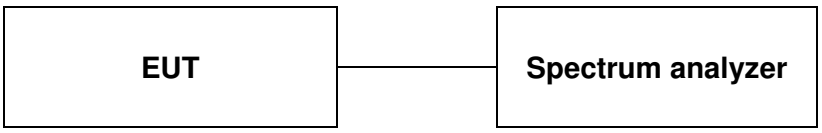
6. 20 dB bandwidth measurement

6.1. Test setup



6.2. Limit

Not applicable

6.3. Test procedure

1. The 20 dB band width was measured with a spectrum analyzer connected to RF antenna connector (conducted measurement) while EUT was operating in transmit mode at the appropriate center frequency. The analyzer center frequency was set to the EUT carrier frequency, using the analyzer. Display Line and Marker Delta functions, the 20 dB band width of the emission was determined.
2. The bandwidth of the fundamental frequency was measured with the spectrum analyzer using RBW ≥ 10 kHz, VBW ≥ 10 kHz, Span = 3 MHz.

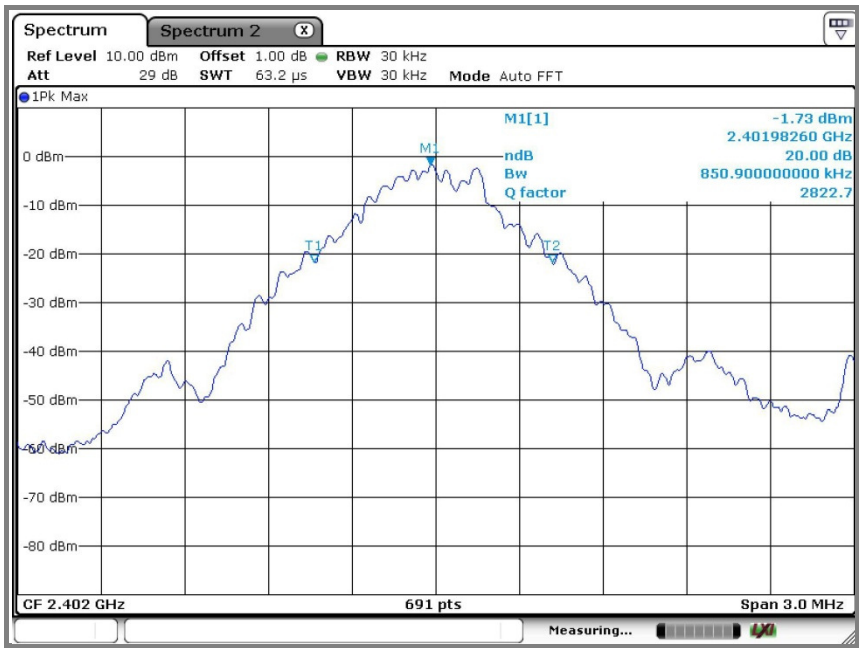
6.4. Test results

Ambient temperature: 23 ℃
Relative humidity: 38 % R.H.

Operation mode	Frequency(MHz)	20 dB bandwidth(MHz)
BASIC	2 402	0.851
	2 441	0.899
	2 480	0.899
EDR	2 402	1.229
	2 441	1.263
	2 480	1.259

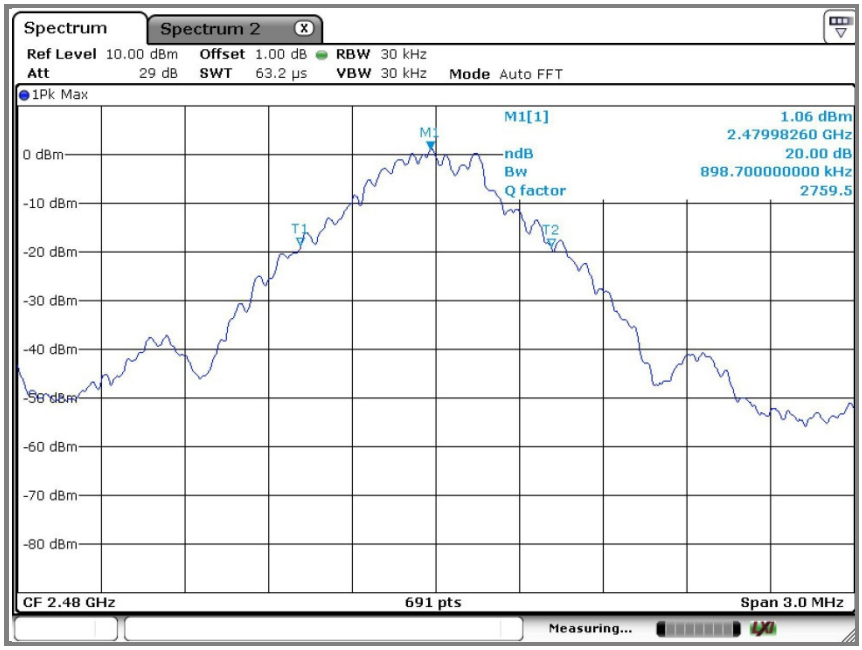
Operation mode: Basic mode

A. Low channel (2 402 ㎒) – 20 ㏈ bandwidth



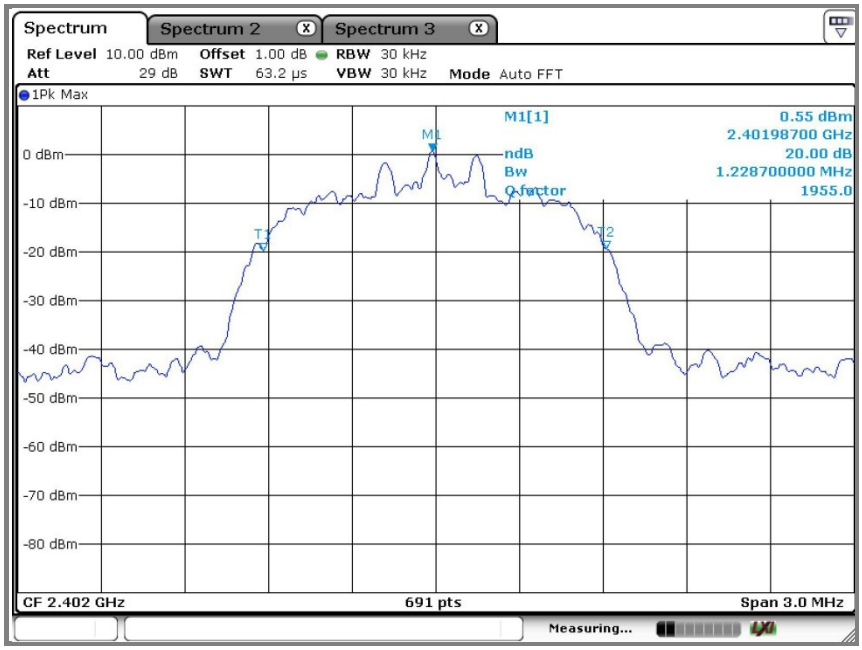
B. Middle channel (2 441 ㎒) – 20 ㏈ bandwidth

