Test report

356782-1TRFWL

Date of issue: February 11, 2020

Applicant:
Wavetronix, LLC

Product:
Radar Vehicle Sensing Device

Model:
Expanse XP20

Specifications:

- FCC 47 CFR Part 15 Subpart C §15.249

Operation within the bands 902-928 MHz, 2400 – 2483.5 MHz, 5725 – 5875 MHz and 24.0 – 24.25 GHz

- ISED RSS-210 Issue 10 December 2019

Licence – Exempt Radio Apparatus: Category I Equipment

Lab and test locations

Company name	Nemko USA Inc.
Address	2210 Faraday Ave, Suite 150
City	Carlsbad
State	California
Postal code	92008
Country	USA
Telephone	+1 760 444 3500
Website	www.nemko.com
FCC Site Number	Test Firm Registration Number: 392943 Designation Number: US5058
ISED Test Site	2040B-3

Tested by	Martha Espinoza, Wireless Engineer
Reviewed by	Chip Fleury, Wireless and Certification Supervisor
Review date	March 2, 2020
Reviewer signature	

Limits of responsibility

Note that the results contained in this report relate only to the items tested and were obtained in the period between the date of initial receipt of samples and the date of issue of the report.
This test report has been completed in accordance with the requirements of ISO/IEC 17025. All results contain in this report are within Nemko USA's ISO/IEC 17025 accreditation.
This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, or any agency of the U.S. Government.

Copyright notification

Table of Contents

Section 1 Report summary

1.1 Test specifications

FCC 47 CFR Part 15, Subpart C, Clause §15.249	Operation within the bands 902-928 MHz, 2400-2483.5 MHz, 5725-5875 MHZ, and 24.0-24.25 GHz
ISED RSS-210	Licence – Exempt radio apparatus: Category I Equipment

1.2 Test methods

KDB 890966 D01	Measurement procedure for level probing radars
Annex B – B.10 - RSS-210 and RSS Gen	Bands: 902-928 MHz, 2400-2483.5 MHz, 5725-5875 MHz and 24 -24.25 GHz

1.3 Exclusions

None

1.4 Statement of compliance

In the configuration tested, the EUT was found compliant.

Testing was performed against all relevant requirements of the test standard. Results obtained indicate that the product under test complies in full with the requirements tested. The test results relate only to the items tested.

See "Summary of test results" for full details.

1.5 Test report revision history

Table 1.5-1: *Test report revision history*

Revision #	Details of changes made to test report
387434-1TRFWL	Original report issued

Notes:

Section 2 Summary of test results

2.1 FCC Part 15 Subpart C §15.249

Table 2.1-1: *Test results: FCC Part 15, Subpart C, §15.249*

Test description	Verdict
KDB 890966 D01 (D). 10 dB bandwidth	Pass
KDB 890966 D01 (F). Fundamental emissions for FMCW transmitters	Pass
KDB 890966 D01 (G). Unwanted emissions	Pass
KDB 890966 D01 (H). Frequency stability	Pass

Notes: None

Table 2.1-2: *Test results: ISED RSS-210*

Test description	Verdict
RSS-GEN 6.6 - 99% Occupied bandwidth	Pass
RSS-GEN 6.11 - Transmitter Frequency Stability	Pass
RSS-210. B.10 - Fundamental emissions within the permitted band	Pass
RSS-210. B.10 - Unwanted emissions	Pass

Notes: None

Section 3 Equipment under test (EUT) details

3.1 Applicant

Company name	Wavetronix, LLC
Address	78 East 1700 South (Building B)
City	Provo
Province/State	UT
Postal/Zip code	84606
Country	USA

3.2 Manufacturer

Company name	Wavetronix, LLC
Address	78 East 1700 South (Building B)
City	Provo
Province/State	UT
Postal/Zip code	84606
Country	USA

3.3 Sample information

Receipt date	November 19, 2019
Nemko sample ID number	387434

3.4 EUT information

Product name	Radar Vehicle Sensing Device
Model	Expanse XP20
Model variant	N/A
Serial number	101-0451 (IP 192.168.1.184)
Power requirements	50 – 56 VDC, 8W
Description/theory of operation	Expanse XP20 is a radar vehicle device with a microstrip patch array. There is a single transmitter that transmits only on one antenna at time and alternates between antennas every chirp. The chirp behavior in time vs frequency has a ramp where the signal ramps approximately increasing from the minimum frequency up to maximum frequency, increasing a total of 245 MHz (from 24.0025 GHz to 24.2475 GHz). The up chirp time is ~255us and the down chirp time is ~24us
Operational frequencies	Frequency start: 24.0025 GHz; Frequency stop: 24.2475 GHz
Software details	At the time of testing the firmware/software version of the EUT was “Version 1.1.7014”. The device was set up for testing using a supplied ARC computer and connection the EUT though POE connection. The XP20 and the ARC were set to the test mode by enabling telnet using command prompts. “telnet 192.168.1.184”

Note: The firmware version will be updated regularly to add new features to the application level. This will NOT affect the transmitter configuration.

3.5 EUT exercise and monitoring details

The radar signal was executed through a telnet terminal using the commands provided by client and the IP address of the device. A PoE was used between the EUT and the laptop where the commands were executed. An adapter was used for connecting the ethernet port of the PoE to USB port of the laptop used for doing the physical connection. The signal was monitored with a spectrum analyzer using the adequate settings.

Table 3.6-1: Support equipment

Description	Brand name	Model/Part number	Serial number	Rev.
Laptop	Dell	Latitude	N/A	N/A
PoE	Wavetronix	Expanse ARC	102-0439	N/A

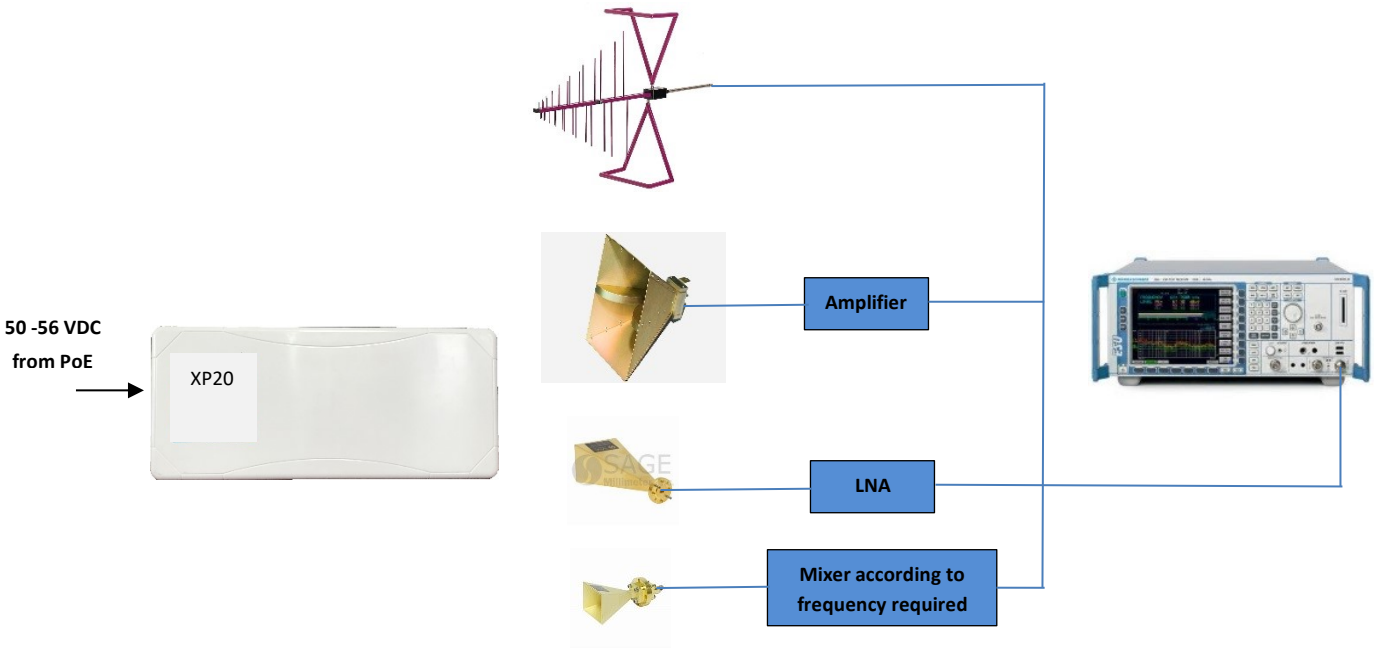


Figure 3.6-1: EUT Test Setup

Section 4 Engineering considerations

4.1 Modifications incorporated in the EUT

None

4.2 Technical judgment

None

4.3 Deviations from laboratory tests procedures

No deviations were made from laboratory procedures.

Section 5 Test conditions

5.1 Atmospheric conditions

Temperature	21.4 °C
Relative humidity	55.7 %
Air pressure	86–106 kPa

When it is impracticable to carry out tests under these conditions, a note to this effect stating the ambient temperature and relative humidity during the tests shall be recorded and stated.

5.2 Power supply range

The normal test voltage for equipment to be connected to the mains shall be the nominal mains voltage. For the purpose of the present document, the nominal voltage shall be the declared voltage, or any of the declared voltages ±5 %, for which the equipment was designed.

Section 6 Measurement uncertainty

6.1 Uncertainty of measurement

Measurement uncertainty budgets for the tests are detailed below. Measurement uncertainty calculations assume a coverage factor of K = 2 with 95% certainty.

Test name	Measurement uncertainty, dB
All antenna port measurements/ including OBW	0.55
Conducted spurious emissions	1.13
Radiated spurious emissions	3.78
AC power line conducted emissions	1.38
Supply Voltages	0.05%
Time	2.09%

Table 6.1-1: Measurement uncertainty.

Important note: All testing in this document were done using the maximum radiation pattern from transmitter antenna for covering the worst case in all the measurements.

Section 7 Testing data

7.1 Fundamental Emissions for FMCW transmitters

7.1.1 References

Title 47 → Part 15→ Subpart C → §15.249 → KDB 890966 D01 (F)
RSS-210 → Annex B→ B.10

(a) Except as provided in paragraph (b) of this section, the field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following:

Fundamental frequency	Field strength of fundamental (mv/m)	Field strength of fundamental (dBuv/m) @ 3m
902 – 928 MHz	50	93.97
2400 – 2483.5 MHz	50	93.97
5725 – 5875 MHz	50	93.97
24.0 – 24.25 GHz	250	107.95

b) Fixed, point-to-point operation as referred to in this paragraph shall be limited to systems employing a fixed transmitter transmitting to a fixed remote location. Point-to-multipoint systems, omnidirectional applications, and multiple co-located intentional radiators transmitting the same information are not allowed. Fixed, point-to-point operation is permitted in the 24.05-24.25 GHz band subject to the following conditions:

(1) The field strength of emissions in this band shall not exceed 2500 millivolts/meter.

(c) Field strength limits are specified at a distance of 3 meters.

(e) As shown in §15.35(b), for frequencies above 1000 MHz, the field strength limits in paragraphs (a) and (b) of this section are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation.

ISED RSS-210→ Annex B B.10 Band 24 – 24.25 GHz

The field strength of fundamental measured at 3 m shall not exceed the limits in table:

Fundamental frequency	Field strength of fundamental (mv/m)	Field strength of fundamental (dBuv/m) @ 3m
902 – 928 MHz	50	93.97
2400 – 2483.5 MHz	50	93.97
5725 – 5875 MHz	50	93.97
24.0 – 24.25 GHz	250	107.95

7.1.2 Test summary

Verdict	Pass		
Test date	December 4, 2019	Temperature	19°C
Test engineer	Martha Espinoza	Air pressure	1004 mbar
Test location	3m semi anechoic chamber	Relative humidity	69 %

7.1.3 Notes

This is a radiated test measurement and it was done at 3 meters of distance (far field). The worst case was considered for all the measurements (the maximum radiation of the antenna).
The field strength limits in paragraphs (a) of this section are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation, so, two measurements shall be done:

1) Measurement with peak detector
2) Measurement with average detector.

