HERMON LABORATORIES

ELECTRICAL TESTING
0839.01

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TEST REPORT

ACCORDING TO:

FCC 47 CFR PART 15 subpart C, section 15.249 and subpart B

RSS-210 Issue 9:2016, RSS-Gen Issue 5:2018, ICES-003 Issue 6:2016

FOR:

ARAD TECHNOLOGIES

Water meter

Model: PMNTULG5

FCC ID: VIDPMNTLG5

IC: 10232A-PMNTULG5

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1 Applicant information

Client name:	ARAD TECHNOLOGIES
Address:	POB 537, HaMada 4, Yokneam Ind. Zone, Yokneam Ilit 20692, Israel
Telephone:	04-9935222 Ext.277
Fax:	04-9935227
E-mail:	viorel.negreanu@aradtec.com
Contact name:	Mr.Vily Negreanu

2 Equipment under test attributes

Product name:	Water meter
Product type:	Transceiver
Model(s):	PMNTULG5
Serial number:	18P00A5852
Hardware version:	P4
Software release:	07.02/08.02
Receipt date	10-Apr-19

3 Manufacturer information

Manufacturer name:	ARAD TECHNOLOGIES
Address:	POB 537, HaMada 4, Yokneam Ind. Zone, Yokneam Ilit 20692, Israel
Telephone:	04-9935222 Ext.277
Fax:	04-9935227
E-Mail:	viorel.negreanu@aradtec.com
Contact name:	Mr.Vily Negreanu

4 Test details

Project ID:	33388
Location:	Hermon Laboratories Ltd. P.O. Box 23, Binyamina 3055001, Israel
Test started:	19-May-19
Test completed:	10-Jun-19
Test specification(s):	FCC 47 CFR PART 15 subpart C, section 15.249 and subpart B RSS-210 Issue 9:2016, RSS-Gen Issue 5:2018, ICES-003 Issue 6:2016

5 Tests summary

Test	
Transmitter characteristics	
Section 15.249(a)(d) / RSS-210 section B.10, Field strength of emissions	Pass
Section 15.215(c), Occupied bandwidth	Pass
Section 15.249(d) / RSS-210 section C.4, Band edge emissions	Pass
Section 15.203, Antenna requirement	Pass
Unintentional emissions	
Section 15.109 / RSS-Gen, section 7.3, ICES-003, Radiated emission	Pass

This test report supersedes the previously issued test report identified by
Doc ID: ARARAD_FCC.33388_Small_Booster_Rev.1

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 EMC & Radio	26-May-19 – 10-Jun-19	
Reviewed by:	Mrs. S Peysahov Sheynin test engineer EMC & Radio	29-Mar-20	
Approved by:	Mr. S. Samokha, technical manager, EMC and Radio	29-Mar-20	

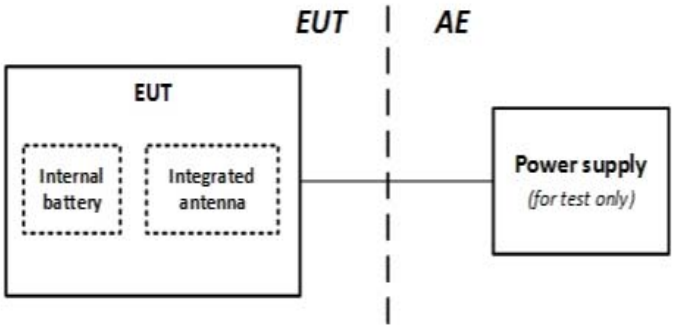
6 EUT description

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

6.1 General information

End unit that has an embedded radio and antenna. Unit has a wire interface to encoders. Unit can read the encoder and to send the read to the network. Unit is designed to be installed in water pits.

6.2 Test configuration



6.3 Transmitter characteristics

Type of equipment	
V	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)

Assigned frequency range	902 - 928 MHz
Operating frequency range	902.3 – 927.8 MHz for 2FSK 9.6 kbps 902.3 – 927.8 MHz for 2FSK 19.2 kbps 902.4 – 927.6 MHz for 2FSK 38.4 kbps 903.8 – 927.4 MHz for GFSK 50.0 kbps
Maximum field strength	92.51 dB(µV/m) at 3 m test distance for 2FSK 9.6 kbps 92.58 dB(µV/m) at 3 m test distance for 2FSK 19.2 kbps 92.62 dB(µV/m) at 3 m test distance for 2FSK 38.4 kbps 92.76 dB(µV/m) at 3 m test distance for GFSK 50.0 kbps

Is transmitter output power variable?				
V	No			
	Yes		continuous variable	
			stepped variable with stepsize, software controlled	dB
		Maximum field strength		

Antenna connection				
V unique coupling	standard connector	Integral		with temporary RF connector
			V	without temporary RF connector

Antenna/s technical characteristics			
Type	Manufacturer	Model number	Gain
Integrated	AT	NA	0 dBi

Type of modulation / data rates	2FSK 9.6 kbps 2FSK 19.2 kbps 2FSK 38.4 kbps GFSK 50.0 kbps
Transmitter duty cycle supplied for test	100%

Transmitter power source					
V	Battery	**Nominal rated voltage**	3.6 VDC	Battery type	
	DC	**Nominal rated voltage**			
	AC mains	**Nominal rated voltage**		Frequency	

Common power source for transmitter and receiver	**V** yes	no

Test specification:	Section 15.249(a)(d)/RSS-210, section B.10, Field strength of emissions		
Test procedure:	ANSI C63.10, Section 6.5, 6.6		
Test mode:	Compliance	Verdict:	PASS
Date(s):	26-May-19		
Temperature: 26 ºC	Relative Humidity: 47 %	Air Pressure: 1015 hPa	Power: 3.6 VDC
Remarks:			

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

7.1 Field strength of emissions

7.1.1 General

This test was performed to measure field strength of fundamental and spurious emissions from the EUT. Specification test limits are given in Table 7.1.1, Table 7.1.2 and Table 7.1.3.

.

Table 7.1.1 Radiated fundamental emission limits

Fundamental frequency, MHz	Field strength at 3 m, dB(μV/m)		
	Peak	Average	Quasi-Peak
902 – 928	**NA**	**NA**	**94**
2400 – 2483.5	114.0	94.0	NA
5725 – 5875	114.0	94.0	NA
24000 – 24250*	128.0	108.0	NA

* The band is not used according to RSS-210 section A2.9

Table 7.1.2 Harmonics limits

Fundamental frequency, MHz	Field strength at 3 m, dB(μV/m)	
	Peak	Average
902 – 928	**74.0**	**54.0**
2400 – 2483.5	74.0	54.0
5725 – 5875	74.0	54.0
24000 – 24250*	88.0	68.0

* The band is not used according to RSS-210 section A2.9

Test specification:	Section 15.249(a)(d)/RSS-210, section B.10, Field strength of emissions		
Test procedure:	ANSI C63.10, Section 6.5, 6.6		
Test mode:	Compliance	Verdict:	PASS
Date(s):	26-May-19		
Temperature: 26 ºC	Relative Humidity: 47 %	Air Pressure: 1015 hPa	Power: 3.6 VDC
Remarks:			

Table 7.1.3 Radiated spurious emissions limits (other than harmonics)

Frequency, MHz	Field strength at 3 m, dB(μV/m)*			
	Peak	Quasi Peak	Average	Attenuation below carrier
0.009 – 0.090	148.5 – 128.5	NA	128.5 – 108.5**	50 dBc (whichever is the less stringent)
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		
Above 1000	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.

Note: The above 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 but not exceeding 40 GHz for intentional radiators operated below 10 GHz and up to the fifth harmonic of the highest fundamental frequency but not exceeding 100 GHz for intentional radiators operated above 10 GHz.

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

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

7.1.2.2 The measurements were performed in typical EUT position.

7.1.2.3 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.

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

7.1.3.1 The EUT was set up as shown in Figure 7.1.2 energized and the performance check was conducted.

7.1.3.2 The measurements were performed in typical EUT position.

7.1.3.3 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.

Test specification:	Section 15.249(a)(d)/RSS-210, section B.10, Field strength of emissions		
Test procedure:	ANSI C63.10, Section 6.5, 6.6		
Test mode:	Compliance	Verdict:	PASS
Date(s):	26-May-19		
Temperature: 26 ºC	Relative Humidity: 47 %	Air Pressure: 1015 hPa	Power: 3.6 VDC
Remarks:			

Figure 7.1.1 Setup for spurious emission field strength measurements below 30 MHz

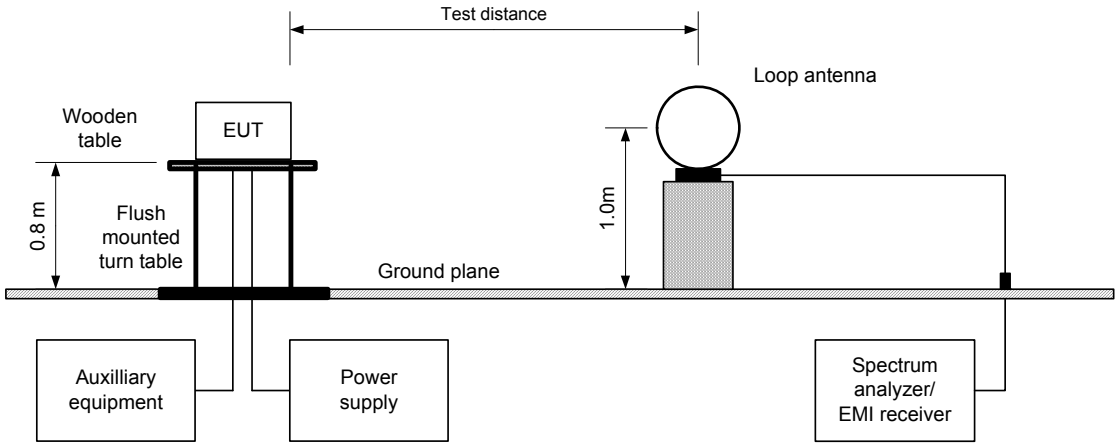
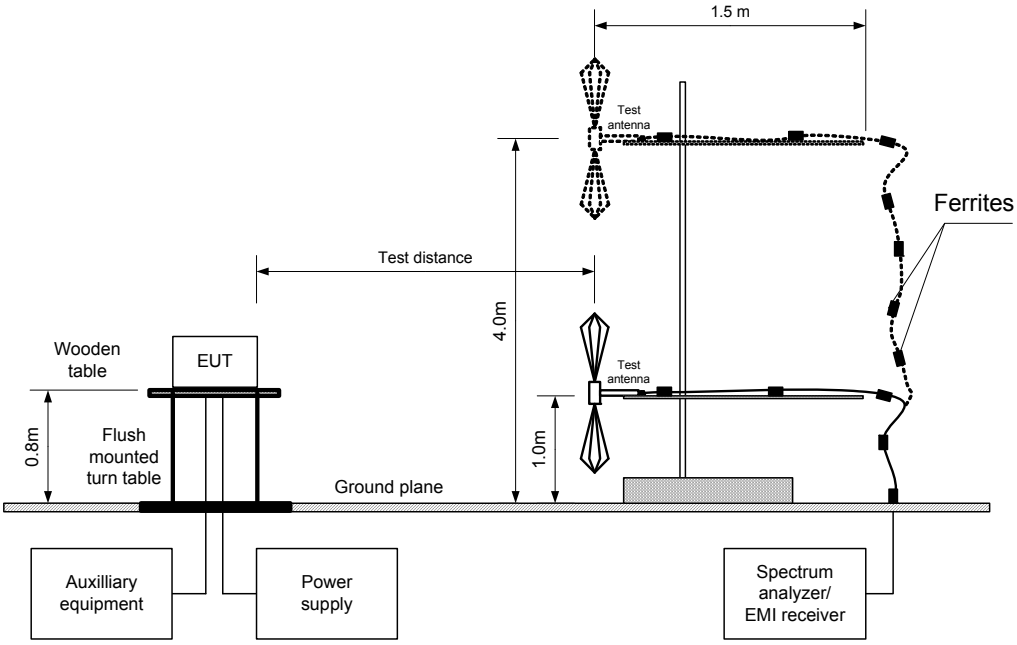
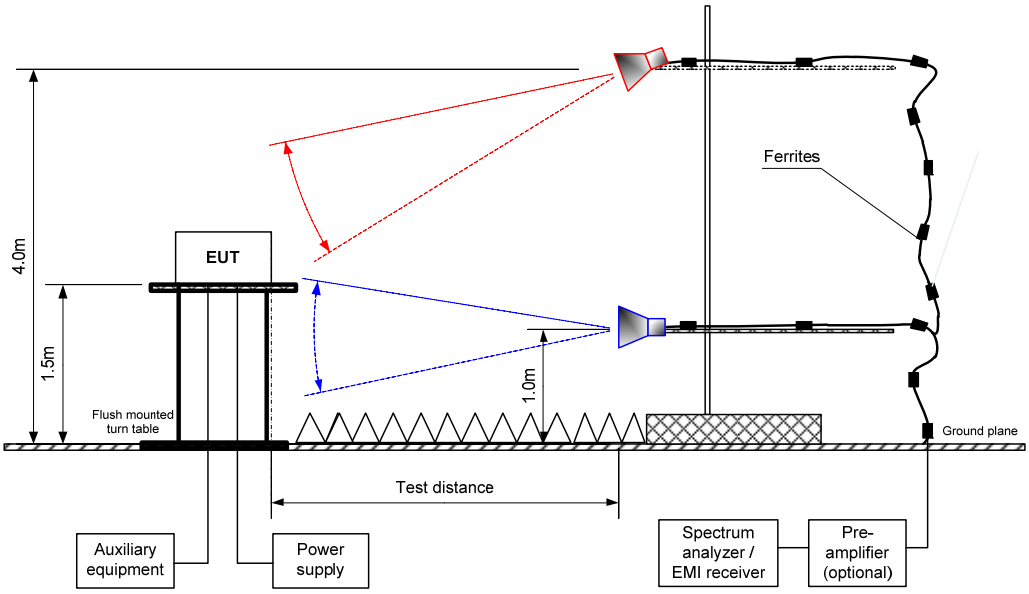


