FCC PART 95, SUBPART M
ISEDC RSS-251, ISSUE 2, JULY 2018

TEST REPORT

For

Tesla, Inc.

3500 Deer Creek Road,
Palo Alto, CA 94304, USA

FCC ID: 2AEIM-1541584
IC: 20098-1541584

Report Type:	**Product Type:**
Original Report	Automotive Radar

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ACCREDITED
CERTIFICATE #3297.02

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DOCUMENT REVISION HISTORY

Revision Number	Report Number	Description of Revision	Date of Revision
0	R2107273-95	Original Report	2022-05-13

1 General Description

1.1 Product Description for Equipment Under Test (EUT)

This test report was prepared on behalf of *Tesla, Inc.*, and their product model: 1541584, *FCC ID: 2AEIM-1541584; IC: 20098-1541584* or the "EUT" as referred to in this report. The EUT is a non-pulsed Automotive Radar which operates in the 76-77 GHz spectrum and supports 3 sensing modes.

1.2 Mechanical Description of EUT

1541584 measures approximately 196 mm (Length) x 82 cm (Width) x 40 mm (Height).

The data gathered is from a production sample provided by Tesla, Inc with serial numbers: BLI21259000005 & BLI22019000042

1.3 Objective

This report was prepared on behalf of *Tesla, Inc.*, in accordance with Part 2, Subpart J, and Part 95, Subpart M of the Federal Communication Commission's rules and ISEDC RSS-251 Issue 2, July 2018 and ISEDC RSS-Gen Issue 5, April 2018.

The objective was to determine compliance with FCC Part 95, Subpart M and ISEDC RSS-251 rules for Peak Fundamental Emission, Average Fundamental Emission, Antenna Requirements, RF Exposure, Occupied Bandwidth, Frequency Stability and Radiated Spurious Emissions.

1.4 Related Submittal(s)/Grant(s)

N/A

1.5 Test Methodology

All measurements contained in this report were conducted in accordance with ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices and ANSI C63.26-2015 American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services.

1.6 Measurement Uncertainty

All measurements involve certain levels of uncertainties, especially in the field of EMC. The factors contributing to uncertainties are spectrum analyzer, cable loss, antenna factor calibration, antenna directivity, antenna factor variation with height, antenna phase center variation, antenna factor frequency interpolation, measurement distance variation, site imperfections, mismatch (average), and system repeatability.

Parameter	Measurement uncertainty
Occupied Channel Bandwidth	±5 %
RF output power, conducted	±0.57 dB
Power Spectral Density, conducted	±1.48dB
Unwanted Emissions, conducted	±1.57dB
All emissions, radiated	±4.0 dB
AC power line Conducted Emission	±2.0 dB
Temperature	±2 º C
Humidity	±5 %
DC and low frequency voltages	±1.0 %
Time	±2 %
Duty Cycle	±3 %

1.7 Test Facility Registrations

BACLs test facilities that are used to perform Radiated and Conducted Emissions tests are currently recognized by the Federal Communications Commission as Accredited with NIST Designation Number US1129.

BACL's test facilities that are used to perform Radiated and Conducted Emissions tests are currently registered with Industry Canada under Registration Numbers: 3062A-1, 3062A-2, and 3062A-3.

BACL is a Chinese Taipei Bureau of Standards Metrology and Inspection (BSMI) validated Conformity Assessment Body (CAB), under Appendix B, Phase I Procedures of the APEC Mutual Recognition Arrangement (MRA). BACL's BSMI Lab Code Number is: SL2-IN-E-1002R.

BACL's test facilities that are used to perform AC Line Conducted Emissions, Telecommunications Line Conducted Emissions, Radiated Emissions from 30 MHz to 1 GHz, and Radiated Emissions from 1 GHz to 6 GHz are currently recognized as Accredited in accordance with the Voluntary Control Council for Interference [VCCI] Article 15 procedures under Registration Number A-0027.

1.8 Test Facility Accreditations

Bay Area Compliance Laboratories Corp. (BACL) is:

A- ***An independent, 3rd-Party, Commercial Test Laboratory accredited to ISO/IEC 17025:2017 by A2LA (Test Laboratory Accreditation Certificate Number 3297.02),*** in the fields of: Electromagnetic Compatibility and Telecommunications. Unless noted by an Asterisk (*) in the Compliance Matrix (See Section 3 of this Test Report), BACL's ISO/IEC 17025:2017 Scope of Accreditation includes all of the Test Method Standards and/or the Product Family Standards detailed in this Test Report.

BACL's ISO/IEC 17025:2017 Scope of Accreditation includes a comprehensive suite of EMC Emissions, EMC Immunity, Radio, RF Exposure, Safety and wireline Telecommunications test methods applicable to a wide range of product categories. These product categories include Central Office Telecommunications Equipment

[including NEBS - Network Equipment Building Systems], Unlicensed and Licensed Wireless and RF devices, Information Technology Equipment (ITE); Telecommunications Terminal Equipment (TTE); Medical Electrical Equipment; Industrial, Scientific and Medical Test Equipment; Professional Audio and Video Equipment; Industrial and Scientific Instruments and Laboratory Apparatus; Cable Distribution Systems, and Energy Efficient Lighting.

B- ***A Product Certification Body accredited to ISO/IEC 17065:2012 by A2LA (Product Certification Body Accreditation Certificate Number 3297.03)*** to certify

- For the USA (Federal Communications Commission):
  - 1- All Unlicensed radio frequency devices within FCC Scopes A1, A2, A3, and A4;
  - 2- All Licensed radio frequency devices within FCC Scopes B1, B2, B3, and B4;
  - 3- All Telephone Terminal Equipment within FCC Scope C.
- For the Canada (Industry Canada):
  - 1 All Scope 1-Licence-Exempt Radio Frequency Devices;
  - 2 All Scope 2-Licensed Personal Mobile Radio Services;
  - 3 All Scope 3-Licensed General Mobile & Fixed Radio Services;
  - 4 All Scope 4-Licensed Maritime & Aviation Radio Services;
  - 5 All Scope 5-Licensed Fixed Microwave Radio Services
  - 6 All Broadcasting Technical Standards (BETS) in the Category I Equipment Standards List.
- For Singapore (Info-Communications Development Authority (IDA)):
  - 1 All Line Terminal Equipment: All Technical Specifications for Line Terminal Equipment – Table 1 of IDA MRA Recognition Scheme: 2011, Annex 2
  - 2. All Radio-Communication Equipment: All Technical Specifications for Radio-Communication Equipment – Table 2 of IDA MRA Recognition Scheme: 2011, Annex 2
- For the Hong Kong Special Administrative Region:
  - 1 All Radio Equipment, per KHCA 10XX-series Specifications;
  - 2 All GMDSS Marine Radio Equipment, per HKCA 12XX-series Specifications;
  - 3 All Fixed Network Equipment, per HKCA 20XX-series Specifications.
- For Japan:
  - 1 MIC Telecommunication Business Law (Terminal Equipment):
    - All Scope A1 - Terminal Equipment for the Purpose of Calls;
    - All Scope A2 - Other Terminal Equipment
  - 2 Radio Law (Radio Equipment):
    - All Scope B1 - Specified Radio Equipment specified in Article 38-2-2, paragraph 1, item 1 of the Radio Law
    - All Scope B2 - Specified Radio Equipment specified in Article 38-2-2, paragraph 1, item 2 of the Radio Law
    - All Scope B3 - Specified Radio Equipment specified in Article 38-2-2, paragraph 1, item 3 of the Radio Law

