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WIRELESS TEST REPORT

Report ID
REP007117-R1

Project ID
PRJ0019071

Type of assessment:
Complete Assessment

Applicant:
Chirp Inc.

Product marketing name (PMN):
Chirp Smart Home Sensor

Model/HVIN:
CHIRP-01-T

Model variant:
CHIRP-01

FCC identifier:
2A9Q4-CHIRP01T

ISED certification number:
29827-CHIRP01T

Specifications:

- FCC 47 CFR Part 15, Subpart C – §15.255
  Operation within the band 57-71 GHz
- ISED RSS-210, Issue 10, December 2019 + Amendment, April 2020
  Licence-Exempt Radio Apparatus: Category I Equipment

April 18, 2023

Martha Espinoza, Wireless Test Engineer
Tested by

Tarek Elkholy, EMC/RF Specialist
Reviewed by

Tarek Elkholy
Signature

Lab locations

Company name	Nemko Canada Inc.
Facilities	Ottawa site: 303 River Road, Ottawa, ON, Canada, K1V 1H2 Tel: +1 613 737 9680 Fax: +1 613 737 9691
Test site registration	**FCC/ISED** **FCC: CA2040; IC: 2040A-4** **SDPPI: 41**
Website	www.nemko.com

Limits of responsibility

Note that this report's results 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 this report.
This test report has been completed following the requirements of ISO/IEC 17025. All results contained in this report are within Nemko Canada's ISO/IEC 17025 accreditation.

Copyright notification

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

Table of Contents

Section 1 Report summary

1.1 Test specifications

FCC 47 CFR Part 15, Subpart C – §15.255	Operation within the band 57-71 GHz
ISED RSS-210 Annex J	Licence-Exempt Radio Apparatus: Category I Equipment: Devices operating in the band 57-71 GHz

1.2 Test methods

ANSI C63.10-2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

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

Report ID	Issue Date	Details of changes made to test report
REP007117	February 24, 2023	Original report issued
REP007117-R1	April 18, 2023	Equipment list was clarified

Notes: None

Section 2 Summary of test results

2.1 FCC Part 15, Subpart C, general requirements

Part	Test description	Verdict
§15.207(a)	Conducted limits	Pass [1]
§15.31(e)	Variation of power source	Pass
§15.203	Antenna requirement	Pass

Note 1: The EUT is AC powered

2.2 FCC Part 15.255

Part	Test description	Verdict
§15.255(e)	Emission bandwidth	Pass
§15.255(c)	Equivalent isotropically radiated power (EIRP)	Pass
§15.255(d)	Transmitter spurious emissions	Pass
§15.255(e)	Peak conducted output power	Pass
§15.255(f)	Frequency stability	Pass

2.3 RSS-210 Annex J

Part	Test description	Verdict
J.4	Emission bandwidth	Pass
J.2	Equivalent isotropically radiated power (EIRP)	Pass
J.3	Transmitter spurious emissions	Pass
J.4	Peak conducted output power	Pass
J.6	Frequency stability	Pass

2.4 RSS-GEN

Part	Test description	Verdict
6.7	99% Occupied bandwidth	Pass
7.3	Receiver radiated emission limits	Not applicable [1]
7.4	Receiver conducted emission limits	Not applicable [1]
8.8	Power Line Conducted Emissions Limits for License-Exempt Radio Apparatus	Pass

Note 1: EUT is neither a stand-alone receiver nor a scanning receiver.
Note 2: The EUT is AC powered

Section 3 Equipment under test (EUT) details

3.1 Disclaimer

This section contains information provided by the applicant and has been utilized to support the test plan. Inaccurate information provided by the applicant can affect the validity of the results within this test report. Nemko accepts no responsibility for the information contained within this section and the impact it may have on the test plan and resulting measurements.

3.2 Sample information

Receipt date	November 16, 2022
Nemko sample ID number	PRJ0019071

3.3 Testing period

Test start date	November 16, 2022
Test end date	November 18, 2022

3.4 Applicant/Manufacture

Company name	Chirp Inc.
Address	155 Lexington Crt
City	Waterloo
Province	Ontario
Postal code	N2J 4R2
Country	Canada

3.5 EUT information

Product	Chirp Smart Home Sensor	
Model	CHIRP-01-T	
Model variant	CHIRP-01	
Serial number	b5de45a3a3d34821	
Power requirements	12 V_{DC} (via external 100–240 V_{AC}, 50/60 Hz power adapter)	
Description/theory of operation	The Chirp device is a smart sensor device used to remotely monitor frail individuals living alone. It tracks the individual's activities in the home, looking for anomalies and emergencies (e.g., call for help) using multiple on board sensors. Notifications are sent to caregivers via the Chirp App (available for Android and iOS). Using the Chirp App, caregivers can initiate a two-way voice communication to the Chirp device.	
Operational frequencies	Crystals: SMD3225 for radar	40 MHz
	Core 3308Y SOM: CPU	1.3 GHz
	Core 3308Y SOM: digital reference clock	24 MHz
	Memory: MX25R1635FZUIH0 Flash for radar	80 MHz
	I/O: SDIO bus between SOM and Wi-Fi module	50 MHz
	I/O: Data UART between SOM and Radar IC	921600 Hz
	I/O: Config UART between SOM and Radar IC	115200 Hz
	I/O: SPI between SOM and LEDs	10 MHz
	I/O: I2C between SOM and sensors	400 kHz
	I/O: I2S between SOM and microphone	1.024 MHz
	Radar	60–64 GHz (Bandwidth 4000 MHz)
	Wi-Fi/BT	2.4 GHz
Software details	Standard release device firmware is provided which will run motion detection, audio processing, provide two-way call etc.	
Operating band	57–71 GHz	
Operational frequencies	60–64 GHz	
Antenna type	Antenna on chip	
Antenna gain (declared)	5 dBi	

3.6 EUT exercise and monitoring details

EUT description of the methods used to exercise the EUT and all relevant ports:

- For this test, the unit was plug in the AC outlet through a DC/AC converter. Once the unit was plug in the transmission is activated and the unit runs in a continuous mode.

EUT setup/configuration rationale:

- The EUT setup in a configuration that was expected to produce the highest amplitude emissions relative to the limit and that satisfy normal operation/installation practice by the end user.
- The type and construction of cables used in the measurement set-up were consistent with normal or typical use. Cables with mitigation features (for example, screening, tighter/more twists per length, ferrite beads) have been noted below:
  - The following deviations were made:
  - None
- The EUT was setup in a manner that was consistent with its typical arrangement and use. The measurement arrangement of the EUT, local ancillary equipment and associated cabling was representative of normal practice. Any deviations from typical arrangements have been noted below:
  - The following deviations were:
  - None

3.7 EUT setup details

Table 3.7-1: EUT sub-assemblies

Description	Brand name	Serial number, Part number, Model, Revision level
AC/DC power adapter	SIMSUKIAN	SN: 22010701000001, MN: SK03T1-1200300U

Table 3.7-2: EUT interface ports

Description	Qty.
DC power input, barrel connector	1

Table 3.7-3: Inter-connection cables

Cable description	From	To	Length (m)
Power cable	AC/DC adapter	Smart sensor	1.5

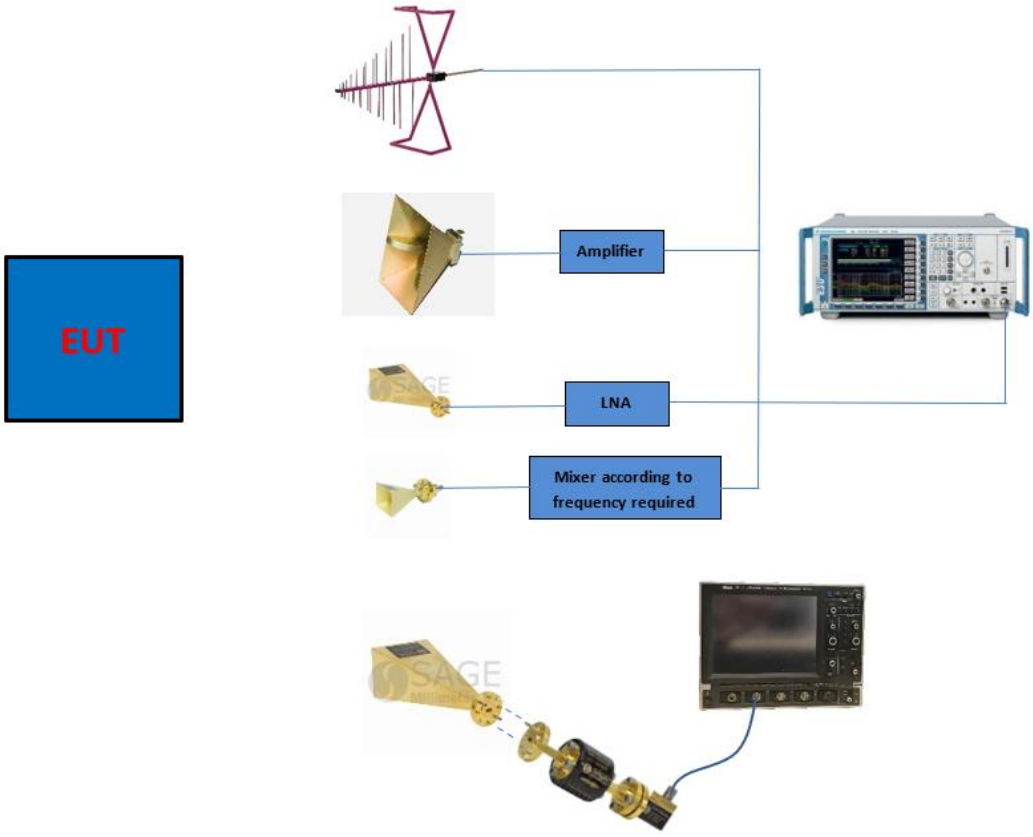


Figure 3.7-1: Test setup diagram

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 Model variant

As declared by the applicant, the EUT model CHIRP-01-T has been chosen to be representative for the other model in the model family. The model family, and the description of the variations, are as follows:

FCC ID: 2A9Q4-CHIRP01T
ISED certification number: **IC:** 29827-CHIRP01T
HVINs/Models: CHIRP-01-T, CHIRP-01

Family Certification request letter

We hereby request Family Certification for the above mentioned HVINs/Models based on them being electrically, and physically identical apart from model name/number.