Figure 7.1.2 Setup for spurious emission field strength measurements in 30 -1000 MHz



Test specification:	Section 15.249(a)(d)/RSS-210, section B.10, Field strength of emissions		
Test procedure:	ANSI C63.10, Section 6.5, 6.6		
Test mode:	Compliance	Verdict:	PASS
Date(s):	26-May-19		
Temperature: 26 ºC	Relative Humidity: 47 %	Air Pressure: 1015 hPa	Power: 3.6 VDC
Remarks:			

Figure 7.1.3 Setup for spurious emission field strength measurements above1000 MHz



Test specification:	**Section 15.249(a)(d)/RSS-210, section B.10, Field strength of emissions**		
Test procedure:	ANSI C63.10, Section 6.5, 6.6		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	26-May-19		
Temperature: 26 ºC	**Relative Humidity:** 47 %	**Air Pressure:** 1015 hPa	**Power:** 3.6 VDC
Remarks:			

Table 7.1.4 Field strength of fundamental emission and spurious emissions

TEST DISTANCE:	3 m
EUT POSITION:	Typical
TRANSMITTER OUTPUT POWER SETTINGS:	Maximum
INVESTIGATED FREQUENCY RANGE:	0.009 – 9500 MHz
DETECTOR USED:	Peak
RESOLUTION BANDWIDTH:	1.0 kHz (9 kHz – 150 kHz) 9.0 kHz (150 kHz – 30 MHz) 120 kHz (30 MHz – 1000 MHz) 1.0 MHz (above 1000 MHz)
VIDEO BANDWIDTH:	≥ Resolution bandwidth
TEST ANTENNA TYPE:	Active loop (9 kHz – 30 MHz) Biconilog (30 MHz – 1000 MHz) Double ridged guide (above 1000 MHz)

INVESTIGATED FREQUENCY RANGE: 0.009 – 1000 MHz

Frequency, MHz	**Antenna**		**Azimuth, degrees***	**Peak emission, dB(μV/m)**	**Quasi-peak**			**Verdict**
	Pol.	**Height, m**			**Measured emission, dB(μV/m)**	**Limit, dB(μV/m)**	**Margin, dB****	
Fundamental emission with 2FSK 9.6 kbps								
902.3	Ver	1.00	217	89.12	89.12	94.0	-4.88	Pass
915.0	Ver	1.00	209	90.18	90.18	94.0	-3.82	
927.8	Ver	1.25	7	92.51	92.51	94.0	-1.49	
Fundamental emission with 2FSK 19.2 kbps								
902.3	Ver	1.00	197	89.35	89.35	94.0	-4.65	Pass
915.0	Ver	1.00	184	90.20	90.20	94.0	-3.80	
927.8	Ver	1.00	212	92.58	92.58	94.0	-1.42	
Fundamental emission with 2FSK 38.4 kbps								
902.4	Ver	1.00	161	89.23	89.23	94.0	-4.77	Pass
915.0	Ver	1.00	194	92.62	92.62	94.0	-1.38	
927.6	Ver	1.00	168	92.36	92.36	94.0	-1.64	
Fundamental emission with GFSK 50 kbps								
903.8	Ver	1.00	306	91.17	91.17	94.0	-2.83	Pass
915.0	Ver	1.00	240	92.11	92.11	94.0	-1.89	
927.4	Ver	1.00	103	92.76	92.76	94.0	-1.24	
Spurious emissions at low frequency								
897.003	Hor	1.04	225	41.86	39.18	46.0	-6.82	Pass
936.008	Vert	1.04	200	40.87	38.19	46.0	-7.81	
Spurious emissions at mid frequency								
896.980	Vert	1.02	250	42.50	40.08	46.0	-5.92	Pass
935.975	Vert	1.02	210	40.54	37.46	46.0	-8.54	
Spurious emissions at high frequency								
897.005	Vert	1.00	300	41.79	39.06	46.0	-6.94	Pass
935.989	Vert	1.00	272	39.76	36.48	46.0	-9.52	

Test specification:	Section 15.249(a)(d)/RSS-210, section B.10, Field strength of emissions		
Test procedure:	ANSI C63.10, Section 6.5, 6.6		
Test mode:	Compliance	Verdict:	PASS
Date(s):	26-May-19		
Temperature: 26 ºC	Relative Humidity: 47 %	Air Pressure: 1015 hPa	Power: 3.6 VDC
Remarks:			

INVESTIGATED FREQUENCY RANGE: 1000 – 9500 MHz

F, MHz	Antenna		Azimuth, degrees*	Peak field strength			Avr factor, dB	Average field strength			Verdict
	Pol.	Height, m		Measured, dB(μV/m)	Limit, dB(μV/m)	Margin, dB**		Measured, dB(μV/m)	Limit, dB(μV/m)	Margin, dB**	
Spurious emissions at low frequency											
1804.50	Hor	1.78	176	38.39	74.0	-35.61	NA	25.28	54.0	-28.72	Pass
3608.99	Vert	1.78	108	42.87	74.0	-31.13	NA	31.29	54.0	-22.71	
Spurious emissions at mid frequency											
1830.14	Vert	1.02	351	39.69	74.0	-34.31	NA	28.62	54.0	-25.38	Pass
3659.94	Vert	1.02	139	42.87	74.0	-31.13	NA	31.27	54.0	-22.73	
Spurious emissions at high frequency											
1855.50	Hor	1.79	139	40.33	74.0	-33.67	NA	30.58	54.0	-23.42	Pass

*- EUT front panel refers to 0 degrees position of turntable.
**- Margin, dB =Measured value, dB(μV/m)-Limit, dB(μV/m).

Table 7.1.5 Average factor calculation

Transmission pulse		Transmission burst		Transmission train duration, ms	Average factor, dB
Duration, ms	Period, ms	Duration, ms	Period, ms		
NA	NA	NA	NA	NA	NA

*- Average factor was calculated as follows

for pulse train shorter than 100 ms: $$Average\ factor = 20 \times \log_{10}\left(\frac{Pulse\ duration}{Pulse\ period} \times \frac{Burst\ duration}{Train\ duration} \times Number\ of\ bursts\ within\ pulse\ train\right)$$

for pulse train longer than 100 ms: $$Average\ factor = 20 \times \log_{10}\left(\frac{Pulse\ duration}{Pulse\ period} \times \frac{Burst\ duration}{100\ ms} \times Number\ of\ bursts\ within\ 100\ ms\right)$$

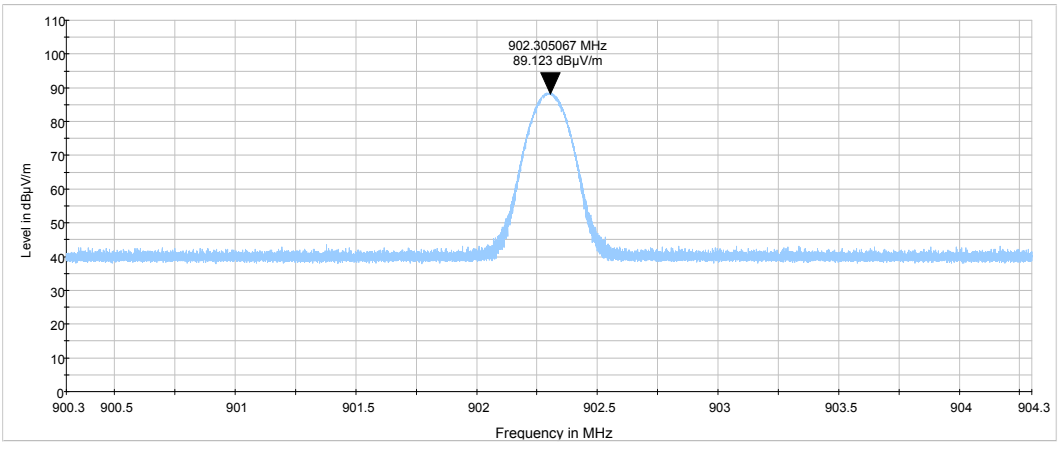
Reference numbers of test equipment used

HL 0446	HL 3903	HL 4360	HL 4933	HL 5288	HL 5405		

Full description is given in Appendix A.

Plot 7.1.1 Radiated emission measurements at the low fundamental frequency with 2FSK 9.6 kbps

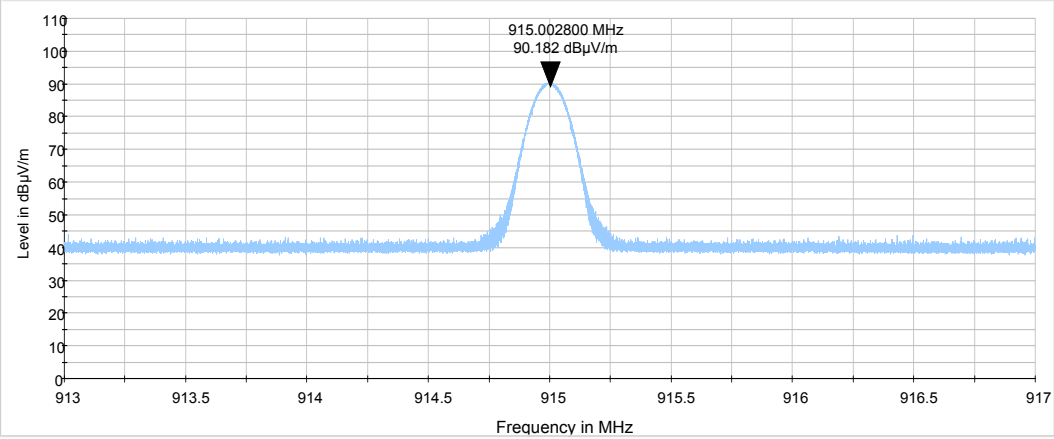
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and horizontal



Test specification:	Section 15.249(a)(d)/RSS-210, section B.10, Field strength of emissions		
Test procedure:	ANSI C63.10, Section 6.5, 6.6		
Test mode:	Compliance	Verdict:	PASS
Date(s):	26-May-19		
Temperature: 26 ºC	Relative Humidity: 47 %	Air Pressure: 1015 hPa	Power: 3.6 VDC
Remarks:			

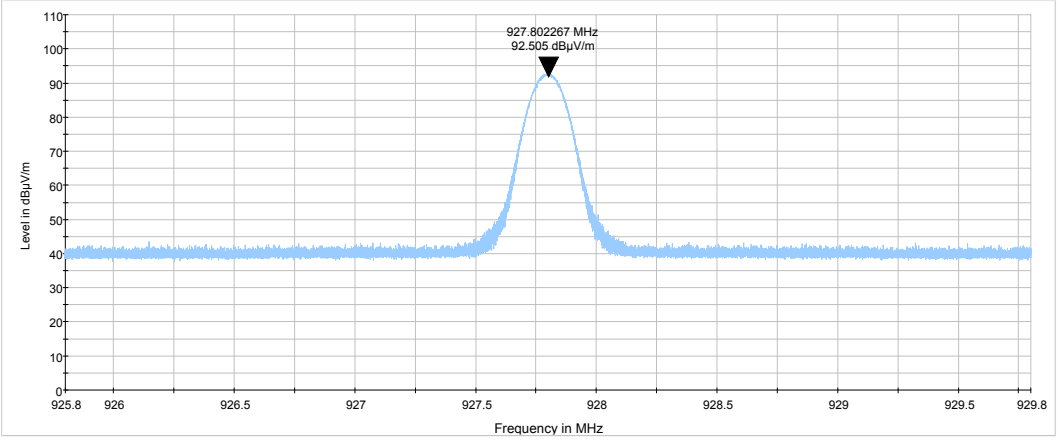
Plot 7.1.2 Radiated emission measurements at the mid fundamental frequency with 2FSK 9.6 kbps

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



Plot 7.1.3 Radiated emission measurements at the high fundamental frequency with 2FSK 9.6 kbps

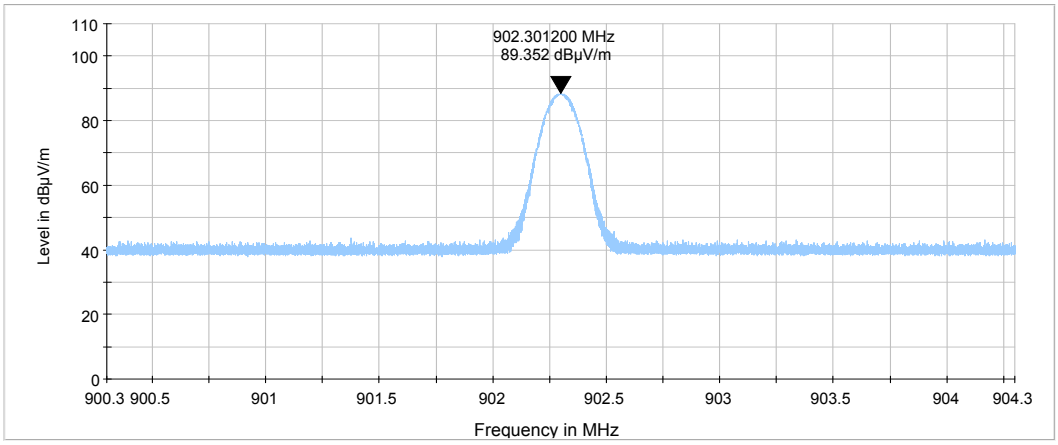
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and horizontal



Test specification:	Section 15.249(a)(d)/RSS-210, section B.10, Field strength of emissions		
Test procedure:	ANSI C63.10, Section 6.5, 6.6		
Test mode:	Compliance	Verdict:	PASS
Date(s):	26-May-19		
Temperature: 26 ºC	Relative Humidity: 47 %	Air Pressure: 1015 hPa	Power: 3.6 VDC
Remarks:			

