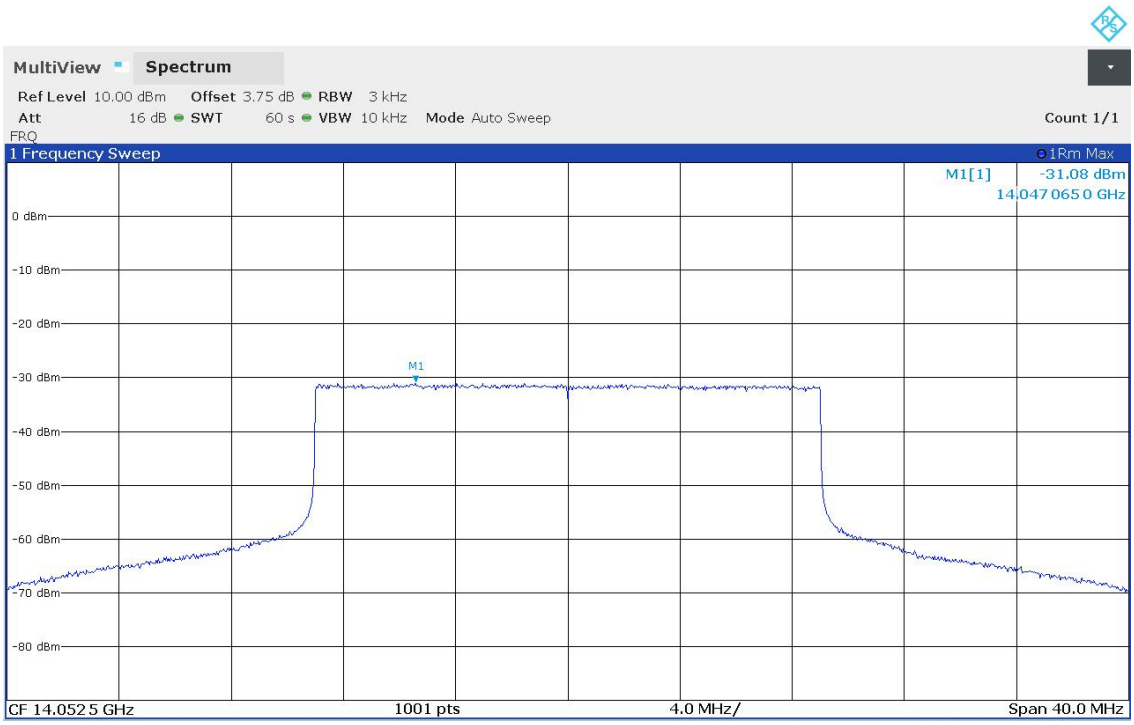
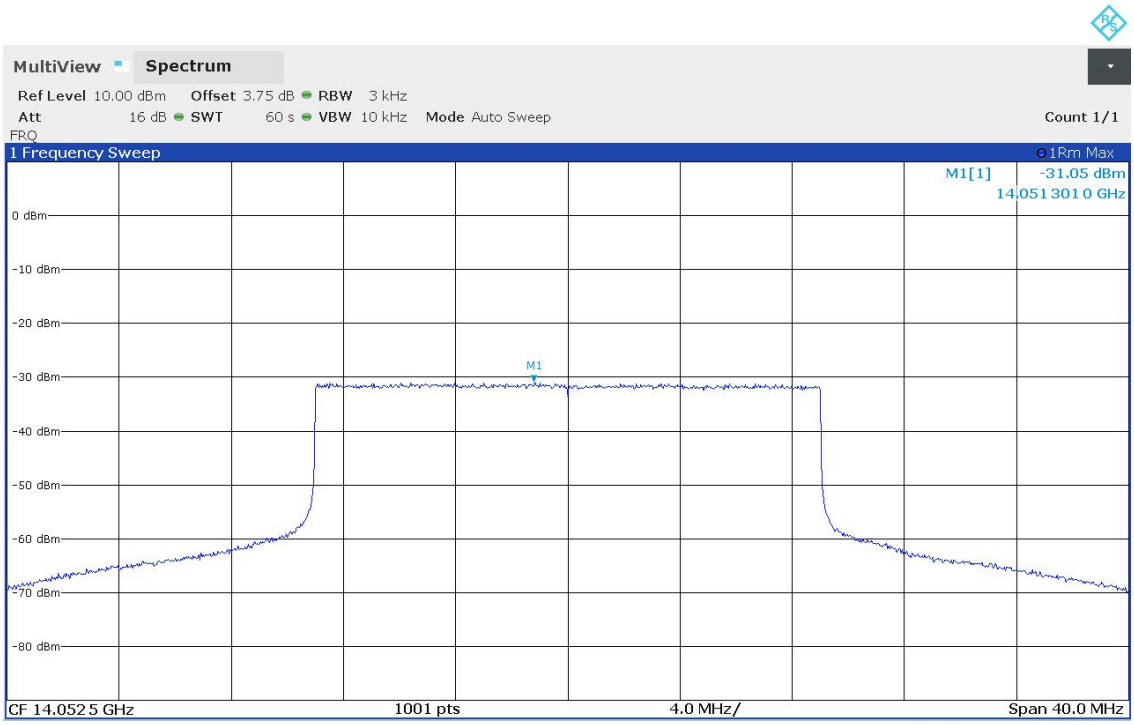
Plots No. 5: Off-axis EIRP Spectrum Density, RMS detector / Power in 3 kHz / 8PSK Modulation



Plots No. 6: Off-axis EIRP Spectrum Density, RMS detector / Power in 3 kHz / 16QAM Modulation

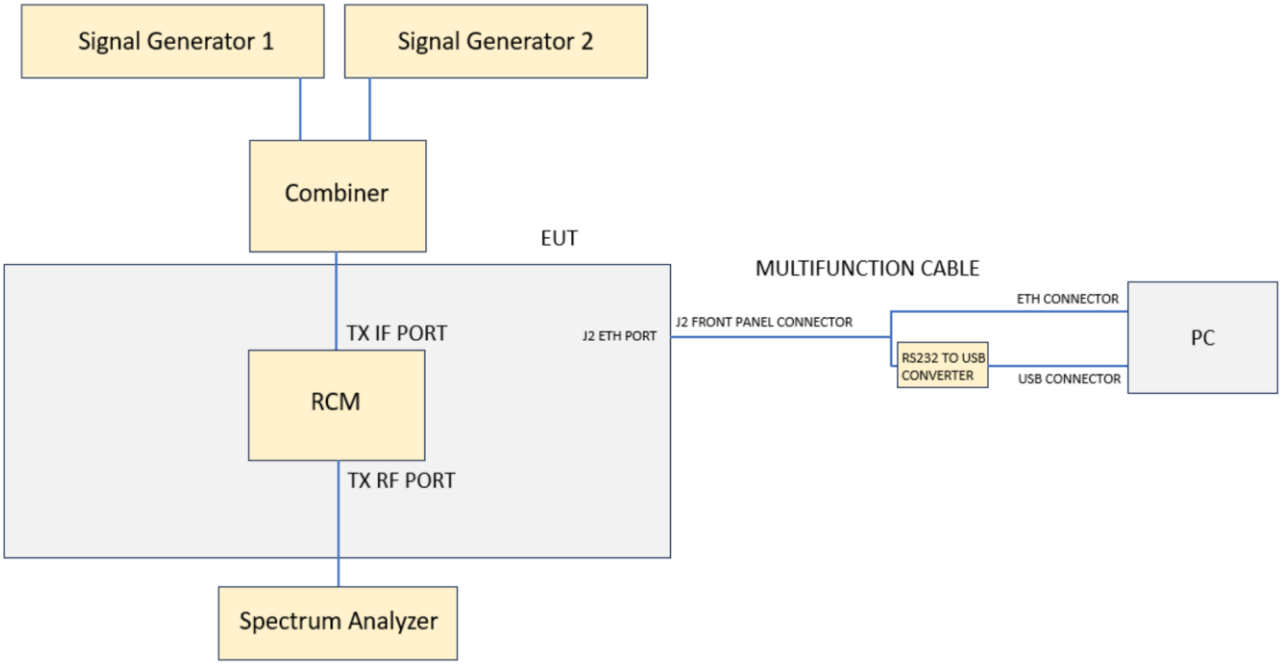


4.3. Occupied Bandwidth [§2.1049]

4.3.1. LIMITS

According to § 2.1049: Measurements required: Occupied bandwidth: The occupied bandwdith, that is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers radiated are each equal to 0.5 percent of the total mean power radiated by a given emission shall be measured.

4.3.2. TEST CONFIGURATION



[Remark: if measurement frequency range over spectrum analyzer covered, using external Harmonic Mixer to extend frequency range]

4.3.3. TEST PROCEDURE

According to ANSI C63.26:2015 section 5.4.4: The occupied bandwidth is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers are equal to 0.5% of the total mean power of the given emission.

The following procedure shall be used for measuring 99% power bandwdith:

a) The instrument center frequency is set to the nominal EUT channel center frequency. The frequency span for the spectrum analyzer shall be between 1.5 times and 5.0 times the OBW.

b) The nominal IF filter bandwidth (3dB RBW) shall be in the range of 1% to 5% of the OBW, and VBW shall be approximately three times the RBW, unless otherwise specified by the applicable requirement.

c) Set the reference level of the instrument as required, keeping the signal from exceeding the maximum input mixer level for linear operation. In general, the peak of the spectral envelope shall be more than [$10\log_{10}$(OBW/RBW] below the reference level. Specific guidance is given in 4.1.5.2.

d) Set the detection mode to peak, and the trace mode to maxhold.

e) If the instrument does not have 99% OBW function, recover the trace data points and sum directly in linear power terms. Placce the recovered amplitude data points, beginning at the lowest frequency, in a running sum until 0.5% of the total is reached. Recorded that frequency as the lower OBW frequency. Repeat the process until 99.5% of the total is reached and record that frequency as the upper OBW frequency. The 99% power OBW can be determined by computing the difference these two frequencies.

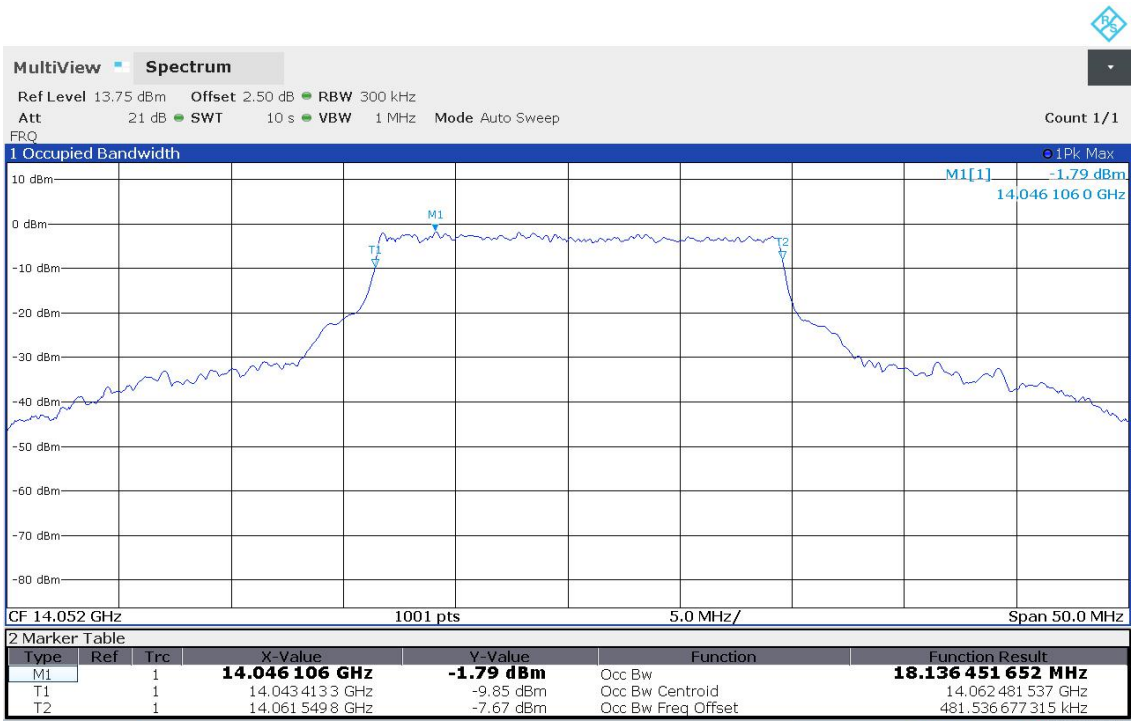
f) The OBW shall be reported and plots of the measuring instrument display shall be provided with the test report. The frequency and amplitude axis and scale shall be clearly labelled. Tabular data can be reported in addition to the plots.

