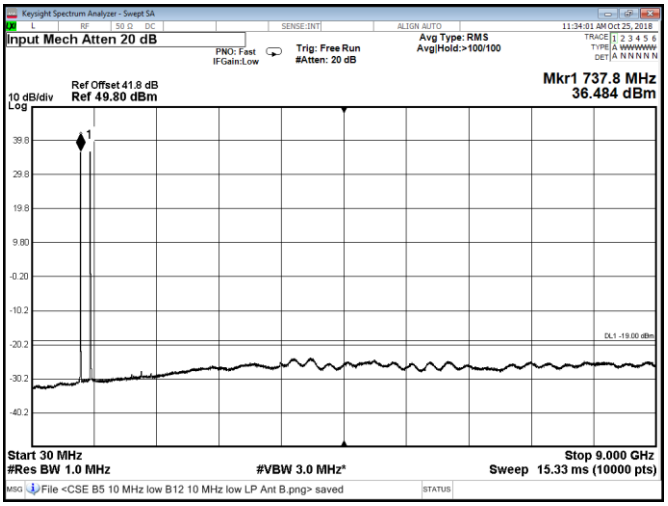


Figure 8.5-21: *Conducted spurious emissions for multi band B5 10 MHz low channel, B12A 10 MHz low channel with 40 W configuration at Port C*

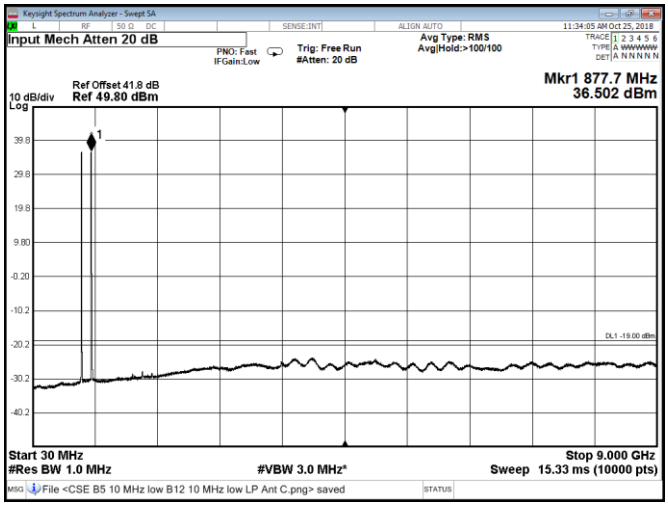


Figure 8.5-22: *Conducted spurious emissions for multi band B5 10 MHz low channel, B12A 10 MHz low channel with 40 W configuration at Port D*

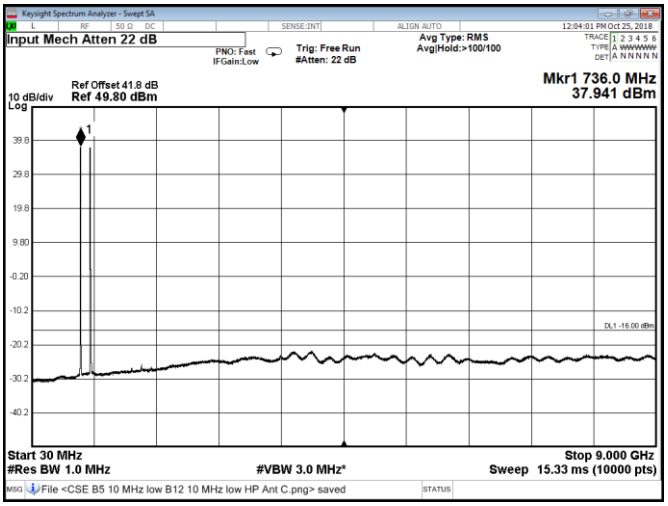


Figure 8.5-23: *Conducted spurious emissions for multi band B5 10 MHz low channel, B12A 10 MHz low channel with 60 W configuration at Port A*

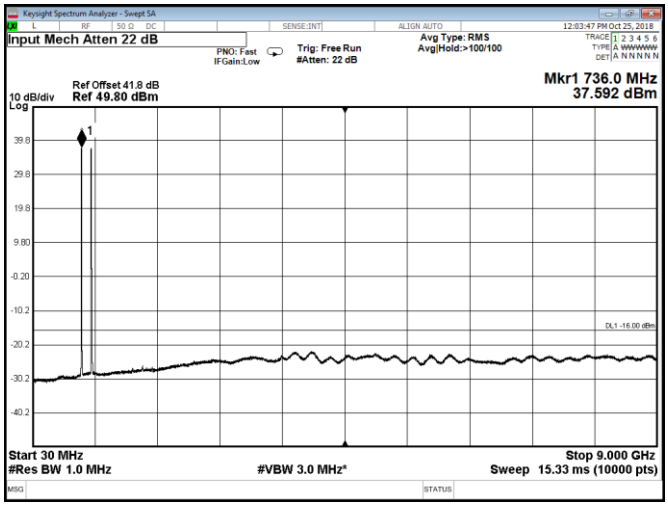


Figure 8.5-24: *Conducted spurious emissions for multi band B5 10 MHz low channel, B12A 10 MHz low channel with 40 W configuration at Port C*

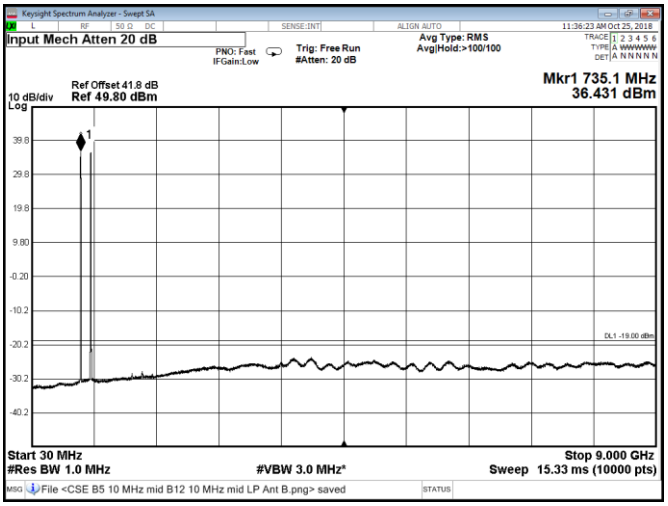


Figure 8.5-25: *Conducted spurious emissions for multi band B5 10 MHz mid channel, B12A 10 MHz mid channel with 40 W configuration at Port A*

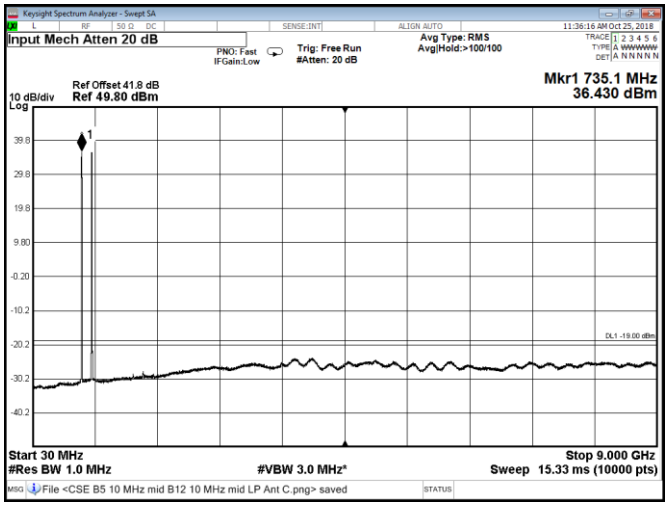


Figure 8.5-26: *Conducted spurious emissions for multi band B5 10 MHz mid channel, B12A 10 MHz mid channel with 40 W configuration at Port B*

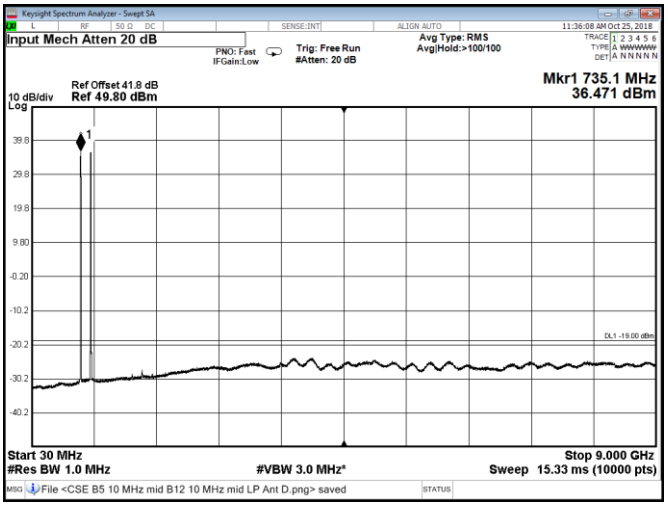


Figure 8.5-27: *Conducted spurious emissions for multi band B5 10 MHz mid channel, B12A 10 MHz mid channel with 40 W configuration at Port C*

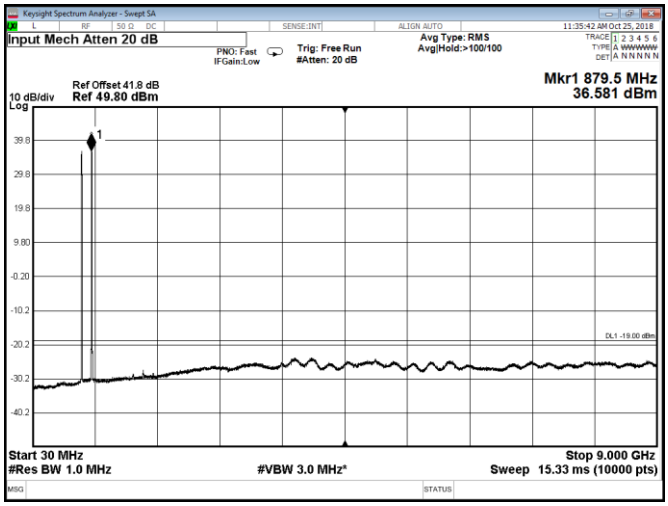


Figure 8.5-28: *Conducted spurious emissions for multi band B5 10 MHz mid channel, B12A 10 MHz mid channel with 40 W configuration at Port D*

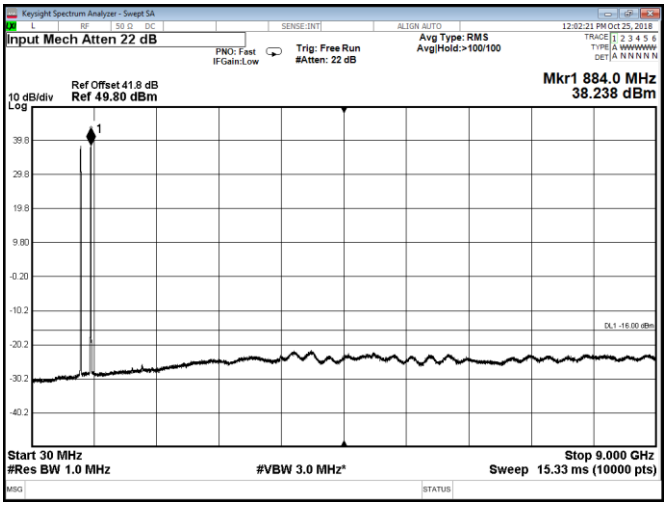


Figure 8.5-29: *Conducted spurious emissions for multi band B5 10 MHz mid channel, B12A 10 MHz mid channel with 60 W configuration at Port A*