C. High channel (2 480 ㎒) – 20 ㏈ bandwidth

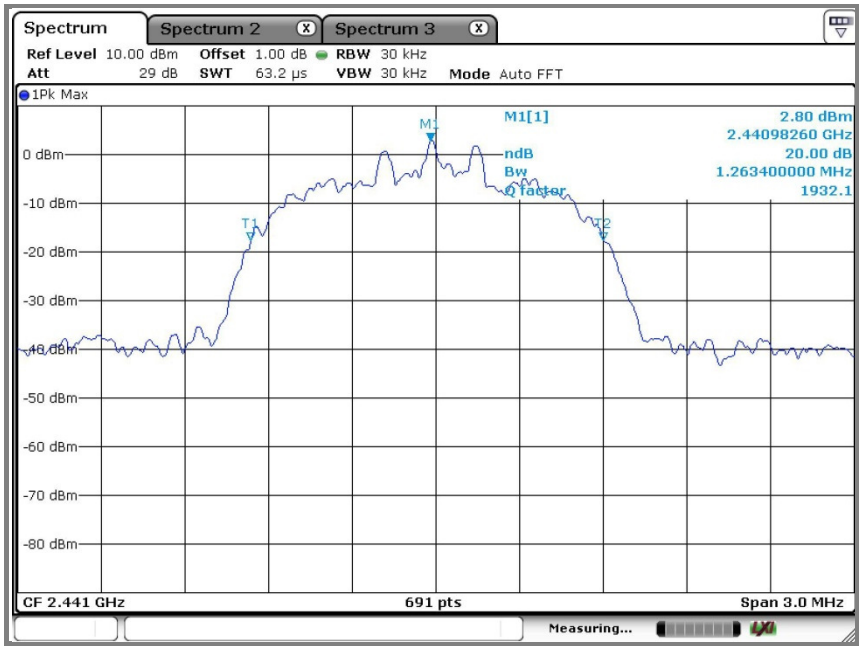


Operation mode: EDR mode

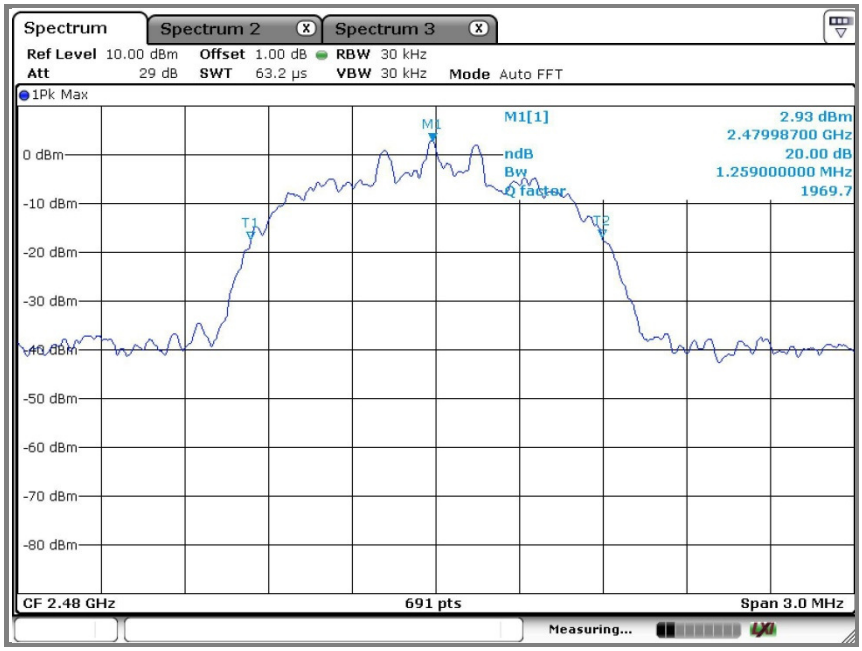
A. Low channel (2 402 ㎒) – 20 ㏈ bandwidth



B. Middle channel (2 441 ㎒) – 20 ㏈ bandwidth

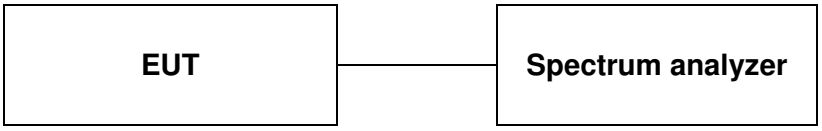


C. High channel (2 480 ㎒) – 20 ㏈ bandwidth



7. Maximum peak output power measurement

7.1. Test setup.



7.2. Limit

The maximum peak output power of the intentional radiator shall not exceed the following:

1. §15.247(a)(1), Frequency hopping systems shall have hopping channel carrier frequencies separated by a minimum of 25 ㎑ or the 20 ㏈ bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 ㎽
2. §15.247(b)(1), For frequency hopping systems operating in the 2 400 – 2 483.5 ㎒ employing at least 75 non-overlapping hopping channels, and all frequency hopping systems in the 5 725 – 5 805 ㎒ band: 1 Watt.

7.3. Test procedure

1. The RF power output was measured with a Spectrum analyzer connected to the RF Antenna connector(conducted measurement) while EUT was operating in transmit mode at the appropriate center frequency, A spectrum analyzer was used to record the shape of the transmit signal.
2. The bandwidth of the fundamental frequency was measured with the spectrum analyzer using;
   Span = approximately 5 times the 20 ㏈ bandwidth, centered on a hopping channel
   RBW ≥ 20 ㏈ BW, VBW ≥ RBW, Sweep = auto, Detector function = peak, Trace = max hold

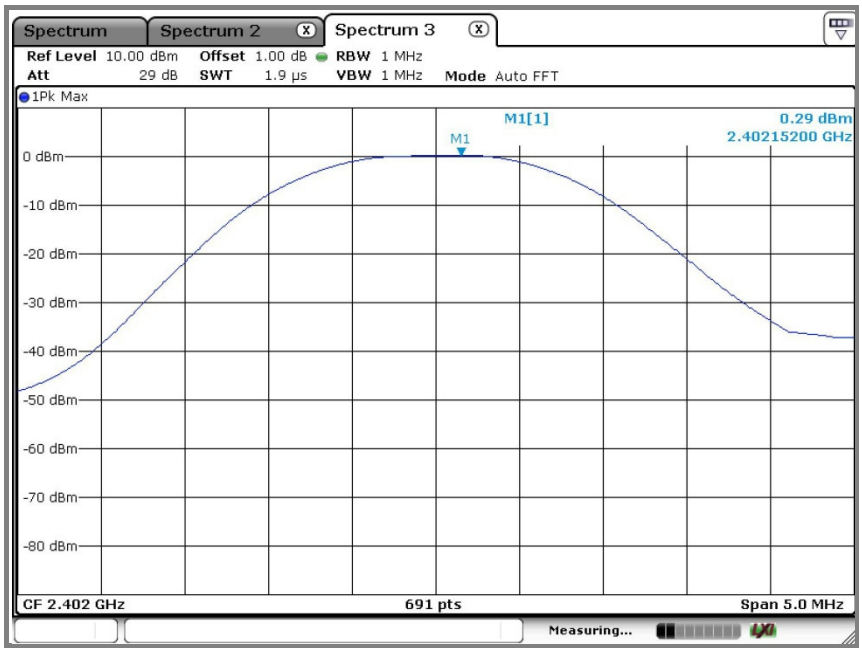
7.4. Test results

Ambient temperature: 23 ℃
Relative humidity: 38 % R.H.

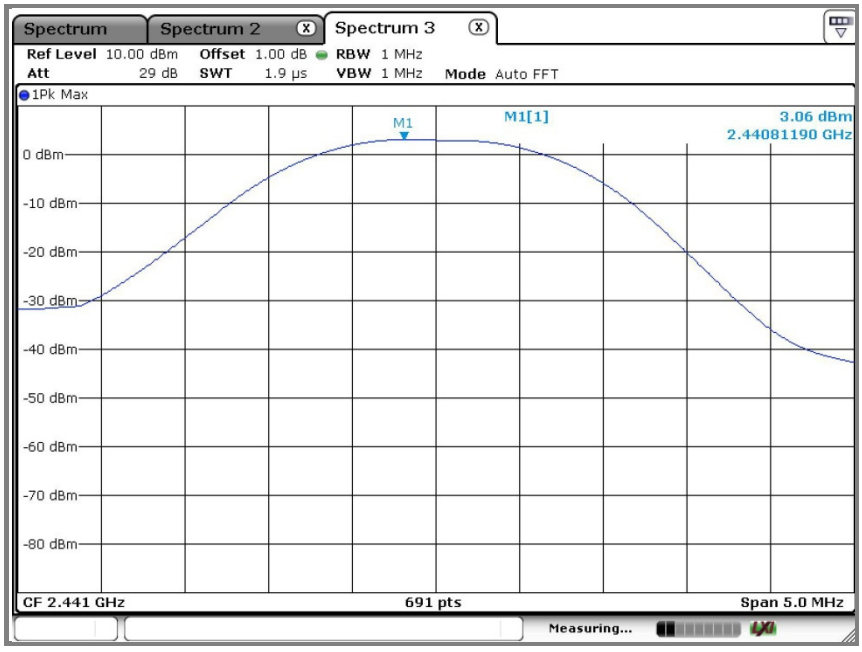
Operation mode	Frequency(㎒)	Peak output power(㏈m)	Limit(㏈m)
BASIC	2 402	0.29	30
	2 441	3.06	30
	2 480	3.03	30
EDR	2 402	2.70	30
	2 441	4.93	30
	2 480	4.99	30

