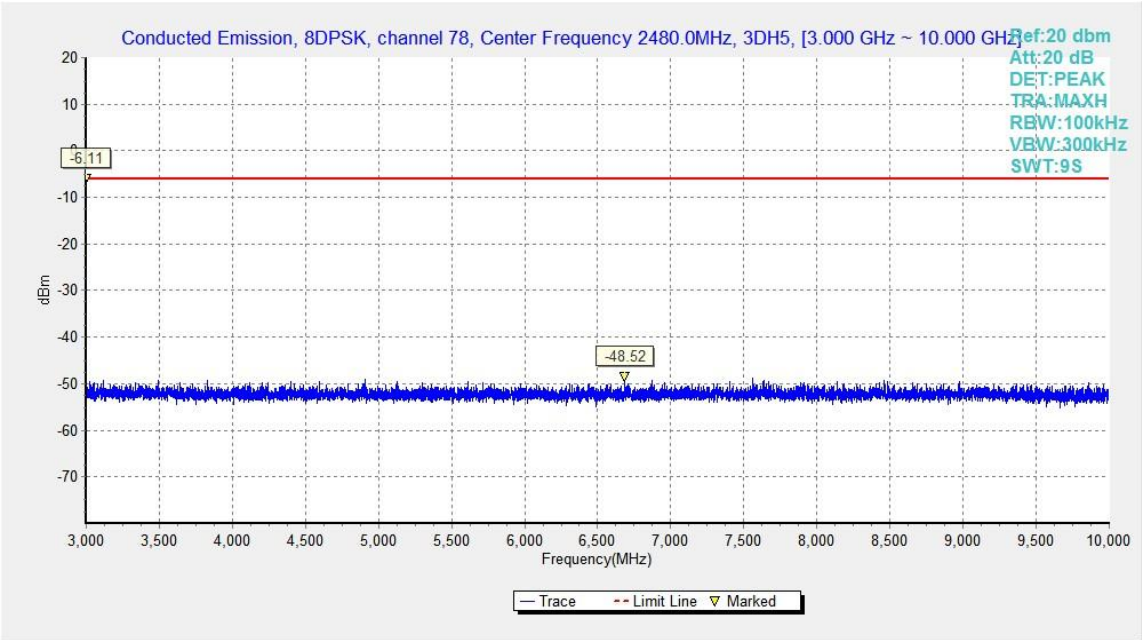



Fig.56. Conducted spurious emission: 8DPSK, Channel 78, 3GHz - 10GHz

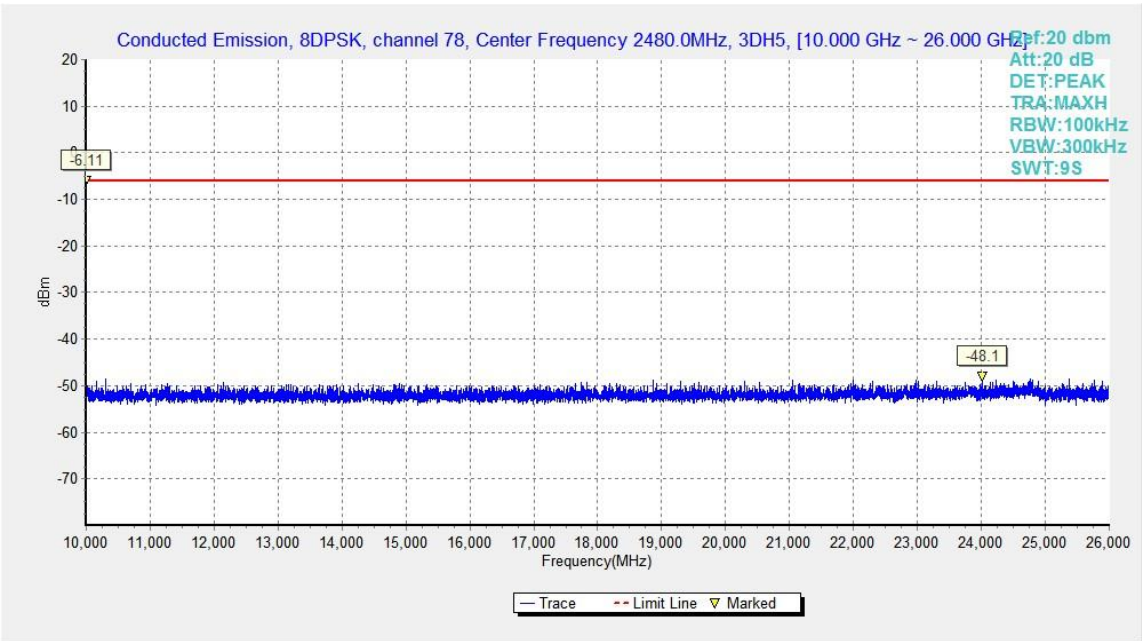



Fig.57. Conducted spurious emission: 8DPSK, Channel 78, 10GHz - 26GHz

©Copyright. All rights reserved by CTTL.

## B.5. Radiated Unwanted Emission

**Limits**

Measurement Limit

| Standard | Limit |
|---|---|
| FCC 47 CFR Part 15.247, 15.205, 15.209 | 20dB below peak output power |

In addition, radiated emissions which fall in the restricted bands, as defined in § 15.205(a), must also comply with the radiated emission limits specified in § 15.209(a) (see § 15.205(c)).

Limit in restricted band

| Frequency (MHz) | Field strength(μV/m) | Measurement distance (m) |
|---|---|---|
| 0.009 - 0.490 | 2400/F(kHz) | 300 |
| 0.490 - 1.705 | 24000/F(kHz) | 30 |
| 1.705 – 30.0 | 30 | 30 |

| Frequency of emission (MHz) | Field strength (uV/m) | Field strength (dBuV/m) | Measurement distance (m) |
|---|---|---|---|
| 30-88 | 100 | 40 | 3 |
| 88-216 | 150 | 43.5 | 3 |
| 216-960 | 200 | 46 | 3 |
| Above 960 | 500 | 54 | 3 |

Note: When performing measurements at a distance other than that specified, the results shall be extrapolated to the specified distance using an extrapolation factor.

**Test setup**

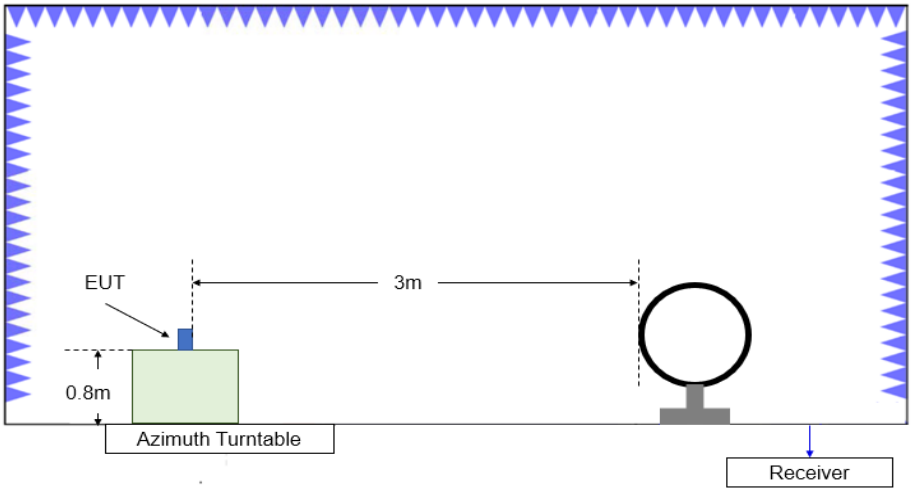



**Figure B.5.1. Test Site Diagram (9kHz-30MHz)**

©Copyright. All rights reserved by CTTL.

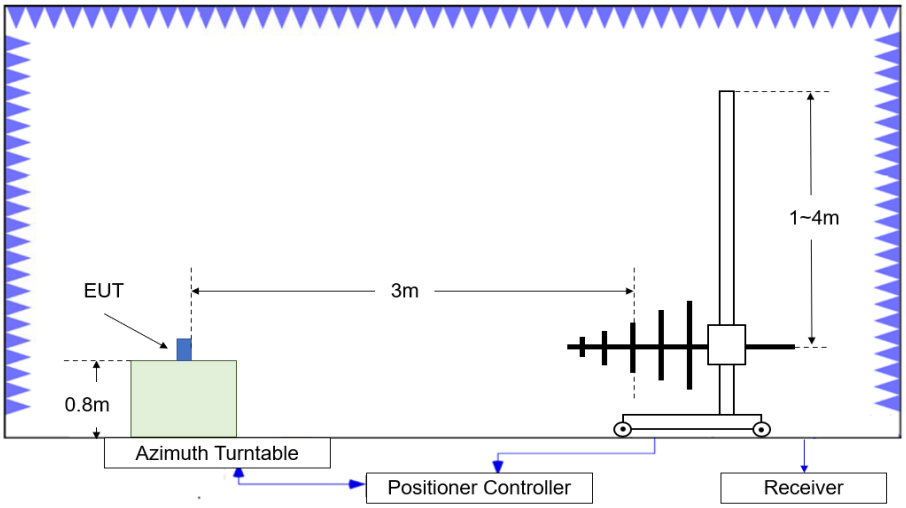



**Figure B.5.2. Test Site Diagram (30MHz-1GHz)**

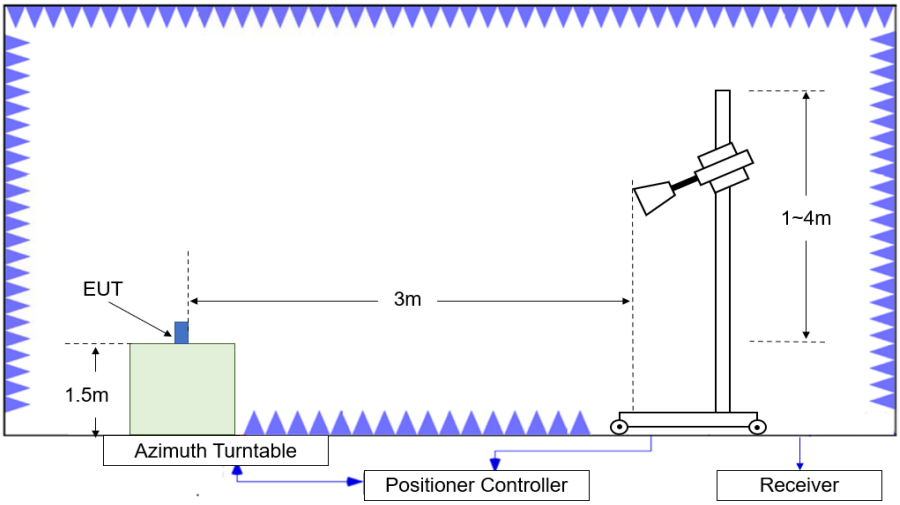



**Figure B.5.3. Test Site Diagram (1GHz-40GHz)**

**Test Procedures**

Radiated unwanted emissions from the EUT were measured according to ANSI C63.10-2013 (ANSI C63.10-2020).

Test setting

| Frequency of emission (MHz) | RBW/VBW | Sweep Time(s) |
|---|---|---|
| 30-1000 | 100kHz/300kHz | 5 |
| 1000-3000 | 1MHz/3MHz | 15 |
| 3000-18000 | 1MHz/3MHz | 40 |
| 18000-26500 | 1MHz/3MHz | 20 |

**Sample Calculation**

A "reference path loss" is established and the $A_{Rpl}$ is the attenuation of “reference path loss”, and including the gain of receive antenna, the gain of the preamplifier, the cable loss.

$P_{Mea}$ is the field strength recorded from the instrument.

The measurement results are obtained as described below:

©Copyright. All rights reserved by CTTL.

Result=$P_{Mea}$+$A_{Rpl=}$ $P_{Mea}$+Cable Loss+Antenna Factor

**Test note**

1. Investigation has been done on all modes and modulations/data rates. Only the radiated emissions of the configuration that produced the worst case emissions are reported in this section.
2. Spurious emissions for all channels were investigated and almost the same below 1GHz. According to FCC 47 CFR §15.31, emission levels are not report much lower than the limit by over 20dB
3. Measurement frequencies were performed from 9 kHz to the 10$^{th}$ harmonic of highest fundamental frequency or 40GHz, whichever is lower.

**Test Result**

**EUT ID: EUT1**

©Copyright. All rights reserved by CTTL.

**Radiated Spurious Emission**

**GFSK Ch 0**

| Frequency (MHz) | Measurement Result (dBuV/m) | Cable Loss (dB) | Antenna Factor (dB/m) | Receiver Reading (dBuV) | Limit (dBuV/m) | Margin (dB) | Antenna Pol. (H/V) |
|---|---|---|---|---|---|---|---|
| 17938.500 | 54.48 | -29.40 | 46.00 | 37.88 | 74.00 | 19.52 | H |
| 14698.000 | 50.08 | -30.00 | 41.50 | 38.58 | 74.00 | 23.92 | V |
| 12895.500 | 47.06 | -31.50 | 40.00 | 38.56 | 74.00 | 26.94 | H |
| 9416.000 | 44.40 | -33.60 | 37.90 | 40.10 | 74.00 | 29.60 | H |
| 7319.500 | 43.20 | -35.40 | 36.60 | 42.00 | 74.00 | 30.80 | V |
| 2357.900 | 56.24 | -19.60 | 28.20 | 47.64 | 74.00 | 17.76 | H |

**GFSK Ch 39**

| Frequency (MHz) | Measurement Result (dBuV/m) | Cable Loss (dB) | Antenna Factor (dB/m) | Receiver Reading (dBuV) | Limit (dBuV/m) | Margin (dB) | Antenna Pol. (H/V) |
|---|---|---|---|---|---|---|---|
| 17987.500 | 54.51 | -29.40 | 46.00 | 37.91 | 74.00 | 19.49 | V |
| 14573.500 | 50.18 | -29.00 | 41.90 | 37.28 | 74.00 | 23.82 | H |
| 11855.500 | 46.21 | -32.80 | 39.10 | 39.81 | 74.00 | 27.79 | V |
| 9036.000 | 44.34 | -34.30 | 37.80 | 40.84 | 74.00 | 29.66 | H |
| 7536.000 | 44.29 | -35.50 | 36.30 | 43.49 | 74.00 | 29.71 | V |
| 4967.000 | 40.36 | -37.40 | 33.60 | 44.16 | 74.00 | 33.64 | H |

**GFSK Ch 78**

| Frequency (MHz) | Measurement Result (dBuV/m) | Cable Loss (dB) | Antenna Factor (dB/m) | Receiver Reading (dBuV) | Limit (dBuV/m) | Margin (dB) | Antenna Pol. (H/V) |
|---|---|---|---|---|---|---|---|
| 17990.500 | 54.43 | -29.40 | 46.00 | 37.83 | 74.00 | 19.57 | V |
| 14588.000 | 50.04 | -29.00 | 41.90 | 37.14 | 74.00 | 23.96 | V |
| 11894.000 | 46.03 | -32.40 | 39.10 | 39.33 | 74.00 | 27.97 | V |
| 9696.500 | 43.91 | -34.00 | 37.70 | 40.21 | 74.00 | 30.09 | V |
| 7423.500 | 42.89 | -35.10 | 36.60 | 41.39 | 74.00 | 31.11 | H |
| 2485.000 | 57.39 | -19.70 | 28.20 | 48.89 | 74.00 | 16.61 | H |

©Copyright. All rights reserved by CTTL.

**π/4 DQPSK Ch 0**

| Frequency (MHz) | Measurement Result (dBuV/m) | Cable Loss (dB) | Antenna Factor (dB/m) | Receiver Reading (dBuV) | Limit (dBuV/m) | Margin (dB) | Antenna Pol. (H/V) |
|---|---|---|---|---|---|---|---|
| 17966.500 | 54.64 | -29.40 | 46.00 | 38.04 | 74.00 | 19.36 | V |
| 14558.500 | 50.50 | -29.00 | 41.90 | 37.60 | 74.00 | 23.50 | H |
| 12918.000 | 46.54 | -31.50 | 40.00 | 38.04 | 74.00 | 27.46 | V |
| 8572.500 | 43.94 | -35.00 | 37.50 | 41.44 | 74.00 | 30.06 | V |
| 7962.500 | 43.16 | -35.40 | 36.80 | 41.76 | 74.00 | 30.84 | V |
| 2382.600 | 55.79 | -19.80 | 28.20 | 47.39 | 74.00 | 18.21 | V |

**π/4 DQPSK Ch 39**

| Frequency (MHz) | Measurement Result (dBuV/m) | Cable Loss (dB) | Antenna Factor (dB/m) | Receiver Reading (dBuV) | Limit (dBuV/m) | Margin (dB) | Antenna Pol. (H/V) |
|---|---|---|---|---|---|---|---|
| 17951.000 | 54.80 | -29.40 | 46.00 | 38.20 | 74.00 | 19.20 | V |
| 14570.000 | 49.74 | -29.00 | 41.90 | 36.84 | 74.00 | 24.26 | H |
| 12842.000 | 45.93 | -31.90 | 39.90 | 37.93 | 74.00 | 28.07 | V |
| 9324.000 | 44.12 | -34.10 | 37.80 | 40.42 | 74.00 | 29.88 | V |
| 7444.500 | 43.36 | -35.50 | 36.50 | 42.36 | 74.00 | 30.64 | V |
| 4315.000 | 40.13 | -37.80 | 32.20 | 45.73 | 74.00 | 33.87 | V |

**π/4 DQPSK Ch 78**

| Frequency (MHz) | Measurement Result (dBuV/m) | Cable Loss (dB) | Antenna Factor (dB/m) | Receiver Reading (dBuV) | Limit (dBuV/m) | Margin (dB) | Antenna Pol. (H/V) |
|---|---|---|---|---|---|---|---|
| 17997.000 | 54.05 | -29.40 | 46.00 | 37.45 | 74.00 | 19.95 | H |
| 14201.500 | 50.57 | -30.20 | 41.70 | 39.07 | 74.00 | 23.43 | H |
| 12258.500 | 46.49 | -32.50 | 39.00 | 39.99 | 74.00 | 27.51 | V |
| 9205.500 | 45.17 | -34.70 | 37.70 | 42.17 | 74.00 | 28.83 | V |
| 7954.500 | 43.37 | -35.40 | 36.80 | 41.97 | 74.00 | 30.63 | V |
| 2485.300 | 55.96 | -19.70 | 28.20 | 47.46 | 74.00 | 18.04 | V |

©Copyright. All rights reserved by CTTL.

