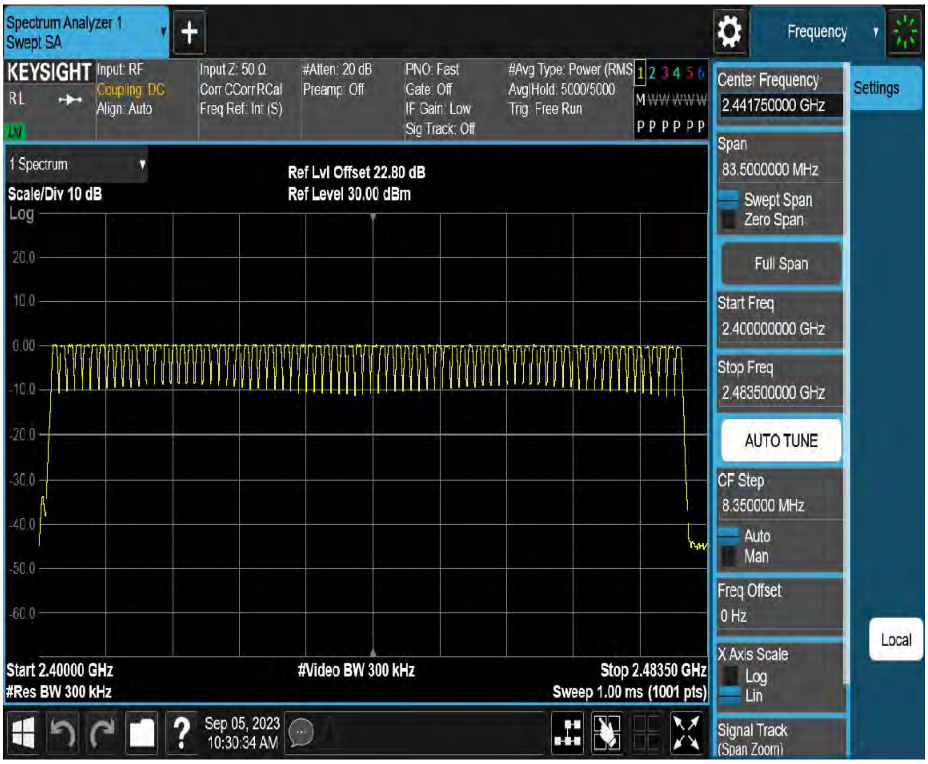
APPENDIX E - NUMBER OF HOPPING FREQUENCY

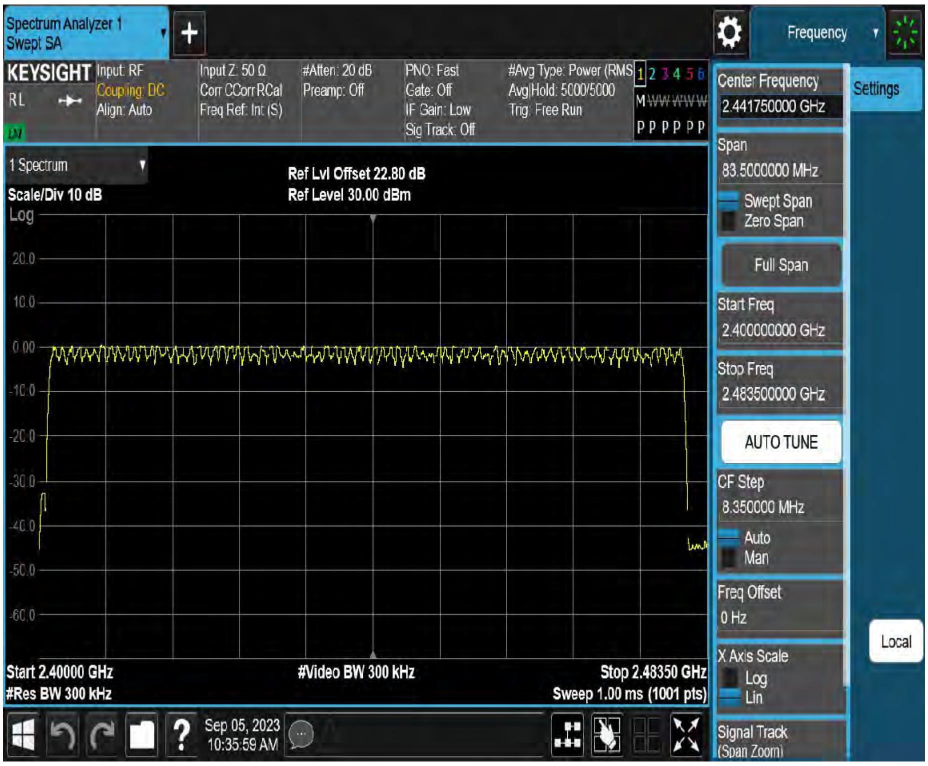
Test Mode	Antenna	Freq(MHz)	Result[Num]	Limit[Num]	Verdict
DH5	Ant1	Hop	79	≥15	PASS
2DH5	Ant1	Hop	79	≥15	PASS
3DH5	Ant1	Hop	79	≥15	PASS

Test Graphs

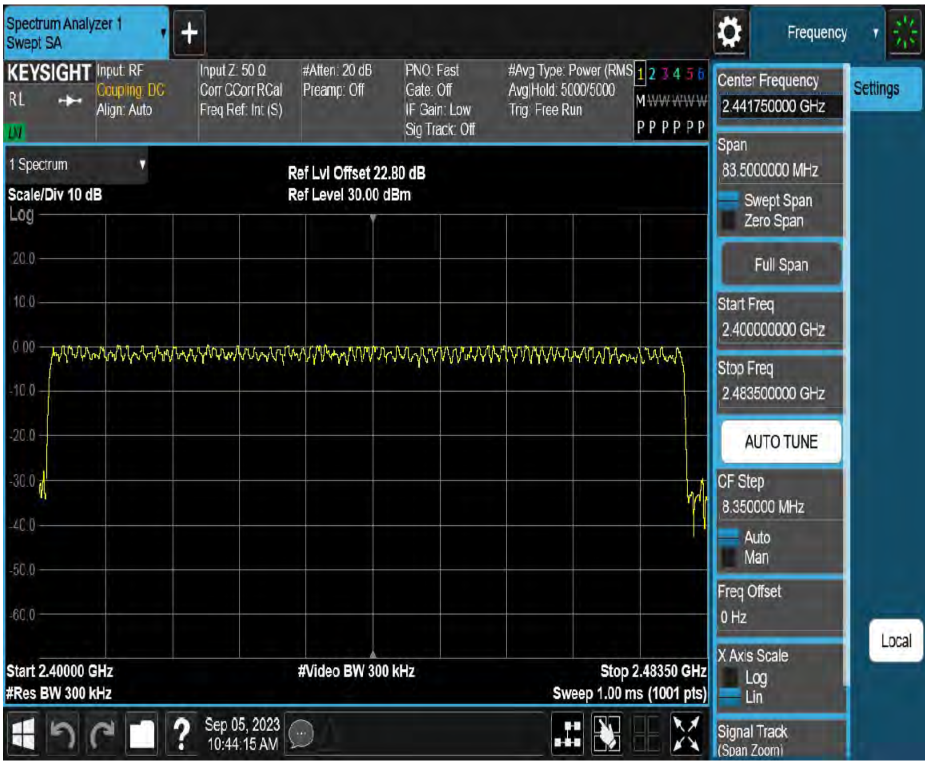
DH5_Ant1_Hop



2DH5_Ant1_Hop



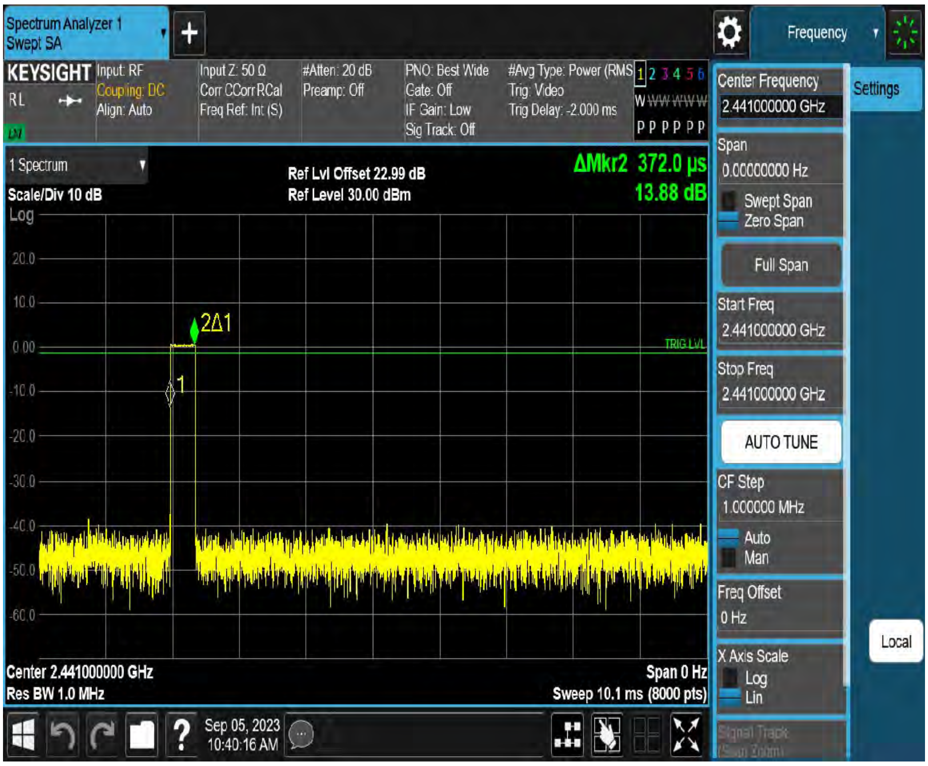
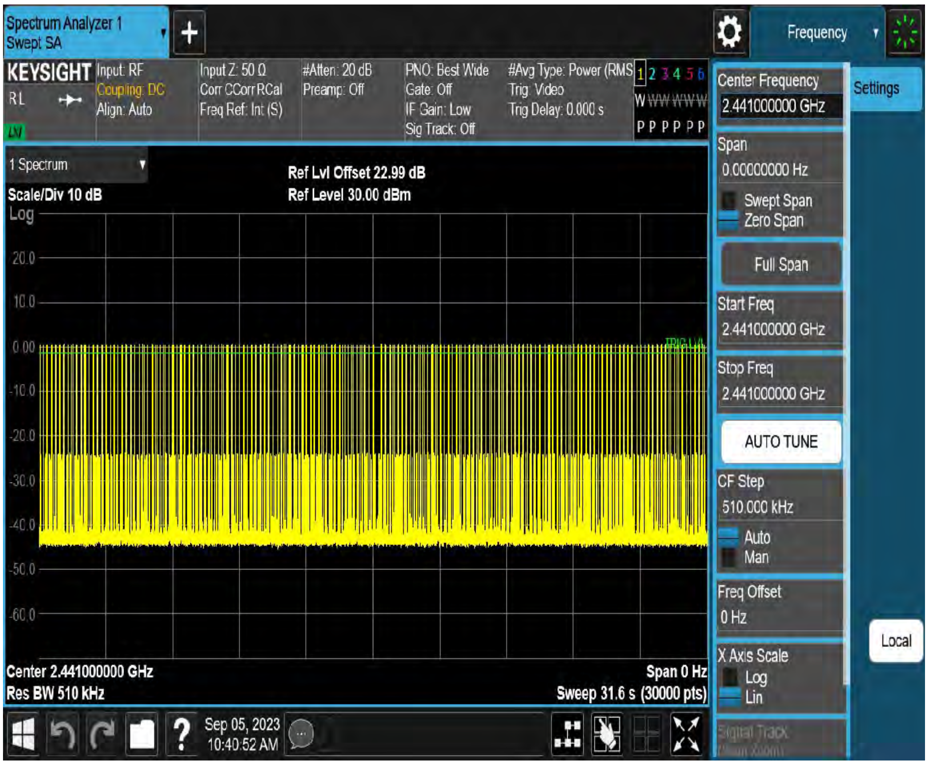
3DH5_Ant1_Hop