4.3.4. TEST RESULTS

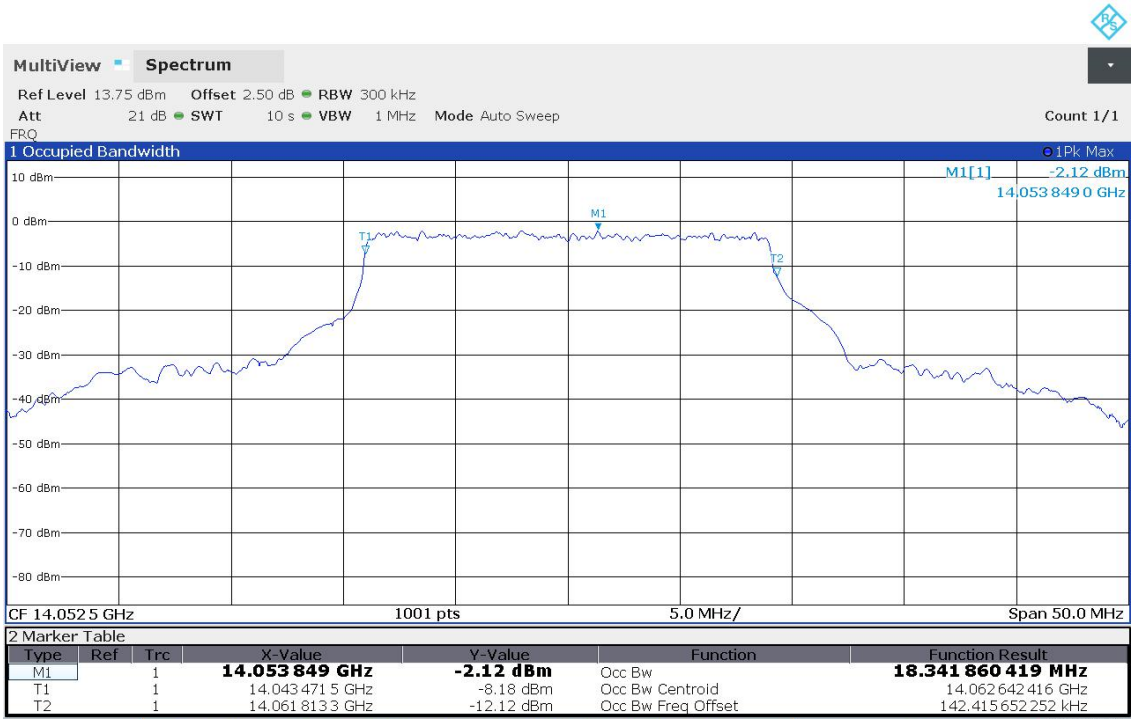
Table 4: Occupied Bandwidth Values

Modulation	Carrier	Frequency [GHz]	99% Occupied Bandwidth Measured Results [MHz]	99% Occupied Bandwidth Limits [MHz]
QPSK	Single	14.0525	18.136	No Limits
8PSK	Single	14.0525	18.341	No Limits
16QAM	Single	14.0525	18.207	No Limits

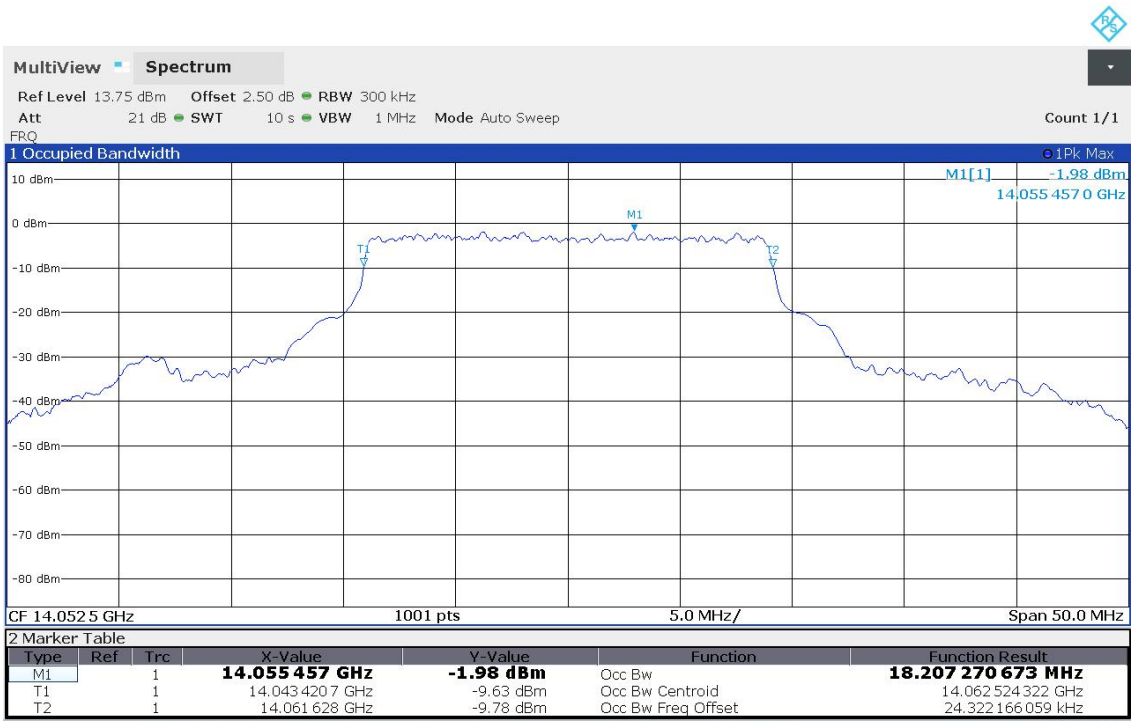
Plots No. 7: 99% OBW, Peak detector / QPSK Modulation



Plots No. 8: 99% OBW, Peak detector / 8PSK Modulation



Plots No. 9: 99% OBW, Peak detector / 16QAM Modulation



4.4. Spurious Emissions at Antenna Terminals / Emission Limitations (Conducted Emissions) [§2.1051 & §25.202]

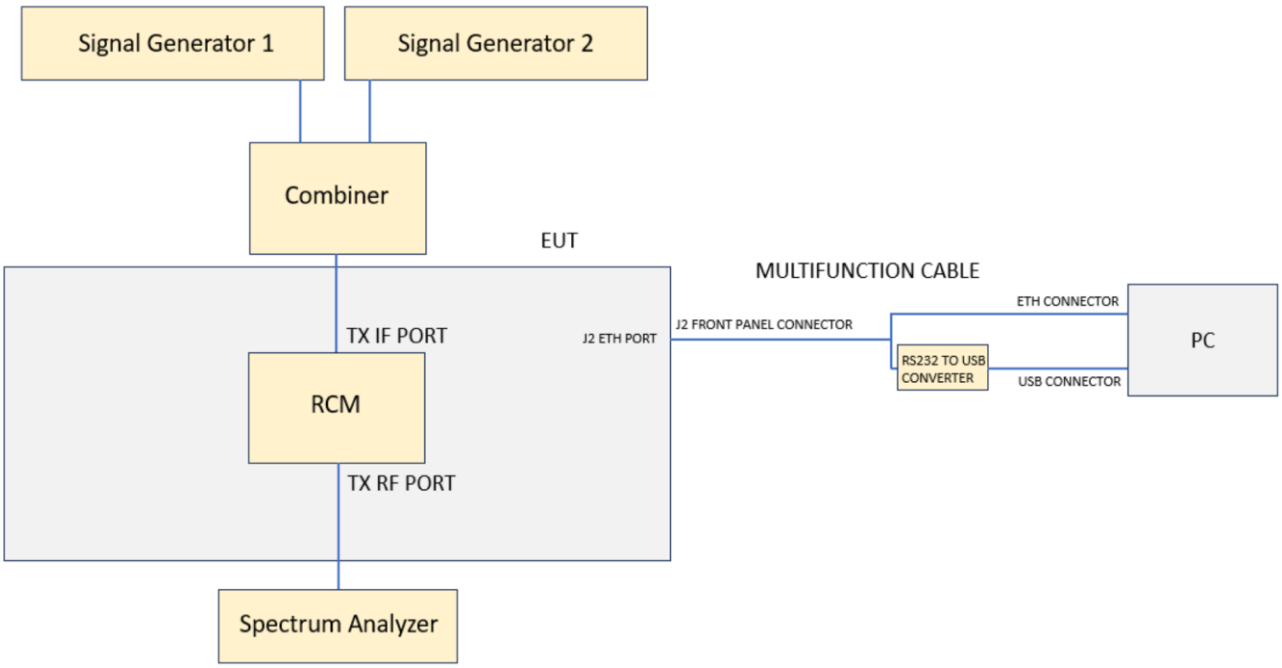
4.4.1. LIMITS

According to §2.1051 - Measurements required: Spurious emissions at antenna terminals
The radio frequency voltage or powers generated within the equipment and appearing on a spurious frequency shall be checked at the equipment output terminals when properly loaded with a suitable artificial antenna. Curves or equivalent data shall show the magnitude of each harmonic and other spurious emission that can be detected when the equipment is operated under the conditions specified in § 2.1049 as appropriate. The magnitude of spurious emissions which are attenuated more than 20 dB below the permissible value need not be specified.

According to §25.202(f) - *Emission limitations.* Except for SDARS terrestrial repeaters and as provided for in paragraph (i), the mean power of emissions shall be attenuated below the mean output power of the transmitter in accordance with the schedule set forth in paragraphs (f)(1) through (f)(4) of this section. The out-of-band emissions of SDARS terrestrial repeaters shall be attenuated in accordance with the schedule set forth in paragraph (h) of this section.

(1) In any 4 kHz band, the center frequency of which is removed from the assigned frequency by more than 50 percent up to and including 100 percent of the authorized bandwidth: 25 dB;
(2) In any 4 kHz band, the center frequency of which is removed from the assigned frequency by more than 100 percent up to and including 250 percent of the authorized bandwidth: 35 dB;
(3) In any 4 kHz band, the center frequency of which is removed from the assigned frequency by more than 250 percent of the authorized bandwidth: An amount equal to 43 dB plus 10 times the logarithm (to the base 10) of the transmitter power in watts;
(4) In any event, when an emission outside of the authorized bandwidth causes harmful interference, the Commission may, at its discretion, require greater attenuation than specified in paragraphs (f) (1), (2) and (3) of this section.

4.4.2. TEST CONFIGURATION



[Remark: if measurement frequency range over spectrum analyzer covered, using external Harmonic Mixer to extend frequency range]

4.4.3. TEST PROCEDURE

According to ANSI C63.26:2015 section 5.7.3 and 5.7.4: The Spurious Emissions at Antenna Terminals were measured with the following settings;
Connect the EUT antenna output port to the spectrum analyzer via an appropriate RF cable. Insert external attenuation as necessary and adjust the spectrum analyzer settings to account for the corresponding insertion loss. The unwated emission limit was expressed in terms of average power. The use of MaxHold will not results in a true average power measurement. Instead, the proper trace mode for performing an average measurement was the trace average mode. Alternatively, a single sweep measurement could be used with

the sweep speed set such that a relatively long dwell was realized in each trace bucket (typically at least 1 ms per trace point).