**8DPSK Ch 0**

| Frequency (MHz) | Measurement Result (dBuV/m) | Cable Loss (dB) | Antenna Factor (dB/m) | Receiver Reading (dBuV) | Limit (dBuV/m) | Margin (dB) | Antenna Pol. (H/V) |
|---|---|---|---|---|---|---|---|
| 17787.000 | 54.16 | -29.40 | 46.00 | 37.56 | 74.00 | 19.84 | H |
| 14210.000 | 50.67 | -30.60 | 41.80 | 39.57 | 74.00 | 23.33 | V |
| 13000.000 | 46.57 | -31.90 | 40.10 | 38.37 | 74.00 | 27.43 | V |
| 9399.500 | 45.18 | -34.10 | 37.90 | 41.38 | 74.00 | 28.82 | H |
| 7896.000 | 43.26 | -35.20 | 36.70 | 41.76 | 74.00 | 30.74 | V |
| 2333.200 | 55.90 | -19.60 | 28.20 | 47.30 | 74.00 | 18.10 | V |

**8DPSK Ch 39**

| Frequency (MHz) | Measurement Result (dBuV/m) | Cable Loss (dB) | Antenna Factor (dB/m) | Receiver Reading (dBuV) | Limit (dBuV/m) | Margin (dB) | Antenna Pol. (H/V) |
|---|---|---|---|---|---|---|---|
| 17928.500 | 54.31 | -29.40 | 46.00 | 37.71 | 74.00 | 19.69 | V |
| 14544.000 | 50.92 | -30.60 | 41.90 | 39.62 | 74.00 | 23.08 | V |
| 11789.500 | 46.92 | -32.00 | 39.20 | 39.72 | 74.00 | 27.08 | V |
| 9204.500 | 44.07 | -34.70 | 37.70 | 41.07 | 74.00 | 29.93 | H |
| 7964.000 | 43.00 | -35.40 | 36.80 | 41.60 | 74.00 | 31.00 | V |
| 4966.500 | 40.28 | -37.40 | 33.60 | 44.08 | 74.00 | 33.72 | V |

**8DPSK Ch 78**

| Frequency (MHz) | Measurement Result (dBuV/m) | Cable Loss (dB) | Antenna Factor (dB/m) | Receiver Reading (dBuV) | Limit (dBuV/m) | Margin (dB) | Antenna Pol. (H/V) |
|---|---|---|---|---|---|---|---|
| 17972.000 | 55.02 | -29.40 | 46.00 | 38.42 | 74.00 | 18.98 | H |
| 14550.500 | 50.12 | -30.60 | 41.90 | 38.82 | 74.00 | 23.88 | H |
| 11690.000 | 47.14 | -32.90 | 39.20 | 40.84 | 74.00 | 26.86 | H |
| 9832.500 | 44.99 | -34.10 | 37.90 | 41.19 | 74.00 | 29.01 | V |
| 7863.000 | 42.99 | -35.20 | 36.60 | 41.59 | 74.00 | 31.01 | V |
| 2498.500 | 55.77 | -19.70 | 28.20 | 47.27 | 74.00 | 18.23 | V |

©Copyright. All rights reserved by CTTL.

**Average Measurement results**

**GFSK Ch 0**

| Frequency (MHz) | Measurement Result (dBuV/m) | Cable Loss (dB) | Antenna Factor (dB/m) | Receiver Reading (dBuV) | Limit (dBuV/m) | Margin (dB) | Antenna Pol. (H/V) |
|---|---|---|---|---|---|---|---|
| 17997.000 | 44.92 | -29.40 | 46.00 | 28.32 | 54.00 | 9.08 | V |
| 14672.500 | 40.58 | -30.00 | 41.50 | 29.08 | 54.00 | 13.42 | H |
| 12851.500 | 36.89 | -31.90 | 39.90 | 28.89 | 54.00 | 17.11 | H |
| 9005.500 | 35.21 | -34.70 | 37.70 | 32.21 | 54.00 | 18.79 | H |
| 7454.500 | 34.07 | -35.50 | 36.50 | 33.07 | 54.00 | 19.93 | H |
| 2336.800 | 44.29 | -19.60 | 28.20 | 35.69 | 54.00 | 9.71 | H |

**GFSK Ch 39**

| Frequency (MHz) | Measurement Result (dBuV/m) | Cable Loss (dB) | Antenna Factor (dB/m) | Receiver Reading (dBuV) | Limit (dBuV/m) | Margin (dB) | Antenna Pol. (H/V) |
|---|---|---|---|---|---|---|---|
| 17942.500 | 44.78 | -29.40 | 46.00 | 28.18 | 54.00 | 9.22 | H |
| 14549.000 | 40.49 | -30.60 | 41.90 | 29.19 | 54.00 | 13.51 | V |
| 12735.000 | 36.67 | -31.80 | 39.60 | 28.77 | 54.00 | 17.33 | V |
| 9857.500 | 34.72 | -33.90 | 37.90 | 30.72 | 54.00 | 19.28 | V |
| 7412.000 | 33.23 | -35.10 | 36.60 | 31.73 | 54.00 | 20.77 | V |
| 4960.000 | 30.18 | -37.40 | 33.60 | 33.98 | 54.00 | 23.82 | V |

**GFSK Ch 78**

| Frequency (MHz) | Measurement Result (dBuV/m) | Cable Loss (dB) | Antenna Factor (dB/m) | Receiver Reading (dBuV) | Limit (dBuV/m) | Margin (dB) | Antenna Pol. (H/V) |
|---|---|---|---|---|---|---|---|
| 17980.000 | 45.32 | -29.40 | 46.00 | 28.72 | 54.00 | 8.68 | V |
| 14574.500 | 40.34 | -29.00 | 41.90 | 27.44 | 54.00 | 13.66 | V |
| 12919.000 | 36.37 | -31.50 | 40.00 | 27.87 | 54.00 | 17.63 | H |
| 9204.500 | 34.58 | -34.70 | 37.70 | 31.58 | 54.00 | 19.42 | V |
| 7972.500 | 33.22 | -35.40 | 36.90 | 31.72 | 54.00 | 20.78 | V |
| 2494.700 | 44.13 | -19.70 | 28.20 | 35.63 | 54.00 | 9.87 | H |

©Copyright. All rights reserved by CTTL.

**π/4 DQPSK Ch 0**

| Frequency (MHz) | Measurement Result (dBuV/m) | Cable Loss (dB) | Antenna Factor (dB/m) | Receiver Reading (dBuV) | Limit (dBuV/m) | Margin (dB) | Antenna Pol. (H/V) |
|---|---|---|---|---|---|---|---|
| 17973.500 | 45.06 | -29.40 | 46.00 | 28.46 | 54.00 | 8.94 | H |
| 14549.000 | 40.25 | -30.60 | 41.90 | 28.95 | 54.00 | 13.75 | V |
| 11779.000 | 36.47 | -32.90 | 39.20 | 30.17 | 54.00 | 17.53 | V |
| 9195.500 | 34.50 | -34.70 | 37.70 | 31.50 | 54.00 | 19.50 | H |
| 7293.000 | 33.51 | -35.40 | 36.60 | 32.31 | 54.00 | 20.49 | H |
| 2355.400 | 43.95 | -19.60 | 28.20 | 35.35 | 54.00 | 10.05 | H |

**π/4 DQPSK Ch 39**

| Frequency (MHz) | Measurement Result (dBuV/m) | Cable Loss (dB) | Antenna Factor (dB/m) | Receiver Reading (dBuV) | Limit (dBuV/m) | Margin (dB) | Antenna Pol. (H/V) |
|---|---|---|---|---|---|---|---|
| 17980.500 | 45.04 | -29.40 | 46.00 | 28.44 | 54.00 | 8.96 | V |
| 14551.500 | 40.38 | -30.60 | 41.90 | 29.08 | 54.00 | 13.62 | H |
| 12990.500 | 36.64 | -31.90 | 40.10 | 28.44 | 54.00 | 17.36 | H |
| 9627.500 | 34.59 | -34.30 | 37.60 | 31.29 | 54.00 | 19.41 | V |
| 7232.500 | 33.30 | -35.60 | 36.40 | 32.50 | 54.00 | 20.70 | V |
| 4977.000 | 30.44 | -37.40 | 33.60 | 34.24 | 54.00 | 23.56 | V |

**π/4 DQPSK Ch 78**

| Frequency (MHz) | Measurement Result (dBuV/m) | Cable Loss (dB) | Antenna Factor (dB/m) | Receiver Reading (dBuV) | Limit (dBuV/m) | Margin (dB) | Antenna Pol. (H/V) |
|---|---|---|---|---|---|---|---|
| 17902.500 | 44.76 | -29.40 | 46.00 | 28.16 | 54.00 | 9.24 | V |
| 14692.000 | 40.68 | -30.00 | 41.50 | 29.18 | 54.00 | 13.32 | H |
| 11887.500 | 36.47 | -32.40 | 39.10 | 29.77 | 54.00 | 17.53 | H |
| 8994.000 | 34.84 | -34.70 | 37.70 | 31.84 | 54.00 | 19.16 | V |
| 7343.500 | 33.33 | -35.90 | 36.60 | 32.63 | 54.00 | 20.67 | V |
| 2488.000 | 44.28 | -19.70 | 28.20 | 35.78 | 54.00 | 9.72 | V |

©Copyright. All rights reserved by CTTL.

**8DPSK Ch 0**

| Frequency (MHz) | Measurement Result (dBuV/m) | Cable Loss (dB) | Antenna Factor (dB/m) | Receiver Reading (dBuV) | Limit (dBuV/m) | Margin (dB) | Antenna Pol. (H/V) |
|---|---|---|---|---|---|---|---|
| 17990.000 | 44.99 | -29.40 | 46.00 | 28.39 | 54.00 | 9.01 | V |
| 14701.000 | 40.51 | -30.00 | 41.50 | 29.01 | 54.00 | 13.49 | V |
| 11731.500 | 36.43 | -32.90 | 39.20 | 30.13 | 54.00 | 17.57 | V |
| 8999.500 | 34.96 | -34.70 | 37.70 | 31.96 | 54.00 | 19.04 | V |
| 7418.500 | 33.22 | -35.10 | 36.60 | 31.72 | 54.00 | 20.78 | V |
| 2360.100 | 44.21 | -19.60 | 28.20 | 35.61 | 54.00 | 9.79 | V |

**8DPSK Ch 39**

| Frequency (MHz) | Measurement Result (dBuV/m) | Cable Loss (dB) | Antenna Factor (dB/m) | Receiver Reading (dBuV) | Limit (dBuV/m) | Margin (dB) | Antenna Pol. (H/V) |
|---|---|---|---|---|---|---|---|
| 17993.500 | 45.13 | -29.40 | 46.00 | 28.53 | 54.00 | 8.87 | H |
| 14557.000 | 40.53 | -29.00 | 41.90 | 27.63 | 54.00 | 13.47 | V |
| 12922.500 | 36.71 | -31.40 | 40.00 | 28.11 | 54.00 | 17.29 | V |
| 9183.500 | 34.93 | -34.70 | 37.70 | 31.93 | 54.00 | 19.07 | V |
| 7558.500 | 33.47 | -35.50 | 36.30 | 32.67 | 54.00 | 20.53 | V |
| 4970.500 | 30.14 | -37.40 | 33.60 | 33.94 | 54.00 | 23.86 | V |

**8DPSK Ch 78**

| Frequency (MHz) | Measurement Result (dBuV/m) | Cable Loss (dB) | Antenna Factor (dB/m) | Receiver Reading (dBuV) | Limit (dBuV/m) | Margin (dB) | Antenna Pol. (H/V) |
|---|---|---|---|---|---|---|---|
| 17917.000 | 44.75 | -29.40 | 46.00 | 28.15 | 54.00 | 9.25 | H |
| 14117.000 | 40.31 | -30.80 | 41.70 | 29.41 | 54.00 | 13.69 | V |
| 11887.000 | 36.98 | -32.40 | 39.10 | 30.28 | 54.00 | 17.02 | H |
| 9082.000 | 34.65 | -34.60 | 37.70 | 31.55 | 54.00 | 19.35 | V |
| 7445.500 | 33.78 | -35.50 | 36.50 | 32.78 | 54.00 | 20.22 | V |
| 2486.900 | 44.15 | -19.70 | 28.20 | 35.65 | 54.00 | 9.85 | V |

**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 |

©Copyright. All rights reserved by CTTL.

| Mode | Channel | Frequency Range | Test Results | Conclusion |
|---|---|---|---|---|
| π/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**

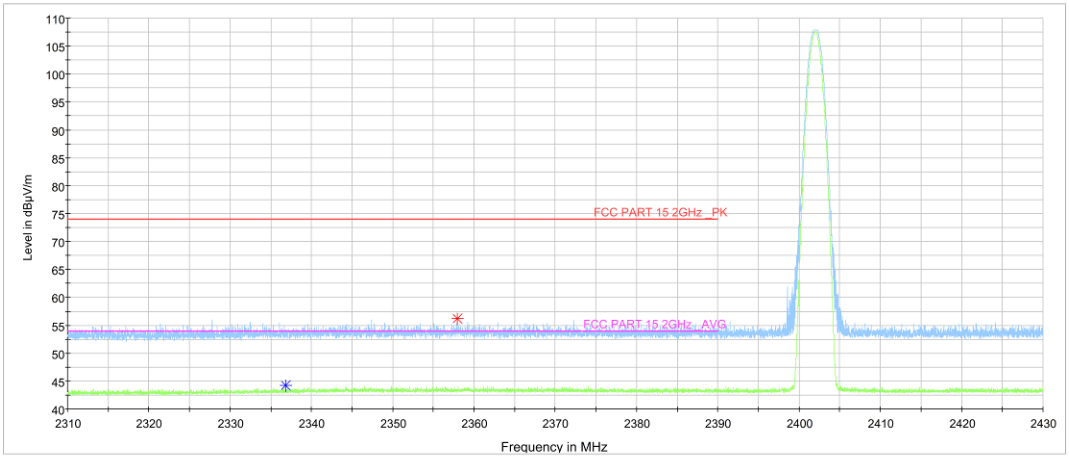



**Fig.58. Frequency Band Edges: GFSK, Channel 0, Hopping Off, 2.31 GHz – 2.45GHz**

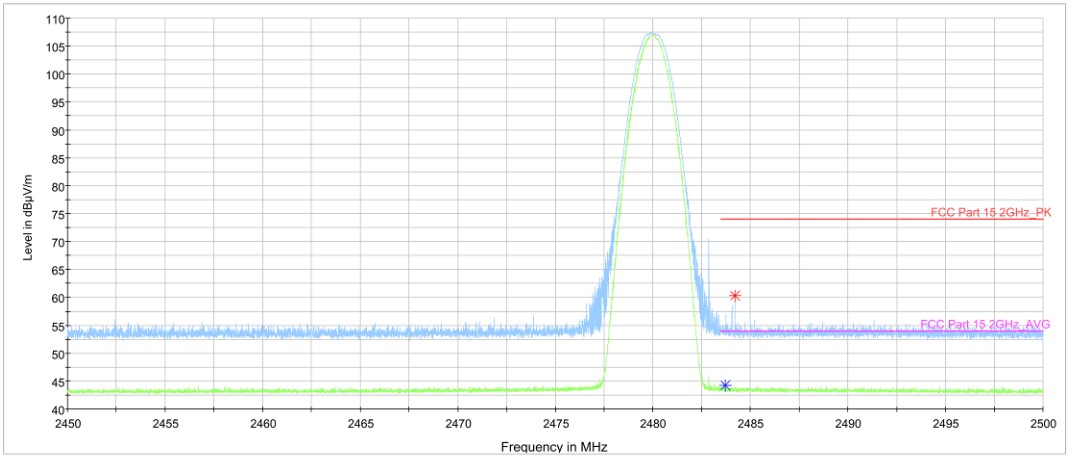



**Fig.59. Frequency Band Edges: GFSK, Channel 78, Hopping Off, ch11, 2.45 GHz - 2.50GHz**

©Copyright. All rights reserved by CTTL.

