8.5.5 Test data, 150 kbps

Table 8.5-7: *20 dB bandwidth results, 150 kbps*

Frequency, MHz	20 dB bandwidth, kHz	Max 20 dB bandwidth limit, kHz	Margin, kHz
902.4	353.1	500	146.9
914.8	350.0	500	150.0
927.6	335.2	500	164.8

Figure 8.5-11: *20 dB bandwidth on low channel, 150 kbps*

Figure 8.5-12: *20 dB bandwidth on mid channel, 150 kbps*

Figure 8.5-13: *20 dB bandwidth on high channel, 150 kbps*

Test data continued, 150 kbps

Table 8.5-8: *99% occupied bandwidth results, 150 kbps*

Frequency, MHz	99% occupied bandwidth, kHz
902.4	315.8
914.8	317.0
927.4	313.0

Note: there is no 99% occupied bandwidth limit in the standard's requirements, the measurement results provided for information purposes only.

Figure 8.5-14: *99% OBW on low channel, 150 kbps*

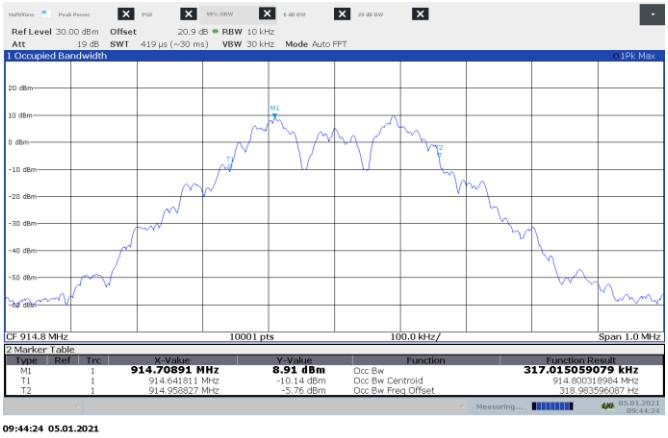


Figure 8.5-15: *99% OBW on mid channel, 150 kbps*

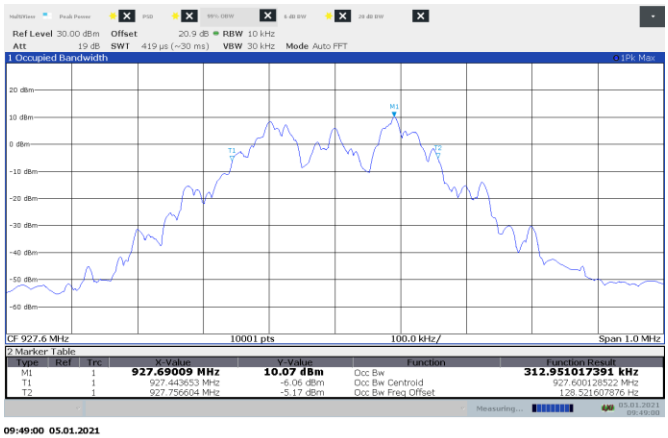


Figure 8.5-16: *99% OBW bandwidth on high channel, 150 kbps*

Test data continued, 150 kbps

Table 8.5-9: *Carrier frequency separation results, 150 kbps*

Carrier frequency separation, kHz	Minimum limit, kHz	Margin, kHz
402.5	353.1	49.4

Note: Minimum limit = 25 kHz or the 20 dB BW whichever is greater

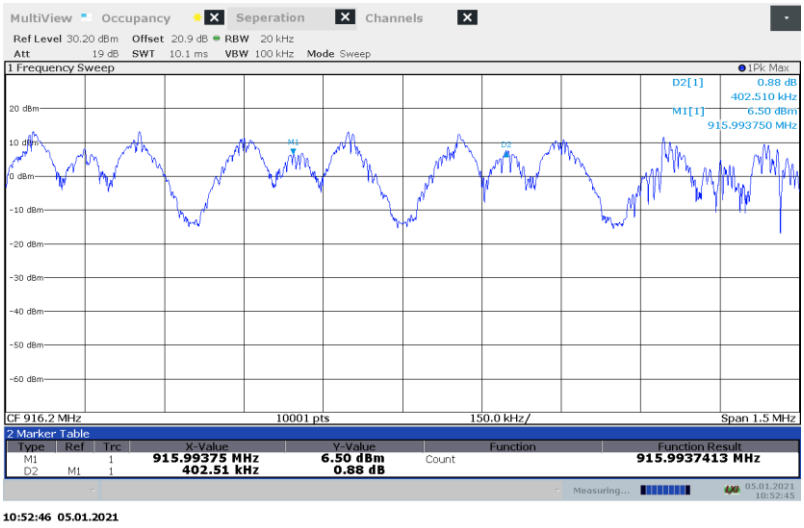


Figure 8.5-17: *Carrier frequency separation*

Test data continued, 150 kbps

Table 8.5-10: *Number of hopping frequencies results, 150 kbps*

Number of hopping frequencies	Minimum limit	Margin
64	25	39

Note: 20 dB bandwidth > 250 kHz, Minimum limit = 25 hopping frequencies

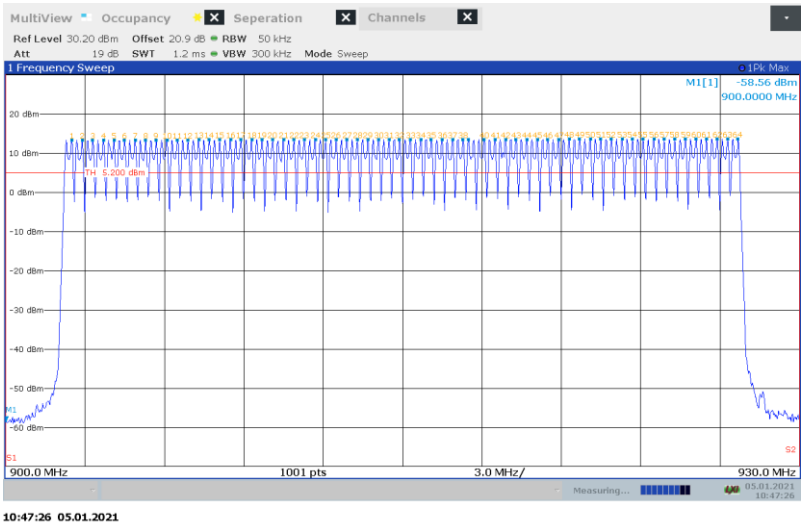
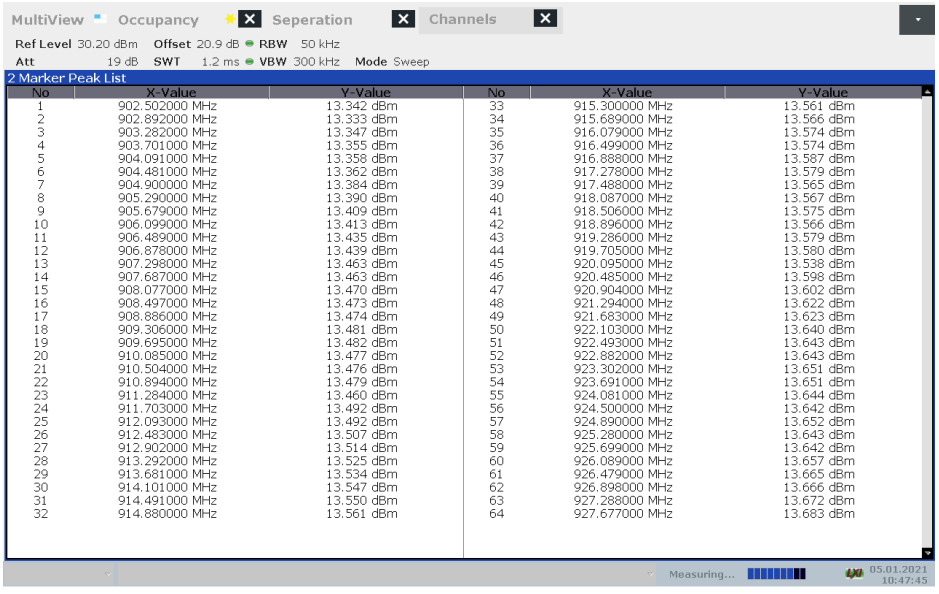


Figure 8.5-18: *Number of hopping frequencies = 64*



No	X-Value	Y-Value	No	X-Value	Y-Value
1	902.502000 MHz	13.342 dBm	33	915.300000 MHz	13.561 dBm
2	902.892000 MHz	13.333 dBm	34	915.689000 MHz	13.566 dBm
3	903.282000 MHz	13.347 dBm	35	916.079000 MHz	13.574 dBm
4	903.701000 MHz	13.355 dBm	36	916.499000 MHz	13.574 dBm
5	904.091000 MHz	13.358 dBm	37	916.888000 MHz	13.587 dBm
6	904.481000 MHz	13.362 dBm	38	917.278000 MHz	13.579 dBm
7	904.900000 MHz	13.384 dBm	39	917.488000 MHz	13.565 dBm
8	905.290000 MHz	13.390 dBm	40	918.087000 MHz	13.567 dBm
9	905.679000 MHz	13.409 dBm	41	918.506000 MHz	13.575 dBm
10	906.099000 MHz	13.413 dBm	42	918.896000 MHz	13.566 dBm
11	906.489000 MHz	13.435 dBm	43	919.286000 MHz	13.579 dBm
12	906.878000 MHz	13.439 dBm	44	919.705000 MHz	13.580 dBm
13	907.298000 MHz	13.463 dBm	45	920.095000 MHz	13.538 dBm
14	907.687000 MHz	13.463 dBm	46	920.485000 MHz	13.598 dBm
15	908.077000 MHz	13.470 dBm	47	920.904000 MHz	13.602 dBm
16	908.497000 MHz	13.473 dBm	48	921.294000 MHz	13.622 dBm
17	908.886000 MHz	13.474 dBm	49	921.683000 MHz	13.623 dBm
18	909.306000 MHz	13.481 dBm	50	922.103000 MHz	13.640 dBm
19	909.695000 MHz	13.482 dBm	51	922.493000 MHz	13.643 dBm
20	910.085000 MHz	13.477 dBm	52	922.882000 MHz	13.643 dBm
21	910.504000 MHz	13.476 dBm	53	923.302000 MHz	13.651 dBm
22	910.894000 MHz	13.479 dBm	54	923.691000 MHz	13.651 dBm
23	911.284000 MHz	13.460 dBm	55	924.081000 MHz	13.644 dBm
24	911.703000 MHz	13.492 dBm	56	924.500000 MHz	13.642 dBm
25	912.093000 MHz	13.492 dBm	57	924.890000 MHz	13.652 dBm
26	912.483000 MHz	13.507 dBm	58	925.280000 MHz	13.643 dBm
27	912.902000 MHz	13.514 dBm	59	925.699000 MHz	13.642 dBm
28	913.292000 MHz	13.525 dBm	60	926.089000 MHz	13.657 dBm
29	913.681000 MHz	13.534 dBm	61	926.479000 MHz	13.665 dBm
30	914.101000 MHz	13.547 dBm	62	926.898000 MHz	13.666 dBm
31	914.491000 MHz	13.550 dBm	63	927.288000 MHz	13.672 dBm
32	914.880000 MHz	13.561 dBm	64	927.677000 MHz	13.683 dBm

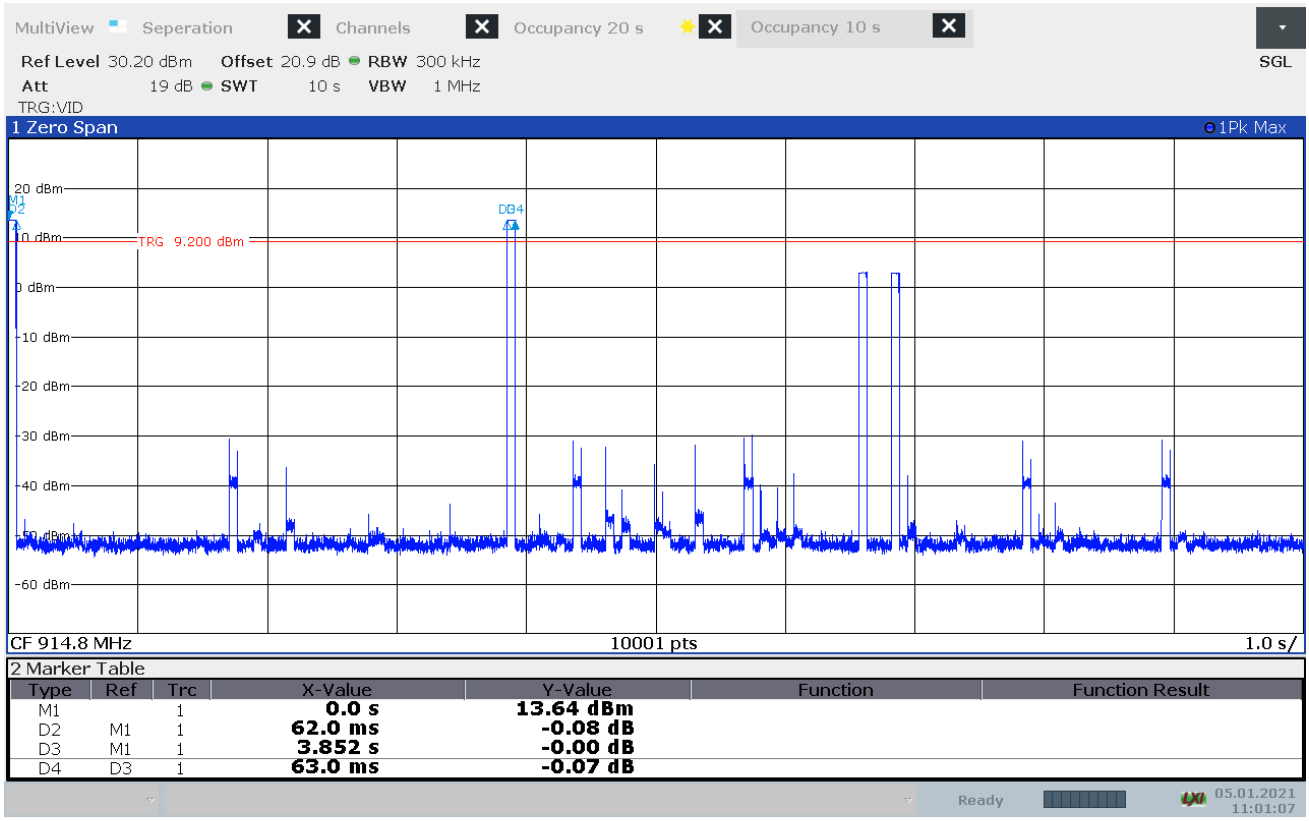
Figure 8.5-19: *List of hopping frequencies*