The following procedure shall be used for measuring out-of-band emissions measurements:

a) Set the spectrum analzyer center frequency to the block, band, or channel edge frequency.
b) Set the span wide enough to capure the fundamental emission closest to the authorized block or band edge, and to include all modulation products that spill into the immediately adjacent frequency band. In some cases, it may be possible to set the center frequency and span so as to encompass the fundamental emission and the unwanted out-of-band (band edge) emissions on either side of the authorized block, band, or channel. This could be accomplished with a single (slow) sweep, if adequate overload protection and sufficient dynamic range could be maintained.
c) Set the number of points in sweep ≥ 2 x span/RBW.
d) Sweep time should be auto for peak detection. For RMS detection the sweep time should be set as follows;
   (1) If the device could be configured to transmit continously, set the (sweep time) > (number of points in sweep) x (sumbol period) (e.g., by a factor of 10 x symbol period x number of points). Increasing the sweep time (ie. Slowing the sweep speed) will allow for averaing over multiple symbols.
   (2) If the devcie could not transmit continously, a gated sweep should be used when possible, set the sweep time > (number of points in sweep) x (symbol period) but the sweep time should always be maintianed at a value that was less than or equal to the minimum transmission time.
   (3) If the device could not be configured to the transmit continuously and a free running sweep must be used, set the sweep time so that the averaging was performed over multiple on/off cycles by setting the sweep time > (number of points in sweep) x (transmitter period) (i.e, the transmit on-time + the off-time). The spectrum analyzer readings should subseqently be corrected by [10 log (1/duty cycle]. This assumes that the transmission period and duty was relatively constant (duty cycle variation ≤ ±2%).
   (4) If the device could not be configured to transmit continuously and a free-running sweep must be used, and if the transmissions exhibit a non-constant duty cycle (duty cycle variations > ±2%), set the sweep time so that the averaging was performed over the non-period by setting the sweep time > (symbol period) x (number of points), while also maintianning the sweep time < (transmitter on-time). The trace mode should be set to maxhold, since not every disaplay points will be averaging only over just the one-time. Thus, multiple sweeps (e.g., 100) in maximum hold are necessary to ensure the maximum power was measured.

The following procedure shall be used for measuring conducted spurious emissions measurements:

(a) Set the spectrum analzyer start frequency to the lowest frequency generated by the EUT, without going below 9 kHz [usually start from 9 kHz], and the stop frequency to the lower frequenecy covered by the out-of-band emissions measurements [usually for frequency supported by the spectrum analyzer, and the measurements were performed from the waveguide cutoff frequency].
(b) When using an average power (RMS) detector, ensure that the number of points in the sweep ≥ 2 x span/RBW. This may requrie that the measurement range defined by the start and stop frequencies be subdivided, depending on the spectrum analzyer capabilities. This requiement does not apply to peak-detected power measurements. When average power was specified by the applicable regulation, a peak-detector could be utilized for preliminary measurements to accommodate wider frequency spans. Any emissions found in the preliminary measurement to exceed the applicable limit(s) should be further examined using a power averaging (RMS) detector with the minimum number of measurement points as defined above.
(c) The sweep time should be set to auto-couple for performing peak-detector measurements. For measurements that use a power averaging (RMS) detector, the sweep time should be set as described for out-of-band emission measuements.
(d) Identify and measure the highest spurious emission levels in each frequency range. It was not necessary to re-measure the out-of-band emissions as a part of this test. Record the frequencies and amplitudes corresponding to the measured emissions and capture the data plots.
(e) Repeate step (b) torough step (d) when the upper spurious emisssion frequency range if not already captured by a wide span measurement.
(f) Compare the results with the corresponding limit in the applicable regulation.

Calculation of bandwidth correction factor

According to ANSI C63.26-2015: If the measurement bandwidth used to perform the measurement is less than the reference bandwidth, the following scaling is applied: 10 x log [(reference bandwidth) / (resolution or measurement bandwidth)]

For example, the reference bandwidth is specified as 4 kHz and the RBW 3 kHz is used during the measurement, the bandwidth correction factor = 10 x log (4 kHz / 3 kHz) = 1.25 dB

4.4.4. TEST RESULTS

Table 5: Out-of-Band Emissions Values (Measured with Spectrum Analyzer in any 4 kHz Band)

Modulation	Carrier	Frequency [GHz]	Conducted Measurement Results	Limits	Results
QPSK	Single	14.0525	See Plots 10	See Plots 10	PASS
8PSK	Single	14.0525	See Plots 11	See Plots 11	PASS
16QAM	Single	14.0525	See Plots 12	See Plots 12	PASS

Note 1: The insertion loss (Waveguide couple, RF cable assembly) was included in the spectrum analyzer as cable loss.
Note 2: Bandwidth correction factor ($10 \times \log_{10}$ (4 kHz / 3 kHz) = 1.25 dB)) was applied to the Offset (Plus insertion loss).

Table 6: Band-edge Values (Measured with Spectrum Analyzer in any 4 kHz Band)

Modulation	Carrier	Frequency [GHz]	Band-edge	Conducted Measurement Results	Limits	Results
QPSK	Single	14.0525	Lower	See Plots 13	See Plots 13	PASS
			Upper	See Plots 14	See Plots 14	PASS
8PSK	Single	14.0525	Lower	See Plots 15	See Plots 15	PASS
			Upper	See Plots 16	See Plots 16	PASS
16QAM	Single	14.0525	Lower	See Plots 17	See Plots 17	PASS
			Upper	See Plots 18	See Plots 18	PASS

Note 1: The insertion loss (Waveguide couple, RF cable assembly) was included in the spectrum analyzer as cable loss.
Note 2: Bandwidth correction factor ($10 \times \log_{10}$ (4 kHz / 3 kHz) = 1.25 dB)) was applied to the Offset (Plus insertion loss).

Table 7: Spurious Emission Values At Antenna Terminals

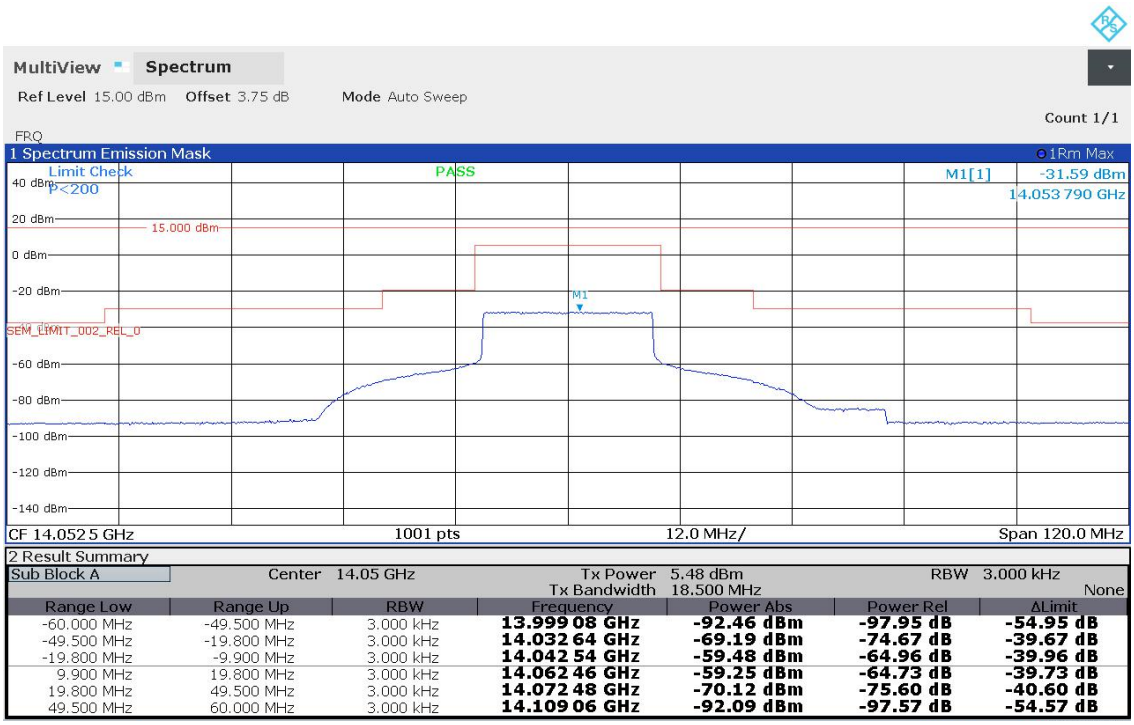
Modulation	Carrier	Frequency [GHz]	Frequency Range	Conducted Measurement Results	Limits	Results
QPSK	Single	14.0525	9 KHz – 40 GHz	See Plots 19	See Plots 19	PASS
			40 GHz – 60 GHz	See Plots 20	See Plots 20	PASS
			60 GHz – 75 GHz	See Plots 21	See Plots 21	PASS
8PSK	Single	14.0525	9 KHz – 40 GHz	See Plots 22	See Plots 22	PASS
			40 GHz – 60 GHz	See Plots 23	See Plots 23	PASS
			60 GHz – 75 GHz	See Plots 24	See Plots 24	PASS
16QAM	Single	14.0525	9 KHz – 40 GHz	See Plots 25	See Plots 25	PASS
			40 GHz – 60 GHz	See Plots 26	See Plots 26	PASS
			60 GHz – 75 GHz	See Plots 27	See Plots 27	PASS

Note 1: The insertion loss (Waveguide couple, RF cable assembly, external harmonic mixer insertion loss) was included in the spectrum analyzer as cable loss.
Note 2: The measurement RBW as follow table during spurious emission at antenna terminals, the averaging detector (RMS) was used for preliminary measurements.

Frequency Range	RBW
9 KHz – 150 KHz	1 KHz
150 KHz – 30 MHz	10 KHz
150 MHz – 1 GHz	100 KHz
1 GHz – 40 GHz	1 MHz
40 GHz – 60 GHz	1 MHz
60 GHz – 75 GHz	1 MHz

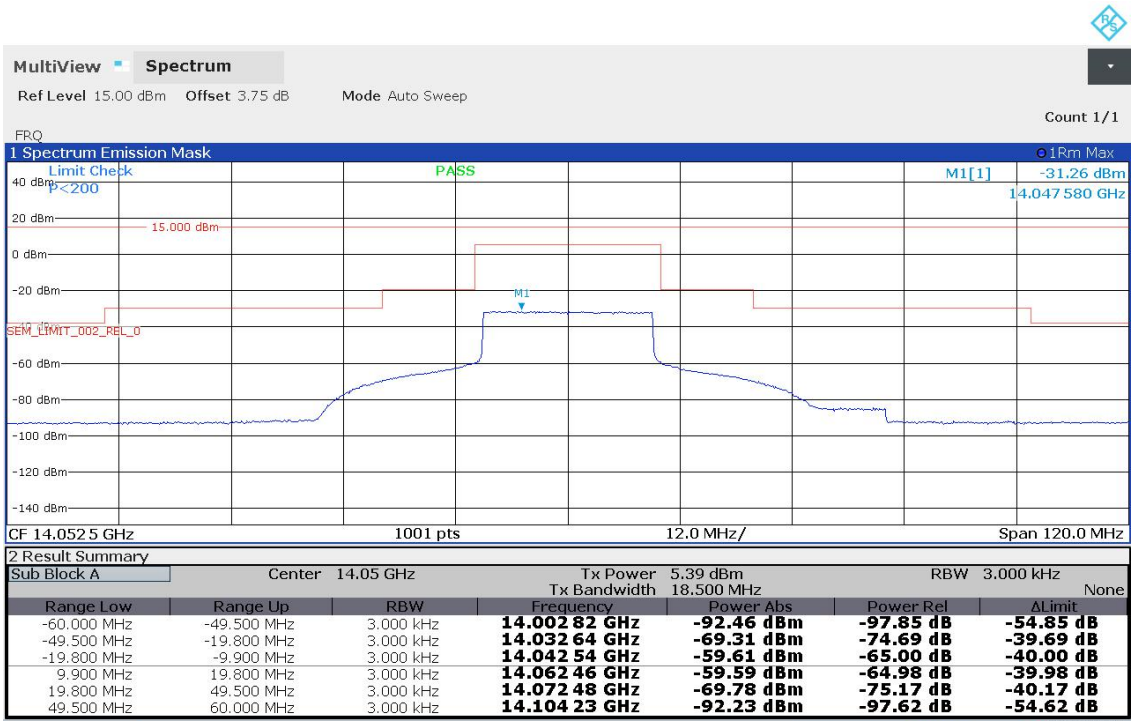
4.4.5. TEST RESULTS

Plots No. 10: Out-of-Band Emissions, RMS detector / Power in 3 kHz / QPSK Modulation