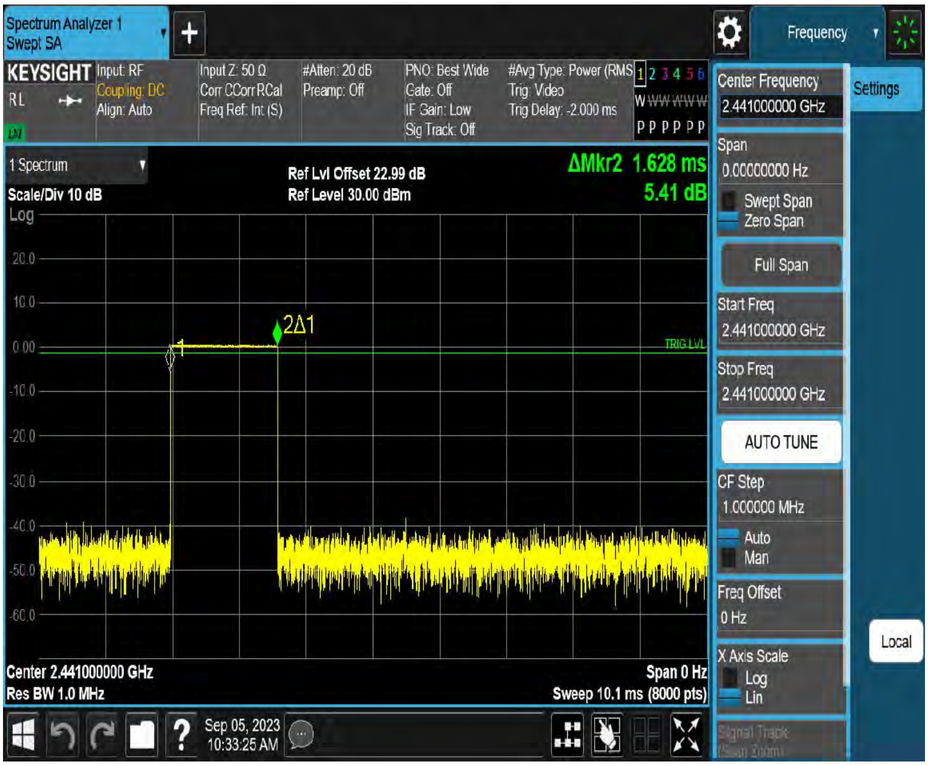
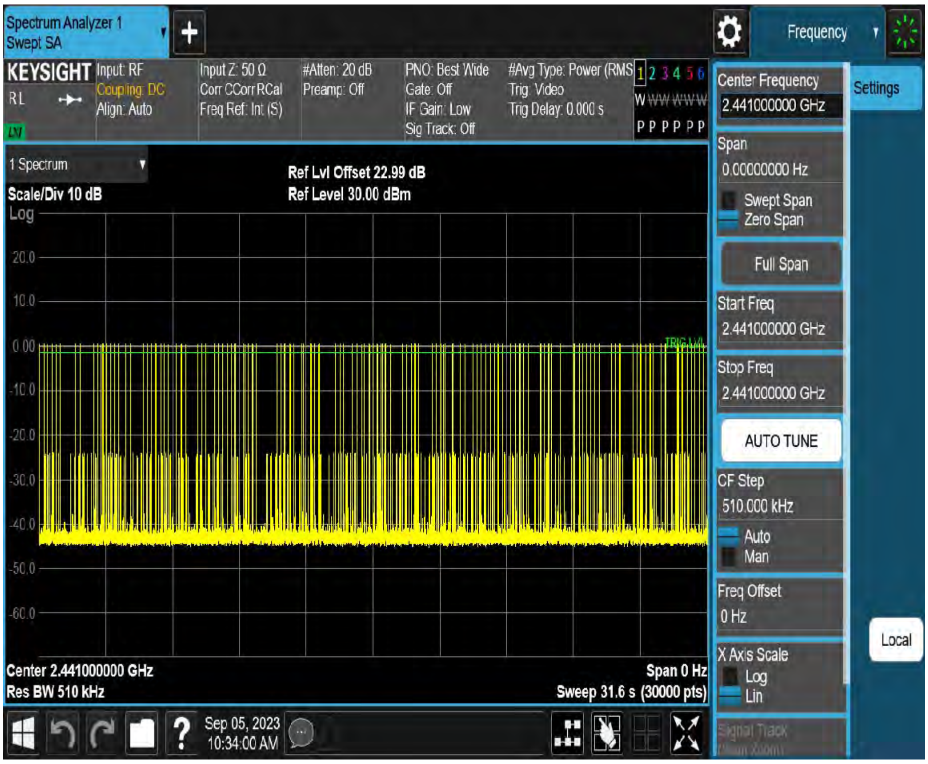


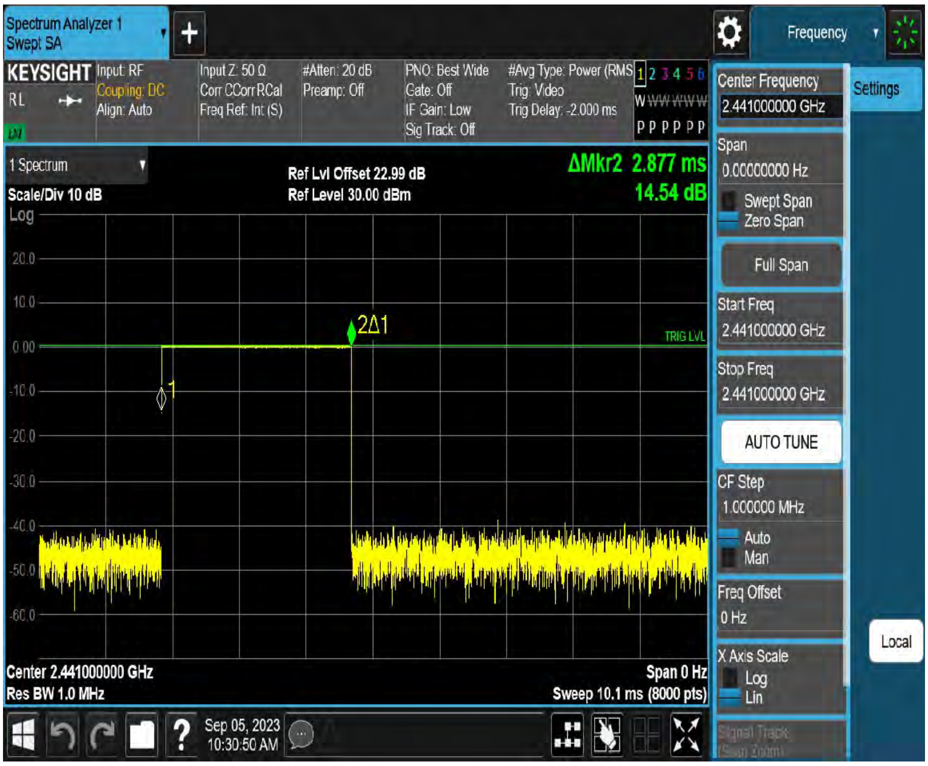
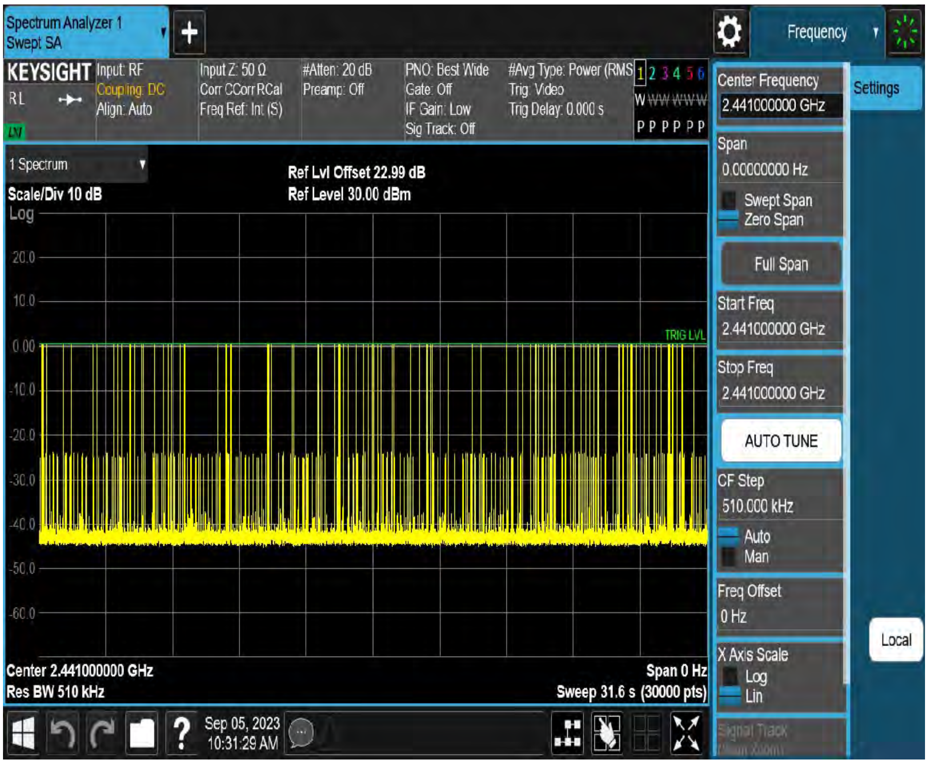
APPENDIX F - AVERAGE TIME OF OCCUPANCY

