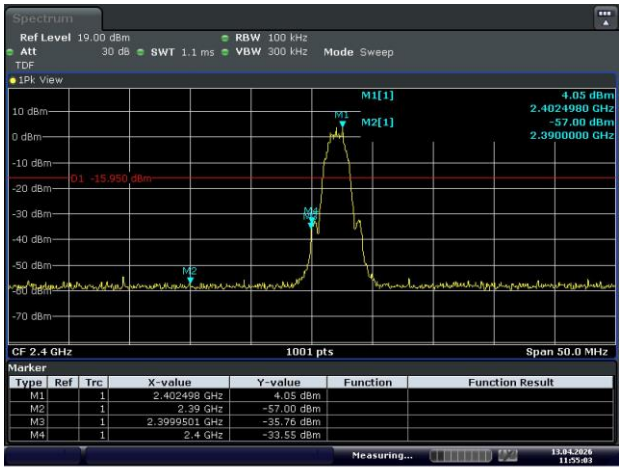
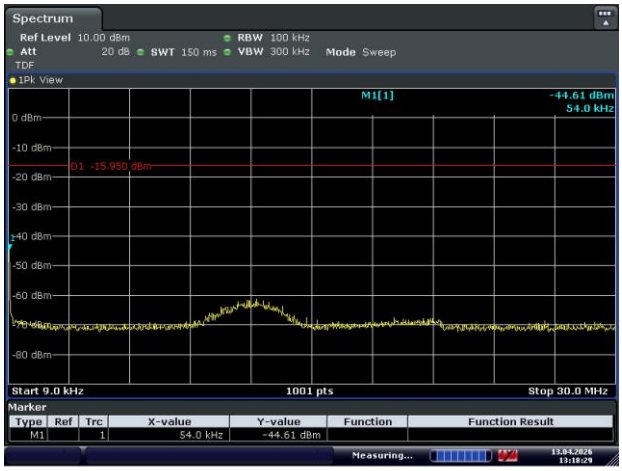
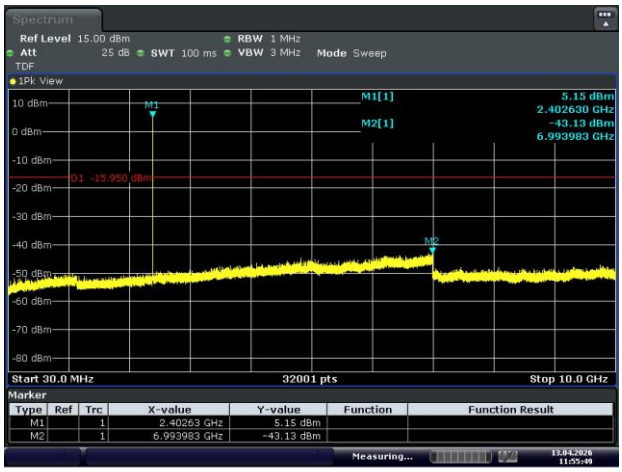
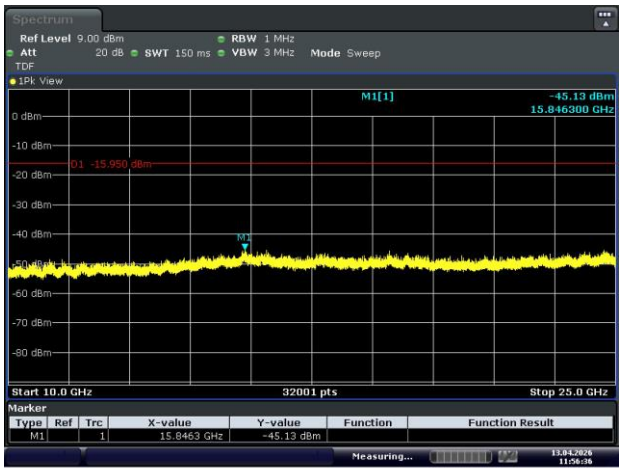
Test mode : PHY 2M

