-30 MHz	0.08	30

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

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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

- 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.
- 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.
- 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.
- The test-receiver system was set to Peak Detect Function and Specified Bandwidth with Maximum Hold Mode.
- 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.

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2.4. Field Strength of Fundamental Test Result

Ambient temperature : $(23 \pm 1) ^\circ\text{C}$
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 μV)	Detect Mode	Pol.	Ant. (dB/m)	Cable (dB)	Actual (dB $\mu\text{V}/\text{m}$) at 3 m	Actual (dB $\mu\text{V}/\text{m}$) at 300 m	Limit (dB $\mu\text{V}/\text{m}$) at 300 m	Margin (dB)
DRV Antenna									
0.125	67.90	Average	H	19.69	0.07	87.66	7.66	25.67	18.01
AST Antenna									
0.125	67.00	Average	H	19.69	0.07	86.76	6.76	25.67	18.91
INT1 Antenna									
0.125	66.90	Average	H	19.69	0.07	86.66	6.66	25.67	19.01
INT2 Antenna									
0.125	66.70	Average	H	19.69	0.07	86.46	6.46	25.67	19.21
TRK Antenna									
0.125	67.50	Average	H	19.69	0.07	87.26	7.26	25.67	18.41
BUM Antenna									
0.125	67.90	Average	H	19.69	0.07	87.66	7.66	25.67	18.01
SSB Antenna									
0.125	73.60	Average	H	19.69	0.07	93.36	13.36	25.67	12.31

Remark;

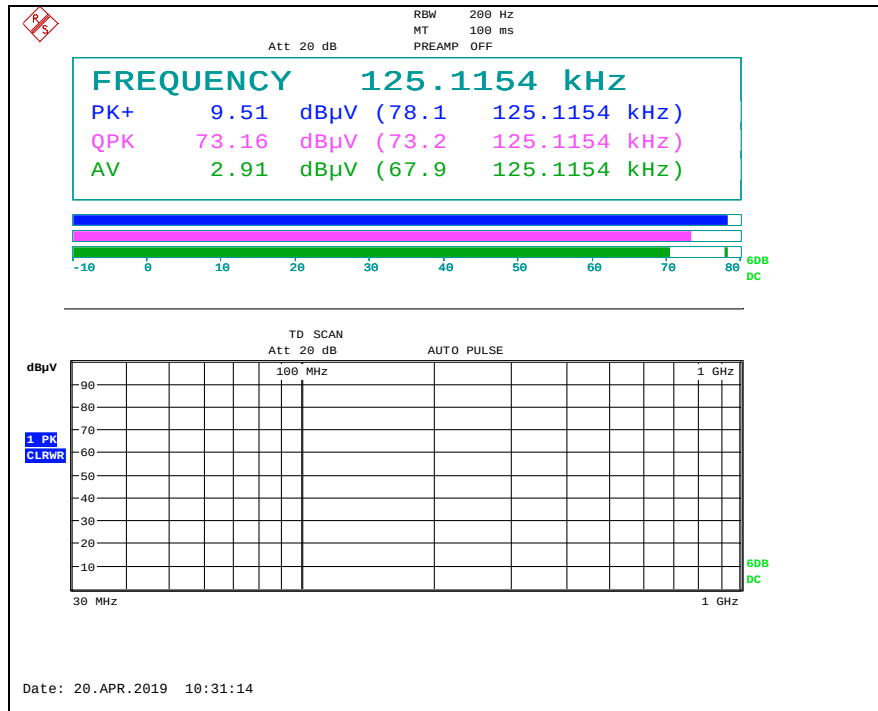
1. According to §15.31(f)(2) 300 m Result (dB $\mu\text{V}/\text{m}$) = 3 m Result (dB $\mu\text{V}/\text{m}$) - $40\log(300/3)$ (dB $\mu\text{V}/\text{m}$).
2. According to §15.209(d), the measurements were tested by using Quasi peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and 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).
4. According to ANSI C63.10: 2013, For measurement below 30 MHz.
conversion factor from E-field to H-field is considered as free-space impedance $[1 \mu\text{V}/\text{m} = (1/377 \Omega) \times 1 \mu\text{A}/\text{m}]$
The FCC limits are same to the IC limits.

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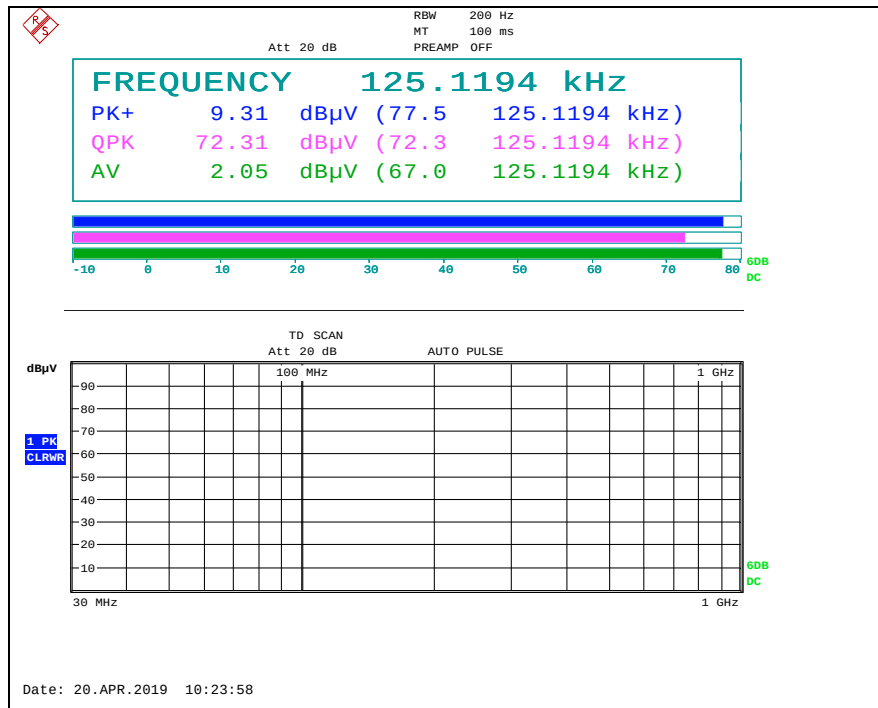
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- Test plots

- DRV Antenna



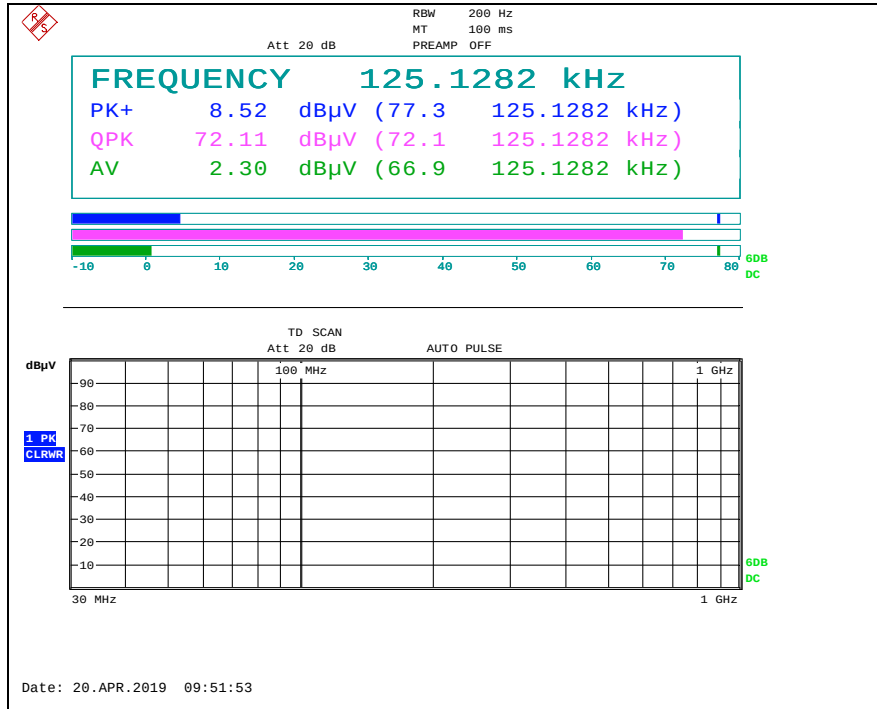
- AST Antenna



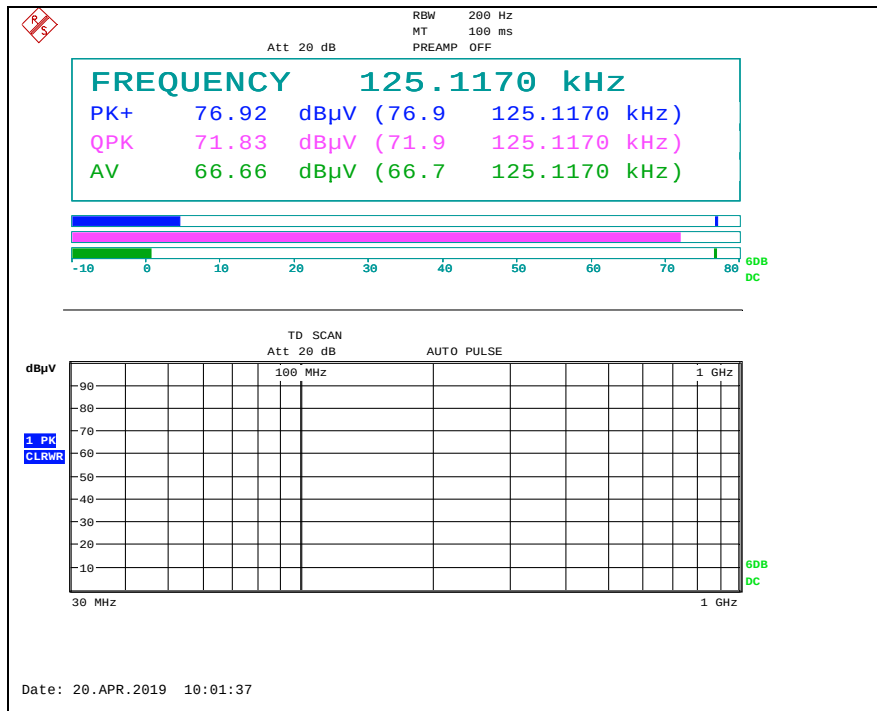
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- INT1 Antenna



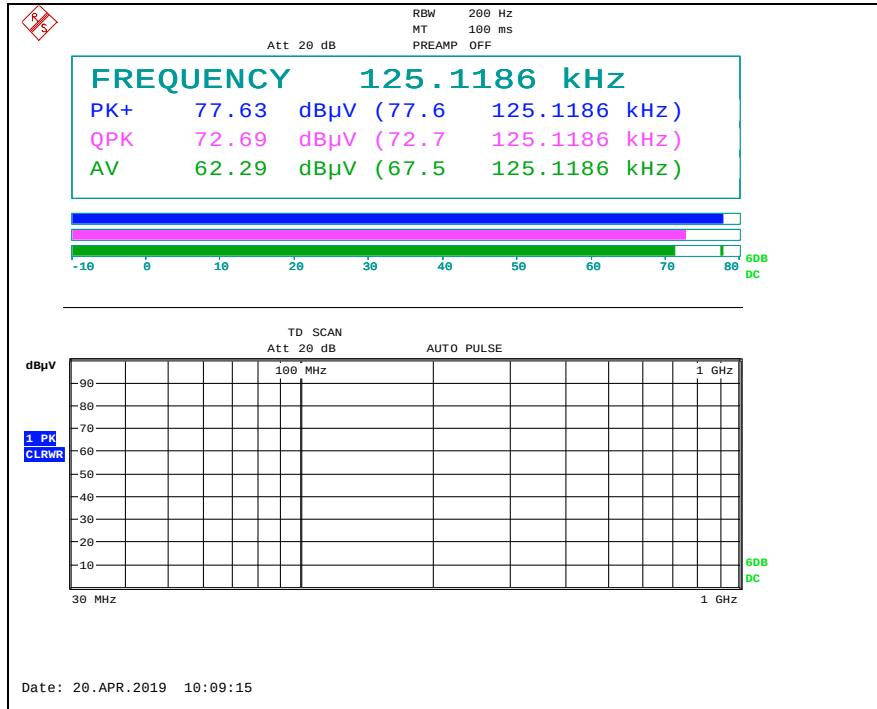
- INT2 Antenna



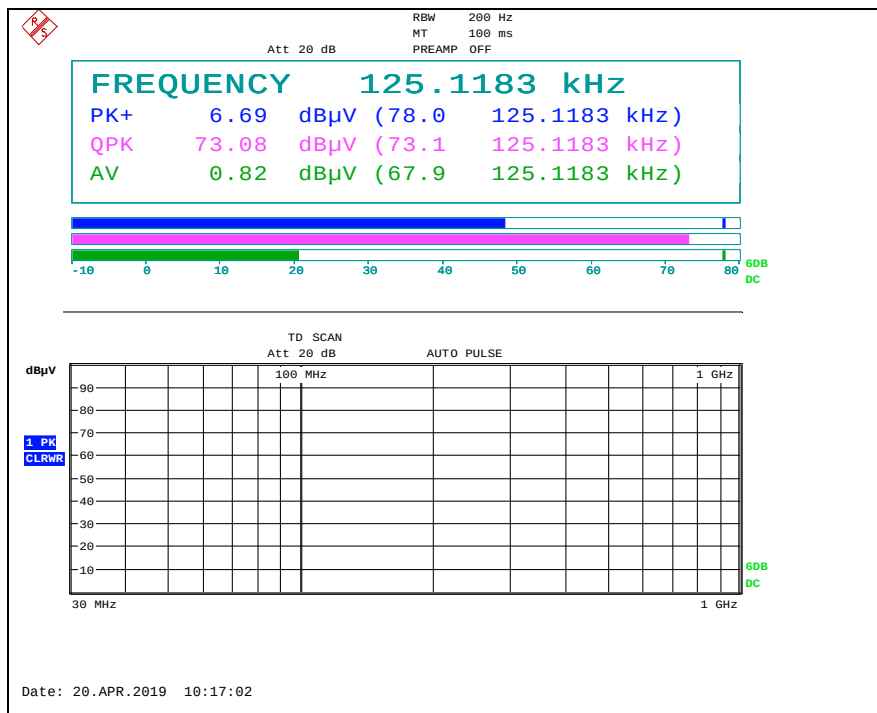
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- TRK Antenna