The following table summarizes the similarity and difference between the two models.

	CHIRP-01-T	**CHIRP-01**
Electrical circuitry	Same	Same
Electrical layout	Same	Same
Electrical components	Thermopile (HTPA32x32d L2.1/0.8) populated	Thermopile not populated
Antenna	Same	Same
Enclosure	3mm diameter circular opening on the case front for thermopile sensor	No opening for thermopile sensor
Software	Thermal video streaming	Thermal video not available

CHIRP-01-T was tested as the representative model to have the maximum power draw and communication during test.

Variant: CHIRP-01 is a depopulated version of the CHIRP-01-T, CHIRP-01-T withdraws the maximum current.

4.4 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 Test equipment

7.1 Test equipment list

Table 7.1-1: Test 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	3 years	VOU
Digital oscilloscope	LeCroy	WS64MXS-B	E1041	2 years	12-08-2023
V-Band X2, Passive Frequency Multiplier	Sage	SFP-152KF-S2	N/A	NCR	NCR
RF Detector	Eravant	STD-15SF-PI	E1310	NCR	NCR
Antenna, Bilog	Schaffner-Chase	CBL6111C	1480	2 years	01-27-2023
Antenna, Horn	ETS	3117-PA	E1139	2 years	04-19-2023
Antenna, Horn	Sage Millimeter	SAR-2309-42-S2	E1143	NCR	NCR
Antenna, Horn	Sage Millimeter	SAR-2309-28-S2	E1148	NCR	NCR
Low Noise Amplifier	Sage Millimeter	SBL-1834034030-KFKF-SI	E1228	VOU	VOU
Antenna, Horn	Sage Millimeter	SAR-2309-19-S2	E1144	NCR*	NCR*
Mixer	Rohde & Schwarz	FS-Z60	E1138	VOU**	VOU**
Antenna, Horn	Sage Millimeter	SAR-2408-15-S2	E1152	NCR*	NCR*
Mixer	Rohde & Schwarz	FS-Z75	E1149	VOU**	VOU**
Antenna, Horn	Sage Millimeter	SAR-2507-10-S2	E1146	NCR*	NCR*
Mixer	Rohde & Schwarz	FS-Z110	E1154	VOU**	VOU**
Antenna, Horn	Sage Millimeter	SAR-2507-06-S2	E1182	NCR*	NCR*
Mixer	Radiometer Physics	HM110-170	E1178	VOU**	VOU**
Antenna, Horn	Sage Millimeter	SAR-2309-05-S2	E1184	NCR*	NCR*
Mixer	Radiometer Physics	HM140-220	E1177	VOU**	VOU**
Temperature Chamber	Test Equity	115A	E1162	1 year	08-29-2023
Added Two Line V-Network	Rohde & Schwartz	ENV216	E1019	1 Year	09-30-2023
Transient Limiter	HP	11947A	684	1 Year	VOU
EMC Test Receiver	Rohde & Schwarz	ESCI 7	E1026	2 Year	03-22-2023

Notes: N/A – Not Applicable
NCR – No Calibration Required
VOU – Verify On Use
**The mixers are verified before each use.
*Standard gain horn antennas are not calibrated (per ANSI C63.26 4.5.3.a) and are verified internally annually.

Table 7.1-2: Test software details

Manufacturer of Software	Details
Rohde & Schwarz	EMC 32 V10.60.15

Notes: None

Section 8 Testing data

8.1 AC power line conducted emissions

8.1.1 References and limits

- FCC 47 CFR Part 15, Subpart C: §15.207
- RSS-Gen: 8.8
- Test method: ANSI C63.10-2014 §6.2

Table 8.1-1: AC power line conducted emissions limit

Frequency of emission, MHz	Conducted limit, dBµV	
	Quasi-peak	Average
0.15 – 0.5	66 to 56*	56 to 46*
0.5 – 5	56	46
5 – 30	60	50

Note: * - Decreases with the logarithm of the frequency.

8.1.2 Test summary

Verdict	Pass		
Test date	November 18, 2022	Temperature	27 °C
Test engineer	Martha Espinoza, Wireless Test Engineer	Air pressure	1002 mbar
Test location	Ground Plane	Relative humidity	49 %

8.1.3 Notes

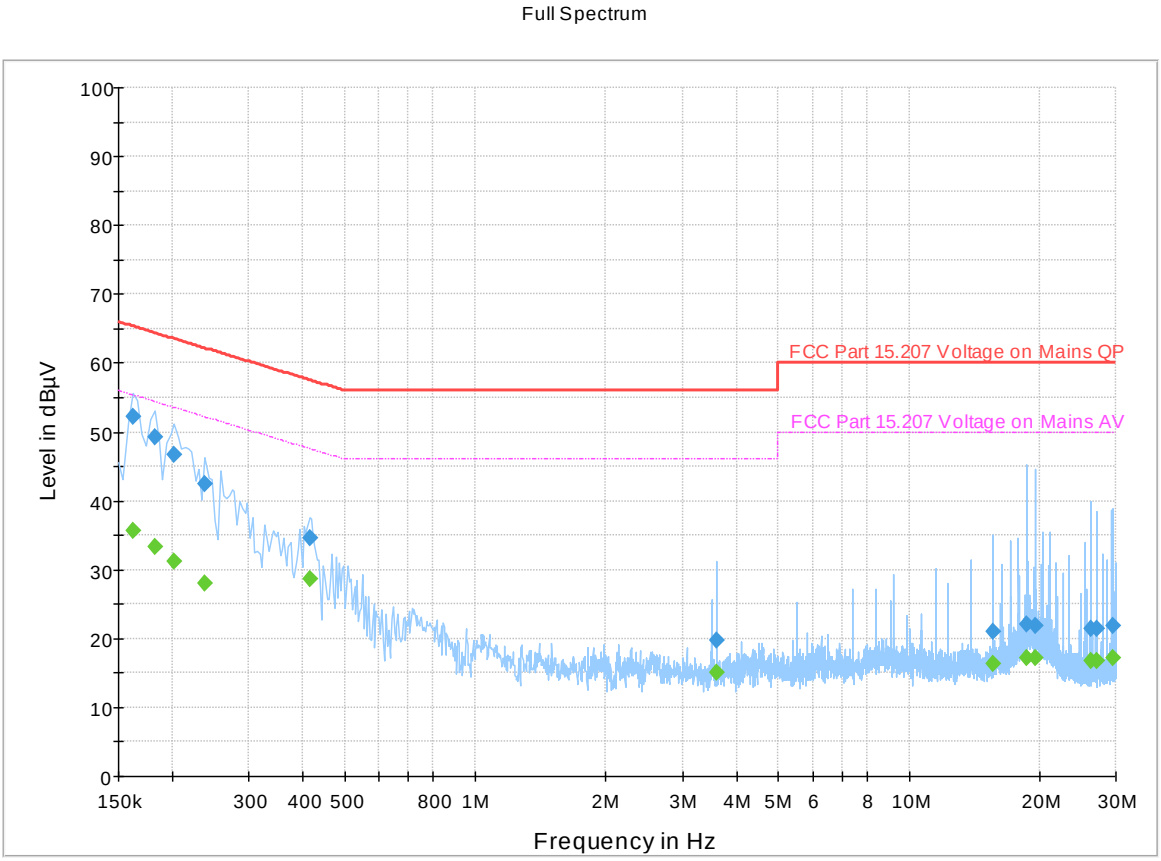
Testing was performed with the transmitter operating on a fixed channel at full power.

8.1.4 Setup details

Port under test	AC power input
EUT power input during test	
EUT setup configuration	☒ Table-top ☐ Floor standing ☐ Other:
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
Detector mode	– Peak (Preview measurement) – Quasi-peak and average (Final measurement)
Trace mode	Max Hold
Measurement time	– 100 ms (Peak preview measurement) – 5000 ms (Quasi-peak and average final measurement)



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

Figure 8.1-1: Conducted disturbance at mains port spectral plot: 300 MHz OBW

Frequency (MHz)	QuasiPeak (dBµV)	CAverage (dBµV)	Limit (dBµV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Filter	Corr. (dB)
0.162000	---	35.68	55.36	19.68	5000.	9.000	N	ON	19.7
0.162000	52.15	---	65.36	13.21	5000.	9.000	N	ON	19.7
0.182000	49.36	---	64.39	15.03	5000.	9.000	L1	ON	19.7
0.182000	---	33.26	54.39	21.13	5000.	9.000	L1	ON	19.7
0.202000	46.76	---	63.53	16.77	5000.	9.000	N	ON	19.6
0.202000	---	31.28	53.53	22.25	5000.	9.000	N	ON	19.6
0.238000	---	28.13	52.17	24.04	5000.	9.000	N	ON	19.6
0.238000	42.54	---	62.17	19.63	5000.	9.000	N	ON	19.6
0.414000	---	28.56	47.57	19.00	5000.	9.000	N	ON	19.5
0.414000	34.68	---	57.57	22.89	5000.	9.000	N	ON	19.5
3.602000	---	15.13	46.00	30.87	5000.	9.000	N	ON	19.4
3.602000	19.71	---	56.00	36.29	5000.	9.000	N	ON	19.4
15.602000	---	16.26	50.00	33.74	5000.	9.000	L1	ON	20.3
15.602000	20.95	---	60.00	39.05	5000.	9.000	L1	ON	20.3
18.698000	22.04	---	60.00	37.96	5000.	9.000	N	ON	20.4
18.698000	---	17.20	50.00	32.80	5000.	9.000	N	ON	20.4
19.502000	21.91	---	60.00	38.09	5000.	9.000	N	ON	20.4
19.502000	---	17.13	50.00	32.87	5000.	9.000	N	ON	20.4
26.298000	---	16.67	50.00	33.33	5000.	9.000	L1	ON	20.1
26.298000	21.39	---	60.00	38.61	5000.	9.000	L1	ON	20.1
27.098000	---	16.75	50.00	33.25	5000.	9.000	N	ON	20.1
27.098000	21.48	---	60.00	38.52	5000.	9.000	N	ON	20.1
29.506000	---	17.12	50.00	32.88	5000.	9.000	N	ON	20.2
29.506000	21.76	---	60.00	38.24	5000.	9.000	N	ON	20.2

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.