Test data continued, 150 kbps

Table 8.5-11: *Average time of occupancy results, 150 kbps*

Dwell time of each pulse, ms	Number of pulses within period	Total dwell time within period, ms	Limit, ms	Margin, ms
63	2	126	400	274

Note: 20 dB bandwidth > 250 kHz, therefore Measurement Period is 10 s



11:01:08 05.01.2021

Figure 8.5-20: *Dwell time*

8.5.1 Test data, 250 kbps

Table 8.5-12: *20 dB bandwidth results, 250 kbps*

Frequency, MHz	20 dB bandwidth, kHz	Max 20 dB bandwidth limit, kHz	Margin, kHz
902.5	408.6	500	91.4
915.0	409.6	500	90.4
927.5	406.6	500	93.4

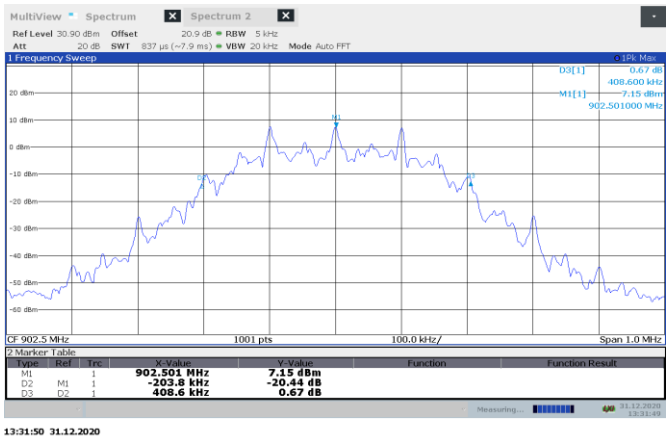


Figure 8.5-21: *20 dB bandwidth on low channel, 250 kbps*

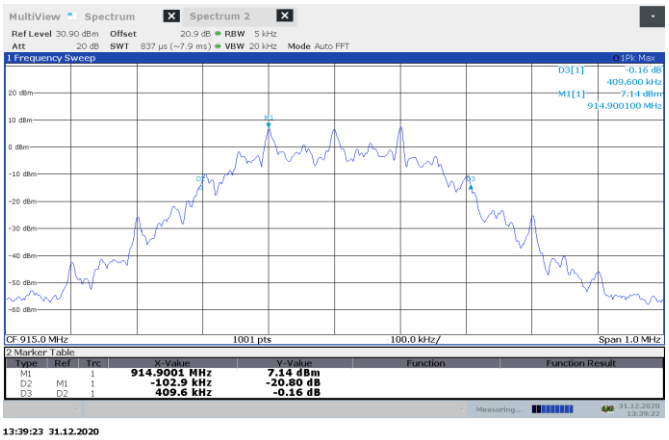


Figure 8.5-22: *20 dB bandwidth on mid channel, 250 kbps*

Figure 8.5-23: *20 dB bandwidth on high channel, 250 kbps*

Test data continued, 250 kbps

Table 8.5-13: *99% occupied bandwidth results, 250 kbps*

Frequency, MHz	99% occupied bandwidth, kHz
902.5	385.0
915.0	388.8
927.5	385.4

Note: there is no 99% occupied bandwidth limit in the standard's requirements, the measurement results provided for information purposes only.

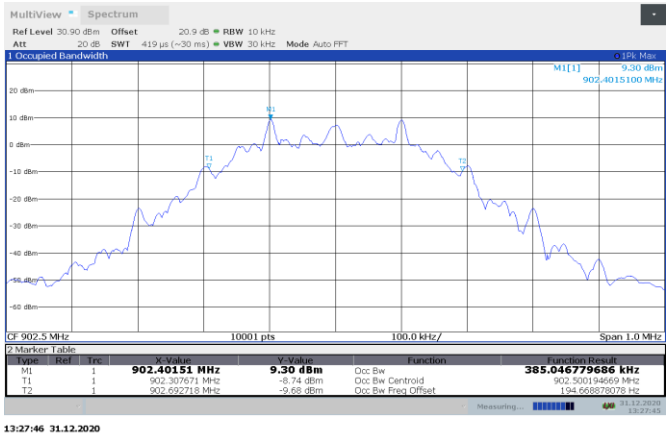


Figure 8.5-24: *99% OBW on low channel, 250 kbps*

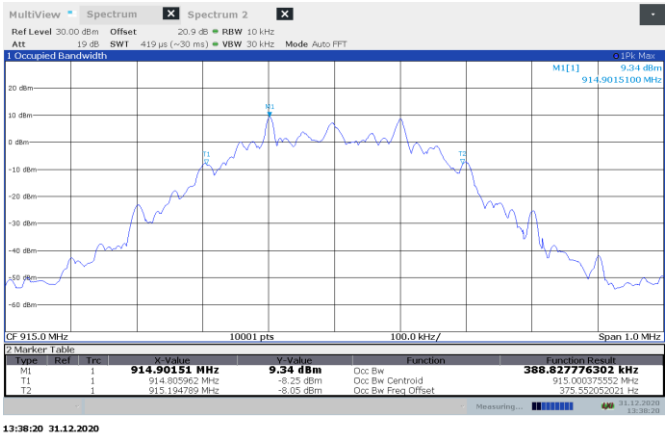


Figure 8.5-25: *99% OBW on mid channel, 250 kbps*

Figure 8.5-26: *99% OBW bandwidth on high channel, 250 kbps*

Test data continued, 250 kbps

Table 8.5-14: *Carrier frequency separation results, 250 kbps*

Carrier frequency separation, kHz	Minimum limit, kHz	Margin, kHz
511.3	409.6	101.7

Note: Minimum limit = 25 kHz or the 20 dB BW whichever is greater

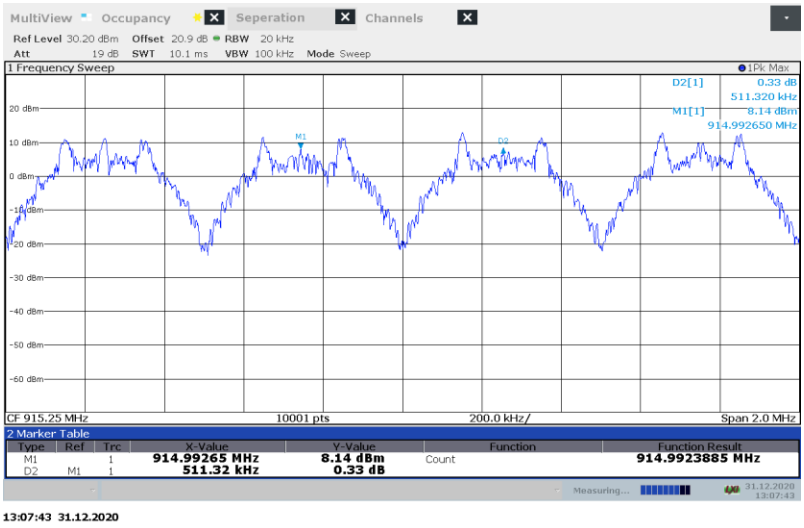


Figure 8.5-27: *Carrier frequency separation*

Test data continued, 250 kbps

Table 8.5-15: *Number of hopping frequencies results, 250 kbps*

Number of hopping frequencies	Minimum limit	Margin
51	25	26

Note: 20 dB bandwidth > 250 kHz, Minimum limit = 25 hopping frequencies

Figure 8.5-28: *Number of hopping frequencies = 51*

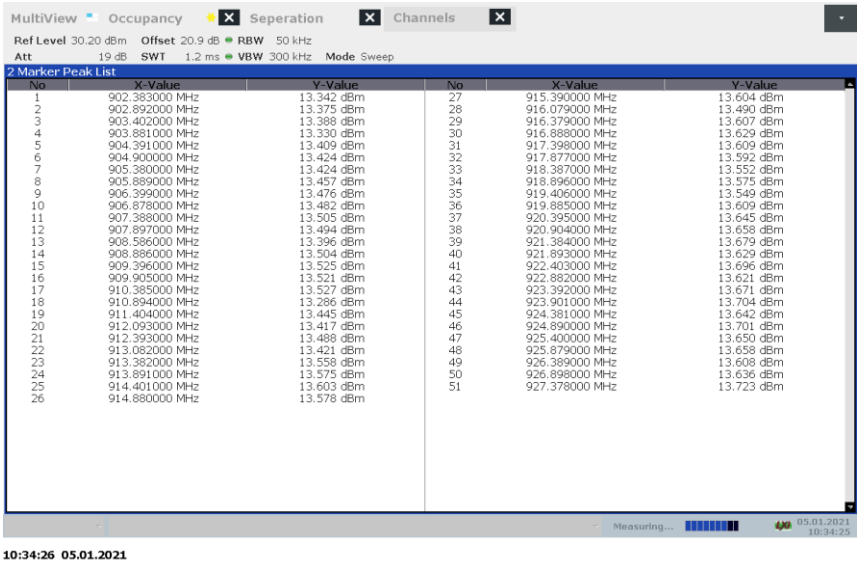


Figure 8.5-29: *List of hopping frequencies*

Test data continued, 250 kbps

Table 8.5-16: *Average time of occupancy results, 250 kbps*

Dwell time of each pulse, ms	Number of pulses within period	Total dwell time within period, ms	Limit, ms	Margin, ms
63	2	126	400	274

Note: 20 dB bandwidth > 250 kHz, therefore Measurement Period is 10 s

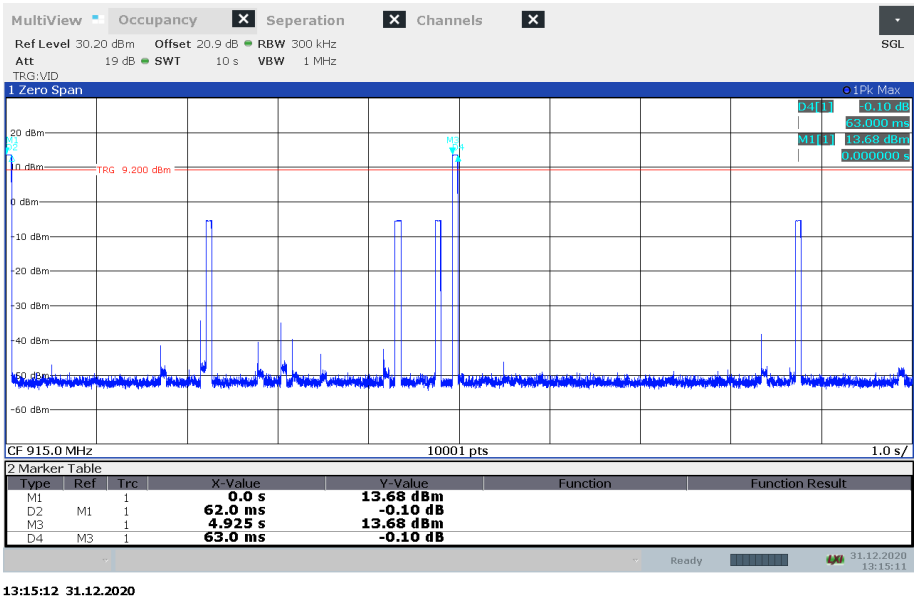


Figure 8.5-30: *Dwell time*

8.6 FCC 15.247(b) and RSS-247 5.4(a) Transmitter output power and e.i.r.p. requirements for FHSS 900 MHz

8.6.1 References, definitions and limits

FCC:

(b) The maximum peak conducted output power of the intentional radiator shall not exceed the following:

(2) For frequency hopping systems operating in the 902–928 MHz band: 1 watt for systems employing at least 50 hopping channels; and, 0.25 watts for systems employing less than 50 hopping channels, but at least 25 hopping channels, as permitted under paragraph (a)(1)(i) of this section.

(4) The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

ISED:

For FHSs operating in the band 902–928 MHz, the maximum peak conducted output power shall not exceed 1.0 W, and the e.i.r.p. shall not exceed 4 W if the hopset uses 50 or more hopping channels; the maximum peak conducted output power shall not exceed 0.25 W and the e.i.r.p. shall not exceed 1 W if the hopset uses less than 50 hopping channels.

