

TEST REPORT

ACCORDING TO: FCC 47CFR part 15 subpart C §15.247 (FHSS) and subpart B,
RSS-247 Issue 3:2023, RSS-Gen Issue 5, ICES-003 Issue 7:2020

FOR:

**TriplePlus
Controller**

**Model: CBM-COAMAP-5-01, CBM-COAMAP-5-02,
CBM-COAMAP-5-03, CBM-COAMAP-5-04,
CBM-COAMAP-5-05, CBM-COAMAP-5-06,
CBM-COAMAP-5-07, CBM-COAMAP-5-08**

FCC ID: 2AFOICBMCOLR5

IC: 20798-CBMCOLR5

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1 Applicant information

Client name: TriplePlus
Address: 5 Hamada street, Yokneam 2069200, Israel
Telephone: +972-72-22-11-370
Fax: +972-4-959-3991
E-mail: oren@tripleplus.io
Contact name: Mr. Oren Niv

2 Equipment under test attributes

Product name: Controller
Product type: Transceiver
Model(s): CBM-COAMAP-5-01*, CBM-COAMAP-5-02, CBM-COAMAP-5-03, CBM-COAMAP-5-04, CBM-COAMAP-5-05, CBM-COAMAP-5-06, CBM-COAMAP-5-07, CBM-COAMAP-5-08
Serial number: NA
Hardware version: V3.2
Software release: 7.40.00.77
Receipt date: 07-Feb-24

*According to manufacturer's declaration provided in Appendix G of the test report model CBM-COAMAP-5-01 (Super Set product). All others model variants have an identical enclosure and the identical electronic card and differ only in components that are removed from the electronic card compared to the corresponding superset product. The components that are removed are not changing the radio functions. All the Radio section remains the same. The reason for removing these components is to save the price for functions that are not required for certain applications. Model CBM-COAMAP-5-01 (Super Set) was tested as a representative for the worst-case scenario.

3 Manufacturer information

Manufacturer name: TriplePlus
Address: 5 Hamada street, Yokneam 2069200, Israel
Telephone: +972-72-22-11-370
Fax: +972-4-959-3991
E-Mail: oren@tripleplus.io
Contact name: Mr. Oren Niv

4 Test details

Project ID: 53211
Location: Hermon Laboratories Ltd. 66 HaTachana str., P.O. Box 23, Binyamina 3055001, Israel
Test started: 25-Feb-24
Test completed: 07-Mar-24
Test specification(s): FCC 47CFR part 15 subpart C §15.247 (FHSS) and subpart B, RSS-247 Issue 3:2023, RSS-Gen Issue 5, ICES-003 Issue 7:2020

5 Tests summary




Test

Transmitter characteristics

Section 15.247(a)1 / RSS-247 section 5.1(c), 20 dB bandwidth	Pass
Section 15.247(b) / RSS-247 section 5.4(a), Peak output power	Pass
Section 15.247(d) / RSS-247 section 5.5, Radiated spurious emissions	Pass
Section 15.247(a)1 / RSS-247 section 5.1(b), Frequency separation	Pass
Section 15.247(a)1 / RSS-247 section 5.1(c), Number of hopping frequencies	Pass
Section 15.247(a)1 / RSS-247 section 5.1(c), Average time of occupancy	Pass
Section 15.247(i)5 / RSS-102 section 2.5, RF exposure	Pass, the exhibit to the application of certification is provided
Section 15.247(d) / RSS-247 section 5.5, Emissions at band edges	Not required
Section 15.203 / RSS-Gen section 8.3, Antenna requirements	Pass

Testing was completed against all relevant requirements of the test standard. However, results obtained indicate that the product under test complies in full with the requirements tested.

The test results relate only to the items tested. Pass/ fail decision was based on nominal values.

	Name and Title	Date	Signature
Tested by:	Mrs. E. Pitt, test engineer, EMC & Radio	25-Feb-24 – 07-Mar-24	
Reviewed by:	Mrs. S. Peysahov Sheynin, certification specialist, EMC & Radio	16-Apr-24	
Approved by:	Mr. M. Nikishin, group leader, EMC & Radio	19-May-24	

6 EUT description

Note: The following data in this clause is provided by the customer and represents his sole responsibility

6.1 General information

A unit is intended for controlling the peripherals, collecting data and communicating by Ethernet or WiFi or Cellular with the cloud.

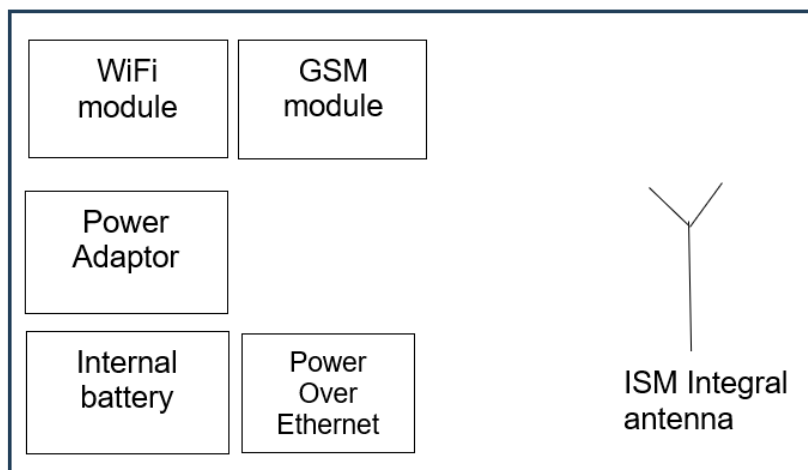
The Unit /EUT Contains 915MHz (USA/CAN) and approved Wi-Fi, GSM module/s.

Powered by 5v power adaptor or PoE (Power Over Ethernet) or backup battery (rechargeable or 2xAA batteries).

Could be provided with rechargeable or disposable batteries.

Full assembly unit (with Power adaptor, rechargeable battery, PoE, ISM, WiFi and GSM) was tested.

6.2 Test configuration



6.3 Changes made in EUT

No changes were implemented in the EUT during the testing.



6.4 Transmitter characteristics

Type of equipment					
X	Stand-alone (Equipment with or without its own control provisions)				
	Combined equipment (Equipment where the radio part is fully integrated within another type of equipment)				
	Plug-in card (Equipment intended for a variety of host systems)				
Intended use		Condition of use			
	fixed	Always at a distance more than 2 m from all people			
X	mobile	Always at a distance more than 20 cm from all people			
	portable	May operate at a distance closer than 20 cm to human body			
Assigned frequency range		902 - 928 MHz			
Operating frequency		902.8 - 927.2 MHz			
Maximum rated output power		Peak output power		13.16 dBm	
Is transmitter output power variable?		X	No		
			Yes	continuous variable	
		stepped variable with stepsize			
		dB			
		minimum RF power			
				dBm	
				dBm	
Antenna connection					
unique coupling		standard connector		X	integral
				X	with temporary RF connector without temporary RF connector
Antenna/s technical characteristics					
Type		Manufacturer		Model number	
Integral		Triple+		920	
				Gain	
				0.9 dBi	
Modulation		GFSK			
Transmitter aggregate data rate/s		5 kbps			
Modulating test signal (baseband)		PRBS			
Transmitter power source					
X	Battery	Nominal rated voltage	3.7v/1500mAh or Batt 2x 1.5v=3v	Battery type	Rechargeable or AA Batteries
X	DC	Nominal rated voltage	VDC, PoE (Power Over Ethernet)		
X	AC mains	Nominal rated voltage	110 VAC	Frequency	50Hz
Spread spectrum technique used		X	Frequency hopping (FHSS)		
			Digital transmission system (DTS)		
			Hybrid		



Test specification: Section 15.247(a)2/ RSS-247 section 5.2(a), 6 dB bandwidth			
Test procedure: ANSI C63.10 section 11.8.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 05-Feb-23			
Temperature: 20 °C	Relative Humidity: 49 %	Air Pressure: 1008 hPa	Power: 3.7 VDC
Remarks:			

7 Transmitter tests according to 47CFR part 15 subpart C and RSS-247 requirements

7.1 20 dB bandwidth

7.1.1 General

This test was performed to measure the 20dB bandwidth of the transmitter hopping channel. Specification test limits are given in Table 7.1.1.

Table 7.1.1 The 20 dB bandwidth limits

Assigned frequency, MHz	Maximum bandwidth, kHz	Modulation envelope reference points*, dBc
902.0 – 928.0	250	20

* - Modulation envelope reference points provided in terms of attenuation below the peak of modulated carrier.

7.1.2 Test procedure

7.1.2.1 The EUT was set up as shown in Figure 7.1.1, energized and its proper operation was checked.

7.1.2.2 The EUT was set to transmit modulated carrier at maximum data rate.

7.1.2.3 The transmitter bandwidth was measured with spectrum analyzer as frequency delta between reference points on modulation envelope and provided in Table 7.1.2 and associated plot.

7.1.2.4 The test was repeated for each data rate and each modulation format.

Figure 7.1.1 The 20 dB bandwidth test setup





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Test specification: Section 15.247(a)2/ RSS-247 section 5.2(a), 6 dB bandwidth			
Test procedure: ANSI C63.10 section 11.8.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 05-Feb-23			
Temperature: 20 °C	Relative Humidity: 49 %	Air Pressure: 1008 hPa	Power: 3.7 VDC
Remarks:			

Table 7.1.2 The 20 dB bandwidth test results

ASSIGNED FREQUENCY BAND: 902 – 928 MHz
DETECTOR USED: Peak
SWEEP TIME: Auto
VIDEO BANDWIDTH: ≥ RBW
MODULATION ENVELOPE REFERENCE POINTS: 20.0 dBc
FREQUENCY HOPPING: Disabled

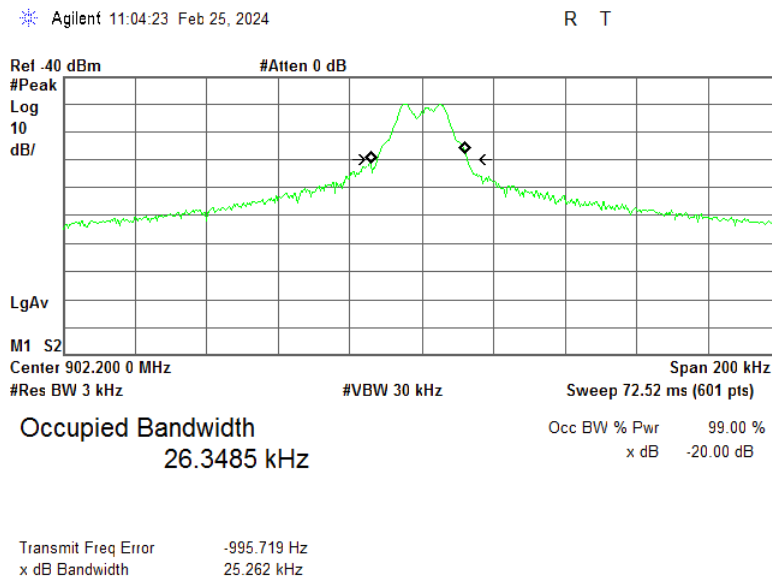
Carrier frequency, MHz	Type of modulation	Data rate, kbps	99% bandwidth, kHz	20 dB bandwidth, kHz	Limit, kHz	Margin, kHz	Verdict
902.2	2 GFSK	5	26.3	25.3	250	-224.7	Pass
915.2			27.2	24.9	250	-225.1	Pass
927.8			27.3	26.9	250	-223.1	Pass

Reference numbers of test equipment used

HL 3818	HL 4136	HI 337	HL 5589					
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Full description is given in Appendix A.

Plot 7.1.1 The 20 dB bandwidth test result at low frequency

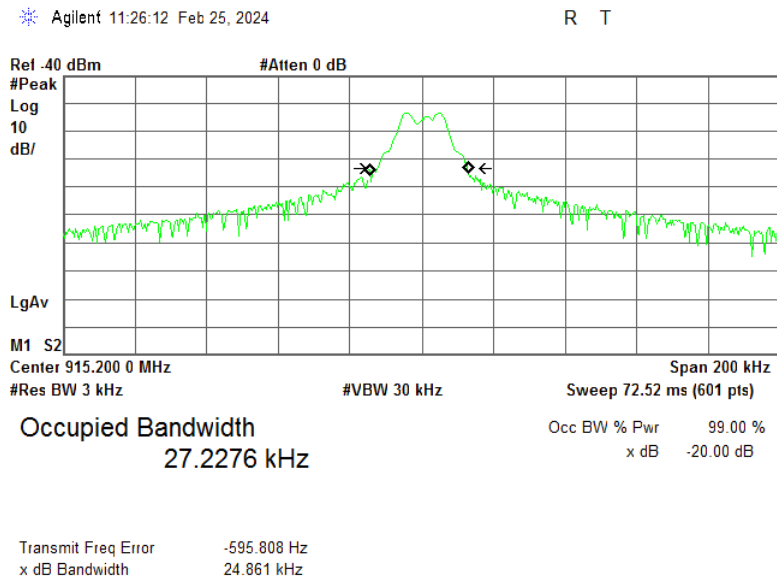




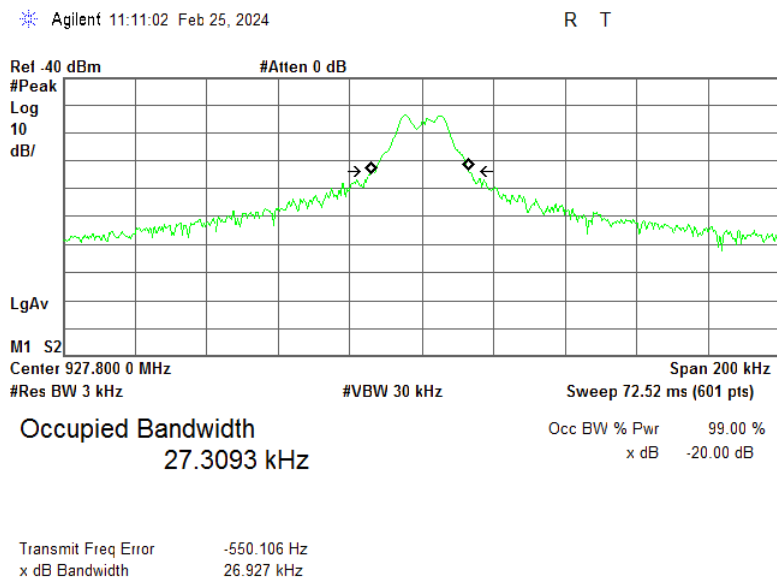
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Test specification: Section 15.247(a)2/ RSS-247 section 5.2(a), 6 dB bandwidth			
Test procedure: ANSI C63.10 section 11.8.1			
Test mode: Compliance		Verdict: PASS	
Date(s): 05-Feb-23			
Temperature: 20 °C	Relative Humidity: 49 %	Air Pressure: 1008 hPa	Power: 3.7 VDC
Remarks:			

Plot 7.1.2 The 20 dB bandwidth test result at mid frequency



Plot 7.1.3 The 20 dB bandwidth test result at high frequency





Test specification:		Section 15.247(a)1, RSS-247 section 5.1(2), Frequency separation	
Test procedure:		ANSI C63.10, section 7.8.2	
Test mode:		Verdict: PASS	
Date(s):			
25-Feb-24			
Temperature: 23 °C	Relative Humidity: 58 %	Air Pressure: 1012 hPa	Power: 110 VAC, 50 Hz
Remarks:			

7.1 Carrier frequency separation

7.1.1 General

This test was performed to measure frequency separation between the peaks of adjacent channels. Specification test limits are given in Table 7.1.1.

Table 7.1.1 Carrier frequency separation limits

Assigned frequency range, MHz	Carrier frequency separation	
	Output power 30 dBm	Output power 21 dBm
902.0 – 928.0	25 kHz or 20 dB bandwidth of the hopping channel, whichever is greater	25 kHz or two-thirds of the 20dB bandwidth of the hopping channel, whichever is greater

7.1.2 Test procedure

- 7.1.2.1** The EUT was set up as shown in Figure 7.1.1, energized with frequency hopping function enabled and its proper operation was checked.
- 7.1.2.2** The spectrum analyzer span was set to capture the carrier frequency and both of adjacent channels, the lower and the higher. The resolution bandwidth was set wider than 1 % of the frequency span.
- 7.1.2.3** The spectrum analyzer was set in max hold mode and allowed trace to stabilize.
- 7.1.2.4** The frequency separation between the peaks of adjacent channels was measured as provided in Table 7.1.2 and associated plots.

Figure 7.1.1 Carrier frequency separation test setup





Test specification:		Section 15.247(a)1, RSS-247 section 5.1(2), Frequency separation	
Test procedure:		ANSI C63.10, section 7.8.2	
Test mode:		Verdict: PASS	
Date(s):			
25-Feb-24			
Temperature: 23 °C	Relative Humidity: 58 %	Air Pressure: 1012 hPa	Power: 110 VAC, 50 Hz
Remarks:			

Table 7.1.2 Carrier frequency separation test results

ASSIGNED FREQUENCY: 902-928 MHz
MODULATION: 2 GFSK
BIT RATE: 5 kbps
DETECTOR USED: Peak
RESOLUTION BANDWIDTH: $\geq 1\%$ of the span
VIDEO BANDWIDTH: \geq RBW
FREQUENCY HOPPING: Enabled
20 dB BANDWIDTH: 26.9 kHz

Carrier frequency separation, kHz	Limit, kHz	Margin*	Verdict
200	26.9	173.1	Pass

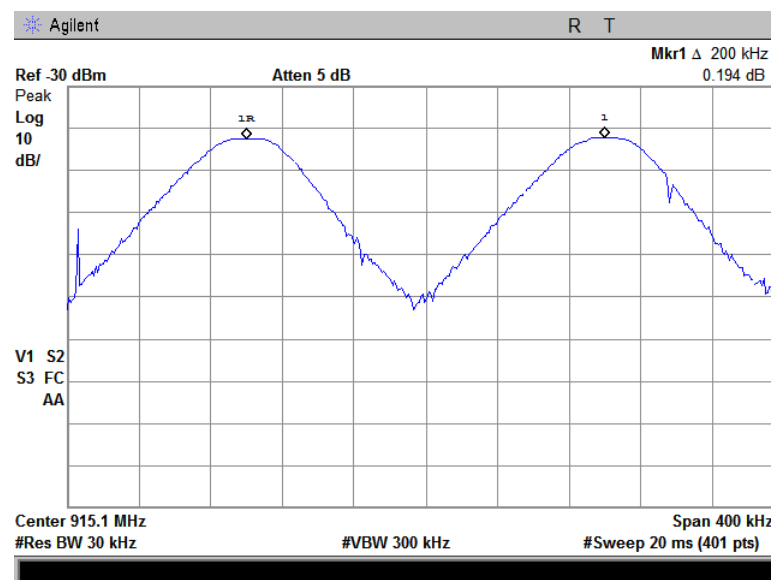
* - Margin = Carrier frequency separation – specification limit.

Reference numbers of test equipment used

HL 3818	HL 4136	HL 337	HL 5589				
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Full description is given in Appendix A.

Plot 7.1.1 Carrier frequency separation





Test specification: Section 15.247(a)1, RSS-247 section 5.1(3), Number of hopping frequencies			
Test procedure: ANSI C63.10, section 7.8.3			
Test mode: Compliance		Verdict: PASS	
Date(s): 25-Feb-24			
Temperature: 23 °C	Relative Humidity: 58 %	Air Pressure: 1012 hPa	Power: 110 VAC, 50 Hz
Remarks:			

7.2 Number of hopping frequencies

7.2.1 General

This test was performed to calculate the number of hopping frequencies used by the EUT. Specification test limits are given in Table 7.2.1.