C- ***A Product Certification Body accredited to ISO/IEC 17065:2012 by A2LA (Product Certification Body Accreditation Certificate Number 3297.01)*** to certify Products to USA's Environmental Protection Agency (EPA) ENERGY STAR Product Specifications for:

1 Electronics and Office Equipment:
- for Telephony (ver. 3.0)
- for Audio/Video (ver. 3.0)
- for Battery Charging Systems (ver. 1.1)
- for Set-top Boxes & Cable Boxes (ver. 4.1)
- for Televisions (ver. 6.1)
- for Computers (ver. 6.0)
- for Displays (ver. 6.0)
- for Imaging Equipment (ver. 2.0)
- for Computer Servers (ver. 2.0)

2 Commercial Food Service Equipment

- for Commercial Dishwashers (ver. 2.0)
- for Commercial Ice Machines (ver. 2.0)
- for Commercial Ovens (ver. 2.1)
- for Commercial Refrigerators and Freezers

3 Lighting Products
- For Decorative Light Strings (ver. 1.5)
- For Luminaires (including sub-components) and Lamps (ver. 1.2)
- For Compact Fluorescent Lamps (CFLs) (ver. 4.3)
- For Integral LED Lamps (ver. 1.4)

4 Heating, Ventilation, and AC Products
- for Residential Ceiling Fans (ver. 3.0)
- for Residential Ventilating Fans (ver. 3.2)

5 Other
- For Water Coolers (ver. 3.0)

D- ***A NIST Designated Phase-I and Phase-II Conformity Assessment Body (CAB) for the following economies and regulatory authorities under the terms of the stated MRAs/Treaties:***

- Australia: ACMA (Australian Communication and Media Authority) – APEC Tel MRA -Phase I;
- Canada: (Innovation, Science and Economic development Canada - ISEDC) Foreign Certification Body – FCB – APEC Tel MRA -Phase I & Phase II;
- Chinese Taipei (Republic of China – Taiwan):
  - BSMI (Bureau of Standards, Metrology and Inspection) APEC Tel MRA -Phase I;
  - NCC (National Communications Commission) APEC Tel MRA -Phase I;
- European Union:
  - EMC Directive 2014/30/EU US-EU EMC & Telecom MRA CAB (NB)
  - Radio Equipment (RE) Directive 2014/53/EU US-EU EMC & Telecom MRA CAB (NB)
  - Low Voltage Directive (LVD) 2014/35/EU
- Hong Kong Special Administrative Region: (Office of the Telecommunications Authority – OFTA) APEC Tel MRA -Phase I & Phase II
- Israel – US-Israel MRA Phase I
- Republic of Korea (Ministry of Communications - Radio Research Laboratory) APEC Tel MRA -Phase I
- Singapore: (Infocomm Media Development Authority - IMDA) APEC Tel MRA -Phase I & Phase II;
- Japan: VCCI - Voluntary Control Council for Interference US-Japan Telecom Treaty VCCI Side Letter-
- USA:
  - ENERGY STAR Recognized Test Laboratory – US EPA
  - Telecommunications Certification Body (TCB) – US FCC;
  - Nationally Recognized Test Laboratory (NRTL) – US OSHA
- Vietnam: APEC Tel MRA -Phase I;

2 System Test Configuration

2.1 Justification

The EUT was configured for testing according to ANSI C63.26-2015.

The EUT was tested in a testing mode to represent worst-case results during the final qualification test.

2.2 EUT Exercise Software

Test Software "Phoenix FCC Tester" was provided by Tesla, Inc., and was verified to be compliant with the standard requirements being tested against. The following modes were set for testing. All the modes were measured for testing, and the corresponding power settings used are listed below.

Mode	Power Setting
3	Default
4	Default
5	Default

Please refer to the Operational Description for detailed description of the test modes.

2.3 Modulation Characteristics

Per FCC §2.1047(d) *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.

Per ISEDC RSS-251 §6: In addition to the reporting requirements of RSS-Gen, the following information shall be provided, as per the applicable modulation type:

(b): Non-pulse radar (e.g. frequency modulated continuous wave (FMCW)): modulation type: (i.e. sawtooth, sinusoid, triangle, or square wave) and sweep characteristics (sweep bandwidth, sweep rate, sweep time).

Comments from manufacturer on modulation characteristics are provided below:

Parameter	Manufacturer Comments
Timing (see section 2.4)	Typical Cycle Time: 67 ms On-time(Sweep Time): 30.6 ms
Modulation	FM-chirps
Sweep Bandwidth	Mode dependent: 210 MHz, 400 MHz, 700 MHz
Sweep Rate	Mode dependent: 210/17.8 MHz/µs, 400/17.8 MHz/µs, 700/17.8 MHz/µs

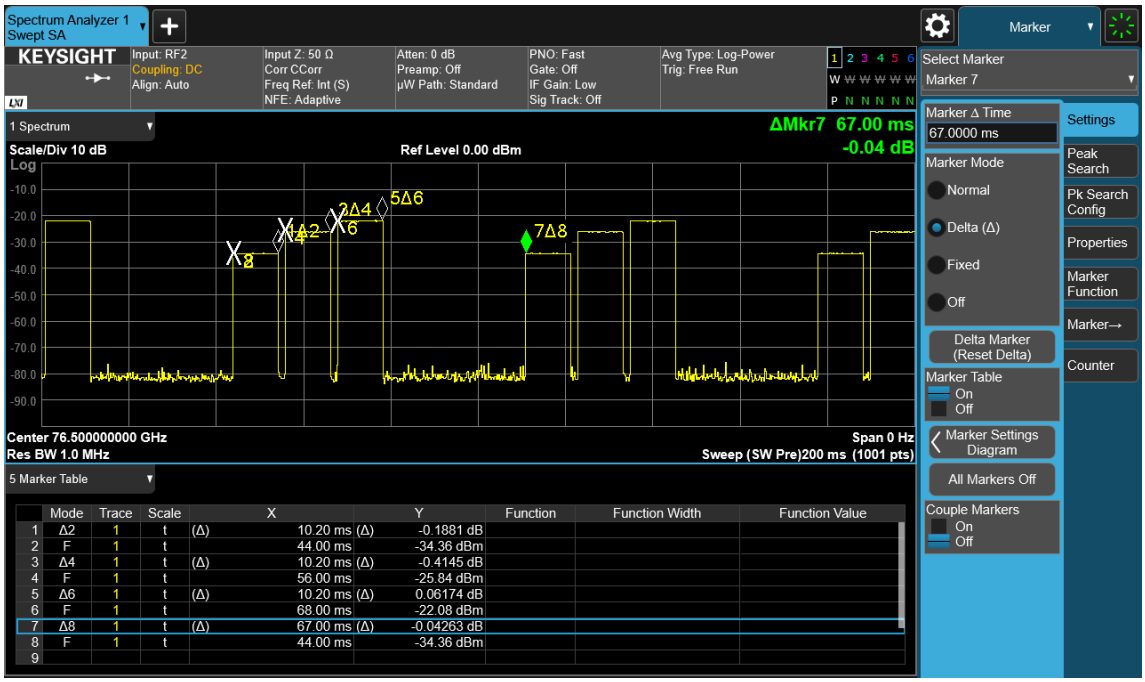
2.4 Duty Cycle Correction Factor

Radio Mode*	On Time (ms)	Period (ms)	Duty Cycle (%)	Duty Cycle Correction Factor (dB)
3,4,5	30.6	67	45.67	3.40