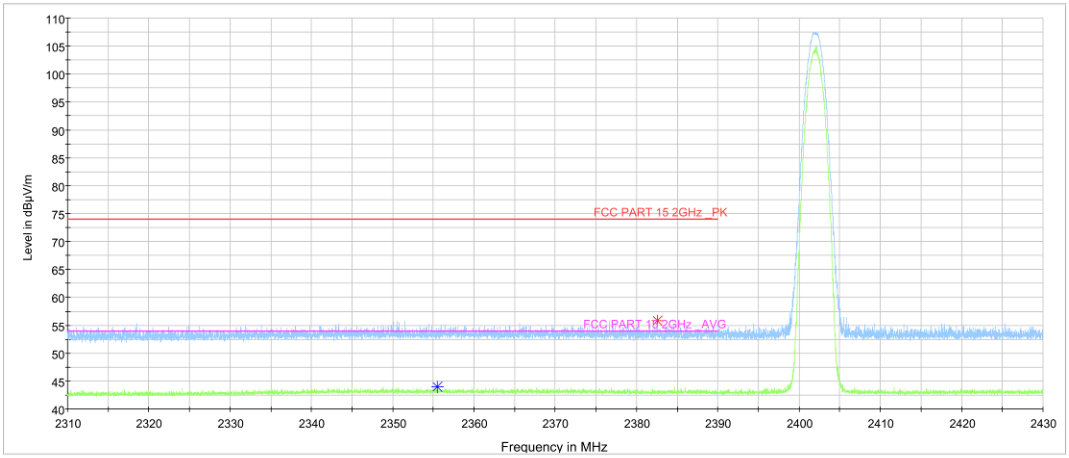



**Fig.60. Frequency Band Edges: π/4 DQPSK, Channel 0, Hopping Off, 2.31 GHz - 2.45GHz**

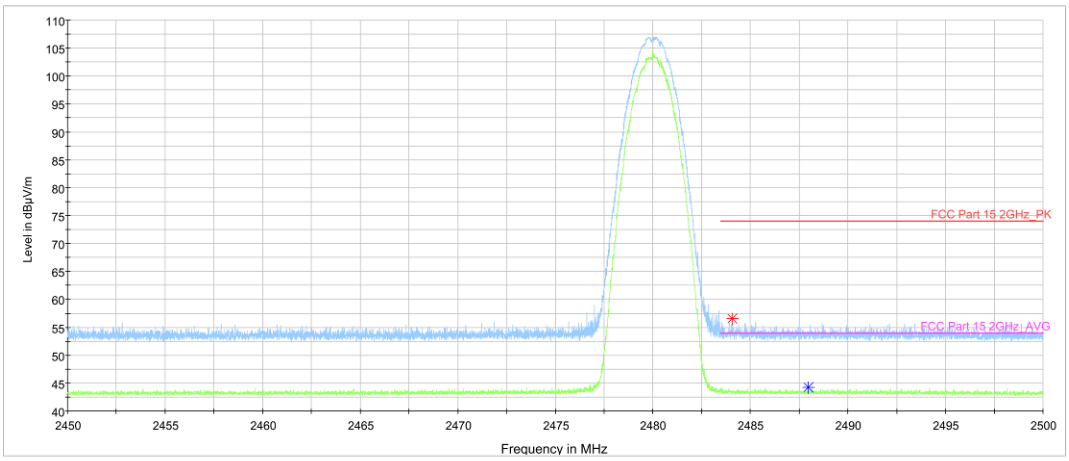



**Fig.61. Frequency Band Edges: π/4 DQPSK, Channel 78, Hopping Off, 2.45 GHz - 2.50GHz**

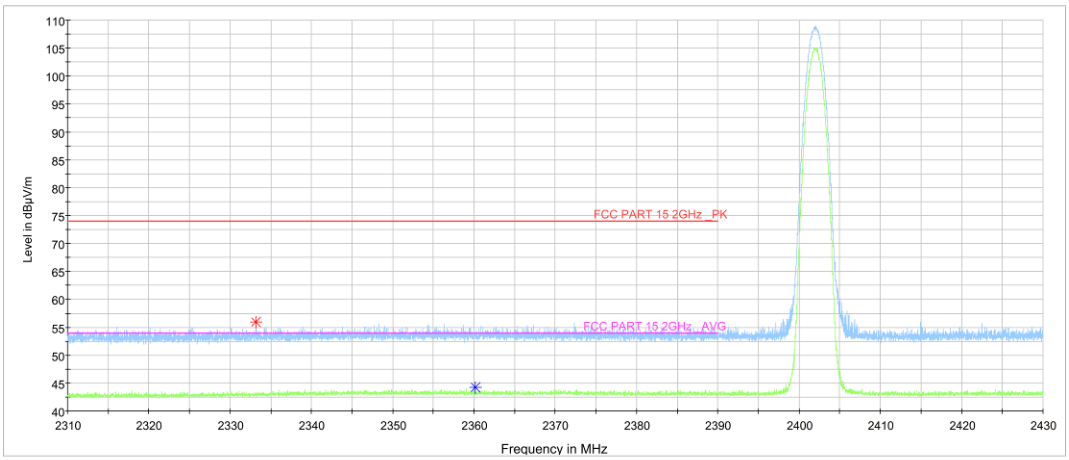



**Fig.62. Frequency Band Edges: 8DPSK, Channel 0, 2.31 GHz - 2.45GHz**

©Copyright. All rights reserved by CTTL.

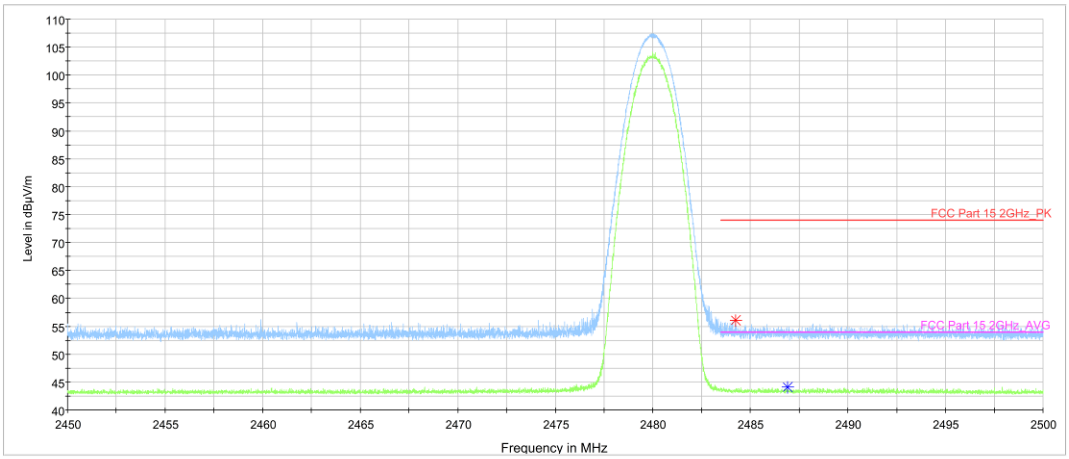



**Fig.63. Frequency Band Edges: 8DPSK, Channel 78, 2.45 GHz - 2.50GHz**

©Copyright. All rights reserved by CTTL.

## 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 ≥ 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 |
|---|---|---|---|---|---|---|---|
| 39 | DH1 | Fig.64 | 0.38 | Fig.65 | 321 | 121.98 | P |
| | DH3 | Fig.66 | 1.64 | Fig.67 | 113 | 185.32 | P |
| | DH5 | Fig.68 | 2.89 | Fig.69 | 70 | 202.3 | P |

**For π/4 DQPSK**

| Channel | Packet | Pulse time (ms) | | Number of Transmissions | | Dwell Time (ms) | Conclusion |
|---|---|---|---|---|---|---|---|
| 39 | 2DH1 | Fig.70 | 0.39 | Fig.71 | 320 | 124.8 | P |
| | 2DH3 | Fig.72 | 1.64 | Fig.73 | 107 | 175.48 | P |
| | 2DH5 | Fig.74 | 2.89 | Fig.75 | 63 | 182.07 | P |

©Copyright. All rights reserved by CTTL.

**For 8DPSK**

| Channel | Packet | Pulse time (ms) | | Number of Transmissions | | Dwell Time (ms) | Conclusion |
|---|---|---|---|---|---|---|---|
| 39 | 3DH1 | Fig.76 | 0.38 | Fig.77 | 320 | 121.6 | P |
| | 3DH3 | Fig.78 | 1.64 | Fig.79 | 101 | 165.64 | P |
| | 3DH5 | Fig.80 | 2.89 | Fig.81 | 57 | 164.73 | P |

**Conclusion: PASS**

**Test graphs as below:**

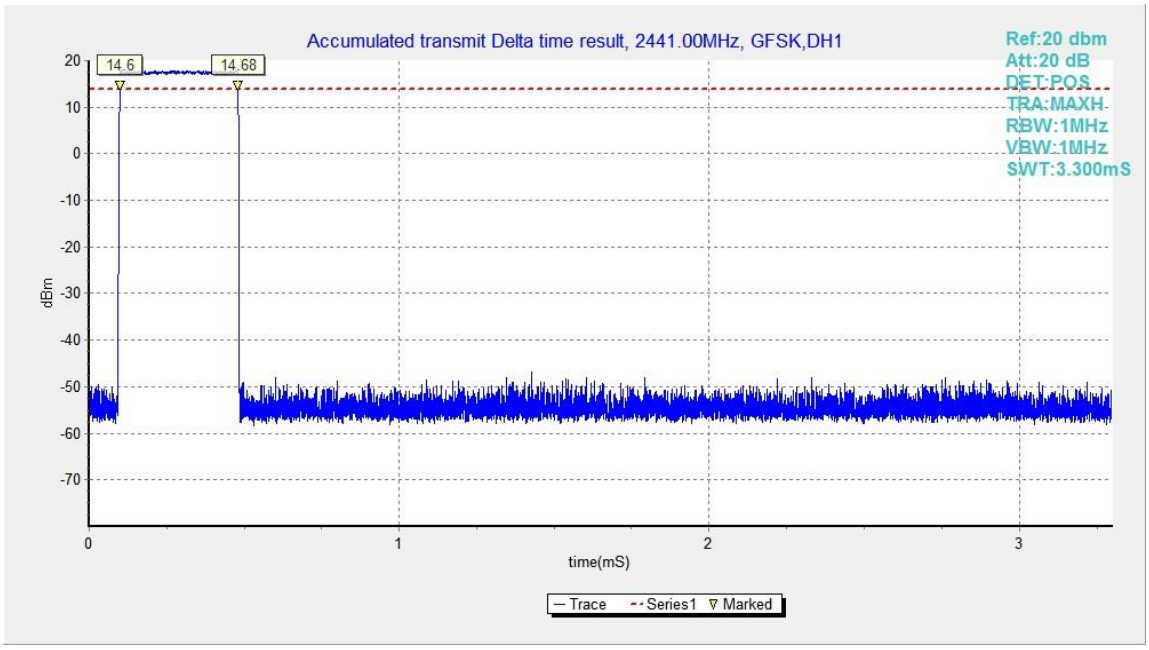



Fig.64. Time of occupancy (Dwell Time): Channel 39, Packet DH1

©Copyright. All rights reserved by CTTL.

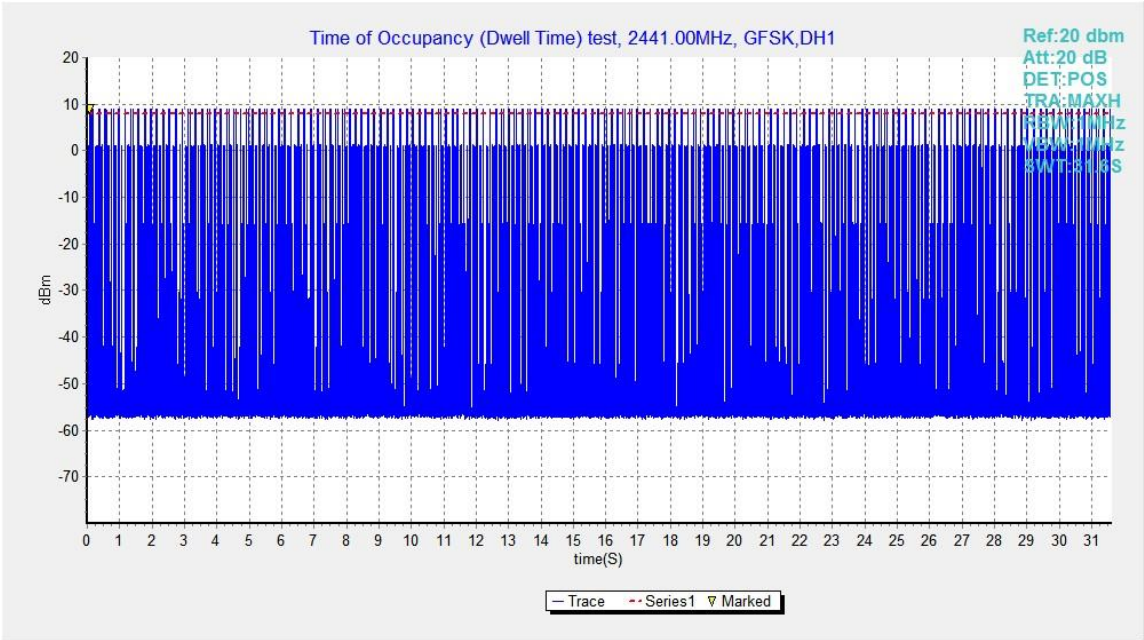



Fig.65. Number of Transmissions Measurement: Channel 39,Packet DH1

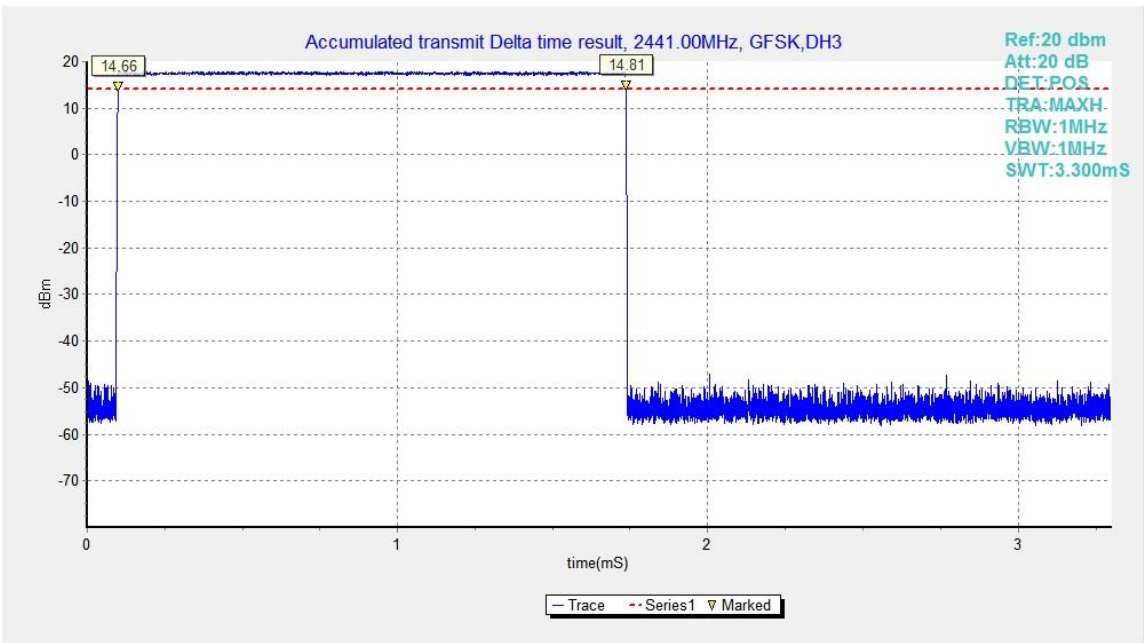



Fig.66. Time of occupancy (Dwell Time): Channel 39, Packet DH3

©Copyright. All rights reserved by CTTL.

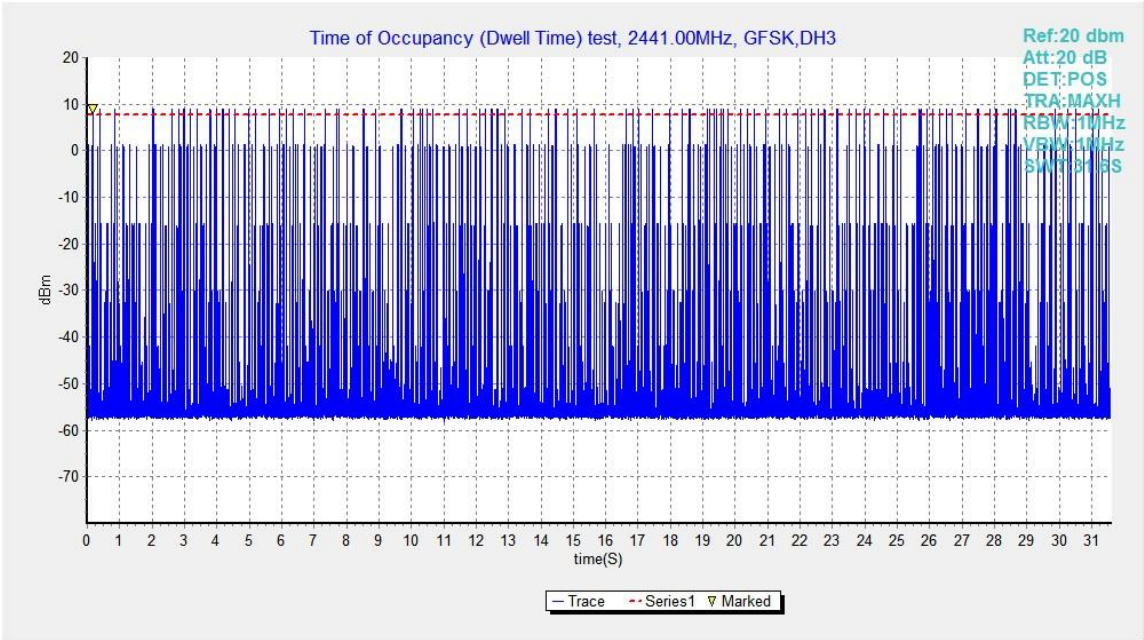



Fig.67. Number of Transmissions Measurement: Channel 39,Packet DH3

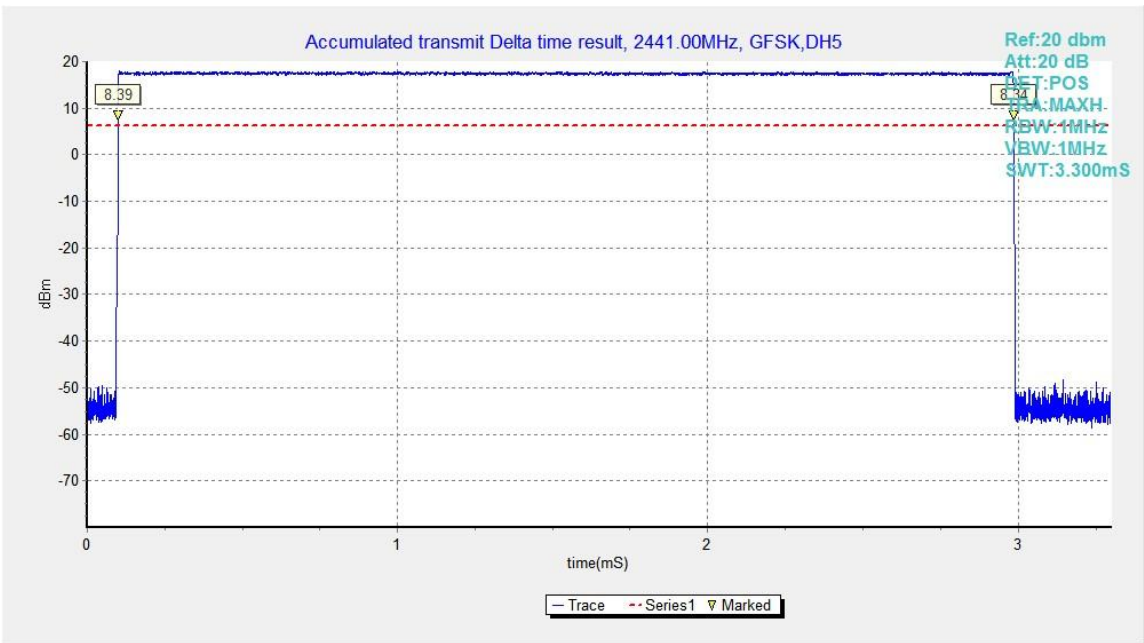



Fig.68. Time of occupancy (Dwell Time): Channel 39, Packet DH5

©Copyright. All rights reserved by CTTL.