Low Channel

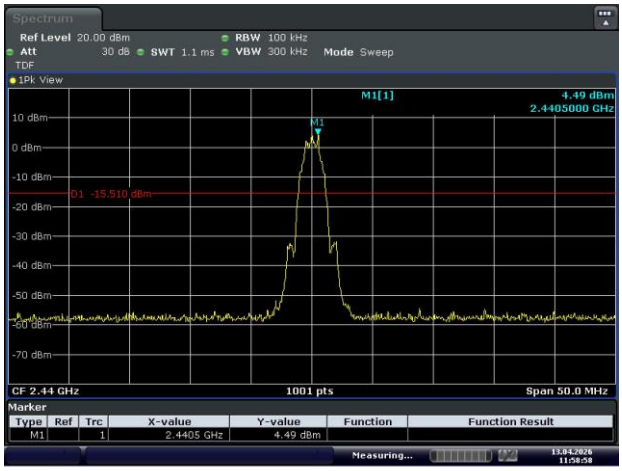


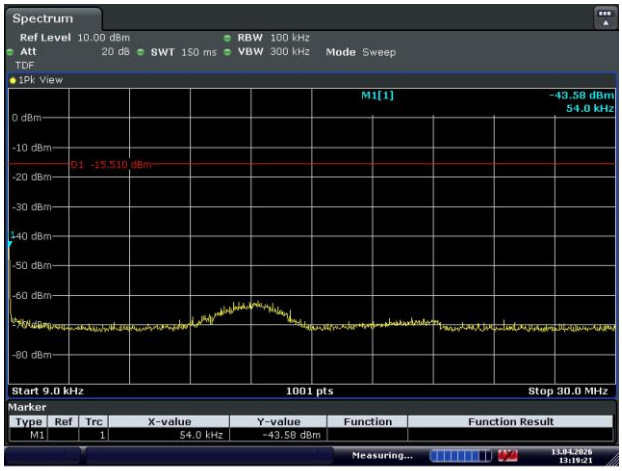


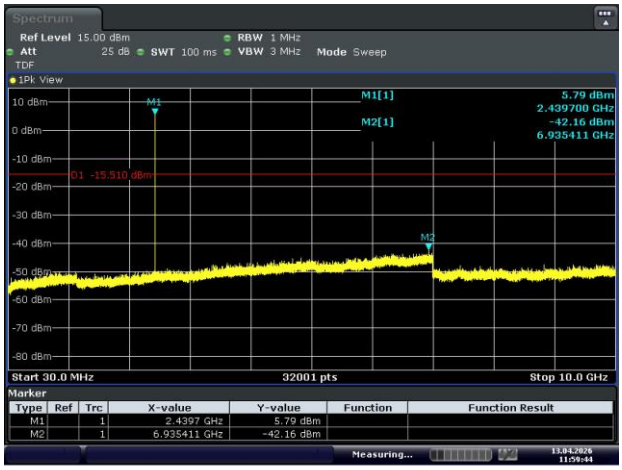


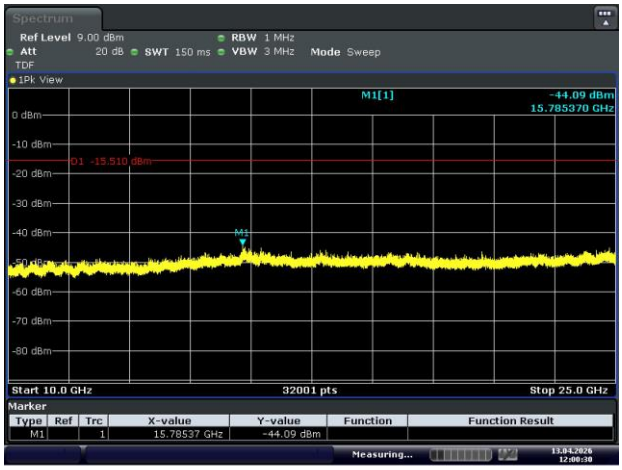


Middle Channel

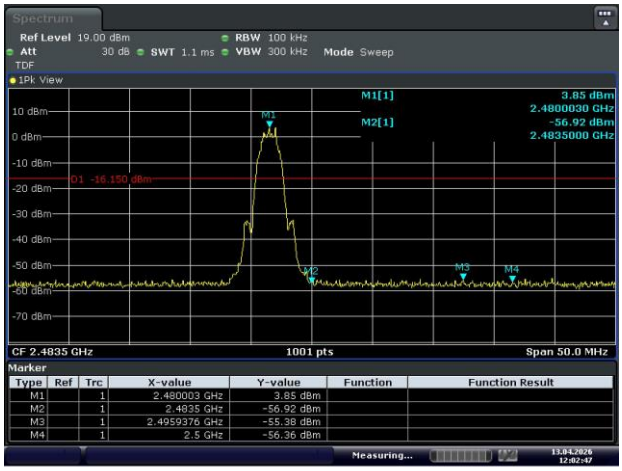


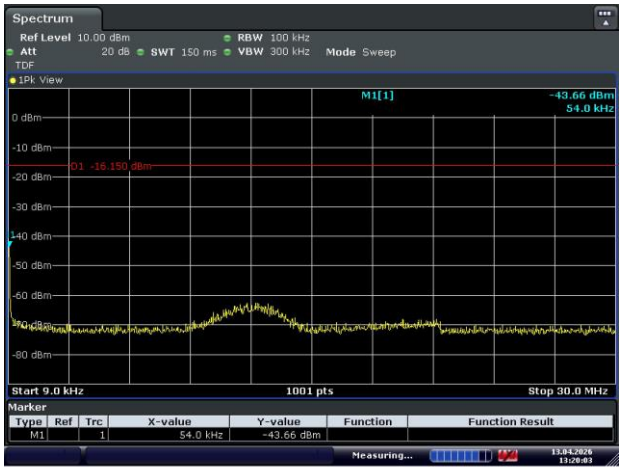


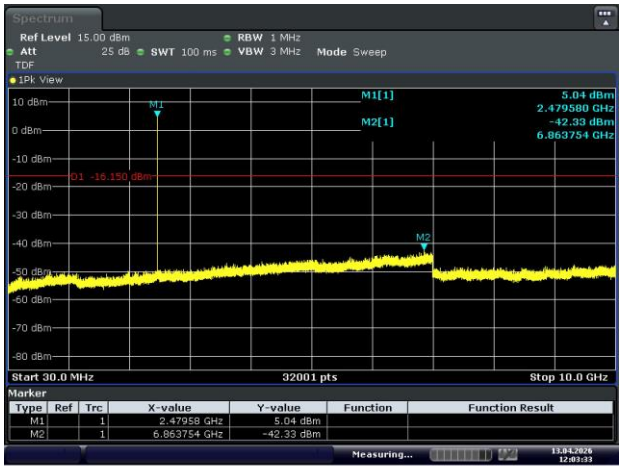


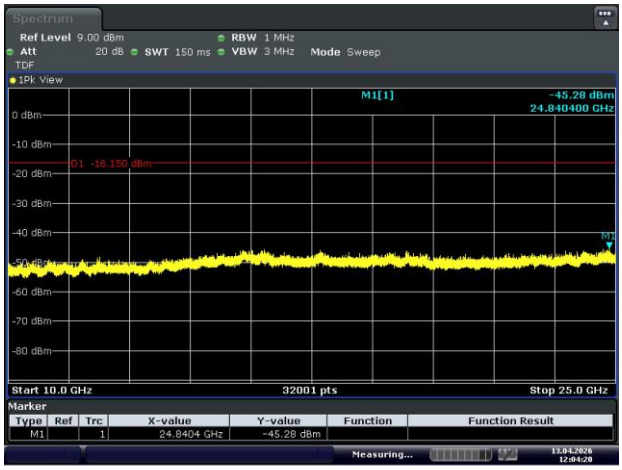


High Channel





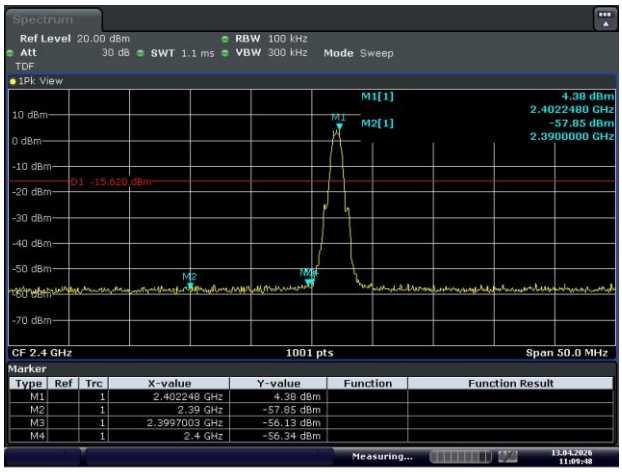


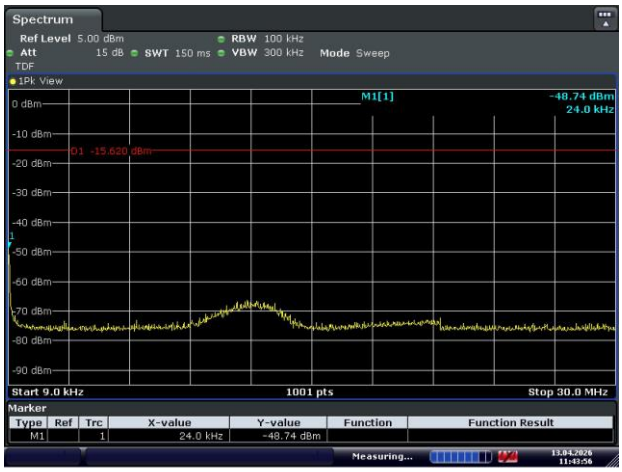


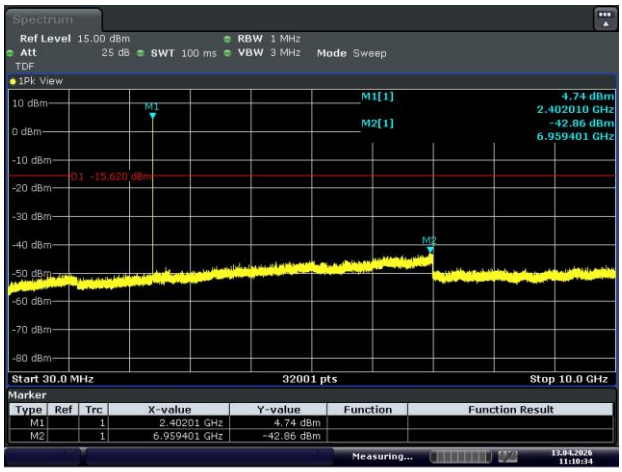
Test mode : PHY 1M

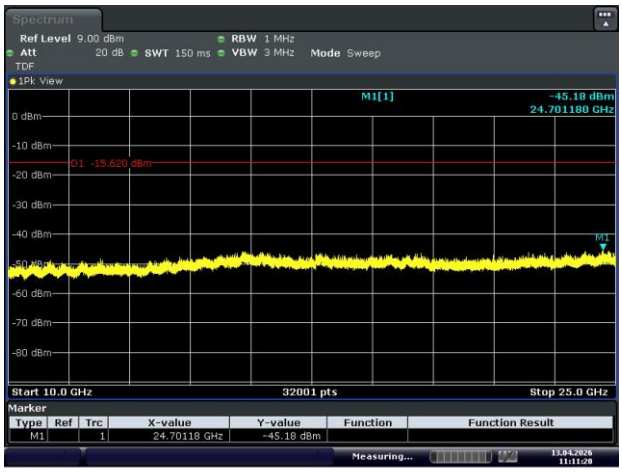
Ant. 1

Low Channel

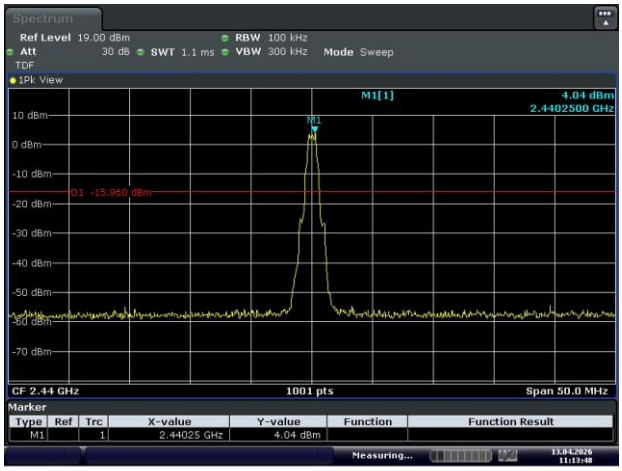


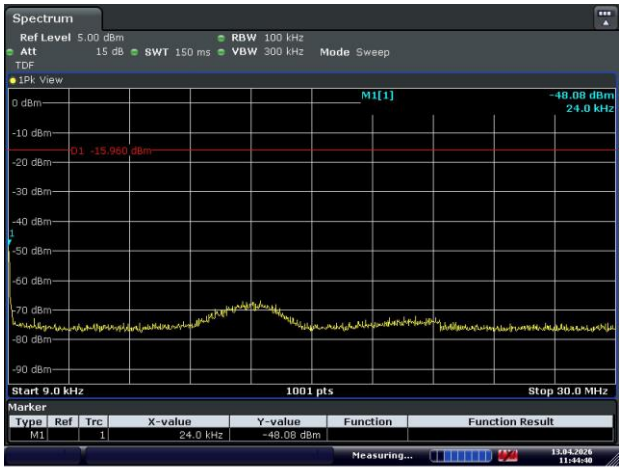


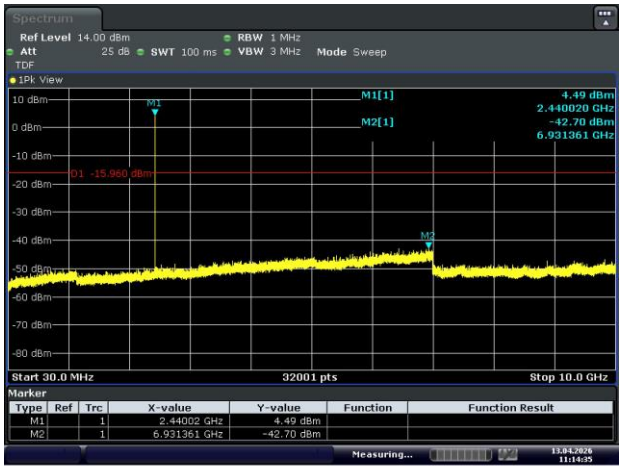


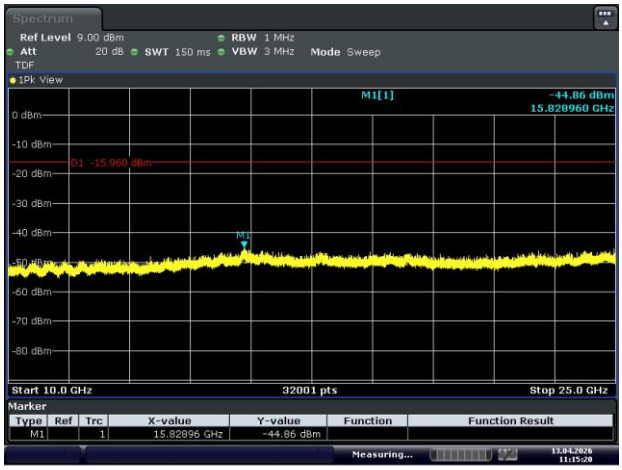


Middle Channel

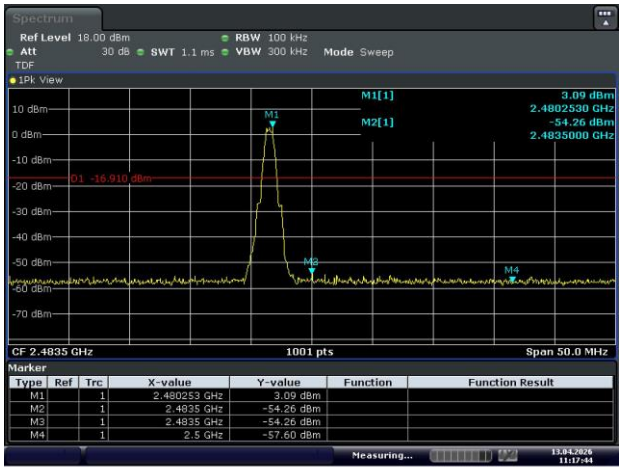


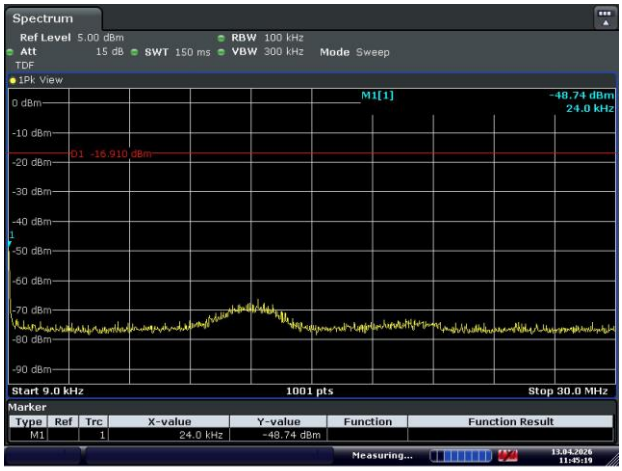


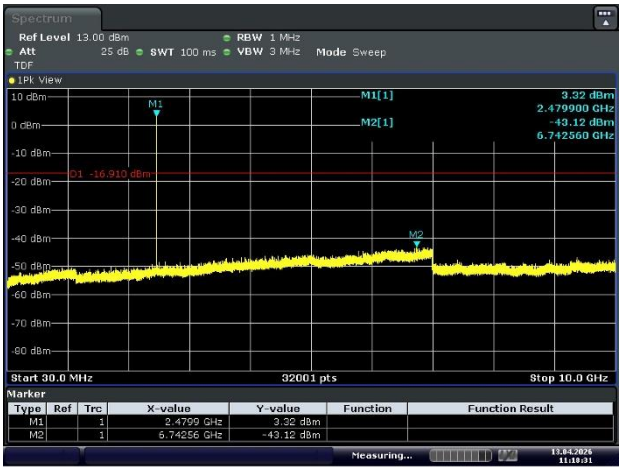


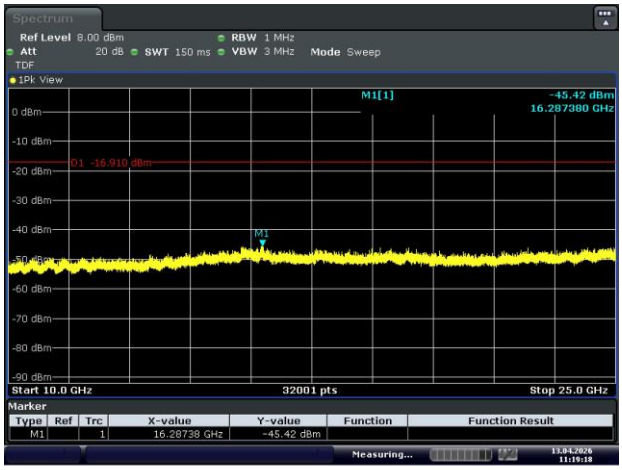


High Channel



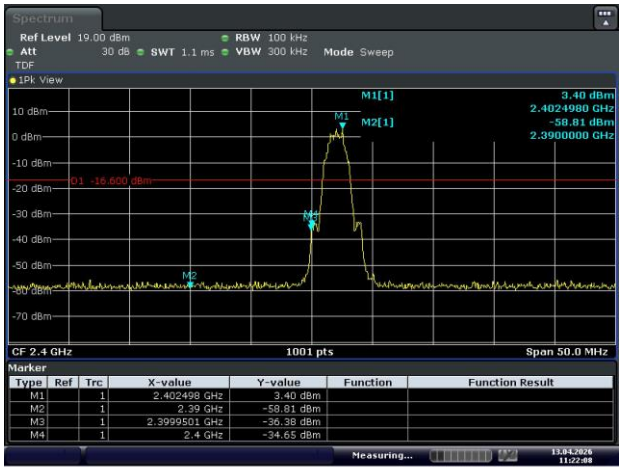


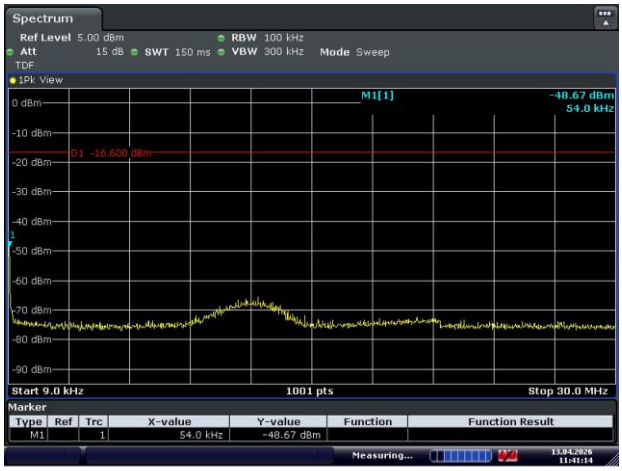


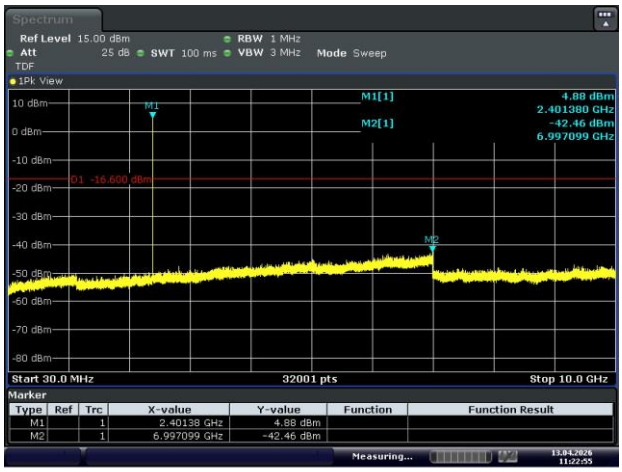


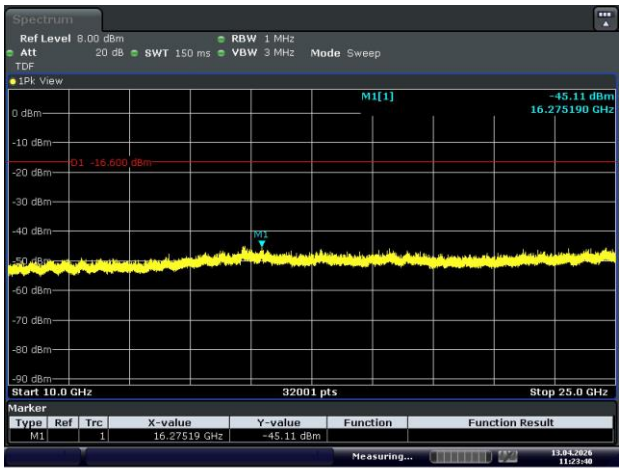
Test mode : PHY 2M

Low Channel

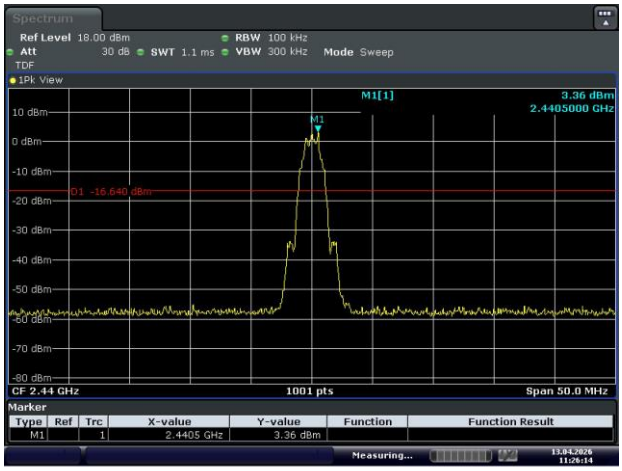


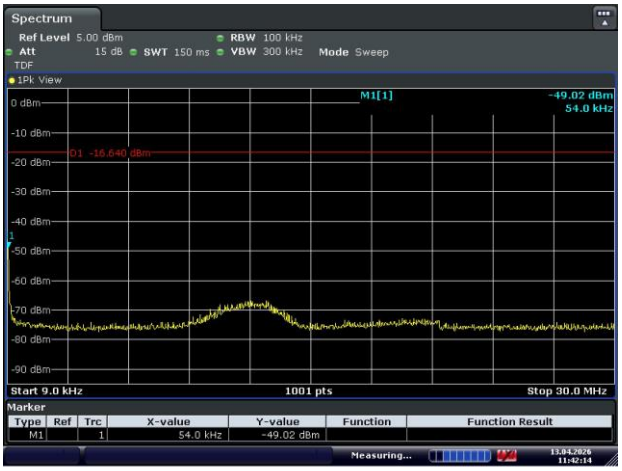


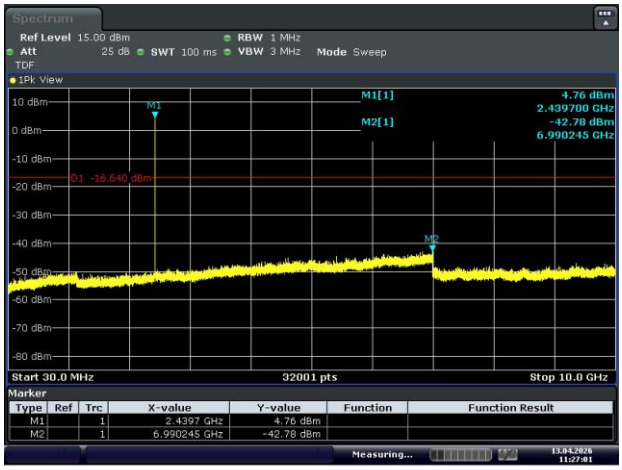


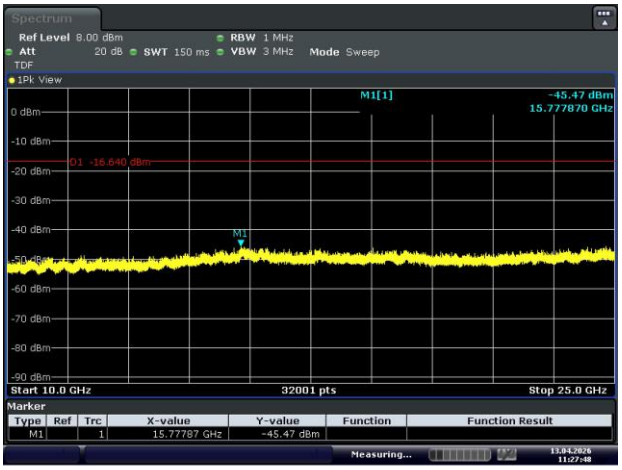


Middle Channel

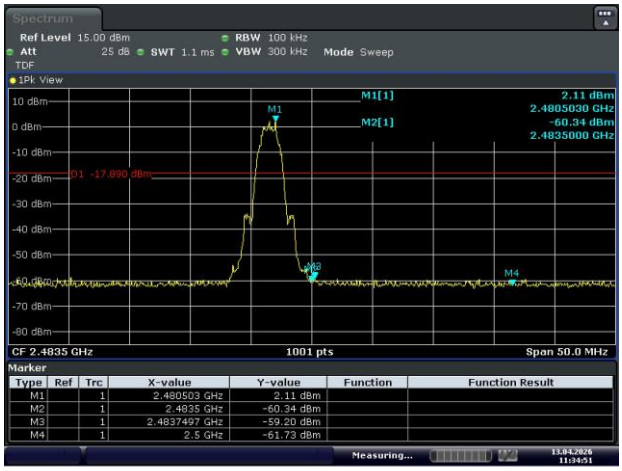


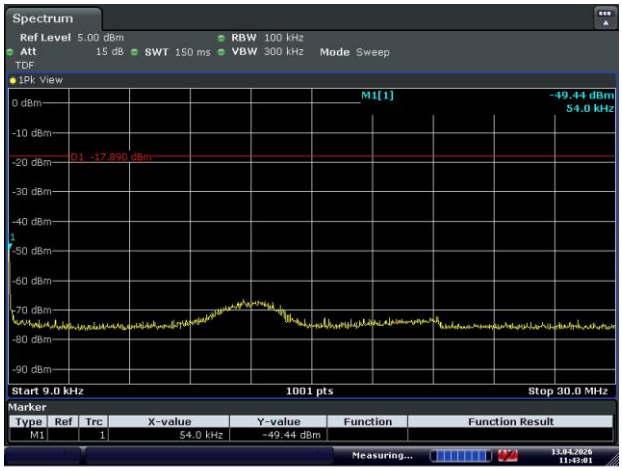


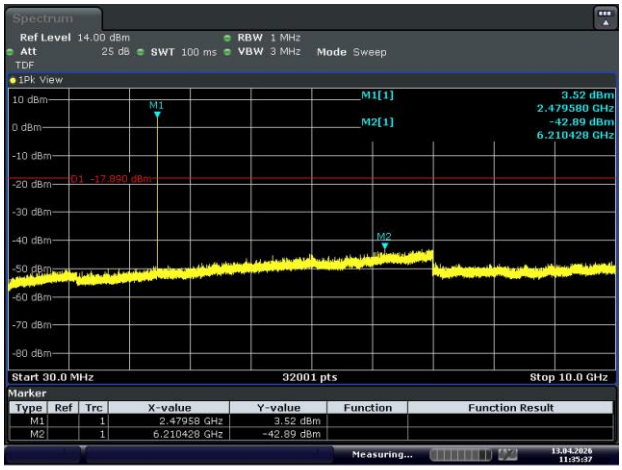


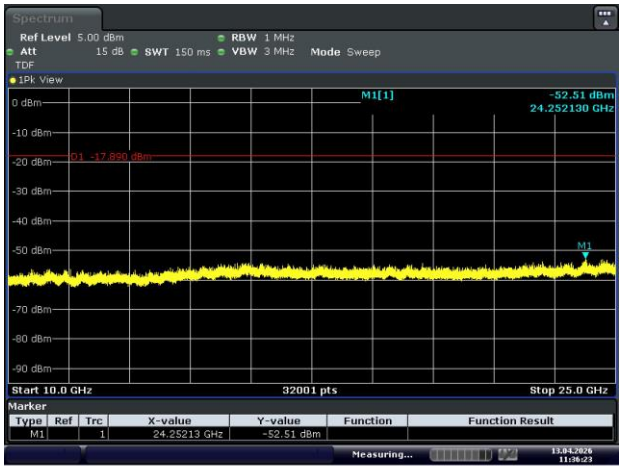


High Channel









3. 6 dB Bandwidth and 99% Bandwidth

3.1. Test Setup

3.2. Limit

3.2.1. FCC

According to §15.247(a)(2), systems using digital modulation techniques may operate in the 902-928 ㎒, 2 400-2 483.5 ㎒, and 5 725-5 850 ㎒ bands. The minimum 6 dB bandwidth shall be at least 500 ㎑.

3.2.2. IC

According to RSS-247 Issue 4, 6.3.1(a), the minimum 6 dB bandwidth shall be 500 ㎑.

