

9. Dwell time

9.1. Applied procedures / Limit

15.247(a) (1) (iii) Frequency hopping systems in the 2400-2483.5 MHz band shall use at least 15 channels. The average time of occupancy on any channel shall not be greater than 0.4 seconds within a period of 0.4 seconds multiplied by the number of hopping channels employed. Frequency hopping systems may avoid or suppress transmissions on a particular hopping frequency provided that a minimum of 15 channels are used.

9.2. Test procedure

- (1) Place the EUT on the table in the chamber or connect the antenna port of the EUT to spectrum analyzer and set it in transmitting mode.
- (2) Set RBW of spectrum analyzer to 1MHz, VBW $\geq$ RBW
- (3) Use a video trigger with the trigger level set to enable triggering only on full pulses.
- (4) Sweep Time is more than once pulse time.
- (5) Set the center frequency on any frequency would be measure and set the frequency span to zero span.
- (6) Measure the maximum time duration of one single pulse.
- (7) Set the EUT for DH5, DH3 and DH1 packet transmitting.
- (8) Measure the maximum time duration of one single pulse.
- (9) A Period Time = $79 \times 0.4 = 31.6$ S
DH1 Time Slot: Reading * $(1600/2) \times 31.6/79$
DH3 Time Slot: Reading * $(1600/4) \times 31.6/79$
DH5 Time Slot: Reading * $(1600/6) \times 31.6/79$

9.3. Deviation from standard

No deviation.

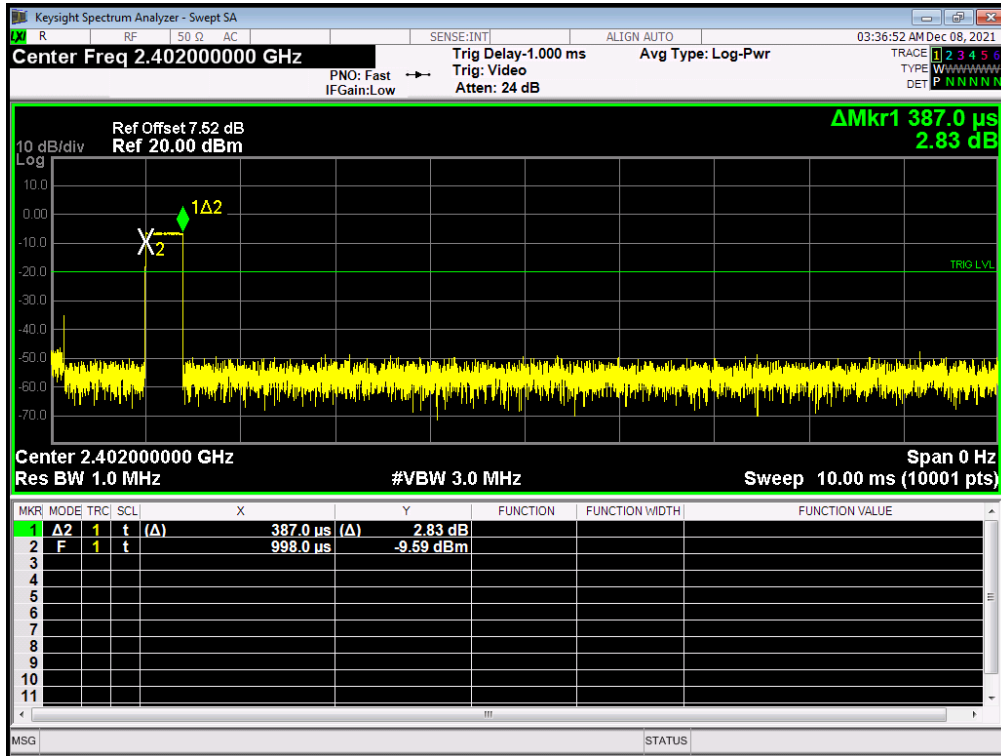
9.4. Test setup



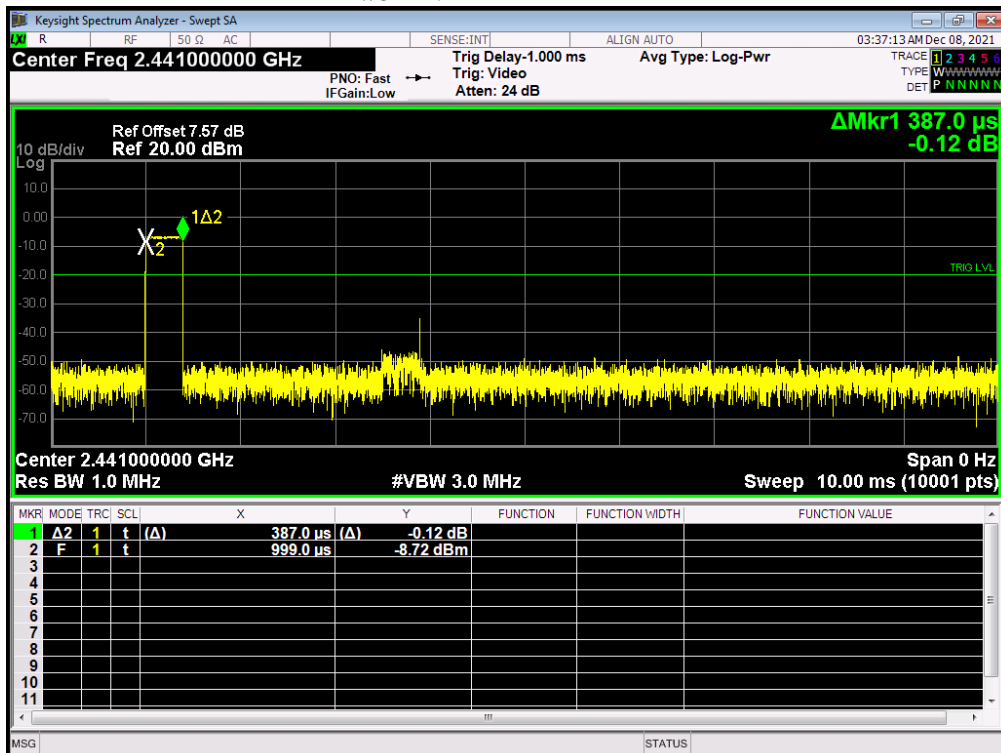
9.5. Test result

Condition	Mode	Frequency (MHz)	Pulse Time (ms)	Total Dwell Time (ms)	Period Time (ms)	Limit (ms)	Verdict
NVNT	1-DH1	2402	0.387	122.292	31600	400	Pass
NVNT	1-DH1	2441	0.387	122.292	31600	400	Pass
NVNT	1-DH1	2480	0.387	122.292	31600	400	Pass

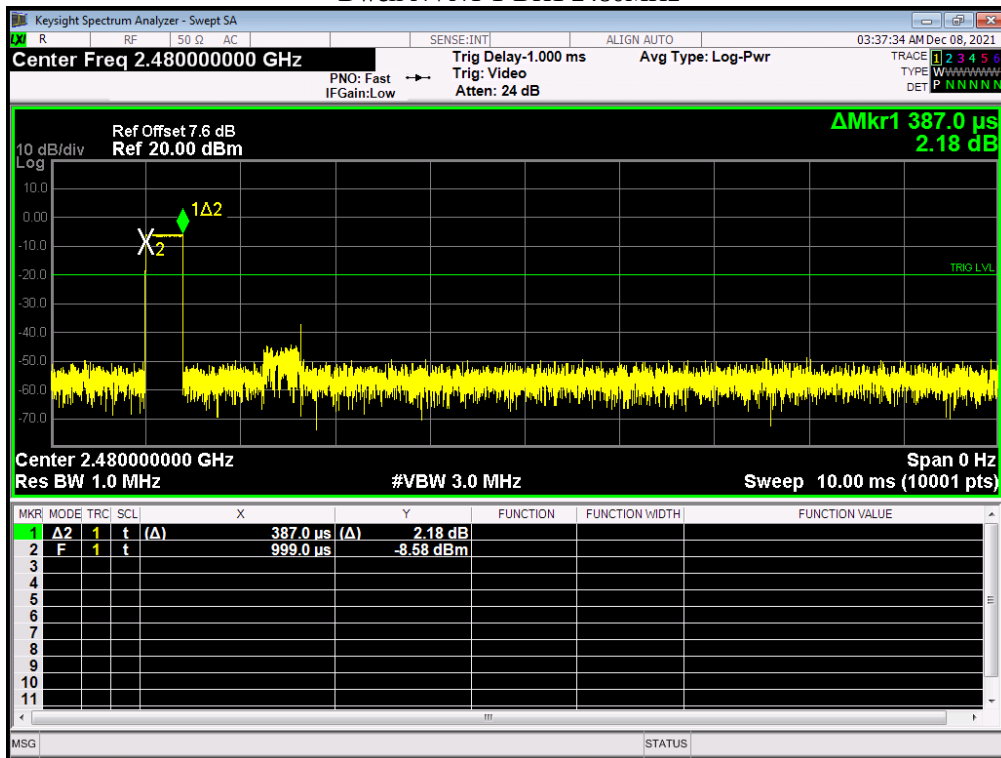
Dwell NVNT 1-DH1 2402MHz



Dwell NVNT 1-DH1 2441MHz

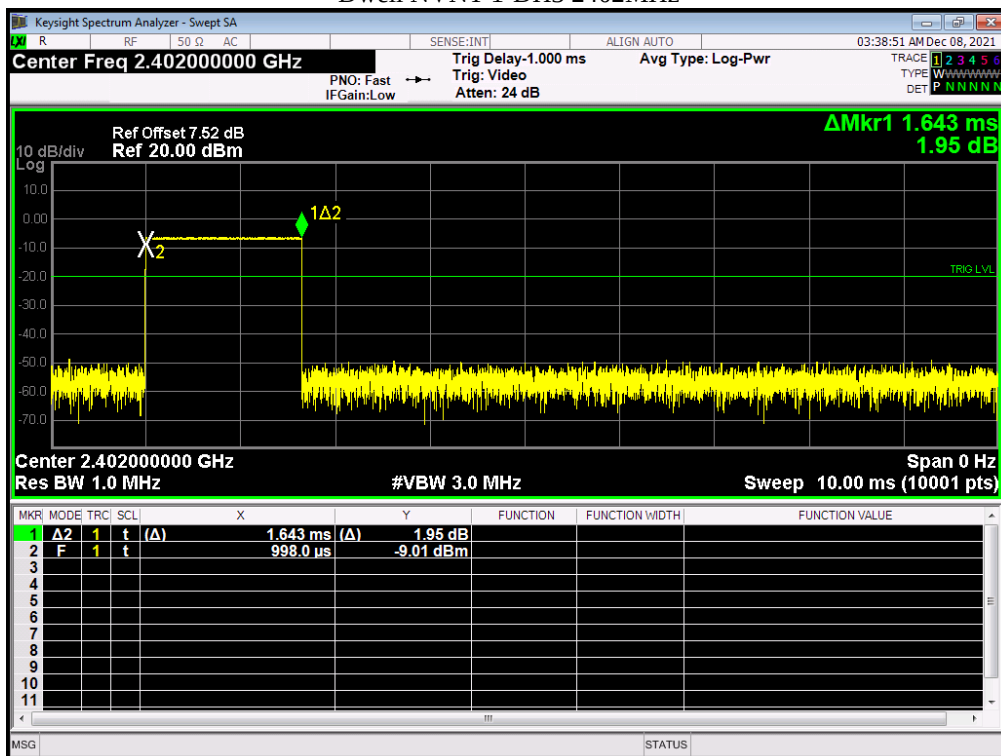


Dwell NVNT 1-DH1 2480MHz

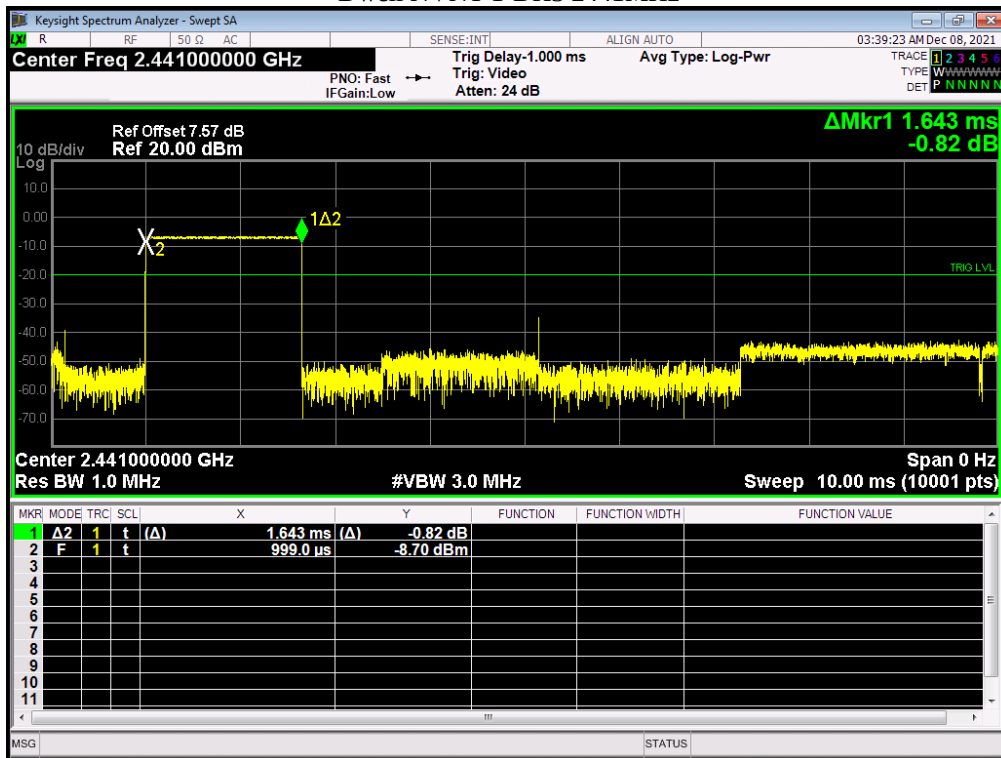


Condition	Mode	Frequency (MHz)	Pulse Time (ms)	Total Dwell Time (ms)	Period Time (ms)	Limit (ms)	Verdict
NVNT	1-DH3	2402	1.643	259.594	31600	400	Pass
NVNT	1-DH3	2441	1.643	259.594	31600	400	Pass
NVNT	1-DH3	2480	1.643	259.594	31600	400	Pass