Table 8.1-2: Conducted disturbance at mains port (Quasi-Peak and CAverage) results: 300 MHz OBW

8.2 Emission bandwidth

8.2.1 References and limits

- FCC 47 CFR Part 15, Subpart C: §15.255(e)
- RSS-210 Annex J.4:
- ANSI C63.10 §6.9

15.255:
(1) 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:
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.

8.2.2 Test summary

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

8.2.3 Notes

Testing was performed with the transmitter operating on a fixed channel at full power.

8.2.4 Setup details

EUT power input during test	
EUT setup configuration	☒ Table-top ☐ Floor standing ☐ Other:

Receiver settings:

Resolution bandwidth	100 kHz (approximately 1-5 % of the emission bandwidth)
Video bandwidth	300 kHz (approximately 3 x resolution bandwidth)
Detector mode	Peak
Trace mode	Max Hold
Measurement time	Long enough for trace to stabilize

Center Frequency (GHz)	Bandwidth (MHz)	6 dB BW (MHz)	99% BW (MHz)
62.5	4000	3894.81	3857.214279

Table 8.2-2: Occupied Bandwidth Results.

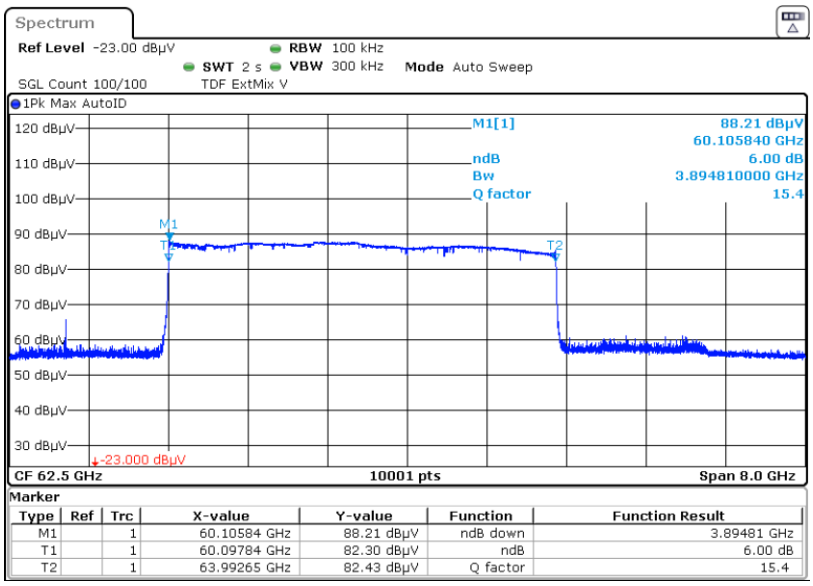


Figure 8.2-1: *6 dB OBW: 4000 MHz bandwidth*

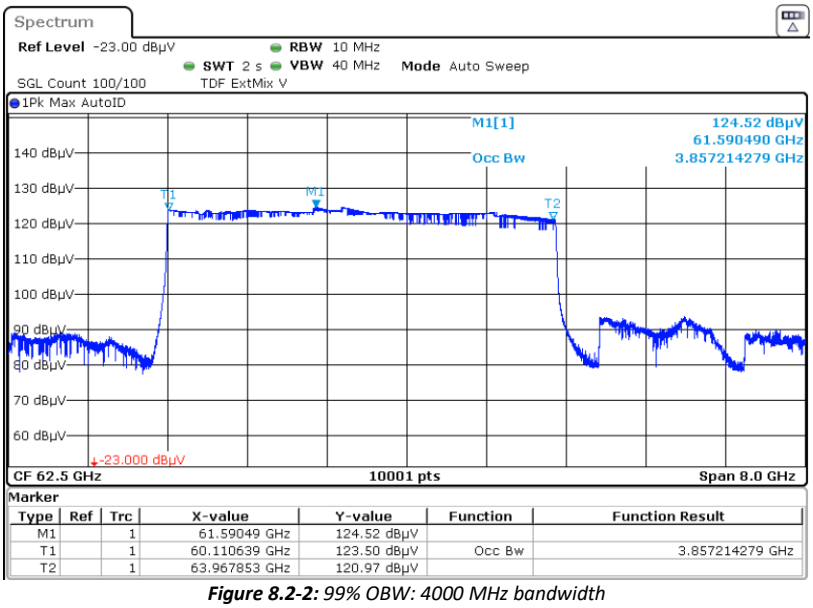


Figure 8.2-2: *99% OBW: 4000 MHz bandwidth*

8.3 Equivalent isotropically radiated power (EIRP)

8.3.1 References and limits

- FCC 47 CFR Part 15, Subpart C: §15.255(c)
- RSS-210 Annex J, J.2
- Test method: ANSI C63.10: §9.11

§15.225:

(c) Within the 57-71 GHz band, emission levels shall not exceed the following equivalent isotropically radiated power (EIRP):

(1) Products other than fixed field disturbance sensors and short-range devices for interactive motion sensing shall comply with one of the following emission limits, as measured during the transmit interval:

(i) The average power of any emission shall not exceed 40 dBm and the peak power of any emission shall not exceed 43 dBm; or

(ii) For fixed point-to-point transmitters located outdoors, the average power of any emission shall not exceed 82 dBm and shall be reduced by 2 dB for every dB that the antenna gain is less than 51 dBi. The peak power of any emission shall not exceed 85 dBm and shall be reduced by 2 dB for every dB that the antenna gain is less than 51 dBi.

(A) The provisions in this paragraph (c) for reducing transmit power based on antenna gain shall not require that the power levels be reduced below the limits specified in paragraph (c)(1)(i) of this section.

(B) The provisions of § 15.204(c)(2) and (4) that permit the use of different antennas of the same type and of equal or less directional gain do not apply to intentional radiator systems operating under this provision. In lieu thereof, intentional radiator systems shall be certified using the specific antenna(s) with which the system will be marketed and operated. Compliance testing shall be performed using the highest gain and the lowest gain antennas for which certification is sought and with the intentional radiator operated at its maximum available output power level. The responsible party, as defined in § 2.909 of this chapter, shall supply a list of acceptable antennas with the application for certification.

(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.

(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.

(4) The peak power shall be measured with an RF detector that has a detection bandwidth that encompasses the 57-71 GHz band and has a video bandwidth of at least 10 MHz. The average emission levels shall be measured over the actual time period during which transmission occurs.

RSS-210 Annex J:

J.2 Limits of radiated emissions within the band 57-71 GHz

Within the band 57-71 GHz, the power of any emissions, measured during the transmit interval, shall comply with the e.i.r.p. limits in this section.

For the purpose of this annex, the terms “average e.i.r.p.” and “peak e.i.r.p.” refer to e.i.r.p. with transmitter output power measured in terms of average value or peak value respectively.

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.

For fixed field disturbance sensors other than those operating under the provisions of (a) above and for interactive motion sensors, the peak transmitter output power shall not exceed -10 dBm, and the peak e.i.r.p. shall not exceed 10 dBm.

J.2.2 Devices other than fixed field disturbance sensors and interactive motion sensors

Following are the conditions for devices other than fixed field disturbance sensors and interactive motion sensors:

For fixed point-to-point equipment located outdoors, the average e.i.r.p. of any emission shall not exceed 82 dBm minus 2 dB for every dB for which the antenna gain is less than 51 dBi. The peak e.i.r.p. of any emission shall not exceed 85 dBm minus 2 dB for every dB that the antenna gain is less than 51 dBi. However, the power shall not be required to be reduced below the limits in (b).

Compliance testing shall be performed using the highest gain and the lowest gain antennas with which the equipment is certified. Further, this equipment shall not be marketed and operated with antennas other than those listed in the certification application with which the equipment is certified.

For other devices, the average and peak e.i.r.p. of any emission shall not exceed 40 dBm and 43 dBm, respectively.

8.3.2 Test summary

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

8.3.3 Notes

This test was performed using the procedure described in ANSI C63.10-2013, section 9.11. The procedure involves several steps using a measurement from EUT through a test antenna, an 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, calculations are 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. Peak for other bandwidths) and the conducted power from equation (19), (22), (24) and (27) from ANSI C63.10-2013.

The emission bandwidth of the EUT is 4000 MHz (See 8.2).

Limit applied:

☐ The average power of any emission shall not exceed 40 dBm and the peak power of any emission shall not exceed 43 dBm

☐ The average power of any emission shall not exceed 82 dBm and shall be reduced by 2 dB for every dB that the antenna gain is less than 51 dBi.

☐ 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.

☒ The peak transmitter conducted output power shall not exceed −10 dBm and the peak EIRP level shall not exceed 10 dBm.

8.3.4 Setup details

EUT power input during test	
EUT setup configuration	☒ Table-top ☐ Floor standing ☐ Other:
Measuring distance	0.15 m
Antenna height	1.53 m
Turn table position	0°
Measurement details	The EUT was measured in the maximum field strength emission.