Operation mode: Basic mode

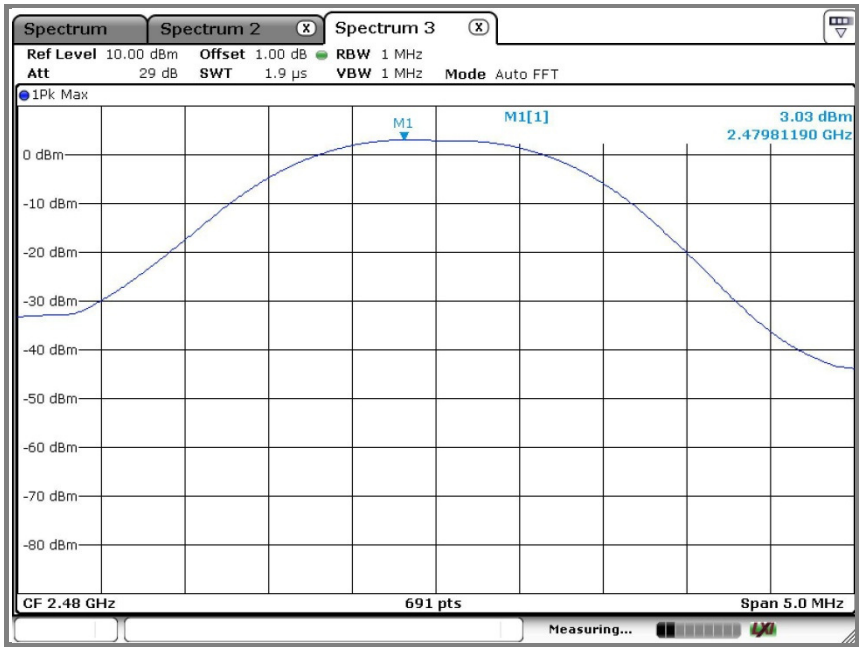
A. Low channel (2 402 ㎒)



B. Middle channel (2 441 ㎒)

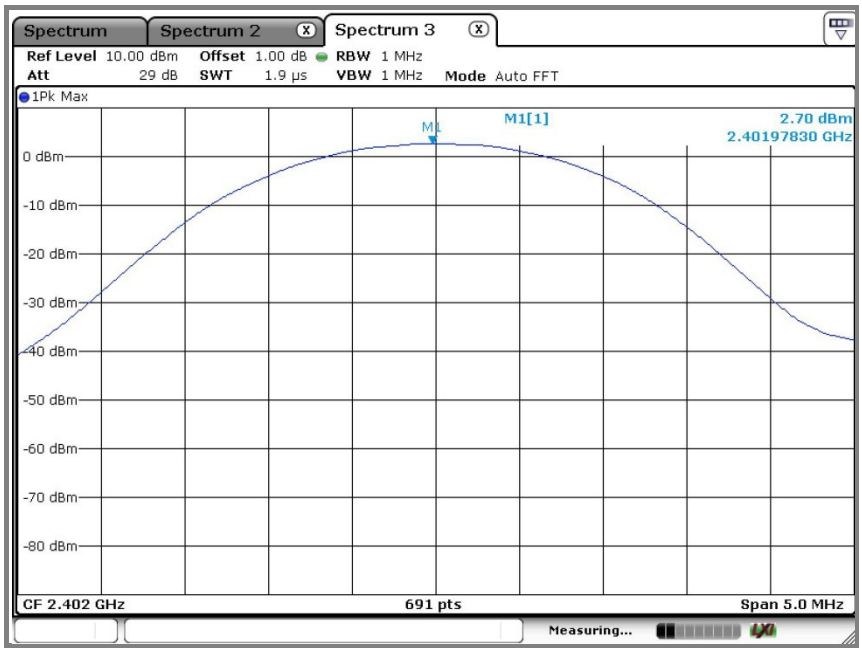


C. High channel (2 480 ㎒)

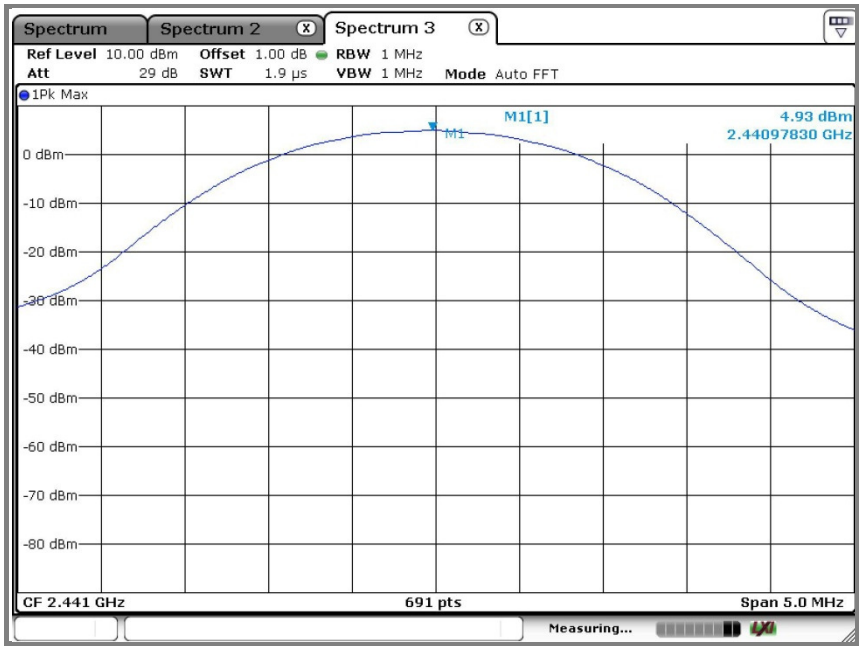


Operation mode: EDR mode

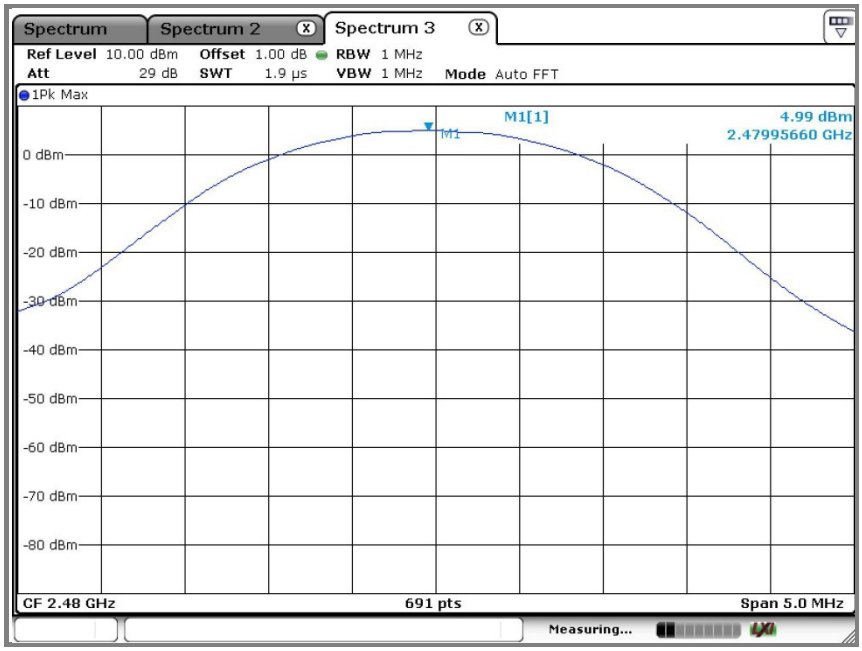
A. Low channel (2 402 ㎒)



B. Middle channel (2 441 ㎒)

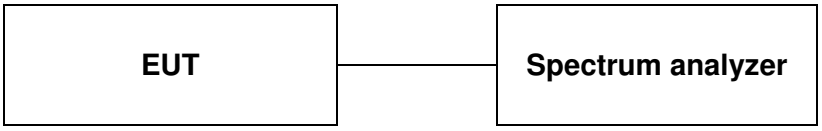


C. High channel (2 480 ㎒)



8. Hopping channel separation

8.1. Test setup



8.2. Limit

§15.247(a)(1) Frequency hopping system operating in 2 400 – 2 483.5 ㎒. Band may have hopping channel carrier frequencies that are separated by 25 ㎑ or two-third of 20 ㏈ bandwidth of the hopping channel, whichever is greater, provided the systems operate with an output power no greater than 125 ㎽.

8.3. Test procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT as shown in test setup without connection to measurement instrument. Turn on the EUT and connect it to measurement instrument. Then set it to any one convenient frequency within its operating range.
3. By using the max hold function record the separation of adjacent channels.
4. Measure the frequency difference of these two adjacent channels by spectrum analyzer mark function. And then plot the result on spectrum analyzer screen.
5. Repeat above procedures until all frequencies measured were complete.
6. Set center frequency of spectrum analyzer = middle of hopping channel.
7. Set the spectrum analyzer as RBW = 10 ㎑, VBW = 10 ㎑, Span = 3 ㎒ and Sweep = auto.