Note: It was verified that duty cycle is same for all three modes of operation.*

Duty Cycle = On Time (ms)/ Period (ms)
*Duty Cycle Correction Factor (dB) = 10*log(1/Duty Cycle)*

Please refer to the following plot



2.5 Peak Desensitization Factor

Fundamental Peak Desensitization Factors:

Radio Mode	Chirp BW (MHz)	Chirp Time (µs)	Measurement BW (MHz)	Peak Desensitization Factor (dB)
3	209.35	17.8	1	7.23
4	400.66	17.8	1	9.99
5	701.03	17.8	1	12.41

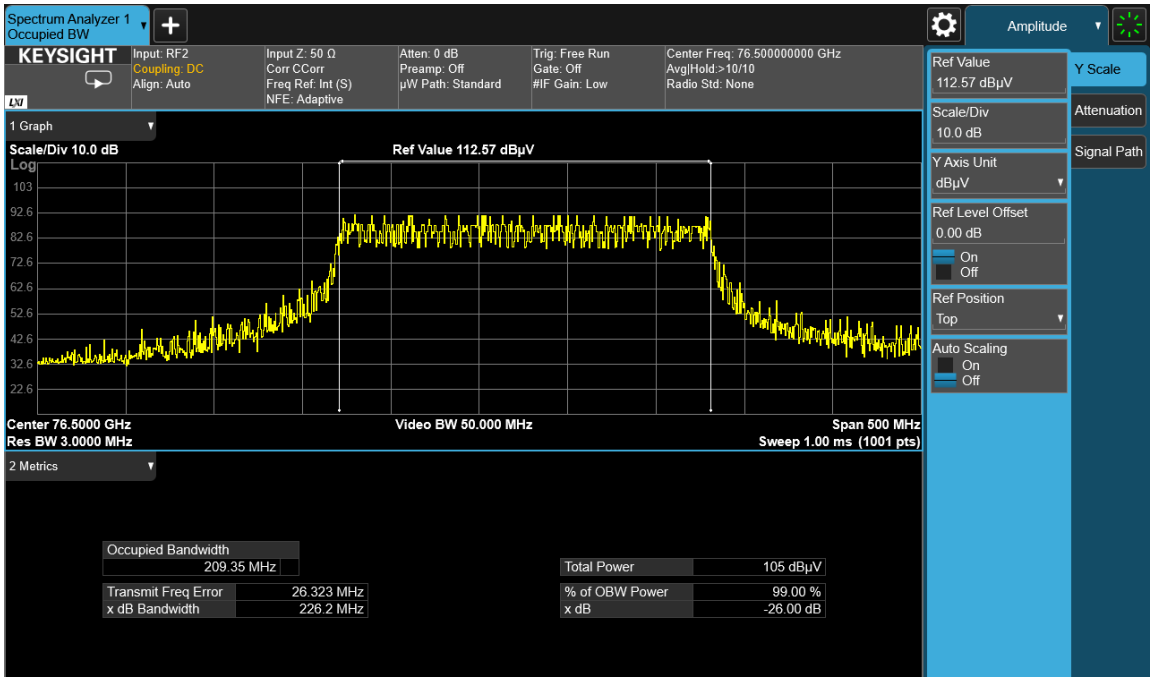
Note: Peak Desensitization Factor determined by using the formula below (According to Keysight Application Note 5952-1039 Annex B)

$$\alpha = \frac{1}{\sqrt[4]{1 + (\frac{2\ln(2)}{\pi})^2 (\frac{BW_{Chirp}}{T_{Chirp} B^2})^2}}$$

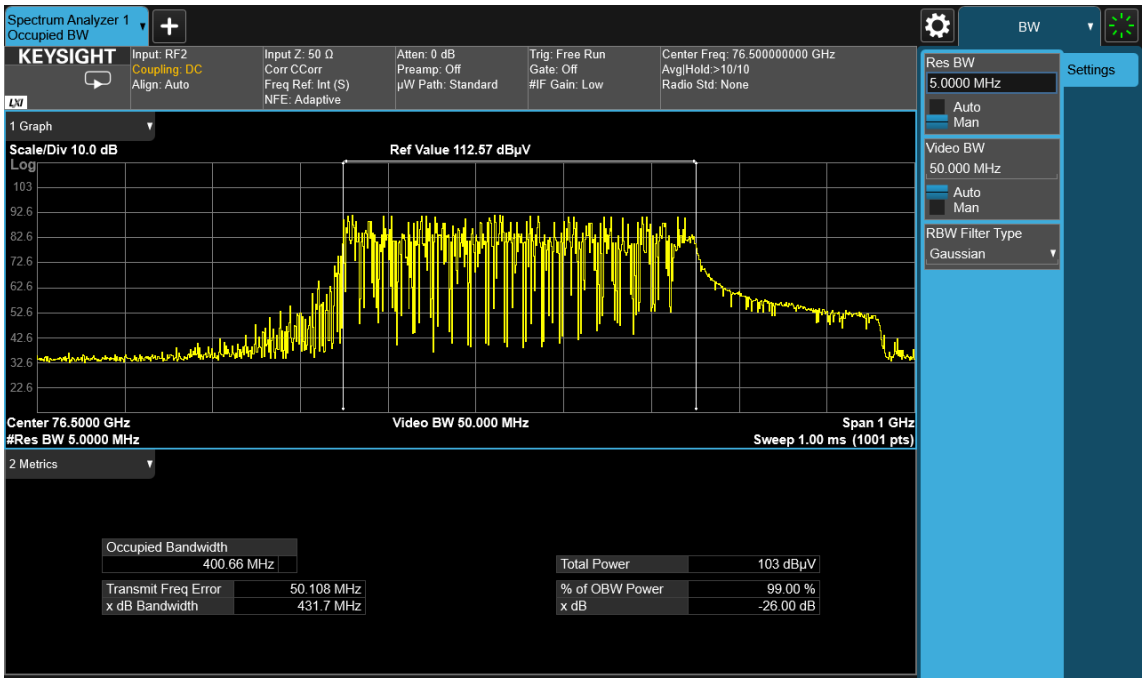
, where the BW_{chirp} is the chirp bandwidth shown in following plots, T_{chirp} is the chirp time (17.8µs from radar specification) and B is the measurement bandwidth(RBW) of 1MHz.

