

TEST REPORT



CTK Co., Ltd.

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Report No.:
CTK-2019-01407
Page (1) / (33) Pages

1. Client

- Name : SystemBase Co., Ltd.
- Address : Daerung Post Tower-1 16F, 288, Digital-ro, Guro-gu, Seoul, Republic of Korea
- Date of Receipt : 2019-01-25

2. Manufacturer

- Name : SystemBase Co., Ltd.
- Address : Daerung Post Tower-1 16F, 288, Digital-ro, Guro-gu, Seoul, Republic of Korea

3. Use of Report : For FCC Certification

4. Test Sample / Model: uLory-1010UIL / uLory

5. Date of Test : 2019-03-19 to 2019-04-08

6. Test Standard(method) used : FCC 47 CFR part 15 subpart C 15.247, ANSI C63.10-2013

7. Testing Environment: Temp.: (23 ± 1) °C, Humidity: (48 ± 5) % R.H.

8. Test Results : Compliance

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.

Affirmation	 Gwanyong Kim: (Signature)	Technical Manager  Young-taek Lee: (Signature)
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2019-04-19

Republic of KOREA **CTK Co., Ltd.**



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REPORT REVISION HISTORY

Date	Revision	Page No
2019-04-19	Issued (CTK-2019-01407)	all

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 CTK Co., Ltd. The Prime Leader of Global Regulatory Certification	CTK Co., Ltd. (Ho-dong), 113, Yejik-ro, Cheoin-gu, Yongin-si, Gyeonggi-do, Korea Tel: +82-31-339-9970 Fax: +82-31-624-9501	Report No.: CTK-2019-01407 Page (4) / (33) Pages	
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1. General Product Description

1.1 Client Information

Company	SystemBase Co., Ltd.
Contact Point	Daerung Post Tower-1 16F, 288, Digital-ro, Guro-gu, Seoul, Republic of Korea
Contact Person	Name : Myunghyun Kim E-mail : mkim@sysbas.com Tel : +82-2-855-0501

1.2 Product Information

FCC ID	PROULORY1010UIL
Product Description	ulory-1010UIL
Model name	ulory
Operating Frequency	917.3 MHz – 923.3 MHz
RF Output Power	10.938 dBm (12.411 mW)
Antenna type	Dipole Antenna
Antenna gain	2.625 dBi
Number of channels	20
Type of Modulation	DSSS
Power Source	DC 5 V (USB VBUS)

1.3 Peripheral Devices

Device	Manufacturer	Model No.	Serial No.
Notebook Computer	HP	15-bs563TU	CND7253R6P
AC/DC Adapter	HP	HSTNN-LA40	7628207801

2. Facility and Accreditations

2.1 Test Facility

The measurement facility is located at (Ho-dong), 113, Yejik-ro, Cheoin-gu, Yongin-si, Gyeonggi-do, Korea.

2.2 Laboratory Accreditations and Listings

Country	Agency	Scope of Accreditation	Registration Number	Logo
USA	FCC	FCC Part 15 & 18 EMI (Electromagnetic Interference / Emission)	805871	
CANADA	ISED	ISED EMI (3/10m test site)	8737A-2	
JAPAN	VCCI	VCCI V-3 EMI (Electromagnetic Interference / Emission)	C-986 T-1843 R-3627 G-387	
KOREA	MSIP	EMI (Electromagnetic Interference / Emission) EMS (Electromagnetic Susceptibility / Immunity)	KR0025	

2.3 Calibration Details of Equipment Used for Measurement

Test equipment and test accessories are calibrated on regular basis. The maximum time between calibrations is one year or what is recommended by the manufacturer, whichever is less. All test equipment calibrations are traceable to the Korea Research Institute of Standards and Science (KRISS), therefore, all test data recorded in this report is traceable to KRISS.

3. Test Specifications

3.1 Standards

Section in FCC	Requirement(s)	Status (Note 1)	Test Condition
15.247(a)	6 dB Bandwidth	C	Conducted
15.247(e)	Transmitter power spectral density	C	
15.247(b)	Maximum peak conducted output power	C	
15.247(d)	Unwanted emission	C	
15.209	Transmitter emission	C	Radiated
15.207(a)	AC Conducted Emission	C	Line Conducted
<u>Note 1:</u> C=Complies NC=Not Complies NT=Not Tested NA=Not Applicable			
<u>Note 2:</u> The data in this test report are traceable to the national or international standards.			
<u>Note 3:</u> The sample was tested according to the following specification: FCC Part 15.247, ANSI C63.10-2013			
<u>Note 4:</u> The tests were performed according to the method of measurements prescribed in KDB No.558074.			

3.2 Mode of operation during the test

The EUT is operated in a manner representative of the typical of the equipments.
During at testing, system components were manipulated within the confines of typical usage to maximize each emission. All modulation modes were tests.
The results are only attached worst cases.

Test Frequency

Lowest channel	Middle channel	Highest channel
917.3 MHz	920.3 MHz	923.3 MHz

Test mode

Modulation	Duty Cycle
DSSS	24.9 %(On time : 249.5 ms, Off time : 752.5 ms)

3.3 Maximum Measurement Uncertainty

The value of the measurement uncertainty for the measurement of each parameter.
Coverage factor $k = 2$, Confidence levels of 95 %

Description	Uncertainty
Conducted RF Output Power	1.5 dB
Power Spectral Density	1.5 dB
Occupied Bandwidth	0.1 MHz
Unwanted Emission(conducted)	3.0 dB
Radiated Emissions ($f \leq 1$ GHz)	4.0 dB
Radiated Emissions ($f > 1$ GHz)	5.0 dB

4. Technical Characteristic Test

4.1 6dB Bandwidth

Test Procedures(ANSI C63.10-2013 6.9.2)

Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

Test Procedures(ANSI C63.10-2013 6.9.3)

The occupied bandwidth is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers are each equal to 0.5% of the total mean power of the given emission.

Use the 99% power bandwidth function of the instrument and report the measured bandwidth.

Test Settings :

Center frequency = the highest, middle and the lowest channels

- a) RBW = 100 kHz
- b) VBW $\geq 3 \times$ RBW
- c) Detector = peak
- d) Trace mode = Max hold
- e) Sweep = auto couple
- f) Allow trace to fully stabilize
- g) Measure the maximum width of the emission that is constrained by the frequencies associated with the two outermost amplitude points (upper and lower frequencies) that are attenuated by 6 dB relative to the maximum level measured in the fundamental emission.

Limit :

6 dB Bandwidth > 500kHz



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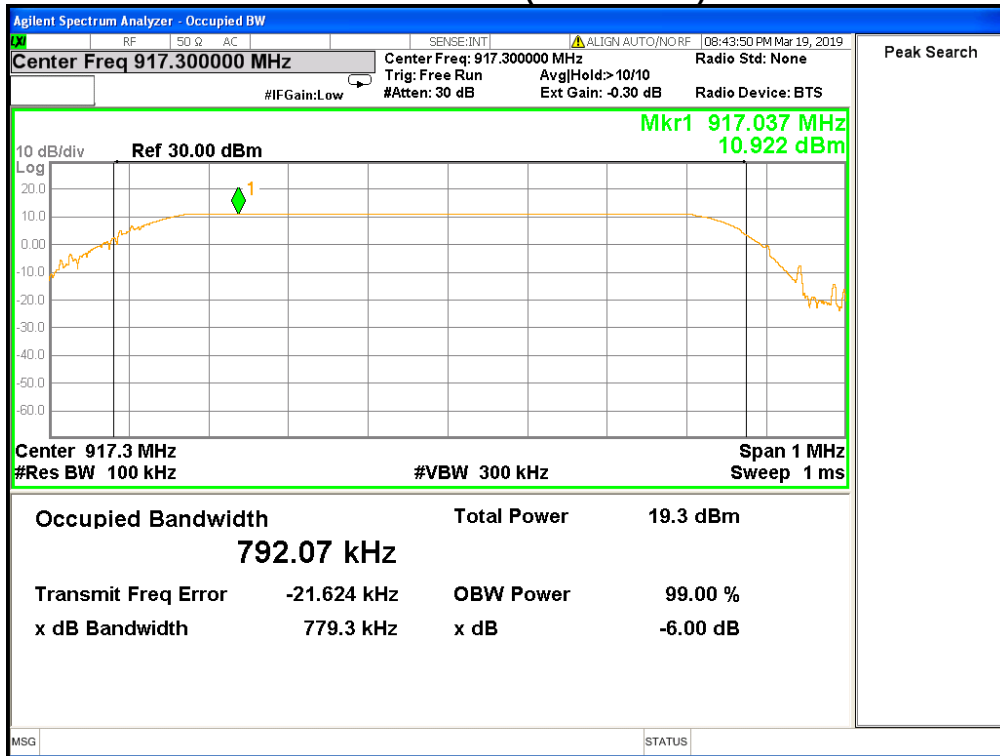
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Test Data :