8.6.2 Test summary

Verdict	Pass		
Tested by	Mark Libbrecht	Test date	November 30, 2020

8.6.3 Observations, settings and special notes

Conducted output power was tested per ANSI C63.10 subclause 7.8.5. The hopping shall be disabled for this test. Spectrum analyser settings:
EUT utilizes > 50 hopping frequencies for all modulations

Resolution bandwidth	> 20 dB bandwidth of the emission being measured
Video bandwidth	≥ RBW
Frequency span	approximately 5 times the 20 dB bandwidth, centered on a hopping channel
Detector mode	Peak
Trace mode	Max Hold

8.6.4 Test data, 50 kbps

Table 8.6-1: *Output power and EIRP results, 50 kbps*

Frequency, MHz	Output power, dBm	Output power limit, dBm	Margin, dB	Antenna gain, dBi	EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
902.2	13.5	30.0	16.5	3.47	17.0	36.0	19.0
915.2	13.6	30.0	16.4	3.47	17.1	36.0	18.9
927.8	13.8	30.0	16.2	3.47	17.3	36.0	18.7

EIRP = Output power + Antenna gain

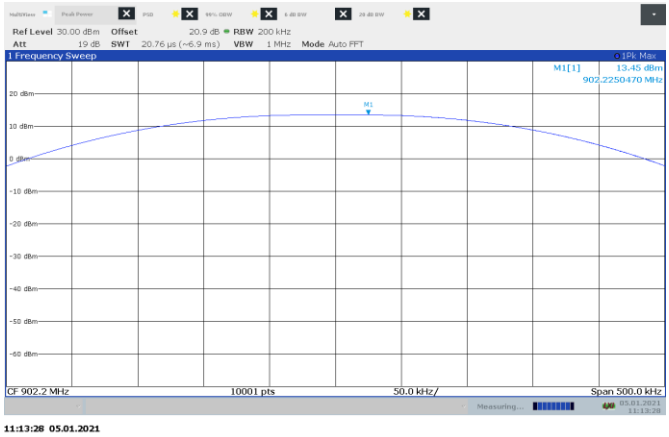


Figure 8.6-1: *Output power on low channel, 50 kbps*

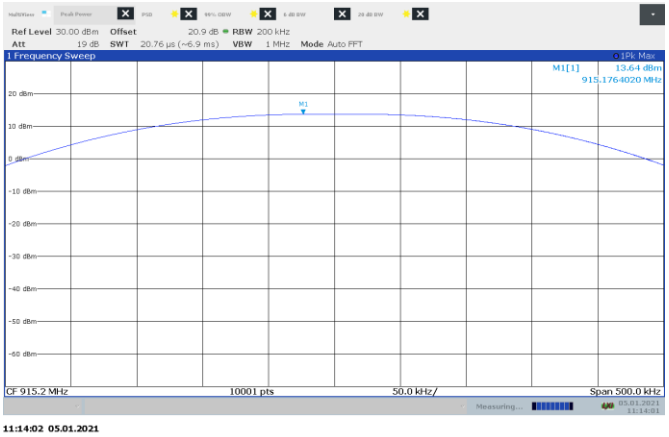


Figure 8.6-2: *Output power on mid channel, 50 kbps*

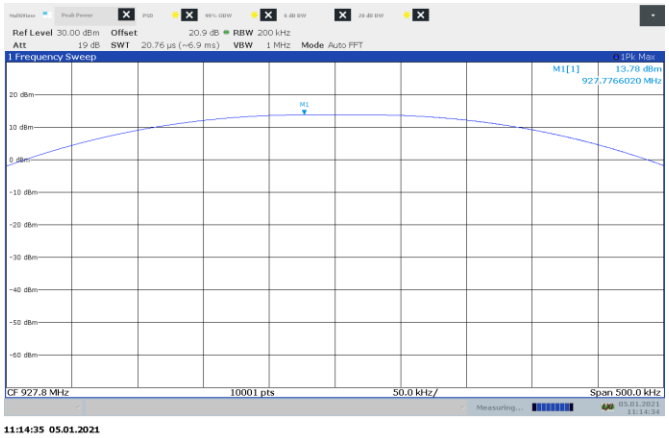


Figure 8.6-3: *Output power on high channel, 50 kbps*

8.6.1 Test data, 150 kbps

Table 8.6-2: *Output power and EIRP results, 150 kbps*

Frequency, MHz	Output power, dBm	Output power limit, dBm	Margin, dB	Antenna gain, dBi	EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
902.4	13.5	30.0	16.5	3.47	17.0	36.0	19.0
914.8	13.7	30.0	16.3	3.47	17.2	36.0	18.8
927.6	13.8	30.0	16.2	3.47	17.3	36.0	18.7

EIRP = Output power + Antenna gain

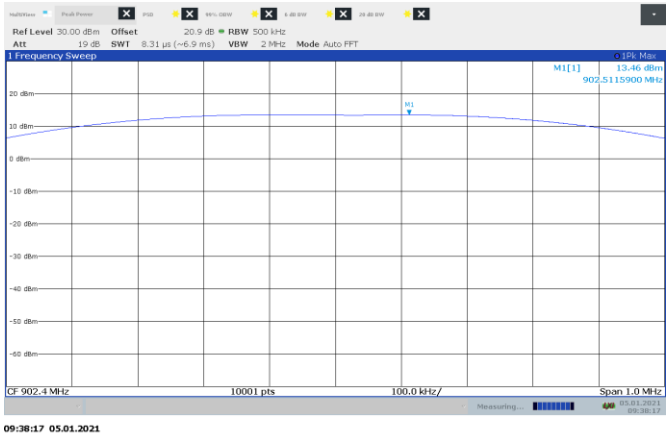


Figure 8.6-4: *Output power on low channel, 150 kbps*

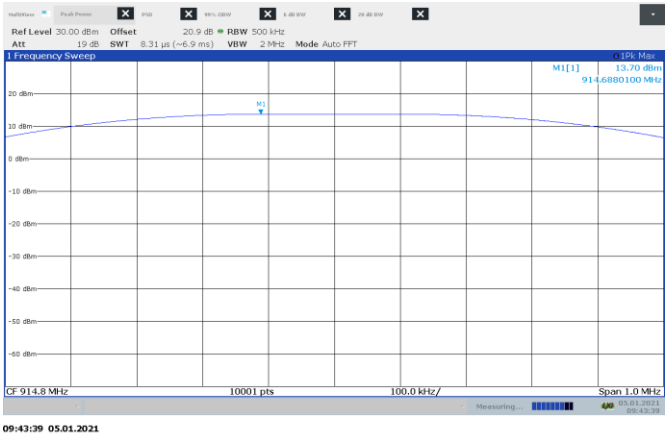


Figure 8.6-5: *Output power on mid channel, 150 kbps*

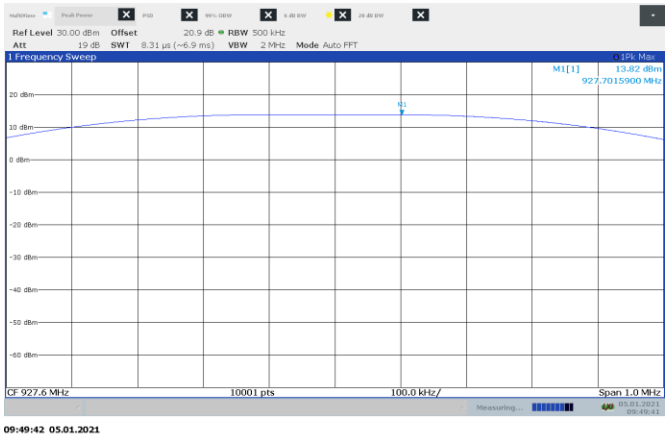


Figure 8.6-6: *Output power on high channel, 150 kbps*

8.6.1 Test data, 250 kbps

Table 8.6-3: *Output power and EIRP results, 250 kbps*

Frequency, MHz	Output power, dBm	Output power limit, dBm	Margin, dB	Antenna gain, dBi	EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
902.5	13.5	30.0	16.5	3.47	17.0	36.0	19.0
915.0	13.7	30.0	16.3	3.47	17.2	36.0	18.8
927.5	13.8	30.0	16.2	3.47	17.3	36.0	18.7

EIRP = Output power + Antenna gain

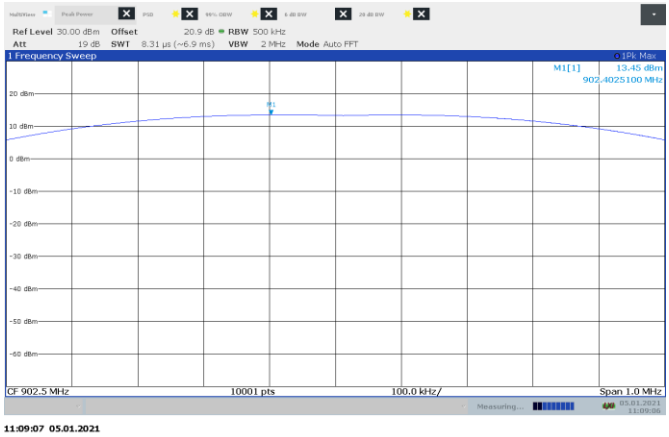


Figure 8.6-7: *Output power on low channel, 250 kbps*

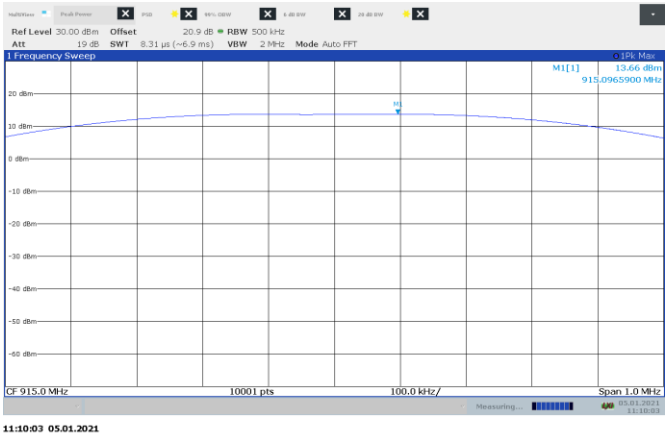


Figure 8.6-8: *Output power on mid channel, 250 kbps*

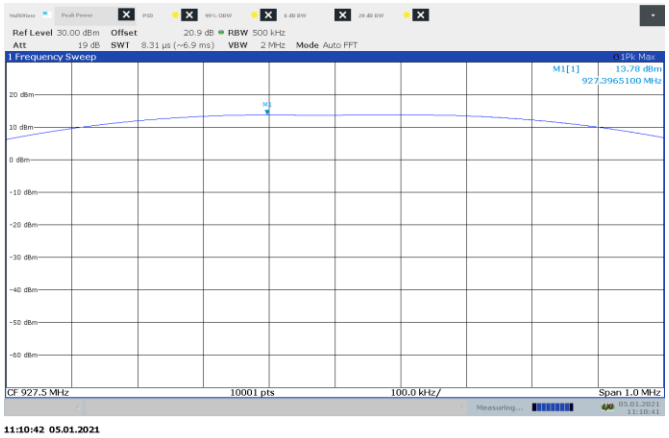


Figure 8.6-9: *Output power on high channel, 250 kbps*

8.7 FCC 15.247(a)(2) and RSS-247 5.2(a) Minimum 6 dB bandwidth for DTS systems

8.7.1 References, definitions and limits

FCC:
Systems using digital modulation techniques may operate in the 902–928 MHz, 2400–2483.5 MHz, and 5725–5850 MHz bands. The minimum 6 dB bandwidth shall be at least 500 kHz.

ISED:
The minimum 6 dB bandwidth shall be 500 kHz.
RSS-GEN, Section 6.7:
6 dB bandwidth is defined as the frequency range between two points, one at the lowest frequency below and one at the highest frequency above the carrier frequency, at which the maximum power level of the transmitted emission is attenuated 6 dB below the maximum in-band power level of the modulated signal, where the two points are on the outskirts of the in-band emission.
For the 99% emission bandwidth, the trace data points are recovered and directly summed in linear power level terms. The recovered amplitude data points, beginning at the lowest frequency, are placed in a running sum until 0.5% of the total is reached, and that frequency recorded. The process is repeated for the highest frequency data points (starting at the highest frequency, at the right side of the span, and going down in frequency). This frequency is then recorded. The difference between the two recorded frequencies is the occupied bandwidth (or the 99% emission bandwidth).

8.7.2 Test summary

Verdict	Pass		
Tested by	Alvin Liu	Test date	November 11, 2020

8.7.3 Observations, settings and special notes

The test was performed as per KDB 558074, section 8.2 with reference to ANSI C63.10 subclause 11.8.
Spectrum analyser settings:

Resolution bandwidth	6 dB BW: 100 kHz; 99% OBW: 1–5% of OBW
Video bandwidth	≥3 × RBW
Frequency span	1 – 5 × OBW
Detector mode	Peak
Trace mode	Max Hold

8.7.4 Test data

Table 8.7-1: *6 dB bandwidth results, Z-Wave Long Range*

Modulation	Frequency, MHz	6 dB bandwidth, kHz	Minimum limit, kHz	Margin, kHz
DSSS-OQPSK	912.0	638.6	500	138.6
DSSS-OQPSK	920.0	633.5	500	133.5

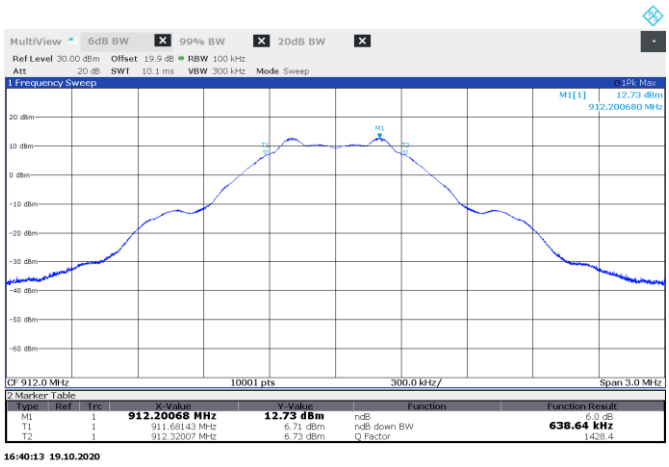


Figure 8.7-1: *6 dB bandwidth on 912 MHz channel, Z-Wave Long Range*

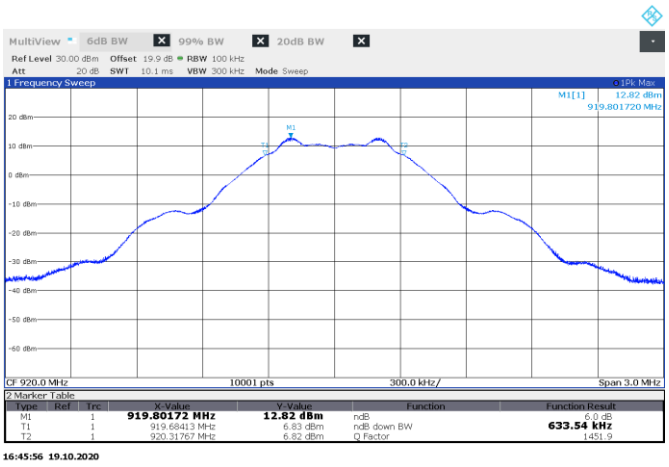


Figure 8.7-2: *6 dB bandwidth on 920 MHz channel, Z-Wave Long Range*

Table 8.7-2: *99% occupied bandwidth results, Z-Wave Long Range*

Frequency, MHz	99% occupied bandwidth, kHz
912.0	933.7
920.0	928.4

Note: there is no 99% occupied bandwidth limit in the standard's requirements, the measurement results provided for information purposes only.