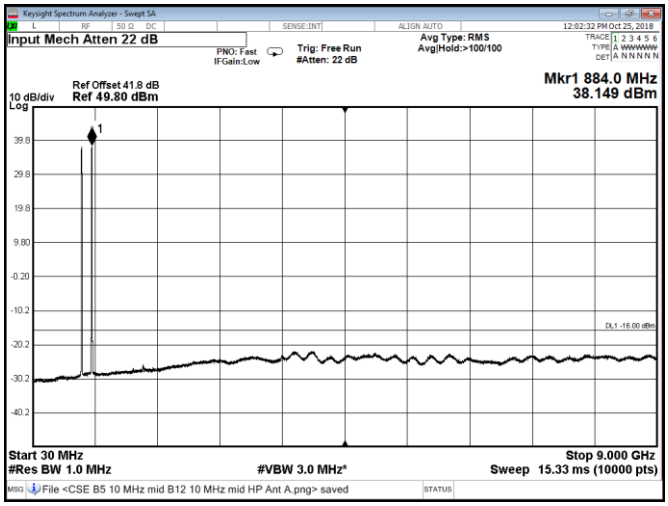


Figure 8.5-30: *Conducted spurious emissions for multi band B5 10 MHz mid channel, B12A 10 MHz mid channel with 60 W configuration at Port C*

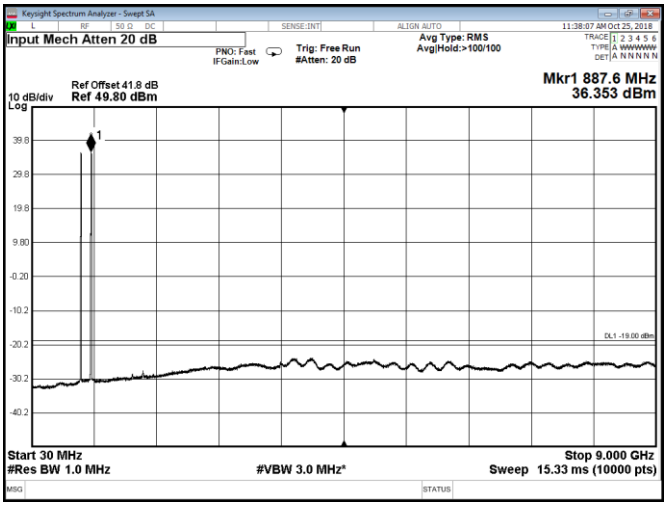


Figure 8.5-31: *Conducted spurious emissions for multi band B5 10 MHz high channel, B12A 10 MHz high channel with 40 W configuration at Port A*

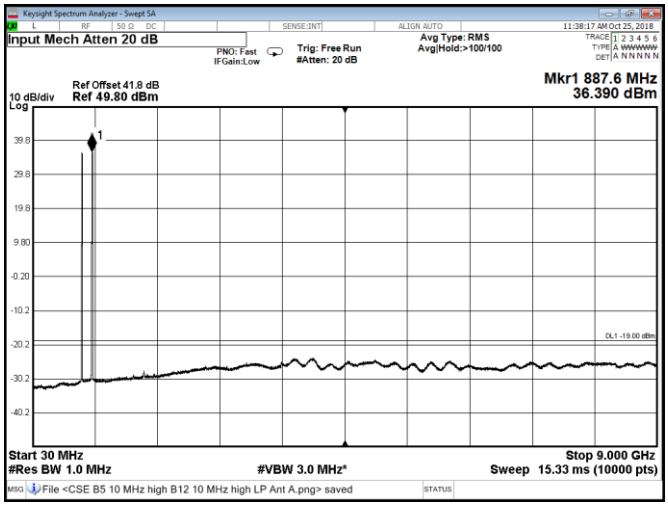


Figure 8.5-32: *Conducted spurious emissions for multi band B5 10 MHz high channel, B12A 10 MHz high channel with 40 W configuration at Port B*

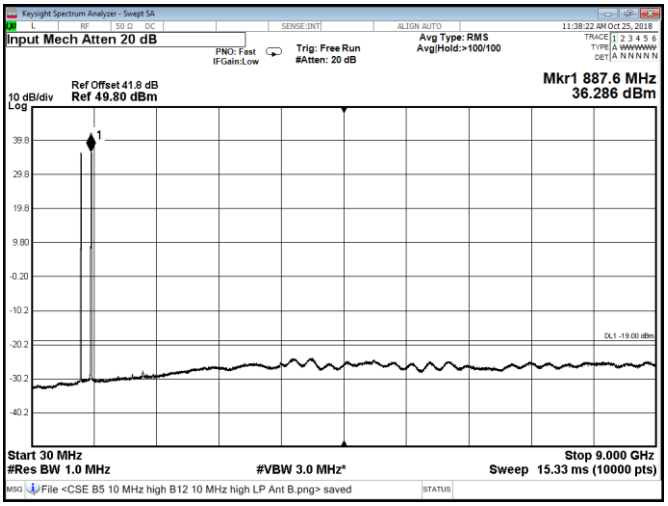


Figure 8.5-33: *Conducted spurious emissions for multi band B5 10 MHz high channel, B12A 10 MHz high channel with 40 W configuration at Port C*

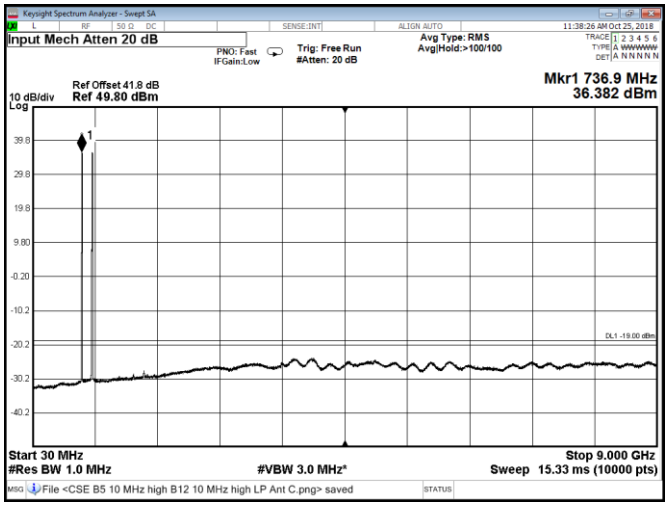


Figure 8.5-34: *Conducted spurious emissions for multi band B5 10 MHz high channel, B12A 10 MHz high channel with 40 W configuration at Port D*

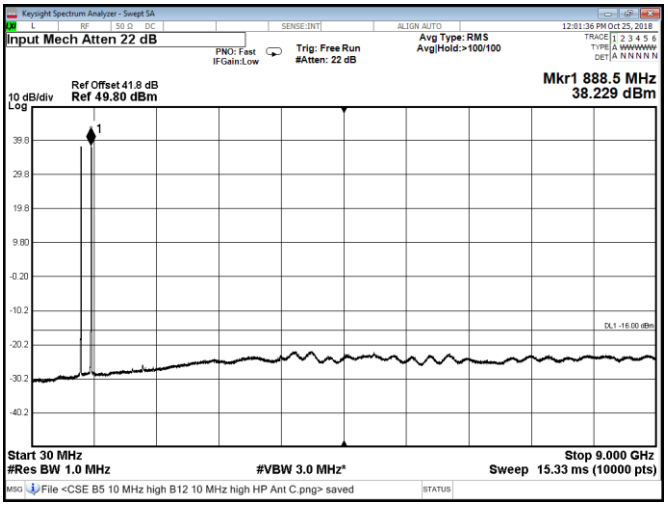


Figure 8.5-35: *Conducted spurious emissions for multi band B5 10 MHz high channel, B12A 10 MHz high channel with 60 W configuration at Port A*

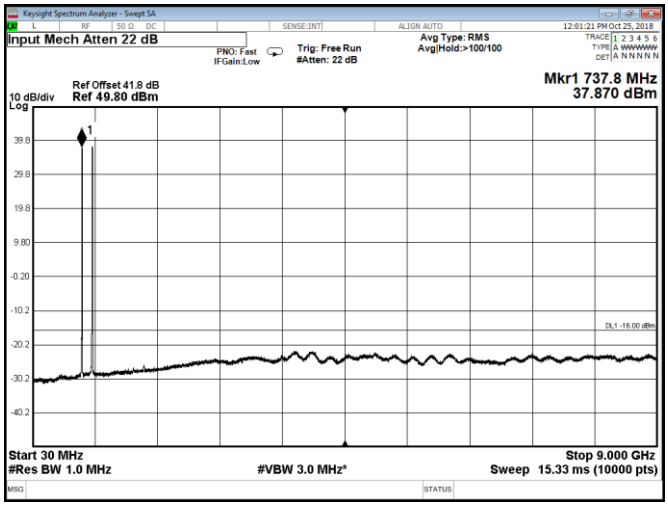


Figure 8.5-36: *Conducted spurious emissions for multi band B5 10 MHz high channel, B12A 10 MHz high channel with 60 W configuration at Port C*

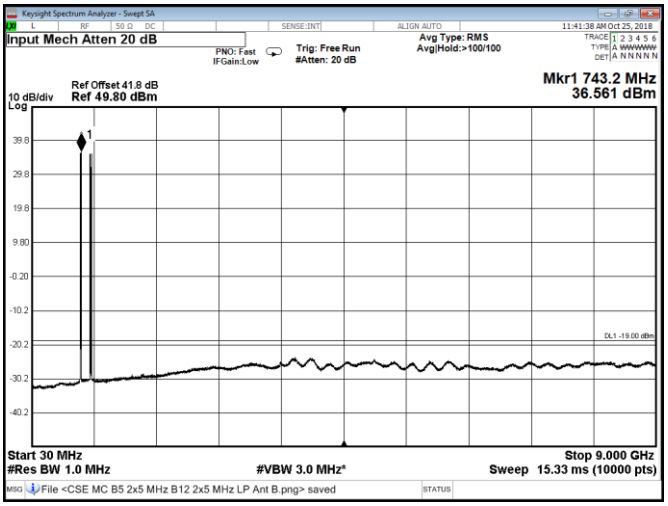


Figure 8.5-37: *Conducted spurious emissions for multi band B5 MC 2×5 MHz channel, B12A MC 2×5 MHz low channel with 40 W configuration at Port A*

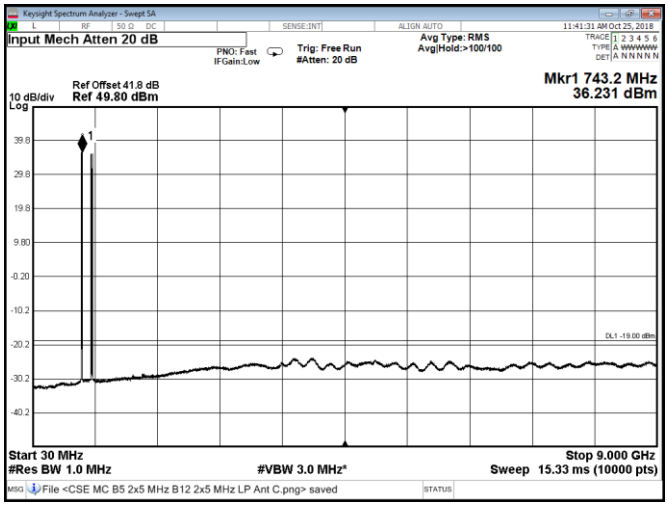


Figure 8.5-38: *Conducted spurious emissions for multi band B5 MC 2×5 MHz channel, B12A MC 2×5 MHz channel with 40 W configuration at Port B*

