

Test report

356782-1TRFWL

Date of issue: July 16, 2021

Applicant:
Canary Medical

Product:
Base Station

Model:
CBS FCC ID: 2AYAJ-CBS

Specifications:
◆ FCC 47 CFR Part 95 Subpart I
Medical Device Radio Communication Service



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ISED Test Site	2040B-3

Tested by	Martha Espinoza, Wireless Engineer
Reviewed by	James Cunningham, EMC/MIL/WL Supervisor
Review date	July 16, 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.

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Section 1 Report summary

1.1 Applicant

Company name	Canary Medical
Address	2710 Loker Ave West, Suite 350
City	Carlsbad
Province/State	CA
Postal/Zip code	92010
Country	USA

1.2 Manufacturer

Company name	Canary Medical
Address	2710 Loker Ave West, Suite 350
City	Carlsbad
Province/State	CA
Postal/Zip code	92010
Country	USA

1.3 Test specifications

FCC 47 CFR Part 95, Subpart I

Medical Device Radio Communications Service

1.4 Test methods

ANSI C63.10-2013

American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

1.5 Exclusions

None

1.6 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.

1.7 Test report revision history

Table 1.7-1: Test report revision history

Revision #	Details of changes made to test report
436028-3TRFWL	Original report issued

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
§15.31(e)	Variation of power source	Pass
§15.203	Antenna requirement	Not applicable ¹

Notes: ¹EUT has an integrate antenna and it is not user accessible.

2.2 FCC Part 95 Subpart I, Medical Device Radio Communications Service, test results

Part	Test description	Verdict
§95.2565	Frequency Accuracy	Pass
§95.2567(a)	Field strength of fundamental	Pass
§95.2573(a)	Emission Bandwidth (20 dB)	Pass
§95.2579	Band Edges	Pass
§95.2579	Unwanted Emissions	Pass

Notes: None

Section 3 Equipment under test (EUT) details

3.1 Sample information

Receipt date	June 21, 2021
Nemko sample ID number	NEx: 436028

3.2 EUT information

Product name	Base station
Model	BS3
Serial number	000010 (conducted sample); 000014 (radiated sample)
Part number	N/A

3.3 Technical information

Frequency band	402 – 406 MHz
Minimum frequency (MHz)	402.15
Maximum frequency (MHz)	404.85
Type of modulation	N/A
Emission classification	N/A
Power requirements	USB Port
Antenna information	+0.67 dBi maximum antenna gain; -1.23 dBi average antenna gain reported. EUT has only one spring antenna.

3.4 EUT exercise and monitoring details

Radiated sample was configured through a console app (previously installed in a laptop) provided by client. The connection between laptop and EUT was through a USB cable. The console app executes the device according to the channel selected: low, middle or high channel. Each fix channel was programmed through cmd window, following the commands provided by manufacturer. The unit was able to transmit continuously in autonomous mode.

3.5 EUT setup details

Table 3.5-1: EUT interface ports

Description	Qty
USB Port	1

Table 3.5-2: Support equipment

Description	Brand name	Model/Part number	Serial number	Rev.
Laptop	Dell	Vostro14 3000	N/A	---

Table 3.5-3: Inter-connection cables

Cable description	From	To	Length (m)
USB Cable	EUT	Laptop	2

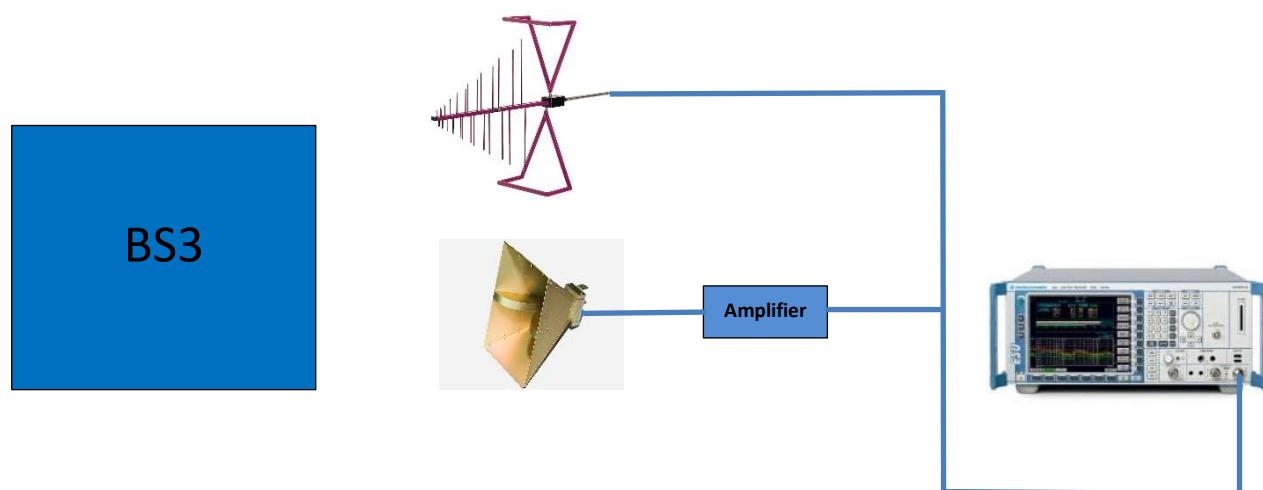


Figure 3.5-1: Test radiated setup

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 $\pm 5\%$, for which the equipment was designed.

Section 6 Measurement uncertainty

6.1 Uncertainty of measurement

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

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

Table 6.1-1: Measurement uncertainty.

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

Section 7 Test equipment

Table 7.1-1: Test Equipment List

Equipment	Manufacturer	Model no.	Asset no.	Cal cycle	Next cal.
EMI Test Receiver	Rohde & Schwarz	ESU40	E1121	19 May 2021	19 May 2022
Spectrum analyzer	Rohde & Schwarz	FSV40	E1120	19 Nov 2019	19 Nov 2021
System controller	Sunol sciences	SC104V	E1191	NCR	NCR
DRG Horn	ETS-Lindgren	3117-PA	E1160	02 Dec 2020	02 Dec 2021
Bilog Antenna	Schaffner	CBL6111C	1763	18 Feb 2020	18 Feb 2022
Temperature chamber	Test Equity	115A	E1062	03 Aug 2020	03 Aug 2021

Table 7.1-2: Test Software

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

Section 8 Testing data

8.1 Emission Bandwidth: 20 dB Bandwidth

8.1.1 References

FCC Part 95 → Subpart I → 95.2573 (a)

Each MedRadio transmitter type must be designed such that the MedRadio emission bandwidth does not exceed the applicable authorized bandwidth set forth in this section.

(a) For MedRadio transmitters operating in the 402-405 MHz band, the maximum authorized bandwidth is 300 kHz. Such transmitters must not use more than 300 kHz of bandwidth (total) during a MedRadio communications session. This provision does not preclude full duplex or half duplex communications provided that the total bandwidth of all of the channels employed in a MedRadio communications session does not exceed 300 kHz.

8.1.2 Test summary

Verdict	Pass		
Test date	July 9, 2021	Temperature	20°C
Test engineer	Martha Espinoza	Air pressure	1007 mbar
Test location	3m semi anechoic chamber	Relative humidity	60 %

8.1.3 Notes

Testing was performed with EUT transmitting on a fixed channel at full power. The transmission was continuously: Low, middle, and high channel were evaluated.

8.1.4 Setup details

EUT setup configuration	Tabletop
Test facility	Wireless Bench
Measurement method	ANSI C63.10

Receiver/spectrum analyzer settings:

Resolution bandwidth	1% - 5% OBW
Video bandwidth	3*RBW
Span	Between two times and five times OBW
Detector mode	Peak
Trace mode	Max Hold
Measurement time	Long enough for trace to stabilize

8.1.5 Test data

Test Frequency (MHz)	20 dB Bandwidth (kHz)	Limit (kHz)	Margin (kHz)
402.15	183.019	300	116.981
403.65	183.944	300	116.056
404.85	183.319	300	116.681

Table 8.1-1: 20 dB occupied bandwidth test data

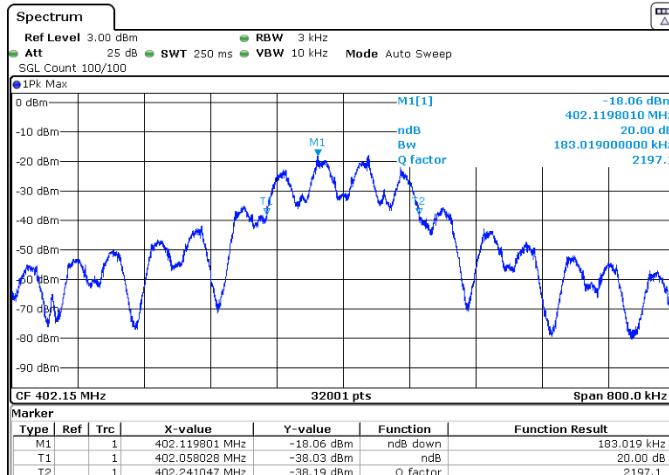


Figure 8.1-2: Low channel (402.15 MHz): 20 dB OBW plot

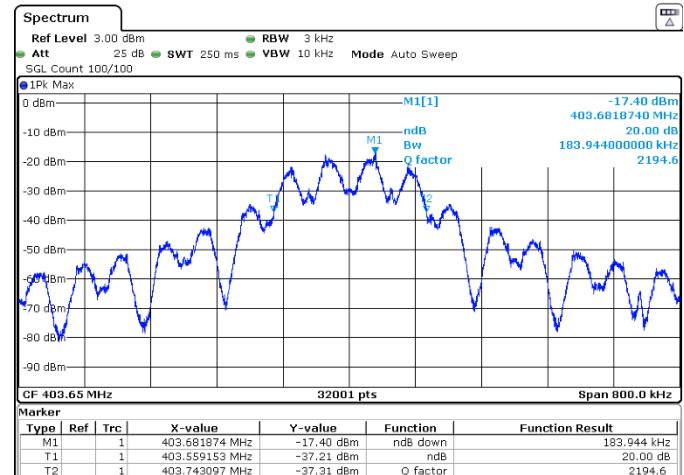


Figure 8.1-2: Middle channel (403.65 MHz): 20 dB OBW plot

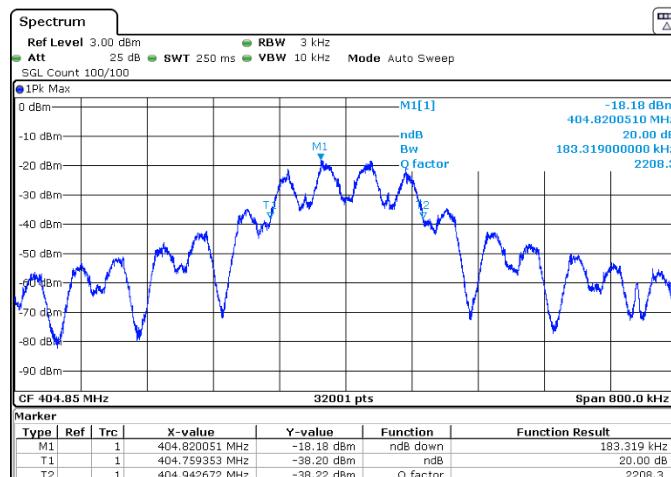


Figure 8.1-3: High channel (404.85 MHz): 20 dB OBW plot

8.2 Frequency Accuracy

8.2.1 Definitions and limits

FCC Part 95 → Subpart I → 95.2565

Each MedRadio transmitter type must be designed to maintain a frequency stability of ± 100 ppm of the operating frequency over the applicable temperature range set forth in this section. Frequency stability testing shall be performed over the appropriate temperature range.

