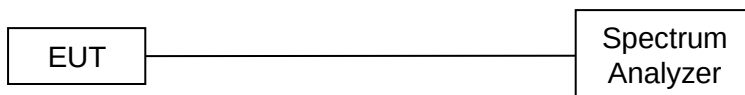


5.9 Conducted spurious emissions

5.9.1 Limits

In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in §15.209(a) is not required. 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)).

5.9.2 Test setup



5.9.3 Test procedure

- Test method: ANSI C63.10-2013 Section 6.10.4
- The EUT was set to non-hopping mode & hopping mode during the test.
- The transmitter output of EUT is connected to the spectrum analyzer.
- Spectrum analyzer setting: RBW = 100 kHz, VBW = 300 kHz, Detector = Peak.

5.9.4 Test results

Notes:

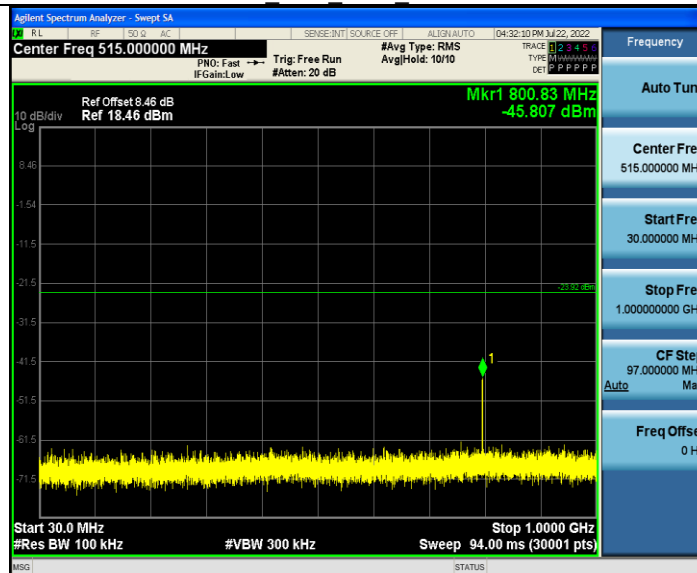
All modes of operation of the EUT were investigated, and only the worst-case results are reported. The worst-case mode: TX mode (GFSK).