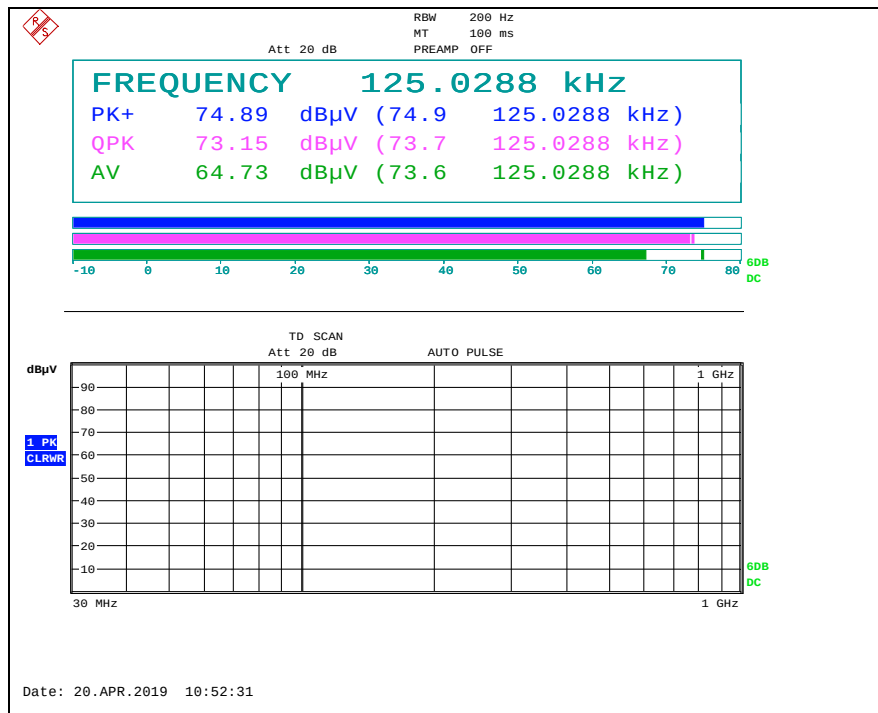
- BUM Antenna



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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									
0.021	26.20	Average	H	19.94	0.01	46.15	-33.85	41.16	75.01
0.069	21.20	Average	H	19.74	0.03	40.97	-39.03	30.83	69.86
0.293	9.90	Average	H	19.60	0.22	29.72	-50.28	18.27	68.55
Above 1.000	Not detected	-	-	-	-	-	-	-	-
AST Antenna									
0.022	26.40	Average	H	19.92	0.01	46.33	-33.67	40.76	74.43
0.069	21.80	Average	H	19.74	0.03	41.57	-38.43	30.83	69.26
0.246	12.60	Average	H	19.63	0.19	32.42	-47.58	19.79	67.37
Above 1.000	Not detected	-	-	-	-	-	-	-	-
INT1 Antenna									
0.022	26.40	Average	H	19.92	0.01	46.33	-33.67	40.76	74.43
0.081	6.30	Average	H	19.73	0.03	26.06	-53.94	29.43	83.37
2.972	5.70	Quasi-Peak	H	19.80	0.52	26.02	-13.98	30.00	43.98
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)
INT2 Antenna									
0.021	40.00	Average	H	19.94	0.01	59.95	-20.05	41.16	61.21
0.069	21.80	Average	H	19.74	0.03	41.57	-38.43	30.83	69.26
0.477	6.30	Average	H	19.60	0.37	26.27	-53.73	14.03	67.76
Above 1.000	Not detected	-	-	-	-	-	-	-	-
TRK Antenna									
0.022	26.90	Average	H	19.92	0.01	46.83	-33.17	40.76	73.93
0.069	21.90	Average	H	19.74	0.03	41.67	-38.33	30.83	69.16
0.430	6.90	Average	H	19.60	0.33	26.83	-53.17	14.93	68.10
Above 1.000	Not detected	-	-	-	-	-	-	-	-
BUM Antenna									
0.021	26.00	Average	H	19.94	0.01	45.95	-34.05	41.16	75.21
0.069	20.10	Average	H	19.74	0.03	39.87	-40.13	30.83	70.96
0.389	7.40	Average	H	19.60	0.30	27.30	-52.70	15.81	68.51
Above 1.000	Not detected	-	-	-	-	-	-	-	-

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Radiated Emissions			Ant.	Correction Factors		Total		Limit	
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SSB Antenna									
0.021	25.70	Average	H	19.94	0.01	45.65	-34.35	41.16	75.51
0.069	21.90	Average	H	19.74	0.03	41.67	-38.33	30.83	69.16
0.373	31.00	Average	H	19.60	0.29	50.89	-29.11	16.17	45.28
0.624	21.90	Quasi-Peak	H	19.62	0.48	42.00	2.00	31.70	29.70
0.876	17.70	Quasi-Peak	H	19.68	0.68	38.06	-1.94	28.75	30.69
Above 1.000	Not detected	-	-	-	-	-	-	-	-

Remark;

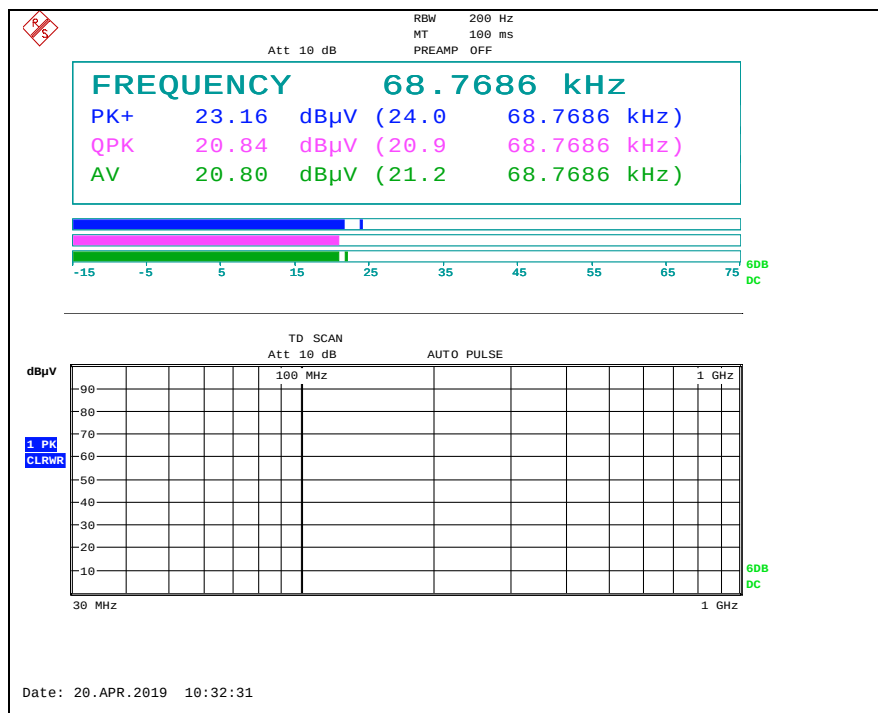
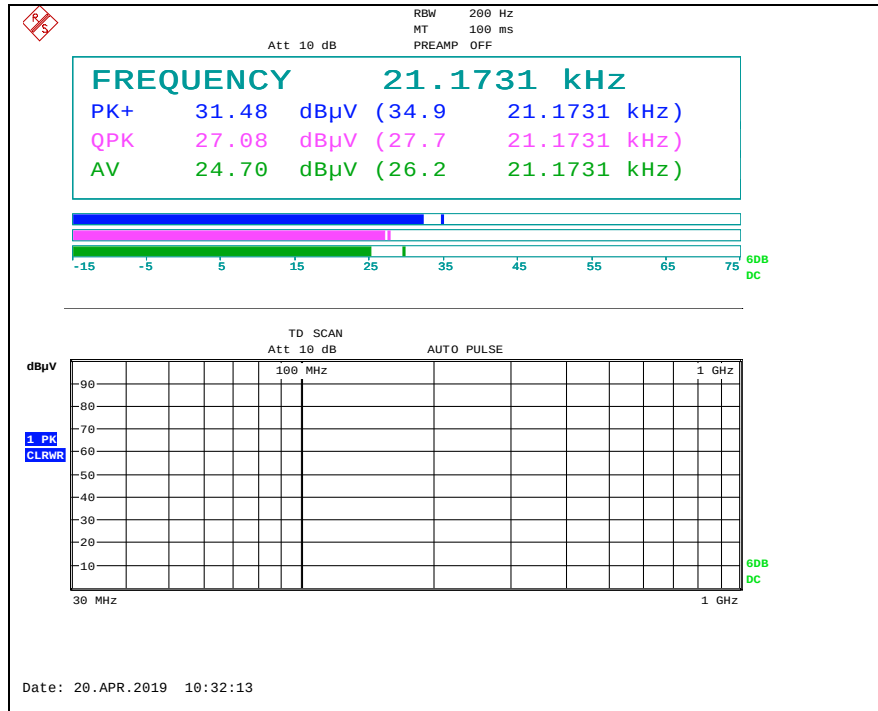
- According to §15.31(f)(2)
 - 300 m Result (dB μ V/m) = 3 m Result (dB μ V/m) - 40log (300/3) (dB μ V/m)
 - 30 m Result (dB μ V/m) = 3 m Result (dB μ V/m) - 40log (30/3) (dB μ V/m)
- According to field strength table of general requirement in §15.209(a), field strength limits below 1.705 MHz were calculated 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.
- According to ANSI C63.10: 2013, For measurement below 30 MHz.
conversion factor from E-field to H-field is considered as free-space impedance [1 μ V/m = (1/377 Ω) $\times$ 1 μ A/m]
The FCC limits are same to the IC limits.