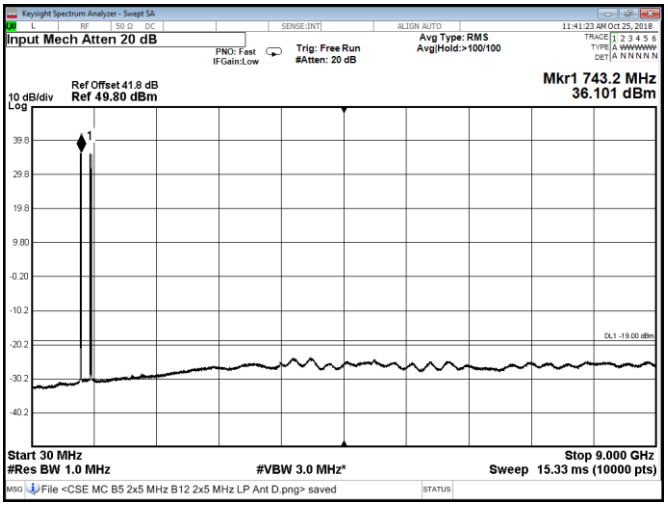


Figure 8.5-39: *Conducted spurious emissions for multi band B5 MC 2×5 MHz channel, B12A MC 2×5 MHz low channel with 40 W configuration at Port C*

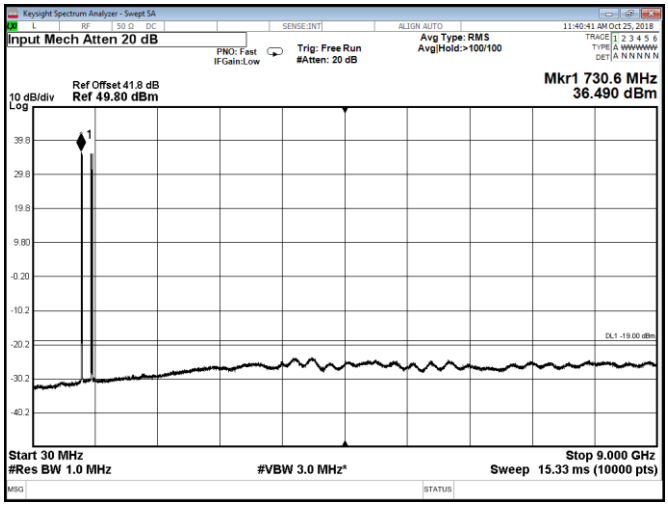


Figure 8.5-40: *Conducted spurious emissions for multi band B5 MC 2×5 MHz channel, B12A MC 2×5 MHz channel with 40 W configuration at Port D*

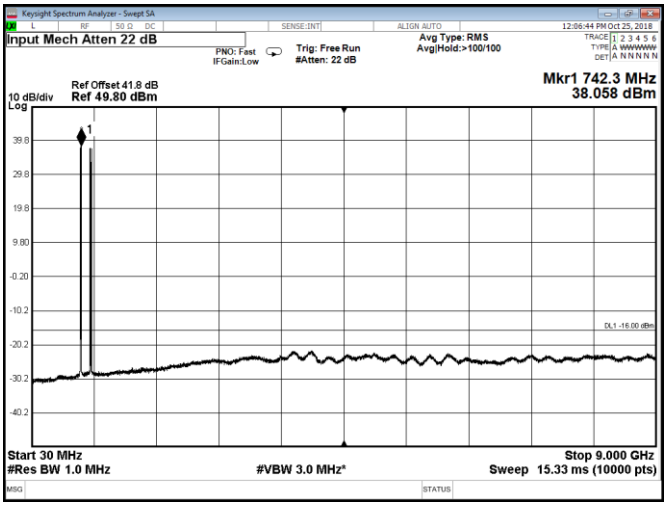


Figure 8.5-41: *Conducted spurious emissions for multi band B5 MC 2×5 MHz channel, B12A MC 2×5 MHz low channel with 60 W configuration at Port A*

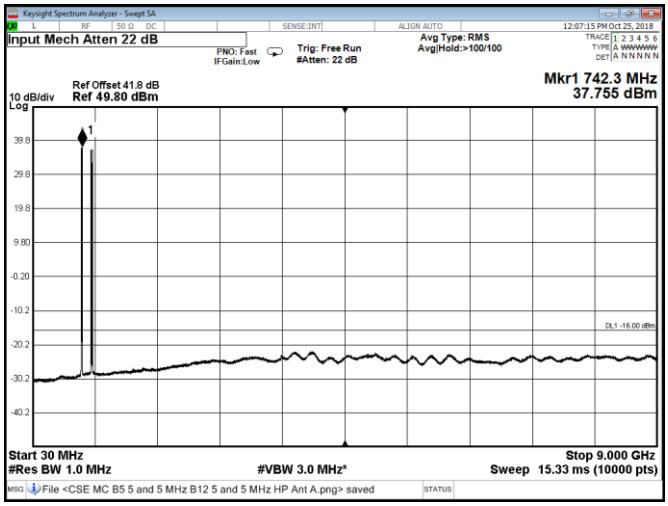


Figure 8.5-42: *Conducted spurious emissions for multi band B5 MC 2×5 MHz channel, B12A MC 2×5 MHz channel with 60 W configuration at Port C*

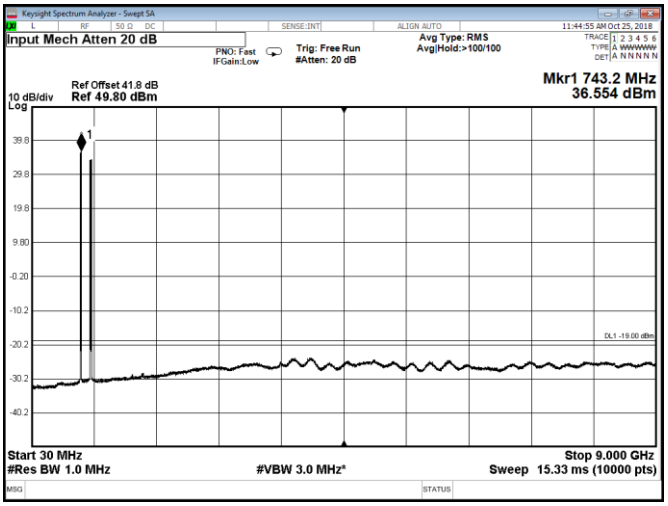


Figure 8.5-43: *Conducted spurious emissions for multi band B5 MC 3×5 MHz channel, B12A MC 2×5 MHz low channel with 40 W configuration at Port A*

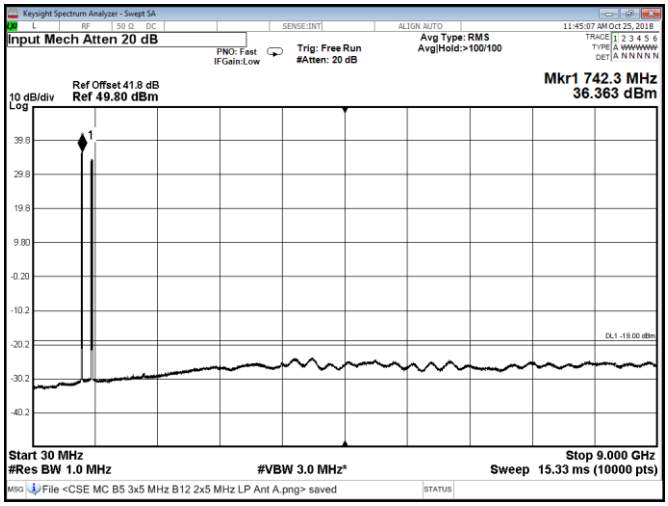


Figure 8.5-44: *Conducted spurious emissions for multi band B5 MC 3×5 MHz channel, B12A MC 2×5 MHz channel with 40 W configuration at Port B*

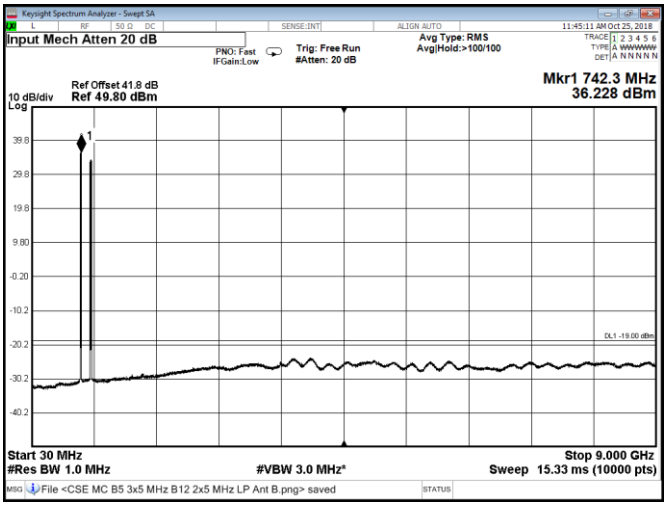


Figure 8.5-45: *Conducted spurious emissions for multi band B5 MC 3×5 MHz channel, B12A MC 2×5 MHz low channel with 40 W configuration at Port C*

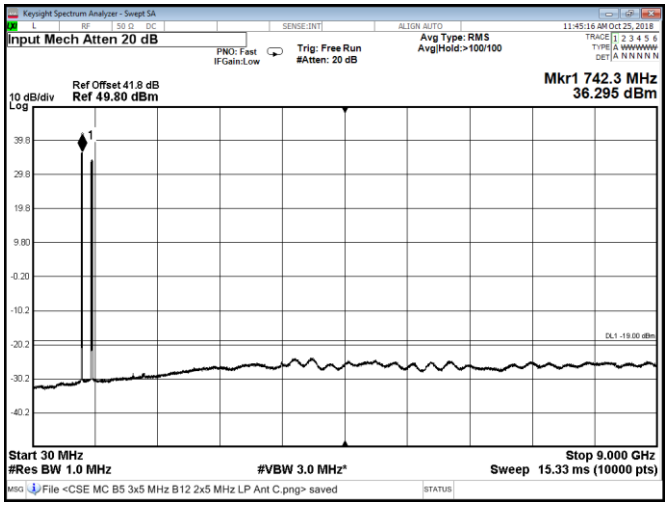


Figure 8.5-46: *Conducted spurious emissions for multi band B5 MC 3×5 MHz channel, B12A MC 2×5 MHz channel with 40 W configuration at Port D*

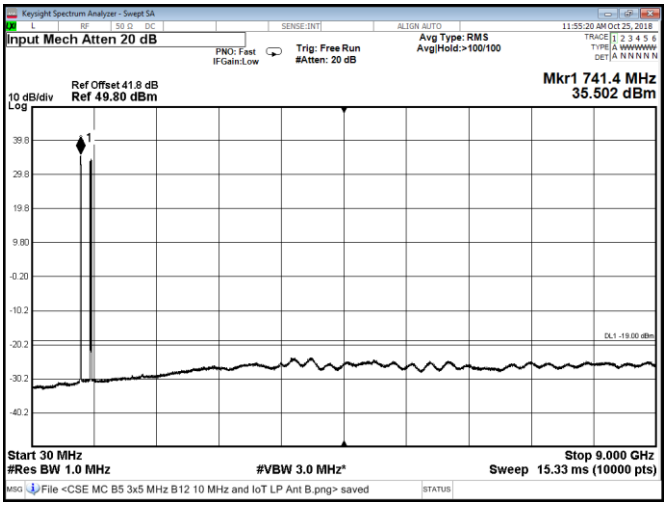


Figure 8.5-47: *Conducted spurious emissions for multi band B5 MC 3×5 MHz channel, B12A 10 MHz channel and IoT with 40 W configuration at Port A*

