Garmin International, Inc.
1200 East 151st Street
Olathe, Kansas 66062
P: 913-397-8200 F: 913-397-8282

16-Feb-26

Manufacturer: Garmin International, Inc.
Address: 1200 E. 151st St.
Olathe, KS 66062-3426
U.S.A.
Chile Representative: Matías Rodríguez Correa
Rosario Norte 660 piso 24, Las Condes Santiago
Province CP 7550083, Chile
Contact Email: matias.rodriguez@garmin.com

Subject: SUBTEL, Chile (Resolution 737) Certification Compliance 2026

Commercial Name: GPSMAP 67i

	Información (Information)
Tipo de equipo (Equipment type)	Digital Transmission System
Marca (Brand)	Garmin GARMIN.
Modelo (Model)	AA4624
Tecnología o modulación (Technology or modulation)	BLE (GMSK), WiFi 2.4GHz (802.11 b/g/n), Iridium
Frecuencias (Frequencies)	BLE (2402MHz- 2480MHz), WiFi 2.4GHz (2412MHz – 2462MHz), Iridium (1616 MHz – 1626 MHz)
Ganancia de antena (dBi) (Antenna gain (dBi)	BLE Trace (-3.29 dBi), WiFi 2.4GHz Trace (-3.29 dBi), Iridium Helical (1.396 dBi)
P.i.r.e. (E.I R P.)	BLE (0.01 dBm, 1.0 mW), WiFi 2.4GHz (13.46 dBm, 22.18 mW), Iridium (31.936 dBm, 1561 mW)
Módulos (Modules)	BLE, WiFi 2.4GHz, Iridium

Declaration of Conformity Statement: the equipment previously identified complies with the provisions established in the Technical Standard for Small Range Equipment, approved by Exempt Resolution No.1,985 of 2017, of the Undersecretary of Telecommunications.

Declaración de conformidad: El equipo anteriormente identificado cumple con las disposiciones establecidas en la Norma Técnica para Equipos de Corto Alcance, aprobada mediante la Resolución Exenta N° 1.985 de 2017, de la Subsecretaría de Telecomunicaciones.

ncee labs
Product Compliance Solutions
4740 Discovery Drive | Lincoln, NE 68521
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FCC/ISED Test Report

Prepared for: **Garmin International, Inc.**

Address: **1200 E. 151st Street**
Olathe, Kansas, 66062, USA

Product: **AA4624**

Test Report No: **R20220615-20-E4**

Approved by:

Fox Lane

Fox Lane,
EMC Test Engineer

DATE: **November 30, 2022**

Total Pages: **87**

REVISION PAGE

Rev. No.	Date	Description
0	29 November 2022	Issued by FLane Reviewed by KVepuri Prepared by FLane

CONTENTS

1.0 SUMMARY OF TEST RESULTS

The worst-case measurements were reported in this report. Summary of test results presented in this report correspond to the following section:

FCC Part 15.247

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

APPLIED STANDARDS AND REGULATIONS		
Standard Section	**Test Type**	**Result**
FCC Part 15.35 RSS Gen, Issue 5, Section 6.10	Duty Cycle	Pass
FCC Part 15.247(b)(3) RSS-247 Issue 2 Section 5.4(d)	Peak output power	Pass
FCC Part 15.247(a)(2) RSS-247 Issue 2 Section 5.2	Bandwidth	Pass
FCC Part 15.209 RSS-Gen Issue 5, Section 7.3	Receiver Radiated Emissions	Pass
FCC Part 15.209 (restricted bands), 15.247 (unrestricted) RSS-247 Issue 2 Section 5.5, RSS-Gen Issue 5, Section 8.9	Transmitter Radiated Emissions	Pass
FCC Part 15.247(e) RSS-247 Issue 2 Section 5.2	Power Spectral Density	Pass
FCC Part 15.209, 15.247(d) RSS-247 Issue 2 Section 5.5	Band Edge Measurement	Pass
FCC Part 15.207 RSS-Gen Issue 5, Section 8.8	Conducted Emissions	Pass

2.0 EUT DESCRIPTION

2.1 EQUIPMENT UNDER TEST

Summary and Operating Condition:

EUT	AA4624
IC	1792A-A4624
FCC ID	IPH-A4624
EUT Received	29 August 2022
EUT Tested	5 September 2022- 28 October 2022
Serial No.	3426363242 (Radiated Measurements) 3426363123 (Conducted Measurements)
Operating Band	2400 – 2483.5 MHz
Device Type	☒ GMSK ☒ GFSK ☐ BT BR ☐ BT EDR 2MB ☐ BT EDR 3MB ☐ 802.11x
Power Supply / Voltage	Internal Battery / 5VDC Charger: Garmin (Phi Hong) Model: LACA046 GPN: 362-00112-00 (Representative Power Supply)
Antenna Type / Gain (dBi)	Trace Antenna -3.29 dBi

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

2.2 DESCRIPTION OF TEST MODES

The operating range of the EUT is dependent on the device type found in section 2.1:

GFSK and GMSK 1MB Transmissions:

Channel	Frequency
Low	2402 MHz
Mid	2440 MHz
High	2480 MHz

GMSK 2MB Transmissions:

Channel	Frequency
Low	2404 MHz
Mid	2440 MHz
High	2478 MHz

These are the only 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.

2.3 DESCRIPTION OF SUPPORT UNITS

None

3.0 LABORATORY AND GENERAL TEST 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
NCC CAB 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	Fox Lane	Test Engineer	Review/Testing and Report
2	Blake Winter	Test Engineer	Testing
3	Grace Larsen	Test Engineer	Testing
4	Ethan Schmidt	Test Technician	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 (44GHz)**	N9038A	MY59050109	July 19, 2022	July 19, 2024
Keysight MXE Signal Analyzer (26.5GHz)**	N9038A	MY56400083	July 19, 2022	July 19, 2024
Keysight EXA Signal Analyzer**	N9010A	MY56070862	July 20, 2021	July 20, 2023
SunAR RF Motion	JB1	A082918-1	July 26, 2022	July 26, 2023
ETS EMCO Red Horn Antenna	3115	00218655	July 21, 2022	July 21, 2023
Com-Power LISN, Single Phase**	LI-220C	20070017	July 18, 2022	July 18, 2024
8447F POT H64 Preamplifier*	8447F POT H64	3113AD4667	March 21, 2022	March 21, 2024
Rohde & Schwarz Preamplifier*	TS-PR18	3545700803	August 22, 2022	August 22, 2024
Trilithic High Pass Filter*	6HC330	23042	March 21, 2022	March 21, 2024
ETS – Lindgren- VSWR on 10m Chamber***	10m Semi-anechoic chamber-VSWR	4740 Discovery Drive	July 30, 2020	July 30, 2023
NCEE Labs-NSA on 10m Chamber*	10m Semi-anechoic chamber-NSA	NCEE-001	May 25, 2022	May 25, 2024
TDK Emissions Lab Software	V11.25	700307	NA	NA
RF Cable (preamplifier to antenna)*	MFR-57500	90-195-040	August 22, 2022	August 22, 2024
RF Cable (antenna to 10m chamber bulkhead)*	FSCM 64639	01E3872	September 24, 2021	September 24, 2023
RF Cable (10m chamber bulkhead to control room bulkhead)*	FSCM 64639	01E3864	September 24, 2021	September 24, 2023
RF Cable (control room bulkhead to test receiver)*	FSCM 64639	01F1206	September 24, 2021	September 24, 2023
N connector bulkhead (10m chamber)*	PE9128	NCEEBH1	September 24, 2021	September 24, 2023
N connector bulkhead (control room)*	PE9128	NCEEBH2	September 24, 2021	September 24, 2023

*Internal Characterization
**2 Year Cal Cycle
***3 Year Cal Cycle

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

3.4 GENERAL TEST PROCEDURE AND SETUP FOR RADIO MEASUREMNTS

Measurement type presented in this report (Please see the checked box below):

Conducted ☒

The conducted measurements were performed by connecting the output of the transmitter directly into a spectrum analyzer using an impedance matched cable and connector soldered to the EUT in place of the antenna. The information regarding resolution bandwidth, video bandwidth, span and the detector used can be found in the graphs provided in the Appendix C. All the radio measurements were performed using the sections from ANSI C63.10, details about the section used can be found in the spectrum analyzer titles on the graph.

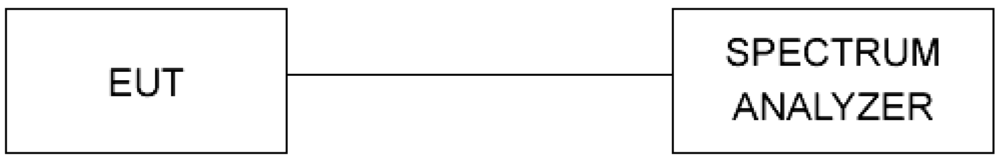


Figure 1 - Bandwidth Measurements Test Setup

Radiated ☒

All the radiated measurements were taken at a distance of 3m from the EUT. The information regarding resolution bandwidth, video bandwidth, span and the detector used can be found in the graphs provided in the Appendix C. All the radio measurements were performed using the sections from ANSI C63.10, details about the section used can be found in the spectrum analyzer titles on the graph.

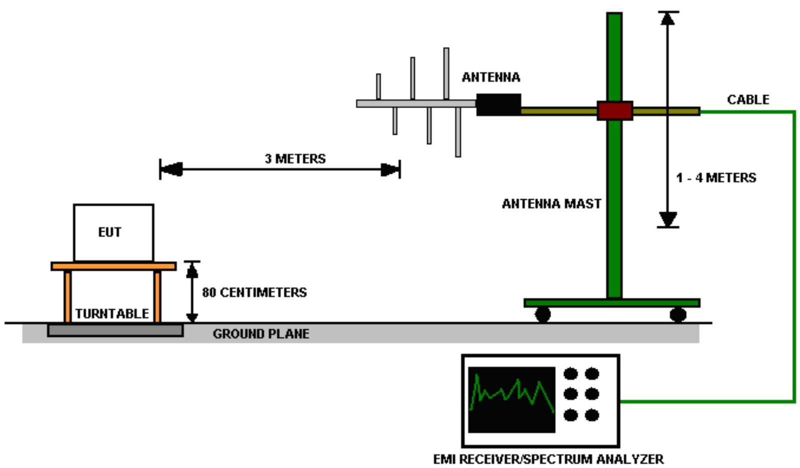


Figure 2 - Radiated Emissions Test Setup

4.0 RESULTS

DTS Radio Measurements							
CHANNEL	Transmitter	Occupied Bandwidth (kHz)	6 dB Bandwidth (kHz)	AVERAGE OUTPUT POWER (dBm)	AVERAGE OUTPUT POWER (mW)	PSD (dBm)	RESULT
Low	GFSK	1323.10	890.60	0.100	1.023	-17.109	PASS
Mid	GFSK	1329.60	928.0	3.010	2.000	-12.55	PASS
High	GFSK	1479.80	879.10	-1.140	0.769	-17.563	PASS
Low	GMSK 1Mb	1310.90	1312.30	0.070	1.016	-17.324	PASS
Mid	GMSK 1Mb	1265.40	1272.80	2.830	1.919	-13.704	PASS
High	GMSK 1Mb	1316.60	1335.70	-1.240	0.752	-18.022	PASS
Low	GMSK 2Mb	2515.60	2465.80	3.300	2.138	-13.552	PASS
Mid	GMSK 2Mb	2550.40	2536.40	2.910	1.954	-14.429	PASS
High	GMSK 2Mb	2492.10	2440.50	-1.210	0.757	-18.071	PASS
Occupied Bandwidth = N/A; 6 dB Bandwidth Limit = 500 kHz				Peak Output Power Limit = 30 dBm; PSD Limit = 8 dBm			
Unrestricted Band-Edge							
CHANNEL	Mode	Band edge /Measurement Frequency (MHz)	Relative Highest out of band level (dBuV)	Relative Fundamental (dBuV)	Delta (dB)	Min Delta (dB)	Result
Low	GMSK 1Mb	2400.00	63.96	105.757	39.797	30.00	PASS
Low	GMSK 2Mb	2400.00	64.37	107.268	42.627	30.00	PASS
Low	GFSK	2400.00	58.989	105.668	36.815	30.00	PASS
High	GMSK 1Mb	2483.50	51.268	104.538	48.664	30.00	PASS
High	GMSK 2Mb	2483.50	58.941	102.579	42.055	30.00	PASS
High	GFSK	2483.50	52.82	104.528	44.105	30.00	PASS
Peak Restricted Band-Edge							
CHANNEL	Mode	Band edge /Measurement Frequency (MHz)	Highest out of band level (dBuV/m @ 3m)	Measurement Type	Limit (dBuV/m @ 3m)	Margin	Result
Low	GMSK 1Mb	2390.00	53.093	Peak	73.98	20.89	PASS
Low	GMSK 2Mb	2390.00	53.257	Peak	73.98	20.72	PASS
Low	GFSK	2390.00	53.986	Peak	73.98	19.99	PASS
High	GMSK 1Mb	2483.50	54.659	Peak	73.98	19.32	PASS
High	GMSK 2Mb	2483.50	56.981	Peak	73.98	17.00	PASS
High	GFSK	2483.50	54.879	Peak	73.98	19.10	PASS
*Limit shown is the peak limit taken from FCC Part 15.209							

Average Restricted Band-Edge							
CHANNEL	**Mode**	**Band edge /Measurement Frequency (MHz)**	**Highest out of band level (dBuV/m @ 3m)**	**Measurement Type**	**Limit (dBuV/m @ 3m)**	**Margin**	**Result**
Low	GMSK 1Mb	2390.00	40.983	Average	53.98	13.00	PASS
Low	GMSK 2Mb	2390.00	41.83	Average	53.98	12.15	PASS
Low	GFSK	2390.00	41.13	Average	53.98	12.85	PASS
High	GMSK 1Mb	2483.50	43.113	Average	53.98	10.87	PASS
High	**GMSK 2Mb**	**2483.50**	**46.441**	**Average**	**53.98**	**7.54**	**PASS**
High	GFSK	2483.50	43.172	Average	53.98	10.81	PASS
*Limit shown is the average limit taken from FCC Part 15.209							

4.1 OUTPUT POWER

Test Method: All measurements were performed using the section 11.9.2.2.2 from ANSI C63.10.

Limits of power measurements:
For FCC Part 15.247 Device:
The maximum allowed output power is 30 dBm.

Test procedures:
Details can be found in section 3.4 of this report.

Deviations from test standard:
No deviation.

Test setup:
Details can be found in section 3.4 of this report.

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

Test results:
Pass
Comments:
1. All the output power plots can be found in the Appendix C.
2. All the measurements were found to be compliant.
3. Tabulated data is listed in section 4.0.

4.2 BANDWIDTH

Test Method: All the radio measurements were performed using the sections from ANSI C63.10, details about the section used can be found in the spectrum analyzer titles on the graph.

Limits of bandwidth measurements:

For FCC Part 15.247 Device:
The 99% occupied bandwidth is for informational purpose only. The 6dB bandwidth of the signal must be greater than 500 kHz.

Test procedures:
Details can be found in section 3.4 of this report.

Deviations from test standard:
No deviation.

Test setup:
Test setup details can be found in section 3.4 of this report.

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

Test results:

Pass

Comments:

1. All the bandwidth plots can be found in the Appendix C.
2. All the measurements were found to be compliant.
3. Tabulated data is listed in section 4.0.

4.3 DUTY CYCLE

Test Method:

All Modulations/transmitters shown have a duty cycle of >98%.

4.4 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.
4. The EUT was tested for spurious emissions while running off of battery power and external USB power. The worse-case emissions were produced while running off of USB power, so results from this mode are presented.

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 from 30MHz-1Ghz and 1.5m for measurements from 1GHz and higher.

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.

Test setup:

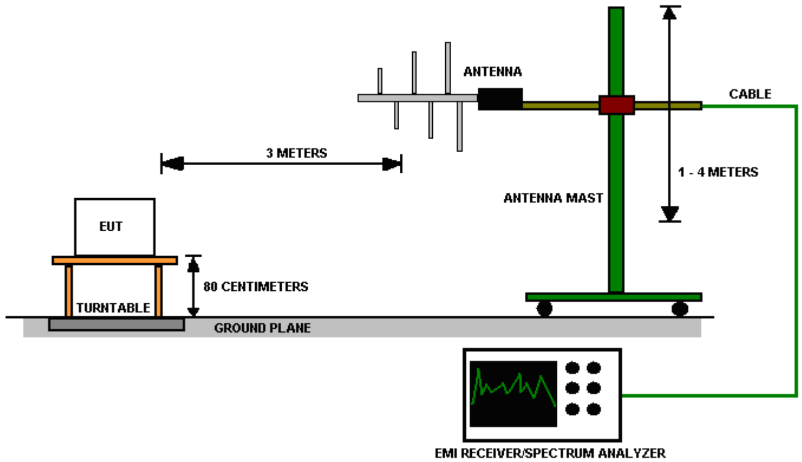


Figure 3 - Radiated Emissions Test Setup

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.

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

Test results:

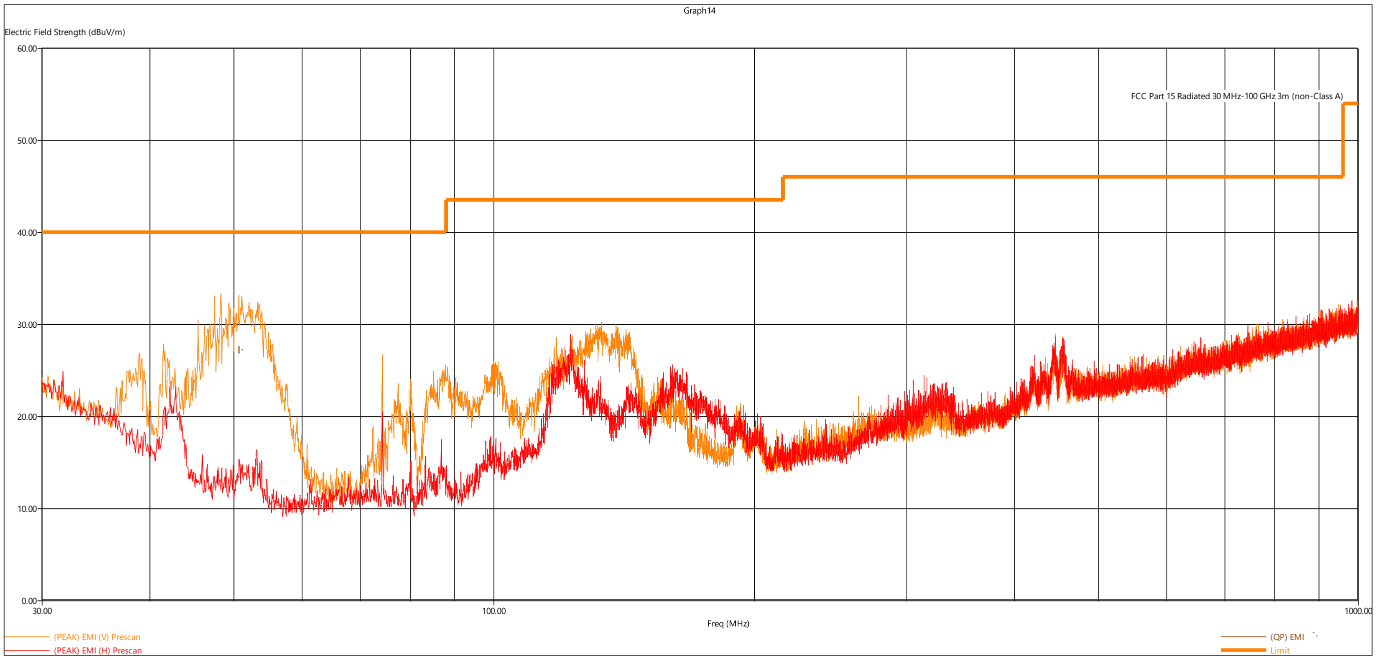


Figure 4 - Radiated Emissions Plot, Receive

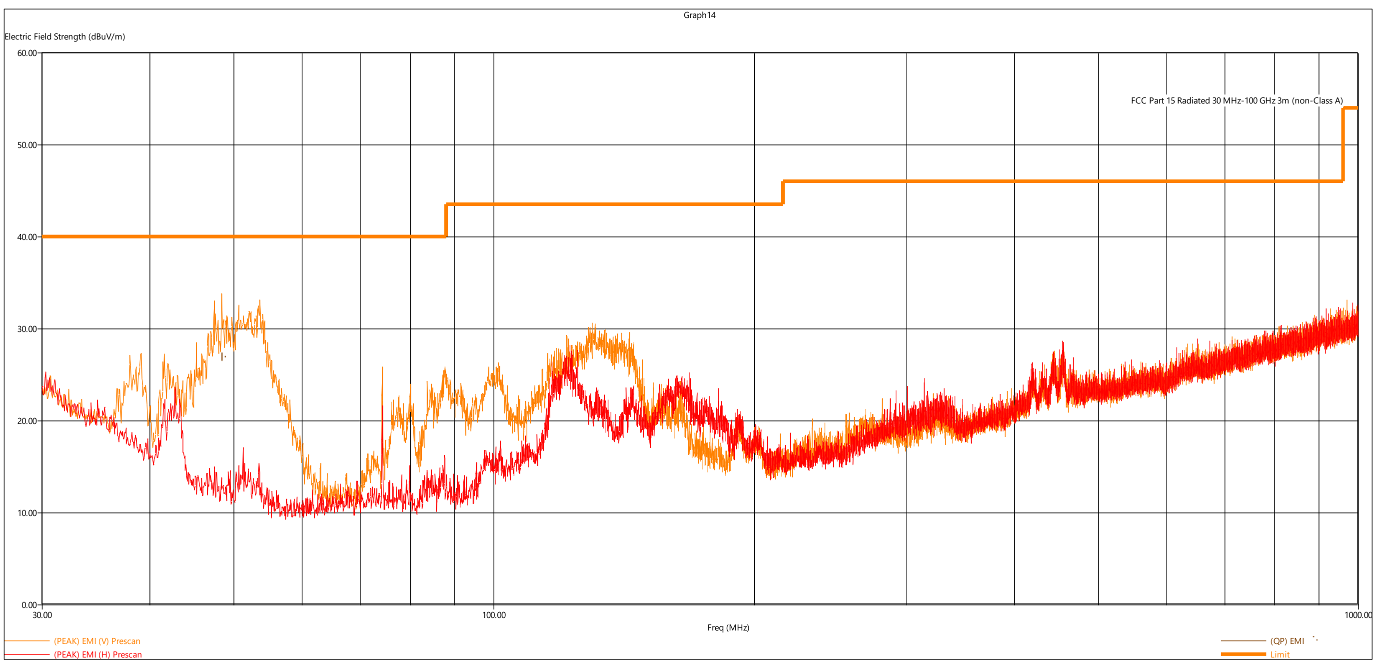


Figure 5 - Radiated Emissions Plot, GFSK

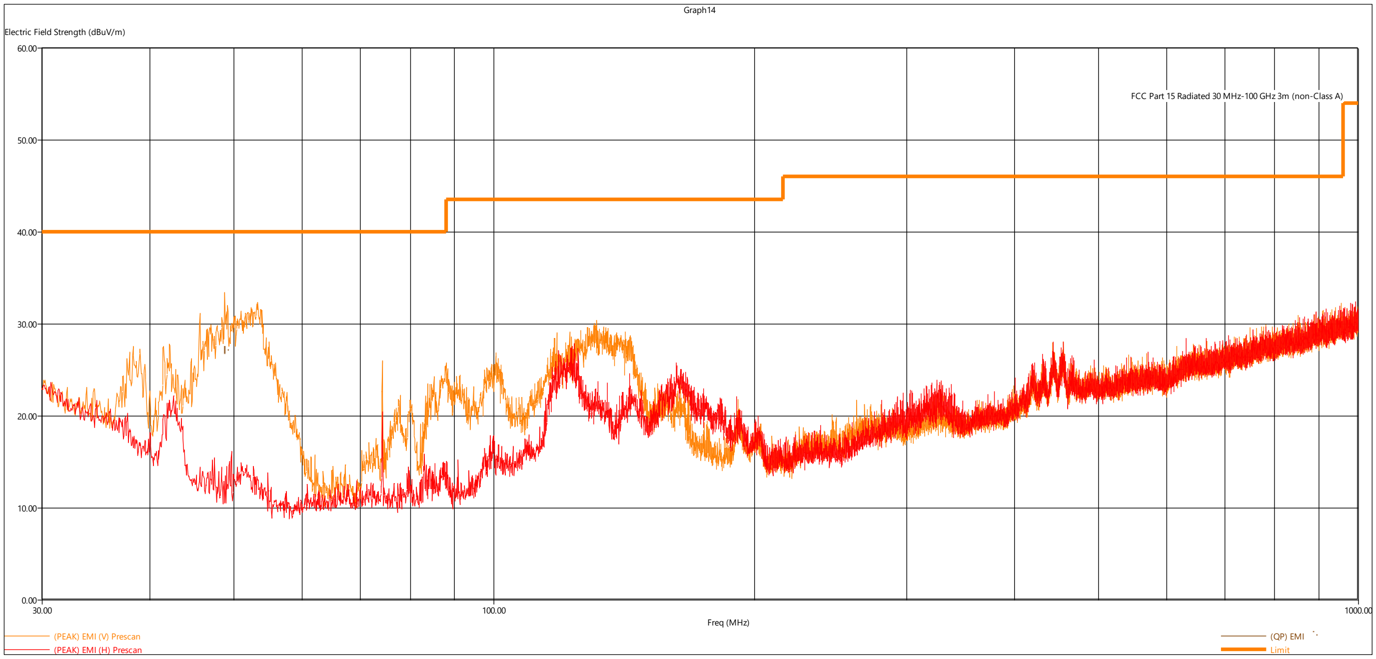


Figure 6 - Radiated Emissions Plot, GMSK 1MB

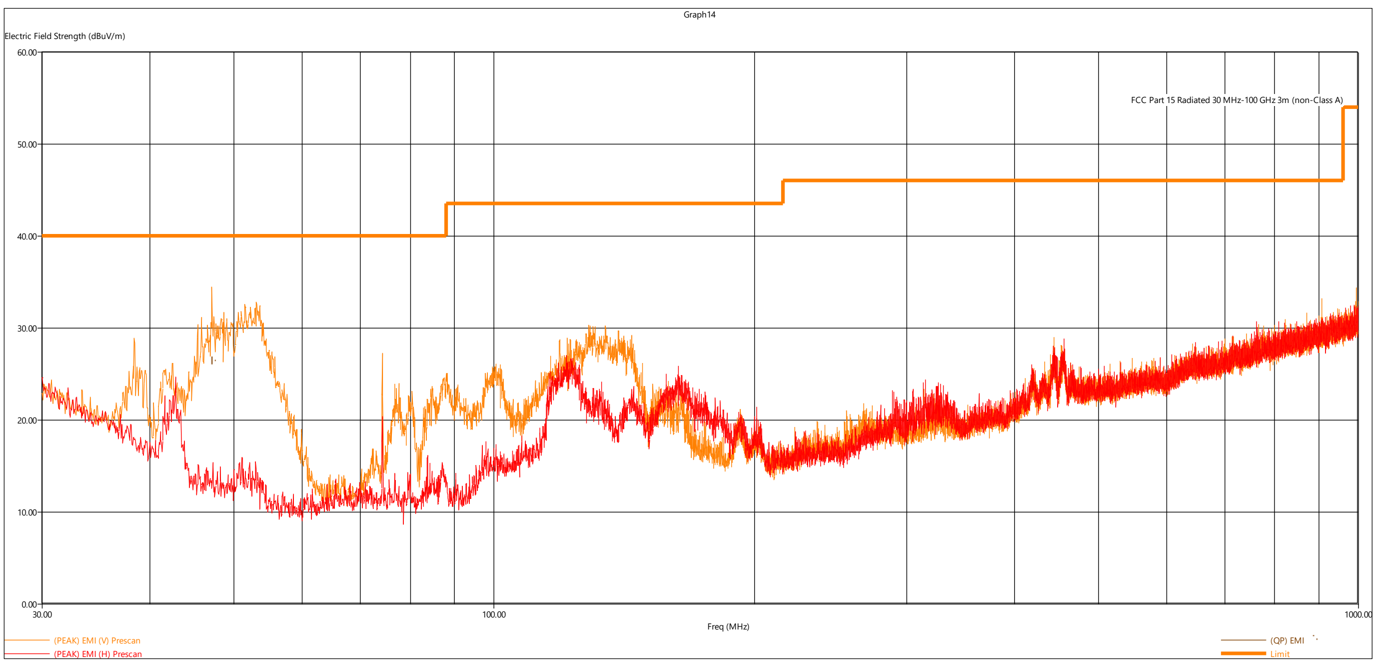


Figure 7 - Radiated Emissions Plot, GMSK 2MB

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 = Limit value - Emission level

Quasi-Peak Measurements, GMSK-GFSK								
Frequency	**Level**	**Limit**	**Margin**	**Height**	**Angle**	**Pol**	**Channel**	**Modulation**
MHz	**dBµV/m**	**dBµV/m**	**dB**	**cm.**	**deg.**			
48.382080	26.87	40.00	13.13	108.00	140.00	V	Low	GFSK
48.788640	27.08	40.00	12.92	107.00	99.00	V	Low	GMSK 1MB
47.134080	26.42	40.00	13.58	112.00	328.00	V	Low	GMSK 2MB
50.845200	27.22	40.00	12.78	116.00	39.00	V	RX	

The EUT was maximized in all 3 orthogonal axes. The worst-case is shown in the plot and table above.
All other measurements were found to be at least 6 dB Below the limit.

Peak Measurements, GMSK-GFSK								
Frequency	**Level**	**Limit**	**Margin**	**Height**	**Angle**	**Pol**	**Channel**	**Modulation**
MHz	**dBµV/m**	**dBµV/m**	**dB**	**cm.**	**deg.**			
2402.232000	92.79	NA	NA	202	120	H	Low	GMSK 1MB
2439.716000	96.86	NA	NA	186	120	H	Mid	GMSK 1MB
2479.712000	93.30	NA	NA	366	122	H	High	GMSK 1MB
2403.496000	96.20	NA	NA	393	120	H	Low	GMSK 2MB
2440.438000	96.65	NA	NA	132	345	H	Mid	GMSK 2MB
2477.552000	92.95	NA	NA	368	122	H	High	GMSK 2MB
2402.244000	92.92	NA	NA	390	122	H	Low	GFSK
2440.258000	97.27	NA	NA	332	122	H	Mid	GFSK
2479.716000	93.56	NA	NA	421	125	H	High	GFSK
7205.536000	51.92	73.98	22.06	401	147	V	Low	GFSK
7319.384000	54.52	73.98	19.46	381	147	V	Mid	GFSK
7438.858000	51.13	73.98	22.85	188	156	V	High	GFSK
7205.372000	53.89	73.98	20.09	135	203	H	Low	GMSK 1MB
7319.572000	54.00	73.98	19.98	473	149	V	Mid	GMSK 1MB
7438.644000	51.62	73.98	22.36	458	147	V	High	GMSK 1MB
7213.174000	53.39	73.98	20.59	199	201	H	Low	GMSK 2MB
7321.702000	54.84	73.98	19.14	127	216	H	Mid	GMSK 2MB
7432.322000	52.28	73.98	21.70	388	210	V	High	GMSK 2MB

The EUT was maximized in all 3 orthogonal axes. The worst-case is shown in the plot and table above.
All other measurements were found to be at least 6 dB Below the limit**.**

Average Measurements, GMSK-GFSK								
Frequency	**Level**	**Limit**	**Margin**	**Height**	**Angle**	**Pol**	**Channel**	**Modulation**
MHz	**dBµV/m**	**dBµV/m**	**dB**	**cm.**	**deg.**			
2402.232000	90.08	NA	NA	202	120	H	Low	GMSK 1MB
2439.716000	93.82	NA	NA	186	120	H	Mid	GMSK 1MB
2479.712000	89.76	NA	NA	366	122	H	High	GMSK 1MB
2403.496000	89.74	NA	NA	393	120	H	Low	GMSK 2MB
2440.438000	91.03	NA	NA	132	345	H	Mid	GMSK 2MB
2477.552000	86.84	NA	NA	368	122	H	High	GMSK 2MB
2402.244000	89.83	NA	NA	332	122	H	Low	GFSK
2440.258000	94.29	NA	NA	390	332	122	Mid	GFSK
2479.716000	89.87	NA	NA	421	125	H	High	GFSK
7205.536000	41.56	53.98	12.42	401	147	V	Low	GFSK
7319.384000	45.82	53.98	8.16	381	147	V	Mid	GFSK
7438.858000	39.53	53.98	14.45	188	156	V	High	GFSK
7205.372000	44.11	53.98	9.87	135	203	H	Low	GMSK 1MB
7319.572000	45.26	53.98	8.72	473	149	V	Mid	GMSK 1MB
7438.644000	39.11	53.98	14.87	458	147	V	High	GMSK 1MB
7213.174000	43.39	53.98	10.59	199	201	H	Low	GMSK 2MB
7321.702000	44.13	53.98	9.85	127	216	H	Mid	GMSK 2MB
7432.322000	40.16	53.98	13.82	388	210	V	High	GMSK 2MB

The EUT was maximized in all 3 orthogonal axes. The worst-case is shown in the table above.
All other measurements were found to be at least 6 dB Below the limit.

4.5 CONDUCTED SPURIOUS EMISSIONS

Test Method: ANSI C63.10-2013, Section 6.7

Limits of spurious emissions:

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)).

Test procedures:

The highest emissions level was measured and recorded. All spurious measurements were evaluated to 30dB below the fundamental. More details can be found in section 3.4 of this report.

Deviations from test standard:
None.

Test setup:
Test setup details can be found in section 3.4 of this report.

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

Test results:
Note that the limit shown on the plots does not apply. It is a line for reference

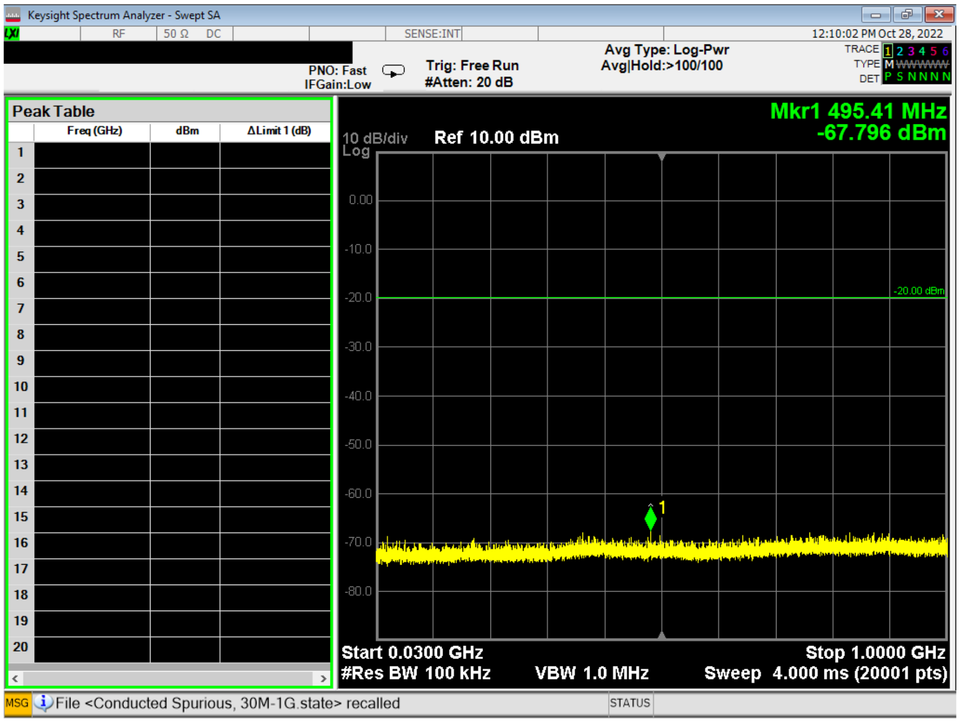


Figure 8 - Radiated Emissions Plot, GFSK, 30MHz – 1GHz, Mid

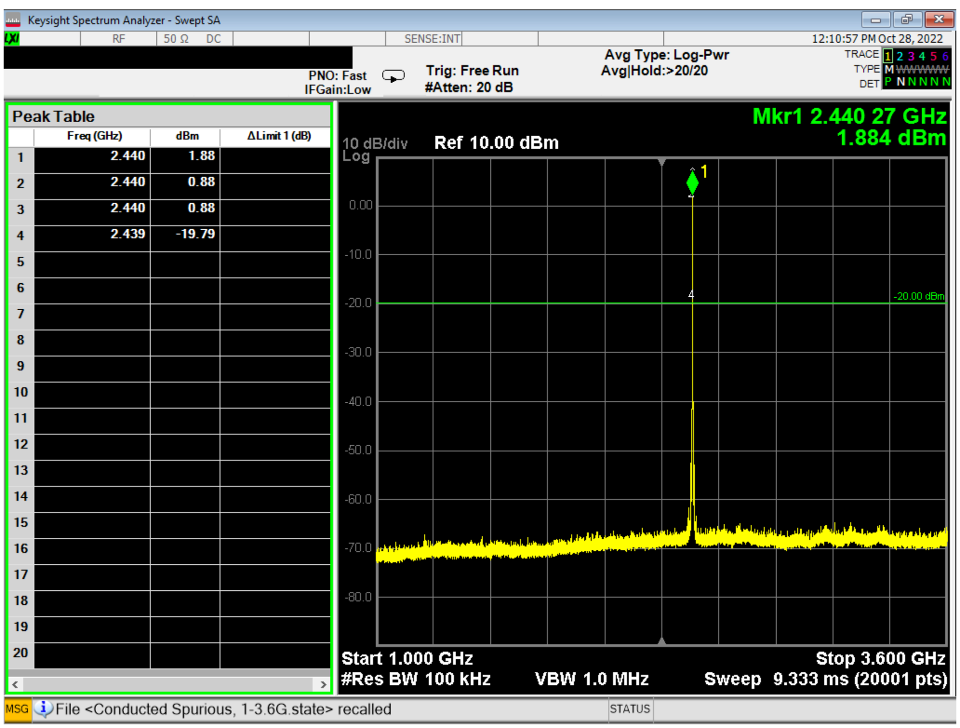


Figure 9 - Radiated Emissions Plot, GFSK, 1GHz – 3.6GHz, Mid

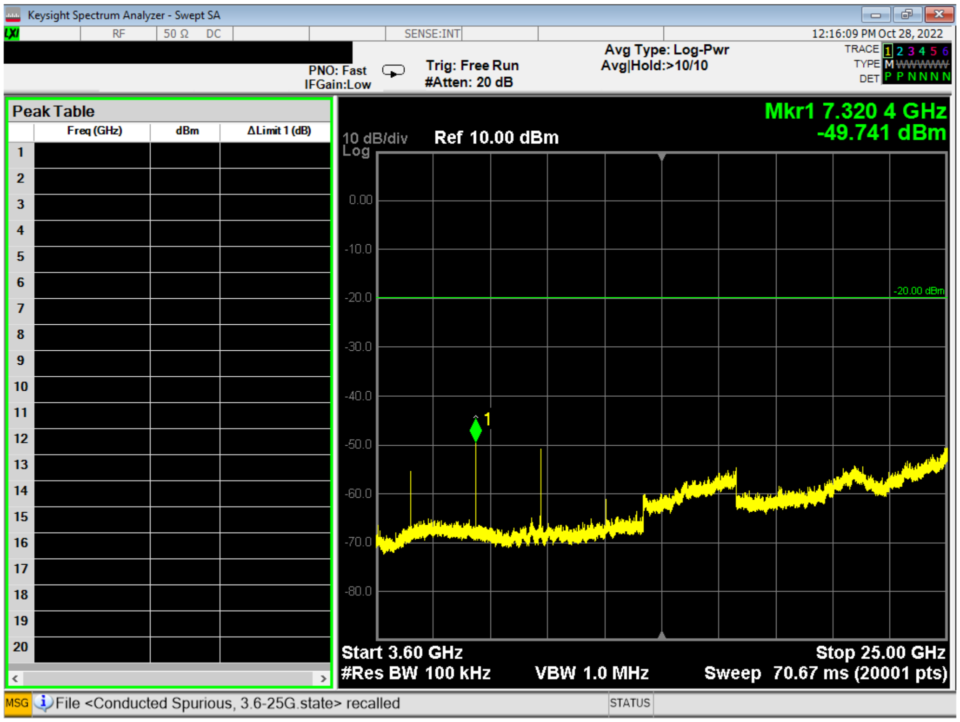


Figure 10 - Radiated Emissions Plot, GFSK, 3.6GHz – 25GHz, Mid

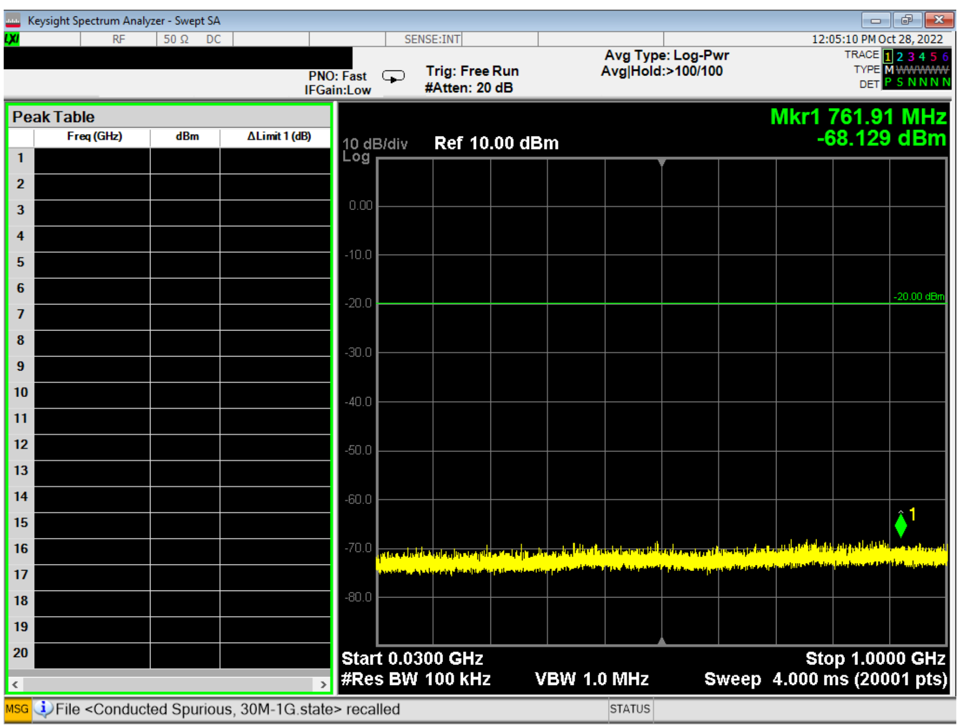


Figure 11 - Radiated Emissions Plot, GMSK 1MB, 30MHz – 1GHz, Mid

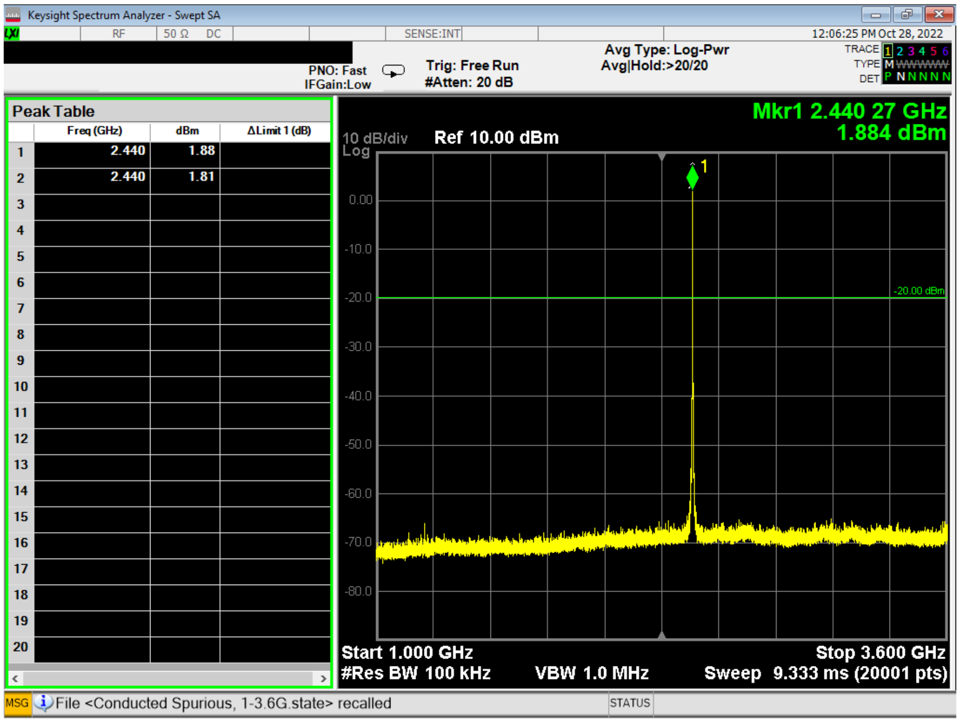


Figure 12 - Radiated Emissions Plot, GMSK 1MB, 1GHz – 3.6GHz, Mid

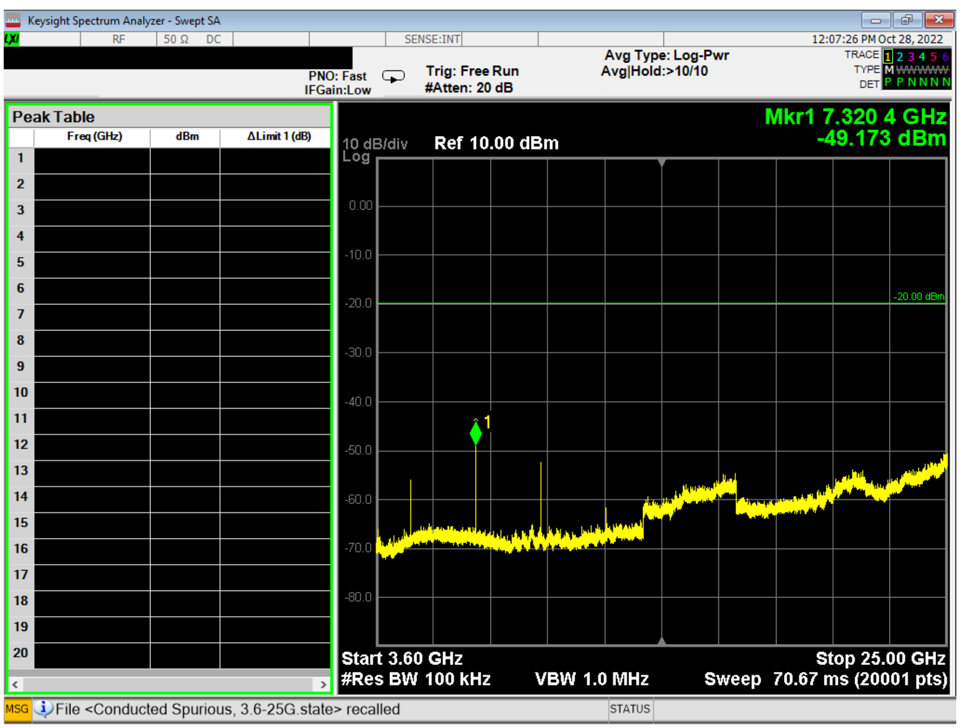


Figure 13 - Radiated Emissions Plot, GMSK 1MB, 3.6GHz – 25GHz, Mid

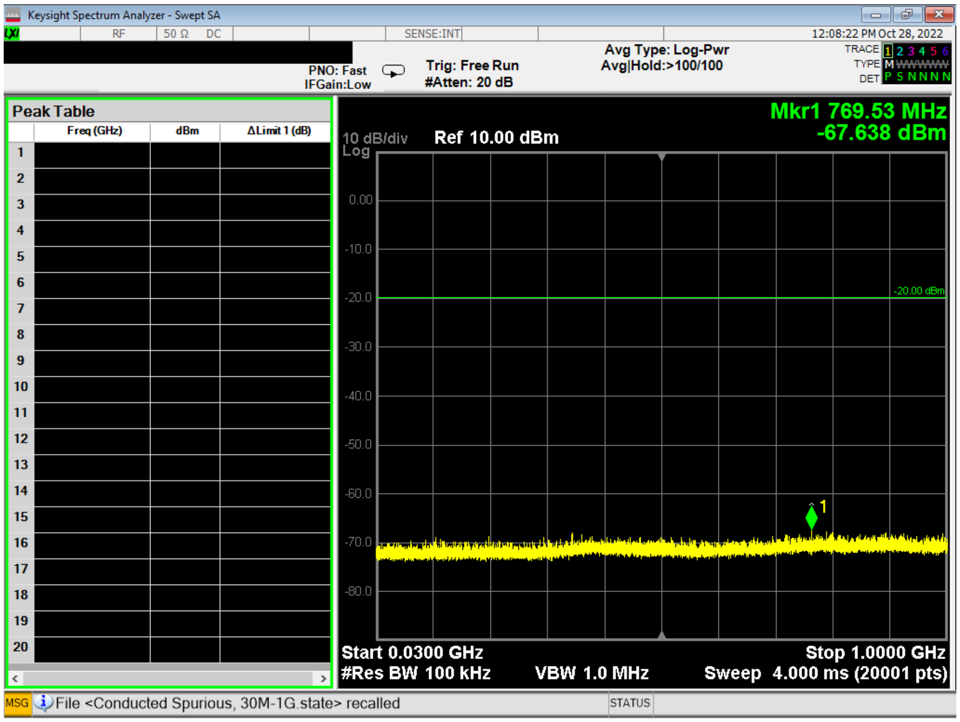


Figure 14 - Radiated Emissions Plot, GMSK 2MB, 30MHz – 1GHz, Mid

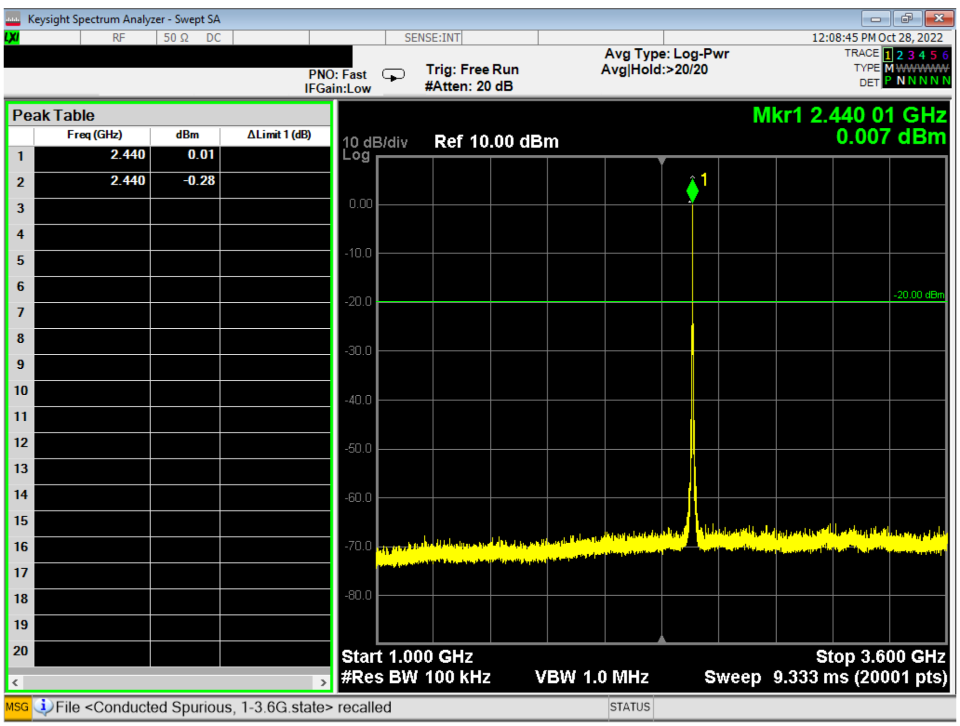


Figure 15 - Radiated Emissions Plot, GMSK 2MB, 1GHz – 3.6GHz, Mid

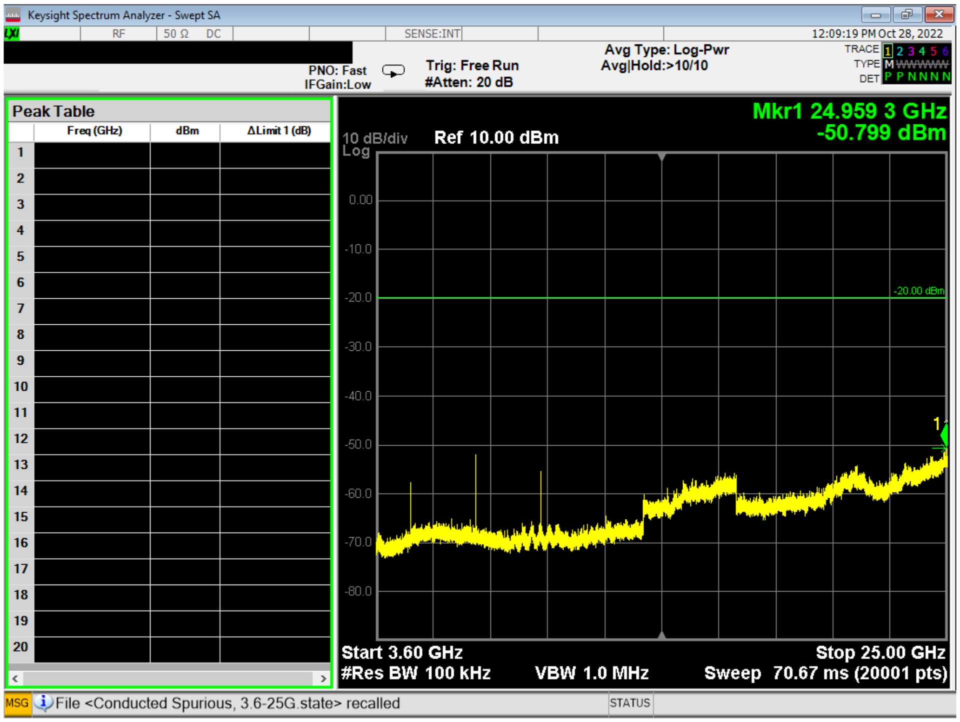


Figure 16 - Radiated Emissions Plot, GMSK 2MB, 3.6GHz – 25GHz, Mid

4.6 BAND EDGES

Test Method: All the radio measurements were performed using the sections from ANSI C63.10, details about the section used can be found in the spectrum analyzer titles on the graph.

Limits of band-edge measurements:
For FCC Part 15.247 Device:
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))

Test procedures:

The highest emissions level beyond the band-edge was measured and recorded. All band edge measurements were evaluated to the general limits in Part 15.209. More details can be found in section 3.4 of this report.

Deviations from test standard:
No deviation.

Test setup:
Test setup details can be found in section 3.4 of this report.

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

Test results:

Pass

Comments:

1. All the band edge plots can be found in the Appendix C.
2. If the device falls under FCC Part 15.247 (Details can be found in summary of test results), compliance is shown in the unrestricted band edges by showing minimum delta of 20 dB between peak and the band edge.
3. The restricted band edge compliance is shown by comparing to the general limit defined in Part 15.209.
4. Tabulated data is listed in section 4.0.

4.7 POWER SPECTRAL DENSITY

Test Method: All the radio measurements were performed using the sections from ANSI C63.10, details about the section used can be found in the spectrum analyzer titles on the graph.

Limits of power measurements:

For FCC Part 15.247 Device:
The maximum PSD allowed is 8 dBm.

Test procedures:
Details can be found in section 3.4 of this report.

Deviations from test standard:
No deviation.

Test setup:
Details can be found in section 3.4 of this report.

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

Test results:

Pass

Comments:

1. All the Power Spectral Density (PSD) plots can be found in the Appendix C.
2. All the measurements were found to be compliant.
3. Tabulated data is listed in section 4.0.

4.8 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:

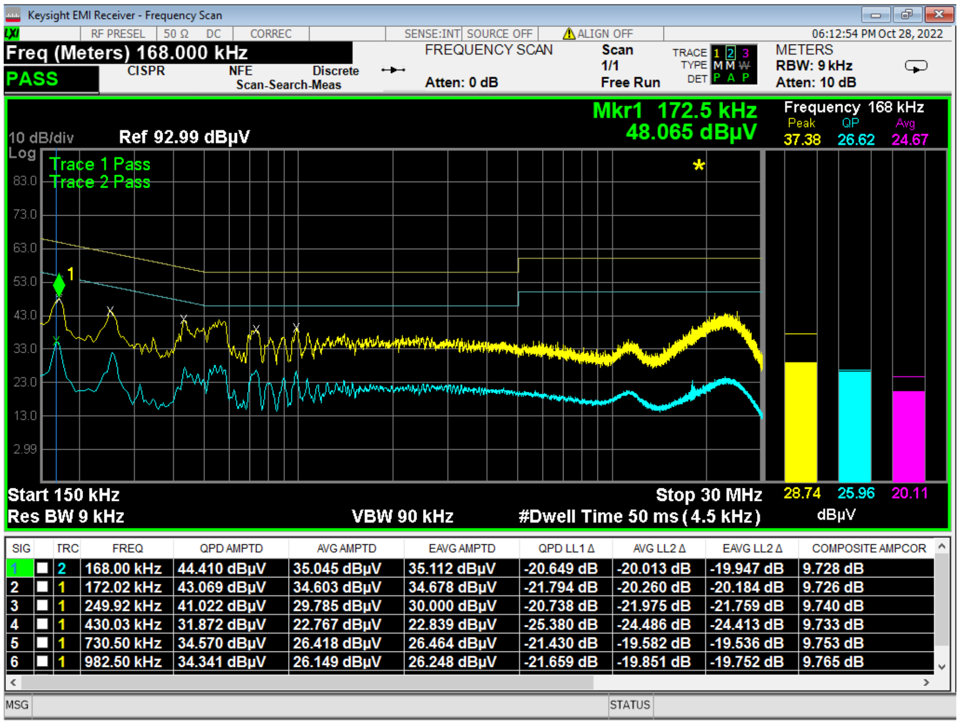


Figure 17 - Conducted Emissions Plot, Line, TX

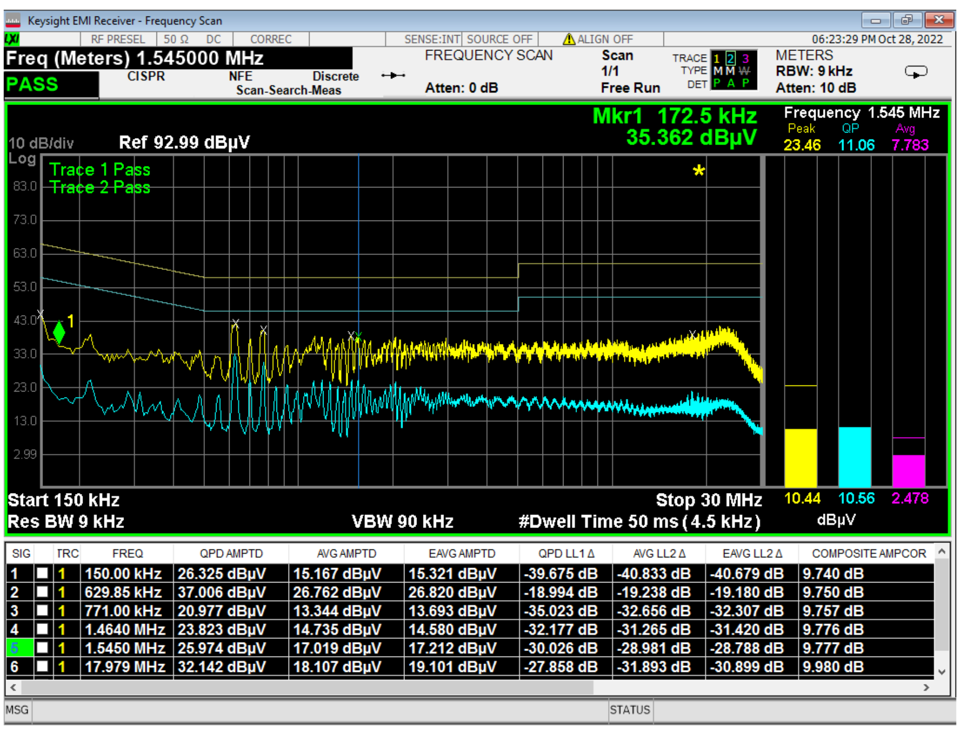
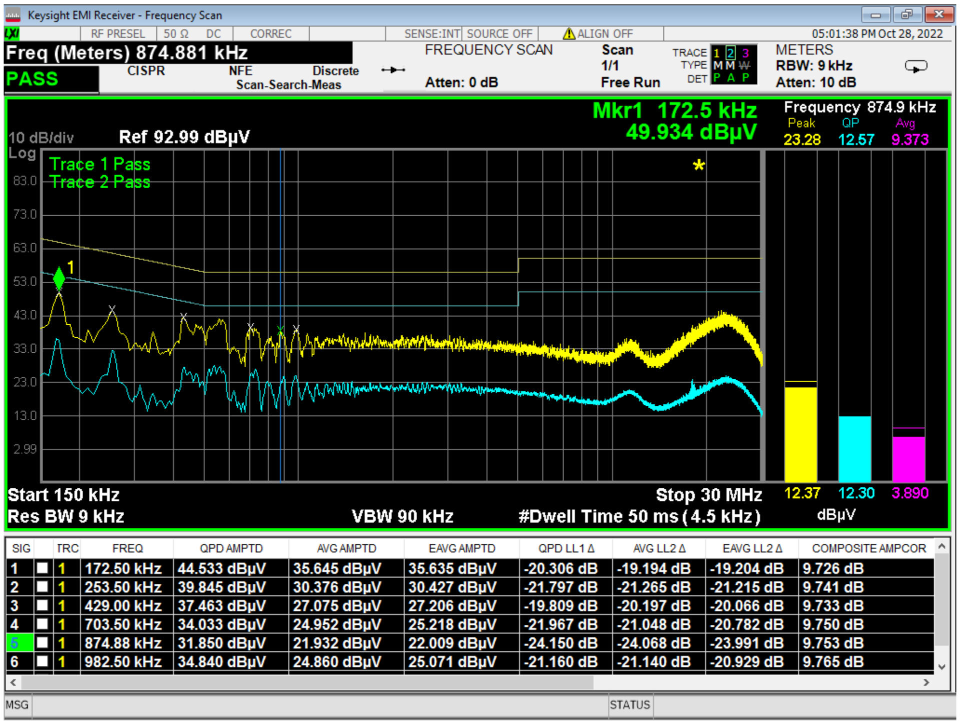
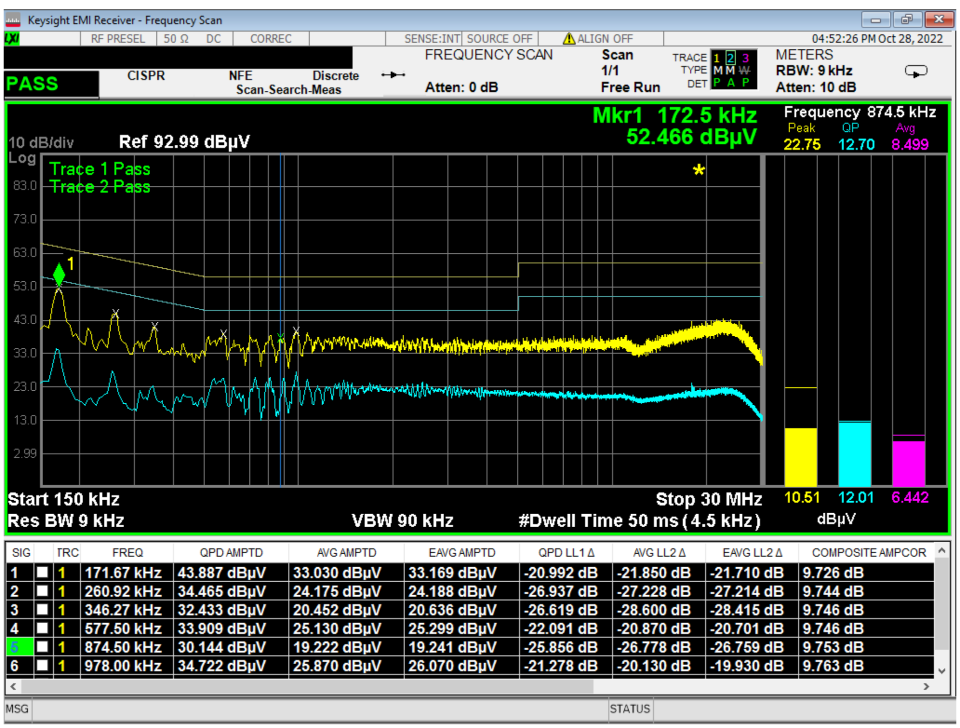


Figure 18 - Conducted Emissions Plot, Neutral, TX



SIG	TRC	FREQ	QPD AMPTD	AVG AMPTD	EAVG AMPTD	QPD LL1 Δ	AVG LL2 Δ	EAVG LL2 Δ	COMPOSITE AMPCOR
1	1	172.50 kHz	44.533 dBµV	35.645 dBµV	35.635 dBµV	-20.306 dB	-19.194 dB	-19.204 dB	9.726 dB
2	1	253.50 kHz	39.845 dBµV	30.376 dBµV	30.427 dBµV	-21.797 dB	-21.265 dB	-21.215 dB	9.741 dB
3	1	429.00 kHz	37.463 dBµV	27.075 dBµV	27.206 dBµV	-19.809 dB	-20.197 dB	-20.066 dB	9.733 dB
4	1	703.50 kHz	34.033 dBµV	24.952 dBµV	25.218 dBµV	-21.967 dB	-21.048 dB	-20.782 dB	9.750 dB
5	1	874.88 kHz	31.850 dBµV	21.932 dBµV	22.009 dBµV	-24.150 dB	-24.068 dB	-23.991 dB	9.753 dB
6	1	982.50 kHz	34.840 dBµV	24.860 dBµV	25.071 dBµV	-21.160 dB	-21.140 dB	-20.929 dB	9.765 dB

Figure 19 - Conducted Emissions Plot, Line, IDLE



SIG	TRC	FREQ	QPD AMPTD	AVG AMPTD	EAVG AMPTD	QPD LL1 Δ	AVG LL2 Δ	EAVG LL2 Δ	COMPOSITE AMPCOR
1	1	171.67 kHz	43.887 dBµV	33.030 dBµV	33.169 dBµV	-20.992 dB	-21.850 dB	-21.710 dB	9.726 dB
2	1	260.92 kHz	34.465 dBµV	24.175 dBµV	24.188 dBµV	-26.937 dB	-27.228 dB	-27.214 dB	9.744 dB
3	1	346.27 kHz	32.433 dBµV	20.452 dBµV	20.636 dBµV	-26.619 dB	-28.600 dB	-28.415 dB	9.746 dB
4	1	577.50 kHz	33.909 dBµV	25.130 dBµV	25.299 dBµV	-22.091 dB	-20.870 dB	-20.701 dB	9.746 dB
5	1	874.50 kHz	30.144 dBµV	19.222 dBµV	19.241 dBµV	-25.856 dB	-26.778 dB	-26.759 dB	9.753 dB
6	1	978.00 kHz	34.722 dBµV	25.870 dBµV	26.070 dBµV	-21.278 dB	-20.130 dB	-19.930 dB	9.763 dB

Figure 20 - Conducted Emissions Plot, Neutral, IDLE

4.9 ANTENNA GAIN

Test procedures:
Device's conducted power was measured then then same measurement was repeated on a radiated sample at 3m test distance and converted to E.I.R.P.

Test setup:
Details can be found in section 2.1 of this report.

EUT operating conditions:
Details can be found in section 2.1 and 2.2 of this report.

Test results:

Antenna Gain:
Radiated Average power – Conducted Average Power = Antenna gain
12.24 dBm – 15.53 dBm = **-3.29 dBi**

Comments:

1. Data was used from a different transmitter that utilizes the same antenna and same frequency band
2. Since antenna gain was negative, conducted values were compared to the limit as if 0dBm gain for worst case

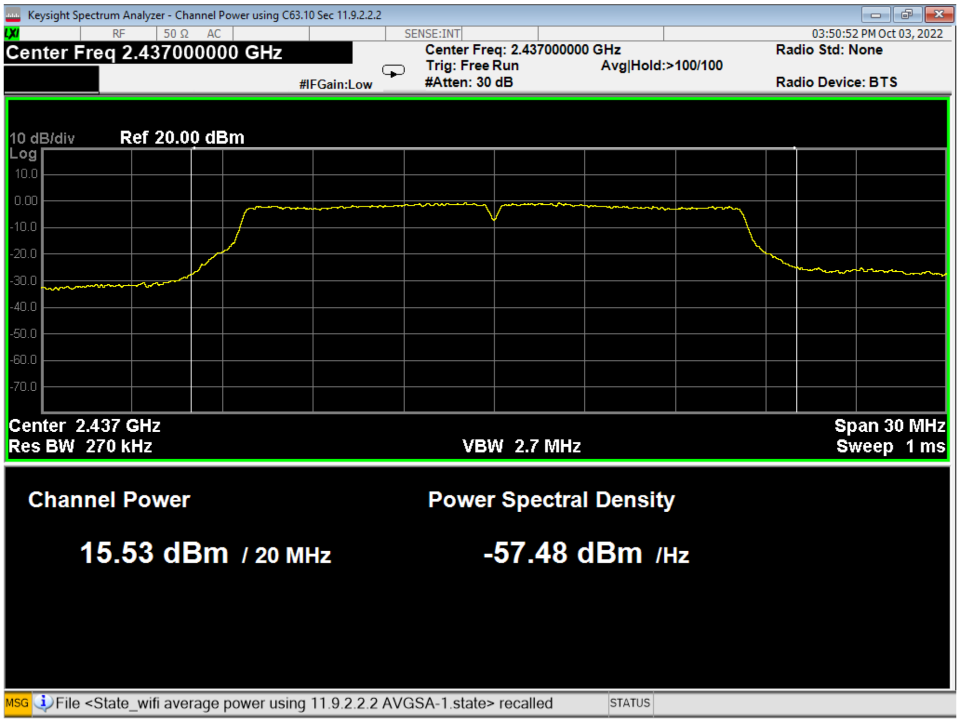


Figure 21 – Conducted Average Power Measurement, 802.11g 6MB

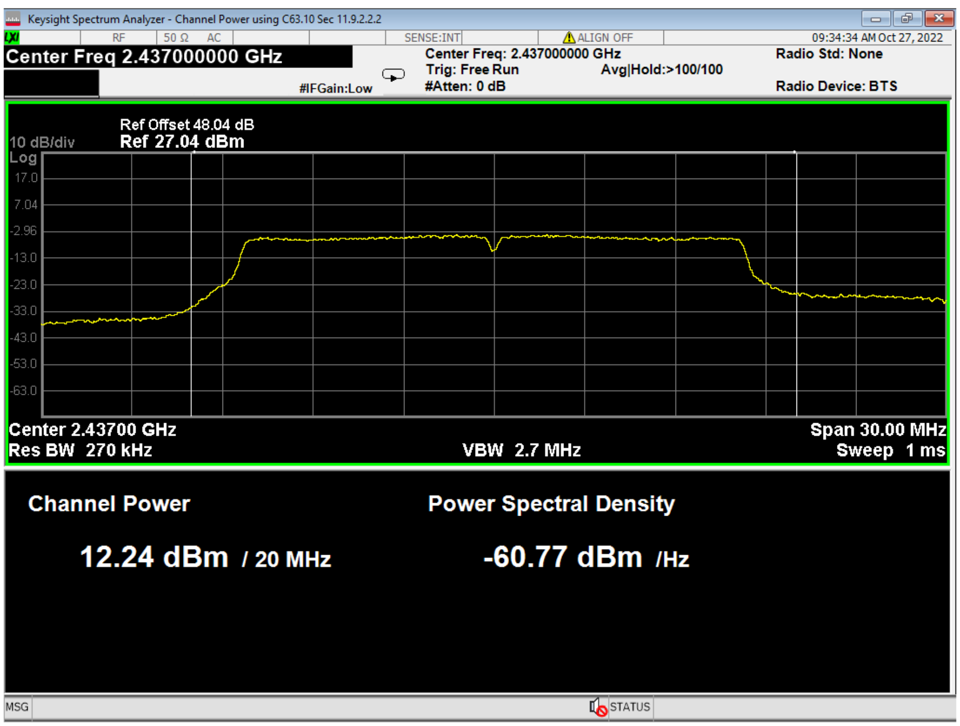


Figure 22 – Radiated Average Power Measurement, 802.11g 6MB

Reference offset includes EIRP conversion and corrections

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

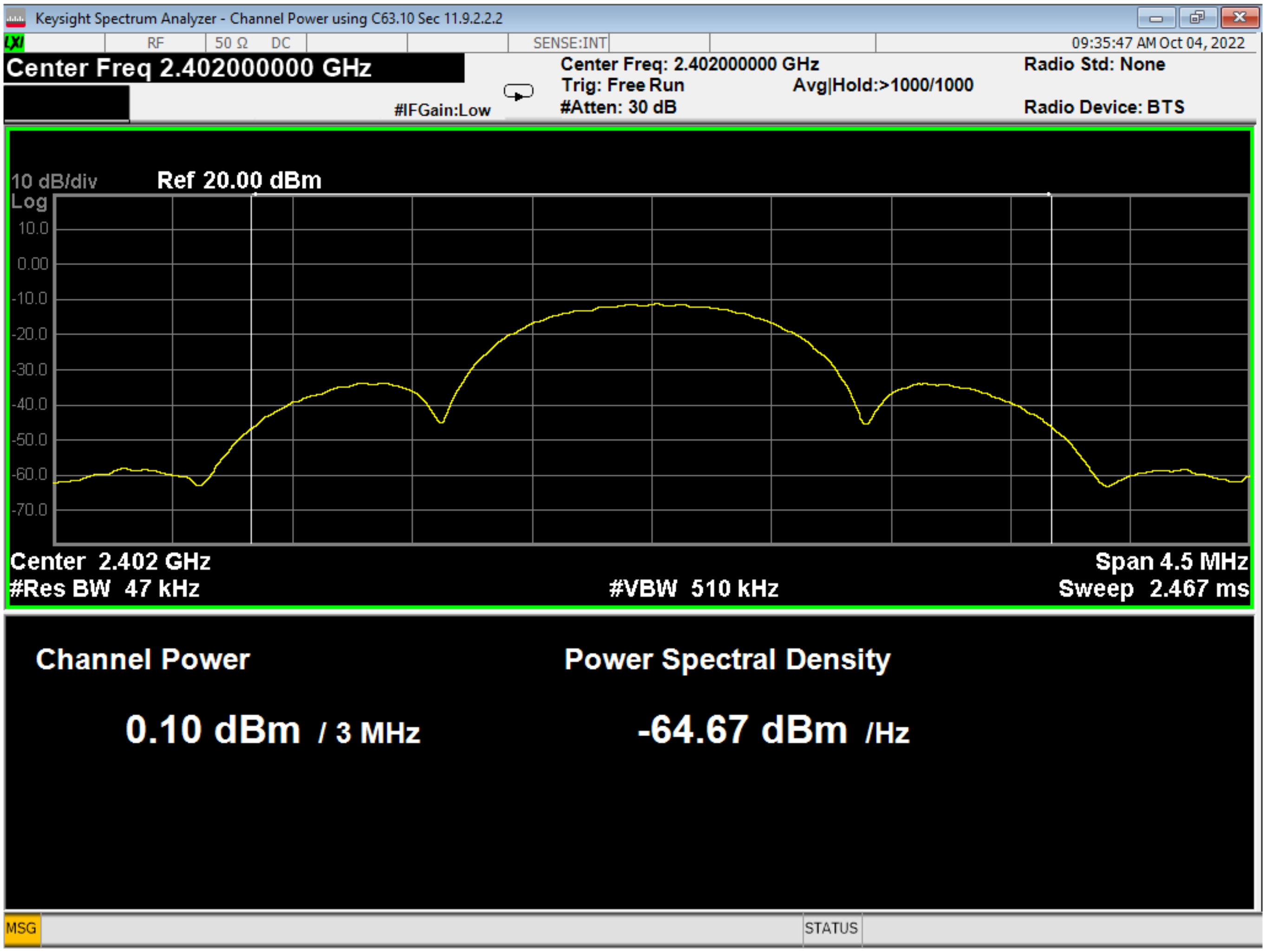
APPENDIX B – MEASUREMENT UNCERTAINTY

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

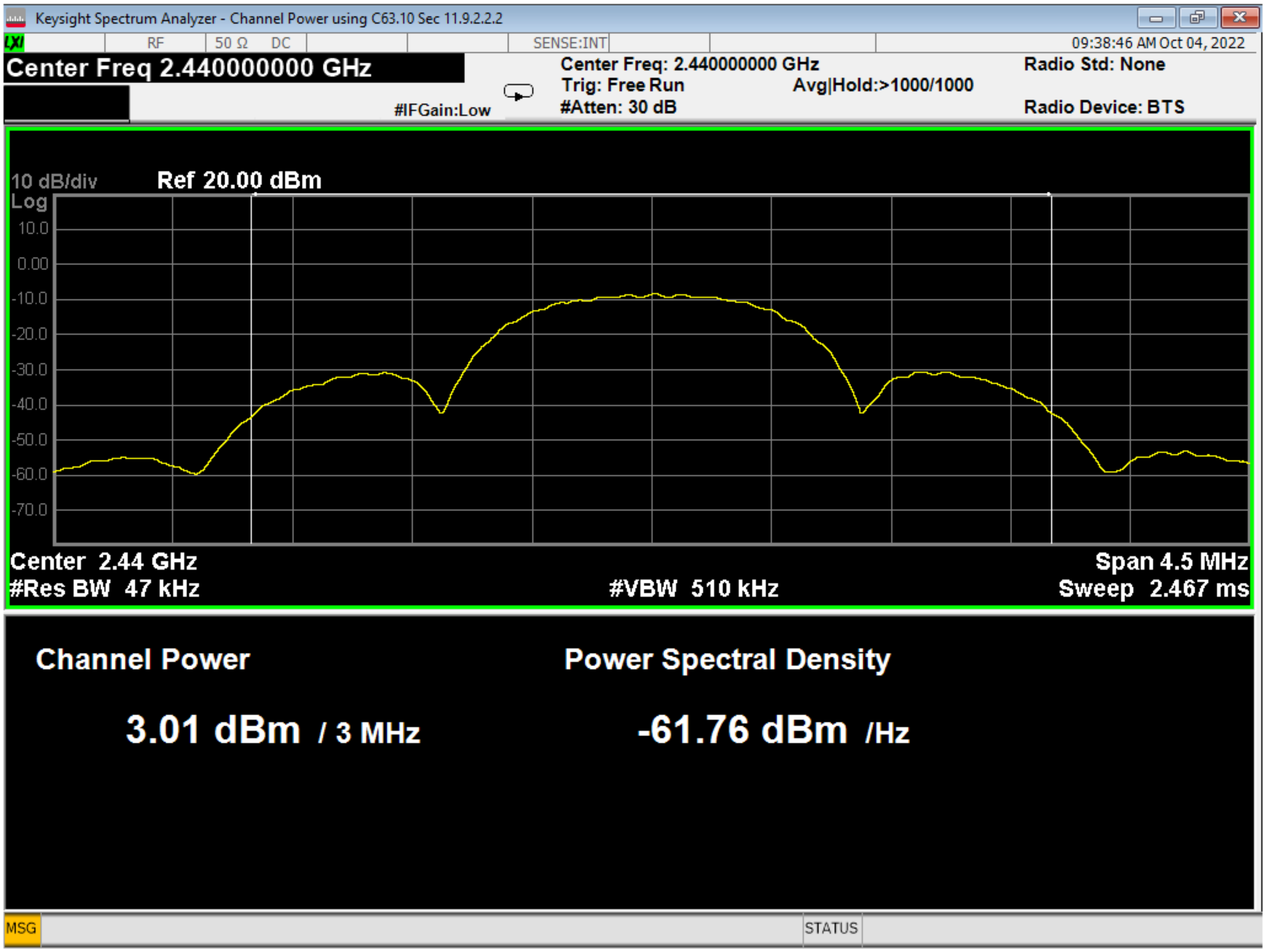
Test	Frequency Range	Uncertainty Value (dB)
Radiated Emissions, 3m	30MHz - 1GHz	±4.31
Radiated Emissions, 3m	1GHz - 18GHz	±5.08
Emissions limits, conducted	30MHz – 18GHz	±3.03