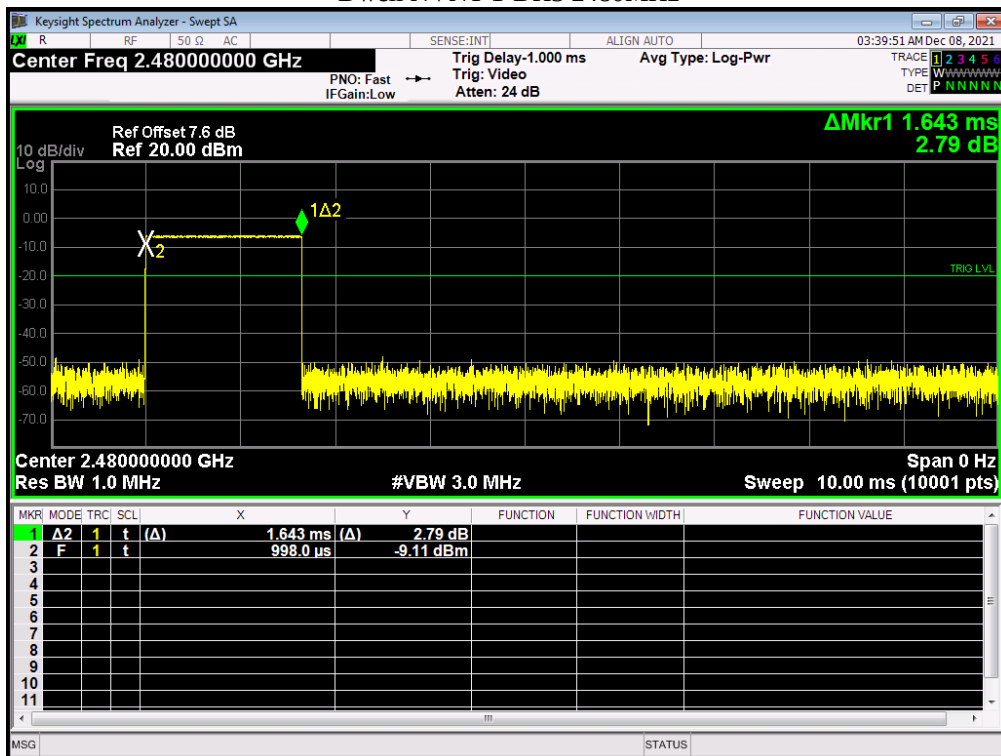
Dwell NVNT 1-DH3 2402MHz



Dwell NVNT 1-DH3 2441MHz

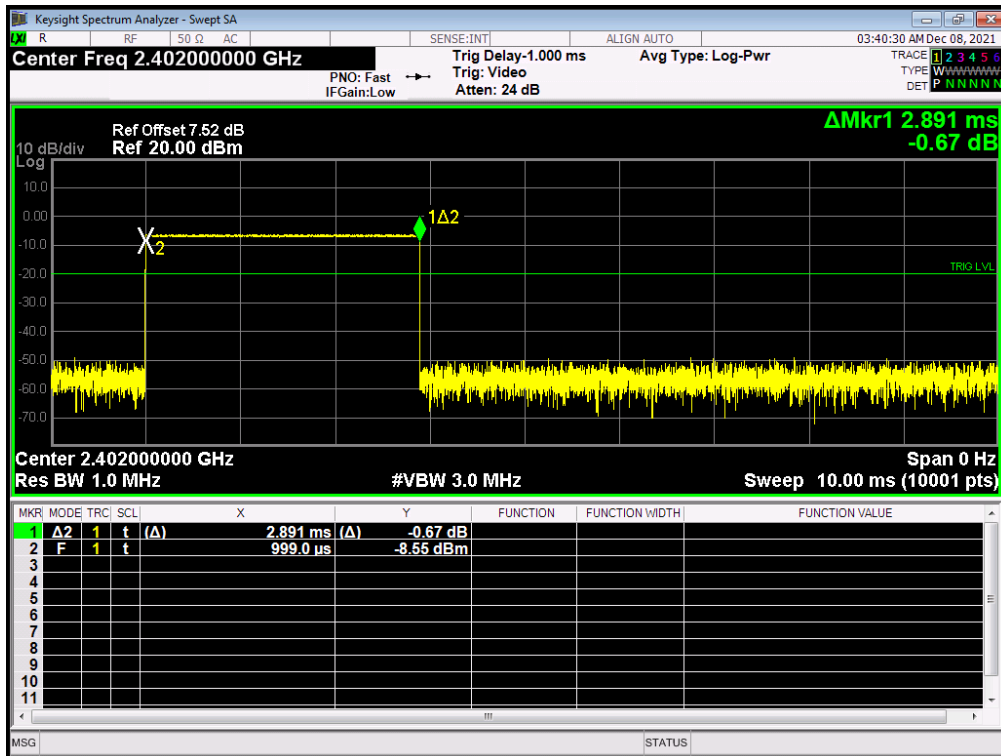


Dwell NVNT 1-DH3 2480MHz

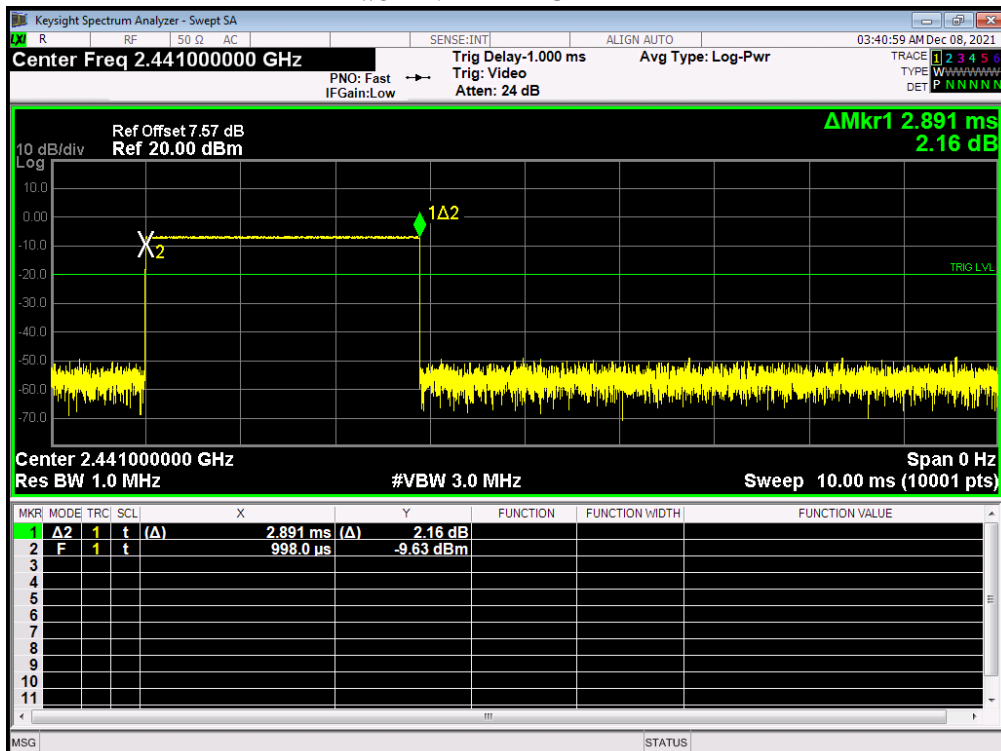


Condition	Mode	Frequency (MHz)	Pulse Time (ms)	Total Dwell Time (ms)	Period Time (ms)	Limit (ms)	Verdict
NVNT	1-DH5	2402	2.891	274.067	31600	400	Pass
NVNT	1-DH5	2441	2.891	274.067	31600	400	Pass
NVNT	1-DH5	2480	2.891	274.067	31600	400	Pass

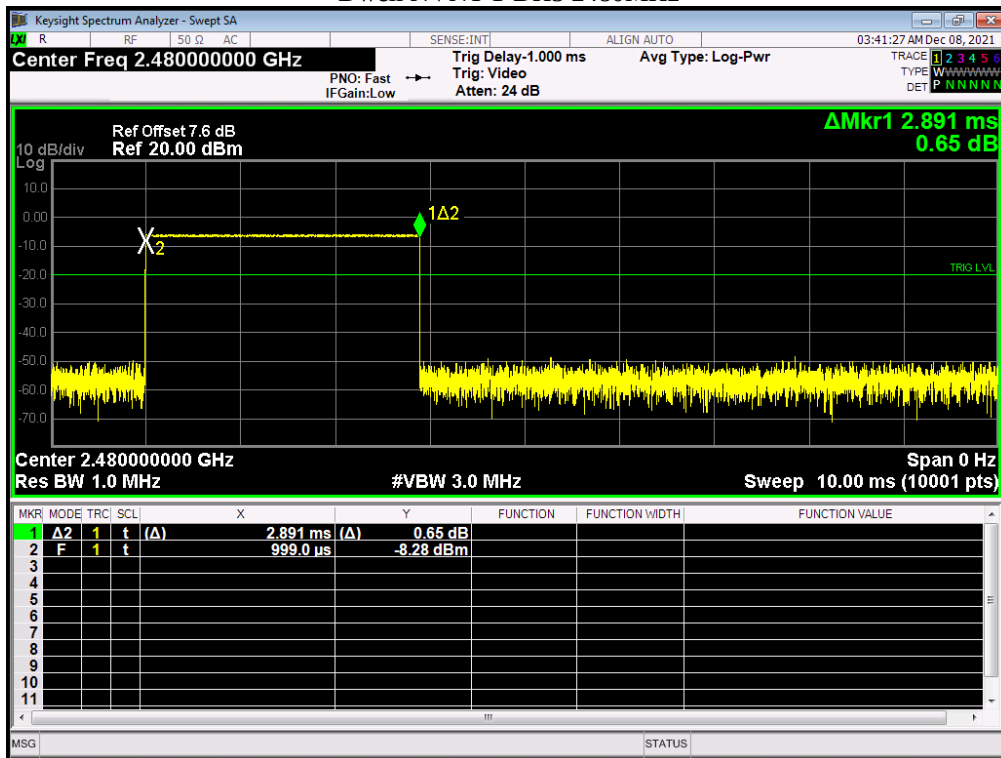
Dwell NVNT 1-DH5 2402MHz



Dwell NVNT 1-DH5 2441MHz

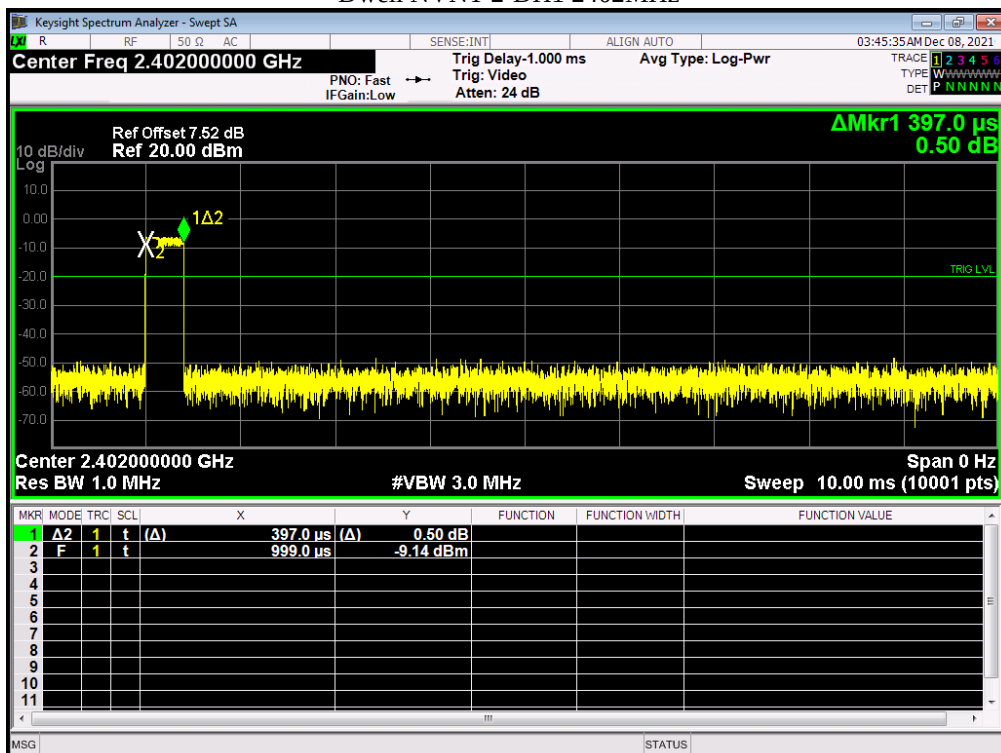


Dwell NVNT 1-DH5 2480MHz

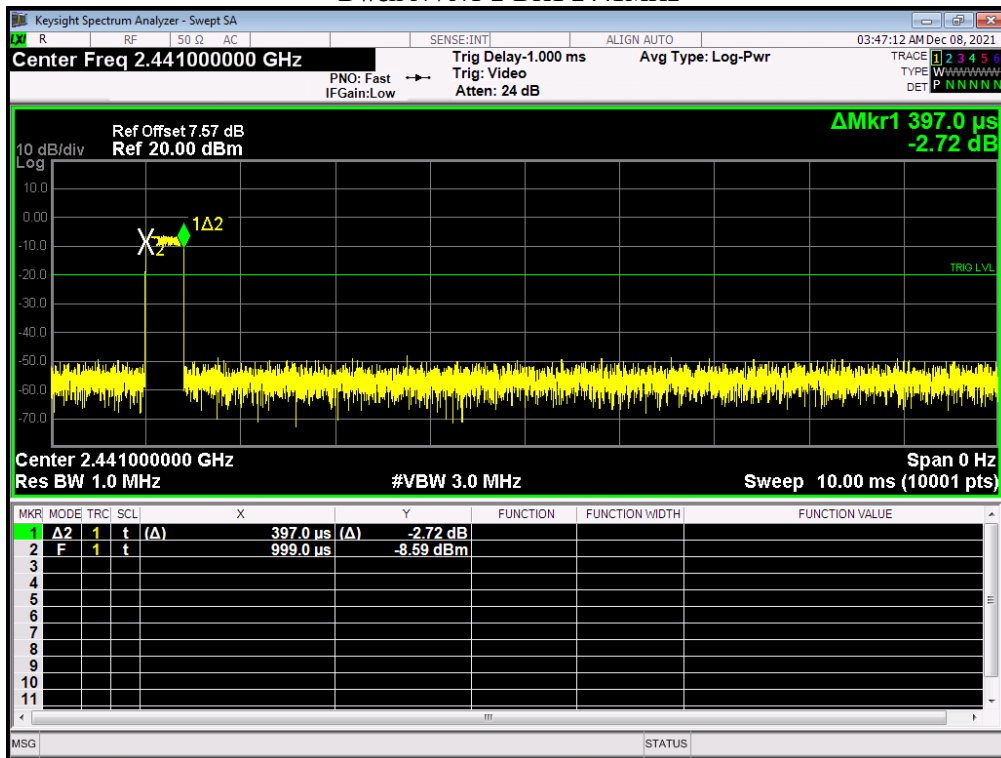


Condition	Mode	Frequency (MHz)	Pulse Time (ms)	Total Dwell Time (ms)	Period Time (ms)	Limit (ms)	Verdict
NVNT	2-DH1	2402	0.397	125.452	31600	400	Pass
NVNT	2-DH1	2441	0.397	125.452	31600	400	Pass
NVNT	2-DH1	2480	0.397	125.452	31600	400	Pass

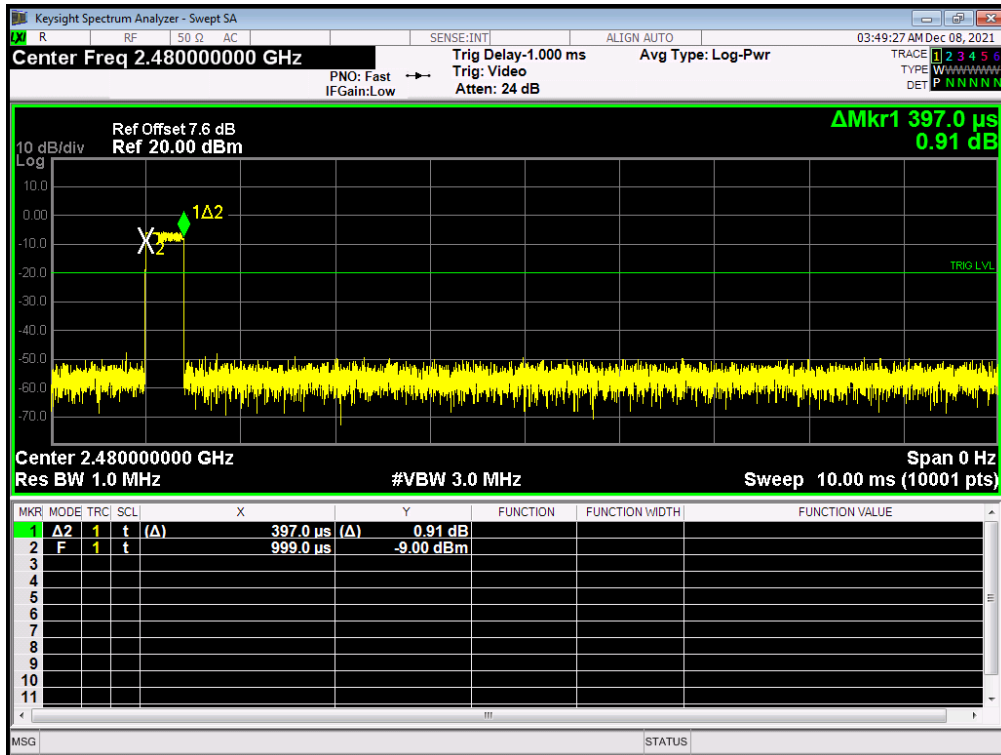
Dwell NVNT 2-DH1 2402MHz



Dwell NVNT 2-DH1 2441MHz

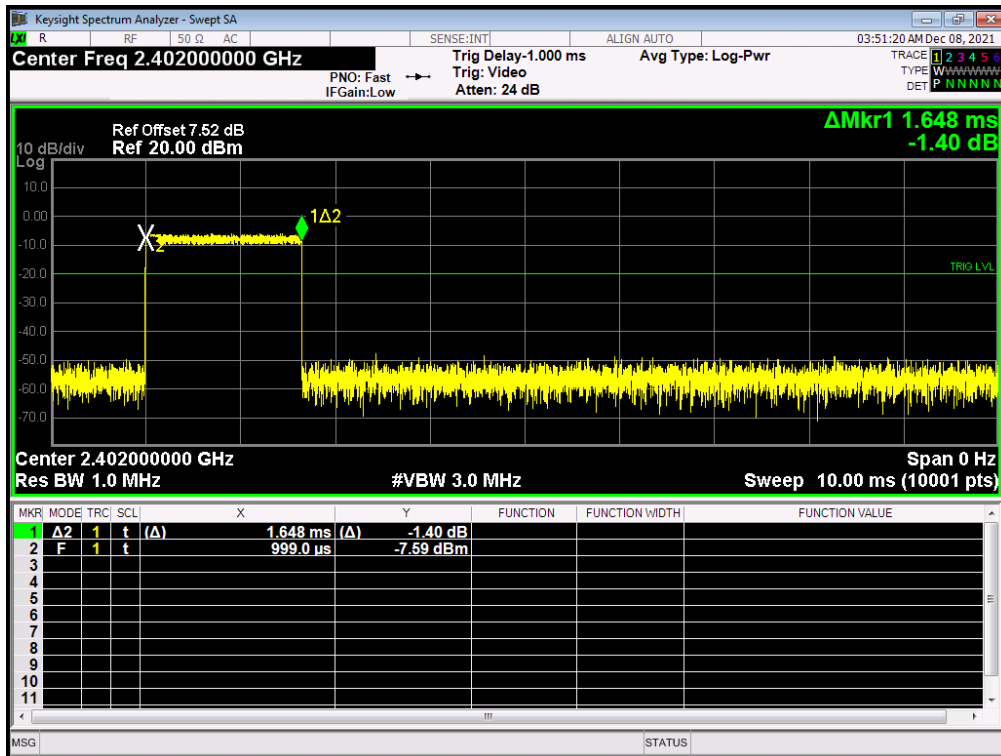


Dwell NVNT 2-DH1 2480MHz

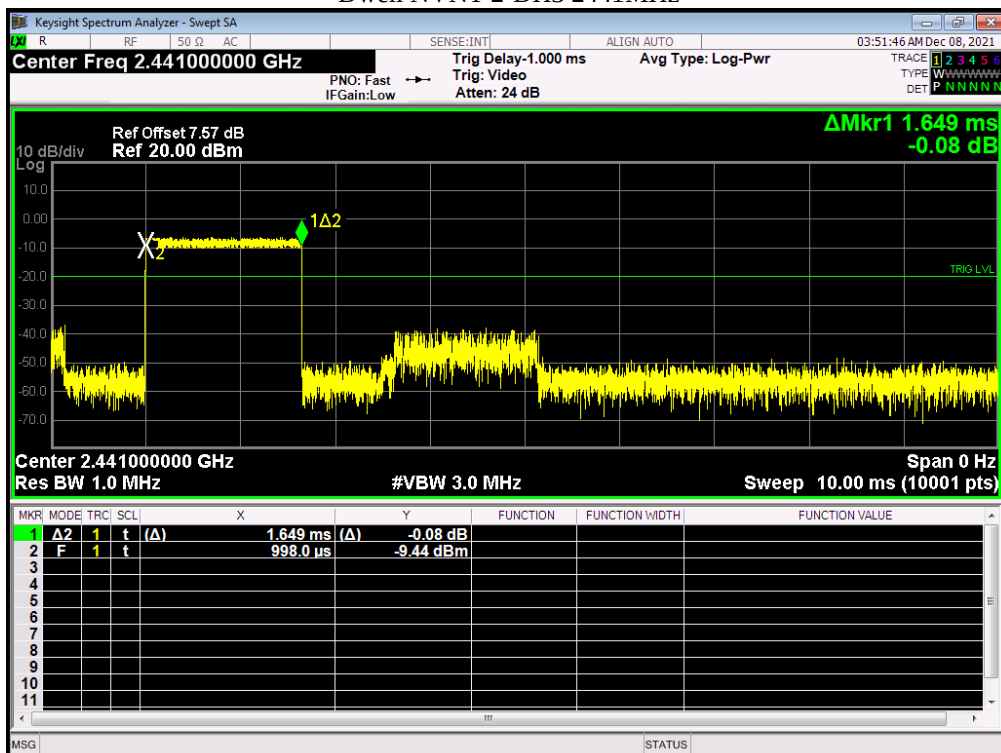


Condition	Mode	Frequency (MHz)	Pulse Time (ms)	Total Dwell Time (ms)	Period Time (ms)	Limit (ms)	Verdict
NVNT	2-DH3	2402	1.648	260.384	31600	400	Pass
NVNT	2-DH3	2441	1.649	260.542	31600	400	Pass
NVNT	2-DH3	2480	1.644	259.752	31600	400	Pass

