

8DPSK Ch 0

| Frequency (MHz) | Measurement Result (dB μ V/m) | Cable Loss (dB) | Antenna Factor (dB/m) | Receiver Reading (dB μ V/m) | Limit (dB μ V/m) | Margin (dB) | Antenna Pol. (H/V) |
|-----------------|-----------------------------------|-----------------|-----------------------|---------------------------------|----------------------|-------------|--------------------|
| 17958 | 51.23 | -29.4 | 46 | 34.63 | 74 | 22.77 | V |
| 4803.5 | 48.24 | -37.7 | 33 | 52.94 | 74 | 25.76 | H |
| 14076 | 47.75 | -30.2 | 41.7 | 36.25 | 74 | 26.25 | V |
| 12860 | 45.01 | -31.9 | 39.9 | 37.01 | 74 | 28.99 | H |
| 9724.5 | 42.93 | -34.5 | 37.8 | 39.63 | 74 | 31.07 | H |
| 2368.6 | 55.24 | -19.6 | 28.2 | 46.64 | 74 | 18.76 | H |

8DPSK Ch 39

| Frequency (MHz) | Measurement Result (dB μ V/m) | Cable Loss (dB) | Antenna Factor (dB/m) | Receiver Reading (dB μ V/m) | Limit (dB μ V/m) | Margin (dB) | Antenna Pol. (H/V) |
|-----------------|-----------------------------------|-----------------|-----------------------|---------------------------------|----------------------|-------------|--------------------|
| 17953 | 51.77 | -29.4 | 46 | 35.17 | 74 | 22.23 | V |
| 14696 | 47.68 | -30 | 41.5 | 36.18 | 74 | 26.32 | V |
| 4882 | 45.09 | -37.5 | 33.4 | 49.19 | 74 | 28.91 | H |
| 11744 | 44.74 | -32.9 | 39.2 | 38.44 | 74 | 29.26 | H |
| 8572.5 | 43.07 | -35 | 37.5 | 40.57 | 74 | 30.93 | V |
| 7387 | 41.97 | -35.1 | 36.6 | 40.47 | 74 | 32.03 | H |

8DPSK Ch 78

| Frequency (MHz) | Measurement Result (dB μ V/m) | Cable Loss (dB) | Antenna Factor (dB/m) | Receiver Reading (dB μ V/m) | Limit (dB μ V/m) | Margin (dB) | Antenna Pol. (H/V) |
|-----------------|-----------------------------------|-----------------|-----------------------|---------------------------------|----------------------|-------------|--------------------|
| 17921.5 | 50.92 | -29.4 | 46 | 34.32 | 74 | 23.08 | V |
| 14302 | 47.64 | -29.9 | 41.8 | 35.74 | 74 | 26.36 | V |
| 4960 | 45.34 | -37.4 | 33.6 | 49.14 | 74 | 28.66 | H |
| 12933.5 | 44.89 | -31.4 | 40 | 36.29 | 74 | 29.11 | H |
| 9639.5 | 43.14 | -34.3 | 37.6 | 39.84 | 74 | 30.86 | V |
| 2488.8 | 56.13 | -19.7 | 28.2 | 47.63 | 74 | 17.87 | H |

Conclusion: Pass

Note: the spurious emission above 18G is noise only and did not show on the report.

Band edge compliance

| Mode | Channel | Frequency Range | Test Results | Conclusion |
|------|---------|------------------|--------------|------------|
| GFSK | 0 | 2.31GHz ~2.43GHz | Fig.58 | P |
| | 78 | 2.45GHz ~2.5GHz | Fig.59 | P |

| Mode | Channel | Frequency Range | Test Results | Conclusion |
|---------------|---------|------------------|--------------|------------|
| $\pi/4$ DQPSK | 0 | 2.31GHz ~2.43GHz | Fig.60 | P |
| | 78 | 2.45GHz ~2.5GHz | Fig.61 | P |

| Mode | Channel | Frequency Range | Test Results | Conclusion |
|-------|---------|------------------|--------------|------------|
| 8DPSK | 0 | 2.31GHz ~2.43GHz | Fig.62 | P |
| | 78 | 2.45GHz ~2.5GHz | Fig.63 | P |

Conclusion: **PASS**

Test graphs as below

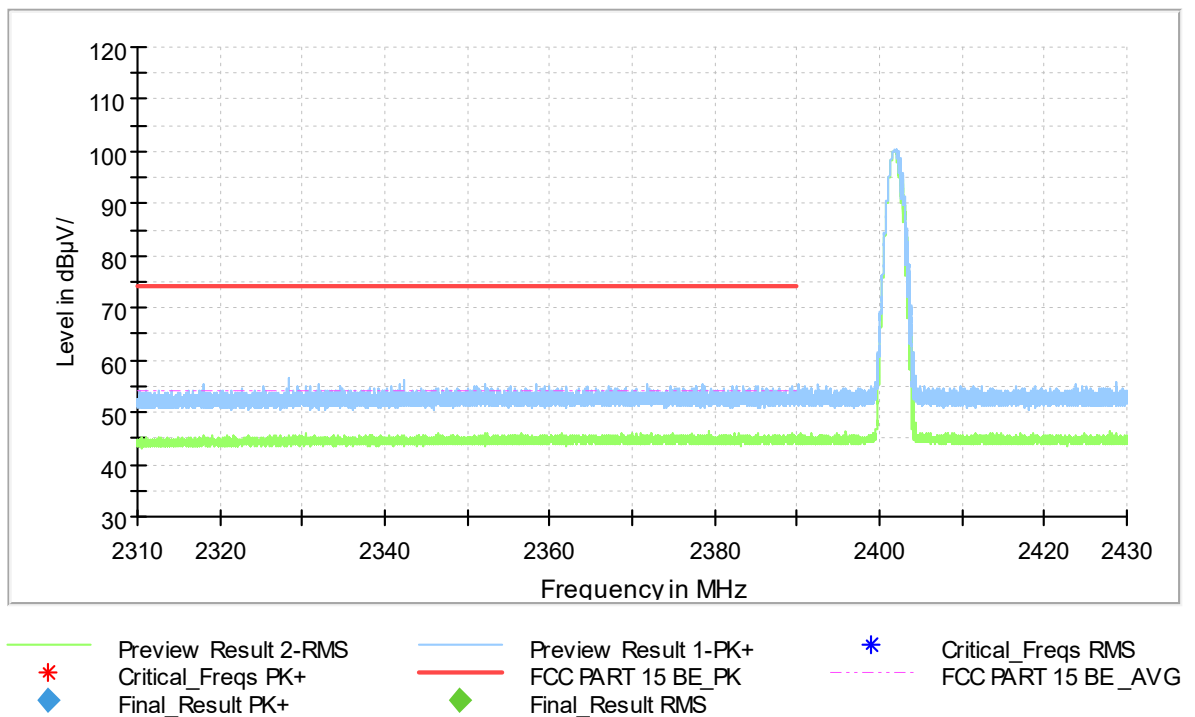


Fig.58. Frequency Band Edges: GFSK, Channel 0, Hopping Off, 2.31 GHz – 2.45GHz

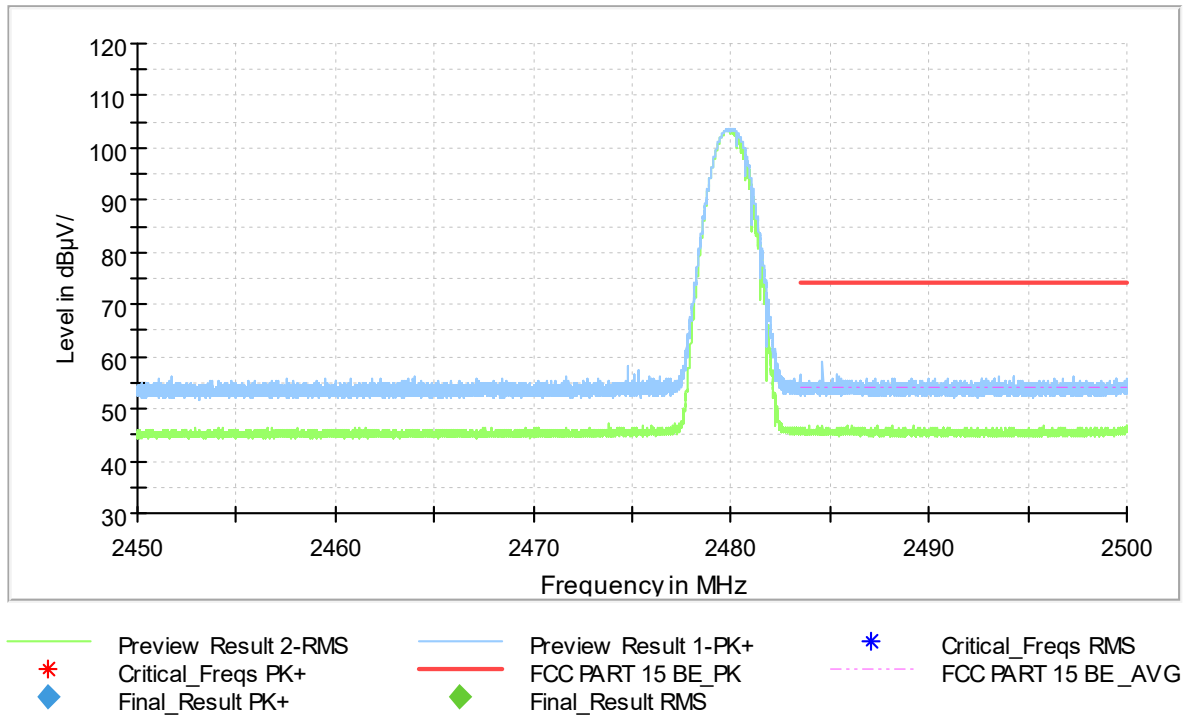


Fig.59. Frequency Band Edges: GFSK, Channel 78, Hopping Off, ch11, 2.45 GHz - 2.50GHz

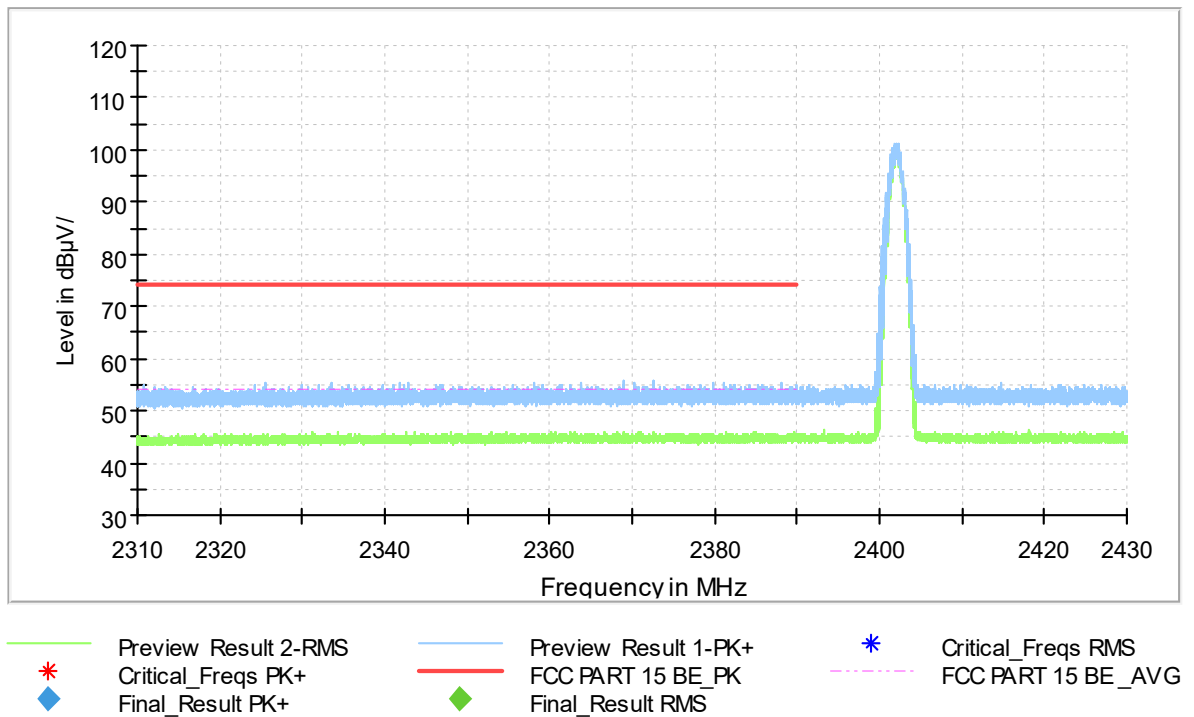


Fig.60. Frequency Band Edges: $\pi/4$ DQPSK, Channel 0, Hopping Off, 2.31 GHz - 2.45GHz

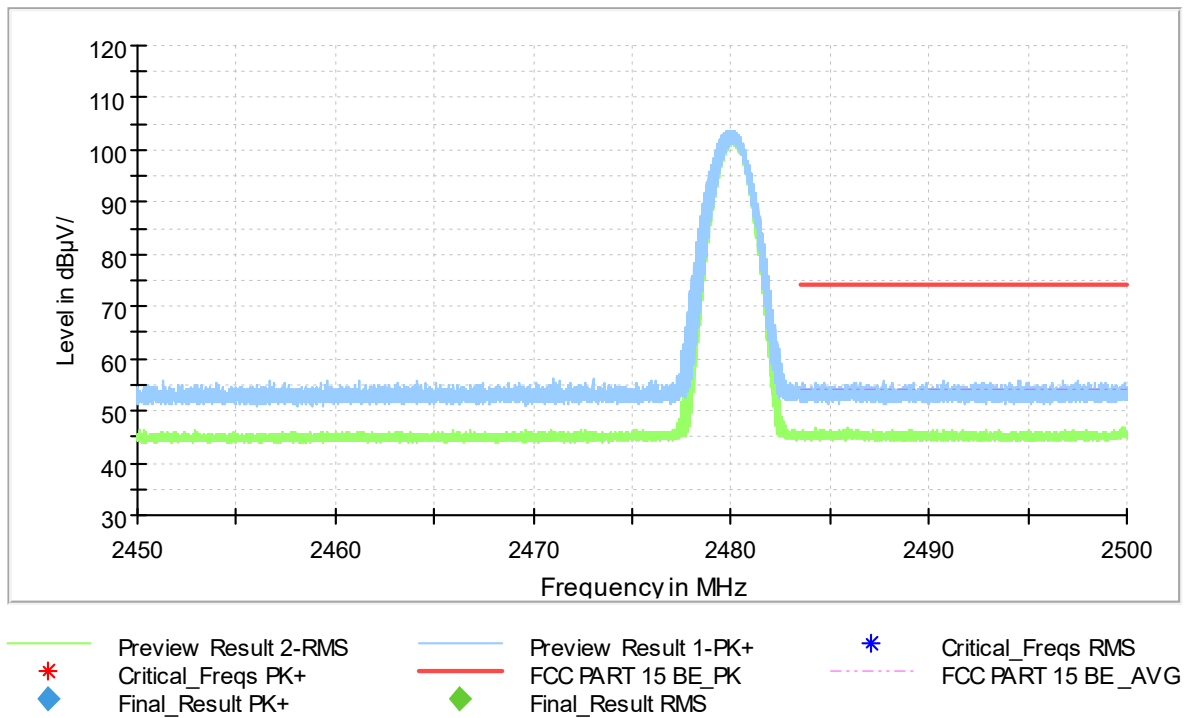


Fig.61. Frequency Band Edges: $\pi/4$ DQPSK, Channel 78, Hopping Off, 2.45 GHz - 2.50GHz