Figure 8.7-3: *99% OBW on 912 MHz channel, Z-Wave Long Range*

Figure 8.7-4: *99% OBW on 920 MHz channel, Z-Wave Long Range*

8.8 FCC 15.247(b) and RSS-247 5.4(d) Transmitter output power and e.i.r.p. requirements for DTS in 900 MHz

8.8.1 References, definitions and limits

FCC:

(b) The maximum peak conducted output power of the intentional radiator shall not exceed the following:

(3) For systems using digital modulation in the 902–928 MHz band: 1 W (30 dBm). As an alternative to a peak power measurement, compliance with the one Watt limit can be based on a measurement of the maximum conducted output power. Maximum Conducted Output Power is defined as the total transmit power delivered to all antennas and antenna elements averaged across all symbols in the signaling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or is transmitting at a reduced power level. If multiple modes of operation are possible (e.g., alternative modulation methods), the maximum conducted output power is the highest total transmit power occurring in any mode.

(4) The conducted output power limit specified in paragraph (b) of this section is based on the use of antennas with directional gains that do not exceed 6 dBi. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraphs (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

(c) Operation with directional antenna gains greater than 6 dBi.

(1) Fixed point-to-point operation:

(iii) Fixed, point-to-point operation, as used in paragraphs (c)(1)(i) and (c)(1)(ii) of this section, excludes the use of point-to-multipoint systems, omnidirectional applications, and multiple co-located intentional radiators transmitting the same information. The operator of the spread spectrum or digitally modulated intentional radiator or, if the equipment is professionally installed, the installer is responsible for ensuring that the system is used exclusively for fixed, point-to-point operations. The instruction manual furnished with the intentional radiator shall contain language in the installation instructions informing the operator and the installer of this responsibility.

ISED:

d. For DTSs employing digital modulation techniques operating in the 902–928 MHz band, the maximum peak conducted output power shall not exceed 1 W. The e.i.r.p. shall not exceed 4 W, except as provided in section 5.4(e).

As an alternative to a peak power measurement, compliance can be based on a measurement of the maximum conducted output power. The maximum conducted output power is the total transmit power delivered to all antennas and antenna elements, averaged across all symbols in the signalling alphabet when the transmitter is operating at its maximum power control level. Power must be summed across all antennas and antenna elements. The average must not include any time intervals during which the transmitter is off or transmitting at a reduced power level. If multiple modes of operation are implemented, the maximum conducted output power is the highest total transmit power occurring in any mode.

8.8.2 Test summary

Verdict	Pass		
Tested by	Alvin Liu	Test date	November 11, 2020

8.8.3 Observations, settings and special notes

The test was performed as per KDB 558074, section 8.3 with reference to ANSI C63.10 subclause 11.9.1 (peak power) using method RBW≥DTS bandwidth (Maximum peak conducted output power).
Spectrum analyser settings:

Resolution bandwidth	≥ OBW
Video bandwidth	≥3 × RBW
Frequency span	2 – 5 × OBW
Detector mode	Peak
Trace mode	Max Hold

8.8.4 Test data

Table 8.8-1: *Output power and EIRP results (antenna port measurement)*

Frequency, MHz	Conducted output power, dBm	Output power limit, dBm	Output power margin, dB	Antenna gain, dBi	EIRP, dBm	EIRP limit, dBm	EIRP margin, dB
912	13.0	30.0	17.0	3.47	16.5	36.0	19.5
920	13.1	30.0	16.9	3.47	16.6	36.0	19.4

Note: EIRP [dBm] = Conducted output power [dBm] + Antenna gain [dBi]

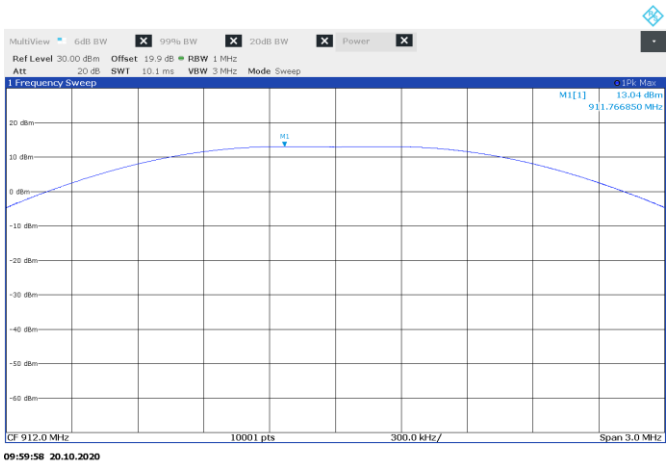


Figure 8.8-1: *Output power on 912 MHz channel*

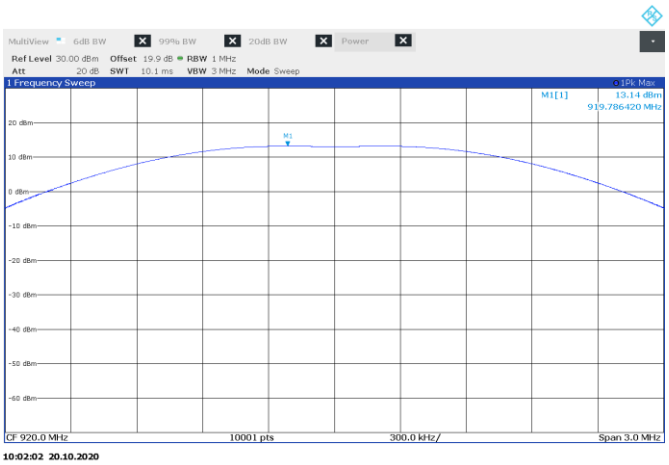


Figure 8.8-2: *Output power on 920 MHz channel*

8.9 FCC 15.247(d) and RSS-247 5.5 Spurious (out-of-band) unwanted emissions

8.9.1 References, definitions and limits

FCC:
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in §15.205(a), must also comply with the radiated emission limits specified in §15.209(a) (see §15.205(c)).

ISED:
In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated device is operating, the RF power that is produced shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided that the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of root-mean-square averaging over a time interval, as permitted under section 5.4(d), the attenuation required shall be 30 dB instead of 20 dB. Attenuation below the general field strength limits specified in RSS-Gen is not required.

Table 8.9-1: *FCC §15.209 and RSS-Gen – Radiated emission limits*

Frequency, MHz	Field strength of emissions		Measurement distance, m
	µV/m	dBµV/m	
0.009–0.490	2400/F	$67.6 - 20 \times \log_{10}(F)$	300
0.490–1.705	24000/F	$87.6 - 20 \times \log_{10}(F)$	30
1.705–30.0	30	29.5	30
30–88	100	40.0	3
88–216	150	43.5	3
216–960	200	46.0	3
above 960	500	54.0	3

Notes: In the emission table above, the tighter limit applies at the band edges.
For frequencies above 1 GHz the limit on peak RF emissions is 20 dB above the maximum permitted average emission limit applicable to the equipment under test

Table 8.9-2: *ISED restricted frequency bands*

MHz	MHz	MHz	GHz
0.090–0.110	12.57675–12.57725	399.9–410	7.25–7.75
0.495–0.505	13.36–13.41	608–614	8.025–8.5
2.1735–2.1905	16.42–16.423	960–1427	9.0–9.2
3.020–3.026	16.69475–16.69525	1435–1626.5	9.3–9.5
4.125–4.128	16.80425–16.80475	1645.5–1646.5	10.6–12.7
4.17725–4.17775	25.5–25.67	1660–1710	13.25–13.4
4.20725–4.20775	37.5–38.25	1718.8–1722.2	14.47–14.5
5.677–5.683	73–74.6	2200–2300	15.35–16.2
6.215–6.218	74.8–75.2	2310–2390	17.7–21.4
6.26775–6.26825	108–138	2483.5–2500	22.01–23.12
6.31175–6.31225	149.9–150.05	2655–2900	23.6–24.0
8.291–8.294	156.52475–156.52525	3260–3267	31.2–31.8
8.362–8.366	156.7–156.9	3332–3339	36.43–36.5
8.37625–8.38675	162.0125–167.17	3345.8–3358	
8.41425–8.41475	167.72–173.2	3500–4400	Above 38.6
12.29–12.293	240–285	4500–5150	
12.51975–12.52025	322–335.4	5350–5460	

Note: Certain frequency bands listed in Table 8.9-2 and above 38.6 GHz are designated for licence-exempt applications. These frequency bands and the requirements that apply to related devices are set out in the 200 and 300 series of RSSs.

Table 8.9-3: *FCC restricted frequency bands*

MHz	MHz	MHz	GHz
0.090–0.110	16.42–16.423	399.9–410	4.5–5.15
0.495–0.505	16.69475–16.69525	608–614	5.35–5.46
2.1735–2.1905	16.80425–16.80475	960–1240	7.25–7.75
4.125–4.128	25.5–25.67	1300–1427	8.025–8.5
4.17725–4.17775	37.5–38.25	1435–1626.5	9.0–9.2
4.20725–4.20775	73–74.6	1645.5–1646.5	9.3–9.5
6.215–6.218	74.8–75.2	1660–1710	10.6–12.7
6.26775–6.26825	108–121.94	1718.8–1722.2	13.25–13.4
6.31175–6.31225	123–138	2200–2300	14.47–14.5
8.291–8.294	149.9–150.05	2310–2390	15.35–16.2
8.362–8.366	156.52475–156.52525	2483.5–2500	17.7–21.4
8.37625–8.38675	156.7–156.9	2690–2900	22.01–23.12
8.41425–8.41475	162.0125–167.17	3260–3267	23.6–24.0
12.29–12.293	167.72–173.2	3332–3339	31.2–31.8
12.51975–12.52025	240–285	3345.8–3358	36.43–36.5
12.57675–12.57725	322–335.4	3600–4400	Above 38.6
13.36–13.41			

8.9.2 Test summary

Verdict	Pass		
Tested by	Mark Libbrecht	Test date	October 20, 2020

8.9.3 Observations, settings and special notes

As part of the current assessment, the test range of 9 kHz to 10th harmonic has been fully considered and compared to the actual frequencies utilized within the EUT. Since the EUT contains a transmitter in the GHz range, the EUT has been deemed compliant without formal testing in the 9 kHz to 30 MHz test range, therefore formal test results (tabular data and/or plots) are not provided within this test report.
EUT was set to transmit with 100 % duty cycle.
Radiated measurements were performed at a distance of 3 m.
DTS emissions in non-restricted frequency bands test was performed as per KDB 558074, section 8.5 with reference to ANSI C63.10 subclause 11.11.
Since fundamental power was tested using the maximum peak conducted output power procedure to demonstrate compliance, the spurious emissions limit is −20 dBc/100 kHz.
DTS emissions in restricted frequency bands test was performed as per KDB 558074, section 8.6 with reference to ANSI C63.10 subclause 11.12.
DTS band-edge emission measurements test was performed as per KDB 558074, section 8.7 with reference to ANSI C63.10 subclause 11.13.

Spectrum analyser settings for radiated measurements within restricted bands below 1 GHz:

Resolution bandwidth:	100 kHz
Video bandwidth:	300 kHz
Detector mode:	Peak
Trace mode:	Max Hold

Spectrum analyser settings for peak radiated measurements within restricted bands above 1 GHz:

Resolution bandwidth:	1 MHz
Video bandwidth:	3 MHz
Detector mode:	Peak
Trace mode:	Max Hold

Spectrum analyser settings for conducted spurious emissions measurements:

Resolution bandwidth:	100 kHz
Video bandwidth:	300 kHz
Detector mode:	Peak
Trace mode:	Max Hold