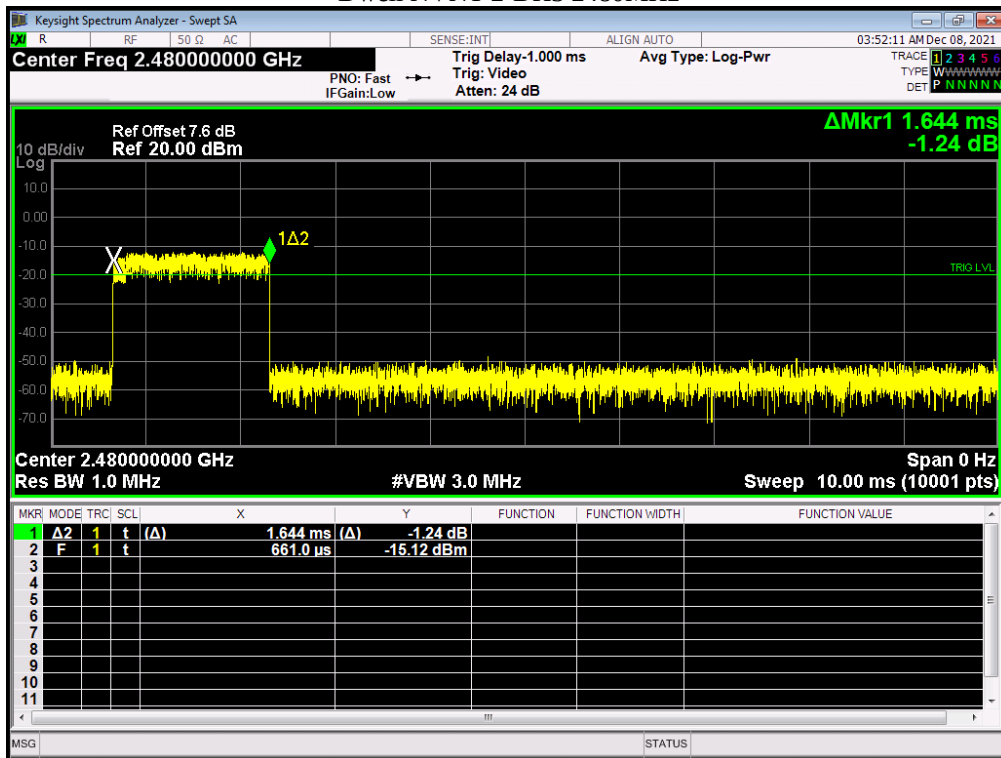
Dwell NVNT 2-DH3 2402MHz



Dwell NVNT 2-DH3 2441MHz

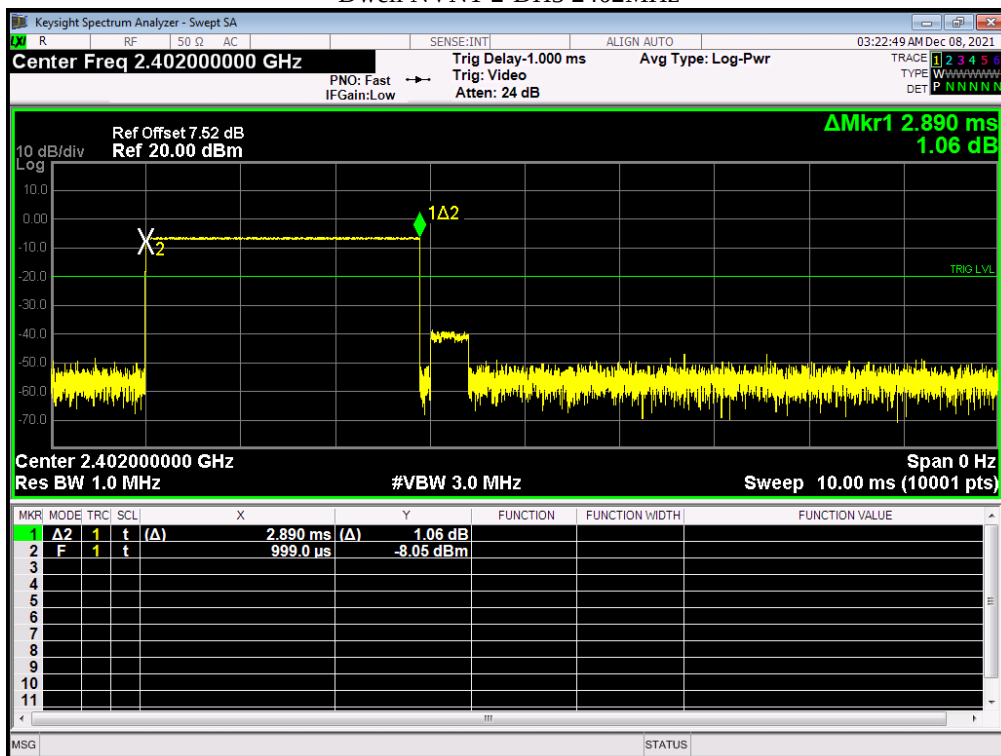


Dwell NVNT 2-DH3 2480MHz

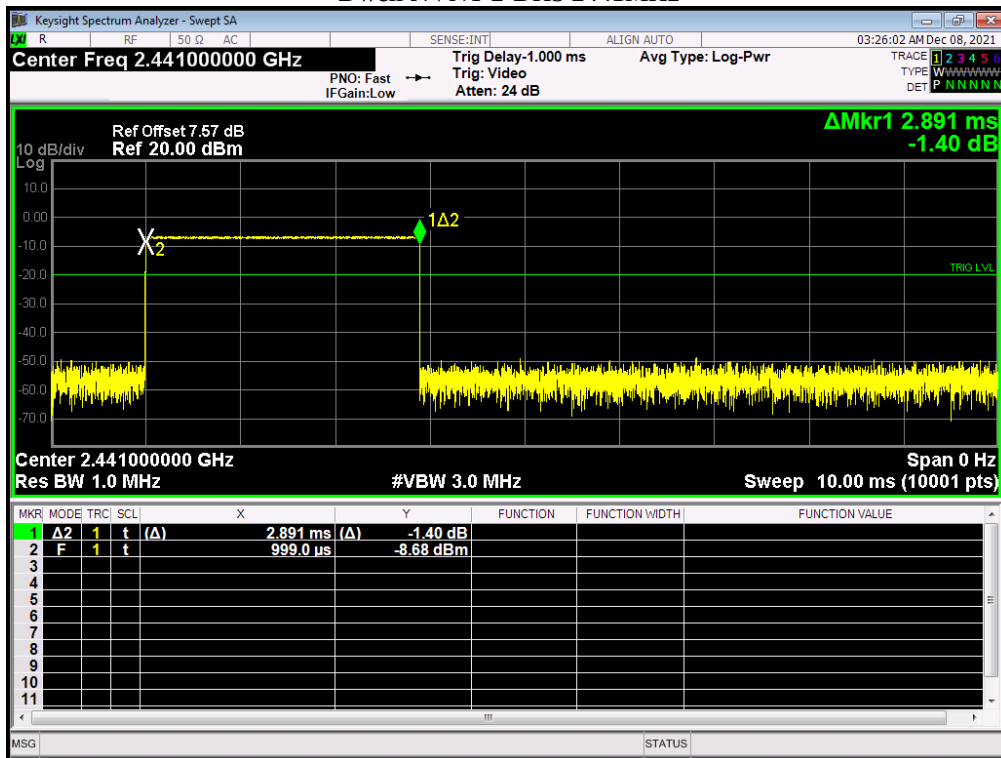


Condition	Mode	Frequency (MHz)	Pulse Time (ms)	Total Dwell Time (ms)	Period Time (ms)	Limit (ms)	Verdict
NVNT	2-DH5	2402	2.89	273.972	31600	400	Pass
NVNT	2-DH5	2441	2.891	274.067	31600	400	Pass
NVNT	2-DH5	2480	2.891	274.067	31600	400	Pass

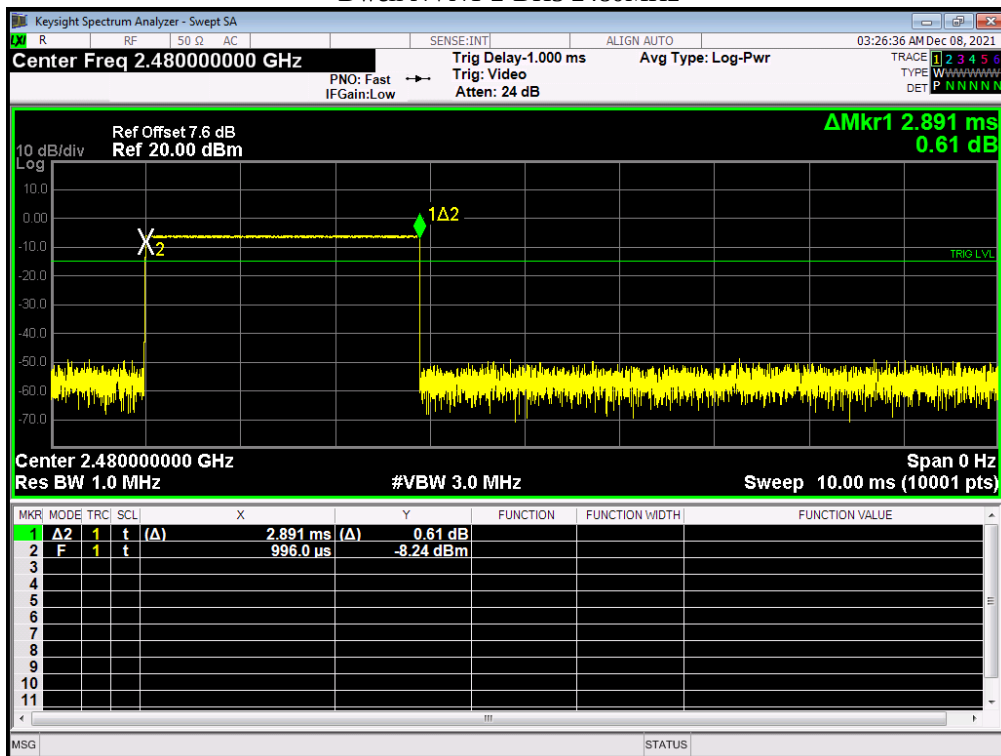
Dwell NVNT 2-DH5 2402MHz



Dwell NVNT 2-DH5 2441MHz

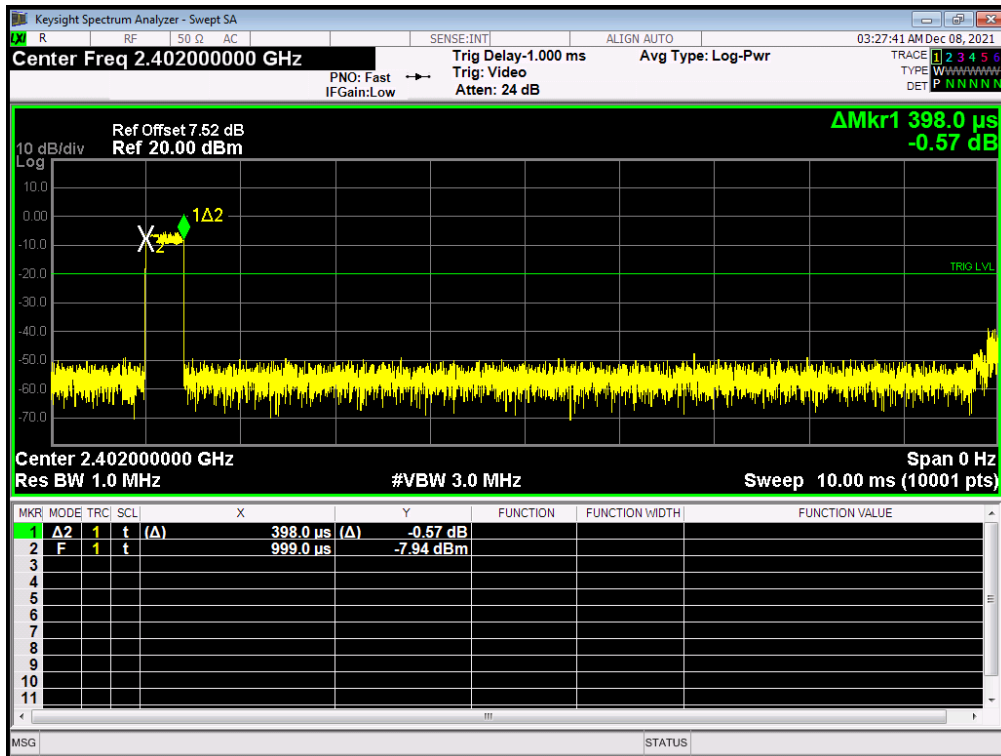


Dwell NVNT 2-DH5 2480MHz

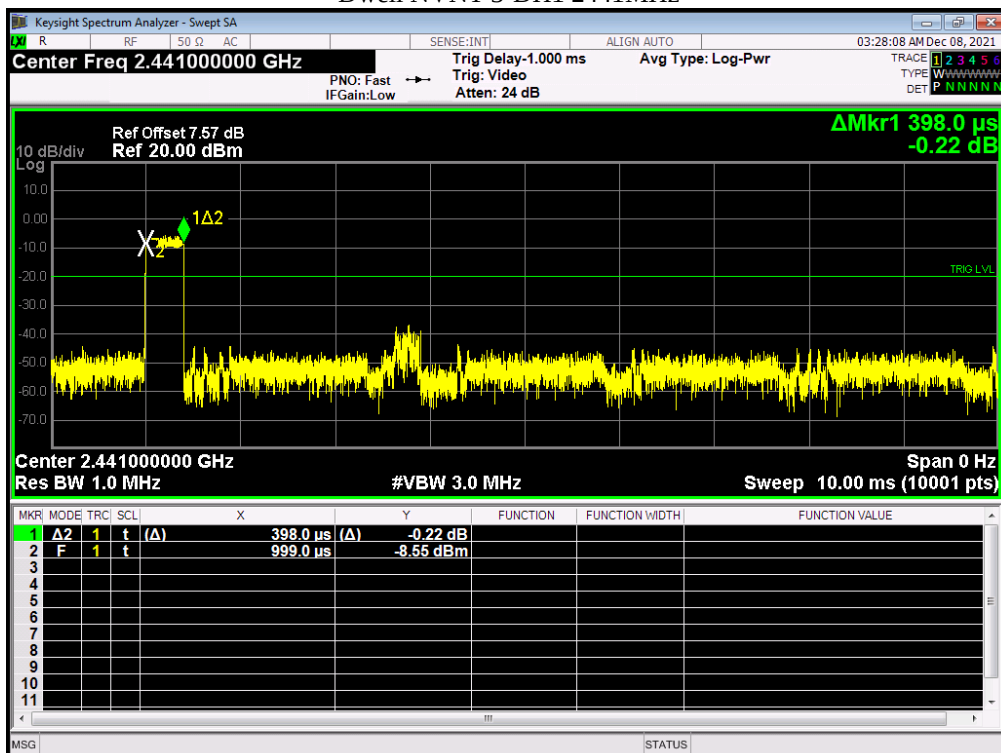


Condition	Mode	Frequency (MHz)	Pulse Time (ms)	Total Dwell Time (ms)	Period Time (ms)	Limit (ms)	Verdict
NVNT	3-DH1	2402	0.398	125.768	31600	400	Pass
NVNT	3-DH1	2441	0.398	125.768	31600	400	Pass
NVNT	3-DH1	2480	0.373	117.868	31600	400	Pass