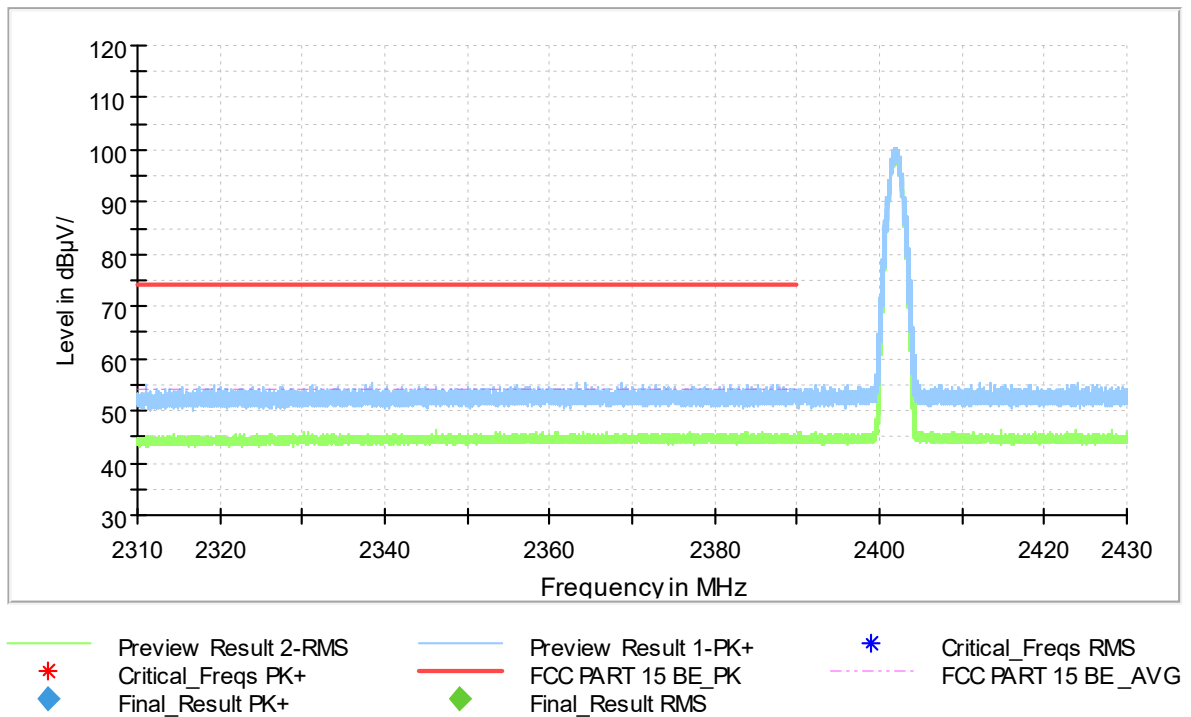


Fig.62. Frequency Band Edges: 8DPSK, Channel 0, 2.31 GHz - 2.45GHz

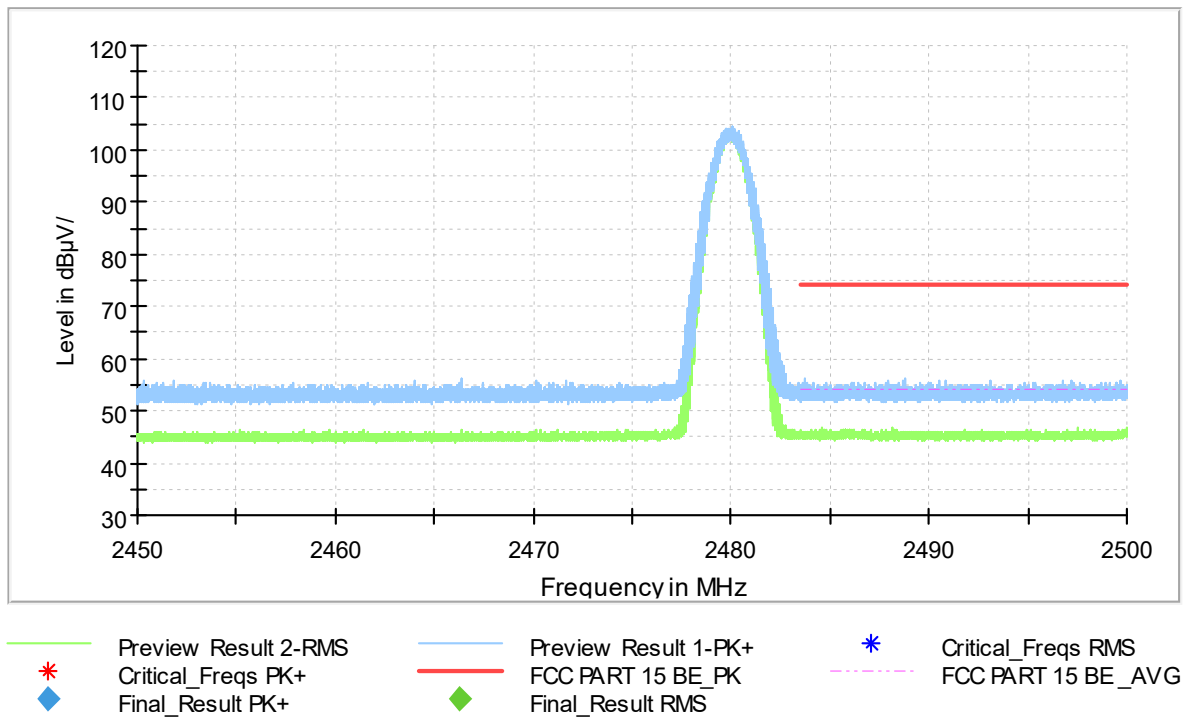


Fig.63. Frequency Band Edges: 8DPSK, Channel 78, 2.45 GHz - 2.50GHz

B.6. Time of Occupancy (Dwell Time)

Method of Measurement: See ANSI C63.10-clause 7.8.4

The EUT must have its hopping function enabled. Use the following spectrum analyzer settings:

- Span = zero span, centered on a hopping channel
- RBW = 1 MHz
- VBW \geq RBW
- Sweep = as necessary to capture the entire dwell time per hopping channel
- Detector function = peak
- Trace = max hold

Measure a pulse time in time domain at middle frequency and then count the hopping number in 31.6s(which equals with 0.4 multiply 79) of middle frequency ,then multiply the pulse time and hopping number and record them.

Measurement Limit:

| Standard | Limit (ms) |
|------------------------------------|------------|
| FCC 47 CFR Part 15.247(a) (1)(iii) | < 400 |

Measurement Result:

For GFSK

| Channel | Packet | Pulse time (ms) | | Number of Transmissions | | Dwell Time (ms) | Conclusion |
|---------|--------|-----------------|-------|-------------------------|-------|-----------------|------------|
| | | Fig. | Value | Fig. | Value | | |
| 39 | DH1 | Fig.64 | 0.37 | Fig.65 | 318 | 117.66 | P |
| | DH3 | Fig.66 | 1.63 | Fig.67 | 108 | 176.04 | P |
| | DH5 | Fig.68 | 2.88 | Fig.69 | 60 | 172.8 | P |

For $\pi/4$ DQPSK

| Channel | Packet | Pulse time (ms) | | Number of Transmissions | | Dwell Time (ms) | Conclusion |
|---------|--------|-----------------|-------|-------------------------|-------|-----------------|------------|
| | | Fig. | Value | Fig. | Value | | |
| 39 | 2DH1 | Fig.70 | 0.38 | Fig.71 | 319 | 121.22 | P |
| | 2DH3 | Fig.72 | 1.64 | Fig.73 | 93 | 152.52 | P |
| | 2DH5 | Fig.74 | 2.88 | Fig.75 | 58 | 167.04 | P |

For 8DPSK

| Channel | Packet | Pulse time (ms) | | Number of Transmissions | | Dwell Time (ms) | Conclusion |
|---------|--------|-----------------|------|-------------------------|-------|-----------------|------------|
| | | Fig. | ms | Fig. | Count | | |
| 39 | 3DH1 | Fig.76 | 0.38 | Fig.77 | 318 | 120.84 | P |
| | 3DH3 | Fig.78 | 1.63 | Fig.79 | 110 | 179.3 | P |
| | 3DH5 | Fig.80 | 2.88 | Fig.81 | 65 | 187.2 | P |

Conclusion: PASS

Test graphs as below:

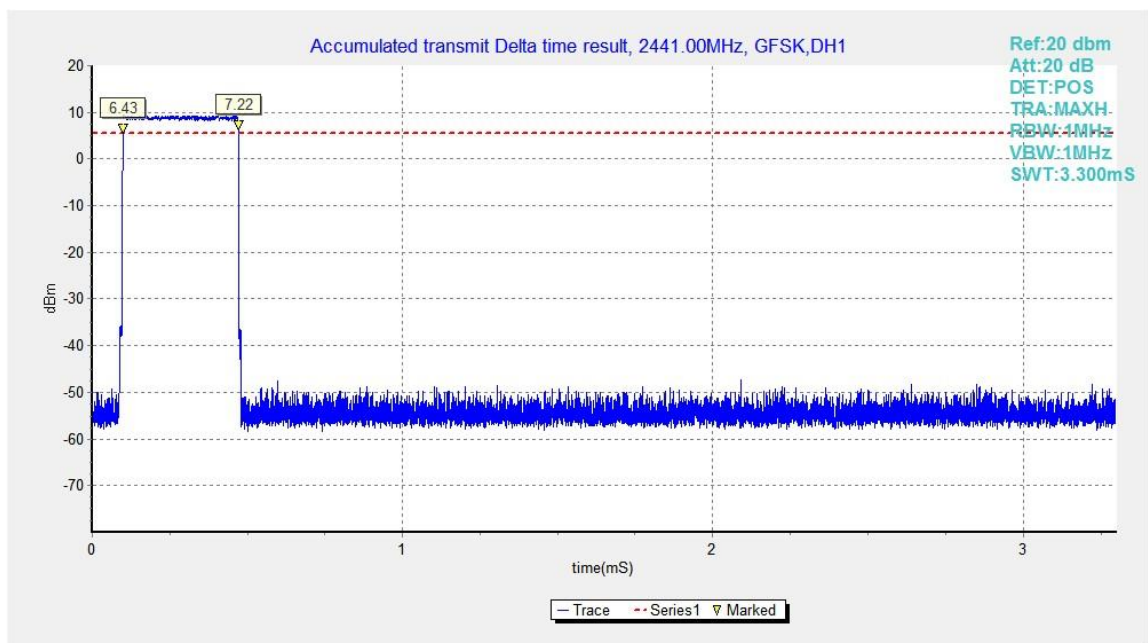


Fig.64. Time of occupancy (Dwell Time): Channel 39, Packet DH1

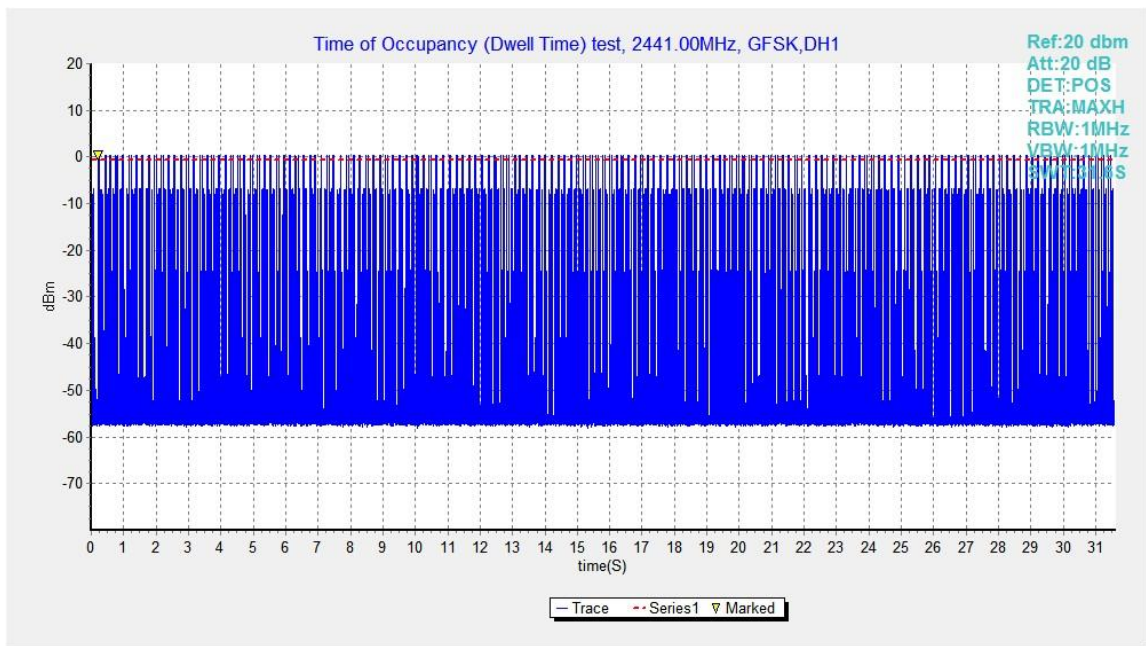


Fig.65. Number of Transmissions Measurement: Channel 39,Packet DH1

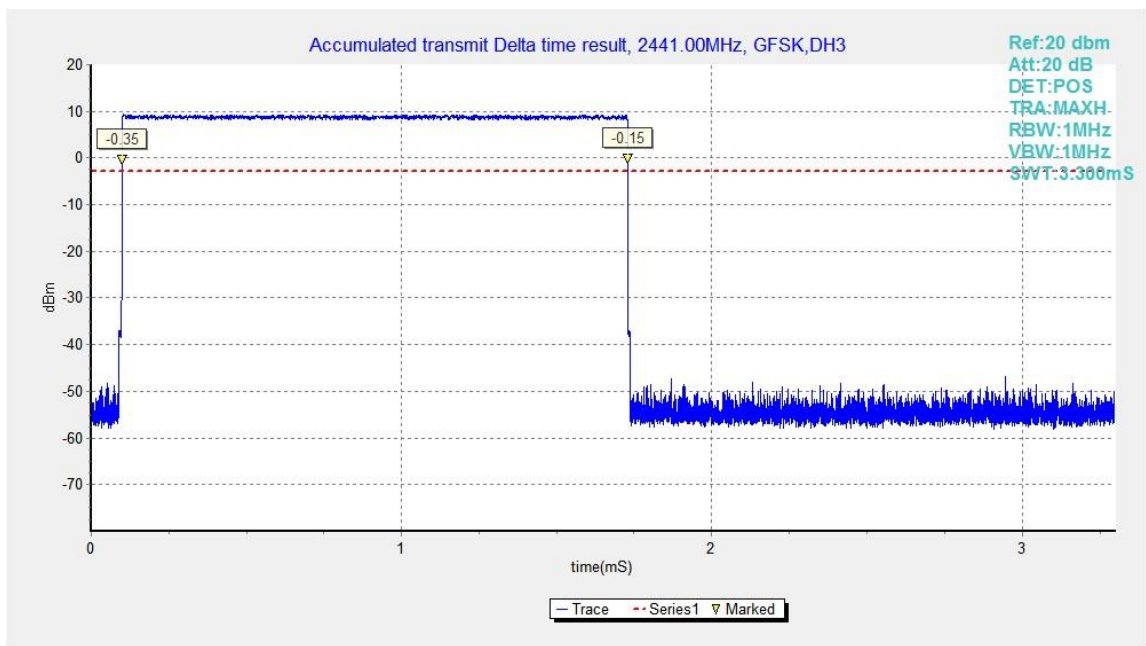


Fig.66. Time of occupancy (Dwell Time): Channel 39, Packet DH3

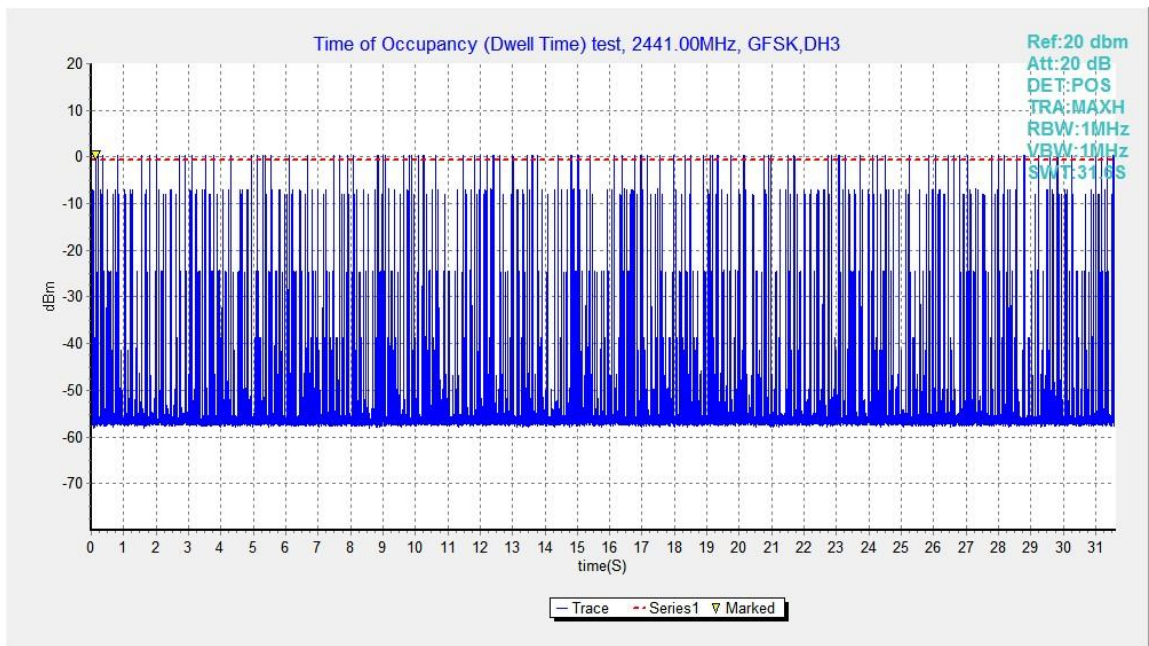


Fig.67. Number of Transmissions Measurement: Channel 39,Packet DH3

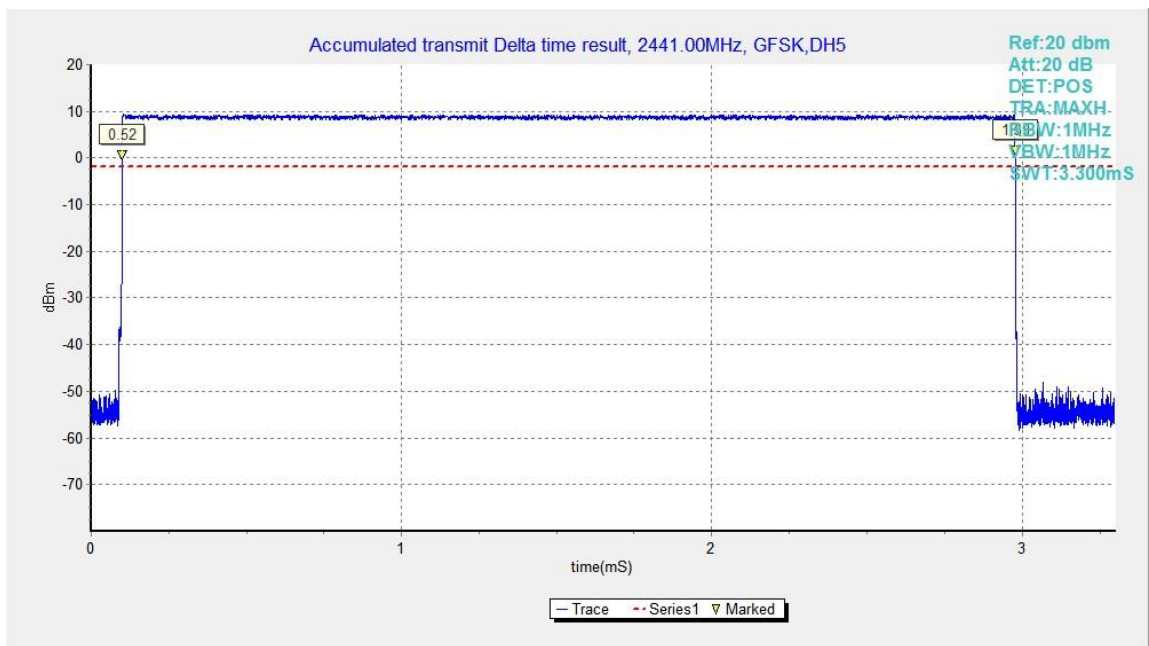


Fig.68. Time of occupancy (Dwell Time): Channel 39, Packet DH5

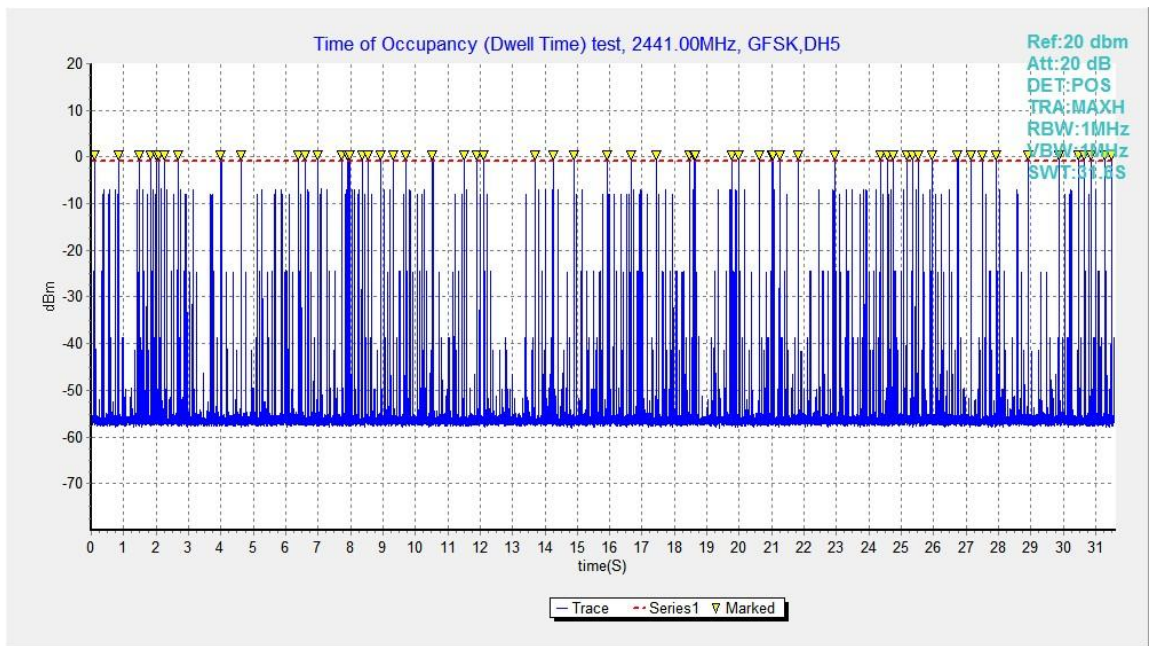


Fig.69. Number of Transmissions Measurement: Channel 39,Packet DH5

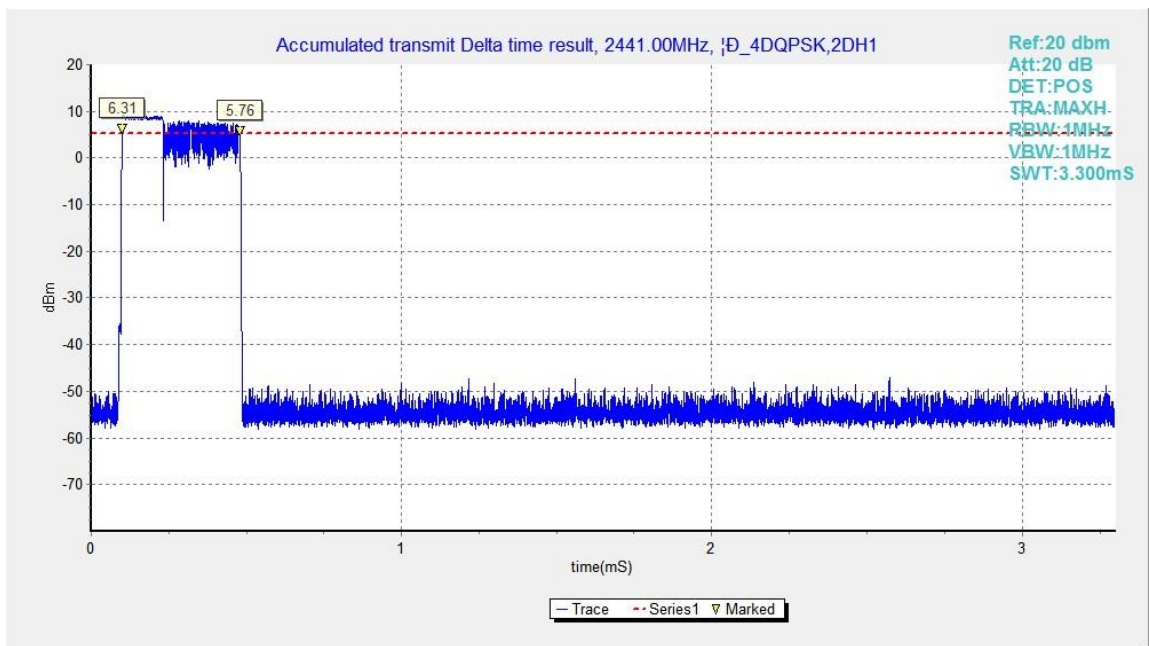


Fig.70. Time of occupancy (Dwell Time): Channel 39, Packet 2-DH1

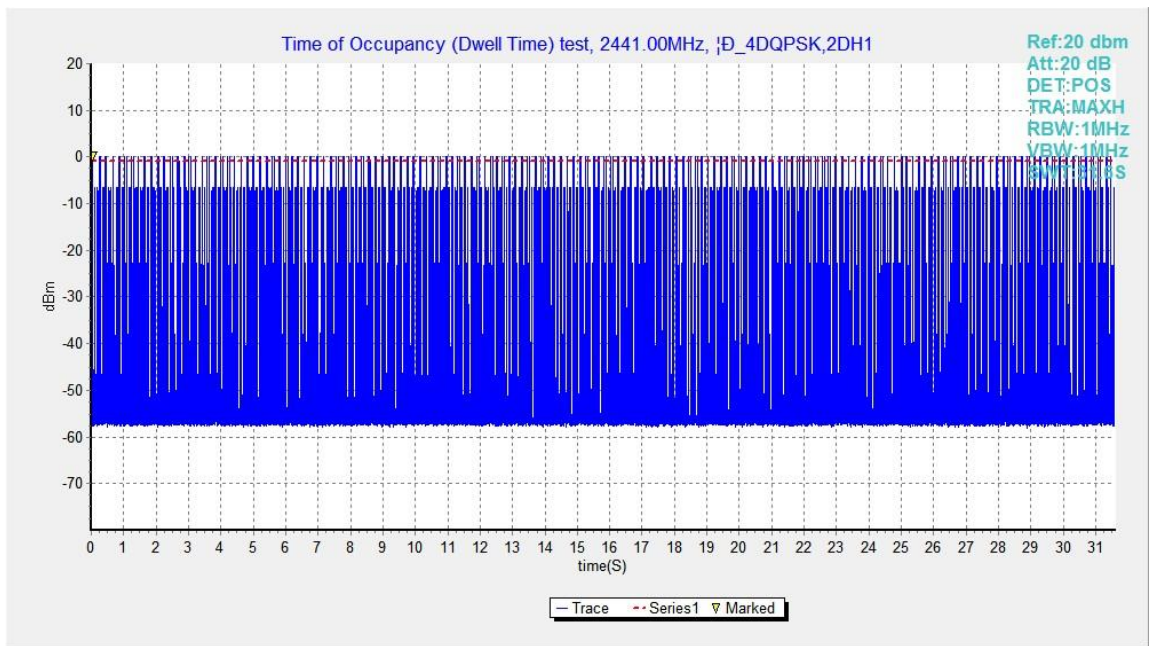


Fig.71. Number of Transmissions Measurement: Channel 39,Packet 2-DH1

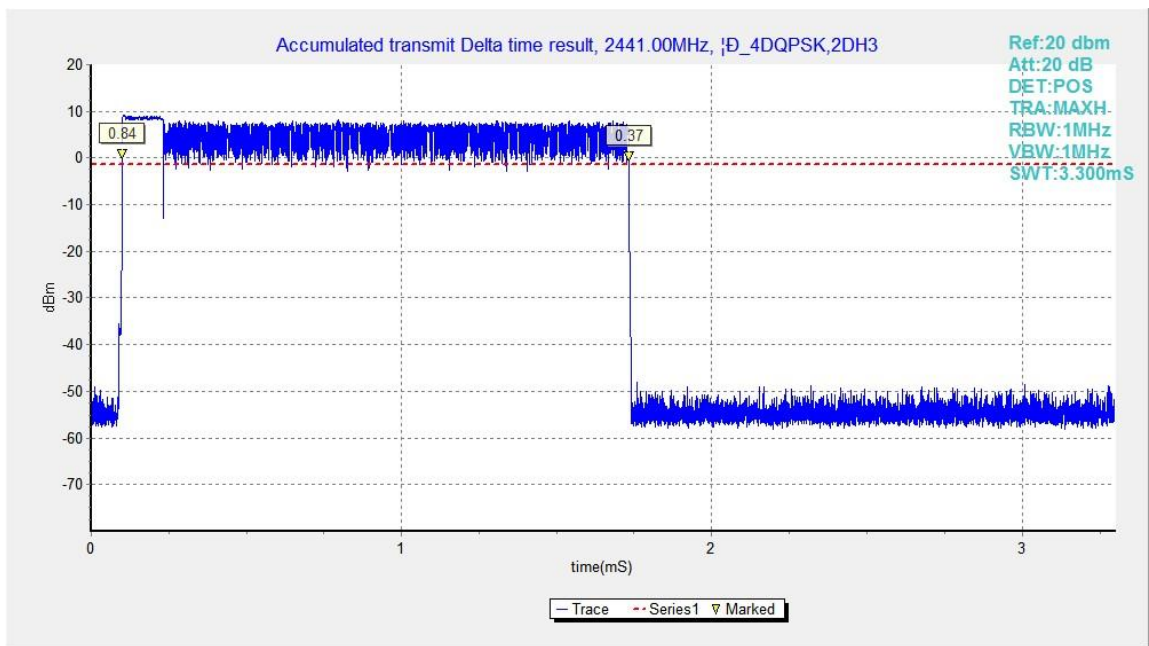


Fig.72. Time of occupancy (Dwell Time): Channel 39, Packet 2-DH3

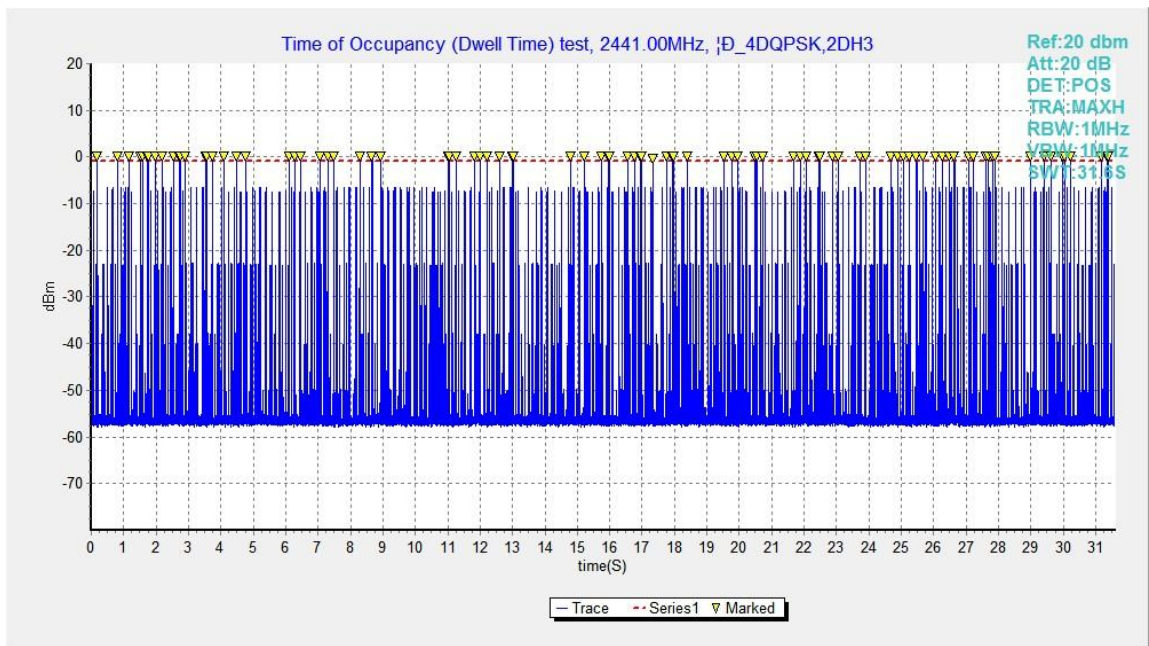


Fig.73. Number of Transmissions Measurement: Channel 39,Packet 2-DH3

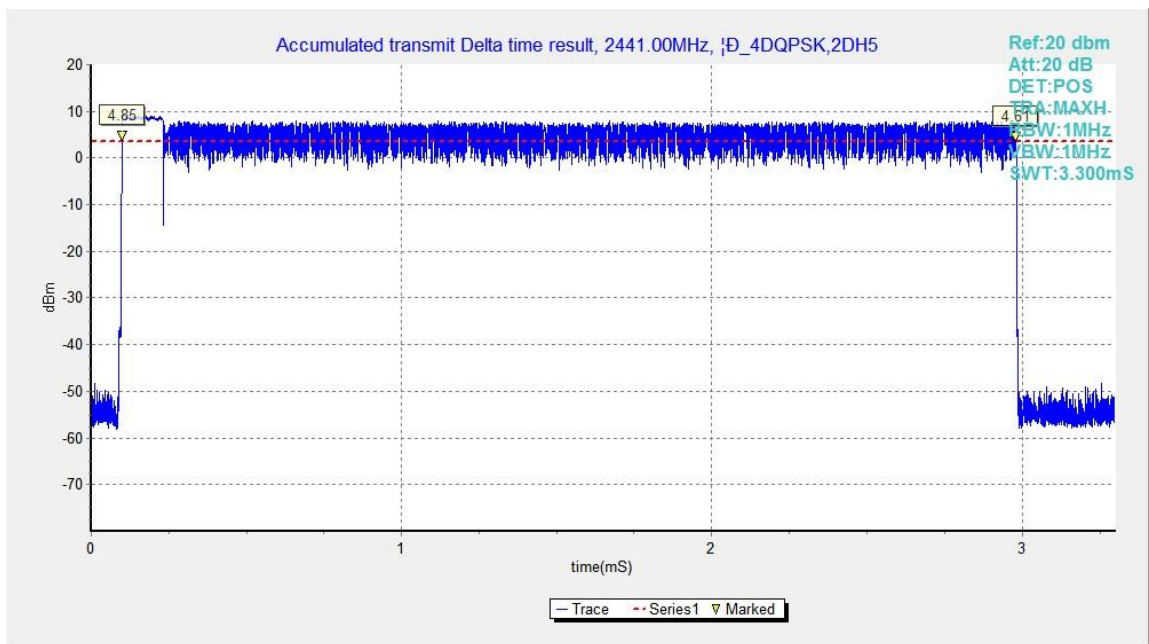


