FCC / IC RF REPORT

Certification

Applicant Name:
Eko Devices, Inc.

Address:
2600 10th St. Ste 260
Berkeley, CA 94710, USA

Date of Issue:
November 11, 2019

Test Site/Location:
EMCE Engineering
1726 Ringwood Avenue San Jose, California USA

Report No.: EMCE-R-1911-002

FCC ID:	**2ANB3-E6**
IC:	**23063-E6**
APPLICANT:	**Eko Devices, Inc.**

Model:	E6
EUT Type:	Electronic Stethoscope System
RF Peak Output Power:	4.88 dBm (3.08 mW)
Frequency Range:	2402 MHz -2480 MHz
Modulation Type	GFSK
FCC Classification:	Digital Transmission System (DTS)
FCC Rule Part(s):	Part 15.247
IC Rule Part(s):	RSS-247 Issue 2 (February 2017), RSS-Gen Issue 5(April 2018)

Engineering Statement:

The measurements shown in this report were made in accordance with the procedures indicated, and the emissions from this equipment were found to be within the limits applicable. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them.

Steve In
Test Engineer
Certification Division

Sunwoo Kim
Technical Manager
Certification Division

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Report History

TEST REPORT NO.	DATE	DESCRIPTION
EMCE-R-1911-002	November 11, 2019	Initial Release

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EMCE Engineering, Inc., 1726 Ringwood Avenue, San Jose, CA 95131, USA
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1. EUT DESCRIPTION

Model	E6
EUT Type	Electronic Stethoscope System
Power Supply	DC 3.7 V
Frequency Range	2402 MHz - 2480 MHz
Max. RF Output Power	Peak : 4.88 dBm (3.08 mW)
Modulation Type	GFSK (1 Mbit/s; 2 Mbit/s)
Number of Channels	40 Channels
Antenna Specification	Antenna Type: PCB Inverted-F antenna Peak Gain: Max +1.6 dBi
Firmware Version	1.0.3
Hardware Version	E6
Date(s) of Tests	October 25, 2019 ~ November 01, 2019

* Firmware& Hardware Version and Antenna Specification are as received by the client.

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2. METHODOLOGY

FCC KDB 558074 D01 DTS Measurement Guidance v05r02 dated April 2nd, 2019 entitled "Guidance for Performing Compliance Measurements on Digital Transmission Systems(DTS) and the measurement procedure described in ANSI C63.10(Version : 2013) 'the American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices'.

EUT CONFIGURATION

The EUT configuration for testing is installed on RF field strength measurement to meet the Commissions requirement and operating in a manner that intends to maximize its emission characteristics in a continuous normal application.

EUT EXERCISE

The EUT was operated in the engineering mode to fix the Tx frequency that was for the purpose of the measurements. According to its specifications, the EUT must comply with the requirements of the Section 15.207, 15.209 and 15.247 under the FCC Rules Part 15 Subpart C / the RSS-GEN issue 5, RSS-247 issue 2.

GENERAL TEST PROCEDURES

Conducted Emissions

The EUT is placed on the turntable, which is 0.8 m above ground plane. According to the requirements in Section 6.2 of ANSI C63.10. (Version :2013) Conducted emissions from the EUT measured in the frequency range between 0.15 MHz and 30MHz using CISPR Quasi-peak and average detector modes.

Radiated Emissions

The EUT is placed on a turn table, which is 0.8 m above ground plane below 1GHz. Above 1GHz with 1.5m using absorbers between the EUT and receive antenna. The turntable shall rotate 360 degrees to determine the position of maximum emission level. EUT is set 3.75 m away from the receiving antenna, which varied from 1 m to 4 m to find out the highest emission. Also, each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical. In order to find out the max. emission, the relative positions of this hand-held transmitter (EUT) was rotated through three orthogonal axes according to the requirements in Section 8 of ANSI C63.10. (Version: 2013)

Conducted Antenna Terminal

KDB 558074 v05r02

DESCRIPTION OF TEST MODES

The EUT has been tested under BLE Test mode operating condition.

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3. INSTRUMENT CALIBRATION

The measuring equipment, which was utilized in performing the tests documented herein, has been calibrated in accordance with the manufacturer's recommendations for utilizing calibration equipment's, which is traceable to recognized national standards.
Especially, all antenna for measurement is calibrated in accordance with the requirements of C63.5 (Version : 2017).

4. FACILITIES AND ACCREDITATIONS

FACILITIES

The SAC (Semi-Anechoic Chamber) and conducted measurement facility used to collect the radiated data are located at 1726 Ringwood Avenue, San Jose, California 95131, USA.
The site is constructed in conformance with the requirements of ANSI C63.4. (Version :2014) and CISPR Publication 22.

EQUIPMENT

Radiated emissions are measured with one or more of the following types of Linearly polarized antennas: tuned dipole, bi-conical, log periodic, bi-log, and/or ridged waveguide, horn. Spectrum analyzers with pre-selectors and quasi-peak detectors are used to perform radiated measurements.
Conducted emissions are measured with Line Impedance Stabilization Networks and EMI Test Receivers. Calibrated wideband preamplifiers, coaxial cables, and coaxial attenuators are also used for making measurements.
All receiving equipment conforms to CISPR Publication 16-1, "Radio Interference Measuring Apparatus and Measurement Methods."

5. ANTENNA REQUIREMENTS

According to FCC 47 CFR §15.203:

"An intentional radiator antenna shall be designed to ensure that no antenna other than that furnished by the responsible party can be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section."

* The antennas of this E.U.T are permanently attached.
* The E.U.T Complies with the requirement of §15.203

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6. MEASUREMENT UNCERTAINTY

The measurement uncertainties shown below were calculated in accordance with the requirements of ANSI C63.10-2013.

All measurement uncertainty values are shown with a coverage factor of k = 2 to indicate a 95 % level of confidence.

The measurement data shown herein meets or exceeds the U_{CISPR} measurement uncertainty values specified in CISPR 16-4-2 and, thus, can be compared directly to specified limits to determine compliance.

Parameter	Expanded Uncertainty (±dB)
Conducted Disturbance (150 kHz ~ 30 MHz)	2.55
Radiated Disturbance (9 kHz ~ 30 MHz)	3.20
Radiated Disturbance (30 MHz ~ 1 GHz)	4.73
Radiated Disturbance (1 GHz ~ 18 GHz)	5.21
Radiated Disturbance (18 GHz ~ 40 GHz)	5.18

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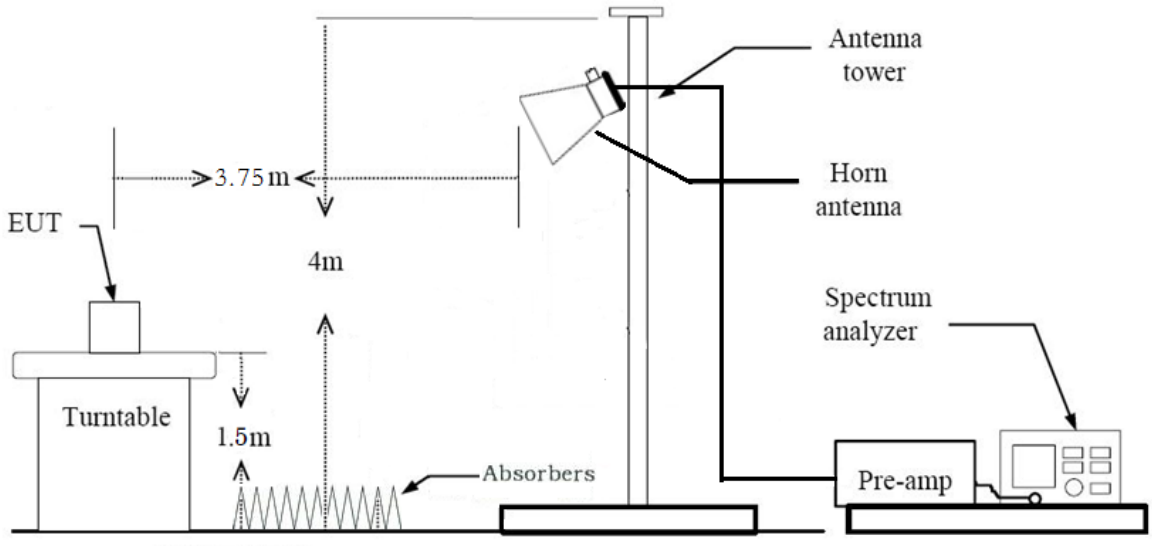
7. DESCRIPTION OF TESTS

7.1. Duty Cycle

TestConfiguration



Test Procedure

The transmitter output is connected to the Spectrum Analyzer.

We tested according to the zero-span measurement method, 6 (b) in KDB 558074 D01 v05r02.

The largest available value of RBW is 8 MHz and VBW is 50 MHz.

The zero-span method of measuring duty cycle shall not be used if T ≤ 6.25 microseconds. (50/6.25 = 8)

The zero-span method was used because all measured T data are > 6.25 microseconds and both RBW and VBW are > 50/*T*.

1. RBW = 8 MHz (the largest available value)
2. VBW = 8 MHz (≥ RBW)
3. SPAN = 0 Hz
4. Detector = Peak
5. Number of points in sweep > 100
6. Trace mode = Clear write
7. Measure T_{total} and T_{on}
8. Calculate Duty Cycle = T_{on}/ T_{total} and Duty Cycle Factor = 10*log(1/Duty Cycle)

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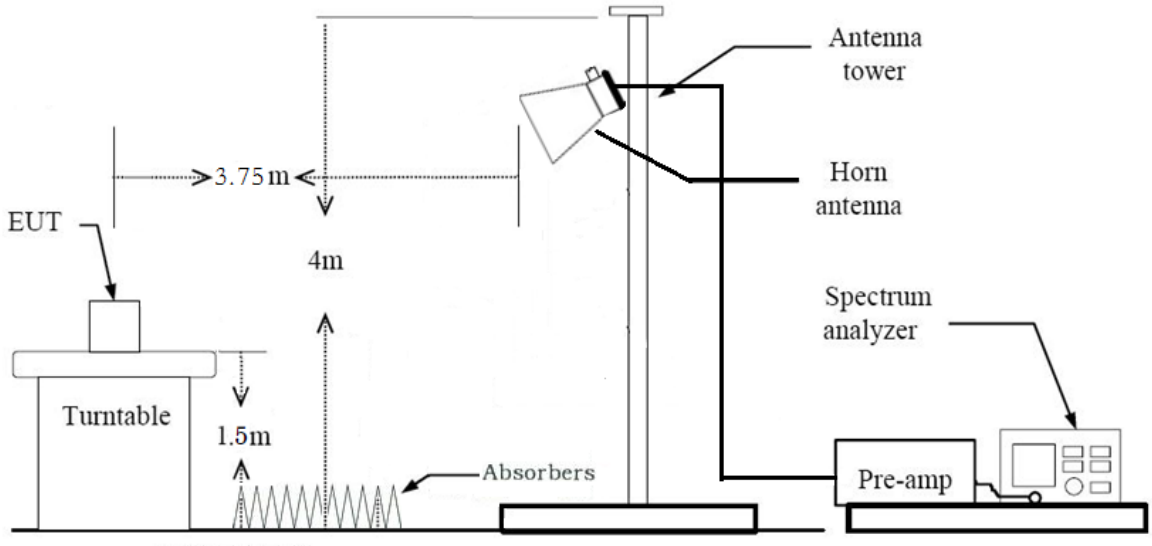
7.2. 6 dB Bandwidth & 99% BANDWIDTH

Limit

Test Requirements and limit, §15.247(a)(2) / RSS-247(Issue 2) Section 5.2.

The minimum permissible 6 dB bandwidth is 500 kHz.

TestConfiguration



Test Procedure

The transmitter output is connected to the Spectrum Analyzer.

The Spectrum Analyzer is set to (Procedure 8.2 in KDB 558074 v05r02,

Procedure 11.8.1 in ANSI 63.10-2013)

1) RBW = 100 kHz
2) VBW ≥ 3 x RBW
3) Detector = Peak
4) Trace mode = max hold
5) Sweep = auto couple
6) Allow the trace to stabilize
7) We tested 6 dB bandwidth using the automatic bandwidth measurement capability of a spectrum analyzer. X dB is set 6 dB.

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Test Procedure (99 % Bandwidth for IC)

The transmitter output is connected to the spectrum analyzer.

RBW = 1% ~ 5% of the occupied bandwidth

VBW ≒ 3 x RBW

Detector = Peak

Trace mode = max hold

Sweep = auto couple

Allow the trace to stabilize

Note : We tested OBW using the automatic bandwidth measurement capability of a spectrum analyzer.

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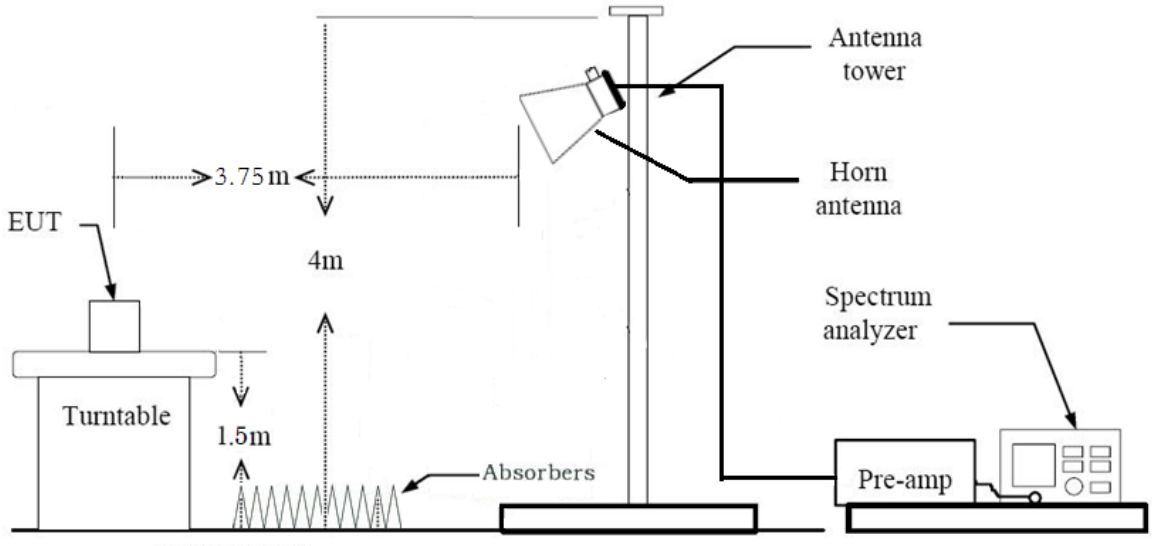
7.3. Output Power

Limit

Test Requirements and limit, §15.247(b)(3) / RSS-247(Issue2) Section 5.4.4.

The maximum permissible output power is 1 Watt.

Test Configuration



Test Procedure

TX condition of the EUT is the actual operating mode by BT LE test program.

The Spectrum Analyzer is set to

- Peak Power (Section 8.3.1.1 in KDB 558074 D01 v05r02, Subclause 11.9.1.1 in ANSI 63.10-2013)
  1) RBW ≥ DTS Bandwidth
  2) VBW ≥ 3 x RBW
  3) SPAN ≥ 3 x RBW
  4) Detector Mode = Peak
  5) Sweep = auto couple
  6) Trace Mode = max hold
  7) Allow trace to fully stabilize.
  8) Use peak marker function to determine the peak amplitude level

Sample Calculation

- The formula in 11.12.2.2 e) in [1] was used to calculate the EIRP power:

  $E = EIRP - 20\log(d) + 104.8$

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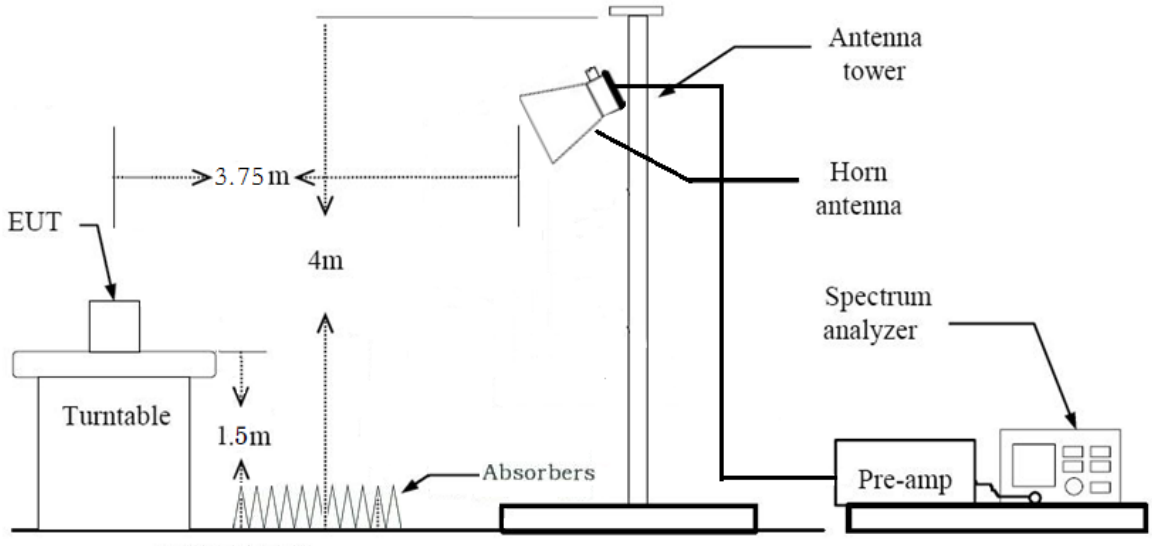
7.4. Power Spectral Density

Limit

Test Requirements and limit, §15.247(e) / RSS-247(Issue 2) Section 5.2.