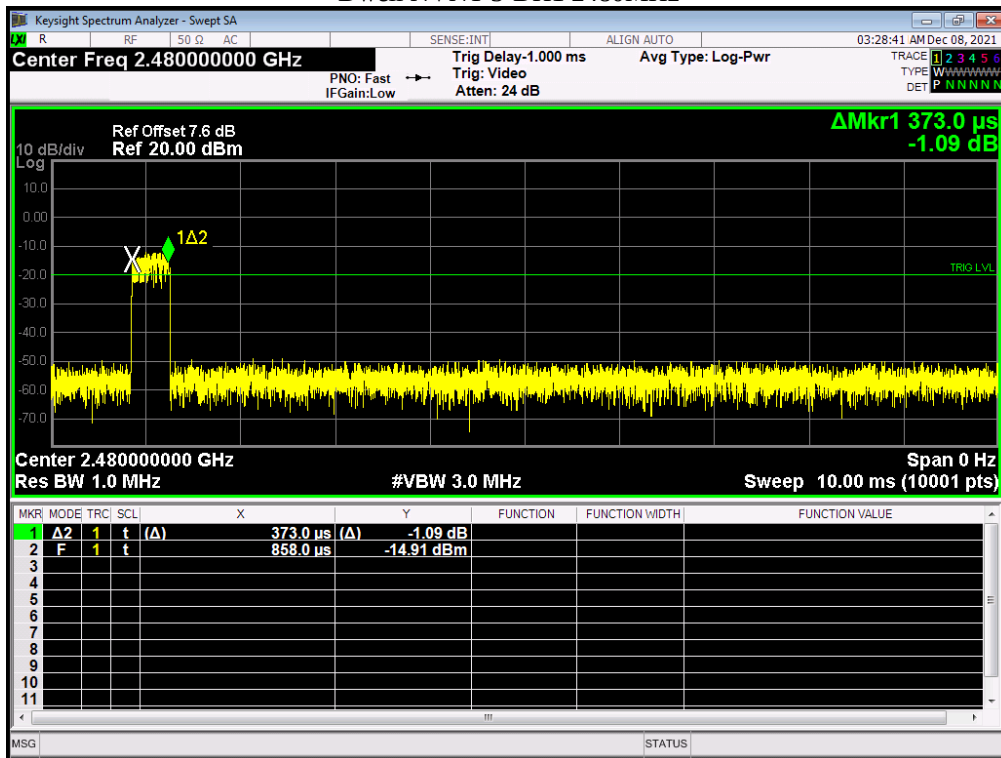
Dwell NVNT 3-DH1 2402MHz



Dwell NVNT 3-DH1 2441MHz

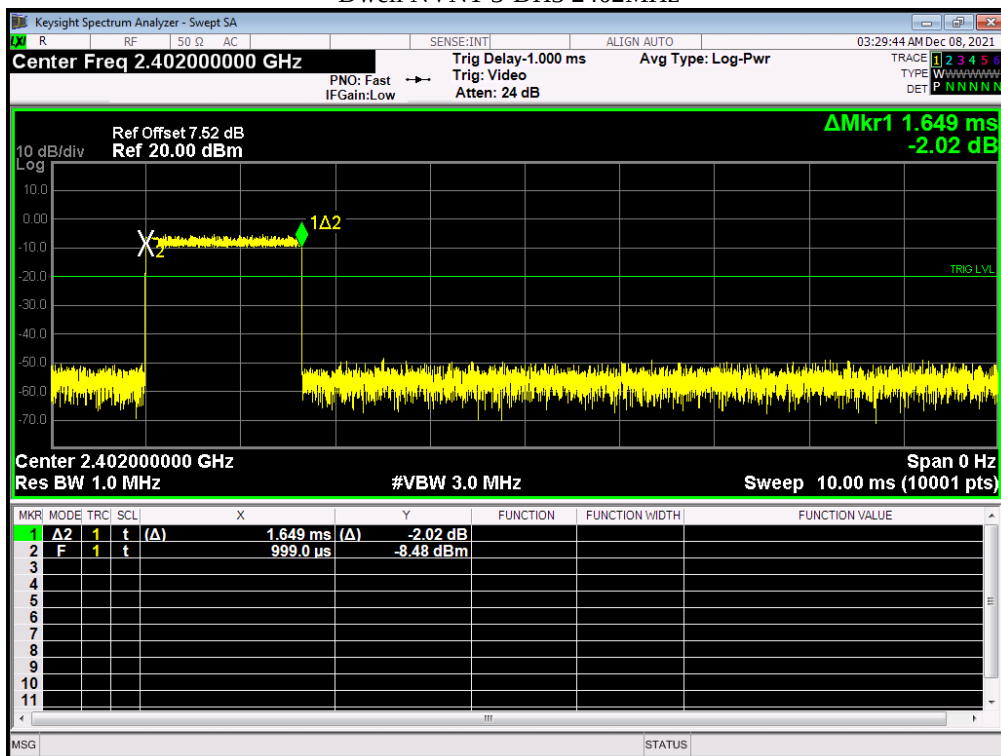


Dwell NVNT 3-DH1 2480MHz

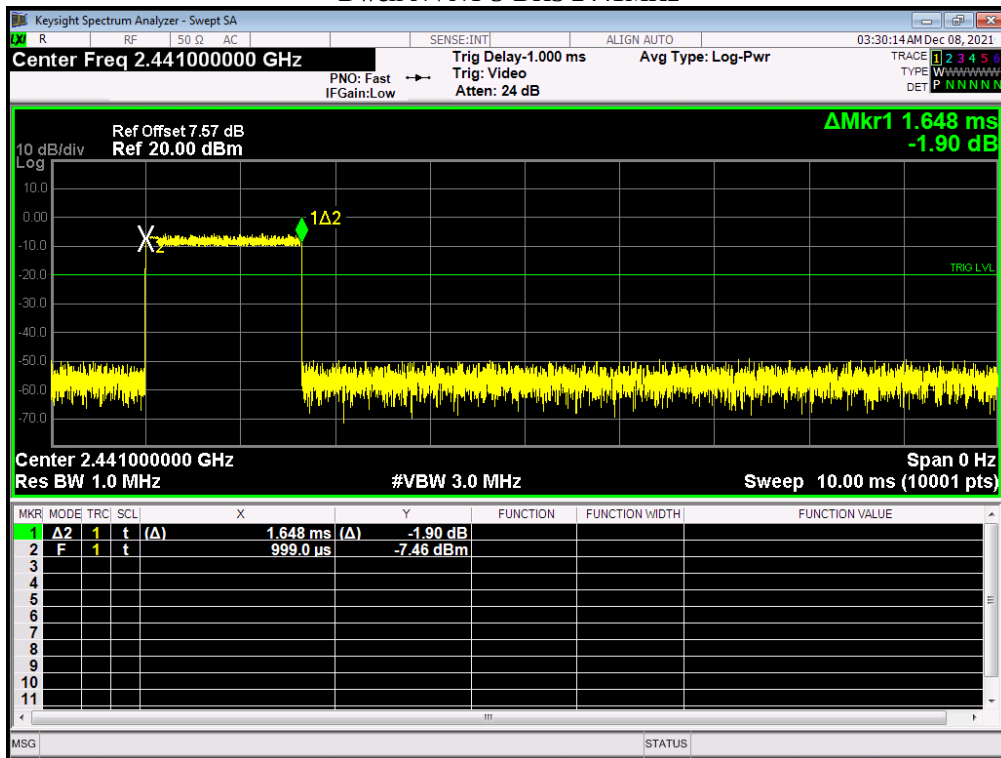


Condition	Mode	Frequency (MHz)	Pulse Time (ms)	Total Dwell Time (ms)	Period Time (ms)	Limit (ms)	Verdict
NVNT	3-DH3	2402	1.649	260.542	31600	400	Pass
NVNT	3-DH3	2441	1.648	260.384	31600	400	Pass
NVNT	3-DH3	2480	1.649	260.542	31600	400	Pass

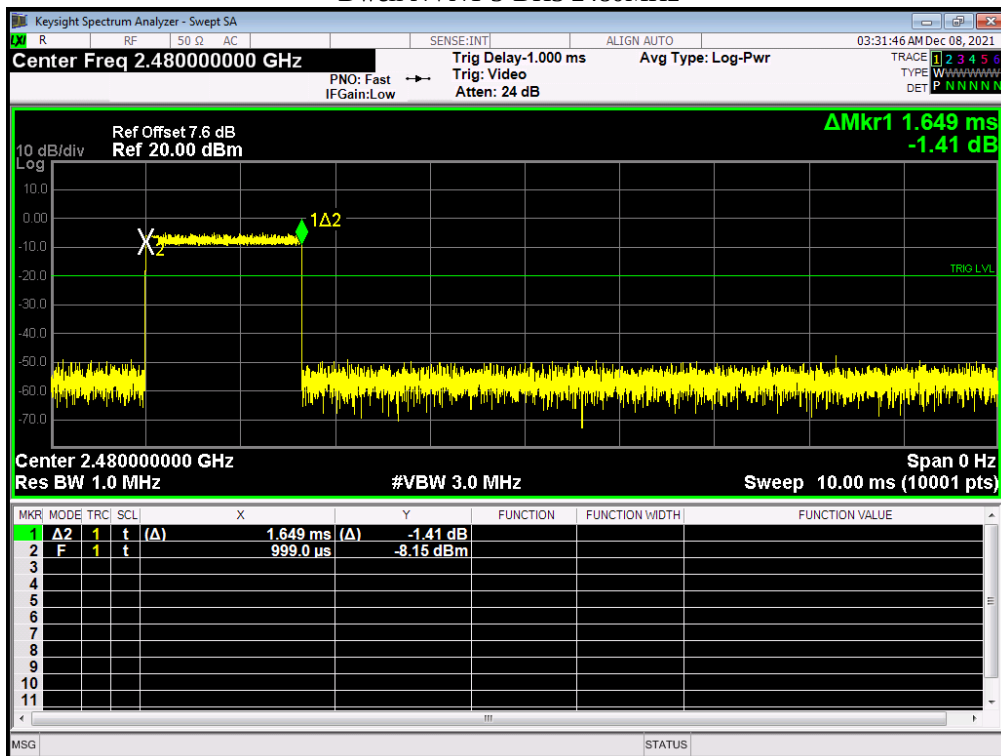
Dwell NVNT 3-DH3 2402MHz



Dwell NVNT 3-DH3 2441MHz

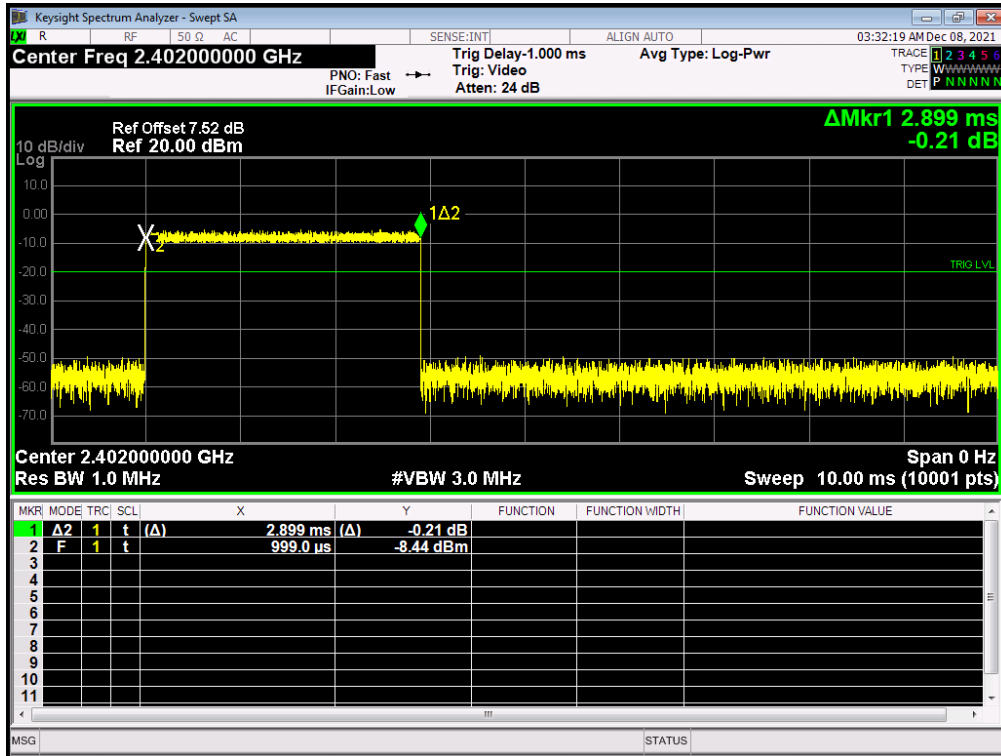


Dwell NVNT 3-DH3 2480MHz

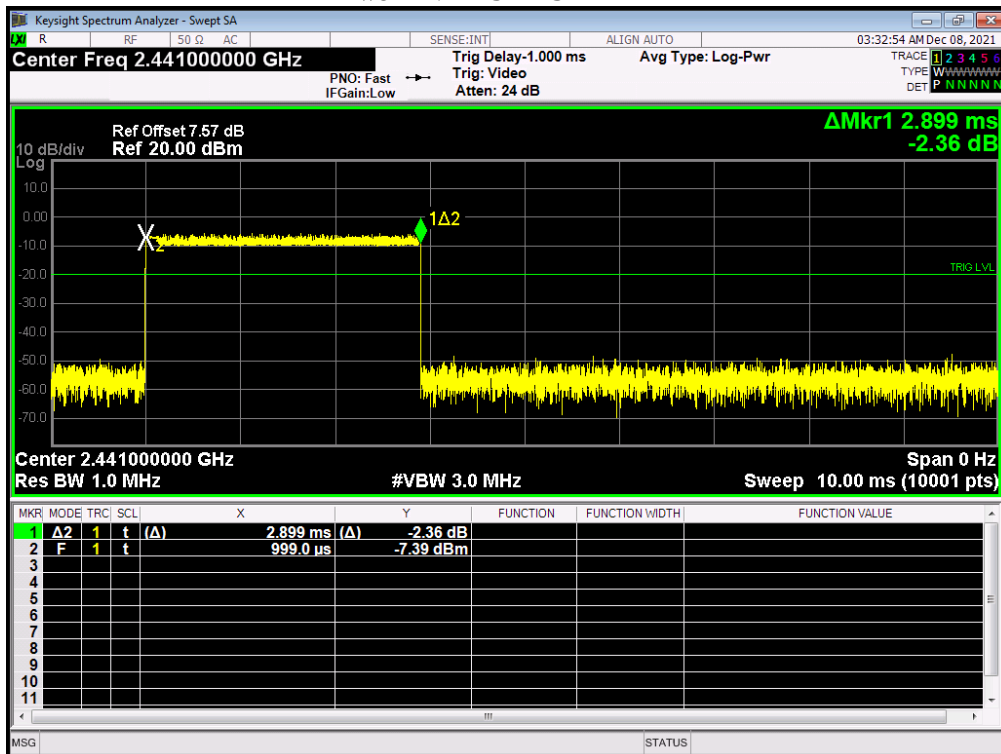


Condition	Mode	Frequency (MHz)	Pulse Time (ms)	Total Dwell Time (ms)	Period Time (ms)	Limit (ms)	Verdict
NVNT	3-DH5	2402	2.899	274.825	31600	400	Pass
NVNT	3-DH5	2441	2.899	274.825	31600	400	Pass
NVNT	3-DH5	2480	2.871	272.171	31600	400	Pass

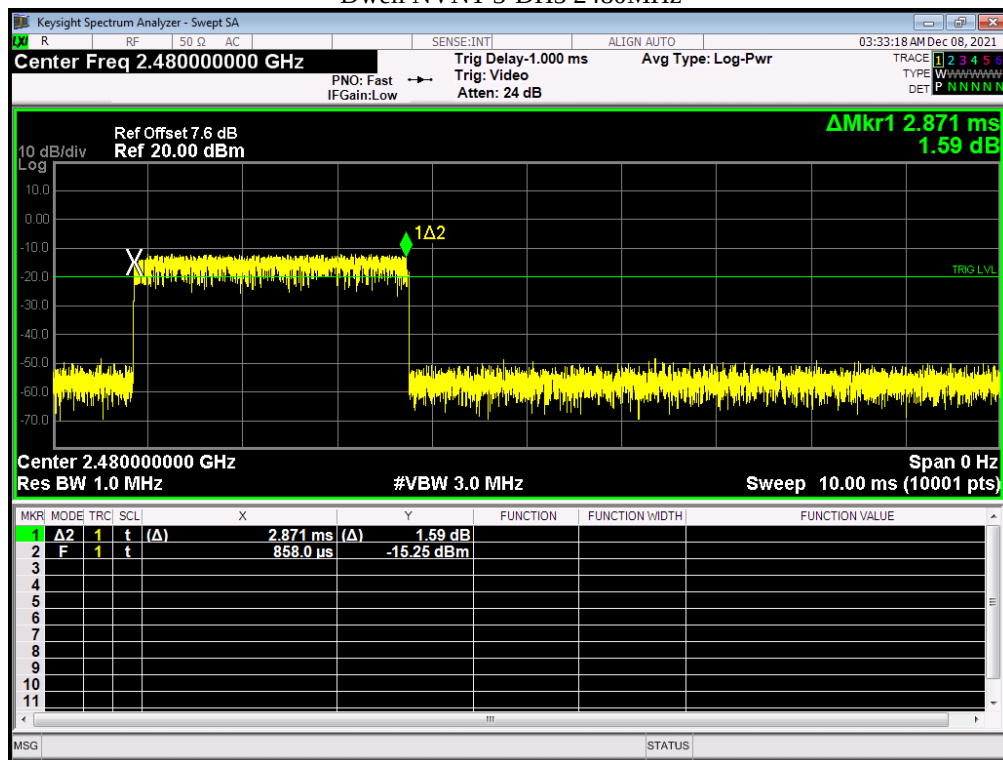
Dwell NVNT 3-DH5 2402MHz



Dwell NVNT 3-DH5 2441MHz



Dwell NVNT 3-DH5 2480MHz



10. Band edge

10.1. Applied procedures / Limit

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 Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

10.2. Test procedure

- a. The EUT was directly connected to the spectrum analyzer and antenna output port as show in the block diagram below.
- b. Span = wide enough to capture the peak level of the emission operating on the channel closest to the band edge, as well as any modulation products which fall outside of the authorized band of operation, RBW $\geq$ 1% of the span, VBW $\geq$ RBW, Sweep = auto, Detector function = peak, Trace = max hold

10.3. Deviation from standard

No deviation.