Fig.74. Time of occupancy (Dwell Time): Channel 39, Packet 2-DH5

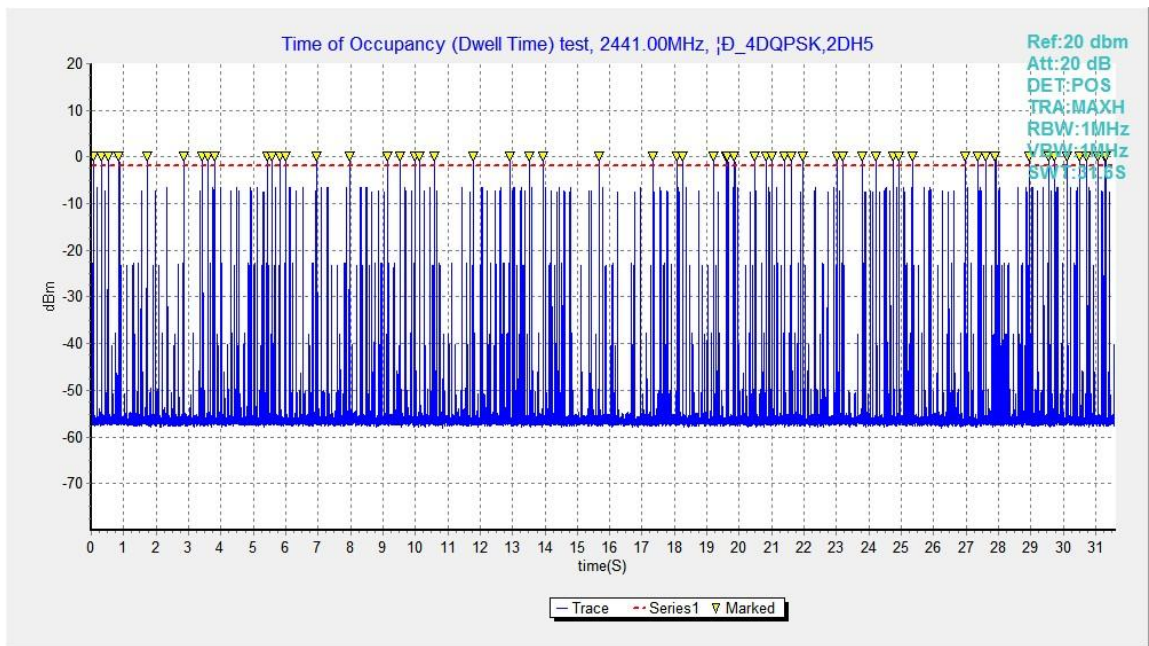


Fig.75. Number of Transmissions Measurement: Channel 39,Packet 2-DH5

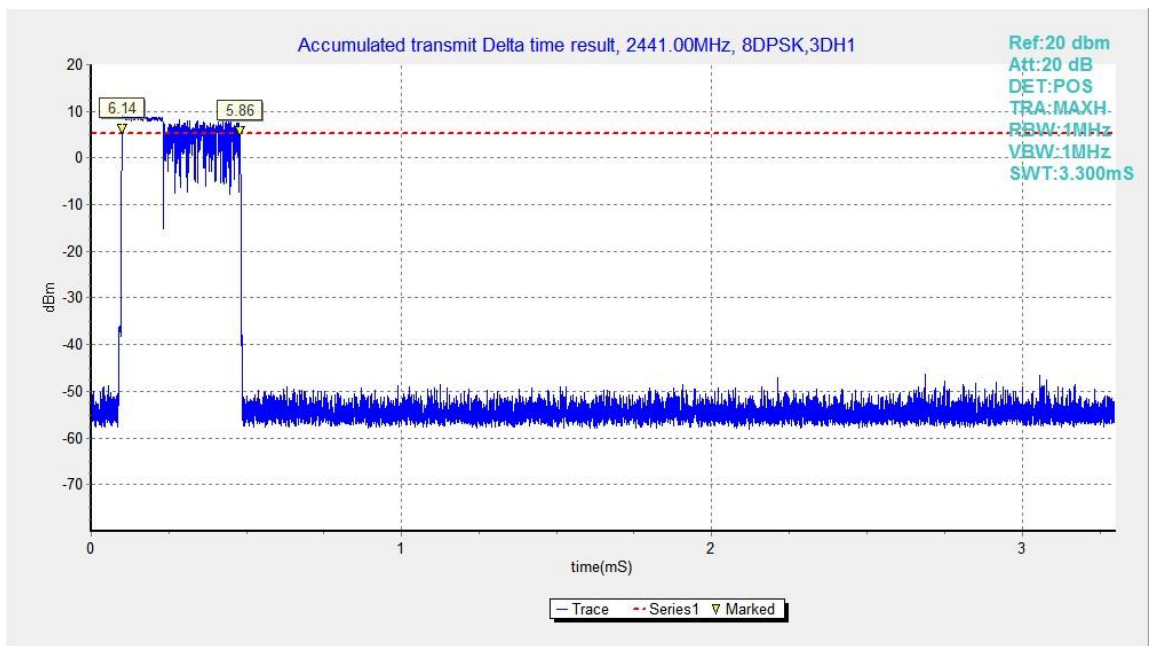


Fig.76. Time of occupancy (Dwell Time): Channel 39, Packet 3-DH1

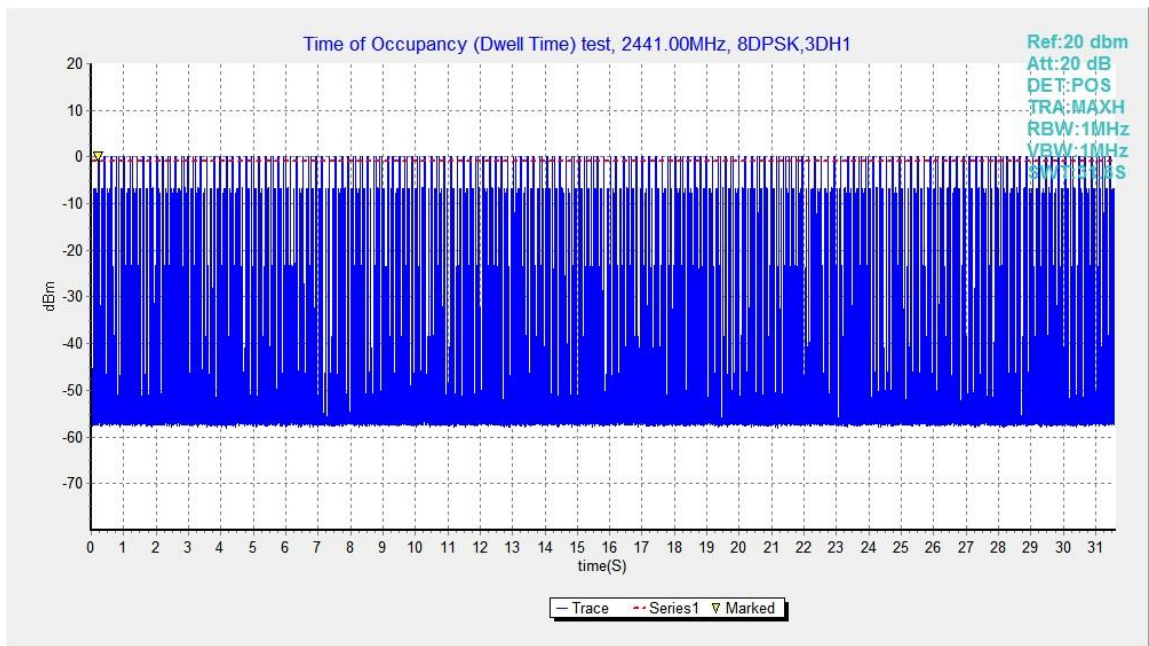


Fig.77. Number of Transmissions Measurement: Channel 39,Packet 3-DH1

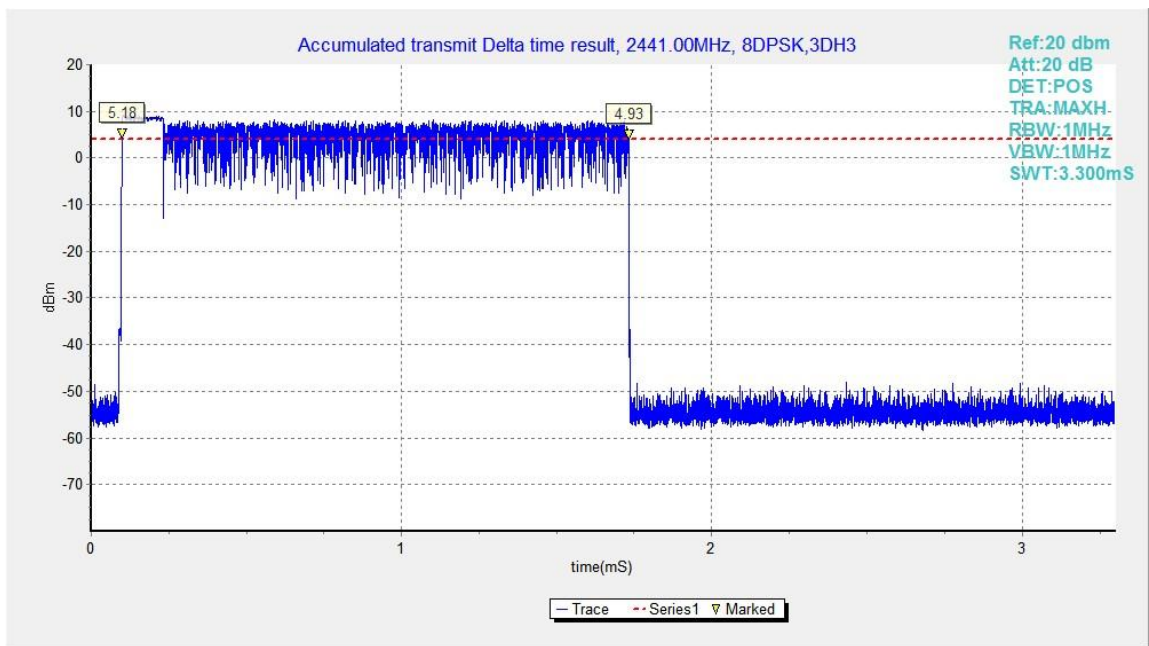


Fig.78. Time of occupancy (Dwell Time): Channel 39, Packet 3-DH3

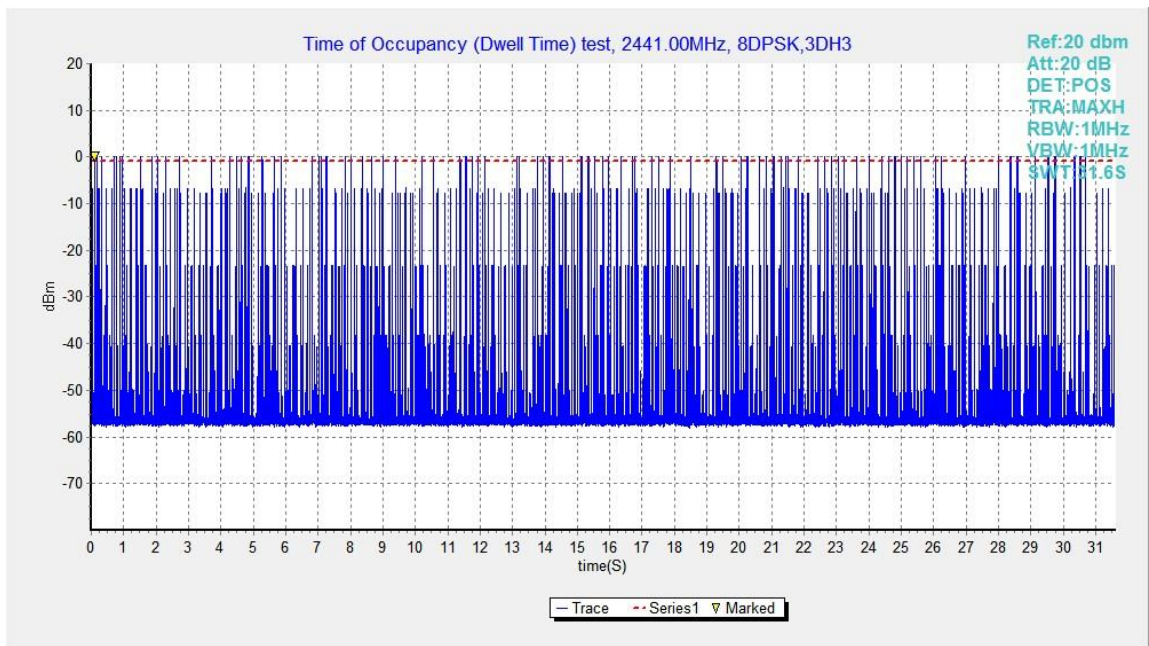


Fig.79. Number of Transmissions Measurement: Channel 39,Packet 3-DH3

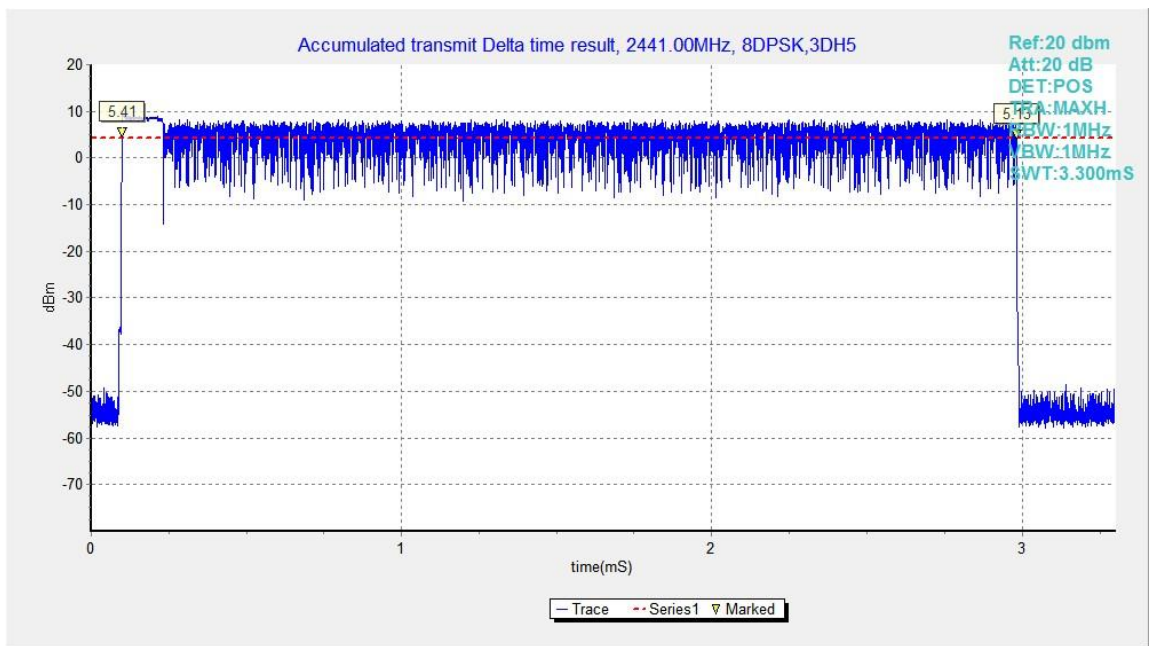


Fig.80. Time of occupancy (Dwell Time): Channel 39, Packet 3-DH5

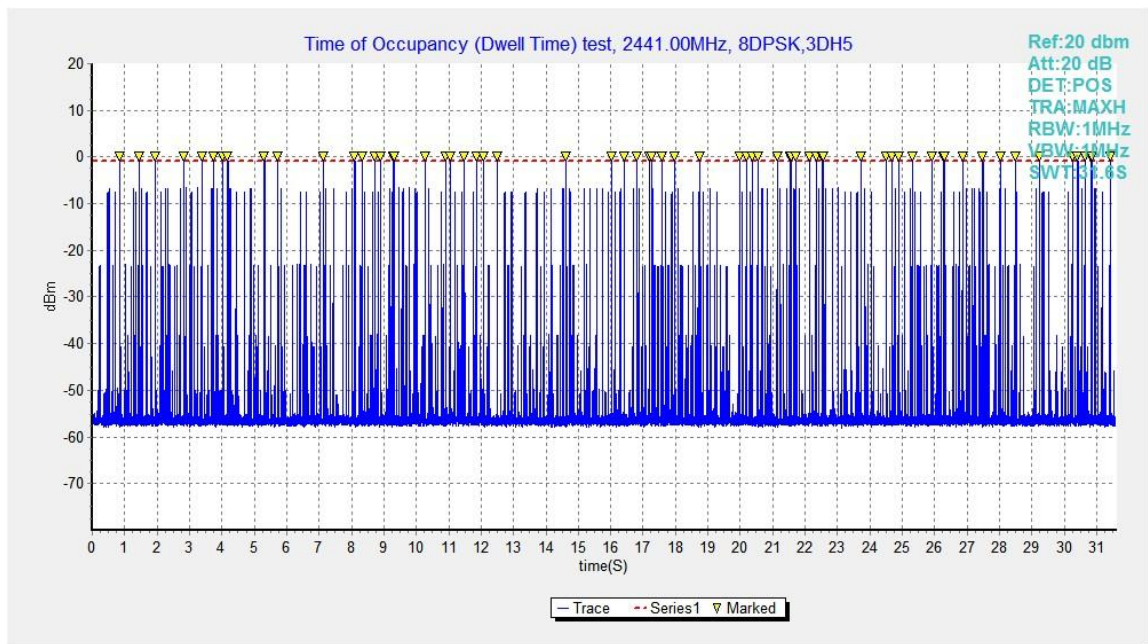


Fig.81. Number of Transmissions Measurement: Channel 39,Packet 3-DH5

B.7. 20dB Bandwidth

Method of Measurement: See ANSI C63.10-clause 6.9.2

Measurement Procedure - Unwanted Emissions

1. Set RBW = 30kHz.
2. Set VBW = 100 kHz.
3. Set span to 3MHz
4. Detector = peak.
5. Trace Mode = max hold.
6. Sweep = auto couple.