Chirp BW

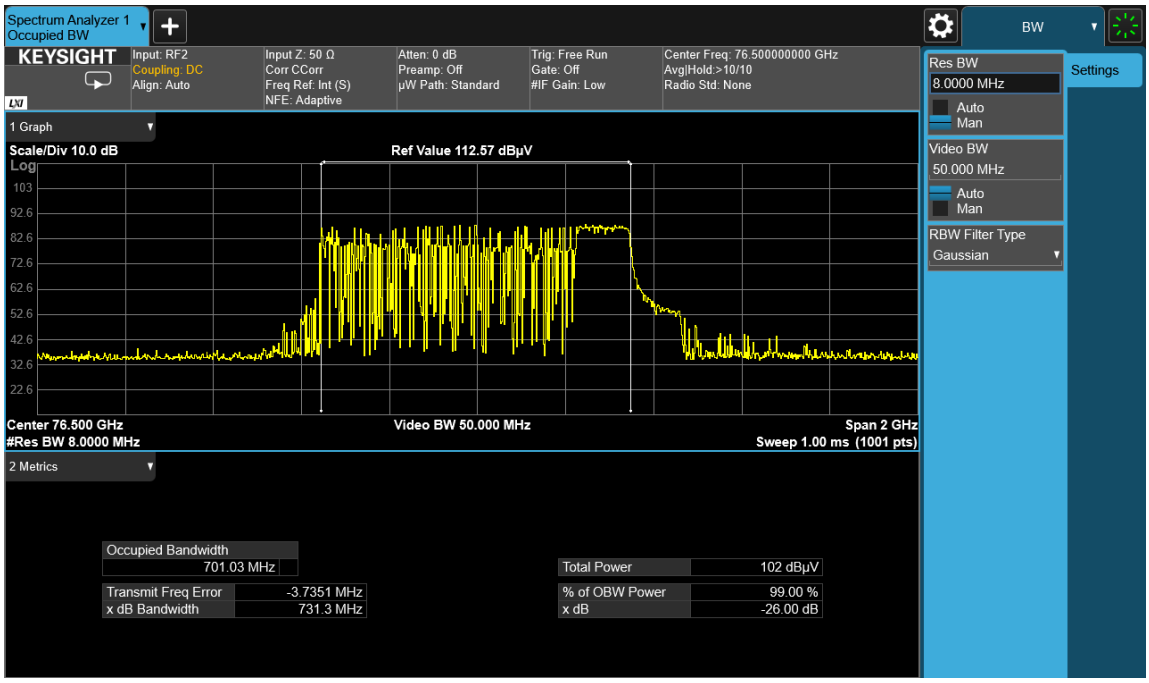
Mode 3



Mode 4



Mode 5



2.6 Far-Field Calculations

Antenna Model	Frequency Range (GHz)	Measurement Antenna			EUT Antenna		
		D (meters)	λ (meters)	R_m (meters)	D (meters)	λ (meters)	R_m (meters)
M19RH	40-60	0.04625	0.004997	0.86	0.014974	0.004997	0.09
M12RH	60-90	0.03002	0.003331	0.54	0.014974	0.003331	0.13
M8RH	90-140	0.01969	0.002141	0.36	0.014974	0.002141	0.21
M5RH	140-162	0.01255	0.001852	0.17	0.014974	0.001852	0.24
	162-220	0.01255	0.001364	0.23	0.014974	0.001364	0.33
M3RH	220-231	0.00836	0.001298	0.11	0.014974	0.001298	0.35

Note: EUT antenna dimension was provided by customer.

Note: Far-Field (Rayleigh) distance formula used is shown below (According to ANSI C63.26-2015 Section 4.4.3 Note f)

$$R_m = 2D^2/\lambda$$

, where the R_m is the Rayleigh (far-field) distance, D is the largest dimension of the antenna aperture and λ is the free-space wavelength in meters at the frequency of measurement (calculated by speed of light divided by frequency).

Note: Measurements in report were made at distances greater than calculated far-field distances shown in table

2.7 Equipment Modifications

None

2.8 Remote Support Equipment

Manufacturer	Description	Model	S/N
Technica Engineering	Fast Ethernet MediaConverter	100 BasT1	-

2.9 Local Support Equipment

Manufacturer	Description	Model	S/N
Volteq	DC Power Supply	HY5003D	160402343
Dell	Laptop	Latitude E6410	-

2.10 Interface Ports and Cabling

Cable Description	Length (m)	To	From
Power Cables	< 2 m	EUT	DC Power Supply
Comms Cable	< 2 m	EUT	Laptop
RS-232 Cable	< 2 m	MediaConverter	Laptop

3 Summary of Test Results

Results reported relate only to the product tested.

FCC and ISEDC Rules	Description of Test	Results
ISEDC RSS-Gen §6.8	Antenna Requirement	Compliant
ISEDC RSS-Gen §8.8	AC Line Conducted Emissions	N/A[1]
FCC §95.3385, §2.1091, §1.1310(d) (3) ISEDC RSS-102	RF Exposure	Compliant
FCC §95.3379(a) ISEDC RSS-251 §10 ISEDC RSS-Gen §8.1, §8.9 & §8.10	Radiated Spurious Emissions	Compliant
FCC §95.3379(b) ISEDC RSS-251 §7, §11	Occupied Bandwidth/Frequency Stability	Compliant
FCC §95.3379(b) ISEDC RSS-251 §9	Peak Fundamental Emission	Compliant
FCC §95.3379(a) ISEDC RSS-251 §8	Average Fundamental Emission	Compliant

Note[1]: Device is powered by car battery.

4 RSS-Gen §6.8 - Antenna Requirements

4.1 Applicable Standards

According to ISEDC RSS-Gen §6.8: Transmitter Antenna

The applicant for equipment certification shall provide a list of all antenna types that may be used with the transmitter, where applicable (i.e. for transmitters with detachable antenna), indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna. The test report shall demonstrate the compliance of the transmitter with the limit for maximum equivalent isotropically radiated power (e.i.r.p.) specified in the applicable RSS, when the transmitter is equipped with any antenna type, selected from this list.

For expediting the testing, measurements may be performed using only the antenna with highest gain of each combination of transmitter and antenna type, with the transmitter output power set at the maximum level. However, the transmitter shall comply with the applicable requirements under all operational conditions and when in combination with any type of antenna from the list provided in the test report (and in the notice to be included in the user manual, provided below).

When measurements at the antenna port are used to determine the RF output power, the effective gain of the device's antenna shall be stated, based on a measurement or on data from the antenna's manufacturer.

The test report shall state the RF power, output power setting and spurious emission measurements with each antenna type that is used with the transmitter being tested.

For licence-exempt equipment with detachable antennas, the user manual shall also contain the following notice in a conspicuous location:

This radio transmitter [enter the device's ISED certification number] has been approved by Innovation, Science and Economic Development Canada to operate with the antenna types listed below, with the maximum permissible gain indicated. Antenna types not included in this list that have a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device.

Immediately following the above notice, the manufacturer shall provide a list of all antenna types which can be used with the transmitter, indicating the maximum permissible antenna gain (in dBi) and the required impedance for each antenna type.

4.2 Antenna Description

External/Internal/Integral	Total Antenna Gain (dBi)	Antenna Type
Integral	20.32	PCB Trace Antenna

The antenna is factory-installed and is not modifiable by users.

Device has 6 Tx antennas, but only 4 can transmit at the same time. The maximum individual antenna gain is 14.3 dBi. Total antenna gain = individual antenna gain + 10log(number of antenna that transmit at the same time) = 14.3 dBi + 10log(4) = 20.32 dBi

The antenna gain is information provided by the customer.

Antenna boresight direction(s) and 3 dB beamwidth in both horizontal and vertical planes:

- Azimuth:
  - Boresight – 0 degrees
  - 3dB beam width – 48 degrees
- Elevation:
  - Boresight – 0 degrees
  - 3dB beam width – 14 degrees

5 FCC §2.1091, §1.1310(d) (3) & ISEDC RSS-102 - RF Exposure

5.1 Applicable Standards

According to FCC KDB 447498 D04 Interim General RF Exposure Guidance v01, Section 2.1 RF Exposure Test Exemptions for Single Source,

2.1.1 General RF Exposure Test Exemption Considerations

RF exposure test exemptions provide means to obtain certification without the need of showing data (measurements, or analytical/numerical modeling) to demonstrate compliance. Hereafter, in this context, an RF source is referred to as "*exempt RF device*" in the sense that it is not required to show data demonstrating compliance to RF exposure limits.

