

# TEST REPORT

ACCORDING TO: FCC CFR 47 Part 90, subpart I, and RSS-119 Issue 12:2015

FOR:

**ST Engineering Telematics Wireless Ltd**

**Allegro Pit Unit**

**Model: ALLPU1**

**FCC ID: NTAALLPU1**

**IC: 4732A-ALLPU1**

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## 1 Applicant information

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

## 2 Equipment under test attributes

**Product:** Allegro Pit Unit  
**Product type:** Transceiver  
**Model(s):** ALLPU1  
**Serial number:** 02116647  
**Hardware version:** Rev A  
**Software release:** 031B  
**Receipt date** 06-Jun-21

## 3 Manufacturer information

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

## 4 Test details

**Project ID:** 43079  
**Location:** Hermon Laboratories Ltd. P.O. Box 23, Binyamina 3055001, Israel  
**Test started:** 07-Jun-21  
**Test completed:** 12-Jul-21  
**Test specification(s):** FCC part 90, subpart I; RSS-119 issue 12



## 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 90.210 / RSS-119 Section 5.8.4, Conducted 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, Exhibit in application for certification 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>	Mr. A. Morozov, test engineer, EMC & Radio	07-Jun-21 – 12-Jul-21	
<b>Reviewed by:</b>	Mrs. S. Peysahov Sheynin, test engineer, EMC & Radio	17-Oct-21	
<b>Approved by:</b>	Mr. S. Samokha, technical manager, EMC & Radio	28-Nov-21	



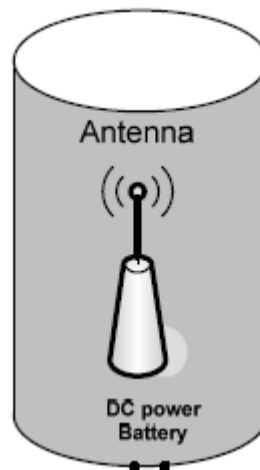
## 6 EUT description

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

### 6.1 General information

The EUT is an interface unit connected to a water meter. The EUT operates at 450-470MHz frequency band and it is powered by 3.6V battery.

### 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 range	450- 470 MHz				
Maximum rated output power	At transmitter 50 Ω RF output connector 32.1 dBm				
	Effective radiated power				
Is transmitter output power variable?	X No				
	Yes continuous variable				
	Yes stepped variable with stepsize				
	Yes minimum RF power				
	Yes maximum RF power				
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	ARAD	N/A	-3dBi		
Transmitter aggregate data rate/s	4.8 kbps				
Type of modulation	4GFSK				
Modulating test signal (baseband)	PRBS				
Transmitter power source					
X	Battery	Nominal rated voltage	3.6 VDC	Battery type	Lithium
	DC	Nominal rated voltage	VDC		
	AC mains	Nominal rated voltage	VAC	Frequency	Hz
Common power source for transmitter and receiver		X	yes	no	



<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> 25-Jun-21 – 05-Oct-21			
<b>Temperature:</b> 24 °C	<b>Relative Humidity:</b> 56 %	<b>Air Pressure:</b> 1009 hPa	<b>Power:</b> 3.6 VDC
<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 the peak output power at RF antenna connector. Specification test limits are given in Table 7.1.1.

Table 7.1.1 Peak output power limits

Assigned frequency range, MHz	ERP	
	W	dBm
<b>According to FCC part 90.205</b>		
450.0 – 470.0	2	33.00
<b>According to RSS-119</b>		
450.0 – 470.0	60	47.78

#### 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.

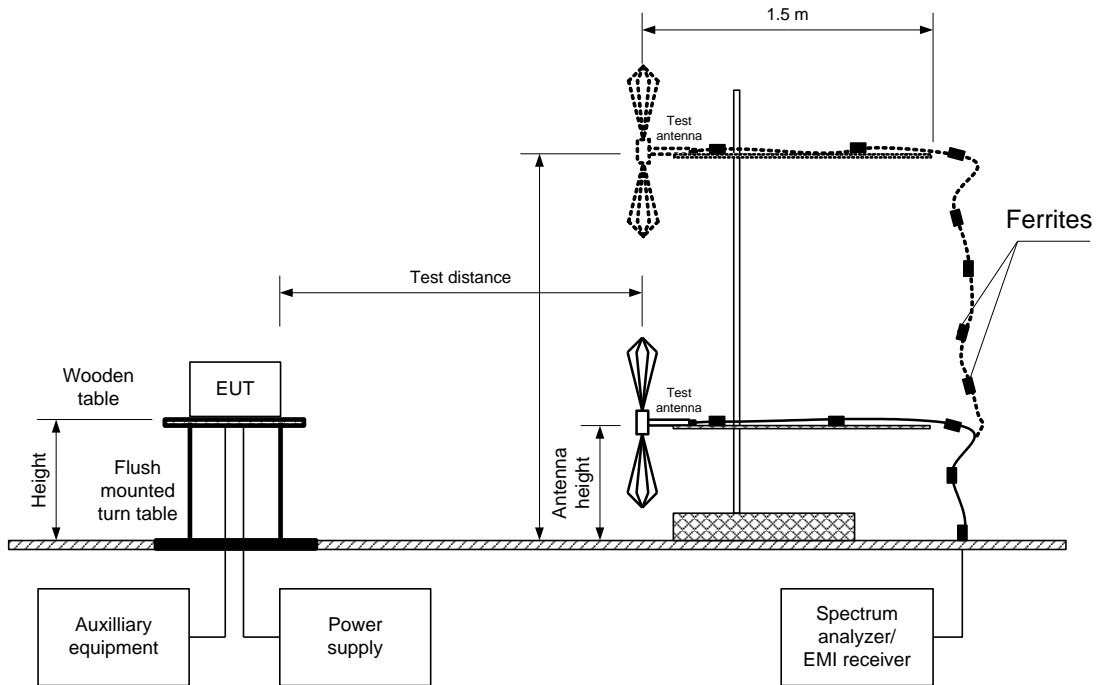
7.1.2.2 The EUT was adjusted to produce maximum available to the end user RF output power.

7.1.2.3 The peak output power was measured with spectrum analyzer as provided in Table 7.1.2, Table 7.1.3 and 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> 25-Jun-21 – 05-Oct-21			
<b>Temperature:</b> 24 °C	<b>Relative Humidity:</b> 56 %	<b>Air Pressure:</b> 1009 hPa	<b>Power:</b> 3.6 VDC
<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> 25-Jun-21 – 05-Oct-21			
<b>Temperature:</b> 24 °C	<b>Relative Humidity:</b> 56 %	<b>Air Pressure:</b> 1009 hPa	<b>Power:</b> 3.6 VDC
<b>Remarks:</b>			

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

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  
 TRANSMITTER OUTPUT POWER: Maximum  
 SETTINGS:

Frequency, MHz	Field strength, dB(µV/m)	Antenna polarization	Antenna height, m	Azimuth, degrees	EUT antenna gain, dBi	ERP, dBm***	Peak output power (conducted), dBm*	ERP Limit, dBm	Margin, dB**	Verdict
450.0031	124.3	Vertical	1.55	30	-3.0	26.9	32.1	33.00	-6.1	Pass
460.0000	124.2	Vertical	1.60	90	-3.0	26.8	32.0	33.00	-6.2	Pass
469.9969	122.6	Vertical	1.55	90	-3.0	25.2	30.4	33.00	-7.8	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*

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

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



<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> 25-Jun-21 – 05-Oct-21			
<b>Temperature:</b> 24 °C	<b>Relative Humidity:</b> 56 %	<b>Air Pressure:</b> 1009 hPa	<b>Power:</b> 3.6 VDC
<b>Remarks:</b>			

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

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  
 TRANSMITTER OUTPUT POWER: Maximum  
 SETTINGS:

Frequency, MHz	Field strength, dB(µV/m)	Antenna polarization	Antenna height, m	Azimuth, degrees	EUT antenna gain, dBi	ERP, dBm***	Peak output power (conducted), dBm*	ERP Limit, dBm	Margin, dB**	Verdict
450.0031	124.3	Vertical	1.55	30	-3.0	26.9	32.1	47.78	-20.88	Pass
460.0000	124.2	Vertical	1.60	90	-3.0	26.8	32.0	47.78	-20.98	Pass
469.9969	122.6	Vertical	1.55	90	-3.0	25.2	30.4	47.78	-22.58	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*

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

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

Reference numbers of test equipment used

HL 3903	HL 2909	HL 5288	HL 5902	HI 5612	HI 5606		
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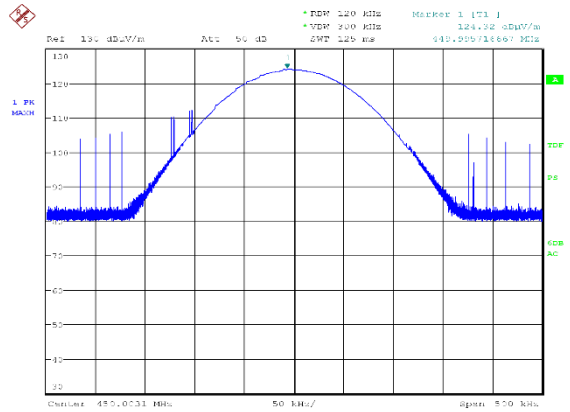
Full description is given in Appendix A.



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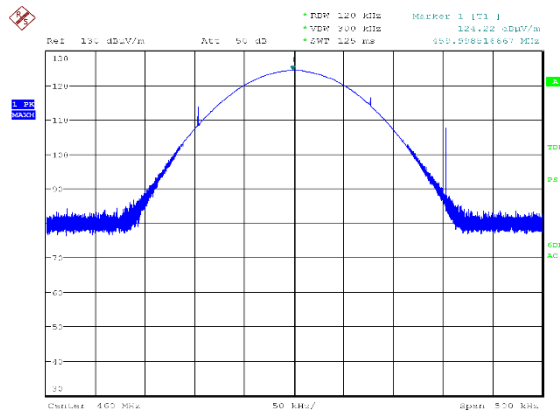
<b>Test specification:</b> Section 90.205 / RSS-119 Section 5.4, Maximum output power			
<b>Test procedure:</b> 47 CFR, Section 2.1046; TIA/EIA-603-E, Section 2.2.1			
<b>Test mode:</b> Compliance		<b>Verdict:</b> PASS	
<b>Date(s):</b> 25-Jun-21 – 05-Oct-21			
<b>Temperature:</b> 24 °C	<b>Relative Humidity:</b> 56 %	<b>Air Pressure:</b> 1009 hPa	<b>Power:</b> 3.6 VDC
<b>Remarks:</b>			

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



Date: 9-OCT-2021 17:06:09

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



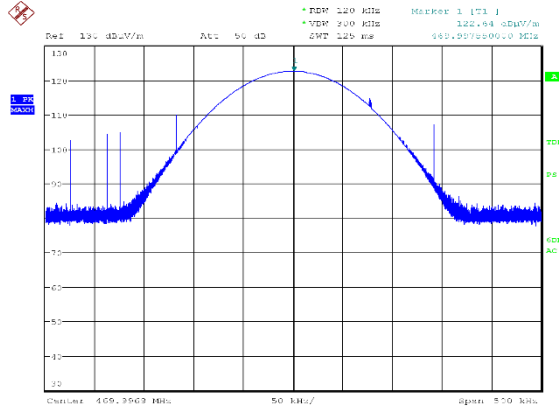
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<b>Test specification:</b> Section 90.205 / RSS-119 Section 5.4, Maximum output power			
<b>Test procedure:</b> 47 CFR, Section 2.1046; TIA/EIA-603-E, Section 2.2.1			
<b>Test mode:</b> Compliance		<b>Verdict:</b> PASS	
<b>Date(s):</b> 25-Jun-21 – 05-Oct-21			
<b>Temperature:</b> 24 °C	<b>Relative Humidity:</b> 56 %	<b>Air Pressure:</b> 1009 hPa	<b>Power:</b> 3.6 VDC
<b>Remarks:</b>			

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



Date: 5.OCT.2021 17:01:02



<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> 07-Jun-21			
<b>Temperature:</b> 25 °C	<b>Relative Humidity:</b> 53 %	<b>Air Pressure:</b> 1009 hPa	<b>Power:</b> 3.6 VDC
<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. The test results are provided in Table 7.2.2 and the associated plots.

