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ELECTRICAL TESTING
0839.01

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TEST REPORT

ACCORDING TO:

FCC 47CFR part 15 subpart C § 15.247 (DTS) and subpart B

FOR:

Somatix Technologies Ltd.

Gesture-detection smartband by Somatix

Model: SB01

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

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Telephone:	+972 54 493 3183
E-mail:	eyall@somatix.com
Contact name:	Mr. Eyal Lasko

2 Equipment under test attributes

Product name:	Gesture-detection smartband by Somatix
Product type:	Transceiver
Model(s):	SB01
Serial number:	8800127
Hardware version:	2.1
Software release:	SmokeBeat – 0.7.39; SafeBeing – 0.2.8
Condition of equipment:	New
Receipt date	01-May-19

3 Manufacturer information

Manufacturer name:	Somatix Technologies Ltd.
Address:	16 HaHaroshet St., P.O.B. 4423, Raanana 4365708, Israel
Telephone:	+972 54 493 3183
E-Mail:	eyall@somatix.com
Contact name:	Mr. Eyal Lasko

4 Test details

Project ID:	32990
Location:	Hermon Laboratories Ltd. P.O. Box 23, Binyamina 3055001, Israel
Test started:	28-Apr-19
Test completed:	01-May-19
Test specification(s):	FCC 47CFR part 15 subpart C § 15.247 (DTS) and subpart B

5 Tests summary

Test	Status
FCC 47CFR part 15 subpart C (DTS) and subpart B	
Transmitter characteristics	
Section 15.247(a)2, 6 dB bandwidth	Pass
Section 15.247(d), Radiated spurious emissions	Pass
Section 15.247(b)3, Peak output power	Pass
Section 15.247(b)5, RF exposure	Pass *
Section 15.247(d), Band edge emissions	Pass
Section 15.247(d), Peak power density	Pass
Section 15.203, Antenna requirements	Pass
Section 15.207(a), Conducted emission	Pass
Unintentional emissions	
Section 15.107, Conducted emission at AC power port	Pass
Section 15.109, Radiated emission	Pass

* - Pass, the exhibit to the application of certification is provided.

This test report supersedes the previously issued test report identified by Doc ID:SOMRAD_FCC.32990.

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	28-Apr-19 – 07-May-19	
Reviewed by:	Mrs. Y. Rapin, Technical Writer	11-Sep-19	
Approved by:	Sergey Samokha, Technical Manager, EMC & Radio	11-Sep-19	

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, Somatix smartband SB01, is a wireless wrist-worn bracelet comprising accelerometer and gyroscope sensors and Bluetooth Low Energy (BLE) radio. The EUT is powered from 3.7 V rechargeable battery. The EUT can run and/or switch between several variants of software on the same electronic circuitry [depending on customer requirements].

6.2 EUT options/configurations

Number	Operating mode description	Configuration
1	operating + charging	smartband sends information via BLE and powered via external PS

6.3 Ports and lines

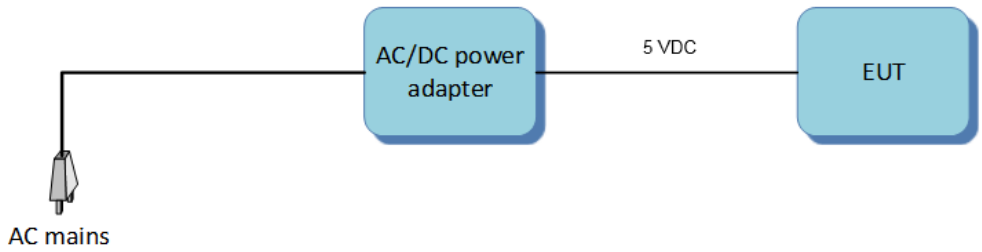
Port type	Port description	Conn. from	Conn. to	Qty.	Cable type	Cable length
Power	AC power input	AC mains	PS	1	Unshielded	1.8 m
Power	DC power input	PS	EUT	1	Shielded	1.0 m

6.4 Auxiliary equipment

Description	Manufacturer	Model number	Serial number
Laptop	Dell	Latitude 5580	6FN7BH2
Power supply adapter	Any 5VDC, 2A max rating; safety approved according to IEC/EN/UL 60950-1		
BLE USB dongle	Nordic semiconductors	nRF51-Dongle	NA

6.5 Test configuration

6.5.1 Charging mode



6.5.2 Operation mode

6.6 Transmitter characteristics

Type of equipment	
	Stand-alone (Equipment with or without its own control provisions)
X	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
	mobile	Always at a distance more than 20 cm from all people
X	portable	May operate at a distance closer than 20 cm to human body

Assigned frequency range	2400.0 – 2483.5 MHz
Operating frequency range	2402.0 – 2480.0 MHz

Maximum rated output power		
	At transmitter 50 Ω RF output connector	NA
	Peak output power	-20.76 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

Antenna/s technical characteristics			
Type	Manufacturer	Model number	Gain
Low Profile Mini Chip Antenna	Johanson Technology	2450AT42E0100	-2 dBi

Type of modulation	GFSK
Modulating test signal (baseband)	PRBS

Transmitter power source					
X	Battery	**Nominal rated voltage**	3.7 VDC	Battery type	LiIon polymer
	DC	**Nominal rated voltage**	VDC		
	AC mains	**Nominal rated voltage**		Frequency	

Common power source for transmitter and receiver	X	yes		no

Spread spectrum technique used		
		Frequency hopping (FHSS)
	X	Digital transmission system (DTS)
		Hybrid

Test specification:	FCC 47 CFR Section 15.247(a)2, 6 dB bandwidth		
Test procedure:	ANSI C63.10 section 11.8.1		
Test mode:	Compliance	Verdict:	PASS
Date(s):	28-Apr-19		
Temperature: 25 ºC	Relative Humidity: 45 %	Air Pressure: 1014 hPa	Power: 3.7 VDC
Remarks:			

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

7.1 Minimum 6 dB bandwidth

7.1.1 General

This test was performed to measure 6 dB bandwidth of the EUT carrier frequency. Specification test limits are given in Table 7.1.1.

Table 7.1.1 The 6 dB bandwidth limits

Assigned frequency, MHz	Modulation envelope reference points*, dBc	Minimum bandwidth, kHz
902.0 – 928.0	6.0	500.0
2400.0 – 2483.5		
5725.0 – 5850.0		

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

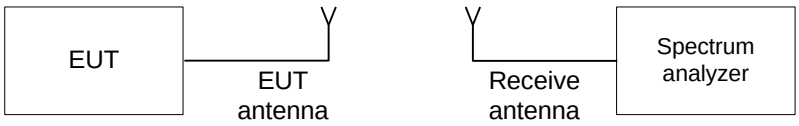
7.1.2 Test procedure

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.

7.1.2.3 The transmitter minimum 6 dB 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.

Figure 7.1.1 The 6 dB bandwidth test setup



Test specification:	**FCC 47 CFR Section 15.247(a)2, 6 dB bandwidth**		
Test procedure:	ANSI C63.10 section 11.8.1		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	28-Apr-19		
Temperature: 25 ºC	**Relative Humidity:** 45 %	**Air Pressure:** 1014 hPa	**Power:** 3.7 VDC
Remarks:			

Table 7.1.2 The 6 dB bandwidth test results

ASSIGNED FREQUENCY BAND:	2400.0 – 2483.5 MHz
DETECTOR USED:	Peak
SWEEP MODE:	Max Hold
SWEEP TIME:	Auto
RESOLUTION BANDWIDTH:	10 kHz
VIDEO BANDWIDTH:	30 kHz
MODULATION ENVELOPE REFERENCE POINTS:	6.0 dBc
MODULATION:	GFSK
MODULATING SIGNAL:	PRBS

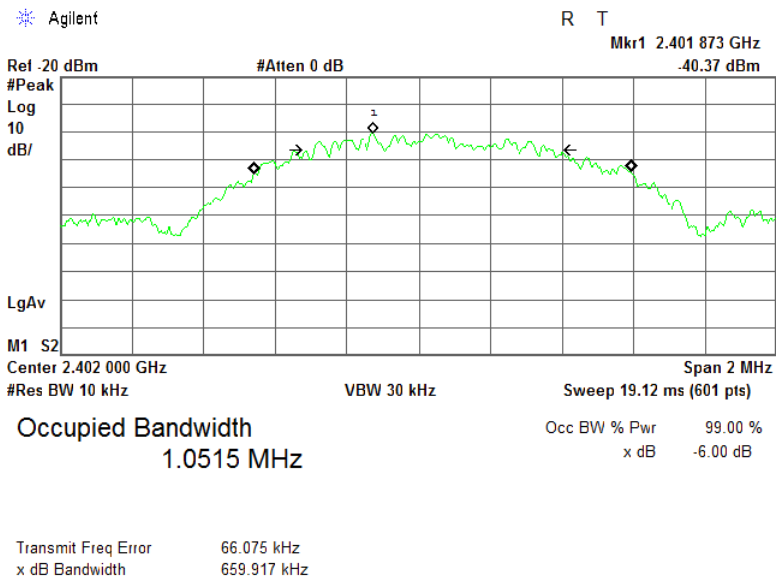
Carrier frequency, MHz	6 dB bandwidth, kHz	Limit, kHz	Margin, kHz	Verdict
Low frequency				
2402.0	659.9	500.0	159.9	Pass
Mid frequency				
2442.0	662.6	500.0	162.6	Pass
High frequency				
2480.0	662.3	500.0	162.3	Pass

Reference numbers of test equipment used

HL 3818	HL 3903	HL 4933	HL 5405					

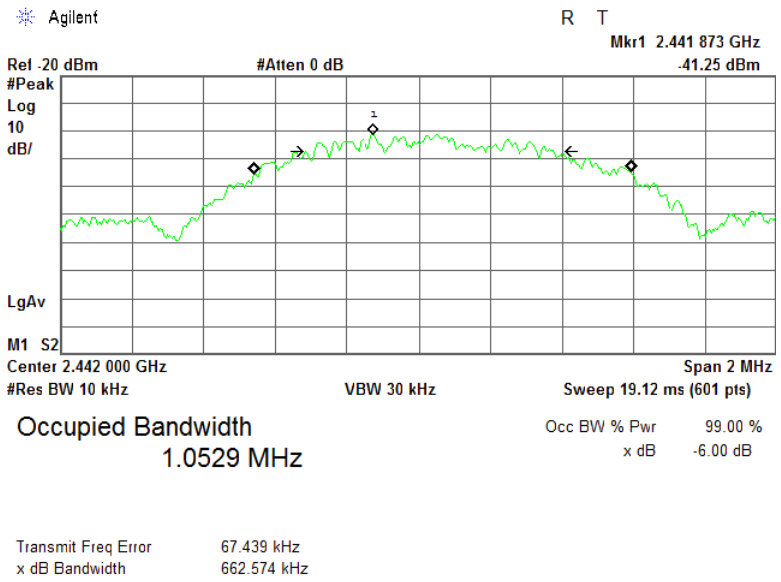
Full description is given in Appendix A.

Plot 7.1.1 The 6 dB bandwidth test result at low frequency

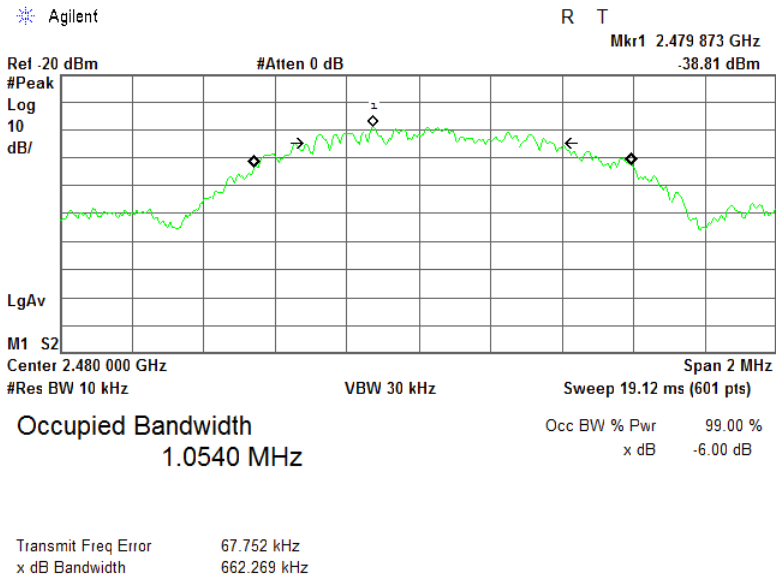


Test specification:	FCC 47 CFR Section 15.247(a)2, 6 dB bandwidth		
Test procedure:	ANSI C63.10 section 11.8.1		
Test mode:	Compliance	Verdict:	PASS
Date(s):	28-Apr-19		
Temperature: 25 ºC	Relative Humidity: 45 %	Air Pressure: 1014 hPa	Power: 3.7 VDC
Remarks:			

Plot 7.1.2 The 6 dB bandwidth test result at mid frequency



Plot 7.1.3 The 6 dB bandwidth test result at high frequency



Test specification:	Section 15.247(b)3, Peak output power		
Test procedure:	ANSI C63.10 section 11.9.1.1		
Test mode:	Compliance	Verdict:	PASS
Date(s):	28-Apr-19		
Temperature: 25 ºC	Relative Humidity: 45 %	Air Pressure: 1014 hPa	Power: 3.7 VDC
Remarks:			

7.2 Peak output power

7.2.1 General

This test was performed to measure the maximum peak output power radiated by transmitter. Specification test limits are given in Table 7.2.1.

Table 7.2.1 Peak output power limits

Assigned frequency range, MHz	Maximum antenna gain, dBi	Peak output power*		Equivalent field strength limit @ 3m, dB(μV/m)**
		W	dBm	
902.0 – 928.0	6.0	1.0	30.0	131.2
2400.0 – 2483.5				
5725.0 – 5850.0				

*- 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.

**- Equivalent field strength limit was calculated from the peak output power as follows: E=sqrt(30×P×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.

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

7.2.2.3 The resolution bandwidth of spectrum analyzer was set wider than 6 dB bandwidth of the EUT and the field strength of the EUT carrier frequency was measured with antenna connected to spectrum analyzer/ EMI receiver. To find maximum radiation the turntable was rotated 360^0 and the measuring antenna height was swept in both vertical and horizontal polarizations.

7.2.2.4 The maximum field strength of the EUT carrier frequency was measured as provided in Table 7.2.2 and associated plots.