The transmitter power density average over 1-second interval shall not be greater than 8dBm in any 3kHz BW.

TestConfiguration



Test Procedure

We tested according to Procedure 8.4 in KDB 558074 v05r02, Procedure 11.10 in ANSI 63.10-2013.

The spectrum analyzer is set to :

1) Set analyzer center frequency to DTS channel center frequency.
2) Set span to at least 1.5 times the OBW.
3) RBW = 3 kHz ≤ RBW ≤ 100 kHz.
4) VBW ≥ 3 x RBW.
5) Sweep = auto couple
6) Detector = power averaging (rms) or sample detector (when rms not available).
7) Ensure that the number of measurement points in the sweep ≥[2 ×span / RBW].
8) Employ trace averaging (rms) modeover a minimum of 100 traces
9) Use the peak marker function to determine the maximum amplitude level.
10) Use the peak marker function to determine the maximum amplitude level within the RBW.
    If measured value exceeds limit, reduce RBW (no less than 3 kHz) and repeat.
11) if then duty factor shall be added to adjust the result if the duty cycle is less than 98%

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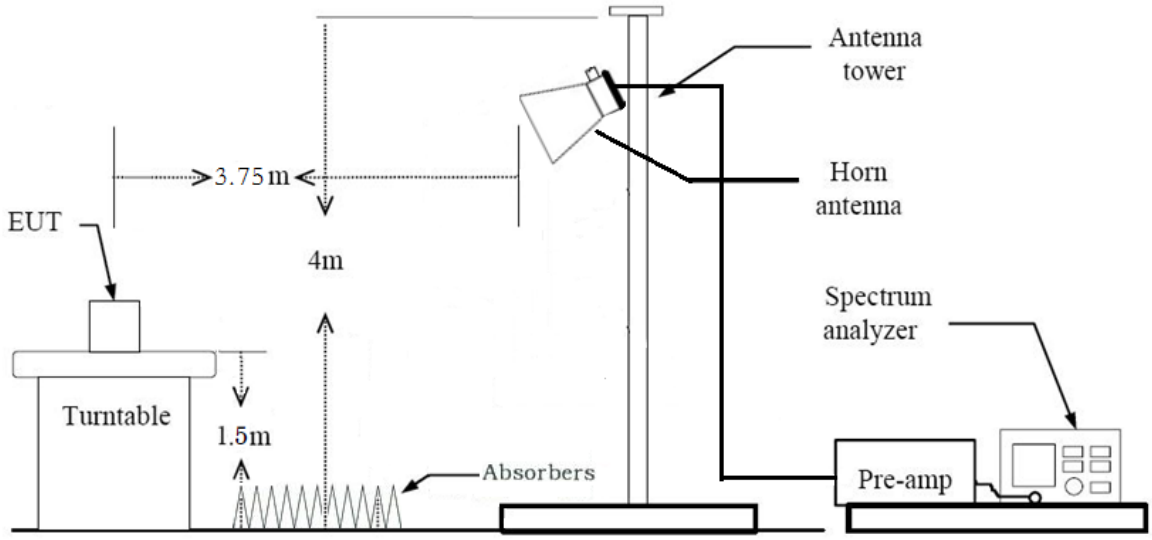
7.5. Band Edge (Out of Band Emissions)

Limit

Test Requirements and limit, §15.247(d) / RSS-247(Issue 2) Section 5.5.

The maximum conducted (average) output power was used to demonstrate compliance, then the peak power in any 100 kHz bandwidth outside of the authorized frequency band shall be attenuated by at least 30 dB relative to the maximum in-band peak PSD level in 100 kHz. [Conducted > 30 dBc]

TestConfiguration



Test Procedure

The transmitter output is connected to the spectrum analyzer.

(Procedure 8.5 in KDB 558074 v05r02, Procedure 11.11 in ANSI 63.10-2013)

1) RBW = 100 kHz
2) VBW ≥ 3 x RBW
3) Set span to encompass the spectrum to be examined
4) Detector = Peak
5) Trace Mode = max hold
6) Sweep time = auto couple
7) Ensure that the number of measurement points ≥ 2*Span/RBW
8) Allow trace to fully stabilize.
9) Use peak marker function to determine the maximum amplitude level.

Measurements are made over the 30 MHz to 25 GHz range with the transmitter set to the lowest, middle, and highest channels.

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7.6. Radiated Test

Limit

FCC

Frequency (MHz)	Field Strength (uV/m)	Measurement Distance (m)
0.009 – 0.490	2400/F(kHz)	300
0.490 – 1.705	24000/F(kHz)	30
1.705 – 30	30	30

IC

Frequency (MHz)	Field Strength (uA/m)	Measurement Distance (m)
0.009 – 0.490	6.37/F(kHz)	300
0.490 – 1.705	63.7/F(kHz)	30
1.705 – 30	0.08	30

FCC & IC

Frequency (MHz)	Field Strength (uV/m)	Measurement Distance (m)
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

Receiver Spurious Emissions

Frequency (MHz)	Field Strength (uV/m)	Measurement Distance (m)
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

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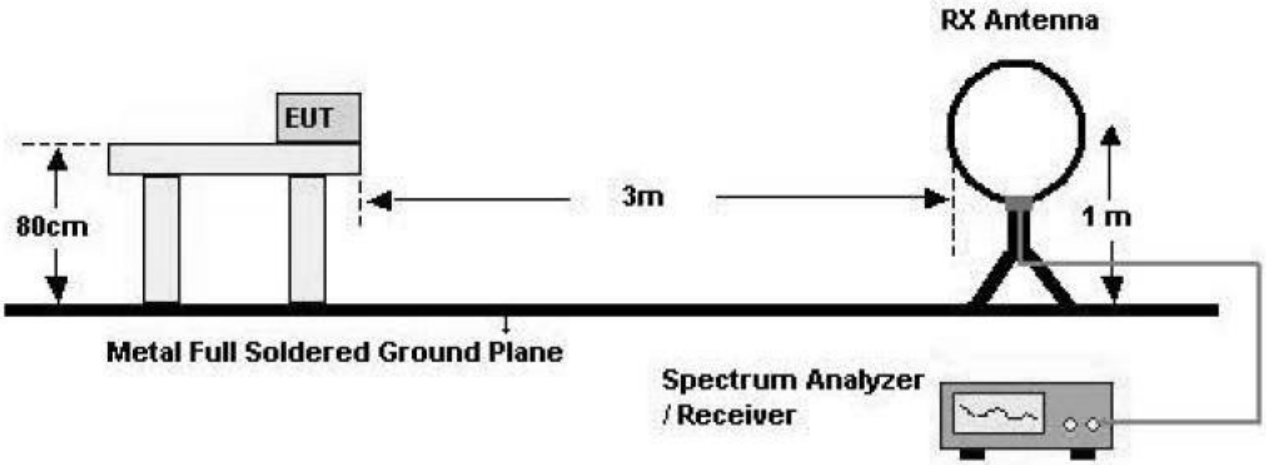
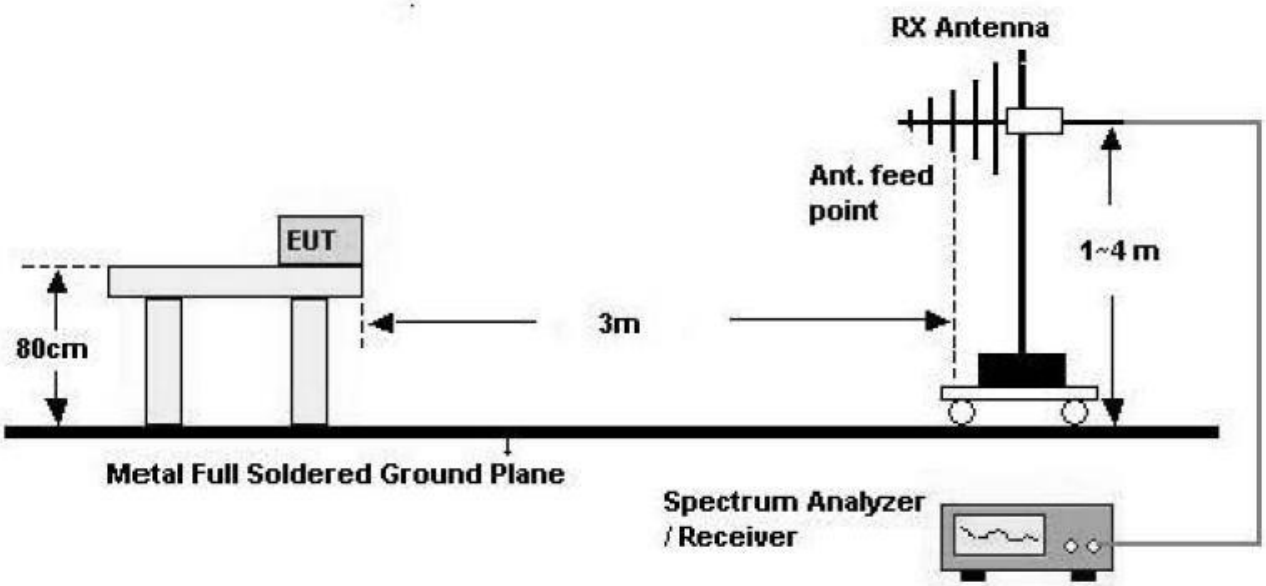
Test Configuration

Below 30 MHz



30 MHz - 1 GHz



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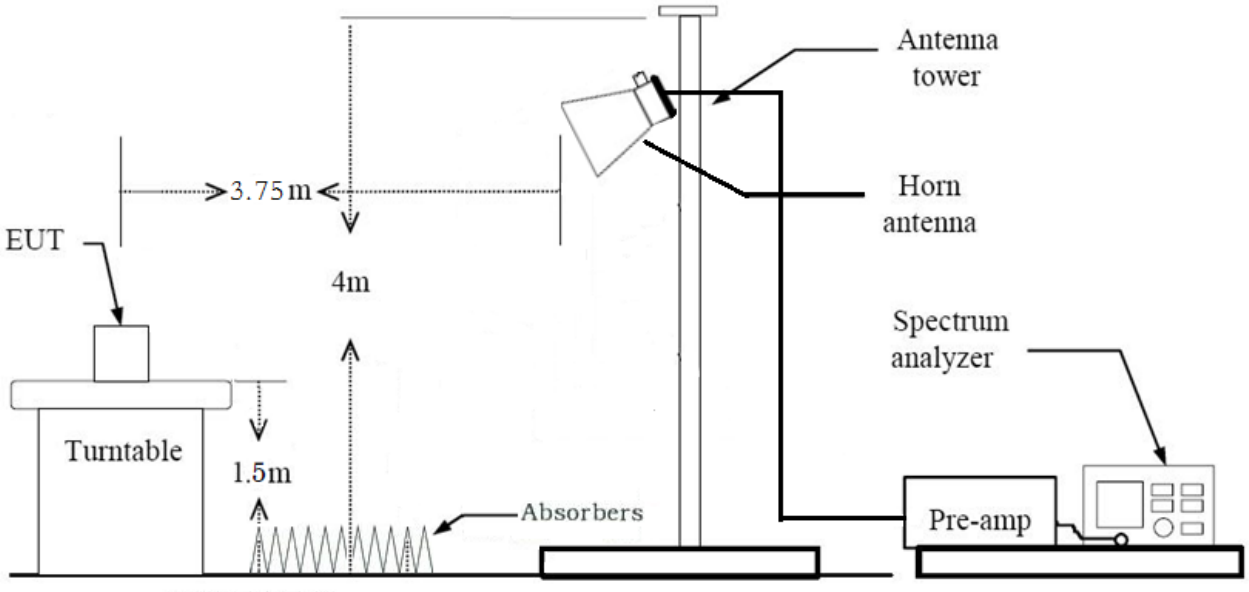
Above 1 GHz



Test Procedure of Radiated spurious emissions (Below 30 MHz)

1. The EUT was placed on a non-conductive table located on semi-anechoic chamber.
2. The loop antenna was placed at a location 3m from the EUT
3. The EUT is placed on a turntable, which is 0.8m above ground plane.
4. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.
5. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
6. Distance Correction Factor (0.009 MHz – 0.490 MHz) = 40*log(3 m/300 m) = - 80 dB

   Measurement Distance: 3 m
7. Distance Correction Factor (0.490 MHz – 30 MHz) = 40*log(3 m/30 m) = - 40 dB

   Measurement Distance: 3 m
8. Spectrum Setting
   - Frequency Range = 9 kHz ~ 30 MHz
   - Detector = Peak
   - Trace = Maxhold
   - RBW = 9 kHz
   - VBW ≥ 3*RBW
9. Total = Reading Value + Antenna Factor (A.F) + Cable Loss (C.L) + Distance Factor (D.F)

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10. Although these tests were performed at a test site other than an open field site, adequate comparison measurements were confirmed against an open field site. Therefore, sufficient test were made to demonstrate that the alternative site produces Result that correlate with the one of test made in an open field site based on KDB 414788

Sample validation

Reference-signal Frequency [kHz]	Reading [dBuV]	Measurement Distance [m]	Extrapolation Factor	Total [dBuV/m]
135	70.1	3	80.0	-9.9
135	47.4	10	59.1	-11.7

Test Procedure of Radiated spurious emissions (Below 1GHz)

1. The EUT was placed on a non-conductive table located on semi-anechoic chamber.
2. The EUT is placed on a turntable, which is 0.8m above ground plane.
3. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.
4. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
5. Spectrum Setting
   (1) Measurement Type (Peak):
      - Measured Frequency Range: 30 MHz – 1 GHz
      - Detector = Peak
      - Trace = Maxhold
      - RBW = 100 kHz
      - VBW ≥ 3*RBW
   (2) Measurement Type(Quasi-peak):
      - Measured Frequency Range: 30 MHz – 1 GHz
      - Detector = Quasi-Peak
      - RBW = 120 kHz
   *In general, (1) is used mainly
6. Total = Reading Value + Antenna Factor (A.F) + Cable Loss (C.L)

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Test Procedure of Radiated spurious emissions (Above 1 GHz)

1. Radiated test is performed with hopping off.
2. The EUT is placed on a turntable, which is 1.5 m above ground plane.
3. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.
4. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
5. EUT is set 3.75 m away from the receiving antenna, which is varied from 1m to 4m to find out the highest emissions.
6. According to SVSWR requirement in ANSI 63.4-2014, We performed the radiated test at 3.75 m distance from center of turn table. So, we applied the distance factor(reference distance : 3 m).
   *Distance extrapolation factor = 20*log (test distance / specific distance) (dB)
7. Maximum procedure was performed on the six highest emissions to ensure EUT compliance.
8. Each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
9. The unit was tested with its standard battery.
10. Spectrum Setting
    (1) Measurement Type(Peak):
        - Measured Frequency Range : 1 GHz – 25 GHz
        - Detector = Peak
        - Trace = Maxhold
        - RBW = 1 MHz
        - VBW ≥ 3*RBW
    (2) Measurement Type(Average):
        - We performed using a reduced video BW method was done with the analyzer in linear mode
        - Measured Frequency Range : 1 GHz – 25 GHz
        - Detector = Peak
        - Trace = Maxhold
        - RBW = 1 MHz
        - VBW ≥ 1/τ Hz, where τ = pulse width in seconds
          The actual setting value of VBW = 1 kHz
11. Measurement value only up to 6 maximum emissions noted, or would be lesser if no specific emissions from the EUT are recorded (ie: margin > 20 dB from the applicable limit) and considered that's already beyond the background noise floor.
12. Total = Reading Value + Antenna Factor(A.F) + Cable Loss(C.L) - Amp Gain(G) + Distance Factor(D.F)

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Test Procedure of Radiated Restricted Band Edge

1. Radiated test is performed with hopping off.
2. The EUT is placed on a turntable, which is 1.5 m above ground plane.
3. We have done x, y, z planes in EUT and horizontal and vertical polarization in detecting antenna.
4. The turntable shall be rotated for 360 degrees to determine the position of maximum emission level.
5. EUT is set 3.75 m away from the receiving antenna, which is varied from 1m to 4m to find out the highest emissions.
6. According to SVSWR requirement in ANSI 63.4-2014, We performed the radiated test at 3.75 m distance from center of turn table. So, we applied the distance factor(reference distance : 3 m).
   *Distance extrapolation factor = 20*log (test distance / specific distance) (dB)
7. Each emission was to be maximized by changing the polarization of receiving antenna both horizontal and vertical.
8. The unit was tested with its standard battery.
9. Spectrum Setting
   (1) Measurement Type(Peak):
      - Detector = Peak
      - Trace = Maxhold
      - RBW = 1 MHz
      - VBW ≥ 3*RBW
   (2) Measurement Type(Average):
      - We performed using a reduced video BW method was done with the analyzer in linear mode
      - Detector = Peak
      - Trace = Maxhold
      - RBW = 1 MHz
      - VBW ≥ 1/τ Hz, where τ = pulse width in seconds
        The actual setting value of VBW = 1 kHz

10. Total

= Reading Value + Antenna Factor (A.F) + Cable Loss (C.L) + Distance Factor (D.F)

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7.7. AC Power line Conducted Emissions

Limit

For an intentional radiator that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 µH/50 ohms line impedance stabilization network (LISN).

