HERMON LABORATORIES

ELECTRICAL TESTING
0839.01

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TEST REPORT

ACCORDING TO: FCC 47CFR part 15 subpart C §15.247 (FHSS) and subpart B

FOR:

Roseman Engineering Ltd.

Car Data Logger

Model: Fleet Journal 3

FCC ID:JAKFG3E

This report is in conformity with ISO/ IEC 17025. The "A2LA Accredited" symbol endorsement applies only to the tests and calibrations that are listed in the scope of Hermon Laboratories accreditation. The test results relate only to the items tested. This test report shall not be reproduced in any form except in full with the written approval of Hermon Laboratories Ltd.

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1 Applicant information

Client name:	Roseman Engineering Ltd.
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E-mail:	haim@roseman.co.il
Contact name:	Mr. Haim Kashi

2 Equipment under test attributes

Product name:	Car Data Logger
Product type:	Transceiver
Model(s):	Fleet Journal 3
Serial number:	00000001
Hardware version:	ASS-22-84Hx
Software release:	FG3.6.1.15
Receipt date	10-Dec-18

3 Manufacturer information

Manufacturer name:	Roseman Engineering Ltd.
Address:	Kiryat Atidim, Building 3, P.O.B 58181, Tel Aviv 6158101, Israel
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4 Test details

Project ID:	31572
Location:	Hermon Laboratories Ltd. P.O. Box 23, Binyamina 3055001, Israel
Test started:	10-Dec-18
Test completed:	03-Jan-19
Test specifications:	FCC 47CFR part 15 subpart C §15.247 (FHSS) and subpart B

5 Tests summary

Test	Status
Transmitter characteristics	
Section 15.247(a)1, 20 dB bandwidth	Pass
Section 15.247(a)1, Frequency separation	Pass
Section 15.247(a)1, Number of hopping frequencies	Pass
Section 15.247(a)1, Average time of occupancy	Pass
Section 15.247(b), Peak output power	Pass
Section 15.247(d), Radiated spurious emissions	Pass
Section 15.247(d), Emissions at band edges	Pass
Section 15.247(i)5, RF exposure	Pass *
Section 15.203, Antenna requirements	Pass
Unintentional emissions	
Section 15.109, Radiated emission	Pass

* The exhibit to the application of certification is provided.

This test report supersedes the previously issued test report identified by Doc ID: ROSRAD_FCC.31572.

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
Tested by:	Mr. A. Morozov, test engineer	10-Dec-18 – 03-Jan-19	
Reviewed by:	Mrs. Y. Rapin, technical writer	01-Apr-19	
Approved by:	Mr. K. Zushchyk, project and customer manager, EMC and radio group	02-Apr-19	

6 EUT description

6.1 General information

The EUT, model: Fleet Journal 3, is a Canbus connection platform collecting data on car, driver and fleet. Web based access and reporting services providing management efficient tools to optimize fleet usage. The EUT is powered by a separate cable with a fuse connected to the vehicle battery. During the testing the device was powered by 12 VDC battery.

The EUT, earlier approved under FCC ID:JAKFG3E in HL pr. # 25713, was revised for antenna connection via SMA connector instead of direct soldering to the PCBA and adding assembly option for the accelerometer component.

6.2 EUT modules and sub-assemblies

Description	Manufacturer	Model or P/N	Hardware rev.	Serial number
Antenna GNR0672	Fatti Components	YT-2.4G-1.5M	1.0	NA
Car Data Logger	Roseman	RID-FG3-14-AW	03	1

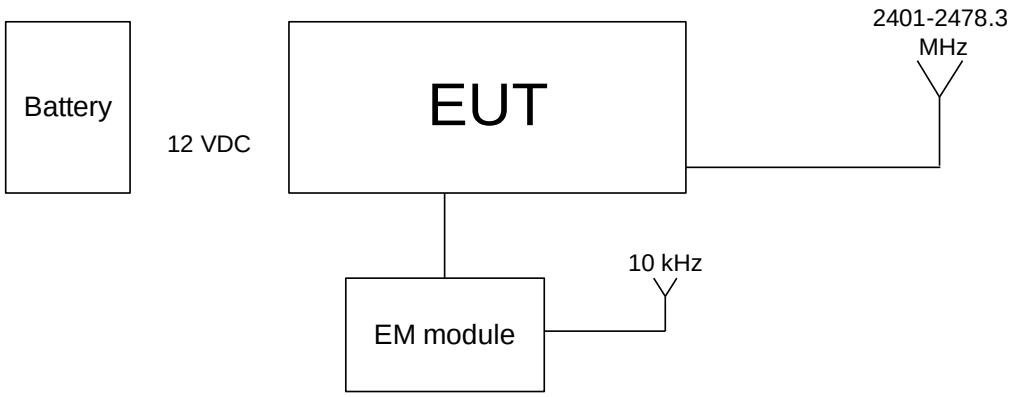
6.3 Ports and lines

Port type	Port description	Conn. from	Conn. to	Qty.	Cable type	Cable length, m	Indoor / outdoor
Power	DC	EUT	Battery	1	Unshielded	0.4	Indoor

6.4 Support and test equipment

Description	Manufacturer	Model number	Serial number
GPS antenna	Locosys	LS23033C	177200531
EM module with 10 kHz Antenna	Roseman	RID-EM-02 / RVC-01-80U	AL17114671201273 / NA
Battery	NA	NA	NA

6.5 Test configuration



6.6 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	2400-2483.5 MHz		
Operating frequencies	2401-2478.3 MHz		
Maximum rated output power	At transmitter 50 Ω RF output connector		dBm
	Peak output power		10.37 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	with temporary RF connector
				X without temporary RF connector

Antennas technical characteristics*

Type	Manufacturer	Model number	Gain
2.4GHz Stick Adhesive Antenna	Fatti Components	YT2400-3-SMA-R/P	5 dBi
2.4GHz Stick Adhesive Antenna	Fatti Components	YT-2.4G-1.5M	5 dBi
2.4GHz Stick Adhesive Antenna	YueYoung Electronics	YUE-WXUG-2400TB	2.5 dBi
2.4GHz Stick Adhesive Antenna	Cirocomm	EWFAWA50	2.26 dBi

Transmitter aggregate data rate/s	250 kbps				
Type of modulation	MSK				
Modulating test signal (baseband)	PRBS				
Transmitter power source					
	Battery	**Nominal rated voltage**		Battery type	
X	DC	**Nominal rated voltage**	12 VDC		
	AC mains	**Nominal rated voltage**		Frequency	

Common power source for transmitter and receiver	X yes	no	
Spread spectrum technique used	X	Frequency hopping (FHSS)	
		Digital transmission system (DTS)	
		Hybrid	

Spread spectrum parameters for transmitters tested per FCC 15.247 only		
FHSS	Total number of hops	16
	Bandwidth per hop	2441.4 kHz
	Max. separation of hops	5185.0 kHz

* - The antennas are interchangeable. The EUT was tested with YT-2.4G-1.5M Fatti Components antenna as worst case.

Test specification:	Section 15.247(a)1, 20 dB bandwidth		
Test procedure:	ANSI C63.10, section 7.8.7		
Test mode:	Compliance	Verdict:	PASS
Date(s):	10-Dec-18		
Temperature: 23 ºC	Relative Humidity: 46 %	Air Pressure: 1018 hPa	Power: 12 VDC
Remarks:			

7 Transmitter tests according to 47CFR part 15 subpart C requirements

7.1 20 dB bandwidth

7.1.1 General

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

Table 7.1.1 The 20 dB bandwidth limits

Assigned frequency, MHz	Maximum bandwidth, kHz	Modulation envelope reference points*, dBc
2400.0 – 2483.5	NA	20

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

7.1.2 Test procedure

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

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

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

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

Figure 7.1.1 The 20 dB bandwidth test setup

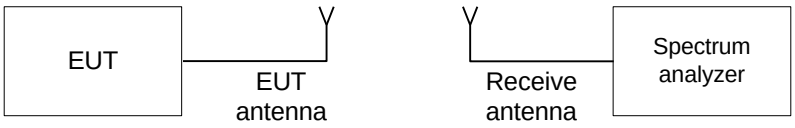


Table 7.1.2 The 20 dB bandwidth test results

ASSIGNED FREQUENCY BAND: 2400.0 – 2483.5 MHz
DETECTOR USED: Peak
SWEEP TIME: Auto
VIDEO BANDWIDTH: ≥ RBW
MODULATION ENVELOPE REFERENCE POINTS: 20.0 dBc
MODULATING SIGNAL: PRBS
FREQUENCY HOPPING: Disabled

Carrier frequency, MHz	Type of modulation	Data rate, kbps	20 dB bandwidth, kHz	Limit, kHz	Margin, kHz	Verdict
Low frequency						
2401.0	MSK	250	2400.542	NA	NA	Pass
Mid frequency						
2442.0	MSK	250	2441.428	NA	NA	Pass
High frequency						
2478.2	MSK	250	2477.776	NA	NA	Pass

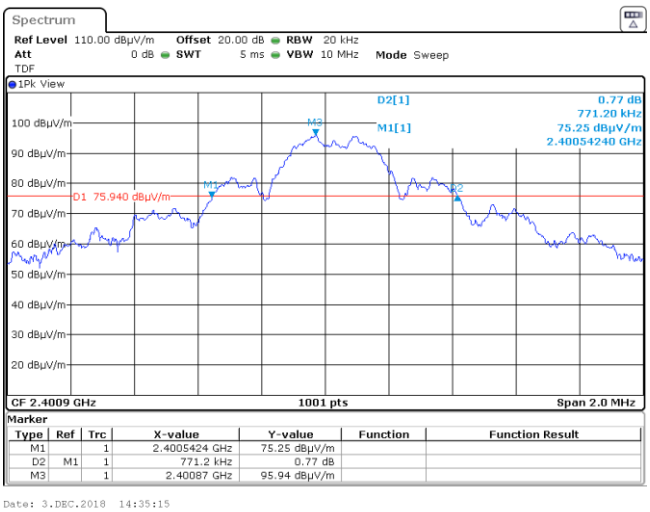
Reference numbers of test equipment used

HL 3903	HL 4355	HL 4933	HL 5405					

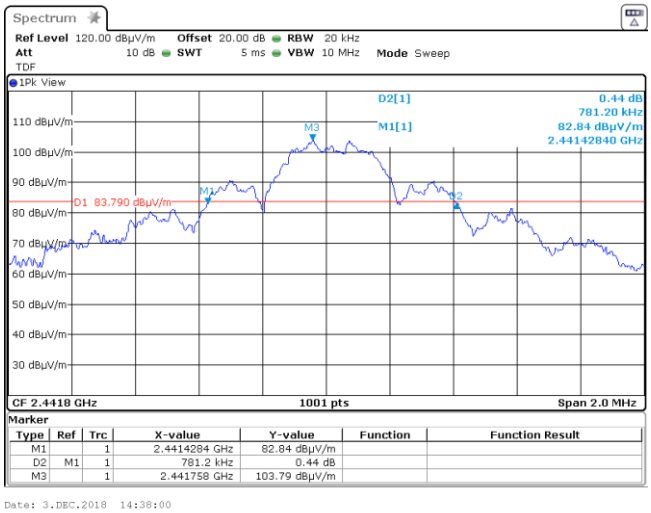
Full description is given in Appendix A.

Test specification:	Section 15.247(a)1, 20 dB bandwidth		
Test procedure:	ANSI C63.10, section 7.8.7		
Test mode:	Compliance	Verdict:	PASS
Date(s):	10-Dec-18		
Temperature: 23 ºC	Relative Humidity: 46 %	Air Pressure: 1018 hPa	Power: 12 VDC
Remarks:			

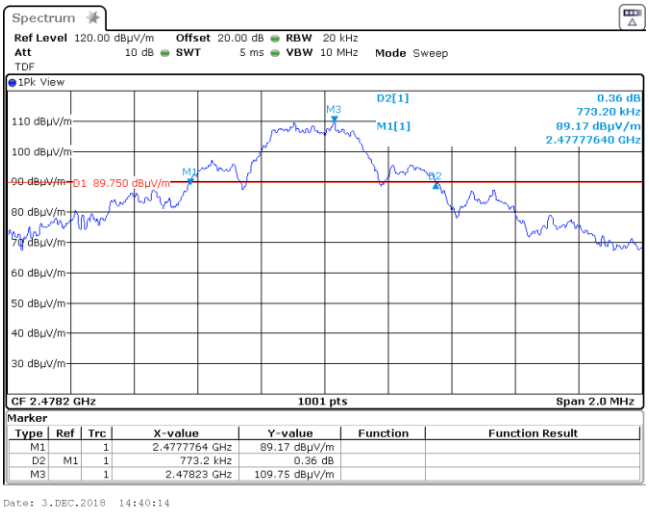
Plot 7.1.1 The 20 dB bandwidth test results



Low Frequency



Mid Frequency



High Frequency

Test specification:	**Section 15.247(a)1, Frequency separation**		
Test procedure:	ANSI C63.10, section 7.8.2		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	10-Dec-18		
Temperature: 23 ºC	**Relative Humidity:** 45 %	**Air Pressure:** 1018 hPa	**Power:** 12 VDC
Remarks:			

7.2 Carrier frequency separation

7.2.1 General

This test was performed to measure frequency separation between the peaks of adjacent channels. Specification test limits are given in Table 7.2.1.

Table 7.2.1 Carrier frequency separation limits

Assigned frequency range, MHz	**Carrier frequency separation**	
	Output power 30 dBm	**Output power 21 dBm**
902.0 – 928.0	25 kHz or 20 dB bandwidth of the hopping channel, whichever is greater	25 kHz or two-thirds of the 20 dB bandwidth of the hopping channel, whichever is greater
2400.0 – 2483.5		
5725.0 – 5850.0		

7.2.2 Test procedure

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

7.2.2.2 The spectrum analyzer span was set to capture the carrier frequency and both of adjacent channels, the lower and the higher. The resolution bandwidth was set wider than 1 % of the frequency span.

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

7.2.2.4 The frequency separation between the peaks of adjacent channels was measured as provided in Table 7.2.2 and associated plots.

Figure 7.2.1 Carrier frequency separation test setup

Test specification:	Section 15.247(a)1, Frequency separation		
Test procedure:	ANSI C63.10, section 7.8.2		
Test mode:	Compliance	Verdict:	PASS
Date(s):	10-Dec-18		
Temperature: 23 ºC	Relative Humidity: 45 %	Air Pressure: 1018 hPa	Power: 12 VDC
Remarks:			

Table 7.2.2 Carrier frequency separation test results

ASSIGNED FREQUENCY: 2400.0 – 2483.5 MHz
MODULATION: MSK
MODULATING SIGNAL: PRBS
BIT RATE: 250 kbps
DETECTOR USED: Peak
RESOLUTION BANDWIDTH: ≥ 1% of the span
VIDEO BANDWIDTH: ≥ RBW
FREQUENCY HOPPING: Enabled
20 dB BANDWIDTH: 2477.776 kHz

Carrier frequency separation, kHz	Limit, kHz	Margin*	Verdict
5185.0	4955.552	-229.448	Pass

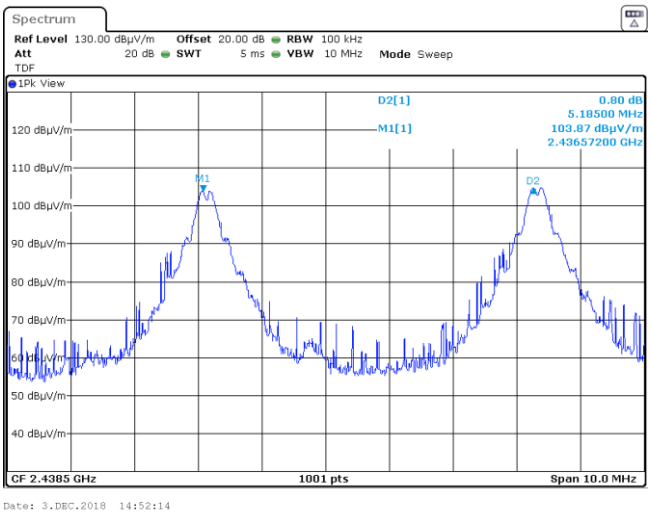
* - Margin = Carrier frequency separation – specification limit.

Reference numbers of test equipment used

HL 3903	HL 4355	HL 4933	HL 5405				

Full description is given in Appendix A.

Plot 7.2.1 Carrier frequency separation



Test specification:	**Section 15.247(a)1, Number of hopping frequencies**		
Test procedure:	ANSI C63.10, section 7.8.3		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	10-Dec-18		
Temperature: 23 ºC	**Relative Humidity:** 45 %	**Air Pressure:** 1018 hPa	**Power:** 12 VDC
Remarks:			

7.3 Number of hopping frequencies

7.3.1 General

This test was performed to calculate the number of hopping frequencies used by the EUT. Specification test limits are given in Table 7.3.1.

Table 7.3.1 Minimum number of hopping frequencies

Assigned frequency range, MHz	Number of hopping frequencies
902.0 – 928.0	50 (if the 20 dB bandwidth is less than 250 kHz) 25 (if the 20 dB bandwidth is 250 kHz or greater)
2400.0 – 2483.5	15
5725.0 – 5850.0	75

7.3.2 Test procedure

7.3.2.1 The EUT was set up as shown in Figure 7.3.1, energized with frequency hopping function enabled and its proper operation was checked.

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

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

7.3.2.4 The number of frequency hopping channels was calculated as provided in Table 7.3.2 and associated plots.

Figure 7.3.1 Hopping frequencies test setup

Test specification:	Section 15.247(a)1, Number of hopping frequencies		
Test procedure:	ANSI C63.10, section 7.8.3		
Test mode:	Compliance	Verdict:	PASS
Date(s):	10-Dec-18		
Temperature: 23 ºC	Relative Humidity: 45 %	Air Pressure: 1018 hPa	Power: 12 VDC
Remarks:			

Table 7.3.2 Hopping frequencies test results

ASSIGNED FREQUENCY: 2400.0 – 2483.5 MHz
MODULATION: MSK
MODULATING SIGNAL: PRBS
BIT RATE: 250 kbps
DETECTOR USED: Peak
RESOLUTION BANDWIDTH: ≥ 1% of the span
VIDEO BANDWIDTH: ≥ RBW
FREQUENCY HOPPING: Enabled

Number of hopping frequencies	Minimum number of hopping frequencies	Margin*	Verdict
16	15	1	Pass

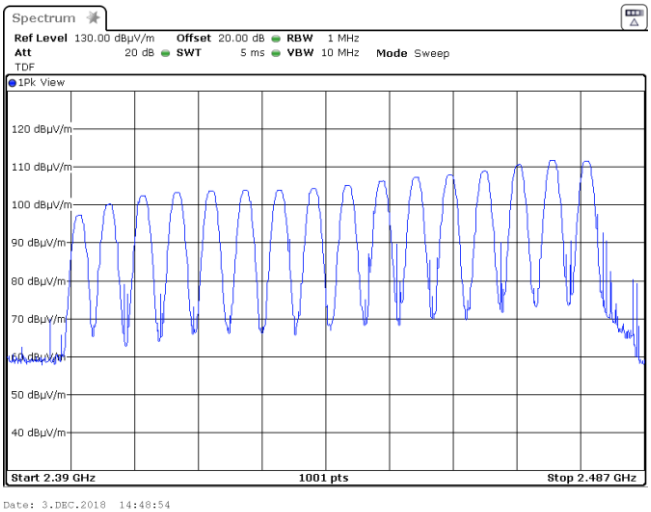
* - Margin = Number of hopping frequencies – Minimum number of hopping frequencies.

