4.2 Test No. 2: Modulation Characteristics (§ 2.1047, § 2.201)

The occupied bandwidth was measured to be 4.50MHz (Config. A), 8.99MHz (Config. B), 13.50MHz (Config. C), 18.06MHz (Config. D) which represents the 99% power bandwidth (see the following section and screenshots on pages 68).

Therefore, the modulation characteristics of the base stations transceiver are:

Config A: 4M50F9W (Channel bandwidth 5MHz)

Config B: 8M99F9W (Channel bandwidth 10MHz)

Config C: 13M50F9W (Channel bandwidth 15MHz)

Config D: 18M06F9W (Channel bandwidth 20MHz)

No further testing is required under this section of the FCC and IC rules. No measurements other than the occupied bandwidth are required.

Sample modulation screenshots are on page 63, in I/Q constellation diagrams and tables, showing QPSK, 16QAM, 64QAM and 256QAM –modulation generation.

The modulation characteristics were found to be compliant with the manufacturer's specifications and with all requirements of the FCC.

4.3 Test No. 3: Occupied Bandwidth (§ 2.1049)

4.3.1. Limits

Para. No. 2.1049. The 99% occupied bandwidth is the width of a frequency band such that, below the lower and above the upper frequency limits, the mean powers emitted are each equal to 0.5% of the emitted power.

4.3.2. Test Procedure and Results

The 99% occupied bandwidth of the carrier emission is measured using a signal analyzer with Resolution Bandwidth set to 100-500 kHz (at least 1% of the bandwidth; see screenshots on page 68 for details). The following tables summarize the results:

Measured laboratory room temperature and humidity during the tests				
Date	Temperature Min-Max:		Humidity Min-Max:	
18 March 2019 – 21 March 2019	23.33 °C	24.03 °C	12.53 RH%	22.42 RH%

Config A:

Carrier Frequency [MHz]	Occupied Bandwidth [MHz]	Result
QPSK-Modulation ANT1		
2112.5	4.49	compliant
2155	4.49	compliant
2197.5	4.49	compliant
QPSK-Modulation ANT2		
2112.5	4.49	compliant
2155	4.49	compliant
2197.5	4.48	compliant
QPSK-Modulation ANT3		
2112.5	4.49	compliant
2155	4.49	compliant
2197.5	4.49	compliant
QPSK-Modulation ANT4		
2112.5	4.49	compliant
2155	4.49	compliant
2197.5	4.49	compliant

64QAM-Modulation ANT1		
2112.5	4.49	compliant
2155	4.49	compliant
2197.5	4.49	compliant
64AM-Modulation ANT2		
2112.5	4.49	compliant
2155	4.49	compliant
2197.5	4.49	compliant
64QAM-Modulation ANT3		
2112.5	4.49	compliant
2155	4.49	compliant
2197.5	4.49	compliant
64QAM-Modulation ANT4		
2112.5	4.49	compliant
2155	4.49	compliant
2197.5	4.50	compliant
16QAM-Modulation ANT1		
2112.5	4.46	compliant
2155	4.47	compliant
2197.5	4.46	compliant
16QAM-Modulation ANT2		
2112.5	4.47	compliant
2155	4.48	compliant
2197.5	4.47	compliant
16QAM-Modulation ANT3		
2112.5	4.47	compliant
2155	4.46	compliant
2197.5	4.48	compliant
16QAM-Modulation ANT4		
2112.5	4.48	compliant
2155	4.48	compliant
2197.5	4.47	compliant
256QAM-Modulation ANT1		
2112.5	4.49	compliant
2155	4.49	compliant
2197.5	4.49	compliant
256QAM-Modulation ANT2		
2112.5	4.49	compliant
2155	4.49	compliant

2197.5	4.49	compliant
256QAM-Modulation ANT3		
2112.5	4.49	compliant
2155	4.49	compliant
2197.5	4.49	compliant
256QAM-Modulation ANT4		
2112.5	4.50	compliant
2155	4.49	compliant
2197.5	4.50	compliant
Measurement Uncertainty:		±48kHz

Table 8 Occupied Bandwidth (5 MHz Channel BW)

Config B:

