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# TEST REPORT

ACCORDING TO: FCC 47 CFR Part 90;  
RSS-119 Issue 12:2015, RSS-Gen Issue 5:2021

FOR:

**ST Engineering Telematics Wireless Ltd.c**  
**Light Control Unit**  
**Model: LCUN35GX**  
**FCC ID: NTAN35GX**  
**IC: 4732A-N35GX**

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## Table of contents

1	Applicant information .....	3
2	Equipment under test attributes .....	3
3	Manufacturer information .....	3
4	Test details .....	3
5	Tests summary .....	4
6	EUT description .....	5
6.1	General information .....	5
6.2	Test configuration .....	5
6.3	Changes made in EUT .....	5
6.4	Transmitter characteristics .....	6
7	Transmitter tests according to 47CFR part 90 and RSS-119 requirements .....	7
7.1	Peak output power test .....	7
7.2	Occupied bandwidth test .....	14
7.3	Emission mask test .....	18
7.4	Radiated spurious emission measurements .....	23
7.5	Frequency stability test .....	35
7.6	Transient frequency behaviour test .....	37
8	APPENDIX A Test equipment and ancillaries used for tests .....	49
9	APPENDIX B Measurement uncertainties .....	51
10	APPENDIX C Test laboratory description .....	52
11	APPENDIX D Specification references .....	52
12	APPENDIX E Test equipment correction factors .....	53
13	APPENDIX F Abbreviations and acronyms .....	63

## 1 Applicant information

**Client name:** ST Engineering Telematics Wireless Ltd.  
**Address:** 26 Hamelacha street, POB 1911, Holon, 5811801, Israel  
**Telephone:** +972 3557 5700  
**Fax:** +972 3557 5703  
**E-mail:** itsikk@tlmw.com  
**Contact name:** Mr. Itsik Kanner

## 2 Equipment under test attributes

**Product name:** Light Control Unit  
**Product type:** Transceiver  
**Model(s):** LCUN35GX  
**Serial number:** 996191900051  
**Hardware version:** REV A  
**Software release:** AU031B  
**Receipt date:** 22-Jul-21

## 3 Manufacturer information

**Manufacturer name:** ST Engineering Telematics Wireless Ltd.  
**Address:** 26 Hamelacha street, POB 1911, Holon, 5811801, Israel  
**Telephone:** +972 3557 5700  
**Fax:** +972 3557 5703  
**E-Mail:** itsikk@tlmw.com  
**Contact name:** Mr. Itsik Kanner




## 4 Test details

**Project ID:** 43552  
**Location:** Hermon Laboratories Ltd. P.O. Box 23, Binyamina 3055001, Israel  
**Test started:** 22-Jul-21  
**Test completed:** 30-Sept-21  
**Test specification(s):** FCC 47 CFR Part 90, RSS-119 Issue 12:2015, RSS-Gen Issue 5:2021

## 5 Tests summary

Test	Status
<b>Transmitter characteristics</b>	
FCC Section 90.205 / RSS-119 Section 5.4, Maximum output power	Pass
FCC Section 90.209 / RSS-119 Section 5.5, Occupied bandwidth	Pass
FCC Section 90.210 / RSS-119 Section 5.8.4, Emission mask	Pass
FCC Section 90.210 / RSS-119 Section 5.8.4, Radiated spurious emissions	Pass
FCC Section 90.213 / RSS-119 Section 5.3, Frequency stability	Pass
FCC Section 90.214 / RSS-119 Section 5.9, Transient frequency behaviour	Pass
FCC Section 2.1091 / RSS-102 section 2.5, RF radiation exposure evaluation	Pass, the exhibit to the application of certification is provided

Testing was completed against all relevant requirements of the test standard. The 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
<b>Tested by:</b>	Mrs. E. Pitt, test engineer	September 30, 2021	
<b>Reviewed by:</b>	Mrs. M. Cherniavsky, certification engineer	November 1, 2021	
<b>Approved by:</b>	Mr. S. Samokha, Technical Manager, EMC and Radio	November 15, 2021	

## 6 EUT description

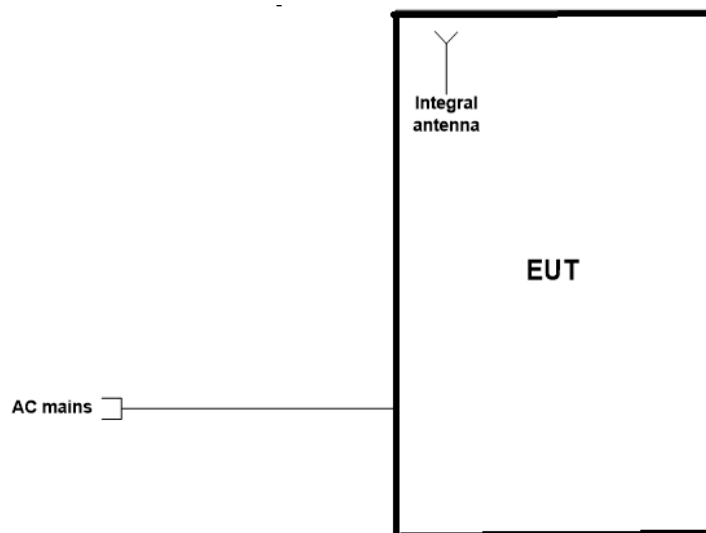
Note: The following data in this clause is provided by the customer and represents his sole responsibility.

### 6.1 General information

The EUT, LCU NEMA is a light control unit, installed on top of the luminaire utilizing a standard (twist and lock) NEMA socket.

The LCU NEMA is powered by 110 - 277 Volt AC and the RF operating frequency band is 450 to 470 MHz. Maximum RF power is 1 Watt, the device utilizes the built in antenna type.

### 6.2 Test configuration



### 6.3 Changes made in EUT

No changes were implemented in the EUT during 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 ranges		450- 470 MHz			
Maximum rated output power		At transmitter 50 Ω RF output connector		29.8 dBm	
Is transmitter output power variable?		X	No		
			Yes	continuous variable	
				stepped variable with stepsize	dB
				minimum RF power	dBm
				maximum RF power	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	Gain		
Printed	NA	NA	-2 dBi at low and mid frequencies -1.5 dBi at high frequency		
Transmitter aggregate data rate/s		4.8 kbps			
Type of modulation		4GFSK			
Modulating test signal (baseband)		PRBS			
Transmitter power source					
	Battery	Nominal rated voltage		Battery type	
	DC	Nominal rated voltage			
X	AC mains	Nominal rated voltage	110-277 VAC	Frequency	60 Hz



<b>Test specification: Section 90.205 / RSS-119 Section 5.4, Maximum output power</b>			
<b>Test procedure:</b> 47 CFR, Section 2.1046; TIA/EIA-603-E, Section 2.2.1			
<b>Test mode:</b> Compliance		<b>Verdict: PASS</b>	
<b>Date(s):</b> 23-Jul-21			
<b>Temperature:</b> 26 °C	<b>Relative Humidity:</b> 54 %	<b>Air Pressure:</b> 1008 hPa	<b>Power:</b> 110 VAC, 60 Hz
<b>Remarks:</b>			

## 7 Transmitter tests according to 47CFR part 90 and RSS-119 requirements

### 7.1 Peak output power test

#### 7.1.1 General

This test was performed to measure effective radiated power emanated by transmitter at carrier frequency. Specification test limits are given in Table 7.1.1

Table 7.1.1 Peak output power limits

Assigned frequency band, MHz	ERP		Equivalent field strength limit @ 3m, dB(μV/m)*
	W	dBm	
<b>FCC</b>			
450.0 – 470.0	2	33.00	130.38
<b>RSS-119 Table 2</b>			
450.0 – 470.0	60	47.78	145.16

\* - Equivalent field strength limit was calculated from maximum allowed ERP 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

#### 7.1.2 Test procedure for field strength measurements

7.1.2.1 The EUT was set up as shown in Figure 7.1.1, energized and the performance check was conducted.

7.1.2.2 The field strength of the EUT carrier frequency was measured with antenna connected to spectrum analyzer/ EMI receiver. To find maximum radiation the turntable was rotated 360°, the measuring antenna height was swept throughout the range, specified in

7.1.2.3 Table 7.1.2 and Table 7.1.3, in both vertical and horizontal polarizations.

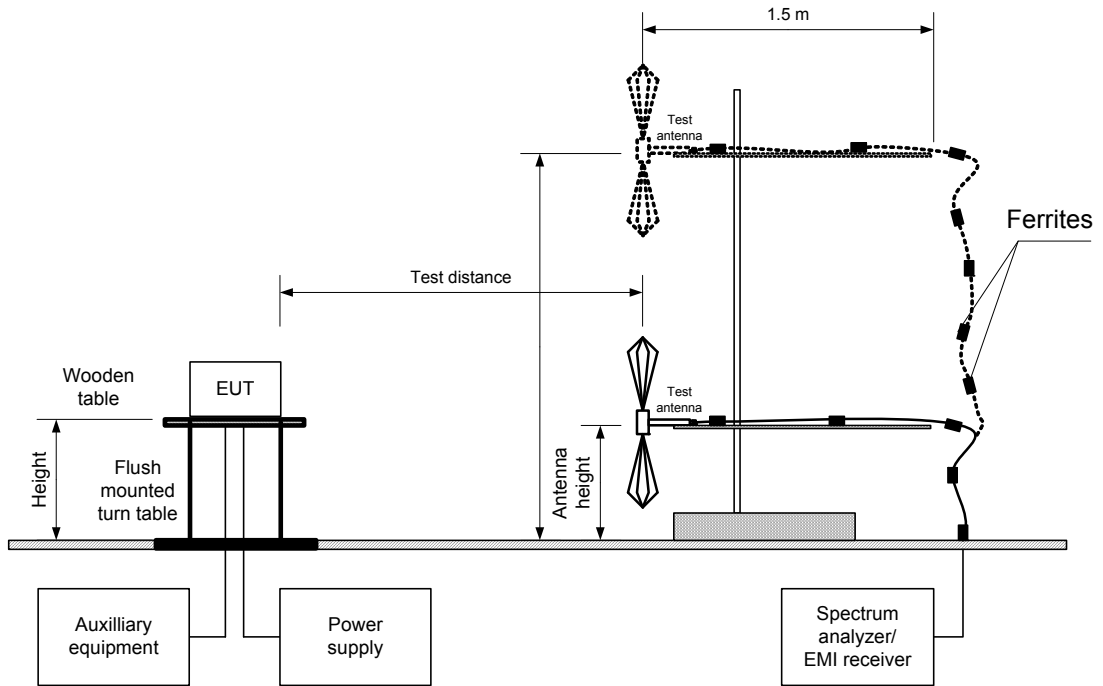
7.1.2.4 The worst test results (the lowest margins) were recorded in

7.1.2.5 Table 7.1.2 and Table 7.1.3 and shown in the associated plots.



<b>Test specification:</b> Section 90.205 / RSS-119 Section 5.4, Maximum output power			
<b>Test procedure:</b> 47 CFR, Section 2.1046; TIA/EIA-603-E, Section 2.2.1			
<b>Test mode:</b> Compliance		<b>Verdict:</b> PASS	
<b>Date(s):</b> 23-Jul-21			
<b>Temperature:</b> 26 °C	<b>Relative Humidity:</b> 54 %	<b>Air Pressure:</b> 1008 hPa	<b>Power:</b> 110 VAC, 60 Hz
<b>Remarks:</b>			

Figure 7.1.1 Setup for carrier field strength measurements







<b>Test specification:</b> Section 90.205 / RSS-119 Section 5.4, Maximum output power			
<b>Test procedure:</b> 47 CFR, Section 2.1046; TIA/EIA-603-E, Section 2.2.1			
<b>Test mode:</b> Compliance		<b>Verdict:</b> PASS	
<b>Date(s):</b> 23-Jul-21			
<b>Temperature:</b> 26 °C	<b>Relative Humidity:</b> 54 %	<b>Air Pressure:</b> 1008 hPa	<b>Power:</b> 110 VAC, 60 Hz
<b>Remarks:</b>			

**Table 7.1.2 Transmitter carrier field strength according to FCC rules**

ASSIGNED FREQUENCY RANGE: 450 - 470 MHz  
 TEST SITE: Semi anechoic chamber  
 TEST DISTANCE: 3 m  
 EUT HEIGHT: 0.8 m  
 TEST ANTENNA HEIGHTS RANGE: 1.0 – 4.0 m  
 DETECTOR USED: Peak  
 RESOLUTION BANDWIDTH: 100 kHz  
 VIDEO BANDWIDTH: > Resolution bandwidth  
 TEST ANTENNA TYPE: Biconilog  
 MODULATION: 4GFSK  
 EUT POWER: Worst case, 110 V / 60 Hz  
 TRANSMITTER OUTPUT POWER SETTINGS: Maximum

Frequency, MHz	Field strength, dB(µV/m)	Antenna polarization	Antenna height, m	Azimuth, degrees	EUT antenna gain, dBi	Peak output power, dBm*	ERP, dBm**	ERP limit, dBm	Margin, dB***	Verdict
450.0031	121.3	Vertical	1.0	35	-2	28.1	23.9	33.00	-9.1	Pass
460.0000	122.8	Vertical	1.0	35	-2	29.6	25.4	33.00	-7.4	Pass
469.9969	123.5	Vertical	1.0	35	-1.5	29.8	26.1	33.00	-6.9	Pass

\*- 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*

\*\* ERP=Field strength in dB(µV/m) - 97.4 dB

\*\*\*- Margin = ERP - specification limit.



<b>Test specification:</b> Section 90.205 / RSS-119 Section 5.4, Maximum output power			
<b>Test procedure:</b> 47 CFR, Section 2.1046; TIA/EIA-603-E, Section 2.2.1			
<b>Test mode:</b> Compliance		<b>Verdict:</b> PASS	
<b>Date(s):</b> 23-Jul-21			
<b>Temperature:</b> 26 °C	<b>Relative Humidity:</b> 54 %	<b>Air Pressure:</b> 1008 hPa	<b>Power:</b> 110 VAC, 60 Hz
<b>Remarks:</b>			

Table 7.1.3 Transmitter carrier field strength according to RSS-119 Table 2

ASSIGNED FREQUENCY RANGE: 450 - 470 MHz  
 TEST SITE: Semi anechoic chamber  
 TEST DISTANCE: 3 m  
 EUT HEIGHT: 0.8 m  
 TEST ANTENNA HEIGHTS RANGE: 1.0 – 4.0 m  
 DETECTOR USED: Peak  
 RESOLUTION BANDWIDTH: 100 kHz  
 VIDEO BANDWIDTH: > Resolution bandwidth  
 TEST ANTENNA TYPE: Biconilog  
 MODULATION: 4GFSK  
 EUT POWER: Worst case, 110 V / 60 Hz  
 TRANSMITTER OUTPUT POWER SETTINGS: Maximum

Frequency, MHz	Field strength, dB(µV/m)	Antenna polarization	Antenna height, m	Azimuth, degrees	EUT antenna gain, dBi	Peak output power, dBm*	ERP, dBm**	ERP limit, dBm	Margin, dB***	Verdict
450.0031	121.3	Vertical	1.0	35	-2	28.1	23.9	47.78	-23.88	Pass
460.0000	122.8	Vertical	1.0	35	-2	29.6	25.4	47.78	-22.38	Pass
469.9969	123.5	Vertical	1.0	35	-1.5	29.8	26.1	47.78	-21.68	Pass

\*- 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*

\*\* ERP=Field strength in dB(µV/m) - 97.4 dB

\*\*\*- Margin = ERP - specification limit.

**Reference numbers of test equipment used**

HL 3903	HL 2909	HL 5288	HL 5902	HI 4232		
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Full description is given in Appendix A.