Test Graphs

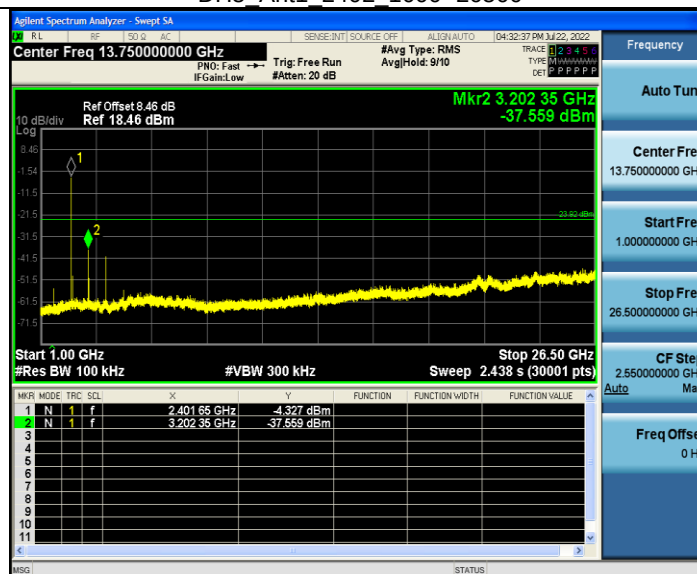
DH5_Ant1_2402_0-Reference



DH5_Ant1_2402_30~1000



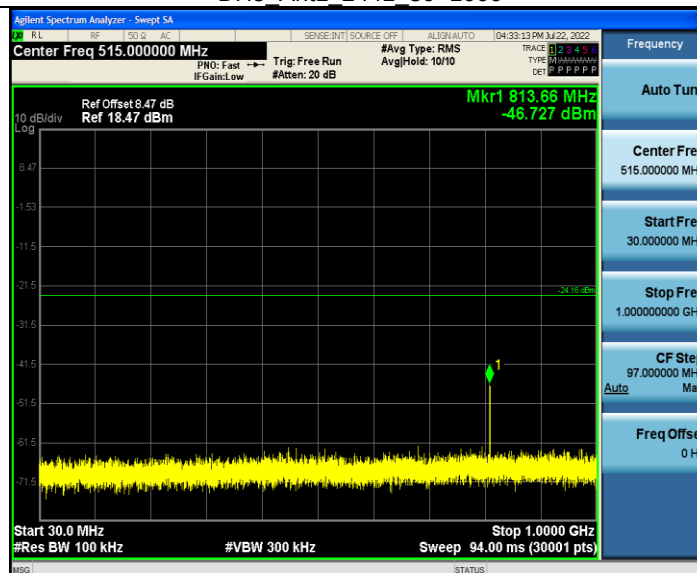
DH5_Ant1_2402_1000~26500



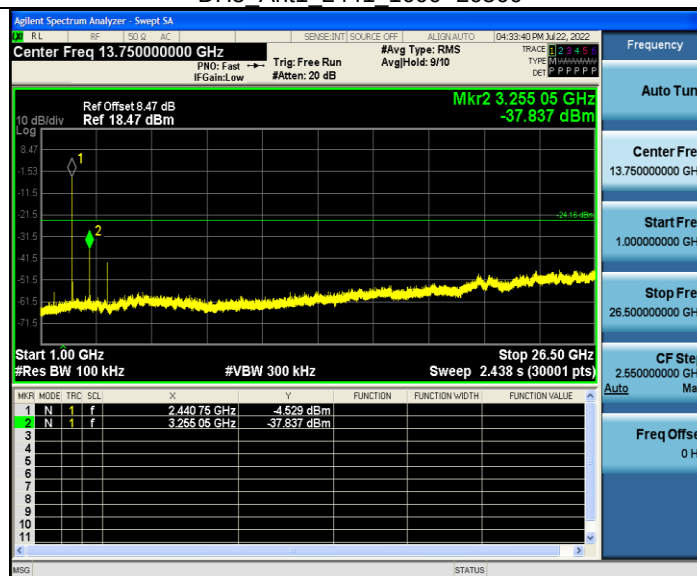
DH5_Ant1_2441_0-Reference



DH5 Ant1 2441 30~1000



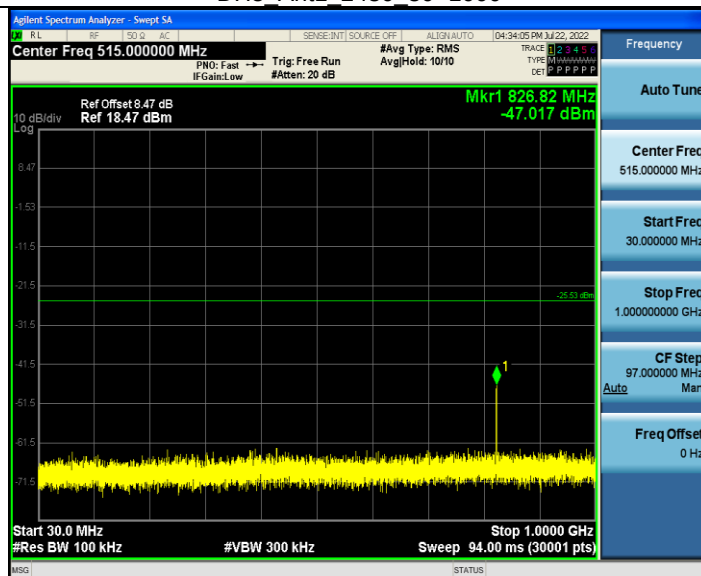
DH5 Ant1 2441 1000~26500



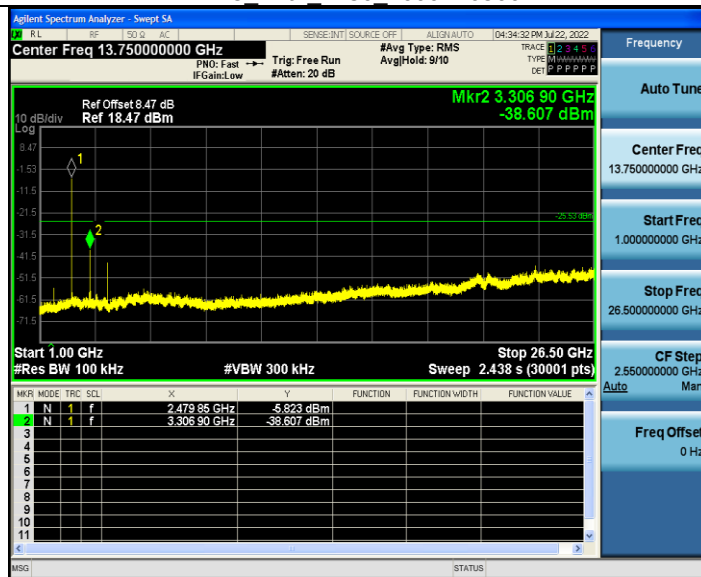
DH5 Ant1 2480 0~Reference



DH5 Ant1 2480 30~1000



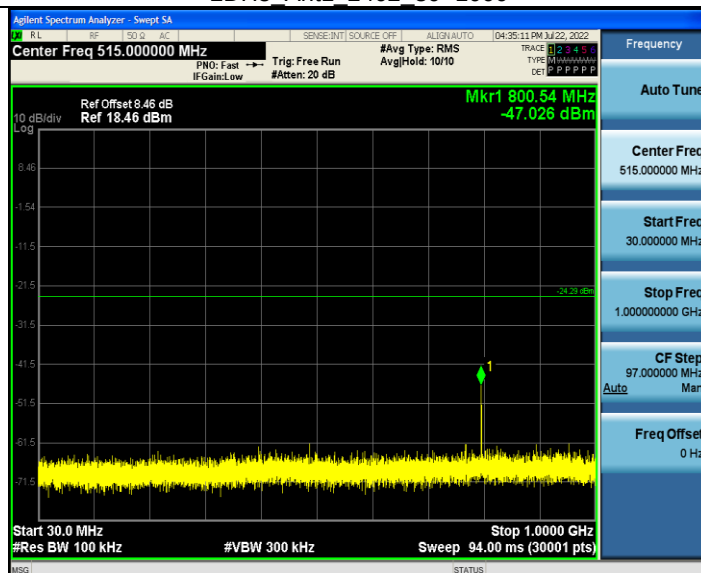
DH5 Ant1 2480 1000~26500



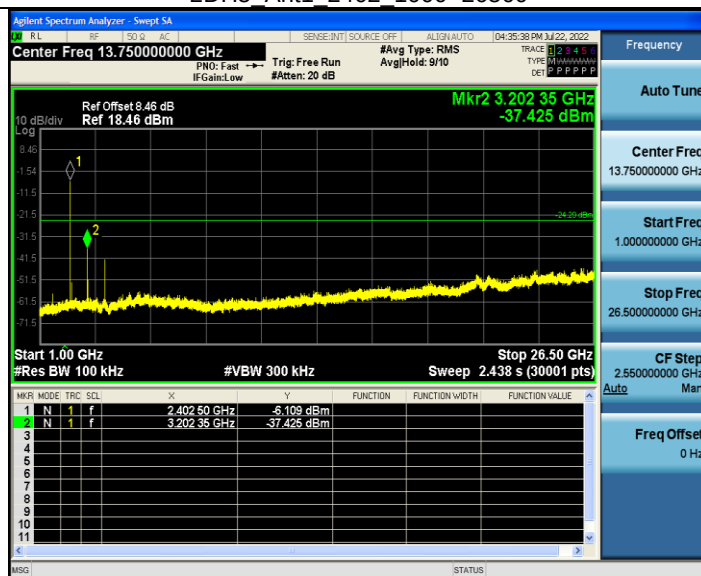
2DH5 Ant1 2402 0~Reference



2DH5 Ant1 2402 30~1000



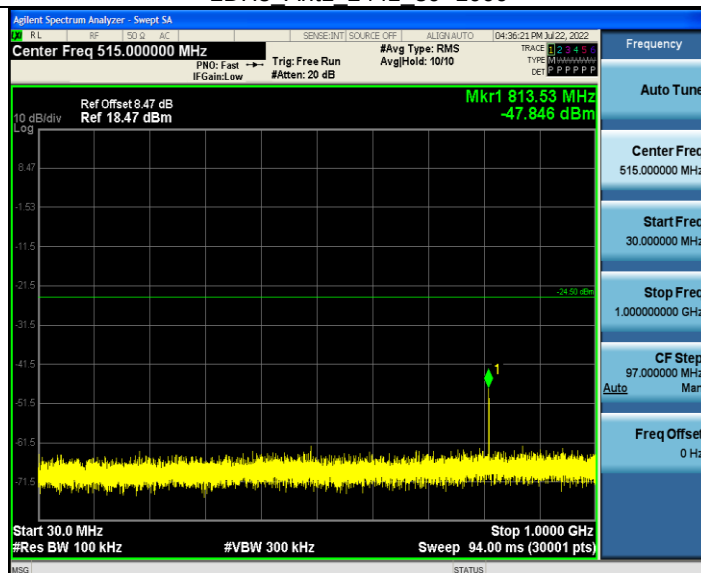
2DH5 Ant1 2402 1000~26500



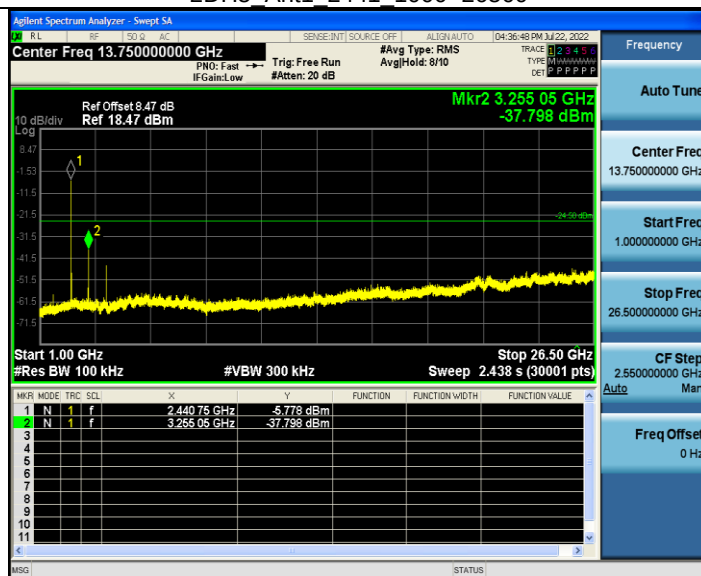
2DH5 Ant1 2441 0~Reference



2DH5 Ant1 2441 30~1000



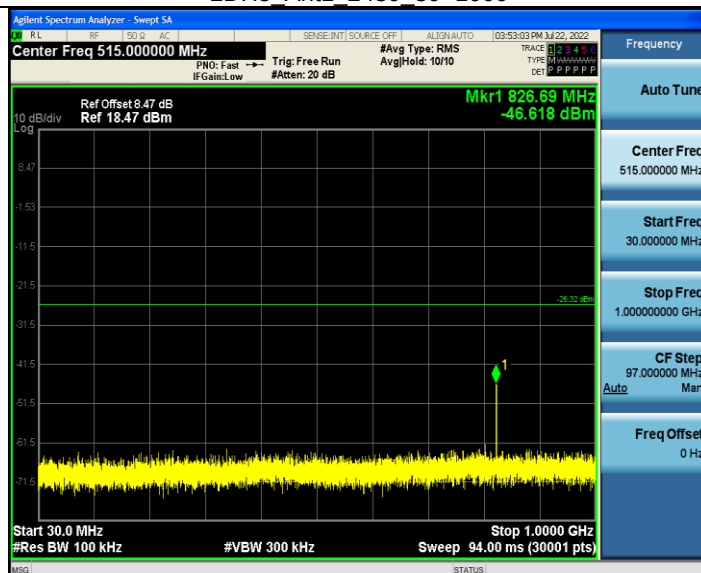
2DH5 Ant1 2441 1000~26500



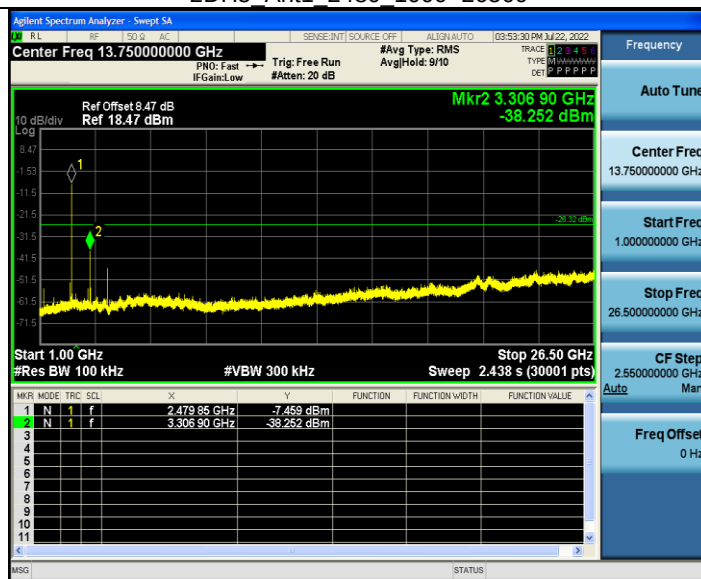
2DH5 Ant1 2480 0~Reference



2DH5 Ant1 2480 30~1000



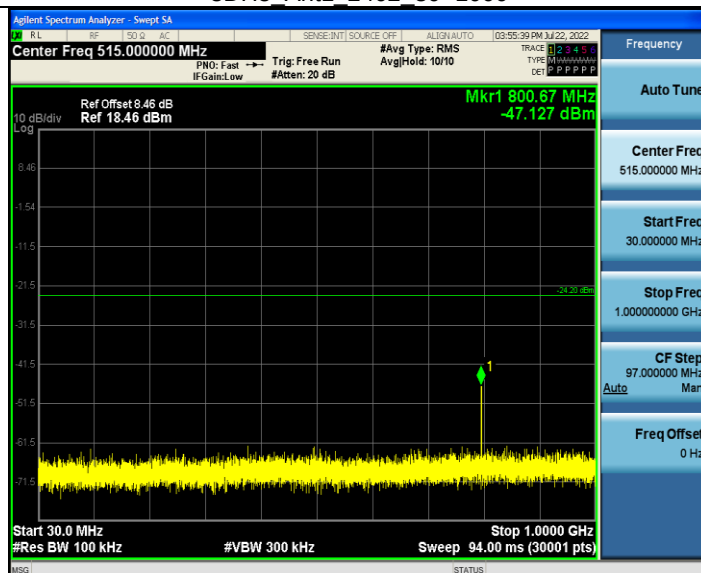
2DH5 Ant1 2480 1000~26500



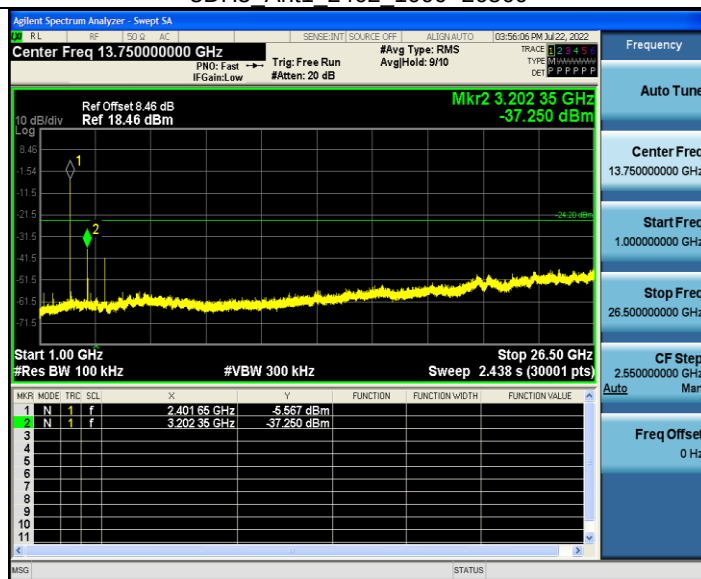