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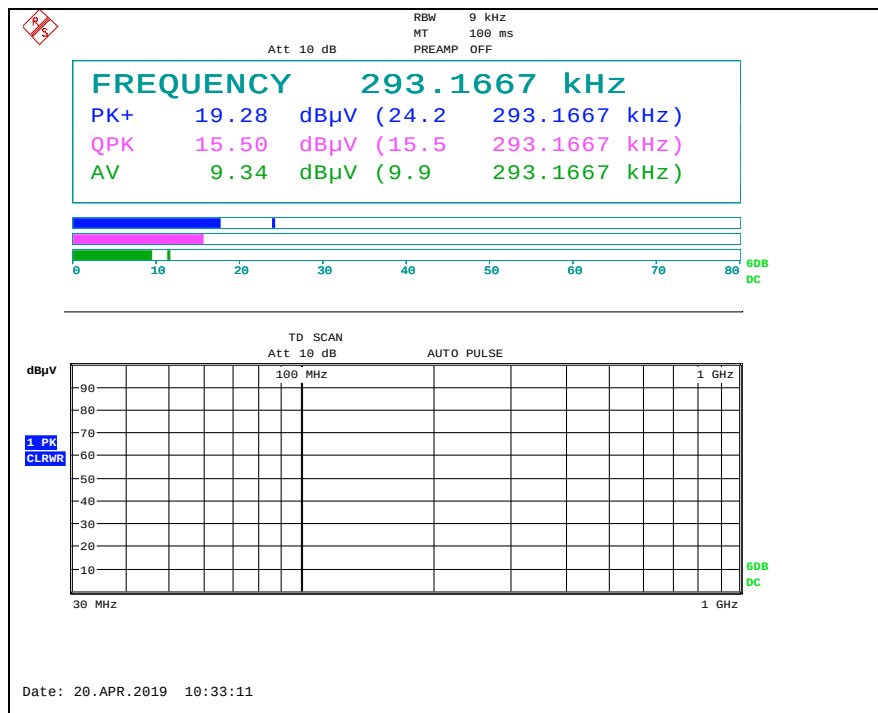
- Test plots

- DRV Antenna



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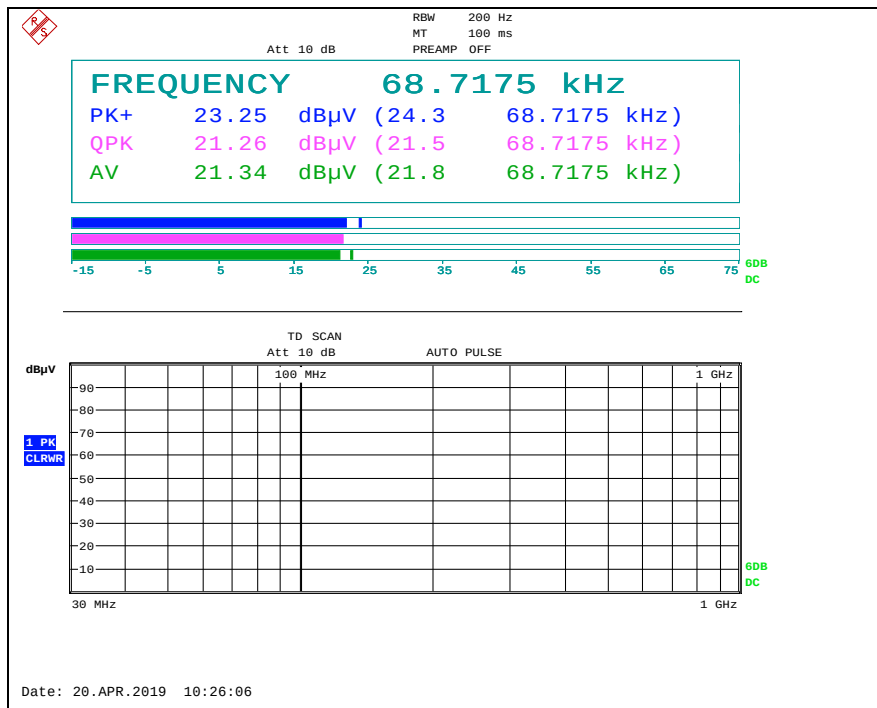
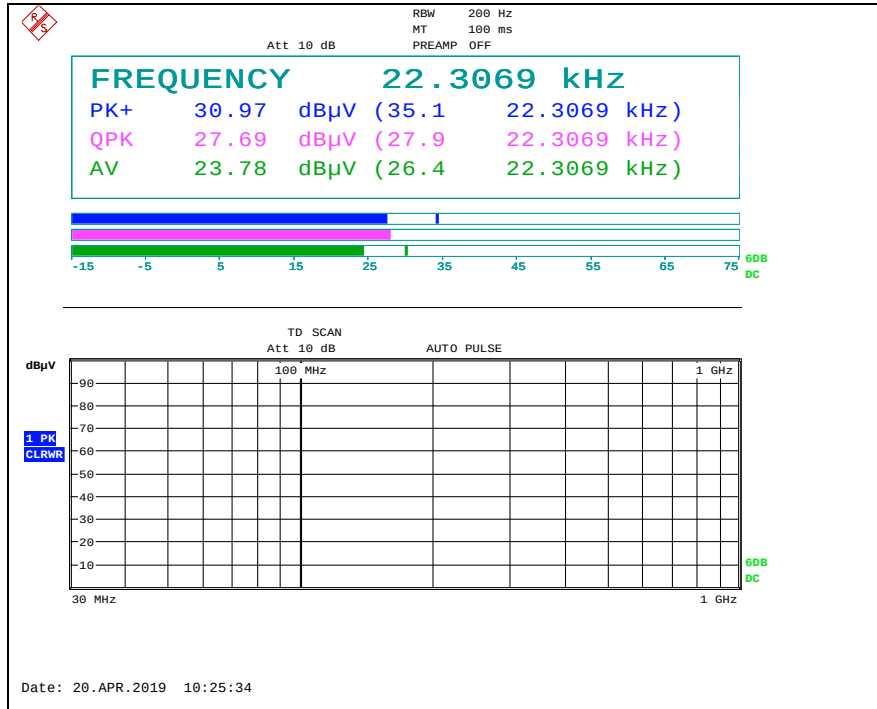
SGS Korea Co., Ltd. (Gunpo Laboratory) 4, LS-ro 182beon-gil, Gunpo-si, Gyeonggi-do, Korea, 15807 <http://www.sgsgroup.kr>



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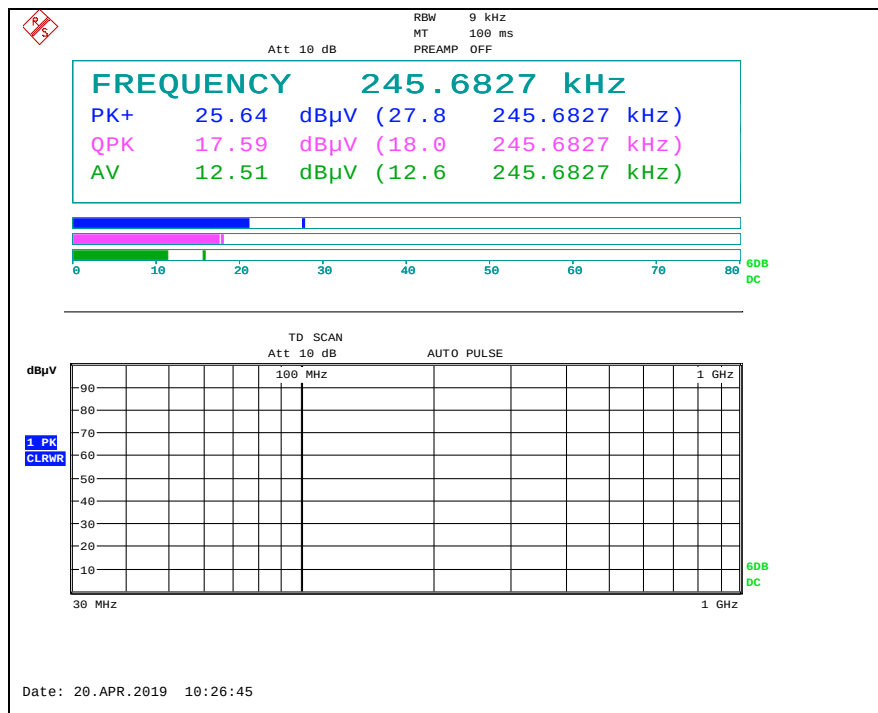
SGS Korea Co., Ltd. (Gunpo Laboratory) 4, LS-ro 182beon-gil, Gunpo-si, Gyeonggi-do, Korea, 15807 <http://www.sgsgroup.kr>

- AST Antenna



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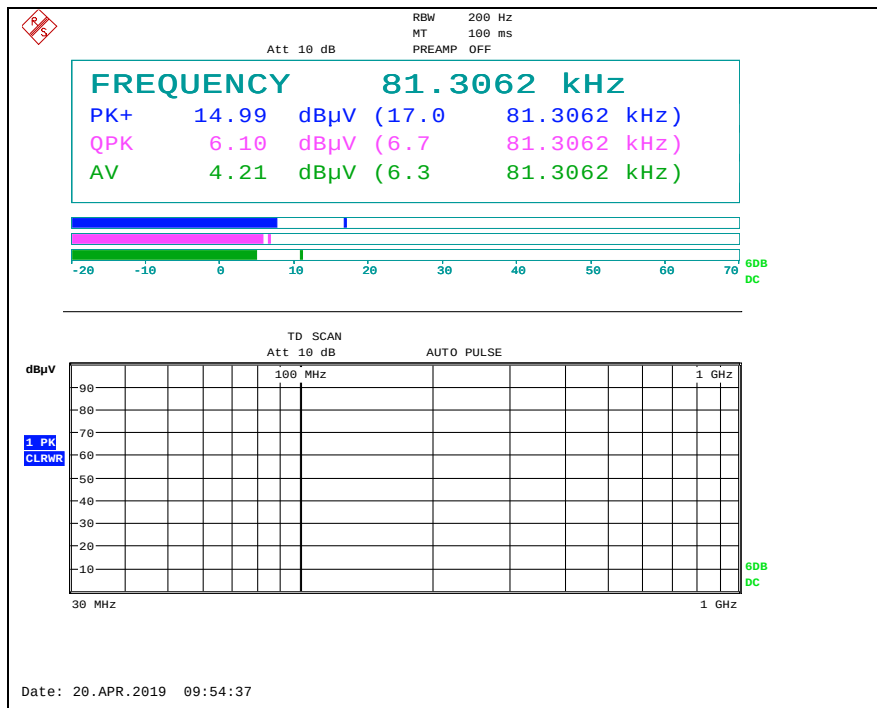
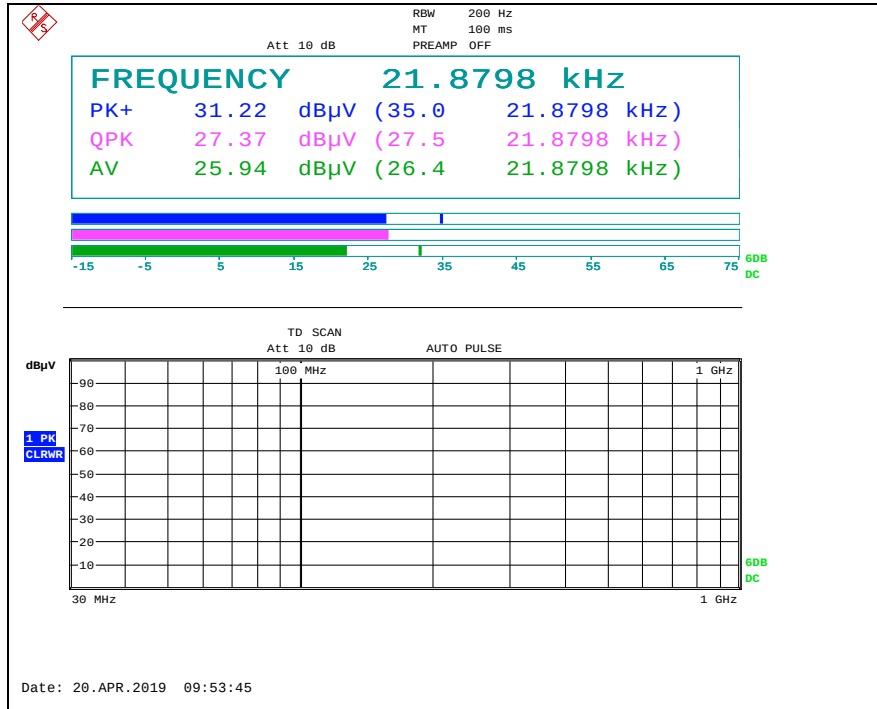
SGS Korea Co., Ltd. (Gunpo Laboratory) 4, LS-ro 182beon-gil, Gunpo-si, Gyeonggi-do, Korea, 15807 <http://www.sgsgroup.kr>

RTT5041-19(2019.04.24)(1)

Tel. +82 31 428 5700 / Fax. +82 31 427 2370

A4(210 mm x 297 mm)