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

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

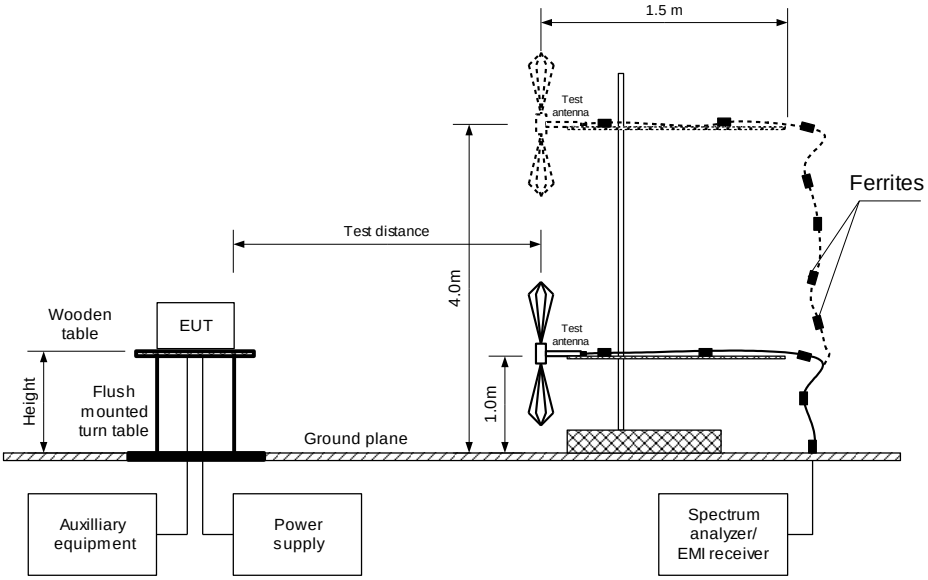
where P is the peak output power in W, E is the field strength in V/m, d is the test distance and G is the transmitter numeric antenna gain over an isotropic radiator.
The above equation was converted in logarithmic units for 3 m test distance:

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

7.2.2.6 The worst test results (the lowest margins) were recorded in Table 7.2.2.

Test specification:	Section 15.247(b)3, Peak output power		
Test procedure:	ANSI C63.10 section 11.9.1.1		
Test mode:	Compliance	Verdict:	PASS
Date(s):	28-Apr-19		
Temperature: 25 ºC	Relative Humidity: 45 %	Air Pressure: 1014 hPa	Power: 3.7 VDC
Remarks:			

Figure 7.2.1 Setup for carrier field strength measurements



Test specification:	**Section 15.247(b)3, Peak output power**		
Test procedure:	ANSI C63.10 section 11.9.1.1		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	28-Apr-19		
Temperature: 25 ºC	**Relative Humidity:** 45 %	**Air Pressure:** 1014 hPa	**Power:** 3.7 VDC
Remarks:			

Table 7.2.2 Peak output power test results

ASSIGNED FREQUENCY: 2400.0 – 2483.5 MHz
TEST DISTANCE: 3 m
TEST SITE: Semi anechoic chamber
EUT HEIGHT: 1.5 m
DETECTOR USED: Peak
TEST ANTENNA TYPE: Double ridged guide (above 1000 MHz)
MODULATION: GFSK
MODULATING SIGNAL: PRBS
TRANSMITTER OUTPUT POWER SETTINGS: Maximum
DETECTOR USED: Peak
RESOLUTION BANDWIDTH: 1 MHz
VIDEO BANDWIDTH: 3 MHz

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
2402.285	71.66	Horizontal	1.4	0	-2.0	-21.54	30.0	-51.54	Pass
2442.280	71.38	Horizontal	1.3	0	-2.0	-21.82	30.0	-51.82	Pass
2479.810	72.44	Vertical	1.6	130	-2.0	-20.76	30.0	-50.76	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.
Note: Maximum peak output power was obtained at Unom (115%Unom, 85%Unom) input power voltage.

Reference numbers of test equipment used

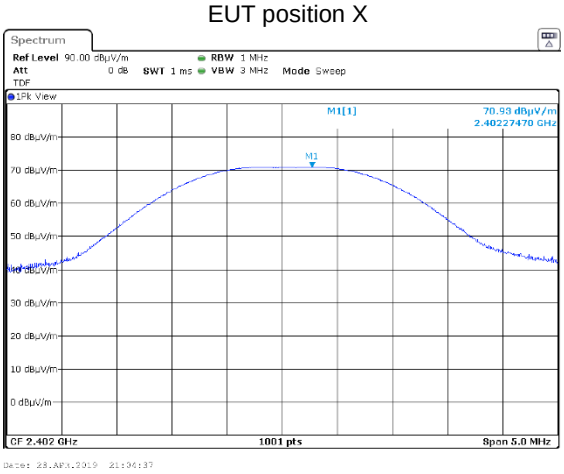
HL 3903	HL 4355	HL 4933	HL 5405				

Full description is given in Appendix A.

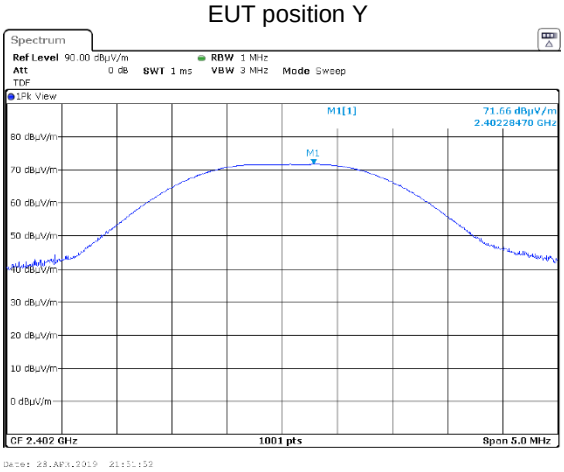
Test specification:	Section 15.247(b)3, Peak output power		
Test procedure:	ANSI C63.10 section 11.9.1.1		
Test mode:	Compliance	Verdict:	PASS
Date(s):	28-Apr-19		
Temperature: 25 ºC	Relative Humidity: 45 %	Air Pressure: 1014 hPa	Power: 3.7 VDC
Remarks:			

Plot 7.2.1 Field strength of carrier at low frequency

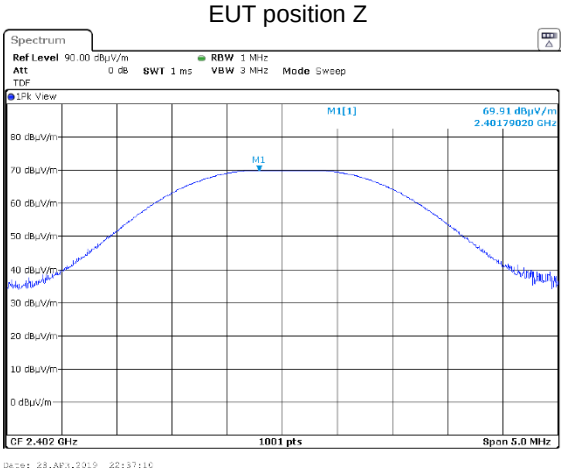
EUT position X



EUT position Y



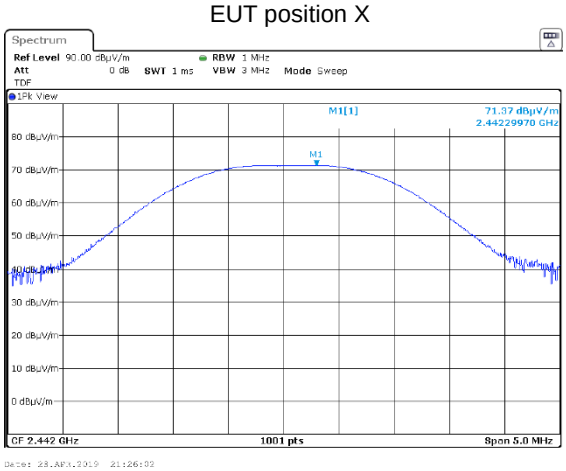
EUT position Z



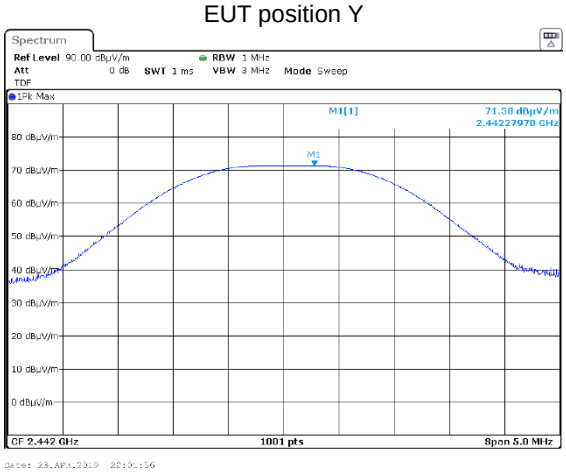
Test specification:	Section 15.247(b)3, Peak output power		
Test procedure:	ANSI C63.10 section 11.9.1.1		
Test mode:	Compliance	Verdict:	PASS
Date(s):	28-Apr-19		
Temperature: 25 ºC	Relative Humidity: 45 %	Air Pressure: 1014 hPa	Power: 3.7 VDC
Remarks:			

Plot 7.2.2 Field strength of carrier at mid frequency

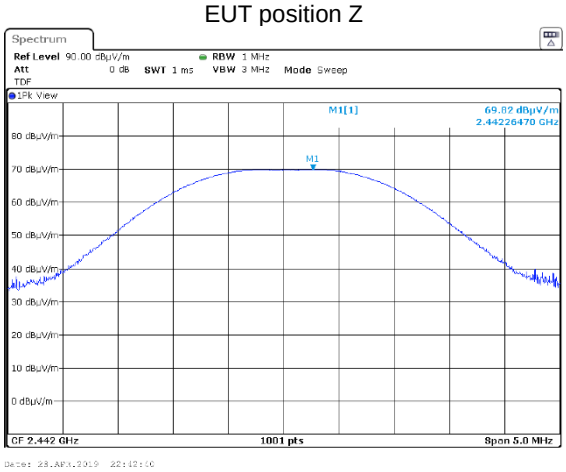
EUT position X



EUT position Y



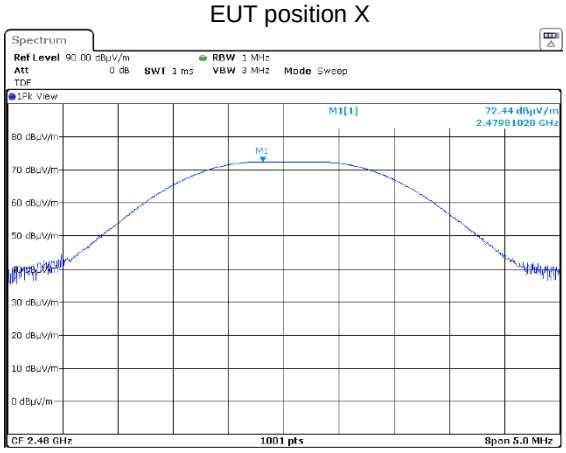
EUT position Z



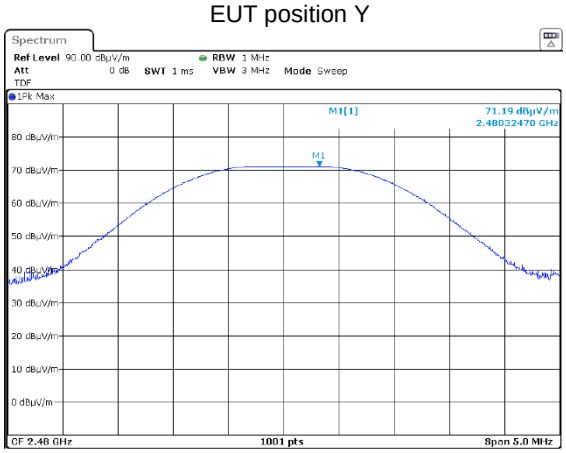
Test specification:	Section 15.247(b)3, Peak output power		
Test procedure:	ANSI C63.10 section 11.9.1.1		
Test mode:	Compliance	Verdict:	PASS
Date(s):	28-Apr-19		
Temperature: 25 ºC	Relative Humidity: 45 %	Air Pressure: 1014 hPa	Power: 3.7 VDC
Remarks:			

Plot 7.2.3 Field strength of carrier at high frequency

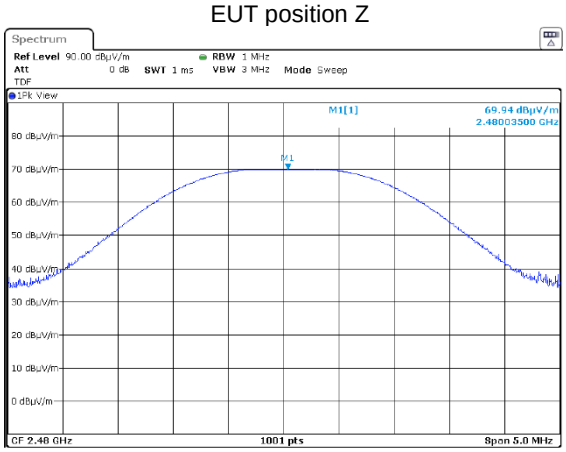
EUT position X



EUT position Y



EUT position Z



Test specification:	Section 15.247(d), Radiated spurious emissions		
Test procedure:	ANSI C63.10 section 11.12.1		
Test mode:	Compliance	Verdict:	PASS
Date(s):	28-Apr-19		
Temperature: 25 ºC	Relative Humidity: 45 %	Air Pressure: 1014 hPa	Power: 3.7 VDC
Remarks:			

7.3 Field strength of spurious emissions

7.3.1 General

This test was performed to measure field strength of spurious emissions from the EUT. Specification test limits are given in Table 7.3.1.

Table 7.3.1 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 – 10th harmonic	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 10th harmonic of the highest fundamental frequency.

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

7.3.2.1 The EUT was set up as shown in Figure 7.3.1, energized and the performance check was conducted.

7.3.2.2 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.

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

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

7.3.3.1 The EUT was set up as shown in Figure 7.3.2, Figure 7.3.3, energized and the performance check was conducted.

7.3.3.2 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.

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

Test specification:	Section 15.247(d), Radiated spurious emissions		
Test procedure:	ANSI C63.10 section 11.12.1		
Test mode:	Compliance	Verdict:	PASS
Date(s):	28-Apr-19		
Temperature: 25 ºC	Relative Humidity: 45 %	Air Pressure: 1014 hPa	Power: 3.7 VDC
Remarks:			

Figure 7.3.1 Setup for spurious emission field strength measurements below 30 MHz

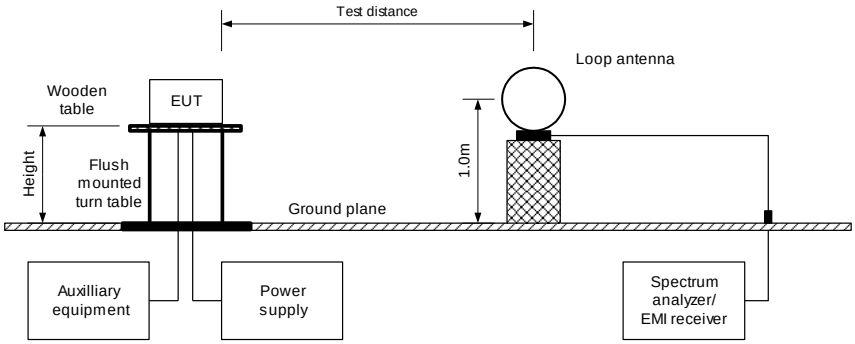


Figure 7.3.2 Setup for spurious emission field strength measurements in 30 – 1000 MHz

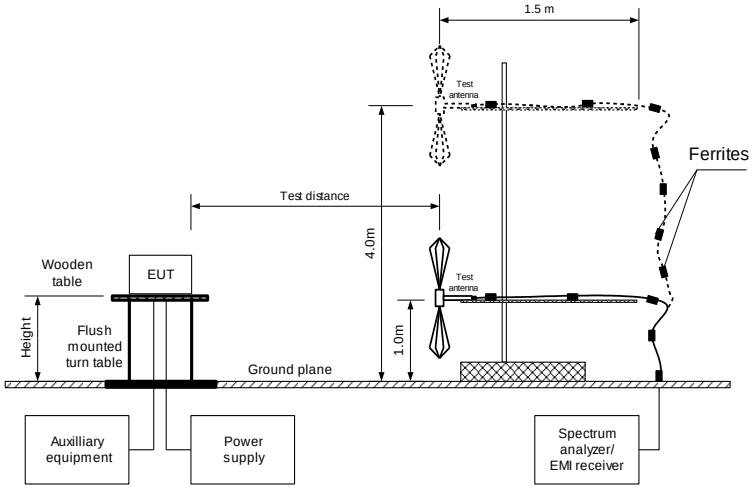
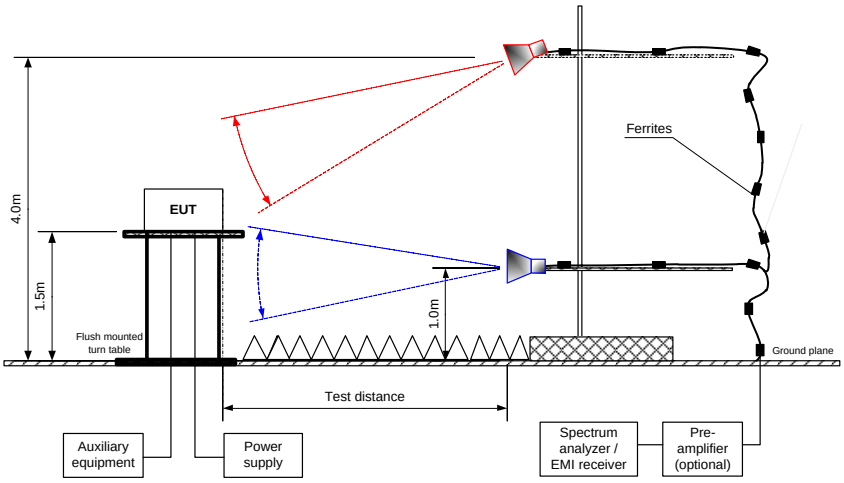