It is important to mention the peak value is 20 dB above the average value, so, the specific limit for the operation frequency of this product is:

Fundamental frequency	Field strength of fundamental (mv/m)	Field strength of fundamental (dBuv/m) @ 3m - RMS	Field strength of fundamental (dBuv/m) @ 3m - Peak
24.0 – 24.25 GHz	250	107.95	127.95

An offset of 18.70 dB was used in this test in order to compensate the losses in the measurement system. This number is the result of different corrections factors such as, cables losses, antenna losses and amplifier gain. Additional to these elements in the system, there is a correction that shall be apply to radar devices based on own features of the radar and other features of the measurement equipment. The equation used for this correction factor is:

$$CFchirp = 5 * Log(1 + K\left(\frac{span}{t * RBW^2}\right)^2)$$

Where:
Span = Occupied bandwidth by the radar.
t = Chirp time declared by manufacturer
RBW = Resolution bandwidth used in the equipment to measure the fundamental
K = Corrector factor for the settling process of the gaussian shaped filter (Internal filter used in the equipment).

Replacing by numbers:

Span = 245 MHz
t = 279 µs
RBW = 1 MHz
K = 0.1947

CFchirp ≈ 0.304 dB

This correction factor shall be added to the correction factor of the system. Together form the total correction factor for the measurement frequency under test.

7.1.4 Setup details

EUT setup configuration	Table top
Test facility	3 m Semi anechoic chamber
Measuring distance	3 m
Antenna height variation	1.85 m (worst case)
Turn table position	0° (worst case)
Measurement details	A preview measurement was generated with receiver in continuous scan or sweep mode while the EUT was rotated and antenna adjusted to maximize radiated emission. Emissions detected within 6 dB or above limit were re-measured with the appropriate detector against the correlating limit and recorded as the final measurement.

Spectrum analyzer settings for frequencies above 1 GHz:

Resolution bandwidth	1 MHz
Video bandwidth	3 MHz
Detector mode	RMS (Average power); Peak (Maximum power)
Trace mode	Max Hold
Measurement time	100 ms

Table 7.1-1: *Fundamental Emissions for FMCW transmitters equipment list*

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
Antenna, Horn	Sage Millimeter	SAR-2309-42-S2	E1143	2 Years	03-05-2020
Signal Analyzer	Rohde & Schwarz	FSV 40	E1120	1 Year	11-19-2020
Low Noise Amplifier	Sage Millimeter	SBL-1834034030-KFKF-SI	E1228	NCR	NCR

Notes: None

7.1.5 Test data Maximum Peak Power

Frequency range	Measured EIRP (dBµv/m)	Limit EIRP (dBµv/m)	Margin (dB)
24.0025 – 24.2475 GHZ	110.34	127.95	17.61

Note. These measured were done at 3m

Table7.1-2: *Maximum peak power test results.*

7.1.6 Test data Maximum RMS Power

Frequency range	Measured EIRP (dBµv/m)	Limit EIRP (dBµv/m)	Margin (dB)
24.0025 – 24.2475 GHZ	107.03	107.95	0.65

Note. These measured were done at 3m

Figure 7.1-3: *Maximum RMS power test results.*

7.1.7 Test plots

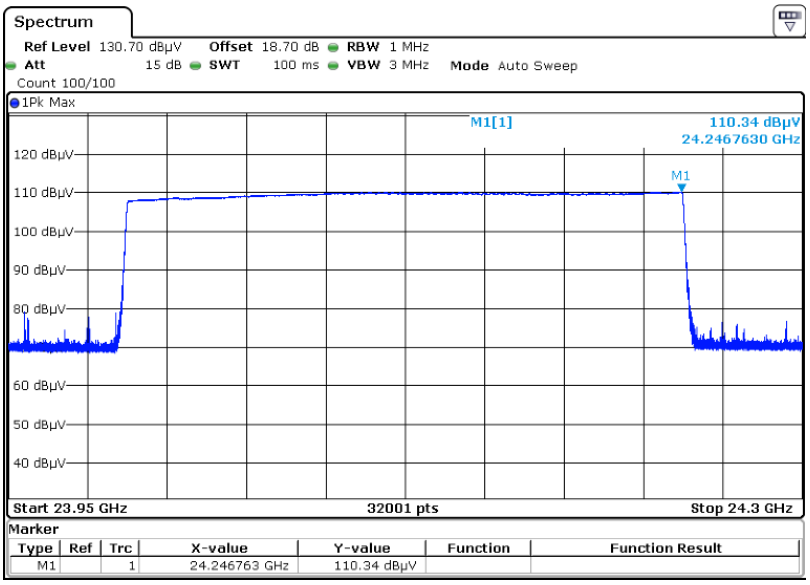


Figure 7.1-1: *Maximum peak power plot (24.0025 – 24.2475 GHZ).*

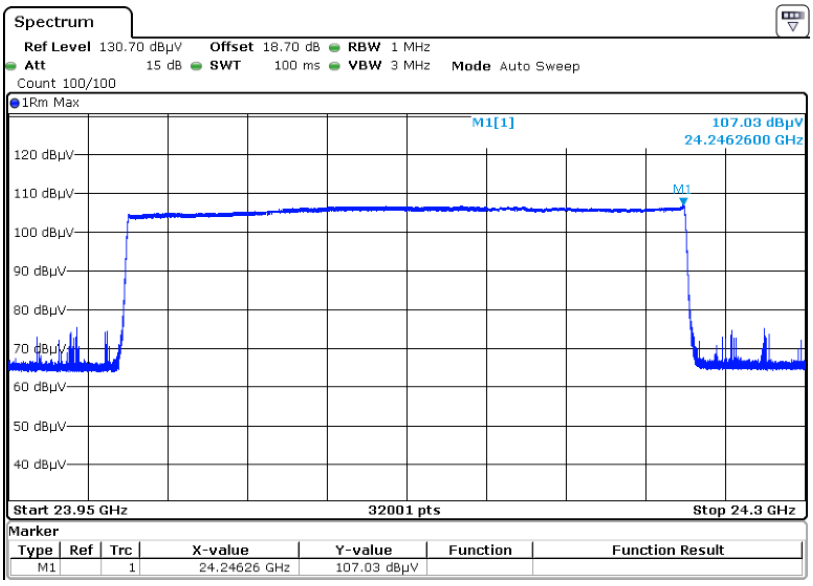


Figure 7.1-2: *Maximum RMS power plot (24.0025 – 24.2475 GHZ).*

7.2 Fundamental Emission Bandwidth: 10 dB bandwidth and 99 %

7.2.1 References

Title 47 → Part 15→ Subpart C → §15.249 → KDB 890966 D01 (D)
Determine the 10 dB emission bandwidth.

ISED RSS GEN→ 6.6 Occupied bandwidth
The emission bandwidth (x dB) is defined as the frequency range between two points, one above and one below the carrier frequency, at which the spectral density of the emission is attenuated x dB below the maximum in-band spectral density of the modulated signal. Spectral density (power per unit bandwidth) is to be measured with a detector of resolution bandwidth in the range of 1% to 5% of the anticipated emission bandwidth, and a video bandwidth at least 3x the resolution bandwidth. When the occupied bandwidth limit is not stated in the applicable RSS or reference measurement method, the transmitted signal bandwidth shall be reported as the 99% emission bandwidth, as calculated or measured.

- The transmitter shall be operated at its maximum carrier power measured under normal test conditions.
- The span of the analyzer shall be set to capture all products of the modulation process, including the emission skirts.
- The resolution bandwidth (RBW) shall be in the range of 1% to 5% of the occupied bandwidth (OBW) and video bandwidth (VBW) shall be approximately 3x RBW.

Note: Video averaging is not permitted.
A peak, or peak hold, may be used in place of the sampling detector as this may produce a wider bandwidth than the actual bandwidth (worst-case measurement). Use of a peak hold may be necessary to determine the occupied bandwidth if the device is not transmitting continuously.

The trace data points are recovered and are directly summed in linear power level terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached and that frequency recorded. The process is repeated for the highest frequency data points (starting at the highest frequency, at the right side of the span, and going down in frequency). This frequency is then recorded.

The difference between the two recorded frequencies is the 99% occupied bandwidth.

7.2.2 Test summary

Verdict	Pass		
Test date	December 4, 2019	Temperature	19°C
Test engineer	Martha Espinoza	Air pressure	1004 mbar
Test location	3m semi anechoic chamber	Relative humidity	69 %

7.2.3 Notes

This is a radiated test measurement and it was done at 3 meters of distance (far field). The worst case was considered for all the measurements (the maximum radiation of the antenna).

An offset of 18.70 dB was used in this test in order to compensate the losses in the measurement system. See note 7.1.3 for more details.

EUT setup configuration	Table top
Test facility	3m Semi anechoic chamber
Measuring distance	3m
Antenna height variation	1.85 m (worst case)
Turn table position	0° (worst case)

Spectrum analyzer settings for frequencies above 1 GHz:

Resolution bandwidth	1 MHz & 3 MHz
Video bandwidth	≥ 3 MHz
Detector mode	Peak
Trace mode	Max hold
Measurement time	100 ms

Note: None.

Table 7.2-1: *Fundamental Emission Bandwidth equipment list*

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
Antenna, Horn	Sage Millimeter	SAR-2309-42-S2	E1143	2 Years	03-05-2020
Signal Analyzer	Rohde & Schwarz	FSV 40	E1120	1 Year	11-19-2020
Low Noise Amplifier	Sage Millimeter	SBL-1834034030-KFKF-SI	E1228	NCR	NCR

Notes: None

7.2.5 Test data

Lowest frequency band permitted	24.00 GHz
Highest frequency band permitted	24.25 GHz
10 dB BW (MHZ) measured	246.477 MHz
Lowest frequency band measured	24.001629 GHz
Highest frequency band measured	24.248106 GHz
Margin from the lowest frequency limit permitted (24 GHz)	1.629 MHz
Margin from the lowest frequency limit permitted (24.25 GHz)	1.894 MHz
Margin from the OBW limit permitted (250 MHz)	3.523 MHz
Result (Fundamental within the permitted frequency range)	Pass

Table 7.2-2: *Occupied bandwidth results (10 dB)*

Lowest frequency band permitted	24.00 GHz
Highest frequency band permitted	24.25 GHz
99% BW (MHZ) measured	245.258 MHz
Lowest frequency band measured	24.0025195 GHz
Highest frequency band measured	24.2477774 GHz
Margin from the lowest frequency limit permitted (24 GHz)	2.519 MHz
Margin from the lowest frequency limit permitted (24.25 GHz)	2.222 MHz
Margin from the OBW limit permitted (250 MHz)	4.742 MHz
Result (Fundamental within the permitted frequency range)	Pass