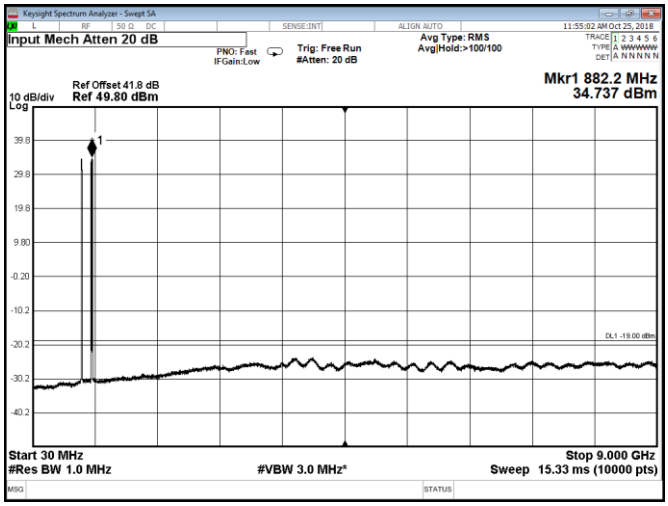


Figure 8.5-48: *Conducted spurious emissions for multi band B5 MC 3×5 MHz channel, B12A 10 MHz channel and IoT with 40 W configuration at Port B*

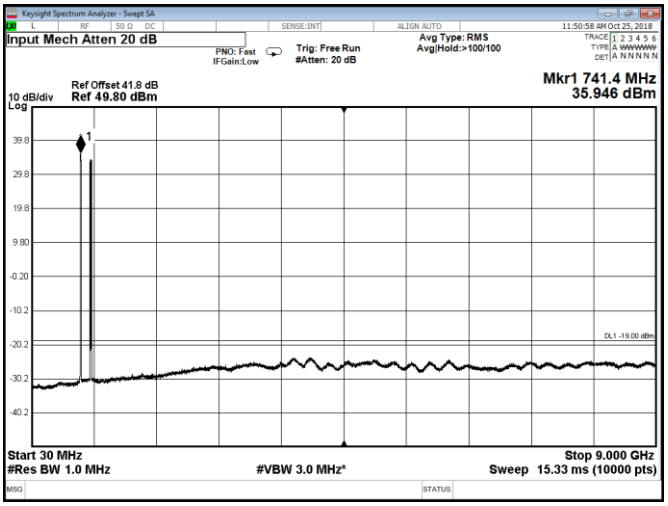


Figure 8.5-49: *Conducted spurious emissions for multi band B5 MC 3×5 MHz channel, B12A 10 MHz channel and IoT with 40 W configuration at Port C*

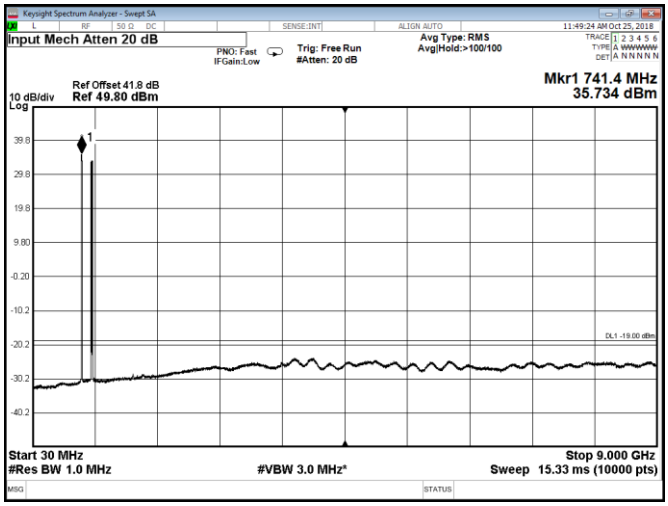


Figure 8.5-50: *Conducted spurious emissions for multi band B5 MC 3×5 MHz channel, B12A 10 MHz channel and IoT with 40 W configuration at Port D*

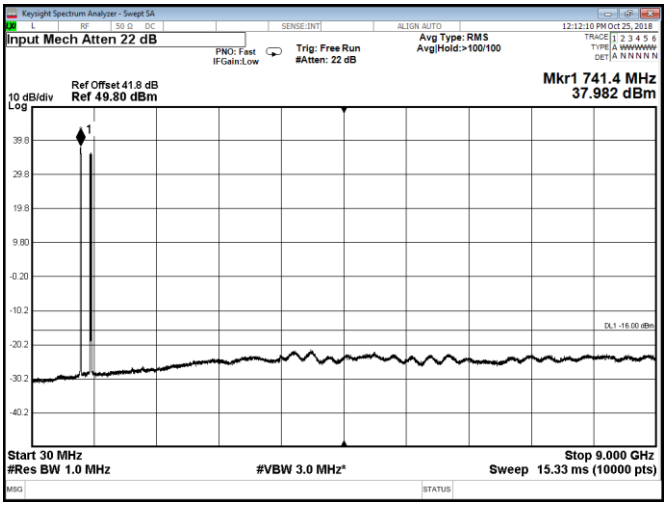


Figure 8.5-51: *Conducted spurious emissions for multi band B5 MC 3×5 MHz channel, B12A 10 MHz channel and IoT with 60 W configuration at Port A*

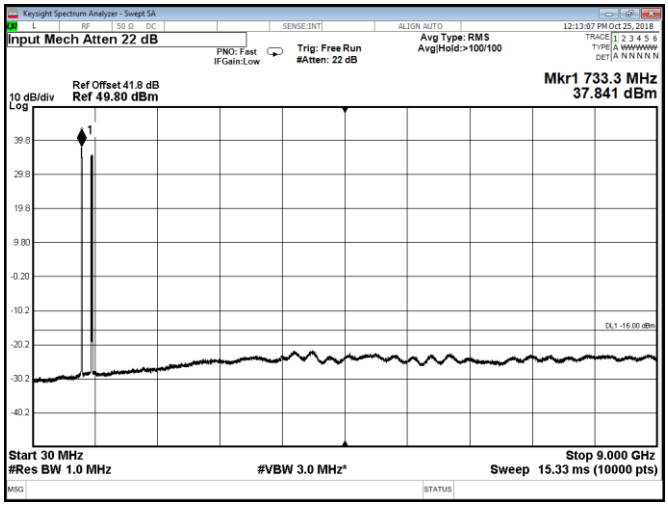


Figure 8.5-52: *Conducted spurious emissions for multi band B5 MC 3×5 MHz channel, B12A 10 MHz channel and IoT with 60 W configuration at Port C*

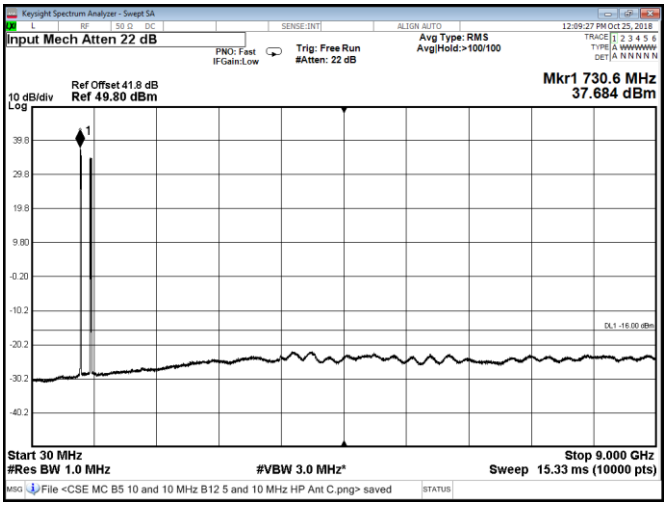


Figure 8.5-53: *Conducted spurious emissions for multi band B5 MC 2×10 MHz channel, B12A 5 and 10 MHz channel and IoT with 60 W configuration at Port A*

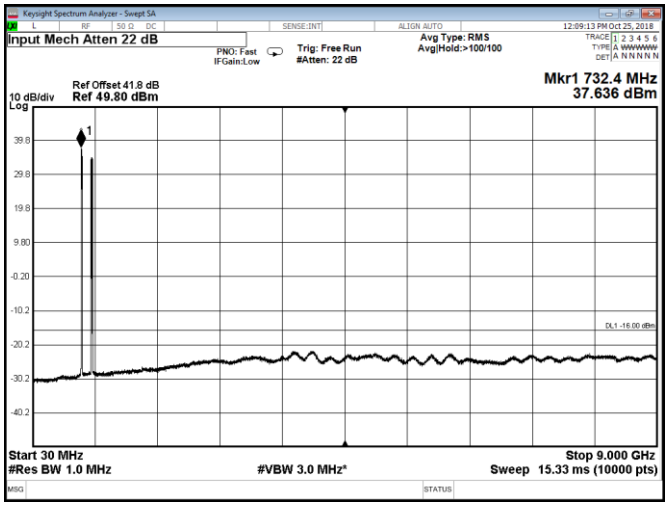


Figure 8.5-54: *Conducted spurious emissions for multi band B5 MC 2×10 MHz channel, B12A 5 and 10 MHz channel and IoT with 60 W configuration at Port C*

8.6 Radiated spurious emissions

8.6.1 Definitions and limits

FCC P27, FCC P22, RSS-130 and RSS-132
Out of band emissions. The power of any emission outside of the authorized operating frequency ranges must be attenuated below the transmitting power (P) by a factor of at least 43 + 10 log(P) dB.

(b) Measurement procedure. Compliance with these rules is based on the use of measurement instrumentation employing a reference bandwidth as follows:

(1) In the spectrum below 1 GHz, instrumentation should employ a reference bandwidth of 100 kHz or greater. In the 1 MHz bands immediately outside and adjacent to the frequency block, a resolution bandwidth of at least one percent of the emission bandwidth of the fundamental emission of the transmitter may be employed. A narrower resolution bandwidth is permitted in all cases to improve measurement accuracy, provided that the measured power is integrated over the full required reference bandwidth (i.e., 100 kHz or 1 percent of emission bandwidth, as specified). The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.

(2) In the spectrum above 1 GHz, instrumentation should employ a reference bandwidth of 1 MHz.

(c) Alternative out of band emission limit. Licensees in this service may establish an alternative out of band emission limit to be used at specified band edge(s) in specified geographical areas, in lieu of that set forth in this section, pursuant to a private contractual arrangement of all affected licensees and applicants. In this event, each party to such contract shall maintain a copy of the contract in their station files and disclose it to prospective assignees or transferees and, upon request, to the FCC.

8.6.2 Test summary

Test date	November 1, 2018	Temperature	22 °C
Test engineer	Shaen He	Air pressure	1000 mbar
Verdict	Pass	Relative humidity	30 %

8.6.3 Observations, settings and special notes

The spectrum was searched from 30 MHz to the 10th harmonic.
All measurements were performed using a peak detector.
RBW within 30–1000 MHz was 100 kHz and 1 MHz above 1 GHz. VBW was wider than RBW.
Testing was performed with all RF ports terminated with 50 Ohm load.
Band 5 and Band 12A simultaneous transmission was tested as a worst-case emissions scenario.