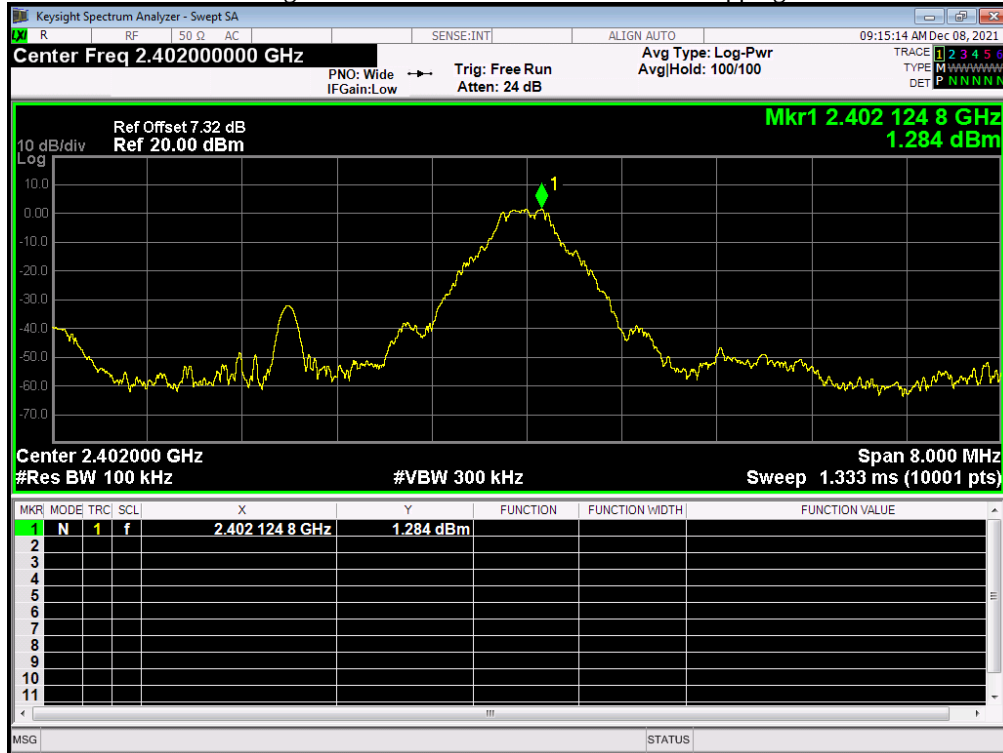
10.4. Test setup



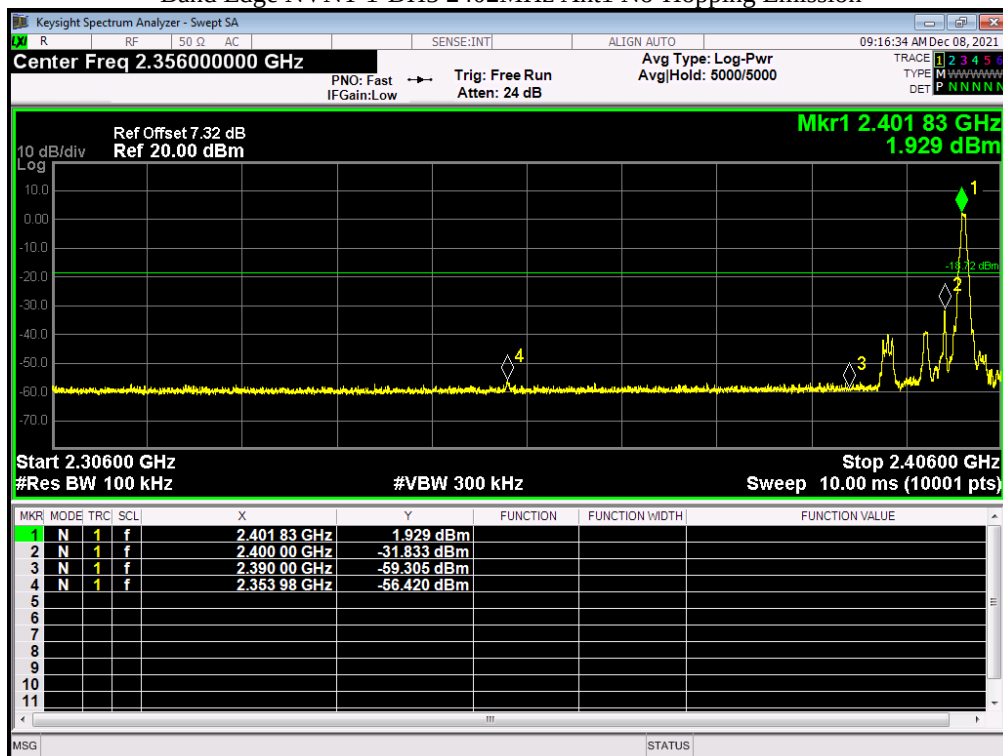
10.5. Test results

Condition	Mode	Frequency (MHz)	Antenna	Hopping Mode	Max Value (dBc)	Limit (dBc)	Verdict
NVNT	1-DH5	2402	Ant 1	No-Hopping	-57.694	-20	Pass
NVNT	1-DH5	2480	Ant 1	No-Hopping	-51.015	-20	Pass

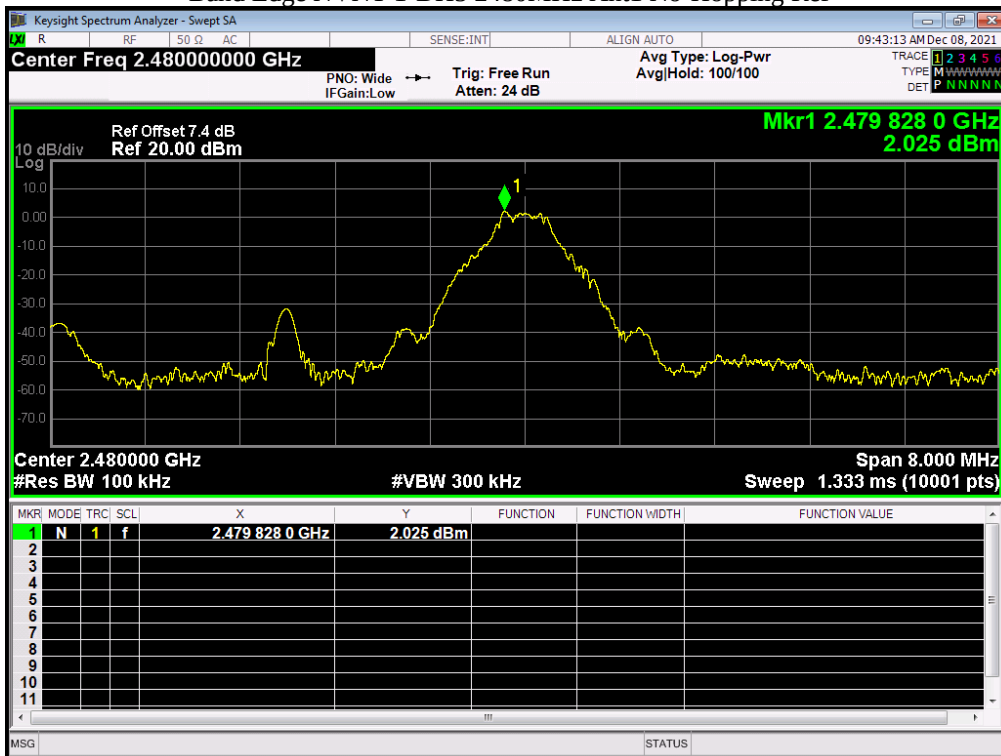
Band Edge NVNT 1-DH5 2402MHz Ant1 No-Hopping Ref



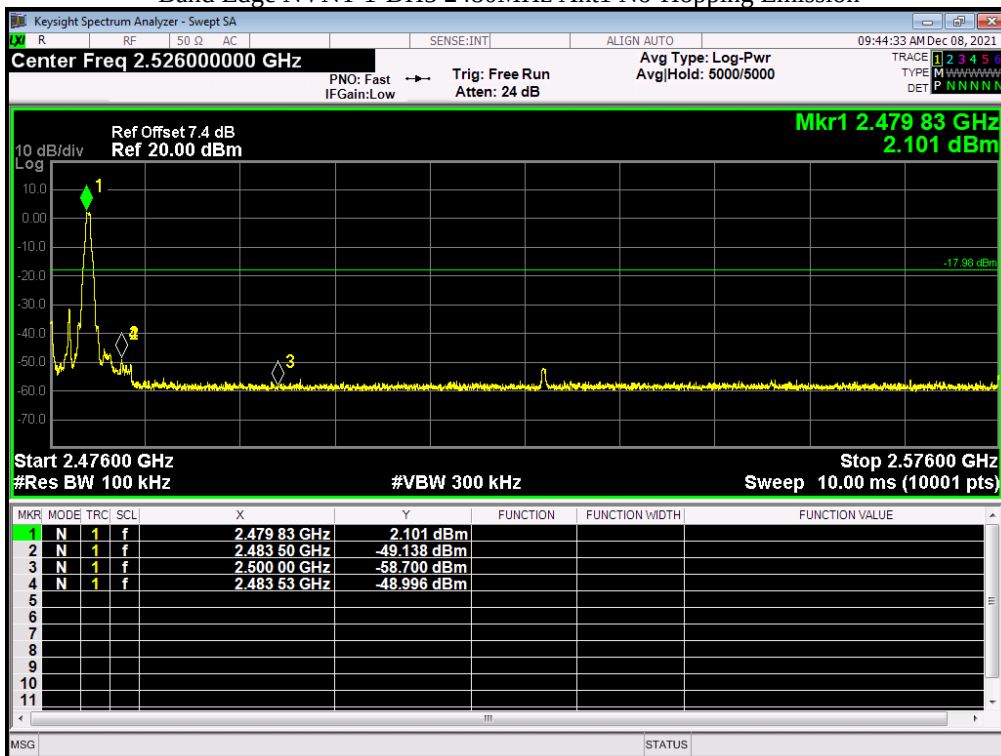
Band Edge NVNT 1-DH5 2402MHz Ant1 No-Hopping Emission



Band Edge NVNT 1-DH5 2480MHz Ant1 No-Hopping Ref

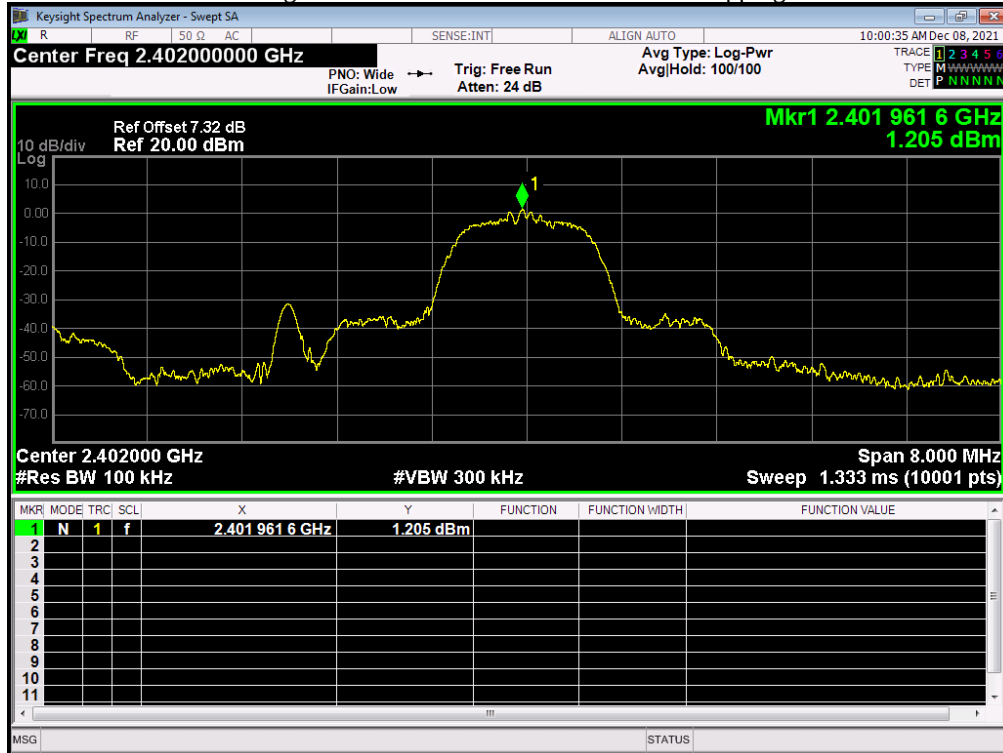


Band Edge NVNT 1-DH5 2480MHz Ant1 No-Hopping Emission

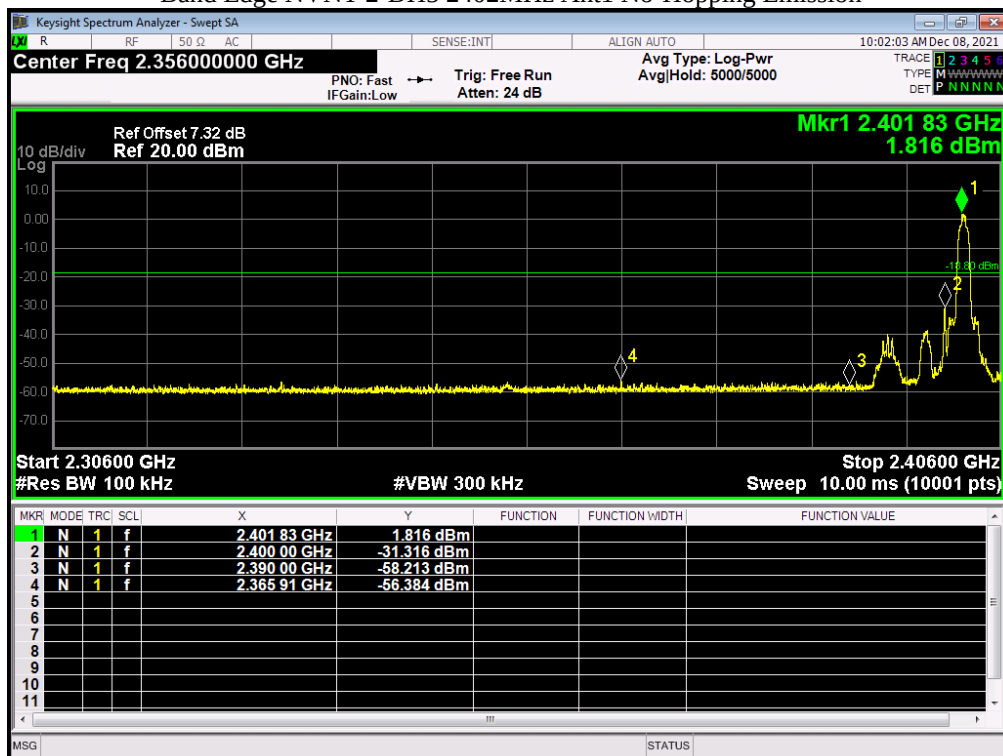


Condition	Mode	Frequency (MHz)	Antenna	Hopping Mode	Max Value (dBc)	Limit (dBc)	Verdict
NVNT	2-DH5	2402	Ant 1	No-Hopping	-57.585	-20	Pass
NVNT	2-DH5	2480	Ant 1	No-Hopping	-50.182	-20	Pass

Band Edge NVNT 2-DH5 2402MHz Ant1 No-Hopping Ref



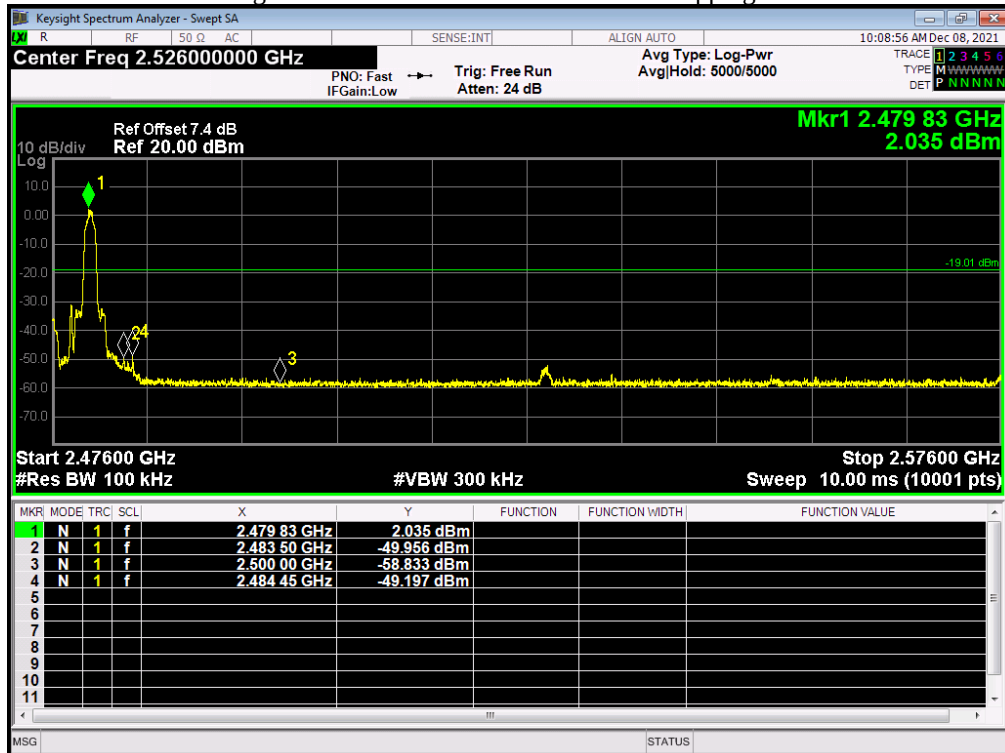
Band Edge NVNT 2-DH5 2402MHz Ant1 No-Hopping Emission