Carrier Frequency [MHz]	Occupied Bandwidth [MHz]	Result
QPSK-Modulation ANT1		
2115	8.98	compliant
2155	8.99	compliant
2195	8.97	compliant
QPSK-Modulation ANT2		
2115	8.98	compliant
2155	8.97	compliant
2195	8.98	compliant
QPSK-Modulation ANT3		
2115	8.98	compliant
2155	8.97	compliant
2195	8.98	compliant
QPSK-Modulation ANT4		
2115	8.96	compliant
2155	8.97	compliant
2195	8.97	compliant
64QAM-Modulation ANT1		
2115	8.97	compliant
2155	8.98	compliant
2195	8.97	compliant
64QAM-Modulation ANT2		
2115	8.97	compliant
2155	8.97	compliant
2195	8.96	compliant

64QAM-Modulation ANT3		
2115	8.98	compliant
2155	8.99	compliant
2195	8.99	compliant
64QAM-Modulation ANT4		
2115	8.97	compliant
2155	8.98	compliant
2195	8.96	compliant
16QAM-Modulation ANT1		
2115	8.97	compliant
2155	8.98	compliant
2195	8.95	compliant
16QAM-Modulation ANT2		
2115	8.96	compliant
2155	8.98	compliant
2195	8.97	compliant
16QAM-Modulation ANT3		
2115	8.96	compliant
2155	8.99	compliant
2195	8.97	compliant
16QAM-Modulation ANT4		
2115	8.95	compliant
2155	8.94	compliant
2195	8.99	compliant
256QAM-Modulation ANT1		
2115	8.97	compliant
2155	8.98	compliant
2195	8.96	compliant
256QAM-Modulation ANT2		
2115	8.97	compliant
2155	8.98	compliant
2195	8.96	compliant
256QAM-Modulation ANT3		
2115	8.97	compliant
2155	8.97	compliant
2195	8.96	compliant
256QAM-Modulation ANT4		
2115	8.97	compliant
2155	8.98	compliant

2195	8.96	compliant
Measurement Uncertainty:		±48kHz

Table 9 Occupied Bandwidth (10 MHz Channel BW)

Config C:

Carrier Frequency [MHz]	Occupied Bandwidth [MHz]	Result
QPSK-Modulation ANT1		
2117.5	13.47	compliant
2155	13.48	compliant
2192.5	13.47	compliant
QPSK-Modulation ANT2		
2117.5	13.46	compliant
2155	13.47	compliant
2192.5	13.46	compliant
QPSK-Modulation ANT3		
2117.5	13.48	compliant
2155	13.47	compliant
2192.5	13.46	compliant
QPSK-Modulation ANT4		
2117.5	13.46	compliant
2155	13.47	compliant
2192.5	13.46	compliant
64QAM-Modulation ANT1		
2117.5	13.46	compliant
2155	13.47	compliant
2192.5	13.46	compliant
64QAM-Modulation ANT2		
2117.5	13.47	compliant
2155	13.46	compliant
2192.5	13.45	compliant
64QAM-Modulation ANT3		
2117.5	13.46	compliant
2155	13.46	compliant
2192.5	13.45	compliant
64QAM-Modulation ANT4		
2117.5	13.45	compliant
2155	13.47	compliant
2192.5	13.44	compliant
16QAM-Modulation ANT1		

2117.5	13.48	compliant
2155	13.43	compliant
2192.5	13.50	compliant
16QAM-Modulation ANT2		
2117.5	13.38	compliant
2155	13.49	compliant
2192.5	13.47	compliant
16QAM-Modulation ANT3		
2117.5	13.47	compliant
2155	13.45	compliant
2192.5	13.42	compliant
16QAM-Modulation ANT4		
2117.5	13.44	compliant
2155	13.49	compliant
2192.5	13.47	compliant
256QAM-Modulation ANT1		
2117.5	13.46	compliant
2155	13.46	compliant
2192.5	13.45	compliant
256QAM-Modulation ANT2		
2117.5	13.46	compliant
2155	13.47	compliant
2192.5	13.46	compliant
256QAM-Modulation ANT3		
2117.5	13.45	compliant
2155	13.47	compliant
2192.5	13.46	compliant
256QAM-Modulation ANT4		
2117.5	13.46	compliant
2155	13.46	compliant
2192.5	13.45	compliant
Measurement Uncertainty:		±48kHz

