ncee labs
Product Compliance Solutions

4740 Discovery Drive | Lincoln, NE 68521
tel- 402.323.6233 | tel -888.657.6860 | fax - 402.323.6238
info@nceelabs.com | http://nceelabs.com

Amended

Test Report

Prepared for:	**Inovonics**
Address:	**397 S. Taylor Ave. Louisville, CO 80027**
Product:	**FFR Module**
Test Report No:	**R20200311-21-E1A**
Approved by:	**Nic S. Johnson, NCE** **Technical Manager** **iNARTE Certified EMC Engineer #EMC-003337-NE**
DATE:	**26 August 2020**
Total Pages:	**50**

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TESTING LABORATORY
CERTIFICATE NO. 1953.01

REVISION PAGE

Rev. No.	Date	Description
0	26 June 2020	Original – NJohnson Prepared by KVepuri/CFarrington
A	26 August 2020	Added conducted emissions plots Includes NCEE Labs report R20200311-21-E1 and its amendment in full. -NJ

CONTENTS

1.0 SUMMARY OF TEST RESULTS

The EUT has been tested according to the following specifications:

(1) US Code of Federal Regulations, Title 47, Part 15
(2) ISED RSS-Gen, Issue 5
(3) ISED RSS-247, Issue 2

SUMMARY			
Standard Section	**Test Type and Limit**	**Result**	**Remark**
FCC 15.203	Unique Antenna Requirement	Pass	PCB antenna
FCC 15.35 RSS-Gen, 6.10	Duty cycle of pulsed emissions	Pass	Pulsed emissions duty cycle was applied
FCC 15.209 RSS-Gen, 7.1	Receiver Radiated Emissions	NA	The EUT has no receiver functionality
FCC 15.247(a)(1)(i) RSS-247, 5.1(c)	Minimum Bandwidth, Limit: Min. 250kHz	Pass	Meets the requirement of the limit.
FCC 15.247(b)(1) RSS-247, 5.1	Maximum Peak Output Power, Limit: Max. 24 dBm	Pass	Meets the requirement of the limit.
FCC 15.209 RSS-Gen, 8.9 RSS-247, 5.5	Transmitter Radiated Emissions	Pass	Meets the requirement of the limit.
FCC 15.247(a) (1) (i) RSS-247, 5.1(c)	Frequency hopping system, Limit: Max. 0.4 Seconds in 10 Second Period	Pass	Meets the requirement of the limit.
FCC 15.209, 15.205 RSS-Gen, 8.9 RSS-247, 5.5	Band Edge Measurement, Limit: 20dB less than the peak value of fundamental frequency	Pass	Meets the requirement of the limit.
FCC 15.207 RSS-Gen. 8.8	Conducted AC Emissions	Pass	Meets the requirement of the limit.

2.0 EUT DESCRIPTION

2.1 EQUIPMENT UNDER TEST

The Equipment Under Test (EUT) was a wireless FHSS transmitter.

EUT	FFR Module
EUT Received	5/4/2020
EUT Tested	5/19/2020 - 6/19/2020
Serial No.	00109 (Assigned by test lab)
Operating Band	902.0 – 928.0 MHz
Device Type	FHSS
Power Supply	GlobTek GT-21088-0805-W2 or 3.7V Battery

NOTE: For more detailed features description, please refer to the manufacturer's specifications or user's manual.

2.2 DESCRIPTION OF TEST MODES

The EUT operates on, and was tested at the frequencies below:

Channel	Frequency
Low	902.4
Middle	914.8
High	927.6

These are the only three representative channels tested in the frequency range according to FCC Part 15.31 and RSS-Gen Table A1. See the operational description for a list of all channel frequency and designations.

This EUT was set to transmit in a worse-case scenario with modulation on. The manufacturer modified the unit to transmit continuously on the lowest, highest and one channel in the middle.

2.3 DESCRIPTION OF SUPPORT UNITS

None

3.0 LABORATORY DESCRIPTION

3.1 LABORATORY DESCRIPTION

All testing was performed at the following Facility:

The Nebraska Center for Excellence in Electronics (NCEE Labs)
4740 Discovery Drive
Lincoln, NE 68521

A2LA Certificate Number:	1953.01
FCC Accredited Test Site Designation No:	US1060
Industry Canada Test Site Registration No:	4294A-1
CAB MRA Recognition Identification No:	US0177

Environmental conditions varied slightly throughout the tests:
Relative humidity of 35 ± 4%
Temperature of 22 ± 3° Celsius

3.2 TEST PERSONNEL

No.	PERSONNEL	TITLE	ROLE
1	Nic Johnson	Technical Manager	Review of Results
2	Karthik Vepuri	EMC Test Engineer	Testing and Report
3	Caleb Farrington	EMC Test Engineer	Testing and Report
4	Fox Lane	EMC Test Engineer	Testing

Notes:
All personnel are permanent staff members of NCEE Labs. No testing or review was sub-contracted or performed by sub-contracted personnel.

3.3 TEST EQUIPMENT

DESCRIPTION AND MANUFACTURER	MODEL NO.	SERIAL NO.	LAST CALIBRATION DATE	CALIBRATION DUE DATE
Keysight MXE Signal Analyzer	N9038A	MY59050109	April 23, 2019	April 23, 2021
Keysight EXA Signal Analyzer	N9010A	MY56070862	December 14, 2018	December 14, 2020
SunAR RF Motion Hybrid Antenna	JB1	A091418	March 6, 2020	March 6, 2021
EMCO Horn Antenna	3115	6415	March 16, 2020	March 16, 2022
Rohde & Schwarz LISN	ESH3-Z5	836679/010	July 25, 2019	July 25, 2020
Rohde & Schwarz Preamplifier*	TS-PR18	3545700803	April 14, 2020	April 14, 2022
Trilithic High Pass Filter*	6HC330	23042	April 14, 2020	April 14, 2022
MiniCircuits High Pass Filter*	VHF-1320+	15542	April 14, 2020	April 14, 2022
RF Cable (preamplifier to antenna)*	MFR-57500	01-07-002	April 14, 2020	April 14, 2022
RF Cable (antenna to 10m chamber bulkhead)*	FSCM 64639	01E3872	April 14, 2020	April 14, 2022
RF Cable (10m chamber bulkhead to control room bulkhead)*	FSCM 64639	01E3874	April 14, 2020	April 14, 2022
RF Cable (control room bulkhead to test receiver)*	FSCM 64639	01F1206	April 14, 2020	April 14, 2022
N connector bulkhead (10m chamber)*	PE9128	NCEEBH1	April 14, 2020	April 14, 2022
N connector bulkhead (control room)*	PE9128	NCEEBH2	April 14, 2020	April 14, 2022
TDK Emissions Lab Software	V11.25	700307	NA	NA

*Internal Characterization

Notes:
All equipment is owned by NCEE Labs and stored permanently at NCEE Labs facilities.

4.0 DETAILED RESULTS

4.1 DUTY CYCLE

Since the device featured pulsed emissions, a duty cycle correction factor was applied to peak measurements to calculate the average measurement per ANSI C63.10-2013, Section 7.5.

On time is 23.6% and Period is greater than 100 ms. The Duty Cycle Correction Factor is calculated to be 20*log(23.6/100) = -12.54 dB

See the plots below for details.

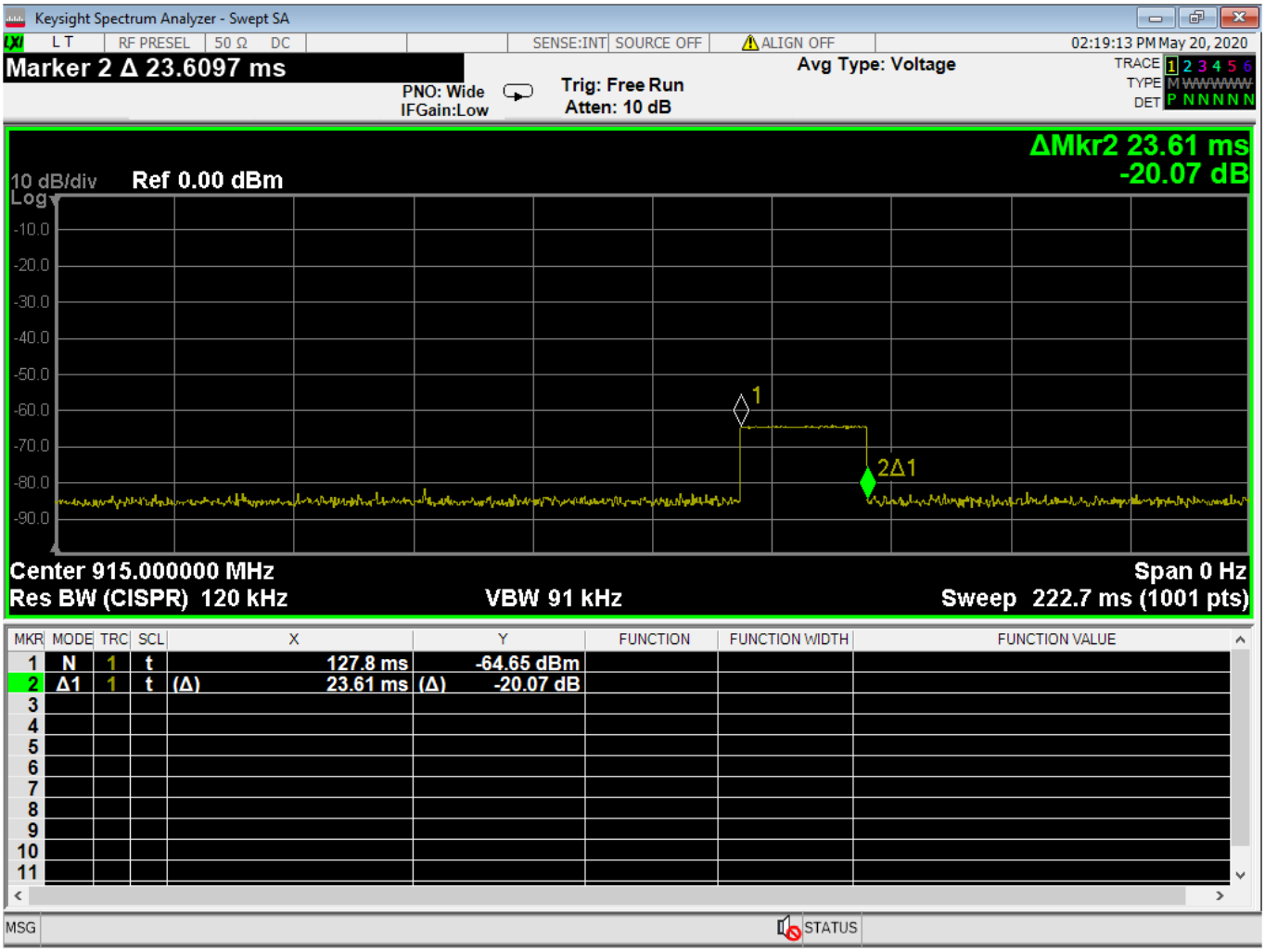

Figure 1 – Duty Cycle, ON Time

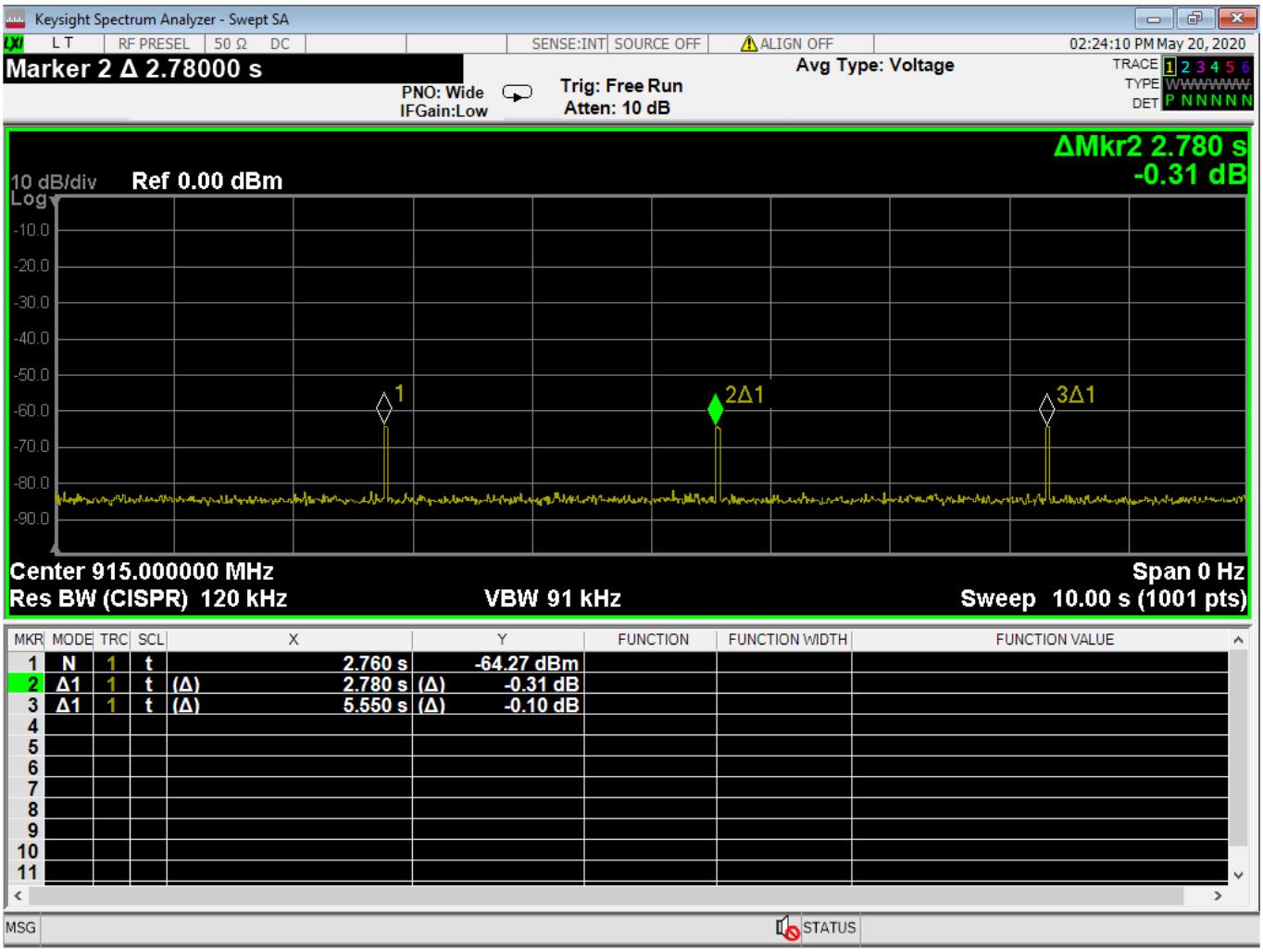

Figure 2 – Duty Cycle, Period

4.2 RADIATED EMISSIONS

Test Method: ANSI C63.10-2013, Section 6.5, 6.6

Limits for radiated emissions measurements:

Emissions radiated outside of the specified bands shall be applied to the limits in 15.209 as followed:

FREQUENCIES (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	3
30-88	100	3
88-216	150	3
216-960	200	3
Above 960	500	3

NOTE:
1. The lower limit shall apply at the transition frequencies.
2. Emission level (dBuV/m) = 20 * log * Emission level (μV/m).
3. As shown in 15.35(b), for frequencies above 1000MHz, the field strength limits are based on average detector, however, the peak field strength of any emission shall not exceed the maximum permitted average limits by more than 20dB under any condition of modulation.

Test procedures:

a. The EUT was placed on the top of a rotating table above the ground plane in a 10 meter semi-anechoic chamber. The table was rotated 360 degrees to determine the position of the highest radiation. The table was 0.8m high for measurements form 30MHz-1GHz and 1.5m for measurements from 1GHz to 10 GHz.

b. The EUT was set 3 meters away from the interference-receiving antenna, which was mounted on the top of a variable-height antenna tower.

c. The antenna was a broadband antenna, and its height is varied from one meter to four meters above the ground to determine the maximum value of the field strength. Both horizontal and vertical polarizations of the antenna are used to make the measurement.

d. For each suspected emission, the EUT was arranged to maximize its emissions and then the antenna height was varied from 1 meter to 4 meters and the rotating table was turned from 0 degrees to 360 degrees to find the maximum emission reading.

e. The test-receiver system was set to use a peak detector with a specified resolution bandwidth. For spectrum analyzer measurements, the composite maximum of several analyzer sweeps was used for final measurements.

f. If the emission level of the EUT in peak mode was 10dB lower than the limit specified, then testing could be stopped and the peak values of the EUT would be reported. Otherwise the emissions that did not have 10 dB margin would be re-tested one by one using peak, quasi-peak or average method as specified and then reported in a data sheet.

g. The EUT was maximized in all 3 orthogonal positions. The results are presented for the axis that had the highest emissions.