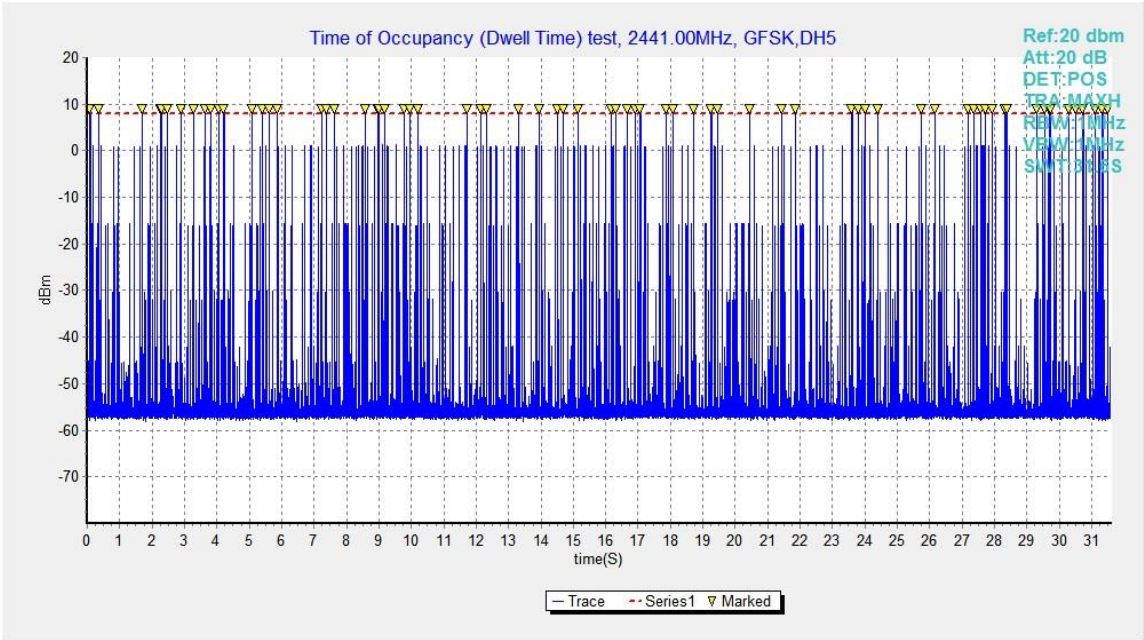



Fig.69. Number of Transmissions Measurement: Channel 39,Packet DH5

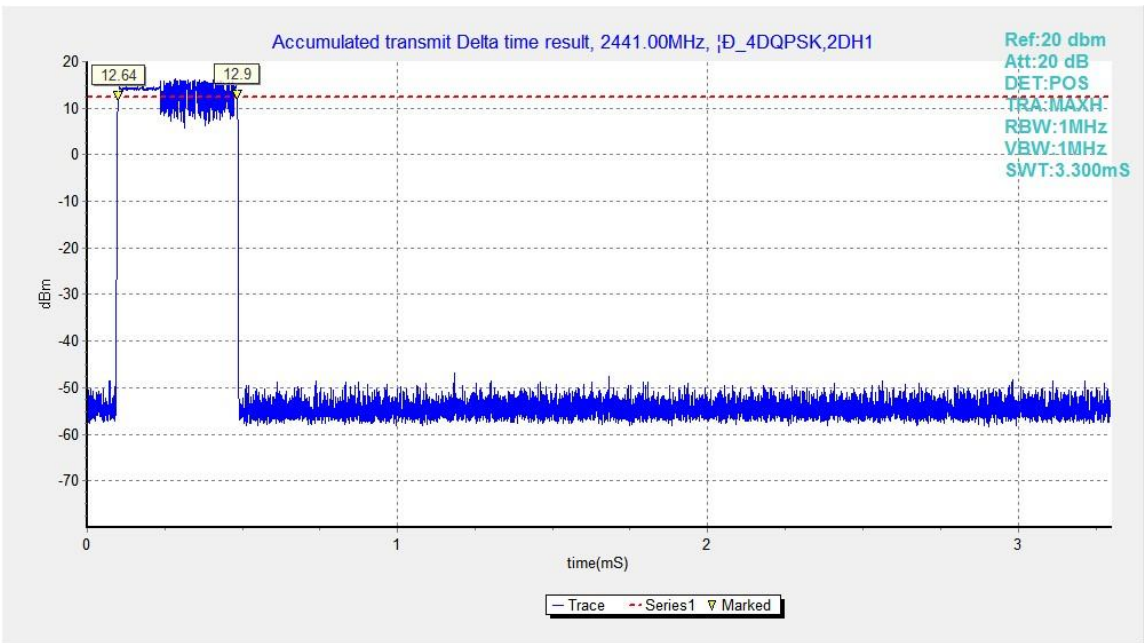



Fig.70. Time of occupancy (Dwell Time): Channel 39, Packet 2-DH1

©Copyright. All rights reserved by CTTL.

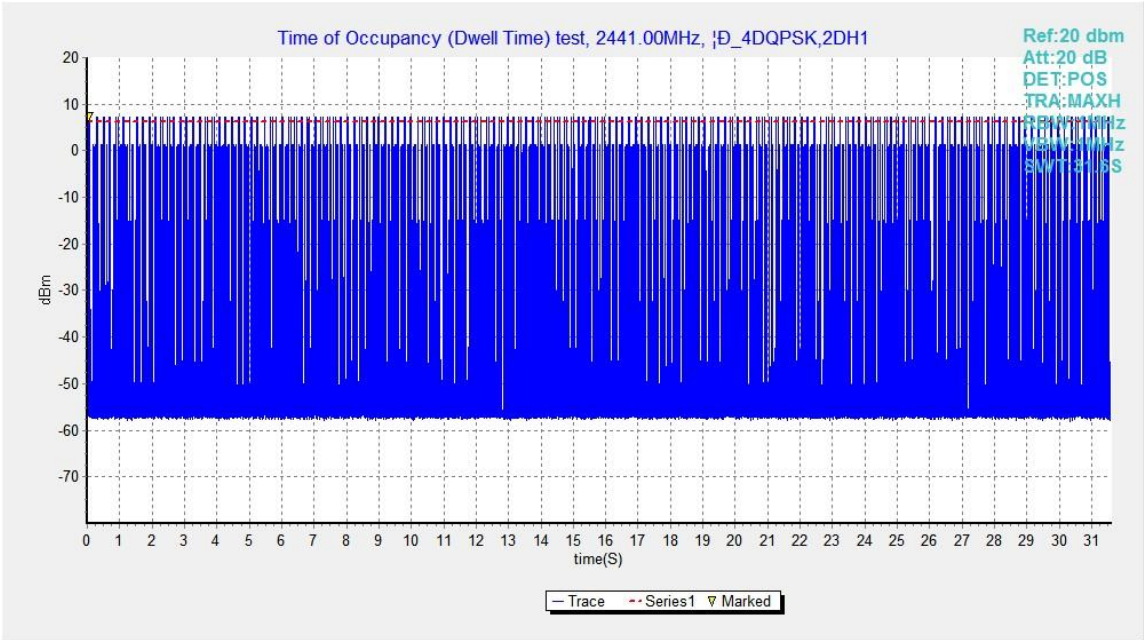



Fig.71. Number of Transmissions Measurement: Channel 39,Packet 2-DH1

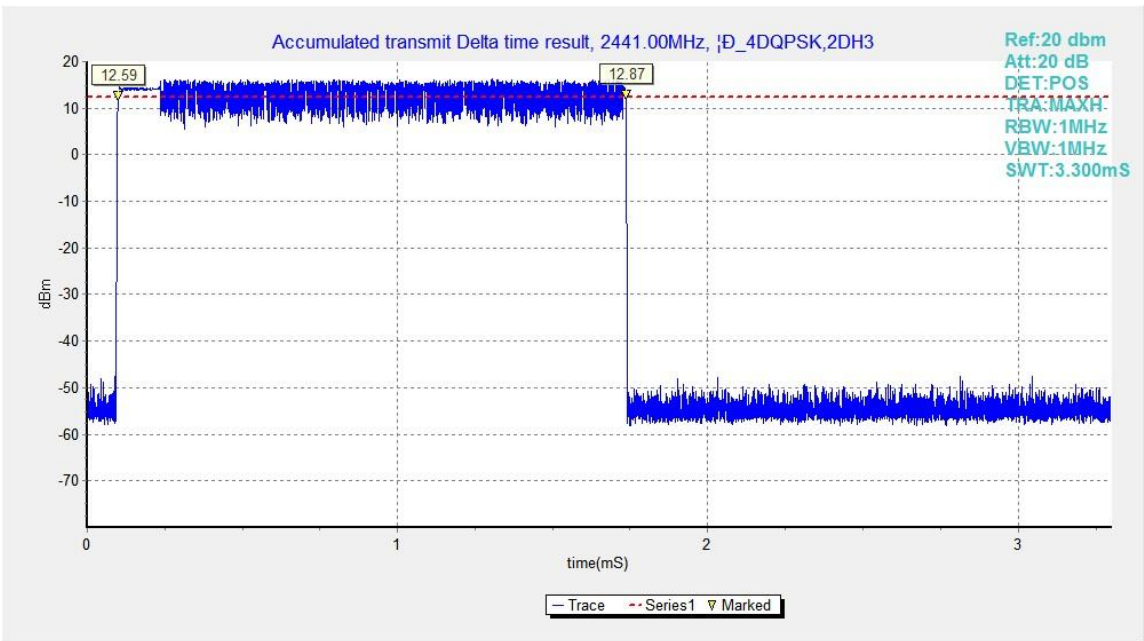



Fig.72. Time of occupancy (Dwell Time): Channel 39, Packet 2-DH3

©Copyright. All rights reserved by CTTL.

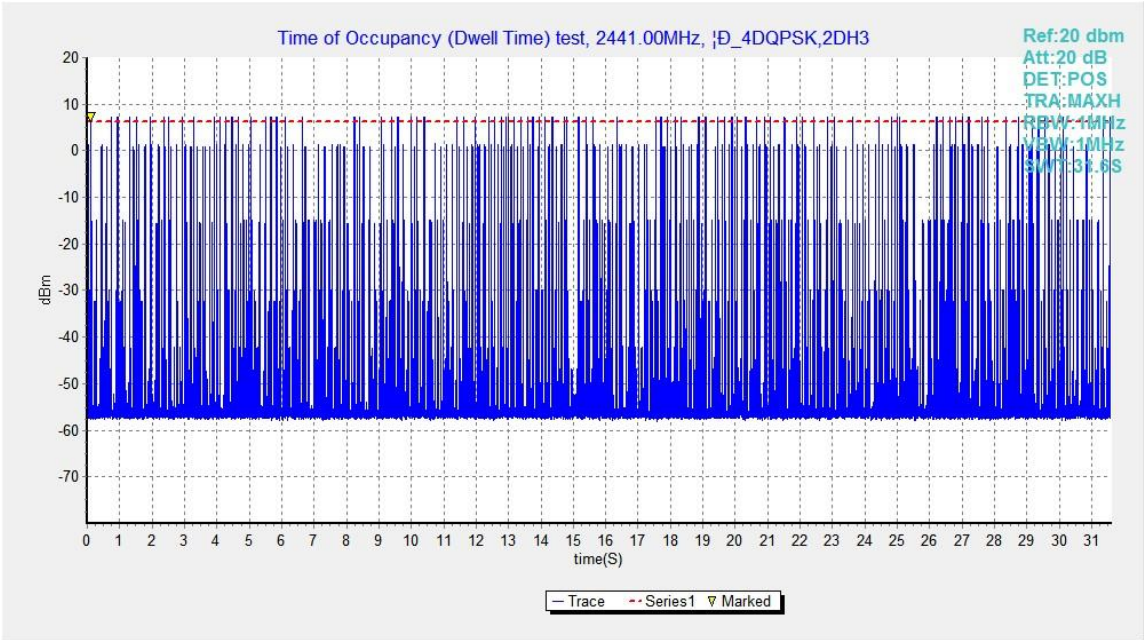



Fig.73. Number of Transmissions Measurement: Channel 39,Packet 2-DH3

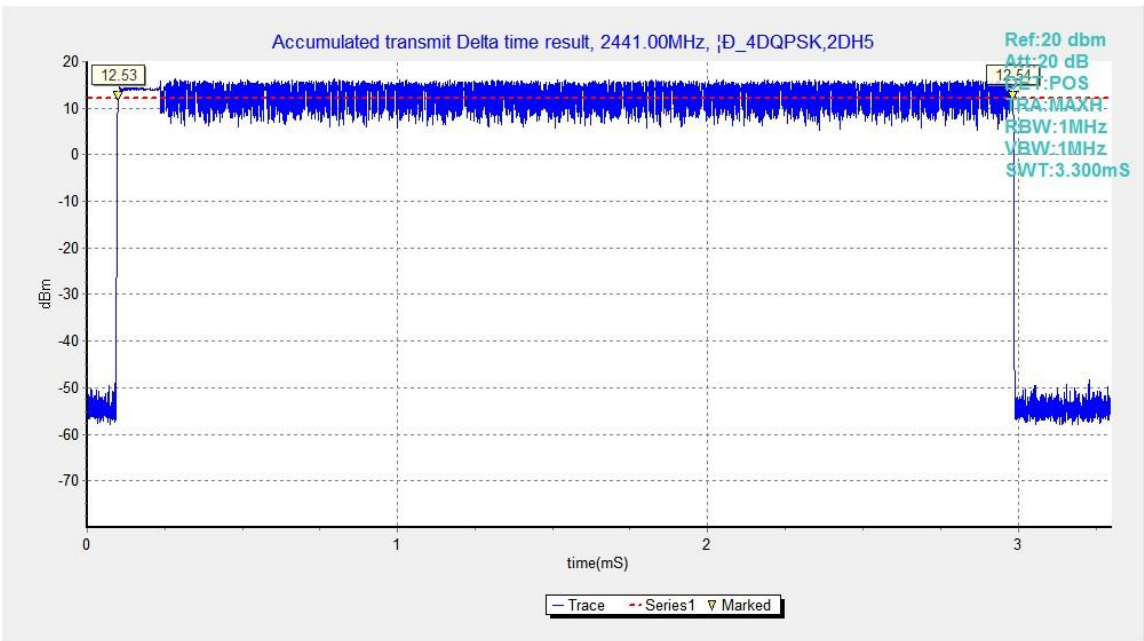



Fig.74. Time of occupancy (Dwell Time): Channel 39, Packet 2-DH5

©Copyright. All rights reserved by CTTL.