Test exemptions apply for devices used in general population/uncontrolled exposure environments, according to the SAR-based, or MPE-based exemption thresholds.[8] However, it is always possible, especially when the potential for exposure cannot be easily determined, that an RF exposure evaluation may become required according §§ 1.1307(c) and (d).

As detailed in Section 2.1.2, the 1 mW and SAR-based test exemption conditions are in terms of source-based available maximum time-averaged (matched conducted) output power for all operating configurations, adjusted for tune-up tolerance, and at the minimum *test separation distance* required for the particular RF exposure scenario under consideration. This minimum *test separation distance* is determined by the smallest distance from the antenna and radiating structures or outer surface of the device, according to the host form factor, exposure conditions and platform requirements, to any part of the body or extremity of a user or bystander. To qualify for SAR test exemption, the *test separation distances* applied must be fully explained and justified (typically in the SAR measurement, or SAR analysis report, according to KDB Pub. 865664) by showing the actual operating configurations and exposure conditions of the transmitter, and applicable host platform requirements (e.g., KDB Pubs. 648474, 616217, 941225)

When no other RF exposure testing or reporting is required, a statement of justification and compliance must be included in the equipment approval, in lieu of the SAR report, to qualify for SAR test exemption.

If RF exposure testing requirements for a specific device are covered in a KDB Publication, those requirements must be satisfied before applying any SAR test exemption provisions. For example, this is the case for handheld PTT two-way radios, handsets, laptops, and tablets, etc.[9]

Finally, when 10-g extremity SAR applies, SAR test exemption may be considered by applying a factor of 2.5 to the SAR-based exemption thresholds.

2.1.2 1-mW Test Exemption

Per §1.1307(b)(3)(i)(A), a single RF source is *exempt RF device* (from the requirement to show data demonstrating compliance to RF exposure limits, as previously mentioned) if the available maximum time-averaged power is no more than 1 mW, regardless of separation distance.

This exemption applies to all operating configurations and exposure conditions, for the frequency range 100 kHz to 100 GHz, regardless of fixed, mobile, or portable device exposure conditions. This is a standalone exemption, and it cannot be applied in conjunction with any other test exemption.

2.1.3 SAR-Based Exemption

A more comprehensive exemption, considering a variable power threshold that depends on both the *separation distance* and power, is provided in §1.1307(b)(3)(ii)(B). This exemption is applicable to the frequency range

between 300 MHz and 6 GHz, with *test separation distances* between 0.5 cm and 40 cm, and for all RF sources in fixed, mobile, and portable device exposure conditions.

Accordingly, a RF source is considered an *RF exempt device* if its available maximum time-averaged (matched conducted) power or its effective radiated power (ERP), whichever is greater, are below a specified threshold. This exemption threshold was derived based on general population 1-g SAR requirements and is detailed in Appendix C.

2.1.4 MPE-Based Exemption

An alternative to the SAR-based exemption is provided in §1.1307(b)(3)(ii)(C), for a much wider frequency range, from 300 kHz to 100 GHz, applicable for separation distances greater or equal to $\lambda/2\pi$, where λ is the free-space operating wavelength in meters. The MPE-based test exemption condition is in terms of ERP, defined as the

[8] Specific test exemption thresholds for operations under occupational/controlled limits are not established.
[9] When SAR evaluation is required by the hotspot mode or UMPC mini-tablet procedures, that is, where an antenna is ≤ 2.5 cm from a surface or edge, the *test separation distance* from the phantom to the antenna or device enclosure, as appropriate, should be applied to determine SAR test exemption for such configurations, according to the criteria in this document. For that case, the *test separation distance* cannot be determined from the distance of the antenna to the device surface or edge.

According to ISED RSS-102 Issue 5 Section 2.5.1 Exemption Limits for Routine Evaluation-SAR Evaluation:

SAR evaluation is required if the separation distance between the user and/or bystander and the antenna and/or radiating element of the device is less than or equal to 20 cm, except when the device operates at or below the applicable output power level (adjusted for tune-up tolerance) for the specified separation distance defined in table below,

Frequency (MHz)	Exemption Limits (mW)				
	At separation distance of ≤5 mm	At separation distance of 10 mm	At separation distance of 15 mm	At separation distance of 20 mm	At separation distance of 25 mm
≤300	71	101	132	162	193
450	52	70	88	106	123
835	17	30	42	55	67
1900	7	10	18	34	60
2450	4	7	15	30	52
3500	2	6	16	32	55
5800	1	6	15	27	41

Frequency (MHz)	Exemption Limits (mW)				
	At separation distance of 30 mm	At separation distance of 35 mm	At separation distance of 40 mm	At separation distance of 45 mm	At separation distance of ≥50 mm
≤300	223	254	284	315	345
450	141	159	177	195	213
835	80	92	105	117	130
1900	99	153	225	316	431
2450	83	123	173	235	309
3500	86	124	170	225	290
5800	56	71	85	97	106

5.2 FCC RF Exposure Exemption Evaluation Procedures

According to FCC KDB 447498 D04 Interim General RF Exposure Guidance v01, Annex B Exemptions for Single Source,

B.1 General

This appendix provides the exemption criteria and summarizes relevant parameters and usage considerations based on descriptions in FCC 19-126.

B.2 Blanket 1 mW Blanket Exemption

The 1 mW Blanket Exemption of § 1.1307(b)(3)(i)(A) applies for single fixed, mobile, and portable RF sources with available maximum time-averaged power of no more than 1 mW, regardless of separation distance. The 1 mW blanket exemption applies at separation distances less than 0.5 cm, including where there is no separation. This exemption shall not be used in conjunction with other exemption criteria other than those for multiple RF sources in paragraph § 1.1307(b)(3)(ii)(A). The 1 mW exemption is independent of service type and covers the full range of 100 kHz to 100 GHz, but it shall not be used in conjunction with other exemption criteria or in devices with higher-power transmitters operating in the same time-averaging period. Exposure from such higher-power transmitters would invalidate the underlying assumption that exposure from the lower-power transmitter is the only contributor to SAR in the relevant volume of tissue.

B.3 MPE-based Exemption

General frequency and separation-distance dependent MPE-based effective radiated power (ERP) thresholds are in Table B.1 [Table 1 of § 1.1307(b)(1)(i)(C)] to support an exemption from further evaluation from 300 kHz through 100 GHz.

Table B.1 – THRESHOLD FOR SINGLE RF SOURCE SUBJECT TO ROUTINE ENVIRONMENTAL EVALUATION

RF Source			**Minimum Distance**			**Threshold ERP**
f_L MHz		f_H MHz	$\lambda_L/2\pi$		$\lambda_H/2\pi$	W
0.3	-	1.34	159 m	-	35.6 m	1,920 R^2
1.34	-	30	35.6 m	-	1.6 m	3,450 R^2/f^2
30	-	300	1.6 m	-	159 mm	3.83 R^2
300	-	1,500	159 mm	-	31.8 mm	0.0128 $R^2 f$
1,500	-	100,000	31.8 mm	-	0.5 mm	19.2 R^2
Subscripts L and H are low and high; λ is wavelength. From § 1.1307(b)(3)(i)(C), modified by adding Minimum Distance columns.						