Figure 7.3.3 Setup for spurious emission field strength measurements above 1000 MHz



Test specification:	Section 15.247(d), Radiated spurious emissions		
Test procedure:	ANSI C63.10 section 11.12.1		
Test mode:	Compliance	Verdict:	PASS
Date(s):	28-Apr-19		
Temperature: 25 ºC	Relative Humidity: 45 %	Air Pressure: 1014 hPa	Power: 3.7 VDC
Remarks:			

Table 7.3.2 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: GFSK
MODULATING SIGNAL: PRBS
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, 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									
48.011	37.71	Vertical	1.33	71	71.52	33.81	20.0	13.81	Pass
60.013	30.23	Vertical	1.33	204		41.29		21.29	
72.017	28.72	Vertical	1.02	155		42.80		22.80	
7206.875	48.43	Horizontal	1.28	168		23.09		3.09	
Mid carrier frequency									
48.011	37.71	Vertical	1.33	71	70.68	32.97	20.0	12.97	Pass
60.013	30.23	Vertical	1.33	204		40.45		20.45	
72.017	28.72	Vertical	1.02	155		41.96		21.96	
High carrier frequency									
48.011	37.71	Vertical	1.33	71	72.29	34.58	20.0	14.58	Pass
60.013	30.23	Vertical	1.33	204		42.06		22.06	
72.017	28.72	Vertical	1.02	155		43.57		23.57	

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

Table 7.3.3 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: GFSK
MODULATING SIGNAL: PRBS
DUTY CYCLE: 100 %
TRANSMITTER OUTPUT POWER SETTINGS: Maximum
DETECTOR USED: Peak
RESOLUTION BANDWIDTH: 1000 kHz
TEST ANTENNA TYPE: Double ridged guide

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)	Limit, dB(μV/m)	Margin, dB**	
Low carrier frequency										
4804.380	Horizontal	1.28	196	47.90	74.0	-26.10	37.70	54.0	-16.30	Pass
Mid carrier frequency										
4884.335	Horizontal	1.02	319	45.88	74.0	-28.12	33.58	54.0	-20.42	Pass
High carrier frequency										
4959.422	Horizontal	1.02	223	46.69	74.0	-27.31	34.80	54.0	-19.20	Pass
7439.715	Vertical	1.02	232	48.29	74.0	-25.71	34.72	54.0	-19.28	

*****- EUT front panel refers to 0 degrees position of turntable.
******- Margin = Measured field strength - specification limit.

Test specification:	Section 15.247(d), Radiated spurious emissions		
Test procedure:	ANSI C63.10 section 11.12.1		
Test mode:	Compliance	Verdict:	PASS
Date(s):	28-Apr-19		
Temperature: 25 ºC	Relative Humidity: 45 %	Air Pressure: 1014 hPa	Power: 3.7 VDC
Remarks:			

Table 7.3.4 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:	GFSK
MODULATING SIGNAL:	PRBS
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, 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 frequencies								
120.009	41.68	40.04	43.5	-3.46	Vertical	1.02	162	Pass
240.023	37.64	36.25	46.0	-9.75	Vertical	1.02	180	

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

Table 7.3.5 Restricted bands

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	

Reference numbers of test equipment used

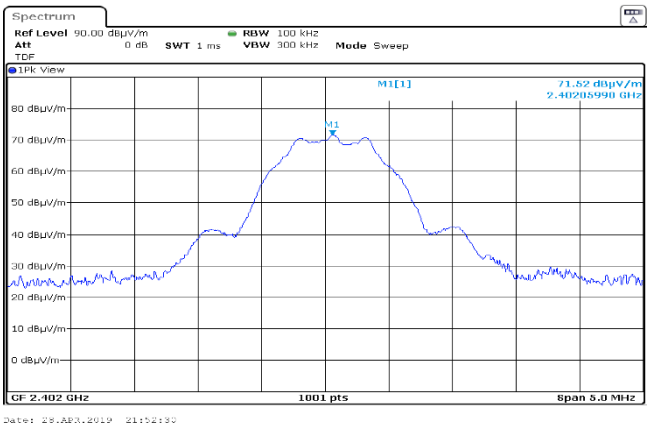
HL 0446	HL 3903	HL 4360	HL 4933	HL 4956	HL 5111	HL 5288	HL 5405

Full description is given in Appendix A.

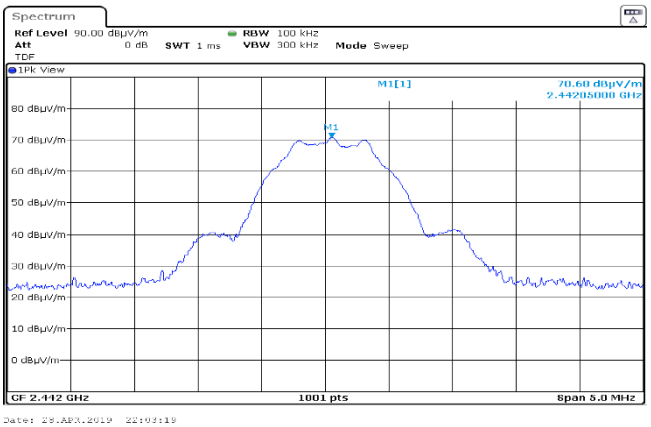
Test specification:	Section 15.247(d), Radiated spurious emissions		
Test procedure:	ANSI C63.10 section 11.12.1		
Test mode:	Compliance	Verdict:	PASS
Date(s):	28-Apr-19		
Temperature: 25 ºC	Relative Humidity: 45 %	Air Pressure: 1014 hPa	Power: 3.7 VDC
Remarks:			

Plot 7.3.1 Fundamental emission measurements

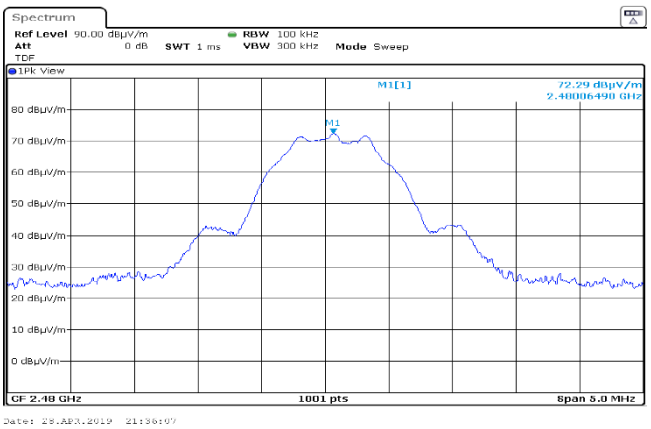
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and horizontal



LOW CARRIER FREQUENCY



MID CARRIER FREQUENCY

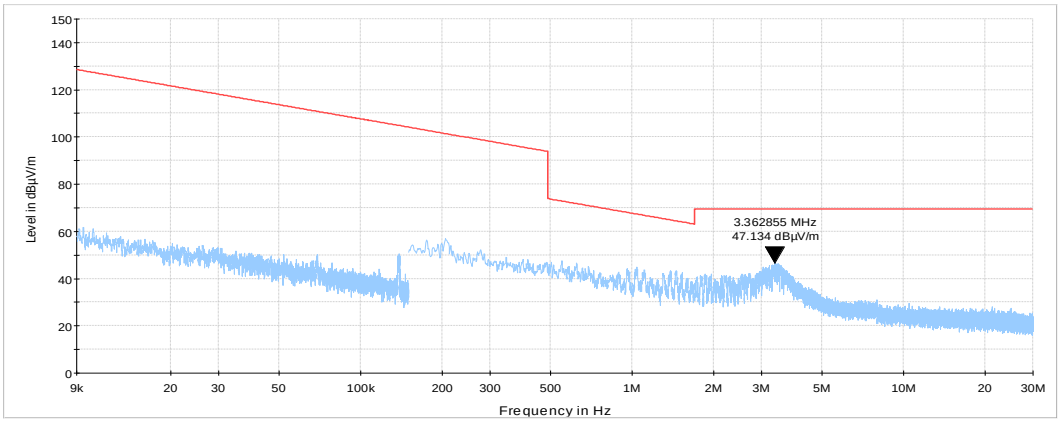


HIGH CARRIER FREQUENCY

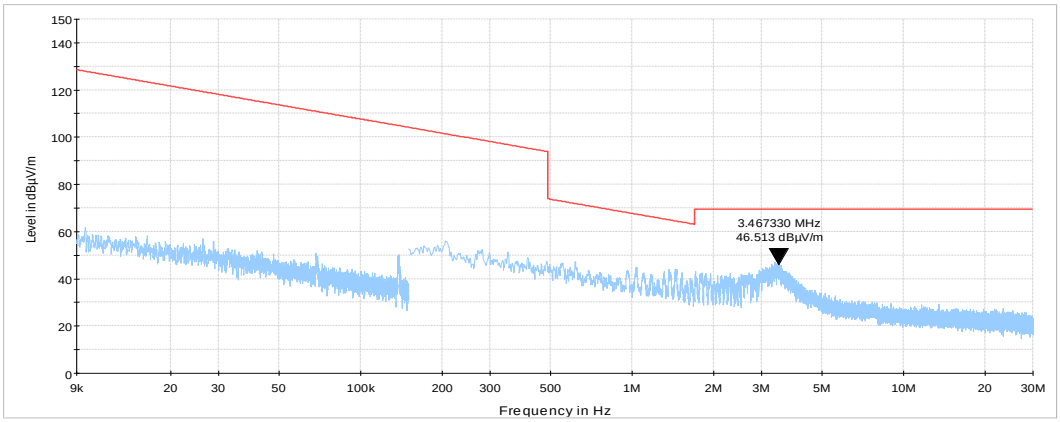
Test specification:	Section 15.247(d), Radiated spurious emissions		
Test procedure:	ANSI C63.10 section 11.12.1		
Test mode:	Compliance	Verdict:	PASS
Date(s):	28-Apr-19		
Temperature: 25 ºC	Relative Humidity: 45 %	Air Pressure: 1014 hPa	Power: 3.7 VDC
Remarks:			

Plot 7.3.2 Radiated emission measurements from 9 kHz to 30 MHz

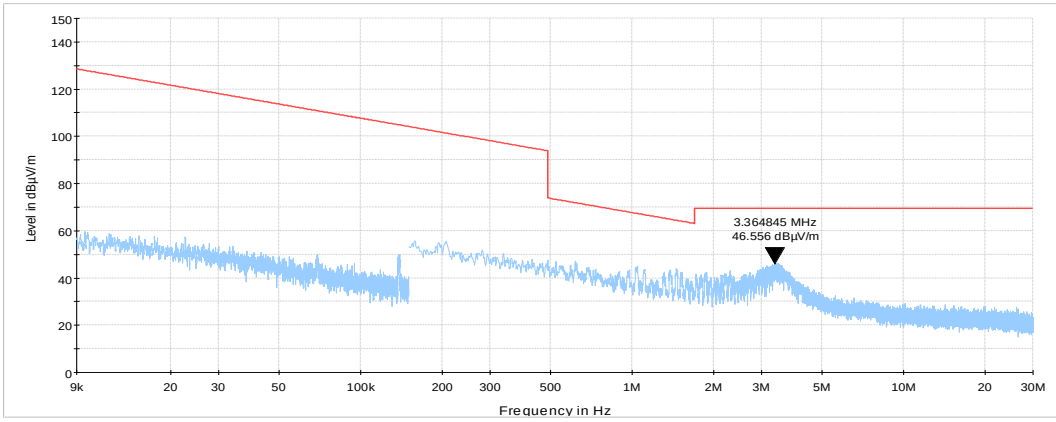
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical



LOW CARRIER FREQUENCY



MID CARRIER FREQUENCY

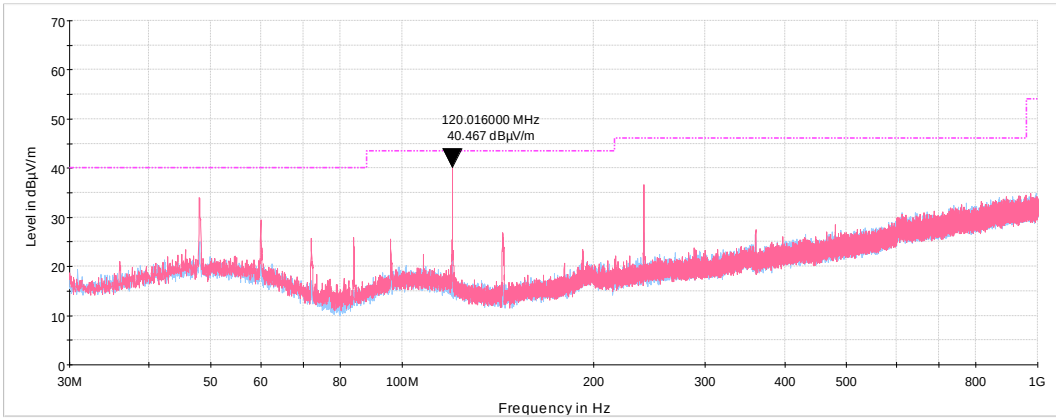


HIGH CARRIER FREQUENCY

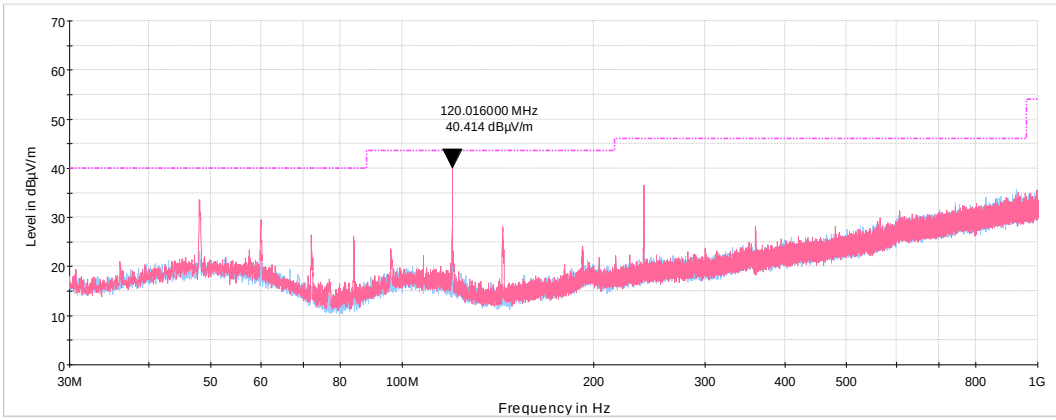
Test specification:	Section 15.247(d), Radiated spurious emissions		
Test procedure:	ANSI C63.10 section 11.12.1		
Test mode:	Compliance	Verdict:	PASS
Date(s):	28-Apr-19		
Temperature: 25 ºC	Relative Humidity: 45 %	Air Pressure: 1014 hPa	Power: 3.7 VDC
Remarks:			

Plot 7.3.3 Radiated emission measurements from 30 to 1000 MHz

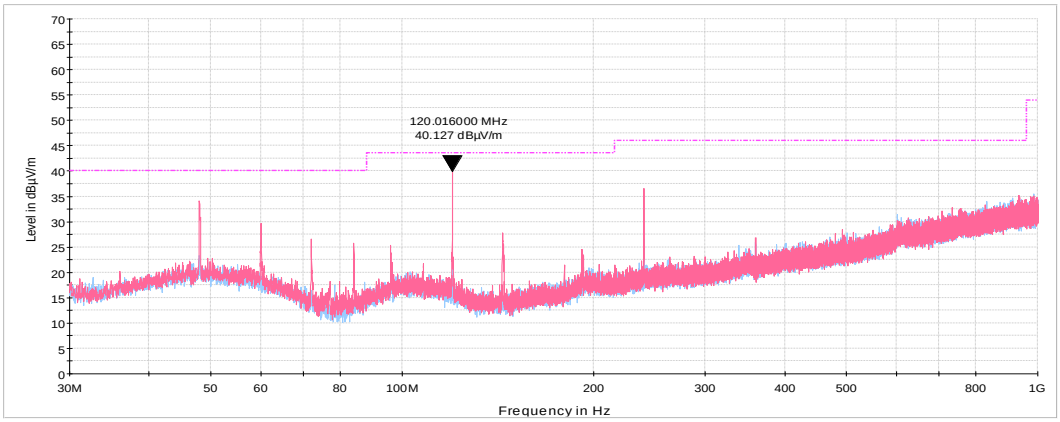
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal



LOW CARRIER FREQUENCY



MID CARRIER FREQUENCY

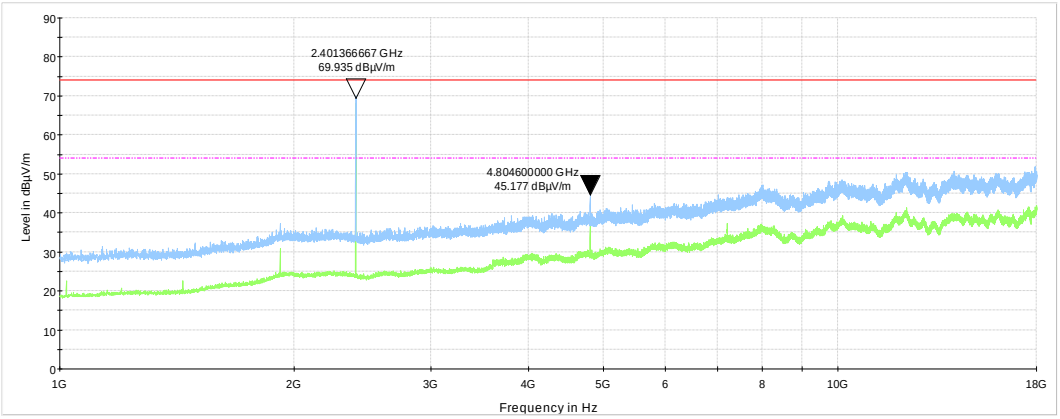


HIGH CARRIER FREQUENCY

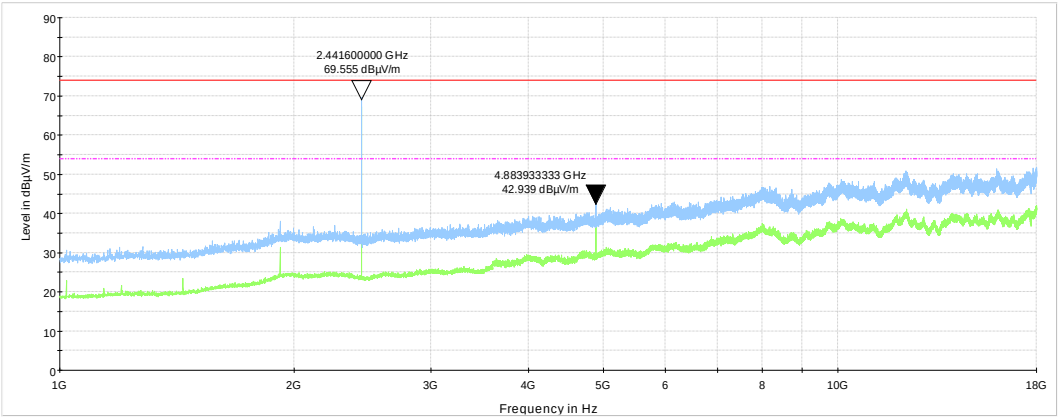
Test specification:	Section 15.247(d), Radiated spurious emissions		
Test procedure:	ANSI C63.10 section 11.12.1		
Test mode:	Compliance	Verdict:	PASS
Date(s):	28-Apr-19		
Temperature: 25 ºC	Relative Humidity: 45 %	Air Pressure: 1014 hPa	Power: 3.7 VDC
Remarks:			

Plot 7.3.4 Radiated emission measurements from 1 to 18 GHz

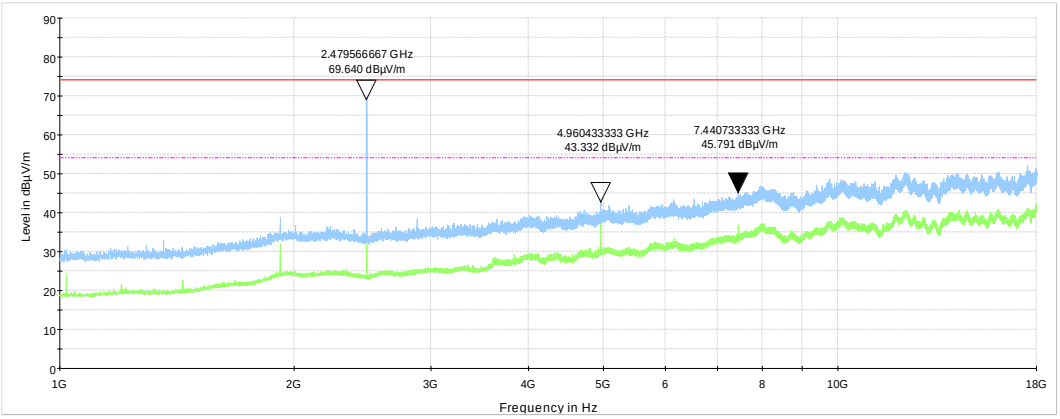
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal



LOW CARRIER FREQUENCY



MID CARRIER FREQUENCY

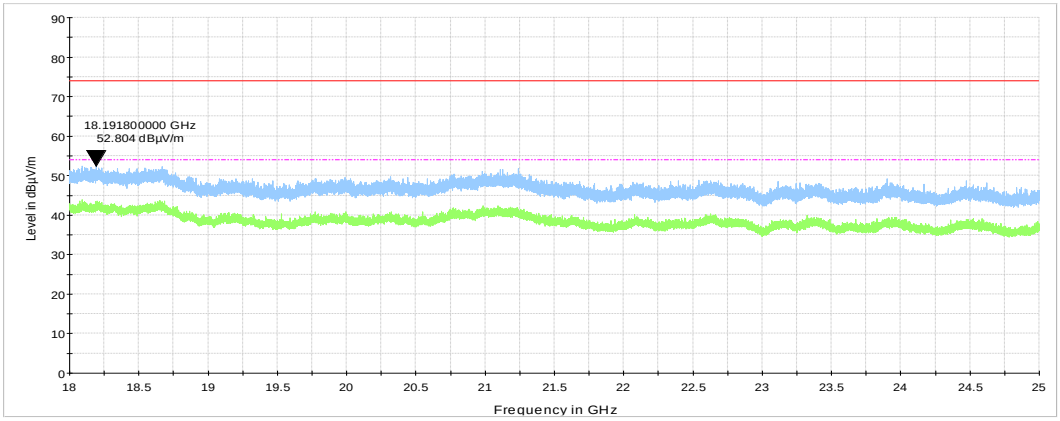


HIGH CARRIER FREQUENCY

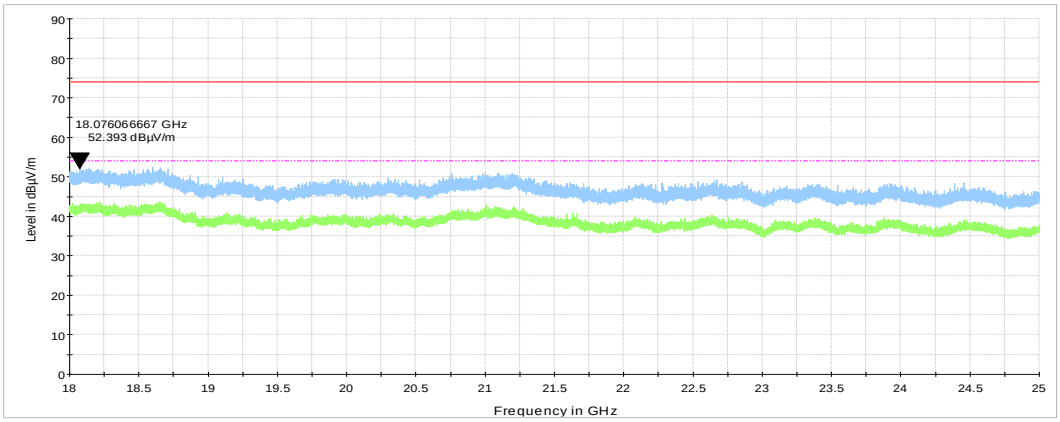
Test specification:	Section 15.247(d), Radiated spurious emissions		
Test procedure:	ANSI C63.10 section 11.12.1		
Test mode:	Compliance	Verdict:	PASS
Date(s):	28-Apr-19		
Temperature: 25 ºC	Relative Humidity: 45 %	Air Pressure: 1014 hPa	Power: 3.7 VDC
Remarks:			

Plot 7.3.5 Radiated emission measurements from 18 to 25 GHz

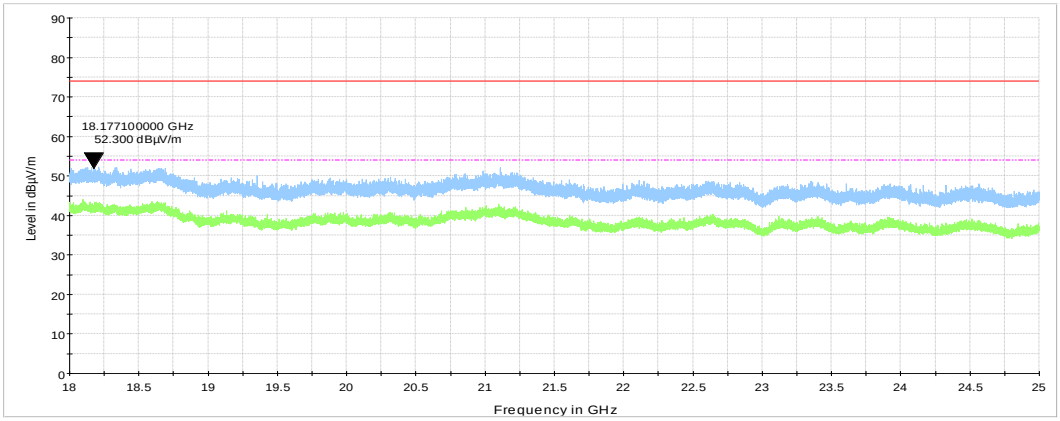
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal



LOW CARRIER FREQUENCY



MID CARRIER FREQUENCY



HIGH CARRIER FREQUENCY

Test specification:	Section 15.247(d), Band edge emissions		
Test procedure:	ANSI C63.10 section 11.12.1		
Test mode:	Compliance	Verdict:	PASS
Date(s):	29-Apr-19		
Temperature: 25 ºC	Relative Humidity: 45 %	Air Pressure: 1014 hPa	Power: 3.7 VDC
Remarks:			

7.4 Band edge radiated emissions

7.4.1 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 7.4.1.

Table 7.4.1 Band edge emission limits

Output power	Assigned frequency, MHz	Attenuation below carrier*, dBc	Field strength at 3 m within restricted bands, dB(μV/m)	
			Peak	Average
Peak	902.0 – 928.0	20.0	74.0	54.0
	2400.0 – 2483.5			
	5725.0 – 5850.0			
Averaged over a time interval	902.0 – 928.0	30.0	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.

7.4.2 Test procedure

7.4.2.1 The EUT was set up as shown in Figure 7.4.1, energized normally modulated at the maximum data rate and its proper operation was checked.

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

7.4.2.3 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.

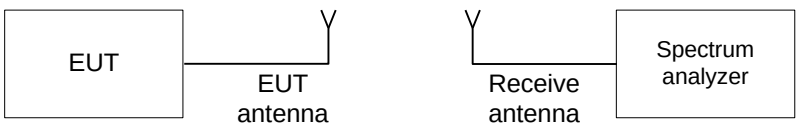
7.4.2.4 The spectrum analyzer was set in max hold mode and allowed trace to stabilize. The highest emission level within the authorized band was measured.

7.4.2.5 The maximum band edge emission and modulation product outside of the band were measured as provided in Table 7.4.2 and associated plots and referenced to the highest emission level measured within the authorized band.

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

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

Figure 7.4.1 Band edge emission test setup



Test specification:	**Section 15.247(d), Band edge emissions**		
Test procedure:	ANSI C63.10 section 11.12.1		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	29-Apr-19		
Temperature: 25 ºC	**Relative Humidity:** 45 %	**Air Pressure:** 1014 hPa	**Power:** 3.7 VDC
Remarks:			

Table 7.4.2 Band edge emission test results

ASSIGNED FREQUENCY RANGE: 2400.0 – 2483.5 MHz
DETECTOR USED: Peak
MODULATION: GFSK
MODULATING SIGNAL: PRBS
TRANSMITTER OUTPUT POWER SETTINGS: Maximum
TRANSMITTER OUTPUT POWER: - 21.54 dBm at low carrier frequency
- 20.76 dBm at high carrier frequency
RESOLUTION BANDWIDTH: ≥ 1% of the span
VIDEO BANDWIDTH: ≥ RBW

Frequency, MHz	Band edge emission, dBm	Emission at carrier, dBm	Attenuation below carrier, dBc	Limit, dBc	Margin, dB*	Verdict
No emissions were found						Pass

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

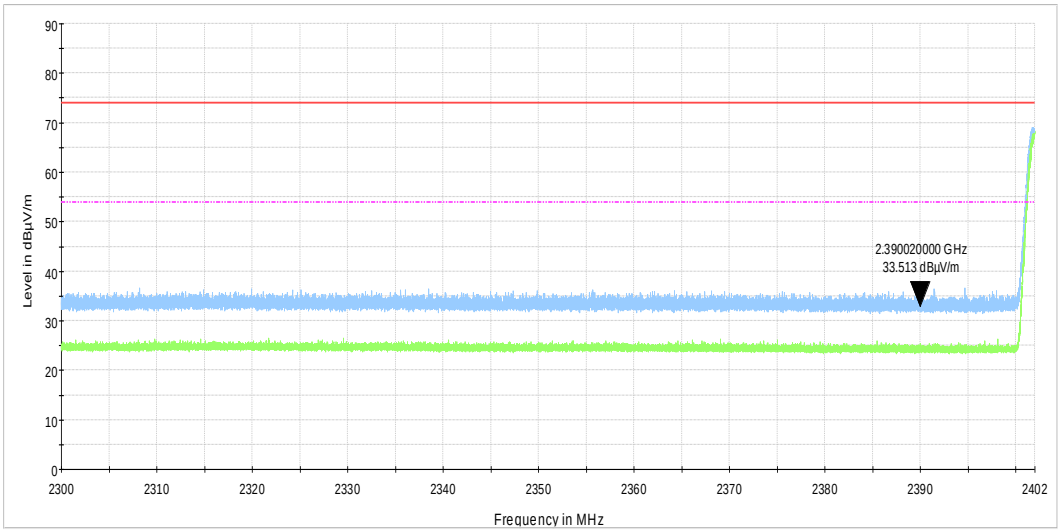
Reference numbers of test equipment used

HL 3903	HL 4360	HL 4933	HL 5405				

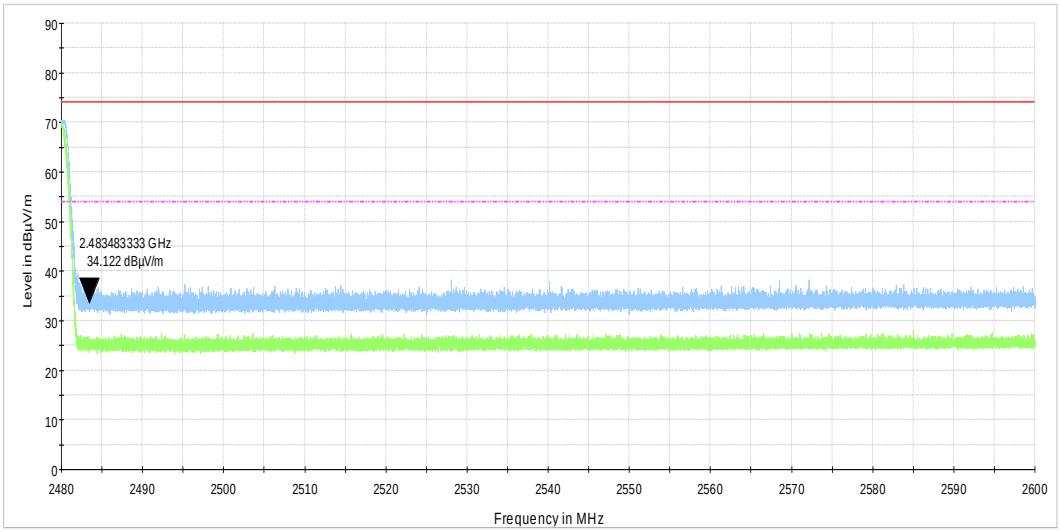
Full description is given in Appendix A.