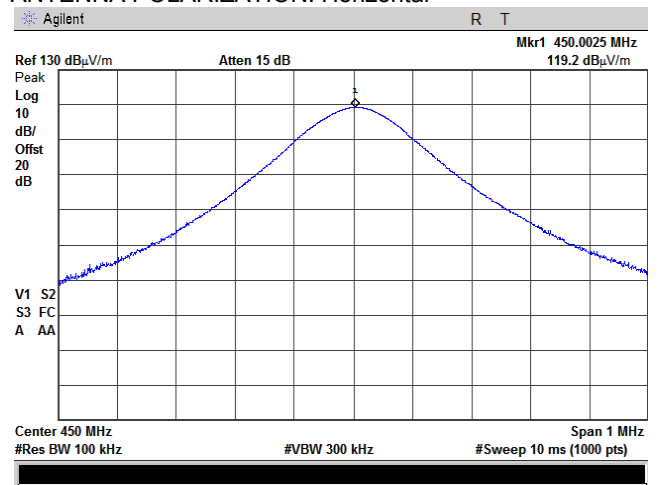
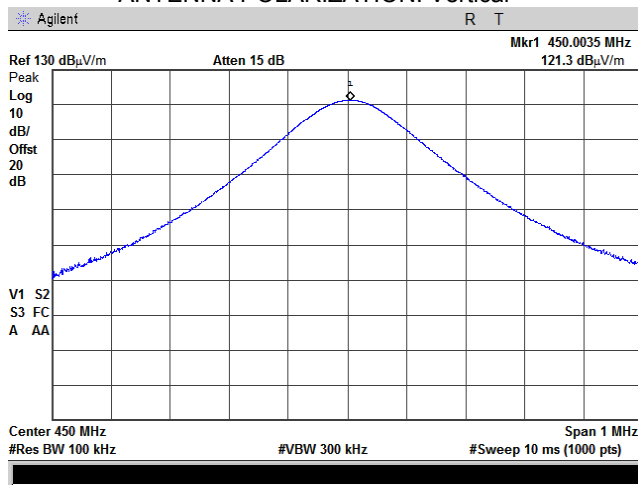
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<b>Test specification: Section 90.205 / RSS-119 Section 5.4, Maximum output power</b>			
<b>Test procedure:</b> 47 CFR, Section 2.1046; TIA/EIA-603-E, Section 2.2.1			
<b>Test mode:</b> Compliance		<b>Verdict:</b> PASS	
<b>Date(s):</b> 23-Jul-21			
<b>Temperature:</b> 26 °C	<b>Relative Humidity:</b> 54 %	<b>Air Pressure:</b> 1008 hPa	<b>Power:</b> 110 VAC, 60 Hz
<b>Remarks:</b>			

Plot 7.1.1 Transmitter carrier field strength at low frequency in vertical and horizontal antenna polarization

CARRIER FREQUENCY:  
EUT POWER:  
ANTENNA POLARIZATION: Vertical

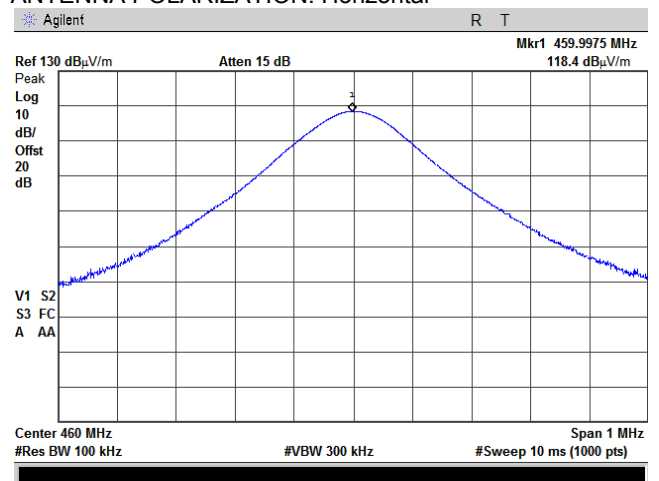
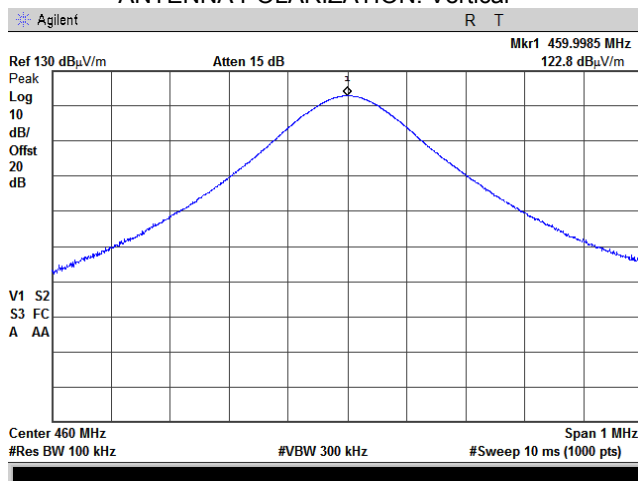
Low  
110V 60Hz  
ANTENNA POLARIZATION: Horizontal



Plot 7.1.2 Transmitter carrier field strength at mid frequency in vertical and horizontal antenna polarization

CARRIER FREQUENCY:  
EUT POWER:  
ANTENNA POLARIZATION: Vertical

Mid  
110V 60Hz  
ANTENNA POLARIZATION: Horizontal





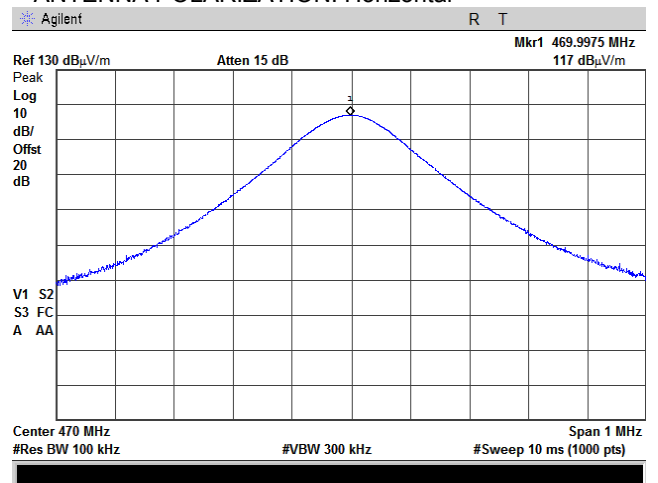
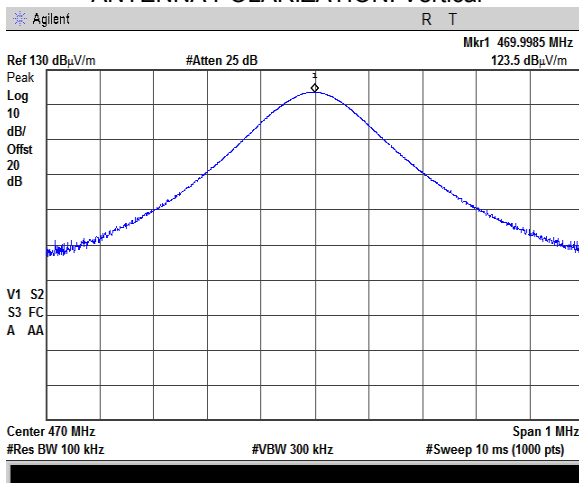
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<b>Test specification:</b> Section 90.205 / RSS-119 Section 5.4, Maximum output power			
<b>Test procedure:</b> 47 CFR, Section 2.1046; TIA/EIA-603-E, Section 2.2.1			
<b>Test mode:</b> Compliance	<b>Verdict:</b> PASS		
<b>Date(s):</b> 23-Jul-21			
<b>Temperature:</b> 26 °C	<b>Relative Humidity:</b> 54 %	<b>Air Pressure:</b> 1008 hPa	<b>Power:</b> 110 VAC, 60 Hz
<b>Remarks:</b>			

**Plot 7.1.3 Transmitter carrier field strength at high frequency in vertical and horizontal antenna polarization**

CARRIER FREQUENCY:  
EUT POWER:  
ANTENNA POLARIZATION: Vertical

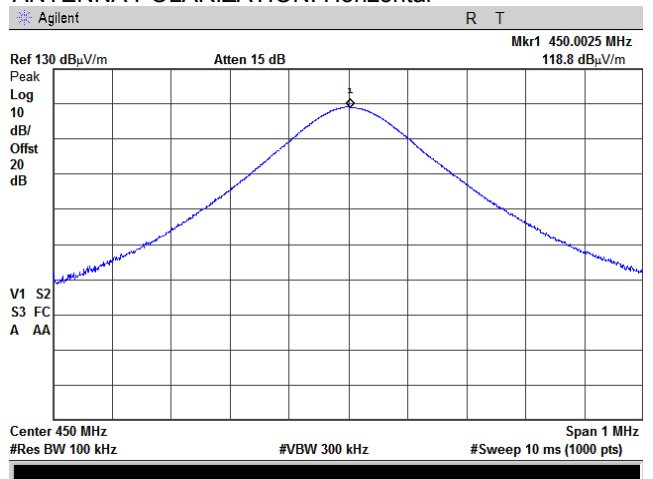
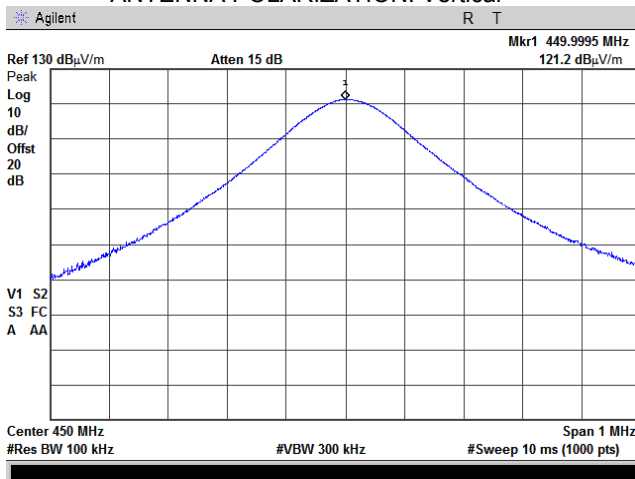
High  
110V 60Hz  
ANTENNA POLARIZATION: Horizontal



**Plot 7.1.4 Transmitter carrier field strength at low frequency in vertical and horizontal antenna polarization**

CARRIER FREQUENCY:  
EUT POWER:  
ANTENNA POLARIZATION: Vertical

Low  
277V 60Hz  
ANTENNA POLARIZATION: Horizontal





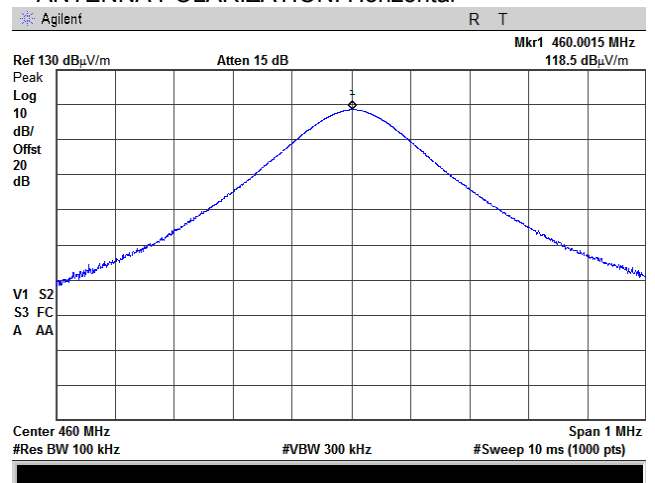
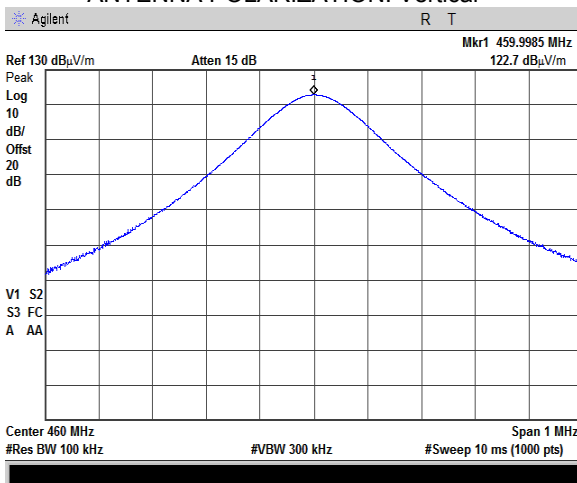
HERMON LABORATORIES

<b>Test specification:</b> Section 90.205 / RSS-119 Section 5.4, Maximum output power			
<b>Test procedure:</b> 47 CFR, Section 2.1046; TIA/EIA-603-E, Section 2.2.1			
<b>Test mode:</b> Compliance		<b>Verdict:</b> PASS	
<b>Date(s):</b> 23-Jul-21			
<b>Temperature:</b> 26 °C	<b>Relative Humidity:</b> 54 %	<b>Air Pressure:</b> 1008 hPa	<b>Power:</b> 110 VAC, 60 Hz
<b>Remarks:</b>			

Plot 7.1.5 Transmitter carrier field strength at mid frequency in vertical and horizontal antenna polarization

CARRIER FREQUENCY:  
EUT POWER:  
ANTENNA POLARIZATION: Vertical

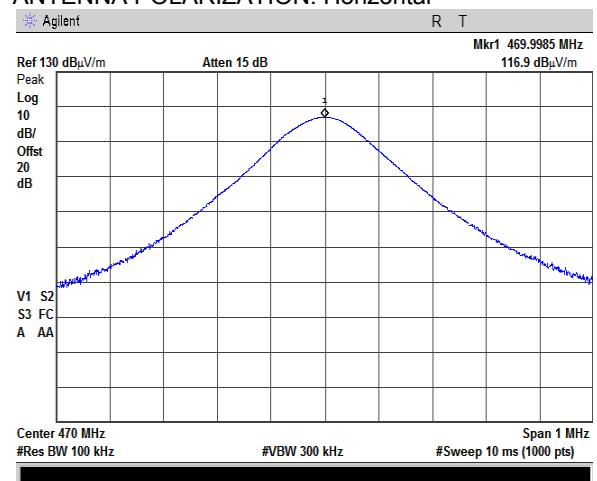
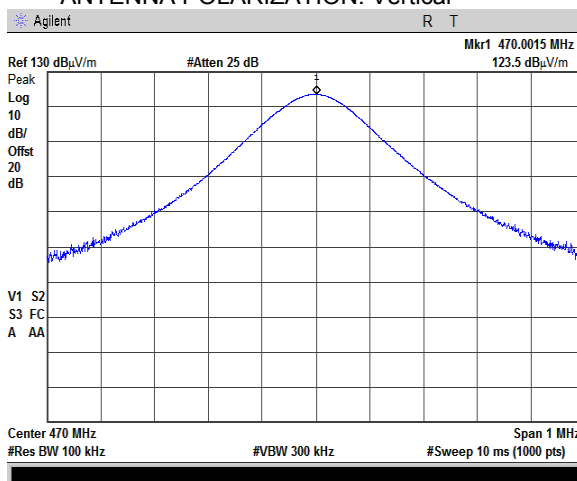
Mid  
277V 60Hz  
ANTENNA POLARIZATION: Horizontal



Plot 7.1.6 Transmitter carrier field strength at high frequency in vertical and horizontal antenna polarization

CARRIER FREQUENCY:  
EUT POWER:  
ANTENNA POLARIZATION: Vertical

High  
277V 60Hz  
ANTENNA POLARIZATION: Horizontal





<b>Test specification: Section 90.209 / RSS-119 Section 5.5, Occupied bandwidth</b>			
<b>Test procedure:</b> 47 CFR, Section 2.1049			
<b>Test mode:</b> Compliance		<b>Verdict:</b> PASS	
<b>Date(s):</b> 22-Aug-21			
<b>Temperature:</b> 25 °C	<b>Relative Humidity:</b> 48 %	<b>Air Pressure:</b> 1005 hPa	<b>Power:</b> 110 VAC, 60 Hz
<b>Remarks:</b>			

## 7.2 Occupied bandwidth test

### 7.2.1 General

This test was performed to measure transmitter occupied bandwidth. Specification test limits are given in Table 7.2.1, Table 7.2.2.

**Table 7.2.1 Occupied bandwidth limits according to FCC requirements**

Assigned frequency, MHz	Modulation envelope reference points*, dBc	Maximum allowed bandwidth, kHz
450.0 – 470.0	26	6.00

\* - Modulation envelope reference points are provided in terms of attenuation below the unmodulated carrier.

**Table 7.2.2 Occupied bandwidth limits according to RSS-119 requirements**

Assigned frequency, MHz	Modulation envelope reference points, %	Maximum allowed bandwidth, kHz
450.0 – 470.0	99	6

### 7.2.2 Test procedure

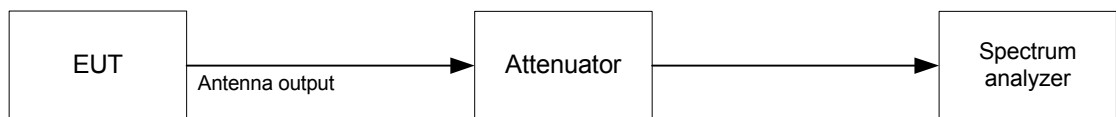
**7.2.2.1** The EUT was set up as shown in Figure 7.2.1, energized and its proper operation was checked.

**7.2.2.2** The EUT was set to transmit the unmodulated carrier and the reference peak power level was measured.

**7.2.2.3** The EUT was set to transmit the normally modulated carrier.

**7.2.2.4** The transmitter occupied bandwidth was measured with spectrum analyzer as a frequency delta between the reference points on modulation envelope and provided in Table 7.2.3 and the associated plots.

**Figure 7.2.1 Occupied bandwidth test setup**





<b>Test specification:</b> Section 90.209 / RSS-119 Section 5.5, Occupied bandwidth			
<b>Test procedure:</b> 47 CFR, Section 2.1049			
<b>Test mode:</b> Compliance		<b>Verdict:</b> PASS	
<b>Date(s):</b> 22-Aug-21			
<b>Temperature:</b> 25 °C	<b>Relative Humidity:</b> 48 %	<b>Air Pressure:</b> 1005 hPa	<b>Power:</b> 110 VAC, 60 Hz
<b>Remarks:</b>			

Table 7.2.3 Occupied bandwidth test results

DETECTOR USED: Peak hold  
RESOLUTION BANDWIDTH: 100 Hz  
VIDEO BANDWIDTH: 1 kHz  
EUT POWER: 110V 60Hz  
MODULATION: 4GFSK  
MODULATING SIGNAL: ID code  
BIT RATE: 4.8 kbps

Carrier frequency, MHz	Occupied bandwidth, kHz	Limit, kHz	Margin, kHz	Verdict
MODULATION ENVELOPE REFERENCE POINTS: 99%				
450.0031	3.899	6.000	-2.101	Pass
460.0000	3.795	6.000	-2.205	Pass
469.9968	3.833	6.000	-2.167	Pass
MODULATION ENVELOPE REFERENCE POINTS: 26 dBc				
450.0031	4.883	6.000	-1.117	Pass
460.0000	4.867	6.000	-1.133	Pass
469.9968	5.049	6.000	-0.951	Pass

Reference numbers of test equipment used

HL 3766	HL 4355	HL 5637				
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Full description is given in Appendix A.