Frequency Range (MHz)	Limits (dBµV)	
	Quasi-peak	Average
0.15 to 0.50	66 to 56*	56 to 46*
0.50 to 5	56	46
5 to 30	60	50

*Decreases with the logarithm of the frequency.

Compliance with this provision shall be based on the measurement of the radio frequency voltage between each power line (LINE and NEUTRAL) and ground at the power terminals.

Test Configuration

See test photographs attached in Annex A for the actual connections between EUT and support equipment.

Test Procedure

1. The EUT is placed on a wooden table 80 cm above the reference ground plane.
2. The EUT is connected via LISN to a test power supply.
3. The measurement results are obtained as described below:
4. Detectors : Quasi Peak and Average Detector.

Sample Calculation

Quasi-peak(Final Result) = Reading Value + Correction Factor

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7.8. Worst case configuration and mode

Radiated test

1. All modes of operation were investigated and the worst case configuration results are reported.
   - Mode: Stand alone mode, Charging mode
   - Worst case: Charging mode
2. EUT Axis
   - Radiated Spurious Emissions: X
   - Radiated Restricted Band Edge: X
3. All packet length of operation were investigated and the test results are worst case in highest packet length.

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8. SUMMARY TEST OF RESULTS

Test Description	FCC Part Section(s)	IC Part Section(s)	Test Limit	Test Condition	Test Result
6 dB Bandwidth	§15.247(a)(2)	RSS-247, 5.2.(a)	> 500 kHz	Radiated	PASS
Occupied Bandwidth	N/A	RSS-GEN, 6.7	N/A		PASS
Conducted Maximum Peak Output Power	§15.247(b)(3)	RSS-247, 5.4.(d)	< 1 Watt		N/A
Power Spectral Density	§15.247(e)	RSS-247, 5.2.(b)	< 8 dBm / 3 kHz Band		PASS
Band Edge (Out of Band Emissions)	§15.247(d)	RSS-247, 5.5	Conducted > 20 dBc		PASS
AC Power line Conducted Emissions	§15.207	RSS-GEN, 8.8	cf. Section 7.7		PASS
Radiated Spurious Emissions	§15.247(d), 15.205, 15.209	RSS-GEN, 8.9	cf. Section 7.6	Radiated	PASS
Radiated Restricted Band Edge	§15.247(d), 15.205, 15.209	RSS-GEN, 8.9 RSS-GEN, 8.10	cf. Section 7.6		PASS
Receiver Spurious Emissions	N/A	RSS-GEN, 7.3	cf. Section 7.8		PASS

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9. TEST RESULT

9.1 DUTY CYCLE

T_{on} (ms)	T_{total} (ms)	Duty Cycle	Duty Cycle Factor (dB)
1	1	1	0

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9.2 6 dB BANDWIDTH MEASUREMENT

1 Mbit/s

Channel	6 dB Bandwidth (kHz)	Limit (kHz)
	Result	
0	736.4	> 500
19	749.8	
39	746.8	

2 Mbit/s

Channel	6 dB Bandwidth (kHz)	Limit (kHz)
	Result	
0	1410.3	> 500
19	1411.0	
39	1402.2	

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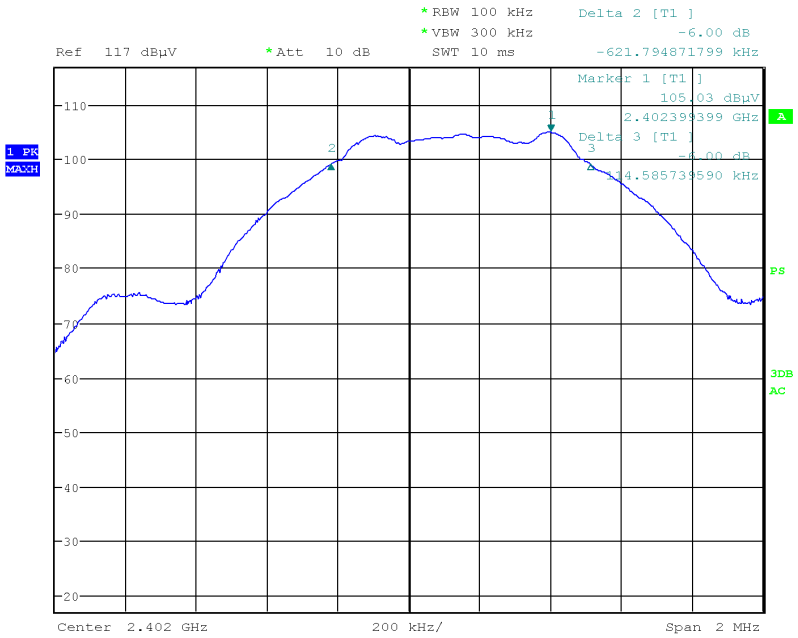
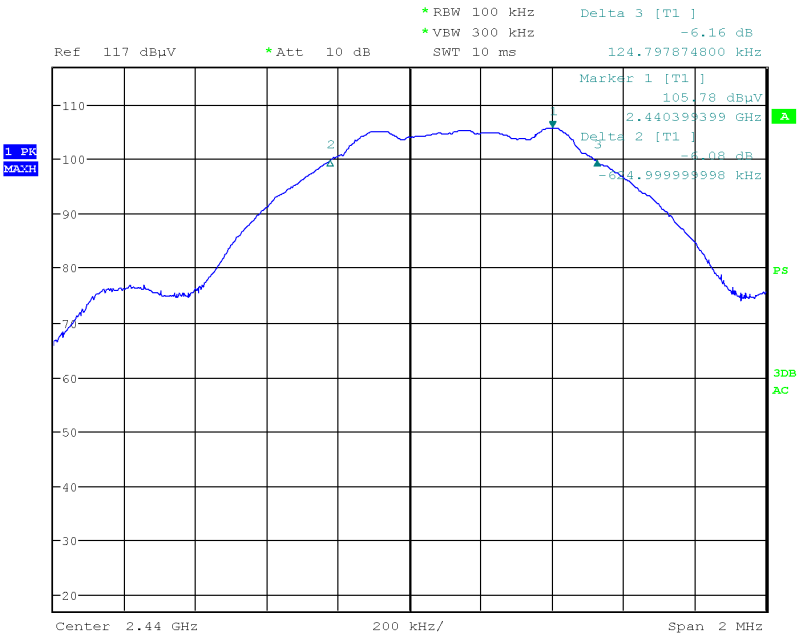
▣ Test Plots

[1 Mbit/s] 6 dB Bandwidth plot (Low-CH 0)



Date: 24.OCT.2019 01:53:10

[1 Mbit/s] 6 dB Bandwidth plot (Mid-CH 19)



Date: 24.OCT.2019 01:57:53

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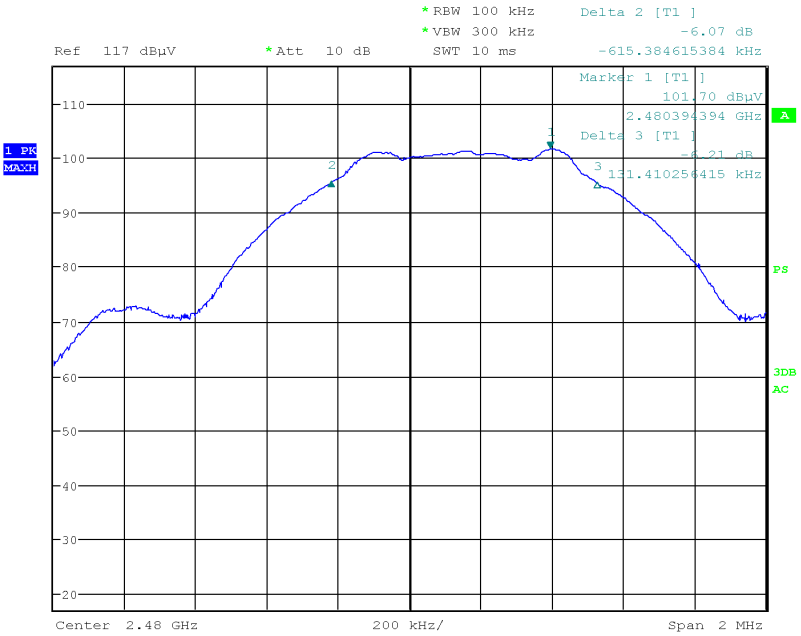
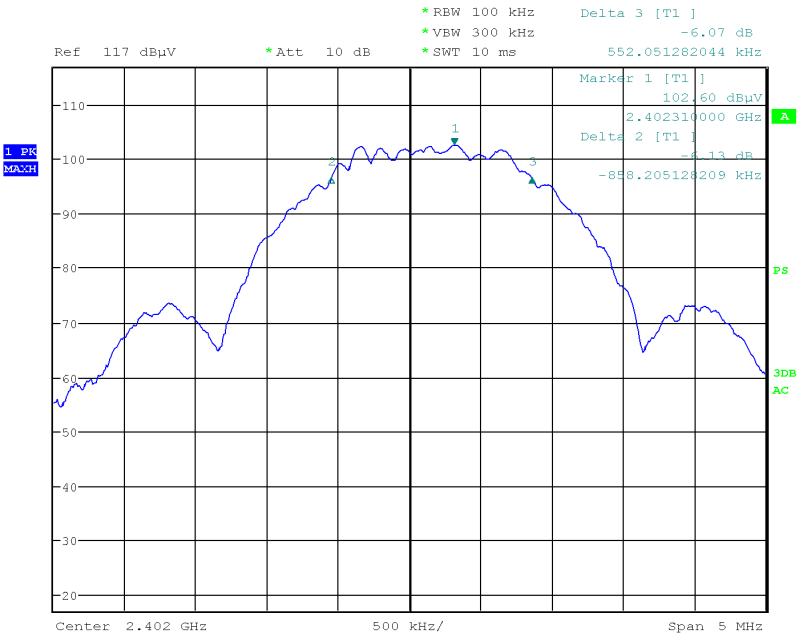
[1 Mbit/s] 6 dB Bandwidth plot (High-CH 39)



Date: 24.OCT.2019 02:00:50

[2 Mbit/s] 6 dB Bandwidth plot (Low-CH 0)



Date: 1.NOV.2019 00:23:25

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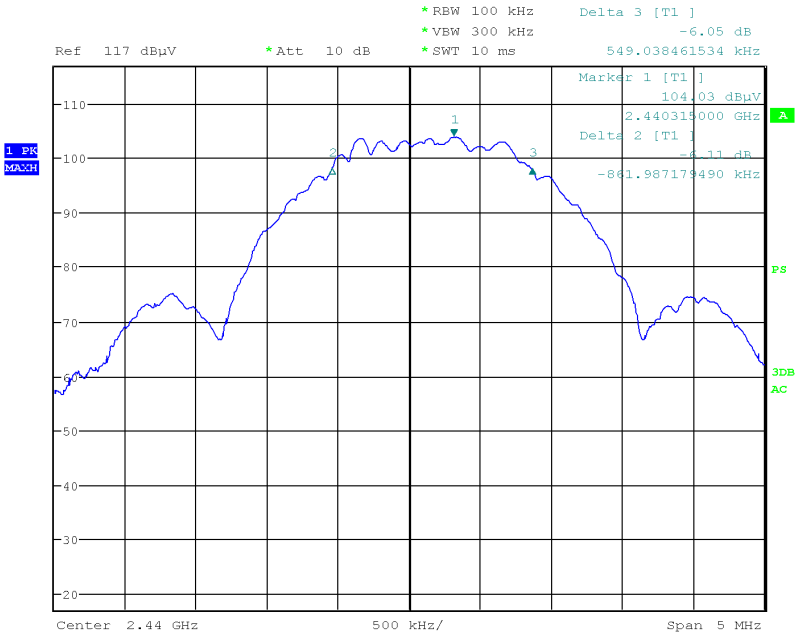
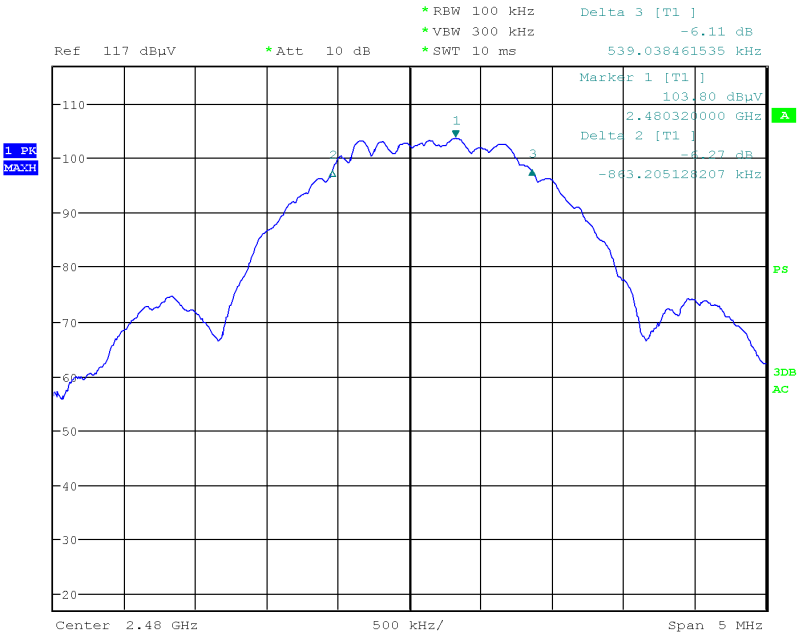
[2 Mbit/s] 6 dB Bandwidth plot (Mid-CH 19)



Date: 1.NOV.2019 00:09:31

[2 Mbit/s] 6 dB Bandwidth plot (High-CH 39)



Date: 1.NOV.2019 00:19:32

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9.3 99% BANDWIDTH

1 Mbit/s

Channel	99% Bandwidth (kHz)	Limit (kHz)
	Result	
0	1067.1	N/A
19	1075.1	
39	1073.1	

2 Mbit/s

Channel	6 dB Bandwidth (kHz)	Limit (kHz)
	Result	
0	2095.0	N/A
19	2107.4	
39	2095.0	

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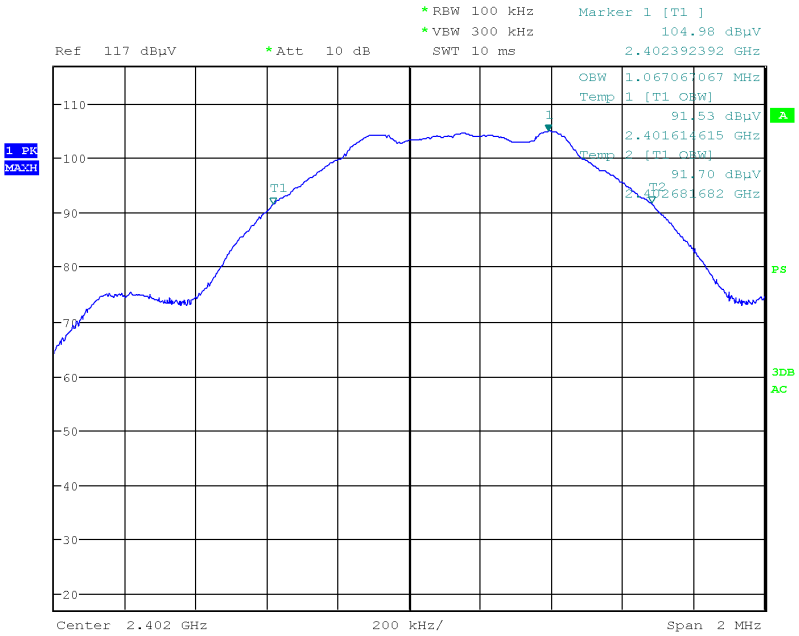
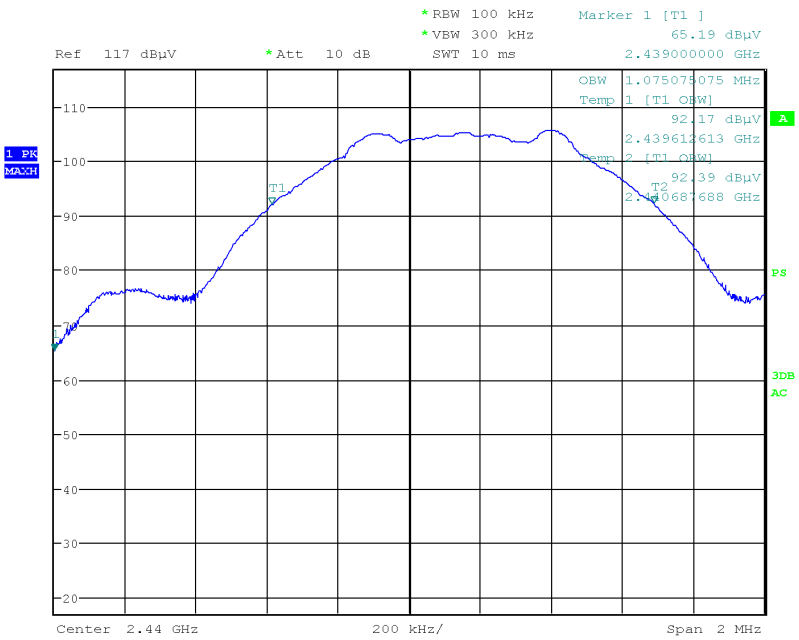
▣ RESULT PLOTS