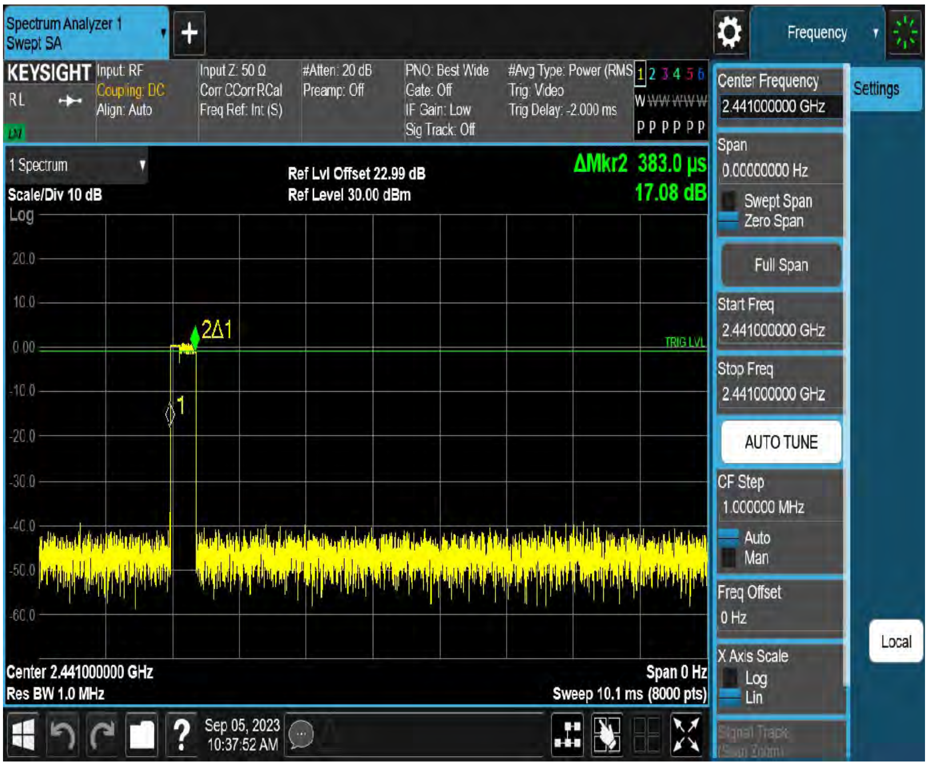
Test Mode	Antenna	Freq(MHz)	Burst Width [ms]	Total Hops [Num]	Result[s]	Limit[s]	Verdict
DH1	Ant1	Hop	0.372	315	0.117	≤0.4	PASS
DH3	Ant1	Hop	1.628	158	0.257	≤0.4	PASS
DH5	Ant1	Hop	2.877	103	0.296	≤0.4	PASS
2DH1	Ant1	Hop	0.383	315	0.121	≤0.4	PASS
2DH3	Ant1	Hop	1.634	158	0.258	≤0.4	PASS
2DH5	Ant1	Hop	2.883	116	0.334	≤0.4	PASS
3DH1	Ant1	Hop	0.383	316	0.121	≤0.4	PASS
3DH3	Ant1	Hop	1.633	167	0.273	≤0.4	PASS
3DH5	Ant1	Hop	2.884	104	0.3	≤0.4	PASS