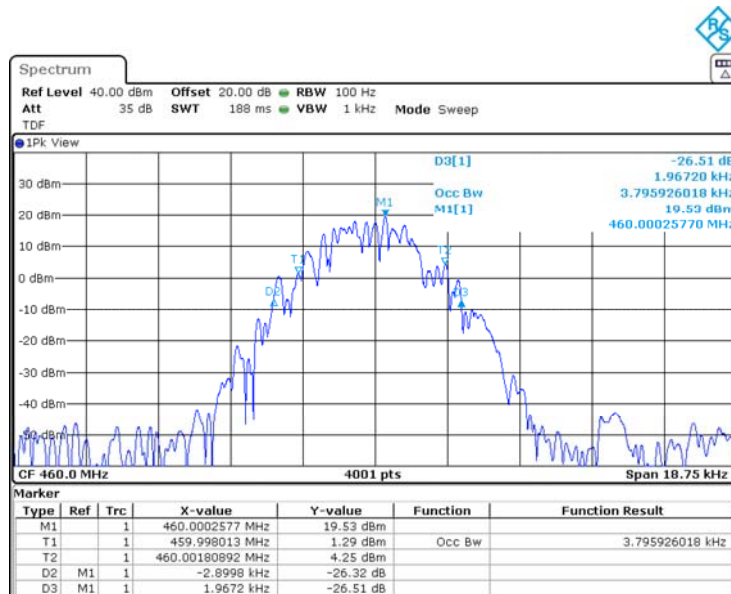
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<b>Test specification:</b> Section 90.209 / RSS-119 Section 5.5, Occupied bandwidth			
<b>Test procedure:</b> 47 CFR, Section 2.1049			
<b>Test mode:</b> Compliance		<b>Verdict:</b> PASS	
<b>Date(s):</b> 22-Aug-21			
<b>Temperature:</b> 25 °C	<b>Relative Humidity:</b> 48 %	<b>Air Pressure:</b> 1005 hPa	<b>Power:</b> 110 VAC, 60 Hz
<b>Remarks:</b>			

Plot 7.2.1 Occupied bandwidth test result at low frequency



Plot 7.2.2 Occupied bandwidth test result at mid frequency



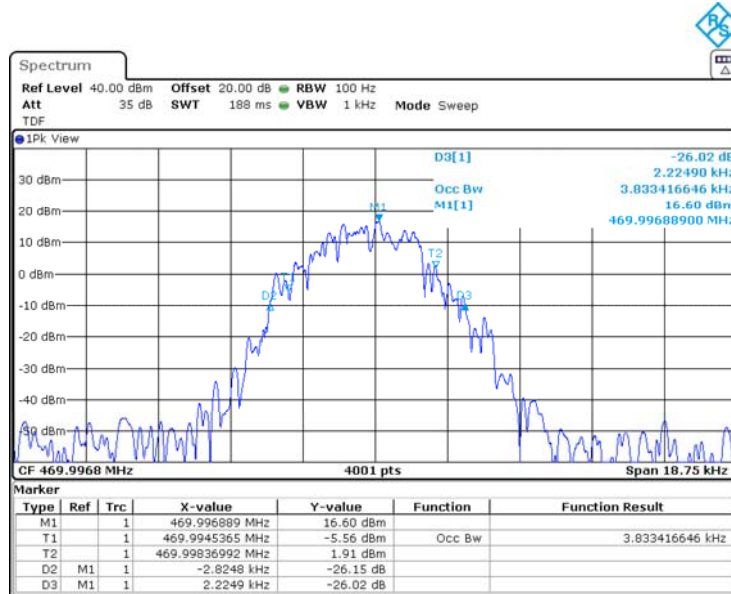




HERMON LABORATORIES

<b>Test specification:</b> Section 90.209 / RSS-119 Section 5.5, Occupied bandwidth			
<b>Test procedure:</b> 47 CFR, Section 2.1049			
<b>Test mode:</b> Compliance		<b>Verdict:</b> PASS	
<b>Date(s):</b> 22-Aug-21			
<b>Temperature:</b> 25 °C	<b>Relative Humidity:</b> 48 %	<b>Air Pressure:</b> 1005 hPa	<b>Power:</b> 110 VAC, 60 Hz
<b>Remarks:</b>			

Plot 7.2.3 Occupied bandwidth test result at high frequency





<b>Test specification:</b> Section 90.210 / RSS-119 Section 5.8.4, Emission mask			
<b>Test procedure:</b> 47 CFR, Sections 2.1051, 2.1047 and 90.210(e); TIA/EIA-603-E, Section 2.2.13			
<b>Test mode:</b> Compliance		<b>Verdict:</b> PASS	
<b>Date(s):</b> 22-Aug-21			
<b>Temperature:</b> 25 °C	<b>Relative Humidity:</b> 48 %	<b>Air Pressure:</b> 1005230 hPa	<b>Power:</b> 110 VAC, 60 Hz
<b>Remarks:</b>			

### 7.3 Emission mask test

#### 7.3.1 General

This test was performed to measure emission mask at RF antenna connector. Specification test limits are given in Table 7.3.1.

Table 7.3.1 Emission mask limits

Frequency displacement from carrier	Attenuation below carrier, dBc
Emission mask E (Channel bandwidth 6.25 kHz, authorized bandwidth 6.0 kHz)	
0 – 3 kHz	0
3 – 4.6 kHz	30 + 16.67(f <sub>d</sub> ** - 3 kHz) or 55+10logP(W) whichever is the lesser
More than 4.6 kHz	55+10logP(W) or 57 whichever is the lesser (RSS119) 55+10logP(W) or 65 whichever is the lesser (FCC210)

\* - linearly increase with frequency

\*\* - displacement frequency

#### 7.3.2 Test procedure

7.3.2.1 The EUT was set up as shown in Figure 7.3.1, energized and its proper operation was checked.

7.3.2.2 The emission mask was measured with spectrum analyzer as provided in the associated plots.

7.3.2.3 The test results are provided in Table 7.3.2 and the associated plots.

Figure 7.3.1 Emission mask test setup

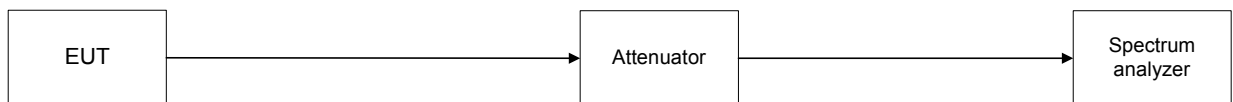


Table 7.3.2 Emission mask test results

Carrier frequency, MHz	Limit	Verdict
450.0031	Emission mask E	Pass
460.0000		
459.9969		

#### Reference numbers of test equipment used

HL 3766	HL 4355	HL 5409				
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Full description is given in Appendix A.

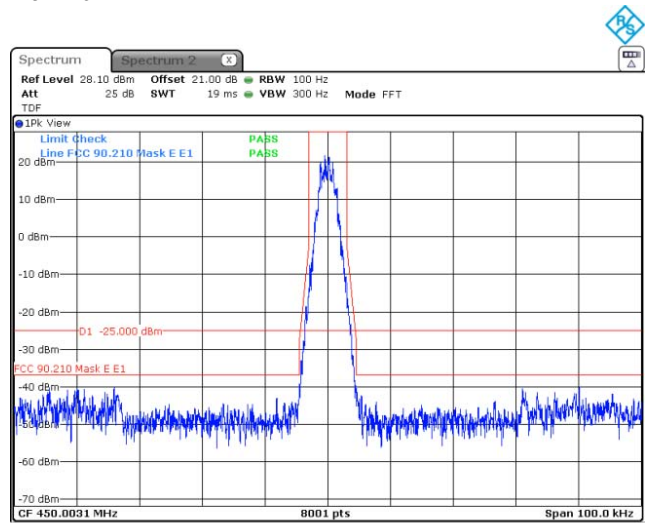
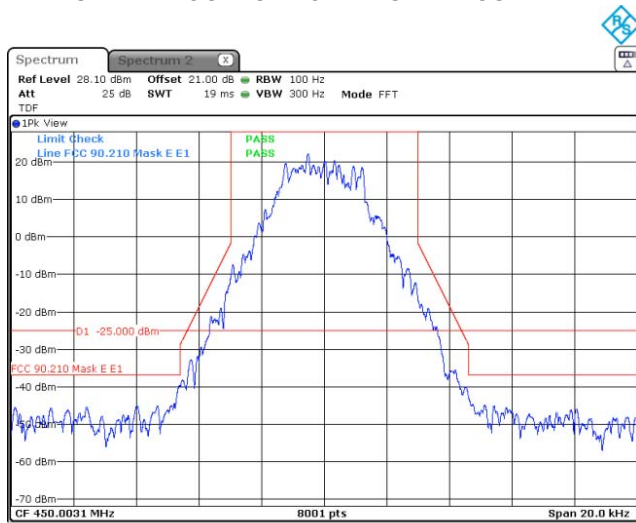


HERMON LABORATORIES

<b>Test specification:</b> Section 90.210 / RSS-119 Section 5.8.4, Emission mask			
<b>Test procedure:</b> 47 CFR, Sections 2.1051, 2.1047 and 90.210(e); TIA/EIA-603-E, Section 2.2.13			
<b>Test mode:</b> Compliance		<b>Verdict:</b> PASS	
<b>Date(s):</b> 22-Aug-21			
<b>Temperature:</b> 25 °C	<b>Relative Humidity:</b> 48 %	<b>Air Pressure:</b> 1005230 hPa	<b>Power:</b> 110 VAC, 60 Hz
<b>Remarks:</b>			

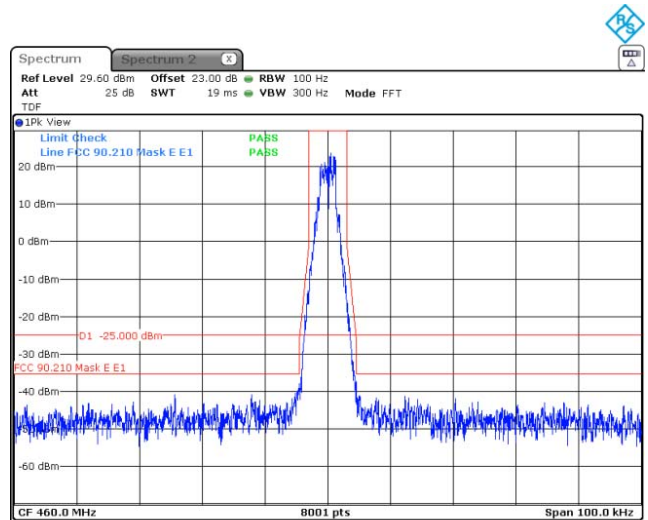
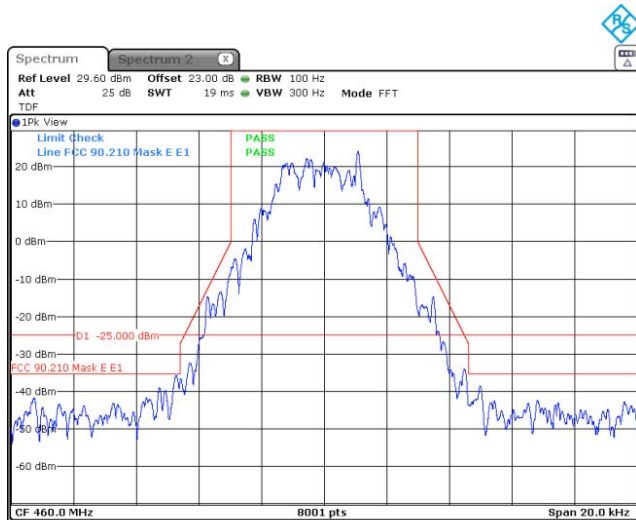
Plot 7.3.1 Emission mask test results at low carrier frequency, FCC part 90.210(e)

OPERATING FREQUENCY RANGE: 450 – 470 MHz  
DETECTOR USED: Peak  
MODULATION: 4GFSK  
MODULATING SIGNAL: PRBS  
TRANSMITTER OUTPUT POWER SETTINGS: Maximum



Plot 7.3.2 Emission mask test results at mid carrier frequency, FCC part 90.210(e)

OPERATING FREQUENCY RANGE: 450 – 470 MHz  
DETECTOR USED: Peak  
MODULATION: 4GFSK  
MODULATING SIGNAL: PRBS  
TRANSMITTER OUTPUT POWER SETTINGS: Maximum





HERMON LABORATORIES

<b>Test specification:</b> Section 90.210 / RSS-119 Section 5.8.4, Emission mask			
<b>Test procedure:</b> 47 CFR, Sections 2.1051, 2.1047 and 90.210(e); TIA/EIA-603-E, Section 2.2.13			
<b>Test mode:</b> Compliance		<b>Verdict:</b> PASS	
<b>Date(s):</b> 22-Aug-21			
<b>Temperature:</b> 25 °C	<b>Relative Humidity:</b> 48 %	<b>Air Pressure:</b> 1005230 hPa	<b>Power:</b> 110 VAC, 60 Hz
<b>Remarks:</b>			

Plot 7.3.3 Emission mask test results at high carrier frequency, FCC part 90.210(e)

OPERATING FREQUENCY RANGE:

450 – 470 MHz

DETECTOR USED:

Peak

MODULATION:

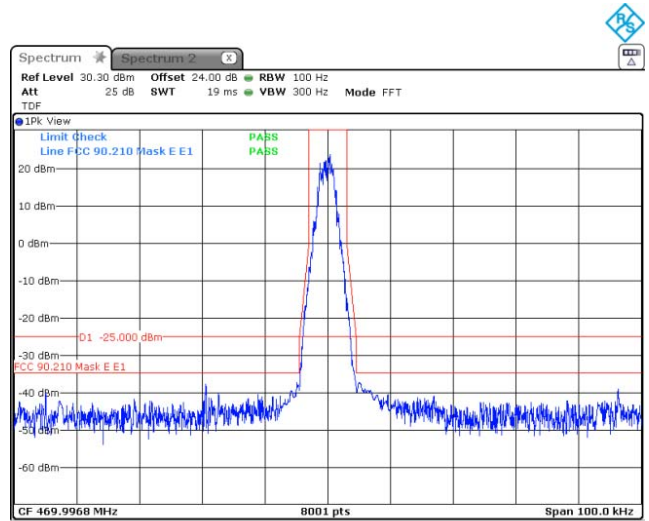
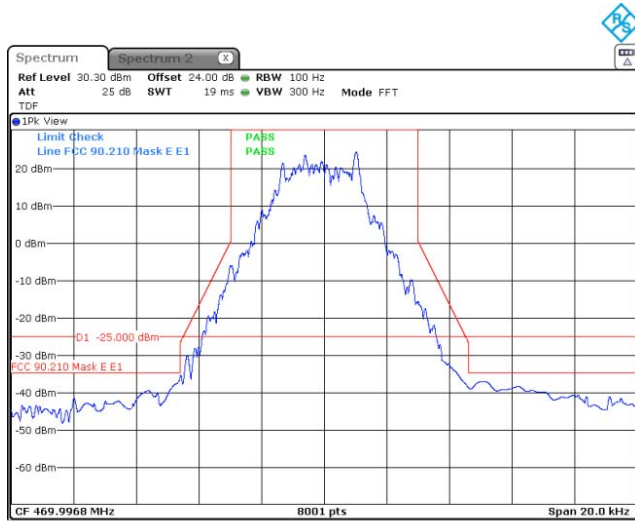
4GFSK

MODULATING SIGNAL:

PRBS

TRANSMITTER OUTPUT POWER SETTINGS:

Maximum



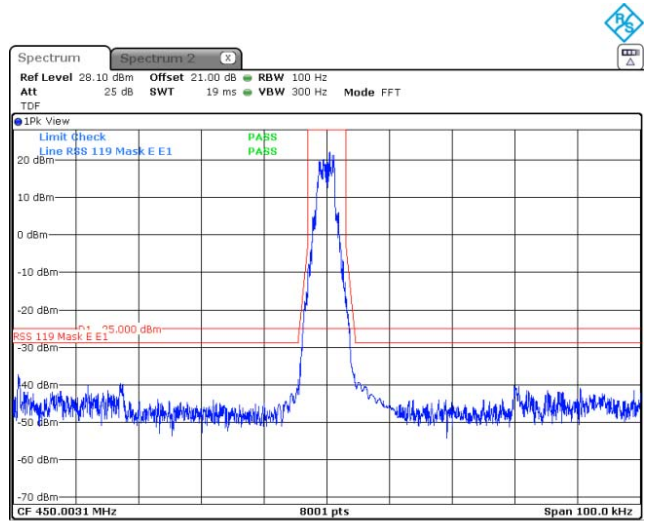
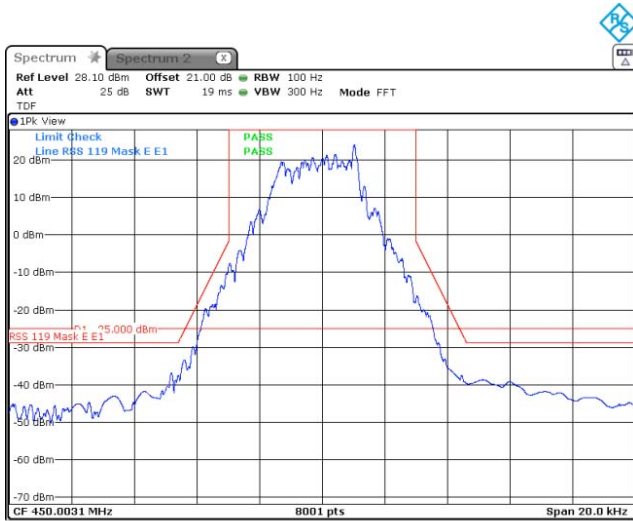


HERMON LABORATORIES

<b>Test specification:</b> Section 90.210 / RSS-119 Section 5.8.4, Emission mask			
<b>Test procedure:</b> 47 CFR, Sections 2.1051, 2.1047 and 90.210(e); TIA/EIA-603-E, Section 2.2.13			
<b>Test mode:</b> Compliance		<b>Verdict:</b> PASS	
<b>Date(s):</b> 22-Aug-21			
<b>Temperature:</b> 25 °C	<b>Relative Humidity:</b> 48 %	<b>Air Pressure:</b> 1005230 hPa	<b>Power:</b> 110 VAC, 60 Hz
<b>Remarks:</b>			

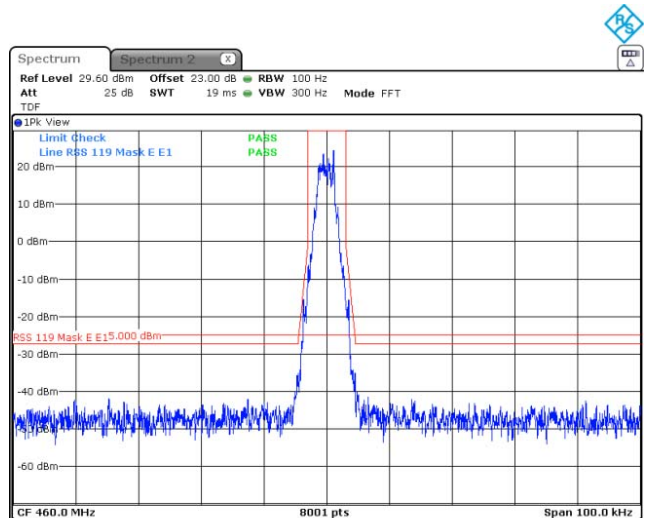
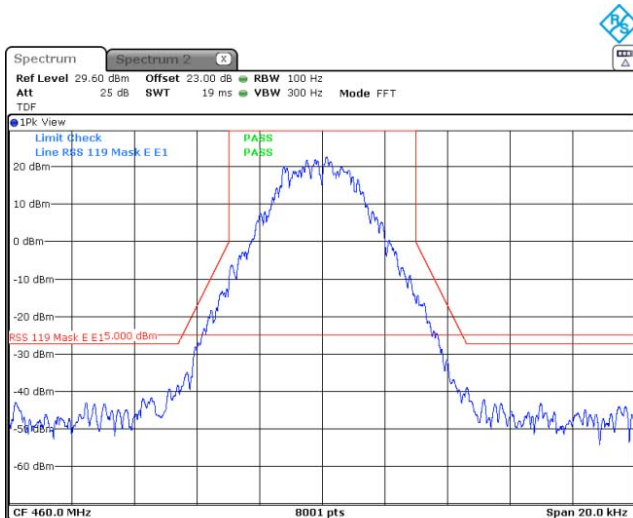
**Plot 7.3.4 Emission mask test results at low carrier frequency, RSS-119**