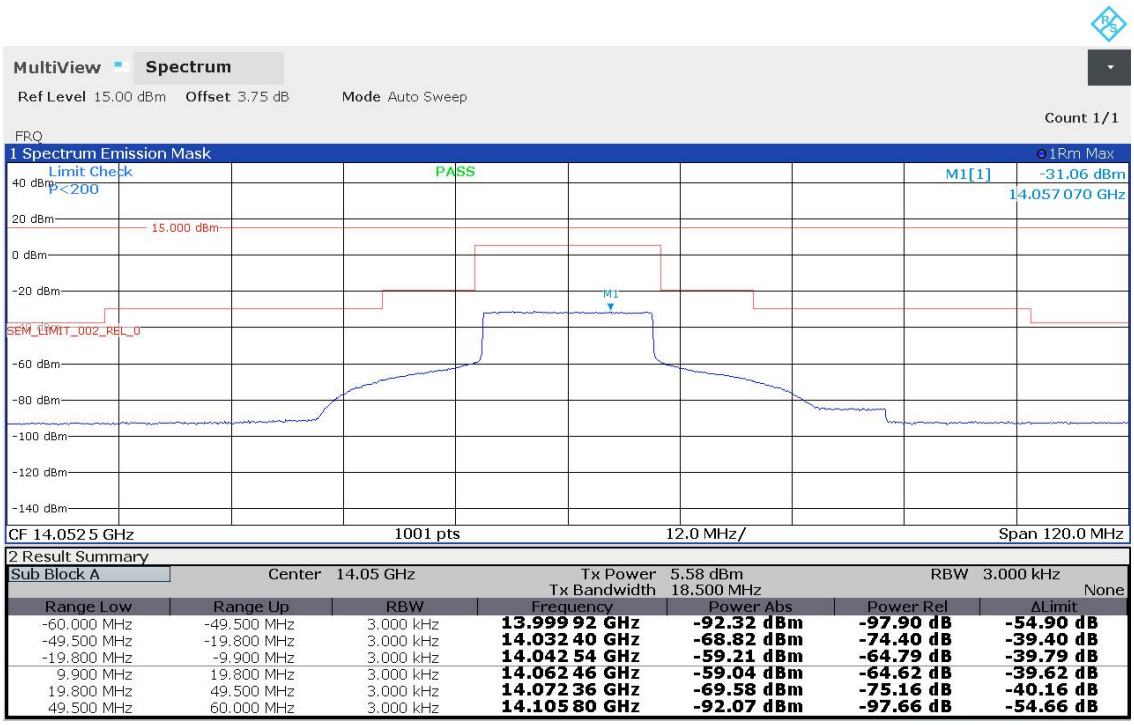
Range Low	Range Up	RBW	Frequency	Power Abs	Power Rel	ΔLimit
-60.000 MHz	-49.500 MHz	3.000 kHz	**13.999 08 GHz**	**-92.46 dBm**	**-97.95 dB**	**-54.95 dB**
-49.500 MHz	-19.800 MHz	3.000 kHz	**14.032 64 GHz**	**-69.19 dBm**	**-74.67 dB**	**-39.67 dB**
-19.800 MHz	-9.900 MHz	3.000 kHz	**14.042 54 GHz**	**-59.48 dBm**	**-64.96 dB**	**-39.96 dB**
9.900 MHz	19.800 MHz	3.000 kHz	**14.062 46 GHz**	**-59.25 dBm**	**-64.73 dB**	**-39.73 dB**
19.800 MHz	49.500 MHz	3.000 kHz	**14.072 48 GHz**	**-70.12 dBm**	**-75.60 dB**	**-40.60 dB**
49.500 MHz	60.000 MHz	3.000 kHz	**14.109 06 GHz**	**-92.09 dBm**	**-97.57 dB**	**-54.57 dB**

Plots No. 11: Out-of-Band Emissions, RMS detector / Power in 3 kHz / 8PSK Modulation



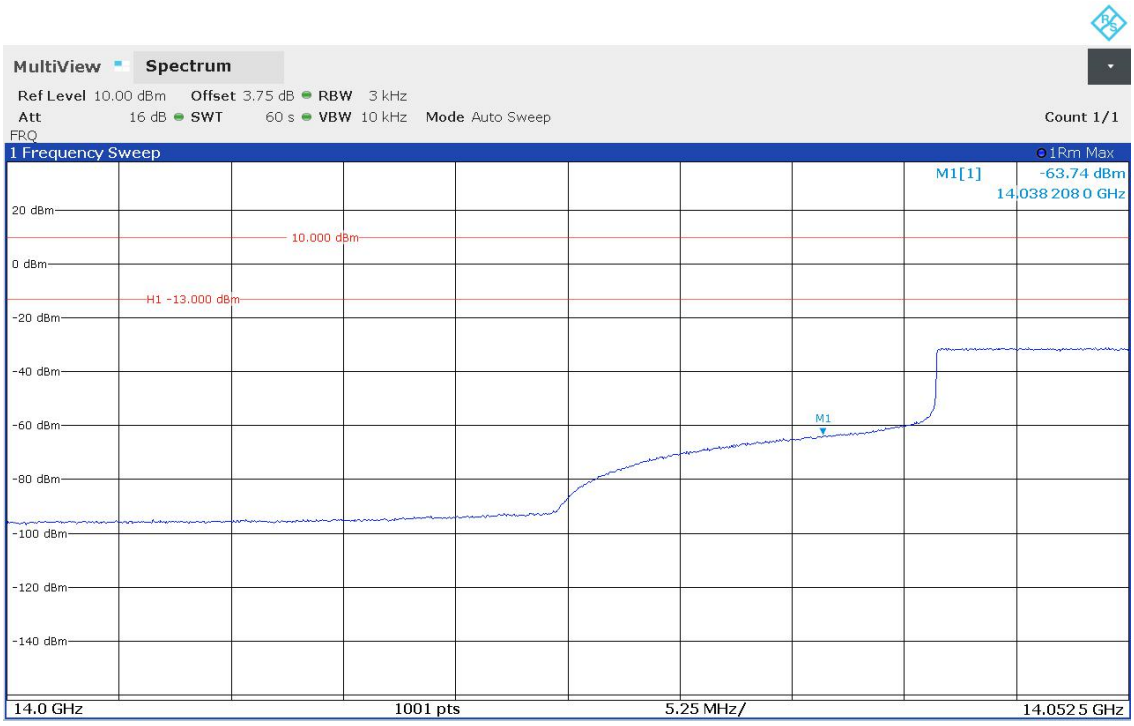
Range Low	Range Up	RBW	Frequency	Power Abs	Power Rel	ΔLimit
-60.000 MHz	-49.500 MHz	3.000 kHz	**14.002 82 GHz**	**-92.46 dBm**	**-97.85 dB**	**-54.85 dB**
-49.500 MHz	-19.800 MHz	3.000 kHz	**14.032 64 GHz**	**-69.31 dBm**	**-74.69 dB**	**-39.69 dB**
-19.800 MHz	-9.900 MHz	3.000 kHz	**14.042 54 GHz**	**-59.61 dBm**	**-65.00 dB**	**-40.00 dB**
9.900 MHz	19.800 MHz	3.000 kHz	**14.062 46 GHz**	**-59.59 dBm**	**-64.98 dB**	**-39.98 dB**
19.800 MHz	49.500 MHz	3.000 kHz	**14.072 48 GHz**	**-69.78 dBm**	**-75.17 dB**	**-40.17 dB**
49.500 MHz	60.000 MHz	3.000 kHz	**14.104 23 GHz**	**-92.23 dBm**	**-97.62 dB**	**-54.62 dB**

Plots No. 12: Out-of-Band Emissions, RMS detector / Power in 3 kHz / 16QAM Modulation

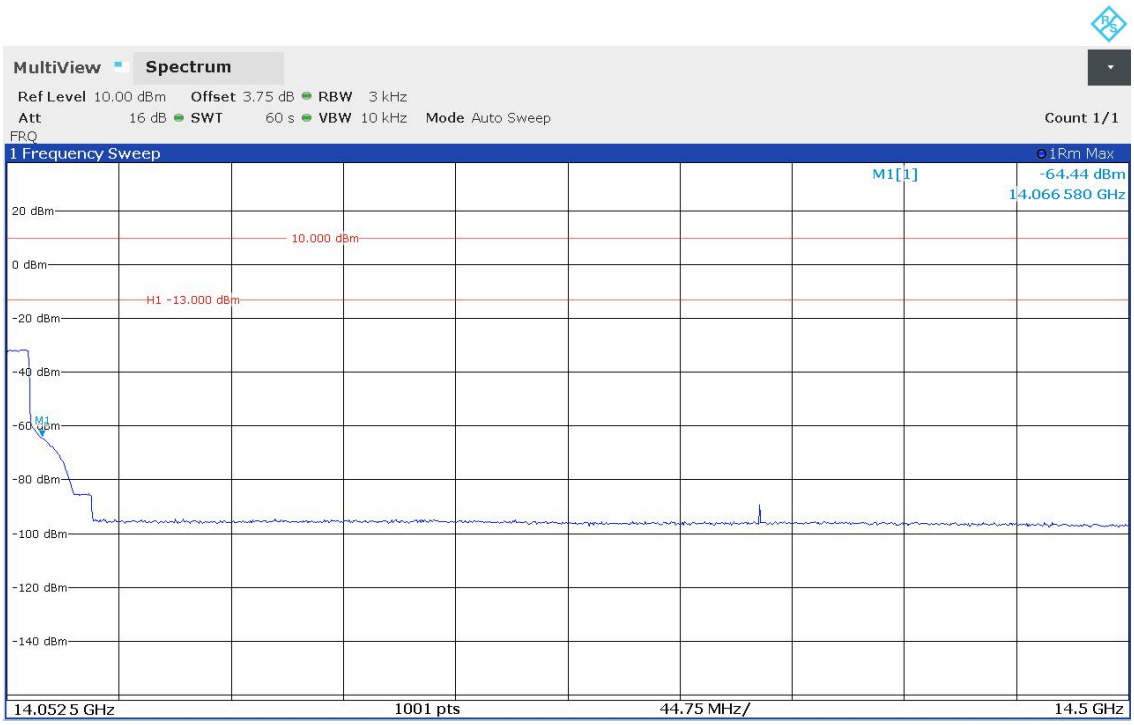


Range Low	Range Up	RBW	Frequency	Power Abs	Power Rel	ΔLimit
-60.000 MHz	-49.500 MHz	3.000 kHz	**13.999 92 GHz**	**-92.32 dBm**	**-97.90 dB**	**-54.90 dB**
-49.500 MHz	-19.800 MHz	3.000 kHz	**14.032 40 GHz**	**-68.82 dBm**	**-74.40 dB**	**-39.40 dB**
-19.800 MHz	-9.900 MHz	3.000 kHz	**14.042 54 GHz**	**-59.21 dBm**	**-64.79 dB**	**-39.79 dB**
9.900 MHz	19.800 MHz	3.000 kHz	**14.062 46 GHz**	**-59.04 dBm**	**-64.62 dB**	**-39.62 dB**
19.800 MHz	49.500 MHz	3.000 kHz	**14.072 36 GHz**	**-69.58 dBm**	**-75.16 dB**	**-40.16 dB**
49.500 MHz	60.000 MHz	3.000 kHz	**14.105 80 GHz**	**-92.07 dBm**	**-97.66 dB**	**-54.66 dB**