- INT1 Antenna



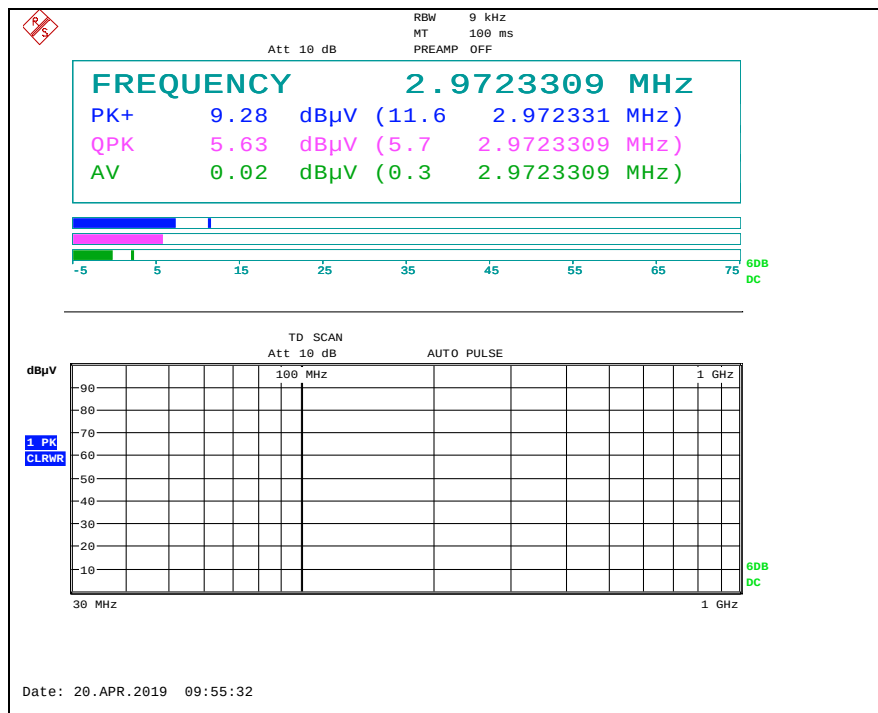
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A4(210 mm x 297 mm)



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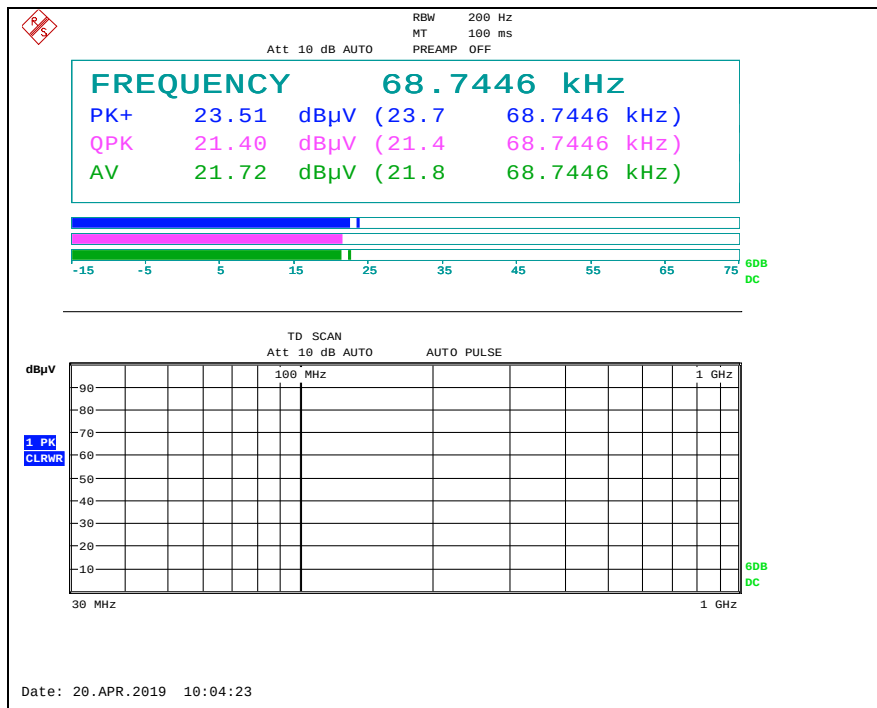
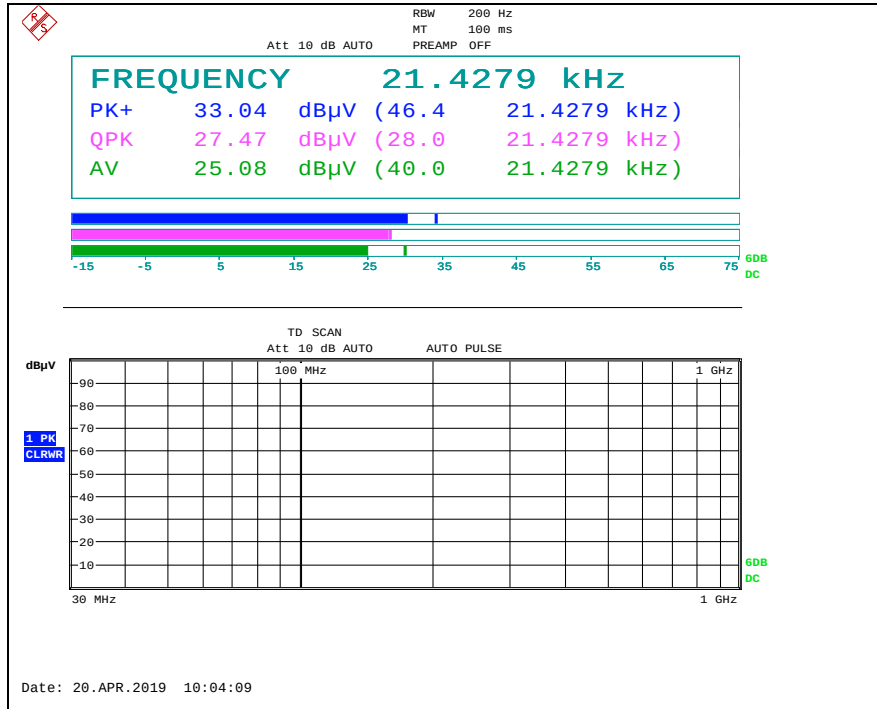
SGS Korea Co., Ltd. (Gunpo Laboratory) 4, LS-ro 182beon-gil, Gunpo-si, Gyeonggi-do, Korea, 15807 <http://www.sgsgroup.kr>

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Tel. +82 31 428 5700 / Fax. +82 31 427 2370

A4(210 mm x 297 mm)

- INT2 Antenna



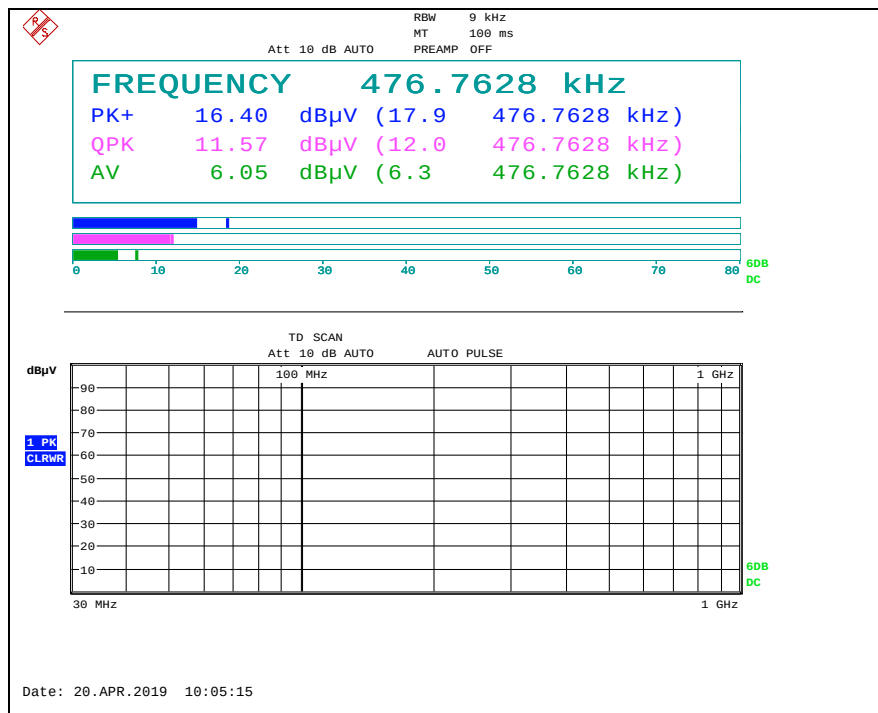
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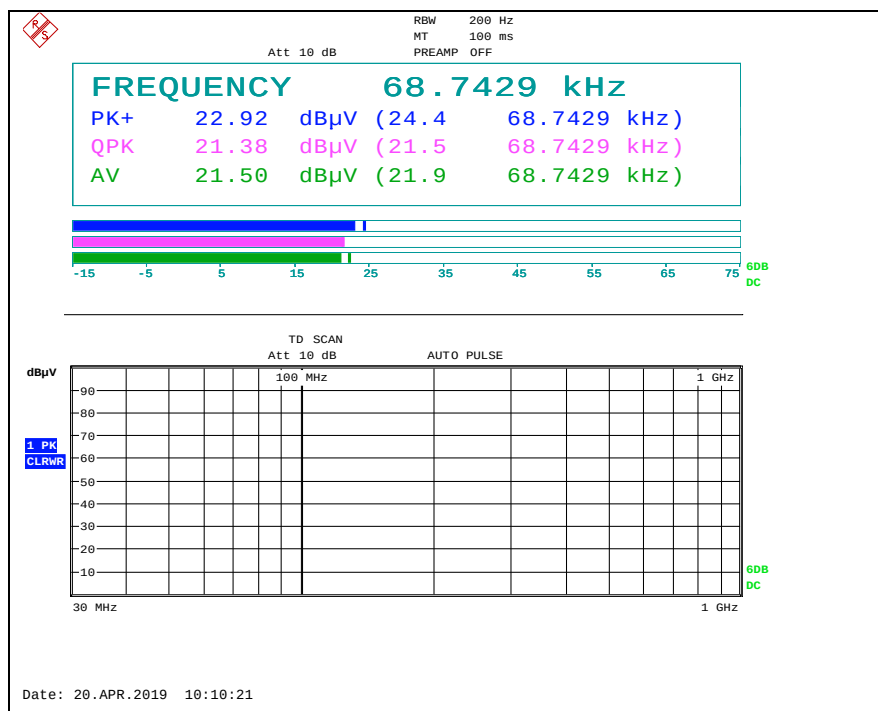
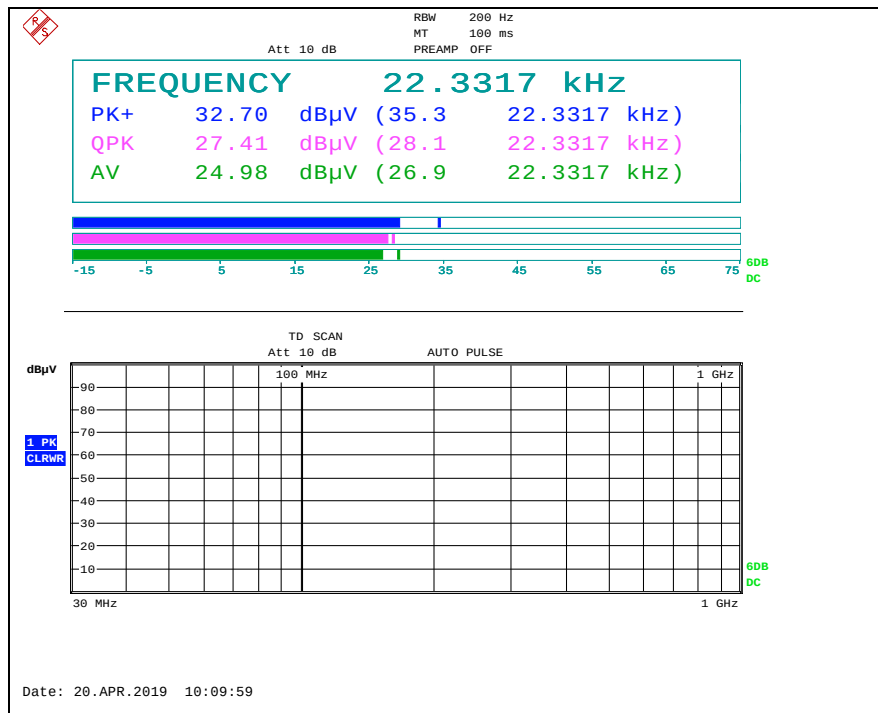
A4(210 mm x 297 mm)