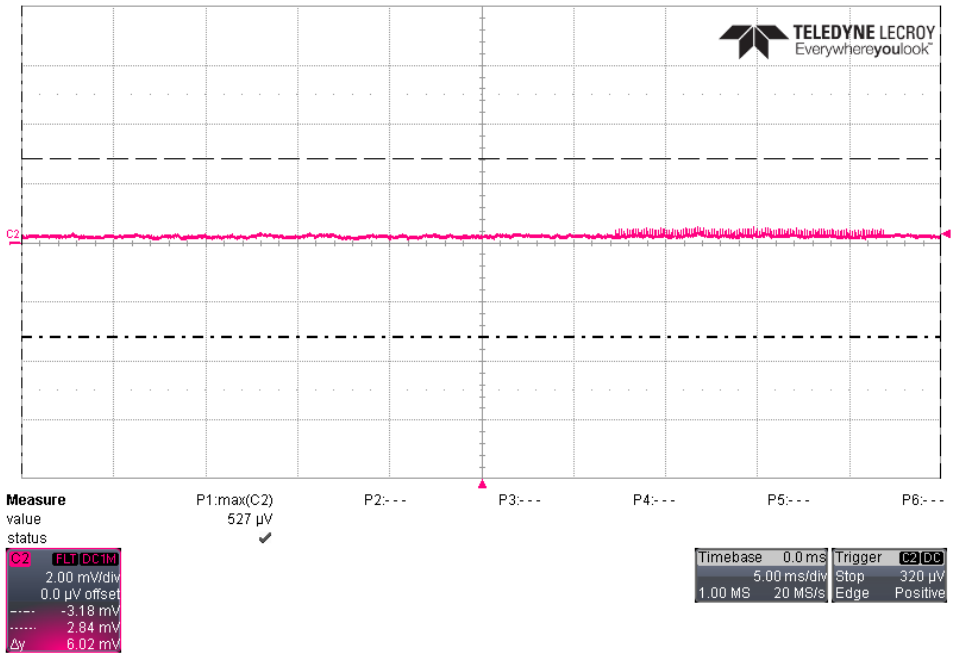


Figure 8.3-3: *4000 MHz occupied bandwidth signal, view on oscilloscope.*

Center Frequency (GHz)	Measured peak Power (dBm)	Field strength (dBµV/m)	EIRP (dBm)	Limit (dBm)	Margin (dB)	Conducted Power (dBm)	Limit (dBm)	Margin (dB)
62.5	-56.5	92.7	-28.5	10.0	38.5	-33.5	-10.00	23.5

Table 8.3-2: EIRP Results: 4000 MHz bandwidth signal

Using equation (19):

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

Where:

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

c=2.99792458X10^8 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*log$_{10}$(2.99792458e8/62.5e9)) +(-56.5) -(24) = 92.7 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 = 92.7 + (20*log$_{10}$(0.15))-104.7
EIRP = -28.5 dBm
Conducted Power (dBm) = EIRP – 5 dBi

8.4 Transmitter spurious emissions

8.4.1 References and limits

- FCC 47 CFR Part 15, Subpart C: §15.255(d)
- RSS-210 Annex J: J.3

§15.255:

(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.

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/cm^2 (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.

RSS-210 Annex J:

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/cm^2 at a distance of 3 m for emissions between 40 GHz and 200 GHz

8.4.2 Test summary

Verdict	Pass		
Test date	November 16, 2022; November 17, 2022	Temperature	25°C;23°C
Test engineer	Martha Espinoza, Wireless Test Engineer	Air pressure	1004 mbar; 1005 mbar
Test location	3m semi anechoic chamber	Relative humidity	50%;55 %

8.4.3 Notes

This test was done at a 3m (below 40 GHz) and 1m (above 40 GHz) measurement distance with the EUT configured to transmit at maximum output power. The spectrum was explored from 30 MHz to 200 GHz. Testing from 30 MHz to 40 GHz was assessed against the FCC 15.209 limits. Above 40 GHz, the limit is defined as 90 pW/cm^2 at 3m.

Calculation from limit line for this test (above 40 GHz):

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

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

$EIRP_{Linear} = (PD)(4\pi)(d^2)$
$EIRP_{Linear} = (90x10^{-12})(4\pi)(300^2)$
$EIRP_{Linear} = 0.10178\ mw \approx 85.31$ dBµV/m @ 3m

At a measurement distance of 1 m the calculated limit is:

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

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

8.4.4 Setup details

EUT power input during test	
EUT setup configuration	☒ Table-top ☐ Floor standing ☐ Other:
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 settings (below 1 GHz):

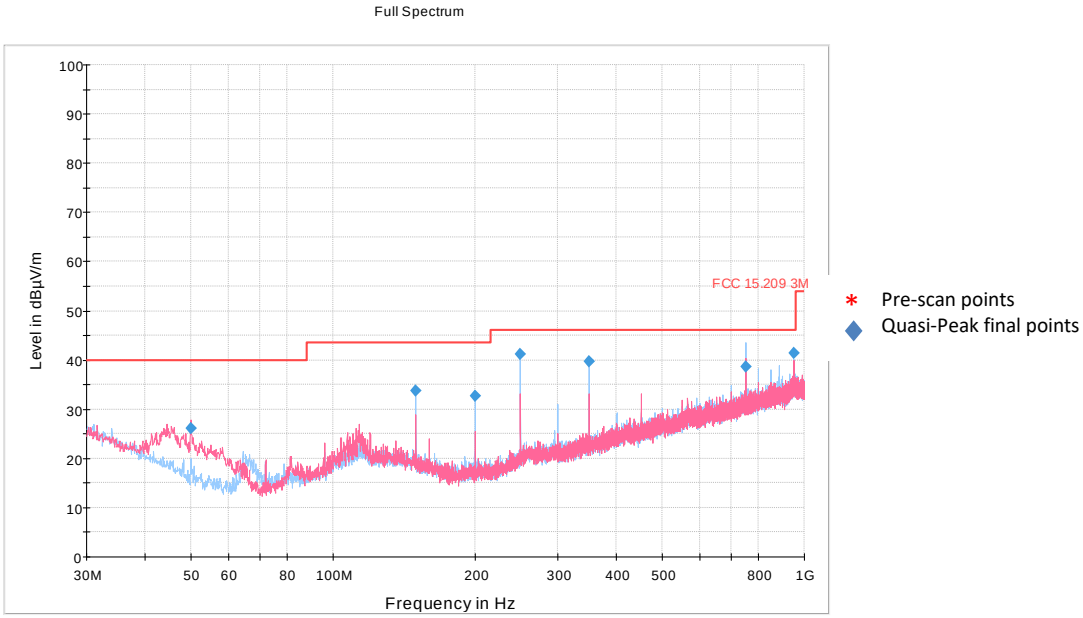
Resolution bandwidth	120 kHz
Video bandwidth	300 kHz
Detector mode	Peak (preview measurements) Quasi-peak (final measurements)
Trace mode	Max Hold
Measurement time	5000 ms (final measurements)

Receiver settings (from 1 -40 GHz):

Resolution bandwidth	1 MHz
Video bandwidth	3 MHz
Detector mode	Peak (preview measurements) Peak and average (final measurements)
Trace mode	Max Hold
Measurement time	5000 ms (final measurements)

Spectrum analyzer settings (above 40 GHz):

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



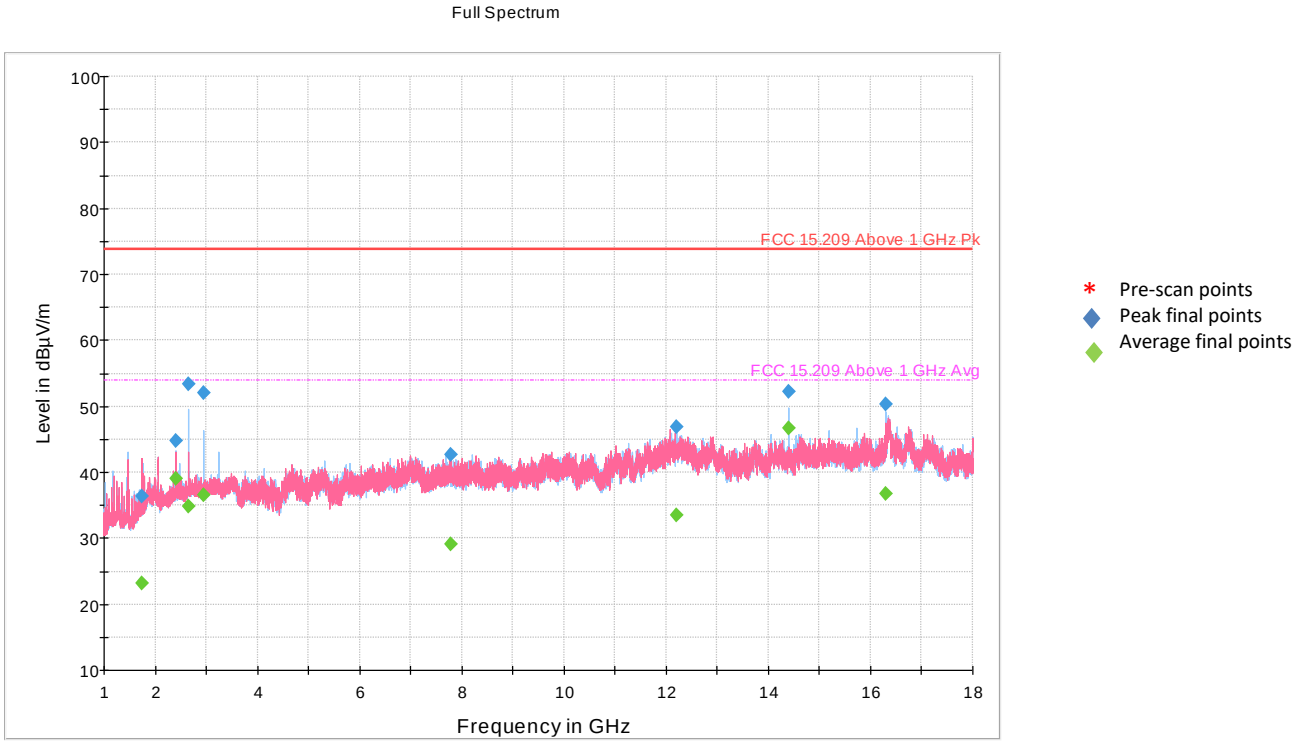
The spectral plot shows a vertical and horizontal scan with different colors. The spectral scan has been corrected with the associated transducer factors (i.e. antenna factors, cable loss, amplifier gains, and attenuators).

Figure 8.4-1: 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)
50.022000	26.22	40.00	13.78	5000.0	120.000	226.0	V	0.0	16.0
149.989000	33.73	43.50	9.77	5000.0	120.000	180.0	H	113.0	19.4
199.984000	32.64	43.50	10.86	5000.0	120.000	100.0	H	233.0	17.8
249.996000	41.23	46.00	4.77	5000.0	120.000	110.0	H	108.0	20.9
350.003000	39.70	46.00	6.30	5000.0	120.000	100.0	H	202.0	23.8
749.991000	38.57	46.00	7.43	5000.0	120.000	379.0	H	234.0	31.7
950.005000	41.32	46.00	4.68	5000.0	120.000	143.0	H	312.0	35.0

Table 8.4-1: 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.