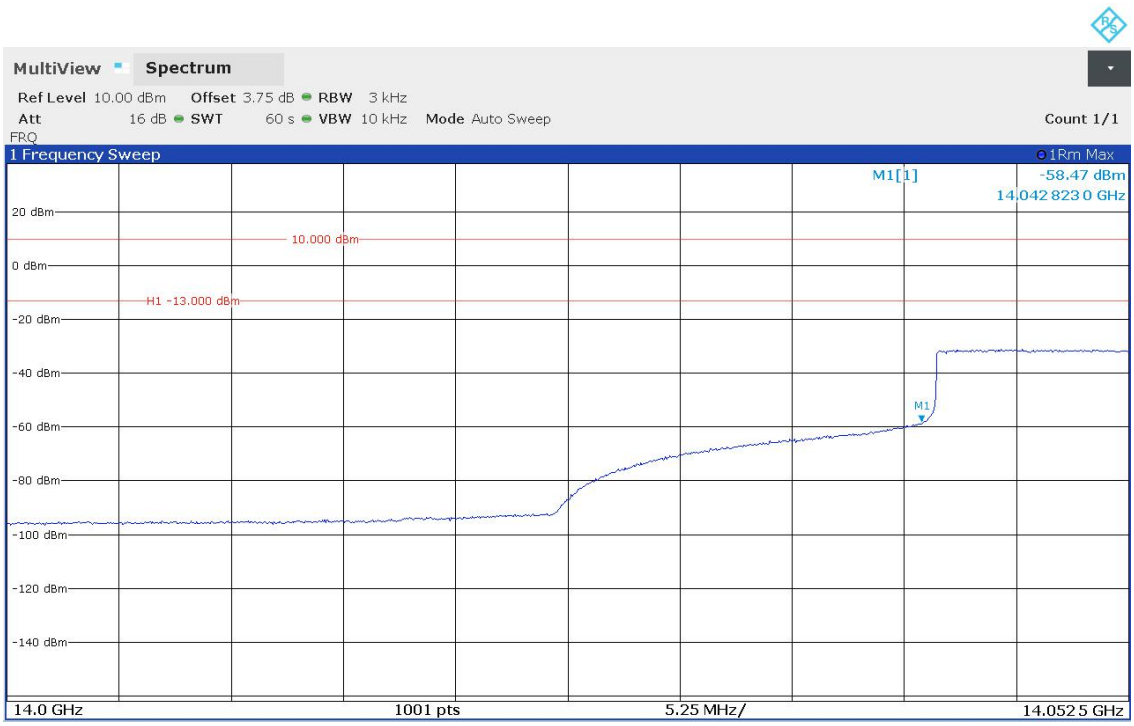
Plots No. 13: Band-edge Valus, RMS detector / Power in 3 kHz / QPSK Modulation / Lower



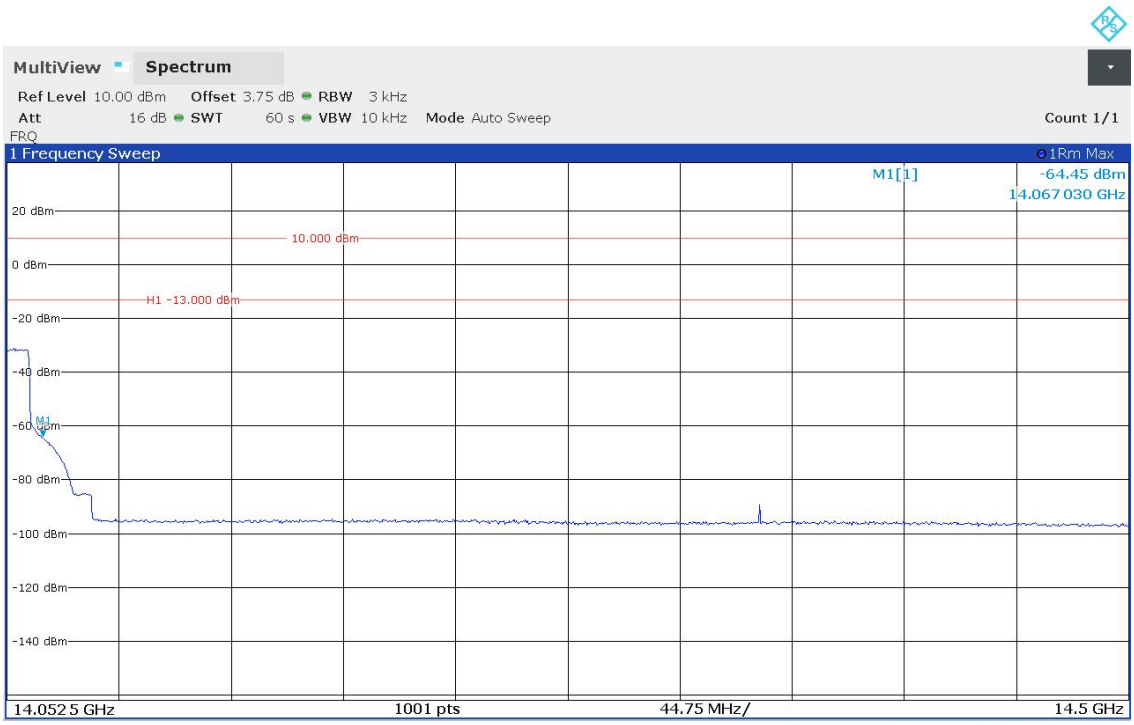
Plots No. 14: Band-edge Valus, RMS detector / Power in 3 kHz / QPSK Modulation / Upper



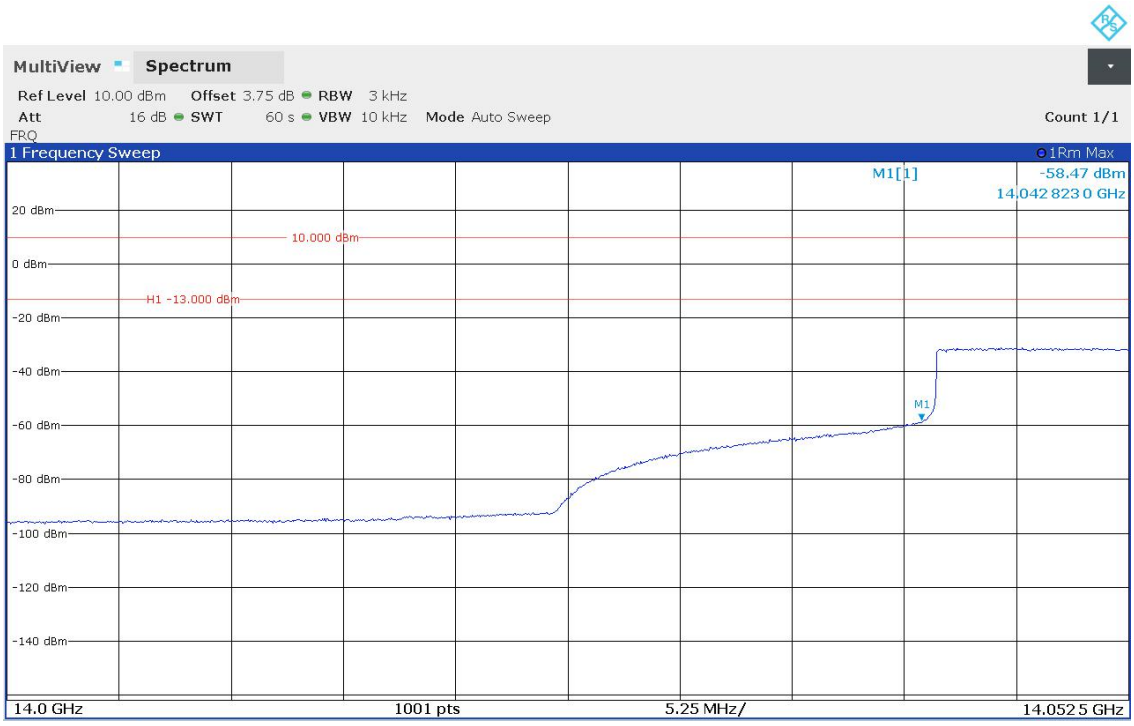
Plots No. 14: Band-edge Valus, RMS detector / Power in 3 kHz / 8PSK Modulation / Lower



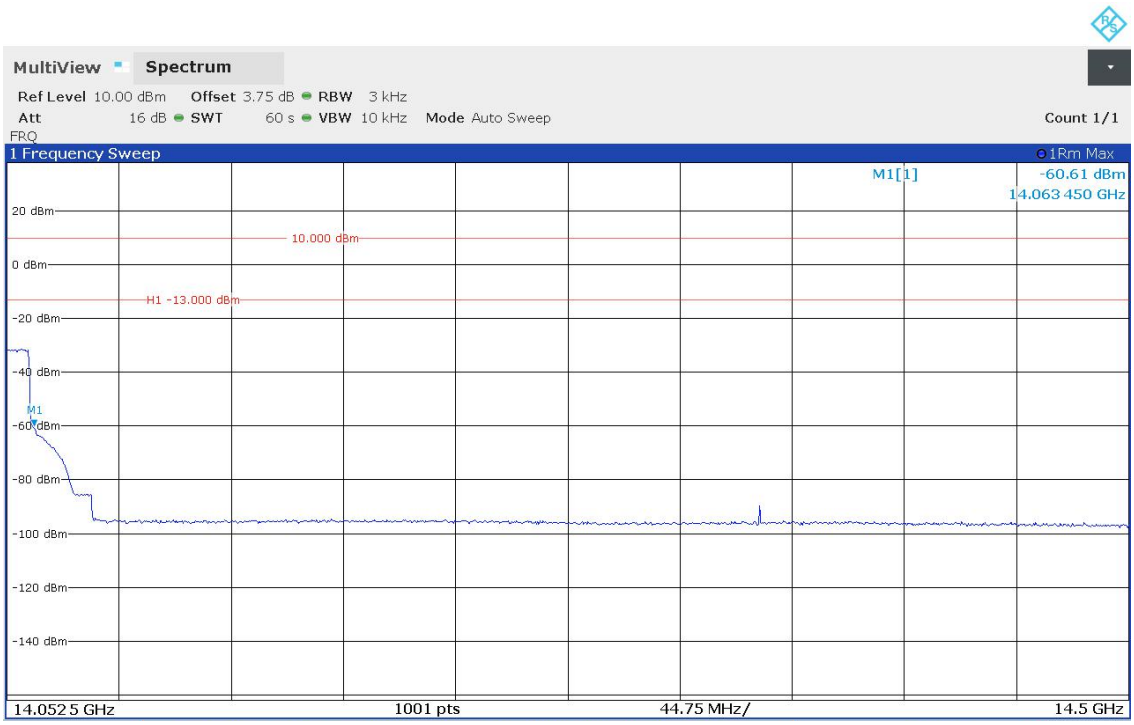
Plots No. 15: Band-edge Valus, RMS detector / Power in 3 kHz / 8PSK Modulation / Upper