OPERATING FREQUENCY RANGE: 450 – 470 MHz  
DETECTOR USED: Peak  
MODULATION: 4GFSK  
MODULATING SIGNAL: PRBS  
TRANSMITTER OUTPUT POWER SETTINGS: Maximum



**Plot 7.3.5 Emission mask test results at mid carrier frequency, RSS-119**

OPERATING FREQUENCY RANGE: 450 – 470 MHz  
DETECTOR USED: Peak  
MODULATION: 4GFSK  
MODULATING SIGNAL: PRBS  
TRANSMITTER OUTPUT POWER SETTINGS: Maximum





HERMON LABORATORIES

<b>Test specification:</b> Section 90.210 / RSS-119 Section 5.8.4, Emission mask			
<b>Test procedure:</b> 47 CFR, Sections 2.1051, 2.1047 and 90.210(e); TIA/EIA-603-E, Section 2.2.13			
<b>Test mode:</b> Compliance		<b>Verdict:</b> PASS	
<b>Date(s):</b> 22-Aug-21			
<b>Temperature:</b> 25 °C	<b>Relative Humidity:</b> 48 %	<b>Air Pressure:</b> 1005230 hPa	<b>Power:</b> 110 VAC, 60 Hz
<b>Remarks:</b>			

Plot 7.3.6 Emission mask test results at high carrier frequency, RSS-119

OPERATING FREQUENCY RANGE:

450 – 470 MHz

DETECTOR USED:

Peak

MODULATION:

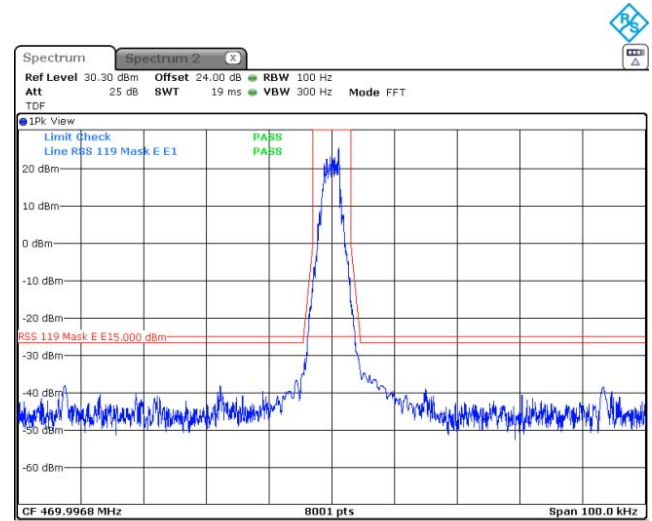
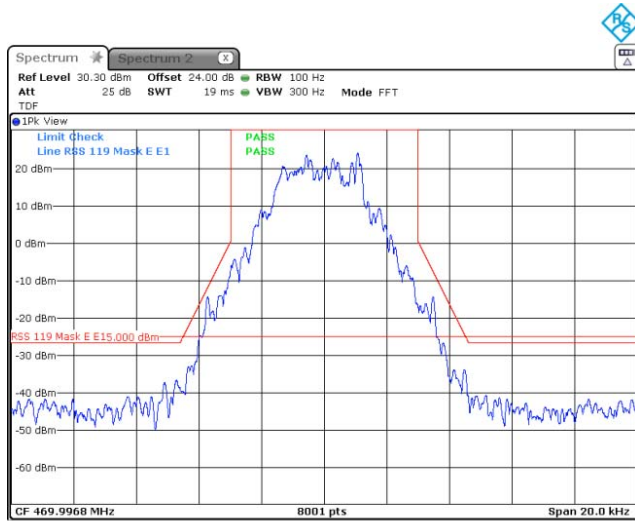
4GFSK

MODULATING SIGNAL:

PRBS

TRANSMITTER OUTPUT POWER SETTINGS:

Maximum





<b>Test specification: Section 90.210 / RSS-119 Section 5.8.4, Radiated spurious emissions</b>			
<b>Test procedure:</b> 47 CFR, Sections 2.1053; TIA/EIA-603-E, Section 2.2.12			
<b>Test mode:</b> Compliance		<b>Verdict:</b> PASS	
<b>Date(s):</b> 23-Jul-21 - 30-Jul-21			
<b>Temperature:</b> 26 °C	<b>Relative Humidity:</b> 54 %	<b>Air Pressure:</b> 1008 hPa	<b>Power:</b> 110 VAC, 60 Hz
<b>Remarks:</b>			

## 7.4 Radiated spurious emission measurements

### 7.4.1 General

This test was performed to measure radiated spurious emissions from the EUT. Specification test limits are given in Table 7.4.1.

**Table 7.4.1 Radiated spurious emission test limits**

Frequency, MHz	Attenuation below carrier, dBc	ERP of spurious, dBm	Equivalent field strength limit @ 3m, dB( $\mu$ V/m) <sup>***</sup>
0.009 – 10th harmonic*	55+10logP <sup>**</sup>	-25	72.4

\* - Excluding the in band emission within  $\pm 250$  % of the authorized bandwidth from the carrier

\*\* - 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

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

**7.4.2.1** The EUT was set up as shown in Figure 7.4.1, energized and the performance check was conducted.

**7.4.2.2** The specified frequency range was investigated with antenna connected to spectrum analyzer. To find maximum radiation the turntable was rotated  $360^\circ$  and the measuring antenna was rotated around its vertical axis.

**7.4.2.3** The worst test results (the lowest margins) were recorded in Table 7.4.2 and shown in the associated plots.

### 7.4.3 Test procedure for spurious emission field strength measurements above 30 MHz

**7.4.3.1** The EUT was set up as shown in Figure 7.4.2, energized and the performance check was conducted.

**7.4.3.2** The specified frequency range was investigated with antenna connected to spectrum analyzer. To find maximum radiation the turntable was rotated  $360^\circ$  and the measuring antenna height was swept from 1 to 4 m in both, vertical and horizontal, polarizations.

**7.4.3.3** The worst test results (the lowest margins) were recorded in Table 7.4.2 and shown in the associated plots.



<b>Test specification:</b> Section 90.210 / RSS-119 Section 5.8.4, Radiated spurious emissions			
<b>Test procedure:</b> 47 CFR, Sections 2.1053; TIA/EIA-603-E, Section 2.2.12			
<b>Test mode:</b> Compliance		<b>Verdict:</b> PASS	
<b>Date(s):</b> 23-Jul-21 - 30-Jul-21			
<b>Temperature:</b> 26 °C	<b>Relative Humidity:</b> 54 %	<b>Air Pressure:</b> 1008 hPa	<b>Power:</b> 110 VAC, 60 Hz
<b>Remarks:</b>			

Figure 7.4.1 Setup for spurious emission field strength measurements in 9 kHz to 30 MHz band

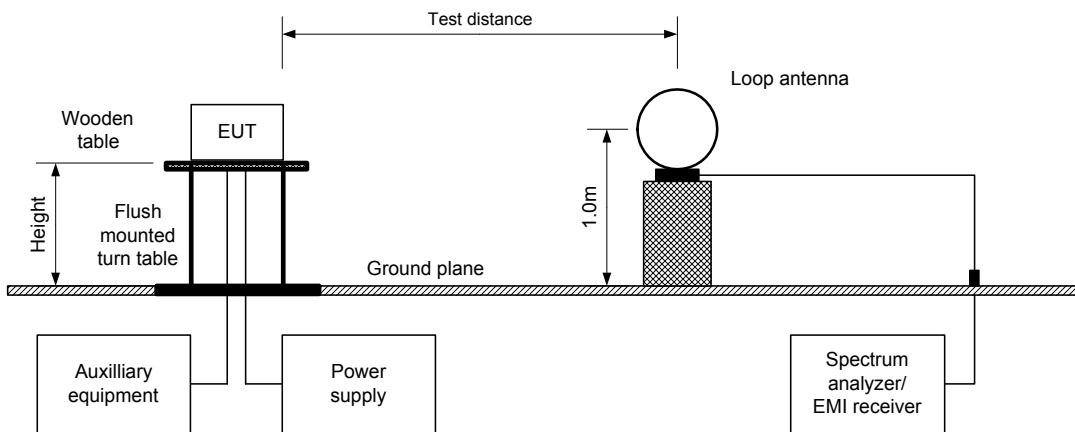
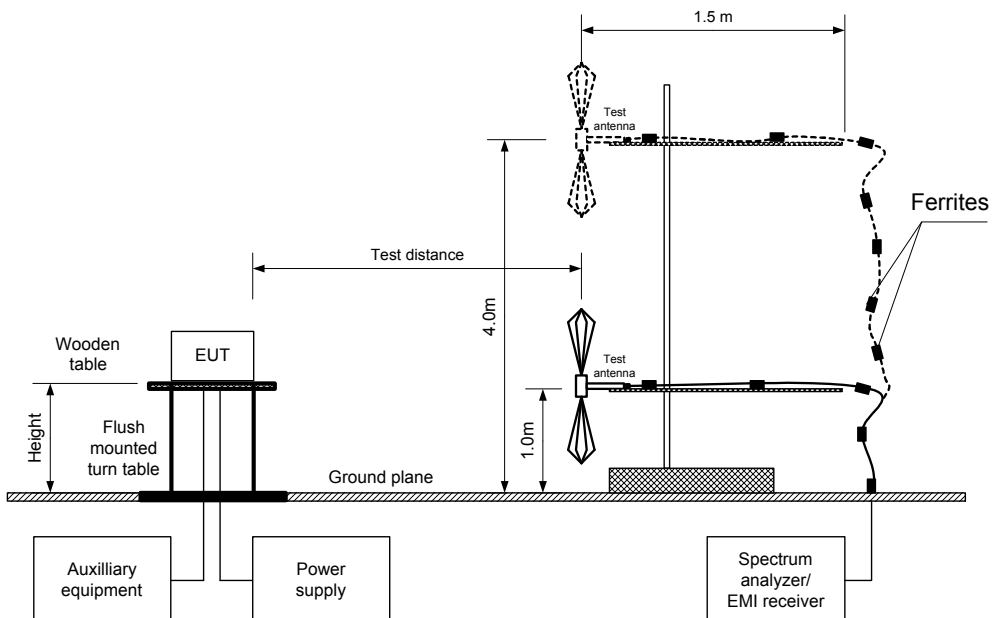


Figure 7.4.2 Setup for spurious emission field strength measurements above 30 MHz







<b>Test specification: Section 90.210 / RSS-119 Section 5.8.4, Radiated spurious emissions</b>			
<b>Test procedure:</b> 47 CFR, Sections 2.1053; TIA/EIA-603-E, Section 2.2.12			
<b>Test mode:</b> Compliance		<b>Verdict: PASS</b>	
<b>Date(s):</b> 23-Jul-21 - 30-Jul-21			
<b>Temperature:</b> 26 °C	<b>Relative Humidity:</b> 54 %	<b>Air Pressure:</b> 1008 hPa	<b>Power:</b> 110 VAC, 60 Hz
<b>Remarks:</b>			

**Table 7.4.2 Spurious emission field strength test results**

ASSIGNED FREQUENCY RANGE: 450.0 – 470.0 MHz  
TEST DISTANCE: 3 m  
TEST SITE: Semi anechoic chamber  
INVESTIGATED FREQUENCY RANGE: 0.009 – 5000 MHz  
DETECTOR USED: Peak  
VIDEO BANDWIDTH: > Resolution bandwidth  
TEST ANTENNA TYPE: Active loop (9 kHz – 30 MHz)  
Biconilog (30 MHz – 1000 MHz)  
Double ridged guide (above 1000 MHz)  
MODULATION: 4GFSK  
BIT RATE: 4.8 kbps  
TRANSMITTER OUTPUT POWER: Maximum

Frequency, MHz	Field strength, dB( $\mu$ V/m)	Limit, dB( $\mu$ V/m)	Margin, dB*	RBW, kHz	Antenna polarization	Antenna height, m	Turn-table position**, degrees	Verdict
<b>Low carrier frequency 450.0031 MHz</b>								
All emissions are more than 20 dB below the limit								Pass
<b>Mid carrier frequency 460.0000 MHz</b>								
All emissions are more than 20 dB below the limit								Pass
<b>High carrier frequency 469.9969 MHz</b>								
All emissions are more than 20 dB below the limit								Pass

\*- Margin = Field strength of spurious – calculated field strength limit.

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

**Reference numbers of test equipment used**

HL 0446	HL 3903	HL 4360	HL 4933	HL 5288	HL 5405	HL 4339	HL 5902
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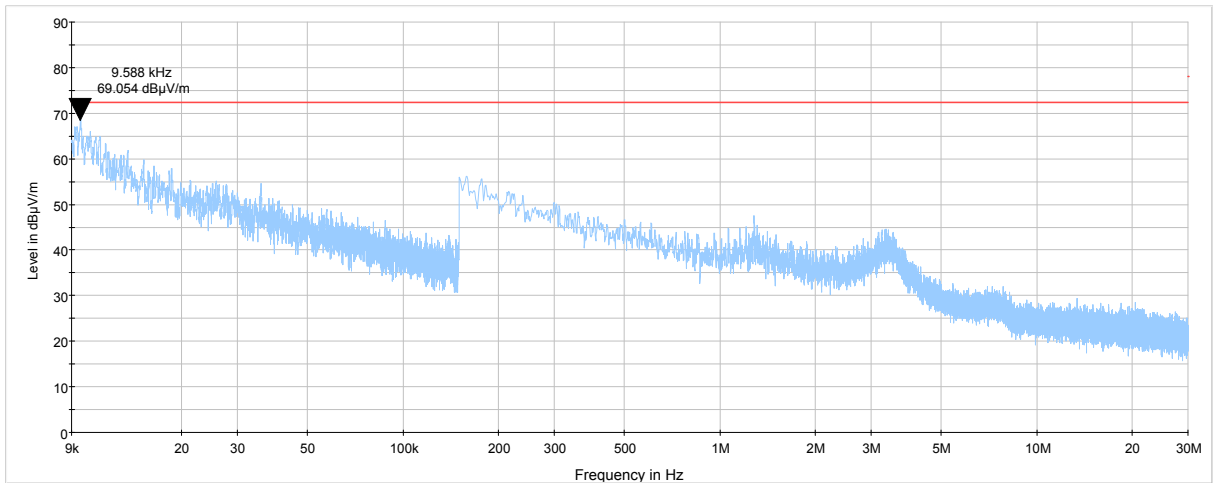
Full description is given in Appendix A.



<b>Test specification: Section 90.210 / RSS-119 Section 5.8.4, Radiated spurious emissions</b>			
<b>Test procedure:</b> 47 CFR, Sections 2.1053; TIA/EIA-603-E, Section 2.2.12			
<b>Test mode:</b> Compliance		<b>Verdict: PASS</b>	
<b>Date(s):</b> 23-Jul-21 - 30-Jul-21			
<b>Temperature:</b> 26 °C	<b>Relative Humidity:</b> 54 %	<b>Air Pressure:</b> 1008 hPa	<b>Power:</b> 110 VAC, 60 Hz
<b>Remarks:</b>			

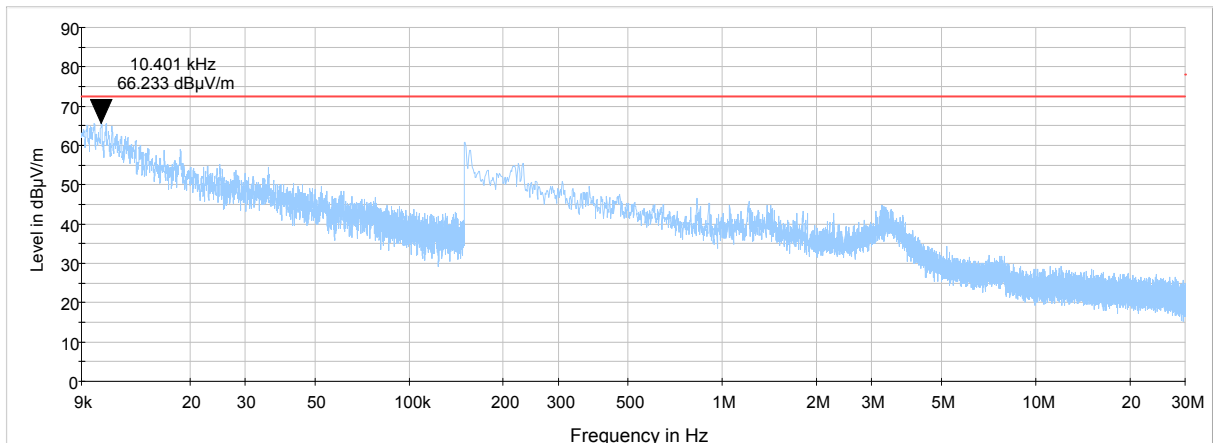
**Plot 7.4.1 Radiated emission measurements in 9 kHz - 30 MHz range**

TEST SITE: Semi anechoic chamber  
 CARRIER FREQUENCY: Low  
 TEST DISTANCE: 3 m  
 EUT POWER: 110 V/60 Hz



**Plot 7.4.2 Radiated emission measurements in 9 kHz - 30 MHz range**

TEST SITE: Semi anechoic chamber  
 CARRIER FREQUENCY: Mid  
 TEST DISTANCE: 3 m  
 EUT POWER: 110 V/60 Hz