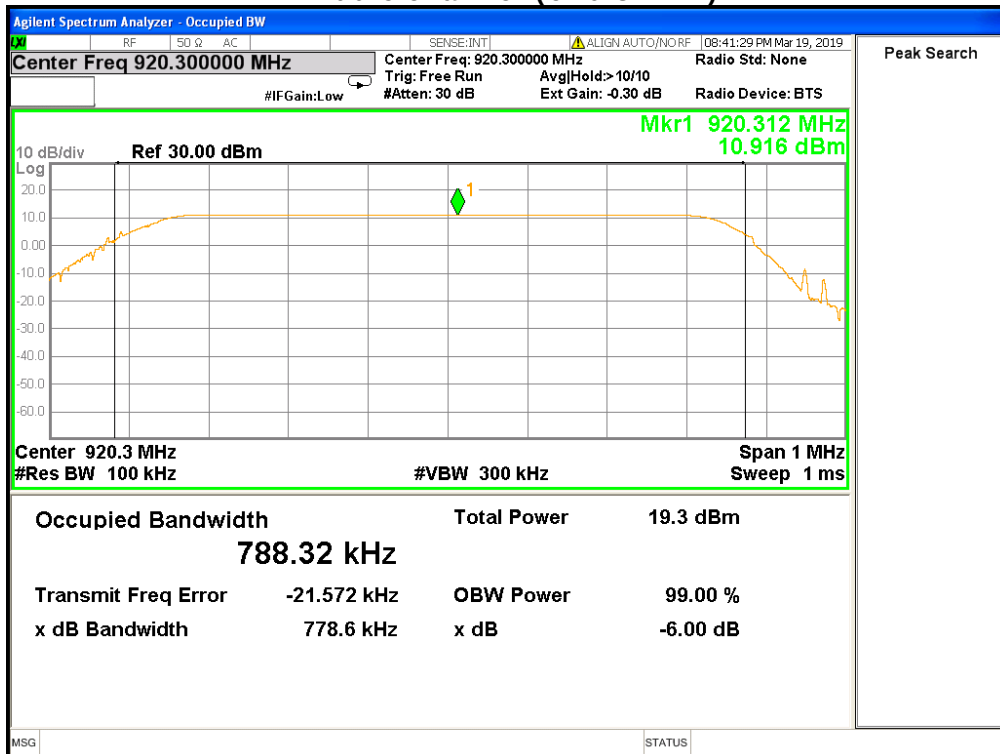
Channel	Frequency [MHz]	6 dB Bandwidth [MHz]	99 % Bandwidth [MHz]	Result
Low	917.3	0.779	0.792	Complies
Middle	920.3	0.779	0.788	
High	923.3	0.776	0.793	

See next pages for actual measured spectrum plots.

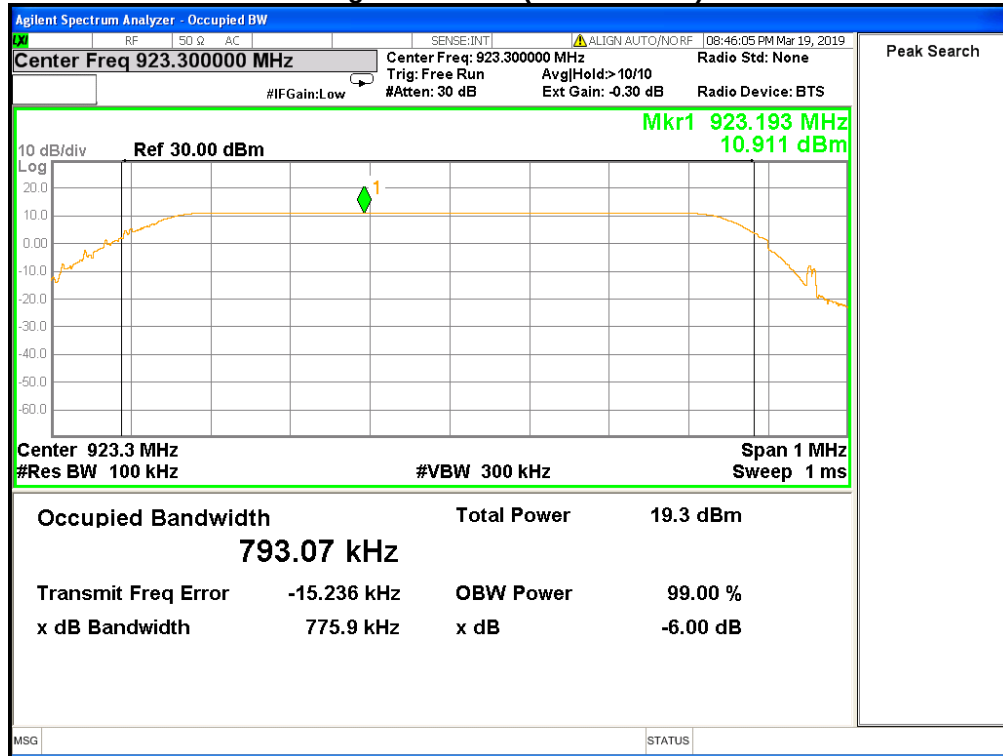
Low channel (917.3 MHz)



Middle channel (920.3 MHz)



High channel (923.3 MHz)



4.2 Maximum peak Conducted Output Power

Test Procedures(ANSI C63.10-2013 11.9.1)

The following procedure can be used when the maximum available RBW of the instrument is less than the DTS bandwidth:

Test Settings:

Center frequency = the highest, middle and the lowest channels

- a) $RBW \geq DTS \text{ Bandwidth}$
- b) $VBW \geq 3 \times RBW$
- c) $span \geq 3 \times RBW$
- d) Sweep time = auto couple
- e) Detector = peak
- f) Trace mode= max hold
- g) Allow trace to fully stabilize
- h) Use peak marker function to determine the peak amplitude level.

Limit :

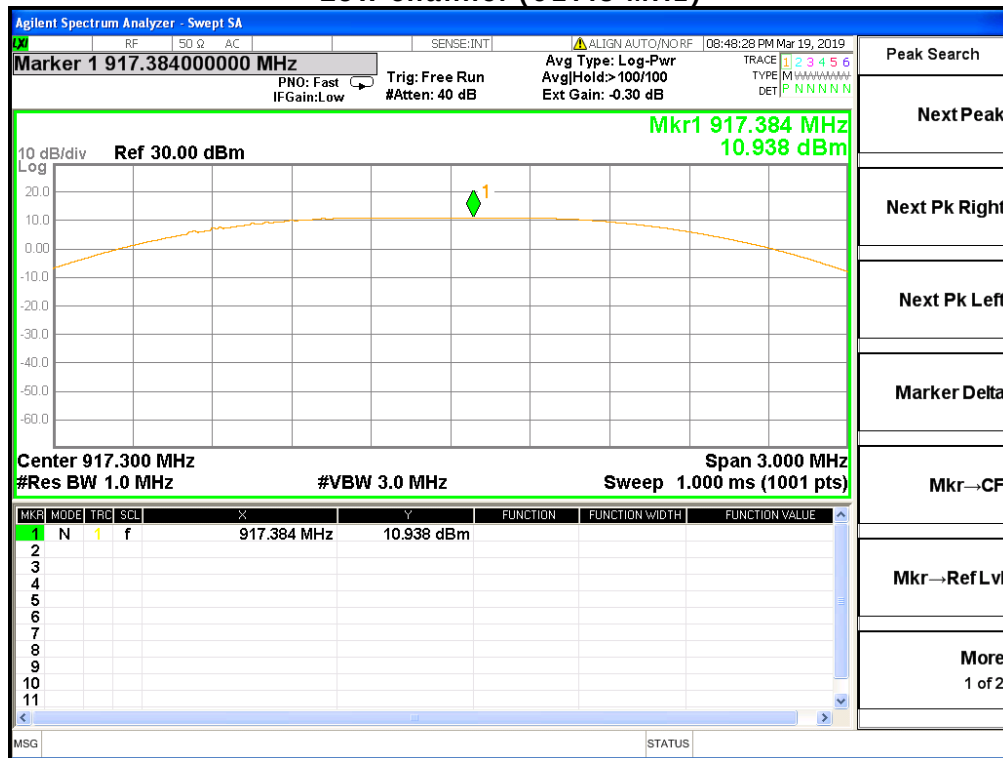
Maximum Output Power < 1 W (30 dBm)

Test Data :