Reference numbers of test equipment used

HL 3903	HL 4355	HL 4933	HL 5405				

Full description is given in Appendix A.

Plot 7.3.1 Number of hopping frequencies



Test specification:	Section 15.247(a)1, Average time of occupancy		
Test procedure:	ANSI C63.10, section 7.8.4		
Test mode:	Compliance	Verdict:	PASS
Date(s):	10-Dec-18		
Temperature: 24 ºC	Relative Humidity: 45 %	Air Pressure: 1018 hPa	Power: 12 VDC
Remarks:			

7.4 Average time of occupancy

7.4.1 General

This test was performed to calculate the average time of occupancy (dwell time) on any frequency channel of the EUT. Specification test limits are given in Table 7.4.1.

Table 7.4.1 Average time of occupancy limits

Assigned frequency range, MHz	Maximum average time of occupancy, s	Investigated period, s	Number of hopping frequencies
902.0 – 928.0	0.4	20.0	≥ 50
902.0 – 928.0	0.4	10.0	< 50
2400.0 – 2483.5	0.4	0.4 × N	N (≥ 15)
5725.0 – 5850.0	0.4	30.0	≥ 75

7.4.2 Test procedure

7.4.2.1 The EUT was set up as shown in Figure 7.4.1, energized with frequency hopping function enabled and its proper operation was checked.

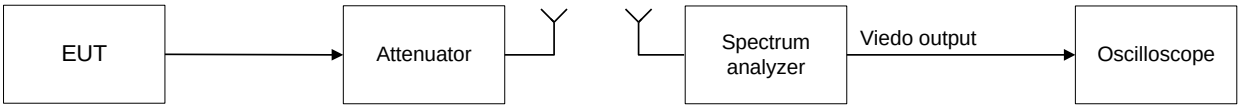
7.4.2.2 The spectrum analyzer span was set to zero centered on a hopping channel.

7.4.2.3 The single transmission duration and period were measured with oscilloscope.

7.4.2.4 The average time of occupancy was calculated as the single transmission time multiplied by the investigated period and divided by the single transmission period.

7.4.2.5 The test was repeated at each data rate and modulation type as provided in Table 7.4.2 and associated plots.

Figure 7.4.1 Average time of occupancy test setup



Test specification:	**Section 15.247(a)1, Average time of occupancy**		
Test procedure:	ANSI C63.10, section 7.8.4		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	10-Dec-18		
Temperature: 24 ºC	**Relative Humidity:** 45 %	**Air Pressure:** 1018 hPa	**Power:** 12 VDC
Remarks:			

Table 7.4.2 Average time of occupancy test results

ASSIGNED FREQUENCY: 2400.0 – 2483.5 MHz
MODULATION: MSK
MODULATING SIGNAL: PRBS
DETECTOR USED: Peak
RESOLUTION BANDWIDTH: 1 MHz
VIDEO BANDWIDTH: 10 MHz
NUMBER OF HOPPING FREQUENCIES: 21
INVESTIGATED PERIOD: 6.4 s
FREQUENCY HOPPING: Enabled

Carrier frequency, MHz	Single transmission duration, s	Single transmission period, s	Average time of occupancy*, s	Bit rate, kbps	Limit, s	Margin, s**	Verdict
2441.8	0.003	0.160	0.008	250	0.4	-0.392	Pass

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

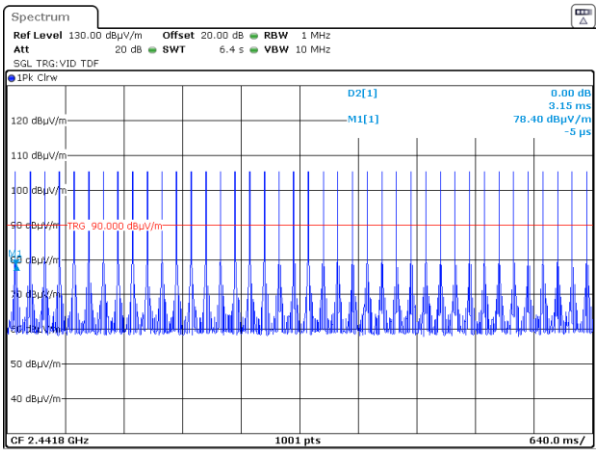
Reference numbers of test equipment used

HL 3903	HL 4355	HL 4933	HL 5405				

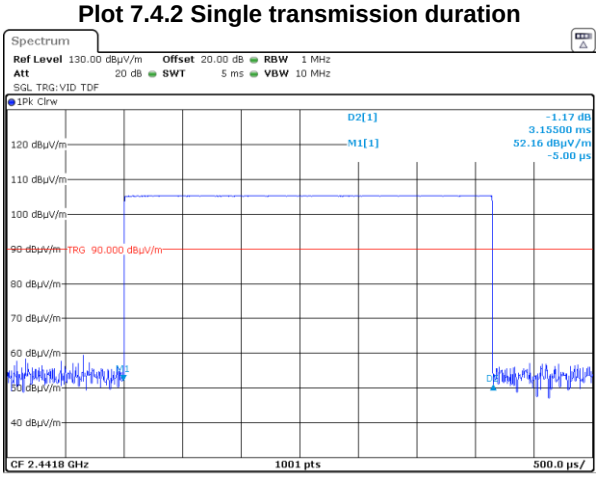
Full description is given in Appendix A.

Test specification:	Section 15.247(a)1, Average time of occupancy		
Test procedure:	ANSI C63.10, section 7.8.4		
Test mode:	Compliance	Verdict:	PASS
Date(s):	10-Dec-18		
Temperature: 24 ºC	Relative Humidity: 45 %	Air Pressure: 1018 hPa	Power: 12 VDC
Remarks:			

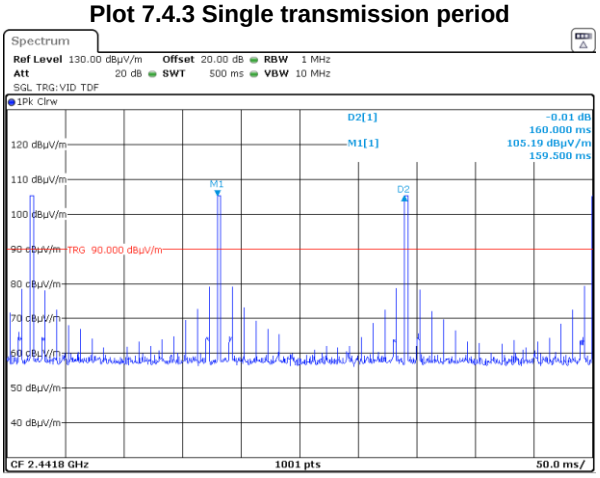
Plot 7.4.1 Number of transmissions



Plot 7.4.2 Single transmission duration



Plot 7.4.3 Single transmission period



Test specification:	**Section 15.247(b), Peak output power**		
Test procedure:	ANSI C63.10, section 7.8.5		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	10-Dec-18		
Temperature: 23 ºC	**Relative Humidity:** 45 %	**Air Pressure:** 1018 hPa	**Power:** 12 VDC
Remarks:			

7.5 Peak output power

7.5.1 General

This test was performed to measure the maximum peak output power radiated by transmitter. Specification test limits are given in Table 7.5.1.

Table 7.5.1 Peak output power limits

Assigned frequency range, MHz	Peak output power*		Equivalent field strength limit @ 3m, dB(µV/m)*	Maximum antenna gain, dBi
	W	dBm		
902.0 – 928.0	0.25 (<50 hopping channels) 1.0 (≥50 hopping channels)	24.0(<50 hopping channels) 30.0 (≥50 hopping channels)	125.2 (<50 hopping channels) 131.2 (≥50 hopping channels)	6.0*
2400.0 – 2483.5	**0.125 (<75 hopping channels)** 1.0 (≥75 hopping channels)	**21.0(<75 hopping channels)** 30.0 (≥75 hopping channels)	**122.2 (<75 hopping channels)** 131.2 (≥75 hopping channels)	
5725.0 – 5850.0	1.0	30.0	131.2	

*- Equivalent field strength limit was calculated from the peak output power as follows:

$$E=\text{sqrt}(30\times P\times G)/r,$$

where P is peak output power in Watts, r is antenna to EUT distance in meters and G is transmitter antenna gain in dBi.

**- The limit is provided in terms of conducted RF power at the antenna connector. If transmitting antennas of directional gain greater than 6 dBi are used, the peak output power limit shall be reduced below the stated value as follows:
- by 1 dB for every 3 dB that the directional gain of antenna exceeds 6 dBi for fixed point-to-point transmitters operate in 2400-2483.5 MHz band;
- without any corresponding reduction for fixed point-to-point transmitters operate in 5725-5850 MHz band;
- by the amount in dB that the directional gain of antenna exceeds 6 dBi for the rest of transmitters.

7.5.2 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 was adjusted to produce maximum available to end user RF output power.

7.5.2.3 The frequency span of spectrum analyzer was set approximately 5 times wider than 20 dB bandwidth of the EUT and the resolution bandwidth was set wider than 20 dB bandwidth of the EUT. To find maximum radiation the turntable was rotated 360^0 and the measuring antenna height was swept in both vertical and horizontal polarizations.

7.5.2.4 The maximum field strength of the EUT carrier frequency was measured as provided in Table 7.5.2 and associated plots.

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

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

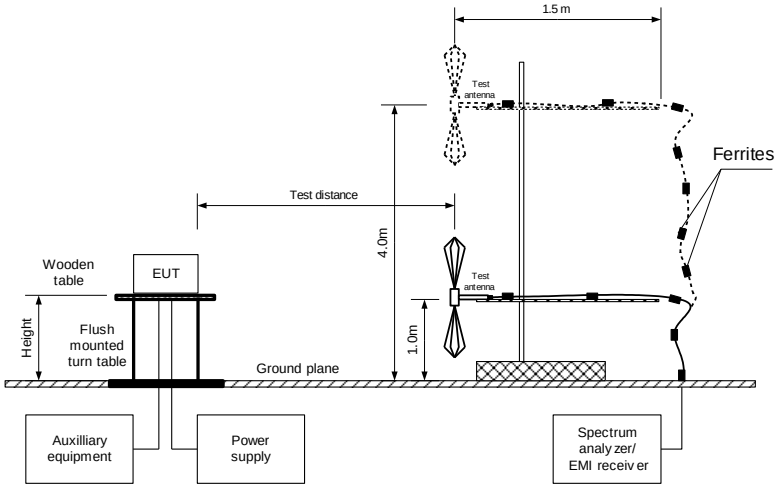
where P is the peak output power in W, E is the field strength in V/m, d is the test distance and G is the transmitter numeric antenna gain over an isotropic radiator.
The above equation was converted in logarithmic units for 3 m test distance:

Peak output power in dBm = Field strength in dB(µV/m) - Transmitter antenna gain in dBi – 95.2 dB

7.5.2.6 The worst test results (the lowest margins) were recorded in Table 7.5.2.

Test specification:	Section 15.247(b), Peak output power		
Test procedure:	ANSI C63.10, section 7.8.5		
Test mode:	Compliance	Verdict:	PASS
Date(s):	10-Dec-18		
Temperature: 23 ºC	Relative Humidity: 45 %	Air Pressure: 1018 hPa	Power: 12 VDC
Remarks:			

Figure 7.5.1 Setup for peak output power measurements



Test specification:	**Section 15.247(b), Peak output power**		
Test procedure:	ANSI C63.10, section 7.8.5		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	10-Dec-18		
Temperature: 23 ºC	**Relative Humidity:** 45 %	**Air Pressure:** 1018 hPa	**Power:** 12 VDC
Remarks:			

Table 7.5.2 Peak output power test results

ASSIGNED FREQUENCY: 2400 – 2483.5 MHz
TEST DISTANCE: 3 m
TEST SITE: Semi anechoic chamber
DETECTOR USED: Peak
TEST ANTENNA TYPE: Double ridged guide
MODULATION: MSK
MODULATING SIGNAL: PRBS
BIT RATE: 250 kBps
TRANSMITTER OUTPUT POWER SETTINGS: Maximum
DETECTOR USED: Peak
EUT 20 dB BANDWIDTH: 2477.8 MHz
RESOLUTION BANDWIDTH: 3 MHz
VIDEO BANDWIDTH: 10 MHz
FREQUENCY HOPPING: Disabled
NUMBER OF FREQUENCY HOPPING CHANNELS: 16

Frequency, MHz	Field strength, dB(μV/m)	Antenna polarization	Antenna height, m	Azimuth, degrees*	EUT antenna gain, dBi	Peak output power, dBm**	Limit, dBm	Margin, dB***	Verdict
2400.371	107.89	Horizontal	1.20	150	5.0	7.69	21.0	-13.31	Pass
2441.570	110.57	Vertical	1.55	65	5.0	10.37	21.0	-10.63	Pass
2447.890	99.63	Horizontal	1.50	-60	5.0	-0.57	21.0	-21.57	Pass

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

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

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

Reference numbers of test equipment used

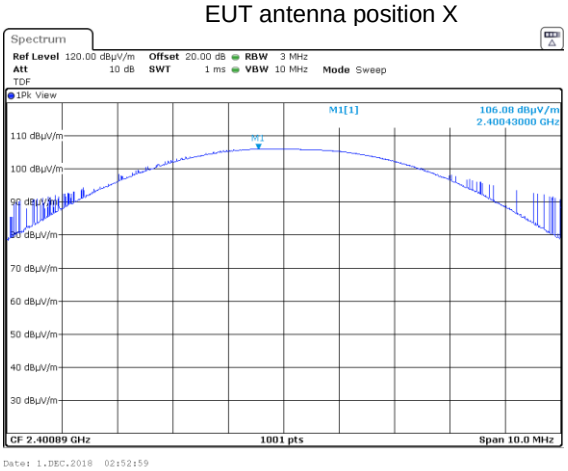
HL 3903	HL 4355	HL 4933	HL 5405				

Full description is given in Appendix A.

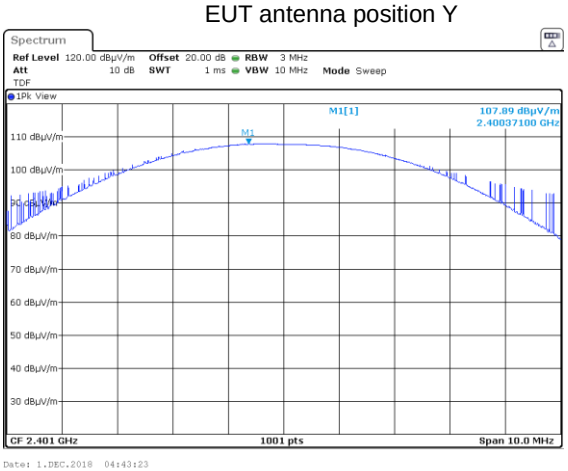
Test specification:	Section 15.247(b), Peak output power		
Test procedure:	ANSI C63.10, section 7.8.5		
Test mode:	Compliance	Verdict:	PASS
Date(s):	10-Dec-18		
Temperature: 23 ºC	Relative Humidity: 45 %	Air Pressure: 1018 hPa	Power: 12 VDC
Remarks:			

Plot 7.5.1 Peak output power at low frequency

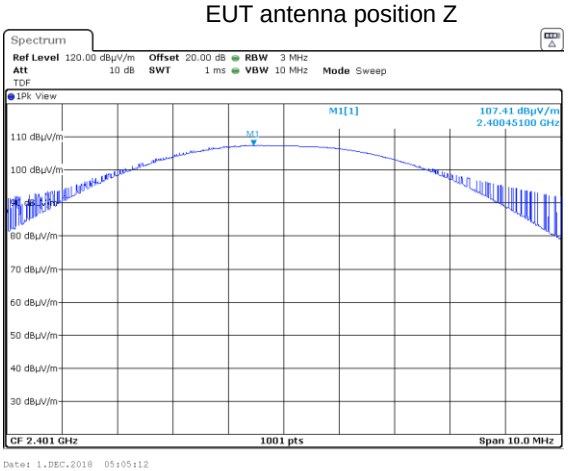
EUT antenna position X



EUT antenna position Y



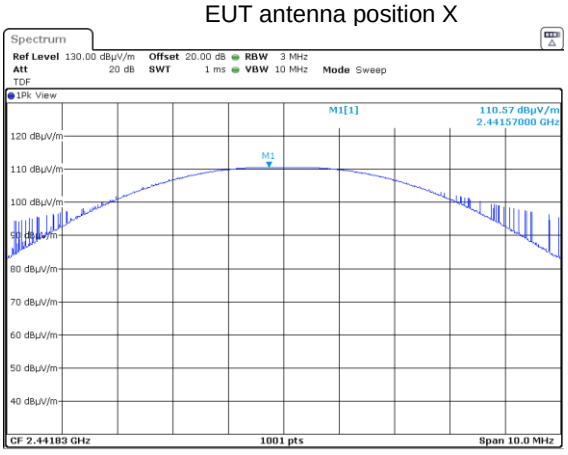
EUT antenna position Z



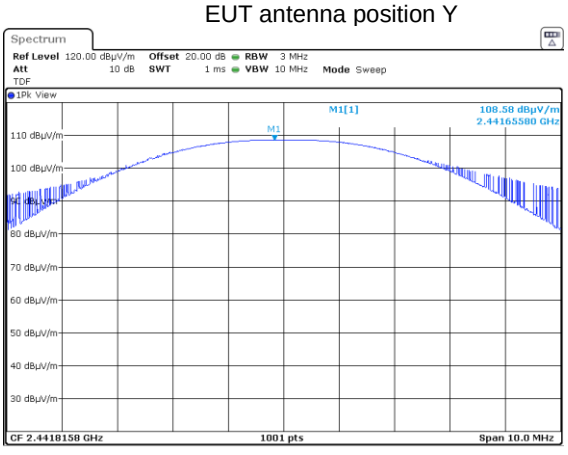
Test specification:	Section 15.247(b), Peak output power		
Test procedure:	ANSI C63.10, section 7.8.5		
Test mode:	Compliance	Verdict:	PASS
Date(s):	10-Dec-18		
Temperature: 23 ºC	Relative Humidity: 45 %	Air Pressure: 1018 hPa	Power: 12 VDC
Remarks:			