3.3. Test Procedure

The test follows section 11.8 DTS bandwidth of ANSI C63.10-2020 (for FCC) and ANSI C63.10-2020 + Cor.1-2023 + C63.10a-2024 + Errata to C63.10a-2024 (for ISED).

3.3.1. 6 dB Bandwidth

Tests performed using section 11.8.1 Option 1.

- Option 1:
1. Set RBW to = shall be in the range of 1% to 5% of the OBW but not less than 100 ㎑.
2. Set the VBW ≥ [3 x RBW].
3. Detector = peak.
4. Trace mode = max hold.
5. Sweep = No faster than coupled (auto) time.
6. Allow the trace to stabilize.
7. Measure the maximum width of the emission by placing two markers, one at the lowest frequency and the other at the highest frequency of the envelope of the spectral display, such that each marker is at or slightly below the "−6 dB down amplitude". If a marker is below this "−6 dB down amplitude" value, then it shall be as close as possible to this value.

3.3.2. 99 % Bandwidth

The test follows section 6.9.3 of ANSI C63.10-2020 (for FCC) and ANSI C63.10-2020 + Cor.1-2023 + C63.10a-2024 + Errata to C63.10a-2024 (for ISED).

The occupied bandwidth is the frequency bandwidth such that, below its lower and above its upper frequency limits, the mean powers are each equal to 0.5% of the total mean power of the given emission. The following procedure shall be used for measuring 99% power bandwidth:

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 (3 dB RBW) shall be in the range of 1% to 5% of the OBW, and VBW shall be at least three times the RBW, unless otherwise specified by the applicable requirement.

1) When measuring OBW for UWB, the VBW shall be set to three times the RBW or the maximum available VBW of the measuring instrument.

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 (OBW/RBW)] below the reference level. Specific guidance is given in 4.1.6.2.

d) Step a) through step c) might require iteration to adjust within the specified range.