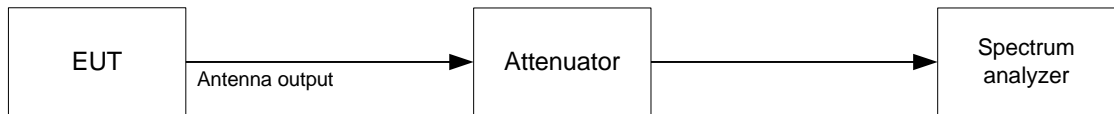
Table 7.2.1 Occupied bandwidth limits

Assigned frequency, MHz	Occupied bandwidth power, %	Maximum allowed bandwidth, kHz
450-470	99.00	6.25
	<b>Occupied bandwidth power, dBc</b>	
	26.00	

### 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 7.2.2 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> 07-Jun-21			
<b>Temperature:</b> 25 °C	<b>Relative Humidity:</b> 53 %	<b>Air Pressure:</b> 1009 hPa	<b>Power:</b> 3.6 VDC
<b>Remarks:</b>			

Table 7.2.2 Occupied bandwidth test results

DETECTOR USED: Peak hold  
 RESOLUTION BANDWIDTH: 100 Hz  
 VIDEO BANDWIDTH: 1 kHz  
 MODULATION: 4GFSK  
 MODULATING SIGNAL: PRBS  
 BIT RATE: 4.8 kbps

Carrier frequency, MHz	Occupied bandwidth, kHz	Limit, kHz	Margin, kHz	Verdict
MODULATION ENVELOPE REFERENCE POINTS: 99%				
450.0031	3.494	6.250	-2.756	Pass
460.0000	3.594	6.250	-2.656	Pass
469.9969	3.534	6.250	-2.716	Pass
MODULATION ENVELOPE REFERENCE POINTS: 26 dBc				
450.0031	4.254	6.250	-1.996	Pass
460.0000	4.534	6.250	-1.716	Pass
469.9969	4.944	6.250	-1.306	Pass

Reference numbers of test equipment used

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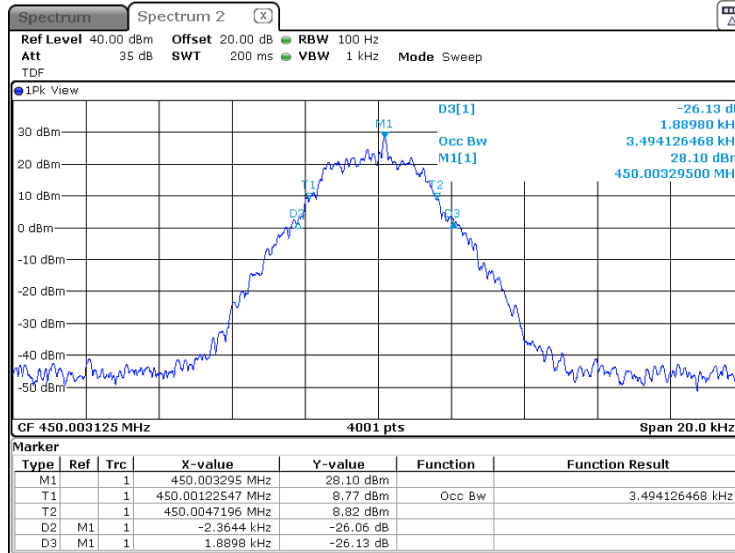
Full description is given in Appendix A.



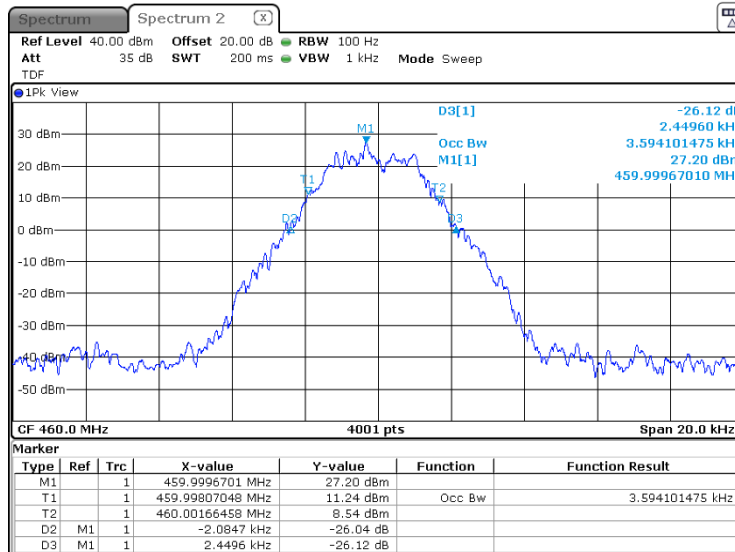
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<b>Test specification: Section 90.209 / RSS-119 Section 5.5, Occupied bandwidth</b>			
<b>Test procedure:</b> 47 CFR, Section 2.1049			
<b>Test mode:</b> Compliance		<b>Verdict: PASS</b>	
<b>Date(s):</b> 07-Jun-21			
<b>Temperature:</b> 25 °C	<b>Relative Humidity:</b> 53 %	<b>Air Pressure:</b> 1009 hPa	<b>Power:</b> 3.6 VDC
<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

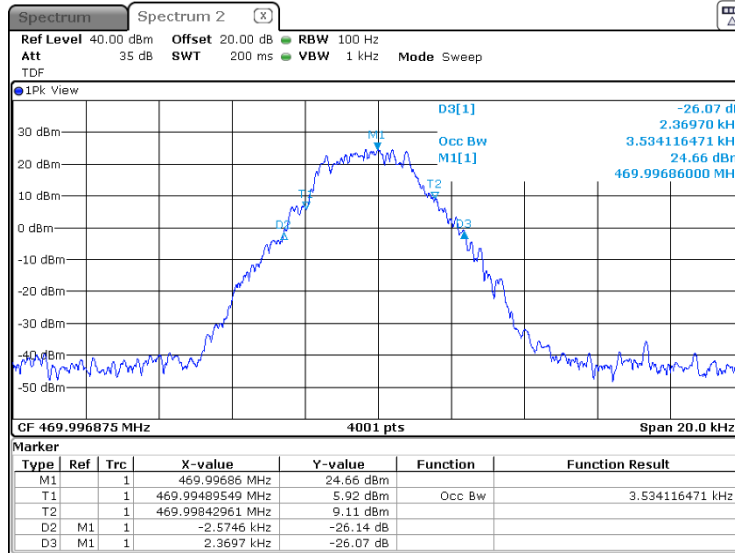




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<b>Test specification:</b> Section 90.209 / RSS-119 Section 5.5, Occupied bandwidth			
<b>Test procedure:</b> 47 CFR, Section 2.1049			
<b>Test mode:</b> Compliance		<b>Verdict:</b> PASS	
<b>Date(s):</b> 07-Jun-21			
<b>Temperature:</b> 25 °C	<b>Relative Humidity:</b> 53 %	<b>Air Pressure:</b> 1009 hPa	<b>Power:</b> 3.6 VDC
<b>Remarks:</b>			

Plot 7.2.3 Occupied bandwidth test result at high frequency







<b>Test specification: Section 90.210 / RSS-119 Section 5.8.4, Emission mask</b>			
<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: PASS</b>	
<b>Date(s):</b> 07-Jun-21 - 12-Jul-21			
<b>Temperature:</b> 24.2 °C	<b>Relative Humidity:</b> 48 %	<b>Air Pressure:</b> 1009 hPa	<b>Power:</b> 3.6 VDC
<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

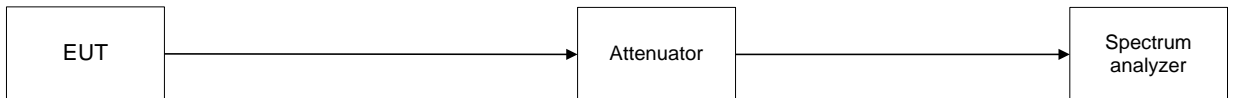
\*\* - displacement frequency

#### 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.

**Figure 7.3.1 Emission mask test setup**





<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> 07-Jun-21 - 12-Jul-21			
<b>Temperature:</b> 24.2 °C	<b>Relative Humidity:</b> 48 %	<b>Air Pressure:</b> 1009 hPa	<b>Power:</b> 3.6 VDC
<b>Remarks:</b>			

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.



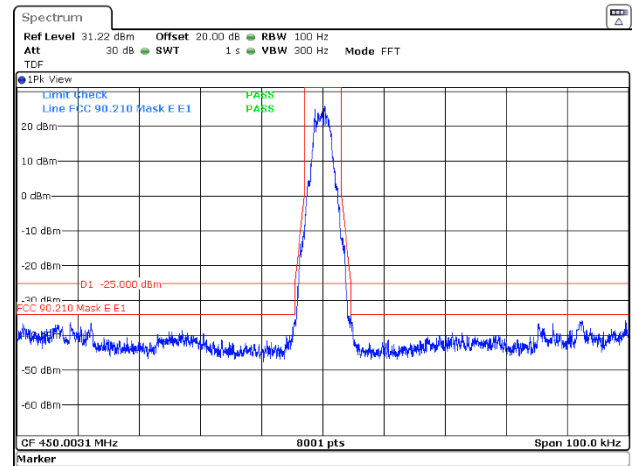
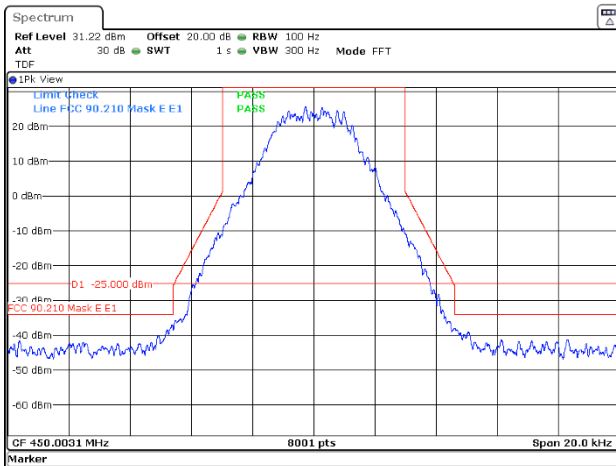
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<b>Test specification:</b> Section 90.210 / RSS-119 Section 5.8.4, Emission mask			
<b>Test procedure:</b> 47 CFR, Sections 2.1051, 2.1047 and 90.210(e); TIA/EIA-603-E, Section 2.2.13			
<b>Test mode:</b> Compliance		<b>Verdict:</b> PASS	
<b>Date(s):</b> 07-Jun-21 - 12-Jul-21			
<b>Temperature:</b> 24.2 °C	<b>Relative Humidity:</b> 48 %	<b>Air Pressure:</b> 1009 hPa	<b>Power:</b> 3.6 VDC
<b>Remarks:</b>			

Plot 7.3.1 Emission mask test results at low carrier frequency FCC part 90

OPERATING FREQUENCY RANGE:  
DETECTOR USED:  
MODULATION:  
MODULATING SIGNAL:  
TRANSMITTER OUTPUT POWER SETTINGS:

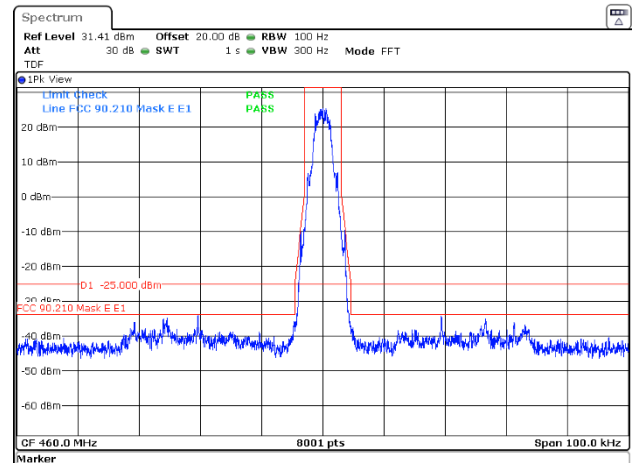
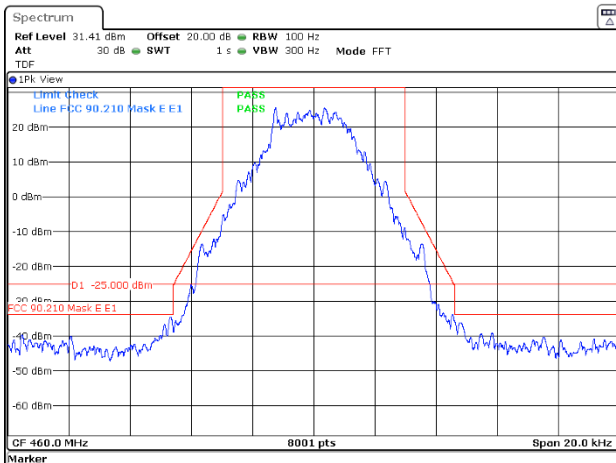
450 – 470 MHz  
Peak  
4GFSK  
PRBS  
Maximum



Plot 7.3.2 Emission mask test results at mid carrier frequency FCC part 90

OPERATING FREQUENCY RANGE:  
DETECTOR USED:  
MODULATION:  
MODULATING SIGNAL:  
TRANSMITTER OUTPUT POWER SETTINGS:

450 – 470 MHz  
Peak  
4GFSK  
PRBS  
Maximum





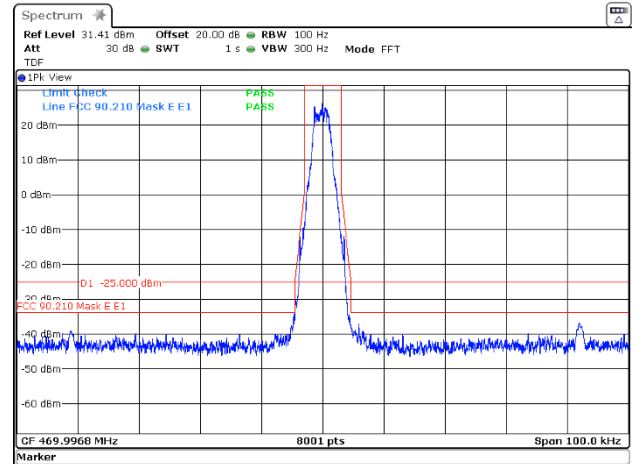
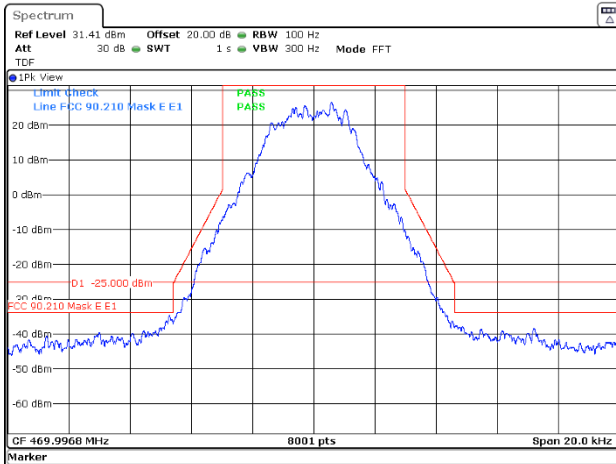
HERMON LABORATORIES

<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> 07-Jun-21 - 12-Jul-21			
<b>Temperature:</b> 24.2 °C	<b>Relative Humidity:</b> 48 %	<b>Air Pressure:</b> 1009 hPa	<b>Power:</b> 3.6 VDC
<b>Remarks:</b>			

Plot 7.3.3 Emission mask test results at high carrier frequency FCC part 90

OPERATING FREQUENCY RANGE:  
DETECTOR USED:  
MODULATION:  
MODULATING SIGNAL:  
TRANSMITTER OUTPUT POWER SETTINGS:

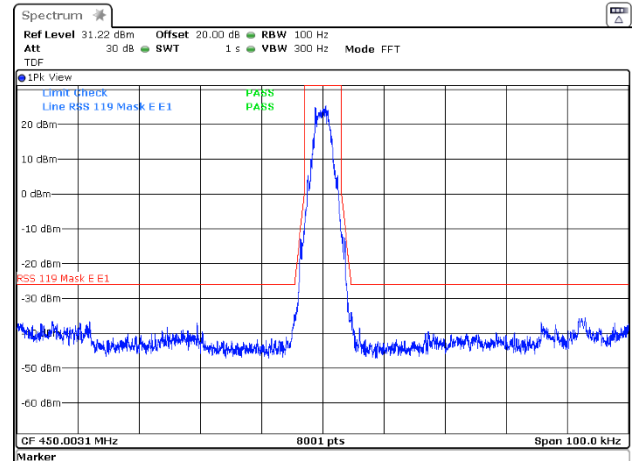
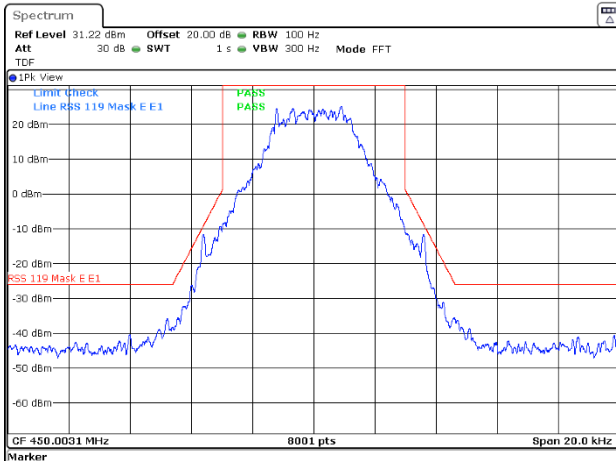
450 – 470 MHz  
Peak  
4GFSK  
PRBS  
Maximum



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

OPERATING FREQUENCY RANGE:  
DETECTOR USED:  
MODULATION:  
MODULATING SIGNAL:  
TRANSMITTER OUTPUT POWER SETTINGS:

450 – 470 MHz  
Peak  
4GFSK  
PRBS  
Maximum





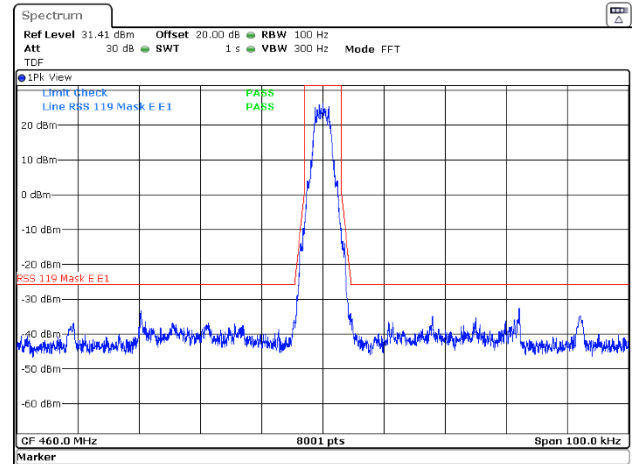
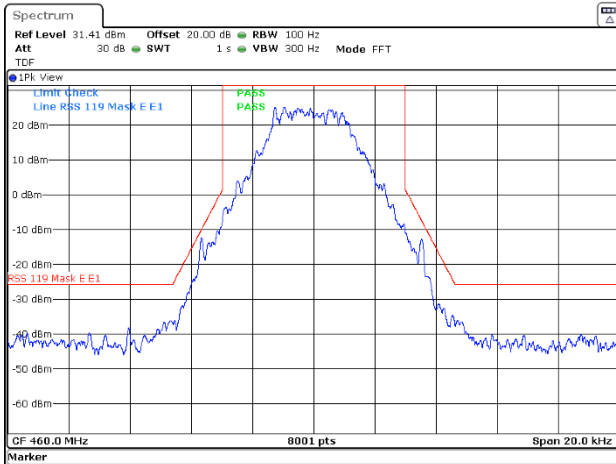
HERMON LABORATORIES

<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> 07-Jun-21 - 12-Jul-21			
<b>Temperature:</b> 24.2 °C	<b>Relative Humidity:</b> 48 %	<b>Air Pressure:</b> 1009 hPa	<b>Power:</b> 3.6 VDC
<b>Remarks:</b>			

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

OPERATING FREQUENCY RANGE:  
DETECTOR USED:  
MODULATION:  
MODULATING SIGNAL:  
TRANSMITTER OUTPUT POWER SETTINGS:

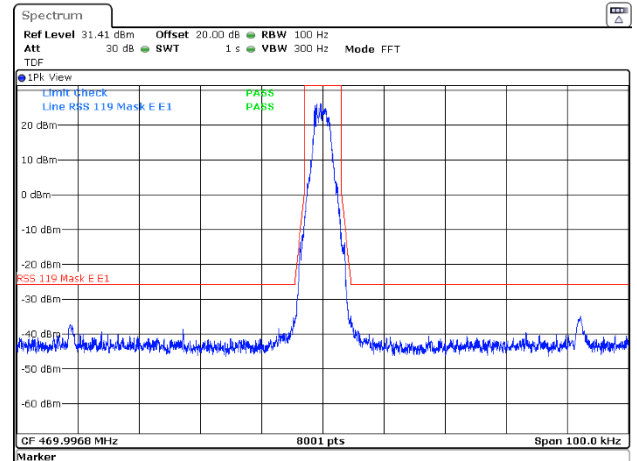
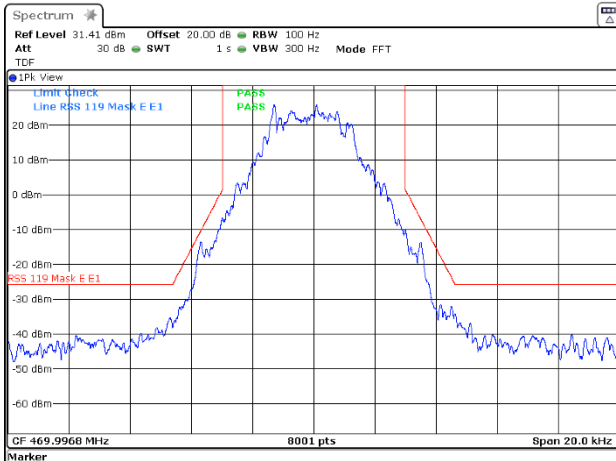
450 – 470 MHz  
Peak  
4GFSK  
PRBS  
Maximum



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

OPERATING FREQUENCY RANGE:  
DETECTOR USED:  
MODULATION:  
MODULATING SIGNAL:  
TRANSMITTER OUTPUT POWER SETTINGS:

450 – 470 MHz  
Peak  
4GFSK  
PRBS  
Maximum





<b>Test specification:</b> Section 90.210 / RSS-119 Section 5.8.4, Radiated spurious emissions			
<b>Test procedure:</b> 47 CFR, Sections 2.1051 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-Jun-21 - 12-Oct-21			
<b>Temperature:</b> 25 °C	<b>Relative Humidity:</b> 60 %	<b>Air Pressure:</b> 1011 hPa	<b>Power:</b> 3.6 VDC
<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(μV/m) <sup>***</sup>
0.009 – 10th harmonic*	55+10logP <sup>**</sup>	-25	72.35

\* - Excluding the in band emission within ± 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° 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° 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: Section 90.210 / RSS-119 Section 5.8.4, Radiated spurious emissions</b>			
<b>Test procedure:</b> 47 CFR, Sections 2.1051 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-Jun-21 - 12-Oct-21			
<b>Temperature:</b> 25 °C	<b>Relative Humidity:</b> 60 %	<b>Air Pressure:</b> 1011 hPa	<b>Power:</b> 3.6 VDC
<b>Remarks:</b>			

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

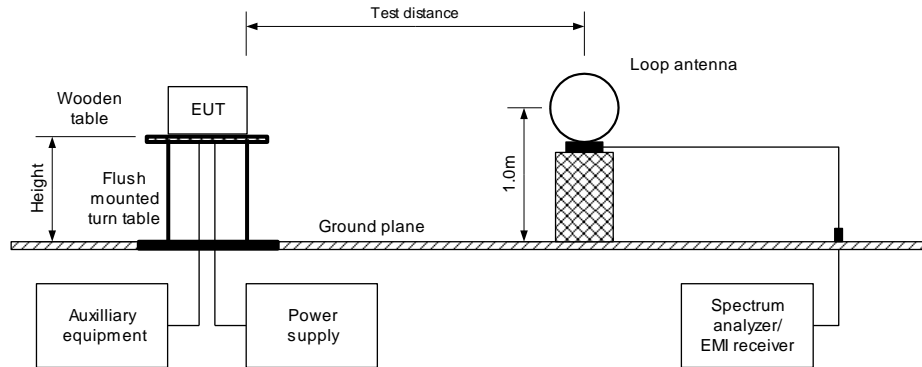
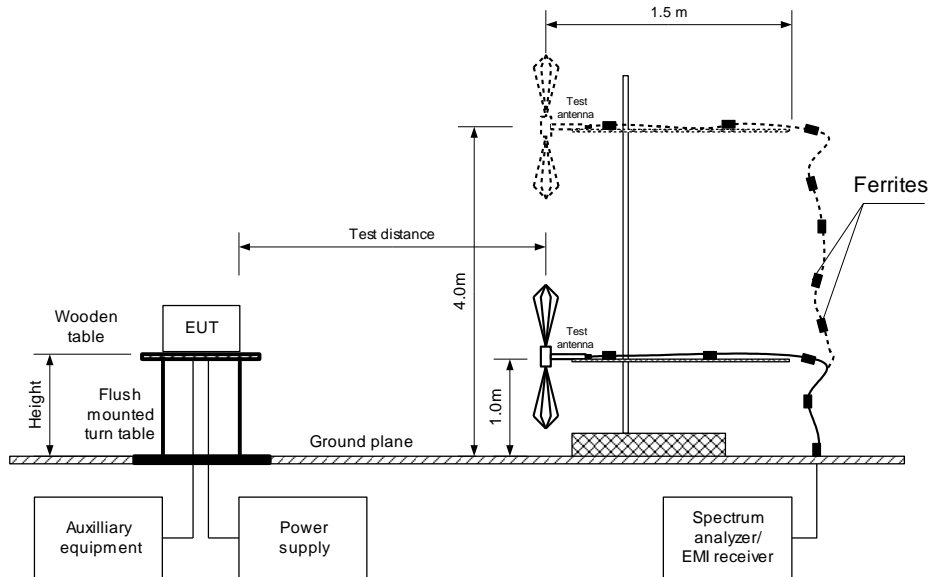