Table 7.2-2: *Occupied bandwidth results (99%)*

7.2.1 Test plots

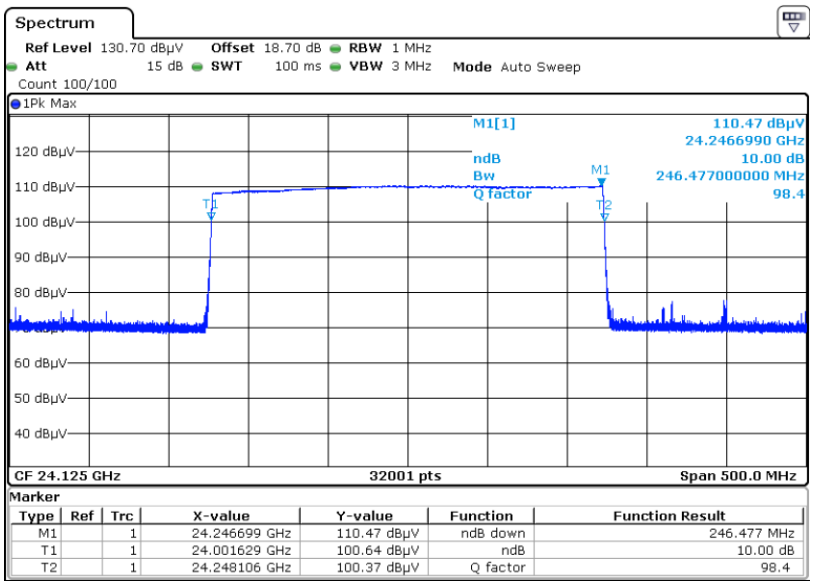


Figure 7.2-1: *Occupied bandwidth results (10 dB) plot*

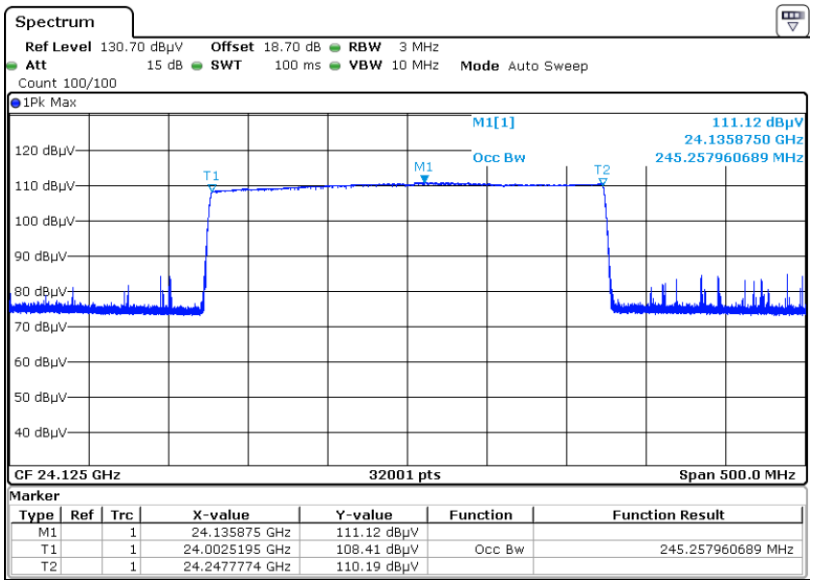


Figure 7.2-2: *Occupied bandwidth results (99%) plot*

7.3 Frequency Stability and Verification of Frequency Range Permitted

7.3.1 References

Title 47 → Part 15→ Subpart C → §15.249 paragraph (b) point (2) and KDB 890966 D01 (H)

As specified in Section 15.215(c), the bandwidth of the fundamental emission must be contained within the frequency band over the temperature range -20 to +50 degrees Celsius with an input voltage variation of 85% to 115% of rated input voltage. Frequency stability is to be measured according to Section 2.1055 at the highest and lowest frequency of operation and with the modulation that produces the widest emission bandwidth.

ISED RSS Gen→ 6.11 Transmitter Frequency Stability

In circumstances when the transmitter frequency stability is not stated in the applicable RSS or reference measurement method, the following applies:

• Frequency stability is a measure of frequency drift due to temperature and supply voltage variations, with reference to the frequency measured at an appropriate reference temperature and the rated supply voltage. Unless specified otherwise in an RSS applicable to the device, the reference temperature for radio transmitters is +20°C (+68°F);

• A hand-held device that is only capable of operating using internal batteries shall be tested at the battery's nominal voltage, and again at the battery's operating end-point voltage, which must be specified by the equipment manufacturer. For this test, either a battery or an external power supply can be used; and

The operating carrier frequency shall be set up in accordance with the manufacturer's published operation and instruction manual prior to the commencement of these tests. No adjustment of any frequency-determining circuit element shall be made subsequent to this initial set-up.

With the transmitter installed in an environmental test chamber, the unmodulated carrier frequency shall be measured under the conditions specified below. A sufficient stabilization period at each temperature shall be used prior to each frequency measurement. The following temperatures and supply voltage ranges apply, unless specified otherwise in the applicable RSS:

(a) at the temperatures of -30°C (-22°F), +20°C (+68°F) and +50°C (+122°F), and at the manufacturer's rated supply voltage; and (b) at the temperature of +20°C (+68°F) and at ±15% of the manufacturer's rated supply voltage.

If the frequency stability limits are only met within a temperature range that is smaller than the -30°C to +50°C range specified in (a), the frequency stability requirement will be deemed to be met if the transmitter is automatically prevented from operating outside this smaller temperature range and if the published operating characteristics for the equipment are revised to reflect this restricted temperature range.

7.3.2 Test summary

Verdict	Pass		
Test date	December 3, 2019	Temperature	See table results
Test engineer	Martha Espinoza	Air pressure	1005 mbar
Test location	Wireless bench	Relative humidity	53 %

7.3.3 Notes

This is a radiated test measurement were done in line of sight between the EUT and receiving antenna to 1-meter distance approximately using a temperature chamber. The EUT was placed inside to the chamber and the receiving antenna was placed outside the chamber just like the spectrum analyzer. The measurement was done through a glass window and the VDC cable for feeding the EUT was introduced to the chamber by a hole which is filled with foam material for maintaining the environmental conditions desired into the temperature chamber.
It is important to mention that although the 99% OBW function was used for this test, this function is relative, and it is just necessary for evaluated the frequency variation of the device with the temperature and the variation voltage. The occupied bandwidth required by this standard is given in the section 7.2 (10 dB OBW).
The extreme temperatures for this test were from -30 degrees Celsius to +70 degrees Celsius. This temperature range was based on the extreme conditions supported by the device according to the manufacturer considering these conditions as the worst case.

7.3.4 Setup details

EUT setup configuration	Table top
Test facility	Wireless bench
Measuring distance	1 m approximately

Spectrum analyzer settings for frequencies above 1 GHz:

Resolution bandwidth	1 MHz
Video bandwidth	3 MHz
Detector mode	Peak
Trace mode	Max Hold
Measurement time	151 ms

Note: None

Table 7.3-1: *Frequency stability equipment list*

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
Antenna, Horn	Sage Millimeter	SAR-2309-42-S2	E1143	2 Years	03-05-2020
Signal Analyzer	Rohde & Schwarz	FSV 40	E1120	1 Year	11-19-2020
Low Noise Amplifier	Sage Millimeter	SBL-1834034030-KFKF-SI	E1228	NCR	NCR
Temperature chamber	Test Equity	115A	E1162	1 Year	06-18-2020

Notes: None

7.3.5 Test Data

Temperature	Lowest frequency band measured (GHz)	Highest frequency band measured (GHz)	99% OBW (MHZ)	Variation percent % Lowest frequency	Variation percent % Highest frequency	Variation percent % OBW
+70°C	24.0036565	24.246334	242.677	0.00280048510	0.00531943759	0.255
+60°C	24.0033379	24.2461979	242.859	0.00147315015	0.00475808576	0.330
+50°C	24.0030973	24.2459774	242.880	0.00047077479	0.00384862155	0.339
+40°C	24.0030548	24.2457861	242.731	0.00029371348	0.00305959433	0.278
+30°C	24.0029788	24.2458189	242.840	0.00002291382	0.00319487971	0.323
+20°C (Reference)	**24.0029843**	**24.2450443**	**242.059**	**N/A**	**N/A**	**N/A**
+10°C	24.0029423	24.2454296	242.487	0.00017497824	0.00158919074	0.177
0°C	24.0029581	24.2453084	242.350	0.00010915309	0.00108929477	0.120
-10°C	24.0029836	24.2450943	242.110	0.00000291630	0.00020622771	0.021
-20°C	24.0028898	24.2449014	242.011	0.00039370104	0.00058939880	0.020
-30°C	24.0028737	24.2447597	241.885	0.00046077604	0.00117384813	0.072

Note 1: The reference value for calculating the variation though the temperatures, it is the value measurement taken at +20°C and 120 V.

Table 7.3-2. *Temperature variation results at 120 V.*

Voltage	Lowest frequency band measured (GHz)	Highest frequency band measured (GHz)	99% OBW (MHZ)	Variation percent % Lowest frequency	Variation percent % Highest frequency	Variation percent % OBW
102 V	24.0030349	24.2447665	241.731	0.00021080712	0.00114580116	0.136
120 V (Reference)	**24.0029843**	**24.2450443**	**242.059**	**N/A**	**N/A**	**N/A**
138 V	24.003037	24.2447551	241.718	0.00021955603	0.00119282108	0.141

Table 7.3-3. *Voltage variation results at +20°C.*

The maximum variation in the lowest frequency band measured was to a temperature of +70°C and 120 V with a percentage of 0.00280% of variation.
The maximum variation in the highest frequency band measured was to a temperature of +70°C and 120 V with a percentage of 0.00532% of variation.
The maximum variation in the lowest frequency band measured was to a temperature of +20°C and 138 V with a percentage of 0.000219% of variation.
The maximum variation in the highest frequency band measured was to a temperature of +20°C and 138 V with a percentage of 0.001192% of variation.

In all cases, the percentage variation is ≤ 0.00532 %. Considering this percentage as the worst case if the lowest frequency and the highest frequency have this variation (0.00532 %) the low and high edge would be stay as follow:

Lowest frequency permitted (measured at 10 dB)	24.001629 GHz
Highest frequency permitted (measured at 10 dB)	24.248106 GHz
Lowest frequency permitted (measured at 10 dB -0.00532%) at 10 dB	24.00035211 GHz
Highest frequency permitted (measured at 10 dB +0.00532%) at 10 dB	24.24939600 GHz
Margin from the lowest frequency limit permitted (24 GHz)	352.11 kHz
Margin from the lowest frequency limit permitted (24.25 GHz)	604.00 kHz
Margin from the OBW limit permitted (250 MHz)	956.11 kHz
Result (Fundamental within the permitted frequency range)	Pass

Table 7.3-4. *Verification of the highest and lowest operation frequencies results.*

Note: This verification was done with the 10 dB occupied bandwidth only, because it was the worst case reported (246.477 MHz) and with this bandwidth in spite of the percentage variation, the signal is within the band, as is showed on the table 7.3-4.

7.3.5 Test plots

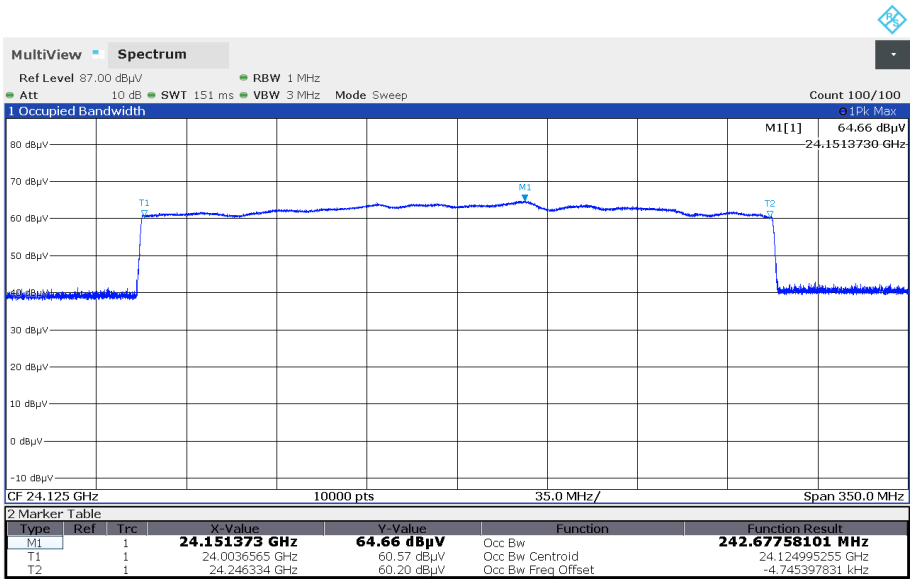


Figure 7.3-1. *Measurement taken at +70°C and 120 V. Maximum variation percent (worst case)*

Important note: The marker placed on the plot is not a real value because the corrections factors were not added for this plot. For frequency stability test, the variations are relative to the temperature and the voltage and for that reason is not necessary to add the correction factors. For seeing the correct EIRP consult the section 7.1.