e) Video averaging is not permitted. Where practical, a sample detection and single sweep mode shall be used. Otherwise, peak detection and max-hold mode (until the trace stabilizes) shall be used.

f) Use the 99% power bandwidth function of the instrument (if available) and report the measured bandwidth.

g) If the instrument does not have a 99% power bandwidth function, then the trace data points are recovered and directly summed in linear power 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; that frequency is recorded as the lower frequency. The process is repeated until 99.5% of the total is reached; that frequency is recorded as the upper frequency. The 99% power bandwidth is the difference between these two frequencies.

h) The occupied bandwidth shall be reported by providing spectral plot(s) of the measuring instrument display; the plot axes and the scale units per division shall be clearly labeled. Tabular data may be reported in addition to the plot(s).

3.4. Test Results

Ambient temperature : (23 ± 1) ℃
Relative humidity : 47 %

- 6 dB Bandwidth

Ant. 0

Mode	Channel	Frequency (㎒)	6 dB Bandwidth (㎒)	Minimum Bandwidth (㎑)
PHY 1M	Low	2 402	0.729	500
	Middle	2 440	0.719	
	High	2 480	0.719	
PHY 2M	Low	2 402	1.299	
	Middle	2 440	1.299	
	High	2 480	1.309	

Ant. 1

Mode	Channel	Frequency (㎒)	6 dB Bandwidth (㎒)	Minimum Bandwidth (㎑)
PHY 1M	Low	2 402	0.719	500
	Middle	2 440	0.729	
	High	2 480	0.729	
PHY 2M	Low	2 402	1.299	
	Middle	2 440	1.309	
	High	2 480	1.319	

- 99 % Bandwidth

Ant. 0

Mode	Channel	Frequency (㎒)	99 % Bandwidth (㎒)	Minimum Bandwidth (㎑)
PHY 1M	Low	2 402	1.039	-
	Middle	2 440	1.039	
	High	2 480	1.044	
PHY 2M	Low	2 402	2.028	
	Middle	2 440	2.028	
	High	2 480	2.028	

Ant. 1

Mode	Channel	Frequency (㎒)	99 % Bandwidth (㎒)	Minimum Bandwidth (㎑)
PHY 1M	Low	2 402	1.039	-
	Middle	2 440	1.039	
	High	2 480	1.044	
PHY 2M	Low	2 402	2.023	
	Middle	2 440	2.023	
	High	2 480	2.028	