Table 7.2.1 Minimum number of hopping frequencies

Assigned frequency range, MHz	Number of hopping frequencies
902.0 – 928.0	50 (if the 20 dB bandwidth is less than 250 kHz) 25 (if the 20 dB bandwidth is 250 kHz or greater)

7.2.2 Test procedure

7.2.2.1 The EUT was set up as shown in Figure 7.2.1, energized with frequency hopping function enabled and its proper operation was checked.

7.2.2.2 Initially the spectrum analyzer span was set equal to frequency band of operation and the resolution bandwidth was set wider than 1 % of the frequency span. If the separate hopping channels were not clearly resolved the frequency band of operation was broken to sections and the resolution bandwidth was set wider than 1 % of the frequency span of each section.

7.2.2.3 The spectrum analyzer was set in max hold mode and allowed trace to stabilize.

7.2.2.4 The number of frequency hopping channels was calculated as provided in Table 7.2.2 and associated plots.

Figure 7.2.1 Hopping frequencies test setup



Table 7.2.2 Hopping frequencies test results

ASSIGNED FREQUENCY: 902-928 MHz
 MODULATION: 2GFSK
 BIT RATE: 5 kbps
 DETECTOR USED: Peak
 VIDEO BANDWIDTH: ≥ RBW
 FREQUENCY HOPPING: Enabled

Number of hopping frequencies	Minimum number of hopping frequencies	Margin*	Verdict
129	50	79	Pass

* - Margin = Number of hopping frequencies – Minimum number of hopping frequencies.

Reference numbers of test equipment used

HL 3818	HL 337	HL 4136	HL 5589				
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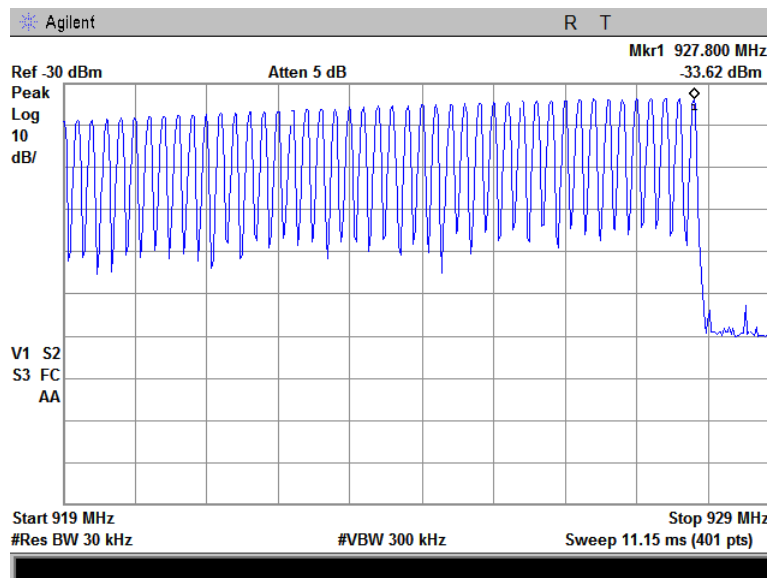
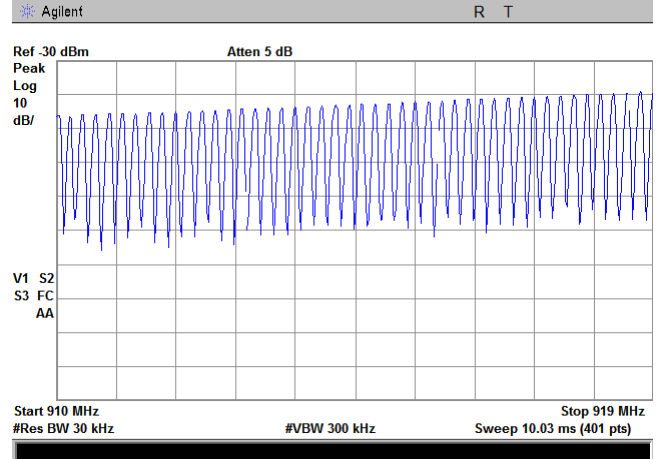
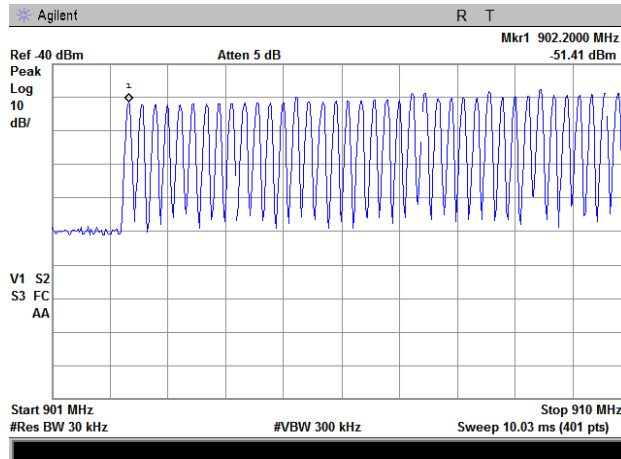
Full description is given in Appendix A.



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Test specification:		Section 15.247(a)1, RSS-247 section 5.1(3), Number of hopping frequencies	
Test procedure:		ANSI C63.10, section 7.8.3	
Test mode:		Verdict: PASS	
Date(s):			
25-Feb-24			
Temperature: 23 °C	Relative Humidity: 58 %	Air Pressure: 1012 hPa	Power: 110 VAC, 50 Hz
Remarks:			

Plot 7.2.1 Number of hopping frequencies





Test specification: Section 15.247(a)1, RSS-247 section 5.1(3), Average time of occupancy			
Test procedure: ANSI C63.10, section 7.8.4			
Test mode: Compliance		Verdict: PASS	
Date(s): 25-Feb-24			
Temperature: 23 °C	Relative Humidity: 58 %	Air Pressure: 1012 hPa	Power: 110 VAC, 50 Hz
Remarks:			

7.3 Average time of occupancy

7.3.1 General

This test was performed to calculate the average time of occupancy (dwell time) on any frequency channel of the EUT. Specification test limits are given in Table 7.3.1.

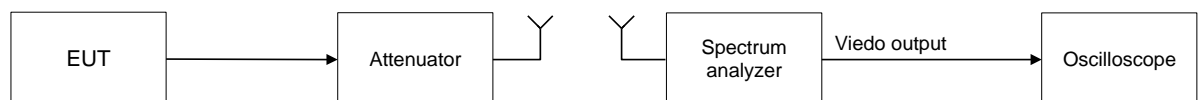
Table 7.3.1 Average time of occupancy limits

Assigned frequency range, MHz	Maximum average time of occupancy, s	Investigated period, s	Number of hopping frequencies
902.0 – 928.0	0.4	20.0	≥ 50

7.3.2 Test procedure

- 7.3.2.1 The EUT was set up as shown in Figure 7.3.1, energized with frequency hopping function enabled and its proper operation was checked.
- 7.3.2.2 The spectrum analyzer span was set to zero centered on a hopping channel.
- 7.3.2.3 The single transmission duration and period were measured with oscilloscope.
- 7.3.2.4 The average time of occupancy was calculated as the single transmission time multiplied by the investigated period and divided by the single transmission period.
- 7.3.2.5 The test was repeated at each data rate and modulation type as provided in Table 7.3.2 and associated plots.

Figure 7.3.1 Average time of occupancy test setup





Test specification: Section 15.247(a)1, RSS-247 section 5.1(3), Average time of occupancy			
Test procedure: ANSI C63.10, section 7.8.4			
Test mode: Compliance		Verdict: PASS	
Date(s): 25-Feb-24			
Temperature: 23 °C	Relative Humidity: 58 %	Air Pressure: 1012 hPa	Power: 110 VAC, 50 Hz
Remarks:			

Table 7.3.2 Average time of occupancy test results

ASSIGNED FREQUENCY: 902 – 928 MHz
 MODULATION: 2 GFSK
 NUMBER OF HOPPING FREQUENCIES: 129
 INVESTIGATED PERIOD: 20 s
 FREQUENCY HOPPING: Enabled

Carrier frequency, MHz	Single transmission duration, ms	Single transmission period, s	Average time of occupancy*, s	Bit rate, kbps	Symbol rate, Msymbol/s	Limit, s	Margin, s**	Verdict
915.2	95.5	1	0.0955	5	NA	0.4	-0.3045	Pass

* - Average time of occupancy = (Single transmission duration × Investigated period) / (Single transmission period × number of hopping channels).

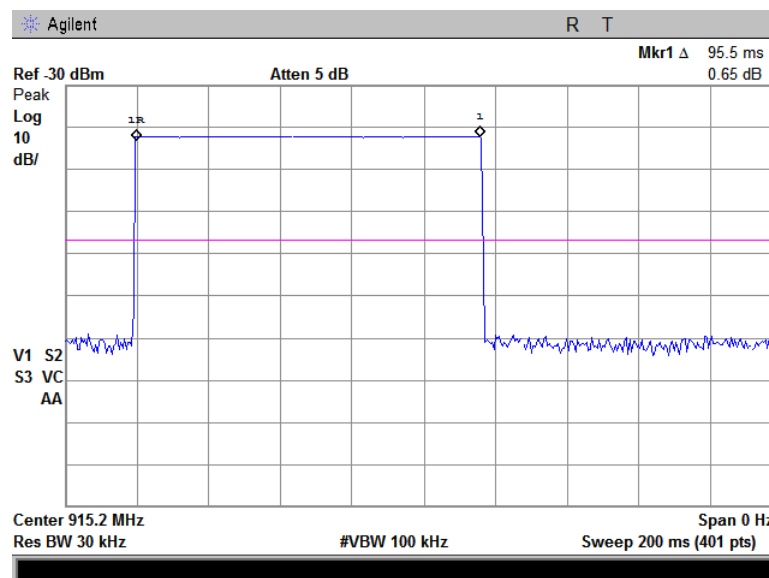
** - Margin = Average time of occupancy – specification limit.

Reference numbers of test equipment used

HL 3818	HL 4136	HL 337					
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Full description is given in Appendix A.

Plot 7.3.1 Single transmission duration

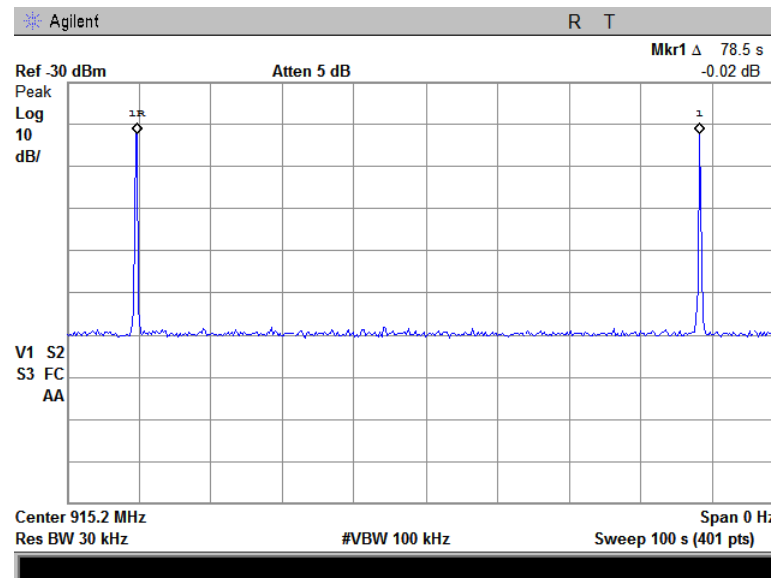




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Test specification:		Section 15.247(a)1, RSS-247 section 5.1(3), Average time of occupancy	
Test procedure:		ANSI C63.10, section 7.8.4	
Test mode:		Verdict: PASS	
Date(s):			
25-Feb-24			
Temperature: 23 °C	Relative Humidity: 58 %	Air Pressure: 1012 hPa	Power: 110 VAC, 50 Hz
Remarks:			

Plot 7.3.2 Transmission pulse period





Test specification: Section 15.247(b), RSS-247 section 5.4(1), Peak output power			
Test procedure: ANSI C63.10, section 7.8.5			
Test mode: Compliance		Verdict: PASS	
Date(s): 28-Feb-24 - 06-Mar-24			
Temperature: 23 °C	Relative Humidity: 58 %	Air Pressure: 1012 hPa	Power: 110 VAC, 50 Hz
Remarks:			

7.4 Peak output power

7.4.1 General

This test was performed to measure the maximum peak output power radiated by transmitter. Specification test limits are given in Table 7.4.1.

Table 7.4.1 Peak output power limits

Assigned frequency range, MHz	Peak output power*		Equivalent field strength limit @ 3m, dB(μV/m)*	Maximum antenna gain, dBi
	W	dBm		
902.0 – 928.0	0.25 (<50 hopping channels)	24.0(<50 hopping channels)	125.2 (<50 hopping channels)	6.0*
	1.0 (≥50 hopping channels)	30.0 (≥50 hopping channels)	131.2 (≥50 hopping channels)	

*- Equivalent field strength limit was calculated from the peak output power as follows: $E = \sqrt{30 \times P \times G} / r$, where P is peak output power in Watts, r is antenna to EUT distance in meters and G is transmitter antenna gain in dBi.

** - The limit is provided in terms of conducted RF power at the antenna connector. If transmitting antennas of directional gain greater than 6 dBi are used, the peak output power limit shall be reduced below the stated value as follows:

- by 1 dB for every 3 dB that the directional gain of antenna exceeds 6 dBi for fixed point-to-point transmitters operate in 2400-2483.5 MHz band;
- without any corresponding reduction for fixed point-to-point transmitters operate in 5725-5850 MHz band;
- by the amount in dB that the directional gain of antenna exceeds 6 dBi for the rest of transmitters.

7.4.2 Test procedure

7.4.2.1 The EUT was set up as shown in Figure 7.4.1, energized and its proper operation was checked.

7.4.2.2 The EUT was adjusted to produce maximum available to end user RF output power.

7.4.2.3 The frequency span of spectrum analyzer was set approximately 5 times wider than 20 dB bandwidth of the EUT and the resolution bandwidth was set wider than 20 dB bandwidth of the EUT. To find maximum radiation the turntable was rotated 360° and the measuring antenna height was swept in both vertical and horizontal polarizations.

7.4.2.4 The maximum field strength of the EUT carrier frequency was measured as provided in

7.4.2.5 Table 7.4.2 and associated plots.

7.4.2.6 The maximum peak output power was calculated from the field strength of carrier as follows:

$$P = (E \times d)^2 / (30 \times G),$$

where P is the peak output power in W, E is the field strength in V/m, d is the test distance and G is the transmitter numeric antenna gain over an isotropic radiator.

The above equation was converted in logarithmic units for 3 m test distance:

$$\text{Peak output power in dBm} = \text{Field strength in dB}(\mu\text{V/m}) - \text{Transmitter antenna gain in dBi} - 95.2 \text{ dB}$$

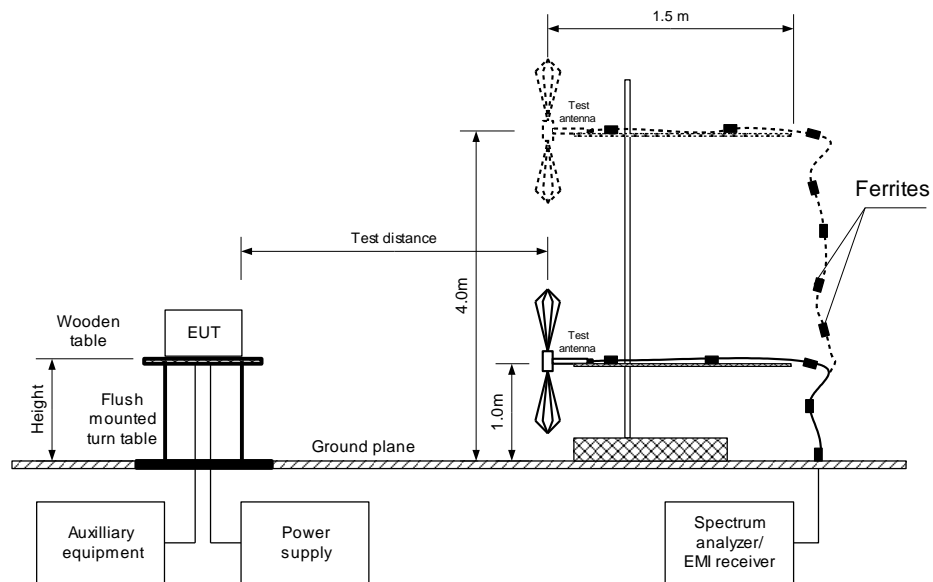
7.4.2.7 The worst test results (the lowest margins) were recorded in Table 7.4.2.



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Test specification:		Section 15.247(b), RSS-247 section 5.4(1), Peak output power	
Test procedure:		ANSI C63.10, section 7.8.5	
Test mode:		Verdict: PASS	
Date(s):			
28-Feb-24 - 06-Mar-24			
Temperature: 23 °C	Relative Humidity: 58 %	Air Pressure: 1012 hPa	Power: 110 VAC, 50 Hz
Remarks:			

Figure 7.4.1 Setup for carrier field strength measurements





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Test specification: Section 15.247(b), RSS-247 section 5.4(1), Peak output power			
Test procedure: ANSI C63.10, section 7.8.5			
Test mode: Compliance		Verdict: PASS	
Date(s): 28-Feb-24 - 06-Mar-24			
Temperature: 23 °C	Relative Humidity: 58 %	Air Pressure: 1012 hPa	Power: 110 VAC, 50 Hz
Remarks:			

Table 7.4.2 Peak output power test results

ASSIGNED FREQUENCY: 902-928 MHz
 TEST DISTANCE: 3 m
 TEST SITE: Semi anechoic chamber
 EUT HEIGHT: 0.8 m
 DETECTOR USED: Peak
 TEST ANTENNA TYPE: Biconilog (30 MHz – 1000 MHz)
 MODULATION: 2GFSK
 BIT RATE: 5 kbps
 DETECTOR USED: Peak
 EUT 20 dB BANDWIDTH: 26.9 kHz
 RESOLUTION BANDWIDTH: 100 kHz
 VIDEO BANDWIDTH: 300 kHz
 FREQUENCY HOPPING: Disabled
 NUMBER OF FREQUENCY HOPPING CHANNELS: 129

Frequency, MHz	Field strength, dB(μV/m)	Antenna polarization	Antenna height, m	Azimuth, degrees*	EUT antenna gain, dBi	Peak output power, dBm**	Limit, dBm	Margin, dB***	Verdict
902.2	108.31	Vertical	1.0	-46	0.9	12.21	30	-17.79	Pass
915.2	109.26	Vertical	1.0	102	0.9	13.16	30	-16.84	Pass
927.8	103.10	Vertical	1.0	121	0.9	7.00	30	-23.00	Pass

*- EUT front panel refer to 0 degrees position of turntable.