7.4 Unwanted emissions and Band Edges

7.4.1 References

Title 47 → Part 15→ Subpart C → §15.249 → KDB 890966 D01 (G)

(a) Except as provided in paragraph (b) of this section, the field strength of emissions from intentional radiators operated within these frequency bands shall comply with the following:

Fundamental frequency	Field strength of fundamental (mv/m)	Field strength of fundamental (dBuv/m) @ 3m
902 – 928 MHz	500	113.97
2400 – 2483.5 MHz	500	113.97
5725 – 5875 MHz	500	113.97
24.0 – 24.25 GHz	2500	127.95

(c) Field strength limits are specified at a distance of 3 meters.

(d) Emissions radiated outside of the specified frequency bands, except for harmonics, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in §15.209, whichever is the lesser attenuation.

(e) As shown in §15.35(b), for frequencies above 1000 MHz, the field strength limits in paragraphs (a) and (b) of this section are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation.

ISED RSS-210→ Annex B B.10 Band 24 – 24.25 GHz

The field strength of harmonic emissions measured at 3 m shall not exceed the limits in table:

Fundamental frequency	Field strength of harmonic emissions (mv/m)	Field strength of harmonic emissions (dBuv/m) @ 3m
902 – 928 MHz	0.5	53.97
2400 – 2483.5 MHz	0.5	53.97
5725 – 5875 MHz	0.5	53.97
24.0 – 24.25 GHz	2.5	67.95

Emissions radiated outside of the specified frequency bands, except for harmonic emissions, shall be attenuated by at least 50 dB below the level of the fundamental emissions or to the general field strength limits listed in RSS-Gen, whichever is less stringent

7.4.2 Test summary

Verdict	Pass		
Test date	November 22, 2019	Temperature	20°C
	November 25, 2019		22°C
	November 27, 2019		20°C
	December 4, 2019		19°C
	December 9, 2019		19°C
Test engineer	Martha Espinoza	Air pressure	1008, 998, 1003, 1004, 1007 mbar respectively
Test location	3m semi anechoic chamber	Relative humidity	52%, 51%, 49 %, 69 % 64% respectively

Note: None

7.4.1 Notes

According to paragraph (d) of this section, the limits for the spurious emissions (except harmonics for USA) are defined by the next rule:
Emissions radiated outside of the specified frequency bands, shall be attenuated by at least 50 dB below the level of the fundamental or to the general radiated emission limits in §15.209, whichever is the lesser attenuation.

Frequency (MHz)	Field Strength (dµv/m)	Measurement distance (meters)
30 – 88	40	3
88 - 216	43.52	3
216 – 960	46.02	3
Above 960	53.97	3

FCC 15.209 Limits

Based on this affirmation to this case, the limits were chosen as follow (see section 7.1.6 for maximum EIRP details):

Maximum EIRP	Limit: Maximum EIRP – 50 dB
107.03 dBµv/m	57.03 dBµv/m

Following the previous rule, the limit level above 1 GHz in average detector is 53.97 dBµv/m which was chosen to be the lesser attenuation. Below 1 GHz the corresponding FCC 15.209 limit shall be applied too using a Quasi-peak detector. The distance is all the cases is 3 m unless otherwise specified.
For frequencies above 1000 MHz, the field strength limits are based on average limits. However, the peak field strength of any emission shall not exceed the maximum permitted average limits specified above by more than 20 dB under any condition of modulation.

7.4.2 Setup details

EUT setup configuration	Table top
Test facility	3m Semi Anechoic Chamber (SAC)
Measuring distance	3 m (Up 40 GHz); 0.53 m (Up 75 GHz); 0.21 m (Up 110 GHz); 0.15 m (Up 140 GHz; 0.005 m (Up 245 GHz)
Antenna height variation	1–4 m (Up 40 GHz); 1.70 m (Up 245 GHz)
Turn table position	0–360° (Up 40 GHz); 0° (Up 245 GHz)
Measurement details	A preview measurement was generated with receiver in continuous scan or sweep mode while the EUT was rotated and antenna adjusted to maximize radiated emission. Emissions detected within 6 dB or above limit were re-measured with the appropriate detector against the correlating limit and recorded as the final measurement.

Receiver/spectrum analyzer settings for frequencies below 1 GHz:

Resolution bandwidth	120 kHz
Video bandwidth	300 kHz
Detector mode	– Peak (Preview measurement) – Quasi-peak (Final measurement)
Trace mode	Max Hold
Measurement time	– 100 ms (Peak preview measurement) – 1000 ms (Quasi-peak final measurement)

Receiver/spectrum analyzer settings for frequencies above 1 GHz:

Resolution bandwidth	1 MHz
Video bandwidth	3 MHz
Detector mode	Peak (Preview measurement) Peak and CAverage (Final measurement)
Trace mode	Max Hold
Measurement time	– 100 ms (Peak preview measurement) – 100 ms (Peak and CAverage final measurement)

7.4.2 Setup details, continued

Table 7.4-1: *Radiated disturbance equipment list*

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
EMI Test Receiver	Rohde & Schwarz	ESU40	E1131	1 Year	08-23-2020
System Controller	Sunoc Sciences	SC104V	E1129	NCR	NCR
Bilog Antenna	Schaffner	CBL 6111D	1763	1 Year	01-17-2020
Horn Antenna	ETS-Lindgren	3117-PA	E1139	1 Year	03-21-2020
Signal Analyzer	Rohde & Schwarz	FSV 40	E1120	1 Year	11-19-2020
Antenna, Horn	Sage Millimeter	SAR-2309-42-S2	E1143	2 Years	03-05-2020
Antenna, Horn	Sage Millimeter	SAR-2309-28-S2	E1148	2 Years	03-13-2020
Low Noise Amplifier	Sage Millimeter	SBL-1834034030-KFKF-SI	E1228	NCR	NCR
Antenna, Horn	Sage Millimeter	SAR-2309-19-S2	E1144	NCR	NCR
Mixer	Rohde & Schwarz	FS-Z60	E1138	2 Years	03-07-2020
Antenna, Horn	Sage Millimeter	SAR-2408-15-S2	E1152	NCR	NCR
Mixer	Rohde & Schwarz	FS-Z75	E1149	2 Years	10-26-2020
Antenna, Horn	Sage Millimeter	SAR-2507-10-S2	E1146	NCR	NCR
Mixer	Rohde & Schwarz	FS-Z110	E1154	2 Years	02-06-2020
Antenna, Horn	Sage Millimeter	SAR-2507-06-S2	E1182	NCR	NCR
Mixer	Radiometer Physics	HM110-170	E1178	2 Years	09-27-2020
Antenna, Horn	Sage Millimeter	SAR-2309-05-S2	E1184	NCR	NCR
Mixer	Radiometer Physics	HM140-220	E1177	2 Years	09-25-2020
Antenna Horn	Sage Millimeter	SAR-2507-03-S2	E1181	NCR	NCR
Mixer	Radiometer Physics	HM220-325	E1236	2 Years	09-26-2020

Notes: NCR - no calibration required

7.4.1 Test Data and Test Plots

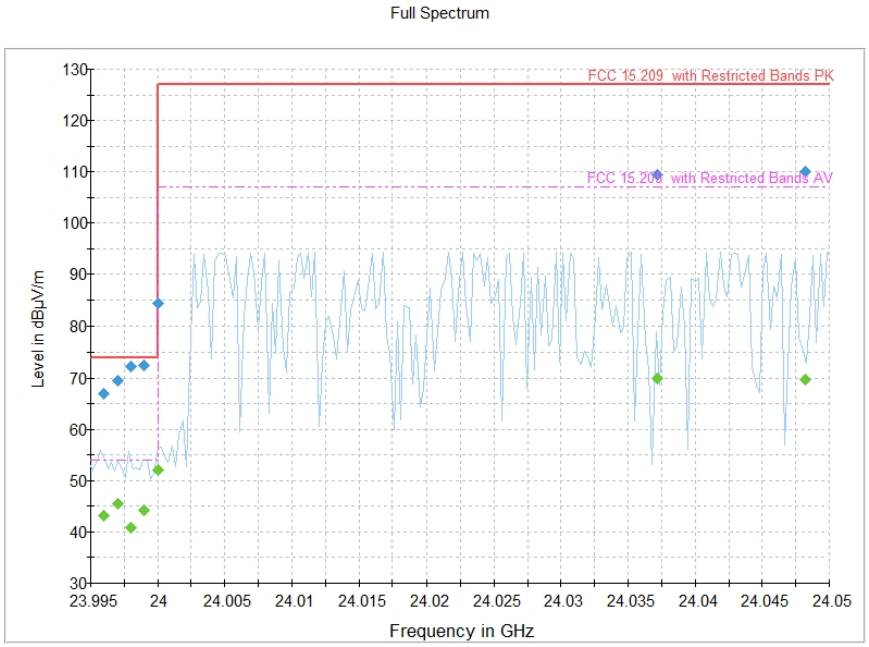


Figure 7.4-1: *Band Edges plot – Low edge.*

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
23996.000000	---	43.20	54.00	10.80	5000.0	1000.000	160.0	H	-2.0	19.1
23996.000000	67.01	---	74.00	6.99	5000.0	1000.000	160.0	H	-2.0	19.1
23997.000000	69.47	---	74.00	4.53	5000.0	1000.000	161.0	H	1.0	19.1
23997.000000	---	45.57	54.00	8.43	5000.0	1000.000	161.0	H	1.0	19.1
23998.000000	72.25	---	74.00	1.75	5000.0	1000.000	154.0	H	0.0	19.1
23998.000000	---	40.76	54.00	13.24	5000.0	1000.000	154.0	H	0.0	19.1
23999.000000	72.44	---	74.00	1.56	5000.0	1000.000	161.0	H	0.0	19.1
23999.000000	---	44.31	54.00	9.69	5000.0	1000.000	161.0	H	0.0	19.1
24000.000050	84.32	---	127.03	42.71	5000.0	1000.000	144.0	H	-2.0	19.1
24000.000050	---	52.14	107.03	54.89	5000.0	1000.000	144.0	H	-2.0	19.1
24037.200000	109.37	---	127.03	17.66	5000.0	1000.000	148.0	H	1.0	19.0
24037.200000	---	69.86	107.03	37.17	5000.0	1000.000	148.0	H	1.0	19.0
24048.205000	110.13	---	127.03	16.90	5000.0	1000.000	150.0	H	0.0	19.0
24048.205000	---	69.76	107.03	37.27	5000.0	1000.000	150.0	H	0.0	19.0

Table 7.4-1: *Band Edges plot – Low edge.*

Notes:
[1] Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factors = antenna factor ACF (dB) + cable loss (dB)
[3] The maximum measured value observed over a period of 15 seconds was recorded.
[4] The spectral plot is a summation of a vertical and horizontal scan.