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

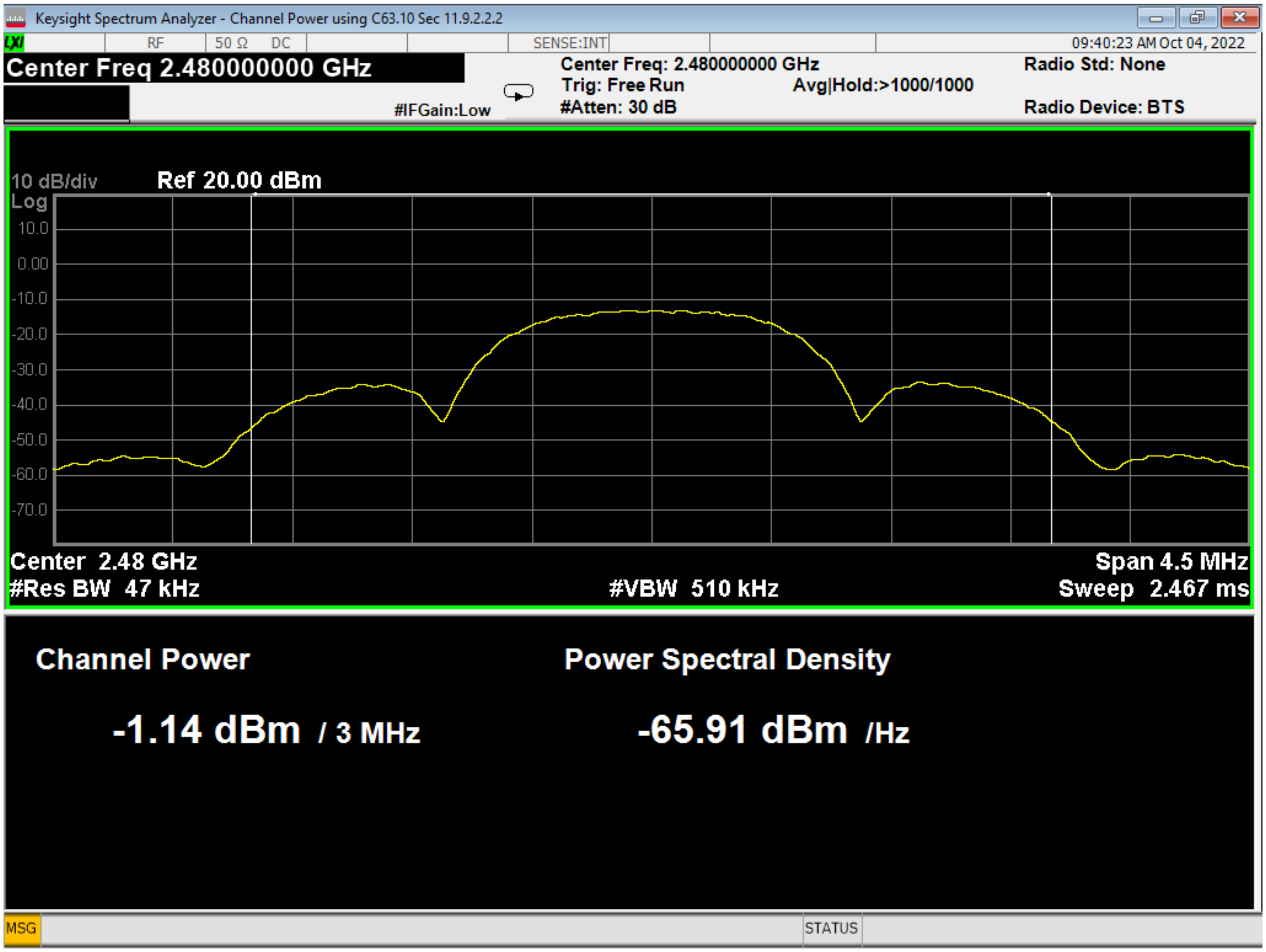
APPENDIX C – GRAPHS AND TABLES



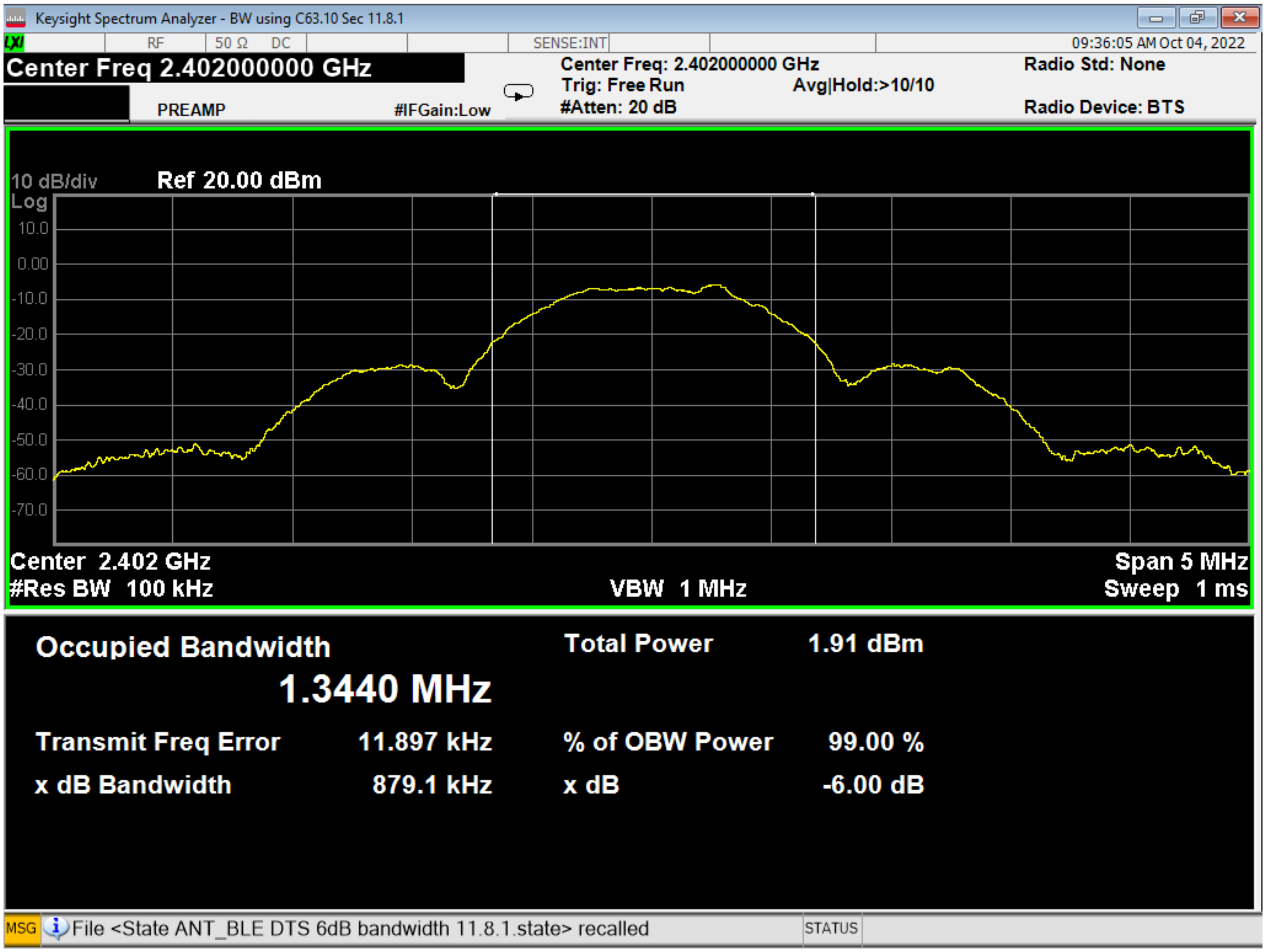
01 Average Power, Low Channel, GFSK



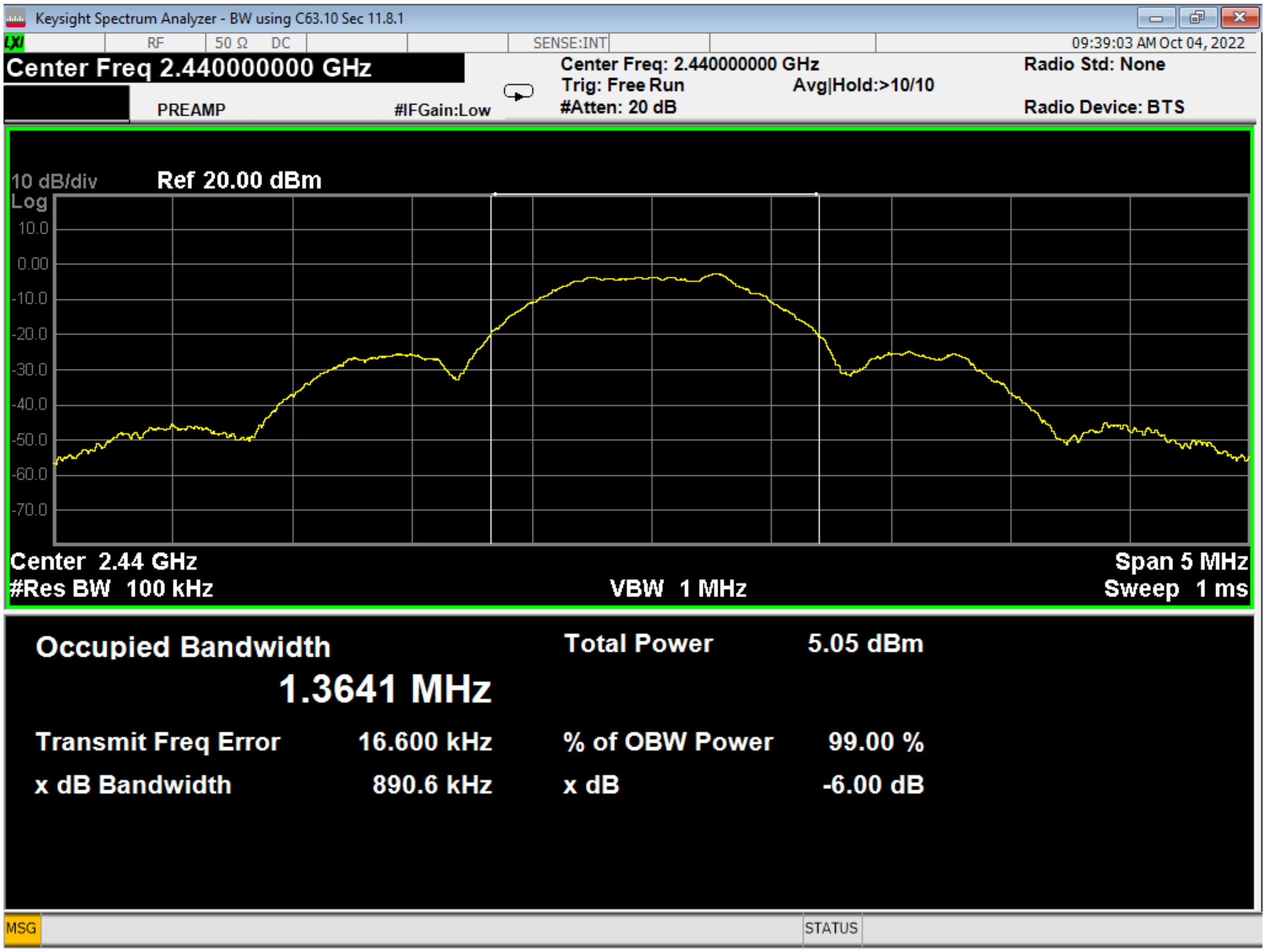
02 Average Power, Mid Channel, GFSK



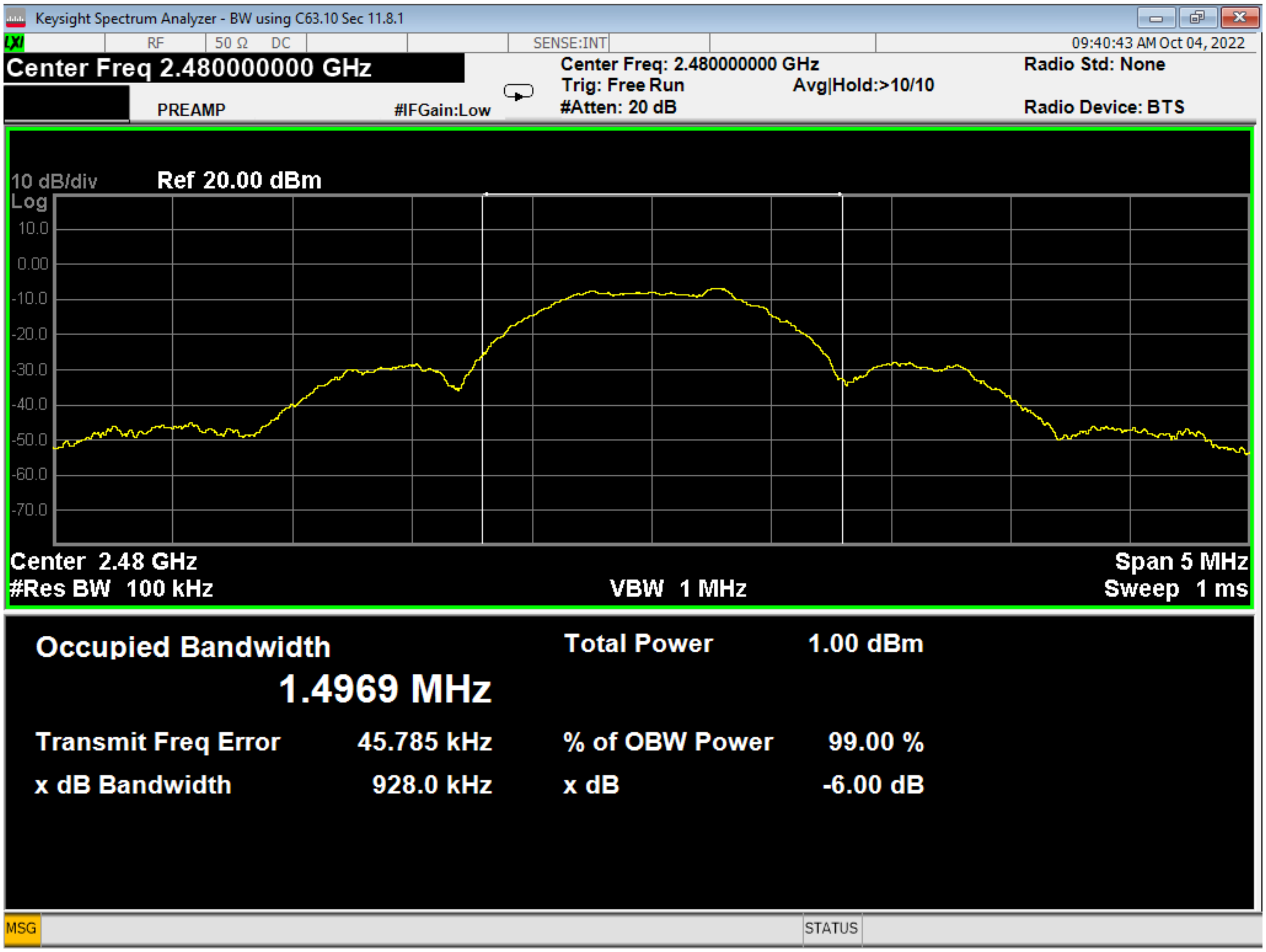
03 Average Power, High Channel, GFSK



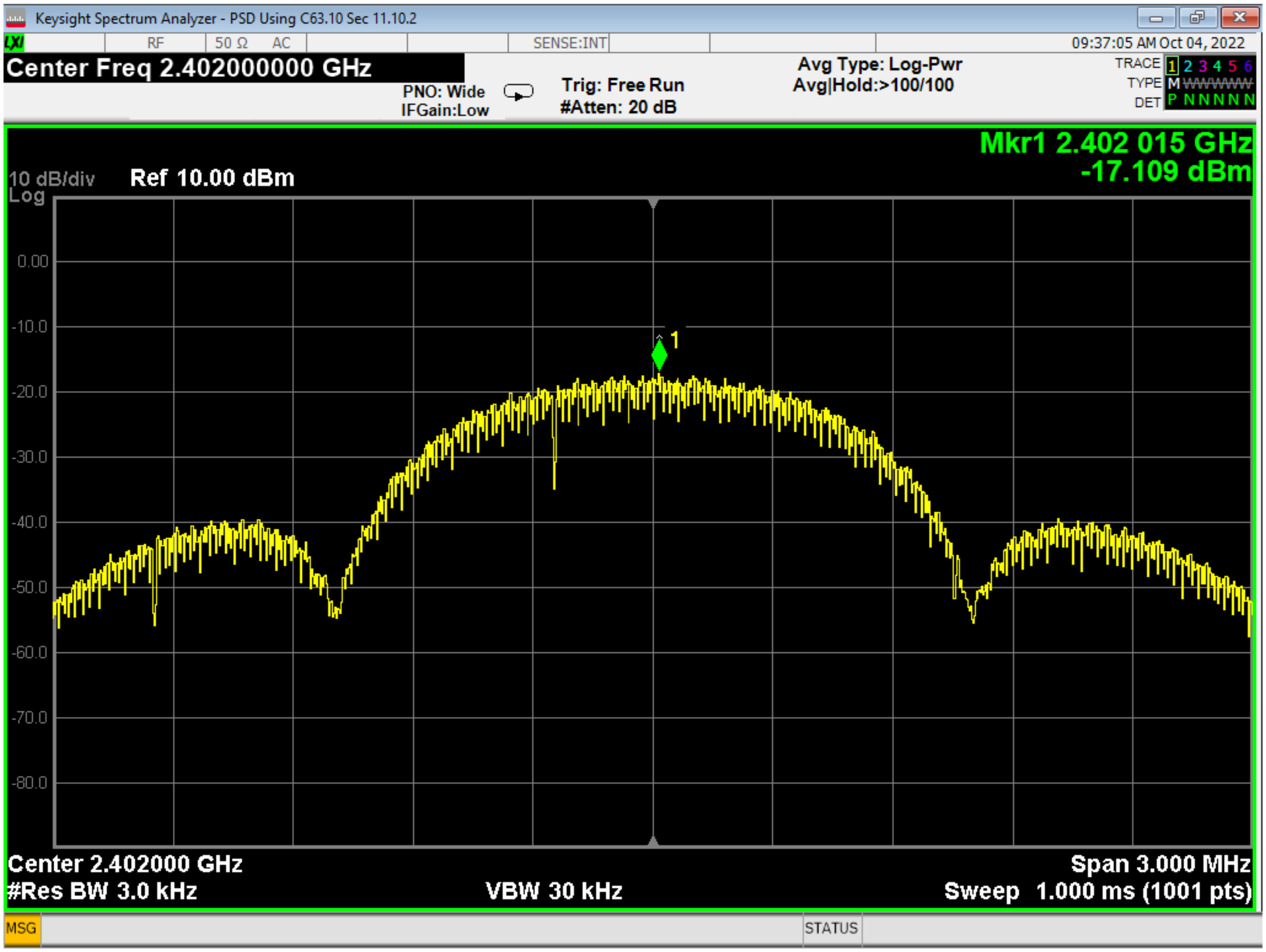
04 6dB Bandwidth, Low Channel, GFSK



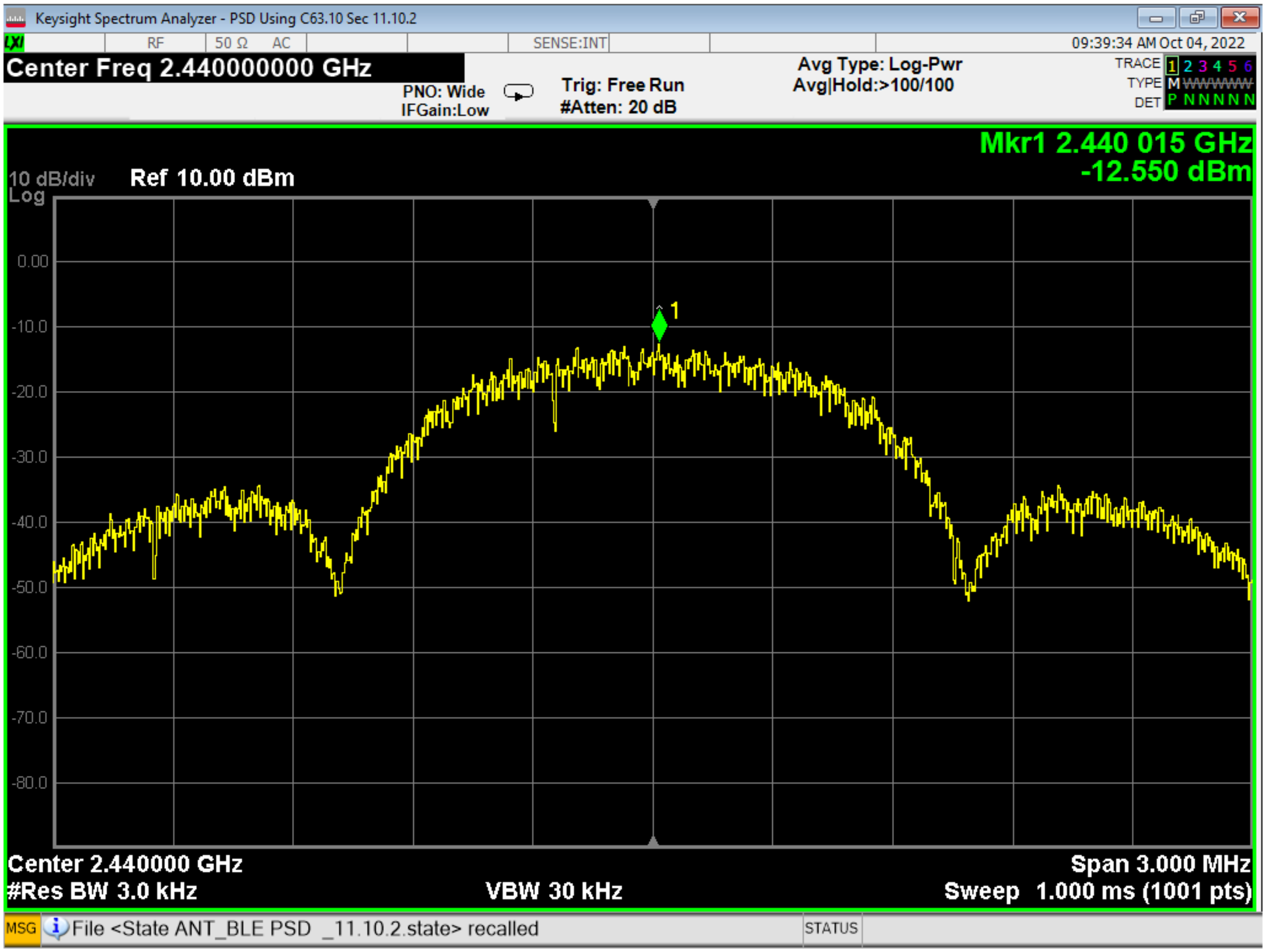
05 6dB Bandwidth, Mid Channel, GFSK



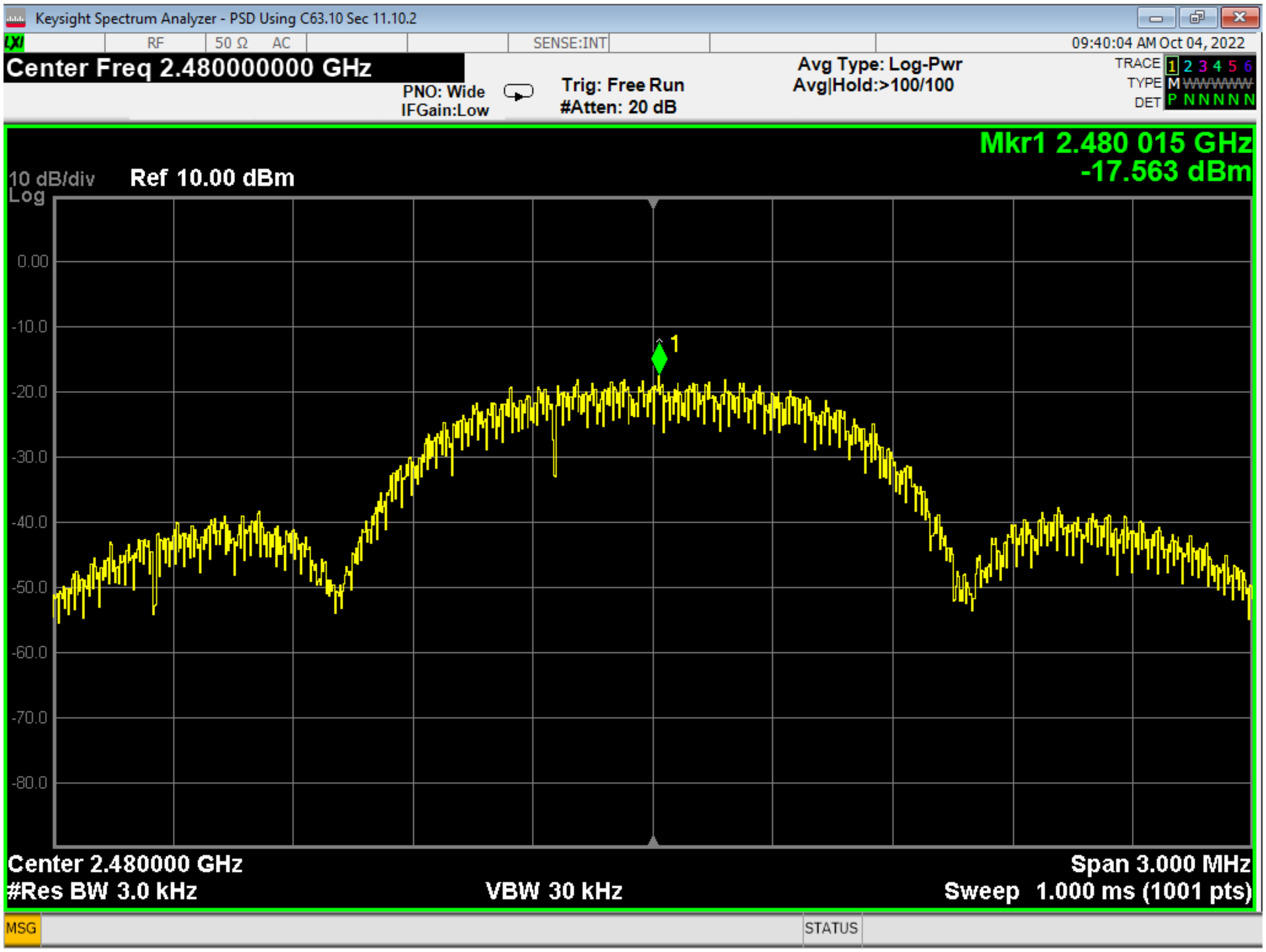
06 6dB Bandwidth, High Channel, GFSK



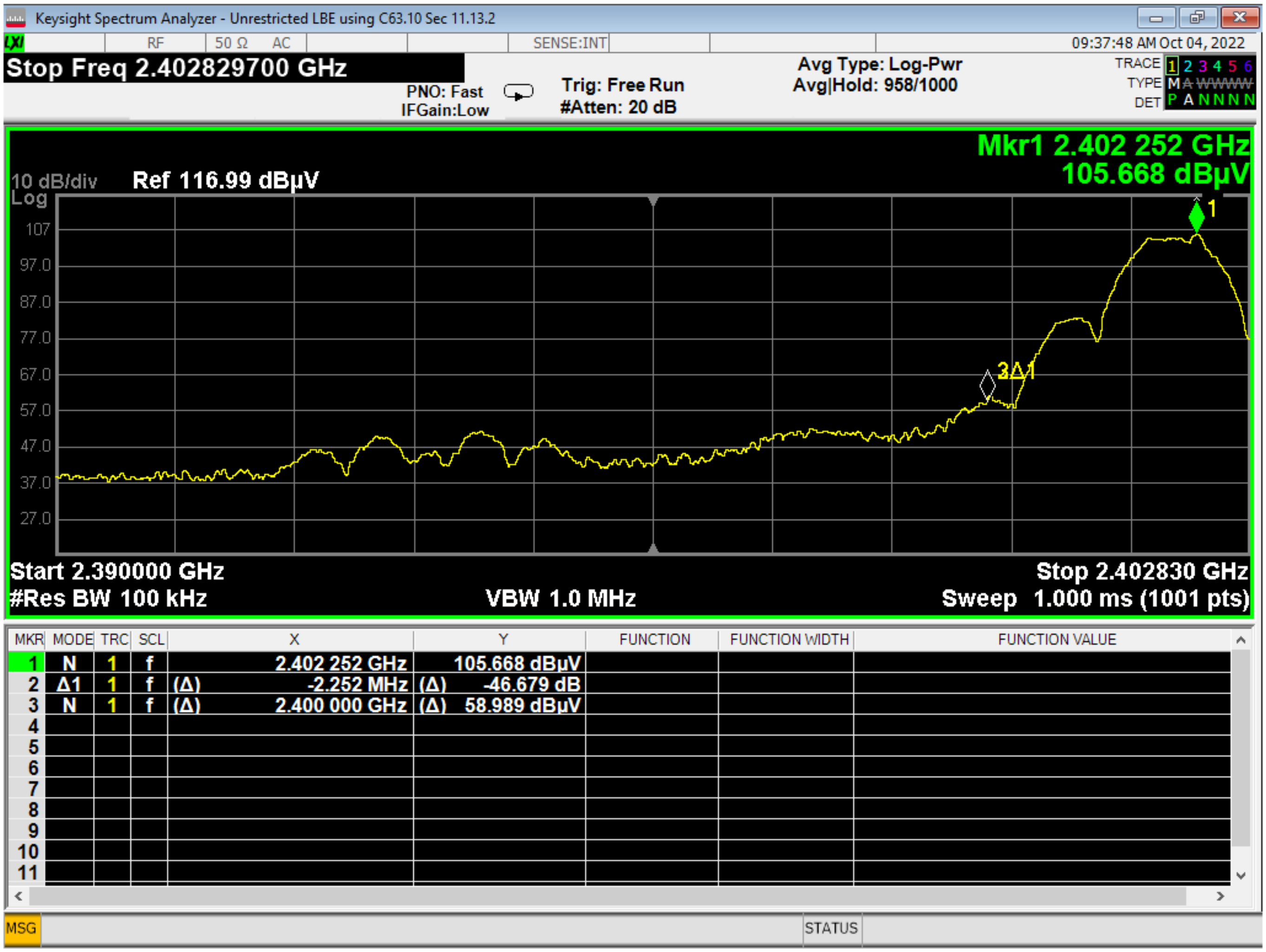
07 PSD, Low Channel, GFSK



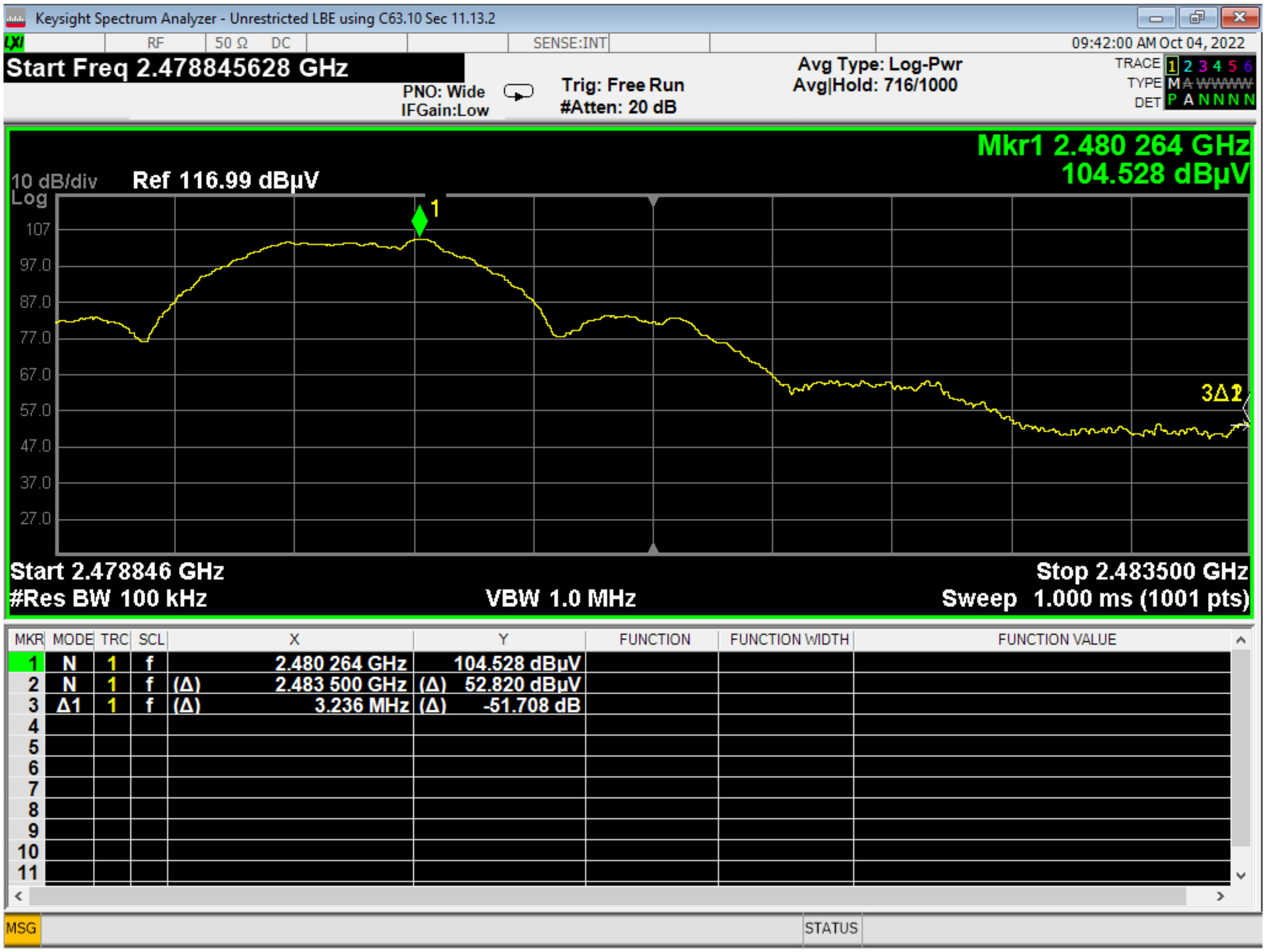
08 PSD, Mid Channel, GFSK



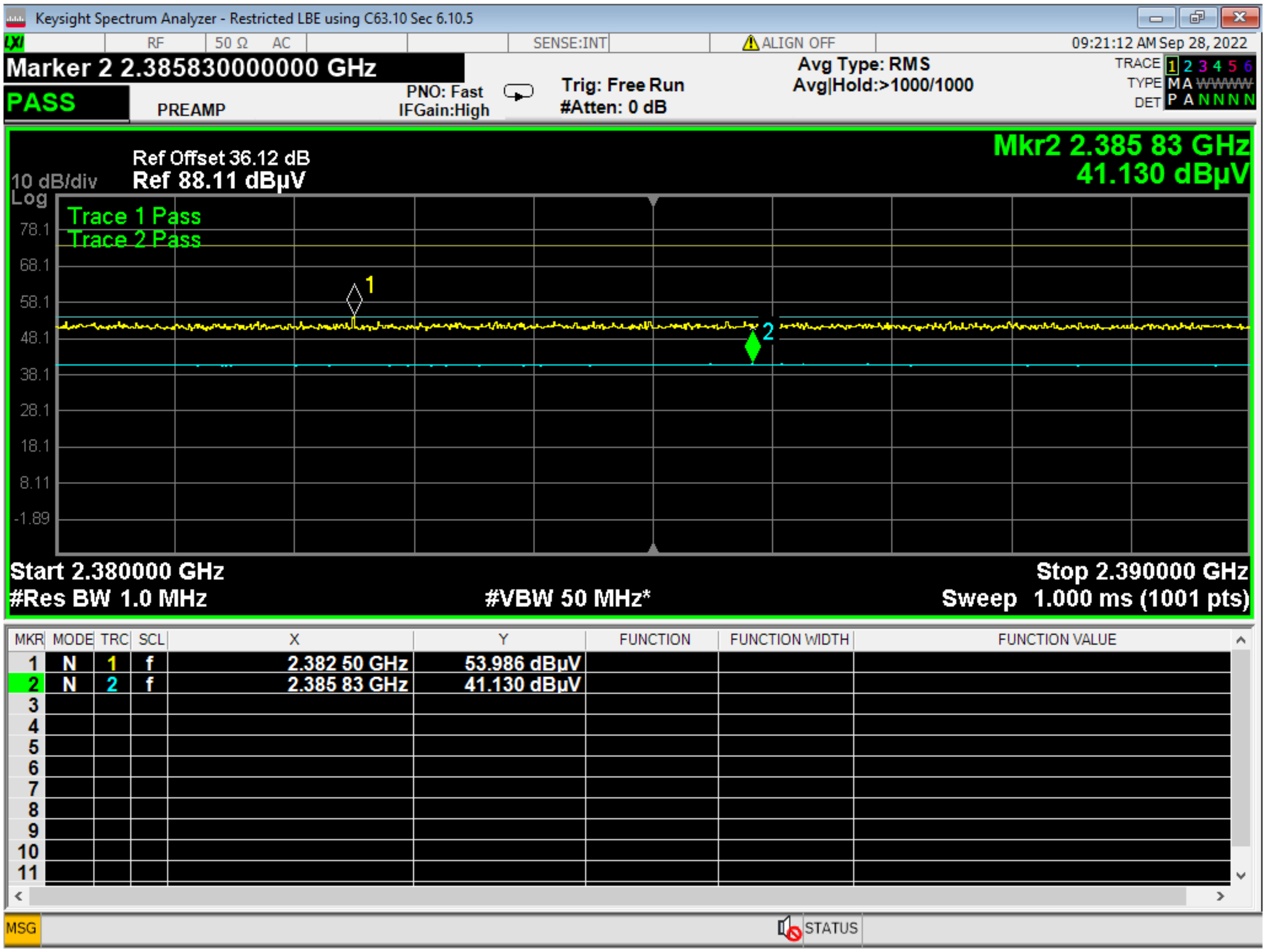
09 PSD, High Channel, GFSK



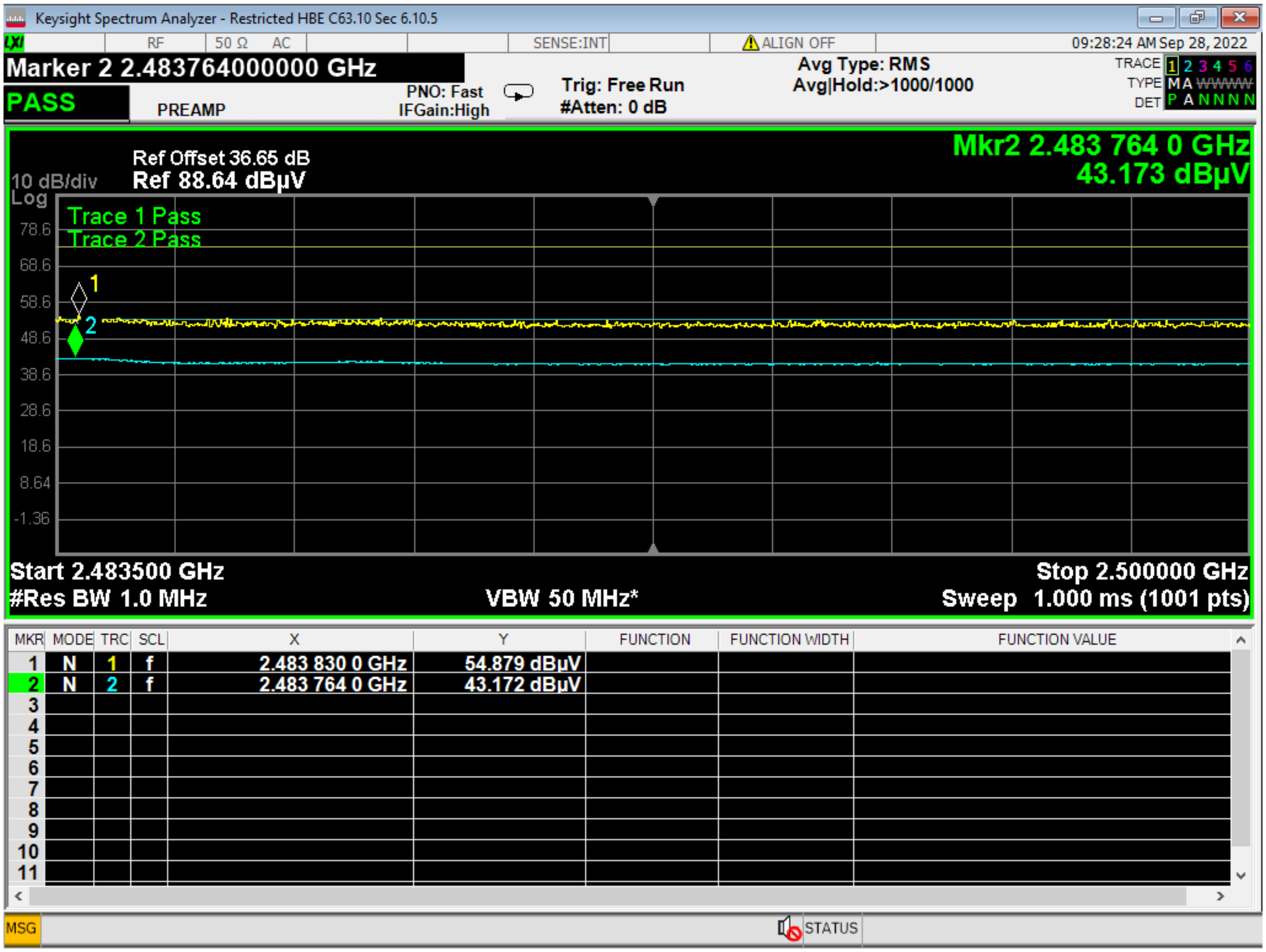
10 Lower Bandedge, Unrestricted, GFSK



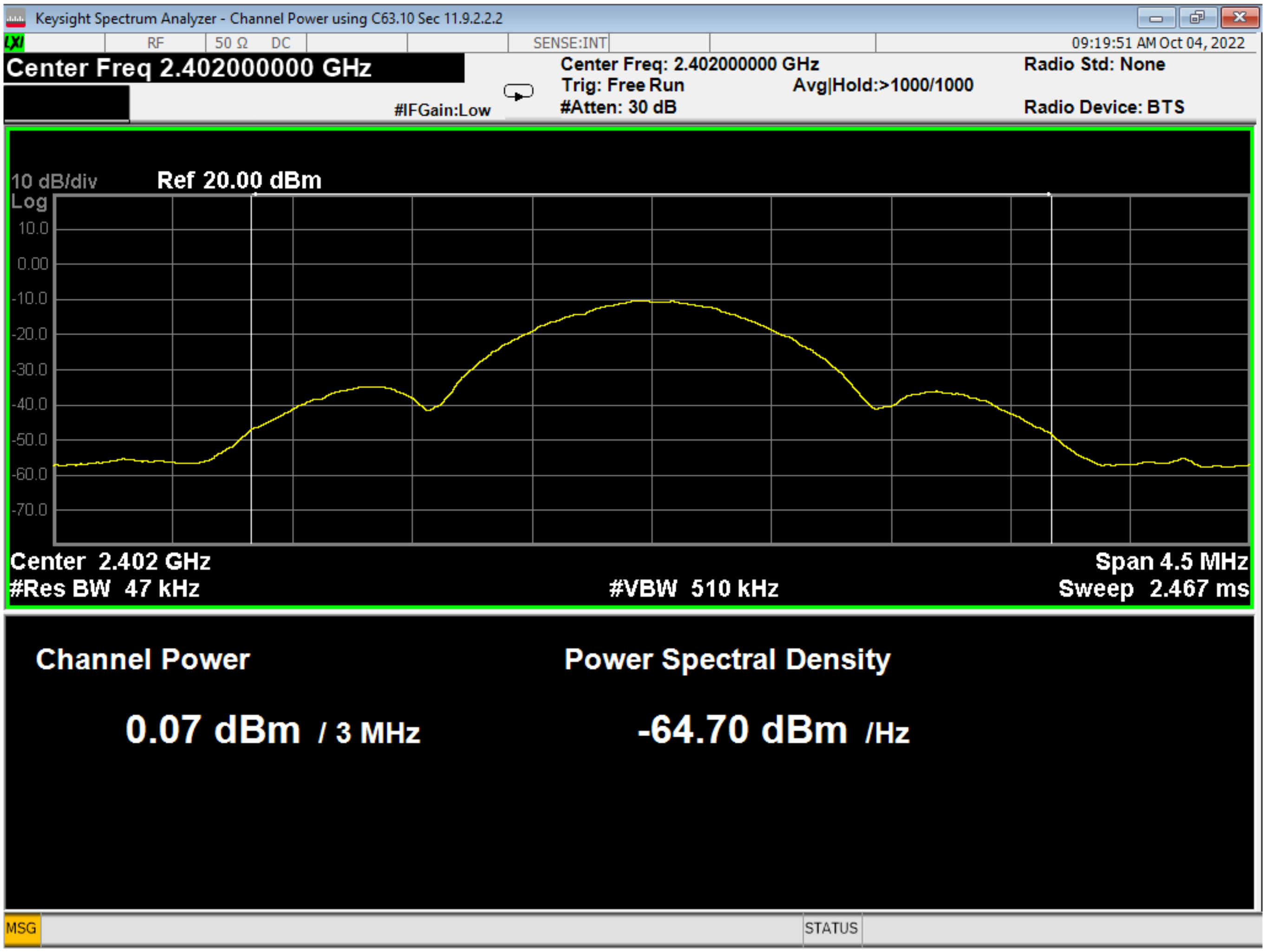
11 Higher Bandedge, Unrestricted, GFSK



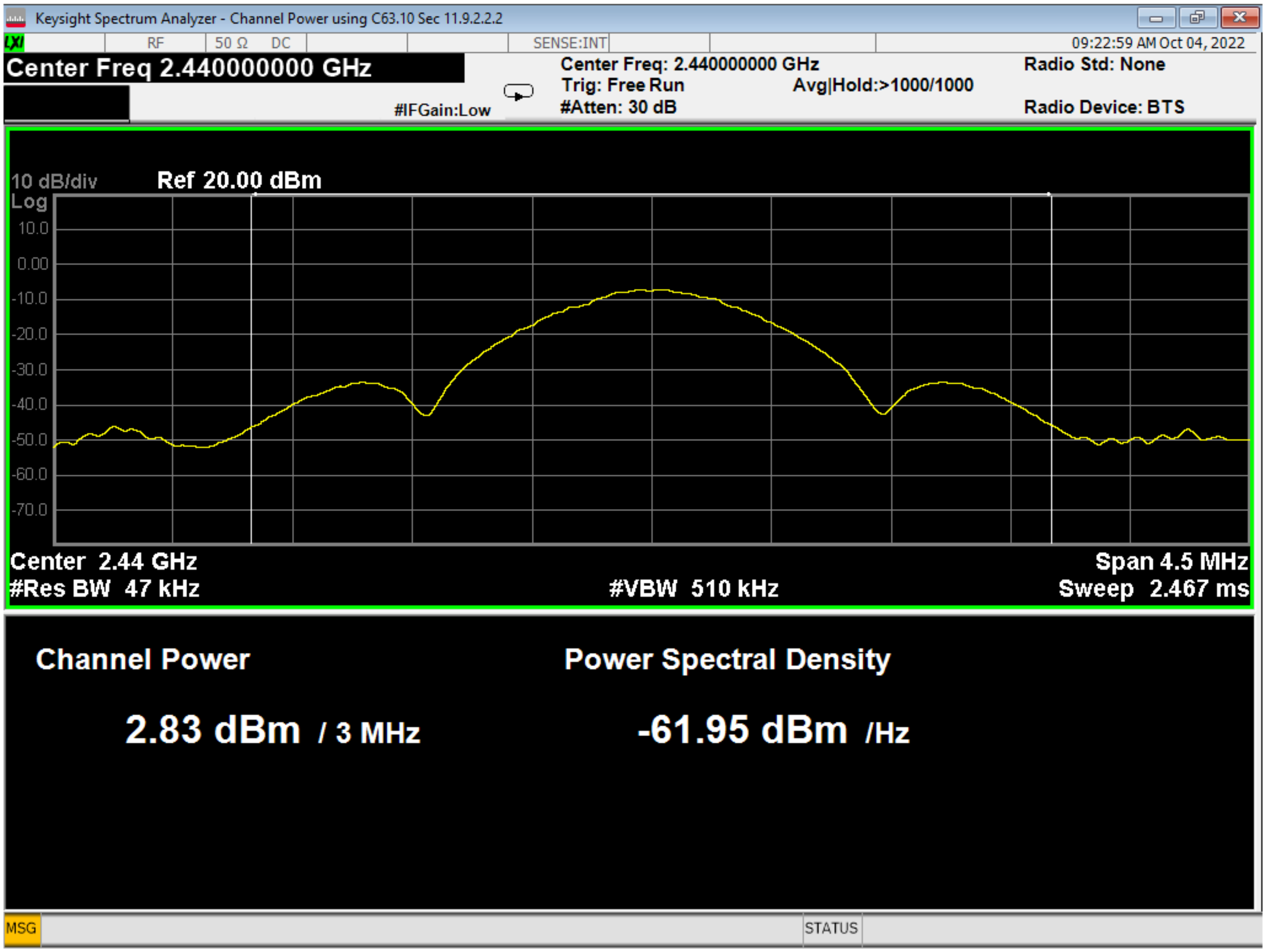
12 Lower Bandedge, Restricted, GFSK



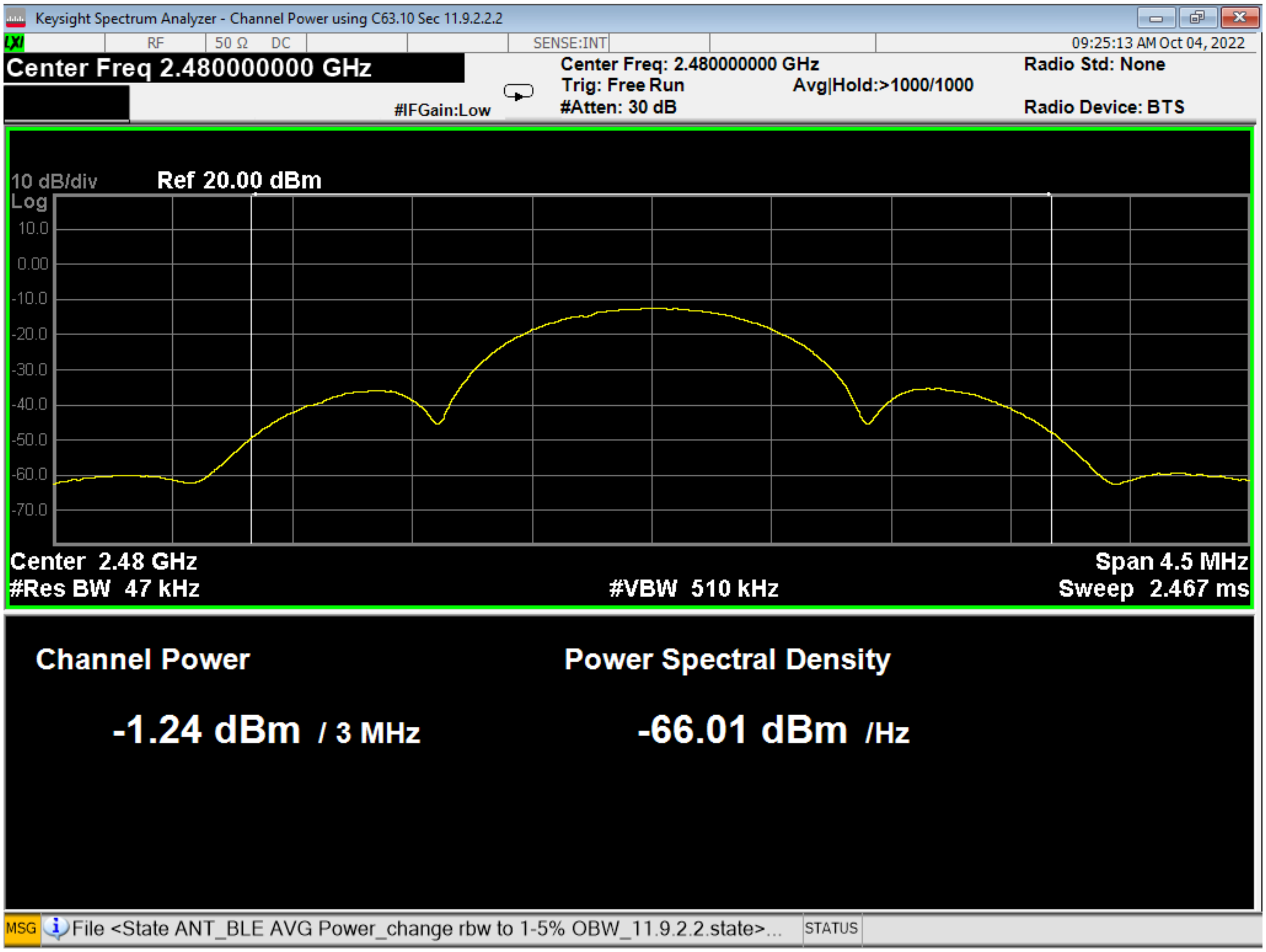
13 Higher Bandedge, Restricted, GFSK



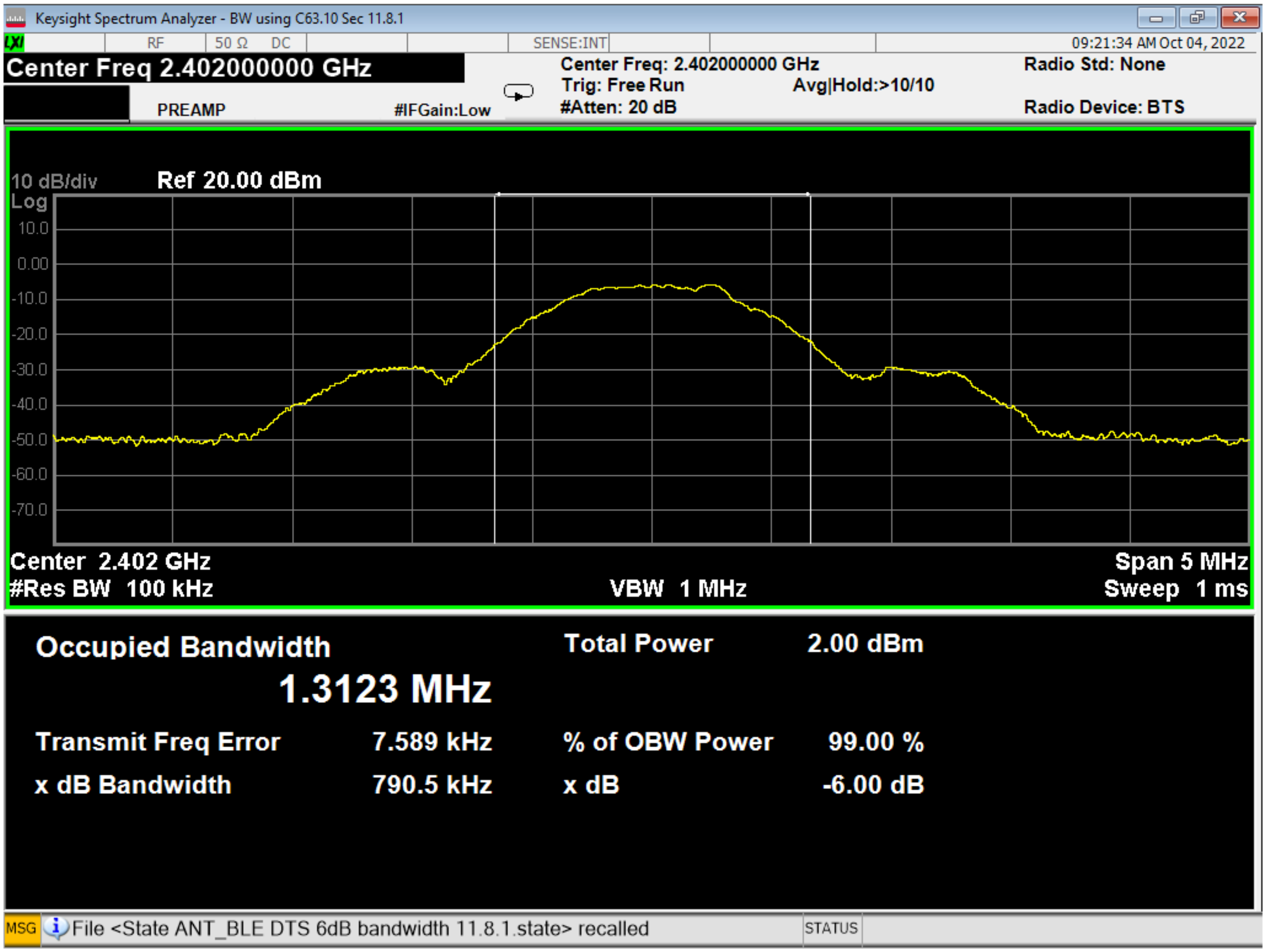
14 Average Power, Low Channel, GMSK 1MB



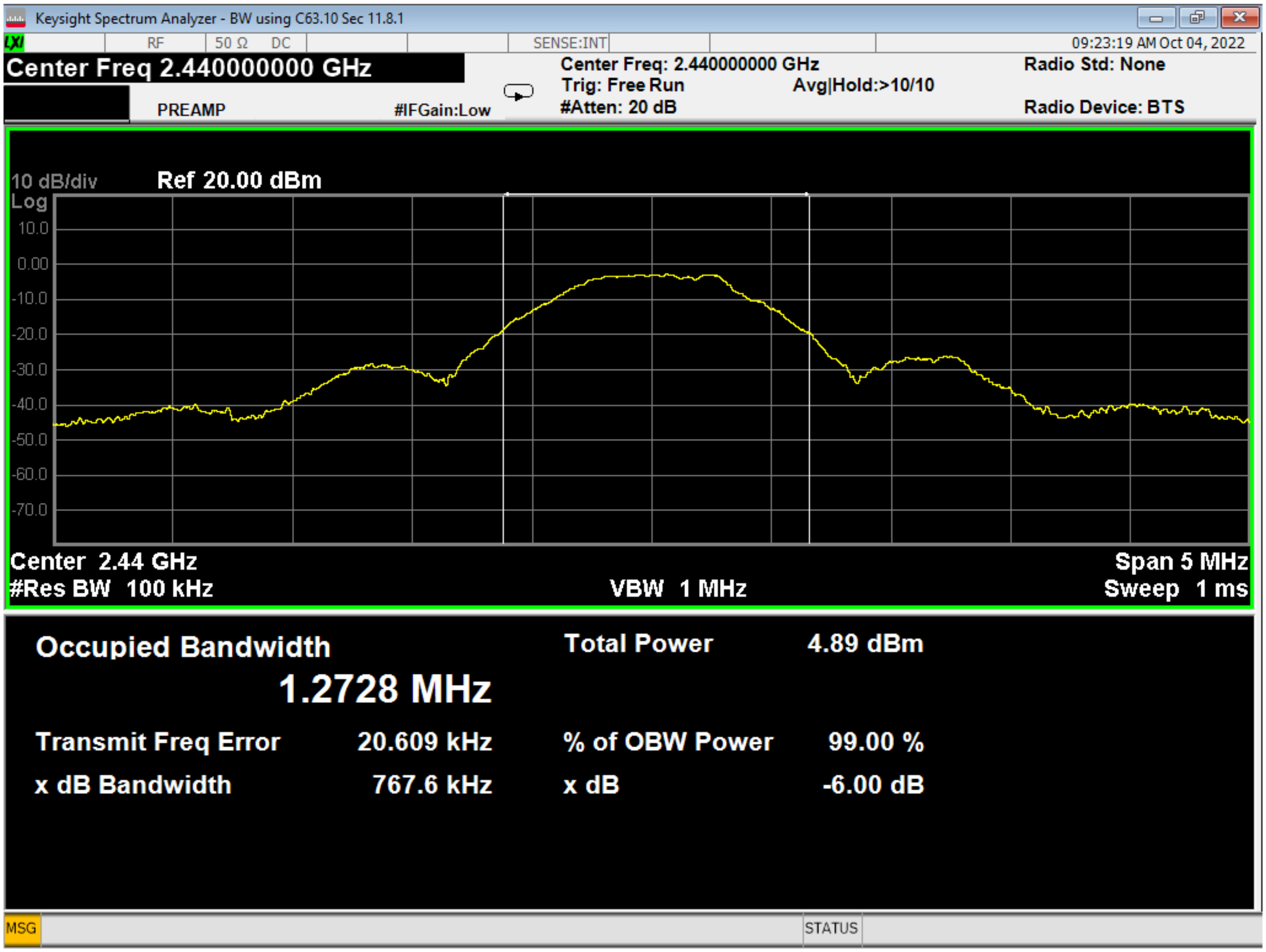
15 Average Power, Mid Channel, GMSK 1MB



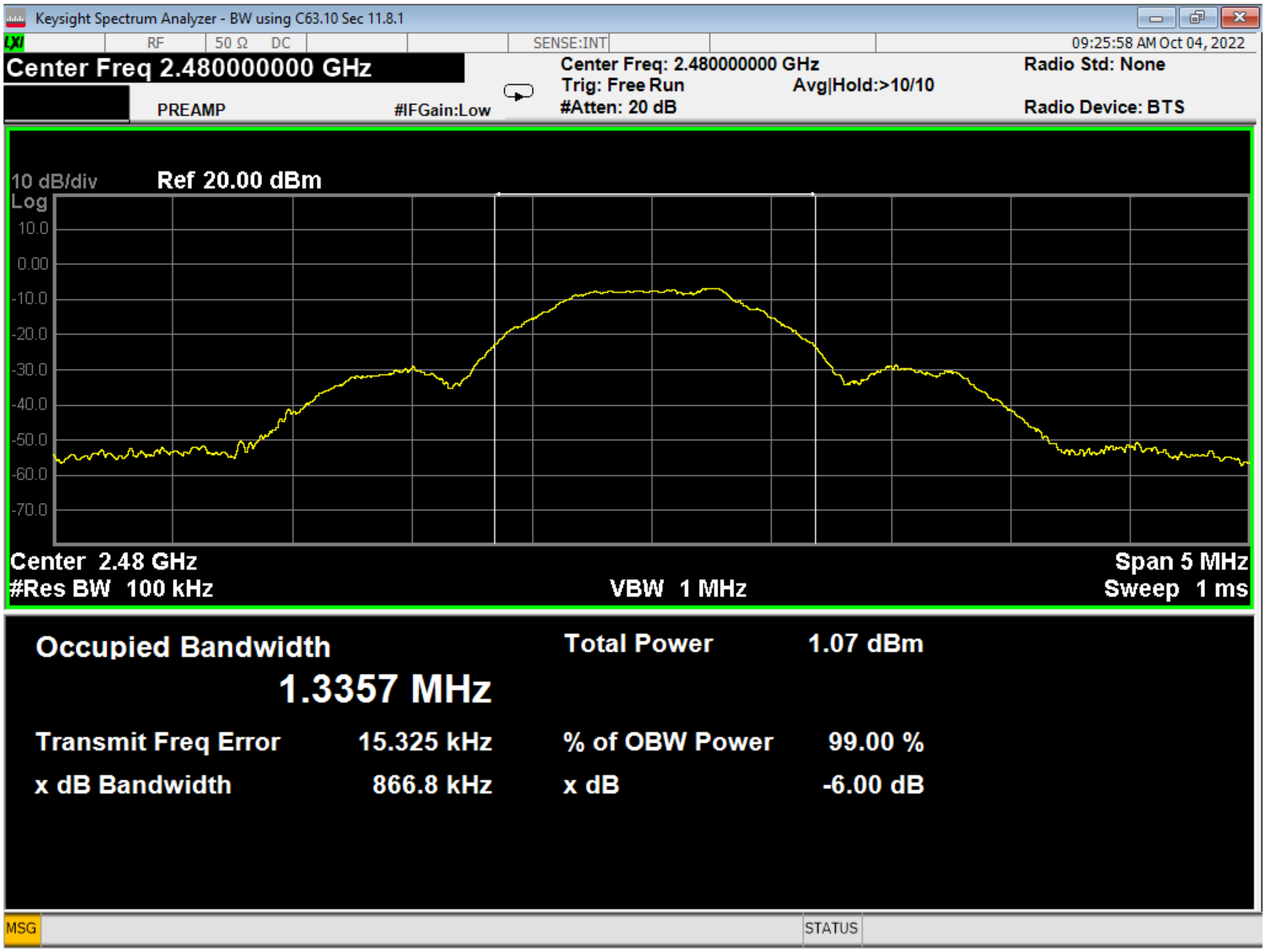
16 Average Power, High Channel, GMSK 1MB



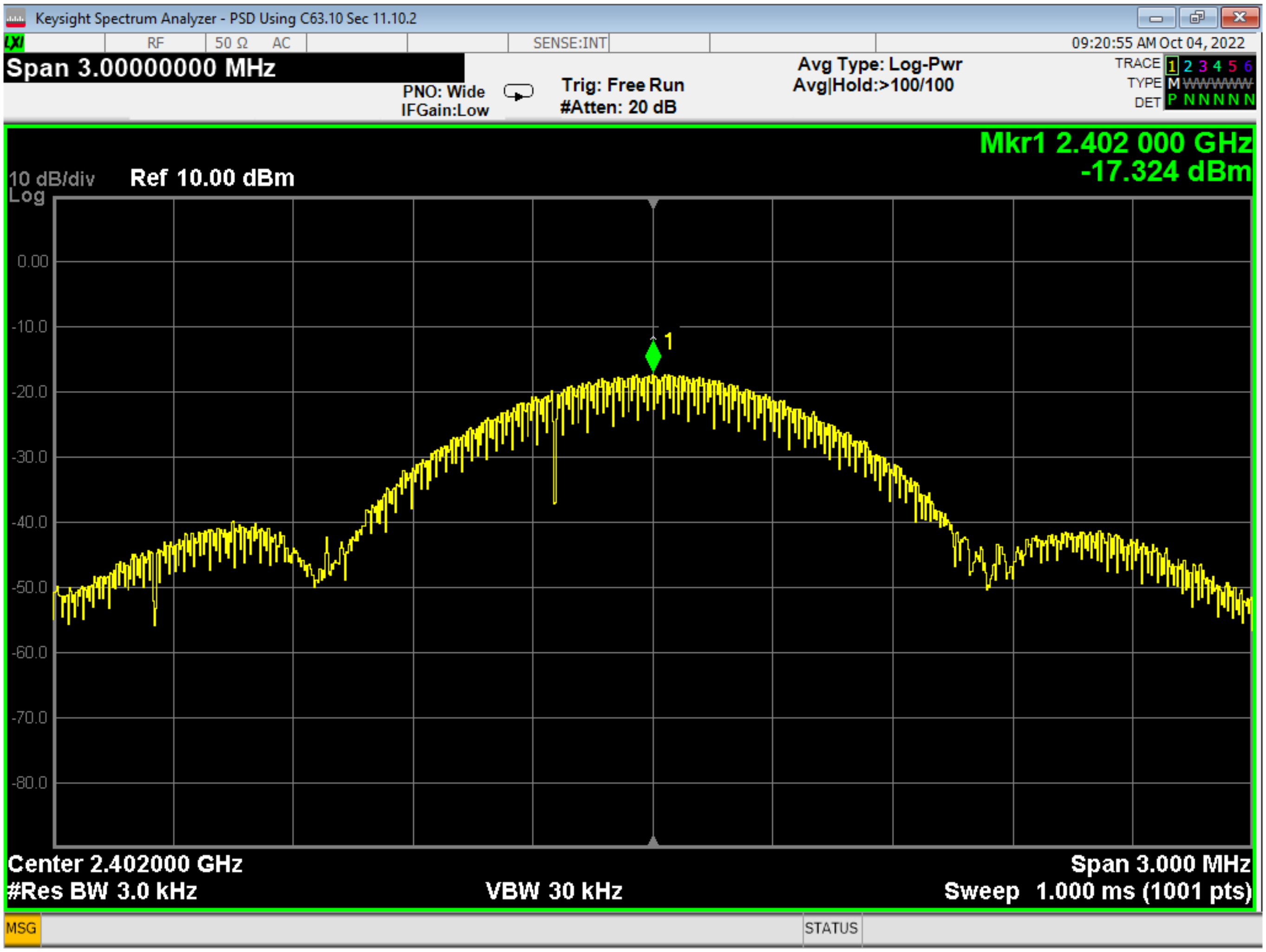
17 6dB Bandwidth, Low Channel, GMSK 1MB



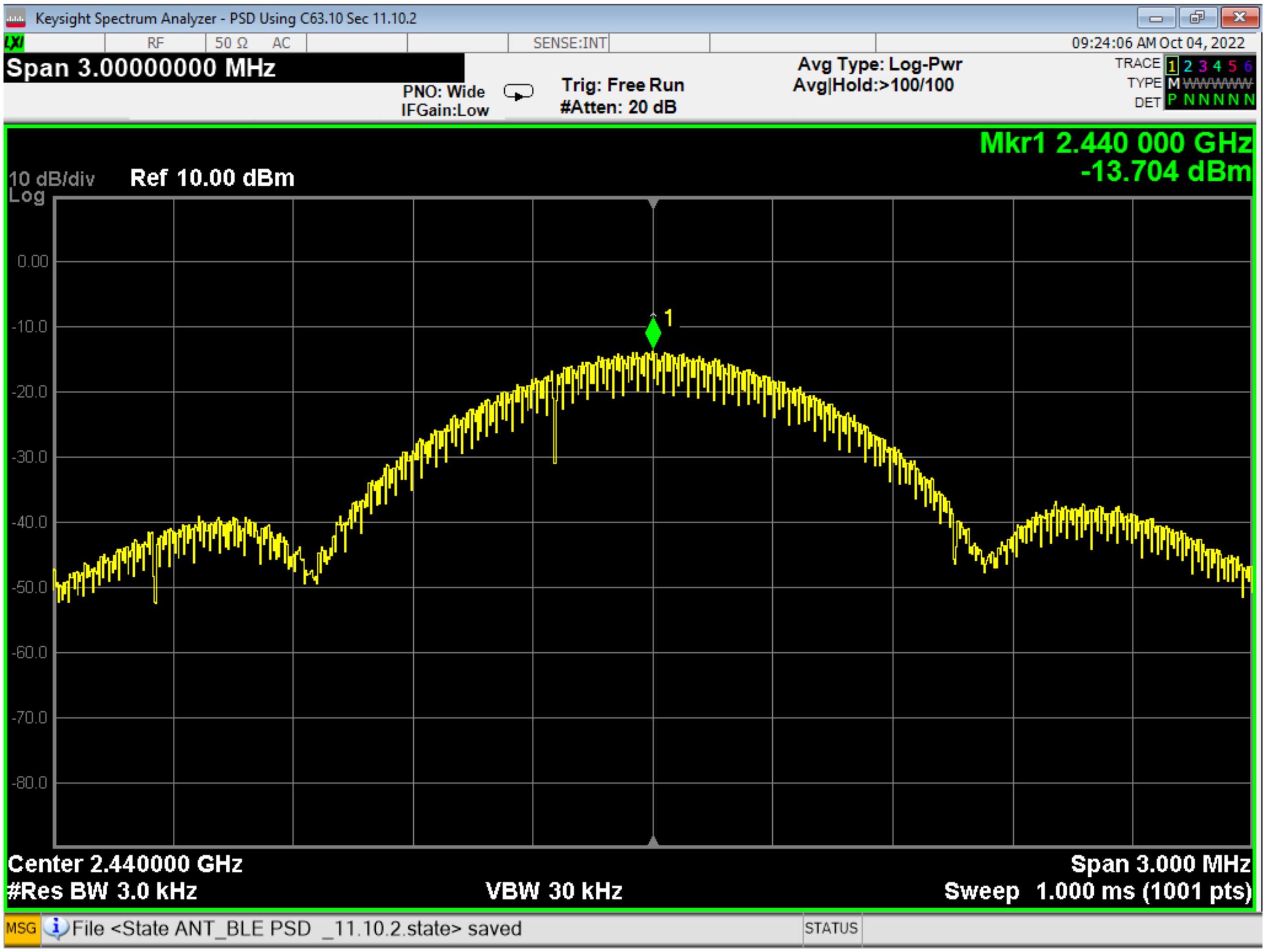
18 6dB Bandwidth, Mid Channel, GMSK 1MB



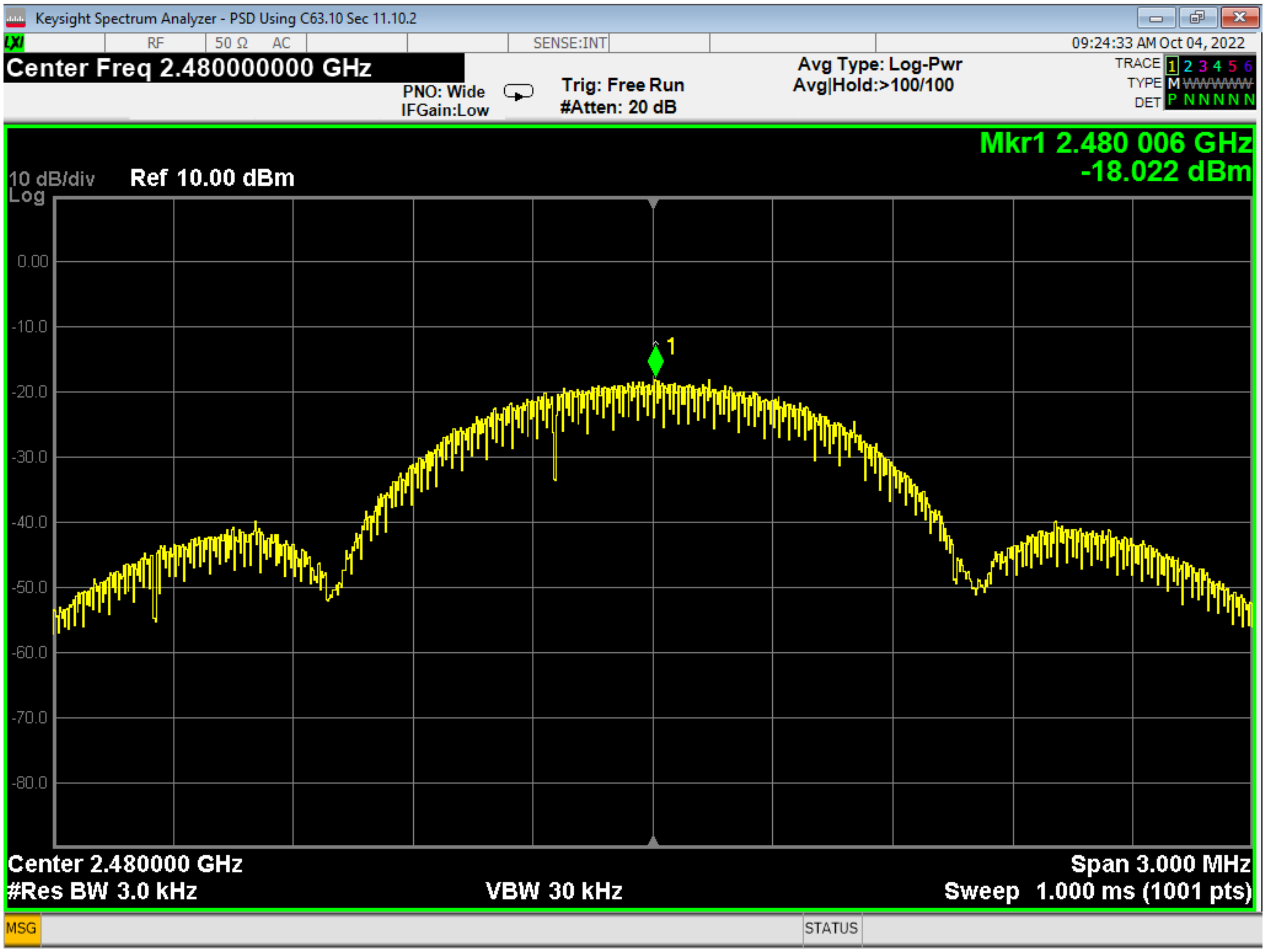
19 6dB Bandwidth, High Channel, GMSK 1MB



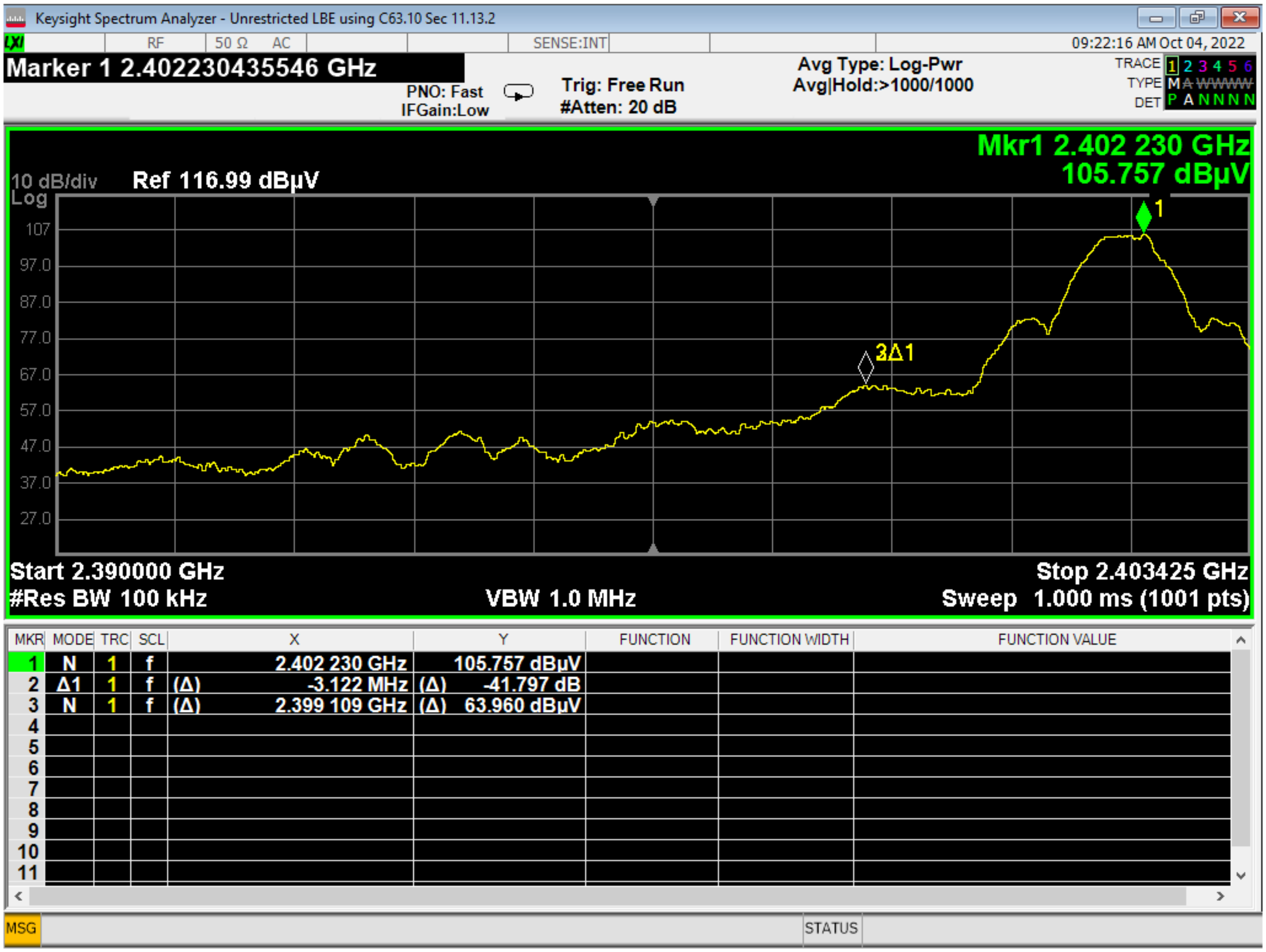
20 PSD, Low Channel, GMSK 1MB



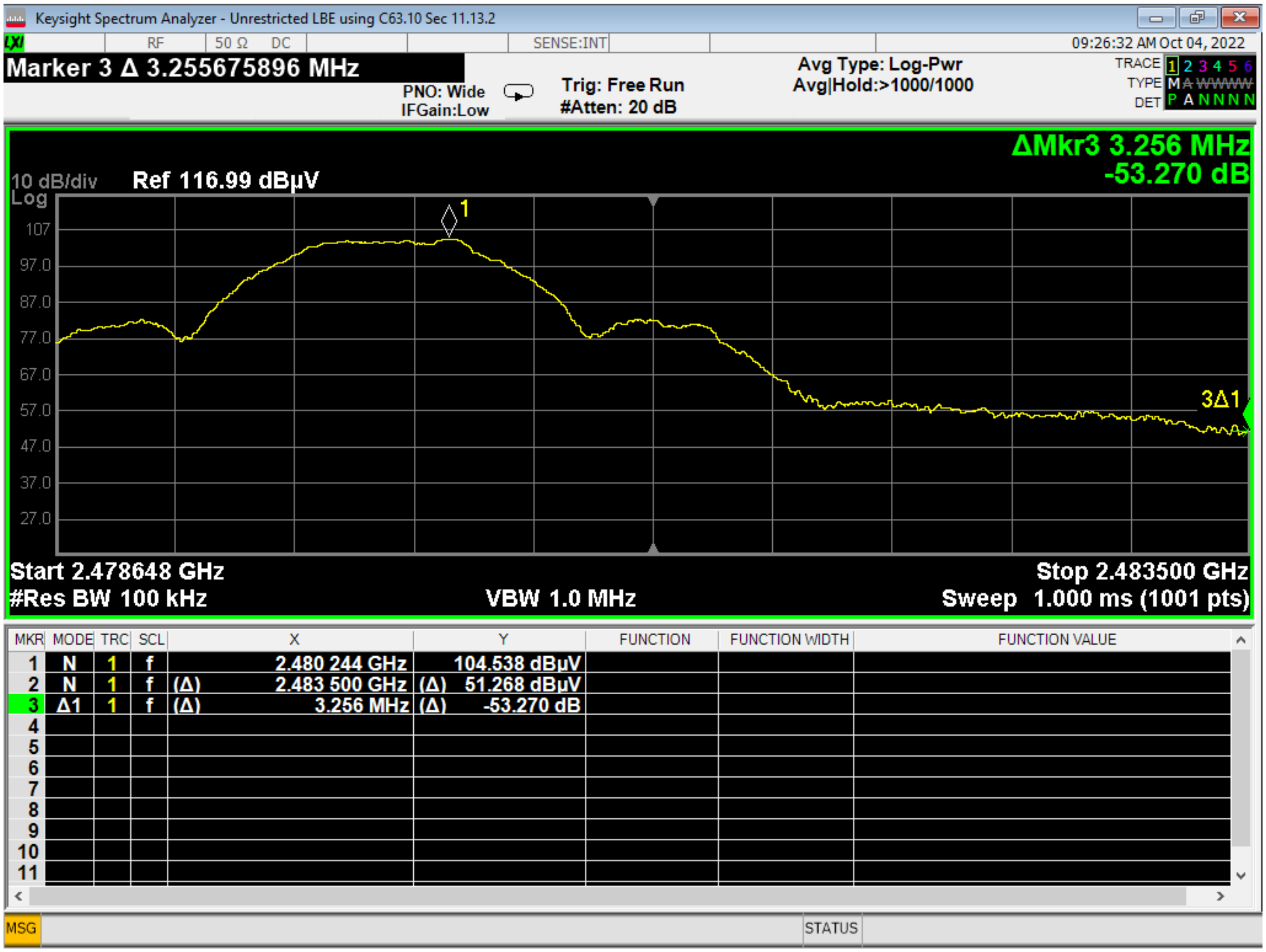
21 PSD, Mid Channel, GMSK 1MB



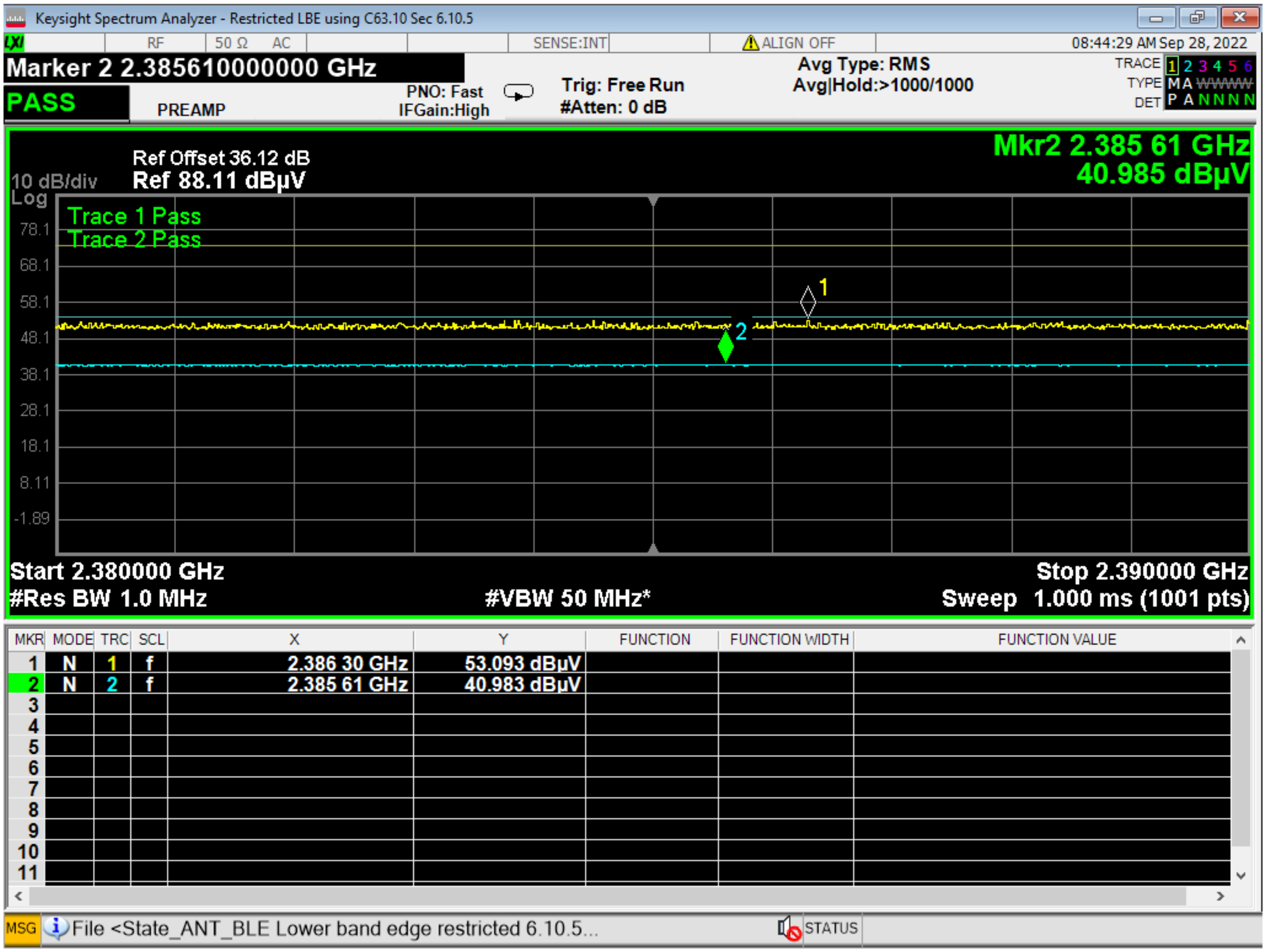
22 PSD, High Channel, GMSK 1MB



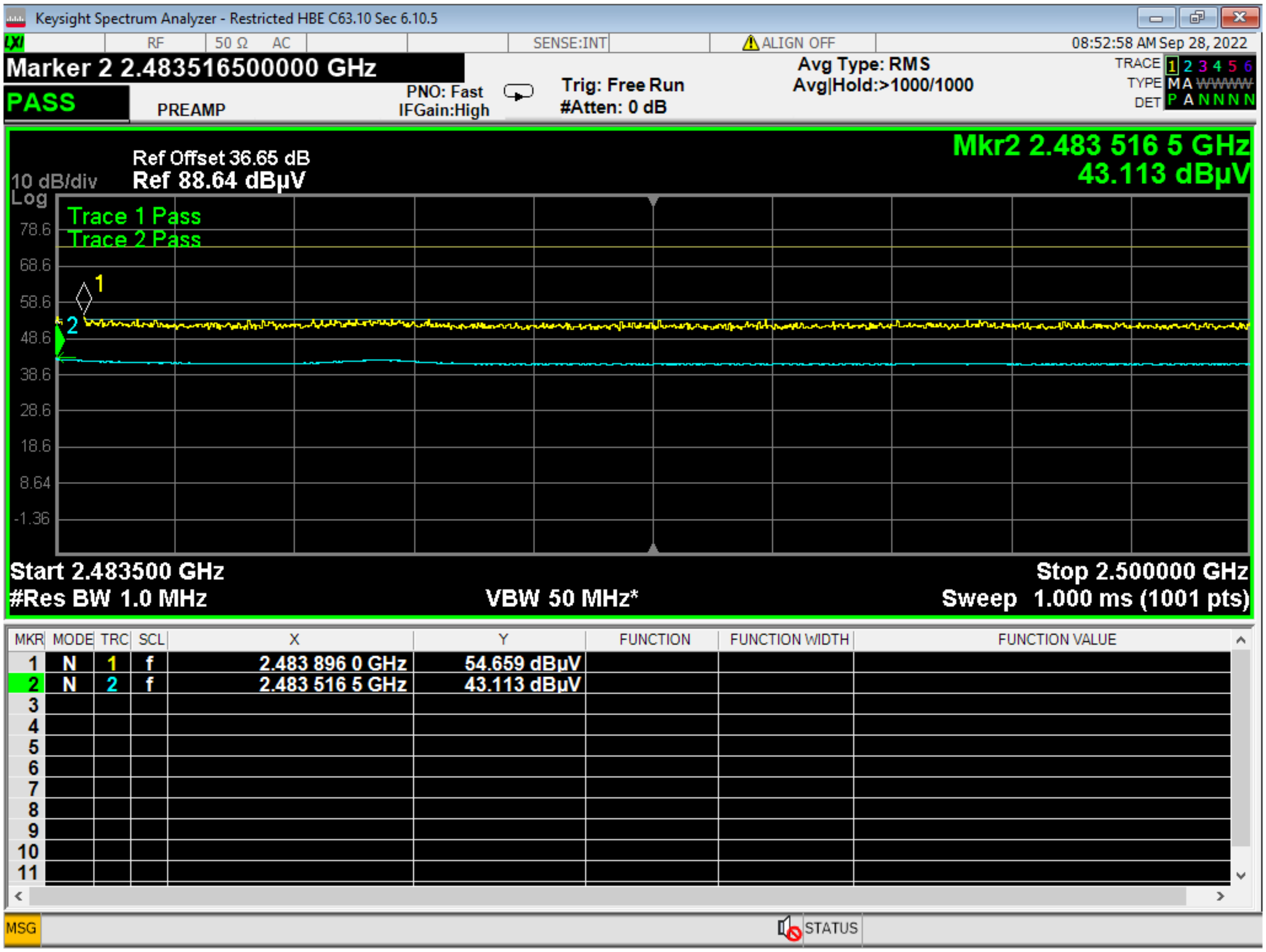
23 LBE, unrestricted GMSK 1MB



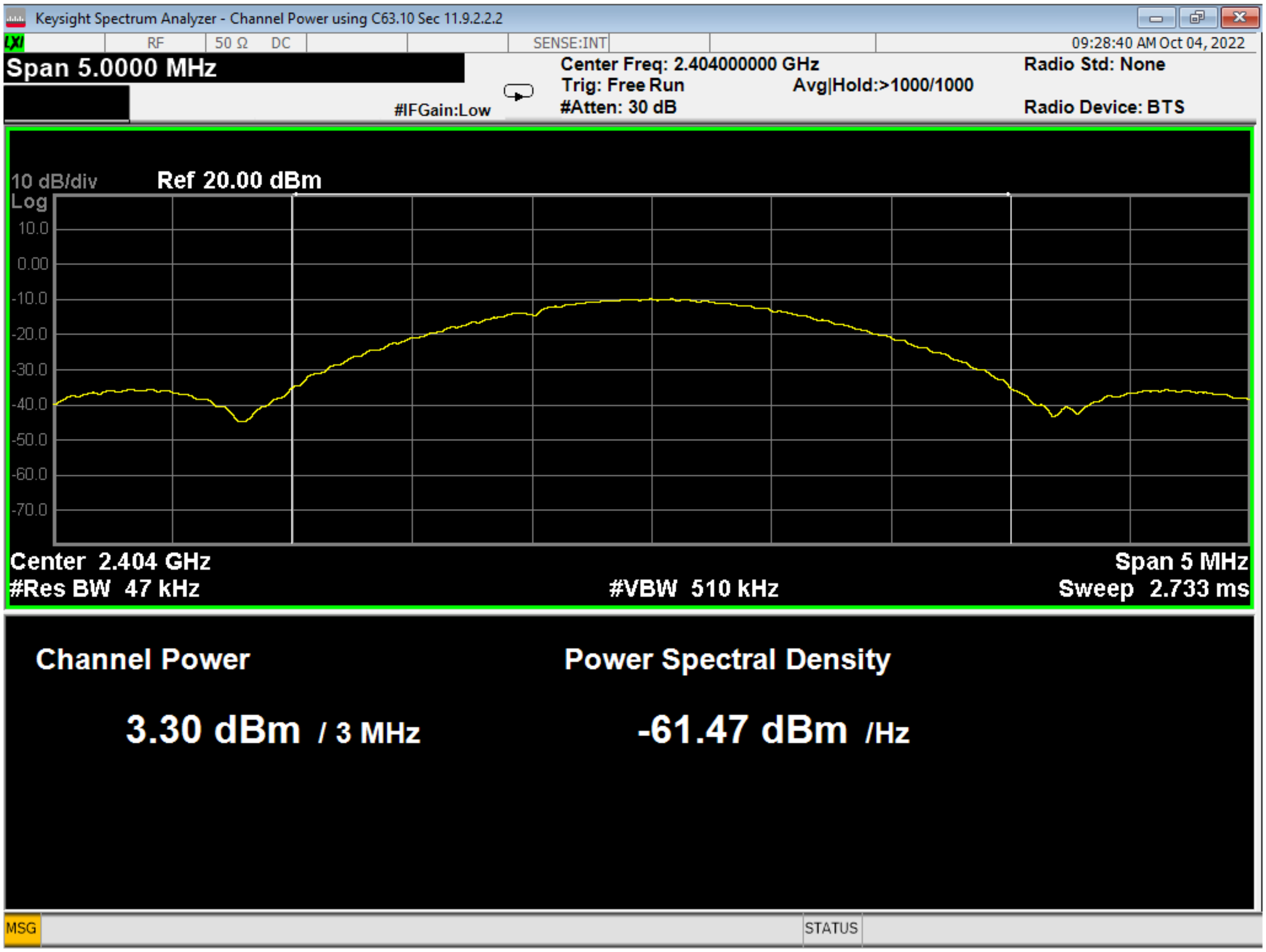
24 HBE, unrestricted GMSK 1MB



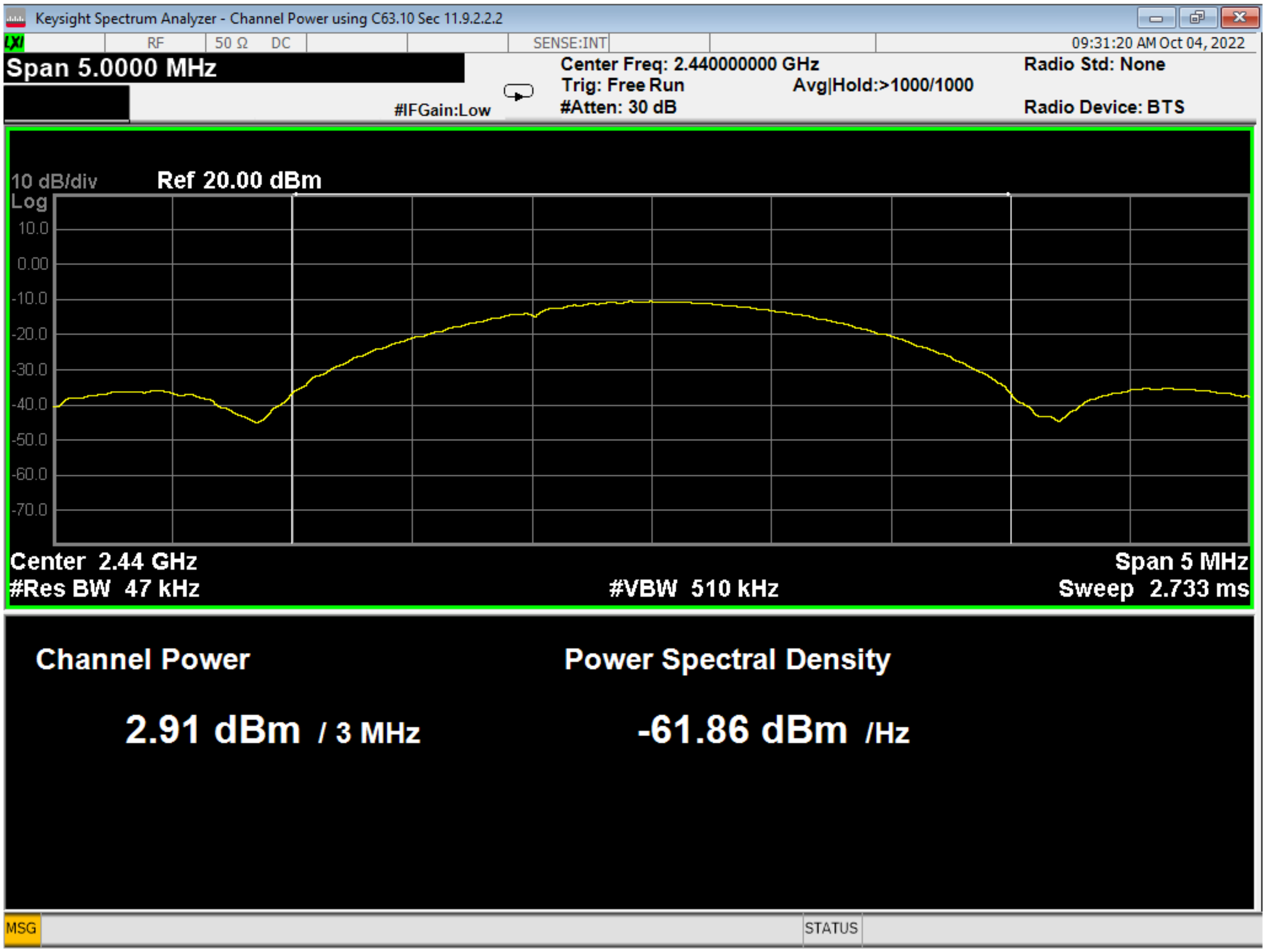
25 LBE, Restricted GMSK 1MB



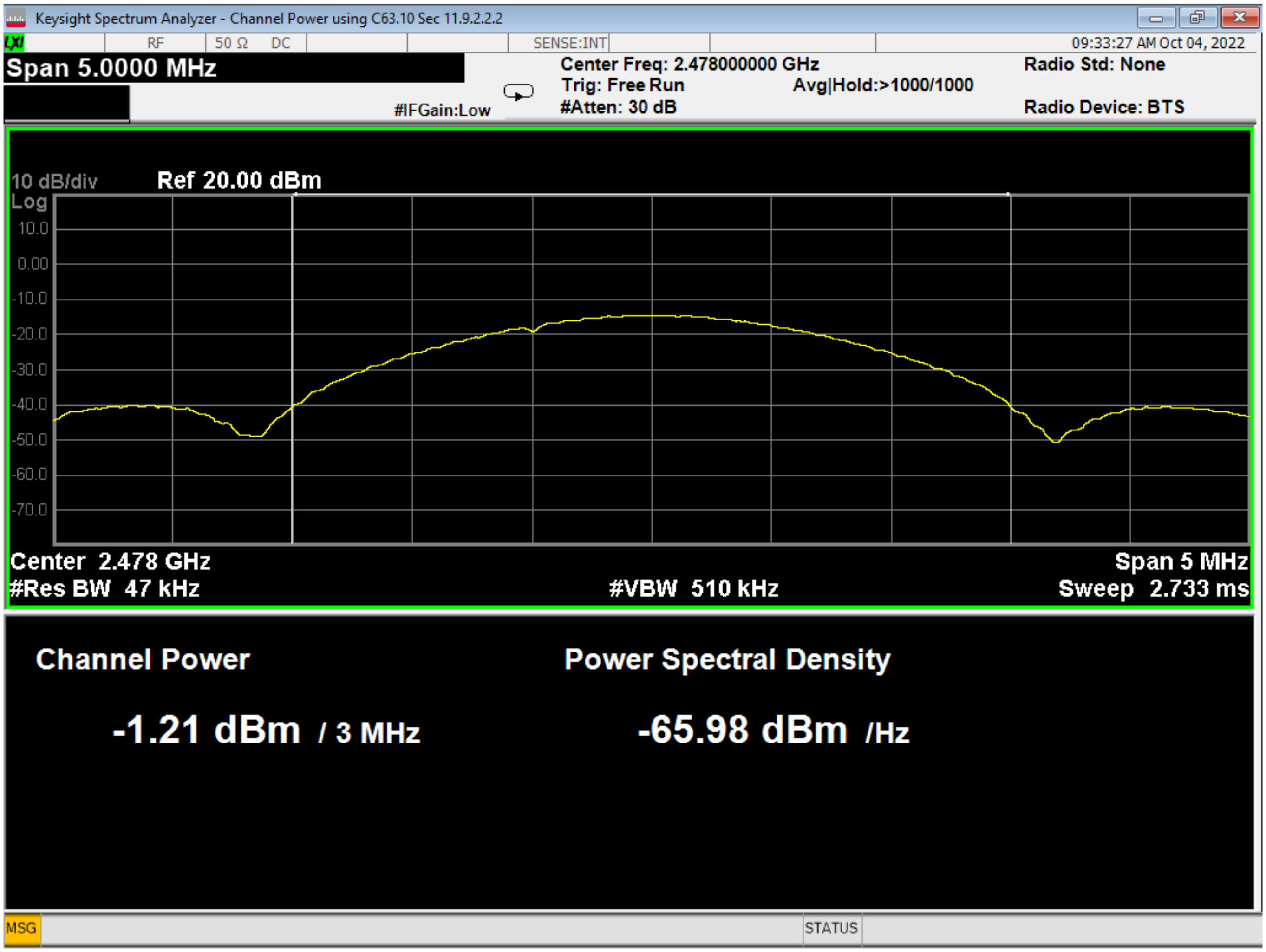
26 HBE, Restricted GMSK 1MB



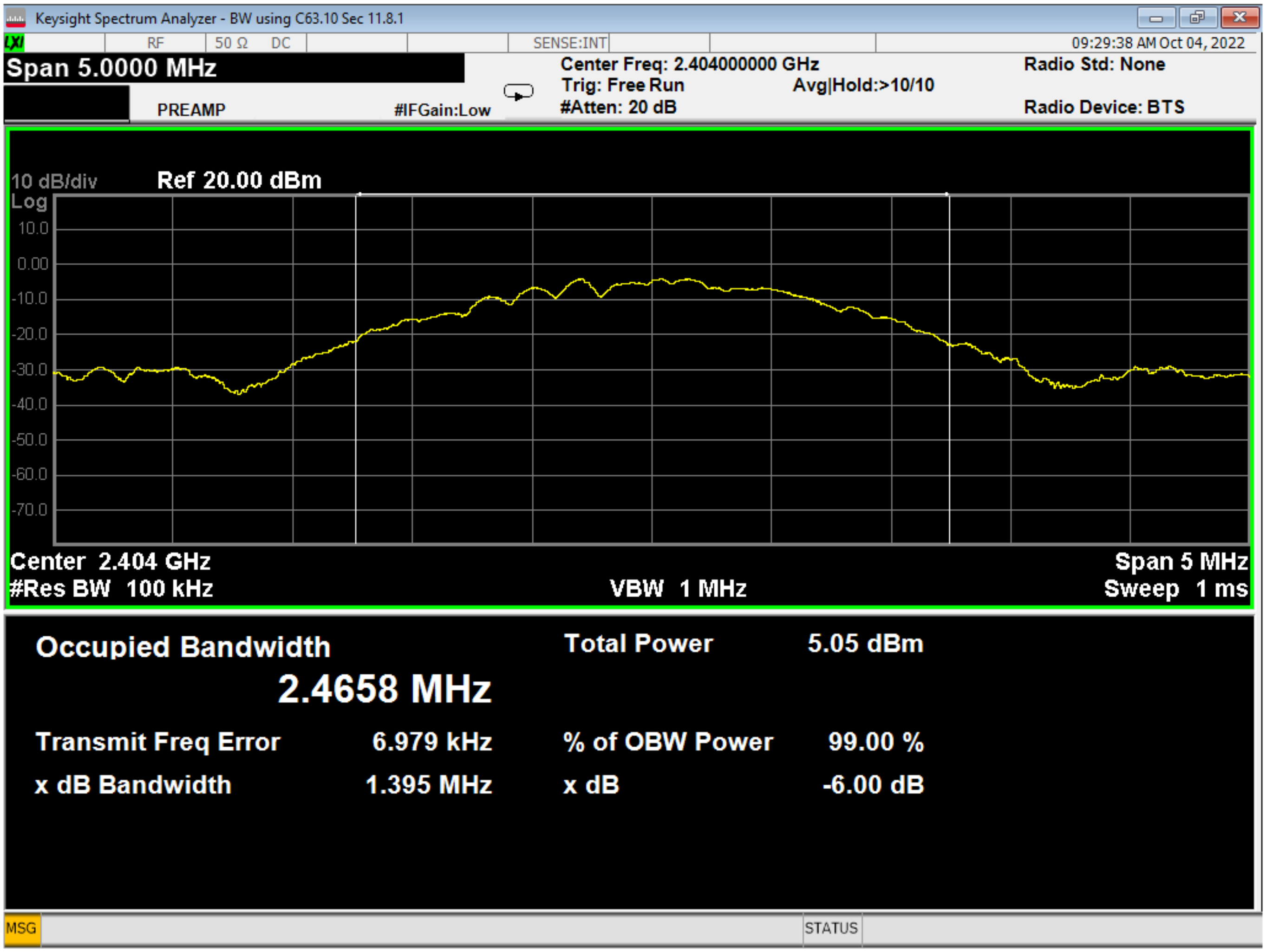
27 Average Power, Low Channel, GMSK 2MB



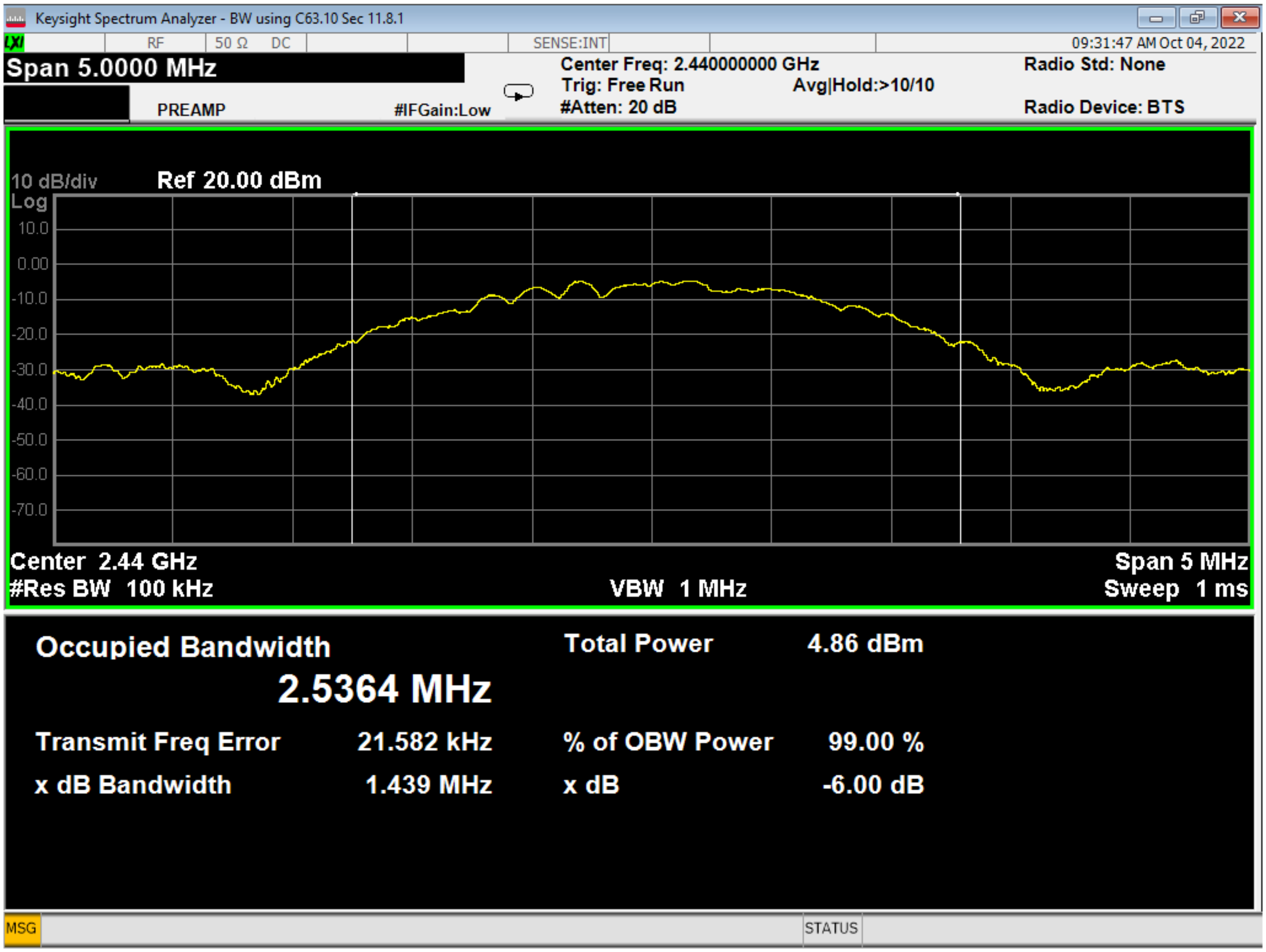
28 Average Power, Mid Channel, GMSK 2MB



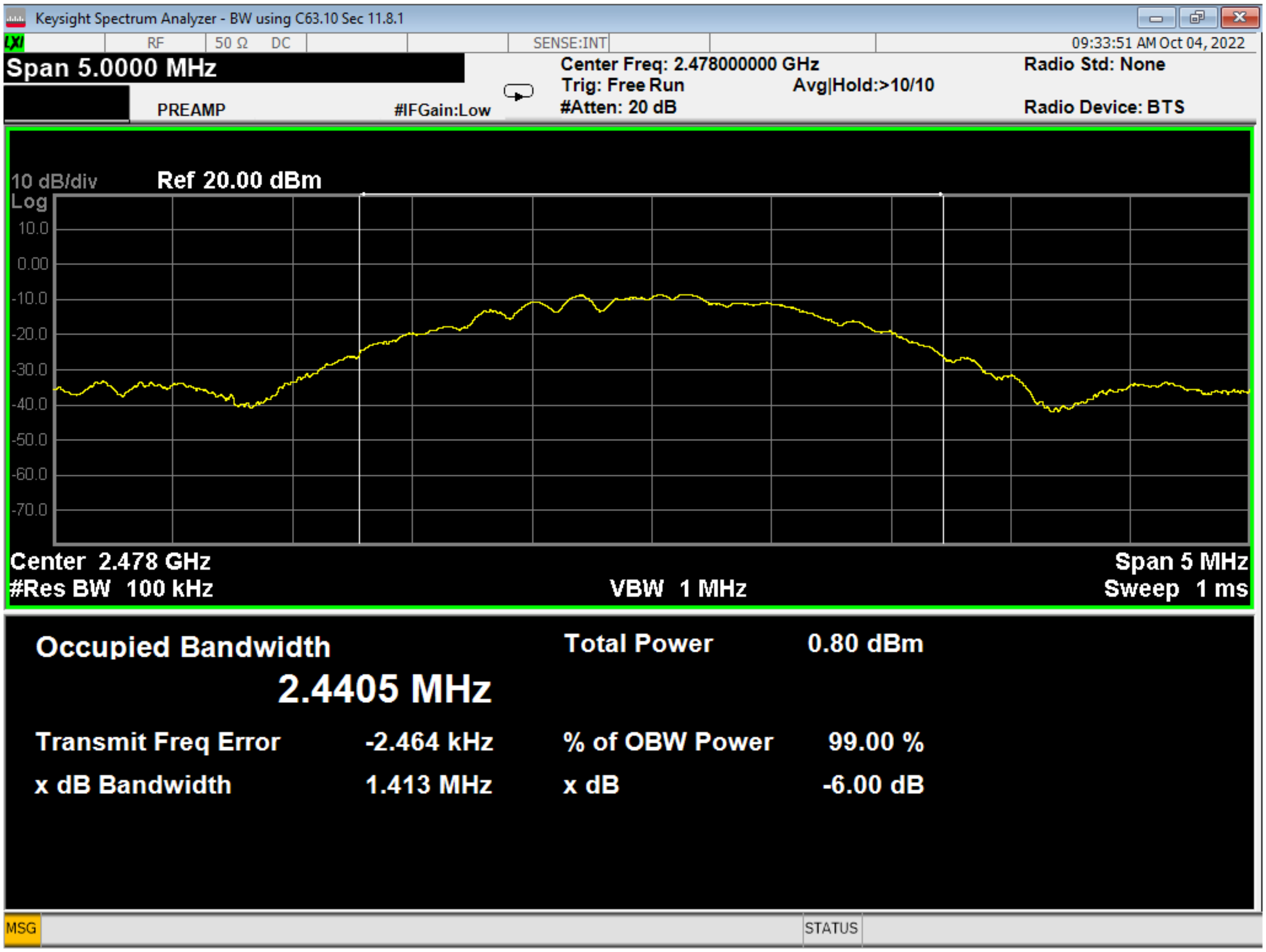
29 Average Power, High Channel, GMSK 2MB



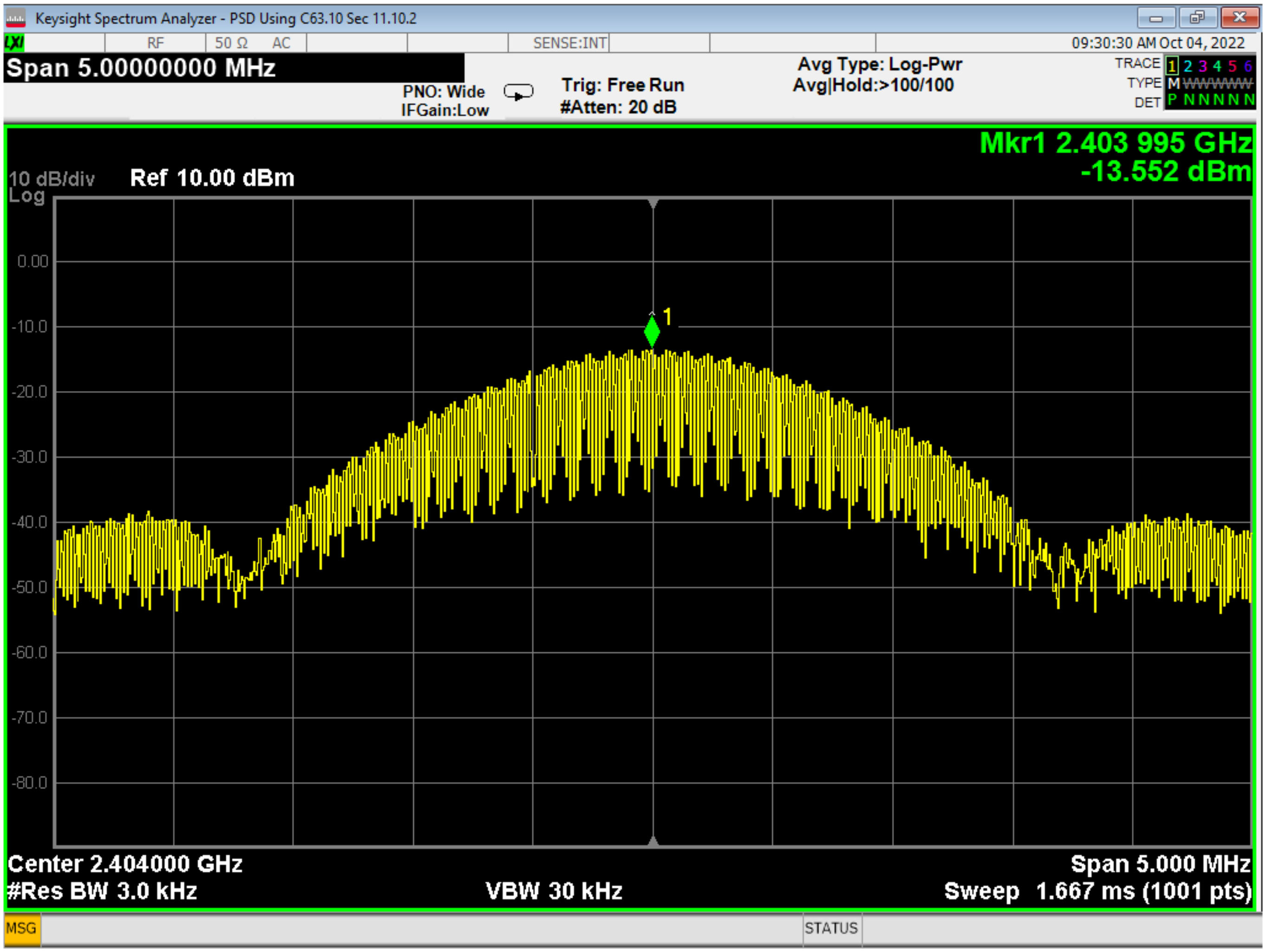
30 6dB Bandwidth, Low Channel, GMSK 2MB



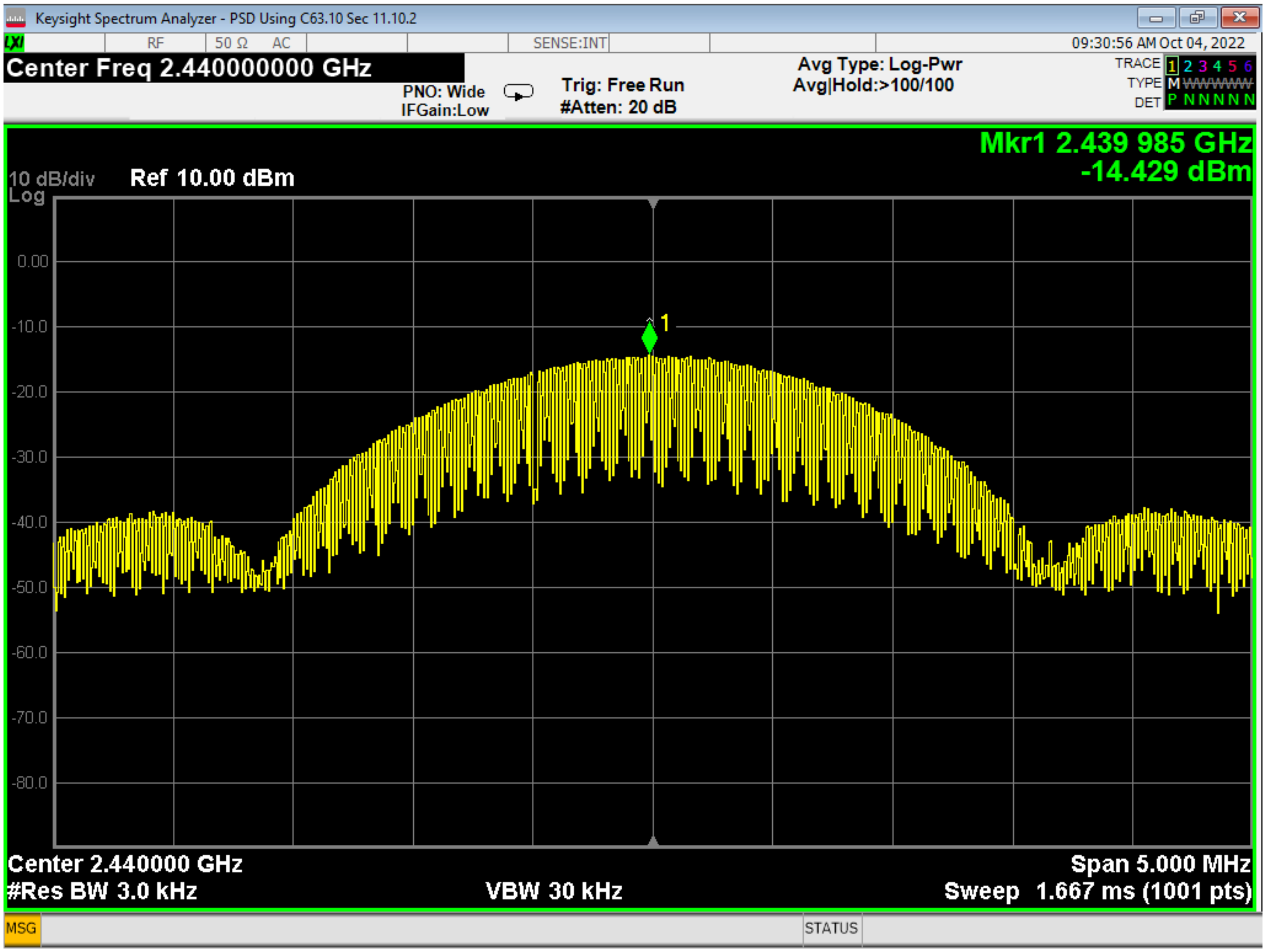
31 6dB Bandwidth, Mid Channel, GMSK 2MB



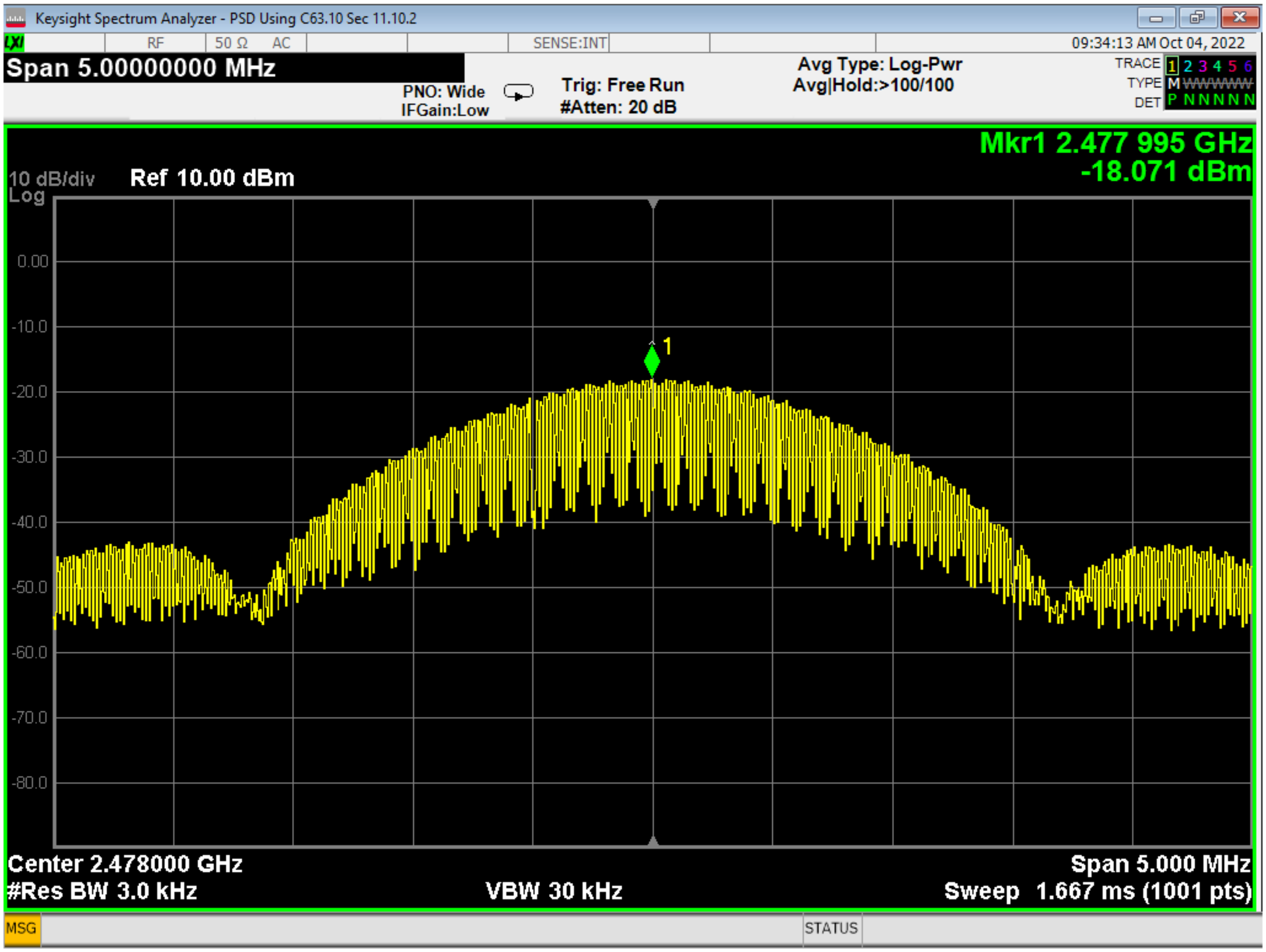
32 6dB Bandwidth, High Channel, GMSK 2MB



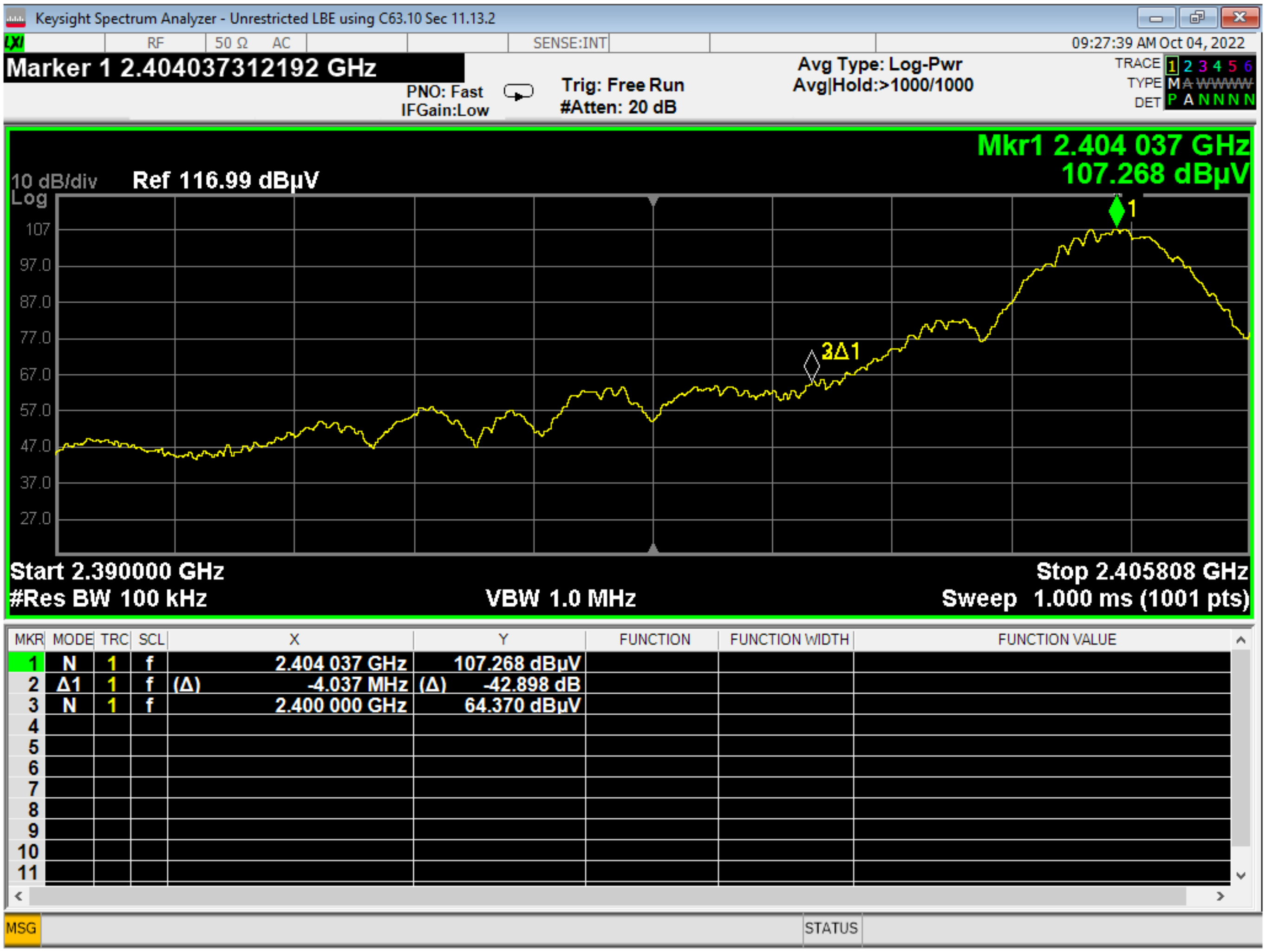
33 PSD, Low Channel, GMSK 2MB



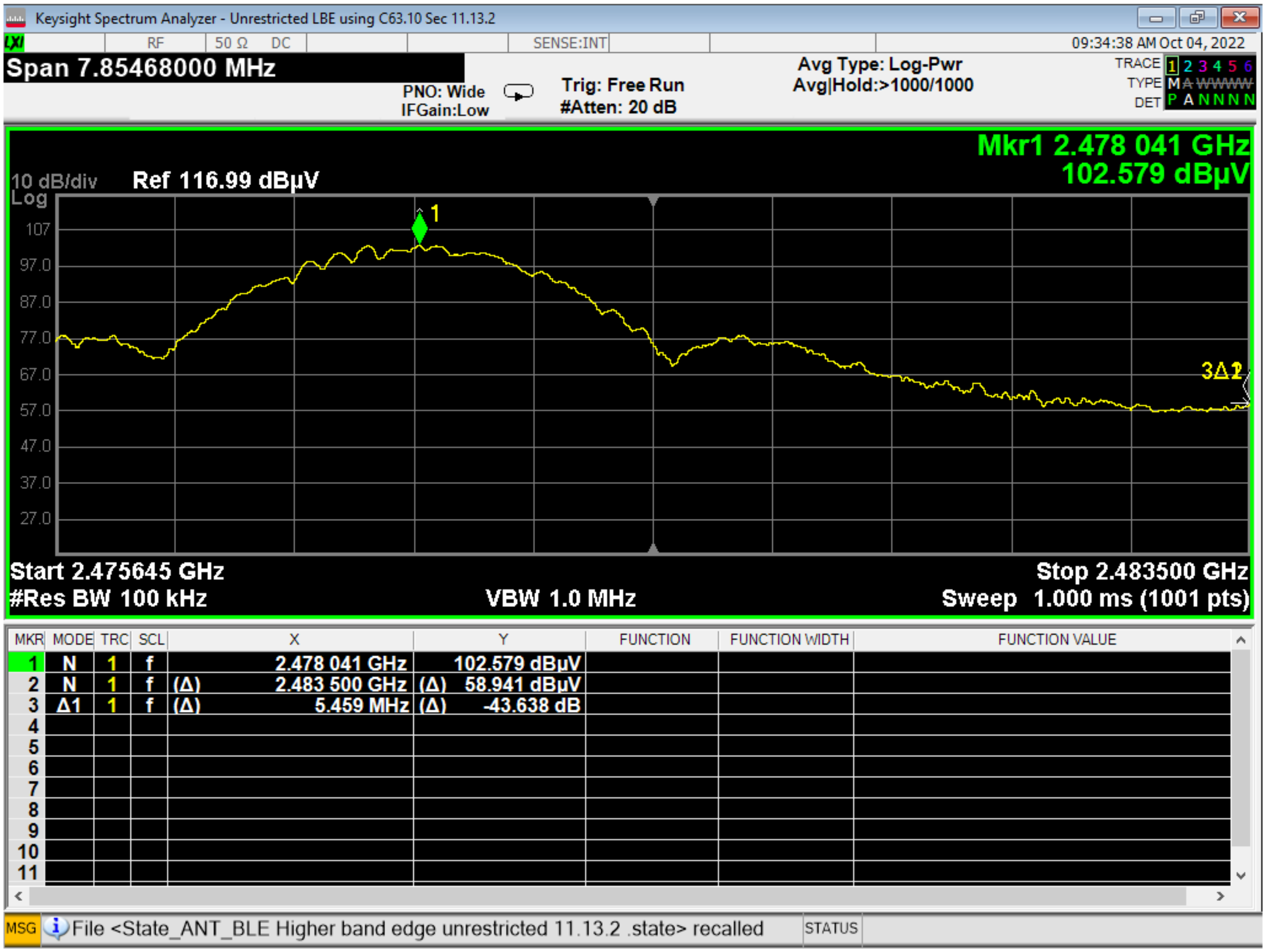
34 PSD, Mid Channel, GMSK 2MB



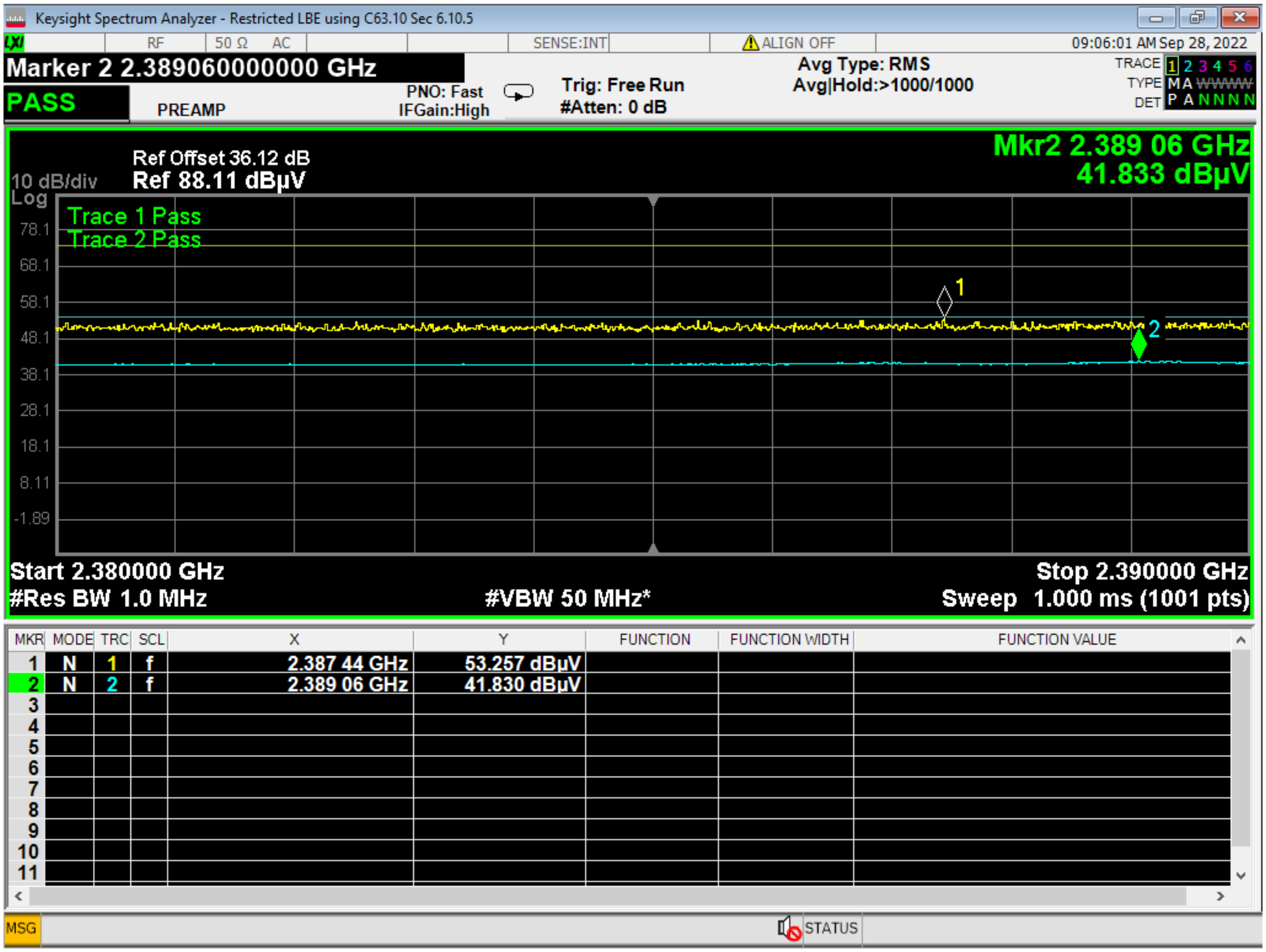
35 PSD, High Channel, GMSK 2MB



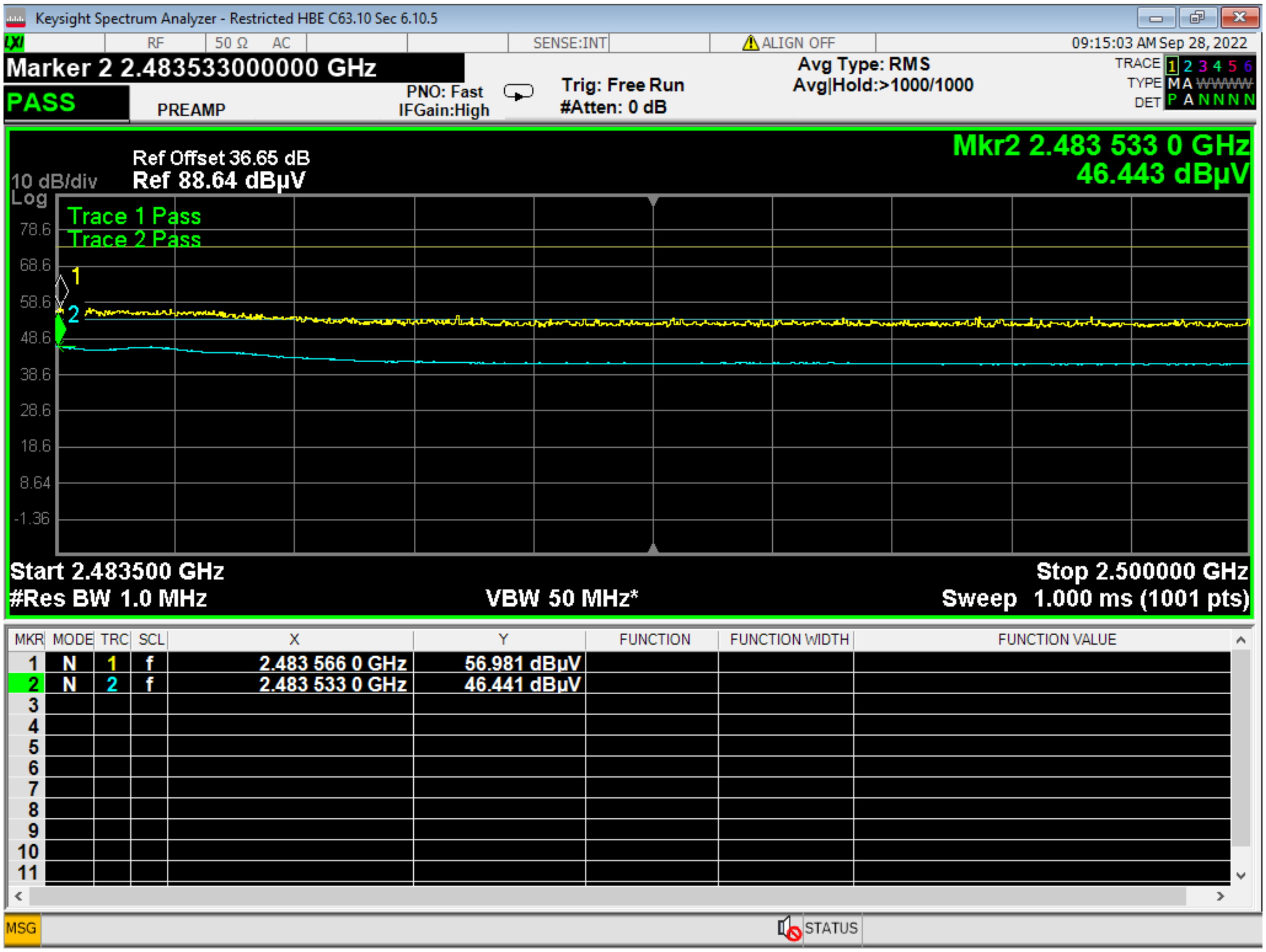
36 Lower Bandedge, Unrestricted, GMSK 2MB



37 Higher Bandedge, Unrestricted, GMSK 2MB

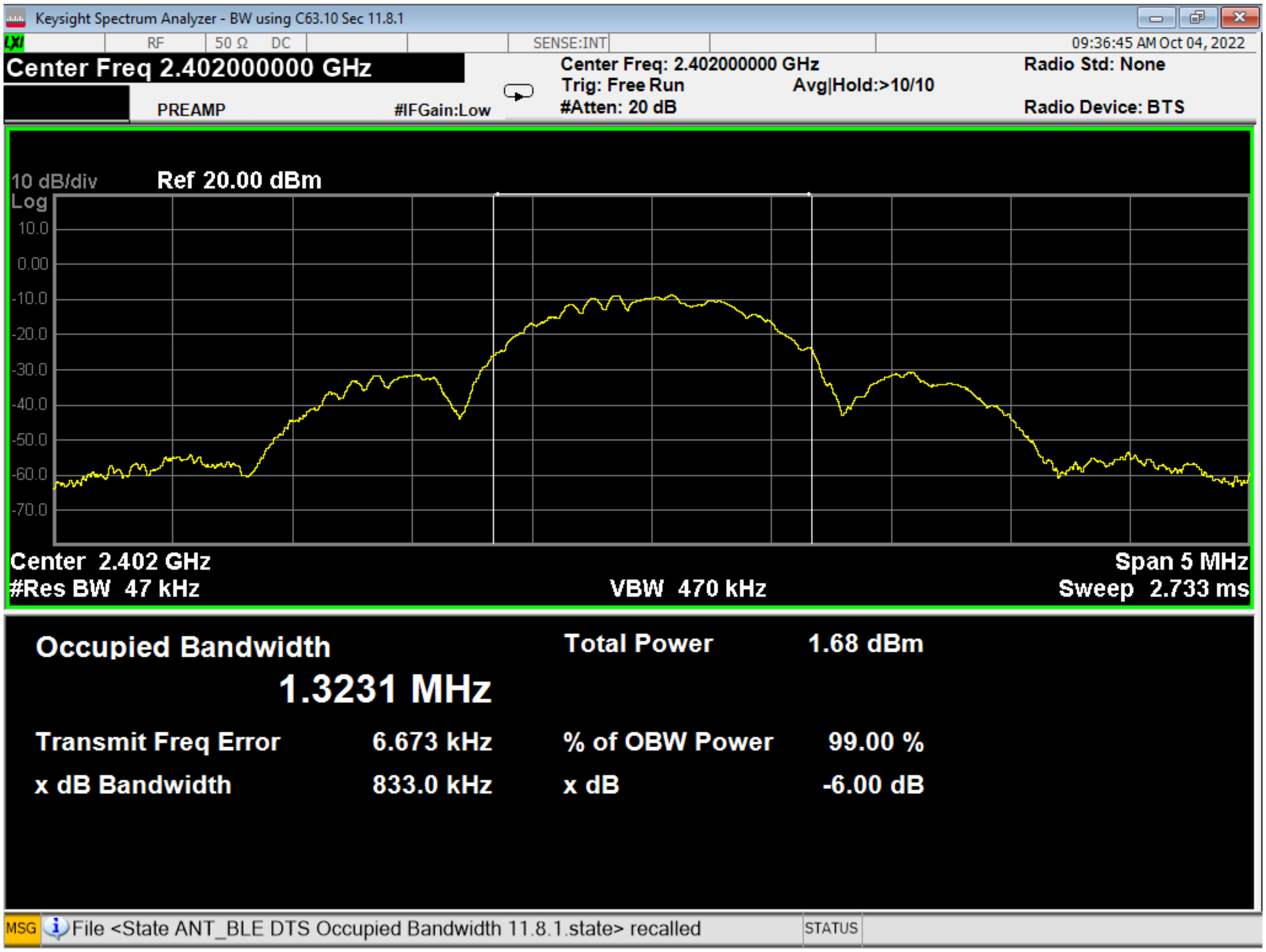


38 Lower Bandedge, Restricted, GMSK 2MB

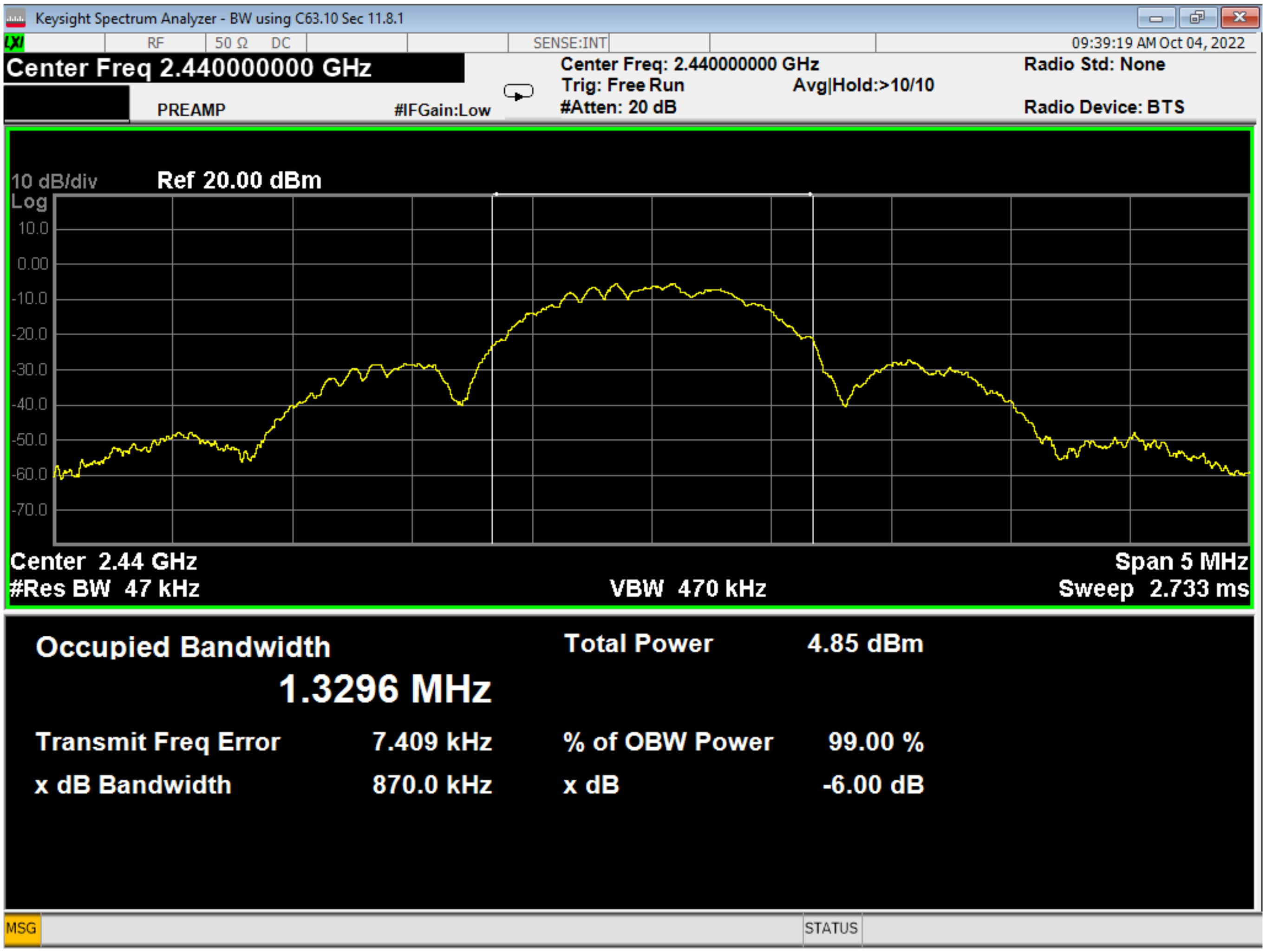


MKR	MODE	TRC	SCL	X	Y	FUNCTION	FUNCTION WIDTH	FUNCTION VALUE
1	N	1	f	2.483 566 0 GHz	56.981 dBµV			
2	N	2	f	2.483 533 0 GHz	46.441 dBµV			
3								
4								
5								
6								
7								
8								
9								
10								
11								