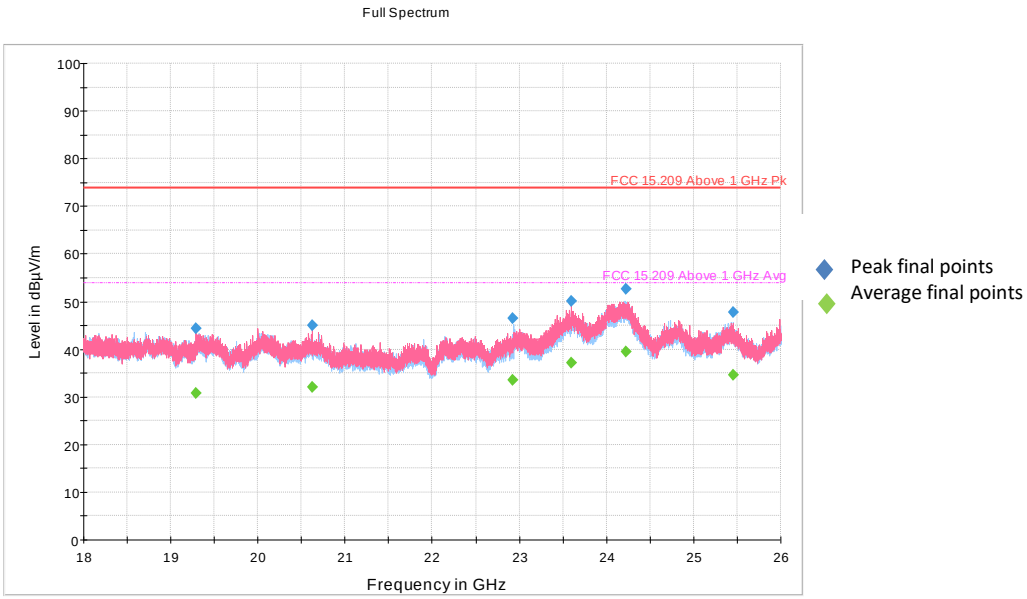
The spectral plot shows a vertical and horizontal scan with different colors. The spectral scan has been corrected with the associated transducer factors (i.e. antenna factors, cable loss, amplifier gains, and attenuators).

Figure 8.4-2: 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)
1743.633333	36.46	---	73.90	37.44	5000.0	1000.000	111.0	V	196.0	-12.6
1743.633333	---	23.15	53.90	30.75	5000.0	1000.000	111.0	V	196.0	-12.6
2400.066667	---	39.05	53.90	14.85	5000.0	1000.000	147.0	H	305.0	-10.0
2400.066667	44.86	---	73.90	29.04	5000.0	1000.000	147.0	H	305.0	-10.0
2654.122222	---	34.75	53.90	19.15	5000.0	1000.000	275.0	H	158.0	-8.9
2654.122222	53.47	---	73.90	20.43	5000.0	1000.000	275.0	H	158.0	-8.9
2949.188889	---	36.59	53.90	17.31	5000.0	1000.000	267.0	H	172.0	-8.3
2949.188889	52.11	---	73.90	21.79	5000.0	1000.000	267.0	H	172.0	-8.3
7786.233333	42.74	---	73.90	31.16	5000.0	1000.000	280.0	V	266.0	1.1
7786.233333	---	29.09	53.90	24.81	5000.0	1000.000	280.0	V	266.0	1.1
12203.400000	46.84	---	73.90	27.06	5000.0	1000.000	400.0	H	198.0	6.8
12203.400000	---	33.48	53.90	20.42	5000.0	1000.000	400.0	H	198.0	6.8
14400.722222	---	46.63	53.90	7.27	5000.0	1000.000	198.0	H	20.0	10.0
14400.722222	52.23	---	73.90	21.67	5000.0	1000.000	198.0	H	20.0	10.0
16305.233333	50.28	---	73.90	23.62	5000.0	1000.000	307.0	H	0.0	13.4
16305.233333	---	36.70	53.90	17.20	5000.0	1000.000	307.0	H	0.0	13.4

Table 8.4-2: 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.



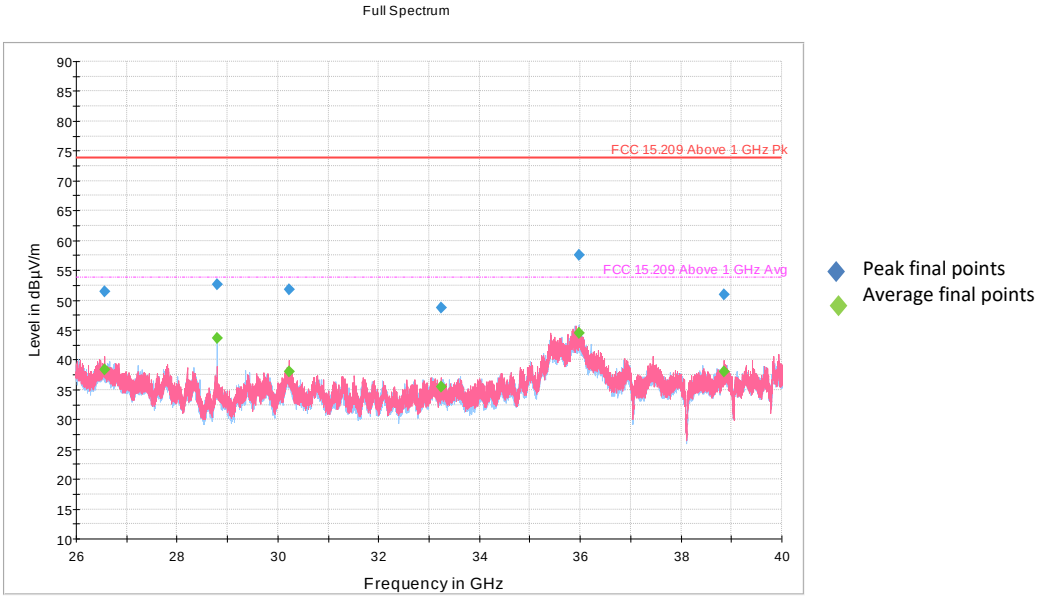
The spectral plot is a summation of a vertical and horizontal scan. The spectral scan has been corrected with the associated transducer factors (i.e. antenna factors, cable loss, amplifier gains, and attenuators).

Figure 8.4-3: 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)
19294.400000	44.46	---	73.90	29.44	5000.0	1000.000	154.0	V	179.0	18.4
19294.400000	---	30.79	53.90	23.11	5000.0	1000.000	154.0	V	179.0	18.4
20627.700000	45.06	---	73.90	28.84	5000.0	1000.000	309.0	V	72.0	19.5
20627.700000	---	32.03	53.90	21.87	5000.0	1000.000	309.0	V	72.0	19.5
22921.300000	---	33.45	53.90	20.45	5000.0	1000.000	385.0	H	215.0	21.2
22921.300000	46.41	---	73.90	27.49	5000.0	1000.000	385.0	H	215.0	21.2
23596.000000	50.15	---	73.90	23.75	5000.0	1000.000	282.0	V	0.0	25.9
23596.000000	---	37.23	53.90	16.67	5000.0	1000.000	282.0	V	0.0	25.9
24219.900000	---	39.48	53.90	14.42	5000.0	1000.000	337.0	H	330.0	29.1
24219.900000	52.62	---	73.90	21.28	5000.0	1000.000	337.0	H	330.0	29.1
25453.500000	47.87	---	73.90	26.03	5000.0	1000.000	144.0	H	186.0	24.0
25453.500000	---	34.56	53.90	19.34	5000.0	1000.000	144.0	H	186.0	24.0

Table 8.4-3: 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 8.4-4: 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)
26566.325000	51.38	---	73.90	22.52	5000.0	1000.000	162.0	V	2.0	12.8
26566.325000	---	38.32	53.90	15.58	5000.0	1000.000	162.0	V	2.0	12.8
28801.475000	---	43.60	53.90	10.30	5000.0	1000.000	200.0	H	-1.0	12.5
28801.475000	52.59	---	73.90	21.31	5000.0	1000.000	200.0	H	-1.0	12.5
30222.875000	51.77	---	73.90	22.13	5000.0	1000.000	162.0	V	10.0	13.9
30222.875000	---	38.11	53.90	15.79	5000.0	1000.000	162.0	V	10.0	13.9
33235.150000	---	35.48	53.90	18.42	5000.0	1000.000	185.0	V	91.0	14.1
33235.150000	48.80	---	73.90	25.10	5000.0	1000.000	185.0	V	91.0	14.1
35967.625000	57.61	---	73.90	16.29	5000.0	1000.000	125.0	H	284.0	23.6
35967.625000	---	44.42	53.90	9.48	5000.0	1000.000	125.0	H	284.0	23.6
38862.350000	50.92	---	73.90	22.98	5000.0	1000.000	200.0	V	7.0	19.1
38862.350000	---	37.96	53.90	15.94	5000.0	1000.000	200.0	V	7.0	19.1

Table 8.4-4: 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.