Band Edge NVNT 2-DH5 2480MHz Ant1 No-Hopping Ref

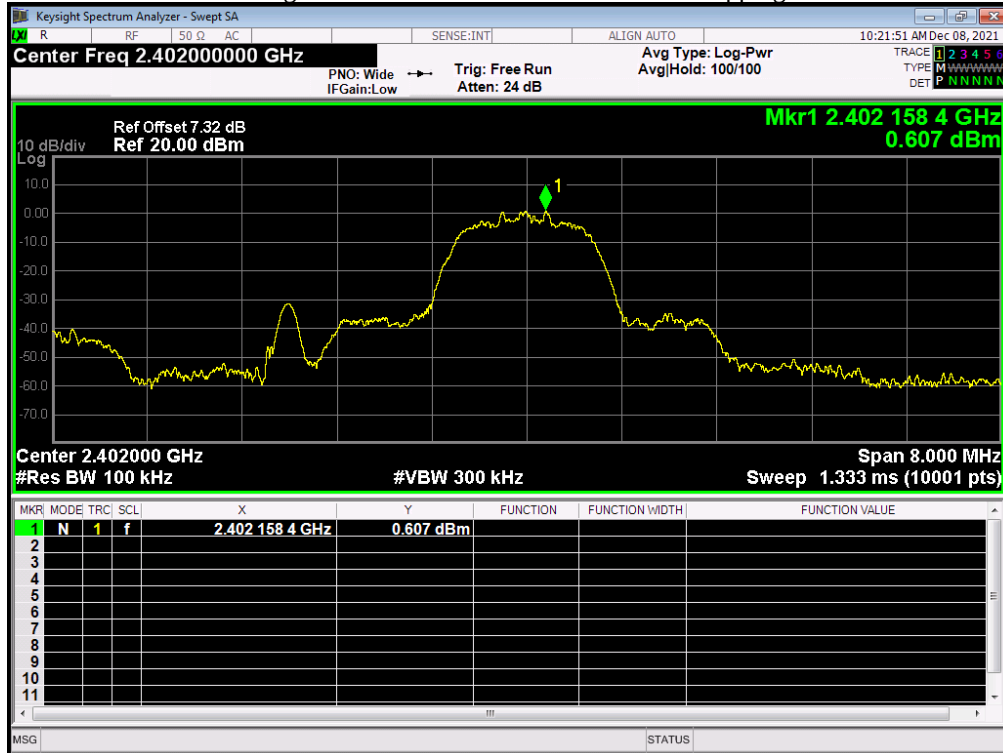


Band Edge NVNT 2-DH5 2480MHz Ant1 No-Hopping Emission

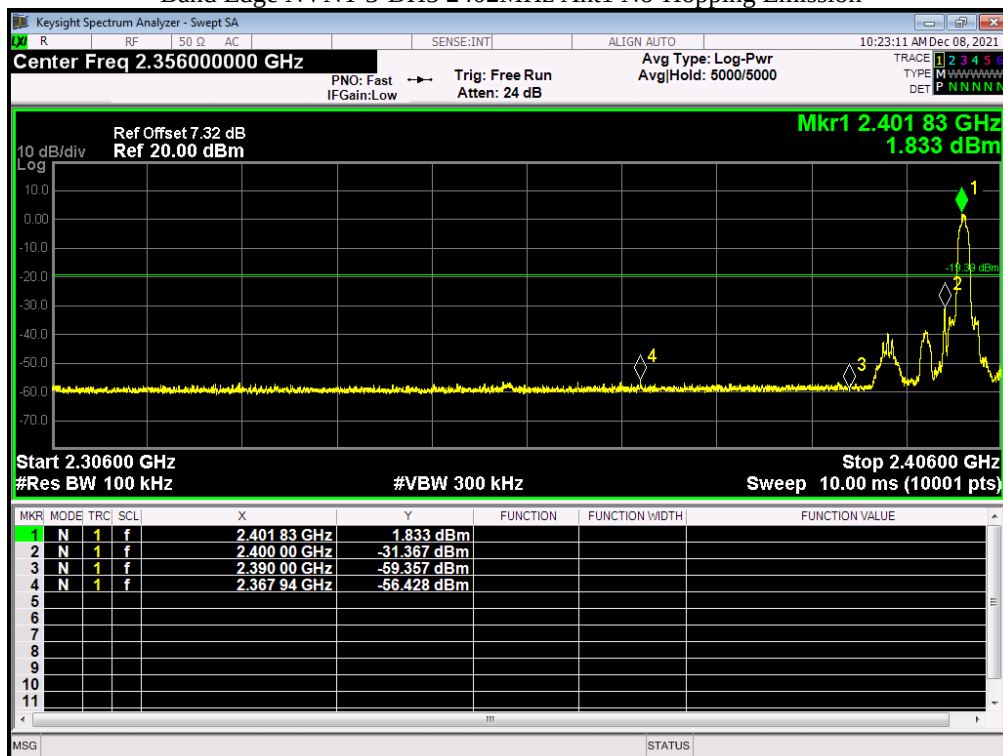


Condition	Mode	Frequency (MHz)	Antenna	Hopping Mode	Max Value (dBc)	Limit (dBc)	Verdict
NVNT	3-DH5	2402	Ant 1	No-Hopping	-57.027	-20	Pass
NVNT	3-DH5	2480	Ant 1	No-Hopping	-50.71	-20	Pass

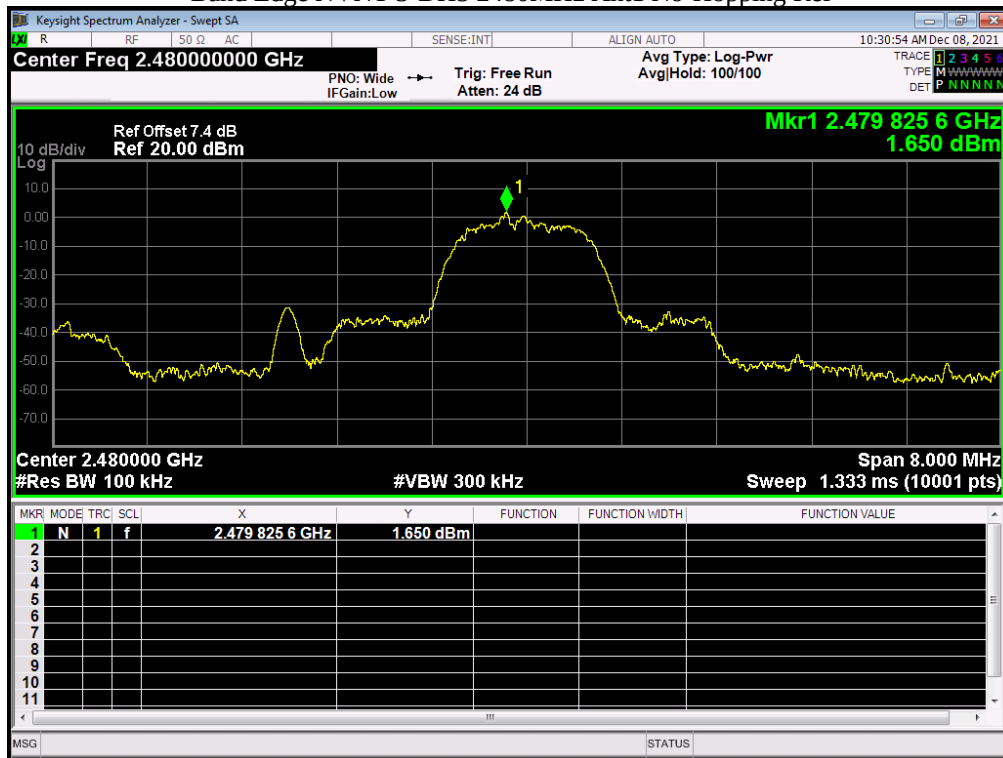
Band Edge NVNT 3-DH5 2402MHz Ant1 No-Hopping Ref



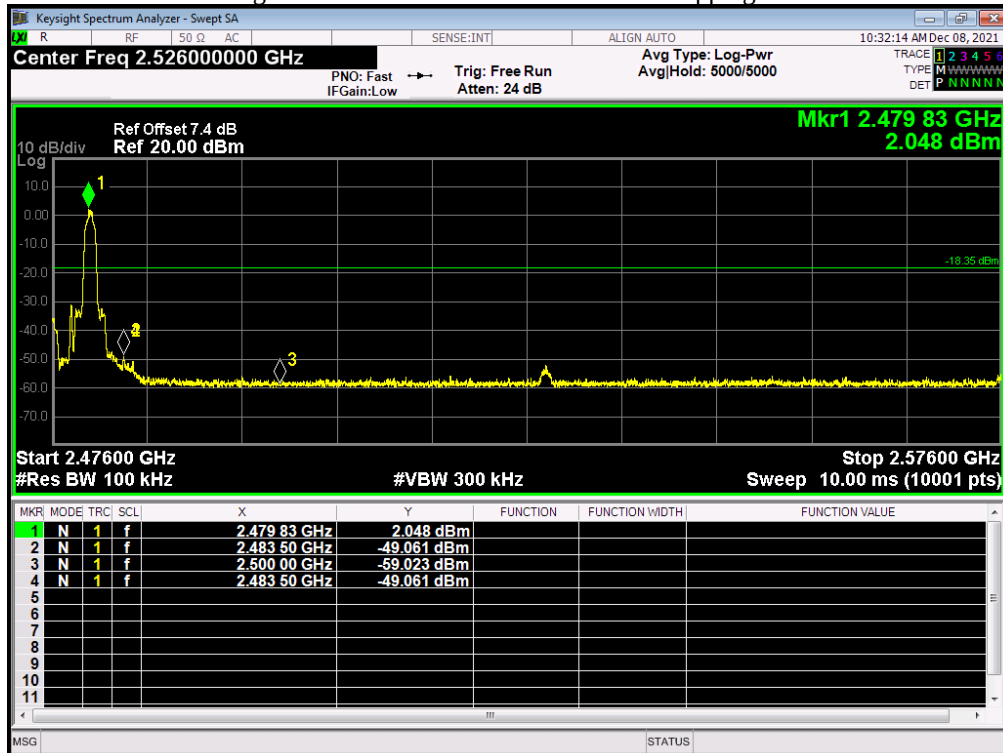
Band Edge NVNT 3-DH5 2402MHz Ant1 No-Hopping Emission



Band Edge NVNT 3-DH5 2480MHz Ant1 No-Hopping Ref



Band Edge NVNT 3-DH5 2480MHz Ant1 No-Hopping Emission



11. Conducted Spurious Emissions

11.1. Applied procedures / Limit

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 Section 15.209(a) is not required. In addition, radiated emissions which fall in the restricted bands, as defined in Section 15.205(a), must also comply with the radiated emission limits specified in Section 15.209(a) (see Section 15.205(c)).

11.2. Test procedure

- a. The EUT was directly connected to the spectrum analyzer and antenna output port as show in the block diagram below.
- b. Span = wide enough to capture the peak level of the in-band emission and all spurious emissions (e.g., harmonics) from the lowest frequency generated in the EUT up through the 10th harmonic. Typically, several plots are required to cover this entire span. RBW = 100 kHz
VBW $\geq$ RBW, Sweep = auto, Detector function = peak, Trace = max hold
sweep points $\geq$ investigated frequency range/RBW.

11.3. Deviation from standard

No deviation.

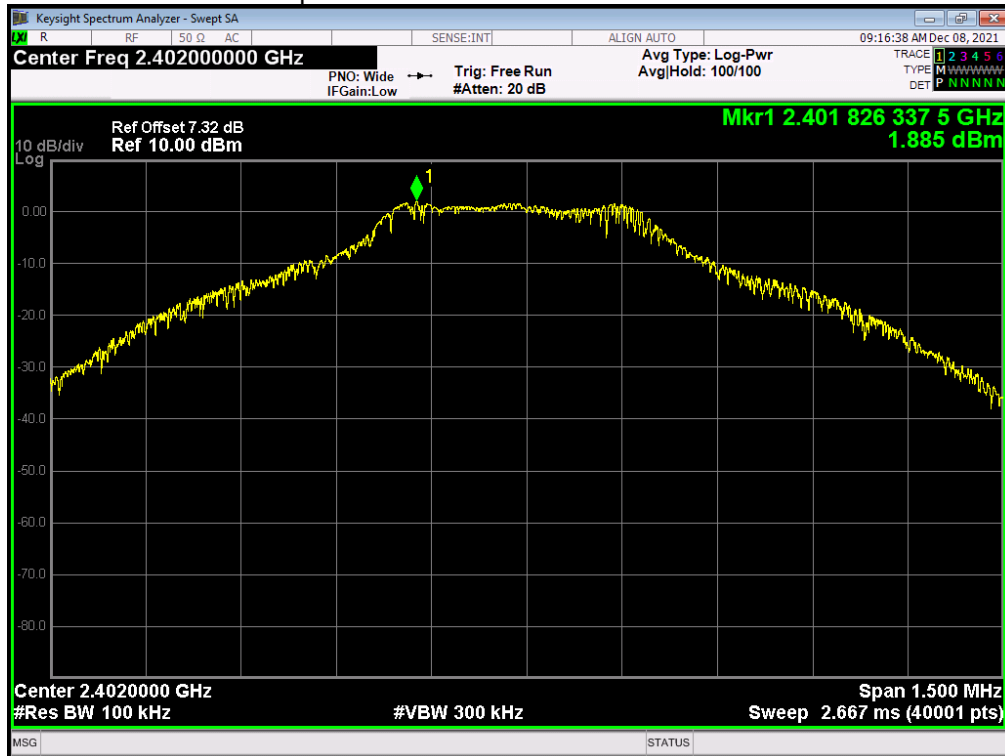
11.4. Test setup



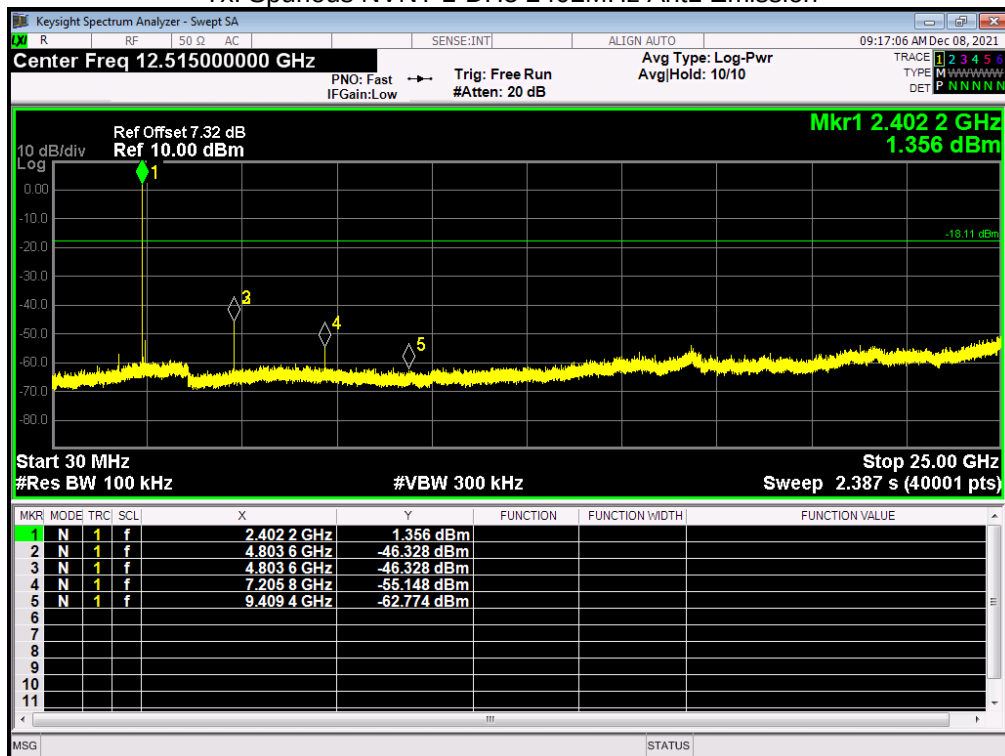
11.5. Test results

Condition	Mode	Frequency (MHz)	Antenna	Max Value (dBc)	Limit (dBc)	Verdict
NVNT	1-DH5	2402	Ant 1	-48.205	-20	Pass
NVNT	1-DH5	2480	Ant 1	-42.767	-20	Pass

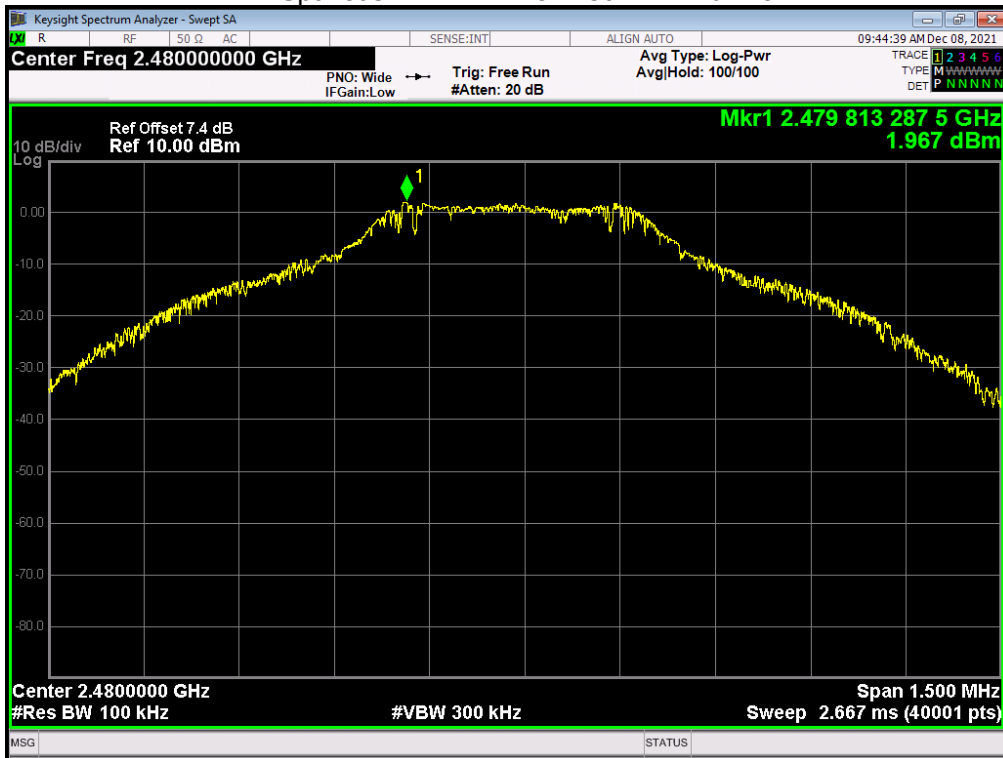
Tx. Spurious NVNT 1-DH5 2402MHz Ant1 Ref