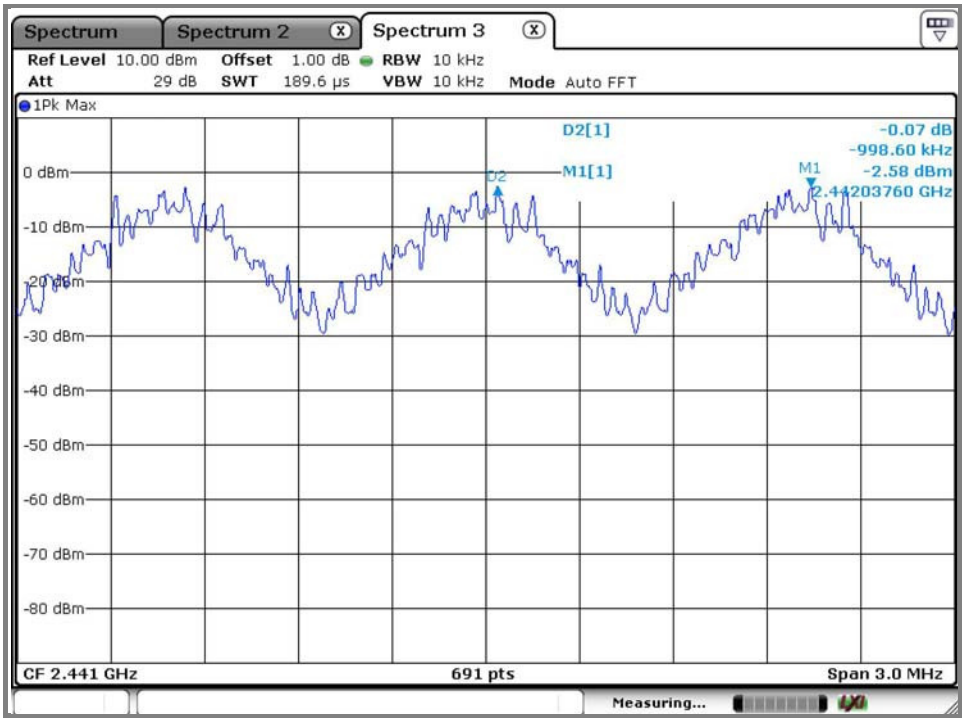
8.4. Test results

Ambient temperature: 23 ℃
Relative humidity: 38 % R.H.

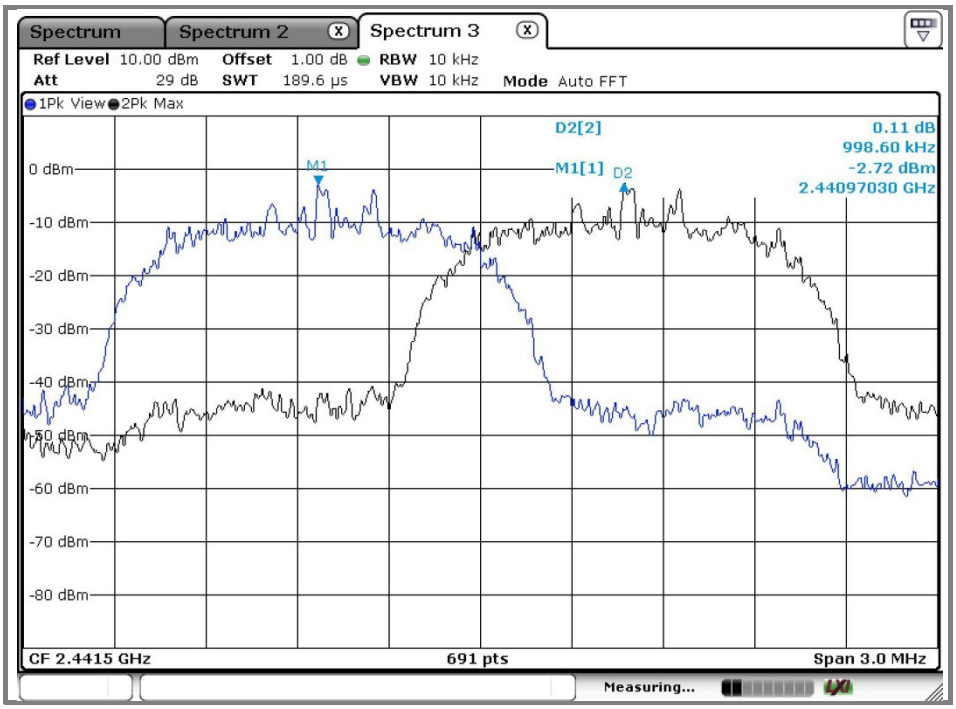
Operation mode	Frequency (㎒)	Adjacent hopping Channel separation (㎑)	Two-third of 20 ㏈ bandwidth (㎑)	Minimum bandwidth (㎑)
BASIC	2 441	998.6	599.1	25
EDR	2 441	998.6	842.2	25

※ Remark:
20 ㏈ bandwidth measurement, the measured channel separation should be greater than two-third of 20 ㏈ bandwidth or Minimum bandwidth.

Operation mode : Basic mode

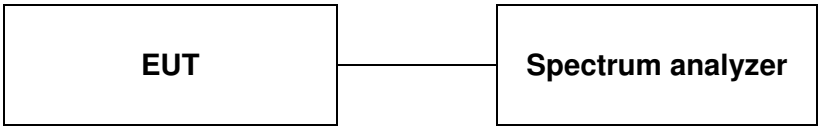


Operation mode : EDR mode



9. Number of hopping frequency

9.1. Test setup



9.2. Limit

§15.247(a)(1)(iii) For frequency hopping system operating in the 2 400 - 2 483.5 ㎒ bands shall use at least 15 hopping frequencies.

9.3. Test procedure

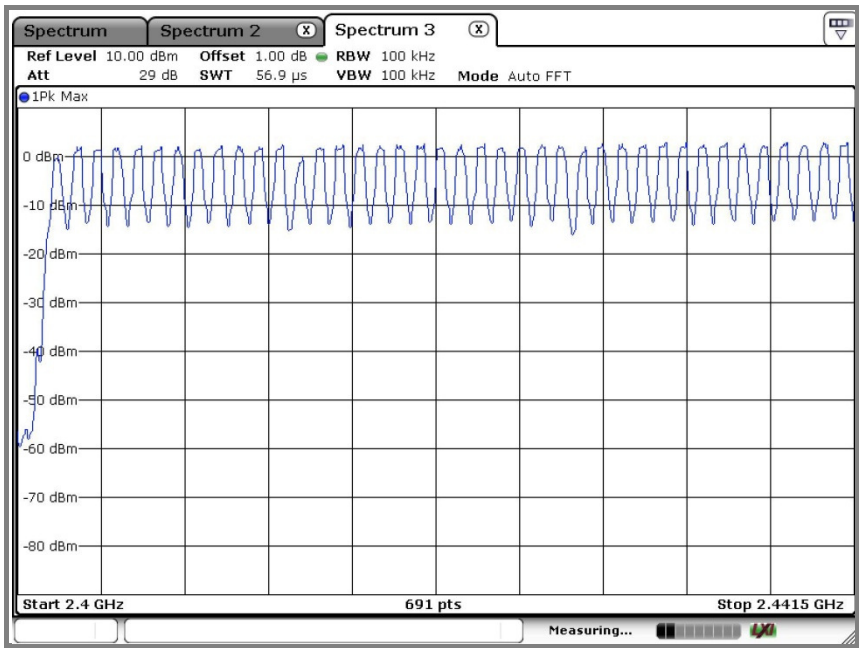
1. Place the EUT on the table and set it in transmitting mode.
2. Remove the antenna from the EUT and then connect a low loss RF cable from the antenna the port to the Spectrum analyzer
3. Set spectrum analyzer Start = 2 400 ㎒, Stop = 2 441.5 ㎒, Sweep = auto and Start = 2 441.5 ㎒, Stop = 2 483.5 ㎒, Sweep = auto.
4. Set the spectrum analyzer as RBW, VBW = 100 ㎑.
5. Max hold, view and count how many channel in the band.