[1 Mbit/s] 99% Bandwidth plot (Low-CH 0)



Date: 24.OCT.2019 01:55:02

[1 Mbit/s] 99% Bandwidth plot (Mid-CH 19)



Date: 24.OCT.2019 01:56:26

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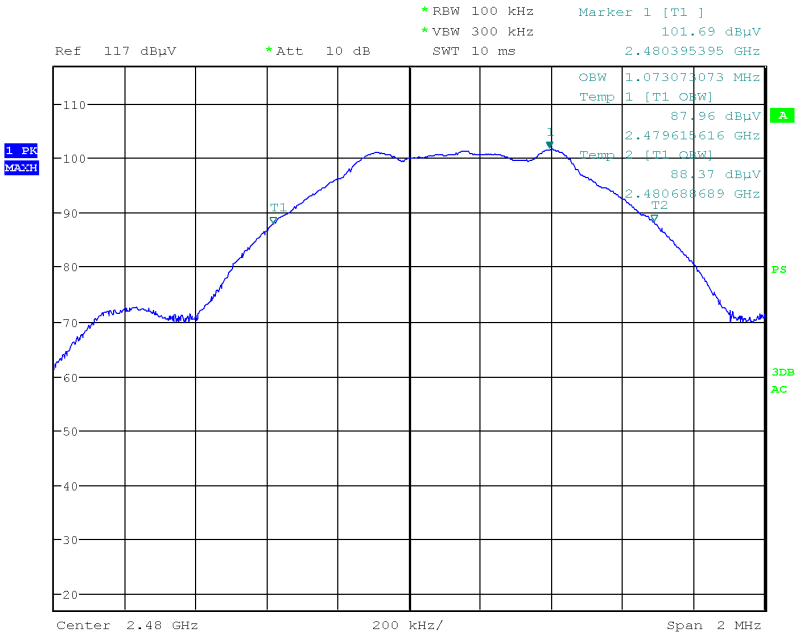
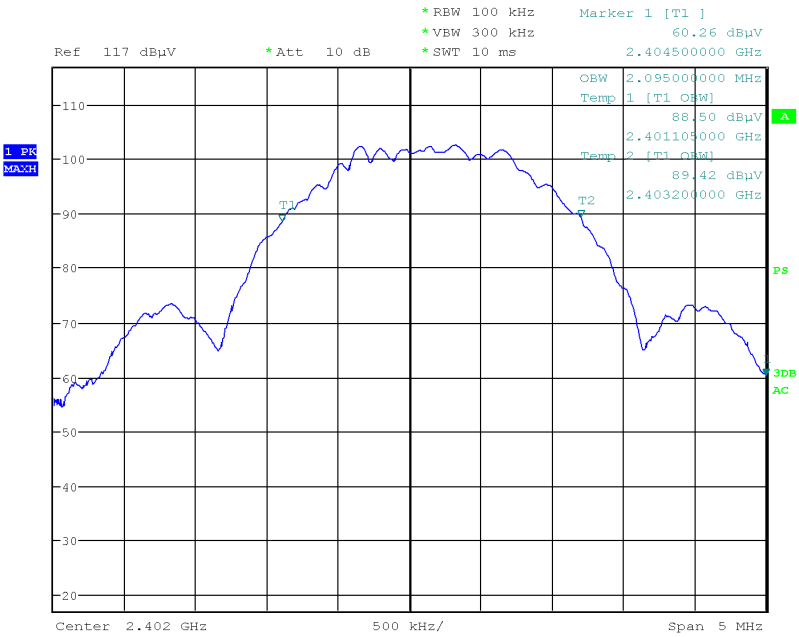
[1 Mbit/s] 99% Bandwidth plot (High-CH 39)



Date: 24.OCT.2019 02:01:47

[2 Mbit/s] 99% Bandwidth plot (Low-CH 0)



Date: 1.NOV.2019 00:22:27

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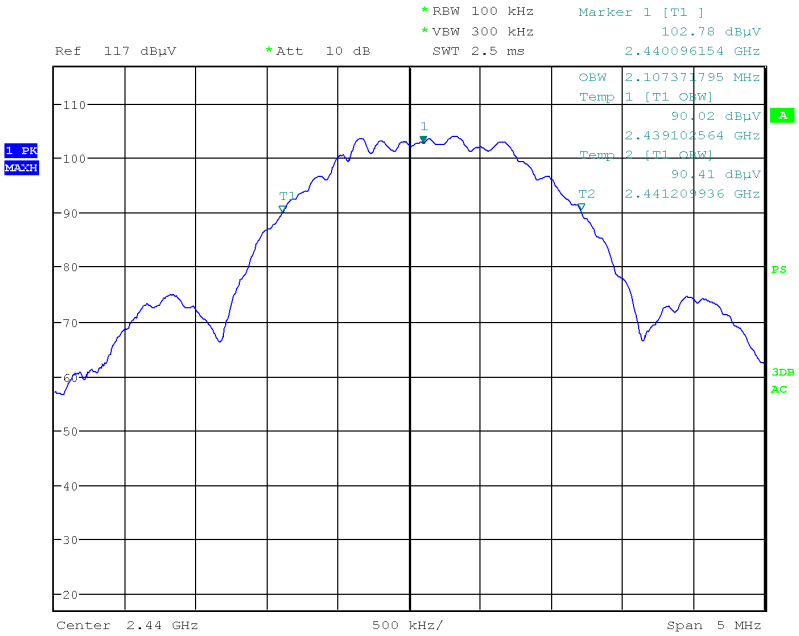
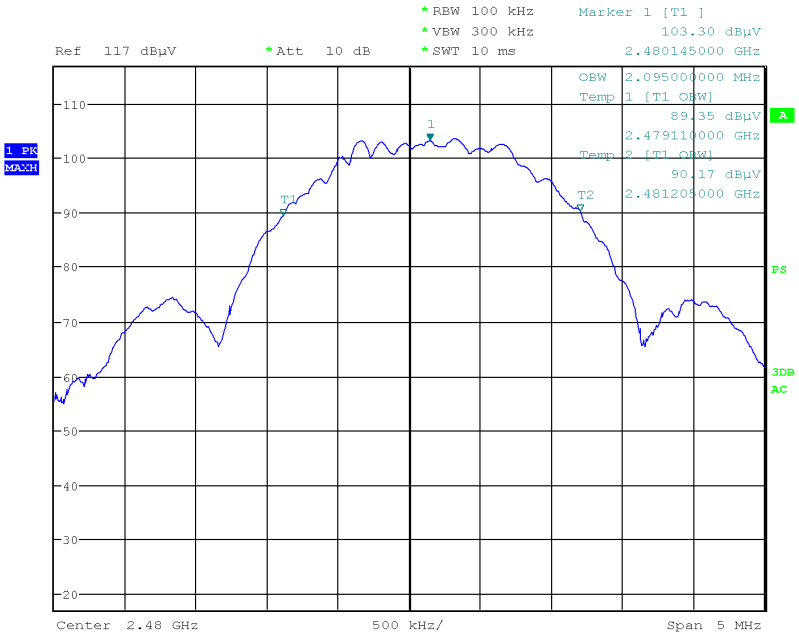
[2 Mbit/s] 99% Bandwidth plot (Mid-CH 19)



Date: 1.NOV.2019 00:06:18

[2 Mbit/s] 99% Bandwidth plot (High-CH 39)



Date: 1.NOV.2019 00:20:35

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9.4 OUTPUT POWER

1 Mbit/s Peak Power

LE Mode		Reading	Factor	Field strength	EIRP	Antenna Gain	Result	Limit (dBm)
Frequency[MHz]	Channel No.	[dBuV]	[dB/m]	[dBuV]	[dBm]	[dBi]	[dBm]	
2402	0	105.84	-6.6	99.24	3.94	1.5	2.44	30
2440	19	106.69	-6.4	100.29	4.99	1.3	3.69	30
2480	39	102.57	-6.2	96.37	1.07	0.2	0.87	30

2 Mbit/s Peak Power

LE Mode		Reading	Factor	Field strength	EIRP	Antenna Gain	Result	Limit (dBm)
Frequency[MHz]	Channel No.	[dBuV]	[dB/m]	[dBuV]	[dBm]	[dBi]	[dBm]	
2402	0	105.63	-6.6	99.03	3.73	1.5	2.23	30
2440	19	107.03	-6.4	100.63	5.33	1.3	4.03	30
2480	39	106.58	-6.2	100.38	5.08	0.2	4.88	30

Note :

1. Corrected reading: Antenna Factor + Cable loss + Read Level
2. Antenna gain of used antenna according to the data sheet

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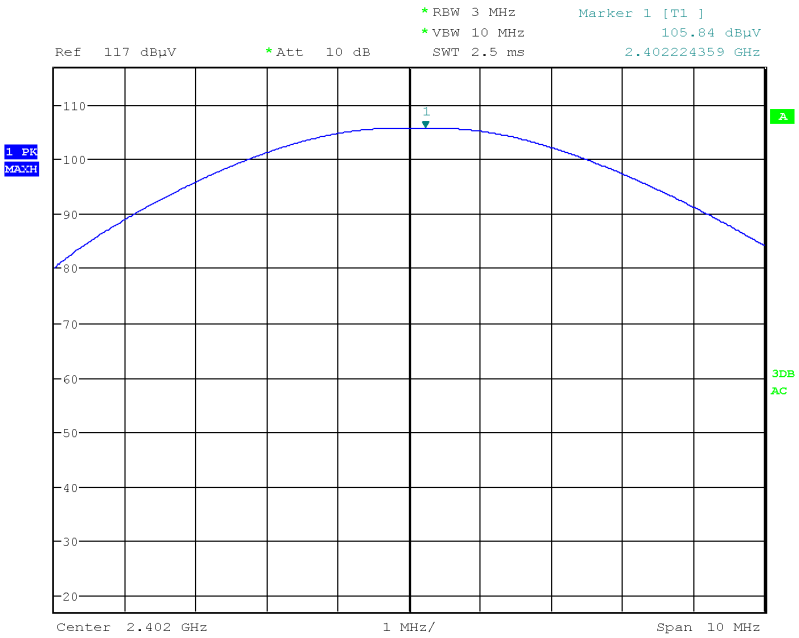
▣ Test Plots

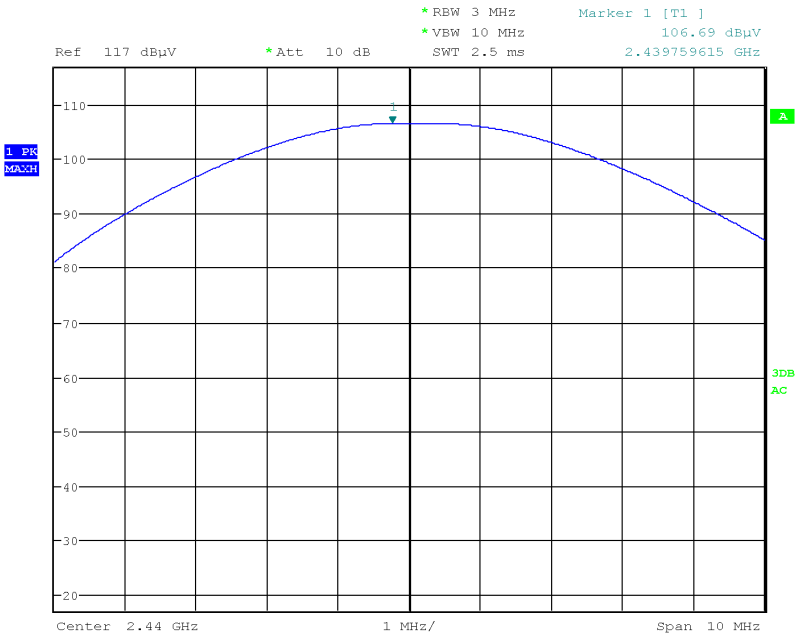
Peak Power

[1 Mbit/s] Output Power (Low-CH 0)



Date: 24.OCT.2019 00:52:16

[1 Mbit/s] Output Power (Mid-CH 19)



Date: 24.OCT.2019 00:42:40

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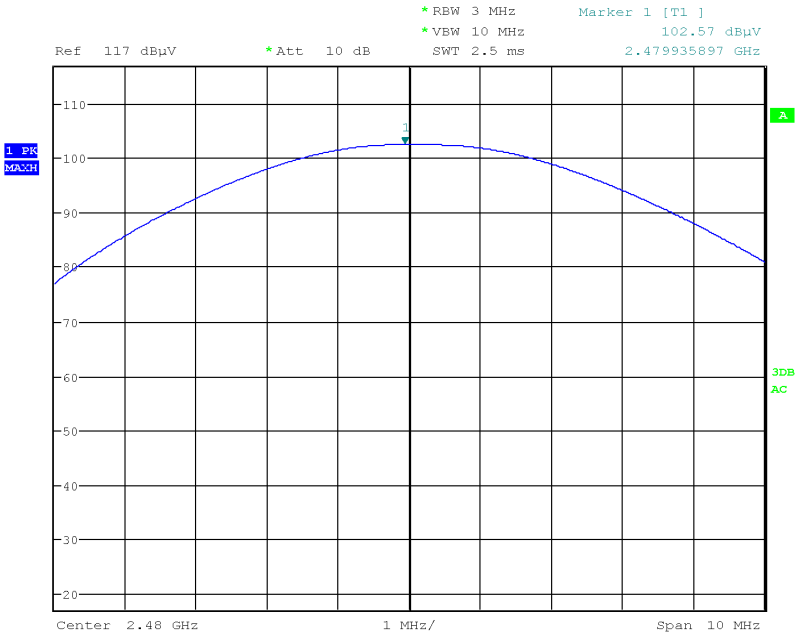
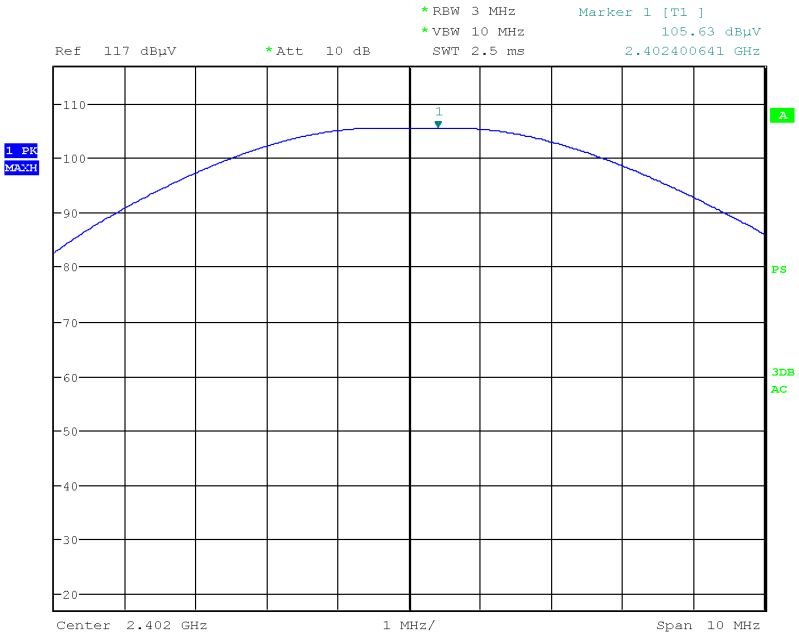
[1 Mbit/s] Output Power (High-CH 39)



Date: 24.OCT.2019 00:50:51

[2 Mbit/s] Output Power (Low-CH 0)