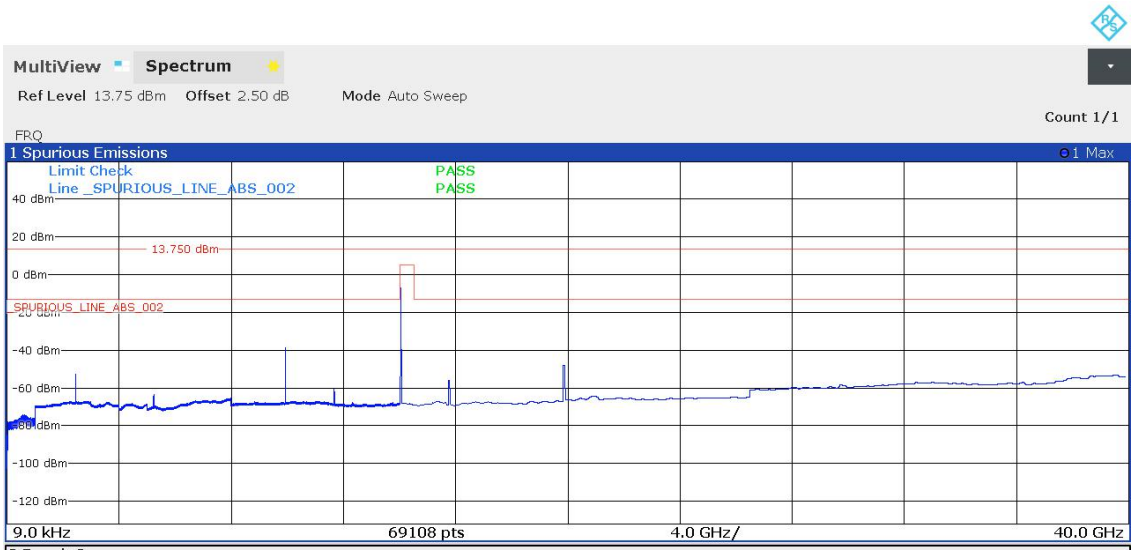
Plots No. 15: Band-edge Valus, RMS detector / Power in 3 kHz / 16QAM Modulation / Lower



Plots No. 16: Band-edge Valus, RMS detector / Power in 3 kHz / 16QAM Modulation / Upper



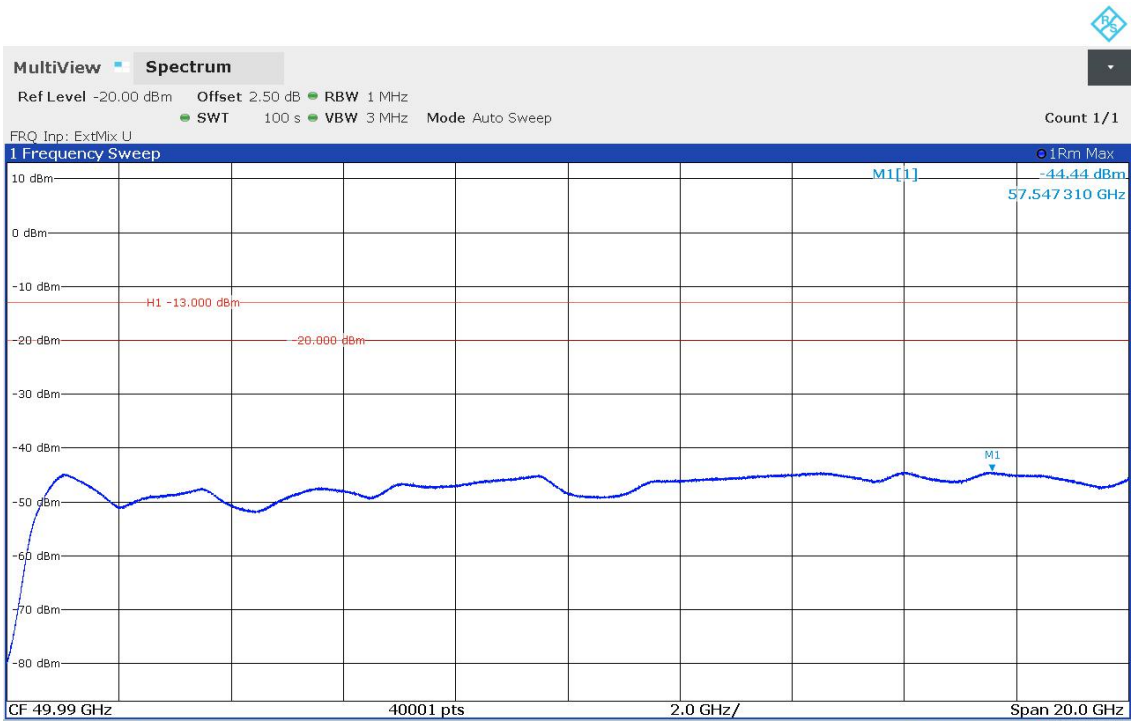
Plots No. 19: Spurious Emission at Antenna Terminal, RMS detector / QPSK Modulation / 9 KHz – 40 GHz



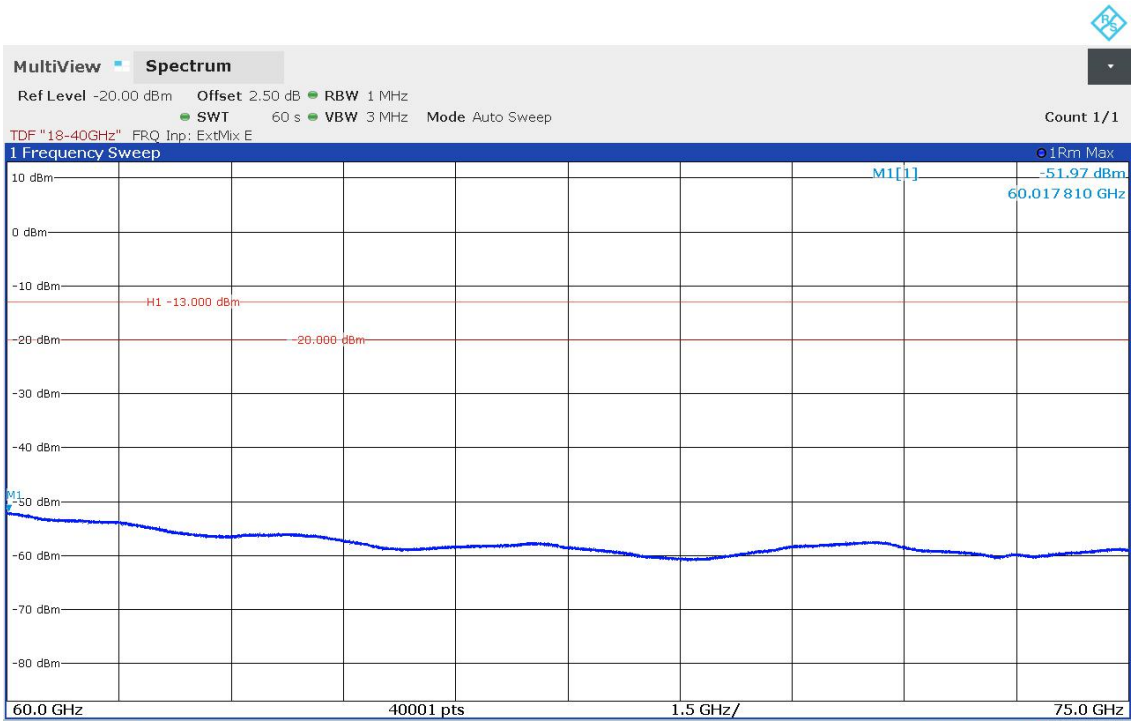
2 Result Summary

Range Low	Range Up	RBW	Frequency	Power Abs	ΔLimit
10.009 MHz	10.150 MHz	1.000 kHz	**31.024 96 kHz**	**-95.78 dBm**	**-82.78 dB**
10.150 MHz	40.000 MHz	10.000 kHz	**7.957 55 MHz**	**-84.21 dBm**	**-71.21 dB**
40.000 MHz	1.010 GHz	100.000 kHz	**643.975 66 MHz**	**-74.24 dBm**	**-61.24 dB**
1.010 GHz	14.010 GHz	1.000 MHz	**9.939 86 GHz**	**-38.55 dBm**	**-25.55 dB**
14.010 GHz	14.510 GHz	1.000 MHz	**14.047 03 GHz**	**-6.86 dBm**	**-11.86 dB**
14.510 GHz	18.010 GHz	1.000 MHz	**15.764 85 GHz**	**-55.81 dBm**	**-42.81 dB**
18.010 GHz	26.510 GHz	1.000 MHz	**19.893 56 GHz**	**-48.25 dBm**	**-35.25 dB**
26.510 GHz	40.010 GHz	3.000 MHz	**39.398 51 GHz**	**-53.00 dBm**	**-40.00 dB**

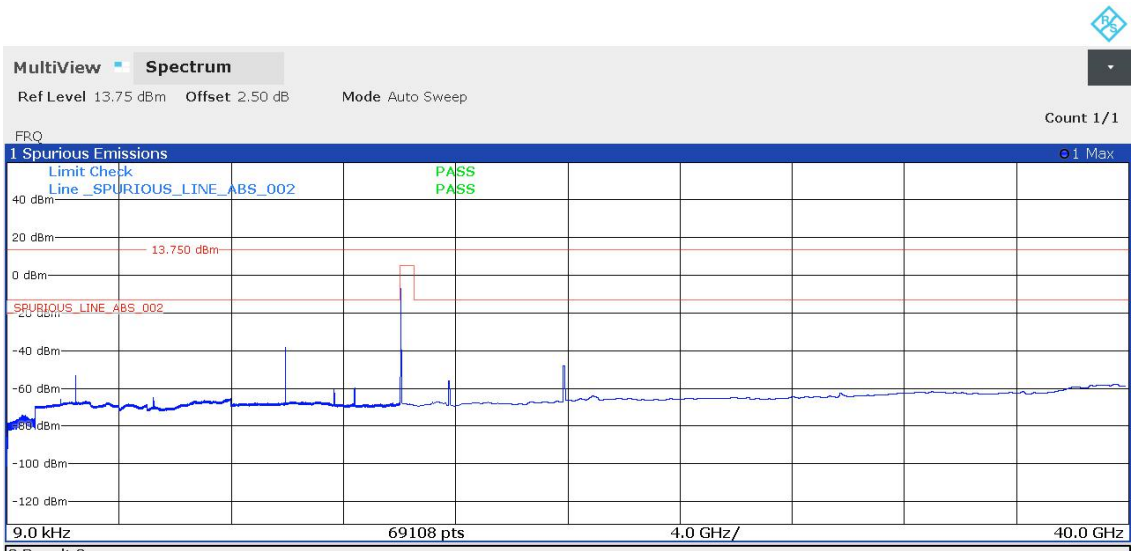
Plots No. 20: Spurious Emission at Antenna Terminal, RMS detector / QPSK Modulation / 40 GHz – 60 GHz



Plots No. 21: Spurious Emission at Antenna Terminal, RMS detector / QPSK Modulation / 60 GHz – 75 GHz