Plot 7.5.2 Peak output power at mid frequency

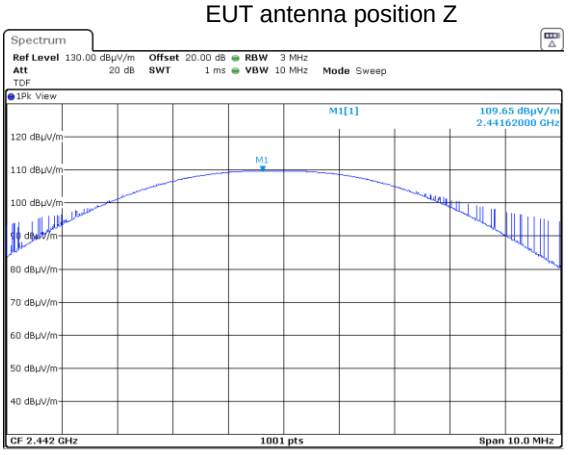
EUT antenna position X



EUT antenna position Y



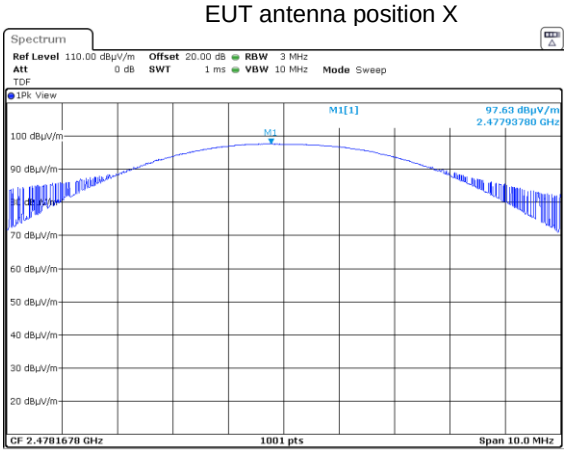
EUT antenna position Z



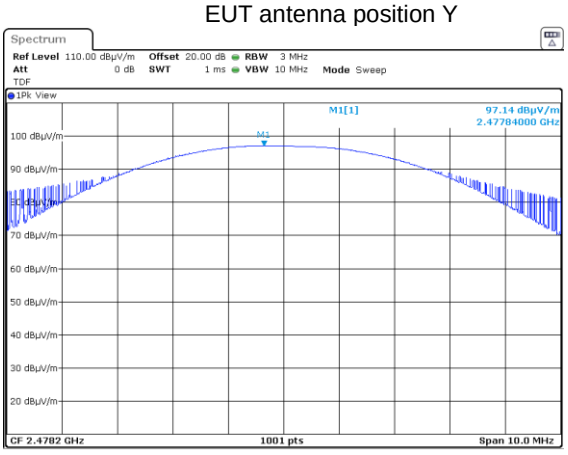
Test specification:	Section 15.247(b), Peak output power		
Test procedure:	ANSI C63.10, section 7.8.5		
Test mode:	Compliance	Verdict:	PASS
Date(s):	10-Dec-18		
Temperature: 23 ºC	Relative Humidity: 45 %	Air Pressure: 1018 hPa	Power: 12 VDC
Remarks:			

Plot 7.5.3 Peak output power at high frequency

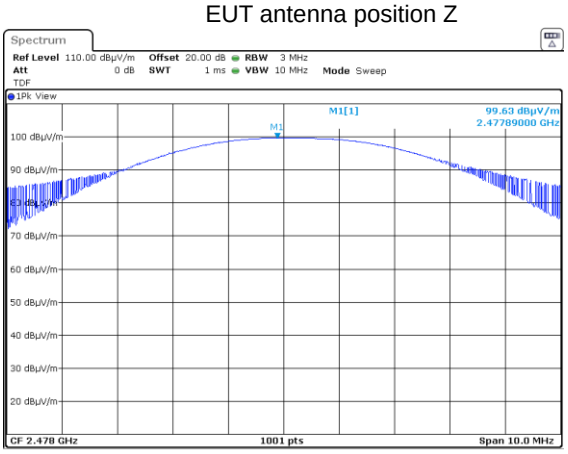
EUT antenna position X



EUT antenna position Y



EUT antenna position Z



Test specification:	Section 15.247(c), Radiated spurious emissions		
Test procedure:	ANSI C63.10, sections 6.5, 6.6		
Test mode:	Compliance	Verdict:	PASS
Date(s):	10-Dec-18		
Temperature: 23 ºC	Relative Humidity: 45 %	Air Pressure: 1018 hPa	Power: 12 VDC
Remarks:			

7.6 Field strength of spurious emissions

7.6.1 General

This test was performed to measure field strength of spurious emissions from the EUT. Specification test limits are given in Table 7.6.1.

Table 7.6.1 Radiated spurious emissions limits

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

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

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

where S_1 and S_2 – standard defined and test distance respectively in meters.
**- The limit decreases linearly with the logarithm of frequency.
*** - The field strength limits applied from the lowest radio frequency generated in the device, without going below 9 kHz up to the tenth harmonic of the highest fundamental frequency.

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

7.6.2.1 The EUT was set up as shown in Figure 7.6.1, energized and the performance check was conducted.

7.6.2.2 The specified frequency range was investigated with antenna connected to spectrum analyzer/ EMI receiver. To find maximum radiation the turntable was rotated 360^0 and the measuring antenna was rotated around its vertical axis.

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

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

7.6.3.1 The EUT was set up as shown in Figure 7.6.2 / Figure 7.6.3, energized and the performance check was conducted.

7.6.3.2 The specified frequency range was investigated with antenna connected to spectrum analyzer/ EMI receiver. To find maximum radiation the turntable was rotated 360^0, the measuring antenna height was changed from 1 to 4 m, its polarization was switched from vertical to horizontal.

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

Test specification:	Section 15.247(c), Radiated spurious emissions		
Test procedure:	ANSI C63.10, sections 6.5, 6.6		
Test mode:	Compliance	Verdict:	PASS
Date(s):	10-Dec-18		
Temperature: 23 ºC	Relative Humidity: 45 %	Air Pressure: 1018 hPa	Power: 12 VDC
Remarks:			

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

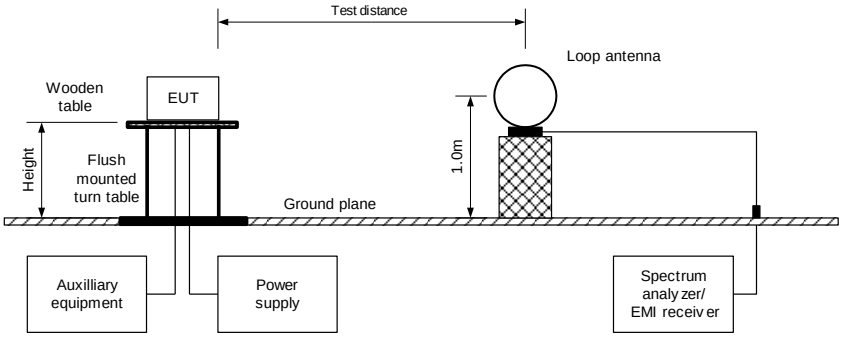


Figure 7.6.2 Setup for spurious emission field strength measurements from 30 to 1000 MHz

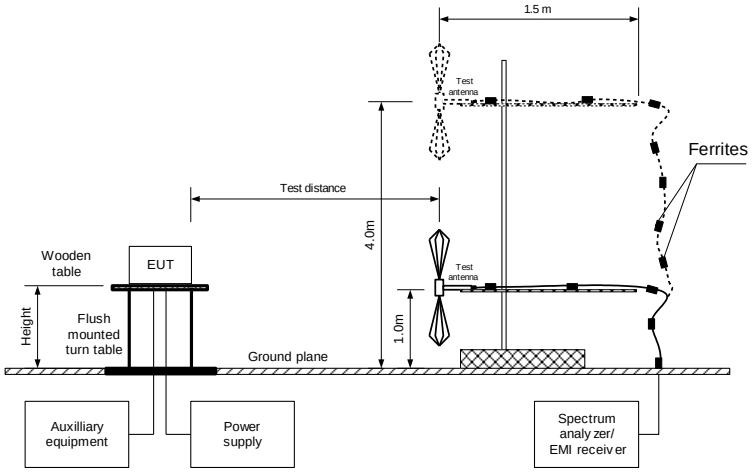
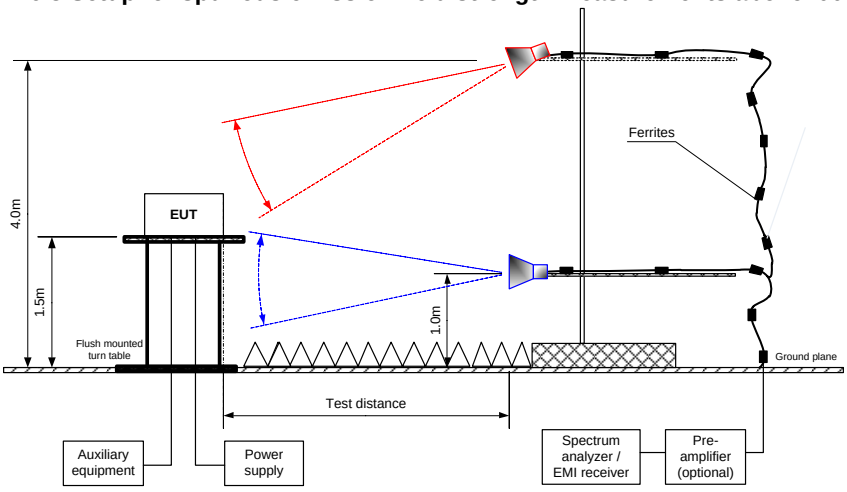


Figure 7.6.3 Setup for spurious emission field strength measurements above1000 MHz



Test specification:	**Section 15.247(c), Radiated spurious emissions**		
Test procedure:	ANSI C63.10, sections 6.5, 6.6		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	10-Dec-18		
Temperature: 23 ºC	**Relative Humidity:** 45 %	**Air Pressure:** 1018 hPa	**Power:** 12 VDC
Remarks:			

Table 7.6.2 Field strength of emissions outside restricted bands

ASSIGNED FREQUENCY: 2400.0 – 2483.5 MHz
INVESTIGATED FREQUENCY RANGE: 0.009 – 25000 MHz
TEST DISTANCE: 3 m
MODULATION: MSK
MODULATING SIGNAL: PRBS
BIT RATE: 250 kbps
DUTY CYCLE: 100 %
TRANSMITTER OUTPUT POWER SETTINGS: Maximum
DETECTOR USED: Peak
RESOLUTION BANDWIDTH: 100 kHz
VIDEO BANDWIDTH: 300 kHz
TEST ANTENNA TYPE: Active loop (9 kHz – 30 MHz)
Biconilog (30 MHz – 1000 MHz)
Double ridged guide (above 1000 MHz)
FREQUENCY HOPPING: Disabled

Frequency, MHz	Field strength of spurious, dB(µV/m)	Antenna polarization	Antenna height, m	Azimuth, degrees*	Field strength of carrier, dB(µV/m)	Attenuation below carrier, dBc	Limit, dBc	Margin, dB**	Verdict
Low carrier frequency									
36.863	40.52	Vertical	1.0	-131.0	107.48	66.96	20.0	46.96	Pass
231.495	32.81	Vertical	1.0	2.0		74.67		54.67	
288.016	38.82	Horizontal	1.0	36.0		68.66		48.66	
2400.000	78.56	Vertical	1.6	-35.0		28.92		8.92	
7202.718	61.64	Vertical	2.8	96.0		45.84		25.84	
9839.555	49.73	Vertical	1.9	135.0		57.75		37.75	
Mid carrier frequency									
36.786	40.24	Vertical	1.0	180.0	110.32	70.08	20.0	50.08	Pass
217.142	32.30	Vertical	1.0	103.0		78.02		58.02	
288.148	38.31	Horizontal	1.0	28.0		72.01		52.01	
High carrier frequency									
36.816	38.41	Vertical	1.0	160.0	99.26	60.85	20.0	40.85	Pass
222.264	32.18	Vertical	1.0	92.0		67.08		47.08	
288.086	38.46	Horizontal	1.0	30.0		60.8		40.8	

*****- EUT front panel refers to 0 degrees position of turntable.
******- Margin = Attenuation below carrier – specification limit.

Test specification:	**Section 15.247(c), Radiated spurious emissions**		
Test procedure:	ANSI C63.10, sections 6.5, 6.6		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	10-Dec-18		
Temperature: 23 ºC	**Relative Humidity:** 45 %	**Air Pressure:** 1018 hPa	**Power:** 12 VDC
Remarks:			

Table 7.6.3 Field strength of spurious emissions above 1 GHz within restricted bands

ASSIGNED FREQUENCY: 2400.0 – 2483.5 MHz
INVESTIGATED FREQUENCY RANGE: 1000 – 25000 MHz
TEST DISTANCE: 3 m
MODULATION: MSK
MODULATING SIGNAL: PRBS
BIT RATE: 250 kbps
DUTY CYCLE: 100 %
TRANSMITTER OUTPUT POWER SETTINGS: Maximum
DETECTOR USED: Peak
RESOLUTION BANDWIDTH: 1000 kHz
TEST ANTENNA TYPE: Double ridged guide
FREQUENCY HOPPING: Disabled

Frequency, MHz	Antenna		Azimuth, degrees*	Peak field strength			Average field strength				Verdict
	Polarization	Height, m		Measured, dB(µV/m)	Limit, dB(µV/m)	Margin, dB**	Measured, dB(µV/m)	Calculated, dB(µV/m)	Limit, dB(µV/m)	Margin, dB***	
Low carrier frequency											
2388.700	Vertical	1.6	-23.0	70.35	74.0	-3.65	47.22	NA	54.0	-6.78	Pass
4801.670	Horizontal	2.5	-167.0	49.37	74.0	-24.63	36.89	NA	54.0	-17.11	
12004.655	Vertical	1.3	24.0	57.50	74.0	-16.5	43.56	NA	54.0	-10.44	
Mid carrier frequency											
4883.783	Vertical	1.9	-126.0	53.69	74.0	-20.31	41.98	NA	54.0	-12.02	Pass
7325.505	Vertical	2.5	180.0	57.96	74.0	-16.04	45.98	NA	54.0	-8.02	
High carrier frequency											
2483.500	Vertical	1.5	-56.0	67.83	74.0	-6.17	47.28	NA	54.0	-6.72	Pass
4956.003	Vertical	2.3	-120.0	53.12	74.0	-20.88	40.78	NA	54.0	-13.22	
7434.638	Vertical	1.9	-126.0	64.67	74.0	-9.33	52.88	NA	54.0	-1.12	
12391.303	Vertical	2.3	-120.0	56.88	74.0	-17.12	42.48	NA	54.0	-11.52	

*****- EUT front panel refers to 0 degrees position of turntable.
******- Margin = Measured field strength - specification limit.
***- Margin = Calculated field strength - specification limit,
where Calculated field strength = Measured field strength + average factor.

Table 7.6.4 Field strength of spurious emissions below 1 GHz within restricted bands

ASSIGNED FREQUENCY: 2400.0 – 2483.5 MHz
INVESTIGATED FREQUENCY RANGE: 0.009 – 1000 MHz
TEST DISTANCE: 3 m
MODULATION: MSK
MODULATING SIGNAL: PRBS
BIT RATE: 250 kbps
DUTY CYCLE: 100 %
TRANSMITTER OUTPUT POWER SETTINGS: Maximum
RESOLUTION BANDWIDTH: 0.2 kHz (9 kHz – 150 kHz)
9.0 kHz (150 kHz – 30 MHz)
120 kHz (30 MHz – 1000 MHz)
VIDEO BANDWIDTH: > Resolution bandwidth
TEST ANTENNA TYPE: Active loop (9 kHz – 30 MHz)
Biconilog (30 MHz – 1000 MHz)
FREQUENCY HOPPING: Disabled

Frequency, MHz	Peak emission, dB(µV/m)	Quasi-peak			Antenna polarization	Antenna height, m	Turn-table position**, degrees	Verdict
		Measured emission, dB(µV/m)	Limit, dB(µV/m)	Margin, dB*				
Low, mid, high carrier frequency								
No emissions were found								Pass

*****- Margin = Measured emission - specification limit.
******- EUT front panel refer to 0 degrees position of turntable.

Test specification:	**Section 15.247(c), Radiated spurious emissions**		
Test procedure:	ANSI C63.10, sections 6.5, 6.6		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	10-Dec-18		
Temperature: 23 ºC	**Relative Humidity:** 45 %	**Air Pressure:** 1018 hPa	**Power:** 12 VDC
Remarks:			

Table 7.6.5 Restricted bands according to FCC section 15.205

MHz	MHz	MHz	MHz	MHz	GHz
0.09 - 0.11	8.37625 - 8.38675	73 - 74.6	399.9 - 410	2690 - 2900	10.6 - 12.7
0.495 - 0.505	8.41425 - 8.41475	74.8 - 75.2	608 - 614	3260 - 3267	13.25 - 13.4
2.1735 - 2.1905	12.29 - 12.293	108 - 121.94	960 - 1240	3332 - 3339	14.47 - 14.5
4.125 - 4.128	12.51975 - 12.52025	123 - 138	1300 - 1427	3345.8 - 3358	15.35 - 16.2
4.17725 - 4.17775	12.57675 - 12.57725	149.9 - 150.05	1435 - 1626.5	3600 - 4400	17.7 - 21.4
4.20725 - 4.20775	13.36 - 13.41	156.52475 - 156.52525	1645.5 - 1646.5	4500 - 5150	22.01 - 23.12
6.215 - 6.218	16.42 - 16.423	156.7 - 156.9	1660 - 1710	5350 – 5460	23.6 - 24
6.26775 - 6.26825	16.69475 - 16.69525	162.0125 - 167.17	1718.8 - 1722.2	7250 - 7750	31.2 - 31.8
6.31175 - 6.31225	16.80425 - 16.80475	167.72 - 173.2	2200 - 2300	8025 – 8500	36.43 - 36.5
8.291 - 8.294	25.5 - 25.67	240 - 285	2310 - 2390	9000 - 9200	Above 38.6
8.362 - 8.366	37.5 - 38.25	322 - 335.4	2483.5 - 2500	9300 - 9500	

Table 7.6.6 Restricted bands according to RSS-Gen

MHz	MHz	MHz	MHz	MHz	GHz
0.09 - 0.11	8.291 - 8.294	16.80425 - 16.80475	399.9 - 410	3260 - 3267	10.6 - 12.7
2.1735 - 2.1905	8.362 - 8.366	25.5 - 25.67	608 - 614	3332 – 3339	13.25 - 13.4
3.020 – 3.026	8.37625 - 8.38675	37.5 - 38.25	960 – 1427	3345.8 – 3358	14.47 – 14.5
4.125 – 4.128	8.41425 - 8.41475	73 - 74.6	1435 – 1626.5	3500 – 4400	15.35 – 16.2
4.17725 – 4.17775	12.29 – 12.293	74.8 - 75.2	1645.5 – 1646.5	4500 – 5150	17.7 – 21.4
4.20725 – 4.20775	12.51975 – 12.52025	108 – 138	1660 - 1710	5350 – 5460	22.01 – 23.12
5.677 – 5.683	12.57675 – 12.57725	156.52475 – 156.52525	1718.8 - 1722.2	7250 - 7750	23.6 - 24
6.215 - 6.218	13.36 – 13.41	156.7 - 156.9	2200 - 2300	8025 – 8500	31.2 - 31.8
6.26775 - 6.26825	16.42 - 16.423	240 - 285	2310 - 2390	9000 - 9200	36.43 - 36.5
6.31175 - 6.31225	16.69475 - 16.69525	322 - 335.4	2655 - 2900	9300 - 9500	Above 38.6

Reference numbers of test equipment used

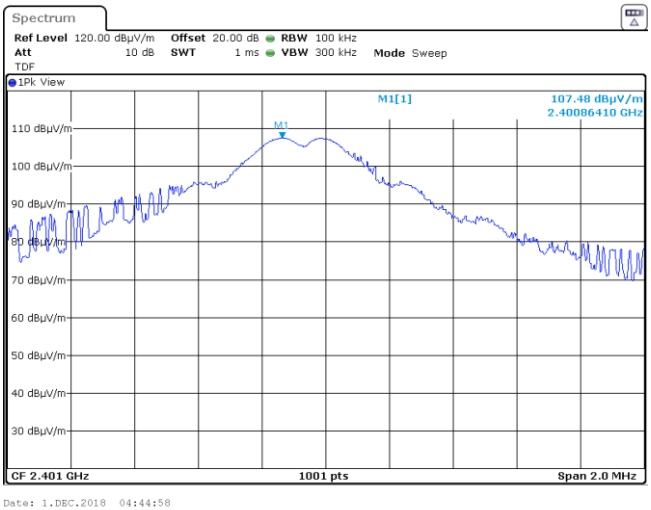
HL 3903	HL 4355	HL 4360	HL 4933	HL 4956	HL 5288	HL 5405	HL 5111

Full description is given in Appendix A.