NOTE:
1. The resolution bandwidth and video bandwidth of test receiver/spectrum analyzer is 120kHz for Peak detection (PK) and Quasi-peak detection (QP) at frequencies below 1GHz.

2. The resolution bandwidth 1 MHz for all measurements and at frequencies above 1GHz, A peak detector was used for all measurements above 1GHz. Measurements were made with an EMI Receiver.

Deviations from test standard:

No deviation.

Test setup:

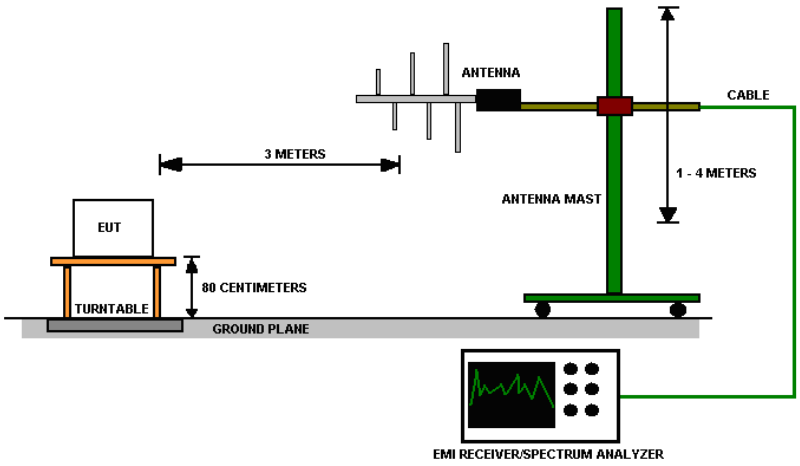

Figure 3 - Radiated Emissions Test Setup

EUT operating conditions
The EUT was powered by 5 VDC unless specified and set to transmit continuously on the lowest frequency channel, highest frequency channel and one in the middle of its operating range.

Test results:

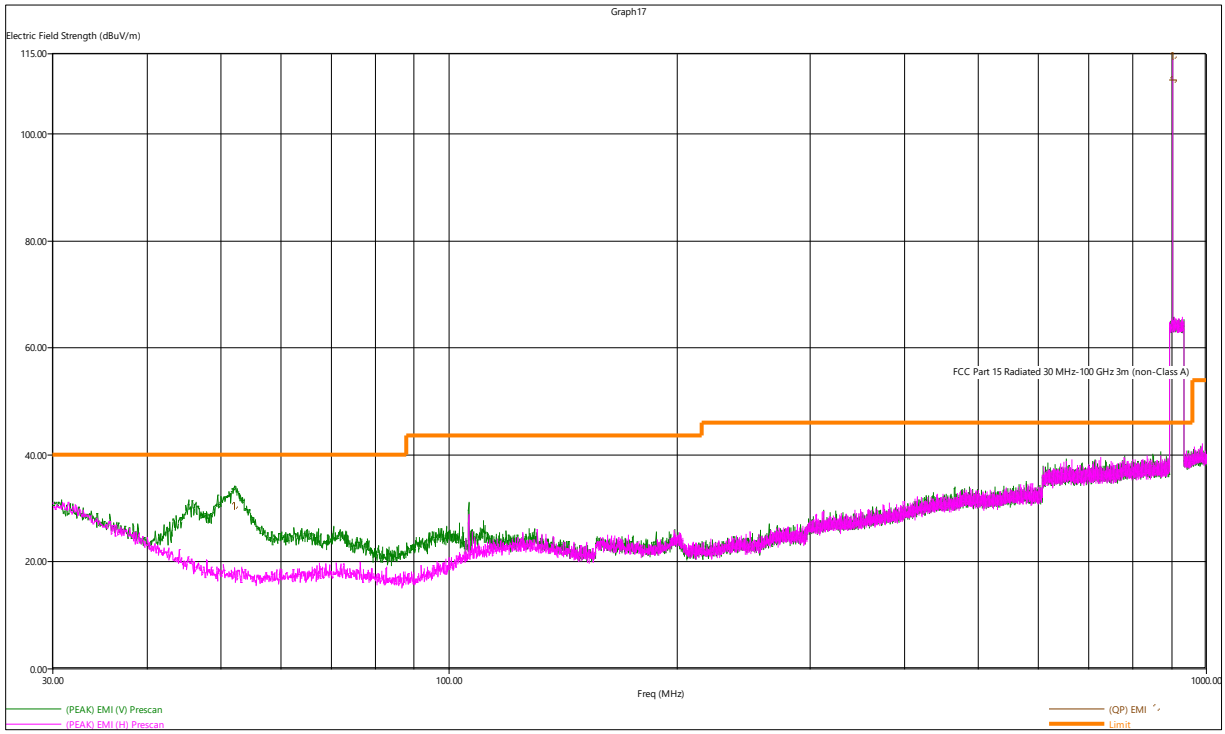

Figure 4 - Radiated Emissions Plot, Low Channel

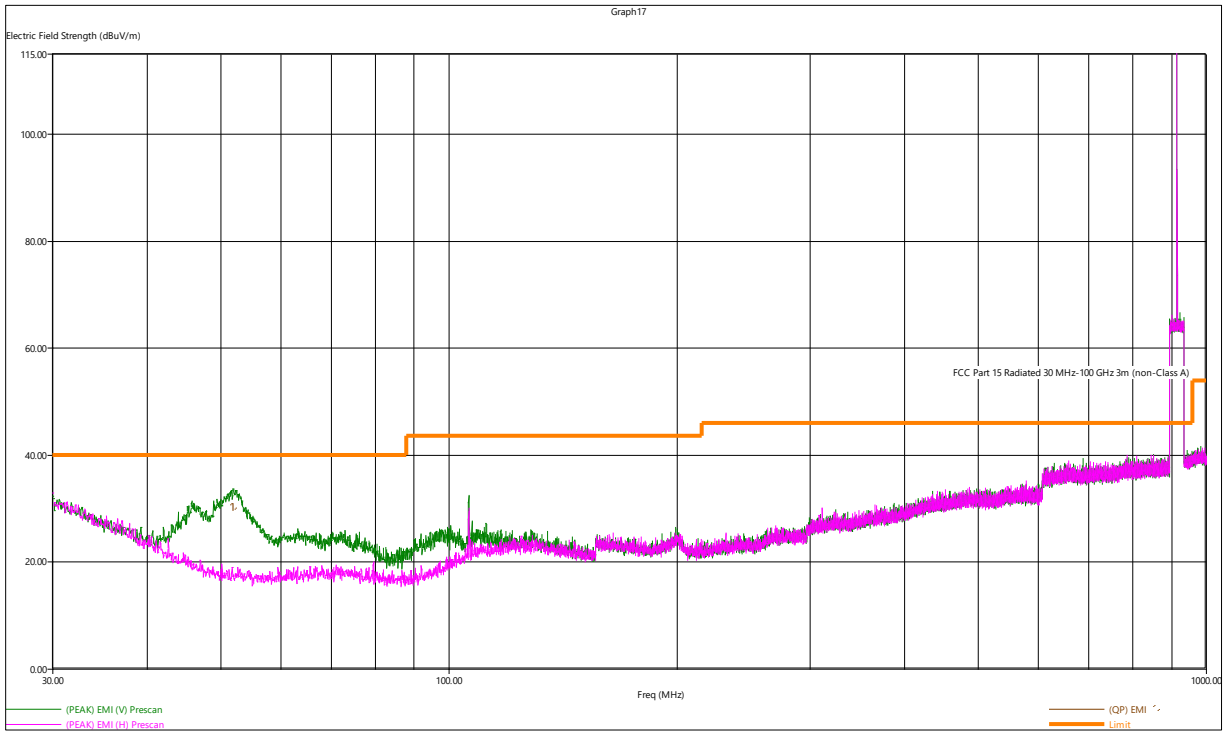

Figure 5 - Radiated Emissions Plot, Mid Channel

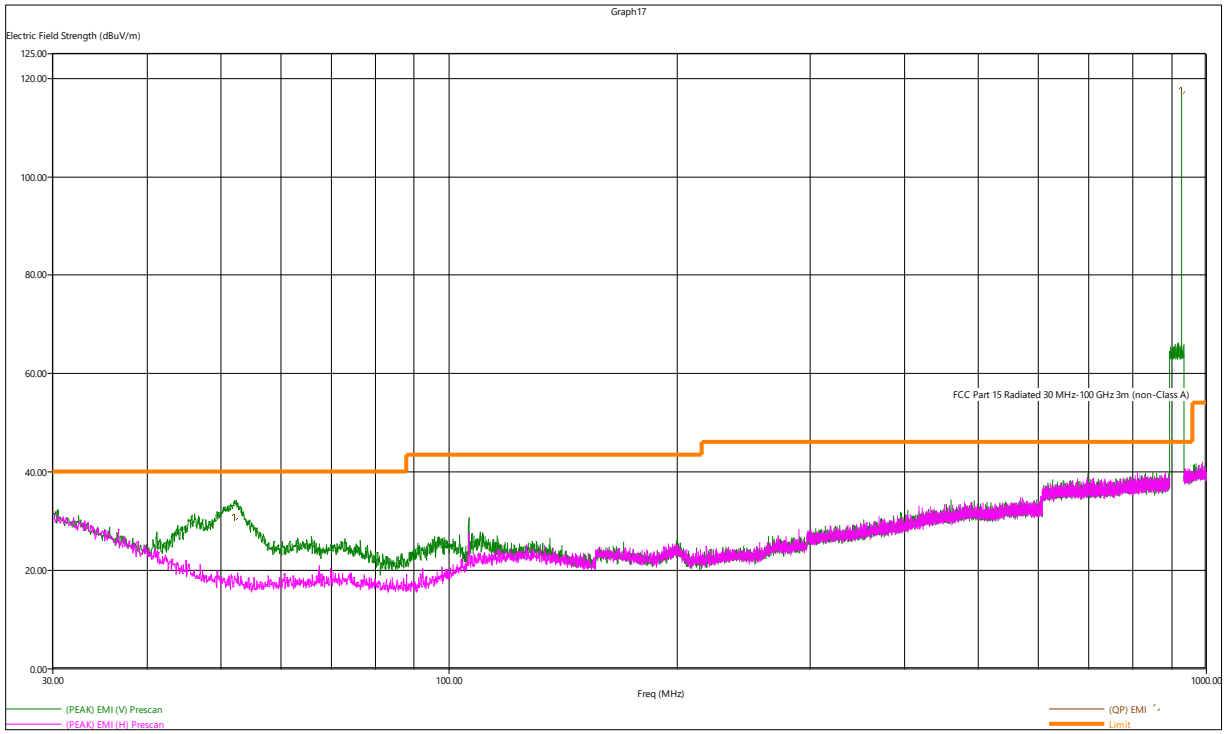

Figure 6 - Radiated Emissions Plot, High Channel

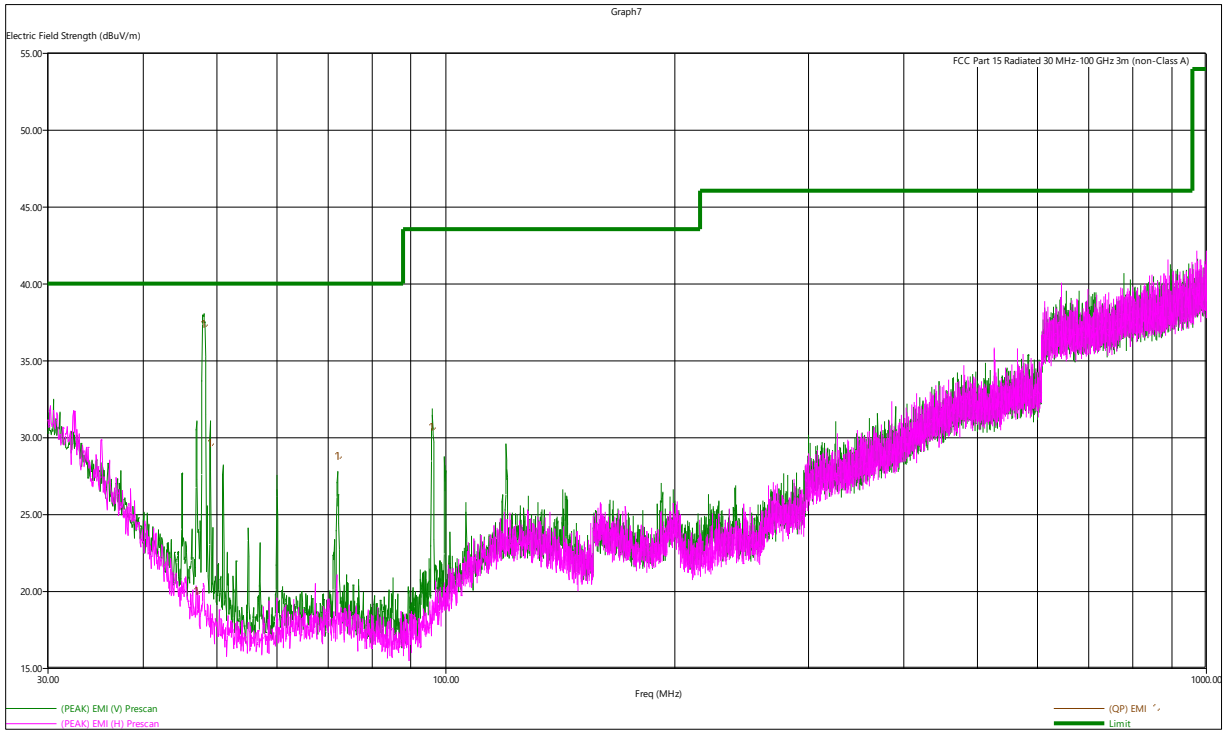

Figure 7 - Radiated Emissions Plot, Receive Channel

Quasi-Peak Measurements							
Frequency	**Level**	**Limit**	**Margin**	**Height**	**Angle**	**Pol**	**Channel**
MHz	**dBµV/m**	**dBµV/m**	**dB**	**cm.**	**deg.**		
52.194960	30.29	40.00	9.71	119	216	V	Low
902.400400	114.47	N/A	N/A	111	51	V	Low
51.942000	30.26	40.00	9.74	107	256	V	Mid
914.798320	115.36	N/A	N/A	112	24	V	Mid
52.220400	30.53	40.00	9.47	112	245	V	High
927.598240	117.28	N/A	N/A	110	26	V	High
47.100000	19.98	40.00	20.02	142	124	V	Receive
48.030000	37.36	40.00	2.64	110	261	V	Receive
49.010000	29.64	40.00	10.36	114	116	V	Receive
72.020000	28.76	40.00	11.24	123	189	V	Receive
96.040000	30.63	43.52	12.89	122	247	V	Receive

Peak Measurements							
Frequency	**Level**	**Limit**	**Margin**	**Height**	**Angle**	**Pol**	**Channel**
MHz	**dBµV/m**	**dBµV/m**	**dB**	**cm.**	**deg.**		
1599.960000	45.22	73.98	28.76	182	64	H	Low
2411.840000	48.93	73.98	25.05	122	92	V	Low
3200.070000	48.12	73.98	25.86	225	84	V	Low
4019.128000	54.46	73.98	19.52	121	34	H	Low
5414.414000	53.93	73.98	20.05	180	52	H	Low
6316.820000	56.99	73.98	16.99	171	19	H	Low
7219.180000	64.07	73.98	9.91	157	8	H	Low
8121.644000	54.27	73.98	19.71	255	15	V	Low
1599.890000	44.97	73.98	29.01	153	64	H	Mid
1829.570000	50.59	73.98	23.39	111	277	H	Mid
1999.920000	46.62	73.98	27.36	198	244	H	Mid
2410.150000	44.61	73.98	29.37	126	104	V	Mid
3200.080000	47.82	73.98	26.16	194	87	V	Mid
5488.720000	52.72	73.98	21.26	200	65	H	Mid
6403.650000	57.25	73.98	16.73	200	23	H	Mid
7318.390000	60.65	73.98	13.33	199	359	H	Mid
8233.290000	55.00	73.98	18.98	199	22	V	Mid
3165.610000	51.67	73.98	22.31	176	29	H	High
1600.100000	46.01	73.98	27.97	148	286	V	High
1855.190000	52.78	73.98	21.20	196	268	V	High
2409.240000	45.87	73.98	28.11	153	271	V	High
3710.350000	50.32	73.98	23.66	114	35	H	High
6493.216000	63.69	73.98	10.29	176	62	H	High
7420.744000	61.70	73.98	12.28	147	6	H	High
8348.388000	59.60	73.98	14.38	223	359	V	High