**- Peak output power was calculated from the field strength of carrier as follows: $P = (E \times d)^2 / (30 \times G)$, where P is the peak output power in W, E is the field strength in V/m, d is the test distance in meters and G is the transmitter numeric antenna gain over an isotropic radiator. The above equation was converted in logarithmic units for 3 m test distance: *Peak output power in dBm = Field strength in dB(μV/m) - Transmitter antenna gain in dBi - 95.2 dB*

***- Margin = Peak output power – specification limit.

Reference numbers of test equipment used

HL 7585	HL 5288	HL 3903	HL 5902				
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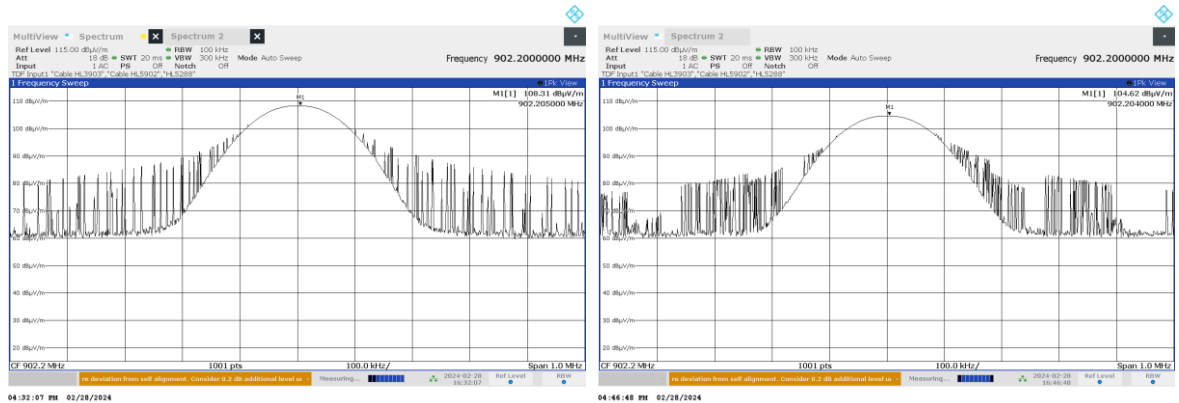
Full description is given in Appendix A.



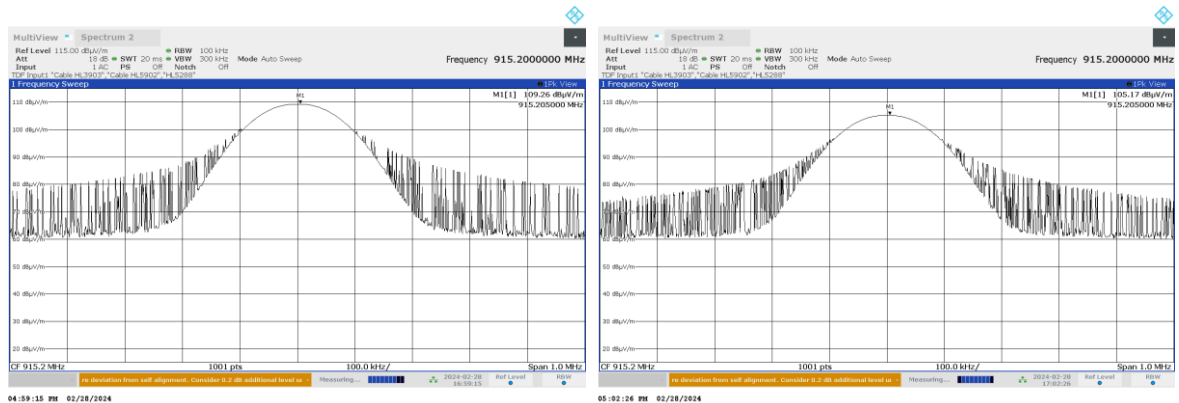
HERMON LABORATORIES

Test specification: Section 15.247(b), RSS-247 section 5.4(1), Peak output power			
Test procedure: ANSI C63.10, section 7.8.5			
Test mode: Compliance		Verdict: PASS	
Date(s): 28-Feb-24 - 06-Mar-24			
Temperature: 23 °C	Relative Humidity: 58 %	Air Pressure: 1012 hPa	Power: 110 VAC, 50 Hz
Remarks:			

Plot 7.4.1 Field strength of carrier at low frequency



Plot 7.4.2 Field strength of carrier at mid frequency

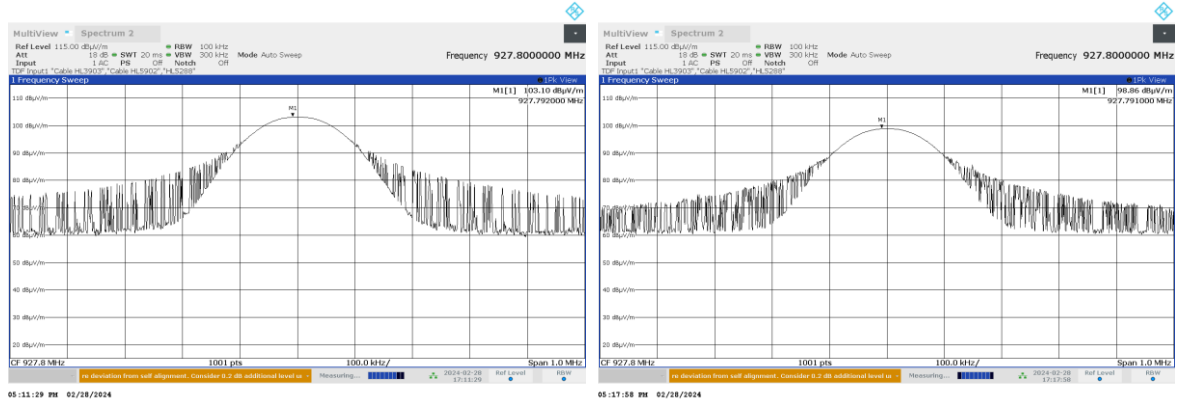




HERMON LABORATORIES

Test specification:		Section 15.247(b), RSS-247 section 5.4(1), Peak output power	
Test procedure:		ANSI C63.10, section 7.8.5	
Test mode:		Verdict: PASS	
Date(s):			
28-Feb-24 - 06-Mar-24			
Temperature: 23 °C	Relative Humidity: 58 %	Air Pressure: 1012 hPa	Power: 110 VAC, 50 Hz
Remarks:			

Plot 7.4.3 Field strength of carrier at high frequency





Test specification: Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions			
Test procedure: ANSI C63.10, sections 6.5, 6.6			
Test mode: Compliance		Verdict: PASS	
Date(s): 28-Feb-24 - 06-Mar-24			
Temperature: 23 °C	Relative Humidity: 58 %	Air Pressure: 1012 hPa	Power: 110 VAC, 50 Hz
Remarks:			

7.5 Field strength of spurious emissions

7.5.1 General

This test was performed to measure field strength of spurious emissions from the EUT. Specification test limits are given in Table 7.5.1.

Table 7.5.1 Radiated spurious emissions limits

Frequency, MHz	Field strength at 3 m within restricted bands, dB(μV/m)***			Attenuation of field strength of spurious versus carrier outside restricted bands, dBc***
	Peak	Quasi Peak	Average	
0.009 – 0.090	148.5 – 128.5	NA	128.5 – 108.5**	20.0
0.090 – 0.110	NA	108.5 – 106.8**	NA	
0.110 – 0.490	126.8 – 113.8	NA	106.8 – 93.8**	
0.490 – 1.705	NA	73.8 – 63.0**	NA	
1.705 – 30.0*		69.5		
30 – 88		40.0		
88 – 216		43.5		
216 – 960		46.0		
960 - 1000		54.0		
1000 – 10 th harmonic	74.0	NA	54.0	

*- The limit for 3 m test distance was calculated using the inverse square distance extrapolation factor as follows:

$$\text{Lim}_{S2} = \text{Lim}_{S1} + 40 \log (S_1/S_2),$$

where S_1 and S_2 – standard defined and test distance respectively in meters.

** - The limit decreases linearly with the logarithm of frequency.

*** - The field strength limits applied from the lowest radio frequency generated in the device, without going below 9 kHz up to the tenth harmonic of the highest fundamental frequency.

7.5.2 Test procedure for spurious emission field strength measurements in 9 kHz to 30 MHz band

7.5.2.1 The EUT was set up as shown in Figure 7.5.1, energized and the performance check was conducted.

7.5.2.2 The specified frequency range was investigated with antenna connected to spectrum analyzer/ EMI receiver. To find maximum radiation the turntable was rotated 360° and the measuring antenna was rotated around its vertical axis.

7.5.2.3 The worst test results (the lowest margins) were recorded and shown in the associated plots.

7.5.3 Test procedure for spurious emission field strength measurements above 30 MHz

7.5.3.1 The EUT was set up as shown in Figure 7.5.2, Figure 1.1.3, energized and the performance check was conducted.

7.5.3.2 The specified frequency range was investigated with antenna connected to spectrum analyzer/ EMI receiver. To find maximum radiation the turntable was rotated 360°, the measuring antenna height was changed from 1 to 4 m, its polarization was switched from vertical to horizontal.

7.5.3.3 The worst test results (the lowest margins) were recorded and shown in the associated plots.



Test specification: Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions			
Test procedure: ANSI C63.10, sections 6.5, 6.6			
Test mode: Compliance		Verdict: PASS	
Date(s): 28-Feb-24 - 06-Mar-24			
Temperature: 23 °C	Relative Humidity: 58 %	Air Pressure: 1012 hPa	Power: 110 VAC, 50 Hz
Remarks:			

Figure 7.5.1 Setup for spurious emission field strength measurements below 30 MHz

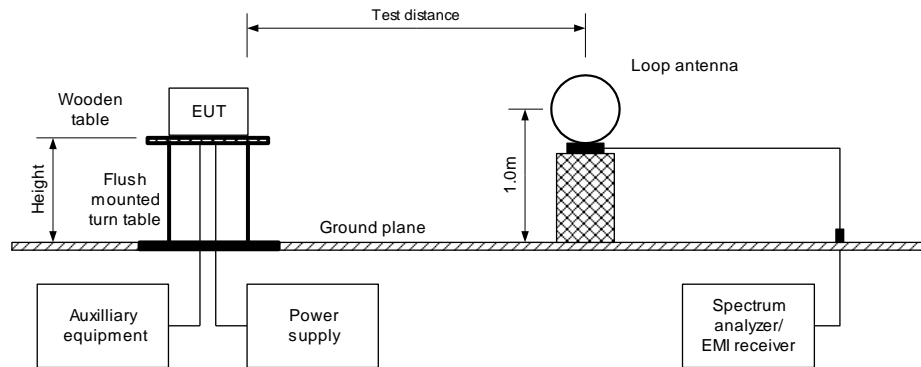
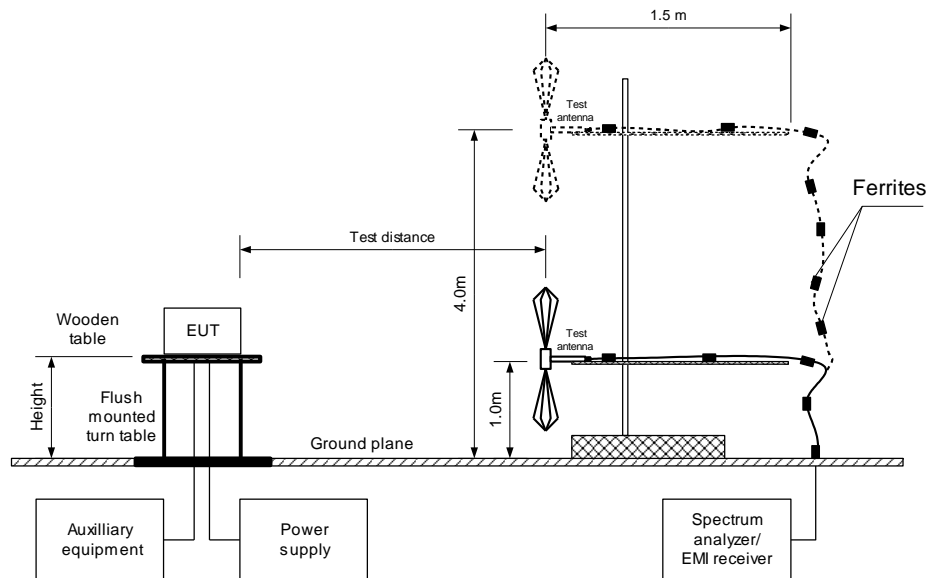


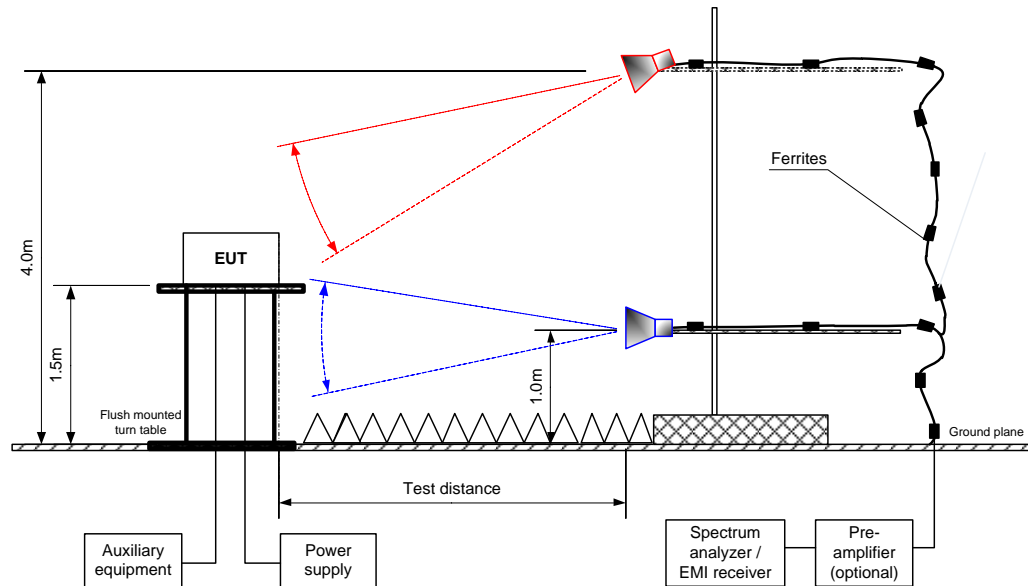
Figure 7.5.2 Setup for spurious emission field strength measurements from 30 to 1000 MHz





Test specification: Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions			
Test procedure: ANSI C63.10, sections 6.5, 6.6			
Test mode: Compliance		Verdict: PASS	
Date(s): 28-Feb-24 - 06-Mar-24			
Temperature: 23 °C	Relative Humidity: 58 %	Air Pressure: 1012 hPa	Power: 110 VAC, 50 Hz
Remarks:			

Figure 7.5.3 Setup for spurious emission field strength measurements above 1000 MHz





Test specification:		Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions	
Test procedure:		ANSI C63.10, sections 6.5, 6.6	
Test mode:		Verdict: PASS	
Date(s):			
28-Feb-24 - 06-Mar-24			
Temperature: 23 °C	Relative Humidity: 58 %	Air Pressure: 1012 hPa	Power: 110 VAC, 50 Hz
Remarks:			

Table 7.5.2 Field strength of emissions outside restricted bands

ASSIGNED FREQUENCY: 902-928 MHz
 INVESTIGATED FREQUENCY RANGE: 0.009 -10000 MHz
 TEST DISTANCE: 3 m
 MODULATION: 2GFSK
 BIT RATE: 5 kbps
 DETECTOR USED: Peak
 RESOLUTION BANDWIDTH: 100 kHz
 VIDEO BANDWIDTH: 300 kHz
 TEST ANTENNA TYPE: Active loop (9 kHz – 30 MHz)
 Biconilog (30 MHz – 1000 MHz)
 Double ridged guide (above 1000 MHz)
 FREQUENCY HOPPING: Disabled

Frequency, MHz	Field strength of spurious, dB(μV/m)	Antenna polarization	Antenna height, m	Azimuth, degrees*	Field strength of carrier, dB(μV/m)	Attenuation below carrier, dBc	Limit, dBc	Margin, dB**	Verdict
Low, mid, high carrier frequency									
At least 60 dB below carrier							20.0	>40	Pass

*- EUT front panel refers to 0 degrees position of turntable.

** - Margin = Attenuation below carrier – specification limit.



Test specification:		Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions	
Test procedure:		ANSI C63.10, sections 6.5, 6.6	
Test mode:		Verdict: PASS	
Date(s):			
28-Feb-24 - 06-Mar-24			
Temperature: 23 °C	Relative Humidity: 58 %	Air Pressure: 1012 hPa	Power: 110 VAC, 50 Hz
Remarks:			

Table 7.5.3 Field strength of spurious emissions above 1 GHz within restricted bands

ASSIGNED FREQUENCY: 902-928 MHz
 INVESTIGATED FREQUENCY RANGE: 1000 -10000 MHz
 TEST DISTANCE: 3 m
 MODULATION: 2GFSK
 BIT RATE: 5 kbps
 DETECTOR USED: Peak
 RESOLUTION BANDWIDTH: 1000 kHz
 TEST ANTENNA TYPE: Double ridged guide
 FREQUENCY HOPPING: Disabled

Frequency, MHz	Antenna		Azimuth, degrees*	Peak field strength			Average field strength				Verdict
	Polarization	Height, m		Measured, dB(μV/m)	Limit, dB(μV/m)	Margin, dB**	Measured, dB(μV/m)	Calculated, dB(μV/m)	Limit, dB(μV/m)	Margin, dB***	
Low, mid, high carrier frequency											
At least 20 dB below limit											Pass

*- EUT front panel refers to 0 degrees position of turntable.

** - Margin = Measured field strength - specification limit.

*** - Margin = Calculated field strength - specification limit,
 where Calculated field strength = Measured field strength + average factor.

Table 7.5.4 Average factor calculation

Transmission pulse		Transmission burst		Transmission train duration, ms	Average factor, dB
Duration, ms	Period, s	Duration, ms	Period, ms		
96	40.2	NA	NA	NA	-0.35

*- Average factor was calculated as follows

for pulse train shorter than 100 ms:

$$\text{Average factor} = 20 \times \log_{10} \left(\frac{\text{Pulse duration}}{\text{Pulse period}} \times \frac{\text{Burst duration}}{\text{Train duration}} \times \text{Number of bursts within pulse train} \right)$$

for pulse train longer than 100 ms:

$$\text{Average factor} = 20 \times \log_{10} \left(\frac{\text{Pulse duration}}{\text{Pulse period}} \times \frac{\text{Burst duration}}{100 \text{ ms}} \times \text{Number of bursts within 100 ms} \right)$$



Test specification:		Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions	
Test procedure:		ANSI C63.10, sections 6.5, 6.6	
Test mode:		Verdict: PASS	
Date(s):			
28-Feb-24 - 06-Mar-24			
Temperature: 23 °C	Relative Humidity: 58 %	Air Pressure: 1012 hPa	Power: 110 VAC, 50 Hz
Remarks:			

Table 7.5.5 Field strength of spurious emissions below 1 GHz within restricted bands

ASSIGNED FREQUENCY: 902-928 MHz
 INVESTIGATED FREQUENCY RANGE: 0.009 – 1000 MHz
 TEST DISTANCE: 3 m
 MODULATION: 2GFSK
 BIT RATE: 5 kbps
 TEST ANTENNA TYPE: Active loop (9 kHz – 30 MHz)
 Biconilog (30 MHz – 1000 MHz)
 FREQUENCY HOPPING: Disabled

Frequency, MHz	Peak emission, dB(μV/m)	Quasi-peak			Antenna polarization	Antenna height, m	Turn-table position**, degrees	Verdict
		Measured emission, dB(μV/m)	Limit, dB(μV/m)	Margin, dB*				
Low, mid, high carrier frequency								
At least 20 dB below limit								Pass

*- Margin = Measured emission - specification limit.

