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Test report

409030-2R1TRFWL

Date of issue: March 11, 2021

Applicant:
DENSITY INC.

Product:
Open Area

Model:
OA1

FCC ID: 2AYY6OA001 **IC: 26986-OA001**

Specifications:

- FCC 47 CFR Part 15.255 Subpart C
  Operation within the band 57 – 71 GHz
- RSS-210 Issue 10 (December 2019) + Amendment (April 2020)
  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

Tested by	Martha Espinoza, Wireless Test Engineer
Reviewed by	James Cunningham, EMC/MIL/WL Supervisor
Review date	March 11, 2021
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 15.255, Subpart C	Title 47: Telecommunication; Part 15C— Operation within the band 57 – 71 GHz
RSS-210 Issue 10 (December 2019) including Amendment (April 2020)	Licence-Exempt Radio Apparatus: Category I Equipment
ANSI C63.10-2013	American National Standard of procedures for compliance testing of unlicensed wireless devices

1.2 Exclusions

None

1.3 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.

1.4 Test report revision history

Table 1.4-1: *Test report revision history*

Revision #	Details of changes made to test report
409030-2TRFWL	Original report issued
409030-2R1TRFWL	Updated to include references to RSS-210

Notes: None

Section 2 Summary of test results

2.1 Emissions Test results

Table 2.1-1: *FCC 47 CFR Part 15.203 results.*

Test description	Verdict
Antenna requirement	Pass

Notes: None

Table 2.1-2 *FCC 47 CFR Part 15.255C results.*

Test description	Verdict
Equivalent Isotropically Radiated Power (E.I.R.P.)	Pass
Occupied Bandwidth	Pass
Peak conducted output power	Pass
Transmitter spurious emissions	Pass
Frequency stability	Pass

Notes: None

Table 2.1-3 *FCC 47 CFR Part 15.207 results.*

Test description	Verdict
AC Line conducted emissions	Pass

Notes: None

Table 2.1-3 *RSS-210 Annex J results.*

Test description	Verdict
Limits of radiated emissions within the band 57 – 71 GHz (J.2.1(b))	Pass
Spurious emissions (J.3)	Pass
Peak transmitter output power (J.4)	Pass
Frequency stability (J.6)	Pass

Section 3 Equipment under test (EUT) details

3.1 Applicant

Company name	Density Inc
Address	369 Sutter street
City	San Francisco
State	CA
Postal/Zip code	94108
Country	United States

3.2 Manufacturer

Company name	Density Inc
Address	369 Sutter street
City	San Francisco
State	CA
Postal/Zip code	94108
Country	United States

3.3 Sample information

Receipt date	November 5, 2020
Nemko sample ID number	NEx: 409030

3.4 EUT information

Product name	Open Area
Model	OA1
Serial number	B2EME013
Part number	890-0012
Power requirements	PoE
Description/theory of operation	Density's OA1 sensor(s) are installed overhead in a space and anonymously monitors human activity. An area can be anything from a conference room, a cafeteria, an open-office, a phone booth, etc. The OA1 sensor continually monitors the occupancy of subareas (e.g., desks) within its field of view. When a subarea occupancy changes, the OA1 sensor sends up meta-data such as subarea coordinates along with total count to the Density API. OA1 gathers its data anonymously, meaning OA1 has no way to determine the identity or even the gender of individual people. All people-count processing is currently implemented local to the OA1 device. People count analytics are published to Density's cloud service via the device's wired or wireless Internet connection. OA1 is powered by Power Over Ethernet (PoE) either from a router, switch, or PoE injector (wall socket power adapter). Customers access people count analytics via Density's cloud service APIs.
Operational frequencies	CF: 62.525 GHz
Software details	Texas Instrument - MMWAVE-SDK - mmWave software development kit (SDK) – The TI Software was used to set parameters for testing
Antenna gain	5 dBi (integrated antenna, not removable)

3.5 EUT exercise and monitoring details

The device was powered through an ethernet cable and ready to go (pre-loaded software by client). The unit was transmitting at max power.

3.6 EUT setup details

Table 3.6-1: *Support equipment*

Description	Brand name	Model/Part number	Serial number	Rev.
Ethernet switch (PoE)	StarTechcom	POEINJ4G	AF00327600957	N/A
Switching adapter	Shenzen heweishun network technology	BN031-A65051	N/A	N/A

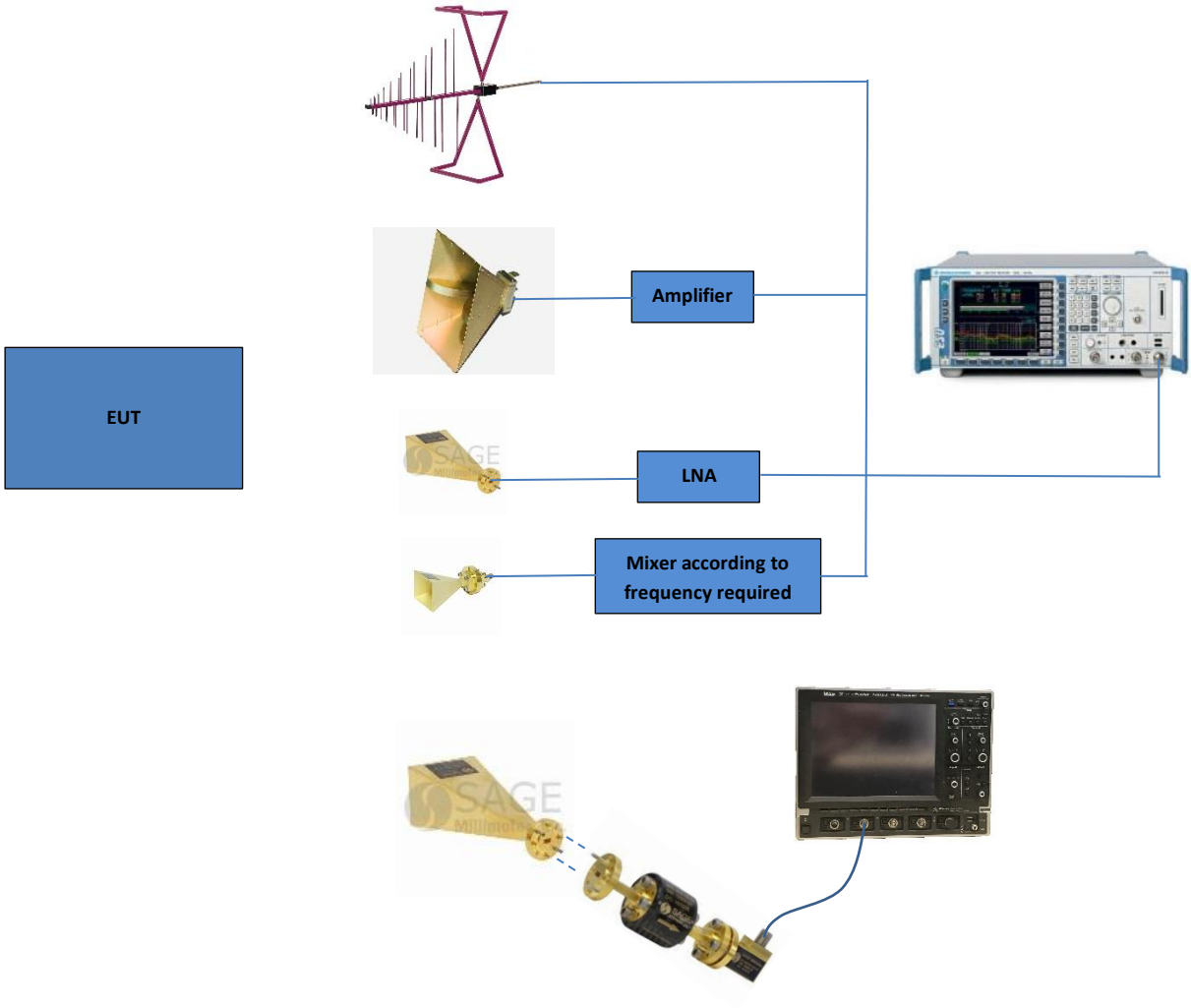


Figure 3.6-1: *EUT Test Setup*

Section 4 Engineering considerations

4.1 Modifications incorporated in the EUT

The following modifications were performed by client:
Reduction of power through a software modification on unit OA1 (B2EME013)

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	15–30 °C
Relative humidity	20–75 %
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.

Table 6.1-1: *Measurement uncertainty.*

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%

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

Section 7 Testing data

7.1 Conducted output Power and Equivalent Isotropically Radiated Power (E.I.R.P.)

7.1.1 References

§15.255 Operation within the band 57-71 GHz.
(c) Within the 57-71 GHz band, emission levels shall not exceed the following equivalent Isotropically radiated power (EIRP):
(3) For fixed field disturbance sensors other than those operating under the provisions of paragraph (c)(2) of this section, and short-range devices for interactive motion sensing, the peak transmitter conducted output power shall not exceed −10 dBm and the peak EIRP level shall not exceed 10 dBm.