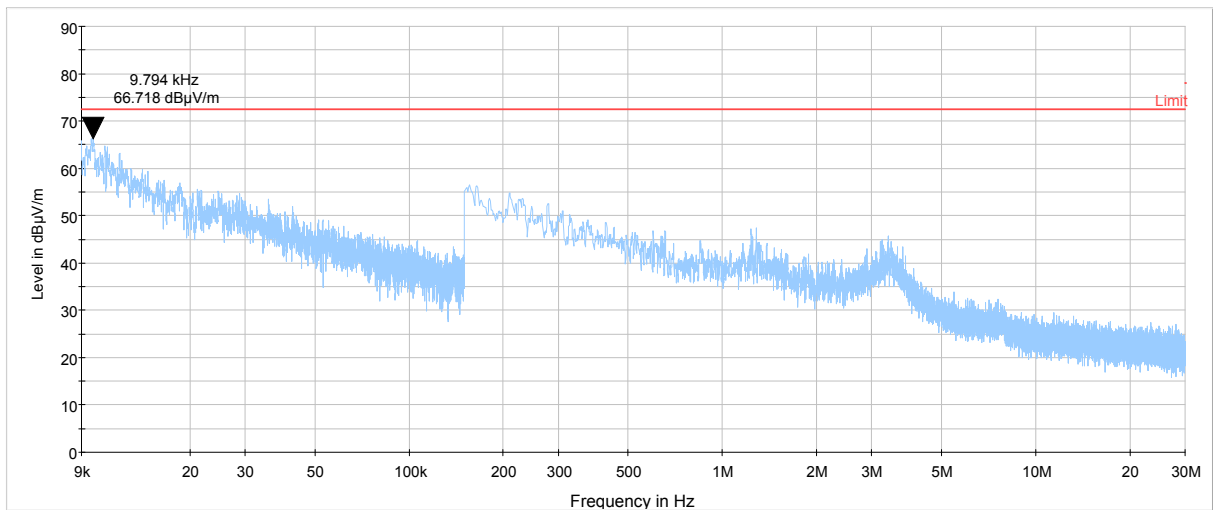




<b>Test specification: Section 90.210 / RSS-119 Section 5.8.4, Radiated spurious emissions</b>			
<b>Test procedure:</b> 47 CFR, Sections 2.1053; TIA/EIA-603-E, Section 2.2.12			
<b>Test mode:</b> Compliance		<b>Verdict:</b> PASS	
<b>Date(s):</b> 23-Jul-21 - 30-Jul-21			
<b>Temperature:</b> 26 °C	<b>Relative Humidity:</b> 54 %	<b>Air Pressure:</b> 1008 hPa	<b>Power:</b> 110 VAC, 60 Hz
<b>Remarks:</b>			

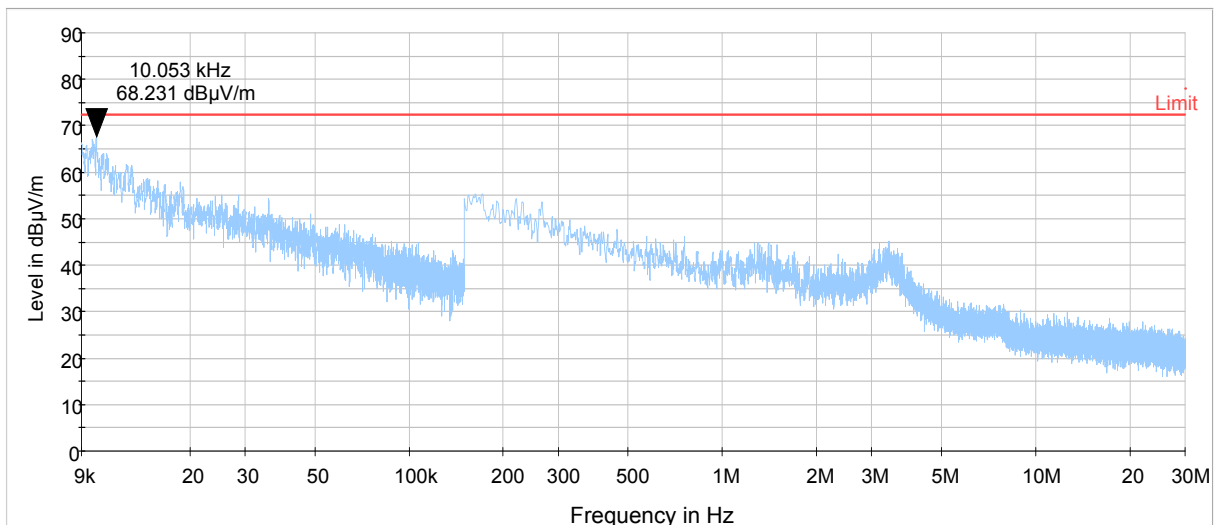
**Plot 7.4.3 Radiated emission measurements in 9 kHz - 30 MHz range**

TEST SITE: Semi anechoic chamber  
 CARRIER FREQUENCY: High  
 TEST DISTANCE: 3 m  
 EUT POWER: 110 V/60 Hz



**Plot 7.4.4 Radiated emission measurements in 9 kHz - 30 MHz range**

TEST SITE: Semi anechoic chamber  
 CARRIER FREQUENCY: Low  
 TEST DISTANCE: 3 m  
 EUT POWER: 277 V/60 Hz

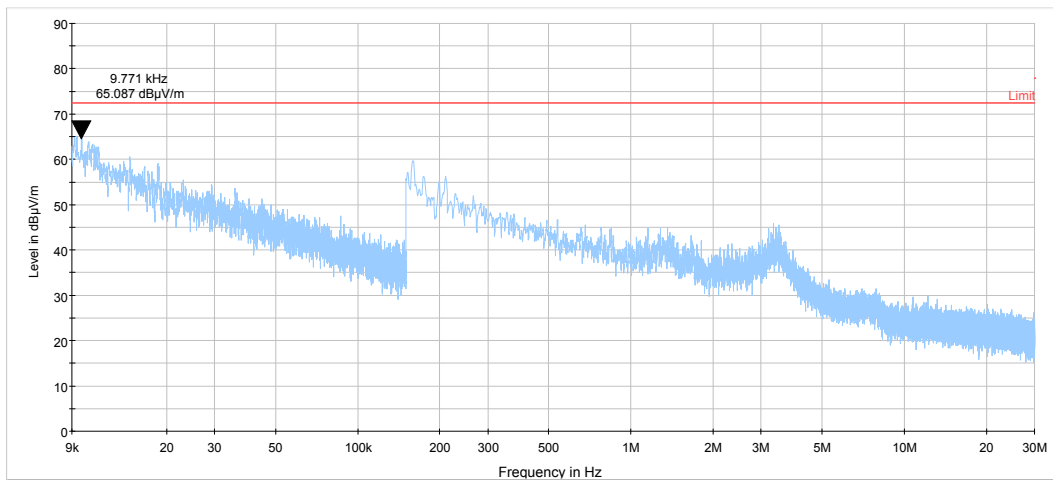




<b>Test specification: Section 90.210 / RSS-119 Section 5.8.4, Radiated spurious emissions</b>			
<b>Test procedure:</b> 47 CFR, Sections 2.1053; TIA/EIA-603-E, Section 2.2.12			
<b>Test mode:</b> Compliance		<b>Verdict:</b> PASS	
<b>Date(s):</b> 23-Jul-21 - 30-Jul-21			
<b>Temperature:</b> 26 °C	<b>Relative Humidity:</b> 54 %	<b>Air Pressure:</b> 1008 hPa	<b>Power:</b> 110 VAC, 60 Hz
<b>Remarks:</b>			

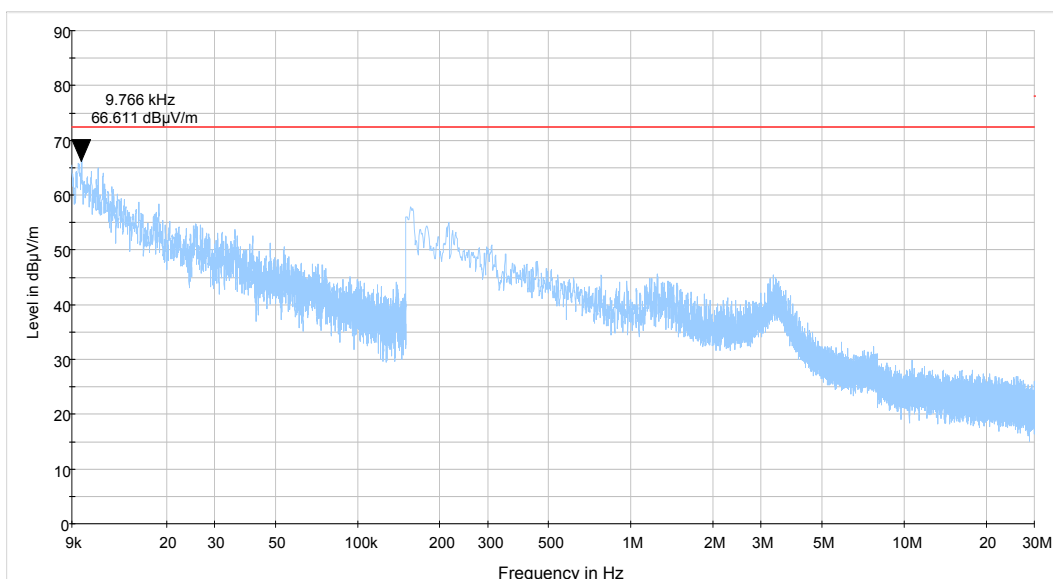
**Plot 7.4.5 Radiated emission measurements in 9 kHz - 30 MHz range**

TEST SITE: Semi anechoic chamber  
 CARRIER FREQUENCY: Mid  
 TEST DISTANCE: 3 m  
 EUT POWER: 277 V/60 Hz



**Plot 7.4.6 Radiated emission measurements in 9 kHz - 30 MHz range**

TEST SITE: Semi anechoic chamber  
 CARRIER FREQUENCY: High  
 TEST DISTANCE: 3 m  
 EUT POWER: 277 V/60 Hz



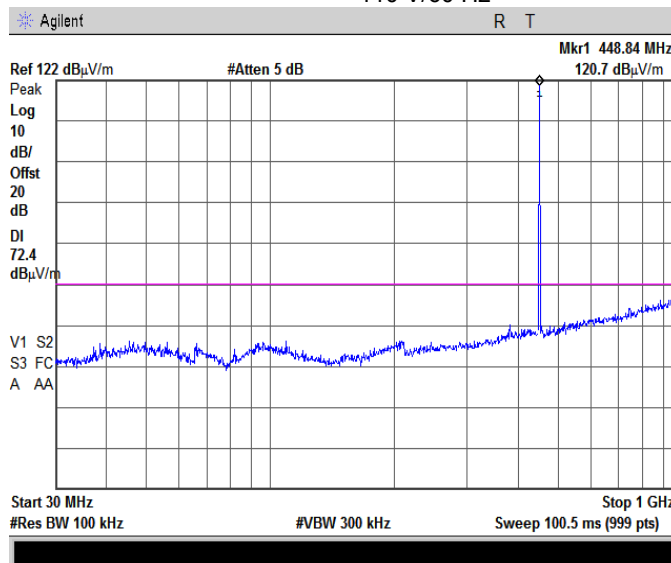


HERMON LABORATORIES

<b>Test specification: Section 90.210 / RSS-119 Section 5.8.4, Radiated spurious emissions</b>			
<b>Test procedure:</b> 47 CFR, Sections 2.1053; TIA/EIA-603-E, Section 2.2.12			
<b>Test mode:</b> Compliance		<b>Verdict:</b> PASS	
<b>Date(s):</b> 23-Jul-21 - 30-Jul-21			
<b>Temperature:</b> 26 °C	<b>Relative Humidity:</b> 54 %	<b>Air Pressure:</b> 1008 hPa	<b>Power:</b> 110 VAC, 60 Hz
<b>Remarks:</b>			

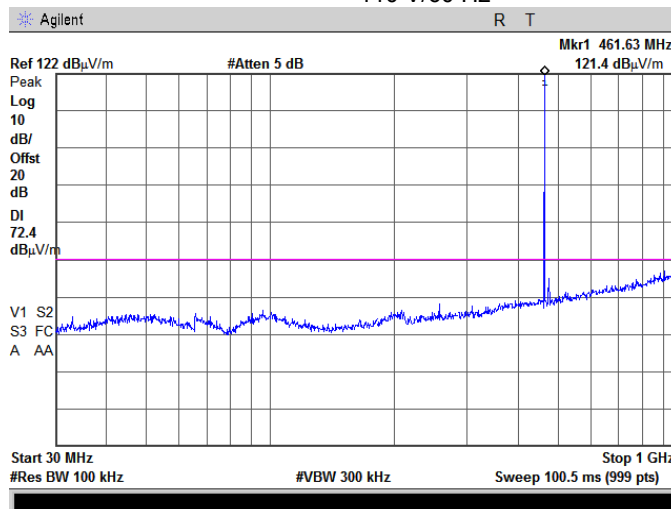
**Plot 7.4.7 Radiated emission measurements in 30 - 1000 MHz range**

TEST SITE: Semi anechoic chamber  
 CARRIER FREQUENCY: Low  
 ANTENNA POLARIZATION: Vertical and Horizontal  
 TEST DISTANCE: 3 m  
 EUT POWER: 110 V/60 Hz



**Plot 7.4.8 Radiated emission measurements in 30 - 1000 MHz range**

TEST SITE: Semi anechoic chamber  
 CARRIER FREQUENCY: Mid  
 ANTENNA POLARIZATION: Vertical and Horizontal  
 TEST DISTANCE: 3 m  
 EUT POWER: 110 V/60 Hz



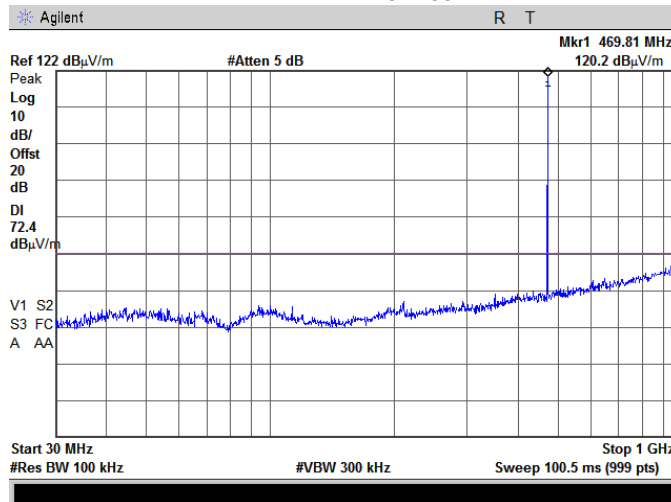


HERMON LABORATORIES

<b>Test specification: Section 90.210 / RSS-119 Section 5.8.4, Radiated spurious emissions</b>			
<b>Test procedure:</b> 47 CFR, Sections 2.1053; TIA/EIA-603-E, Section 2.2.12			
<b>Test mode:</b> Compliance		<b>Verdict:</b> PASS	
<b>Date(s):</b> 23-Jul-21 - 30-Jul-21			
<b>Temperature:</b> 26 °C	<b>Relative Humidity:</b> 54 %	<b>Air Pressure:</b> 1008 hPa	<b>Power:</b> 110 VAC, 60 Hz
<b>Remarks:</b>			

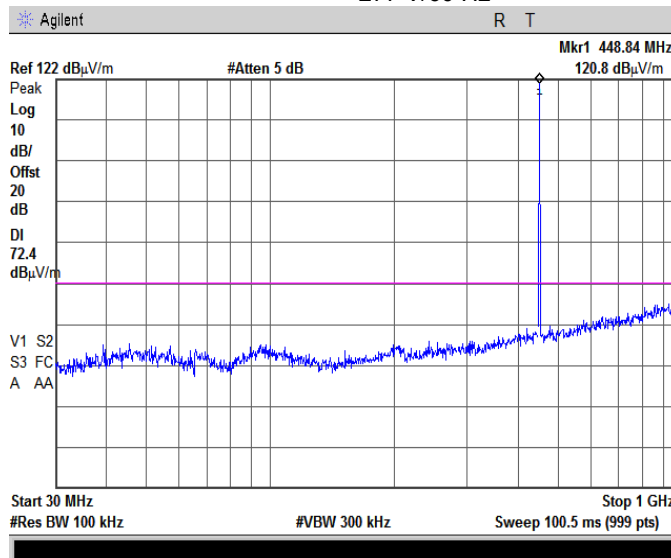
Plot 7.4.9 Radiated emission measurements in 30 - 1000 MHz range

TEST SITE: Semi anechoic chamber  
 CARRIER FREQUENCY: High  
 ANTENNA POLARIZATION: Vertical and Horizontal  
 TEST DISTANCE: 3 m  
 EUT POWER: 110 V/60 Hz



Plot 7.4.10 Radiated emission measurements in 30 - 1000 MHz range

TEST SITE: Semi anechoic chamber  
 CARRIER FREQUENCY: Low  
 ANTENNA POLARIZATION: Vertical and Horizontal  
 TEST DISTANCE: 3 m  
 EUT POWER: 277 V/60 Hz



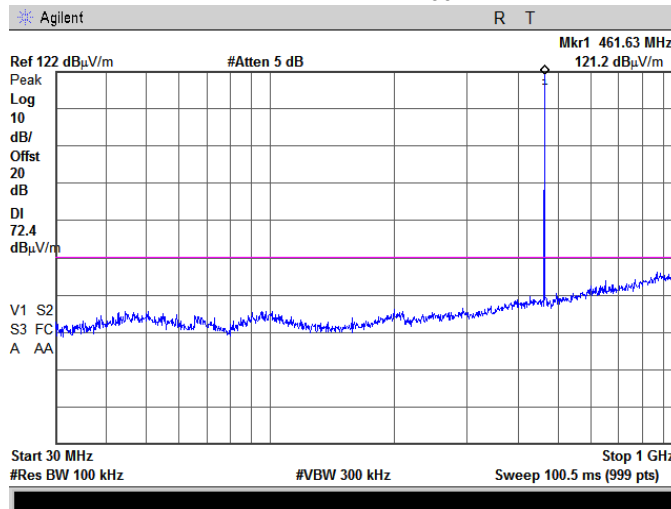


HERMON LABORATORIES

<b>Test specification: Section 90.210 / RSS-119 Section 5.8.4, Radiated spurious emissions</b>			
<b>Test procedure:</b> 47 CFR, Sections 2.1053; TIA/EIA-603-E, Section 2.2.12			
<b>Test mode:</b> Compliance		<b>Verdict:</b> PASS	
<b>Date(s):</b> 23-Jul-21 - 30-Jul-21			
<b>Temperature:</b> 26 °C	<b>Relative Humidity:</b> 54 %	<b>Air Pressure:</b> 1008 hPa	<b>Power:</b> 110 VAC, 60 Hz
<b>Remarks:</b>			