Test specification:	Section 15.247(c), Radiated spurious emissions		
Test procedure:	ANSI C63.10, sections 6.5, 6.6		
Test mode:	Compliance	Verdict:	PASS
Date(s):	10-Dec-18		
Temperature: 23 ºC	Relative Humidity: 45 %	Air Pressure: 1018 hPa	Power: 12 VDC
Remarks:			

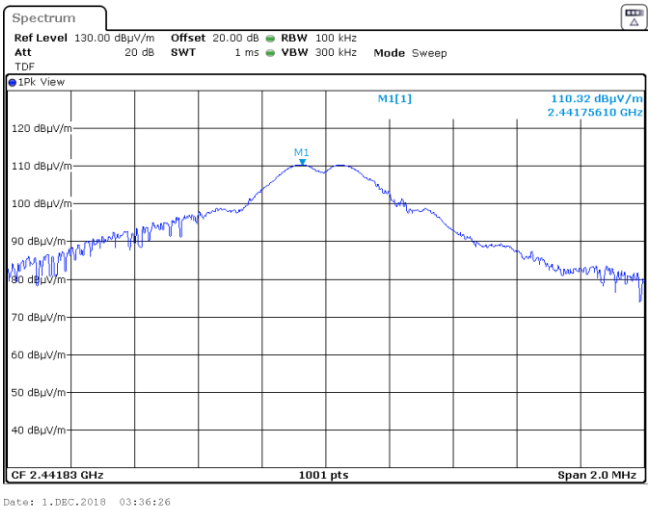
Plot 7.6.1 Peak output power at the low carrier frequency

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m



Plot 7.6.2 Peak output power at the mid carrier frequency

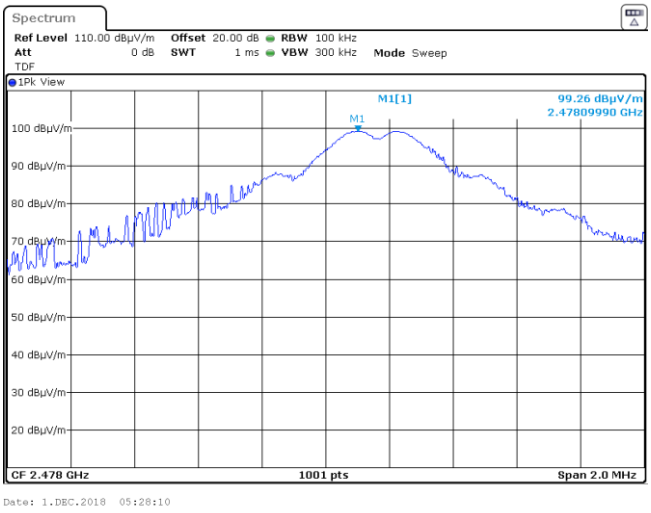
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m



Test specification:	Section 15.247(c), Radiated spurious emissions		
Test procedure:	ANSI C63.10, sections 6.5, 6.6		
Test mode:	Compliance	Verdict:	PASS
Date(s):	10-Dec-18		
Temperature: 23 ºC	Relative Humidity: 45 %	Air Pressure: 1018 hPa	Power: 12 VDC
Remarks:			

Plot 7.6.3 Peak output power at the high carrier frequency

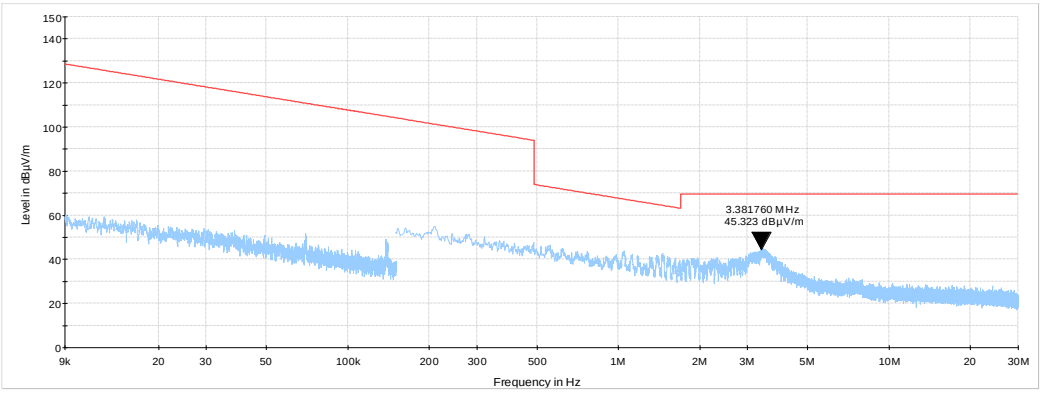
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m



Test specification:	Section 15.247(c), Radiated spurious emissions		
Test procedure:	ANSI C63.10, sections 6.5, 6.6		
Test mode:	Compliance	Verdict:	PASS
Date(s):	10-Dec-18		
Temperature: 23 ºC	Relative Humidity: 45 %	Air Pressure: 1018 hPa	Power: 12 VDC
Remarks:			

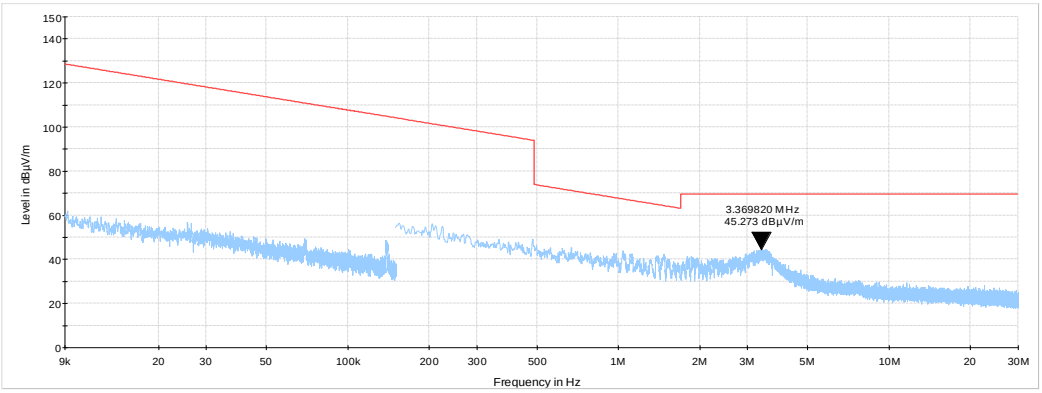
Plot 7.6.4 Radiated emission measurements from 9 kHz to 30 MHz at the low carrier frequency

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



Plot 7.6.5 Radiated emission measurements from 9 kHz to 30 MHz at the mid carrier frequency

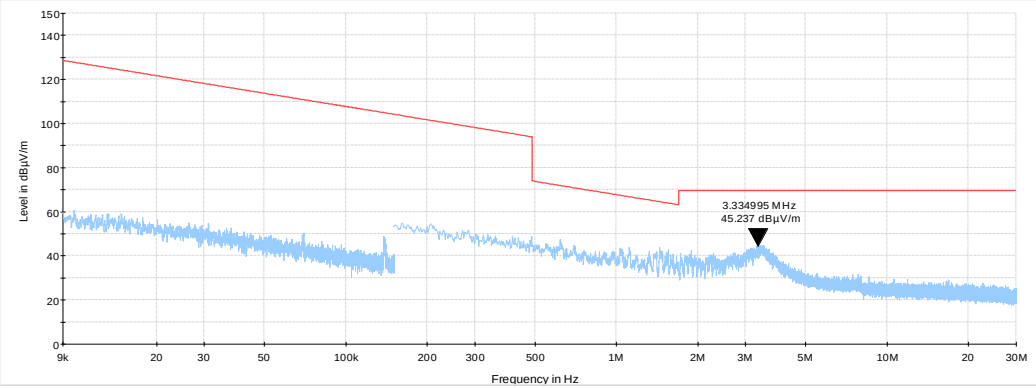
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical



Test specification:	Section 15.247(c), Radiated spurious emissions		
Test procedure:	ANSI C63.10, sections 6.5, 6.6		
Test mode:	Compliance	Verdict:	PASS
Date(s):	10-Dec-18		
Temperature: 23 ºC	Relative Humidity: 45 %	Air Pressure: 1018 hPa	Power: 12 VDC
Remarks:			

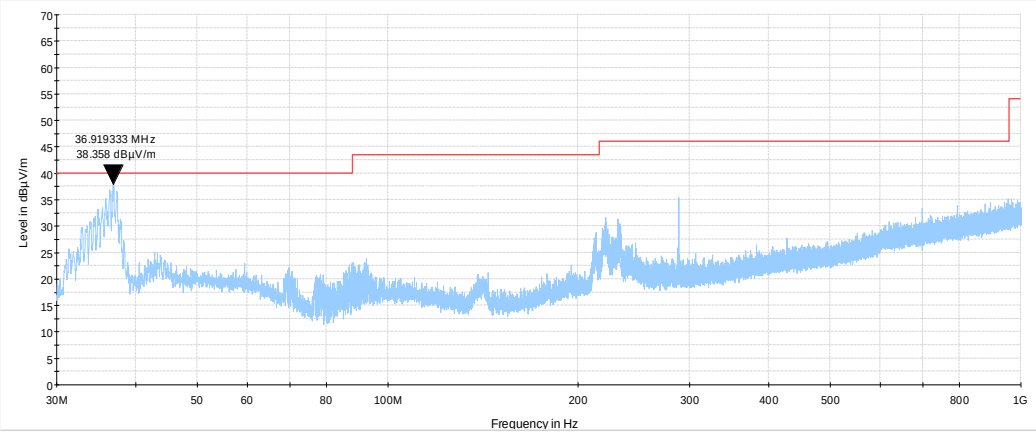
Plot 7.6.6 Radiated emission measurements from 9 kHz to 30 MHz at the high carrier frequency

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



Plot 7.6.7 Radiated emission measurements from 30 to 1000 MHz at the low carrier frequency

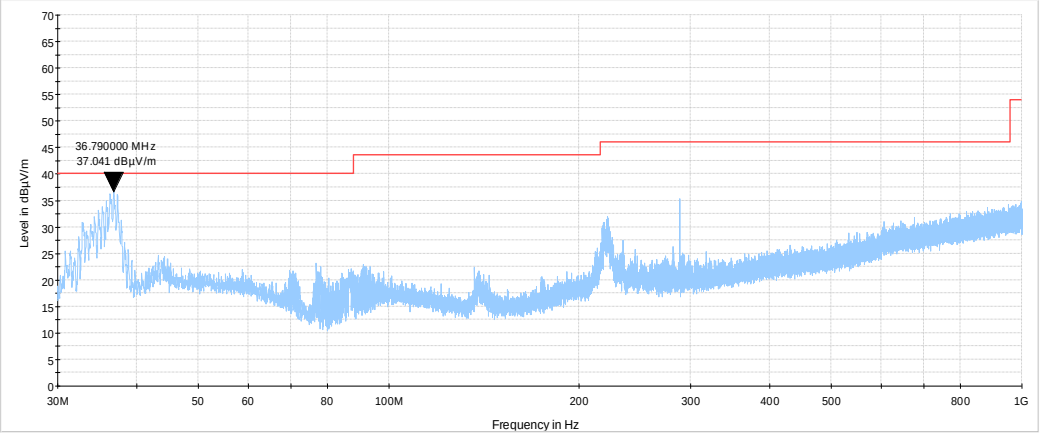
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal



Test specification:	Section 15.247(c), Radiated spurious emissions		
Test procedure:	ANSI C63.10, sections 6.5, 6.6		
Test mode:	Compliance	Verdict:	PASS
Date(s):	10-Dec-18		
Temperature: 23 ºC	Relative Humidity: 45 %	Air Pressure: 1018 hPa	Power: 12 VDC
Remarks:			

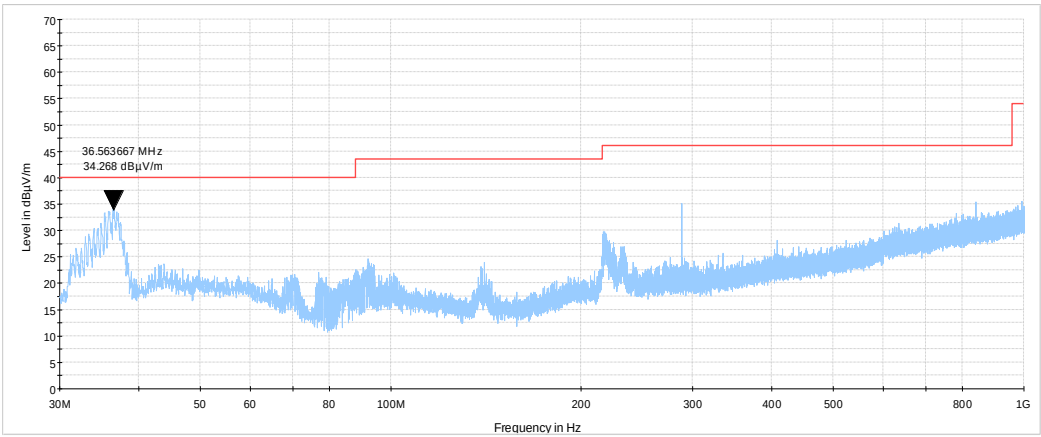
Plot 7.6.8 Radiated emission measurements from 30 to 1000 MHz at the mid carrier frequency

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



Plot 7.6.9 Radiated emission measurements from 30 to 1000 MHz at the high carrier frequency

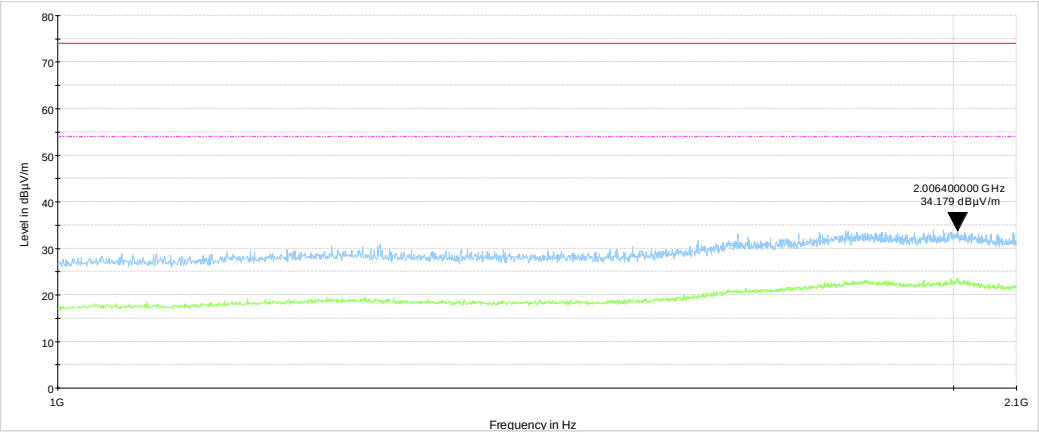
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal



Test specification:	Section 15.247(c), Radiated spurious emissions		
Test procedure:	ANSI C63.10, sections 6.5, 6.6		
Test mode:	Compliance	Verdict:	PASS
Date(s):	10-Dec-18		
Temperature: 23 ºC	Relative Humidity: 45 %	Air Pressure: 1018 hPa	Power: 12 VDC
Remarks:			

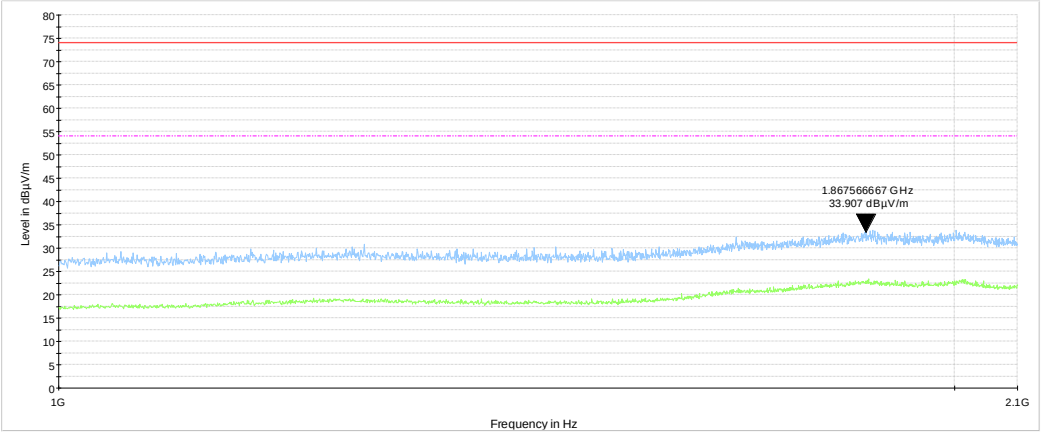
Plot 7.6.10 Radiated emission measurements from 1000 to 2100 MHz at the low carrier frequency