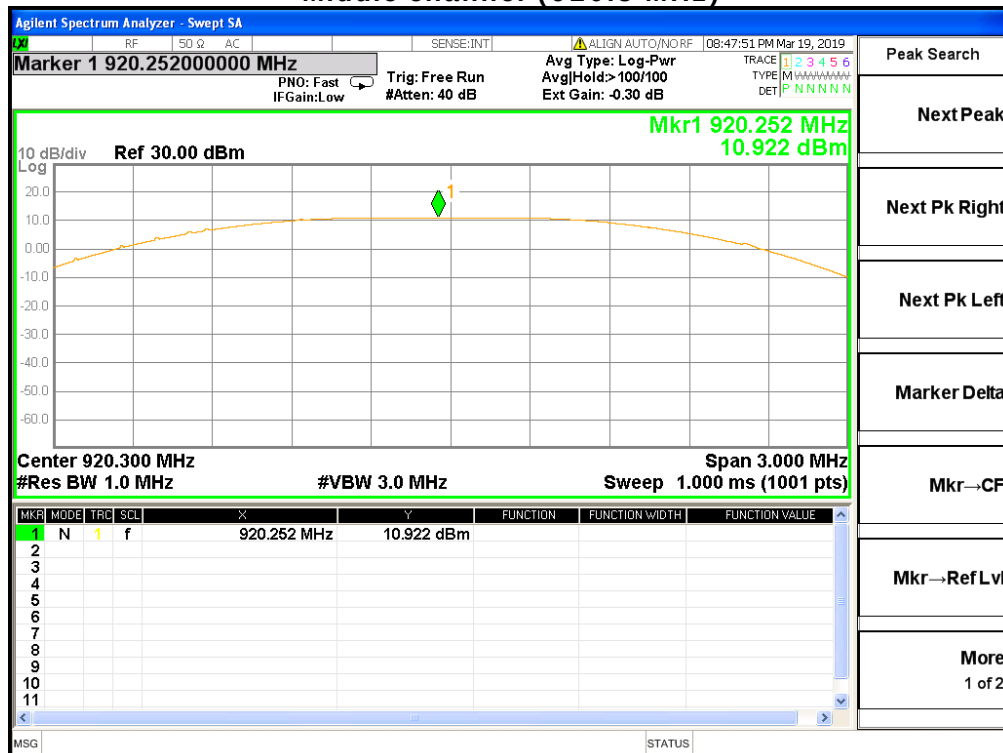
Channel	Frequency [MHz]	Measurement data [dBm]	Limit [dBm]	Result
Low	917.3	10.938	30	Complies
Middle	920.3	10.922	30	
High	923.3	10.907	30	

See next pages for actual measured spectrum plots.

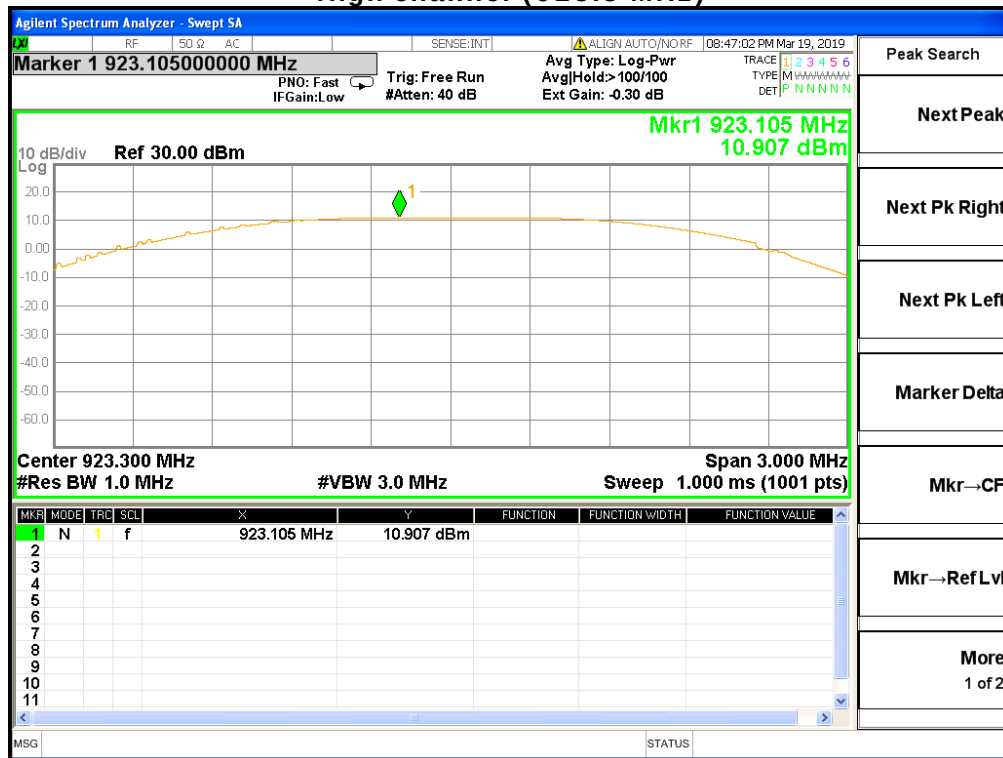
Low channel (917.3 MHz)



Middle channel (920.3 MHz)



High channel (923.3 MHz)



4.3 Power Spectral Density

Test Procedures(ANSI C63.10-2013 11.10.2)

This procedure shall be used if maximum peak conducted output power was used to demonstrate compliance.

Test Settings:

Center frequency = the highest, middle and the lowest channels

- a) RBW : $3 \text{ kHz} \leq \text{RBW} \leq 100 \text{ kHz}$
- b) VBW $\geq 3 \times \text{RBW}$
- c) span $\geq 1.5 \times \text{DTS bandwidth}$
- d) Sweep time = auto couple
- e) Detector = peak
- f) Trace mode= max hold
- g) Allow trace to fully stabilize
- h) Use the peak marker function to determine the maximum amplitude level within the RBW.

Limit :

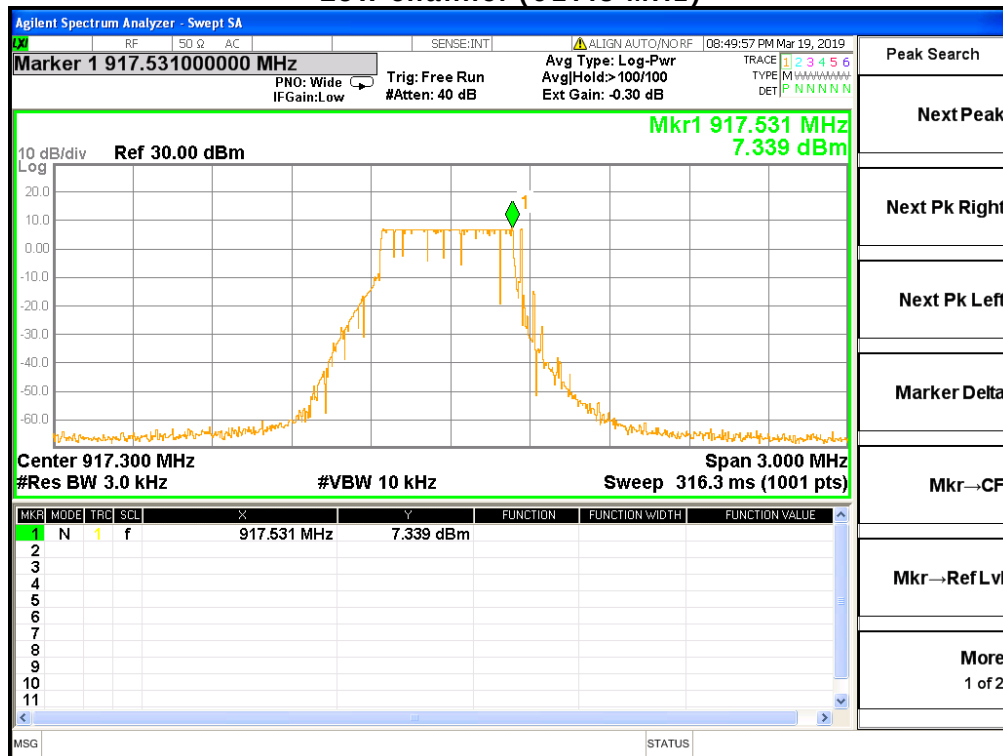
Power Spectral Density < 8 dBm @ 3 kHz BW

Test Data :

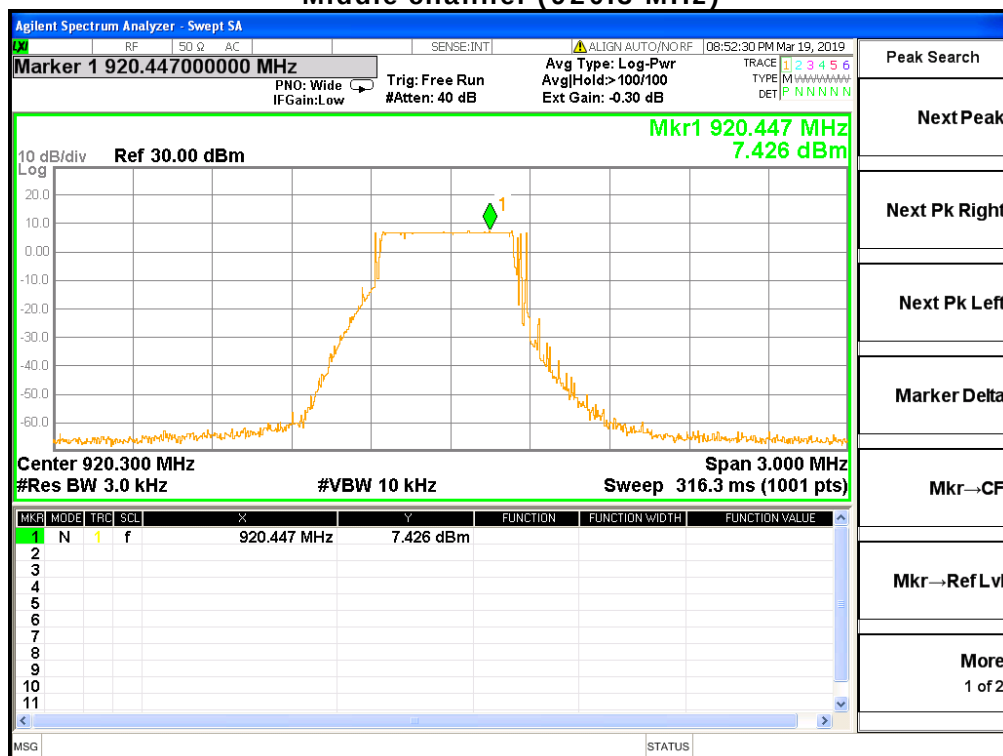
Channel	Frequency [MHz]	Measurement data [dBm]	Limit [dBm]	Result
Low	917.3	7.339	8	Complies
Middle	920.3	7.426		
High	923.3	7.462		

See next pages for actual measured spectrum plots.