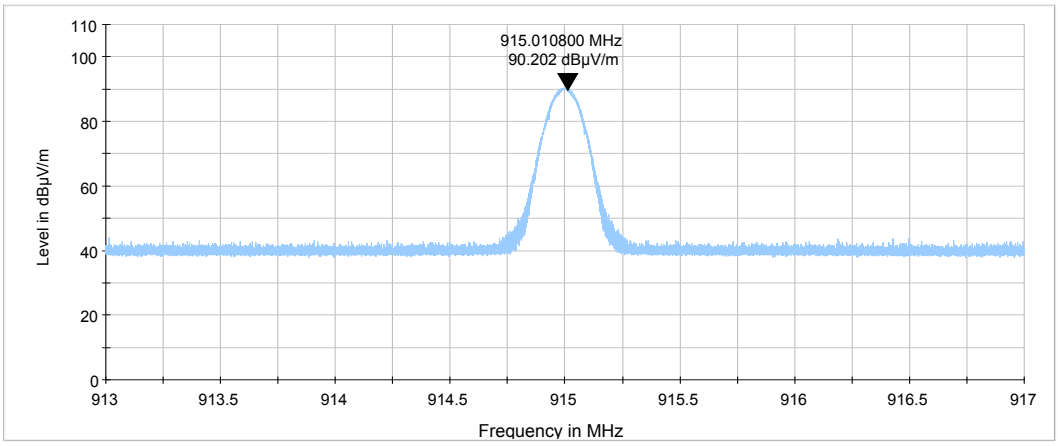
Plot 7.1.4 Radiated emission measurements at the low fundamental frequency with 2FSK 19.2 kbps

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



Plot 7.1.5 Radiated emission measurements at the mid fundamental frequency with 2FSK 19.2 kbps

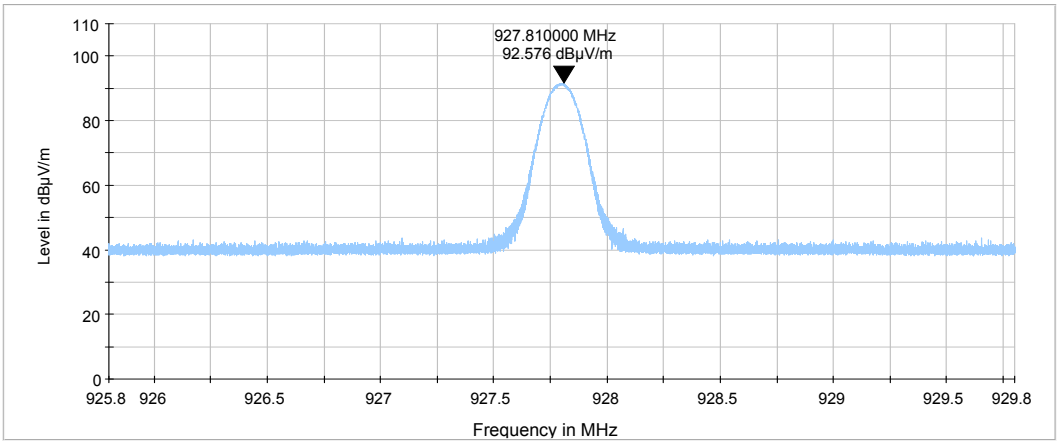
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and horizontal



Test specification:	Section 15.249(a)(d)/RSS-210, section B.10, Field strength of emissions		
Test procedure:	ANSI C63.10, Section 6.5, 6.6		
Test mode:	Compliance	Verdict:	PASS
Date(s):	26-May-19		
Temperature: 26 ºC	Relative Humidity: 47 %	Air Pressure: 1015 hPa	Power: 3.6 VDC
Remarks:			

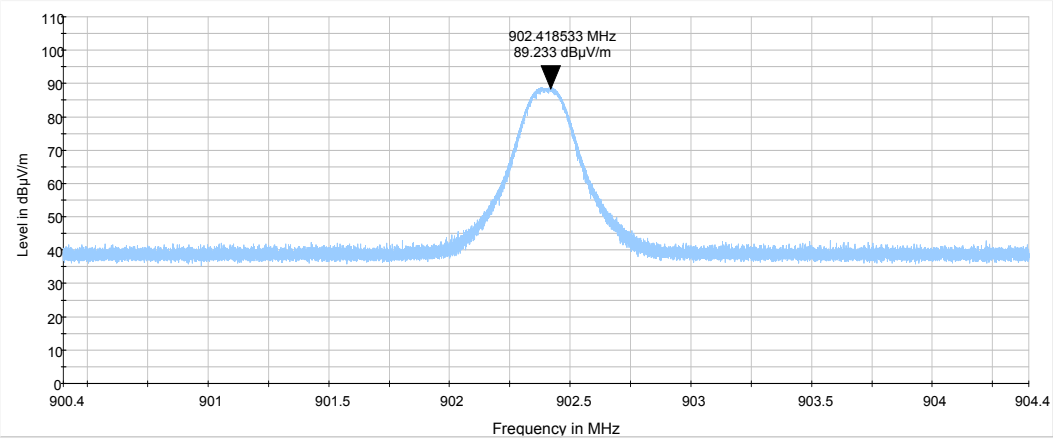
Plot 7.1.6 Radiated emission measurements at the high fundamental frequency with 2FSK 19.2 kbps

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



Plot 7.1.7 Radiated emission measurements at the low fundamental frequency with 2FSK 38.4 kbps

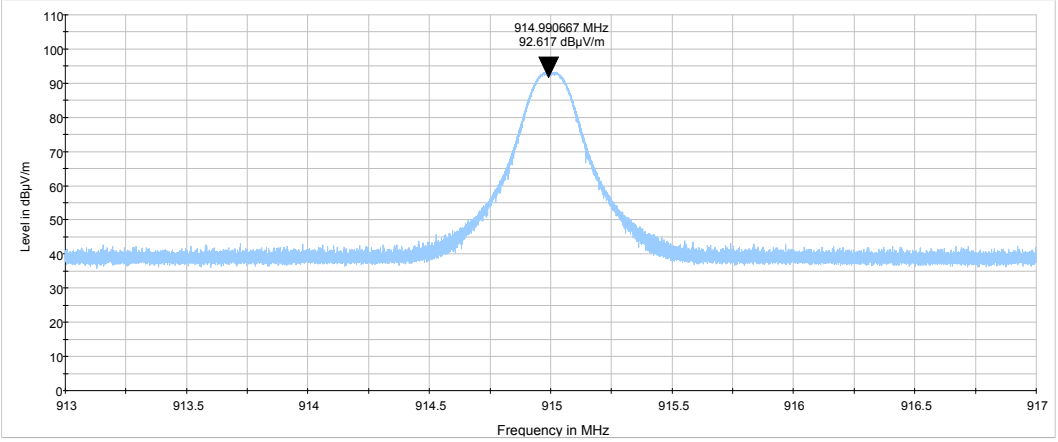
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and horizontal



Test specification:	Section 15.249(a)(d)/RSS-210, section B.10, Field strength of emissions		
Test procedure:	ANSI C63.10, Section 6.5, 6.6		
Test mode:	Compliance	Verdict:	PASS
Date(s):	26-May-19		
Temperature: 26 ºC	Relative Humidity: 47 %	Air Pressure: 1015 hPa	Power: 3.6 VDC
Remarks:			

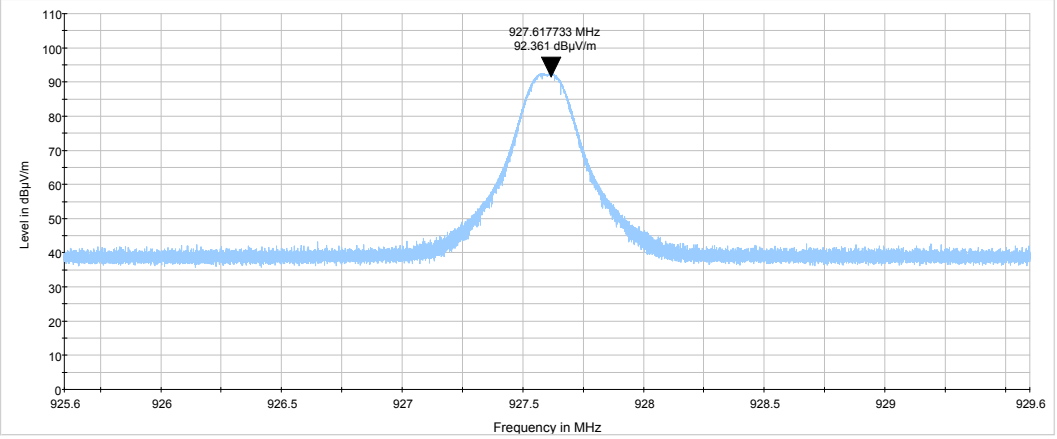
Plot 7.1.8 Radiated emission measurements at the mid fundamental frequency with 2FSK 38.4 kbps

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



Plot 7.1.9 Radiated emission measurements at the high fundamental frequency with 2FSK 38.4 kbps

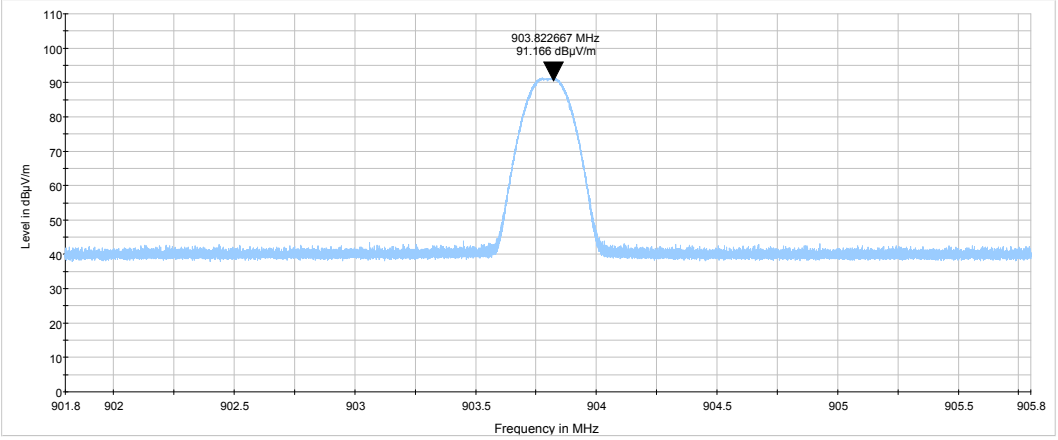
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and horizontal



Test specification:	Section 15.249(a)(d)/RSS-210, section B.10, Field strength of emissions		
Test procedure:	ANSI C63.10, Section 6.5, 6.6		
Test mode:	Compliance	Verdict:	PASS
Date(s):	26-May-19		
Temperature: 26 ºC	Relative Humidity: 47 %	Air Pressure: 1015 hPa	Power: 3.6 VDC
Remarks:			

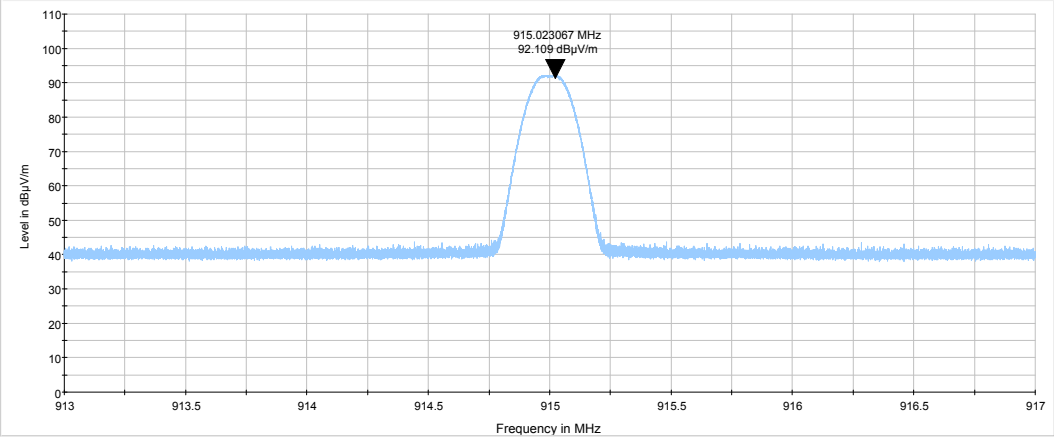
Plot 7.1.10 Radiated emission measurements at the low fundamental frequency with GFSK 50 kbps

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



Plot 7.1.11 Radiated emission measurements at the mid fundamental frequency with GFSK 50 kbps

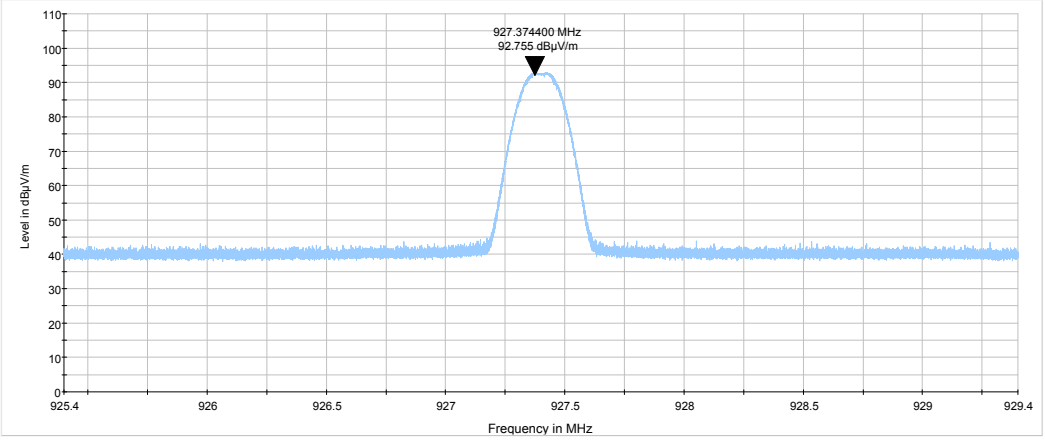
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and horizontal