Figure 7.4.2 Setup for spurious emission field strength measurements above 30 MHz





<b>Test specification:</b> Section 90.210 / RSS-119 Section 5.8.4, Radiated spurious emissions			
<b>Test procedure:</b> 47 CFR, Sections 2.1051 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-Jun-21 - 12-Oct-21			
<b>Temperature:</b> 25 °C	<b>Relative Humidity:</b> 60 %	<b>Air Pressure:</b> 1011 hPa	<b>Power:</b> 3.6 VDC
<b>Remarks:</b>			

Table 7.4.2 Spurious emission field strength test results

ASSIGNED FREQUENCY RANGE: 450 - 470 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 SETTINGS: Maximum

Frequency, MHz	Field strength, dB(μV/m)	Limit, dB(μV/m)	Margin, dB*	RBW, kHz	Antenna polarization	Antenna height, m	Turn-table position**, degrees	Verdict
<b>Low carrier frequency 450.0031 MHz</b>								
900.0062	68.18	72.4	-4.30	120	Vertical	1.0	0	Pass
<b>Mid carrier frequency 460.0000 MHz</b>								
920.0000	60.77	72.4	-11.63	120	Vertical	1.0	0	Pass
<b>High carrier frequency 469.9969 MHz</b>								
939.9936	59.80	72.4	-12.60	120	Vertical	1.0	0	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 3903	HL 4355	HL 4360	HL 4933	HL 5288	HL 5405		
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Full description is given in Appendix A.



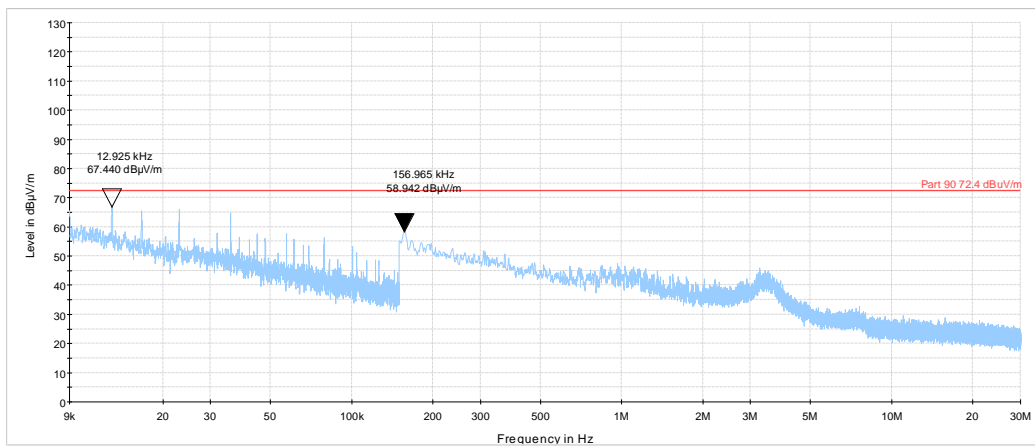


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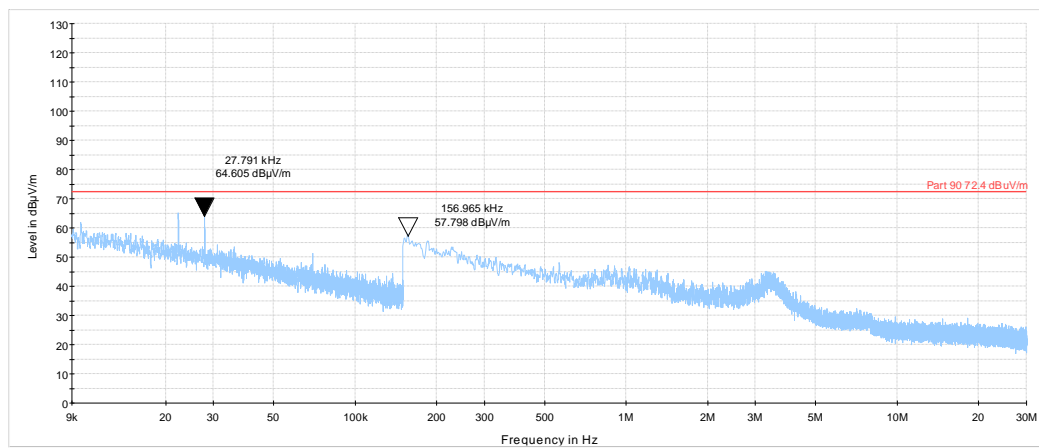
<b>Test specification:</b> Section 90.210 / RSS-119 Section 5.8.4, Radiated spurious emissions			
<b>Test procedure:</b> 47 CFR, Sections 2.1051 and 90.210(e); TIA/EIA-603-E, Section 2.2.13			
<b>Test mode:</b> Compliance		<b>Verdict:</b> PASS	
<b>Date(s):</b> 22-Jun-21 - 12-Oct-21			
<b>Temperature:</b> 25 °C	<b>Relative Humidity:</b> 60 %	<b>Air Pressure:</b> 1011 hPa	<b>Power:</b> 3.6 VDC
<b>Remarks:</b>			

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

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



CARRIER FREQUENCY: Mid





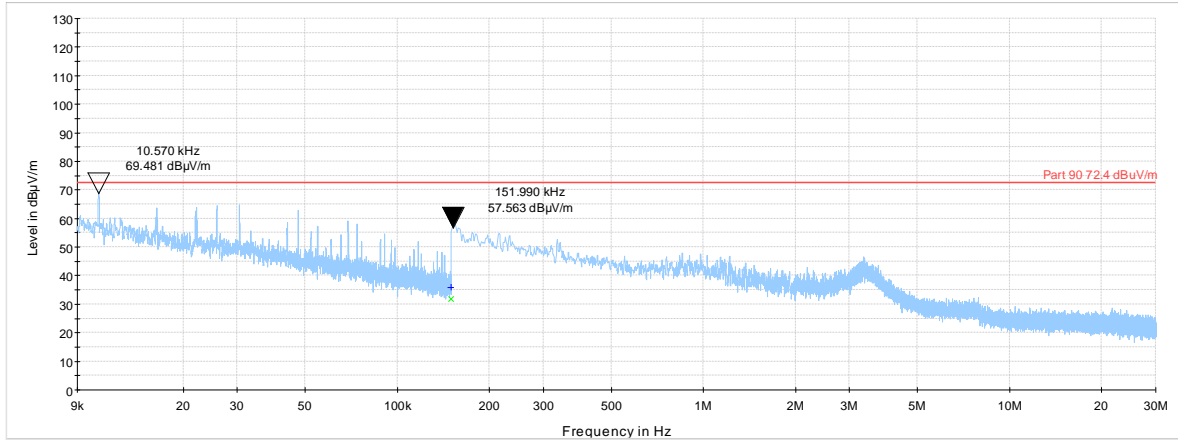
HERMON LABORATORIES

Report ID: TELRAD\_FCC.43079  
Date of Issue: 28-Nov-21

<b>Test specification:</b> Section 90.210 / RSS-119 Section 5.8.4, Radiated spurious emissions			
<b>Test procedure:</b> 47 CFR, Sections 2.1051 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-Jun-21 - 12-Oct-21			
<b>Temperature:</b> 25 °C	<b>Relative Humidity:</b> 60 %	<b>Air Pressure:</b> 1011 hPa	<b>Power:</b> 3.6 VDC
<b>Remarks:</b>			

CARRIER FREQUENCY:

High



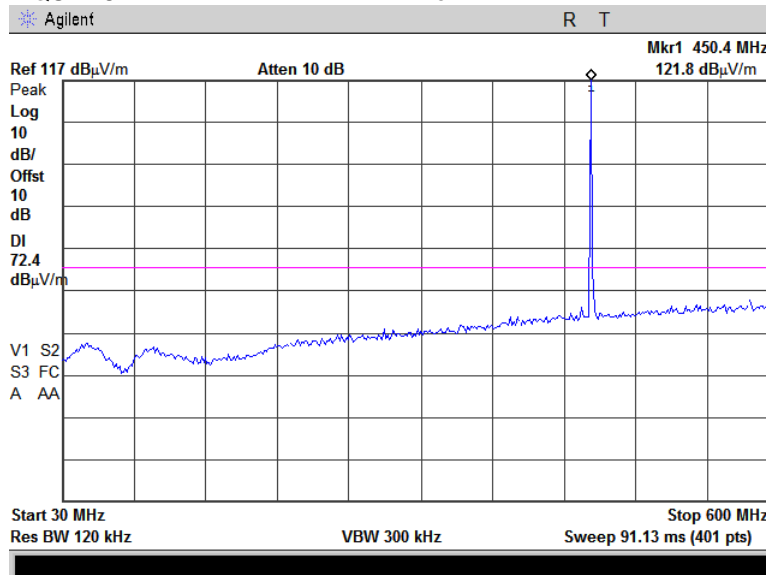


<b>Test specification:</b> Section 90.210 / RSS-119 Section 5.8.4, Radiated spurious emissions			
<b>Test procedure:</b> 47 CFR, Sections 2.1051 and 90.210(e); TIA/EIA-603-E, Section 2.2.13			
<b>Test mode:</b> Compliance		<b>Verdict:</b> PASS	
<b>Date(s):</b> 22-Jun-21 - 12-Oct-21			
<b>Temperature:</b> 25 °C	<b>Relative Humidity:</b> 60 %	<b>Air Pressure:</b> 1011 hPa	<b>Power:</b> 3.6 VDC
<b>Remarks:</b>			

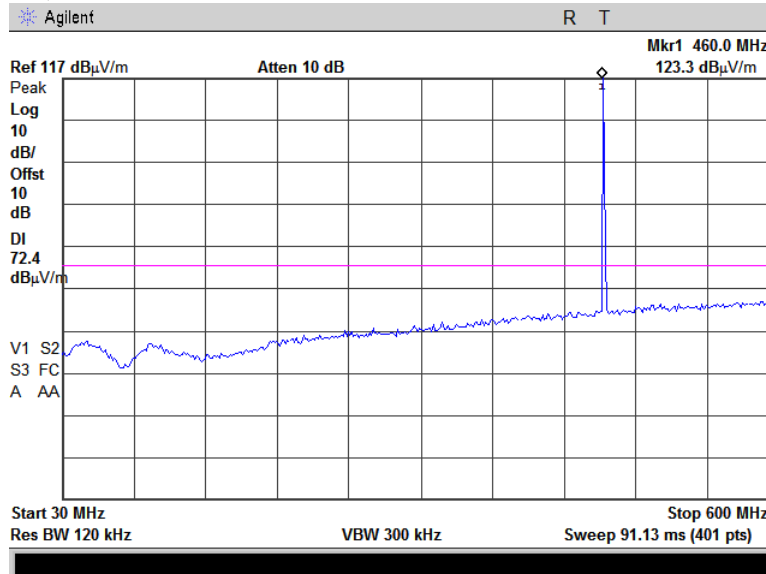
**Plot 7.4.2 Radiated spurious emission measurements in 30 - 600 MHz range**

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

CARRIER FREQUENCY: Low



CARRIER FREQUENCY: Mid

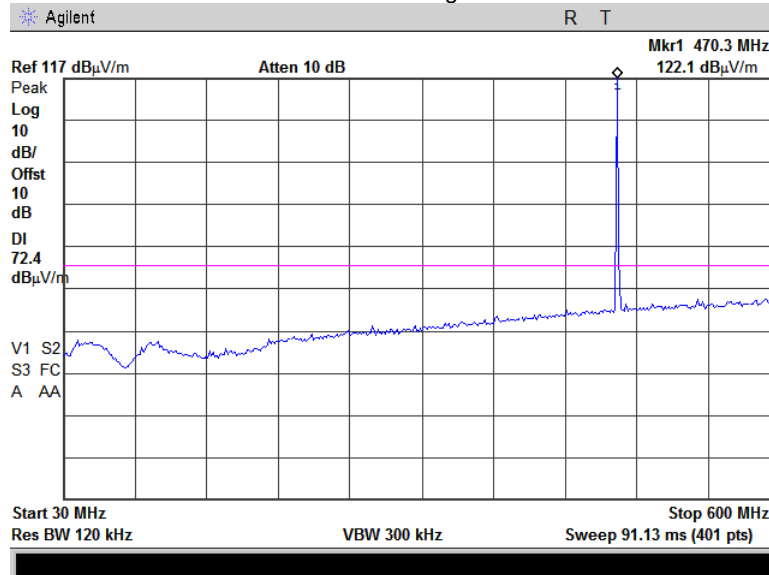




HERMON LABORATORIES

<b>Test specification:</b> Section 90.210 / RSS-119 Section 5.8.4, Radiated spurious emissions			
<b>Test procedure:</b> 47 CFR, Sections 2.1051 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-Jun-21 - 12-Oct-21			
<b>Temperature:</b> 25 °C	<b>Relative Humidity:</b> 60 %	<b>Air Pressure:</b> 1011 hPa	<b>Power:</b> 3.6 VDC
<b>Remarks:</b>			