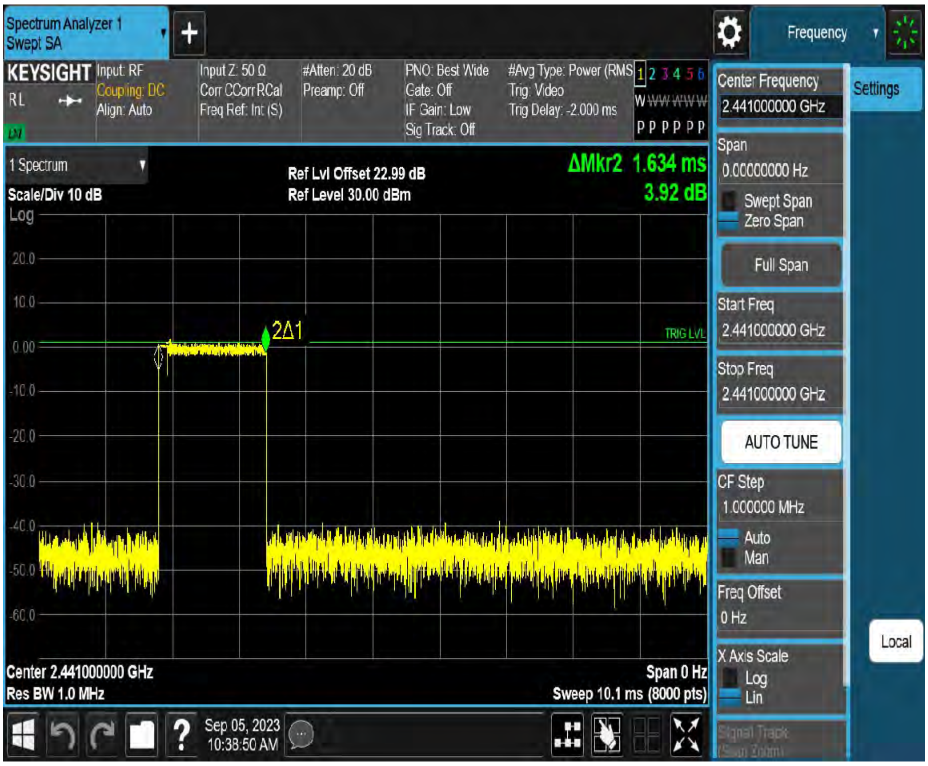
Test Graphs

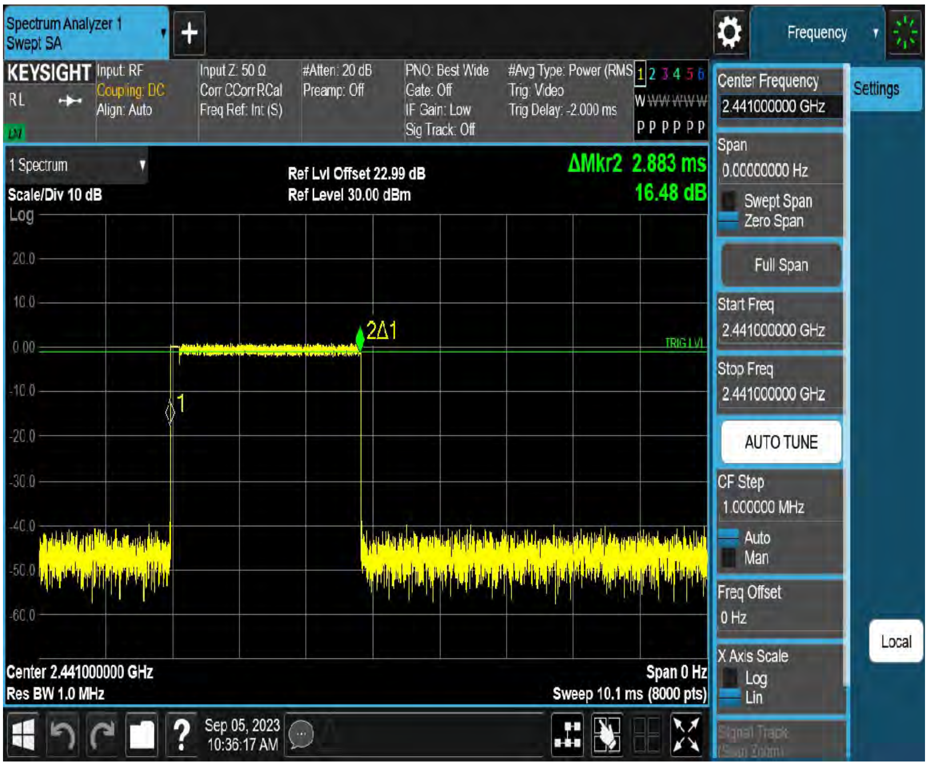
DH1_Ant1_Hop



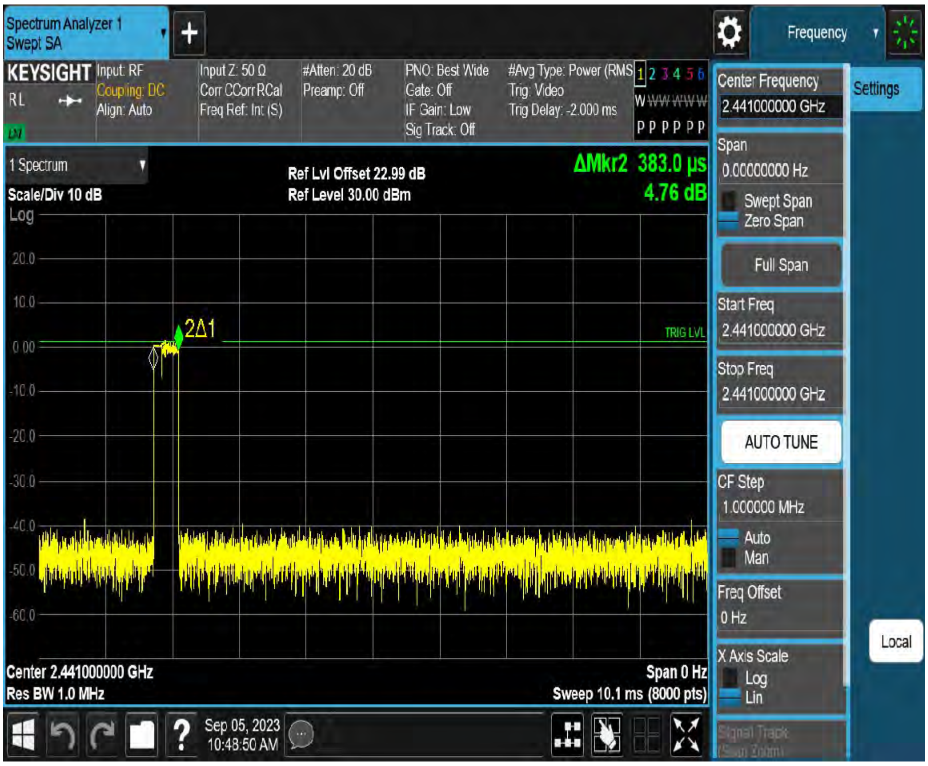
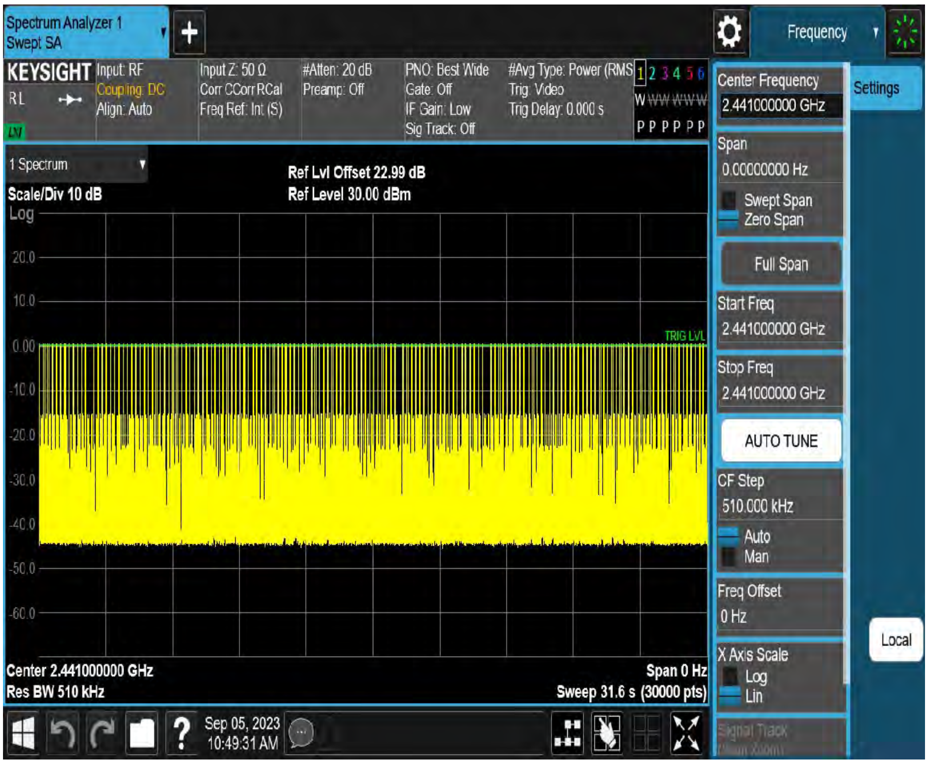
DH3_Ant1_Hop
 Spectrum Analyzer 1 Swept SA KEYSIGHT Input: RF Coupling: DC Align: Auto Input Z: 50 Ω Corr CCorr RCal Freq Ref: Int (S) #Atten: 20 dB Preamp: Off PNO: Best Wide Gate: Off IF Gain: Low Sig Track: Off #Avg Type: Power (RMS) Trig: Video Trig Delay: -2.000 ms 1 Spectrum Scale/Div 10 dB Log Ref Lvl Offset 22.99 dB Ref Level 30.00 dBm ΔMkr2 1.628 ms 5.41 dB 2Δ1 TRIG LVL Center 2.441000000 GHz Res BW 1.0 MHz Span 0 Hz Sweep 10.1 ms (8000 pts) Sep 05, 2023 10:33:25 AM Frequency Settings Center Frequency 2.441000000 GHz Span 0.00000000 Hz Swept Span Zero Span Full Span Start Freq 2.441000000 GHz Stop Freq 2.441000000 GHz AUTO TUNE CF Step 1.000000 MHz Auto Man Freq Offset 0 Hz X Axis Scale Log Lin Local
 Spectrum Analyzer 1 Swept SA KEYSIGHT Input: RF Coupling: DC Align: Auto Input Z: 50 Ω Corr CCorr RCal Freq Ref: Int (S) #Atten: 20 dB Preamp: Off PNO: Best Wide Gate: Off IF Gain: Low Sig Track: Off #Avg Type: Power (RMS) Trig: Video Trig Delay: 0.000 s 1 Spectrum Scale/Div 10 dB Log Ref Lvl Offset 22.99 dB Ref Level 30.00 dBm Center 2.441000000 GHz Res BW 510 kHz Span 0 Hz Sweep 31.6 s (30000 pts) Sep 05, 2023 10:34:00 AM Frequency Settings Center Frequency 2.441000000 GHz Span 0.00000000 Hz Swept Span Zero Span Full Span Start Freq 2.441000000 GHz Stop Freq 2.441000000 GHz AUTO TUNE CF Step 510.000 kHz Auto Man Freq Offset 0 Hz X Axis Scale Log Lin Local

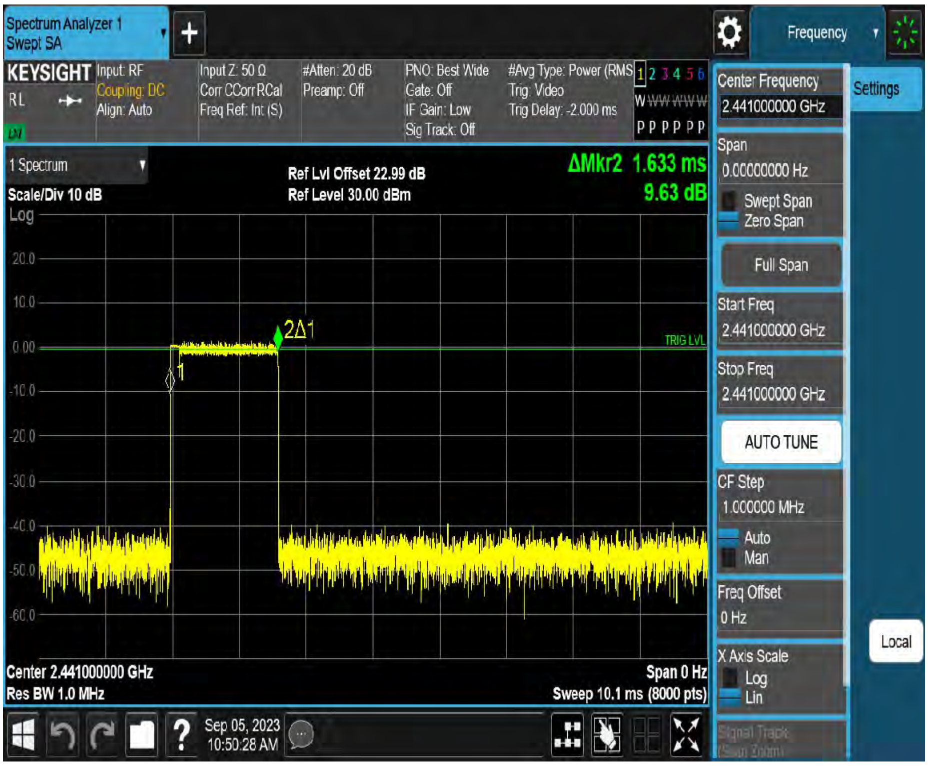
DH5_Ant1_Hop
 Spectrum Analyzer 1 Swept SA Frequency KEYSIGHT Input: RF Coupling: DC Align: Auto Input Z: 50 Ω Corr CCorr RCal Freq Ref: Int (S) #Atten: 20 dB Preamp: Off PNO: Best Wide Gate: Off IF Gain: Low Sig Track: Off #Avg Type: Power (RMS) Trig: Video Trig Delay: -2.000 ms 1 Spectrum Scale/Div 10 dB Log Ref Lvl Offset 22.99 dB Ref Level 30.00 dBm ΔMkr2 2.877 ms 14.54 dB TRIG LVL Center 2.441000000 GHz Res BW 1.0 MHz Span 0 Hz Sweep 10.1 ms (8000 pts) Sep 05, 2023 10:30:50 AM Center Frequency 2.441000000 GHz Settings Span 0.00000000 Hz Swept Span Zero Span Full Span Start Freq 2.441000000 GHz Stop Freq 2.441000000 GHz AUTO TUNE CF Step 1.000000 MHz Auto Man Freq Offset 0 Hz X Axis Scale Log Lin Local
 Spectrum Analyzer 1 Swept SA Frequency KEYSIGHT Input: RF Coupling: DC Align: Auto Input Z: 50 Ω Corr CCorr RCal Freq Ref: Int (S) #Atten: 20 dB Preamp: Off PNO: Best Wide Gate: Off IF Gain: Low Sig Track: Off #Avg Type: Power (RMS) Trig: Video Trig Delay: 0.000 s 1 Spectrum Scale/Div 10 dB Log Ref Lvl Offset 22.99 dB Ref Level 30.00 dBm TRIG LVL Center 2.441000000 GHz Res BW 510 kHz Span 0 Hz Sweep 31.6 s (30000 pts) Sep 05, 2023 10:31:29 AM Center Frequency 2.441000000 GHz Settings Span 0.00000000 Hz Swept Span Zero Span Full Span Start Freq 2.441000000 GHz Stop Freq 2.441000000 GHz AUTO TUNE CF Step 510.000 kHz Auto Man Freq Offset 0 Hz X Axis Scale Log Lin Local

