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Test report

436339-6TRFWL

Date of issue: March 8, 2022

Applicant:

SENSORMATIC ELECTRONICS LLC

Product:

RADAR SENSOR

Model:

GFRADAR2001-FE

FCC ID:

BVC21RDRPC

IC:

3506A-GFRADAR2001

Specifications:

- FCC 47 CFR Part 15.255 Subpart C

Operation within the band 57 – 71 GHz.

- RSS-210 Issue 10, December 2019

License-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 8, 2022
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
ANSI C63.10-2013	American National Standard of procedures for compliance testing of unlicensed wireless devices
RSS-210 Issue 10	Licence-Exempt Radio Apparatus: Category I Equipment
RSS-GEN Issue 5	General Requirements for Compliance of Radio Apparatus

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
4363395-6TRFWL	Original report issued

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
6 dB Occupied Bandwidth	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 2.1-4: *RSS-Gen results.*

Test description	Verdict
Antenna requirement	Pass
99% Occupied Bandwidth	Pass

Notes: None

Table 2.1-5 *RSS-210 results.*

Test description	Verdict
Equivalent Isotropically Radiated Power (E.I.R.P.)	Pass
6 dB Occupied Bandwidth	Pass
Radiated emissions	Pass
Frequency stability	Pass

Notes: None

Section 3 Equipment under test (EUT) details

3.1 Applicant

Company name	Sensormatic Electronics LLC
Address	6600 Congress Ave
City	Boca Raton
State	FL
Postal/Zip code	33487
Country	USA

3.2 Manufacturer

Company name	Sensormatic Electronics LLC
Address	6600 Congress Ave
City	Boca Raton
State	FL
Postal/Zip code	33487
Country	USA

3.3 Sample information

Receipt date	February 17, 2022
Nemko sample ID number	NEx: 436339

3.4 EUT information

Product name	Radar Sensor
Model	GFRADAR2001-FE
Serial number	123S2139017750
Power requirements	48 V_{DC} Power over Ethernet
Description/theory of operation	Fixed mmWave sensor (IT Equipment) used to measure and record movement of people and objects in retail store environment. Sensor to be installed in a (separate) protective housing.
Operational frequencies	61-61.5 GHz
Software details	N/A

3.5 EUT exercise and monitoring details

EUT was plugged in the AC network, and it transmitted by default to the design frequency. There were not additional arrangements.

3.6 EUT setup details

Table 3.6-1: *Support equipment*

Description	Brand name	Model/Part number	Serial number	Rev.
PoE injector	Microsemi	PD-9001GR/AT/AC	--	--

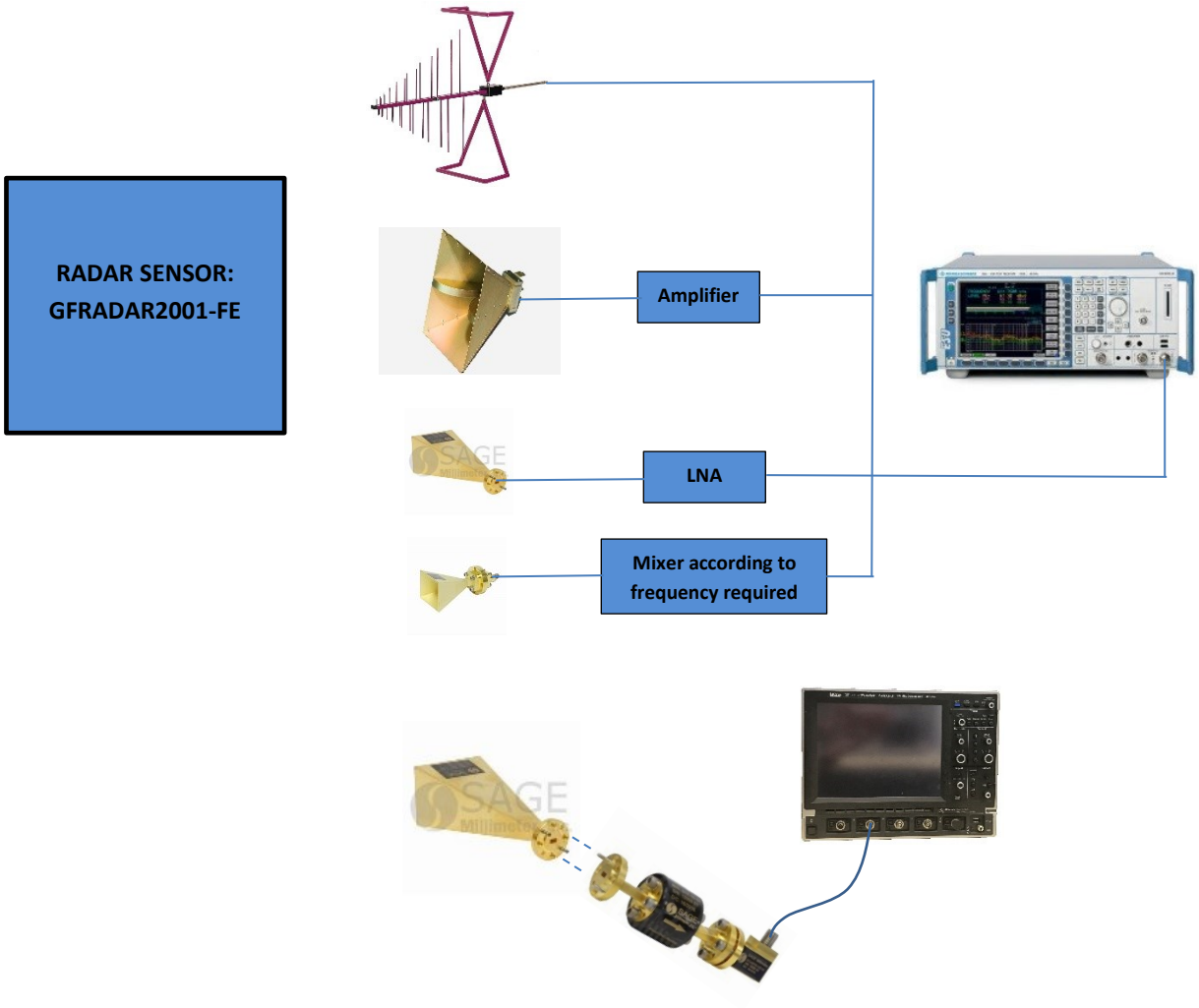


Figure 3.6-1: *EUT Test Setup*

Section 4 Engineering considerations

4.1 Modifications incorporated in the EUT

There were no modifications performed to the EUT during this assessment.

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 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):

(2) For fixed field disturbance sensors that occupy 500 MHz or less of bandwidth and that are contained wholly within the frequency band 61.0-61.5 GHz, the average power of any emission, measured during the transmit interval, shall not exceed 40 dBm, and the peak power of any emission shall not exceed 43 dBm. In addition, the average power of any emission outside of the 61.0-61.5 GHz band, measured during the transmit interval, but still within the 57-71 GHz band, shall not exceed 10 dBm, and the peak power of any emission shall not exceed 13 dBm.