Test specification:	Section 15.249(a)(d)/RSS-210, section B.10, Field strength of emissions		
Test procedure:	ANSI C63.10, Section 6.5, 6.6		
Test mode:	Compliance	Verdict:	PASS
Date(s):	26-May-19		
Temperature: 26 ºC	Relative Humidity: 47 %	Air Pressure: 1015 hPa	Power: 3.6 VDC
Remarks:			

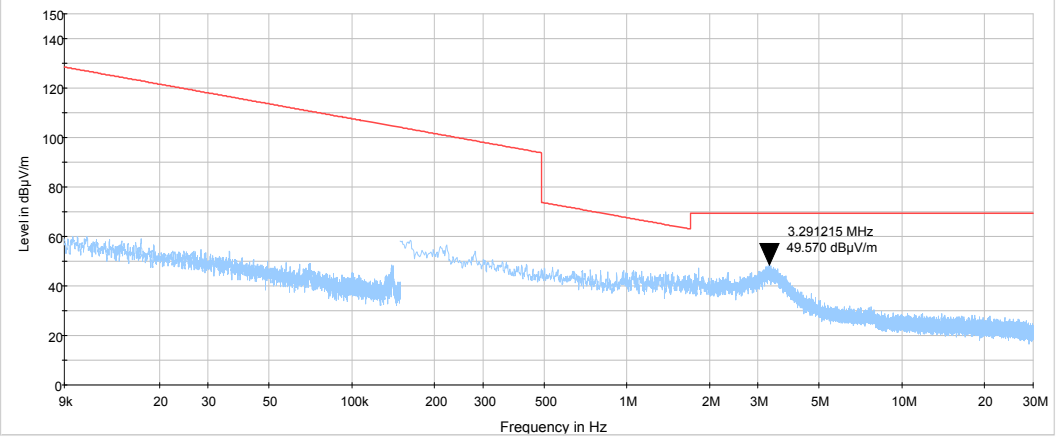
Plot 7.1.12 Radiated emission measurements at the high fundamental frequency with GFSK 50 kbps

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



Plot 7.1.13 Radiated emission measurements from 9 kHz to 30 MHz at the low carrier frequency

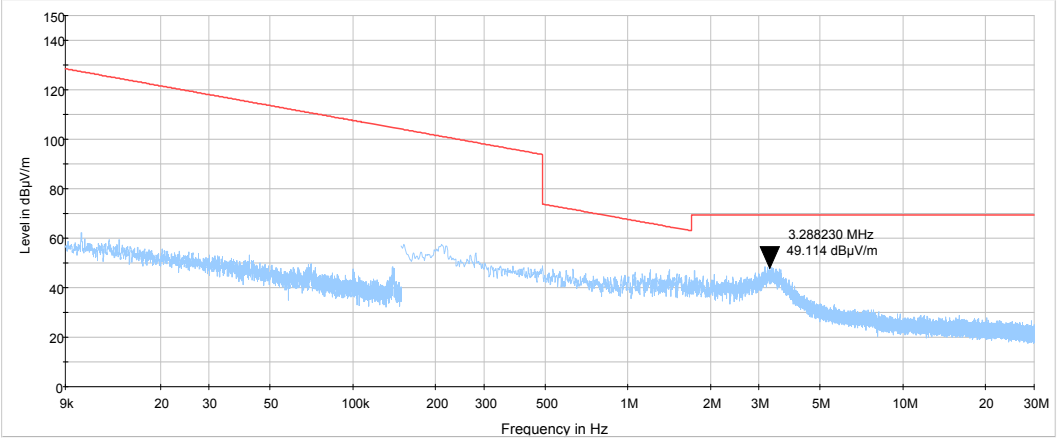
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical



Test specification:	Section 15.249(a)(d)/RSS-210, section B.10, Field strength of emissions		
Test procedure:	ANSI C63.10, Section 6.5, 6.6		
Test mode:	Compliance	Verdict:	PASS
Date(s):	26-May-19		
Temperature: 26 ºC	Relative Humidity: 47 %	Air Pressure: 1015 hPa	Power: 3.6 VDC
Remarks:			

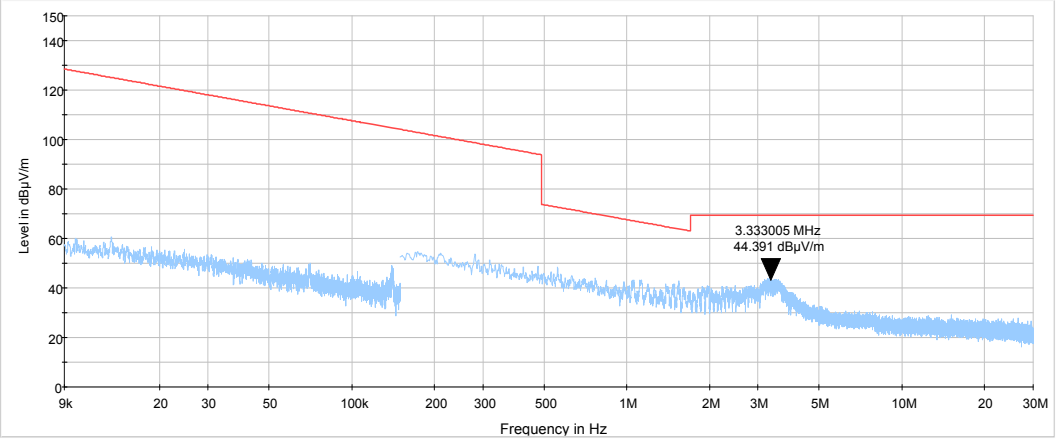
Plot 7.1.14 Radiated emission measurements from 9 kHz to 30 MHz at the mid carrier frequency

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



Plot 7.1.15 Radiated emission measurements from 9 kHz to 30 MHz at the high carrier frequency

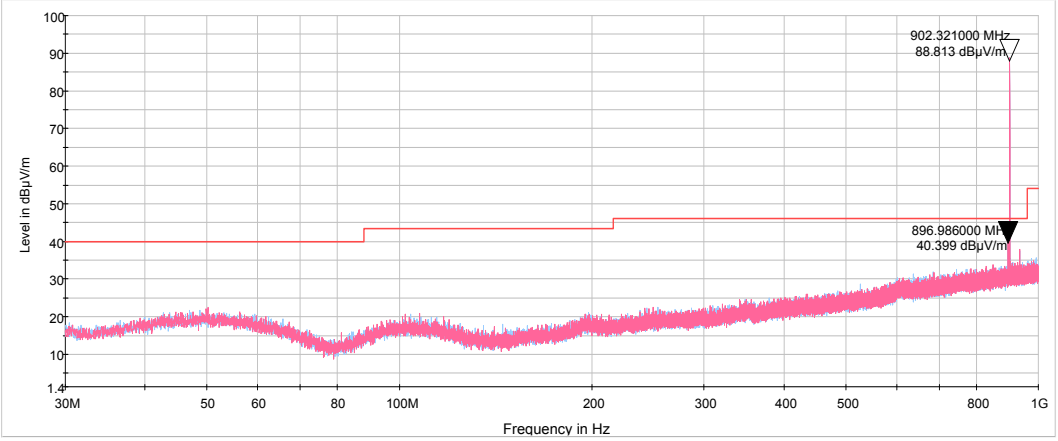
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical



Test specification:	Section 15.249(a)(d)/RSS-210, section B.10, Field strength of emissions		
Test procedure:	ANSI C63.10, Section 6.5, 6.6		
Test mode:	Compliance	Verdict:	PASS
Date(s):	26-May-19		
Temperature: 26 ºC	Relative Humidity: 47 %	Air Pressure: 1015 hPa	Power: 3.6 VDC
Remarks:			

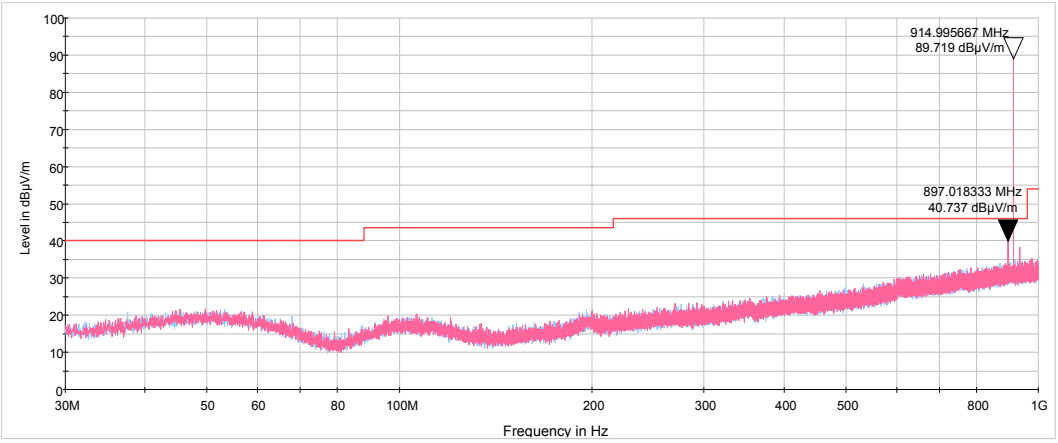
Plot 7.1.16 Radiated emission measurements from 30 to 1000 MHz at the low carrier frequency

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



Plot 7.1.17 Radiated emission measurements from 30 to 1000 MHz at the mid carrier frequency

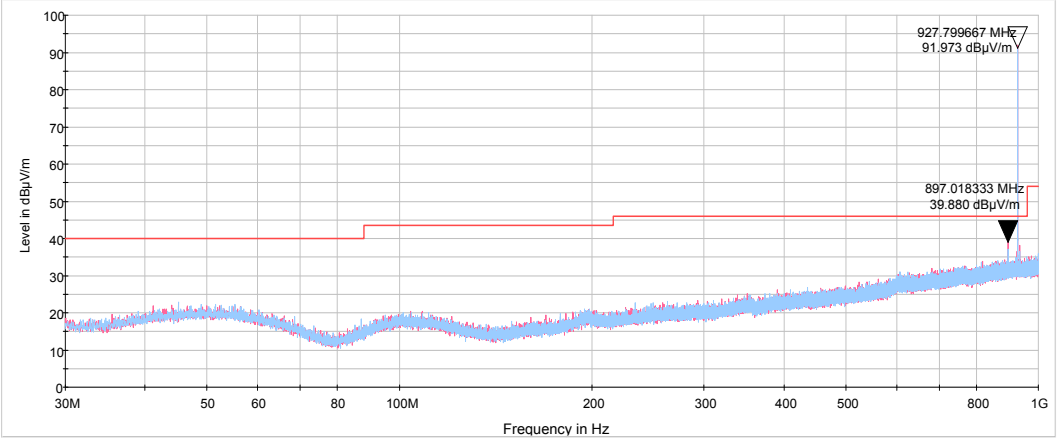
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal



Test specification:	Section 15.249(a)(d)/RSS-210, section B.10, Field strength of emissions		
Test procedure:	ANSI C63.10, Section 6.5, 6.6		
Test mode:	Compliance	Verdict:	PASS
Date(s):	26-May-19		
Temperature: 26 ºC	Relative Humidity: 47 %	Air Pressure: 1015 hPa	Power: 3.6 VDC
Remarks:			

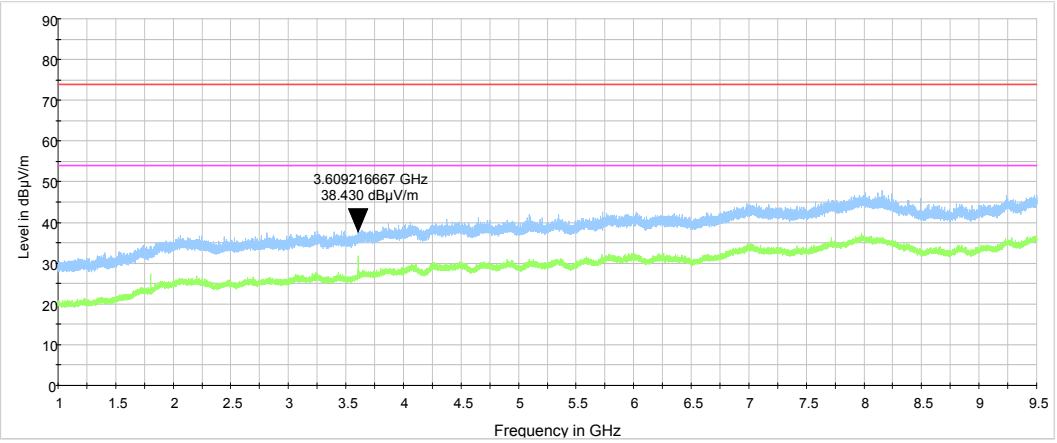
Plot 7.1.18 Radiated emission measurements from 30 to 1000 MHz at the high carrier frequency

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



Plot 7.1.19 Radiated emission measurements from 1 – 9.5 GHz at the low carrier frequency