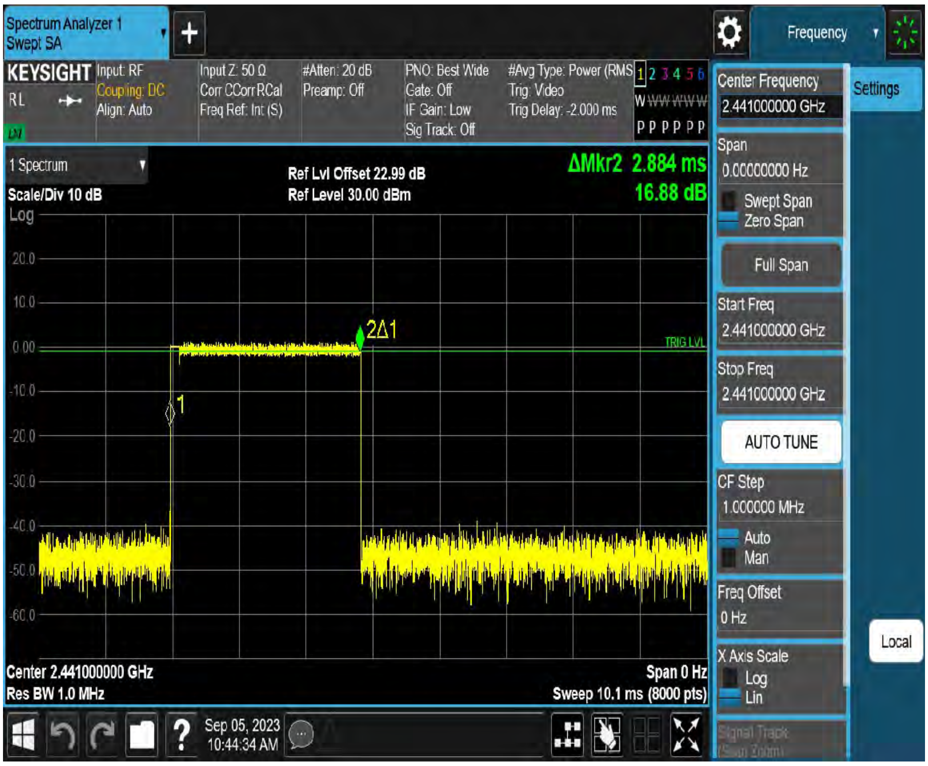
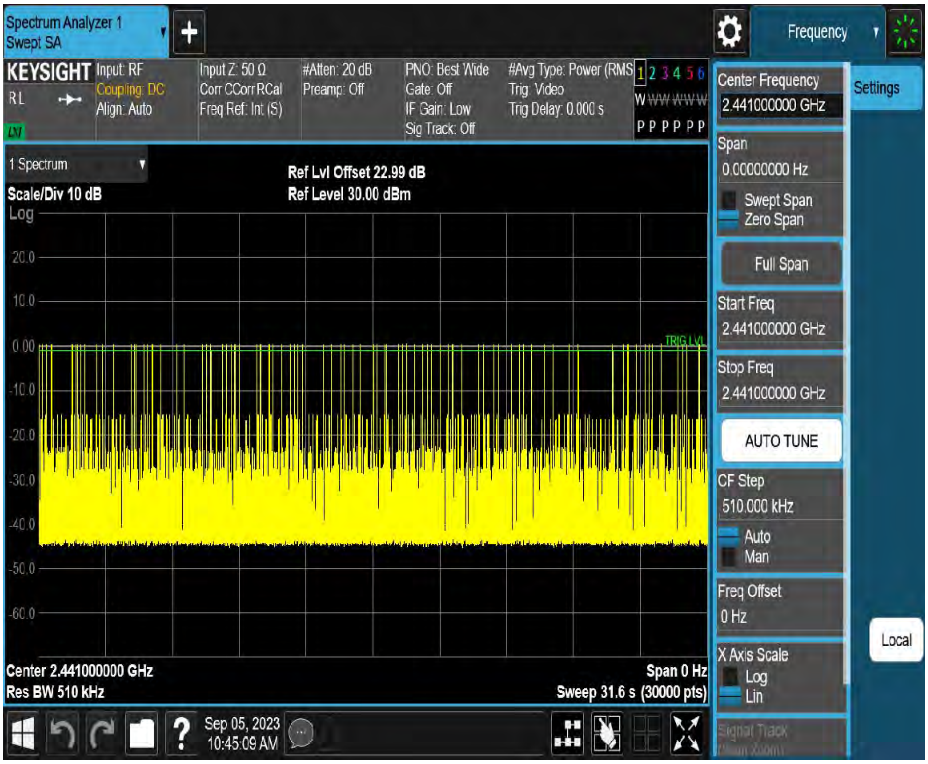
2DH1_Ant1_Hop



2DH3_Ant1_Hop



2DH5_Ant1_Hop



3DH1_Ant1_Hop



3DH3_Ant1_Hop



3DH5_Ant1_Hop



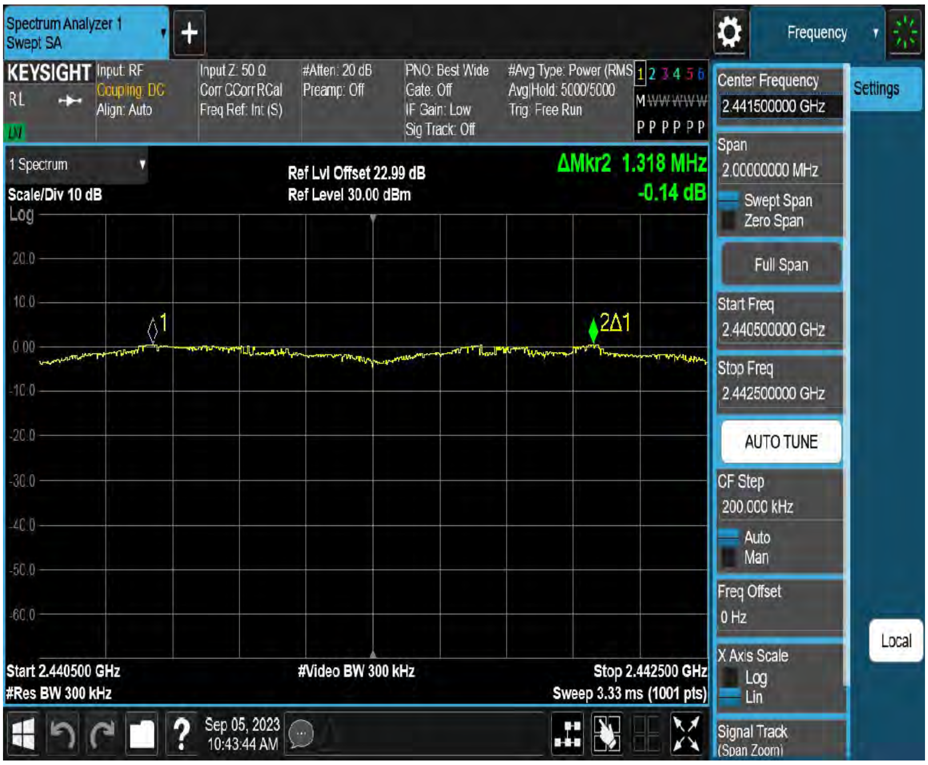
APPENDIX G - HOPPING CHANNEL SEPARATION

Test Mode	Antenna	Freq(MHz)	Result[MHz]	Limit[MHz]	Verdict
DH5	Ant1	Hop	0.692	≥0.634	PASS
2DH5	Ant1	Hop	1.012	≥0.856	PASS
3DH5	Ant1	Hop	1.318	≥1.305	PASS

Test Graphs

DH5_Ant1_Hop


2DH5_Ant1_Hop


3DH5_Ant1_Hop


APPENDIX H - BANDWIDTH

20dB Emission Bandwidth

Test Mode	Antenna	Freq(MHz)	20dB EBW[MHz]	FL[MHz]	FH[MHz]	Limit[MHz]	Verdict
DH5	Ant1	2402	0.951	2401.529	2402.480	---	---
		2441	0.948	2440.529	2441.477	---	---
		2480	0.948	2479.532	2480.480	---	---
2DH5	Ant1	2402	1.272	2401.373	2402.645	---	---
		2441	1.284	2440.364	2441.648	---	---
		2480	1.281	2479.367	2480.648	---	---
3DH5	Ant1	2402	1.293	2401.355	2402.648	---	---
		2441	1.305	2440.346	2441.651	---	---
		2480	1.305	2479.346	2480.651	---	---