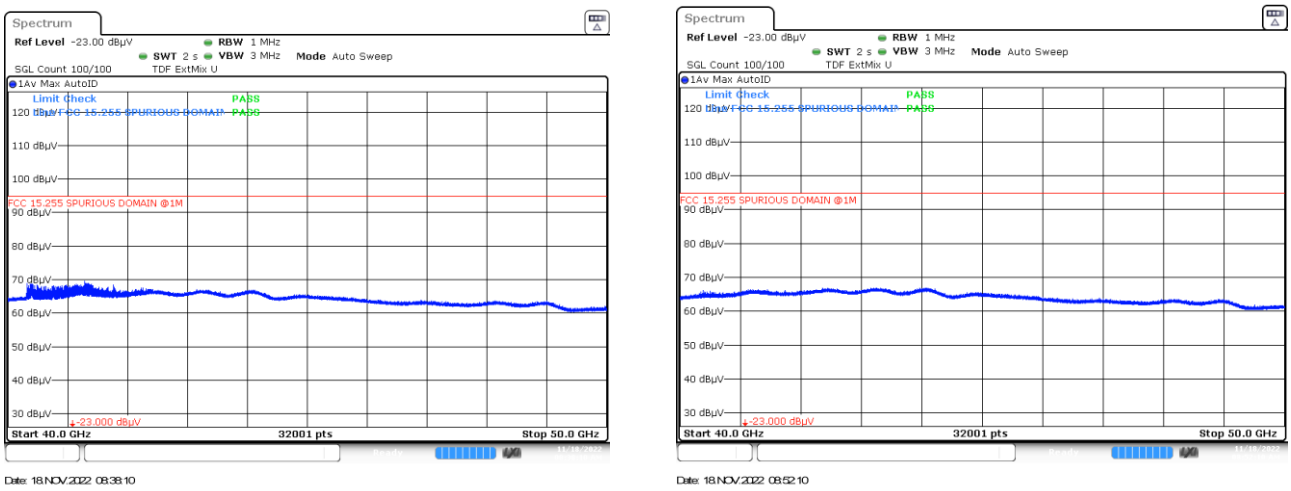


Figure* 8.4-5*: *Unwanted emissions spurious band plot – Field strength measured from 40 to 50 GHz, horizontal and vertical polarization respectively:*

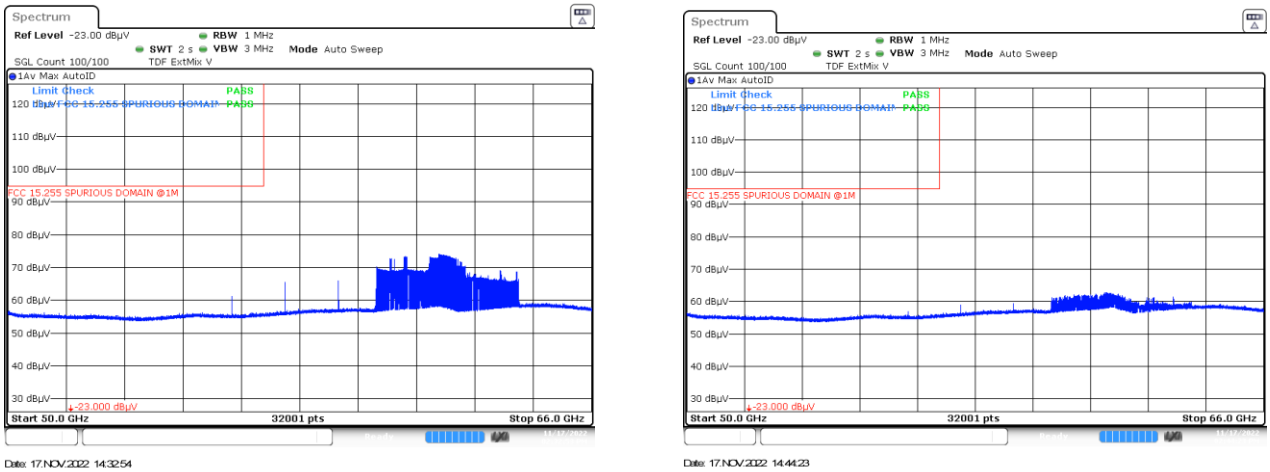


Figure* 8.4-6*: *Unwanted emissions spurious band plot – Field strength measured from 50 to 66 GHz, horizontal and vertical polarization respectively:*

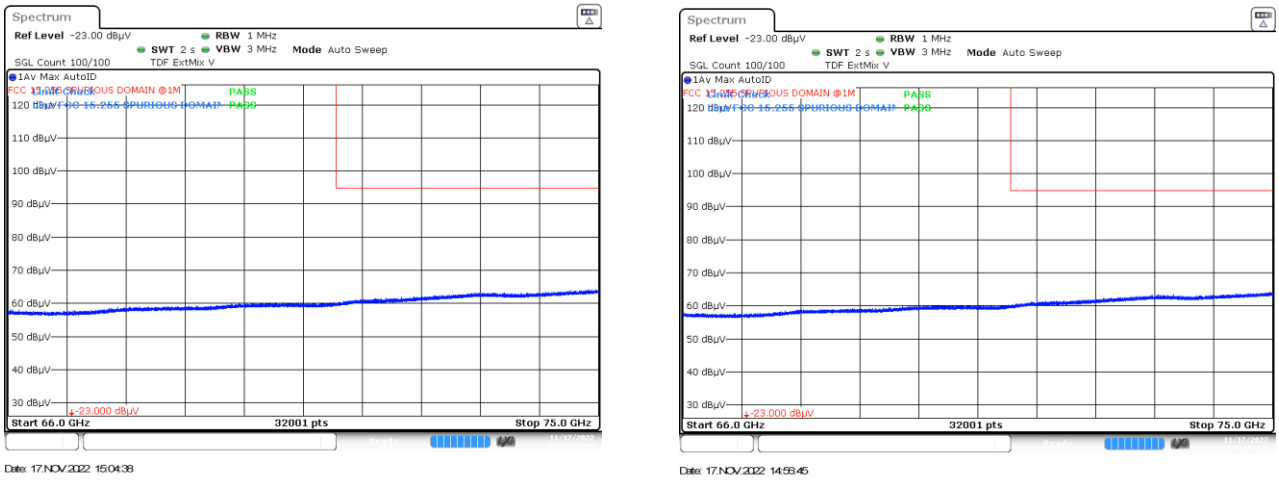


***Figure* 8.4-7:** *Unwanted emissions spurious band plot – Field strength measured from 66 to 75 GHz, horizontal and vertical polarization respectively*

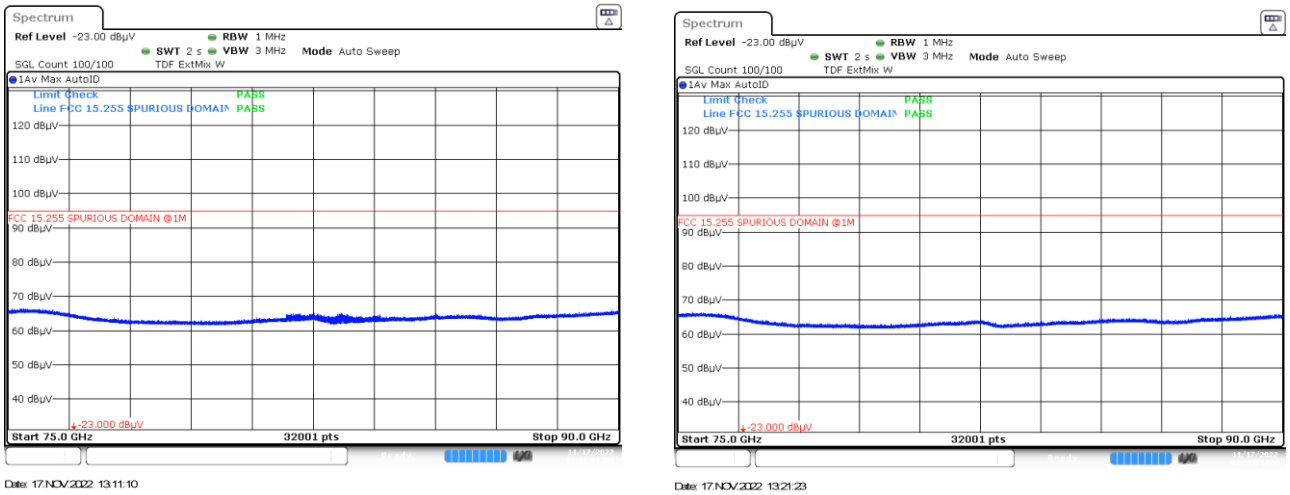


***Figure* 8.4-8:** *Unwanted emissions spurious band plot – Field strength measured from 75 to 90 GHz, horizontal and vertical polarization respectively:*

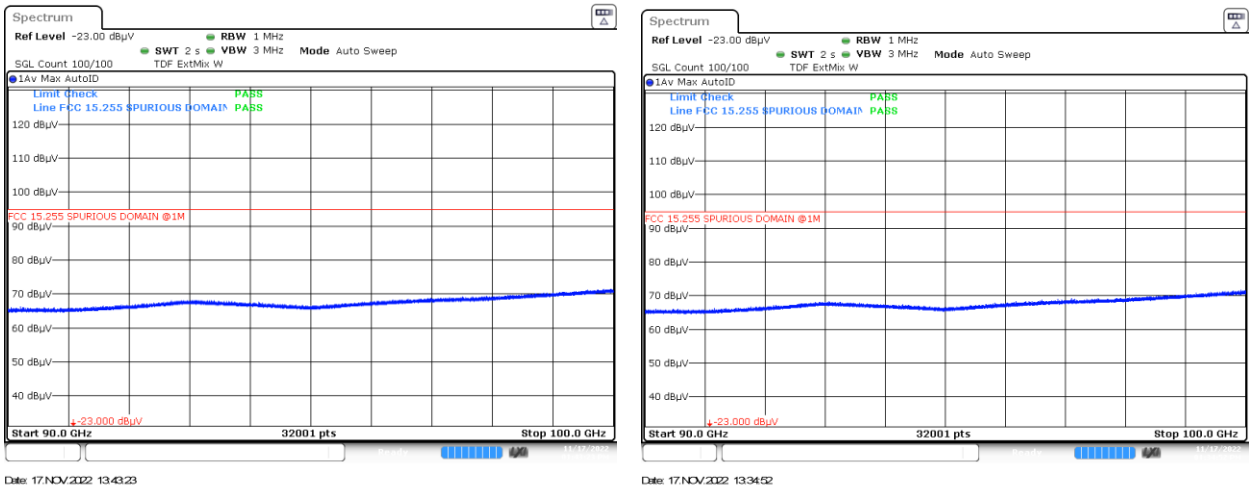


***Figure* 8.4-9:** *Unwanted emissions spurious band plot – Field strength measured from 90 to 100 GHz, horizontal and vertical polarization respectively:*