RSS-210 Annex J: J.2.1(b)
For fixed field disturbance sensors other than those operating under the provisions of J.2.1(a) and for interactive motion sensors, the peak transmitter output power shall not exceed -10 dBm and the peak EIRP shall not exceed 10 dBm.

7.1.2 Test summary

Verdict	Pass		
Test date	March 2, 2021	Temperature	19 °C
Test engineer	Martha Espinoza, Wireless Test Engineer	Air pressure	1002 mbar
Test location	3m semi anechoic chamber	Relative humidity	34 %

7.1.3 Notes

This test performed using the procedure describe on ANSI C63.10-2013, section 9.11. The procedure indicates several steps using a measurement from EUT through a test antenna, a RF detector and a digital oscilloscope. A substitution method is used replacing the EUT by a mmWave source. to match the delivered power by mmWave source to the EUT. From this data, some calculus was done to determine the EIRP (peak and average) and the conducted power from equation (19), (22), (24) and (27) from ANSI C63.10-2013.
Minimum Far field distance declared by manufacturer: 0.081 mm; Antenna gain declared by manufacturer: 5 dBi; Gain of the test antenna: 24 dBi.

7.1.4 Setup details

EUT setup configuration	Tabletop
Test facility	3M Semi anechoic chamber
Measuring distance	0.15 m
Antenna height variation	1.50 m
Turn table position	0°
Measurement details	The EUT was measured in the maximum field strength emission.

Receiver/spectrum analyzer settings for frequencies above 1 GHz:

Resolution bandwidth	1 MHz
Video bandwidth	3 MHz
Detector mode	Peak
Trace mode	Max Hold

7.1.4 Setup details, continued

Table 7.1-1: *Radiated EIRP equipment list*

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
Antenna, Horn	Sage Millimeter	SAR-2408-15-S2	E1152	NCR	NCR
Signal analyzer	Rohde & Schwarz	FSV40	E1120	11-19-2019	11-19-2021
Mixer	Rohde & Schwarz	FS-Z75	E1149	03-07-2019	03-07-2021
Signal generator	Rohde & Schwarz	SMB100A	E1128	12-14-2020	12-14-2021
Digital oscilloscope	LeCroy	WS64MXS-B	E1041	12-13-2019	12-13-2021
V-Band X2, Passive Frequency Multiplier	Sage	SFP-152KF-S2	N/A	NCR	NCR
RF Detector	Eravant	STD-15SF-PI	E1310	NCR	NCR

Notes: NCR - no calibration required

7.1.5 Test data

Center Frequency (GHz)	Bandwidth (MHz)	Power (dBm)	Radiated Field Strength (Calculated – see example below)	EIRP (dBm)	Limit (dBm)	EIRP Margin (dB)	Conducted Power (dBm) (EIRP – declared antenna gain)	Conducted Power Limit (dBm)	Conducted Power Margin (dB)
62.525	2705	-35.51	113.668	-7.509	+10	17.509	-12.509	-10	**2.509**

Table 7.1-2: *EIRP Results.*

Using equation (19):

$$E = 126.8 - 20\log(\lambda) + P - G \qquad (19)$$

Where:

$$\lambda = \frac{c}{f}$$

c=3_X10^8 m/s

E = Field strength of the emission at the measurement distance, in dBµv/m

P = Power measured at the output of the test antenna, in dBm

λ = Wavelength of the emission under investigation, in m.

G = Gain of the antenna test, in dBi

E = 126.8 – (20*log10(3e8/62.525e9))+(-35.52)-(24) = 113.668 dBµV/m

Using equation (22):

$$\mathrm{EIRP} = E_{\mathrm{Meas}} + 20\log(d_{\mathrm{Meas}}) - 104.7 \qquad (22)$$

EIRP = Equivalent Isotropically Radiated Power, in dBm

E_{meas} = Field strength of the emission at the measurement distance, in dBµv/m

d_{meas} = Measurement distance, in m (0.15 m in this case)

EIRP = 113.668 + (20*log10(0.15))-104.7

EIRP = -7.509 dBm

7.2 Occupied bandwidth

7.2.1 References

§15.255 Operation within the band 57-71 GHz.
(e)(1) Transmitters with an emission bandwidth of less than 100 MHz must limit their peak transmitter conducted output power to the product of 500 mW times their emission bandwidth divided by 100 MHz. For the purposes of this paragraph, emission bandwidth is defined as the instantaneous frequency range occupied by a steady state radiated signal with modulation, outside which the radiated power spectral density never exceeds 6 dB below the maximum radiated power spectral density in the band, as measured with a 100 kHz resolution bandwidth spectrum analyzer. The center frequency must be stationary during the measurement interval, even if not stationary during normal operation (e.g., for frequency hopping devices).
RSS-210 Annex J.4
For devices with an emission bandwidth greater than or equal to 100 MHZ, the peak transmitter output power shall not exceed 500 mW. Emission bandwidth is defined as the instantaneous frequency range occupied by a steady radiated signal with modulation, outside which the radiated power spectral density shall be 6 dB below the maximum radiated power spectral density in the band, as measured with a 100 kHz resolution bandwidth. The center frequency must be stationary during the measurement even if not stationary during normal operation.
ANSI C63.4-2014

7.2.2 Test summary

Verdict	Pass		
Test date	December 15, 2020	Temperature	21 °C
Test engineer	Martha Espinoza, Wireless Test Engineer	Air pressure	1004 mbar
Test location	3m semi anechoic chamber	Relative humidity	52 %

7.2.3 Notes

7.2.4 Setup details

EUT setup configuration	Tabletop
Test facility	3M Semi anechoic chamber
Measuring distance	0.5 m
Antenna height variation	1.60 m
Turn table position	0°

Receiver/spectrum analyzer settings for frequencies above 1 GHz:

Resolution bandwidth	100 kHz (6 dB OBW) and 3 MHz - 10 MHz[1] (99% OBW)
Video bandwidth	300 kHz (6 dB OBW) and 10 MHz - 40 MHz[1] (99% OBW)
Detector mode	Peak (Preview measurement)
Trace mode	Max Hold

Note: [1]This value is the maximum RBW permitted by used equipment.

Table 7.2-1: *Occupied bandwidth equipment list*

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
Antenna, Horn	Sage Millimeter	SAR-2408-15-S2	E1152	NCR	NCR
Signal analyzer	Rohde & Schwarz	FSV40	E1120	19-Nov-2019	19-Nov-2021
Mixer	Rohde & Schwarz	FS-Z75	E1149	NCR	NCR

Notes: NCR - no calibration required

7.2.5 Test data

Center Frequency (GHz)	Bandwidth (MHz)	6 dB BW (MHz)	99% BW (MHz)
62.525	300	2705.77	2705.24