Test specification:	Section 15.247(d), Band edge emissions		
Test procedure:	ANSI C63.10 section 11.12.1		
Test mode:	Compliance	Verdict:	PASS
Date(s):	29-Apr-19		
Temperature: 25 ºC	Relative Humidity: 45 %	Air Pressure: 1014 hPa	Power: 3.7 VDC
Remarks:			

Plot 7.4.1 The highest band edge emission at low carrier frequency



Plot 7.4.2 The highest band edge emission at high carrier frequency



Test specification:	Section 15.247(d), Peak power density		
Test procedure:	ANSI C63.10 section 11.10.2		
Test mode:	Compliance	Verdict:	PASS
Date(s):	28-Apr-19		
Temperature: 25 ºC	Relative Humidity: 45 %	Air Pressure: 1014 hPa	Power: 3.7 VDC
Remarks:			

7.5 Peak spectral power density

7.5.1 General

This test was performed to measure the peak spectral power density radiated by the transmitter RF antenna. Specification test limits are given in Table 7.5.1.

Table 7.5.1 Peak spectral power density limits

Assigned frequency range, MHz	Measurement bandwidth, kHz	Peak spectral power density, dBm	Equivalent field strength limit @ 3m, dB(µV/m)*
902.0 – 928.0	3.0	8.0	103.2
2400.0 – 2483.5			
5725.0 – 5850.0			

* - Equivalent field strength limit was calculated from the peak spectral power density as follows: E=sqrt(30×P)/r, where P is peak spectral power density and r is antenna to EUT distance in meters.

7.5.2 Test procedure for field strength measurements

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.

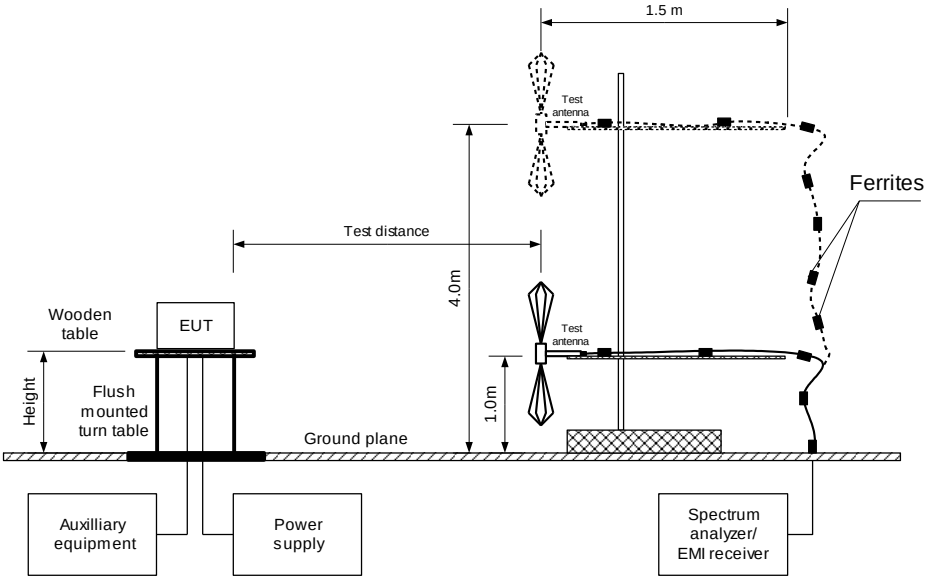
7.5.2.3 The field strength of the EUT carrier frequency was measured with antenna connected to spectrum analyzer/ EMI receiver. To find maximum radiation the turntable was rotated 360^0 and the measuring antenna height was swept in both vertical and horizontal polarizations.

7.5.2.4 The frequency span of spectrum analyzer was set to capture the entire 6 dB band of the transmitter, in peak hold mode with resolution bandwidth set to 3.0 kHz, video bandwidth wider than resolution bandwidth, auto sweep time and sufficient number of sweeps was allowed for trace stabilization. The spectrum lines spacing was verified to be wider than 3 kHz. Otherwise the resolution bandwidth was reduced until individual spectrum lines were resolved and the power of individual spectrum lines was integrated over 3 kHz band.

7.5.2.5 The peak of emission was zoomed with span set just wide enough to capture the emission peak area and sweep time was set equal to span width divided by resolution bandwidth. Spectrum analyzer was set in peak hold mode, sufficient number of sweeps was allowed for trace stabilization and peak spectral power density was measured as provided in Table 7.5.2 and associated plots.

Test specification:	Section 15.247(d), Peak power density		
Test procedure:	ANSI C63.10 section 11.10.2		
Test mode:	Compliance	Verdict:	PASS
Date(s):	28-Apr-19		
Temperature: 25 ºC	Relative Humidity: 45 %	Air Pressure: 1014 hPa	Power: 3.7 VDC
Remarks:			

Figure 7.5.1 Setup for carrier field strength measurements



Test specification:	Section 15.247(d), Peak power density		
Test procedure:	ANSI C63.10 section 11.10.2		
Test mode:	Compliance	Verdict:	PASS
Date(s):	28-Apr-19		
Temperature: 25 ºC	Relative Humidity: 45 %	Air Pressure: 1014 hPa	Power: 3.7 VDC
Remarks:			

Table 7.5.2 Field strength measurement of peak spectral power density

ASSIGNED FREQUENCY:	2400.0 – 2483.5 MHz
TEST DISTANCE:	3 m
TEST SITE:	Semi anechoic chamber
EUT HEIGHT:	1.5 m
DETECTOR USED:	Peak
RESOLUTION BANDWIDTH:	100 kHz
VIDEO BANDWIDTH:	300 kHz
TEST ANTENNA TYPE:	Double ridged guide (above 1000 MHz)
MODULATION:	GFSK
MODULATING SIGNAL:	PRBS
TRANSMITTER OUTPUT POWER SETTINGS:	Maximum

Frequency, MHz	Field strength, dB(µV/m)	EUT antenna gain, dBi	Limit, dB(µV/m)	Margin, dB*	Antenna polarization	Antenna height, m	Turn-table position**, degrees
2402.059	71.45	-2.0	103.2	-29.75	Horizontal	1.4	0
2442.050	70.64	-2.0	103.2	-30.56	Horizontal	1.3	0
2480.053	71.49	-2.0	103.2	-29.71	Vertical	1.6	130

*****- Margin = Field strength - EUT antenna gain - calculated field strength limit.
******- EUT front panel refer to 0 degrees position of turntable.

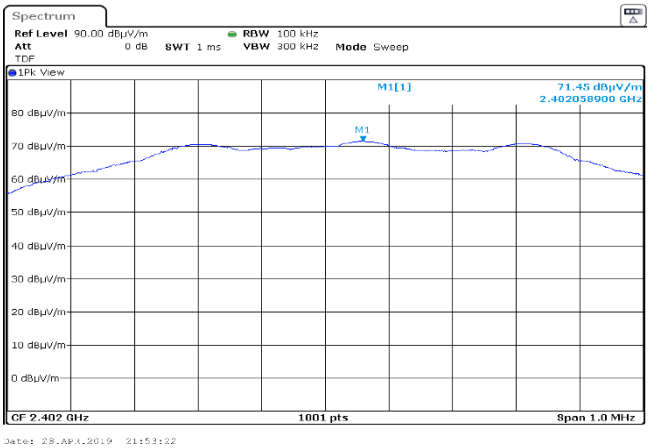
Reference numbers of test equipment used

HL 3903	HL 4355	HL 4933	HL 5405				

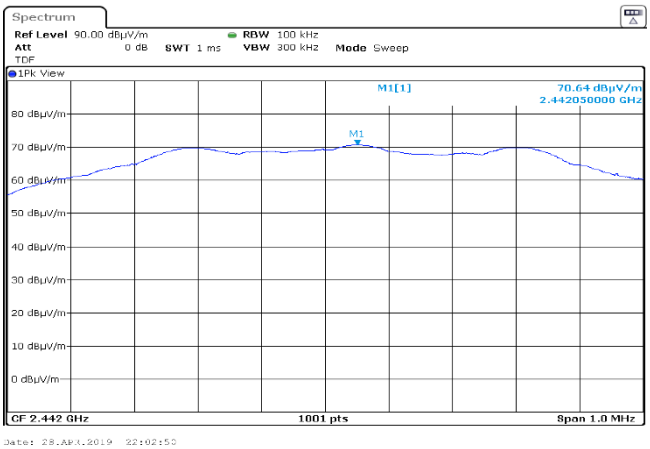
Full description is given in Appendix A.

Test specification:	Section 15.247(d), Peak power density		
Test procedure:	ANSI C63.10 section 11.10.2		
Test mode:	Compliance	Verdict:	PASS
Date(s):	28-Apr-19		
Temperature: 25 ºC	Relative Humidity: 45 %	Air Pressure: 1014 hPa	Power: 3.7 VDC
Remarks:			

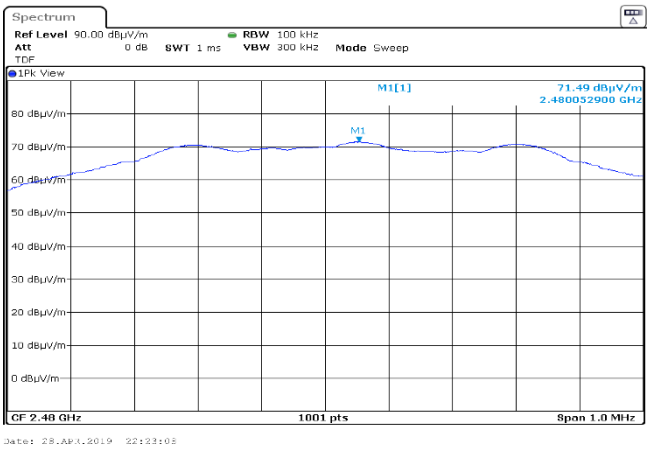
Plot 7.5.1 Peak spectral power density at low frequency



Plot 7.5.2 Peak spectral power density at mid frequency



Plot 7.5.3 Peak spectral power density at high frequency



Test specification:	FCC 47 CFR Section 15.207(a), Conducted emissions at AC mains port		
Test procedure:	ANSI C63.10 section 6.2		
Test mode:	Compliance	Verdict:	PASS
Date(s):	28-Apr-19		
Temperature: 25 ºC	Relative Humidity: 45 %	Air Pressure: 1014 hPa	Power: 110 VAC, 60 Hz
Remarks:			

7.6 Conducted emissions

7.6.1 General

This test was performed to measure common mode conducted emissions at the power port. Specification test limits are given in Table 7.6.1. The worst test results (the lowest margins) were recorded in Table 7.6.2 and shown in the associated plots.

Table 7.6.1 Limits for conducted emissions

Frequency, MHz	Class B limit, dB(μV)	
	QP	AVRG
0.15 - 0.5	66 - 56*	56 - 46*
0.5 - 5.0	56	46
5.0 - 30	60	50

* The limit decreases linearly with the logarithm of frequency.

7.6.2 Test procedure

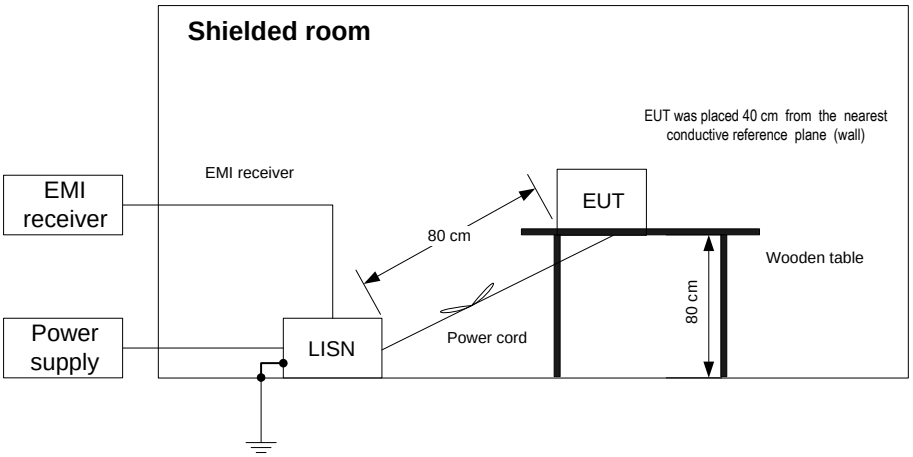
7.6.2.1 The EUT was set up as shown in Figure 7.6.1 and associated photographs, energized and the performance check was conducted.

7.6.2.2 The measurements were performed at power terminals with the LISN, connected to a spectrum analyzer in the frequency range referred to in Table 7.6.2. Unused coaxial connector of the LISN was terminated with 50 Ohm. Quasi-peak and average detectors were used throughout the testing.

7.6.2.3 The position of the device cables was varied to determine maximum emission level.

Test specification:	FCC 47 CFR Section 15.207(a), Conducted emissions at AC mains port		
Test procedure:	ANSI C63.10 section 6.2		
Test mode:	Compliance	Verdict:	PASS
Date(s):	28-Apr-19		
Temperature: 25 ºC	Relative Humidity: 45 %	Air Pressure: 1014 hPa	Power: 110 VAC, 60 Hz
Remarks:			

Figure 7.6.1 Setup for conducted emission measurements



Photograph 7.6.1 Setup for conducted emission measurements

Test specification:	**FCC 47 CFR Section 15.207(a), Conducted emissions at AC mains port**		
Test procedure:	ANSI C63.10 section 6.2		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	28-Apr-19		
Temperature: 25 ºC	**Relative Humidity:** 45 %	**Air Pressure:** 1014 hPa	**Power:** 110 VAC, 60 Hz
Remarks:			

Table 7.6.2 Conducted emission test results

LINE: AC mains
EUT OPERATING MODE: Transmit
EUT SET UP: TABLE-TOP
TEST SITE: SHIELDED ROOM
DETECTORS USED: PEAK / QUASI-PEAK / AVERAGE
FREQUENCY RANGE: 150 kHz - 30 MHz
RESOLUTION BANDWIDTH: 9 kHz

Frequency, MHz	Peak emission, dB(μV)	Quasi-peak			Average			Line ID	Verdict
		Measured emission, dB(μV)	Limit, dB(μV)	Margin, dB*	Measured emission, dB(μV)	Limit, dB(μV)	Margin, dB*		
0.482	44.2	38.3	56.3	-18.0	21.9	46.3	-24.4	L1	Pass
0.587	46.5	39.7	56.0	-16.3	20.5	46.0	-25.5		
1.205	43.8	39.5	56.0	-16.5	25.4	46.0	-20.6		
2.915	44.3	37.7	56.0	-18.3	24.9	46.0	-21.1		
4.873	41.6	35.2	56.0	-20.8	22.8	46.0	-23.2		
22.353	49.1	47.8	60.0	-12.2	38.1	50.0	-11.9		
0.156	49.9	42.6	65.7	-23.1	25.8	55.7	-29.9	L2	Pass
0.243	46.7	39.2	62.0	-22.8	23.6	52.0	-28.4		
0.552	45.3	38.6	56.0	-17.4	22.8	46.0	-23.2		
1.211	40.1	36.8	56.0	-19.2	20.1	46.0	-25.9		
3.764	41.3	36.5	56.0	-19.5	24.1	46.0	-21.9		
26.124	49.2	46.7	60.0	-13.3	37.5	50.0	-12.5		

*****- Margin = Measured emission - specification limit.

Reference numbers of test equipment used

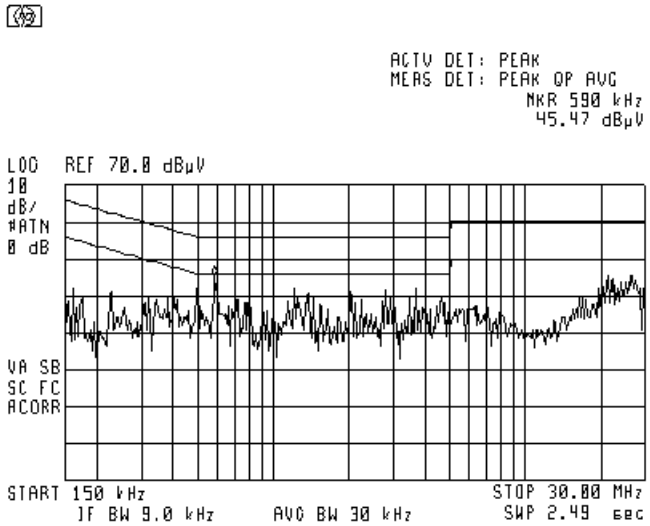
HL 0447	HL 0787	HL 1500	HL 4778				

Full description is given in Appendix A.