The table applies to any RF source (i.e., single fixed, mobile, and portable transmitters) and specifies power and distance criteria for each of the five frequency ranges used for the MPE limits. These criteria apply at separation distances from any part of the radiating structure of at least $\lambda/2\pi$. The thresholds are based on the general population MPE limits with a single perfect reflection, outside of the reactive near-field, and in the main beam of the radiator.

For mobile devices that are not exempt per Table B.1 [Table 1 of § 1.1307(b)(1)(i)(C)] at distances from 20 cm to 40 cm and in 0.3 GHz to 6 GHz, evaluation of compliance with the exposure limits in § 1.1310 is necessary if the ERP of the device is greater than ERP20cm in Formula (B.1) [repeated from § 2.1091(c)(1) and § 1.1307(b)(1)(i)(B)].

$$P_{th}\,(\text{mW}) = ERP_{20\,cm}\,(\text{mW}) = 2040f \quad 0.3\ \text{GHz} \le f < 1.5\ \text{GHz}$$
$$P_{th}\,(\text{mW}) = ERP_{20\,cm}\,(\text{mW}) = 3060 \quad 1.5\ \text{GHz} \le f \le 6\ \text{GHz} \qquad \text{(B.1)}$$

If the ERP is not easily obtained, then the available maximum time-averaged power may be used (i.e., without consideration of ERP only if the physical dimensions of the radiating structure(s) do not exceed the electrical length of $\lambda/4$ or if the antenna gain is less than that of a half-wave dipole.

SAR-based exemptions are constant at separation distances between 20 cm and 40 cm to avoid discontinuities in the threshold when transitioning between SAR-based and MPE-based exemption criteria at 40 cm, considering the importance of reflections.

B.4 SAR-based Exemption

SAR-based thresholds are derived based on frequency, power, and separation distance of the RF source. The formula defines the thresholds in general for either available maximum time-averaged power or maximum time-averaged ERP, whichever is greater.

If the ERP of a device is not easily determined, such as for a portable device with a small form factor, the applicant may use the available maximum time-averaged power exclusively if the device antenna or radiating structure does not exceed an electrical length of $\lambda/4$.

As for devices with antennas of length greater than $\lambda/4$ where the gain is not well defined, but always less than that of a half-wave dipole (length $\lambda/2$), the available maximum time-averaged power generated by the device may be used in place of the maximum time-averaged ERP, where that value is not known.

The separation distance is the smallest distance from any part of the antenna or radiating structure for all persons, during operation at the applicable ERP. In the case of mobile or portable devices, the separation distance is from the outer housing of the device where it is closest to the antenna.

The SAR-based exemption formula of § 1.1307(b)(3)(i)(B), repeated here as Formula (B.2), applies for single fixed, mobile, and portable RF sources with available maximum time-averaged power or effective radiated power (ERP), whichever is greater, of less than or equal to the threshold P_{th} (mW).

This method shall only be used at separation distances from 0.5 cm to 40 cm and at frequencies from 0.3 GHz to 6 GHz (inclusive). P_{th} is given by Formula (B.2).

$$P_{th}\ (\text{mW}) = ERP_{20\ \text{cm}}\ (d/20\ \text{cm})^{x} \quad d \leq 20\ \text{cm}$$
$$P_{th}\ (\text{mW}) = ERP_{20\ \text{cm}} \quad 20\ \text{cm} < d \leq 40\ \text{cm} \qquad \text{(B.2)}$$

Where

$$x = -\log_{10}\ (60/(ERP_{20\ \text{cm}}\sqrt{f}))$$

and f is in GHz, d is the separation distance (cm), and EPR20cm is per Formula (B.1).

The example values shown in Table B.2 are for illustration only.

Table B.2 – Example Power Thresholds (mW)

Frequency (MHz)	**Distance (mm)**										
		5	10	15	20	25	30	35	40	45	50
	300	39	65	88	110	129	148	166	184	201	217
	450	22	44	67	89	112	135	158	180	203	226
	835	9	25	44	66	90	116	145	175	207	240
	1900	3	12	26	44	66	92	122	157	195	236
	2450	3	10	22	38	59	83	111	143	179	219
	3600	2	8	18	32	49	71	96	125	158	195
	5800	1	6	14	25	40	58	80	106	136	169

5.3 IC RF Exposure Exemption

According to ISED RSS-102 Issue 5:

2.5.2 Exemption Limits for Routine Evaluation – RF Exposure Evaluation

RF exposure evaluation is required if the separation distance between the user and/or bystander and the device's radiating element is greater than 20 cm, except when the device operates as follows:

- below 20 MHz[6] and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 1 W (adjusted for tune-up tolerance);
- at or above 20 MHz and below 48 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $4.49/f^{0.5}$ W (adjusted for tune-up tolerance), where f is in MHz;
- at or above 48 MHz and below 300 MHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 0.6 W (adjusted for tune-up tolerance);
- at or above 300 MHz and below 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than $1.31 \times 10^{-2} f^{0.6834}$ W (adjusted for tune-up tolerance), where f is in MHz;
- at or above 6 GHz and the source-based, time-averaged maximum e.i.r.p. of the device is equal to or less than 5 W (adjusted for tune-up tolerance).

In these cases, the information contained in the RF exposure technical brief may be limited to information that demonstrates how the e.i.r.p. was derived.

5.4 RF exposure evaluation exemption for FCC

<table>
<tr><td>Prediction frequency (GHz)</td><td colspan="2">76.5</td></tr>
<tr><td>Maximum EIRP (dBm)</td><td colspan="2">22.49</td></tr>
<tr><td>Maximum ERP (dBm)</td><td colspan="2">20.34</td></tr>
<tr><td>Maximum ERP (mW)</td><td colspan="2">108.14</td></tr>
<tr><td>Prediction distance (cm)</td><td colspan="2">20</td></tr>
<tr><td rowspan="4">1.5 GHz ≤ f ≤ 100 GHz</td><td colspan="2">MPE-based Exemption Threshold</td></tr>
<tr><td rowspan="2">d ≤ 20 cm</td><td>P_{th} (mW)</td></tr>
<tr><td>768</td></tr>
<tr><td rowspan="2">20 cm < d ≤ 40 cm</td><td>P_{th} (mW)</td></tr>
<tr><td>-</td></tr>
</table>

As shown in the table above, the EUT's Max Power is lower than the MPE-based Exemption Threshold. RF Exposure evaluation for this device is exempted.

5.5 RF Exposure Evaluation Exemption for IC

The EIRP of this device is 22.49 dBm (177.42 mW) which is less than the exemption threshold, i.e., 5 W. Therefore, the RF exposure evaluation is exempt.

6 FCC §95.3367(b) & ISEDC RSS-251 §9 - Peak Fundamental Emission

6.1 Applicable Standards

According to FCC §95.3367(b): The maximum peak power (EIRP) within the 76-81 GHz band shall not exceed 55 dBm based on measurements employing a peak detector with a 1 MHz RBW.

According to ISEDC RSS-251 §9.1: the peak e.i.r.p measurement shall be performed by sweeping the transmitted occupied bandwidth with a positive peak power detector, using a peak hold display mode, and a 1 MHz resolution bandwidth. The power integration is not to be used in performing this measurement.

According to ISEDC RSS-251 §9.2: The radar device's peak e.i.r.p. spectral density shall not exceed 55 dBm/MHz.