(a) 25 °C to 45 °C in the case of medical implant transmitters; and

(b) 0 °C to 55 °C in the case of MedRadio programmer/control transmitters and medical body-worn transmitters

8.2.2 Test summary

Verdict	Pass		
Test date	July 12, 2021	Temperature	22°
Test engineer	Martha Espinoza	Air pressure	1005 mbar
Test location	Wireless Bench	Relative humidity	60%

8.2.3 Notes

This was a conducted test. Measurement was performed with EUT transmitting on a fixed channel at full power. The transmission made in continuous wave: only middle channel was measured as a representative test of the device. 20 dB occupied bandwidth was measured to get the frequency accuracy.

8.2.4 Setup details

EUT setup configuration	Tabletop
Test facility	Wireless Bench
Measurement method	ANSI C63.10

Receiver/spectrum analyzer settings:

Resolution bandwidth	1% - 5% OBW
Video bandwidth	3*RBW
Span	Between two times and five times OBW
Detector mode	Peak
Trace mode	Max Hold
Measurement time	Long enough for trace to stabilize

8.2.5 Test data

Temperature (°C)	Voltage	Low Frequency (Hz)	High Frequency (Hz)	Center frequency (Hz)	Drift (ppm)	Limit	Verdict
0	USB Port Voltage	403555203	403740297	403647750	5.57	±100	Pass
10	USB Port Voltage	403557003	403741197	403649100	2.23	±100	Pass
20	USB Port Voltage	403559453	403742622	403651038	-2.57	±100	Pass
30	USB Port Voltage	403562953	403745447	403654200	-10.41	±100	Pass
40	USB Port Voltage	403565253	403747797	403656525	-16.16	±100	Pass
50	USB Port Voltage	403568428	403750622	403659525	-23.60	±100	Pass
55	USB Port Voltage	403570302	403752372	403661337	-28.09	±100	Pass

Note: Middle channel was evaluated: 403.65 MHz is the center frequency.

Table 8.2-1: Frequency accuracy test data

8.3 Field Strength of Fundamental

8.3.1 Definitions and limits

FCC Part 95 → Subpart I → 95.2567 (a)

Each MedRadio transmitter type must be designed such that the MedRadio equivalent isotropically radiated power (M-EIRP) does not exceed the limits in this section. Compliance with these limits must be determined as set forth in §95.2569.

(a) Transmitters subject to frequency monitoring—401-406 MHz. For MedRadio transmitters that are not excepted under §95.2559(b) from the frequency monitoring requirements of §95.2559(a):

(1) The M-EIRP within any 300 kHz bandwidth within the 402-405 MHz band must not exceed 25 microwatts.

8.3.2 Test summary

Verdict	Pass		
Test date	July 8, 2021	Temperature	22°
Test engineer	Martha Espinoza	Air pressure	1001 mbar
Test location	3m semi anechoic chamber	Relative humidity	65%

8.3.3 Notes

This was a radiated test. Measurement was performed with EUT transmitting on a fixed channel at full power. The transmission made in continuous wave: low, middle and high channel.

25 microwatts must be transformed to $\text{dB}\mu\text{V}/\text{m}$ to get a radiated limit. Following equations are used with this end:

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

$$\text{Electric field strength (v/m)} = \sqrt{(PD)(Z_0 \text{Vacuumm})}$$

$$\text{Electric field strength (dB}\mu\text{V}/\text{m)} = 20\text{Log}(\text{Electric field strength in v/m}) + 120$$

$$\text{Electric field limit} = 81.036 \text{ dB}\mu\text{V}/\text{m}$$

Where:
 PD = Power Density (Watts/m²)
 ERP = Radiated power in Watts
 d = Distance in meters

8.3.4 Setup details

EUT setup configuration	Tabletop
Test facility	3m semi anechoic chamber
Measurement method	ANSI C63.10

Receiver settings for radiated measurements within restricted bands below 1 GHz:

Resolution bandwidth	300 kHz
Video bandwidth	1 MHz
Detector mode	Peak (preview and final measurements)
Trace mode	Max Hold
Measurement time	5 s (final measurements)

8.3.5 Test data

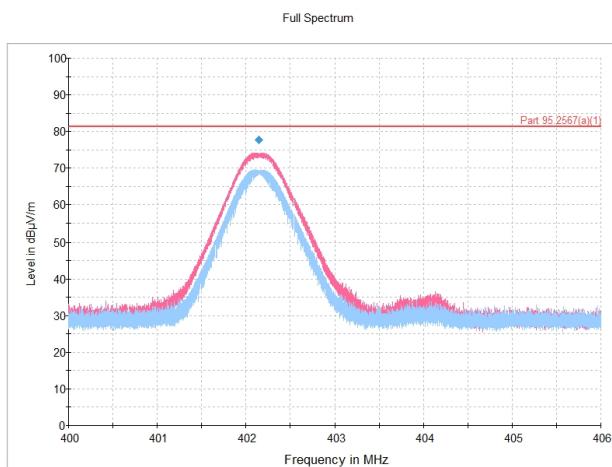


Figure 8.3-1: Field strength of fundamental: low channel (402.15 MHz)

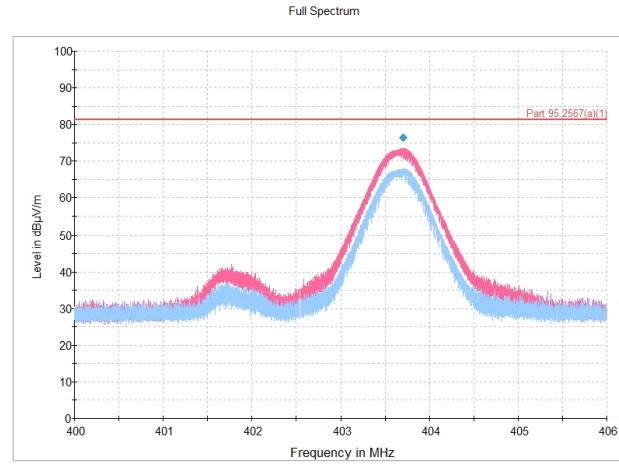


Figure 8.3-2: Field strength of fundamental: middle channel (403.65) MHz

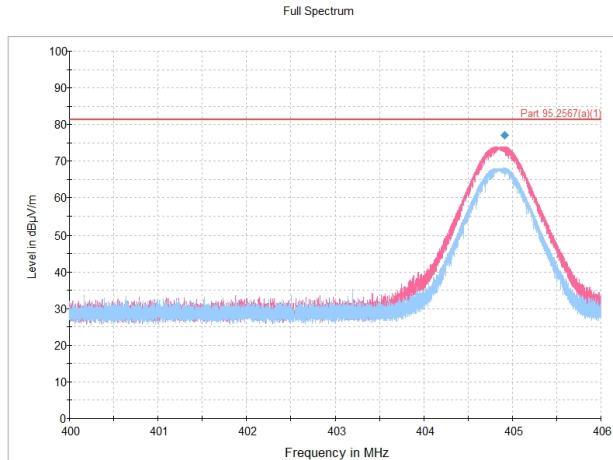


Figure 8.3-3: Field strength of fundamental: middle channel (404.85) MHz

Frequency (MHz)	MaxPeak (dBμV/m)	Limit (dBμV/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
402.152800	77.63	81.36	3.73	5000.0	300.000	157.0	V	123.0	25.1
403.700000	76.50	81.36	4.86	5000.0	300.000	152.0	V	32.0	25.1
404.914800	77.03	81.36	4.33	5000.0	300.000	149.0	V	32.0	25.2

Table 8.3-1: Peak field strength of fundamental.

8.4 Transmitter Unwanted Emissions and Band Edges

8.4.1 Definitions and limits

FCC Part 95 → Subpart I → 95.2579

Unwanted emission field strength limits and attenuation requirements apply to each MedRadio transmitter type, as set forth in this section and part 2.

(a) Field strength limits. The field strengths of unwanted emissions from each MedRadio transmitter type, measured at a distance of 3 meters, must not exceed the field strength limits shown in the table in this paragraph for the indicated frequency ranges, if the frequencies of these emissions are:

(1) More than 250 kHz outside of the 402-405 MHz band (for devices designed to operate in the 402-405 MHz band);

Frequency range (MHz)	Field strength (μ V/m)
30-88	100
88-216	150
216-960	200
960 and above	500

Note to table in paragraph (a)(5): At the boundaries between frequency ranges, the tighter limit (lower field strength) applies. Below 1 GHz, field strength is measured using a CISPR quasi-peak detector. Above 1 GHz, field strength is measured using an average detector with a minimum reference bandwidth of 1 MHz. See also part 2, subpart J of this chapter.

(b) Harmonic emissions. Radiated unwanted emissions from a MedRadio transmitter type must be measured to at least the tenth harmonic of the highest fundamental frequency emitted.