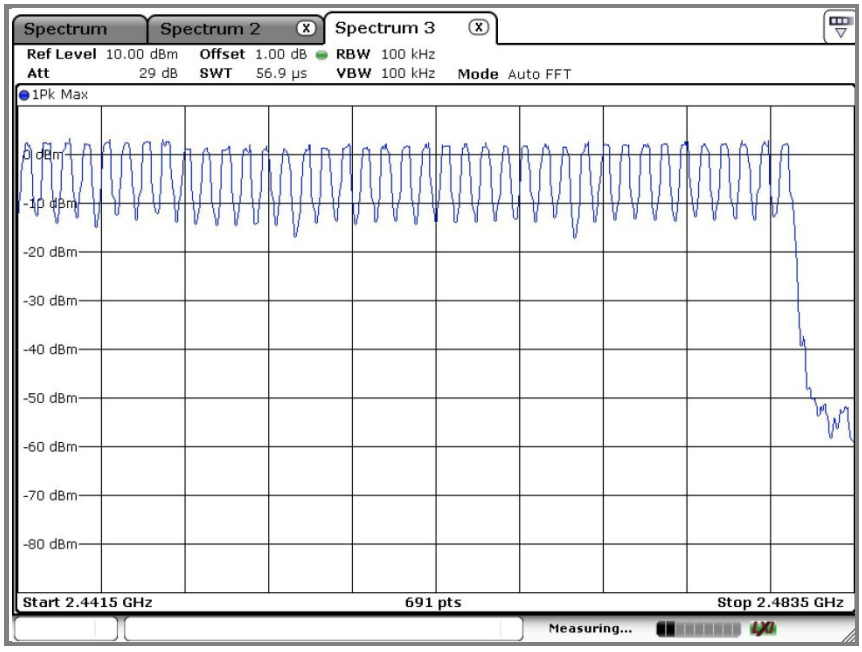
9.4. Test results

Ambient temperature: 23 ℃
Relative humidity: 38 % R.H.

Number of Hopping Frequency	Limit
79	≥ 15

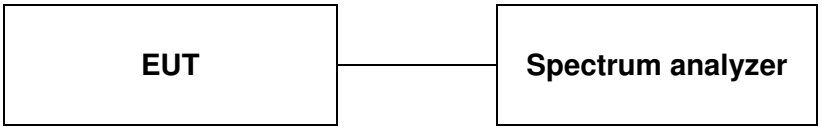
Operation mode: Basic mode





10. Time of occupancy (Dwell time)

10.1. Test setup



10.2. Limit

§15.247(a)(1)(iii) For frequency hopping system operating in the 2 400 – 2 483.5 ㎒ band, the average time of occupancy on any frequency shall not be greater than 0.4 second within a 31.6 second period.

A period time = 0.4(s) * 79 = 31.6(s)

10.3. Test procedure

1. Check the calibration of the measuring instrument using either an internal calibrator or a known signal from an external generator.
2. Position the EUT as shown in test setup without connection to measurement instrument. Turn on the EUT and connect its antenna terminal to measurement instrument via a low loss cable.
3. Adjust the center frequency of spectrum analyzer on any frequency be measured and set spectrum analyzer to zero span mode. And then, set RBW and VBW of spectrum analyzer to proper value.
4. Measure the time duration of one transmission on the measured frequency. And then plot the result with time difference of this time duration.
5. Repeat above procedures until all frequencies measured were complete.
6. The hopping rate is 1 600 per second.

10.4. Test results

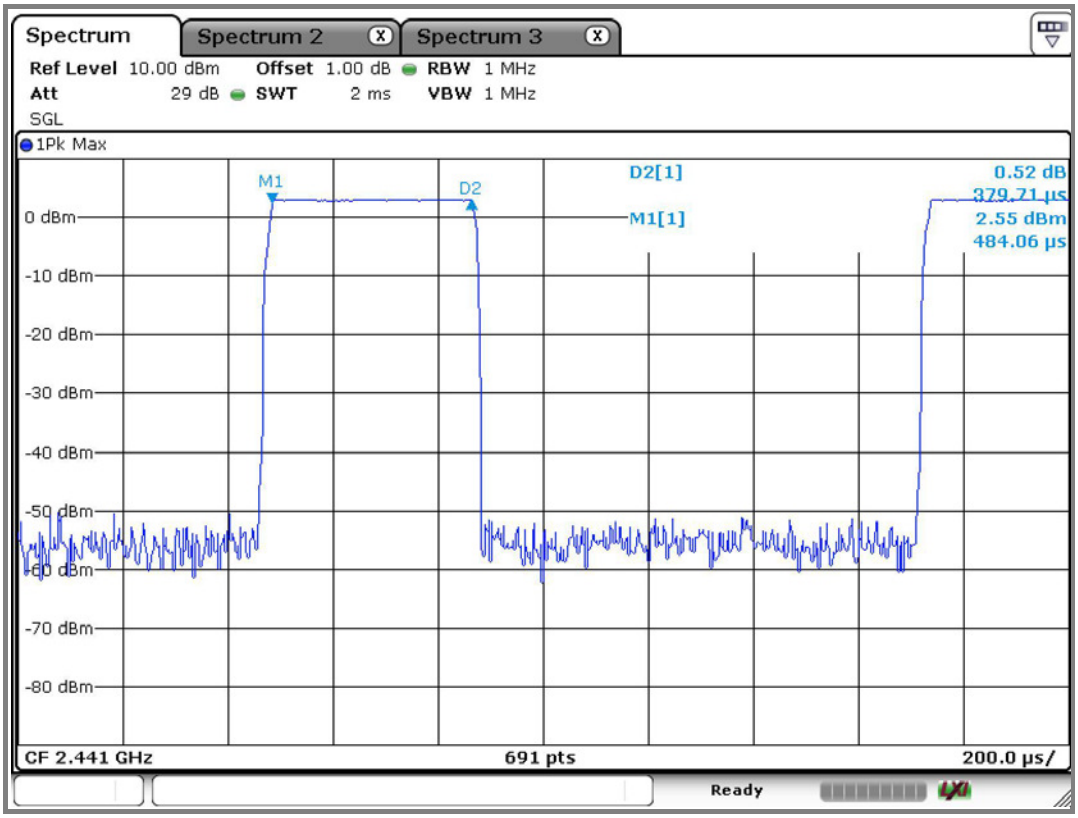
Ambient temperature: 23 ℃
Relative humidity: 38 % R.H.

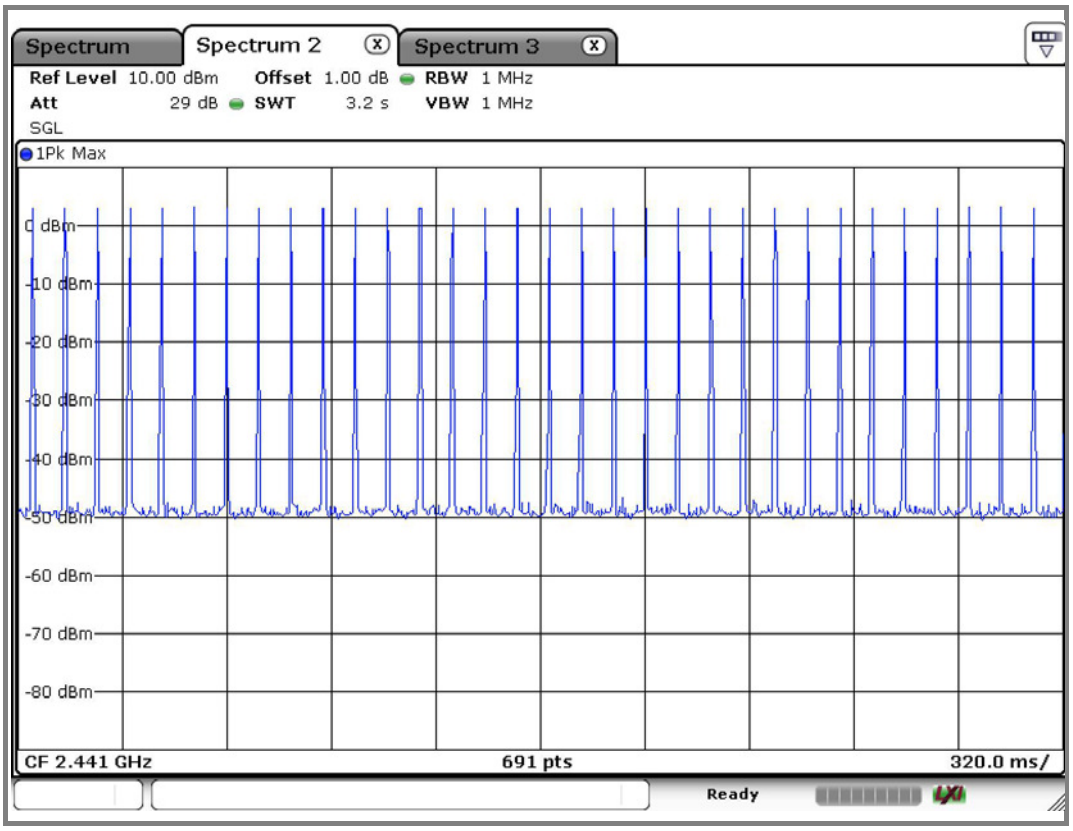
0.4 seconds within a 30 second period per any frequency