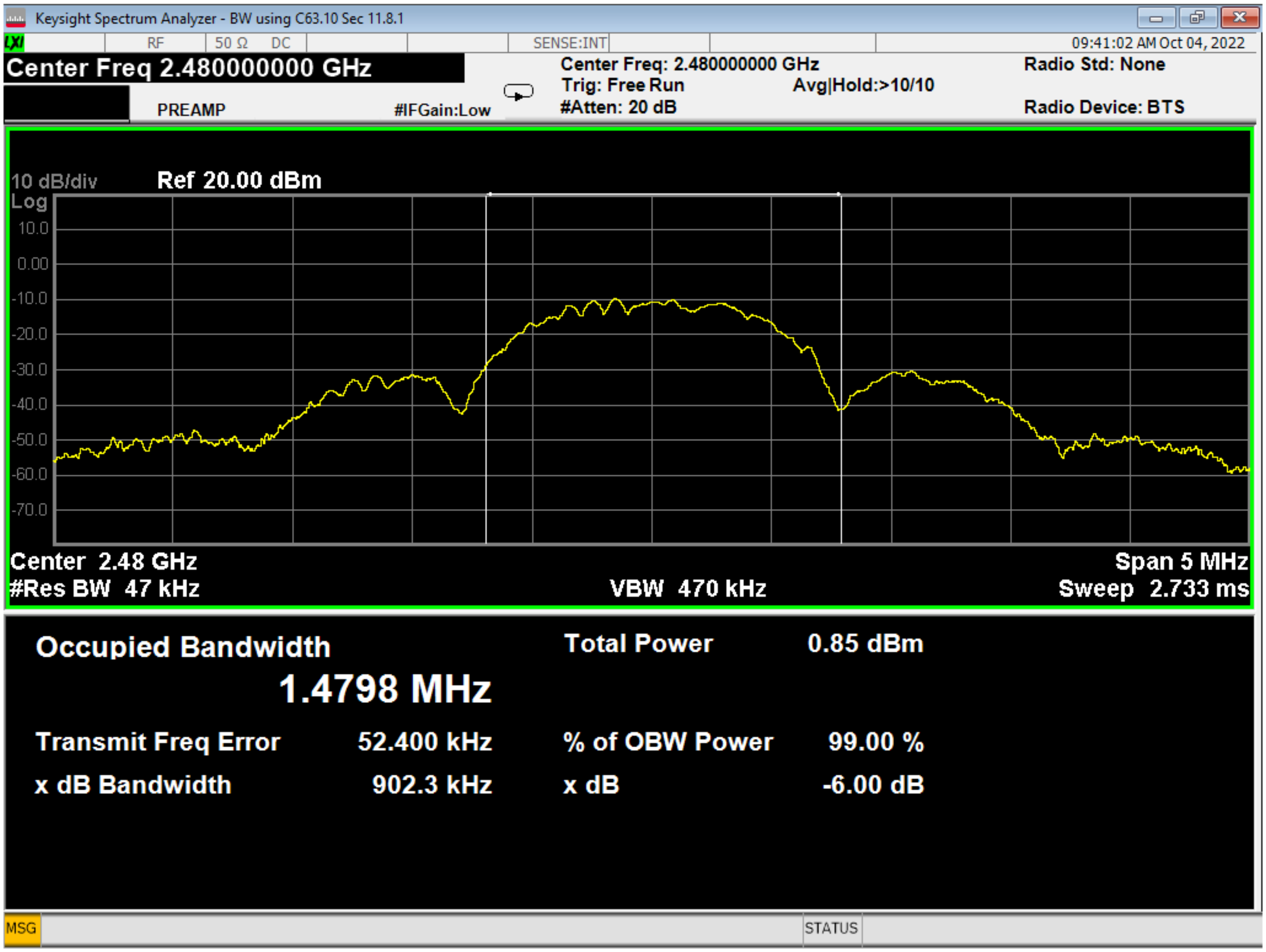
39 Higher Bandedge, Restricted, GMSK 2MB



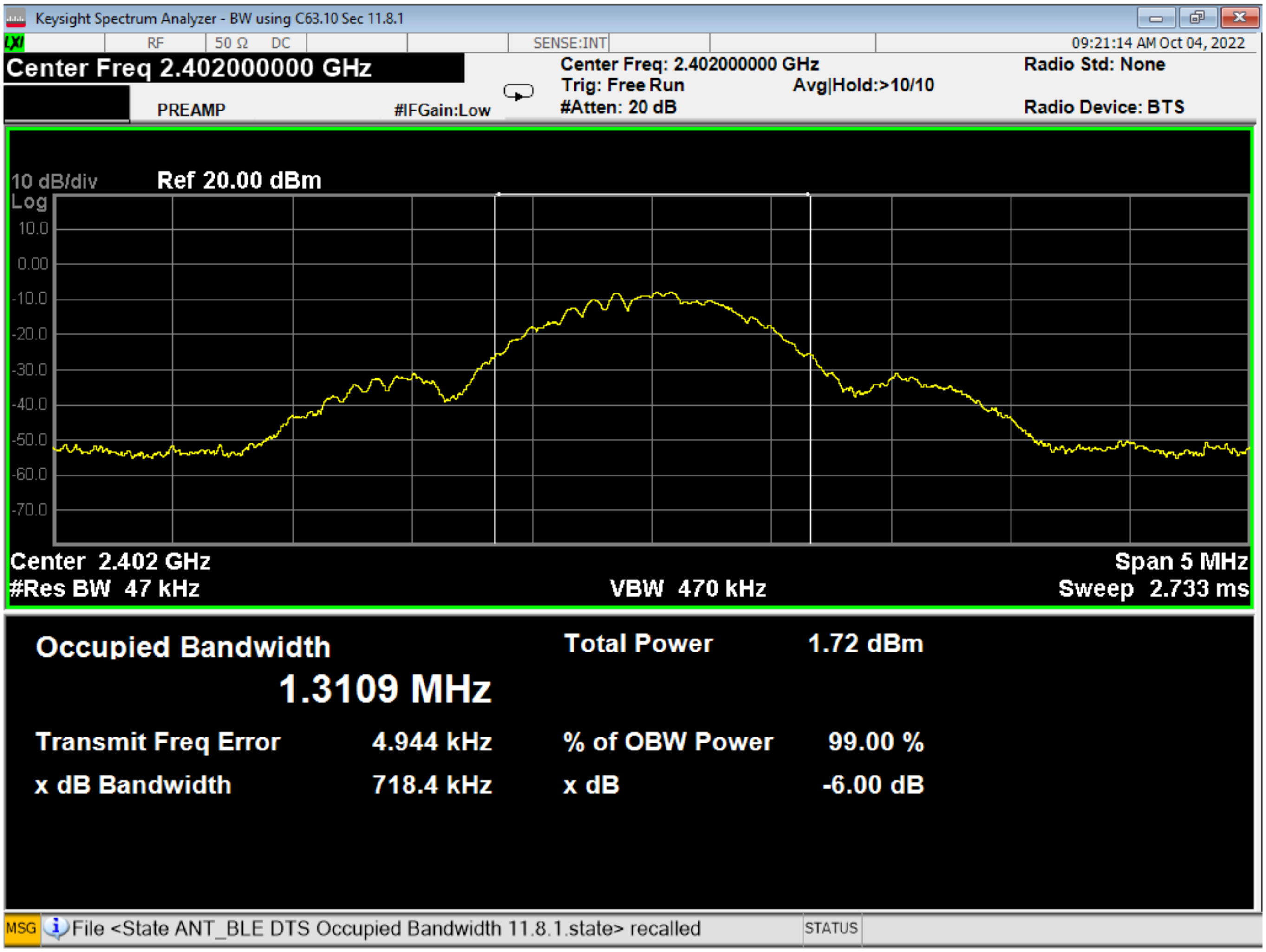
40 Occupied Bandwidth, Low Channel, GFSK



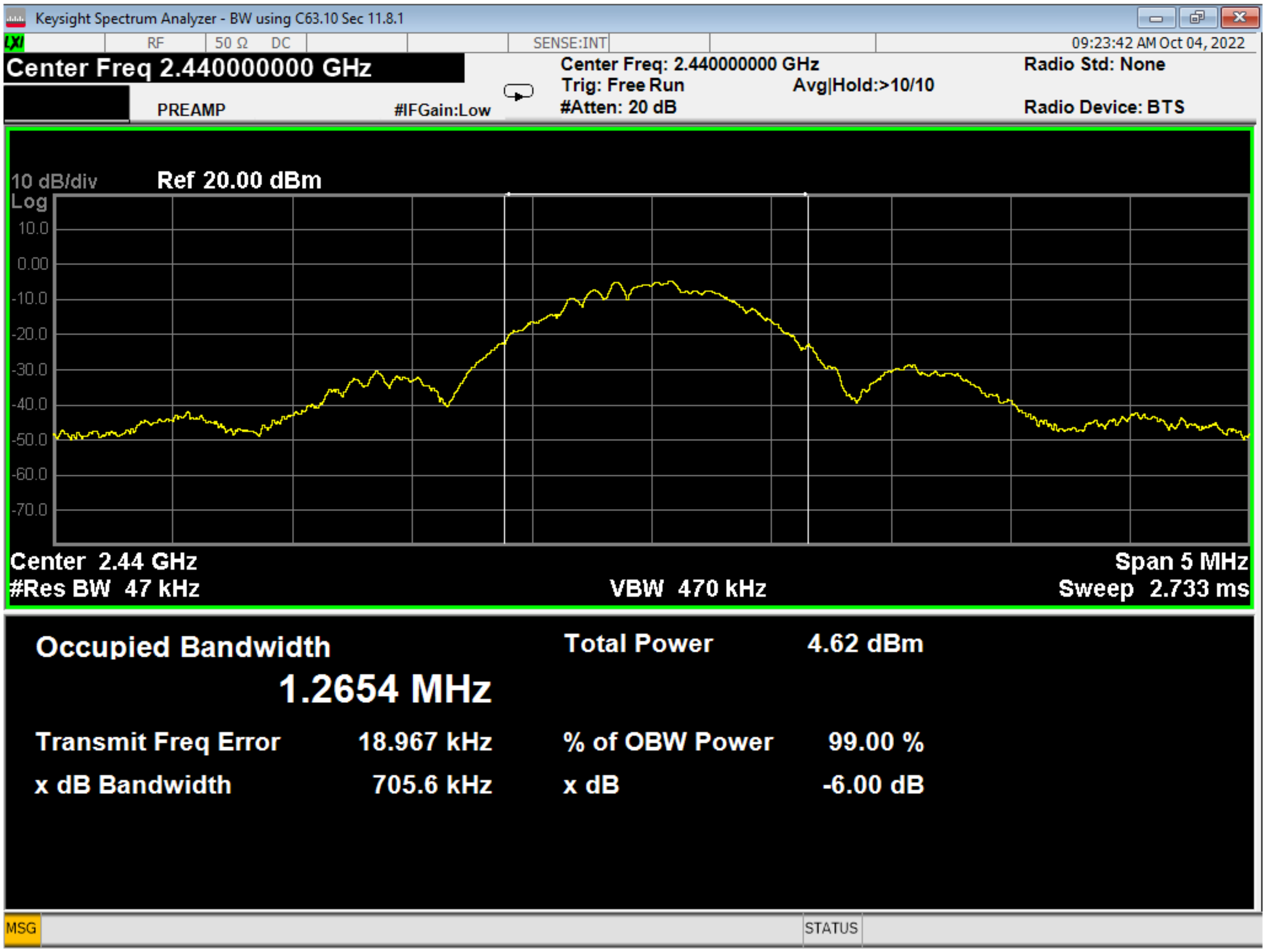
41 Occupied Bandwidth, Mid Channel, GFSK



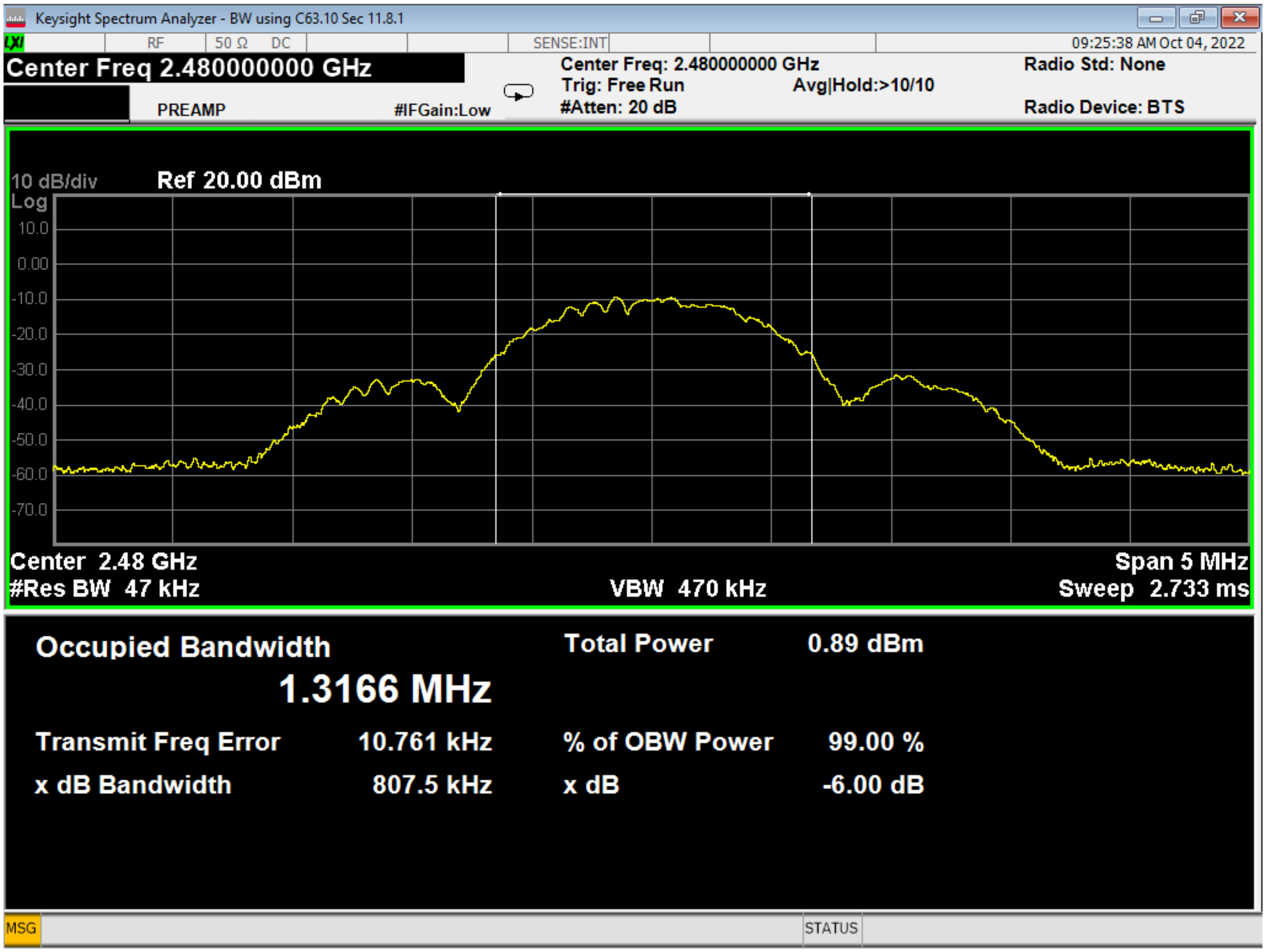
42 Occupied Bandwidth, High Channel, GFSK



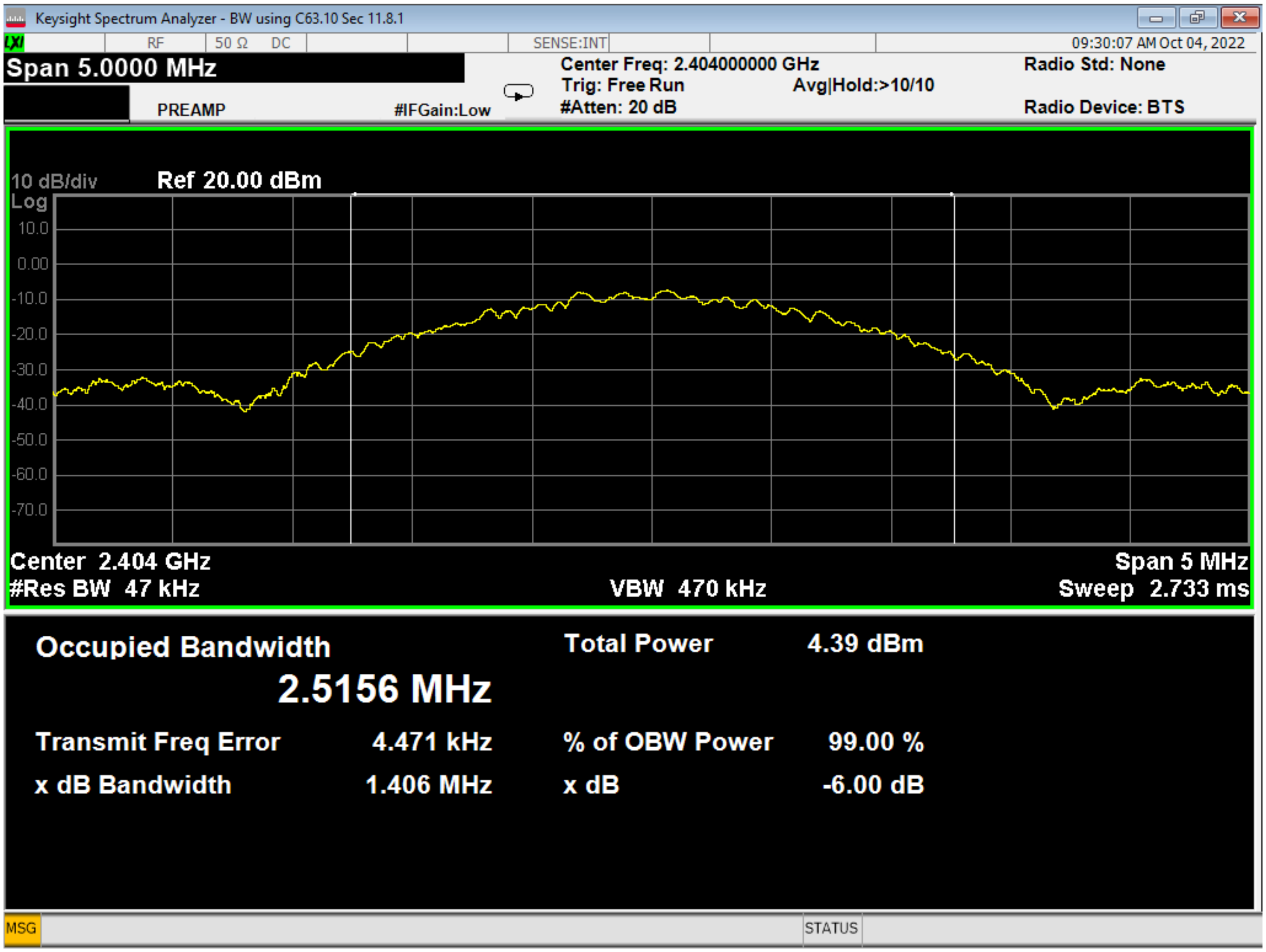
43 Occupied Bandwidth, Low Channel, GMSK 1MB



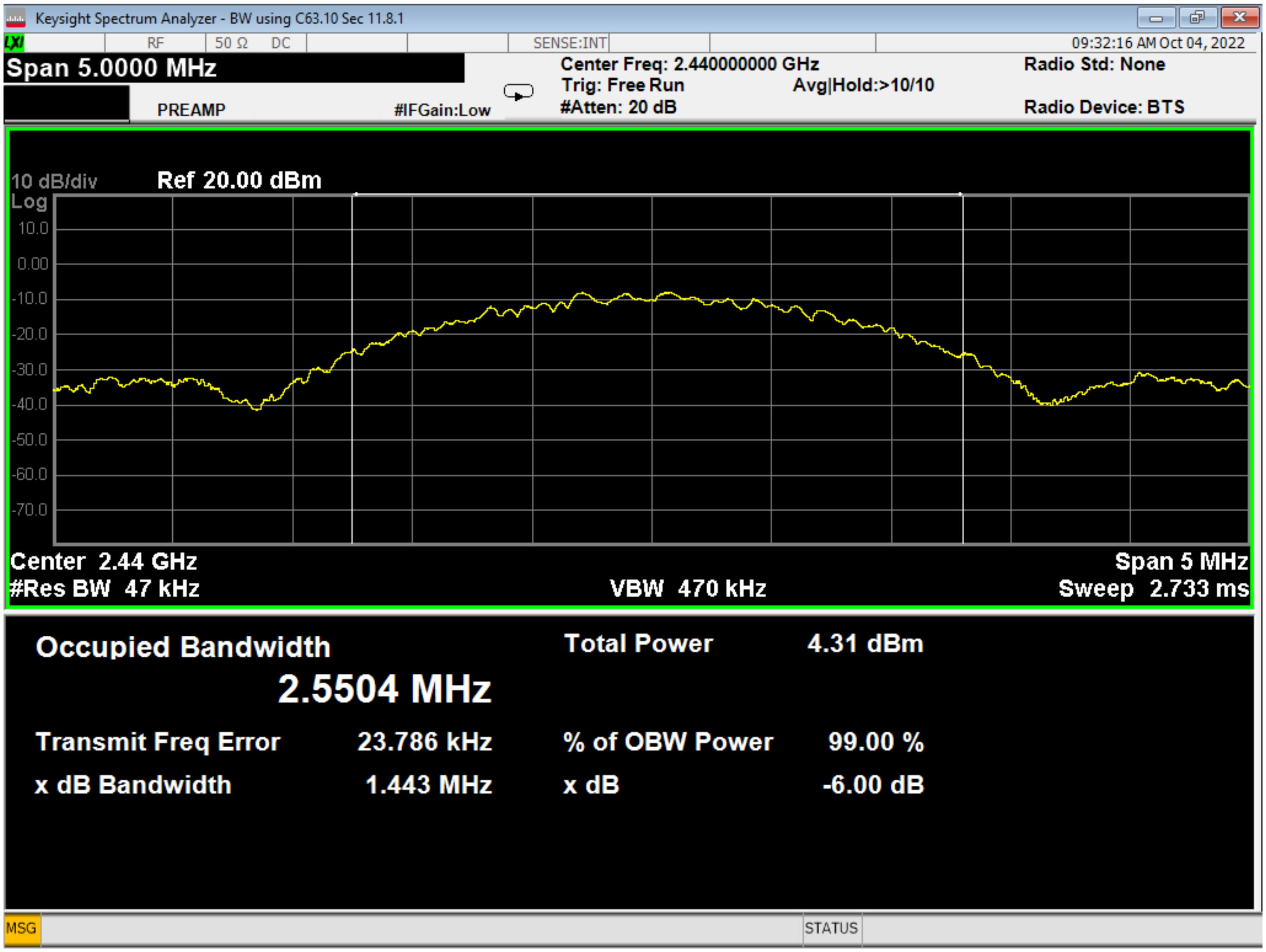
44 Occupied Bandwidth, Mid Channel, GMSK 1MB



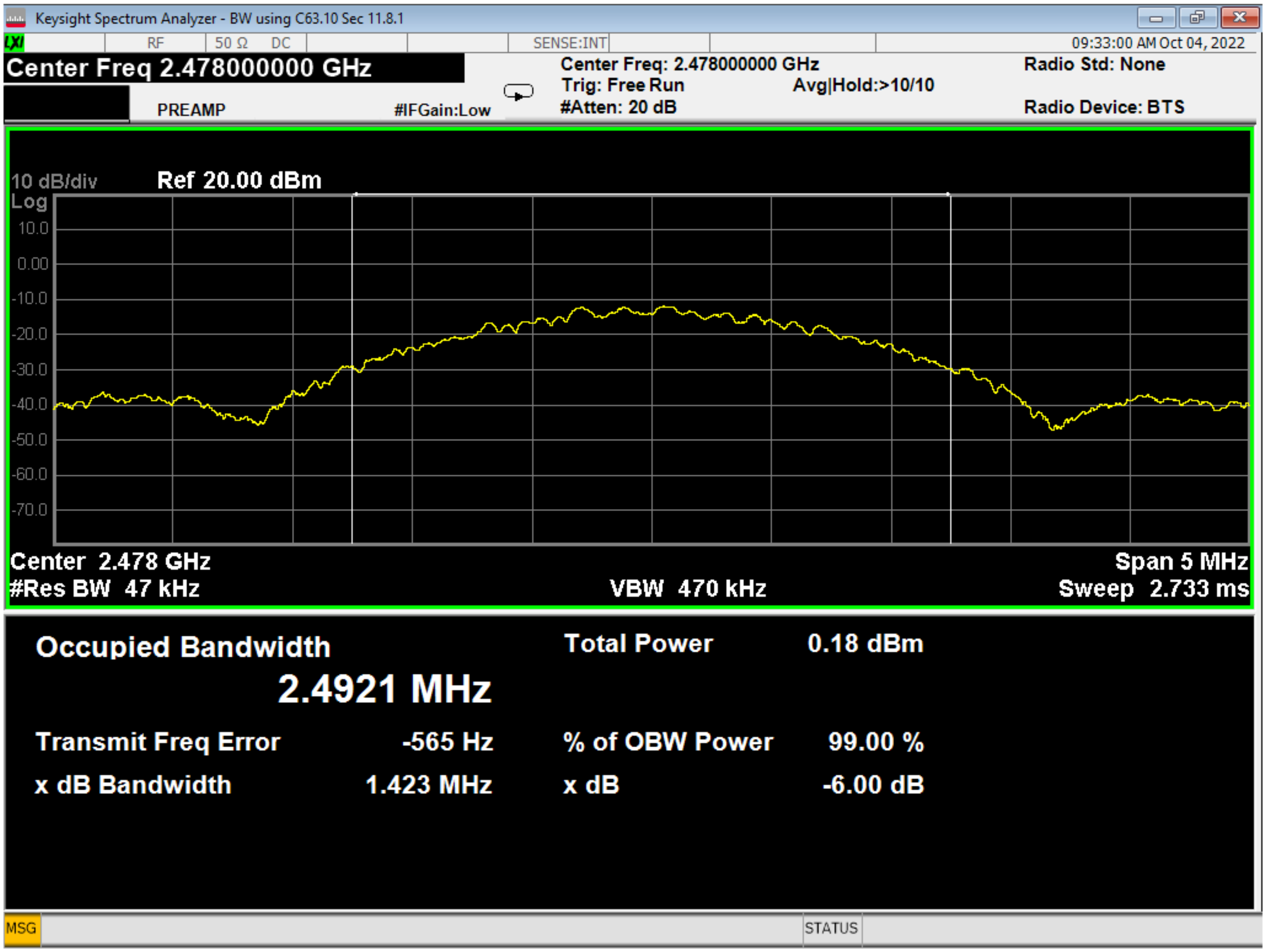
45 Occupied Bandwidth, High Channel, GMSK 1MB



46 Occupied Bandwidth, Low Channel, GMSK 2MB



47 Occupied Bandwidth, Mid Channel, GMSK 2MB



48 Occupied Bandwidth, High Channel, GMSK 2MB

REPORT END

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

FCC/ISED Test Report

Prepared for: **Garmin International, Inc.**

Address: **1200 E. 151st Street**
Olathe, Kansas, 66062, USA

Product: **AA4624**

Test Report No: **R20220615-20-E5**

Approved by:

Fox Lane,
EMC Test Engineer

DATE: **November 30, 2022**

Total Pages: **141**

REVISION PAGE

Rev. No.	Date	Description
0	30 November 2022	Issued by FLane Reviewed by KVepuri Prepared by FLane

CONTENTS

1.0 SUMMARY OF TEST RESULTS

FCC Part 15.247 ☒

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

APPLIED STANDARDS AND REGULATIONS		
Standard Section	**Test Type**	**Result**
FCC Part 15.35 RSS Gen, Issue 5, Section 6.10	Duty Cycle	Pass
FCC Part 15.247(b)(3) RSS-247 Issue 2 Section 5.4(d)	Peak output power	Pass
FCC Part 15.247(a)(2) RSS-247 Issue 2 Section 5.2	Bandwidth	Pass
FCC Part 15.209 RSS-Gen Issue 5, Section 7.3	Receiver Radiated Emissions	Pass
FCC Part 15.209 (restricted bands), 15.247 (unrestricted) RSS-247 Issue 2 Section 5.5, RSS-Gen Issue 5, Section 8.9	Transmitter Radiated Emissions	Pass
FCC Part 15.247(e) RSS-247 Issue 2 Section 5.2	Power Spectral Density	Pass
FCC Part 15.209, 15.247(d) RSS-247 Issue 2 Section 5.5	Band Edge Measurement	Pass
FCC Part 15.207 RSS-Gen Issue 5, Section 8.8	Conducted Emissions	Pass

2.0 EUT DESCRIPTION

2.1 EQUIPMENT UNDER TEST

Summary and Operating Condition:
Device under test was a rechargeable battery powered transceiver manufactured by Garmin International, Inc.

EUT	AA4624
IC	1792A-A4624
FCC ID	IPH-A4624
EUT Received	29 August 2022
EUT Tested	5 September 2022- 28 October 2022
Serial No.	3426363242 (Radiated Measurements) 3426363123 (Conducted Measurements)
Operating Band	2400 – 2483.5 MHz
Device Type	☐ GMSK ☐ GFSK ☐ BT BR ☐ BT EDR 2MB ☐ BT EDR 3MB ☒ 802.11x
Power Supply / Voltage	Internal Battery / 5VDC Charger: Garmin (Phi Hong) Model: LACA046 GPN: 362-00112-00 (Representative Power Supply)
Antenna Type / Gain (dBi)	Trace Antenna -3.29 dBi

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

2.2 DESCRIPTION OF TEST MODES

The operating range of the EUT is dependent on the device type found in section 2.1:

The EUT was powered by 5 VDC. It was set to transmit continuously on the 3 different channels of its operating range where available.

For 802.11x Transmissions:

Channel	Frequency
Low	2412 MHz
Mid	2437 MHz
High	2462 MHz

Data Rate		
Modulation	Low	High
802.11b	1Mb	11Mb
802.11g	6Mb	54Mb
802.11n	MCS0	MCS7

These are the only 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.

The following power table was used for the entirety of testing:

802.11x Power Table			
Modulation	Low	Mid	High
802.11b	42	42	42
802.11g	33	42	33
802.11n	32	42	32

2.3 DESCRIPTION OF SUPPORT UNITS

None

3.0 LABORATORY AND GENERAL TEST 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
NCC CAB 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/editing
2	Fox Lane	Test Engineer	Testing/Review and Report
3	Blake Winter	Test Engineer	Testing
4	Grace Larsen	Test Engineer	Testing and Report
5	Ethan Schmidt	Test Technician	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 (44GHz)**	N9038A	MY59050109	July 19, 2022	July 19, 2024
Keysight MXE Signal Analyzer (26.5GHz)**	N9038A	MY56400083	July 19, 2022	July 19, 2024
Keysight EXA Signal Analyzer**	N9010A	MY56070862	July 20, 2021	July 20, 2023
SunAR RF Motion	JB1	A082918-1	July 26, 2022	July 26, 2023
ETS EMCO Red Horn Antenna	3115	00218655	July 21, 2022	July 21, 2023
Com-Power LISN, Single Phase**	LI-220C	20070017	July 18, 2022	July 18, 2024
8447F POT H64 Preamplifier*	8447F POT H64	3113AD4667	March 21, 2022	March 21, 2024
Rohde & Schwarz Preamplifier*	TS-PR18	3545700803	August 22, 2022	August 22, 2024
Trilithic High Pass Filter*	6HC330	23042	March 21, 2022	March 21, 2024
ETS – Lindgren- VSWR on 10m Chamber***	10m Semi-anechoic chamber-VSWR	4740 Discovery Drive	July 30, 2020	July 30, 2023
NCEE Labs-NSA on 10m Chamber*	10m Semi-anechoic chamber-NSA	NCEE-001	May 25, 2022	May 25, 2024
TDK Emissions Lab Software	V11.25	700307	NA	NA
RF Cable (preamplifier to antenna)*	MFR-57500	90-195-040	August 22, 2022	August 22, 2024
RF Cable (antenna to 10m chamber bulkhead)*	FSCM 64639	01E3872	September 24, 2021	September 24, 2023
RF Cable (10m chamber bulkhead to control room bulkhead)*	FSCM 64639	01E3864	September 24, 2021	September 24, 2023
RF Cable (control room bulkhead to test receiver)*	FSCM 64639	01F1206	September 24, 2021	September 24, 2023
N connector bulkhead (10m chamber)*	PE9128	NCEEBH1	September 24, 2021	September 24, 2023
N connector bulkhead (control room)*	PE9128	NCEEBH2	September 24, 2021	September 24, 2023

*Internal Characterization

**2 Year Cal Cycle

Notes:

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

3.4 GENERAL TEST PROCEDURE AND SETUP FOR RADIO MEASUREMNTS

Measurement type presented in this report (Please see the checked box below):

Conducted ☒

The conducted measurements were performed by connecting the output of the transmitter directly into a spectrum analyzer using an impedance matched cable and connector soldered to the EUT in place of the antenna. The information regarding resolution bandwidth, video bandwidth, span and the detector used can be found in the graphs provided in the Appendix C. All the radio measurements were performed using the sections from ANSI C63.10, details about the section used can be found in the spectrum analyzer titles on the graph.

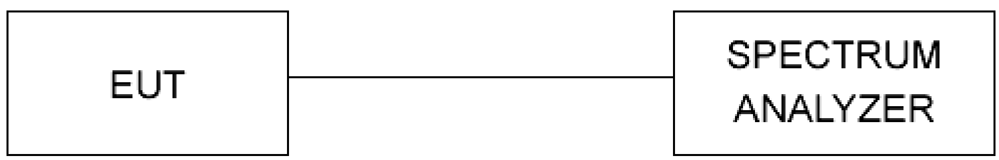


Figure 1 - Bandwidth Measurements Test Setup

Radiated ☒

All the radiated measurements were taken at a distance of 3m from the EUT. The information regarding resolution bandwidth, video bandwidth, span and the detector used can be found in the graphs provided in the Appendix C. All the radio measurements were performed using the sections from ANSI C63.10, details about the section used can be found in the spectrum analyzer titles on the graph.

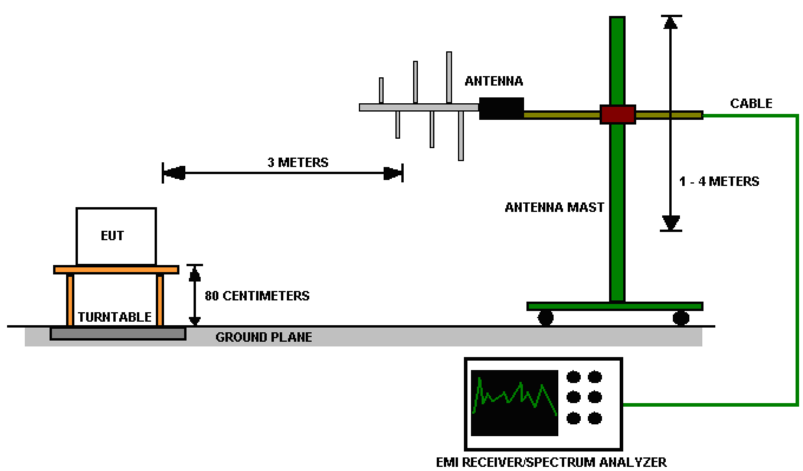


Figure 2 - Radiated Emissions Test Setup

4.0 RESULTS

DTS Radio Measurements, Low Data Rate							
CHANNEL	Transmitter	Occupied Bandwidth (MHz)	6 dB Bandwidth (MHz)	AVERAGE OUTPUT POWER (dBm)	AVERAGE OUTPUT POWER (mW)	PSD (dBm)	RESULT
Low	802.11 b	15.19	10.06	15.380	34.514	0.755	PASS
Mid	802.11 b	15.19	10.06	15.010	31.696	0.595	PASS
High	802.11 b	15.49	10.06	16.740	47.206	2.226	PASS
Low	802.11 g	16.76	16.46	13.940	24.774	-9.423	PASS
Mid	802.11 g	16.96	16.50	15.530	35.727	-8.139	PASS
High	802.11 g	16.88	16.50	14.120	25.823	-8.951	PASS
Low	802.11 n	17.599	17.63	13.5	22.387	-11.124	PASS
Mid	802.11 n	17.616	17.65	14.38	27.416	-9.951	PASS
High	802.11 n	17.634	17.63	13.3	21.380	-11.155	PASS
Occupied Bandwidth = N/A; 6 dB Bandwidth Limit = 500 kHz				Peak Output Power Limit = 30 dBm; PSD Limit = 8 dBm			

DTS Radio Measurements, High Data Rate							
CHANNEL	Transmitter	Occupied Bandwidth (MHz)	6 dB Bandwidth (MHz)	AVERAGE OUTPUT POWER (dBm)	AVERAGE OUTPUT POWER (mW)	PSD (dBm)	RESULT
Low	802.11 b	14.73	8.94	14.770	29.992	-7.901	PASS
Mid	802.11 b	14.70	9.01	14.700	29.512	-8.107	PASS
High	802.11 b	14.88	9.04	16.510	44.771	-6.363	PASS
Low	802.11 g	16.58	16.53	11.150	13.032	-12.525	PASS
Mid	802.11 g	16.57	16.51	10.750	11.885	-13.459	PASS
High	802.11 g	16.60	16.52	10.770	11.940	-13.149	PASS
Low	802.11 n	17.56	17.53	5.340	3.420	-14.501	PASS
Mid	802.11 n	17.53	17.66	5.030	3.184	-14.683	PASS
High	802.11 n	17.54	17.65	5.130	3.258	-15.051	PASS
Occupied Bandwidth = N/A; 6 dB Bandwidth Limit = 500 kHz				Peak Output Power Limit = 30 dBm; PSD Limit = 8 dBm			

Unrestricted Band-Edge, Low Data Rate							
CHANNEL	Mode	Band edge /Measurement Frequency (MHz)	Relative Highest out of band level (dBuV)	Relative Fundamental (dBuV)	Delta (dB)	Min Delta (dB)	Result
Low	802.11 b	2390.00	80.71	113.34	32.64	30.00	PASS
Low	802.11 g	2390.00	75.71	108.24	32.53	30.00	PASS
Low	802.11 n	2390.00	77.28	108.59	31.31	30.00	PASS
High	802.11 b	2483.50	59.89	114.74	54.85	30.00	PASS
High	802.11 g	2483.50	77.17	108.87	31.69	30.00	PASS
High	802.11 n	2483.50	77.23	108.03	30.80	30.00	PASS

Unrestricted Band-Edge, High Data Rate							
CHANNEL	**Mode**	**Band edge /Measurement Frequency (MHz)**	**Relative Highest out of band level (dBuV)**	**Relative Fundamental (dBuV)**	**Delta (dB)**	**Min Delta (dB)**	**Result**
Low	802.11 b	2400.00	80.52	113.41	32.89	30.00	PASS
Low	802.11 g	2400.00	74.01	106.45	32.45	30.00	PASS
Low	802.11 n	2400.00	70.78	104.99	34.21	30.00	PASS
High	802.11 b	2483.50	69.88	114.87	44.99	30.00	PASS
High	802.11 g	2483.50	66.50	105.53	39.03	30.00	PASS
High	802.11 n	2483.50	65.16	104.94	39.78	30.00	PASS

Peak Restricted Band-Edge, Low Data Rate							
CHANNEL	**Mode**	**Band edge /Measurement Frequency (MHz)**	**Highest out of band level (dBuV/m @ 3m)**	**Measurement Type**	**Limit (dBuV/m @ 3m)**	**Margin**	**Result**
Low	802.11 b	2390.00	55.56	Peak	73.98	18.42	PASS
Low	802.11 g	2390.00	66.01	Peak	73.98	7.97	PASS
Low	802.11 n	2390.00	60.50	Peak	73.98	13.48	PASS
High	802.11 b	2483.50	55.08	Peak	73.98	18.90	PASS
High	802.11 g	2483.50	70.36	Peak	73.98	3.63	PASS
High	802.11 n	2483.50	69.30	Peak	73.98	4.68	PASS
*Limit shown is the peak limit taken from FCC Part 15.209							

Average Restricted Band-Edge, Low Data Rate							
CHANNEL	**Mode**	**Band edge /Measurement Frequency (MHz)**	**Highest out of band level (dBuV/m @ 3m)**	**Measurement Type**	**Limit (dBuV/m @ 3m)**	**Margin**	**Result**
Low	802.11 b	2390.00	44.84	Average	53.98	9.14	PASS
Low	802.11 g	2390.00	52.91	Average	53.98	1.07	PASS
Low	**802.11 n**	**2390.00**	**53.71**	**Average**	**53.98**	**0.27**	**PASS**
High	802.11 b	2483.50	43.84	Average	53.98	10.14	PASS
High	802.11 g	2483.50	53.05	Average	53.98	0.93	PASS
High	802.11 n	2483.50	53.09	Average	53.98	0.89	PASS
*Limit shown is the average limit taken from FCC Part 15.209							

Peak Restricted Band-Edge, High Data Rate							
CHANNEL	**Mode**	**Band edge /Measurement Frequency (MHz)**	**Highest out of band level (dBuV/m @ 3m)**	**Measurement Type**	**Limit (dBuV/m @ 3m)**	**Margin**	**Result**
Low	802.11 b	2390.00	56.16	Peak	73.98	17.82	PASS
Low	802.11 g	2390.00	64.71	Peak	73.98	9.28	PASS
Low	802.11 n	2390.00	63.53	Peak	73.98	10.45	PASS
High	802.11 b	2483.50	54.81	Peak	73.98	19.17	PASS
High	802.11 g	2483.50	60.85	Peak	73.98	13.13	PASS
High	802.11 n	2483.50	58.20	Peak	73.98	15.78	PASS
*Limit shown is the peak limit taken from FCC Part 15.209							

Average Restricted Band-Edge, High Data Rate							
CHANNEL	**Mode**	**Band edge /Measurement Frequency (MHz)**	**Highest out of band level (dBuV/m @ 3m)**	**Measurement Type**	**Limit (dBuV/m @ 3m)**	**Margin**	**Result**
Low	802.11 b	2390.00	44.84	Average	53.98	9.14	PASS
Low	802.11 g	2390.00	48.97	Average	53.98	5.01	PASS
Low	802.11 n	2390.00	47.50	Average	53.98	6.48	PASS
High	802.11 b	2483.50	43.38	Average	53.98	10.60	PASS
High	802.11 g	2483.50	45.57	Average	53.98	8.41	PASS
High	802.11 n	2483.50	44.27	Average	53.98	9.71	PASS
*Limit shown is the average limit taken from FCC Part 15.209							

4.1 OUTPUT POWER

Test Method: All the radio measurements were performed using the sections from ANSI C63.10, details about the section used can be found in the spectrum analyzer titles on the graph.

Limits of power measurements:
For FCC Part 15.247 Device:
The maximum allowed peak output power is 30 dBm.

Test procedures:
Details can be found in section 3.4 of this report.

Deviations from test standard:
No deviation.

Test setup:
Details can be found in section 3.4 of this report.

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

Test results:

Pass

Comments:
1. All the output power plots can be found in the Appendix C.
2. All the measurements were found to be compliant.
3. Results were all within measurement tolerance.

4.2 BANDWIDTH

Test Method: All the radio measurements were performed using the sections from ANSI C63.10, details about the section used can be found in the spectrum analyzer titles on the graph.

Limits of bandwidth measurements:

For FCC Part 15.247 Device:
The 99% occupied bandwidth is for informational purpose only. The 6dB bandwidth of the signal must be greater than 500 kHz.

Test procedures:
Details can be found in section 3.4 of this report.

Deviations from test standard:
No deviation.

Test setup:
Test setup details can be found in section 3.4 of this report.

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

Test results:

Pass

Comments:
1. All the bandwidth plots can be found in the Appendix C.
2. All the measurements were found to be compliant.

4.3 POWER SPECTRAL DENSITY

Test Method: All the radio measurements were performed using the sections from ANSI C63.10, details about the section used can be found in the spectrum analyzer titles on the graph.

Limits of power measurements:

For FCC Part 15.247 Device:
The maximum PSD allowed is 8 dBm.

Test procedures:
Details can be found in section 3.4 of this report.

Deviations from test standard:
No deviation.

Test setup:
Details can be found in section 3.4 of this report.

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

Test results:

Pass

Comments:

1. All the Power Spectral Density (PSD) plots can be found in the Appendix C.
2. All the measurements were found to be compliant.
3. The measurements are reported on the graph.

4.4 CONDUCTED SPURIOUS EMISSIONS

Test Method: ANSI C63.10-2013, Section 7.8.8

Limits of spurious emissions:

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)).

Test procedures:

The highest emissions level was measured and recorded. All spurious measurements were evaluated to 20dB below the fundamental. More details can be found in section 3.4 of this report.

Deviations from test standard:
No deviation.

Test setup:
Test setup details can be found in section 3.4 of this report.

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

Test results:

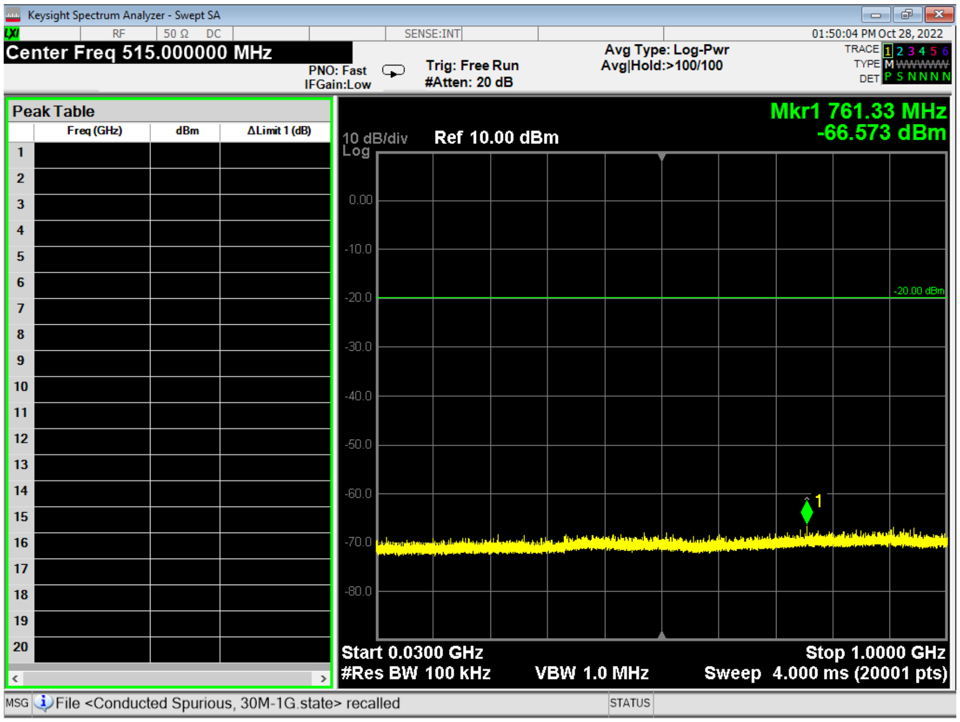


Figure 3 - Conducted Emissions Plot, Wifi B 1MB, 30M – 1G

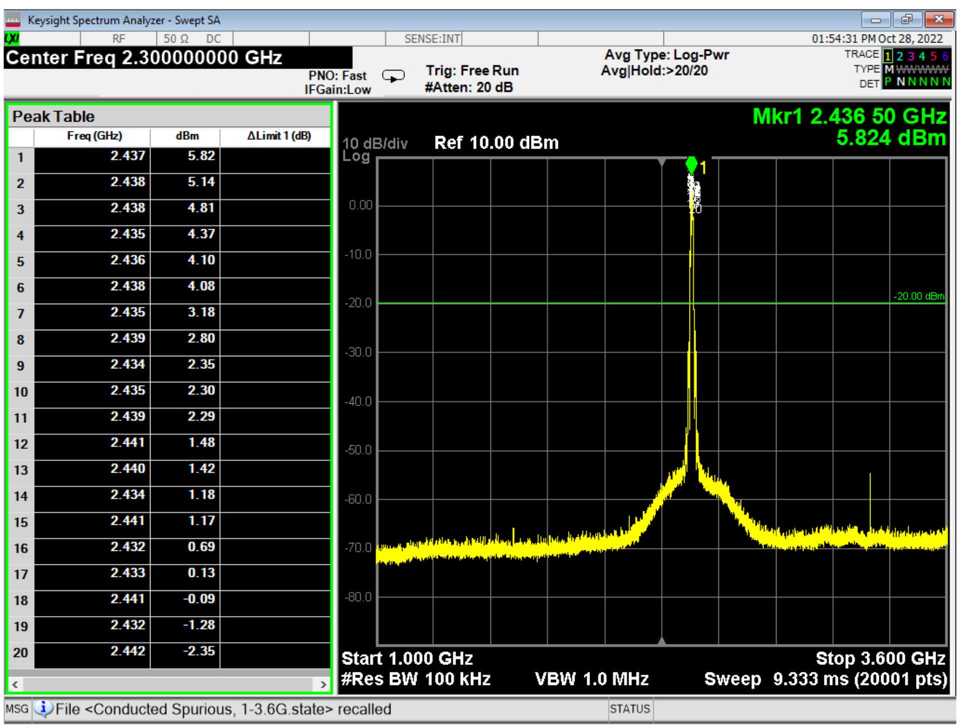


Figure 4 - Conducted Emissions Plot, Wifi B 1MB, 1G – 3.6G

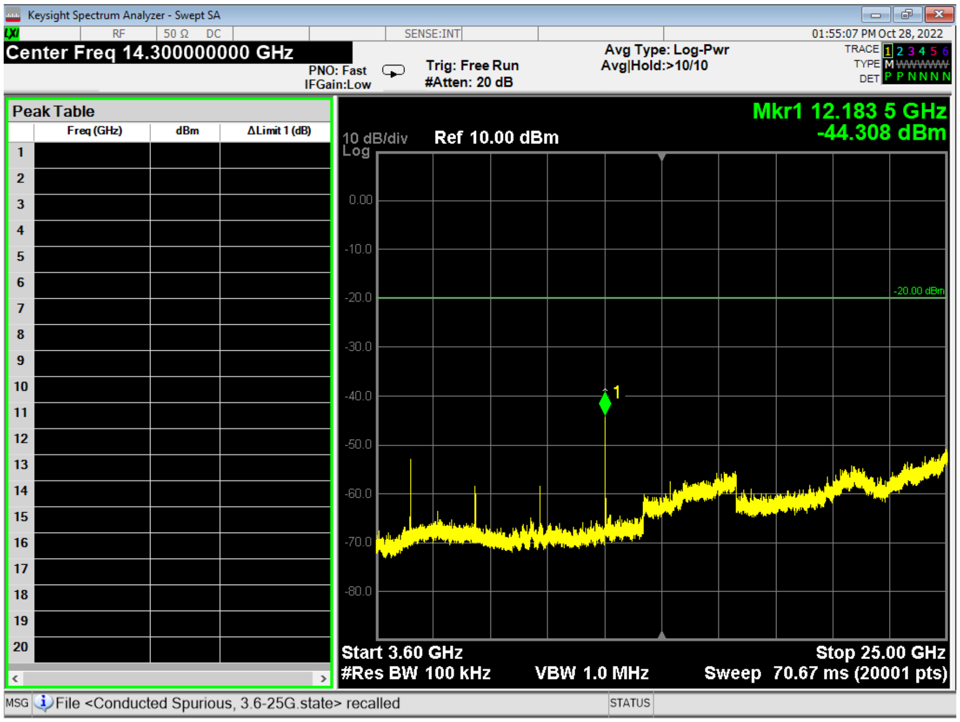


Figure 5 - Conducted Emissions Plot, Wifi B 1MB, 3.6G – 25G

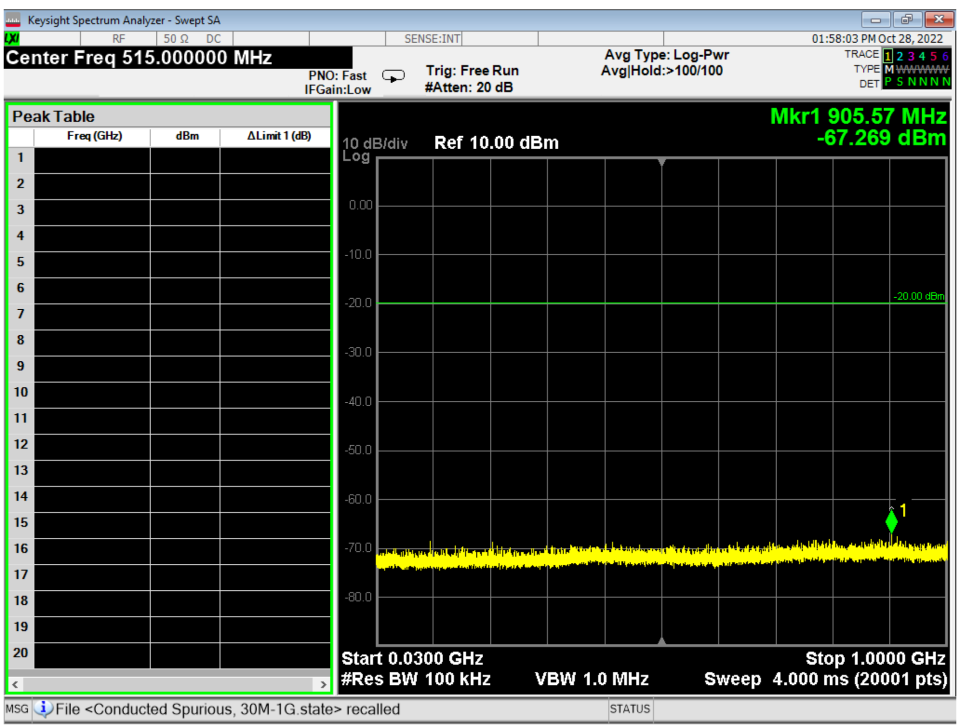


Figure 6 - Conducted Emissions Plot, Wifi G 6MB, 30M – 1G

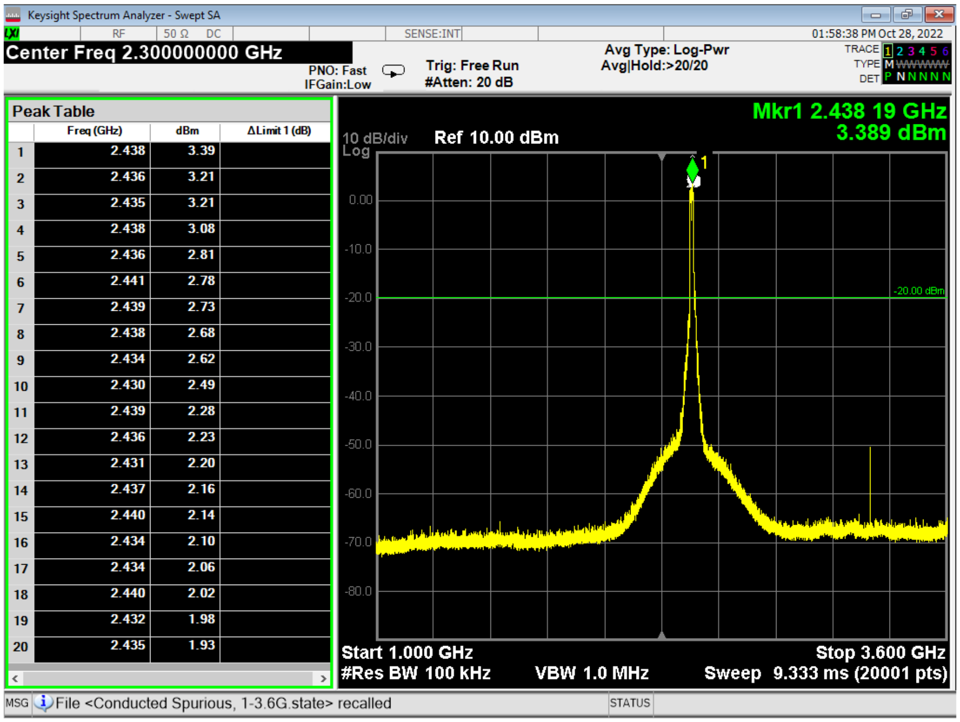


Figure 7 - Conducted Emissions Plot, Wifi G 6MB, 1G – 3.6G

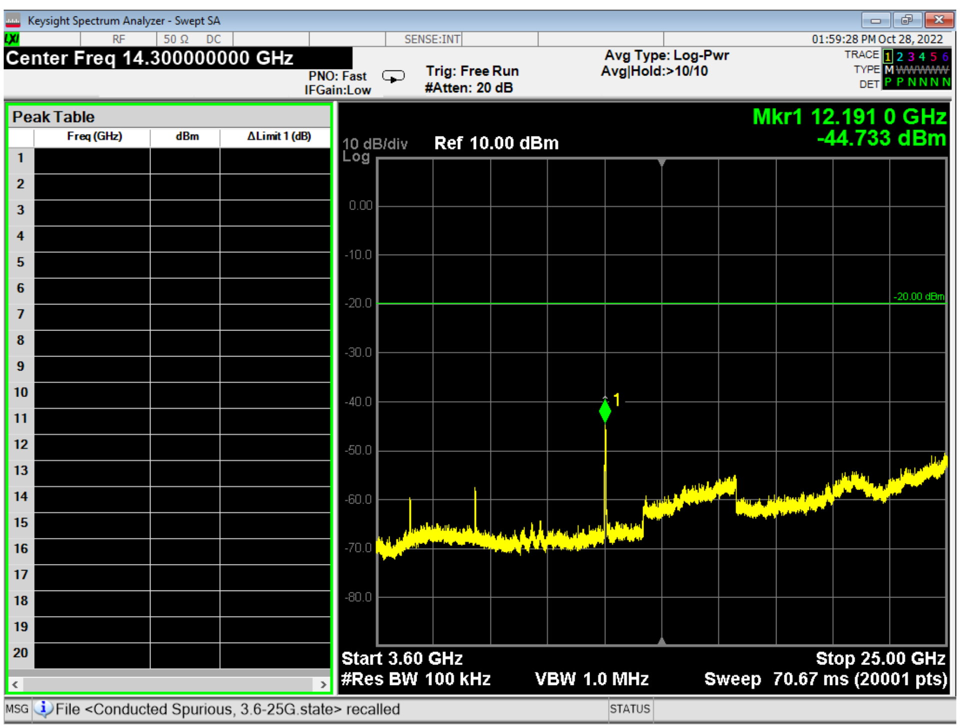


Figure 8 - Conducted Emissions Plot, Wifi G 6MB, 3.6G – 25G

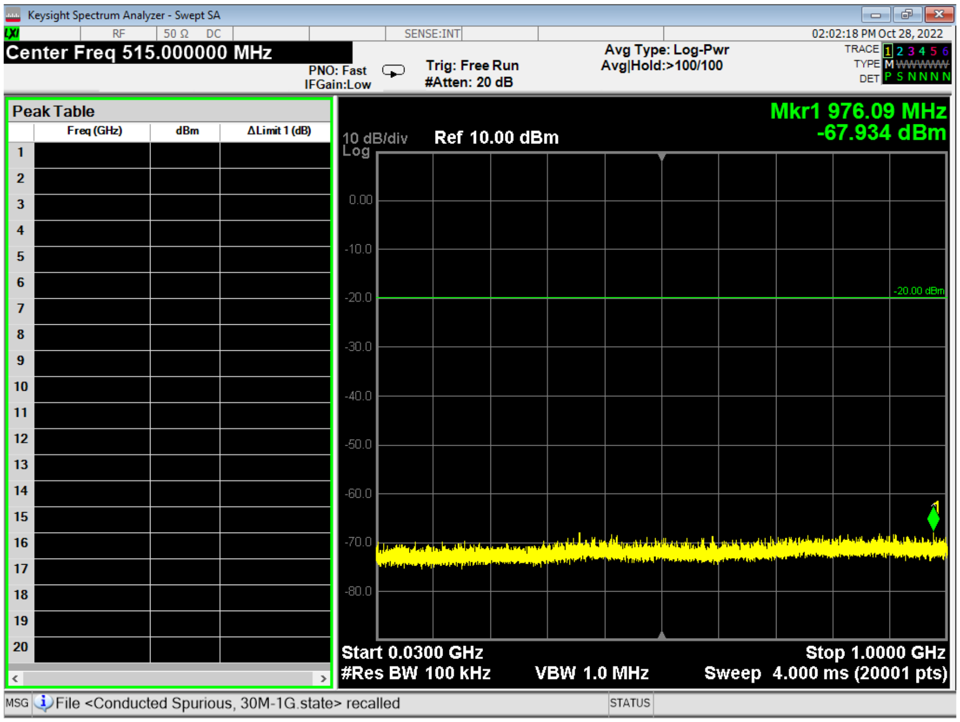


Figure 9 - Conducted Emissions Plot, Wifi N MCS0, 30M – 1G

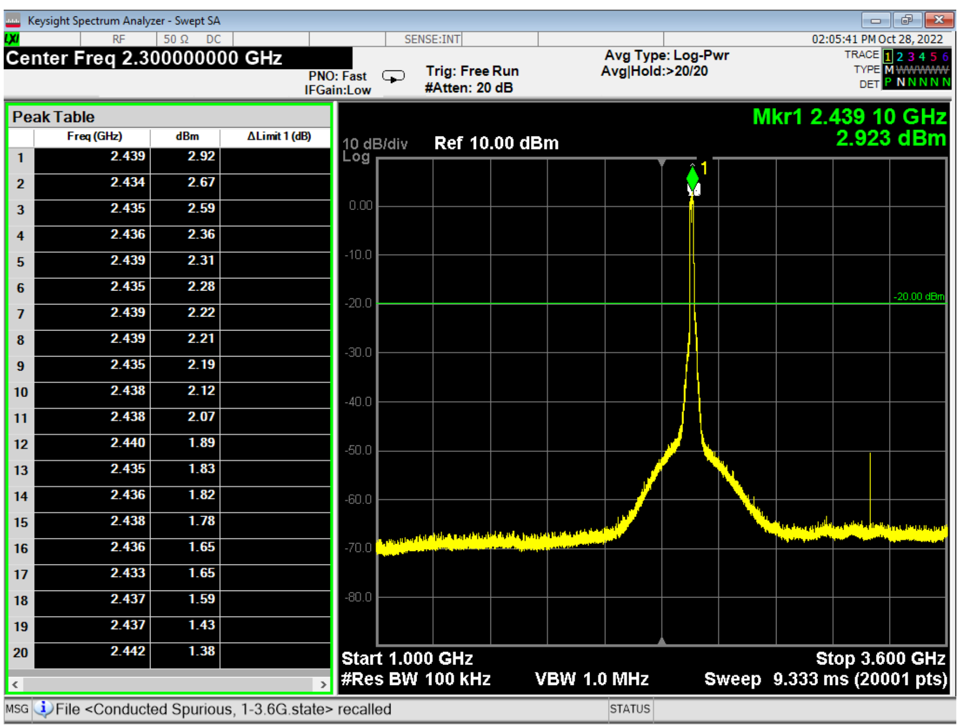


Figure 10 - Conducted Emissions Plot, Wifi N MCS0, 1G – 3.6G

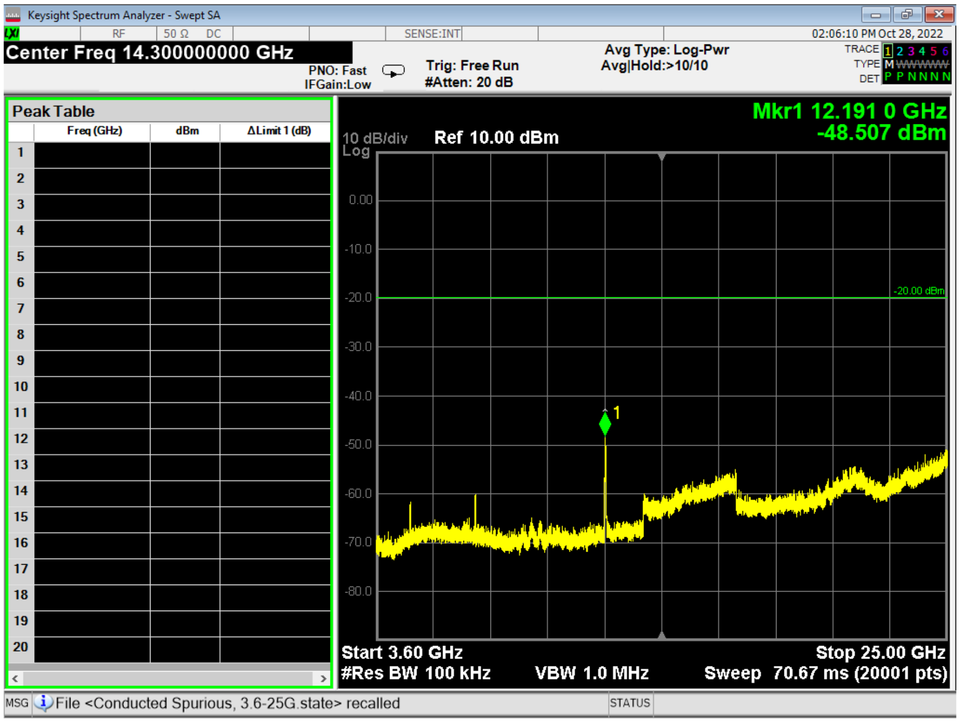


Figure 11 - Conducted Emissions Plot, Wifi N MCS0, 3.6G – 25G

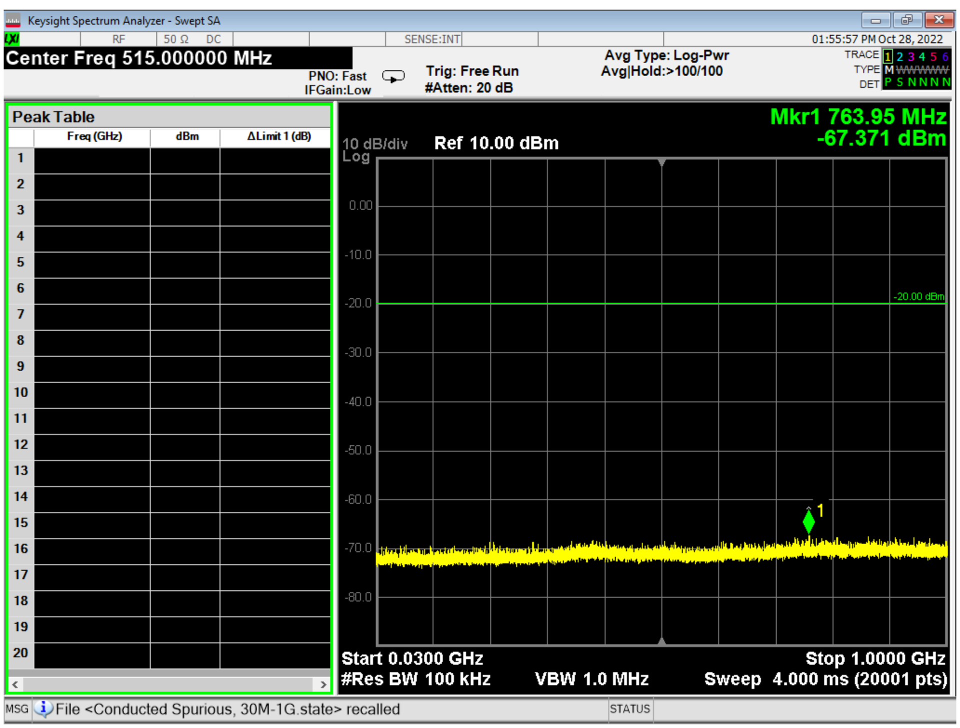


Figure 12 - Conducted Emissions Plot, Wifi B 11MB, 30M – 1G

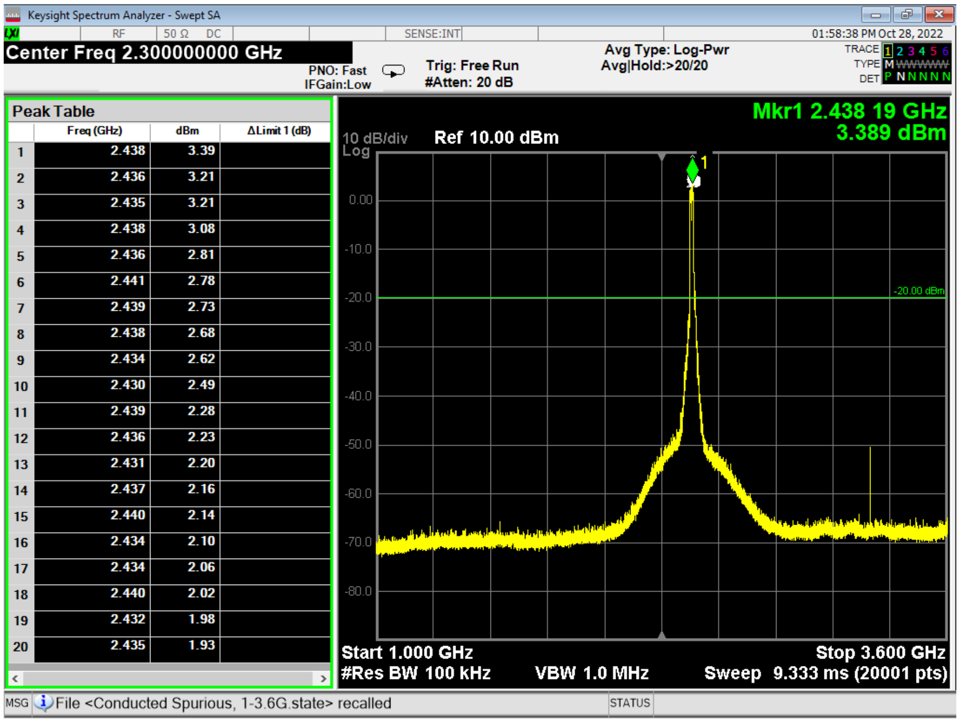


Figure 13 - Conducted Emissions Plot, Wifi B 11MB, 1G – 3.6G

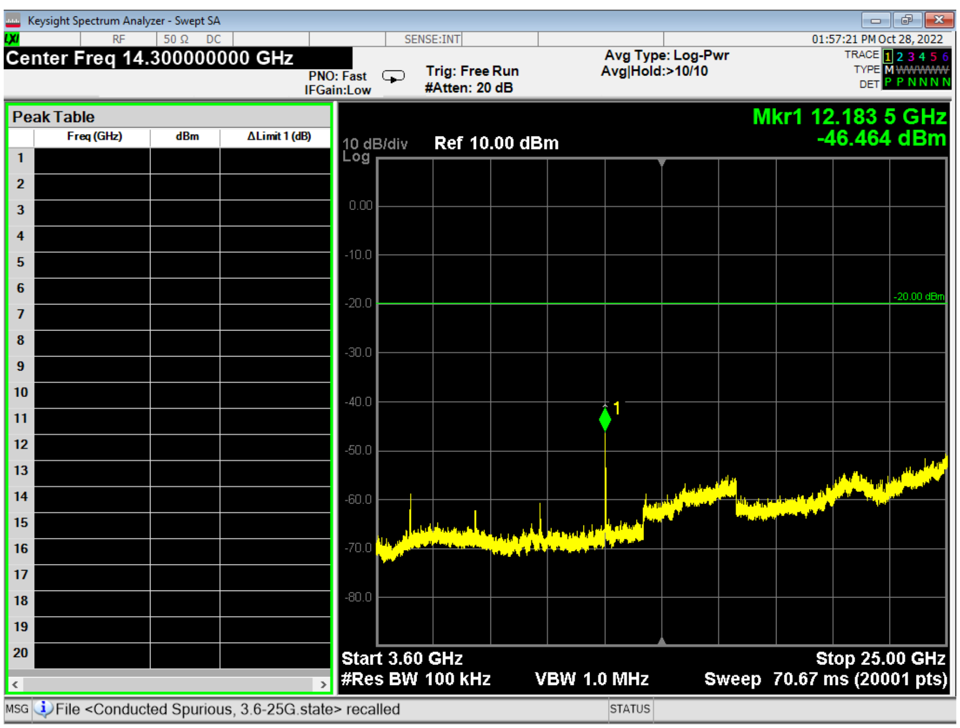


Figure 14 - Conducted Emissions Plot, Wifi B 11MB, 3.6G – 25G

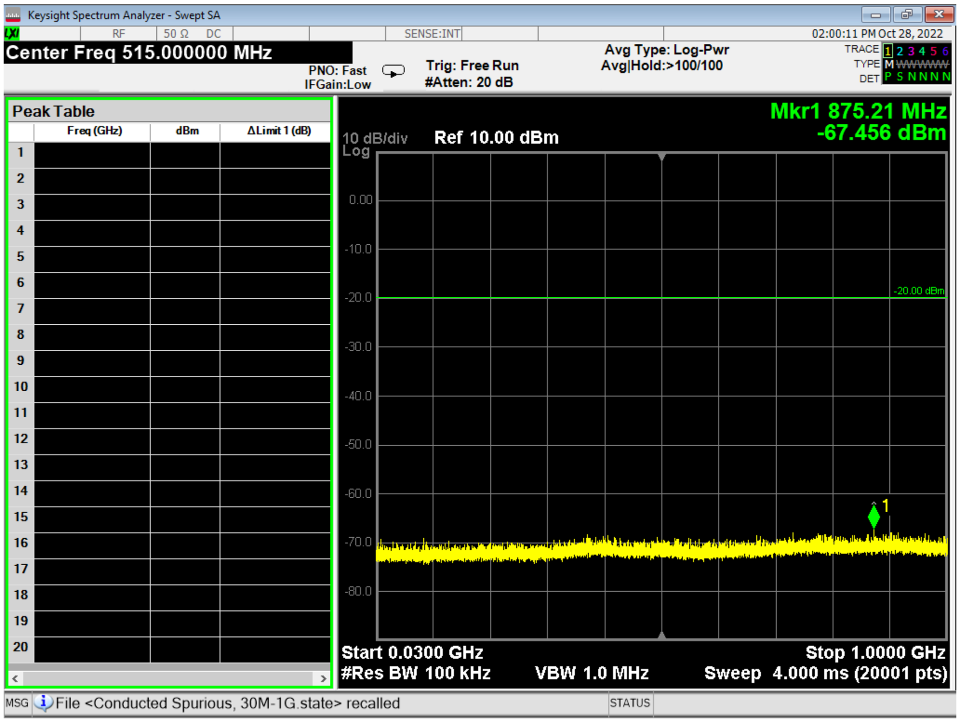


Figure 15 - Conducted Emissions Plot, Wifi G 54MB, 30M – 1G

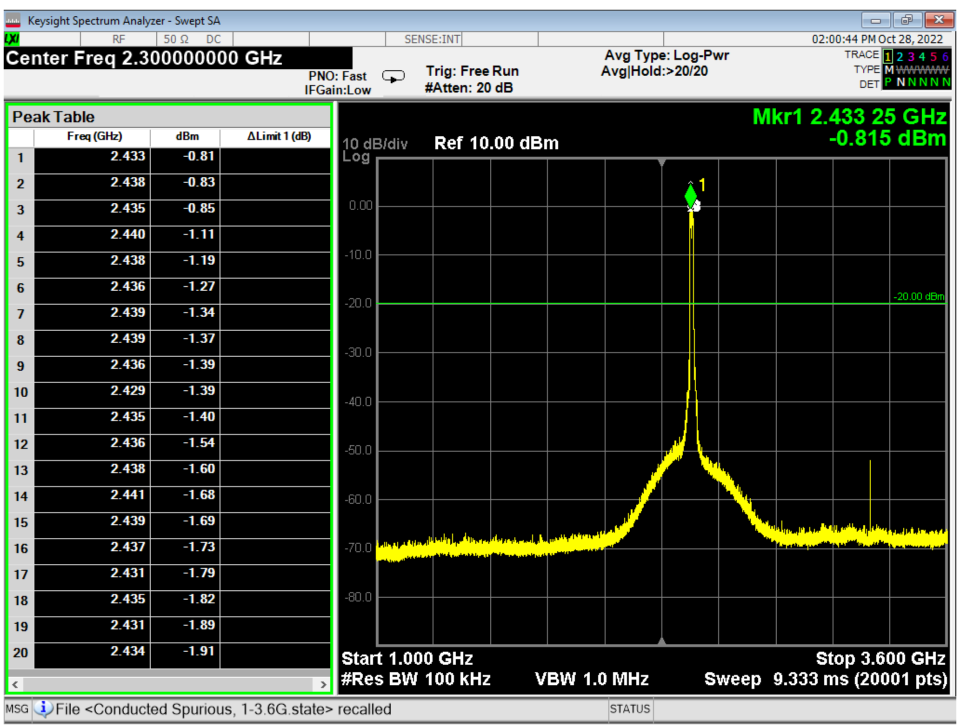


Figure 16 - Conducted Emissions Plot, Wifi G 54MB, 1G – 3.6G

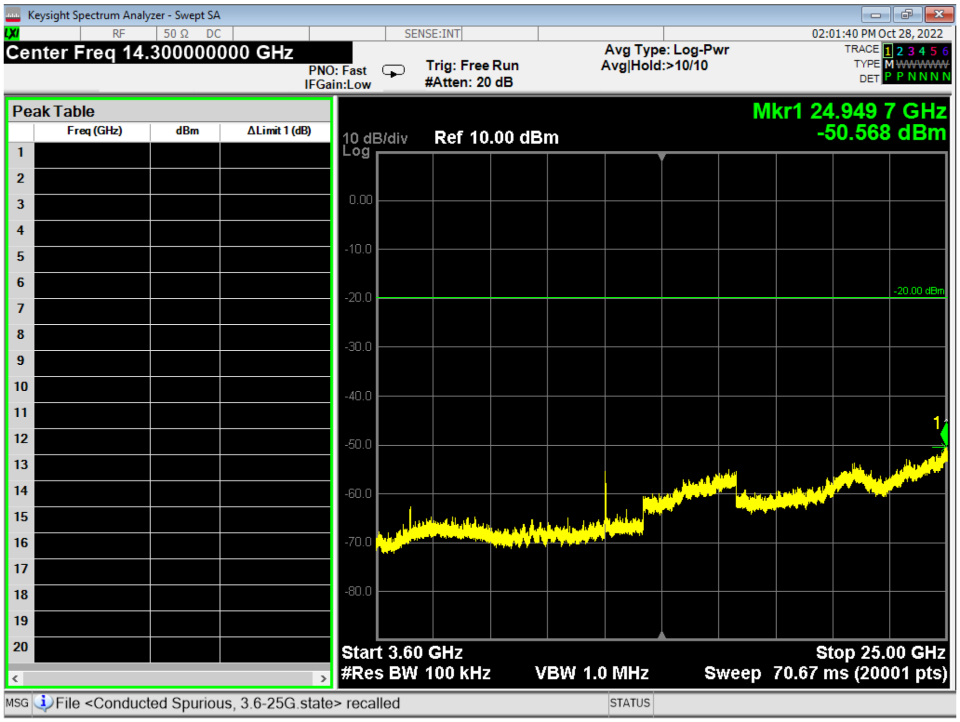


Figure 17 - Conducted Emissions Plot, Wifi G 54MB, 3.6G – 25G

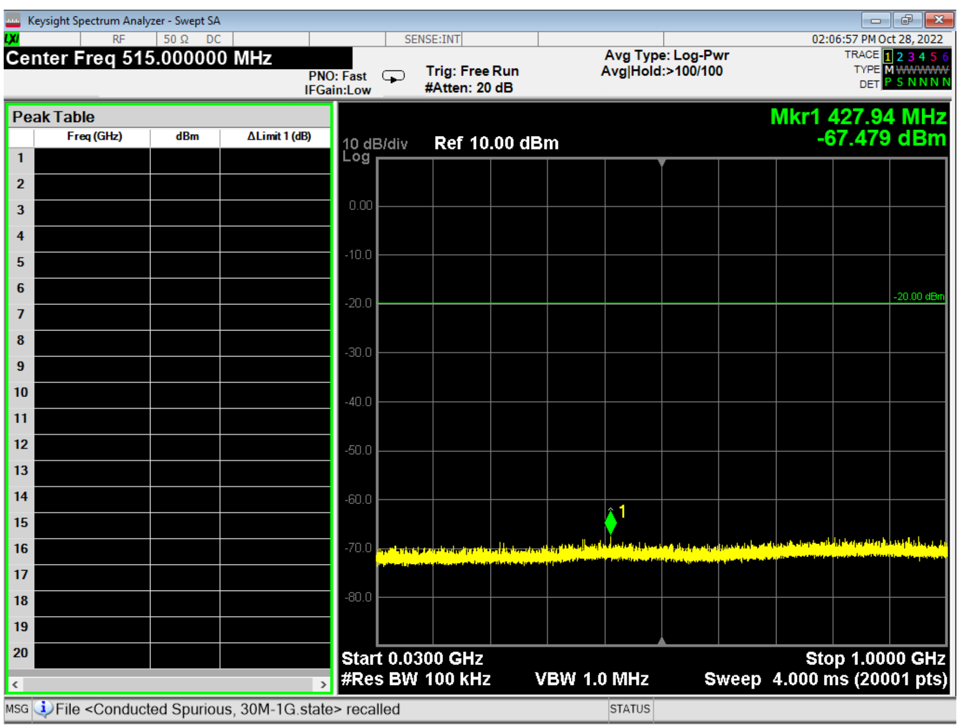


Figure 18 - Conducted Emissions Plot, Wifi N MCS7, 30M – 1G

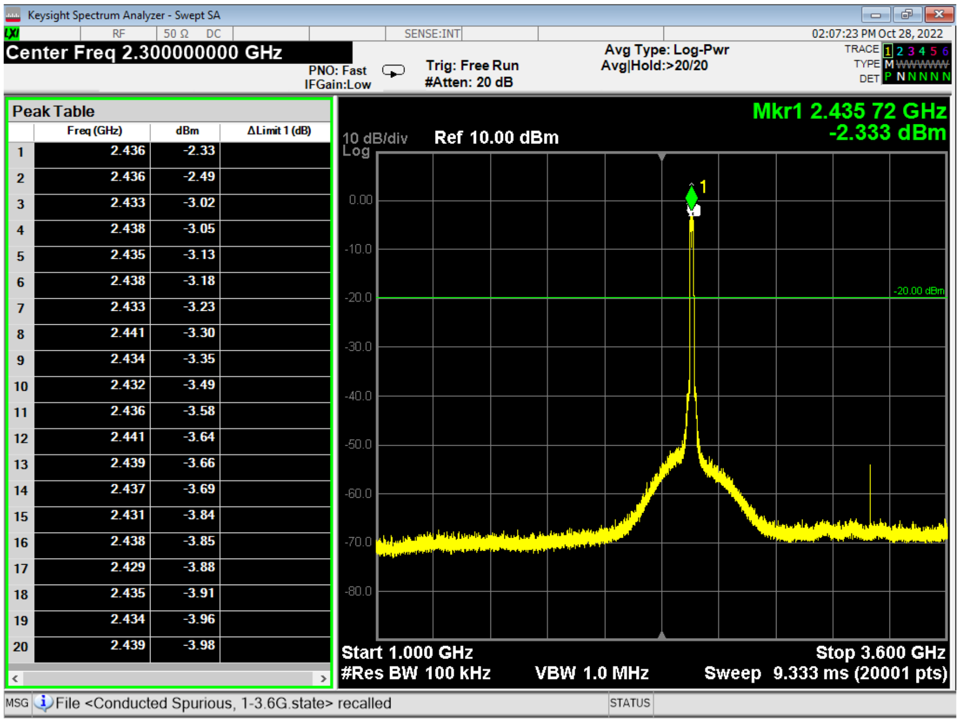


Figure 19 - Conducted Emissions Plot, Wifi N MCS7, 1G – 3.6G

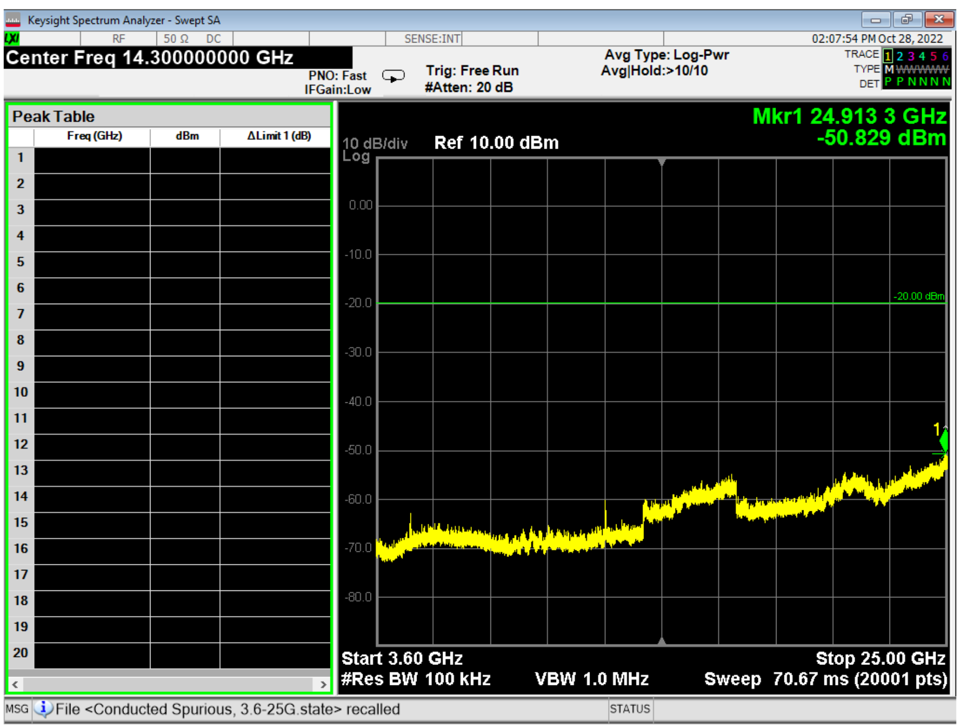


Figure 20 - Conducted Emissions Plot, Wifi N MCS7, 3.6G – 25G

4.5 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:

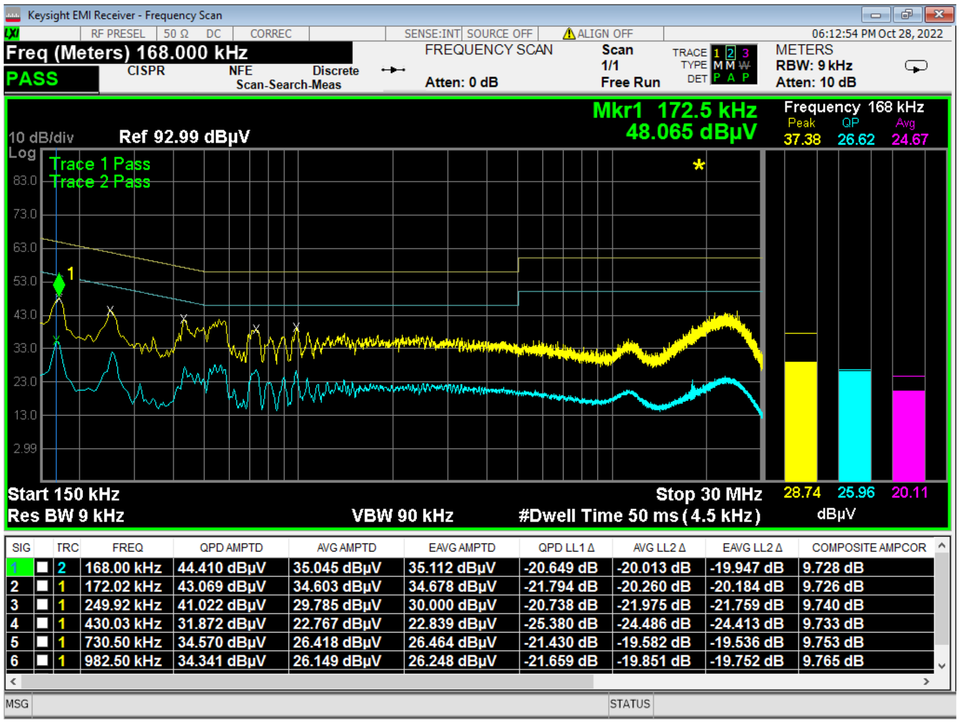
No deviation

EUT operating conditions:

Details can be found in section 2.1 of this report.

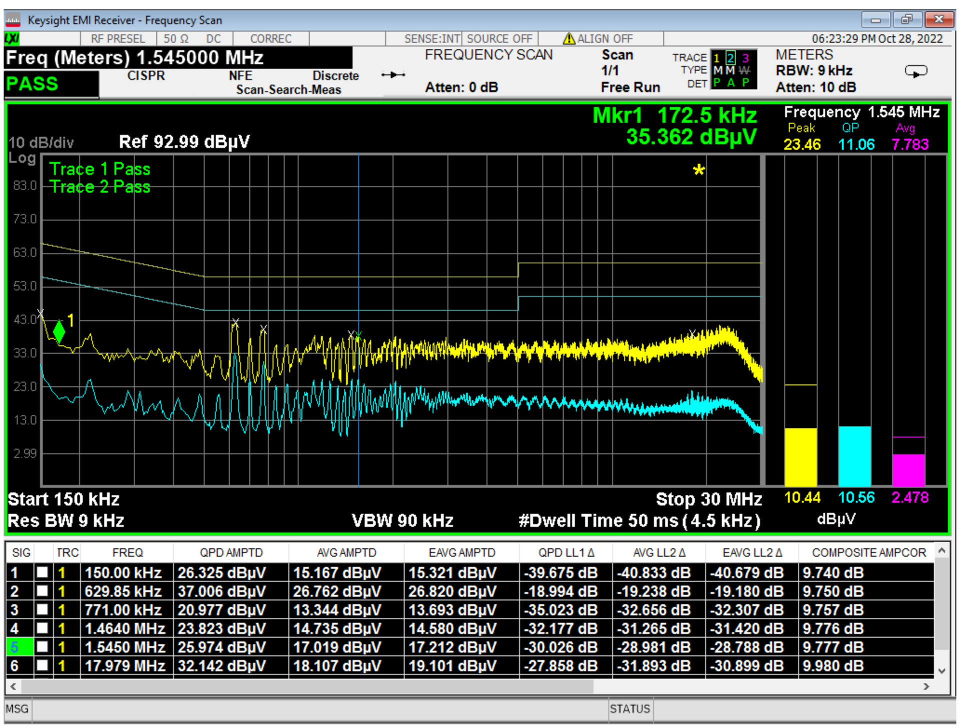
.

Test Results:



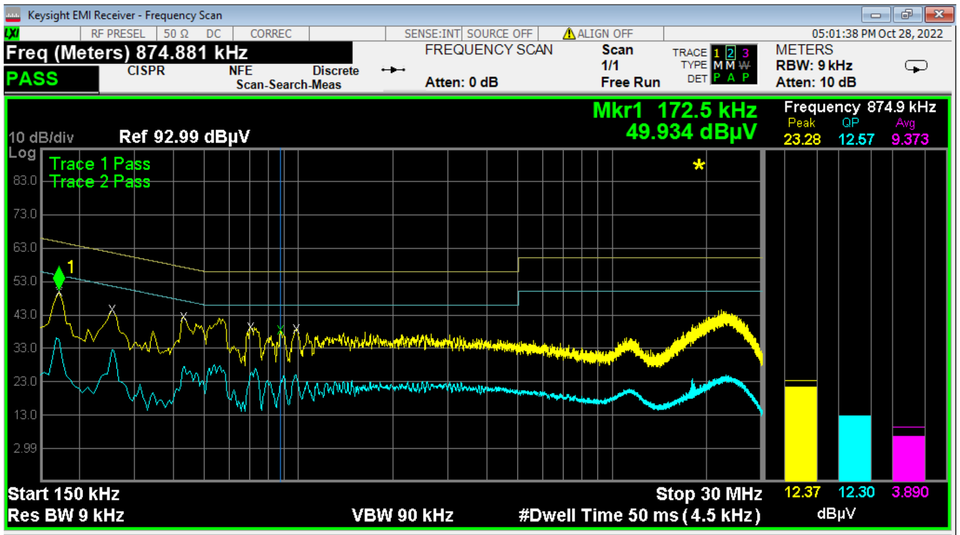
SIG	TRC	FREQ	QPD AMPTD	AVG AMPTD	EAVG AMPTD	QPD LL1 Δ	AVG LL2 Δ	EAVG LL2 Δ	COMPOSITE AMPCOR
1	2	168.00 kHz	44.410 dBµV	35.045 dBµV	35.112 dBµV	-20.649 dB	-20.013 dB	-19.947 dB	9.728 dB
2	1	172.02 kHz	43.069 dBµV	34.603 dBµV	34.678 dBµV	-21.794 dB	-20.260 dB	-20.184 dB	9.726 dB
3	1	249.92 kHz	41.022 dBµV	29.785 dBµV	30.000 dBµV	-20.738 dB	-21.975 dB	-21.759 dB	9.740 dB
4	1	430.03 kHz	31.872 dBµV	22.767 dBµV	22.839 dBµV	-25.380 dB	-24.486 dB	-24.413 dB	9.733 dB
5	1	730.50 kHz	34.570 dBµV	26.418 dBµV	26.464 dBµV	-21.430 dB	-19.582 dB	-19.536 dB	9.753 dB
6	1	982.50 kHz	34.341 dBµV	26.149 dBµV	26.248 dBµV	-21.659 dB	-19.851 dB	-19.752 dB	9.765 dB

Figure 21 - Conducted Emissions Plot, Line, TX



SIG	TRC	FREQ	QPD AMPTD	AVG AMPTD	EAVG AMPTD	QPD LL1 Δ	AVG LL2 Δ	EAVG LL2 Δ	COMPOSITE AMPCOR
1	1	150.00 kHz	26.325 dBµV	15.167 dBµV	15.321 dBµV	-39.675 dB	-40.833 dB	-40.679 dB	9.740 dB
2	1	629.85 kHz	37.006 dBµV	26.762 dBµV	26.820 dBµV	-18.994 dB	-19.238 dB	-19.180 dB	9.750 dB
3	1	771.00 kHz	20.977 dBµV	13.344 dBµV	13.693 dBµV	-35.023 dB	-32.656 dB	-32.307 dB	9.757 dB
4	1	1.4640 MHz	23.823 dBµV	14.735 dBµV	14.580 dBµV	-32.177 dB	-31.265 dB	-31.420 dB	9.776 dB
5	1	1.5450 MHz	25.974 dBµV	17.019 dBµV	17.212 dBµV	-30.026 dB	-28.981 dB	-28.788 dB	9.777 dB
6	1	17.979 MHz	32.142 dBµV	18.107 dBµV	19.101 dBµV	-27.858 dB	-31.893 dB	-30.899 dB	9.980 dB

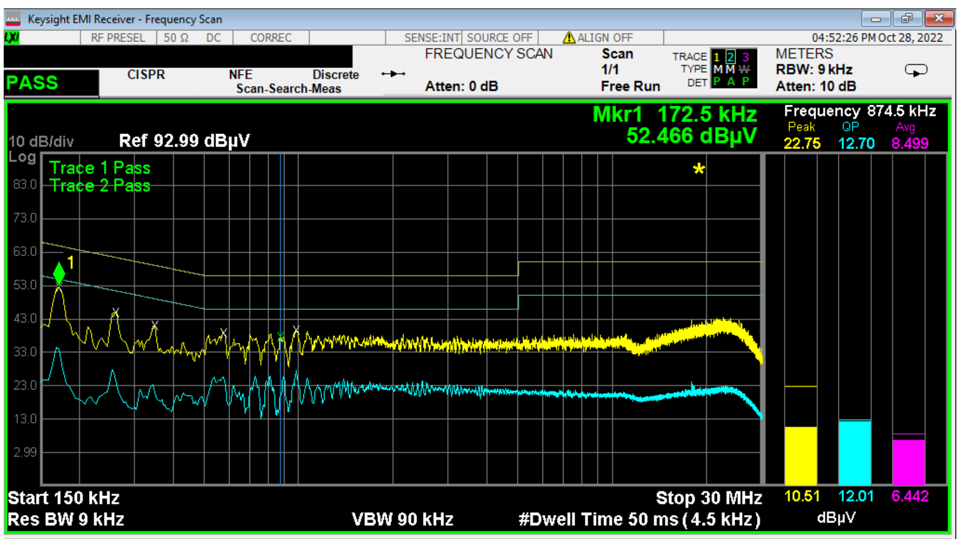
Figure 22 - Conducted Emissions Plot, Neutral, TX



SIG	TRC	FREQ	QPD AMPTD	AVG AMPTD	EAVG AMPTD	QPD LL1 Δ	AVG LL2 Δ	EAVG LL2 Δ	COMPOSITE AMPCOR
1	1	172.50 kHz	44.533 dBµV	35.645 dBµV	35.635 dBµV	-20.306 dB	-19.194 dB	-19.204 dB	9.726 dB
2	1	253.50 kHz	39.845 dBµV	30.376 dBµV	30.427 dBµV	-21.797 dB	-21.265 dB	-21.215 dB	9.741 dB
3	1	429.00 kHz	37.463 dBµV	27.075 dBµV	27.206 dBµV	-19.809 dB	-20.197 dB	-20.066 dB	9.733 dB
4	1	703.50 kHz	34.033 dBµV	24.952 dBµV	25.218 dBµV	-21.967 dB	-21.048 dB	-20.782 dB	9.750 dB
5	1	874.88 kHz	31.850 dBµV	21.932 dBµV	22.009 dBµV	-24.150 dB	-24.068 dB	-23.991 dB	9.753 dB
6	1	982.50 kHz	34.840 dBµV	24.860 dBµV	25.071 dBµV	-21.160 dB	-21.140 dB	-20.929 dB	9.765 dB

MSG STATUS

Figure 23 - Conducted Emissions Plot, Line, IDLE



SIG	TRC	FREQ	QPD AMPTD	AVG AMPTD	EAVG AMPTD	QPD LL1 Δ	AVG LL2 Δ	EAVG LL2 Δ	COMPOSITE AMPCOR
1	1	171.67 kHz	43.887 dBµV	33.030 dBµV	33.169 dBµV	-20.992 dB	-21.850 dB	-21.710 dB	9.726 dB
2	1	260.92 kHz	34.465 dBµV	24.175 dBµV	24.188 dBµV	-26.937 dB	-27.228 dB	-27.214 dB	9.744 dB
3	1	346.27 kHz	32.433 dBµV	20.452 dBµV	20.636 dBµV	-26.619 dB	-28.600 dB	-28.415 dB	9.746 dB
4	1	577.50 kHz	33.909 dBµV	25.130 dBµV	25.299 dBµV	-22.091 dB	-20.870 dB	-20.701 dB	9.746 dB
5	1	874.50 kHz	30.144 dBµV	19.222 dBµV	19.241 dBµV	-25.856 dB	-26.778 dB	-26.759 dB	9.753 dB
6	1	978.00 kHz	34.722 dBµV	25.870 dBµV	26.070 dBµV	-21.278 dB	-20.130 dB	-19.930 dB	9.763 dB

MSG STATUS

Figure 24 - Conducted Emissions Plot, Neutral, IDLE

4.6 DUTY CYCLE

Test Method:

All Modulations/Transmitters in this report had a duty cycle of >98%

4.7 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.
4. The EUT was tested for spurious emissions while running off of battery power and external USB power. The worse-case emissions were produced while running off of USB power, so results from this mode are presented.

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 from 30MHz-1Ghz and 1.5m for measurements from 1GHz and higher.

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.

Test setup:

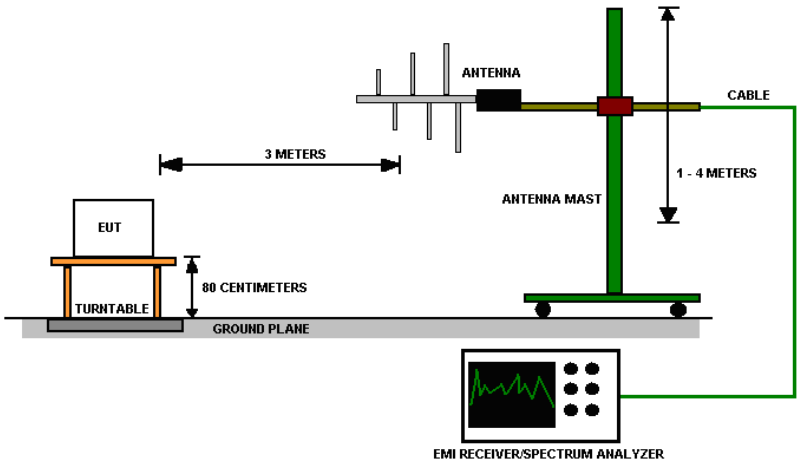


Figure 25 - Radiated Emissions Test Setup

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.