CARRIER FREQUENCY: High

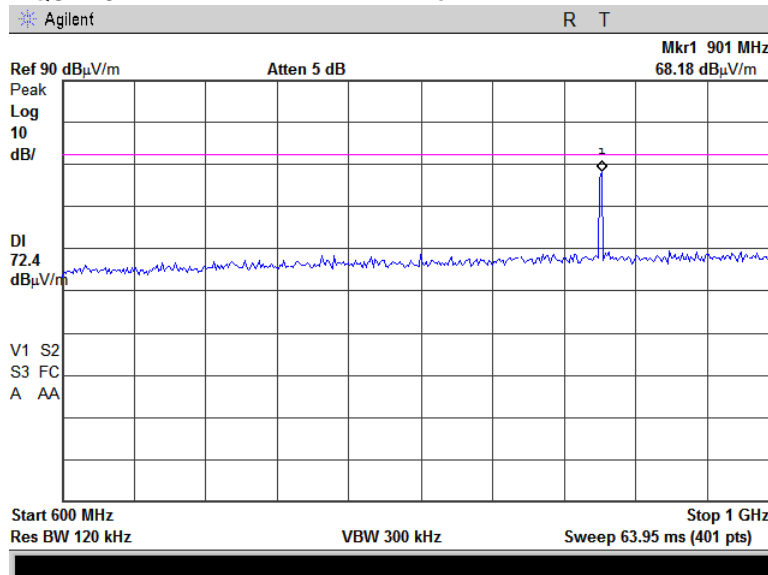




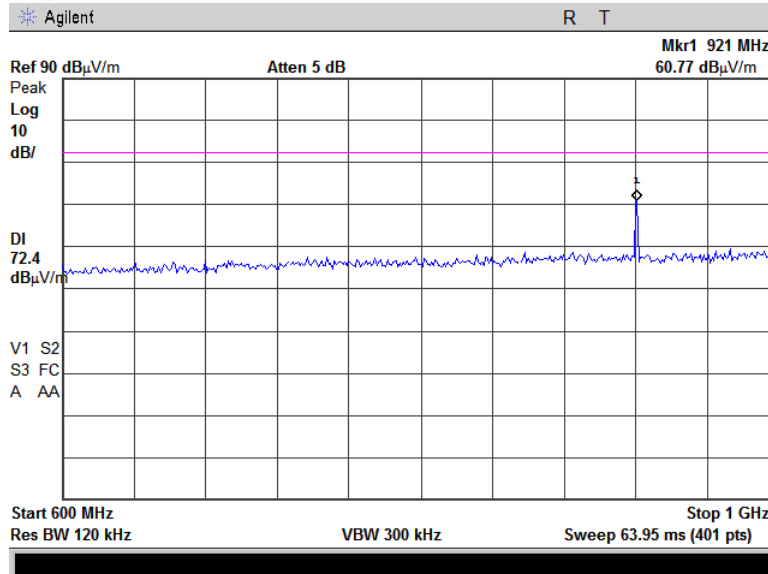
<b>Test specification:</b> Section 90.210 / RSS-119 Section 5.8.4, Radiated spurious emissions			
<b>Test procedure:</b> 47 CFR, Sections 2.1051 and 90.210(e); TIA/EIA-603-E, Section 2.2.13			
<b>Test mode:</b> Compliance		<b>Verdict:</b> PASS	
<b>Date(s):</b> 22-Jun-21 - 12-Oct-21			
<b>Temperature:</b> 25 °C	<b>Relative Humidity:</b> 60 %	<b>Air Pressure:</b> 1011 hPa	<b>Power:</b> 3.6 VDC
<b>Remarks:</b>			

**Plot 7.4.3 Radiated spurious emission measurements in 600 - 1000 MHz range**

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



CARRIER FREQUENCY: Mid

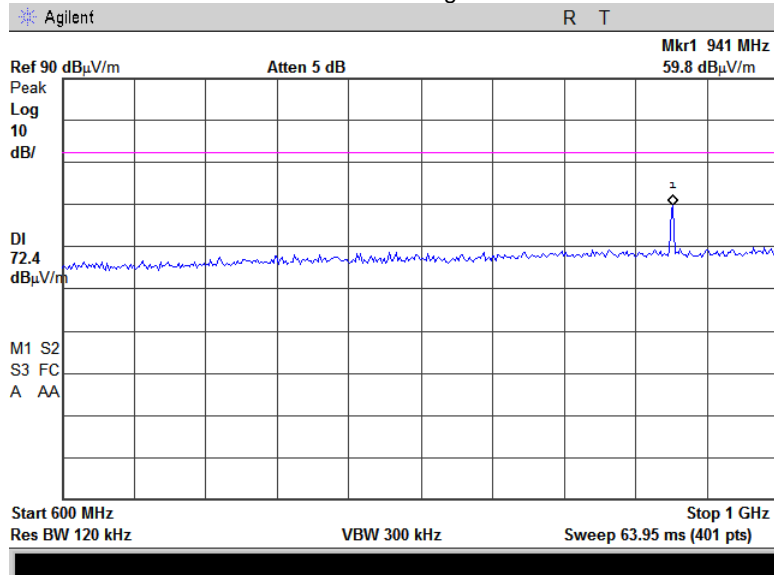




HERMON LABORATORIES

<b>Test specification:</b> Section 90.210 / RSS-119 Section 5.8.4, Radiated spurious emissions			
<b>Test procedure:</b> 47 CFR, Sections 2.1051 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-Jun-21 - 12-Oct-21			
<b>Temperature:</b> 25 °C	<b>Relative Humidity:</b> 60 %	<b>Air Pressure:</b> 1011 hPa	<b>Power:</b> 3.6 VDC
<b>Remarks:</b>			

CARRIER FREQUENCY: High

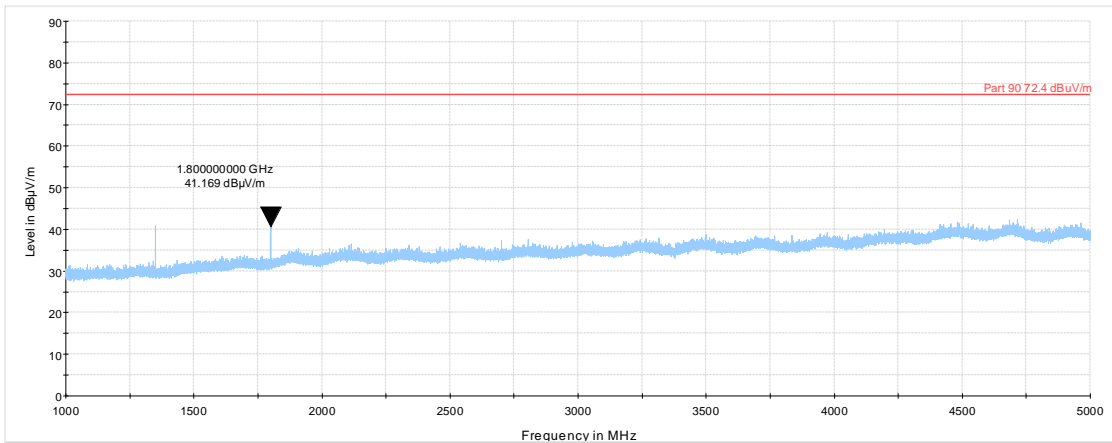




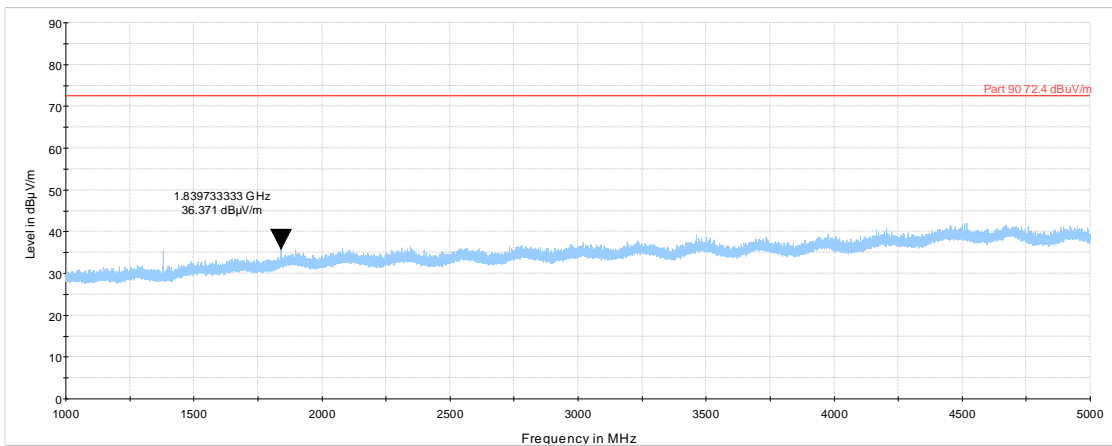
<b>Test specification:</b> Section 90.210 / RSS-119 Section 5.8.4, Radiated spurious emissions			
<b>Test procedure:</b> 47 CFR, Sections 2.1051 and 90.210(e); TIA/EIA-603-E, Section 2.2.13			
<b>Test mode:</b> Compliance		<b>Verdict:</b> PASS	
<b>Date(s):</b> 22-Jun-21 - 12-Oct-21			
<b>Temperature:</b> 25 °C	<b>Relative Humidity:</b> 60 %	<b>Air Pressure:</b> 1011 hPa	<b>Power:</b> 3.6 VDC
<b>Remarks:</b>			

**Plot 7.4.4 Radiated spurious emission measurements in 1000 – 5000 MHz range**

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



CARRIER FREQUENCY:	Mid
--------------------	-----



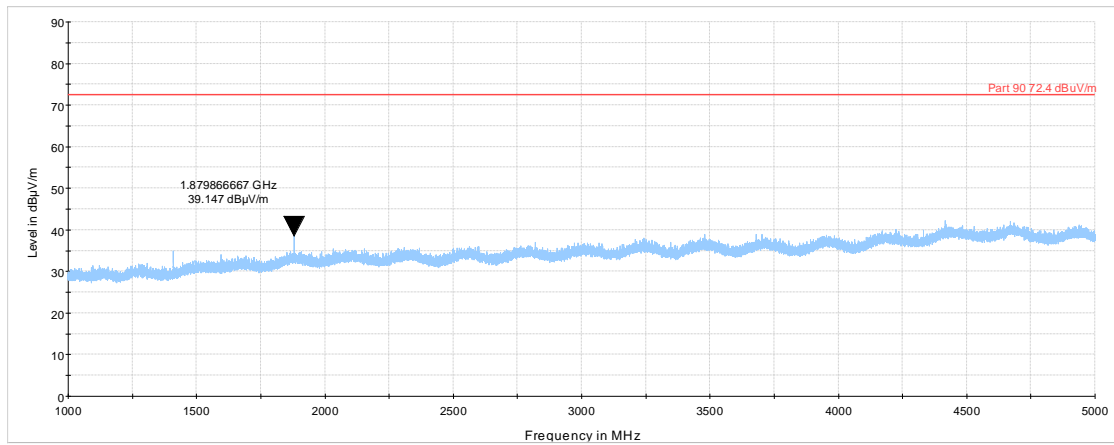


HERMON LABORATORIES

Report ID: TELRAD\_FCC.43079  
Date of Issue: 28-Nov-21

<b>Test specification:</b> Section 90.210 / RSS-119 Section 5.8.4, Radiated spurious emissions			
<b>Test procedure:</b> 47 CFR, Sections 2.1051 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-Jun-21 - 12-Oct-21			
<b>Temperature:</b> 25 °C	<b>Relative Humidity:</b> 60 %	<b>Air Pressure:</b> 1011 hPa	<b>Power:</b> 3.6 VDC
<b>Remarks:</b>			

CARRIER FREQUENCY: High







<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> 14-Jun-21 - 01-Jul-21			
<b>Temperature:</b> 25 °C	<b>Relative Humidity:</b> 47 %	<b>Air Pressure:</b> 1008 hPa	<b>Power:</b> 3.6 VDC
<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.