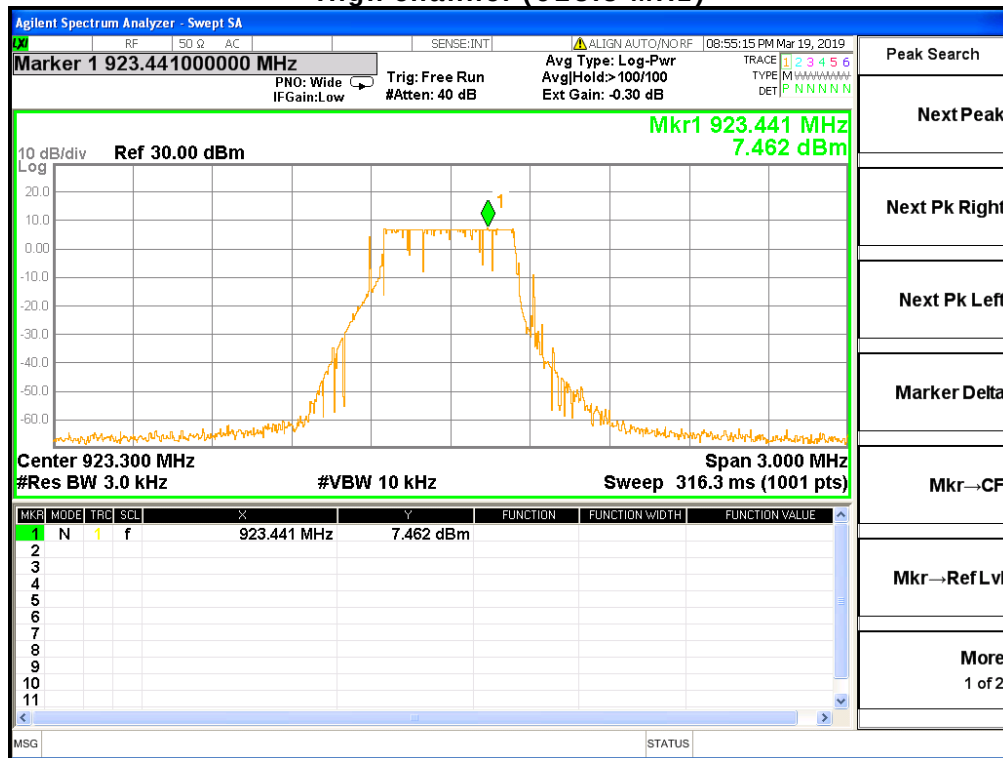
Low channel (917.3 MHz)



Middle channel (920.3 MHz)



High channel (923.3 MHz)



4.4 Band Edge & Conducted Spurious emission

Test Procedures(ANSI C63.10-2013 11.11.3)

The Unwanted emission from the EUT were measured according to the dictates PKPSD measurement procedure in section 11.11 of ANSI C63.10-2013.

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under Section 5.4(4), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

Test Settings:

Center frequency = the highest, middle and the lowest channels

- a) RBW = 100 kHz
- b) VBW $\geq 3 \times$ RBW
- c) Detector = peak
- d) Sweep time = auto couple
- e) Trace mode= max hold
- f) Allow trace to fully stabilize
- g) Use the peak marker function to determine the maximum amplitude level.

Limit :

Emission level < 20 dBc

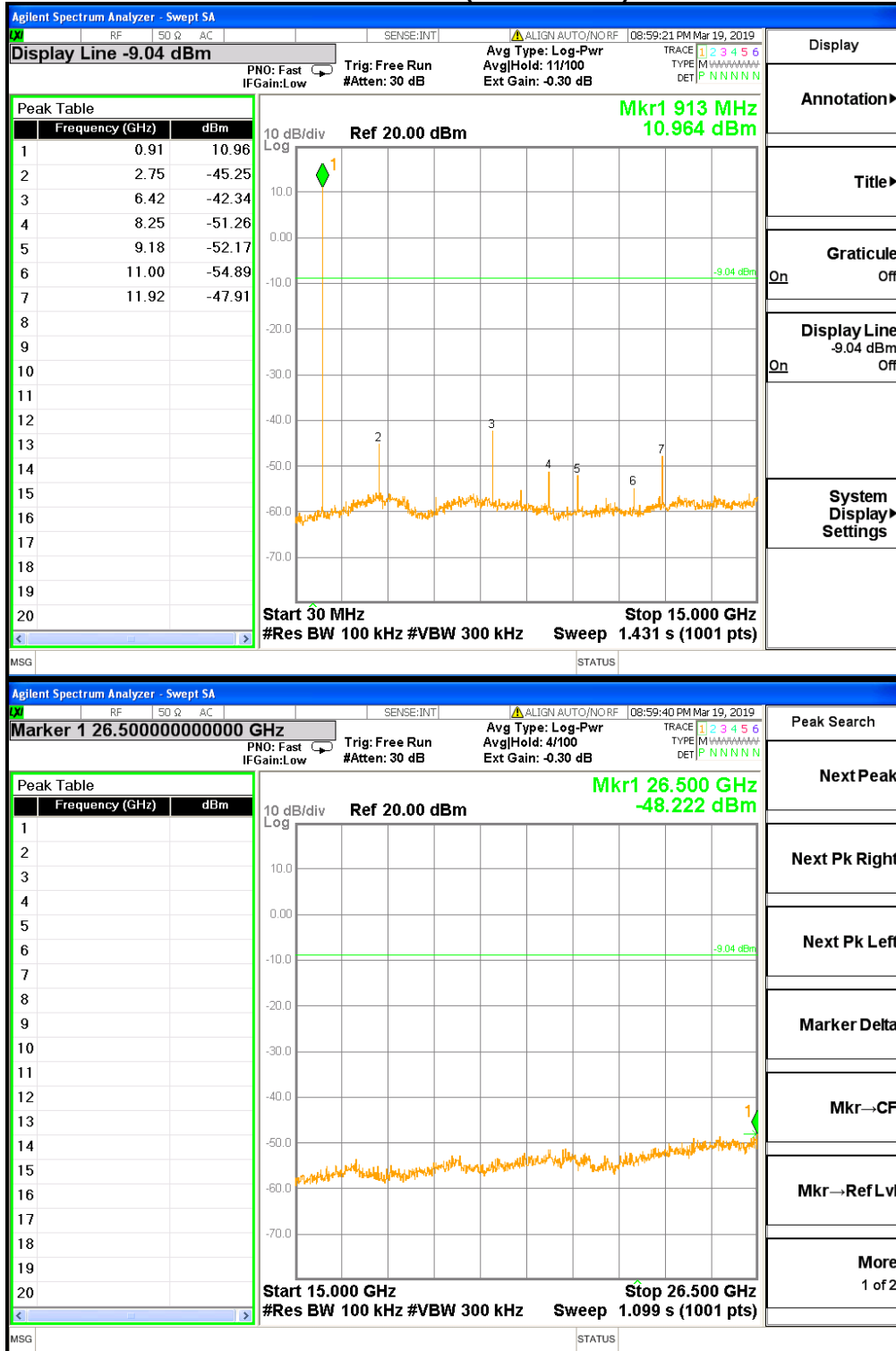
Test results: Complies

- All conducted emission in any 100kHz bandwidth outside of the spread spectrum band was at least 20dB lower than the highest in-band spectral density. Therefore the applying equipment meets the requirement.