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

Test results:

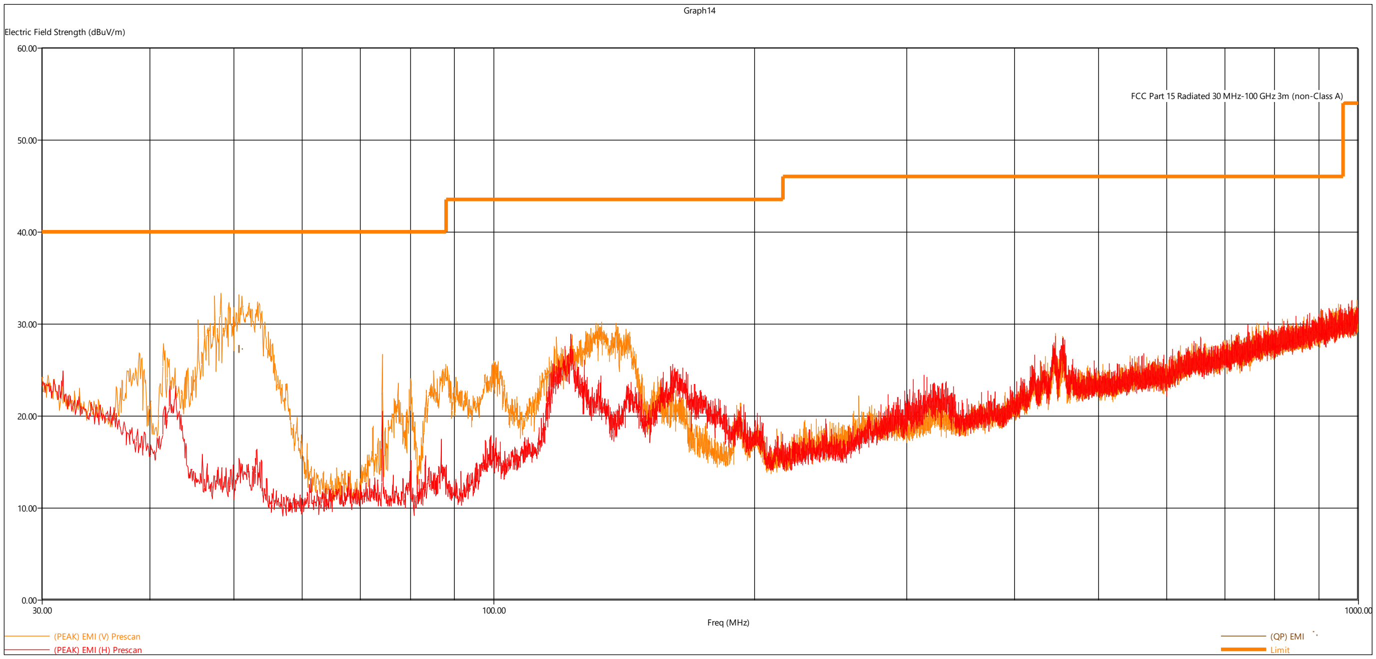


Figure 26 - Radiated Emissions Plot, Receive

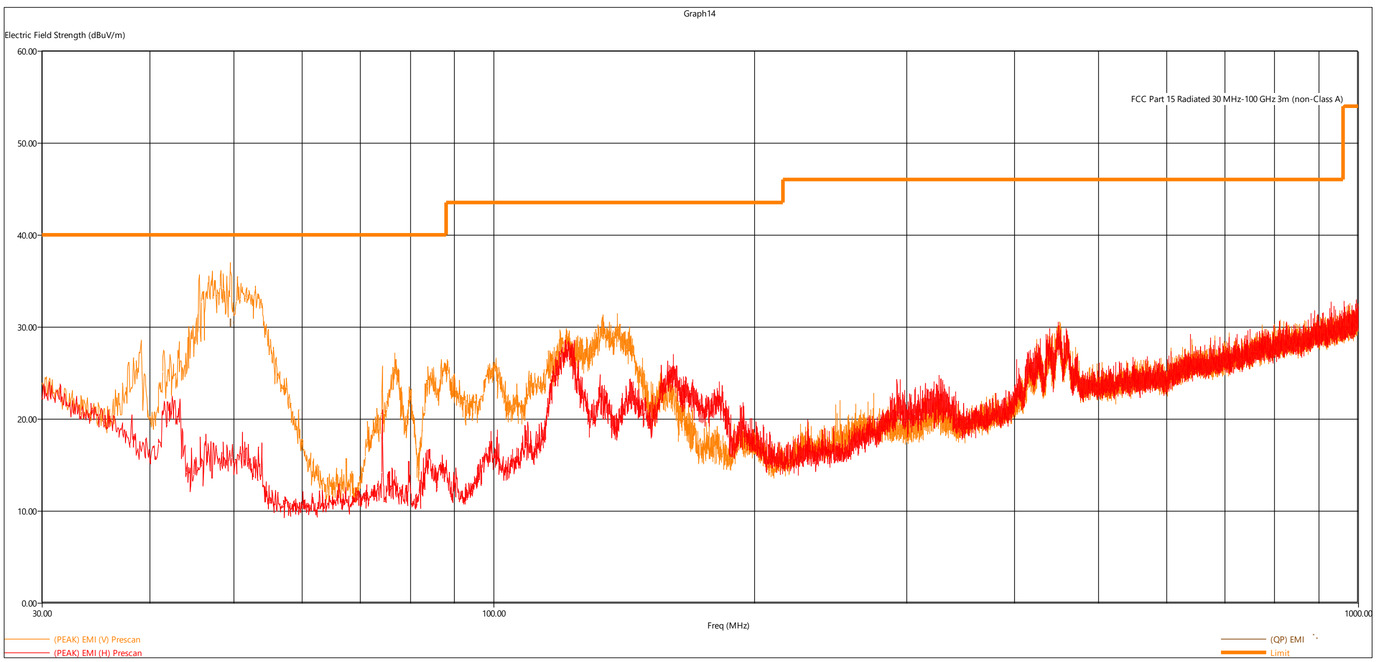


Figure 27 - Radiated Emissions Plot, 802.11b, Low Data Rate

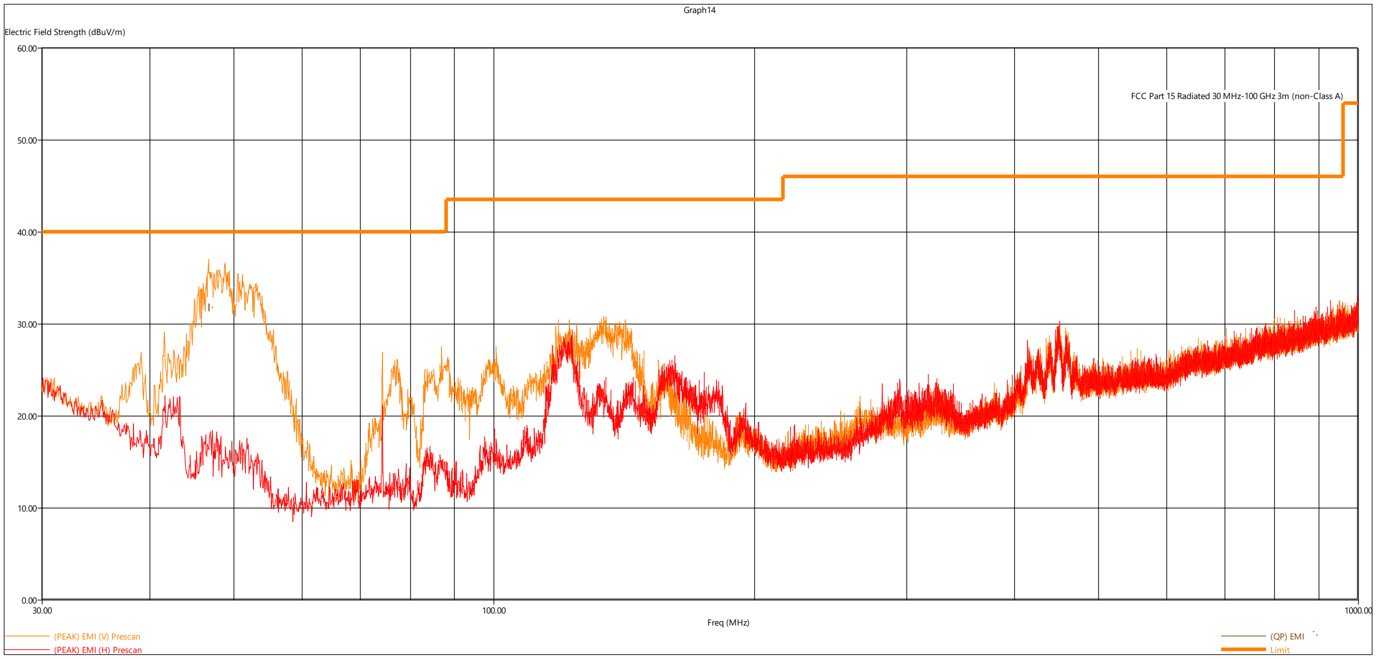


Figure 28 - Radiated Emissions Plot, 802.11g, Low Data Rate

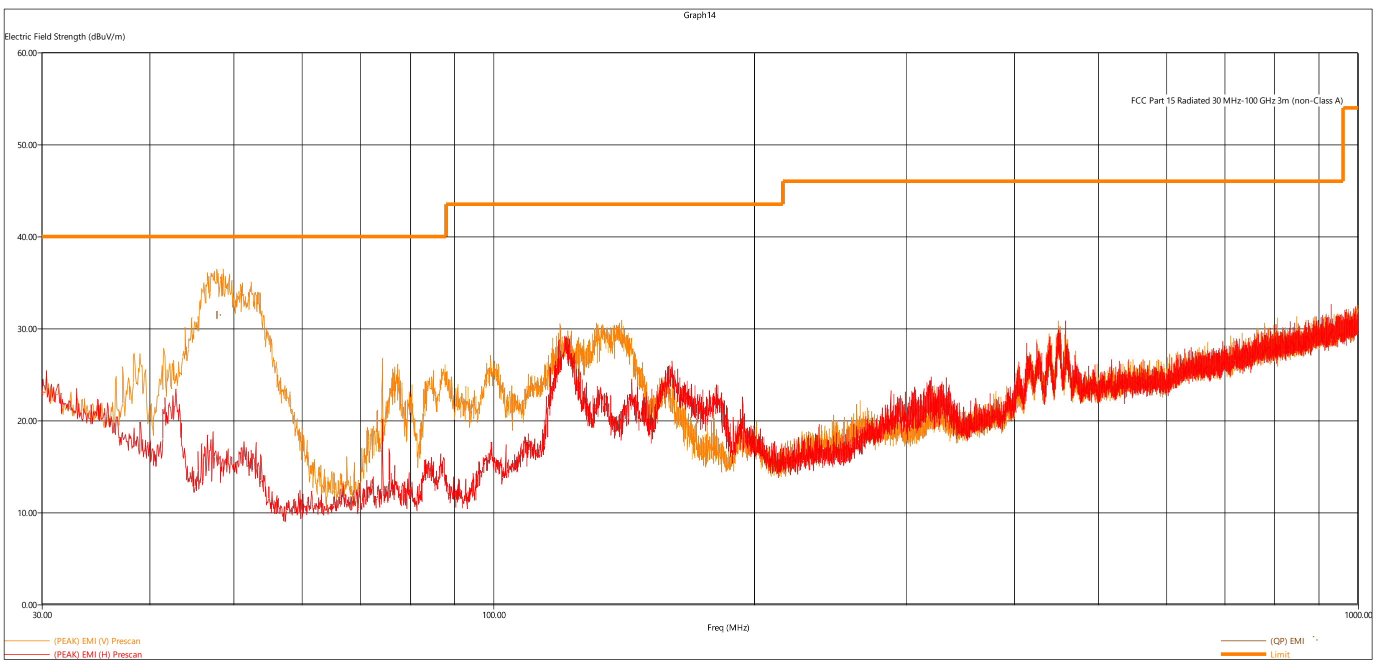


Figure 29 - Radiated Emissions Plot, 802.11n, Low Data Rate

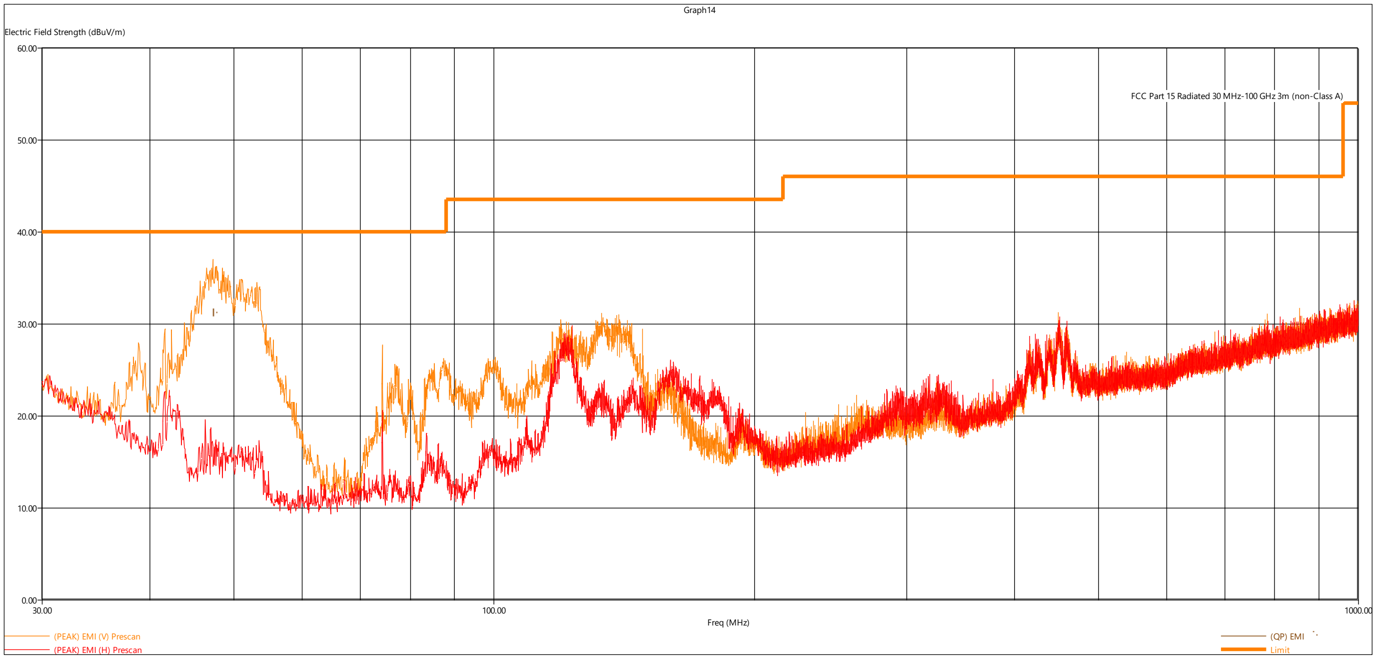


Figure 30 - Radiated Emissions Plot, 802.11b, High Data Rate

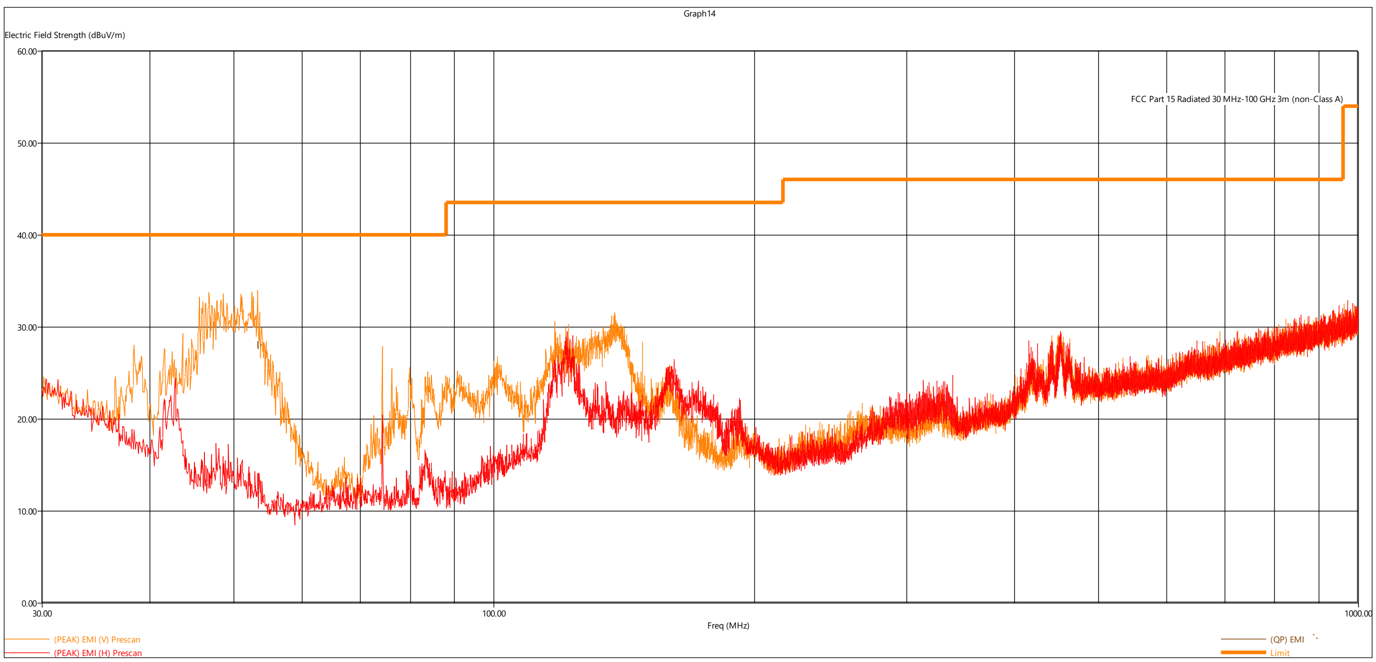


Figure 31 - Radiated Emissions Plot, 802.11g, High Data Rate

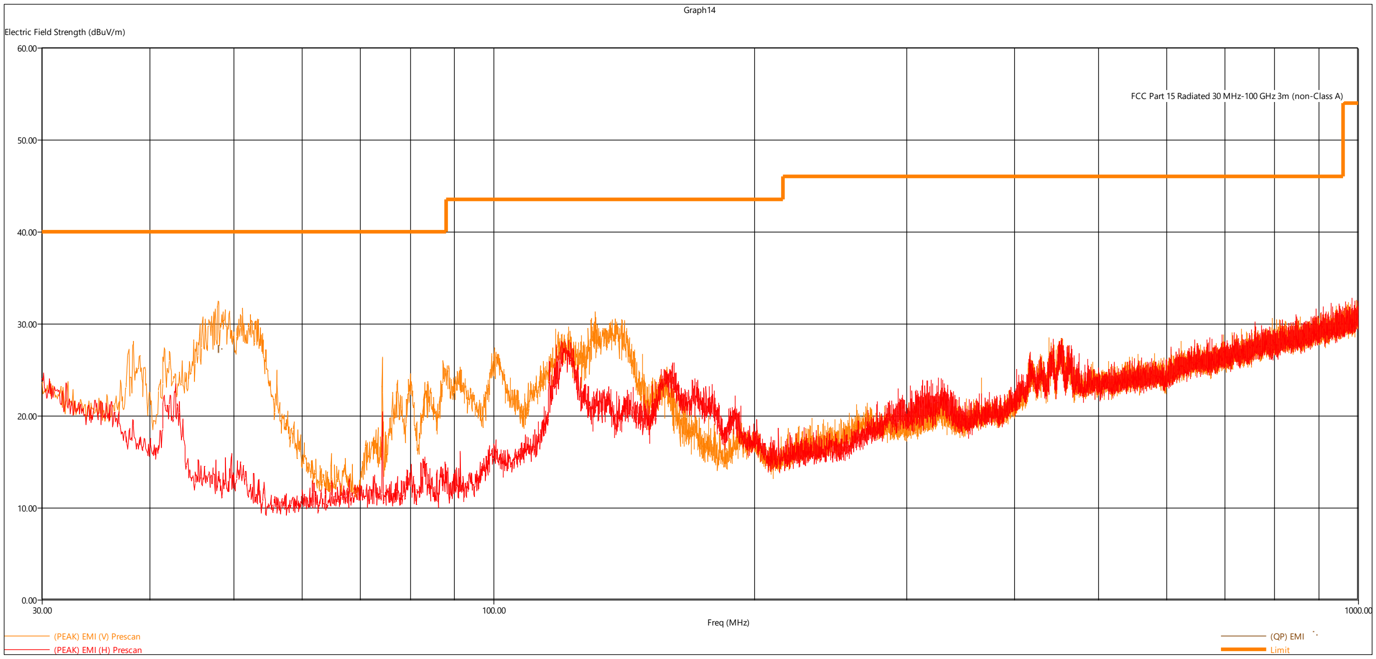


Figure 32 - Radiated Emissions Plot, 802.11n, High Data Rate

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 = Limit value - Emission level

Quasi-Peak Measurements, 802.11x								
Frequency	**Level**	**Limit**	**Margin**	**Height**	**Angle**	**Pol**	**Channel**	**Modulation**
MHz	**dBµV/m**	**dBµV/m**	**dB**	**cm.**	**deg.**			
49.538160	30.35	40.00	9.65	106.00	22.00	V	Low	WIFI B 1MB
47.420640	31.15	40.00	8.85	111.00	298.00	V	Low	WIFI B 11MB
46.832640	31.71	40.00	8.29	112.00	321.00	V	Low	WIFI G 6MHz
53.470560	27.97	40.00	12.03	108.00	24.00	V	Low	WIFI G 54MHz
47.860080	31.44	40.00	8.56	106.00	314.00	V	Low	WIFI N MCS0
47.778960	27.20	40.00	12.80	116.00	316.00	V	Low	WIFI N MCS7
50.845200	27.22	40.00	12.78	116.00	39.00	V	RX	

All other measurements found to be at least 6dB below the limit line

Peak Measurements, 802.11x								
Frequency	**Level**	**Limit**	**Margin**	**Height**	**Angle**	**Pol**	**Channel**	**Modulation**
MHz	**dBµV/m**	**dBµV/m**	**dB**	**cm.**	**deg.**			
2411.116000	98.80	NA	NA	170	189	H	Low	WIFI B 1MB
2436.094000	98.98	NA	NA	125	32	H	Mid	WIFI B 1MB
2461.082000	99.48	NA	NA	211	183	H	High	WIFI B 1MB
2412.346000	102.40	NA	NA	169	188	H	Low	WIFI B 11MB
2436.234000	103.61	NA	NA	134	186	H	Mid	WIFI B 11MB
2461.218000	103.96	NA	NA	209	185	H	High	WIFI B 11MB
2410.898000	99.74	NA	NA	146	25	H	Low	WIFI G 6MHz
2435.156000	103.46	NA	NA	158	188	H	Mid	WIFI G 6MHz
2459.818000	101.41	NA	NA	278	177	H	High	WIFI G 6MHz
2412.520000	98.85	NA	NA	203	185	H	Low	WIFI G 54MHz
2435.178000	98.97	NA	NA	163	29	H	Mid	WIFI G 54MHz
2461.174000	97.94	NA	NA	112	181	H	High	WIFI G 54MHz
2409.936000	101.28	NA	NA	396	297	H	Low	WIFI N MCS0
2434.892000	102.73	NA	NA	206	32	H	Mid	WIFI N MCS0
2461.230000	100.04	NA	NA	192	20	H	High	WIFI N MCS0
2410.754000	98.43	NA	NA	397	299	H	Low	WIFI N MCS7
2435.420000	96.46	NA	NA	161	26	H	Mid	WIFI N MCS7
2461.472000	96.96	NA	NA	237	18	H	High	WIFI N MCS7

The EUT was maximized in all 3 orthogonal axes. The worst-case is shown in the plot and table above.
All other emissions found to be at least 6dB below the limit line. System Noise floor was at least 6 dB below the limit line throughout the test range.

Average Measurements, 802.11x								
Frequency	Level	Limit	Margin	Height	Angle	Pol	Channel	Modulation
MHz	dBµV/m	dBµV/m	dB	cm.	deg.			
2411.116000	95.93	NA	NA	170	189	H	Low	WIFI B 1MB
2436.094000	96.02	NA	NA	125	32	H	Mid	WIFI B 1MB
2461.082000	96.47	NA	NA	211	183	H	High	WIFI B 1MB
2412.346000	94.91	NA	NA	169	188	H	Low	WIFI B 11MB
2436.234000	95.49	NA	NA	134	186	H	Mid	WIFI B 11MB
2461.218000	95.83	NA	NA	209	185	H	High	WIFI B 11MB
2410.898000	90.60	NA	NA	146	25	H	Low	WIFI G 6MHz
2435.156000	94.23	NA	NA	158	188	H	Mid	WIFI G 6MHz
2459.818000	91.36	NA	NA	278	177	H	High	WIFI G 6MHz
2412.520000	87.77	NA	NA	203	185	H	Low	WIFI G 54MHz
2435.178000	88.19	NA	NA	163	29	H	Mid	WIFI G 54MHz
2461.174000	88.13	NA	NA	112	181	H	High	WIFI G 54MHz
2409.936000	91.44	NA	NA	396	297	H	Low	WIFI N MCS0
2434.892000	93.01	NA	NA	206	32	H	Mid	WIFI N MCS0
2461.230000	90.78	NA	NA	192	20	H	High	WIFI N MCS0
2410.754000	87.65	NA	NA	397	299	H	Low	WIFI N MCS7
2435.420000	85.80	NA	NA	161	26	H	Mid	WIFI N MCS7
2461.472000	85.94	NA	NA	237	18	H	High	WIFI N MCS7

The EUT was maximized in all 3 orthogonal axes. The worst-case is shown in the plot and table above.
All other emissions found to be at least 6dB below the limit line. System Noise floor was at least 6 dB below the limit line throughout the test range.

4.8 BAND EDGES

Test Method: All the radio measurements were performed using the sections from ANSI C63.10, details about the section used can be found in the spectrum analyzer titles on the graph.

Limits of band-edge measurements:
For FCC Part 15.247 Device:
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))

Test procedures:

The highest emissions level beyond the band-edge was measured and recorded. All band edge measurements were evaluated to the general limits in Part 15.209. More details can be found in section 3.4 of this report.

Deviations from test standard:
No deviation.

Test setup:
Test setup details can be found in section 3.4 of this report.

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

Test results:

Pass

Comments:

1. All the band edge plots can be found in the Appendix C.
2. If the device falls under FCC Part 15.247 (Details can be found in summary of test results), compliance is shown in the unrestricted band edges by showing minimum delta of 20 dB between peak and the band edge.
3. The restricted band edge compliance is shown by comparing to the general limit defined in Part 15.209. The limit shown in the graph accounts for the antenna gain of the device.

4.9 ANTENNA GAIN

Test procedures:
Device's conducted power was measured then then same measurement was repeated on a radiated sample at 3m test distance and converted to E.I.R.P.

Test setup:
Details can be found in section 2.1 of this report.

EUT operating conditions:
Details can be found in section 2.1 and 2.2 of this report.

Test results:

Antenna Gain:
Radiated Average power – Conducted Average Power = Antenna gain
12.24 dBm – 15.53 dBm = **-3.29 dBi**

Comments:

1. Since antenna gain was negative, conducted values were compared to the limit as if it has 0dBm gain for worst case

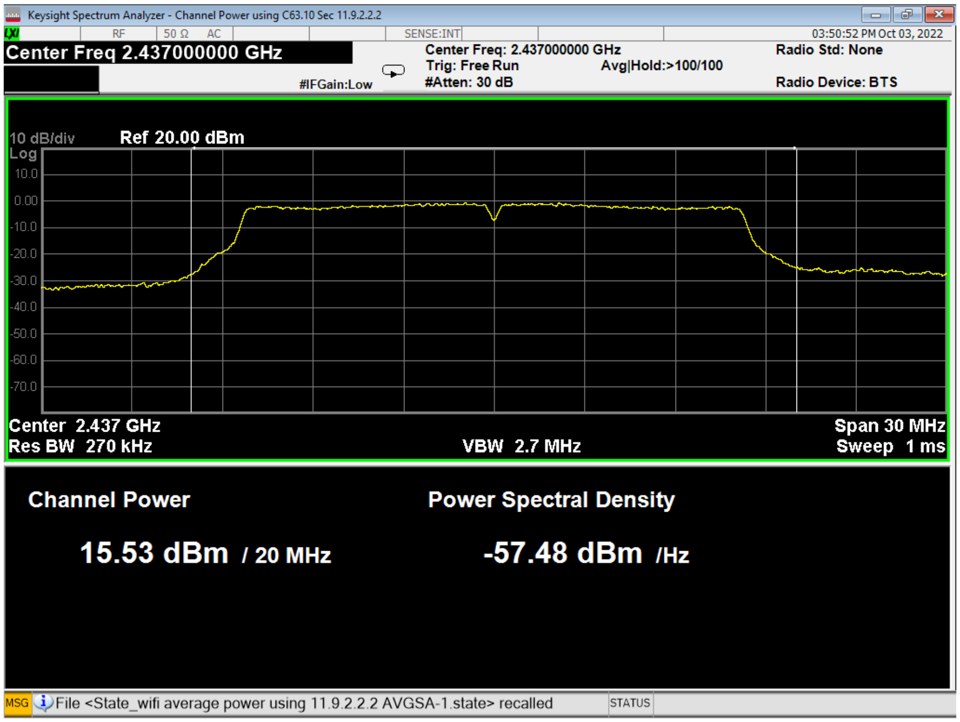


Figure 33 – Conducted Average Power Measurement, 802.11g 6MB

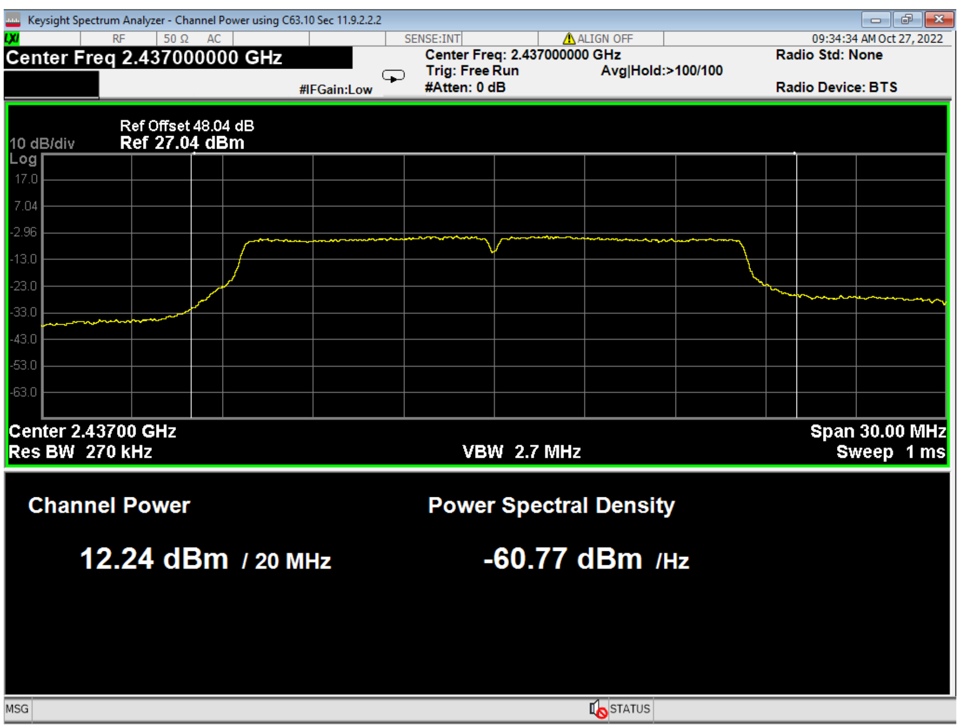


Figure 34 – Radiated Average Power Measurement, 802.11g 6MB

Reference offset includes EIRP conversion and corrections

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

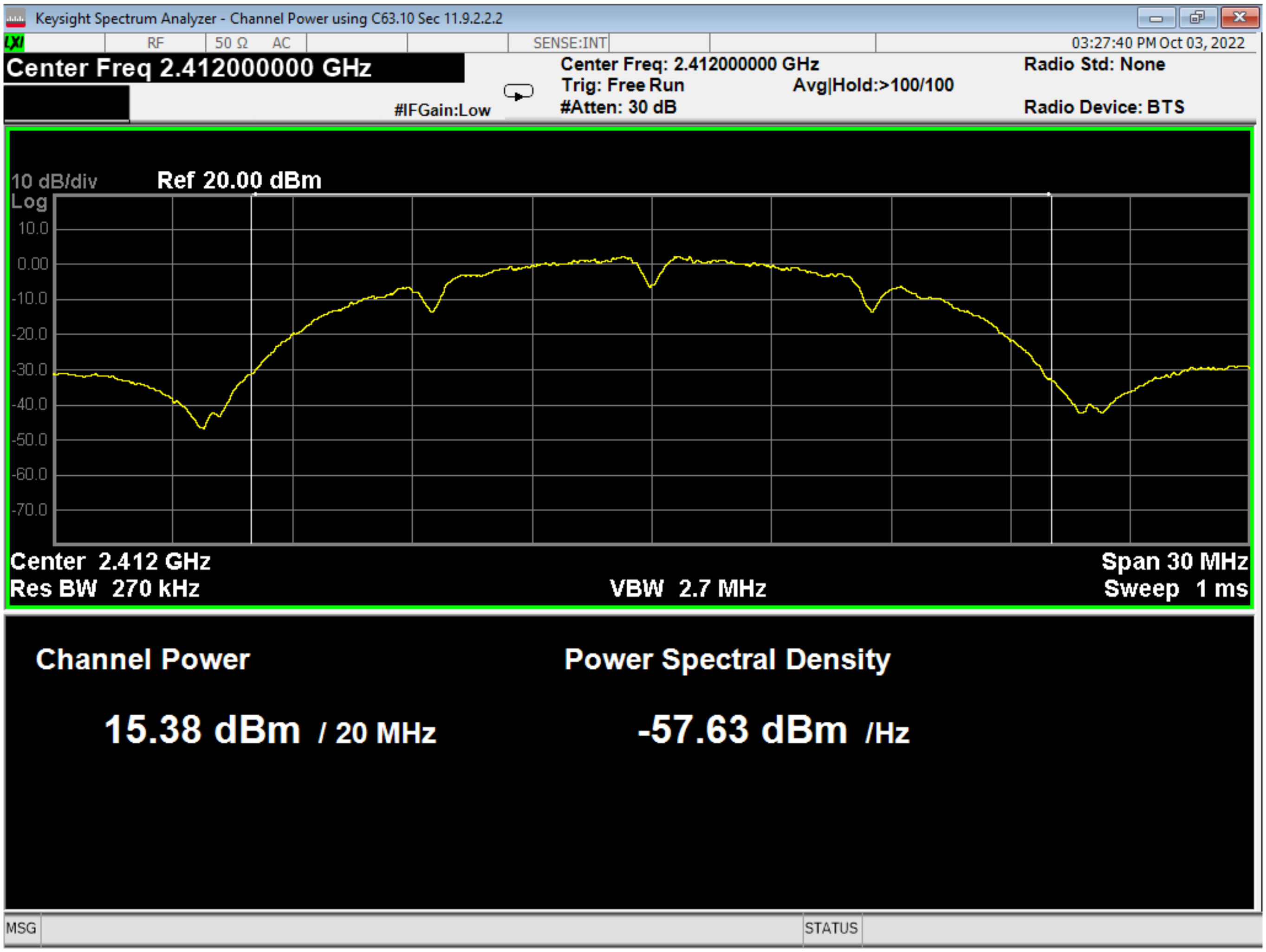
APPENDIX B – MEASUREMENT UNCERTAINTY

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

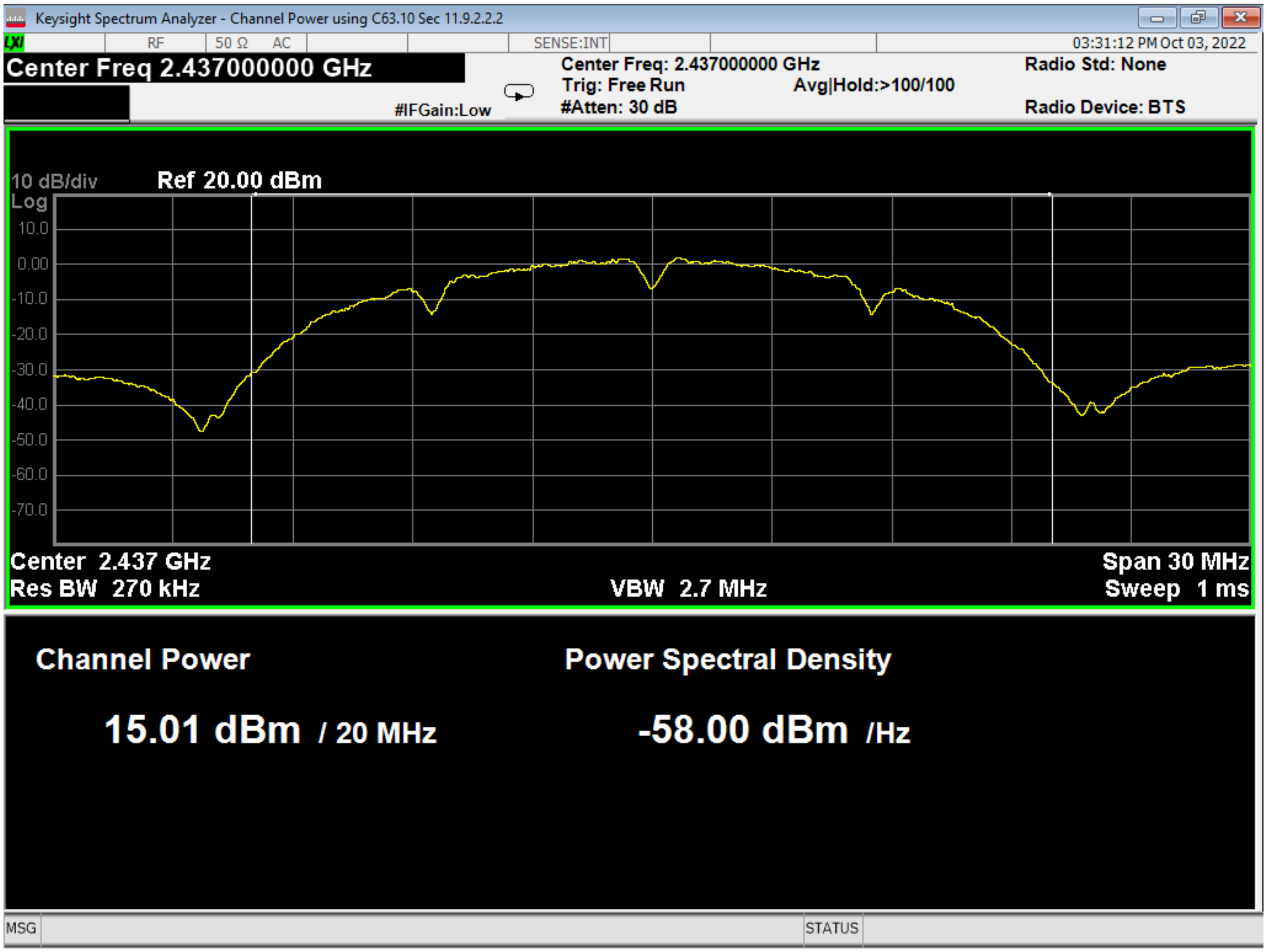
Test	Frequency Range	Uncertainty Value (dB)
Radiated Emissions, 3m	30MHz - 1GHz	±4.31
Radiated Emissions, 3m	1GHz - 18GHz	±5.08
Emissions limits, conducted	150kHz – 30MHz	±3.03

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

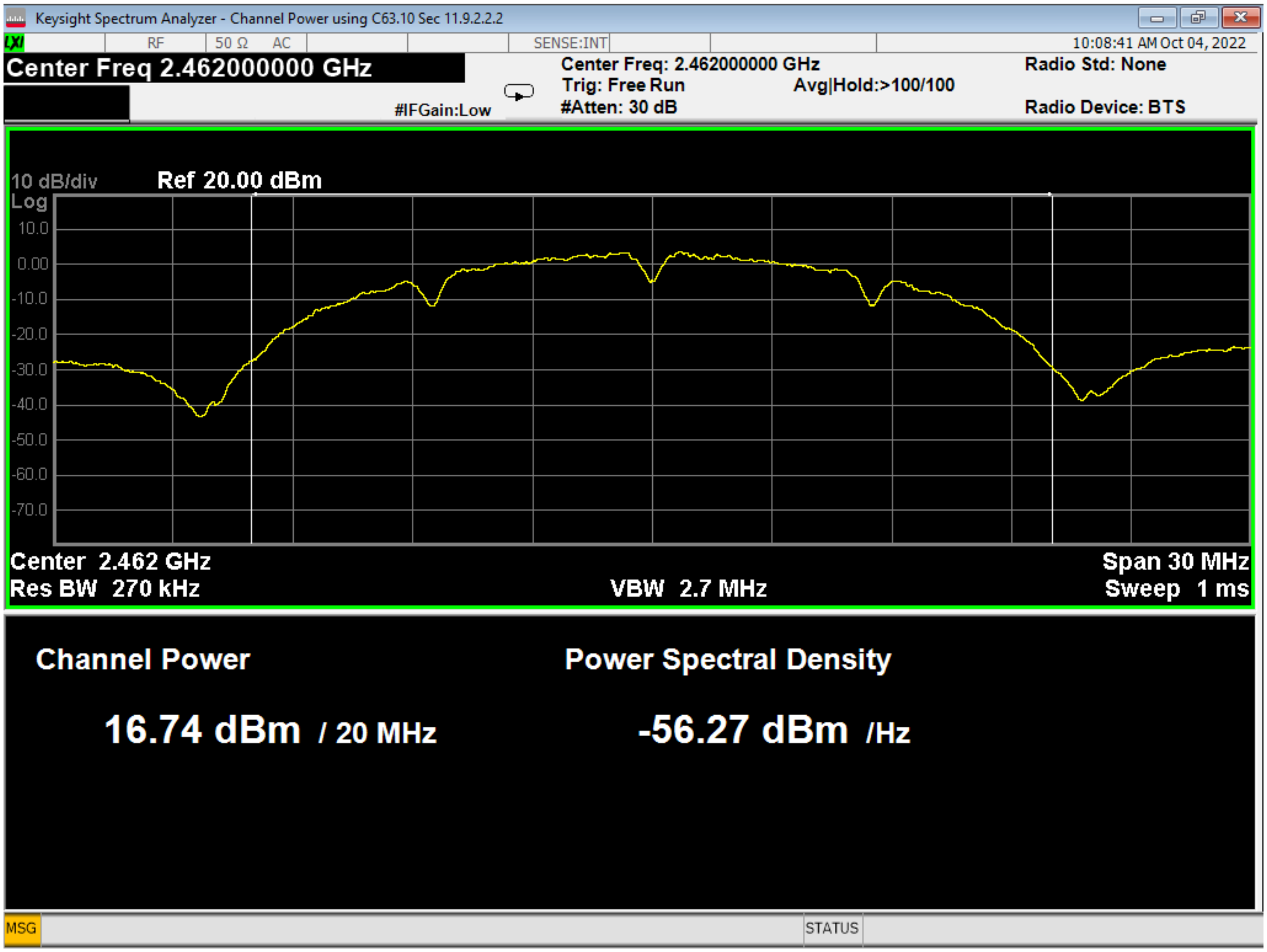
APPENDIX C – GRAPHS AND TABLES



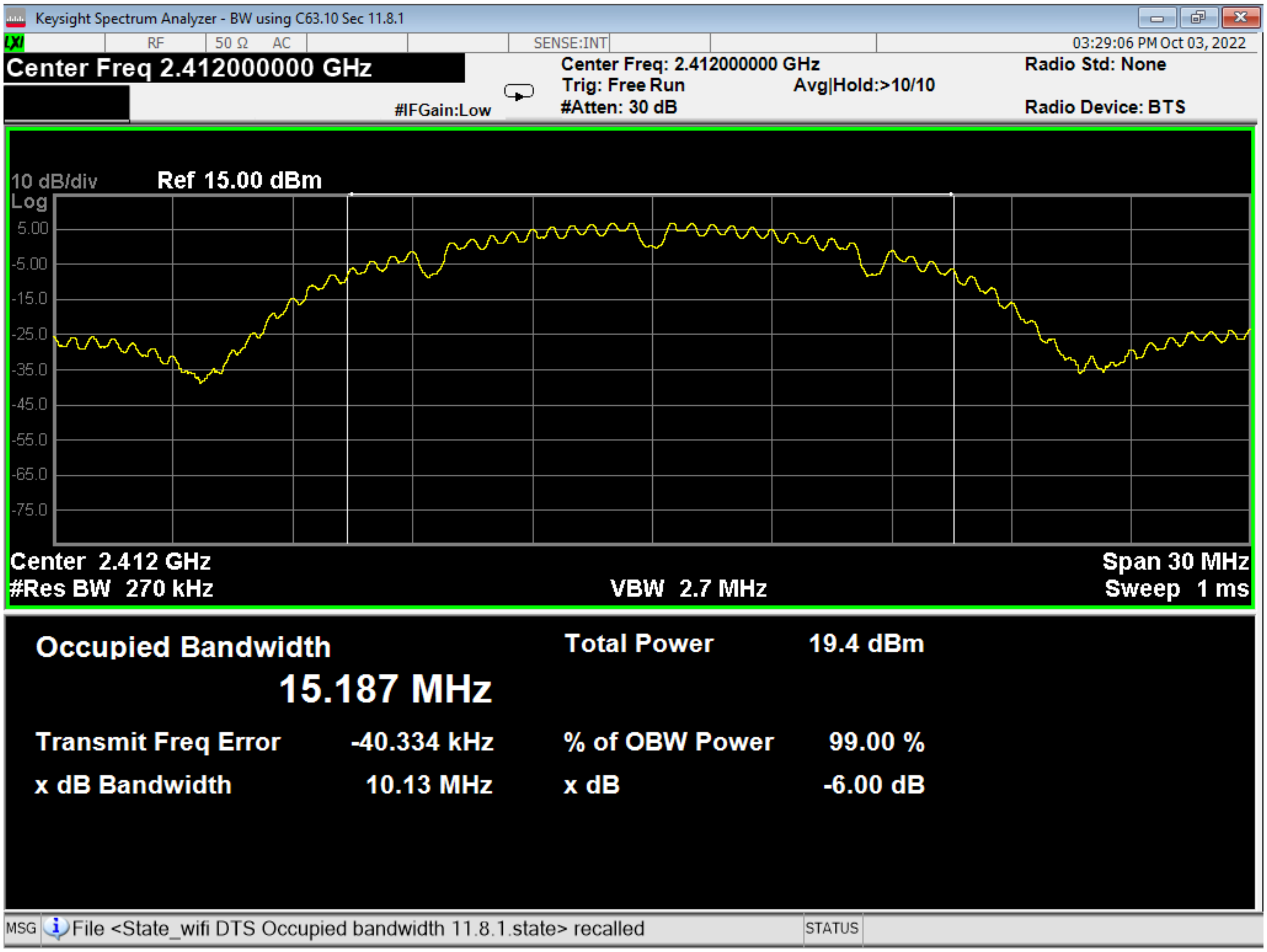
01 Average Power, Low, Wifi B, Low Data Rate



02 Average Power, Mid, Wifi B, Low Data Rate



03 Average Power, High, Wifi B, Low Data Rate



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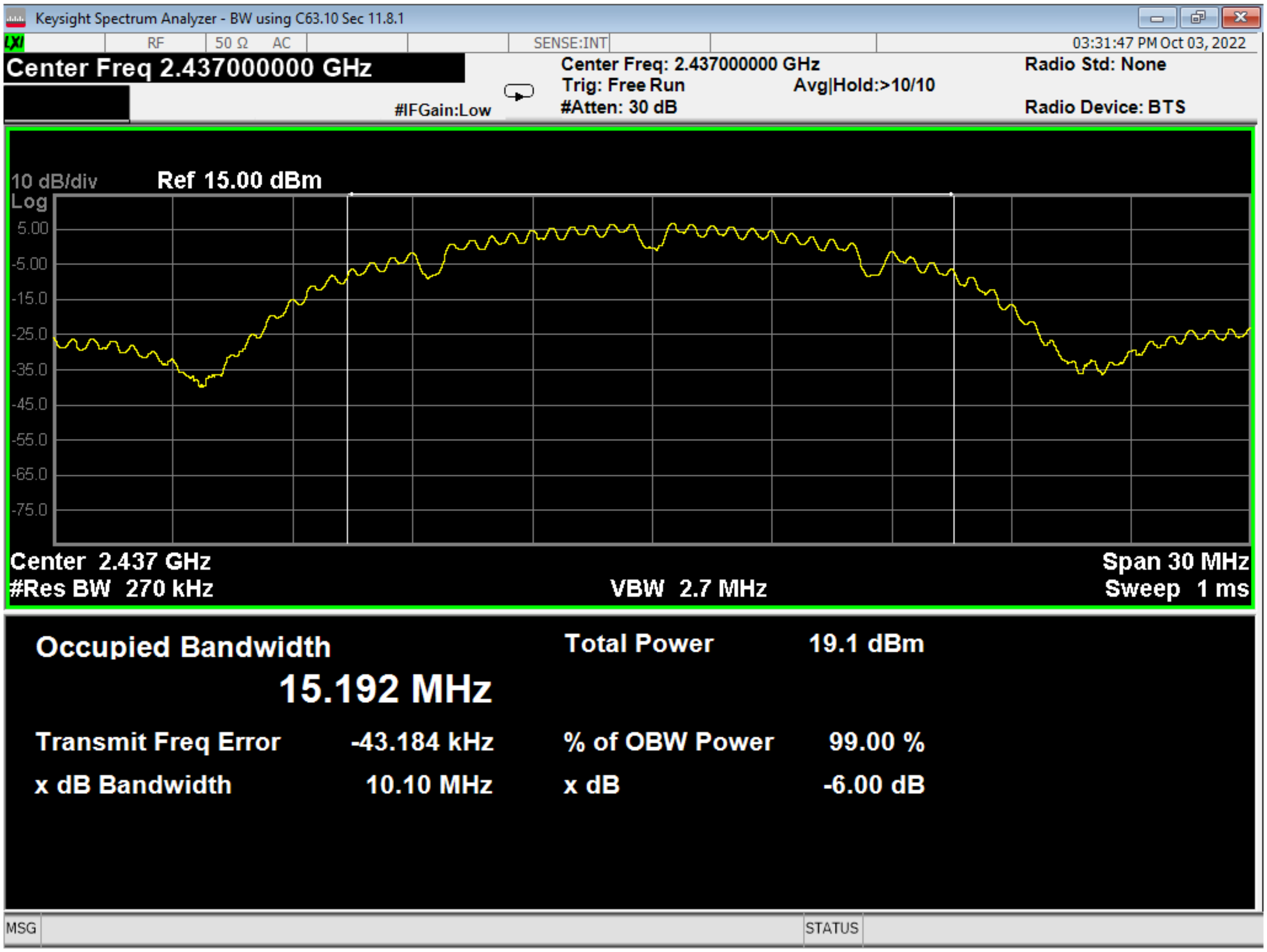

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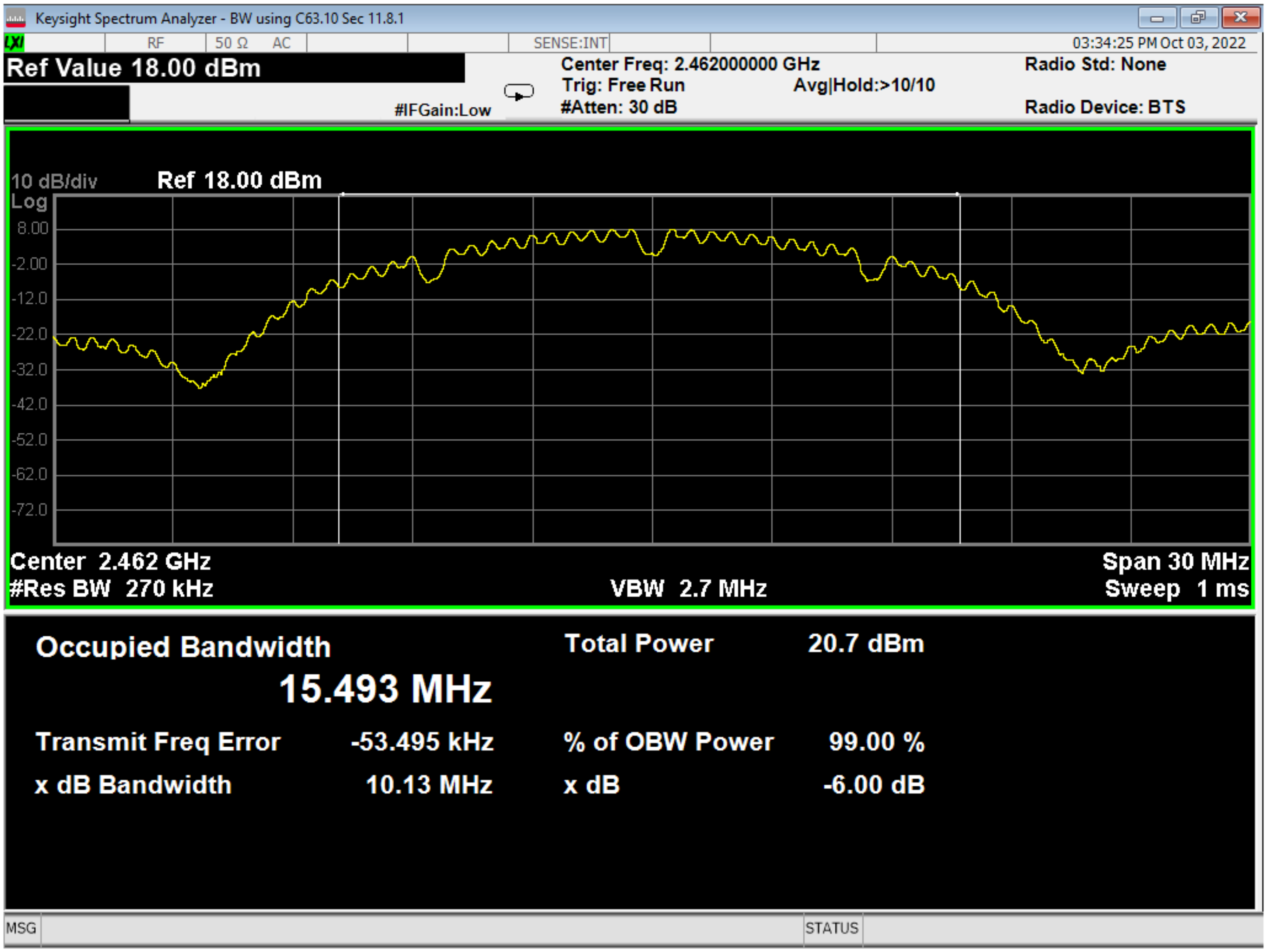
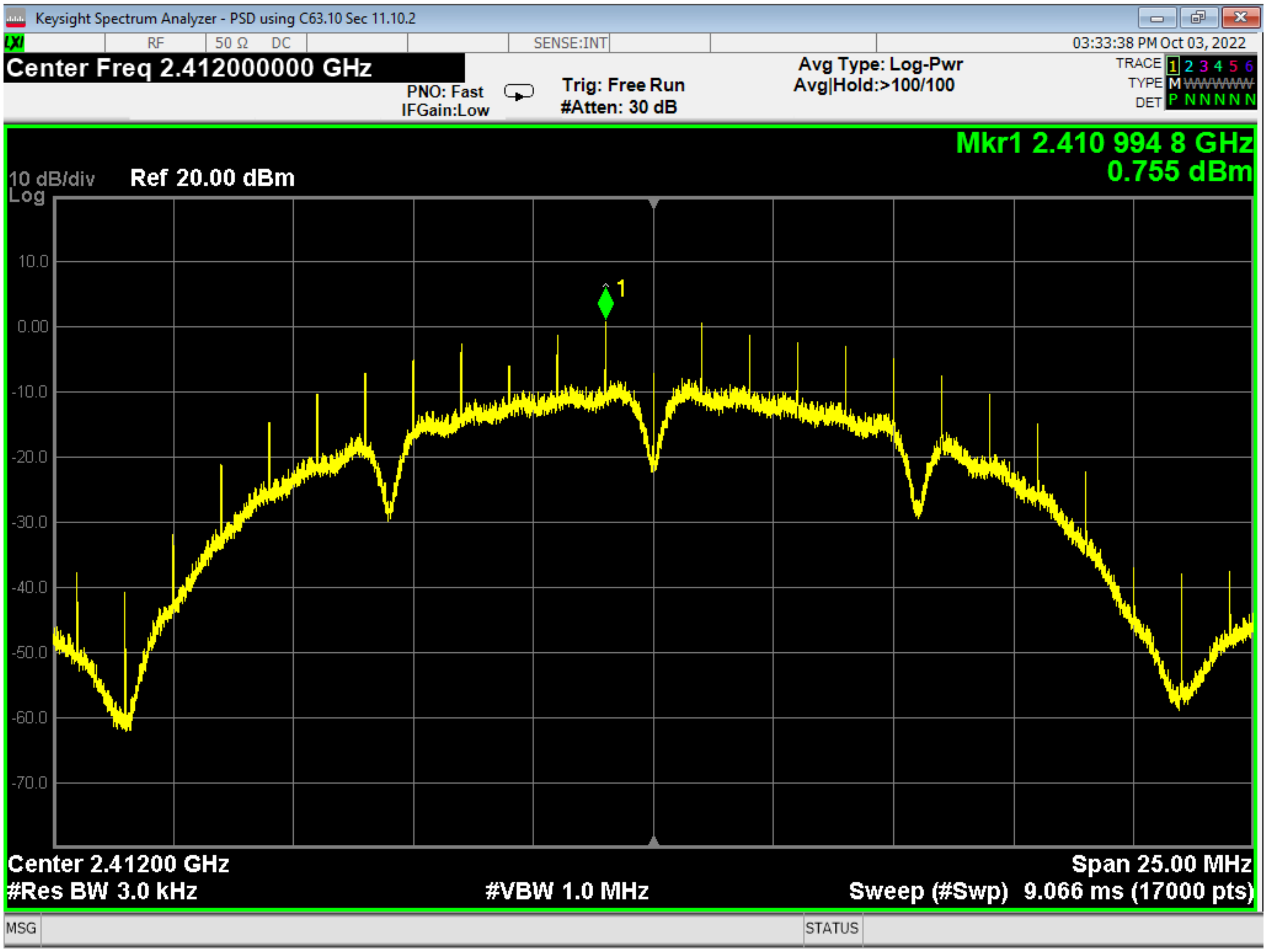
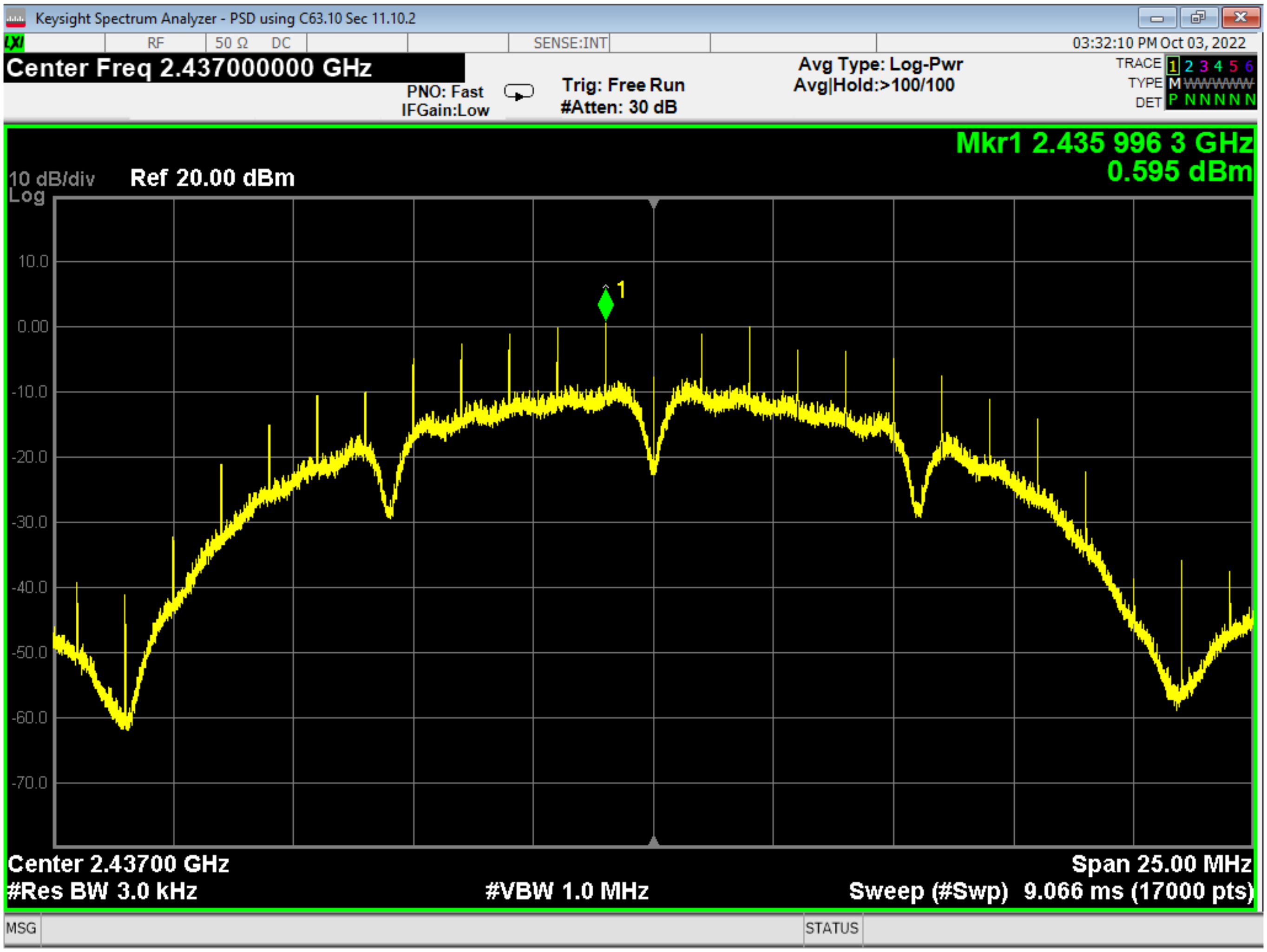


06 Bandwidth, High, Wifi B, Low Data Rate

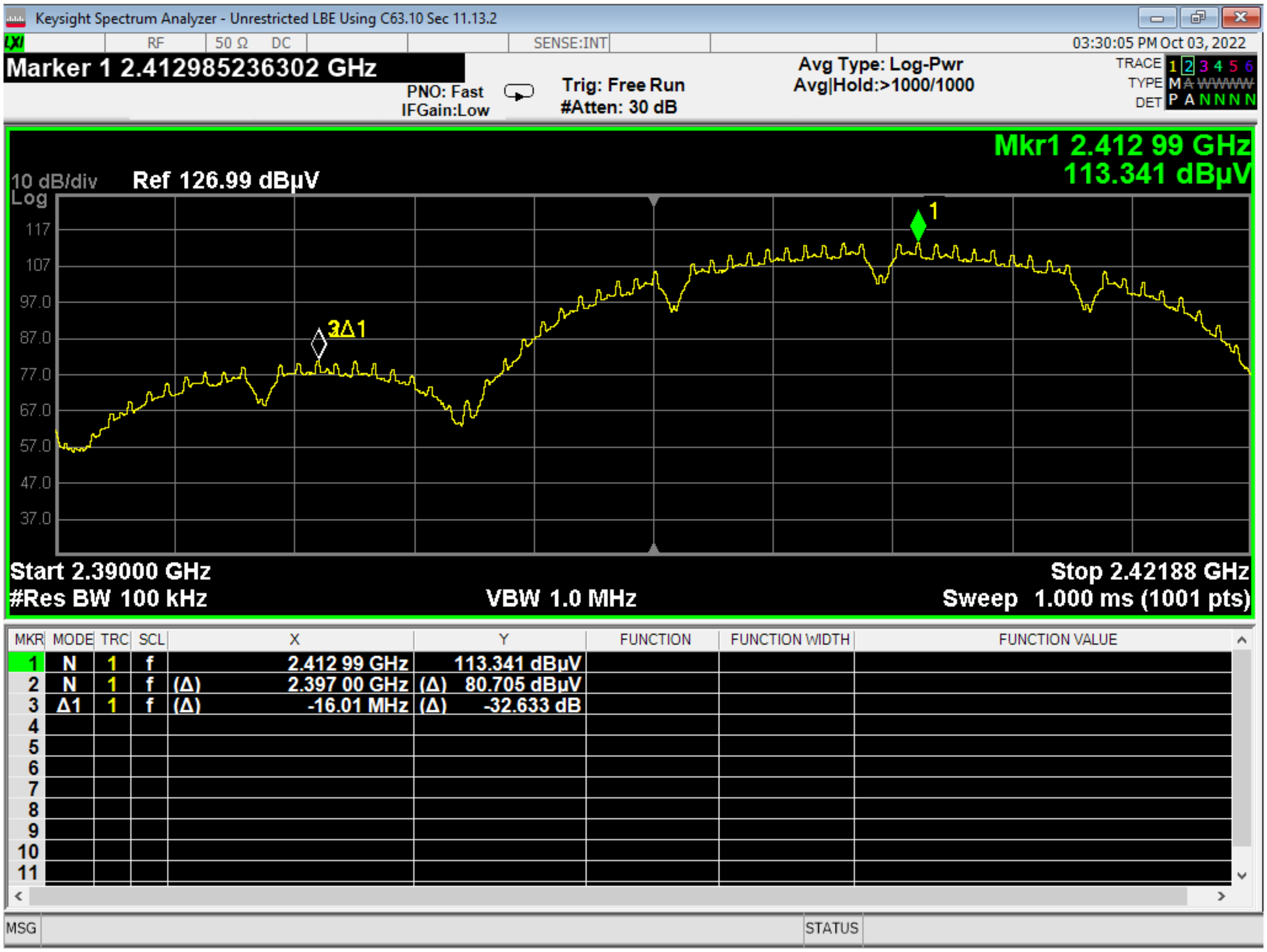


07 PSD, Low, Wifi B, Low Data Rate

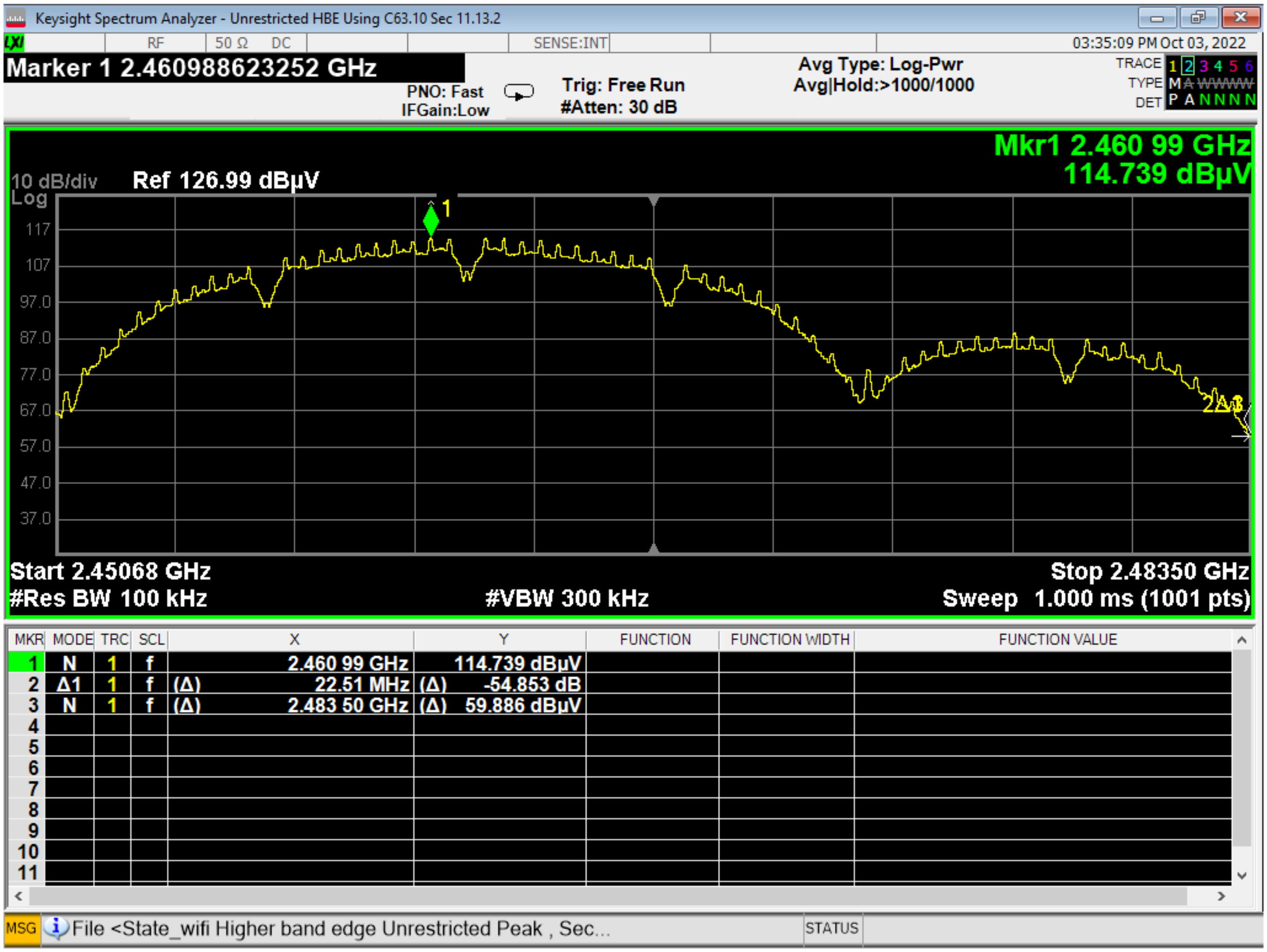


08 PSD, Mid, Wifi B, Low Data Rate

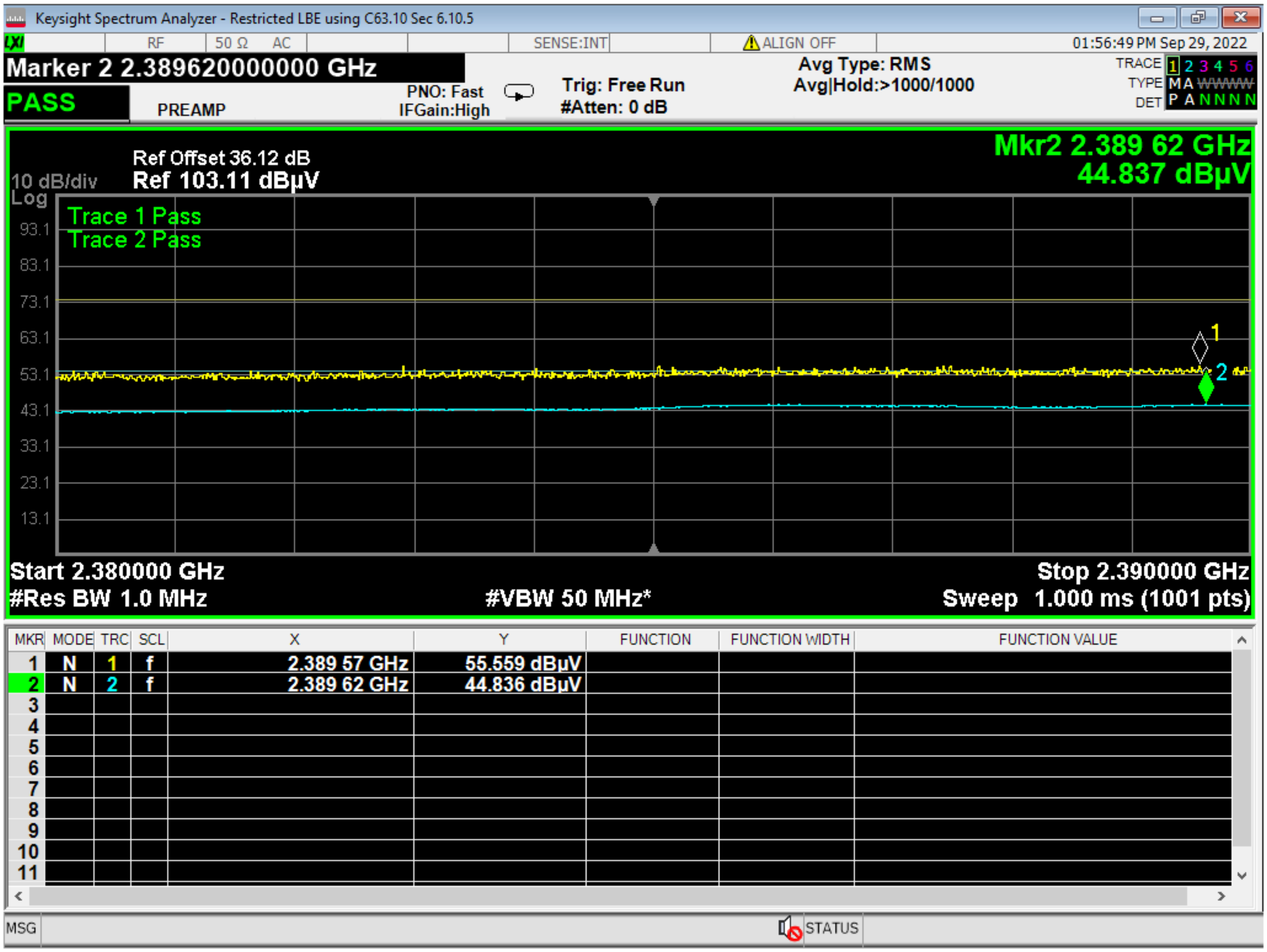
09 PSD, High, Wifi B, Low Data Rate



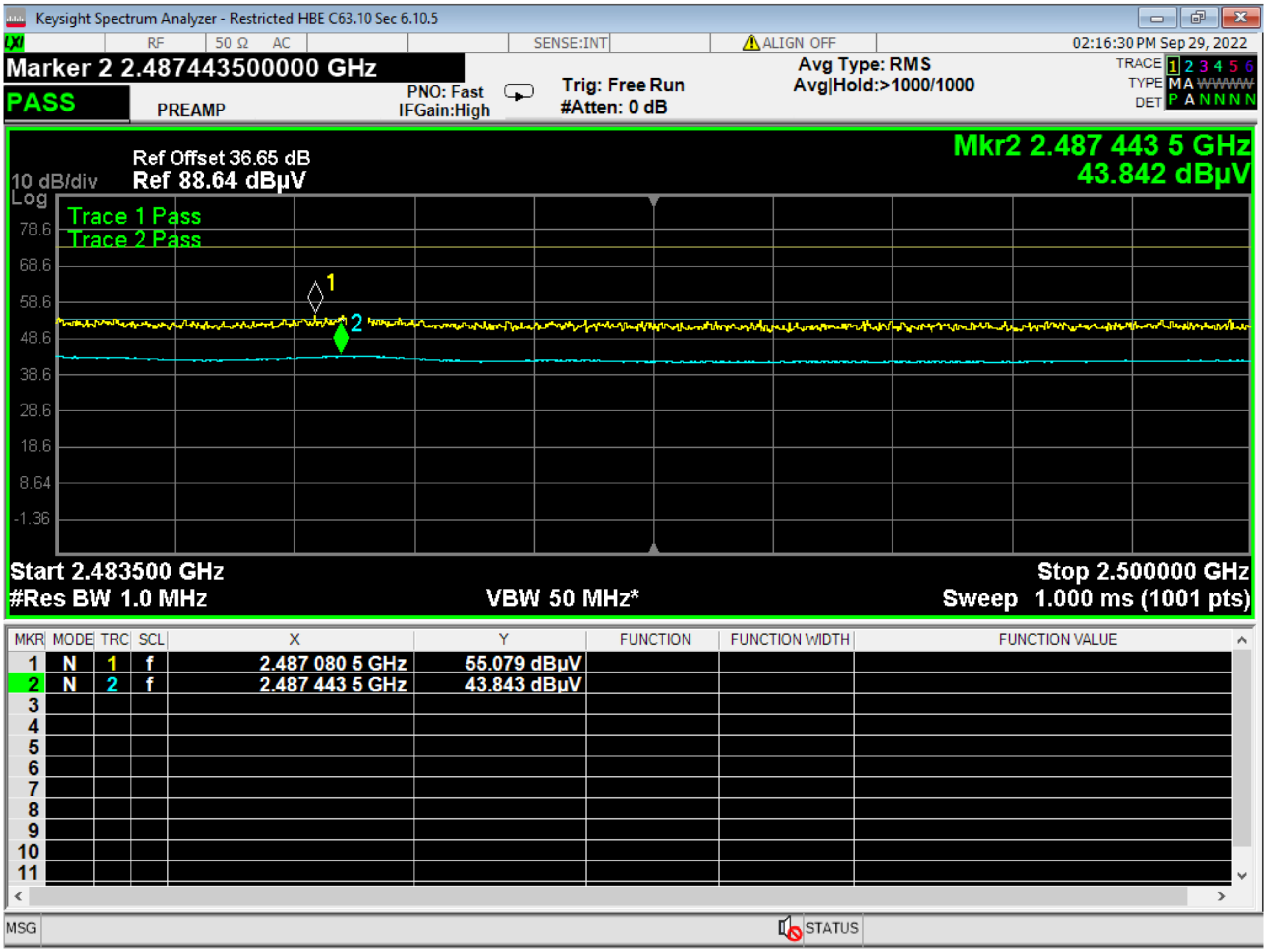
10 Lower Bandedge, Unrestricted, Wifi B, Low Data Rate



11 Higher Bandedge, Unrestricted, Wifi B, Low Data Rate



12 Lower Bandedge, Restricted, Wifi B, Low Data Rate



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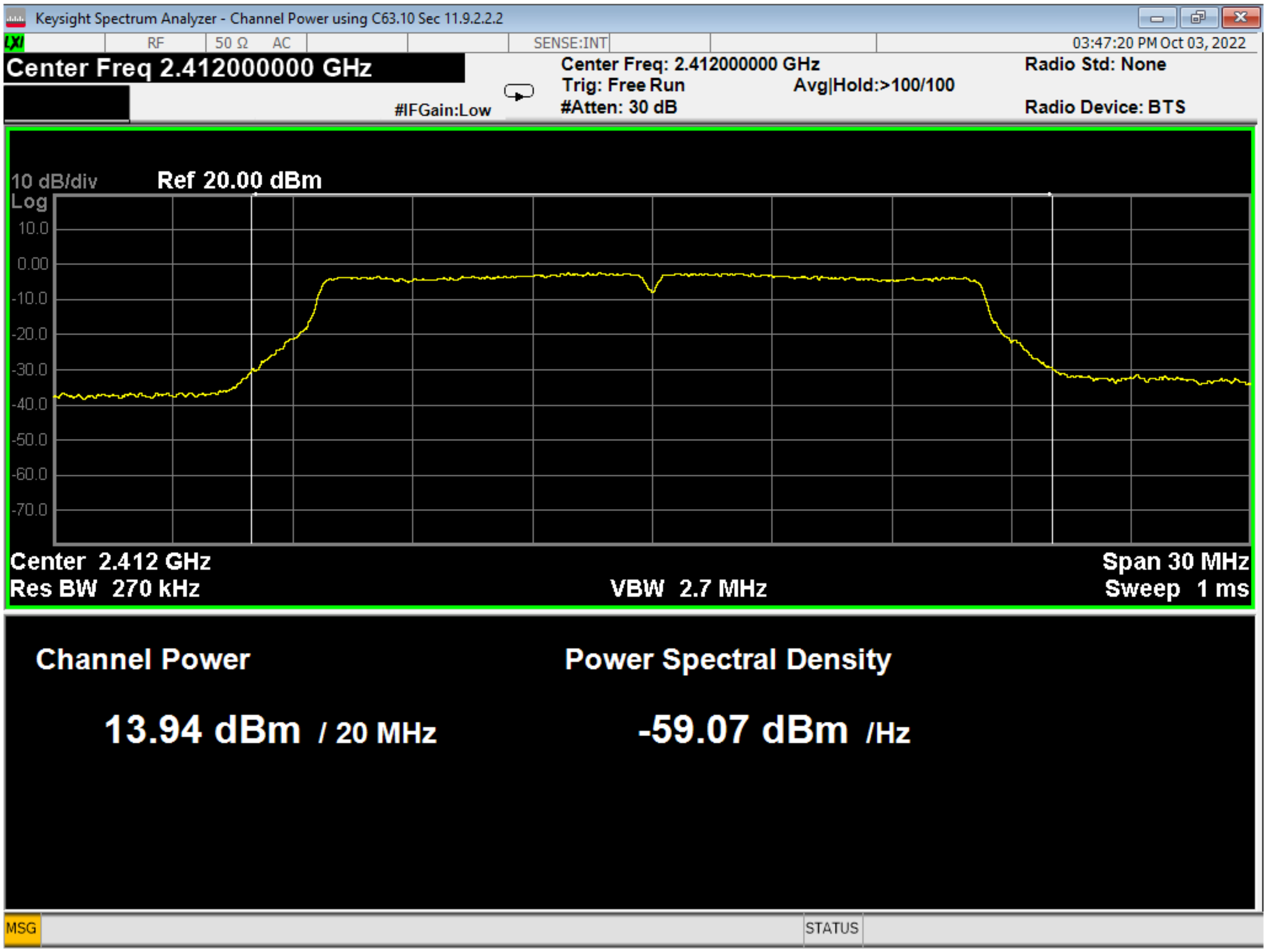
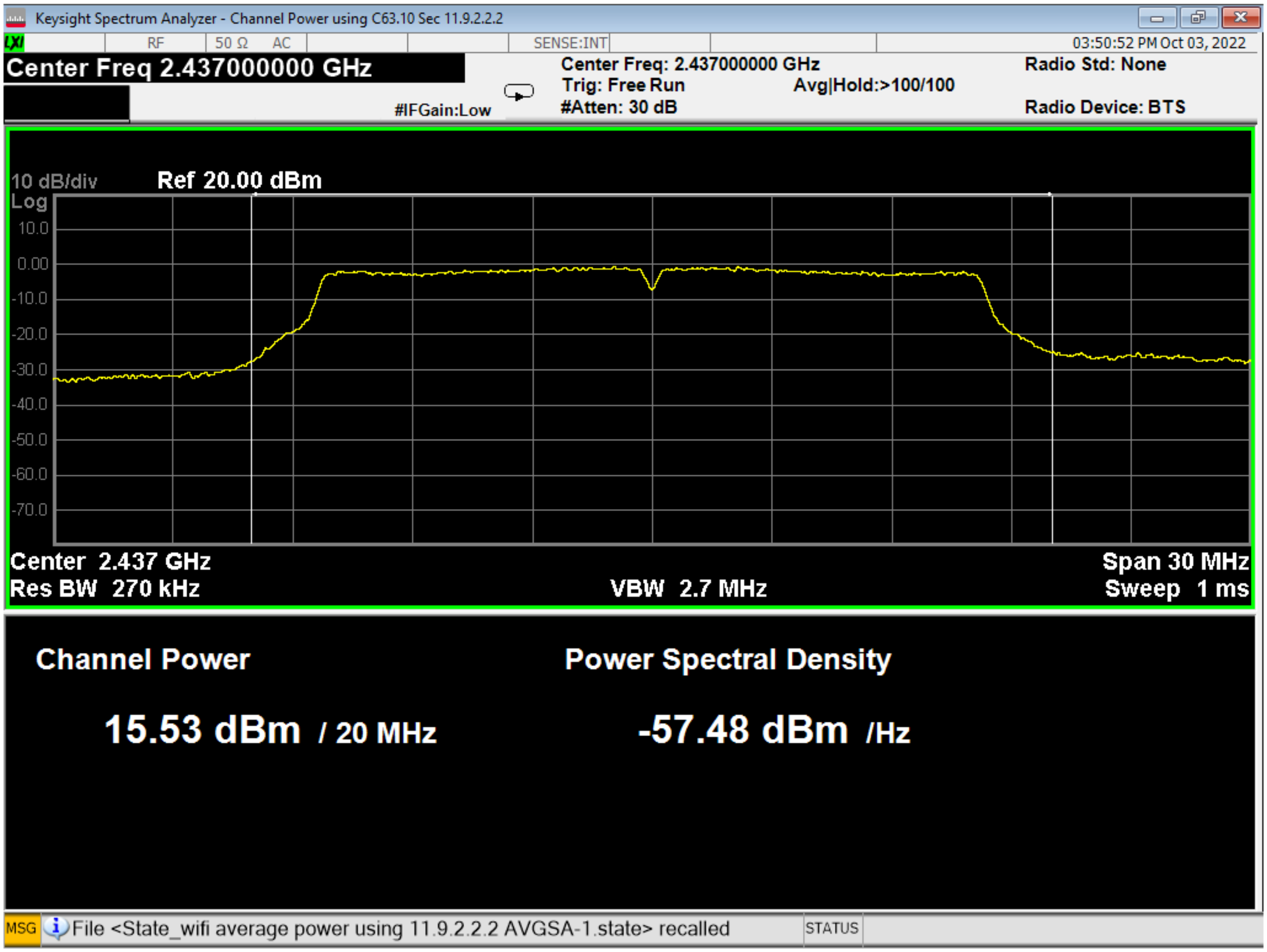
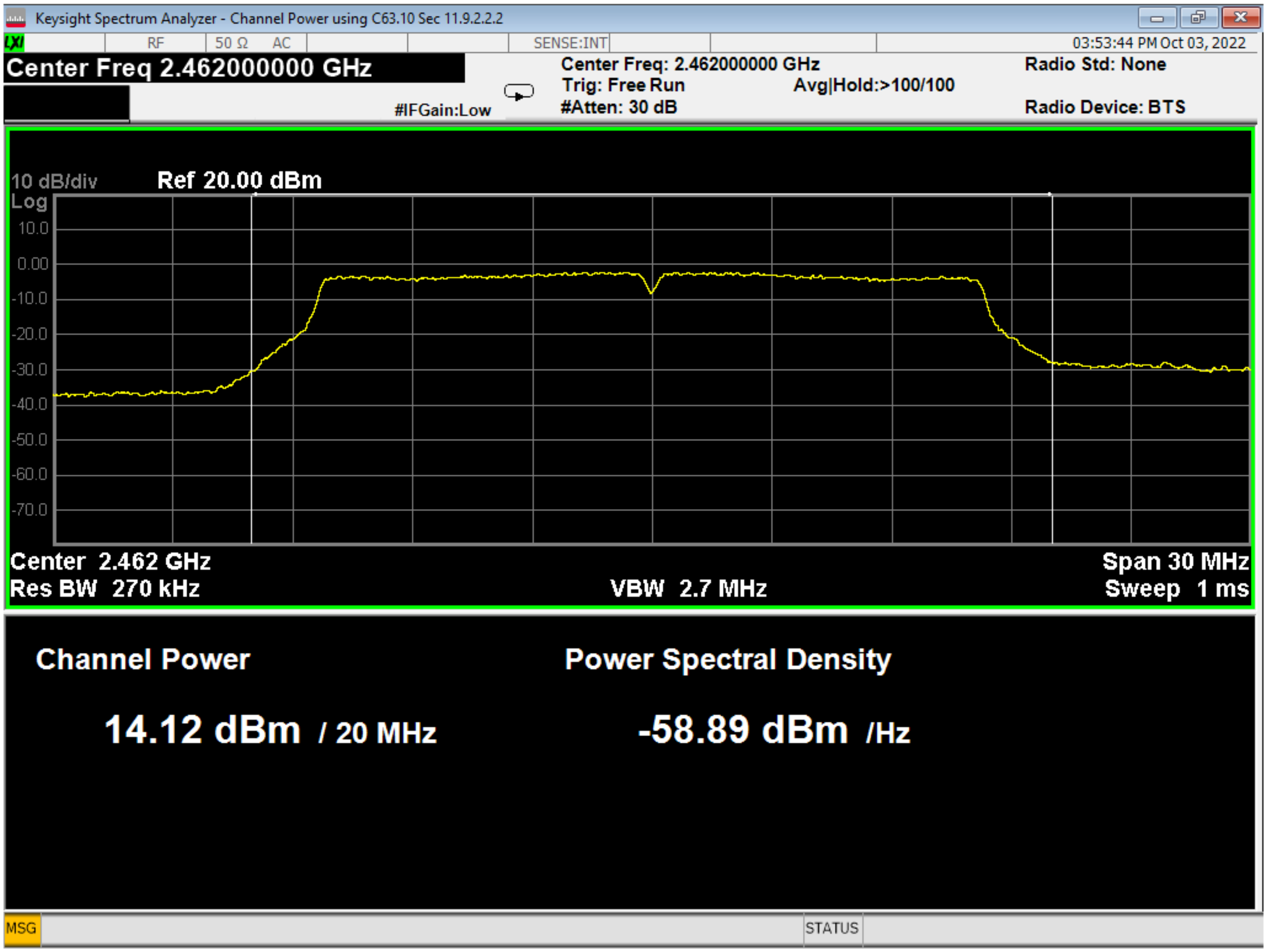


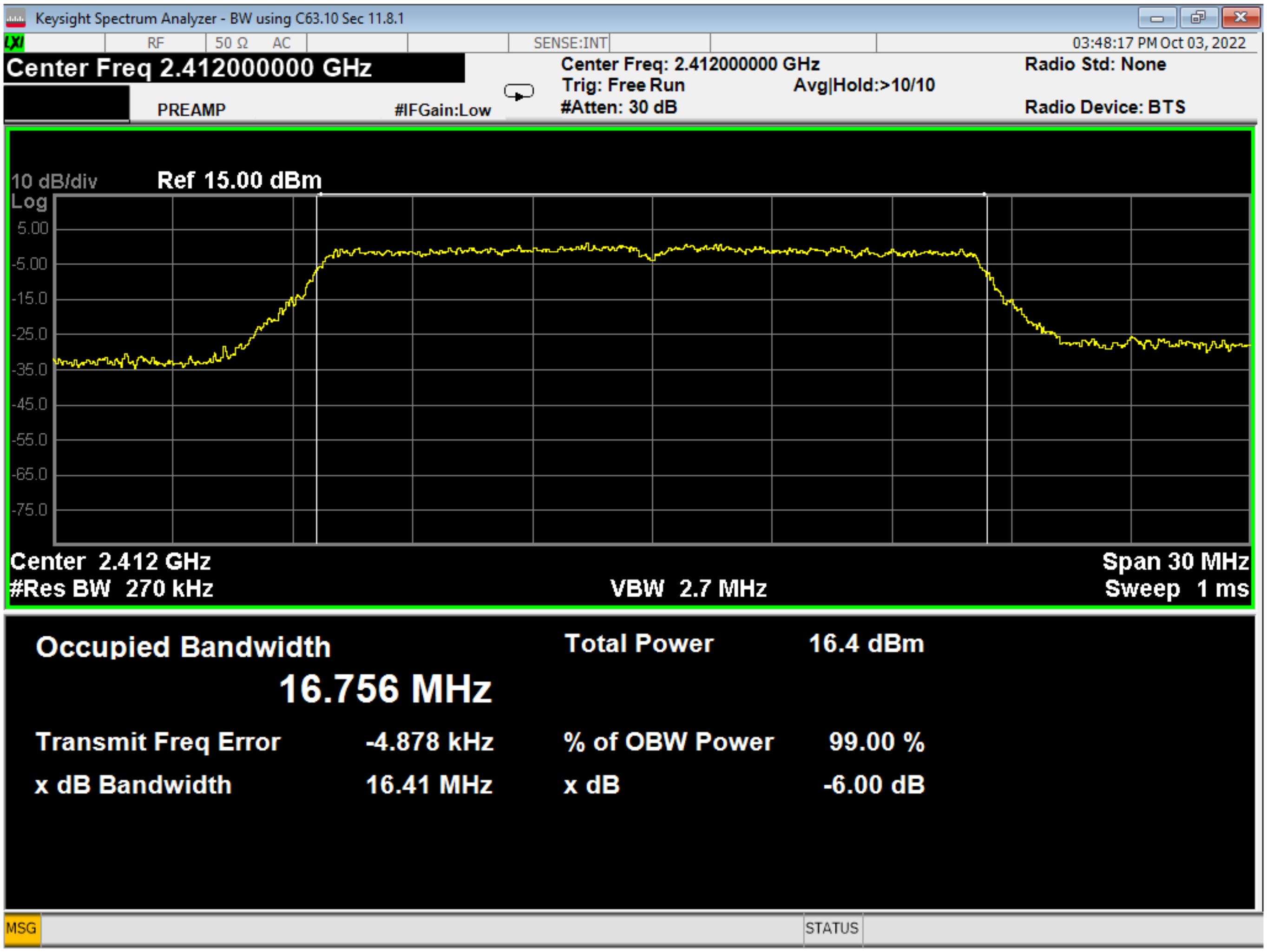
14 Average Power, Low, Wifi G, Low Data Rate



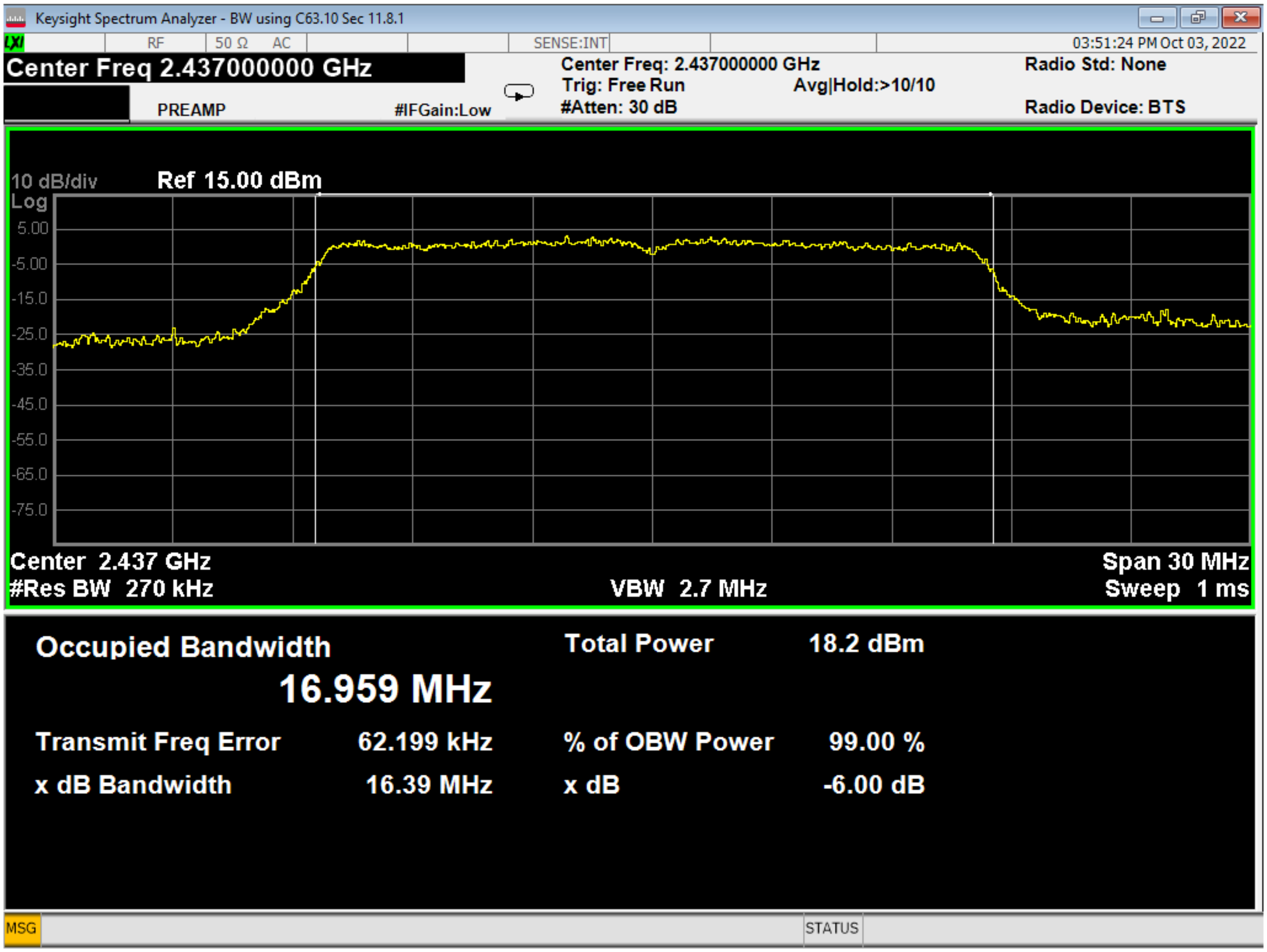
15 Average Power, Mid, Wifi G, Low Data Rate



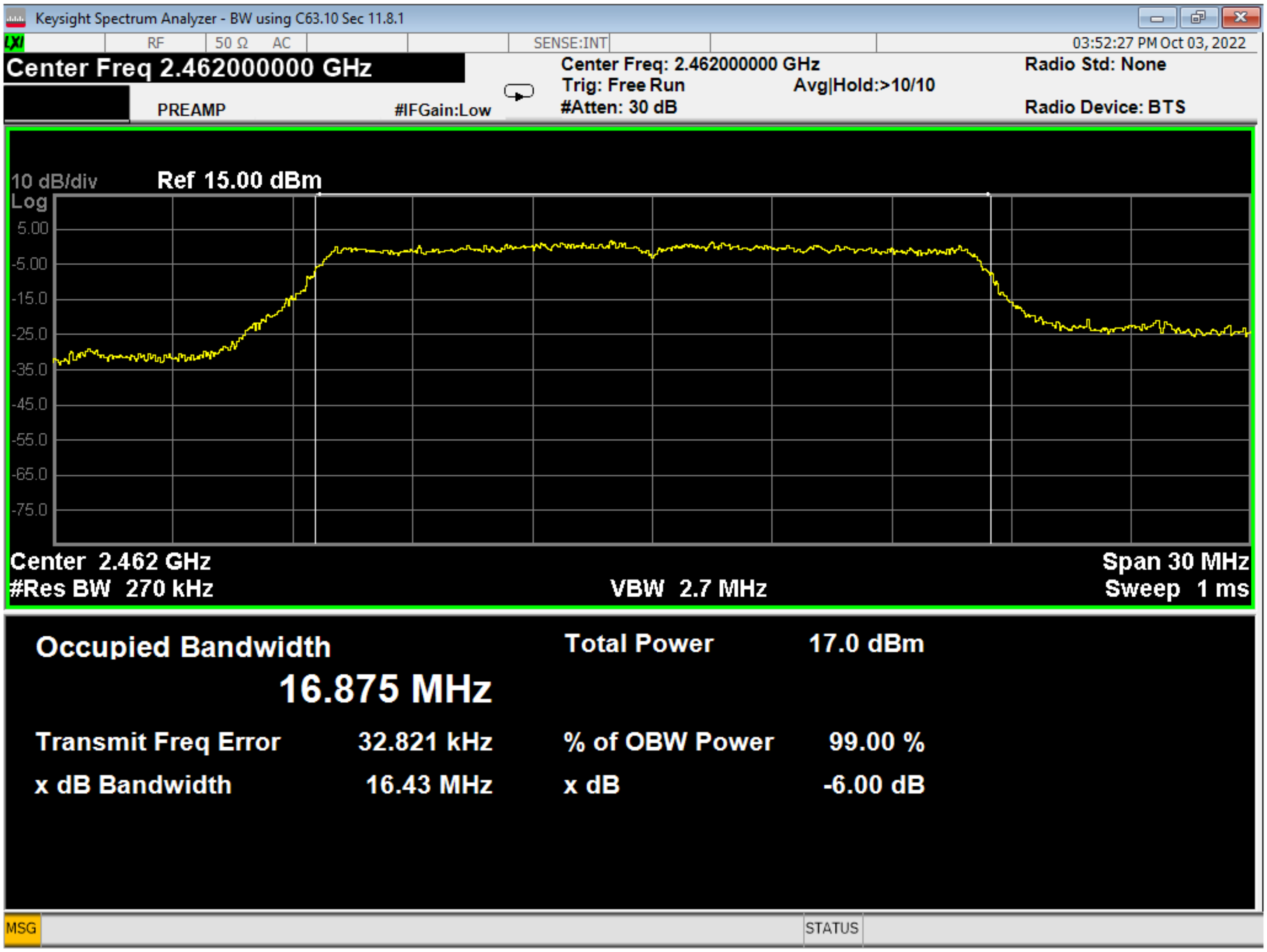
16 Average Power, High, Wifi G, Low Data Rate



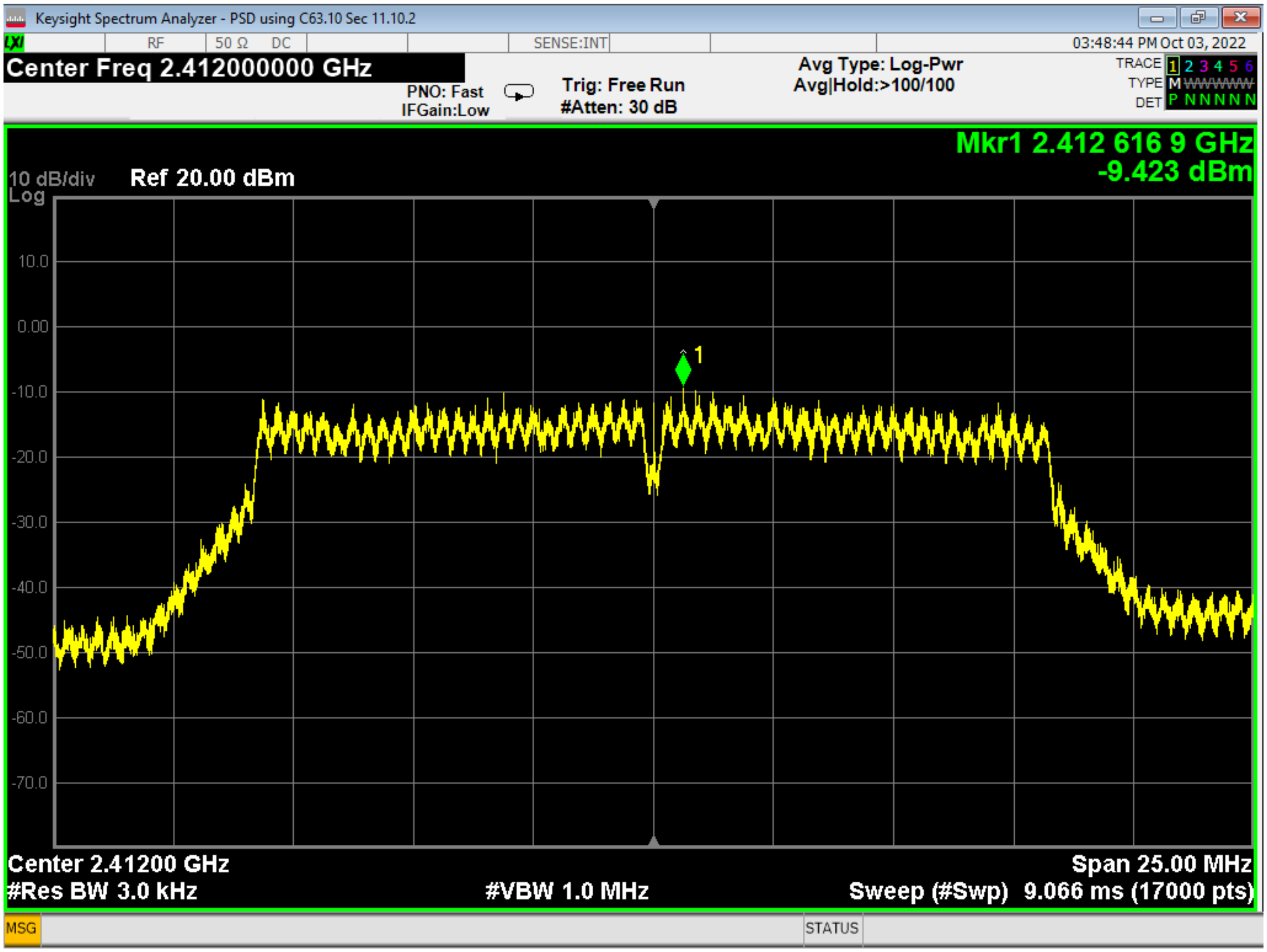
17 Bandwidth, Low, Wifi G, Low Data Rate



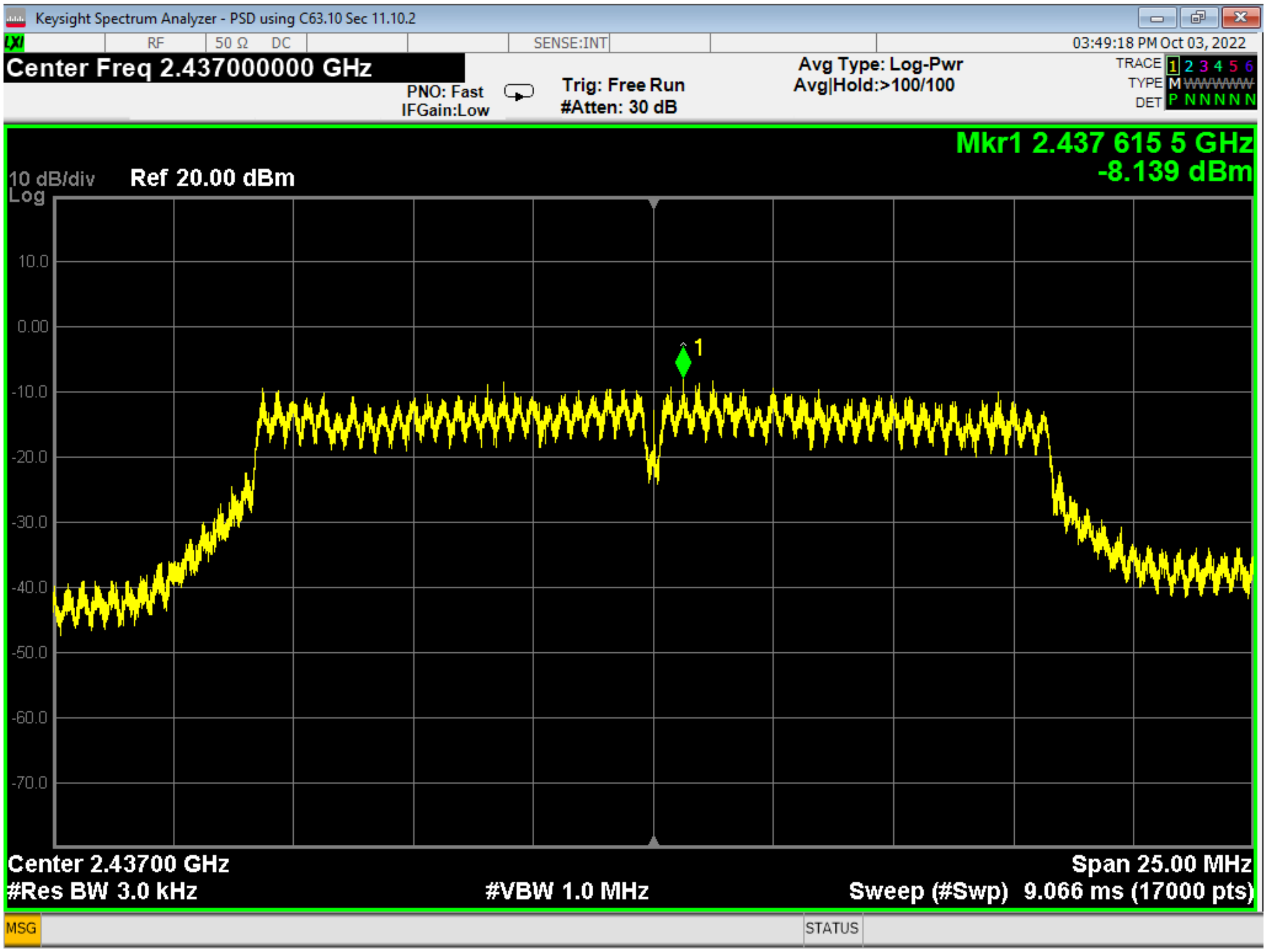
18 Bandwidth, Mid, Wifi G, Low Data Rate



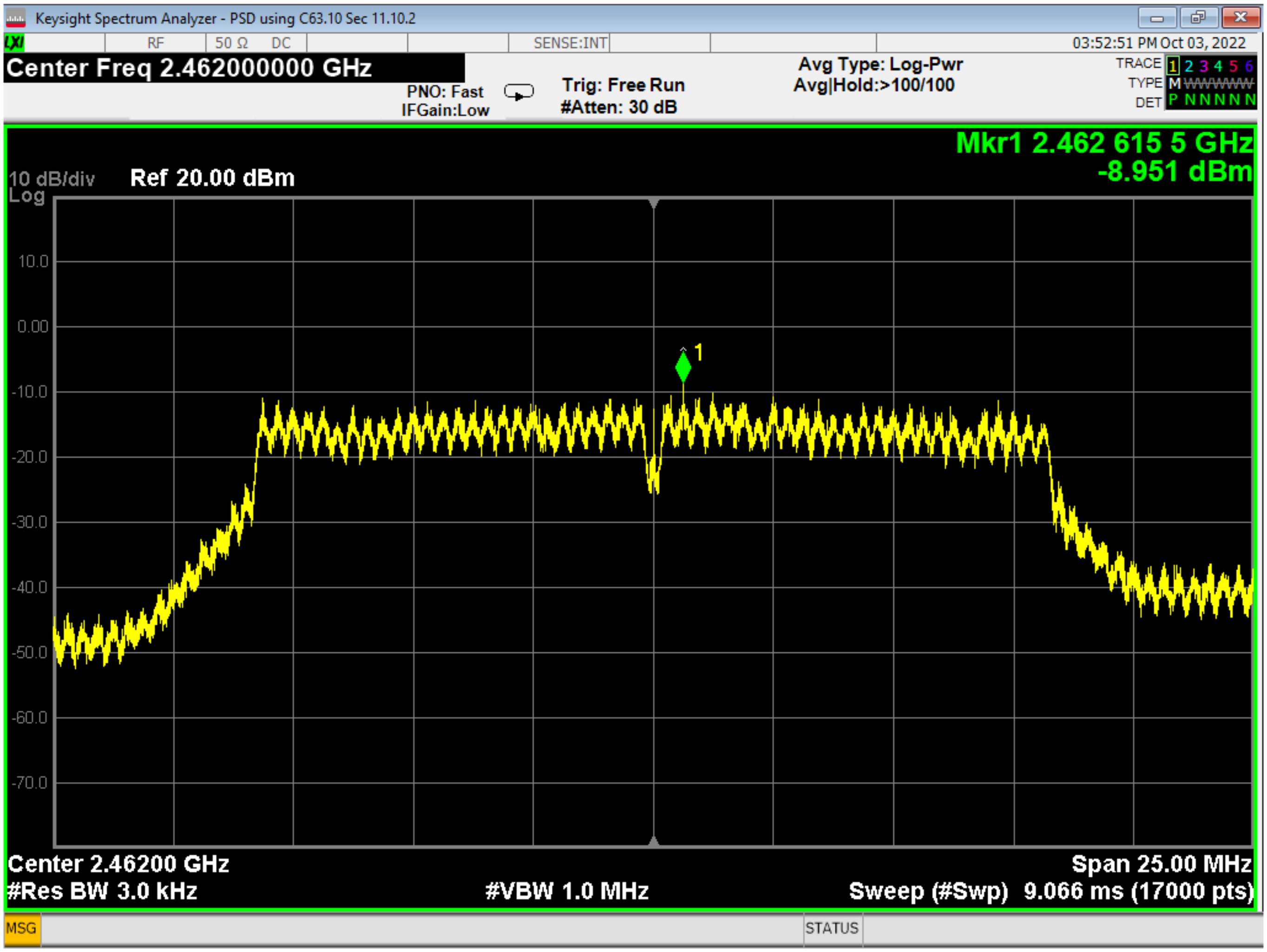
19 Bandwidth, High, Wifi G, Low Data Rate



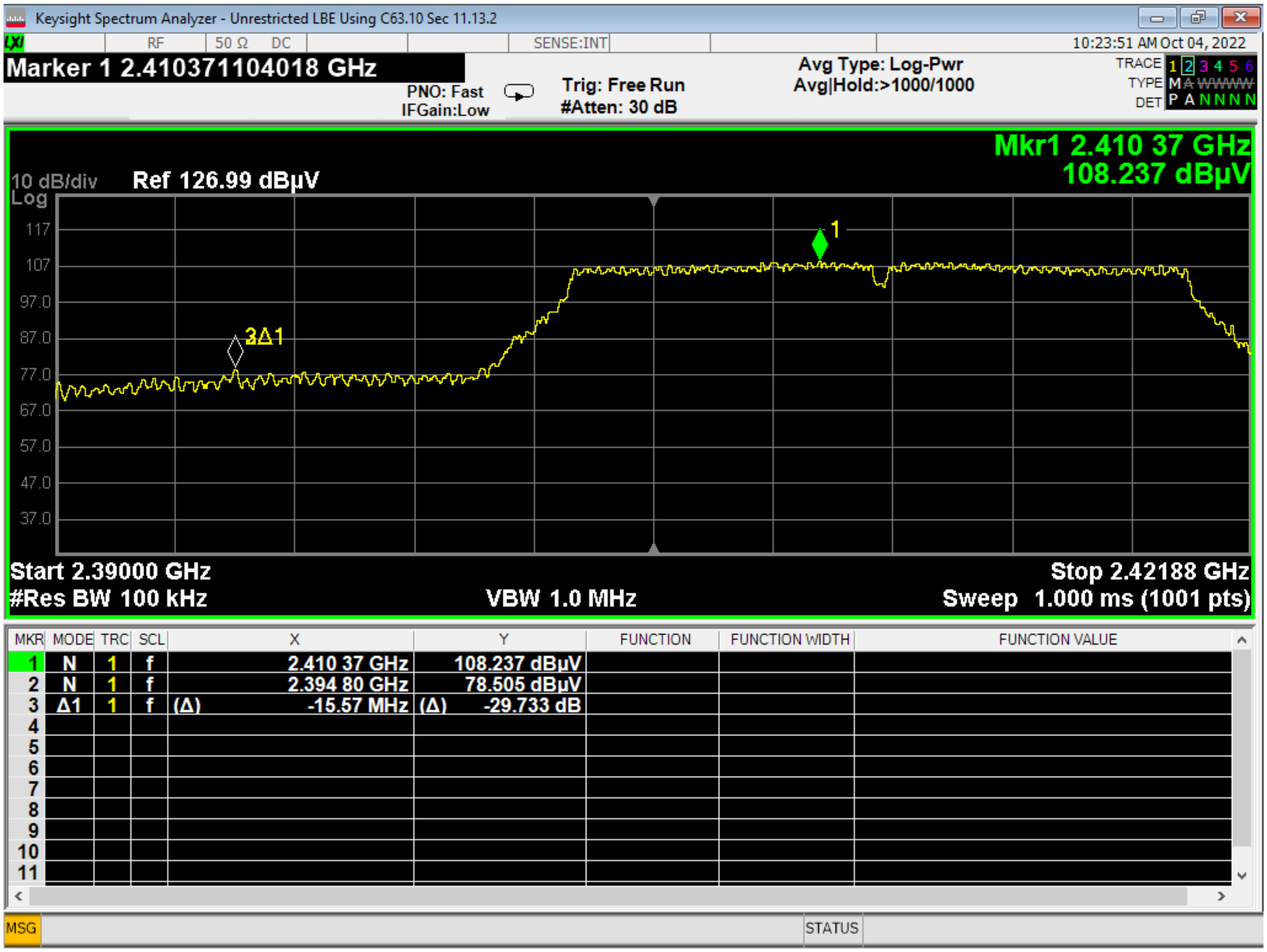
20 PSD, Low, Wifi G, Low Data Rate



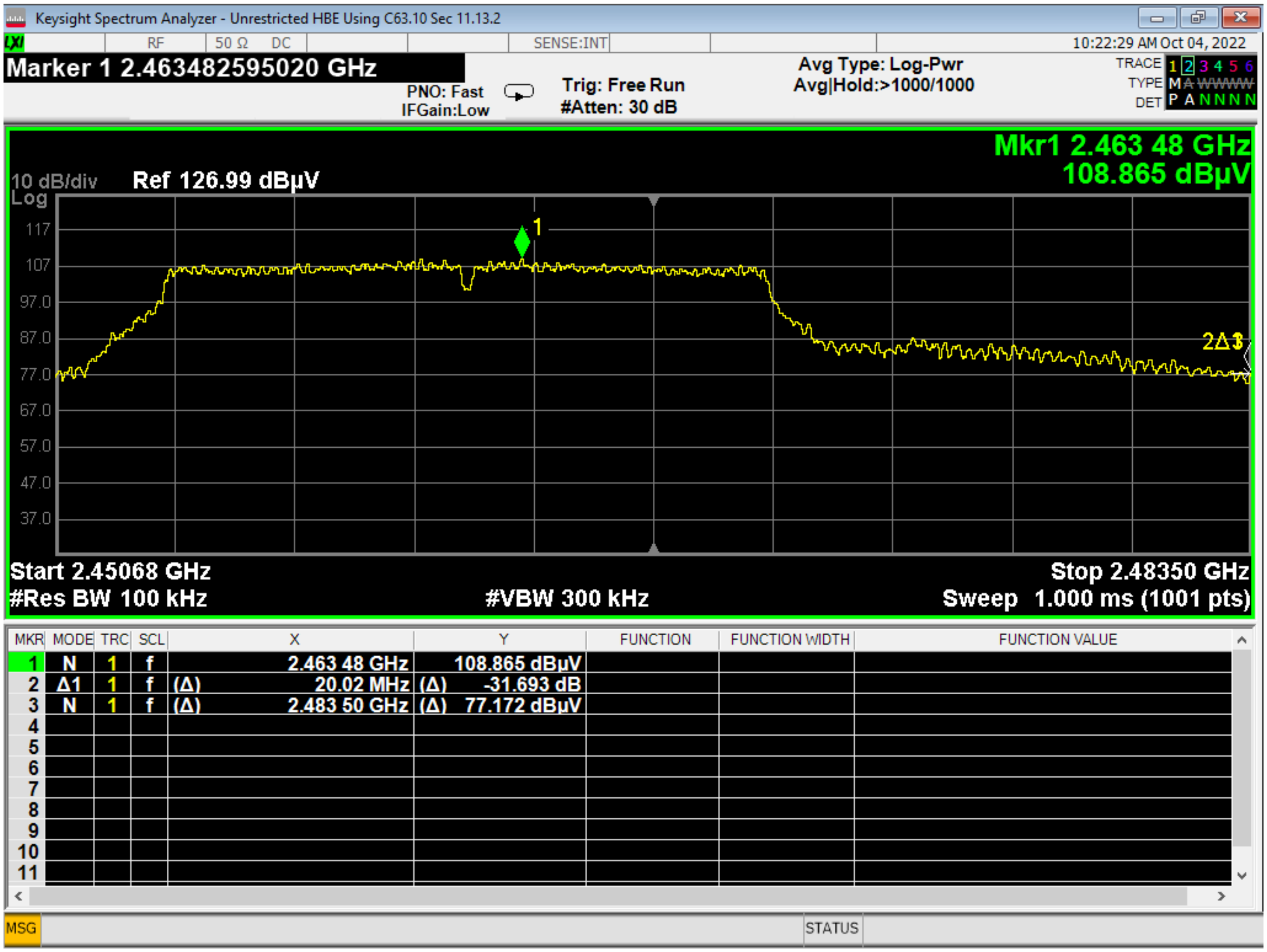
21 PSD, Mid, Wifi G, Low Data Rate



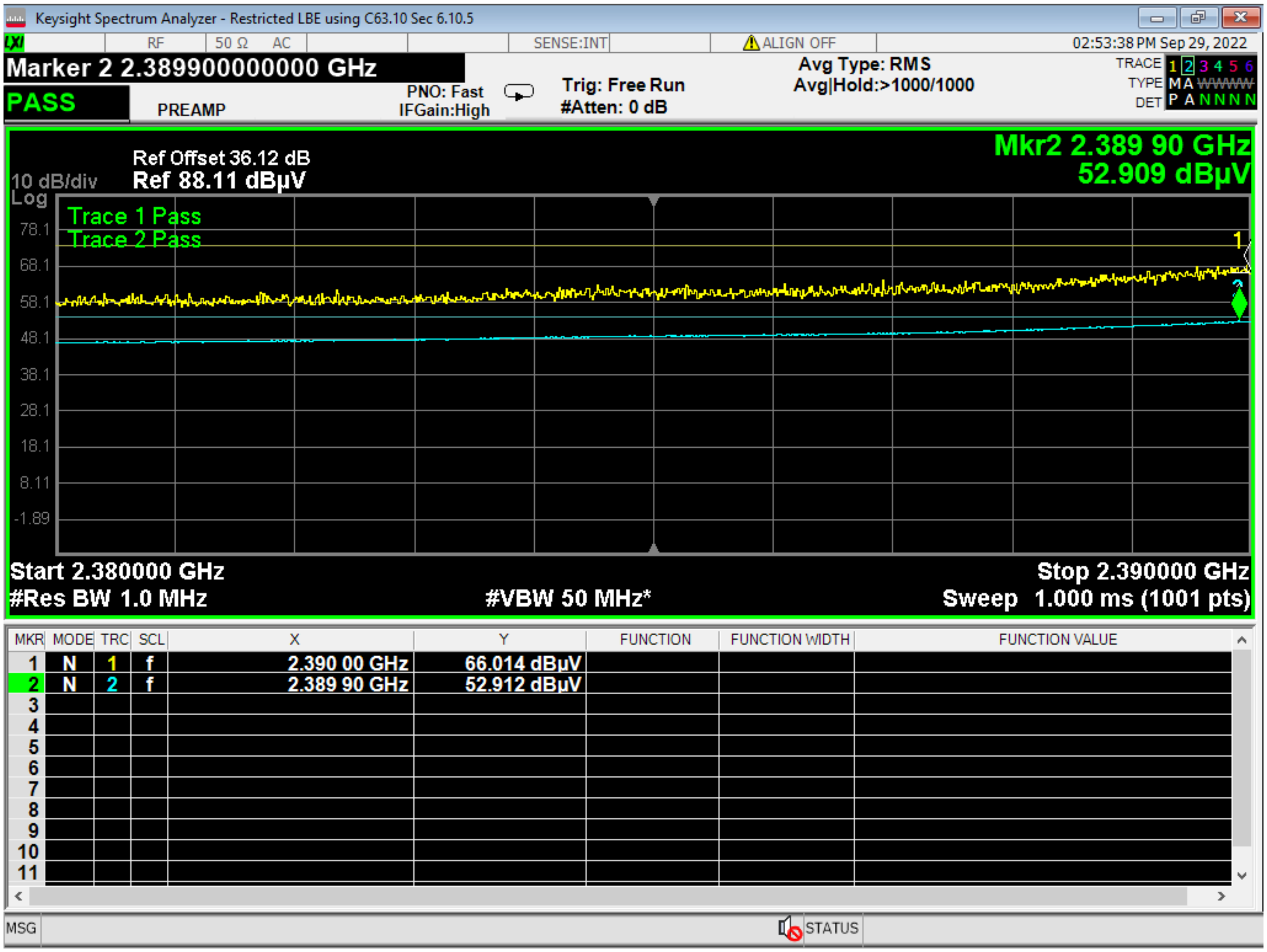
22 PSD, High, Wifi G, Low Data Rate



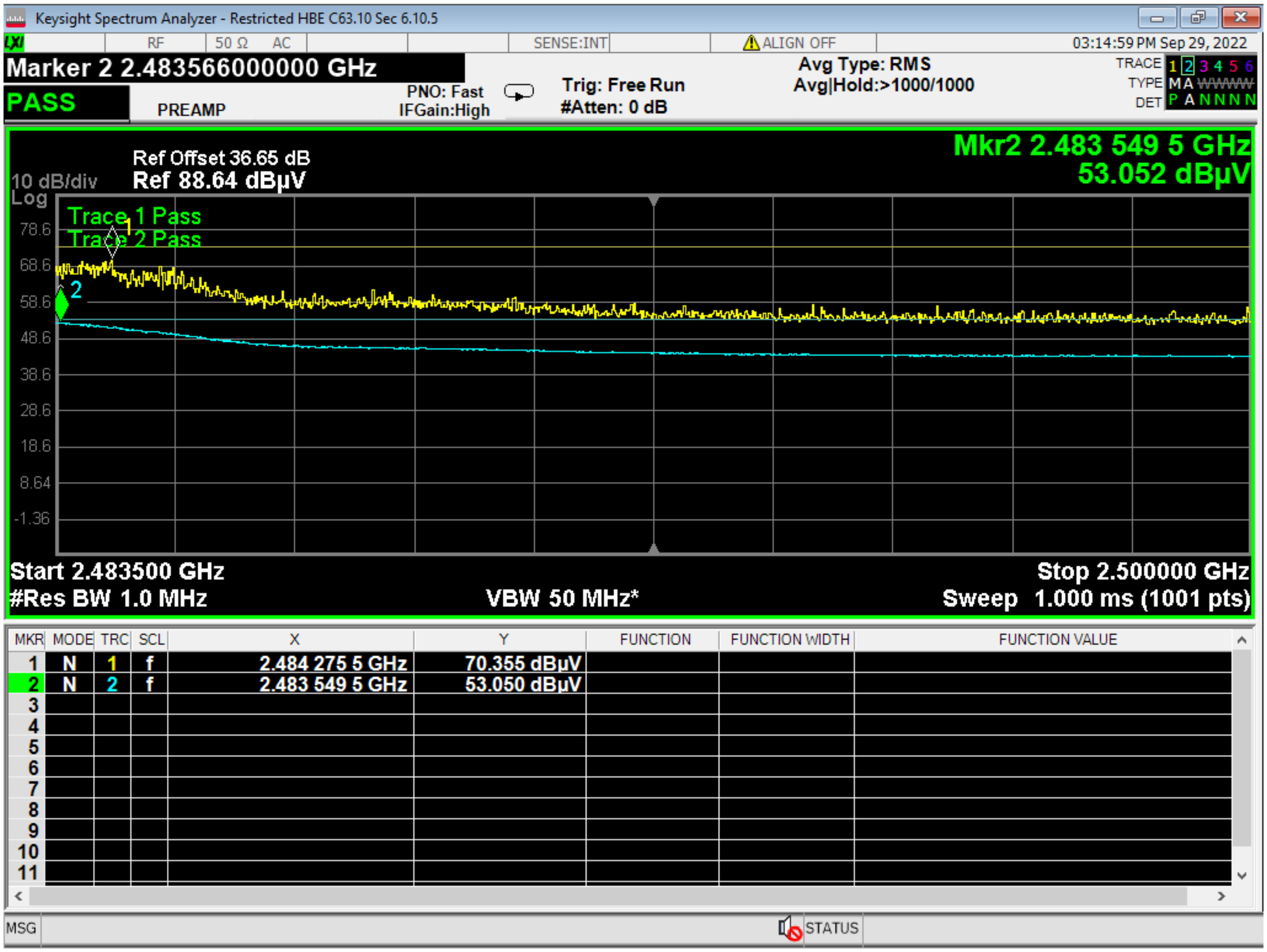
23 Lower Bandedge, Unrestricted, Wifi G, Low Data Rate