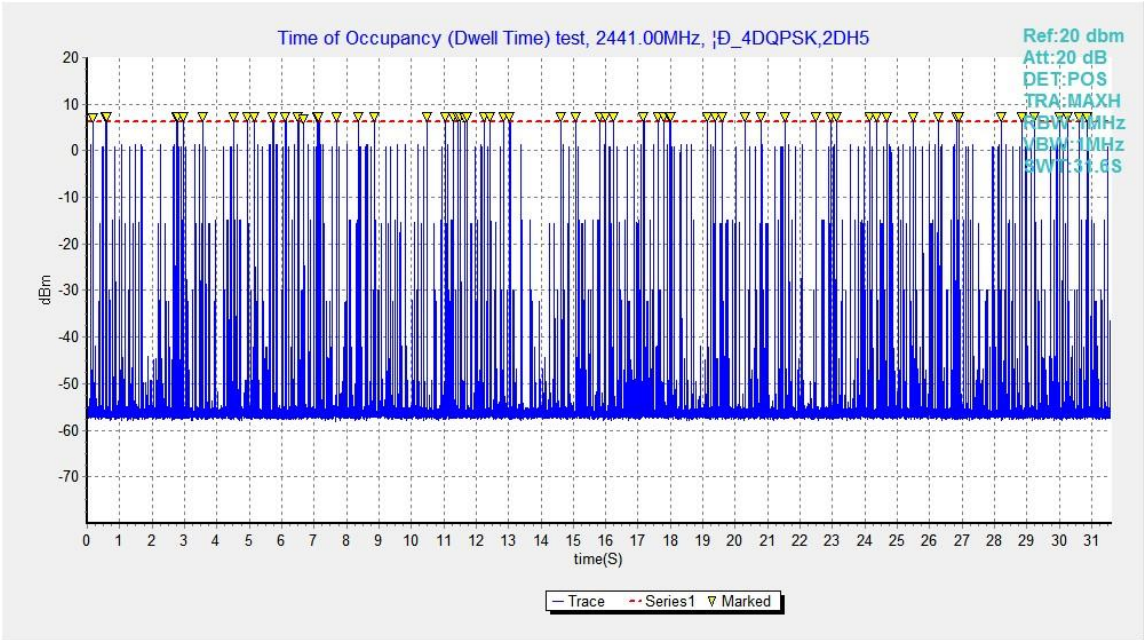



Fig.75. Number of Transmissions Measurement: Channel 39,Packet 2-DH5

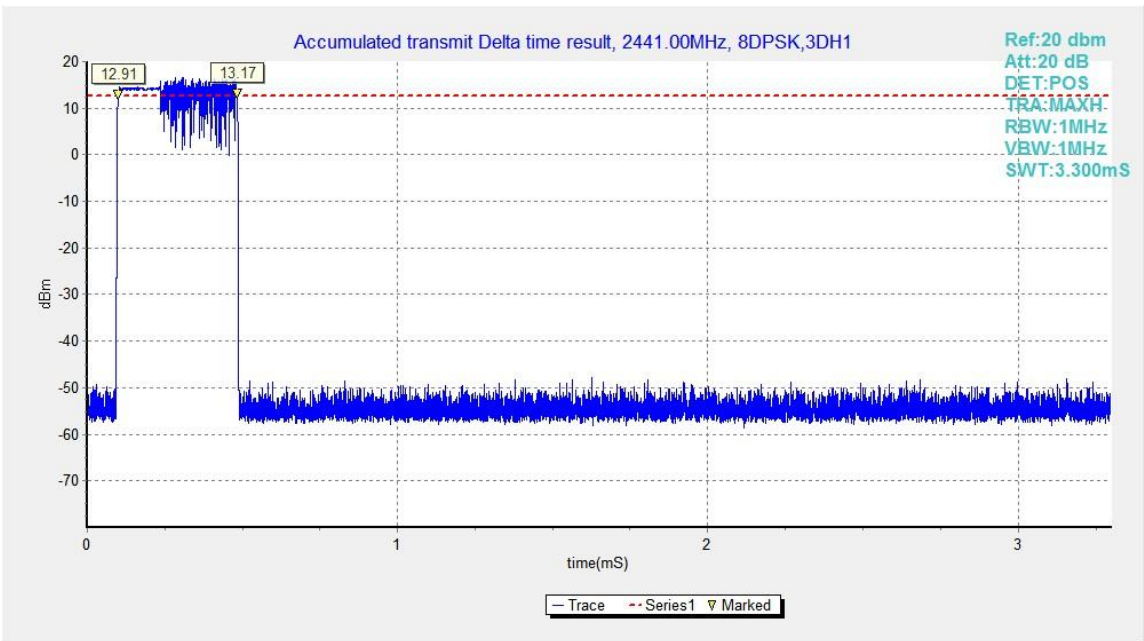



Fig.76. Time of occupancy (Dwell Time): Channel 39, Packet 3-DH1

©Copyright. All rights reserved by CTTL.

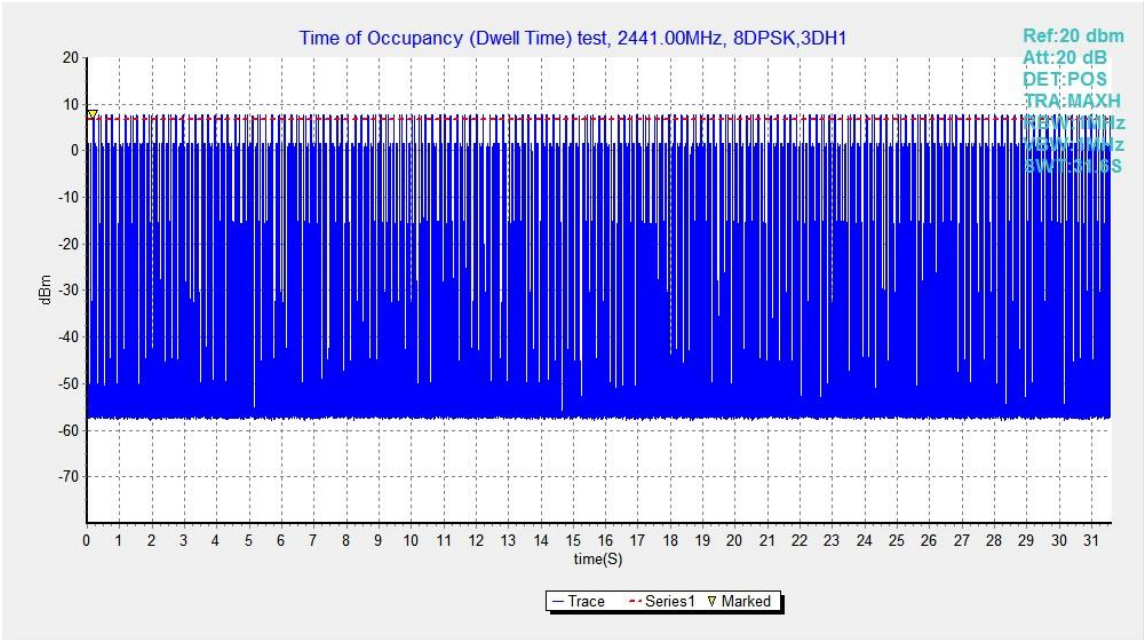



Fig.77. Number of Transmissions Measurement: Channel 39,Packet 3-DH1

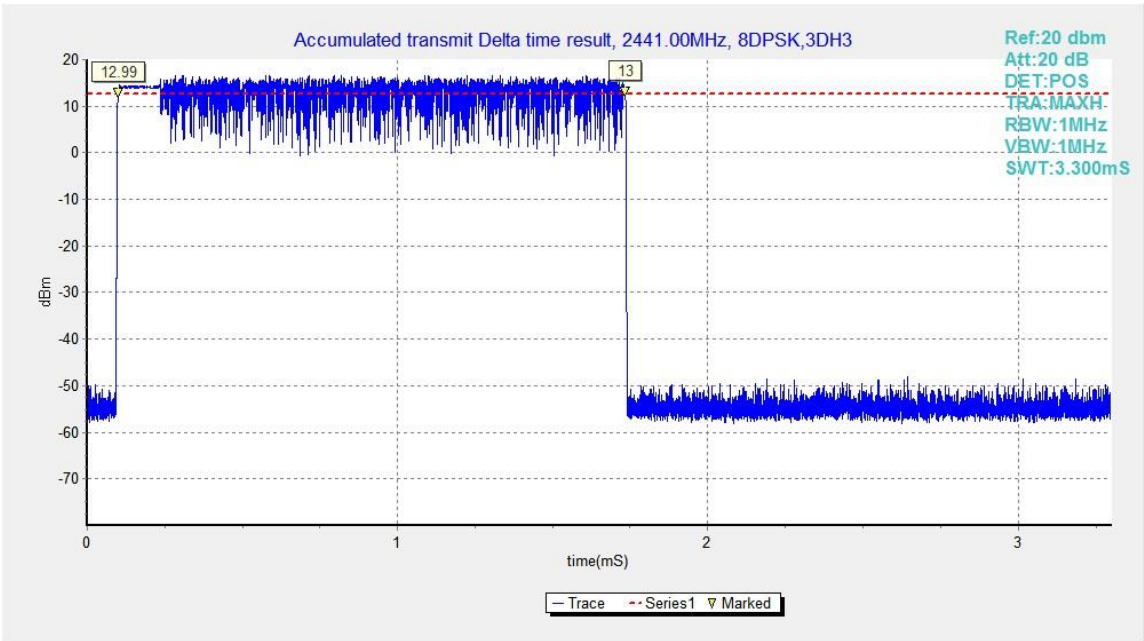



Fig.78. Time of occupancy (Dwell Time): Channel 39, Packet 3-DH3

©Copyright. All rights reserved by CTTL.

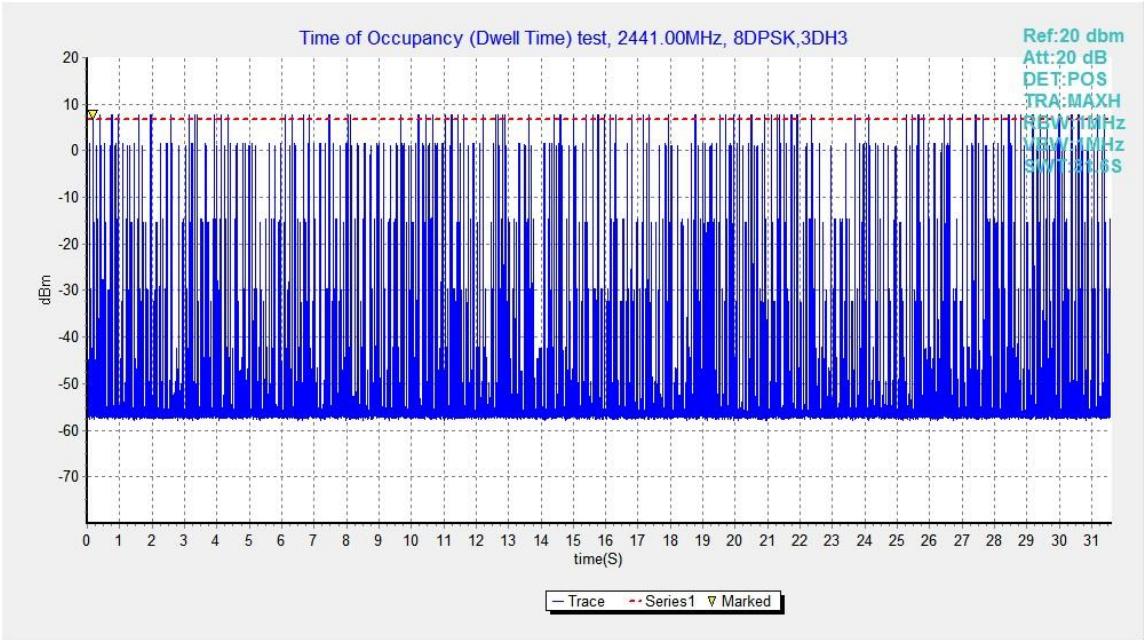



Fig.79. Number of Transmissions Measurement: Channel 39,Packet 3-DH3

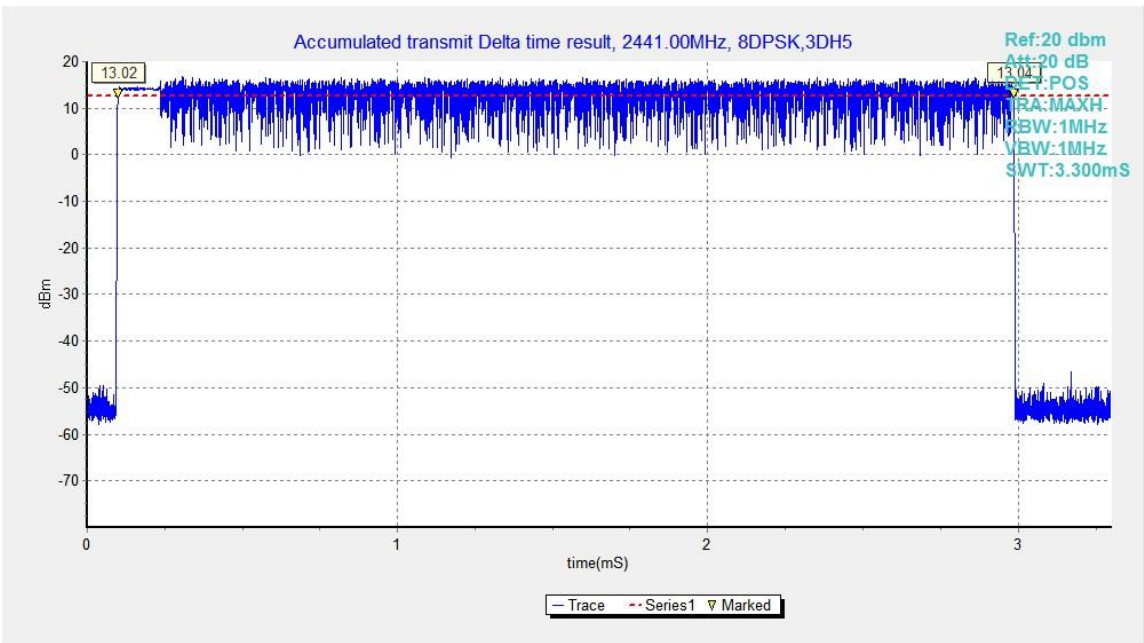



Fig.80. Time of occupancy (Dwell Time): Channel 39, Packet 3-DH5

©Copyright. All rights reserved by CTTL.

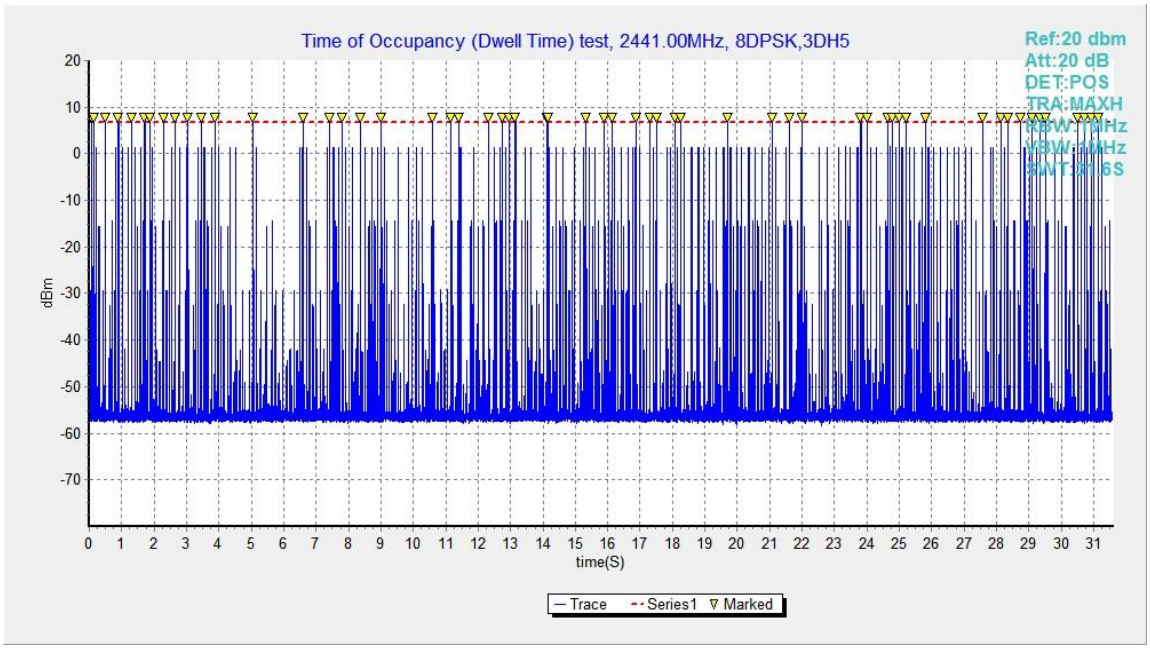



Fig.81. Number of Transmissions Measurement: Channel 39,Packet 3-DH5

©Copyright. All rights reserved by CTTL.

## 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 | 947.25 | NA |
| 39 | Fig.83 | 926.25 | NA |
| 78 | Fig.84 | 945.00 | NA |

**For π/4 DQPSK**

| Channel | 20dB Bandwidth (kHz) | | Conclusion |
|---|---|---|---|
| 0 | Fig.85 | 1290.00 | NA |
| 39 | Fig.86 | 1287.00 | NA |
| 78 | Fig.87 | 1326.00 | NA |

**For 8DPSK**

| Channel | 20dB Bandwidth (kHz) | | Conclusion |
|---|---|---|---|
| 0 | Fig.88 | 1298.25 | NA |
| 39 | Fig.89 | 1284.75 | NA |
| 78 | Fig.90 | 1284.75 | NA |

**Conclusion: NA**

**Test graphs as below:**

©Copyright. All rights reserved by CTTL.