7. Allow the trace to stabilize (this may take some time, depending on the extent of the span).

Measurement Limit:

| Standard | Limit |
|------------------------------|-------|
| FCC 47 CFR Part 15.247(a)(1) | NA * |

Use NdB Down function of the SA to measure the 20dB Bandwidth

* Comment: This test case is not required according to the latest FCC 47 CFR Part 15.247. But the test results are necessary for “carrier frequency separation” test case, in Annex A.8.

Measurement Results:

For GFSK

| Channel | 20dB Bandwidth (kHz) | | Conclusion |
|---------|----------------------|--------|------------|
| 0 | Fig.82 | 940.50 | NA |
| 39 | Fig.83 | 959.25 | NA |
| 78 | Fig.84 | 941.25 | NA |

For $\pi/4$ DQPSK

| Channel | 20dB Bandwidth (kHz) | | Conclusion |
|---------|----------------------|---------|------------|
| 0 | Fig.85 | 1260.75 | NA |
| 39 | Fig.86 | 1229.25 | NA |
| 78 | Fig.87 | 1269.00 | NA |

For 8DPSK

| Channel | 20dB Bandwidth (kHz) | | Conclusion |
|---------|----------------------|---------|------------|
| 0 | Fig.88 | 1233.75 | NA |
| 39 | Fig.89 | 1269.00 | NA |
| 78 | Fig.90 | 1272.00 | NA |

Conclusion: NA

Test graphs as below:

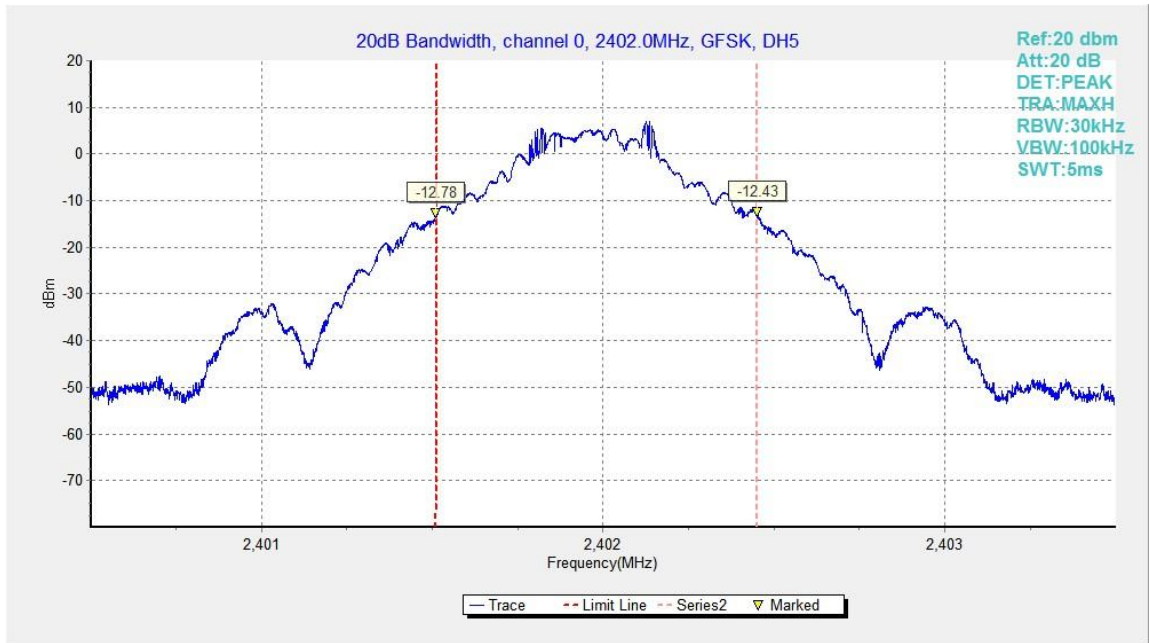


Fig.82. 20dB Bandwidth: GFSK, Channel 0

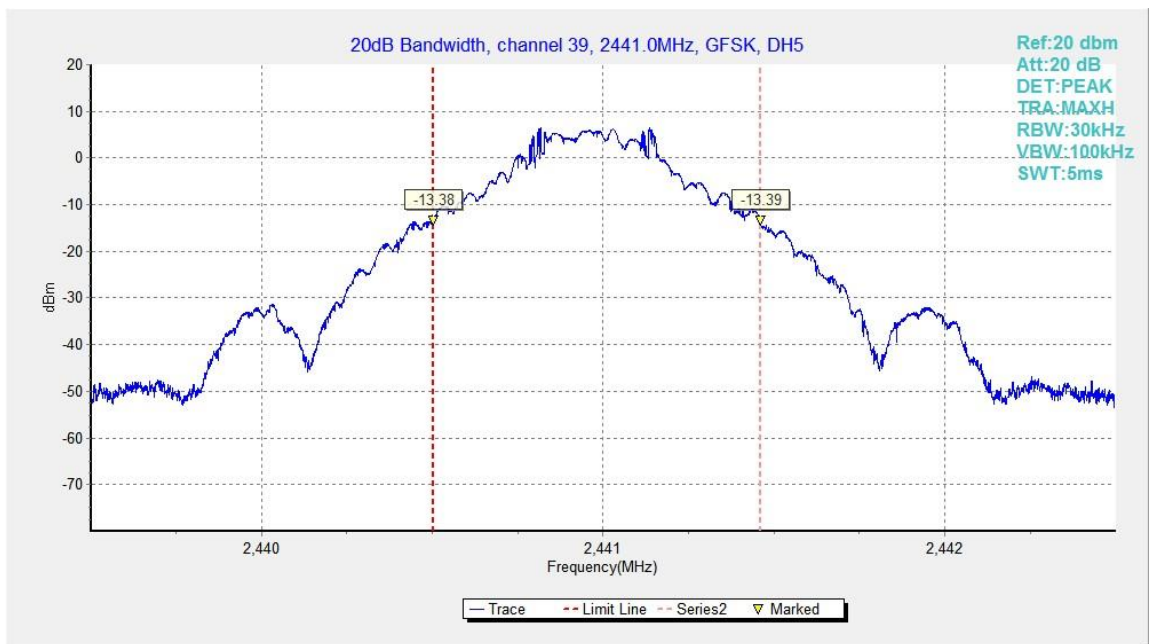


Fig.83. 20dB Bandwidth: GFSK, Channel 39

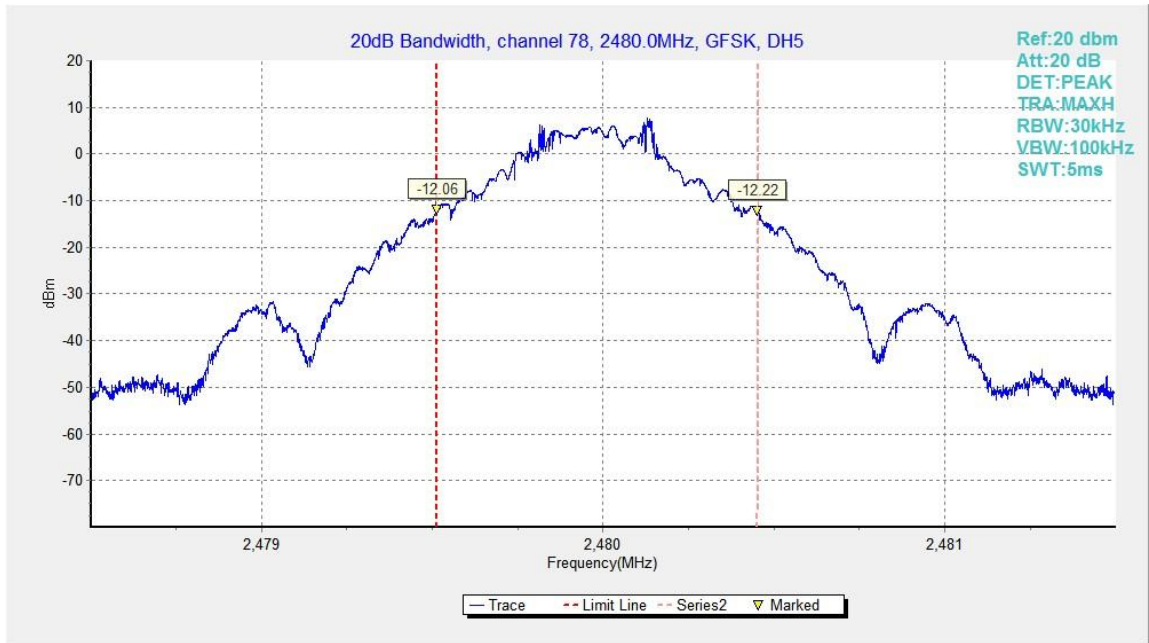


Fig.84. 20dB Bandwidth: GFSK, Channel 78

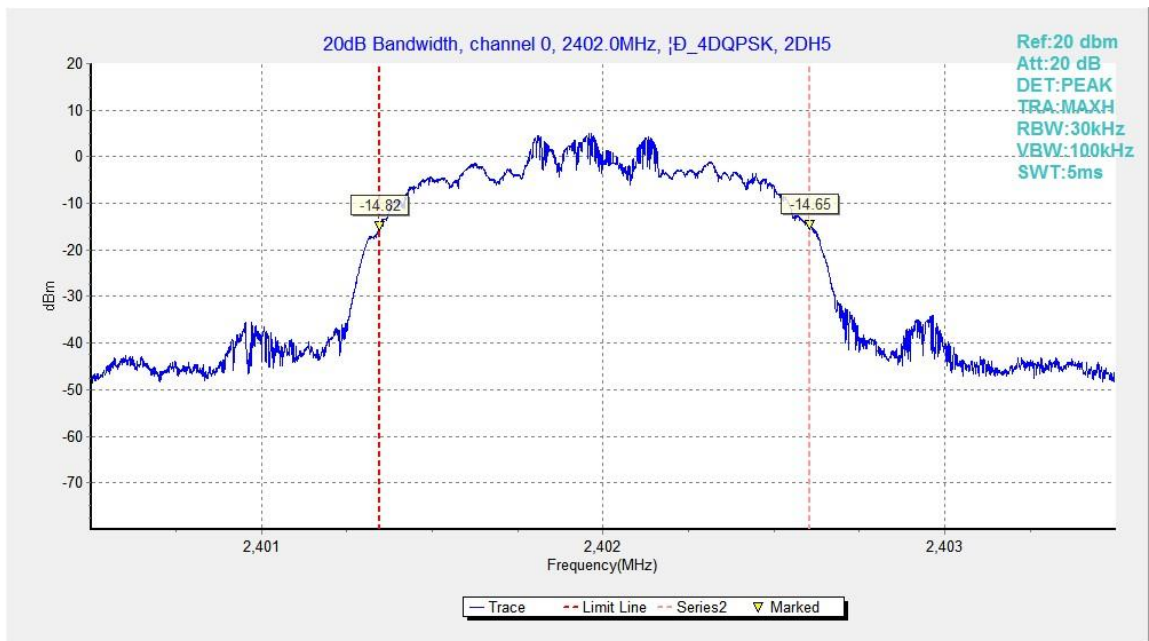


Fig.85. 20dB Bandwidth: $\pi/4$ DQPSK, Channel 0

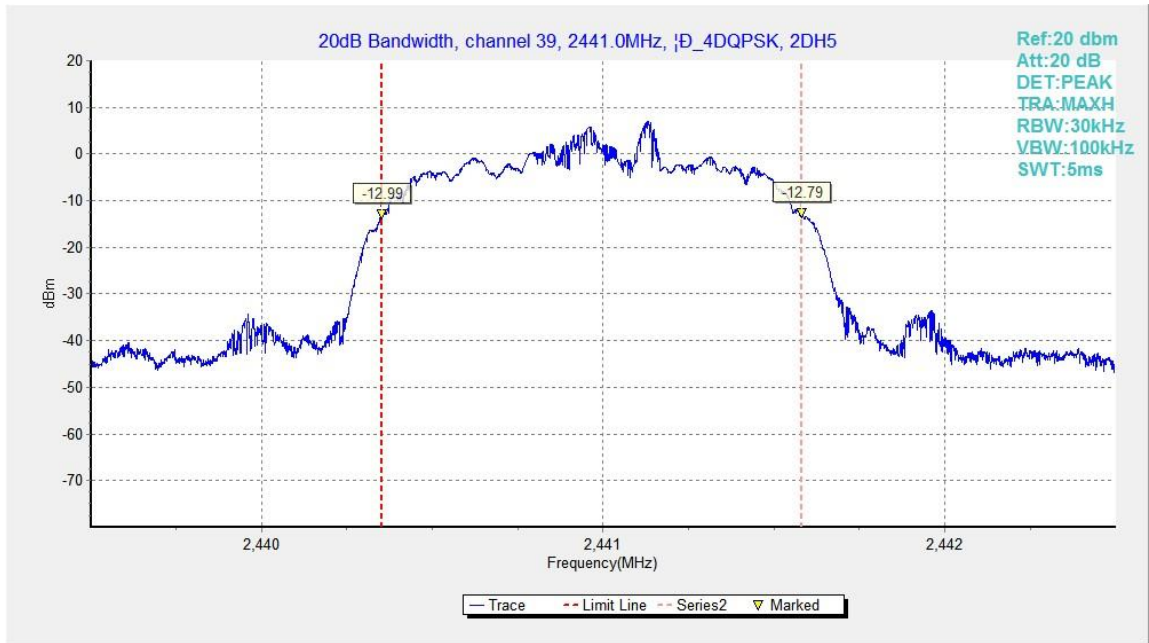


Fig.86. 20dB Bandwidth: $\pi/4$ DQPSK, Channel 39

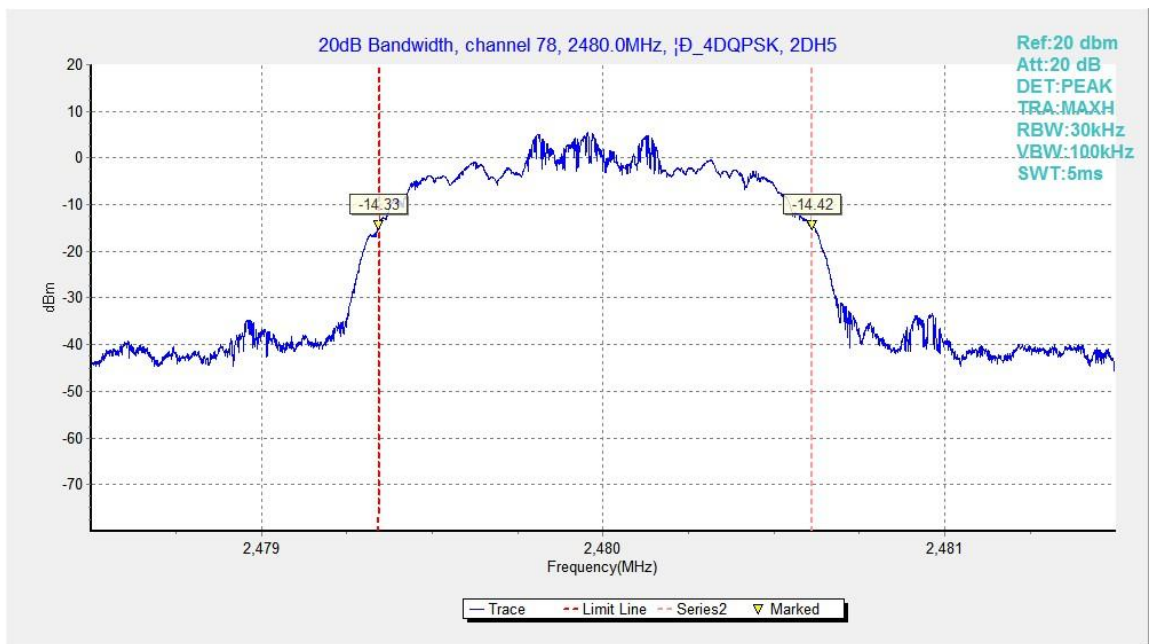


Fig.87. 20dB Bandwidth: $\pi/4$ DQPSK, Channel 78

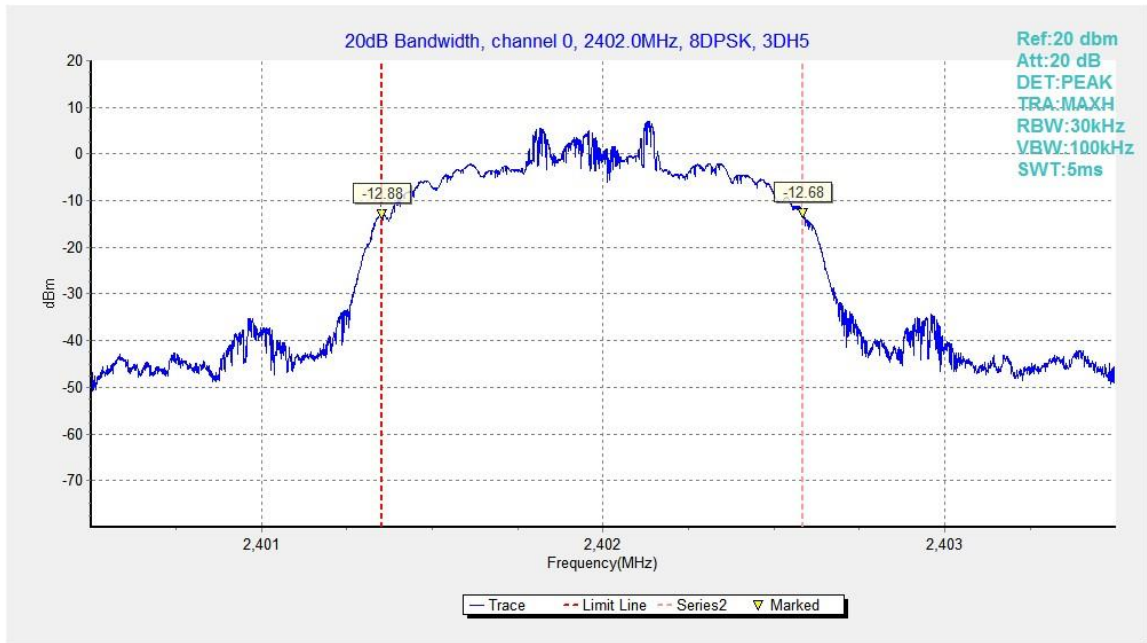


Fig.88. 20dB Bandwidth: 8DPSK, Channel 0

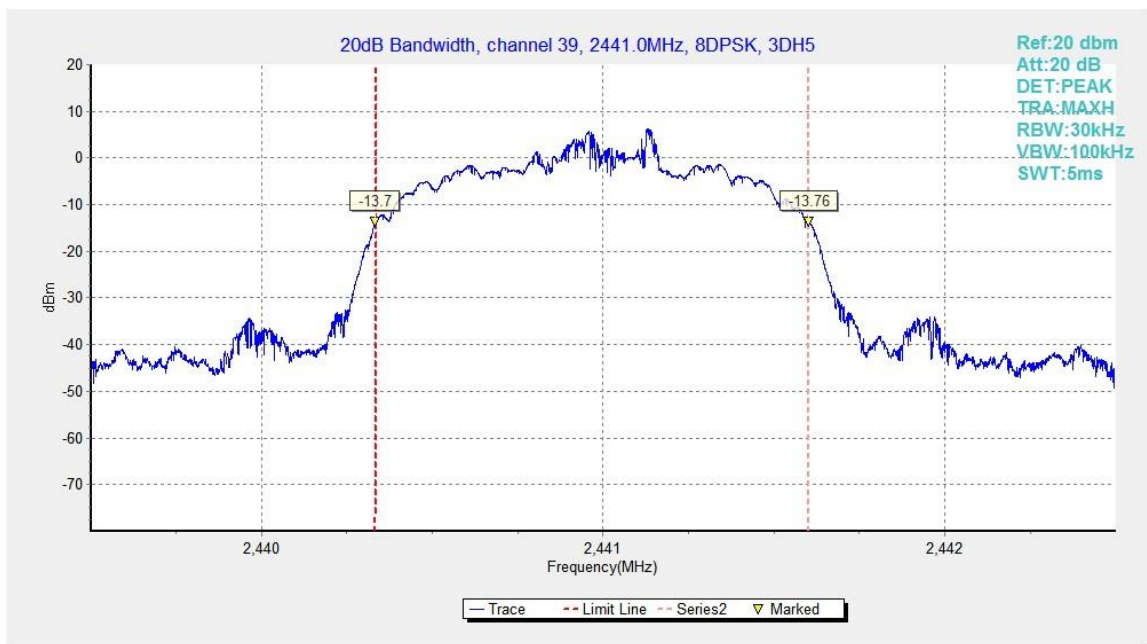


Fig.89. 20dB Bandwidth: 8DPSK, Channel 39

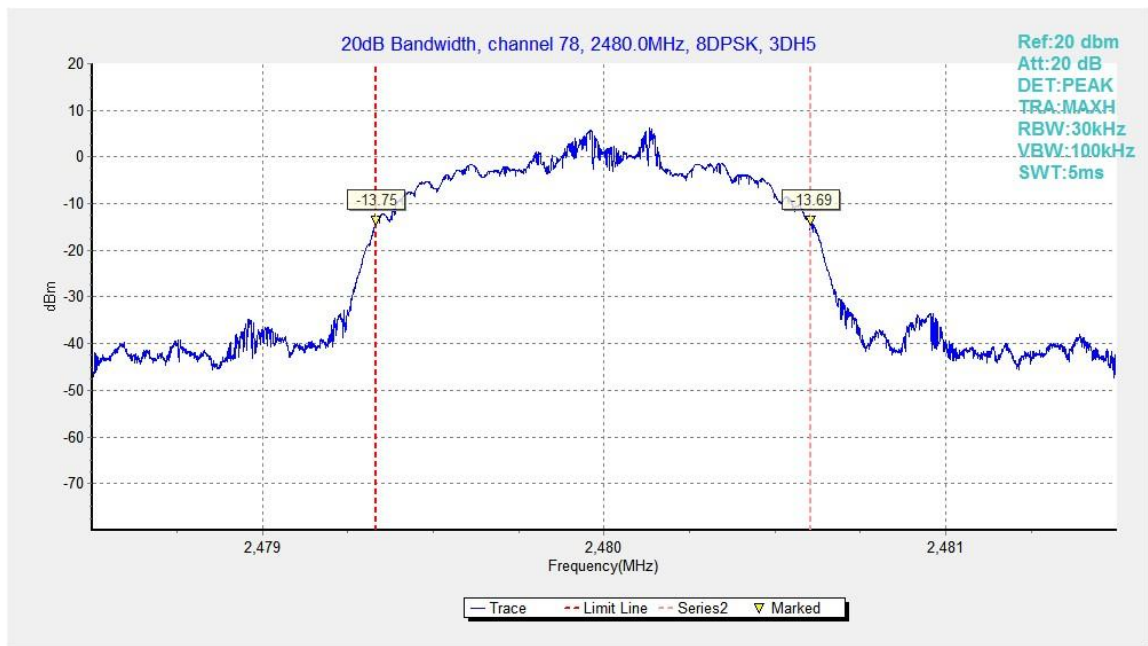


Fig.90. 20dB Bandwidth: 8DPSK, Channel 78

B.8. Carrier Frequency Separation

Method of Measurement: See ANSI C63.10-clause 7.8.2

The EUT must have its hopping function enabled. Use the following spectrum analyzer settings:

- Span = 3MHz
- RBW=300kHz
- VBW=300kHz
- Sweep = auto
- Detector function = peak
- Trace = max hold
- Allow the trace to stabilize

Search the peak marks of the middle frequency and adjacent channel, then record the separation between them.

* Comment: This limit should be over 25 kHz or $(2/3) * 20\text{dB}$ bandwidth, whichever is greater.

Measurement Limit:

| Standard | Limit(kHz) |
|------------------------------|--|
| FCC 47 CFR Part 15.247(a)(1) | over 25 kHz or $(2/3) * 20\text{dB}$ bandwidth |

Measurement Result:

For GFSK

| Channel | Carrier frequency separation (kHz) | Conclusion | |
|---------|------------------------------------|------------|---|
| 39 | Fig.91 | 983.25 | P |

For $\pi/4$ DQPSK

| Channel | Carrier frequency separation (kHz) | Conclusion | |
|---------|------------------------------------|------------|---|
| 39 | Fig.92 | 1032.75 | P |

For 8DPSK

| Channel | Carrier frequency separation (kHz) | Conclusion | |
|---------|------------------------------------|------------|---|
| 39 | Fig.93 | 981.75 | P |

Conclusion: PASS

Test graphs as below:

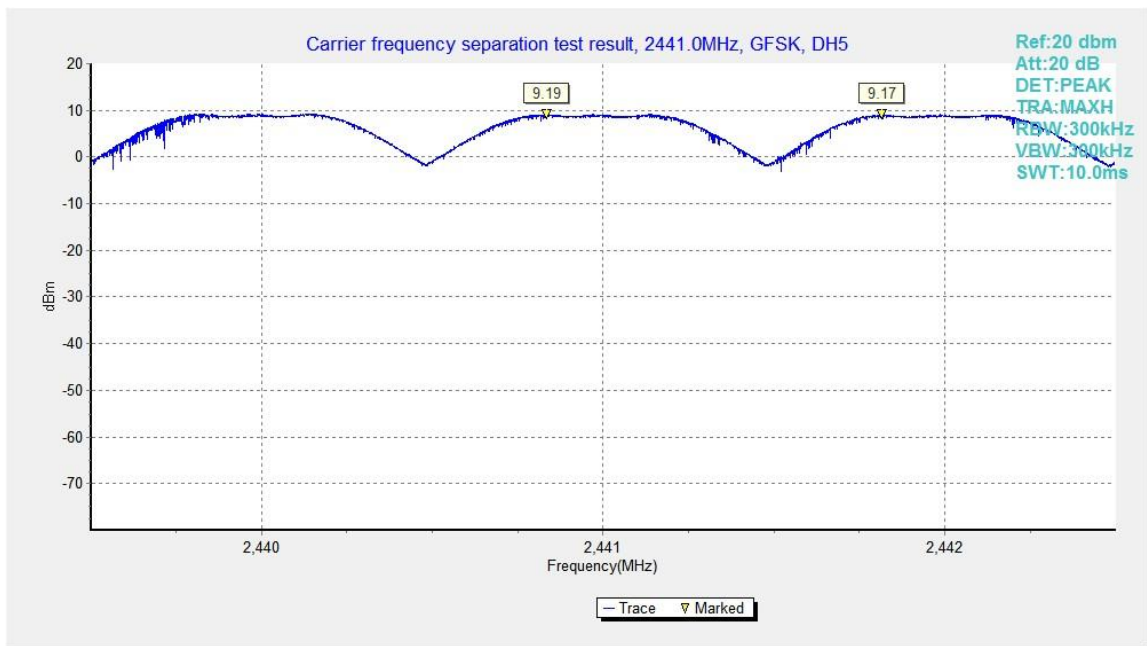


Fig.91. Carrier frequency separation measurement: GFSK, Channel 39

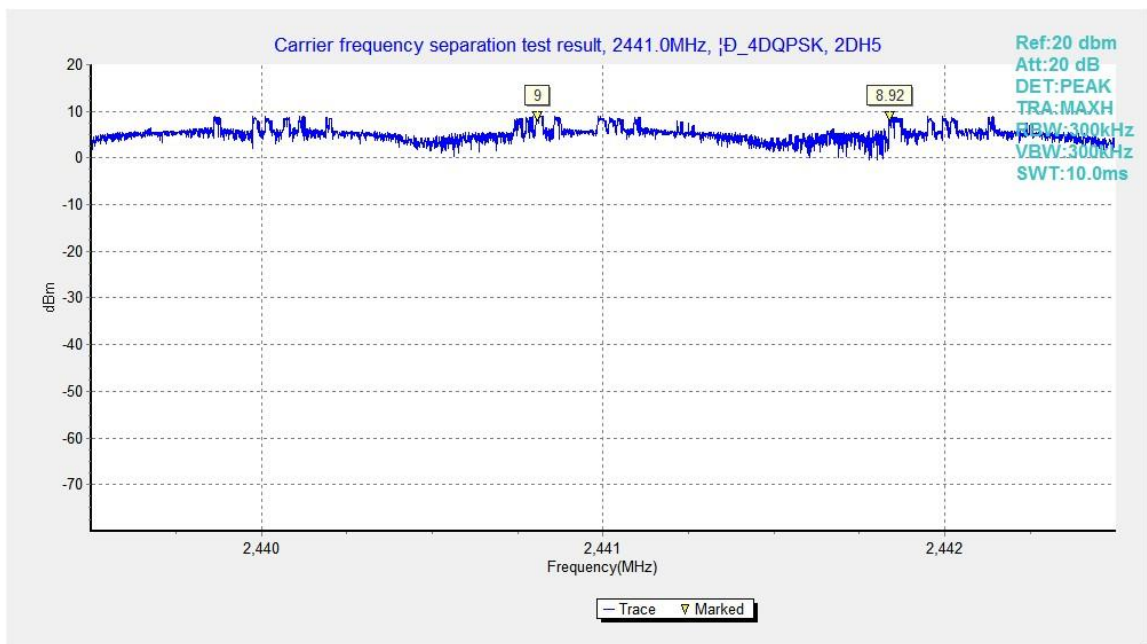


Fig.92. Carrier frequency separation measurement: $\pi/4$ DQPSK, Channel 39

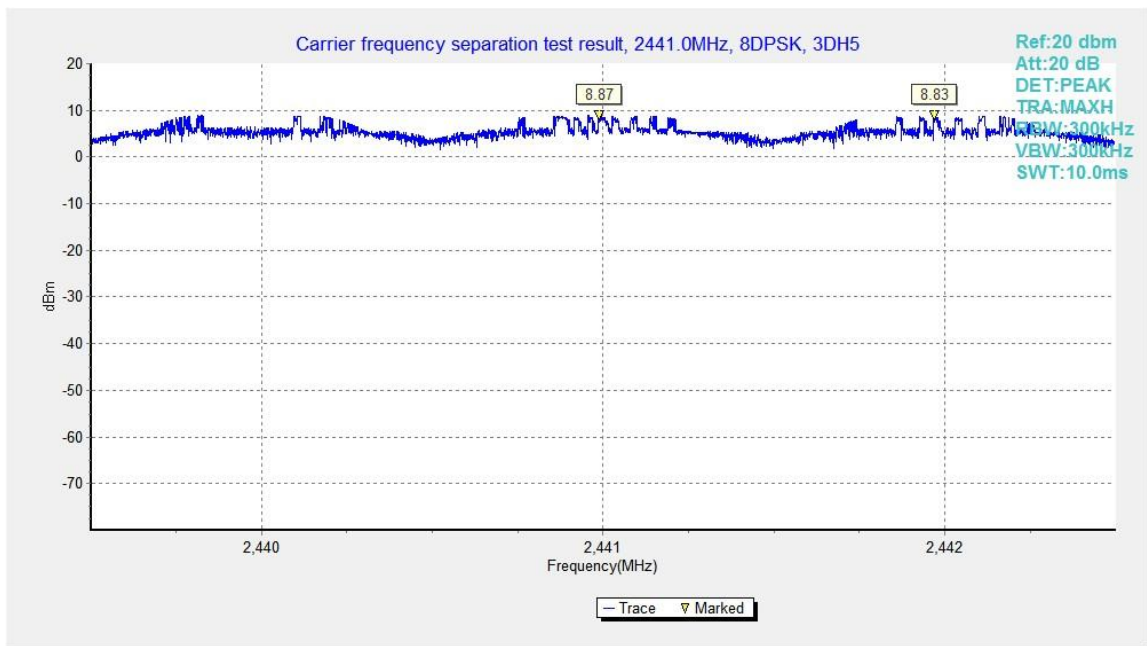


Fig.93. Carrier frequency separation measurement: 8DPSK, Channel 39

B.9. Number of Hopping Channels

Method of Measurement: See ANSI C63.10-clause 7.8.3

The EUT must have its hopping function enabled. Use the following spectrum analyzer settings:

- Span = the frequency band of operation
- RBW = 500kHz
- VBW = 500kHz
- Sweep = auto
- Detector function = peak
- Trace = max hold
- Allow the trace to stabilize

It might prove necessary to break the span up into subranges to show clearly all of the hopping frequencies. Compliance of an EUT with the appropriate regulatory limit shall be determined for the number of hopping channels. A plot of the data shall be included in the test report.

Measurement Limit:

| Standard | Limit |
|------------------------------------|--------------------------------------|
| FCC 47 CFR Part 15.247(a) (1)(iii) | At least 15 non-overlapping channels |

Measurement Result:

For GFSK

| Channel | Number of hopping channels | Conclusion |
|---------|----------------------------|------------|
| 0~39 | Fig.94 | P |
| 40~78 | Fig.95 | |

For $\pi/4$ DQPSK

| Channel | Number of hopping channels | Conclusion |
|---------|----------------------------|------------|
| 0~39 | Fig.96 | P |
| 40~78 | Fig.97 | |

For 8DPSK

| Channel | Number of hopping channels | Conclusion |
|---------|----------------------------|------------|
| 0~39 | Fig.98 | P |
| 40~78 | Fig.99 | |

Conclusion: PASS

Test graphs as below:

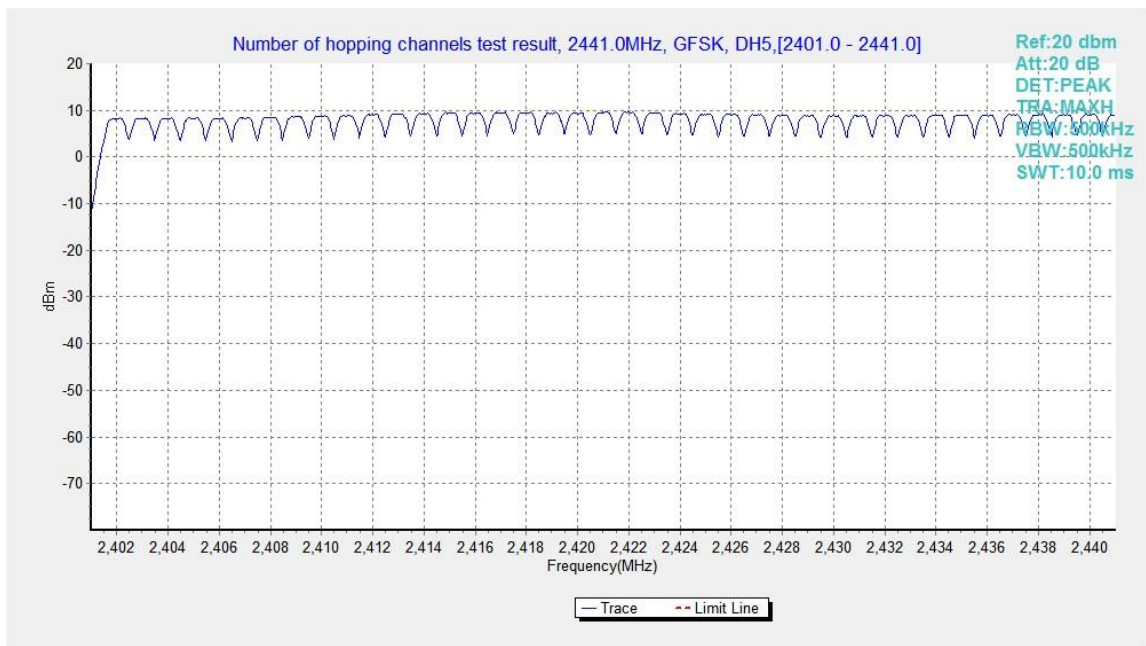


Fig.94. Number of hopping frequencies: GFSK, Channel 0 - 39

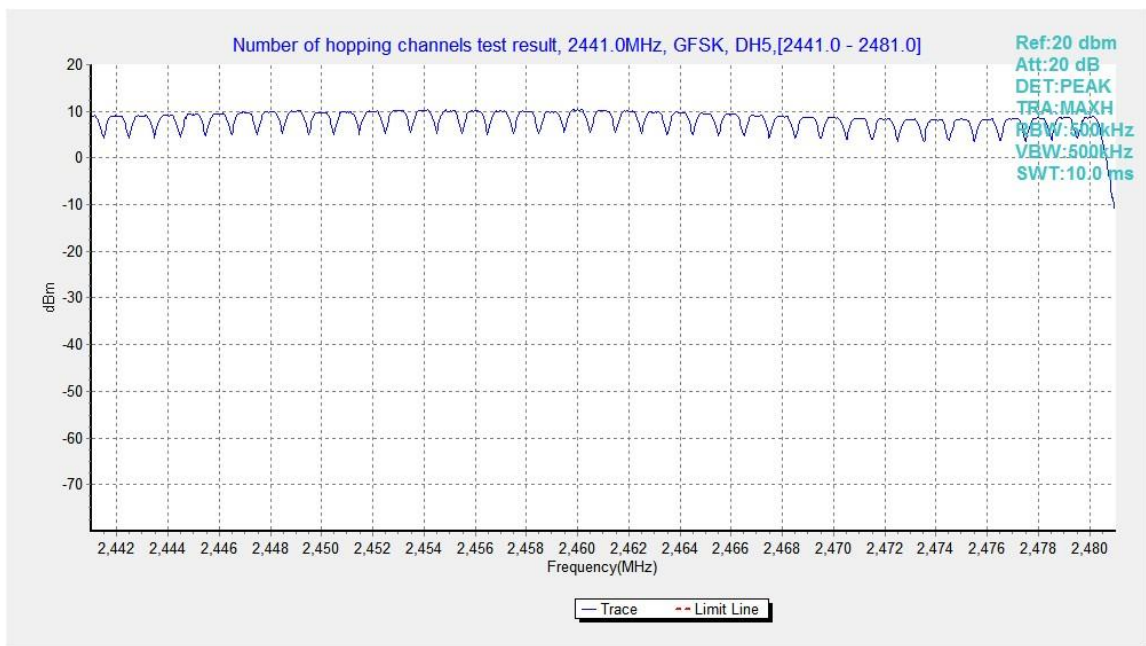


Fig.95. Number of hopping frequencies: GFSK, Channel 40 - 78

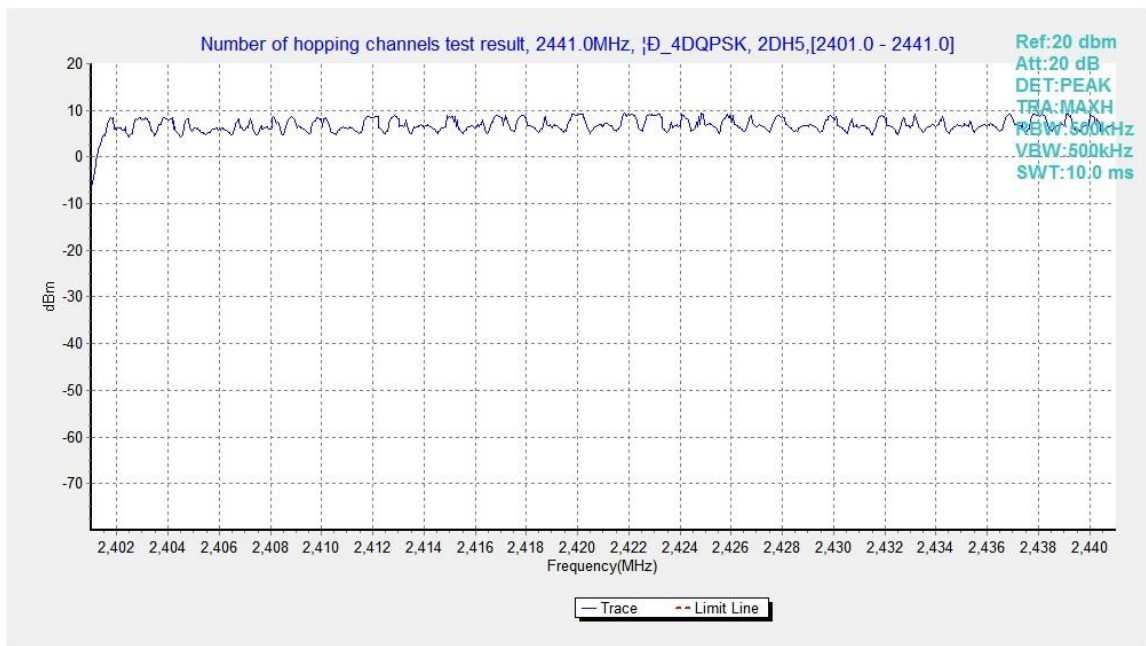


Fig.96. Number of hopping frequencies: $\pi/4$ DQPSK, Channel 0 - 39

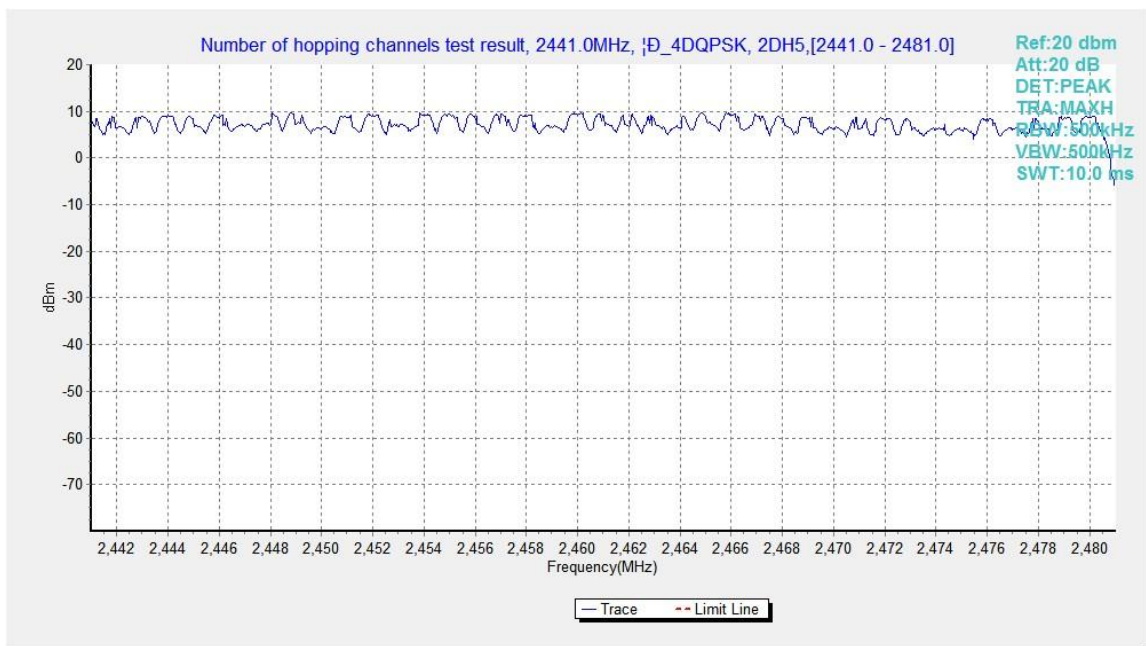


Fig.97. Number of hopping frequencies: $\pi/4$ DQPSK, Channel 40 - 78

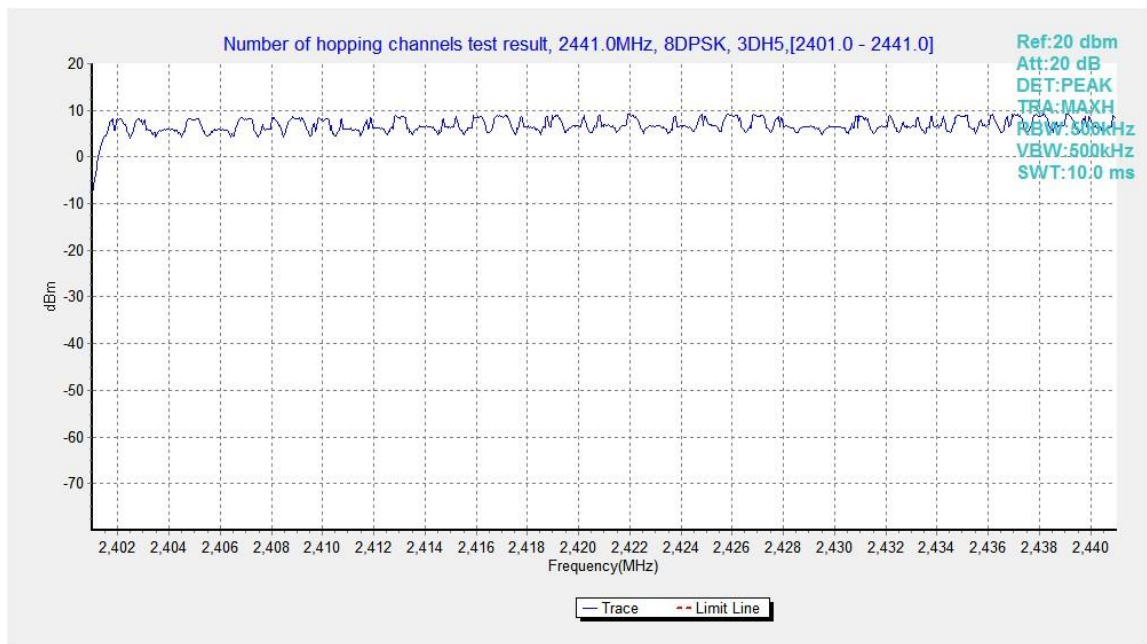


Fig.98. Number of hopping frequencies: 8DPSK, Channel 0 - 39

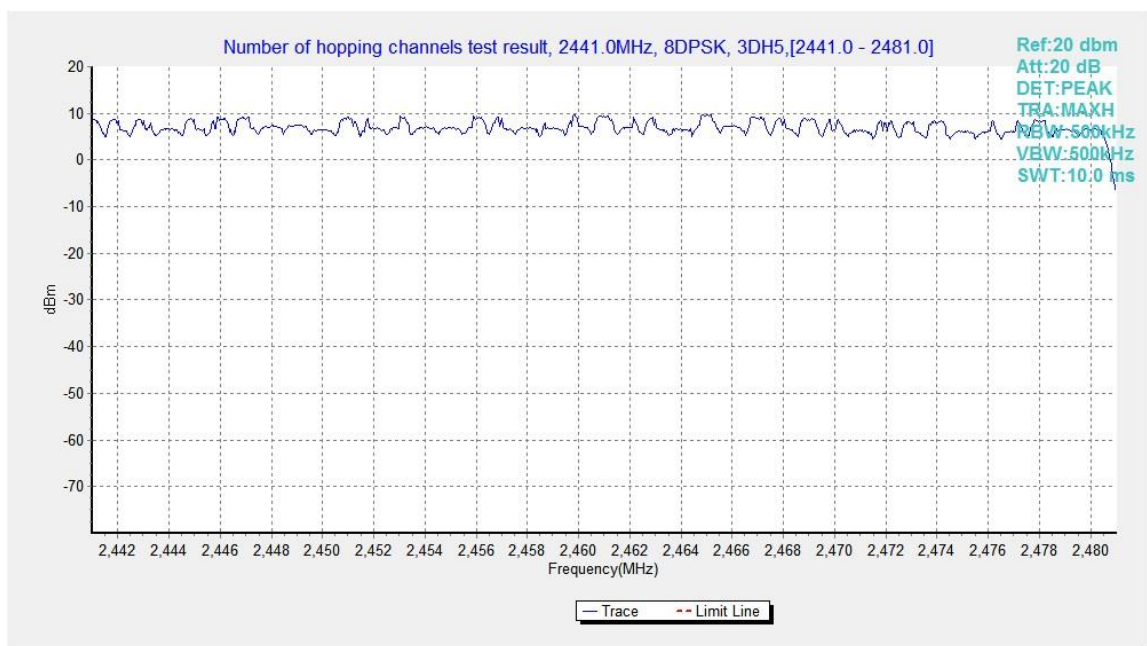


Fig.99. Number of hopping frequencies: 8DPSK, Channel 40 - 78

B.10. AC Powerline Conducted Emission

Summary

All AC line conducted spurious emissions are measured with a receiver connected to a grounded LISN while the EUT is operating at its maximum duty cycle, at maximum power, and at the appropriate frequencies. All data rates and modes were investigated for conducted spurious emissions. Only the conducted emissions of the configuration that produced the worst case emissions are reported in this section

Method of Measurement:

See Clause 6.2 of ANSI C63.10 specifically.

See Clause 4 and Clause 5 of ANSI C63.10 generally.

The conducted emissions from the AC port of the EUT are measured in a shielding room. The EUT is connected to a Line Impedance Stabilization Network (LISN). An overview sweep with peak detection was performed. The measurements were performed with a quasi-peak detector and if required, an average detector.

The conducted emission measurements were made with the following detector of the test receiver: Quasi-Peak / Average Detector.

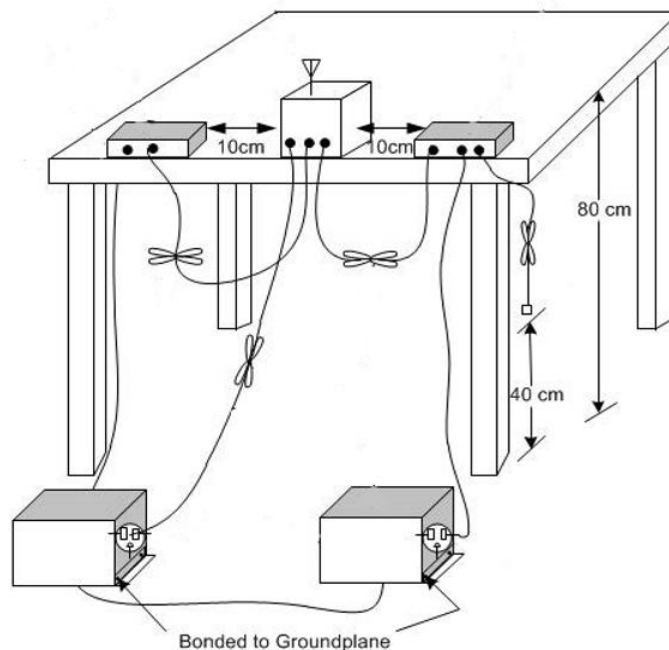
The measurement bandwidth is:

| Frequency of Emission (MHz) | RBW/IF bandwidth |
|-----------------------------|------------------|
| 0.15-30 | 9kHz |

Test Condition:

| Voltage (V) | Frequency (Hz) |
|-------------|----------------|
| 120 | 60 |

Test setup



Measurement Result and limit:

Bluetooth (Quasi-peak Limit)

| Frequency range (MHz) | Quasi-peak Limit (dB μ V) | Result (dB μ V) | | Conclusion |
|-----------------------|-------------------------------|---------------------|-------------|------------|
| | | With charger | | |
| | | bluetooth | Idle | |
| 0.15 to 0.5 | 66 to 56 | Fig.B.10.1 | Fig. B.10.2 | P |
| 0.5 to 5 | 56 | | | |
| 5 to 30 | 60 | | | |

NOTE: The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.5 MHz.

Bluetooth (Average Limit)

| Frequency range (MHz) | Average Limit (dB μ V) | Result (dB μ V) | | Conclusion |
|-----------------------|----------------------------|---------------------|-------------|------------|
| | | With charger | | |
| | | bluetooth | Idle | |
| 0.15 to 0.5 | 56 to 46 | Fig.B.10.1 | Fig. B.10.2 | P |
| 0.5 to 5 | 46 | | | |
| 5 to 30 | 50 | | | |

NOTE: The limit decreases linearly with the logarithm of the frequency in the range 0.15 MHz to 0.5 MHz.

Conclusion: Pass
Test graphs as below:

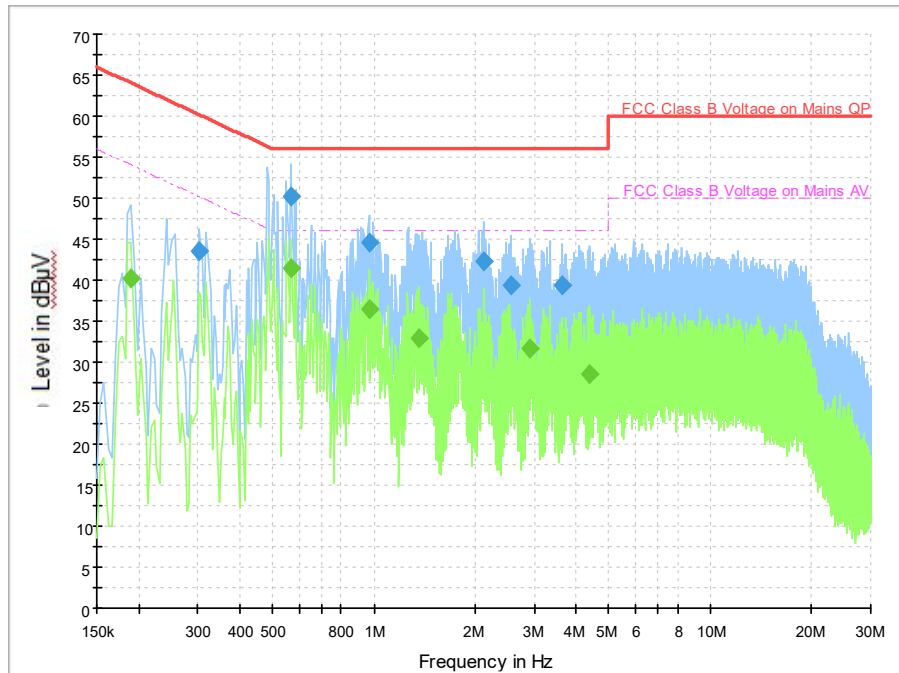


Fig.B.10.1 AC Powerline Conducted Emission- bluetooth

Note: The graphic result above is the maximum of the measurements for both phase line and neutral line.

Final Result 1

| Frequency (MHz) | QuasiPeak (dBuV) | Meas. Time | Bandwidth (kHz) | Filter | Line | Corr. (dB) | Margin (dB) | Limit (dBuV) | Comment |
|-----------------|------------------|------------|-----------------|--------|------|------------|-------------|--------------|----------|
| 0.302000 | 43.6 | 2000.0 | 9.000 | On | L1 | 19.7 | 16.6 | 60.2 | 0.302000 |
| 0.566000 | 50.3 | 2000.0 | 9.000 | On | L1 | 19.7 | 5.7 | 56.0 | 0.566000 |
| 0.966000 | 44.6 | 2000.0 | 9.000 | On | L1 | 19.7 | 11.4 | 56.0 | 0.966000 |
| 2.114000 | 42.3 | 2000.0 | 9.000 | On | L1 | 19.6 | 13.7 | 56.0 | 2.114000 |
| 2.566000 | 39.5 | 2000.0 | 9.000 | On | L1 | 19.6 | 16.5 | 56.0 | 2.566000 |
| 3.638000 | 39.3 | 2000.0 | 9.000 | On | L1 | 19.6 | 16.7 | 56.0 | 3.638000 |

Final Result 2

| Frequency (MHz) | CAverage (dBuV) | Meas. Time | Bandwidth (kHz) | Filter | Line | Corr. (dB) | Margin (dB) | Limit (dBuV) | Comment |
|-----------------|-----------------|------------|-----------------|--------|------|------------|-------------|--------------|----------|
| 0.190000 | 40.1 | 2000.0 | 9.000 | On | L1 | 19.7 | 13.9 | 54.0 | 0.190000 |
| 0.566000 | 41.4 | 2000.0 | 9.000 | On | L1 | 19.7 | 4.6 | 46.0 | 0.566000 |
| 0.966000 | 36.4 | 2000.0 | 9.000 | On | L1 | 19.7 | 9.6 | 46.0 | 0.966000 |
| 1.362000 | 32.8 | 2000.0 | 9.000 | On | L1 | 19.6 | 13.2 | 46.0 | 1.362000 |
| 2.902000 | 31.7 | 2000.0 | 9.000 | On | L1 | 19.6 | 14.3 | 46.0 | 2.902000 |
| 4.370000 | 28.6 | 2000.0 | 9.000 | On | L1 | 19.6 | 17.4 | 46.0 | 4.370000 |

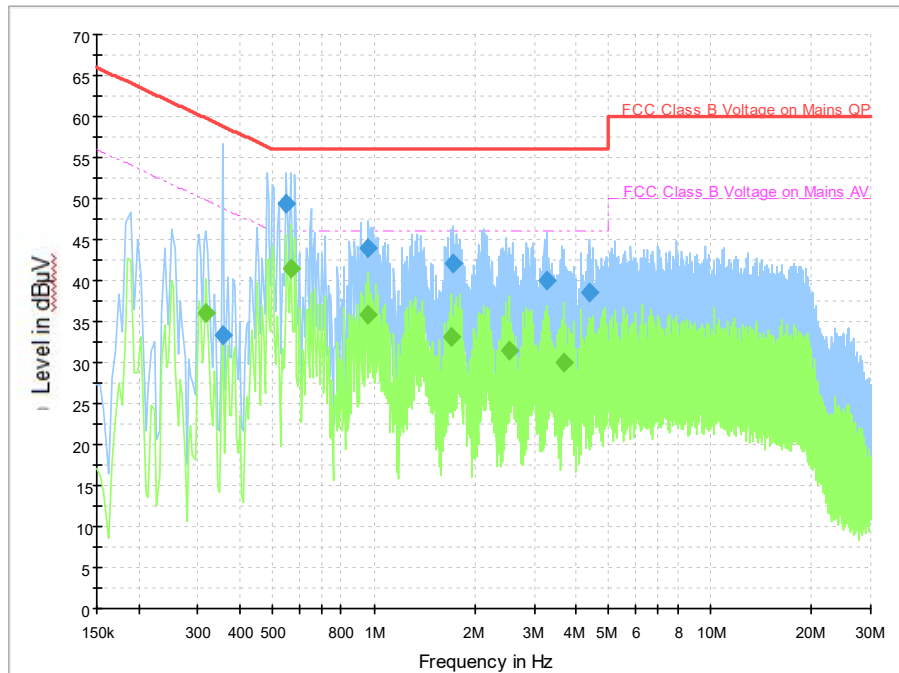


Fig.B.10.2 AC Powerline Conducted Emission-Idle

Note: The graphic result above is the maximum of the measurements for both phase line and neutral line.

Final Result 1

| Frequency (MHz) | QuasiPeak (dBµV) | Meas. Time | Bandwidth (kHz) | Filter | Line | Corr. (dB) | Margin (dB) | Limit (dBµV) | Comment |
|-----------------|------------------|------------|-----------------|--------|------|------------|-------------|--------------|----------|
| 0.354000 | 33.3 | 2000.0 | 9.000 | On | L1 | 19.7 | 25.6 | 58.9 | 0.354000 |
| 0.550000 | 49.4 | 2000.0 | 9.000 | On | L1 | 19.7 | 6.6 | 56.0 | 0.550000 |
| 0.962000 | 43.9 | 2000.0 | 9.000 | On | L1 | 19.7 | 12.1 | 56.0 | 0.962000 |
| 1.726000 | 42.0 | 2000.0 | 9.000 | On | L1 | 19.6 | 14.0 | 56.0 | 1.726000 |
| 3.270000 | 39.9 | 2000.0 | 9.000 | On | L1 | 19.6 | 16.1 | 56.0 | 3.270000 |
| 4.386000 | 38.4 | 2000.0 | 9.000 | On | L1 | 19.6 | 17.6 | 56.0 | 4.386000 |

Final Result 2

| Frequency (MHz) | CAverage (dBµV) | Meas. Time | Bandwidth (kHz) | Filter | Line | Corr. (dB) | Margin (dB) | Limit (dBµV) | Comment |
|-----------------|-----------------|------------|-----------------|--------|------|------------|-------------|--------------|----------|
| 0.318000 | 36.1 | 2000.0 | 9.000 | On | L1 | 19.7 | 13.6 | 49.8 | 0.318000 |
| 0.566000 | 41.5 | 2000.0 | 9.000 | On | L1 | 19.7 | 4.5 | 46.0 | 0.566000 |
| 0.962000 | 35.9 | 2000.0 | 9.000 | On | L1 | 19.7 | 10.1 | 46.0 | 0.962000 |
| 1.694000 | 33.1 | 2000.0 | 9.000 | On | L1 | 19.6 | 12.9 | 46.0 | 1.694000 |
| 2.526000 | 31.5 | 2000.0 | 9.000 | On | L1 | 19.6 | 14.5 | 46.0 | 2.526000 |
| 3.686000 | 30.0 | 2000.0 | 9.000 | On | L1 | 19.6 | 16.0 | 46.0 | 3.686000 |



B.11. Antenna Requirement

The antenna of the device is permanently attached. There are no provisions for connection to an external antenna.

The unit complies with the requirement of FCC Part 15.203.

ANNEX C: Accreditation Certificate



Accredited Laboratory

A2LA has accredited

TELECOMMUNICATION TECHNOLOGY LABS, CAICT

Beijing, People's Republic of China

for technical competence in the field of

Electrical Testing

This laboratory is accredited in accordance with the recognized International Standard ISO/IEC 17025:2017 General requirements for the competence of testing and calibration laboratories. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer to joint ISO-ILAC-IAF Communiqué dated April 2017).



Presented this 26th day of June 2023.



Mr. Trace McInturf, Vice President, Accreditation Services
For the Accreditation Council
Certificate Number 7049.01
Valid to July 31, 2024

For the tests to which this accreditation applies, please refer to the laboratory's Electrical Scope of Accreditation.

END OF REPORT