24 Higher Bandedge, Unrestricted, Wifi G, Low Data Rate



25 Lower Bandedge, Restricted, Wifi G, Low Data Rate



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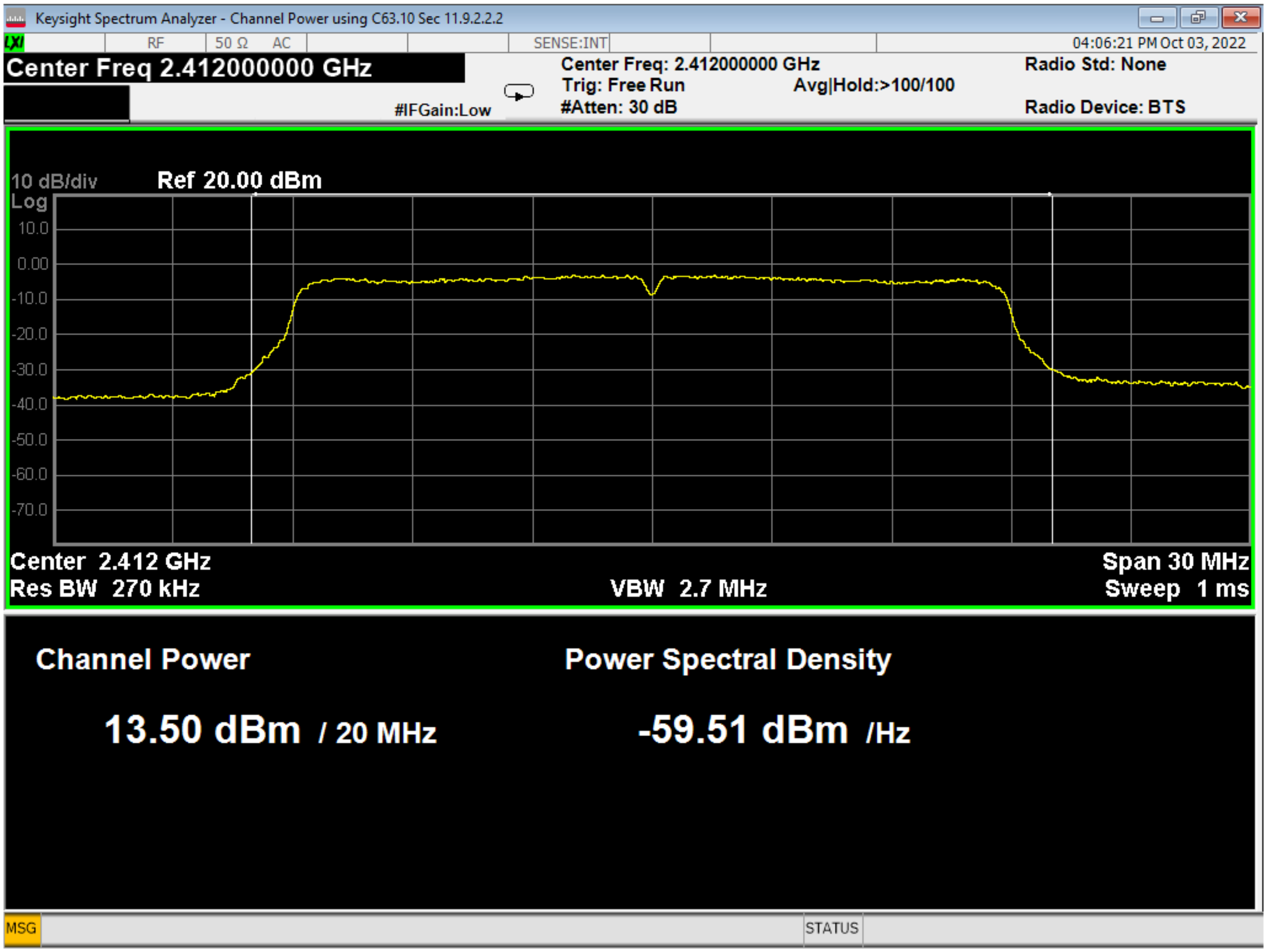

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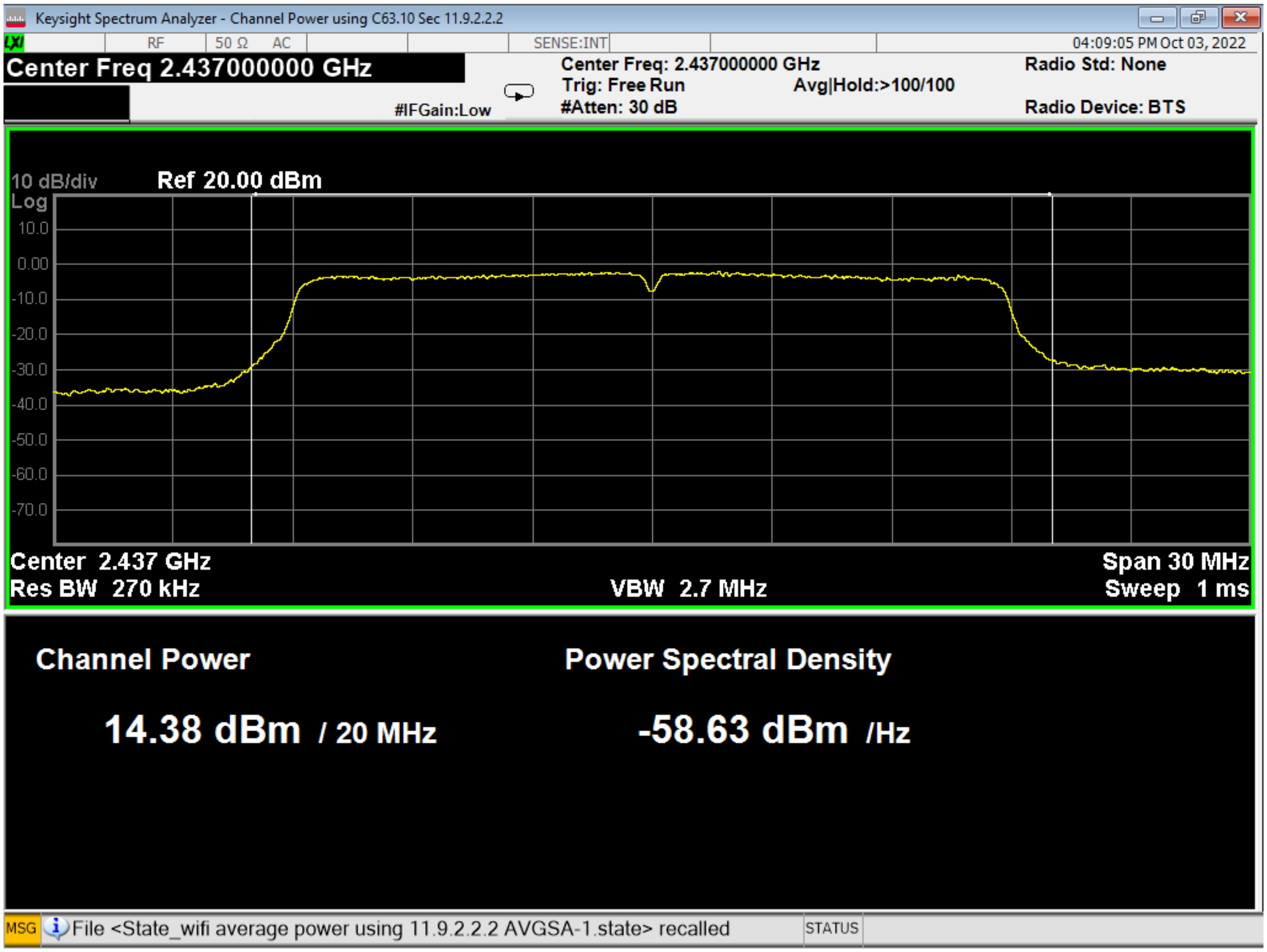
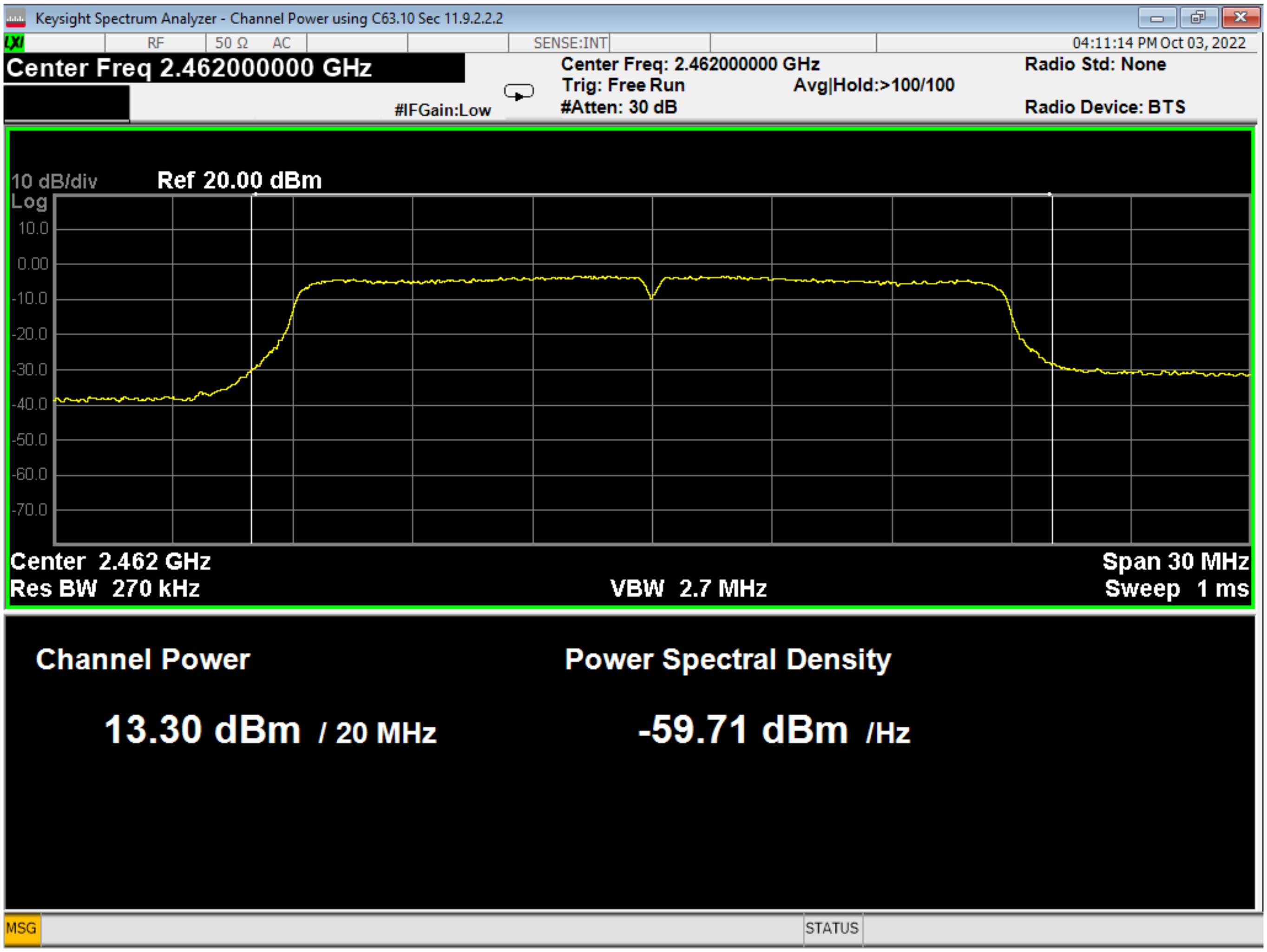
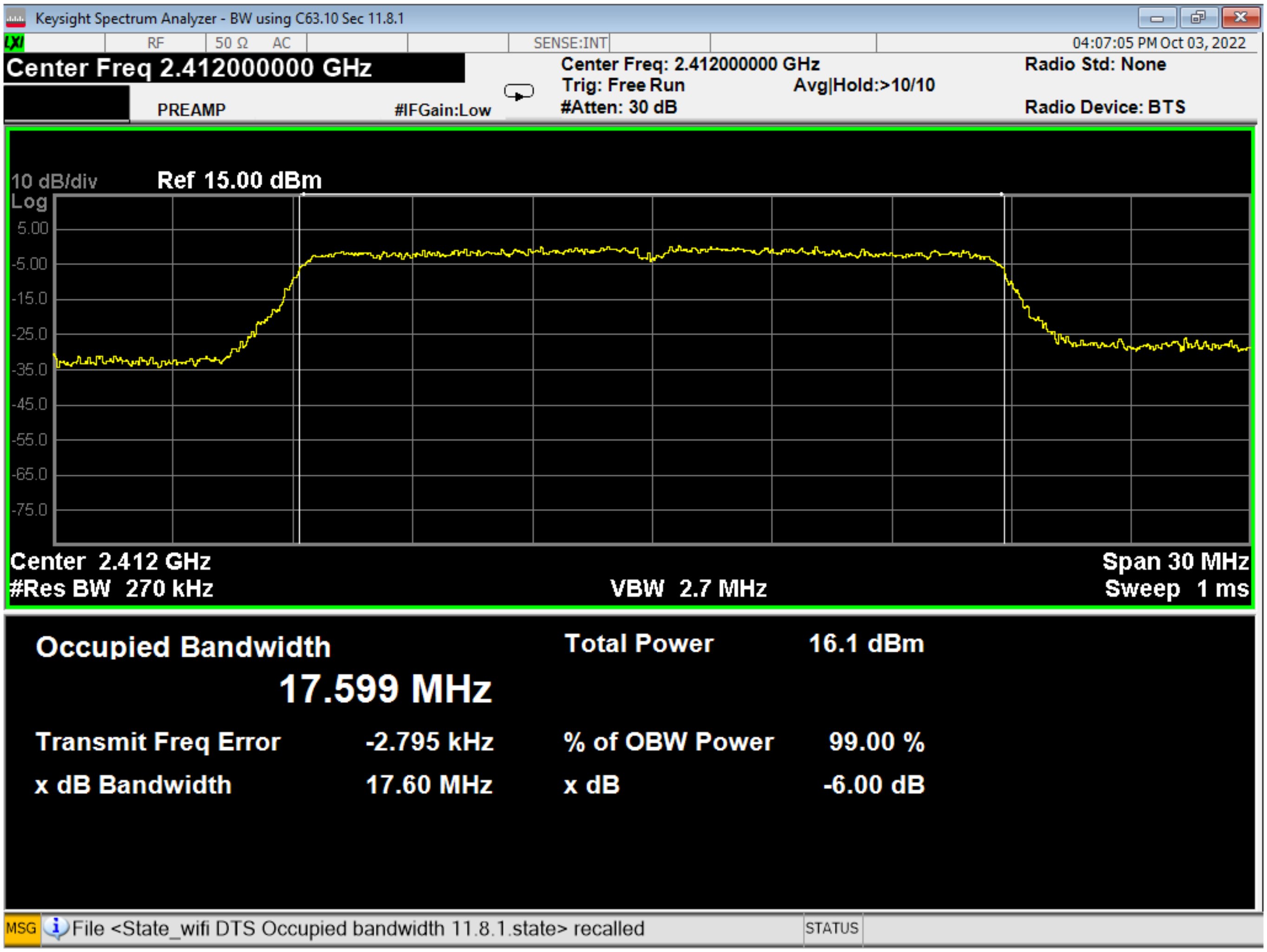


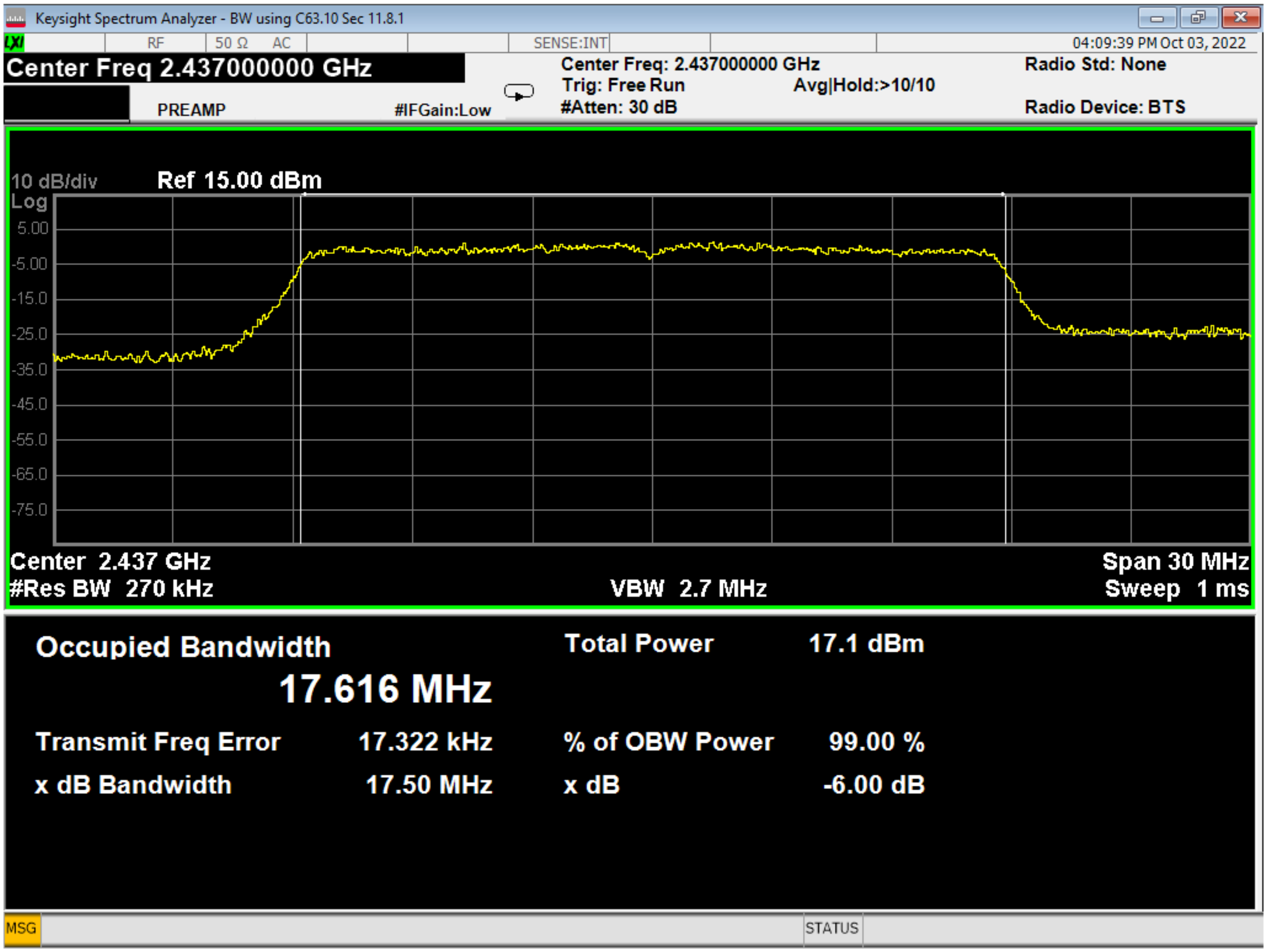
28 Average Power, Mid, Wifi N, Low Data Rate



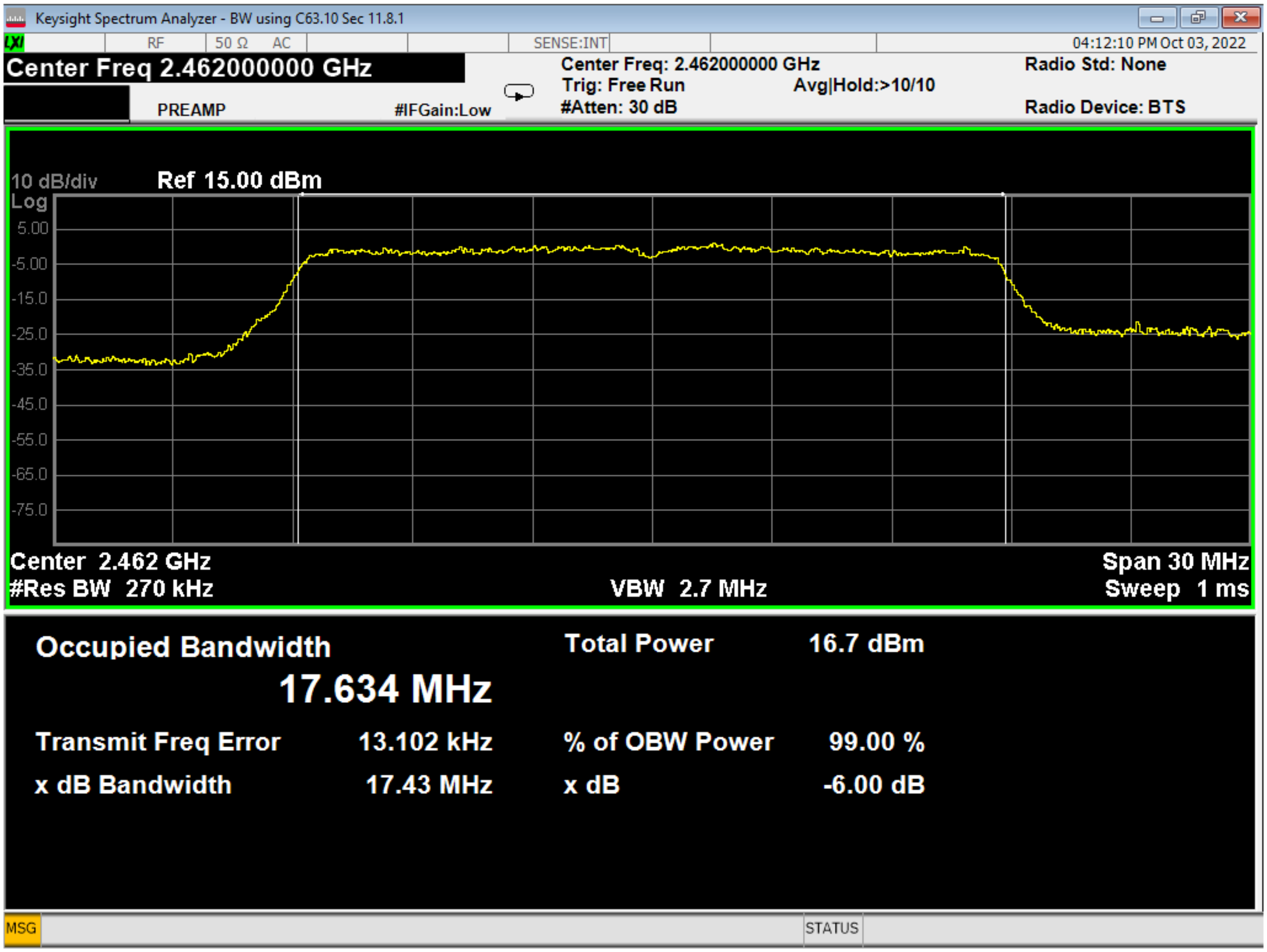
29 Average Power, High, Wifi N, Low Data Rate



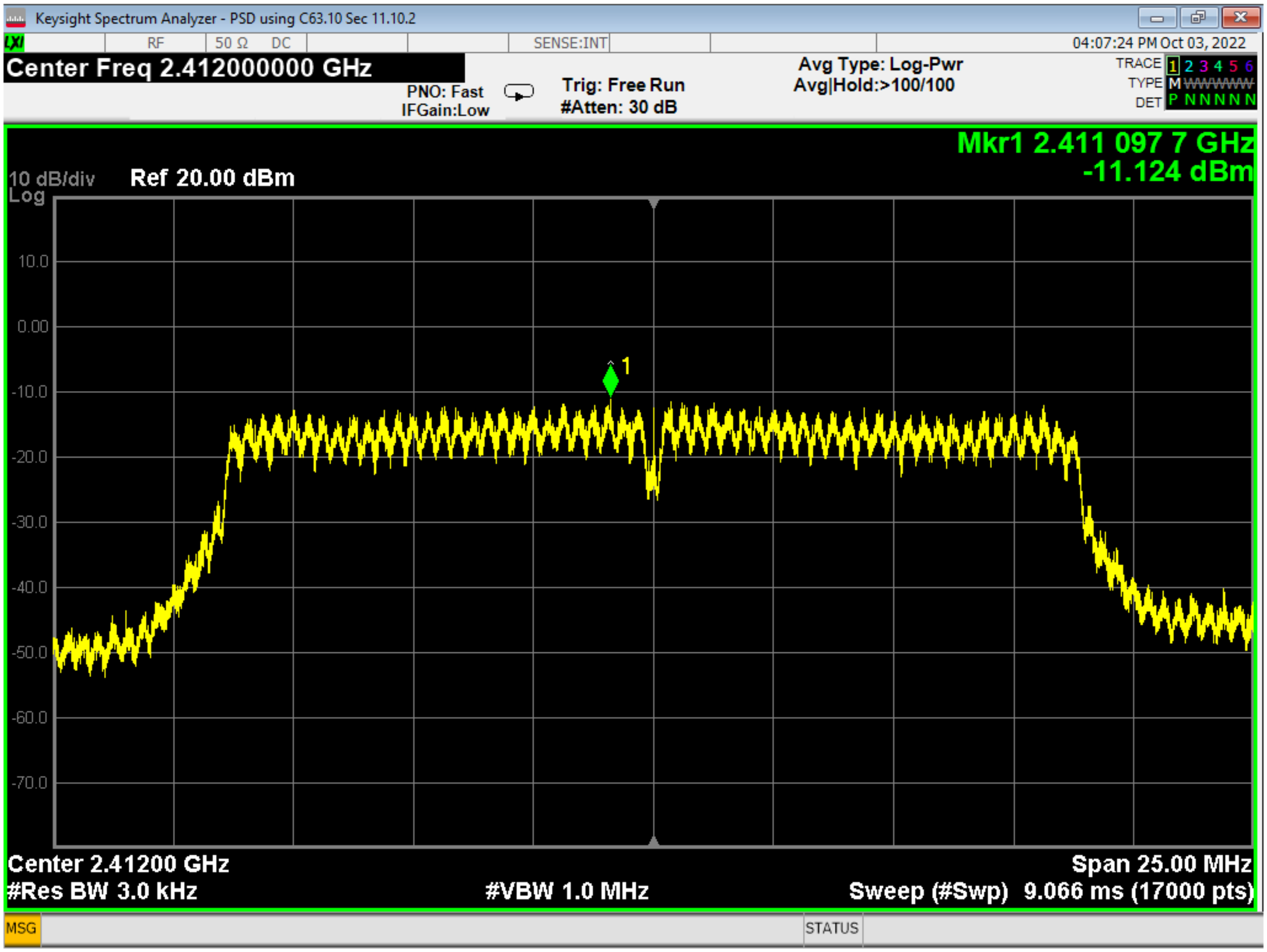
30 Bandwidth, Low, Wifi N, Low Data Rate



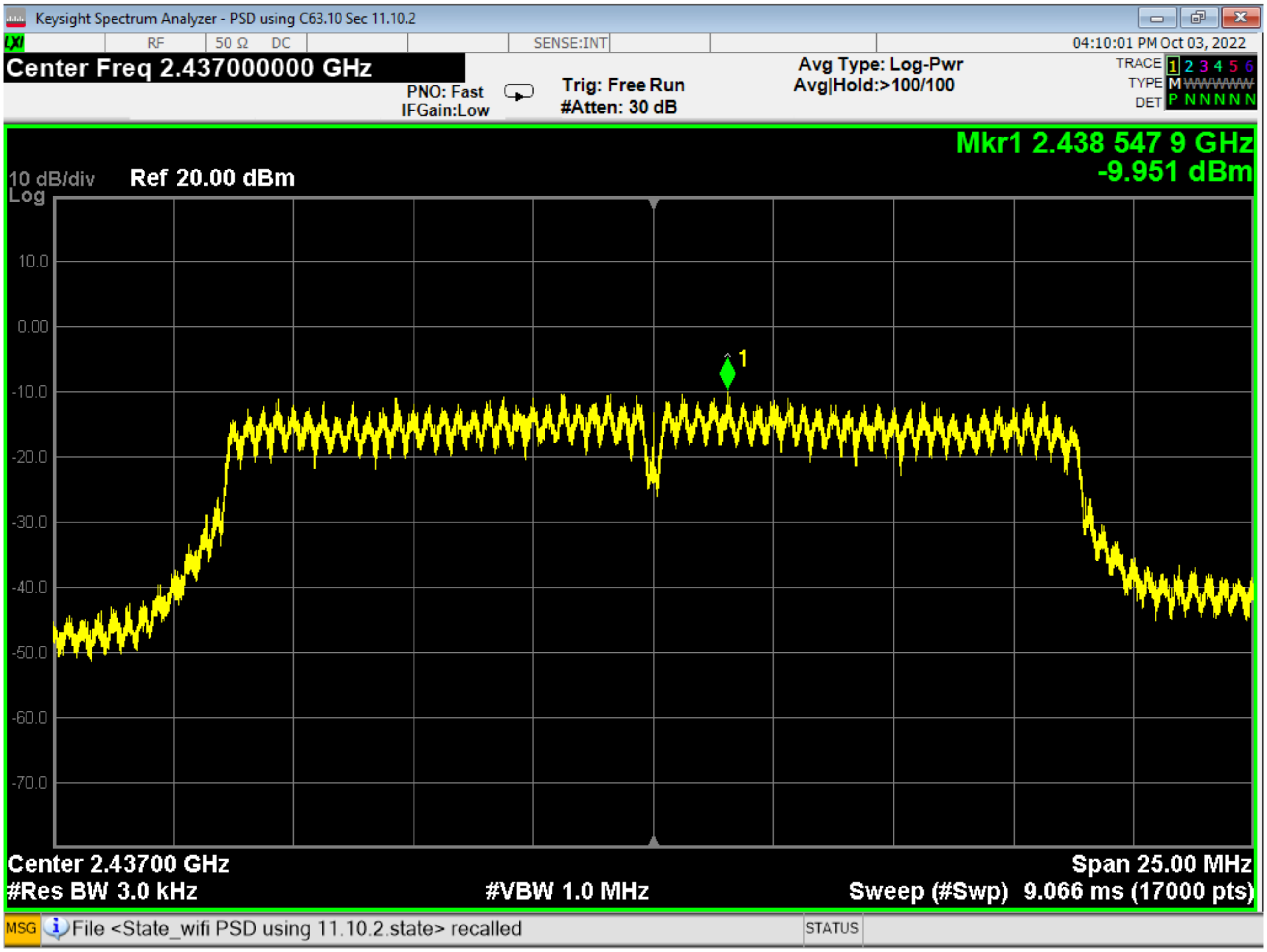
31 Bandwidth, Mid, Wifi N, Low Data Rate



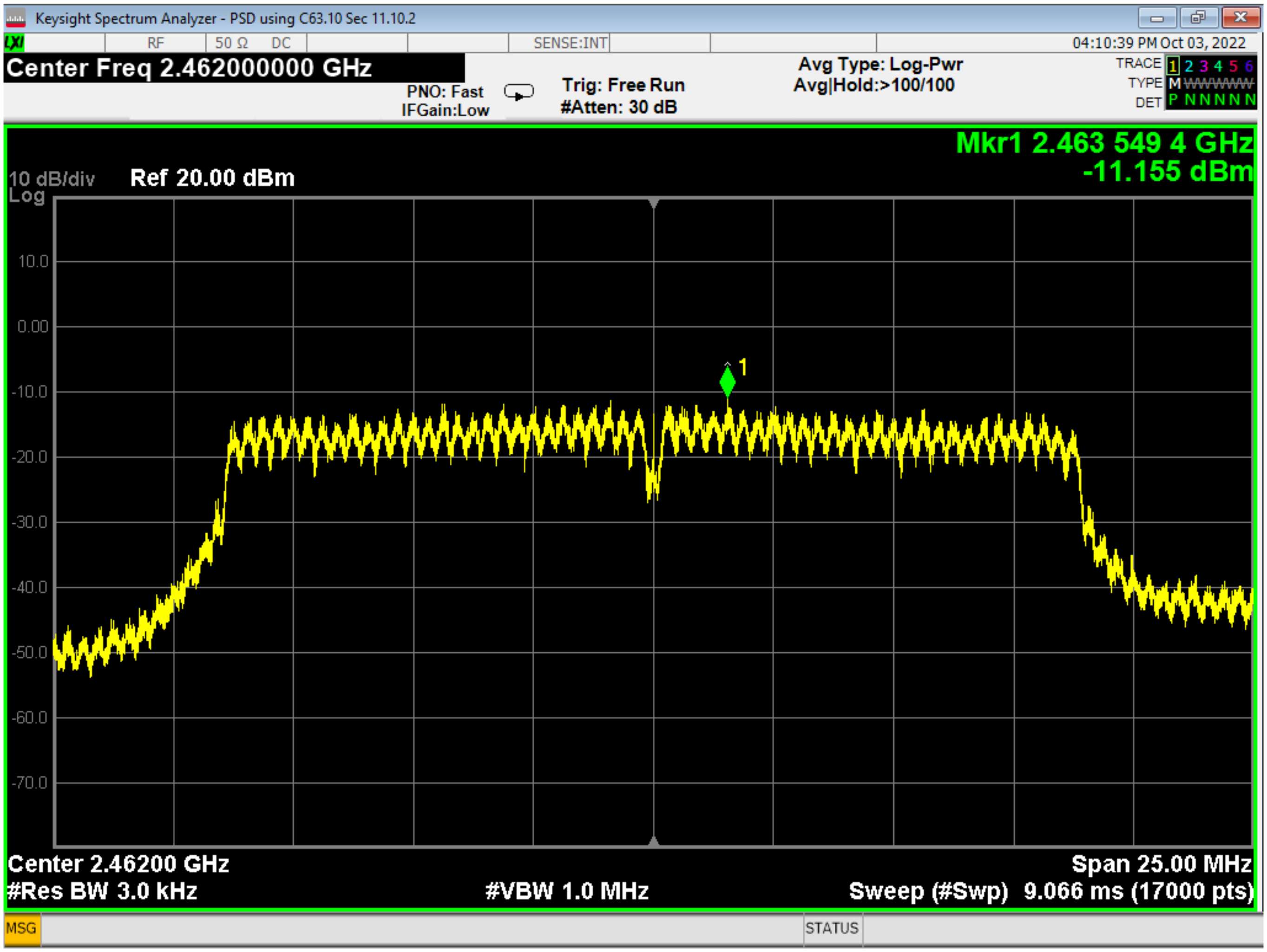
32 Bandwidth, High, Wifi N, Low Data Rate



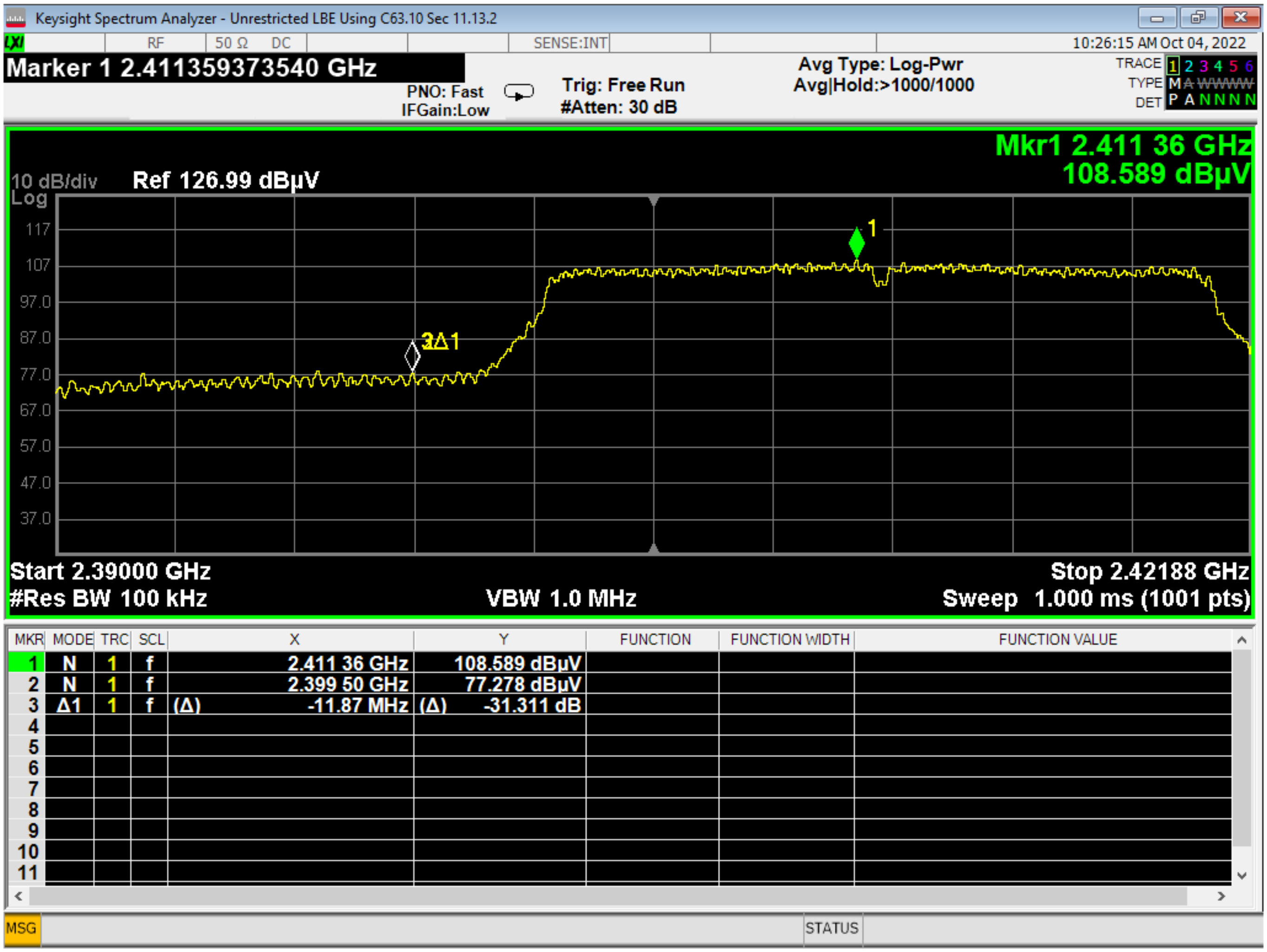
33 PSD, Low, Wifi N, Low Data Rate



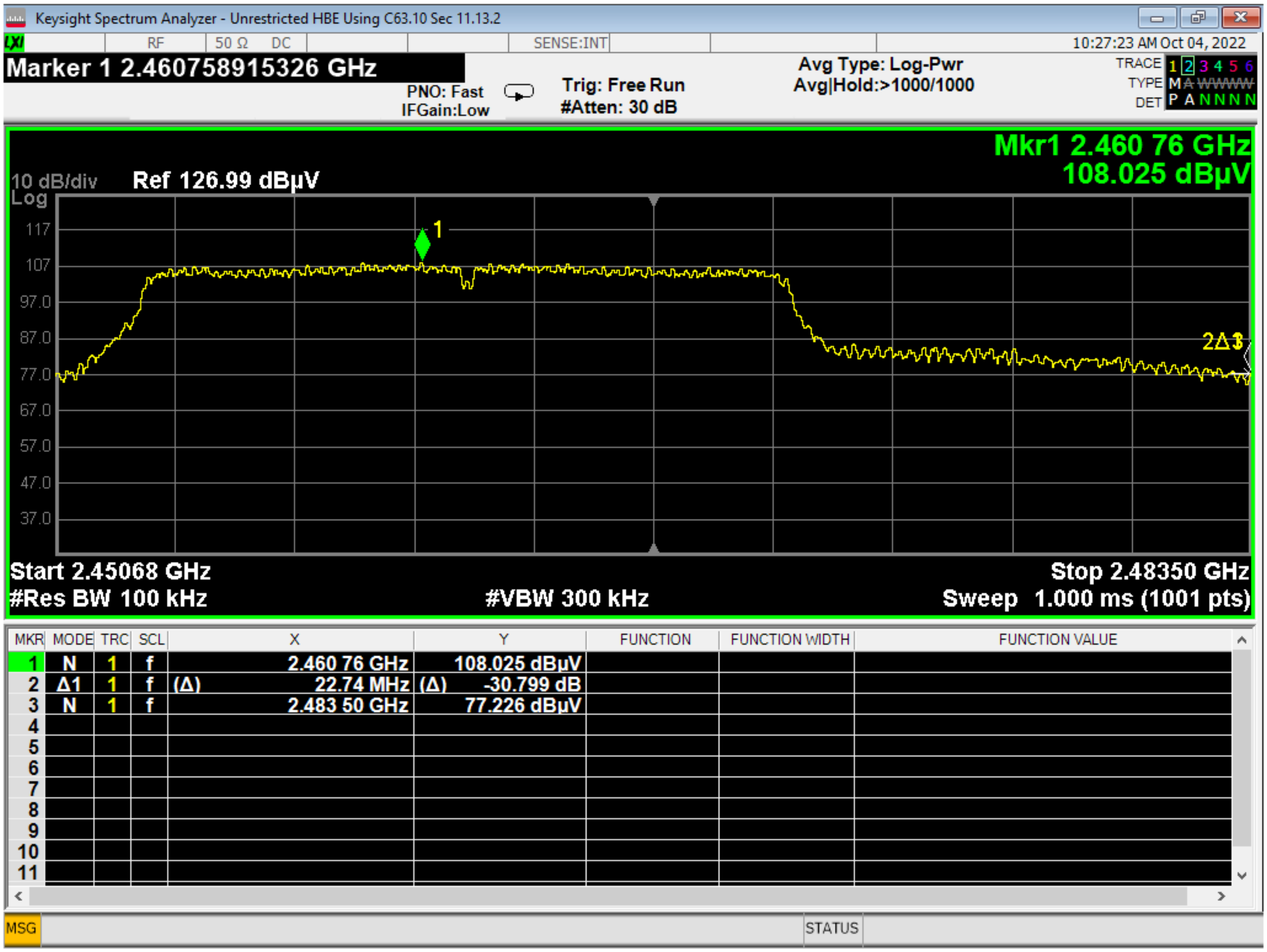
34 PSD, Mid, Wifi N, Low Data Rate



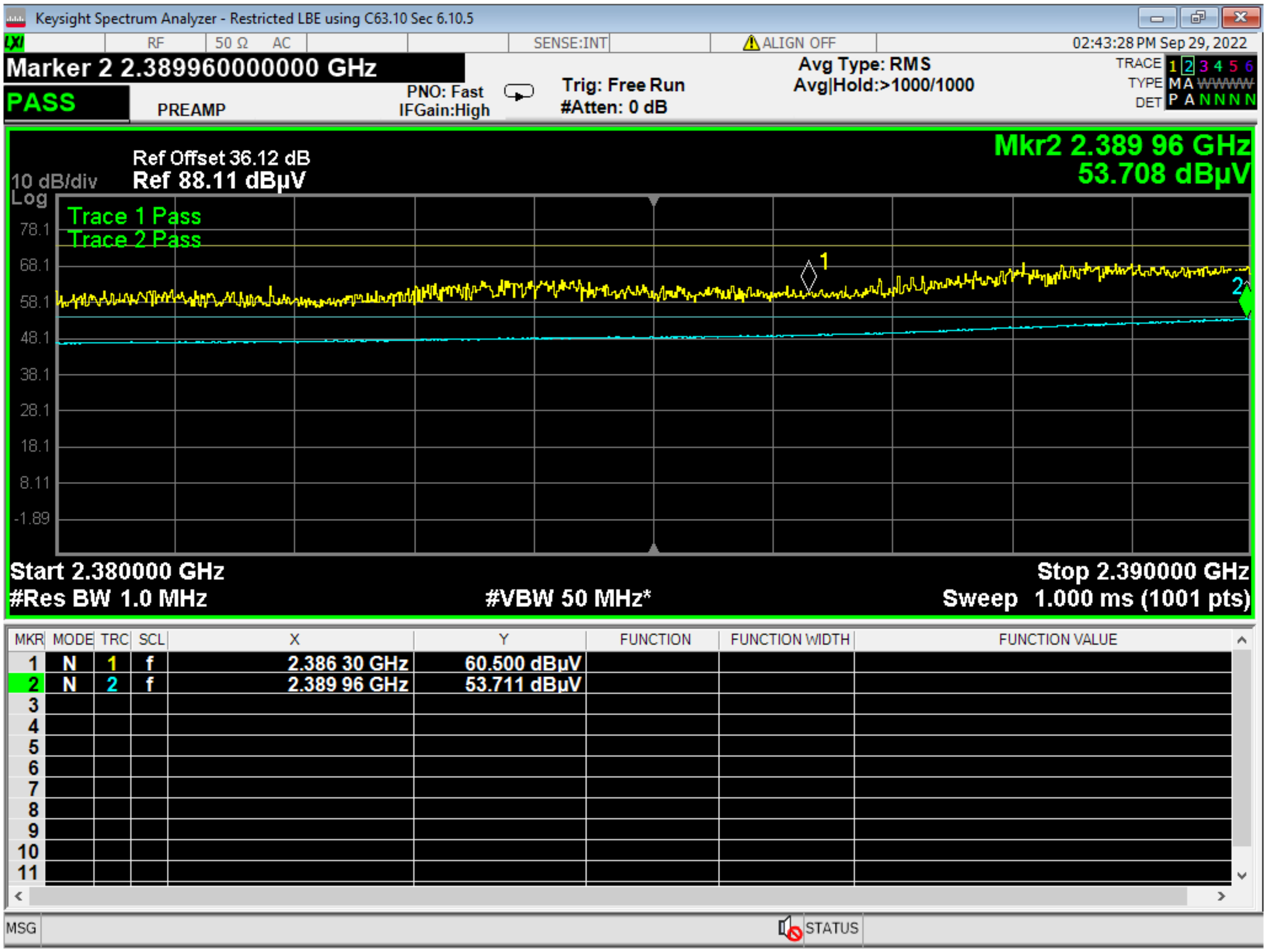
35 PSD, High, Wifi N, Low Data Rate



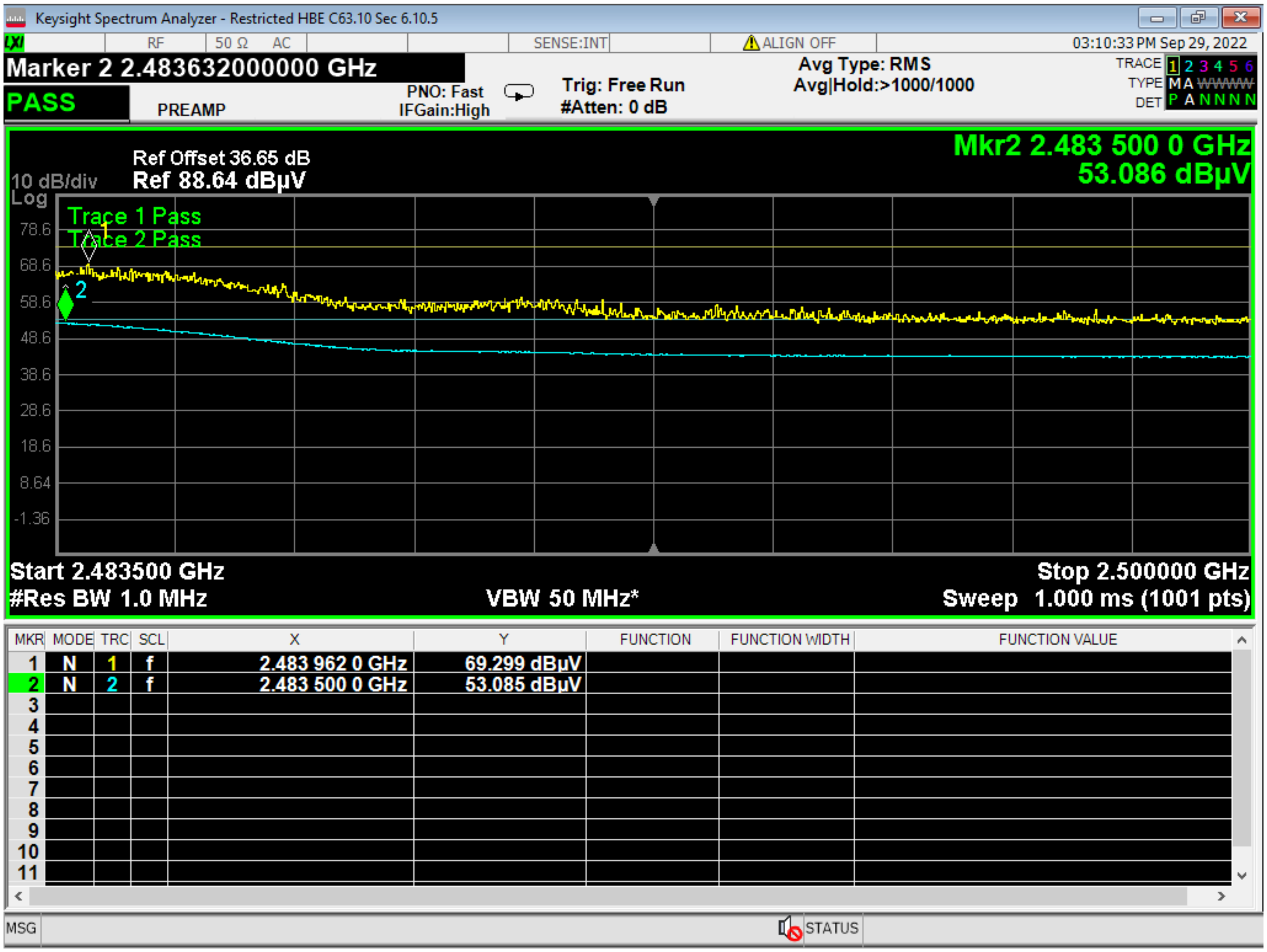
36 Lower Bandedge, Unrestricted, Wifi N, Low Data Rate



37 Higher Bandedge, Unrestricted, Wifi N, Low Data Rate



38 Lower Bandedge, Restricted, Wifi N, Low Data Rate



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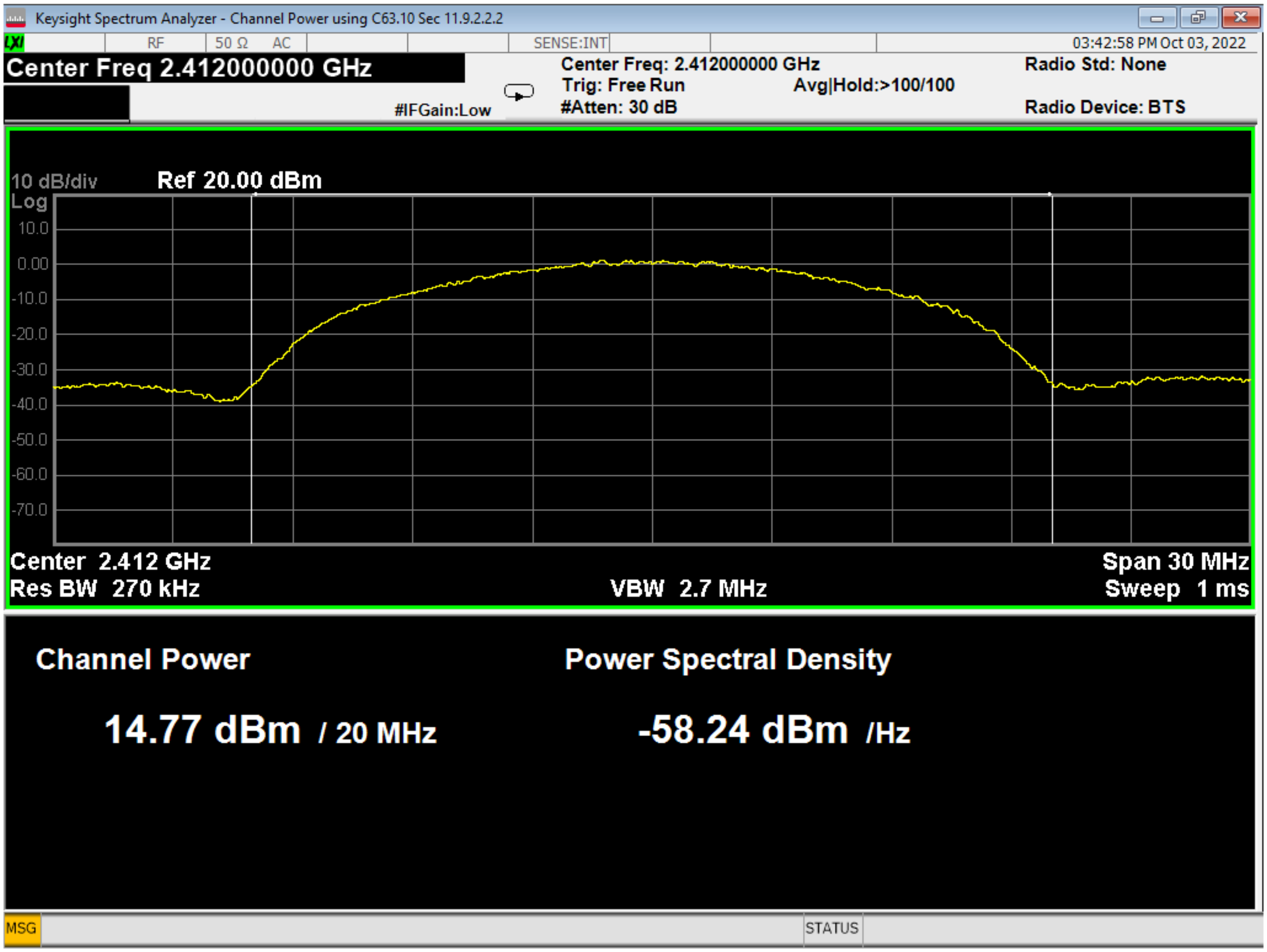
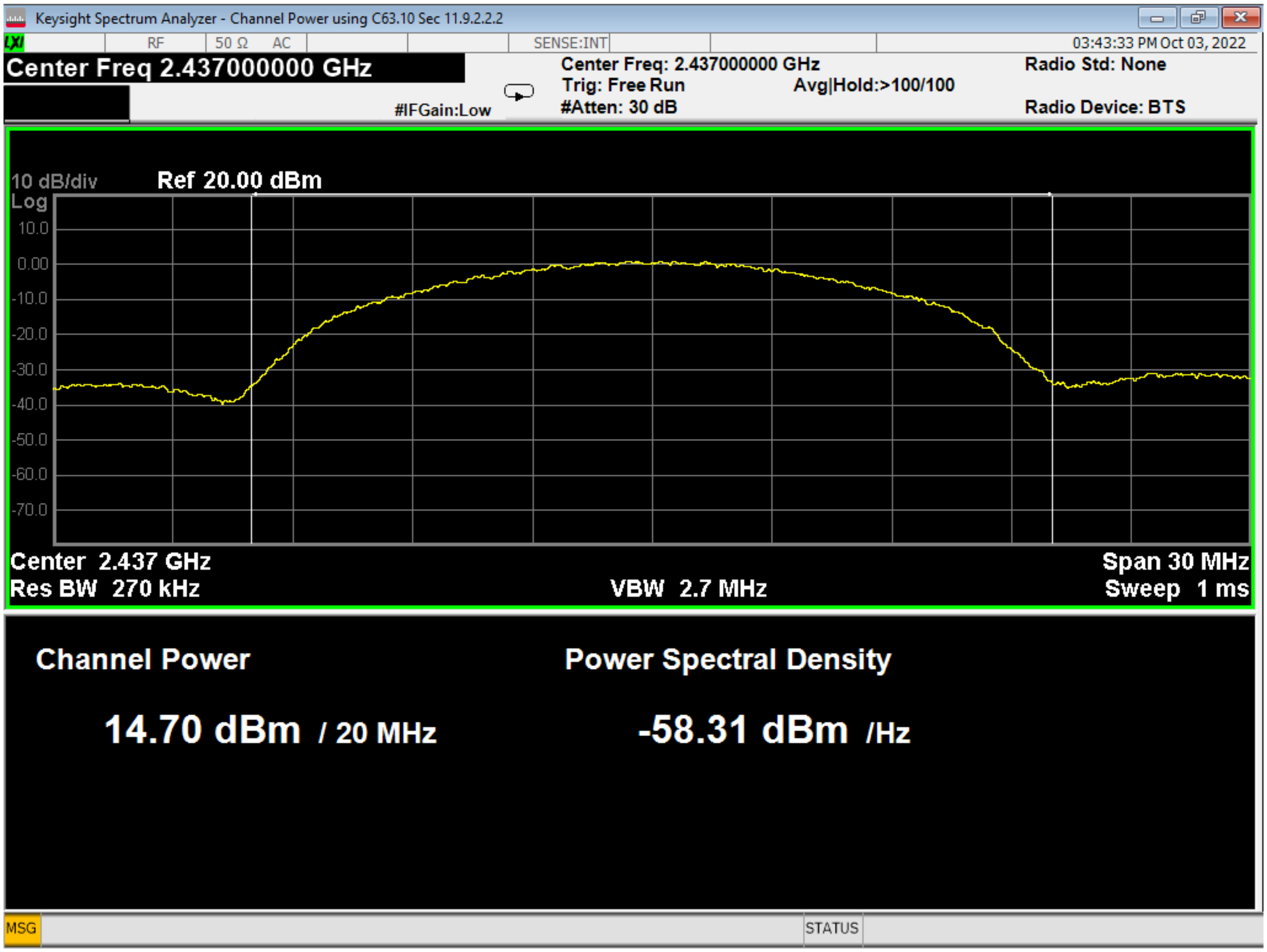


40 Average Power, Low, Wifi B, High Data Rate



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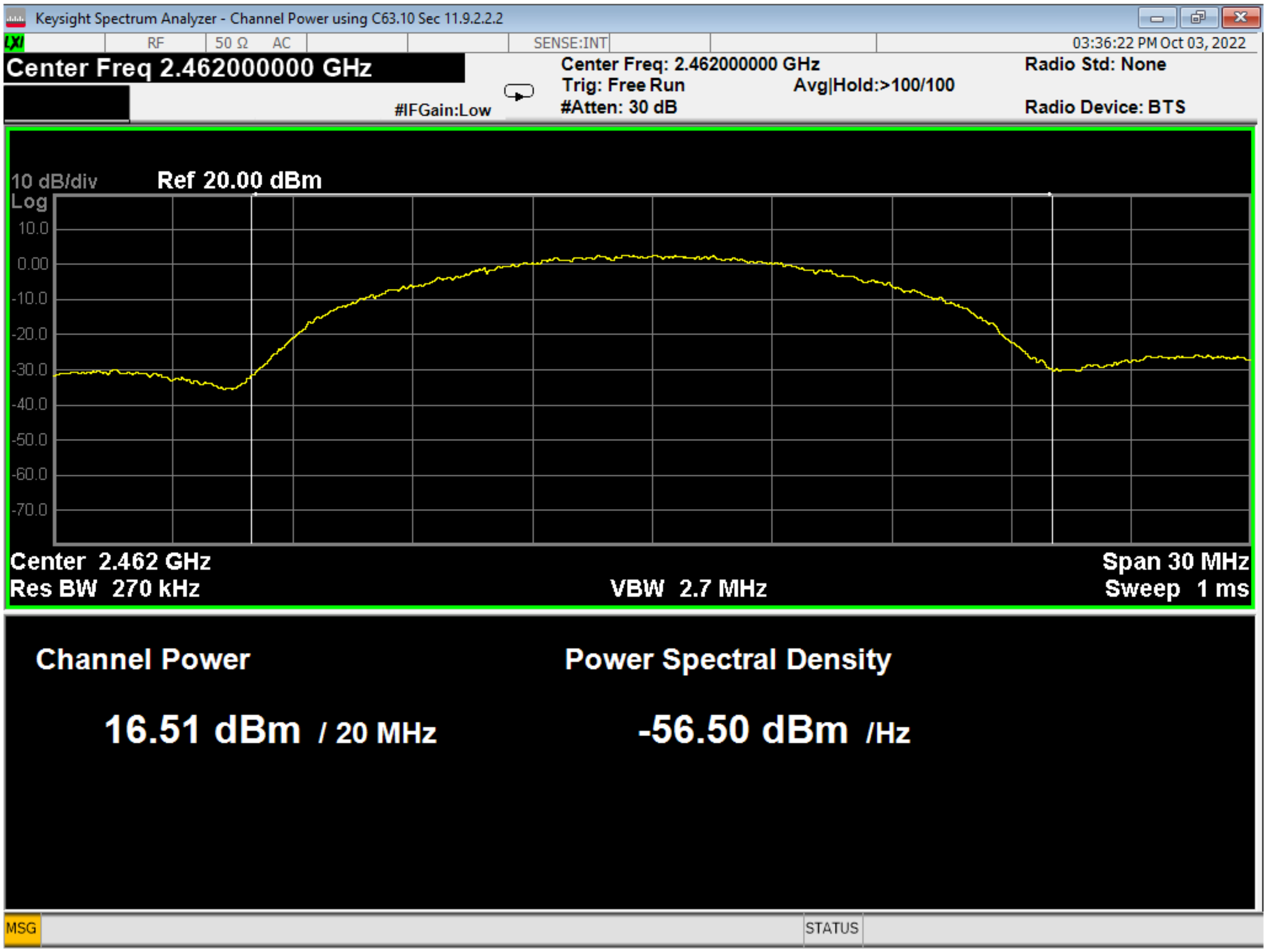
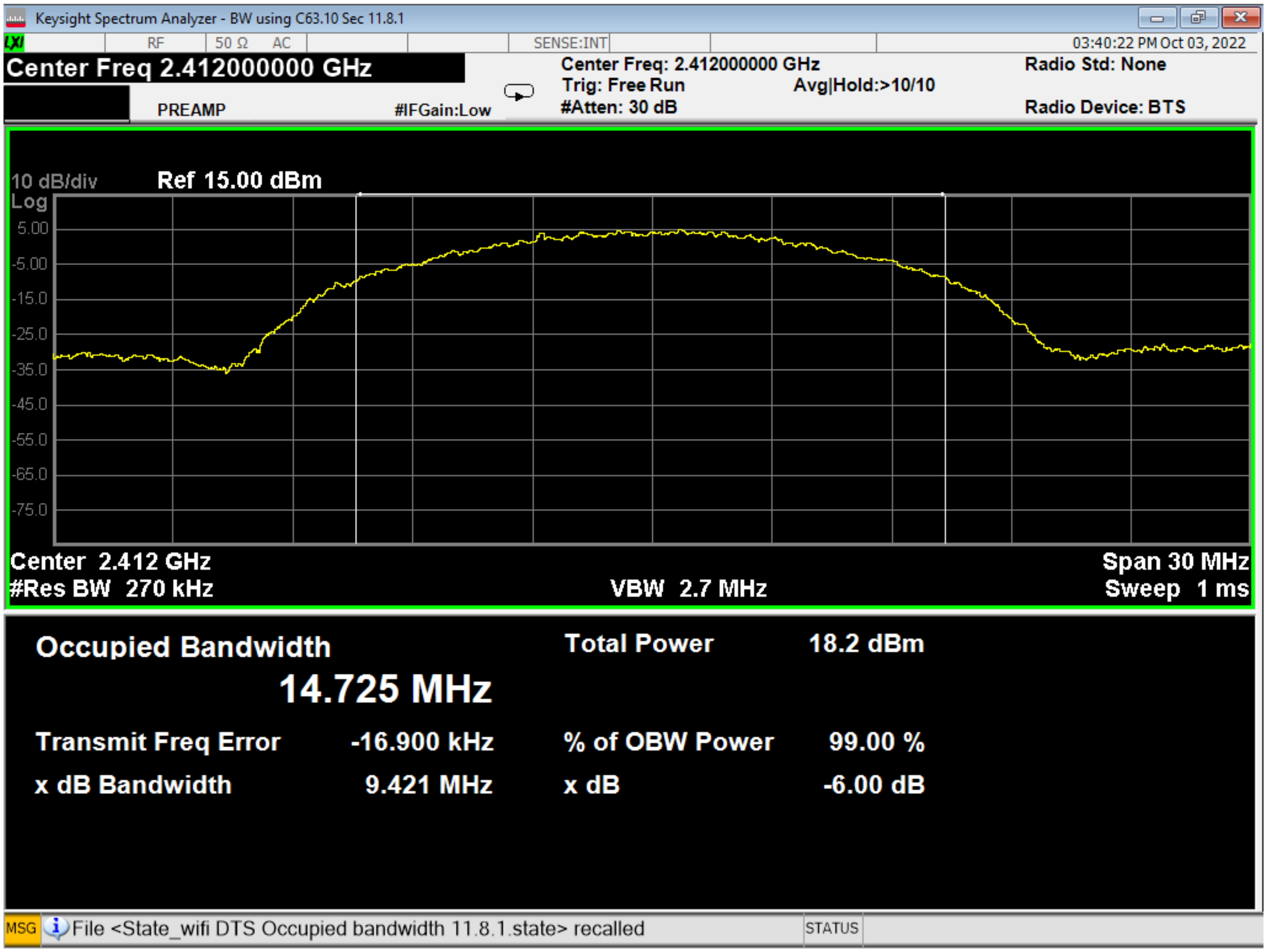
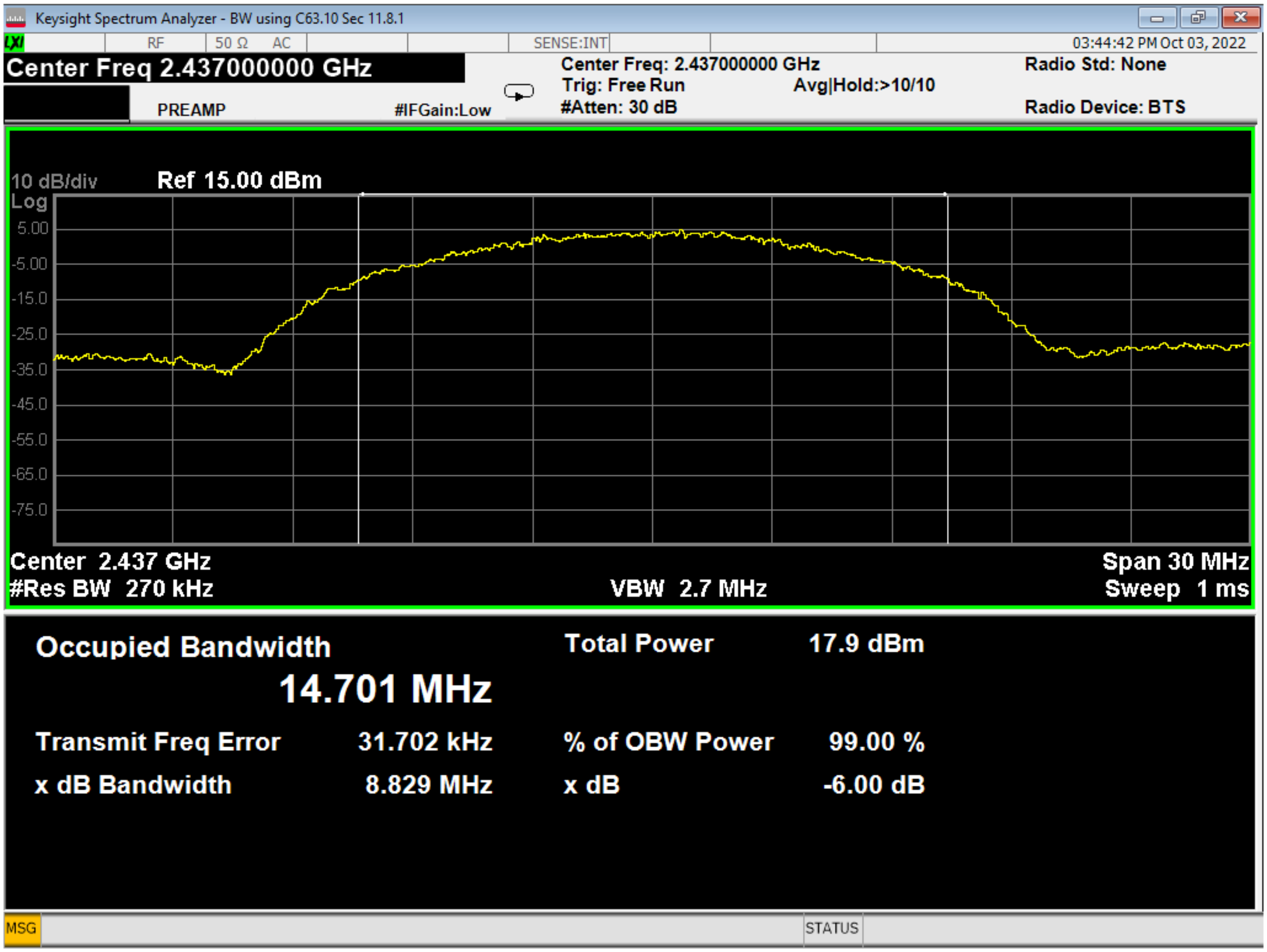


42 Average Power, High, Wifi B, High Data Rate



43 Bandwidth, Low, Wifi B, High Data Rate



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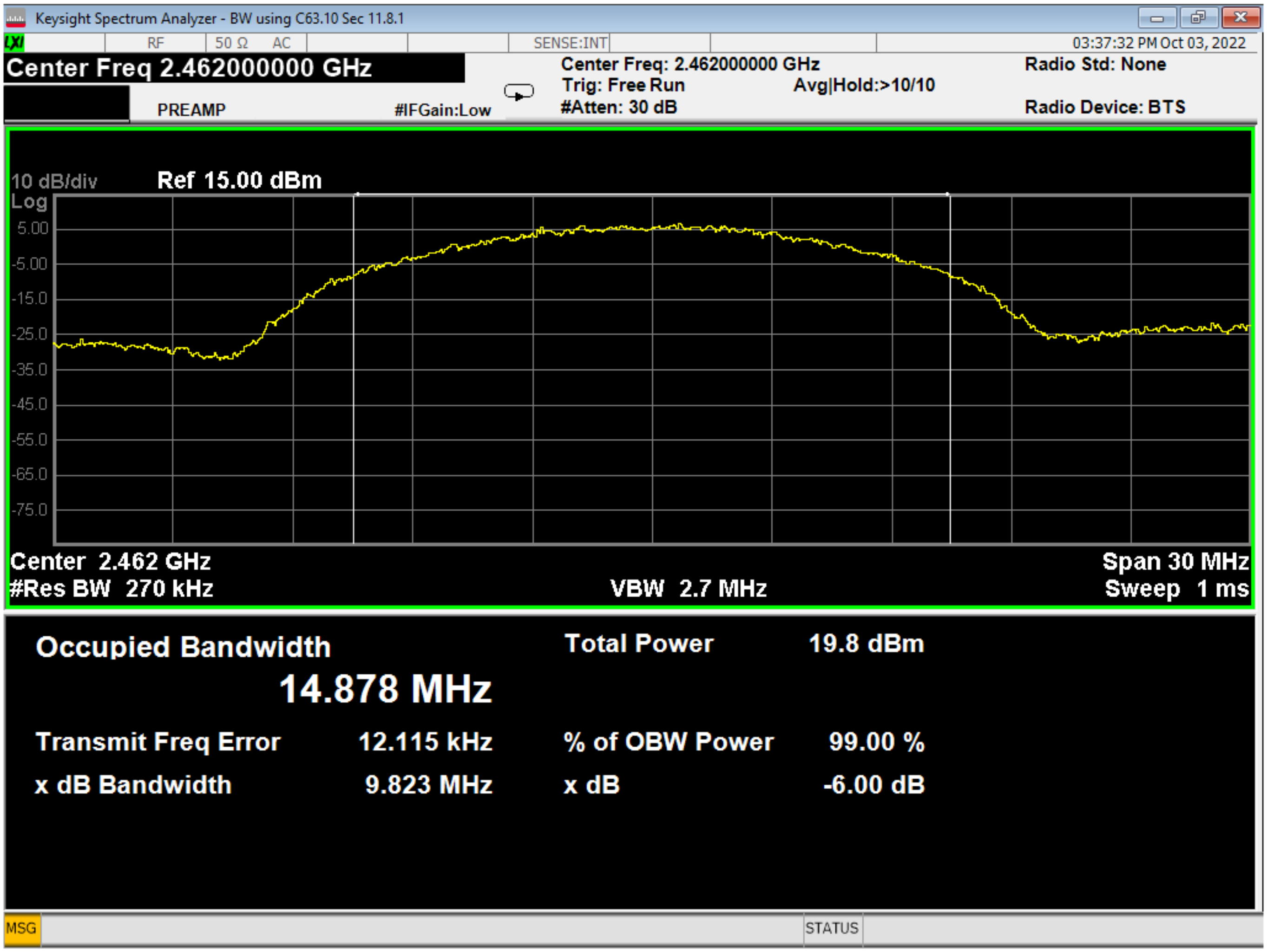

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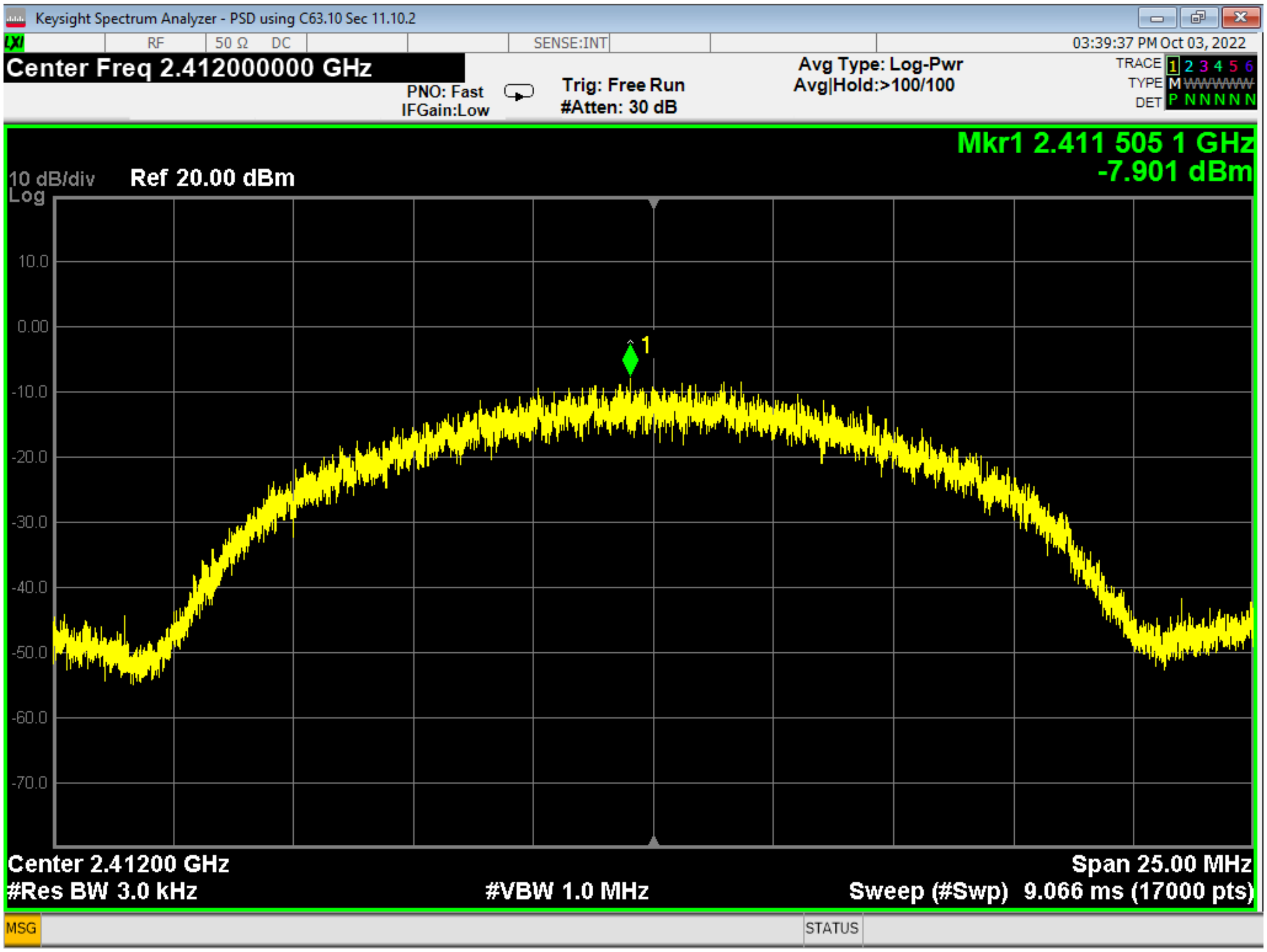
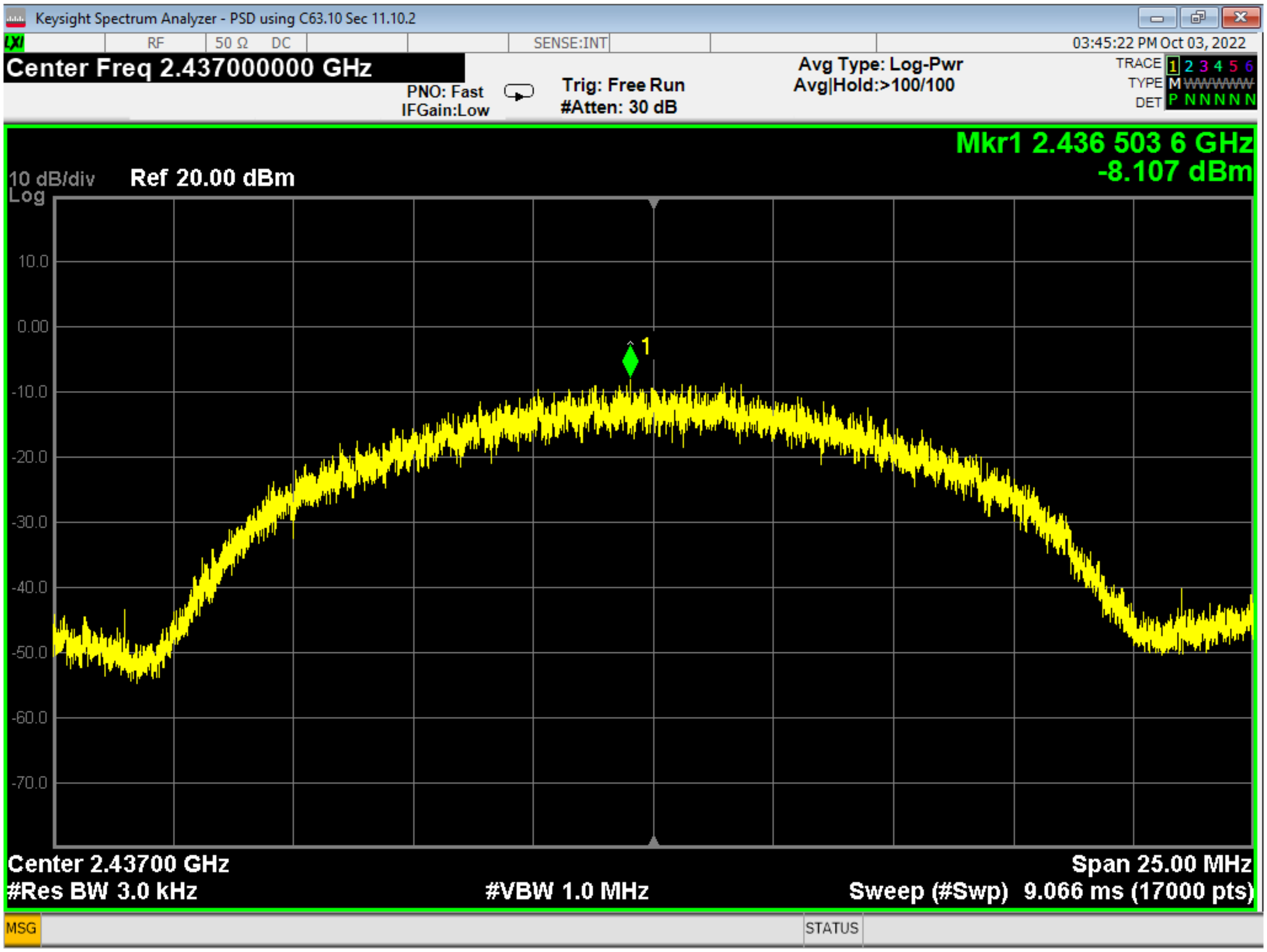


46 PSD, Low, Wifi B, High Data Rate



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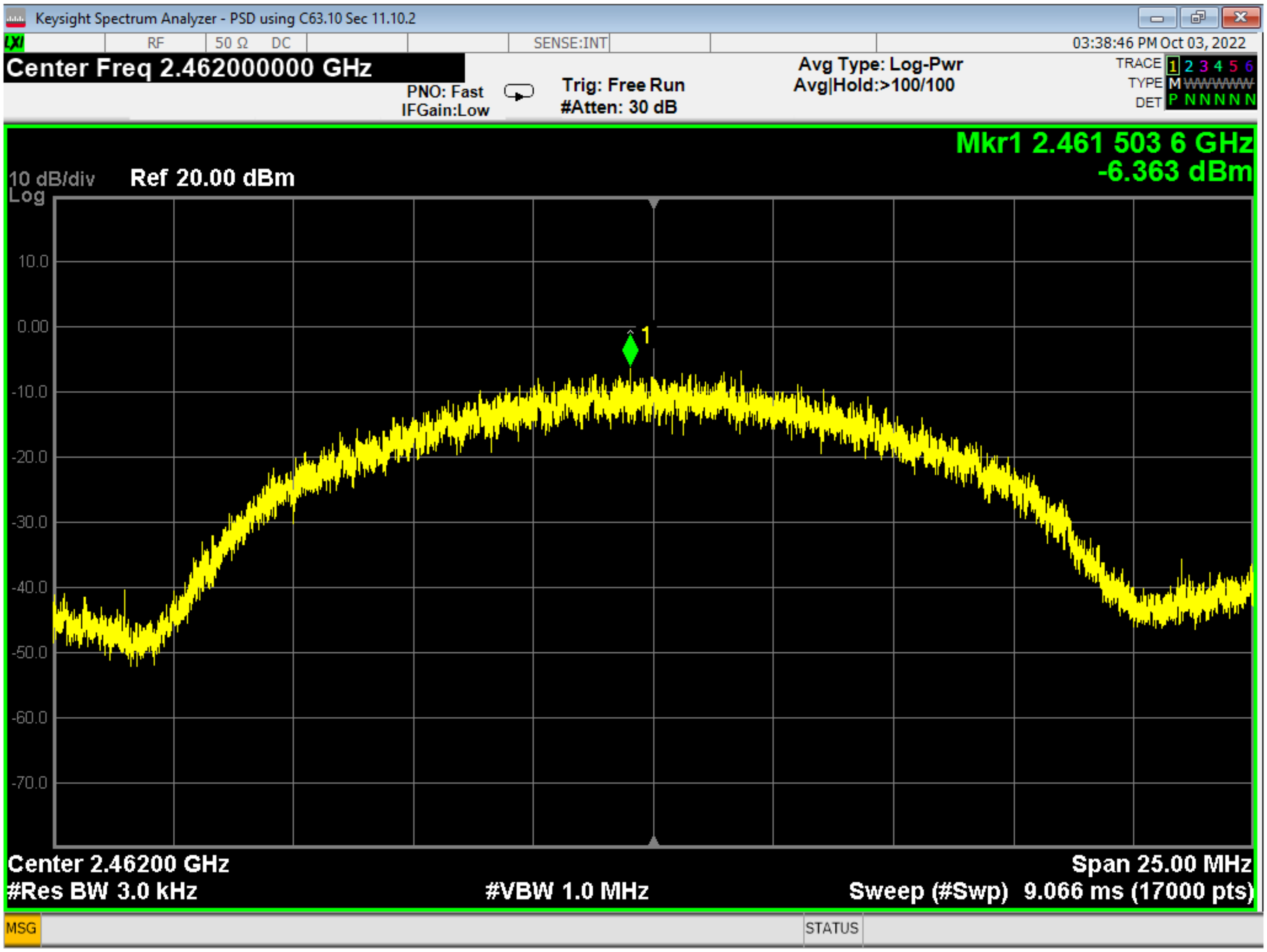
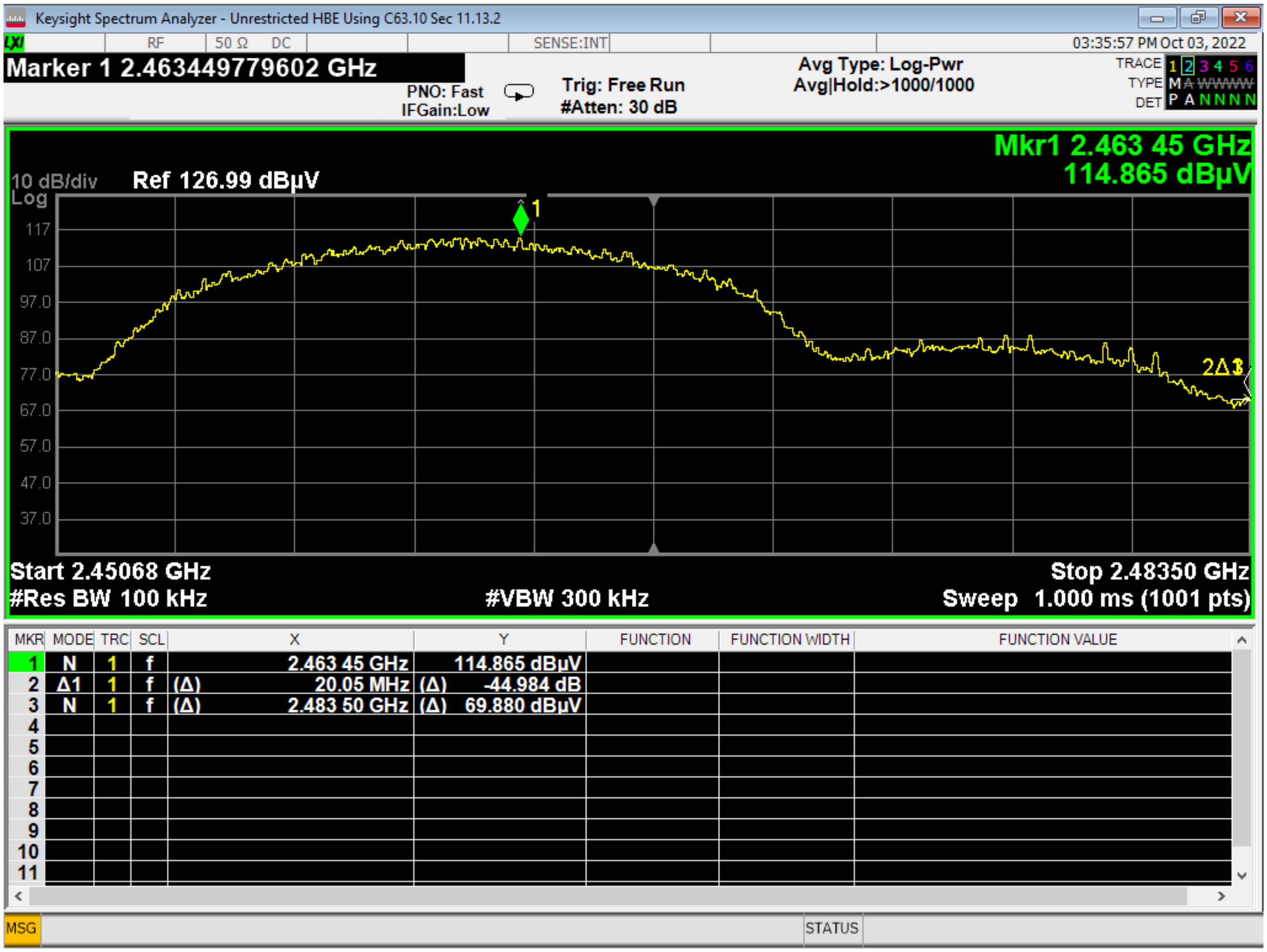


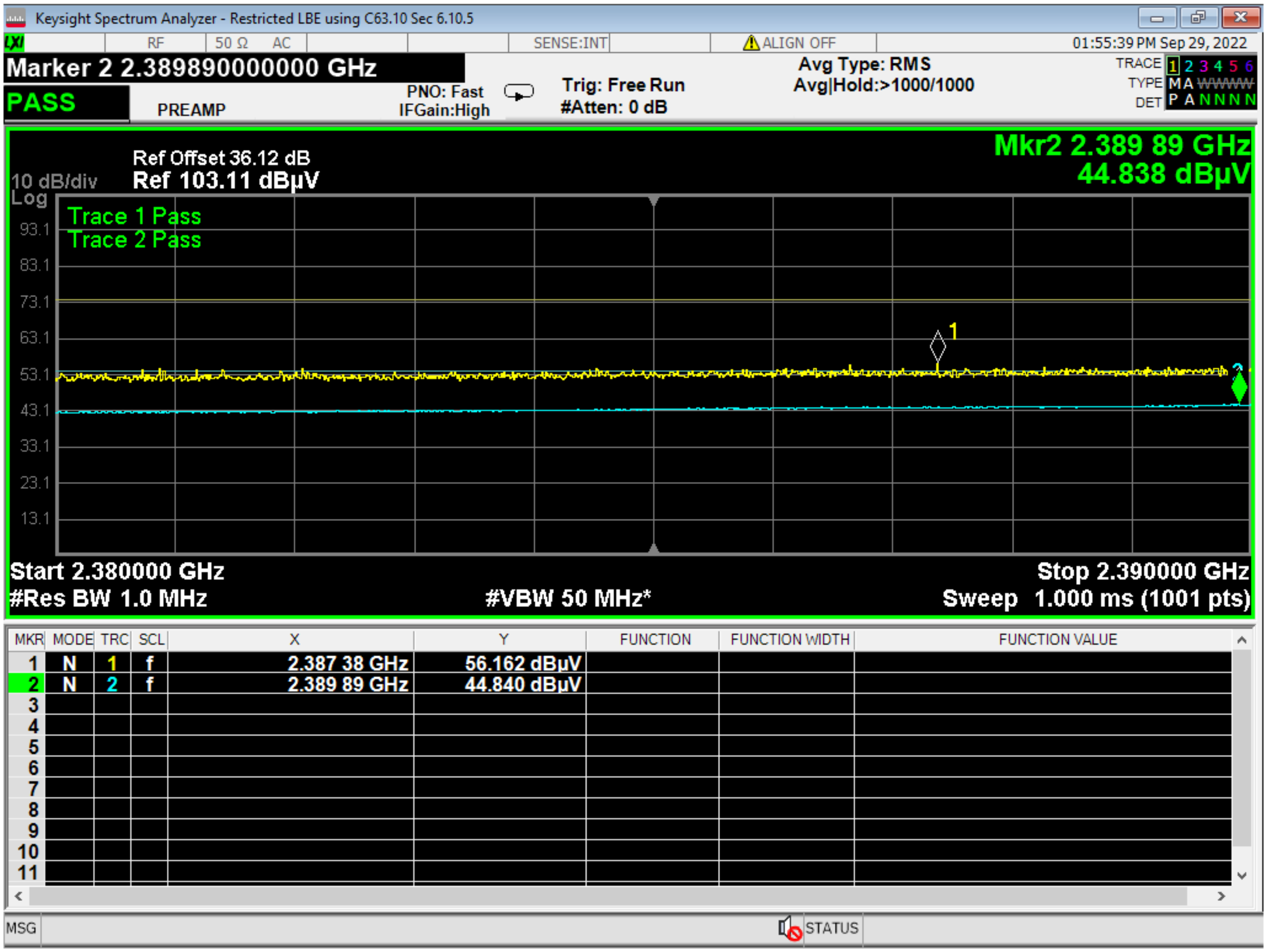
48 PSD, High, Wifi B, High Data Rate

MKR	MODE	TRC	SCL	X	Y	FUNCTION	FUNCTION WIDTH	FUNCTION VALUE
1	N	1	f	2.411 74 GHz	113.413 dBµV			
2	N	1	f (Δ)	2.396 53 GHz	(Δ) 80.523 dBµV			
3	Δ1	1	f (Δ)	-15.22 MHz	(Δ) -32.889 dB			
4								
5								
6								
7								
8								
9								
10								
11								

49 Lower Bandedge, Unrestricted, Wifi B, High Data Rate



50 Higher Bandedge, Unrestricted, Wifi B, High Data Rate



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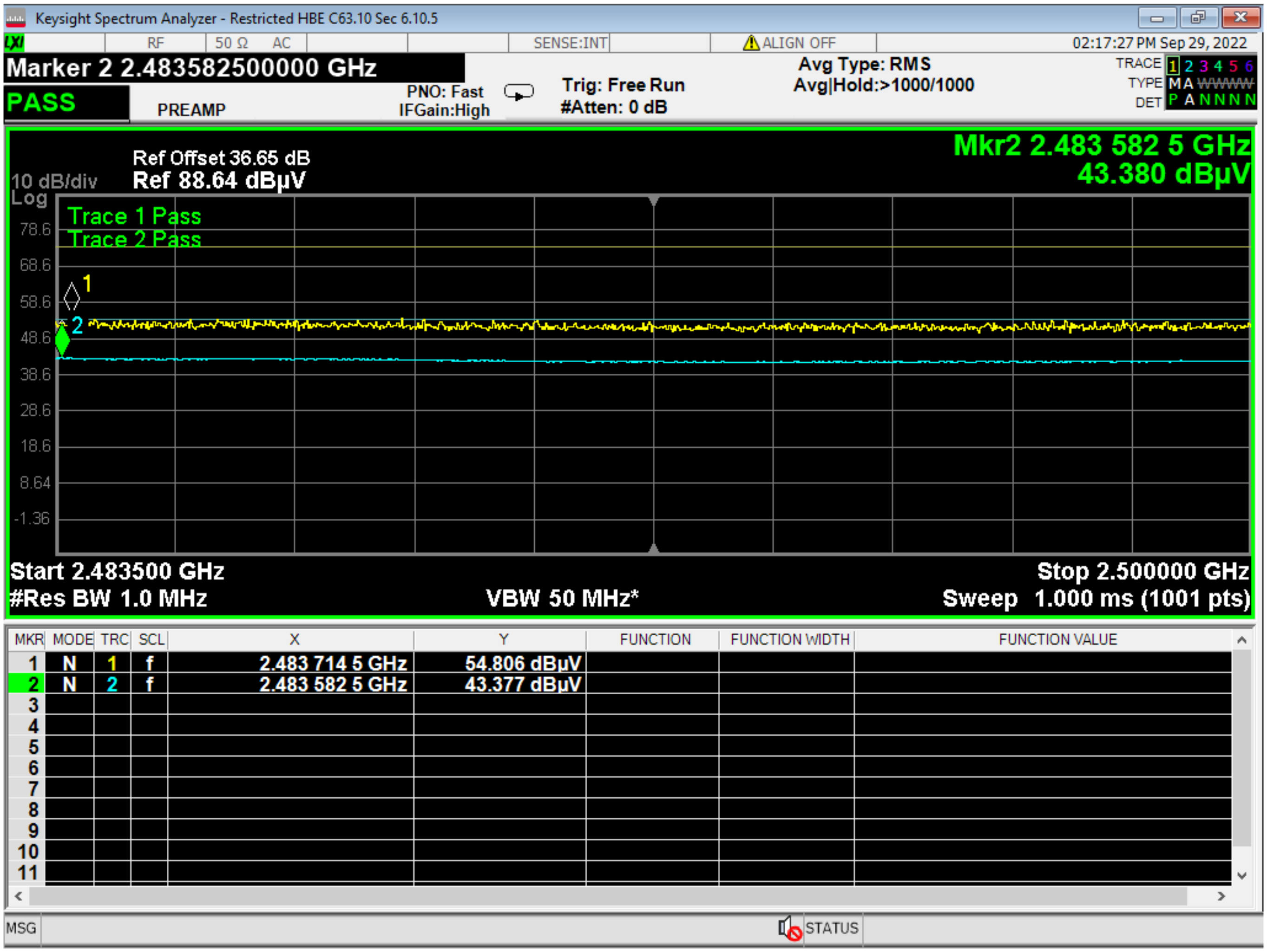

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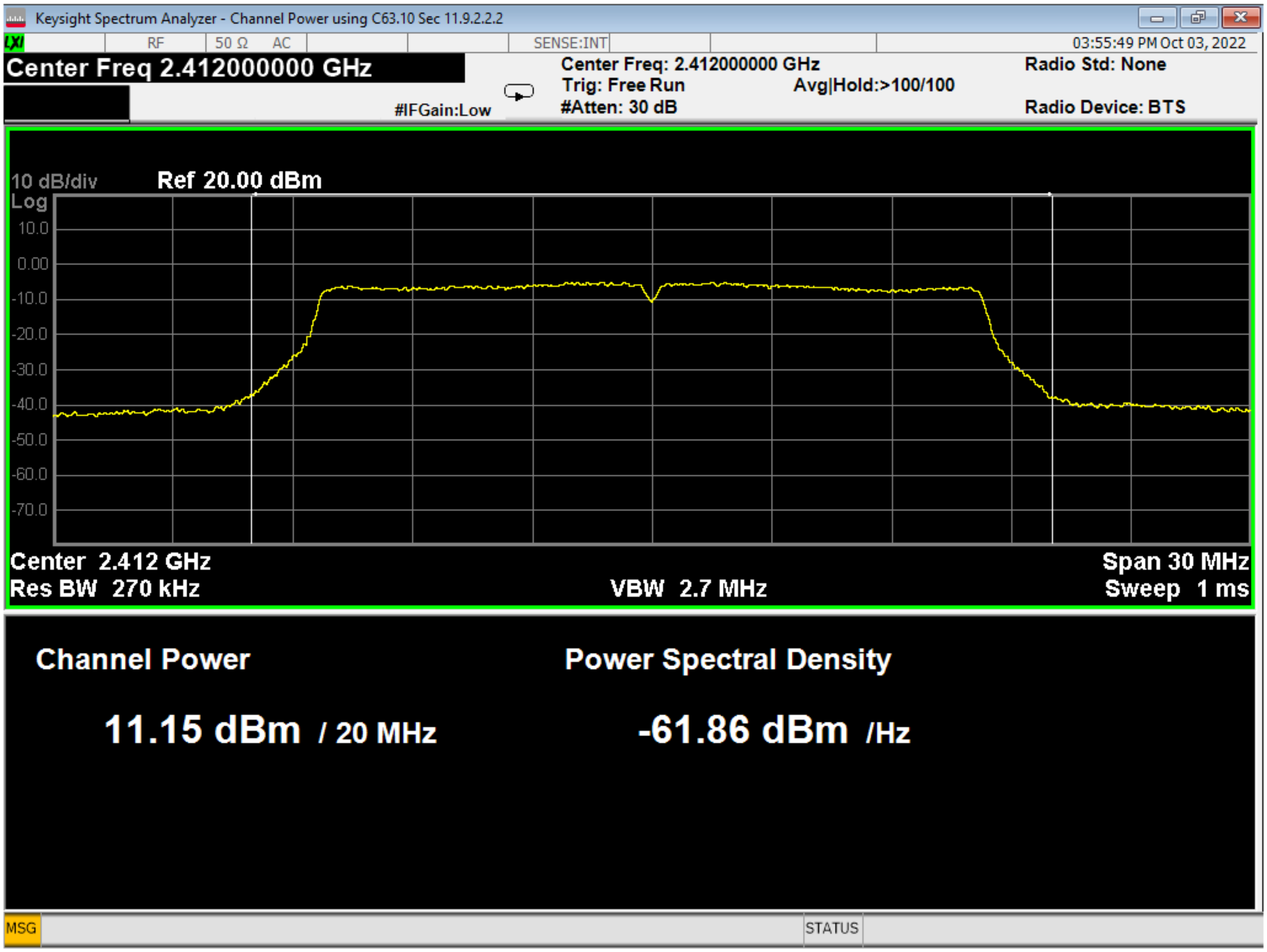
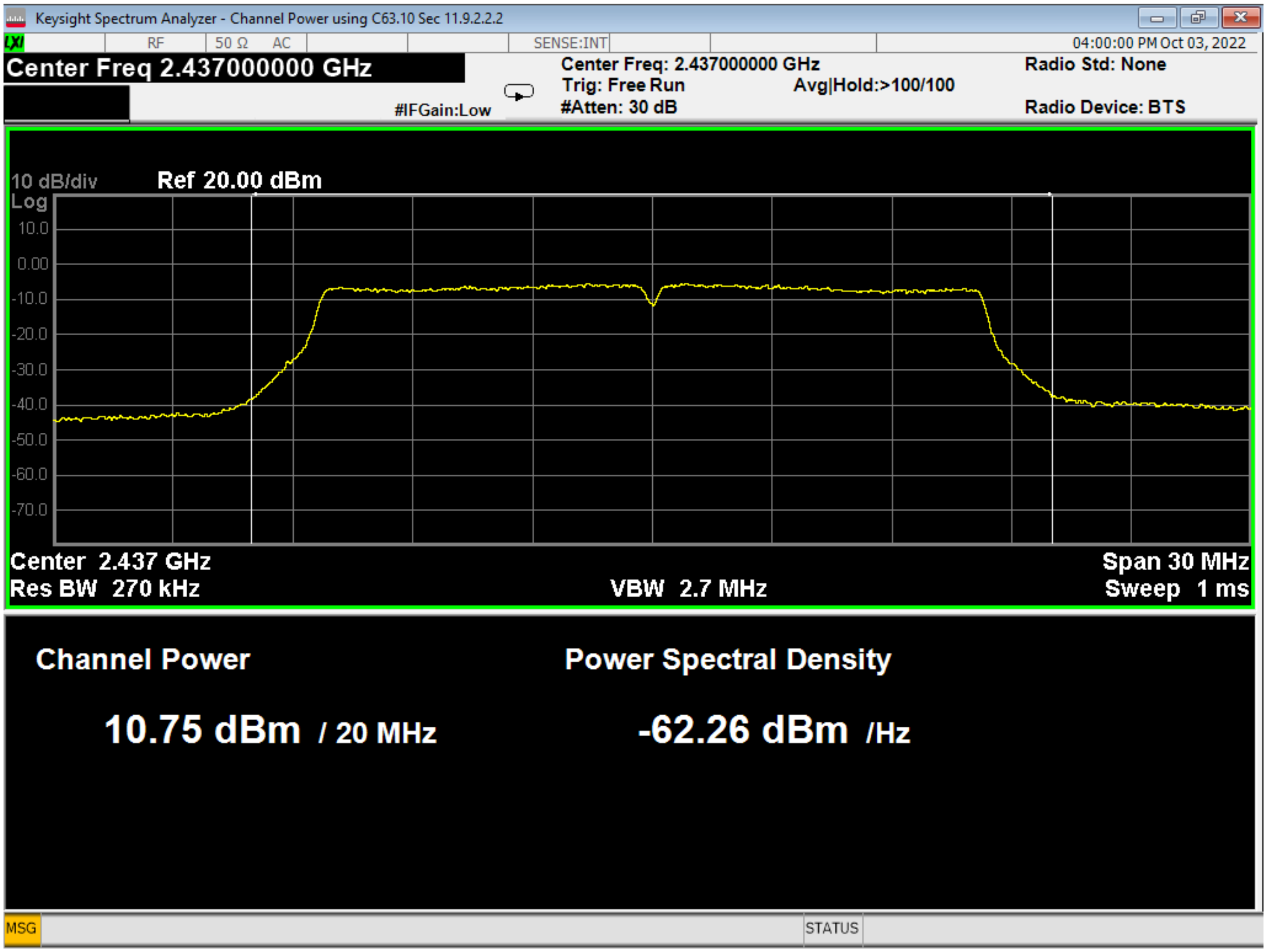


53 Average Power, Low, Wifi G, High Data Rate



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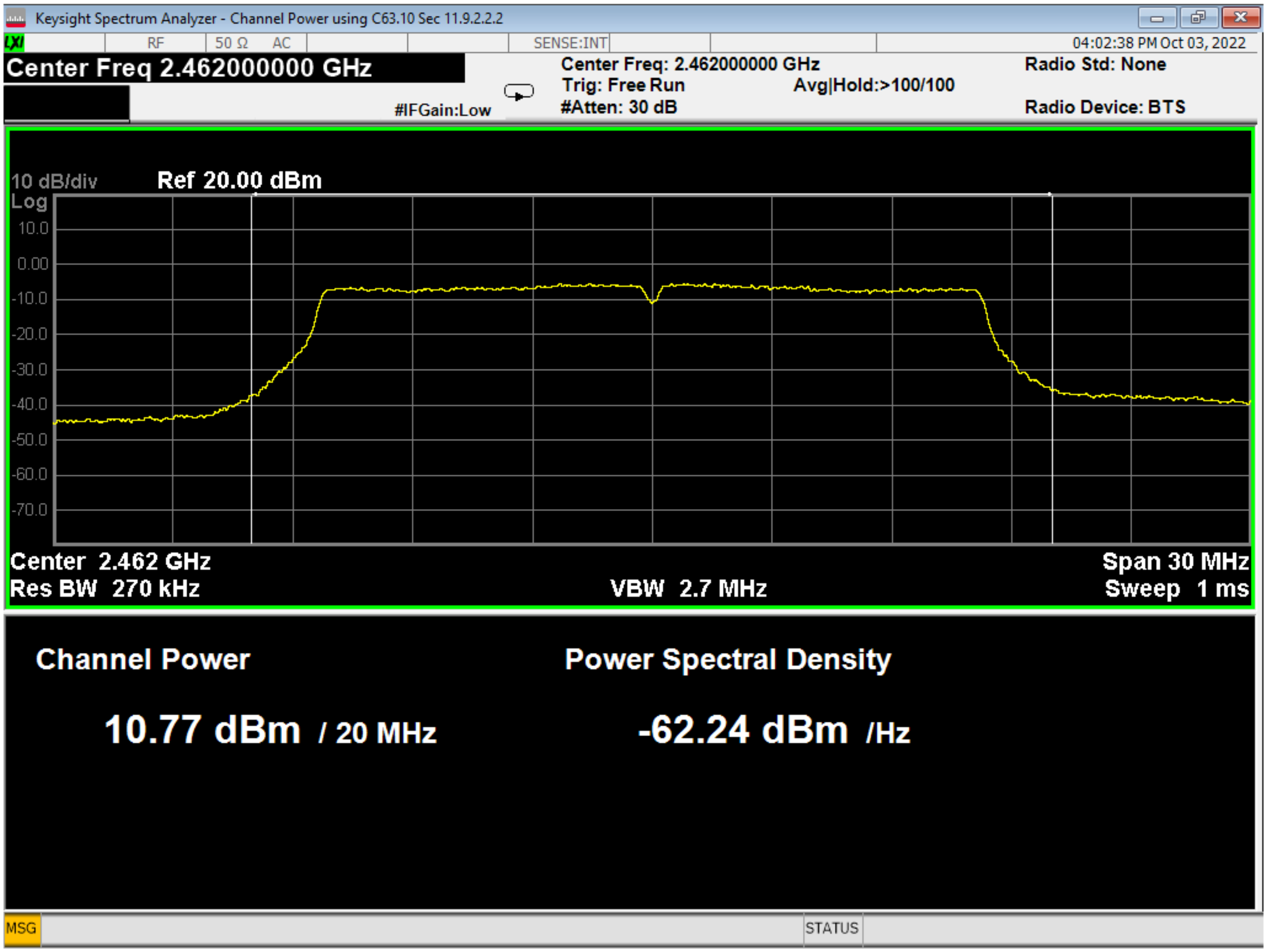