§ RSS-210, Annex J:
J.2.1 Fixed field disturbance sensors and interactive motion sensors.
Following are the conditions for fixed field disturbance sensors and interactive motion sensors:
For fixed field disturbance sensors that occupy a bandwidth of 500 MHz or less and for which the bandwidth is contained wholly within the frequency band 61.0-61.5 GHz, the equipment's average and peak e.i.r.p. in the channel bandwidth shall not exceed 40 dBm and 43 dBm respectively. In addition, the average and peak e.i.r.p. of any emission outside of the band 61.0-61.5 GHz, but still within the band 57-71 GHz, shall not exceed 10 dBm and 13 dBm respectively.

7.1.2 Test summary

Verdict	Pass		
Test date	February 28, 2022	Temperature	21 °C
Test engineer	Martha Espinoza, Wireless Test Engineer	Air pressure	1002 mbar
Test location	3m semi anechoic chamber	Relative humidity	53 %

7.1.3 Notes

This test performed using the procedure described in 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 calculations were performed to determine the EIRP, peak and average for signals with bandwidth equal or less than 500 MHz and within 61 – 61.5 GHz band from equation (19) and (22) from ANSI C63.10-2013. Antenna gain from EUT declared by manufacturer: 5 dBi; Gain of the test antenna: 24 dBi
Distance use for measurement: 0.47 m.

7.1.4 Setup details

EUT setup configuration	Tabletop
Test facility	3M Semi anechoic chamber
Measuring distance	0.47 m
Antenna height variation	1.55 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 and RMS
Trace mode	Max Hold

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	2 years	12-09-2023
Mixer	Rohde & Schwarz	FS-Z75	E1324	NCR	NCR
Signal generator	Rohde & Schwarz	SMB100A	E1128	2 years	12-23-2023
Digital oscilloscope	LeCroy	620Zi	17298*	1 year	06-17-2022
V-Band X2, Passive Frequency Multiplier	Sage	SFP-152KF-S2	N/A	NCR	NCR
RF Detector	Eravant	STD-15SF-PI	E1334	NCR	NCR

Notes: NCR - no calibration required; *Rental equipment.

7.1.5 Test data

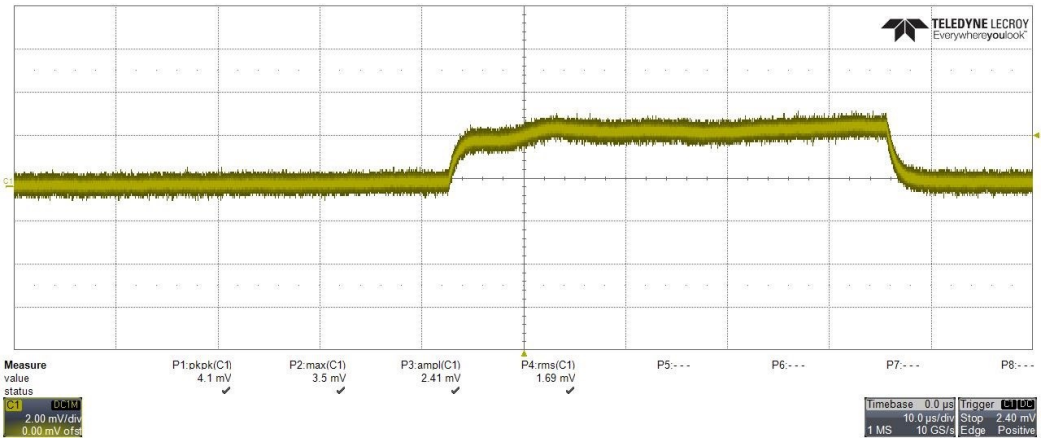


Figure 7.1-1: *Fundamental signal, view on oscilloscope.*

Center Frequency (GHz)	Bandwidth (MHz)	Power (dBm)	Radiated Power (dBµV/m) (Calculated – see example below)	EIRP (dBm) (Calculated – see example below)	Limit (dBm)	Margin (dB)
61.202 (Peak)	387.9128	-28.70	120.2928872	9.035	+43	33.965
61.202 (RMS)		-30.48	118.5128872	7.255	+40	32.745

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=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(3e8/61.202e9)) +(-28.70) -(24)

E = 120.292 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 (0.5 m in this case)

EIRP = 120.292 + (20*log10(0.47))-104.7

EIRP = 9.035 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).
ANSI C63.4-2014

J.4 Peak transmitter output power
C.-For the purpose of this standard, 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 centre frequency must be stationary during the measurement interval, even if not stationary during normal operation

7.2.2 Test summary

Verdict	Pass		
Test date	February 17, 2022	Temperature	19 °C
Test engineer	Martha Espinoza, Wireless Test Engineer	Air pressure	1002 mbar
Test location	3m semi anechoic chamber	Relative humidity	52 %

7.2.3 Notes

None

7.2.4 Setup details

EUT setup configuration	Tabletop
Test facility	3M Semi anechoic chamber
Measuring distance	3 meter
Antenna height variation	1.55 m
Turn table position	0°

Receiver/spectrum analyzer settings for frequencies above 1 GHz:

Resolution bandwidth	100 kHz (6 dB OBW) and 5 MHz (99% OBW)
Video bandwidth	300 kHz (6 dB OBW) and 20 MHz (99% OBW)
Detector mode	Peak (Preview measurement)
Trace mode	Max Hold

Note: None

7.2.4 Setup details, continued

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	2 years	12-09-2023
Mixer	Rohde & Schwarz	FS-Z75	E1324	NCR	NCR