Table 7.2-2: *Occupied Bandwidth Results*

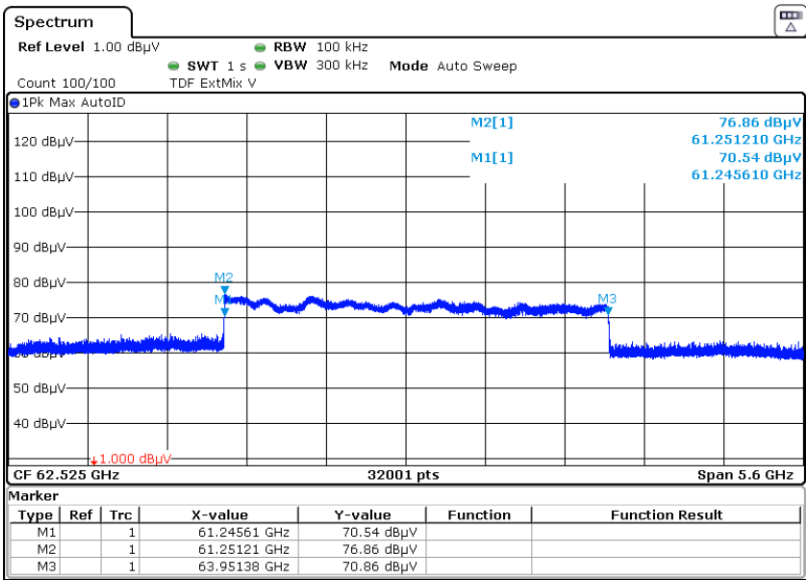


Figure 7.2-1: *6 dB Occupied Bandwidth plot.*

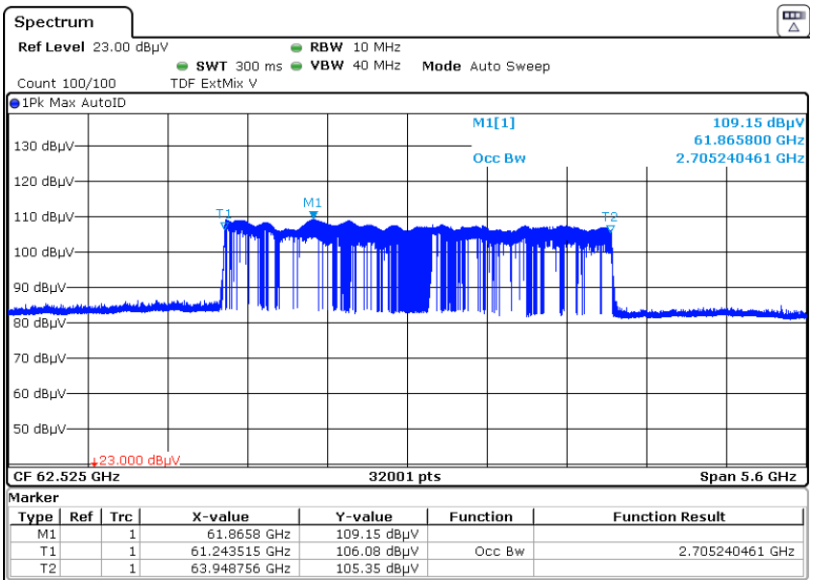


Figure 7.2-2: *99% Occupied Bandwidth plot.*

7.3 Peak conducted output power

7.3.1 References

§15.255 Operation within the band 57-71 GHz.
(e) Except as specified paragraph (e)(1) of this section, the peak transmitter conducted output power shall not exceed 500 mW. Depending on the gain of the antenna, it may be necessary to operate the intentional radiator using a lower peak transmitter output power in order to comply with the EIRP limits specified in paragraph (b) of this section.
RSS-210 Annex J.4
For devices with an emission bandwidth greater than or equal to 100 MHZ, the peak transmitter output power shall not exceed 500 mW. Emission bandwidth is defined as the instantaneous frequency range occupied by a steady radiated signal with modulation, outside which the radiated power spectral density shall be 6 dB below the maximum radiated power spectral density in the band, as measured with a 100 kHz resolution bandwidth. The center frequency must be stationary during the measurement even if not stationary during normal operation.

ANSI C63.4-2014

7.3.2 Test summary

Verdict	Pass		
Test date	March 2, 2021	Temperature	19 °C
Test engineer	Martha Espinoza, Wireless Test Engineer	Air pressure	1002 mbar
Test location	3m semi anechoic chamber	Relative humidity	34 %

7.3.3 Test Data

The Peak output power as measured in section with an appropriate RF Detector is -7.509 dBm or 0.177mW which is less than 500mW

Center Frequency (GHz)	Bandwidth (MHz)	Power (dBm)	Radiated Field Strength (Calculated – see example below)	EIRP (dBm)	Limit (dBm)	EIRP Margin (dB)	Conducted Power (dBm) (EIRP – declared antenna gain)	Conducted Power Limit (dBm)	Conducted Power Margin (dB)
62.525	2705	-35.51	113.668	-7.509	+10	17.509	-12.509	-10	**2.509**

Table 7.3-2: *EIRP Results.*

Using equation (19):

$$E = 126.8 - 20\log(\lambda) + P - G \qquad (19)$$

Where:

$$\lambda = \frac{c}{f}$$

c=3x10^8 m/s
E = Field strength of the emission at the measurement distance, in dBµv/m
P = Power measured at the output of the test antenna, in dBm
λ = Wavelength of the emission under investigation, in m.
G = Gain of the antenna test, in dBi

E = 126.8 – (20*log10(3e8/62.525e9))+(-35.52)-(24) = 113.668 dBµV/m

Using equation (22):

$$\mathrm{EIRP} = E_{\mathrm{Meas}} + 20\log(d_{\mathrm{Meas}}) - 104.7 \qquad (22)$$

EIRP = Equivalent Isotropically Radiated Power, in dBm
E_{meas} = Field strength of the emission at the measurement distance, in dBµv/m
d_{meas} = Measurement distance, in m (0.15 m in this case)
EIRP = 113.668 + (20*log10(0.15))-104.7
EIRP = -7.509 dBm

7.4 Transmitter spurious emissions

7.4.1 References

§15.255 Operation within the band 57-71 GHz.

(d) Limits on spurious emissions:

(1) The power density of any emissions outside the 57-71 GHz band shall consist solely of spurious emissions.

(2) Radiated emissions below 40 GHz shall not exceed the general limits in §15.209.

(3) Between 40 GHz and 200 GHz, the level of these emissions shall not exceed 90 pW/cm^2 at a distance of 3 meters.

(4) The levels of the spurious emissions shall not exceed the level of the fundamental emission.

ANSI C63.4-2014

Spurious radiated emissions below 40 GHz must comply with the general field strength limits of Section 15.209. Below 1000 MHz, measurements are made with a CISPR quasi-peak detector and above 1000 MHz measurements are made with an average detector with a 1 MHz RBW at 3 meters. From 40 GHz to 200 GHz the emissions must not exceed 90 pW/cm2 (18,000 µV/m) at 3 meters. Measurements are to be performed at the specified limit distance. If it is impractical to make measurements at the limit distance because of the distance or low signal levels, measurements may be performed at a closer distance but a low noise amplifier and/or a higher gain test antenna should be used to make measurements at the greatest distance from the EUT which provides an adequate signal to noise ratio to permit accurate amplitude measurements and extrapolated to the limit distance as specified in Section 15.31.

200443 D02 RF Detector Method v01

RSS-210 Annex J.3

The power of any emissions outside the band 57-71 GHZ shall consist solely of spurious emissions and shall not exceed:

a. The fundamental levels
b. The general field strength limits specified in RSS-Gen for emissions below 40 GHz
c. 90 pW/cm^2 at a distance of 3m for emissions between 40 GHz and 200 GHz.

7.4.2 Test summary

Verdict	Pass		
Test date	December 16, 2020; December 17, 2020; December 18, 2020	Temperature	23;20;20 °C
Test engineer	Martha Espinoza, Wireless Test Engineer	Air pressure	1003;1005;1002 mbar
Test location	3m semi anechoic chamber	Relative humidity	45;55; 50 %

7.4.3 Notes

This test was done at 3M of distance using the maximum radiated energy from the EUT. The spectrum was explored from 30 MHz to 200 GHz.

Calculation from limit line for this test:

$$PD = \frac{EIRP_{Linear}}{4\pi d^2}$$

Where:

PD = Power density at the distance specified by the limit, in w/cm^2

$EIRP_{Linear}$ = Equivalent Isotropically Radiated Power, in watts.

d = Distance at which the power density limit is specified, in cm

$EIRP_{Linear} = (PD)(4\pi)(d^2)$

$EIRP_{Linear} = (90x10^{-12})(4\pi)(300^2)$

$EIRP_{Linear} = 0.10178\ mw$ ≈ 85.31 dBµv/m @ 3m

All the measurements above 40 GHz were done at 1 m of distance to get a good read of the signal (the power is low to be seen without a LNA at 3m). To compensate this problem, an extrapolation to a short distance was done.

$$E_{SpecLimit} = E_{Meas} + 20\ Log\left(\frac{d_{Meas}}{d_{SpecLimit}}\right)$$

$$E_{SpecLimit} = 85.31 + 20\ Log\left(\frac{3}{1}\right) \approx 94.85\ dB\mu v/m\ @\ 1\ m$$

7.4.4 Setup details

EUT setup configuration	Table top
Test facility	3m Semi anechoic chamber
Measuring distance	3m and 1m
Antenna height variation	1–4 m; 1.60 m above 40 GHz
Turn table position	0–360°
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) – 5000 ms (Quasi-peak final measurement)

Receiver/spectrum analyzer settings for frequencies from 1 GHz to 40 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) – 5000 ms (Peak and CAverage final measurement)

Receiver/spectrum analyzer settings for frequencies above 40 GHz:

Resolution bandwidth	1 MHz
Video bandwidth	3 MHz
Detector mode	Average
Trace mode	Max Hold