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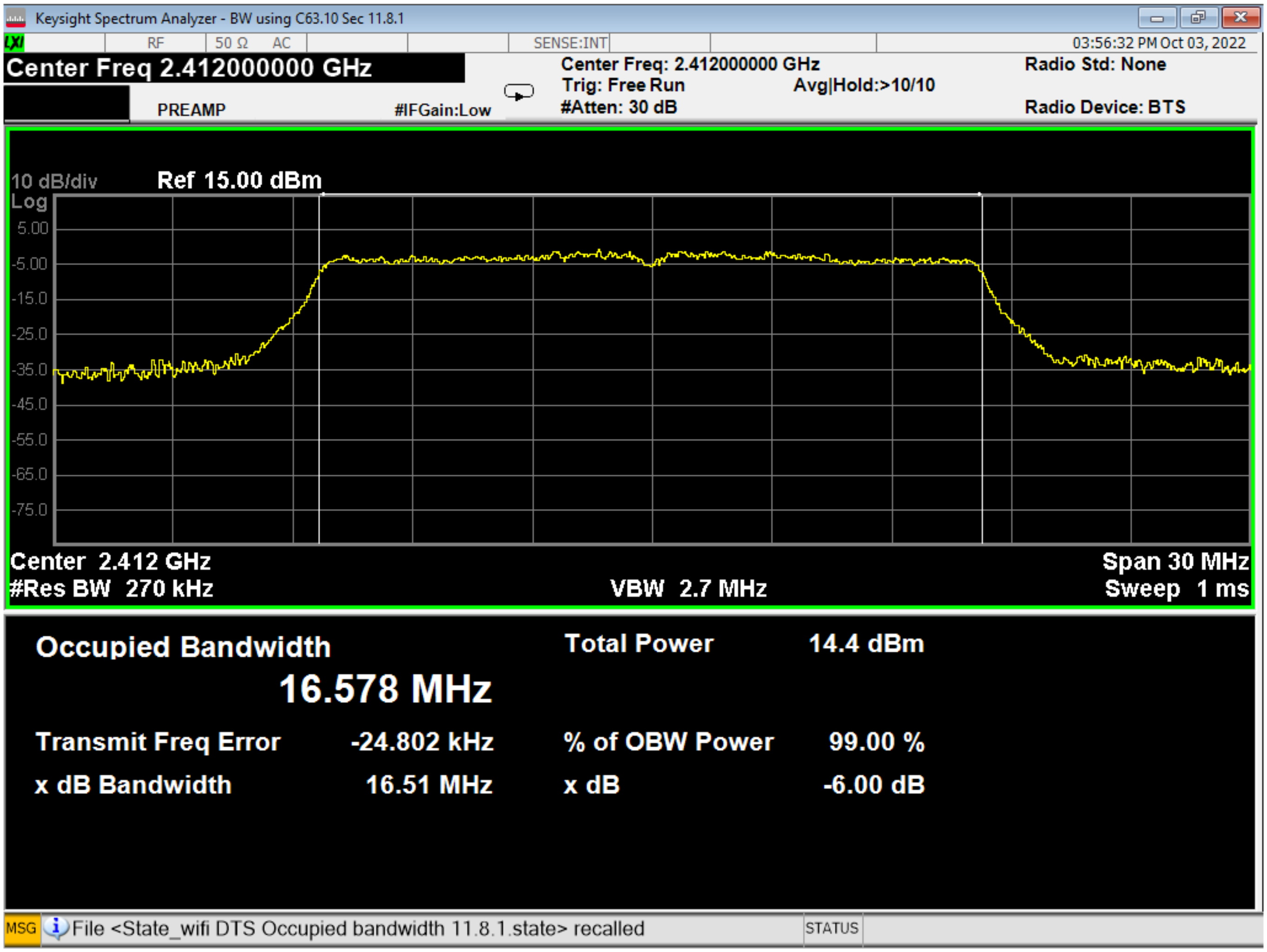

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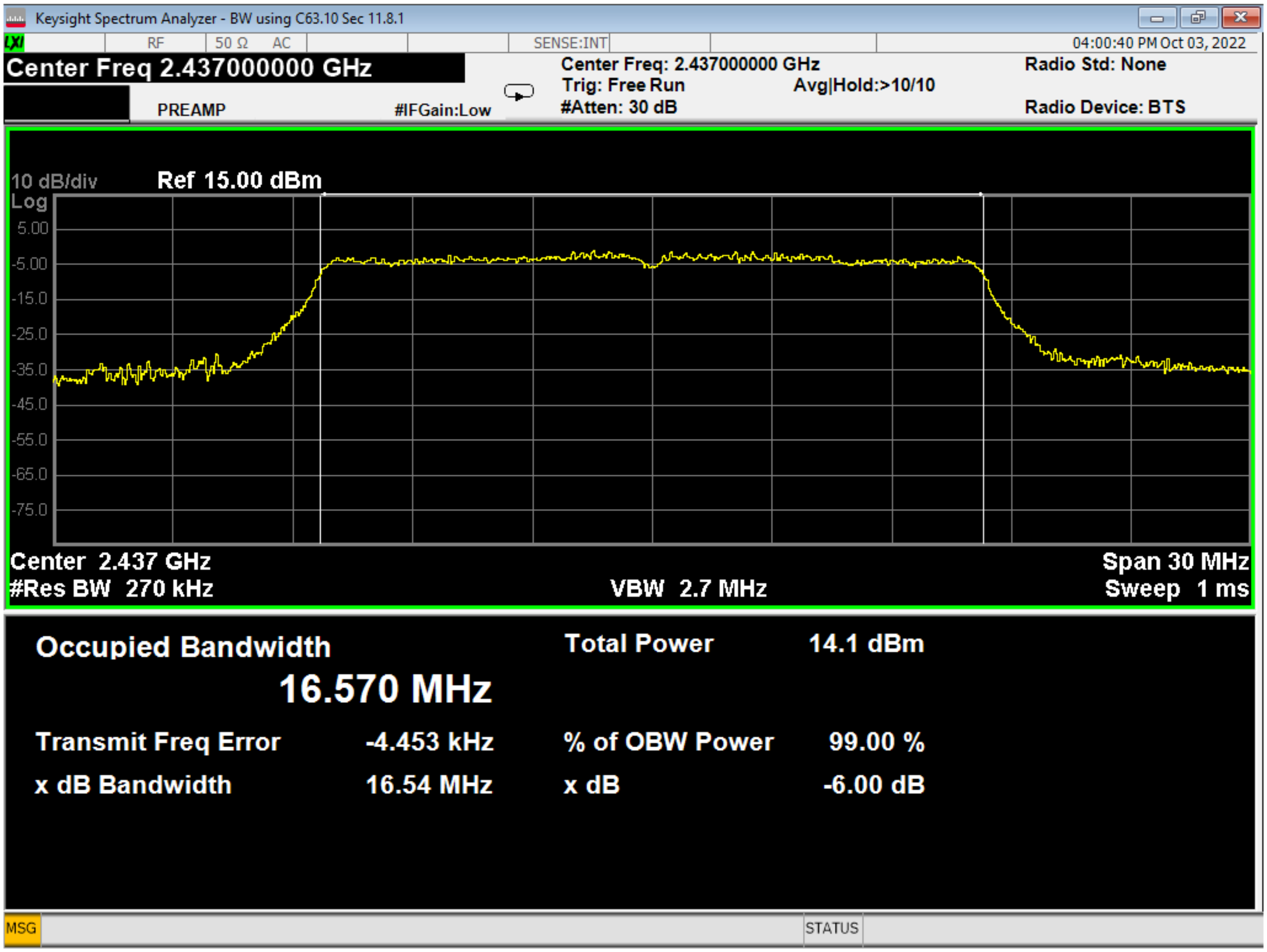

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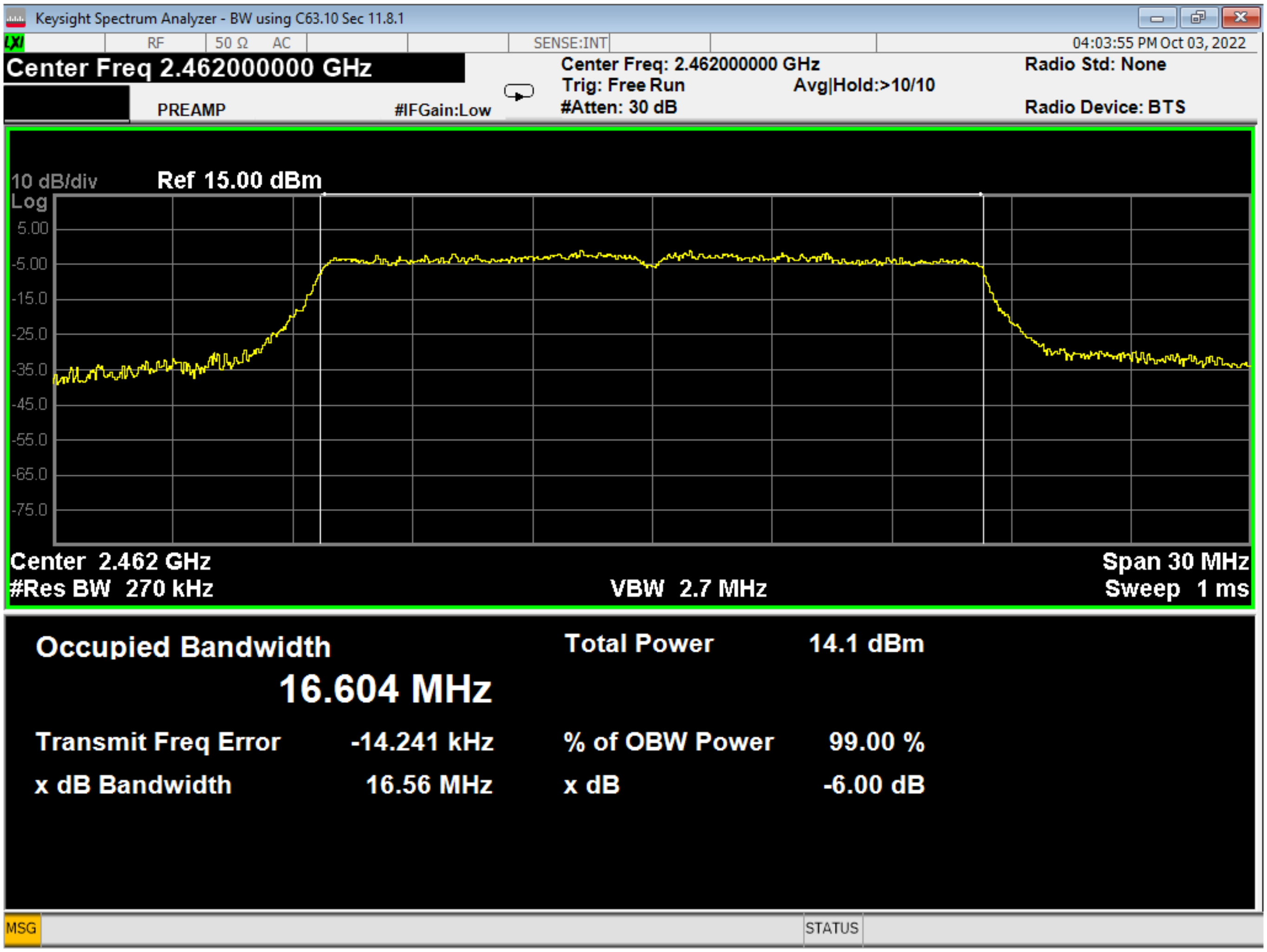

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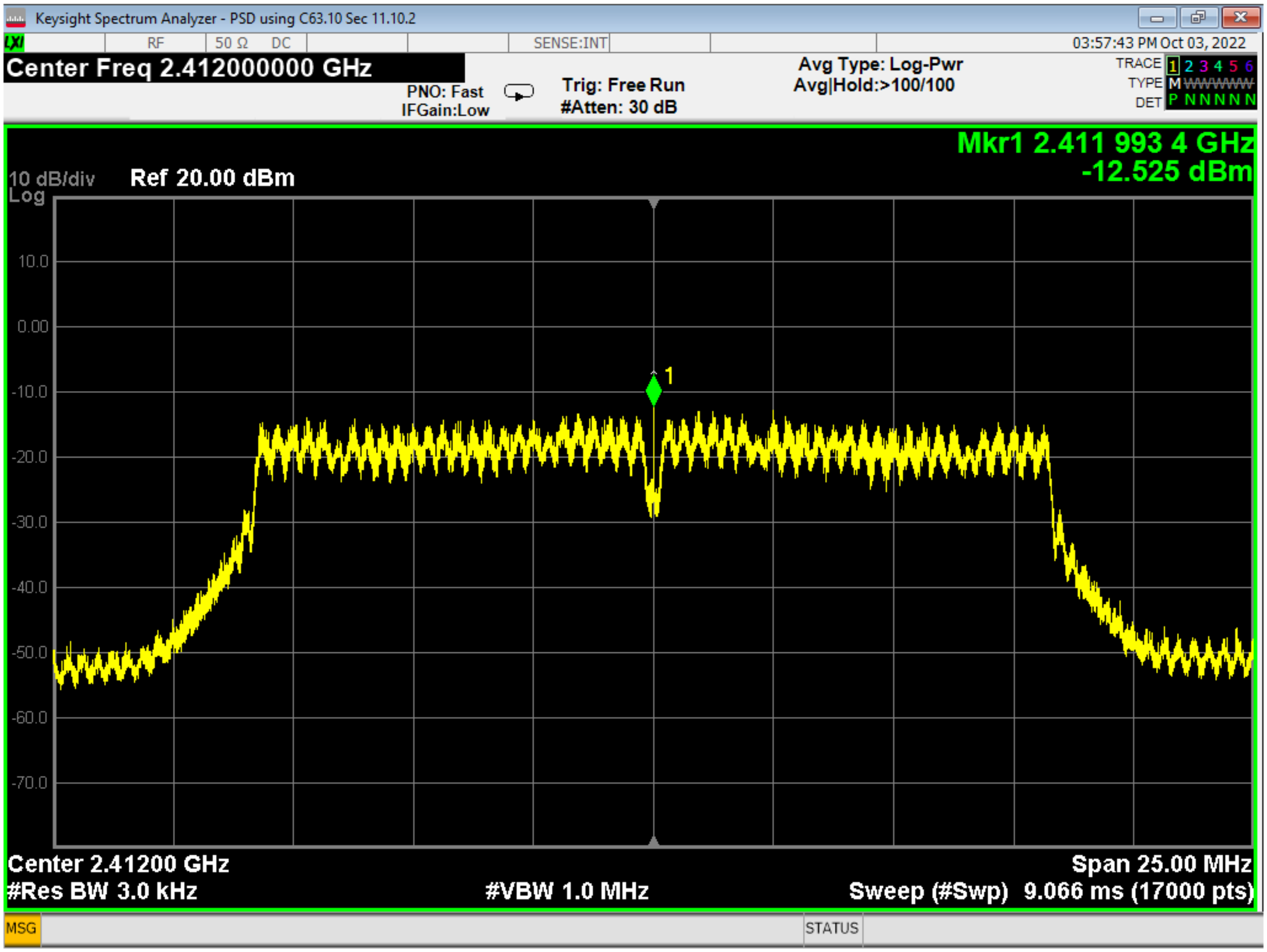

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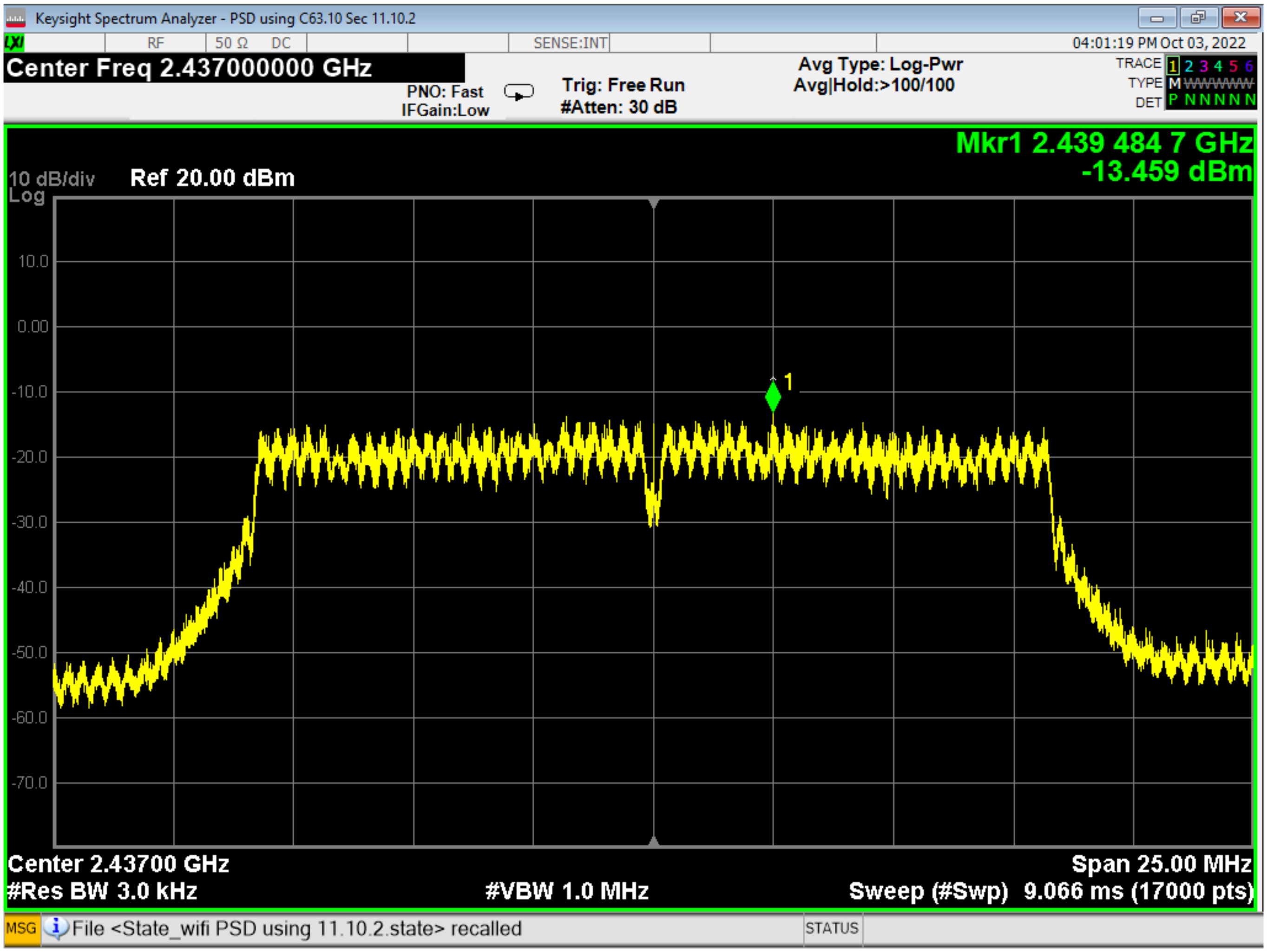

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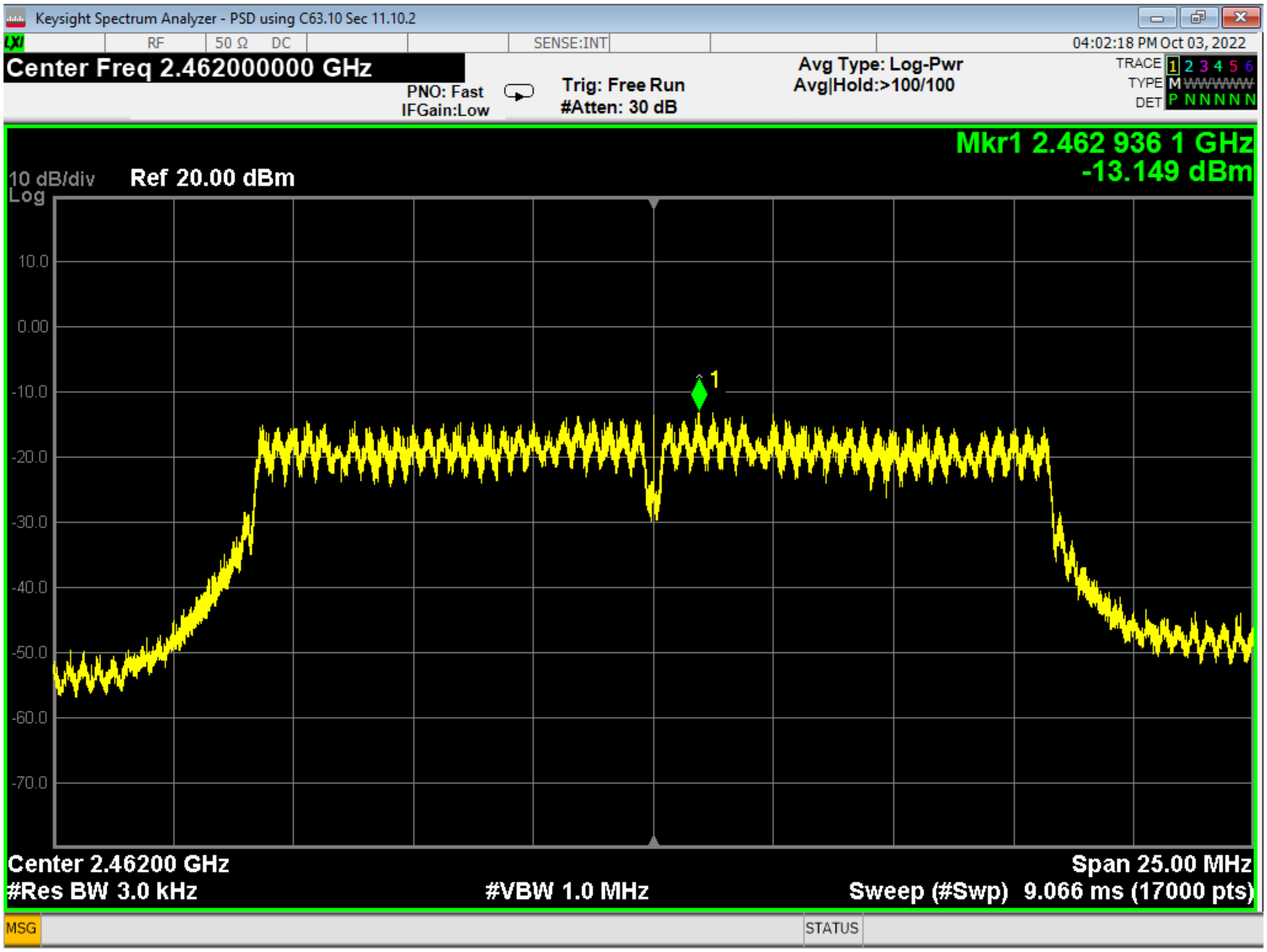

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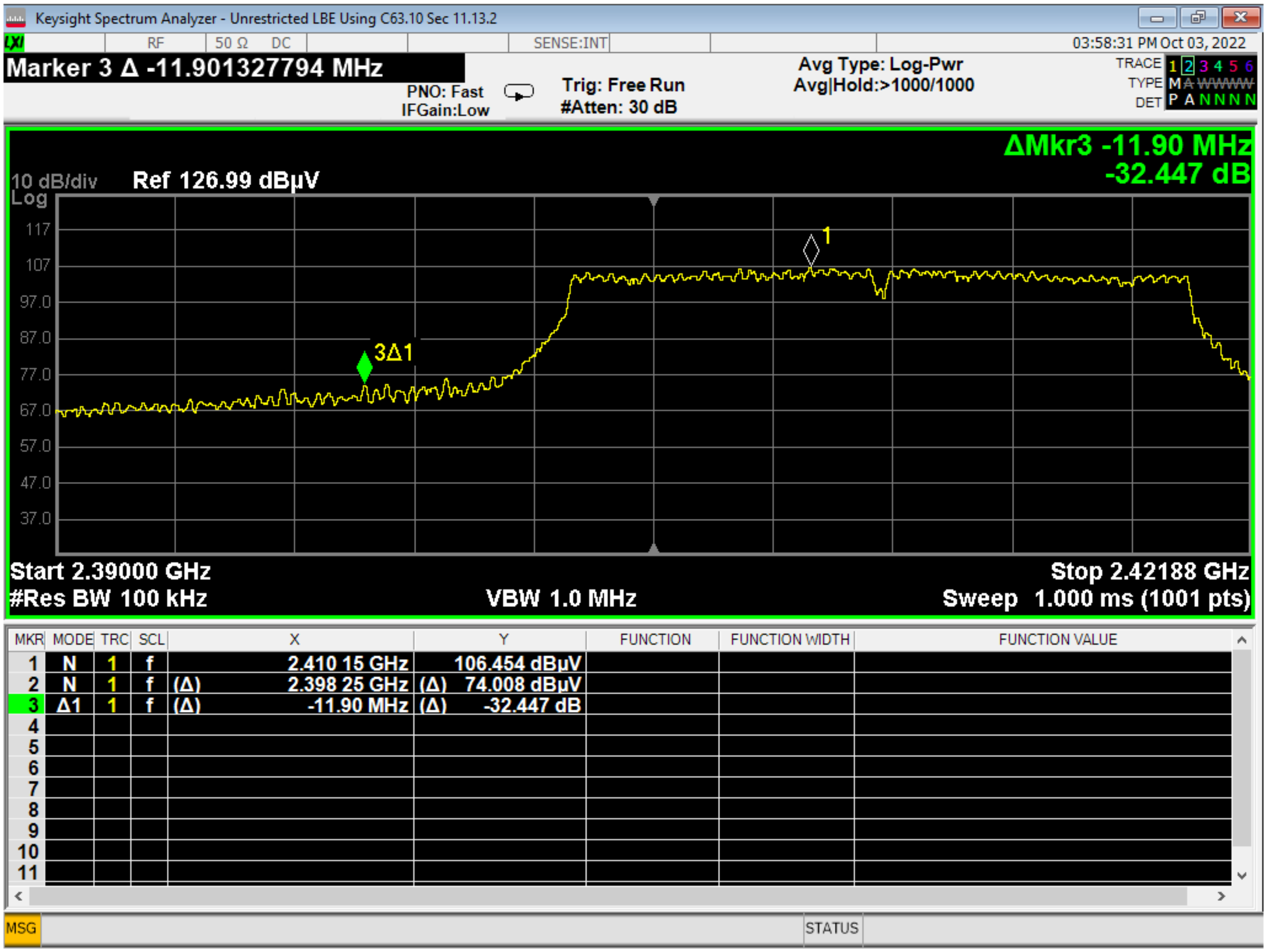

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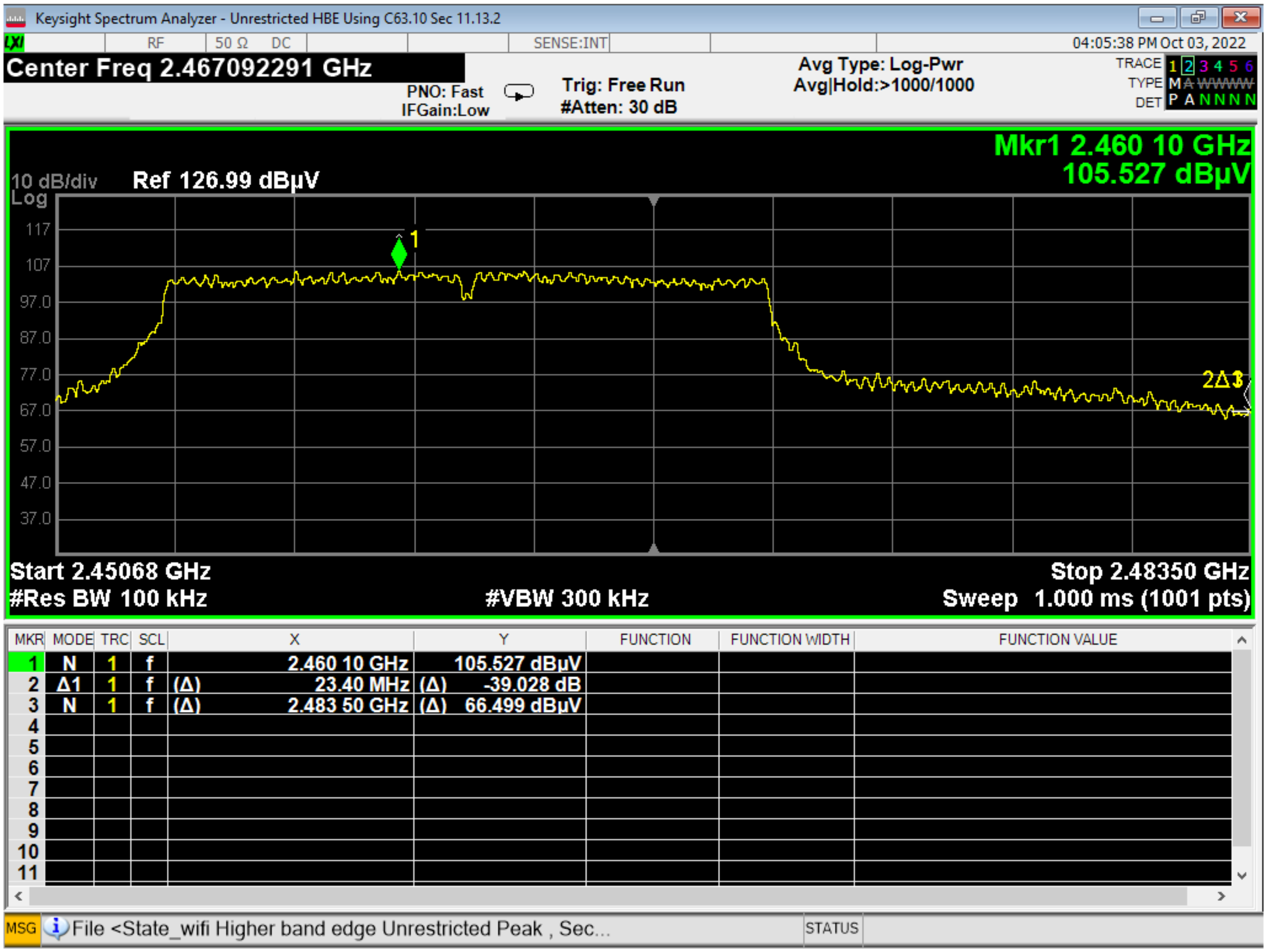

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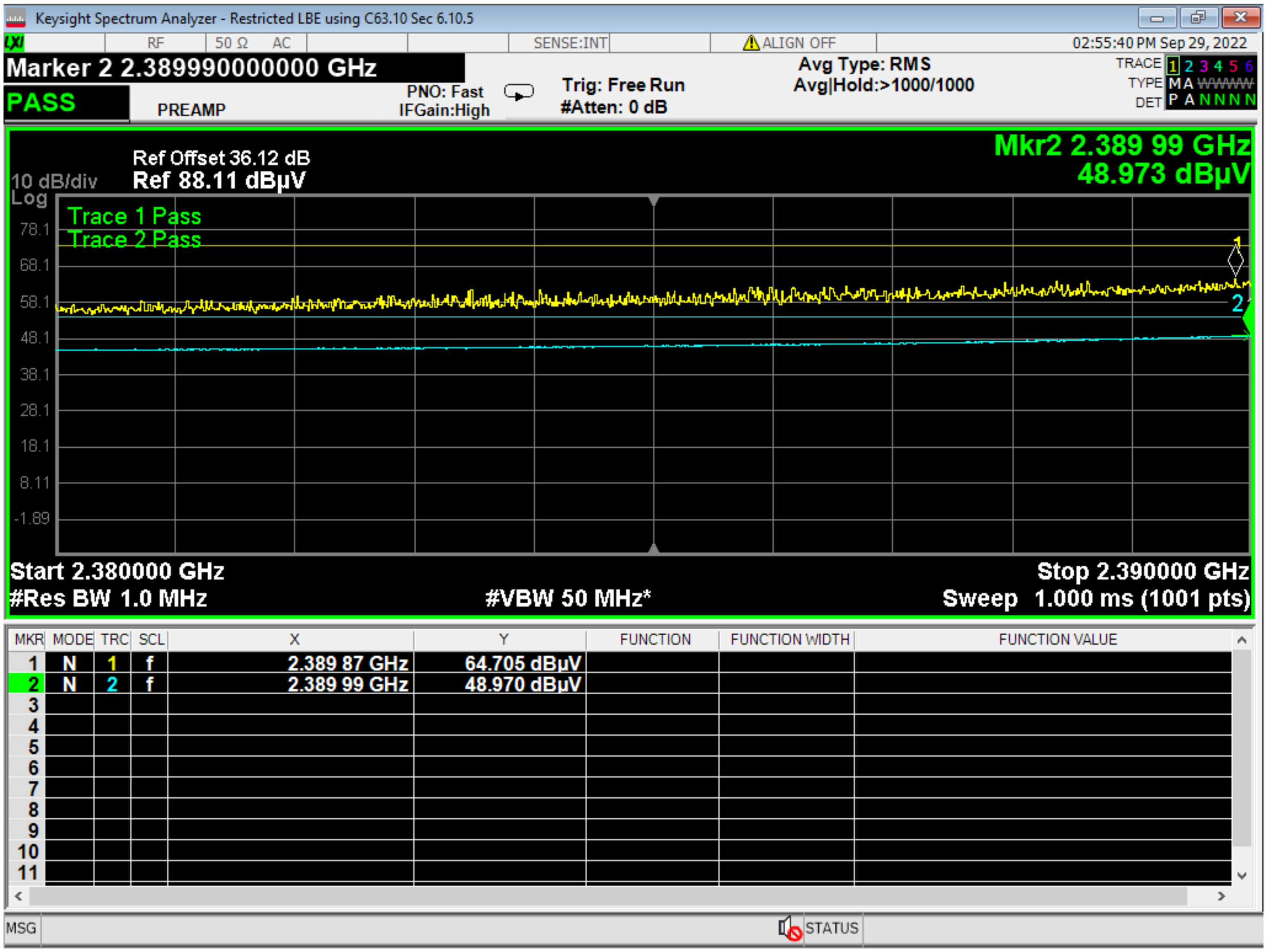

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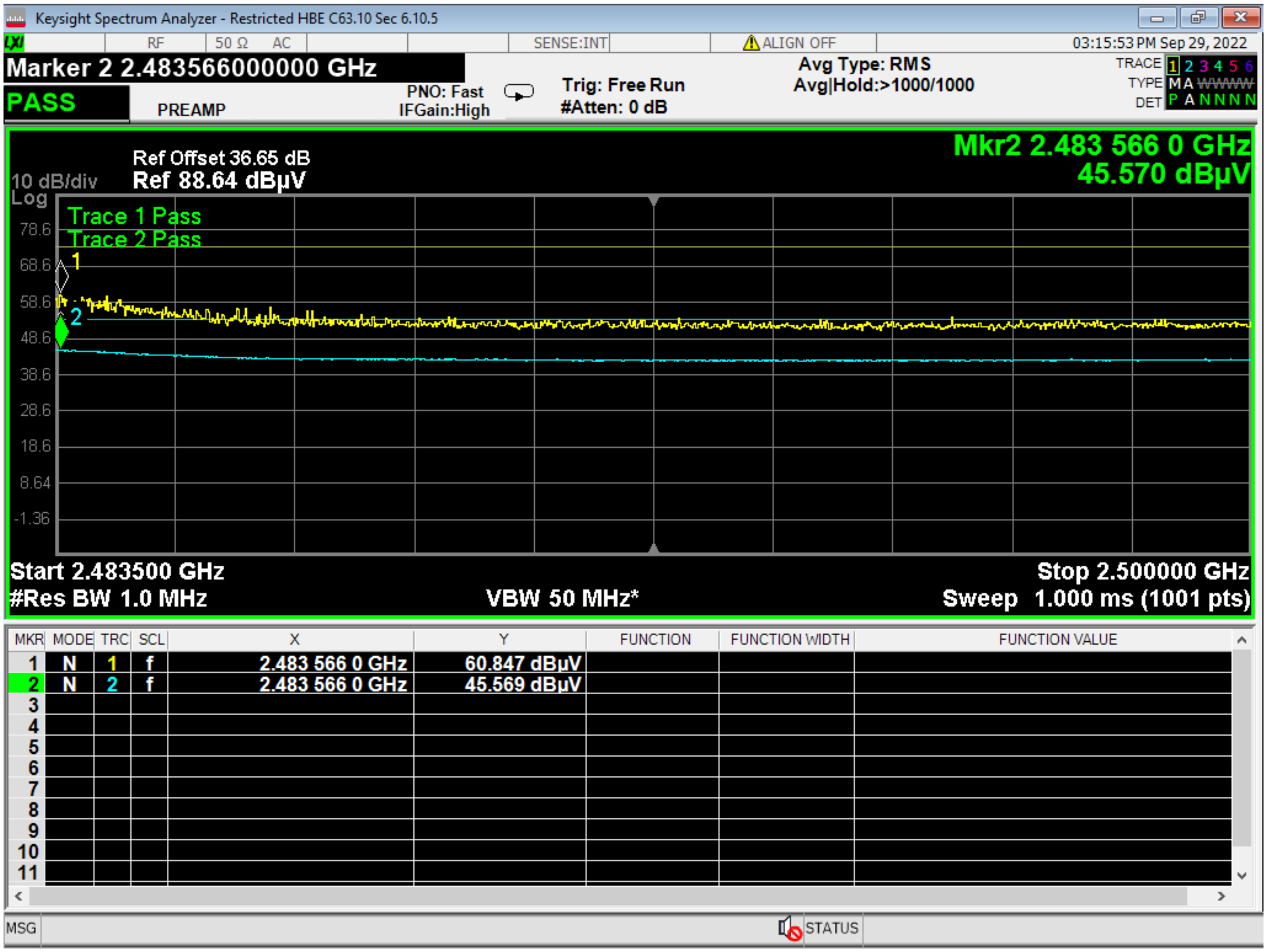

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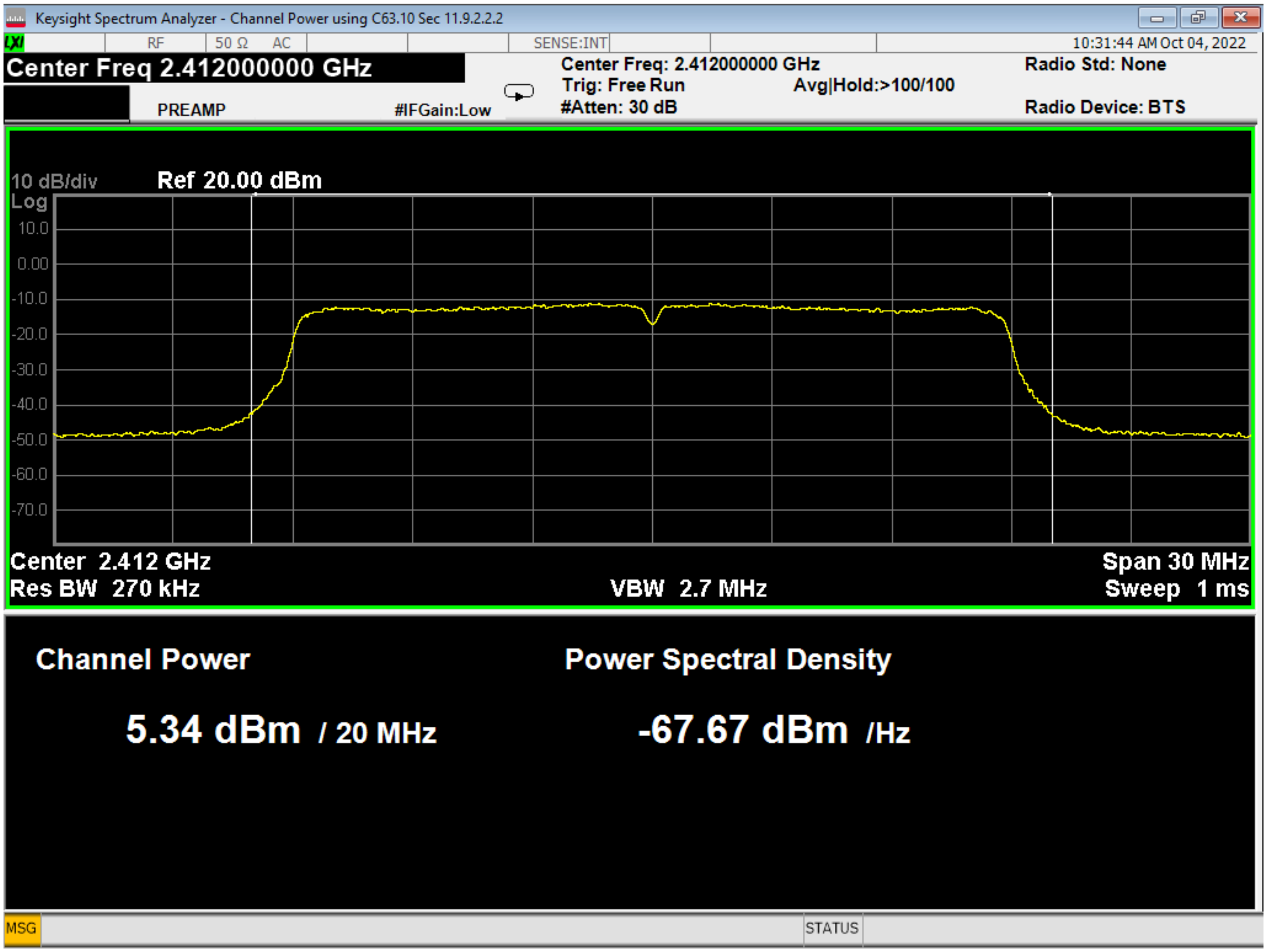
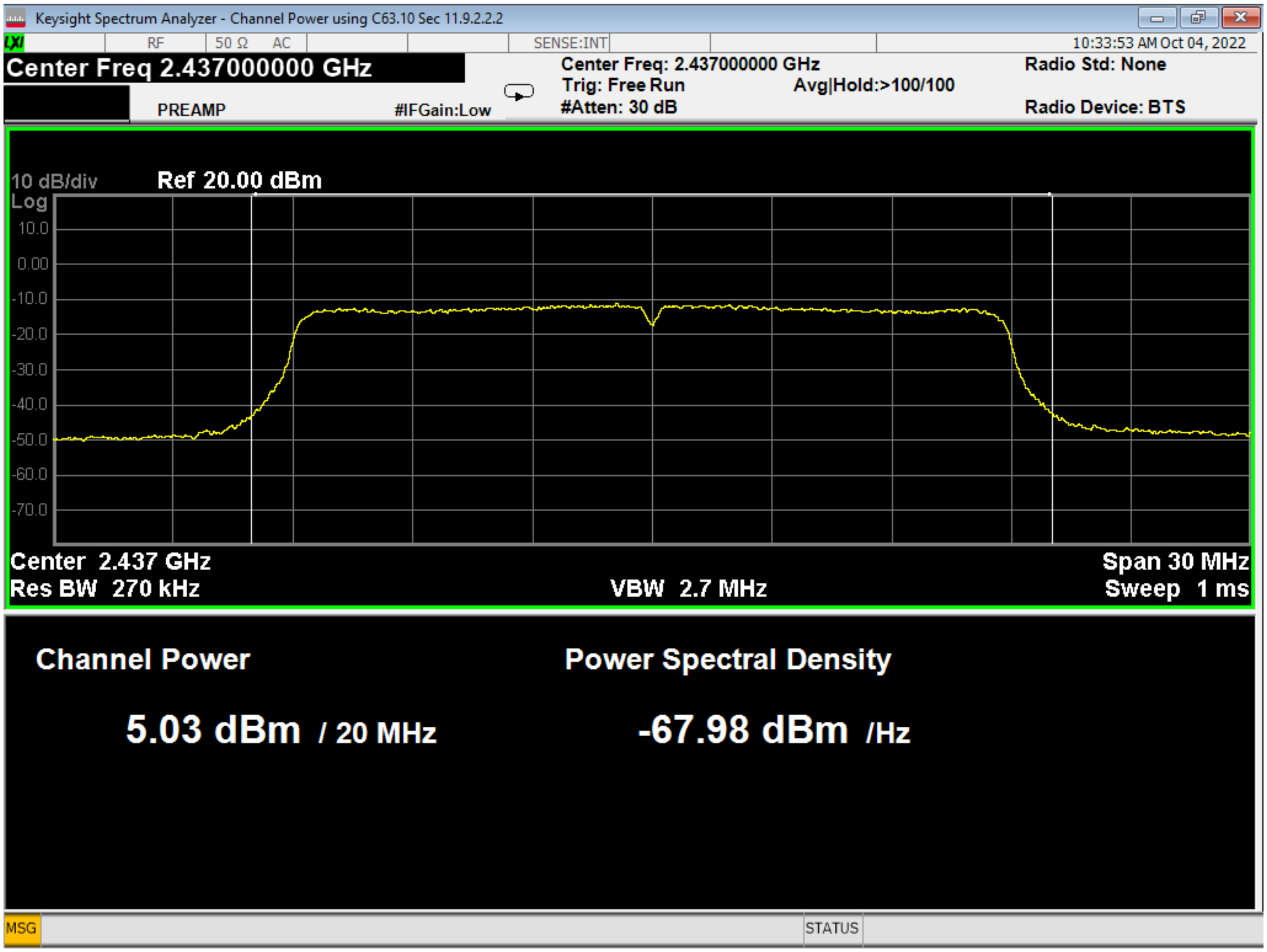
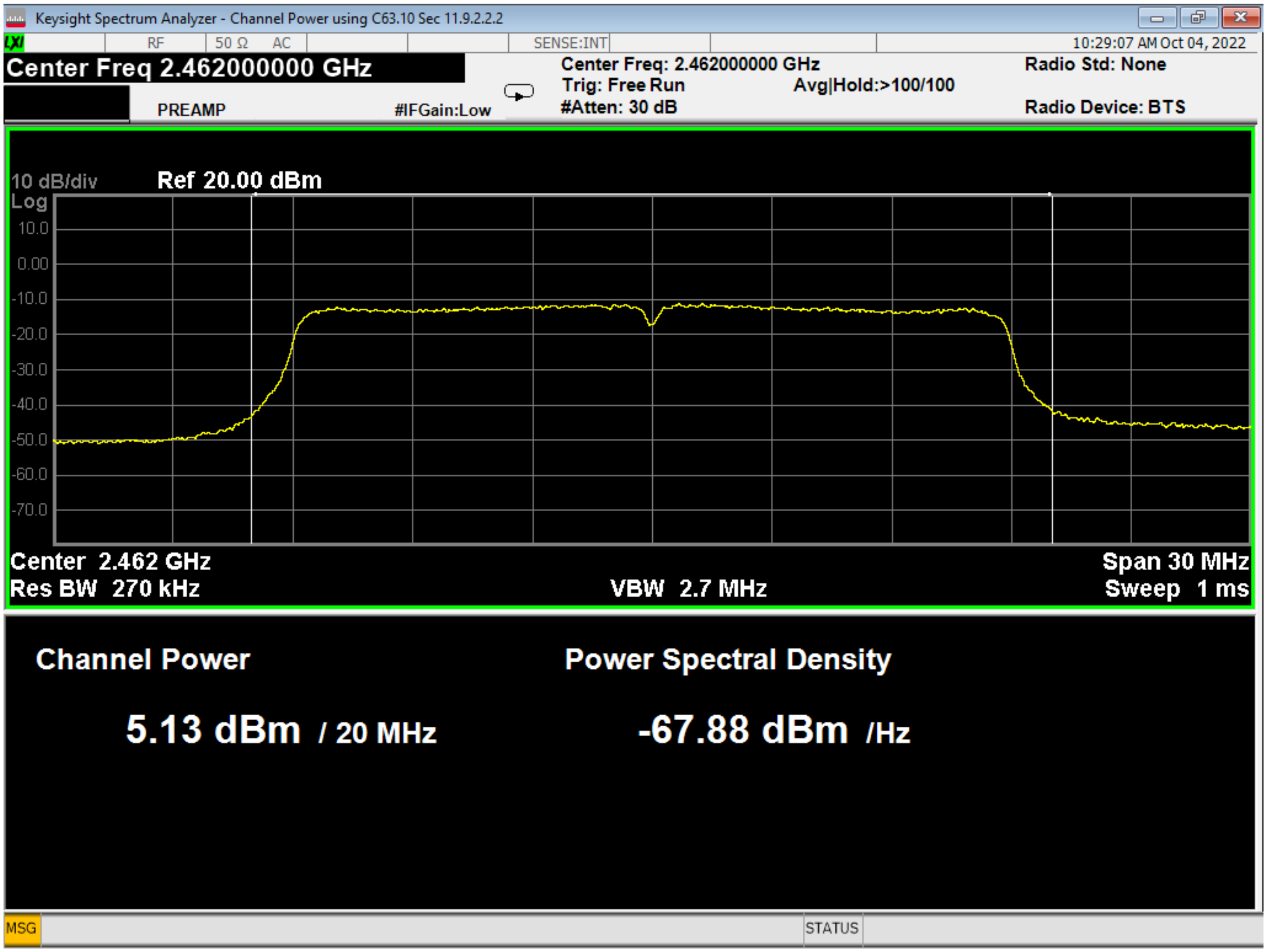


66 Average Power, Low, Wifi N, High Data Rate



67 Average Power, Mid, Wifi N, High Data Rate



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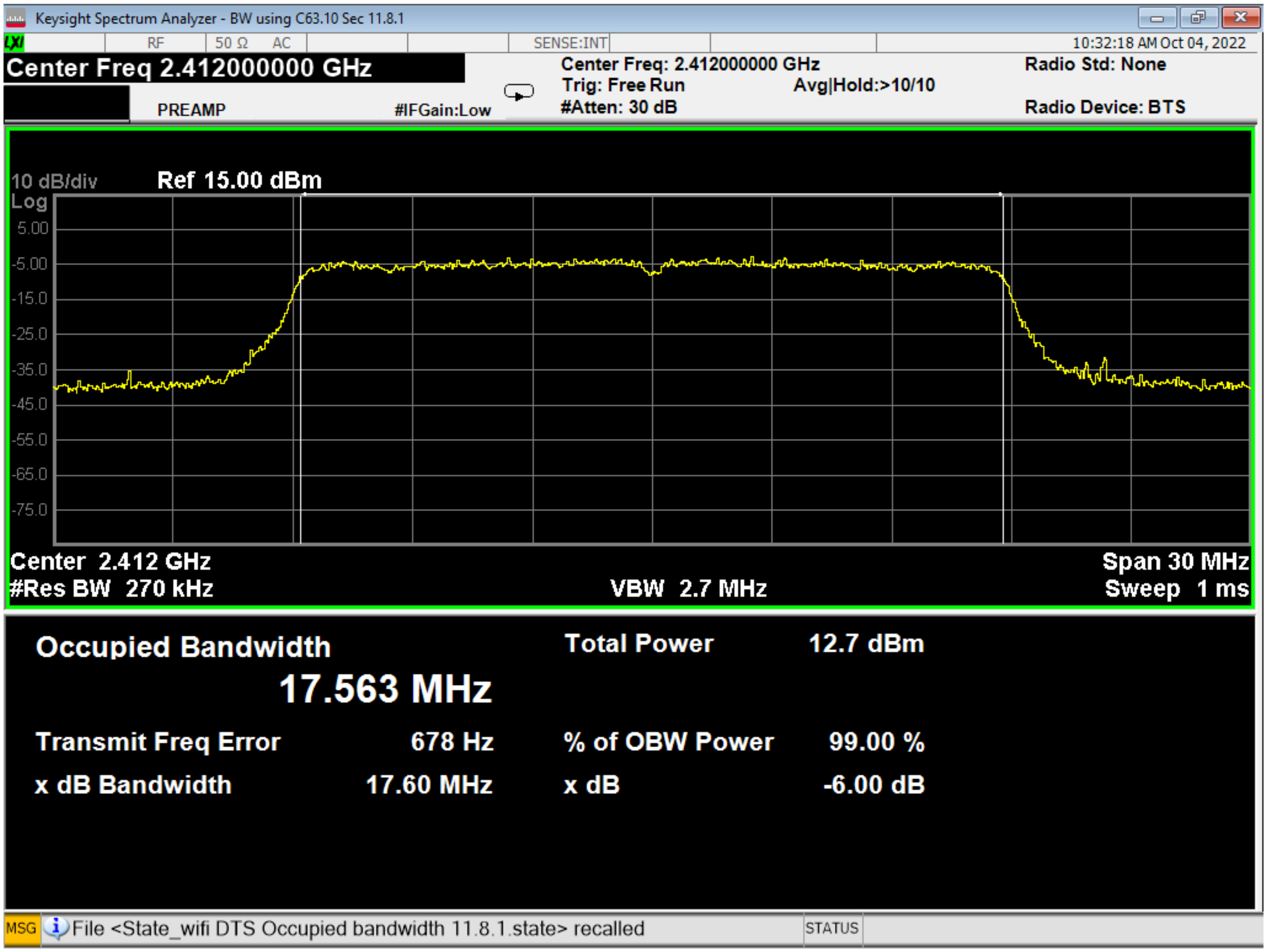

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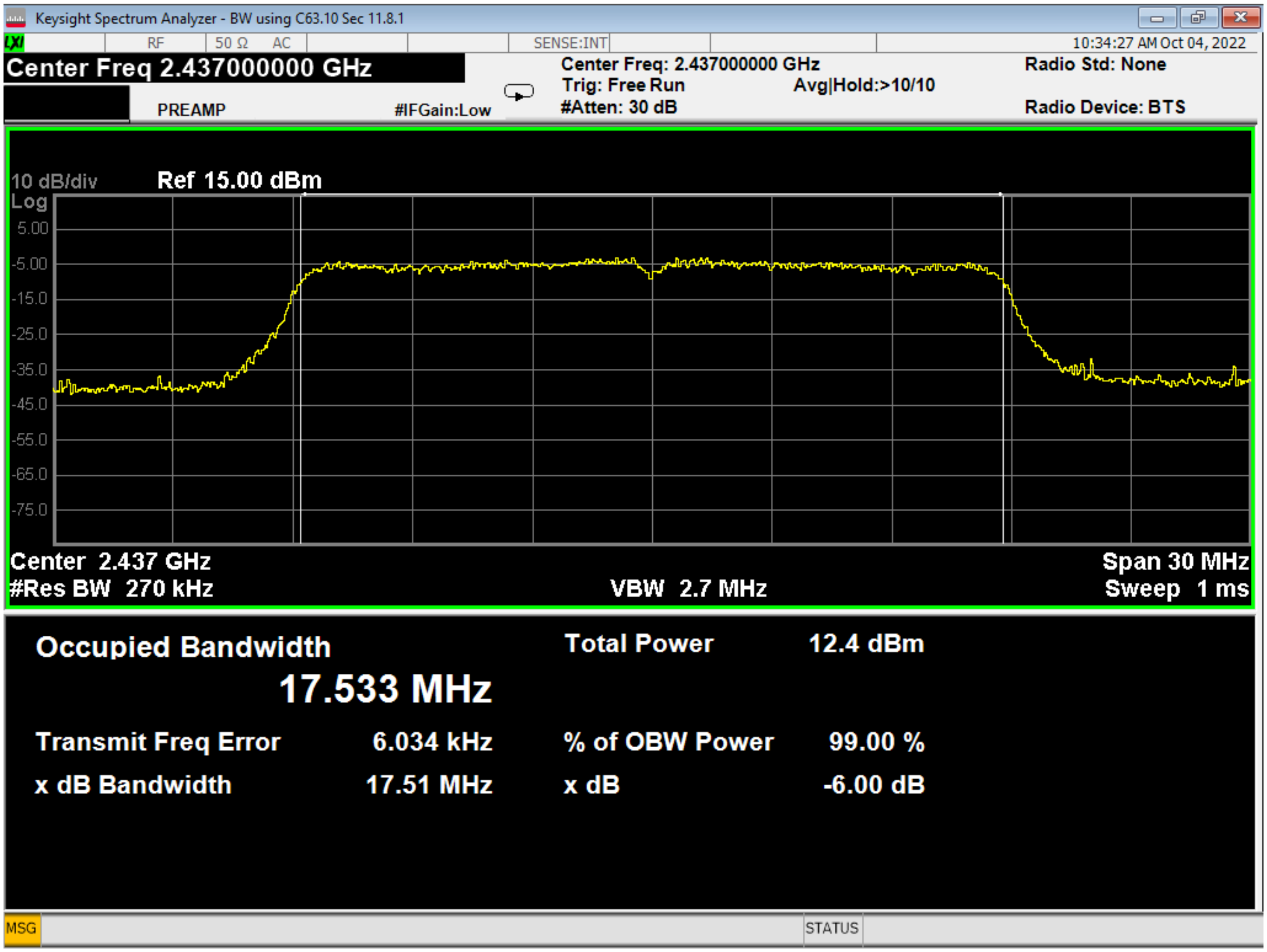

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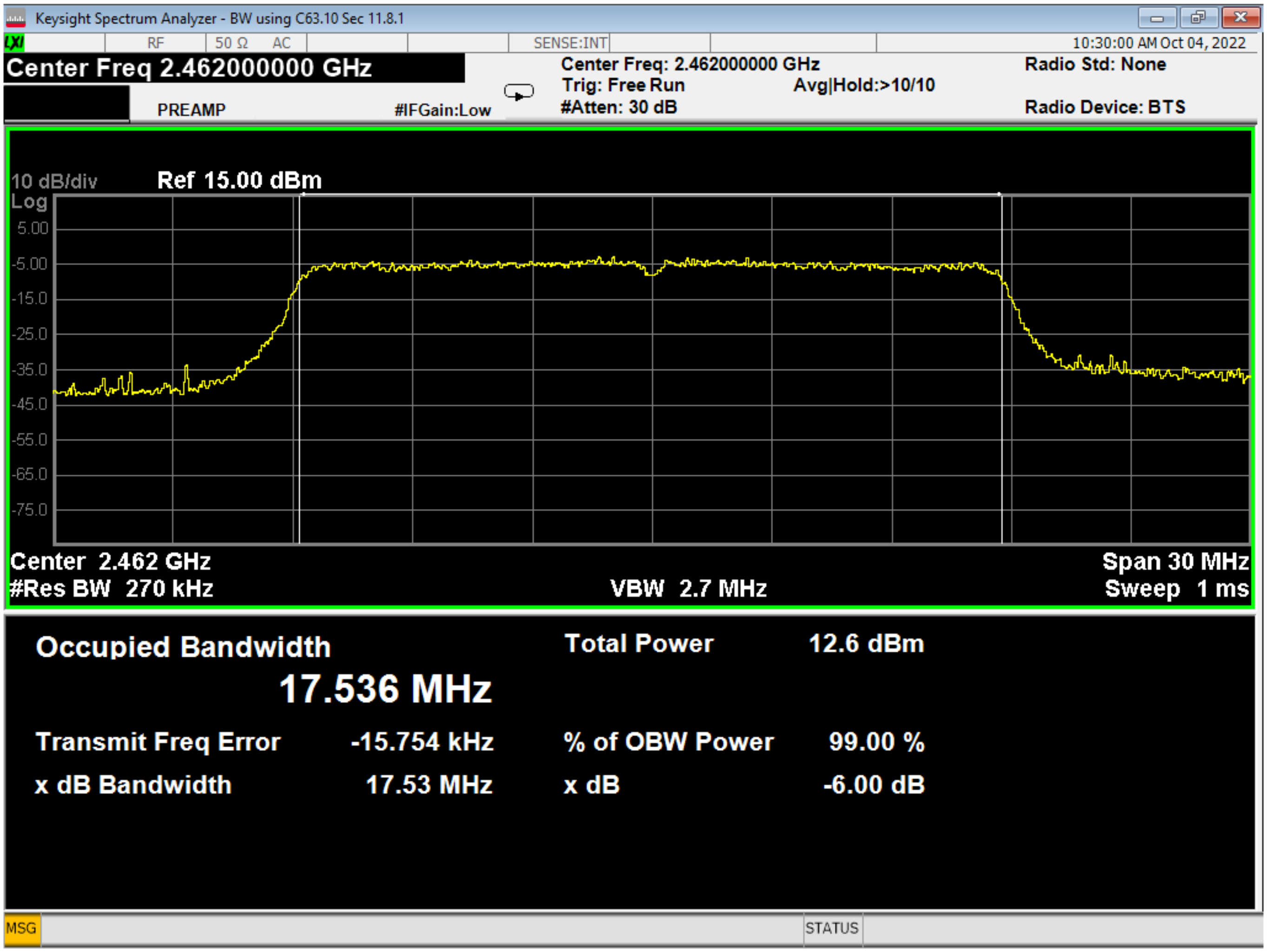
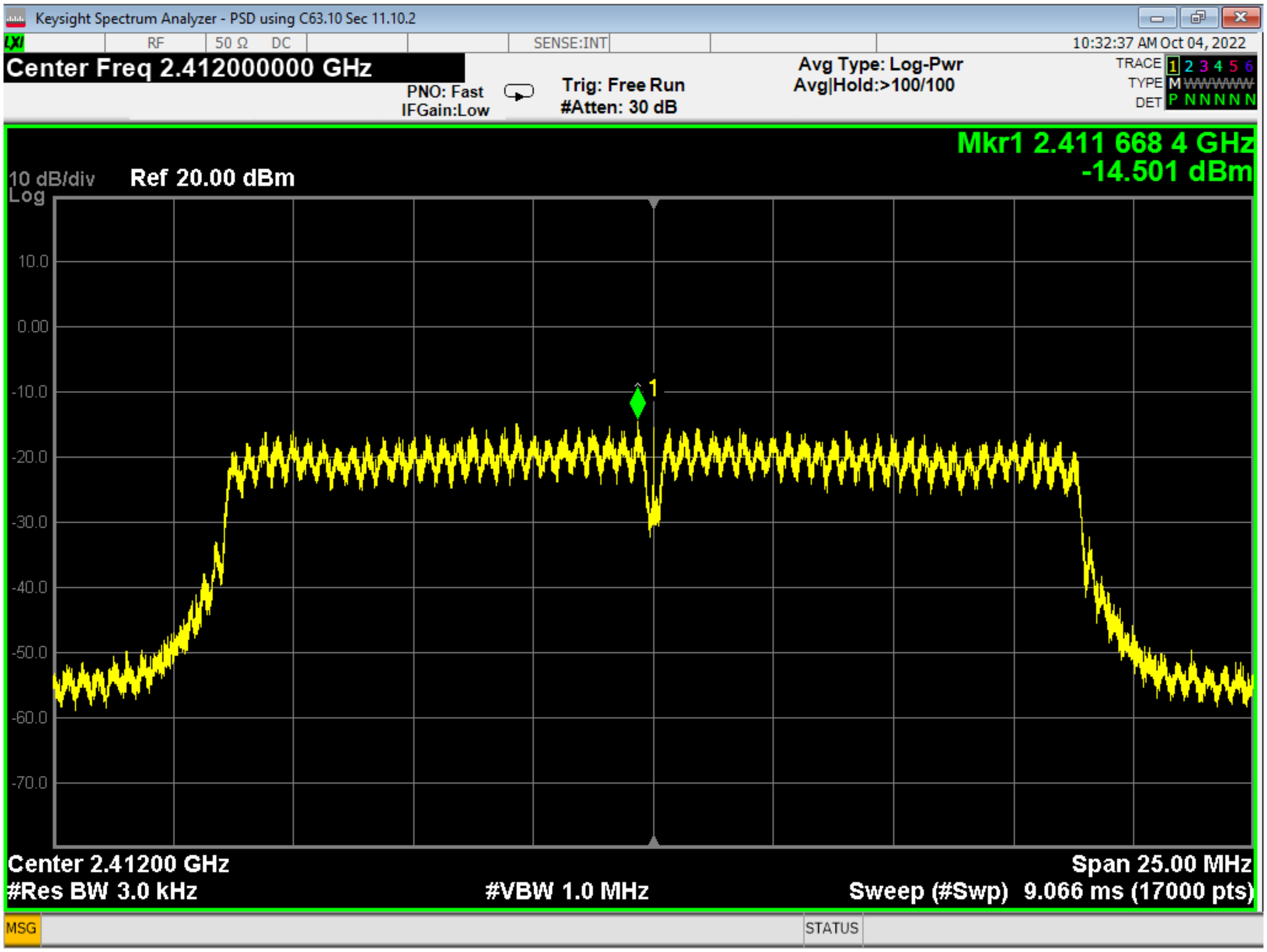
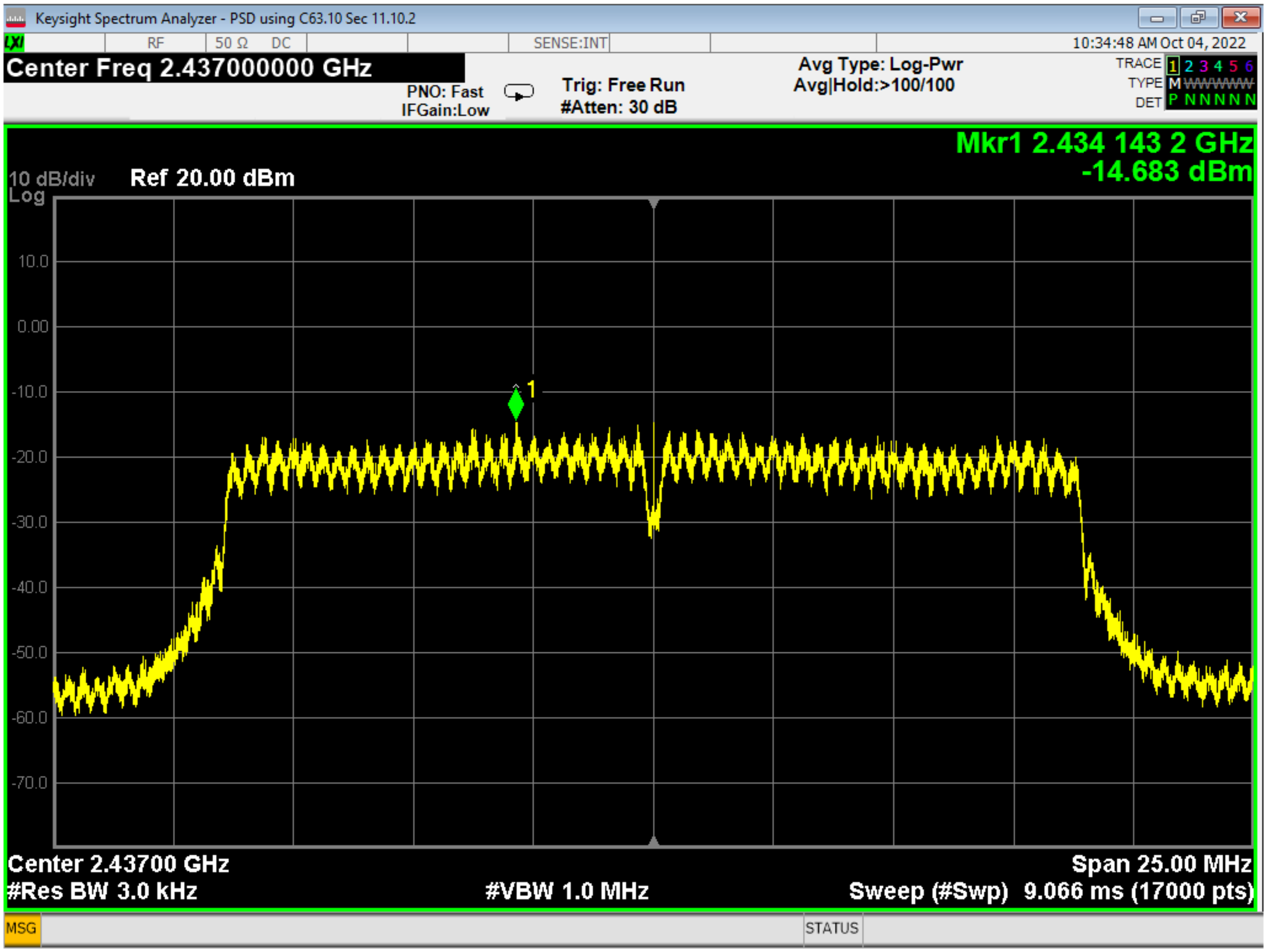


71 Bandwidth, High, Wifi N, High Data Rate



72 PSD, Low, Wifi N, High Data Rate



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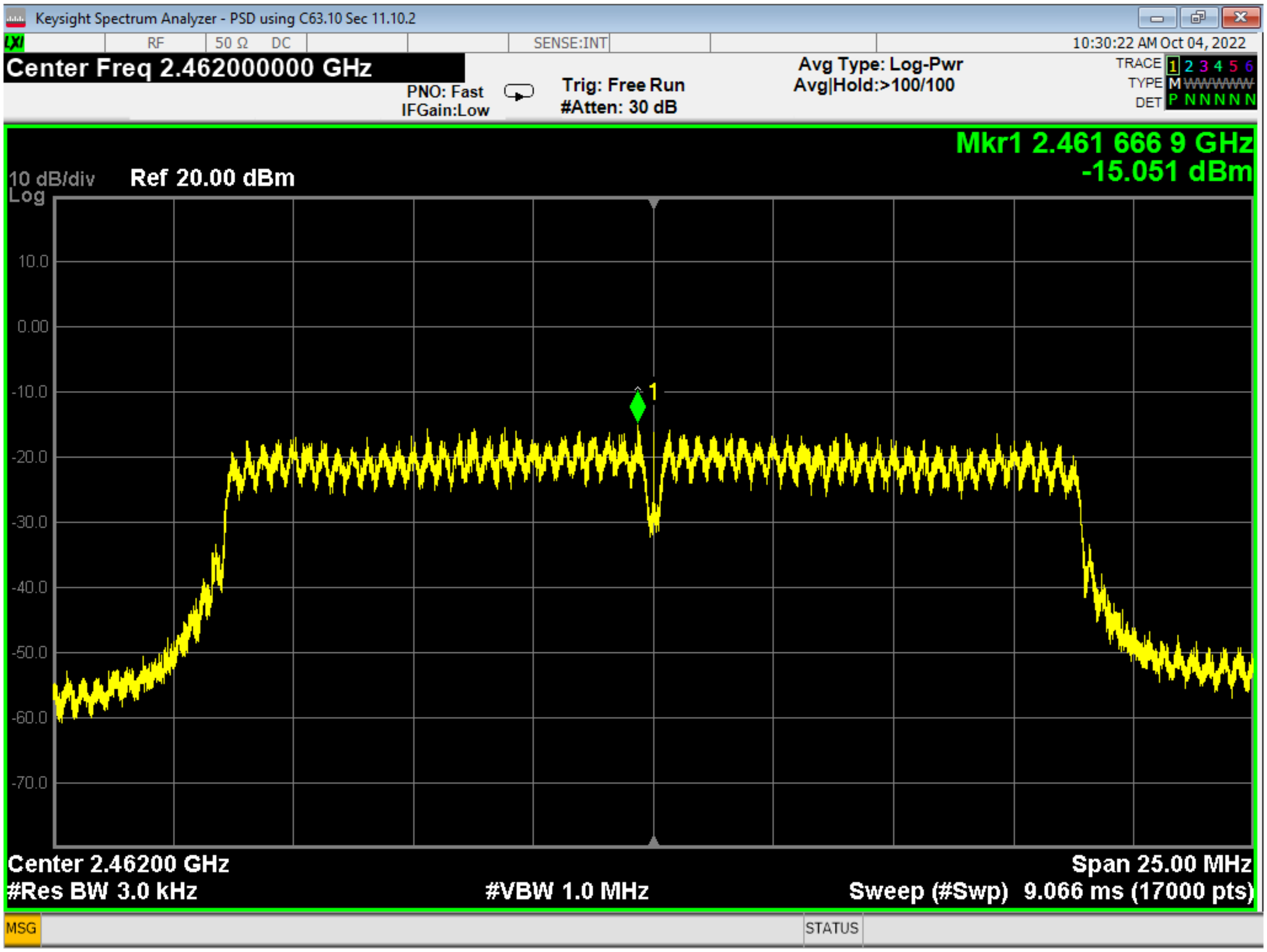
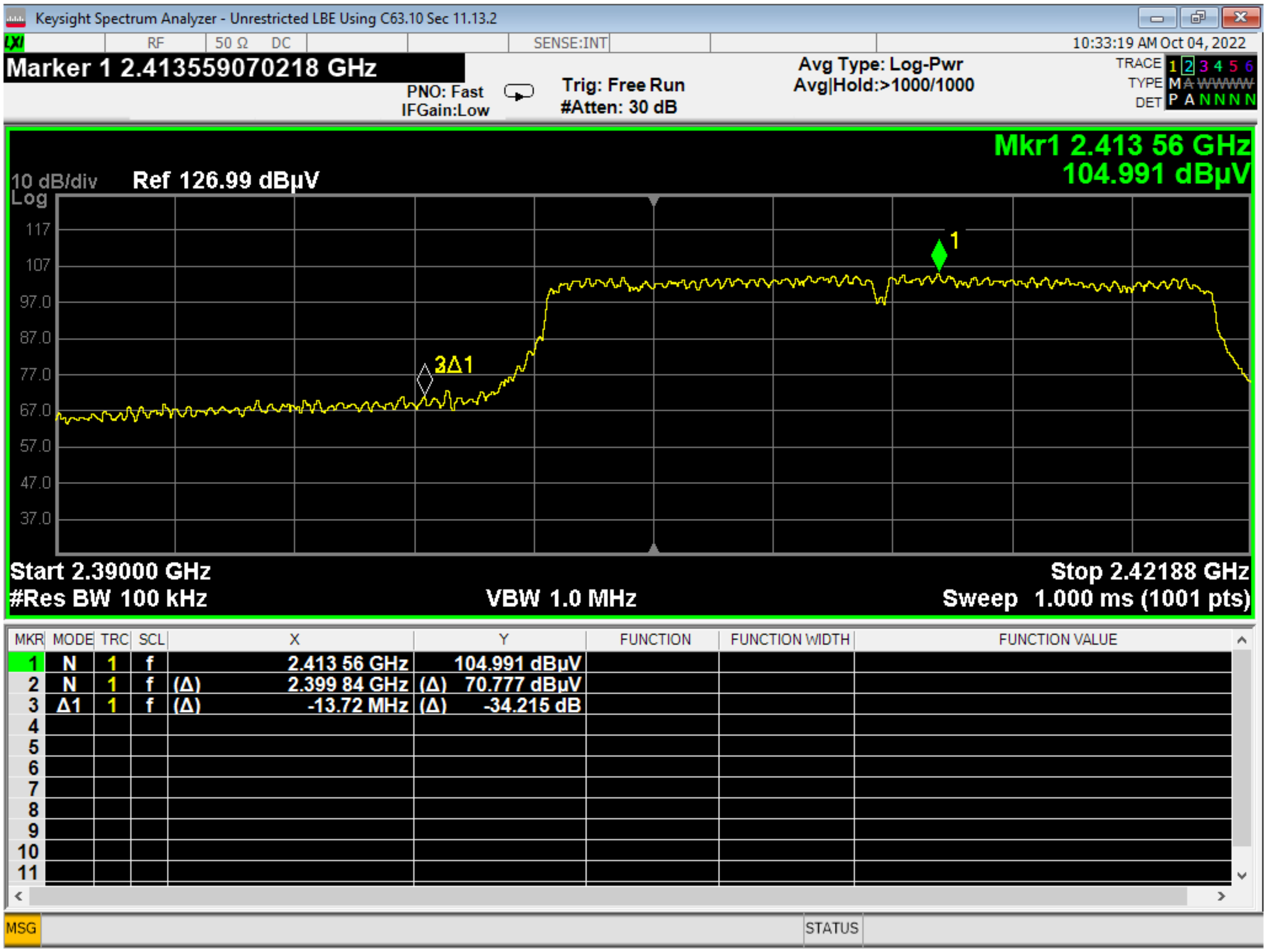
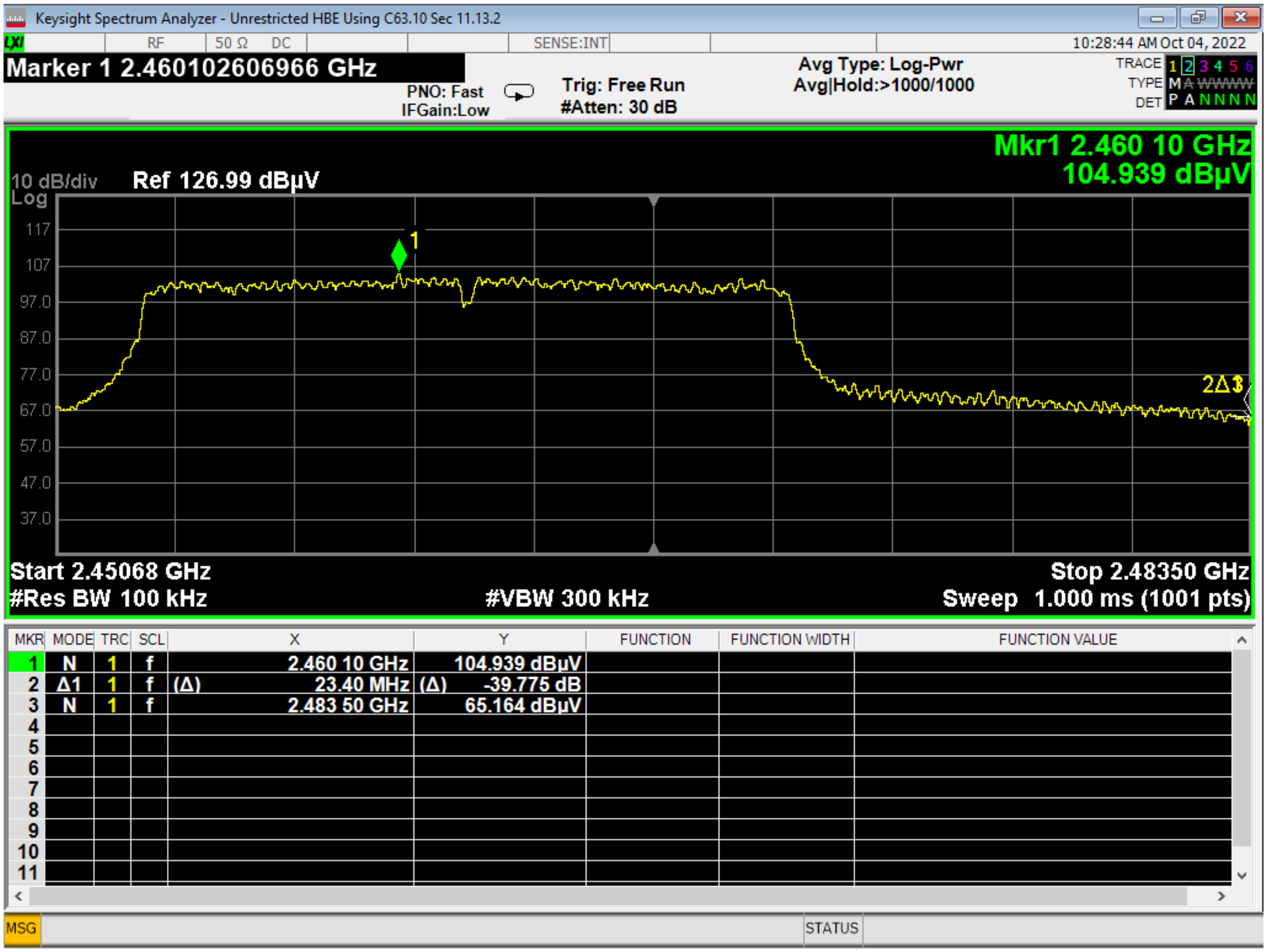


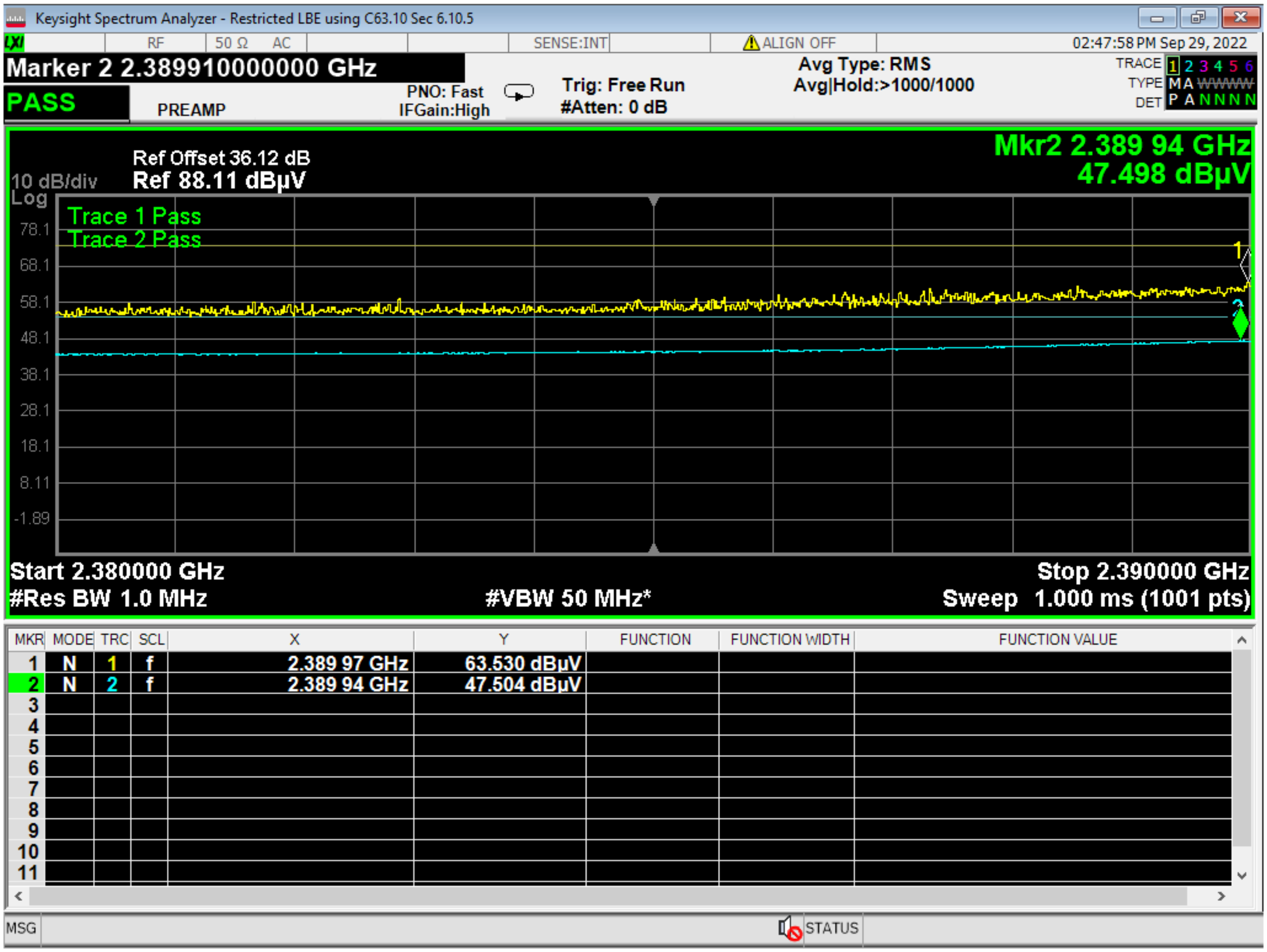
74 PSD, High, Wifi N, High Data Rate



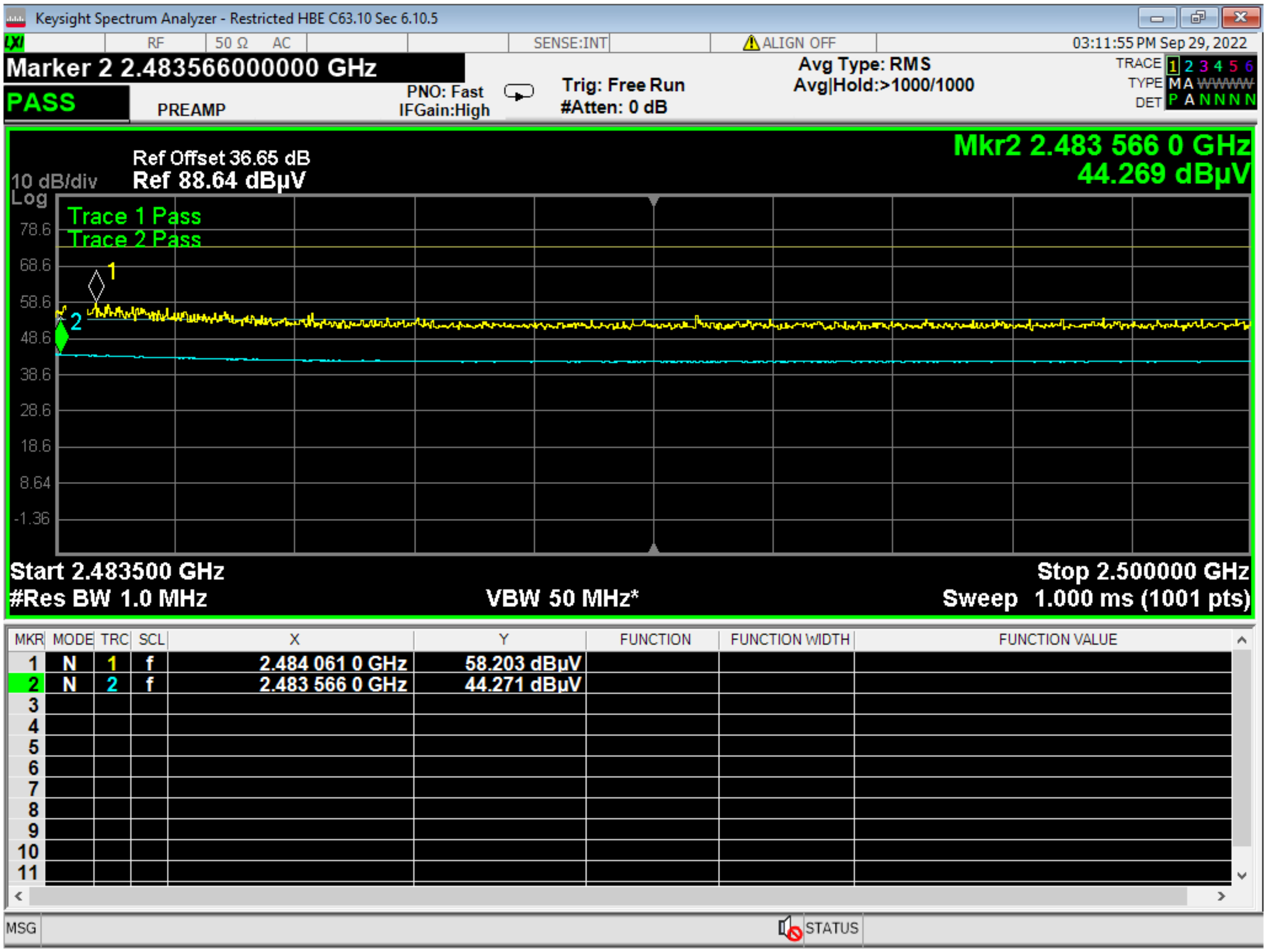
75 Lower Bandedge, Unrestricted, Wifi N, High Data Rate



76 Higher Bandedge, Unrestricted, Wifi N, High Data Rate



77 Lower Bandedge, Restricted, Wifi N, High Data Rate



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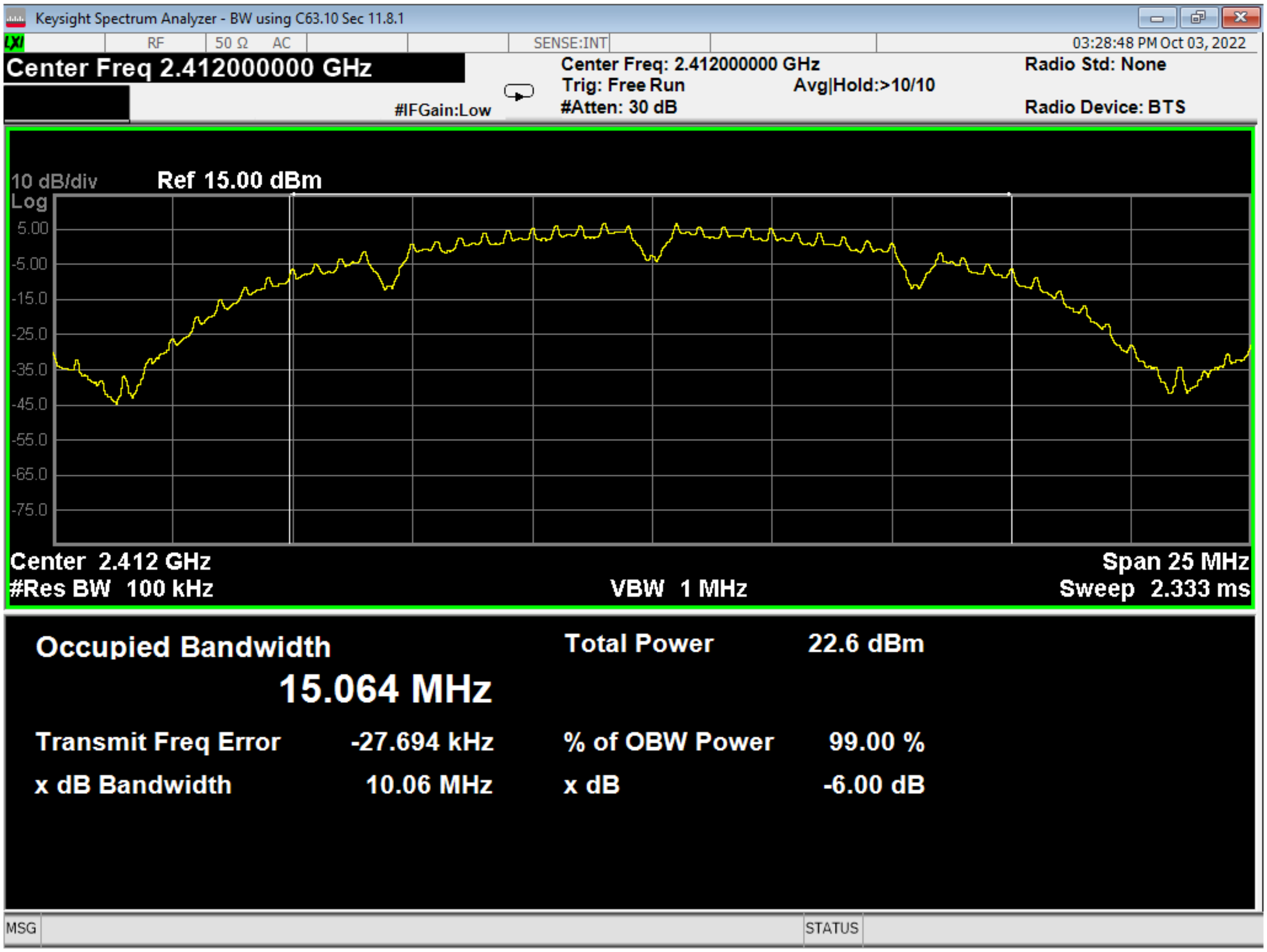
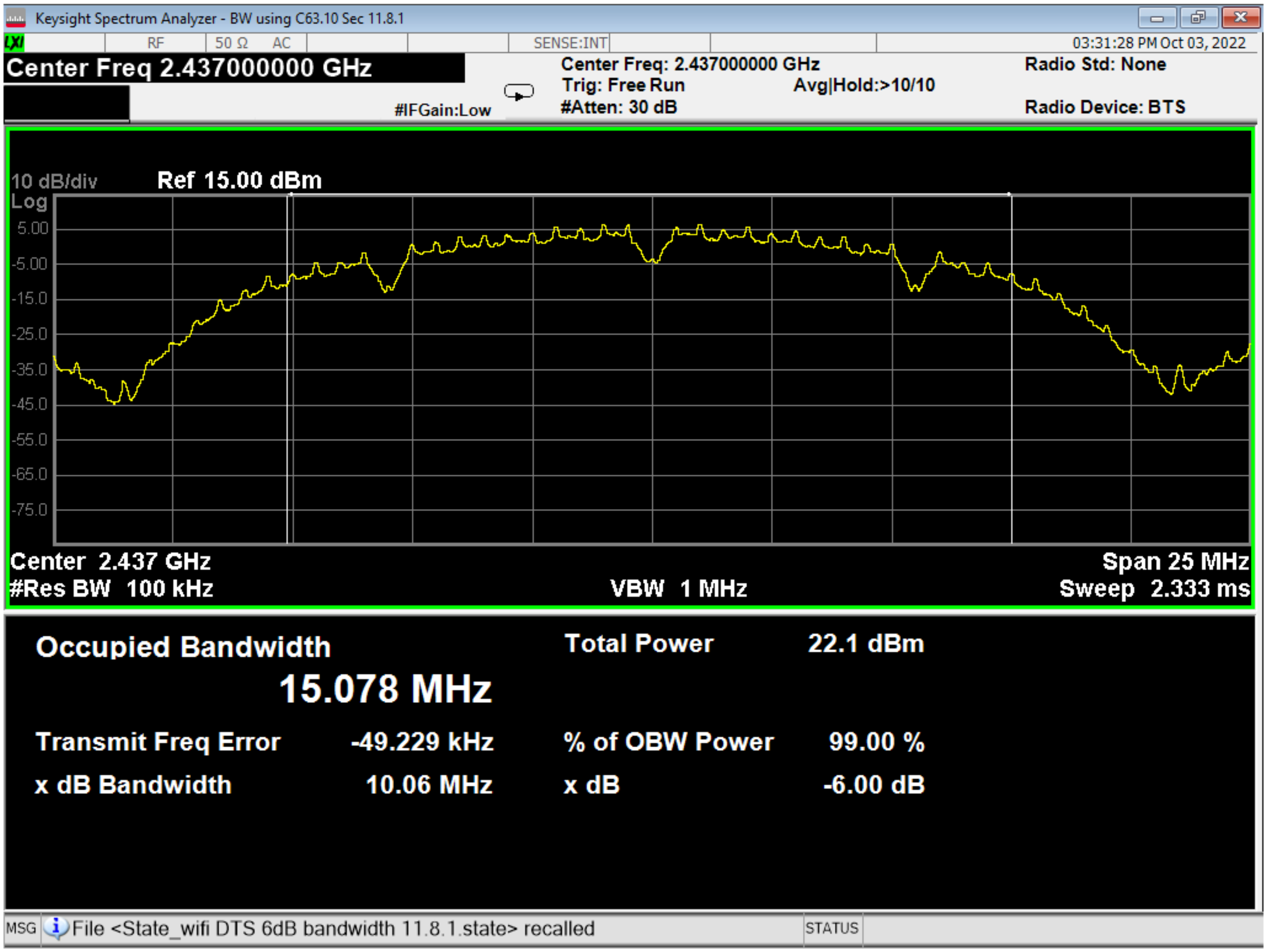
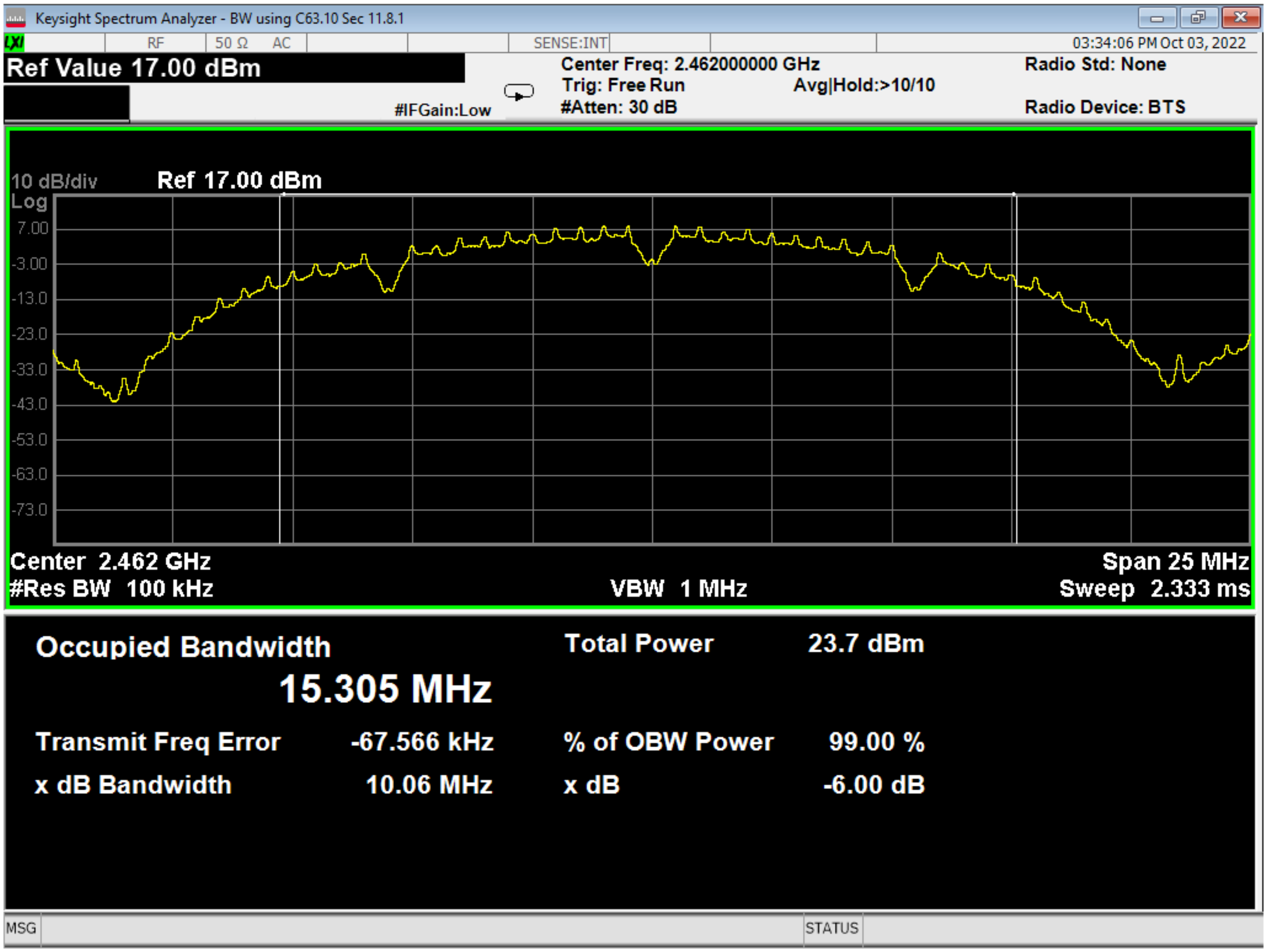


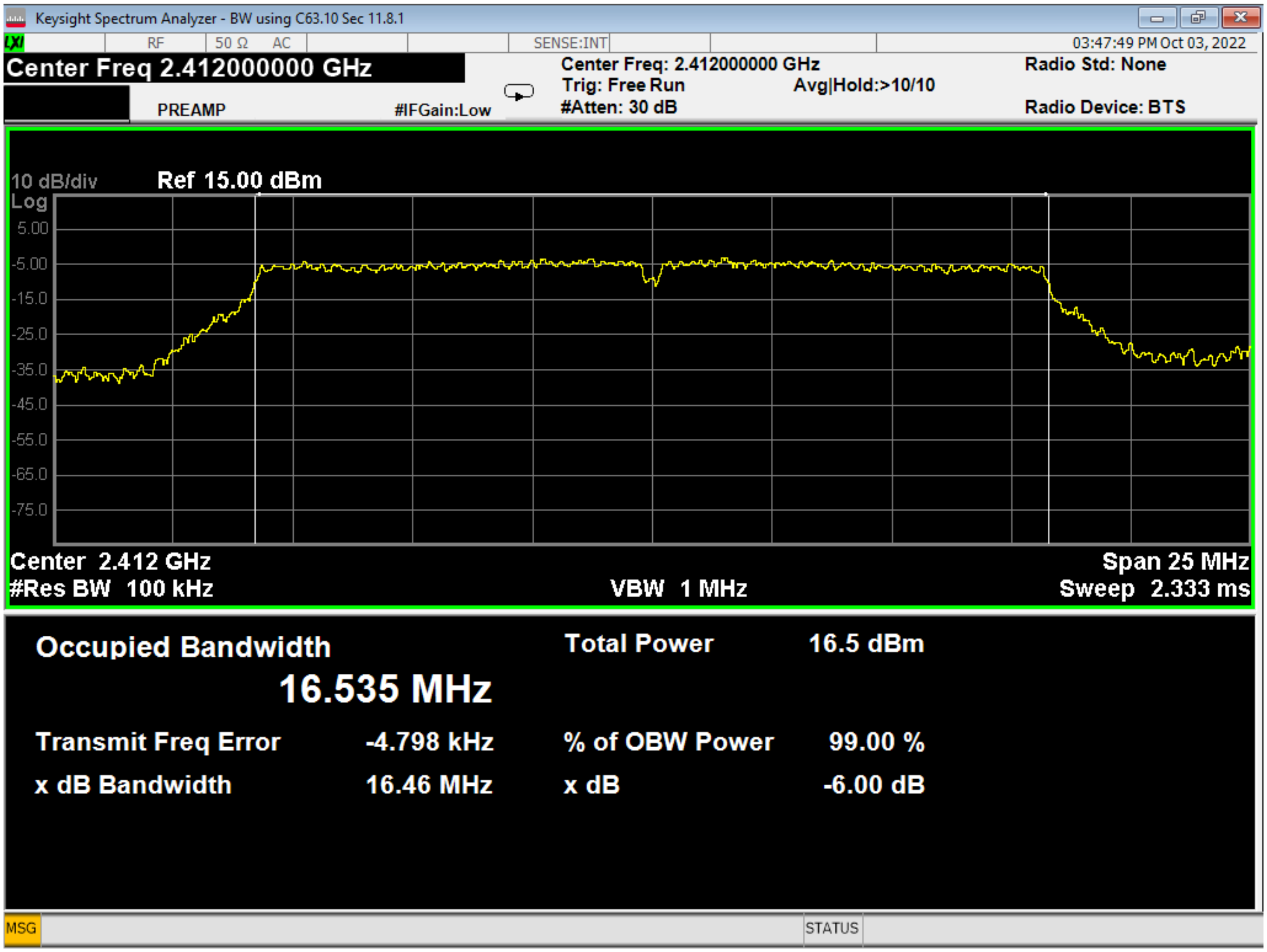
79 6dB Bandwidth, Low, Wifi B, Low Data Rate



80 6dB Bandwidth, Mid, Wifi B, Low Data Rate



81 6dB Bandwidth, High, Wifi B, Low Data Rate



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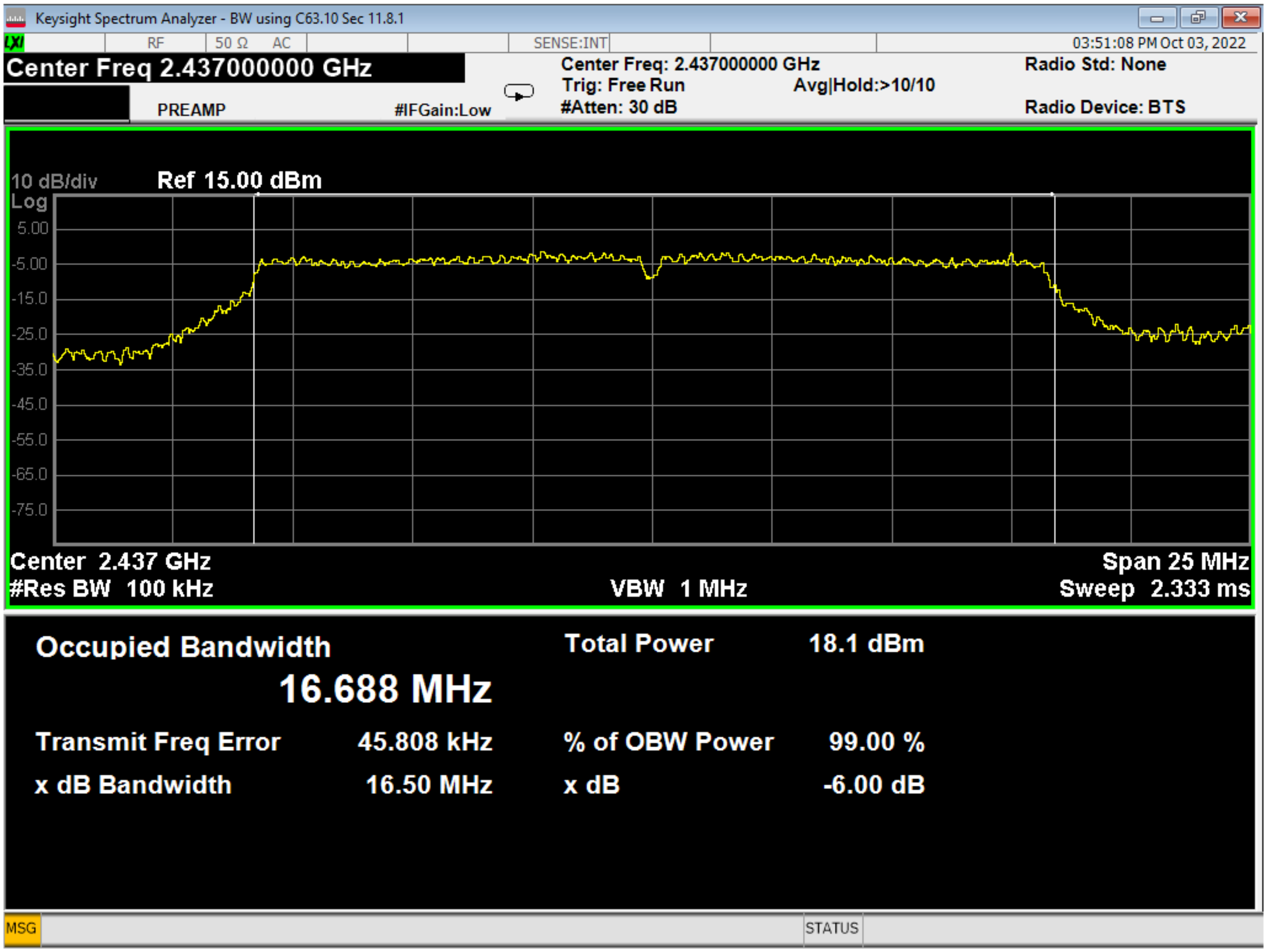

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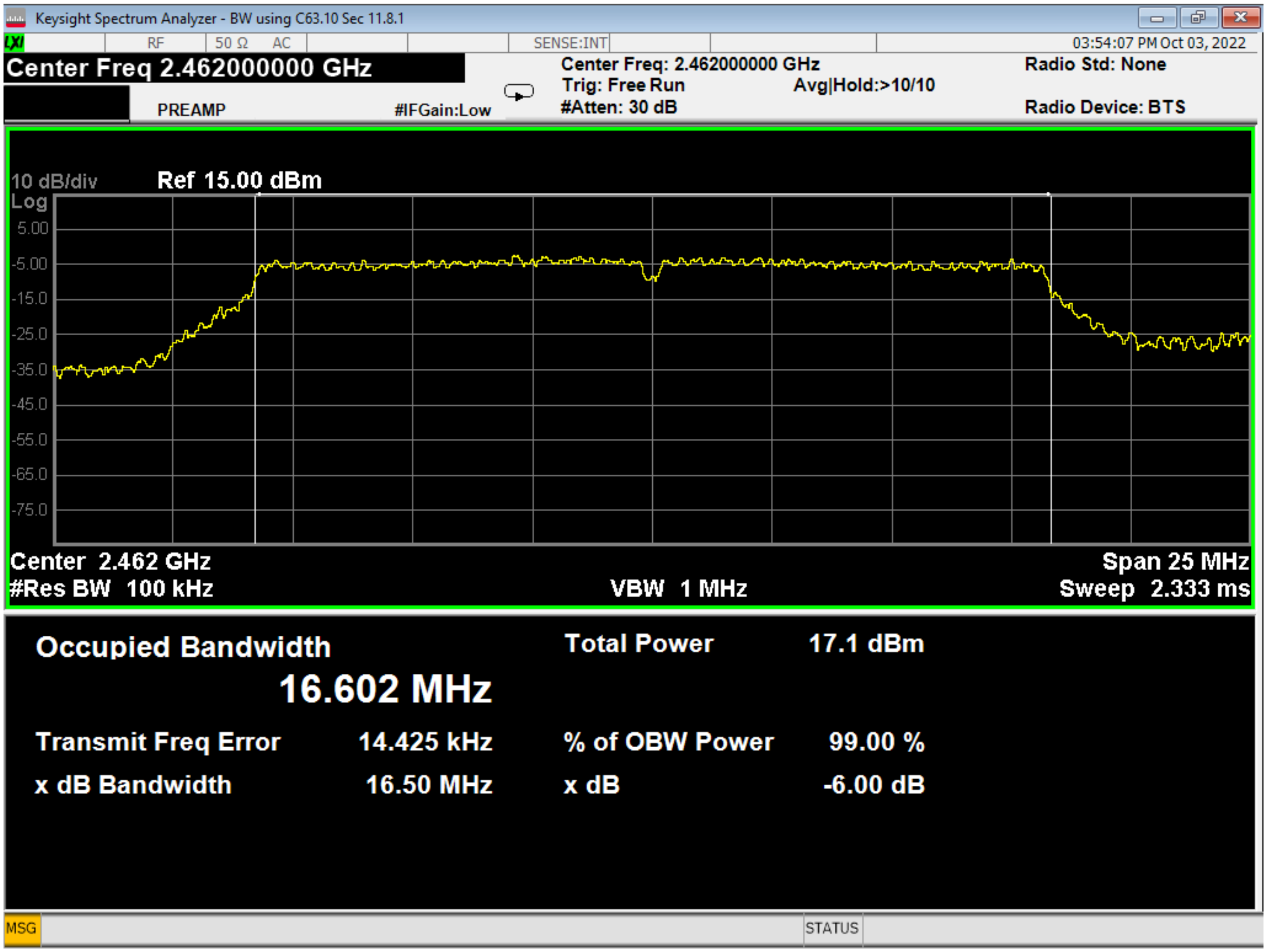

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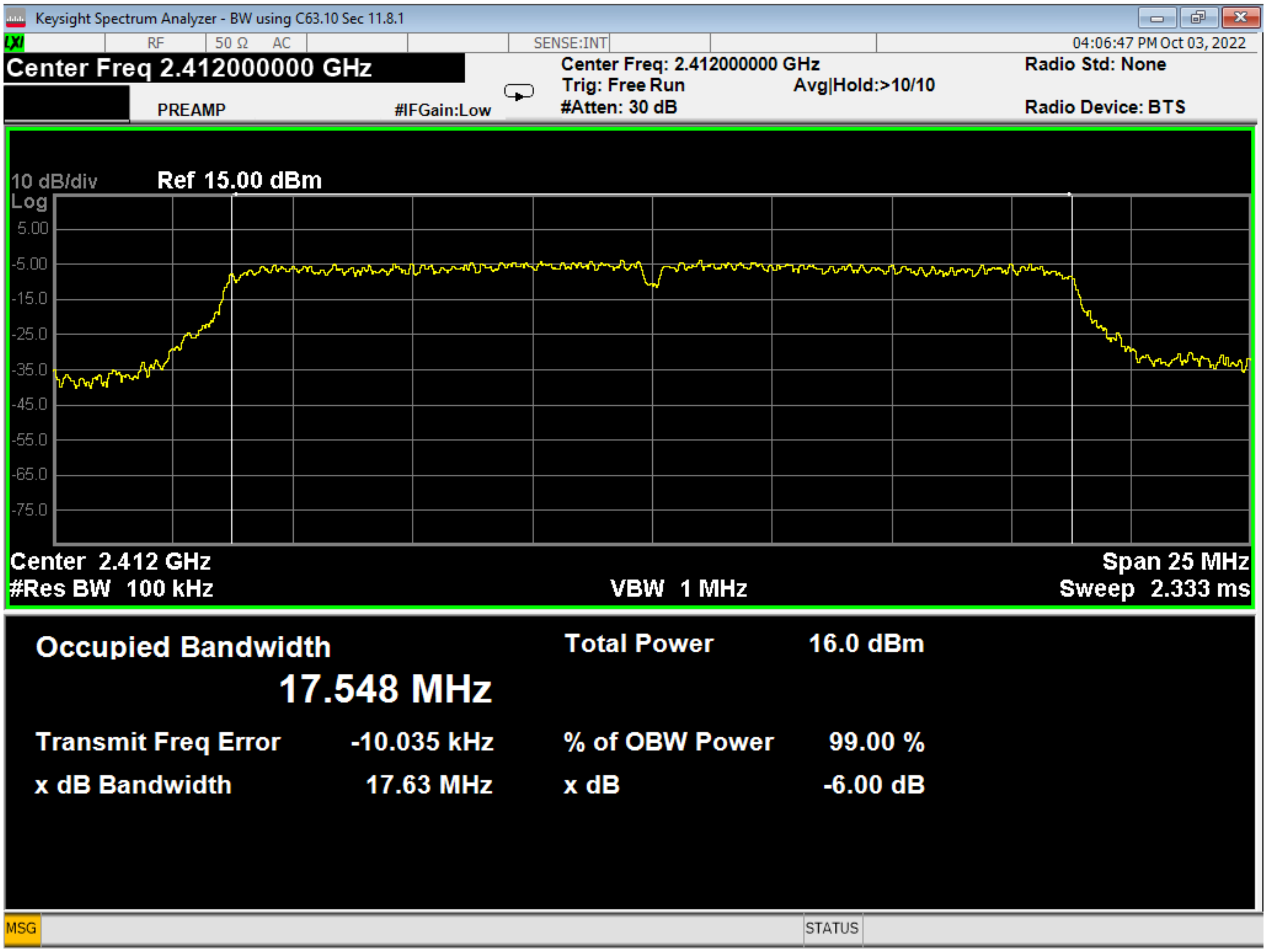