Notes: NCR - no calibration required

7.2.5 Test data

Center Frequency (GHz)	6 dB BW (MHz)	99% BW (MHz)
61.2023	385.513	387.913

Table 7.2-2: *Occupied Bandwidth Results.*

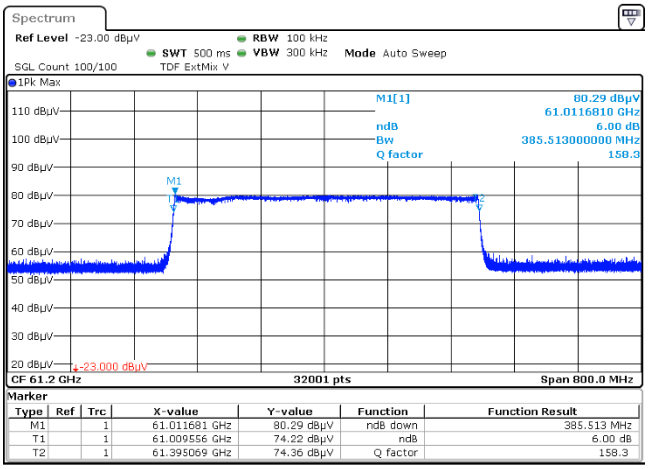


Figure 7.2-1: *6 dB OBW.*

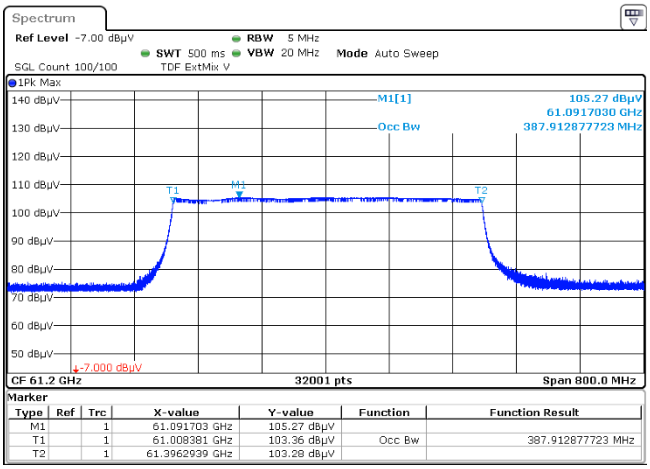


Figure 7.2-2: *99% OBW.*

7.3 Transmitter spurious emissions

7.3.1 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/cm² 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

J.3 Spurious emissions

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

a) the fundamental emission levels
b) the general field strength limits specified in RSS-Gen for emissions below 40 GHz
c) 90 pW/cm2 at a distance of 3 m for emissions between 40 GHz and 200 GHz

7.3.2 Test summary

Verdict	Pass		
Test date	February 17, 2022; February 18, 2022;	Temperature	19°C; 20°C
Test engineer	Martha Espinoza, Wireless Test Engineer	Air pressure	1002mbar; 1005mbar
Test location	3m semi anechoic chamber	Relative humidity	52%; 56%

7.3.3 Notes

This test was done at a 3m measurement 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/cm²

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

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

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

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

$EIRP_{Linear} = 0.10178\ mw \approx 85.31$ dBµV/m @ 3m

This limit was used from 40 GHz to 75 GHz. From 75 GHz to 200 GHz, the noise floor is less than 6 dB below the limit calculated at 3m. To compensate this problem, an extrapolation to shorter distances were done. The new two distances are 1 m (75-140 GHz) and 0.4 m (from 140-200 GHz). The new limit lines are:

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

$$E_{SpecLimit} = 85.31 + 20\ Log\left(\frac{3}{1}\right) \approx 94.85\ dB\mu v/m\ @\ 1\ m \qquad E_{SpecLimit} = 85.31 + 20\ Log\left(\frac{3}{0.4}\right) \approx 102.81\ dB\mu v/m\ @\ 0.4\ m$$

7.3.4 Setup details

EUT setup configuration	Tabletop
Test facility	3m Semi anechoic chamber
Measuring distance	3m
Antenna height variation	1–4 m
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	Peak
Trace mode	Max Hold
Measuring distance	3m; 1m; 0.4m
Antenna height	1.48 m
Turn table position	0°

Table 7.3-1: *Radiated disturbance equipment list*

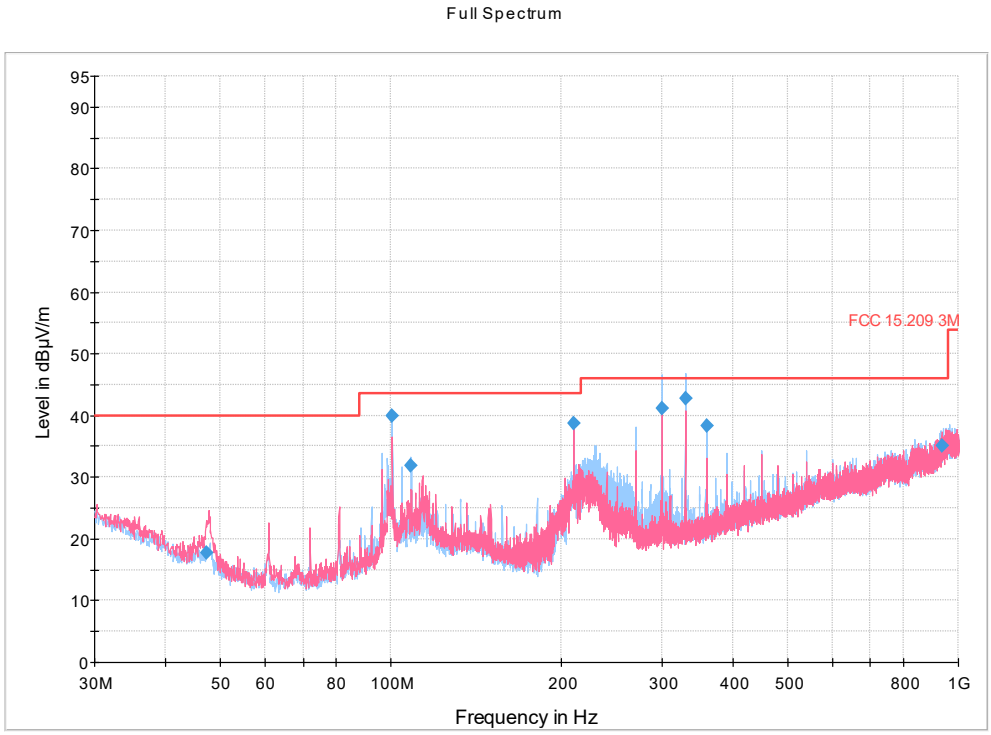
Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
EMC Test Receiver	Rohde & Schwarz	ESU 40	E1121	1 year	05-19-2022
Signal analyzer	Rohde & Schwarz	FSV40	E1120	2 years	12-09-2023
Signal Generator	Rohde & Schwarz	SMB 100A	E1128	2 years	12-23-2023
Antenna, Bilog	Schaffner-Chase	CBL6111C	1480	2 years	10-28-2022
Antenna, Horn	ETS	3117-PA	E1160	2 years	01-26-2023
Antenna, Horn	Sage Millimeter	SAR-2309-42-S2	E1143	2 years	11-13-2022
Antenna, Horn	Sage Millimeter	SAR-2309-28-S2	E1148	2 years	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	E1324	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 7.3-1: *Radiated disturbance test software details*