3DH5 Ant1 2402 0~Reference



3DH5 Ant1 2402 30~1000



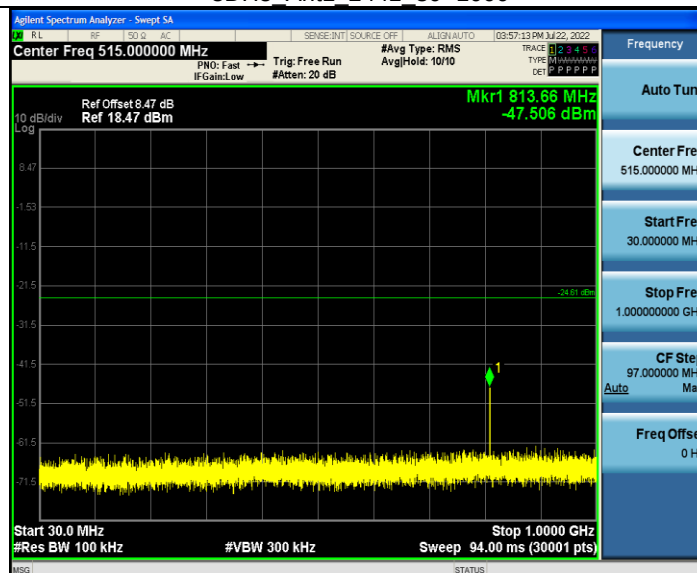
3DH5 Ant1 2402 1000~26500



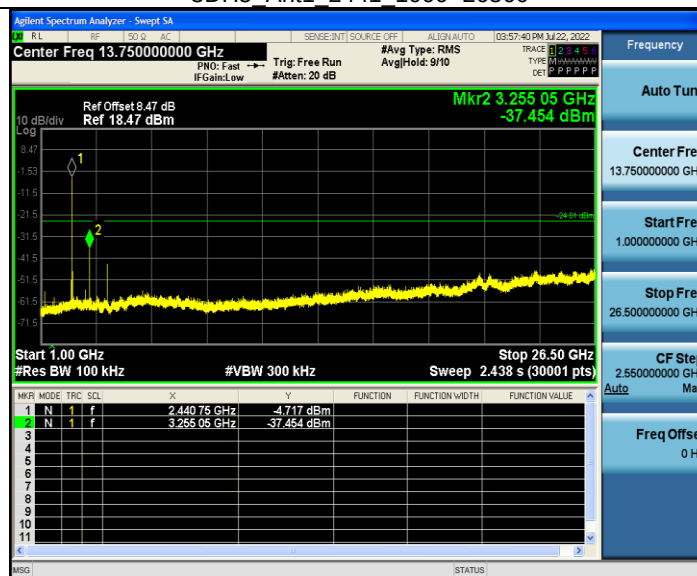
3DH5 Ant1 2441 0~Reference



3DH5 Ant1 2441 30~1000



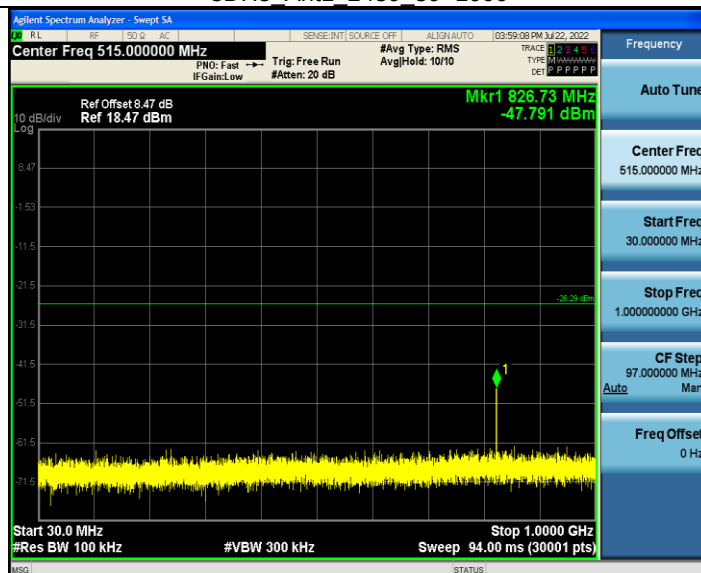
3DH5 Ant1 2441 1000~26500



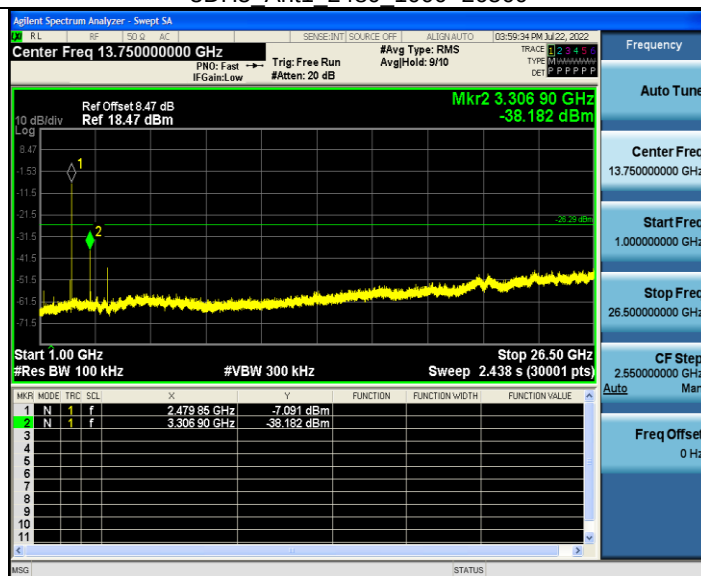
3DH5 Ant1 2480 0~Reference



3DH5_Ant1_2480_30~1000



3DH5_Ant1_2480_1000~26500



5.10 Radiated spurious emission

5.10.1 Limits

§ 15.247 (d) In any 100 kHz bandwidth outside the frequency band in which the spread spectrum or digitally modulated intentional radiator is operating, the radio frequency power that is produced by the intentional radiator shall be at least 20 dB below that in the 100 kHz bandwidth within the band that contains the highest level of the desired power, based on either an RF conducted or a radiated measurement, provided the transmitter demonstrates compliance with the peak conducted power limits. If the transmitter complies with the conducted power limits based on the use