(c) Attenuation requirements, 402-405 MHz. For MedRadio transmitter types designed to operate in the 402-405 MHz band, unwanted emissions must be attenuated below the maximum permitted transmitter output power by at least:

(1) 20 dB, on any frequency within the 402-405 MHz band that is more than 150 kHz away from the center frequency of the occupied bandwidth;

g) Measurements. Compliance with the limits in paragraphs (c), (d), and (e) of this section is based on the use of measurement instrumentation using a peak detector function with an instrument reference bandwidth approximately equal to 1.0 percent of the emission bandwidth of the device under measurement.

8.4.2 Test summary

Verdict	Pass		
Test date	July 6, 2021	Temperature	23°C
	July 7, 2021		24°C
	July 8, 2021		22°C
Test engineer	Martha Espinoza	Air pressure	1005; 1002 ; 1001 mbar
Test location	3m semi anechoic chamber	Relative humidity	61; 65; 65%

8.4.3 Notes

Testing was performed with EUT transmitting on a fixed channel at full power. The transmission made in continuous wave: low, middle and high channel were evaluated. The spectrum was search from 30 MHz to 5 GHz (above the 10th harmonic of the highest transmit frequency). Radiated measurements were performed at a 3 m measurement distance.

8.4.4 Setup details

EUT setup configuration	Tabletop
Test facility	3M Chamber
Measurement method	ANSI C63.10

Spectrum analyzer settings for band edges:

Resolution bandwidth	10 kHz (Minimum 1% of Emission bandwidth)
Video bandwidth	1 MHz
Detector mode	Peak
Trace mode	Max Hold
Measurement time	Long enough for trace to stabilize

Receiver settings for radiated measurements within restricted bands below 1 GHz:

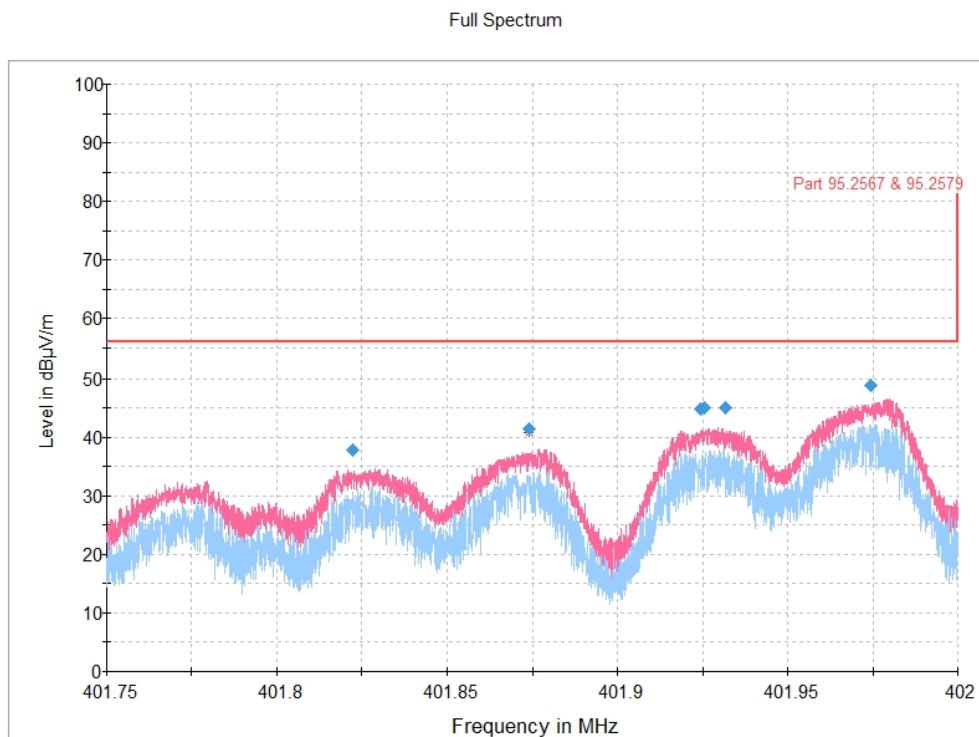
Resolution bandwidth	120 kHz
Video bandwidth	300 kHz
Detector mode	Peak (preview measurements) Quasi-Peak (final measurements)
Trace mode	Max Hold
Measurement time	5 s (final measurements)

Receiver settings for radiated measurements within restricted bands above 1 GHz:

Resolution bandwidth	1 MHz
Video bandwidth	3 MHz
Detector mode	Average and peak (final measurements)
Trace mode	Max Hold
Measurement time	5 s (final measurements)

Note: None

8.4.5 Test data



The spectral plot shows the vertical (red plot) and horizontal (blue plot) scans. 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: Band edge: low channel (402.15 MHz)

Frequency (MHz)	MaxPeak (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
401.822233	37.84	56.00	18.16	5000.0	10.000	157.0	V	121.0	25.1
401.873858	41.41	56.00	14.59	5000.0	10.000	157.0	V	123.0	25.1
401.924308	44.71	56.00	11.29	5000.0	10.000	159.0	V	120.0	25.1
401.925333	44.95	56.00	11.05	5000.0	10.000	157.0	V	122.0	25.1
401.931658	44.92	56.00	11.08	5000.0	10.000	164.0	V	124.0	25.1
401.974367	48.94	56.00	7.06	5000.0	10.000	154.0	V	114.0	25.1

Table 8.4-1: Band edge: low channel (402.15 MHz) results

Notes:

¹ Field strength (dB μ V/m) = receiver/spectrum analyzer value (dB μ V) + correction factor (dB)

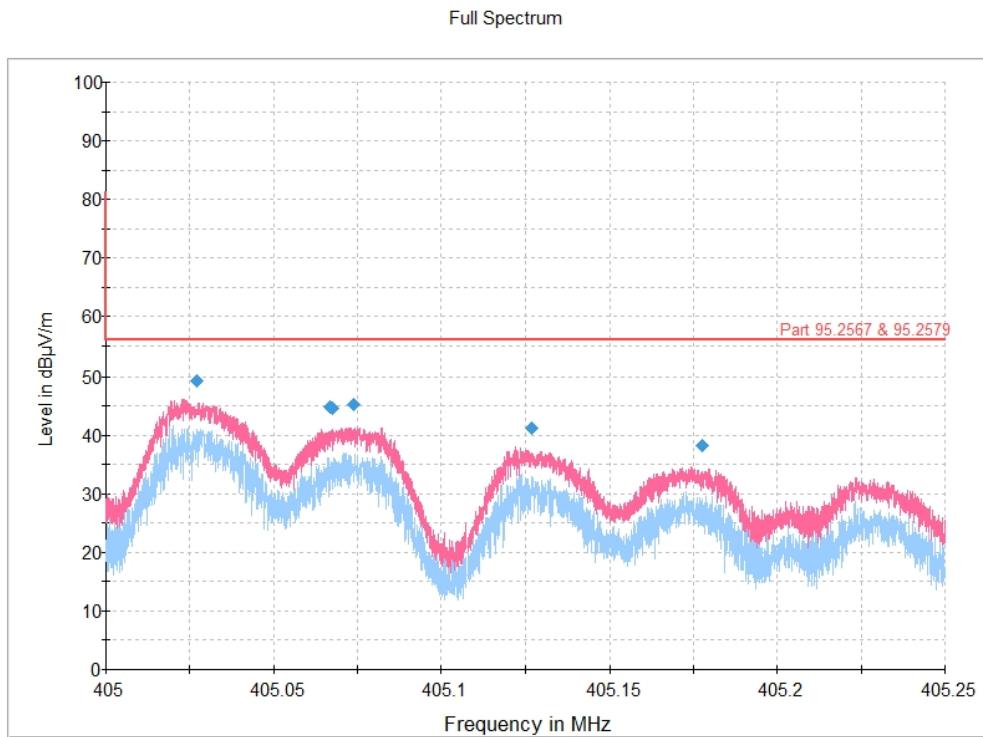
² Correction factors = antenna factor ACF (dB) + cable loss (dB)

³ The maximum measured value observed over a period of 5 seconds was recorded.

⁴The spectral plot shows the vertical and horizontal scan separately.

⁵This measurement was done at 3m

8.4.5 Test data, continued



The spectral plot shows the vertical (red plot) and horizontal (blue plot) scans. 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: Band edge: high channel (404.85 MHz)

Frequency (MHz)	MaxPeak (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
405.027292	49.16	56.00	6.84	5000.0	10.000	149.0	V	122.0	25.2
405.066983	44.85	56.00	11.15	5000.0	10.000	152.0	V	123.0	25.2
405.067558	44.52	56.00	11.48	5000.0	10.000	149.0	V	23.0	25.2
405.073742	45.20	56.00	10.80	5000.0	10.000	159.0	V	124.0	25.2
405.126592	41.16	56.00	14.84	5000.0	10.000	153.0	V	30.0	25.2
405.177742	38.29	56.00	17.71	5000.0	10.000	158.0	V	126.0	25.2

Table 8.4-2: Band edge: high channel (404.85 MHz) results

Notes:

¹ Field strength (dB μ V/m) = receiver/spectrum analyzer value (dB μ V) + correction factor (dB)

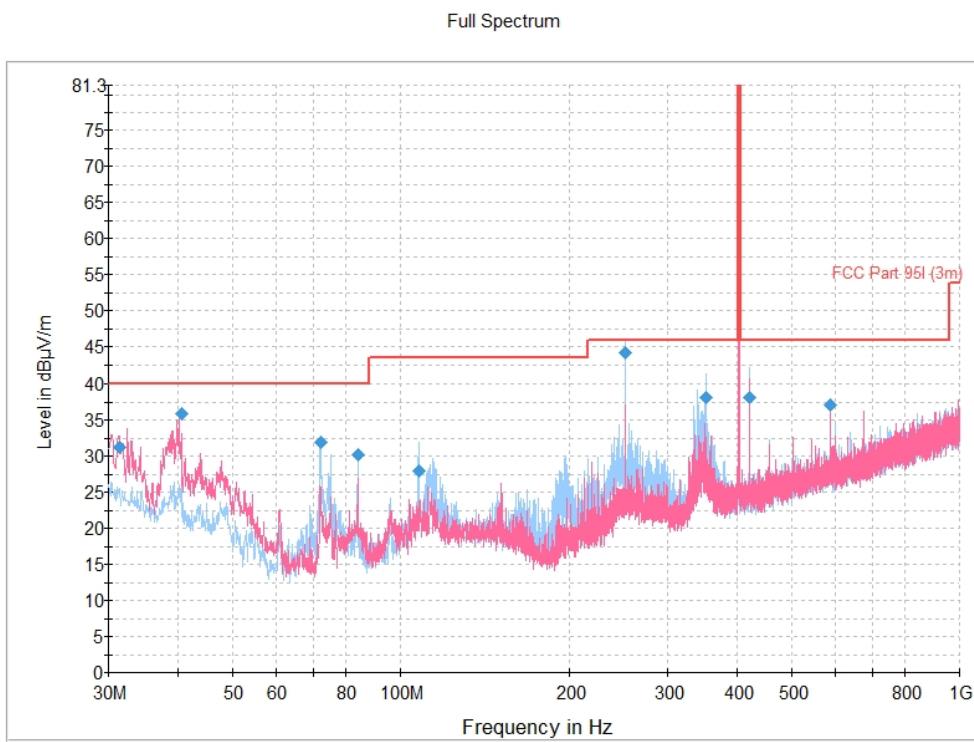
² Correction factors = antenna factor ACF (dB) + cable loss (dB)

³ The maximum measured value observed over a period of 5 seconds was recorded.