6.2 Measurement Procedure

.RBW = 1MHz, VBW = 3MHz

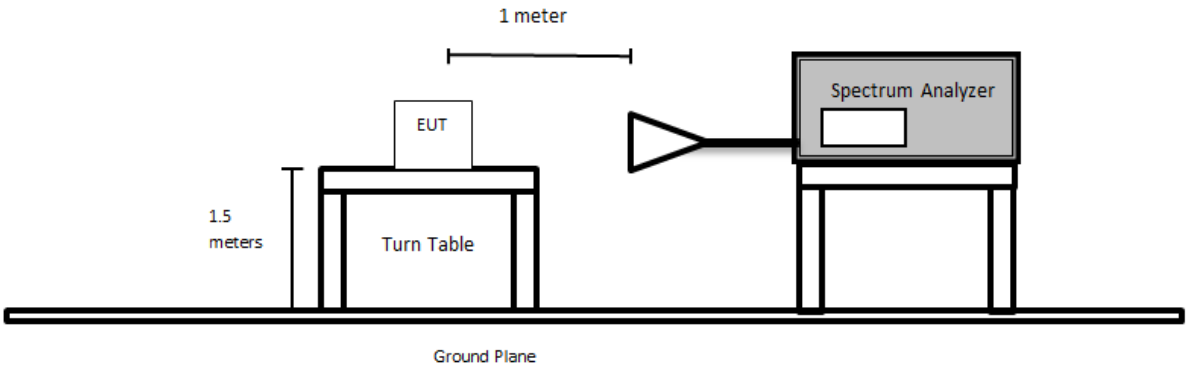
.Peak detector

.Maxhold trace

.Sweep Time > EUT Cycle Time (67ms) * sweep points

.Peak marker placed on the highest point and recorded

6.3 Test Setup Block Diagram



6.4 Test Equipment List and Details

BACL No.	Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
-	Keysight	UXA Signal Analyzer	N9041B	US57220232	2021-12-08	1 year
861	OML Inc.	Horn Antenna	M12RH	17061501	N/R	N/A
-	-	RF cable	-	-	Each time[1]	N/A

Note[1]: cables included in the test set-up will be checked each time before testing.

Statement of Traceability: BACL Corp. *attests that all of the calibrations on the equipment items listed above were traceable to NIST or to another internationally recognized National Metrology Institute (NMI), and were compliant with the latest version of A2LA policy P102 "A2LA Policy on Metrological Traceability".*

6.5 Test Environmental Conditions

Temperature:	23º C
Relative Humidity:	42 %
ATM Pressure:	102.7 KPa

The testing was performed by Christian McCaig on 2022-05-09 in 5 meter chamber 3.

6.6 Test Results

Measurements were taken at 1 meter

*The "**Margin**" column of the following data tables indicates the degree of compliance within the applicable limit. For example, a margin of -7 dB means the emission is 7 dB below the limit. The equation for margin calculation is as follows:*

Margin = Corrected Amplitude – Limit

Peak Power

Mode	PSA Reading (dBuV)	Equipment Factors (dB/m)	Peak Desensitization Factor (dB)	Distance Correction Factor (dB)	Corrected Field Strength (dBµV/m at 3m)	Peak Power (dBm/MHz)	Limit (dBm/MHz)	Margin (dB)
3	80.95	48.2	7.23	-9.54	126.84	31.54	55	-23.46
4	79.62	48.2	9.99	-9.54	128.27	32.97	55	-22.03
5	80.42	48.2	12.41	-9.54	131.49	36.19	55	-18.81

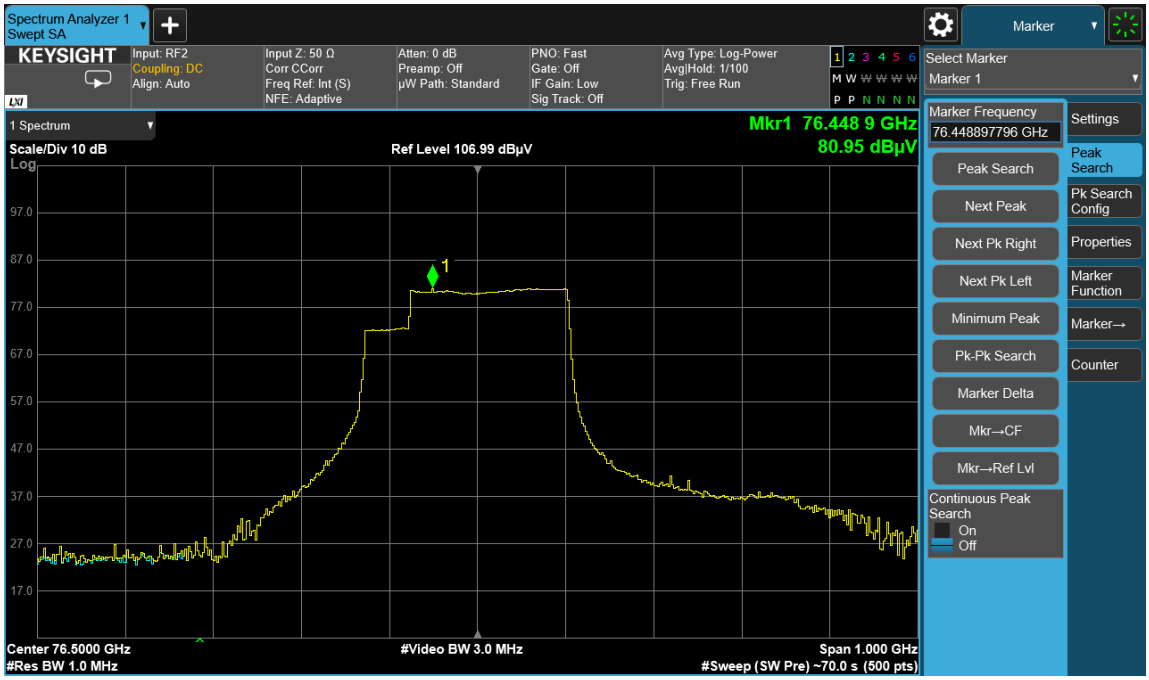
Note: Equipment Factors(dB/m) = Antenna Factor (dB/m) + Cable Loss (dB) + Waveguide Insertion Loss (dB).

*Note: Distance correction factor accounts for extrapolation from 1 meters to 3 meters. Formula used is as follows: 20*log(1meter/3meters) = -9.54 (According to ANSI C63.10-2013 Section 9.4)*