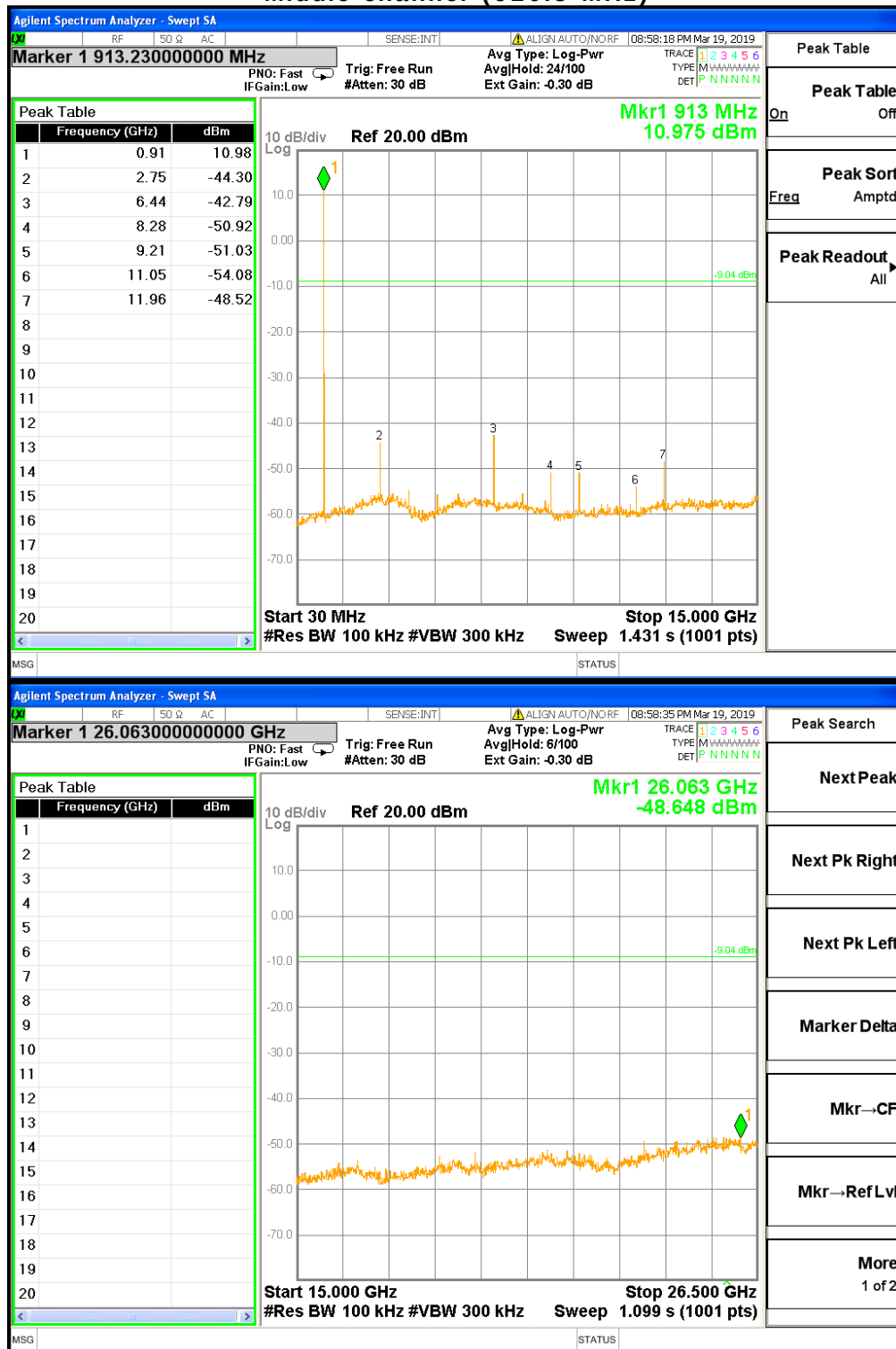
See next pages for actual measured spectrum plots.

Conducted Spurious emission

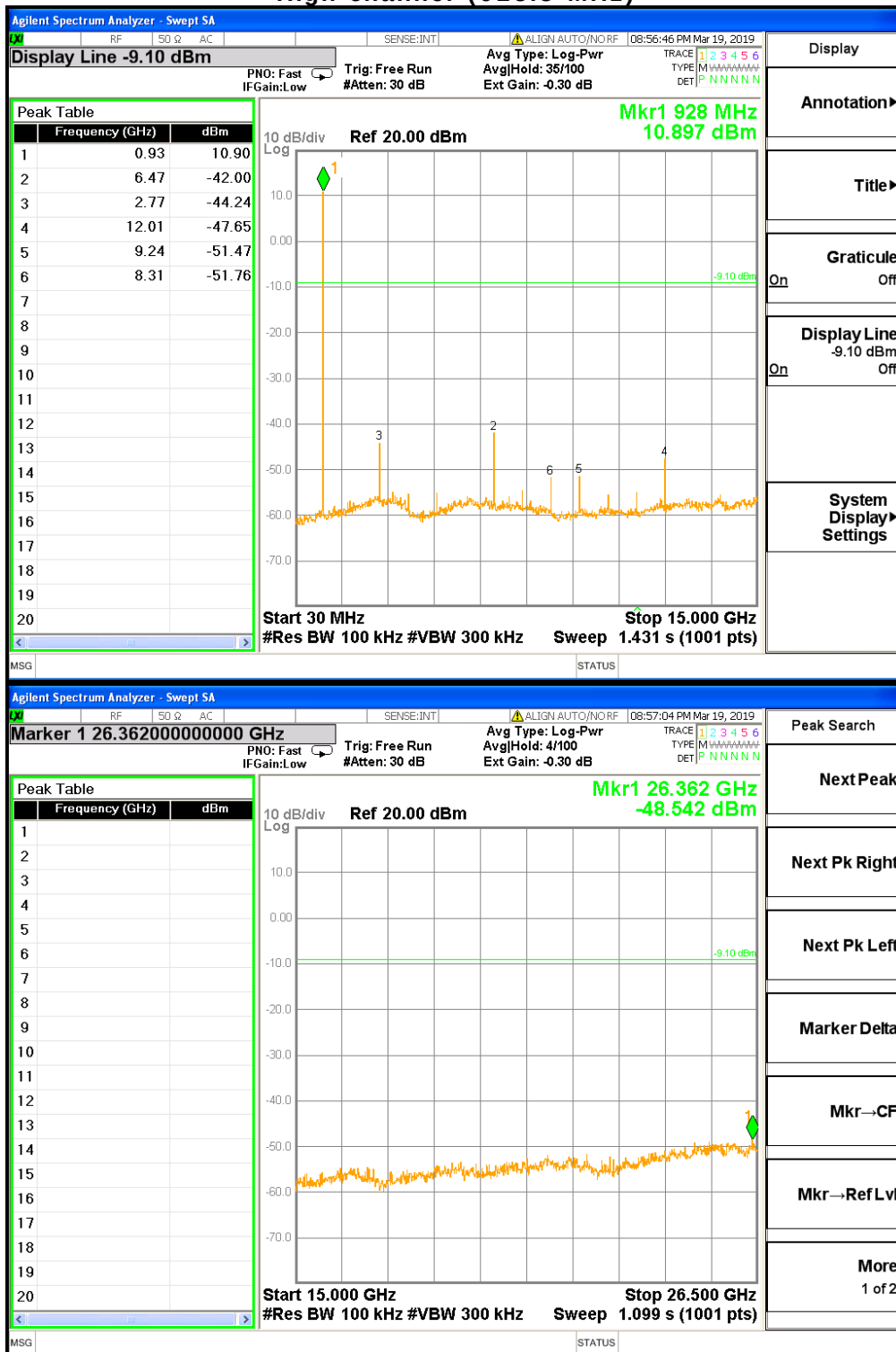
Low channel (917.3 MHz)



Middle channel (920.3 MHz)



High channel (923.3 MHz)



4.5 Radiated Emission

Test Location

- ☒ 10 m SAC (test distance : ☐ 10 m, ☒ 3 m)
☒ 3 m SAC (test distance : 3 m)

Test Procedures

- 1) In the frequency range of 9 kHz to 30 MHz, magnetic field is measured with Loop Antenna. The center of the Loop Test Antenna is 1m above the ground. During the measurement the Loop Test Antenna rotates about its vertical axis for maximum response at each azimuth about the EUT.
- 2) In the frequency range above 30 MHz, Bi-Log Test Antenna(30 MHz to 1 GHz) and Horn Test Antenna(above 1 GHz) are used. Test Antenna is 3m away from the EUT. Test Antenna height is carried from 1m to 4m above the ground to determine the maximum value of the field strength. The emissions levels at both horizontal and vertical polarizations should be tested.

Instrument Settings

Frequency Range = 9 kHz ~ 12.75 GHz (10th harmonic)

- a) RBW = 1 MHz for $f \geq 1$ GHz, 120 kHz for $f < 1$ GHz, 9 kHz for $f < 30$ MHz
- b) VBW $\geq$ RBW
- c) Sweep time = auto couple

Limit :

FCC Part 15 § 15.205 (a) Except as shown in paragraph (d) of this section, only spurious emissions are permitted in any of the frequency bands listed below:

Table 1. Restricted Frequency Bands

MHz	MHz	MHz	MHz	MHz	GHz
0.09-0.11	8.37626-8.38675	73-74.6	399.9-410	2690-2900	10.6-12.7
¹ 0.495-0.505	8.41425-8.41475	74.8-75.2	608-614	3260-3267	13.25-13.4
2.1735-2.1905	12.29-12.293	108-121.94	960-1240	3332-3339	14.47-14.5
4.125-4.128	12.51975-12.52025	123-138	1300-1427	3345.8-3358	15.35-16.2
4.17725-4.17775	12.57675-12.57725	149.9-150.05	1435-1626.5	3600-4400	17.7-21.4
4.20725-4.20775	13.36-13.41	156.52475-156.52525	1645.5-1646.5	4500-5150	22.01-23.12
6.215-6.218	16.42-16.423	156.7-156.9	1660-1710	5350-5460	23.6-24
6.26775-6.26825	16.69475-16.69525	162.0125-167.17	1718.8-1722.2	7250-7750	31.2-31.8
6.31175-6.31225	16.80425-16.80475	167.72-173.2	2200-2300	8025-8500	36.43-36.5
8.291-8.294	25.5-25.67	240-285	2310-2390	9000-9200	² Above 38.6
8.362-8.366	37.5-38.25	322-335.4	2483.5-2500	9300-9500	

¹ Until February 1, 1999, this restricted band shall be 0.490-0.510 MHz.