⁴The spectral plot shows the vertical and horizontal scan separately.

⁵This measurement was done at 3m

8.4.5 Test data, continued



The spectral plot shows the vertical (red plot) and horizontal (blue plot) scans. 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 emissions, low channel (402.15 MHz), 30 – 1000 MHz

Frequency (MHz)	QuasiPeak (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
31.425000	31.20	40.00	8.80	5000.0	120.000	100.0	V	0.0	25.7
40.504167	35.83	40.00	4.17	5000.0	120.000	100.0	V	268.0	20.8
71.951667	32.01	40.00	7.99	5000.0	120.000	233.0	H	204.0	13.9
83.996667	30.20	40.00	9.80	5000.0	120.000	340.0	H	227.0	15.3
108.044167	27.93	43.50	15.57	5000.0	120.000	165.0	H	208.0	18.6
252.009167	44.19	46.00	1.81	5000.0	120.000	232.0	H	176.0	21.1
351.954167	38.20	46.00	7.80	5000.0	120.000	100.0	H	37.0	23.7
420.020833	38.16	46.00	7.84	5000.0	120.000	175.0	H	100.0	25.7
587.992500	37.05	46.00	8.95	5000.0	120.000	100.0	V	221.0	29.0

Table 8.4-3: Radiated emissions, low channel (402.15 MHz), 30 – 1000 MHz

Notes: ¹Field strength (dB μ V/m) = receiver/spectrum analyzer value (dB μ V) + correction factor (dB)

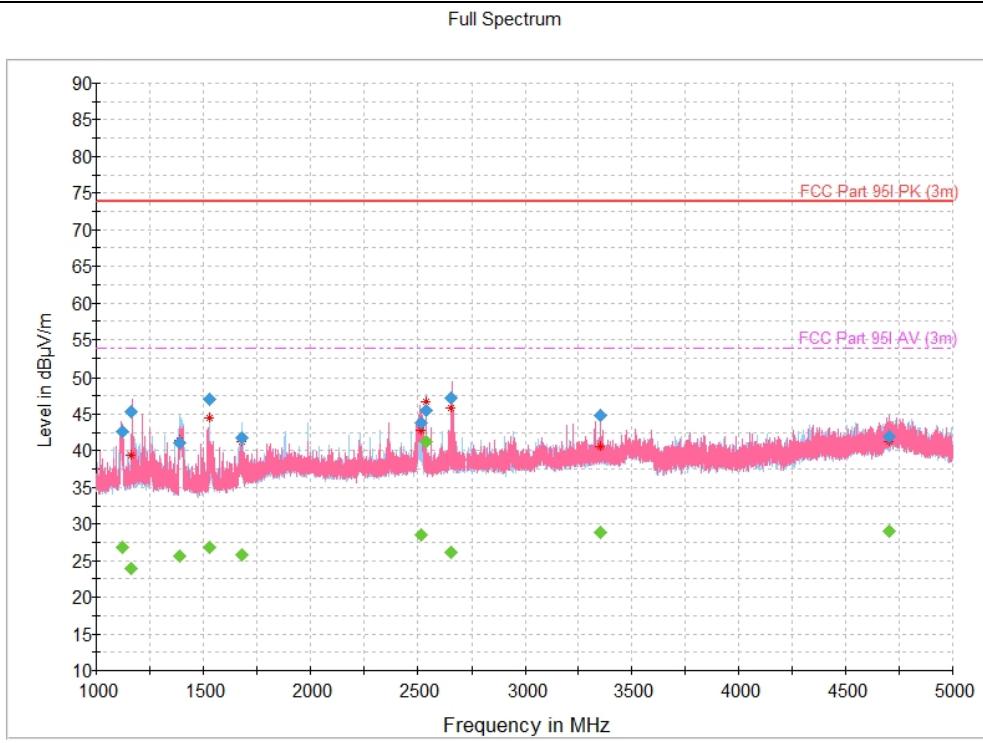
² Correction factors = antenna factor ACF (dB) + cable loss (dB)

³ The maximum measured value observed over a period of 5 seconds was recorded.

⁴The spectral plot shows the vertical and horizontal scan separately.

⁵This measurement was done at 3m

8.4.5 Test data, continued



The spectral plot shows the vertical (red plot) and horizontal (blue plot) scans. 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 emissions, low channel (402.15 MHz), 1 – 5 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)
1120.800000	---	26.88	53.90	27.02	5000.0	1000.000	164.0	V	272.0	-13.7
1120.800000	42.63	---	73.90	31.27	5000.0	1000.000	164.0	V	272.0	-13.7
1165.200000	---	23.94	53.90	29.96	5000.0	1000.000	100.0	V	276.0	-13.3
1165.200000	45.35	---	73.90	28.55	5000.0	1000.000	100.0	V	276.0	-13.3
1391.200000	---	25.56	53.90	28.34	5000.0	1000.000	277.0	H	69.0	-13.7
1391.200000	41.04	---	73.90	32.86	5000.0	1000.000	277.0	H	69.0	-13.7
1530.000000	47.10	---	73.90	26.80	5000.0	1000.000	230.0	H	234.0	-13.6
1530.000000	---	26.86	53.90	27.04	5000.0	1000.000	230.0	H	234.0	-13.6
1683.200000	---	25.79	53.90	28.11	5000.0	1000.000	296.0	H	266.0	-12.2
1683.200000	41.68	---	73.90	32.22	5000.0	1000.000	296.0	H	266.0	-12.2
2518.200000	43.86	---	73.90	30.04	5000.0	1000.000	125.0	V	220.0	-8.6
2518.200000	---	28.57	53.90	25.33	5000.0	1000.000	125.0	V	220.0	-8.6
2543.800000	45.44	---	73.90	28.46	5000.0	1000.000	135.0	H	202.0	-8.4
2543.800000	---	41.22	53.90	12.68	5000.0	1000.000	135.0	H	202.0	-8.4
2657.200000	---	26.19	53.90	27.71	5000.0	1000.000	260.0	V	203.0	-8.0
2657.200000	47.15	---	73.90	26.75	5000.0	1000.000	260.0	V	203.0	-8.0
3351.000000	44.81	---	73.90	29.09	5000.0	1000.000	203.0	V	256.0	-5.7
3351.000000	---	28.77	53.90	25.13	5000.0	1000.000	203.0	V	256.0	-5.7
4701.200000	---	28.97	53.90	24.93	5000.0	1000.000	329.0	V	0.0	-0.6
4701.200000	41.92	---	73.90	31.98	5000.0	1000.000	329.0	V	0.0	-0.6

Table 8.4-4: Radiated emissions, low channel (402.15 MHz), 1 - 5 GHz

Notes:

¹ Field strength (dBμV/m) = receiver/spectrum analyzer value (dBμV) + correction factor (dB)

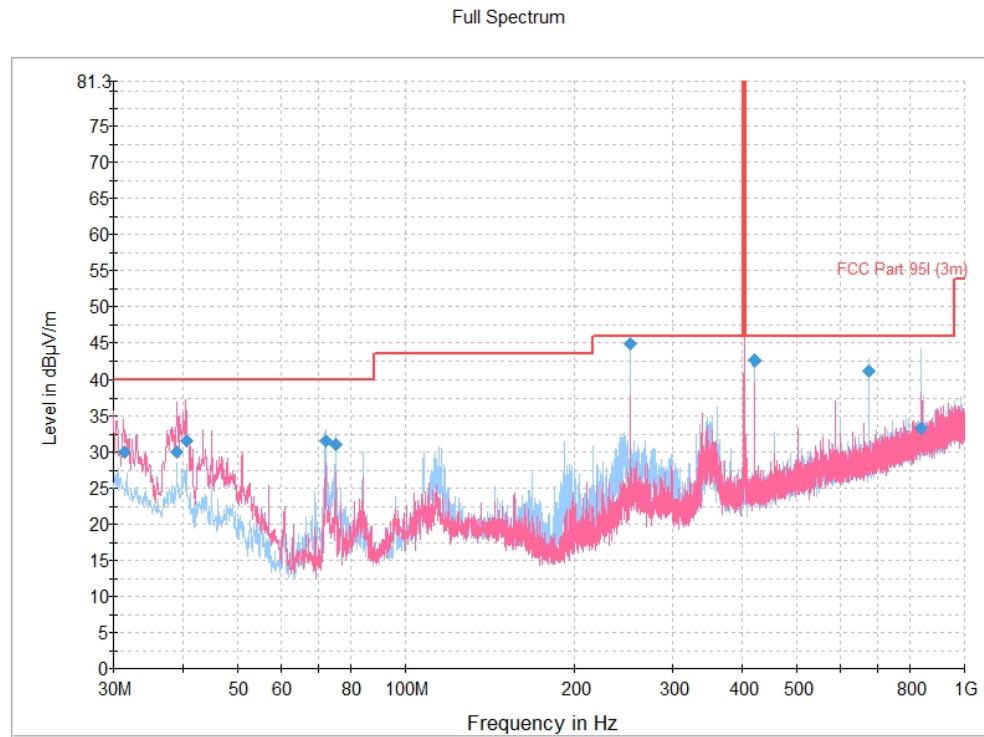
² Correction factors = antenna factor ACF (dB) + cable loss (dB)

³ The maximum measured value observed over a period of 5 seconds was recorded.