of RMS averaging over a time interval, as permitted under paragraph (b)(3) of this section, the attenuation required under this paragraph shall be 30 dB instead of 20 dB. Attenuation below the general limits specified in § 15.209(a) is not required. 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)).

§ 15.209 Radiated emission limits; general requirements.

Frequency (MHz)	Field strength (microvolts/meter)	Measurement distance (meters)
0.009-0.490	2400/F(kHz)	300
0.490-1.705	24000/F(kHz)	30
1.705-30.0	30	30
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

Note 1: the tighter limit applies at the band edges.

Note 2: the emission limits shown in the above table are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9-90 kHz, 110-490 kHz and above 1000 MHz. Radiated emission limits in these three bands are based on measurements employing an average detector

§ 15.35 (b) requirements:

When average radiated emission measurements are specified in this part, including average emission measurements below 1000 MHz, there also is a limit on the peak level of the radio frequency emissions. Unless otherwise specified, e.g., see §§ 15.250, 15.252, 15.253(d), 15.255, 15.256, and 15.509 through 15.519, the limit on peak radio frequency emissions is 20 dB above the maximum permitted average emission limit applicable to the equipment under test.

According to ANSI C63.10-2013, the tests shall be performed in the frequency range shown in the following table:

Frequency range of measurements for unlicensed wireless device

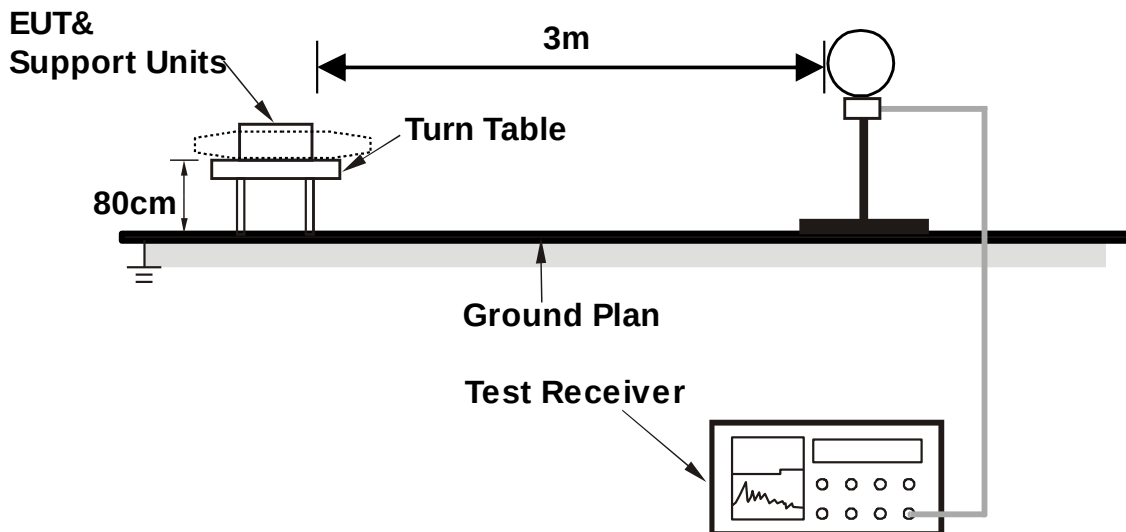
Lowest frequency generated in the device	Upper frequency range of measurement
9 kHz to below 10 GHz	10th harmonic of highest fundamental frequency or to 40 GHz, whichever is lower
At or above 10 GHz to below 30 GHz	5th harmonic of highest fundamental frequency or to 100 GHz, whichever is lower
At or above 30 GHz	5th harmonic of highest fundamental frequency or to 200 GHz, whichever is lower, unless otherwise specified

Frequency range of measurements for unlicensed wireless device with digital device