** - EUT front panel refer to 0 degrees position of turntable.



HERMON LABORATORIES

Test specification: Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions			
Test procedure: ANSI C63.10, sections 6.5, 6.6			
Test mode: Compliance		Verdict: PASS	
Date(s): 28-Feb-24 - 06-Mar-24			
Temperature: 23 °C	Relative Humidity: 58 %	Air Pressure: 1012 hPa	Power: 110 VAC, 50 Hz
Remarks:			

Table 7.5.6 Restricted bands according to FCC section 15.205

MHz	MHz	MHz	MHz	MHz	GHz
0.09 - 0.11	8.37625 - 8.38675	73 - 74.6	399.9 - 410	2690 - 2900	10.6 - 12.7
0.495 - 0.505	8.41425 - 8.41475	74.8 - 75.2	608 - 614	3260 - 3267	13.25 - 13.4
2.1735 - 2.1905	12.29 - 12.293	108 - 121.94	960 - 1240	3332 - 3339	14.47 - 14.5
4.125 - 4.128	12.51975 - 12.52025	123 - 138	1300 - 1427	3345.8 - 3358	15.35 - 16.2
4.17725 - 4.17775	12.57675 - 12.57725	149.9 - 150.05	1435 - 1626.5	3600 - 4400	17.7 - 21.4
4.20725 - 4.20775	13.36 - 13.41	156.52475 - 156.52525	1645.5 - 1646.5	4500 - 5150	22.01 - 23.12
6.215 - 6.218	16.42 - 16.423	156.7 - 156.9	1660 - 1710	5350 - 5460	23.6 - 24
6.2675 - 6.26825	16.69475 - 16.69525	162.0125 - 167.17	1718.8 - 1722.2	7250 - 7750	31.2 - 31.8
6.31175 - 6.31225	16.80425 - 16.80475	167.72 - 173.2	2200 - 2300	8025 - 8500	36.43 - 36.5
8.291 - 8.294	25.5 - 25.67	240 - 285	2310 - 2390	9000 - 9200	Above 38.6
8.362 - 8.366	37.5 - 38.25	322 - 335.4	2483.5 - 2500	9300 - 9500	

Table 7.5.7 Restricted bands according to RSS-Gen

MHz	MHz	MHz	MHz	MHz	GHz
0.09 - 0.11	8.291 - 8.294	16.80425 - 16.80475	399.9 - 410	3260 - 3267	10.6 - 12.7
2.1735 - 2.1905	8.362 - 8.366	25.5 - 25.67	608 - 614	3332 - 3339	13.25 - 13.4
3.020 - 3.026	8.37625 - 8.38675	37.5 - 38.25	960 - 1427	3345.8 - 3358	14.47 - 14.5
4.125 - 4.128	8.41425 - 8.41475	73 - 74.6	1435 - 1626.5	3500 - 4400	15.35 - 16.2
4.17725 - 4.17775	12.29 - 12.293	74.8 - 75.2	1645.5 - 1646.5	4500 - 5150	17.7 - 21.4
4.20725 - 4.20775	12.51975 - 12.52025	108 - 138	1660 - 1710	5350 - 5460	22.01 - 23.12
5.677 - 5.683	12.57675 - 12.57725	156.52475 - 156.52525	1718.8 - 1722.2	7250 - 7750	23.6 - 24
6.215 - 6.218	13.36 - 13.41	156.7 - 156.9	2200 - 2300	8025 - 8500	31.2 - 31.8
6.2675 - 6.26825	16.42 - 16.423	240 - 285	2310 - 2390	9000 - 9200	36.43 - 36.5
6.31175 - 6.31225	16.69475 - 16.69525	322 - 335.4	2655 - 2900	9300 - 9500	Above 38.6

Reference numbers of test equipment used

HL 7585	HL5288	HL3903	HL5902	HL 4933	HL 446	HL 4339	HL
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Full description is given in Appendix A.

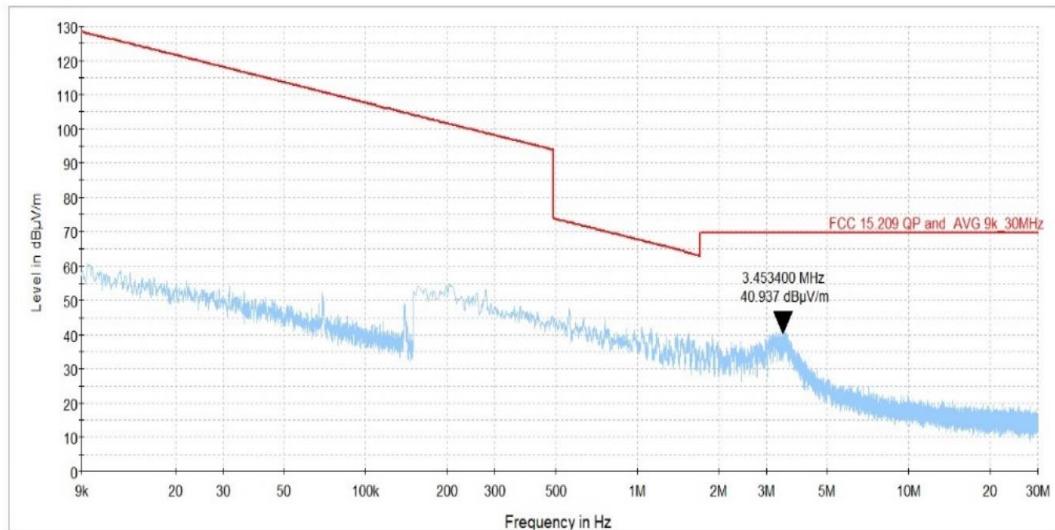


HERMON LABORATORIES

Test specification: Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions			
Test procedure: ANSI C63.10, sections 6.5, 6.6			
Test mode: Compliance		Verdict: PASS	
Date(s): 28-Feb-24 - 06-Mar-24			
Temperature: 23 °C	Relative Humidity: 58 %	Air Pressure: 1012 hPa	Power: 110 VAC, 50 Hz
Remarks:			

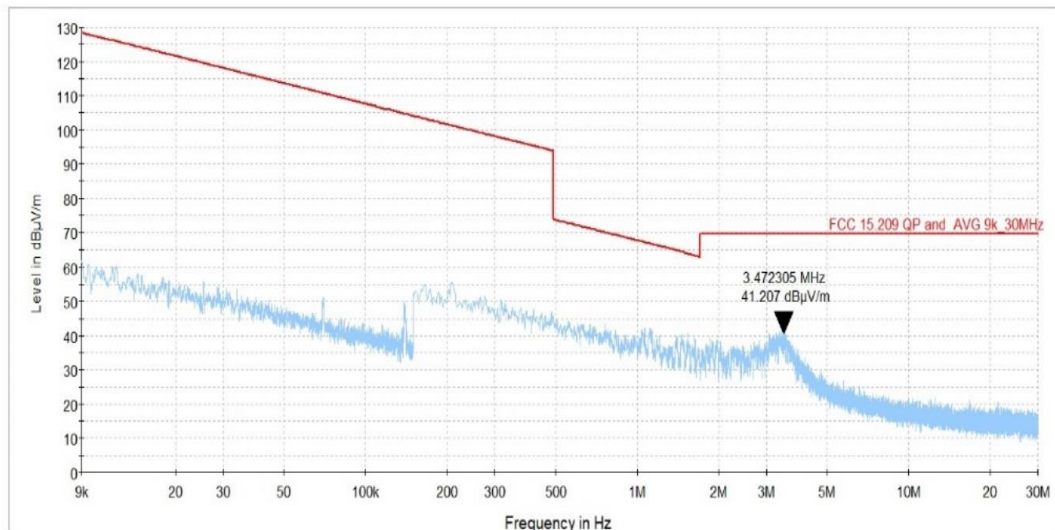
Plot 7.5.1 Radiated emission measurements from 9 to 30 MHz at the low carrier frequency

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical



Plot 7.5.2 Radiated emission measurements from 9 to 30 MHz at the mid carrier frequency

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical



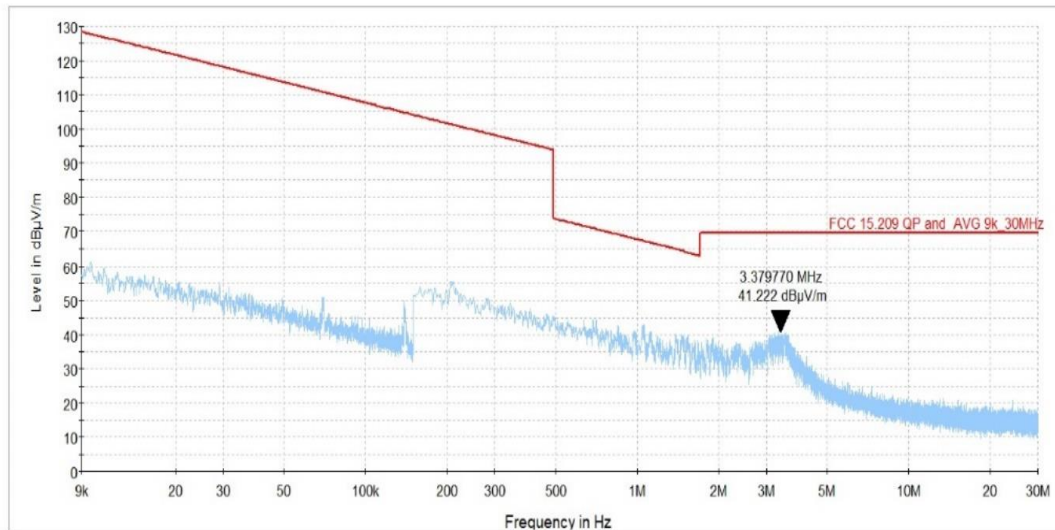


HERMON LABORATORIES

Test specification:		Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions	
Test procedure:		ANSI C63.10, sections 6.5, 6.6	
Test mode:		Verdict: PASS	
Date(s):			
28-Feb-24 - 06-Mar-24			
Temperature: 23 °C	Relative Humidity: 58 %	Air Pressure: 1012 hPa	Power: 110 VAC, 50 Hz
Remarks:			

Plot 7.5.3 Radiated emission measurements from 9 to 30 MHz at the high carrier frequency

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical



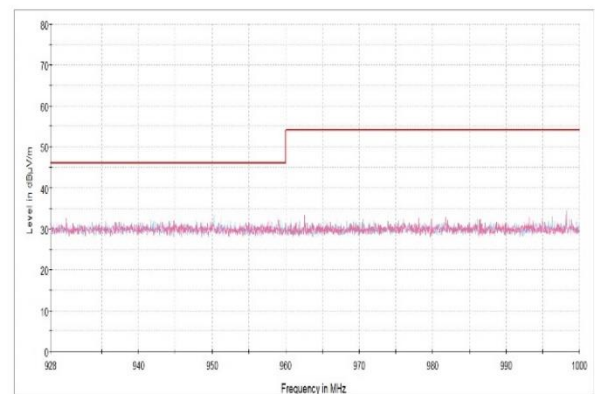
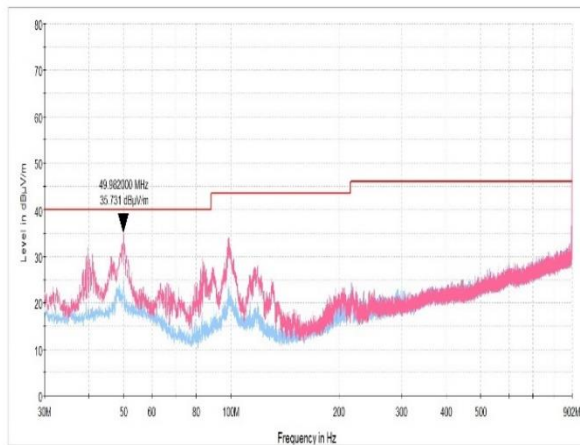


HERMON LABORATORIES

Test specification: Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions			
Test procedure: ANSI C63.10, sections 6.5, 6.6			
Test mode: Compliance		Verdict: PASS	
Date(s): 28-Feb-24 - 06-Mar-24			
Temperature: 23 °C	Relative Humidity: 58 %	Air Pressure: 1012 hPa	Power: 110 VAC, 50 Hz
Remarks:			

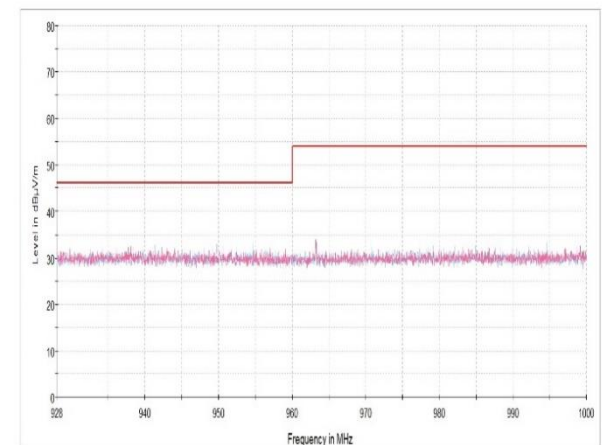
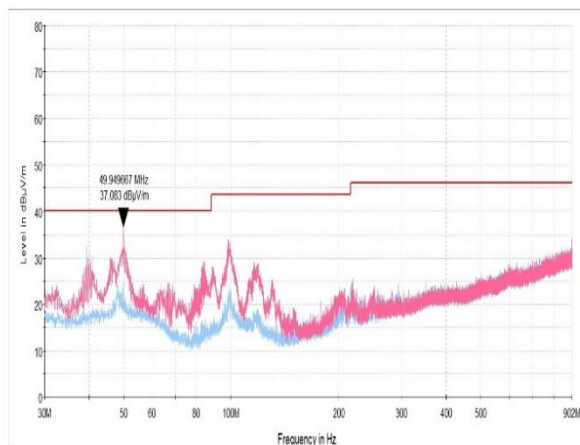
Plot 7.5.4 Radiated emission measurements from 30 to 1000 MHz at the low carrier frequency

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal



Plot 7.5.5 Radiated emission measurements from 30 to 1000 MHz at the mid carrier frequency

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal



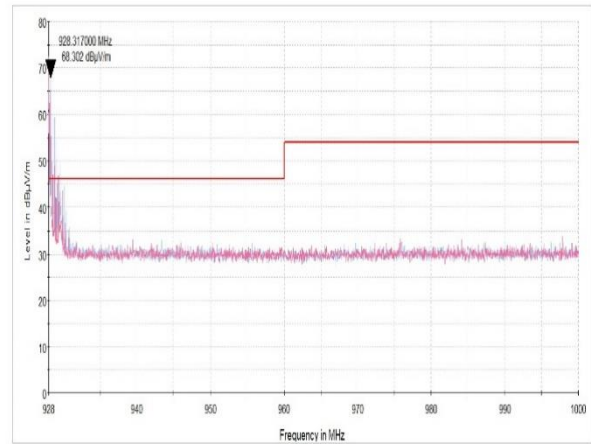
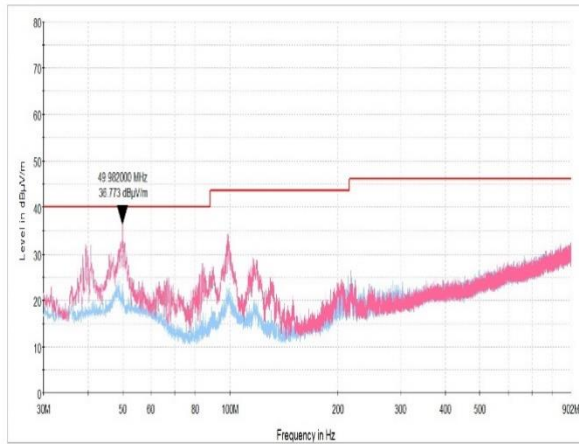


HERMON LABORATORIES

Test specification:		Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions	
Test procedure:		ANSI C63.10, sections 6.5, 6.6	
Test mode:		Verdict: PASS	
Date(s):			
28-Feb-24 - 06-Mar-24			
Temperature: 23 °C	Relative Humidity: 58 %	Air Pressure: 1012 hPa	Power: 110 VAC, 50 Hz
Remarks:			

Plot 7.5.6 Radiated emission measurements from 30 to 1000 MHz at the high carrier frequency

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal



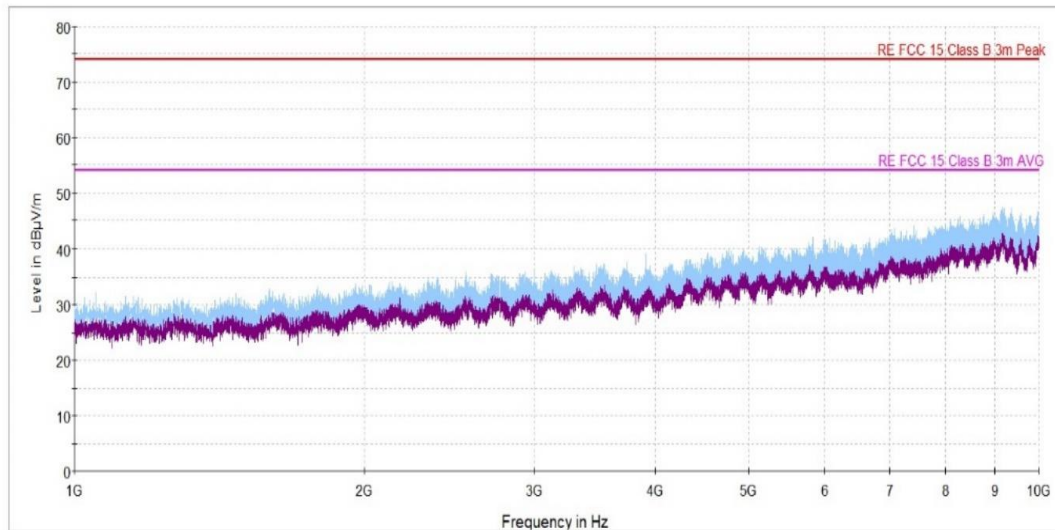


HERMON LABORATORIES

Test specification: Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions			
Test procedure: ANSI C63.10, sections 6.5, 6.6			
Test mode: Compliance		Verdict: PASS	
Date(s): 28-Feb-24 - 06-Mar-24			
Temperature: 23 °C	Relative Humidity: 58 %	Air Pressure: 1012 hPa	Power: 110 VAC, 50 Hz
Remarks:			

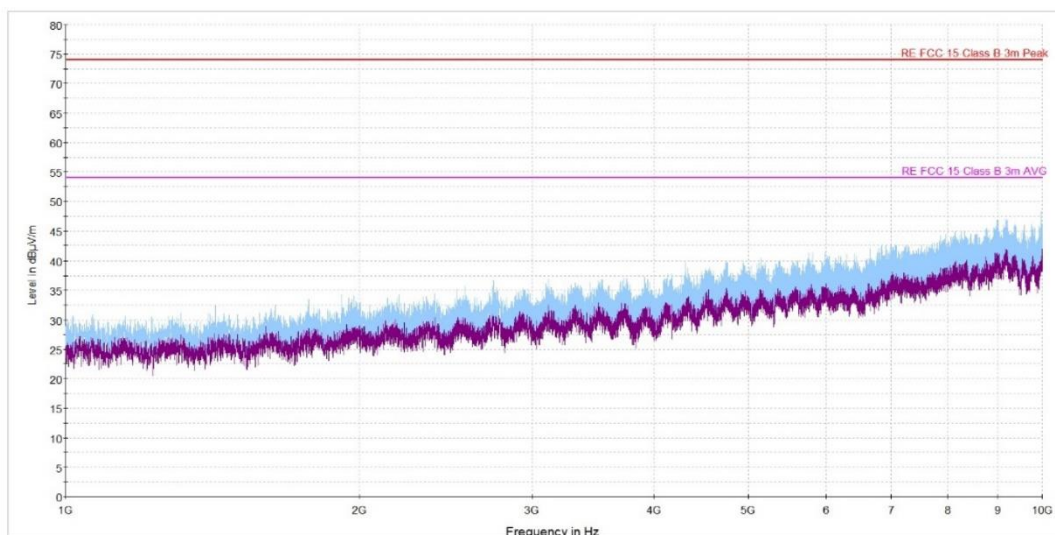
Plot 7.5.7 Radiated emission measurements from 1000 to 10000 MHz at the low carrier frequency