8.6.4 Test data

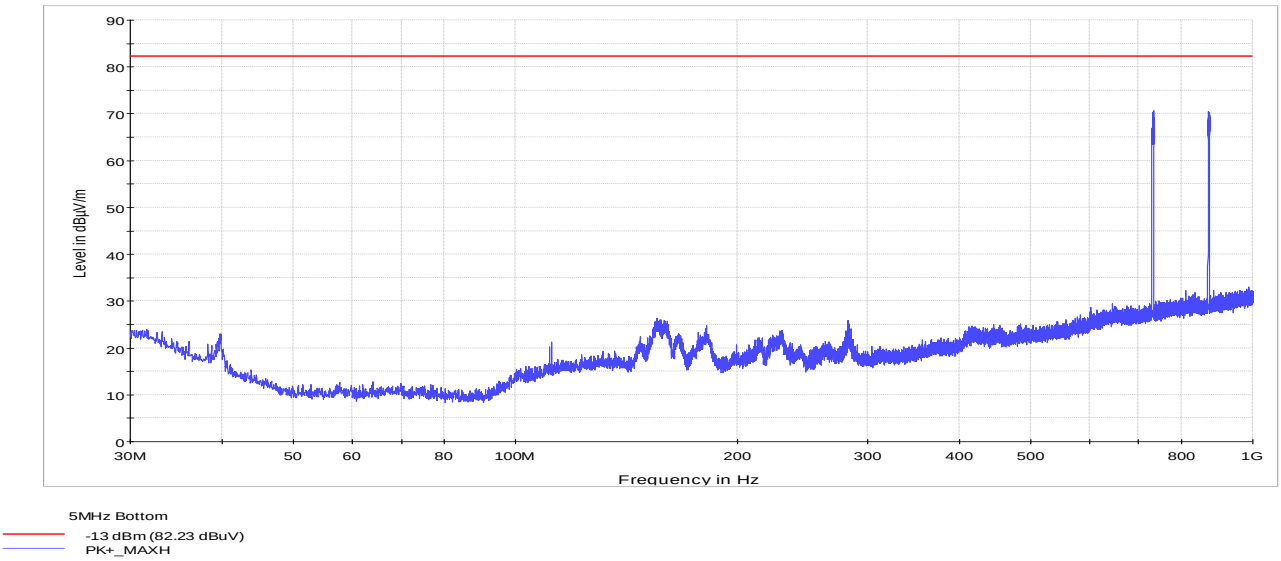


Figure 8.6-1: *Radiated spurious emission below 1 GHz, B5 and B12A at low 5 MHz channel*

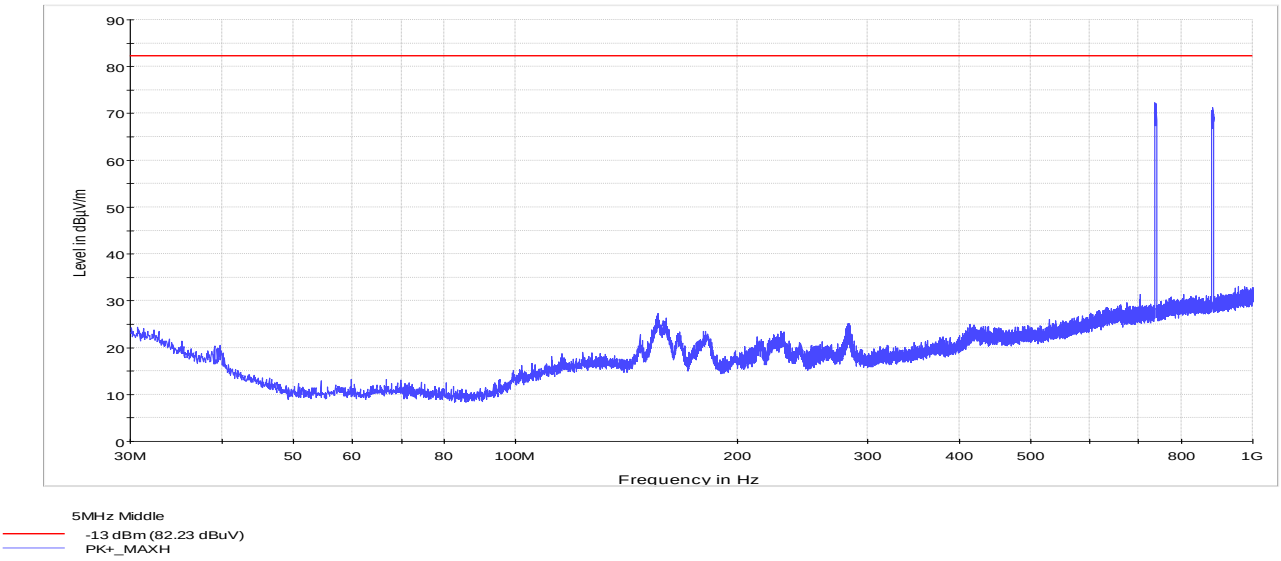


Figure 8.6-2: *Radiated spurious emission below 1 GHz, B5 and B12A at mid 5 MHz channel*

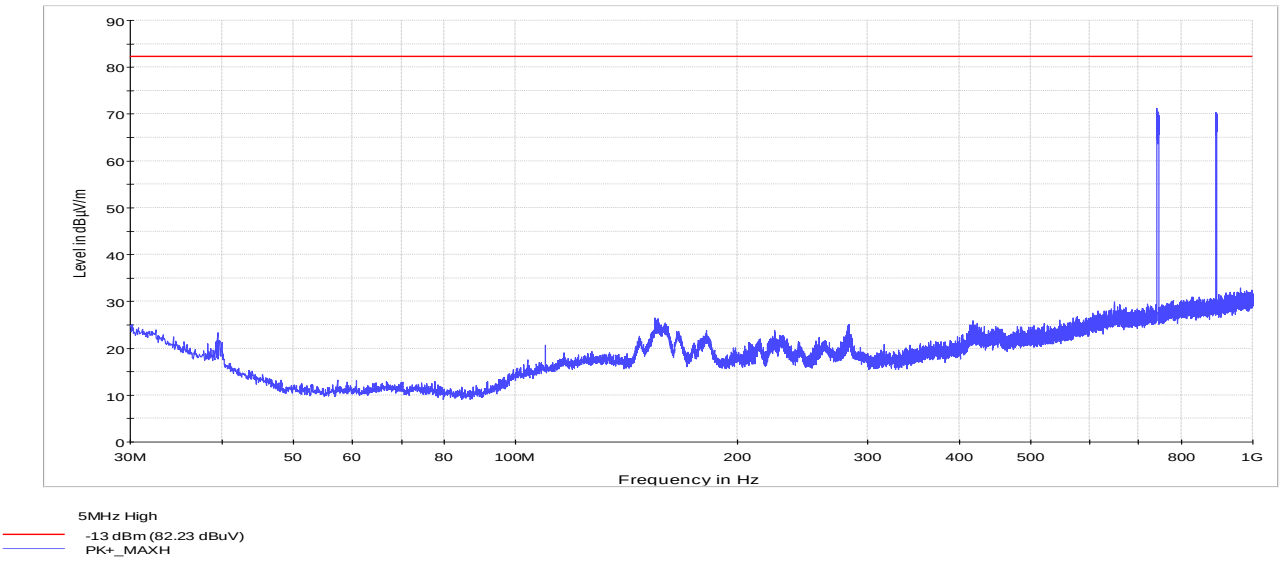


Figure 8.6-3: *Radiated spurious emission below 1 GHz, B5 and B12A at high 5 MHz channel*

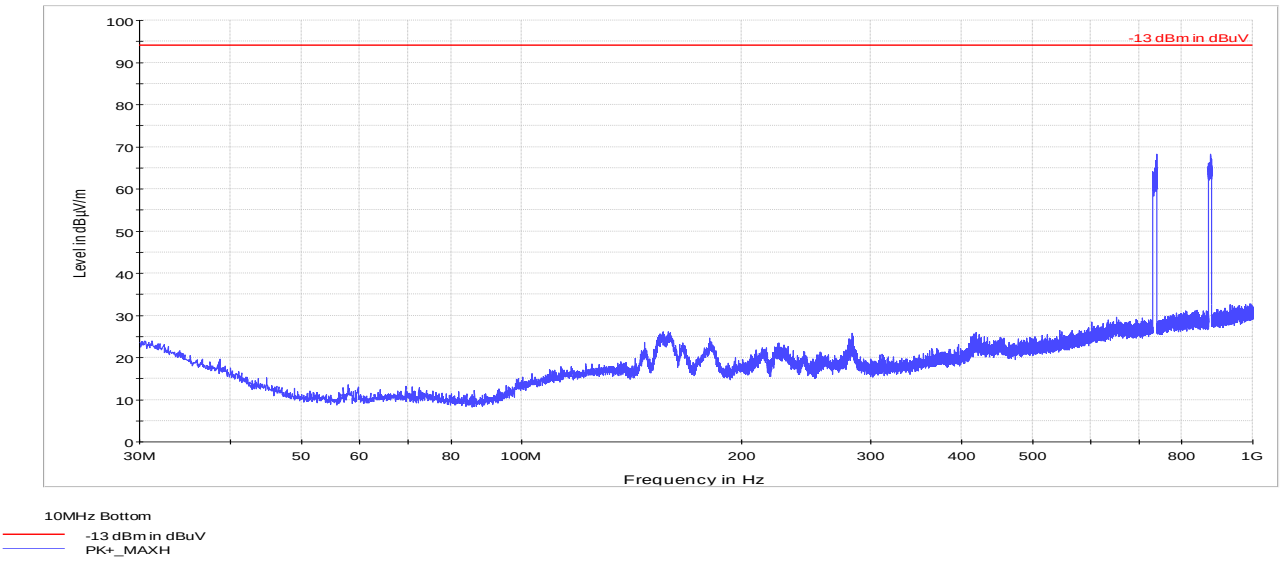


Figure 8.6-4: *Radiated spurious emission below 1 GHz, B5 and B12A at low 10 MHz channel*

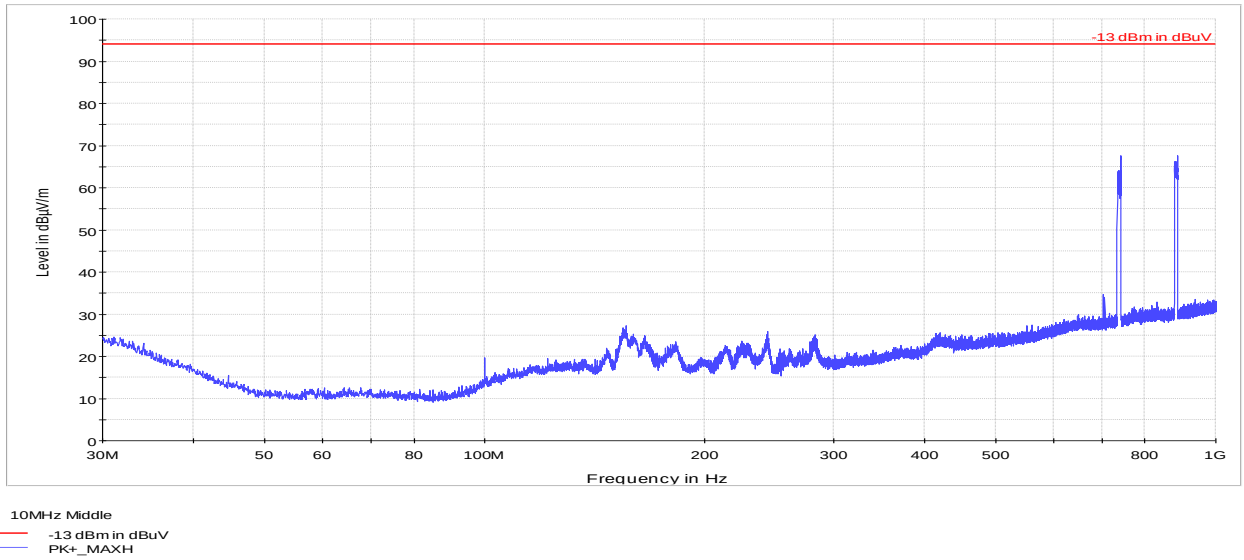


Figure 8.6-5: *Radiated spurious emission below 1 GHz, B5 and B12A at mid 10 MHz channel*