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



Plot 7.6.11 Radiated emission measurements from 1000 to 2100 MHz at the mid carrier frequency

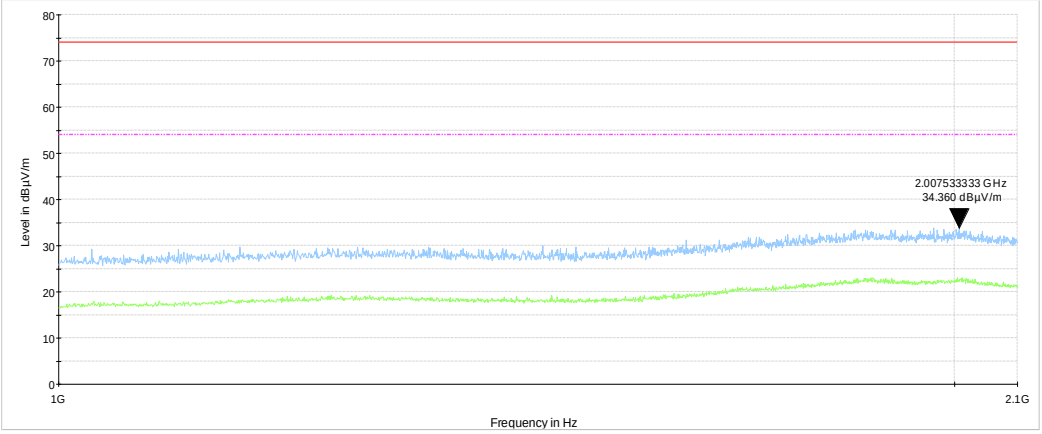
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal



Test specification:	Section 15.247(c), Radiated spurious emissions		
Test procedure:	ANSI C63.10, sections 6.5, 6.6		
Test mode:	Compliance	Verdict:	PASS
Date(s):	10-Dec-18		
Temperature: 23 ºC	Relative Humidity: 45 %	Air Pressure: 1018 hPa	Power: 12 VDC
Remarks:			

Plot 7.6.12 Radiated emission measurements from 1000 to 2100 MHz at the high carrier frequency

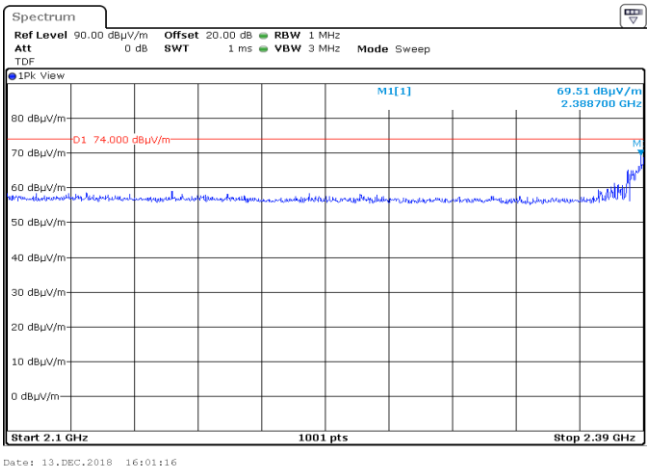
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal

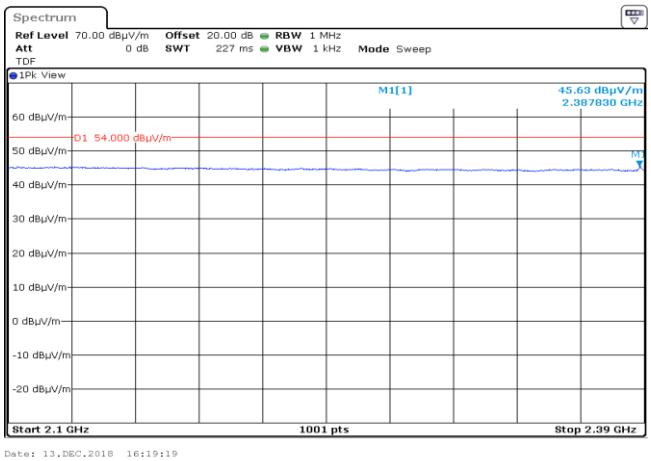


Test specification:	Section 15.247(c), Radiated spurious emissions		
Test procedure:	ANSI C63.10, sections 6.5, 6.6		
Test mode:	Compliance	Verdict:	PASS
Date(s):	10-Dec-18		
Temperature: 23 ºC	Relative Humidity: 45 %	Air Pressure: 1018 hPa	Power: 12 VDC
Remarks:			

Plot 7.6.13 Radiated emission measurements from 2100 to 2390 MHz at the low carrier frequency

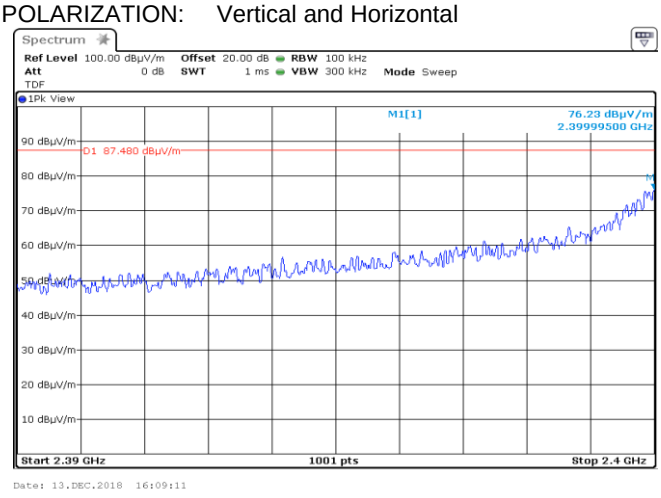
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal





Plot 7.6.14 Radiated emission measurements from 2390 to 2400 MHz at the low carrier frequency

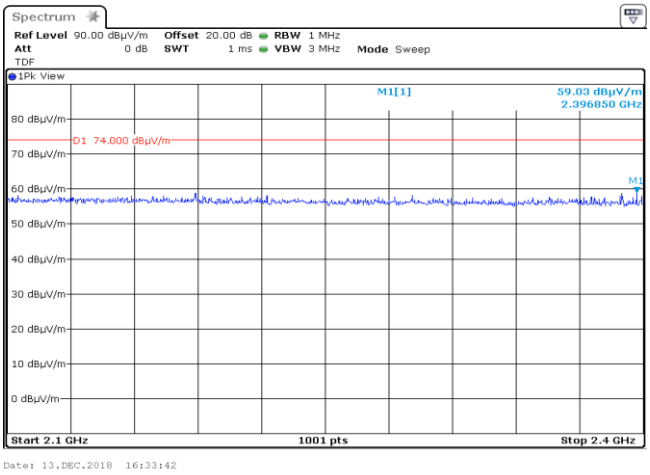
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal

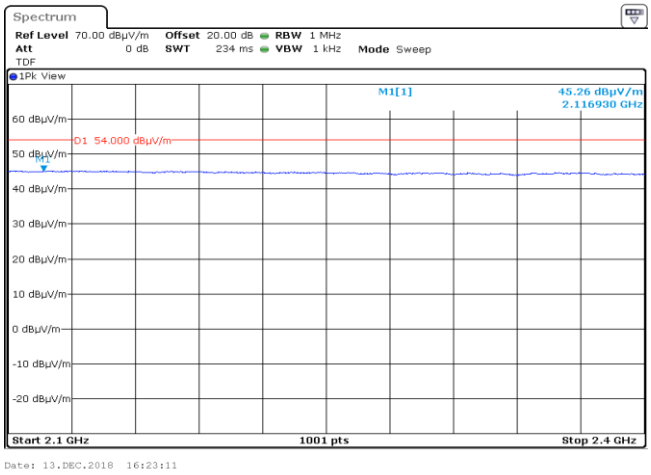


Test specification:	Section 15.247(c), Radiated spurious emissions		
Test procedure:	ANSI C63.10, sections 6.5, 6.6		
Test mode:	Compliance	Verdict:	PASS
Date(s):	10-Dec-18		
Temperature: 23 ºC	Relative Humidity: 45 %	Air Pressure: 1018 hPa	Power: 12 VDC
Remarks:			

Plot 7.6.15 Radiated emission measurements from 2100 to 2400 MHz at the mid carrier frequency

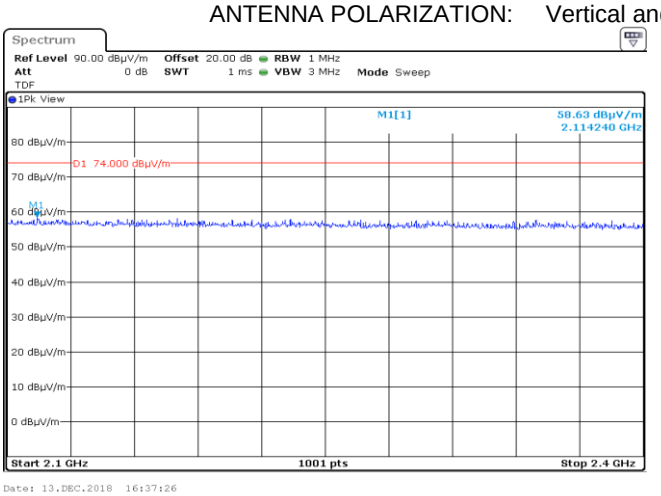
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal

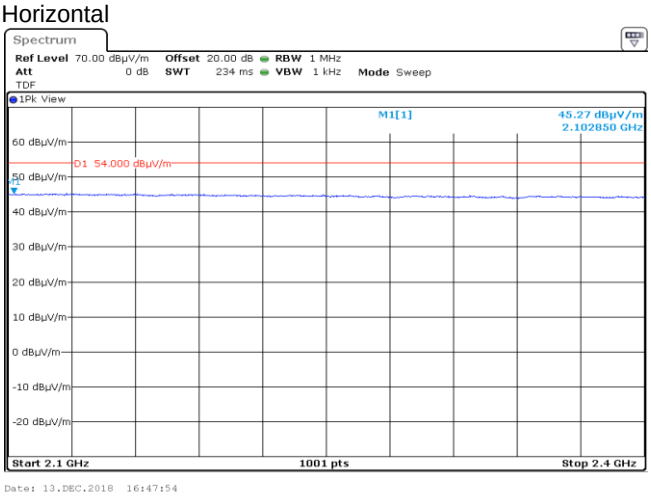




Plot 7.6.16 Radiated emission measurements from 2100 to 2400 MHz at the high carrier frequency

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

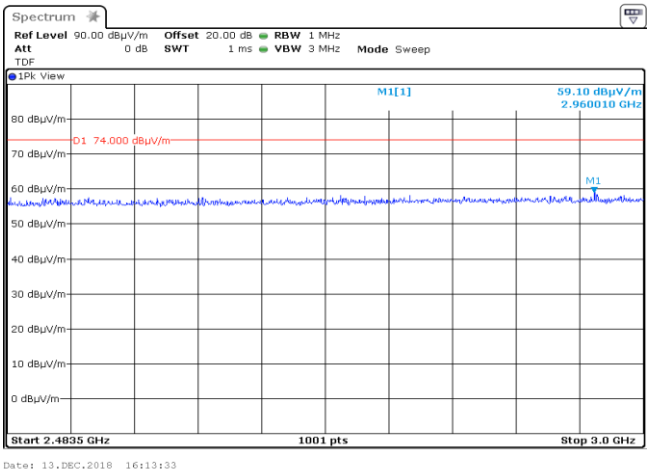


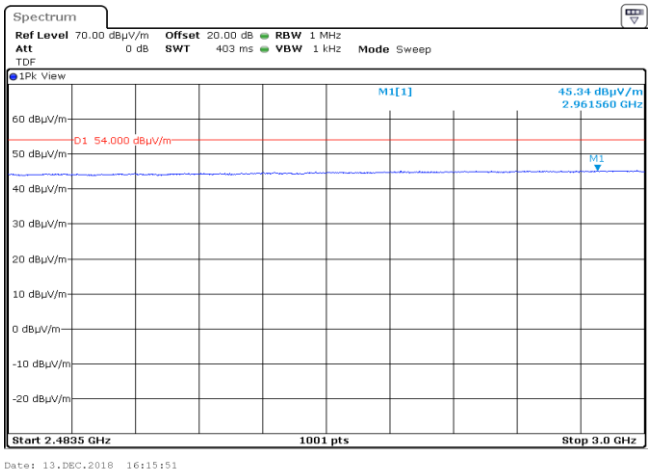


Test specification:	Section 15.247(c), Radiated spurious emissions		
Test procedure:	ANSI C63.10, sections 6.5, 6.6		
Test mode:	Compliance	Verdict:	PASS
Date(s):	10-Dec-18		
Temperature: 23 ºC	Relative Humidity: 45 %	Air Pressure: 1018 hPa	Power: 12 VDC
Remarks:			

Plot 7.6.17 Radiated emission measurements from 2483.5 to 3000 MHz at the low carrier frequency

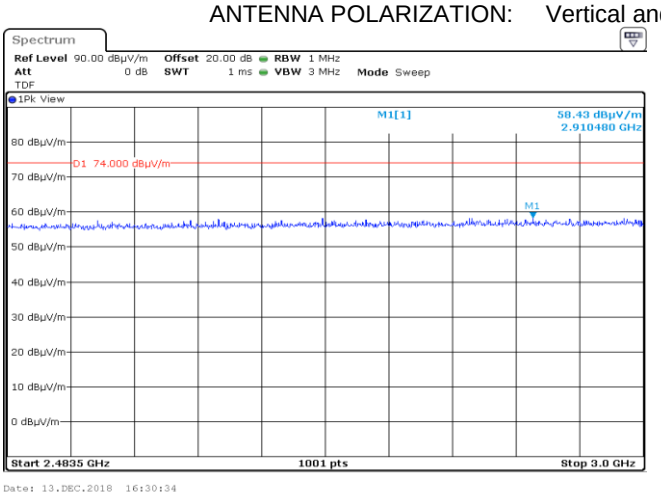
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal

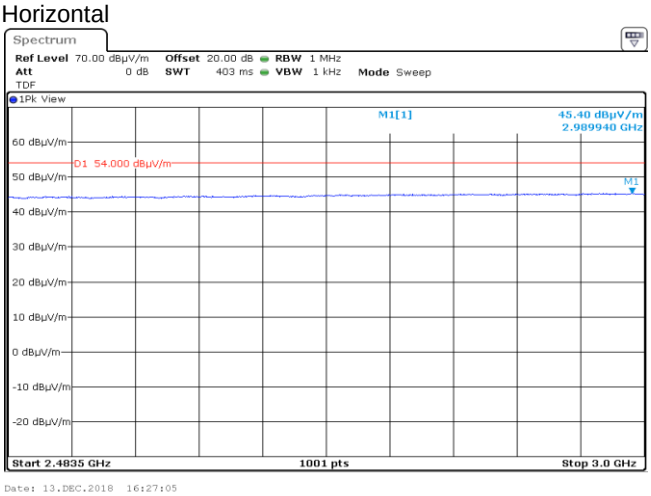




Plot 7.6.18 Radiated emission measurements from 2483.5 to 3000 MHz at the mid carrier frequency

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

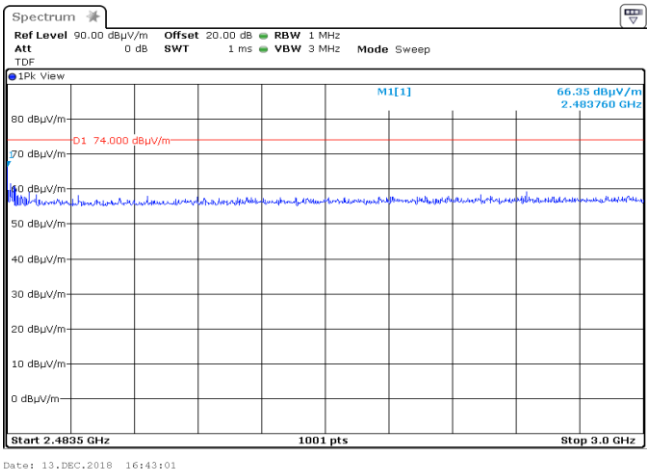


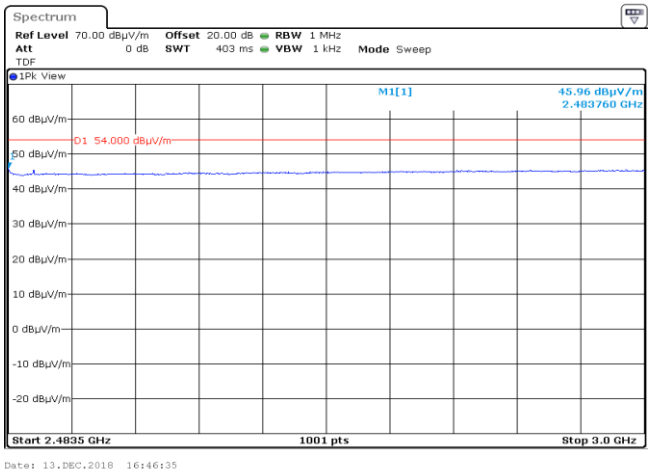


Test specification:	Section 15.247(c), Radiated spurious emissions		
Test procedure:	ANSI C63.10, sections 6.5, 6.6		
Test mode:	Compliance	Verdict:	PASS
Date(s):	10-Dec-18		
Temperature: 23 ºC	Relative Humidity: 45 %	Air Pressure: 1018 hPa	Power: 12 VDC
Remarks:			

Plot 7.6.19 Radiated emission measurements from 2483.5 to 3000 MHz at the high carrier frequency

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

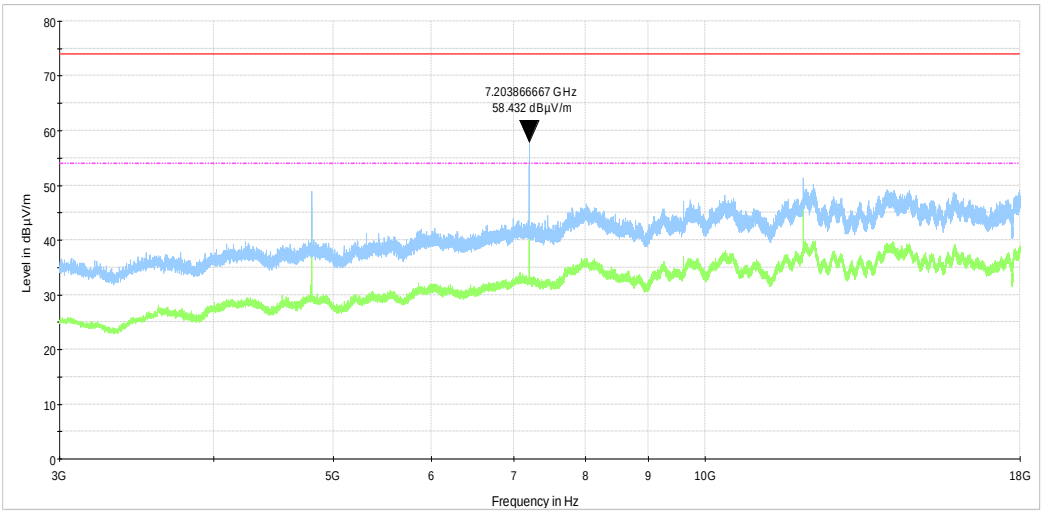




Test specification:	Section 15.247(c), Radiated spurious emissions		
Test procedure:	ANSI C63.10, sections 6.5, 6.6		
Test mode:	Compliance	Verdict:	PASS
Date(s):	10-Dec-18		
Temperature: 23 ºC	Relative Humidity: 45 %	Air Pressure: 1018 hPa	Power: 12 VDC
Remarks:			