Date: 1.NOV.2019 00:02:41

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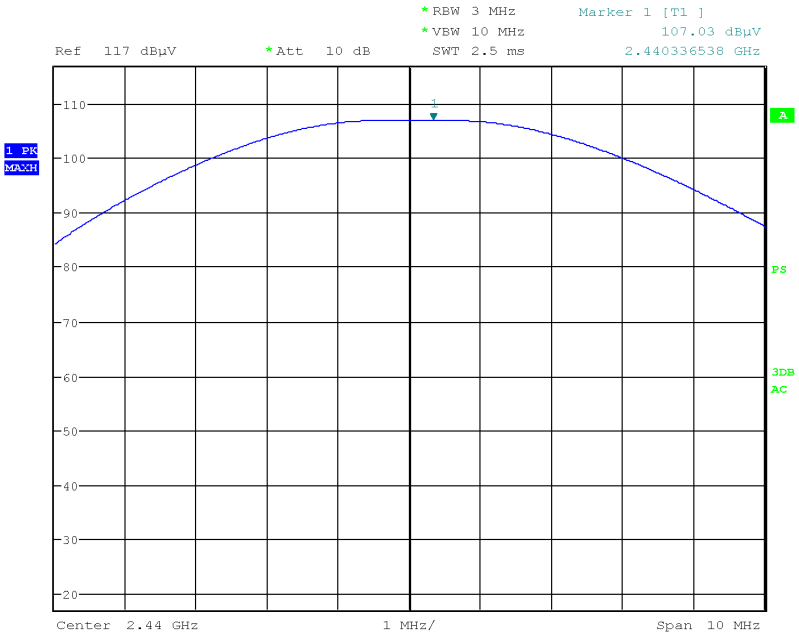
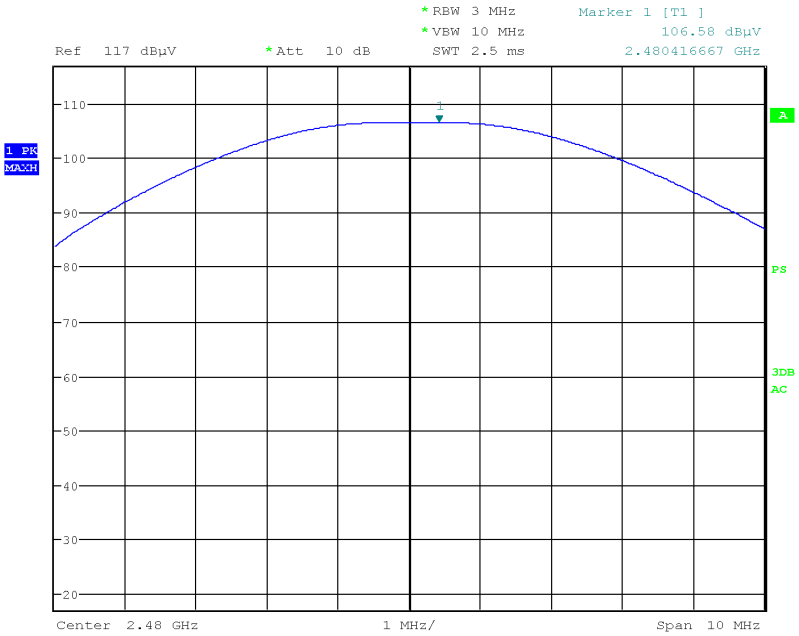
[2 Mbit/s] Output Power (Mid-CH 19)



Date: 1.NOV.2019 00:04:04

[2 Mbit/s] Output Power (High-CH 39)



Date: 31.OCT.2019 23:57:35

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9.5 POWER SPECTRAL DENSITY

1 Mbit/s POWER SPECTRAL DENSITY

LE Mode		Reading	Factor	Field strength	EIRP	Antenna Gain	Result	Limit (dBm)
Frequency[MHz]	Channel No.	[dBuV]	[dB/m]	[dBuV]	[dBm]	[dBi]	[dBm]	
2402	0	89.87	-6.6	83.27	-12.03	1.5	-13.53	30
2440	19	90.74	-6.4	84.34	-10.96	1.3	-12.26	30
2480	39	86.67	-6.2	80.47	-14.83	0.2	-15.03	30

2 Mbit/s POWER SPECTRAL DENSITY

LE Mode		Reading	Factor	Field strength	EIRP	Antenna Gain	Result	Limit (dBm)
Frequency[MHz]	Channel No.	[dBuV]	[dB/m]	[dBuV]	[dBm]	[dBi]	[dBm]	
2402	0	84.73	-6.6	78.13	-17.17	1.5	-18.67	30
2440	19	86.25	-6.4	79.85	-15.45	1.3	-16.75	30
2480	39	85.76	-6.2	79.56	-15.74	0.2	-15.94	30

Note :

1. Corrected reading: Antenna Factor + Cable loss + Read Level
2. Antenna gain of used antenna according to the data sheet

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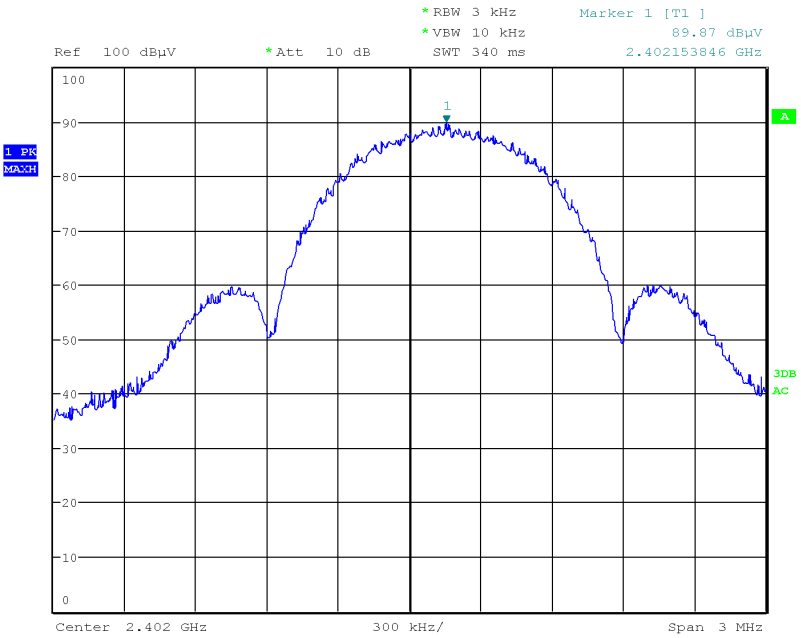
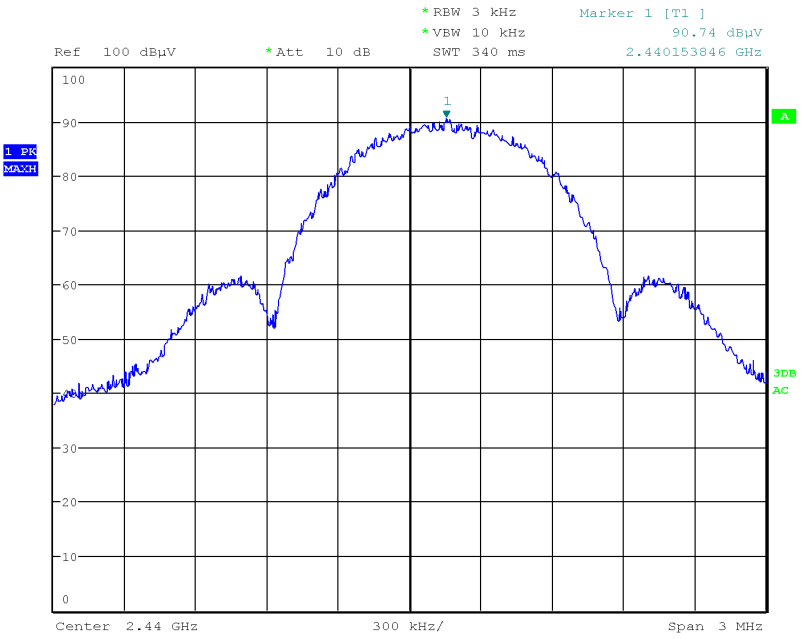
▣ Test Plots

[1 Mbit/s] Power Spectral Density (Low-CH 0)



Date: 24.OCT.2019 00:53:16

[1 Mbit/s] Power Spectral Density (Mid-CH 19)



Date: 24.OCT.2019 00:45:00

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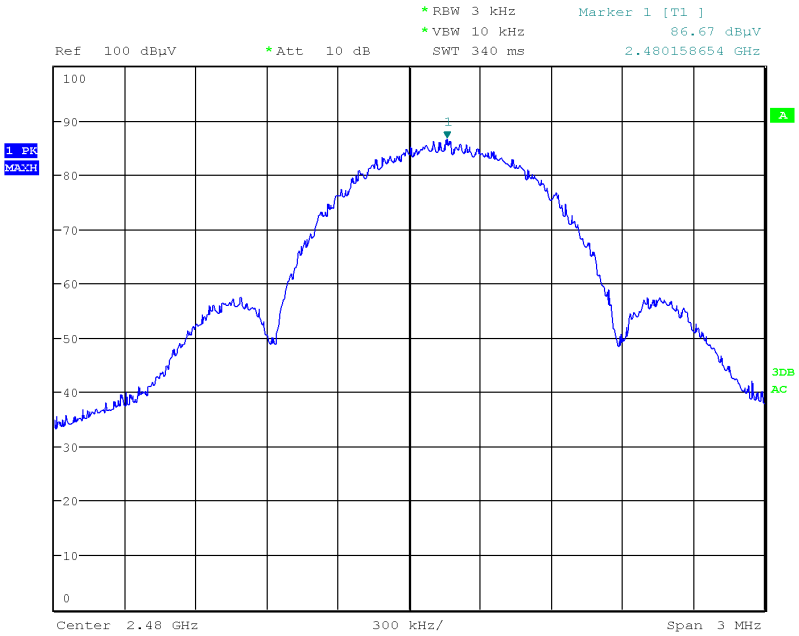
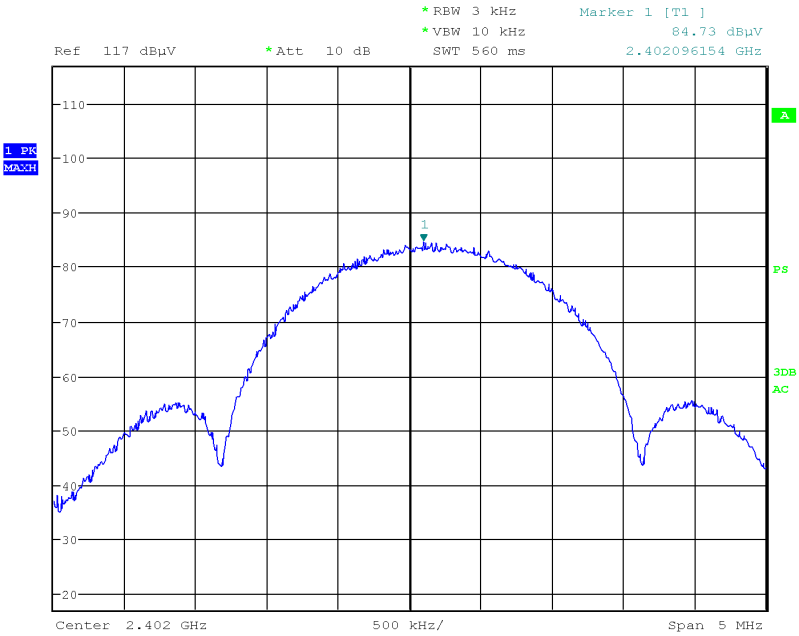
[1 Mbit/s] Power Spectral Density (High-CH 39)



Date: 24.OCT.2019 00:47:42

[2 Mbit/s] Power Spectral Density (Low-CH 0)



Date: 1.NOV.2019 00:01:40

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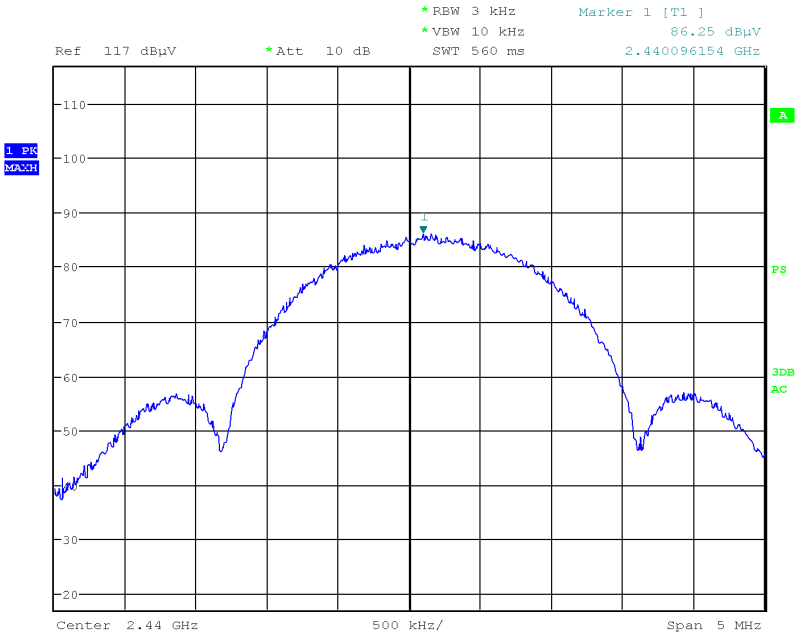
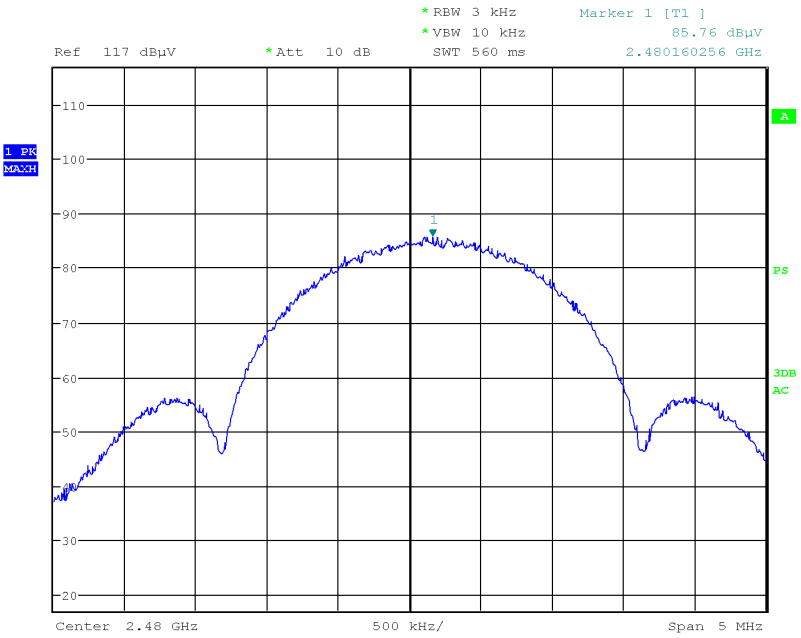
[2 Mbit/s] Power Spectral Density (Mid-CH 19)



Date: 1.NOV.2019 00:04:53

[2 Mbit/s] Power Spectral Density (High-CH 39)



Date: 1.NOV.2019 00:00:03

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9.6 OUT OF BAND EMISSIONS AT THE BANDEDGE

▣ TEST RESULTS

[1 Mbit/s] Out of Band Emissions at the Band Edge

Frequency [MHz]	Channel No.	Position	Test Result		
			Measured Level [dB]	Limit [dBc]	Pass/Fail
2402	0	Lower	62.07	20	Pass
2480	39	Upper	57.98	20	Pass

[2 Mbit/s] Out of Band Emissions at the Band Edge

Frequency [MHz]	Channel No.	Position	Test Result		
			Measured Level [dB]	Limit [dBc]	Pass/Fail
2402	0	Lower	61.37	20	Pass
2480	39	Upper	52.38	20	Pass

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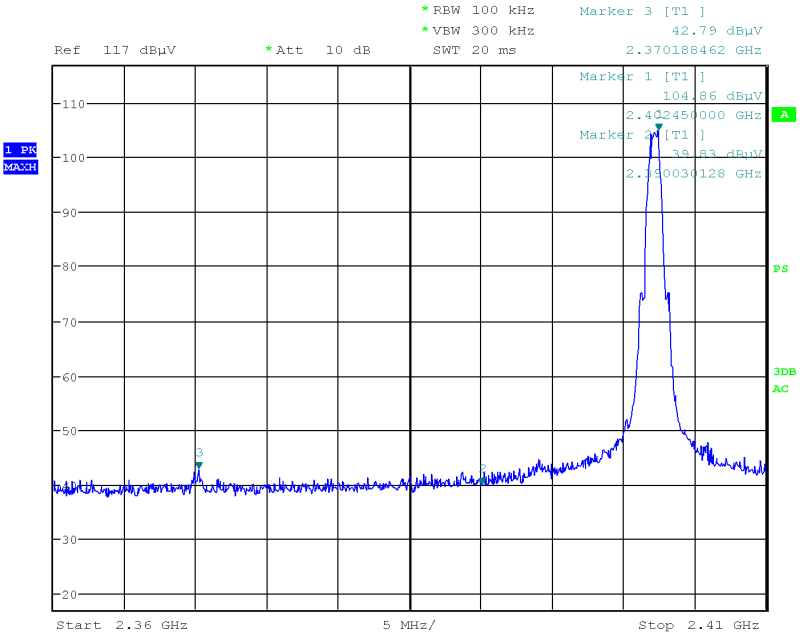
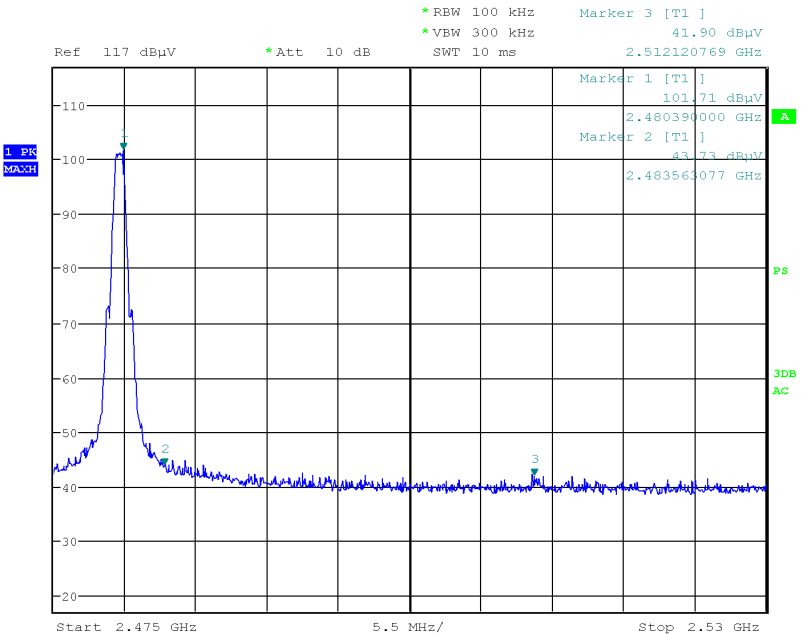
▣ Test Plots (BandEdge)