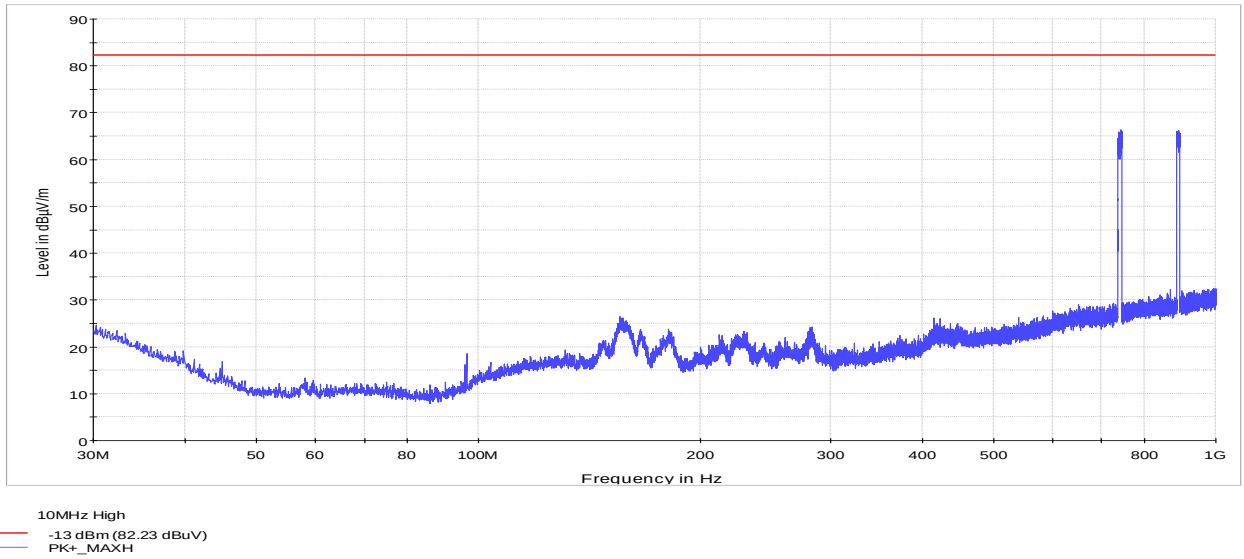


Figure 8.6-6: *Radiated spurious emission below 1 GHz, B5 and B12A at high 10 MHz channel*

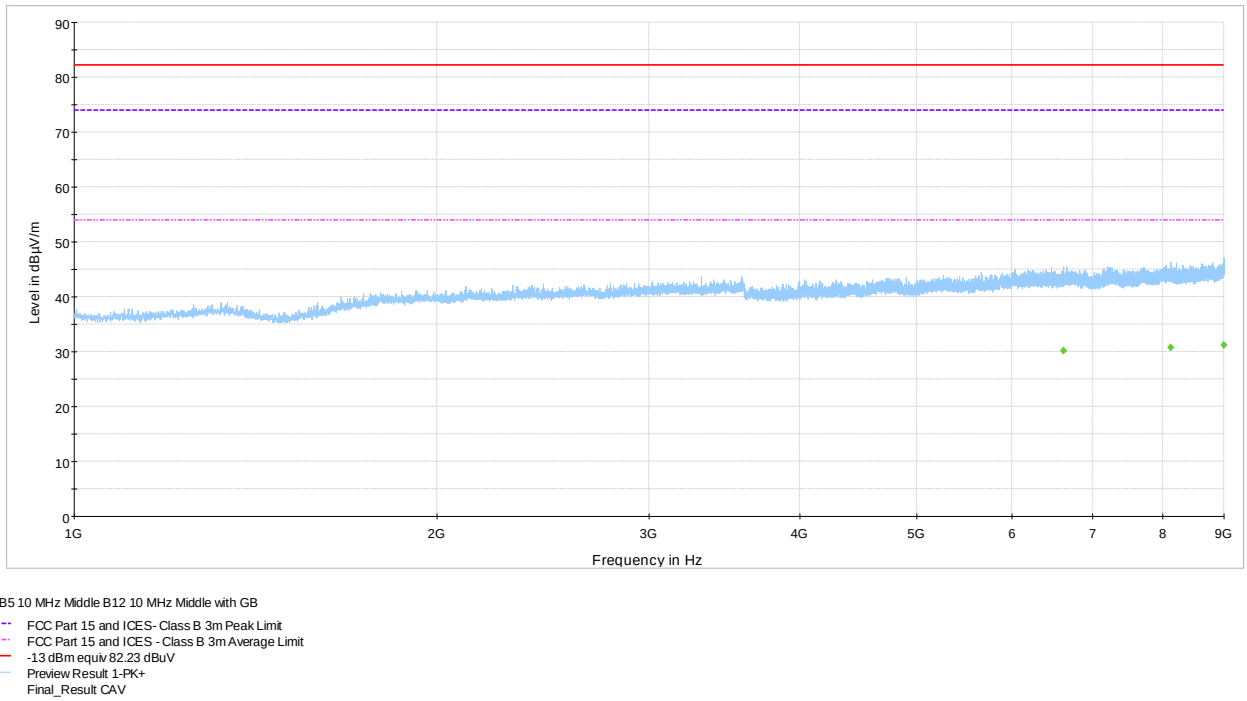


Figure 8.6-7: *Radiated spurious emission above 1 GHz, B5 and B12A at mid 10 MHz channel*

Note: there is no observable difference between 5 MHz and 10 MHz channels results at low, mid or high channels, so one representative plot was recorded.

8.7 FCC 27.54 and RSS-130 4.3 Frequency stability (B12A)

8.7.1 Definitions and limits

FCC:
The frequency stability shall be sufficient to ensure that the fundamental emissions stay within the authorized bands of operation.
ISED:
The transmitter frequency stability limit shall be determined as follows:

- (a) The frequency offset shall be measured according to the procedure described in RSS-Gen and recorded;
- (b) Using a resolution bandwidth of 1% of the occupied bandwidth, a reference point at the unwanted emission level which complies with the attenuation of 43 + 10 $\log_{10}$ p (watts) on the emission mask of the lowest and highest channel shall be selected, and the frequency at these points shall be recorded as f_L and f_H respectively.

The applicant shall ensure frequency stability by showing that f_L minus the frequency offset and f_H plus the frequency offset shall be within the frequency range in which the equipment is designed to operate

8.7.2 Test summary

Test date	October 25, 2018

8.7.3 Observations, settings and special notes

None

8.7.4 Test data

Table 8.7-1: *Frequency error results*

Temperature, °C	Voltage, V_{DC}	Frequency error, Hz
+50	48.0	-1.1
+40	48.0	-0.6
+30	48.0	-0.3
+20	55.2	-0.7
+20	48.0	-0.6
+20	40.8	-0.8
+10	48.0	0.8
0	48.0	0.9
−10	48.0	-0.7
−20	48.0	0.7
−30	48.0	-0.8

8.8 FCC 22.355 and RSS-132 5.3 Frequency tolerance (B5)

8.8.1 Definitions and limits

FCC:
The carrier frequency of each transmitter in the Public Mobile Services must be maintained within the tolerance of ±1.5 ppm for Base/fixed stations operating within 821–896 MHz.
ISED:
The carrier frequency shall not depart from the reference frequency in excess of ±2.5 ppm for mobile stations and ±1.5 ppm for base stations.

In lieu of meeting the above stability values, the test report may show that the frequency stability is sufficient to ensure that the occupied bandwidth stays within each of the sub-bands (see Section 5.1) when tested to the temperature and supply voltage variations specified in RSS-Gen.

8.8.2 Test summary

Test date	October 25, 2018

8.8.3 Observations, settings and special notes

1.5 ppm of 881.5 MHz is 1322 Hz.

8.8.4 Test data

Table 8.8-1: *Frequency tolerance results*

Temperature, °C	Voltage, V_{DC}	Frequency error, Hz	Limit, ±Hz
+50	48.0	-0.8	1322
+40	48.0	-0.9	1322
+30	48.0	-1.0	1322
+20	55.2	-0.9	1322
+20	48.0	-1.1	1322
+20	40.8	0.7	1322
+10	48.0	-1.2	1322
0	48.0	-1.0	1322
−10	48.0	0.9	1322
−20	48.0	-0.7	1322
−30	48.0	1.0	1322

8.9 FCC Part 2.1049 and RSS-Gen 6.7 Occupied bandwidth (B12A)

8.9.1 Definitions and limits

FCC:
The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.
ISED:
The occupied bandwidth or the "99% emission bandwidth" is defined as the frequency range between two points, one above and the other below the carrier frequency, within which 99% of the total transmitted power of the fundamental transmitted emission is contained. The occupied bandwidth shall be reported for all equipment in addition to the specified bandwidth required in the applicable RSSs.

8.9.2 Test summary

Test date	October 24, 2018

8.9.3 Observations, settings and special notes

None

8.9.4 Test data

Table 8.9-1: *Occupied bandwidth measurement results for 40 W operation (Configuration 1)*

Remarks	26 dB BW, Port A, MHz	99% OBW, Port A, MHz	26 dB BW, Port B, MHz	99% OBW, Port B, MHz	26 dB BW, Port C, MHz	99% OBW, Port C, MHz	26 dB BW, Port D, MHz	99% OBW, Port D, MHz
5M bottom (QPSK)	4.79	4.47	4.81	4.48	4.80	4.50	4.79	4.48
5M bottom (16QAM)	4.78	4.46	4.76	4.47	4.73	4.49	4.78	4.47
5M bottom (64QAM)	4.79	4.48	4.81	4.49	4.78	4.49	4.79	4.48
5M bottom (256QAM)	4.81	4.48	4.81	4.48	4.79	4.49	4.75	4.48
10M bottom (QPSK)	9.63	8.95	9.55	8.96	9.62	8.95	9.57	8.95
10M bottom + IoT	9.76	9.40	9.73	9.39	9.70	9.40	9.72	9.40
5M middle (QPSK)	4.80	4.48	4.80	4.48	4.78	4.48	4.82	4.48
10M middle (QPSK)	9.61	8.93	9.47	8.95	9.53	8.95	9.51	8.96
10M middle + IoT	9.74	9.40	9.73	9.41	9.69	9.40	9.70	9.40
5M top (QPSK)	4.77	4.48	4.79	4.49	4.82	4.49	4.80	4.48
10M top (QPSK)	9.61	8.94	9.56	8.95	9.53	8.96	9.61	8.95
10M top + IoT	9.76	9.40	9.77	9.40	9.72	9.40	9.74	9.40

Table 8.9-2: *Occupied bandwidth measurement results for 60 W operation (Configuration 2)*

Remarks	26 dB BW, Port A, MHz	99% OBW, Port A, MHz	26 dB BW, Port C, MHz	99% OBW, Port C, MHz
10M bottom (QPSK)	9.51	8.94	9.53	8.94
10M bottom + IoT	9.72	9.38	9.66	9.37
5M middle (QPSK)	4.81	4.48	4.80	4.48
10M middle (QPSK)	9.59	8.94	9.60	8.85
10M middle + IoT	9.76	9.4	9.73	9.41
5M top (QPSK)	4.77	4.48	4.80	4.48
10M top (QPSK)	9.60	8.94	9.55	8.95
10M top + IoT	9.73	9.4	9.74	9.39