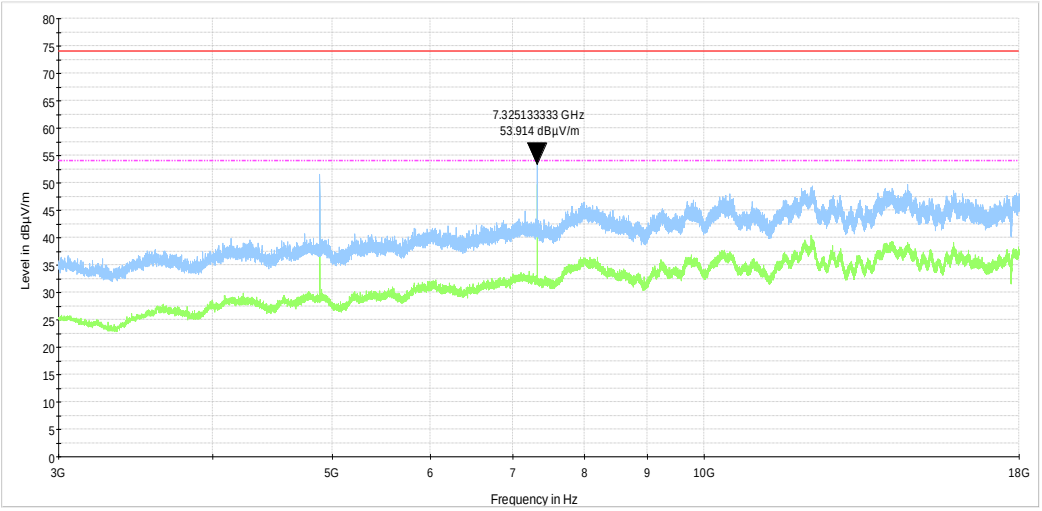
Plot 7.6.20 Radiated emission measurements from 3000 to 18000 MHz at the low carrier frequency

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



Plot 7.6.21 Radiated emission measurements from 3000 to 18000 MHz at the mid carrier frequency

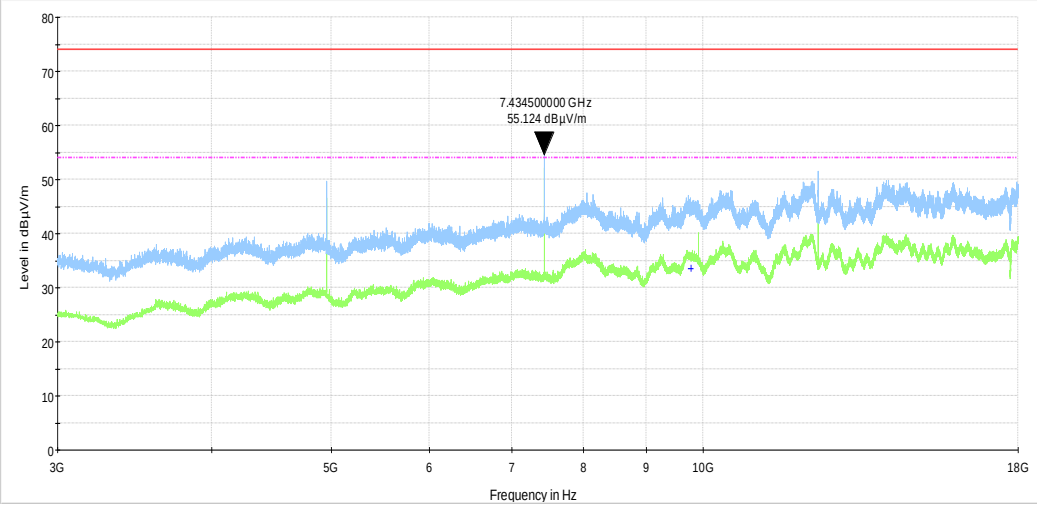
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal



Test specification:	Section 15.247(c), Radiated spurious emissions		
Test procedure:	ANSI C63.10, sections 6.5, 6.6		
Test mode:	Compliance	Verdict:	PASS
Date(s):	10-Dec-18		
Temperature: 23 ºC	Relative Humidity: 45 %	Air Pressure: 1018 hPa	Power: 12 VDC
Remarks:			

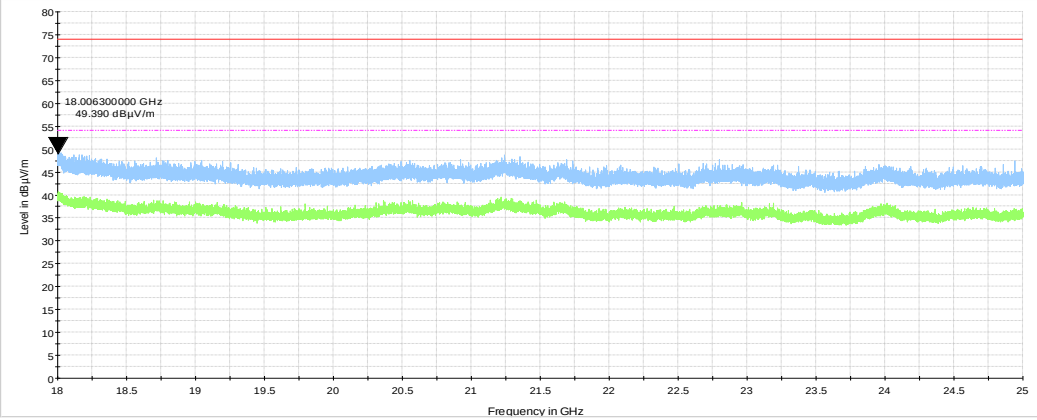
Plot 7.6.22 Radiated emission measurements from 3000 to 18000 MHz at the high carrier frequency

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



Plot 7.6.23 Radiated emission measurements from 18000 to 25000 MHz at the low carrier frequency

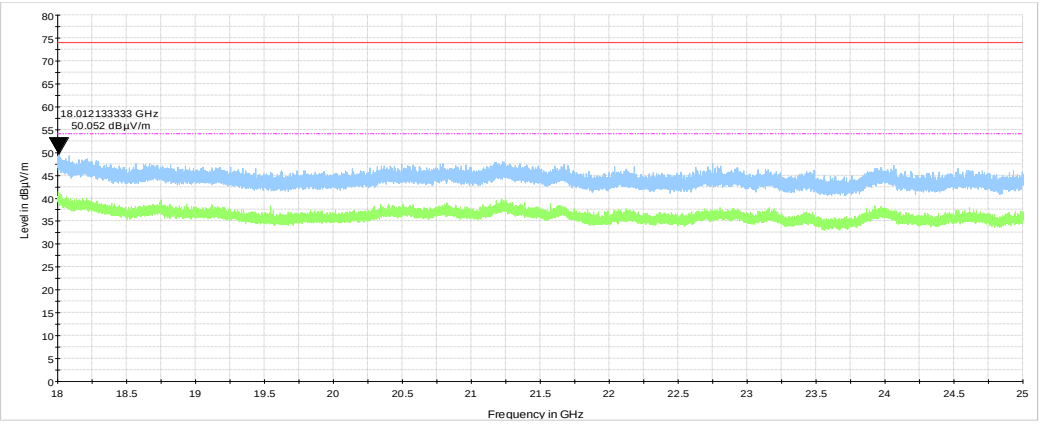
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal



Test specification:	Section 15.247(c), Radiated spurious emissions		
Test procedure:	ANSI C63.10, sections 6.5, 6.6		
Test mode:	Compliance	Verdict:	PASS
Date(s):	10-Dec-18		
Temperature: 23 ºC	Relative Humidity: 45 %	Air Pressure: 1018 hPa	Power: 12 VDC
Remarks:			

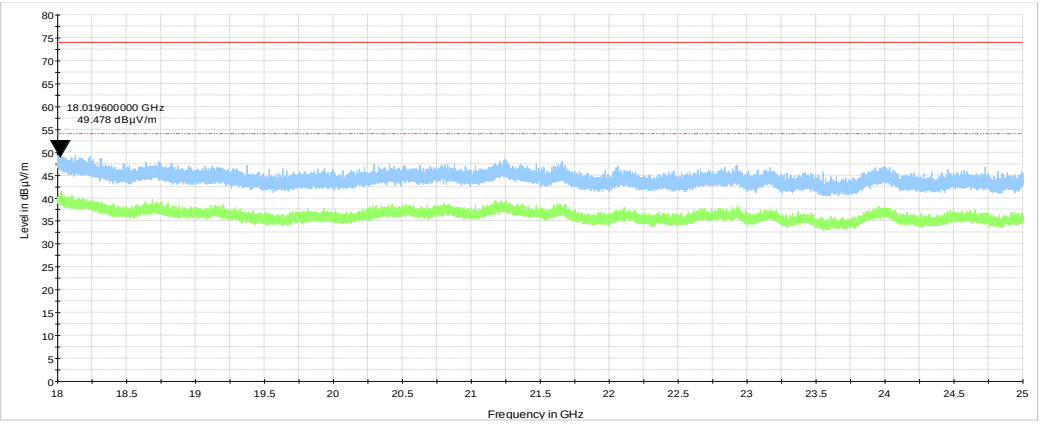
Plot 7.6.24 Radiated emission measurements from 18000 to 25000 MHz at the mid carrier frequency

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



Plot 7.6.25 Radiated emission measurements from 18000 to 25000 MHz the high carrier frequency

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



Test specification:	**Section 15.247(c), Emissions at band edges**		
Test procedure:	ANSI C63.10, section 7.8.6		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	10-Dec-18		
Temperature: 23 ºC	**Relative Humidity:** 45 %	**Air Pressure:** 1018 hPa	**Power:** 12 VDC
Remarks:			

7.7 Band edge radiated emissions

7.7.1 General

This test was performed to measure emissions, radiated from the EUT at the assigned frequency band edges. Specification test limits are given in Table 7.7.1.

Table 7.7.1 Band edge emission limits

Assigned frequency, MHz	Attenuation below carrier*, dBc	Field strength at 3 m within restricted bands, dB(μV/m)	
		Peak	Average
902.0 – 928.0	20.0	74.0	54.0
2400.0 – 2483.5			
5725.0 – 5850.0			

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

7.7.2 Test procedure

7.7.2.1 The EUT was set up as shown in Figure 7.7.1, energized normally modulated at the maximum data rate with its hopping function disabled and its proper operation was checked.

7.7.2.2 The EUT was adjusted to produce maximum available to end user RF output power at the lowest carrier frequency.

7.7.2.3 The spectrum analyzer span was set to capture the carrier frequency and associated modulation products. The resolution bandwidth was set wider than 1 % of the frequency span.

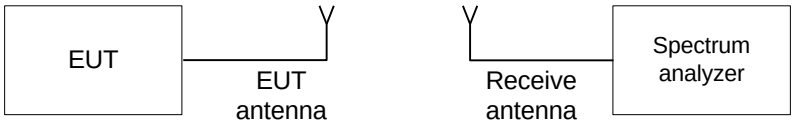
7.7.2.4 The spectrum analyzer was set in max hold mode and allowed trace to stabilize. The highest emission level within the authorized band was measured.

7.7.2.5 The maximum band edge emission and modulation product outside of the band were measured as provided in Table 7.7.2 and associated plots and referenced to the highest emission level measured within the authorized band.

7.7.2.6 The above procedure was repeated with the EUT adjusted to produce maximum RF output power at the highest carrier frequency.

7.7.2.7 The above procedure was repeated with the frequency hopping function enabled.

Figure 7.7.1 Band edge emission test setup



Test specification:	Section 15.247(c), Emissions at band edges		
Test procedure:	ANSI C63.10, section 7.8.6		
Test mode:	Compliance	Verdict:	PASS
Date(s):	10-Dec-18		
Temperature: 23 ºC	Relative Humidity: 45 %	Air Pressure: 1018 hPa	Power: 12 VDC
Remarks:			

Table 7.7.2 Band edge emission outside restricted band test results

ASSIGNED FREQUENCY RANGE: 2400.0 – 2483.5 MHz
DETECTOR USED: Peak
MODULATION: MSK
MODULATING SIGNAL: PRBS
BIT RATE: 250 kbps
TRANSMITTER OUTPUT POWER SETTINGS: Maximum
RESOLUTION BANDWIDTH: 100 kHz
VIDEO BANDWIDTH: 300 kHz

Frequency, MHz	Band edge emission, dBm	Emission at carrier, dBm	Attenuation below carrier, dBc	Limit, dBc	Margin, dB*	Verdict
Frequency hopping disabled						
2399.945	78.84	107.48	28.64	20.0	8.64	Pass
Frequency hopping enabled						
2399.925	76.91	99.26	22.35	20.0	2.35	Pass

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

Table 7.7.3 Band edge emission within restricted band test results

ASSIGNED FREQUENCY RANGE: 2400.0 – 2483.5 MHz
DETECTOR USED: Peak
MODULATION: MSK
MODULATING SIGNAL: PRBS
BIT RATE: 250 kbps
TRANSMITTER OUTPUT POWER SETTINGS: Maximum
RESOLUTION BANDWIDTH: 100 kHz

Frequency, MHz	Peak field strength(VBW=3 MHz)			Average field strength(VBW=10 Hz)			Verdict
	Measured, dB(µV/m)	Limit, dB(µV/m)	Margin, dB*	Measured, dB(µV/m)	Limit, dB(µV/m)	Margin, dB**	
Frequency hopping disabled							
2389.865	70.53	74.0	-3.47	45.79	54.0	-8.21	Pass
2483.508	68.27	74.0	-5.73	46.19	54.0	-7.81	Pass
Frequency hopping enabled							
2389.505	70.03	74.0	-3.97	45.88	54.0	-8.12	Pass
2483.574	68.62	74.0	-5.38	46.08	54.0	-7.92	Pass

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

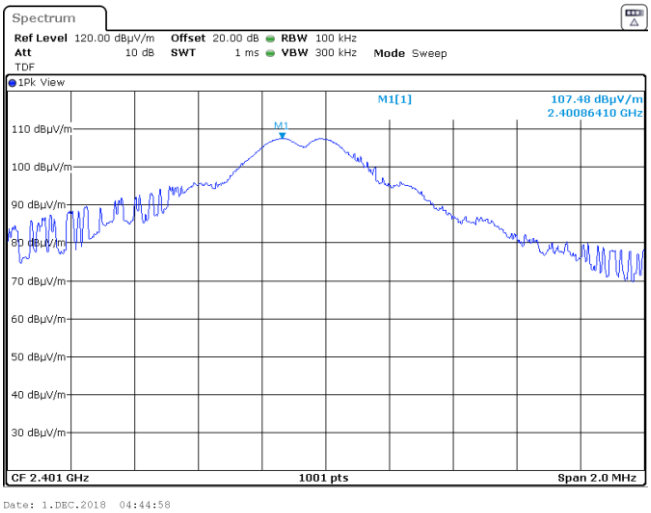
Reference numbers of test equipment used

HL 3903	HL 4355	HL 4933	HL 5405				

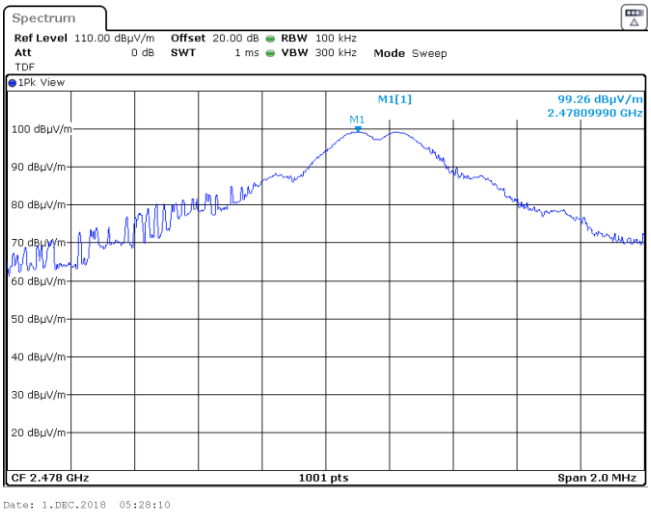
Full description is given in Appendix A.