⁴The spectral plot shows the vertical and horizontal scan separately.

⁵This measurement was done at 3m

8.4.5 Test data, continued



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

Figure 8.4-5: Radiated emissions, middle channel (403.65 MHz), 30 – 1000 MHz

Frequency (MHz)	QuasiPeak (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
31.413333	30.02	40.00	9.98	5000.0	120.000	128.0	V	208.0	25.7
38.972500	30.03	40.00	9.97	5000.0	120.000	110.0	V	0.0	21.6
40.507500	31.62	40.00	8.38	5000.0	120.000	100.0	V	240.0	20.8
71.952500	31.58	40.00	8.42	5000.0	120.000	250.0	H	191.0	13.9
74.983333	31.01	40.00	8.99	5000.0	120.000	235.0	H	193.0	14.4
252.008333	44.86	46.00	1.14	5000.0	120.000	204.0	H	177.0	21.1
420.020000	42.63	46.00	3.37	5000.0	120.000	100.0	H	178.0	25.7
674.996667	41.29	46.00	4.71	5000.0	120.000	235.0	H	306.0	29.8
837.876667	33.27	46.00	12.73	5000.0	120.000	262.0	H	82.0	32.5

Table 8.4-5: Radiated emissions, middle channel (403.65 MHz), 30 – 1000 MHz

Notes: ¹Field strength (dB μ V/m) = receiver/spectrum analyzer value (dB μ V) + correction factor (dB)

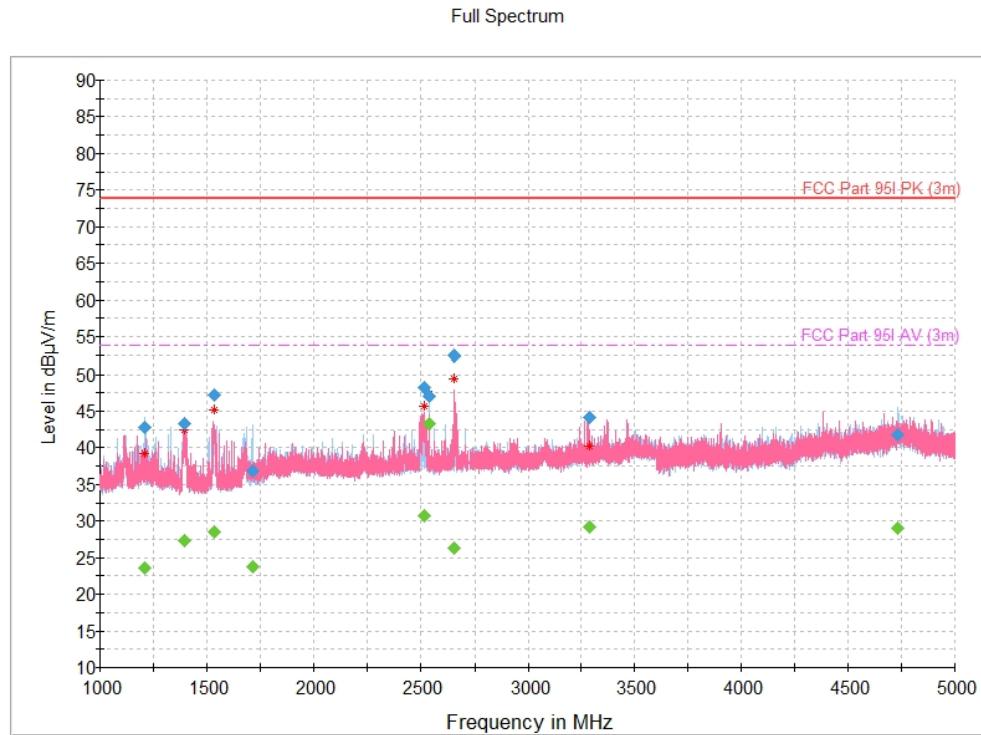
² Correction factors = antenna factor ACF (dB) + cable loss (dB)

³ The maximum measured value observed over a period of 5 seconds was recorded.

⁴The spectral plot shows the vertical and horizontal scan separately.

⁵This measurement was done at 3m

8.4.5 Test data, continued



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

Figure 8.4-6: Radiated emissions, middle channel (403.65 MHz), 1 – 5 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)
1207.600000	---	23.67	53.90	30.23	5000.0	1000.000	231.0	H	189.0	-13.1
1207.600000	42.76	---	73.90	31.14	5000.0	1000.000	231.0	H	189.0	-13.1
1393.400000	---	27.37	53.90	26.53	5000.0	1000.000	118.0	V	150.0	-13.7
1393.400000	43.23	---	73.90	30.67	5000.0	1000.000	118.0	V	150.0	-13.7
1536.600000	---	28.56	53.90	25.34	5000.0	1000.000	256.0	H	237.0	-13.5
1536.600000	47.13	---	73.90	26.77	5000.0	1000.000	256.0	H	237.0	-13.5
1718.200000	---	23.83	53.90	30.07	5000.0	1000.000	203.0	H	37.0	-11.7
1718.200000	36.85	---	73.90	37.05	5000.0	1000.000	203.0	H	37.0	-11.7
2521.200000	48.23	---	73.90	25.67	5000.0	1000.000	252.0	V	274.0	-8.6
2521.200000	---	30.72	53.90	23.18	5000.0	1000.000	252.0	V	274.0	-8.6
2544.000000	47.08	---	73.90	26.82	5000.0	1000.000	116.0	H	206.0	-8.4
2544.000000	---	43.28	53.90	10.62	5000.0	1000.000	116.0	H	206.0	-8.4
2657.000000	---	26.37	53.90	27.53	5000.0	1000.000	157.0	V	220.0	-8.0
2657.000000	52.40	---	73.90	21.50	5000.0	1000.000	157.0	V	220.0	-8.0
3286.000000	---	29.18	53.90	24.72	5000.0	1000.000	206.0	V	286.0	-6.0
3286.000000	44.17	---	73.90	29.73	5000.0	1000.000	206.0	V	286.0	-6.0
4733.800000	41.84	---	73.90	32.06	5000.0	1000.000	155.0	H	0.0	-0.7
4733.800000	---	28.97	53.90	24.93	5000.0	1000.000	155.0	H	0.0	-0.7

Table 8.4-6: Radiated emissions, middle channel (403.65 MHz), 1 - 5 GHz

Notes: ¹Field strength (dBμV/m) = receiver/spectrum analyzer value (dBμV) + correction factor (dB)

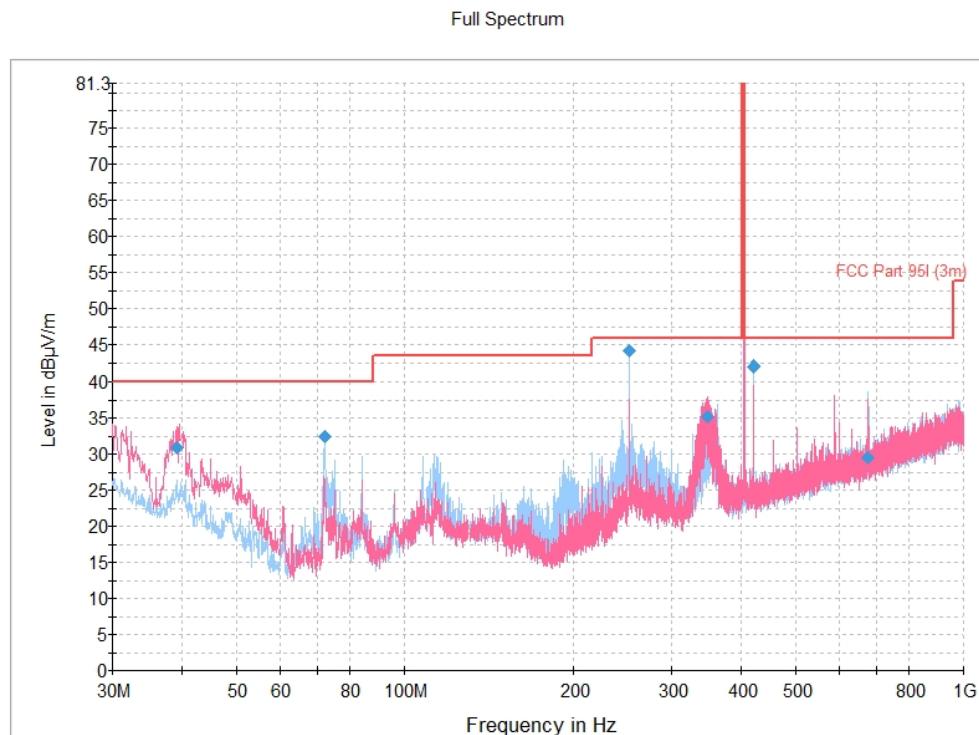
² Correction factors = antenna factor ACF (dB) + cable loss (dB)

³ The maximum measured value observed over a period of 5 seconds was recorded.

⁴The spectral plot shows the vertical and horizontal scan separately.