Test specification:	FCC 47 CFR Section 15.207(a), Conducted emissions at AC mains port		
Test procedure:	ANSI C63.10 section 6.2		
Test mode:	Compliance	Verdict:	PASS
Date(s):	28-Apr-19		
Temperature: 25 ºC	Relative Humidity: 45 %	Air Pressure: 1014 hPa	Power: 110 VAC, 60 Hz
Remarks:			

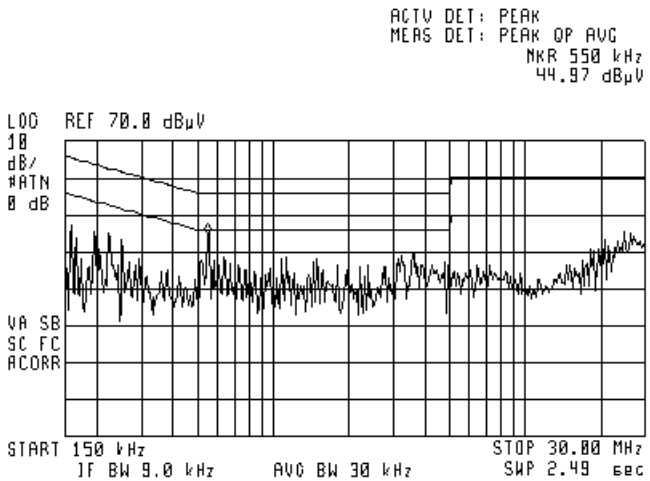
Plot 7.6.1 Conducted emission measurements

LINE: L1
EUT OPERATING MODE: Transmit
LIMIT: QUASI-PEAK, AVERAGE
DETECTOR: PEAK



Plot 7.6.2 Conducted emission measurements

LINE: L2
EUT OPERATING MODE: Transmit
LIMIT: QUASI-PEAK, AVERAGE
DETECTOR: PEAK



Test specification:	FCC Part 15, Section 15.203, Antenna requirements		
Test procedure:	Visual inspection		
Test mode:	Compliance	Verdict:	PASS
Date(s):	28-Apr-19		
Temperature: 25 ºC	Relative Humidity: 45 %	Air Pressure: 1014 hPa	Power: NA
Remarks:			

7.7 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 7.7.1.

Table 7.7.1 Antenna requirements

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

Test specification:	FCC 47 CFR Section 15.107, Conducted emissions at AC mains port		
Test procedure:	ANSI C63.4 section 7.3		
Test mode:	Compliance	Verdict:	PASS
Date(s):	28-Apr-19		
Temperature: 25 ºC	Relative Humidity: 45 %	Air Pressure: 1014 hPa	Power: 110 VAC, 60 Hz
Remarks:			

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

8.1 Conducted emissions

8.1.1 General

This test was performed to measure common mode conducted emissions at the power port. Specification test limits are given in Table 8.1.1. The worst test results (the lowest margins) were recorded in Table 8.1.2 and shown in the associated plots.

Table 8.1.1 Limits for conducted emissions

Frequency, MHz	Class B limit, dB(μV)	
	QP	AVRG
0.15 - 0.5	66 - 56*	56 - 46*
0.5 - 5.0	56	46
5.0 - 30	60	50

* The limit decreases linearly with the logarithm of frequency.

8.1.2 Test procedure

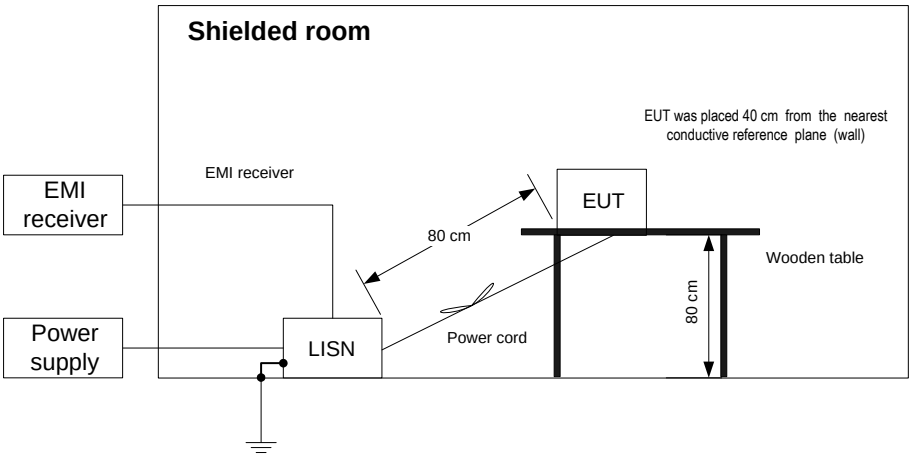
8.1.2.1 The EUT was set up as shown in Figure 8.1.1 and associated photographs, energized and the performance check was conducted.

8.1.2.2 The measurements were performed at power terminals with the LISN, connected to a spectrum analyzer in the frequency range referred to in Table 8.1.2. Unused coaxial connector of the LISN was terminated with 50 Ohm. Quasi-peak and average detectors were used throughout the testing.

8.1.2.3 The position of the device cables was varied to determine maximum emission level.

Test specification:	FCC 47 CFR Section 15.107, Conducted emissions at AC mains port		
Test procedure:	ANSI C63.4 section 7.3		
Test mode:	Compliance	Verdict:	PASS
Date(s):	28-Apr-19		
Temperature: 25 ºC	Relative Humidity: 45 %	Air Pressure: 1014 hPa	Power: 110 VAC, 60 Hz
Remarks:			

Figure 8.1.1 Setup for conducted emission measurements



Photograph 8.1.1 Setup for conducted emission measurements

Test specification:	**FCC 47 CFR Section 15.107, Conducted emissions at AC mains port**		
Test procedure:	ANSI C63.4 section 7.3		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	28-Apr-19		
Temperature: 25 ºC	**Relative Humidity:** 45 %	**Air Pressure:** 1014 hPa	**Power:** 110 VAC, 60 Hz
Remarks:			

Table 8.1.2 Conducted emission test results

LINE: AC mains
EUT OPERATING MODE: Transmit
EUT SET UP: TABLE-TOP
TEST SITE: SHIELDED ROOM
DETECTORS USED: PEAK / QUASI-PEAK / AVERAGE
FREQUENCY RANGE: 150 kHz - 30 MHz
RESOLUTION BANDWIDTH: 9 kHz

Frequency, MHz	Peak emission, dB(μV)	Quasi-peak			Average			Line ID	Verdict
		Measured emission, dB(μV)	Limit, dB(μV)	Margin, dB*	Measured emission, dB(μV)	Limit, dB(μV)	Margin, dB*		
0.482	44.2	38.3	56.3	-18.0	21.9	46.3	-24.4	L1	Pass
0.587	46.5	39.7	56.0	-16.3	20.5	46.0	-25.5		
1.205	43.8	39.5	56.0	-16.5	25.4	46.0	-20.6		
2.915	44.3	37.7	56.0	-18.3	24.9	46.0	-21.1		
4.873	41.6	35.2	56.0	-20.8	22.8	46.0	-23.2		
22.353	49.1	47.8	60.0	-12.2	38.1	50.0	-11.9		
0.156	49.9	42.6	65.7	-23.1	25.8	55.7	-29.9	L2	Pass
0.243	46.7	39.2	62.0	-22.8	23.6	52.0	-28.4		
0.552	45.3	38.6	56.0	-17.4	22.8	46.0	-23.2		
1.211	40.1	36.8	56.0	-19.2	20.1	46.0	-25.9		
3.764	41.3	36.5	56.0	-19.5	24.1	46.0	-21.9		
26.124	49.2	46.7	60.0	-13.3	37.5	50.0	-12.5		

*****- Margin = Measured emission - specification limit.

Reference numbers of test equipment used

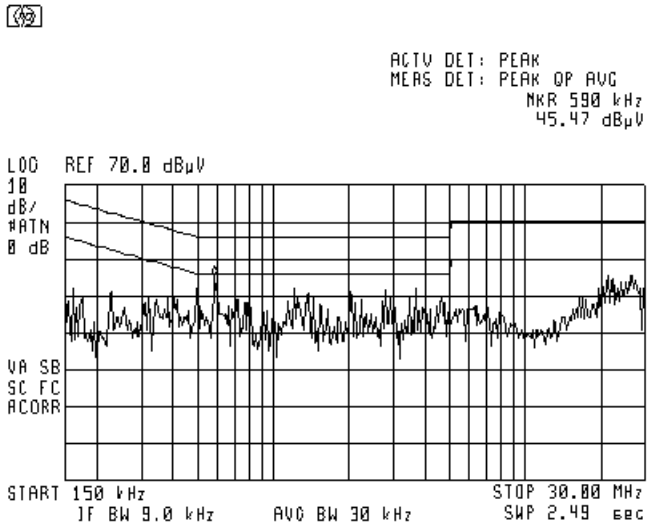
HL 0447	HL 0787	HL 1500	HL 4778				

Full description is given in Appendix A.

Test specification:	FCC 47 CFR Section 15.107, Conducted emissions at AC mains port		
Test procedure:	ANSI C63.4 section 7.3		
Test mode:	Compliance	Verdict:	PASS
Date(s):	28-Apr-19		
Temperature: 25 ºC	Relative Humidity: 45 %	Air Pressure: 1014 hPa	Power: 110 VAC, 60 Hz
Remarks:			

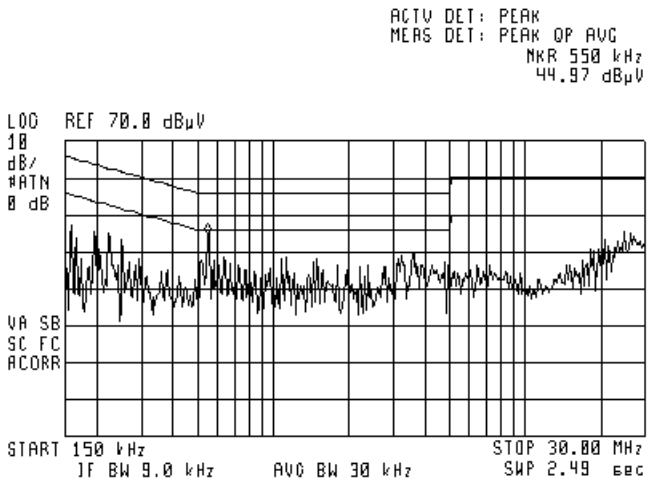
Plot 8.1.1 Conducted emission measurements

LINE: L1
EUT OPERATING MODE: Transmit
LIMIT: QUASI-PEAK, AVERAGE
DETECTOR: PEAK



Plot 8.1.2 Conducted emission measurements

LINE: L2
EUT OPERATING MODE: Transmit
LIMIT: QUASI-PEAK, AVERAGE
DETECTOR: PEAK



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):	28-Apr-19		
Temperature: 25 ºC	Relative Humidity: 45 %	Air Pressure: 1014 hPa	Power: 3.7 VDC
Remarks:			

8.2 Radiated emission measurements

8.2.1 General

This test was performed to measure radiated emissions from the EUT enclosure. Specification test limits are given in Table 8.2.1.

Table 8.2.1 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.

8.2.2 Test procedure

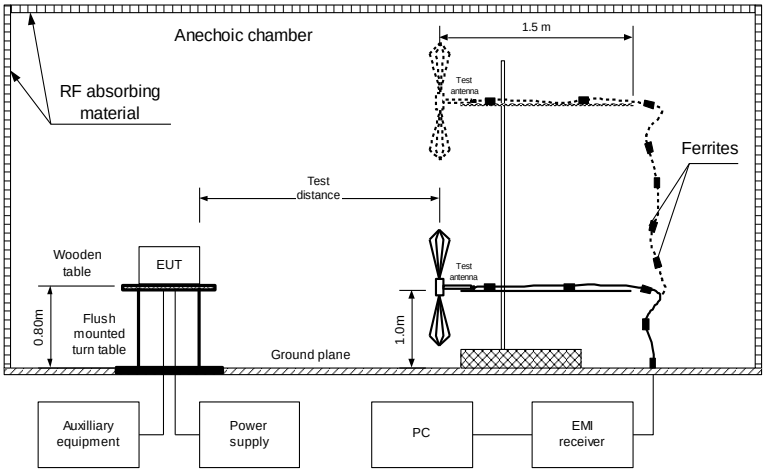
8.2.2.1 The EUT was set up as shown in Figure 8.2.1 and associated photographs, energized and the performance check was conducted.

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

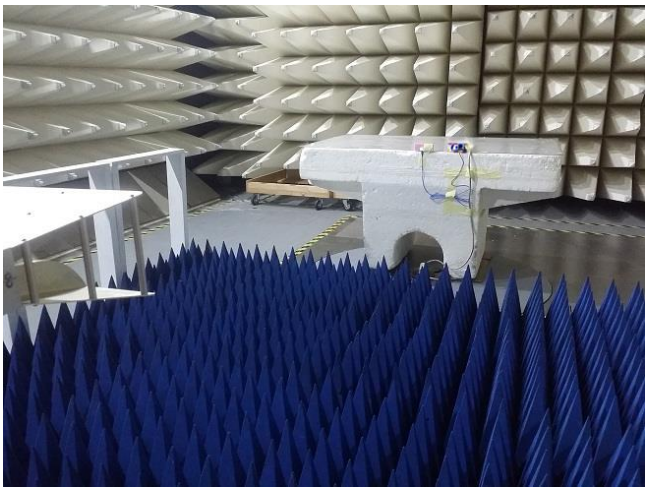
8.2.2.3 The worst test results (the lowest margins) were recorded in Table 8.2.2 and shown in the associated plots.