7.4.4 Setup details, continued

Table 7.4-1: *Radiated disturbance equipment list*

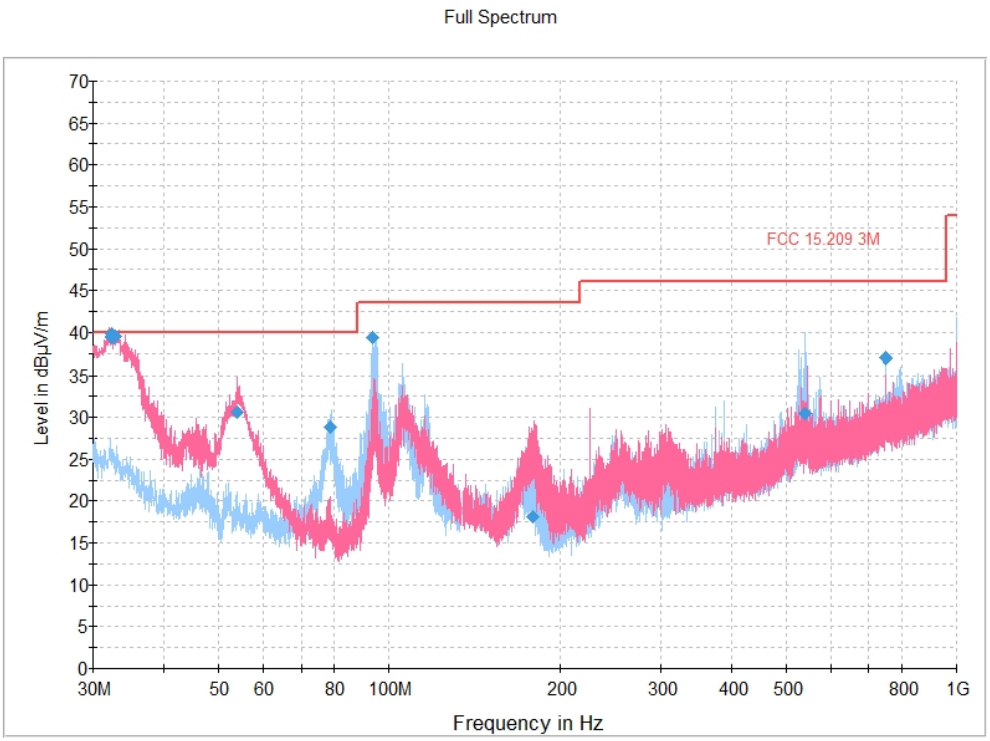
Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
EMC Test Receiver	Rohde & Schwarz	ESU 40	E1131	12-03-2020	12-03-2021
Signal Analyzer	Rohde & Schwarz	FSV 40	E1120	11-19-2019	11-19-2021
Signal Generator	Rohde & Schwarz	SMB 100A	E1128	12-14-2020	12-14-2021
Antenna, Bilog	Schaffner-Chase	CBL6111C	1763	02-18-2020	02-18-2021
Antenna, Horn	ETS	3117-PA	E1139	03-21-2019	03-21-2021
Antenna, Horn	Sage Millimeter	SAR-2309-42-S2	E1143	11-13-2020	11-13-2022
Antenna, Horn	Sage Millimeter	SAR-2309-28-S2	E1148	11-05-2020	11-05-2022
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	NCR	NCR
Antenna, Horn	Sage Millimeter	SAR-2408-15-S2	E1152	NCR	NCR
Mixer	Rohde & Schwarz	FS-Z75	E1149	NCR	NCR
Antenna, Horn	Sage Millimeter	SAR-2507-10-S2	E1146	NCR	NCR
Mixer	Rohde & Schwarz	FS-Z110	E1154	NCR	NCR
Antenna, Horn	Sage Millimeter	SAR-2507-06-S2	E1182	NCR	NCR
Mixer	Radiometer Physics	HM110-170	E1178	NCR	NCR
Antenna, Horn	Sage Millimeter	SAR-2309-05-S2	E1184	NCR	NCR
Mixer	Radiometer Physics	HM140-220	E1177	NCR	NCR

Table 7.4-2: *Radiated disturbance test software details*

Manufacturer of Software	Details
Rohde & Schwarz	EMC 32 V10.00.00

Notes: None

7.4.5 Test data



The spectral plot is a summation of a vertical and horizontal scan. The spectral scan has been corrected with the associated transducer factors (i.e. antenna factors, cable loss, amplifier gains, and attenuators).

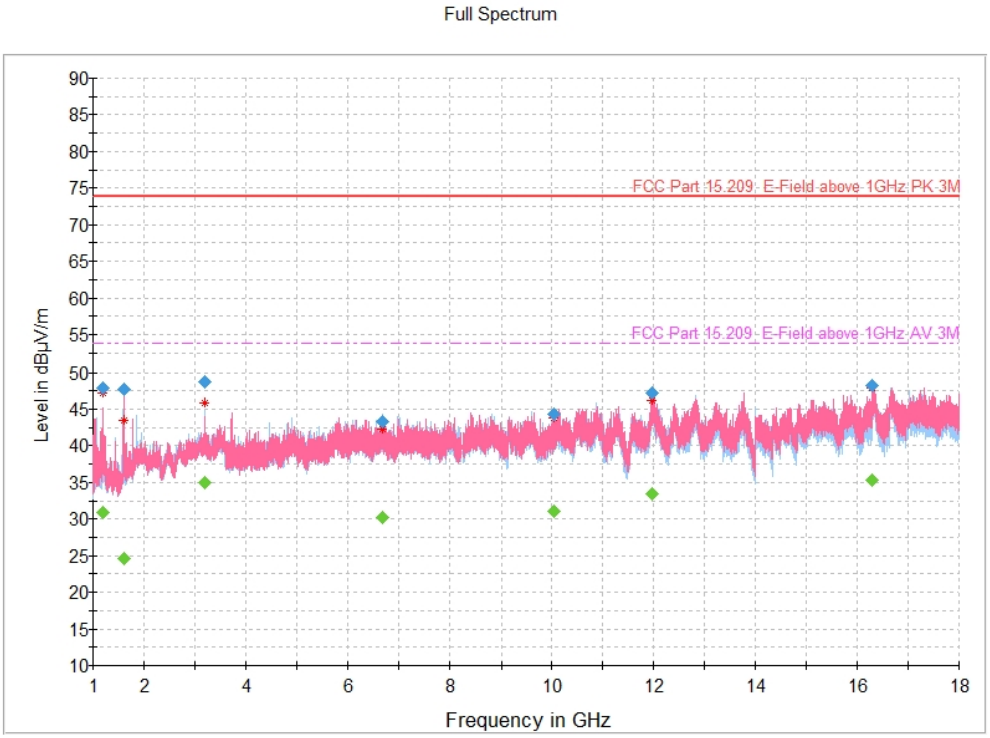
Figure 7.4-1: *Radiated transmitter spurious emissions spectral plot (0.03 - 1 GHz).*

Frequency (MHz)	QuasiPeak (dBµV/m)	Limit (dBµV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
32.362667	39.49	40.00	0.51	5000.0	120.000	104.0	V	238.0	25.2
32.376333	39.46	40.00	0.54	5000.0	120.000	100.0	V	292.0	25.2
32.396000	39.83	40.00	0.17	5000.0	120.000	100.0	V	244.0	25.2
32.412333	39.54	40.00	0.46	5000.0	120.000	107.0	V	231.0	25.1
32.625000	39.35	40.00	0.65	5000.0	120.000	107.0	V	245.0	25.0
32.891000	39.49	40.00	0.51	5000.0	120.000	100.0	V	255.0	24.9
53.951333	30.63	40.00	9.37	5000.0	120.000	104.0	V	181.0	14.2
78.632667	28.77	40.00	11.23	5000.0	120.000	248.0	H	34.0	14.8
93.655000	39.38	43.50	4.12	5000.0	120.000	186.0	H	70.0	16.7
178.523000	18.06	43.50	25.44	5000.0	120.000	383.0	V	0.0	17.2
540.066000	30.50	46.00	15.50	5000.0	120.000	209.0	H	245.0	27.7
750.031000	37.08	46.00	8.92	5000.0	120.000	147.0	H	194.0	31.5

Table 7.4-3: *Radiated transmitter spurious emissions: Quasi-peak results (0.03 - 1 GHz).*

Notes:
[1] Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factor = antenna factor ACF (dB) + cable loss (dB)
[3] The maximum measured value observed over a period of 1 second was recorded.

7.4.5 Test data, continued



The spectral plot is a summation of a vertical and horizontal scan. The spectral scan has been corrected with the associated transducer factors (i.e. antenna factors, cable loss, amplifier gains, and attenuators).