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal



Plot 7.5.8 Radiated emission measurements from 1000 to 10000 MHz at the mid carrier frequency

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal



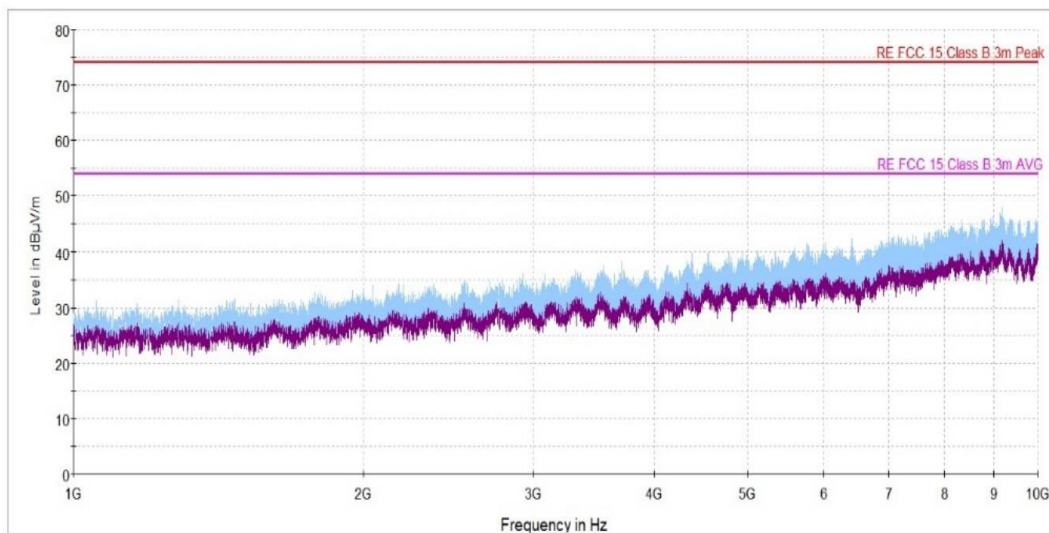


HERMON LABORATORIES

Test specification: Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions			
Test procedure: ANSI C63.10, sections 6.5, 6.6			
Test mode: Compliance		Verdict: PASS	
Date(s): 28-Feb-24 - 06-Mar-24			
Temperature: 23 °C	Relative Humidity: 58 %	Air Pressure: 1012 hPa	Power: 110 VAC, 50 Hz
Remarks:			

Plot 7.5.9 Radiated emission measurements from 1000 to 10000 MHz at the high carrier frequency

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal





Test specification: Section 27.53, Radiated spurious emissions			
Test procedure: 47 CFR, Section 2.1053			
Test mode: Compliance		Verdict: PASS	
Date(s): 06-Mar-24 - 07-Mar-24			
Temperature: 23 °C	Relative Humidity: 58 %	Air Pressure: 1012 hPa	Power: 110 VAC, 50 Hz
Remarks: Co-location 915.2 + GSM 1850MHz			

7.6 Field strength of spurious emissions at 915 MHz and GSM 1850 MHz module simultaneous transmitting mode

7.6.1 General

This test was performed to measure field strength of spurious emissions from the EUT. Specification test limits are given in Table 7.5.1.

Table 7.6.1 Radiated spurious emissions limits

Frequency, MHz	Attenuation below carrier, dBc	ERP of spurious, dBm	Equivalent field strength limit @ 3m, dB(μV/m)***
0.009 – 10 th harmonic*	43+10logP**	-13	84.4

- Excluding the band emission

** - P is transmitter output power in Watts

*** - Equivalent field strength limit was calculated from maximum allowed ERP of spurious as follows:

$$E = \sqrt{30 \times P \times 1.64} / r,$$

where P is ERP in Watts, 1.64 is numeric gain of ideal dipole and r is antenna to EUT distance in meters

7.6.2 Test procedure for spurious emission field strength measurements in 9 kHz to 30 MHz band

7.6.2.1 The EUT was set up as shown in Figure 7.5.1, energized and the performance check was conducted.

7.6.2.2 The specified frequency range was investigated with antenna connected to spectrum analyzer/ EMI receiver. To find maximum radiation the turntable was rotated 360° and the measuring antenna was rotated around its vertical axis.

7.6.2.3 The worst test results (the lowest margins) were recorded and shown in the associated plots.

7.6.3 Test procedure for spurious emission field strength measurements above 30 MHz

7.6.3.1 The EUT was set up as shown in Figure 7.5.2, Figure 1.1.3, energized and the performance check was conducted.

7.6.3.2 The specified frequency range was investigated with antenna connected to spectrum analyzer/ EMI receiver. To find maximum radiation the turntable was rotated 360°, the measuring antenna height was changed from 1 to 4 m, its polarization was switched from vertical to horizontal.

7.6.3.3 The worst test results (the lowest margins) were recorded and shown in the associated plots.



HERMON LABORATORIES

Test specification: Section 27.53, Radiated spurious emissions			
Test procedure: 47 CFR, Section 2.1053			
Test mode: Compliance		Verdict: PASS	
Date(s): 06-Mar-24 - 07-Mar-24			
Temperature: 23 °C	Relative Humidity: 58 %	Air Pressure: 1012 hPa	Power: 110 VAC, 50 Hz
Remarks: Co-location 915.2 + GSM 1850MHz			

Figure 7.6.1 Setup for spurious emission field strength measurements below 30 MHz

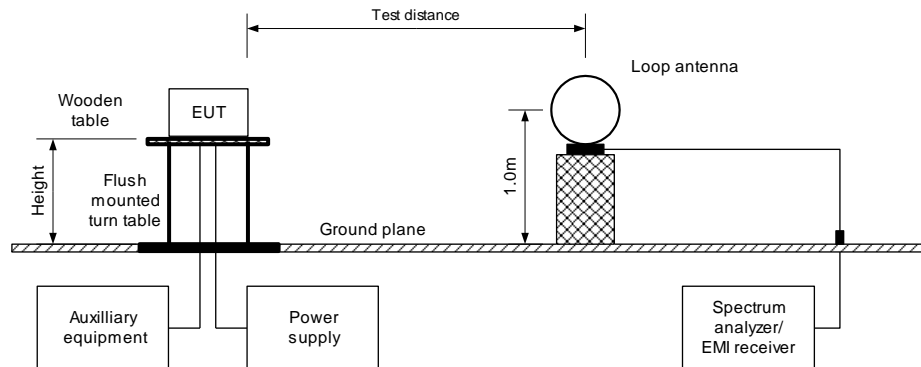
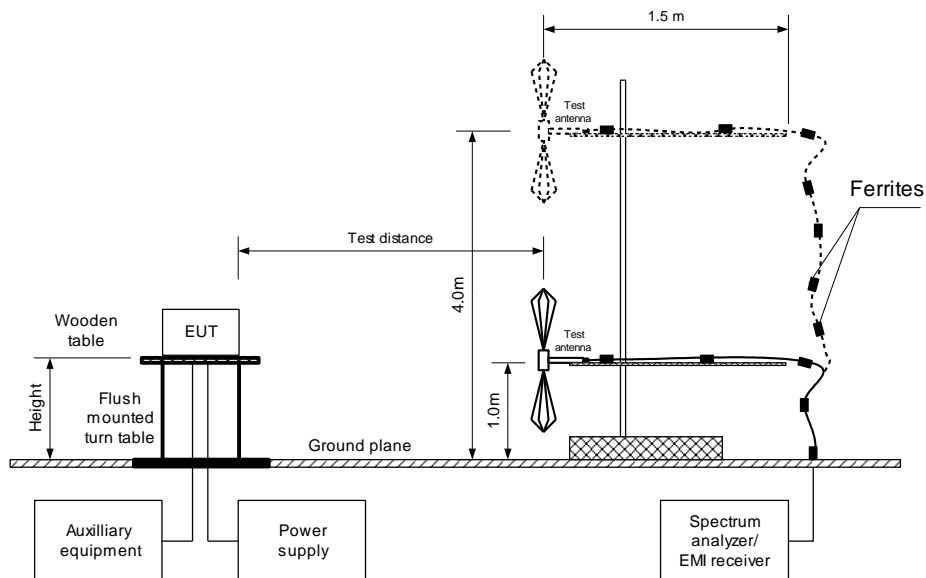


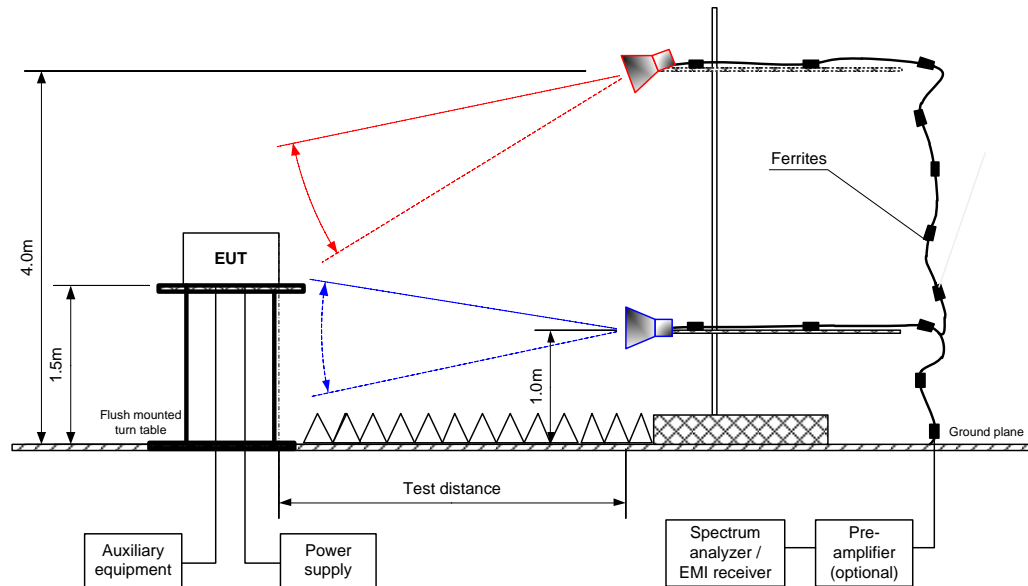
Figure 7.6.2 Setup for spurious emission field strength measurements from 30 to 1000 MHz





Test specification: Section 27.53, Radiated spurious emissions			
Test procedure: 47 CFR, Section 2.1053			
Test mode: Compliance		Verdict: PASS	
Date(s): 06-Mar-24 - 07-Mar-24			
Temperature: 23 °C	Relative Humidity: 58 %	Air Pressure: 1012 hPa	Power: 110 VAC, 50 Hz
Remarks: Co-location 915.2 + GSM 1850NHZ			

Figure 7.6.3 Setup for spurious emission field strength measurements above 1000 MHz





Test specification: Section 27.53, Radiated spurious emissions			
Test procedure: 47 CFR, Section 2.1053			
Test mode: Compliance		Verdict: PASS	
Date(s): 06-Mar-24 - 07-Mar-24			
Temperature: 23 °C	Relative Humidity: 58 %	Air Pressure: 1012 hPa	Power: 110 VAC, 50 Hz
Remarks: Co-location 915.2 + GSM 1850MHz			

Table 7.6.2 Field strength of spurious emissions below 1 GHz

INVESTIGATED FREQUENCY RANGE: 0.009 – 1000 MHz
 TEST DISTANCE: 3 m
 MODULATION: 2GFSK
 RESOLUTION BANDWIDTH: 0.2 kHz (9 kHz – 150 kHz)
 9.0 kHz (150 kHz – 30 MHz)
 120 kHz (30 MHz – 1000 MHz)
 VIDEO BANDWIDTH: > Resolution bandwidth
 TEST ANTENNA TYPE: Active loop (9 kHz – 30 MHz)
 Biconilog (30 MHz – 1000 MHz)
 FREQUENCY HOPPING: Disabled

Frequency, MHz		Peak emission, dB(μV/m)			Antenna polarization	Antenna height, m	Turn-table position**, degrees	Verdict
Measured emission, dB(μV/m)		Limit, dB(μV/m)						
At least 20 dB below limit								Pass

*- Margin = Measured emission - specification limit.

** - EUT front panel refer to 0 degrees position of turntable.

Table 7.6.3 Field strength of spurious emissions above 1 GHz

TEST DISTANCE: 3 m
 MODULATION: GFSK
 DETECTOR USED: Peak
 RESOLUTION BANDWIDTH: 1000 kHz
 TEST ANTENNA TYPE: Double ridged guide
 FREQUENCY HOPPING: Disabled

Frequency, MHz	Antenna		Azimuth, degrees*	Peak field strength)			Verdict
	Polarization	Height, m		Measured, dB(μV/m)	Limit, dB(μV/m)	Margin, dB**	
36970.0	Vertical	1.5	-100	63.5	82.2	-18.7	Pass
55550.0	Vertical	1.5	-100	67.8	82.2	-14.4	Pass

*- EUT front panel refers to 0 degrees position of turntable.

** - Margin = Measured field strength - specification limit.

*** - Margin = Calculated field strength - specification limit,

where Calculated field strength = Measured field strength + average factor.

Reference numbers of test equipment used

HL 5288	HL 446	HL 4339	HL 3903	HL 5902	HL 7585	HL 5112	HL 4933
HL 4909	HL 4956						

Full description is given in Appendix A.

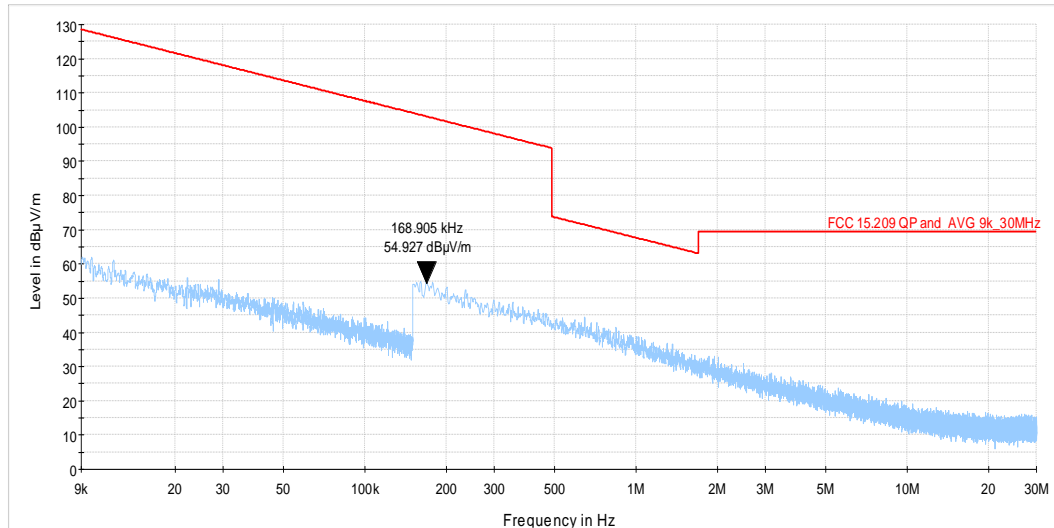


HERMON LABORATORIES

Test specification: Section 27.53, Radiated spurious emissions			
Test procedure: 47 CFR, Section 2.1053			
Test mode: Compliance		Verdict: PASS	
Date(s): 06-Mar-24 - 07-Mar-24			
Temperature: 23 °C	Relative Humidity: 58 %	Air Pressure: 1012 hPa	Power: 110 VAC, 50 Hz
Remarks: Co-location 915.2 + GSM 1850MHz			

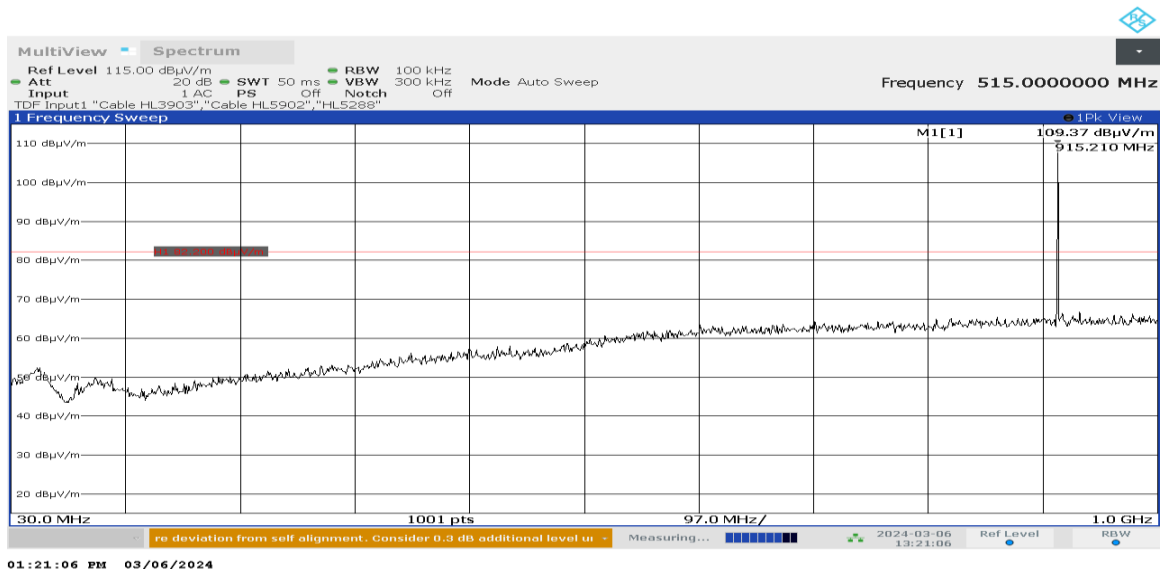
Plot 7.6.1 Radiated emission measurements from 9 kHz to 30 MHz

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical



Plot 7.6.2 Radiated emission measurements from 30 to 1000 MHz

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal



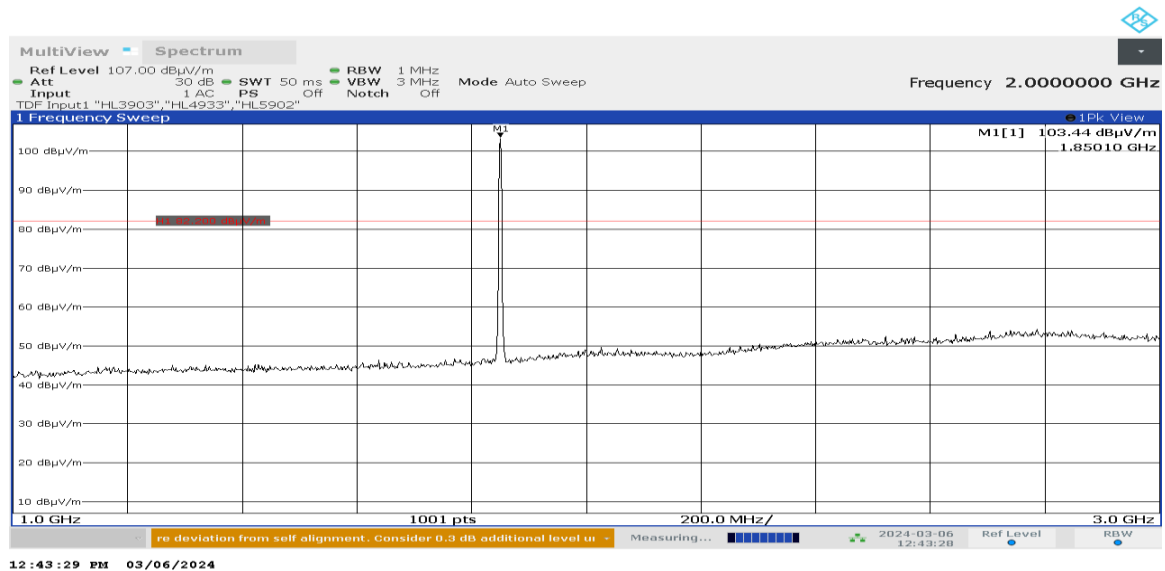


HERMON LABORATORIES

Test specification: Section 27.53, Radiated spurious emissions			
Test procedure: 47 CFR, Section 2.1053			
Test mode: Compliance		Verdict: PASS	
Date(s): 06-Mar-24 - 07-Mar-24			
Temperature: 23 °C	Relative Humidity: 58 %	Air Pressure: 1012 hPa	Power: 110 VAC, 50 Hz
Remarks: Co-location 915.2 + GSM 1850MHz			