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

Notes: None

7.3.5 Test data



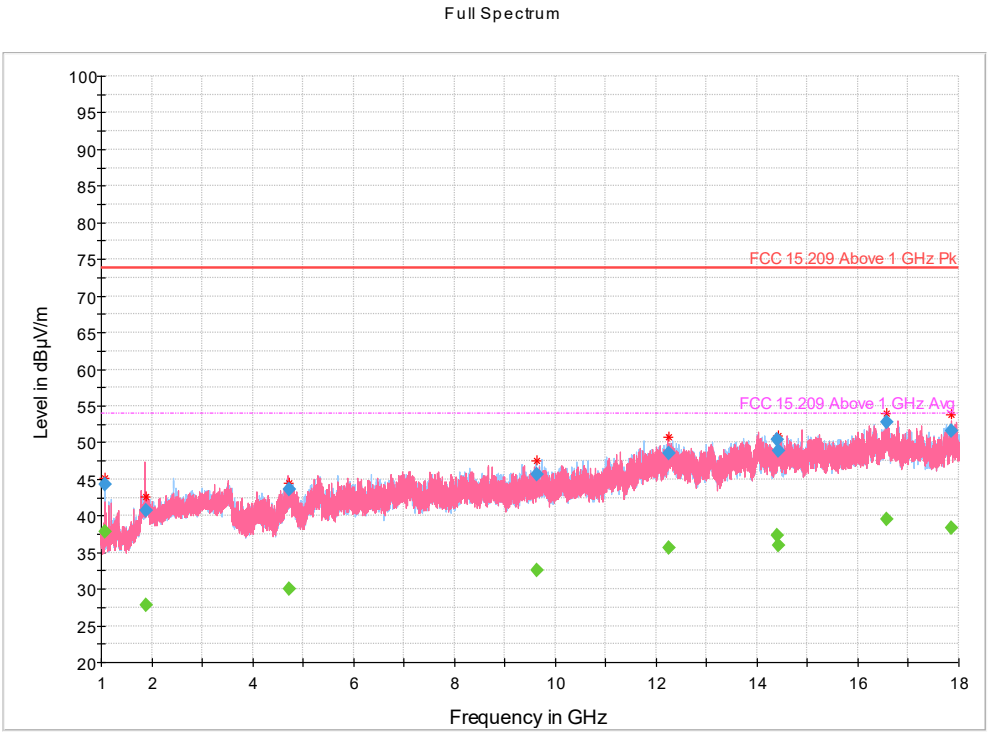
The spectral plot shows a vertical and horizontal scan with different colors. The spectral scan has been corrected with the associated transducer factors (i.e. antenna factors, cable loss, amplifier gains, and attenuators).

Figure 7.3-1: *Radiated disturbance spectral plot (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)
47.303333	17.67	40.00	22.33	5000.0	120.000	117.0	V	350.0	15.7
100.446667	40.01	43.50	3.49	5000.0	120.000	292.0	H	271.0	17.1
108.489167	31.83	43.50	11.67	5000.0	120.000	271.0	H	258.0	18.1
210.015000	38.82	43.50	4.68	5000.0	120.000	127.0	H	124.0	16.7
299.983333	41.25	46.00	4.75	5000.0	120.000	147.0	H	103.0	21.1
329.972500	42.79	46.00	3.21	5000.0	120.000	100.0	H	320.0	22.1
360.001667	38.27	46.00	7.73	5000.0	120.000	100.0	H	132.0	22.9
937.081667	35.10	46.00	10.90	5000.0	120.000	280.0	V	294.0	35.3

Table 7.3-2: *Radiated disturbance (Quasi-Peak) results.*

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.



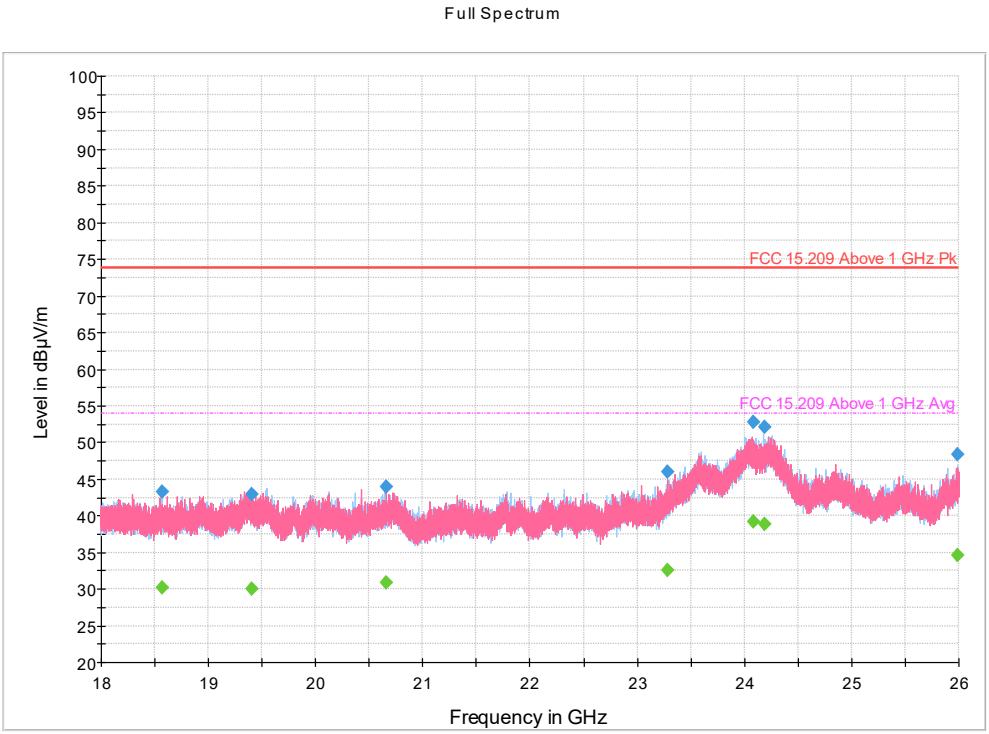
The spectral plot shows a vertical and horizontal scan with different colors. The spectral scan has been corrected with the associated transducer factors (i.e. antenna factors, cable loss, amplifier gains, and attenuators).

Figure 7.3-2: *Radiated disturbance 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)
1079.733333	44.34	---	73.90	29.56	5000.0	1000.000	162.0	H	156.0	-13.4
1079.733333	---	37.83	53.90	16.07	5000.0	1000.000	162.0	H	156.0	-13.4
1877.300000	40.74	---	73.90	33.16	5000.0	1000.000	402.0	V	43.0	-6.7
1877.300000	---	27.76	53.90	26.14	5000.0	1000.000	402.0	V	43.0	-6.7
4717.900000	---	29.94	53.90	23.96	5000.0	1000.000	288.0	V	170.0	0.8
4717.900000	43.57	---	73.90	30.33	5000.0	1000.000	288.0	V	170.0	0.8
9628.000000	---	32.54	53.90	21.36	5000.0	1000.000	354.0	H	132.0	8.4
9628.000000	45.61	---	73.90	28.29	5000.0	1000.000	354.0	H	132.0	8.4
12240.266667	---	35.70	53.90	18.20	5000.0	1000.000	226.0	V	286.0	14.4
12240.266667	48.48	---	73.90	25.42	5000.0	1000.000	226.0	V	286.0	14.4
14399.733333	---	37.29	53.90	16.61	5000.0	1000.000	161.0	H	65.0	14.5
14399.733333	50.46	---	73.90	23.44	5000.0	1000.000	161.0	H	65.0	14.5
14415.266667	---	35.94	53.90	17.96	5000.0	1000.000	135.0	V	52.0	15.0
14415.266667	48.84	---	73.90	25.06	5000.0	1000.000	135.0	V	52.0	15.0
16578.666667	52.83	---	73.90	21.07	5000.0	1000.000	331.0	H	0.0	21.0
16578.666667	---	39.54	53.90	14.36	5000.0	1000.000	331.0	H	0.0	21.0
17844.900000	51.67	---	73.90	22.23	5000.0	1000.000	368.0	V	0.0	21.1
17844.900000	---	38.27	53.90	15.63	5000.0	1000.000	368.0	V	0.0	21.1