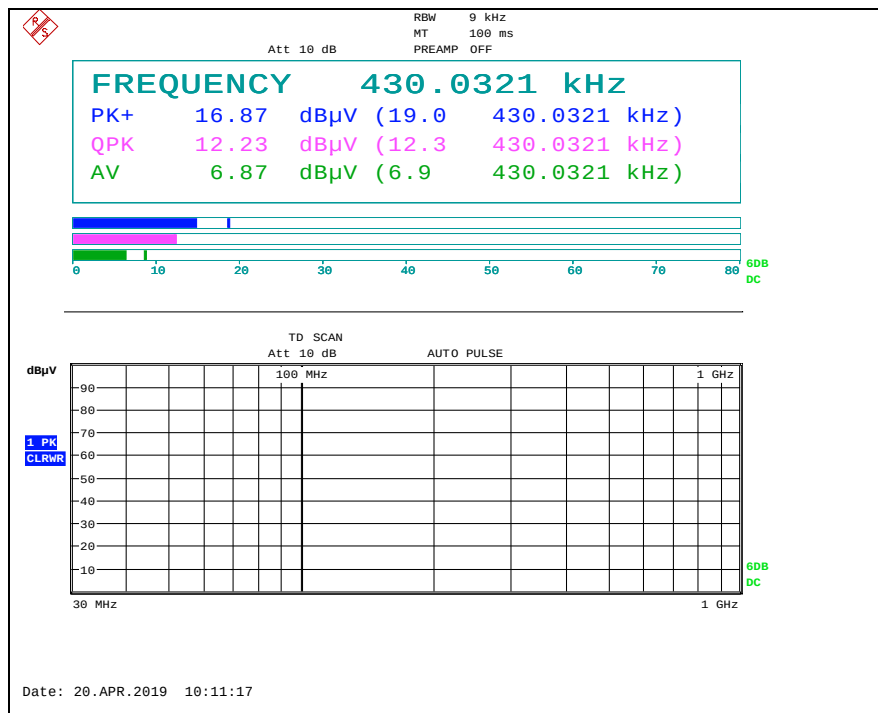
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- TRK Antenna



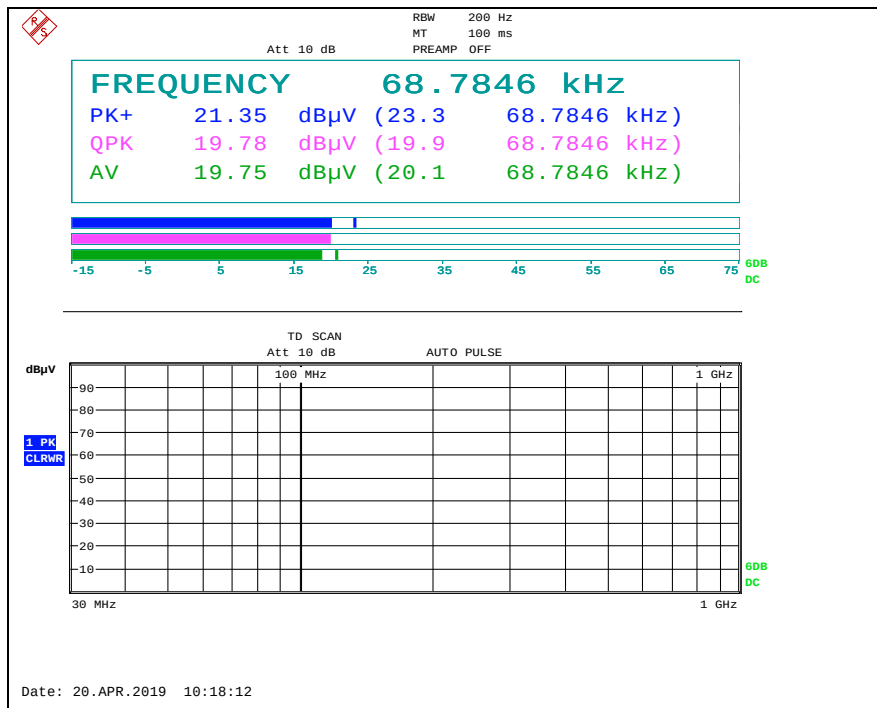
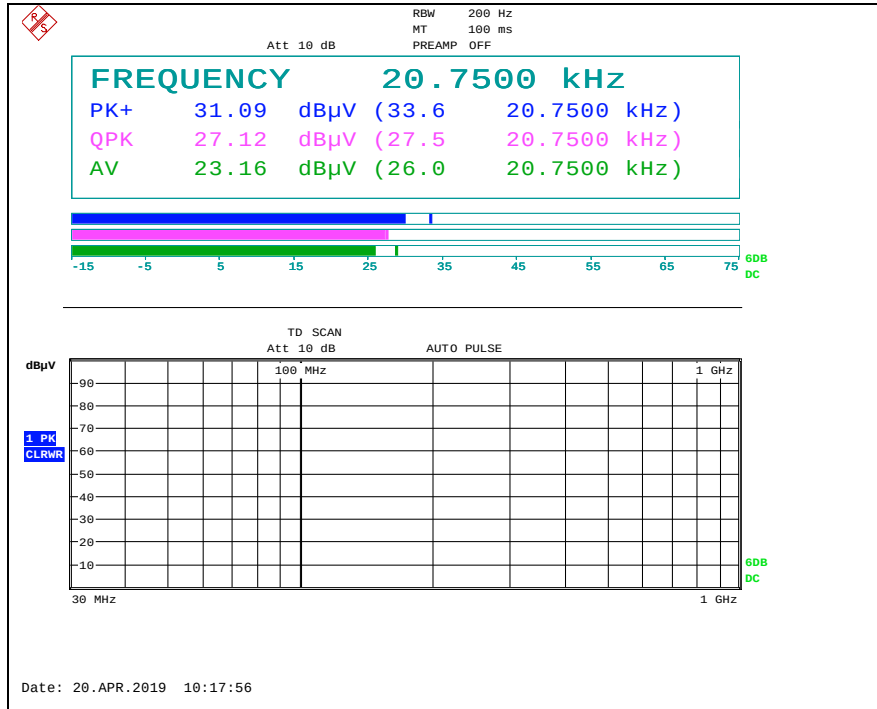
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- BUM Antenna



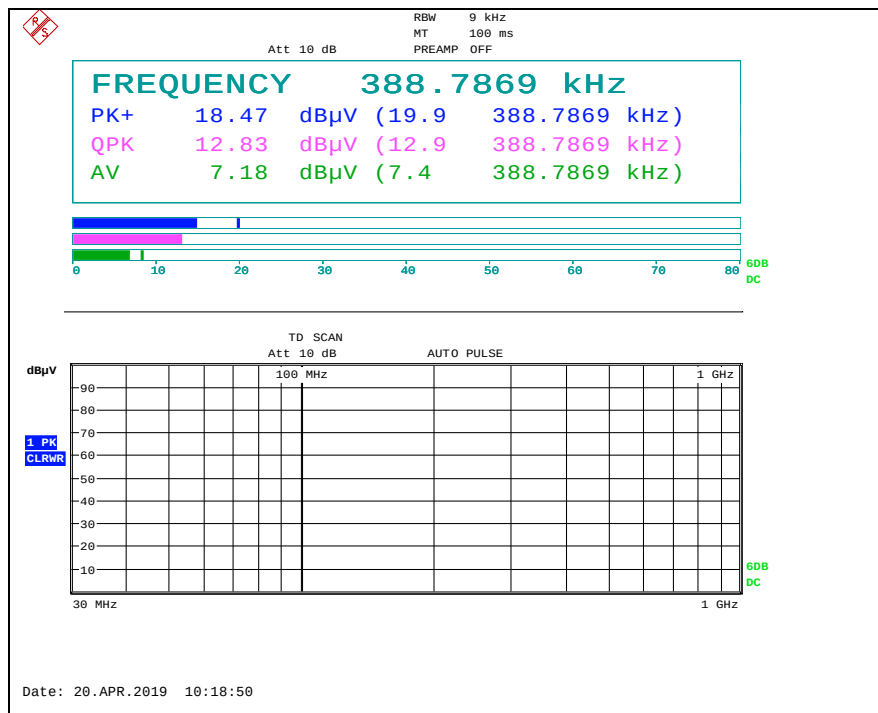
The results of this test report are effective only to the items tested. The SGS Korea is not responsible for the sampling, the results of this test report apply to the sample as received. This test report cannot be reproduced, except in full, without prior written permission of the Company. This test report does not assure KOLAS accreditation.

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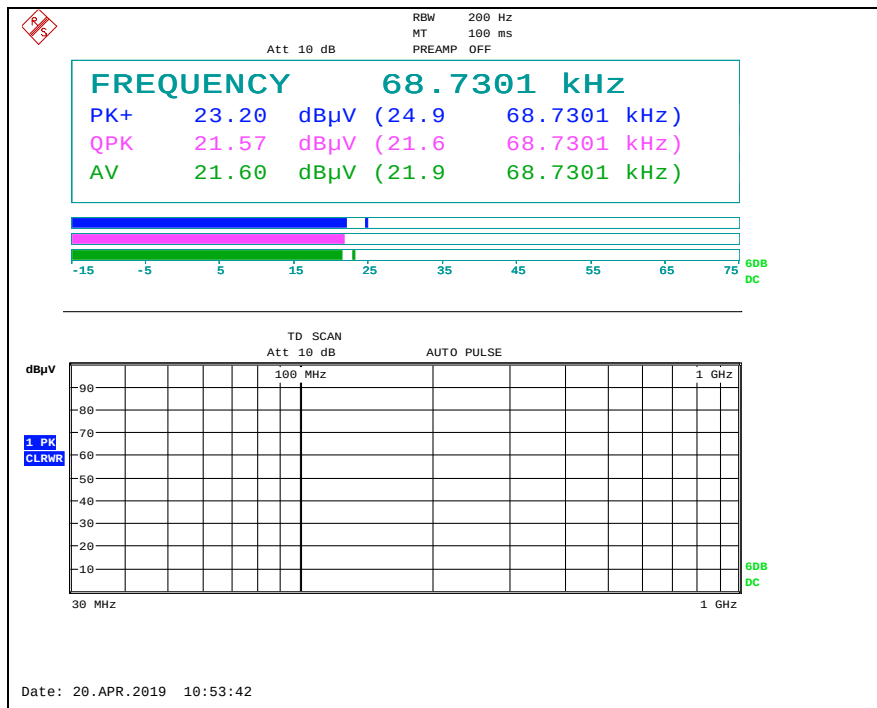
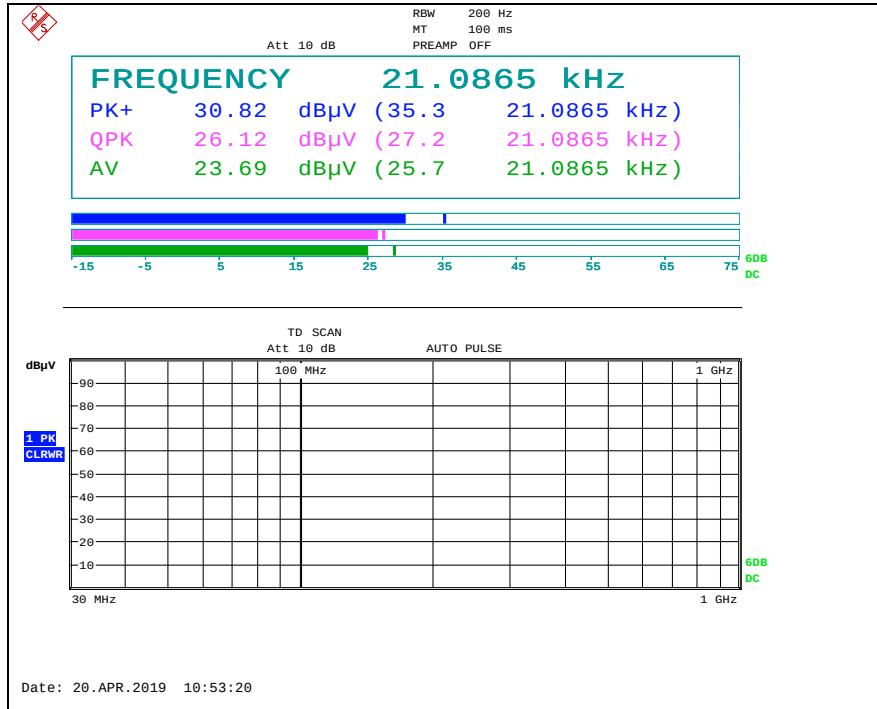
A4(210 mm x 297 mm)