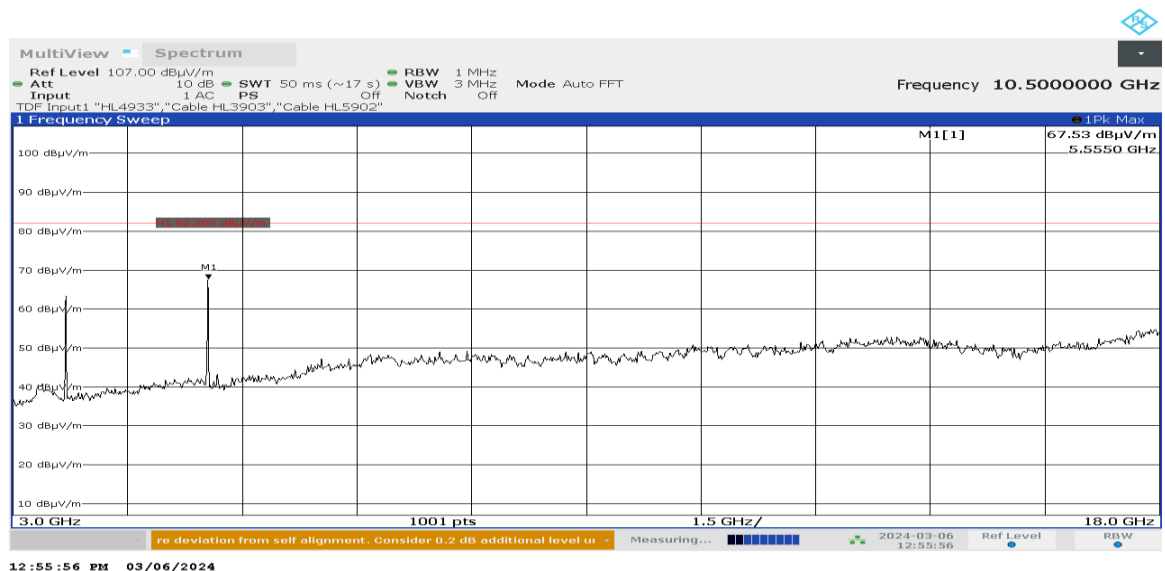
Plot 7.6.3 Radiated emission measurements from 1000 to 3000 MHz

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal



Plot 7.6.4 Radiated emission measurements from 3000 to 18000 MHz

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal



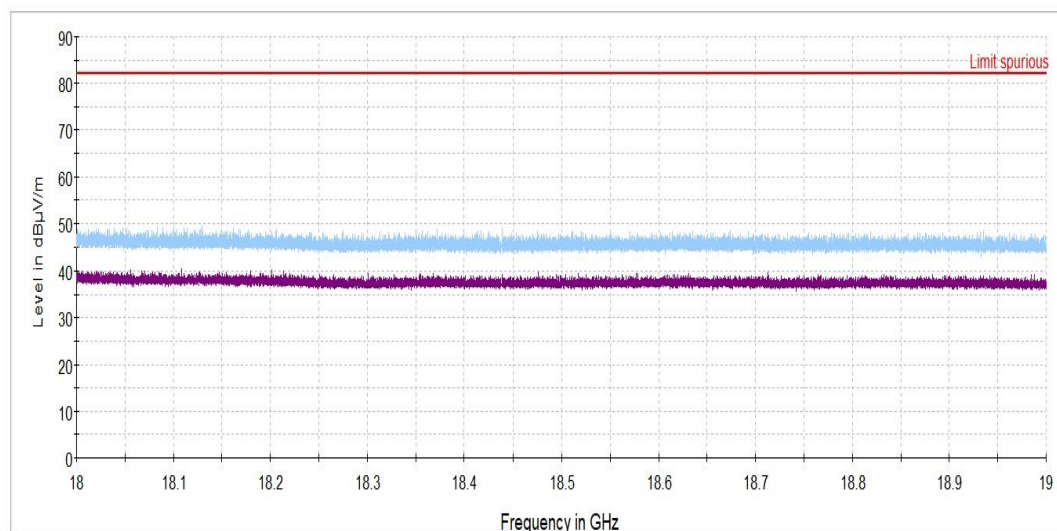


HERMON LABORATORIES

Test specification:		Section 27.53, Radiated spurious emissions	
Test procedure:		47 CFR, Section 2.1053	
Test mode:		Verdict: PASS	
Date(s):			
06-Mar-24 - 07-Mar-24			
Temperature: 23 °C	Relative Humidity: 58 %	Air Pressure: 1012 hPa	Power: 110 VAC, 50 Hz
Remarks: Co-location 915.2 + GSM 1850MHz			

Plot 7.6.5 Radiated emission measurements from 18000 to 19000 MHz

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal





Test specification: Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions			
Test procedure: ANSI C63.10, sections 6.5, 6.6			
Test mode: Compliance		Verdict: PASS	
Date(s): 06-Mar-24 - 07-Mar-24			
Temperature: 23 °C	Relative Humidity: 58 %	Air Pressure: 1012 hPa	Power: 110 VAC, 50 Hz
Remarks: Co-location 915.2+ WiFi			

7.7 Field strength of spurious emissions at 915 MHz and Wi-Fi module simultaneous transmitting mode

7.7.1 General

This test was performed to measure field strength of spurious emissions from the EUT. Specification test limits are given in Table 7.5.1.

Table 7.7.1 Radiated spurious emissions limits

Frequency, MHz	Field strength at 3 m within restricted bands, dB(μV/m)***			Attenuation of field strength of spurious versus carrier outside restricted bands, dBc***
	Peak	Quasi Peak	Average	
0.009 – 0.090	148.5 – 128.5	NA	128.5 – 108.5**	20.0
0.090 – 0.110	NA	108.5 – 106.8**	NA	
0.110 – 0.490	126.8 – 113.8	NA	106.8 – 93.8**	
0.490 – 1.705	NA	73.8 – 63.0**	NA	
1.705 – 30.0*		69.5		
30 – 88		40.0		
88 – 216		43.5		
216 – 960		46.0		
960 - 1000		54.0		
1000 – 10 th harmonic	74.0	NA	54.0	

*- The limit for 3 m test distance was calculated using the inverse square distance extrapolation factor as follows:

$$\text{Lim}_{S2} = \text{Lim}_{S1} + 40 \log (S_1/S_2),$$

where S_1 and S_2 – standard defined and test distance respectively in meters.

** - The limit decreases linearly with the logarithm of frequency.

*** - The field strength limits applied from the lowest radio frequency generated in the device, without going below 9 kHz up to the tenth harmonic of the highest fundamental frequency.

7.7.2 Test procedure for spurious emission field strength measurements in 9 kHz to 30 MHz band

7.7.2.1 The EUT was set up as shown in Figure 7.5.1, energized and the performance check was conducted.

7.7.2.2 The specified frequency range was investigated with antenna connected to spectrum analyzer/ EMI receiver. To find maximum radiation the turntable was rotated 360° and the measuring antenna was rotated around its vertical axis.

7.7.2.3 The worst test results (the lowest margins) were recorded and shown in the associated plots.

7.7.3 Test procedure for spurious emission field strength measurements above 30 MHz

7.7.3.1 The EUT was set up as shown in Figure 7.5.2, Figure 1.1.3, energized and the performance check was conducted.

7.7.3.2 The specified frequency range was investigated with antenna connected to spectrum analyzer/ EMI receiver. To find maximum radiation the turntable was rotated 360°, the measuring antenna height was changed from 1 to 4 m, its polarization was switched from vertical to horizontal.

7.7.3.3 The worst test results (the lowest margins) were recorded and shown in the associated plots.



Test specification: Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions			
Test procedure: ANSI C63.10, sections 6.5, 6.6			
Test mode: Compliance		Verdict: PASS	
Date(s): 06-Mar-24 - 07-Mar-24			
Temperature: 23 °C	Relative Humidity: 58 %	Air Pressure: 1012 hPa	Power: 110 VAC, 50 Hz
Remarks: Co-location 915.2+ WiFi			

Figure 7.7.1 Setup for spurious emission field strength measurements below 30 MHz

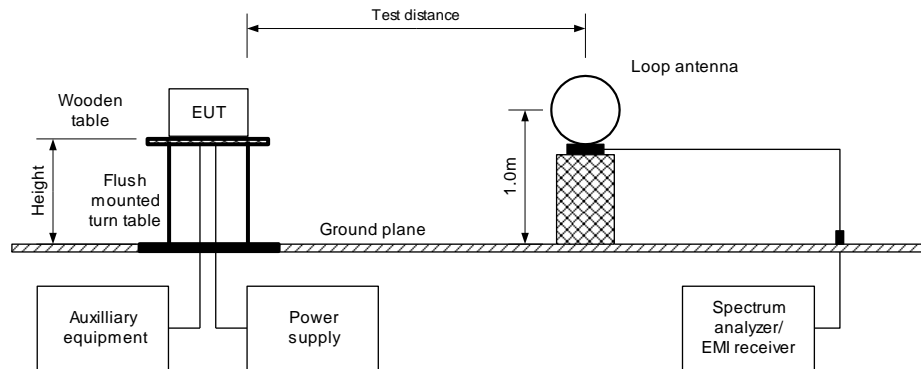
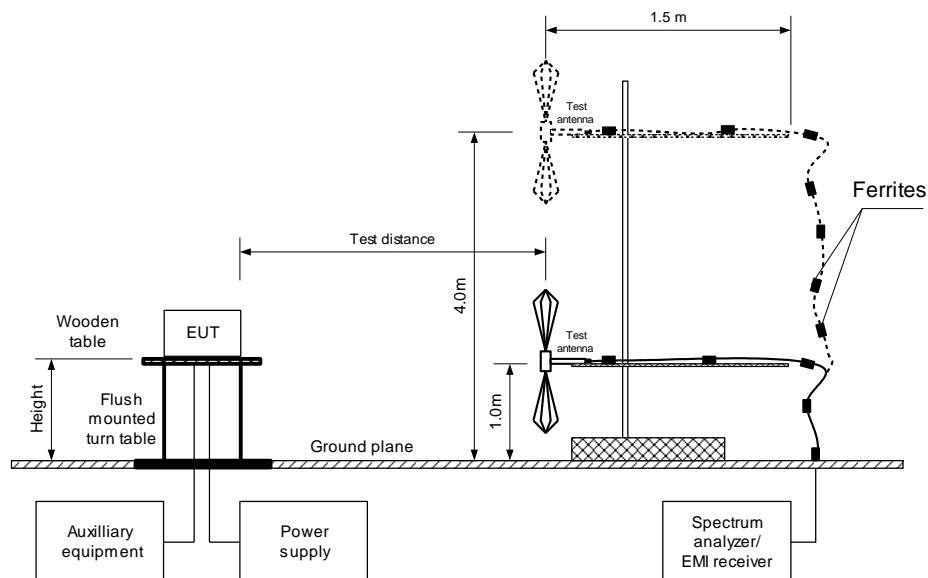


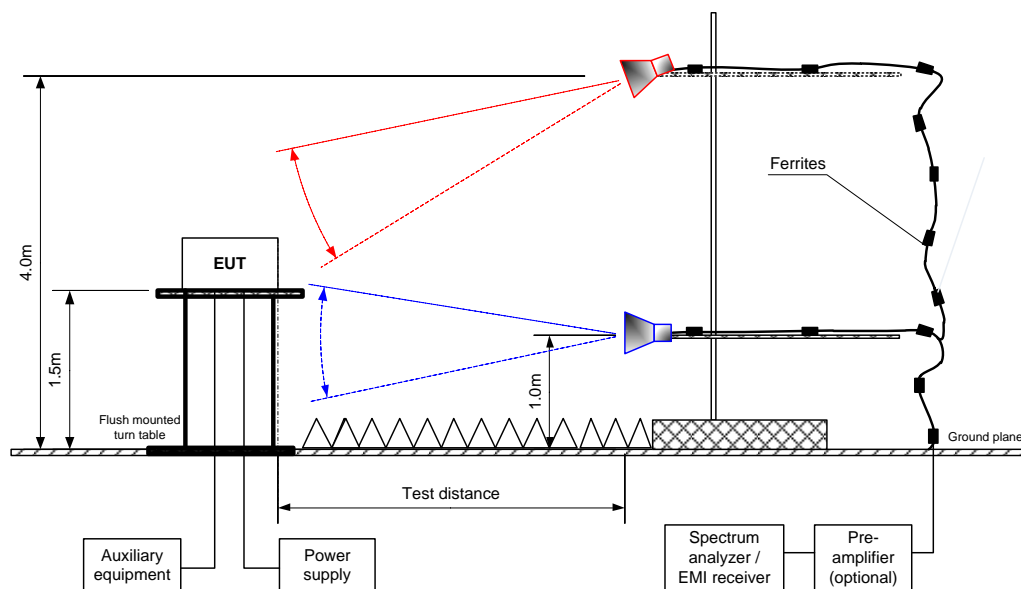
Figure 7.7.2 Setup for spurious emission field strength measurements from 30 to 1000 MHz





Test specification: Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions			
Test procedure: ANSI C63.10, sections 6.5, 6.6			
Test mode: Compliance		Verdict: PASS	
Date(s): 06-Mar-24 - 07-Mar-24			
Temperature: 23 °C	Relative Humidity: 58 %	Air Pressure: 1012 hPa	Power: 110 VAC, 50 Hz
Remarks: Co-location 915.2+ WiFi			

Figure 7.7.3 Setup for spurious emission field strength measurements above 1000 MHz





Test specification: Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions			
Test procedure: ANSI C63.10, sections 6.5, 6.6			
Test mode: Compliance		Verdict: PASS	
Date(s): 06-Mar-24 - 07-Mar-24			
Temperature: 23 °C	Relative Humidity: 58 %	Air Pressure: 1012 hPa	Power: 110 VAC, 50 Hz
Remarks: Co-location 915.2+ WiFi			

Table 7.7.2 Field strength of emissions outside restricted bands

INVESTIGATED FREQUENCY RANGE: 0.009 - 25000 MHz
 TEST DISTANCE: 3 m
 MODULATION: 2GFSK
 BIT RATE: 5 kbps
 DETECTOR USED: Peak
 RESOLUTION BANDWIDTH: 100 kHz
 VIDEO BANDWIDTH: 300 kHz
 TEST ANTENNA TYPE: Active loop (9 kHz – 30 MHz)
 Biconical (30 MHz – 200 MHz)
 Log periodic (200 MHz – 1000 MHz)
 Biconilog (30 MHz – 1000 MHz)
 Double ridged guide (above 1000 MHz)
 FREQUENCY HOPPING: Disabled

Frequency, MHz	Field strength of spurious, dB(μV/m)	Antenna polarization	Antenna height, m	Azimuth, degrees*	Field strength of carrier, dB(μV/m)	Attenuation below carrier, dBc	Limit, dBc	Margin, dB**	Verdict
At least 60 dB bellow carrier							20	>40	Pass

*- EUT front panel refers to 0 degrees position of turntable.

**- Margin = Attenuation below carrier – specification limit.

Table 7.7.3 Field strength of spurious emissions above 1 GHz within restricted bands

INVESTIGATED FREQUENCY RANGE: 1– 25GHz
 TEST DISTANCE: 3 m
 MODULATION: 2GFSK
 BIT RATE: 5 kbps
 DETECTOR USED: Peak
 RESOLUTION BANDWIDTH: 1000 kHz
 TEST ANTENNA TYPE: Double ridged guide
 FREQUENCY HOPPING: Disabled

Frequency, MHz	Antenna		Azimuth, degrees*	Peak field strength			Average field strength				Verdict
	Polarization	Height, m		Measured, dB(μV/m)	Limit, dB(μV/m)	Margin, dB**	Measured, dB(μV/m)	Calculated, dB(μV/m)	Limit, dB(μV/m)	Margin, dB***	
2745.6	Vertical	1.5	93	41.2	74	-32.8	41.2	40.85	54	-13.15	Pass

*- EUT front panel refers to 0 degrees position of turntable.

**- Margin = Measured field strength - specification limit.

***- Margin = Calculated field strength - specification limit,
 where Calculated field strength = Measured field strength + average factor.

Table 7.7.4 Average factor calculation

Transmission pulse		Transmission burst		Transmission train duration, ms	Average factor, dB
Duration, ms	Period, s	Duration, ms	Period, ms		
96	40.2	NA	NA	NA	-0.35

*- Average factor was calculated as follows



Test specification:		Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions	
Test procedure:		ANSI C63.10, sections 6.5, 6.6	
Test mode:		Verdict: PASS	
Date(s):			
06-Mar-24 - 07-Mar-24			
Temperature: 23 °C	Relative Humidity: 58 %	Air Pressure: 1012 hPa	Power: 110 VAC, 50 Hz
Remarks: Co-location 915.2+ WiFi			

Table 7.7.5 Field strength of spurious emissions below 1 GHz within restricted bands

INVESTIGATED FREQUENCY RANGE: 0.009 – 1000 MHz
 TEST DISTANCE: 3 m
 MODULATION: 2GFSK
 RESOLUTION BANDWIDTH: 0.2 kHz (9 kHz – 150 kHz)
 9.0 kHz (150 kHz – 30 MHz)
 120 kHz (30 MHz – 1000 MHz)
 VIDEO BANDWIDTH: > Resolution bandwidth
 TEST ANTENNA TYPE: Active loop (9 kHz – 30 MHz)
 Biconilog (30 MHz – 1000 MHz)
 FREQUENCY HOPPING: Disabled

Frequency, MHz	Peak emission, dB(μV/m)	Quasi-peak			Antenna polarization	Antenna height, m	Turn-table position**, degrees	Verdict
		Measured emission, dB(μV/m)	Limit, dB(μV/m)	Margin, dB*				
At least 20 dB below limit								Pass

*- Margin = Measured emission - specification limit.