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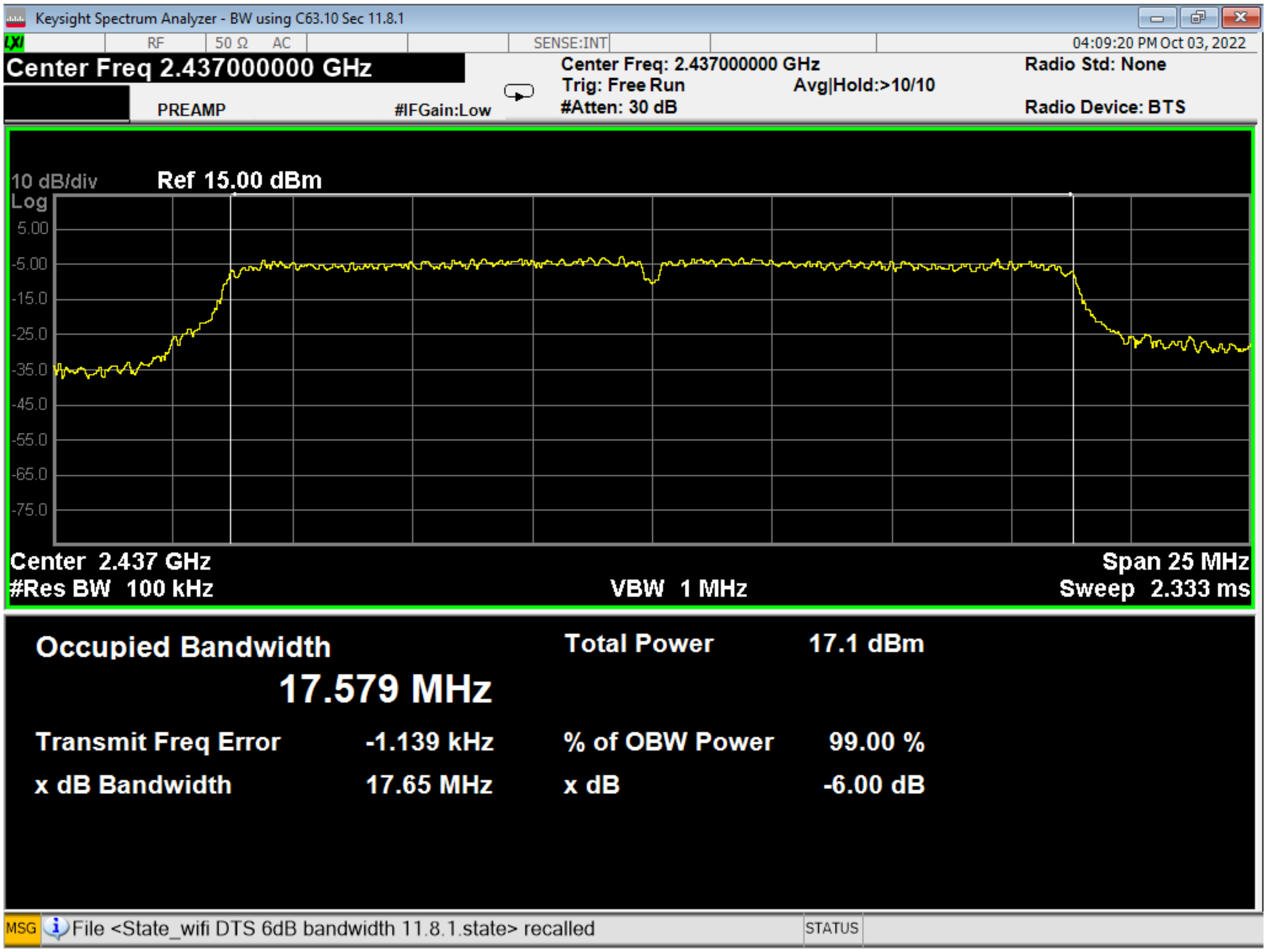
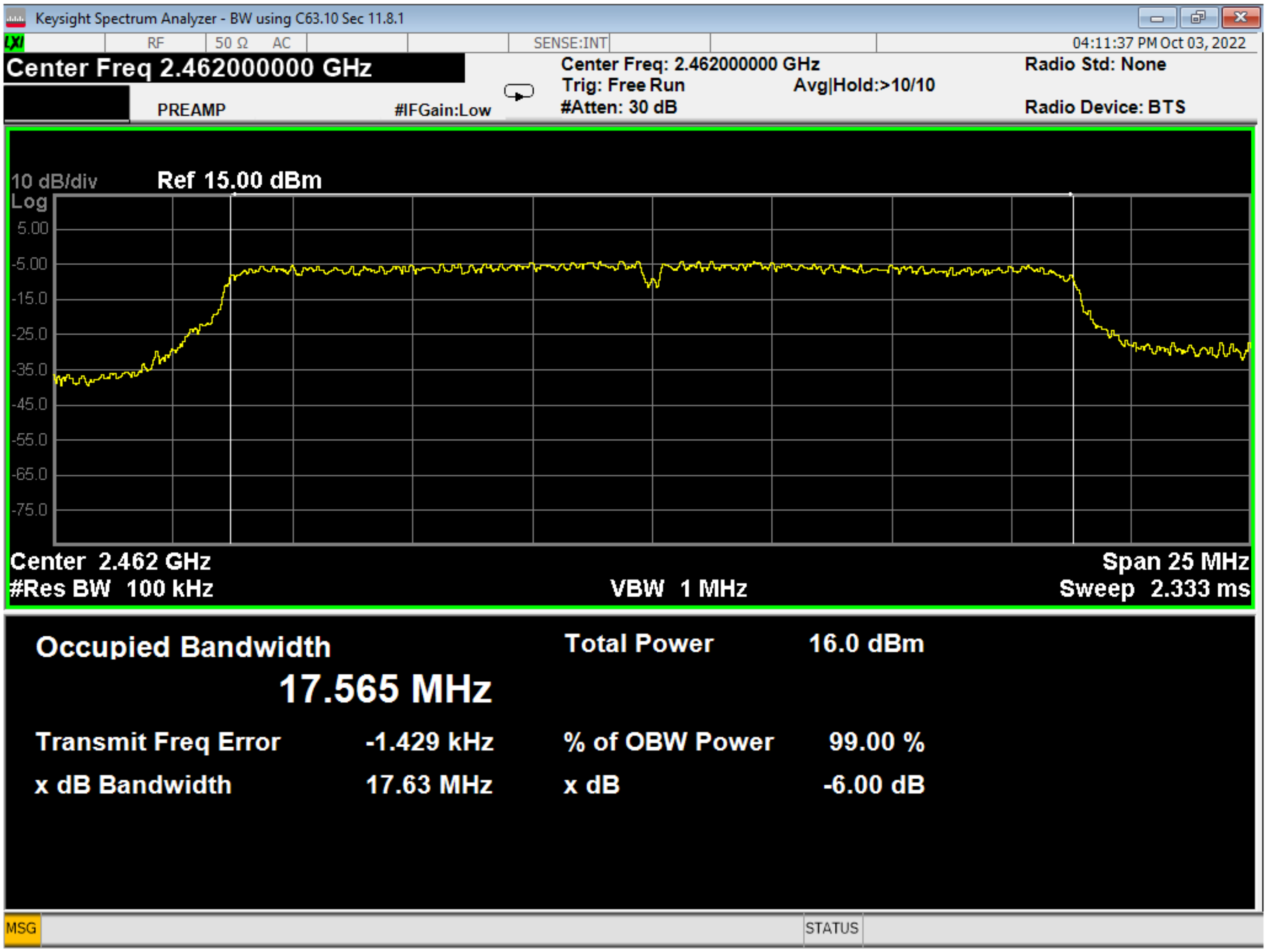


86 6dB Bandwidth, Mid, Wifi N, Low Data Rate



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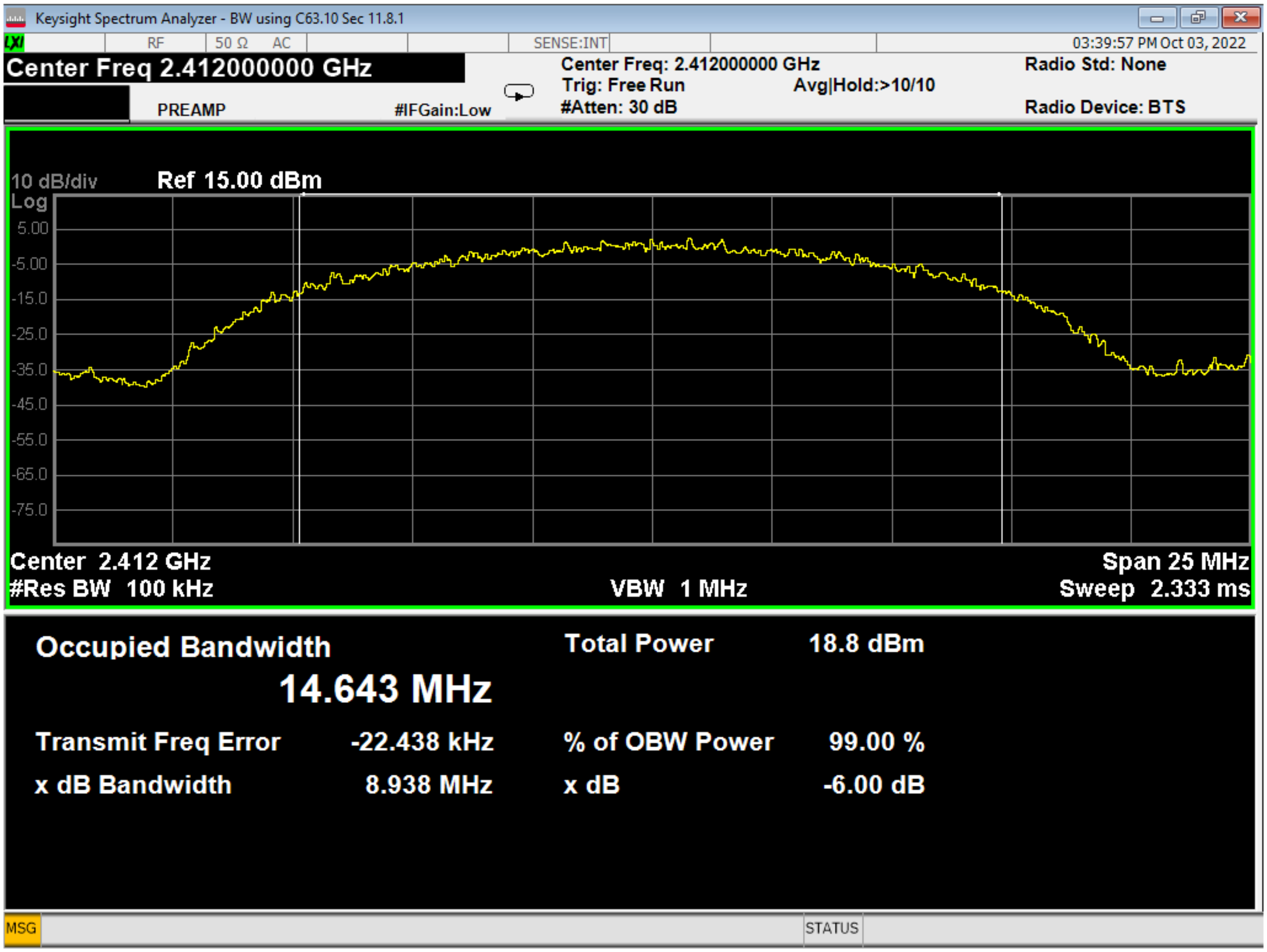
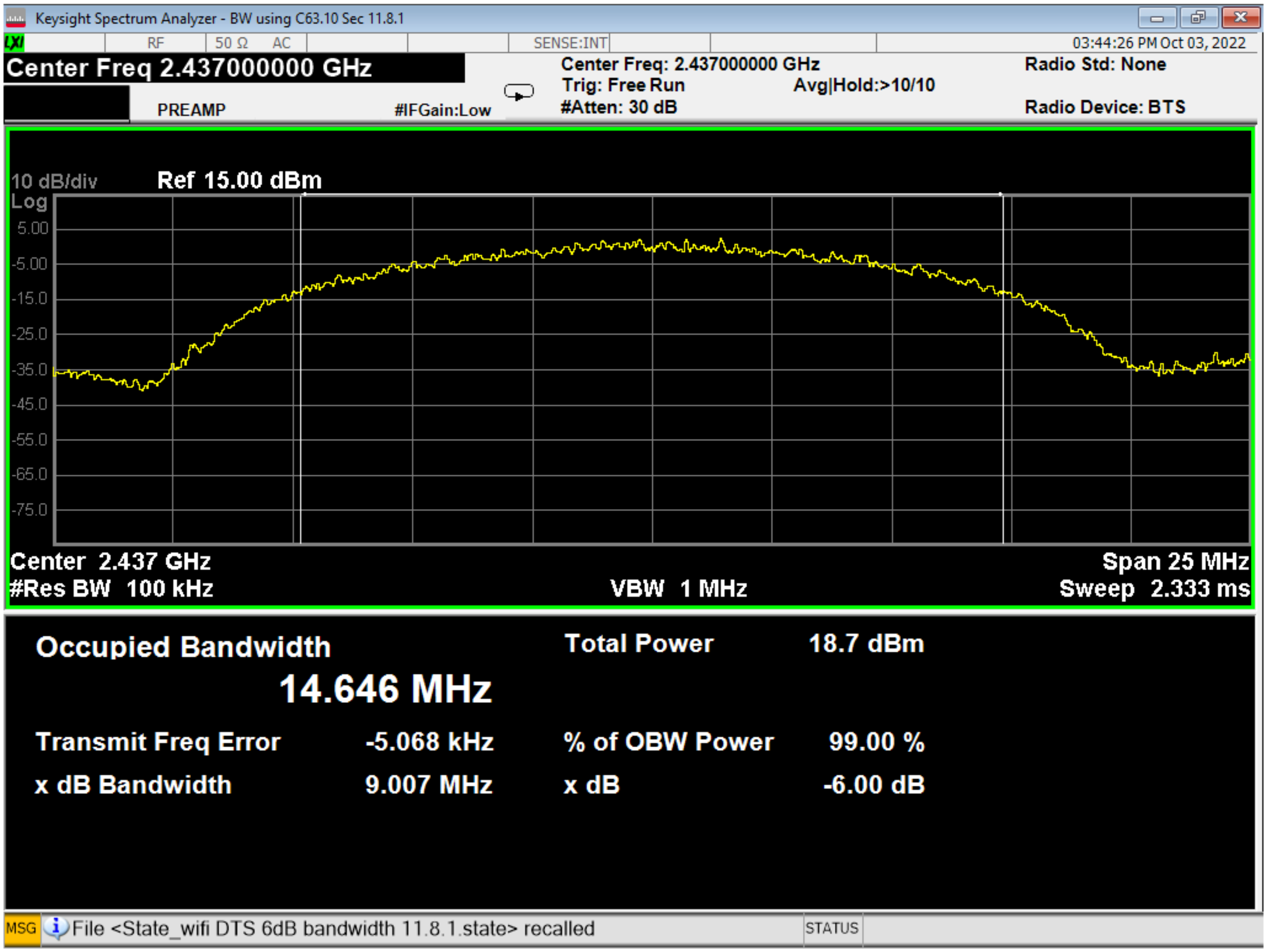


88 6dB Bandwidth, Low, Wifi B, High Data Rate



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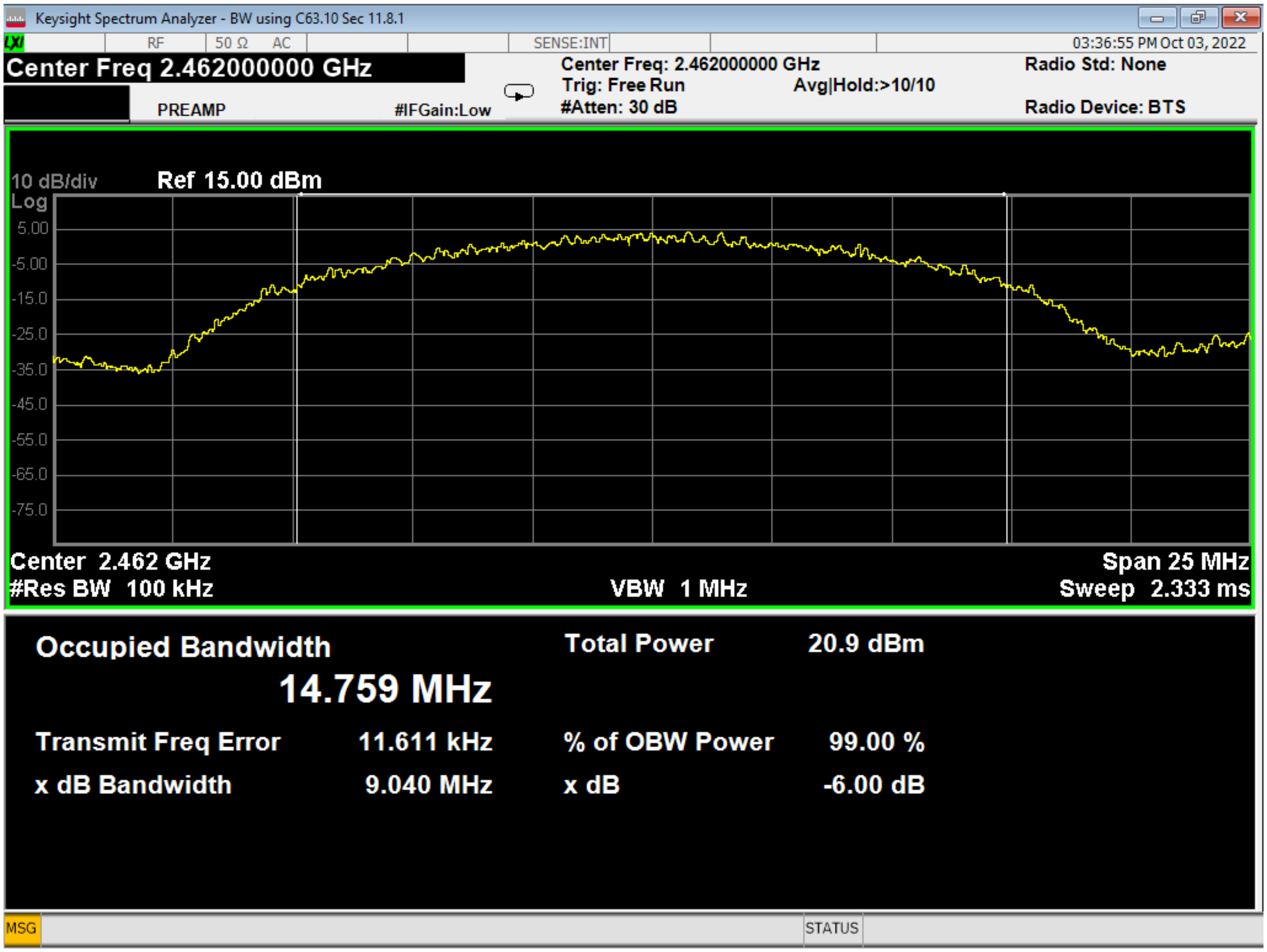
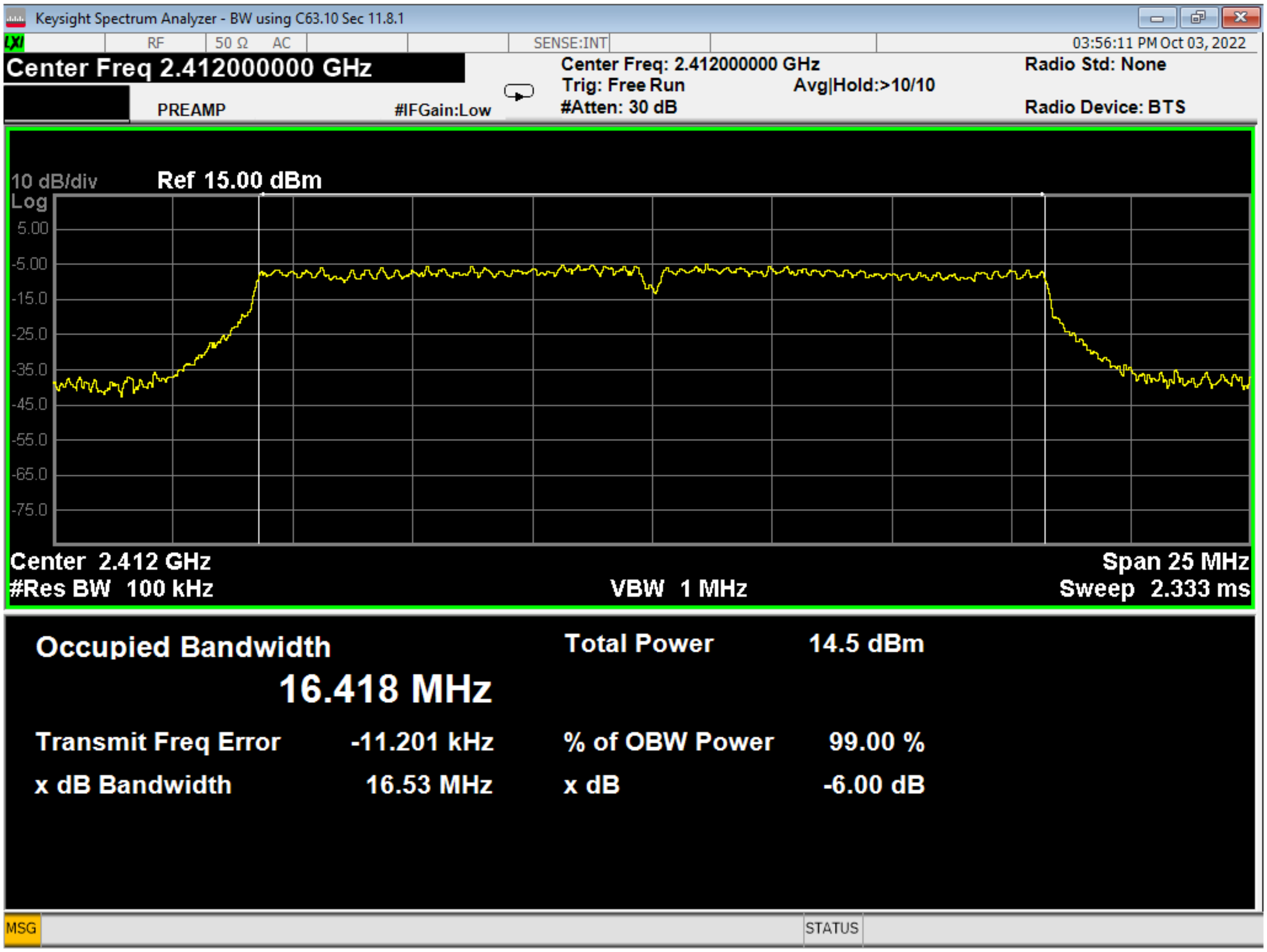
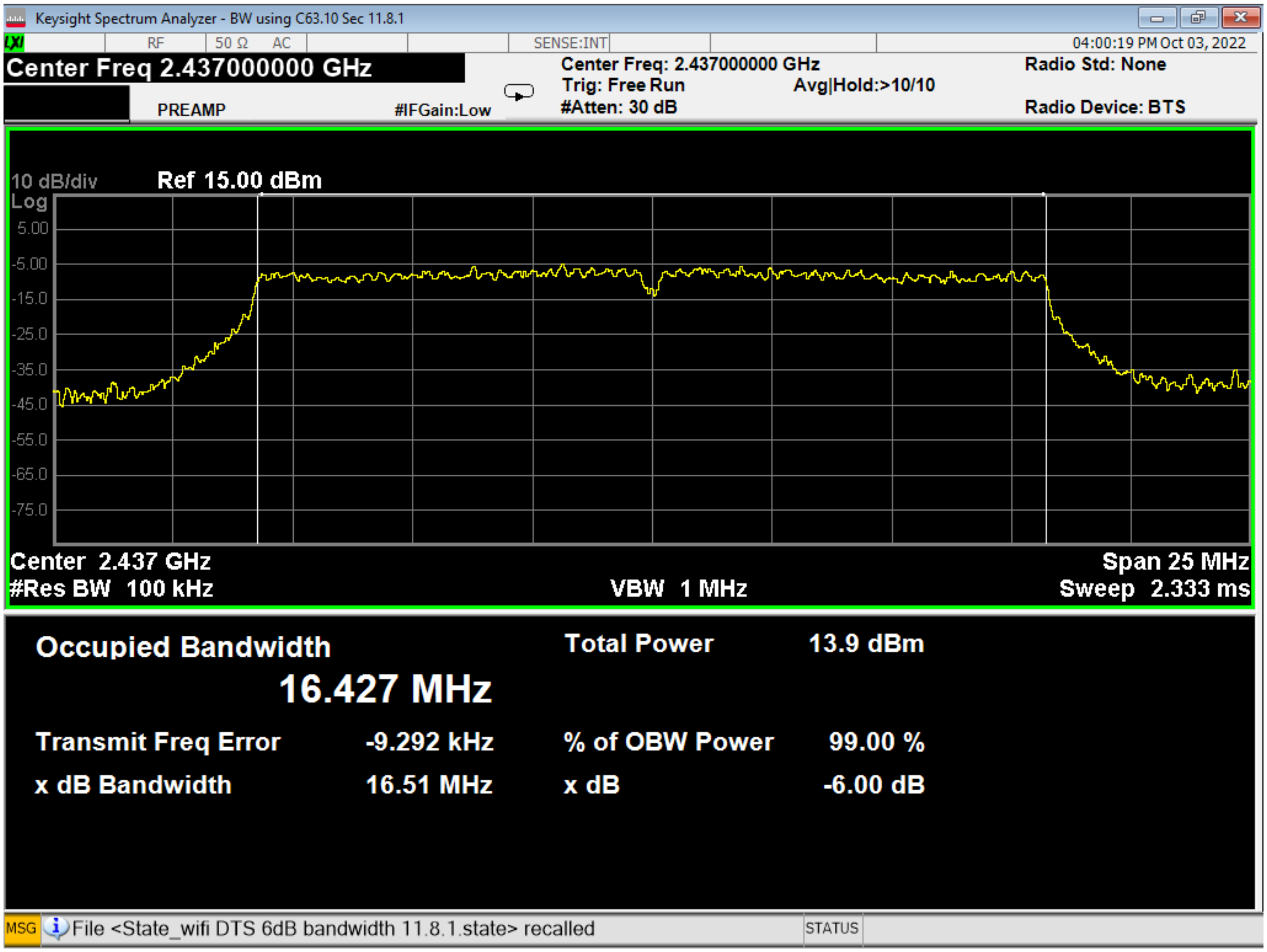


90 6dB Bandwidth, High, Wifi B, High Data Rate



91 6dB Bandwidth, Low, Wifi G, High Data Rate



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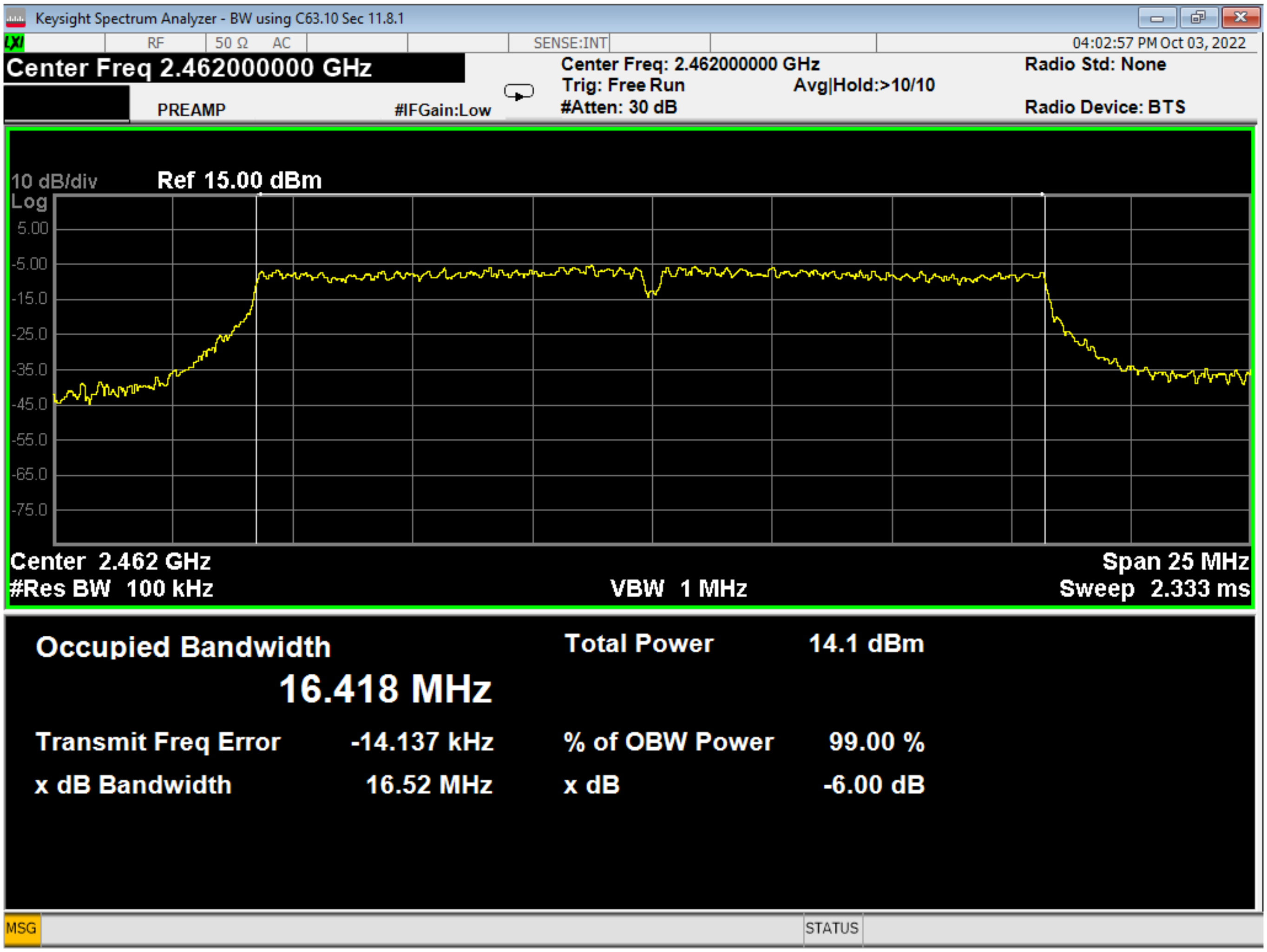

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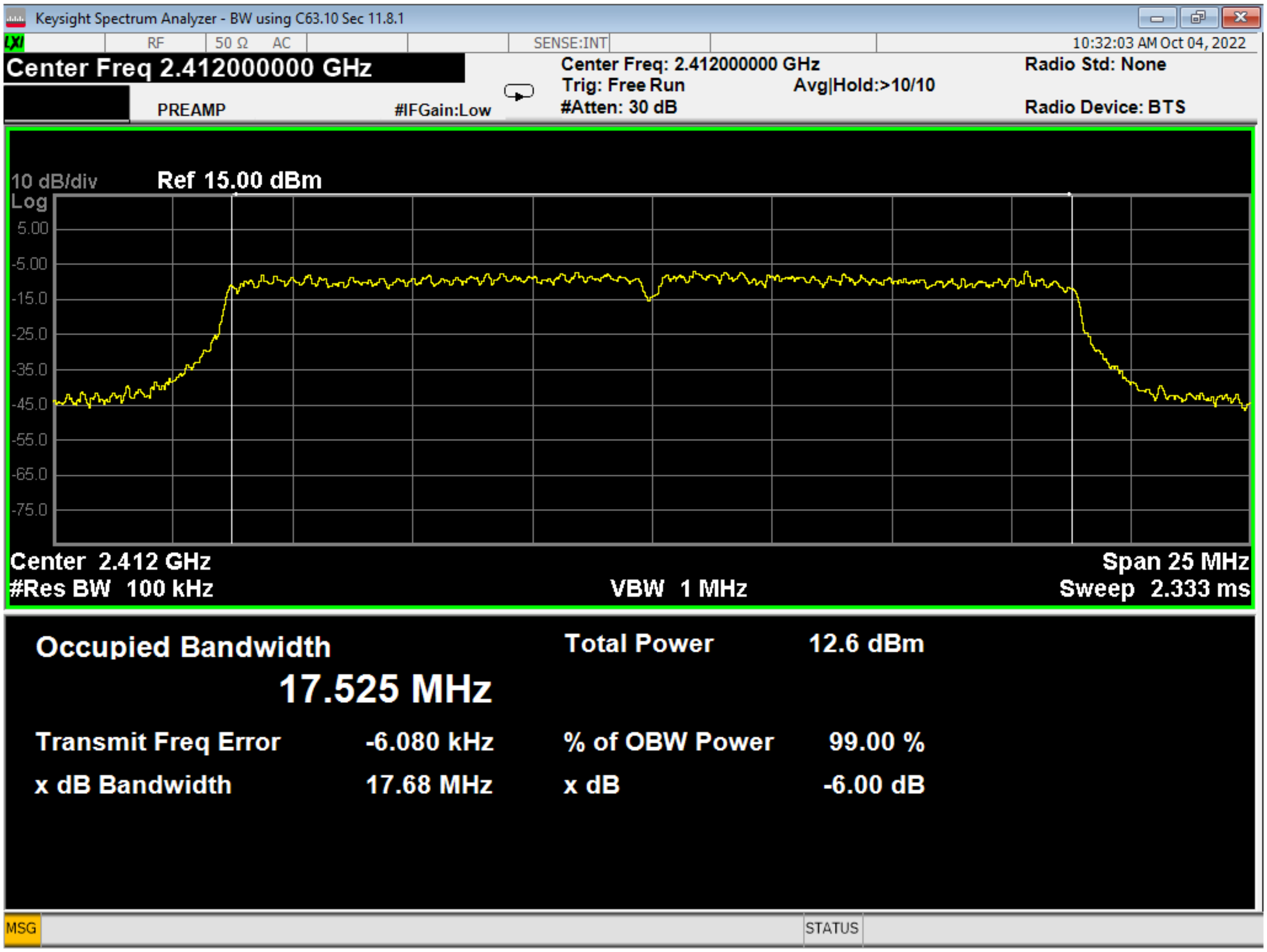

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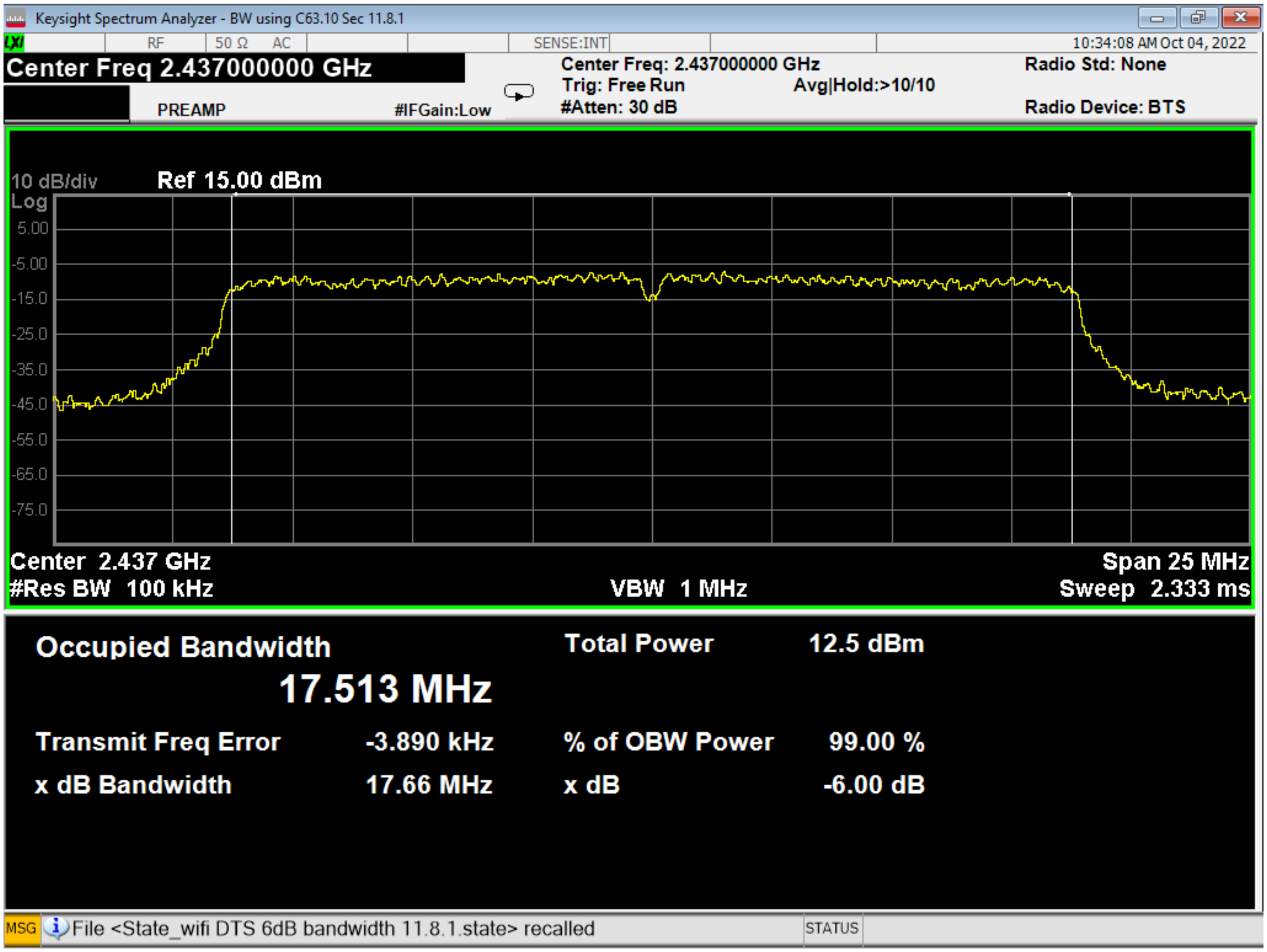

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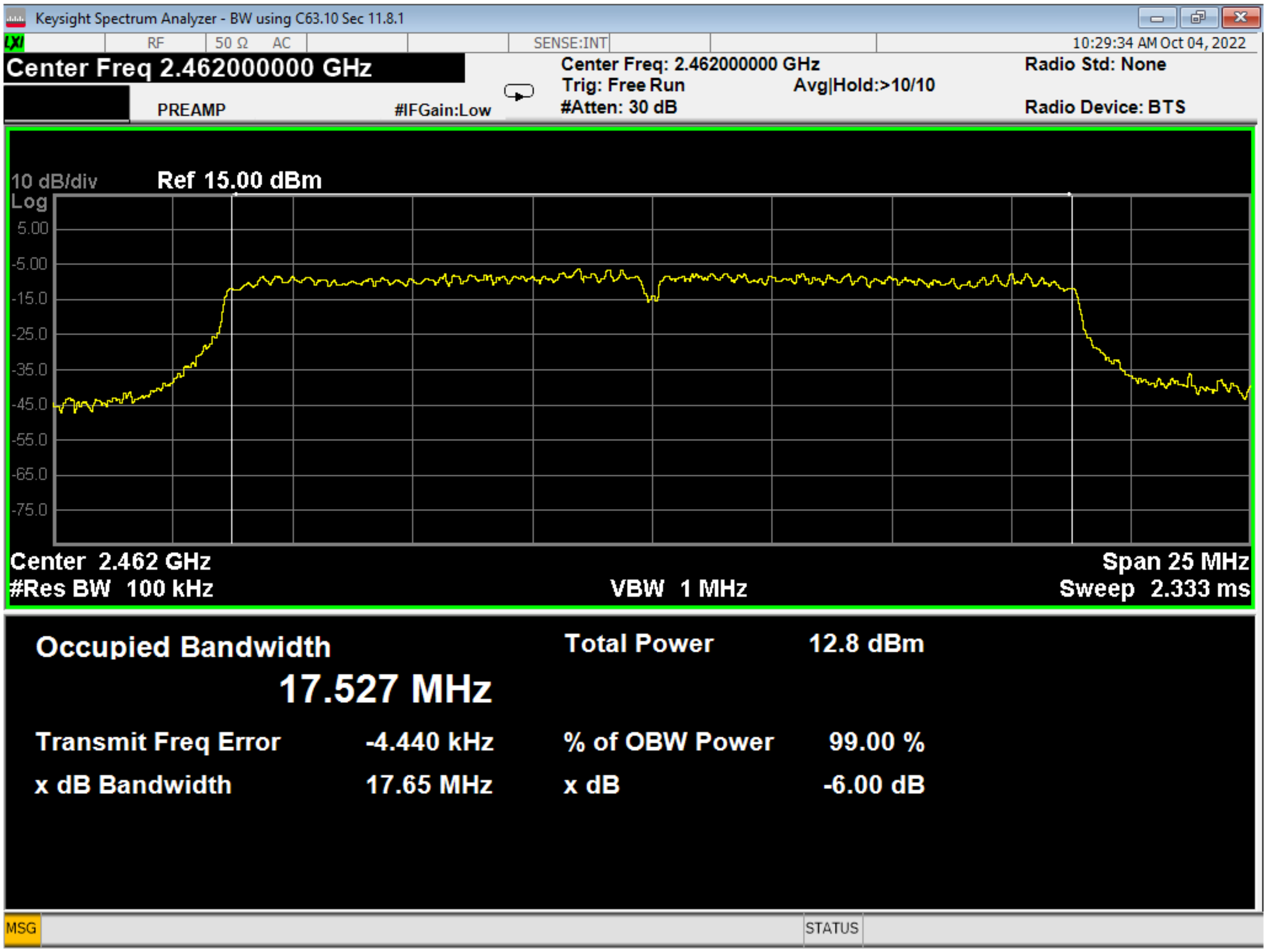


96 6dB Bandwidth, High, Wifi N, High Data Rate

REPORT END

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

FCC/ISED Test Report

Prepared for: **Garmin International, Inc.**

Address: **1200 E. 151st Street**
Olathe, Kansas, 66062, USA

Product: **AA4264**

Test Report No: **R20220615-20-E3**

Approved by:

Nic S. Johnson, NCE
Technical Manager
iNARTE Certified EMC Engineer #EMC-003337-NE

DATE: **November 30, 2022**

Total Pages: **34**

REVISION PAGE

Rev. No.	Date	Description
0	30 November 2022	Original –NJohnson Prepared by Flane

CONTENTS

1.0 SUMMARY OF TEST RESULTS

The equipment under test (EUT) was tested for compliance to FCC Part 25 and Part 2 as well as RSS-170, Issue 3. Below is a summary of the test results. Complete results can be found in Section 3.

Report Section	47 CFR FCC Rule Part	Description	Results
4.1	FCC Part 25.204 FCC Part 25.202 (f) RSS-170 Issue 3, Section 5.4.3	Output Power and Emissions Mask	Compliant
4.2	FCC Part 25.216 (c) RSS-170 Issue 3, Section 5.4.3	Emissions Limits for Mobile Earth Stations	Compliant
4.3	FCC Part 25.216 (g) RSS-170 Issue 3, Section 5.4.4 RSS Gen 7.1, 7.3	Receive Emissions Limits for Mobile Earth Stations	Compliant
4.4	FCC Part 25.202 (f) RSS Gen 7.4 RSS-170 Issue 3, Section 5.4.3	Conducted Spurious Emissions	Compliant
4.5	FCC 25.202 (d) RSS Gen 6.11 RSS-170 Issue 3, Section 5.2	Frequency Stability	Compliant
4.6	FCC Part 2.1047(d) FCC Part 15.202	Modulation Characteristics Occupied Bandwidth	Compliant

Test Methods:

(1) ANSI C63.26-2015

2.0 EUT DESCRIPTION

2.1 EQUIPMENT UNDER TEST

Summary and Operating Condition:

EUT	AA4264
IC	1792A-A4264
FCC ID	IPH-A4264
EUT Received	29 August 2022
EUT Tested	5 September 2022- 27 October 2022
Serial No.	3426363242 (Radiated Measurements) 3426363185 (Conducted Measurements)
Operating Band	1616 – 1626 MHz
Device Type	☒ Iridium
Power Supply / Voltage	Internal Battery / 5VDC Charger: Garmin (Phi Hong) Model: LACA046 GPN: 362-00112-00 (Representative Power Supply)
Antenna Gain (dBi)	1.396dBi

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

2.2 DESCRIPTION OF TEST MODES

The operating range of the EUT is dependent on the device type found in section 2.1:

Iridium Transmissions:

Channel	Frequency
Low	1616.020833 MHz
Mid	1620.979167 MHz
High	1625.979167 MHz

2.3 DESCRIPTION OF SUPPORT UNITS

None

3.0 LABORATORY AND GENERAL TEST 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
NCC CAB 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	Fox Lane	Test Engineer	Testing and Report

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 (44GHz)	N9038A	MY59050109	July 21, 2021	July 21, 2023
Keysight MXE Signal Analyzer (26.5GHz)	N9038A	MY56400083	May 5, 2020	May 5, 2023
Keysight EXA Signal Analyzer	N9010A	MY56070862	July 20, 2021	July 20, 2023
SunAR RF Motion	JB1	A091418	July 27, 2021	July 27, 2022
EMCO Horn Antenna	3115	6415	March 16, 2020	March 16, 2023
EMCO Horn Antenna	3116	2576	March 9, 2020	March 9, 2023
Com-Power LISN 50µH / 250µH - 50Ω	LI-220C	20070017	September 22, 2020	September 22, 2022
8447F POT H64 Preamplifier*	8447F POT H64	3113AD4667	March 21, 2022	March 21, 2024
Rohde & Schwarz Preamplifier*	TS-PR18	3545700803	March 21, 2022	March 21, 2024
Trilithic High Pass Filter*	6HC330	23042	March 21, 2022	March 21, 2024
ETS – Lindgren- VSWR on 10m Chamber	10m Semi-anechoic chamber-VSWR	4740 Discovery Drive	July 30, 2020	July 30, 2023
NCEE Labs-NSA on 10m Chamber	10m Semi-anechoic chamber-NSA	NCEE-001	May 25, 2022	May 25, 2024
TDK Emissions Lab Software	V11.25	700307	NA	NA
RF Cable (preamplifier to antenna)*	MFR-57500	01-07-002	March 21, 2022	March 21, 2024
RF Cable (antenna to 10m chamber bulkhead)*	FSCM 64639	01E3872	September 24, 2021	September 24, 2023
RF Cable (10m chamber bulkhead to control room bulkhead)*	FSCM 64639	01E3864	September 24, 2021	September 24, 2023
RF Cable (control room bulkhead to test receiver)*	FSCM 64639	01F1206	September 24, 2021	September 24, 2023
N connector bulkhead (10m chamber)**	PE9128	NCEEBH1	September 24, 2021	September 24, 2023
N connector bulkhead (control room)**	PE9128	NCEEBH2	September 24, 2021	September 24, 2023

*Internal Characterization

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

3.4 GENERAL TEST PROCEDURE AND SETUP FOR RADIO MEASUREMNTS

Measurement type presented in this report (Please see the checked box below):

Conducted ☒

The conducted measurements were performed by connecting the output of the transmitter directly into a spectrum analyzer using an impedance matched cable and connector soldered to the EUT in place of the antenna. The information regarding resolution bandwidth, video bandwidth, span and the detector used can be found in the graphs provided in the Appendix C. All the radio measurements were performed using the sections from ANSI C63.10, details about the section used can be found in the spectrum analyzer titles on the graph.

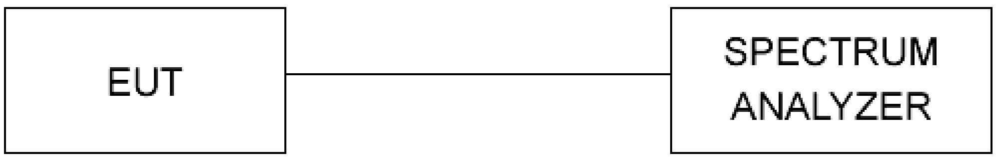


Figure 1 - Bandwidth Measurements Test Setup

4.0 RESULTS

4.1 OUTPUT POWER AND EMISSION MASK

Test Method:

Output Power:

Output Power measurements were performed using section 5.2.4.3.1 from ANSI C63.26.

Emissions Mask:

FCC Part 25.202(f) – emissions mask
FCC Part 25.204, 2.1046 – output power

(f) Emission limitations. Except for SDARS terrestrial repeaters and as provided for in paragraph (i), the mean power of emissions shall be attenuated below the mean output power of the transmitter in accordance with the schedule set forth in paragraphs (f)(1) through (f)(4) of this section. The out-of-band emissions of SDARS terrestrial repeaters shall be attenuated in accordance with the schedule set forth in paragraph (h) of this section.

(1) In any 4 kHz band, the center frequency of which is removed from the assigned frequency by more than 50 percent up to and including 100 percent of the authorized bandwidth: 25 dB;

(2) In any 4 kHz band, the center frequency of which is removed from the assigned frequency by more than 100 percent up to and including 250 percent of the authorized bandwidth: 35 dB;

(3) In any 4 kHz band, the center frequency of which is removed from the assigned frequency by more than 250 percent of the authorized bandwidth: An amount equal to 43 dB plus 10 times the logarithm (to the base 10) of the transmitter power in watts;

(4) In any event, when an emission outside of the authorized bandwidth causes harmful interference, the Commission may, at its discretion, require greater attenuation than specified in paragraphs (f) (1), (2) and (3) of this section.

Test procedures:

All the measurements were done as conducted measurements. Details can be found in section 3.4 of this report.

Deviations from test standard:

No deviation.

Test setup:

Details can be found in section 3.4 of this report.

EUT operating conditions:

Details can be found in section 2.1 of this report.

Test results:

Modulation	Frequency	Conducted Peak Output Power (dBm)	Conducted Peak Output Power (mW)	Antenna Gain (dBi)**	EIRP (dBm)
iridium - LOW*	1616.020833	30.539	1132.14	1.396	31.935
iridium - MID*	1620.979167	30.449	1108.92	1.396	31.845
iridium - HIGH*	1625.979167	30.346	1082.93	1.396	31.742
*Interpolated antenna gain **See section 4.7 for more information					

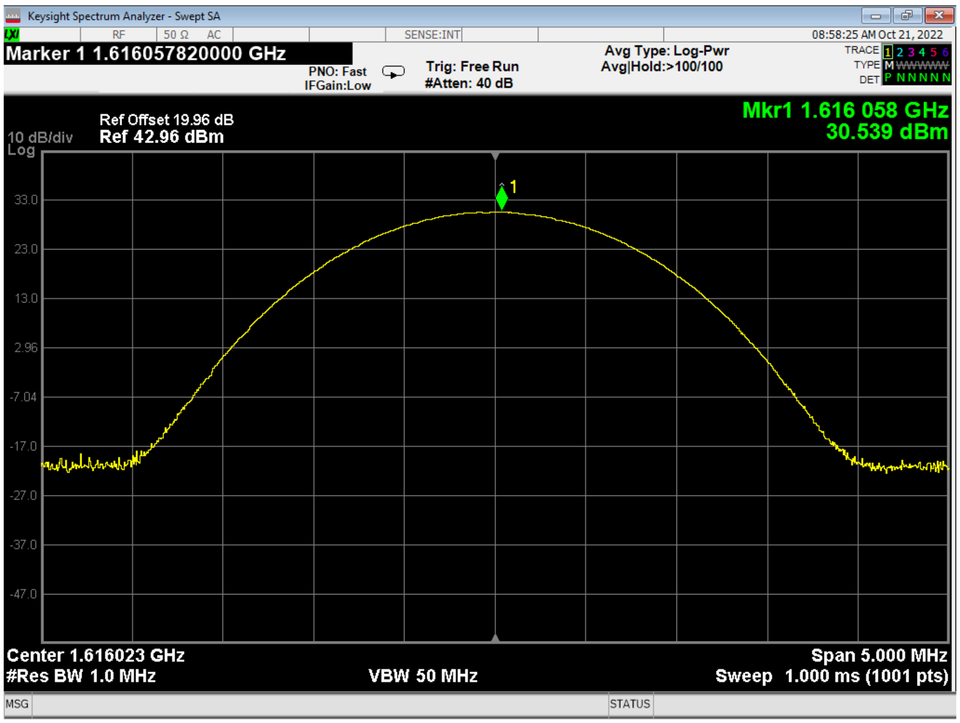


Figure 2 – Conducted Average Output Power, Transmitting at 1616.020833 MHz

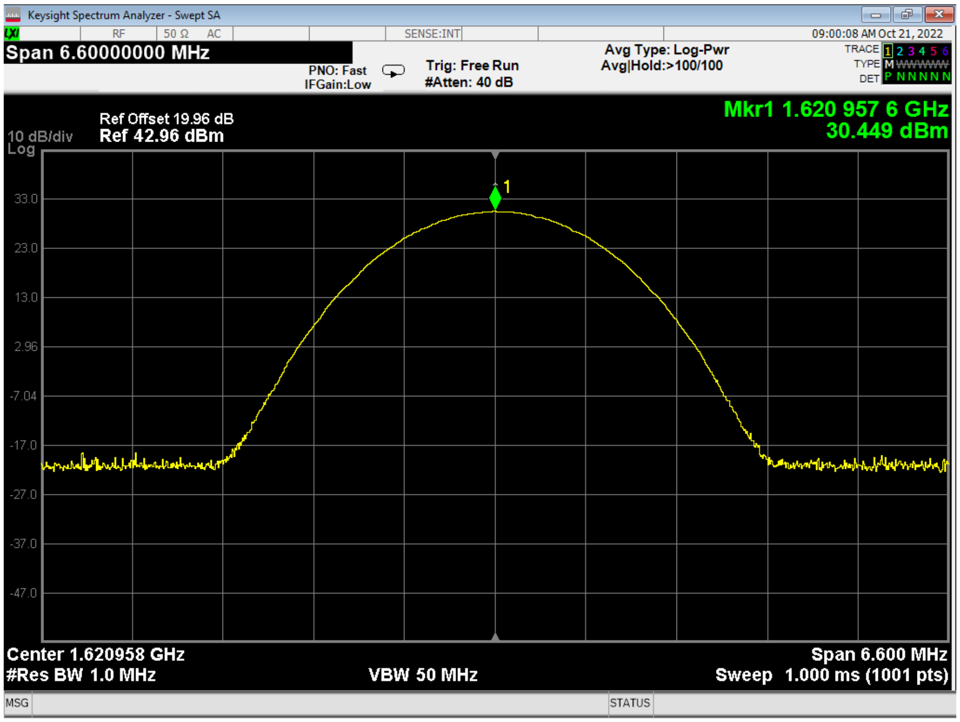


Figure 3 – Conducted Average Output Power, Transmitting at 1620.979167 MHz

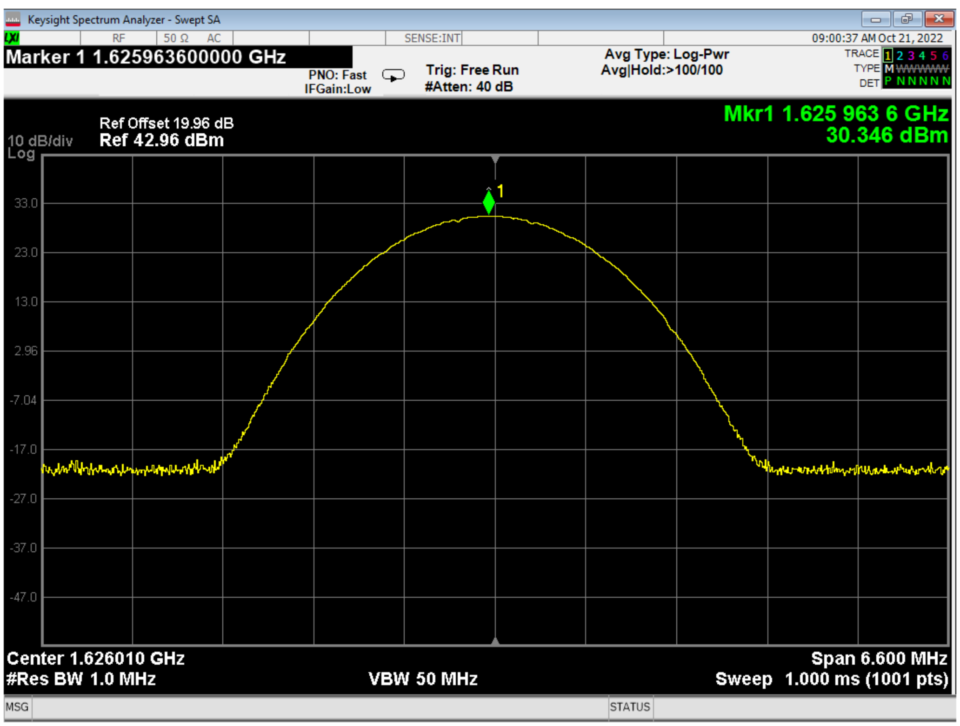


Figure 4 – Conducted Average Output Power, Transmitting at 1625.979167 MHz

Figure 5 – Part 25.202(f) Mask, Transmitting at 1616.020833 MHz

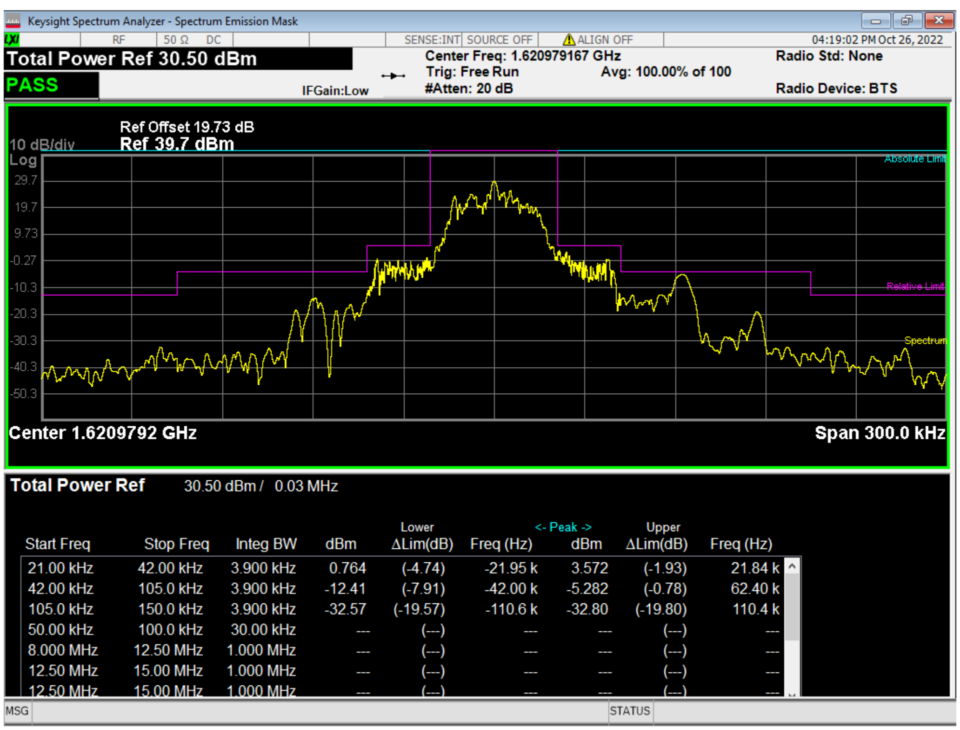


Figure 6 – Part 25.202(f) Mask, Transmitting at 1620.979167 MHz

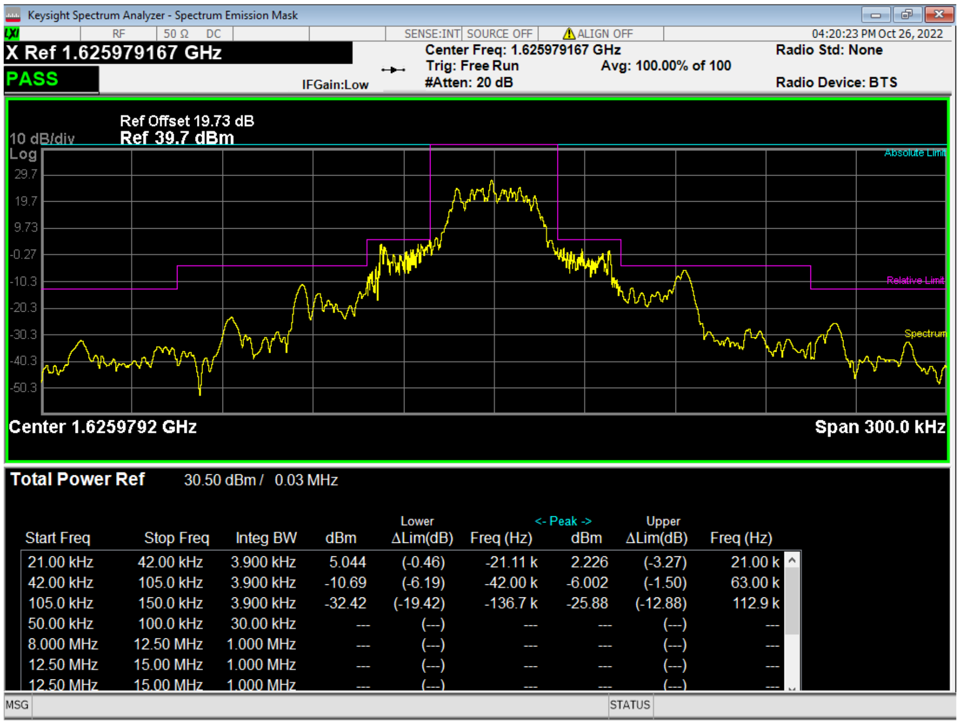


Figure 7 – Part 25.202(f) Mask, Transmitting at 1625.979167 MHz

4.2 EMISSIONS LIMITS FOR MOBILE EARTH STATIONS FCC PART 25.216 (c)

Test Method:
(c) The e.i.r.p. density of emissions from mobile earth stations placed in service after July 21, 2002 with assigned uplink frequencies between 1610 MHz and 1660.5 MHz shall not exceed −70 dBW/MHz, averaged over any 2-millisecond active transmission interval, in the band 1559-1605 MHz. The e.i.r.p. of discrete emissions of less than 700 Hz bandwidth from such stations shall not exceed −80 dBW, averaged over any 2-millisecond active transmission interval, in the 1559-1605 MHz band.

Test procedures:
All the measurements were done as conducted measurements. Details can be found in section 3.4 of this report.

Deviations from test standard:
No deviation.

Test setup:
Test setup details can be found in section 3.4 of this report.

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

Test results:

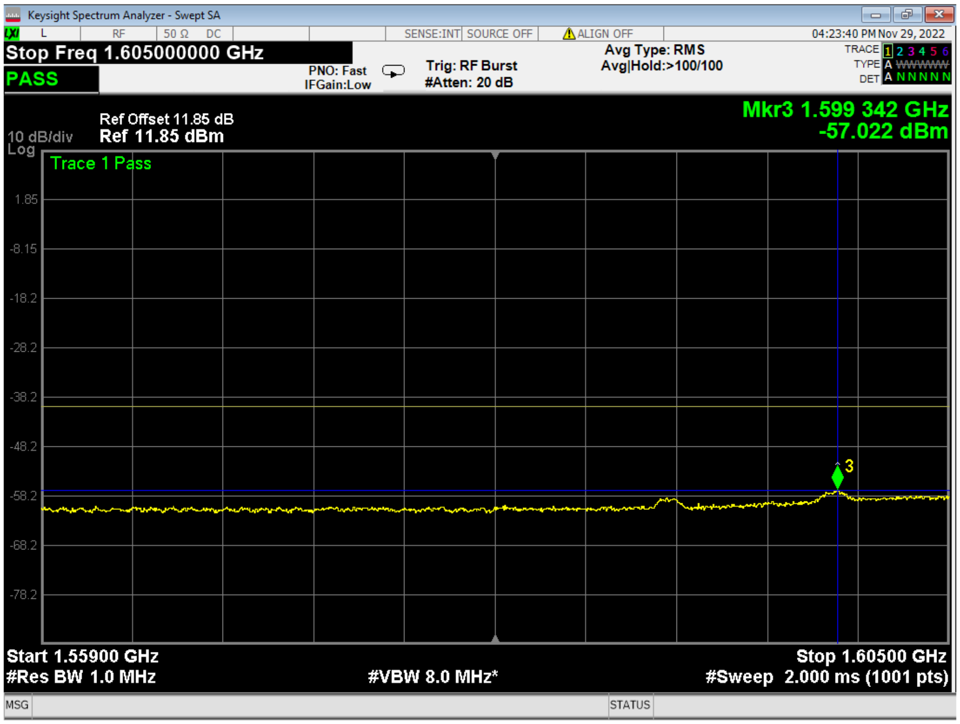


Figure 8 – Part 25.216(c), Transmitting at 1616.020833 MHz, Conducted Measurement
*Limits have been converted from dBW to dBm. dBW = dBm + 30
Antenna Gain = 1.396 dB; Limit = -40.00 dBm; Margin=-40.00-(-47.747+1.396) = 3.982 dB

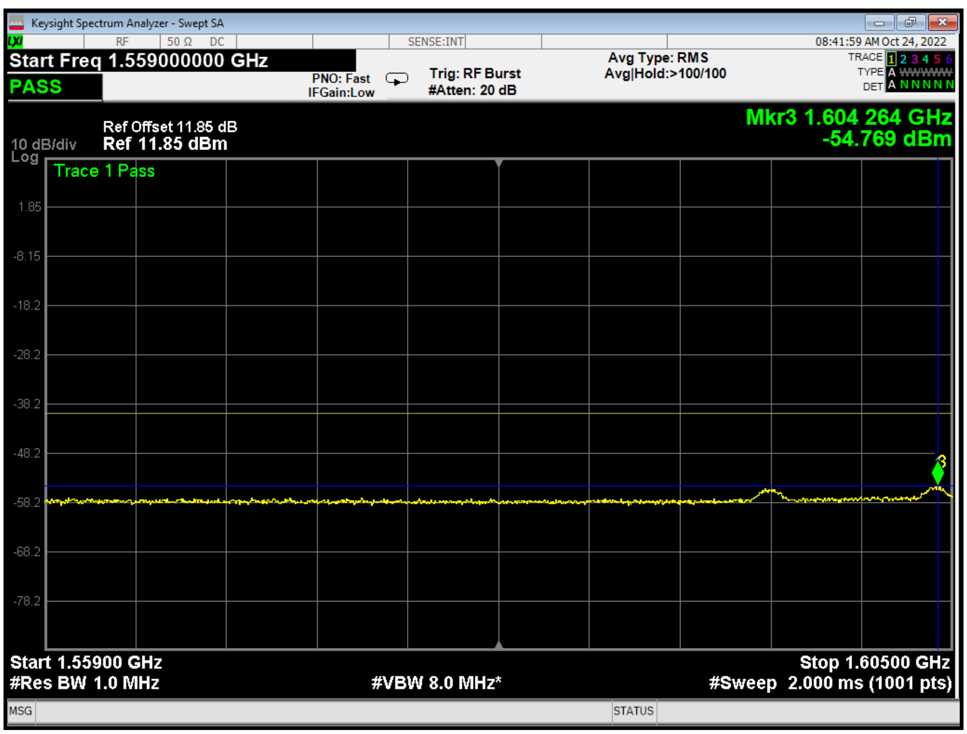


Figure 9 – Part 25.216(c), Transmitting at 1620.979167 MHz, Conducted Measurement
*Limits have been converted from dBW to dBm. dBW = dBm + 30
Antenna Gain = 1.396 dB; Limit = -40.00 dBm; Margin=-40.00-(-54.769+1.396) =16.17 dB

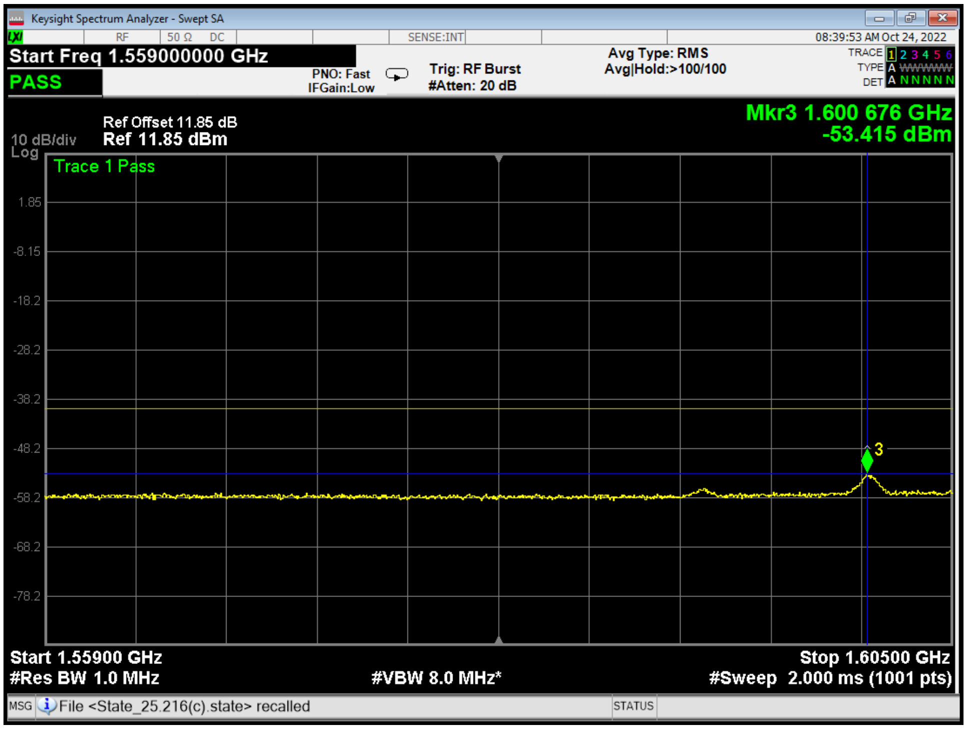


Figure 10 – Part 25.216(c), Transmitting at 1625.979167 MHz, Conducted Measurement

*Limits have been converted from dBW to dBm. dBW = dBm + 30

Antenna Gain = 1.396 dB; Limit = -40.00 dBm; Margin=-40.00-(-53.415+1.396) = 14.811 dB

4.3 EMISSIONS LIMITS FOR MOBILE EARTH STATIONS FCC PART 25.216 (g)

Test Method:
(g) Mobile earth stations manufactured more than six months after FEDERAL REGISTER publication of the rule changes adopted in FCC 03-283 with assigned uplink frequencies in the 1610-1626.5 MHz band shall suppress the power density of emissions in the 1605-1610 MHz band-segment to an extent determined by linear interpolation from −70 dBW/MHz at 1605 MHz to −10 dBW/MHz at 1610 MHz averaged over any 2-millisecond active transmission interval. The e.i.r.p of discrete emissions of less than 700 Hz bandwidth from such stations shall not exceed a level determined by linear interpolation from −80 dBW at 1605 MHz to −20 dBW at 1610 MHz, averaged over any 2 milli-second active transmission interval.

Test procedures:
All the measurements were done as conducted measurements. More details can be found in section 3.4 of this report.

Deviations from test standard:
No deviation.

Test setup:
Test setup details can be found in section 3.4 of this report.

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

Test results:

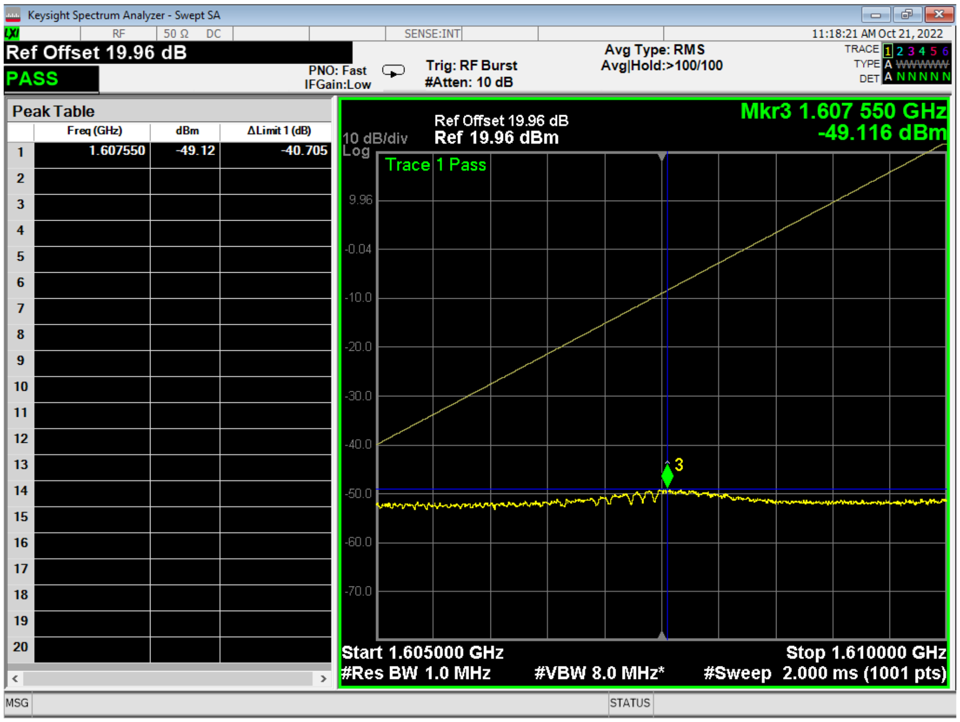


Figure 11 – Part 25.216(g), Transmitting at 1616.020833 MHz, Conducted Measurement

*Limits have been converted from dBW to dBm. dBW = dBm + 30

Margin shown in the plot does not include antenna gain.

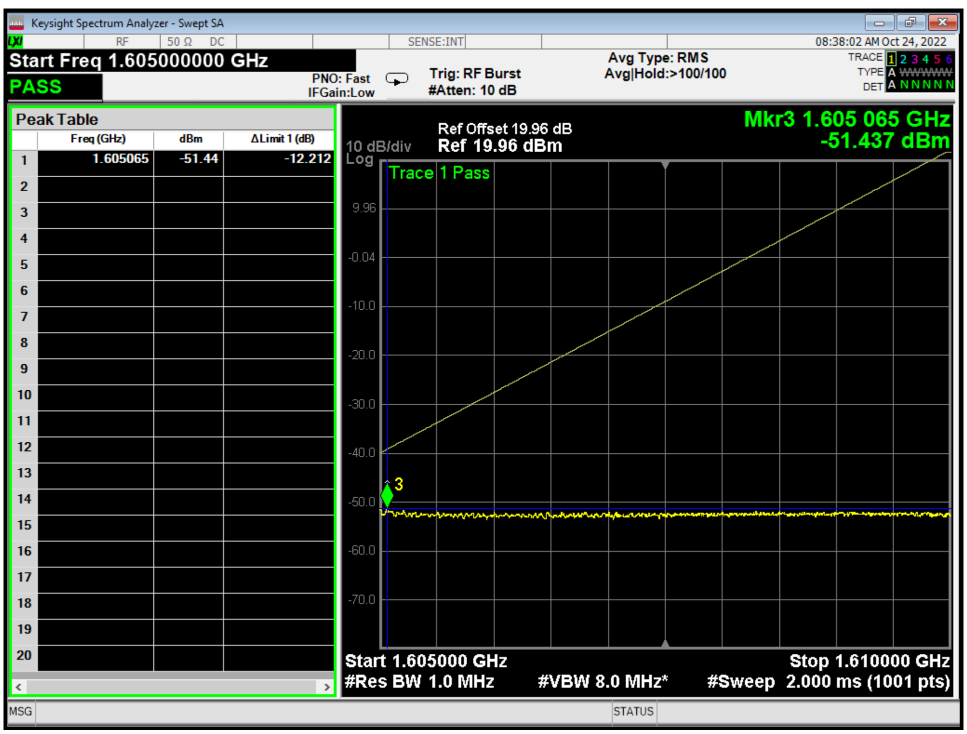


Figure 12 – Part 25.216(g), Transmitting at 1620.979167 MHz, Conducted Measurement

*Limits have been converted from dBW to dBm. dBW = dBm + 30

Figure 13 – Part 25.216(g), Transmitting at 1625.979167 MHz, Conducted Measurement

*Limits have been converted from dBW to dBm. dBW = dBm + 30

4.4 CONDUCTED SPURIOUS EMISSIONS

Test Method: ANSI C63.26-2015, Section 5.7.4

Limits of spurious emissions:

FCC Part 25.202(f)

43+10*Log (Power in Watts) = 43+10*Log (1.645508) =45.163 dBc

Absolute Limit= 32.163 dBm-45.163 dBc = -13 dBm

Test procedures:

All the measurements were done as conducted measurements. More details can be found in section 3.4 of this report.

Deviations from test standard:
NA

Test setup:
Test setup details can be found in section 3.4 of this report.

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

Test results:

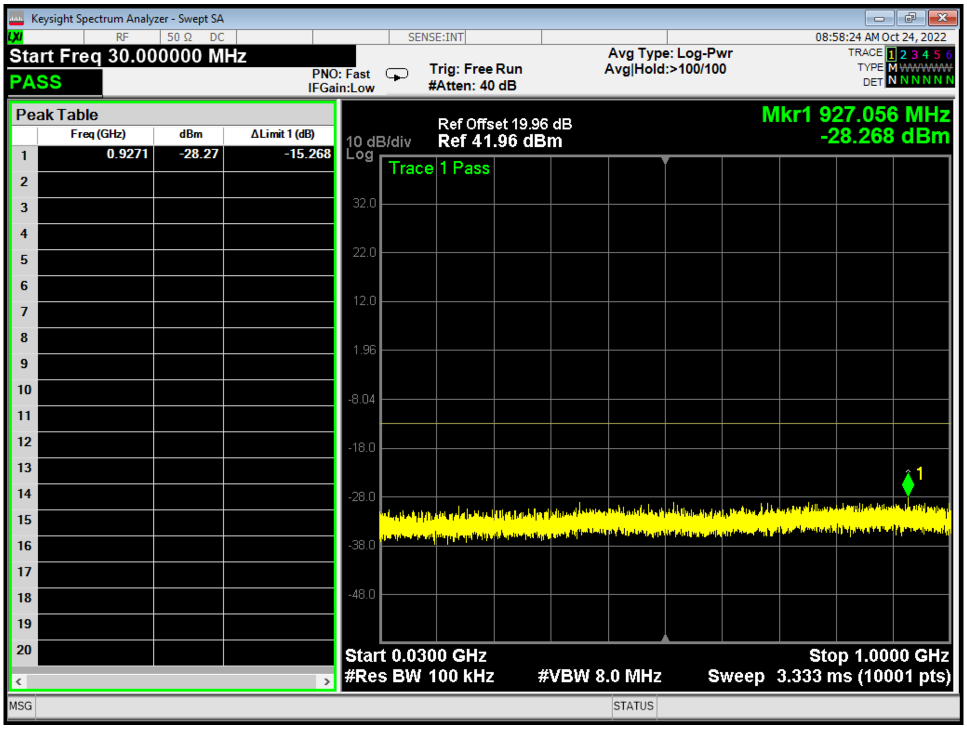


Figure 14 - Conducted Spurious Plot, 30M – 1G

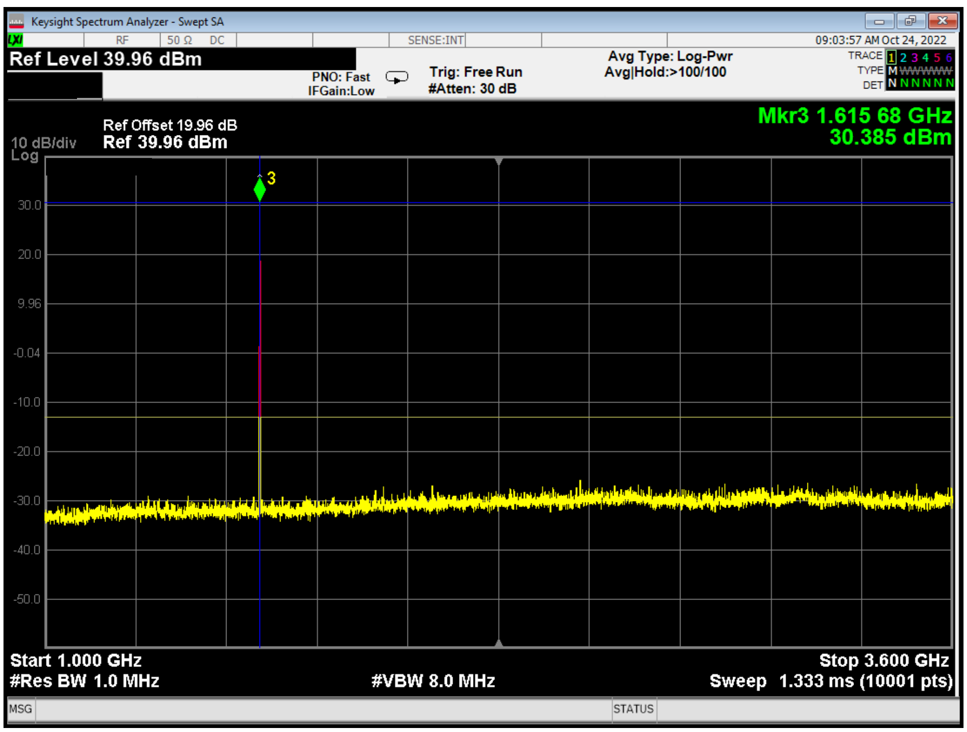


Figure 15 - Conducted Spurious Plot, 1G – 3.6G, Fundamental

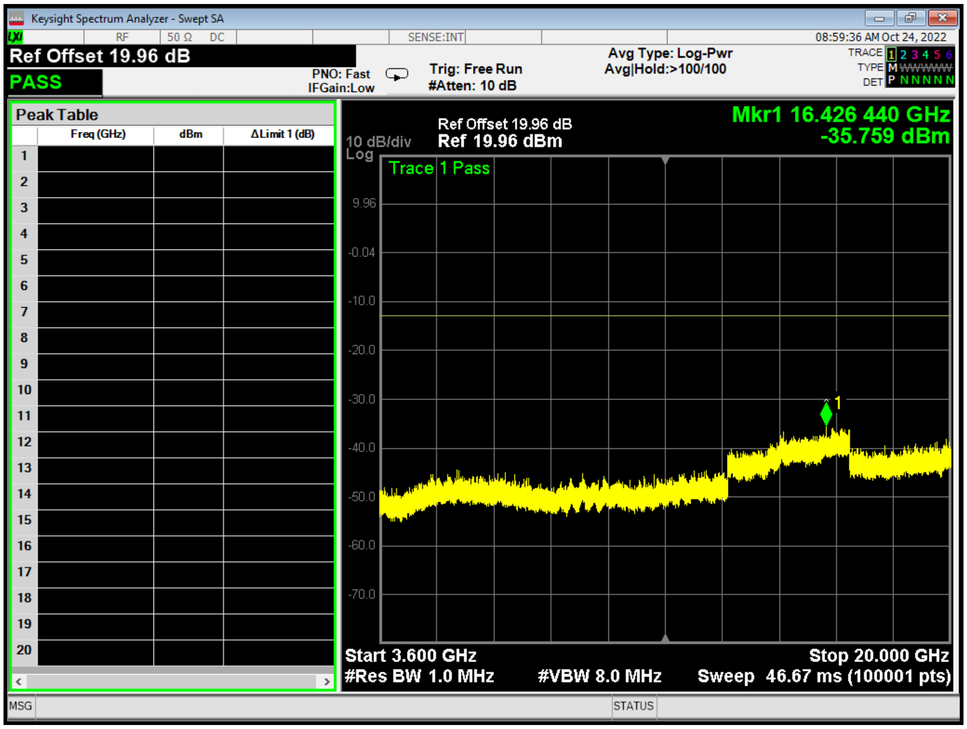


Figure 16 – Conducted Spurious Plot, 3.6G – 20G

4.5 FREQUENCY STABILITY

Test Method: ANSI C63.26-2015, Section 5.7.4

Limits of spurious emissions:

Frequency stability is tested:
a) At 10 C intervals of temperatures between -30 C and +50 C at the manufacturer's rated supply voltage, and
b) At +20 C temperature and ±15% supply voltage variations. If a product is specified to operate over a range of input voltage, then the -15% variation is applied to the lowermost voltage and the +15% is applied to the uppermost voltage.

Limit: 10 ppm

Test procedures:

All the measurements were done as conducted measurements. More details can be found in section 3.4 of this report.

Deviations from test standard:
NA

Test setup:
Test setup details can be found in section 3.4 of this report.

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

Test results:

Iridium				
	Voltage	**Frequency Error (Hz)**		
Temperature (°C)	**(VDC)**	**Ch 1**	**Ch 2**	**Ch 3**
	Nom=	**1616.020833 MHz**	**1620.979167 MHz**	**1625.979167 MHz**
-30	5	703	1008	649
-20	5	552	171	41
-10	5	159	84	117
0	5	123	159	221
10	5	127	210	128
20	5	364	101	103
30	5	128	40	234
40	5	147	155	144
50	5	127	100	161
Limit = 10 PPM		**Pass**	**Pass**	**Pass**

Iridium				
	Voltage	**Frequency Error (Hz)**		
Temperature (°C)	**(VDC)**	**Ch 1**	**Ch 2**	**Ch 3**
	Nom=	1616.020833 MHz	1620.979167 MHz	1625.979167 MHz
20	4.25	234	202	164
20	5	176	210	168
20	5.75	155	98	128
Worst case PPM		0.469053383	0.402842942	0.402219186
Limit = 10 PPM		Pass	Pass	Pass

4.6 MODULATION CHARACTERISTICS AND OCCUPIED BANDWIDTH

Test Method: FCC Part 2.1047(d)

Requirements:

Other types of equipment. A curve or equivalent data which shows that the equipment will meet the modulation requirements of the rules under which the equipment is to be licensed.

Test procedures:

All the measurements were done as conducted measurements. More details can be found in section 3.4 of this report.

Deviations from test standard:
NA

Test setup:
Test setup details can be found in section 3.4 of this report.

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

Test results:

The manufacturer provided the following modulation details:

Traffic, broadcast, and ring alert channels use differentially encoded quaternary phase shift keyed (DE-QPSK) modulation with 40% square root raised cosine pulse shaping. The burst transmission rate is 25ksps or 50 kbps. The phase of the QPSK symbol states relative to the carrier phase is (Symbol State/Phase in deg): 00/0, 01/-90, 10/+90, 11/180.

The acquisition channel uses differentially encoded binary phase shift keyed (DE-BPSK) with 40% square root raised cosine pulse shaping. The burst rate on these channels is 25 kbps. The sync channel uses 25 kbps DE-BPSK on the uplink and 50 kbps DE-QPSK on the downlink. Both with 40% square root raised cosine pulse shaping.

Following plots are provided supporting the modulation description provided by the manufacturer:

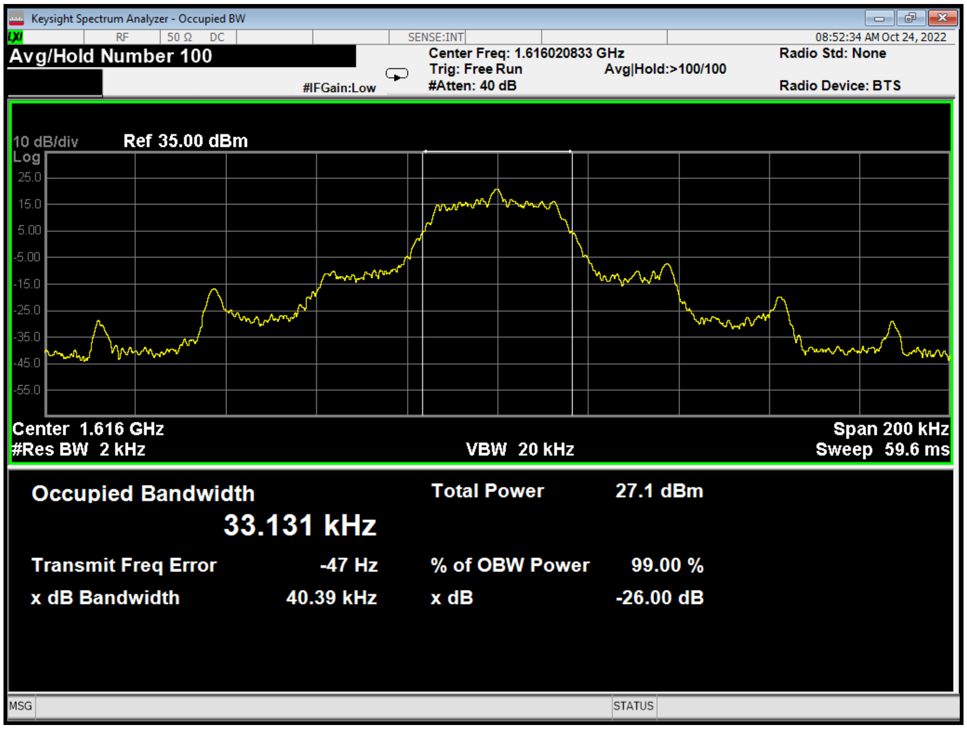


Figure 17 – Supporting Plots for modulation characteristic, Low Channel

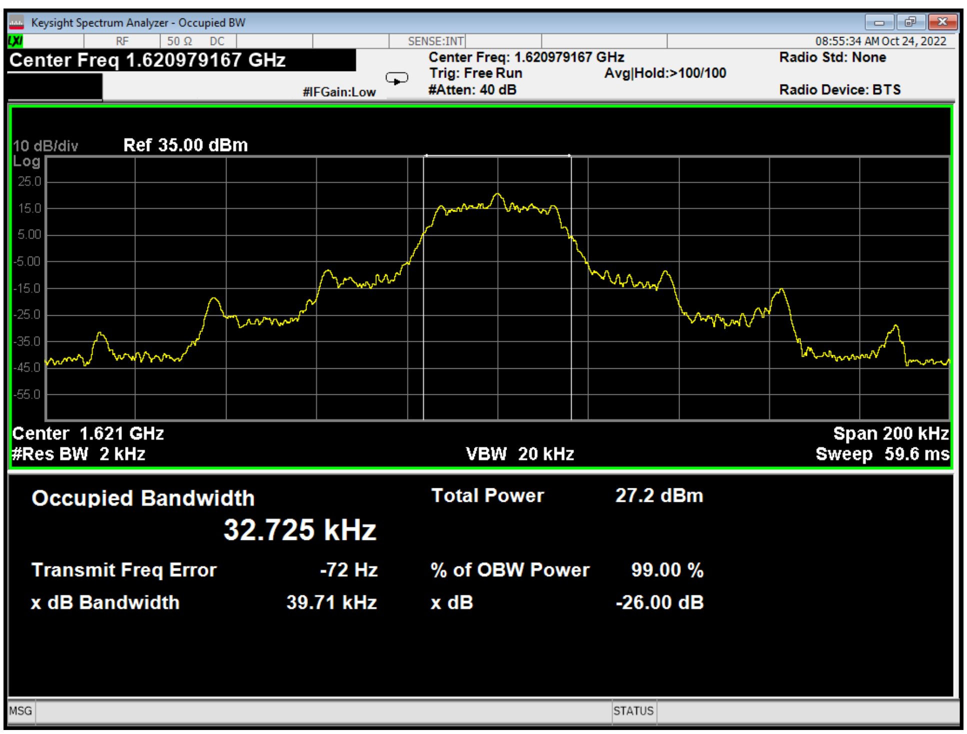


Figure 18 – Supporting Plots for modulation characteristic, Mid Channel

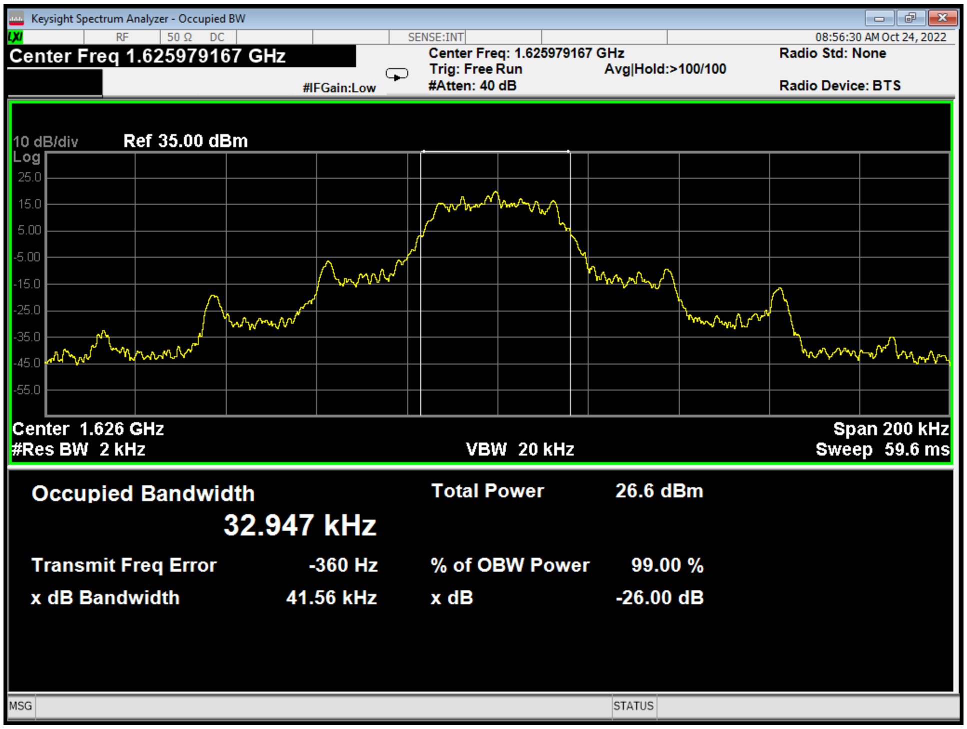


Figure 19 – Supporting Plots for modulation characteristic, High Channel

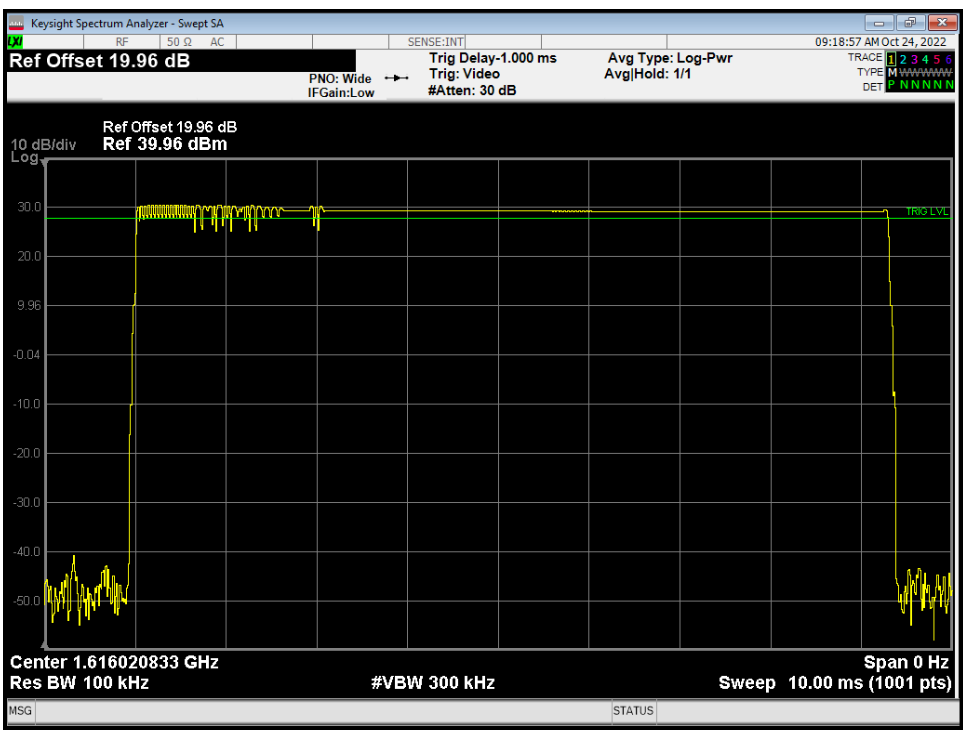


Figure 20 – Supporting Plots for modulation characteristic, Low Channel

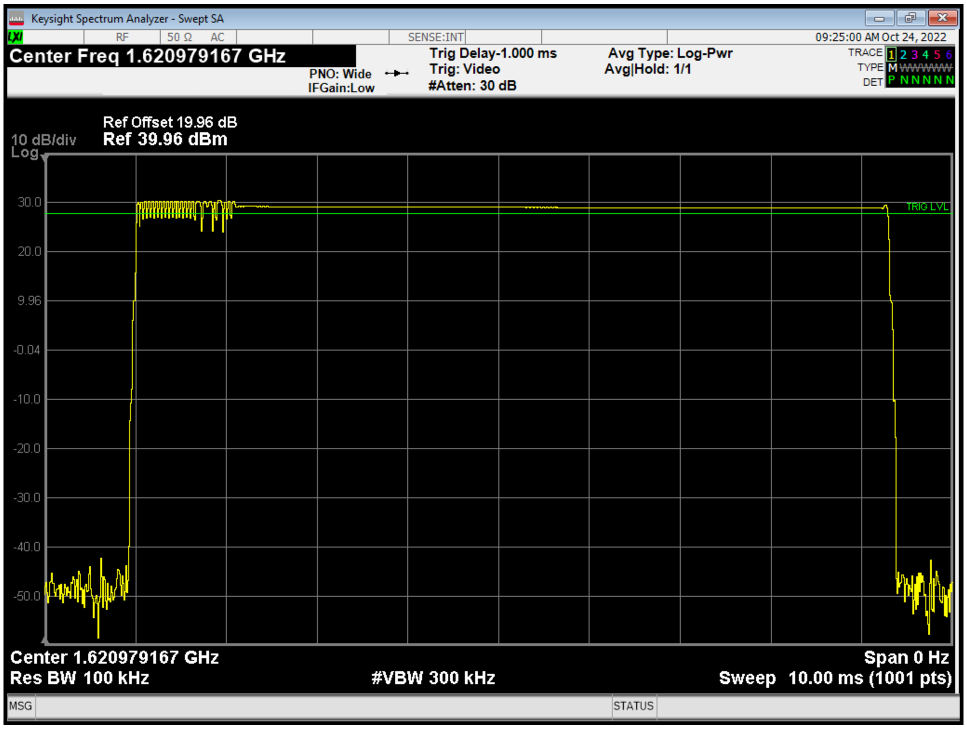


Figure 21 – Supporting Plots for modulation characteristic, Mid Channel

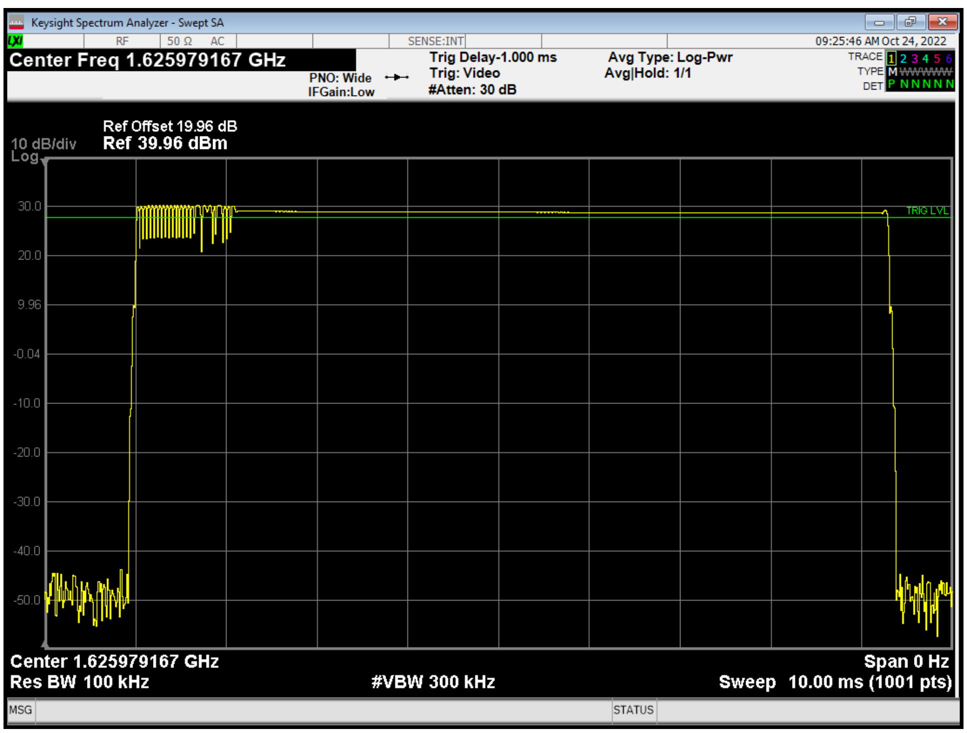


Figure 22 – Supporting Plots for modulation characteristic, High Channel

4.7 ANTENNA GAIN

Test procedures:
Device's conducted power was measured then then same measurement was repeated on a radiated sample at 3m test distance and converted to E.I.R.P.

Test setup:
Details can be found in section 2.1 of this report.

EUT operating conditions:
Details can be found in section 2.1 and 2.2 of this report.

Test results:

Antenna Gain:
Radiated Average power – Conducted Average Power = Antenna gain
31.935 dBm – 30.539 dBm = **1.396 dBi**

Comments:

1. None

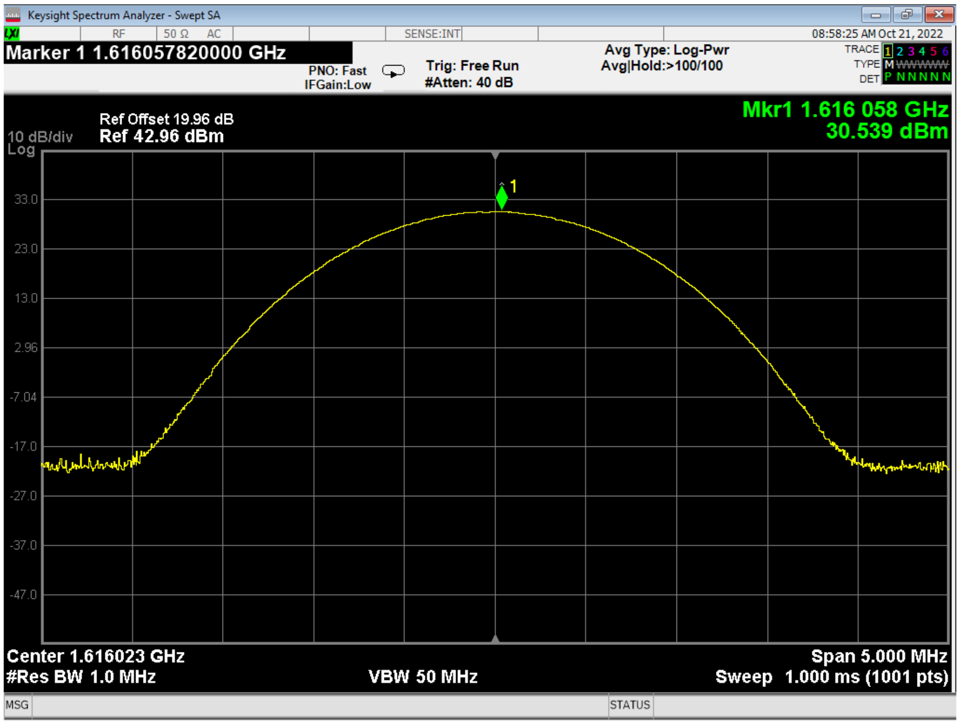


Figure 23 – Conducted Average Power Measurement, Iridium, Low

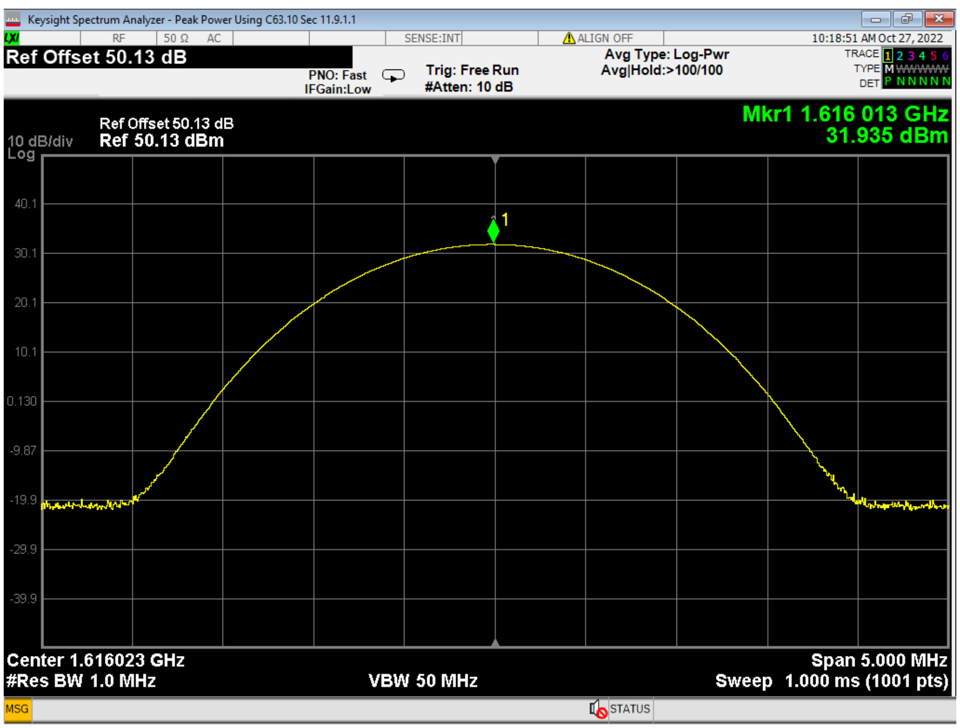


Figure 24 – Radiated Average Power Measurement, Iridium, Low

Reference offset includes EIRP conversion and corrections

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	±4.31
Radiated Emissions, 3m	1GHz - 18GHz	±5.08
Emissions limits, conducted	150kHz – 30MHz	±3.03

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

REPORT END

802 N. Twin Oaks Valley Road, Suite 105 • San Marcos, CA 92069 • U.S.A.
TEL (760) 471-2100 • FAX (760) 471-2121
http://www.rfexposurelab.com

CERTIFICATE OF COMPLIANCE
SAR EVALUATION

Garmin International, Inc.	Dates of Test: November 7-8, 2022
1200 E. 151st Street	Test Report Number: SAR.20221102
Olathe, KS 66062	Revision B
	Lab Designation Number: US1195(FCC) & US0194(ISED)

FCC ID:	IPH-A4624
IC Certificate:	1792A-A4624
Model(s):	AA4624
Test Sample:	Engineering Unit Same as Production
Serial Number:	Eng 1
Equipment Type:	Wireless GPS Location Device
Classification:	Portable Transmitter Next to Body
TX Frequency Range:	1616 – 1626 MHz; 2412 – 2462 MHz, 2402 – 2480 MHz
Frequency Tolerance:	± 2.5 ppm
Maximum RF Output:	1620 MHz – 31.0 dBm; 2450 MHz (b) – 17.0 dBm, 2450 MHz (g) – 16.0 dBm, 2450 MHz (n20) – 15.0 dBm, 2450 MHz (BT) – 3.5 dBm, 2450 MHz (ANT) – 3.5 dBm Conducted
Signal Modulation:	FDMA-FM; DSSS, OFDM, GFSK
Antenna Type:	Internal: WiFi/BT/ANT; External Stubby: Satellite
Application Type:	Certification
FCC Rule Parts:	Part 2, 15C, 25
KDB Test Methodology:	KDB 447498 D01 v06, KDB 248227 v02r02
Industry Canada:	RSS-102 Issue 5, Safety Code 6
Maximum SAR Value:	1.51 W/kg Reported
Simultaneous SAR Value:	0.04 Separation Ratio
Separation Distance:	0 mm

This wireless mobile and/or portable device has been shown to be compliant for localized specific absorption rate (SAR) for uncontrolled environment/general exposure limits specified in ANSI/IEEE Std. C95.1-1992 and had been tested in accordance with the measurement procedures specified in IEEE 1528-2013 and IEC 62209-2:2010 (See test report).
I attest to the accuracy of the data. All measurements were performed by myself or were made under my supervision and are correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.

RF Exposure Lab, LLC certifies that no party to this application is subject to a denial of Federal benefits that includes FCC benefits pursuant to Section 5301 of the Anti-Drug Abuse Act of 1988, 21 U.S.C. 853(a).

Jay M. Moulton
Vice President

ACCREDITED
Testing Cert. # 2387.01

Table of Contents

Comment/Revision	Date
Original Release	November 16, 2022
Revision A – Correct model number, FCC ID, IC certificate and change file name	December 20, 2022
Revision B – Correct model number, FCC ID, IC certificate and change file name	December 21, 2022

Note: The latest version supersedes all previous versions listed in the above table. The latest version shall be used.

1. Introduction

This measurement report shows compliance of the Garmin International, Inc. Model AA4624 FCC ID: IPH-A4624 with FCC Part 2, 1093, ET Docket 93-62 Rules and IC Certificate: 1792A-A4624 with RSS102 Issue 5 & Safety Code 6 for mobile and portable devices. The FCC/ISED have adopted the guidelines for evaluating the environmental effects of radio frequency radiation to protect the public and workers from the potential hazards of RF emissions due to FCC/ISED regulated portable devices. [1], [6]

The test results recorded herein are based on a single type test of Garmin International, Inc. Model AA4624 and therefore apply only to the tested sample.

The test procedures and limits, as described in ANSI C95.1 – 1999 Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz [2], ANSI C95.3 – 2002 Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields [3], IEEE Std.1528 – 2013 Recommended Practice [5], and Industry Canada Safety Code 6 Limits of Human Exposure to Radiofrequency Electromagnetic Fields in the Frequency Range from 3kHz to 300 GHz were employed.

The following table indicates all the wireless technologies operating in the AA4624 Wireless GPS Location Device. The table also shows the tolerance for the power level for each mode.

Band	Modulation	Calibrated Nominal Power dBm	Tolerance dBm	Lower Tolerance dBm	Upper Tolerance dBm
1620 MHz	FDMA-FM	N/A	N/A	N/A	31.0
2450 MHz	802.11b	N/A	N/A	N/A	17.0
2450 MHz	802.11g	N/A	N/A	N/A	16.0
2450 MHz	802.11n20	N/A	N/A	N/A	15.0
2450 MHz	Ant+	N/A	N/A	N/A	3.5
2450 MHz	Bluetooth	N/A	N/A	N/A	3.5

SAR Definition [5]

Specific Absorption Rate is defined as the time derivative (rate) of the incremental energy (*dW*) absorbed by (dissipated in) an incremental mass (*dm*) contained in a volume element (*dV*) of a given density (ρ).

$$SAR = \frac{d}{dt}\left(\frac{dW}{dm}\right) = \frac{d}{dt}\left(\frac{dW}{\rho dV}\right)$$

SAR is expressed in units of watts per kilogram (W/kg). *SAR* can be related to the electric field at a point by

$$SAR = \frac{\sigma \mid E \mid^2}{\rho}$$

where:

σ = conductivity of the tissue (S/m)
ρ = mass density of the tissue (kg/m^3)
E = rms electric field strength (V/m)

2. SAR Measurement Setup

Robotic System

These measurements are performed using the DASY52 automated dosimetric assessment system. The DASY52 is made by Schmid & Partner Engineering AG (SPEAG) in Zurich, Switzerland and consists of high precision robotics system (Staubli), robot controller, Intel Core2 computer, near-field probe, probe alignment sensor, and the generic twin phantom containing the brain equivalent material. The robot is a six-axis industrial robot performing precise movements to position the probe to the location (points) of maximum electromagnetic field (EMF) (see Fig. 2.1).