² Above 38.6

§ 15.205 (b) Except as provided in paragraphs (d) and (e), the field strength of emissions appearing within these frequency bands shall not exceed the limits shown in Section 15.209. At frequencies equal to or less than 1000 MHz, compliance with the limits in Section 15.209 shall be demonstrated using measurement instrumentation employing a CISPR quasi-peak detector. Above 1000 MHz, compliance with the emission limits in Section 15.209 shall be demonstrated based on the average value of the measured emissions. The provisions in Section 15.35 apply to these measurements.

FCC Part 15 § 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 :

Table 2. General Field Strength Limits for Licence-Exempt Transmitters

Frequency(MHz)	Field Strength uV/m@3m	Field Strength dBuV/m@3m	Measurement Distance (meters)
0.009-0.490	2400/F(kHz)	-	300
0.490-1.705	24000/F(kHz)	-	30
1.705-30	30	-	30
30-88	100**	40	3
88-216	150**	43.5	3
216-960	200**	46	3
Above 960	500	54	3

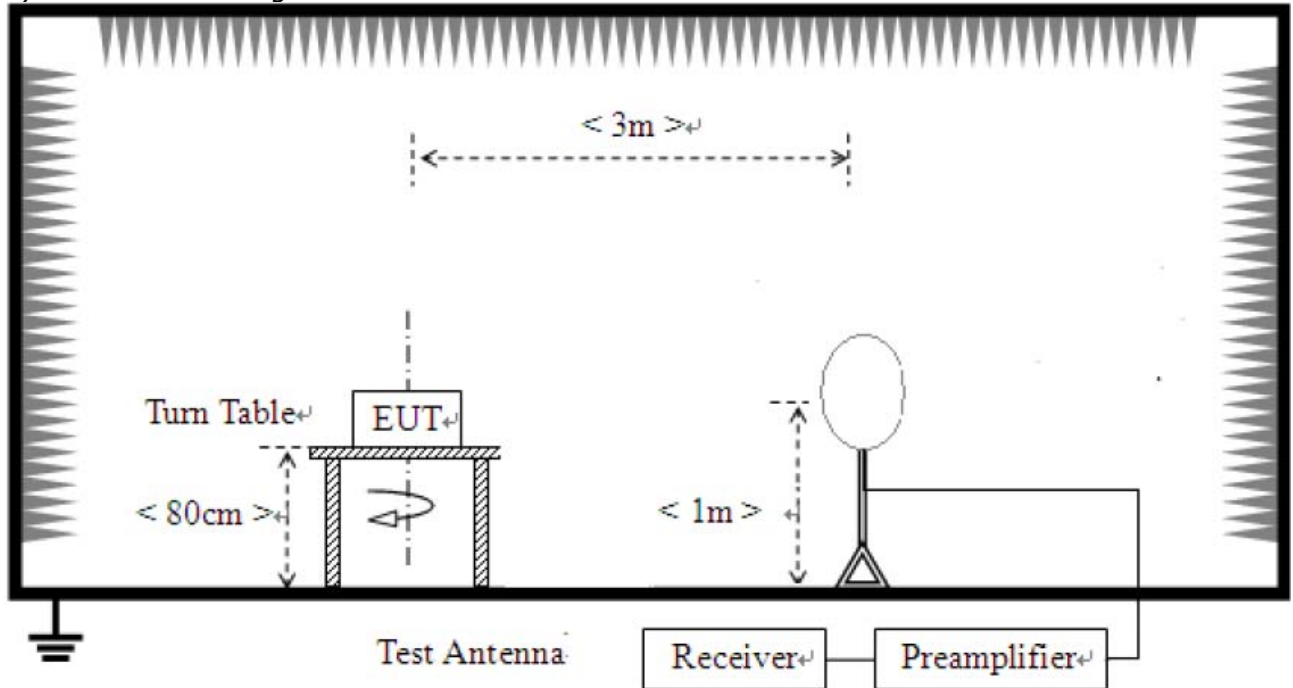
** Except as provided in 15.209(g).fundamental emissions from intentional radiators operating under this Section shall not be located in the frequency bands 54-72MHz, 76-88MHz, 174-216MHz, 470-806MHz. However, operation within these frequency bands is permitted under other sections of this Part, e.g.15.231 and 15.241.

Note :

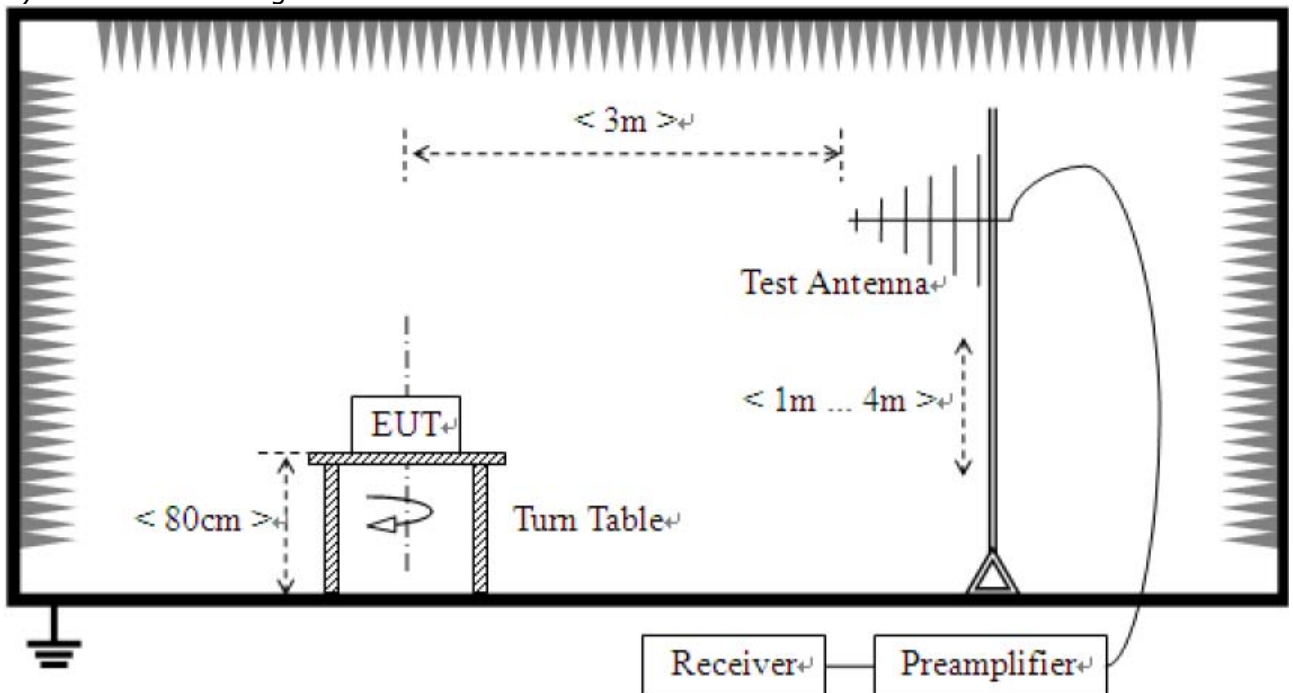
- 1) For above 1 GHz, the emission limit in this paragraph is based on measurement instrumentation employing an average detector, measurement using instrumentation with a peak detector function, corresponding to 20 dB above the maximum permitted average limit.
- 2) For above 1 GHz, limit field strength of harmonics : 54 dBuV/m@3m (AV) and 74 dBuV/m@3m (PK)
- 3) For measurement above 1GHz, the resolution bandwidth is set to 1 MHz and video bandwidth is set to 3 MHz for peak measurement.