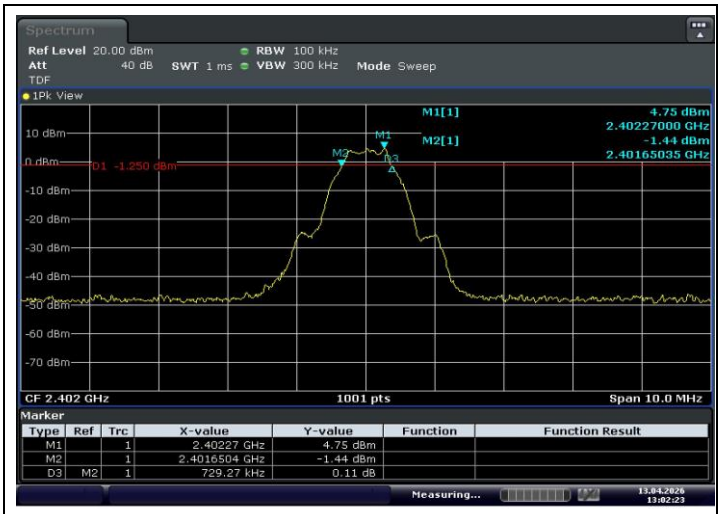
- Test plots

- 6 dB Bandwidth

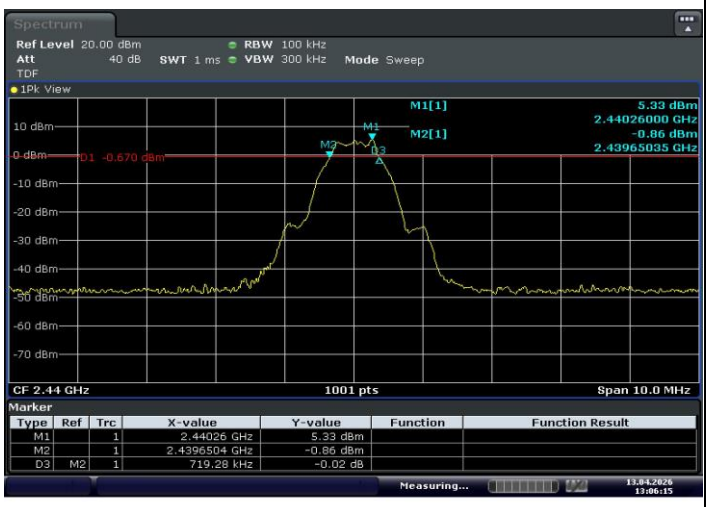
Ant. 0

Test mode: PHY 1M

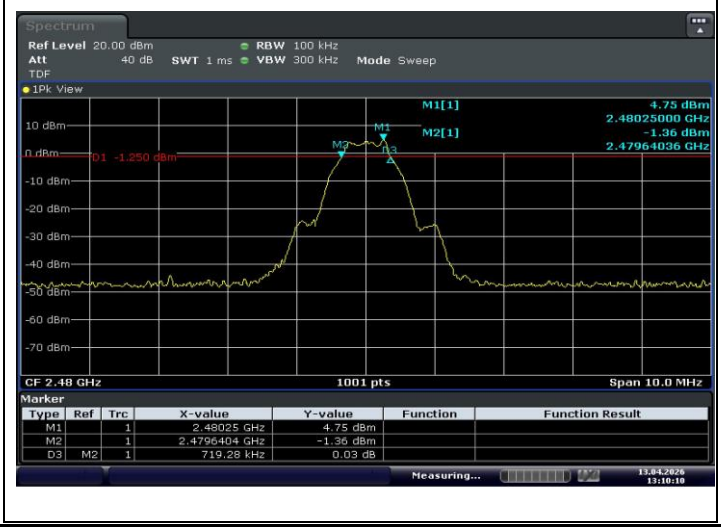
Low Channel



Middle Channel



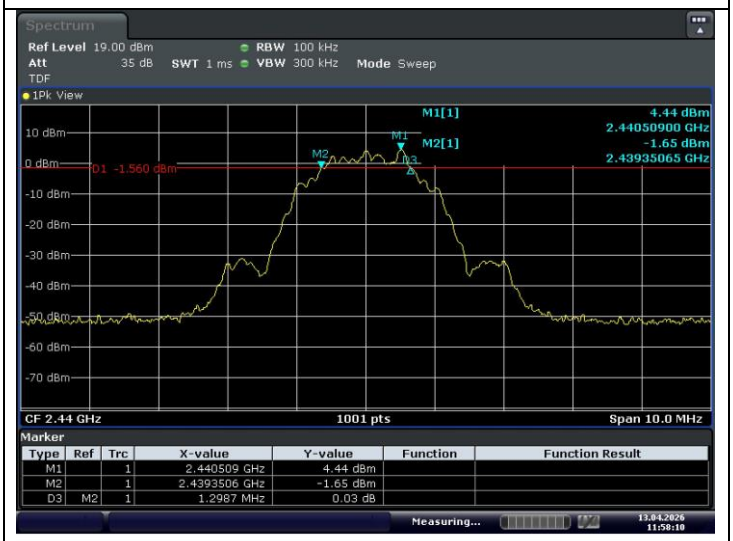
High Channel



Test mode: PHY 2M

Low Channel

Middle Channel

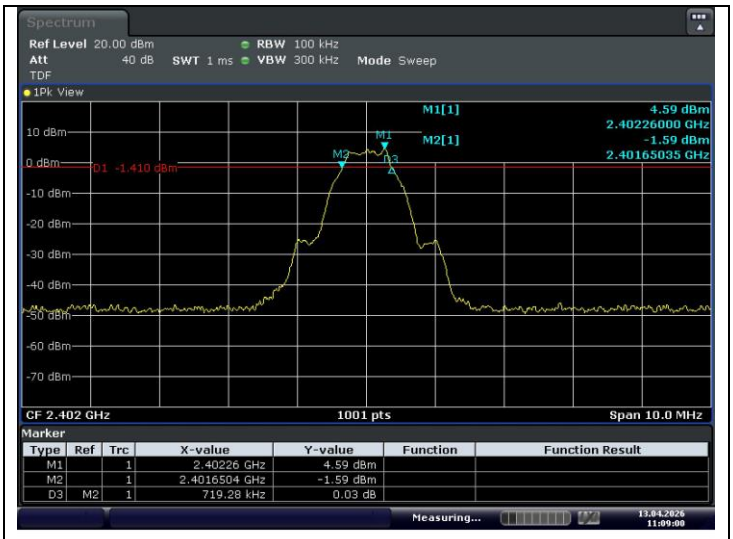


High Channel

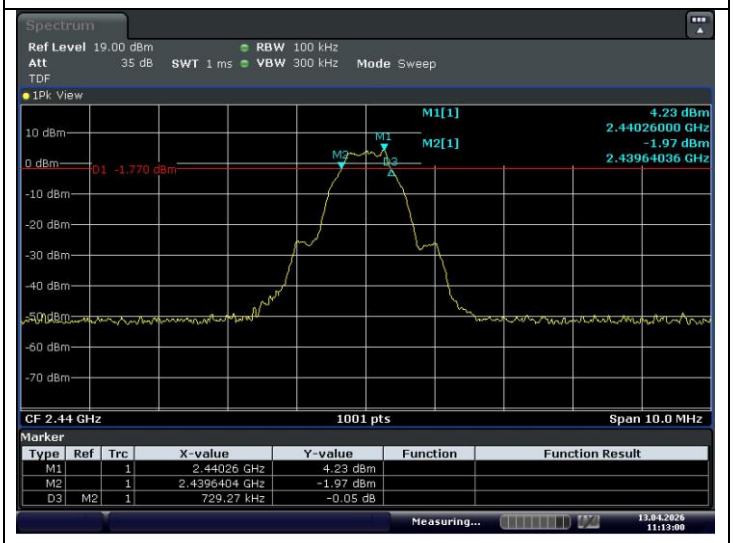
Ant. 1

Test mode: PHY 1M

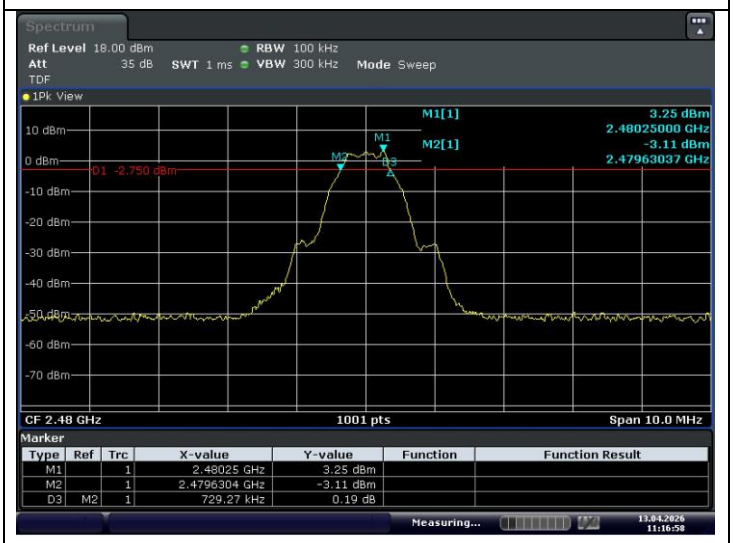
Low Channel



Middle Channel

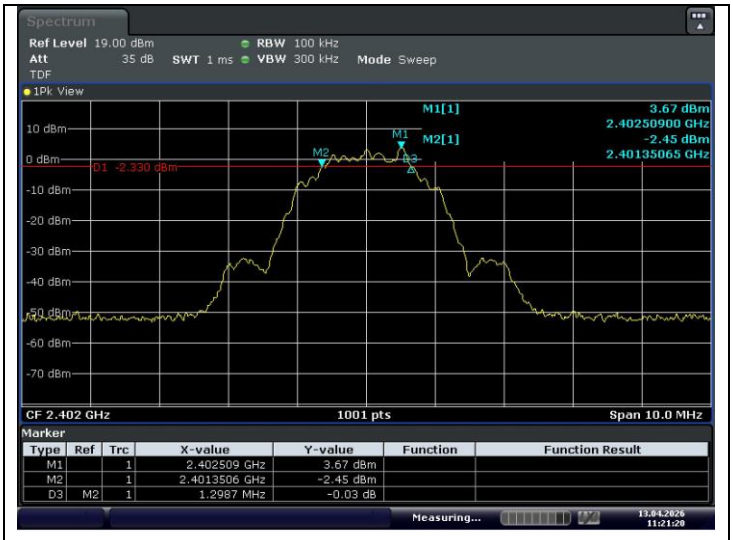


High Channel

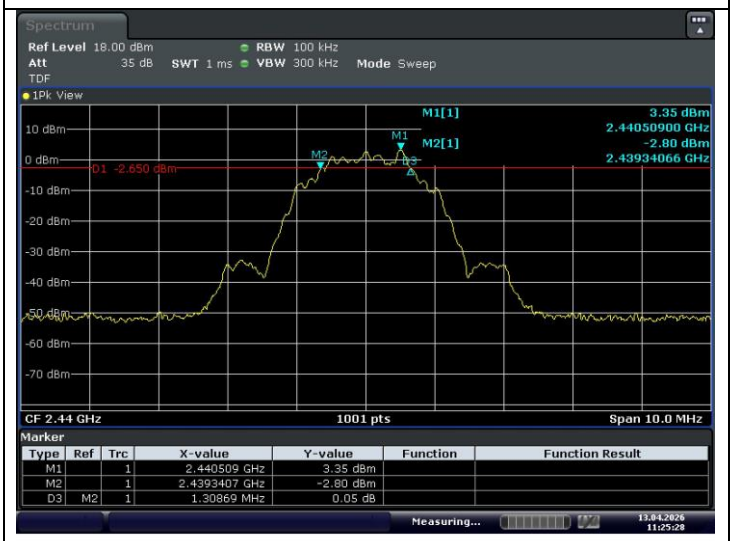


Test mode: PHY 2M

Low Channel



Middle Channel



High Channel

- 99 % Bandwidth

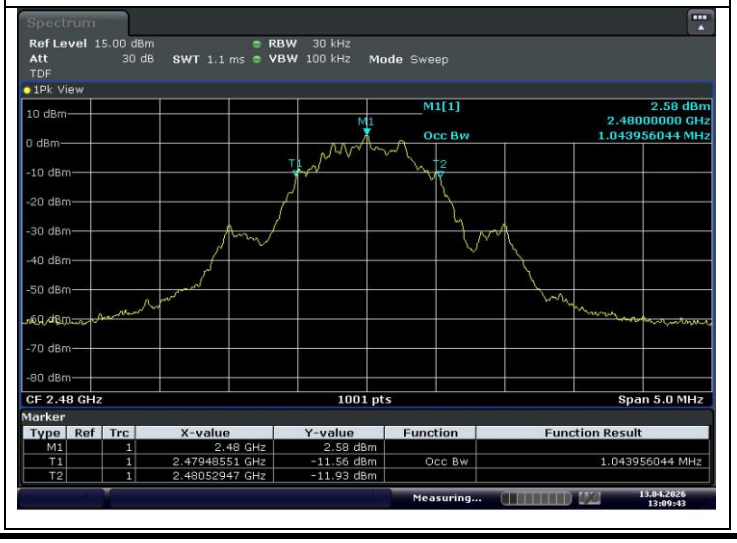
Ant. 0

Test mode: PHY 1M

Low Channel

Middle Channel

High Channel



Test mode : PHY 2M

Low Channel

Middle Channel

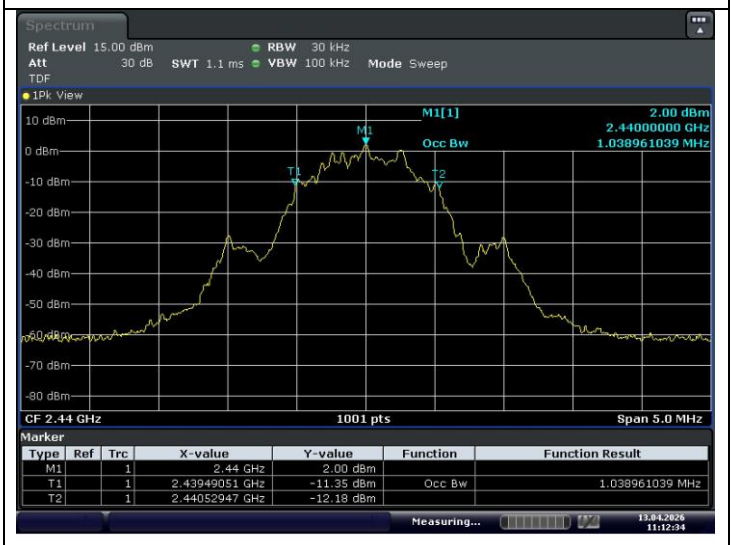
High Channel

Ant. 1

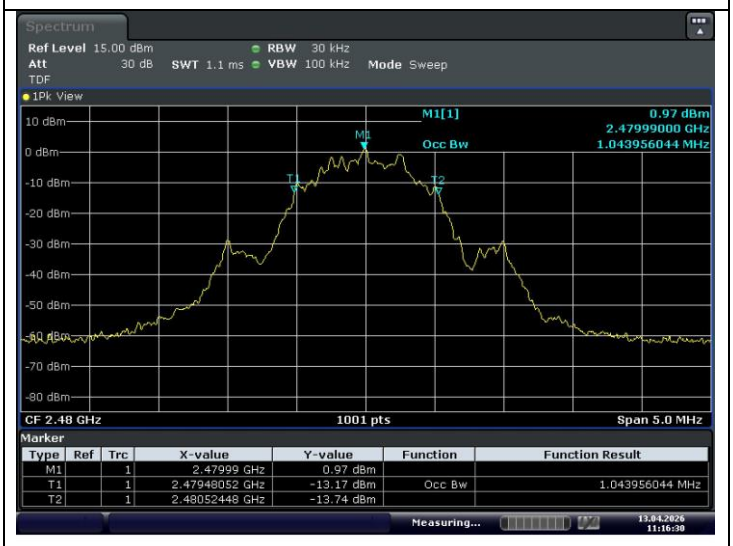
Test mode: PHY 1M

Low Channel

Middle Channel



High Channel



Test mode : PHY 2M

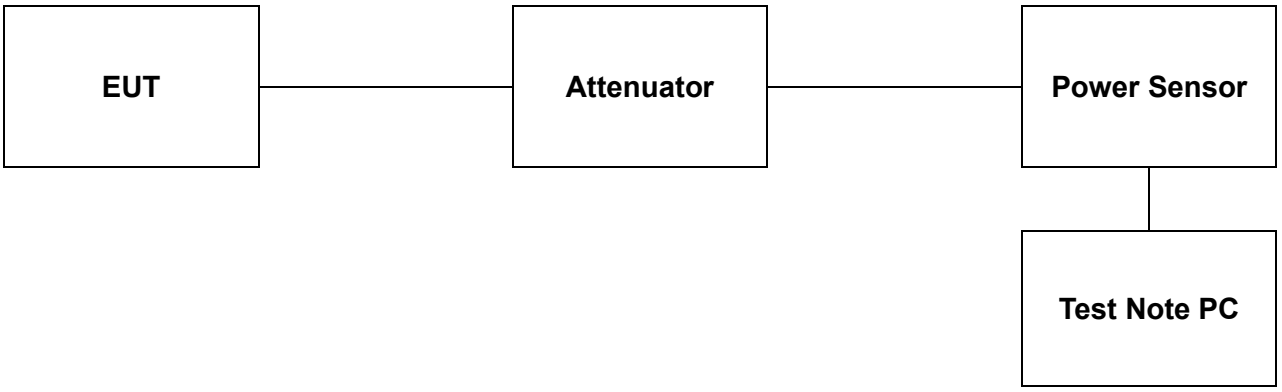
Low Channel

Middle Channel

High Channel

4. Maximum Peak Conducted Output Power

4.1. Test Setup



4.2. Limit

4.2.1. FCC

According to §15.247(b)(3), for systems using digital modulation in the 902-928 ㎒, 2 400-2 483.5 ㎒, and 5 725-5 850 ㎒ bands: 1 Watt. 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.

According to §15.247(b)(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 ㏈i. Except as shown in paragraph (c) of this section, if transmitting antennas of directional gain greater than 6 ㏈i are used, the conducted output power from the intentional radiator shall be reduced below the stated values in paragraph (b)(1), (b)(2), and (b)(3) of this section, as appropriate, by the amount in ㏈ that the directional gain of the antenna exceeds 6㏈i.

4.2.2. IC

According to RSS-247 Issue 4, 6.3.2, For DTS operating in the band 902-928 ㎒, the maximum peak conducted output power shall not exceed 1W, and the e.i.r.p. shall not exceed 4 W.

For DTS operating in the band 2 400-2 483.5 ㎒, the maximum peak conducted output power shall not exceed 1W, and the e.i.r.p. shall not exceed 4 W, except as provided in section 6.5 a) and b).

As an alternative to a peak power measurement, compliance can be based on a measurement of the maximum conducted output power.

4.3. Test Procedure