Average Measurements							
Frequency	**Level**	**Limit**	**Margin**	**Height**	**Angle**	**Pol**	**Channel**
MHz	**dBµV/m**	**dBµV/m**	**dB**	**cm.**	**deg.**		
1599.960000	32.68	53.98	21.30	182	64	H	Low
2411.840000	36.39	53.98	17.59	122	92	V	Low
3200.070000	35.58	53.98	18.40	225	84	V	Low
4019.128000	41.92	53.98	12.06	121	34	H	Low
5414.414000	41.39	53.98	12.59	180	52	H	Low
6316.820000	44.45	53.98	9.53	171	19	H	Low
7219.180000	51.53	53.98	2.45	157	8	H	Low
8121.644000	41.73	53.98	12.25	255	15	V	Low
1599.890000	32.43	53.98	21.55	153	64	H	Mid
1829.570000	38.05	53.98	15.93	111	277	H	Mid
1999.920000	34.08	53.98	19.90	198	244	H	Mid
2410.150000	32.07	53.98	21.91	126	104	V	Mid
3200.080000	35.28	53.98	18.70	194	87	V	Mid
5488.720000	40.18	53.98	13.80	200	65	H	Mid
6403.650000	44.71	53.98	9.27	200	23	H	Mid
7318.390000	48.11	53.98	5.87	199	359	H	Mid
8233.290000	42.46	53.98	11.52	199	22	V	Mid
3165.610000	39.13	53.98	14.85	176	29	H	High
1600.100000	33.47	53.98	20.51	148	286	V	High
1855.190000	40.24	53.98	13.74	196	268	V	High
2409.240000	33.33	53.98	20.65	153	271	V	High
3710.350000	37.78	53.98	16.20	114	35	H	High
6493.216000	51.15	53.98	2.83	176	62	H	High
7420.744000	49.16	53.98	4.82	147	6	H	High
8348.388000	47.06	53.98	6.92	223	359	V	High

*Average Level=Peak Level- Duy Cycle

REMARKS:

1. Emission level (dBuV/m) = Raw Value (dBuV) + Correction Factor (dB)
2. Correction Factor (dB/m) = Antenna Factor (dB/m) + Cable Factor (dB)
3. The other emission levels were very low against the limit.
4. Margin value = Emission level – Limit value.
5. The EUT was measured in all 3 orthogonal axes. See the test setup photo exhibit for details on the orientations.

4.3 PEAK OUTPUT POWER

Test Method: ANSI C63.10, Section(s) 7.8.5

Limits of bandwidth measurements:
Per FCC Part 15
For an FHSS system with 25 channels, the output power is required to be less than 250 mW or 24 dBm.

Test procedures:
Spectrum analyzer was set with a resolution bandwidth greater than occupied bandwidth and centered on the operating channel.

Deviations from test standard:
No deviation.

Test setup:
Device was connected to a spectrum analyzer with a low loss shielded cable. All attenuators and cables were accounted for.

EUT operating conditions:
The EUT was powered by 5 VDC unless specified and set to transmit continuously on the lowest frequency channel, highest frequency channel and one in the middle of its operating range.

Test results:

Peak Output Power

CHANNEL	CHANNEL FREQUENCY (MHz)	PEAK OUTPUT POWER (dBm)	Method	RESULT
Low	902.4	22.272	Conducted	PASS
Middle	914.8	22.294	Conducted	PASS
High	927.6	21.920	Conducted	PASS

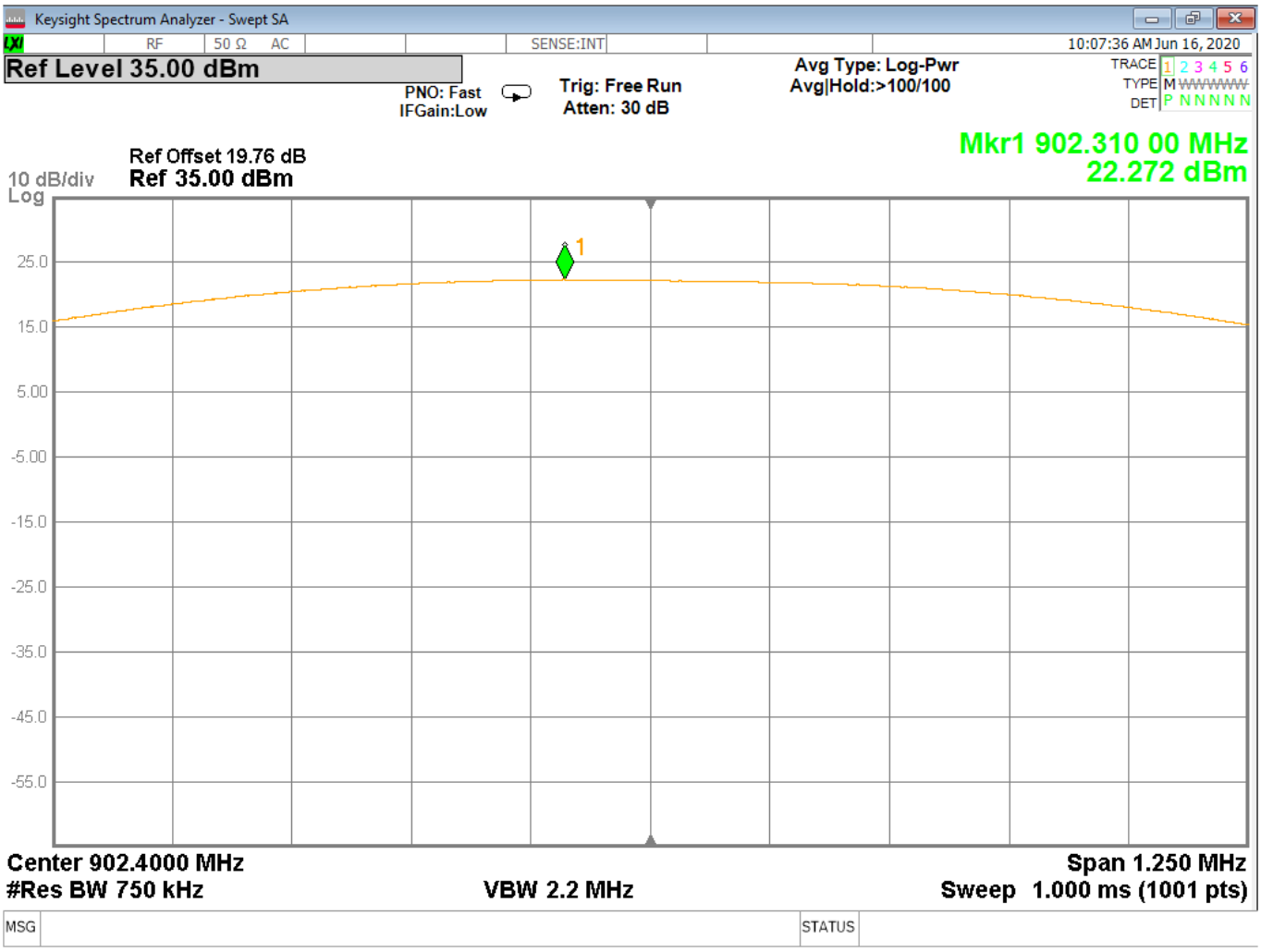

Figure 8 – Output Power, Low Channel

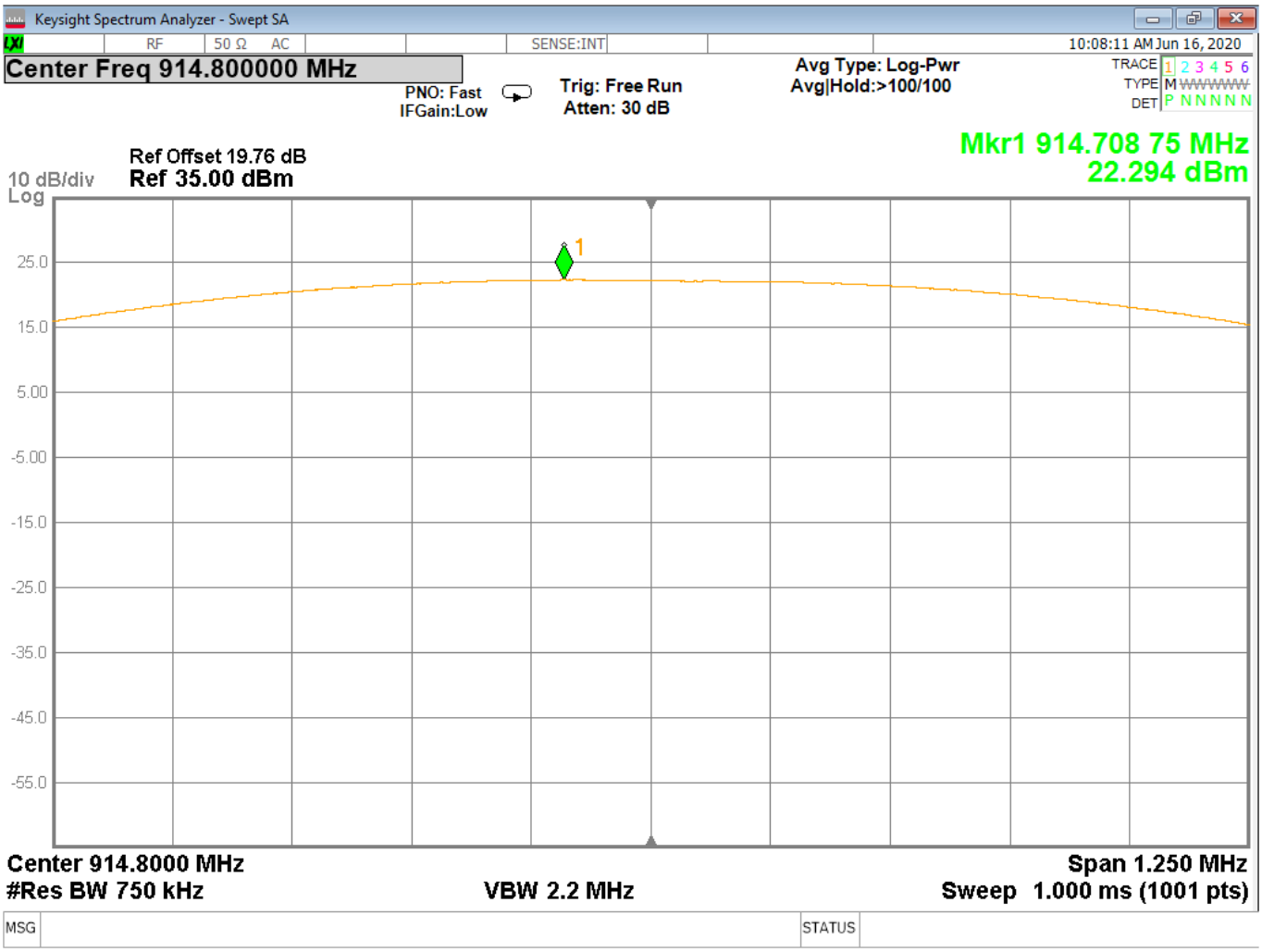

Figure 9 - Output Power, Mid Channel

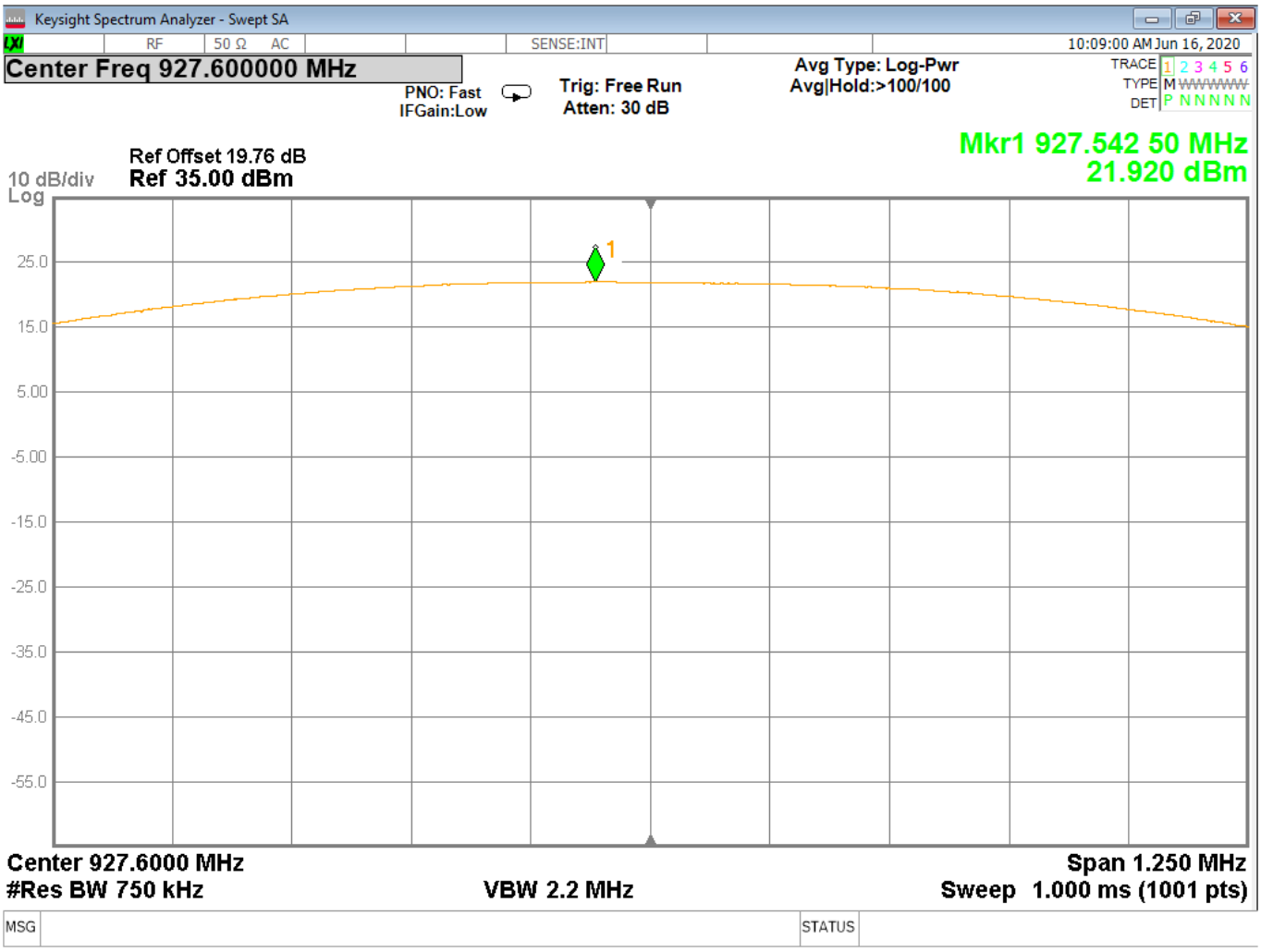

Figure 10 - Output Power, High Channel

4.4 BANDWIDTH

Test Method: ANSI C63.10, Section(s) 6.9.2

Limits of bandwidth measurements:
The allowed 20 dB bandwidth of the hopping channel is 250 kHz ≤ BW ≤ 500 kHz.

Test procedures:
The bandwidth of the fundamental frequency was measured by spectrum analyzer with 9 kHz RBW and 30 kHz VBW.

The 20 dB bandwidth is defined as the bandwidth of which is higher than peak power minus 20dB. The 99% bandwidth is defined as the bandwidth that contains 99% of the power.

Deviations from test standard:
No deviation.

Test setup:
Device was connected to a spectrum analyzer with a low loss shielded cable. All attenuators and cables were accounted for.

EUT operating conditions:
The EUT was powered by 5 VDC unless specified and set to transmit continuously on the lowest frequency channel, highest frequency channel and one in the middle of its operating range.