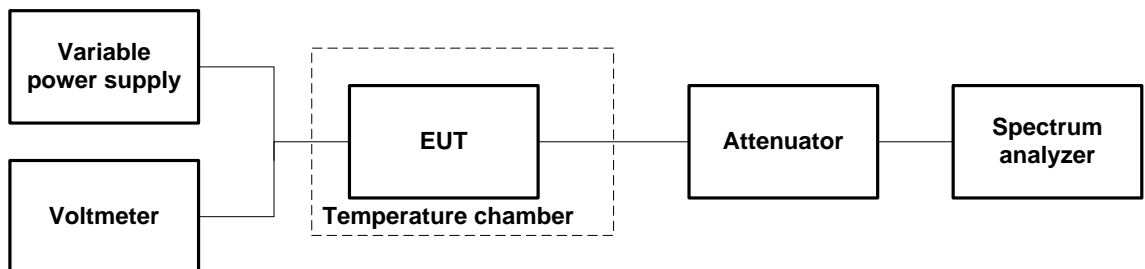
Table 7.5.1 Frequency stability limits

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.

Figure 7.5.1 Frequency stability test setup





<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> 14-Jun-21 - 01-Jul-21			
<b>Temperature:</b> 25 °C	<b>Relative Humidity:</b> 47 %	<b>Air Pressure:</b> 1008 hPa	<b>Power:</b> 3.6 VDC
<b>Remarks:</b>			

Table 7.5.2 Frequency stability test results

OPERATING FREQUENCY: 450 – 470 MHz  
 NOMINAL POWER VOLTAGE: 3.6 V DC  
 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	450.003073	450.003088	450.003035	450.003045	450.003045	450.003073	450.003028	63	0	450	-387	Pass		
-20	nominal	450.003025	NA	NA	NA	NA	NA	450.003060	35	0		-415	Pass		
-10	nominal	450.003013	NA	NA	NA	NA	NA	450.003075	50	-12		-400	Pass		
0	nominal	450.002975	450.002988	450.002938	450.002980	450.002980	450.002975	450.002975	0	-87		-363	Pass		
10	nominal	450.002988	NA	NA	NA	NA	NA	450.002825	0	-200		-250	Pass		
20	+15%	450.002888	NA	NA	NA	NA	NA	450.002800	0	-225		-225	Pass		
20	nominal	450.003025	NA	NA	NA	NA	NA	450.003025	0	0		-450	Pass		
20	-15%	450.002838	NA	NA	NA	NA	NA	450.002850	0	-187		-263	Pass		
30	nominal	450.002950	450.002900	450.002900	450.002950	450.002938	450.002938	450.002962	0	-125		-325	Pass		
40	nominal	450.002988	NA	NA	NA	NA	NA	450.002913	0	-112		-338	Pass		
50	nominal	450.003001	NA	NA	NA	NA	NA	450.002981	0	-44		-406	Pass		
<b>Mid frequency 460.0000 MHz</b>															
-30	nominal	459.999800	459.999888	460.000075	460.000050	460.000037	460.000087	460.000000	199	-88	460	-261	Pass		
-20	nominal	459.999863	NA	NA	NA	NA	NA	460.000062	174	0		-286	Pass		
-10	nominal	459.999888	NA	NA	NA	NA	NA	460.000000	112	0		-348	Pass		
0	nominal	459.999888	459.999950	459.999913	459.999888	459.999888	459.999913	459.999925	100	0		-360	Pass		
10	nominal	459.999950	NA	NA	NA	NA	NA	459.999825	62	-63		-397	Pass		
20	+15%	459.999913	NA	NA	NA	NA	NA	459.999738	25	-150		-310	Pass		
20	nominal	459.999800	NA	NA	NA	NA	NA	459.999888	0	-88		-372	Pass		
20	-15%	459.999825	NA	NA	NA	NA	NA	459.999850	62	-63		-397	Pass		
30	nominal	459.999888	459.999838	459.999763	459.999700	459.999713	459.999675	459.999715	0	-213		-247	Pass		
40	nominal	459.999813	NA	NA	NA	NA	NA	459.999863	25	-125		-335	Pass		
50	nominal	459.999825	NA	NA	NA	NA	NA	459.999788	0	-100		-360	Pass		
<b>High frequency 469.9969 MHz</b>															
-30	nominal	469.996832	469.996832	469.996870	469.996870	469.996871	469.996886	469.996876	0	-108	470	-324	Pass		
-20	nominal	469.996838	NA	NA	NA	NA	NA	469.996950	210	0		-260	Pass		
-10	nominal	469.996763	NA	NA	NA	NA	NA	469.996738	23	-2		-447	Pass		
0	nominal	469.996738	469.996725	469.996700	469.996675	469.996670	469.996675	469.996675	0	-70		-400	Pass		
10	nominal	469.996738	NA	NA	NA	NA	NA	469.996525	0	-215		-255	Pass		
20	+15%	469.996700	NA	NA	NA	NA	NA	469.996515	0	-225		-245	Pass		
20	nominal	469.996733	NA	NA	NA	NA	NA	469.996740	0	-7		-463	Pass		
20	-15%	469.996463	NA	NA	NA	NA	NA	469.996535	0	-277		-193	Pass		
30	nominal	469.996513	469.996588	469.996575	469.996575	469.996525	469.996527	469.996525	0	-227		-243	Pass		
40	nominal	469.996543	NA	NA	NA	NA	NA	469.996538	0	-202		-268	Pass		
50	nominal	469.996563	NA	NA	NA	NA	NA	469.996562	0	-178		-292	Pass		

\* - Reference frequency

Reference numbers of test equipment used

HL 4355	HL 5623					
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Full description is given in Appendix A.



<b>Test specification:</b> Section 90.214 / RSS-119 Section 5.9, Transient frequency behaviour			
<b>Test procedure:</b> TIA/EIA-603-A, Section 2.2.19			
<b>Test mode:</b> Compliance		<b>Verdict:</b> PASS	
<b>Date(s):</b> 21-Jun-21 - 28-Jun-21			
<b>Temperature:</b> 26 °C	<b>Relative Humidity:</b> 42 %	<b>Air Pressure:</b> 1005 hPa	<b>Power:</b> 3.6 VDC
<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*
6.25	± 6.25	10.0	t <sub>1</sub>
	± 3.125	25.0	t <sub>2</sub>
	± 6.25	10.0	t <sub>3</sub>

\* - t<sub>on</sub> is the instant when a 1 kHz test signal is completely suppressed;  
t<sub>1</sub> is the time period immediately following t<sub>on</sub>;  
t<sub>2</sub> is the time period immediately following t<sub>1</sub>;  
t<sub>3</sub> is the time period from the instant when the transmitter is turned off until t<sub>off</sub>;  
t<sub>off</sub> 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 ± 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 7.7.2 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-A, Section 2.2.19			
<b>Test mode:</b> Compliance		<b>Verdict:</b> PASS	
<b>Date(s):</b> 21-Jun-21 - 28-Jun-21			
<b>Temperature:</b> 26 °C	<b>Relative Humidity:</b> 42 %	<b>Air Pressure:</b> 1005 hPa	<b>Power:</b> 3.6 VDC
<b>Remarks:</b>			

Figure 7.6.1 Transient frequency test setup

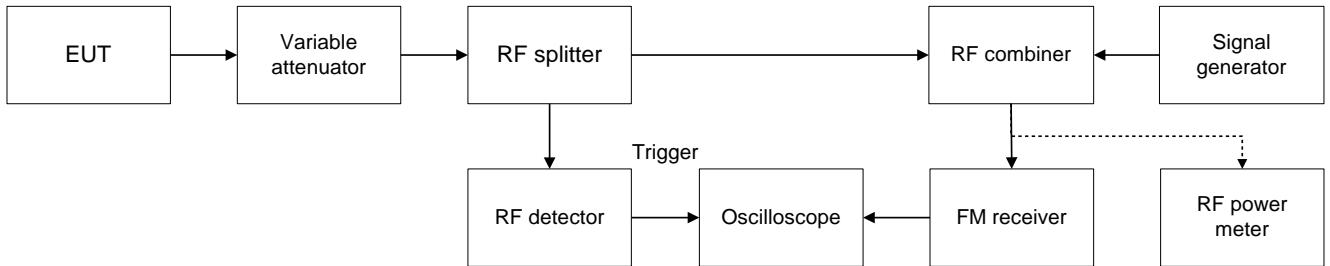


Table 7.6.2 Transient frequency behaviour test results

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	3.173	± 6.25	-3.077	Pass
	t <sub>2</sub>	25.0	1.562	± 3.125	-1.563	
	t <sub>3</sub>	10.0	1.123	± 6.25	-5.127	
460.0000	t <sub>1</sub>	10.0	2.148	± 6.25	-4.102	Pass
	t <sub>2</sub>	25.0	1.123	± 3.125	-2.002	
	t <sub>3</sub>	10.0	1.464	± 6.25	-4.786	
469.9969	t <sub>1</sub>	10.0	2.538	± 6.25	-3.712	Pass
	t <sub>2</sub>	25.0	1.562	± 3.125	-1.563	
	t <sub>3</sub>	10.0	1.123	± 6.25	-5.127	

Reference numbers of test equipment used

HL 5971	HL 2017	HL 3434	HL 3766	HL 4785	HL 5212	HL 5409	HL 5472
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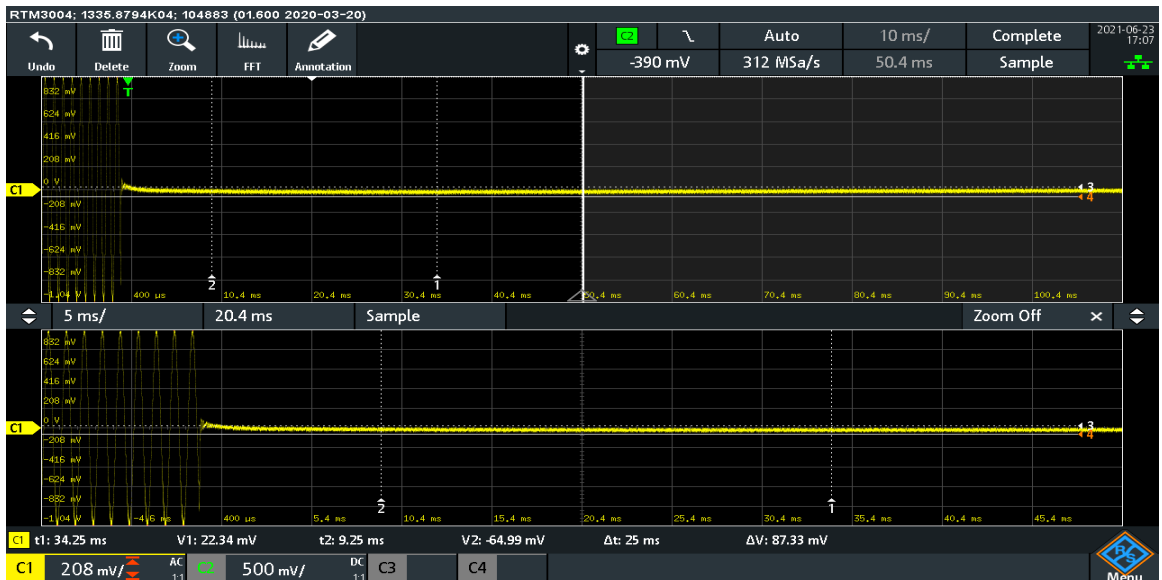
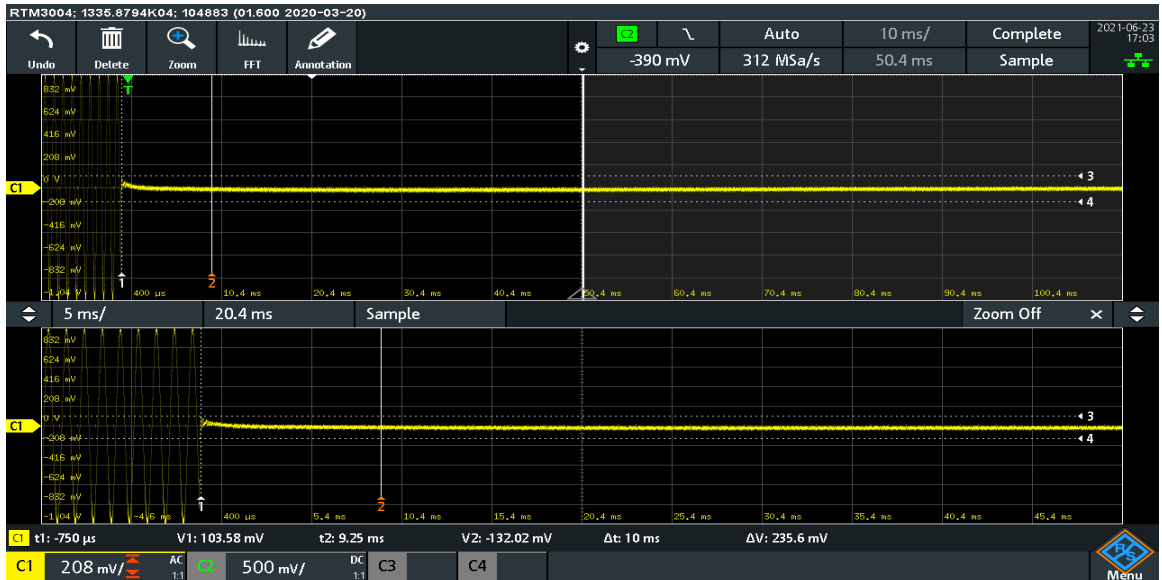
Full description is given in Appendix A.