⁵This measurement was done at 3m

8.4.5 Test data, continued



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

Figure 8.4-7: Radiated emissions, high channel (404.85 MHz), 30 – 1000 MHz

Frequency (MHz)	QuasiPeak (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
39.178333	30.94	40.00	9.06	5000.0	120.000	118.0	V	316.0	21.5
71.993333	32.44	40.00	7.56	5000.0	120.000	250.0	H	207.0	13.9
252.008333	44.21	46.00	1.79	5000.0	120.000	185.0	H	174.0	21.1
348.639167	35.14	46.00	10.86	5000.0	120.000	164.0	V	55.0	23.6
419.980833	42.12	46.00	3.88	5000.0	120.000	100.0	H	178.0	25.7
673.643333	29.44	46.00	16.56	5000.0	120.000	156.0	H	351.0	29.8

Table 8.4-7: Radiated emissions, high channel (404.85 MHz), 30 – 1000 MHz

Notes:

¹Field strength (dB μ V/m) = receiver/spectrum analyzer value (dB μ V) + correction factor (dB)

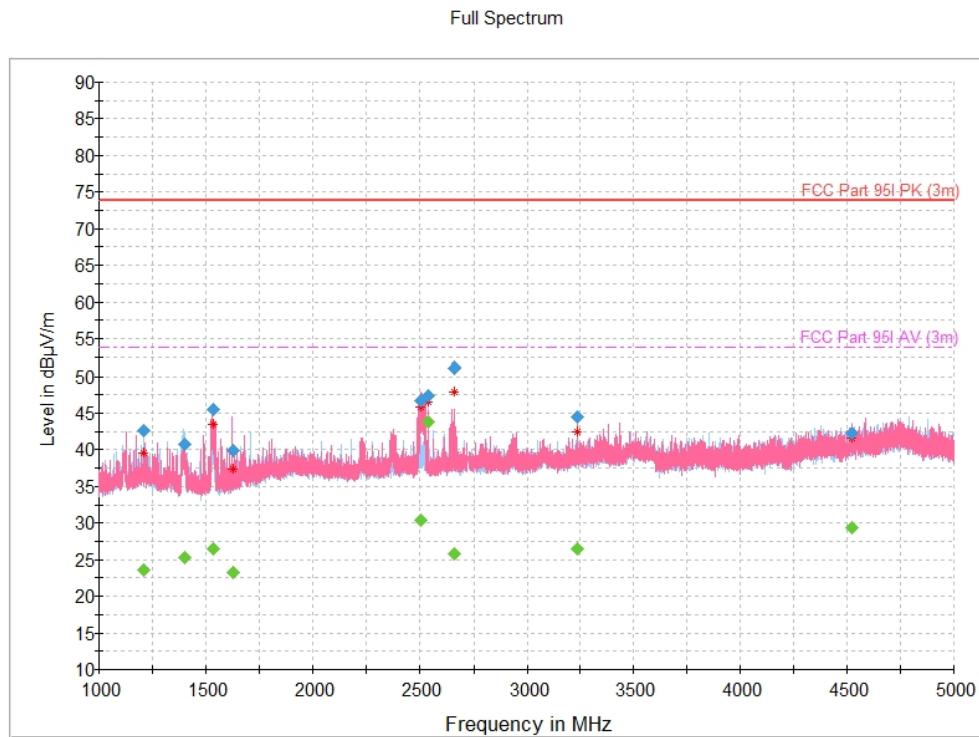
² Correction factors = antenna factor ACF (dB) + cable loss (dB)

³ The maximum measured value observed over a period of 5 seconds was recorded.

⁴The spectral plot shows the vertical and horizontal scan separately.

⁵This measurement was done at 3m

8.4.5 Test data, continued



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

Figure 8.4-8: Radiated emissions, high channel (404.85 MHz), 1 – 5 GHz

Frequency (MHz)	MaxPeak (dB μ V/m)	CAverage (dB μ V/m)	Limit (dB μ V/m)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Height (cm)	Pol	Azimuth (deg)	Corr. (dB/m)
1211.000000	---	23.67	53.90	30.23	5000.0	1000.000	410.0	H	352.0	-13.1
1211.000000	42.59	---	73.90	31.31	5000.0	1000.000	410.0	H	352.0	-13.1
1401.800000	---	25.30	53.90	28.60	5000.0	1000.000	206.0	H	220.0	-13.7
1401.800000	40.73	---	73.90	33.17	5000.0	1000.000	206.0	H	220.0	-13.7
1535.000000	---	26.54	53.90	27.36	5000.0	1000.000	197.0	V	292.0	-13.5
1535.000000	45.53	---	73.90	28.37	5000.0	1000.000	197.0	V	292.0	-13.5
1627.000000	---	23.21	53.90	30.69	5000.0	1000.000	108.0	V	264.0	-12.9
1627.000000	39.96	---	73.90	33.94	5000.0	1000.000	108.0	V	264.0	-12.9
2509.800000	46.70	---	73.90	27.20	5000.0	1000.000	282.0	V	266.0	-8.6
2509.800000	---	30.38	53.90	23.52	5000.0	1000.000	282.0	V	266.0	-8.6
2543.800000	47.32	---	73.90	26.58	5000.0	1000.000	135.0	H	172.0	-8.4
2543.800000	---	43.77	53.90	10.13	5000.0	1000.000	135.0	H	172.0	-8.4
2663.000000	51.12	---	73.90	22.78	5000.0	1000.000	184.0	V	210.0	-8.0
2663.000000	---	25.80	53.90	28.10	5000.0	1000.000	184.0	V	210.0	-8.0
3234.800000	---	26.55	53.90	27.35	5000.0	1000.000	197.0	V	265.0	-6.1
3234.800000	44.40	---	73.90	29.50	5000.0	1000.000	197.0	V	265.0	-6.1
4521.400000	---	29.31	53.90	24.59	5000.0	1000.000	251.0	H	12.0	-1.3
4521.400000	42.32	---	73.90	31.58	5000.0	1000.000	251.0	H	12.0	-1.3

Table 8.4-8: Radiated emissions, high channel (403.65 MHz), 1 - 5 GHz

Notes:

¹ Field strength (dB μ V/m) = receiver/spectrum analyzer value (dB μ V) + correction factor (dB)

² Correction factors = antenna factor ACF (dB) + cable loss (dB)

³ The maximum measured value observed over a period of 5 seconds was recorded.

⁴The spectral plot shows the vertical and horizontal scan separately.

⁵This measurement was done at 3m

8.5 AC Power Line Conducted Emissions

8.5.1 Definitions and limits

Title 47 → Chapter I → Subchapter A → Part 15 → Subpart C → §15.207(a)

For Low-power radio-frequency devices that is designed to be connected to the public utility (AC) power line, the radio frequency voltage that is conducted back onto the AC power line on any frequency or frequencies, within the band 150 kHz to 30 MHz, shall not exceed the limits in the following table, as measured using a 50 μ H/50 Ω line impedance stabilization network (LISN). The lower limit applies at the boundary between the frequency ranges.

Table 8.5-1: Conducted emissions limit

Frequency of emission, MHz	Quasi-peak	Conducted limit, dB μ V	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.

8.5.2 Test Summary

Verdict	Pass		
Test date	July 2, 2021	Temperature	24 °C
Test engineer	Martha Espinoza	Air pressure	1002 mbar
Test location	Ground plane	Relative humidity	65 %

8.5.3 Notes

Testing was performed with the EUT transmitting on a fixed channel at full power. The transmission was transmitting continuously: low, middle, and high channel were evaluated.

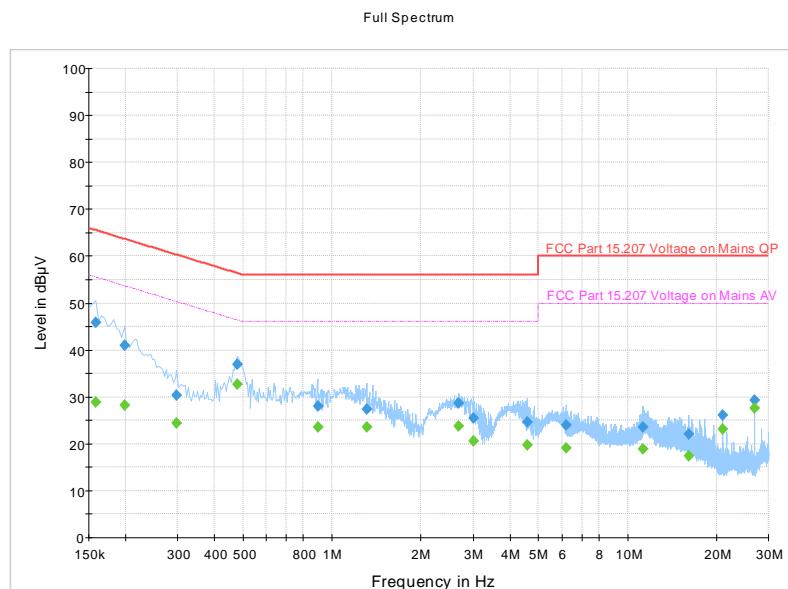
8.5.4 Setup Details

Port under test	AC mains
EUT setup configuration	Tabletop
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	<ul style="list-style-type: none"> – Peak and Average (Preview measurement) – Quasi-peak and CAverage (Final measurement)
Trace mode	Max Hold
Measurement time	<ul style="list-style-type: none"> – 100 ms (Peak and Average preview measurement) – 5000 ms (Quasi-peak final measurement) – 5000 ms (CAverage final measurement)

8.5.5 Test Data



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

Figure 8.5-1: AC conducted emissions, 150 kHz – 30 MHz (Unit transmitting at low channel, 402.15 MHz)

Frequency (MHz)	QuasiPeak (dB μ V)	CAverage (dB μ V)	Limit (dB μ V)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Filter	Corr. (dB)
0.158000	---	28.95	55.57	26.62	5000.0	9.000	N	ON	19.6
0.158000	45.93	---	65.57	19.64	5000.0	9.000	N	ON	19.6
0.198000	41.08	---	63.69	22.62	5000.0	9.000	L1	ON	19.5
0.198000	---	28.16	53.69	25.53	5000.0	9.000	L1	ON	19.5
0.298000	---	24.35	50.30	25.95	5000.0	9.000	L1	ON	19.5
0.298000	30.40	---	60.30	29.89	5000.0	9.000	L1	ON	19.5
0.478000	36.93	---	56.37	19.44	5000.0	9.000	L1	ON	19.4
0.478000	---	32.74	46.37	13.63	5000.0	9.000	L1	ON	19.4
0.894000	28.11	---	56.00	27.89	5000.0	9.000	L1	ON	19.4
0.894000	---	23.55	46.00	22.45	5000.0	9.000	L1	ON	19.4
1.310000	27.36	---	56.00	28.64	5000.0	9.000	L1	ON	19.4
1.310000	---	23.49	46.00	22.51	5000.0	9.000	L1	ON	19.4
2.686000	28.60	---	56.00	27.40	5000.0	9.000	L1	ON	19.4
2.686000	---	23.86	46.00	22.14	5000.0	9.000	L1	ON	19.4
3.002000	---	20.68	46.00	25.32	5000.0	9.000	L1	ON	19.4
3.002000	25.41	---	56.00	30.59	5000.0	9.000	L1	ON	19.4
4.570000	24.69	---	56.00	31.31	5000.0	9.000	L1	ON	19.3
4.570000	---	19.77	46.00	26.23	5000.0	9.000	L1	ON	19.3
6.194000	23.97	---	60.00	36.03	5000.0	9.000	L1	ON	19.3
6.194000	---	19.11	50.00	30.89	5000.0	9.000	L1	ON	19.3
11.294000	---	18.95	50.00	31.05	5000.0	9.000	L1	ON	19.8
11.294000	23.63	---	60.00	36.37	5000.0	9.000	L1	ON	19.8
16.118000	---	17.37	50.00	32.63	5000.0	9.000	N	ON	20.3
16.118000	22.19	---	60.00	37.81	5000.0	9.000	N	ON	20.3
21.002000	26.11	---	60.00	33.89	5000.0	9.000	L1	ON	20.2
21.002000	---	23.13	50.00	26.87	5000.0	9.000	L1	ON	20.2
27.002000	---	27.56	50.00	22.44	5000.0	9.000	N	ON	20.1
27.002000	29.34	---	60.00	30.66	5000.0	9.000	N	ON	20.1