Test results:

20 dB Bandwidth

CHANNEL	CHANNEL FREQUENCY (MHz)	20dB BW (kHz)
Low	902.4	260.7
Mid	914.8	261.4
High	927.6	262.4

99% dB Bandwidth

CHANNEL	CHANNEL FREQUENCY (MHz)	99% BW (kHz)
Low	902.4	246.78
Mid	914.8	245.21
High	927.6	244.92

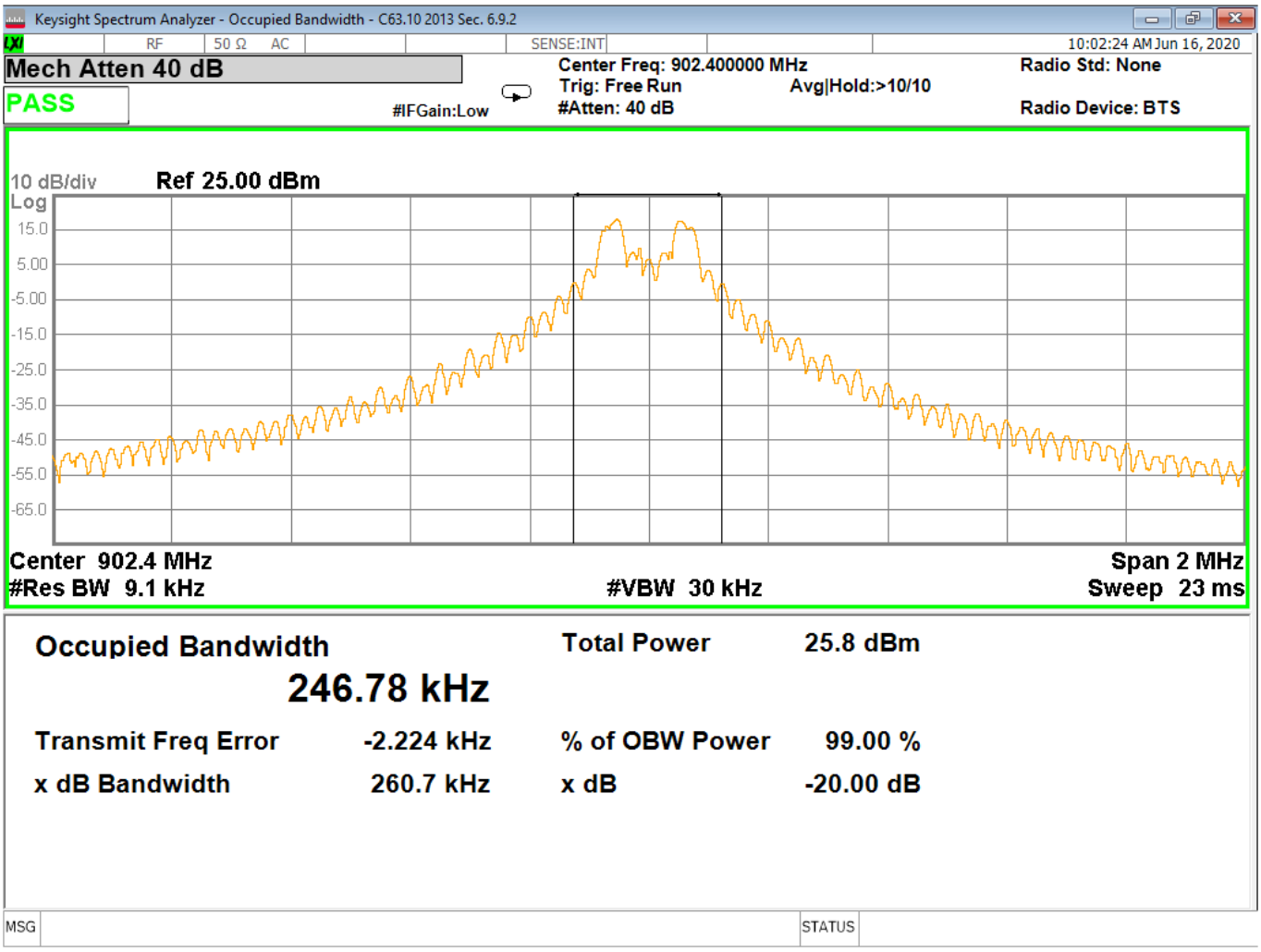

Figure 11 – Bandwidth, Low Channel

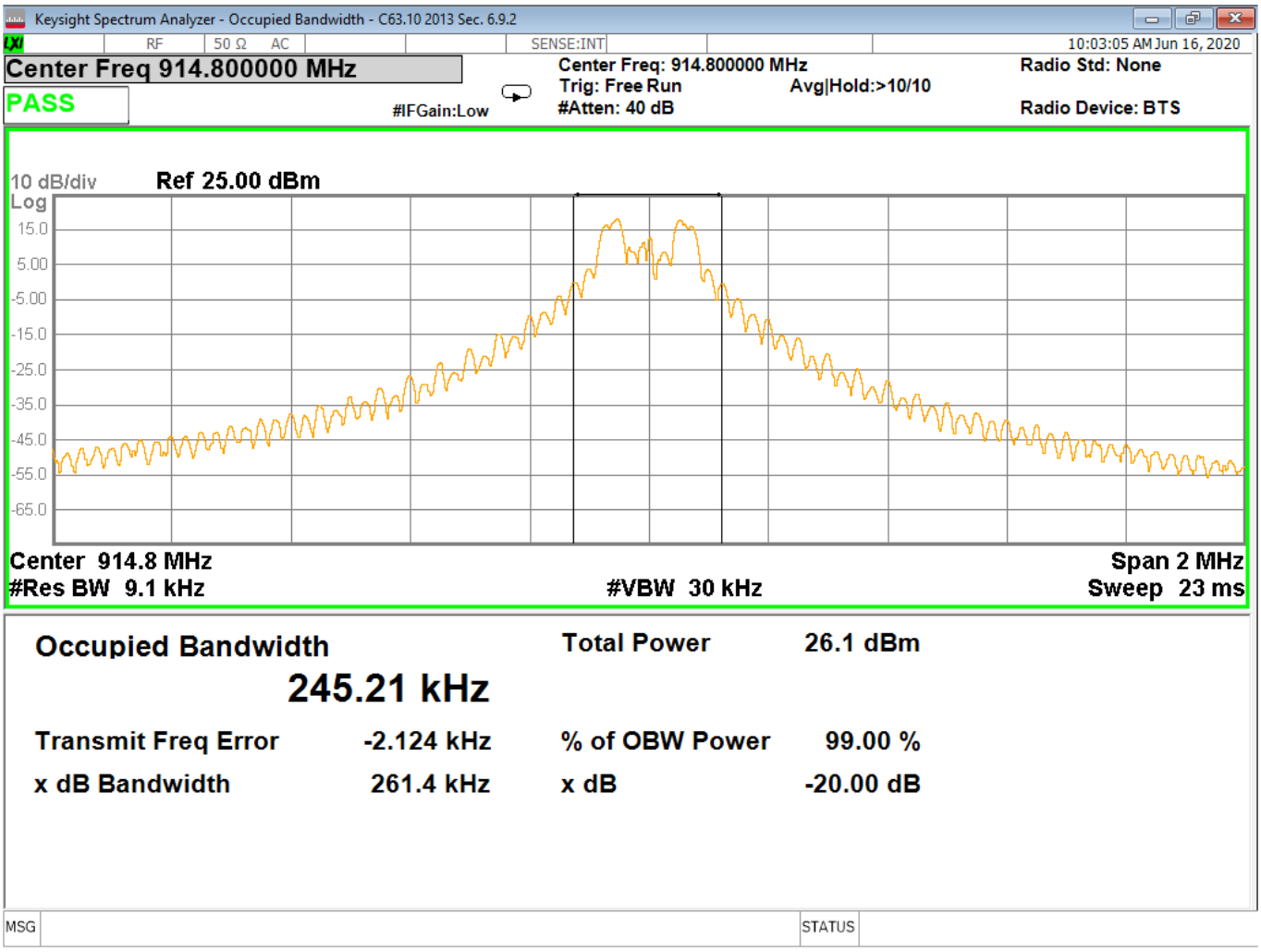

Figure 12 - Bandwidth, Mid Channel

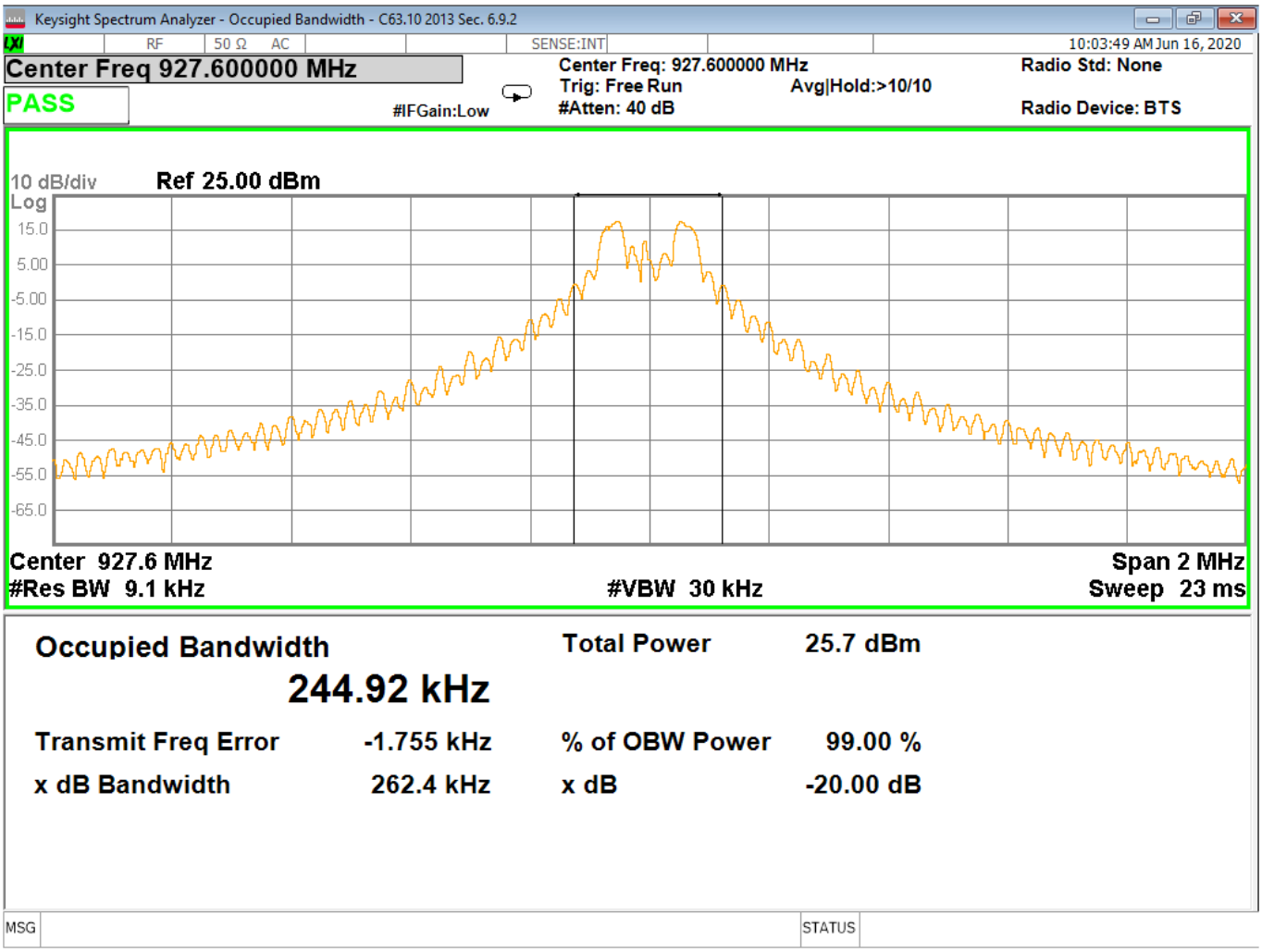

Figure 13 - Bandwidth, High Channel

4.5 BANDEDGES

Test Method: ANSI C63.10, Section(s) 6.10.6

Limits of band edge measurements:
For emissions outside of the allowed band of operation (902 – 928MHz), the emission level needs to be 20dB under the maximum fundamental field strength. However, if the emissions fall within one of the restricted bands from 15.205 the field strength levels need to be under that of the limits in 15.209.

Test procedures:
The EUT was tested in the same method as described in section *4.4 - Bandwidth*. The resolution bandwidth was set to 100kHz and the EMI receiver was used to scan from the band edge to the fundamental frequency with a quasi-peak detector. The highest emissions level beyond the band edge was measured and recorded. For restricted band edge measurements, the unit was tested to the same method as section 4.2 of this report.

Deviations from test standard:
No deviation.

Test setup:
The plots shown below indicate whether the measurement was performed radiated or conducted. For radiated setup, see section 4.2 of this report. For conducted setup, see section 4.3 of this report.

EUT operating conditions:
The EUT was powered by 5 VDC unless specified and set to transmit both continuously on the lowest and highest frequency channel and in normal hopping operation.

Test results:

Unrestricted Band-Edge, US							
CHANNEL	**Mode**	**Band edge /Measurement Frequency (MHz)**	**Relative Highest out of band level (dBm)**	**Relative Fundamental (dBm)**	**Delta (dB)**	**Min Delta (dB)**	**Result**
Low	Continuous	902.00	-33.480	54.991	55.013	20.00	PASS
Low	Hopping	902.00	-14.171	24.728	38.899	20.00	PASS
High	Continuous	928.00	-33.203	21.809	55.013	20.00	PASS
High	Hopping	928.00	-16.279	20.719	36.999	20.00	PASS
Levels are uncorrected and are used only in relative calculations.							

Restricted Band-Edge, US							
CHANNEL	**Mode**	**Band edge /Measurement Frequency (MHz)**	**Highest out of band level (dBuV/m @ 3m)**	**Detector**	**Limit (dBuV/m @ 3m)**	**Margin (dB)**	**Result**
Low	Continuous	612.08	36.170	Peak	46.020	9.85	PASS
Low	Hopping	613.46	38.560	Peak	46.020	7.46	PASS
High	Continuous	977.16	41.370	Peak	53.980	12.61	PASS
High	Hopping	975.54	40.190	Peak	53.980	13.79	PASS
*Limits shown are the quasi-peak limits taken from FCC Part 15.209. Peak levels are compliant with quasi-peak limit.							