[1 Mbit/s] Out of Band Emissions at the Band Edge (Low-CH 0)



Date: 24.OCT.2019 01:02:17

[1 Mbit/s] Out of Band Emissions at the Band Edge (High-CH 39)



Date: 24.OCT.2019 01:05:28

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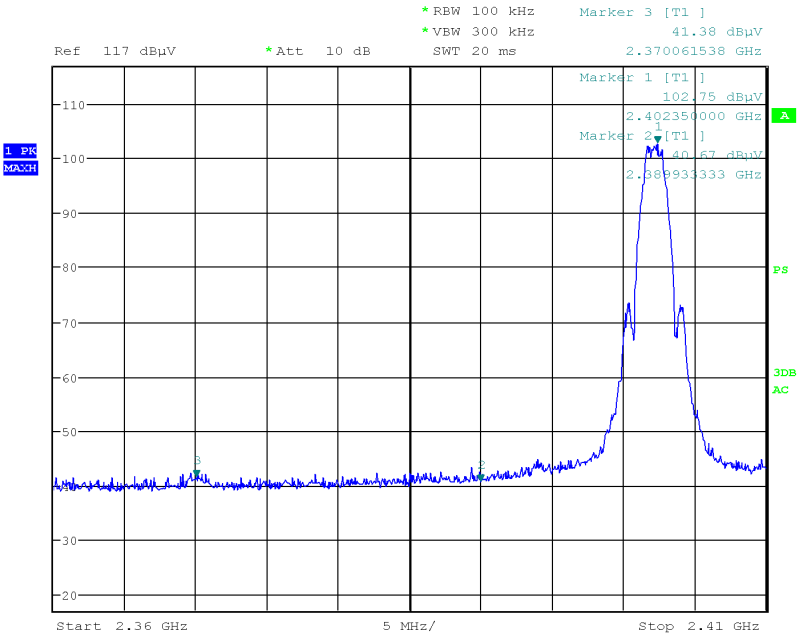
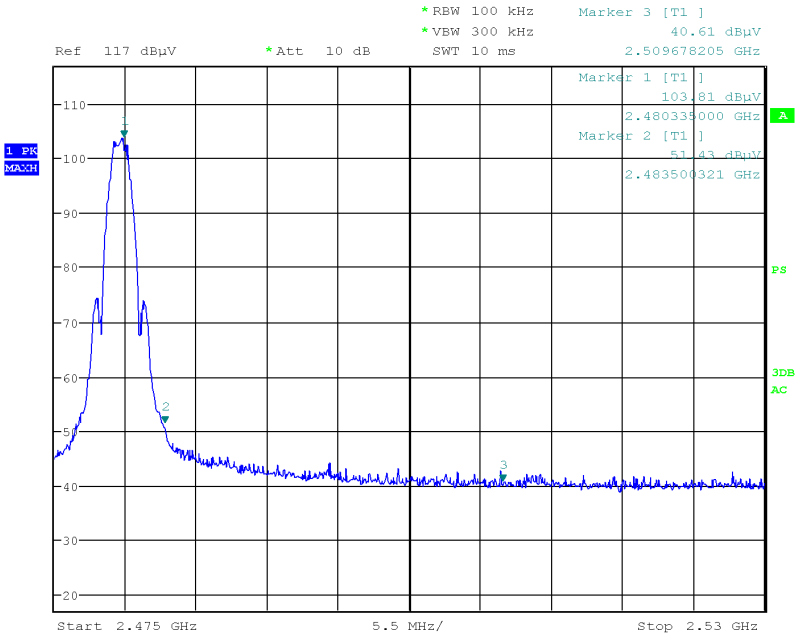
[2 Mbit/s] Out of Band Emissions at the Band Edge (Low-CH 0)



Date: 1.NOV.2019 00:26:57

[2 Mbit/s] Out of Band Emissions at the Band Edge (High-CH 39)



Date: 1.NOV.2019 00:33:31

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9.6 RADIATED SPURIOUS EMISSIONS

9 kHz – 30MHz

Frequency [kHz]	ANT. POL [H/V]	Reading [dBuV]	※A.F.+C.L. [dB]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Measurement Type
No Critical peaks found							

Notes:

1. The measurement distance is 3 meters.
2. Distance extrapolation factor = 40 log (specific distance / test distance) (dB)
3. Limit line = specific Limits (dBuV) + Distance extrapolation factor
4. Corrected reading: Antenna Factor + Cable loss + Read Level
5. The other Frequencies are attenuated more than 20 dB below the permissible limits.
   In order to simplify the report, attached worst-case mode result.

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Frequency Range : Below 1 GHz

CH 0

Frequency [MHz]	ANT. POL [H/V]	Reading [dBuV]	※A.F.+C.L. [dB]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Measurement Type
52.664	V	39.9	-13.9	26.0	40	14	QP

CH 19

Frequency [MHz]	ANT. POL [H/V]	Reading [dBuV]	※A.F.+C.L. [dB]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Measurement Type
52.898	V	40.0	-14.0	26.0	40	14.0	QP
820.747	V	23.8	1.2	25.0	46	21.0	QP

CH 39

Frequency [MHz]	ANT. POL [H/V]	Reading [dBuV]	※A.F.+C.L. [dB]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Measurement Type
52.932	V	40.7	-14.0	26.7	40	13.3	QP

Notes:

1. Corrected reading: Antenna Factor + Cable loss + Read Level

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Frequency Range : Above 1 GHz

Operation Mode: [1 Mbit/s] CH 0

Frequency MHz	Polarization	Reading dB(uV)			Level dB(uV/m)		Limit dB(uV/m)		Margin dB	
		AV	PK	Factor	AV	PK	AV	PK	AV	PK
4804	V	38.0	48.3	-2.7	35.3	45.6	54	74	18.7	28.4
4804	H	38.1	48.6	-2.7	35.4	45.9	54	74	18.6	28.1
15948	V	29.3	42.0	15.4	44.7	57.4	54	74	9.3	16.6
16549	V	28.8	42.0	15.2	44.0	57.2	54	74	10.0	16.8
17773	H	27.2	40.6	15.1	42.3	55.7	54	74	11.7	18.3
24834	V	35.5	48.7	5.0	40.5	53.7	54	74	13.5	20.3

Operation Mode: [1 Mbit/s] CH 19

Frequency MHz	Polarization	Reading dB(uV)			Level dB(uV/m)		Limit dB(uV/m)		Margin dB	
		AV	PK	Factor	AV	PK	AV	PK	AV	PK
4880	V	36.9	48.6	-2.7	34.2	45.9	54	74	19.8	28.1
4880	H	39.6	49.2	-2.7	36.9	46.5	54	74	17.1	27.5
15951	V	29.2	42.6	15.4	44.6	58.0	54	74	9.4	16.0
16504	V	28.8	41.8	15.4	44.2	57.2	54	74	9.8	16.8
17717	H	27.7	40.8	15.0	42.7	55.8	54	74	11.3	18.2

Operation Mode: [1 Mbit/s] CH 39

Frequency MHz	Polarization	Reading dB(uV)			Level dB(uV/m)		Limit dB(uV/m)		Margin dB	
		AV	PK	Factor	AV	PK	AV	PK	AV	PK
4960	V	33.6	46.7	-2.5	31.1	44.2	54	74	22.9	29.8
4960	H	38.4	49.4	-2.5	35.9	46.9	54	74	18.1	27.1
15934	V	29.3	42.4	15.3	44.6	57.7	54	74	9.4	16.3
16488	H	28.9	42.7	15.4	44.3	58.1	54	74	9.7	15.9
17745	H	27.0	40.1	15.0	42.0	55.1	54	74	12.0	18.9

Notes:

1. Corrected reading: Antenna Factor + Cable loss + Read Level

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Operation Mode: [2 Mbit/s] CH 0

Frequency MHz	Polarization	Reading dB(uV)			Level dB(uV/m)		Limit dB(uV/m)		Margin dB	
		AV	PK	Factor	AV	PK	AV	PK	AV	PK
4804	H	38.4	49.7	-2.7	35.7	47.0	54	74	18.7	28.4
4804	V	35.6	47.4	-2.7	32.9	44.7	54	74	18.6	28.1
7206	H	34.2	45.6	2.5	36.7	48.1	54	74	9.3	16.6
7206	V	34.1	45.8	2.5	36.6	48.3	54	74	10.0	16.8
15956	H	32.3	43.7	15.4	47.7	59.1	54	74	6.3	14.9
15956	V	32.6	44.1	15.4	48.0	59.5	54	74	6.0	14.5
24563	V	34.7	49.0	4.9	39.6	53.9	54	74	14.4	20.1

Operation Mode: [2 Mbit/s] CH 19

Frequency MHz	Polarization	Reading dB(uV)			Level dB(uV/m)		Limit dB(uV/m)		Margin dB	
		AV	PK	Factor	AV	PK	AV	PK	AV	PK
4880	H	40.0	50.0	-2.7	37.3	47.3	54	74	16.7	26.7
4880	V	35.9	47.4	-2.7	33.2	44.7	54	74	20.8	29.3
7320	H	34.1	46.0	2.8	36.9	48.8	54	74	17.1	25.2
7320	V	34.3	45.6	2.8	37.1	48.4	54	74	16.9	25.6
16065	H	32.5	44.1	15.3	47.8	59.4	54	74	6.2	14.6
16065	V	32.4	43.8	15.3	47.7	59.1	54	74	6.3	14.9

Operation Mode: [2 Mbit/s] CH 39

Frequency MHz	Polarization	Reading dB(uV)			Level dB(uV/m)		Limit dB(uV/m)		Margin dB	
		AV	PK	Factor	AV	PK	AV	PK	AV	PK
4960	H	39.2	49.2	-2.5	36.7	46.7	54	74	17.3	27.3
4960	V	35.4	47.6	-2.5	32.9	45.1	54	74	21.1	28.9
7440	H	34.1	46.2	2.9	37.0	49.1	54	74	17.0	24.9
7440	V	34.1	45.9	2.9	37.0	48.8	54	74	17.0	25.2
16038	H	32.0	44.5	15.5	47.5	60.0	54	74	6.5	14.0
16038	V	31.8	44.4	15.5	47.3	59.9	54	74	6.7	14.1

Notes:

1. Corrected reading: Antenna Factor + Cable loss + Read Level

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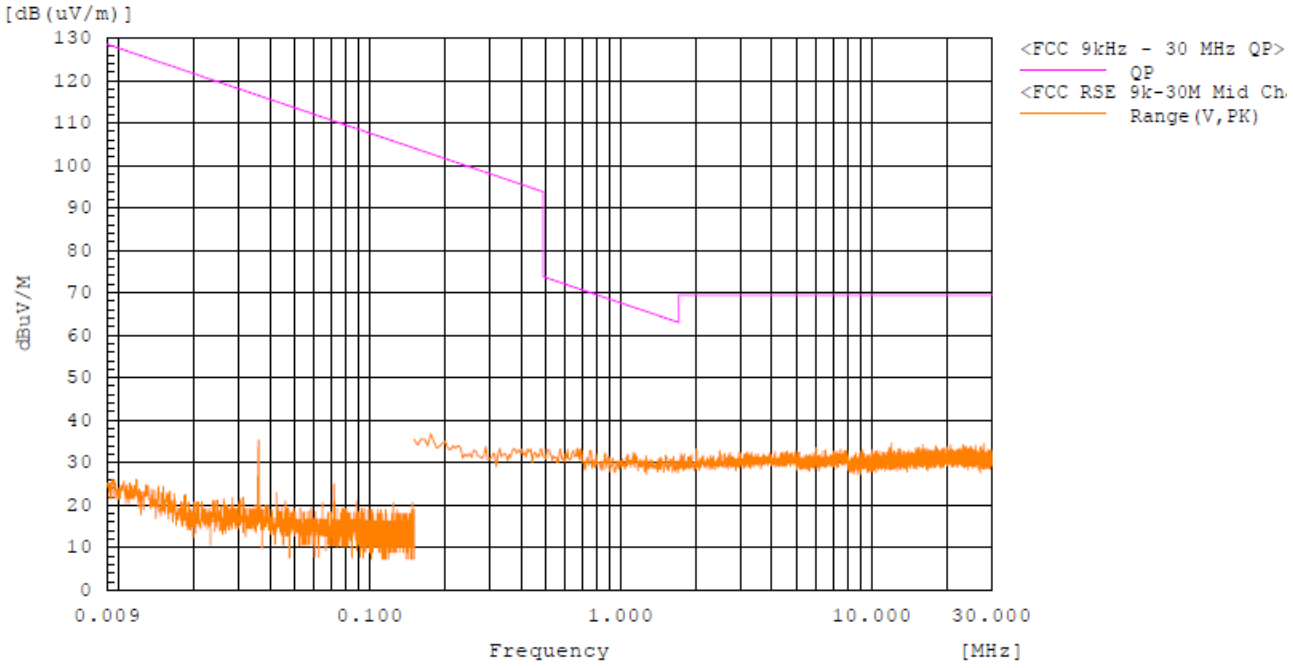
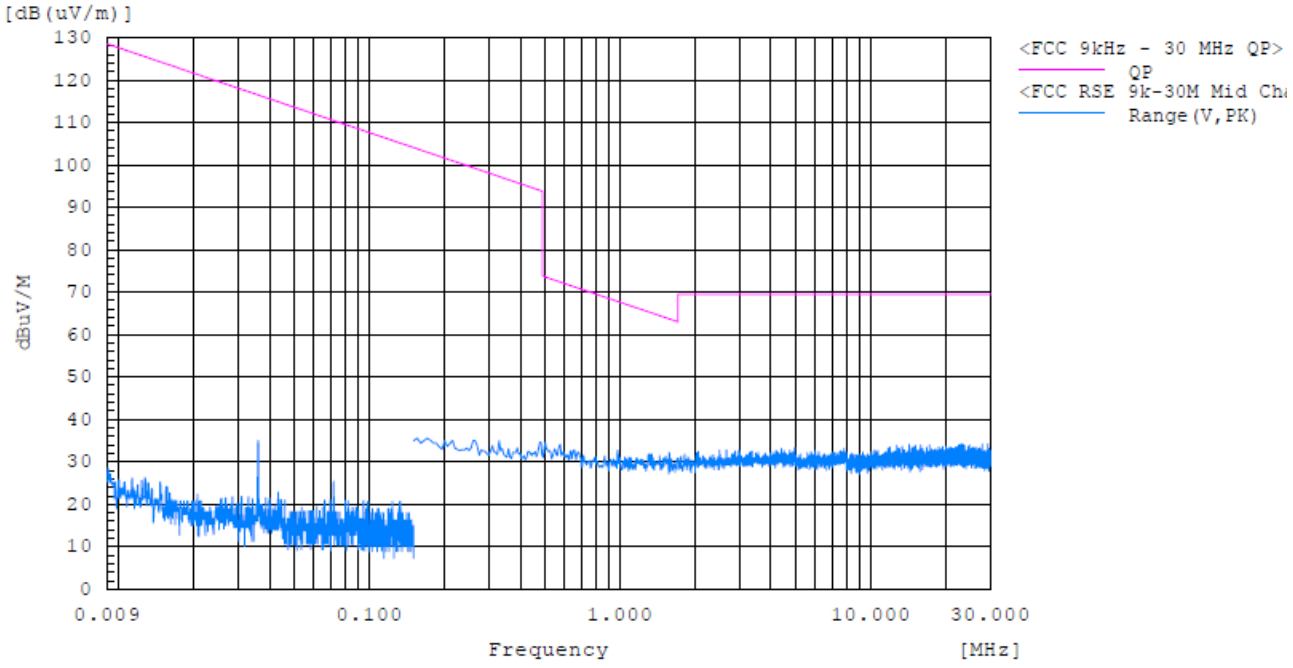
▣ Test Plots