Test Setup:

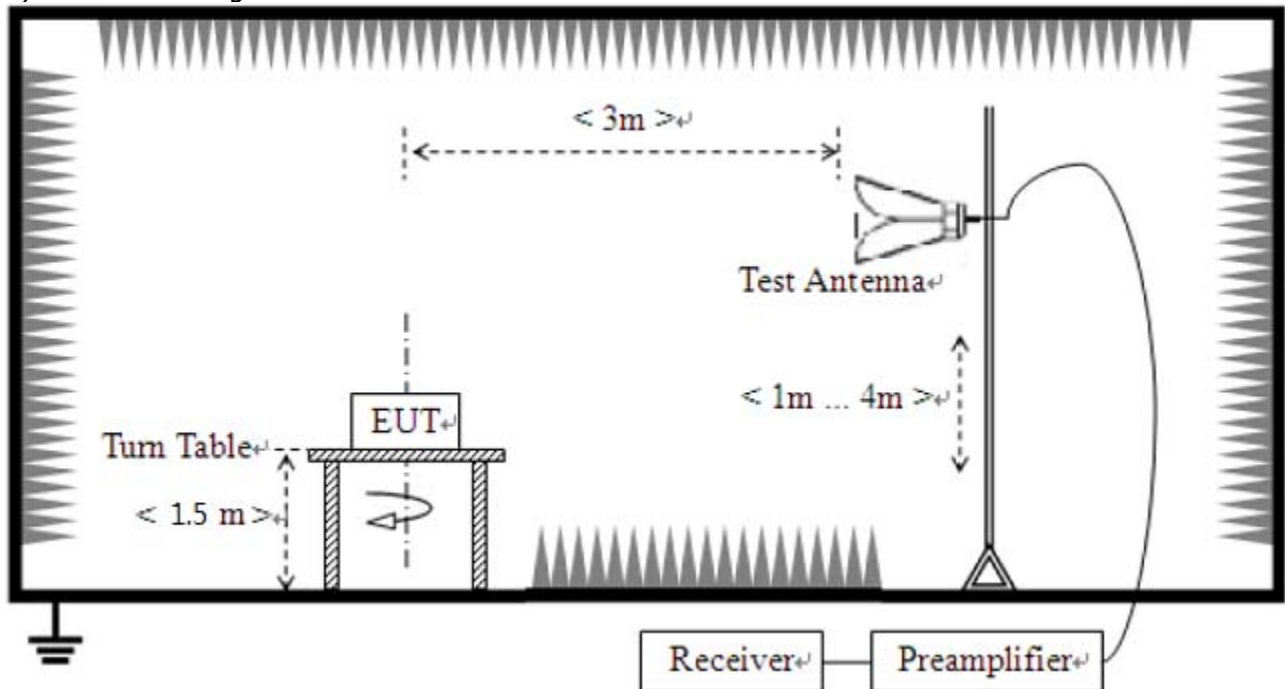
- 1) For field strength of emissions from 9 kHz to 30 MHz



- 2) For field strength of emissions from 30 MHz to 1 GHz



3) For field strength of emissions above 1 GHz



Test results

1) 9 kHz to 30 MHz

The requirements are:

☒ Complies

Frequency (MHz)	Measured Data (dBuV/m)	Margin (dB)	Remark
-	-	-	See note

Note :

The amplitude of spurious emissions that are attenuated by more than 20 dB below the permissible value has no need to be reported.

Distance extrapolation factor = $40 \log (\text{specific distance} / \text{test distance})$ (dB)

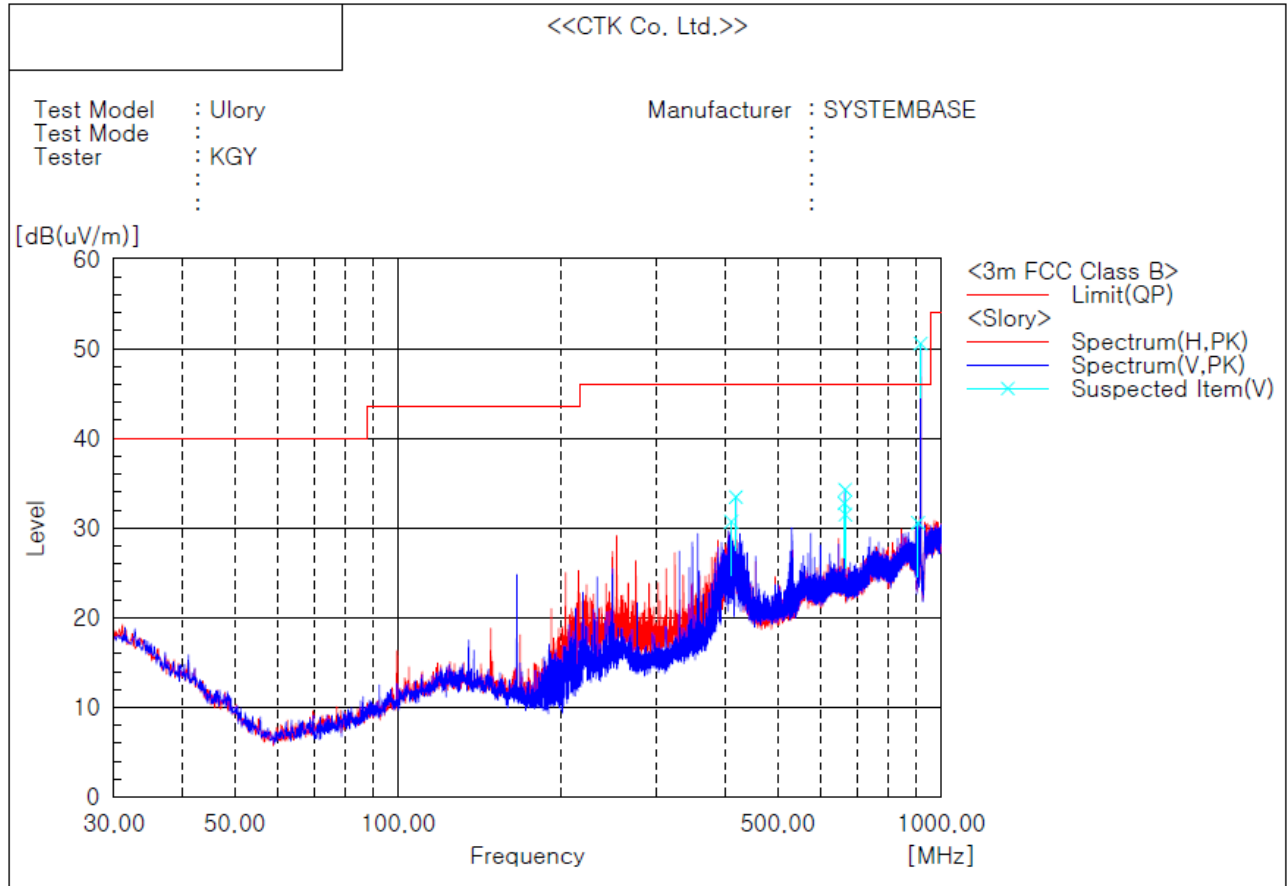
2) 30 MHz to 1 GHz

Test mode : Low Channel(Worst case)

The requirements are:

☒ Complies

Test Data



Spectrum Selection

No.	Frequency [MHz]	(P)	Reading [dB(uV)]	c.f [dB(1/m)]	Result PK [dB(uV/m)]	Limit QP [dB(uV/m)]	Margin QP [dB]	Height [cm]	Angle [deg]
1	411.089	V	35.3	-4.6	30.7	46.0	15.3	101.0	145.0
2	419.091	V	37.7	-4.3	33.4	46.0	12.6	101.0	145.0
3	664.016	V	32.2	0.6	32.8	46.0	13.2	101.0	40.0
4	665.714	V	33.8	0.5	34.3	46.0	11.7	101.0	303.0
5	666.684	V	31.0	0.5	31.5	46.0	14.5	200.0	83.0
6	906.880	V	25.2	5.4	30.6	46.0	15.4	399.0	0.0
7	917.550	V	44.6	5.9	50.5	46.0	-4.5	101.0	303.0

Remark :

1. The Unwanted emission was measured in the following position: EUT stand-up position(Z axis), lie-down position(X,Y axis). The worst emission was found in stand-up position(Z axis) and the worst case was recorded.
2. Result = Reading + c.f(Correction factor)
3. Correction factor = Antenna factor + Cable loss + 6 dB attenuator - Amp Gain
4. This data is the Peak(PK) value.
5. No.7(Vertical Polarization) are the carrier frequencies.

3) 1 GHz to 12.75 GHz

The requirements are:

☒ Complies

Test Data

Channel	Frequency [MHz]	Ant. Pol. (V/H)	Reading [dBuV/m]	c.f [dB/m]	Result [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Remark
Low	5 504.88	H	45.70	3.4	49.10	54	4.90	Peak
	5 504.88	V	48.50	3.4	51.90	54	2.10	Peak
Middle	5 522.02	H	44.00	3.5	47.50	54	6.50	Peak
	5 520.70	V	45.70	3.5	49.20	54	4.80	Peak
High	5 984.90	H	41.90	5.5	47.40	54	6.60	Peak
	5 537.85	V	45.30	3.6	48.90	54	5.10	Peak

Remarks

1. The Unwanted emission was measured in the following position: EUT stand-up position(Z axis), lie-down position(X,Y axis). The worst emission was found in stand-up position(Z axis) and the worst case was recorded.
2. Result = Reading + c.f(correction factor)
3. Correction factor = Antenna factor + Cable loss - Amp Gain
4. The peak value is lower than the average limit value. (Peak < 54 dBuV/m)

4.6 AC Conducted Emissions

A radio apparatus that is designed to be connected to the public utility (AC) power line shall ensure that the radio frequency voltage, which is conducted back onto the AC power line on any frequency or frequencies within the band 150 kHz-30 MHz, shall not exceed the limits.