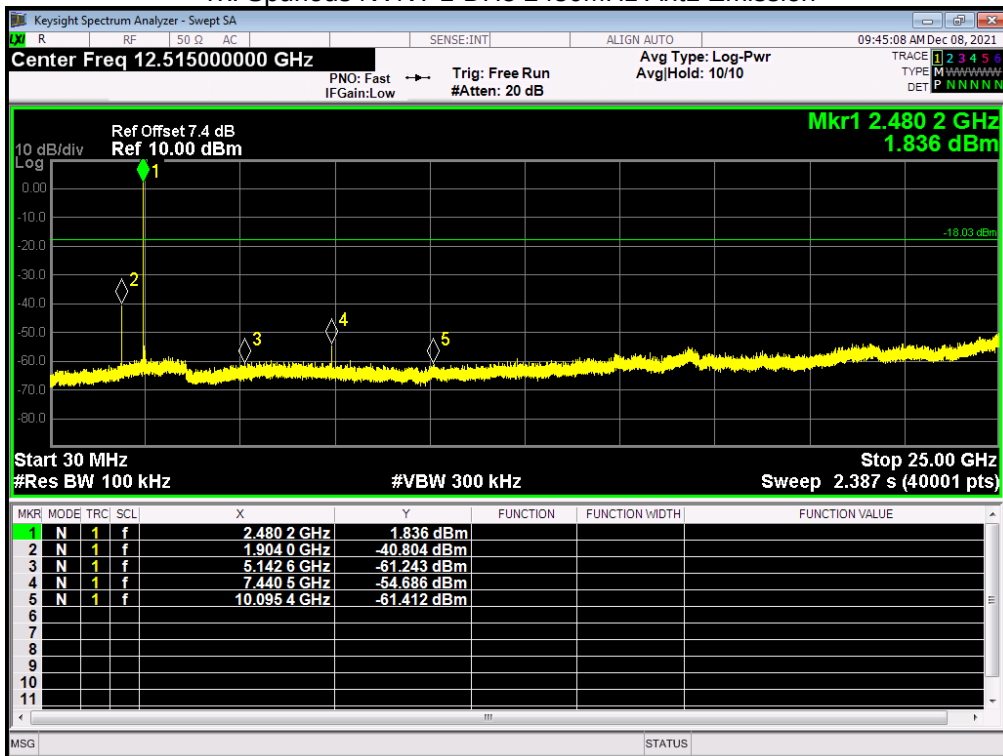
Tx. Spurious NVNT 1-DH5 2402MHz Ant1 Emission



Tx. Spurious NVNT 1-DH5 2480MHz Ant1 Ref

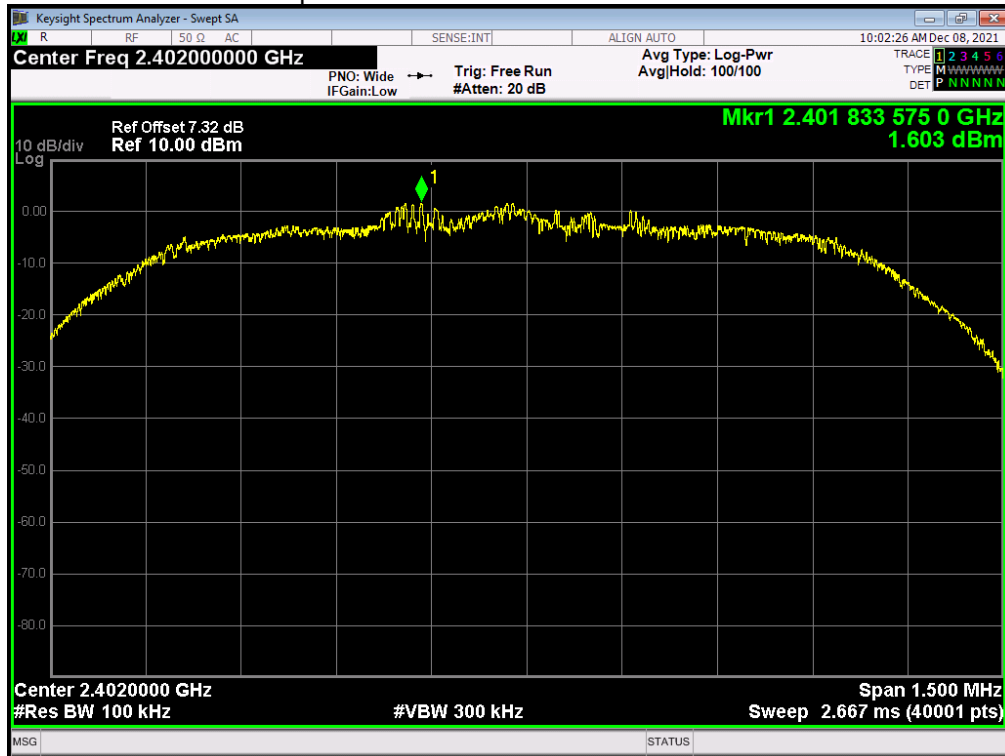


Tx. Spurious NVNT 1-DH5 2480MHz Ant1 Emission

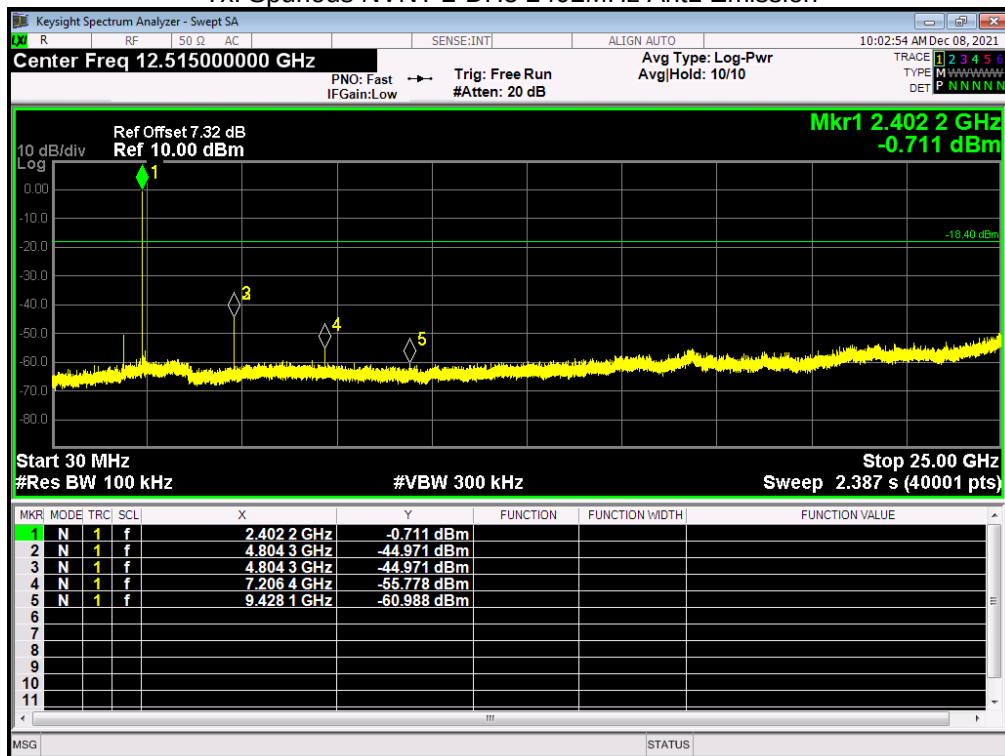


Condition	Mode	Frequency (MHz)	Antenna	Max Value (dBc)	Limit (dBc)	Verdict
NVNT	2-DH5	2402	Ant 1	-46.573	-20	Pass
NVNT	2-DH5	2480	Ant 1	-47.986	-20	Pass

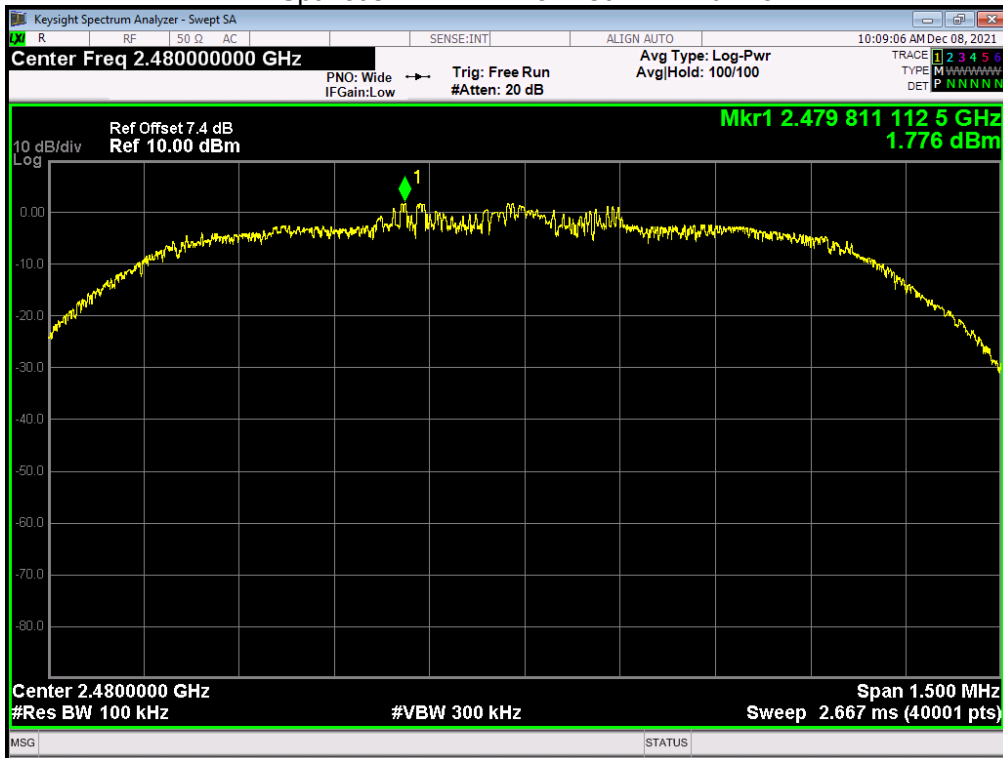
Tx. Spurious NVNT 2-DH5 2402MHz Ant1 Ref



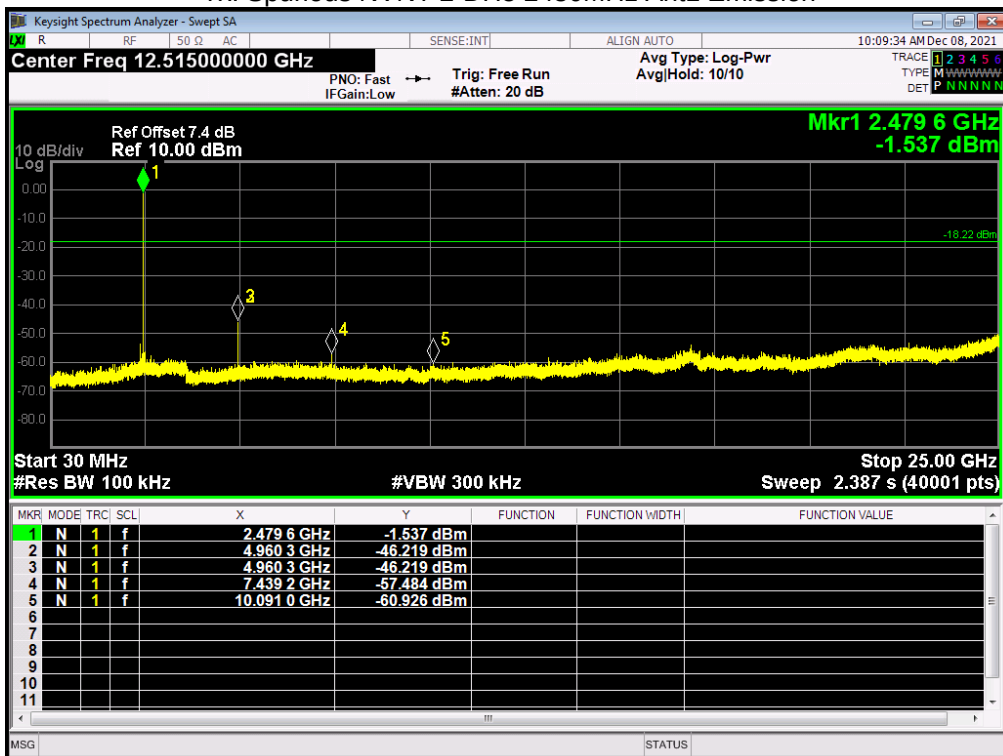
Tx. Spurious NVNT 2-DH5 2402MHz Ant1 Emission



Tx. Spurious NVNT 2-DH5 2480MHz Ant1 Ref

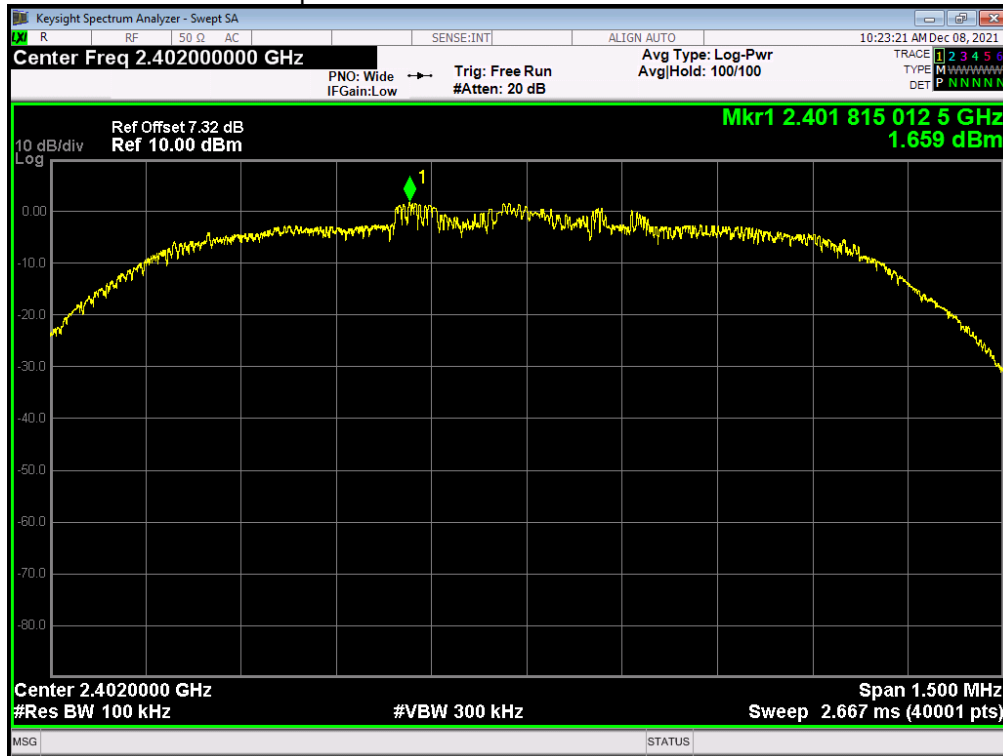


Tx. Spurious NVNT 2-DH5 2480MHz Ant1 Emission

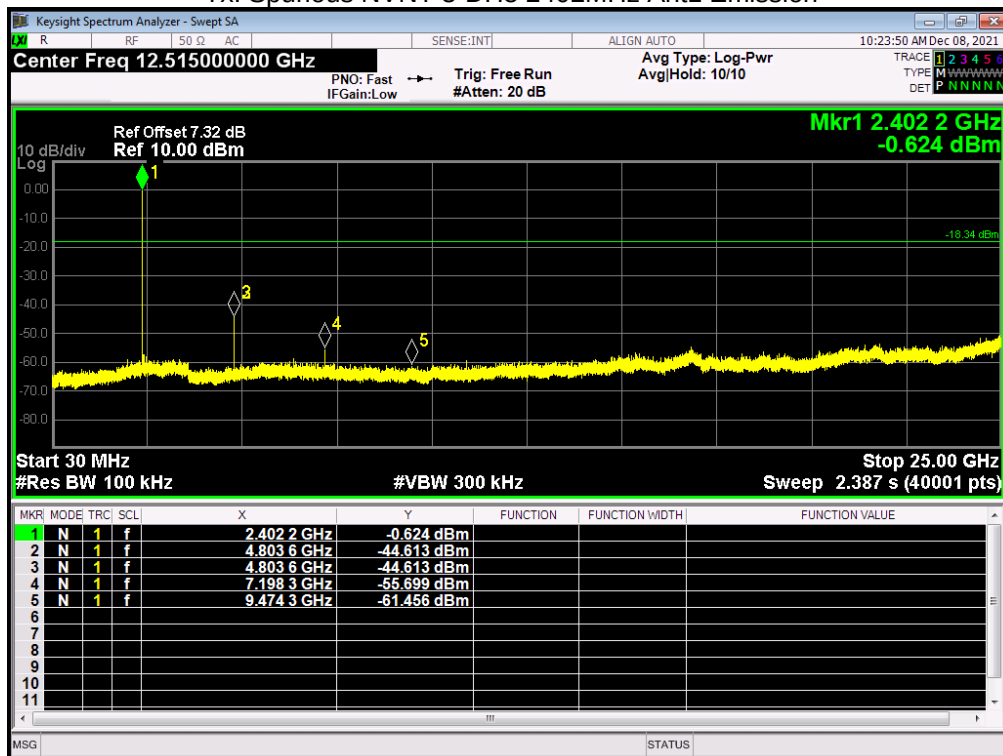


Condition	Mode	Frequency (MHz)	Antenna	Max Value (dBc)	Limit (dBc)	Verdict
NVNT	3-DH5	2402	Ant 1	-46.269	-20	Pass
NVNT	3-DH5	2480	Ant 1	-45.324	-20	Pass