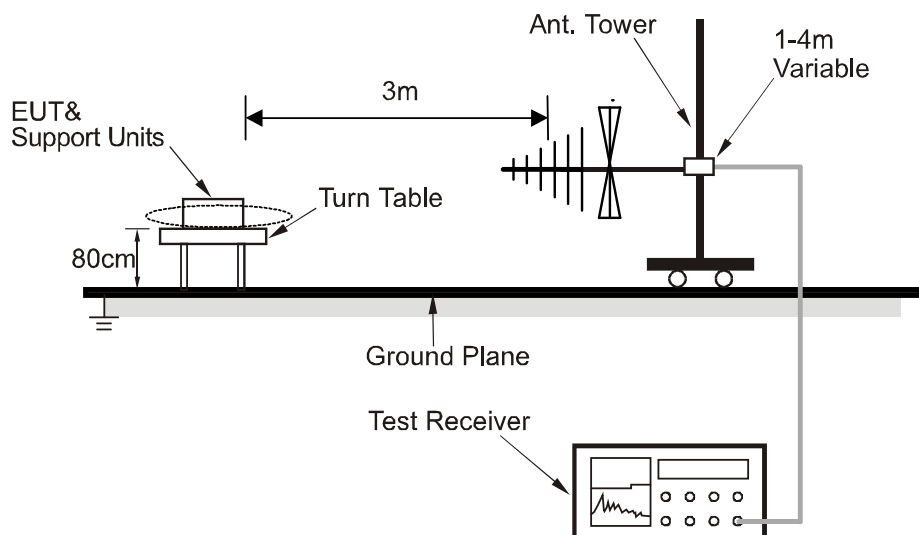
Highest frequency generated or used in the device or on which the device operates or tunes	Upper frequency range of measurement
Below 1.705 MHz	30 MHz
1.705 MHz to 108 MHz	1000 MHz
108 MHz to 500 MHz	2000 MHz
500 MHz to 1000 MHz	5000 MHz
Above 1000 MHz	5th harmonic of the highest frequency or 40 GHz, whichever is lower

5.10.2 Test setup

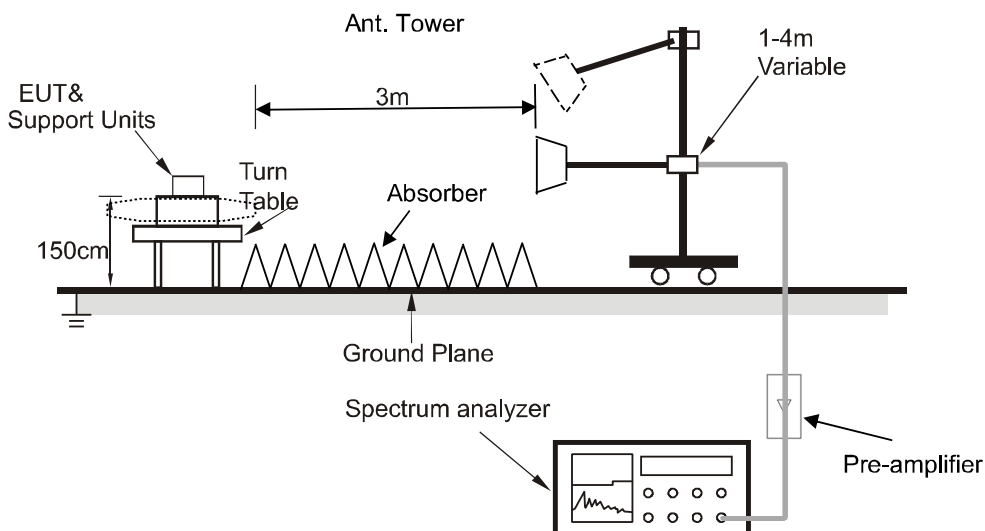
Below 30MHz



30MHz~1GHz



Above 1GHz



For the actual test configuration, please refer to the related item – Photographs of the test setup.

5.10.3 Test procedure

- a) Test method: ANSI C63.10-2013 Section 6.3, 6.4, 6.5, 6.6, 6.10.
- b) The EUT is placed on an on-conducting table 0.8 meters above the ground plane for measurement below 1GHz, 1.5 meters above the ground plane for measurement above 1GHz.
- c) Emission blew 18 GHz were measured at a 3 meters test distance, above 18 GHz were measured at 1.5-meter test distance with the application of a distance correction factor
- d) The frequency range of interest is monitored at a fixed antenna height and EUT azimuth. The EUT is rotated through 360 degrees to maximize emissions received. The antenna is scanned from 1 to 4 meters above the ground plane to further maximize the emission. Measurements are made with the antenna polarized in both the vertical and the horizontal positions.

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The use of a duty cycle correction factor (DCCF) is permitted for calculating average radiated field strength emission levels for an FHSS device in 15.247. This DCCF can be applied when the unwanted emission limit is subject to an average field strength limit (e.g., within a Government Restricted band) and the conditions specified in Section 15.35(c) can be satisfied. The average radiated field strength is calculated by subtracting the DCCF from the maximum radiated field strength level as determined through measurement. The maximum radiated field strength level represents the worst-case (maximum amplitude) RMS measurement of the emission(s) during continuous transmission (i.e., not including any time intervals during which the transmitter is off or is transmitting at a reduced power level). It is also acceptable to apply the DCCF to a measurement performed with a peak detector instead of the specified RMS power averaging detector. Note that Section 15.35(c) specifies that the DCCF shall represent the worst-case (greatest duty cycle) over any 100 msec transmission period.

Test instrument setup

Frequency	Test receiver / Spectrum analyzer setting
9 kHz ~ 150 kHz	Quasi Peak / RBW: 200 Hz
150 kHz ~ 30 MHz	Quasi Peak / RBW: 9 kHz
30 MHz ~ 1 GHz	Quasi Peak / RBW: 120 kHz
Above 1 GHz	Peak / RBW: 1 MHz, VBW: 3MHz, Peak detector AVG / RBW: 1 MHz, VBW: 1/T, Peak detector

5.10.4 Test results

Notes:

The amplitude of spurious emissions which are attenuated more than 20 dB below the limits are not reported.

All modes of operation of the EUT were investigated, and only the worst-case results are reported.

There were no emissions found below 30MHz within 20dB of the limit.