Mode	Number of transmission in a 31.6s (79Hopping*0.4)	Length of Transmission Time (msec)	Result (msec)	Limit (msec)
DH1	32(Times / 3.16sec) *10 = 320	0.380	121.60	400
DH3	16(Times / 3.16sec) *10= 160	1.641	262.56	400
DH5	11(Times / 3.16sec) *10= 110	2.887	317.57	400
2-DH5	11(Times / 3.16sec) *10= 110	2.909	319.99	400
3-DH5	11(Times / 3.16sec) *10= 110	2.909	319.99	400

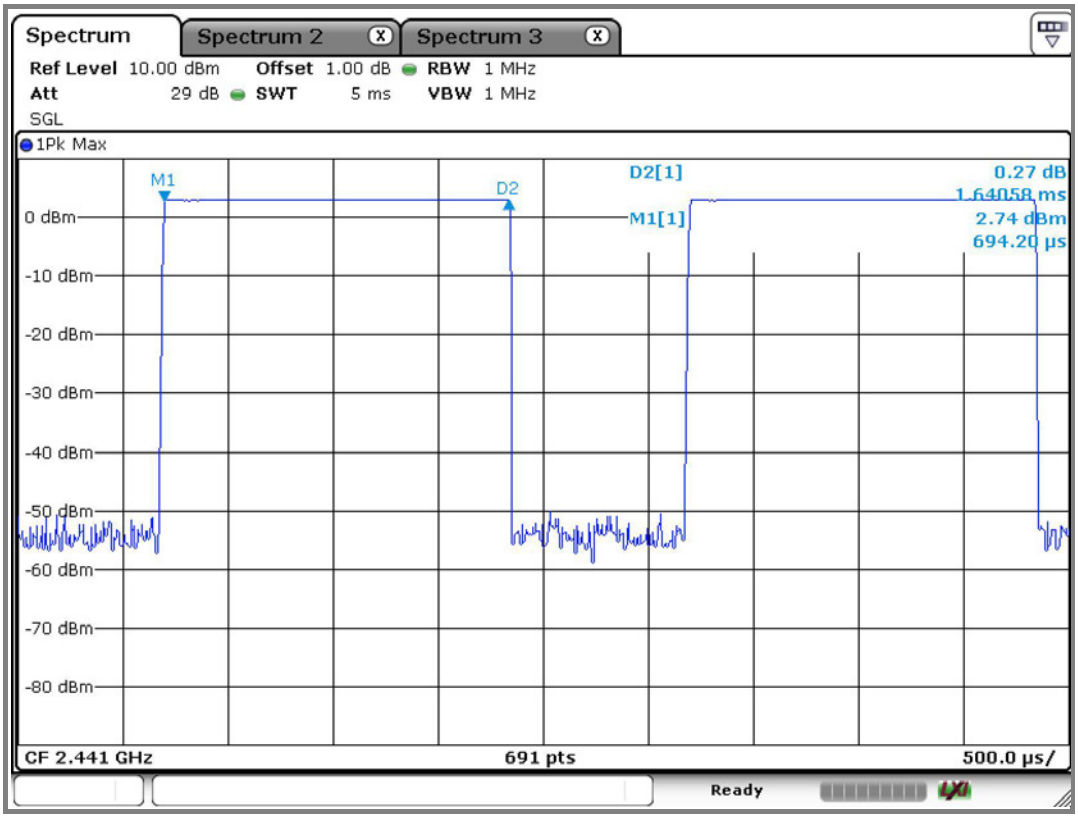
※ Remark:
dwell time = {(number of hopping per second / number of slot) x duration time per channel} x 0.4 ms