Table 7.3-4: *Radiated disturbance (Peak and CAverage) results.*

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.



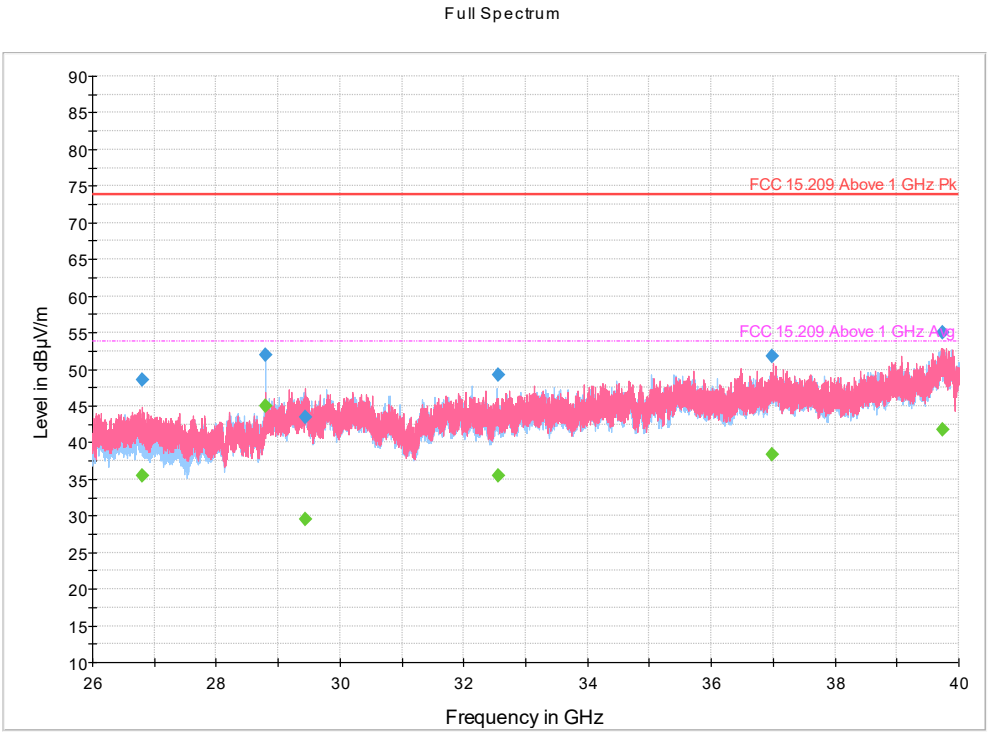
The spectral plot is a summation of a vertical and horizontal scan. The spectral scan has been corrected with the associated transducer factors (i.e. antenna factors, cable loss, amplifier gains, and attenuators).

Figure 7.3-3: *Radiated disturbance 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)
18573.800000	---	30.12	53.90	23.78	5000.0	1000.000	279.0	H	304.0	18.0
18573.800000	43.29	---	73.90	30.61	5000.0	1000.000	279.0	H	304.0	18.0
19400.733333	---	29.94	53.90	23.96	5000.0	1000.000	359.0	V	92.0	18.4
19400.733333	42.88	---	73.90	31.02	5000.0	1000.000	359.0	V	92.0	18.4
20657.000000	43.94	---	73.90	29.96	5000.0	1000.000	342.0	H	115.0	19.7
20657.000000	---	30.86	53.90	23.04	5000.0	1000.000	342.0	H	115.0	19.7
23278.866667	---	32.62	53.90	21.28	5000.0	1000.000	175.0	H	314.0	22.8
23278.866667	45.97	---	73.90	27.93	5000.0	1000.000	175.0	H	314.0	22.8
24080.466667	52.82	---	73.90	21.08	5000.0	1000.000	294.0	V	314.0	29.6
24080.466667	---	39.17	53.90	14.73	5000.0	1000.000	294.0	V	314.0	29.6
24185.266667	---	38.87	53.90	15.03	5000.0	1000.000	156.0	H	203.0	29.2
24185.266667	52.08	---	73.90	21.82	5000.0	1000.000	156.0	H	203.0	29.2
25992.733333	---	34.59	53.90	19.31	5000.0	1000.000	263.0	H	285.0	25.4
25992.733333	48.39	---	73.90	25.51	5000.0	1000.000	263.0	H	285.0	25.4

Table 7.3-5: *Radiated disturbance (Peak and CAverage) results.*

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.



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 7.3-4: *Radiated disturbance 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)
26797.733333	48.56	---	73.90	25.34	5000.0	1000.000	108.0	V	248.0	8.8
26797.733333	---	35.44	53.90	18.46	5000.0	1000.000	108.0	V	248.0	8.8
28800.266667	51.88	---	73.90	22.02	5000.0	1000.000	132.0	H	293.0	12.0
28800.266667	---	44.92	53.90	8.98	5000.0	1000.000	132.0	H	293.0	12.0
29436.200000	---	29.60	53.90	24.30	5000.0	1000.000	125.0	V	342.0	12.7
29436.200000	43.38	---	73.90	30.52	5000.0	1000.000	125.0	V	342.0	12.7
32551.000000	49.20	---	73.90	24.70	5000.0	1000.000	225.0	H	301.0	12.7
32551.000000	---	35.56	53.90	18.34	5000.0	1000.000	225.0	H	301.0	12.7
36983.000000	51.77	---	73.90	22.13	5000.0	1000.000	225.0	V	197.0	15.9
36983.000000	---	38.35	53.90	15.55	5000.0	1000.000	225.0	V	197.0	15.9
39729.466667	55.03	---	73.90	18.87	5000.0	1000.000	135.0	V	111.0	20.2
39729.466667	---	41.68	53.90	12.22	5000.0	1000.000	135.0	V	111.0	20.2

Table 7.3-6: *Radiated disturbance (Peak and CAverage) results.*

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.