Test specification:	Section 15.247(c), Emissions at band edges		
Test procedure:	ANSI C63.10, section 7.8.6		
Test mode:	Compliance	Verdict:	PASS
Date(s):	10-Dec-18		
Temperature: 23 ºC	Relative Humidity: 45 %	Air Pressure: 1018 hPa	Power: 12 VDC
Remarks:			

Plot 7.7.1 The highest emission level within the assigned band at low carrier frequency

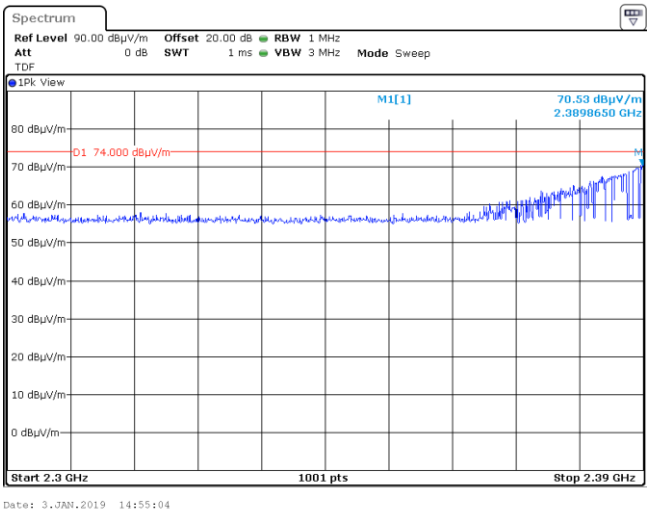


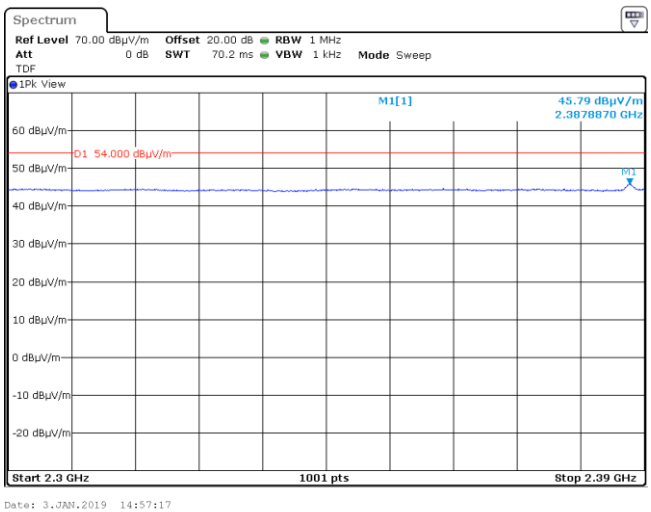
Plot 7.7.2 The highest emission level within the assigned band at high carrier frequency

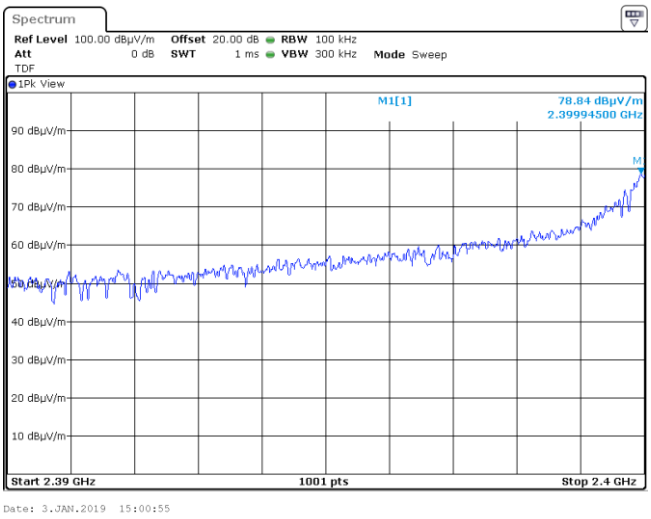


Test specification:	Section 15.247(c), Emissions at band edges		
Test procedure:	ANSI C63.10, section 7.8.6		
Test mode:	Compliance	Verdict:	PASS
Date(s):	10-Dec-18		
Temperature: 23 ºC	Relative Humidity: 45 %	Air Pressure: 1018 hPa	Power: 12 VDC
Remarks:			

Plot 7.7.3 The lowest band edge emission at low carrier frequency with hopping function disabled

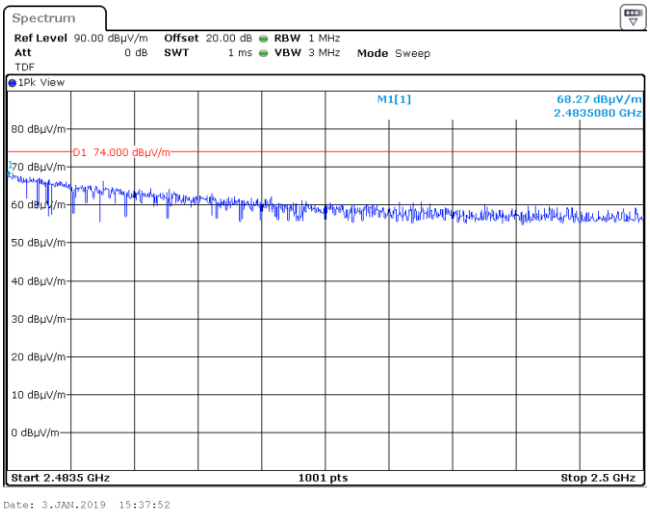


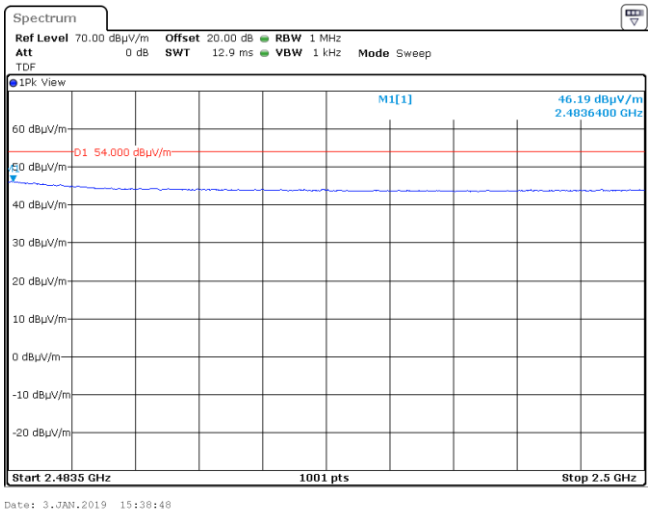




Test specification:	Section 15.247(c), Emissions at band edges		
Test procedure:	ANSI C63.10, section 7.8.6		
Test mode:	Compliance	Verdict:	PASS
Date(s):	10-Dec-18		
Temperature: 23 ºC	Relative Humidity: 45 %	Air Pressure: 1018 hPa	Power: 12 VDC
Remarks:			

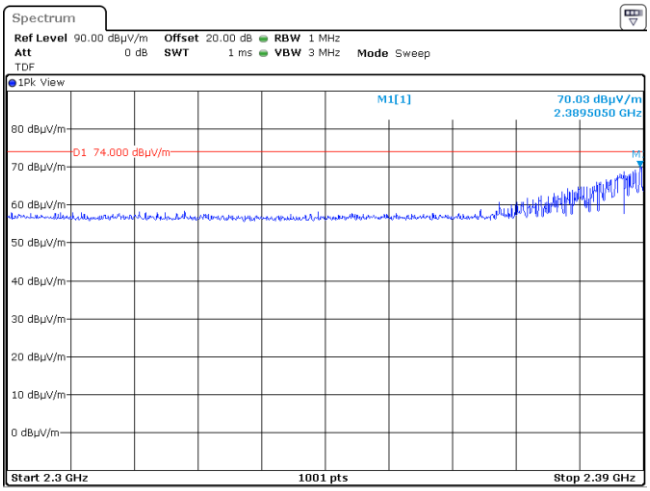
Plot 7.7.4 The highest band edge emission at high carrier frequency with hopping function disabled



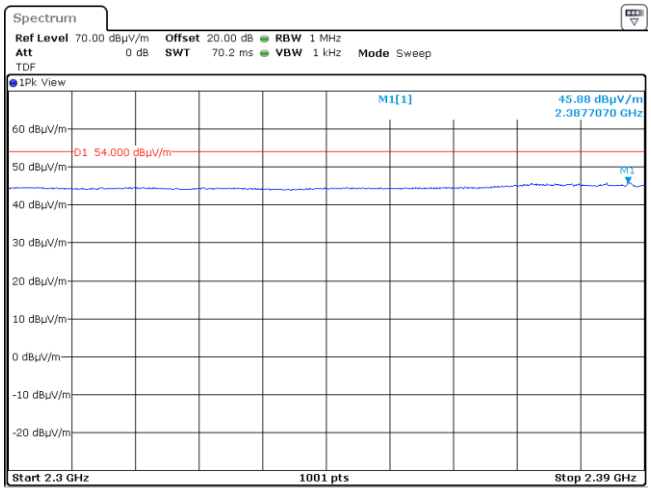


Test specification:	Section 15.247(c), Emissions at band edges		
Test procedure:	ANSI C63.10, section 7.8.6		
Test mode:	Compliance	Verdict:	PASS
Date(s):	10-Dec-18		
Temperature: 23 ºC	Relative Humidity: 45 %	Air Pressure: 1018 hPa	Power: 12 VDC
Remarks:			

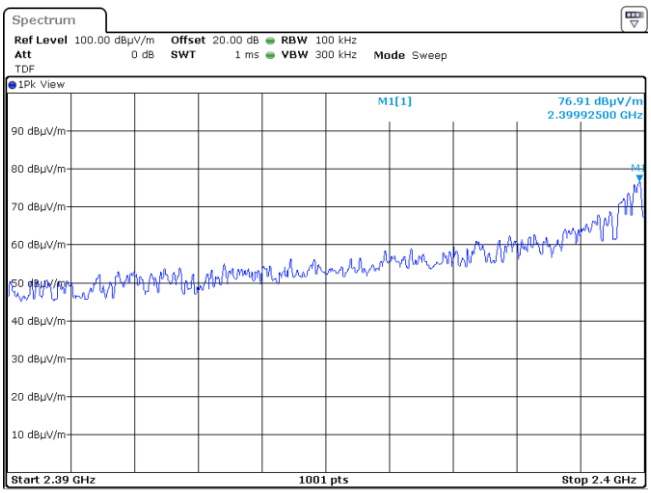
Plot 7.7.5 The lowest band edge emission at low carrier frequency with hopping function enabled



Date: 3.JAN.2019 15:15:52



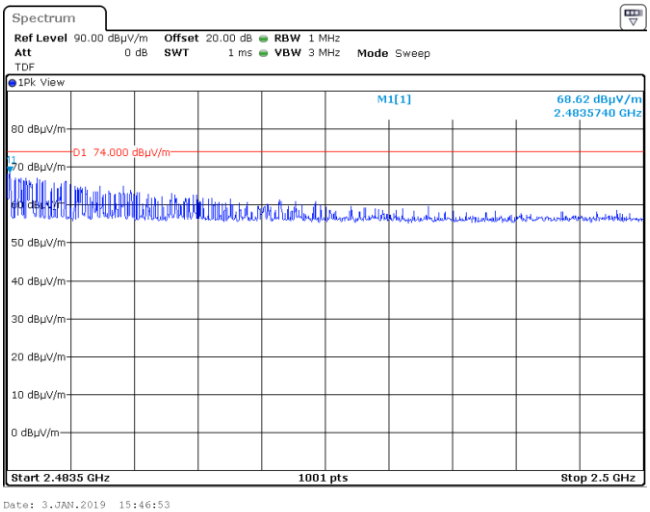
Date: 3.JAN.2019 15:19:09

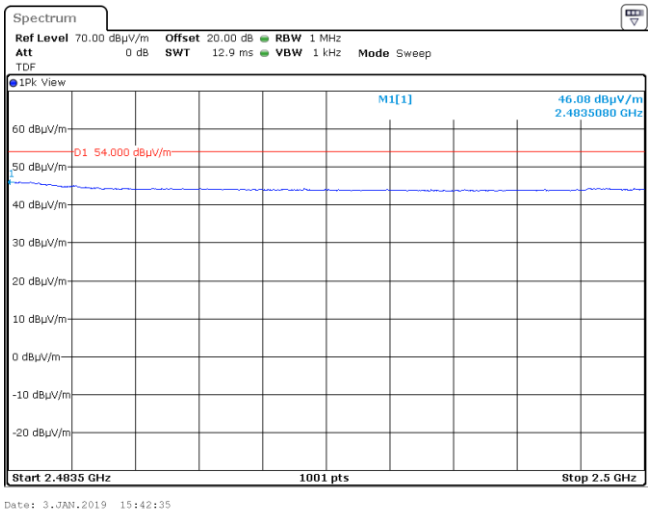


Date: 3.JAN.2019 15:08:20

Test specification:	Section 15.247(c), Emissions at band edges		
Test procedure:	ANSI C63.10, section 7.8.6		
Test mode:	Compliance	Verdict:	PASS
Date(s):	10-Dec-18		
Temperature: 23 ºC	Relative Humidity: 45 %	Air Pressure: 1018 hPa	Power: 12 VDC
Remarks:			

Plot 7.7.6 The highest band edge emission at high carrier frequency with hopping function enabled





Test specification:	Section 15.203, Antenna requirements		
Test procedure:	Visual inspection		
Test mode:	Compliance	Verdict:	PASS
Date(s):	03-Jan-19		
Temperature: 23 ºC	Relative Humidity: 53 %	Air Pressure: 1018 hPa	Power: 12 VDC
Remarks:			

7.8 Antenna requirements

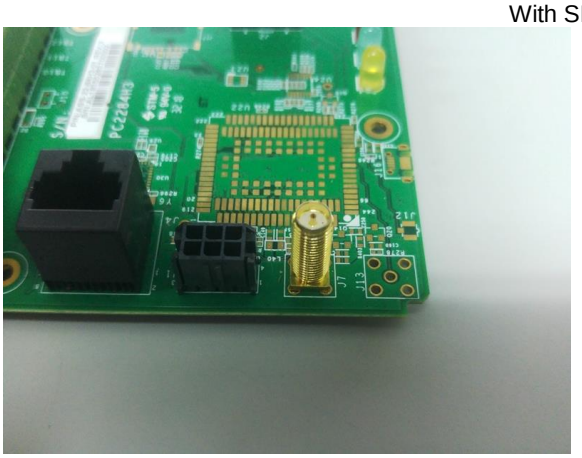
The EUT was verified for compliance with antenna requirements. A transmitter shall be designed to ensure that no antenna other than that furnished by the responsible party will be used with the device. It may be either permanently attached or employs a unique antenna connector for every antenna proposed for use with the EUT. This requirement does not apply to professionally installed transmitters.
The rationale for compliance with the above requirements was either visual inspection results or supplier declaration. The summary of results is provided in Table 7.8.1.

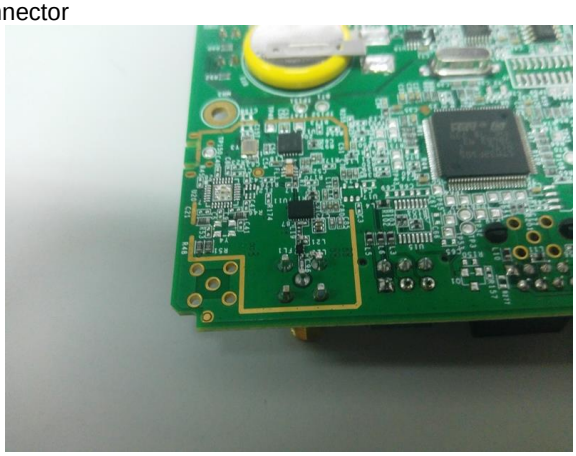
Table 7.8.1 Antenna requirements

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

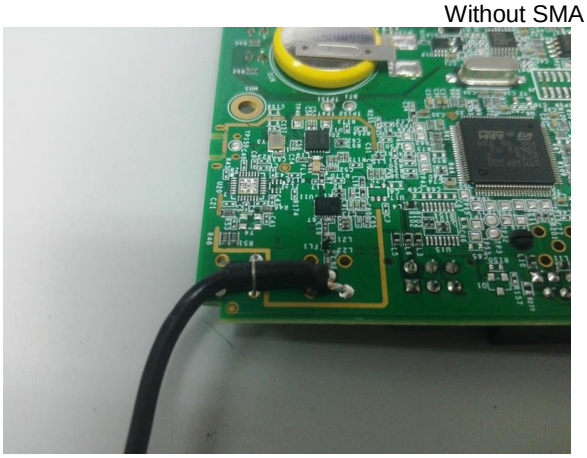
Photograph 7.8.1 Antenna assembly

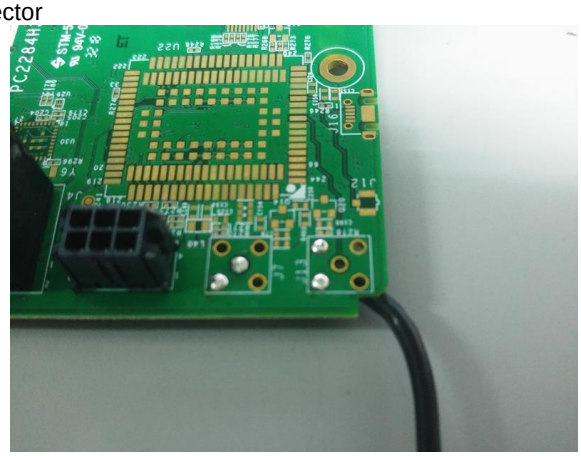
With SMA connector





Without SMA connector





Test specification:	Section 15.109, Radiated emission		
Test procedure:	ANSI C63.4, Sections 11.6 and 12.1.4		
Test mode:	Compliance	Verdict:	PASS
Date(s):	03-Jan-19		
Temperature: 23 ºC	Relative Humidity: 53 %	Air Pressure: 1018 hPa	Power: 12 VDC
Remarks:			

8 Unintentional emissions according to 47CFR part 15 subpart B requirements

8.1 Radiated emission measurements

8.1.1 General

This test was performed to measure radiated emissions from the EUT enclosure. Specification test limits are given in Table 8.1.1.

Table 8.1.1 Radiated emission test limits

Frequency, MHz	Class B limit, dB(μV/m)		Class A limit, dB(μV/m)	
	10 m distance	3 m distance	10 m distance	3 m distance
30 - 88	29.5*	40.0	39.0	49.5*
88 - 216	33.0*	43.5	43.5	54.0*
216 - 960	35.5*	46.0	46.4	56.9*
Above 960	43.5*	54.0	49.5	60.0*

* The limit for test distance other than specified was calculated using the inverse linear distance extrapolation factor as follows: $Lim_{S2} = Lim_{S1} + 20 \log (S_1/S_2)$,
where S_1 and S_2 – standard defined and test distance respectively in meters.

8.1.2 Test procedure for measurements in semi-anechoic chamber

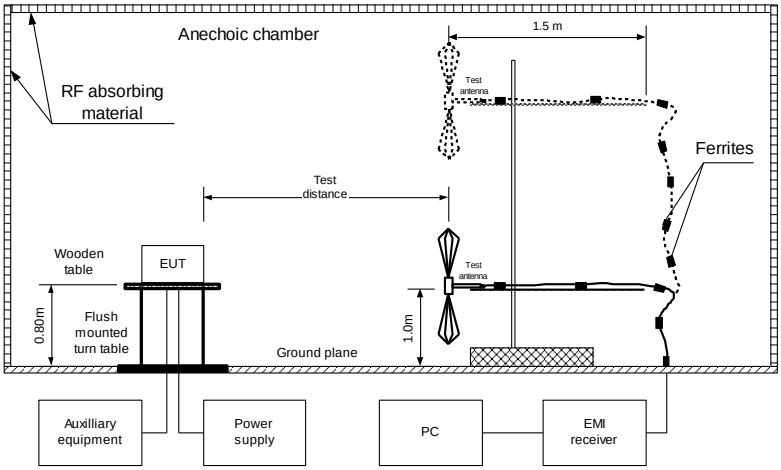
8.1.2.1 The EUT was set up as shown in Figure 8.1.1 and associated photographs, energized and the performance check was conducted.

8.1.2.2 The specified frequency range was investigated with biconilog antenna connected to EMI receiver. To find maximum radiation the turntable was rotated 360^0, the measuring antenna height was changed from 1 to 4 m, its polarization was switched from vertical to horizontal and the EUT cables position was varied.