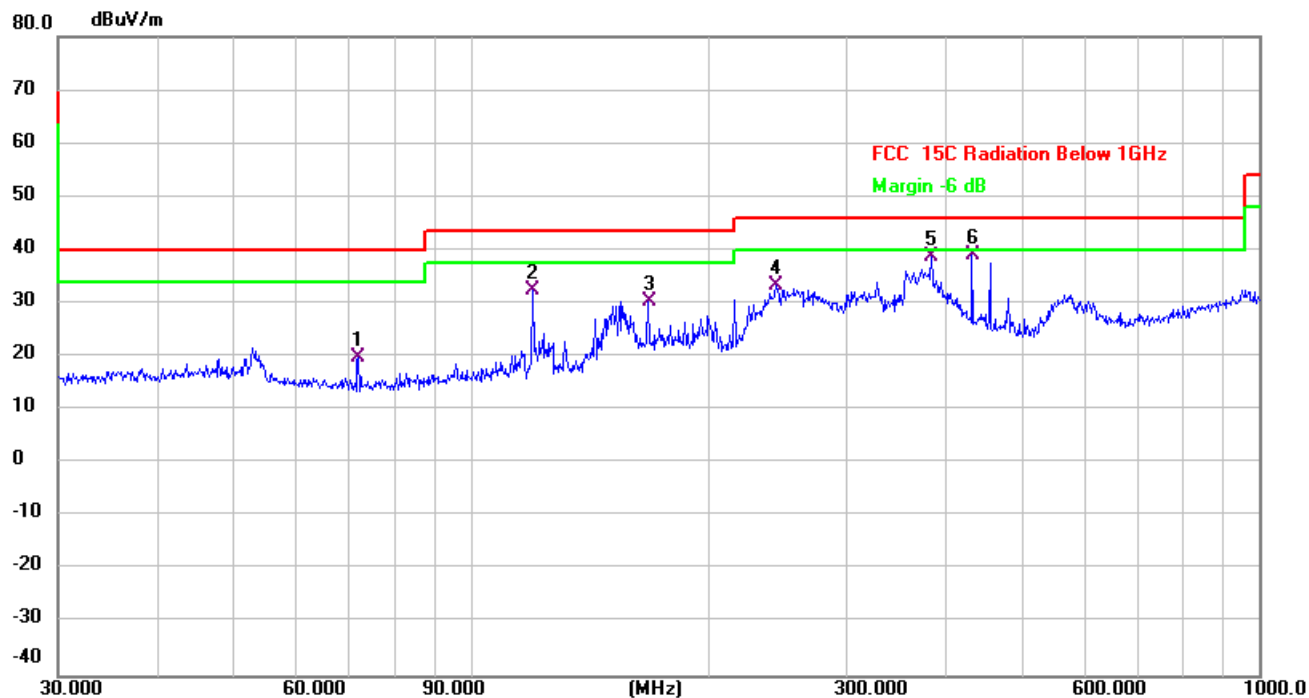
Calculation formula:

Measurement (dB μ V/m) = Reading Level (dB μ V) + Correct Factor (dB/m)

Over (dB) = Measurement (dB μ V/m) – Limit (dB μ V/m)

Radiated emissions between 30MHz – 1GHz

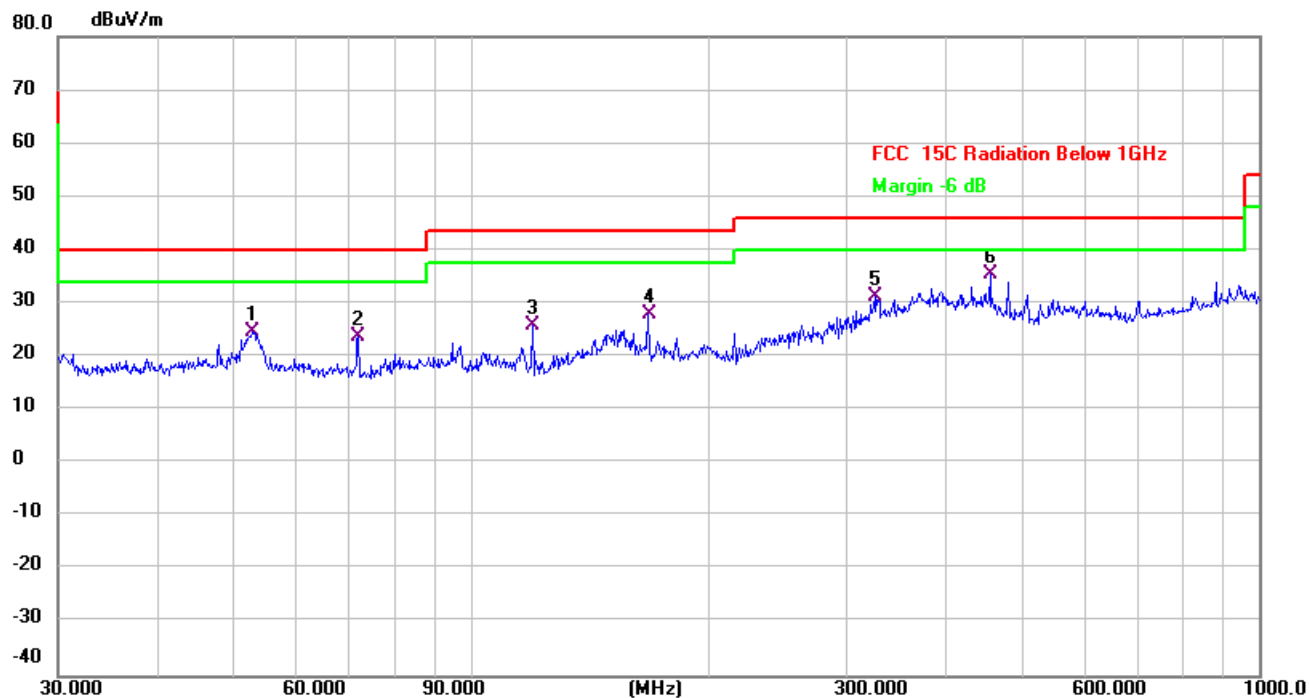
Test mode:	TX DH5-2441	Polarization:	Horizontal
Power supply:	DC 24V	Test site:	RE chamber 2



No.	Mk.	Freq. MHz	Reading Level dBuV	Correct Factor dB	Measure- ment dBuV/m	Limit dBuV/m	Over dB	Detector
1		72.0843	29.86	-10.04	19.82	40.00	-20.18	QP
2		119.8556	42.56	-10.21	32.35	43.50	-11.15	QP
3		167.8243	40.00	-9.66	30.34	43.50	-13.16	QP
4		244.2321	39.40	-6.10	33.30	46.00	-12.70	QP
5		383.9318	43.12	-4.45	38.67	46.00	-7.33	QP
6	*	432.5457	42.43	-3.27	39.16	46.00	-6.84	QP