Table 10 Occupied Bandwidth (15 MHz Channel BW)

Config D:

Carrier Frequency [MHz]	Occupied Bandwidth [MHz]	Result
QPSK-Modulation ANT1		

2120	17.96	compliant
2155	17.97	compliant
2190	17.98	compliant
QPSK-Modulation ANT2		
2120	17.97	compliant
2155	17.99	compliant
2190	17.96	compliant
QPSK-Modulation ANT3		
2120	17.98	compliant
2155	17.97	compliant
2190	17.97	compliant
QPSK-Modulation ANT4		
2120	17.98	compliant
2155	17.97	compliant
2190	17.98	compliant
64QAM-Modulation ANT1		
2120	17,97	compliant
2155	17.99	compliant
2190	17.97	compliant
64QAM-Modulation ANT2		
2120	17.99	compliant
2155	17.99	compliant
2190	17.96	compliant
64QAM-Modulation ANT3		
2120	17.99	compliant
2155	17.98	compliant
2190	17.98	compliant
64QAM-Modulation ANT4		
2120	17.98	compliant
2155	18.00	compliant
2190	17.94	compliant
16QAM-Modulation ANT1		
2120	18.00	compliant
2155	18.06	compliant
2190	18.00	compliant
16QAM-Modulation ANT2		
2120	17.99	compliant
2155	17.97	compliant
2190	17.97	compliant

16QAM-Modulation ANT3		
2120	18.00	compliant
2155	18.00	compliant
2190	17.94	compliant
16QAM-Modulation ANT4		
2120	17.94	compliant
2155	17.98	compliant
2190	17.99	compliant
256QAM-Modulation ANT1		
2120	17.99	compliant
2155	17.99	compliant
2190	17.96	compliant
256QAM-Modulation ANT2		
2120	17.98	compliant
2155	18.00	compliant
2190	17.97	compliant
256QAM-Modulation ANT3		
2120	17.98	compliant
2155	17.98	compliant
2190	17.98	compliant
256QAM-Modulation ANT4		
2120	17.99	compliant
2155	17.98	compliant
2190	17.99	compliant
Measurement Uncertainty:		±48kHz

Table 11 Occupied Bandwidth (20 MHz Channel BW)

The occupied bandwidth was found to be compliant with the manufacturer's specifications and with all requirements of the FCC rules.

4.4 Test No. 4: Spurious Emissions at Antenna Terminals (§ 2.1051, § 2.1057, § 27.53)

4.4.1. Limits

Para. No. 27.53(m). For BRS and EBS stations, the power of any emissions outside the licensee's frequency bands of operation shall be attenuated below the transmitter power (P) measured in watts.

(m)(2) For digital base stations, the attenuation shall be not less than 43 + 10 log10 (P) dB.

The compliance limit was calculated in the following way:

Maximum transmitter output power [W]: P

Maximum transmitter output power [dBm]: 30 + 10 log10 P (conversion from W to dBm)

Attenuation required by FCC and IC: 43 + 10 log10 P

Compliance limit = Maximum transmitter output power - Required attenuation

= 30 + 10 log10 P - (43 + 10 log10 P) = -13 dBm

For MiMo output each antenna connectors were measured individually and each individual limit line was reduced by additional 10log(4) -6.02dB (four way MiMo config) and limit line was calculated to show -19.02dB emission limit, according to FCC KDB 662911 D02 guidance.

4.4.2. Test Procedure and Results

The tests were carried out in accordance with § 27.53. For all frequency ranges except two (immediately below and above the carrier frequency block). Resolution bandwidth of at least 1% of OBW or greater was employed.

In the 1MHz bands immediately outside and adjacent to the authorized frequency range or channel, a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter was employed.

According to § 2.1057, all emissions including the fundamental frequency from the lowest radio frequency generated in the equipment, without going below 9kHz, up to the 10th harmonic were investigated.

The following tables summarize the worst case detected emission levels in all antenna ports (see screenshots of highest emission antenna on page xxx for details). The external attenuation (cable loss of the set up) is already added in the results. Limit line is set fixed to level -19.02dB.