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):	28-Apr-19		
Temperature: 25 ºC	Relative Humidity: 45 %	Air Pressure: 1014 hPa	Power: 3.7 VDC
Remarks:			

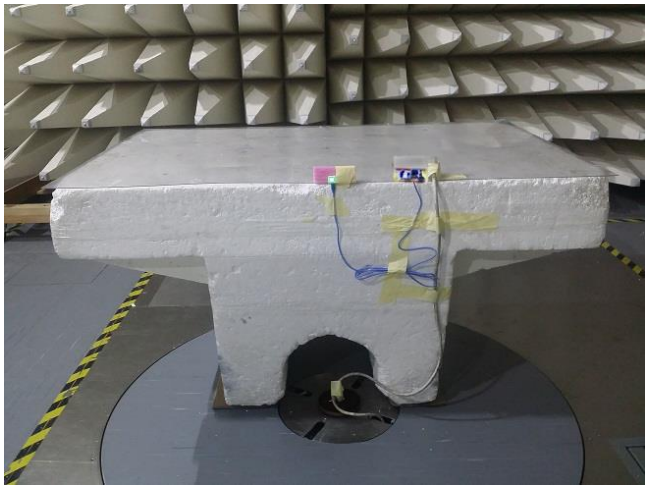
Figure 8.2.1 Setup for radiated emission measurements



Photograph 8.2.1 Setup for radiated emission measurements, general view



Photograph 8.2.2 Setup for 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):	28-Apr-19		
Temperature: 25 ºC	Relative Humidity: 45 %	Air Pressure: 1014 hPa	Power: 3.7 VDC
Remarks:			

Table 8.2.2 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*				
48.011	37.71	35.33	40.0	-4.67	Vertical	1.33	71	Pass
60.013	30.23	26.08	40.0	-13.92	Vertical	1.33	204	
72.017	28.72	25.72	40.0	-14.28	Vertical	1.02	155	
120.009	41.68	40.04	43.5	-3.46	Vertical	1.02	162	
240.023	37.64	36.25	46.0	-9.75	Vertical	1.02	180	

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*				
No emissions were found										Pass

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

Reference numbers of test equipment used

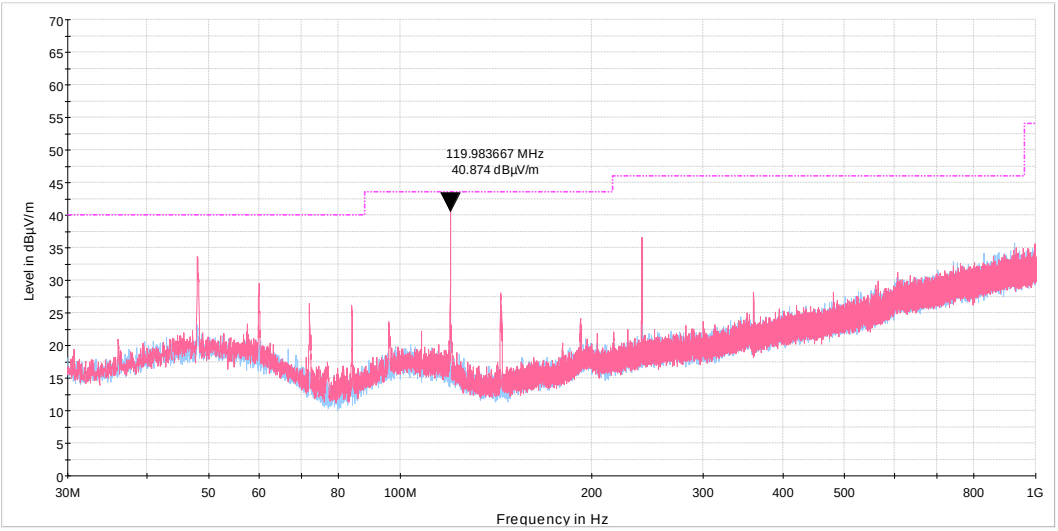
HL 3903	HL 4360	HL 4933	HL 5288	HL 5405			

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):	28-Apr-19		
Temperature: 25 ºC	Relative Humidity: 45 %	Air Pressure: 1014 hPa	Power: 3.7 VDC
Remarks:			

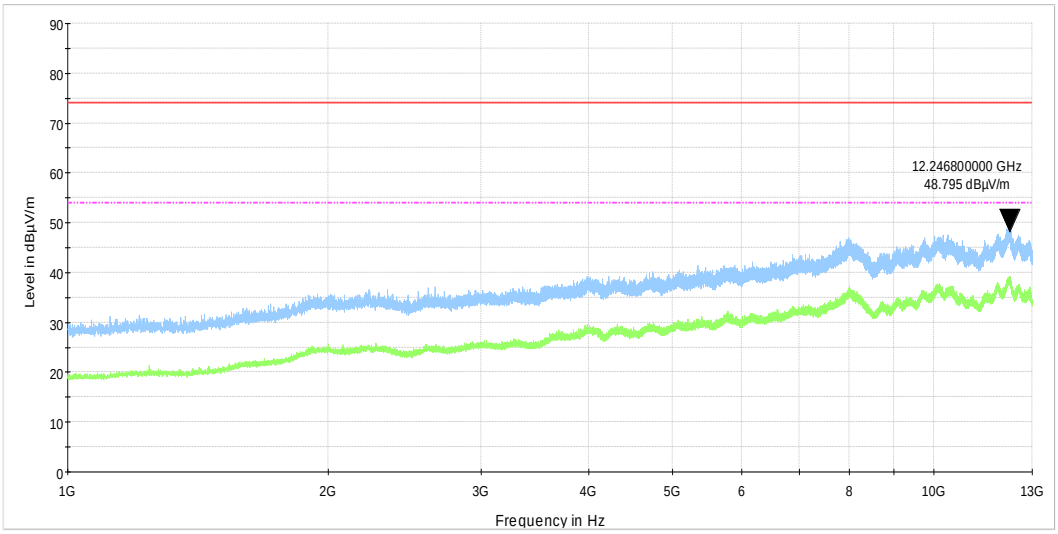
Plot 8.2.1 Radiated emission measurements in 30 - 1000 MHz range, vertical and horizontal antenna polarization

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



Plot 8.2.2 Radiated emission measurements above 1000 MHz, 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 equipment and ancillaries used for tests

HL No	Description	Manufacturer	Model	Ser. No.	Last Cal./ Check	Due Cal./ Check
0446	Antenna, Loop, Active, 10 (9) kHz - 30 MHz	EMCO	6502	2857	24-Feb-19	24-Feb-20
0661	Generator Swept Signal, 10 MHz to 40 GHz, + 10 dBm	Hewlett Packard	83640B	3614A00266	11-Jul-18	11-Jul-19
1906	Power Divider, 0.5-18.0 GHz, 80 W	Omni Spectra	2090-6204-00	NA	21-Jan-19	21-Jan-21
2016	Attenuator, Manual Step, 0-9/1 dB, 0-8 GHz, 2 W	Midwest Microwave	1072	1315	05-Mar-19	05-Mar-20
2017	Attenuator, Manual Step, 0-60/10 dB, 0-8.0 GHz	Midwest Microwave	1071	2017	05-Mar-19	05-Mar-20
2432	Antenna, Double-Ridged Waveguide Horn 1 to 18 GHz	EMC Test Systems	3115	00027177	06-Jan-19	06-Jan-20
2697	Antenna, 30 MHz - 3.0 GHz	Sunol Sciences Corp.	JB3	A022805	03-Jun-18	03-Jun-19
2909	Spectrum analyzer, ESA-E, 100 Hz to 26.5 GHz	Agilent Technologies	E4407B	MY41444762	04-Apr-19	04-Apr-20
3301	Power Meter, P-series, 50 MHz to 40 GHz	Agilent Technologies	N1911A	MY45101057	28-Apr-19	28-Apr-20
3818	PSA Series Spectrum Analyzer, 3 Hz- 44 GHz	Agilent Technologies	E4446A	MY48250288	24-Apr-19	24-Apr-20
3903	Microwave Cable Assembly, 40.0 GHz, 1.5 m, SMA/SMA	Huber-Suhner	SUCOFLEX 102A	1226/2A	07-Apr-19	07-Apr-20
4276	Test Cable , DC-18 GHz, 3.05 m, N/M - N/M	Mini-Circuits	APC-10FT-NMNM+	0747A	01-Aug-18	01-Aug-19
4278	Test Cable , DC-18 GHz, 4.6 m, N/M - N/M	Mini-Circuits	APC-15FT-NMNM+	0755A	01-Aug-18	01-Aug-19
4355	Signal and Spectrum Analyzer, 9 kHz to 7 GHz	Rohde & Schwarz	FSV 7	101630	28-Jun-18	28-Jun-19
4360	EMI Test Receiver, 20 Hz to 40 GHz.	Rohde & Schwarz	ESU40	100322	31-Dec-18	31-Dec-19
4474	Double Ridged Waveguide Antenna, 0.8 to 18 GHz	FT-RT Antenna, Inc.	HA-08M18G-NF	2012060901	29-Aug-18	29-Aug-19
4932	Microwave preamplifier, 500 MHz to 18 GHz, 40 dB Gain	COM-POWER CORPORATION	PAM-118A	551029	24-Apr-19	24-Apr-20
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
5107	RF cable, 18 GHz, 4.5 m, N-type	Huber-Suhner	SF106A/11N/ 11N/4500MM	500845/6A	05-Aug-18	05-Aug-19
5110	RF cable, 18 GHz, 3 m, N-type	Huber-Suhner	ST18A/Nm/Nm/3000	600818/18A	01-Aug-18	01-Aug-19
5111	RF cable, 40 GHz, 5.5 m, K-type	Huber-Suhner	SF102EA/11SK/11SK/5500MM	502493/2EA	18-Apr-19	18-Apr-20
5288	Trilog Antenna, 25 MHz - 8 GHz, 100W	Frankonia	ALX-8000E	00809	08-Feb-19	08-Feb-22
5391	Temperature/Humidity Cycle Chamber, -77 - +177 deg., Humidity Range 20% RH to 95% RH	Thermotron	SM-8C	27737	22-Jul-18	22-Jul-19
5405	RF cable, 18 GHz, N-N, 6 m	Huber-Suhner	SF118/11N(x2)	500023/118	01-Aug-18	01-Aug-19

10 APPENDIX B 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), CAB identifier is IL1001, ISED# number 2186A; 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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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 2697: Biconilog Antenna,
Sunol Sciences. Corp. Pleasanton, California USA, model: JB3, s/n A022805

Frequency, MHz	Antenna factor, dB/m
30	21.9
35	18.2
40	14.1
45	10.4
50	8.2
60	8.1
70	8.5
80	7.9
90	7.6
100	9.9
120	14.1
140	13.0

Frequency, MHz	Antenna factor, dB/m
160	12.4
180	11.4
200	12.4
250	11.4
300	13.4
400	15.8
500	18.0
600	18.1
700	19.6
800	21.0
900	22.4
1000	23.4

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

HL 4474: Double Ridged Waveguide Antenna,
FT-RT Antenna, Inc., model: HA-08M18G-NF, s/n 2012060901

Frequency, MHz	Antenna factor, dB/m
1000	23.9
1500	24.8
2000	27.3
2500	28.2
3000	29.1
3500	30.4
4000	32.0
4500	33.3
5000	34.8
5500	35.6
6000	36.1
6500	37.2
7000	37.9
7500	38.1
8000	38.6
8500	38.3
9000	38.6
9500	38.5

Frequency, MHz	Antenna factor, dB/m
10000	39.2
10500	40.0
11000	40.6
11500	40.4
12000	39.8
12500	39.8
13000	40.5
13500	41.0
14000	41.9
14500	41.2
15000	40.0
15500	39.9
16000	39.5
16500	41.0
17000	41.7
17500	43.6
18000	45.0

The antenna factor shall be added to receiver reading in dBμV to obtain field strength in dBμV/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 4276: Test Cable
Mini-Circuits, model: APC-10FT-NMNM+, s/n 0748A

Set / Applied, MHz	Measured, dB	Uncertainty, dB
0.1	0.02	+0.07 / -0.07
50	0.26	+0.07 / -0.07
100	0.38	+0.07 / -0.07
200	0.55	+0.07 / -0.07
300	0.68	+0.08 / -0.09
400	0.79	+0.08 / -0.09
500	0.89	+0.08 / -0.09
600	0.98	+0.08 / -0.09
700	1.07	+0.08 / -0.09
800	1.15	+0.08 / -0.09
900	1.23	+0.08 / -0.09
1000	1.30	+0.08 / -0.09
1100	1.37	+0.12 / -0.13
1200	1.43	+0.12 / -0.13
1300	1.49	+0.12 / -0.13
1400	1.56	+0.12 / -0.13
1500	1.62	+0.12 / -0.13
1600	1.68	+0.12 / -0.13
1700	1.73	+0.12 / -0.13
1800	1.79	+0.12 / -0.13
1900	1.84	+0.12 / -0.13
2000	1.90	+0.12 / -0.13
2100	1.96	+0.12 / -0.13
2200	2.01	+0.12 / -0.13
2300	2.06	+0.12 / -0.13
2400	2.12	+0.12 / -0.13
2500	2.17	+0.17 / -0.18
2600	2.24	+0.17 / -0.18
2700	2.30	+0.17 / -0.18
2800	2.37	+0.17 / -0.18
2900	2.44	+0.17 / -0.18
3000	2.53	+0.17 / -0.18
3100	2.59	+0.19 / -0.2
3200	2.62	+0.19 / -0.2
3300	2.64	+0.19 / -0.2
3400	2.66	+0.19 / -0.2
3500	2.68	+0.19 / -0.2
3600	2.71	+0.19 / -0.2
3700	2.74	+0.19 / -0.2
3800	2.78	+0.19 / -0.2
3900	2.81	+0.19 / -0.2
4000	2.85	+0.19 / -0.2

Set / Applied, MHz	Measured, dB	Uncertainty, dB
4100	2.89	+0.3 / -0.33
4200	2.94	+0.3 / -0.33
4300	2.97	+0.3 / -0.33
4400	3.01	+0.3 / -0.33
4500	3.05	+0.3 / -0.33
4600	3.09	+0.3 / -0.33
4700	3.12	+0.3 / -0.33
4800	3.16	+0.3 / -0.33
4900	3.20	+0.3 / -0.33
5000	3.24	+0.3 / -0.33
5100	3.28	+0.3 / -0.33
5200	3.32	+0.3 / -0.33
5300	3.35	+0.3 / -0.33
5400	3.39	+0.3 / -0.33
5500	3.42	+0.3 / -0.33
5600	3.46	+0.3 / -0.33
5700	3.50	+0.3 / -0.33
5800	3.54	+0.3 / -0.33
5900	3.59	+0.3 / -0.33
6000	3.62	+0.3 / -0.33
6100	3.66	+0.3 / -0.33
6200	3.70	+0.3 / -0.33
6300	3.73	+0.3 / -0.33
6400	3.77	+0.3 / -0.33
6500	3.80	+0.3 / -0.33
6600	3.85	+0.3 / -0.33
6700	3.88	+0.3 / -0.33
6800	3.92	+0.3 / -0.33
6900	3.95	+0.3 / -0.33
7000	4.00	+0.3 / -0.33
7100	4.04	+0.3 / -0.33
7200	4.07	+0.3 / -0.33
7300	4.12	+0.3 / -0.33
7400	4.15	+0.3 / -0.33
7500	4.19	+0.3 / -0.33
7600	4.23	+0.3 / -0.33
7700	4.26	+0.3 / -0.33
7800	4.29	+0.3 / -0.33
7900	4.33	+0.3 / -0.33
8000	4.36	+0.3 / -0.33
8100	4.40	+0.34 / -0.36
8200	4.42	+0.34 / -0.36

HL 4276: Test Cable (continued)

Set / Applied, MHz	Measured, dB	Uncertainty, dB
8300	4.45	+0.34 / -0.36
8400	4.48	+0.34 / -0.36
8500	4.52	+0.34 / -0.36
8600	4.54	+0.34 / -0.36
8700	4.56	+0.34 / -0.36
8800	4.59	+0.34 / -0.36
8900	4.62	+0.34 / -0.36
9000	4.65	+0.34 / -0.36
9100	4.68	+0.34 / -0.36
9200	4.69	+0.34 / -0.36
9300	4.71	+0.34 / -0.36
9400	4.73	+0.34 / -0.36
9500	4.75	+0.34 / -0.36
9600	4.79	+0.34 / -0.36
9700	4.81	+0.34 / -0.36
9800	4.85	+0.34 / -0.36
9900	4.88	+0.34 / -0.36
10000	4.91	+0.34 / -0.36
10100	4.93	+0.4 / -0.44
10200	4.97	+0.4 / -0.44
10300	5.00	+0.4 / -0.44
10400	5.04	+0.4 / -0.44
10500	5.07	+0.4 / -0.44
10600	5.12	+0.4 / -0.44
10700	5.14	+0.4 / -0.44
10800	5.15	+0.4 / -0.44
10900	5.18	+0.4 / -0.44
11000	5.19	+0.4 / -0.44
11100	5.21	+0.4 / -0.44
11200	5.24	+0.4 / -0.44
11300	5.28	+0.4 / -0.44
11400	5.32	+0.4 / -0.44
11500	5.35	+0.4 / -0.44
11600	5.39	+0.4 / -0.44
11700	5.42	+0.4 / -0.44
11800	5.45	+0.4 / -0.44
11900	5.47	+0.4 / -0.44
12000	5.50	+0.4 / -0.44
12100	5.54	+0.4 / -0.44
12200	5.57	+0.4 / -0.44
12300	5.60	+0.4 / -0.44
12400	5.63	+0.4 / -0.44
12500	5.64	+0.47 / -0.52
12600	5.67	+0.47 / -0.52
12700	5.68	+0.47 / -0.52
12800	5.70	+0.47 / -0.52
12900	5.72	+0.47 / -0.52
13000	5.75	+0.47 / -0.52
13100	5.47	+0.4 / -0.44
13200	5.50	+0.4 / -0.44
13300	5.54	+0.4 / -0.44