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- SSB Antenna



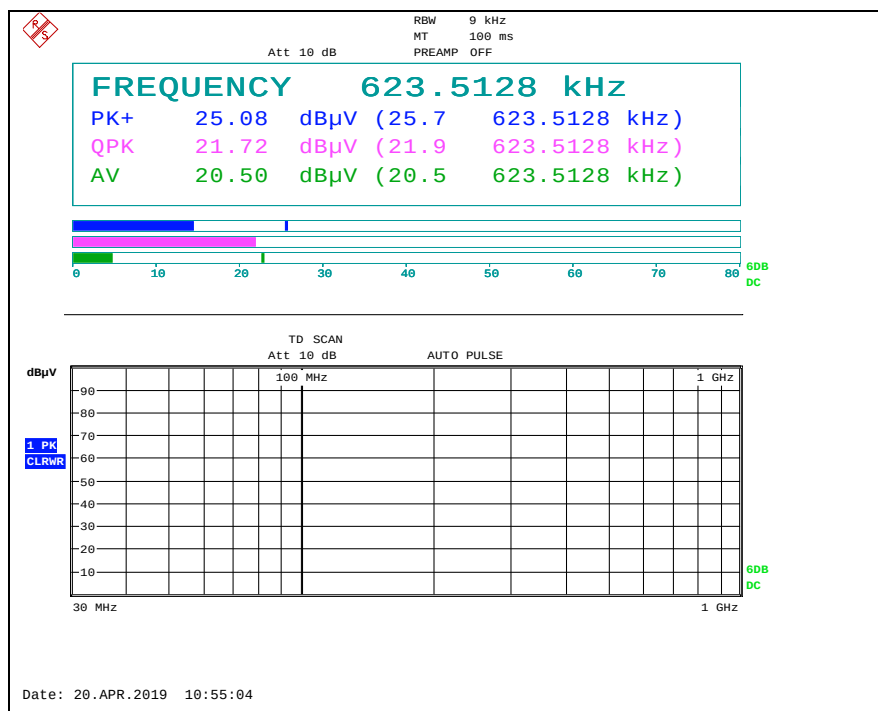
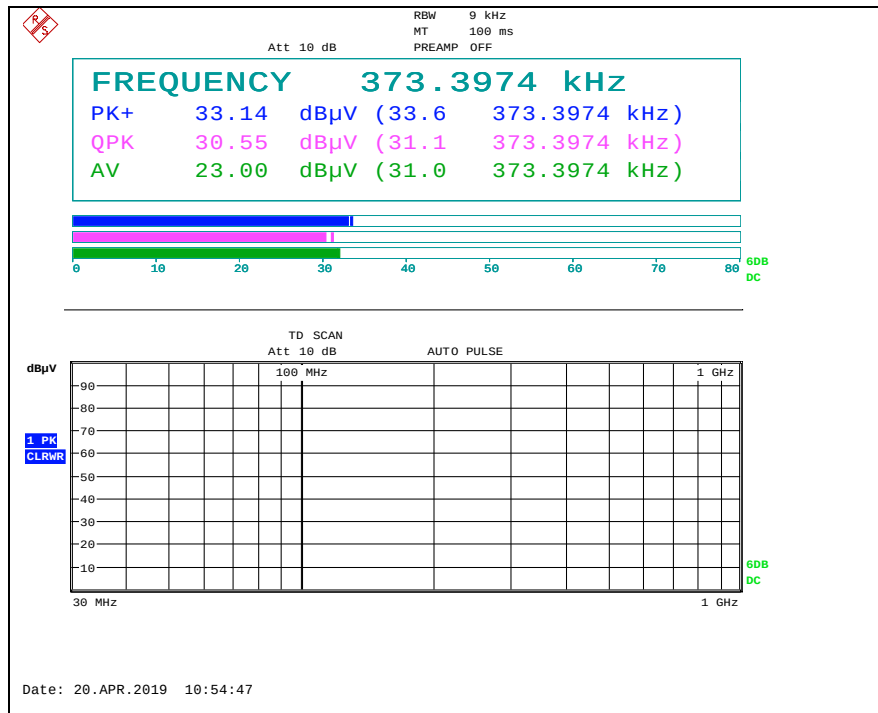
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RTT5041-19(2019.04.24)(1)

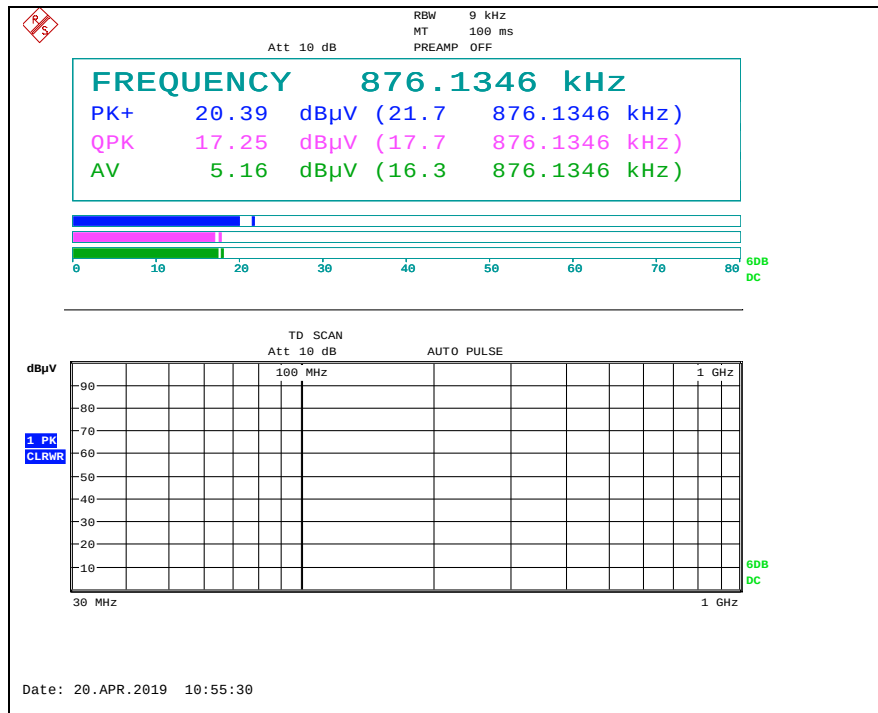
Tel. +82 31 428 5700 / Fax. +82 31 427 2370

A4(210 mm x 297 mm)



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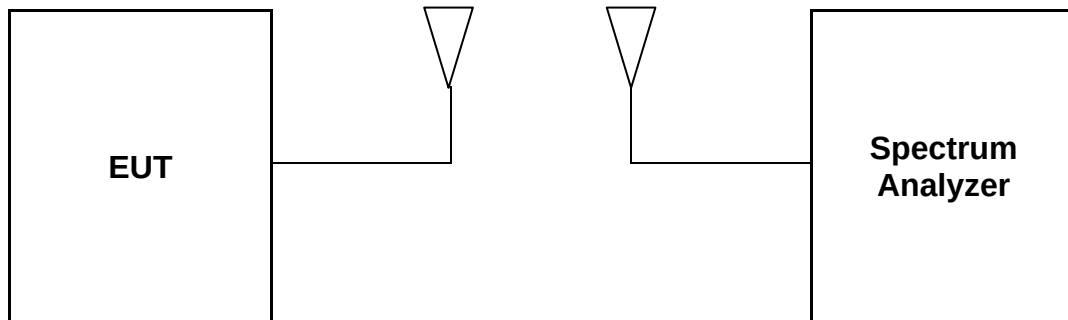


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3. 20 dB Bandwidth

3.1. Test Setup



3.2. Limits

None; for reporting purposed only

3.3. Test Procedure

- a. Span = the spectrum analyzer shall be between two times and five times the OBW, RBW = 1% to 5% of the OBW, VBW = set approximately $3 \times \text{RBW}$, 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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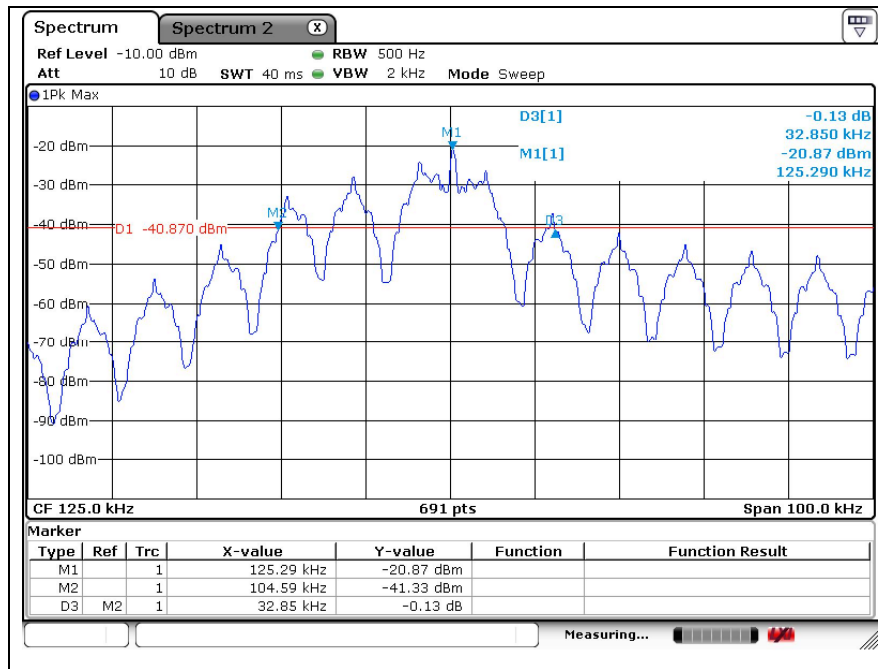
3.4. Test Result

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

Test Antenna	Carrier Frequency (kHz)	20 dB Bandwidth (kHz)	Limit
DRV Antenna	125.290	32.850	Reporting proposed only
AST Antenna	125.290	34.010	
INT1 Antenna	125.072	9.407	
INT2 Antenna	125.072	9.262	
TRK Antenna	125.000	84.520	
BUM Antenna	125.000	94.500	
SSB Antenna	125.000	9.479	

- Test plots

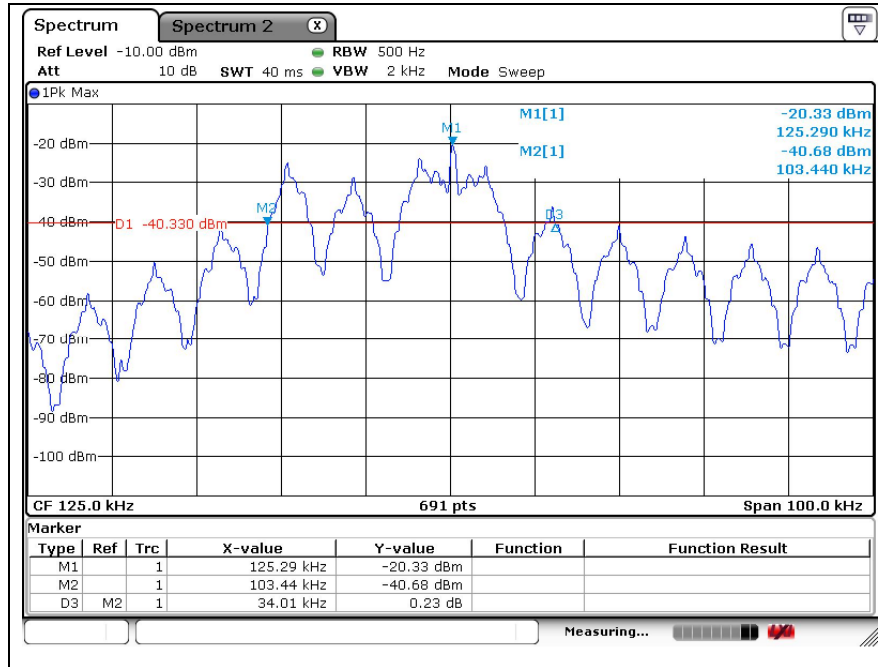
- DRV Antenna



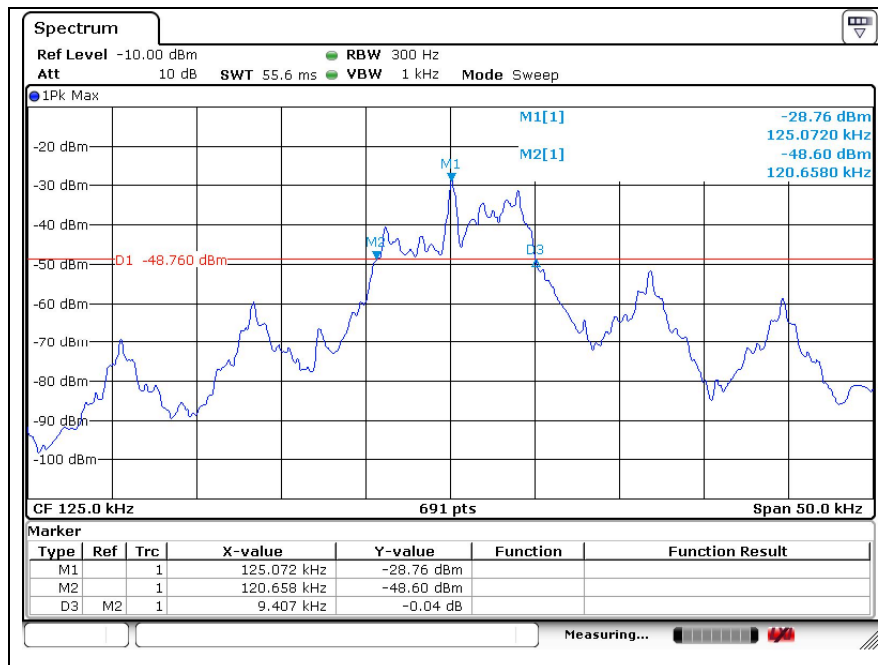
The results of this test report are effective only to the items tested. The SGS Korea is not responsible for the sampling, the results of this test report apply to the sample as received. This test report cannot be reproduced, except in full, without prior written permission of the Company. This test report does not assure KOLAS accreditation.