8.9.4 Test data

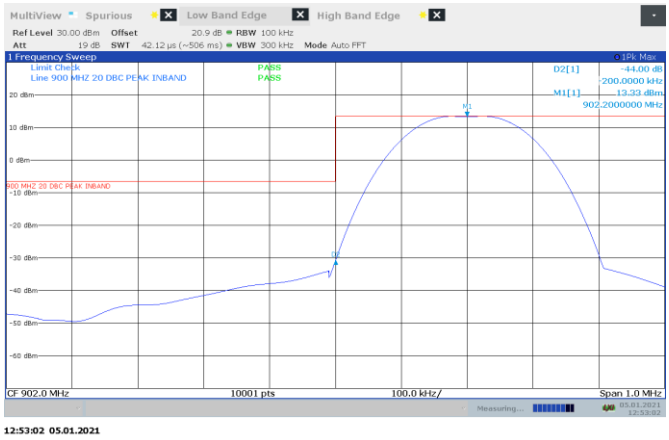


Figure 8.9-1: *Conducted Band-edge on low channel, FSK 50kbps*

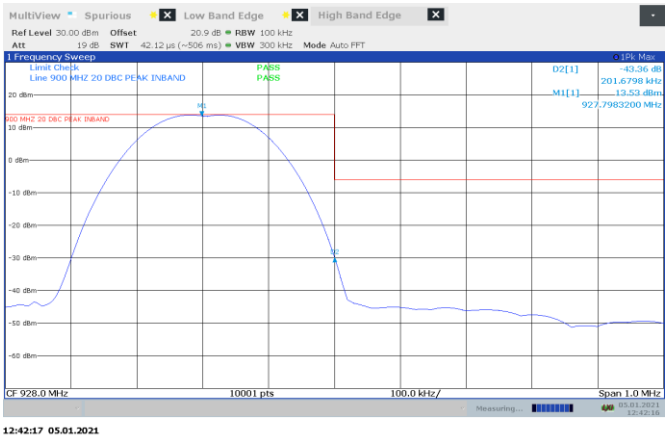


Figure 8.9-2: *Conducted Band-edge on high channel, FSK 50kbps*

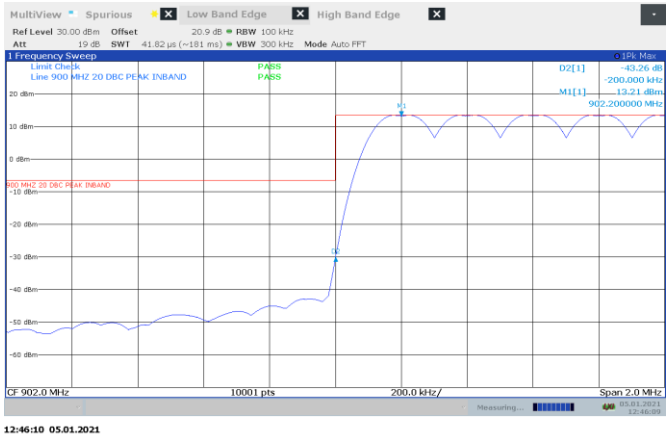


Figure 8.9-3: *Conducted Low Band-edge on hopping, FSK 50kbps*

Figure 8.9-4: *Conducted High Band-edge on hopping, FSK 50kbps*

Test data, continued

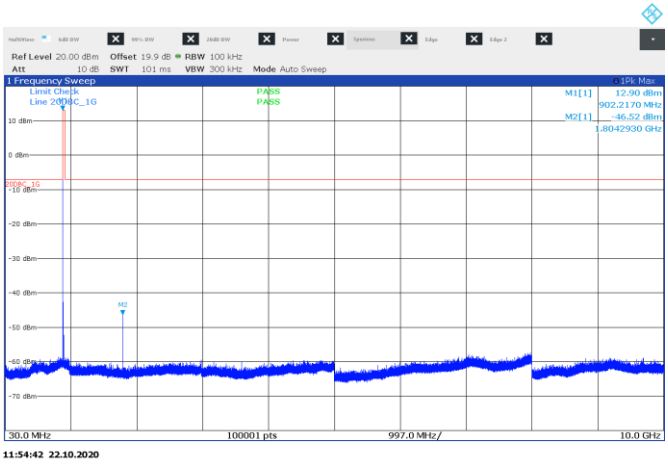


Figure 8.9-5: *Conducted spurious emissions on low channel, FSK 50kbps*

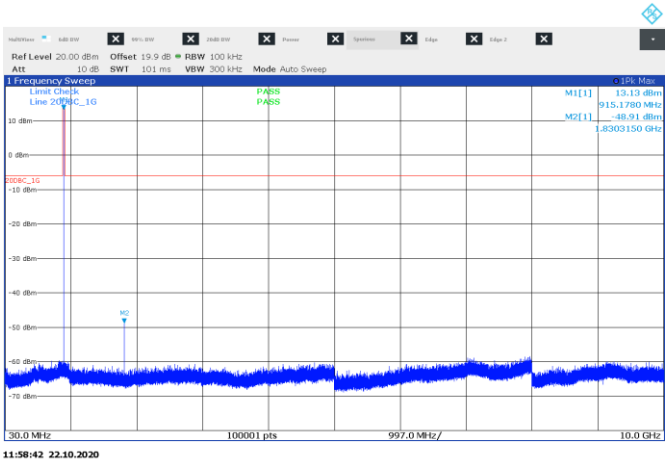


Figure 8.9-6: *Conducted spurious emissions on mid channel, FSK 50kbps*

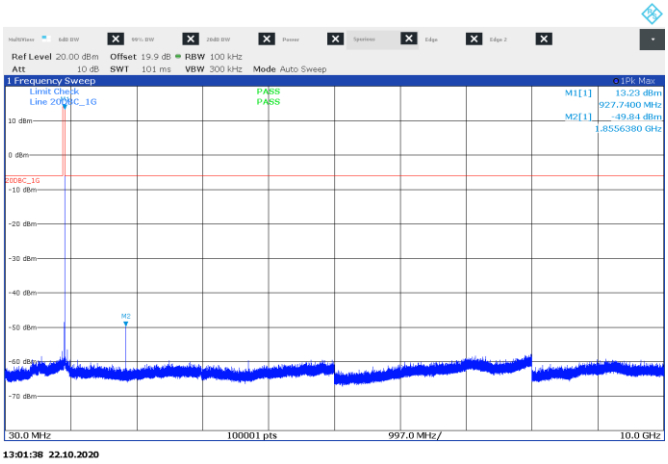


Figure 8.9-7: *Conducted spurious emissions on high channel, FSK 50kbps*

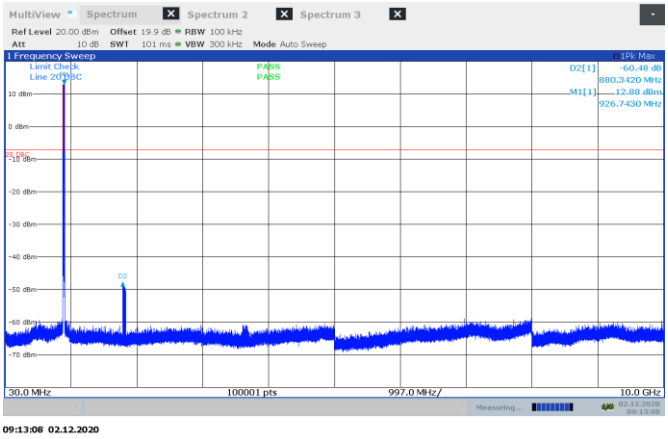


Figure 8.9-8: *Conducted spurious emissions on Hopping, FSK 50kbps*

Test data, continued

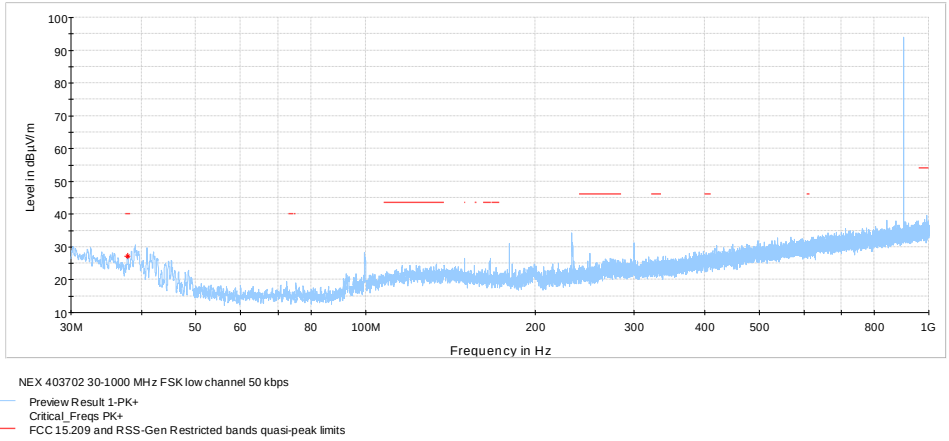


Figure 8.9-9: *Radiated spurious emissions 30 MHz – 1 GHz on low channel, FSK 50kbps*

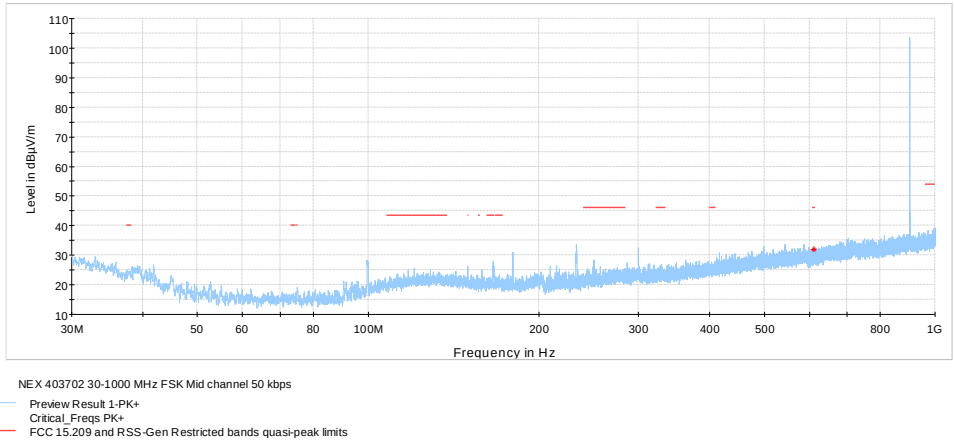


Figure 8.9-10: *Radiated spurious emissions 30 MHz – 1 GHz on mid channel, FSK 50kbps*

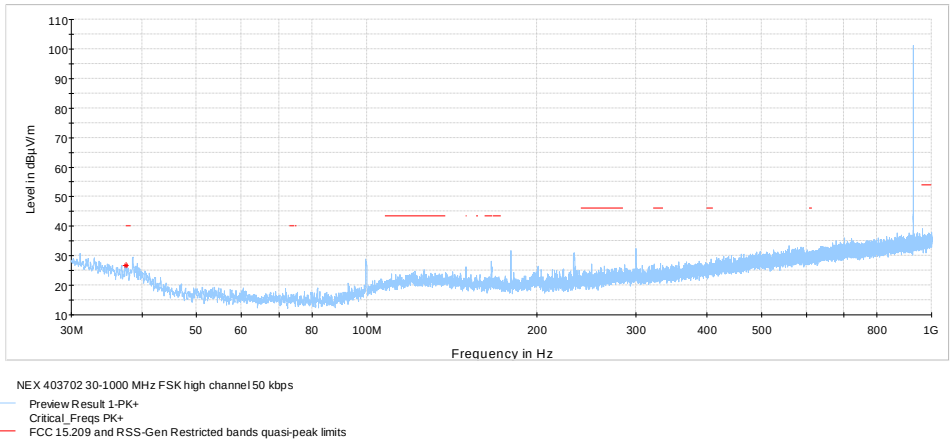


Figure 8.9-11: *Radiated spurious emissions 30 MHz – 1 GHz on high channel, FSK 50kbps*

Test data, continued

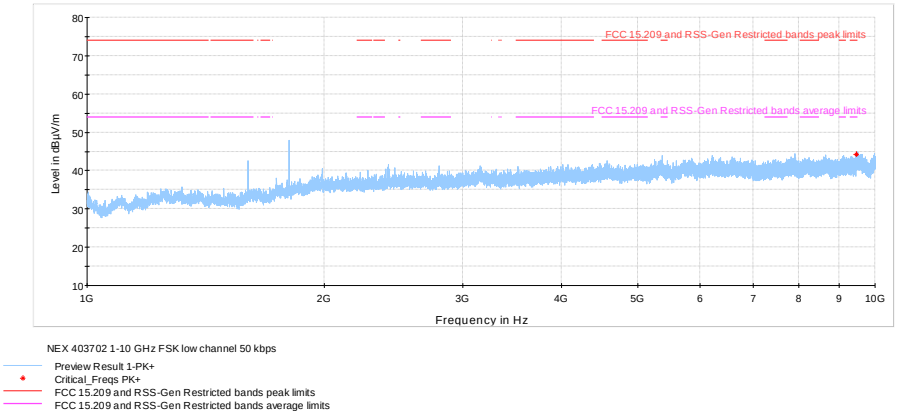


Figure 8.9-12: *Radiated spurious emissions 1 – 10 GHz on low channel, FSK 50kbps*

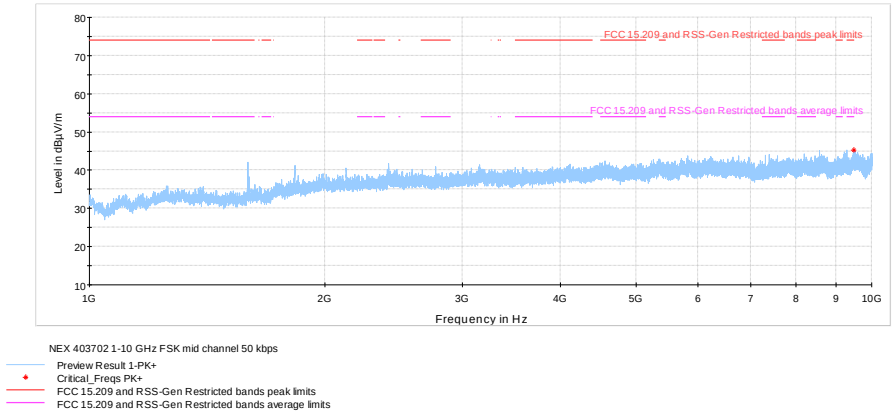


Figure 8.9-13: *Radiated spurious emissions 1 – 10 GHz on mid channel, FSK 50kbps*

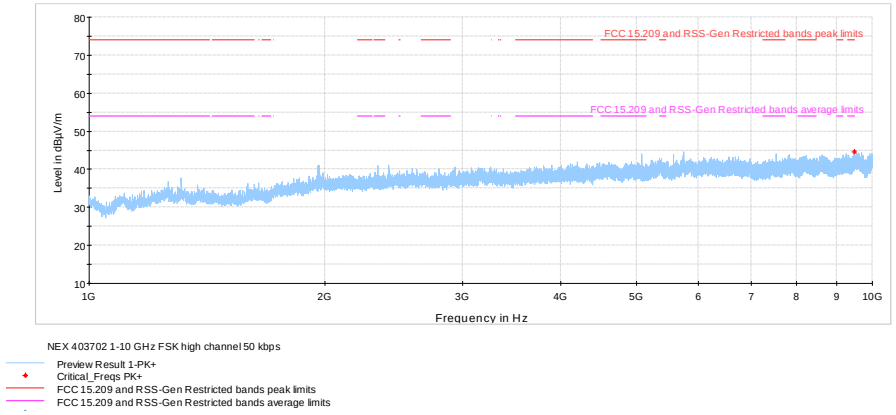


Figure 8.9-14: *Radiated spurious emissions 1 – 10 GHz on high channel, FSK 50kbps*