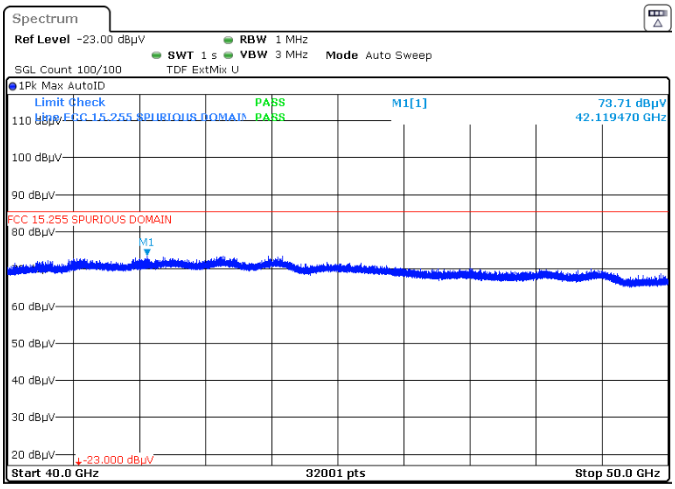


Figure 7.3-5: *Unwanted emissions spurious band plot @3m– Field strength measured from 40 to 50 GHz, horizontal and vertical polarization respectively.*

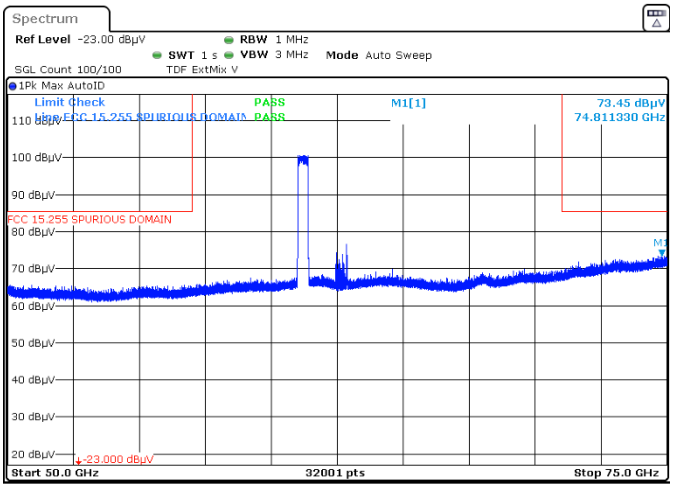


Figure7.3-6: *Unwanted emissions spurious band plot @3m – Field strength measured from 50 to 75 GHz, horizontal and vertical polarization respectively.*

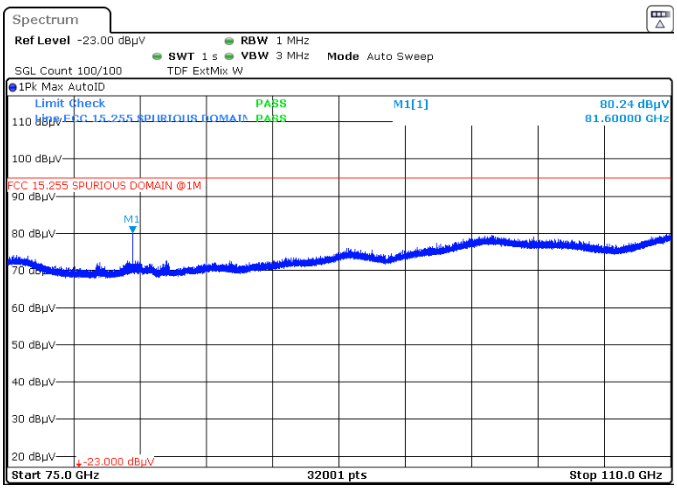


Figure7.3-7: *Unwanted emissions spurious band plot @1m – Field strength measured from 75 to 110 GHz, horizontal and vertical polarization respectively.*

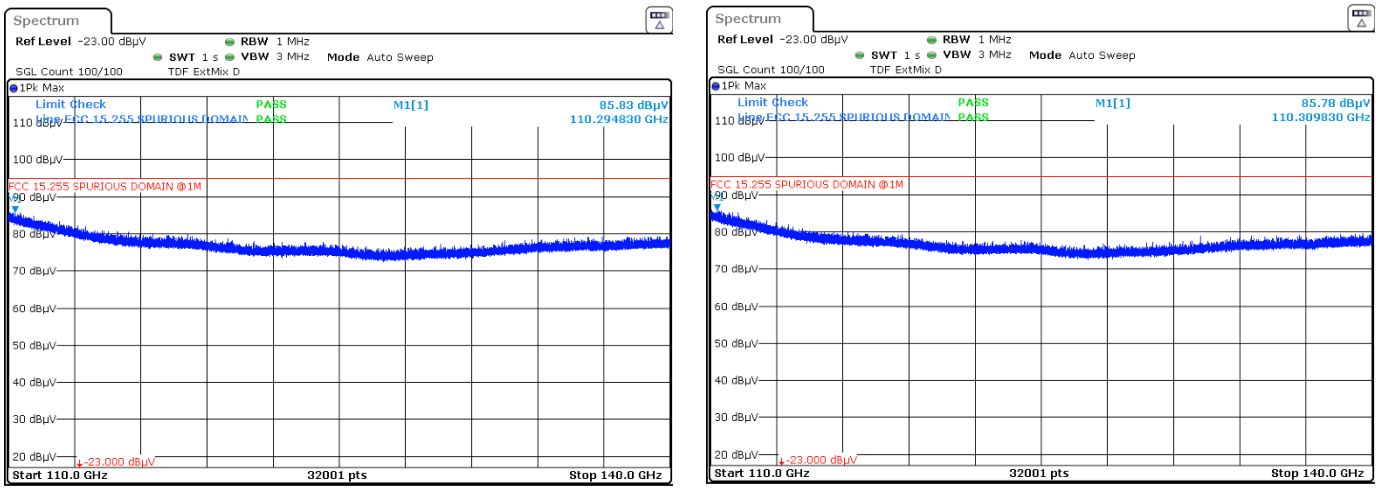


Figure 7.3-8: *Unwanted emissions spurious band plot @1m – Field strength measured from 110 to 140 GHz, horizontal and vertical polarization respectively.*