Set / Applied, MHz	Measured, dB	Uncertainty, dB
13100	5.77	+0.47 / -0.52
13200	5.82	+0.47 / -0.52
13300	5.84	+0.47 / -0.52
13400	5.88	+0.47 / -0.52
13500	5.90	+0.47 / -0.52
13600	5.93	+0.47 / -0.52
13700	5.95	+0.47 / -0.52
13800	6.00	+0.47 / -0.52
13900	6.02	+0.47 / -0.52
14000	6.05	+0.47 / -0.52
14100	6.08	+0.47 / -0.52
14200	6.11	+0.47 / -0.52
14300	6.12	+0.47 / -0.52
14400	6.15	+0.47 / -0.52
14500	6.18	+0.47 / -0.52
14600	6.22	+0.47 / -0.52
14700	6.25	+0.47 / -0.52
14800	6.29	+0.47 / -0.52
14900	6.33	+0.47 / -0.52
15000	6.35	+0.47 / -0.52
15100	6.38	+0.47 / -0.52
15200	6.40	+0.47 / -0.52
15300	6.44	+0.47 / -0.52
15400	6.48	+0.47 / -0.52
15500	6.52	+0.47 / -0.52
15600	6.54	+0.47 / -0.52
15700	6.59	+0.47 / -0.52
15800	6.60	+0.47 / -0.52
15900	6.64	+0.47 / -0.52
16000	6.62	+0.47 / -0.52
16100	6.67	+0.47 / -0.52
16200	6.71	+0.47 / -0.52
16300	6.75	+0.47 / -0.52
16400	6.79	+0.47 / -0.52
16500	6.81	+0.47 / -0.52
16600	6.85	+0.47 / -0.52
16700	6.85	+0.47 / -0.52
16800	6.89	+0.47 / -0.52
16900	6.89	+0.47 / -0.52
17000	6.93	+0.47 / -0.52
17100	6.93	+0.47 / -0.52
17200	6.99	+0.47 / -0.52
17300	7.00	+0.47 / -0.52
17400	7.01	+0.47 / -0.52
17500	7.01	+0.47 / -0.52
17600	7.02	+0.47 / -0.52
17700	7.05	+0.47 / -0.52
17800	7.06	+0.47 / -0.52
17900	7.08	+0.47 / -0.52
18000	7.09	+0.47 / -0.52

HL 4278: Test Cable
Mini-Circuits, model: APC-15FT-NMNM+, s/n 0755A

Set / Applied, MHz	Measured, dB	Uncertainty, dB
0.1	0.03	+0.07 / -0.07
50	0.40	+0.07 / -0.07
100	0.59	+0.07 / -0.07
200	0.85	+0.07 / -0.07
300	1.05	+0.08 / -0.09
400	1.23	+0.08 / -0.09
500	1.38	+0.08 / -0.09
600	1.52	+0.08 / -0.09
700	1.64	+0.08 / -0.09
800	1.77	+0.08 / -0.09
900	1.88	+0.08 / -0.09
1000	1.99	+0.08 / -0.09
1100	2.09	+0.12 / -0.13
1200	2.19	+0.12 / -0.13
1300	2.29	+0.12 / -0.13
1400	2.38	+0.12 / -0.13
1500	2.47	+0.12 / -0.13
1600	2.56	+0.12 / -0.13
1700	2.64	+0.12 / -0.13
1800	2.72	+0.12 / -0.13
1900	2.80	+0.12 / -0.13
2000	2.89	+0.12 / -0.13
2100	2.96	+0.12 / -0.13
2200	3.04	+0.12 / -0.13
2300	3.12	+0.12 / -0.13
2400	3.19	+0.12 / -0.13
2500	3.26	+0.17 / -0.18
2600	3.33	+0.17 / -0.18
2700	3.40	+0.17 / -0.18
2800	3.47	+0.17 / -0.18
2900	3.54	+0.17 / -0.18
3000	3.61	+0.17 / -0.18
3100	3.67	+0.19 / -0.2
3200	3.74	+0.19 / -0.2
3300	3.80	+0.19 / -0.2
3400	3.87	+0.19 / -0.2
3500	3.94	+0.19 / -0.2
3600	4.00	+0.19 / -0.2
3700	4.06	+0.19 / -0.2
3800	4.12	+0.19 / -0.2
3900	4.19	+0.19 / -0.2
4000	4.25	+0.19 / -0.2

Set / Applied, MHz	Measured, dB	Uncertainty, dB
4100	4.30	+0.3 / -0.33
4200	4.38	+0.3 / -0.33
4300	4.43	+0.3 / -0.33
4400	4.48	+0.3 / -0.33
4500	4.54	+0.3 / -0.33
4600	4.60	+0.3 / -0.33
4700	4.65	+0.3 / -0.33
4800	4.71	+0.3 / -0.33
4900	4.76	+0.3 / -0.33
5000	4.83	+0.3 / -0.33
5100	4.88	+0.3 / -0.33
5200	4.93	+0.3 / -0.33
5300	4.99	+0.3 / -0.33
5400	5.05	+0.3 / -0.33
5500	5.10	+0.3 / -0.33
5600	5.15	+0.3 / -0.33
5700	5.20	+0.3 / -0.33
5800	5.26	+0.3 / -0.33
5900	5.31	+0.3 / -0.33
6000	5.37	+0.3 / -0.33
6100	5.41	+0.3 / -0.33
6200	5.47	+0.3 / -0.33
6300	5.52	+0.3 / -0.33
6400	5.58	+0.3 / -0.33
6500	5.62	+0.3 / -0.33
6600	5.68	+0.3 / -0.33
6700	5.73	+0.3 / -0.33
6800	5.79	+0.3 / -0.33
6900	5.83	+0.3 / -0.33
7000	5.89	+0.3 / -0.33
7100	5.94	+0.3 / -0.33
7200	5.98	+0.3 / -0.33
7300	6.04	+0.3 / -0.33
7400	6.08	+0.3 / -0.33
7500	6.14	+0.3 / -0.33
7600	6.18	+0.3 / -0.33
7700	6.23	+0.3 / -0.33
7800	6.28	+0.3 / -0.33
7900	6.33	+0.3 / -0.33
8000	6.38	+0.3 / -0.33
8100	6.43	+0.34 / -0.36
8200	6.49	+0.34 / -0.36

HL 4278: Test Cable (continued)

Set / Applied, MHz	Measured, dB	Uncertainty, dB
8300	6.54	+0.34 / -0.36
8400	6.60	+0.34 / -0.36
8500	6.65	+0.34 / -0.36
8600	6.71	+0.34 / -0.36
8700	6.75	+0.34 / -0.36
8800	6.81	+0.34 / -0.36
8900	6.85	+0.34 / -0.36
9000	6.89	+0.34 / -0.36
9100	6.95	+0.34 / -0.36
9200	6.98	+0.34 / -0.36
9300	7.03	+0.34 / -0.36
9400	7.07	+0.34 / -0.36
9500	7.11	+0.34 / -0.36
9600	7.16	+0.34 / -0.36
9700	7.21	+0.34 / -0.36
9800	7.25	+0.34 / -0.36
9900	7.32	+0.34 / -0.36
10000	7.37	+0.34 / -0.36
10100	7.40	+0.4 / -0.44
10200	7.47	+0.4 / -0.44
10300	7.53	+0.4 / -0.44
10400	7.55	+0.4 / -0.44
10500	7.62	+0.4 / -0.44
10600	7.66	+0.4 / -0.44
10700	7.68	+0.4 / -0.44
10800	7.74	+0.4 / -0.44
10900	7.76	+0.4 / -0.44
11000	7.81	+0.4 / -0.44
11100	7.86	+0.4 / -0.44
11200	7.89	+0.4 / -0.44
11300	7.94	+0.4 / -0.44
11400	7.99	+0.4 / -0.44
11500	8.02	+0.4 / -0.44
11600	8.07	+0.4 / -0.44
11700	8.14	+0.4 / -0.44
11800	8.17	+0.4 / -0.44
11900	8.22	+0.4 / -0.44
12000	8.27	+0.4 / -0.44
12100	8.30	+0.4 / -0.44
12200	8.35	+0.4 / -0.44
12300	8.38	+0.4 / -0.44
12400	8.41	+0.4 / -0.44
12500	8.47	+0.47 / -0.52
12600	8.47	+0.47 / -0.52
12700	8.52	+0.47 / -0.52
12800	8.57	+0.47 / -0.52
12900	8.60	+0.47 / -0.52
13000	8.65	+0.47 / -0.52
13100	8.68	+0.47 / -0.52

Set / Applied, MHz	Measured, dB	Uncertainty, dB
13200	8.74	+0.47 / -0.52
13300	8.77	+0.47 / -0.52
13400	8.83	+0.47 / -0.52
13500	8.87	+0.47 / -0.52
13600	8.90	+0.47 / -0.52
13700	8.95	+0.47 / -0.52
13800	8.99	+0.47 / -0.52
13900	9.02	+0.47 / -0.52
14000	9.07	+0.47 / -0.52
14100	9.11	+0.47 / -0.52
14200	9.16	+0.47 / -0.52
14300	9.19	+0.47 / -0.52
14400	9.24	+0.47 / -0.52
14500	9.29	+0.47 / -0.52
14600	9.33	+0.47 / -0.52
14700	9.37	+0.47 / -0.52
14800	9.42	+0.47 / -0.52
14900	9.47	+0.47 / -0.52
15000	9.51	+0.47 / -0.52
15100	9.56	+0.47 / -0.52
15200	9.62	+0.47 / -0.52
15300	9.65	+0.47 / -0.52
15400	9.71	+0.47 / -0.52
15500	9.74	+0.47 / -0.52
15600	9.75	+0.47 / -0.52
15700	9.82	+0.47 / -0.52
15800	9.84	+0.47 / -0.52
15900	9.90	+0.47 / -0.52
16000	9.90	+0.47 / -0.52
16100	9.97	+0.47 / -0.52
16200	10.02	+0.47 / -0.52
16300	10.05	+0.47 / -0.52
16400	10.09	+0.47 / -0.52
16500	10.13	+0.47 / -0.52
16600	10.18	+0.47 / -0.52
16700	10.21	+0.47 / -0.52
16800	10.26	+0.47 / -0.52
16900	10.29	+0.47 / -0.52
17000	10.35	+0.47 / -0.52
17100	10.36	+0.47 / -0.52
17200	10.42	+0.47 / -0.52
17300	10.46	+0.47 / -0.52
17400	10.49	+0.47 / -0.52
17500	10.53	+0.47 / -0.52
17600	10.56	+0.47 / -0.52
17700	10.65	+0.47 / -0.52
17800	10.68	+0.47 / -0.52
17900	10.72	+0.47 / -0.52
18000	10.76	+0.47 / -0.52

HL 5110: RF Cable
Huber-Suhner, ST18A/Nm/Nm/3000, s/n 600818/18A, HL 5110

Set / Applied, MHz	Measured, dB	Uncertainty, dB
0.1	0.00	±0.07
50	0.17	±0.07
100	0.25	±0.07
200	0.35	±0.08
300	0.43	±0.08
400	0.49	±0.08
500	0.55	±0.08
600	0.61	±0.08
700	0.66	±0.08
800	0.71	±0.08
900	0.76	±0.08
1000	0.79	±0.08
1100	0.84	±0.08
1200	0.87	±0.08
1300	0.92	±0.08
1400	0.95	±0.08
1500	0.99	±0.08
1600	1.02	±0.08
1700	1.05	±0.08
1800	1.09	±0.08
1900	1.13	±0.08
2000	1.15	±0.08
2500	1.31	±0.10
3000	1.45	±0.10
3500	1.58	±0.10
4000	1.71	±0.10
4500	1.83	±0.10

Set / Applied, MHz	Measured, dB	Uncertainty, dB
5000	1.96	±0.10
5500	2.08	±0.10
6000	2.17	±0.10
6500	2.28	±0.10
7000	2.40	±0.13
7500	2.53	±0.13
8000	2.65	±0.13
8500	2.76	±0.13
9000	2.80	±0.13
9500	2.85	±0.13
10000	2.90	±0.13
10500	2.98	±0.13
11000	3.06	±0.13
11500	3.12	±0.13
12000	3.20	±0.13
12500	3.30	±0.18
13000	3.38	±0.18
13500	3.51	±0.18
14000	3.58	±0.18
14500	3.61	±0.18
15000	3.66	±0.22
15500	3.74	±0.22
16000	3.80	±0.22
16500	3.88	±0.22
17000	3.99	±0.22
17500	4.04	±0.22
18000	4.01	±0.27

HL 5111: RF Cable
Huber-Suhner, SF102EA/11SK/11SK/5500MM, s/n 502493/2EA

Set / Applied, MHz	Measured, dB	Uncertainty, dB
100	0.71	±0.07
200	1.01	±0.08
300	1.24	±0.08
500	1.60	±0.08
1000	2.24	±0.08
1500	2.75	±0.08
2000	3.17	±0.08
2500	3.55	±0.10
3000	3.91	±0.10
3500	4.21	±0.10
4000	4.52	±0.10
4500	4.79	±0.10
5000	5.07	±0.10
5500	5.36	±0.10
6000	5.61	±0.10
6500	5.84	±0.10
7000	6.11	±0.10
7500	6.25	±0.10
8000	6.55	±0.10
8500	6.71	±0.10
9000	6.96	±0.10
9500	7.18	±0.10
10000	7.28	±0.10
10500	7.55	±0.10
11000	7.67	±0.10
11500	7.92	±0.10
12000	8.08	±0.10
12500	8.23	±0.13
13000	8.38	±0.13
13500	8.54	±0.13
14000	8.71	±0.13
14500	8.94	±0.18
15000	9.05	±0.18
15500	9.21	±0.18
16000	9.35	±0.18
16500	9.49	±0.18
17000	9.69	±0.18
17500	9.81	±0.18
18000	9.99	±0.18
18500	10.10	±0.23

Set / Applied, MHz	Measured, dB	Uncertainty, dB
19000	10.23	±0.23
19500	10.38	±0.23
20000	10.52	±0.23
20500	10.67	±0.23
21000	10.80	±0.23
21500	10.93	±0.23
22000	11.07	±0.23
22500	11.19	±0.29
23000	11.36	±0.29
23500	11.53	±0.29
24000	11.65	±0.29
24500	11.80	±0.29
25000	11.94	±0.23
25500	12.07	±0.23
26000	12.25	±0.23
26500	12.37	±0.23
27000	12.55	±0.33
27500	12.68	±0.33
28000	12.72	±0.40
28500	12.87	±0.40
29000	12.95	±0.40
29500	13.10	±0.40
30000	13.27	±0.40
30500	13.29	±0.33
31000	13.43	±0.33
31500	13.53	±0.33
32000	13.66	±0.33
32500	13.87	±0.33
33000	14.05	±0.33
33500	14.11	±0.33
34000	14.31	±0.33
34500	14.30	±0.40
35000	14.45	±0.40
35500	14.64	±0.40
36000	14.59	±0.40
36500	14.75	±0.40
37000	14.82	±0.33
37500	14.92	±0.33
38000	15.28	±0.33

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

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.

13 APPENDIX E Specification references

FCC 47CFR part 15:2017	Radio Frequency Devices
ANSI C63.2:2016	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
ANSI C63.10:2013	American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

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

END OF DOCUMENT