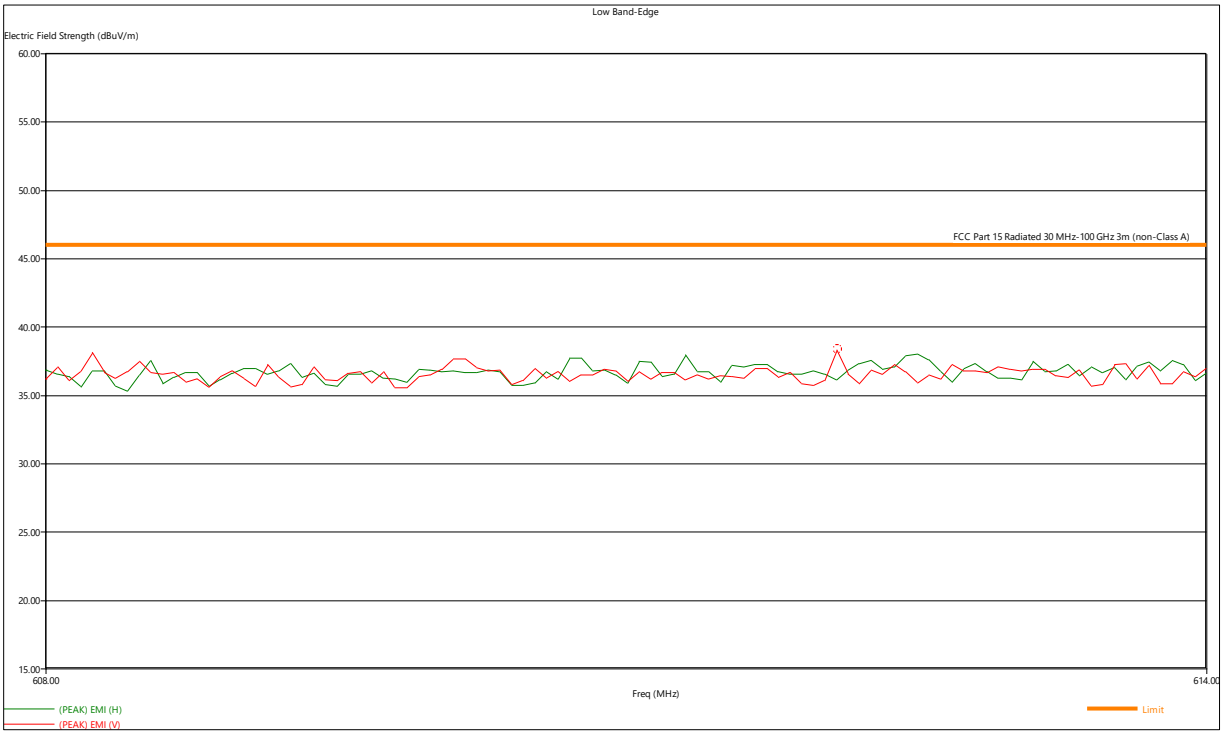

Figure 14 - Band-edge Measurement, Low Channel, Restricted Frequency, Continuous Transmit

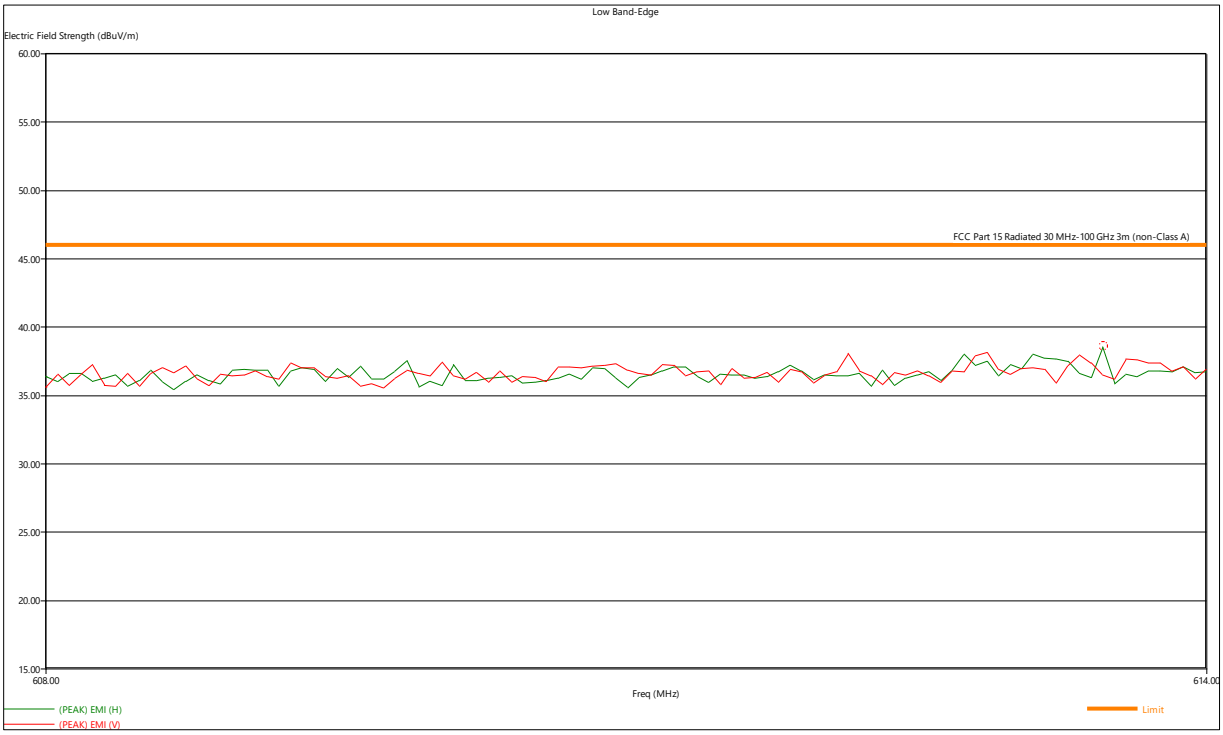

Figure 15 - Band-edge Measurement, Low Channel, Restricted Frequency, Hopping

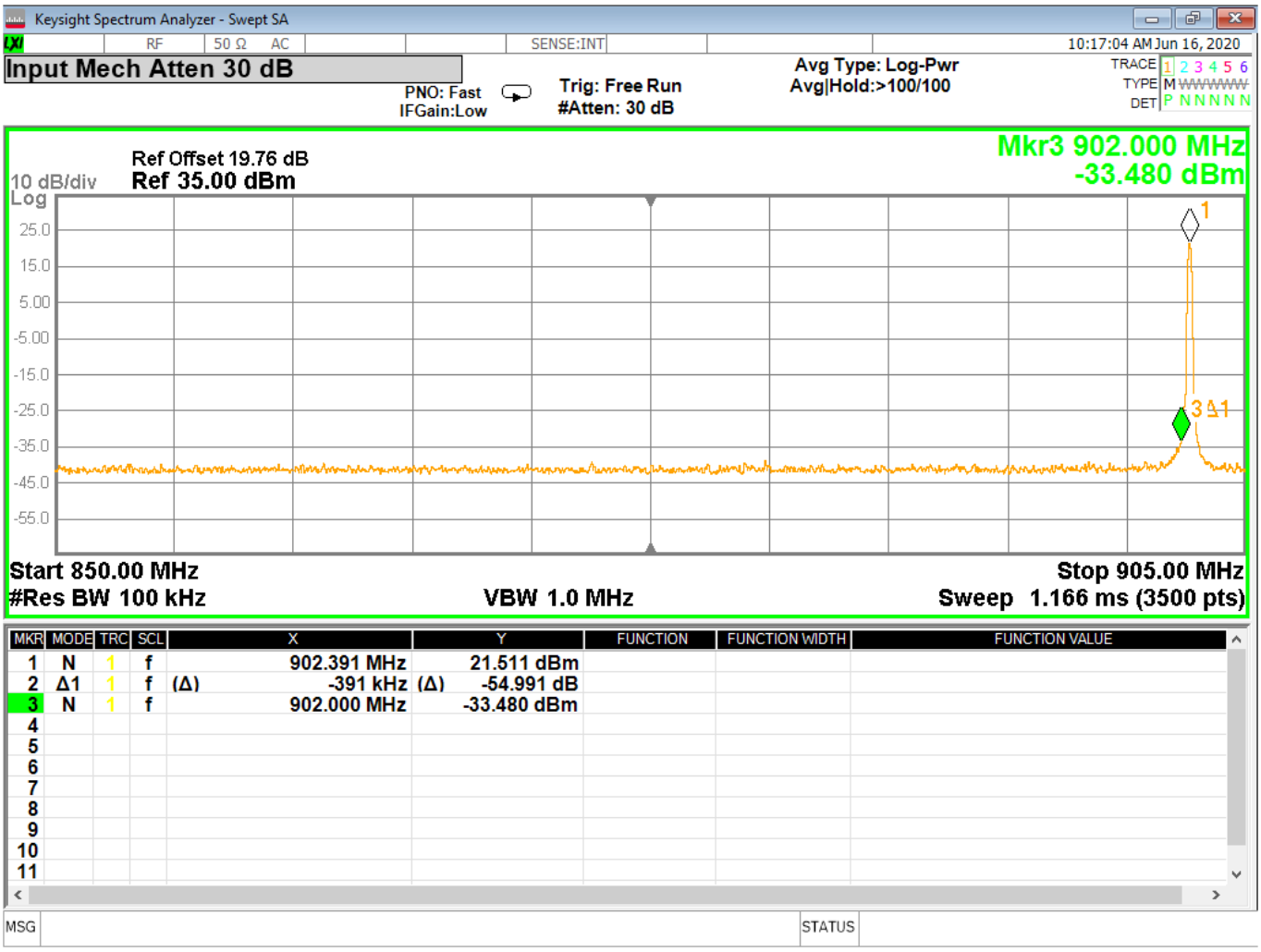

Figure 16 - Band-edge Measurement, Low Channel, Fundamental, Continuous

The plot shows an uncorrected measurement, used for relative measurements only.

Delta = 55.013 dB > 20 dB Passing unrestricted band edge

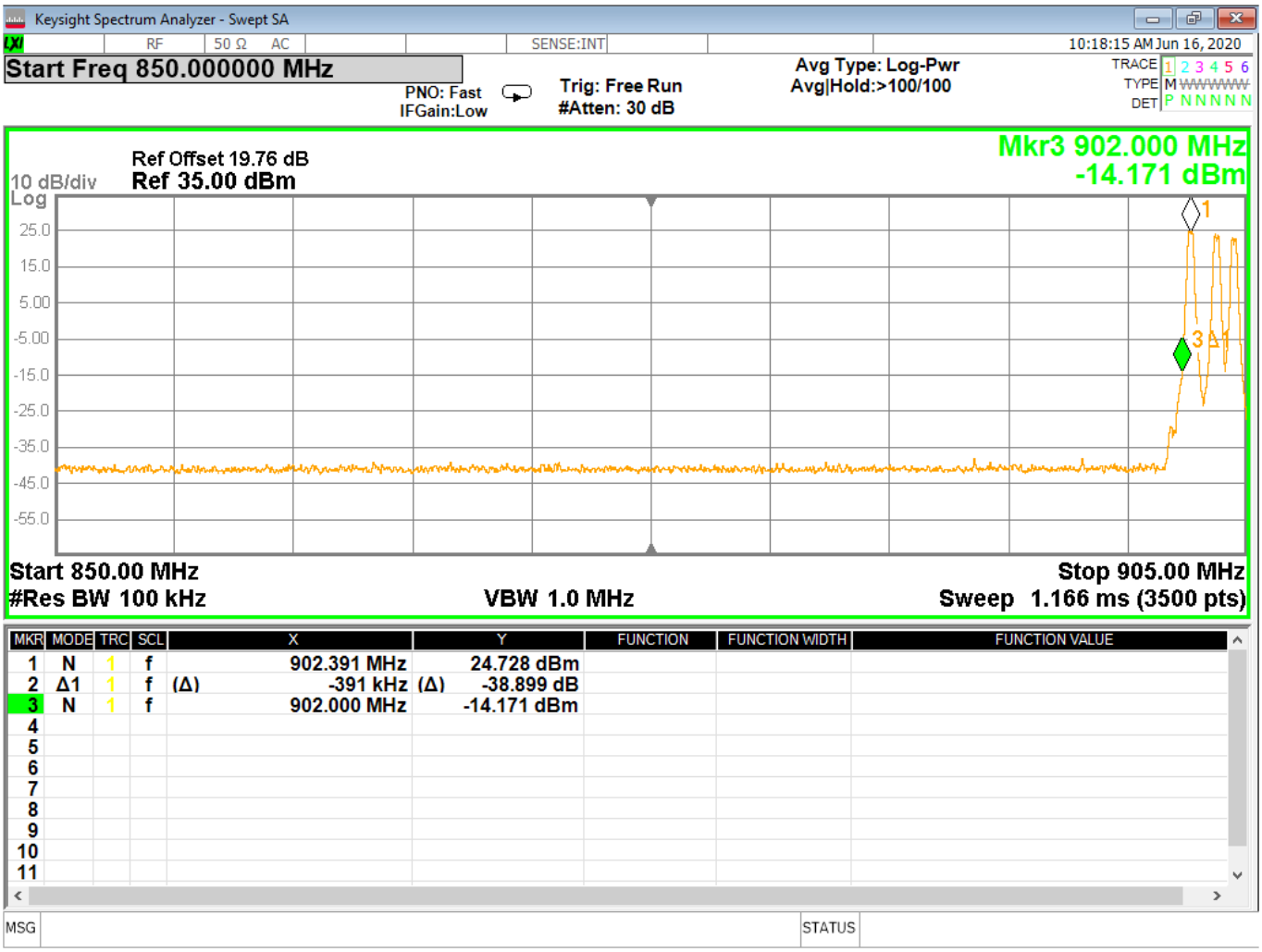

Figure 17 - Band-edge Measurement, Low Channel, Fundamental, Hopping Transmit

The plot shows an uncorrected measurement, used for relative measurements only.

Delta = 38.899 dB > 20 dB Passing unrestricted band edge

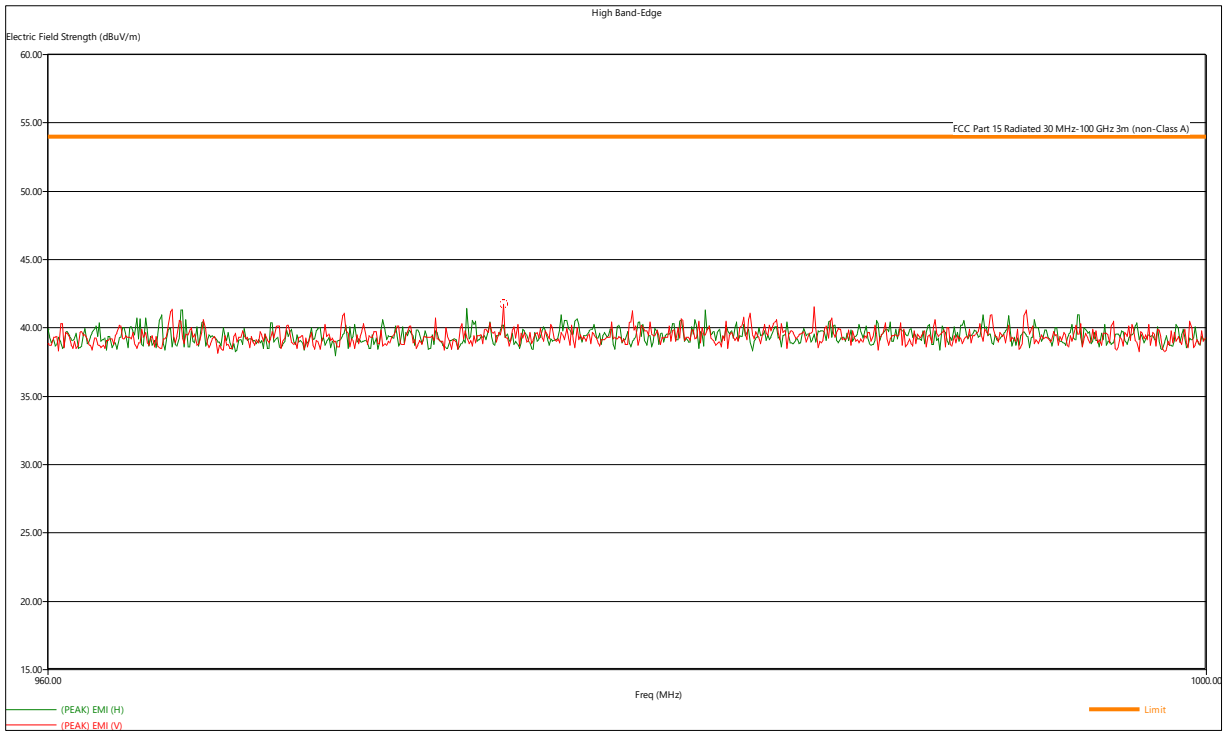

Figure 18 - Band-edge Measurement, High Channel, Restricted Frequency, Continuous Transmit