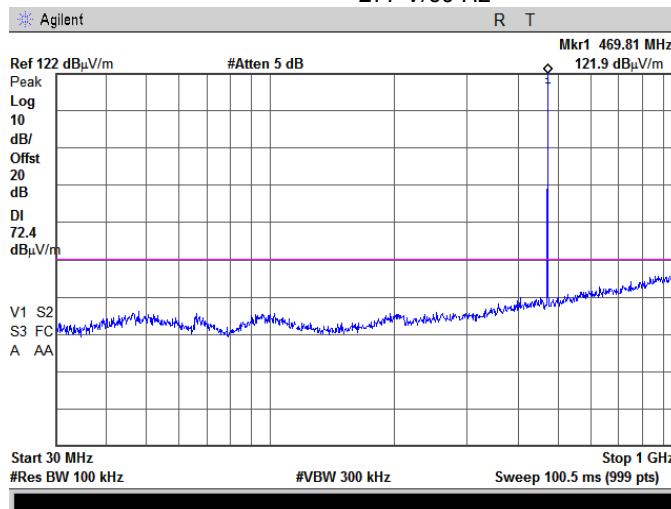
Plot 7.4.11 Radiated emission measurements in 30 - 1000 MHz range

TEST SITE: Semi anechoic chamber  
 CARRIER FREQUENCY: Mid  
 ANTENNA POLARIZATION: Vertical and Horizontal  
 TEST DISTANCE: 3 m  
 EUT POWER: 277 V/60 Hz



Plot 7.4.12 Radiated emission measurements in 30 - 1000 MHz range

TEST SITE: Semi anechoic chamber  
 CARRIER FREQUENCY: High  
 ANTENNA POLARIZATION: Vertical and Horizontal  
 TEST DISTANCE: 3 m  
 EUT POWER: 277 V/60 Hz



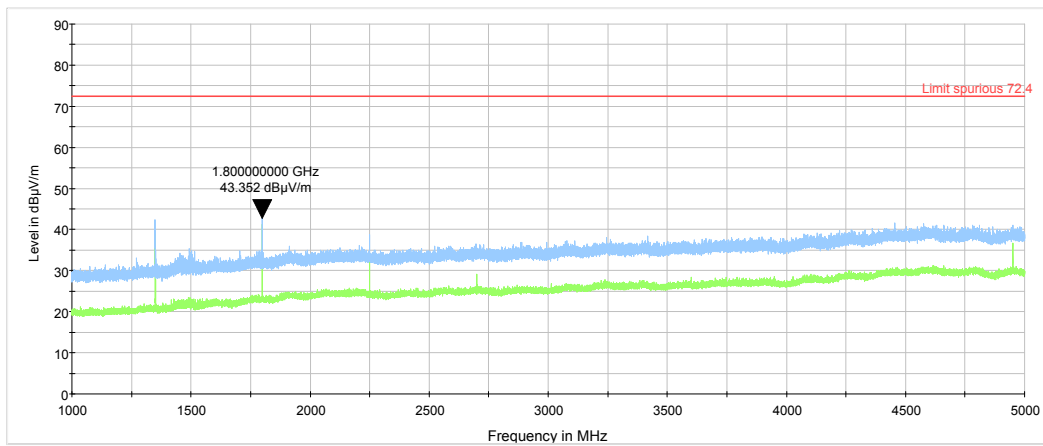


HERMON LABORATORIES

<b>Test specification: Section 90.210 / RSS-119 Section 5.8.4, Radiated spurious emissions</b>			
<b>Test procedure:</b> 47 CFR, Sections 2.1053; TIA/EIA-603-E, Section 2.2.12			
<b>Test mode:</b> Compliance		<b>Verdict: PASS</b>	
<b>Date(s):</b> 23-Jul-21 - 30-Jul-21			
<b>Temperature:</b> 26 °C	<b>Relative Humidity:</b> 54 %	<b>Air Pressure:</b> 1008 hPa	<b>Power:</b> 110 VAC, 60 Hz
<b>Remarks:</b>			

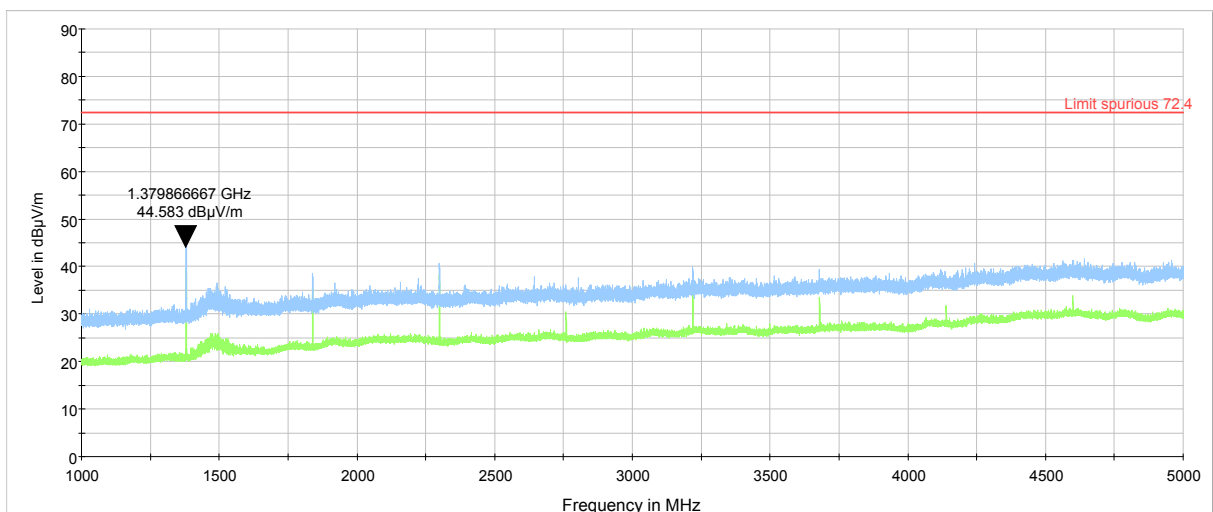
**Plot 7.4.13 Radiated emission measurements in 1000 – 5000 MHz range**

TEST SITE: Semi anechoic chamber  
 CARRIER FREQUENCY: Low  
 ANTENNA POLARIZATION: Vertical and Horizontal  
 TEST DISTANCE: 3 m  
 EUT POWER: 110 V/60 Hz



**Plot 7.4.14 Radiated emission measurements in 1000 – 5000 MHz range**

TEST SITE: Semi anechoic chamber  
 CARRIER FREQUENCY: Mid  
 ANTENNA POLARIZATION: Vertical and Horizontal  
 TEST DISTANCE: 3 m  
 EUT POWER: 110 V/60 Hz





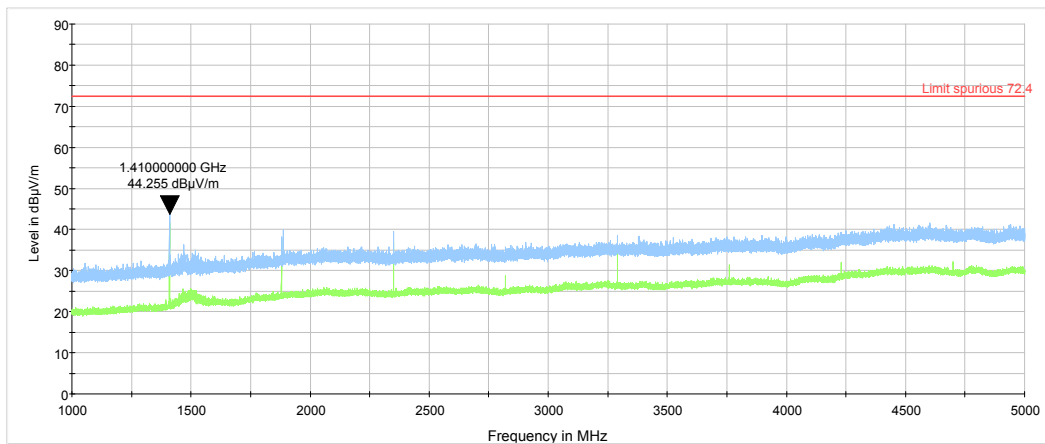


HERMON LABORATORIES

<b>Test specification: Section 90.210 / RSS-119 Section 5.8.4, Radiated spurious emissions</b>			
<b>Test procedure:</b> 47 CFR, Sections 2.1053; TIA/EIA-603-E, Section 2.2.12			
<b>Test mode:</b> Compliance		<b>Verdict:</b> PASS	
<b>Date(s):</b> 23-Jul-21 - 30-Jul-21			
<b>Temperature:</b> 26 °C	<b>Relative Humidity:</b> 54 %	<b>Air Pressure:</b> 1008 hPa	<b>Power:</b> 110 VAC, 60 Hz
<b>Remarks:</b>			

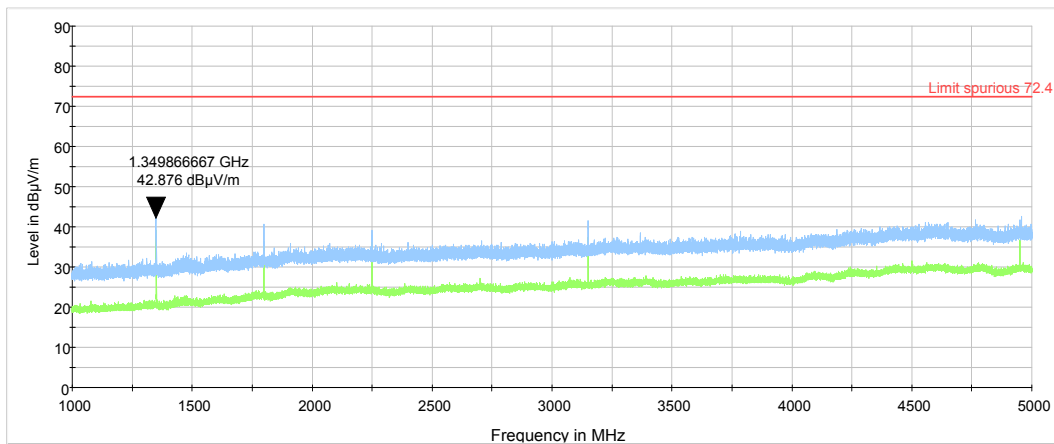
Plot 7.4.15 Radiated emission measurements in 1000 – 5000 MHz range

TEST SITE: Semi anechoic chamber  
 CARRIER FREQUENCY: High  
 ANTENNA POLARIZATION: Vertical and Horizontal  
 TEST DISTANCE: 3 m  
 EUT POWER: 110 V/60 Hz



Plot 7.4.16 Radiated emission measurements in 1000 – 5000 MHz range

TEST SITE: Semi anechoic chamber  
 CARRIER FREQUENCY: Low  
 ANTENNA POLARIZATION: Vertical and Horizontal  
 TEST DISTANCE: 3 m  
 EUT POWER: 277 V/60 Hz



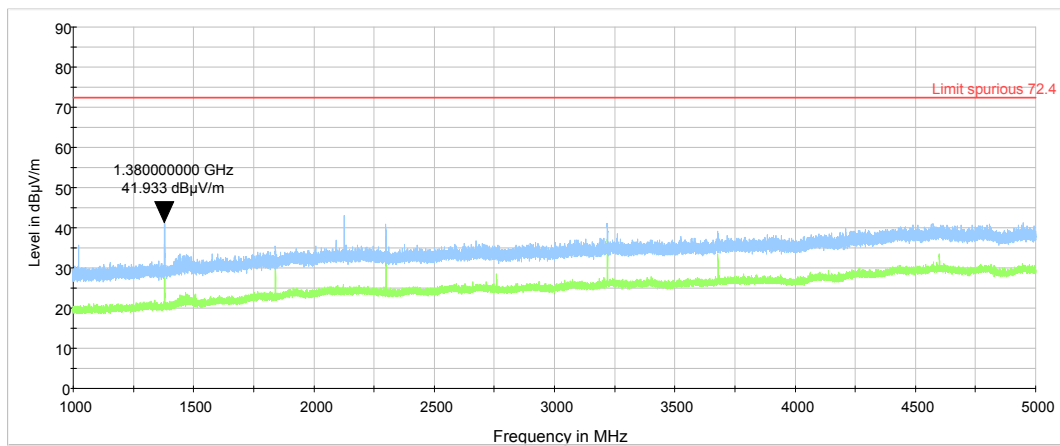


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<b>Test specification: Section 90.210 / RSS-119 Section 5.8.4, Radiated spurious emissions</b>			
<b>Test procedure:</b> 47 CFR, Sections 2.1053; TIA/EIA-603-E, Section 2.2.12			
<b>Test mode:</b> Compliance		<b>Verdict:</b> PASS	
<b>Date(s):</b> 23-Jul-21 - 30-Jul-21			
<b>Temperature:</b> 26 °C	<b>Relative Humidity:</b> 54 %	<b>Air Pressure:</b> 1008 hPa	<b>Power:</b> 110 VAC, 60 Hz
<b>Remarks:</b>			

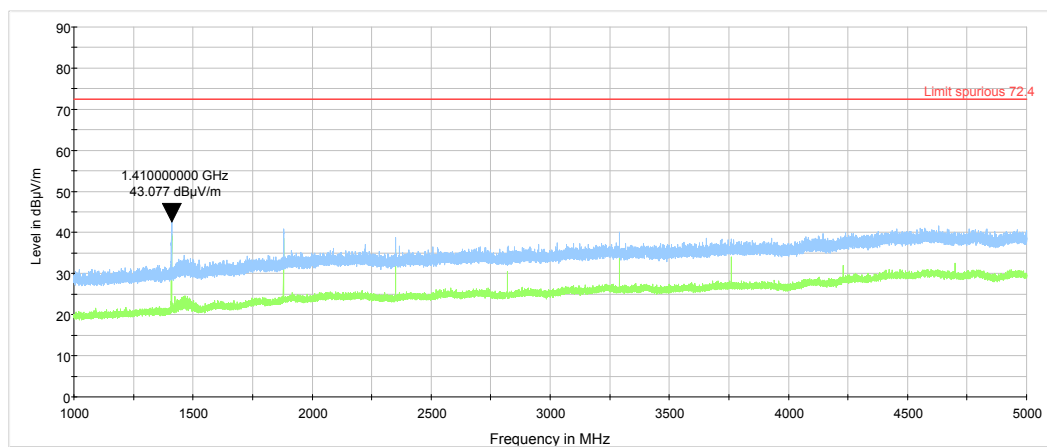
**Plot 7.4.17 Radiated emission measurements in 1000 – 5000 MHz range**

TEST SITE: Semi anechoic chamber  
 CARRIER FREQUENCY: Mid  
 ANTENNA POLARIZATION: Vertical and Horizontal  
 TEST DISTANCE: 3 m  
 EUT POWER: 277 V/60 Hz



**Plot 7.4.18 Radiated emission measurements in 1000 – 5000 MHz range**

TEST SITE: Semi anechoic chamber  
 CARRIER FREQUENCY: High  
 ANTENNA POLARIZATION: Vertical and Horizontal  
 TEST DISTANCE: 3 m  
 EUT POWER: 277 V/60 Hz





<b>Test specification: Section 90.213 / RSS-119 Section 5.3, Frequency stability</b>			
<b>Test procedure:</b> 47 CFR, Section 2.1055; TIA/EIA-603-E Section 2.2.2			
<b>Test mode:</b> Compliance		<b>Verdict:</b> PASS	
<b>Date(s):</b> 25-Aug-21			
<b>Temperature:</b> 24 °C	<b>Relative Humidity:</b> 55 %	<b>Air Pressure:</b> 1002 hPa	<b>Power:</b> 110 VAC, 60 Hz
<b>Remarks:</b>			

## 7.5 Frequency stability test

### 7.5.1 General

This test was performed to measure frequency stability of transmitter RF carrier. Specification test limits are given in Table 7.5.1.

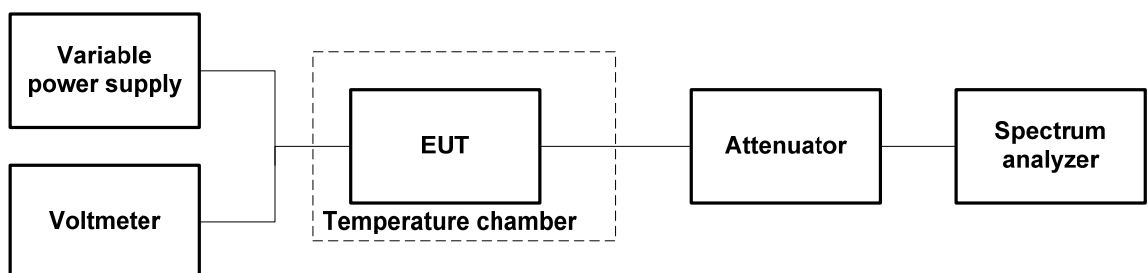
Table 7.5.1 Frequency stability limits

Assigned frequency, MHz	Maximum allowed frequency displacement	
	ppm	Hz
450.0031	1.0	450
460.0000		460
469.9969		470

### 7.5.2 Test procedure

- 7.5.2.1 The EUT was set up as shown in Figure 7.5.1, energized and its proper operation was checked.
- 7.5.2.2 The EUT power was turned off. Temperature within test chamber was set to +30°C and a period of time sufficient to stabilize all of the oscillator circuit components was allowed.
- 7.5.2.3 The EUT was powered on and carrier frequency was measured at start up moment and then every minute until frequency had been stabilized or 10 minutes elapsed whichever reached the last. The EUT was powered off.
- 7.5.2.4 The above procedure was repeated at 0°C and at the lowest test temperature.
- 7.5.2.5 The EUT was powered on and carrier frequency was measured at start up moment and at the end of stabilization period at the rest of test temperatures and voltages. The EUT was powered off.
- 7.5.2.6 Frequency displacement was calculated and compared with the limit as provided in Table 7.5.2.
- 7.5.2.7 The test results are provided in Table 7.5.2.