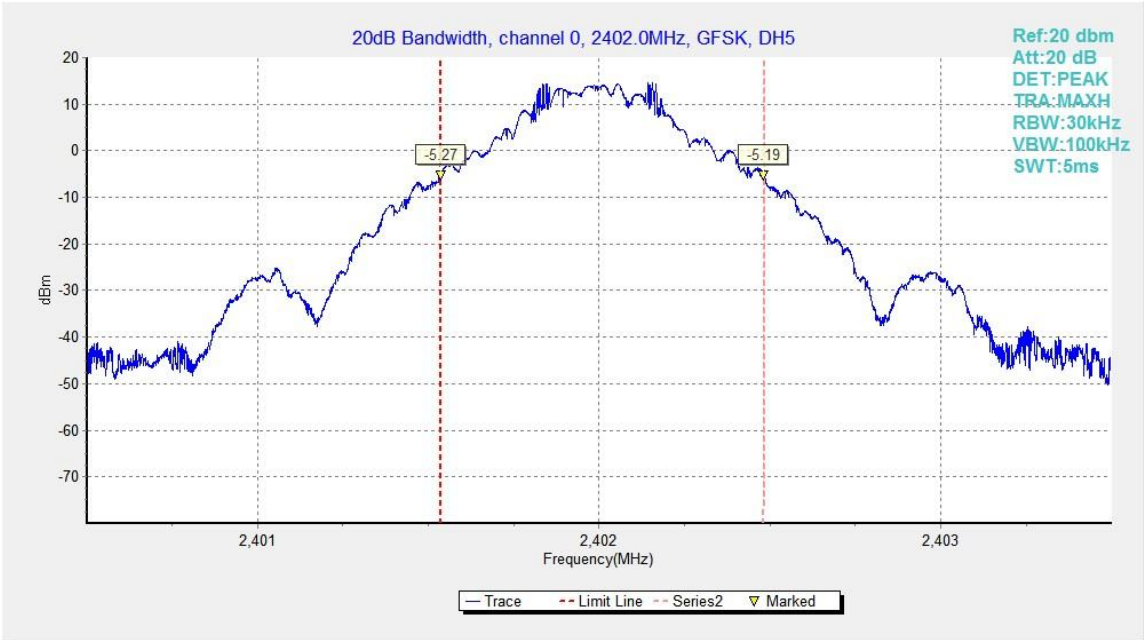



Fig.82. 20dB Bandwidth: GFSK, Channel 0

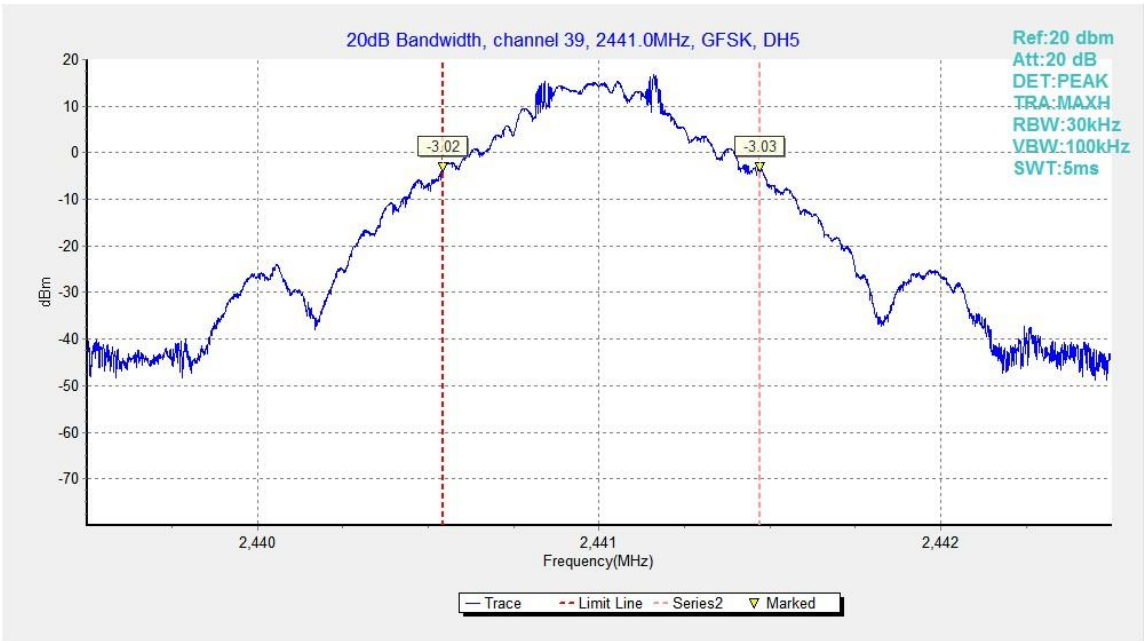



Fig.83. 20dB Bandwidth: GFSK, Channel 39

©Copyright. All rights reserved by CTTL.

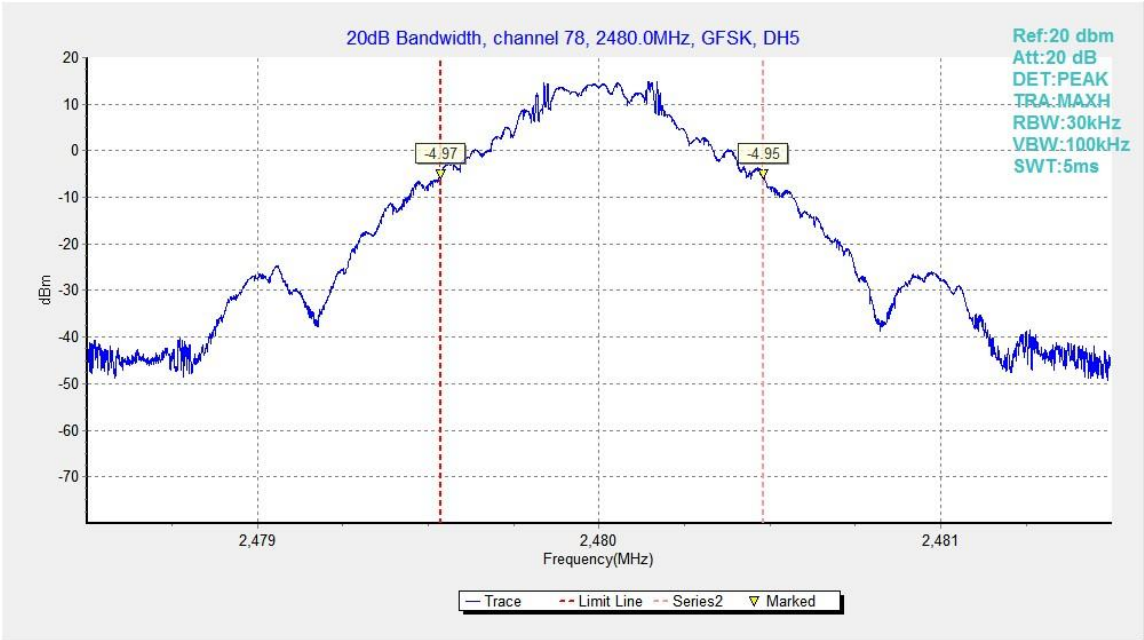



Fig.84. 20dB Bandwidth: GFSK, Channel 78

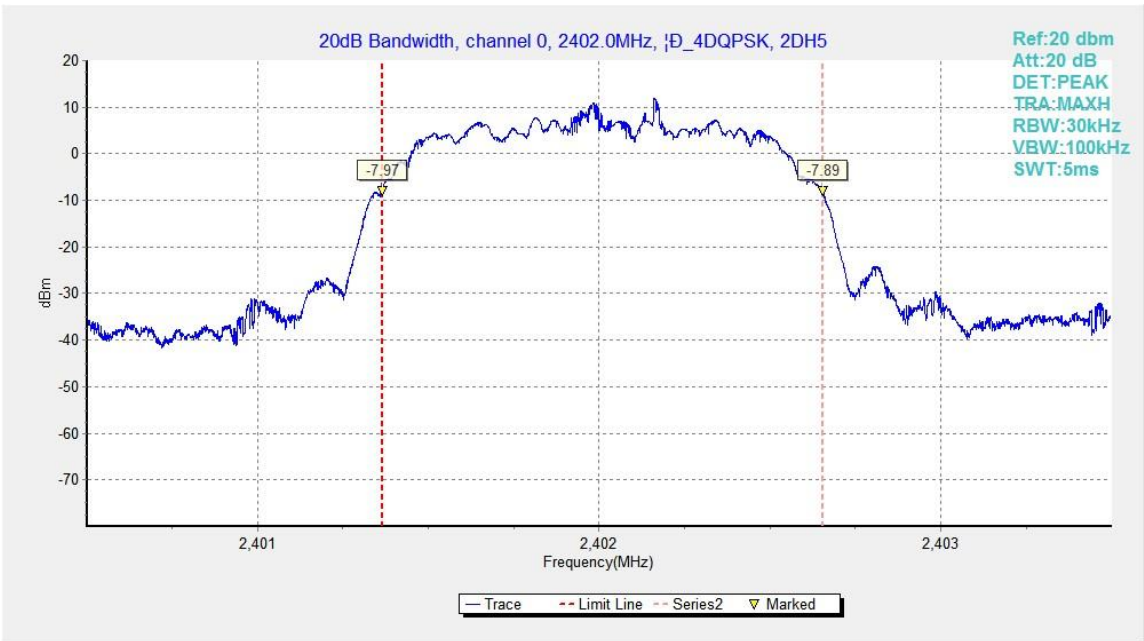



Fig.85. 20dB Bandwidth: π/4 DQPSK, Channel 0

©Copyright. All rights reserved by CTTL.

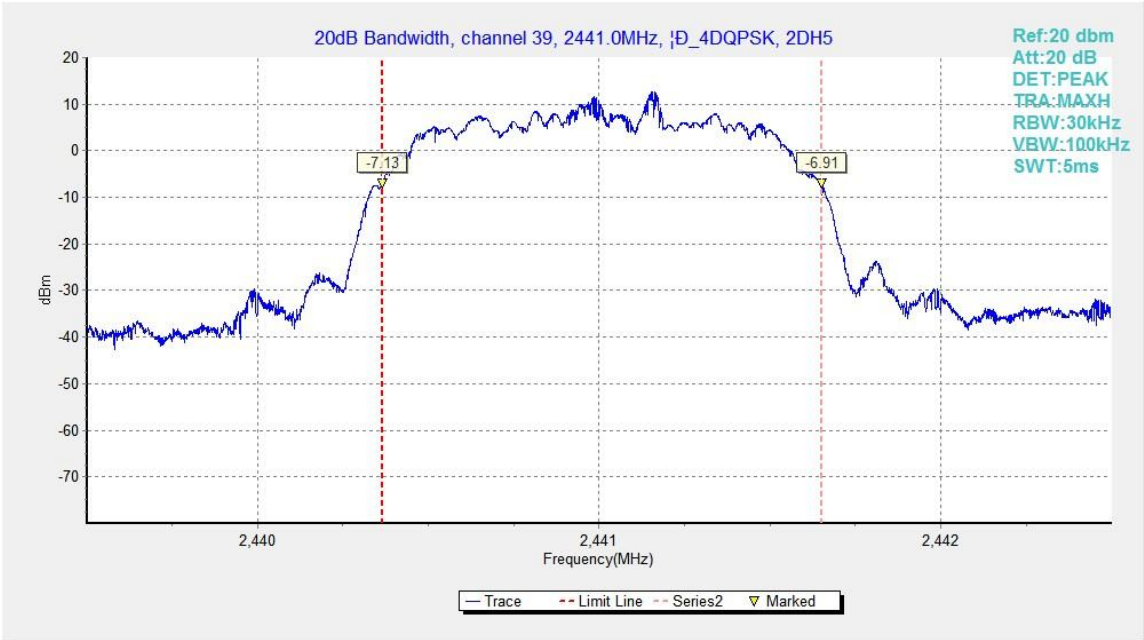



Fig.86. 20dB Bandwidth: π/4 DQPSK, Channel 39

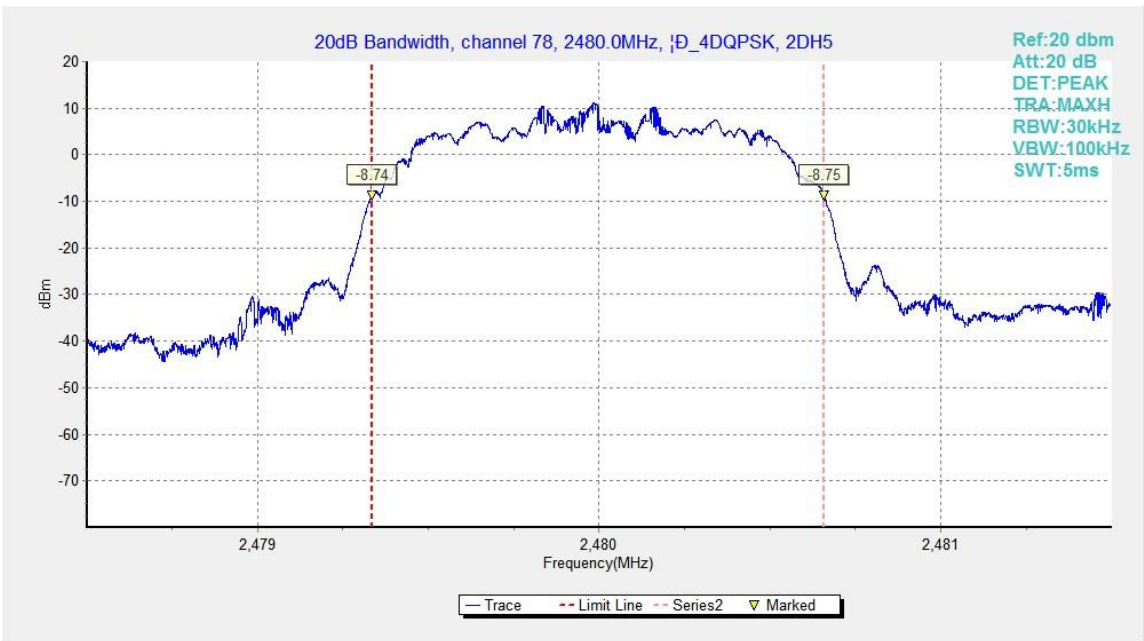



Fig.87. 20dB Bandwidth: π/4 DQPSK, Channel 78

©Copyright. All rights reserved by CTTL.

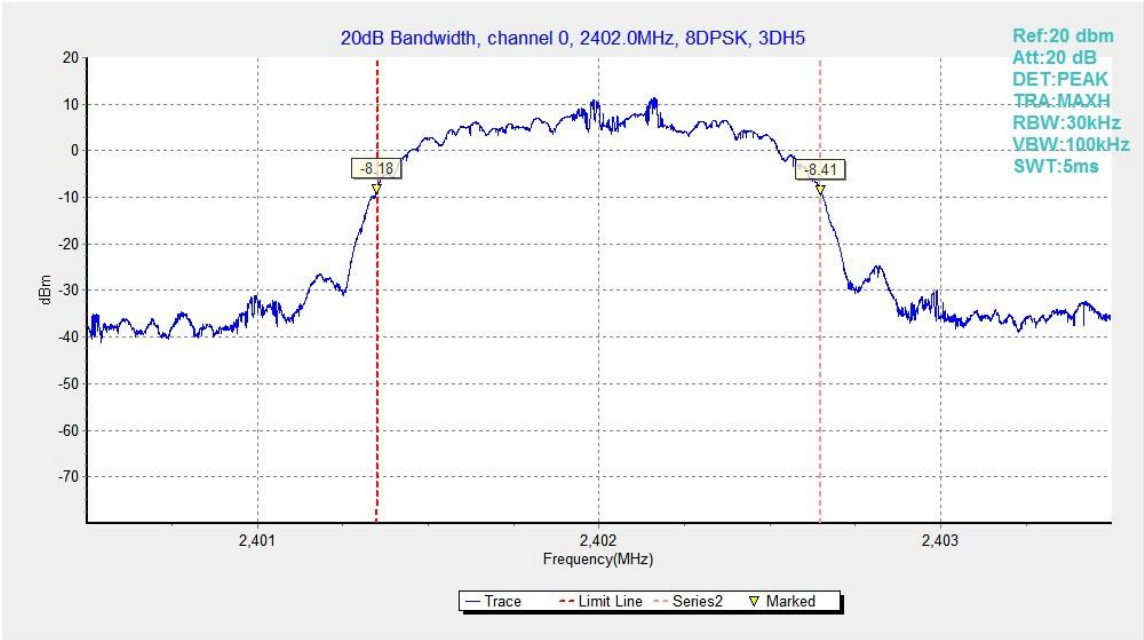



Fig.88. 20dB Bandwidth: 8DPSK, Channel 0

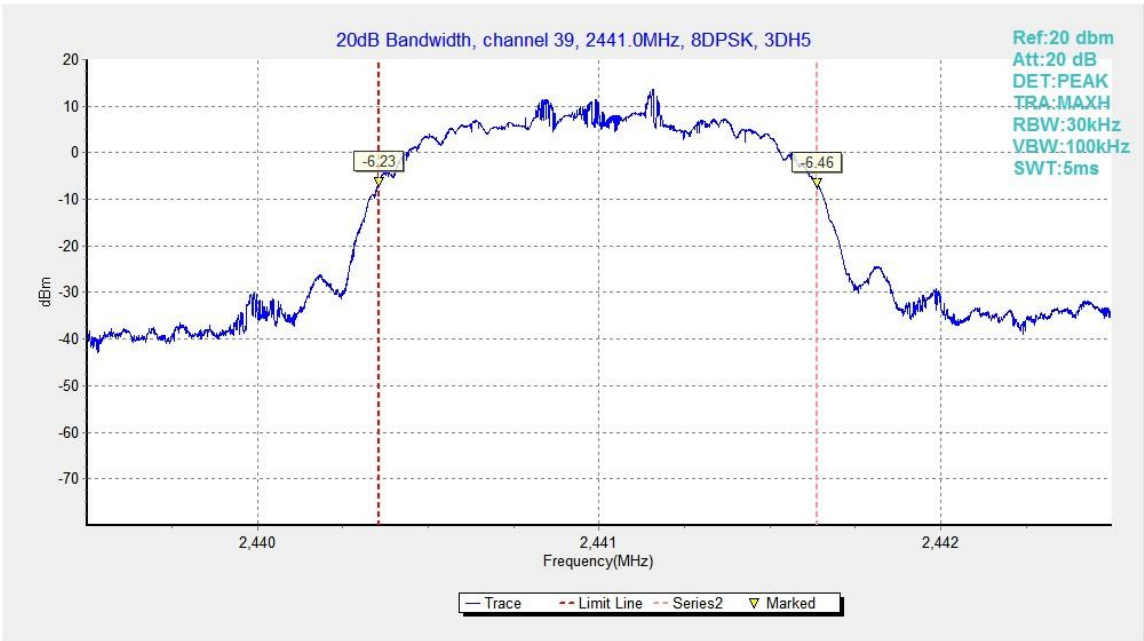



Fig.89. 20dB Bandwidth: 8DPSK, Channel 39

©Copyright. All rights reserved by CTTL.