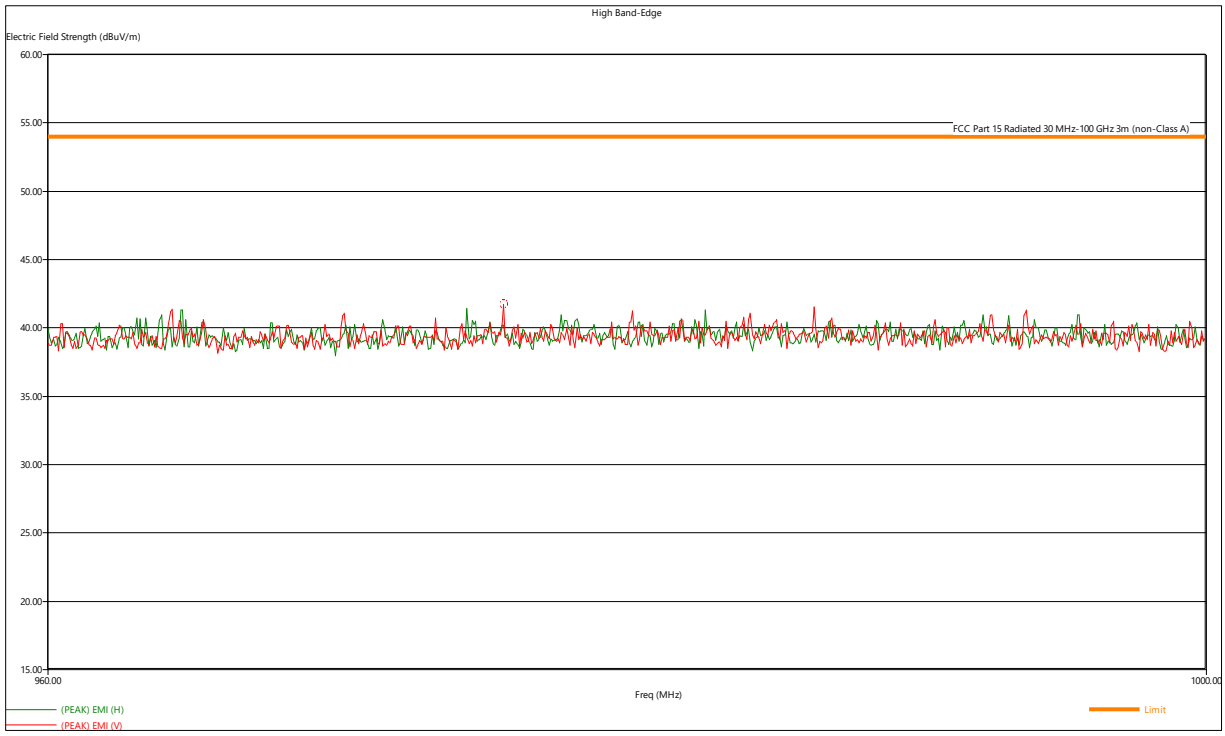

Figure 19 - Band-edge Measurement, High Channel, Restricted Frequency, Hopping

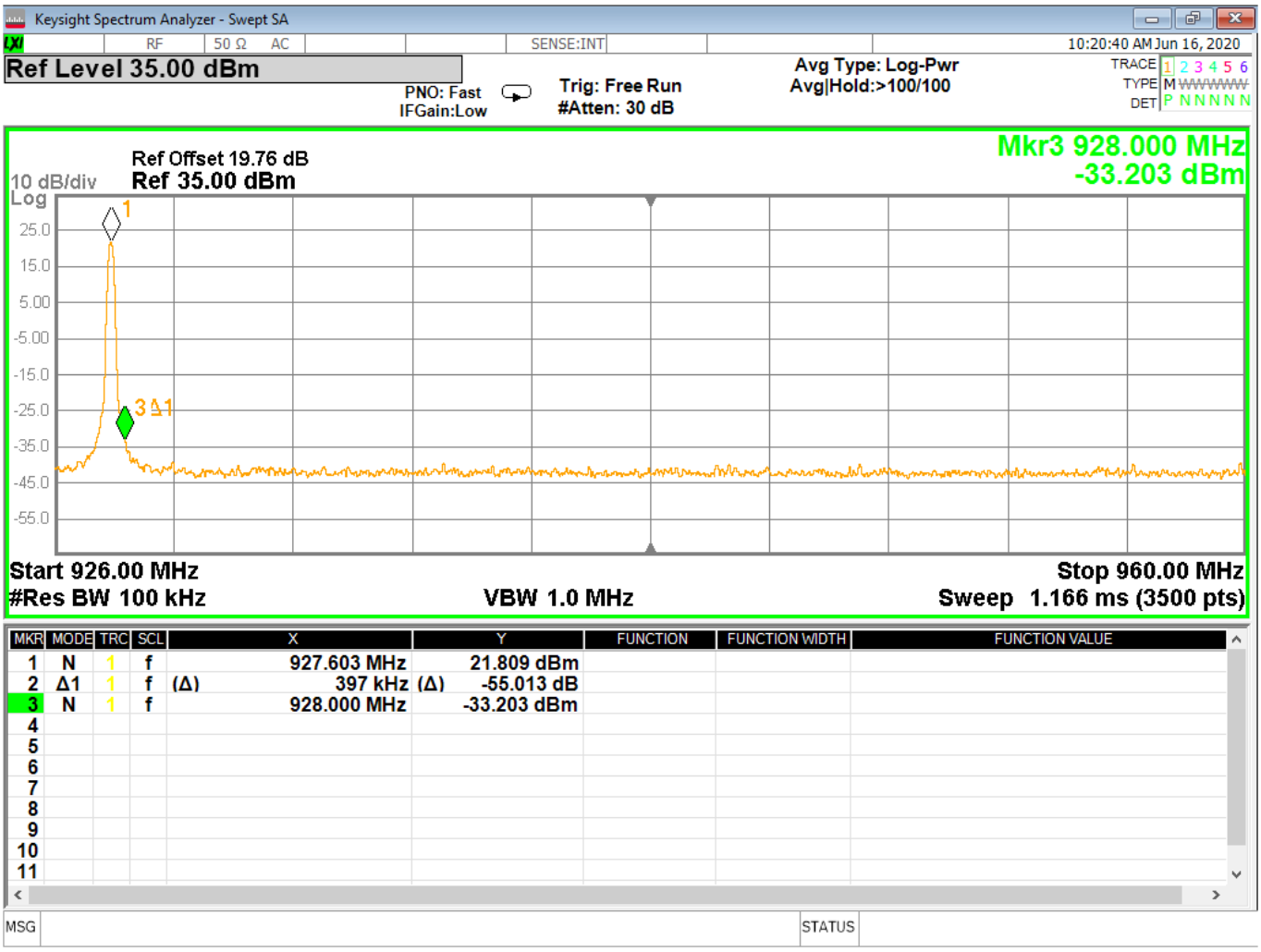

Figure 20 - Band-edge Measurement, High Channel, Fundamental, Continuous Transmit

The plot shows an uncorrected measurement, used for relative measurements only.

Delta = 55.013 dB > 20 dB Passing unrestricted band edge

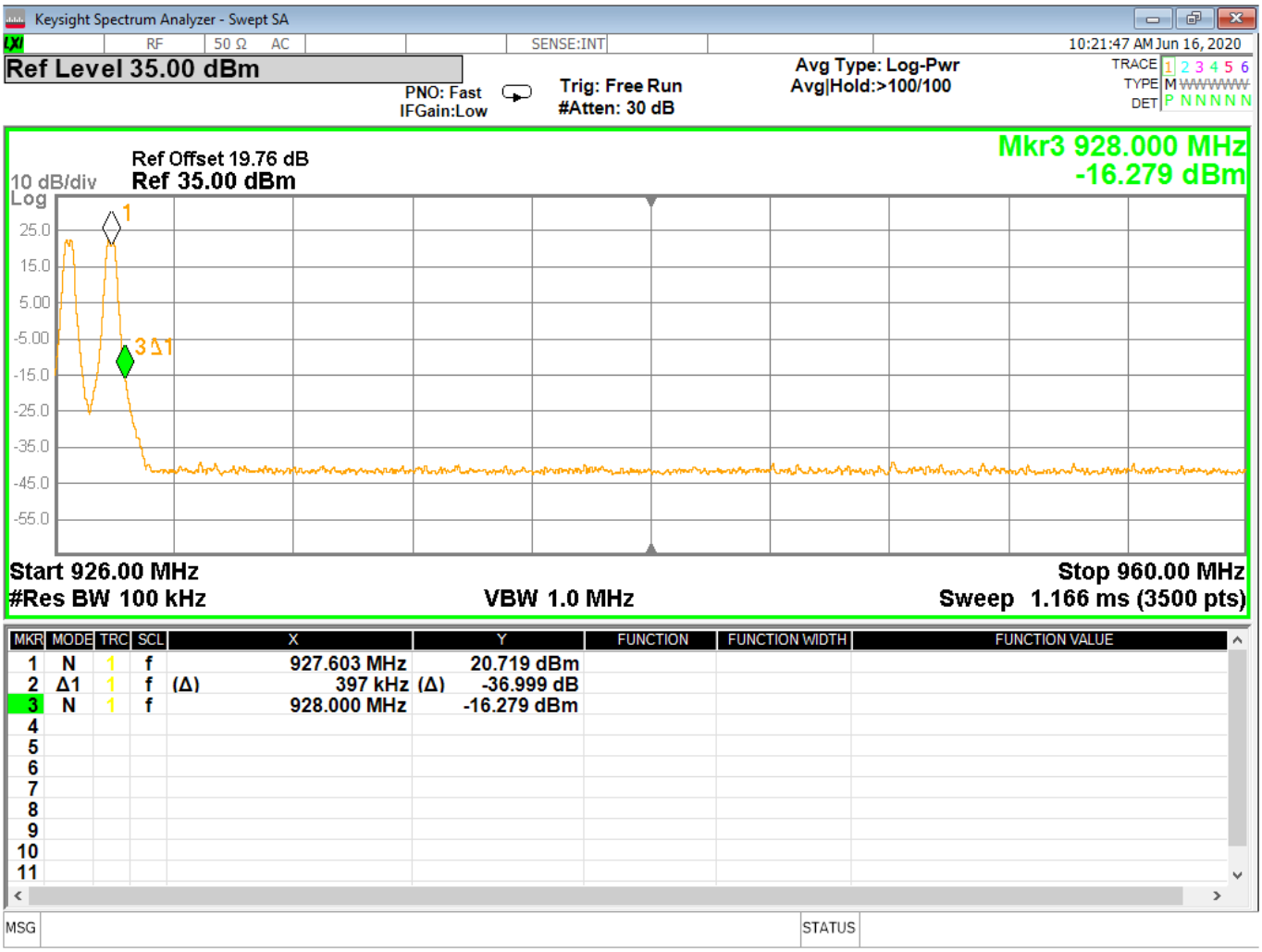

Figure 21 - Band-edge Measurement, High Channel, Fundamental, Hopping Transmit

The plot shows an uncorrected measurement, used for relative measurements only.

Delta = 36.999 dB > 20 dB Passing unrestricted band edge

4.6 CARRIER FREQUENCY SEPERATION, NUMBER OF HOPPING CHANNELS, TIME OF OCCUPANCY

Test Method: ANSI C63.10, Section 7.8.2, 7.8.3, 7.8.4

Limits for Time of Occupancy

Average time of occupancy on any frequency, not to exceed 0.4 seconds within a 10 second period.

Test procedures:
The method from KDB 558074 D01 v05

Test setup:
All measurements were performed with the EUT connected directly to a spectrum analyzer with a low loss shielded cable and attenuator. All losses were accounted for.

EUT operating conditions:
The EUT was powered by 5VDC unless specified and set to transmit while hopping.

Test results:

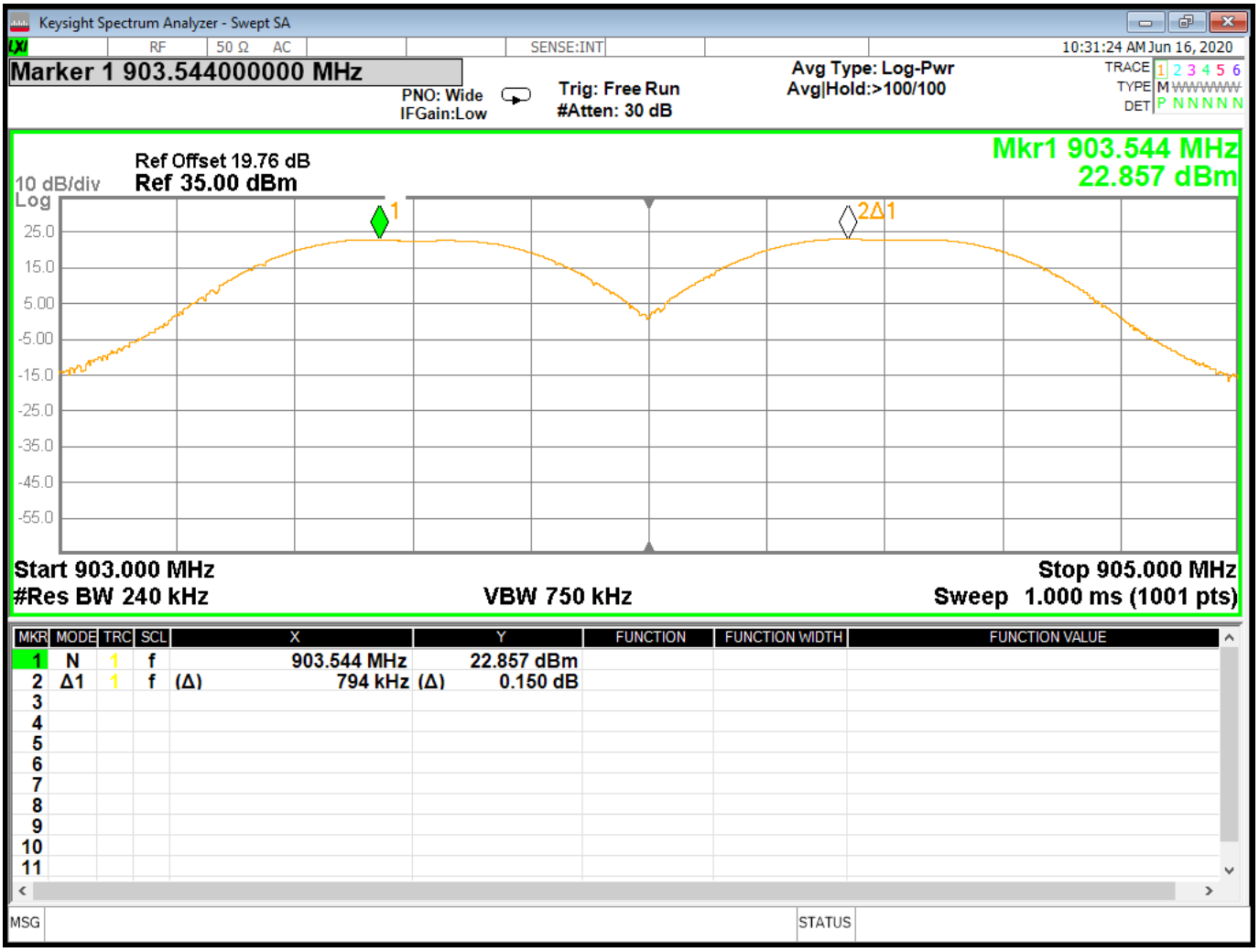

Figure 22 – Frequency Separation, Minimum

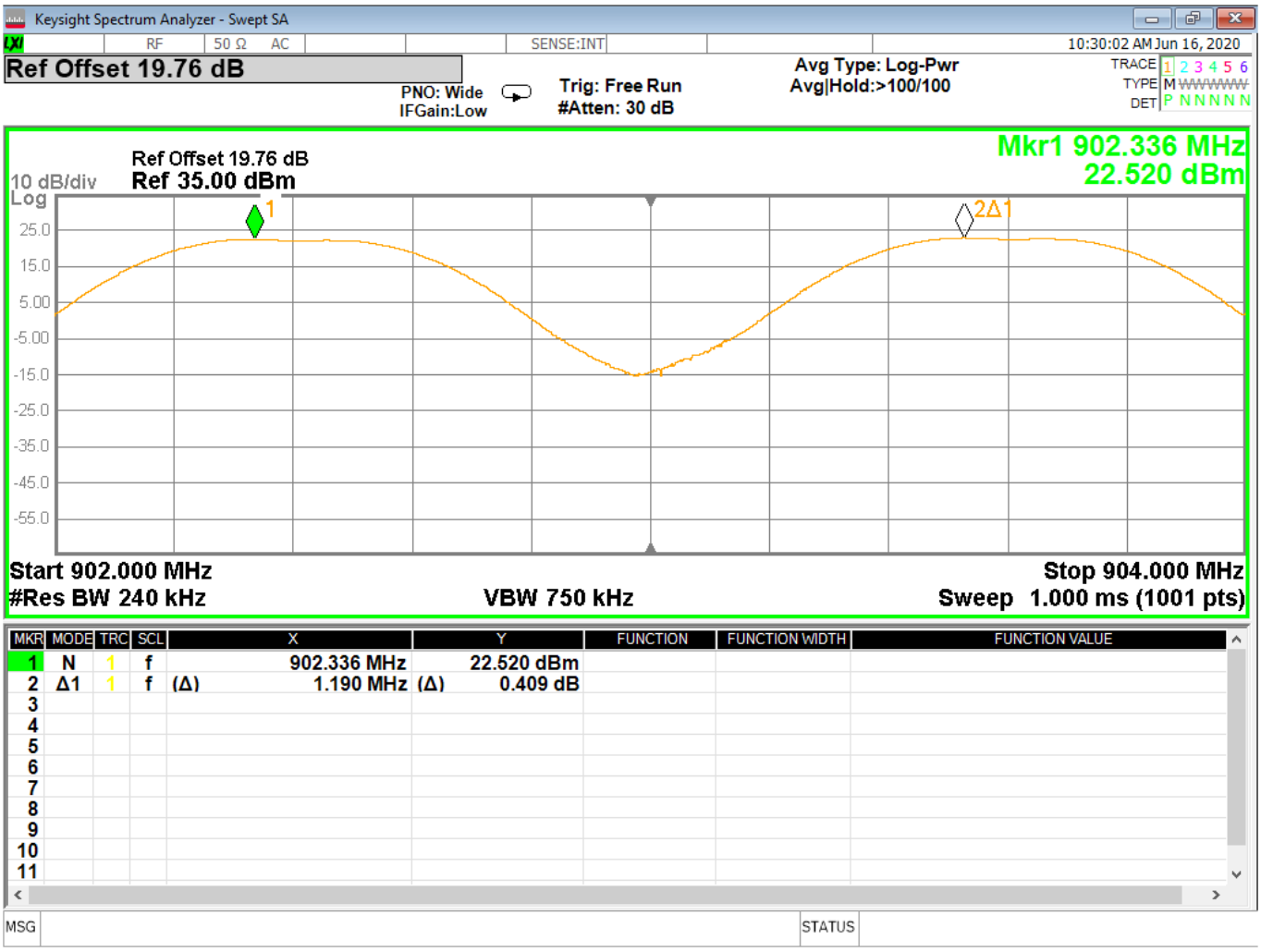

Figure 23 – Frequency Separation, Maximum

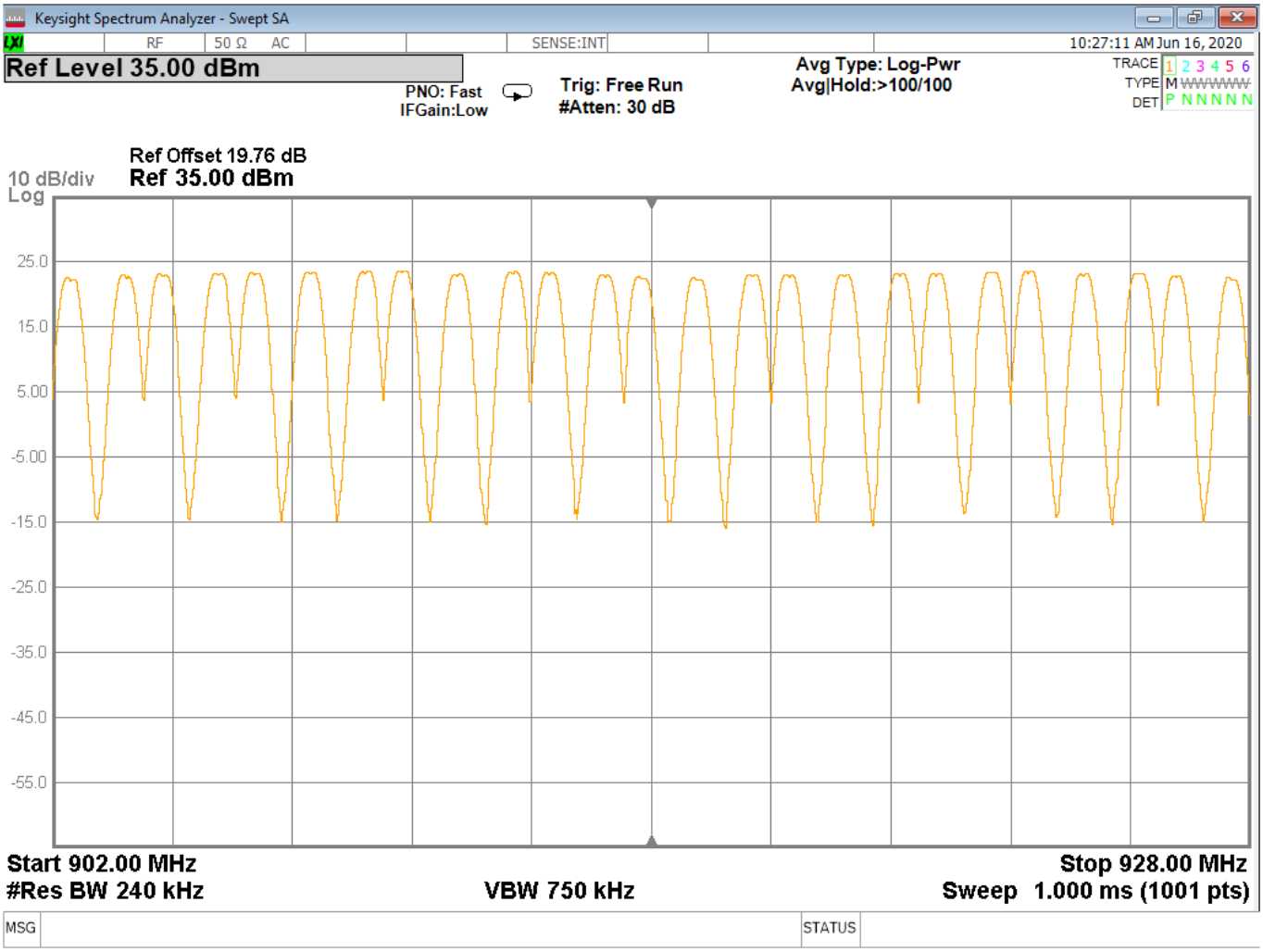

Figure 24 – Hop Count, 25 Hops

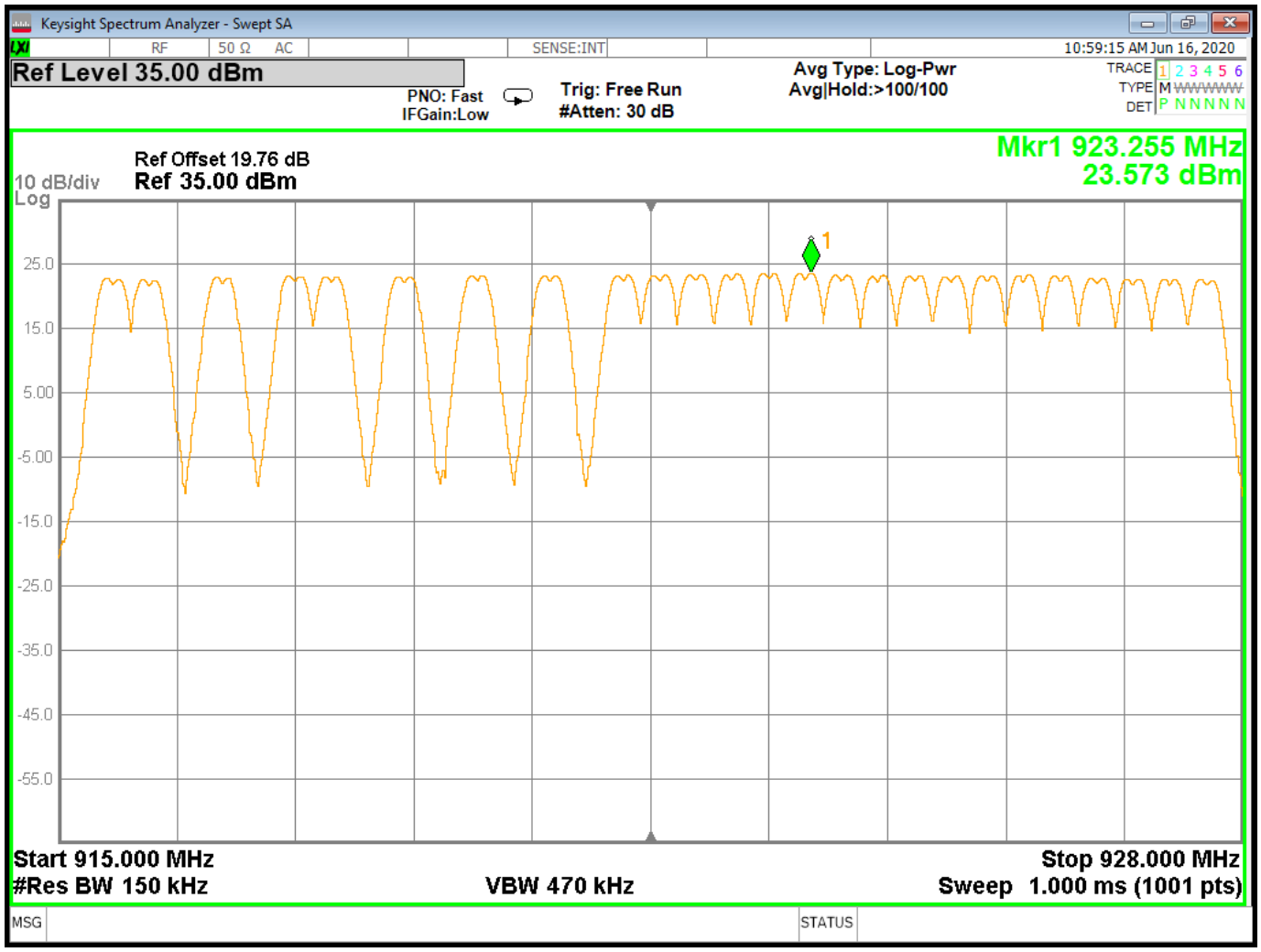

Figure 25 – Hop Count, Australia

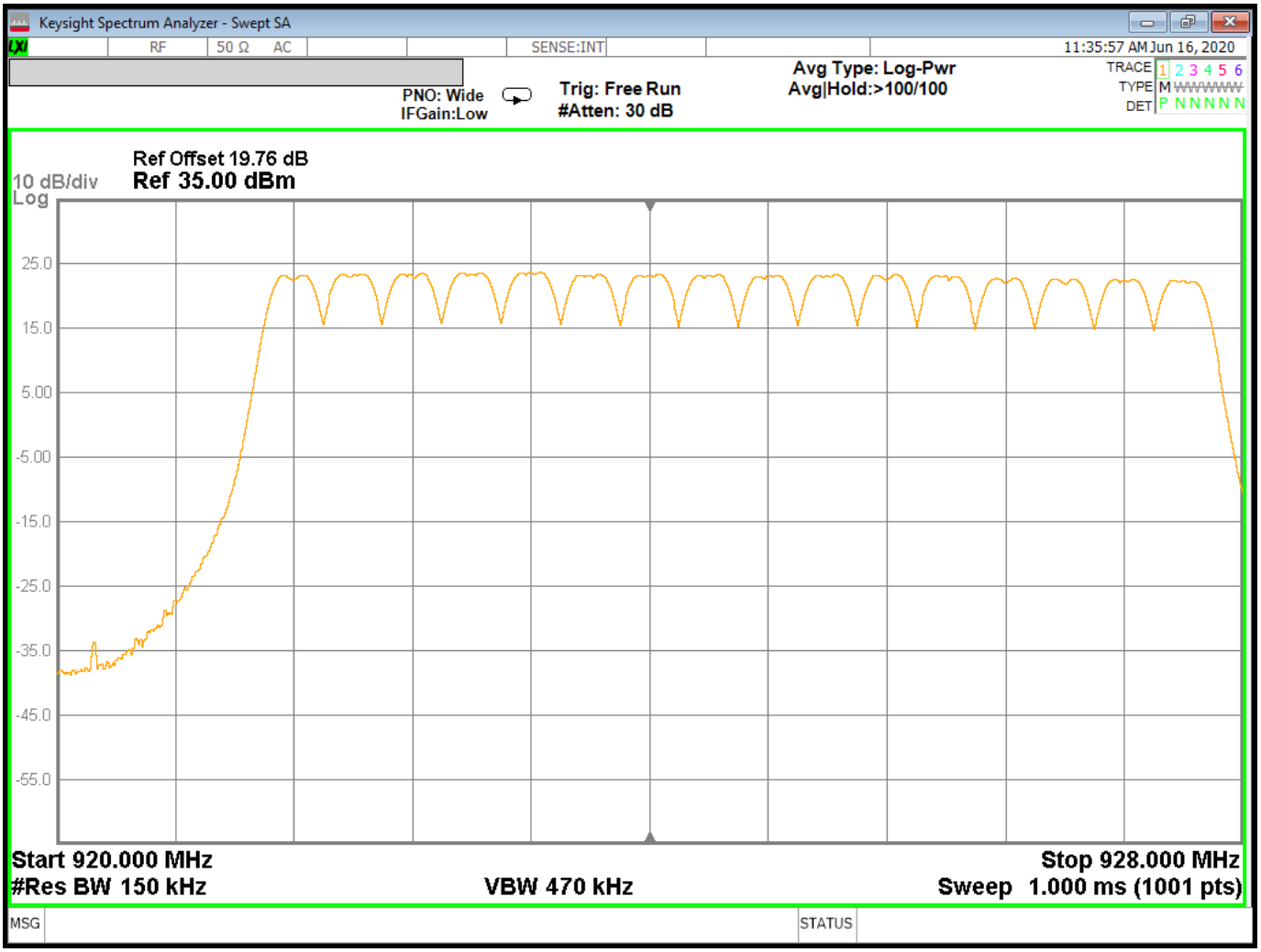

Figure 26 – Hop Count, New Zealand

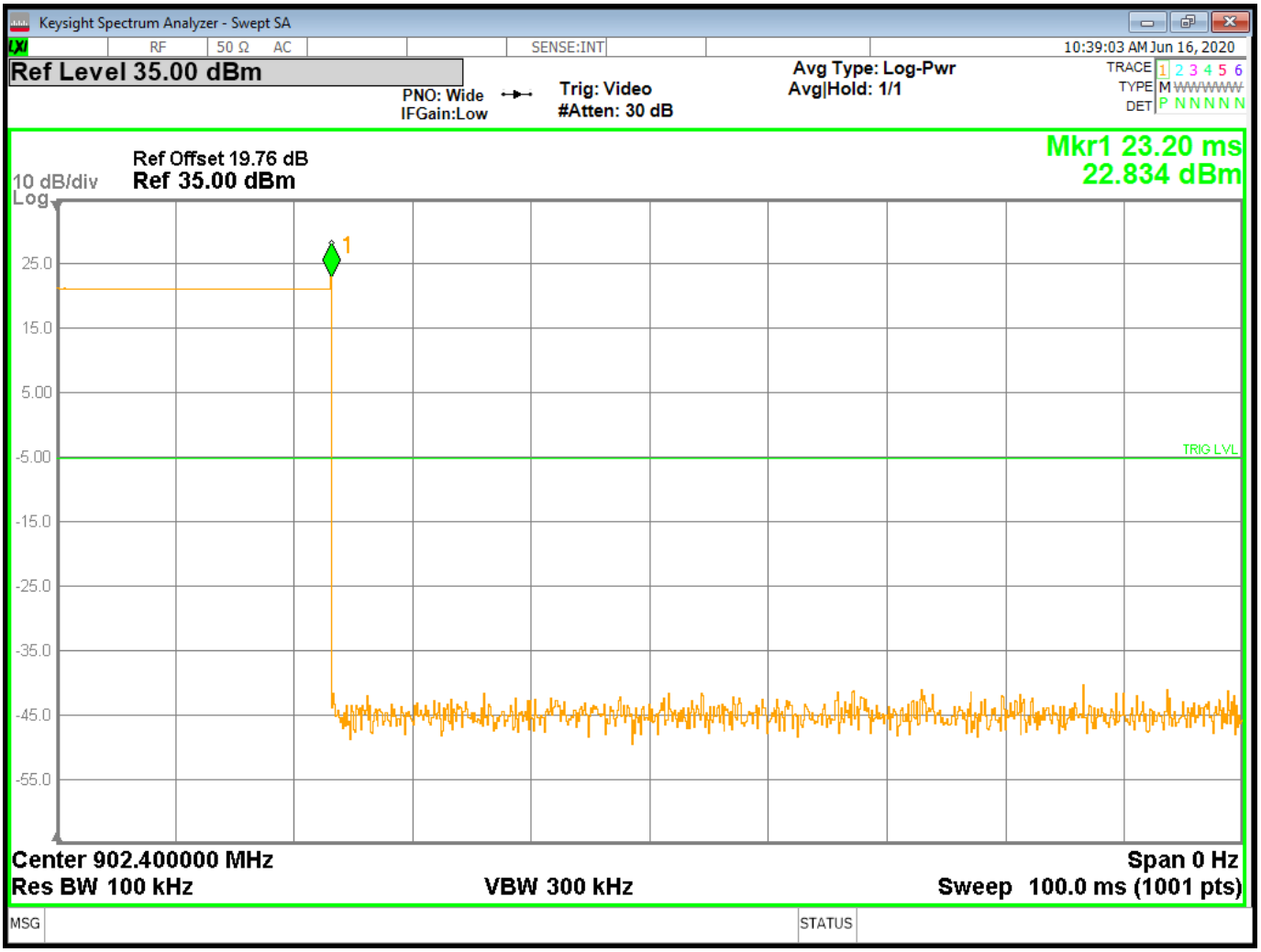

Figure 27 – Time of Occupancy, On Time

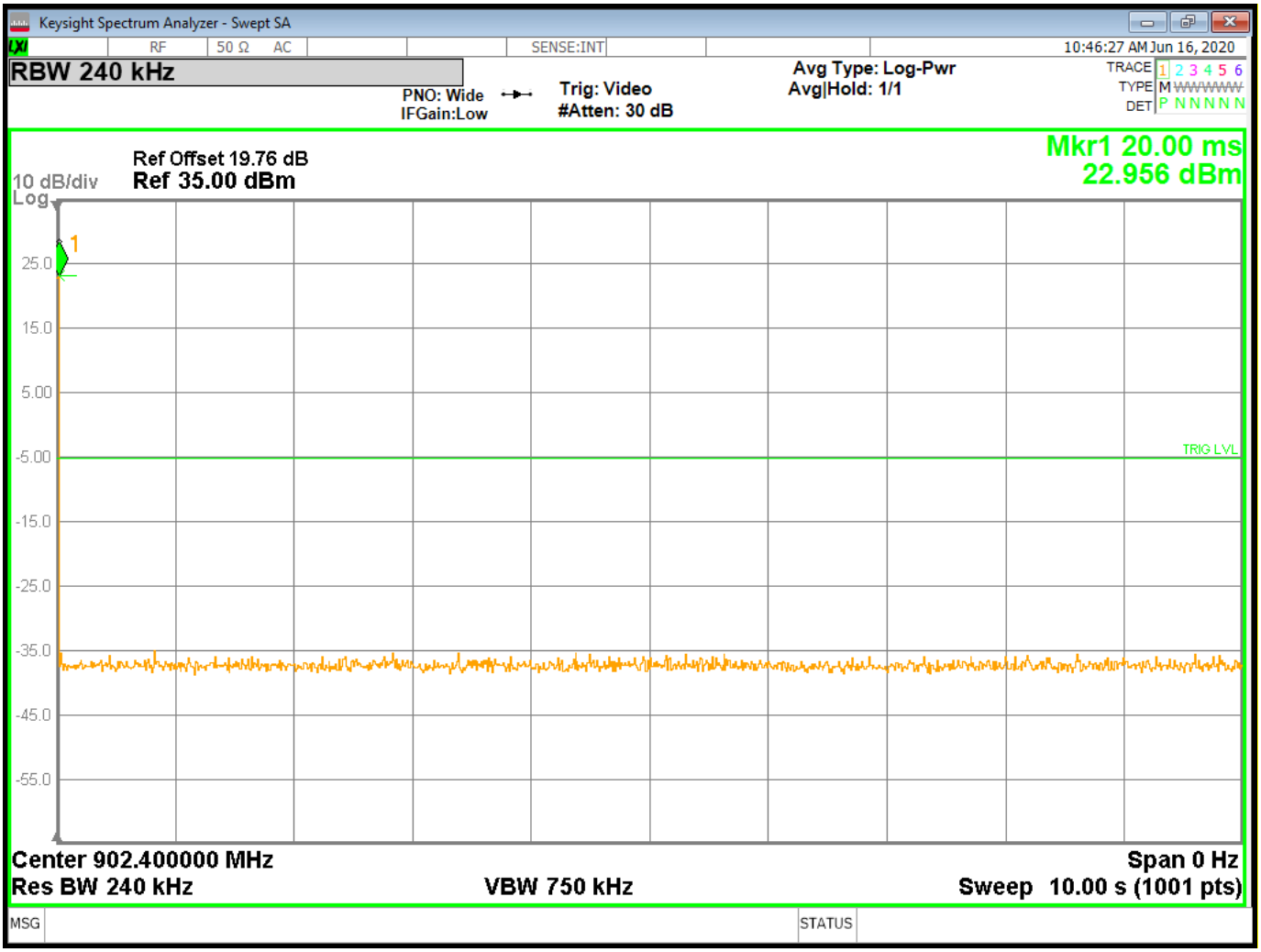

Figure 28 – Time of Occupancy, Period

4.7 CONDUCTED AC MAINS EMISSIONS

Test Method: ANSI C63.10-2013, Section(s) 6.2

Limits for conducted emissions measurements:

FREQUENCY OF EMISSION (MHz)	CONDUCTED LIMIT (dBµV)	
	Quasi-peak	Average
0.15-0.5	66 to 56	56 to 46
0.5-5	56	46
5-30	60	50

Notes:
1. The lower limit shall apply at the transition frequencies.
2. The limit decreases in line with the logarithm of the frequency in the range of 0.15 to 0.50 MHz
3. All emanations from a class A/B digital device or system, including any network of conductors and apparatus connected thereto, shall not exceed the level of field strengths specified above.

Test Procedures:

a. The EUT was placed 0.8m above a ground reference plane and 0.4 meters from the conducting wall of a shielded room with EUT being connected to the power mains through a line impedance stabilization network (LISN). The LISN provides 50 ohm/ 50uH of coupling impedance for the measuring instrument.
b. Both lines of the power mains connected to the EUT were checked for maximum conducted interference as well as the ground.
c. The frequency range from 150 kHz to 30 MHz was searched. Emission levels over 10dB under the prescribed limits are not reported.
d. Results were compared to the 15.207 limits.

Deviation from the test standard:
No deviation

EUT operating conditions:
Details can be found in section 2.1 of this report.
.

Test Results:

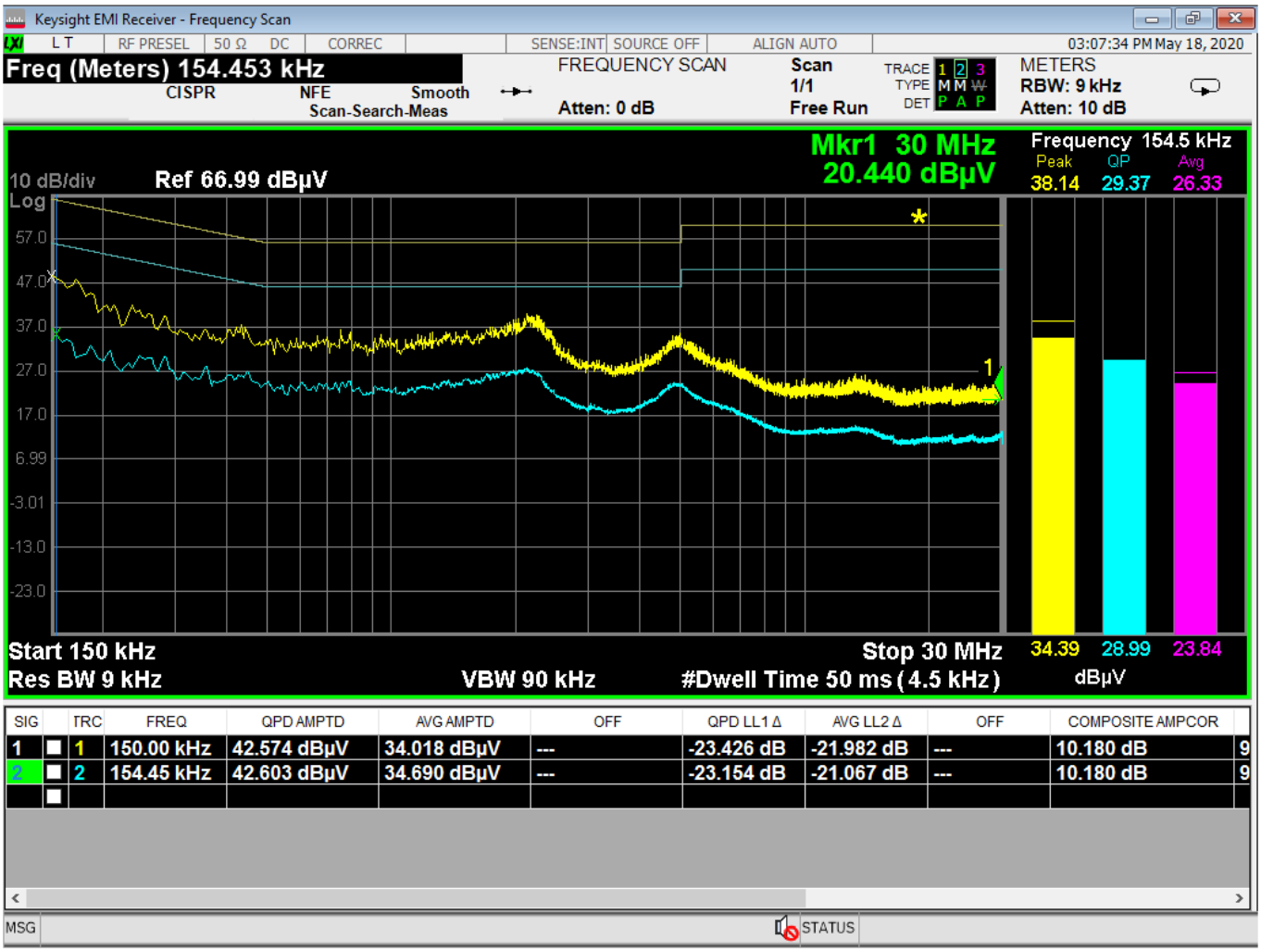

Figure 29 - Conducted Emissions Plot, Line

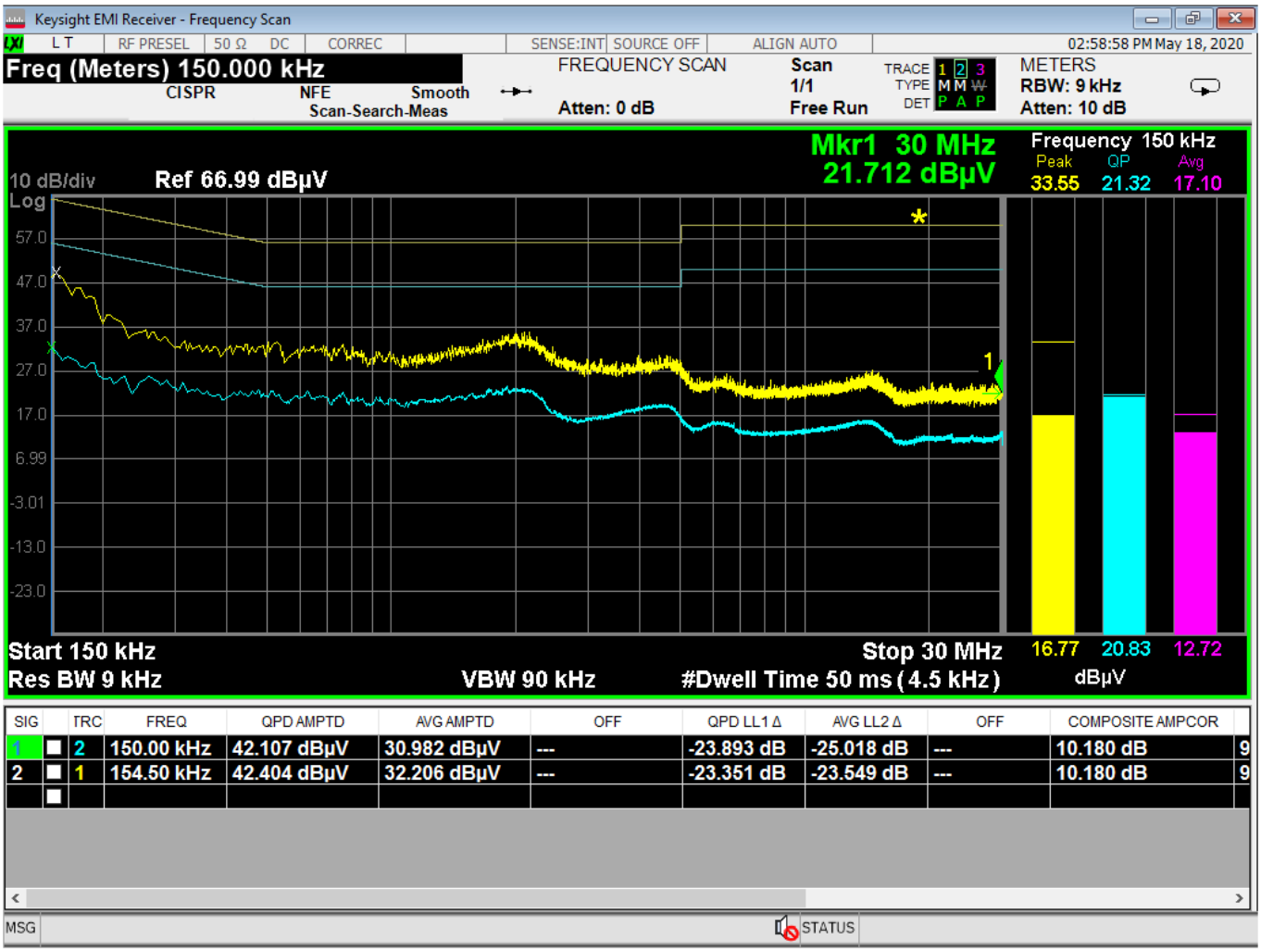

Figure 30 - Conducted Emissions Plot, Neutral

APPENDIX A: SAMPLE CALCULATION