Measured laboratory room temperature and humidity during the tests				
Date	Temperature Min-Max:		Humidity Min-Max:	
21 March 2019 – 27 March 2019	23.33 °C	24.03 °C	12.53 RH%	22.42 RH%

Config A Lower band edge:

Carrier Frequency: 2112.5 MHz			
Frequency Range [MHz]	**Emission Frequency [MHz]**	**Maximum Emission Level [dBm]**	**Result**
QPSK-Modulation ANT1			
	2109.9	-31.80	compliant
QPSK-Modulation ANT2			
	2109.9	-32.32	compliant
QPSK-Modulation ANT3			
	2109.9	-32.08	compliant
QPSK-Modulation ANT4			
	2109.9	-31.90	compliant
64QAM-Modulation ANT1			
	2109.9	-32.50	compliant
64QAM-Modulation ANT2			
	2109.9	-32.45	compliant
64QAM-Modulation ANT3			
	2109.9	-32.08	compliant
64QAM-Modulation ANT4			
	2109.9	-32.02	compliant
16QAM-Modulation ANT1			
	2109.9	-33.06	compliant
16QAM-Modulation ANT2			
	2109.9	-32.09	compliant
16QAM-Modulation ANT3			
	2109.9	-32.25	compliant
16QAM-Modulation ANT4			
	2109.9	-32.51	compliant
256QAM-Modulation ANT1			
	2109.9	-32.12	compliant
256QAM-Modulation ANT2			
	2109.9	-31.98	compliant
256QAM-Modulation ANT3			

	2109.9	-32.07	compliant
256QAM-Modulation ANT4			
	2109.9	-31.99	compliant
Measurement Uncertainty:		f < 1.0GHz: ±1.1dB, 1.0GHz ≤ f <3.6GHz: ±1.2dB, 3.6GHz ≤ f <8.0GHz: ±1.6dB, 8.0GHz ≤ f: ±1.9dB	

Table 12 Spurious Emissions (Lower band edge) (5 MHz CH BW)

Config A Upper band edge:

Carrier Frequency: 2197.5 MHz			
Frequency Range [MHz]	**Emission Frequency [MHz]**	**Maximum Emission Level [dBm]**	**Result**
QPSK-Modulation ANT1			
	2200	-31.95	compliant
QPSK-Modulation ANT2			
	2200	-31.56	compliant
QPSK-Modulation ANT3			
	2200	-31.44	compliant
QPSK-Modulation ANT4			
	2200	-31.21	compliant
64QAM-Modulation ANT1			
	2200	-31.92	compliant
64QAM-Modulation ANT2			
	2200	-30.99	compliant
646QAM-Modulation ANT3			
	2200	-30.96	compliant
64QAM-Modulation ANT4			
	2200	-31.01	compliant
16QAM-Modulation ANT1			
	2200	-31.74	compliant
16QAM-Modulation ANT2			
	2200	-31.51	compliant
16QAM-Modulation ANT3			
	2200	-31.68	compliant
16QAM-Modulation ANT4			
	2200	-31.20	compliant

256QAM-Modulation ANT1			
	2200	-31.42	compliant
256QAM-Modulation ANT2			
	2200	-30.83	compliant
256QAM-Modulation ANT3			
	2200	-31.07	compliant
256QAM-Modulation ANT4			
	2200	-30.52	compliant

Table 13 Spurious Emissions (Upper band edge) (5 MHz CH BW)

Config A Spurious emissions:

Carrier Frequency: 2155 MHz			
Frequency Range [MHz]	**Emission Frequency [MHz]**	**Maximum Emission Level [dBm]**	**Result**
QPSK-Modulation ANT1			
0.009 – 22000	2151.4	-25.09	compliant
QPSK-Modulation ANT2			
0.009 – 22000	2151.4	-23.85	compliant
QPSK-Modulation ANT3			
0.009 – 22000	2151.4	-24.35	compliant
QPSK-Modulation ANT4			
0.009 – 22000	2151.4	-24.05	compliant
64AM-Modulation ANT1			
0.009 – 22000	2151.4	-25.00	compliant
64QAM-Modulation ANT2			
0.009 – 22000	2151.4	-23.85	compliant
64QAM-Modulation ANT3			
0.009 – 22000	2151.4	-24.21	compliant
64QAM-Modulation ANT4			
0.009 – 22000	2151.4	-23.94	compliant
16QAM-Modulation ANT1			
0.009 – 22000	2151.4	24-90	compliant
164QAM-Modulation ANT2			
0.009 – 22000	2151.4	-24.39	compliant
16QAM-Modulation ANT3			
0.009 – 22000	2151.4	-24.39	compliant
16QAM-Modulation ANT4			
0.009 – 22000	2151.4	-24.35	compliant