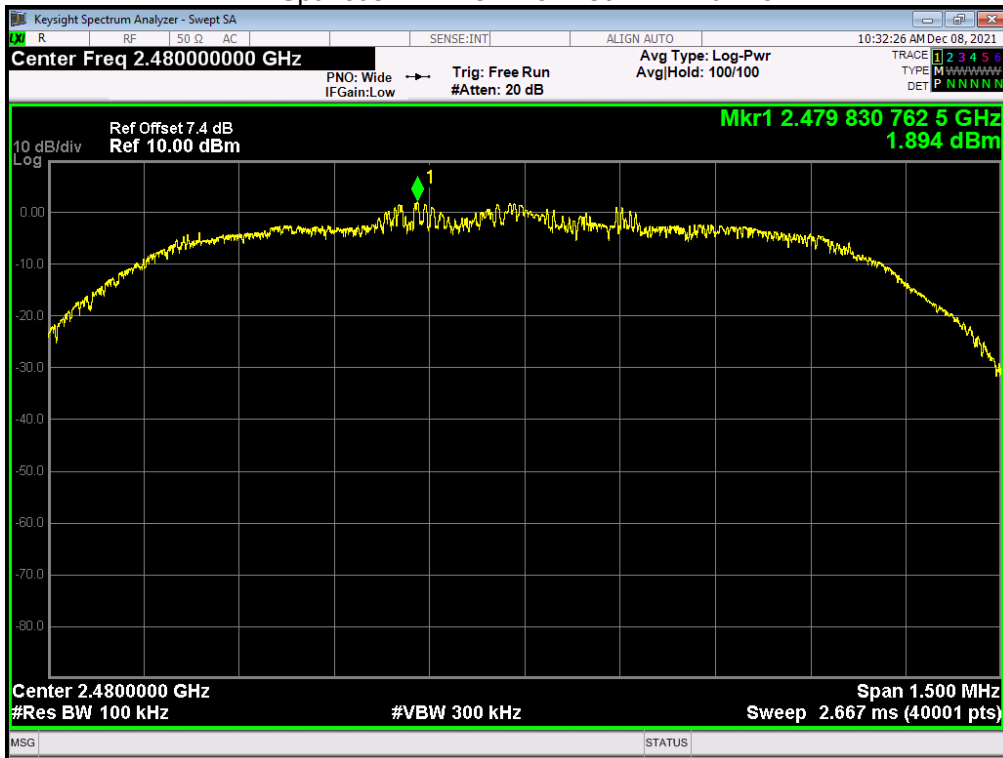
Tx. Spurious NVNT 3-DH5 2402MHz Ant1 Ref



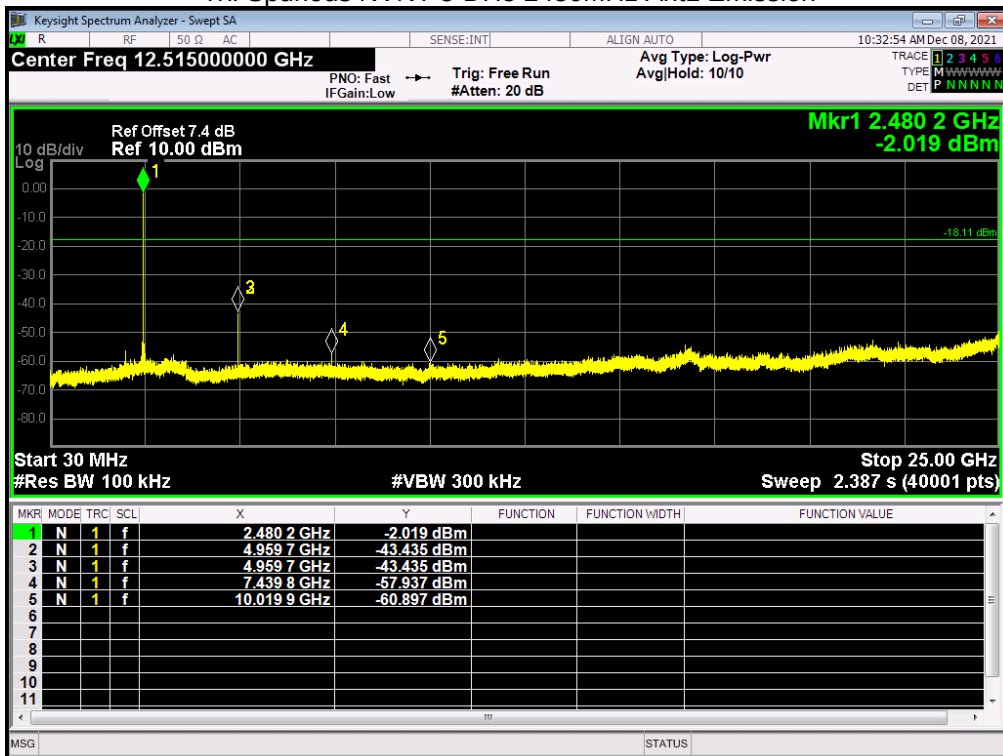
Tx. Spurious NVNT 3-DH5 2402MHz Ant1 Emission



Tx. Spurious NVNT 3-DH5 2480MHz Ant1 Ref



Tx. Spurious NVNT 3-DH5 2480MHz Ant1 Emission



12. Antenna Requirement

12.1. Standard requirement

15.203 requirement: For intentional device, according to 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. 15.247(c) (1)(i) requirement: (i) Systems operating in the 2400-2483.5 MHz band that is used exclusively for fixed. Point-to-point operations may employ transmitting antennas with directional gain greater than 6dBi provided the maximum conducted output power of the intentional radiator is reduced by 1 dB for every 3 dB that the directional gain of the antenna exceeds 6dBi.

12.2. EUT Antenna

The antenna is Integral Antenna and no consideration of replacement. Antenna gain is Maximum 0.0dBi from 2.4GHz to 2.5GHz.

13. Test setup photograph

Photos of power line conducted emission test



Photos of radiated emission test
30MHz – 1GHz



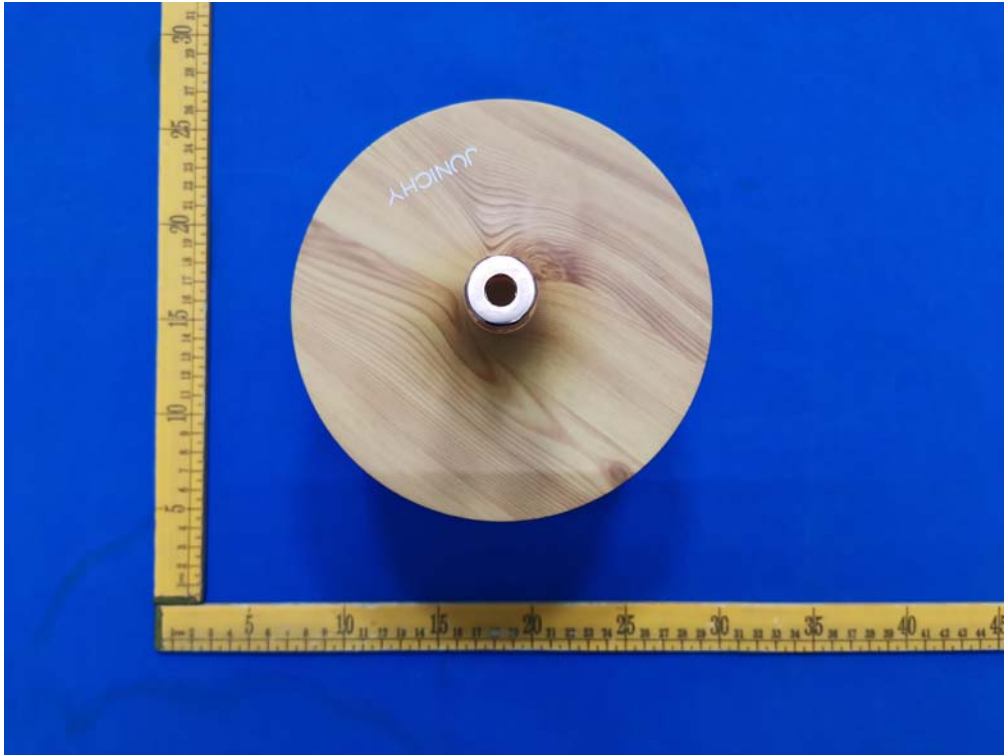
Photos of radiated emission test
Above 1GHz

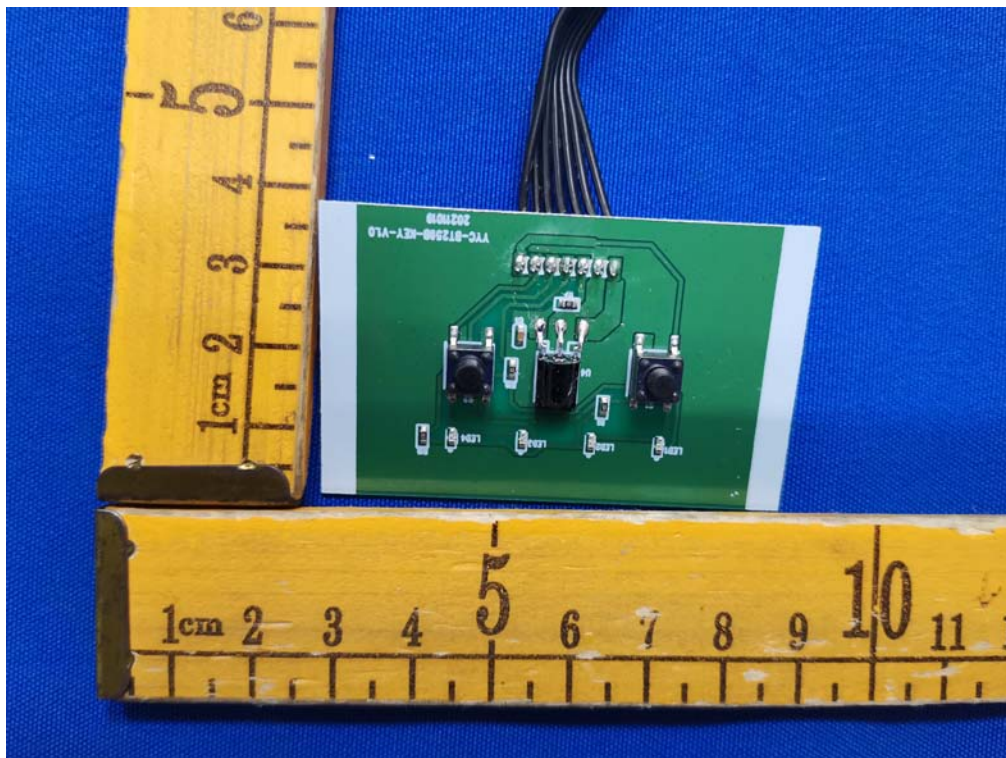


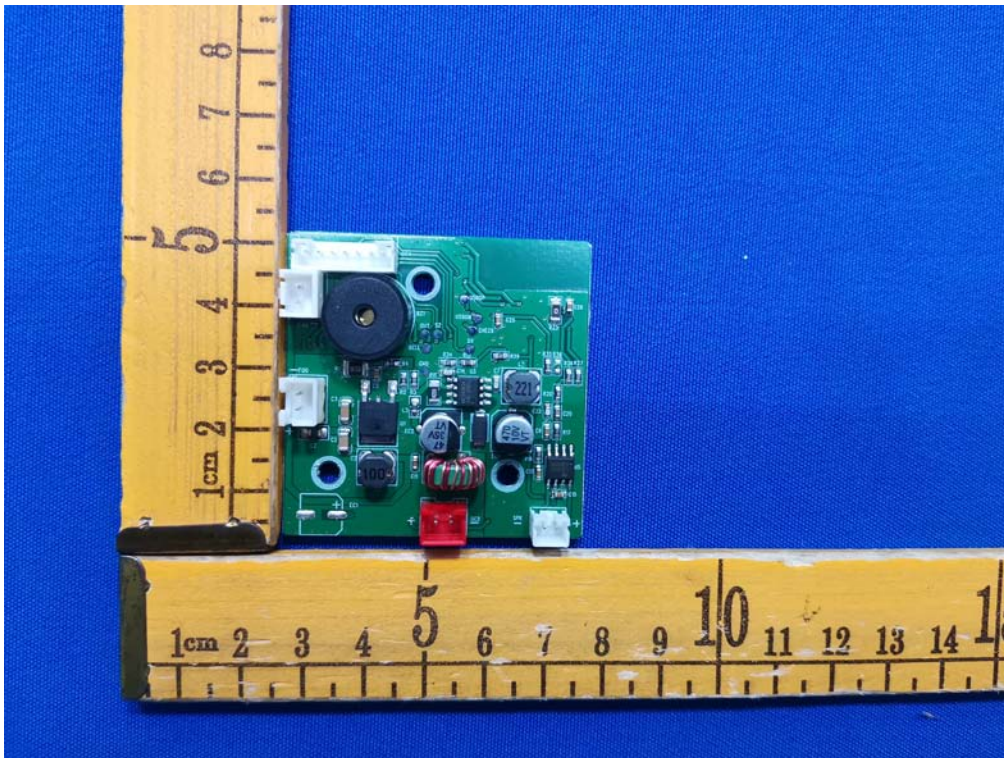
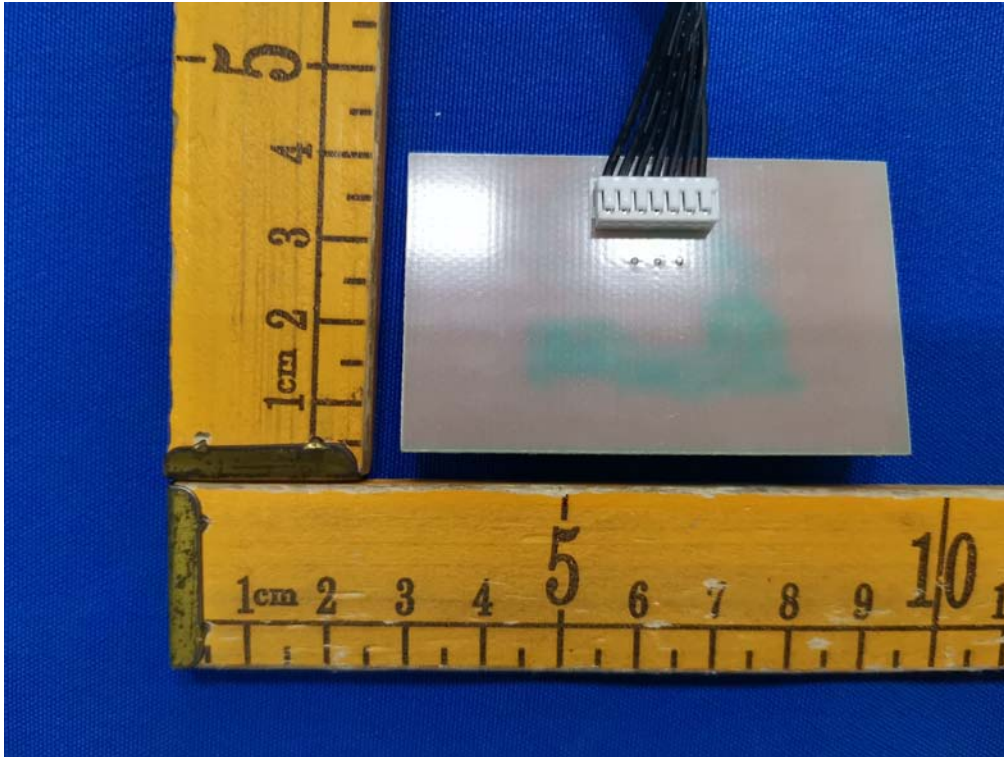
14. Photos of the EUT



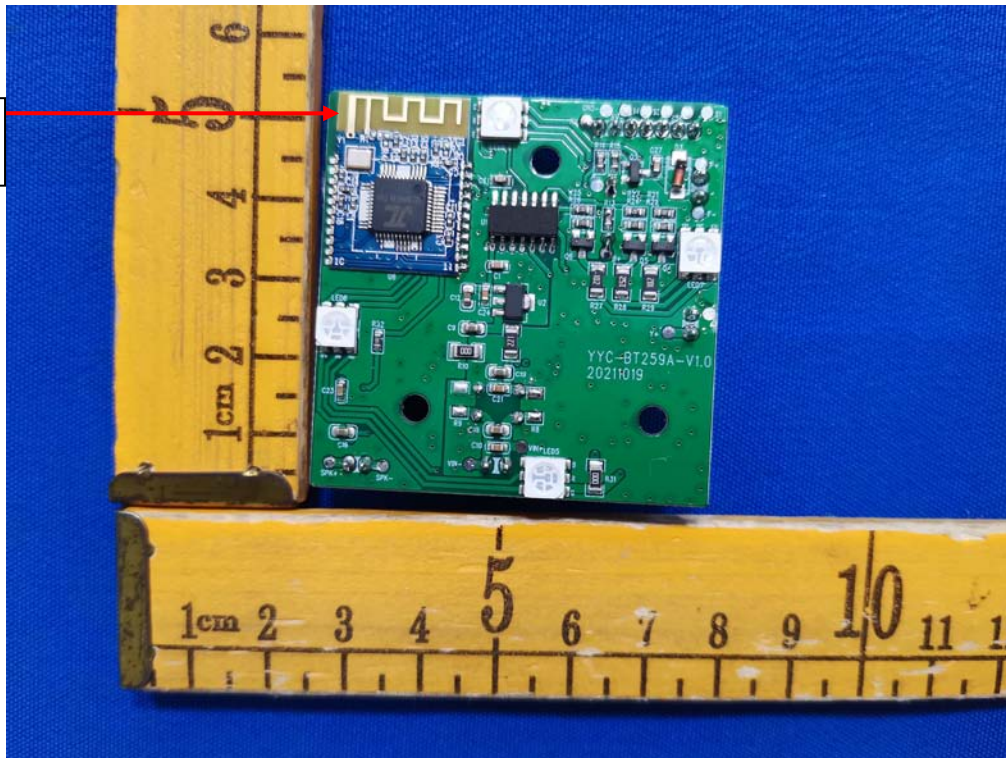








Antenna



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