Field Strength Calculation

The field strength is calculated by adding the Antenna Factor and Cable Factor, and subtracting the Amplifier Gain (if any) from the measured reading. The basic equation with a sample calculation is as follows:
FS = RA + AF – (-CF + AG) + AV

where FS = Field Strength

RA = Receiver Amplitude

AF = Antenna Factor

CF = Cable Attenuation Factor

AG = Amplifier Gain

AV = Averaging Factor (if applicable)

Assume a receiver reading of 55 dBμV is obtained. The Antenna Factor of 12 and a Cable Factor of 1.1 is added. The Amplifier Gain of 20 dB is subtracted, giving a field strength of 48.1 dBμV/m.

FS = 55 + 12 – (-1.1 + 20) + 0 = 48.1 dBμV/m

The 48.1 dBμV/m value can be mathematically converted to its corresponding level in μV/m.

Level in μV/m = Common Antilogarithm [(48.1 dBμV/m)/20]= 254.1 μV/m

AV is calculated by the taking the 20*log(T_{on}/100) where T_{on} is the maximum transmission time in any 100ms window.

EIRP Calculations

In cases where direct antenna port measurement is not possible or would be inaccurate, output power is measured in EIRP. The maximum field strength is measured at a specified distance and the EIRP is calculated using the following equation;

EIRP (Watts) = [Field Strength (V/m) x antenna distance (m)]^2 / 30

Power (watts) = 10^[Power (dBm)/10] / 1000

Voltage (dBµV) = Power (dBm) + 107 (for 50Ω measurement systems)

Field Strength (V/m) = 10^[Field Strength (dBµV/m) / 20] / 10^6

Gain = 1 (numeric gain for isotropic radiator)

Conversion from 3m field strength to EIRP (d=3):

EIRP = [FS(V/m) x d^2]/30 = FS [0.3] for d = 3

EIRP(dBm) = FS(dBµV/m) – 10(log 10^9)+ 10log[0.3] = FS(dBµV/m) - 95.23

10log(10^9) is the conversion from micro to milli

APPENDIX B – MEASUREMENT UNCERTAINTY

Where relevant, the following measurement uncertainty levels have been for tests performed in this test report:

Test	Frequency Range	Uncertainty Value (dB)
Radiated Emissions, 3m	30MHz - 1GHz	3.82
Radiated Emissions, 3m	1GHz - 18GHz	4.44
Emissions limits, conducted	30MHz – 18GHz	±3.30 dB

Expanded uncertainty values are calculated to a confidence level of 95%.

REPORT END