** - EUT front panel refer to 0 degrees position of turntable.



HERMON LABORATORIES

Test specification: Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions			
Test procedure: ANSI C63.10, sections 6.5, 6.6			
Test mode: Compliance		Verdict: PASS	
Date(s): 06-Mar-24 - 07-Mar-24			
Temperature: 23 °C	Relative Humidity: 58 %	Air Pressure: 1012 hPa	Power: 110 VAC, 50 Hz
Remarks: Co-location 915.2+ WiFi			

Table 7.7.6 Restricted bands according to FCC section 15.205

MHz	MHz	MHz	MHz	MHz	GHz
0.09 - 0.11	8.37625 - 8.38675	73 - 74.6	399.9 - 410	2690 - 2900	10.6 - 12.7
0.495 - 0.505	8.41425 - 8.41475	74.8 - 75.2	608 - 614	3260 - 3267	13.25 - 13.4
2.1735 - 2.1905	12.29 - 12.293	108 - 121.94	960 - 1240	3332 - 3339	14.47 - 14.5
4.125 - 4.128	12.51975 - 12.52025	123 - 138	1300 - 1427	3345.8 - 3358	15.35 - 16.2
4.17725 - 4.17775	12.57675 - 12.57725	149.9 - 150.05	1435 - 1626.5	3600 - 4400	17.7 - 21.4
4.20725 - 4.20775	13.36 - 13.41	156.52475 - 156.52525	1645.5 - 1646.5	4500 - 5150	22.01 - 23.12
6.215 - 6.218	16.42 - 16.423	156.7 - 156.9	1660 - 1710	5350 - 5460	23.6 - 24
6.2675 - 6.26825	16.69475 - 16.69525	162.0125 - 167.17	1718.8 - 1722.2	7250 - 7750	31.2 - 31.8
6.31175 - 6.31225	16.80425 - 16.80475	167.72 - 173.2	2200 - 2300	8025 - 8500	36.43 - 36.5
8.291 - 8.294	25.5 - 25.67	240 - 285	2310 - 2390	9000 - 9200	Above 38.6
8.362 - 8.366	37.5 - 38.25	322 - 335.4	2483.5 - 2500	9300 - 9500	

Table 7.7.7 Restricted bands according to RSS-Gen

MHz	MHz	MHz	MHz	MHz	GHz
0.09 - 0.11	8.291 - 8.294	16.80425 - 16.80475	399.9 - 410	3260 - 3267	10.6 - 12.7
2.1735 - 2.1905	8.362 - 8.366	25.5 - 25.67	608 - 614	3332 - 3339	13.25 - 13.4
3.020 - 3.026	8.37625 - 8.38675	37.5 - 38.25	960 - 1427	3345.8 - 3358	14.47 - 14.5
4.125 - 4.128	8.41425 - 8.41475	73 - 74.6	1435 - 1626.5	3500 - 4400	15.35 - 16.2
4.17725 - 4.17775	12.29 - 12.293	74.8 - 75.2	1645.5 - 1646.5	4500 - 5150	17.7 - 21.4
4.20725 - 4.20775	12.51975 - 12.52025	108 - 138	1660 - 1710	5350 - 5460	22.01 - 23.12
5.677 - 5.683	12.57675 - 12.57725	156.52475 - 156.52525	1718.8 - 1722.2	7250 - 7750	23.6 - 24
6.215 - 6.218	13.36 - 13.41	156.7 - 156.9	2200 - 2300	8025 - 8500	31.2 - 31.8
6.2675 - 6.26825	16.42 - 16.423	240 - 285	2310 - 2390	9000 - 9200	36.43 - 36.5
6.31175 - 6.31225	16.69475 - 16.69525	322 - 335.4	2655 - 2900	9300 - 9500	Above 38.6

Reference numbers of test equipment used

HL 5288	HL 446	HL 4339	HL 3903	HL 5902	HL 7585	HL 5112	HL 4933
HL 4919	HL 4956						

Full description is given in Appendix A.

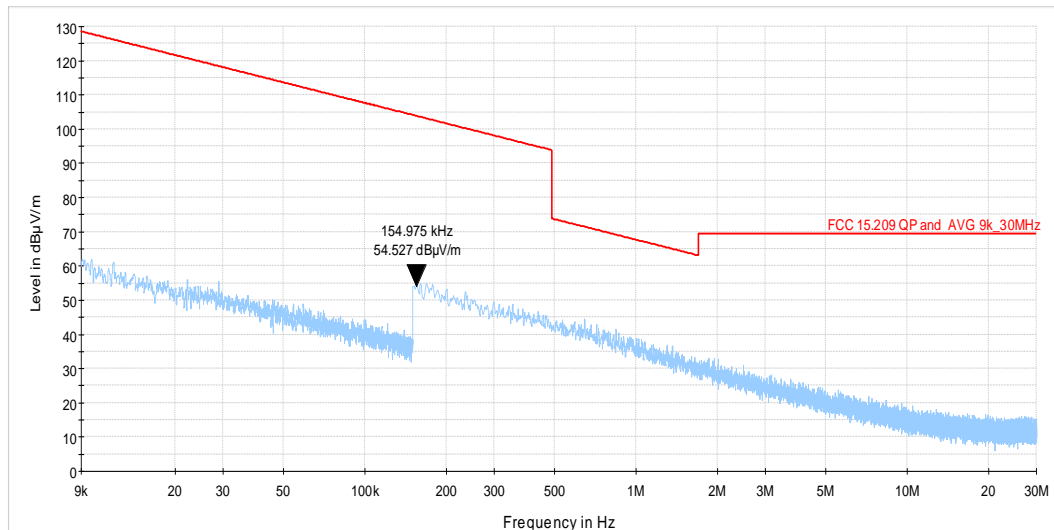


HERMON LABORATORIES

Test specification: Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions			
Test procedure: ANSI C63.10, sections 6.5, 6.6			
Test mode: Compliance		Verdict: PASS	
Date(s): 06-Mar-24 - 07-Mar-24			
Temperature: 23 °C	Relative Humidity: 58 %	Air Pressure: 1012 hPa	Power: 110 VAC, 50 Hz
Remarks: Co-location 915.2+ WiFi			

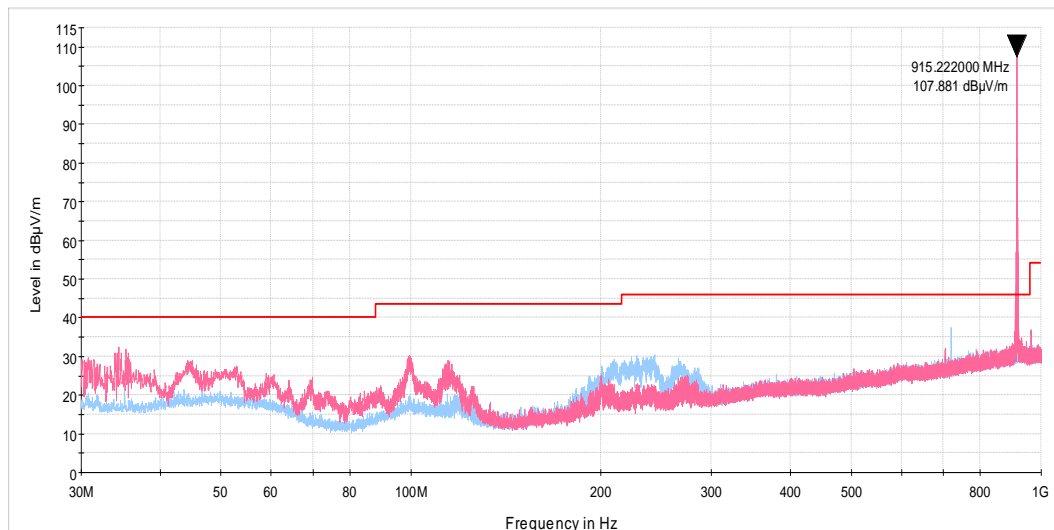
Plot 7.7.1 Radiated emission measurements from 9k to 30 MHz at the low carrier frequency

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical



Plot 7.7.2 Radiated emission measurements from 30 to 1000 MHz

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal



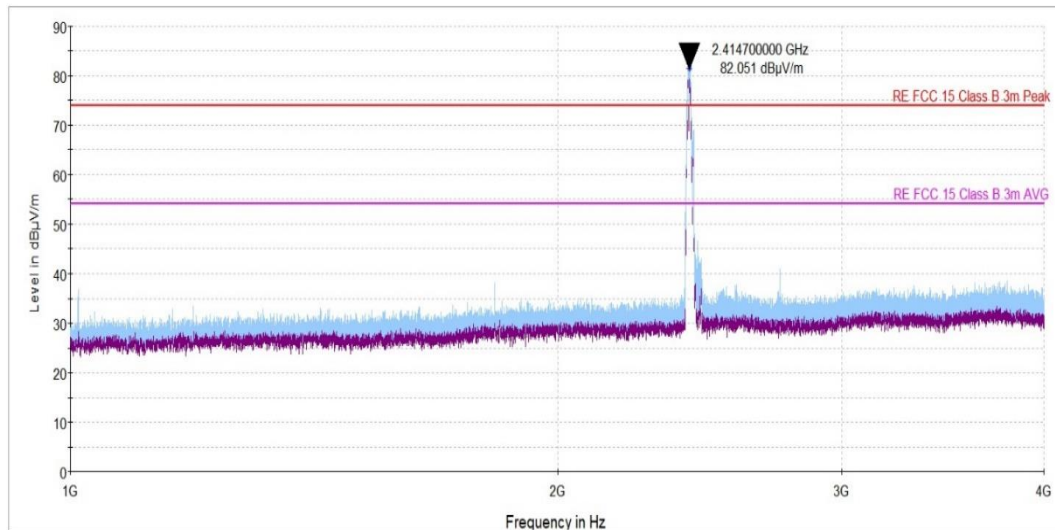


HERMON LABORATORIES

Test specification: Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions			
Test procedure: ANSI C63.10, sections 6.5, 6.6			
Test mode: Compliance		Verdict: PASS	
Date(s): 06-Mar-24 - 07-Mar-24			
Temperature: 23 °C	Relative Humidity: 58 %	Air Pressure: 1012 hPa	Power: 110 VAC, 50 Hz
Remarks: Co-location 915.2+ WiFi			

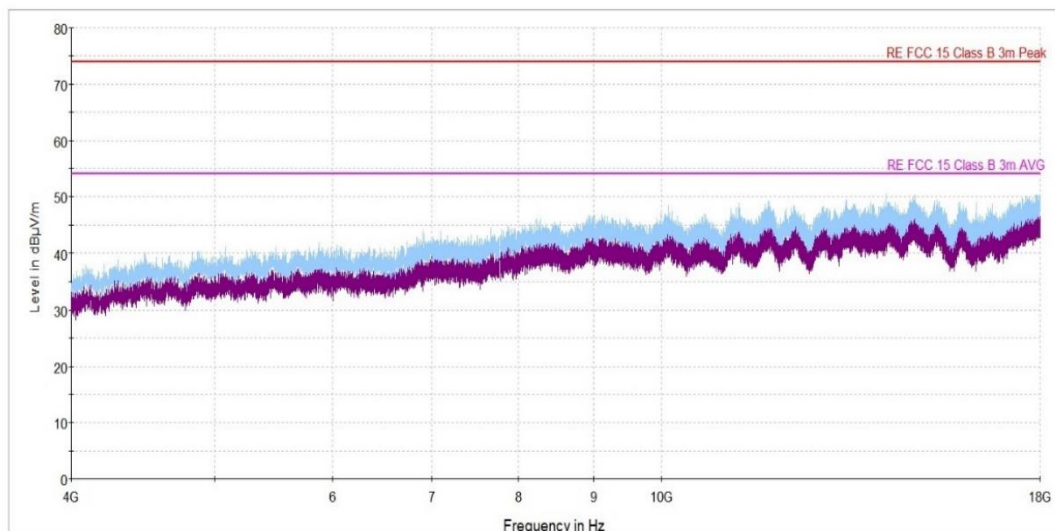
Plot 7.7.3 Radiated emission measurements from 1000 to 4000 MHz

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal



Plot 7.7.4 Radiated emission measurements from 4000 to 18000 MHz

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal



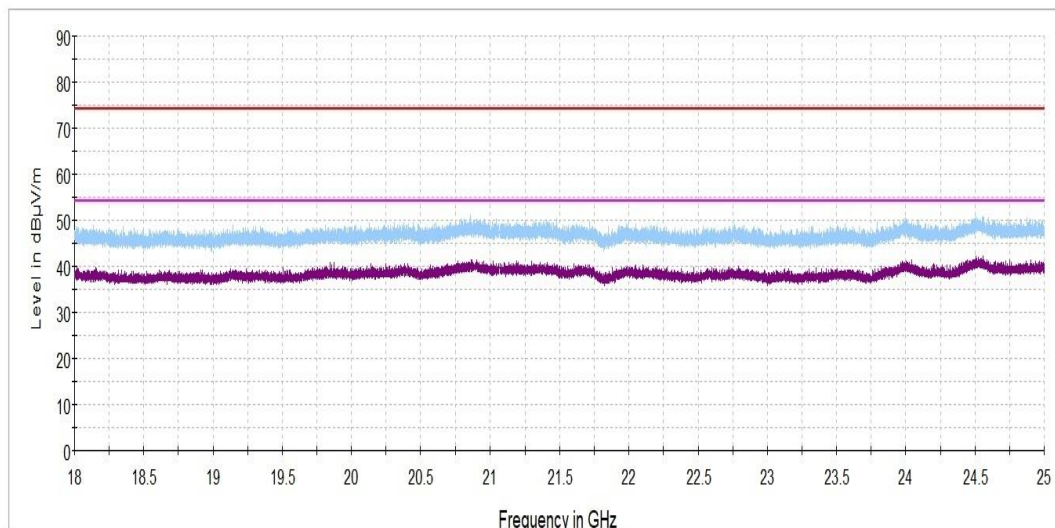


HERMON LABORATORIES

Test specification: Section 15.247(d), RSS-247 section 5.5, Radiated spurious emissions			
Test procedure: ANSI C63.10, sections 6.5, 6.6			
Test mode: Compliance		Verdict: PASS	
Date(s): 06-Mar-24 - 07-Mar-24			
Temperature: 23 °C	Relative Humidity: 58 %	Air Pressure: 1012 hPa	Power: 110 VAC, 50 Hz
Remarks: Co-location 915.2+ WiFi			

Plot 7.7.5 Radiated emission measurements from 18000 to 25000 MHz

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal





Test specification:		Section 15.247(d), RSS-247 section 5.5, Emissions at band edges	
Test procedure:		ANSI C63.10, section 7.8.6	
Test mode:		Verdict: PASS	
Date(s):			
25-Feb-24			
Temperature: 23 °C	Relative Humidity: 58 %	Air Pressure: 1012 hPa	Power: 110 VAC, 50 Hz
Remarks:			

7.8 Band edge radiated emissions

7.8.1 General

This test was performed to measure emissions, radiated from the EUT at the assigned frequency band edges. Specification test limits are given in Table 7.8.1.

Table 7.8.1 Band edge emission limits

Assigned frequency, MHz	Attenuation below carrier*, dBc	Field strength at 3 m within restricted bands, dB(μV/m)	
		Peak	Average
902.0 – 928.0	20.0	74.0	54.0

* - Band edge emission limit is provided in terms of attenuation below the peak of modulated carrier measured with the same resolution bandwidth.

7.8.2 Test procedure

- 7.8.2.1 The EUT was set up as shown in Figure 7.8.1, energized normally modulated at the maximum data rate with its hopping function disabled and its proper operation was checked.
- 7.8.2.2 The EUT was adjusted to produce maximum available to end user RF output power at the lowest carrier frequency.
- 7.8.2.3 The spectrum analyzer span was set to capture the carrier frequency and associated modulation products. The resolution bandwidth was set wider than 1 % of the frequency span.
- 7.8.2.4 The spectrum analyzer was set in max hold mode and allowed trace to stabilize. The highest emission level within the authorized band was measured.
- 7.8.2.5 The maximum band edge emission and modulation product outside of the band were measured as provided in Table 7.8.2 and associated plots and referenced to the highest emission level measured within the authorized band.
- 7.8.2.6 The above procedure was repeated with the EUT adjusted to produce maximum RF output power at the highest carrier frequency.
- 7.8.2.7 The above procedure was repeated with the frequency hopping function enabled.

Figure 7.8.1 Band edge emission test setup





HERMON LABORATORIES

Test specification:		Section 15.247(d), RSS-247 section 5.5, Emissions at band edges	
Test procedure:		ANSI C63.10, section 7.8.6	
Test mode:		Verdict: PASS	
Date(s):			
25-Feb-24			
Temperature: 23 °C	Relative Humidity: 58 %	Air Pressure: 1012 hPa	Power: 110 VAC, 50 Hz
Remarks:			

Table 7.8.2 Band edge emission test results

ASSIGNED FREQUENCY RANGE: 902 – 928 MHz
 DETECTOR USED: Peak
 MODULATION: 2 GFSK
 BIT RATE: 5 kbps
 VIDEO BANDWIDTH: ≥ RBW

Frequency, MHz	Band edge emission, dBm	Emission at carrier, dBm	Attenuation below carrier, dBc	Limit, dBc	Margin, dB*	Verdict
Frequency hopping disabled						
902.2	-94.07	-50.30	43.77	20.0	23.77	Pass
927.8	-90.31	-50.44	39.87		19.87	
Frequency hopping enabled						
902.2	-94.17	-51.32	42.85	20.0	22.85	Pass
927.8	-90.22	-47.67	42.55		22.55	

Reference numbers of test equipment used

HL 3818	HL 3433	HL 4136	HI 5689	HL 5589			
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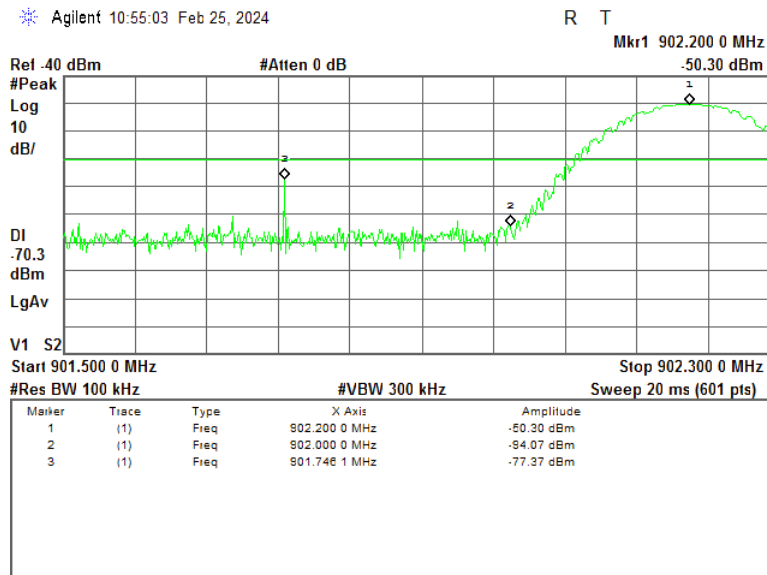
Full description is given in Appendix A.