Table 8.5-1: AC conducted emissions, 150 kHz – 30 MHz (Unit transmitting at low channel, 402.15 MHz)

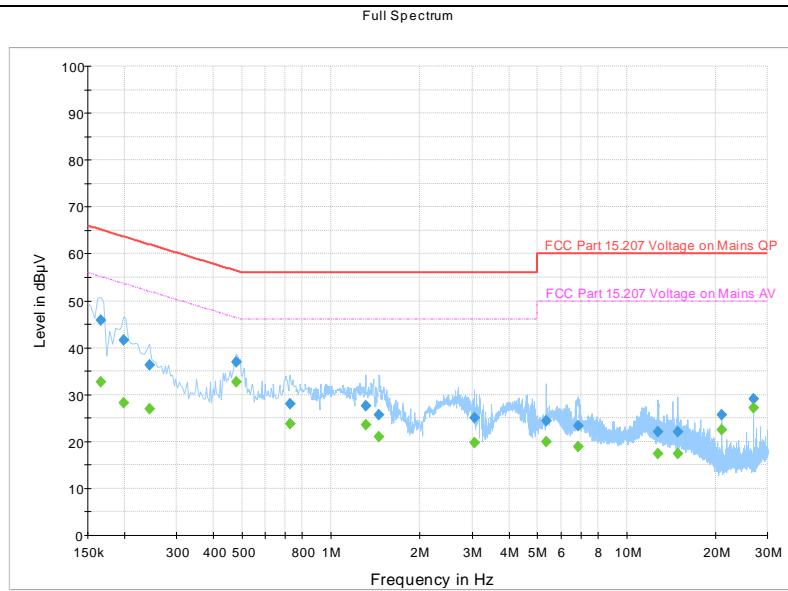
Notes:

¹ Result (dB μ V) = receiver/spectrum analyzer value (dB μ V) + correction factor (dB)

² Correction factor (dB) = LISN factor IL (dB) + cable loss (dB) + attenuator (dB)

³ The maximum measured value observed over a period of 5 seconds was recorded.

8.5.5 Test Data, continued



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

Figure 8.5-2: AC conducted emissions, 150 kHz – 30 MHz (Unit transmitting at middle channel, 403.65 MHz)

Frequency (MHz)	QuasiPeak (dBμV)	CAverage (dBμV)	Limit (dBμV)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Filter	Corr. (dB)
0.166000	---	32.61	55.16	22.55	5000.0	9.000	N	ON	19.5
0.166000	45.77	---	65.16	19.39	5000.0	9.000	N	ON	19.5
0.198000	41.59	---	63.69	22.10	5000.0	9.000	L1	ON	19.5
0.198000	---	28.31	53.69	25.38	5000.0	9.000	L1	ON	19.5
0.242000	---	26.88	52.03	25.15	5000.0	9.000	L1	ON	19.5
0.242000	36.33	---	62.03	25.70	5000.0	9.000	L1	ON	19.5
0.478000	36.90	---	56.37	19.47	5000.0	9.000	L1	ON	19.4
0.478000	---	32.72	46.37	13.66	5000.0	9.000	L1	ON	19.4
0.726000	28.03	---	56.00	27.97	5000.0	9.000	L1	ON	19.4
0.726000	---	23.72	46.00	22.28	5000.0	9.000	L1	ON	19.4
1.310000	27.68	---	56.00	28.32	5000.0	9.000	L1	ON	19.4
1.310000	---	23.55	46.00	22.45	5000.0	9.000	L1	ON	19.4
1.454000	25.64	---	56.00	30.36	5000.0	9.000	L1	ON	19.4
1.454000	---	21.07	46.00	24.93	5000.0	9.000	L1	ON	19.4
3.058000	---	19.78	46.00	26.22	5000.0	9.000	L1	ON	19.4
3.058000	25.08	---	56.00	30.92	5000.0	9.000	L1	ON	19.4
5.346000	---	20.02	50.00	29.98	5000.0	9.000	L1	ON	19.3
5.346000	24.46	---	60.00	35.54	5000.0	9.000	L1	ON	19.3
6.850000	---	18.85	50.00	31.15	5000.0	9.000	L1	ON	19.3
6.850000	23.41	---	60.00	36.59	5000.0	9.000	L1	ON	19.3
12.810000	---	17.51	50.00	32.49	5000.0	9.000	N	ON	20.0
12.810000	22.17	---	60.00	37.83	5000.0	9.000	N	ON	20.0
14.930000	22.06	---	60.00	37.94	5000.0	9.000	N	ON	20.2
14.930000	---	17.34	50.00	32.66	5000.0	9.000	N	ON	20.2
21.002000	---	22.59	50.00	27.41	5000.0	9.000	L1	ON	20.2
21.002000	25.75	---	60.00	34.25	5000.0	9.000	L1	ON	20.2
27.002000	---	27.16	50.00	22.84	5000.0	9.000	N	ON	20.1
27.002000	29.12	---	60.00	30.88	5000.0	9.000	N	ON	20.1

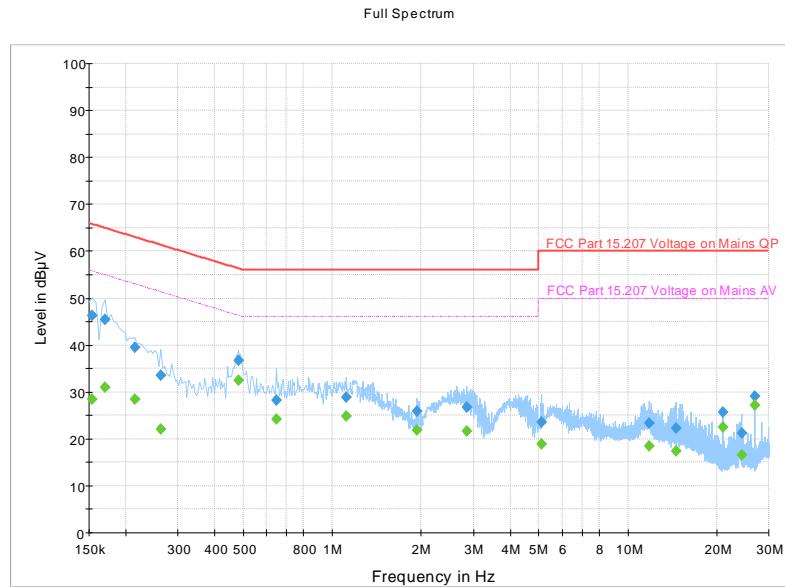
Table 8.5-2: AC conducted emissions, 150 kHz – 30 MHz (Unit transmitting at middle channel, 403.65 MHz)

Notes:

¹Result (dBμV) = receiver/spectrum analyzer value (dBμV) + correction factor (dB)

²Correction factor (dB) = LISN factor IL (dB) + cable loss (dB) + attenuator (dB)

³The maximum measured value observed over a period of 5 seconds was recorded.



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

Figure 8.5-3: AC conducted emissions, 150 kHz – 30 MHz (Unit transmitting at high channel, 404.85 MHz)

Frequency (MHz)	QuasiPeak (dB μ V)	CAverage (dB μ V)	Limit (dB μ V)	Margin (dB)	Meas. Time (ms)	Bandwidth (kHz)	Line	Filter	Corr. (dB)
0.154000	---	28.44	55.78	27.34	5000.0	9.000	L1	ON	19.6
0.154000	46.26	---	65.78	19.53	5000.0	9.000	L1	ON	19.6
0.170000	---	31.06	54.96	23.90	5000.0	9.000	L1	ON	19.6
0.170000	45.50	---	64.96	19.46	5000.0	9.000	L1	ON	19.6
0.214000	---	28.41	53.05	24.64	5000.0	9.000	L1	ON	19.5
0.214000	39.48	---	63.05	23.57	5000.0	9.000	L1	ON	19.5
0.262000	33.49	---	61.37	27.88	5000.0	9.000	N	ON	19.4
0.262000	---	22.02	51.37	29.35	5000.0	9.000	N	ON	19.4
0.482000	36.83	---	56.31	19.47	5000.0	9.000	L1	ON	19.4
0.482000	---	32.40	46.31	13.90	5000.0	9.000	L1	ON	19.4
0.646000	28.27	---	56.00	27.73	5000.0	9.000	L1	ON	19.4
0.646000	---	24.16	46.00	21.84	5000.0	9.000	L1	ON	19.4
1.114000	28.83	---	56.00	27.17	5000.0	9.000	L1	ON	19.4
1.114000	---	24.92	46.00	21.08	5000.0	9.000	L1	ON	19.4
1.938000	25.85	---	56.00	30.15	5000.0	9.000	N	ON	19.3
1.938000	---	21.84	46.00	24.16	5000.0	9.000	N	ON	19.3
2.846000	26.75	---	56.00	29.25	5000.0	9.000	L1	ON	19.4
2.846000	---	21.66	46.00	24.34	5000.0	9.000	L1	ON	19.4
5.114000	23.49	---	60.00	36.51	5000.0	9.000	L1	ON	19.3
5.114000	---	18.85	50.00	31.15	5000.0	9.000	L1	ON	19.3
11.774000	---	18.52	50.00	31.48	5000.0	9.000	L1	ON	19.8
11.774000	23.40	---	60.00	36.60	5000.0	9.000	L1	ON	19.8
14.526000	22.22	---	60.00	37.78	5000.0	9.000	L1	ON	20.2
14.526000	---	17.50	50.00	32.50	5000.0	9.000	L1	ON	20.2
21.002000	25.79	---	60.00	34.21	5000.0	9.000	L1	ON	20.2
21.002000	---	22.59	50.00	27.41	5000.0	9.000	L1	ON	20.2
24.230000	21.18	---	60.00	38.82	5000.0	9.000	L1	ON	20.0
24.230000	---	16.52	50.00	33.48	5000.0	9.000	L1	ON	20.0
27.002000	---	27.15	50.00	22.85	5000.0	9.000	N	ON	20.1
27.002000	29.05	---	60.00	30.95	5000.0	9.000	N	ON	20.1

Table 8.5-3: AC conducted emissions, 150 kHz – 30 MHz (Unit transmitting at high channel, 404.85 MHz)

Notes:

¹Result (dB μ V) = receiver/spectrum analyzer value (dB μ V) + correction factor (dB)

²Correction factor (dB) = LISN factor IL (dB) + cable loss (dB) + attenuator (dB)

³The maximum measured value observed over a period of 5 seconds was recorded.