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- AST Antenna



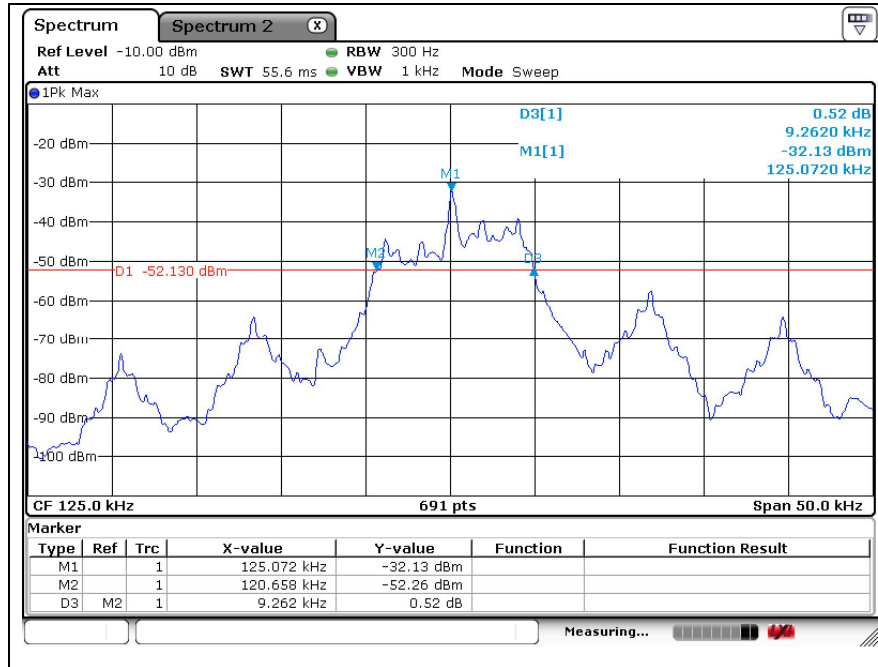
- INT1 Antenna



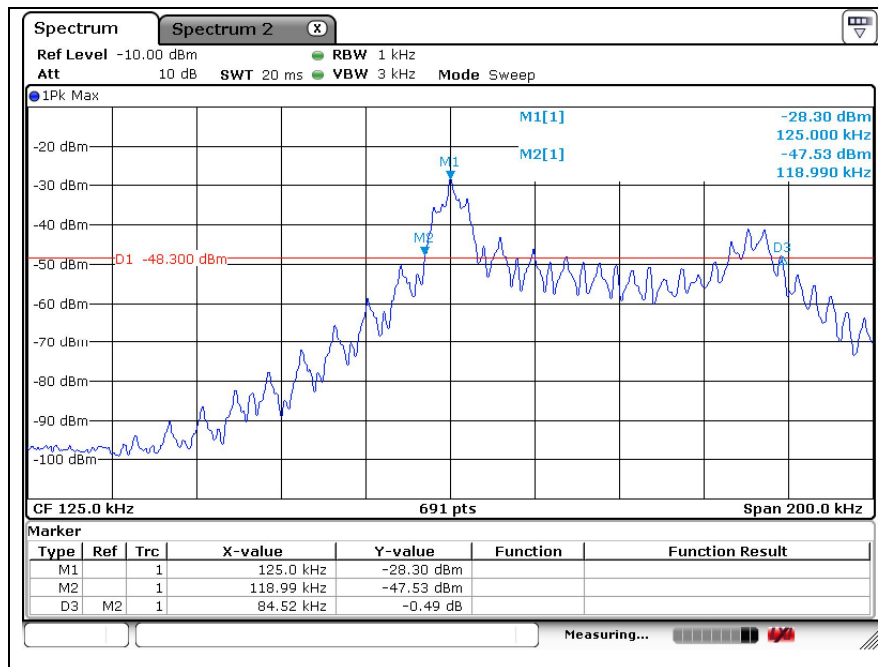
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- INT2 Antenna



- TRK Antenna



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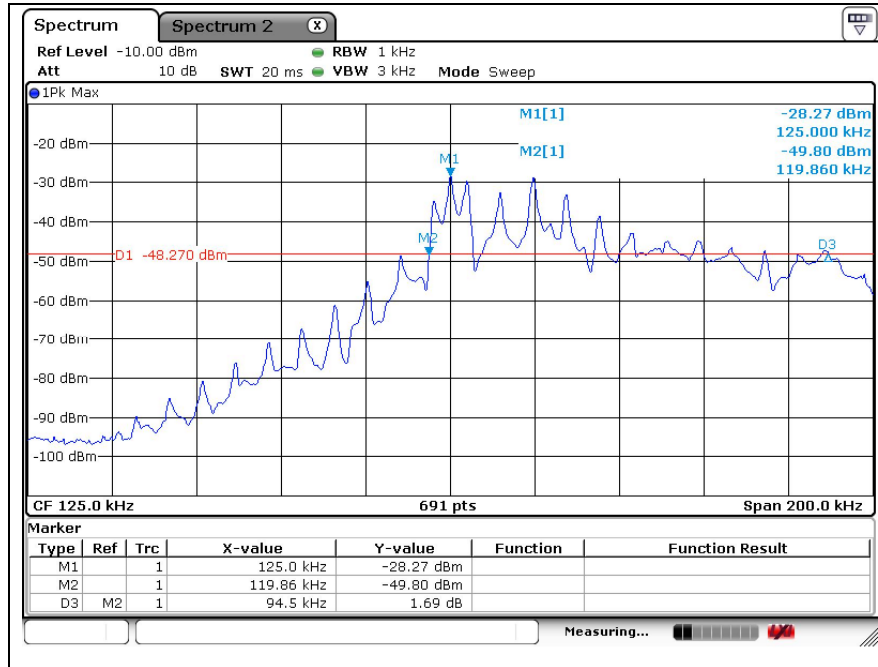
SGS Korea Co., Ltd. (Gunpo Laboratory) 4, LS-ro 182beon-gil, Gunpo-si, Gyeonggi-do, Korea, 15807 <http://www.sgsgroup.kr>

RTT5041-19(2019.04.24)(1)

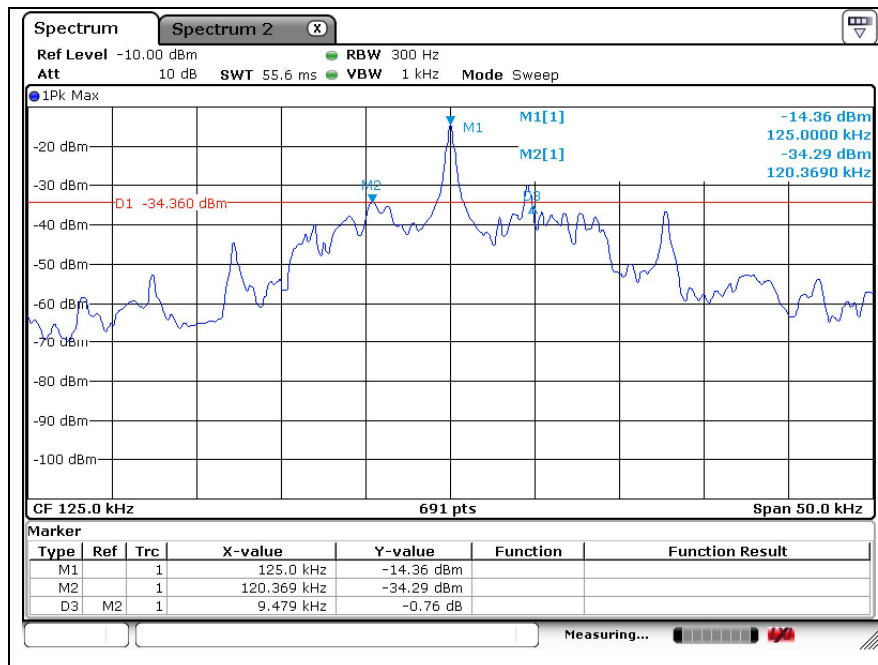
Tel. +82 31 428 5700 / Fax. +82 31 427 2370

A4(210 mm x 297 mm)

- BUM Antenna



- SSB Antenna



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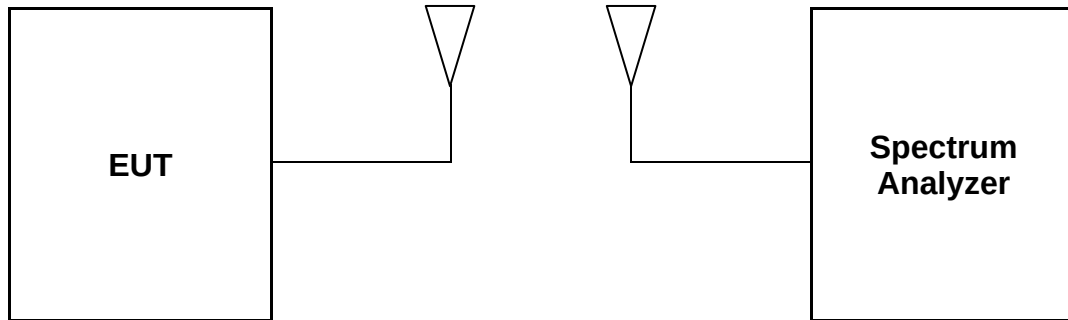
RTT5041-19(2019.04.24)(1)

Tel. +82 31 428 5700 / Fax. +82 31 427 2370

A4(210 mm x 297 mm)

4. Occupied Bandwidth

4.1. Test Setup



4.2. Limit

None; for reporting purposed only

4.3. Test Procedure

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

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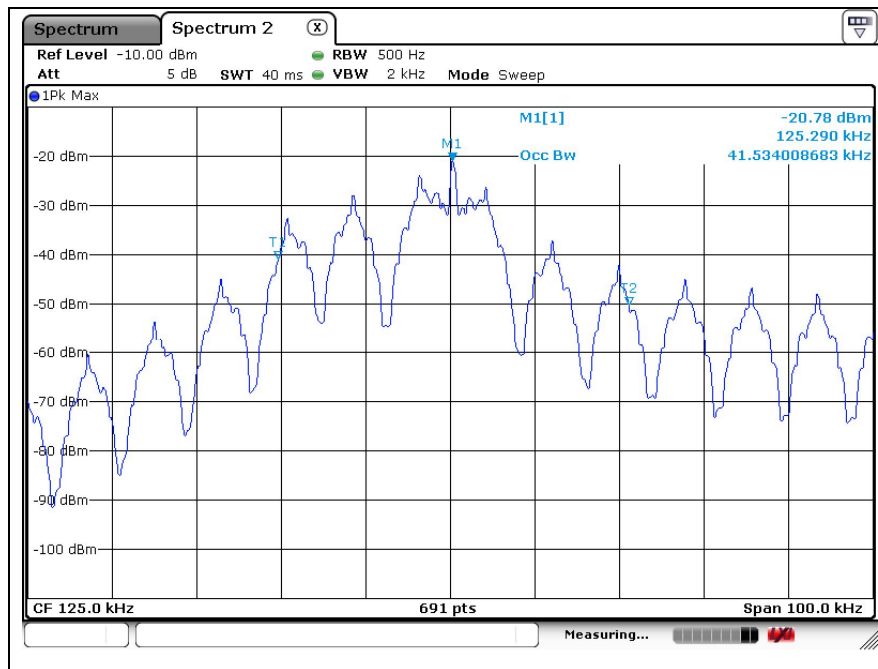
4.4. Test Result

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

Test Antenna	Carrier Frequency (MHz)	Occupied Bandwidth (kHz)	Limit
DRV Antenna	125.290	41.534	Reporting proposed only
AST Antenna	125.290	42.258	
INT1 Antenna	125.072	10.203	
INT2 Antenna	125.072	9.841	
TRK Antenna	125.000	87.988	
BUM Antenna	125.070	94.935	
SSB Antenna	125.000	19.899	