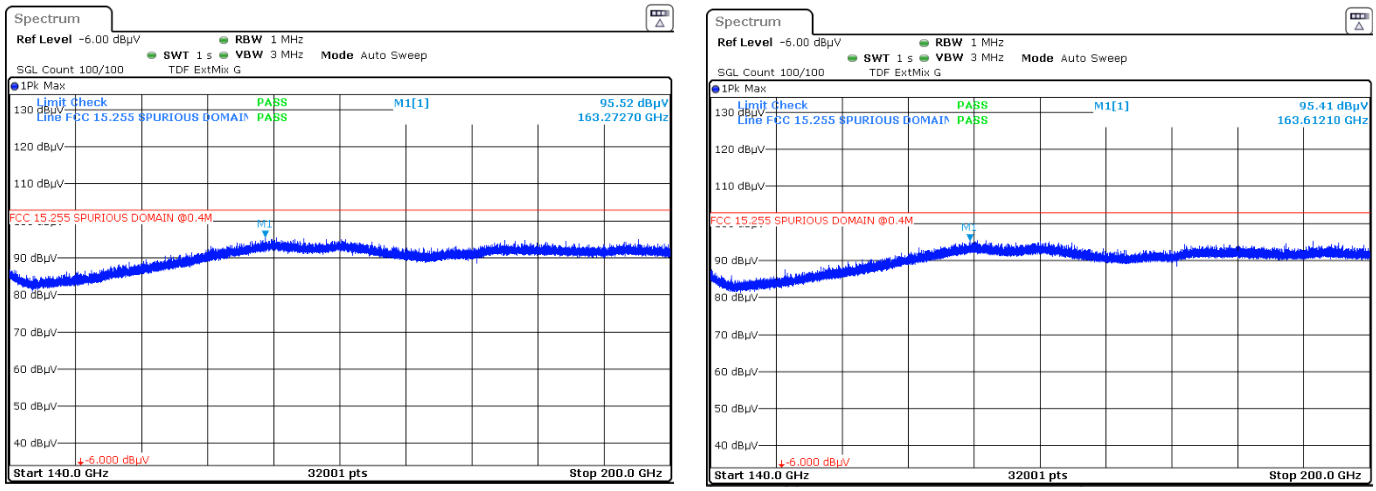


Figure 7.3-9: *Unwanted emissions spurious band plo @0.4m – Field strength measured from 140 to 200 GHz, horizontal and vertical polarization respectively.*

7.4 Frequency Stability

7.4.1 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.
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

J.6 Transmitter frequency stability
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.

7.4.2 Test summary

Verdict	Pass		
Test date	February 18, 2022	Temperature	20 °C
Test engineer	Martha Espinoza, Wireless Test Engineer	Air pressure	1005 mbar
Test location	Wireless Bench	Relative humidity	56 %

7.4.3 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.

7.4.4 Setup details

EUT setup configuration	Table top
Test facility	Wireless Bench
Measuring distance	0.5 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

7.4.5 Test data

Table 7.4-1: *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	2 years	12-09-2023
Mixer	Rohde & Schwarz	FS-Z75	E1324	NCR	NCR
Temperature Chamber	Test Equity	115A	E1162	1 year	08-18-2022

Table 7.4-2: *Frequency stability results.*

Voltage	*Temperature*	*Frequency (GHz)*	*Frequency (GHz)*	*CF*	*ppm*
120V	-20	61.006856	61.3947189	61.20079	21.854
120V	-10	61.006781	61.3955189	61.20115	15.931
120V	0	61.006506	61.3955689	61.20104	17.769
120V	10	61.006631	61.3958689	61.20125	14.297
120V	20	61.007881	61.3963689	61.20212	Reference
120V	30	61.007506	61.3965189	61.20201	1.838
120V	40	61.007906	61.3968188	61.20236	-3.880
120V	50	61.008706	61.3971688	61.20294	-13.275

Voltage	*Temperature*	*Frequency (GHz)*	*Frequency (GHz)*	*CF*	*ppm*
120	20	61.007881	61.3963689	61.20212	Reference
102	20	61.007831	61.3962689	61.20205	1.225
138	20	61.007831	61.3963189	61.20207	0.817

$$ppm = (\frac{CH\ frequency - Measured\ CH\ frequency}{CH\ frequency}) * 1000000$$

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.

7.5 AC Line conducted emissions

7.5.1 References

ANSI C63.4-2014

7.5.2 Test summary

Verdict	Pass		
Test date	February 18, 2022	Temperature	20 °C
Test engineer	Martha Espinoza, Wireless Test Engineer	Air pressure	1005 mbar
Test location	Ground Plane	Relative humidity	56 %

7.5.3 Notes

None

7.5.4 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 7.5-1: *Conducted disturbance at mains port equipment list*

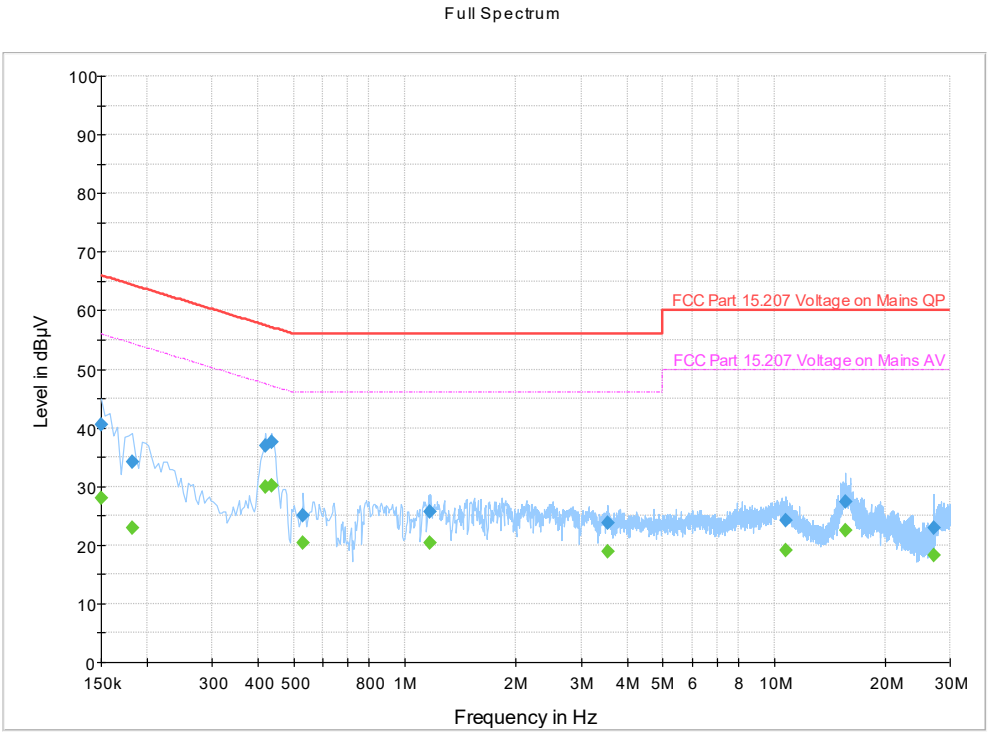
Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
Two Line V-Network	Rohde & Schwartz	ENV216	E1019	1 year	09-20-2022
Transient Limiter	HP	11947A	684	1 year	05-19-2022
EMC Test Receiver	Rohde & Schwarz	ESCI 7	E1026	1 yeara	02-24-2022