Figure 7.5.1 Frequency stability test setup





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<b>Test specification:</b> Section 90.213 / RSS-119 Section 5.3, Frequency stability			
<b>Test procedure:</b> 47 CFR, Section 2.1055; TIA/EIA-603-E Section 2.2.2			
<b>Test mode:</b> Compliance		<b>Verdict:</b> PASS	
<b>Date(s):</b> 25-Aug-21			
<b>Temperature:</b> 24 °C	<b>Relative Humidity:</b> 55 %	<b>Air Pressure:</b> 1002 hPa	<b>Power:</b> 110 VAC, 60 Hz
<b>Remarks:</b>			

Table 7.5.2 Frequency stability test results

OPERATING FREQUENCY: 450 – 470 MHz  
 NOMINAL POWER VOLTAGE: 110 VAC 60 Hz  
 TEMPERATURE STABILIZATION PERIOD: 20 min  
 POWER DURING TEMPERATURE TRANSITION: Off  
 SPECTRUM ANALYZER MODE: Counter  
 RESOLUTION BANDWIDTH: 10 Hz  
 VIDEO BANDWIDTH: 30 Hz  
 MODULATION: Unmodulated

T, °C	Voltage, V	Frequency, MHz							Max frequency drift, Hz		Limit, Hz	Margin, Hz	Verdict
		Start up	1 <sup>st</sup> min	2 <sup>nd</sup> min	3 <sup>rd</sup> min	4 <sup>th</sup> min	5 <sup>th</sup> min	10 <sup>th</sup> min	Positive	Negative			
<b>Low frequency 450.0031 MHz</b>													
-30	nominal	450.003062	450.003068	450.003046	450.003030	450.003015	450.002995	450.002962	58	-48	450	-392	Pass
-20	nominal	450.003047	NA	NA	NA	NA	NA	450.003000	37	-10		-413	Pass
-10	nominal	450.003057	NA	NA	NA	NA	NA	450.003047	47	0		-403	Pass
0	nominal	450.003106	450.003106	450.003111	450.003115	450.003118	450.003123	450.003135	125	0		-325	Pass
10	nominal	450.003048	NA	NA	NA	NA	NA	450.003140	130	0		-320	Pass
20	+15%	450.003060	NA	NA	NA	NA	NA	450.003052	50	0		-400	Pass
20	nominal	450.003020	NA	NA	NA	NA	NA	450.003010	10	0		-440	Pass
20	-15%	450.003042	NA	NA	NA	NA	NA	450.003084	74	0		-376	Pass
30	nominal	450.003035	450.003029	450.003033	450.003033	450.003035	450.003035	450.003037	27	0		-423	Pass
40	nominal	450.003039	NA	NA	NA	NA	NA	450.003022	29	0		-421	Pass
50	nominal	450.003058	NA	NA	NA	NA	NA	450.003061	51	0		-399	Pass
<b>Mid frequency 460.0000MHz</b>													
-30	nominal	460.000016	460.000028	460.000008	460.000002	459.999995	459.999990	459.999958	118	0	460	-342	Pass
-20	nominal	460.000066	NA	NA	NA	NA	NA	460.000065	156	0		-304	Pass
-10	nominal	460.000041	NA	NA	NA	NA	NA	460.000033	131	0		-329	Pass
0	nominal	460.000011	460.000011	460.000013	460.000018	460.000021	460.000025	460.000035	125	0		-335	Pass
10	nominal	460.000002	NA	NA	NA	NA	NA	460.000043	133	0		-327	Pass
20	+15%	459.999928	NA	NA	NA	NA	NA	459.999910	18	0		-442	Pass
20	nominal	459.999914	NA	NA	NA	NA	NA	459.999910	4	0		-456	Pass
20	-15%	459.999914	NA	NA	NA	NA	NA	459.999929	19	0		-441	Pass
30	nominal	459.999963	459.999944	459.999948	459.999949	459.999950	459.999950	459.999953	53	0		-407	Pass
40	nominal	459.999919	NA	NA	NA	NA	NA	459.999904	9	-6		-451	Pass
50	nominal	459.999874	NA	NA	NA	NA	NA	459.999858	0	-52		-408	Pass
<b>High frequency 469.9969 MHz</b>													
-30	nominal	469.996780	469.996786	469.996762	469.996748	469.996735	469.996725	469.996693	10	-83	470	-387	Pass
-20	nominal	469.996888	NA	NA	NA	NA	NA	469.996895	119	0		-351	Pass
-10	nominal	469.996858	NA	NA	NA	NA	NA	469.996862	86	0		-384	Pass
0	nominal	469.996888	469.996893	469.996905	469.996915	469.996922	469.996930	469.996956	180	0		-290	Pass
10	nominal	469.996825	NA	NA	NA	NA	NA	469.996843	67	0		-403	Pass
20	+15%	469.996742	NA	NA	NA	NA	NA	469.996702	0	-74		-396	Pass
20	nominal	469.996682	NA	NA	NA	NA	NA	469.996776	0	-94		-376	Pass
20	-15%	469.996700	NA	NA	NA	NA	NA	469.996708	0	-76		-394	Pass
30	nominal	469.996670	469.996657	469.996658	469.996656	469.996660	469.996659	469.996661	0	-120		-350	Pass
40	nominal	469.996604	NA	NA	NA	NA	NA	469.996614	0	-172		-298	Pass
50	nominal	469.996620	NA	NA	NA	NA	NA	469.996567	0	-209		-261	Pass

\* - Reference frequency

Reference numbers of test equipment used

HL 0493	HL 3766	HL 4355				
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Full description is given in Appendix A.



<b>Test specification: Section 90.214 / RSS-119 Section 5.9, Transient frequency behaviour</b>			
<b>Test procedure:</b> TIA/EIA-603-E, Section 2.2.19			
<b>Test mode:</b> Compliance		<b>Verdict: PASS</b>	
<b>Date(s):</b> 30-Sep-21			
<b>Temperature:</b> 24 °C	<b>Relative Humidity:</b> 55 %	<b>Air Pressure:</b> 1008 hPa	<b>Power:</b> 110 VAC, 60 Hz
<b>Remarks:</b>			

## 7.6 Transient frequency behaviour test

### 7.6.1 General

This test was performed to measure carrier frequency drift as function of time during transmitter start up and shut down. Specification test limits are given in Table 7.6.1.

Table 7.6.1 Transient frequency limits

Channel bandwidth, kHz	Carrier frequency tolerance, kHz	Duration, ms	Time interval*
<b>421.0 – 512.0 MHz band</b>			
6.25	$\pm 6.25$	10.0	$t_1$
	$\pm 3.125$	25.0	$t_2$
	$\pm 6.25$	10.0	$t_3$

\* -  $t_{on}$  is the instant when a 1 kHz test signal is completely suppressed;

$t_1$  is the time period immediately following  $t_{on}$ ;

$t_2$  is the time period immediately following  $t_1$ ;

$t_3$  is the time period from the instant when the transmitter is turned off until  $t_{off}$ ;

$t_{off}$  is the instant when the 1 kHz test signal starts to rise.

### 7.6.2 Test procedure

**7.6.2.1** The EUT was set up as shown in Figure 7.6.1, energized and its proper operation was checked. Variable attenuator was adjusted to provide signal level approximately 40 dB below the FM receiver maximum allowed level as measured with RF power meter. The EUT was turned off.

**7.6.2.2** The signal generator was set to the assigned transmitter frequency modulated with 1 kHz tone at 25 kHz deviation and the output power was adjusted to provide the same as the EUT signal level at the FM receiver input as measured with power meter.

**7.6.2.3** The storage oscilloscope was set to provide horizontal sweep rate 10 milliseconds per division. Amplitude control of the storage oscilloscope was adjusted to obtain 1 kHz sinusoidal signal vertically centered with  $\pm 4$  divisions amplitude.

**7.6.2.4** The variable attenuator was adjusted to increase RF level supplied to splitter by 30 dB and the EUT was consequently turned on and off. Transient frequency during power switching was captured and shown in the associated plots.

**7.6.2.5** The test results are provided in Table 7.6.2 and the associated plots.





<b>Test specification:</b> Section 90.214 / RSS-119 Section 5.9, Transient frequency behaviour			
<b>Test procedure:</b> TIA/EIA-603-E, Section 2.2.19			
<b>Test mode:</b> Compliance		<b>Verdict:</b> PASS	
<b>Date(s):</b> 30-Sep-21			
<b>Temperature:</b> 24 °C	<b>Relative Humidity:</b> 55 %	<b>Air Pressure:</b> 1008 hPa	<b>Power:</b> 110 VAC, 60 Hz
<b>Remarks:</b>			

Table 7.6.2 Transient frequency behaviour test results

Carrier frequency, MHz	Time interval	Duration, ms	Frequency tolerance, kHz	Limit, kHz	Margin, kHz	Verdict
<b>Channel bandwidth 6.25 kHz</b>						
450.0031	t <sub>1</sub>	10.0	2.075	± 6.25	-4.175	Pass
	t <sub>2</sub>	25.0	1.281	± 3.125	-1.844	
	t <sub>3</sub>	10.0	0.854	± 6.25	-5.396	
460.0000	t <sub>1</sub>	10.0	2.319	± 6.25	-3.931	Pass
	t <sub>2</sub>	25.0	1.831	± 3.125	-1.294	
	t <sub>3</sub>	10.0	0.854	± 6.25	-5.396	
469.9969	t <sub>1</sub>	10.0	2.746	± 6.25	-4.602	Pass
	t <sub>2</sub>	25.0	1.037	± 3.125	-2.088	
	t <sub>3</sub>	10.0	0.915	± 6.25	-5.335	

**Reference numbers of test equipment used**

HL 2667	HL 3433	HL 3438	HL 3442	HL 3785	HL 4413	HL 4778	HL 4938
HL 5472	HL 5971						

Full description is given in Appendix A.



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<b>Test specification:</b> Section 90.214 / RSS-119 Section 5.9, Transient frequency behaviour			
<b>Test procedure:</b> TIA/EIA-603-E, Section 2.2.19			
<b>Test mode:</b> Compliance		<b>Verdict:</b> PASS	
<b>Date(s):</b> 30-Sep-21			
<b>Temperature:</b> 24 °C	<b>Relative Humidity:</b> 55 %	<b>Air Pressure:</b> 1008 hPa	<b>Power:</b> 110 VAC, 60 Hz
<b>Remarks:</b>			

Plot 7.6.1 Transient frequency during power ON test results at low carrier frequency







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<b>Test specification:</b> Section 90.214 / RSS-119 Section 5.9, Transient frequency behaviour			
<b>Test procedure:</b> TIA/EIA-603-E, Section 2.2.19			
<b>Test mode:</b> Compliance		<b>Verdict:</b> PASS	
<b>Date(s):</b> 30-Sep-21			
<b>Temperature:</b> 24 °C	<b>Relative Humidity:</b> 55 %	<b>Air Pressure:</b> 1008 hPa	<b>Power:</b> 110 VAC, 60 Hz
<b>Remarks:</b>			

Plot 7.6.2 Transient frequency during power ON test results at low carrier frequency





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<b>Test specification:</b> Section 90.214 / RSS-119 Section 5.9, Transient frequency behaviour			
<b>Test procedure:</b> TIA/EIA-603-E, Section 2.2.19			
<b>Test mode:</b> Compliance		<b>Verdict:</b> PASS	
<b>Date(s):</b> 30-Sep-21			
<b>Temperature:</b> 24 °C	<b>Relative Humidity:</b> 55 %	<b>Air Pressure:</b> 1008 hPa	<b>Power:</b> 110 VAC, 60 Hz
<b>Remarks:</b>			

Plot 7.6.3 Transient frequency during power OFF test results at low carrier frequency





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<b>Test specification:</b> Section 90.214 / RSS-119 Section 5.9, Transient frequency behaviour			
<b>Test procedure:</b> TIA/EIA-603-E, Section 2.2.19			
<b>Test mode:</b> Compliance		<b>Verdict:</b> PASS	
<b>Date(s):</b> 30-Sep-21			
<b>Temperature:</b> 24 °C	<b>Relative Humidity:</b> 55 %	<b>Air Pressure:</b> 1008 hPa	<b>Power:</b> 110 VAC, 60 Hz
<b>Remarks:</b>			

Plot 7.6.4 Transient frequency during power ON test results at mid carrier frequency





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<b>Test specification:</b> Section 90.214 / RSS-119 Section 5.9, Transient frequency behaviour			
<b>Test procedure:</b> TIA/EIA-603-E, Section 2.2.19			
<b>Test mode:</b> Compliance		<b>Verdict:</b> PASS	
<b>Date(s):</b> 30-Sep-21			
<b>Temperature:</b> 24 °C	<b>Relative Humidity:</b> 55 %	<b>Air Pressure:</b> 1008 hPa	<b>Power:</b> 110 VAC, 60 Hz
<b>Remarks:</b>			

Plot 7.6.5 Transient frequency during power ON test results at mid carrier frequency





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<b>Test specification:</b> Section 90.214 / RSS-119 Section 5.9, Transient frequency behaviour			
<b>Test procedure:</b> TIA/EIA-603-E, Section 2.2.19			
<b>Test mode:</b> Compliance		<b>Verdict:</b> PASS	
<b>Date(s):</b> 30-Sep-21			
<b>Temperature:</b> 24 °C	<b>Relative Humidity:</b> 55 %	<b>Air Pressure:</b> 1008 hPa	<b>Power:</b> 110 VAC, 60 Hz
<b>Remarks:</b>			

Plot 7.6.6 Transient frequency during power OFF test results at mid carrier frequency





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<b>Test specification:</b> Section 90.214 / RSS-119 Section 5.9, Transient frequency behaviour			
<b>Test procedure:</b> TIA/EIA-603-E, Section 2.2.19			
<b>Test mode:</b> Compliance		<b>Verdict:</b> PASS	
<b>Date(s):</b> 30-Sep-21			
<b>Temperature:</b> 24 °C	<b>Relative Humidity:</b> 55 %	<b>Air Pressure:</b> 1008 hPa	<b>Power:</b> 110 VAC, 60 Hz
<b>Remarks:</b>			

Plot 7.6.7 Transient frequency during power ON test results at high carrier frequency





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<b>Test specification:</b> Section 90.214 / RSS-119 Section 5.9, Transient frequency behaviour			
<b>Test procedure:</b> TIA/EIA-603-E, Section 2.2.19			
<b>Test mode:</b> Compliance		<b>Verdict:</b> PASS	
<b>Date(s):</b> 30-Sep-21			
<b>Temperature:</b> 24 °C	<b>Relative Humidity:</b> 55 %	<b>Air Pressure:</b> 1008 hPa	<b>Power:</b> 110 VAC, 60 Hz
<b>Remarks:</b>			

Plot 7.6.8 Transient frequency during power ON test results at high carrier frequency









## 8 APPENDIX A Test equipment and ancillaries used for tests

HL No	Description	Manufacturer	Model	Ser. No.	Last Cal./ Check	Due Cal./ Check
0446	Antenna, Loop, Active, 10 (9) kHz - 30 MHz	EMCO	6502	2857	28-Feb-21	28-Feb-22
0493	Temperature Chamber -45...175 deg C	Thermotron	S-1.2 Mini-Max	14016	24-Jun-21	24-Jun-22
2667	Signal generator, 9 kHz - 3.3 GHz	Rohde & Schwarz	SML03	101909	24-Sep-20	24-Oct-21
2909	Spectrum analyzer, ESA-E, 100 Hz to 26.5 GHz	Agilent Technologies	E4407B	MY414447 62	12-May-21	12-Jun-22
3433	Test Cable , DC-18 GHz, 1.5 m, SMA – SMA	Mini-Circuits	CBL-5FT-SMSM+	25679	19-Apr-21	19-Apr-22
3438	Precision Fixed Attenuator, 50 Ohm, 5 W, 10 dB, DC to 18 GHz	Mini-Circuits	BW-S10W5+	NA	25-Feb-21	25-Feb-22
3442	Precision Fixed Attenuator, 50 Ohm, 5 W, 20 dB, DC to 18 GHz	Mini-Circuits	BW-S20W5+	NA	25-Feb-21	25-Feb-22
3766	Attenuator, N-type, 20 dB, DC to 18 GHz, 5 W	Mini-Circuits	BW-N20W5+	NA	01-Jan-21	01-Jan-22
3785	Precision Fixed Attenuator, 50 Ohm, 5 W, 10 dB, DC to 18 GHz	Mini-Circuits	BW-S10W5+	NA	25-Feb-21	25-Feb-22
3903	Microwave Cable Assembly, 40.0 GHz, 1.5 m, SMA/SMA	Huber-Suhner	SUCOFLE X 102A	1226/2A	06-Apr-21	06-Apr-22
4232	Precision Fixed Attenuator, 50 Ohm, 5W, 20dB, DC to 18000 MHz	Mini-Circuits	BW-N20W5+	NA	20-Sep-21	20-Sep-22
4339	High pass Filter, 50 Ohm, 1000 to 18000 MHz, SMA-FM / SMA-M	Micro-Tronics	HPM5011 5-02	001	15-Jun-21	15-Jun-23
4355	Signal and Spectrum Analyzer, 9 kHz to 7 GHz	Rohde & Schwarz	FSV 7	101630	20-Sep-21	20-Sep-22
4360	EMI Test Receiver, 20 Hz to 40 GHz.	Rohde & Schwarz	ESU40	100322	19-Jan-21	19-Jan-22
4413	Resistive divider, DC to 1.5 GHz, 2 W	Microlab	DA-3FN	NA	14-Nov-19	14-Nov-21
4778	EMI Receiver, 9 kHz - 2.9 GHz, System: HL1431, HL4777	Hewlett Packard	8542E	30807A00 262, 3427A001 23	09-Nov-20	09-Nov-21
4914	Bandpass filter, 600 to 1100 MHz, SMA/F-SMA/F	K&L Microwave Inc.	71B44-900/U600-O/O	24	15-Jun-21	15-Jun-23
4933	Active Horn Antenna, 1 GHz to 18 GHz	Com-Power Corporation	AHA-118	701046	26-Jan-21	26-Jan-22
4938	Test Cable, 50Ω, 1.8 m, DC to 18 GHz	Mini-Circuits	CBL-6FT-SMNM+	NA	19-Apr-21	19-Apr-22
5288	Trilog Antenna, 25 MHz - 8 GHz, 100W	Frankonia	ALX-8000E	00809	08-Feb-19	08-Feb-22
5405	RF cable, 18 GHz, N-N, 6 m	Huber-Suhner	SF118/11 N(x2)	500023/118	19-Nov-20	19-Nov-21
5409	RF cable, 40 GHz, SMA-SMA, 2 m	Huber-Suhner	SF102EA/11SK/11S K/2000M M	503973/2EA	10-Aug-21	10-Aug-22
5472	Power Splitter / Combiner 0.5-1 GHz	Mini Circuits	ZAPD-1	NA	28-Jan-21	28-Jan-23
5637	Cable, 50 Ohm, DC to 18 GHz, 1.8 m, SMA/SMA	Mini Circuits	CBL-6FT-SMSM+	NA	08-Aug-21	08-Aug-22
5902	RF cable, 18 GHz, 6.0m, N-type	Huber-Suhner	SF126EA/11N/11N/6000	NA	01-Dec-20	01-Dec-21



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HL No	Description	Manufacturer	Model	Ser. No.	Last Cal./ Check	Due Cal./ Check
5971	Oscilloscope, 500 MHz, digital 4 channel	Rohde & Schwarz	RTM3004	104883	20-Feb-21	20-Jan-22

## 9 APPENDIX B Measurement uncertainties

### Expanded uncertainty at 95% confidence in Hermon Labs EMC measurements

Test description	Expanded uncertainty
<b>Transmitter tests</b>	
Carrier power conducted at antenna connector	± 1.7 dB
Carrier power radiated (substitution method)	± 4.5 dB
Occupied bandwidth	±8%
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
Spurious emissions radiated 30 MHz – 40 GHz (substitution method)	± 4.5 dB
Frequency error	30 – 300 MHz: ± 50.5 Hz (1.68 ppm) 300 – 1000 MHz: ± 168 Hz (0.56 ppm)
Transient frequency behaviour	187 Hz ± 13.9 %
Duty cycle, timing (Tx ON / OFF) and average factor measurements	± 1.0 %
<b>Unintentional radiator tests</b>	
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	Biconilog antenna: ± 5.3 dB Biconical antenna: ± 5.0 dB Log periodic antenna: ± 5.3 dB Double ridged horn antenna: ± 5.3 dB
Vertical polarization	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.