9 kHz – 30MHz

Radiated Spurious Emissions Horizontal plot



Radiated Spurious Emissions Vertical plot



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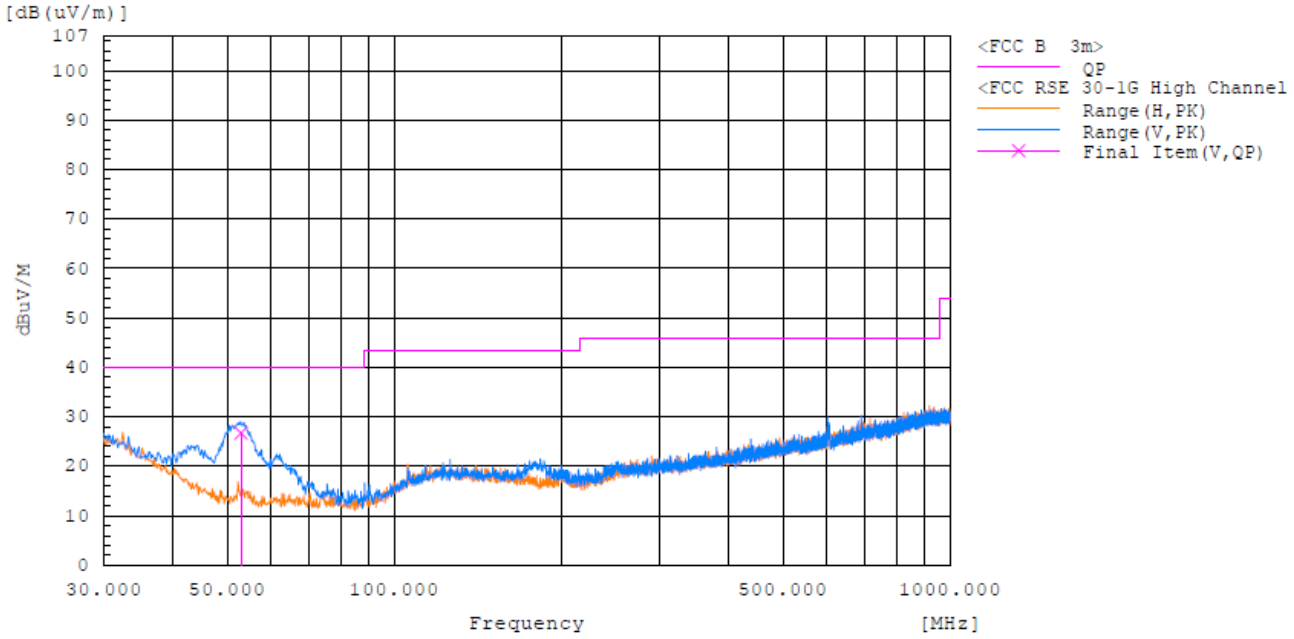
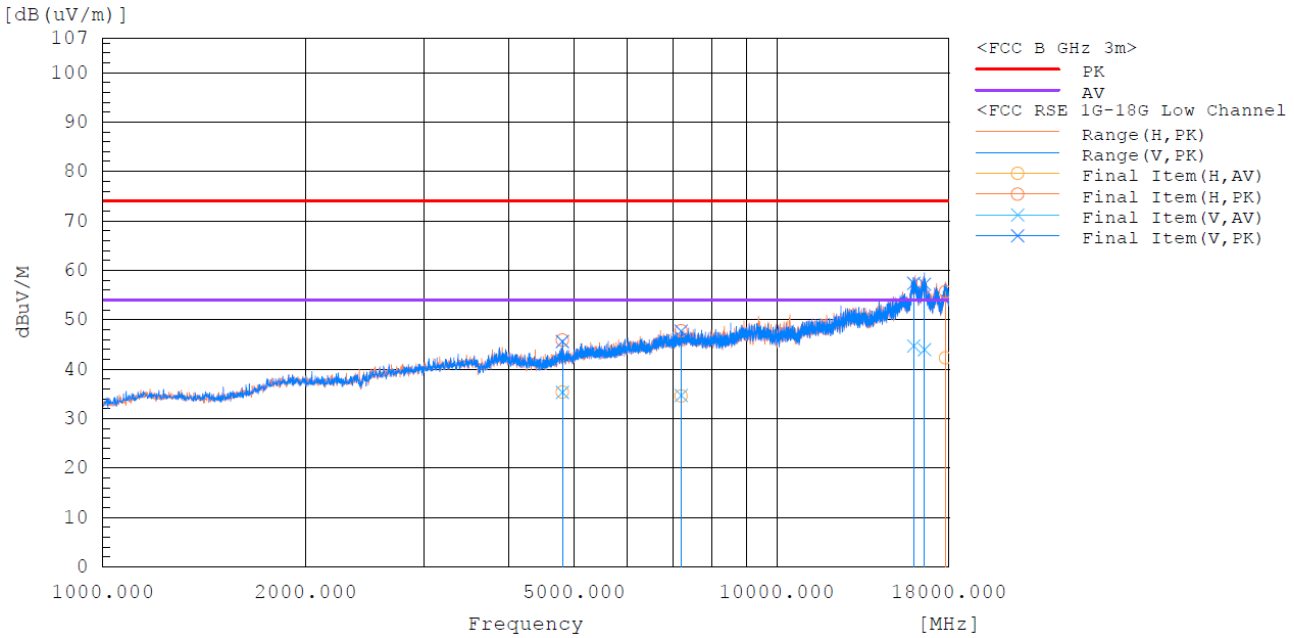
Radiated Spurious Emissions plot Below 1 GHz



Radiated Spurious Emissions plot 1 GHz ~ 18 GHz



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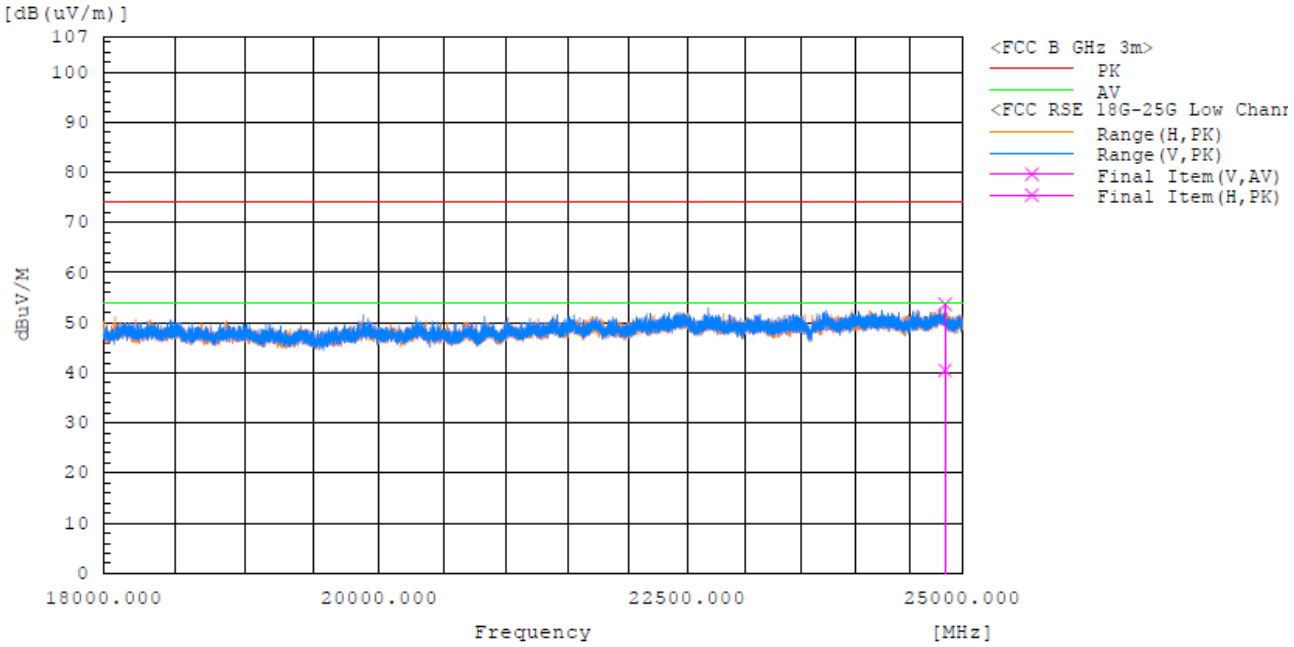
Radiated Spurious Emissions plot 18 GHz ~ 25 GHz



Note:

Plot of worst case are only reported.

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9.7 RADIATED RESTRICTED BAND EDGES

Operating Frequency [1 Mbit/s] 2402 MHz

Channel No. 0

Frequency MHz	Polarization	Reading dB(uV)			Level dB(uV/m)		Limit dB(uV/m)		Margin dB	
		AV	PK	Factor	AV	PK	AV	PK	AV	PK
2390	V	34	47	-8.2	25.8	38.8	54	74	28.2	35.2
2390	H	35	48.3	-8.2	26.8	40.1	54	74	27.2	33.9

Operating Frequency [1 Mbit/s] 2480 MHz

Channel No. 39

Frequency MHz	Polarization	Reading dB(uV)			Level dB(uV/m)		Limit dB(uV/m)		Margin dB	
		AV	PK	Factor	AV	PK	AV	PK	AV	PK
2483.5	V	39.7	53.5	-7.7	32	45.8	54	74	22	28.2
2483.5	H	46.7	60.2	-7.7	39	52.5	54	74	15	21.5

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Operating Frequency [2 Mbit/s] 2402 MHz

Channel No. 0

Frequency MHz	Polarization	Reading dB(uV)			Level dB(uV/m)		Limit dB(uV/m)		Margin dB	
		AV	PK	Factor	AV	PK	AV	PK	AV	PK
2390	H	36.0	49.4	-8.2	27.8	41.2	54	74	26.2	32.8
2390	V	34.8	48.0	-8.2	26.6	39.8	54	74	27.4	34.2

Operating Frequency [2 Mbit/s] 2480 MHz

Channel No. 39

Frequency MHz	Polarization	Reading dB(uV)			Level dB(uV/m)		Limit dB(uV/m)		Margin dB	
		AV	PK	Factor	AV	PK	AV	PK	AV	PK
2483.5	H	48.3	61.3	-7.7	40.6	53.6	54	74	13.4	20.4
2483.5	V	38.6	51.1	-7.7	30.9	43.4	54	74	23.1	30.6

Notes:

1. Corrected reading: Antenna Factor + Cable loss + Read Level

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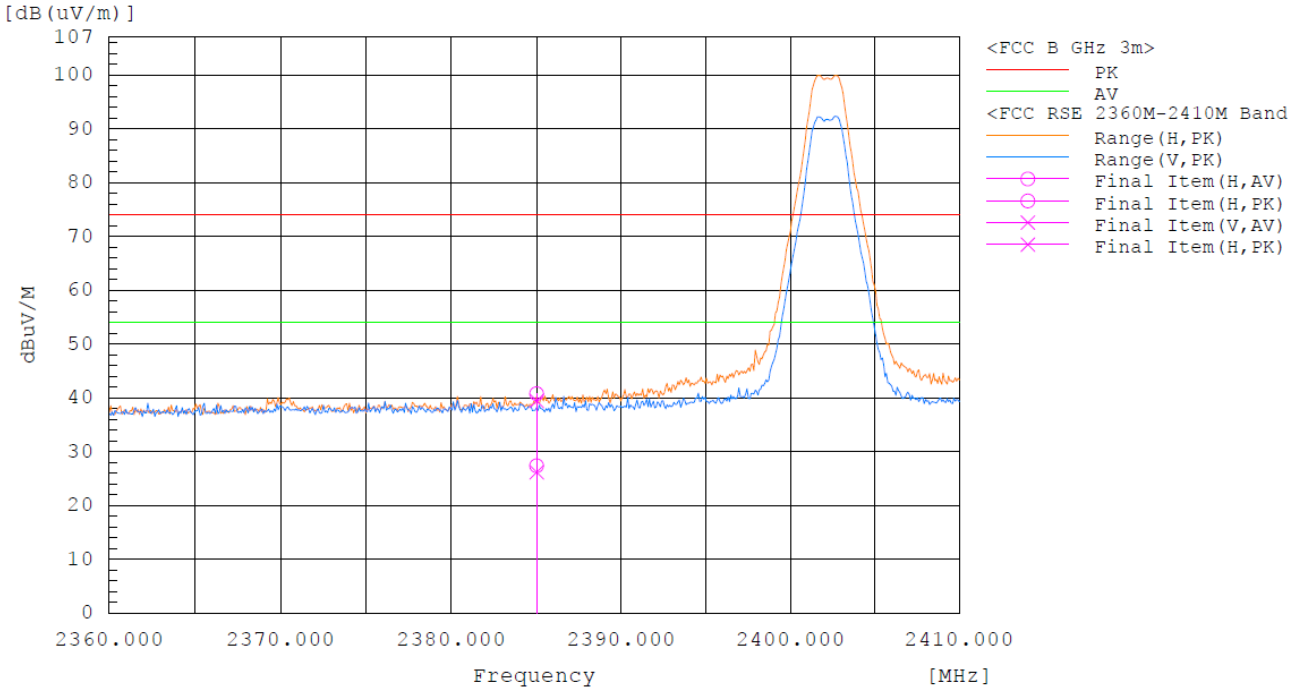
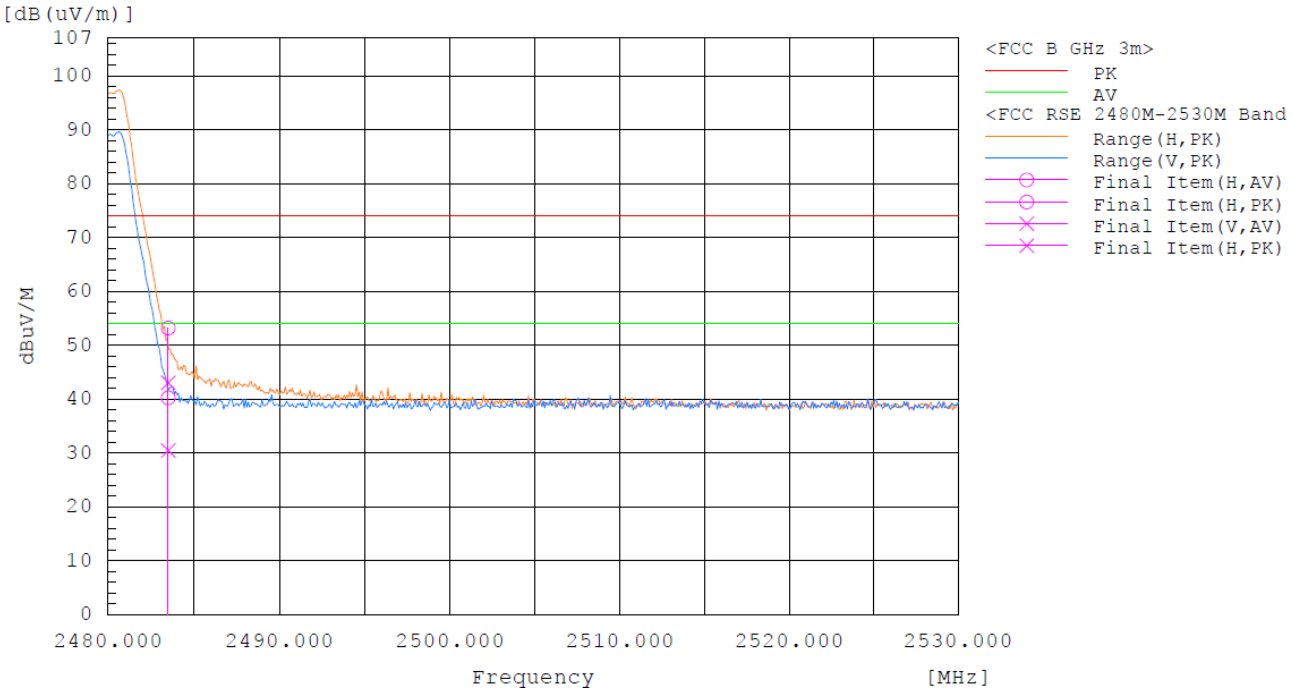
▣ Test Plots

Radiated Restricted Band Edges plot –(2 Mbit/s_Ch.0)



Radiated Restricted Band Edges plot – (2 Mbit/s_ch.39)



Note:

Plot of worst case are only reported.

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9.8 RECEIVER SPURIOUS EMISSIONS

Frequency Range : Below 1 GHz

Frequency [MHz]	ANT. POL [H/V]	Reading [dBuV]	※A.F.+C.L. [dB]	Total [dBuV/m]	Limit [dBuV/m]	Margin [dB]	Measurement Type
32.066	V	36.4	-1.9	34.5	40	5.5	QP
43.543	V	47.6	-10.2	37.4	40	2.6	QP

Note:

1. Radiated emissions measured in frequency range from 30 MHz to 1000 MHz were made with an instrument using Quasi peak detector mode.