Instrument Settings

IF Band Width: 9 kHz

Test Procedures

The EUT was placed on a non-metallic table 0.8m above the metallic, grounded floor and 0.4m from the reference ground plane wall. The distance to other metallic surfaces was at least 0.8m.

Amplitude measurements were performed with a quasi-peak detector and an average detector.

Limit

Frequency (MHz)	Conducted Limit (dBuV)	
	Quasi-peak	Average **
0.15 ~ 0.5	66 to 56*	56 to 46*
0.5 ~ 5	56	46
5 ~ 30	60	50

* The level decreases linearly with the logarithm of the frequency.

** A linear average detector is required.

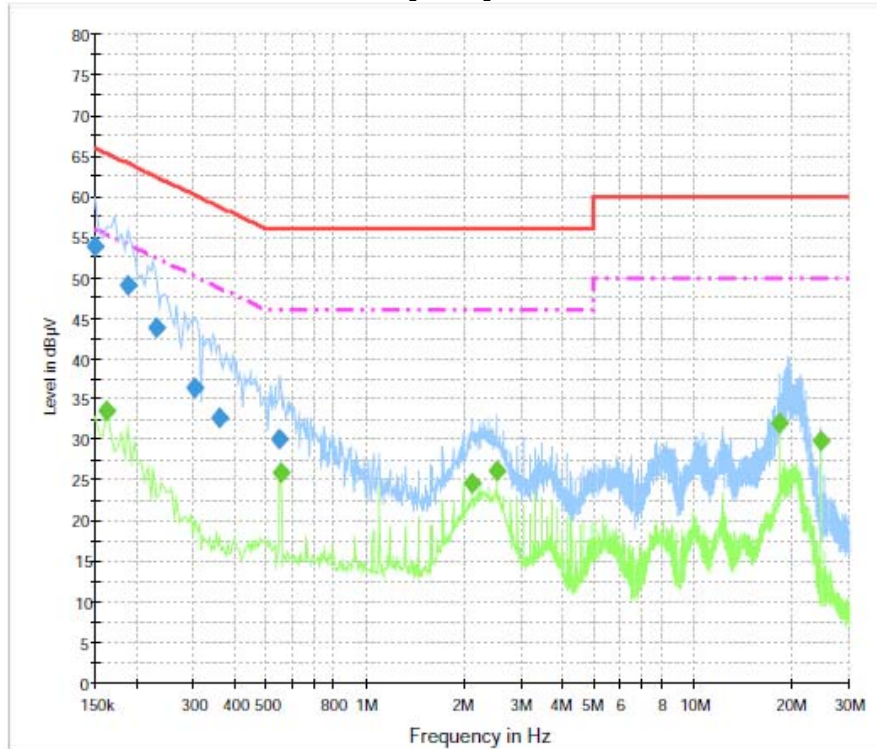
Test Results

The requirements are:

☒ Complies

Test Data

[LINE]



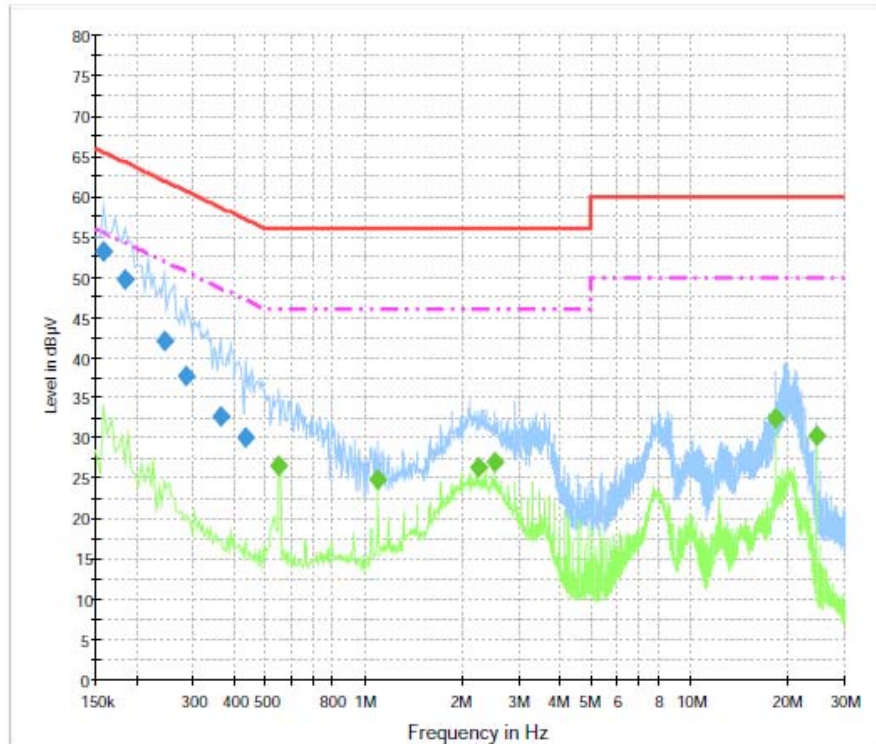
Final Result 1

Frequency (MHz)	QuasiPeak (dBμV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBμV)
0.150000	53.8	1000.0	9.000	On	L1	10.0	12.2	66.0
0.190500	49.0	1000.0	9.000	On	L1	10.2	15.0	64.0
0.231000	43.9	1000.0	9.000	On	L1	10.0	18.5	62.4
0.303000	36.5	1000.0	9.000	On	L1	10.0	23.6	60.2
0.361500	32.8	1000.0	9.000	On	L1	10.1	25.9	58.7
0.550500	30.0	1000.0	9.000	On	L1	10.1	26.0	56.0

Final Result 2

Frequency (MHz)	CAverage (dBμV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBμV)
0.163500	33.6	1000.0	9.000	On	L1	10.2	21.7	55.3
0.555000	26.0	1000.0	9.000	On	L1	10.1	20.0	46.0
2.125500	24.6	1000.0	9.000	On	L1	10.0	21.4	46.0
2.521500	26.1	1000.0	9.000	On	L1	10.0	19.9	46.0
18.433500	32.1	1000.0	9.000	On	L1	10.1	17.9	50.0
24.576000	29.9	1000.0	9.000	On	L1	10.2	20.1	50.0

[NEUTRAL]



Final Result 1

Frequency (MHz)	QuasiPeak (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.159000	53.2	1000.0	9.000	On	N	10.5	12.3	65.5
0.186000	49.6	1000.0	9.000	On	N	10.5	14.6	64.2
0.244500	42.0	1000.0	9.000	On	N	10.2	20.0	61.9
0.285000	37.8	1000.0	9.000	On	N	10.3	22.9	60.7
0.366000	32.6	1000.0	9.000	On	N	10.5	26.0	58.6
0.433500	30.0	1000.0	9.000	On	N	10.5	27.1	57.2

Final Result 2

Frequency (MHz)	CAverage (dBµV)	Meas. Time (ms)	Bandwidth (kHz)	Filter	Line	Corr. (dB)	Margin (dB)	Limit (dBµV)
0.550500	26.7	1000.0	9.000	On	N	10.5	19.3	46.0
1.104000	24.8	1000.0	9.000	On	N	10.3	21.2	46.0
2.256000	26.5	1000.0	9.000	On	N	10.3	19.6	46.0
2.521500	27.0	1000.0	9.000	On	N	10.3	19.0	46.0
18.433500	32.5	1000.0	9.000	On	N	10.5	17.5	50.0
24.576000	30.3	1000.0	9.000	On	N	10.6	19.7	50.0

APPENDIX A – Test Equipment Used For Tests

	Name of Equipment	Manufacturer	Model No.	Serial No.	Cal Date	Due Date
1	Signal Analyzer	Rohde & Schwarz	FSV40	101574	2019-01-28	2020-01-28
2	Signal Generator	Rohde & Schwarz	SMB100A	175528	2018-10-24	2019-10-24
3	EMI Test Receiver	Rohde & Schwarz	ESCI7	100814	2018-10-25	2019-10-25
4	Bilog Antenna	Schaffner	CBL6111C	2551	2018-05-10	2020-05-10
5	Active Loop Antenna	SCHWARZBECK	FMZB 1513	1513-125	2018-05-02	2020-05-02
6	6dB Attenuator	Rohde & Schwarz	DNF	272.4110.50-2	2018-10-25	2019-10-25
7	AMPLIFIER	SONOMA	310	291721	2019-01-28	2020-01-28
8	Preamplifier	Agilent	8449B	3008A02011	2018-12-03	2019-12-03
9	EMI Test Receiver	Rohde & Schwarz	ESU40	100336	2019-01-29	2020-01-29
10	Preamplifier	Agilent	8449B	3008A02011	2018-12-03	2019-12-03
11	Horn Antenna	ETS-Lindgren	3117	00154525	2017-09-14	2019-09-14
12	Signal Analyzer	Agilent	N9020A	MY50510324	2019-01-28	2020-01-28
13	Band Reject Filter	FILTRON	R16025FL	1604001S-6	2018-10-24	2019-10-24
14	LISN	Rohde & Schwarz	ENV216	101760	2019-01-29	2020-01-29
15	EMI Test Receiver	Rohde & Schwarz	ESU40	100336	2019-01-29	2020-01-29