The test follows section 11.9.1.2 of ANSI C63.10-2020 (for FCC) and ANSI C63.10-2020 + Cor.1-2023 + C63.10a-2024 + Errata to C63.10a-2024 (for ISED).

PKPM1 Peak-reading power meter method
- The maximum peak conducted output power may be measured using a broadband peak RF power meter. The power meter shall have a video bandwidth that is greater than or equal to the DTS bandwidth and shall utilize a fast-responding diode detector.

Method AVGPM-G (Measurement using a gated RF average-reading power meter)
- Alternatively, measurements may be performed using a wideband gated RF power meter provided that the gate parameters are adjusted such that the power is measured only when the EUT is transmitting at its maximum power control level. Since this measurement is made only during the ON time of the transmitter, no duty cycle correction is required.

Gate triggering can be implemented in such a way that the sweep of the instrument is only active during the burst period of the device. Any Gate triggering shall be performed on the full power portion of the pulses and care must be taken to ensure that static portions of the pulse are not included in the measurement (ensuring that the trace is averaged over the entire symbol range). All Gate triggered measurements shall be accompanied by a Gate setup plot in the test report.

Test program: (S/W name: R&S Power Viewer, Version: 3.2.0)

1. Initially overall offset for attenuator and cable loss is measured per frequency.
2. Measured offset is inserted in test program in advance of measurement for output power.
3. Power for each frequency (channel) of device is investigated as final result.
4. Final result reported on this section from R&S power viewer program includes with several factors and test program shows only final result.

4.4. Test Results

Ambient temperature : (23 ± 1) ℃
Relative humidity : 47 %

Ant. 0

Mode	Channel	Frequency (㎒)	Average Power Result (dB m)	Peak Power Result (dB m)	Limit (dB m)
PHY 1M	Low	2 402	6.13	6.69	30.00
	Middle	2 440	**6.58**	**6.96**	
	High	2 480	5.96	6.52	
PHY 2M	Low	2 402	6.06	6.73	
	Middle	2 440	**6.62**	**7.20**	
	High	2 480	6.05	6.64	

Ant. 1

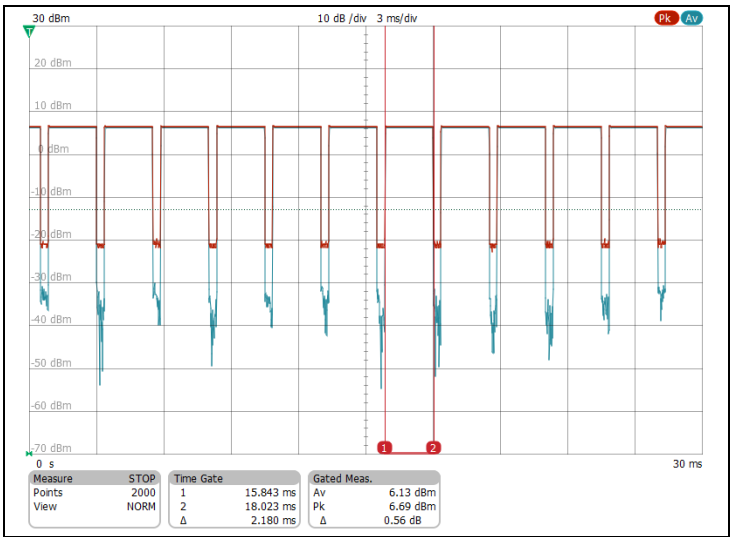
Mode	Channel	Frequency (㎒)	Average Power Result (dB m)	Peak Power Result (dB m)	Limit (dB m)
PHY 1M	Low	2 402	**5.79**	**6.22**	30.00
	Middle	2 440	5.35	5.87	
	High	2 480	4.37	4.74	
PHY 2M	Low	2 402	**5.72**	**6.56**	
	Middle	2 440	5.15	6.13	
	High	2 480	4.30	5.09	