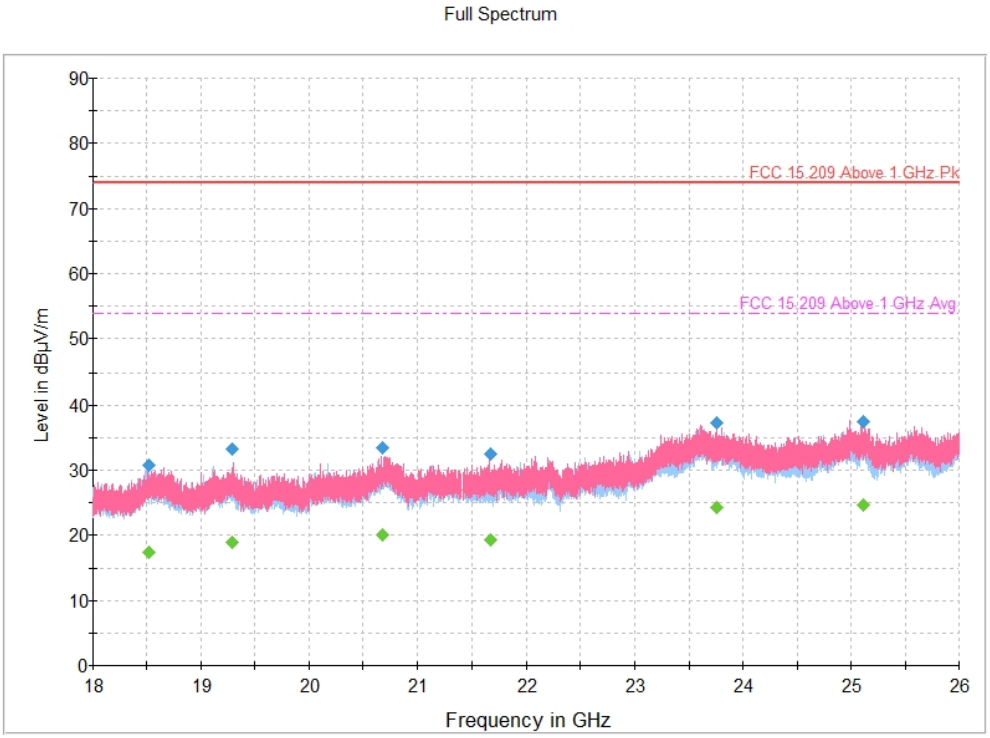
Figure 7.4-2: *Radiated transmitter spurious emissions spectral plot (1 to 18 GHz).*

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)
1200.166667	47.92	---	73.90	25.98	5000.0	1000.000	127.0	V	11.0	-13.8
1200.166667	---	30.91	53.90	22.99	5000.0	1000.000	127.0	V	11.0	-13.8
1599.566667	47.70	---	73.90	26.20	5000.0	1000.000	137.0	V	22.0	-14.4
1599.566667	---	24.59	53.90	29.31	5000.0	1000.000	137.0	V	22.0	-14.4
3192.033333	---	34.92	53.90	18.98	5000.0	1000.000	116.0	H	318.0	-7.0
3192.033333	48.64	---	73.90	25.26	5000.0	1000.000	116.0	H	318.0	-7.0
6702.566667	---	30.13	53.90	23.77	5000.0	1000.000	345.0	H	0.0	1.2
6702.566667	43.35	---	73.90	30.55	5000.0	1000.000	345.0	H	0.0	1.2
10025.633333	---	31.11	53.90	22.79	5000.0	1000.000	307.0	V	40.0	4.1
10025.633333	44.30	---	73.90	29.60	5000.0	1000.000	307.0	V	40.0	4.1
11955.766667	---	33.45	53.90	20.45	5000.0	1000.000	197.0	V	288.0	5.9
11955.766667	47.20	---	73.90	26.70	5000.0	1000.000	197.0	V	288.0	5.9
16300.766667	---	35.23	53.90	18.67	5000.0	1000.000	118.0	H	333.0	13.4
16300.766667	48.21	---	73.90	25.69	5000.0	1000.000	118.0	H	333.0	13.4

Table 7.4-4: *Radiated transmitter spurious emissions: Peak and CAverage results (1 – 18 GHz).*

Notes:
[1] Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factor = antenna factor ACF (dB) + cable loss (dB) − amplifier gain (dB)
[3] The maximum measured value observed over a period of 5 seconds was recorded.

7.4.5 Test data, continued



The spectral plot is a summation of a vertical and horizontal scan. The spectral scan has been corrected with the associated transducer factors (i.e. antenna factors, cable loss, amplifier gains, and attenuators).

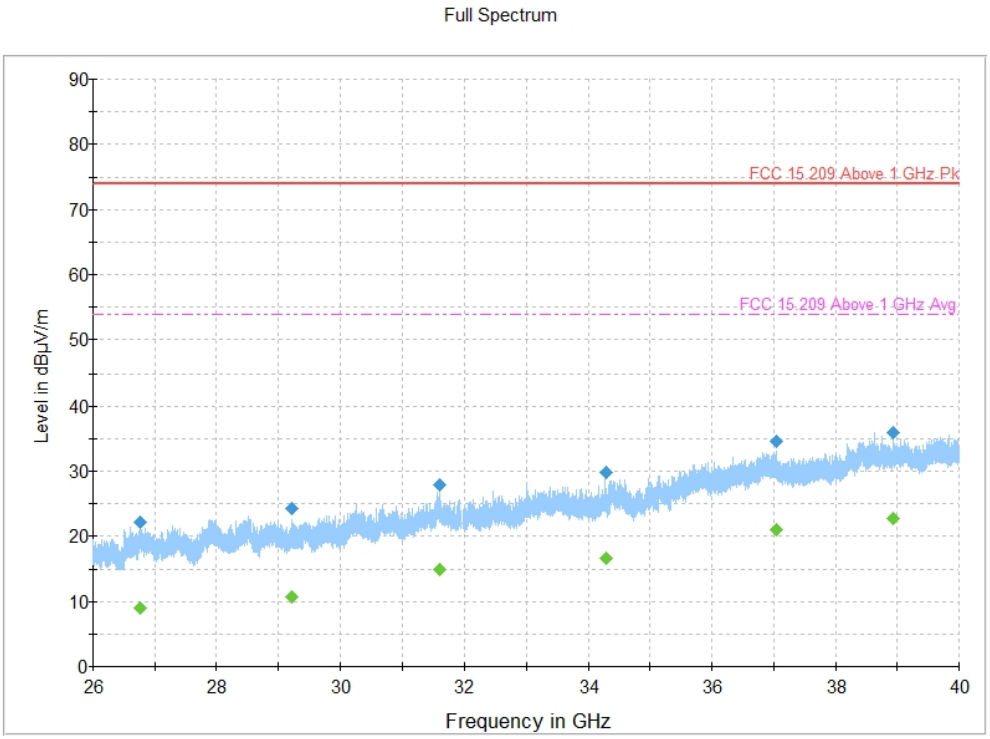
Figure 7.4-3: *Radiated transmitter spurious emissions spectral plot (18 to 26 GHz).*

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)
18520.333333	---	17.40	53.90	36.50	5000.0	1000.000	410.0	H	87.0	18.0
18520.333333	30.77	---	73.90	43.13	5000.0	1000.000	410.0	H	87.0	18.0
19288.600000	---	18.93	53.90	34.97	5000.0	1000.000	369.0	V	331.0	18.6
19288.600000	33.16	---	73.90	40.74	5000.0	1000.000	369.0	V	331.0	18.6
20673.933333	33.47	---	73.90	40.43	5000.0	1000.000	105.0	V	207.0	20.3
20673.933333	---	20.02	53.90	33.88	5000.0	1000.000	105.0	V	207.0	20.3
21664.066667	---	19.30	53.90	34.60	5000.0	1000.000	390.0	V	85.0	19.1
21664.066667	32.41	---	73.90	41.49	5000.0	1000.000	390.0	V	85.0	19.1
23759.933333	37.34	---	73.90	36.56	5000.0	1000.000	378.0	V	47.0	22.7
23759.933333	---	24.21	53.90	29.69	5000.0	1000.000	378.0	V	47.0	22.7
25111.533333	---	24.62	53.90	29.28	5000.0	1000.000	279.0	V	69.0	22.8
25111.533333	37.39	---	73.90	36.51	5000.0	1000.000	279.0	V	69.0	22.8

Table 7.4-5: *Radiated transmitter spurious emissions: Peak and CAverage results (18 – 26 GHz).*

Notes:
[1] Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factor = antenna factor ACF (dB) + cable loss (dB) − amplifier gain (dB)
[3] The maximum measured value observed over a period of 5 seconds was recorded.

7.4.5 Test data, continued



The spectral plot is a summation of a vertical and horizontal scan. The spectral scan has been corrected with the associated transducer factors (i.e. antenna factors, cable loss, amplifier gains, and attenuators).

Figure 7.4-4: *Radiated transmitter spurious emissions spectral plot (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)
26767.333333	22.21	---	73.90	51.69	5000.0	1000.000	147.0	V	-11.0	5.7
26767.333333	---	8.91	53.90	44.99	5000.0	1000.000	147.0	V	-11.0	5.7
29224.133333	---	10.79	53.90	43.11	5000.0	1000.000	151.0	V	43.0	8.0
29224.133333	24.34	---	73.90	49.56	5000.0	1000.000	151.0	V	43.0	8.0
31612.400000	27.96	---	73.90	45.94	5000.0	1000.000	125.0	V	157.0	9.9
31612.400000	---	14.95	53.90	38.95	5000.0	1000.000	125.0	V	157.0	9.9
34282.533333	---	16.54	53.90	37.36	5000.0	1000.000	224.0	V	133.0	11.7
34282.533333	29.80	---	73.90	44.10	5000.0	1000.000	224.0	V	133.0	11.7
37044.533333	34.64	---	73.90	39.26	5000.0	1000.000	122.0	V	6.0	12.9
37044.533333	---	21.06	53.90	32.84	5000.0	1000.000	122.0	V	6.0	12.9
38927.600000	35.88	---	73.90	38.02	5000.0	1000.000	205.0	H	89.0	15.2
38927.600000	---	22.67	53.90	31.23	5000.0	1000.000	205.0	H	89.0	15.2

Table 7.4-6: *Radiated transmitter spurious emissions: Peak and CAverage results (26 – 40 GHz).*

Notes:
[1] Field strength (dBµV/m) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factor = antenna factor ACF (dB) + cable loss (dB) − amplifier gain (dB)
[3] The maximum measured value observed over a period of 5 seconds was recorded.