System Hardware

A cell controller system contains the power supply, robot controller teach pendant (Joystick), and a remote control used to drive the robot motors. The PC consists of the HP Intel Core2 computer with Windows XP system and SAR Measurement Software DASY52, A/D interface card, monitor, mouse, and keyboard. The Staubli Robot is connected to the cell controller to allow software manipulation of the robot. A data acquisition electronic (DAE) circuit that performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. is connected to the Electro-optical coupler (EOC). The EOC performs the conversion from the optical into digital electric signal of the DAE and transfers data to the PC plug-in card.

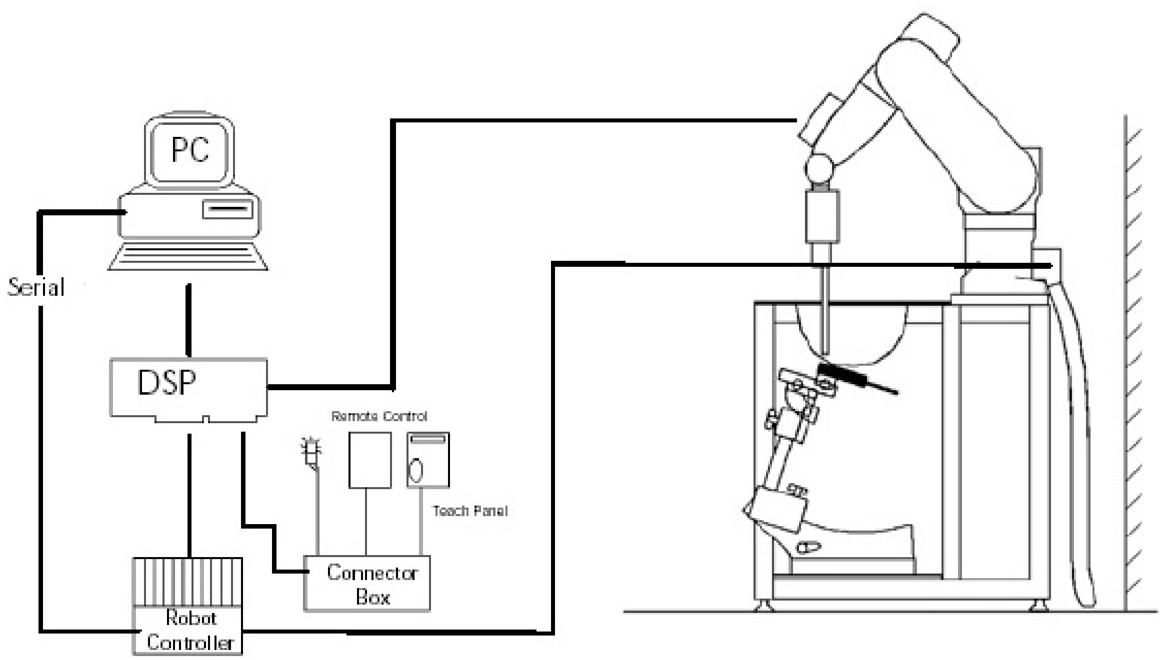


Figure 2.1 SAR Measurement System Setup

System Electronics

The DAE4 consists of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD-converter and a command decoder and control logic unit. Transmission to the PC-card is accomplished through an optical downlink for data and status information and an optical uplink for commands and clock lines. The mechanical probe mounting device includes two different sensor systems for frontal and sidewise probe contacts. They are also used for mechanical surface detection and probe collision detection. The robot uses its own controller with a built in VME-bus computer. The system is described in detail in.

Probe Measurement System

The SAR measurements were conducted with the dosimetric probe EX3DV4, designed in the classical triangular configuration (see Fig. 2.2) and optimized for dosimetric evaluation. The probe is constructed using the thick film technique; with printed resistive lines on ceramic substrates. The probe is equipped with an optical multi fiber line ending at the front of the probe tip. (see Fig. 2.3) It is connected to the EOC box on the robot arm and provides an automatic detection of the phantom surface. Half of the fibers are connected to a pulsed infrared transmitter, the other half to a synchronized receiver. As the probe approaches the surface, the reflection from the surface produces a coupling from the transmitting to the receiving fibers. This reflection increases first during the approach, reaches maximum and then decreases. If the probe is flatly touching the surface, the coupling is zero. The distance of the coupling maximum to the surface is independent of the surface reflectivity and largely independent of the surface to probe angle. The DASY52 software reads the reflection during a software approach and looks for the maximum using a 2nd order fitting. The approach is stopped at reaching the maximum.

DAE System

Probe Specifications

Calibration: In air from 10 MHz to 6.0 GHz
In brain and muscle simulating tissue at Frequencies of 450 MHz, 835 MHz, 1750 MHz, 1900 MHz, 2450 MHz, 2600 MHz, 3500 MHz, 5200 MHz, 5300 MHz, 5600 MHz, 5800 MHz

Frequency: 10 MHz to 6 GHz

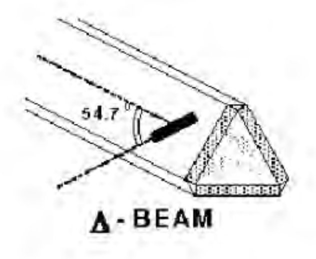


Figure 2.2 Triangular Probe Configurations

Linearity: ±0.2dB (30 MHz to 6 GHz)

Dynamic: 10 mW/kg to 100 W/kg

Range: Linearity: ±0.2dB

Dimensions: Overall length: 330 mm

Tip length: 20 mm

Body diameter: 12 mm

Tip diameter: 2.5 mm

Distance from probe tip to sensor center: 1 mm

Figure 2.3 Probe Thick-Film Technique

Application: SAR Dosimetry Testing
Compliance tests of wireless device

Probe Calibration Process

Dosimetric Assessment Procedure

Each probe is calibrated according to a dosimetric assessment procedure described in with accuracy better than +/- 10%. The spherical isotropy was evaluated with the procedure described in and found to be better than +/- 0.25dB. The sensitivity parameters (Norm X, Norm Y, Norm Z), the diode compression parameter (DCP) and the conversion factor (Conv F) of the probe is tested.

Free Space Assessment

The free space E-field from amplified probe outputs is determined in a test chamber. This is performed in a TEM cell for frequencies below 1 GHz, and in a waveguide above 1GHz for free space. For the free space calibration, the probe is placed in the volumetric center of the cavity at the proper orientation with the field. The probe is then rotated 360 degrees until the three channels show the maximum reading. The power density readings equates to 1 mW/cm^2.

Temperature Assessment *

E-field temperature correlation calibration is performed in a flat phantom filled with the appropriate simulated brain tissue. The measured free space E-field in the medium, correlates to temperature rise in a dielectric medium. For temperature correlation calibration a RF transparent thermistor based temperature probe is used in conjunction with the E-field probe

$$\text{SAR} = C\frac{\Delta T}{\Delta t}$$

where:

Δt = exposure time (30 seconds),

C = heat capacity of tissue (brain or muscle),

ΔT = temperature increase due to RF exposure.

$$\text{SAR} = \frac{|E|^2 \cdot \sigma}{\rho}$$

where:

σ = simulated tissue conductivity,

ρ = Tissue density (1.25 g/cm^3 for brain tissue)

SAR is proportional to $\Delta T / \Delta t$, the initial rate of tissue heating, before thermal diffusion takes place.
Now it's possible to quantify the electric field in the simulated tissue by equating the thermally derived SAR to the E- field;

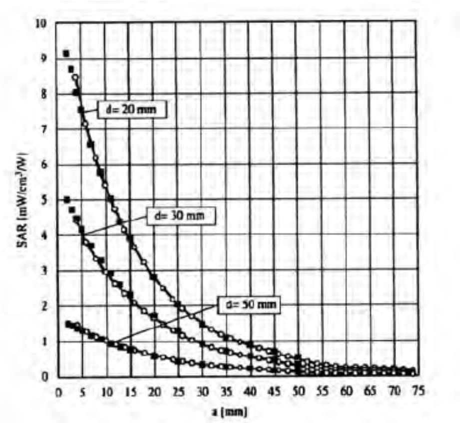


Figure 2.4 E-Field and Temperature Measurements at 900MHz

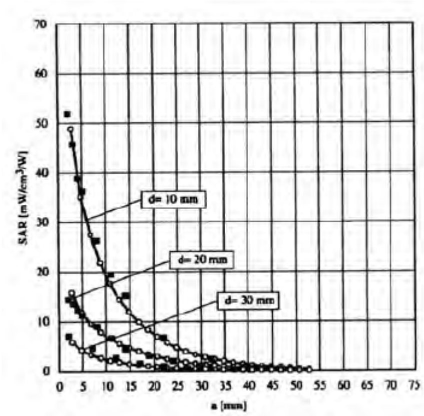


Figure 2.5 E-Field and Temperature Measurements at 1800MHz

Data Extrapolation

The DASY52 software automatically executes the following procedures to calculate the field units from the microvolt readings at the probe connector. The first step of the evaluation is a linearization of the filtered input signal to account for the compression characteristics of the detector diode. The compensation depends on the input signal, the diode type and the DC-transmission factor from the diode to the evaluation electronics. If the exciting field is pulsed, the crest factor of the signal must be known to correctly compensate for peak power. The formula for each channel can be given like below;

$$V_i = U_i + U_i^2 \cdot \frac{cf}{dcp_i}$$

with V_i = compensated signal of channel i (i=x,y,z)
U_i = input signal of channel i (i=x,y,z)
cf = crest factor of exciting field (DASY parameter)
dcp_i = diode compression point (DASY parameter)

From the compensated input signals the primary field data for each channel can be evaluated:

E-field probes:

$$E_i = \sqrt{\frac{V_i}{Norm_i \cdot ConvF}}$$

with V_i = compensated signal of channel i (i = x,y,z)
$Norm_i$ = sensor sensitivity of channel i (i = x,y,z) $\mu V/(V/m)^2$ for E-field probes
ConvF = sensitivity of enhancement in solution
E_i = electric field strength of channel i in V/m

The RSS value of the field components gives the total field strength (Hermetian magnitude):

$$E_{tot} = \sqrt{E_x^2 + E_y^2 + E_z^2}$$

The primary field data are used to calculate the derived field units.

$$SAR = E_{tot}^2 \cdot \frac{\sigma}{\rho \cdot 1000}$$

with SAR = local specific absorption rate in W/g
E_{tot} = total field strength in V/m
σ = conductivity in [mho/m] or [Siemens/m]
ρ = equivalent tissue density in g/cm^3

The power flow density is calculated assuming the excitation field to be a free space field.

$$P_{pwe} = \frac{E_{tot}^2}{3770}$$

with P_{pwe} = equivalent power density of a plane wave in W/cm^2
E_{tot} = total electric field strength in V/m

Scanning procedure

- The DASY installation includes predefined files with recommended procedures for measurements and system check. They are read-only document files and destined as fully defined but unmeasured masks. All test positions (head or body-worn) are tested with the same configuration of test steps differing only in the grid definition for the different test positions.

- The „reference“ and „drift“ measurements are located at the beginning and end of the batch process. They measure the field drift at one single point in the liquid over the complete procedure. The indicated drift is mainly the variation of the DUT's output power and should vary max. +/- 5 %.

- The highest integrated SAR value is the main concern in compliance test applications. These values can mostly be found at the inner surface of the phantom and cannot be measured directly due to the sensor offset in the probe. To extrapolate the surface values, the measurement distances to the surface must be known accurately. A distance error of 0.5mm could produce SAR errors of 6% at 1800 MHz. Using predefined locations for measurements is not accurate enough. Any shift of the phantom (e.g., slight deformations after filling it with liquid) would produce high uncertainties. For an automatic and accurate detection of the phantom surface, the DASY5 system uses the mechanical surface detection. The detection is always at touch, but the probe will move backward from the surface the indicated distance before starting the measurement.

- The „area scan“ measures the SAR above the DUT or verification dipole on a parallel plane to the surface. It is used to locate the approximate location of the peak SAR with 2D spline interpolation. The robot performs a stepped movement along one grid axis while the local electrical field strength is measured by the probe. The probe is touching the surface of the SAM during acquisition of measurement values. The scan uses different grid spacings for different frequency measurements. Standard grid spacing for head measurements in frequency ranges ≤ 2GHz is 15 mm in x - and y- dimension. For higher frequencies a finer resolution is needed, thus for the grid spacing is reduced according the following table:

Area scan grid spacing for different frequency ranges	
Frequency range	Grid spacing
≤ 2 GHz	≤ 15 mm
2 – 4 GHz	≤ 12 mm
4 – 6 GHz	≤ 10 mm

Grid spacing and orientation have no influence on the SAR result. For special applications where the standard scan method does not find the peak SAR within the grid, e.g. mobile phones with flip cover, the grid can be adapted in orientation. Results of this coarse scan are shown in annex B.

- A „zoom scan" measures the field in a volume around the 2D peak SAR value acquired in the previous „coarse" scan. It uses a fine meshed grid where the robot moves the probe in steps along all the 3 axis (x,y and z-axis) starting at the bottom of the Phantom. The grid spacing for the cube measurement is varied according to the measured frequency range, the dimensions are given in the following table:

Zoom scan grid spacing and volume for different frequency ranges			
Frequency range	Grid spacing for x, y axis	Grid spacing for z axis	Minimum zoom scan volume
≤ 2 GHz	≤ 8 mm	≤ 5 mm	≥ 30 mm
2 – 3 GHz	≤ 5 mm	≤ 5 mm	≥ 28 mm
3 – 4 GHz	≤ 5 mm	≤ 4 mm	≥ 28 mm
4 – 5 GHz	≤ 4 mm	≤ 3 mm	≥ 25 mm
5 – 6 GHz	≤ 4 mm	≤ 2 mm	≥ 22 mm

DASY is also able to perform repeated zoom scans if more than 1 peak is found during area scan. In this document, the evaluated peak 1g and 10g averaged SAR values are shown in the 2D-graphics in annex B. Test results relevant for the specified standard (see section 3) are shown in table form in section 7.

Spatial Peak SAR Evaluation

The spatial peak SAR - value for 1 and 10 g is evaluated after the Cube measurements have been done. The basis of the evaluation are the SAR values measured at the points of the fine cube grid consisting of all points in the three directions x, y and z. The algorithm that finds the maximal averaged volume is separated into three different stages.

- The data between the dipole center of the probe and the surface of the phantom are extrapolated. This data cannot be measured since the center of the dipole is 1 to 2.7 mm away from the tip of the probe and the distance between the surface and the lowest measuring point is about 1 mm (see probe calibration sheet). The extrapolated data from a cube measurement can be visualized by selecting 'Graph Evaluated'.

- The maximum interpolated value is searched with a straight-forward algorithm. Around this maximum the SAR - values averaged over the spatial volumes (1g or 10 g) are computed using the 3d-spline interpolation algorithm. If the volume cannot be evaluated (i.e., if a part of the grid was cut off by the boundary of the measurement area) the evaluation will be started on the corners of the bottom plane of the cube.

- All neighbouring volumes are evaluated until no neighbouring volume with a higher average value is found.

Extrapolation

The extrapolation is based on a least square algorithm [W. Gander, Computermathematik, p.168-180]. Through the points in the first 3 cm along the z-axis, polynomials of order four are calculated. These polynomials are then used to evaluate the points between the surface and the probe tip. The points, calculated from the surface, have a distance of 1 mm from each other.

Interpolation

The interpolation of the points is done with a 3d-Spline. The 3d-Spline is composed of three one-dimensional splines with the "Not a knot"-condition [W. Gander, Computermathematik, p.141-150] (x, y and z -direction) [Numerical Recipes in C, Second Edition, p.123ff].

Volume Averaging

At First the size of the cube is calculated. Then the volume is integrated with the trapezoidal algorithm. 8000 points (20x20x20) are interpolated to calculate the average.

Advanced Extrapolation

DASY uses the advanced extrapolation option which is able to compensate boundary effects on E-field probes.

SAM PHANTOM

The SAM Twin Phantom V4.0 is constructed of a fiberglass shell integrated in a wooden table. The shape of the shell is based on data from an anatomical study designed to determine the maximum exposure in at least 90% of all users. It enables the dosimetric evaluation of left and right hand phone usage as well as body mounted usage at the flat phantom region. A cover prevents the evaporation of the liquid. Reference markings on the Phantom allow the complete setup of all predefined phantom positions and measurement grids by manually teaching three points in the robot. (see Fig. 2.6)

Phantom Specification

Phantom: SAM Twin Phantom (V4.0)
Shell Material: Vivac Composite
Thickness: 2.0 ± 0.2 mm

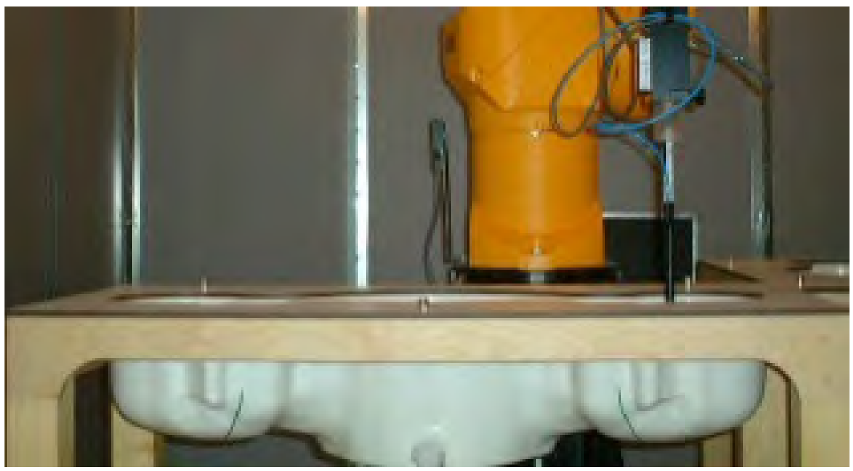


Figure 2.6 SAM Twin Phantom

Device Holder for Transmitters

In combination with the SAM Twin Phantom V4.0 the Mounting Device (see Fig. 2.7), enables the rotation of the mounted transmitter in spherical coordinates whereby the rotation point is the ear opening. The devices can be easily, accurately, and repeat ably be positioned according to the FCC, CENELEC, IEC and IEEE specifications. The device holder can be locked at different phantom locations (left head, right head, flat phantom).

Figure 2.7 Mounting Device

Note: A simulating human hand is not used due to the complex anatomical and geometrical structure of the hand that may produce infinite number of configurations. To produce the worst-case condition (the hand absorbs antenna output power), the hand is omitted during the tests.

3. Probe and Dipole Calibration

See Appendix D and E.

4. Phantom & Simulating Tissue Specifications

Head & Body Simulating Mixture Characterization

The head and body mixtures consist of the material based on the table listed below. The mixture is calibrated to obtain proper dielectric constant (permittivity) and conductivity of the desired tissue. Body tissue parameters that have not been specified in IEEE1528 – 2013 are derived from the issue dielectric parameters computed from the 4-Cole-Cole equations.

Table 4.1 Typical Composition of Ingredients for Tissue

Ingredients		Simulating Tissue	
		1640 MHz Head	2450 MHz Head
Mixing Percentage			
Water		Proprietary Mixture Procured from Speag	Proprietary Mixture Procured from Speag
Sugar			
Salt			
HEC			
Bactericide			
DGBE			
Dielectric Constant	Target	40.20	39.20
Conductivity (S/m)	Target	1.31	1.80

5. ANSI/IEEE C95.1 – 1992 RF Exposure Limits [2]

Uncontrolled Environment

Uncontrolled Environments are defined as locations where there is the exposure of individuals who have no knowledge or control of their exposure. The general population/uncontrolled exposure limits are applicable to situations in which the general public may be exposed or in which persons who are exposed as a consequence of their employment may not be made fully aware of the potential for exposure or cannot exercise control over their exposure. Members of the general public would come under this category when exposure is not employment-related; for example, in the case of a wireless transmitter that exposes persons in its vicinity.

Controlled Environment

Controlled Environments are defined as locations where there is exposure that may be incurred by persons who are aware of the potential for exposure, (i.e. as a result of employment or occupation). In general, occupational/controlled exposure limits are applicable to situations in which persons are exposed as a consequence of their employment, who have been made fully aware of the potential for exposure and can exercise control over their exposure. This exposure category is also applicable when the exposure is of a transient nature due to incidental passage through a location where the exposure levels may be higher than the general population/uncontrolled limits, but the exposed person is fully aware of the potential for exposure and can exercise control over his or her exposure by leaving the area or by some other appropriate means.

Table 5.1 Human Exposure Limits

	UNCONTROLLED ENVIRONMENT General Population (W/kg) or (mW/g)	CONTROLLED ENVIROMENT Professional Population (W/kg) or (mW/g)
SPATIAL PEAK SAR [1] Head	1.60	8.00
SPATIAL AVERAGE SAR [2] Whole Body	0.08	0.40
SPATIAL PEAK SAR [3] Hands, Feet, Ankles, Wrists	4.00	20.00

[1] The Spatial Peak value of the SAR averaged over any 1 gram of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.
[2] The Spatial Average value of the SAR averaged over the whole body.
[3] The Spatial Peak value of the SAR averaged over any 10 grams of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.

6. Measurement Uncertainty

Exposure Assessment Measurement Uncertainty

Relative DASY5 Uncertainty Budget for SAR Tests								
According to IEC62209-2/2010 (30 MHz - 6 GHz range)								
Error Description	Uncertainty Value	Probability Distribution	Divisor	c_i (1g)	c_i (10g)	Standard Uncertainty ± %, (1g)	Standard Uncertainty ± %, (10g)	v_i^2 or v_{eff}
Measurement System								
Probe calibration	± 6.6%	Normal	1	1	1	± 6.6%	± 6.6%	∞
Axial isotropy	± 4.7%	Rectangular	√3	0.7	0.7	± 1.9%	± 1.9%	∞
Hemispherical isotropy	± 9.6%	Rectangular	√3	0.7	0.7	± 3.9%	± 3.9%	∞
Boundary effects	± 2.0%	Rectangular	√3	1	1	± 1.2%	± 1.2%	∞
Probe linearity	± 4.7%	Rectangular	√3	1	1	± 2.7%	± 2.7%	∞
System detection limits	± 1.0%	Rectangular	√3	1	1	± 0.6%	± 0.6%	∞
Modulation response	± 2.4%	Rectangular	√3	1	1	± 1.4%	± 1.4%	∞
Readout electronics	± 0.3%	Normal	1	1	1	± 0.3%	± 0.3%	∞
Response time	± 0.8%	Rectangular	√3	1	1	± 0.5%	± 0.5%	∞
Integration time	± 2.6%	Rectangular	√3	1	1	± 1.5%	± 1.5%	∞
RF ambient noise	± 3.0%	Rectangular	√3	1	1	± 1.7%	± 1.7%	∞
RF ambient reflections	± 3.0%	Rectangular	√3	1	1	± 1.7%	± 1.7%	∞
Probe positioner	± 0.8%	Rectangular	√3	1	1	± 0.5%	± 0.5%	∞
Probe positioning	± 6.7%	Rectangular	√3	1	1	± 3.9%	± 3.9%	∞
Post-processing	± 4.0%	Rectangular	√3	1	1	± 2.3%	± 2.3%	∞
Test Sample Related								
Device positioning	± 2.9%	Normal	1	1	1	± 2.9%	± 2.9%	145
Device holder uncertainty	± 3.6%	Normal	1	1	1	± 3.6%	± 3.6%	5
Power drift	± 5.0%	Rectangular	√3	1	1	± 2.9%	± 2.9%	∞
Phantom and Setup								
Phantom uncertainty	± 7.9%	Rectangular	√3	1	1	± 4.6%	± 4.6%	∞
SAR algorithm correction	± 1.9%	Normal	1	1	0.84	± 1.9%	± 1.9%	∞
Liquid conductivity (meas.)	± 5.0%	Rectangular	√3	0.78	0.71	± 0.1%	± 0.1%	∞
Liquid permittivity (meas.)	± 5.0%	Rectangular	√3	0.26	0.26	± 0.1%	± 0.1%	∞
Temp. Unc. – Conductivity	± 3.4%	Rectangular	√3	0.78	0.71	± 1.5%	± 1.5%	∞
Temp. Unc. – Permittivity	± 0.4%	Rectangular	√3	0.23	0.26	± 0.1%	± 0.1%	∞
Combined Uncertainty						± 12.4%	± 12.3%	330
Expanded Std. Uncertainty						± 24.8%	± 24.6%	

Worst case uncertainty budget for DASY5 assessed according to IEC62209-2/2010 standard. The budget is valid for the frequency range 30 MHz – 6 GHz and represents a worst-case analysis. For specific tests and configurations, the uncertainty could be considerable smaller.

7. System Verification

Tissue Verification

Table 7.1 Measured Tissue Parameters

		1640 MHz Head		2450 MHz Head	
Date(s)		Nov. 7, 2022		Nov. 7, 2022	
Liquid Temperature (˚C)	20.0	Target	Measured	Target	Measured
Dielectric Constant: ε		40.23	39.66	39.20	38.57
Conductivity: σ		1.30	1.32	1.80	1.84

See Appendix A for data printout.

Test System Verification

Prior to assessment, the system is verified to the ±10% of the specifications at the test frequency by using the system kit. Power is normalized to 1 watt. (Graphic Plots Attached)

Table 7.2 System Dipole Verification Target & Measured

	Test Frequency	Targeted SAR_{1g} (W/kg)	Measure SAR_{1g} (W/kg)	Tissue Used for Verification	Deviation (%)	Plot Number
07-Nov-2022	1640 MHz	34.40	34.60	Head	+ 0.58	1
07-Nov-2022	2450 MHz	54.10	52.70	Head	- 3.88	2

See Appendix A for data plots.

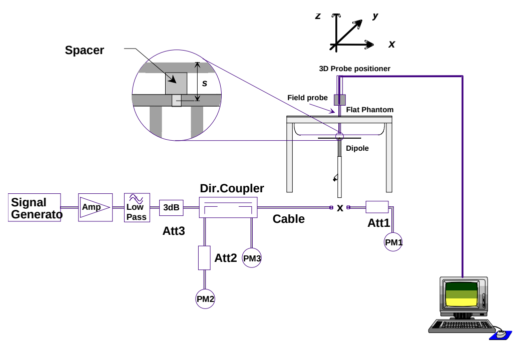


Figure 7.1 Dipole Verification Test Setup

8. SAR Test Data Summary

See Measurement Result Data Pages

See Appendix B for SAR Test Data Plots.
See Appendix C for SAR Test Setup Photos.

Procedures Used To Establish Test Signal

The device was either placed into simulated transmit mode using the manufacturer's test codes or the actual transmission is activated through a base station simulator or similar equipment. See data pages for actual procedure used in measurement.

Device Test Condition

In order to verify that the device was tested at full power, conducted output power measurements were performed before and after each SAR measurement to confirm the output power unless otherwise noted. If a conducted power deviation of more than 5% occurred, the test was repeated. The power drift of each test is measured at the start of the test and again at the end of the test. The drift percentage is calculated by the formula ((end/start)-1)*100 and rounded to three decimal places. The drift percentage is calculated into the resultant SAR value on the data sheet for each test.

The testing was conducted on the front, back, left and right of the unit with 0 mm gap. The device would only be next to the body. The top and bottom was not tested as it would not be close to the body.

The maximum transmit duty cycle is 25% for the satellite transmitter in 1640 MHz band. The unit was measured at the 25% duty cycle and the SAR value was scaled to the upper end of the tolerance. All measurements were conducted with the device on a minimum of 10 cm of Styrofoam.

The data rates used when evaluating the WiFi transmitter were the lowest data rates for each mode. The device was operating at its maximum output power at the lowest data rate for all measurements.

The BLE and ANT transmitters are excluded due to the low power of the transmitters. Both transmitters maximum Tx power is 3.5 dBm (2.2 mW) which is below the threshold to be excluded for both the FCC and ISED.

1620 MHz		
Freq	Channel	Power Measured
1616.02	1	30.539
1620.98	2	30.449
1625.98	3	30.346

Conduct Power Measurements

Band	Mode	Bandwidth (MHz)	Channel	Frequency (MHz)	Data Rate	Avg Power (dBm)	Tune-up Pwr (dBm)
2450 MHz	802.11b	20	1	2412	1 Mbps	15.38	17.0
			6	2437		15.01	17.0
			11	2462		16.74	17.0
	802.11g	20	1	2412	6 Mbps	Not Required	16.0
			6	2437			16.0
			11	2462			16.0
	802.11n	20	1	2412	HT0		15.0
			6	2437			15.0
			11	2462			15.0

Figure 8.1 Test Reduction Table – 1640 MHz

Band	Side	Required Channel	Tested/Reduced
1640 MHz	Back	1 – 1616.02 MHz	Reduced[1]
		2 – 1620.98 MHz	Tested
		3 – 1625.98 MHz	Reduced[1]
	Front	1 – 1616.02 MHz	Tested
		2 – 1620.98 MHz	Tested
		3 – 1625.98 MHz	Tested
	Left	1 – 1616.02 MHz	Reduced[1]
		2 – 1620.98 MHz	Tested
		3 – 1625.98 MHz	Reduced[1]
	Right	1 – 1616.02 MHz	Reduced[1]
		2 – 1620.98 MHz	Tested
		3 – 1625.98 MHz	Reduced[1]

Reduced[1] – When the reported SAR is ≤ 0.8 W/kg, SAR is not required for the remaining test configuration per KDB 447498 D01 v06 section 4.4.1 a) page 16.

Figure 8.2 Test Reduction Table – 2.4 GHz

Mode	Side	Required Channel	Tested/Reduced
802.11b	Back	1 – 2412 MHz	Reduced[1]
		6 – 2437 MHz	Tested
		11 – 2462 MHz	Reduced[1]
	Front	1 – 2412 MHz	Reduced[1]
		6 – 2437 MHz	Tested
		11 – 2462 MHz	Reduced[1]
	Left	1 – 2412 MHz	Reduced[1]
		6 – 2437 MHz	Tested
		11 – 2462 MHz	Reduced[1]
	Right	1 – 2412 MHz	Tested
		6 – 2437 MHz	Tested
		11 – 2462 MHz	Tested
802.11g	Back	1 – 2412 MHz	Reduced[3]
		6 – 2437 MHz	Reduced[3]
		11 – 2462 MHz	Reduced[3]
	Front	1 – 2412 MHz	Reduced[3]
		6 – 2437 MHz	Reduced[3]
		11 – 2462 MHz	Reduced[3]
	Left	1 – 2412 MHz	Reduced[3]
		6 – 2437 MHz	Reduced[3]
		11 – 2462 MHz	Reduced[3]
	Right	1 – 2412 MHz	Reduced[3]
		6 – 2437 MHz	Reduced[3]
		11 – 2462 MHz	Reduced[3]
802.11n	Back	1 – 2412 MHz	Reduced[3]
		6 – 2437 MHz	Reduced[3]
		11 – 2462 MHz	Reduced[3]
	Front	1 – 2412 MHz	Reduced[3]
		6 – 2437 MHz	Reduced[3]
		11 – 2462 MHz	Reduced[3]
	Left	1 – 2412 MHz	Reduced[3]
		6 – 2437 MHz	Reduced[3]
		11 – 2462 MHz	Reduced[3]
	Right	1 – 2412 MHz	Reduced[3]
		6 – 2437 MHz	Reduced[3]
		11 – 2462 MHz	Reduced[3]

Reduced[1] – When the reported SAR is ≤ 0.4 W/kg, SAR is not required for the remaining test configuration per KDB 248227 D01 v02r02 section 5.1.1 1) page 9.

Reduced[2] – When the reported SAR is >0.4 W/kg, test the next highest configuration until the SAR value is ≤ 0.8 W/kg per KDB 248227 D01 v02r02 section 5.1.1 2) page 9.

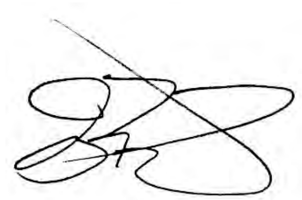
Reduced[3] – When the highest reported SAR for DSSS is adjusted by the ratio of OFDM to DSSS specified maximum output power and the adjusted SAR is ≤ 1.2 W/kg, SAR is not required per KDB 248227 D01 v02r02 section 5.2.2 2) page 10.

SAR Data Summary – 1640 MHz Body

MEASUREMENT RESULTS								
Gap	**Plot**	**Frequency**		**Modulation**	**Position**	**End Power**	**Measured SAR (W/kg)**	**Reported SAR (W/kg)**
		MHz	**Ch.**			**(dBm)**		
0 mm	1	1616.02	1	FDMA-FM	Front	30.539	1.36	1.51
	----	1620.98	2	FDMA-FM		30.449	1.17	1.33
	----	1625.98	3	FDMA-FM		30.346	1.28	1.49
	----	1620.98	2	FDMA-FM	Back	30.449	0.369	0.42
	----	1620.98	2	FDMA-FM	Left	30.449	0.399	0.45
	----	1620.98	2	FDMA-FM	Right	30.449	0.0738	0.08
	----	1625.98	3	FDMA-FM	Repeated	30.539	1.34	1.49

Body
1.6 W/kg (mW/g)
averaged over 1 gram

1. SAR Measurement
   Phantom Configuration ☐ Left Head ☒ Eli4 ☐ Right Head
   SAR Configuration ☐ Head ☒ Body
2. Test Signal Call Mode ☐ Test Code ☒ Base Station Simulator
3. Test Configuration ☐ With Belt Clip ☐ Without Belt Clip ☒ N/A
4. Tissue Depth is at least 15.0 cm



Jay Moulton
Vice President

SAR Data Summary – 2450 MHz Body 802.11b

MEASUREMENT RESULTS								
Plot	Gap	Position	Frequency		Modulation	End Power	Measured SAR (W/kg)	Reported SAR (W/kg)
			MHz	Ch.		(dBm)		
-----	0 mm	Back	2437	6	DSSS	15.01	0.127	0.20
-----		Front	2437	6	DSSS	15.01	0.157	0.25
-----		Left	2437	6	DSSS	15.01	0.0920	0.15
-----		Right	2412	1	DSSS	15.38	0.206	0.30
2			2437	6	DSSS	15.01	0.237	0.38
-----			2462	11	DSSS	16.74	0.228	0.24

Body
1.6 W/kg (mW/g)
averaged over 1 gram

1. Battery is fully charged for all tests.
   Power Measured ☒Conducted ☐ERP ☐EIRP
2. SAR Measurement
   Phantom Configuration ☐Left Head ☒Eli4 ☐Right Head
   SAR Configuration ☐Head ☒Body
3. Test Signal Call Mode ☒Test Code ☐Base Station Simulator
4. Test Configuration ☐With Belt Clip ☐Without Belt Clip ☒N/A
5. Tissue Depth is at least 15.0 cm

Jay M. Moulton
Vice President

SAR Data Summary – Simultaneous Evaluation

MEASUREMENT RESULTS – Satellite & WiFi Front Side								
Frequency		Modulation	Frequency		Modulation	SAR_1	SAR_2	SAR Total
MHz	Ch.		MHz	Ch.				
1616.02	1	FDMA-FM	2437	6	DSSS	1.51	0.25	1.76
					Body **1.6 W/kg (mW/g)** averaged over 1 gram			

All remaining sides are less than the limit for the WiFi and Satellite combination. See below for the calculation for the SPLSR.

MEASUREMENT RESULTS – Satellite & ANT+								
Frequency		Modulation	Frequency		Modulation	SAR_1	SAR_2	SAR Total
MHz	Ch.		MHz	Ch.				
1616.02	1	FDMA-FM	2457	N/A	GFSK	1.51	0.09	1.60
					Body **1.6 W/kg (mW/g)** averaged over 1 gram			

MEASUREMENT RESULTS – Satellite & BT								
Frequency		Modulation	Frequency		Modulation	SAR_1	SAR_2	SAR Total
MHz	Ch.		MHz	Ch.				
1616.02	1	FDMA-FM	2480	N/A	GFSK	1.51	0.09	1.60
					Body **1.6 W/kg (mW/g)** averaged over 1 gram			

The sum of the two transmitters is less than or equal to the limit for the Ant+ and BT combinations; therefore, the simultaneous transmission meets the requirements of KDB447498 D01 v06 section 4.3.2 page 11 for these transmitter combinations.

The estimated SAR value for the BT and ANT+ transmitters are listed below.

[max. power, mW / min. separation distance, mm] * [$\sqrt{f_{(GHz)}}$ / x], where x = 7.5 for 1 gram SAR

BT

[2.2/5] * [√2.48 / 7.5] = 0.09

ANT+

[2.2/5] * [√2.457 / 7.5] = 0.09

MEASUREMENT RESULTS – WWAN-WiFi (Main)													
Position	**Frequency**		**Maxima**			**Frequency**		**Maxima**			**SAR_1**	**SAR_2**	**SAR Total**
	MHz	**Ch.**	**X**	**Y**	**Z**	**MHz**	**Ch.**	**X**	**Y**	**Z**			
Front	1616.02	1	-13.74	80.69	-1.27	2437	6	23.56	35.81	-1.48	1.51	0.38	1.89

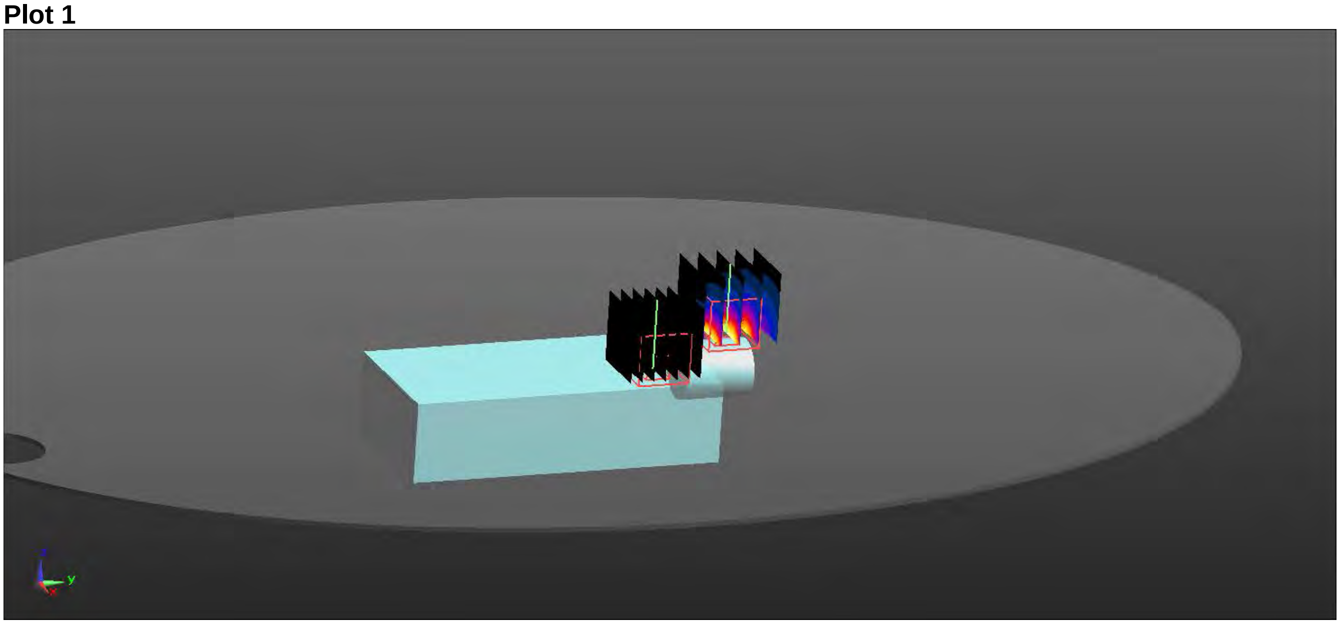
Head Tissue
1.6 W/kg (mW/g)
averaged over 1 gram

Front – 58.36 mm SPLSR=0.04 See Plot 1 Below

Simultaneous Separation Ratio Calculation

$(SAR_1 + SAR_2)^{1.5}/R_i \leq 0.04$ rounded to two digits

Plot 1



9. Test Equipment List

Table 9.1 Equipment Specifications

Type	Calibration Due Date	Calibration Done Date	Serial Number
Staubli Robot TX60L	N/A	N/A	F07/55M6A1/A/01
Measurement Controller CS8c	N/A	N/A	1012
ELI5 Flat Phantom	N/A	N/A	2037
Device Holder	N/A	N/A	N/A
Data Acquisition Electronics 4	04/12/2023	04/12/2022	1416
SPEAG E-Field Probe EX3DV4	02/16/2023	02/16/2022	3662
Speag Validation Dipole D1640V2	02/11/2023	02/11/2022	330
Speag Validation Dipole D2450V2	06/03/2023	06/03/2021	881
Agilent N1911A Power Meter	03/16/2023	03/16/2022	GB45100254
Agilent N1922A Power Sensor	03/17/2023	03/17/2022	MY45240464
Agilent (HP) 8561E Spectrum Analyzer	03/17/2023	03/17/2022	31720068
Agilent (HP) 83752A Synthesized Sweeper	03/17/2023	03/17/2022	3610A01048
Agilent (HP) 8753C Vector Network Analyzer	03/17/2023	03/17/2022	3135A01724
Agilent (HP) 85047A S-Parameter Test Set	03/16/2023	03/16/2022	2904A00595
Agilent 778D Dual Directional Coupler	N/A	N/A	MY48220184
MiniCircuits BW-N20W5+ Fixed 20 dB Attenuator	N/A	N/A	N/A
MiniCircuits SPL-10.7+ Low Pass Filter	N/A	N/A	R8979513746
Aprel Dielectric Probe Assembly	N/A	N/A	0011
Head Equivalent Matter (1640 MHz)	N/A	N/A	N/A
Head Equivalent Matter (2450 MHz)	N/A	N/A	N/A

10. Conclusion

The SAR measurement indicates that the EUT complies with the RF radiation exposure limits of the FCC/IC. These measurements are taken to simulate the RF effects exposure under worst-case conditions. Precise laboratory measures were taken to assure repeatability of the tests. The tested device complies with the requirements in respect to all parameters subject to the test. The test results and statements relate only to the item(s) tested.

Please note that the absorption and distribution of electromagnetic energy in the body is a very complex phenomena that depends on the mass, shape, and size of the body; the orientation of the body with respect to the field vectors; and, the electrical properties of both the body and the environment. Other variables that may play a substantial role in possible biological effects are those that characterize the environment (e.g. ambient temperature, air velocity, relative humidity, and body insulation) and those that characterize the individual (e.g. age, gender, activity level, debilitation, or disease). Because innumerable factors may interact to determine the specific biological outcome of an exposure to electromagnetic fields, any protection guide shall consider maximal amplification of biological effects as a result of field-body interactions, environmental conditions, and physiological variables.

11. References

[1] Federal Communications Commission, ET Docket 93-62, Guidelines for Evaluating the Environmental Effects of Radio Frequency Radiation, August 1996

[2] ANSI/IEEE C95.1 – 1992, American National Standard Safety Levels with respect to Human Exposure to Radio Frequency Electromagnetic Fields, 300kHz to 100GHz, New York: IEEE, 1992.

[3] ANSI/IEEE C95.3 – 2002, IEEE Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields – RF and Microwave, New York: IEEE, 2002.

[4] International Electrotechnical Commission, IEC 62209-2 (Edition 1.0), Human Exposure to radio frequency fields from hand-held and body mounted wireless communication devices – Human models, instrumentation, and procedures – Part 2: Procedure to determine the specific absorption rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz), March 2010.

[5] IEEE Standard 1528 – 2013, IEEE Recommended Practice for Determining the Peak-Spatial Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communication Devices: Measurement Techniques, June 2013.

[6] Industry Canada, RSS – 102 Issue 5, Radio Frequency Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands), March 2015.

[7] Health Canada, Safety Code 6, Limits of Human Exposure to Radiofrequency Electromagnetic Fields in the Frequency Range from 3kHz to 300 GHz, 2009.

Appendix A – System Verification Plots and Data

```
************************************************************
Test Result for UIM Dielectric Parameter
Mon 07/Nov/2022
Freq   Frequency(GHz)
FCC_eH FCC Limits for Head Epsilon
FCC_sH FCC Limits for Head Sigma
Test_e Epsilon  of  UIM
Test_s Sigma of UIM
************************************************************
Freq          FCC_eH FCC_sH Test_e Test_s
1.6100        40.29  1.28   39.71  1.29
1.6160        40.278 1.286  39.704 1.296*
1.6200        40.27  1.29   39.70  1.30
1.6210        40.268 1.29   39.697 1.301*
1.6260        40.258 1.29   39.682 1.306*
1.6300        40.25  1.29   39.67  1.31
1.6400        40.23  1.30   39.66  1.32
1.6500        40.21  1.31   39.65  1.33

* value interpolated
```

```
************************************************************
Test Result for UIM Dielectric Parameter
Mon 07/Nov/2022
Freq   Frequency(GHz)
FCC_eH Limits for Head Epsilon
FCC_sH Limits for Head Sigma
Test_e Epsilon  of  UIM
Test_s Sigma of UIM
************************************************************
Freq          FCC_eH FCC_sH Test_e Test_s
2.4100        39.26  1.76   38.64  1.79
2.4120        39.258 1.762  38.636 1.792*
2.4200        39.25  1.77   38.62  1.80
2.4300        39.24  1.78   38.61  1.82
2.4370        39.226 1.787  38.596 1.827*
2.4400        39.22  1.79   38.59  1.83
2.4500        39.20  1.80   38.57  1.84
2.4600        39.19  1.81   38.55  1.85
2.4620        39.186 1.812  38.546 1.852*
2.4700        39.17  1.82   38.53  1.86
2.4800        39.16  1.83   38.52  1.87

* value interpolated
```

RF Exposure Lab

Plot 1

DUT: Dipole 1640 MHz D1640V2; Type: Dipole; Serial: 330

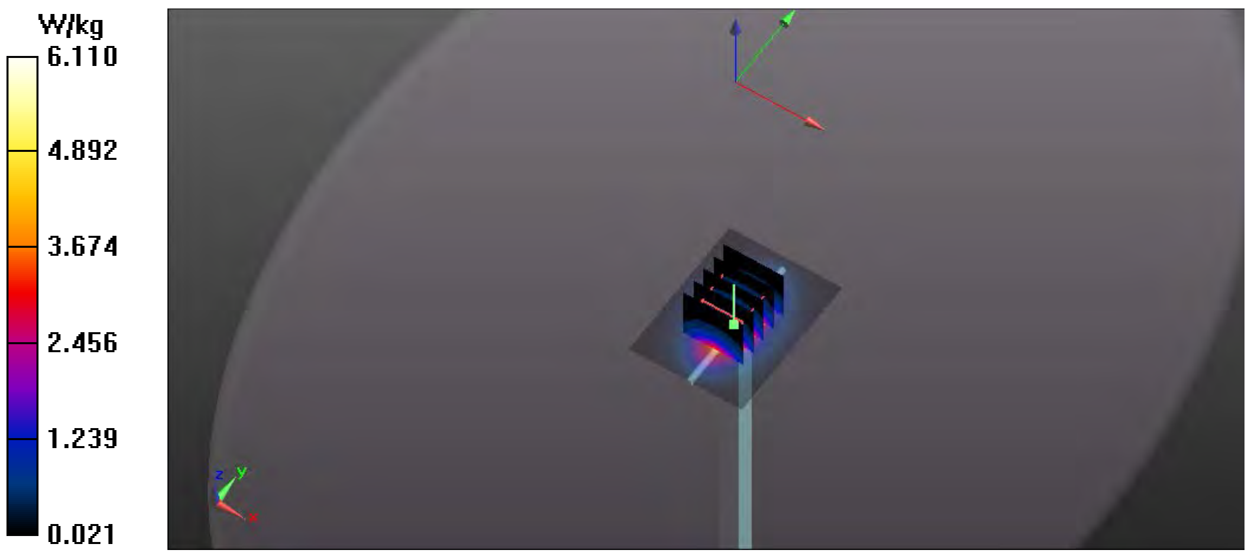
Communication System: CW; Frequency: 1640 MHz; Duty Cycle: 1:1
Medium: HSL1640; Medium parameters used: f = 1640 MHz; σ = 1.32 S/m; ε_r = 39.66; ρ = 1000 kg/m^3
Phantom section: Flat Section

Test Date: Date: 11/7/2022; Ambient Temp: 23 °C; Tissue Temp: 21 °C
Probe: EX3DV4 – SN3662; ConvF(8.03, 8.03, 8.03); Calibrated: 2/16/2022;
Sensor-Surface: 2mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1416; Calibrated: 4/12/2022
Phantom: ELI v5.0; Type: QDOVA002AA; Serial: 2037
Measurement SW: DASY52, Version 52.10 (0); SEMCAD X Version 14.6.10 (7417)

Procedure Notes:

1640 MHz Head/Verification/Area Scan (61x81x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 5.72 W/kg

1640 MHz Head/Verification/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 54.367 V/m; Power Drift = -0.03 dB
Peak SAR (extrapolated) = 7.05 W/kg
P_{in}= 100 mW
SAR(1 g) = 3.46 W/kg; SAR(10 g) = 1.87 W/kg
Maximum value of SAR (measured) = 6.11 W/kg



RF Exposure Lab

Plot 2

DUT: Dipole 2450 MHz D2450V2; Type: D2450V2; Serial: D2450V2 - SN: 881

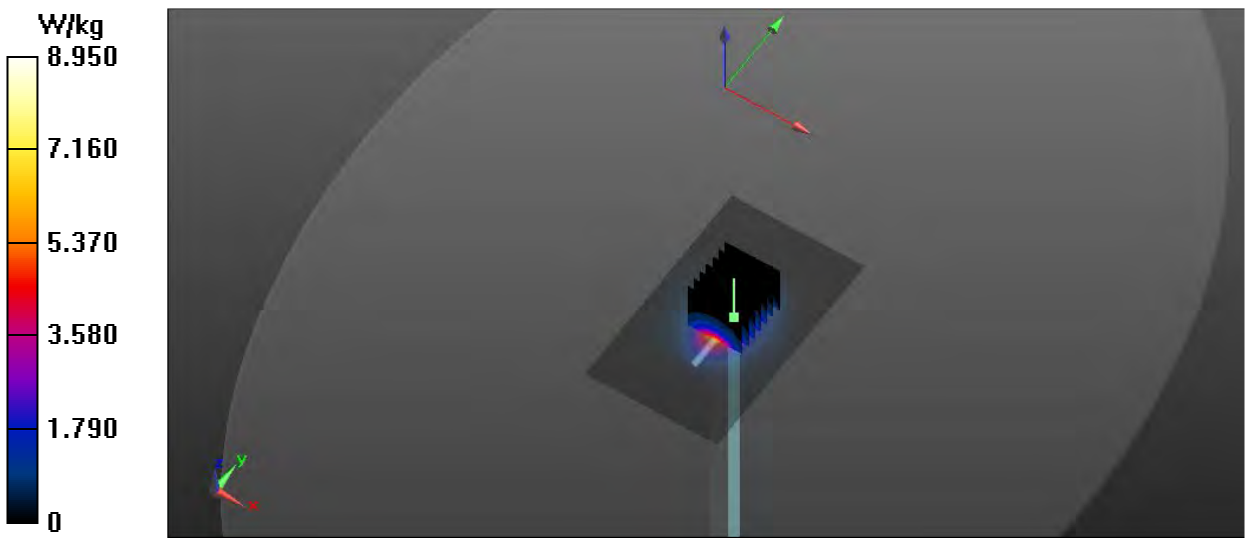
Communication System: CW; Frequency: 2450 MHz; Duty Cycle: 1:1
Medium: HSL2450; Medium parameters used: f = 2450 MHz; σ = 1.84 S/m; ε_r = 38.57; ρ = 1000 kg/m^3
Phantom section: Flat Section

Test Date: Date: 11/7/2022; Ambient Temp: 23 °C; Tissue Temp: 21 °C
Probe: EX3DV4 – SN3662; ConvF(7.28, 7.28, 7.28); Calibrated: 2/16/2022;
Sensor-Surface: 2mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1416; Calibrated: 4/12/2022
Phantom: ELI v5.0; Type: QDOVA002AA; Serial: 2037
Measurement SW: DASY52, Version 52.10 (0); SEMCAD X Version 14.6.10 (7417)

Procedure Notes:

Head Verification/2450 MHz/Area Scan (61x101x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm
Maximum value of SAR (interpolated) = 8.42 W/kg

Head Verification/2450 MHz/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 55.261 V/m; Power Drift = -0.02 dB
Peak SAR (extrapolated) = 11.04 W/kg
P_{in}= 100 mW
SAR(1 g) = 5.27 W/kg; SAR(10 g) = 2.47 W/kg
Maximum value of SAR (measured) = 8.95 W/kg



Appendix B – SAR Test Data Plots

RF Exposure Lab

Plot 1

DUT: AA4624; Type: Satellite Location Device; Serial: Eng 1

Communication System: FDMA-FM; Frequency: 1616.02 MHz; Duty Cycle: 1:4.00037
Medium: HSL1640; Medium parameters used (interpolated): f = 1616.02 MHz; σ = 1.296 S/m; ε_r = 39.704; ρ = 1000 kg/m^3
Phantom section: Flat Section

Test Date: Date: 11/7/2022; Ambient Temp: 23 °C; Tissue Temp: 21 °C

Probe: EX3DV4 - SN3662; ConvF(8.03, 8.03, 8.03); Calibrated: 2/16/2022
Sensor-Surface: 2mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1416; Calibrated: 4/12/2022
Phantom: ELI v5.0; Type: QDOVA002AA; Serial: 2037
Measurement SW: DASY52, Version 52.10 (0); SEMCAD X Version 14.6.10 (7417)

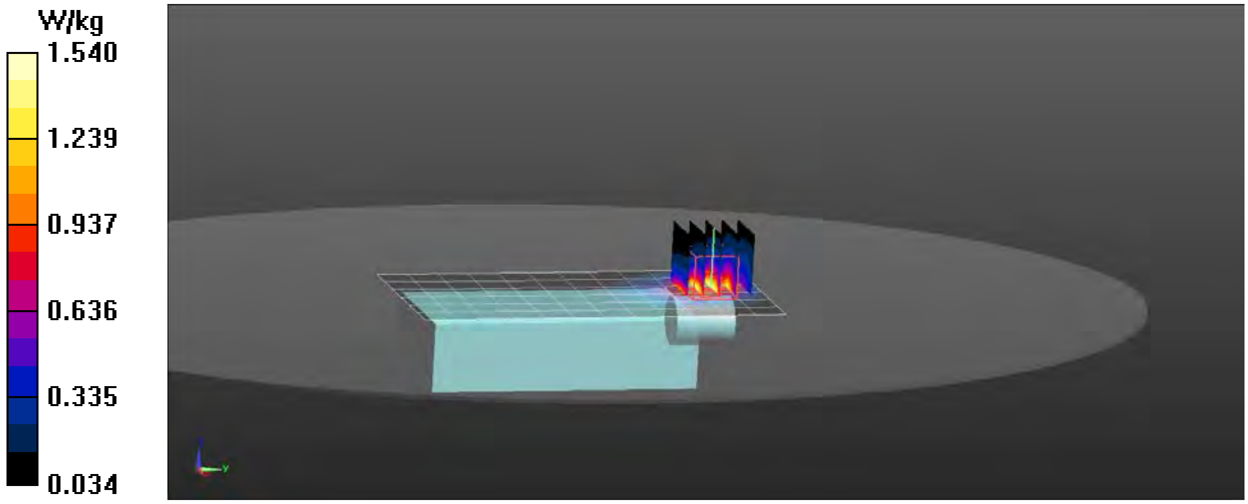
Procedure Notes:

1640 MHz/Front Low/Area Scan (7x13x1): Measurement grid: dx=15mm, dy=15mm

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 1.26 W/kg

1640 MHz/Front Low/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 5.479 V/m; Power Drift = 0.06 dB
Peak SAR (extrapolated) = 2.46 W/kg
SAR(1 g) = 1.36 W/kg; SAR(10 g) = 0.788 W/kg

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 1.54 W/kg



RF Exposure Lab

Plot 2

DUT: AA4624; Type: Satellite Location Device; Serial: Eng 1

Communication System: WiFi 802.11b (DSSS, 1 Mbps); Frequency: 2437 MHz; Duty Cycle: 1:1
Medium: HSL2450; Medium parameters used (interpolated): f = 2437 MHz; σ = 1.827 S/m; ε_r = 38.596021; ρ = 1000 kg/m^3
Phantom section: Flat Section

Test Date: Date: 11/7/2022; Ambient Temp: 23 °C; Tissue Temp: 21 °C

Probe: EX3DV4 - SN3662; ConvF(7.28, 7.28, 7.28); Calibrated: 2/16/2022
Sensor-Surface: 2mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1416; Calibrated: 4/12/2022
Phantom: ELI v5.0; Type: QDOVA002AA; Serial: 2037
Measurement SW: DASY52, Version 52.10 (0); SEMCAD X Version 14.6.10 (7417)

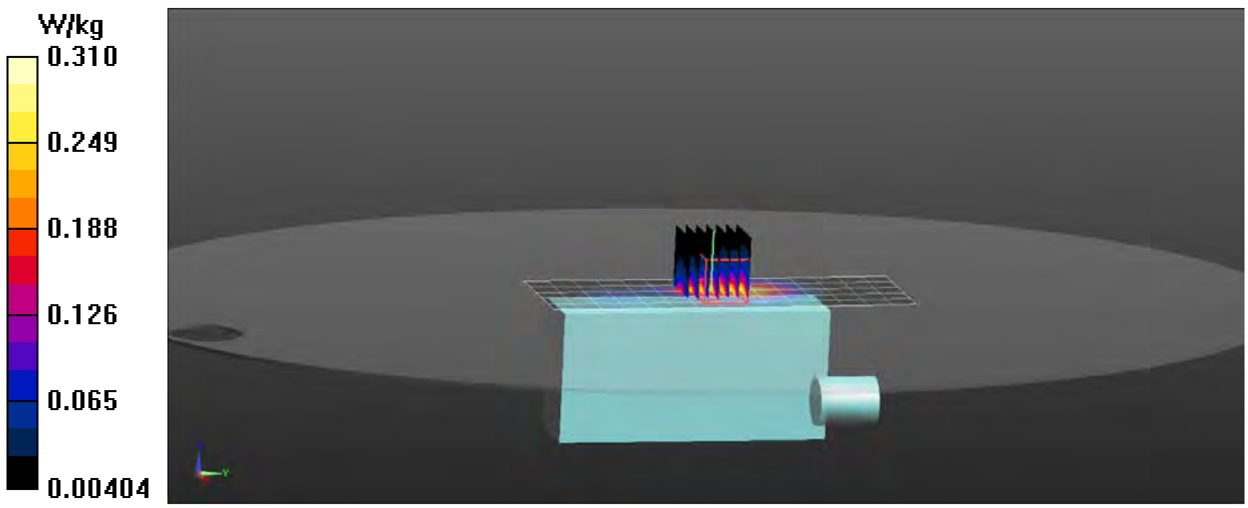
Procedure Notes:

2450 MHz/Right Mid/Area Scan (6x16x1): Measurement grid: dx=12mm, dy=12mm

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 0.312 W/kg

2450 MHz/Right Mid/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 10.79 V/m; Power Drift = -0.04 dB
Peak SAR (extrapolated) = 0.518 W/kg
SAR(1 g) = 0.237 W/kg; SAR(10 g) = 0.121 W/kg

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 0.310 W/kg



Appendix D – Probe Calibration Data Sheets

Calibration Laboratory of
Schmid & Partner
Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland

S **Schweizerischer Kalibrierdienst**
C **Service suisse d'étalonnage**
S **Servizio svizzero di taratura**
Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS)
The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: SCS 0108

Client **RF Exposure Lab**

Certificate No: EX3-3662_Feb22

CALIBRATION CERTIFICATE

Object	EX3DV4 - SN:3662
Calibration procedure(s)	QA CAL-01.v9, QA CAL-12.v9, QA CAL-14.v6, QA CAL-23.v5, QA CAL-25.v7 Calibration procedure for dosimetric E-field probes
Calibration date:	February 16, 2022

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	09-Apr-21 (No. 217-03291/03292)	Apr-22
Power sensor NRP-Z91	SN: 103244	09-Apr-21 (No. 217-03291)	Apr-22
Power sensor NRP-Z91	SN: 103245	09-Apr-21 (No. 217-03292)	Apr-22
Reference 20 dB Attenuator	SN: CC2552 (20x)	09-Apr-21 (No. 217-03343)	Apr-22
DAE4	SN: 660	13-Oct-21 (No. DAE4-660_Oct21)	Oct-22
Reference Probe ES3DV2	SN: 3013	27-Dec-21 (No. ES3-3013_Dec21)	Dec-22
Secondary Standards	ID	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB41293874	06-Apr-16 (in house check Jun-20)	In house check: Jun-22
Power sensor E4412A	SN: MY41498087	06-Apr-16 (in house check Jun-20)	In house check: Jun-22
Power sensor E4412A	SN: 000110210	06-Apr-16 (in house check Jun-20)	In house check: Jun-22
RF generator HP 8648C	SN: US3642U01700	04-Aug-99 (in house check Jun-20)	In house check: Jun-22
Network Analyzer E8358A	SN: US41080477	31-Mar-14 (in house check Oct-20)	In house check: Oct-22

	Name	Function	Signature
Calibrated by:	Jeton Kastrati	Laboratory Technician	
Approved by:	Sven Kühn	Deputy Manager	S. K

Issued: February 18, 2022

Glossary:

TSL	tissue simulating liquid
NORMx,y,z	sensitivity in free space
ConvF	sensitivity in TSL / NORMx,y,z
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A, B, C, D	modulation dependent linearization parameters
Polarization φ	φ rotation around probe axis
Polarization ϑ	ϑ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., ϑ = 0 is normal to probe axis
Connector Angle	information used in DASY system to align probe sensor X to the robot coordinate system

Calibration is Performed According to the Following Standards:

a) IEC/IEEE 62209-1528, "Measurement Procedure For The Assessment Of Specific Absorption Rate Of Human Exposure To Radio Frequency Fields From Hand-Held And Body-Worn Wireless Communication Devices - Part 1528: Human Models, Instrumentation And Procedures (Frequency Range of 4 MHz to 10 GHz)", October 2020.
b) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Methods Applied and Interpretation of Parameters:

- *NORMx,y,z:* Assessed for E-field polarization ϑ = 0 (f ≤ 900 MHz in TEM-cell; f > 1800 MHz: R22 waveguide). NORMx,y,z are only intermediate values, i.e., the uncertainties of NORMx,y,z does not affect the E^2-field uncertainty inside TSL (see below *ConvF*).
- *NORM(f)x,y,z = NORMx,y,z * frequency_response* (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of *ConvF*.
- *DCPx,y,z:* DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal (no uncertainty required). DCP does not depend on frequency nor media.
- *PAR:* PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- *Ax,y,z; Bx,y,z; Cx,y,z; Dx,y,z; VRx,y,z: A, B, C, D* are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. *VR* is the maximum calibration range expressed in RMS voltage across the diode.
- *ConvF and Boundary Effect Parameters:* Assessed in flat phantom using E-field (or Temperature Transfer Standard for f ≤ 800 MHz) and inside waveguide using analytical field distributions based on power measurements for f > 800 MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to *NORMx,y,z * ConvF* whereby the uncertainty corresponds to that given for *ConvF*. A frequency dependent *ConvF* is used in DASY version 4.4 and higher which allows extending the validity from ± 50 MHz to ± 100 MHz.
- *Spherical isotropy (3D deviation from isotropy)*: in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- *Sensor Offset*: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- *Connector Angle*: The angle is assessed using the information gained by determining the *NORMx* (no uncertainty required).

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3662

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu V/(V/m)^2$)[A]	0.42	0.49	0.48	± 10.1 %
DCP (mV)[B]	99.8	99.6	98.2	

Calibration Results for Modulation Response

UID	Communication System Name		A dB	B dB$\sqrt{\mu V}$	C	D dB	VR mV	Max dev.	Unc[E] (k=2)
0	CW	X	0.0	0.0	1.0	0.00	147.3	±2.7 %	± 4.7 %
		Y	0.0	0.0	1.0		161.3		
		Z	0.0	0.0	1.0		168.0		

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.

[A] The uncertainties of Norm X,Y,Z do not affect the E^2-field uncertainty inside TSL (see Pages 5 and 6).
[B] Numerical linearization parameter: uncertainty not required.
[E] Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3662

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	-94.7
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	9 mm
Tip Diameter	2.5 mm
Probe Tip to Sensor X Calibration Point	1 mm
Probe Tip to Sensor Y Calibration Point	1 mm
Probe Tip to Sensor Z Calibration Point	1 mm
Recommended Measurement Distance from Surface	1.4 mm

Note: Measurement distance from surface can be increased to 3-4 mm for an *Area Scan* job.

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3662

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unc (k=2)
150	52.3	0.76	11.58	11.58	11.58	0.00	1.00	± 13.3 %
220	49.0	0.81	11.43	11.43	11.43	0.00	1.00	± 13.3 %
300	45.3	0.87	11.15	11.15	11.15	0.09	1.00	± 13.3 %
450	43.5	0.87	10.72	10.72	10.72	0.16	1.30	± 13.3 %
750	41.9	0.89	9.23	9.23	9.23	0.52	0.80	± 12.0 %
900	41.5	0.97	8.76	8.76	8.76	0.44	0.80	± 12.0 %
1450	40.5	1.20	8.18	8.18	8.18	0.37	0.80	± 12.0 %
1640	40.2	1.31	8.03	8.03	8.03	0.35	0.86	± 12.0 %
1750	40.1	1.37	7.87	7.87	7.87	0.32	0.86	± 12.0 %
1900	40.0	1.40	7.66	7.66	7.66	0.27	0.86	± 12.0 %
2300	39.5	1.67	7.54	7.54	7.54	0.34	0.90	± 12.0 %
2450	39.2	1.80	7.28	7.28	7.28	0.38	0.90	± 12.0 %
2600	39.0	1.96	7.10	7.10	7.10	0.38	0.90	± 12.0 %
3500	37.9	2.91	6.73	6.73	6.73	0.35	1.30	± 13.1 %
3700	37.7	3.12	6.53	6.53	6.53	0.35	1.30	± 13.1 %
5250	35.9	4.71	4.95	4.95	4.95	0.40	1.80	± 13.1 %
5600	35.5	5.07	4.66	4.66	4.66	0.40	1.80	± 13.1 %
5750	35.4	5.22	4.80	4.80	4.80	0.40	1.80	± 13.1 %

[C] Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Validity of ConvF assessed at 6 MHz is 4-9 MHz, and ConvF assessed at 13 MHz is 9-19 MHz. Above 5 GHz frequency validity can be extended to ± 110 MHz.
[F] At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.
[G] Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

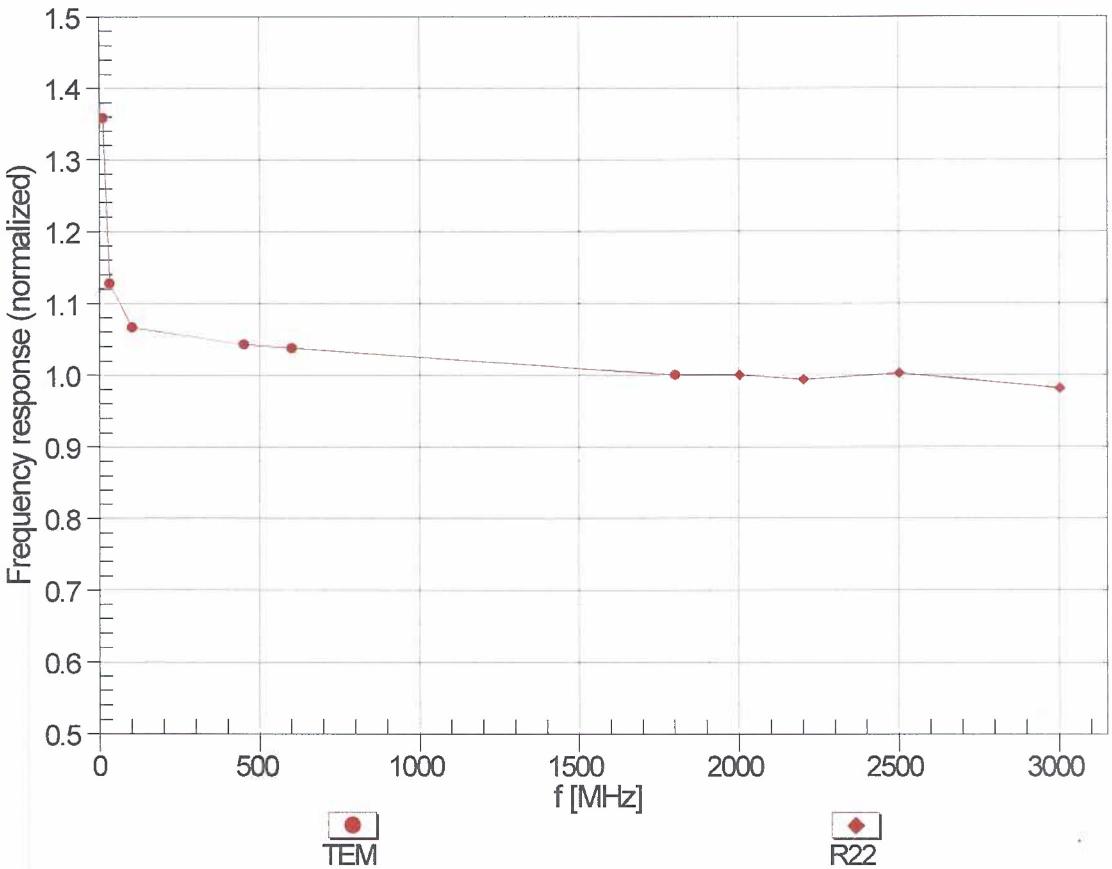
DASY/EASY - Parameters of Probe: EX3DV4 - SN:3662

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha[G]	Depth[G] (mm)	Unc (k=2)
6500	34.5	6.07	5.50	5.50	5.50	0.20	2.00	± 18.6 %

[C] Frequency validity above 6GHz is ± 700 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.
[F] At frequencies 6-10 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.
[G] Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz; below ± 2% for frequencies between 3-6 GHz; and below ± 4% for frequencies between 6-10 GHz at any distance larger than half the probe tip diameter from the boundary.

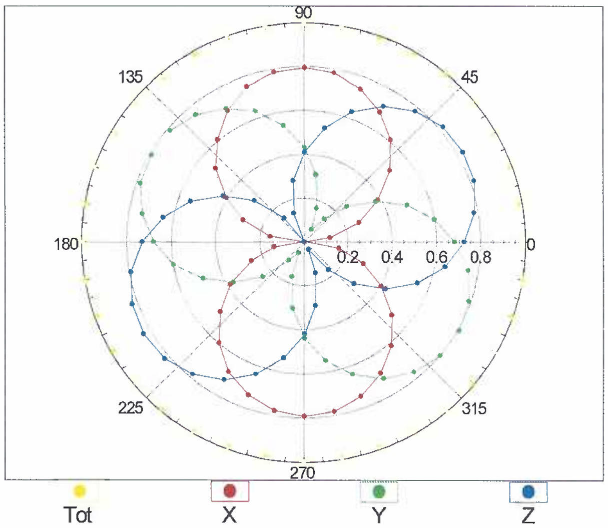
Frequency Response of E-Field
(TEM-Cell:ifi110 EXX, Waveguide: R22)



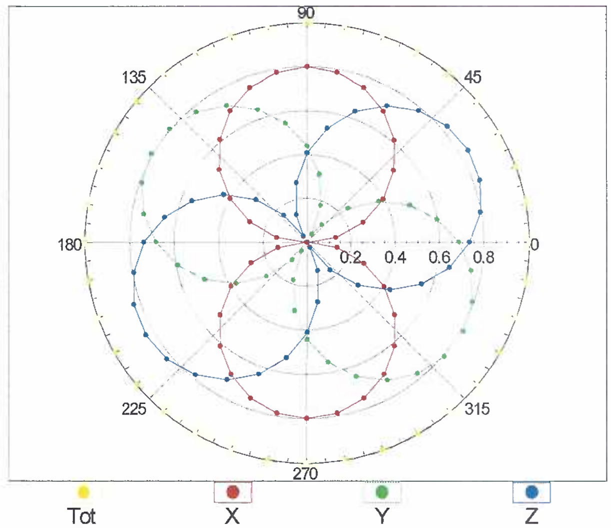
Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

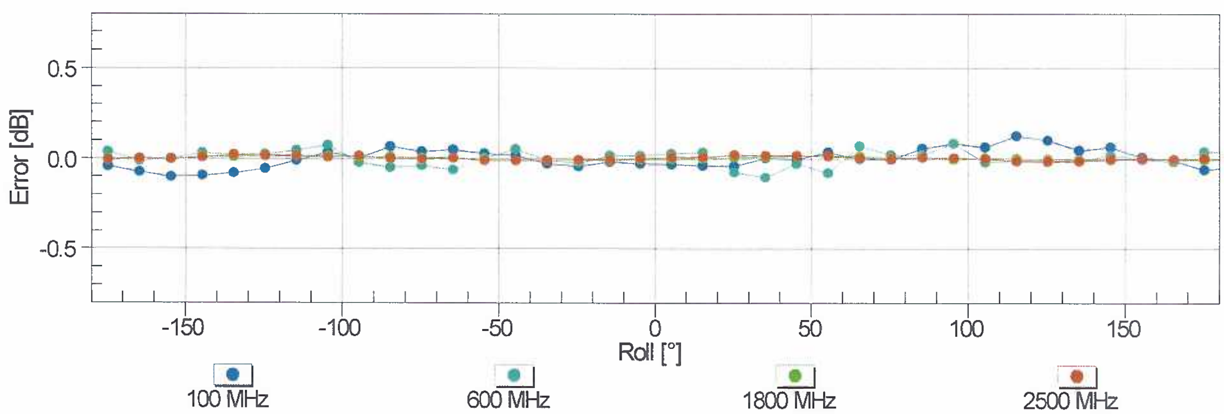
Receiving Pattern (ϕ), ϑ = 0°

f=600 MHz,TEM



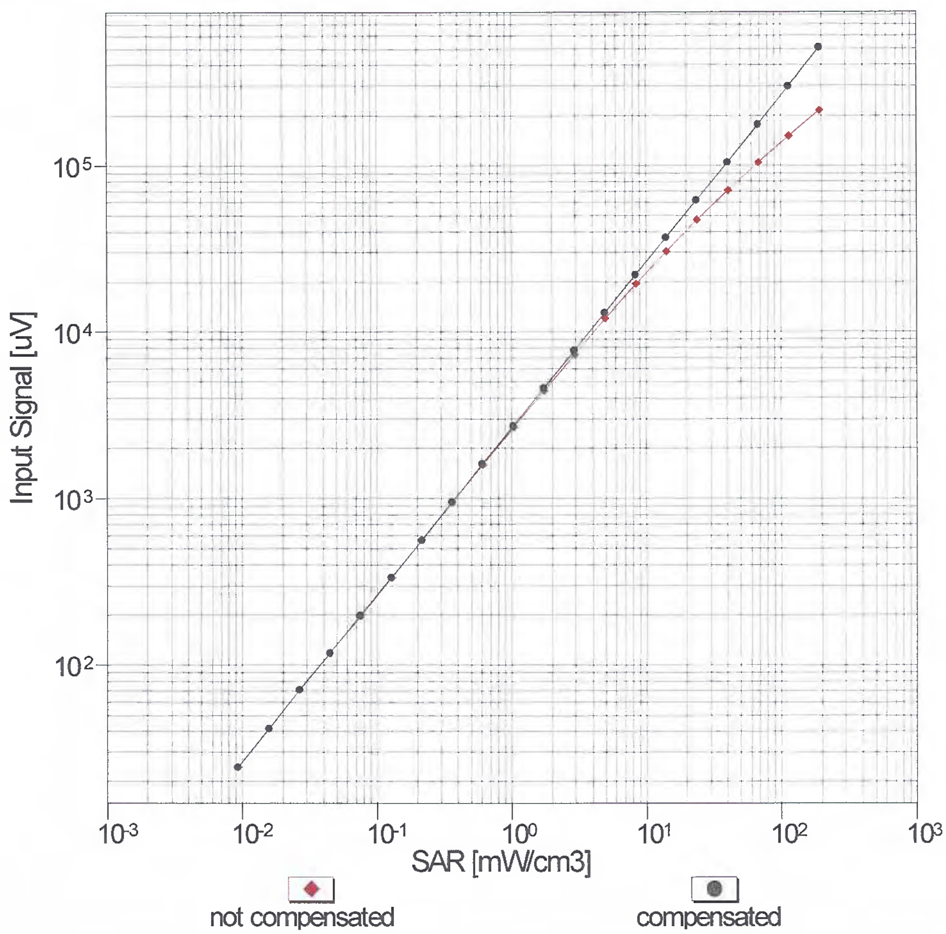
f=1800 MHz,R22

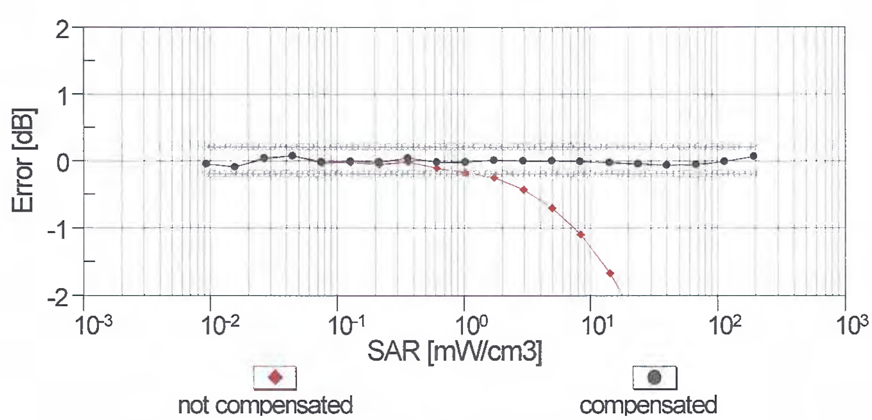




Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

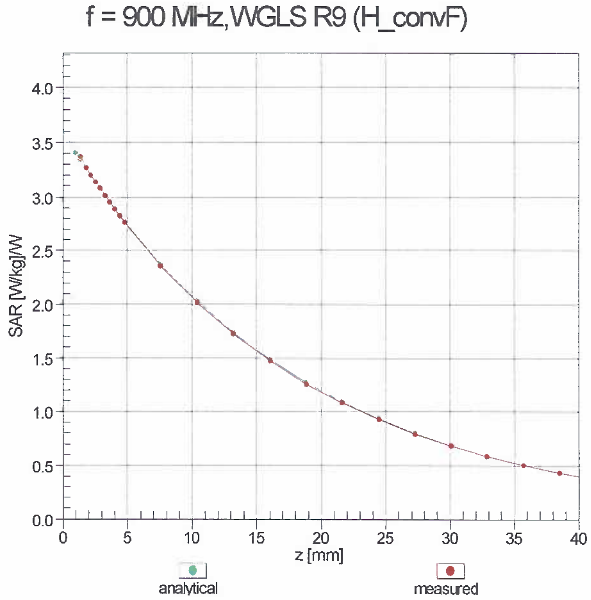
Dynamic Range f(SAR_{head})
(TEM cell , f_{eval}= 1900 MHz)

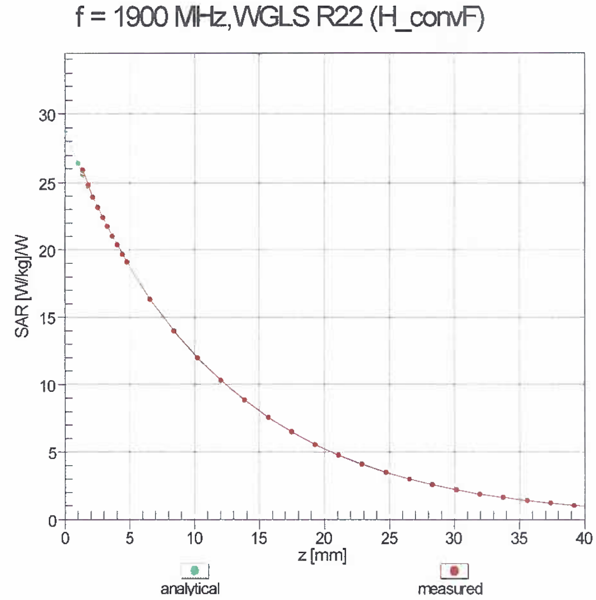




Uncertainty of Linearity Assessment: ± 0.6% (k=2)

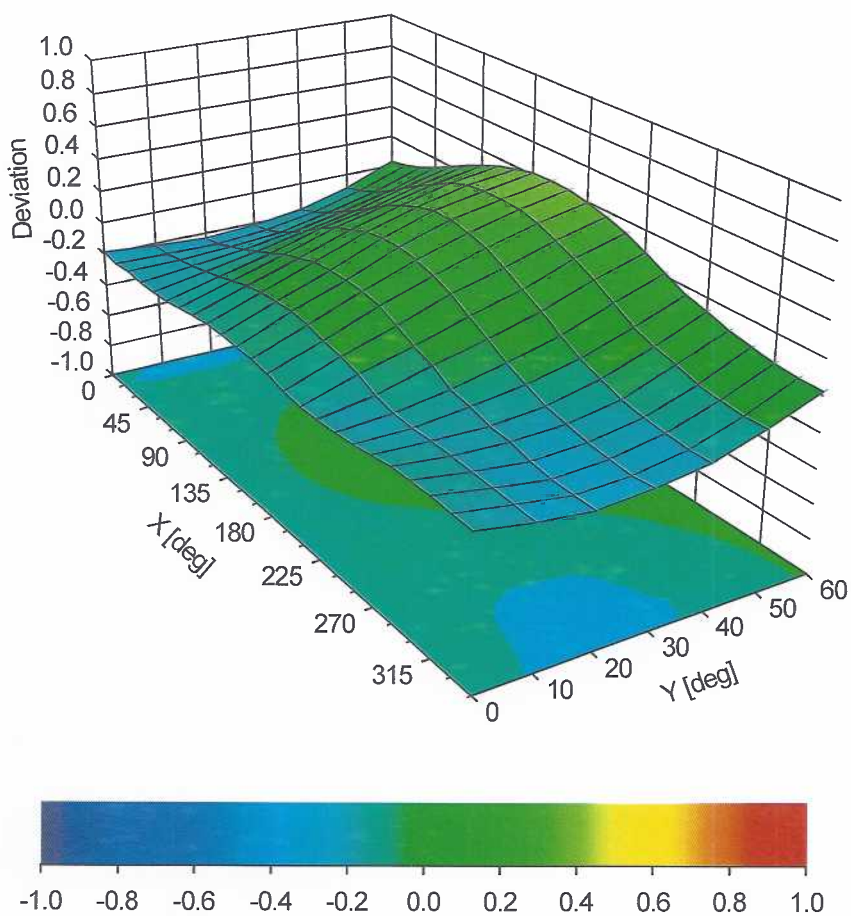
Conversion Factor Assessment





Deviation from Isotropy in Liquid

Error (ϕ, ϑ), f = 900 MHz



Uncertainty of Spherical Isotropy Assessment: ± 2.6% (k=2)

Appendix E – Dipole Calibration Data Sheets

Calibration Laboratory of
Schmid & Partner
Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland

S **Schweizerischer Kalibrierdienst**
C **Service suisse d'étalonnage**
S **Servizio svizzero di taratura**
Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS)
The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: SCS 0108

Client RF Exposure Lab

Certificate No: D1640V2-330_Feb22

CALIBRATION CERTIFICATE

Object	D1640V2 - SN:330
Calibration procedure(s)	QA CAL-05.v11 Calibration Procedure for SAR Validation Sources between 0.7-3 GHz
Calibration date:	February 11, 2022

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	09-Apr-21 (No. 217-03291/03292)	Apr-22
Power sensor NRP-Z91	SN: 103244	09-Apr-21 (No. 217-03291)	Apr-22
Power sensor NRP-Z91	SN: 103245	09-Apr-21 (No. 217-03292)	Apr-22
Reference 20 dB Attenuator	SN: BH9394 (20k)	09-Apr-21 (No. 217-03343)	Apr-22
Type-N mismatch combination	SN: 310982 / 06327	09-Apr-21 (No. 217-03344)	Apr-22
Reference Probe EX3DV4	SN: 7349	31-Dec-21 (No. EX3-7349_Dec21)	Dec-22
DAE4	SN: 601	01-Nov-21 (No. DAE4-601_Nov21)	Nov-22

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB39512475	30-Oct-14 (in house check Oct-20)	In house check: Oct-22
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-20)	In house check: Oct-22
Power sensor HP 8481A	SN: MY41093315	07-Oct-15 (in house check Oct-20)	In house check: Oct-22
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-20)	In house check: Oct-22
Network Analyzer Agilent E8358A	SN: US41080477	31-Mar-14 (in house check Oct-20)	In house check: Oct-22

	Name	Function	Signature
Calibrated by:	Aidonia Georgiadou	Laboratory Technician	
Approved by:	Sven Kühn	Deputy Manager	

Issued: February 17, 2022

Glossary:

TSL	tissue simulating liquid
ConvF	sensitivity in TSL / NORM x,y,z
N/A	not applicable or not measured

Calibration is Performed According to the Following Standards:

a) IEC/IEEE 62209-1528, "Measurement Procedure For The Assessment Of Specific Absorption Rate Of Human Exposure To Radio Frequency Fields From Hand-Held And Body-Worn Wireless Communication Devices - Part 1528: Human Models, Instrumentation And Procedures (Frequency Range of 4 MHz to 10 GHz)", October 2020.
b) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

c) DASY System Handbook

Methods Applied and Interpretation of Parameters:

- *Measurement Conditions:* Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- *Antenna Parameters with TSL:* The source is mounted in a touch configuration below the center marking of the flat phantom.
- *Return Loss:* This parameter is measured with the source positioned under the liquid filled phantom (as described in the measurement condition clause). The Return Loss ensures low reflected power. No uncertainty required.
- *SAR measured:* SAR measured at the stated antenna input power.
- *SAR normalized:* SAR as measured, normalized to an input power of 1 W at the antenna connector.
- *SAR for nominal TSL parameters:* The measured TSL parameters are used to calculate the nominal SAR result.

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.

Measurement Conditions

DASY system configuration, as far as not given on page 1.

DASY Version	DASY52	V52.10.4
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	1640 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	**Permittivity**	**Conductivity**
Nominal Head TSL parameters	22.0 °C	40.2	1.31 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	40.6 ± 6 %	1.29 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	8.49 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**34.4 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	250 mW input power	4.57 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**18.4 W/kg ± 16.5 % (k=2)**

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	53.6 Ω + 2.5 jΩ
Return Loss	- 27.5 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.232 ns

After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.
No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

Additional EUT Data

Manufactured by	SPEAG

DASY5 Validation Report for Head TSL

Date: 11.02.2022

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1640 MHz; Type: D1640V2; Serial: D1640V2 - SN:330

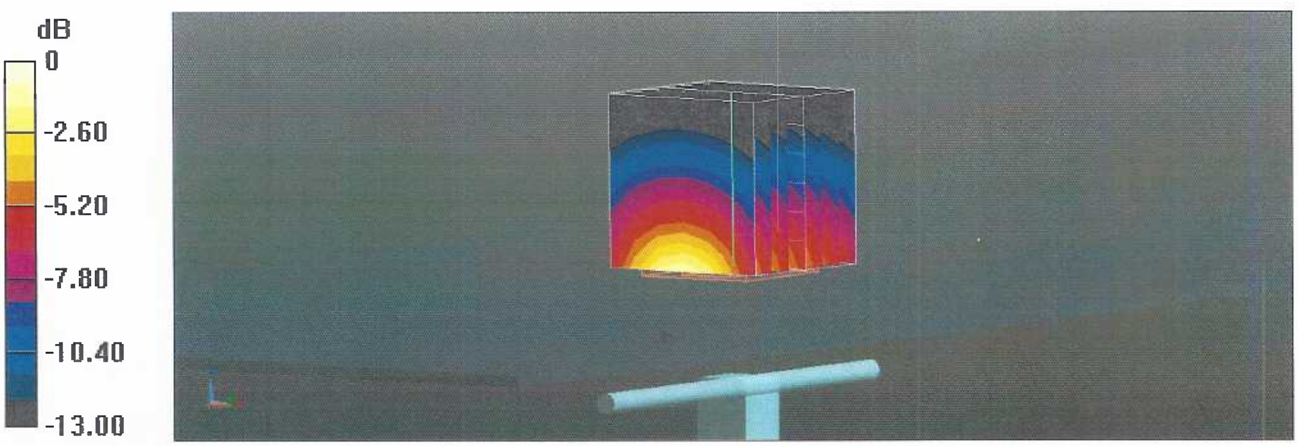
Communication System: UID 0 - CW; Frequency: 1640 MHz
Medium parameters used: f = 1640 MHz; $\sigma = 1.29$ S/m; $\varepsilon_r = 40.6$; $\rho = 1000$ kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(8.68, 8.68, 8.68) @ 1640 MHz; Calibrated: 31.12.2021
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 01.11.2021
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

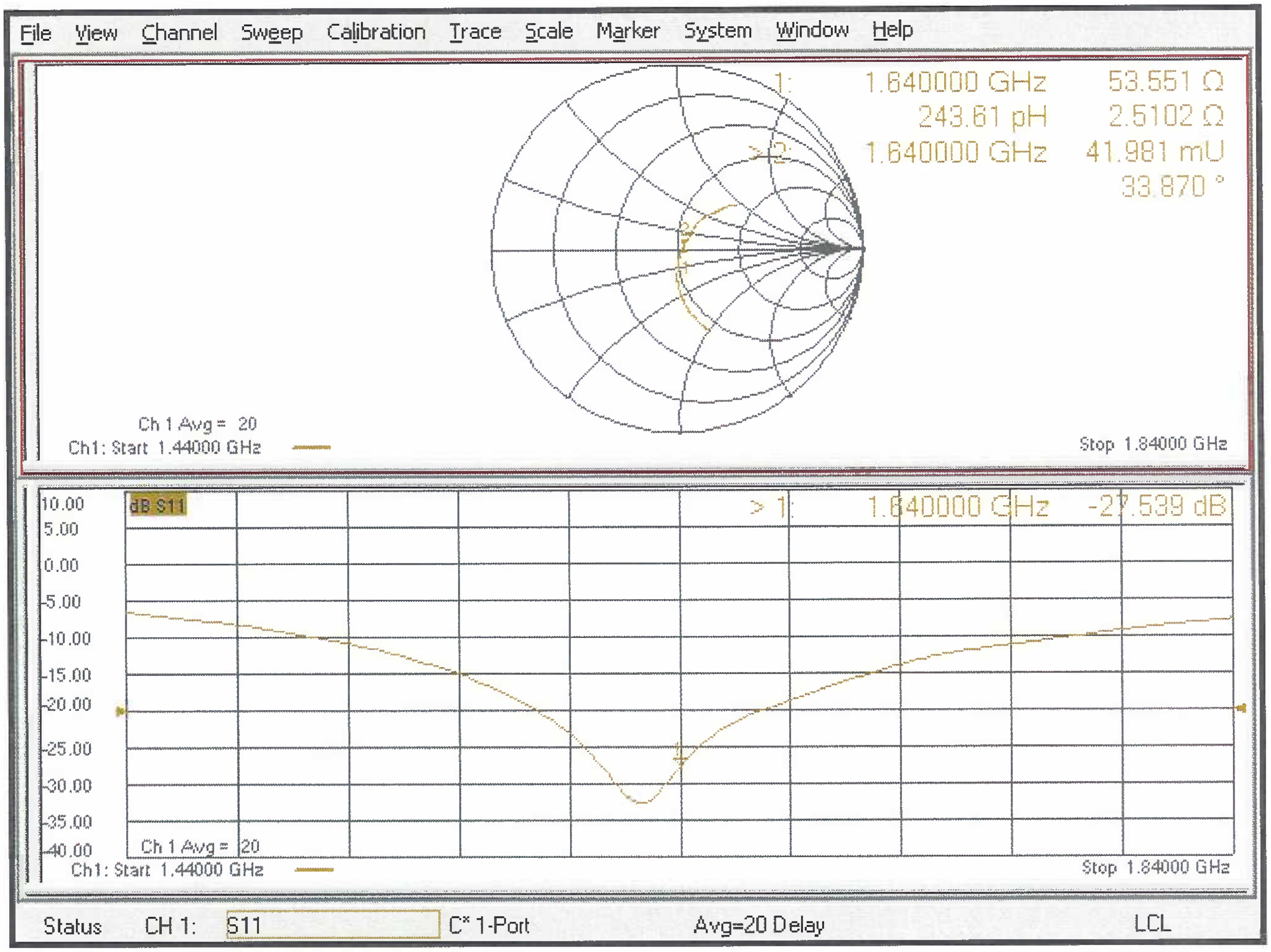
Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 104.6 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 15.4 W/kg
SAR(1 g) = 8.49 W/kg; SAR(10 g) = 4.57 W/kg
Smallest distance from peaks to all points 3 dB below = 10 mm
Ratio of SAR at M2 to SAR at M1 = 55.4%
Maximum value of SAR (measured) = 12.9 W/kg



0 dB = 12.9 W/kg = 11.11 dBW/kg

Impedance Measurement Plot for Head TSL



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Calibration Laboratory of
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Accreditation No.: SCS 0108

Client RF Exposure Lab

Certificate No: D2450V2-881_Jun21

CALIBRATION CERTIFICATE

Object	D2450V2 - SN:881
Calibration procedure(s)	QA CAL-05.v11 Calibration Procedure for SAR Validation Sources between 0.7-3 GHz
Calibration date:	June 03, 2021

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	09-Apr-21 (No. 217-03291/03292)	Apr-22
Power sensor NRP-Z91	SN: 103244	09-Apr-21 (No. 217-03291)	Apr-22
Power sensor NRP-Z91	SN: 103245	09-Apr-21 (No. 217-03292)	Apr-22
Reference 20 dB Attenuator	SN: BH9394 (20k)	09-Apr-21 (No. 217-03343)	Apr-22
Type-N mismatch combination	SN: 310982 / 06327	09-Apr-21 (No. 217-03344)	Apr-22
Reference Probe EX3DV4	SN: 7349	28-Dec-20 (No. EX3-7349_Dec20)	Dec-21
DAE4	SN: 601	02-Nov-20 (No. DAE4-601_Nov20)	Nov-21

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB39512475	30-Oct-14 (in house check Oct-20)	In house check: Oct-22
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-20)	In house check: Oct-22
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (in house check Oct-20)	In house check: Oct-22
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-20)	In house check: Oct-22
Network Analyzer Agilent E8358A	SN: US41080477	31-Mar-14 (in house check Oct-20)	In house check: Oct-21

	Name	Function	Signature
Calibrated by:	Jeffrey Katzman	Laboratory Technician	J. Katzman
Approved by:	Katja Pokovic	Technical Manager	

Issued: June 8, 2021

Glossary:

TSL	tissue simulating liquid
ConvF	sensitivity in TSL / NORM x,y,z
N/A	not applicable or not measured

Calibration is Performed According to the Following Standards:

a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
b) IEC 62209-1, "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
c) IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

e) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

- *Measurement Conditions:* Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- *Antenna Parameters with TSL:* The dipole is mounted with the spacer to position its feed point exactly below the center marking of the flat phantom section, with the arms oriented parallel to the body axis.
- *Feed Point Impedance and Return Loss:* These parameters are measured with the dipole positioned under the liquid filled phantom. The impedance stated is transformed from the measurement at the SMA connector to the feed point. The Return Loss ensures low reflected power. No uncertainty required.
- *Electrical Delay:* One-way delay between the SMA connector and the antenna feed point. No uncertainty required.
- *SAR measured:* SAR measured at the stated antenna input power.
- *SAR normalized:* SAR as measured, normalized to an input power of 1 W at the antenna connector.
- *SAR for nominal TSL parameters:* The measured TSL parameters are used to calculate the nominal SAR result.

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.

Measurement Conditions

DASY system configuration, as far as not given on page 1.

DASY Version	DASY5	V52.10.4
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2450 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	**Permittivity**	**Conductivity**
Nominal Head TSL parameters	22.0 °C	39.2	1.80 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	37.7 ± 6 %	1.87 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.9 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**54.1 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.34 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**25.0 W/kg ± 16.5 % (k=2)**

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	54.3 Ω + 4.3 jΩ
Return Loss	- 24.7 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.156 ns

After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.
No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

Additional EUT Data

Manufactured by	SPEAG

Extended Calibration
Usage of SAR dipoles calibrated less than 3 years ago but more than 1 year ago were confirmed in maintaining return loss (<-20 dB, within 20% of prior calibration) and impedance (within 5 ohm from prior calibration) requirements per extended calibrations in KDB Publication 865664 D01 v01r04.

D2450V2 SN: 829 - Head

Date of Measurement	Return Loss (dB)	Δ%	Impedance Real (Ω)	ΔΩ	Impedance Imaginary (jΩ)	ΔΩ
6/3/2021	-24.7		54.3		4.3	
6/3/2022	-25.3	2.4	55.2	0.9	4.1	-0.2

DASY5 Validation Report for Head TSL

Date: 03.06.2021

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:881

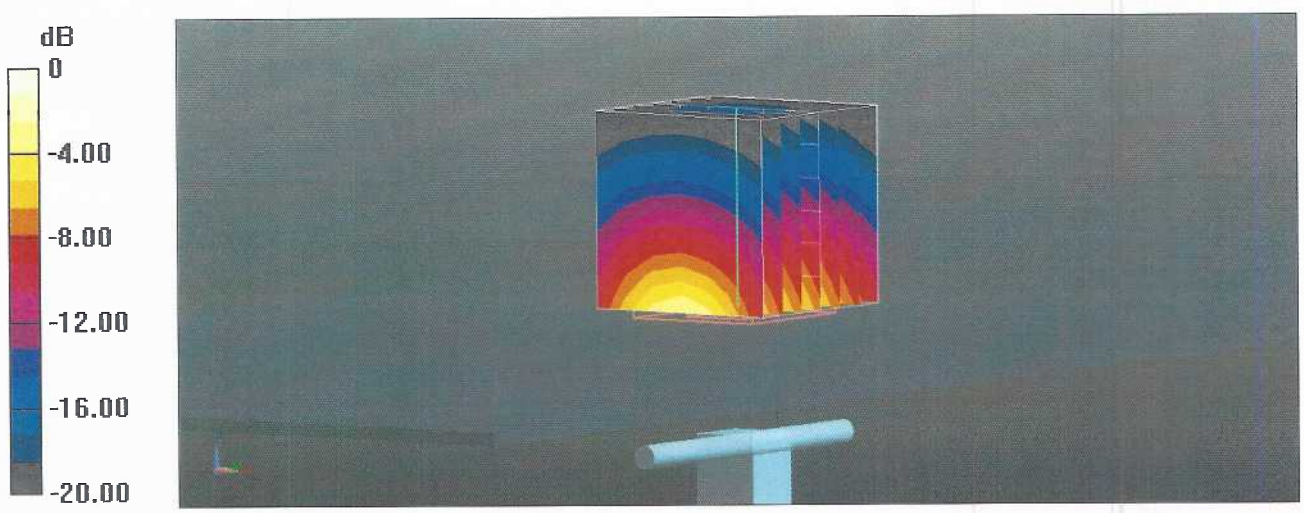
Communication System: UID 0 - CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; $\sigma = 1.87$ S/m; $\varepsilon_r = 37.7$; $\rho = 1000$ kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.96, 7.96, 7.96) @ 2450 MHz; Calibrated: 28.12.2020
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 02.11.2020
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

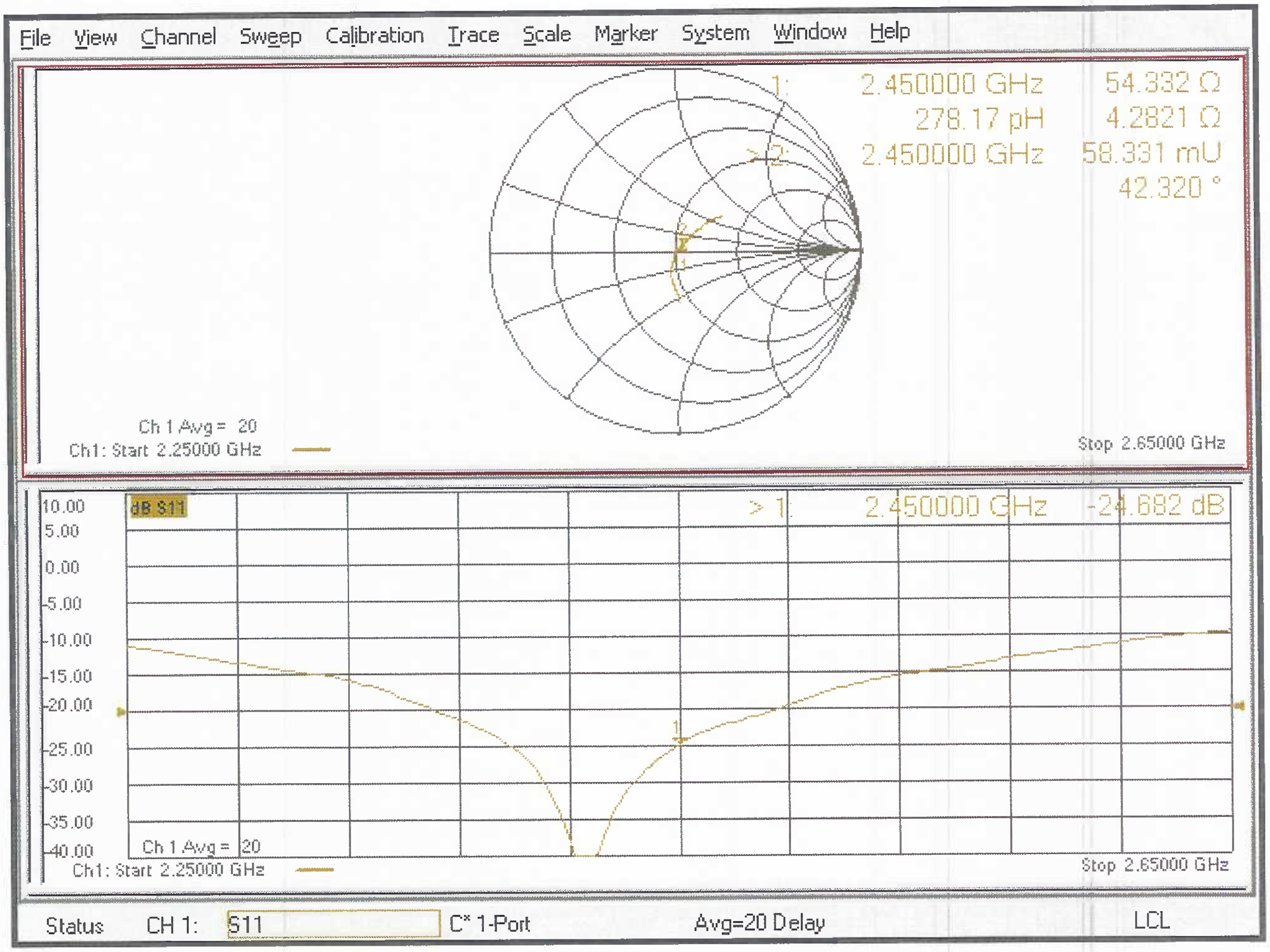
Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 119.0 V/m; Power Drift = 0.05 dB
Peak SAR (extrapolated) = 28.0 W/kg
SAR(1 g) = 13.9 W/kg; SAR(10 g) = 6.34 W/kg
Smallest distance from peaks to all points 3 dB below = 9 mm
Ratio of SAR at M2 to SAR at M1 = 49.5%
Maximum value of SAR (measured) = 23.1 W/kg



0 dB = 23.1 W/kg = 13.64 dBW/kg

Impedance Measurement Plot for Head TSL



Appendix F – DAE Calibration Data Sheets

Calibration Laboratory of
Schmid & Partner
Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland

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Accreditation No.: SCS 0108

Client **RF Exposure Lab**

Certificate No: DAE4-1416_Apr22

CALIBRATION CERTIFICATE

Object: DAE4 - SD 000 D04 BM - SN: 1416

Calibration procedure(s): QA CAL-06.v30
Calibration procedure for the data acquisition electronics (DAE)

Calibration date: April 12, 2022

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Keithley Multimeter Type 2001	SN: 0810278	31-Aug-21 (No:31368)	Aug-22
Secondary Standards	**ID #**	**Check Date (in house)**	**Scheduled Check**
Auto DAE Calibration Unit	SE UWS 053 AA 1001	24-Jan-22 (in house check)	In house check: Jan-23
Calibrator Box V2.1	SE UMS 006 AA 1002	24-Jan-22 (in house check)	In house check: Jan-23

	Name	Function	Signature
Calibrated by:	Adrian Gehring	Laboratory Technician	A Ge
Approved by:	Sven Kühn	Deputy Manager	i.V.

Issued: April 12, 2022

Glossary

DAE	data acquisition electronics
Connector angle	information used in DASY system to align probe sensor X to the robot coordinate system.

Methods Applied and Interpretation of Parameters

- *DC Voltage Measurement:* Calibration Factor assessed for use in DASY system by comparison with a calibrated instrument traceable to national standards. The figure given corresponds to the full scale range of the voltmeter in the respective range.
- *Connector angle*: The angle of the connector is assessed measuring the angle mechanically by a tool inserted. Uncertainty is not required.
- The following parameters as documented in the Appendix contain technical information as a result from the performance test and require no uncertainty.
    - *DC Voltage Measurement Linearity:* Verification of the Linearity at +10% and -10% of the nominal calibration voltage. Influence of offset voltage is included in this measurement.
    - *Common mode sensitivity:* Influence of a positive or negative common mode voltage on the differential measurement.
    - *Channel separation:* Influence of a voltage on the neighbor channels not subject to an input voltage.
    - *AD Converter Values with inputs shorted:* Values on the internal AD converter corresponding to zero input voltage
    - *Input Offset Measurement*: Output voltage and statistical results over a large number of zero voltage measurements.
    - *Input Offset Current:* Typical value for information; Maximum channel input offset current, not considering the input resistance.
    - *Input resistance:* Typical value for information: DAE input resistance at the connector, during internal auto-zeroing and during measurement.
    - *Low Battery Alarm Voltage:* Typical value for information. Below this voltage, a battery alarm signal is generated.
    - *Power consumption:* Typical value for information. Supply currents in various operating modes.

DC Voltage Measurement

A/D - Converter Resolution nominal

High Range: 1LSB = 6.1μV , full range = -100...+300 mV

Low Range: 1LSB = 61nV , full range = -1.......+3mV

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

Calibration Factors	**X**	**Y**	**Z**
High Range	403.562 ± 0.02% (k=2)	403.870 ± 0.02% (k=2)	404.137 ± 0.02% (k=2)
Low Range	3.97865 ± 1.50% (k=2)	3.99513 ± 1.50% (k=2)	3.97046 ± 1.50% (k=2)

Connector Angle

Connector Angle to be used in DASY system	107.5 ° ± 1 °

Appendix (Additional assessments outside the scope of SCS0108)

1. DC Voltage Linearity

High Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	199993.69	0.39	0.00
Channel X	+ Input	20001.91	0.04	0.00
Channel X	- Input	-20001.32	0.29	-0.00
Channel Y	+ Input	199995.49	2.37	0.00
Channel Y	+ Input	20001.59	-0.18	-0.00
Channel Y	- Input	-20002.90	-1.28	0.01
Channel Z	+ Input	199997.14	3.84	0.00
Channel Z	+ Input	20000.35	-1.29	-0.01
Channel Z	- Input	-20003.32	-1.40	0.01

Low Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	2001.25	0.20	0.01
Channel X	+ Input	201.83	0.41	0.20
Channel X	- Input	-198.42	0.20	-0.10
Channel Y	+ Input	2000.98	-0.02	-0.00
Channel Y	+ Input	200.80	-0.47	-0.23
Channel Y	- Input	-199.14	-0.51	0.25
Channel Z	+ Input	2000.99	0.08	0.00
Channel Z	+ Input	200.25	-0.91	-0.45
Channel Z	- Input	-200.06	-1.29	0.65

2. Common mode sensitivity

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	Common mode Input Voltage (mV)	High Range Average Reading (μV)	Low Range Average Reading (μV)
Channel X	200	-3.28	-4.95
	- 200	6.21	4.15
Channel Y	200	-6.92	-7.58
	- 200	6.27	6.10
Channel Z	200	-23.61	-23.40
	- 200	21.76	21.65

3. Channel separation

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	Input Voltage (mV)	Channel X (μV)	Channel Y (μV)	Channel Z (μV)
Channel X	200	-	2.55	-3.59
Channel Y	200	7.33	-	2.96
Channel Z	200	8.86	6.81	-

4. AD-Converter Values with inputs shorted

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	High Range (LSB)	Low Range (LSB)
Channel X	15996	17631
Channel Y	16152	16767
Channel Z	16134	15846

5. Input Offset Measurement

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec
Input 10MΩ

	Average (μV)	min. Offset (μV)	max. Offset (μV)	Std. Deviation (μV)
Channel X	0.76	-0.27	1.42	0.33
Channel Y	-0.76	-2.04	0.57	0.45
Channel Z	-0.41	-1.10	0.34	0.30

6. Input Offset Current

Nominal Input circuitry offset current on all channels: <25fA

7. Input Resistance (Typical values for information)

	Zeroing (kOhm)	Measuring (MOhm)
Channel X	200	200
Channel Y	200	200
Channel Z	200	200

8. Low Battery Alarm Voltage (Typical values for information)

Typical values	Alarm Level (VDC)
Supply (+ Vcc)	+7.9
Supply (- Vcc)	-7.6

9. Power Consumption (Typical values for information)

Typical values	Switched off (mA)	Stand by (mA)	Transmitting (mA)
Supply (+ Vcc)	+0.01	+6	+14
Supply (- Vcc)	−0.01	-8	-9

Appendix G – Phantom Calibration Data Sheets

Zeughausstrasse 43, 8004 Zurich, Switzerland
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Certificate of Conformity / First Article Inspection

Item	Oval Flat Phantom ELI 4.0
Type No	QD OVA 001 B
Series No	1003 and higher
Manufacturer	Untersee Composites Knebelstrasse 8 CH-8268 Mannenbach, Switzerland

Tests

Complete tests were made on the prototype units QD OVA 001 AA 1001, QD OVA 001 AB 1002, pre-series units QD OVA 001 BA 1003-1005 as well as on the series units QD OVA 001 BB, 1006 ff.

Test	Requirement	Details	Units tested
Material thickness	Compliant with the standard requirements	Bottom plate: 2.0mm +/- 0.2mm	all
Material parameters	Dielectric parameters for required frequencies	< 6 GHz: Rel. permittivity = 4 +/-1, Loss tangent ≤ 0.05	Material sample
Material resistivity	The material has been tested to be compatible with the liquids defined in the standards if handled and cleaned according to the instructions.	DGBE based simulating liquids. Observe Technical Note for material compatibility.	Equivalent phantoms, Material sample
Shape	Thickness of bottom material, Internal dimensions, Sagging compatible with standards from minimum frequency	Bottom elliptical 600 x 400 mm Depth 190 mm, Shape is within tolerance for filling height up to 155 mm, Eventual sagging is reduced or eliminated by support via DUT	Prototypes, Sample testing

Standards

[1] CENELEC EN 50361-2001, « Basic standard for the measurement of the Specific Absorption Rate related to human exposure to electromagnetic fields from mobile phones (300 MHz – 3 GHz) », July 2001

[2] IEEE 1528-2003, "Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques, December 2003

[3] IEC 62209 – 1, "Specific Absorption Rate (SAR) in the frequency range of 300 MHz to 3 GHz – Measurement Procedure, Part 1: Hand-held mobile wireless communication devices", February 2005

[4] IEC 62209 – 2, Draft, "Human Exposure to Radio Frequency Fields from Handheld and Body-Mounted Wireless Communication Devices – Human models, Instrumentation and Procedures – Part 2: Procedure to determine the Specific Absorption Rate (SAR) in the head and body for 30 MHz to 6 GHz Handheld and Body-Mounted Devices used in close proximity to the Body.", February 2005

[5] OET Bulletin 65, Supplement C, "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields", Edition January 2001

Based on the tests above, we certify that this item is in compliance with the standards [1] to [5] if operated according to the specific requirements and considering the thickness. The dimensions are fully compliant with [4] from 30 MHz to 6 GHz. For the other standards, the minimum lower frequency limit is limited due to the dimensional requirements ([1]: 450 MHz, [2]: 300 MHz, [3]: 800 MHz, [5]: 375 MHz) and possibly further by the dimensions of the DUT.

Date 28.4.2008 **Signature / Stamp**

s p e a g
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