7.4.1 Test Data and Test Plots

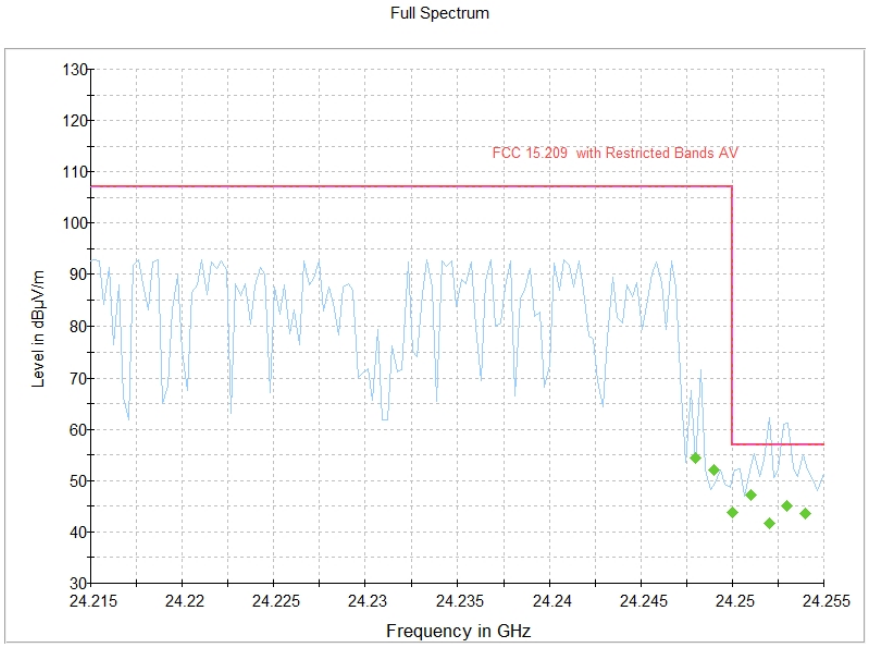


Figure 7.4-1: *Band Edges plot – High edge.*

Frequency (MHz)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
24248.000000	54.52	107.03	52.51	5000.0	1000.000	145.0	H	0.0	17.5
24249.000000	51.98	107.03	55.05	5000.0	1000.000	155.0	H	0.0	17.5
24249.995000	43.72	107.03	63.31	5000.0	1000.000	149.0	H	-4.0	17.5
24251.000000	47.16	57.03	9.87	5000.0	1000.000	149.0	H	2.0	17.5
24252.000000	41.61	57.03	15.42	5000.0	1000.000	175.0	H	-2.0	17.5
24253.000000	45.02	57.03	12.01	5000.0	1000.000	156.0	H	0.0	17.5
24254.000000	43.69	57.03	13.34	5000.0	1000.000	143.0	H	0.0	17.5

Table 7.4-1: *Band Edges plot – High edge.*

Notes:
[1] Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factors = antenna factor ACF (dB) + cable loss (dB)
[3] The maximum measured value observed over a period of 15 seconds was recorded.
[4] The spectral plot is a summation of a vertical and horizontal scan.

7.4.2 Test Data and Test Plots

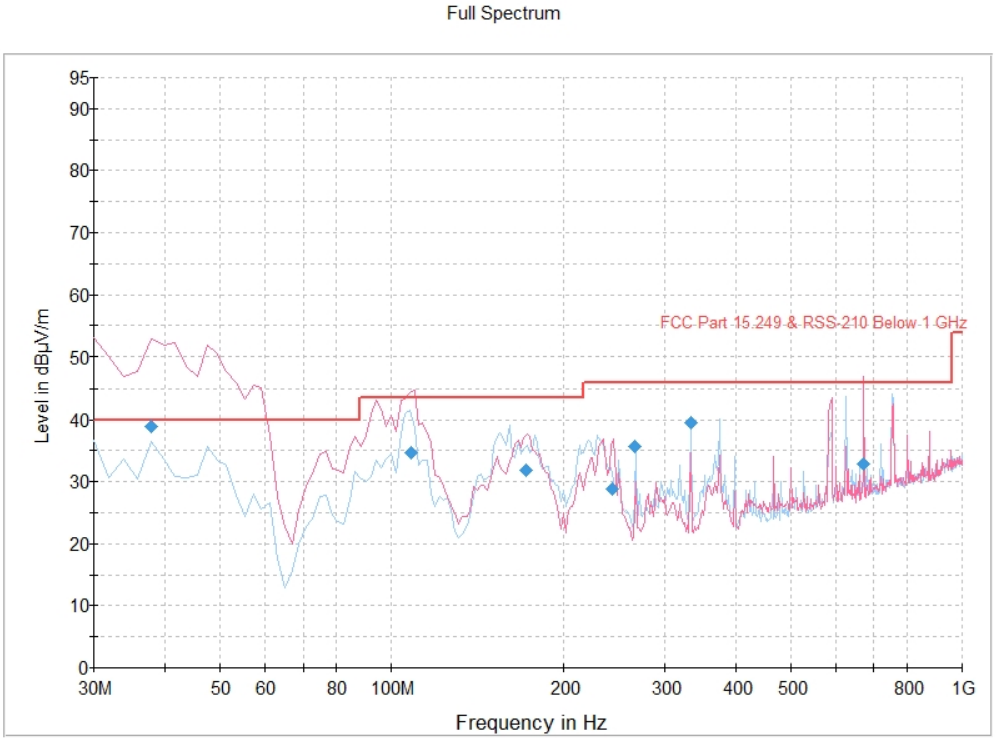


Figure 7.4-1: *Radiated emissions plot – Field strength measured from 30 to 1000 MHZ.*

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
37.895551	38.93	40.00	1.07	1000.0	120.000	103.0	V	167.0	15.5
108.339399	34.77	43.50	8.73	1000.0	120.000	114.0	V	347.0	12.7
171.703808	31.89	43.50	11.61	1000.0	120.000	104.0	V	223.0	11.7
243.387655	28.86	46.00	17.14	1000.0	120.000	109.0	V	200.0	14.6
266.674309	35.60	46.00	10.40	1000.0	120.000	98.0	H	202.0	15.8
333.326493	39.55	46.00	6.45	1000.0	120.000	102.0	H	224.0	17.2
671.282966	32.79	46.00	13.21	1000.0	120.000	150.0	V	333.0	24.2

Table 7.4-2: *Radiated emissions results – Field strength measured from 30 to 1000 MHZ.*

Notes:
[1] Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factors = antenna factor ACF (dB) + cable loss (dB)
[3] The maximum measured value observed over a period of 15 seconds was recorded.
[4] The spectral plot is a summation of a vertical and horizontal scan.

Important note: The lowest frequency response in the plot it is produced by the PoE which feed the EUT. Several ferrites were added for decreasing the exceeded signal above the limit. However, once the lowest frequency passed the limit, the working on the PoE with ferrites was stopped, because the PoE response, it is not part of this test.

7.4.4 Test Data and Test Plots continued

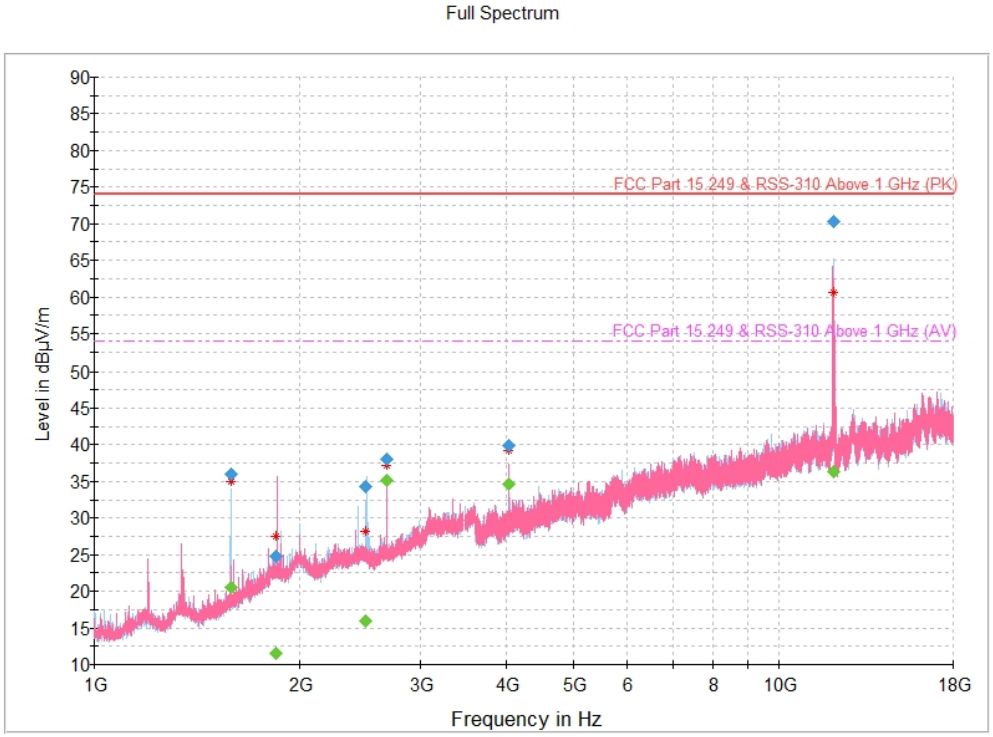


Figure 7.4-2: *Radiated emissions plot – Field strength measured from 1 to 18 GHZ.*

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1584.066667	36.01	---	73.97	37.96	5000.0	1000.000	110.0	H	180.0	-15.3
1584.066667	---	20.51	53.97	33.46	5000.0	1000.000	110.0	H	180.0	-15.3
1847.633333	24.71	---	73.97	49.26	5000.0	1000.000	242.0	V	-10.0	-12.2
1847.633333	---	11.55	53.97	42.42	5000.0	1000.000	242.0	V	-10.0	-12.2
2499.833333	34.32	---	73.97	39.65	5000.0	1000.000	105.0	H	122.0	-10.4
2499.833333	---	15.99	53.97	37.98	5000.0	1000.000	105.0	H	122.0	-10.4
2680.000000	38.02	---	73.97	35.95	5000.0	1000.000	102.0	V	328.0	-9.8
2680.000000	---	35.09	53.97	18.88	5000.0	1000.000	102.0	V	328.0	-9.8
4020.166667	39.81	---	73.97	34.16	5000.0	1000.000	98.0	V	309.0	-4.7
4020.166667	---	34.56	53.97	19.41	5000.0	1000.000	98.0	V	309.0	-4.7
12013.433333	70.27	---	73.97	3.70	5000.0	1000.000	171.0	H	50.0	3.7
12013.433333	---	36.38	53.97	17.59	5000.0	1000.000	171.0	H	50.0	3.7

Table 7.4-4: *Radiated emissions results – Field strength measured from 1 to 18 GHZ.*

Notes:
[1] Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factors = antenna factor ACF (dB) + cable loss (dB)
[3] The maximum measured value observed over a period of 15 seconds was recorded.
[4] The spectral plot is a summation of a vertical and horizontal scan.

7.4.4 Test Data and Test Plots continued

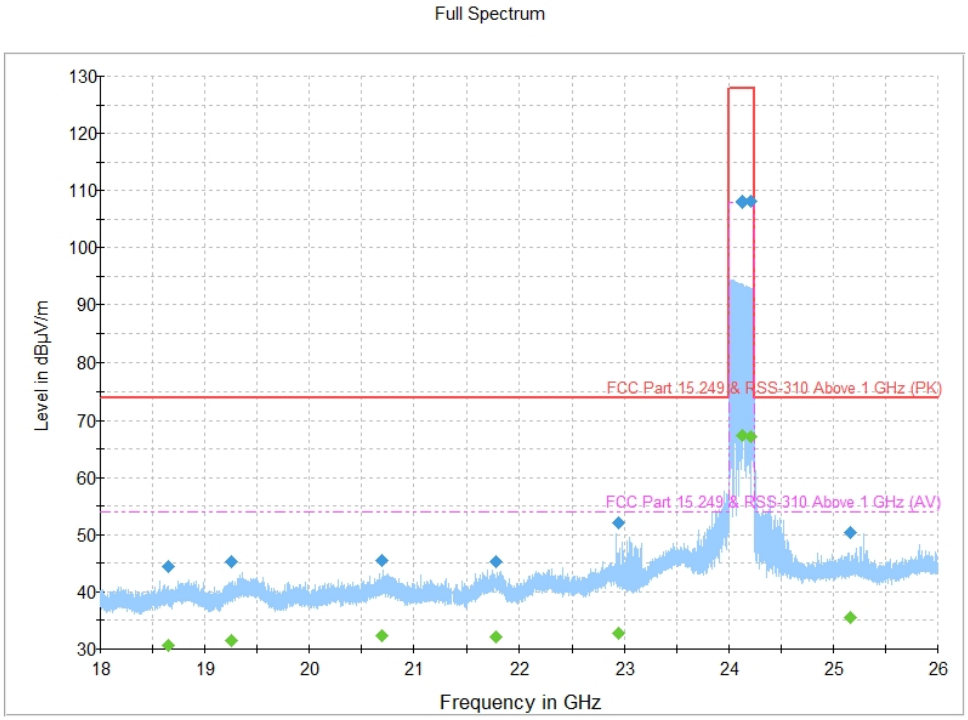


Figure 7.4-10: *Radiated emissions plot – Field strength measured from 18 GHZ to 26 GHZ.*