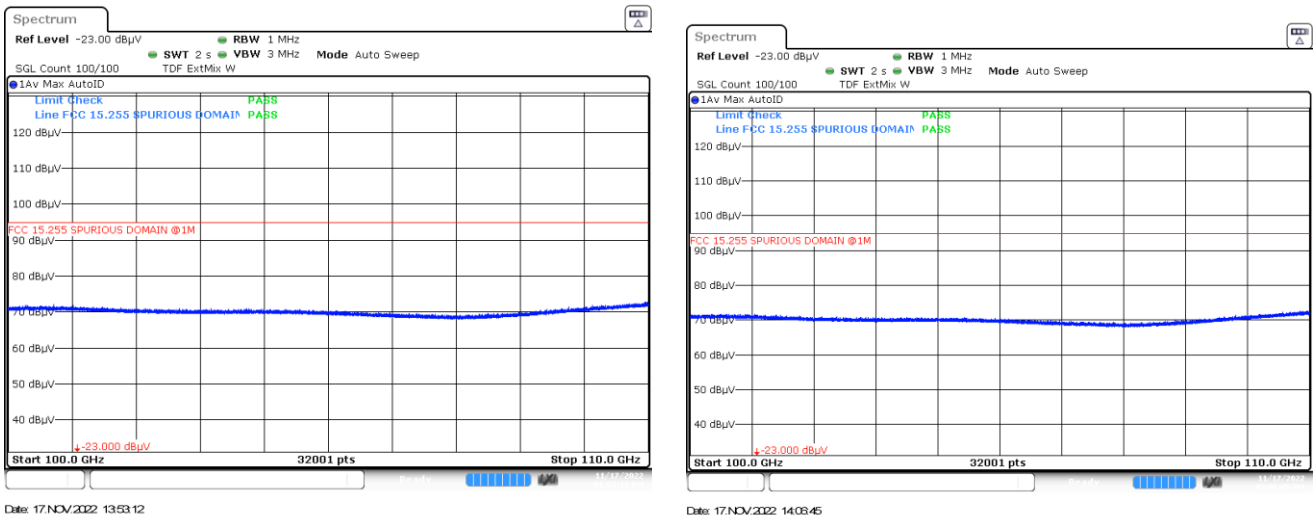


***Figure* 8.4-10:** *Unwanted emissions spurious band plot – Field strength measured from 100 to 110 GHz, horizontal and vertical polarization respectively:*

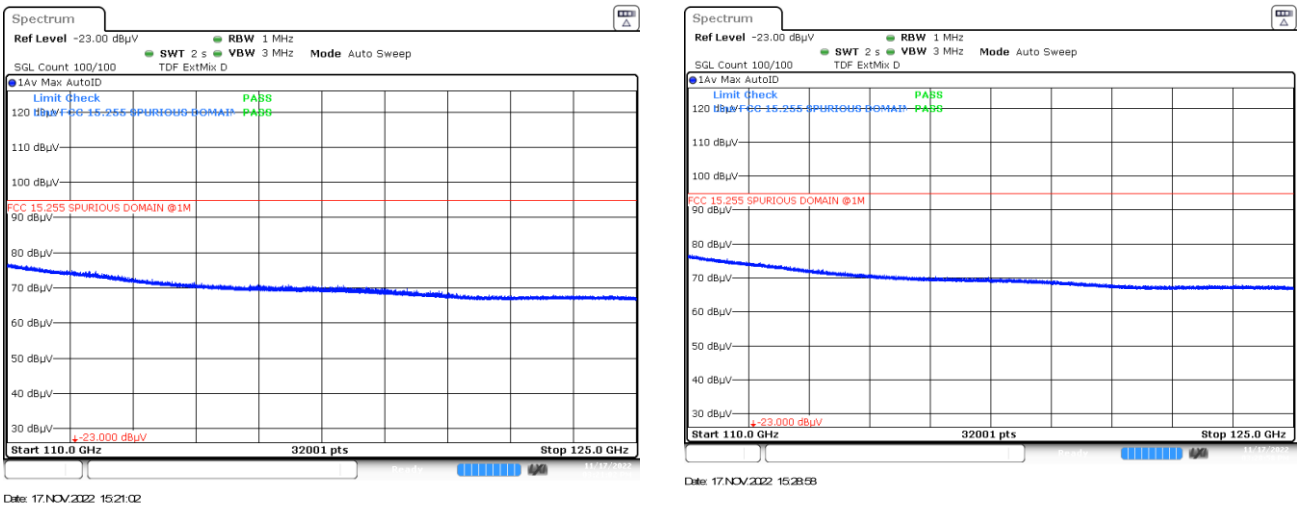


***Figure* 8.4-11:** *Unwanted emissions spurious band plot – Field strength measured from 110 to 125 GHz, horizontal and vertical polarization respectively:*

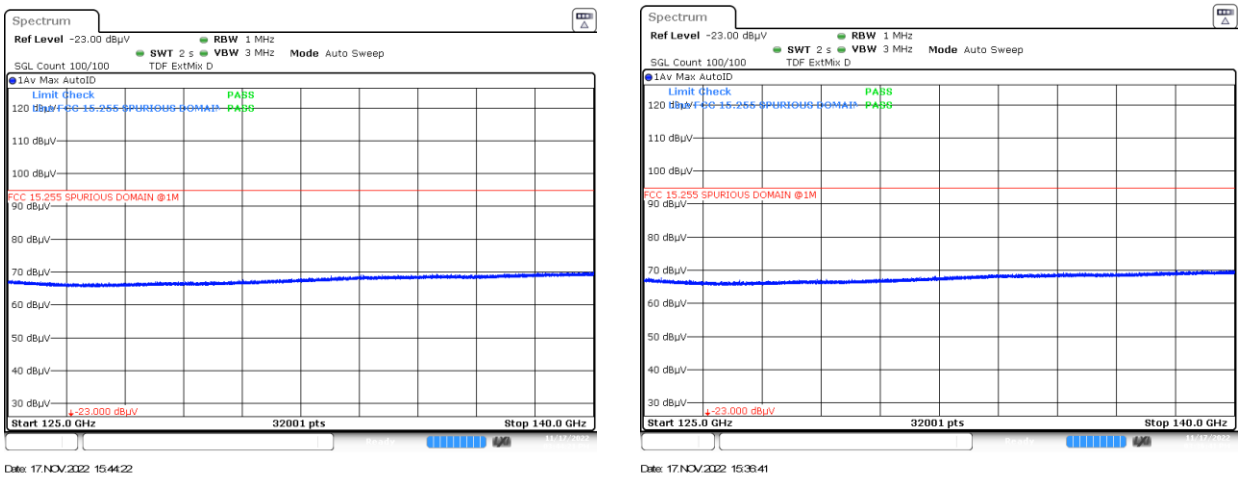


***Figure* 8.4-12:** *Unwanted emissions spurious band plot – Field strength measured from 125 to 140 GHz, horizontal and vertical polarization respectively:*

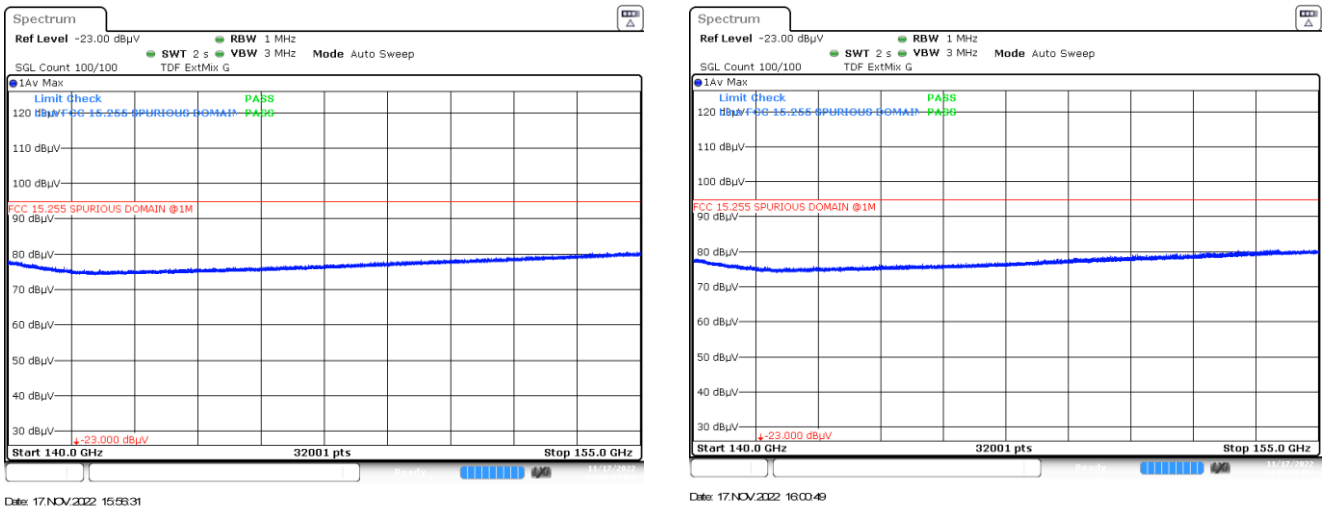


***Figure* 8.4-13:** *Unwanted emissions spurious band plot – Field strength measured from 140 to 155 GHz, horizontal and vertical polarization respectively:*