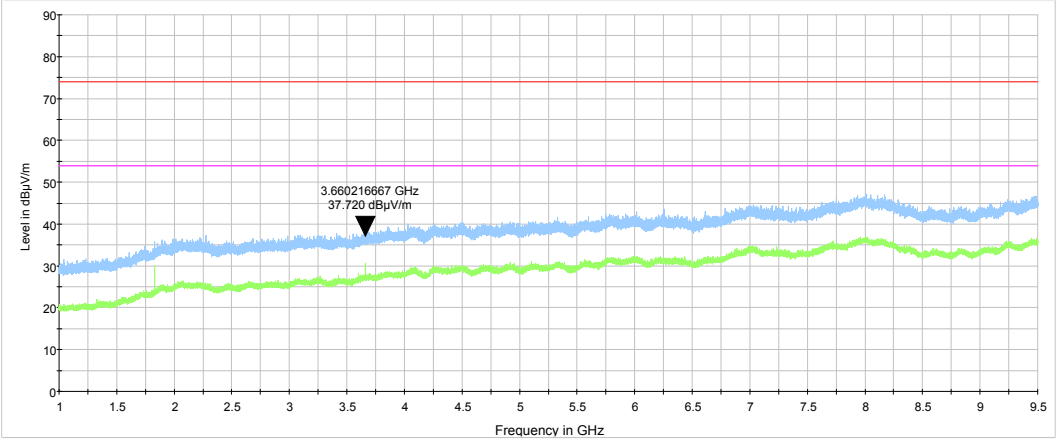
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal



Test specification:	Section 15.249(a)(d)/RSS-210, section B.10, Field strength of emissions		
Test procedure:	ANSI C63.10, Section 6.5, 6.6		
Test mode:	Compliance	Verdict:	PASS
Date(s):	26-May-19		
Temperature: 26 ºC	Relative Humidity: 47 %	Air Pressure: 1015 hPa	Power: 3.6 VDC
Remarks:			

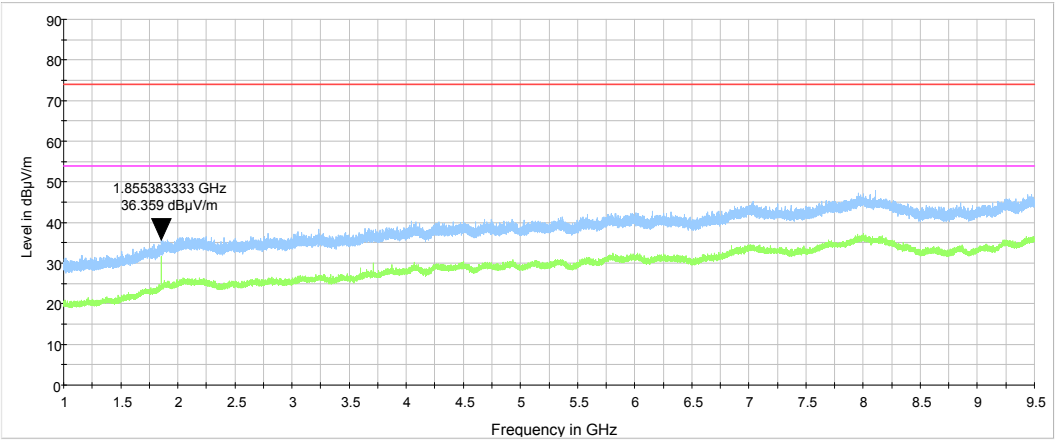
Plot 7.1.20 Radiated emission measurements from 1 – 9.5 GHz at the mid carrier frequency

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



Plot 7.1.21 Radiated emission measurements from 1 – 9.5 GHz at the high carrier frequency

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



Test specification:	Section 15.215(c), Occupied bandwidth		
Test procedure:	ANSI C63.10, Section 6.9.2		
Test mode:	Compliance	Verdict:	PASS
Date(s):	30-May-19		
Temperature: 26 ºC	Relative Humidity: 45 %	Air Pressure: 1009 hPa	Power: 3.6 VDC
Remarks:			

7.2 Occupied bandwidth test

7.2.1 General

This test was performed to verify that the 20 dB bandwidth of the emissions was contained within the standard specified frequency band according to FCC §15.215 requirements. Specification test limits are given in Table 7.2.1.

Table 7.2.1 Occupied bandwidth limits FCC 15.249

Assigned frequency, MHz	Modulation envelope reference points*, dBc
902 - 928	20.0
2400 – 2483.5	
5725 – 5875	
24000 – 24250	

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

Table 7.2.2 Occupied bandwidth limits RSS-210

Assigned frequency, MHz	Modulation envelope reference points*, %
902 - 928	99
2400 – 2483.5	
5725 – 5875	
24000 – 24250	

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

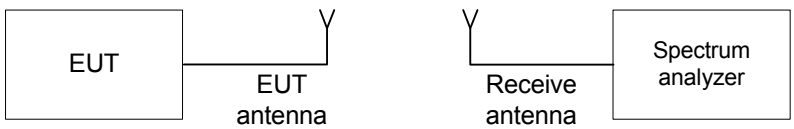
7.2.2 Test procedure

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 spectrum analyzer sweep time and bandwidth were set to capture all major modulation sidebands of emission and sweep time was set sufficiently slow to ensure peak measurements. Spectrum analyzer was set in peak hold mode and time sufficient for trace stabilization was allowed.

7.2.2.3 The peak of emission was measured. The transmitter occupied bandwidth was measured with spectrum analyzer as frequency delta between reference points on modulation envelope and provided in Table 7.2.2 and associated plot.

Figure 7.2.1 Occupied bandwidth test setup



Test specification:	**Section 15.215(c), Occupied bandwidth**		
Test procedure:	ANSI C63.10, Section 6.9.2		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	30-May-19		
Temperature: 26 ºC	**Relative Humidity:** 45 %	**Air Pressure:** 1009 hPa	**Power:** 3.6 VDC
Remarks:			

Table 7.2.3 Occupied bandwidth test results RSS-210 & FCC 15.249

ASSIGNED FREQUENCY BAND: 902.0 – 928.0 MHz
DETECTOR USED: Peak hold
MODULATION: 2FSK
BIT RATE: 9.6 kbps
MODULATING SIGNAL: enable
RESOLUTION BANDWIDTH: 1 kHz
VIDEO BANDWIDTH: 3 kHz

Carrier frequency, MHz	99% Occupied bandwidth, kHz	20 dBc OBW, kHz	Verdict
902.3	21.149	21.967	Pass
915.0	21.204	22.221	Pass
927.8	20.990	21.983	Pass

MODULATION: 2FSK
BIT RATE: 19.2 kbps
MODULATING SIGNAL: enable
RESOLUTION BANDWIDTH: 1 kHz
VIDEO BANDWIDTH: 3 kHz

Carrier frequency, MHz	99% Occupied bandwidth, kHz	20 dBc OBW, kHz	Verdict
902.4	42.244	41.975	Pass
915.0	42.312	42.628	Pass
927.6	42.112	41.984	Pass

MODULATION: 2FSK
BIT RATE: 38.4 kbps
MODULATING SIGNAL: enable
RESOLUTION BANDWIDTH: 3 kHz
VIDEO BANDWIDTH: 10 kHz

Carrier frequency, MHz	99% Occupied bandwidth, kHz	20 dBc OBW, kHz	Verdict
902.4	85.483	88.105	Pass
915.0	85.450	87.815	Pass
927.6	84.713	87.203	Pass

Test specification:	Section 15.215(c), Occupied bandwidth		
Test procedure:	ANSI C63.10, Section 6.9.2		
Test mode:	Compliance	Verdict:	PASS
Date(s):	30-May-19		
Temperature: 26 ºC	Relative Humidity: 45 %	Air Pressure: 1009 hPa	Power: 3.6 VDC
Remarks:			

MODULATION: GFSK
BIT RATE: 50.0 kbps
MODULATING SIGNAL: enable
RESOLUTION BANDWIDTH: 3 kHz
VIDEO BANDWIDTH: 10 kHz

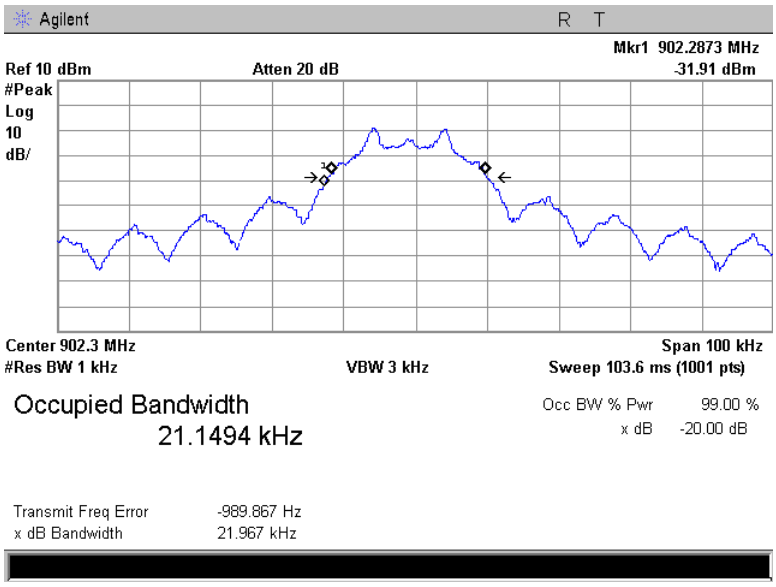
Carrier frequency, MHz	99% Occupied bandwidth, kHz	20 dBc OBW, kHz	Verdict
903.8	85.517	90.719	Pass
915.0	85.797	89.664	Pass
927.4	84.861	90.398	Pass

Reference numbers of test equipment used

HL 0337	HL 2909	HL 4136						

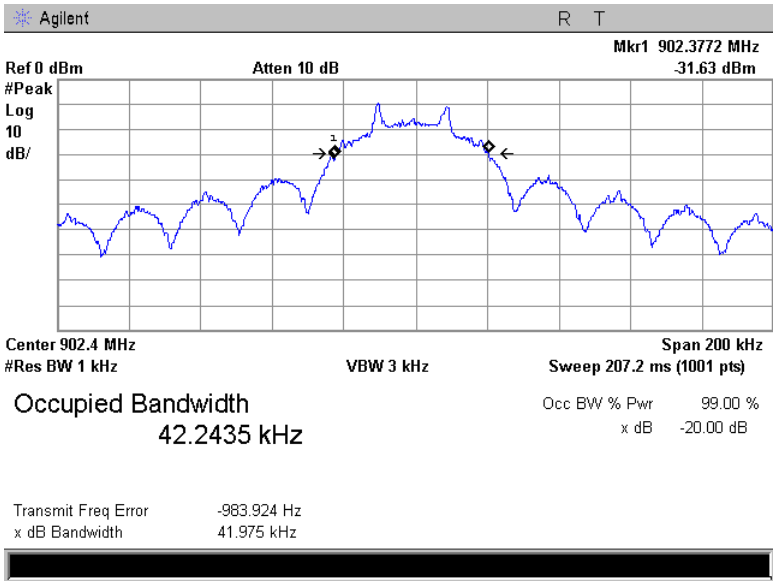
Full description is given in Appendix A.

Plot 7.2.1 The 20 dB bandwidth test result at low frequency with 2FSK 9.6 kbps

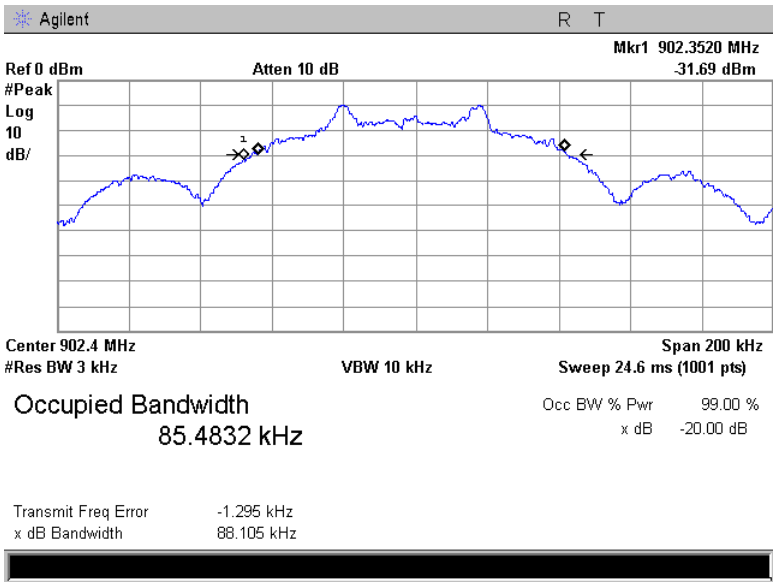


Test specification:	Section 15.215(c), Occupied bandwidth		
Test procedure:	ANSI C63.10, Section 6.9.2		
Test mode:	Compliance	Verdict:	PASS
Date(s):	30-May-19		
Temperature: 26 ºC	Relative Humidity: 45 %	Air Pressure: 1009 hPa	Power: 3.6 VDC
Remarks:			