Test data, continued

Figure 8.9-15: *Conducted Band-edge on low channel, FSK 150kbps*

Figure 8.9-16: *Conducted Band-edge on high channel, FSK 150kbps*

Figure 8.9-17: *Conducted Low Band-edge on Hopping, FSK 150kbps*

Figure 8.9-18: *Conducted High Band-edge on Hopping, FSK 150kbps*

Test data, continued

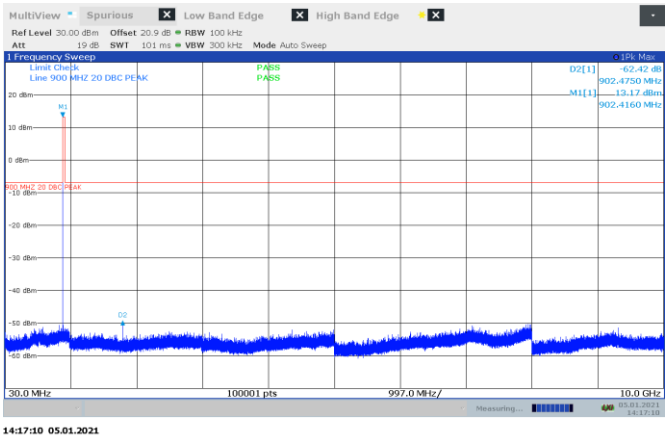


Figure 8.9-19: *Conducted spurious emissions on low channel, FSK 150kbps*

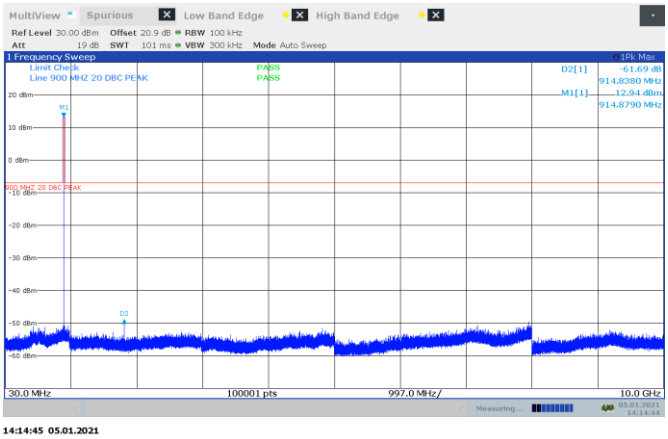


Figure 8.9-20: *Conducted spurious emissions on mid channel, FSK 150kbps*

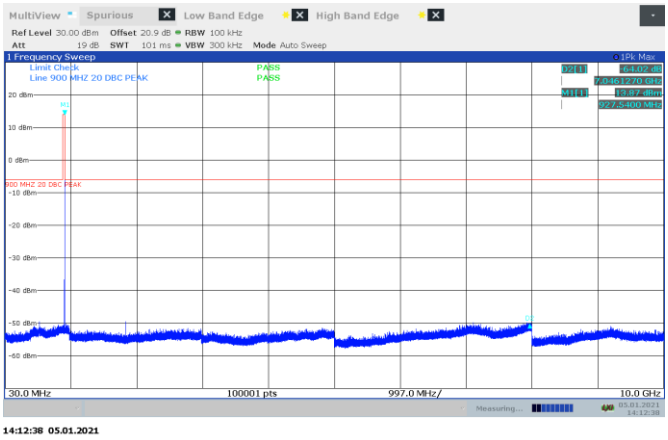


Figure 8.9-21: *Conducted spurious emissions on high channel, FSK 150kbps*

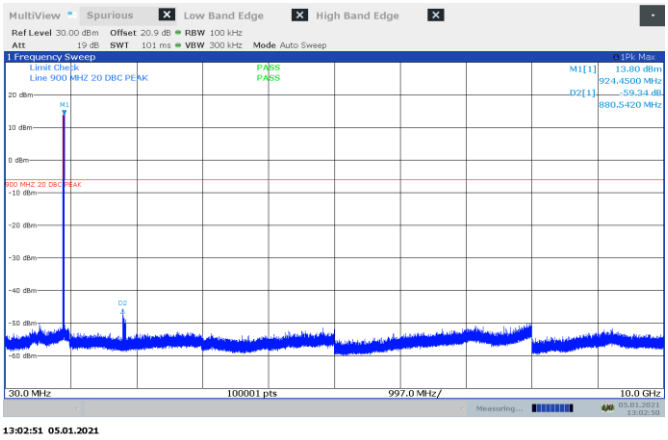


Figure 8.9-22: *Conducted spurious emissions on Hopping, FSK 150kbps*

Test data, continued

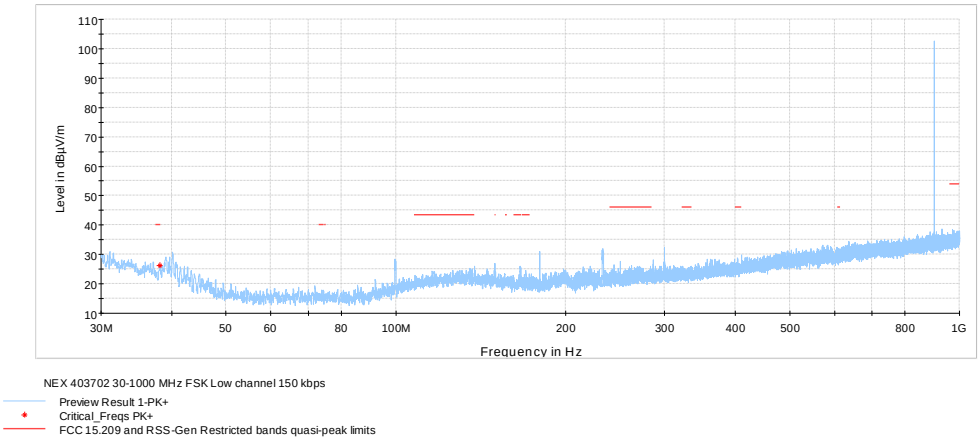


Figure 8.9-23: *Radiated spurious emissions 30 MHz – 1 GHz on low channel, FSK 150kbps*

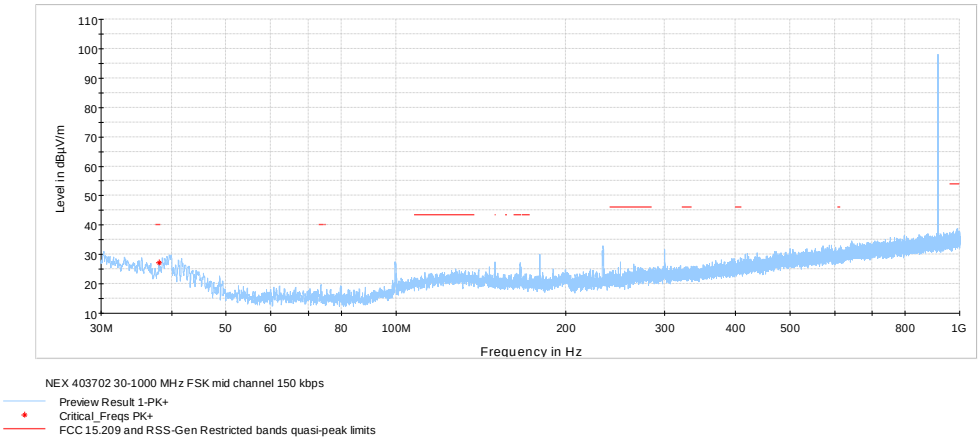


Figure 8.9-24: *Radiated spurious emissions 30 MHz – 1 GHz on mid channel, FSK 150kbps*

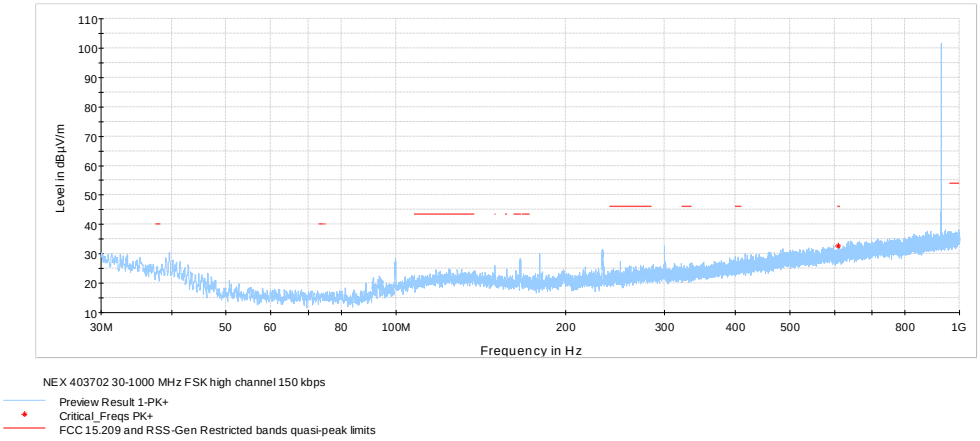


Figure 8.9-25: *Radiated spurious emissions 30 MHz – 1 GHz on high channel, FSK 150kbps*

Test data, continued

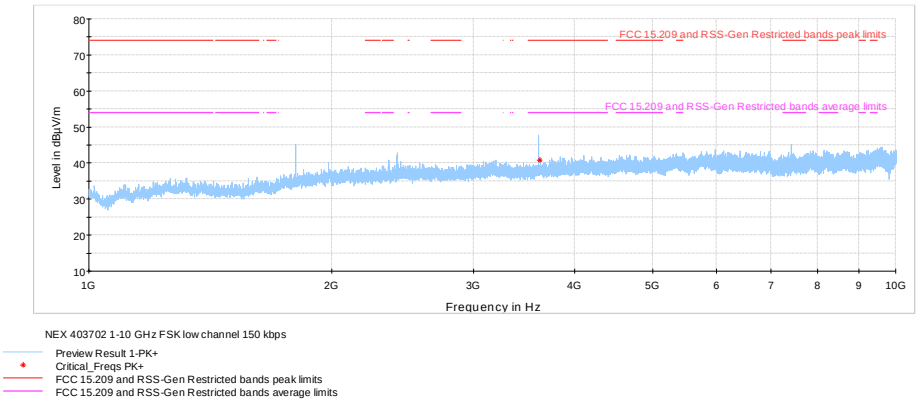


Figure 8.9-26: *Radiated spurious emissions 1 – 10 GHz on low channel, FSK 150kbps*

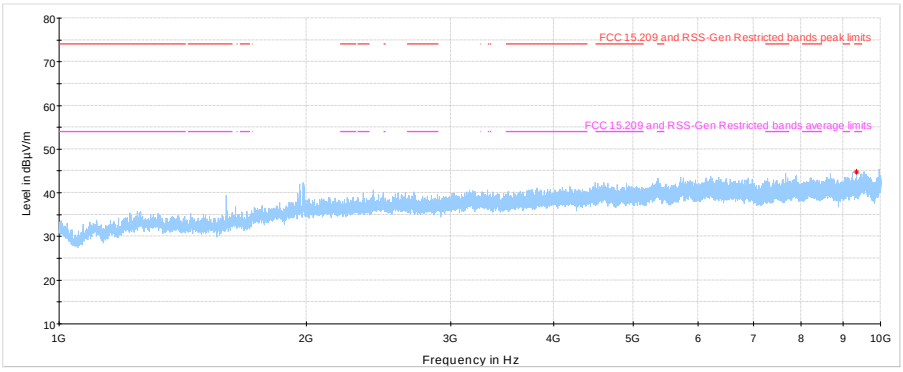


Figure 8.9-27: *Radiated spurious emissions 1 – 10 GHz on mid channel, FSK 150kbps*

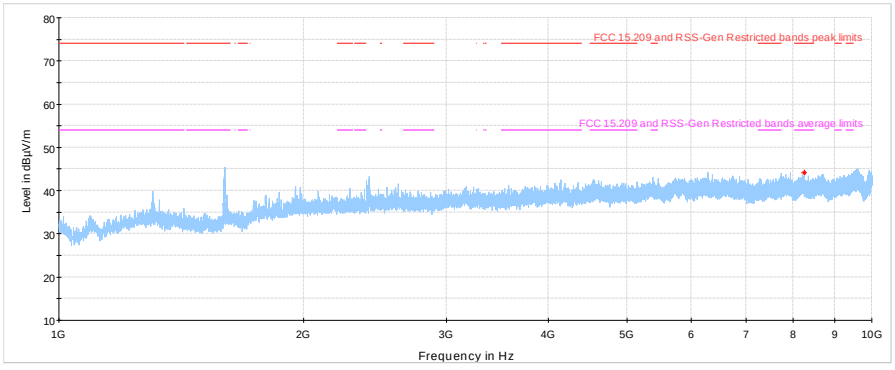


Figure 8.9-28: *Radiated spurious emissions 1 – 10 GHz on high channel, FSK 150kbps*