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
18647.972167	---	30.56	53.97	23.41	5000.0	1000.000	125.0	H	147.0	14.2
18647.972167	44.36	---	73.97	29.61	5000.0	1000.000	125.0	H	147.0	14.2
19251.964000	---	31.56	53.97	22.41	5000.0	1000.000	225.0	V	316.0	14.5
19251.964000	45.19	---	73.97	28.78	5000.0	1000.000	225.0	V	316.0	14.5
20692.121167	45.60	---	73.97	28.37	5000.0	1000.000	214.0	H	47.0	15.8
20692.121167	---	32.24	53.97	21.73	5000.0	1000.000	214.0	H	47.0	15.8
21770.073833	---	32.16	53.97	21.81	5000.0	1000.000	125.0	H	54.0	16.2
21770.073833	45.26	---	73.97	28.71	5000.0	1000.000	125.0	H	54.0	16.2
22949.084667	51.99	---	73.97	21.98	5000.0	1000.000	153.0	V	0.0	16.9
22949.084667	---	32.86	53.97	21.11	5000.0	1000.000	153.0	V	0.0	16.9
24131.392667	---	67.39	107.96	40.57	5000.0	1000.000	186.0	V	0.0	18.4
24131.392667	107.99	---	127.96	19.97	5000.0	1000.000	186.0	V	0.0	18.4
24134.103333	---	67.39	107.96	40.57	5000.0	1000.000	184.0	V	0.0	18.4
24134.103333	108.03	---	127.96	19.93	5000.0	1000.000	184.0	V	0.0	18.4
24207.638500	108.15	---	127.96	19.81	5000.0	1000.000	184.0	V	0.0	17.8
24207.638500	---	67.25	107.96	40.71	5000.0	1000.000	184.0	V	0.0	17.8
25160.904500	---	35.48	53.97	18.49	5000.0	1000.000	166.0	V	2.0	18.8
25160.904500	50.40	---	73.97	23.57	5000.0	1000.000	166.0	V	2.0	18.8

Table 7.4-6: *Radiated emissions results – Field strength measured from 18 to 26 GHZ.*

Notes:
[1] Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factors = antenna factor ACF (dB) + cable loss (dB)
[3] The maximum measured value observed over a period of 15 seconds was recorded.
[4] The spectral plot is a summation of a vertical and horizontal scan.
[5] The Fundamental is not restricted under limits of this section and it is showed just as reference.

7.4.4 Test Data and Test Plots continued

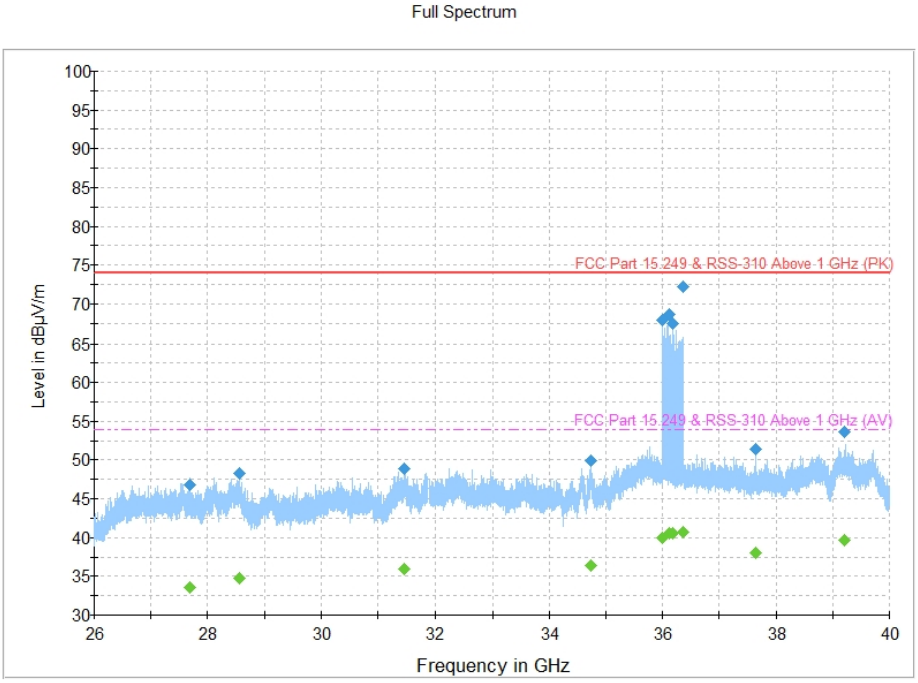


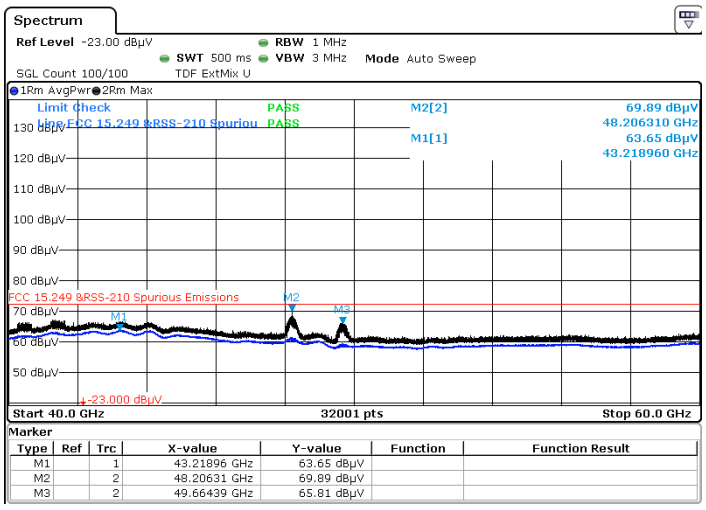
Figure 7.4-11: *Radiated emissions plot – Field strength measured from 26 to 40 GHZ.*

Frequency (MHz)	MaxPeak (dBµV/m)	CAverage (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
27686.666667	---	33.63	53.97	20.34	5000.0	1000.000	182.0	H	253.0	9.4
27686.666667	46.80	---	73.97	27.17	5000.0	1000.000	182.0	H	253.0	9.4
28557.533333	---	34.72	53.97	19.25	5000.0	1000.000	175.0	V	211.0	10.5
28557.533333	48.25	---	73.97	25.72	5000.0	1000.000	175.0	V	211.0	10.5
31469.333333	48.83	---	73.97	25.14	5000.0	1000.000	108.0	V	248.0	13.0
31469.333333	---	35.91	53.97	18.06	5000.0	1000.000	108.0	V	248.0	13.0
34743.866667	---	36.45	53.97	17.52	5000.0	1000.000	216.0	V	8.0	14.4
34743.866667	49.89	---	73.97	24.08	5000.0	1000.000	216.0	V	8.0	14.4
36004.400000	---	39.94	53.97	14.03	5000.0	1000.000	154.0	V	308.0	16.4
36004.400000	67.86	---	73.97	6.11	5000.0	1000.000	154.0	V	308.0	16.4
36112.400000	---	40.55	53.97	13.42	5000.0	1000.000	151.0	V	310.0	16.6
36112.400000	68.68	---	73.97	5.29	5000.0	1000.000	151.0	V	310.0	16.6
36170.866667	---	40.50	53.97	13.47	5000.0	1000.000	125.0	V	325.0	16.6
36170.866667	67.50	---	73.97	6.47	5000.0	1000.000	125.0	V	325.0	16.6
36370.000000	---	40.73	53.97	13.24	5000.0	1000.000	151.0	V	330.0	16.4
36370.000000	72.26	---	73.97	1.71	5000.0	1000.000	151.0	V	330.0	16.4
37646.133333	51.34	---	73.97	22.63	5000.0	1000.000	187.0	V	8.0	15.8
37646.133333	---	37.98	53.97	15.99	5000.0	1000.000	187.0	V	8.0	15.8
39212.333333	---	39.72	53.97	14.25	5000.0	1000.000	151.0	V	6.0	18.4
39212.333333	53.59	---	73.97	20.38	5000.0	1000.000	151.0	V	6.0	18.4

Table 7.4-9: *Radiated emissions results – Field strength measured from 26 to 40 GHZ.*

Notes:
[1] Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factors = antenna factor ACF (dB) + cable loss (dB)
[3] The maximum measured value observed over a period of 15 seconds was recorded.
[4] The spectral plot is a summation of a vertical and horizontal scan.

7.4.4 Test Data and Test Plots continued



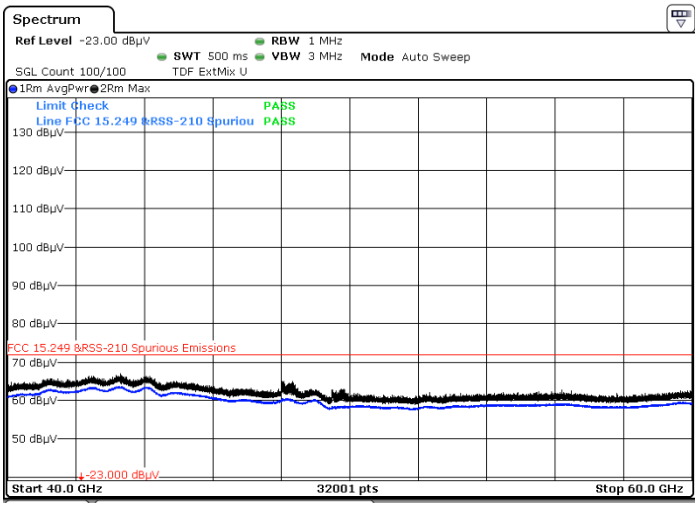
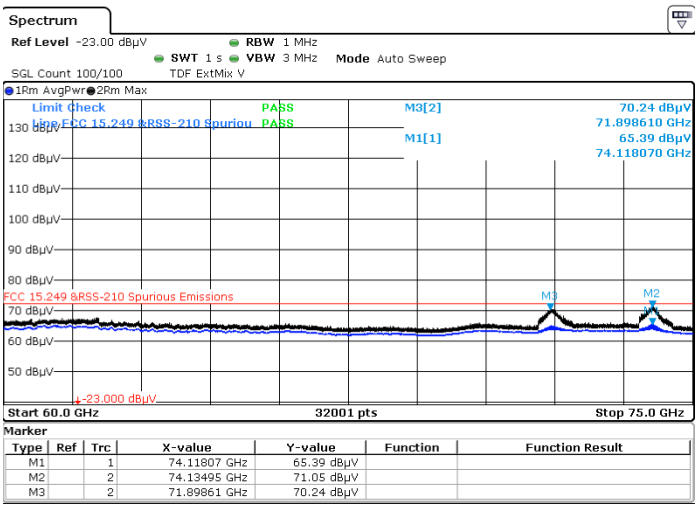


Figure 7.4-12: Radiated emissions plot – Field strength measured from 40 to 60 GHZ, Rx antenna in horizontal and vertical polarization, respectively.