Plot 7.2.2 The 20 dB bandwidth test result at low frequency with 2FSK 19.2 kbps

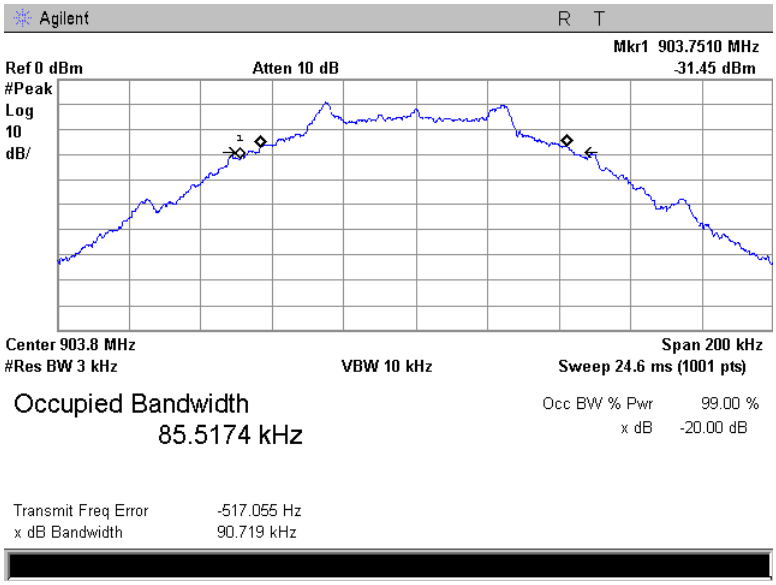


Plot 7.2.3 The 20 dB bandwidth test result at low frequency with 2FSK 38.4 kbps

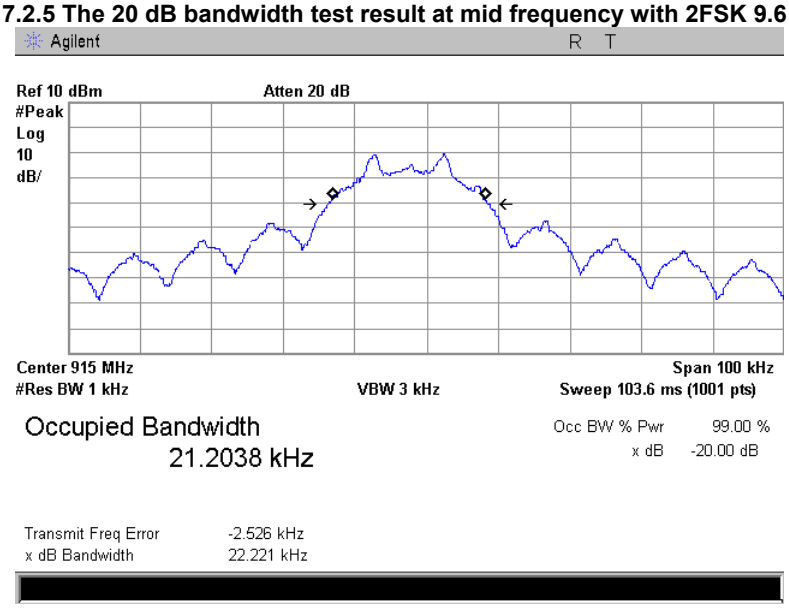


Test specification:	Section 15.215(c), Occupied bandwidth		
Test procedure:	ANSI C63.10, Section 6.9.2		
Test mode:	Compliance	Verdict:	PASS
Date(s):	30-May-19		
Temperature: 26 ºC	Relative Humidity: 45 %	Air Pressure: 1009 hPa	Power: 3.6 VDC
Remarks:			

Plot 7.2.4 The 20 dB bandwidth test result at low frequency with GFSK 50.0 kbps

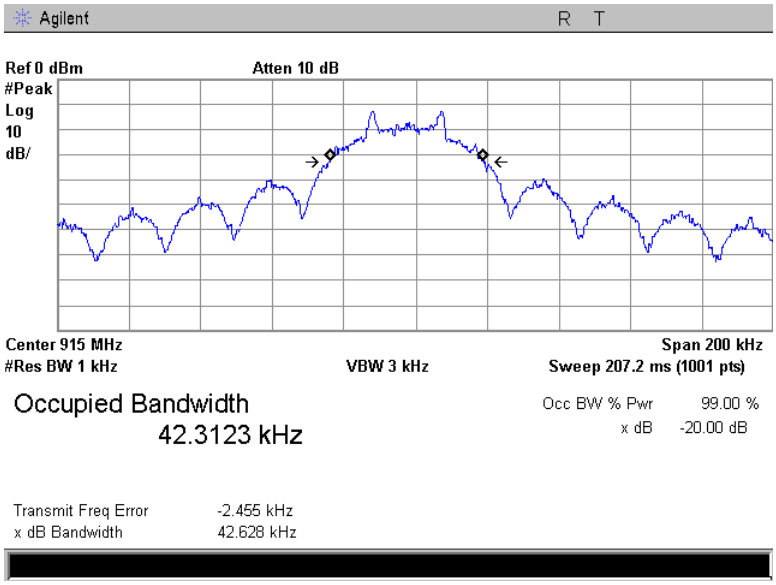


Plot 7.2.5 The 20 dB bandwidth test result at mid frequency with 2FSK 9.6 kbps

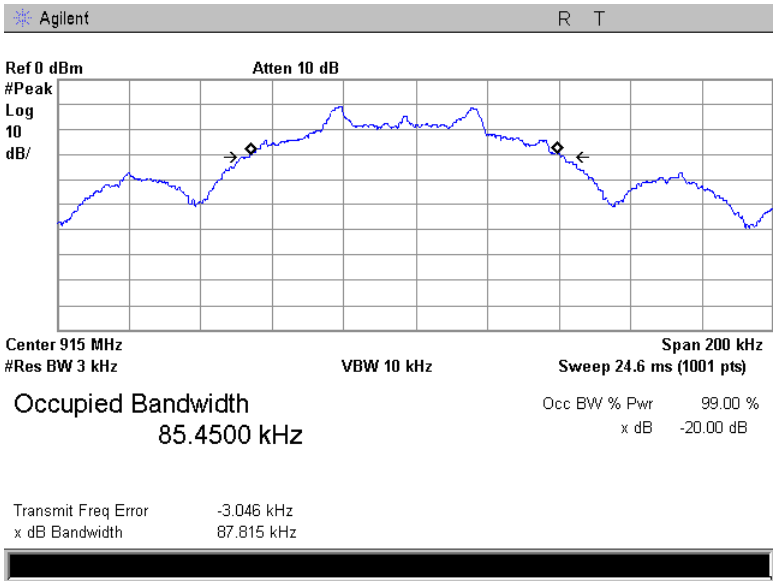


Test specification:	Section 15.215(c), Occupied bandwidth		
Test procedure:	ANSI C63.10, Section 6.9.2		
Test mode:	Compliance	Verdict:	PASS
Date(s):	30-May-19		
Temperature: 26 ºC	Relative Humidity: 45 %	Air Pressure: 1009 hPa	Power: 3.6 VDC
Remarks:			

Plot 7.2.6 The 20 dB bandwidth test result at mid frequency with 2FSK 19.2 kbps

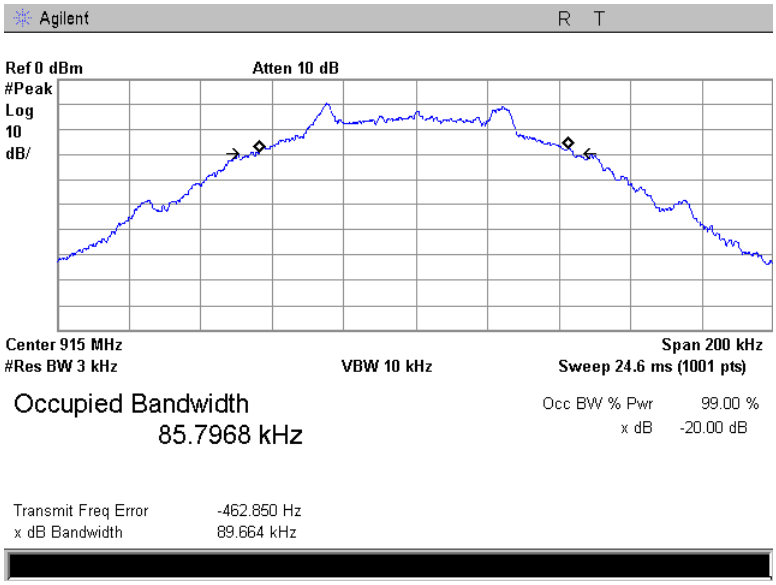


Plot 7.2.7 The 20 dB bandwidth test result at mid frequency with 2FSK 38.4 kbps

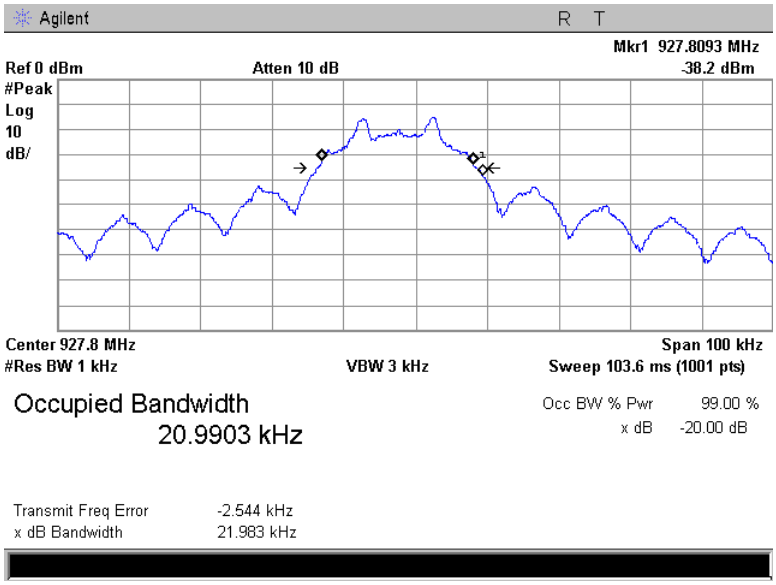


Test specification:	Section 15.215(c), Occupied bandwidth		
Test procedure:	ANSI C63.10, Section 6.9.2		
Test mode:	Compliance	Verdict:	PASS
Date(s):	30-May-19		
Temperature: 26 ºC	Relative Humidity: 45 %	Air Pressure: 1009 hPa	Power: 3.6 VDC
Remarks:			

Plot 7.2.8 The 20 dB bandwidth test result at mid frequency with GFSK 50.0 kbps

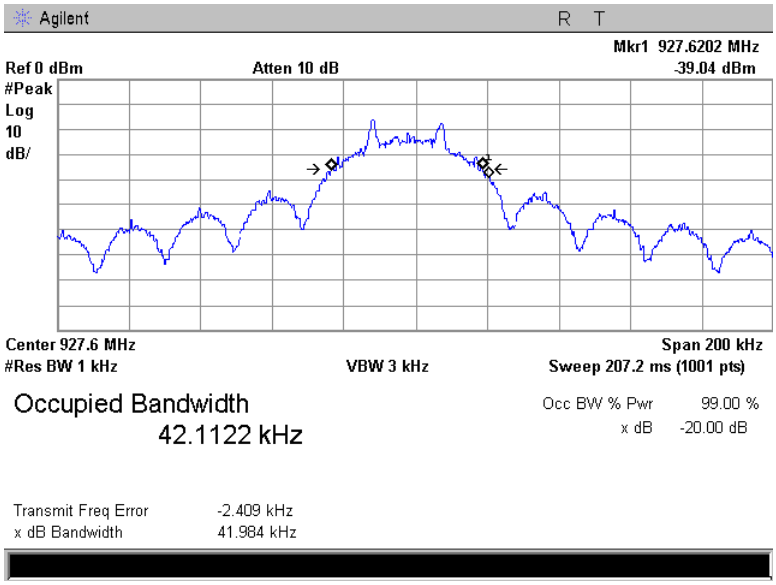


Plot 7.2.9 The 20 dB bandwidth test result at high frequency with 2FSK 9.6 kbps

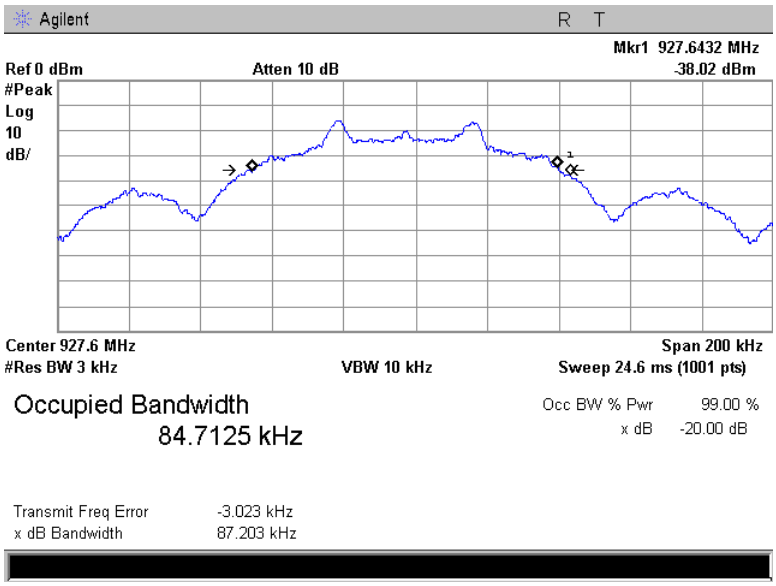


Test specification:	Section 15.215(c), Occupied bandwidth		
Test procedure:	ANSI C63.10, Section 6.9.2		
Test mode:	Compliance	Verdict:	PASS
Date(s):	30-May-19		
Temperature: 26 ºC	Relative Humidity: 45 %	Air Pressure: 1009 hPa	Power: 3.6 VDC
Remarks:			

Plot 7.2.10 The 20 dB bandwidth test result at high frequency with 2FSK 19.2 kbps

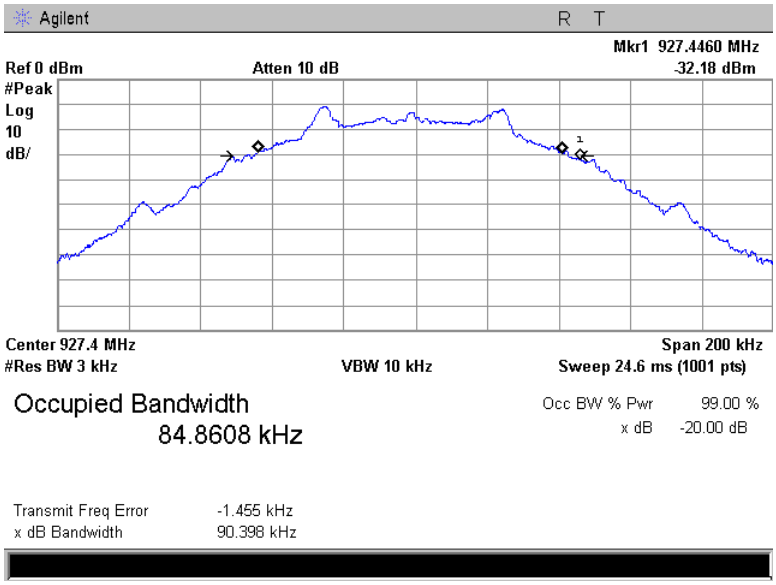


Plot 7.2.11 The 20 dB bandwidth test result at high frequency with 2FSK 38.4 kbps



Test specification:	Section 15.215(c), Occupied bandwidth		
Test procedure:	ANSI C63.10, Section 6.9.2		
Test mode:	Compliance	Verdict:	PASS
Date(s):	30-May-19		
Temperature: 26 ºC	Relative Humidity: 45 %	Air Pressure: 1009 hPa	Power: 3.6 VDC
Remarks:			

Plot 7.2.12 The 20 dB bandwidth test result at high frequency with GFSK 50.0 kbps



Test specification:	Section 15.249(d)/RSS-210, section C.4, Band edge emissions		
Test procedure:	ANSI C63.10, Section 6.10		
Test mode:	Compliance	Verdict:	PASS
Date(s):	27-May-19		
Temperature: 26 ºC	Relative Humidity: 45 %	Air Pressure: 1013 hPa	Power: 3.6 VDC
Remarks:			

7.3 Band edge emission

7.3.1 General

This test was performed to verify the EUT band edge emission including all associated side bands was attenuated at least 50 dB below the unmodulated carrier level or below the general spurious emission limit. Specification test limits are given in Table 7.3.1.