- Test plots

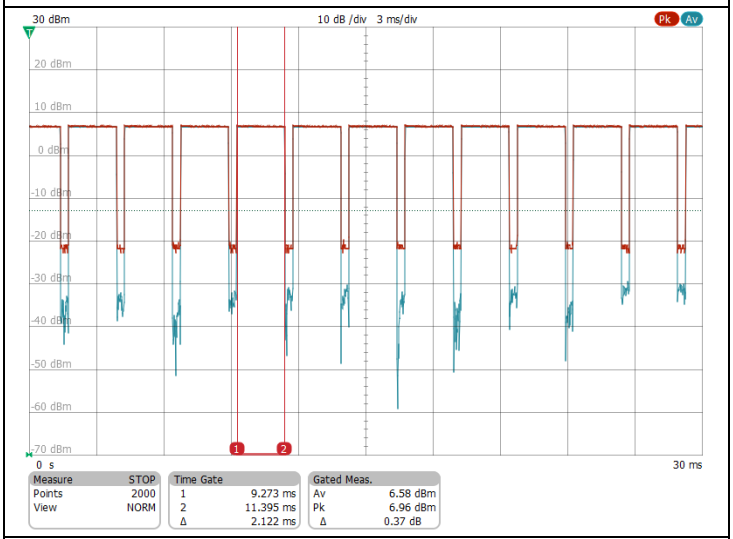
Ant. 0

Test mode : PHY 1M

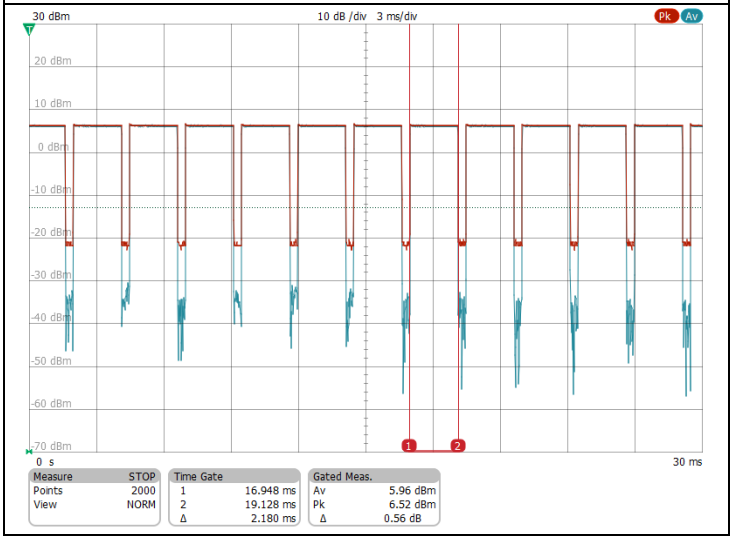
Low Channel



Middle Channel

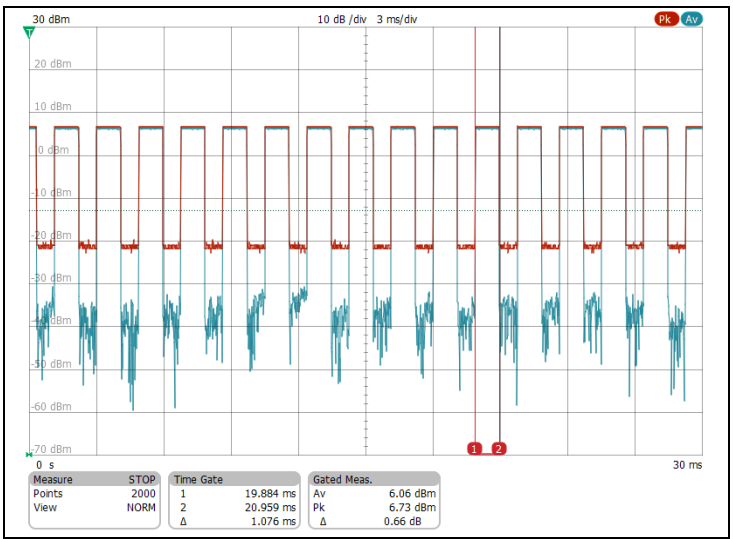


High Channel

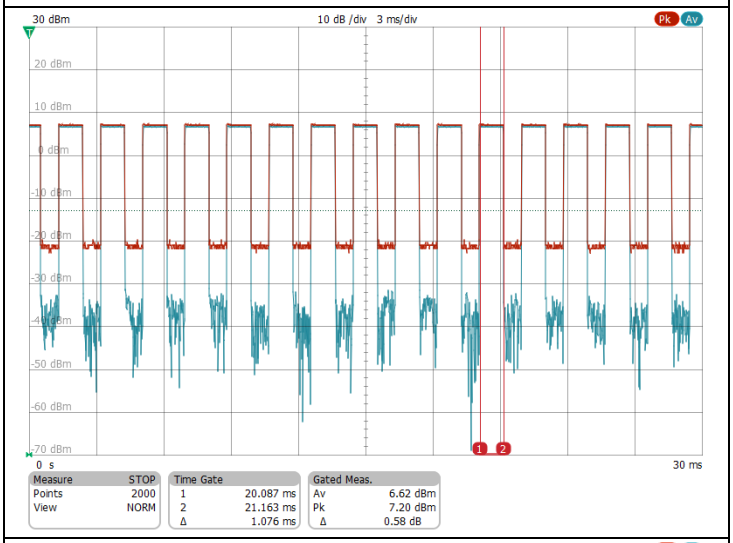


Test mode : PHY 2M

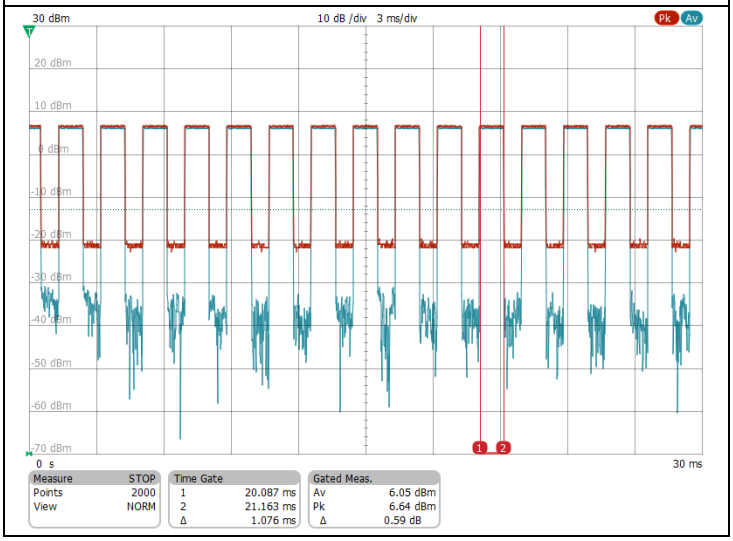
Low Channel



Middle Channel



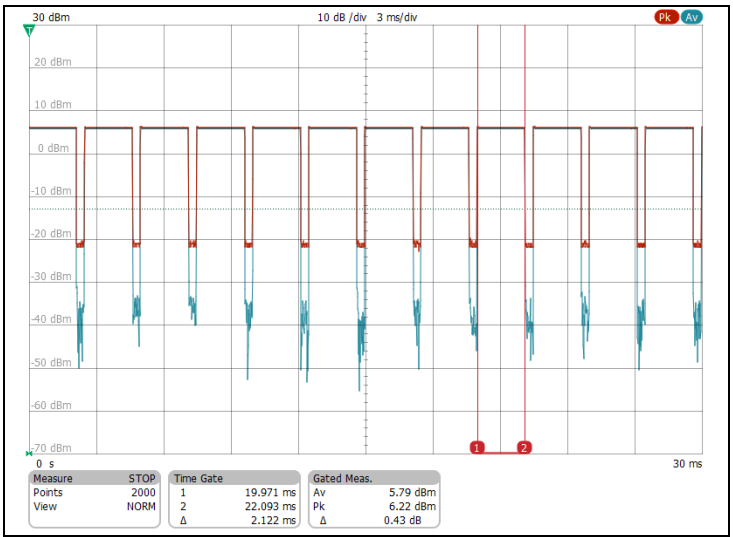
High Channel



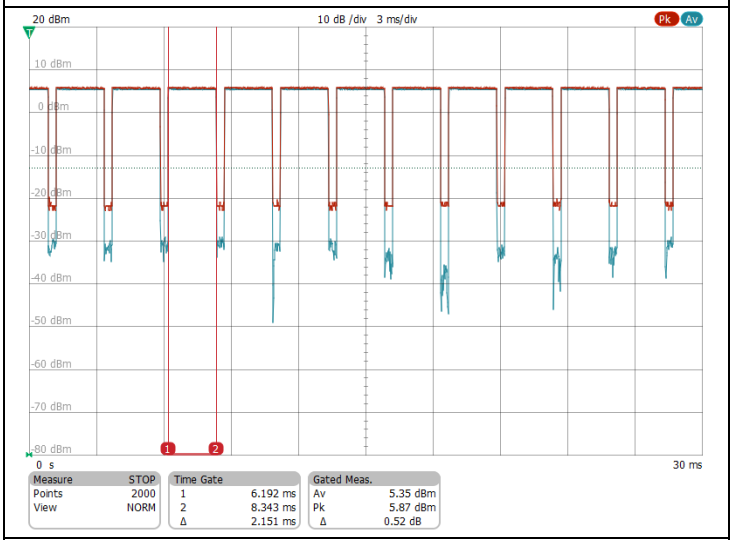
Ant. 1

Test mode : PHY 1M

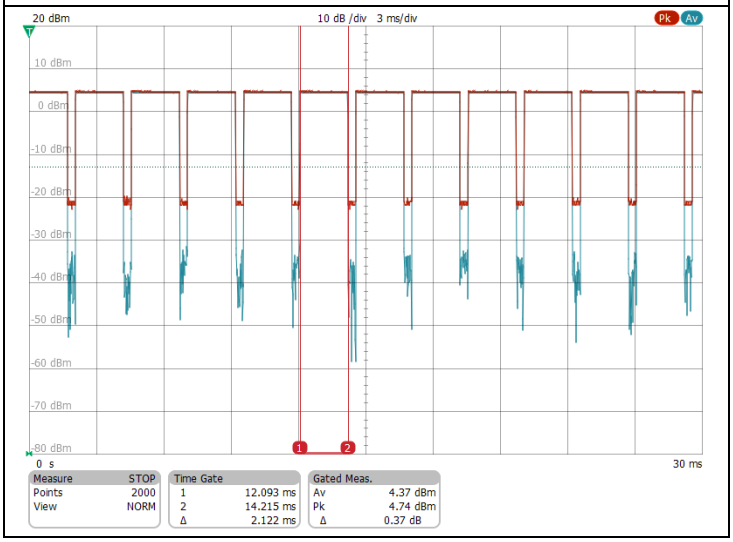
Low Channel



Middle Channel

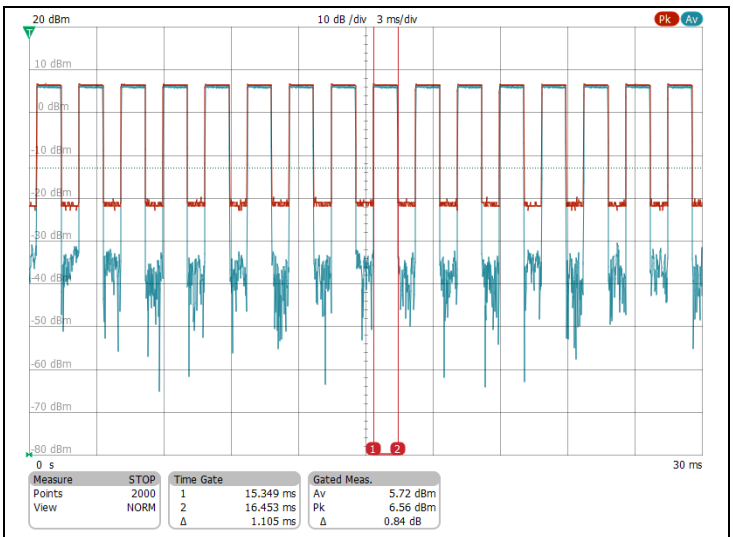


High Channel

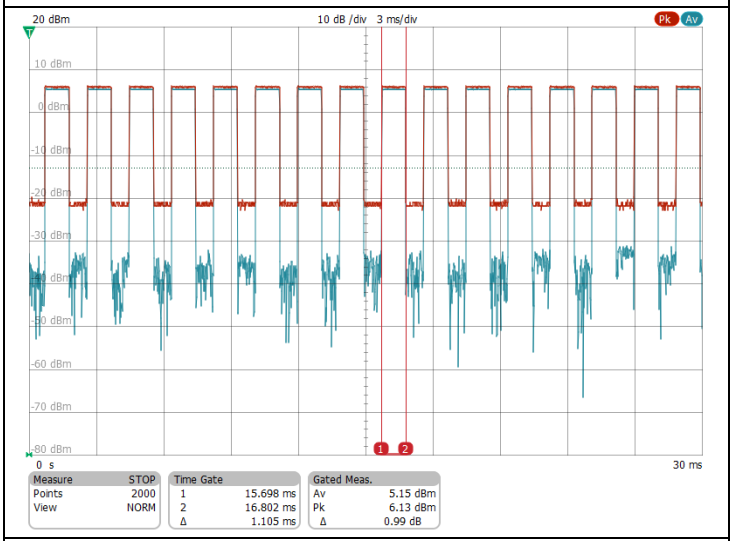


Test mode : PHY 2M

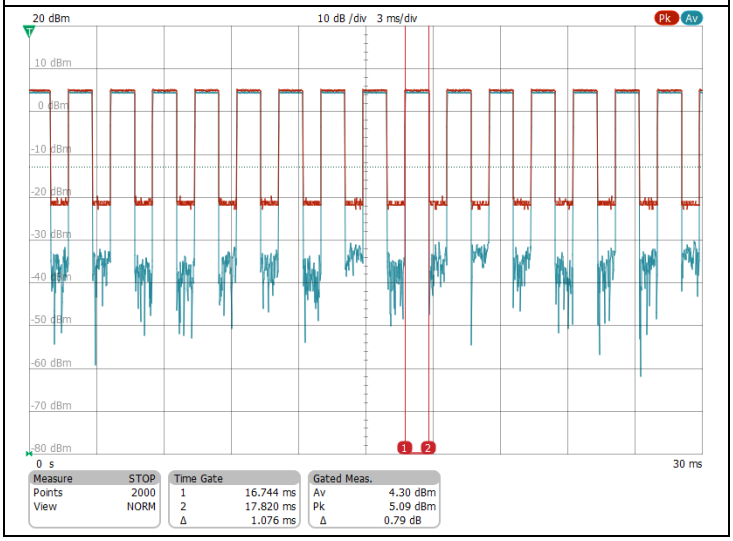
Low Channel



Middle Channel



High Channel



5. Power Spectral Density

5.1. Test Setup

5.2. Limit

5.2.1 FCC

According to §15.247(e), for digitally modulated systems, the power spectral density conducted from the intentional radiator to the antenna shall not be greater than 8 ㏈m in any 3 ㎑ 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.