## **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 for OATS are R-10808 for RE measurements below 1 GHz, G-20112 for RE measurements above 1 GHz, R-11082 for anechoic chamber for RE measurements below 1 GHz, 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).

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## **11 APPENDIX D Specification references**

FCC 47CFR part 90: 2020	Private land mobile radio services
FCC 47CFR part 2: 2020	Frequency allocations and radio treaty matters; general rules and regulations
ANSI/TIA/EIA-603-E:2016	Land Mobile FM or PM Communications Equipment Measurement and Performance Standards
RSS-119 Issue 12: 2015	Land Mobile and Fixed Equipment Operating in the Frequency Range 27.41-960 MHz
RSS-Gen Issue 5: 2021	General Requirements for Compliance of Radio Apparatus



## 12 APPENDIX E Test equipment correction factors

Antenna factor  
Active loop antenna  
Model 6502, S/N 2857, HL 0446

Frequency, MHz	Measured antenna factor, dBS/m
0.009	-32.5
0.010	-33.4
0.020	-37.9
0.050	-40.6
0.075	-41.0
0.100	-41.2
0.150	-41.2
0.250	-41.2
0.500	-41.3
0.750	-41.3
1.000	-41.4
2.000	-41.4
3.000	-41.4
4.000	-41.5
5.000	-41.5
10.000	-41.8
15.000	-42.2
20.000	-42.9
25.000	-43.9
30.000	-45.4

Antenna factor in dB(1/m) is to be added to receiver meter reading in dB( $\mu$ V) to convert it into field strength in dB( $\mu$ V/m).



**Antenna factor**  
**Trilog antenna**  
**Model ALX-8000E, Frankonia, S/N 00809, HL 5288, 30-1000 MHz**

Frequency, MHz	Antenna factor, dB/m		
	Vert Up	Vert Down	Delta
30	-51.19	-51.28	0.09
35	-44.03	-44.12	0.09
40	-43.07	-43.12	0.05
45	-39.61	-39.79	0.18
50	-37.84	-38.14	0.3
60	-34.93	-34.9	0.03
70	-29.76	-29.66	0.1
80	-27.69	-27.82	0.13
90	-29.05	-29.07	0.02
100	-31.19	-31.19	0
120	-31.61	-31.6	0.01
140	-28.13	-28.06	0.07
160	-27.71	-27.75	0.04
180	-26.19	-26.15	0.04
200	-28.2	-28.15	0.05
250	-27.45	-27.47	0.02
300	-29.61	-29.63	0.02
400	-31.77	-31.78	0.01
500	-32.81	-32.81	0
600	-33.64	-33.61	0.03
700	-34.21	-34.21	0
800	-35.66	-35.66	0
900	-36.99	-36.91	0.08
1000	-38	-37.91	0.09

Antenna factor in dB(1/m) is to be added to receiver meter reading in dB( $\mu$ V) to convert it into field intensity in dB( $\mu$ V/m).



**Antenna factor**  
**Active Horn Antenna,**  
**Com-Power Corporation, model: AHA-118, s/n 701046, HL 4933**

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 $\mu$ V to obtain field strength in dB $\mu$ V/m.



**Cable loss**  
**Test Cable, Mini-Circuits, CBL-5FT-SMSM+, SMA-SMA, 18 GHz, 1.5 m, S/N 25679**  
**Mini-Circuits, HL 3433**

Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB
10.0	0.06	9000	2.01
100	0.17	9500	2.06
500	0.41	10000	2.05
1000	0.58	10500	2.18
1500	0.72	11000	2.26
2000	0.86	11500	2.28
2500	0.96	12000	2.43
3000	1.04	12500	2.53
3500	1.13	13000	2.52
4000	1.23	13500	2.56
4500	1.31	14000	2.60
5000	1.41	14500	2.59
5500	1.49	15000	2.67
6000	1.55	15500	2.76
6500	1.63	16000	2.86
7000	1.71	16500	2.91
7500	1.78	17000	2.95
8000	1.86	17500	3.02
8500	1.92	18000	3.07





**Cable loss**  
**Microwave Cable Assembly, Huber-Suhner, 40 GHz, 1.5 m, SMA-SMA, S/N 1226/2A**  
**HL 3903**

Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB
10	-0.02	9500	1.84	21000	2.98
100	0.15	10000	1.86	22000	3.07
500	0.38	10500	1.93	23000	3.13
1000	0.56	11000	1.99	24000	3.21
1500	0.69	11500	2.04	25000	3.26
2000	0.82	12000	2.10	26000	3.48
2500	0.90	12500	2.15	27000	3.44
3000	0.98	13000	2.21	28000	3.53
3500	1.06	13500	2.25	29000	3.59
4000	1.11	14000	2.29	30000	3.66
4500	1.17	14500	2.34	31000	3.70
5000	1.24	15000	2.36	32000	3.79
5500	1.32	15500	2.40	33000	3.88
6000	1.40	16000	2.45	34000	3.94
6500	1.50	16500	2.48	35000	3.91
7000	1.56	17000	2.56	36000	4.05
7500	1.62	17500	2.58	37000	4.22
8000	1.68	18000	2.60	38000	4.25
8500	1.74	19000	2.84	39000	4.27
9000	1.78	20000	2.88	40000	4.33



**Cable loss**  
**RF cable, DC to 18 GHz, 1.8m, 50 Ohm, Mini-Circuits,**  
**CBL-6FT-SMNM+, HL 4938**

Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB
0.1	0.16	5100	2.10	10300	3.37	15500	4.59
50	0.23	5200	2.15	10400	3.39	15600	4.61
100	0.29	5300	2.16	10500	3.41	15700	4.64
200	0.38	5400	2.19	10600	3.42	15800	4.66
300	0.46	5500	2.23	10700	3.45	15900	4.71
400	0.53	5600	2.29	10800	3.49	16000	4.72
500	0.59	5700	2.27	10900	3.52	16100	4.73
600	0.64	5800	2.31	11000	3.52	16200	4.80
700	0.69	5900	2.36	11100	3.53	16300	4.83
800	0.74	6000	2.38	11200	3.59	16400	4.82
900	0.78	6100	2.41	11300	3.60	16500	4.86
1000	0.83	6200	2.44	11400	3.59	16600	4.88
1100	0.87	6300	2.49	11500	3.64	16700	4.89
1200	0.91	6400	2.51	11600	3.67	16800	4.95
1300	0.95	6500	2.54	11700	3.67	16900	4.93
1400	0.99	6600	2.58	11800	3.69	17000	4.94
1500	1.03	6700	2.61	11900	3.73	17100	4.97
1600	1.06	6800	2.63	12000	3.74	17200	5.00
1700	1.10	6900	2.66	12100	3.76	17300	5.03
1800	1.13	7000	2.70	12200	3.79	17400	5.03
1900	1.16	7100	2.73	12300	3.83	17500	5.05
2000	1.19	7200	2.76	12400	3.86	17600	5.11
2100	1.23	7300	2.77	12500	3.87	17700	5.12
2200	1.25	7400	2.80	12600	3.94	17800	5.11
2300	1.28	7500	2.83	12700	3.96	17900	5.13
2400	1.31	7600	2.85	12800	3.98	18000	4.87
2500	1.35	7700	2.85	12900	4.05		
2600	1.38	7800	2.88	13000	4.06		
2700	1.40	7900	2.90	13100	4.07		
2800	1.43	8000	2.89	13200	4.13		
2900	1.47	8100	2.92	13300	4.20		
3000	1.49	8200	2.93	13400	4.18		
3100	1.52	8300	2.94	13500	4.24		
3200	1.56	8400	2.95	13600	4.30		
3300	1.59	8500	2.99	13700	4.33		
3400	1.61	8600	2.99	13800	4.37		
3500	1.64	8700	3.01	13900	4.39		
3600	1.69	8800	3.03	14000	4.40		
3700	1.70	8900	3.07	14100	4.38		
3800	1.72	9000	3.08	14200	4.40		
3900	1.76	9100	3.09	14300	4.41		
4000	1.80	9200	3.12	14400	4.42		
4100	1.81	9300	3.15	14500	4.42		
4200	1.84	9400	3.17	14600	4.43		
4300	1.88	9500	3.18	14700	4.46		
4400	1.90	9600	3.22	14800	4.46		
4500	1.93	9700	3.24	14900	4.49		
4600	1.95	9800	3.25	15000	4.49		
4700	1.99	9900	3.27	15100	4.51		
4800	2.01	10000	3.31	15200	4.55		
4900	2.04	10100	3.34	15300	4.56		
5000	2.09	10200	3.34	15400	4.55		



**Cable loss**  
**RF Cable, Huber-Suhner, 18 GHz, 6 m,**  
**SF118/11N(x2), S/N 500023/118**  
**HL 5405**

Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB
0.1	0.04	5500	2.61
50	0.24	6000	2.88
100	0.33	6500	2.92
200	0.47	7000	2.97
300	0.57	7500	3.05
400	0.66	8000	3.16
500	0.75	8500	3.28
600	0.81	9000	3.49
700	0.87	9500	3.52
800	0.93	10000	3.63
900	0.99	10500	3.73
1000	1.06	11000	3.84
1100	1.10	11500	3.97
1200	1.15	12000	4.02
1300	1.19	12500	4.13
1400	1.27	13000	4.17
1500	1.31	13500	4.28
1600	1.37	14000	4.35
1700	1.40	14500	4.56
1800	1.42	15000	4.87
1900	1.46	15500	4.76
2000	1.50	16000	4.81
2500	1.71	16500	4.87
3000	1.90	17000	5.01
3500	2.03	17500	5.05
4000	2.23	18000	5.52
4500	2.42		
5000	2.46		



**Cable loss**  
**RF Cable, Huber-Suhner, 40 GHz, 2 m, ,**  
**SF102EA/11SK/11SK/2000MM, S/N 503973/2EA**  
**HL 5409**

Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB
100	0.26	20500	3.75
200	0.36	21000	3.80
300	0.45	21500	3.85
500	0.58	22000	3.90
1000	0.82	22500	3.95
1500	0.99	23000	4.00
2000	1.15	23500	4.04
2500	1.28	24000	4.09
3000	1.40	24500	4.13
3500	1.51	25000	4.19
4000	1.61	25500	4.25
4500	1.71	26000	4.30
5000	1.80	26500	4.37
5500	1.89	27000	4.45
6000	1.98	27500	4.47
6500	2.06	28000	4.45
7000	2.14	28500	4.49
7500	2.22	29000	4.57
8000	2.29	29500	4.60
8500	2.36	30000	4.59
9000	2.43	30500	4.63
9500	2.50	31000	4.68
10000	2.58	31500	4.74
10500	2.63	32000	4.81
11000	2.70	32500	4.89
11500	2.76	33000	4.89
12000	2.82	33500	4.92
12500	2.87	34000	4.94
13000	2.94	34500	4.99
13500	3.00	35000	5.07
14000	3.06	35500	5.12
14500	3.11	36000	5.14
15000	3.17	36500	5.22
15500	3.23	37000	5.28
16000	3.29	37500	5.30
16500	3.35	38000	5.39
17000	3.41	38500	5.48
17500	3.47	39000	5.44
18000	3.51	39500	5.45
18500	3.56	40000	5.51
19000	3.60		
19500	3.66		
20000	3.71		



**Cable loss**  
**RF Cable, Mini Circuits, DC to 18 GHz, 1.8 m,**  
**CBL-6FT-SMSM+, HL 5637**

Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB
0.1	0.02	8750	2.34
10	0.83	9000	2.35
30	0.49	9250	2.37
50	0.15	9500	2.40
100	0.21	9750	2.40
250	0.33	10000	2.43
500	0.48	10250	2.44
750	0.59	10500	2.45
1000	0.68	10750	2.48
1250	0.77	11000	2.51
1500	0.85	11250	2.55
1750	0.92	11500	2.60
2000	0.99	11750	2.64
2250	1.06	12000	2.68
2500	1.12	12250	2.73
2750	1.19	12500	2.76
3000	1.25	12750	2.80
3250	1.30	13000	2.86
3500	1.36	13250	2.88
3750	1.41	13500	2.92
4000	1.46	13750	2.96
4250	1.52	14000	2.99
4500	1.57	14250	3.03
4750	1.61	14500	3.06
5000	1.65	14750	3.07
5250	1.68	15000	3.14
5500	1.73	15250	3.16
5750	1.77	15500	3.21
6000	1.81	15750	3.26
6250	1.87	16000	3.29
6500	1.92	16250	3.34
6750	1.96	16500	3.36
7000	2.00	16750	3.37
7250	2.07	17000	3.42
7500	2.11	17250	3.42
7750	2.14	17500	3.43
8000	2.21	17750	3.42
8250	2.26	18000	3.43
8500	2.29		



**Cable loss**  
**RF cable, 18 GHz, 6.0m, N-type, Huber-Suhner, S/N 511435/126EA,**  
**SF126EA/11N/11N/6000, HL 5902**

Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB	Frequency, MHz	Cable loss, dB
0.1	0.00	4800	3.24	10000	4.82	15200	6.08
1	0.01	4900	3.30	10100	4.85	15300	6.11
10	0.07	5000	3.32	10200	4.87	15400	6.12
30	0.18	5100	3.37	10300	4.91	15500	6.14
50	0.25	5200	3.40	10400	4.93	15600	6.15
100	0.41	5300	3.42	10500	4.95	15700	6.18
200	0.56	5400	3.46	10600	4.99	15800	6.20
300	0.68	5500	3.50	10700	5.01	15900	6.23
400	0.76	5600	3.53	10800	5.03	16000	6.22
500	0.87	5700	3.56	10900	5.06	16100	6.26
600	1.03	5800	3.58	11000	5.08	16200	6.29
700	1.14	5900	3.63	11100	5.12	16300	6.30
800	1.23	6000	3.67	11200	5.13	16400	6.33
900	1.34	6100	3.69	11300	5.16	16500	6.35
1000	1.43	6200	3.73	11400	5.18	16600	6.37
1100	1.51	6300	3.76	11500	5.22	16700	6.40
1200	1.59	6400	3.80	11600	5.24	16800	6.43
1300	1.66	6500	3.81	11700	5.25	16900	6.46
1400	1.73	6600	3.83	11800	5.28	17000	6.47
1500	1.78	6700	3.87	11900	5.32	17100	6.49
1600	1.82	6800	3.91	12000	5.33	17200	6.51
1700	1.87	6900	3.91	12100	5.35	17300	6.53
1800	1.89	7000	3.93	12200	5.38	17400	6.56
1900	1.95	7100	3.95	12300	5.39	17500	6.60
2000	1.99	7200	3.98	12400	5.43	17600	6.62
2100	2.02	7300	4.02	12500	5.46	17700	6.60
2200	2.06	7400	4.04	12600	5.48	17800	6.63
2300	2.11	7500	4.07	12700	5.50	17900	6.64
2400	2.16	7600	4.11	12800	5.52	18000	6.66
2500	2.21	7700	4.15	12900	5.57		
2600	2.29	7800	4.17	13000	5.57		
2700	2.32	7900	4.20	13100	5.60		
2800	2.38	8000	4.22	13200	5.61		
2900	2.44	8100	4.26	13300	5.64		
3000	2.47	8200	4.30	13400	5.67		
3100	2.53	8300	4.32	13500	5.70		
3200	2.57	8400	4.35	13600	5.71		
3300	2.61	8500	4.39	13700	5.73		
3400	2.67	8600	4.43	13800	5.74		
3500	2.71	8700	4.45	13900	5.80		
3600	2.76	8800	4.47	14000	5.82		
3700	2.80	8900	4.49	14100	5.85		
3800	2.85	9000	4.53	14200	5.86		
3900	2.89	9100	4.55	14300	5.87		
4000	2.93	9200	4.57	14400	5.92		
4100	2.98	9300	4.61	14500	5.93		
4200	3.01	9400	4.64	14600	5.95		
4300	3.05	9500	4.68	14700	5.97		
4400	3.10	9600	4.70	14800	6.01		
4500	3.12	9700	4.73	14900	6.04		
4600	3.18	9800	4.78	15000	6.04		
4700	3.21	9900	4.80	15100	6.08		



### 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( $\mu$ V)	decibel referred to one microvolt
dB( $\mu$ V/m)	decibel referred to one microvolt per meter
dB( $\mu$ 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
$\mu$ s	microsecond
NA	not applicable
NB	narrow band
OATS	open area test site
$\Omega$	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

END OF DOCUMENT