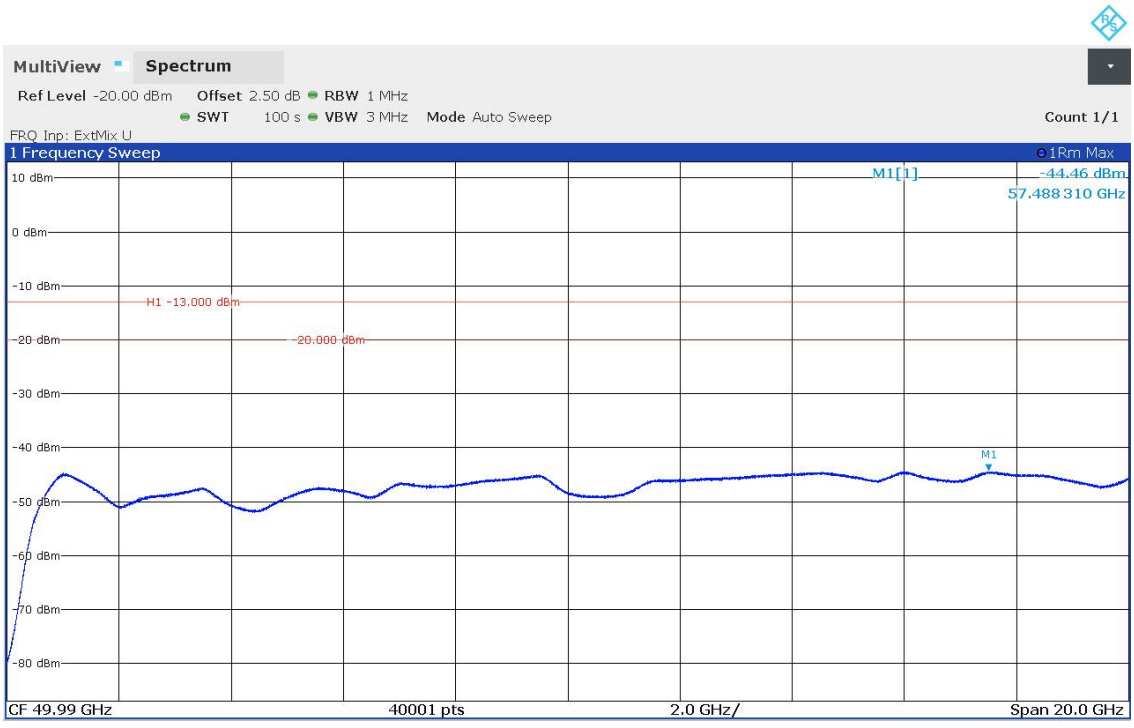
Plots No. 22: Spurious Emission at Antenna Terminal, RMS detector / 8PSK Modulation / 9 KHz – 40 GHz



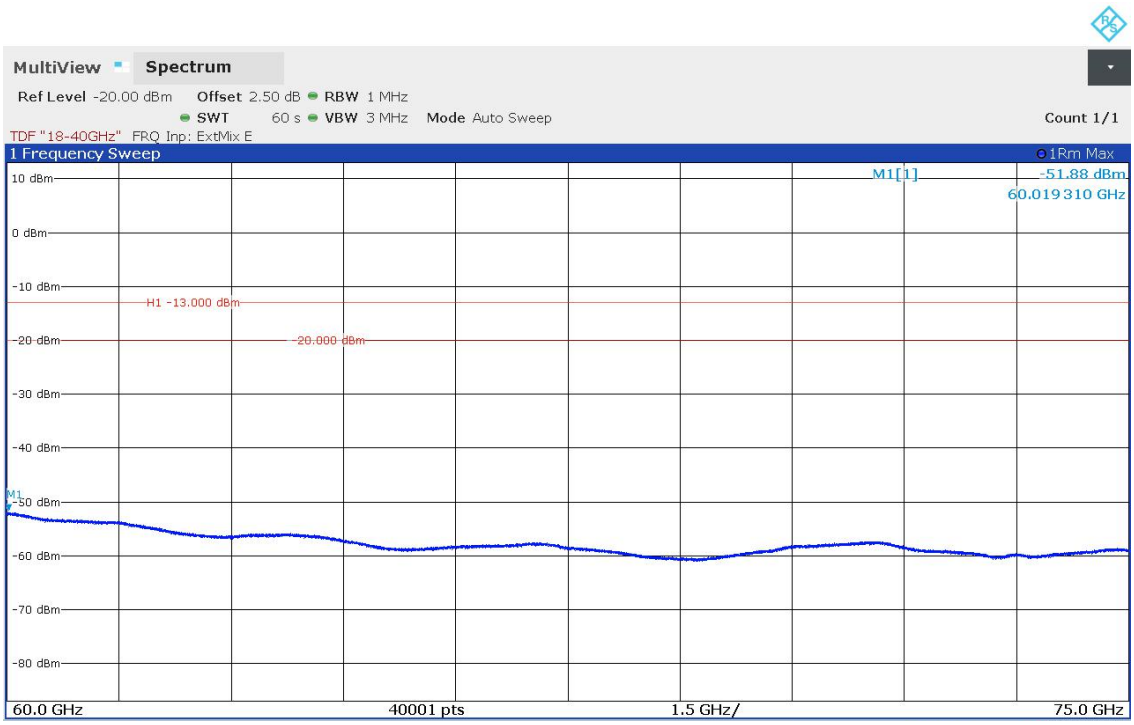
2 Result Summary

Range Low	Range Up	RBW	Frequency	Power Abs	ΔLimit
10.009 MHz	10.150 MHz	1.000 kHz	**125.360 20 kHz**	**-95.84 dBm**	**-82.84 dB**
10.150 MHz	40.000 MHz	10.000 kHz	**11.128 32 MHz**	**-85.41 dBm**	**-72.41 dB**
40.000 MHz	1.010 GHz	100.000 kHz	**619.514 23 MHz**	**-74.09 dBm**	**-61.09 dB**
1.010 GHz	14.010 GHz	1.000 MHz	**9.939 86 GHz**	**-38.57 dBm**	**-25.57 dB**
14.010 GHz	14.510 GHz	1.000 MHz	**14.047 03 GHz**	**-6.88 dBm**	**-11.88 dB**
14.510 GHz	18.010 GHz	1.000 MHz	**15.764 85 GHz**	**-55.81 dBm**	**-42.81 dB**
18.010 GHz	26.510 GHz	1.000 MHz	**19.893 56 GHz**	**-48.23 dBm**	**-35.23 dB**
26.510 GHz	40.010 GHz	1.000 MHz	**39.398 51 GHz**	**-57.74 dBm**	**-44.74 dB**

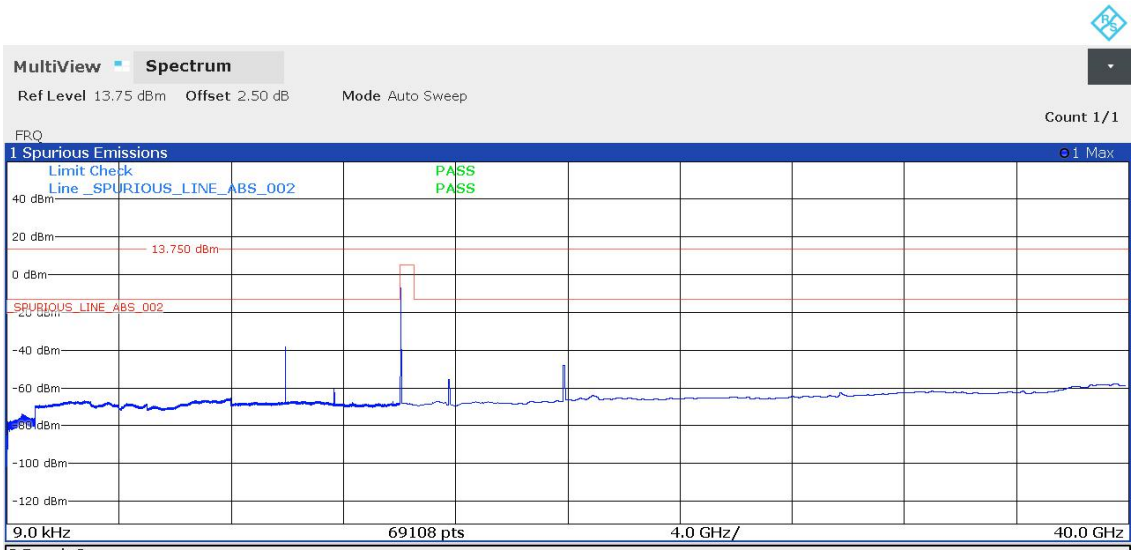
Plots No. 23: Spurious Emission at Antenna Terminal, RMS detector / 8PSK Modulation / 40 GHz – 60 GHz



Plots No. 24: Spurious Emission at Antenna Terminal, RMS detector / 8PSK Modulation / 60 GHz – 75 GHz



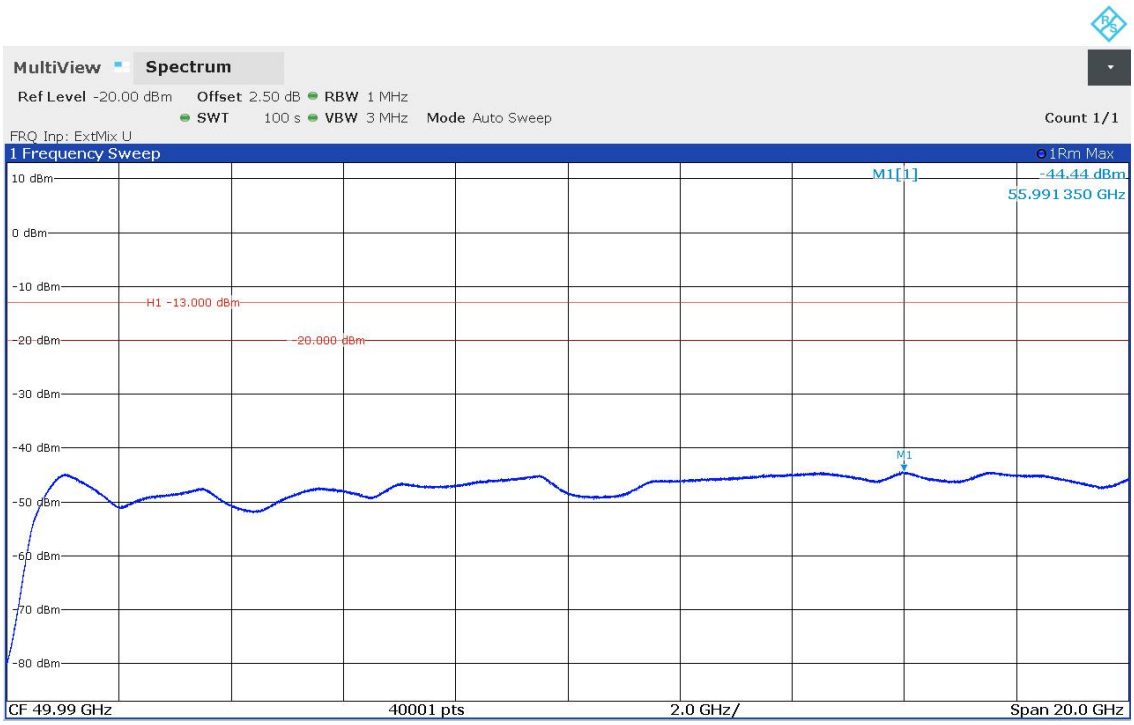
Plots No. 25: Spurious Emission at Antenna Terminal, RMS detector / 16QAM Modulation / 9 KHz – 40 GHz