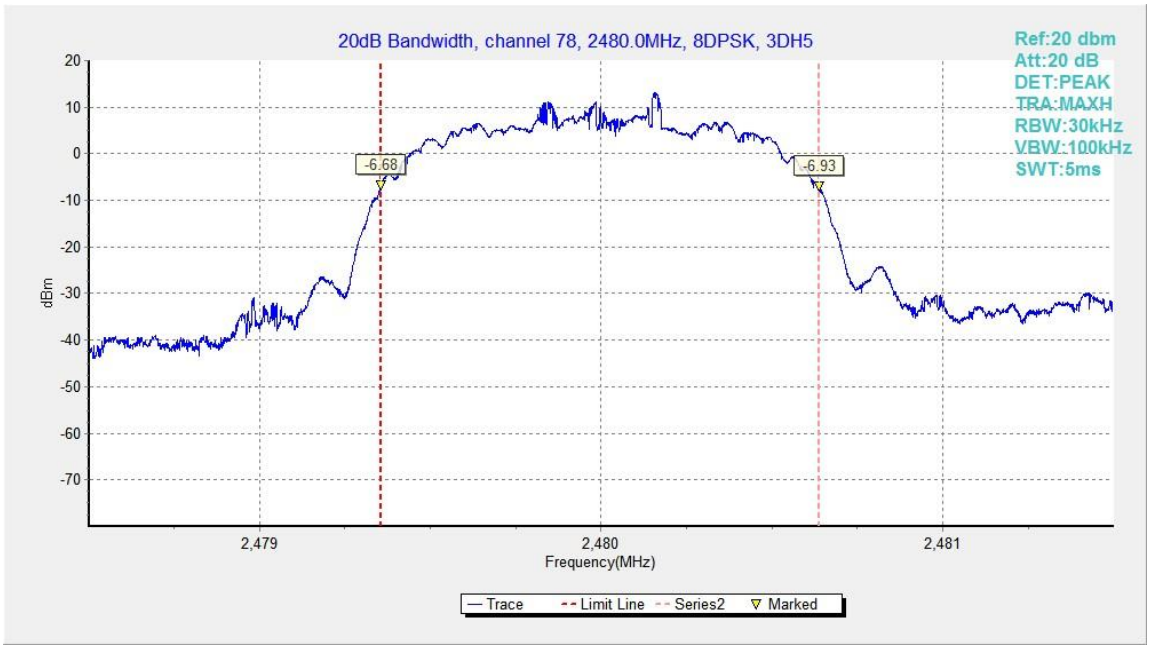



Fig.90. 20dB Bandwidth: 8DPSK, Channel 78

©Copyright. All rights reserved by CTTL.

## 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) * 20dB bandwidth, whichever is greater.

**Measurement Limit:**

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

**Measurement Result:**

**For GFSK**

| Channel | Carrier frequency separation (kHz) | | Conclusion |
|---|---|---|---|
| 39 | Fig.91 | 1164.00 | P |

**For π/4 DQPSK**

| Channel | Carrier frequency separation (kHz) | | Conclusion |
|---|---|---|---|
| 39 | Fig.92 | 1169.25 | P |

**For 8DPSK**

| Channel | Carrier frequency separation (kHz) | | Conclusion |
|---|---|---|---|
| 39 | Fig.93 | 996.00 | P |

**Conclusion: PASS**

**Test graphs as below:**

©Copyright. All rights reserved by CTTL.

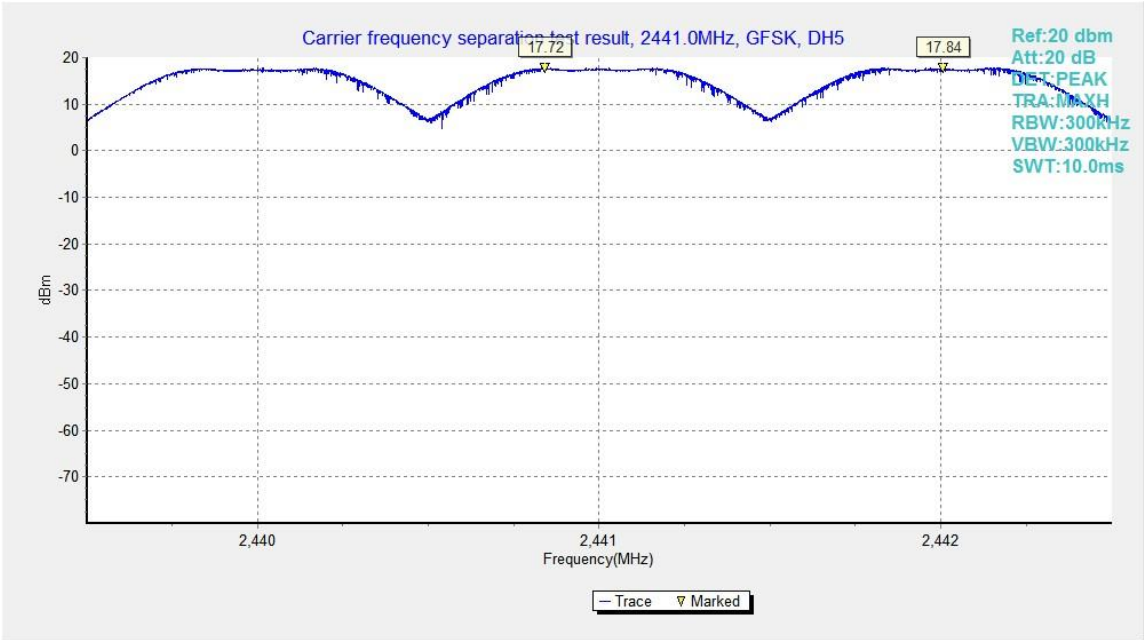



Fig.91. Carrier frequency separation measurement: GFSK, Channel 39

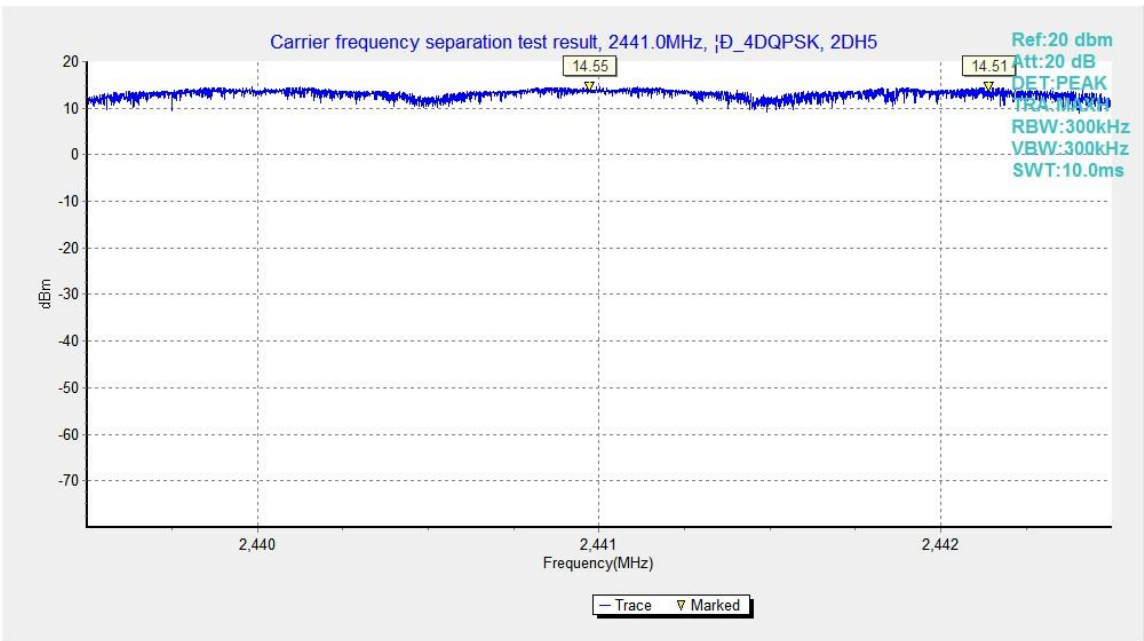



Fig.92. Carrier frequency separation measurement: π/4 DQPSK, Channel 39

©Copyright. All rights reserved by CTTL.

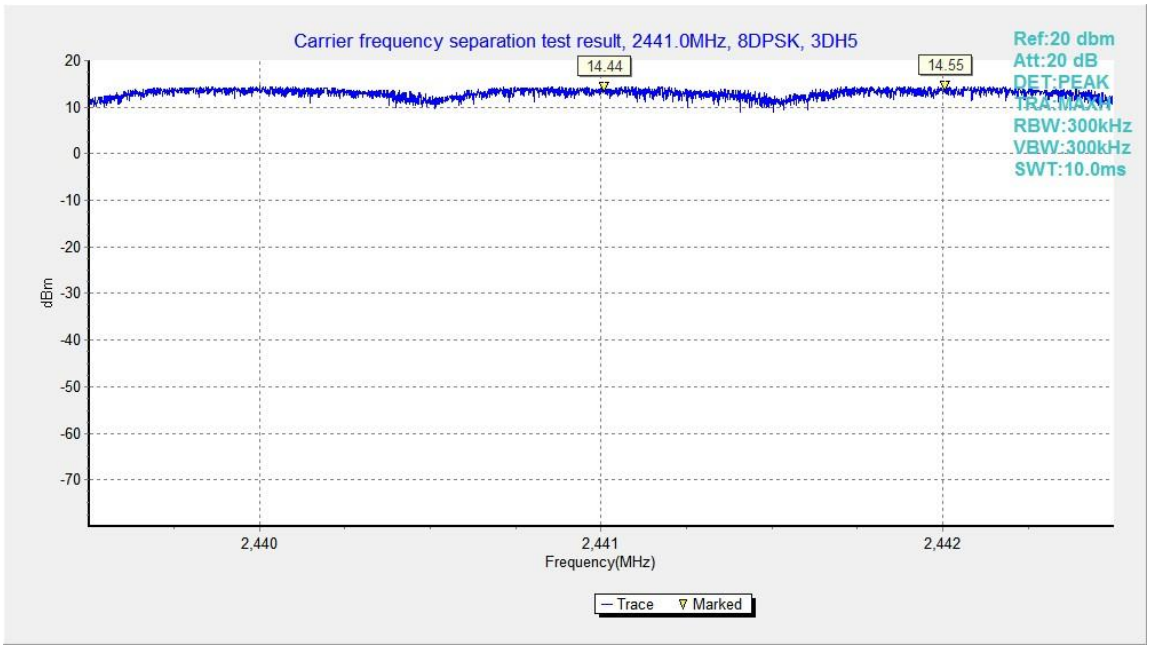



Fig.93. Carrier frequency separation measurement: 8DPSK, Channel 39

©Copyright. All rights reserved by CTTL.

## 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 | 79 | P |
| 40~78 | Fig.95 | | |

**Forπ/4 DQPSK**

| Channel | Number of hopping channels | | Conclusion |
|---|---|---|---|
| 0~39 | Fig.96 | 79 | P |
| 40~78 | Fig.97 | | |

**For 8DPSK**

| Channel | Number of hopping channels | | Conclusion |
|---|---|---|---|
| 0~39 | Fig.98 | 79 | P |
| 40~78 | Fig.99 | | |

**Conclusion: PASS**

**Test graphs as below:**

©Copyright. All rights reserved by CTTL.

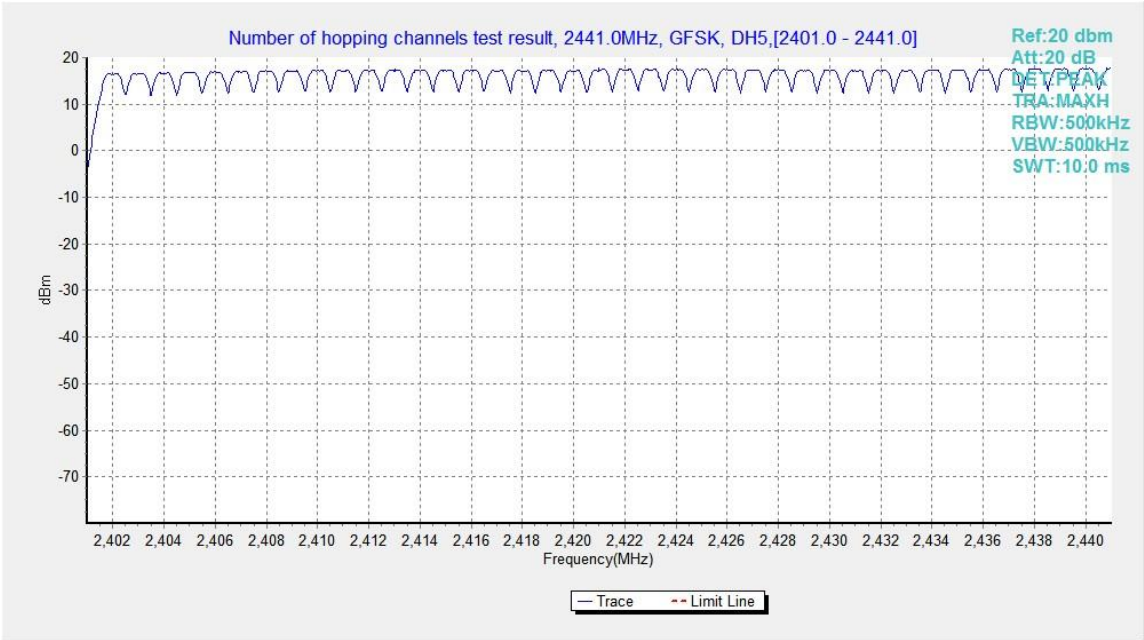



Fig.94. Number of hopping frequencies: GFSK, Channel 0 - 39

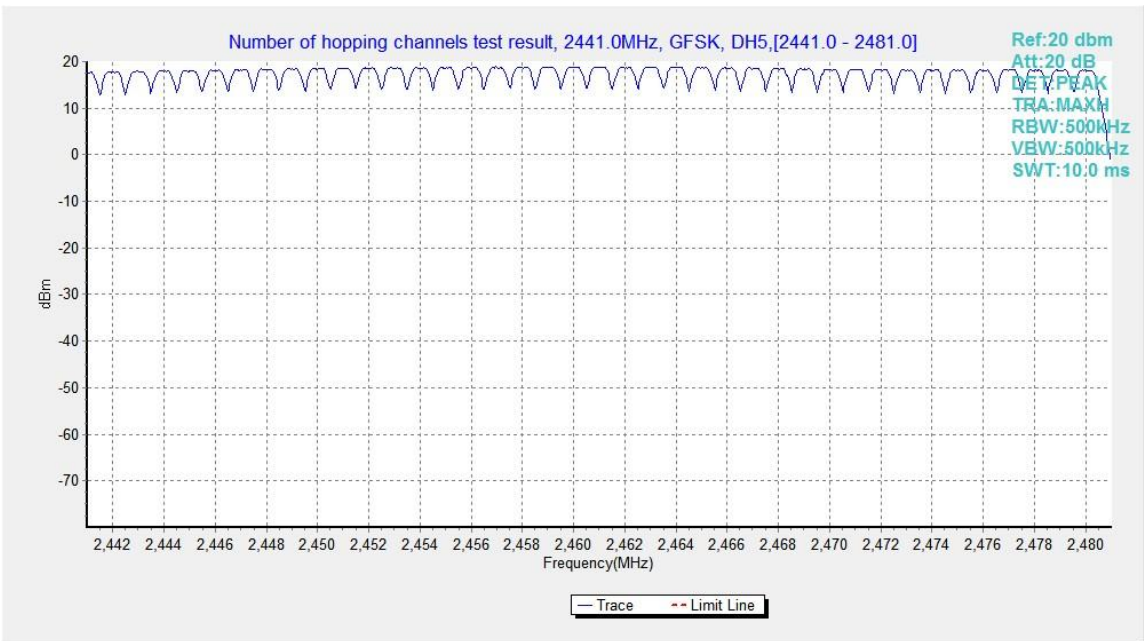



Fig.95. Number of hopping frequencies: GFSK, Channel 40 - 78

©Copyright. All rights reserved by CTTL.