Test Graphs

DH5_Ant1_2402

DH5_Ant1_2441

DH5_Ant1_2480

2DH5_Ant1_2402

2DH5_Ant1_2441

2DH5_Ant1_2480

3DH5_Ant1_2402

3DH5_Ant1_2441

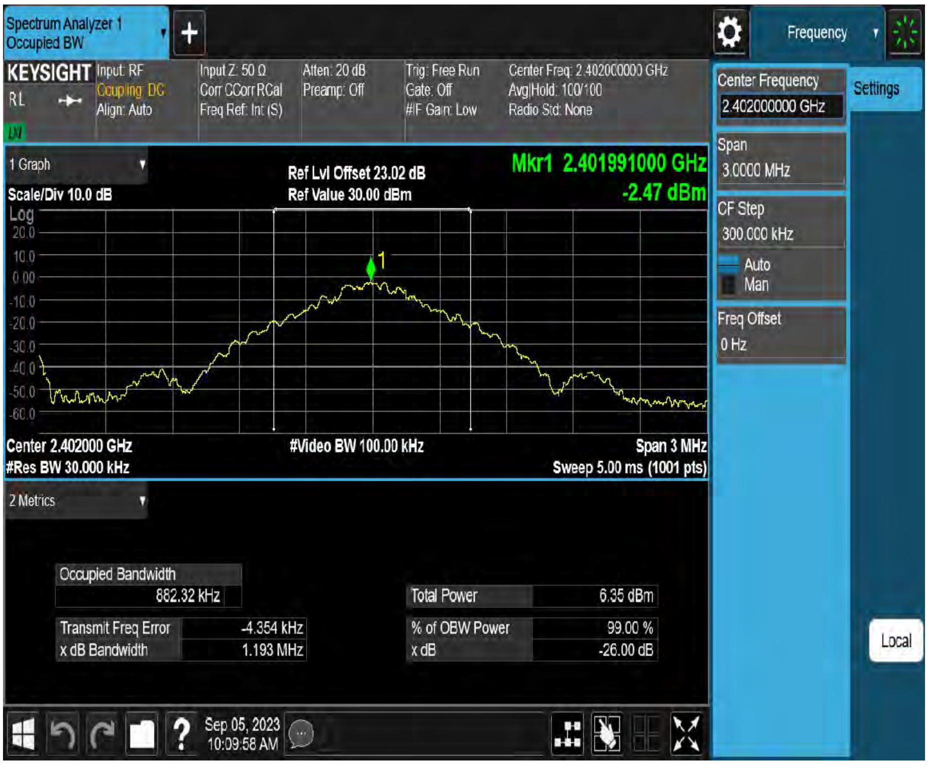
3DH5_Ant1_2480


Occupied Channel Bandwidth

Test Mode	Antenna	Freq(MHz)	OCB [MHz]	FL[MHz]	FH[MHz]	Limit[MHz]	Verdict
DH5	Ant1	2402	0.88232	2401.5545	2402.4368	---	---
		2441	0.88306	2440.5544	2441.4375	---	---
		2480	0.88173	2479.5552	2480.4370	---	---
2DH5	Ant1	2402	1.1875	2401.4033	2402.5908	---	---
		2441	1.1837	2440.4044	2441.5881	---	---
		2480	1.1814	2479.4043	2480.5857	---	---
3DH5	Ant1	2402	1.1857	2401.4040	2402.5897	---	---
		2441	1.1892	2440.4015	2441.5907	---	---
		2480	1.1857	2479.4042	2480.5899	---	---

Test Graphs

DH5_Ant1_2402



DH5_Ant1_2441

DH5_Ant1_2480

2DH5_Ant1_2402


2DH5_Ant1_2441


2DH5_Ant1_2480


3DH5_Ant1_2402

3DH5_Ant1_2441


3DH5_Ant1_2480

APPENDIX I - MAXIMUM OUTPUT POWER

Test Mode	Antenna	Freq(MHz)	Conducted Peak Powert[dBm]	Conducted Limit[dBm]	Verdict
DH5	Ant1	2402	0.31	≤20.97	PASS
		2441	0.58	≤20.97	PASS
		2480	0.17	≤20.97	PASS
2DH5	Ant1	2402	1.66	≤20.97	PASS
		2441	1.43	≤20.97	PASS
		2480	1.01	≤20.97	PASS
3DH5	Ant1	2402	**1.95**	≤20.97	PASS
		2441	1.8	≤20.97	PASS
		2480	1.41	≤20.97	PASS