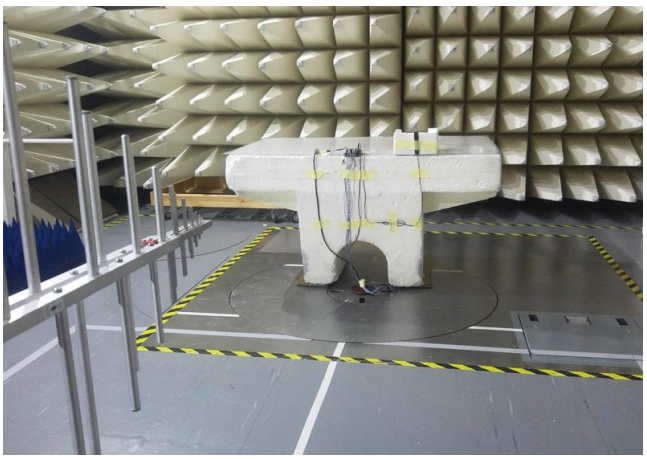
8.1.2.3 The worst test results (the lowest margins) were recorded in Table 8.1.2 and shown in the associated plots.

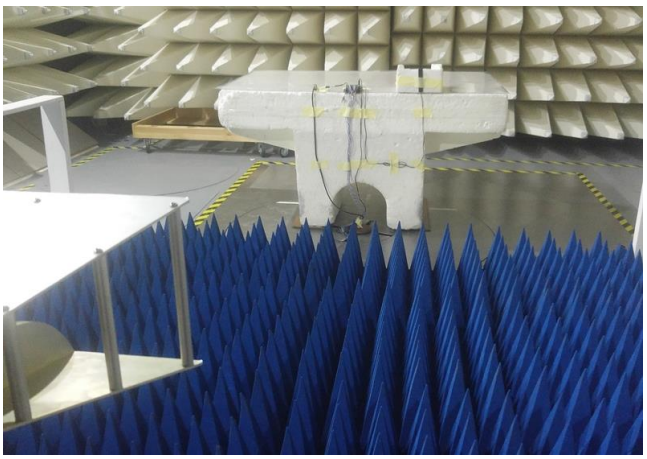
Test specification:	Section 15.109, Radiated emission		
Test procedure:	ANSI C63.4, Sections 11.6 and 12.1.4		
Test mode:	Compliance	Verdict:	PASS
Date(s):	03-Jan-19		
Temperature: 23 ºC	Relative Humidity: 53 %	Air Pressure: 1018 hPa	Power: 12 VDC
Remarks:			

Figure 8.1.1 Setup for radiated emission measurements

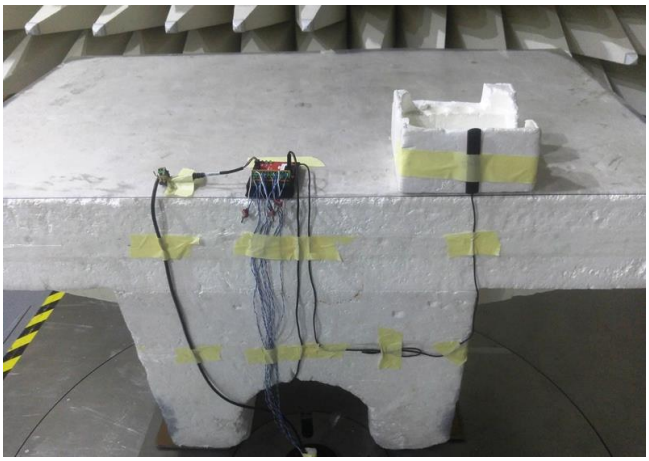


Photograph 8.1.1 Setup for radiated emission measurements





Photograph 8.1.2 Setup for final radiated emission measurements, EUT cabling



Test specification:	**Section 15.109, Radiated emission**		
Test procedure:	ANSI C63.4, Sections 11.6 and 12.1.4		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	03-Jan-19		
Temperature: 23 ºC	**Relative Humidity:** 53 %	**Air Pressure:** 1018 hPa	**Power:** 12 VDC
Remarks:			

Table 8.1.2 Radiated emission test results

EUT SET UP: TABLE-TOP
LIMIT: Class B
EUT OPERATING MODE: Receive
TEST SITE: SEMI ANECHOIC CHAMBER
TEST DISTANCE: 3 m
DETECTORS USED: PEAK / QUASI-PEAK
FREQUENCY RANGE: 30 MHz – 1000 MHz
RESOLUTION BANDWIDTH: 120 kHz

Frequency, MHz	Peak emission, dB(μV/m)	Quasi-peak			Antenna polarization	Antenna height, m	Turn-table position**, degrees	Verdict
		Measured emission, dB(μV/m)	Limit, dB(μV/m)	Margin, dB*				
36.827	37.97	33.80	40.0	-6.20	Vertical	104	-157	Pass
43.421	27.08	22.41	40.0	-17.59	Vertical	102	-8	
70.482	23.94	17.67	40.0	-22.33	Vertical	220	-78	
77.017	22.42	15.98	40.0	-24.02	Vertical	175	180	
86.102	23.07	16.33	40.0	-23.67	Vertical	100	13	
91.848	23.15	16.28	43.5	-27.22	Vertical	104	103	
141.067	23.26	16.83	43.5	-26.67	Vertical	102	-55	
219.843	31.95	25.72	46.0	-20.28	Vertical	100	-8	
288.043	37.89	35.64	46.0	-10.36	Horizontal	102	25	

TEST SITE: SEMI ANECHOIC CHAMBER
TEST DISTANCE: 3 m
DETECTORS USED: PEAK / AVERAGE
FREQUENCY RANGE: 1000 MHz – 13000 MHz
RESOLUTION BANDWIDTH: 1000 kHz

Frequency, MHz	Peak			Average			Antenna polarization	Antenna height, m	Turn-table position**, degrees	Verdict
	Measured emission, dB(μV/m)	Limit, dB(μV/m)	Margin, dB*	Measured emission, dB(μV/m)	Limit, dB(μV/m)	Margin, dB*				
4955.320	43.22	74.0	-30.78	39.55	54.0	-14.45	Vertical	260	-112.0	Pass

*****- Margin = Measured emission - specification limit.
******- EUT front panel refer to 0 degrees position of turntable.

Reference numbers of test equipment used

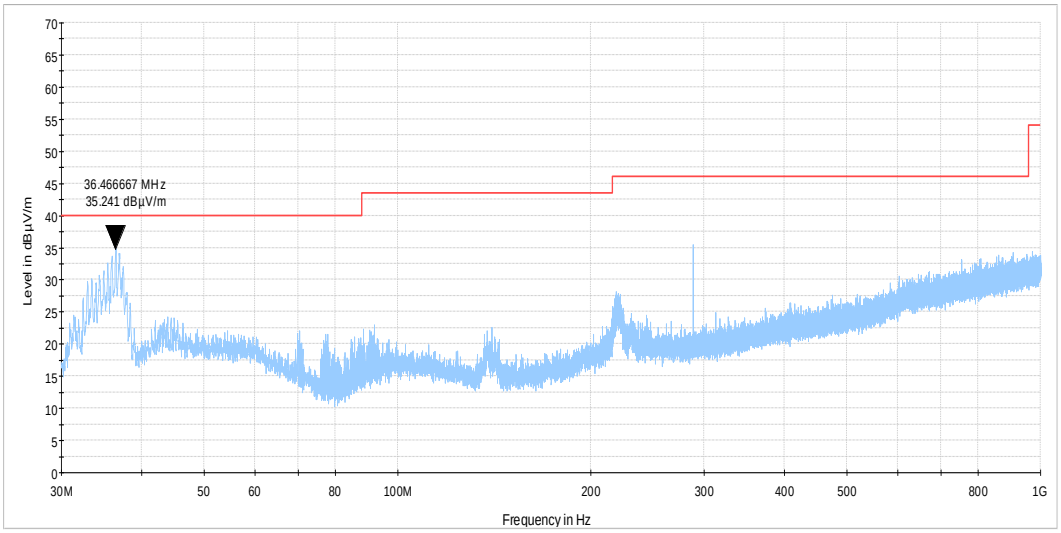
HL 3903	HL 4360	HL 4933	HL 5288	HL 5405			

Full description is given in Appendix A.

Test specification:	Section 15.109, Radiated emission		
Test procedure:	ANSI C63.4, Sections 11.6 and 12.1.4		
Test mode:	Compliance	Verdict:	PASS
Date(s):	03-Jan-19		
Temperature: 23 ºC	Relative Humidity: 53 %	Air Pressure: 1018 hPa	Power: 12 VDC
Remarks:			

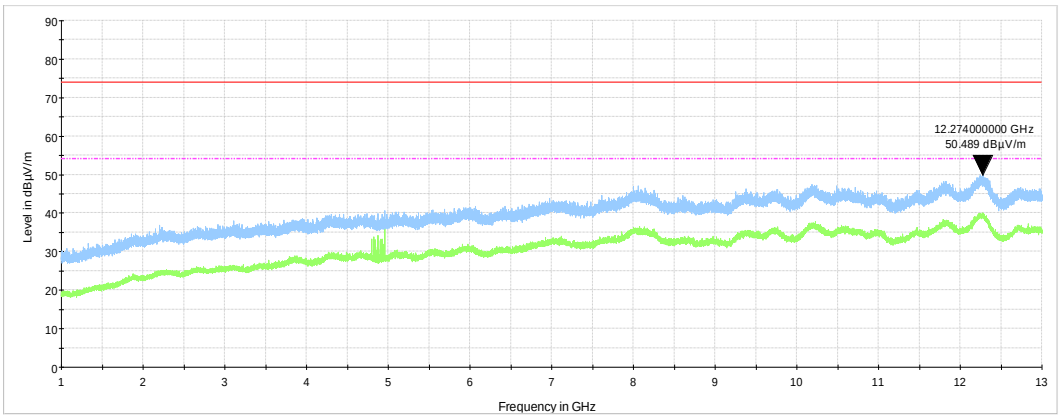
Plot 8.1.1 Radiated emission measurements in 30 - 1000 MHz range, vertical and horizontal antenna polarization

TEST SITE:	Semi anechoic chamber
LIMIT:	Class B
TEST DISTANCE:	3 m
EUT OPERATING MODE:	Receive



Plot 8.1.2 Radiated emission measurements in 1 – 13 GHz range, vertical and horizontal antenna polarization

TEST SITE:	Semi anechoic chamber
LIMIT:	Class B
TEST DISTANCE:	3 m
EUT OPERATING MODE:	Receive



9 APPENDIX A 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 1, 2, 15, 18 parts of Code of Federal Regulations 47 (CFR 47), Test Firm Registration Number is 927748, Designation Number is IL1001; registered by Industry Canada for electromagnetic emissions, file number IC 2186A-1 for OATS, certified by VCCI, Japan (the registration numbers are R-10808 for OATS, R-1082 for anechoic chamber, G-10869 for RE measurements above 1 GHz, C-10845 for conducted emissions site and T-11606 for conducted emissions at telecommunication ports).
The laboratory is accredited by American Association for Laboratory Accreditation (USA) according to ISO/IEC 17025 for electromagnetic compatibility, product safety, telecommunications testing, environmental simulation and calibration (for exact scope please refer to Certificate No. 839.01, 839.03 and 839.04).

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e-mail: mail@hermonlabs.com
website: www.hermonlabs.com

Person for contact: Mr. M. Nikishin, EMC and radio group leader

10 APPENDIX B 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 kHz - 30 MHz	EMCO	l6502	2857	11-Feb-18	11-Feb-19
3903	Microwave Cable Assembly, 40.0 GHz, 1.5 m, SMA/SMA	Huber-Suhner	SUCOFLEX 102A	1226/2A	07-Feb-18	07-Feb-19
4355	Signal and Spectrum Analyzer, 9 kHz to 7 GHz	Rohde & Schwarz	FSV 7	101630	28-Jun-18	28-Sep-19
4360	EMI Test Receiver, 20 Hz to 40 GHz	Rohde & Schwarz	ESU40	100322	31-Dec-18	31-Dec-19
4933	Active Horn Antenna, 1 GHz to 18 GHz	COM-POWER CORPORATION	AHA-118	701046	06-Jan-19	06-Jan-20
4956	Active horn antenna, 18 to 40 GHz	COM-POWER CORPORATION	AHA-840	105004	25-Jan-19	25-Jan-20
5111	RF cable, 40 GHz, 5.5 m, K-type	Huber-Suhner	SF102EA/11SK/ 11SK/5500MM	502493/2EA	09-Apr-18	09-Apr-19
5288	Trilog Antenna, 25 MHz - 8 GHz, 100W	Frankonia	ALX-8000E	809	21-Jan-18	21-Jan-19
5405	RF cable, 18 GHz, N-N, 6 m	Huber-Suhner	SF118/11N (x2)	500023/118	01-Aug-18	01-Aug-19

11 APPENDIX C Test equipment correction factors

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

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

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

The antenna factor shall be added to receiver reading in dBμV to obtain field strength in dBμA/m.

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

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

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

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

HL 4956: Active Horn Antenna
COM-POWER Corp., model: AHA-840, s/n 105004

Frequency, MHz	Measured antenna factor, dB/m
18000	5.1
18500	3.6
19000	2.2
19500	0.7
20000	0.7
20500	0.8
21000	0.5
21500	-1.3
22000	-2.1
22500	-2.0
23000	-1.6
23500	-2.9
24000	-2.3
24500	-2.6
25000	-1.8
25500	-1.2
26000	-0.5
26500	-1.2
27000	-0.1
27500	-1.0
28000	-0.7
28500	0.5

Frequency, MHz	Measured antenna factor, dB/m
29500	1.4
30000	2.9
30500	2.9
31000	2.9
31500	1.2
32000	0.7
32500	0.2
33000	-1.7
33500	-2.2
34000	2.3
34500	-1.1
35000	0.7
35500	-1.1
36000	0.1
36500	1.4
37000	3.7
37500	5.8
38000	6.6
38500	7.3
39000	6.5
39500	7.3
40000	7.1

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

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

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 dBμV to obtain field strength in dBμV/m.

HL 5111: RF cable

Huber-Suhner, SF102EA/11SK/11SK/5500MM, s/n 502493/2EA

Set / Applied, MHz	Measured, dB	Uncertainty, dB
100	0.70	±0.07
200	0.99	±0.08
300	1.21	±0.08
500	1.56	±0.08
1000	2.20	±0.08
1500	2.69	±0.08
2000	3.11	±0.08
2500	3.50	±0.10
3000	3.85	±0.10
3500	4.16	±0.10
4000	4.47	±0.10
4500	4.74	±0.10
5000	5.03	±0.10
5500	5.30	±0.10
6000	5.57	±0.10
6500	5.76	±0.10
7000	6.00	±0.10
7500	6.20	±0.10
8000	6.44	±0.10
8500	6.67	±0.10
9000	6.82	±0.10
9500	7.04	±0.10
10000	7.18	±0.10
10500	7.36	±0.10
11000	7.55	±0.10
11500	7.75	±0.10
12000	7.90	±0.10
12500	8.08	±0.13
13000	8.19	±0.13
13500	8.39	±0.13
14000	8.58	±0.13
14500	8.76	±0.18
15000	8.92	±0.18
15500	9.03	±0.18
16000	9.18	±0.18
16500	9.34	±0.18
17000	9.51	±0.18
17500	9.66	±0.18
18000	9.80	±0.18
18500	9.94	±0.23
19000	10.05	±0.23
19500	10.22	±0.23

Set / Applied, MHz	Measured, dB	Uncertainty, dB
20000	10.32	±0.23
20500	10.48	±0.23
21000	10.60	±0.23
21500	10.73	±0.23
22000	10.87	±0.23
22500	10.97	±0.29
23000	11.09	±0.29
23500	11.26	±0.29
24000	11.37	±0.29
24500	11.50	±0.29
25000	11.61	±0.23
25500	11.72	±0.23
26000	11.87	±0.23
26500	11.99	±0.23
27000	12.09	±0.33
27500	12.24	±0.33
28000	12.34	±0.40
28500	12.47	±0.40
29000	12.61	±0.40
29500	12.70	±0.40
30000	12.86	±0.40
30500	12.92	±0.33
31000	13.09	±0.33
31500	13.16	±0.33
32000	13.33	±0.33
32500	13.40	±0.33
33000	13.62	±0.33
33500	13.70	±0.33
34000	13.88	±0.33
34500	13.97	±0.40
35000	14.05	±0.40
35500	14.23	±0.40
36000	14.25	±0.40
36500	14.46	±0.40
37000	14.49	±0.33
37500	14.72	±0.33
38000	14.77	±0.33
38500	14.97	±0.33
39000	15.04	±0.33
39500	15.22	±0.33
40000	15.63	±0.47

12 APPENDIX D Measurement uncertainties

Expanded uncertainty at 95% confidence in Hermon Labs EMC measurements

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

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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.

13 APPENDIX E Specification references

FCC 47CFR part 15: 2017	Radio Frequency Devices
ANSI C63.10: 2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
KDB 558074 D01 15.247 Meas Guidance v05:2018	Guidance for Compliance Measurements on Digital Transmission System, Frequency Hopping Spread Spectrum System, and Hybrid System Devices Operating under Section 15.247 of the FCC Rules
ANSI C63.2: 1996	American National Standard for Instrumentation-Electromagnetic Noise and Field Strength, 10 kHz to 40 GHz-Specifications
ANSI C63.4: 2014	American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
RSS-247 Issue 2: 2017	Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) Devices
RSS-Gen Issue 5: 2018	General Requirements for Compliance of Radio Apparatus

14 APPENDIX F Abbreviations and acronyms

A	ampere
AC	alternating current
A/m	ampere per meter
AM	amplitude modulation
ASSL	abnormal steady state limits
ATP	acceptance test procedure
AVRG	average (detector)
BB	broad band
cm	centimeter
dB	decibel
dBm	decibel referred to one milliwatt
dB(μA)	decibel referred to one microampere
dBμV	decibel referred to one microvolt
dBμV/m	decibel referred to one microvolt per meter
DC	direct current
EMI	electromagnetic interference
ESS	environmental stress screening
ESSL	emergency steady state limits
EUT	equipment under test
FTE	functional test equipment
GHz	gigahertz
GND	ground
H	height
HL	Hermon laboratories
Hz	hertz
k	kilo
kHz	kilohertz
kV	kilovolt
L	length
LISN	line impedance stabilization network
m	meter
MHz	megahertz
MIL	military
mm	millimeter
ms	millisecond
μF	microfarad
μs	microsecond
NA	not applicable
NB	narrow band
NP	normal performance
NSSL	normal steady state limits
NT	not tested
OATS	open area test site
Ω	Ohm
QP	quasi-peak
PBIT	periodic built in test
PM	pulse modulation
PS	power supply
RE	radiated emission
RF	radio frequency
rms	root mean square
s	second
STD	standard
TBD	to be defined
V	volt
VA	volt-ampere
W	width
W	watt

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