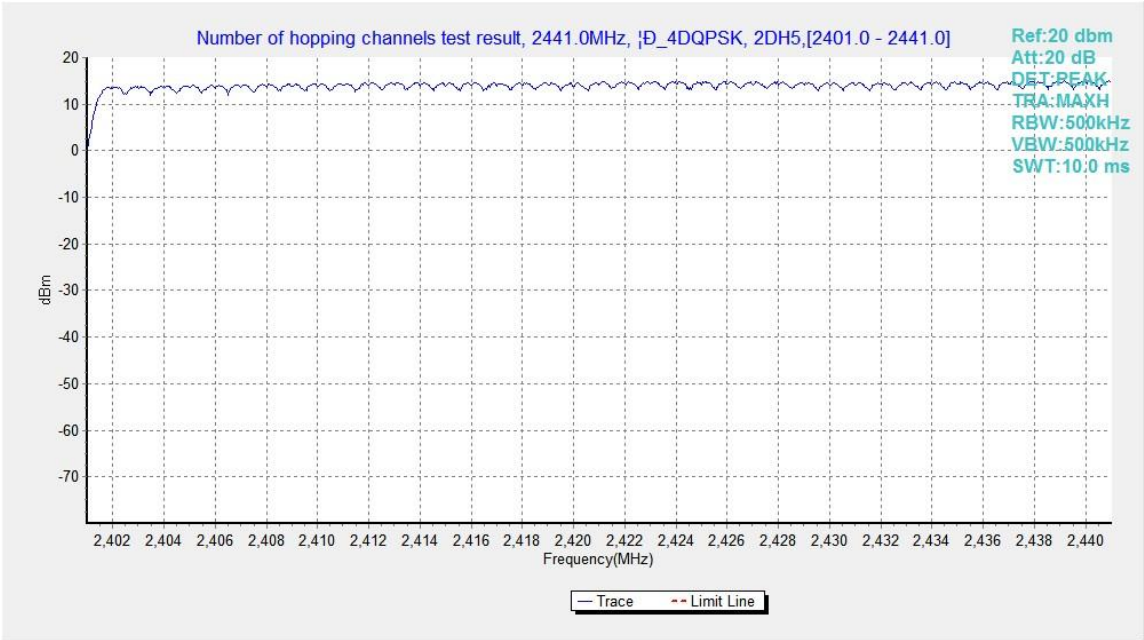



Fig.96. Number of hopping frequencies: π/4 DQPSK, Channel 0 - 39

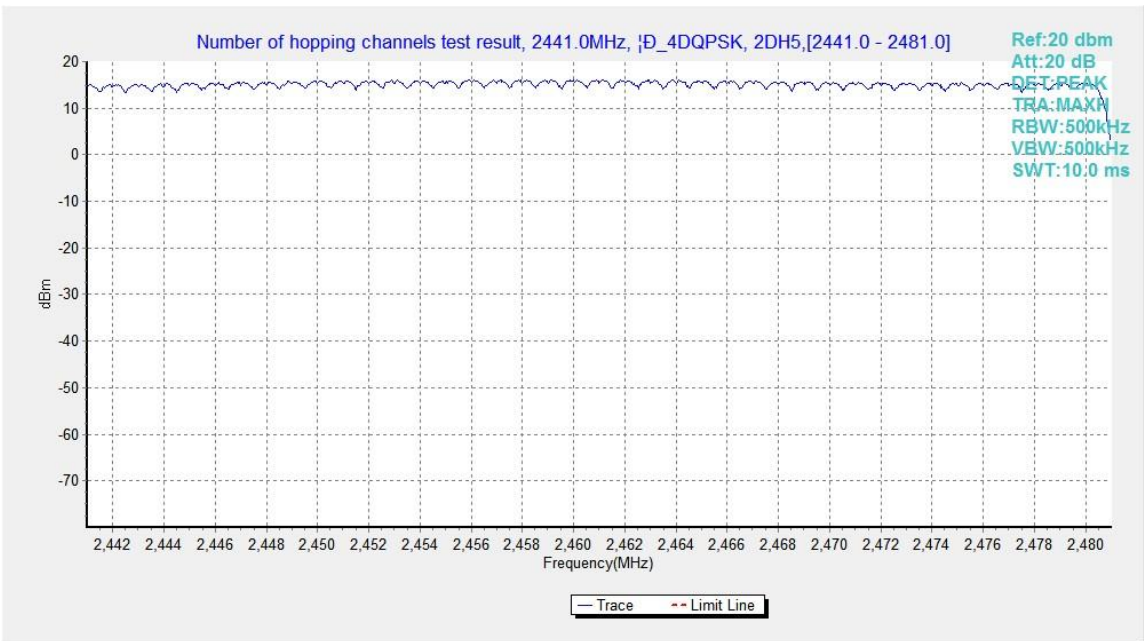



Fig.97. Number of hopping frequencies: π/4 DQPSK, Channel 40 - 78

©Copyright. All rights reserved by CTTL.

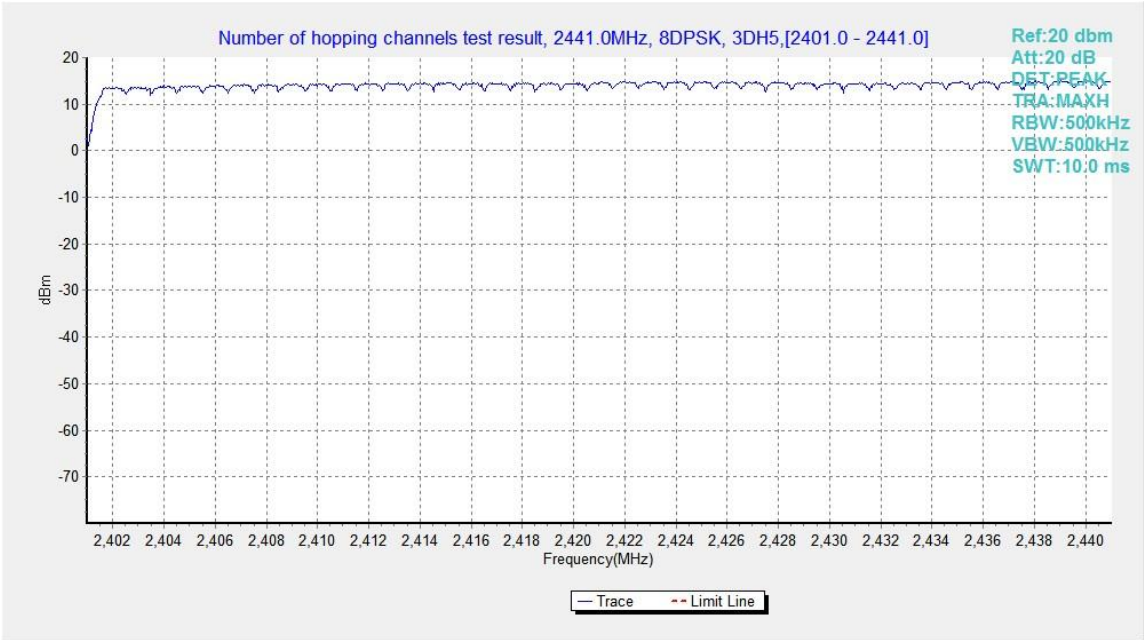



Fig.98. Number of hopping frequencies: 8DPSK, Channel 0 - 39

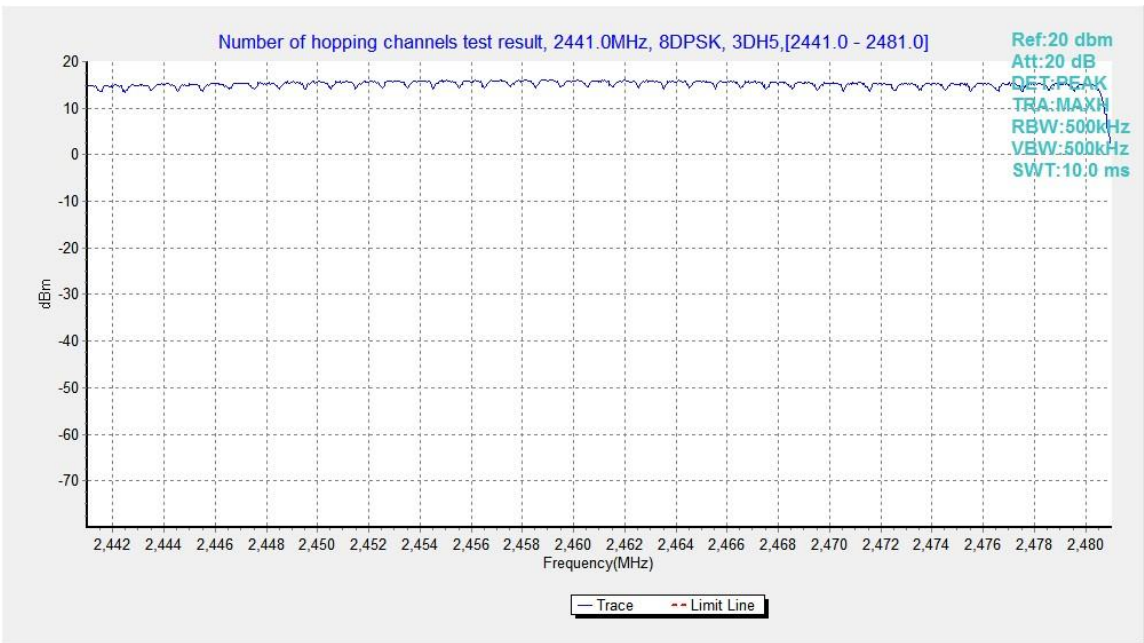



Fig.99. Number of hopping frequencies: 8DPSK, Channel 40 - 78

©Copyright. All rights reserved by CTTL.

## 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.

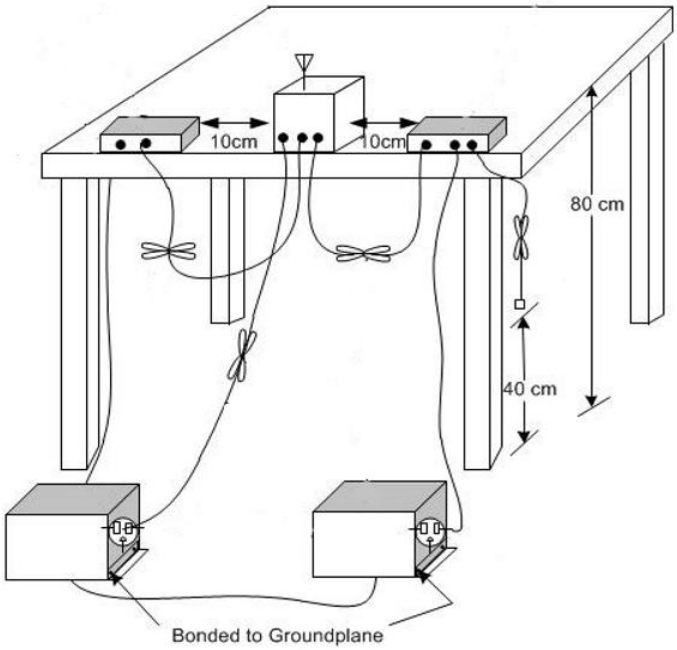
The measurement bandwidth is:

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

**Test Condition:**

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

**Test setup**




©Copyright. All rights reserved by CTTL.

**Measurement Result and limit:**

Bluetooth (Quasi-peak Limit)

| Frequency range (MHz) | Quasi-peak Limit (dBμV) | Result (dBμV) | | 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 (dBμV) | Result (dBμV) | | 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:**

©Copyright. All rights reserved by CTTL.

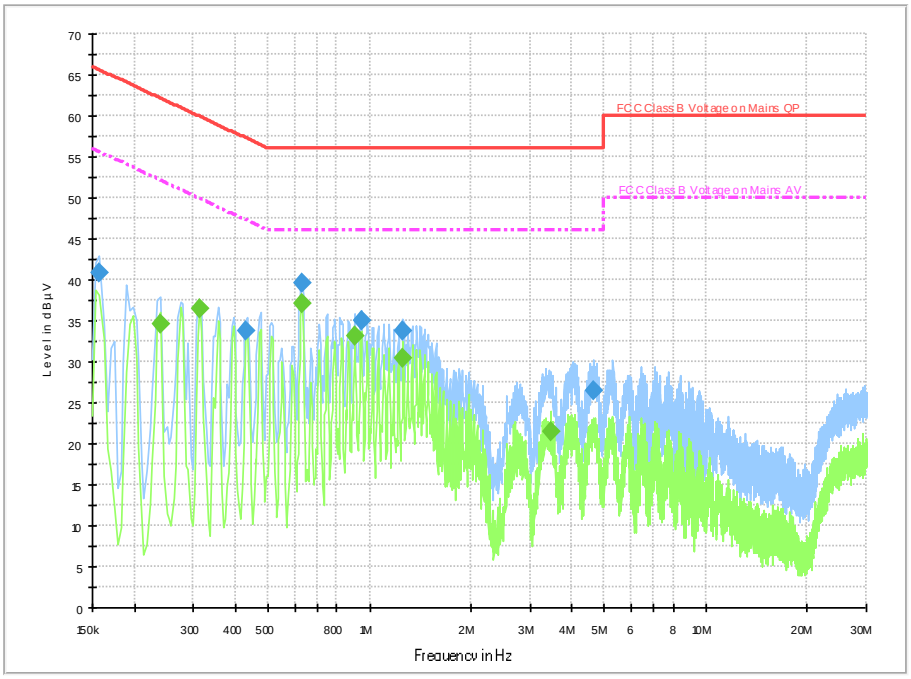



**Fig.B.10.1 AC Powerline Conducted Emission- bluetooth**

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

**Final Result 1**

| Frequency (MHz) | QuasiPeak (dBµV) | Meas. Time | Bandwidth (kHz) | Filter | Line | Corr. (dB) | Margin (dB) | Limit (dBµV) | Comment |
|---|---|---|---|---|---|---|---|---|---|
| **0.158000** | **40.8** | **2000.0** | **9.000** | **On** | **N** | **19.7** | **24.8** | **65.6** | |
| **0.430000** | **33.8** | **2000.0** | **9.000** | **On** | **N** | **19.7** | **23.5** | **57.3** | |
| **0.630000** | **39.5** | **2000.0** | **9.000** | **On** | **N** | **19.6** | **16.5** | **56.0** | |
| **0.946000** | **34.9** | **2000.0** | **9.000** | **On** | **L1** | **19.7** | **21.1** | **56.0** | |
| **1.262000** | **33.7** | **2000.0** | **9.000** | **On** | **L1** | **19.7** | **22.3** | **56.0** | |
| **4.618000** | **26.4** | **2000.0** | **9.000** | **On** | **L1** | **19.6** | **29.6** | **56.0** | |

**Final Result 2**

| Frequency (MHz) | CAverage (dBµV) | Meas. Time | Bandwidth (kHz) | Filter | Line | Corr. (dB) | Margin (dB) | Limit (dBµV) | Comment |
|---|---|---|---|---|---|---|---|---|---|
| **0.238000** | **34.5** | **2000.0** | **9.000** | **On** | **N** | **19.7** | **17.6** | **52.2** | |
| **0.314000** | **36.5** | **2000.0** | **9.000** | **On** | **N** | **19.7** | **13.4** | **49.9** | |
| **0.630000** | **37.0** | **2000.0** | **9.000** | **On** | **N** | **19.6** | **9.0** | **46.0** | |
| **0.906000** | **33.2** | **2000.0** | **9.000** | **On** | **L1** | **19.7** | **12.8** | **46.0** | |
| **1.262000** | **30.4** | **2000.0** | **9.000** | **On** | **N** | **19.6** | **15.6** | **46.0** | |
| **3.470000** | **21.5** | **2000.0** | **9.000** | **On** | **N** | **19.6** | **24.5** | **46.0** | |

©Copyright. All rights reserved by CTTL.

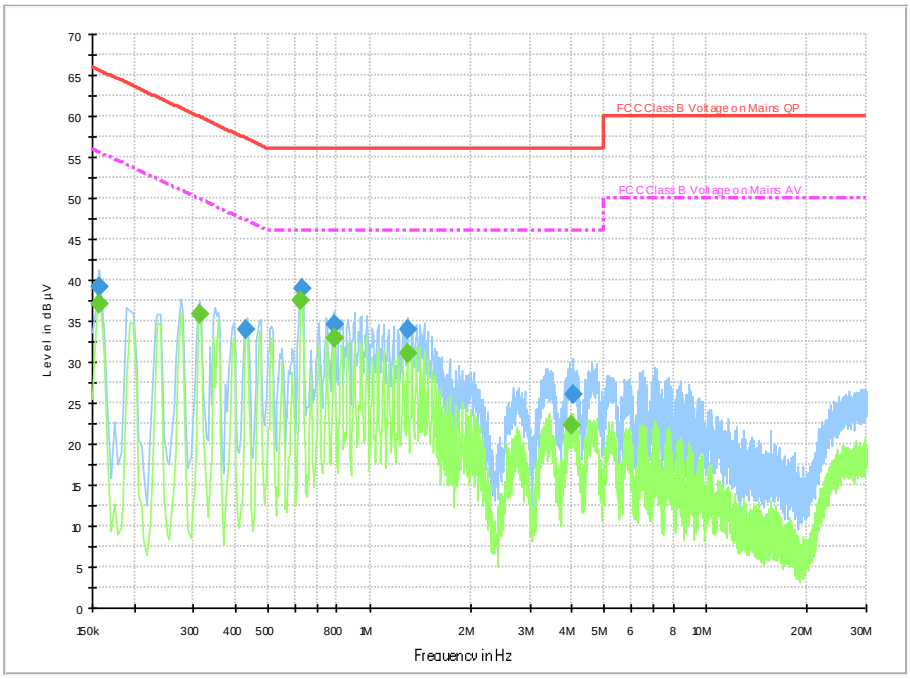



**Fig.B.10.2 AC Powerline Conducted Emission-Idle**

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 |
|---|---|---|---|---|---|---|---|---|---|
| **0.158000** | **39.1** | **2000.0** | **9.000** | **On** | **L1** | **19.8** | **26.4** | **65.6** | |
| **0.430000** | **33.9** | **2000.0** | **9.000** | **On** | **N** | **19.7** | **23.4** | **57.3** | |
| **0.630000** | **39.0** | **2000.0** | **9.000** | **On** | **N** | **19.6** | **17.0** | **56.0** | |
| **0.786000** | **34.6** | **2000.0** | **9.000** | **On** | **L1** | **19.7** | **21.4** | **56.0** | |
| **1.298000** | **33.9** | **2000.0** | **9.000** | **On** | **L1** | **19.7** | **22.1** | **56.0** | |
| **4.022000** | **25.9** | **2000.0** | **9.000** | **On** | **L1** | **19.6** | **30.1** | **56.0** | |

**Final Result 2**

| Frequency (MHz) | CAverage (dBµV) | Meas. Time | Bandwidth (kHz) | Filter | Line | Corr. (dB) | Margin (dB) | Limit (dBµV) | Comment |
|---|---|---|---|---|---|---|---|---|---|
| **0.158000** | **37.0** | **2000.0** | **9.000** | **On** | **L1** | **19.8** | **18.5** | **55.6** | |
| **0.314000** | **35.9** | **2000.0** | **9.000** | **On** | **L1** | **19.7** | **14.0** | **49.9** | |
| **0.626000** | **37.5** | **2000.0** | **9.000** | **On** | **L1** | **19.7** | **8.5** | **46.0** | |
| **0.786000** | **33.0** | **2000.0** | **9.000** | **On** | **L1** | **19.7** | **13.0** | **46.0** | |
| **1.298000** | **31.1** | **2000.0** | **9.000** | **On** | **L1** | **19.7** | **14.9** | **46.0** | |
| **3.974000** | **22.3** | **2000.0** | **9.000** | **On** | **L1** | **19.6** | **23.7** | **46.0** | |

©Copyright. All rights reserved by CTTL.

## 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.

©Copyright. All rights reserved by CTTL.

## 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 McInturff, 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*****

©Copyright. All rights reserved by CTTL.