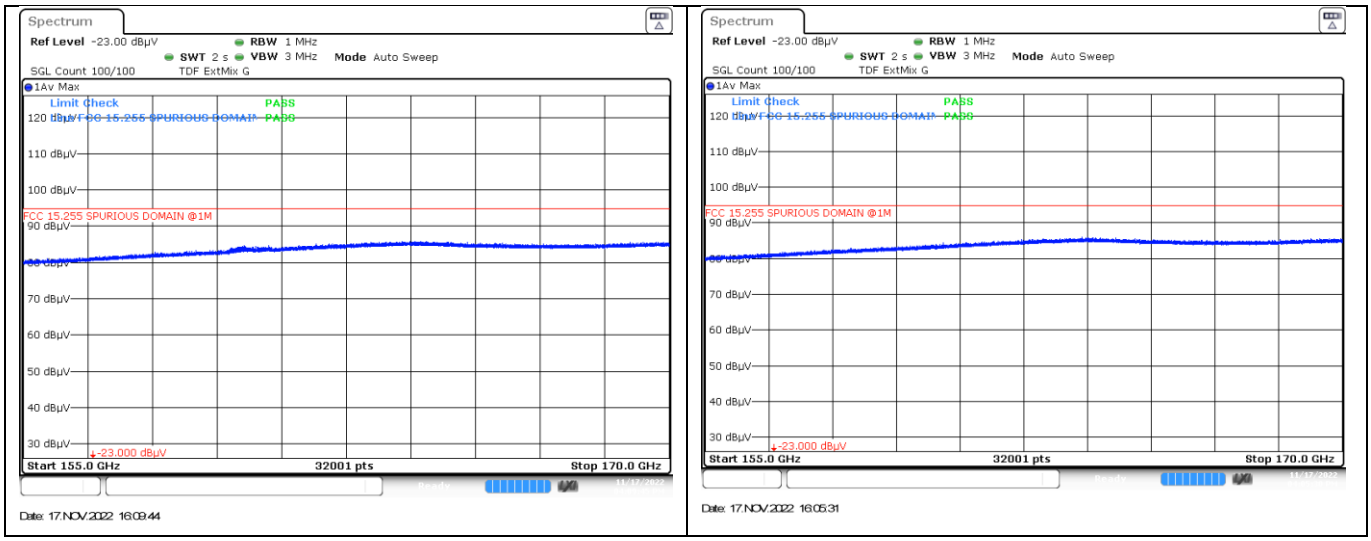
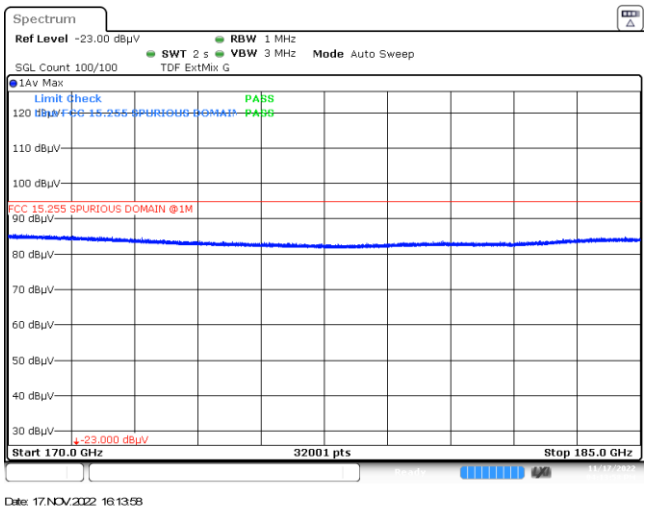


***Figure* 8.4-14:** *Unwanted emissions spurious band plot – Field strength measured from 155 to 170 GHz, horizontal and vertical polarization respectively:*



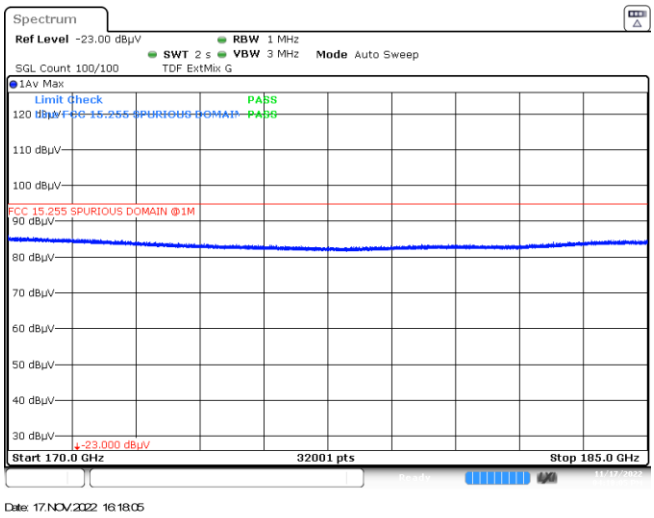
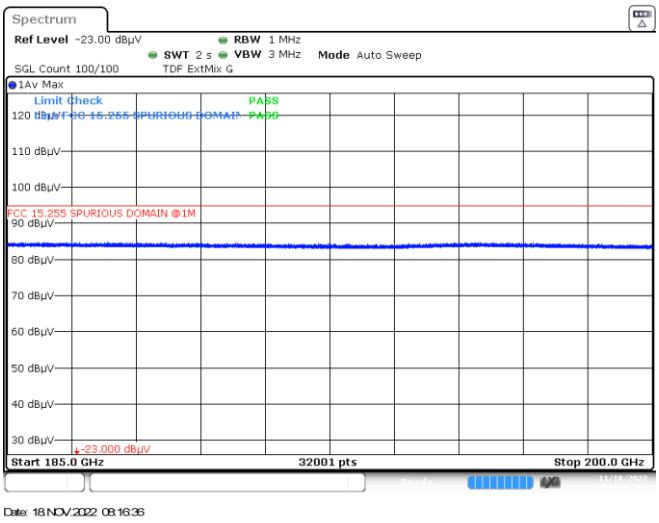


***Figure* 8.4-15:** *Unwanted emissions spurious band plot – Field strength measured from 170 to 185 GHz, horizontal and vertical polarization respectively:*



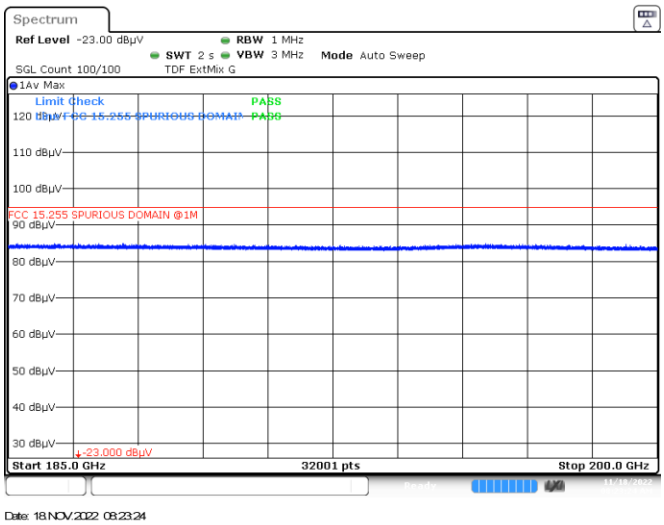


***Figure* 8.4-16:** *Unwanted emissions spurious band plot – Field strength measured from 185 to 200 GHz, horizontal and vertical polarization respectively:*

8.5 Peak conducted output power

8.5.1 References and limits

- FCC 47 CFR Part 15, Subpart C: §15.255(e)
- RSS-210 Annex J: J.4

§15.255:

(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.

(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).

(2) Peak transmitter conducted output power shall be measured with an RF detector that has a detection bandwidth that encompasses the 57-71 GHz band and that has a video bandwidth of at least 10 MHz.

(3) For purposes of demonstrating compliance with this paragraph, corrections to the transmitter conducted output power may be made due to the antenna and circuit loss.

RSS-210 Annex J:

J.4 Peak transmitter output power

Following are the conditions for peak transmitter output power:

For devices with an emission bandwidth greater than or equal to 100 MHz, the peak transmitter output power shall not exceed 500 mW. For devices with an emission bandwidth less than 100 MHz, the peak transmitter output power shall be less than the product of 500 mW and their emission bandwidth divided by 100 MHz.

For the purposes of demonstrating compliance with this RSS, corrections to the transmitter output power may be made to compensate for antenna and circuit loss.

8.5.2 Test summary

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

8.5.3 Notes

- Compliance is shown by calculation based on the EIRP measurement from Section 8.3. Peak conducted output power is calculated from the measured EIRP by subtracting the declared antenna gain and feed cable losses (if any).
- Limit 500 mW = 27 dBm

8.5.4 Setup details

Not applicable.

8.5.5 Test data

These results were calculated by subtracting the maximum antenna gain declared by manufacturer from the EIRP

Center Frequency (GHz)	Measured peak Power (dBm)	Field strength (dBµV/m)	EIRP (dBm)	Antenna Gain (dBi)	Calculated conducted Power (dBm)	Limit (dBm)	Margin (dB)
62.5	-56.5	92.7	-28.5	5	-33.5	27.0	60.5

Table 8.5-1: Peak conducted output power results.

8.6 Frequency stability

8.6.1 References and limits

- FCC 47 CFR Part 15, Subpart C: §15.255(f)
- RSS-210 Annex J: J.6

§15.255:

(f) Frequency stability. Fundamental emissions must be contained within the frequency bands specified in this section during all conditions of operation. Equipment is presumed to operate over the temperature range −20 to + 50 degrees Celsius with an input voltage variation of 85% to 115% of rated input voltage, unless justification is presented to demonstrate otherwise.

RSS-210 Annex J:

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.

8.6.2 Test summary

Verdict	Pass		
Test date	November 18, 2022	Temperature	26 °C
Test engineer	Martha Espinoza, Wireless Test Engineer	Air pressure	999 mbar
Test location	Wireless Bench	Relative humidity	53 %

8.6.3 Notes

Testing was performed with the transmitter operating on a fixed channel at full power.

8.6.4 Setup details

EUT power input during test	
EUT setup configuration	☒ Table-top ☐ Floor standing ☐ Other:

Spectrum analyzer settings:

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

8.6.5 Test data

Table 8.6-1: Frequency stability results

Voltage	*Temperature*	*F1*	*F2*	*CF*	*ppm*
120V	-20	60.1729	63.8661	62.01950	94.31627552
120V	-10	60.1845	63.8893	62.03690	-186.214185
120V	0	60.1961	63.8893	62.04270	-279.7243385
120V	10	60.1845	63.8893	62.03690	-186.214185
120V	20	60.2077	63.843	62.02535	***REFERENCE***
120V	30	60.1961	63.8661	62.03110	-92.7040315
120V	40	60.2077	63.843	62.02535	0
120V	50	60.1961	63.8082	62.00215	374.040614

Voltage	*Temperature*	*F1*	*F2*	*CF*	*ppm*
120	20	60.1961	63.843	62.01955	93.51015351
102	20	60.2077	63.843	62.02535	REFERENCE
138	20	60.2077	63.843	62.02535	0

Note: In the table above Minimum limit for F1 is 57 GHz and maximum limit for F2 is 71 GHz.