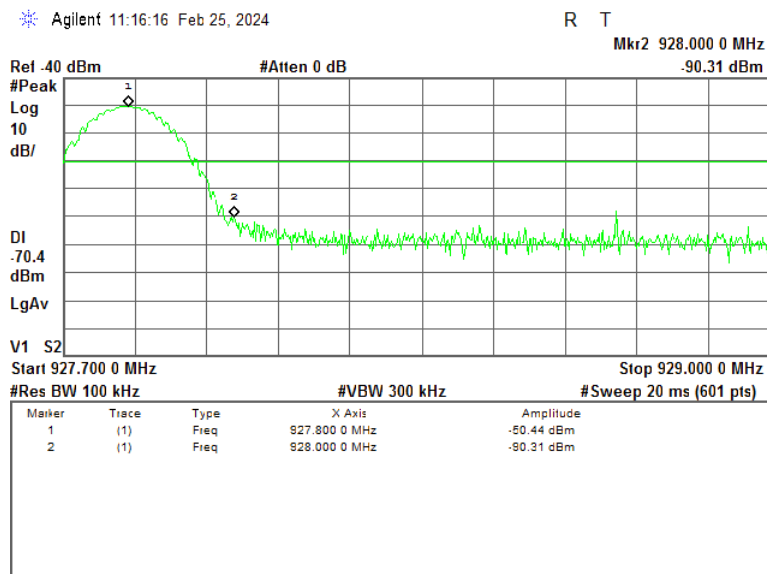
HERMON LABORATORIES

Test specification: Section 15.247(d), RSS-247 section 5.5, Emissions at band edges			
Test procedure: ANSI C63.10, section 7.8.6			
Test mode: Compliance		Verdict: PASS	
Date(s): 25-Feb-24			
Temperature: 23 °C	Relative Humidity: 58 %	Air Pressure: 1012 hPa	Power: 110 VAC, 50 Hz
Remarks:			

Plot 7.8.1 The highest band edge emission at low carrier frequency with hopping function disabled



Plot 7.8.2 The highest band edge emission at high carrier frequency with hopping function disabled

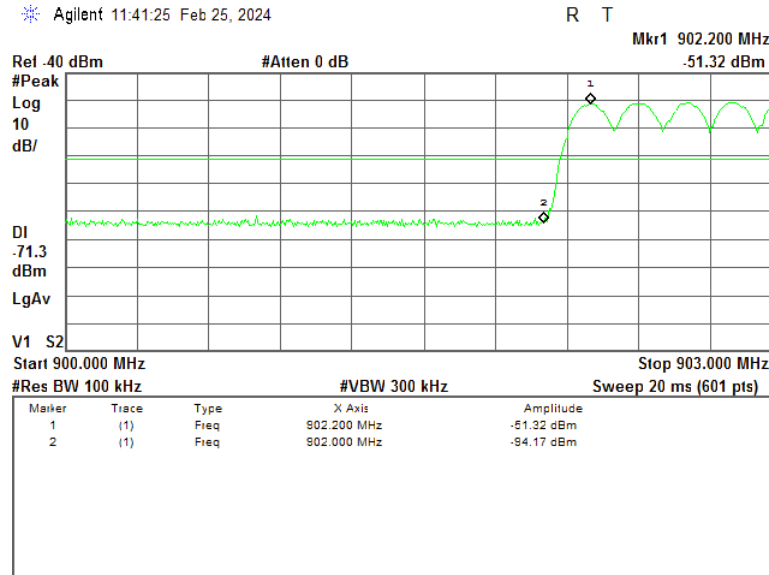




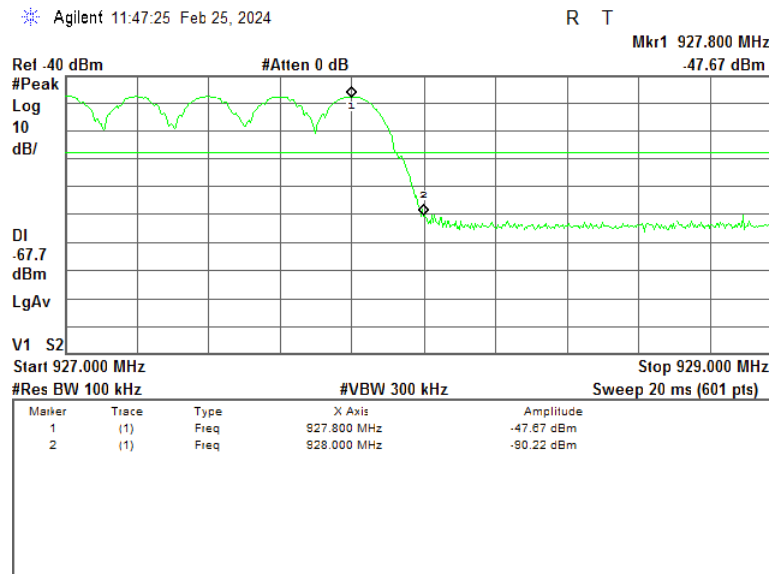
HERMON LABORATORIES

Test specification: Section 15.247(d), RSS-247 section 5.5, Emissions at band edges			
Test procedure: ANSI C63.10, section 7.8.6			
Test mode: Compliance		Verdict: PASS	
Date(s): 25-Feb-24			
Temperature: 23 °C	Relative Humidity: 58 %	Air Pressure: 1012 hPa	Power: 110 VAC, 50 Hz
Remarks:			

Plot 7.8.5 The highest band edge emission at low carrier frequency with hopping function enabled



Plot 7.8.6 The highest band edge emission at high carrier frequency with hopping function enabled





Test specification: FCC section 15.203, RSS-Gen section 6.8, Antenna requirement			
Test procedure: Visual inspection		Verdict: PASS	
Test mode: Compliance			
Date(s): 07-Mar-24			
Temperature: 23 °C	Relative Humidity: 58 %	Air Pressure: 1012 hPa	Power: 110 VAC, 50 Hz
Remarks:			

7.9 Antenna requirements

The EUT was verified for compliance with antenna requirements. A transmitter shall be designed to ensure that no antenna other than that furnished by the responsible party will be used with the device. It may be either permanently attached or employs a unique antenna connector for every antenna proposed for use with the EUT. This requirement does not apply to professionally installed transmitters.

The rationale for compliance with the above requirements was either visual inspection results or supplier declaration. The summary of results is provided in Table 7.9.1.

Table 7.9.1 Antenna requirements

Requirement	Rationale	Verdict
The transmitter antenna is permanently attached	Visual inspection	Comply
The transmitter employs a unique antenna connector	NA	
The transmitter requires professional installation	NA	

8 APPENDIX A Test equipment and ancillaries used for tests

HL No	Description	Manufacturer	Model	Ser. No.	Last Cal./ Check	Due Cal./ Check
337	Probe Set, Hand held, 5 probes	Electro-Metrics	EHFP-30	238	05-Jun-23	05-Jun-24
0446	Antenna, Loop, Active, 10 (9) kHz - 30 MHz	EMCO	6502	2857	07-Mar-23	07-Mar-24
3433	Test Cable , DC-18 GHz, 1.5 m, SMA - SMA	Mini-Circuits	CBL-5FT-SMSM+	25679	23-Apr-23	23-Apr-24
3818	PSA Series Spectrum Analyzer, 3 Hz- 44 GHz	Agilent Technologies	E4446A	MY48250288	23-Jul-23	23-Jul-24
3903	Microwave Cable Assembly, 40.0 GHz, 1.5 m, SMA/SMA	Huber-Suhner	SUCOFL EX 102A	1226/2A	16-Apr-23	16-Apr-24
4136	Shield Box	TESCOM CO., LTD	TC-5916A	5916A000137	03-May-23	03-May-24
4339	High pass Filter, 50 Ohm, 1000 to 18000 MHz, SMA-FM / SMA-M	Micro-Tronics	HPM50115-02	001	21-Jun-23	21-Jun-25
4909	High Pass Filter, 50 Ohm, 2640 to 6230 MHz., SMA-FM / SMA-M	Mini-Circuits	VHF-2275+	NA	22-Jun-23	22-Jun-25
4919	High Pass Filter, 50 Ohm, 3900 to 9800 MHz, SMA-FM / SMA-M	Mini-Circuits	VHF-3500+	NA	21-Jun-23	21-Jun-25
4933	Active Horn Antenna, 1 GHz to 18 GHz	COM-POWER CORPORATION	AHA-118	701046	20-Feb-24	20-Feb-25
4956	Active horn antenna, 18 to 40 GHz	COM-POWER CORPORATION	AHA-840	105004	08-Mar-23	08-Mar-24
5112	RF cable, 40 GHz, 5.5 m, K-type	Huber-Suhner	SF102EA/11SK/11SK/5500MM	502494/2EA	16-Apr-23	16-Apr-24
5288	Trilog Antenna, 25 MHz - 8 GHz, 100W	Frankonia	ALX-8000E	00809	24-Mar-22	24-Mar-25
5589	Cable, 50 Ohm, DC to 18 GHz, 1.8 m, SMA/N	Mini Circuits	CBL-6FT-SNMN+	NA	19-Nov-23	19-Nov-24
5902	RF cable, 18 GHz, 6.0m, N-type	Huber-Suhner	SF126EA/11N/11N/6000	NA	19-Nov-23	19-Nov-24
7585	EMI Test Receiver, 1 Hz to 44 GHz	Rohde & Schwarz	ESW44	103130	21-Sep-23	21-Sep-24

* Software Version of EMC 32 is 10.60.20

9 APPENDIX B Test equipment correction factors

HL 5288: Trilog Antenna
Frankonia, model: ALX-8000E, s/n: 00809
30-1000 MHz

Frequency, MHz	Antenna factor, dB/m
30	14.96
35	15.33
40	16.37
45	17.56
50	17.95
60	16.87
70	13.22
80	10.56
90	13.61
100	15.46
120	14.03
140	12.23

Frequency, MHz	Antenna factor, dB/m
160	12.67
180	13.34
200	15.40
250	16.42
300	17.28
400	19.98
500	21.11
600	22.90
700	24.13
800	25.25
900	26.35
1000	27.18

The antenna factor shall be added to receiver reading in dB μ V to obtain field strength in dB μ V/m.

above 1000 MHz

Frequency, MHz	Antenna factor, dB/m
1000	26.9
1100	28.1
1200	28.4
1300	29.6
1400	29.1
1500	30.4
1600	30.7
1700	31.5
1800	32.3
1900	32.6
2000	32.5
2100	32.9
2200	33.5
2300	33.2
2400	33.7
2500	34.6
2600	34.7
2700	34.6
2800	35.0
2900	35.5
3000	36.2
3100	36.8
3200	36.8
3300	37.0
3400	37.5
3500	38.2

Frequency, MHz	Antenna factor, dB/m
3600	38.9
3700	39.4
3800	39.4
3900	39.6
4000	39.7
4100	39.8
4200	40.5
4300	40.9
4400	41.1
4500	41.4
4600	41.3
4700	41.6
4800	41.9
4900	42.3
5000	42.7
5100	43.0
5200	42.9
5300	43.5
5400	43.6
5500	44.3
5600	44.7
5700	45.0
5800	45.0
5900	45.3
6000	45.9

The antenna factor shall be added to receiver reading in dB μ V to obtain field strength in dB μ V/m.

HL 0446: Active Loop Antenna
EMCO, model: 6502, s/n 2857

Frequency,	Measured antenna factor, dBS/m	Measurement uncertainty, dB
10	-33.4	±1.0
20	-37.8	±1.0
50	-40.5	±1.0
75	-41.0	±1.0
100	-41.2	±1.0
150	-41.2	±1.0
250	-41.1	±1.0
500	-41.2	±1.0
750	-41.3	±1.0
1000	-41.3	±1.0

Frequency,	Measured antenna factor, dBS/m	Measurement uncertainty, dB
2000	-41.4	±1.0
3000	-41.4	±1.0
4000	-41.5	±1.0
5000	-41.5	±1.0
10000	-41.7	±1.0
15000	-42.1	±1.0
20000	-42.7	±1.0
25000	-44.2	±1.0
30000	-45.8	±1.0

The antenna factor shall be added to receiver reading in dB μ V to obtain field strength in dB μ A/m.

HL 4933: Active Horn Antenna
COM-POWER CORPORATION, model: AHA-118, s/n 701046

Frequency, MHz	Measured antenna factor (with preamplifier), dB/m
1000	-16.1
1500	-15.1
2000	-10.9
2500	-11.9
3000	-11.1
3500	-10.6
4000	-8.6
4500	-8.3
5000	-5.9
5500	-5.7
6000	-3.3
6500	-4.0
7000	-2.2
7500	-1.7
8000	1.1
8500	-0.8
9000	-1.5
9500	-0.2

Frequency, MHz	Measured antenna factor (with preamplifier), dB/m
10000	1.8
10500	1.0
11000	0.3
11500	-0.5
12000	3.1
12500	1.4
13000	-0.3
13500	-0.4
14000	2.5
14500	2.2
15000	1.9
15500	0.5
16000	2.1
16500	1.2
17000	0.6
17500	3.1
18000	4.2

The antenna factor shall be added to receiver reading in dB μ V to obtain field strength in dB μ V/m.

10 APPENDIX C Test laboratory description

Tests were performed at Hermon Laboratories Ltd., which is a fully independent, private, EMC, Radio, Safety, Environmental and Telecommunication testing facility.

Hermon Laboratories is recognized and accredited by the Federal Communications Commission (USA) for relevant parts of Code of Federal Regulations 47 (CFR 47), Test Firm Registration Number is 927748, Designation Number is IL1001; Recognized by Innovation, Science and Economic Development Canada for wireless and terminal testing (ISED), ISED #2186A, CAB identifier is IL1001; Certified by VCCI, Japan (the registration numbers are R-10808 for OATS, R-1082 for anechoic chamber, G-10869 for RE measurements above 1 GHz, C-10845 for conducted emissions site and T-11606 for conducted emissions at telecommunication ports).

The laboratory is accredited by American Association for Laboratory Accreditation (USA) according to ISO/IEC 17025 for electromagnetic compatibility, product safety, telecommunications testing, environmental simulation and calibration (for exact scope please refer to Certificate No. 839.01, 839.03 and 839.04).

Address: P.O. Box 23, Binyamina 3055001, Israel.
Telephone: +972 4628 8001
Fax: +972 4628 8277
e-mail: mail@hermonlabs.com
website: www.hermonlabs.com

Person for contact: Mr. Michael Nikishin, EMC&Radio group manager

11 APPENDIX D Measurement uncertainties

Expanded uncertainty at 95% confidence in Hermon Labs EMC measurements

Test description	Expanded uncertainty
Conducted carrier power at RF antenna connector	Below 12.4 GHz: ± 1.7 dB 12.4 GHz to 40 GHz: ± 2.3 dB
Conducted emissions at RF antenna connector	9 kHz to 2.9 GHz: ± 2.6 dB 2.9 GHz to 6.46 GHz: ± 3.5 dB 6.46 GHz to 13.2 GHz: ± 4.3 dB 13.2 GHz to 22.0 GHz: ± 5.0 dB 22.0 GHz to 26.8 GHz: ± 5.5 dB 26.8 GHz to 40.0 GHz: ± 4.8 dB
Occupied bandwidth	± 8.0 %
Duty cycle, timing (Tx ON / OFF) and average factor measurements	± 1.0 %
Conducted emissions with LISN	9 kHz to 150 kHz: ± 3.9 dB 150 kHz to 30 MHz: ± 3.8 dB
Radiated emissions at 3 m measuring distance Horizontal polarization Vertical polarization	Biconilog antenna: ± 5.3 dB Biconical antenna: ± 5.0 dB Log periodic antenna: ± 5.3 dB Double ridged horn antenna: ± 5.3 dB Biconilog antenna: ± 6.0 dB Biconical antenna: ± 5.7 dB Log periodic antenna: ± 6.0 dB Double ridged horn antenna: ± 6.0 dB

Hermon Laboratories is accredited by A2LA for calibration according to present requirements of ISO/IEC 17025 and NCSL Z540-1. The accreditation is granted to perform calibration of parameters that are listed in the Scope of Hermon Laboratories Accreditation.

Hermon Laboratories calibrates its reference and transfer standards by calibration laboratories accredited to ISO/IEC 17025 by a mutually recognized Accreditation Body or by a recognized national metrology institute. All reference and transfer standards used in the calibration system are traceable to national or international standards.

In-house calibration of all test and measurement equipment is performed on a regular basis according to Hermon Laboratories calibration procedures, manufacturer calibration/verification procedures or procedures defined in the relevant standards. The Hermon Laboratories test and measurement equipment is calibrated within the tolerances specified by the manufacturers and/or by the relevant standards.

12 APPENDIX E

Specification references

FCC 47CFR part 15: 2022

47CFR part 27: 2022

ANSI C63.10: 2013

ANSI C63.4: 2014

RSS-247 Issue 3: 2023

RSS-Gen Issue 5

with_amendment_1_2: 2021

ICES-003: 2020, Issue 7

Radio Frequency Devices

Private land mobile radio services

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

American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz.

Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence- Exempt Local Area Network (LE-LAN) Devices


General Requirements and Information for the Certification of Radiocommunication Equipment

Information Technology Equipment (Including Digital Apparatus) – Limits and methods of measurement

13 APPENDIX F Abbreviations and acronyms

A	ampere
AC	alternating current
A/m	ampere per meter
AM	amplitude modulation
AVRG	average (detector)
cm	centimeter
dB	decibel
dBm	decibel referred to one milliwatt
dB(μ V)	decibel referred to one microvolt
dB(μ V/m)	decibel referred to one microvolt per meter
dB(μ A)	decibel referred to one microampere
DC	direct current
EIRP	equivalent isotropically radiated power
ERP	effective radiated power
EUT	equipment under test
F	frequency
GHz	gigahertz
GND	ground
H	height
HL	Hermon laboratories
Hz	hertz
k	kilo
kHz	kilohertz
LO	local oscillator
m	meter
MHz	megahertz
min	minute
mm	millimeter
ms	millisecond
μ s	microsecond
NA	not applicable
NB	narrow band
OATS	open area test site
Ω	Ohm
PM	pulse modulation
PS	power supply
ppm	part per million (10^{-6})
QP	quasi-peak
RE	radiated emission
RF	radio frequency
rms	root mean square
Rx	receive
s	second
T	temperature
Tx	transmit
V	volt
WB	wideband

14 APPENDIX G Manufacturer's declaration



Innovative leak prevention and water-saving systems

Model Difference Letter

We, the undersigned hereby declare, that the following equipment:

Product Name: Controller

Model: CBM-COAMAP-5-01

Is electrically equal to:

Models: CBM-COAMAP-5-02, CBM-COAMAP-5-03, CBM-COAMAP-5-04, CBM COAMAP-5-05, CBM-COAMAP-5-06, CBM-COAMAP-5-07, CBM-COAMAP-5-08

Their Difference is:


These are subset products of the product Controller, Model CBM-COAMAP-5-01 for each of these products some components were removed because they are not required for the functionality of their specific application and to save cost (please relate to **Appendix A** for further details).


All subset products are identical externally by using the same mechanics box which includes the changes described in Appendix A and Appendix B (please relate to Appendix B for further details).

Point of Contact:


YOKNEAM, 4/27/2024
(place, date of issue)

OREN NIV, CTO
(Name and title in block letters)


(Signature/stamp)



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Innovative leak prevention and water-saving systems

Appendix A

The Controller is a smart HUB that connect different kind of devices and controlling their operation, configuration and functionality, and update their status. The Controller itself connected to the cloud by Ethernet or cellular or WiFi connection and communicate with the end user by different Applications (WEB or Mobile) to operate and configure the system and its devices.

The controller has subset products which are listed in this document. Each subset product has the same enclosure and the same electronic card as its superset products but for each subset product certain components are removed from the electronic card compared to the corresponding superset product. The components that are removed are not changing the radio functions. The reason for removing these components is to save the price for functions that are not required for certain applications.

The following equipment:

Brand/Item	Type/Model	Short Product description
Controller – Full configuration	CBM-COAMAP-5-01	WiFi, Eth, PoE, GSM-M3, Terminal ports, Rechargeable Battery

is a **Superset** to the following equipment (including Software/Hardware version(s)):

Brand/Item	Type/Model	Short Product description
Controller – partial configuration	CBM-COAMAP-5-02	WiFi, Eth, PoE, AA Battery
Controller – partial configuration	CBM-COAMAP-5-03	WiFi, Eth, PoE, Rechargeable Battery
Controller – partial configuration	CBM-COAMAP-5-04	WiFi, Eth, Rechargeable Battery
Controller – partial configuration	CBM-COAMAP-5-05	WiFi Only, Rechargeable Battery
Controller – partial configuration	CBM-COAMAP-5-06	Full configuration (WiFi, Eth, PoE, GSM(M3), AA Battery
Controller – partial configuration	CBM-COAMAP-5-07	WiFi, Eth, AA Battery
Controller – partial configuration	CBM-COAMAP-5-08	WiFi Only, AA Battery



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END OF DOCUMENT