Radiated emissions between 30MHz – 1GHz

Test mode:	TX DH5-2441	Polarization:	Vertical
Power supply:	DC 24V	Test site:	RE chamber 2



No.	Mk.	Freq. MHz	Reading Level dBuV	Correct Factor dB	Measure- ment dBuV/m	Limit dBuV/m	Over dB	Detector
1		52.9453	32.74	-8.19	24.55	40.00	-15.45	QP
2		72.0843	33.78	-10.04	23.74	40.00	-16.26	QP
3		119.8556	36.01	-10.21	25.80	43.50	-17.70	QP
4		167.8243	37.51	-9.66	27.85	43.50	-15.65	QP
5		325.5958	35.74	-4.51	31.23	46.00	-14.77	QP
6	*	455.9058	38.85	-3.52	35.33	46.00	-10.67	QP

Radiated emissions 1 GHz ~ 25 GHz

Frequency	Reading Level	Correct Factor	Measurement	Limits	Over	Detector	Polarization
(MHz)	(dBμV)	(dB/m)	(dBμV/m)	(dBμV/m)	(dB)	Peak/AVG	H/V
GFSK - 2402 MHz TX mode							
4804.000	40.96	1.52	42.48	74.00	-31.52	Peak	V
4804.000	34.69	1.52	36.21	54.00	-17.79	AVG	V
7206.000	41.14	5.46	46.60	74.00	-27.40	Peak	V
7206.000	34.80	5.46	40.26	54.00	-13.74	AVG	V
9608.000	42.16	6.33	48.49	74.00	-25.51	Peak	V
9608.000	35.86	6.33	42.19	54.00	-11.81	AVG	V
4804.000	42.04	1.52	43.56	74.00	-30.44	Peak	H
4804.000	35.66	1.52	37.18	54.00	-16.82	AVG	H
7206.000	40.34	5.46	45.80	74.00	-28.20	Peak	H
7206.000	33.90	5.46	39.36	54.00	-14.64	AVG	H
9608.000	42.01	6.33	48.34	74.00	-25.66	Peak	H
9608.000	35.80	6.33	42.13	54.00	-11.87	AVG	H
GFSK - 2441 MHz TX mode							
4882.000	40.20	1.68	41.88	74.00	-32.12	Peak	V
4882.000	33.56	1.68	35.24	54.00	-18.76	AVG	V
7323.000	41.02	5.45	46.47	74.00	-27.53	Peak	V
7323.000	34.72	5.45	40.17	54.00	-13.83	AVG	V
9764.000	41.81	6.37	48.18	74.00	-25.82	Peak	V
9764.000	35.76	6.37	42.13	54.00	-11.87	AVG	V
4882.000	41.63	1.68	43.31	74.00	-30.69	Peak	H
4882.000	35.50	1.68	37.18	54.00	-16.82	AVG	H
7323.000	40.75	5.45	46.20	74.00	-27.80	Peak	H
7323.000	34.65	5.45	40.10	54.00	-13.90	AVG	H
9764.000	41.95	6.37	48.32	74.00	-25.68	Peak	H
9764.000	35.89	6.37	42.26	54.00	-11.74	AVG	H

Frequency	Reading Level	Correct Factor	Measurement	Limits	Over	Detector	Polarization
(MHz)	(dBμV)	(dB/m)	(dBμV/m)	(dBμV/m)	(dB)	Peak/AVG	H/V
GFSK - 2480 MHz TX mode							
4960.000	40.99	1.83	42.82	74.00	-31.18	Peak	V
4960.000	34.42	1.83	36.25	54.00	-17.75	AVG	V
7440.000	41.85	5.43	47.28	74.00	-26.72	Peak	V
7440.000	35.69	5.43	41.12	54.00	-12.88	AVG	V
9920.000	42.47	6.41	48.88	74.00	-25.12	Peak	V
9920.000	35.96	6.41	42.37	54.00	-11.63	AVG	V
4960.000	41.51	1.83	43.34	74.00	-30.66	Peak	H
4960.000	35.32	1.83	37.15	54.00	-16.85	AVG	H
7440.000	40.23	5.43	45.66	74.00	-28.34	Peak	H
7440.000	33.92	5.43	39.35	54.00	-14.65	AVG	H
9920.000	40.93	6.41	47.34	74.00	-26.66	Peak	H
9920.000	34.73	6.41	41.14	54.00	-12.86	AVG	H

Radiated emissions at band edge

Frequency	Reading Level	Correct Factor	Measurement	Limits	Over	Detector	Polarization
(MHz)	(dBμV)	(dB/m)	(dBμV/m)	(dBμV/m)	(dB)	Peak/AVG	H/V
GFSK – Low band-edge							
(MHz)	(dBμV)	(dB/m)	(dBμV/m)	(dBμV/m)	(dB)	Peak/AVG	H/V
2310.000	48.05	-6.60	41.45	74.00	-32.55	Peak	V
2310.000	37.42	-6.60	30.82	54.00	-23.18	AVG	V
2390.000	49.29	-6.23	43.06	74.00	-30.94	Peak	V
2390.000	37.99	-6.23	31.76	54.00	-22.24	AVG	V
2310.000	47.85	-6.60	41.25	74.00	-32.75	Peak	H
2310.000	37.37	-6.60	30.77	54.00	-23.23	AVG	H
2390.000	51.37	-6.23	45.14	74.00	-28.86	Peak	H
2390.000	37.95	-6.23	31.72	54.00	-22.28	AVG	H
GFSK – High band-edge							
2483.500	56.51	-5.79	50.72	74.00	-23.28	Peak	V
2483.500	39.11	-5.79	33.32	54.00	-20.68	AVG	V
2500.000	48.14	-5.72	42.42	74.00	-31.58	Peak	V
2500.000	37.86	-5.72	32.14	54.00	-21.86	AVG	V
2483.500	60.82	-5.79	55.03	74.00	-18.97	Peak	H
2483.500	41.18	-5.79	35.39	54.00	-18.61	AVG	H
2500.000	49.68	-5.72	43.96	74.00	-30.04	Peak	H
2500.000	37.86	-5.72	32.14	54.00	-21.86	AVG	H

Photographs of the Test Setup

See the Appendix – Test Setup Photos.

Photographs of the EUT

See the Appendix - EUT Photos.

---End of Report---