Frequency Range : Above 1 GHz

Frequency MHz	Polarization	Reading dB(uV)		Level dB(uV/m)	Limit dB(uV/m)	Margin dB
		AV	Factor	AV	AV	AV
4802	V	43.5	-3.3	40.2	54	13.8
4802	H	44.8	-3.3	41.5	54	12.5
17835.7	V	30.5	13.8	44.3	54	9.7
24563.9	V	34.7	4.9	39.6	54	14.4

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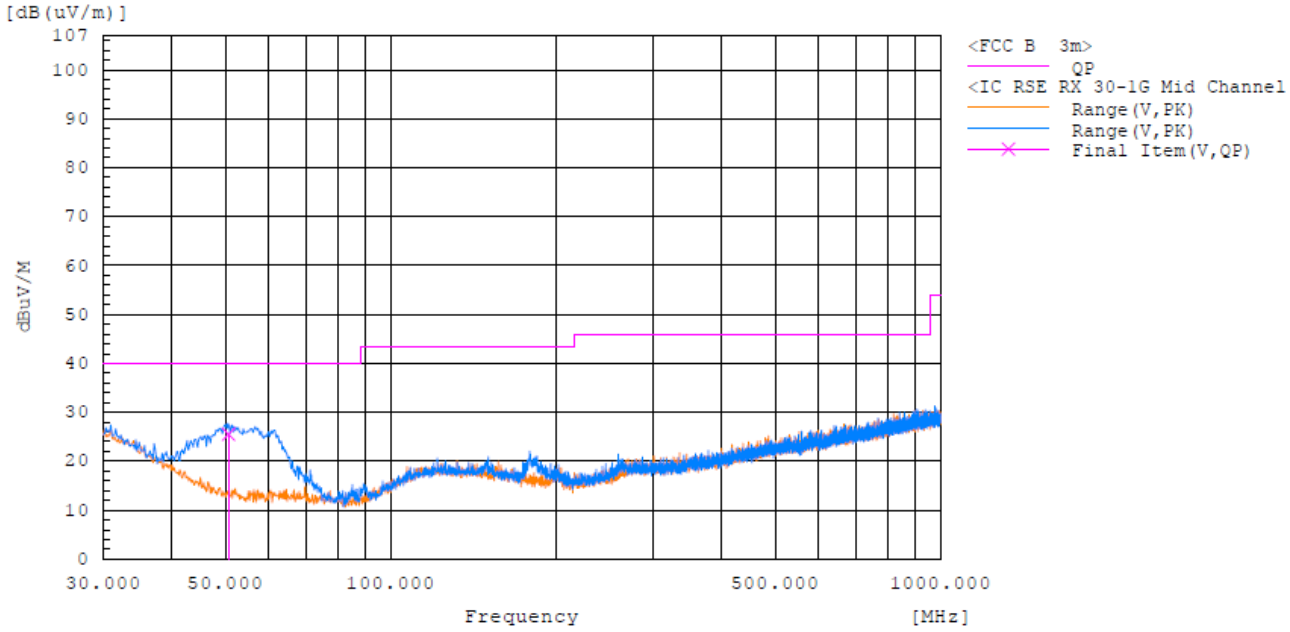
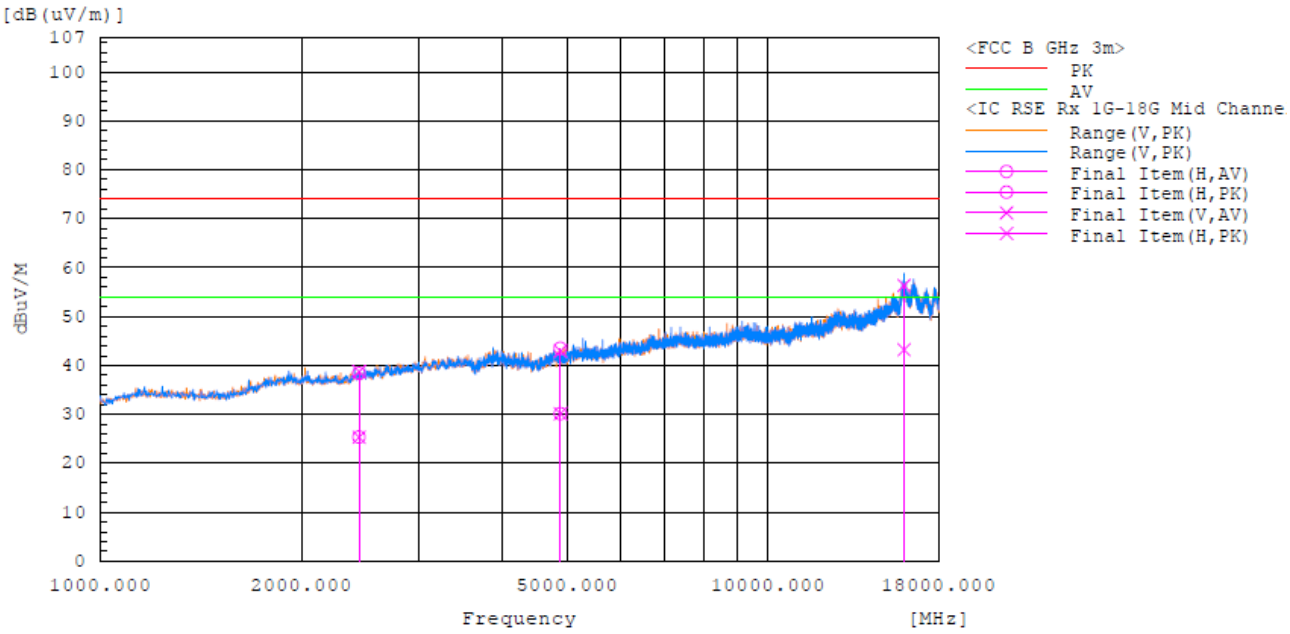
Receiver Spurious Emissions plot Below 1 GHz



Receiver Spurious Emissions plot 1 GHz ~ 18GHz



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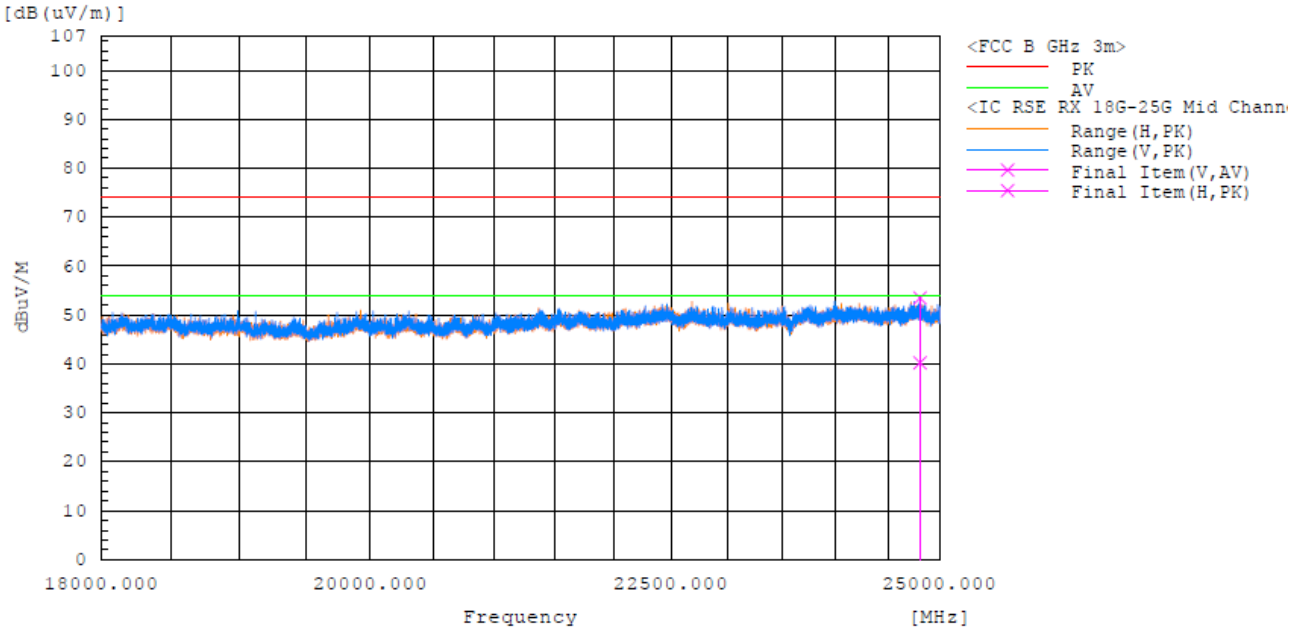
Receiver Spurious Emissions plot 18 GHz ~ 25 GHz



Note:

Plot of worst case are only reported.

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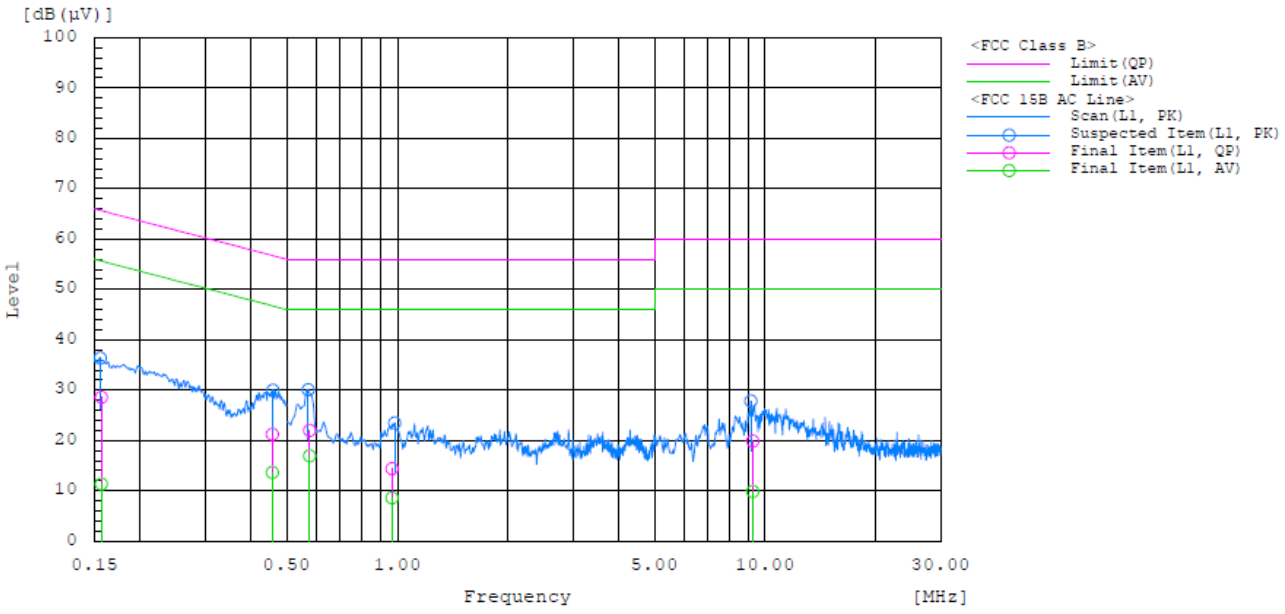
9.6 POWERLINE CONDUCTED EMISSIONS

[AC Mains (L1)]



[Final Results]

Frequency MHz	Line	Reading dB(μV)		Corr. dB	Level dB(μV)		Limit dB(μV)		Margin dB	
		QP	CAV		QP	CAV	QP	CAV	QP	CAV
0.457	L1	11.7	4.1	9.6	21.3	13.7	56.8	46.8	35.5	33.1
0.157	L1	19	1.8	9.6	28.6	11.4	65.6	55.6	37	44.2
0.966	L1	4.7	-1.1	9.7	14.4	8.6	56	46	41.6	37.4
0.577	L1	12.4	7.4	9.6	22	17	56	46	34	29
9.243	L1	10	0	9.9	19.9	9.9	60	50	40.1	40.1

Note : Quasi-peak(Final Result) = Reading Value + Correction Factor

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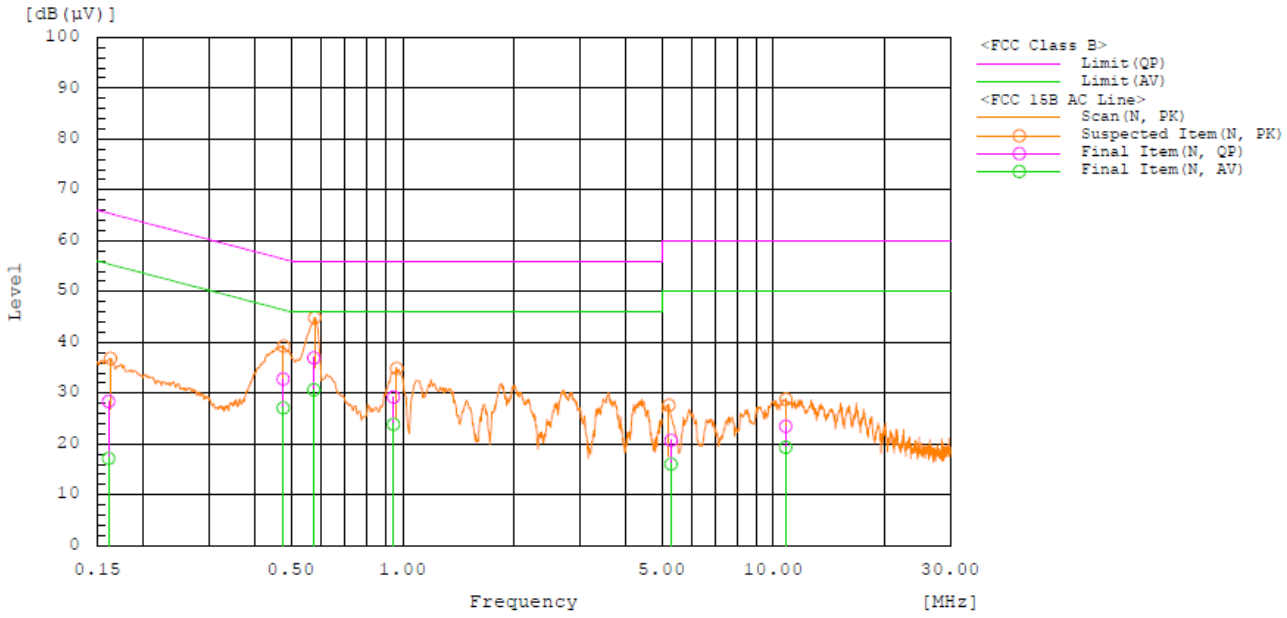
[AC Mains (N)]



[Final Results]

Frequency MHz	Line	Reading dB(µV)		Corr. dB	Level dB(µV)		Limit dB(µV)		Margin dB	
		QP	CAV		QP	CAV	QP	CAV	QP	CAV
0.476	N	23.2	17.5	9.6	32.8	27.1	56.4	46.4	23.6	19.3
0.161	N	18.8	7.6	9.6	28.4	17.2	65.4	55.4	37	38.2
0.944	N	19.6	14.2	9.7	29.3	23.9	56	46	26.7	22.1
0.576	N	27.4	21.1	9.6	37	30.7	56	46	19	15.3
10.793	N	13.5	9.4	10	23.5	19.4	60	50	36.5	30.6
5.289	N	11	6.3	9.8	20.8	16.1	60	50	39.2	33.9

Note : Quasi-peak(Final Result) = Reading Value + Correction Factor

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10. LIST OF TEST EQUIPMENT

No.	Instrument	Model No.	Due to Calibration	Manufacture	Serial No.
☒	Signal Analyzer (20 Hz ~ 40.0 GHz)	ESU40	2019-12-20	ROHDE & SCHWARZ	100529
☒	Signal Analyzer (3 Hz ~ 50 GHz)	N9030A	2020-02-15	AGILENT	MY53311083
☒	BI-LOG Antenna (30 MHz ~ 1 GHz)	JB6	2020-11-29	Sunol	A071116
☒	Attenuator (20 dB, DC ~ 26.5 GHz)	8493C	2019-12-20	HP	09072
☒	POWER AMP (1 GHz ~ 18 GHz)	PAM-118A	2020-08-22	Com-Power Corporation	18040074
☒	POWER AMP (0.3GHz ~ 1GHz)	PAM-103A	2020-01-18	Com-Power Corporation	18020005
☒	Horn Antenna (1 GHz ~ 18 GHz)	DRH-118	2020-05-24	Sunol	A070516
☒	Loop Antenna (0.009 ~ 30 MHz)	HLA 6121	2020-08-27	Teseq	43964
☒	Horn Antenna (18 GHz ~ 40 GHz)	DRH-1840	2020-02-20	Sunol	17120
☒	POWER AMP (18 GHz ~ 40 GHz)	CBL184050-45-01	2020-02-20	CERNEX,Inc.	43964
☒	ISM Band Reject filter (2370 ~ 2400 - 2483.5 ~2520 MHz)	WRCJV12	2020-01-18	Wainwright	4
☒	EMI Test Receiver	ESR3	2019-12-20	Rohde & Schwarz	102363
☒	LISN	3816/2SH	2020-01-19	EMCO	00205729
☒	LISN	ENV216	2020-01-19	Rohde & Schwarz	101349

Note:

1. Equipment listed above that calibrated during the testing period was set for test after the calibration.
2. Equipment listed above that has a calibration due date during the testing period, the testing is completed before equipment expiration date

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11. ANNEX A TEST SETUP PHOTO

The setup photo will be provided as a separate document

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