7.4.5 Test data, continued

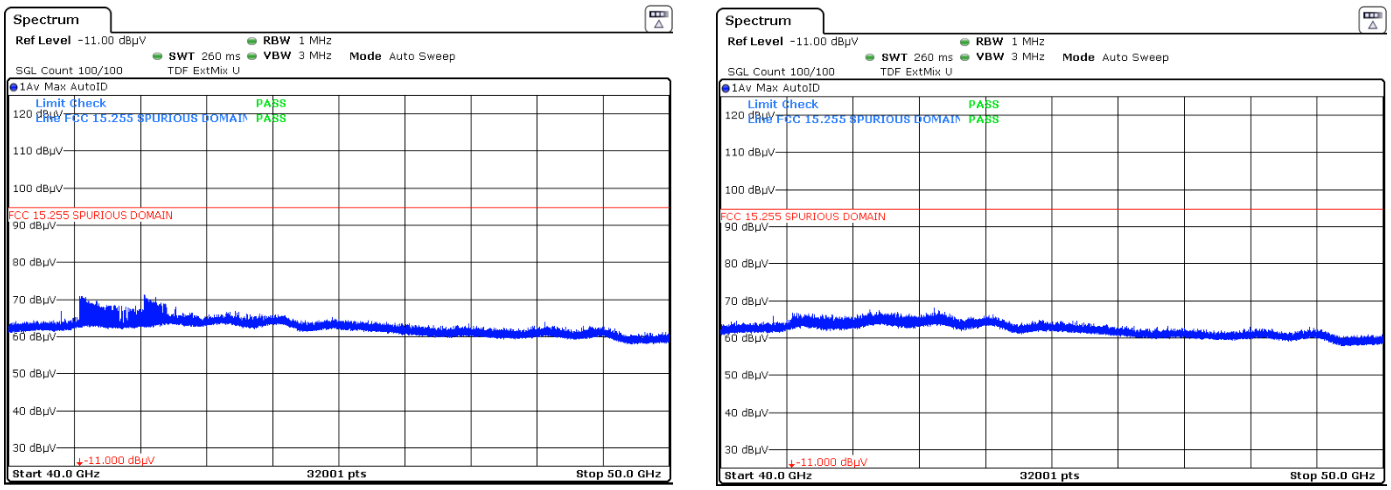
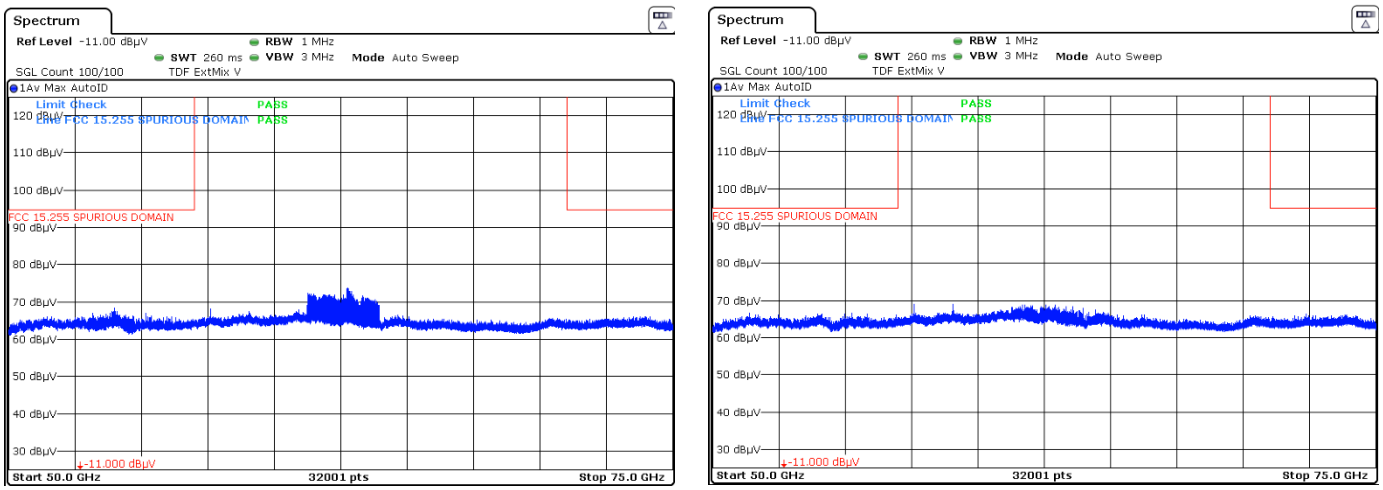


Figure 7.4: *Radiated transmitter spurious emissions spectral plot (40 to 50 GHz) horizontal and vertical polarization respectively.*



Note: The excluded band (non-restrictive) corresponds to the frequency band which is allowed the fundamental transmission (from 57 to 71 GHz) and it was showed on the plot as reference because it is not part of the evaluation in this test.

7.4.5 Test data, continued

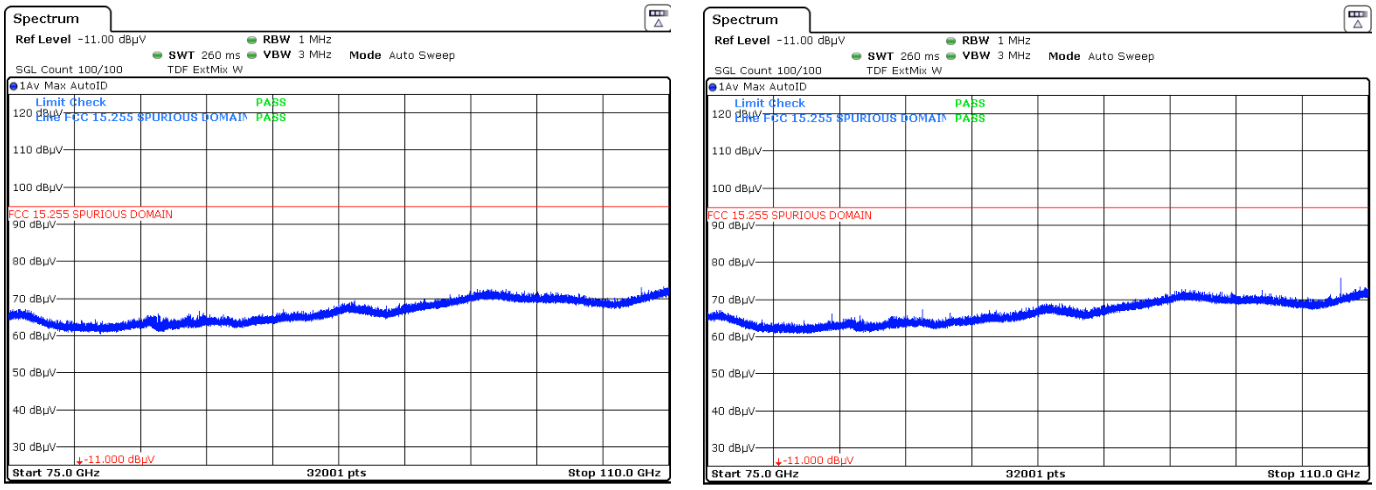


***Figure* 7.5:** *Radiated transmitter spurious emissions spectral plot (75 to 110 GHz) horizontal and vertical polarization respectively.*