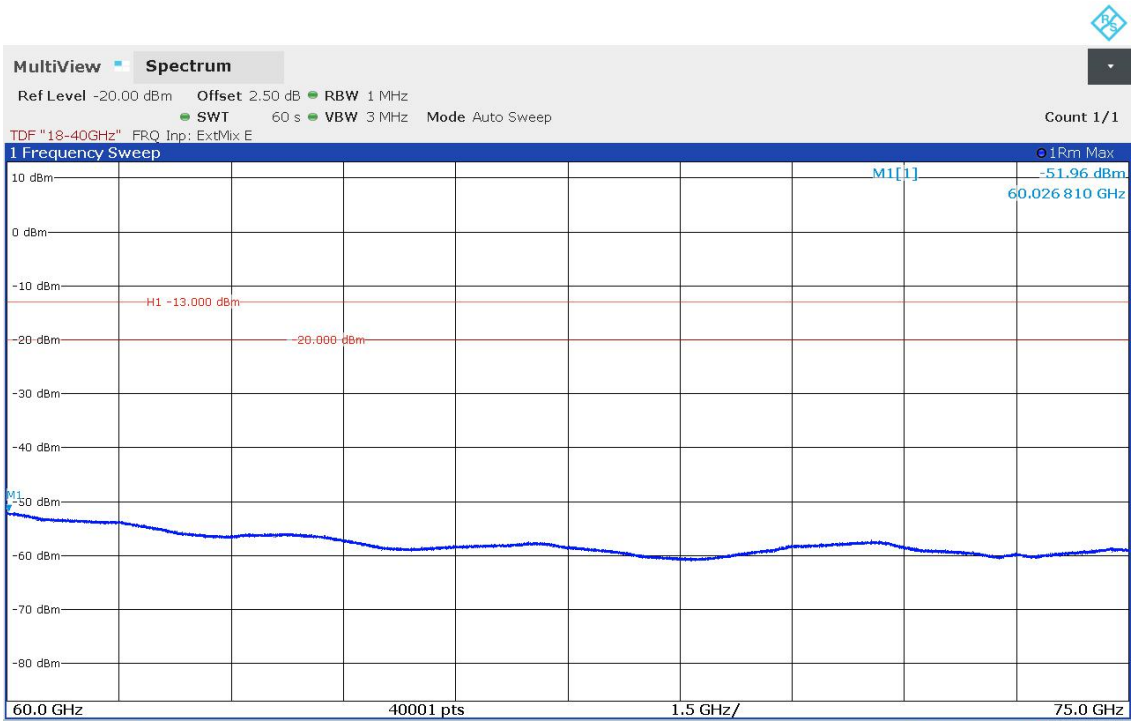
2 Result Summary

Range Low	Range Up	RBW	Frequency	Power Abs	ΔLimit
10.009 MHz	10.150 MHz	1.000 kHz	**84.729 67 kHz**	**-95.54 dBm**	**-82.54 dB**
10.150 MHz	40.000 MHz	10.000 kHz	**15.477 87 MHz**	**-85.80 dBm**	**-72.80 dB**
40.000 MHz	1.010 GHz	100.000 kHz	**648.583 01 MHz**	**-74.12 dBm**	**-61.12 dB**
1.010 GHz	14.010 GHz	1.000 MHz	**9.939 86 GHz**	**-38.48 dBm**	**-25.48 dB**
14.010 GHz	14.510 GHz	1.000 MHz	**14.047 03 GHz**	**-6.89 dBm**	**-11.89 dB**
14.510 GHz	18.010 GHz	1.000 MHz	**15.764 85 GHz**	**-55.82 dBm**	**-42.82 dB**
18.010 GHz	26.510 GHz	1.000 MHz	**19.893 56 GHz**	**-48.24 dBm**	**-35.24 dB**
26.510 GHz	40.010 GHz	1.000 MHz	**39.398 51 GHz**	**-57.74 dBm**	**-44.74 dB**

Plots No. 26: Spurious Emission at Antenna Terminal, RMS detector / 16QAM Modulation / 40 GHz – 60 GHz



Plots No. 27: Spurious Emission at Antenna Terminal, RMS detector / 16QAM Modulation / 60 GHz – 75 GHz



4.5. Field Strength of Spurious Radiation [§2.1053 & §25.202]

4.5.1. LIMITS

According to § 2.1053 (b): The measurements specified in paragraph (a) of this section shall be made for the following equipment:

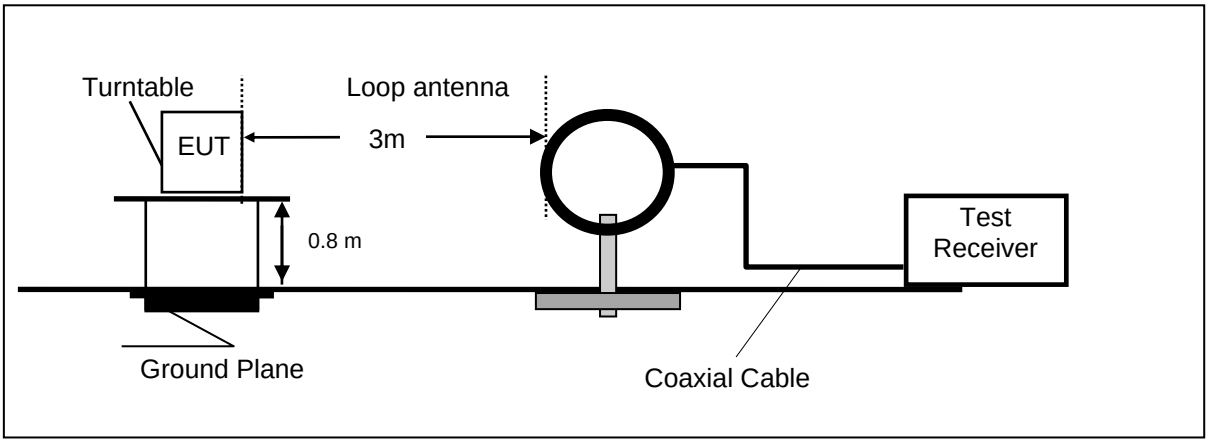
(1) Those in which the spurious emissions are required to be 60 dB or more below the mean power of the transmitter.
(2) All equipment operating on frequencies higher than 25 MHz.
(3) All equipment where the antenna is an integral part of, and attached directly to the transmitter.
(4) Other types of equipment as required, when deemed necessary by the Commission.

According to §25.202(f) - *Emission limitations.* Except for SDARS terrestrial repeaters and as provided for in paragraph (i), the mean power of emissions shall be attenuated below the mean output power of the transmitter in accordance with the schedule set forth in paragraphs (f)(1) through (f)(4) of this section. The out-of-band emissions of SDARS terrestrial repeaters shall be attenuated in accordance with the schedule set forth in paragraph (h) of this section.

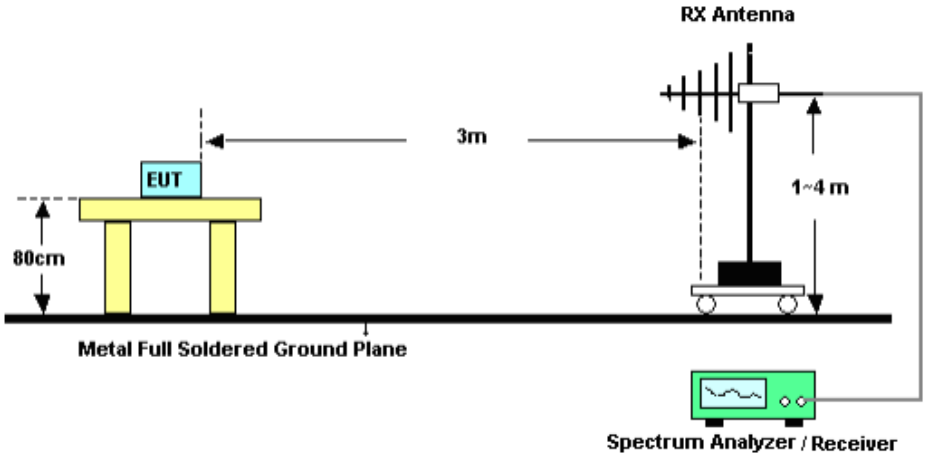
(1) In any 4 kHz band, the center frequency of which is removed from the assigned frequency by more than 50 percent up to and including 100 percent of the authorized bandwidth: 25 dB;
(2) In any 4 kHz band, the center frequency of which is removed from the assigned frequency by more than 100 percent up to and including 250 percent of the authorized bandwidth: 35 dB;
(3) In any 4 kHz band, the center frequency of which is removed from the assigned frequency by more than 250 percent of the authorized bandwidth: An amount equal to 43 dB plus 10 times the logarithm (to the base 10) of the transmitter power in watts;
(4) In any event, when an emission outside of the authorized bandwidth causes harmful interference, the Commission may, at its discretion, require greater attenuation than specified in paragraphs (f) (1), (2) and (3) of this section.

4.5.2. TEST CONFIGURATION

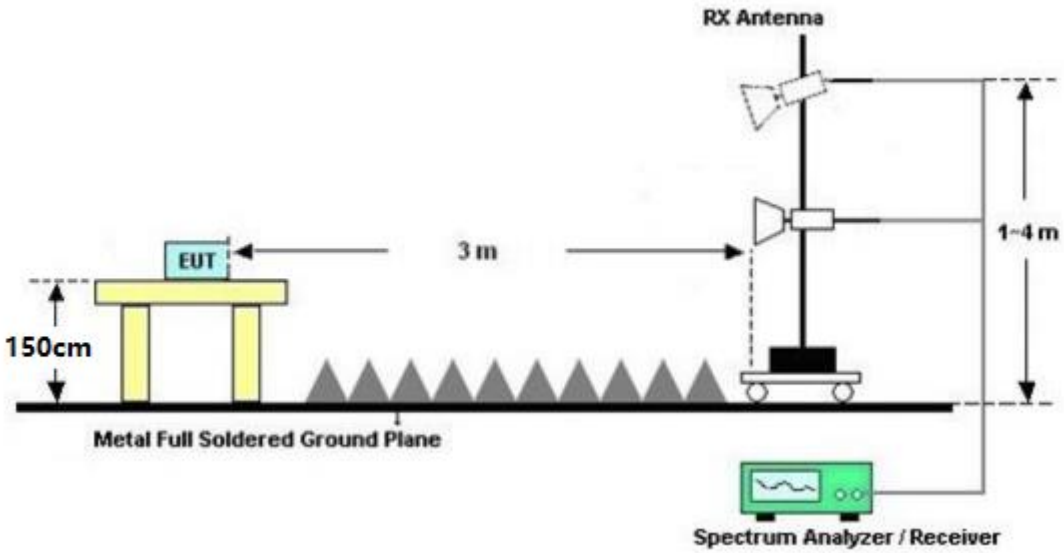
(a) Frequency range 9 KHz – 30MHz



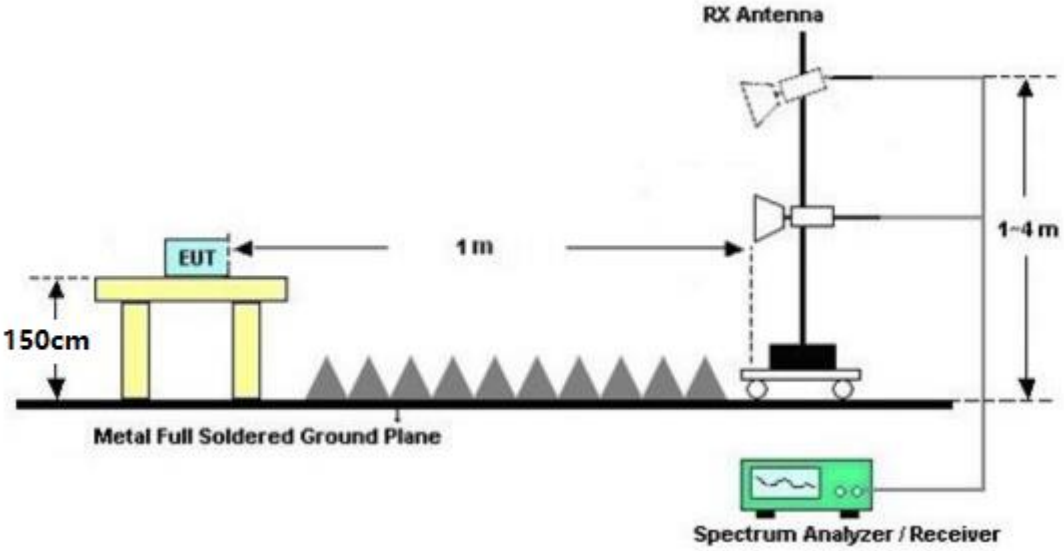
(b) Radiated emission test set-up, frequency range: 30 - 1000MHz



(c) Radiated emission test set-up, frequency range 1GHz – 18 GHz



(d) Radiated emission test set-up, frequency range 18GHz – 42 GHz



(e) Radiated emission test set-up, frequency range 40GHz – 75 GHz