Test Graphs

DH5_Ant1_2402

DH5_Ant1_2441

DH5_Ant1_2480

2DH5_Ant1_2402


2DH5_Ant1_2441

2DH5_Ant1_2480

3DH5_Ant1_2402

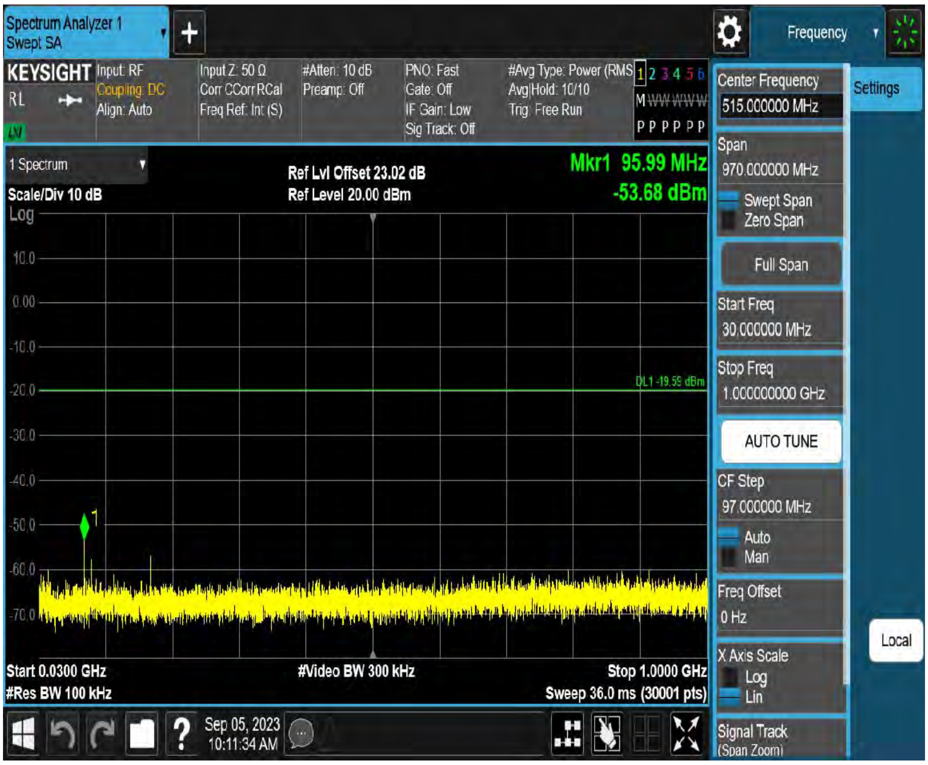
3DH5_Ant1_2441

3DH5_Ant1_2480


APPENDIX J - CONDUCTED SPURIOUS EMISSION

Test Graphs

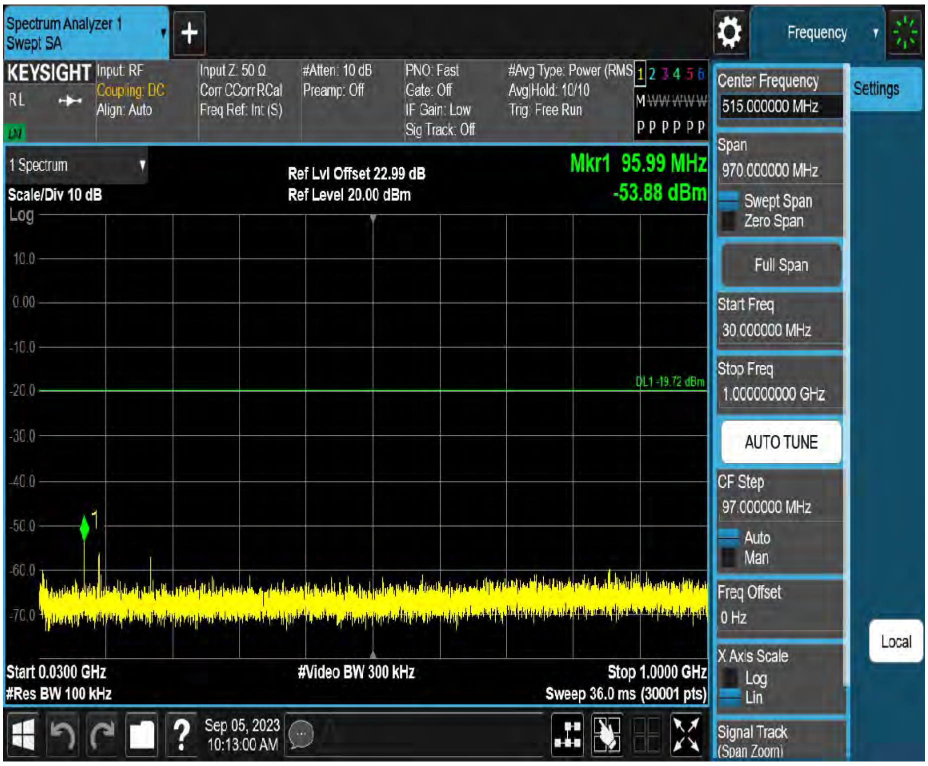
DH5_Ant1_2402_0~Reference

DH5_Ant1_2402_30~1000


DH5_Ant1_2402_1000~26500

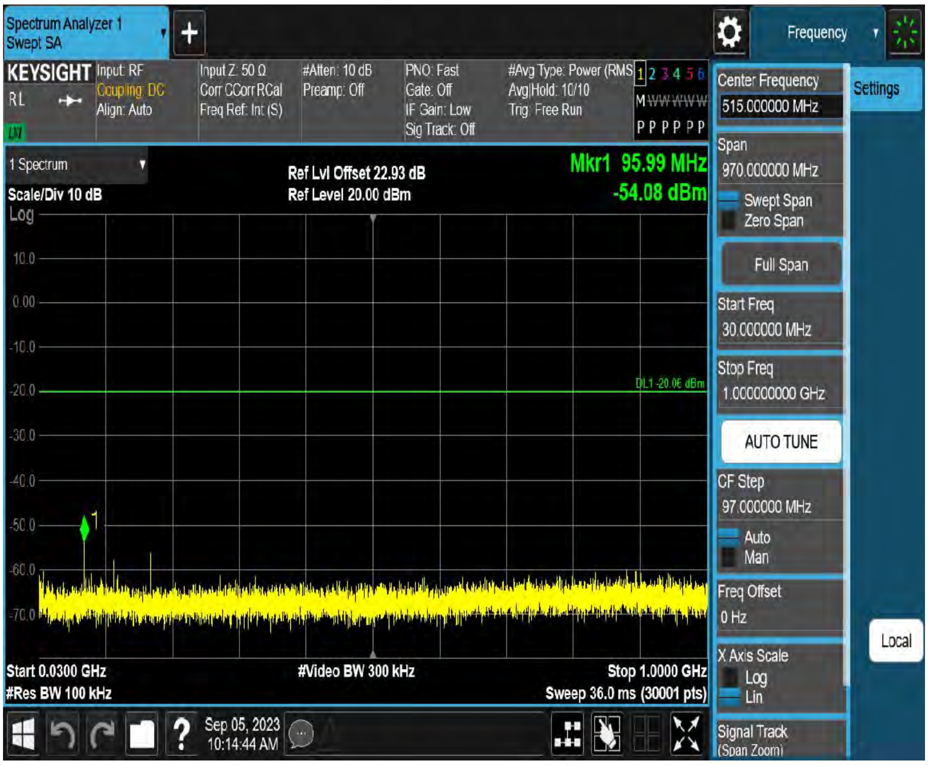
DH5_Ant1_2441_0~Reference

DH5_Ant1_2441_30~1000



DH5_Ant1_2441_1000~26500

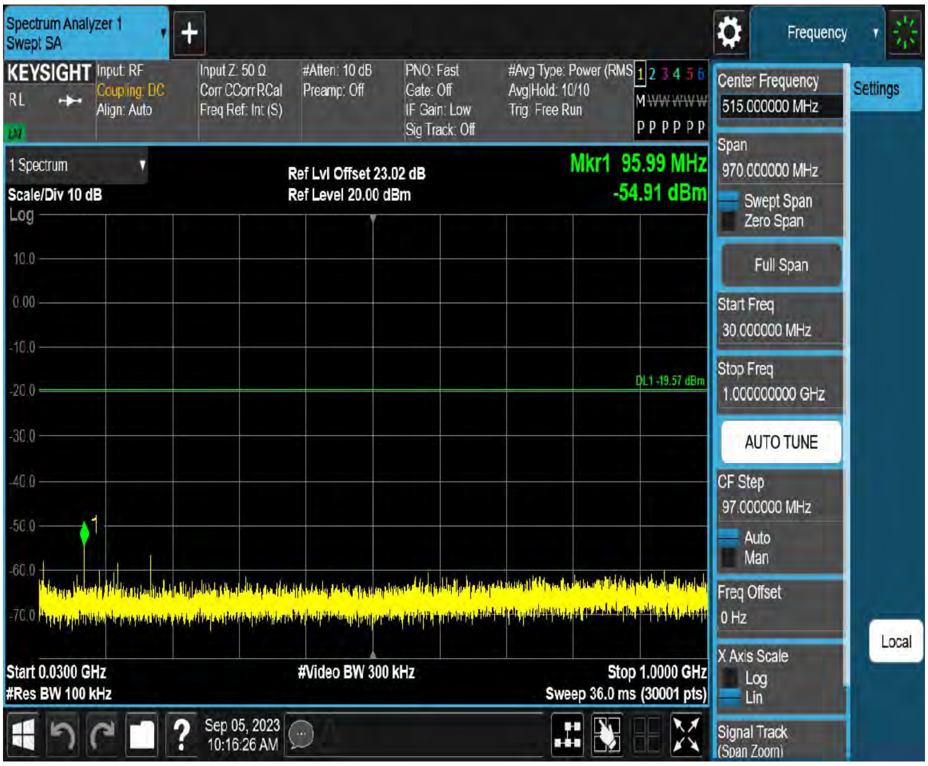
DH5_Ant1_2480_0~Reference

DH5_Ant1_2480_30~1000


DH5_Ant1_2480_1000~26500

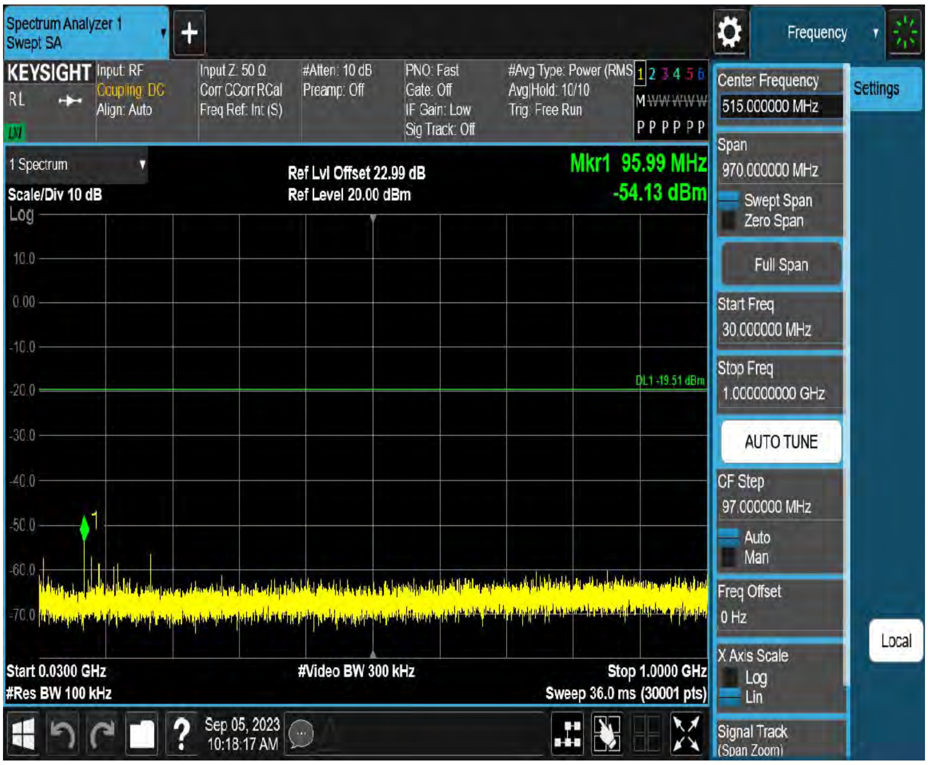
2DH5_Ant1_2402_0~Reference

2DH5_Ant1_2402_30~1000



2DH5_Ant1_2402_1000~26500

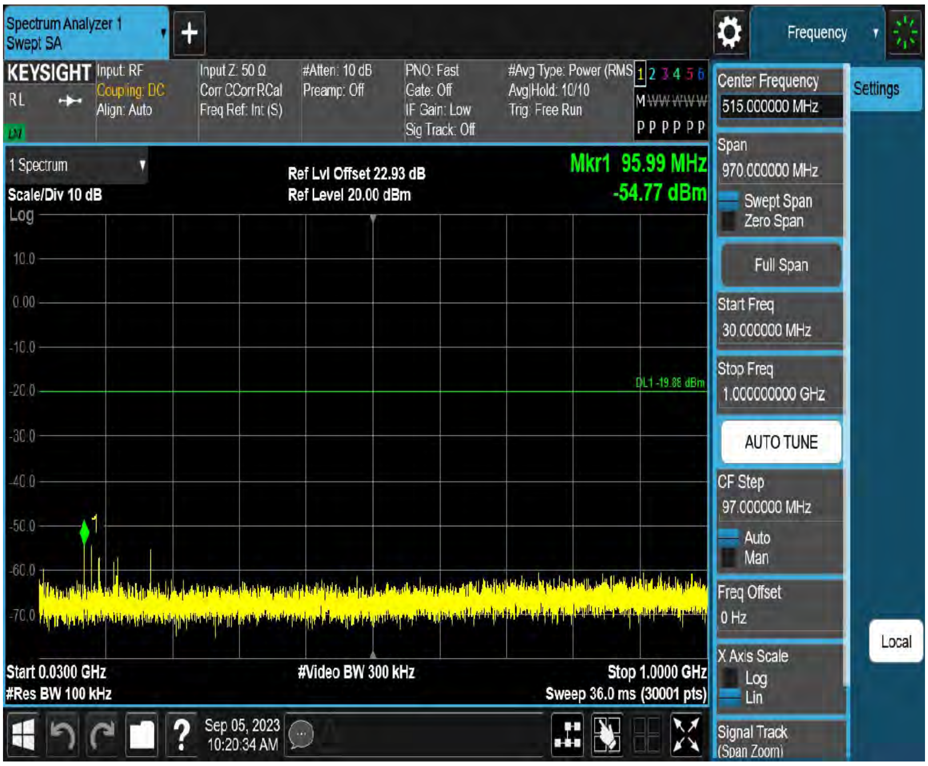
2DH5_Ant1_2441_0~Reference

2DH5_Ant1_2441_30~1000


2DH5_Ant1_2441_1000~26500

2DH5_Ant1_2480_0~Reference

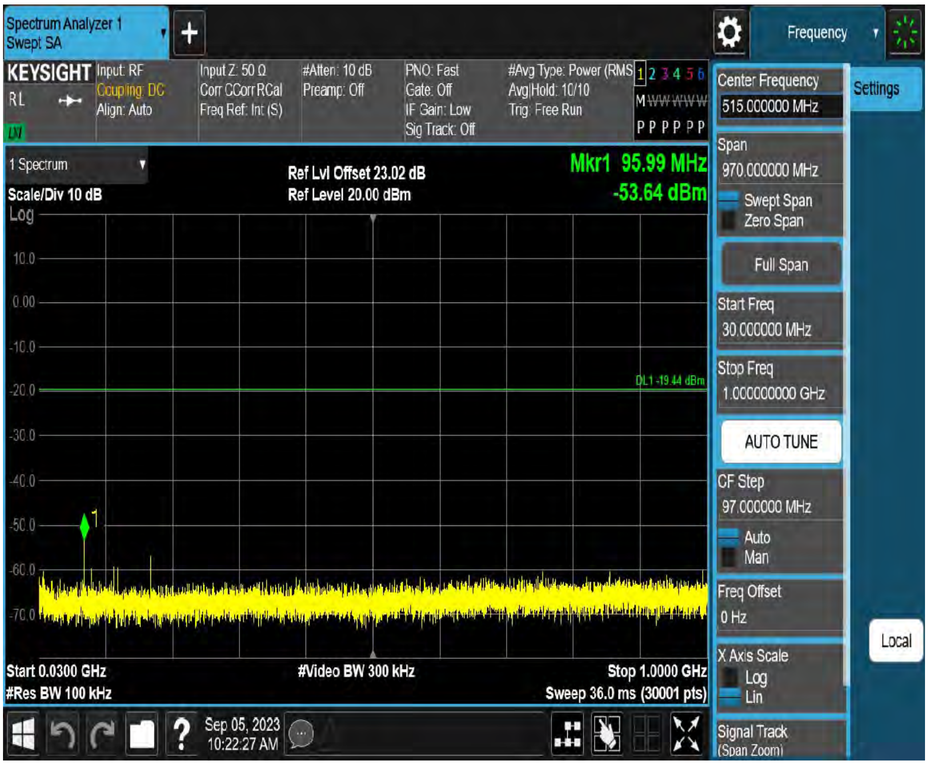
2DH5_Ant1_2480_30~1000



2DH5_Ant1_2480_1000~26500

3DH5_Ant1_2402_0~Reference

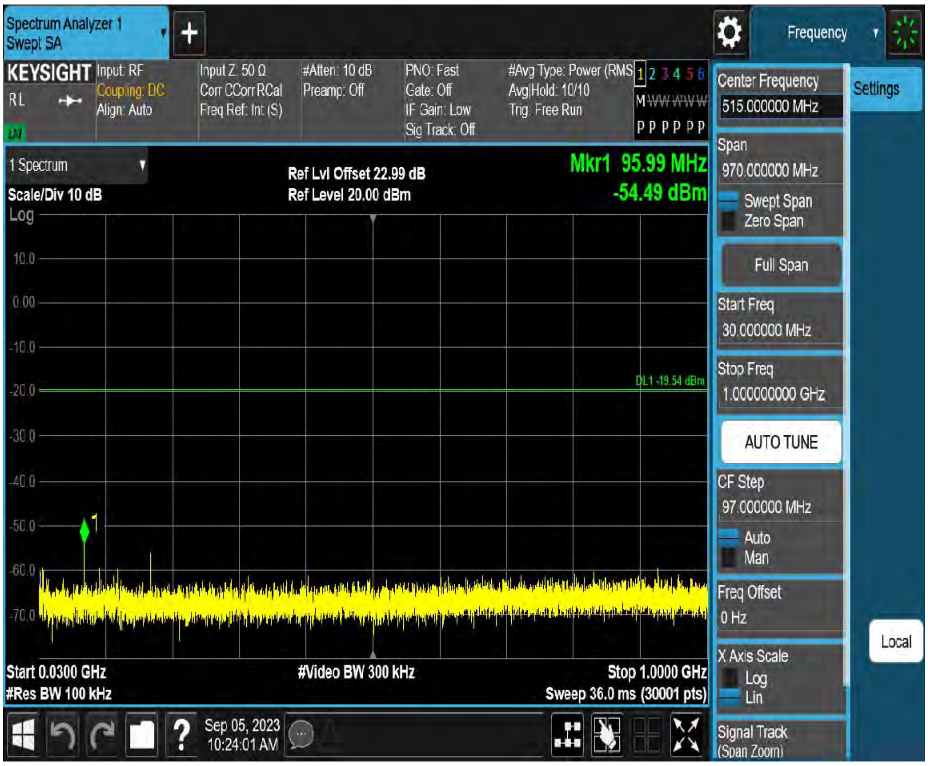
3DH5_Ant1_2402_30~1000



3DH5_Ant1_2402_1000~26500

3DH5_Ant1_2441_0~Reference

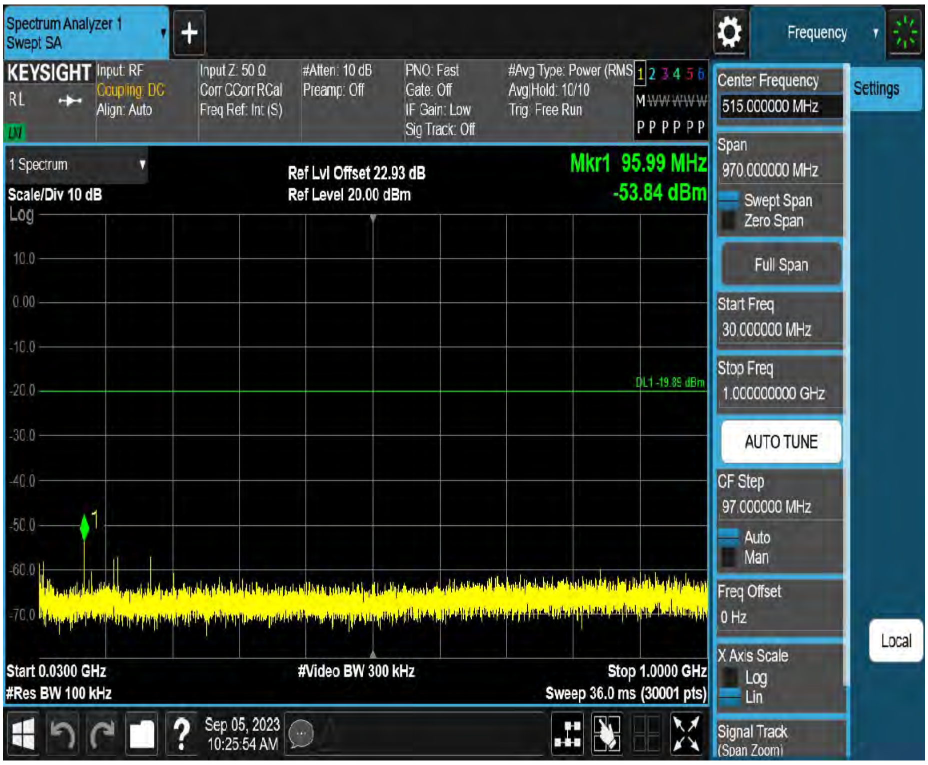

3DH5_Ant1_2441_30~1000



3DH5_Ant1_2441_1000~26500

3DH5_Ant1_2480_0~Reference

3DH5_Ant1_2480_30~1000



3DH5_Ant1_2480_1000~26500


APPENDIX K - DECLARATION FOR BLUETOOTH DEVICE

1. **Output power and channel separation of a Bluetooth device in the different operating modes:**

The different operating modes (data-mode, acquisition-mode) of a Bluetooth device has no influence on the output power and the channel spacing. There is only one transmitter which is driven by identical input parameters concerning these two parameters.
Only a different hopping sequence will be used. For this reason the check of these RF parameters in one op-mode is sufficient.

2. **Frequency range of a Bluetooth device:**

Hereby we declare that the maximum frequency of this device is: 2402 - 2480MHz. This is according to the Bluetooth Core Specification (+ critical errata) for devices which will be operated in the USA.
This was checked during the Bluetooth Qualification tests (Test Case: TRM/CA/04-E). Other frequency ranges (e.g. for Spain, France, Japan) which are allowed according the Core Specification are not supported by this device.

3. **Co-ordination of the hopping sequence in data mode to avoid simultaneous occupancy by multiple transmitters:**

Bluetooth units which want to communicate with other units must be organised in a structure called piconet. This piconet consist of max. 8 Bluetooth units. One unit is the master the other seven are the slaves. The master co-ordinates frequency occupation in this piconet for all units. As the master hop sequence is derived from its BD address which is unique for each Bluetooth device, additional masters intending to establish new piconets will always use different hop sequences.

4. **Example of a hopping sequence in data mode:**

Example of a 79 hopping sequence in data mode:
40, 21, 44, 23, 42, 53, 46, 55, 48, 33, 52, 35, 50, 65, 54, 67, 56, 37, 60, 39, 58, 69, 62, 71, 64, 25, 68, 27, 66, 57, 70, 59, 72, 29, 76, 31, 74, 61, 78, 63, 01, 41, 05, 43, 03, 73, 07, 75, 09, 45, 13, 47, 11, 77, 15, 00, 64, 49, 66, 53, 68, 02, 70, 06, 01, 51, 03, 55, 05, 04

5. **Equally average use of frequencies in data mode and behaviour for short transmissions:**

The generation of the hopping sequence in connection mode depends essentially on two input values:
a) LAP/UAP of the master of the connection.
b) Internal master clock.

The LAP (lower address part) are the 24 LSB's of the 48 BD_ADDRESS. The BD_ADDRESS is an unambiguous number of every Bluetooth unit. The UAP (upper address part) are the 24 MSB's of the 48 BD_ADDRESS.

The internal clock of a Bluetooth unit is derived from a free running clock which is never adjusted and is never turned off. For synchronisation with other units only offset are used. It has no relation to the time of the day. Its resolution is at least half the RX/TX slot length of 312.5 μs. The clock has a cycle of about one day (23h30). In most case it is implemented as 28 bit counter. For the deriving of the hopping sequence the entire.
LAP (24 bits), 4 LSB's (4 bits) (Input 1) and the 27 MSB's of the clock (Input 2) are used. With this input values different mathematical procedures (permutations, additions, XOR- operations) are performed to generate the sequence. This will be done at the beginning of every new transmission.

Regarding short transmissions the Bluetooth system has the following behaviour:
The first connection between the two devices is established, a hopping sequence was generated. For transmitting the wanted data the complete hopping sequence was not used. The connection ended.
The second connection will be established. A new hopping sequence is generated. Due to the fact that the Bluetooth clock has a different value, because the period between the two transmission is longer (and it cannot be shorter) than the minimum resolution of the clock (312.5 μs). The hopping sequence will always

differ from the first one.

6. Receiver input bandwidth and behaviour for repeated single or multiple packets:

The input bandwidth of the receiver is 1 MHz. In every connection one Bluetooth device is the master and the other one is the slave. The master determines the hopping sequence (see chapter 5). The slave follows this sequence. Both devices shift between RX and TX time slot according to the clock of the master.
Additionally the type of connection (e.g. single or multislot packet) is set up at the beginning of the connection. The master adapts its hopping frequency and its TX/RX timing according to the packet type of the connection. Also the slave of the connection will use these settings.
Repeating of a packet has no influence on the hopping sequence. The hopping sequence generated by the master of the connection will be followed in any case. That means, a repeated packet will not be send on the same frequency, it is send on the next frequency of the hopping sequence.

End of Test Report