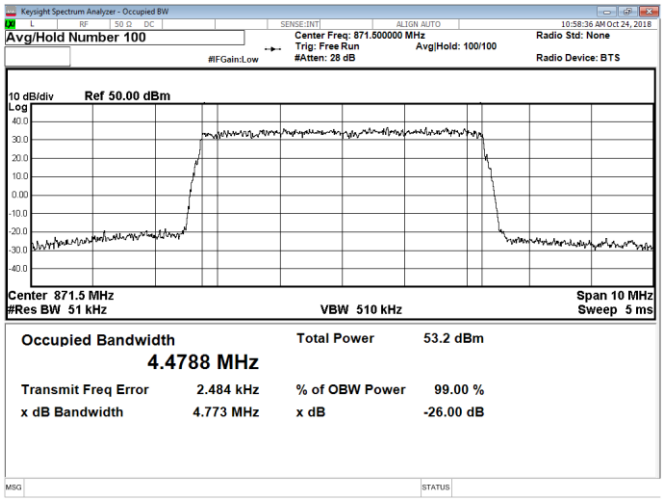


Figure 8.9-1: *Occupied bandwidth 5 MHz channel, sample plot*

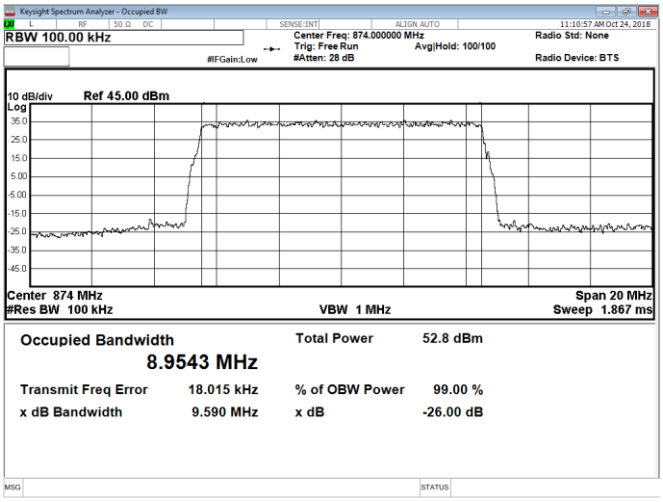


Figure 8.9-2: *Occupied bandwidth 10 MHz channel, sample plot*

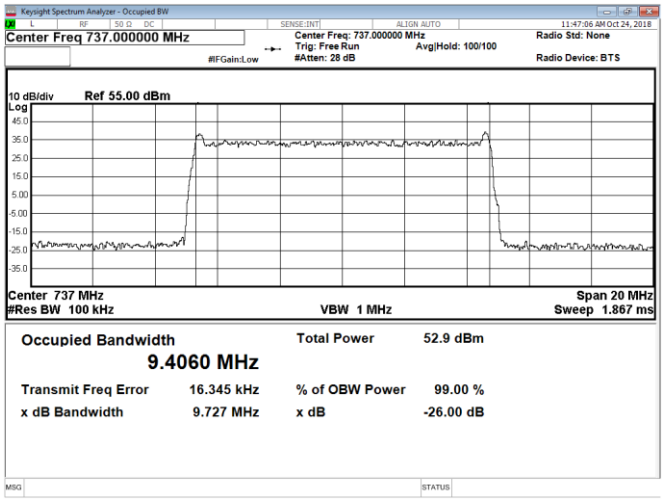


Figure 8.9-3: *Occupied bandwidth 10 MHz channel and IoT, sample plot*

8.10 FCC Part 22.917(b) and RSS-Gen 6.7 Occupied bandwidth (B5)

8.10.1 Definitions and limits

FCC:
The emission bandwidth is defined as the width of the signal between two points, one below the carrier center frequency and one above the carrier center frequency, outside of which all emissions are attenuated at least 26 dB below the transmitter power.
ISED:
The occupied bandwidth or the "99% emission bandwidth" is defined as the frequency range between two points, one above and the other below the carrier frequency, within which 99% of the total transmitted power of the fundamental transmitted emission is contained. The occupied bandwidth shall be reported for all equipment in addition to the specified bandwidth required in the applicable RSSs.

8.10.2 Test summary

Test date	October 24, 2018

8.10.3 Observations, settings and special notes

EUT was assessed and tested for worst case configurations: LTE + NB IoT (GB)

8.10.4 Test data

Table 8.10-1: *Occupied bandwidth measurement results for 40 W operation (Configuration 1)*

Remarks	26 dB BW, Port A, MHz	99% OBW, Port A, MHz	26 dB BW, Port B, MHz	99% OBW, Port B, MHz	26 dB BW, Port C, MHz	99% OBW, Port C, MHz	26 dB BW, Port D, MHz	99% OBW, Port D, MHz
5M bottom (QPSK)	4.77	4.48	4.76	4.48	4.77	4.48	4.79	4.48
5M bottom (16QAM)	4.77	4.48	4.75	4.48	4.76	4.46	4.77	4.46
5M bottom (64QAM)	4.78	4.48	4.77	4.48	4.76	4.48	4.79	4.47
5M bottom (256QAM)	4.78	4.47	4.78	4.48	4.79	4.70	4.77	4.48
10M bottom (QPSK)	9.53	8.94	9.44	8.95	9.56	8.96	9.59	8.95
5M middle (QPSK)	4.77	4.48	4.78	4.48	4.79	4.49	4.78	4.48
10M middle (QPSK)	9.61	8.94	9.55	8.94	9.55	8.96	9.57	8.94
5M top (QPSK)	4.79	4.48	4.76	4.48	4.78	4.47	4.79	4.47
10M top (QPSK)	9.54	8.95	9.63	8.95	9.48	8.93	9.52	8.95

Table 8.10-2: *Occupied bandwidth measurement results for 60 W operation (Configuration 2)*

Remarks	26 dB BW, Port A, MHz	99% OBW, Port A, MHz	26 dB BW, Port C, MHz	99% OBW, Port C, MHz
5M bottom (QPSK)	4.80	4.48	4.80	4.48
10M bottom (QPSK)	9.54	8.94	9.60	8.95
5M middle (QPSK)	4.79	4.48	4.79	4.48
10M middle (QPSK)	9.60	8.97	9.57	8.85
5M top (QPSK)	9.52	8.94	9.57	8.84
10M top (QPSK)	4.80	4.48	4.80	4.48

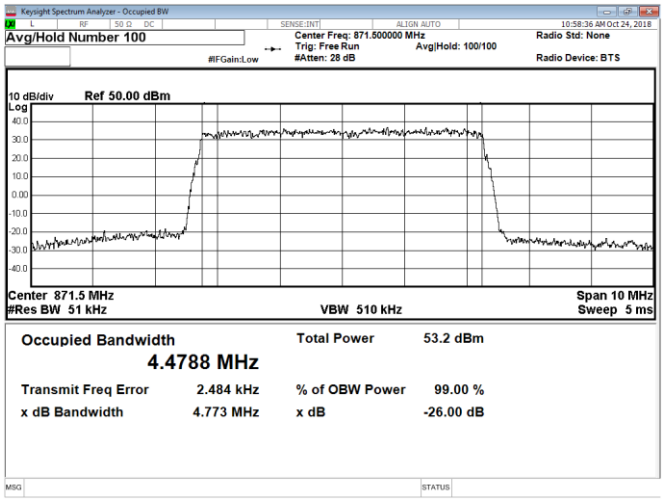


Figure 8.10-1: *Occupied bandwidth 5 MHz channel, sample plot*

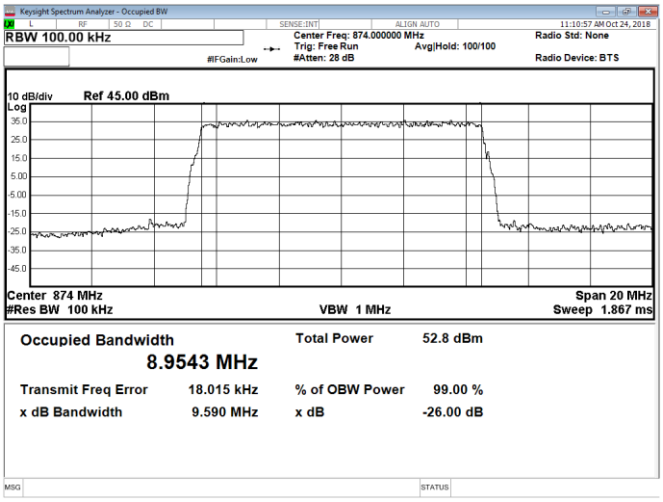


Figure 8.10-2: *Occupied bandwidth 10 MHz channel, sample plot*

8.11 RSS-132 5.6 Receiver Spurious Emissions (B5)

8.11.1 Definitions and limits

Receiver spurious emissions shall comply with the limits specified in RSS-Gen.
RSS-Gen, 7.4:
The antenna-conducted test shall be performed with the antenna disconnected and with the receiver antenna port connected to a measuring instrument having equal input impedance to that specified for the antenna. The RF cable connecting the receiver under test to the measuring instrument shall also have the same impedance to that specified for the receiver's antenna.

The spurious emissions from the receiver at any discrete frequency, measured at the antenna port by the antenna-conducted method, shall not exceed 2 nW in the frequency range 30-1000 MHz and 5 nW above 1 GHz.