256QAM-Modulation ANT1			
0.009 – 22000	2151.4	-24.80	compliant
256QAM-Modulation ANT2			
0.009 – 22000	2151.4	-24.12	compliant
256QAM-Modulation ANT3			
0.009 – 22000	2151.4	-24.50	compliant
256QAM-Modulation ANT4			
0.009 – 22000	2151.4	-24.50	compliant
Measurement Uncertainty:		f < 1.0GHz: ±1.1dB, 1.0GHz ≤ f <3.6GHz: ±1.2dB, 3.6GHz ≤ f <8.0GHz: ±1.6dB, 8.0GHz ≤ f: ±1.9dB	

Table 14 Spurious Emissions (5 MHz Channel BW)

Config B Lower band edge:

Carrier Frequency: 2115 MHz			
Frequency Range [MHz]	**Emission Frequency [MHz]**	**Maximum Emission Level [dBm]**	**Result**
QPSK-Modulation ANT1			
	2110	-32.06	compliant
QPSK-Modulation ANT2			
	2110	-32.17	compliant
QPSK-Modulation ANT3			
	2110	-31.98	compliant
QPSK-Modulation ANT4			
	2110	-31.49	compliant
64QAM-Modulation ANT1			
	2110	-32.05	compliant
64QAM-Modulation ANT2			
	2110	-31.99	compliant
64QAM-Modulation ANT3			
	2110	-31.34	compliant
64QAM-Modulation ANT4			
	2110	-31.87	compliant
16QAM-Modulation ANT1			
	2110	-32.75	compliant
16QAM-Modulation ANT2			
	2110	-32.48	compliant

16QAM-Modulation ANT3			
	2110	-32.23	compliant
16QAM-Modulation ANT4			
	2110	-31.86	compliant
256QAM-Modulation ANT1			
	2110	-32.10	compliant
256QAM-Modulation ANT2			
	2110	-31.71	compliant
256QAM-Modulation ANT3			
	2110	-31.94	compliant
256QAM-Modulation ANT4			
	2110	-32.11	compliant
Measurement Uncertainty:		f < 1.0GHz: ±1.1dB, 1.0GHz ≤ f <3.6GHz: ±1.2dB, 3.6GHz ≤ f <8.0GHz: ±1.6dB, 8.0GHz ≤ f: ±1.9dB	

Table 15 Spurious Emissions (Lower band edge) (10 MHz CH BW)

Config B Upper band edge:

Carrier Frequency: 2195 MHz			
Frequency Range [MHz]	**Emission Frequency [MHz]**	**Maximum Emission Level [dBm]**	**Result**
QPSK-Modulation ANT1			
	2200	-32.40	compliant
QPSK-Modulation ANT2			
	2200	-31.72	compliant
QPSK-Modulation ANT3			
	2200	-31.84	compliant
QPSK-Modulation ANT4			
	2200	-31.42	compliant
64QAM-Modulation ANT1			
	2200	-32.30	compliant
64QAM-Modulation ANT2			
	2200	-31.86	compliant
64QAM-Modulation ANT3			
	2200	-31.94	compliant
64QAM-Modulation ANT4			
	2200	-31.67	compliant

16QAM-Modulation ANT1			
	2200	-31.99	compliant
16QAM-Modulation ANT2			
	2200	-31.40	compliant
16QAM-Modulation ANT3			
	2200	-31.35	compliant
16QAM-Modulation ANT4			
	2200	-31.44	compliant
256QAM-Modulation ANT1			
	2200	-31.74	compliant
256QAM-Modulation ANT2			
	2200	-31.36	compliant
256QAM-Modulation ANT3			
	2200	-30.93	compliant
256QAM-Modulation ANT4			
	2200	-30.87	compliant
Measurement Uncertainty:		f < 1.0GHz: ±1.1dB, 1.0GHz ≤ f <3.6GHz: ±1.2dB, 3.6GHz ≤ f <8.0GHz: ±1.6dB, 8.0GHz ≤ f: ±1.9dB	