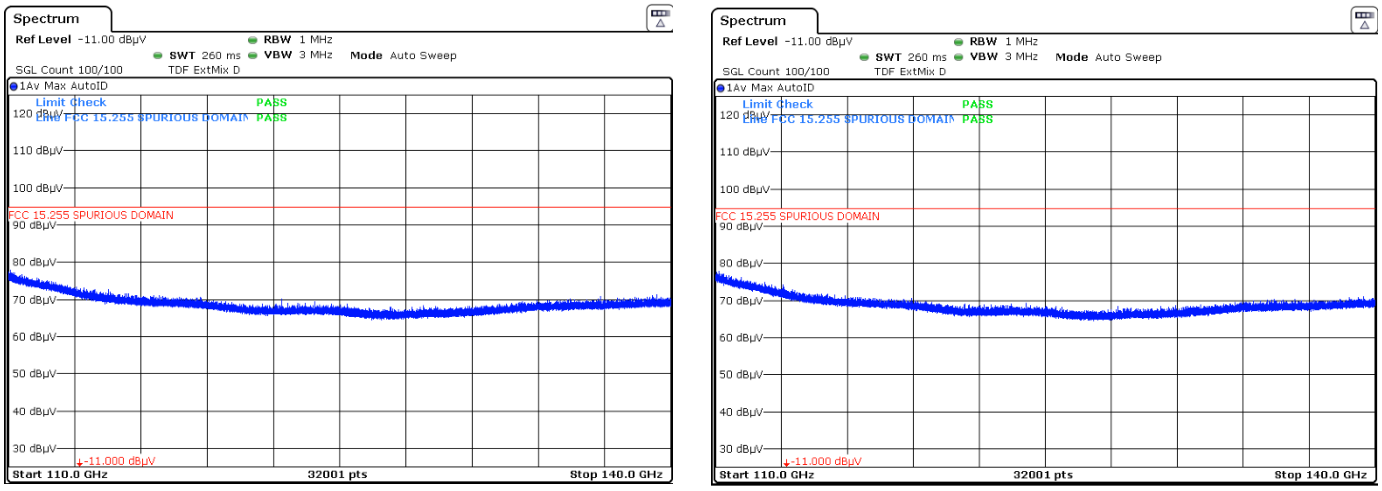


***Figure* 7.5:** *Radiated transmitter spurious emissions spectral plot (110 to 140 GHz) horizontal and vertical polarization respectively*

7.4.5 Test data, continued

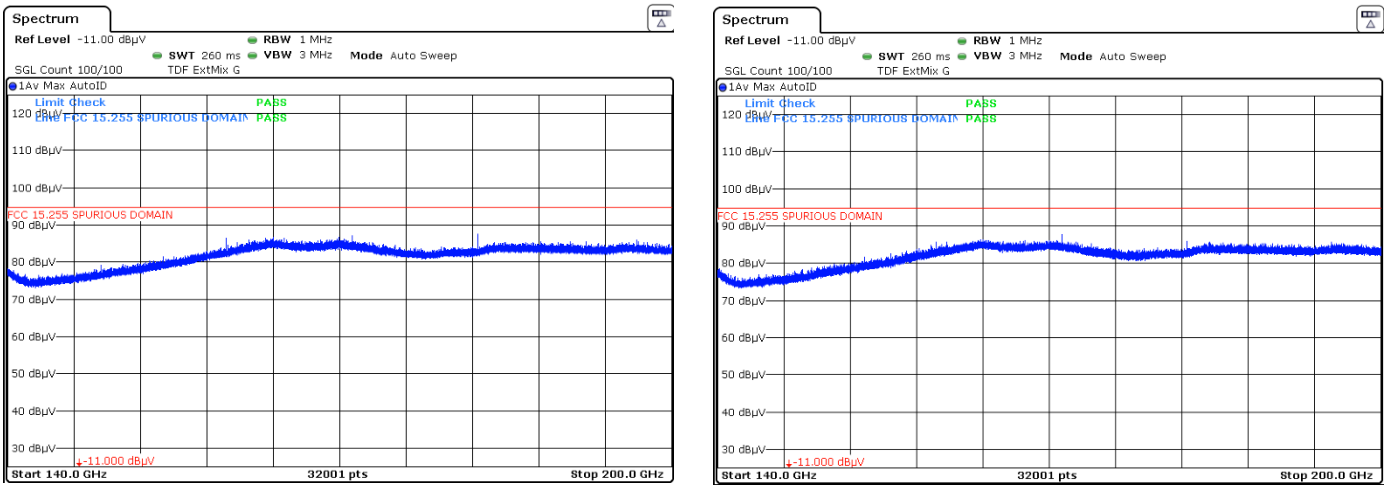


Figure 7.4: *Radiated transmitter spurious emissions spectral plot (140 to 200 GHz) horizontal and vertical polarization respectively*

7.5 Frequency Stability

7.5.1 References

200443 D02 RF Detector Method v01
As specified in Section 15.215(c), the 20 dB 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.
RSS-210 Annex J.6
Fundamental emissions shall be contained within the 57-71 GHz frequency band during all conditions of operation when tested at the temperature and voltage variations specified for the frequency stability measurement in RSS-Gen.

ANSI C63.10-2013
With the EUT at ambient temperature (approximately 25 °C) and voltage source set to the EUT nominal operating voltage (100%), record the spectrum mask of the EUT emission on the spectrum analyzer.
Vary EUT power supply between 85% and 115% of nominal, and record the frequency excursion of the EUT emission mask. Set the power supply to 100% nominal setting, and raise EUT operating temperature to 50 °C.
Record the frequency excursion of the EUT emission mask. Repeat step d) at each 10 °C increment down to 20 °C

7.5.2 Test summary

Verdict	Pass		
Test date	December 15, 2020	Temperature	21°C
Test engineer	Martha Espinoza, Wireless Test Engineer	Air pressure	1004 mbar
Test location	Wireless Bench	Relative humidity	52 %

7.5.3 Notes

The test can be measured using the general ANSI C63.10-2013 or the specific procedure KDB 200443 D02 RF Detector Method v01. The first one requires a reference mask when the EUT is in the optimal conditions (20°C and 100% from the power source) which was taken using the power function of 99%. The second one required a 20-dB occupied bandwidth as a reference mask. The first method per ANSI C63.10-2013 was used.

7.5.4 Setup details

EUT setup configuration	Table top
Test facility	Wireless Bench
Measuring distance	0.3 m
Antenna height variation	1 m
Turn table position	0°

Receiver/spectrum analyzer settings for frequencies above 1 GHz:

Resolution bandwidth	1 MHz
Video bandwidth	3 MHz
Detector mode	Peak
Trace mode	Max Hold

Table 7.5-1: *Frequency stability equipment list*

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
Antenna, Horn	Sage Millimeter	SAR-2408-15-S2	E1152	NCR	NCR
Signal analyzer	Rohde & Schwarz	FSV40	E1120	19-November-2019	19-November-2021
Mixer	Rohde & Schwarz	FS-Z75	E1149	NCR	NCR
Temperature Chamber	Test Equity	115A	E1162	03-August-2020	03-August-2021

7.5.5 Test data

Table 7.5-2: *Frequency stability results, 300 MHz bandwidth operation*

Voltage (Volts)	*Temperature (°C)*	*Frequency 1 (GHz)*	*Frequency 2 (GHz)*	*Center frequency (GHz)*	*ppm*
120	-20	61.24070	63.97936	62.61003	-212.152
120	-10	61.24179	63.98023	62.61101	-227.808
120	0	61.23348	63.98046	61.60697	-163.268
120	10	61.23413	63.98089	62.60751	-171.894
120	20	61.22698	63.96652	62.59675	Reference
120	30	61.22801	63.96689	62.59745	-11.183
120	40	61.22895	63.96477	62.59686	-1.758
120	50	61.22895	63.96630	62.59763	-13.979

Voltage (Volts)	*Temperature (°C)*	*Frequency 1 (GHz)*	*Frequency 2 (GHz)*	*Center frequency (GHz)*	*ppm*
102	20	61.22085	63.99652	62.59369	48.965
120	20	61.22698	63.96652	62.59675	Reference
138	20	61.23201	63.96783	62.59992	-50.642

Note: This standard does not specify a ppm value as a limit. This table is just for reference and the only requirement by standard is the fundamental emission must to be inside to the band assigned.

7.6 AC Line conducted emissions

7.6.1 References

ANSI C63.4-2014

7.6.2 Test summary

Verdict	Pass		
Test date	December 11, 2020	Temperature	20 °C
Test engineer	Martha Espinoza, Wireless Test Engineer	Air pressure	1000 mbar
Test location	Ground Plane	Relative humidity	46 %

7.6.3 Notes

None

7.6.4 Setup details

Port under test	AC Main Port
EUT setup configuration	Table top
Measurement details	A preview measurement was generated with the receiver in continuous scan mode. 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 settings:

Resolution bandwidth	9 kHz
Video bandwidth	30 kHz
Detector mode	– Peak and Average (Preview measurement) – Quasi-peak and CAverage (Final measurement)
Trace mode	Max Hold
Measurement time	– 100 ms (Peak and Average preview measurement) – 5000 ms (Quasi-peak final measurement) – 5000 ms (CAverage final measurement)