Table 7.5-2: *Conducted disturbance at mains port test software details*

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

Notes: None

7.5.5 Test data



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

Figure 7.5-1: *Conducted disturbance at mains port spectral plot.*

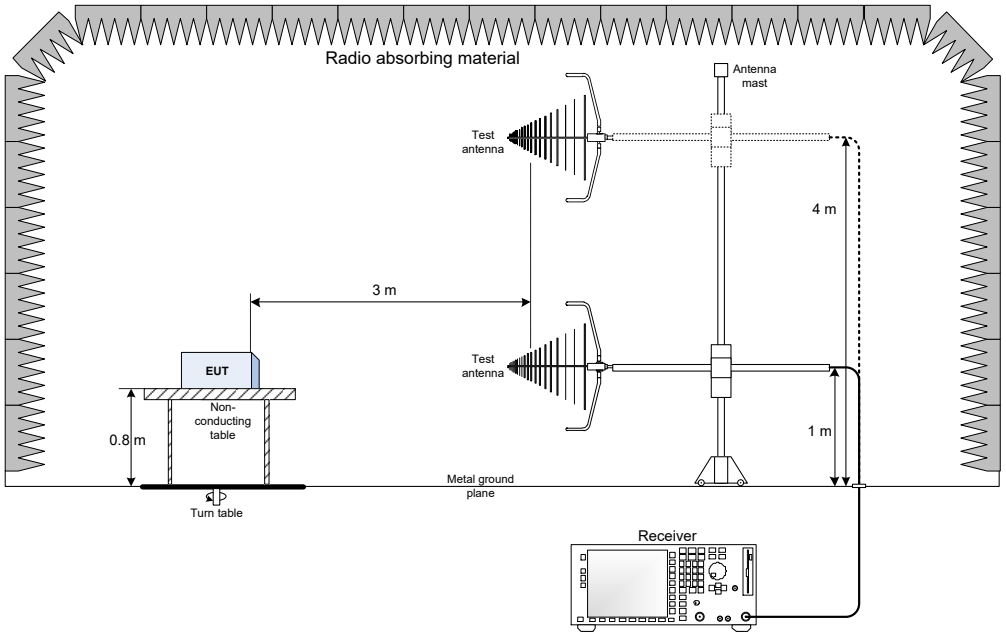
Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Filter	Corr. (dB)
0.150000	---	28.03	56.00	27.97	5000.0	9.000	L1	ON	19.6
0.150000	40.59	---	66.00	25.41	5000.0	9.000	L1	ON	19.6
0.182000	---	22.92	54.39	31.47	5000.0	9.000	L1	ON	19.5
0.182000	34.15	---	64.39	30.25	5000.0	9.000	L1	ON	19.5
0.418000	---	30.03	47.49	17.46	5000.0	9.000	L1	ON	19.4
0.418000	37.00	---	57.49	20.49	5000.0	9.000	L1	ON	19.4
0.434000	---	30.05	47.18	17.12	5000.0	9.000	L1	ON	19.4
0.434000	37.61	---	57.18	19.57	5000.0	9.000	L1	ON	19.4
0.530000	---	20.44	46.00	25.56	5000.0	9.000	L1	ON	19.4
0.530000	25.15	---	56.00	30.85	5000.0	9.000	L1	ON	19.4
1.170000	---	20.33	46.00	25.67	5000.0	9.000	L1	ON	19.4
1.170000	25.65	---	56.00	30.35	5000.0	9.000	L1	ON	19.4
3.546000	---	18.84	46.00	27.16	5000.0	9.000	L1	ON	19.3
3.546000	23.77	---	56.00	32.23	5000.0	9.000	L1	ON	19.3
10.746000	---	19.12	50.00	30.88	5000.0	9.000	N	ON	19.7
10.746000	24.13	---	60.00	35.87	5000.0	9.000	N	ON	19.7
15.618000	---	22.40	50.00	27.60	5000.0	9.000	N	ON	20.3
15.618000	27.49	---	60.00	32.51	5000.0	9.000	N	ON	20.3
27.086000	---	18.17	50.00	31.83	5000.0	9.000	N	ON	20.1
27.086000	22.89	---	60.00	37.11	5000.0	9.000	N	ON	20.1

Table 7.5-3: *Conducted disturbance at mains port (Quasi-Peak and CAverage) results.*

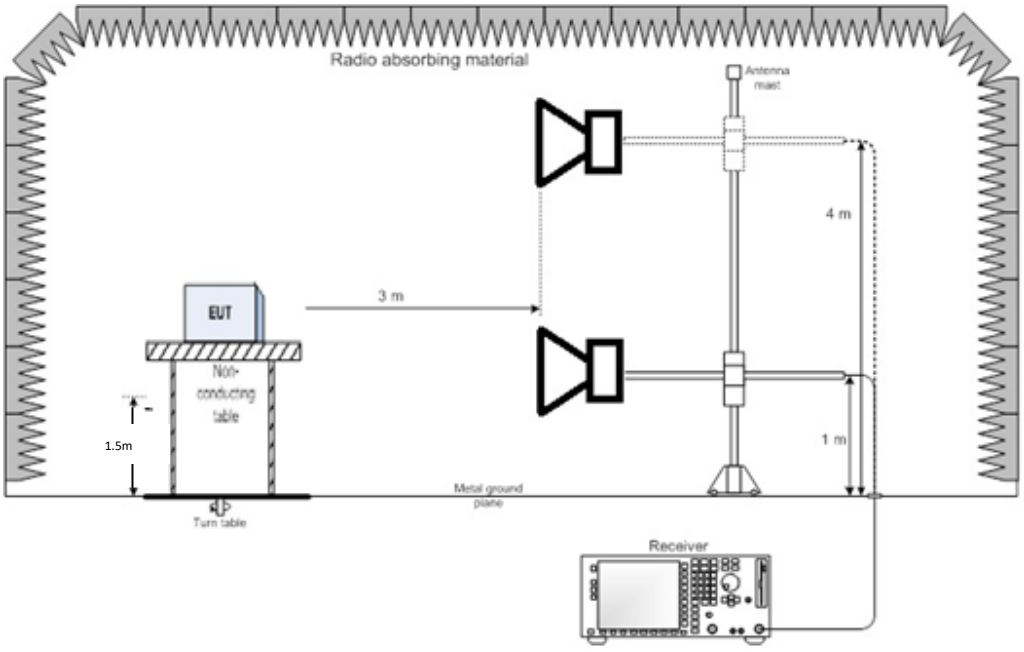
Notes:
[1]Result (dBµV) = receiver/spectrum analyzer value (dBµV) + correction factor (dB)
[2]Correction factor (dB) = LISN factor IL (dB) + cable loss (dB) + transient limiter (dB)
[3]The maximum measured value observed over a period of 5 seconds was recorded.

Section 8 Block diagrams of test set-ups

8.1 Radiated emissions set-up



30-1000MHz Setup



Above 1GHz Setup