5.2.2 IC

According to RSS-247 Issue 4, 6.3.1(b), the transmitter power spectral density conducted from the transmitter to the antenna(s) shall not be greater than 8 ㏈m/3 ㎑ band during any time interval of continuous transmission. This power spectral density shall be determined in accordance with the provisions of section 6.3.2 The power spectral density shall be determined using the same method as is used to determine the maximum conducted output power.

5.3. Test Procedure

The measurements are recorded using the PKPSD measurement procedure in section 11.10.2 of ANSI C63.10-2020 (for FCC) and ANSI C63.10-2020 + Cor.1-2023 + C63.10a-2024 + Errata to C63.10a-2024 (for ISED).

- This procedure shall be used if maximum peak conducted output power was used to demonstrate compliance, and is optional if the maximum conducted (average) output power was used to demonstrate compliance.

1. Set analyzer center frequency to DTS channel center frequency.
2. Set the span > 1.5 times the DTS bandwidth.
3. Set the RBW to 3 ㎑ ≤ RBW ≤ 100 ㎑.
4. Set the VBW ≥ [3 x RBW].
5. Detector = peak.
6. Sweep time = No faster than coupled (auto) time.
7. Trace mode = max hold.
8. Allow trace to fully stabilize.
9. Use the peak marker function to determine the maximum amplitude level within the RBW.
10. If measured value exceeds requirement, then reduce RBW (but no less than 3 ㎑) and repeat.

Note;
- For test plots, the reading values shown in plots were final results because all path loss of the cable and attenuator were investigated and compensated to spectrum analyzer as TDF function.

5.4. Test Results

Ambient temperature : (23 ± 1) ℃
Relative humidity : 47 %

Ant. 0

Mode	Channel	Frequency (㎒)	Measured PSD (dB m/3 ㎑)	Limit (dB m/3 ㎑)
PHY 1M	Low	2402	-10.86	8
	Middle	2440	-10.32	
	High	2480	-11.04	
PHY 2M	Low	2402	-14.72	
	Middle	2440	-14.21	
	High	2480	-14.88	

Ant. 1

Mode	Channel	Frequency (㎒)	Measured PSD (dB m/3 ㎑)	Limit (dB m/3 ㎑)
PHY 1M	Low	2402	-11.24	8
	Middle	2440	-11.55	
	High	2480	-12.68	
PHY 2M	Low	2402	-15.19	
	Middle	2440	-15.40	
	High	2480	-16.34	

- Test plots

Ant. 0

Test mode: PHY 1M

Low Channel

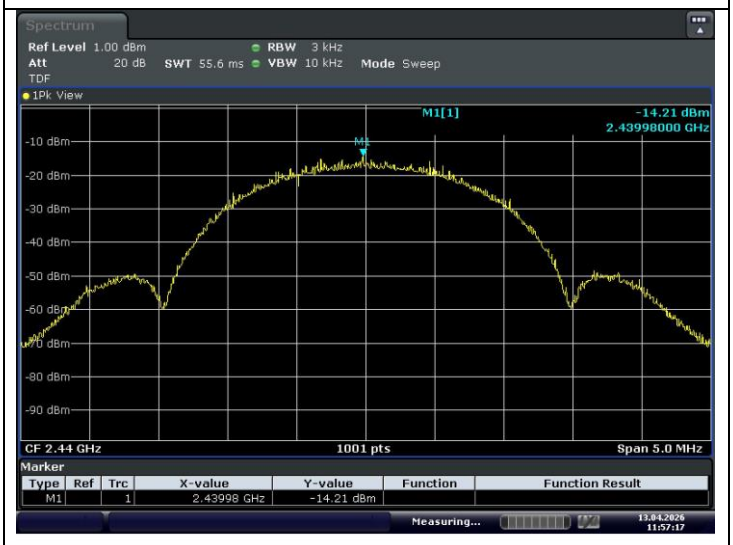
Middle Channel

High Channel

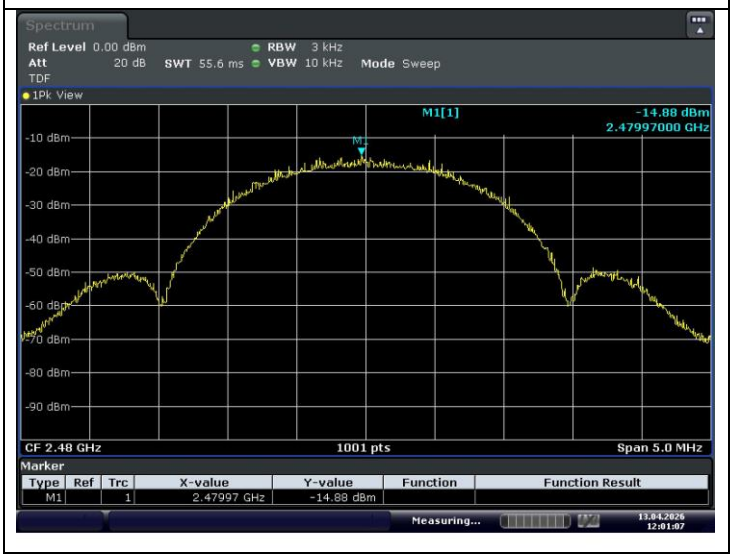
Test mode: PHY 2M

Low Channel

Middle Channel



High Channel



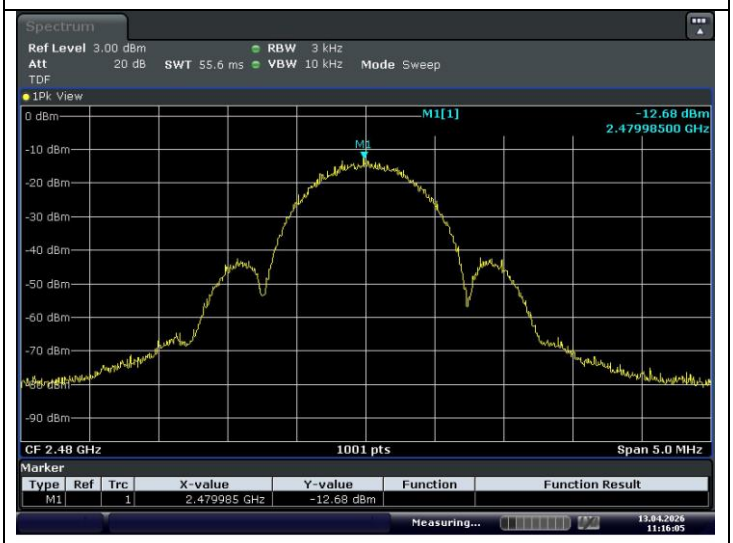
Ant. 1

Test mode: PHY 1M

Low Channel

Middle Channel

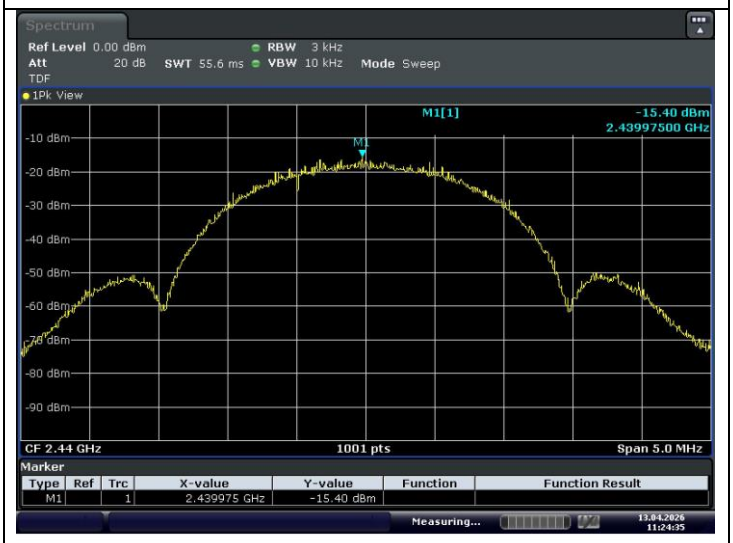
High Channel



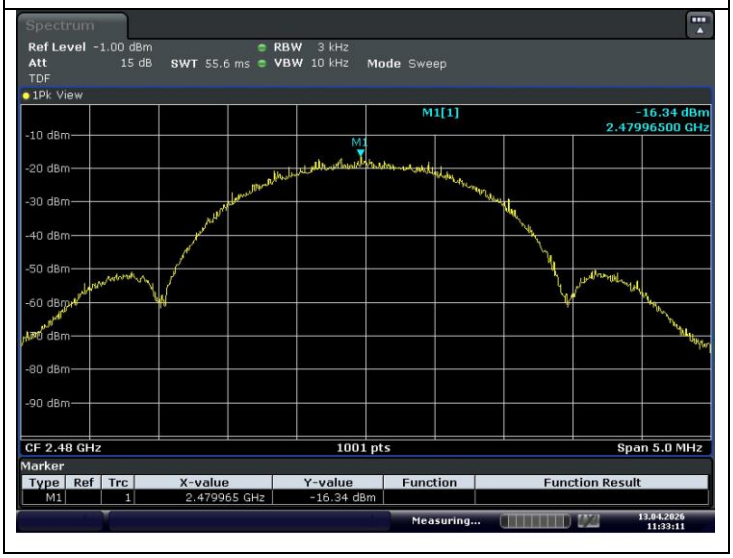
Test mode: PHY 2M

Low Channel

Middle Channel



High Channel



6. Antenna Requirement

6.1. Standard Applicable

For intentional device, according to FCC 47 CFR Section §15.203, an intentional radiator shall be designed to ensure that no antenna other than that furnished by the responsible party shall be used with the device. The use of a permanently attached antenna or of an antenna that uses a unique coupling to the intentional radiator shall be considered sufficient to comply with the provisions of this section. The manufacturer may design the unit so that a broken antenna can be replaced by the user, but the use of a standard antenna jack or electrical connector is prohibited. Further, this requirement does not apply to intentional radiators that must be professionally installed, such as perimeter protection systems and some field disturbance sensors, or to other intentional radiators which, in accordance with §15.31(d), must be measured at the installation site. However, the installer shall be responsible for ensuring that the proper antenna is employed so that the limits in this part are not exceeded. And according to FCC 47 CFR Section §15.247(b) if transmitting antennas of directional gain greater than 6 dBi are used, the conducted output power shall be reduced appropriate, by the amount in dB that the directional gain of the antenna exceeds 6 dBi.

6.2. Antenna Connected Construction

Antenna 0 used in this product is PCB Pattern Antenna with gain of 0.93 dBi
Antenna 1 used in this product is PCB Pattern Antenna with gain of 0.21 dBi

- End of the Test Report -