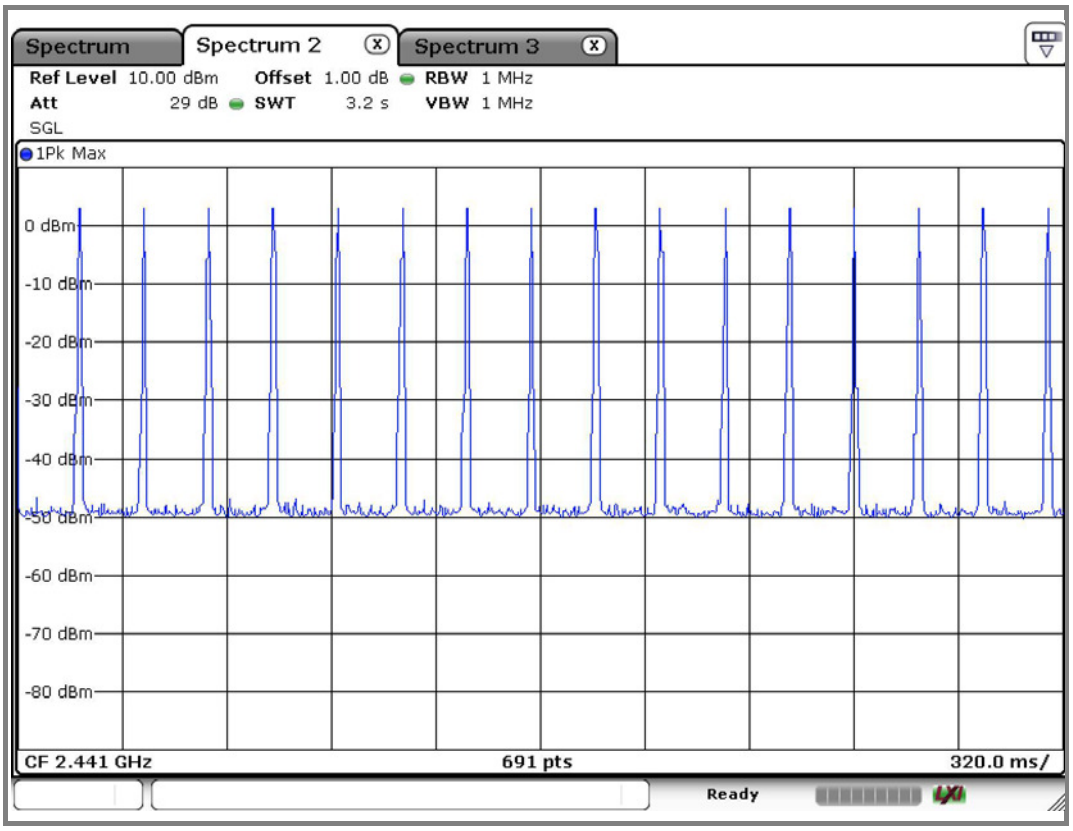
A. DH1



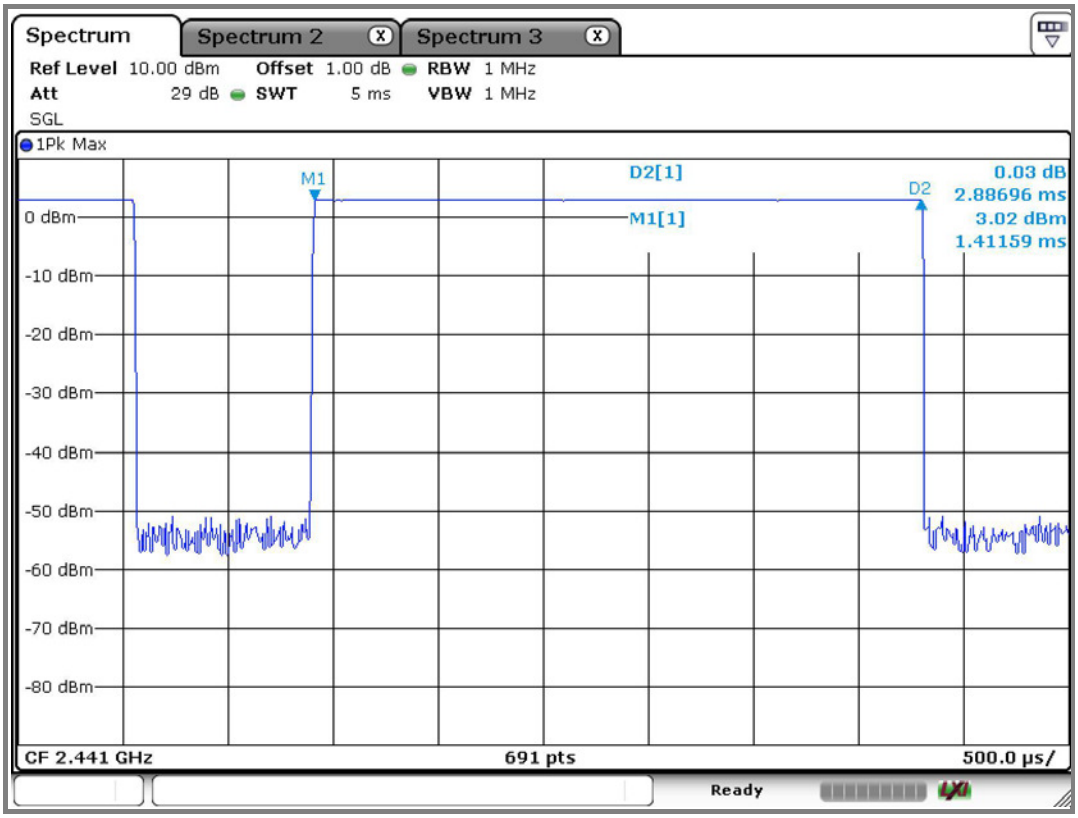


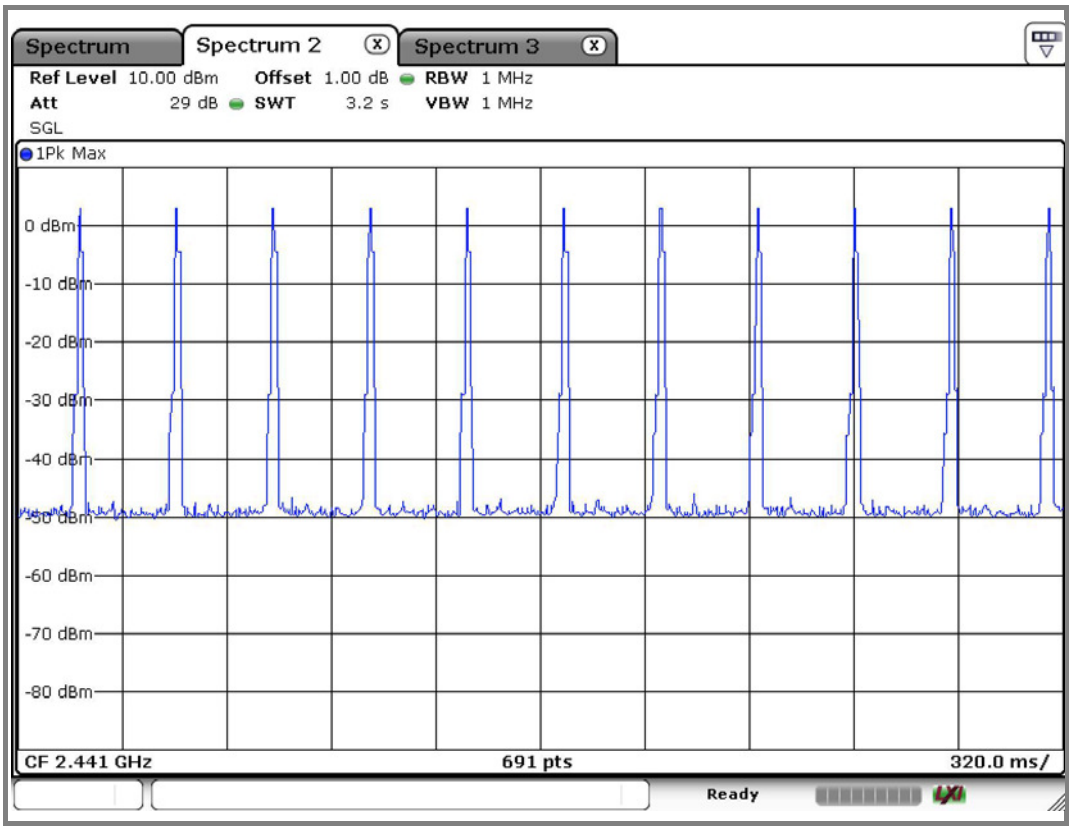
B. DH3



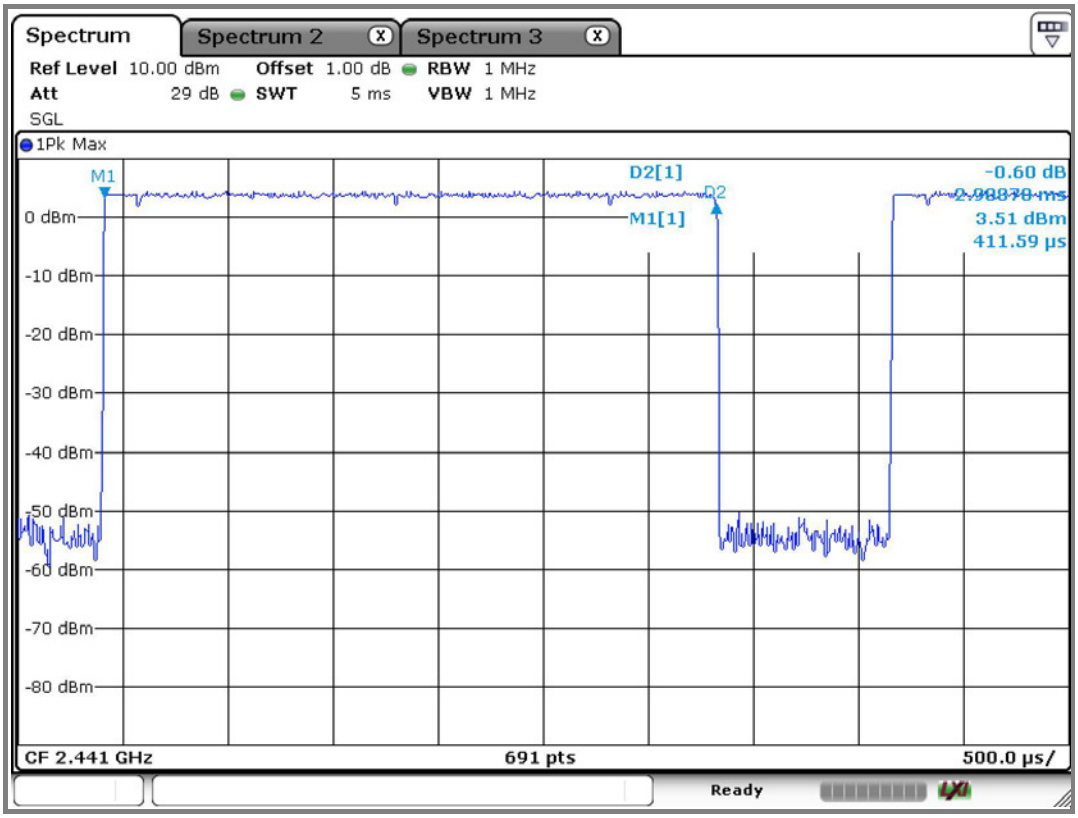


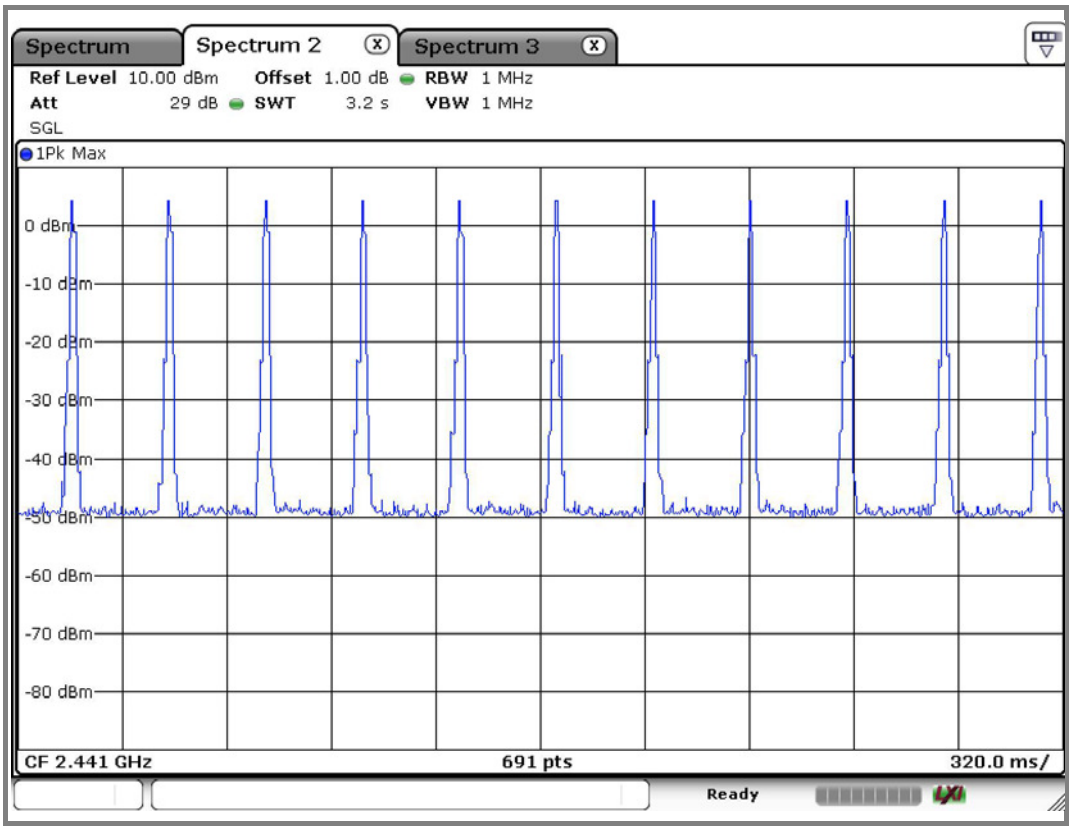
C. DH5



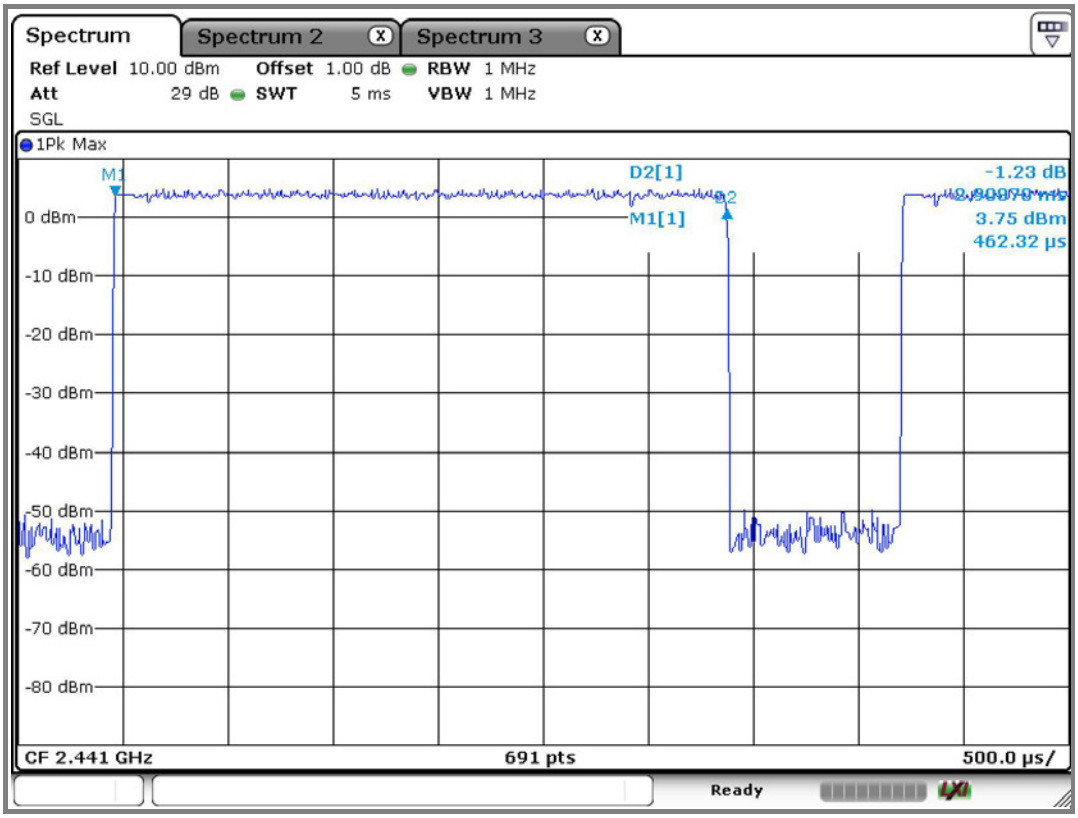


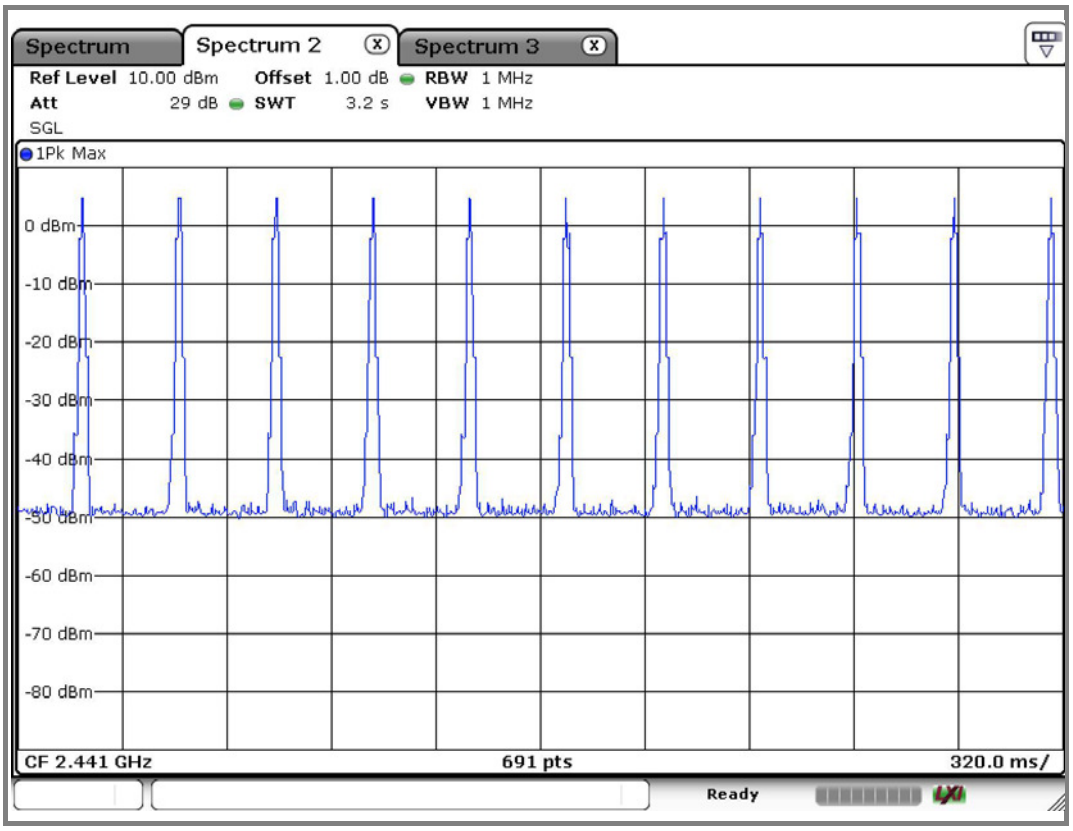
D. 2-DH5





E. 3-DH5





11. Antenna requirement

11.1. 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. And according to FCC 47 CFR Section §15.247 (b) if transmitting antennas of directional gain greater than 6 dBi are used.

11.2. Antenna Connected Construction

Antenna used in this product is Chip type antenna.
Antenna gain is 1.799 dBi.

12. RF exposure evaluation

12.1 RF Exposure Compliance Requirement

12.1.1 Standard Requirement

According to FCC KDB 447498D01 General RF Exposure Guidance v05

4.3.1. Standalone SAR test exclusion considerations
Unless specifically required by the published RF exposure KDB procedures, standalone 1-g head or body and 10-g extremity SAR evaluation for general population exposure conditions, by measurement or numerical simulation, is not required when the corresponding SAR Exclusion Threshold condition, listed below, is satisfied.

12.1.2 Limits

The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by:
[(max. power of channel, including tune-up tolerance, mW)/(min. test separation distance, mm)] · [√f(GHz)] ≤ 3.0 for 1-g SAR and ≤ 7.5 for 10-g extremity SAR, where
f(GHz) is the RF channel transmit frequency in GHz
Power and distance are rounded to the nearest mW and mm before calculation
The result is rounded to one decimal place for comparison
The test exclusions are applicable only when the minimum test separation distance is ≤ 50 mm and for transmission frequencies between 100 MHz and 6 GHz. When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test exclusion

12.1.3 EUT RF Exposure

For EDR mode

The Max Conducted Peak Output Power is **4.99** dBm in High channel(2.480 GHz) ;
4.99 dBm logarithmic terms convert to numeric result is nearly **3.155** mW
According to the formula.
[(max. power of channel, including tune-up tolerance, mW)/(min. test separation distance, mm)] · [√f(GHz)]
General RF Exposure = (3.155 mW / 5 mm) x √2.480 GHz = **0.9937** ①;
SAR requirement:
S= **3.0** ②;
① < ②.

So the SAR report is not required.