8.11.2 Test summary

Test date	November 19, 2018

8.11.3 Observations, settings and special notes

None

8.11.4 Test data

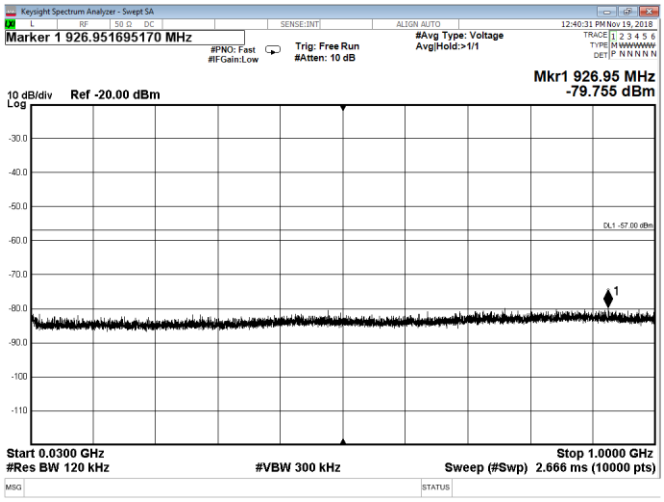


Figure 8.11-1: *Receiver spurious emissions below 1 GHz, antenna port A*

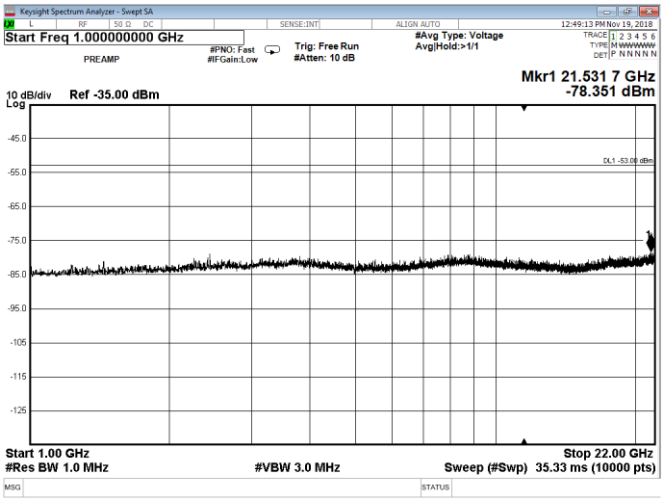


Figure 8.11-2: *Receiver spurious emissions above 1 GHz, antenna port A*

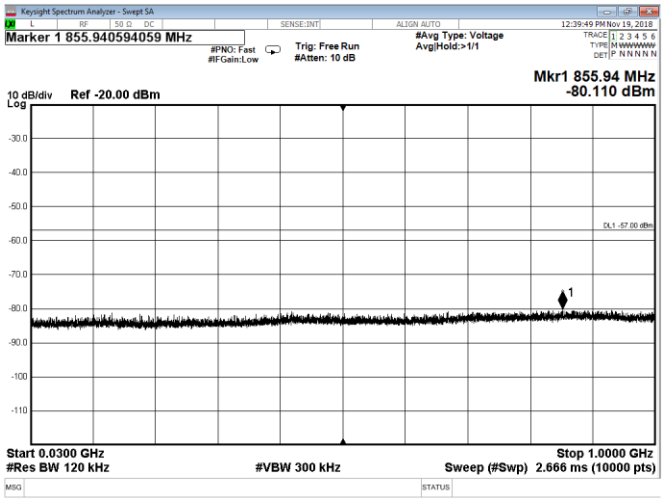


Figure 8.11-3: *Receiver spurious emissions below 1 GHz, antenna port B*

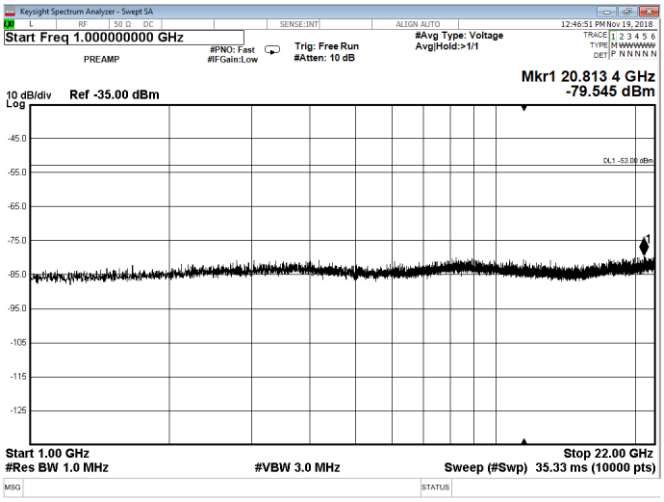


Figure 8.11-4: *Receiver spurious emissions above 1 GHz, antenna port B*

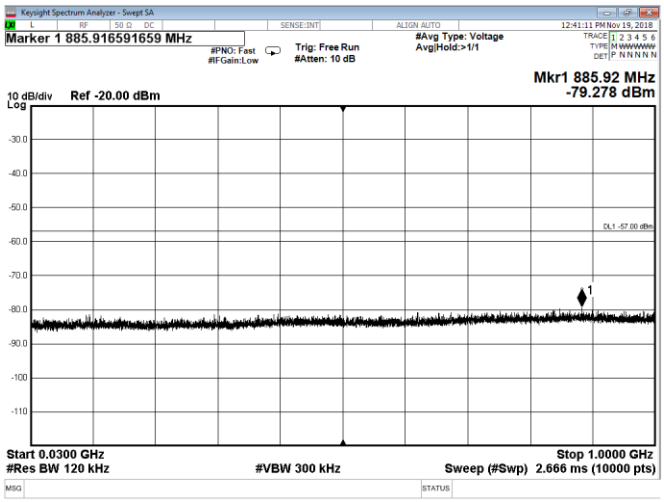


Figure 8.11-5: *Receiver spurious emissions below 1 GHz, antenna port C*

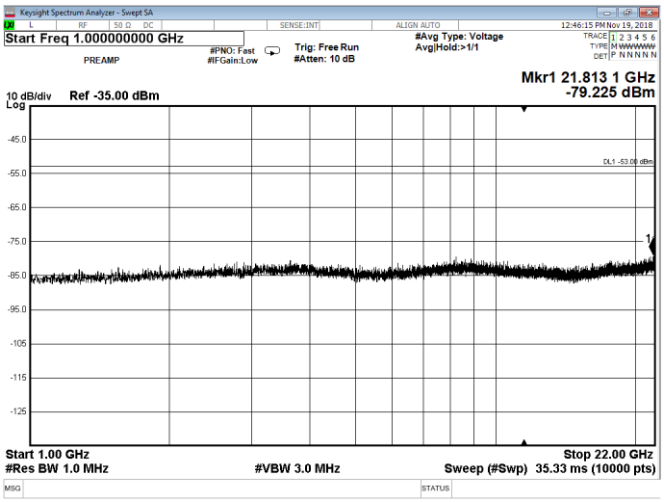


Figure 8.11-6: *Receiver spurious emissions above 1 GHz, antenna port C*

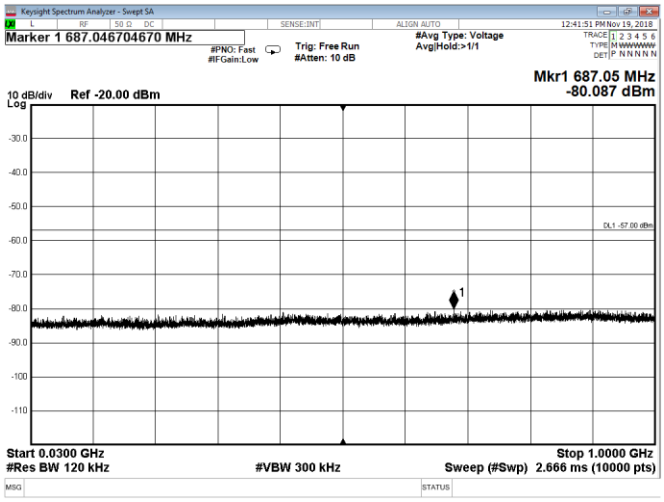


Figure 8.11-7: *Receiver spurious emissions below 1 GHz, antenna port D*

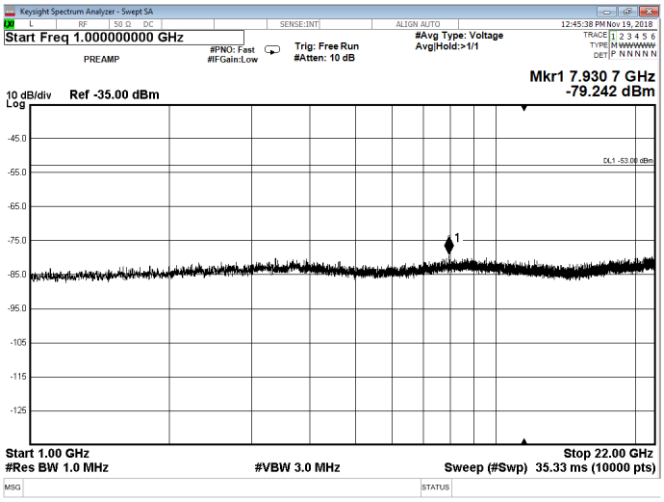
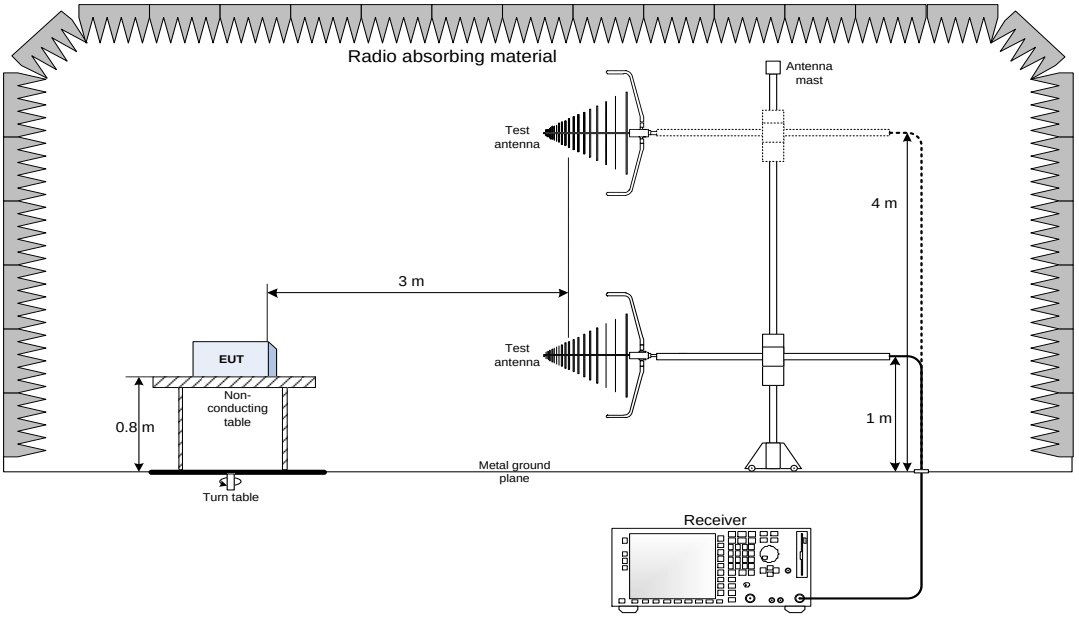


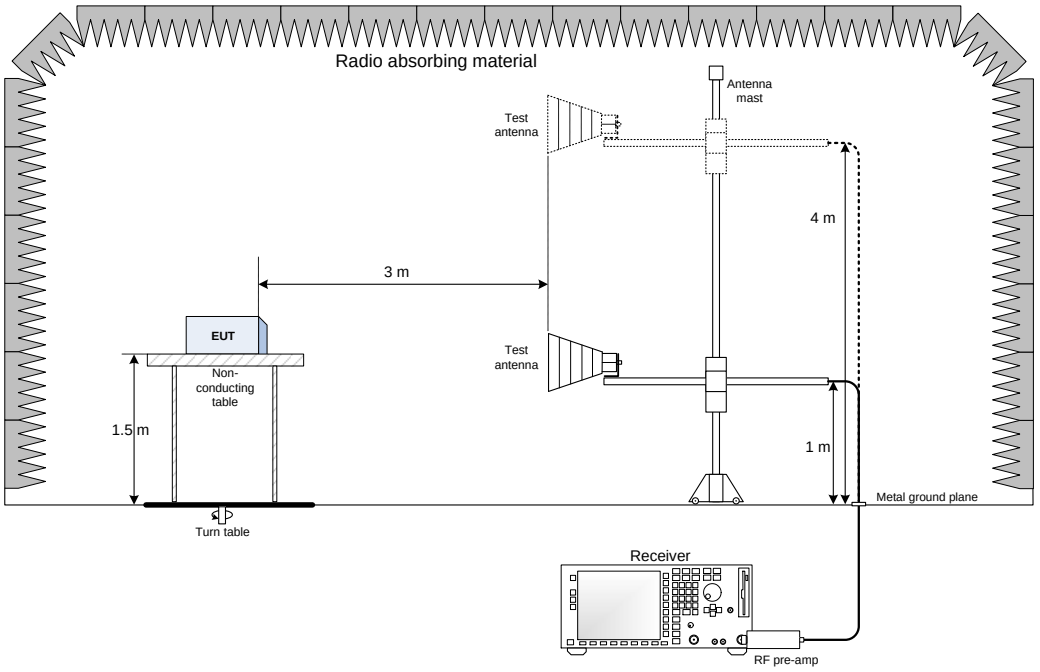
Figure 8.11-8: *Receiver spurious emissions above 1 GHz, antenna port D*

Section 9. Block diagrams of test set-ups

9.1 Radiated emissions set-up for frequencies below 1 GHz



9.2 Radiated emissions set-up for frequencies above 1 GHz



9.3 Antenna port set-up