HERMON LABORATORIES

<b>Test specification:</b> Section 90.214 / RSS-119 Section 5.9, Transient frequency behaviour	
<b>Test procedure:</b> TIA/EIA-603-A, Section 2.2.19	
<b>Test mode:</b> Compliance	<b>Verdict:</b> PASS
<b>Date(s):</b> 21-Jun-21 - 28-Jun-21	
<b>Temperature:</b> 26 °C	<b>Relative Humidity:</b> 42 %
<b>Air Pressure:</b> 1005 hPa	<b>Power:</b> 3.6 VDC
<b>Remarks:</b>	

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

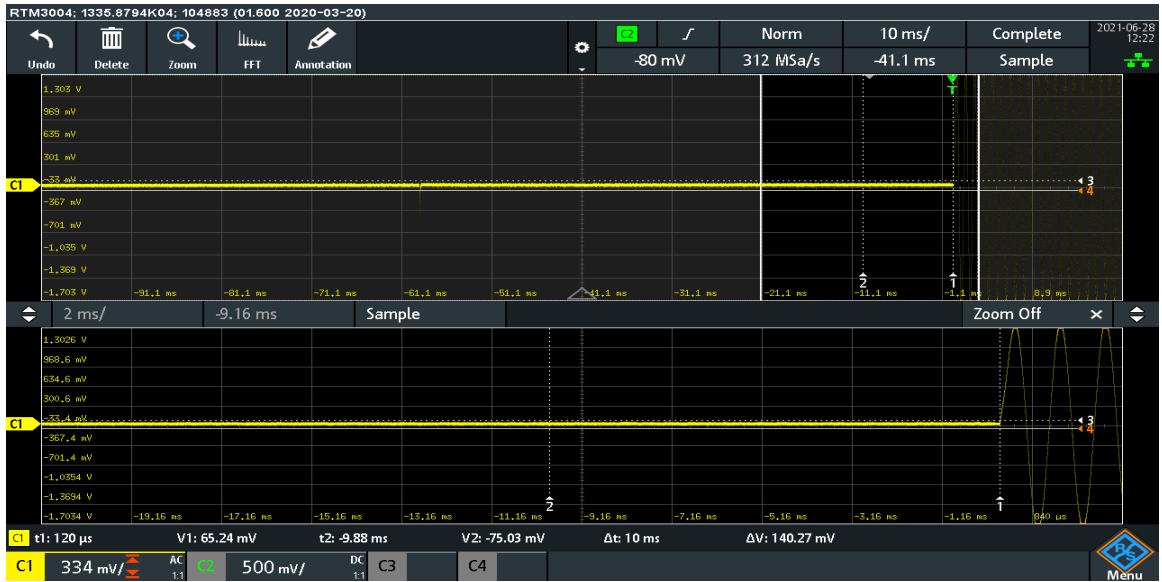




HERMON LABORATORIES

<b>Test specification:</b> Section 90.214 / RSS-119 Section 5.9, Transient frequency behaviour			
<b>Test procedure:</b> TIA/EIA-603-A, Section 2.2.19			
<b>Test mode:</b> Compliance	<b>Verdict:</b> PASS		
<b>Date(s):</b> 21-Jun-21 - 28-Jun-21			
<b>Temperature:</b> 26 °C	<b>Relative Humidity:</b> 42 %	<b>Air Pressure:</b> 1005 hPa	<b>Power:</b> 3.6 VDC
<b>Remarks:</b>			

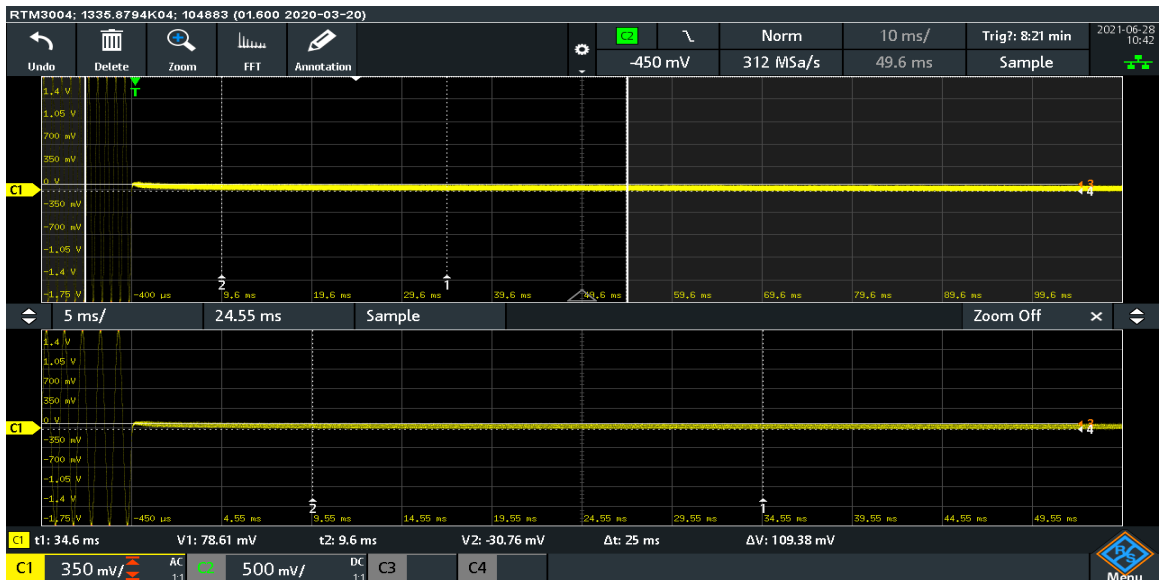
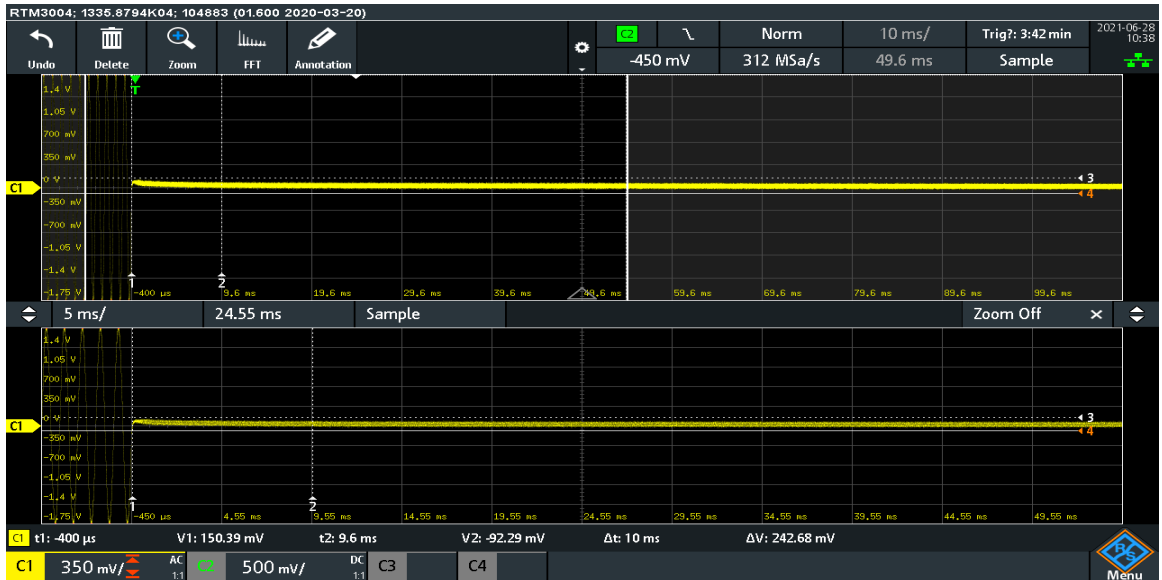
Plot 7.6.2 Transient frequency during power OFF test results at low carrier frequency





<b>Test specification:</b> Section 90.214 / RSS-119 Section 5.9, Transient frequency behaviour	
<b>Test procedure:</b> TIA/EIA-603-A, Section 2.2.19	
<b>Test mode:</b> Compliance	<b>Verdict:</b> PASS
<b>Date(s):</b> 21-Jun-21 - 28-Jun-21	
<b>Temperature:</b> 26 °C	<b>Relative Humidity:</b> 42 %
<b>Air Pressure:</b> 1005 hPa	<b>Power:</b> 3.6 VDC
<b>Remarks:</b>	

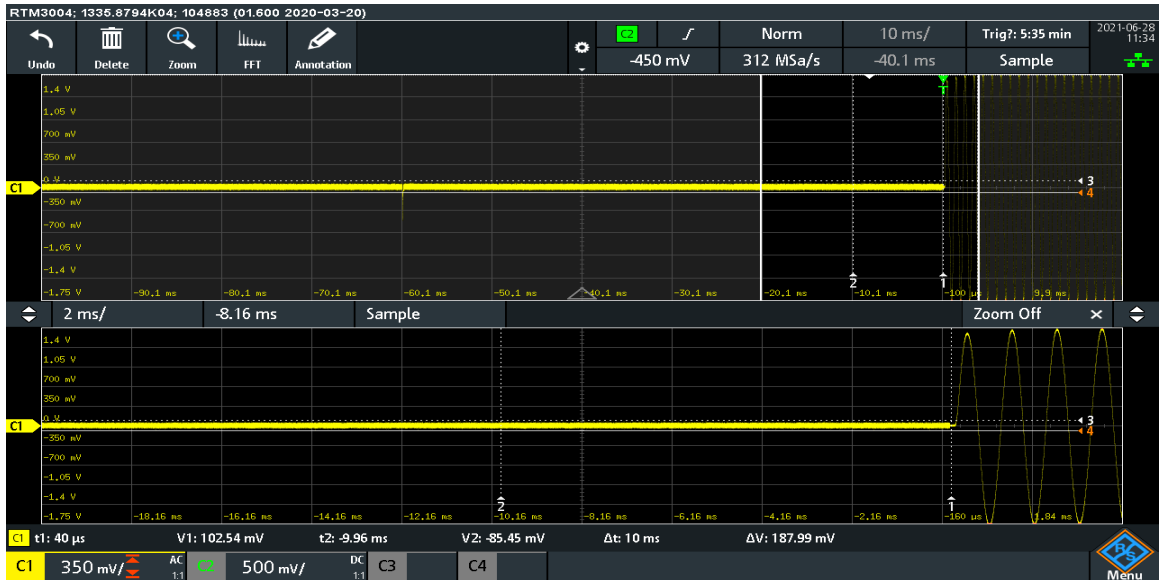
Plot 7.6.3 Transient frequency during power ON test results at mid carrier frequency





<b>Test specification:</b> Section 90.214 / RSS-119 Section 5.9, Transient frequency behaviour			
<b>Test procedure:</b> TIA/EIA-603-A, Section 2.2.19			
<b>Test mode:</b> Compliance	<b>Verdict:</b> PASS		
<b>Date(s):</b> 21-Jun-21 - 28-Jun-21			
<b>Temperature:</b> 26 °C	<b>Relative Humidity:</b> 42 %	<b>Air Pressure:</b> 1005 hPa	<b>Power:</b> 3.6 VDC
<b>Remarks:</b>			