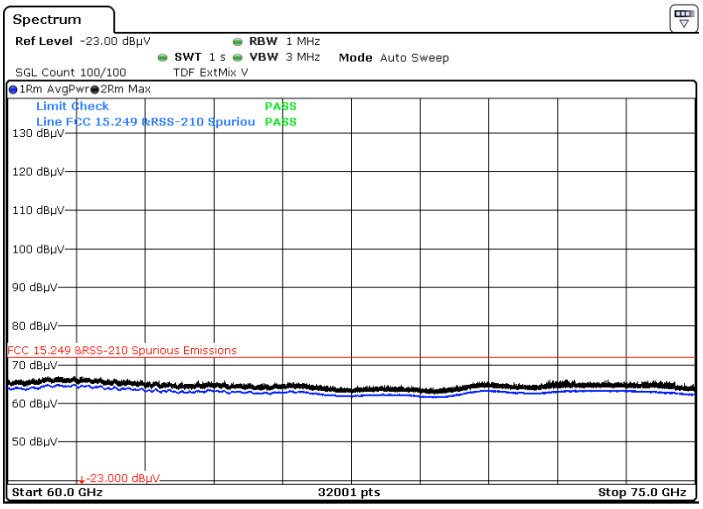


Figure 7.4-13: Radiated emissions plot – Field strength measured from 60 to 75 GHZ, Rx antenna in horizontal and vertical polarization, respectively.

For these ranges, the measurement distance was different to 3 meters, because above 40 GHz, the test setup has not a pre-amplifier, which favors the increasing the noise floor. For compensating this situation, the measurements were done a close distance to the receiving antenna and the limit level was extrapolated. The extrapolation of the limit level and the new distance, were calculated with the follow equation:

$$Espec\ limit = Emeas + 20\ Log\ (\frac{Distance\ meas}{Distance\ spec\ limit}) \qquad \text{(Equation 1.0)}$$

It is important to mention that before to use the equation 1.0, do a measurement of the level of noise floor is paramount, in order to get a noise floor at least 6 dB below the limit line. In this way, every time the noise floor changes, the limit line level and the measurement distance shall be recalculated.
For this case, the new limit level from 40 GHz to 75 GHz is 72.08 dBµv/m with a new distance between the EUT and the receiving antenna of 53 cm. The antenna height was optimized too because the measurement distance was reduced, and the new final height is 1.70 m (worst case).

7.4.4 Test Data and Test Plots continued

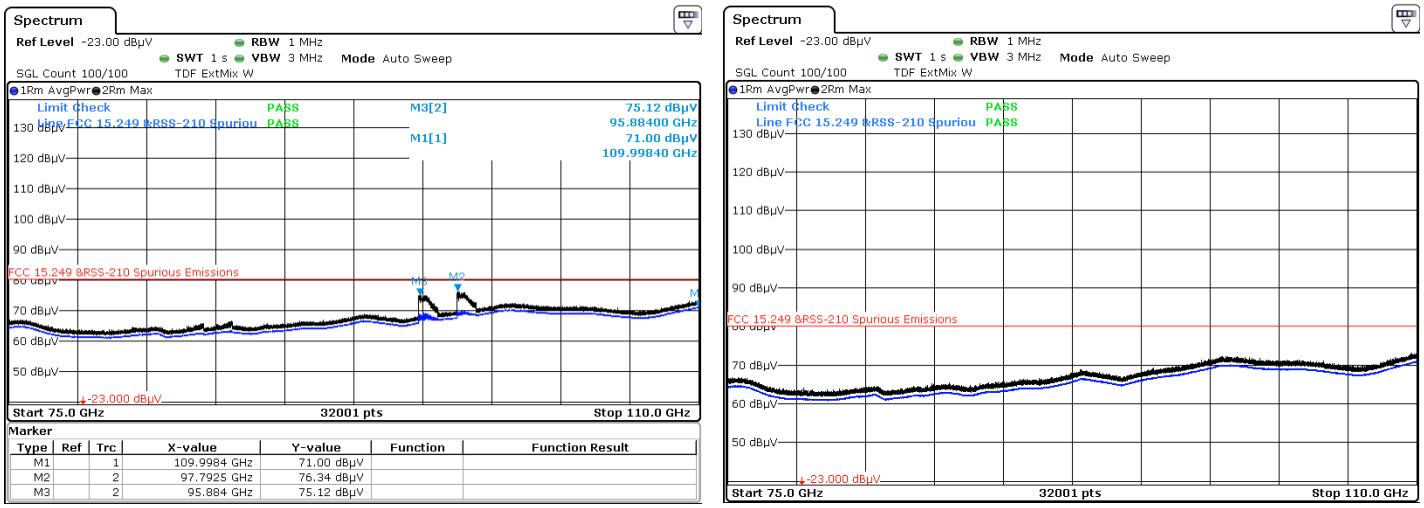


Figure 7.4-14: Radiated emissions plot – Field strength measured from 75 to 110 GHZ, Rx antenna in horizontal and vertical polarization, respectively.

This range shows a similar problem with the noise floor to the previous range. However, the noise floor usually increases as the frequency increases. So, it means, the same methodology needs to be applied to the new problem using equation 1.0.

Therefore, the new limit level from 75 GHz to 110 GHz is 80.12 dBµv/m with a new distance between the EUT and the receiving antenna of 21 cm and an antenna height of 1.70 m.

Previous three ranges (from 40 to 110 Ghz) shows the second, third and fourth harmonic. The limit applied to these harmonics is the spurious limit (57.03 dBuv/m at 3m) which is more restrictive to harmonic limit (67.95 dBuv/m @ 3m). Considering this paragraph, if the EUT is passing spurious emissions with its respective limit, it is passing harmonic limits too and it was not necessary to add this limit line.

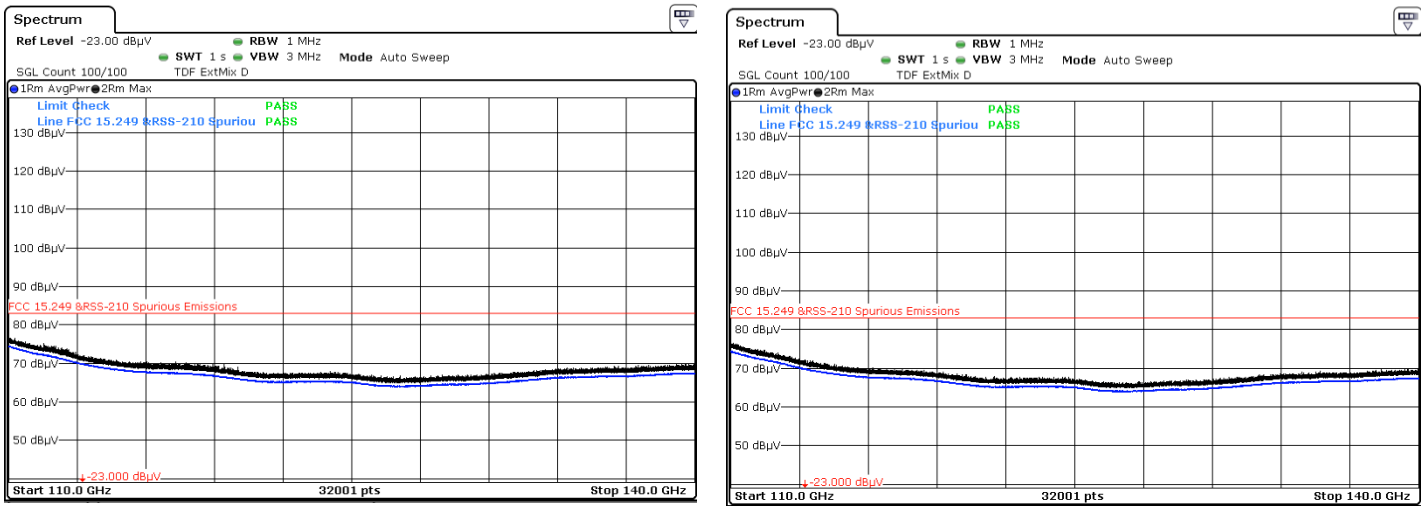


Figure 7.4-15: Radiated emissions plot – Field strength measured from 110 to 140 GHZ, Rx antenna in horizontal and vertical polarization, respectively.

This range shows a similar problem with the noise floor to the previous ranges. However, the noise floor usually increases as the frequency increases. So, it means, the same methodology needs to be applied to the new problem using equation 1.0.

Therefore, the new limit level from 110 GHz to 140 GHz is 83.05 dBµv/m with a new distance between the EUT and the receiving antenna of 15 cm and an antenna height of 1.70 m.

7.4.4 Test Data and Test Plots continued

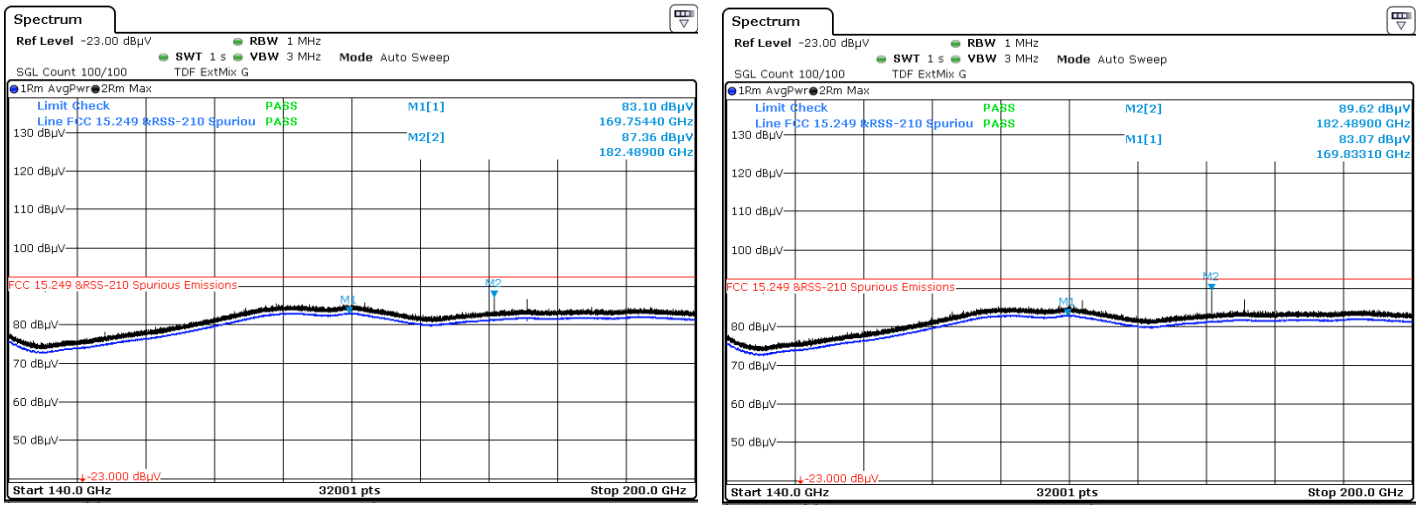


Figure 7.4-16: Radiated emissions plot – Field strength measured from 140 to 200 GHZ, Rx antenna in horizontal and vertical polarization, respectively.

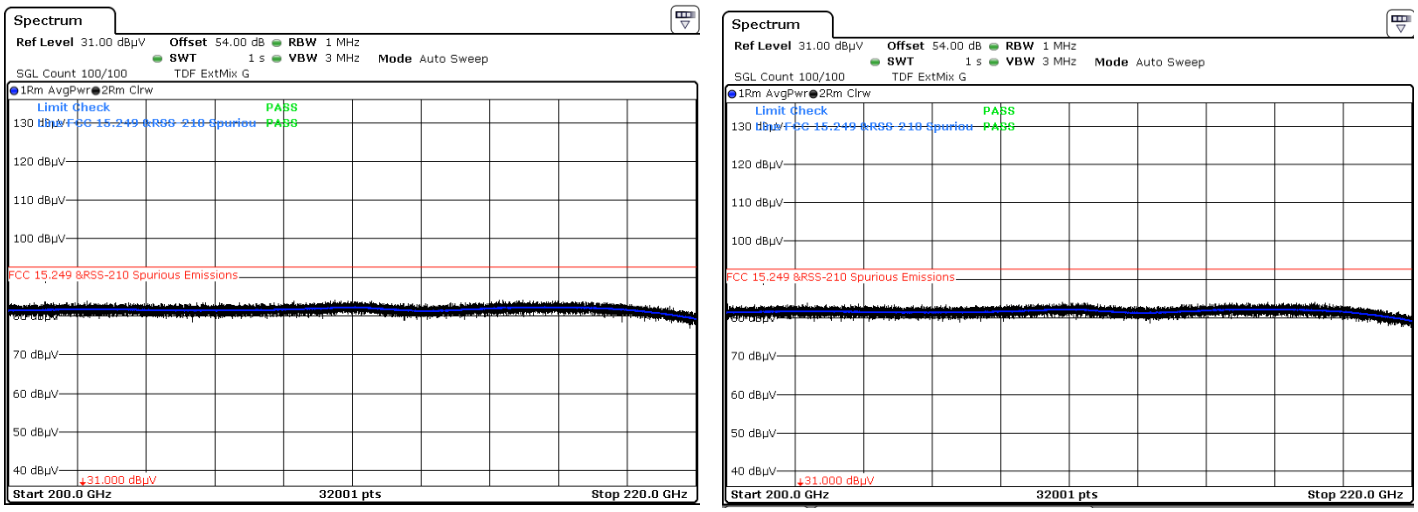


Figure 7.4-17: Radiated emissions plot – Field strength measured from 200 to 220 GHZ, Rx antenna in horizontal and vertical polarization, respectively.