Table 7.6-1: *Conducted disturbance at mains port equipment list*

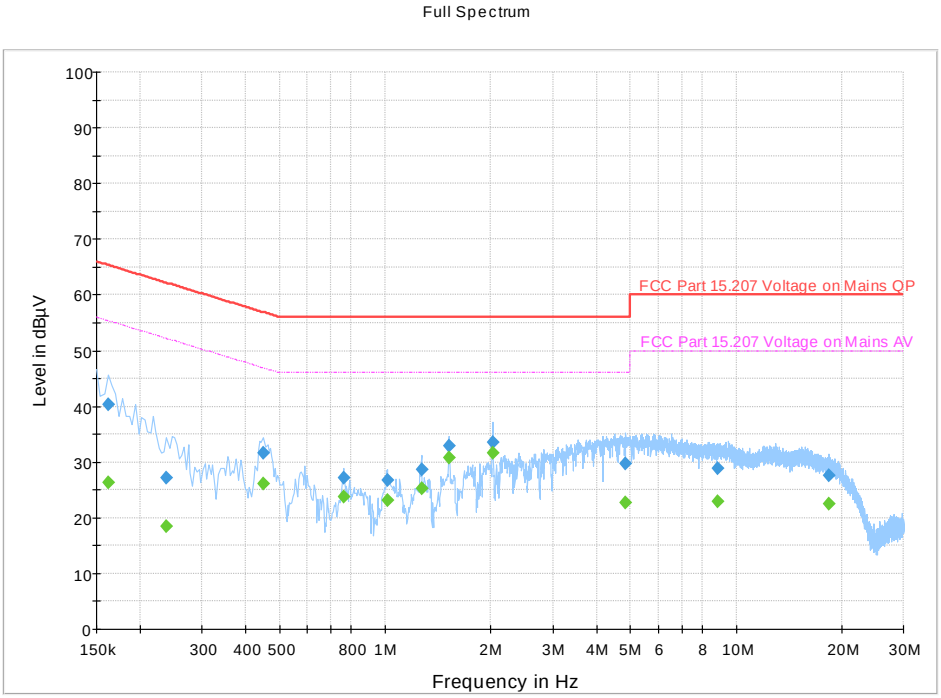
Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
Two Line V-Network	Rohde & Schwartz	ENV216	E1019	1 Year	08-04-2021
Transient Limiter	HP	11947A	684	1 Year	01-20-2021
EMC Test Receiver	Rohde & Schwarz	ESCI 7	E1026	2 Year	05-29-2021

Table 7.6-2: *Conducted disturbance at mains port test software details*

Manufacturer of Software	Details
Rohde & Schwarz	EMC 32 V10.20.01

Notes: None

7.6.5 Test data



The spectral plot has been corrected with transducer factors (i.e. cable loss, LISN factors, and transient limiter).

Figure 7.6-1: *Conducted disturbance at mains port spectral plot.*

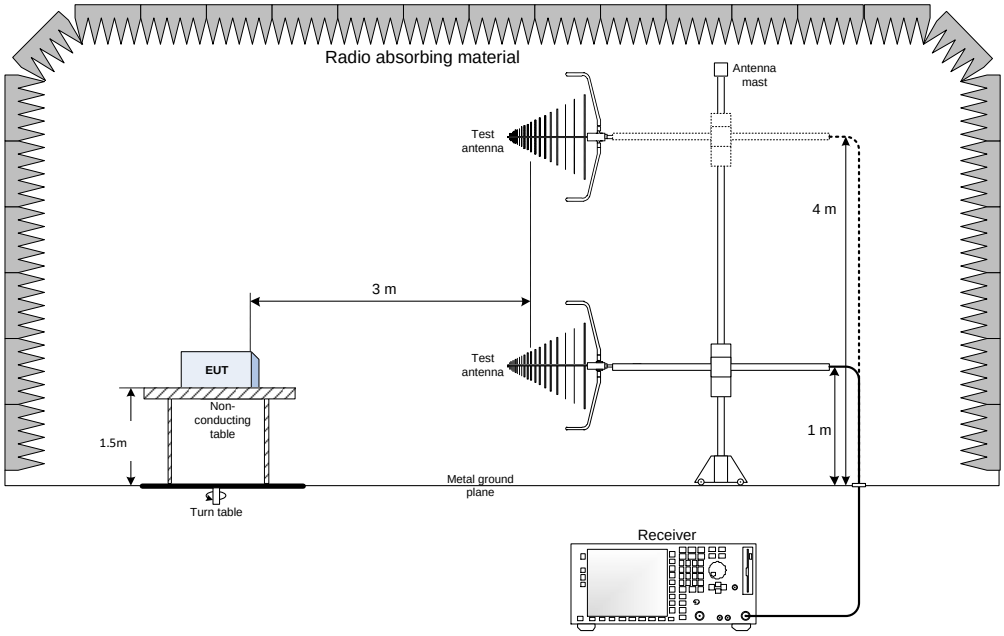
Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Filter	Corr. (dB)
0.162000	---	26.27	55.36	29.09	5000.0	9.000	N	ON	19.5
0.162000	40.32	---	65.36	25.04	5000.0	9.000	N	ON	19.5
0.238000	27.08	---	62.17	35.09	5000.0	9.000	N	ON	19.5
0.238000	---	18.52	52.17	33.65	5000.0	9.000	N	ON	19.5
0.450000	---	26.05	46.88	20.83	5000.0	9.000	L1	ON	19.4
0.450000	31.72	---	56.88	25.15	5000.0	9.000	L1	ON	19.4
0.758000	---	23.79	46.00	22.21	5000.0	9.000	N	ON	19.4
0.758000	27.09	---	56.00	28.91	5000.0	9.000	N	ON	19.4
1.014000	26.76	---	56.00	29.24	5000.0	9.000	L1	ON	19.4
1.014000	---	23.15	46.00	22.85	5000.0	9.000	L1	ON	19.4
1.266000	28.76	---	56.00	27.24	5000.0	9.000	L1	ON	19.4
1.266000	---	25.27	46.00	20.73	5000.0	9.000	L1	ON	19.4
1.518000	32.90	---	56.00	23.10	5000.0	9.000	L1	ON	19.4
1.518000	---	30.80	46.00	15.20	5000.0	9.000	L1	ON	19.4
2.022000	---	31.61	46.00	14.39	5000.0	9.000	L1	ON	19.4
2.022000	33.64	---	56.00	22.36	5000.0	9.000	L1	ON	19.4
4.850000	29.71	---	56.00	26.29	5000.0	9.000	N	ON	19.2
4.850000	---	22.64	46.00	23.36	5000.0	9.000	N	ON	19.2
8.894000	---	22.97	50.00	27.03	5000.0	9.000	N	ON	19.4
8.894000	28.80	---	60.00	31.20	5000.0	9.000	N	ON	19.4
18.430000	27.64	---	60.00	32.36	5000.0	9.000	L1	ON	20.3
18.430000	---	22.50	50.00	27.50	5000.0	9.000	L1	ON	20.3

Table 7.6-3: *Conducted disturbance at mains port (Quasi-Peak and CAverage) results.*

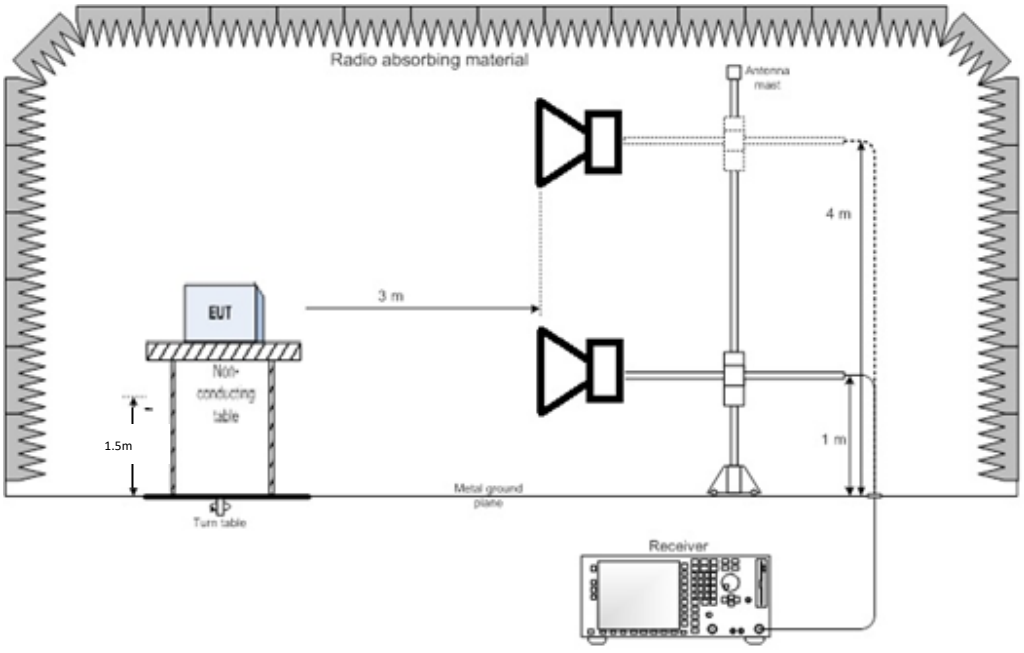
Notes: [1] Result (dBµV) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2] Correction factor (dB) = LISN factor IL (dB) + cable loss (dB) + transient limiter (dB)
[3] The maximum measured value observed over a period of 5 seconds was recorded.

Section 8 Block diagrams of test set-ups

8.1 Radiated emissions set-up



30-1000MHz Setup



Above 1GHz Setup

Thank you for choosing