Table 16 Spurious Emissions (Upper band edge) (10 MHz CH BW)

Config B Spurious emissions:

Carrier Frequency: 2155 MHz			
Frequency Range [MHz]	**Emission Frequency [MHz]**	**Maximum Emission Level [dBm]**	**Result**
QPSK-Modulation ANT1			
0.009 – 22000	21820	-24.70	compliant
QPSK-Modulation ANT2			
0.009 – 22000	21850	-24.60	compliant
QPSK-Modulation ANT3			
0.009 – 22000	21950	-24.14	compliant
QPSK-Modulation ANT4			
0.009 – 22000	21610	-24.70	compliant
64QAM-Modulation ANT1			
0.009 – 22000	21940	-24.72	compliant
64QAM-Modulation ANT2			
0.009 – 22000	21960	-24.67	compliant

64QAM-Modulation ANT3			
0.009 – 22000	21570	-24.72	compliant
64QAM-Modulation ANT4			
0.009 – 22000	21530	-24.94	compliant
16QAM-Modulation ANT1			
0.009 – 22000	21850	-24.71	compliant
16QAM-Modulation ANT2			
0.009 – 22000	21590	-24.64	compliant
16QAM-Modulation ANT3			
0.009 – 22000	21830	-24.57	compliant
16QAM-Modulation ANT4			
0.009 – 22000	21620	-24.83	compliant
256QAM-Modulation ANT1			
0.009 – 22000	21840	-24.64	compliant
256QAM-Modulation ANT2			
0.009 – 22000	21830	-24.62	compliant
256QAM-Modulation ANT3			
0.009 – 22000	21970	-24.81	compliant
256QAM-Modulation ANT4			
0.009 – 22000	21592	-24.7	compliant
Measurement Uncertainty:		f < 1.0GHz: ±1.1dB, 1.0GHz ≤ f <3.6GHz: ±1.2dB, 3.6GHz ≤ f <8.0GHz: ±1.6dB, 8.0GHz ≤ f: ±1.9dB	

Table 67 Spurious Emissions (10 MHz CH BW)

Config C Lower band edge:

Carrier Frequency: 2117.5 MHz			
Frequency Range [MHz]	**Emission Frequency [MHz]**	**Maximum Emission Level [dBm]**	**Result**
QPSK-Modulation ANT1			
	2110	-28.90	compliant
QPSK-Modulation ANT2			
	2110	-28.84	compliant
QPSK-Modulation ANT3			
	2110	-28.83	compliant
QPSK-Modulation ANT4			
	2110	-28.80	compliant

64QAM-Modulation ANT1			
	2110	-28.75	compliant
64QAM-Modulation ANT2			
	2110	-28.87	compliant
64QAM-Modulation ANT3			
	2110	-28.7	compliant
64QAM-Modulation ANT4			
	2110	-28.57	compliant
16QAM-Modulation ANT1			
	2110	-28.33	compliant
16QAM-Modulation ANT2			
	2110	-28.97	compliant
16QAM-Modulation ANT3			
	2110	-28.50	compliant
16QAM-Modulation ANT4			
	2110	-28.57	compliant
256QAM-Modulation ANT1			
	2110	-28.6	compliant
256QAM-Modulation ANT2			
	2110	-28.36	compliant
256QAM-Modulation ANT3			
	2110	-28.56	compliant
256QAM-Modulation ANT4			
	2110	-28.73	compliant
Measurement Uncertainty:		f < 1.0GHz: ±1.1dB, 1.0GHz ≤ f <3.6GHz: ±1.2dB, 3.6GHz ≤ f <8.0GHz: ±1.6dB, 8.0GHz ≤ f: ±1.9dB	

Table 78 Spurious Emissions (Lower band edge) (15 MHz CH BW)

Config C Upper band edge:

Carrier Frequency: 2192.5 MHz			
Frequency Range [MHz]	**Emission Frequency [MHz]**	**Maximum Emission Level [dBm]**	**Result**
QPSK-Modulation ANT1			
	2200	-28.86	compliant
QPSK-Modulation ANT2			
	2200	-28.56	compliant