This range shows a similar problem with the noise floor to the previous ranges. However, the noise floor usually increases as the frequency increases. So, it means, the same methodology needs to be applied to the new problem using equation 1.0.

Therefore, the new limit level from 140 GHz to 220 GHz is 92.59 dBµv/m with a new distance between the EUT and the receiving antenna of 5 cm and an antenna height of 1.70 m.

7.4.4 Test Data and Test Plots continued

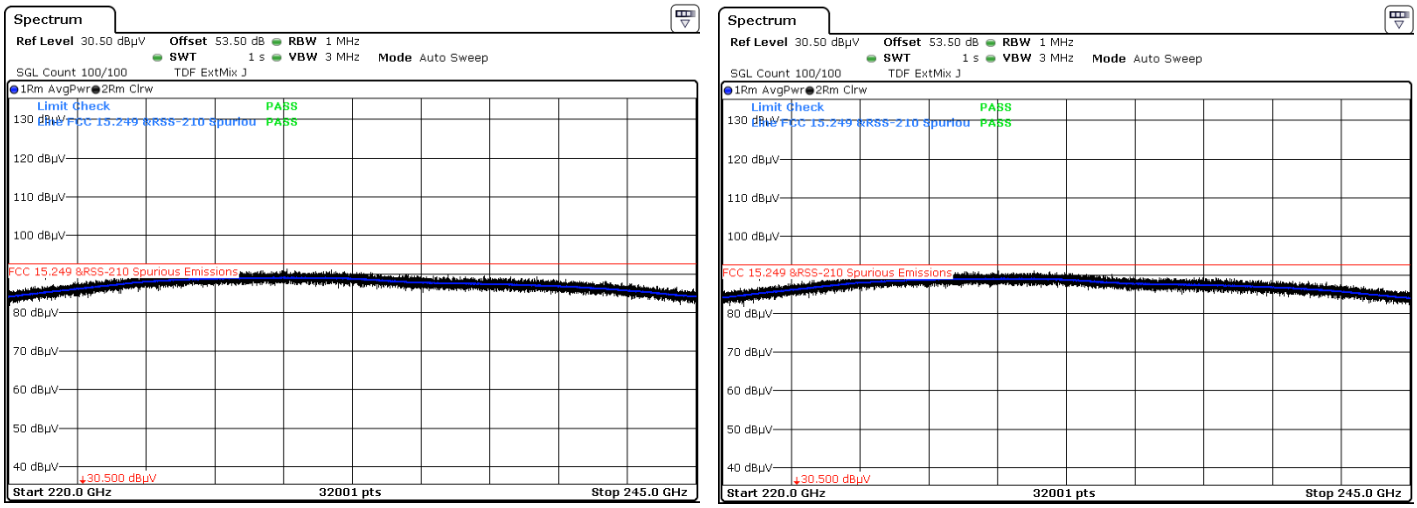


Figure 7.4-18: Radiated emissions plot – Field strength measured from 200 to 220 GHZ, Rx antenna in horizontal and vertical polarization, respectively.

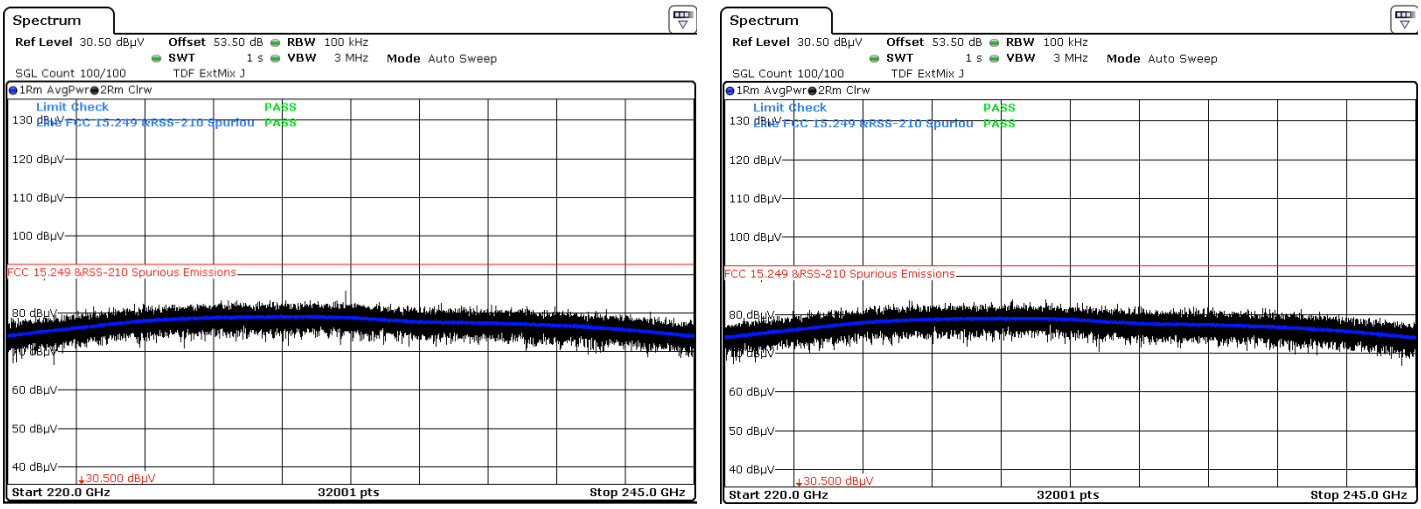


Figure 7.4-18: Radiated emissions plot – Field strength measured from 200 to 220 GHZ, Rx antenna in horizontal and vertical polarization, respectively (100 kHz RBW).

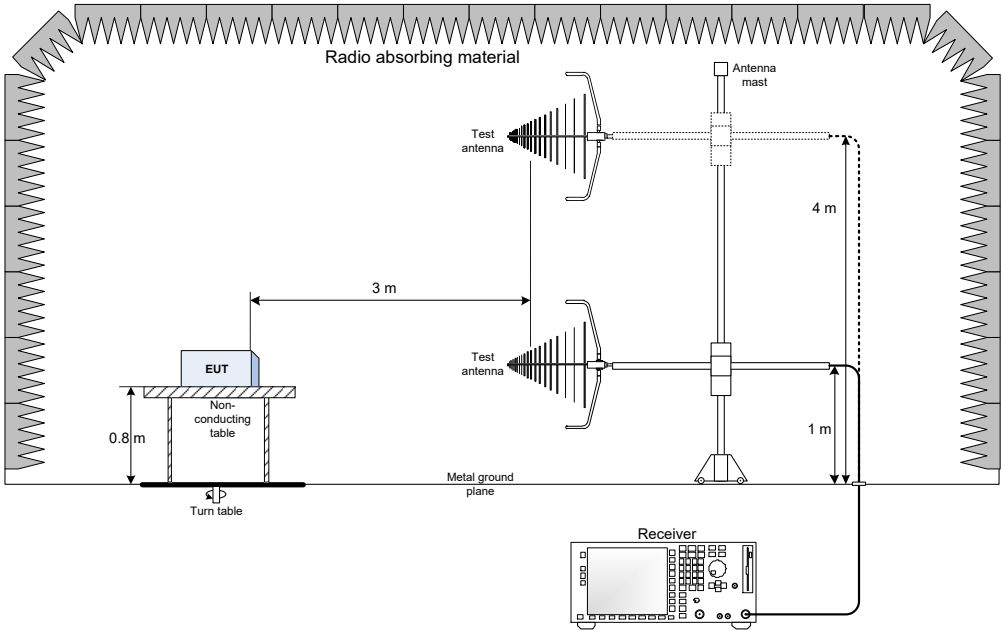
This range shows a similar problem with the noise floor to the previous ranges. However, the noise floor as was mention before, it is very high just like the frequency in this range. The range from 140 GHz to 220 GHz gave a measurement distance of 5 cm. If an extrapolation wants to be applied in this frequency range, the measuring distance shall be around 0 cm. For that reason, the best option for this range, is do it at 5 cm even though the noise floor has a separation from the limit line lesser than 6 dB. In the graph it is very clear that there is not any spurious in the complete range. For demonstrate the last words, the resolution bandwidth was changed from 1 MHz to 100 KHz, where obviously, the noise floor is reduced, and the complete range shows the cleaning of the frequency range.

Therefore, the limit level from 220 GHz to 245 GHz is 92.59 dBµv/m with a distance between the EUT and the receiving antenna of 5 cm and an antenna height of 1.70 m such as the previous range.

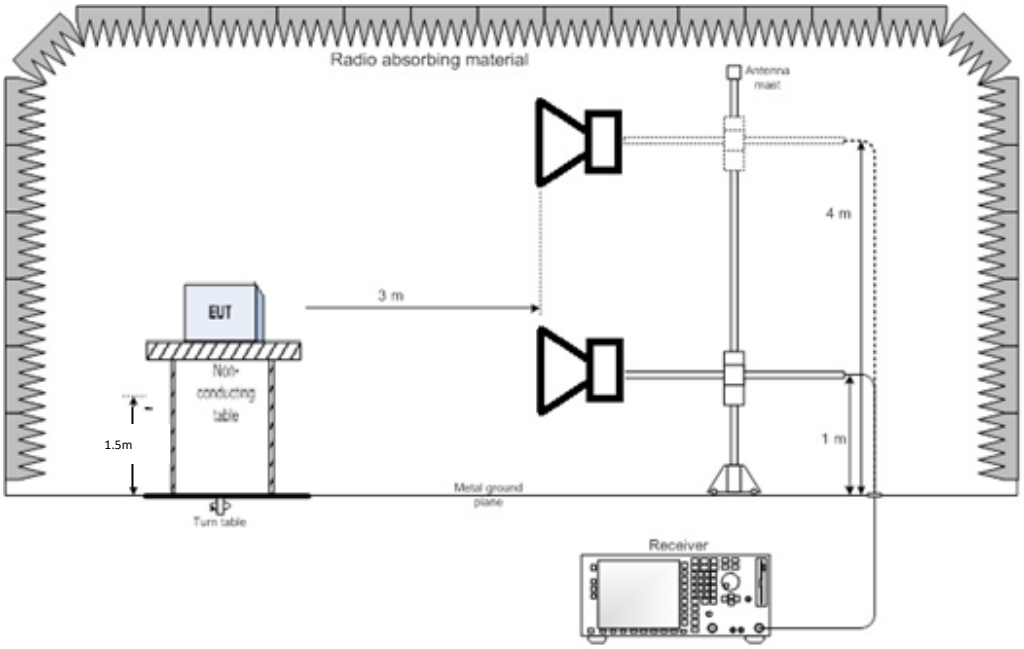
There is not harmonic presence from 110 to 245 GHz. Only spurious limit line was added.

Section 8 Block diagrams of test set-ups

8.1 Radiated emissions set-up



30-1000MHz Setup



Above 1GHz Setup

Thank you for choosing