Table 7.3.1 Band edge emission limits

Frequency band, MHz	Field strength limit at 3 m, dBµV/m		Attenuation below carrier, dBc
	Peak	QP	
902.000 - 928.000	NA	46.0	50

7.3.2 Test procedure

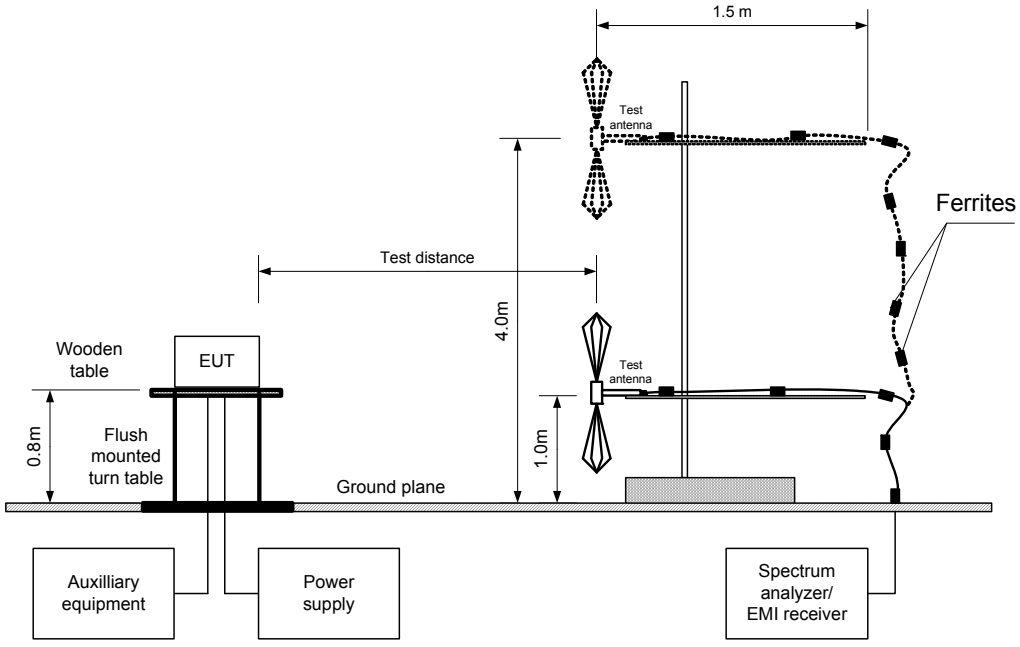
7.3.2.1 The EUT was set up as shown in Figure 7.3.1, energized and the performance check was conducted.

7.3.2.2 The spectrum analyzer frequency span was set to capture all major modulation sidebands of emission and sweep time was set sufficiently slow to ensure peak measurements. Spectrum analyzer was set in peak hold mode and time sufficient for trace stabilization was allowed.

7.3.2.3 The frequency of modulation envelope points beyond which power level drops below the band edge emission limit was measured.

7.3.2.4 The test results were recorded in Table 7.3.2 and shown in the associated plots.

Figure 7.3.1 Band edge emission measurement set up



Test specification:	**Section 15.249(d)/RSS-210, section C.4, Band edge emissions**		
Test procedure:	ANSI C63.10, Section 6.10		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	27-May-19		
Temperature: 26 ºC	**Relative Humidity:** 45 %	**Air Pressure:** 1013 hPa	**Power:** 3.6 VDC
Remarks:			

Table 7.3.2 Band edge emission test results

OPERATING FREQUENCY RANGE: 902.0 – 928.0 MHz
DETECTOR USED: Peak hold
RESOLUTION BANDWIDTH: 100 kHz
VIDEO BANDWIDTH: 300 kHz
MODULATING SIGNAL: PRBS
TRANSMITTER OUTPUT POWER SETTINGS: Maximum

MODULATION: 2FSK
BIT RATE: 9.6 kbps
LOW CARRIER FREQUENCY: 902.3 MHz
HIGH CARRIER FREQUENCY: 927.8 MHz

Modulation envelope		**Measured peak emission, dBµV/m**	**Measured QP emission, dBµV/m**	**QP limit, dBµV/m**	**Margin, dB ***	**Verdict**
Edge	**Frequency, MHz**					
Low	897.000	42.39	39.87	46.0	-6.13	Pass
	901.994	40.16	33.15	46.0	-12.85	
High	928.000	52.29	45.86	46.0	-0.14	Pass

MODULATION: 2FSK
BIT RATE: 38.4 kbps
LOW CARRIER FREQUENCY: 902.3 MHz
HIGH CARRIER FREQUENCY: 927.8 MHz

Modulation envelope		**Measured peak emission, dBµV/m**	**Measured QP emission, dBµV/m**	**QP limit, dBµV/m**	**Margin, dB ***	**Verdict**
Edge	**Frequency, MHz**					
Low	901.995	41.49	36.32	46.0	-9.68	Pass
High	928.001	46.83	41.38	46.0	-4.62	Pass

MODULATION: GFSK
BIT RATE: 50 kbps
LOW CARRIER FREQUENCY: 903.8 MHz
HIGH CARRIER FREQUENCY: 927.4 MHz

Modulation envelope		**Measured peak emission, dBµV/m**	**Measured QP emission, dBµV/m**	**QP limit, dBµV/m**	**Margin, dB ***	**Verdict**
Edge	**Frequency, MHz**					
Low	No emission were found					Pass
High	928.056	35.89	29.93	46.0	-16.07	Pass

* - Margin = measured value– limit

The test shows compliance with 15.249(d) requirements.

Reference numbers of test equipment used

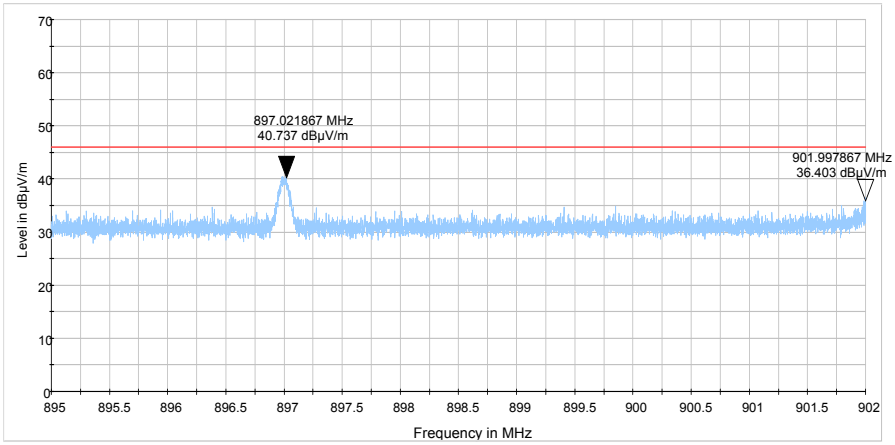
HL 3903	HL 4360	HL 5288	HL 5405				

Full description is given in Appendix A.

Test specification:	Section 15.249(d)/RSS-210, section C.4, Band edge emissions		
Test procedure:	ANSI C63.10, Section 6.10		
Test mode:	Compliance	Verdict:	PASS
Date(s):	27-May-19		
Temperature: 26 ºC	Relative Humidity: 45 %	Air Pressure: 1013 hPa	Power: 3.6 VDC
Remarks:			

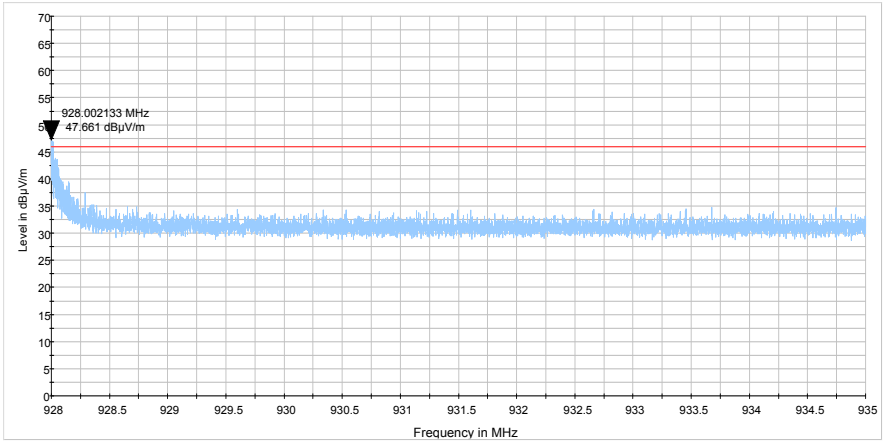
Plot 7.3.1 Low band edge emission test result

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
MODULATION: 2FSK
BIT RATE: 9.6 kbps



Plot 7.3.2 High band edge emission test result

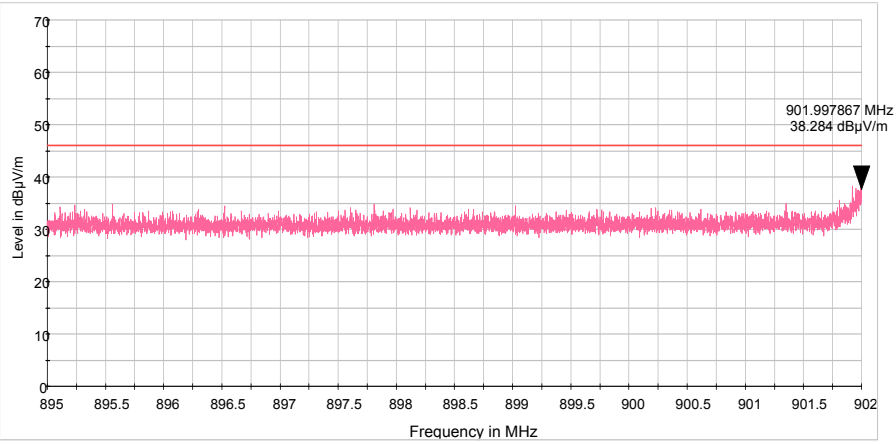
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
MODULATION: 2FSK
BIT RATE: 9.6 kbps



Test specification:	Section 15.249(d)/RSS-210, section C.4, Band edge emissions		
Test procedure:	ANSI C63.10, Section 6.10		
Test mode:	Compliance	Verdict:	PASS
Date(s):	27-May-19		
Temperature: 26 ºC	Relative Humidity: 45 %	Air Pressure: 1013 hPa	Power: 3.6 VDC
Remarks:			

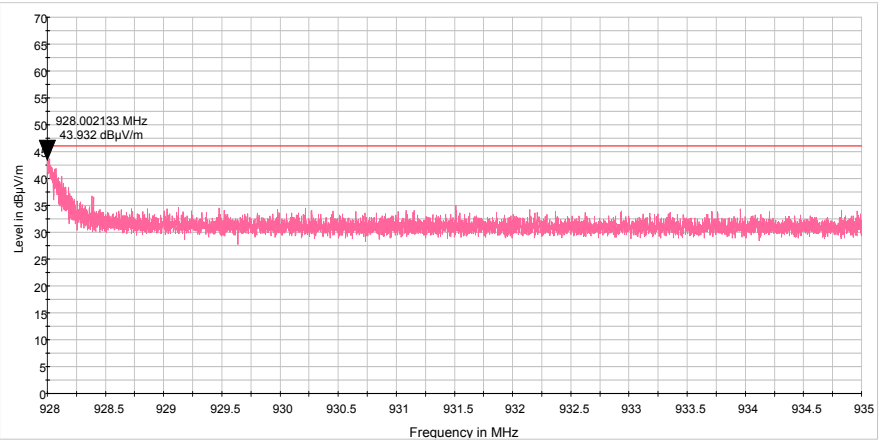
Plot 7.3.3 Low band edge emission test result

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
MODULATION: 2FSK
BIT RATE: 38.4 kbps