Test data, continued

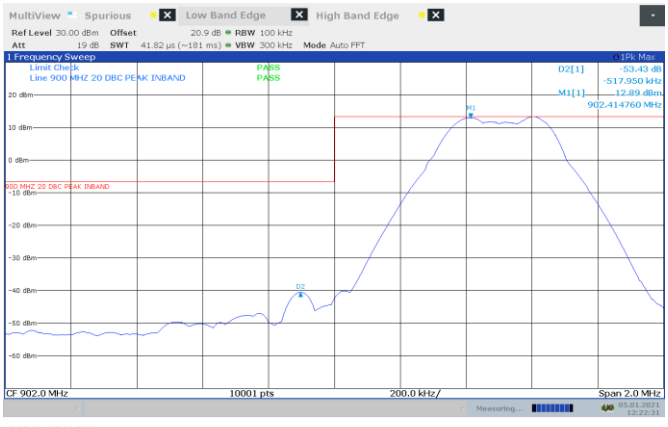


Figure 8.9-29: *Conducted Band-edge on low channel, FSK 250kbps*

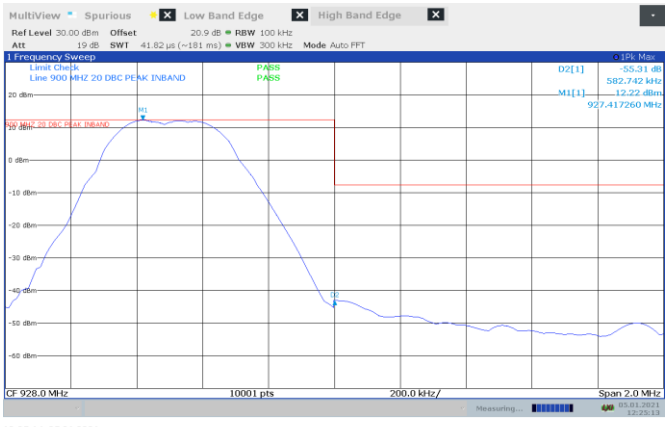


Figure 8.9-30: *Conducted Band-edge on high channel, FSK 250kbps*

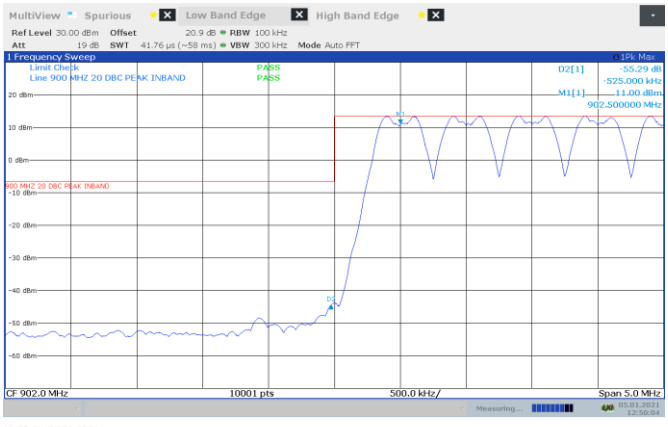


Figure 8.9-31: *Conducted Low Band-edge on hopping, FSK 250kbps*

Figure 8.9-32: *Conducted High Band-edge on hopping, FSK 250kbps*

Test data, continued

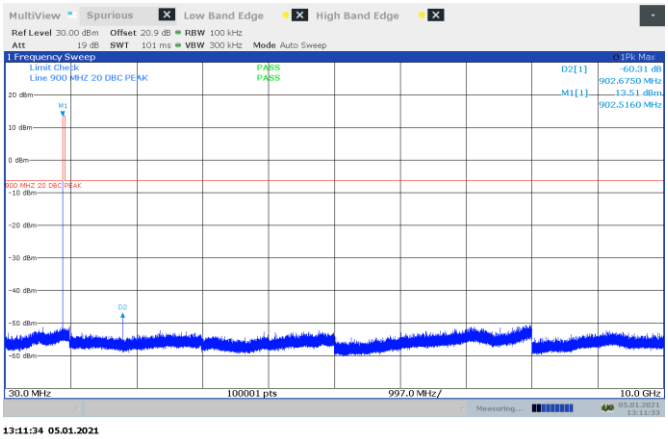


Figure 8.9-33: *Conducted spurious emissions on low channel, FSK 250kbps*

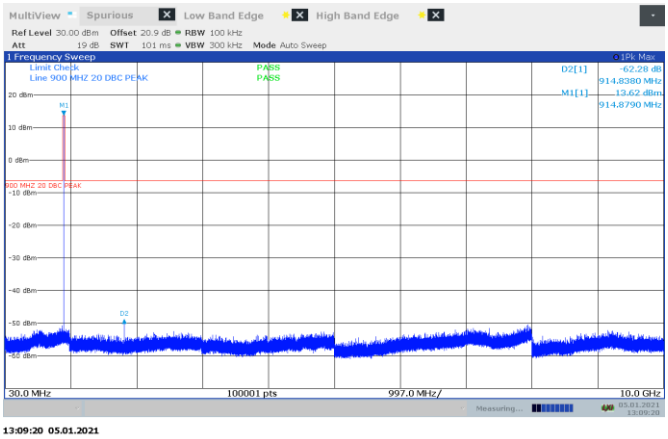


Figure 8.9-34: *Conducted spurious emissions on mid channel, FSK 250kbps*

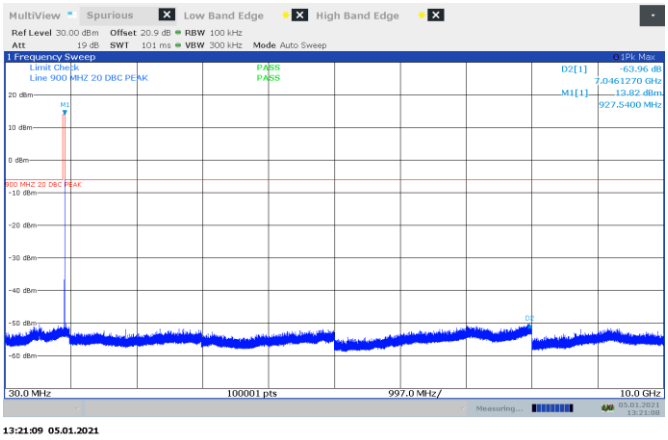


Figure 8.9-35: *Conducted spurious emissions on high channel, FSK 250kbps*

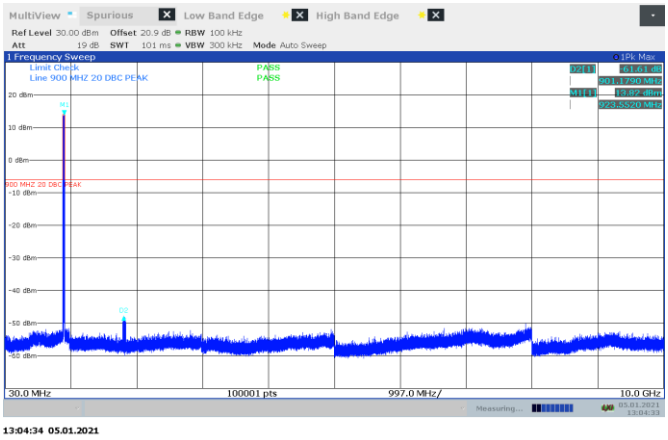


Figure 8.9-36: *Conducted spurious emissions on hopping, FSK 250kbps*

Test data, continued

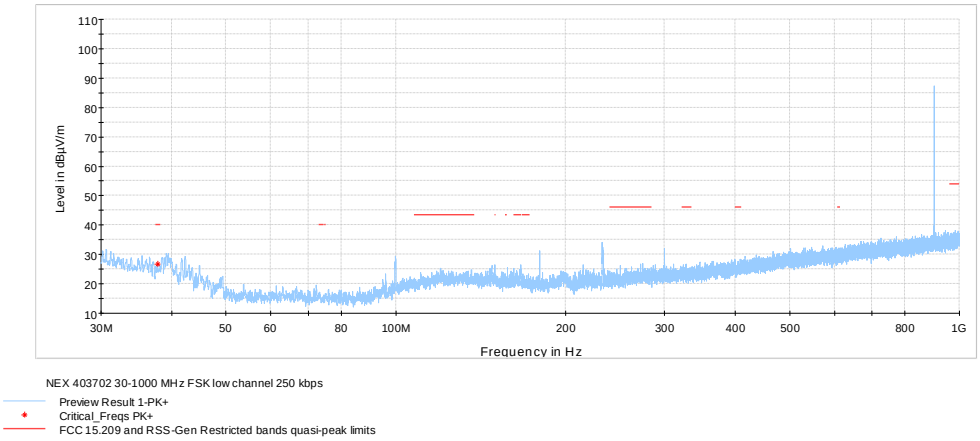


Figure 8.9-37: *Radiated spurious emissions 30 MHz – 1 GHz on low channel, FSK 250kbps*

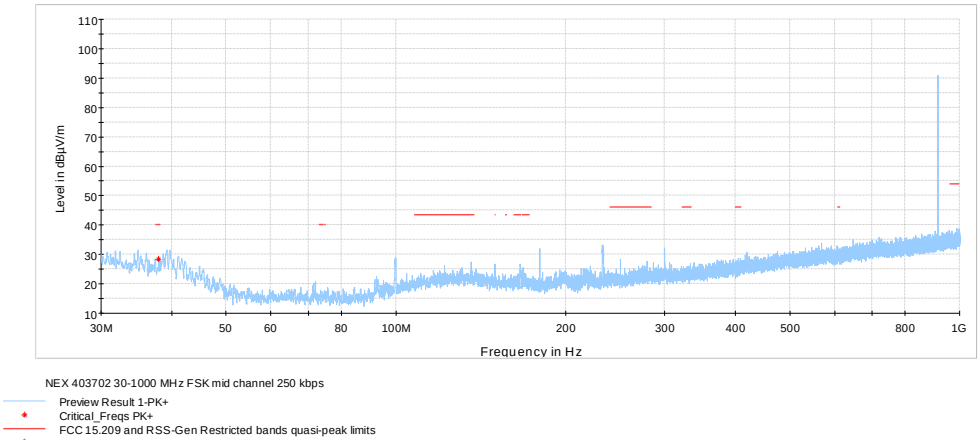


Figure 8.9-38: *Radiated spurious emissions 30 MHz – 1 GHz on mid channel, FSK 250kbps*

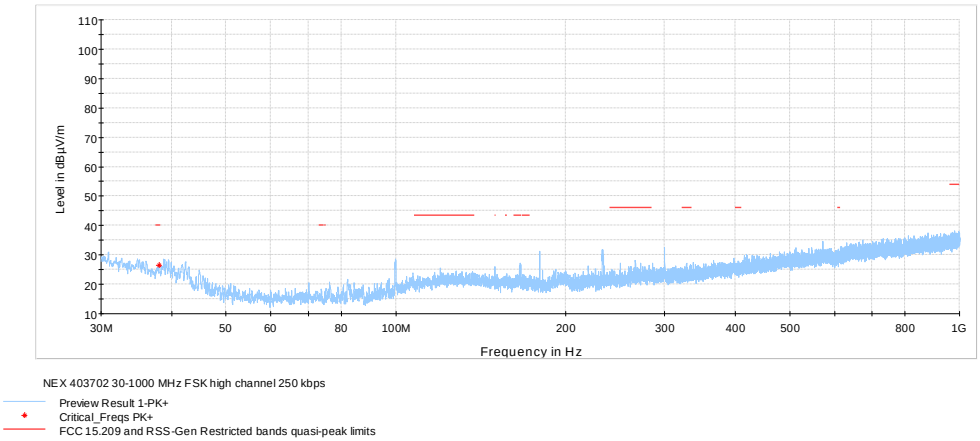


Figure 8.9-39: *Radiated spurious emissions 30 MHz – 1 GHz on high channel, FSK 250kbps*

Test data, continued

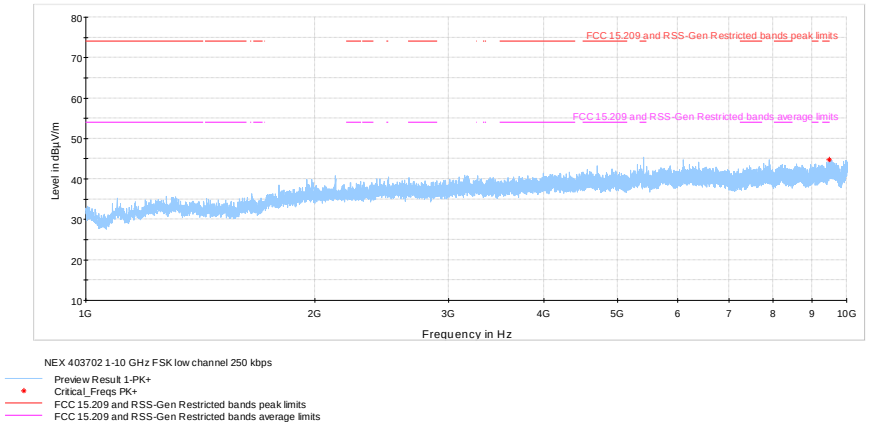


Figure 8.9-40: *Radiated spurious emissions 1 – 10 GHz on low channel, FSK 250kbps*

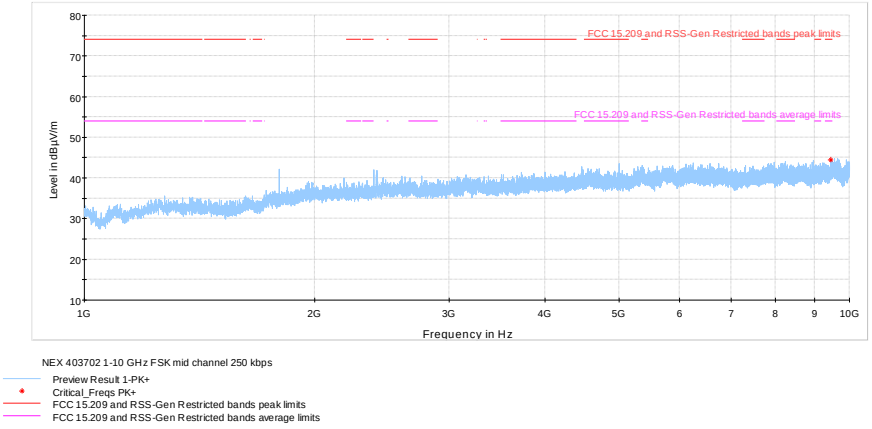


Figure 8.9-41: *Radiated spurious emissions 1 – 10 GHz on mid channel, FSK 250kbps*

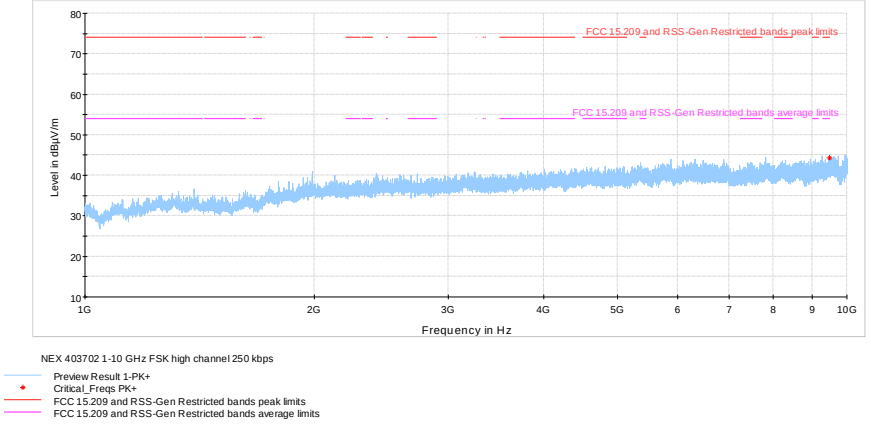


Figure 8.9-42: *Radiated spurious emissions 1 – 10 GHz on high channel, FSK 250kbps*