- Test plots

- DRV Antenna



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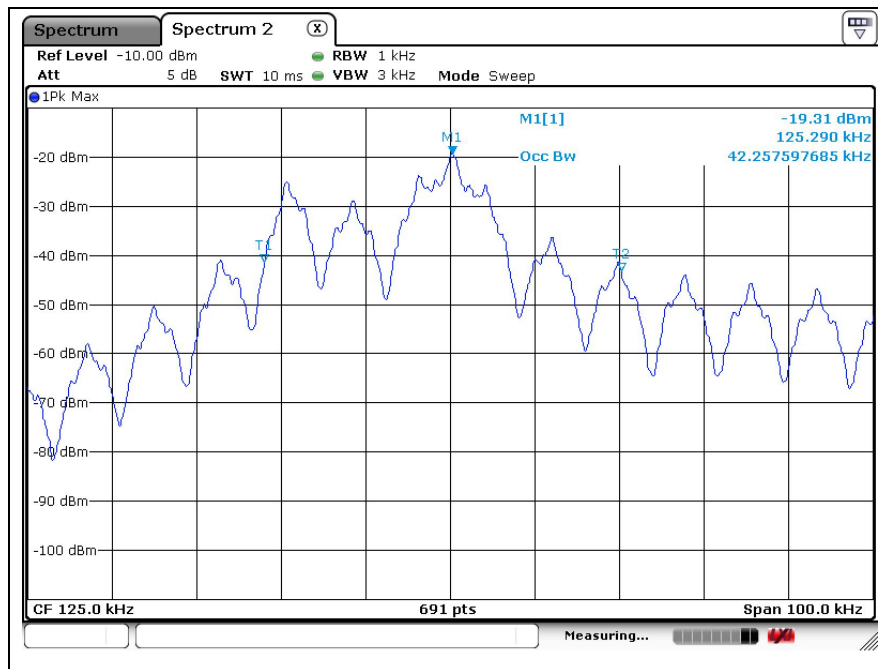
SGS Korea Co., Ltd. (Gunpo Laboratory) 4, LS-ro 182beon-gil, Gunpo-si, Gyeonggi-do, Korea, 15807 <http://www.sgsgroup.kr>

RTT5041-19(2019.04.24)(1)

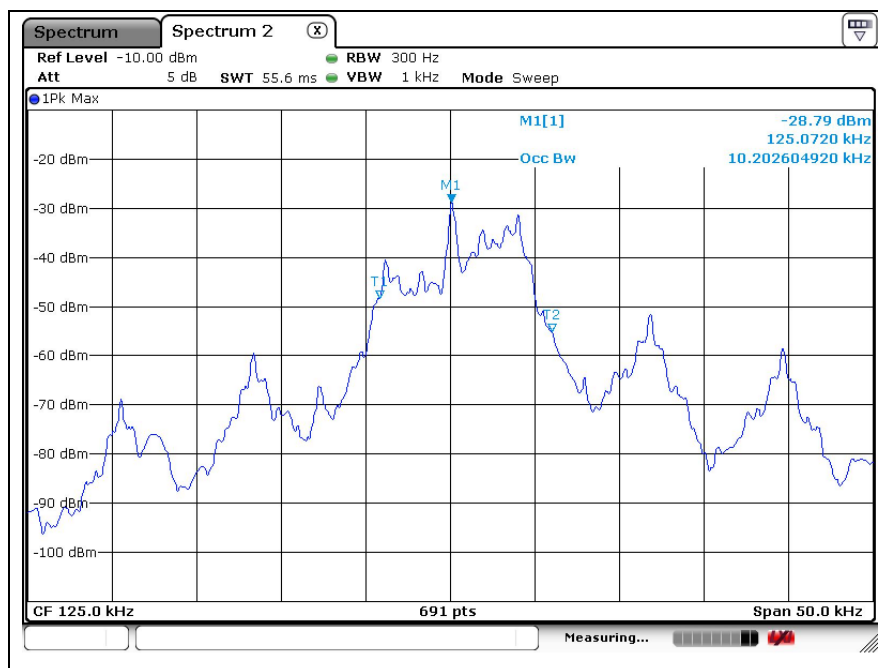
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A4(210 mm x 297 mm)

- AST Antenna



- INT1 Antenna



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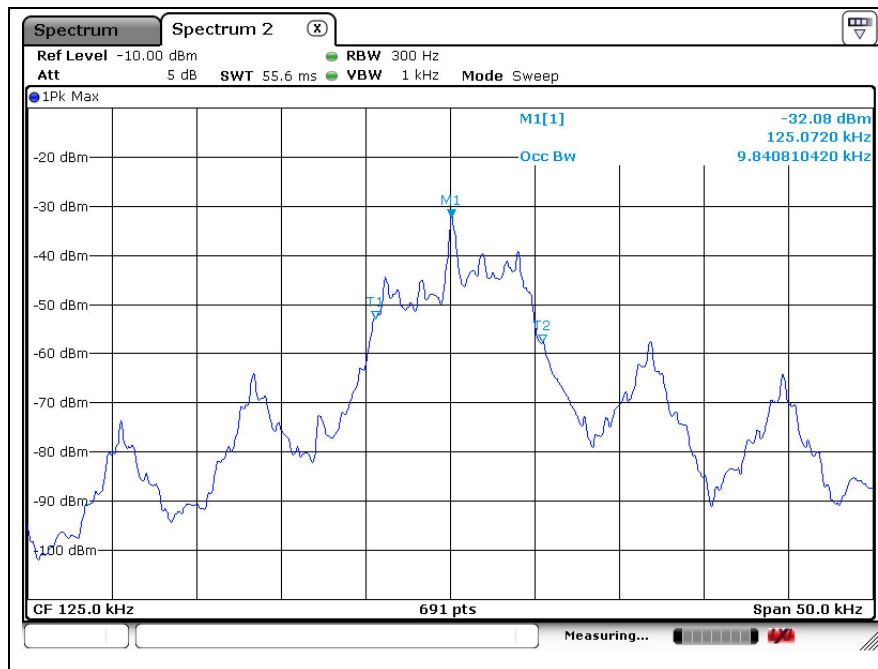
SGS Korea Co., Ltd. (Gunpo Laboratory) 4, LS-ro 182beon-gil, Gunpo-si, Gyeonggi-do, Korea, 15807 <http://www.sgsgroup.kr>

RTT5041-19(2019.04.24)(1)

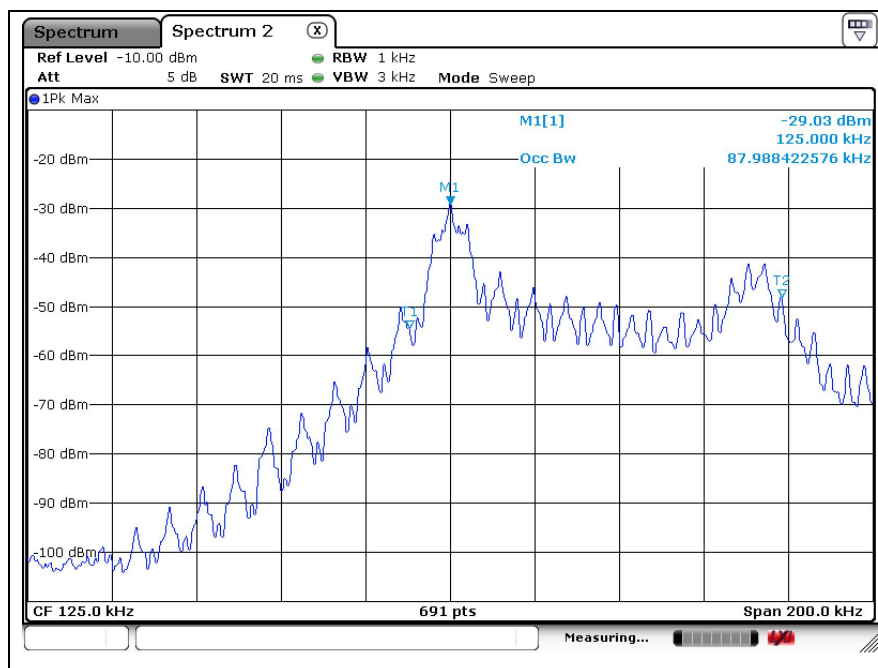
Tel. +82 31 428 5700 / Fax. +82 31 427 2370

A4(210 mm x 297 mm)

- INT2 Antenna



- TRK Antenna



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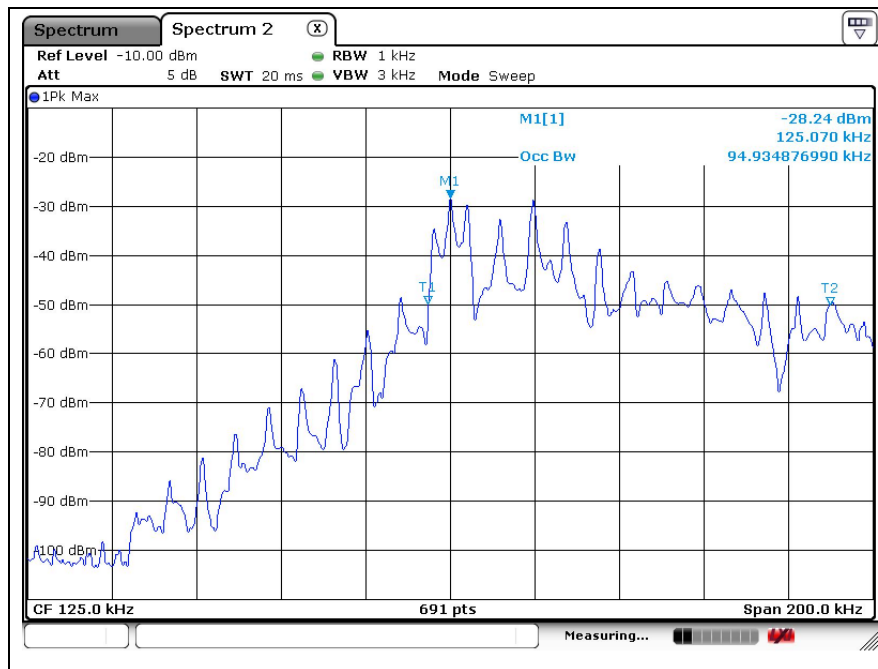
SGS Korea Co., Ltd. (Gunpo Laboratory) 4, LS-ro 182beon-gil, Gunpo-si, Gyeonggi-do, Korea, 15807 <http://www.sgsgroup.kr>

RTT5041-19(2019.04.24)(1)

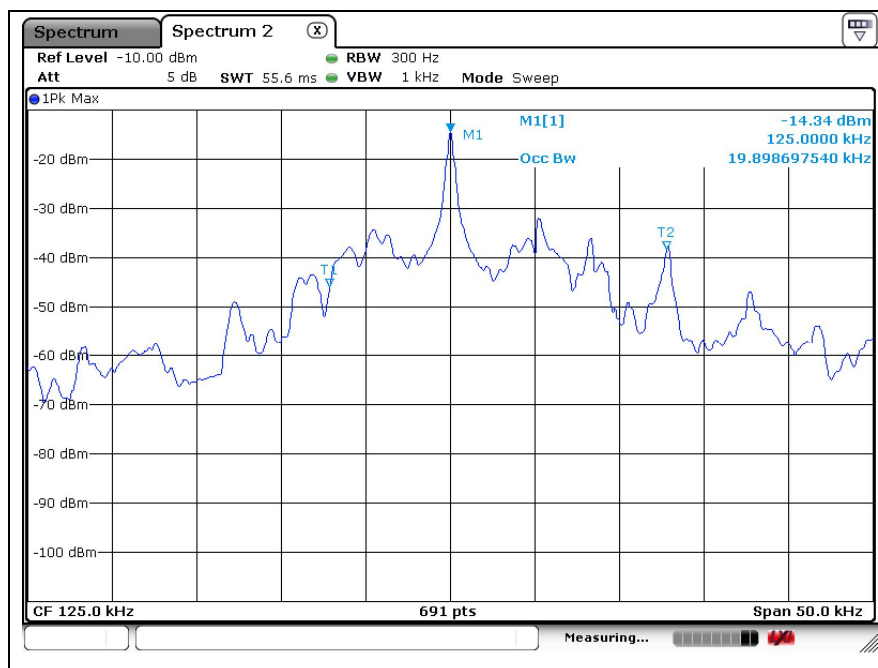
Tel. +82 31 428 5700 / Fax. +82 31 427 2370

A4(210 mm x 297 mm)

- BUM Antenna



- SSB Antenna



- End of the Test Report -

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A4(210 mm x 297 mm)