8.6 99% Occupied Bandwidth

8.6.1 References

FCC Part 15 → §2.202 (a)

(a) Occupied bandwidth. The frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission. In some cases, for example multichannel frequency-division systems, the percentage of 0.5 percent may lead to certain difficulties in the practical application of the definitions of occupied and necessary bandwidth; in such cases a different percentage may prove useful.

8.6.2 Test summary

Verdict	Pass	Temperature	20°C
Test date	July 9, 2021	Air pressure	1007 mbar
Test engineer	Martha Espinoza	Relative humidity	60 %
Test location	3m semi anechoic chamber		

8.1.3 Notes

Testing was performed with EUT transmitting on a fixed channel at full power. The transmission was continuously: Low, middle, and high channel were evaluated.

8.1.4 Setup details

EUT setup configuration	Tabletop
Test facility	Wireless Bench
Measurement method	ANSI C63.10

Receiver/spectrum analyzer settings:

Resolution bandwidth	1% - 5% OBW
Video bandwidth	3*RBW
Span	Between 1.5 times and 5 times OBW
Detector mode	Peak
Trace mode	Max Hold
Measurement time	Long enough for trace to stabilize

8.1.5 Test data

Test Frequency (MHz)	99% OBW (kHz)
402.15	248.398
403.65	246.179
404.85	248.960

Table 8.6-1: 99% OBW occupied bandwidth test data

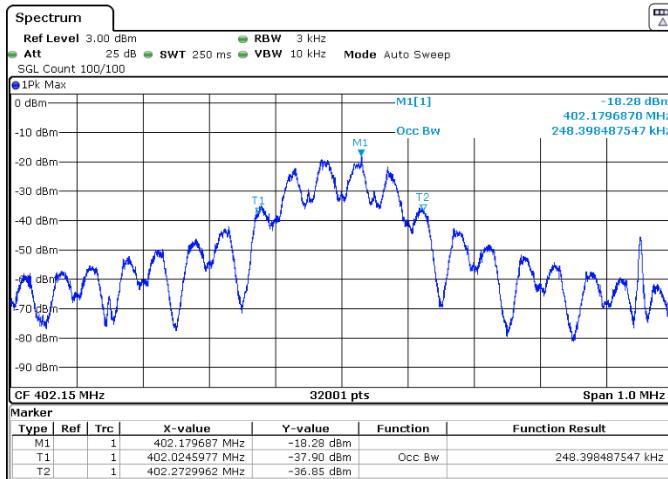


Figure 8.6-2: Low channel (402.15 MHz): 99% OBW plot

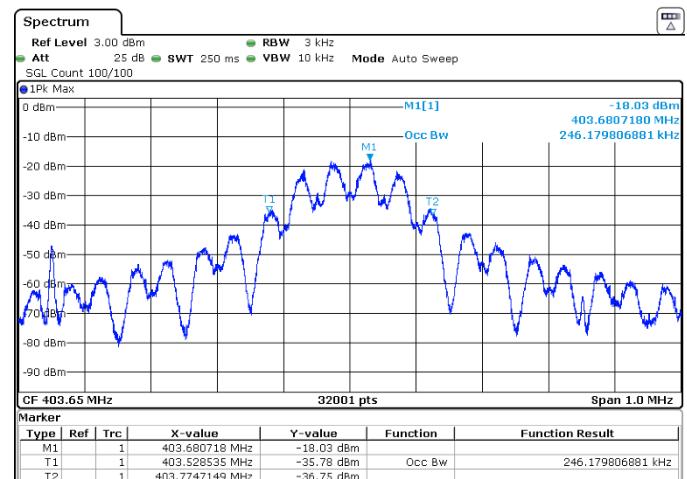


Figure 8.6-2: Middle channel (403.65 MHz): 99% OBW plot

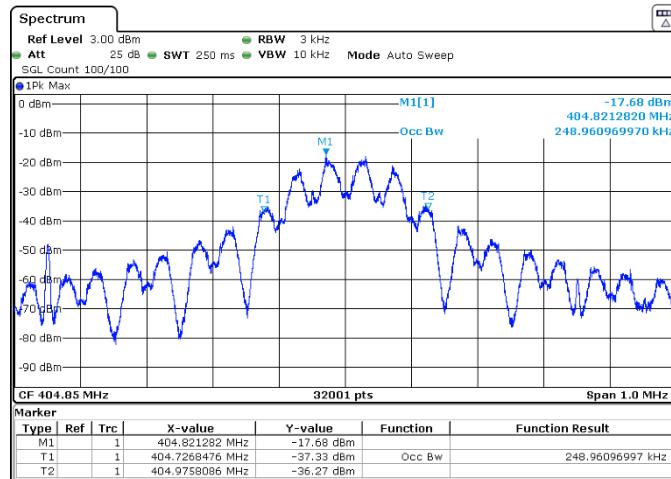
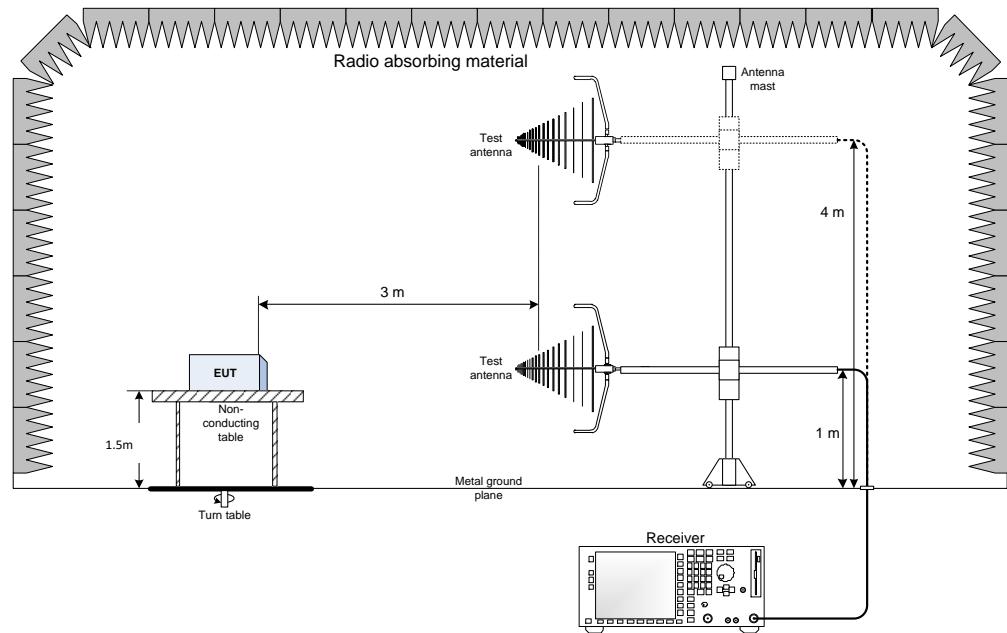


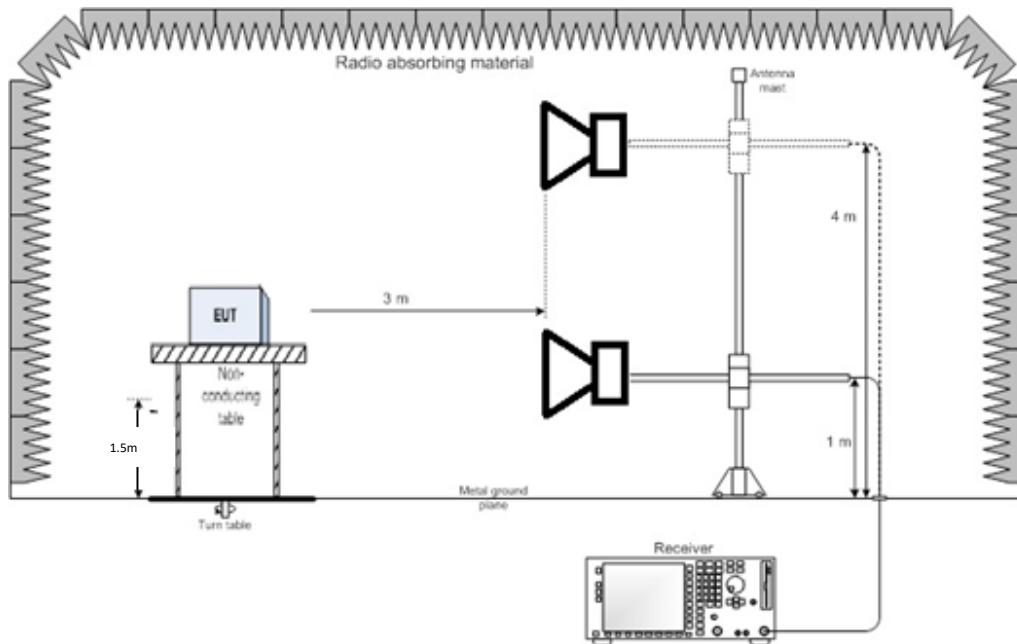
Figure 8.6-3: High channel (404.85 MHz): 99% OBW plot

Section 9 Block diagrams of test set-ups

9.1 Radiated emissions set-up



30-1000MHz Setup



Above 1GHz Setup

Thank you for choosing