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



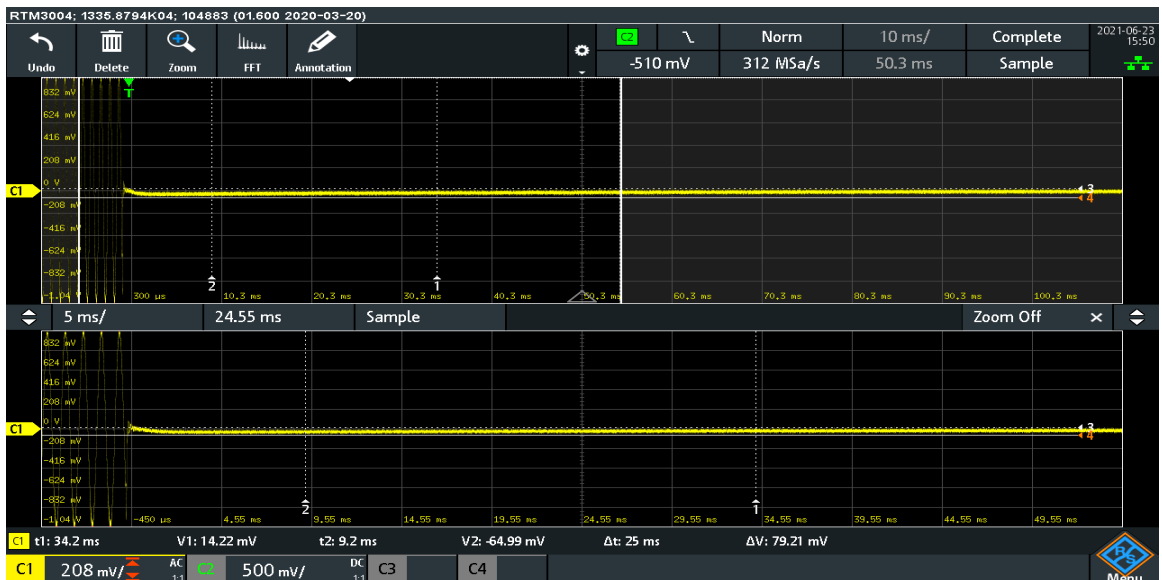
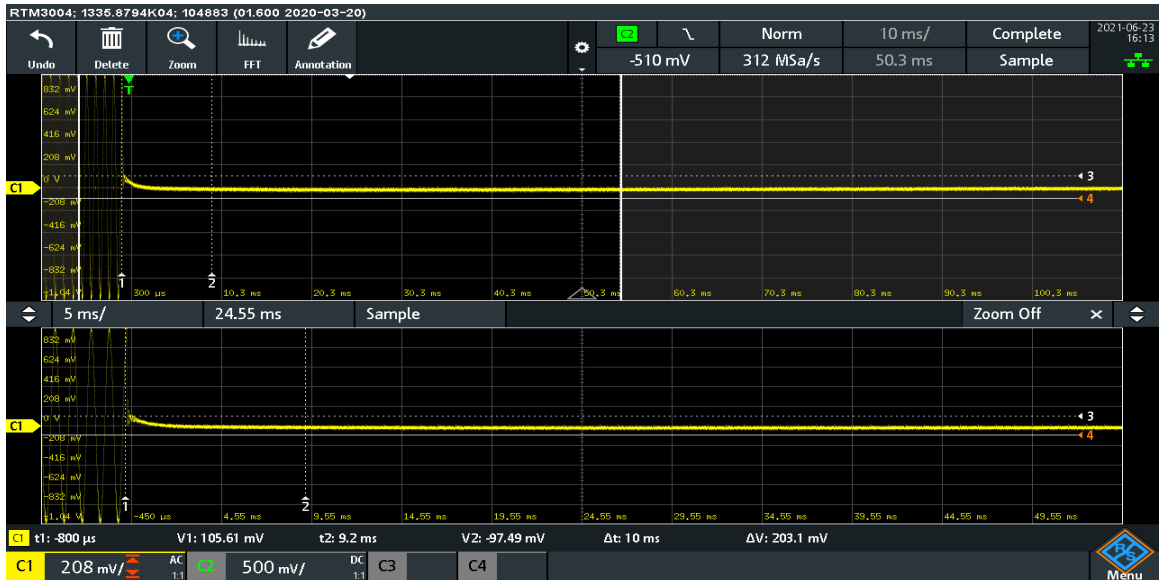




HERMON LABORATORIES

<b>Test specification:</b> Section 90.214 / RSS-119 Section 5.9, Transient frequency behaviour			
<b>Test procedure:</b> TIA/EIA-603-A, Section 2.2.19			
<b>Test mode:</b> Compliance		<b>Verdict:</b> PASS	
<b>Date(s):</b> 21-Jun-21 - 28-Jun-21			
<b>Temperature:</b> 26 °C	<b>Relative Humidity:</b> 42 %	<b>Air Pressure:</b> 1005 hPa	<b>Power:</b> 3.6 VDC
<b>Remarks:</b>			

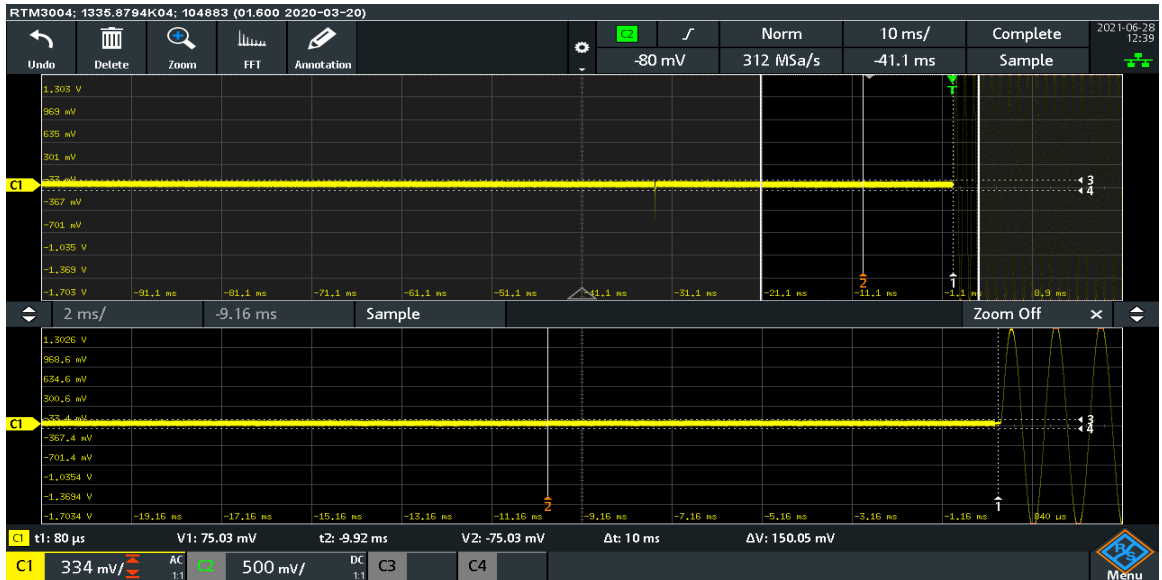
Plot 7.6.5 Transient frequency during power ON test results at high carrier frequency





<b>Test specification:</b> Section 90.214 / RSS-119 Section 5.9, Transient frequency behaviour			
<b>Test procedure:</b> TIA/EIA-603-A, Section 2.2.19			
<b>Test mode:</b> Compliance	<b>Verdict:</b> PASS		
<b>Date(s):</b> 21-Jun-21 - 28-Jun-21			
<b>Temperature:</b> 26 °C	<b>Relative Humidity:</b> 42 %	<b>Air Pressure:</b> 1005 hPa	<b>Power:</b> 3.6 VDC
<b>Remarks:</b>			

Plot 7.6.6 Transient frequency during power OFF 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
0493	Temperature Chamber -45...175 deg C	Thermotron	S-1.2 Mini-Max	14016	17-Jun-20	17-Jun-21
2017	Attenuator, Manual Step, 0-60/10 dB, 0-8.0 GHz	Midwest Microwave	1071	2017	13-Apr-21	13-Apr-22
2909	Spectrum analyzer, ESA-E, 100 Hz to 26.5 GHz	Agilent Technologies	E4407B	MY41444762	12-May-21	12-Jun-22
3434	Test Cable , DC-18 GHz, 1.5 m, SMA - SMA	Mini-Circuits	CBL-5FT-SMSM+	25683	19-Apr-21	19-Apr-22
3766	Attenuator, N-type, 20 dB, DC to 18 GHz, 5 W	Mini-Circuits	BW-N20W5+	NA	15-Sep-20	15-Sep-21
3903	Microwave Cable Assembly, 40.0 GHz, 1.5 m, SMA/SMA	Huber-Suhner	SUCOFLEX 102A	1226/2A	06-Apr-21	06-Apr-22
4068	Attenuator, SMA, 30 dB, DC to 12.4 GHz	Midwest Microwave	ATT-0527-30-SMA-07	NA	06-Aug-20	06-Sep-21
4339	High pass Filter, 50 Ohm, 1000 to 18000 MHz, SMA-FM / SMA-M	Micro-Tronics	HPM50115-02	001	05-Jun-19	05-Jun-21
4355	Signal and Spectrum Analyzer, 9 kHz to 7 GHz	Rohde & Schwarz	FSV 7	101630	09-Sep-20	09-Sep-21
4360	EMI Test Receiver, 20 Hz to 40 GHz.	Rohde & Schwarz	ESU40	100322	19-Jan-21	19-Jan-22
4785	Signal generator, 9 kHz - 3.2 GHz	Rohde & Schwarz	SMC 100A	103279	16-Nov-20	16-Nov-21
4914	Bandpass filter, 600 to 1100 MHz, SMA/F-SMA/F	K&L Microwave Inc.	7IB44-900/U600-O/O	24	05-Jun-19	05-Jun-21
4933	Active Horn Antenna, 1 GHz to 18 GHz	COM-POWER CORPORATION	AHA-118	701046	26-Jan-21	26-Jan-22
5212	Load Termination 50 Ohm, 0.5 W, DC-1GHz	Amphenol	R404051	NA	02-May-21	02-May-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	SF118/11N (x2)	500023/118	19-Nov-20	19-Nov-21
5409	RF cable, 40 GHz, SMA-SMA, 2 m	Huber-Suhner	SF102EA/11SK/11SK/2000MM	503973/2EA	03-Aug-20	03-Aug-21
5472	Power Splitter / Combiner 0.5-1 GHz	Mini Circuits	ZAPD-1	NA	28-Jan-21	28-Jan-23
5902	RF cable, 18 GHz, 6.0m, N-type	Huber-Suhner	SF126EA/11N/11N/6000		01-Dec-20	01-Dec-21
5971	Oscilloscope, 500 MHz, digital 4 channel	Rohde & Schwarz	RTM3004	104883	20-Feb-21	20-Jan-22



### 9 APPENDIX B Test equipment correction factors

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



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



HL 5405: RF Cable  
Huber-Suhner, model: SF118/11N(x2), s/n: 500023/118

Set / Applied, MHz	Measured, dB	Uncertainty, dB
0.1	0.01	±0.07
50	0.23	±0.07
100	0.32	±0.07
200	0.45	±0.08
300	0.55	±0.08
400	0.64	±0.08
500	0.71	±0.08
600	0.78	±0.08
700	0.85	±0.08
800	0.91	±0.08
900	0.97	±0.08
1000	1.02	±0.08
1100	1.07	±0.08
1200	1.12	±0.08
1300	1.16	±0.08
1400	1.21	±0.08
1500	1.25	±0.08
1600	1.30	±0.08
1700	1.34	±0.08
1800	1.38	±0.08
1900	1.42	±0.08
2000	1.47	±0.08
2500	1.64	±0.10
3000	1.81	±0.10
3500	1.97	±0.10
4000	2.11	±0.10
4500	2.25	±0.10
5000	2.38	±0.10
5500	2.48	±0.10
6000	2.59	±0.10
6500	2.72	±0.10
7000	2.84	±0.13
7500	2.97	±0.13
8000	3.08	±0.13
8500	3.21	±0.13
9000	3.31	±0.13
9500	3.42	±0.13
10000	3.52	±0.13



10 APPENDIX C 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  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.



HERMON LABORATORIES

## 11 APPENDIX D 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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Person for contact: Mr. Michael Nikishin, EMC&Radio group manager





HERMON LABORATORIES

## 12 APPENDIX E

### Specification references

FCC 47CFR part 90: 2020  
FCC 47CFR part 2: 2020  
ANSI/TIA/EIA-603-E:2016  
RSS-119 Issue 12: 2015  
RSS-Gen Issue 5: 2019

Private land mobile radio services  
Frequency allocations and radio treaty matters; general rules and regulations  
Land Mobile FM or PM Communications Equipment Measurement and Performance Standards  
Land Mobile and Fixed Equipment Operating in the Frequency Range 27.41-960 MHz  
General Requirements for Compliance of Radio Apparatus



### 13 APPENDIX F Abbreviations and acronyms

A	ampere
AC	alternating current
AM	amplitude modulation
AVRG	average (detector)
BB	broad band
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
QP	quasi-peak
RE	radiated emission
RF	radio frequency
rms	root mean square
Rx	receive
s	second
T	temperature
Tx	transmit
V	volt

END OF DOCUMENT