Test data, continued

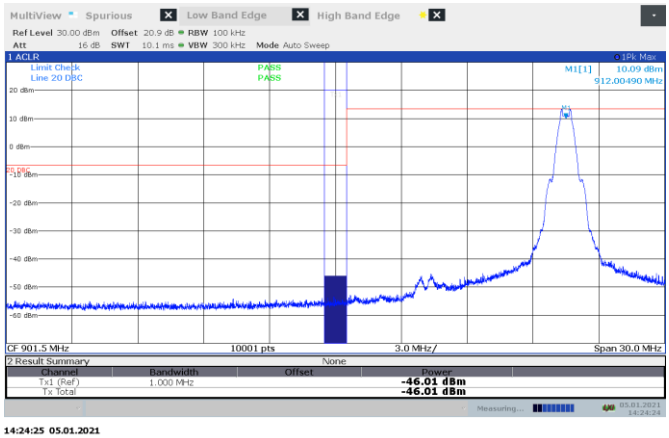


Figure 8.9-43: *Conducted Band-edge on 912 MHz channel, Z-Wave Long Range*

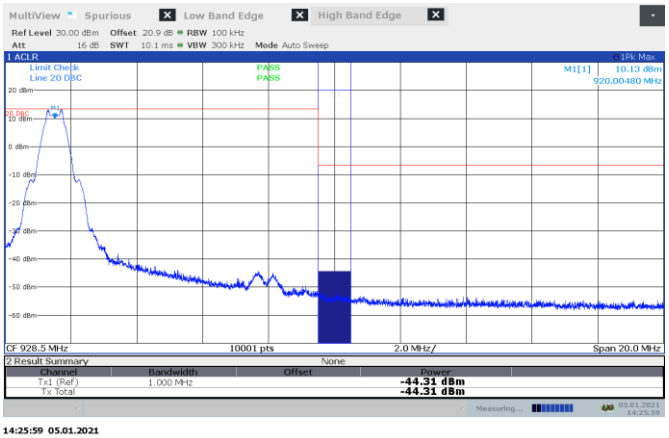


Figure 8.9-44: *Conducted Band-edge on 920 MHz channel, Z-Wave Long Range*

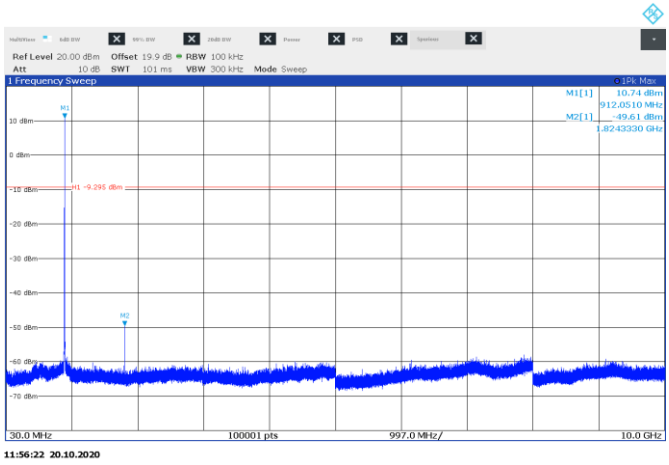


Figure 8.9-45: *Conducted spurious emissions on 912 MHz channel, Z-Wave Long Range*

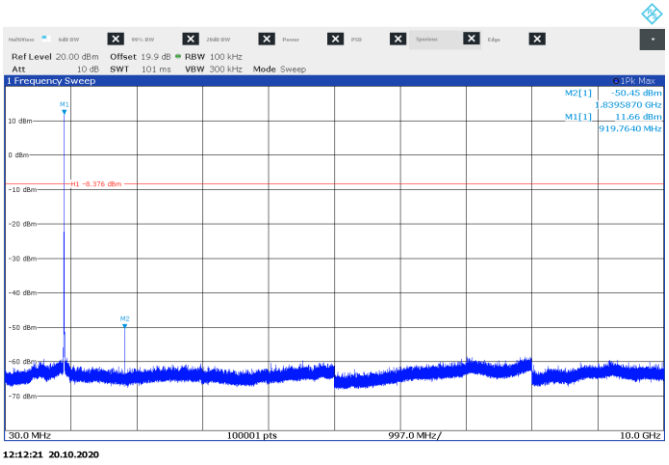


Figure 8.9-46: *Conducted spurious emissions on 920 MHz channel, Z-Wave Long Range*

Test data, continued

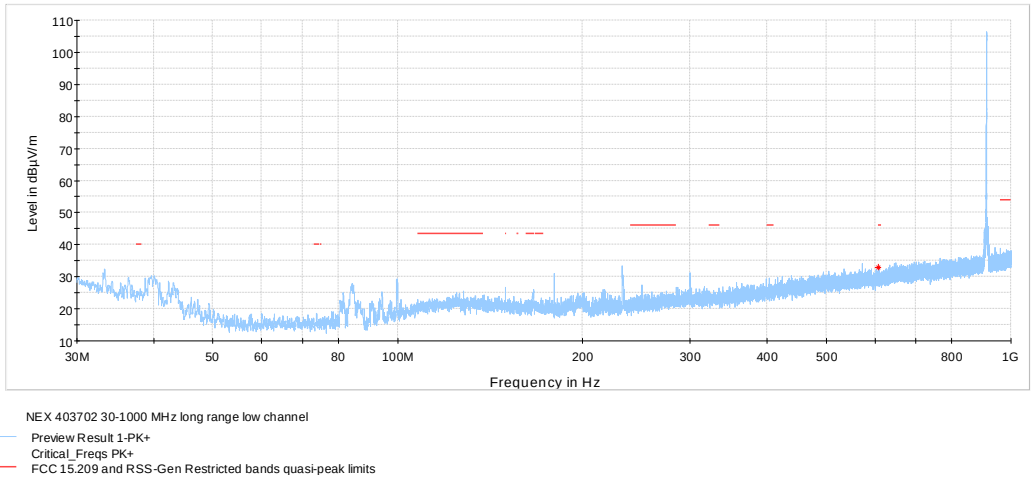


Figure 8.9-47: *Radiated spurious emissions 30 MHz – 1 GHz, on 912 MHz channel, Z-Wave Long Range*

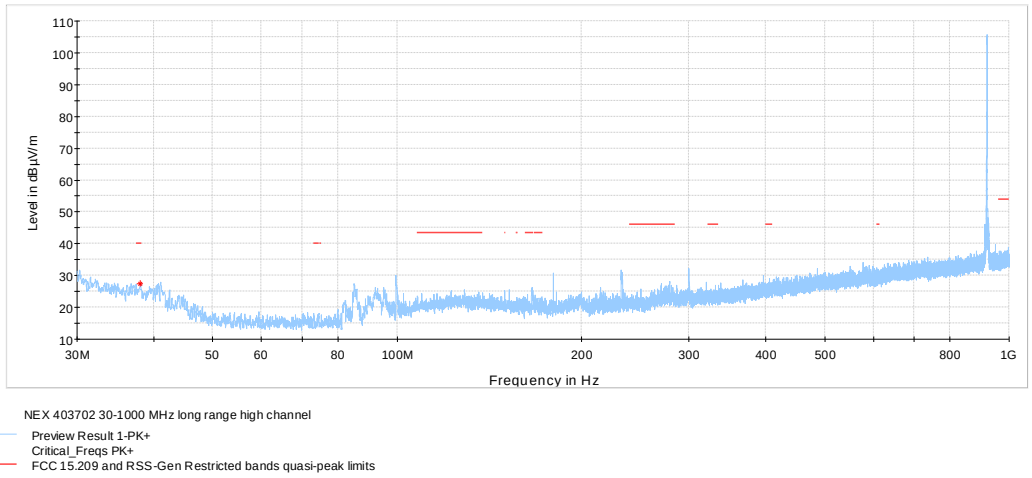
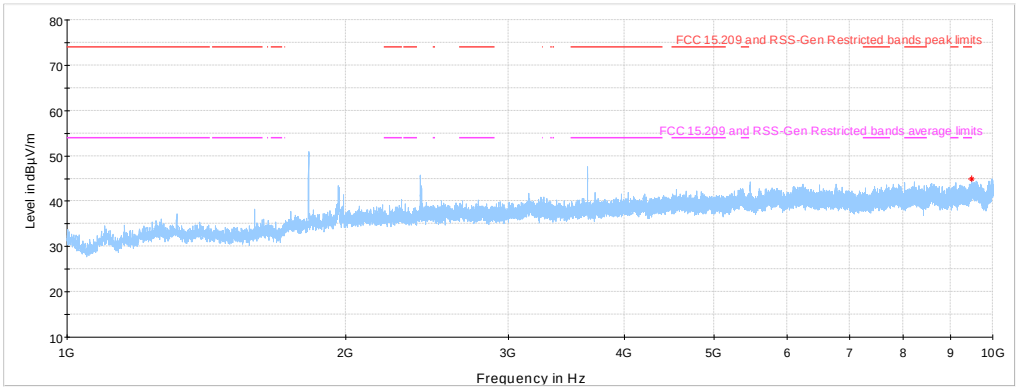


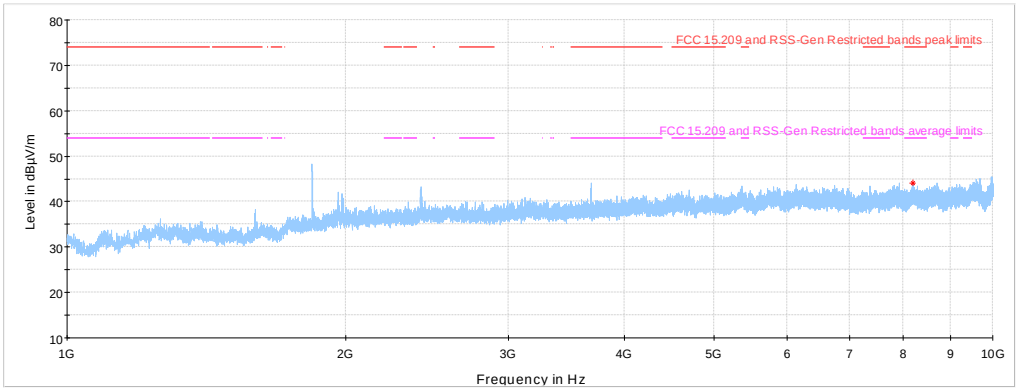
Figure 8.9-48: *Radiated spurious emissions 30 MHz – 1 GHz, on 920 MHz channel, Z-Wave Long Range*

Test data, continued



NEX 403702 1-10 GHz long range Low channel
Preview Result 1-PK+
Critical_Freqs PK+
FCC 15.209 and RSS-Gen Restricted bands peak limits
FCC 15.209 and RSS-Gen Restricted bands average limits

Figure 8.9-49: *Radiated spurious emissions 1 - 10 GHz, on 912 MHz channel, Z-Wave Long Range*



NEX 403702 1-10 GHz long range high channel
Preview Result 1-PK+
Critical_Freqs PK+
FCC 15.209 and RSS-Gen Restricted bands peak limits
FCC 15.209 and RSS-Gen Restricted bands average limits

Figure 8.9-50: *Radiated spurious emissions 1 - 10 GHz, on 920 MHz channel, Z-Wave Long Range*

8.10 FCC 15.247(e) and RSS-247 5.2(b) Power spectral density for digitally modulated devices

8.10.1 References, definitions and limits

FCC:
For digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of paragraph (b) of this section. The same method of determining the conducted output power shall be used to determine the power spectral density.

(f) For the purposes of this section, hybrid systems are those that employ a combination of both frequency hopping and digital modulation techniques. The frequency hopping operation of the hybrid system, with the direct sequence or digital modulation operation turned-off, shall have an average time of occupancy on any frequency not to exceed 0.4 seconds within a time period in seconds equal to the number of hopping frequencies employed multiplied by 0.4. The power spectral density conducted from the intentional radiator to the antenna due to the digital modulation operation of the hybrid system, with the frequency hopping operation turned off, shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission.

ISED:
The transmitter power spectral density conducted from the transmitter to the antenna shall not be greater than 8 dBm in any 3 kHz band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of section 5.4(d), (i.e. the power spectral density shall be determined using the same method as is used to determine the conducted output power).

5.3 Hybrid systems
Hybrid systems employ a combination of both frequency hopping and digital transmission techniques and shall comply with the following:
With the frequency hopping turned off, the digital transmission operation shall comply with the power spectral density requirements for digital modulation systems set out in of section 5.2(b) or section 6.2.4 for hybrid devices operating in the band 5725–5850 MHz.

8.10.2 Test summary

Verdict	Pass		
Tested by	Alvin Liu	Test date	October 20, 2020

8.10.3 Observations, settings and special notes

Power spectral density test was performed as per KDB 558074, section 8.4 with reference to ANSI C63.10 subclause 11.10.
The test was performed using method PKPSD (peak PSD).
Spectrum analyser settings:

Resolution bandwidth:	3 kHz
Video bandwidth:	≥3 × RBW
Frequency span:	1.5 times the DTS BW (Peak)
Detector mode:	Peak
Trace mode:	Max Hold

8.10.4 Test data

Table 8.10-1: *PSD results (antenna port measurement)*

Frequency, MHz	PSD, dBm/3 kHz	PSD limit, dBm/3 kHz	Margin, dB
912	1.0	8.00	7.0
920	1.0	8.00	7.0

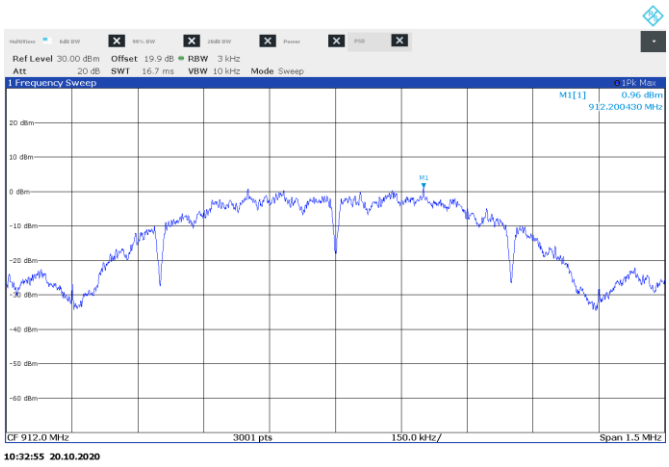


Figure 8.10-1: *PSD on 912 MHz channel, Z-Wave Long Range*

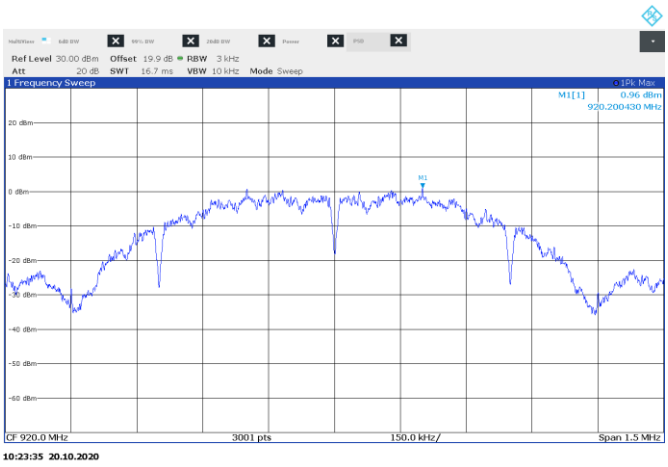


Figure 8.10-2: *PSD on 920 MHz channel, Z-Wave Long Range*

End of the test report