Plot 7.3.4 High band edge emission test result

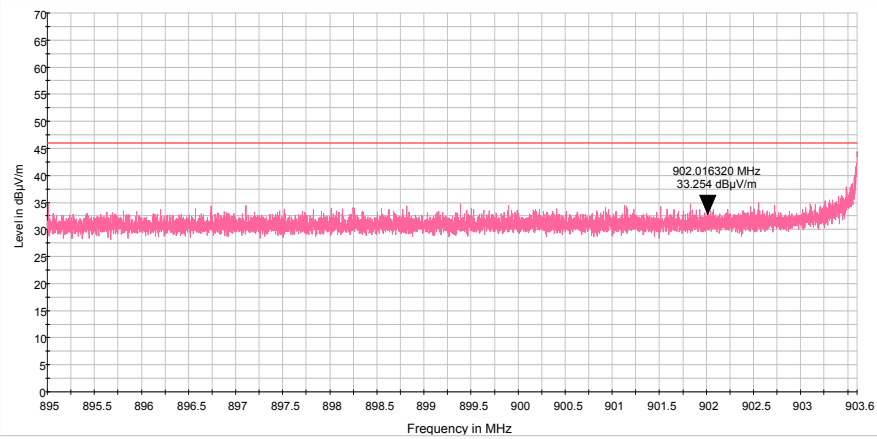
TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
MODULATION: 2FSK
BIT RATE: 38.4 kbps



Test specification:	Section 15.249(d)/RSS-210, section C.4, Band edge emissions		
Test procedure:	ANSI C63.10, Section 6.10		
Test mode:	Compliance	Verdict:	PASS
Date(s):	27-May-19		
Temperature: 26 ºC	Relative Humidity: 45 %	Air Pressure: 1013 hPa	Power: 3.6 VDC
Remarks:			

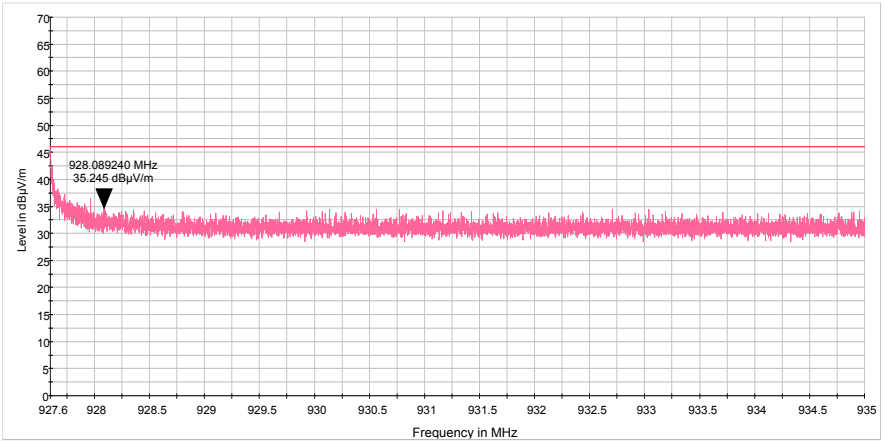
Plot 7.3.5 Low band edge emission test result

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
MODULATION: GFSK
BIT RATE: 50 kbps



Plot 7.3.6 High band edge emission test result

TEST SITE: Semi anechoic chamber
TEST DISTANCE: 3 m
ANTENNA POLARIZATION: Vertical and Horizontal
MODULATION: GFSK
BIT RATE: 50 kbps



Test specification:	**Section 15.203, Antenna requirement**		
Test procedure:	Visual inspection / supplier declaration		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	10-Jun-19		
Temperature: 25 ºC	**Relative Humidity:** 46 %	**Air Pressure:** 1008 hPa	**Power:** 3.6 VDC
Remarks:			

7.4 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 7.4.1.

Table 7.4.1 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:	Section 15.109 / RSS-Gen, section 7.3, ICES-003, Radiated emission		
Test procedure:	ANSI C63.4, Sections 11.6 and 12.1.4		
Test mode:	Compliance	Verdict:	PASS
Date(s):	28-May-19		
Temperature: 24 ºC	Relative Humidity: 48 %	Air Pressure: 1012 hPa	Power: 3.6 VDC
Remarks:			

8 Unintentional emission tests

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.

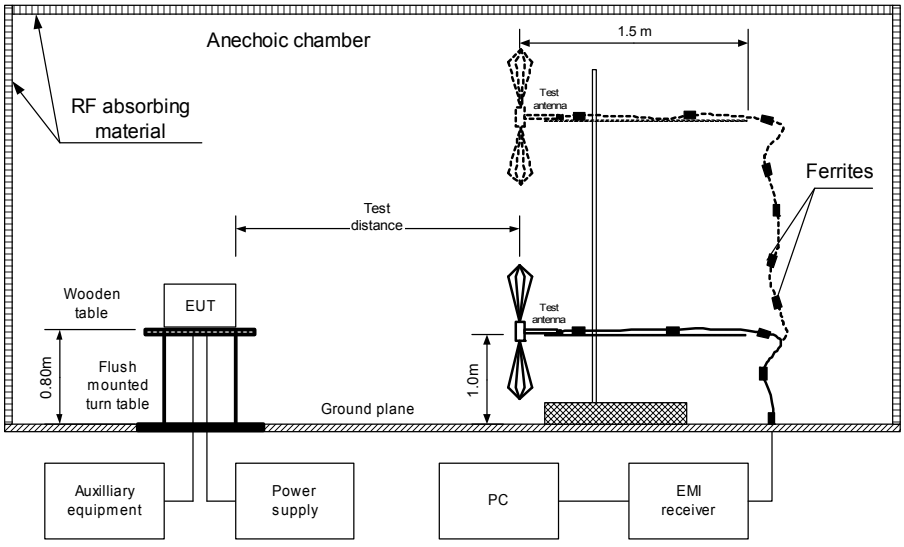
8.1.2 Test procedure for measurements in semi-anechoic chamber

8.1.2.1 The EUT was set up as shown in Figure 8.1.1 and associated photograph/s, 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.

Figure 8.1.1 Setup for radiated emission measurements in anechoic chamber, table-top equipment



Test specification:	**Section 15.109 / RSS-Gen, section 7.3, ICES-003, Radiated emission**		
Test procedure:	ANSI C63.4, Sections 11.6 and 12.1.4		
Test mode:	Compliance	**Verdict:**	PASS
Date(s):	28-May-19		
Temperature: 24 ºC	**Relative Humidity:** 48 %	**Air Pressure:** 1012 hPa	**Power:** 3.6 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*				
No emission were found								Pass

TEST SITE: SEMI ANECHOIC CHAMBER
TEST DISTANCE: 3 m
DETECTORS USED: PEAK / AVERAGE
FREQUENCY RANGE: 1000 MHz – 5000 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 emission were found										Pass

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

Reference numbers of test equipment used

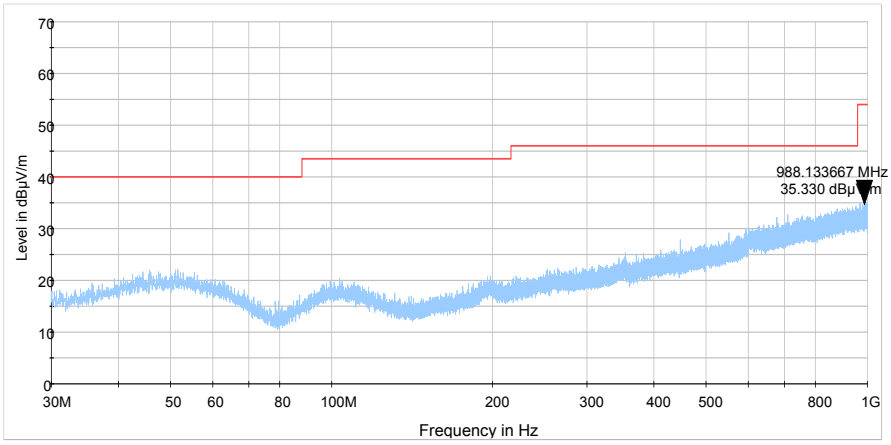
HL 3903	HL 4360	HL 4933	HL 5288	HL 5405			

Full description is given in Appendix A.

Test specification:	Section 15.109 / RSS-Gen, section 7.3, ICES-003, Radiated emission		
Test procedure:	ANSI C63.4, Sections 11.6 and 12.1.4		
Test mode:	Compliance	Verdict:	PASS
Date(s):	28-May-19		
Temperature: 24 ºC	Relative Humidity: 48 %	Air Pressure: 1012 hPa	Power: 3.6 VDC
Remarks:			

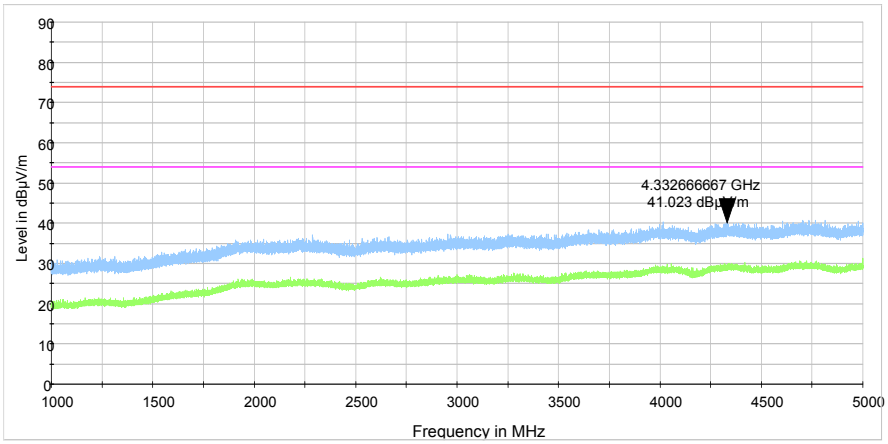
Plot 8.1.1 Radiated emission measurements in 30 - 1000 MHz range, vertical and horizontal antenna polarization

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 - 5 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 equipment and ancillaries used for tests

HL No	Description	Manufacturer	Model	Ser. No.	Last Cal./ Check	Due Cal./ Check
0337	Probe Set, Hand held, 5 probes	Electro-Metrics	EHFP-30	238	26-Jun-19	26-Jun-20
0446	Antenna, Loop, Active, 10 (9) kHz - 30 MHz	EMCO	6502	2857	24-Feb-19	24-Feb-20
2909	Spectrum analyzer, ESA-E, 100 Hz to 26.5 GHz	Agilent Technologies	E4407B	MY41444762	04-Apr-19	04-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
4136	Shield Box	TESCOM CO., LTD	TC-5916A	5916A000137	24-Apr-19	24-Apr-20
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
5288	Trilog Antenna, 25 MHz - 8 GHz, 100W	Frankonia	ALX-8000E	00809	08-Feb-19	08-Feb-22
5405	RF cable, 18 GHz, N-N, 6 m	Huber-Suhner	SF118/11N(x2)	500023/118	11-Aug-19	11-Aug-20

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

Frequency, MHz	Antenna factor, dB/m	Frequency, MHz	Antenna factor, dB/m
30	14.96	160	12.67
35	15.33	180	13.34
40	16.37	200	15.40
45	17.56	250	16.42
50	17.95	300	17.28
60	16.87	400	19.98
70	13.22	500	21.11
80	10.56	600	22.90
90	13.61	700	24.13
100	15.46	800	25.25
120	14.03	900	26.35
140	12.23	1000	27.18

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

above 1000 MHz

Frequency, MHz	Antenna factor, dB/m	Frequency, MHz	Antenna factor, dB/m
1000	26.9	3600	38.9
1100	28.1	3700	39.4
1200	28.4	3800	39.4
1300	29.6	3900	39.6
1400	29.1	4000	39.7
1500	30.4	4100	39.8
1600	30.7	4200	40.5
1700	31.5	4300	40.9
1800	32.3	4400	41.1
1900	32.6	4500	41.4
2000	32.5	4600	41.3
2100	32.9	4700	41.6
2200	33.5	4800	41.9
2300	33.2	4900	42.3
2400	33.7	5000	42.7
2500	34.6	5100	43.0
2600	34.7	5200	42.9
2700	34.6	5300	43.5
2800	35.0	5400	43.6
2900	35.5	5500	44.3
3000	36.2	5600	44.7
3100	36.8	5700	45.0
3200	36.8	5800	45.0
3300	37.0	5900	45.3
3400	37.5	6000	45.9
3500	38.2		

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

HL 5405: RF Cable
Huber-Suhner, model: SF118/11N(x2), s/n: 500023/118
Calibration date: 01-Aug-2018

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

11 APPENDIX C Measurement uncertainties

Expanded uncertainty at 95% confidence in Hermon Labs EMC measurements

Test description	Expanded uncertainty
Radiated emissions at 10 m measuring distance Horizontal polarization Vertical polarization	 Biconilog antenna: ± 5.0 dB Biconical antenna: ± 5.0 dB Log periodic antenna: ± 5.1 dB Double ridged horn antenna: ± 5.3 dB Biconilog antenna: ± 5.5 dB Biconical antenna: ± 5.5 dB Log periodic antenna: ± 5.6 dB Double ridged horn antenna: ± 5.8 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
Duty cycle, timing (Tx ON / OFF) and average factor measurements	 ± 1.0 %
Occupied bandwidth	± 8.0 %

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

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

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

12 APPENDIX D Test laboratory description

Tests were performed at Hermon Laboratories Ltd., which is a fully independent, private, EMC, Radio, Safety, Environmental and Telecommunication testing facility.
Hermon Laboratories is recognized and accredited by the Federal Communications Commission (USA) for relevant parts of Code of Federal Regulations 47 (CFR 47), Test Firm Registration Number is 927748, Designation Number is IL1001; Recognized by Innovation, Science and Economic Development Canada for wireless and terminal testing (ISED), ISED #2186A, CAB identifier is IL1001; Certified by VCCI, Japan (the registration numbers are R-10808 for OATS, R-11082 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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Person for contact: Mr. Michael Nikishin, EMC&Radio group manager

13 APPENDIX E Specification references

47CFR part 15: 2018	Radio Frequency Devices.
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
RSS-210 Issue 9: 2016	Licence–Exempt Radio Apparatus: Category I Equipment
RSS-Gen:2018, Issue 5	General Requirements for Compliance of Radio Apparatus
ICES-003:2016, Issue 6	Information Technology Equipment (Including Digital Apparatus) – Limits and methods of measurement

14 APPENDIX F Abbreviations and acronyms

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

END OF DOCUMENT