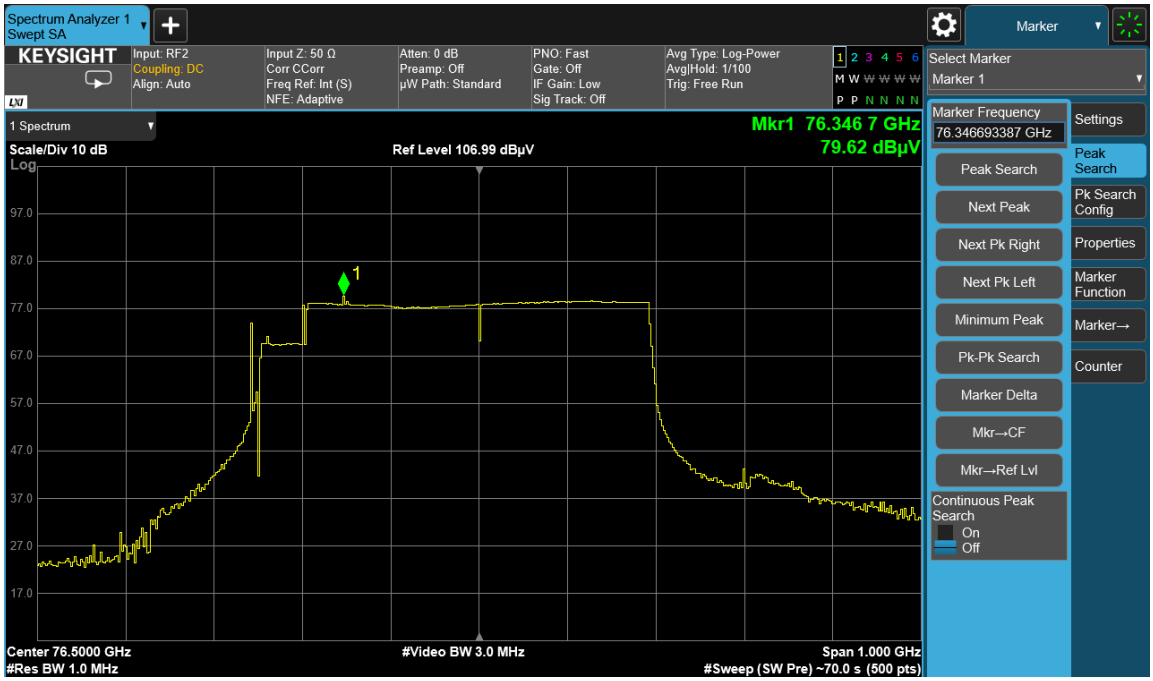
Note: To convert from dBuV/m at 3m to dBm, the formula is as follows: EIRP(dBm) = E (dBuV/m) – 95.3 (According to ANSI C63.10-2013 Section 10.3.9)

Please refer to the following plots.

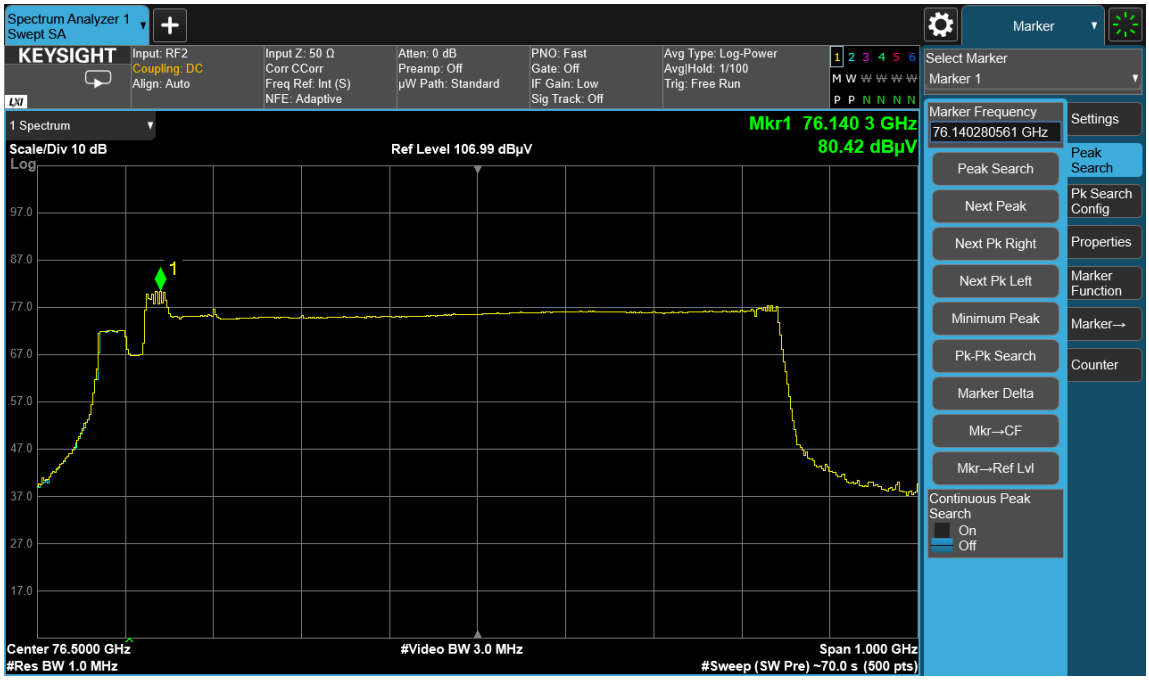
Mode 3


Spectrum Analyzer 1
Swept SA
KEYSIGHT
Input: RF2
Coupling: DC
Align: Auto
Input Z: 50 Ω
Corr CCorr
Freq Ref: Int (S)
NFE: Adaptive
Atten: 0 dB
Preamp: Off
µW Path: Standard
PNO: Fast
Gate: Off
IF Gain: Low
Sig Track: Off
Avg Type: Log-Power
Avg|Hold: 1/100
Trig: Free Run
Marker
Select Marker
Marker 1
1 Spectrum
Mkr1 76.448 9 GHz
80.95 dBµV
Scale/Div 10 dB
Ref Level 106.99 dBµV
Log
97.0
87.0
77.0
67.0
57.0
47.0
37.0
27.0
17.0
Marker Frequency
76.448897796 GHz
Settings
Peak Search
Next Peak
Next Pk Right
Next Pk Left
Minimum Peak
Pk-Pk Search
Marker Delta
Mkr→CF
Mkr→Ref Lvl
Continuous Peak Search
On
Off
Pk Search Config
Properties
Marker Function
Marker→
Counter
Center 76.5000 GHz
#Res BW 1.0 MHz
#Video BW 3.0 MHz
Span 1.000 GHz
#Sweep (SW Pre) ~70.0 s (500 pts)

Mode 4


Spectrum Analyzer 1
Swept SA
KEYSIGHT
Input: RF2
Coupling: DC
Align: Auto
Input Z: 50 Ω
Corr CCorr
Freq Ref: Int (S)
NFE: Adaptive
Atten: 0 dB
Preamp: Off
µW Path: Standard
PNO: Fast
Gate: Off
IF Gain: Low
Sig Track: Off
Avg Type: Log-Power
Avg|Hold: 1/100
Trig: Free Run
Marker
Select Marker
Marker 1
1 Spectrum
Mkr1 76.346 7 GHz
79.62 dBµV
Scale/Div 10 dB
Ref Level 106.99 dBµV
Log
97.0
87.0
77.0
67.0
57.0
47.0
37.0
27.0
17.0
Marker Frequency
76.346693387 GHz
Settings
Peak Search
Next Peak
Next Pk Right
Next Pk Left
Minimum Peak
Pk-Pk Search
Marker Delta
Mkr→CF
Mkr→Ref Lvl
Continuous Peak Search
On
Off
Pk Search Config
Properties
Marker Function
Marker→
Counter
Center 76.5000 GHz
#Res BW 1.0 MHz
#Video BW 3.0 MHz
Span 1.000 GHz
#Sweep (SW Pre) ~70.0 s (500 pts)

Mode 5


Spectrum Analyzer 1
Swept SA
KEYSIGHT
Input: RF2
Coupling: DC
Align: Auto
Input Z: 50 Ω
Corr CCorr
Freq Ref: Int (S)
NFE: Adaptive
Atten: 0 dB
Preamp: Off
µW Path: Standard
PNO: Fast
Gate: Off
IF Gain: Low
Sig Track: Off
Avg Type: Log-Power
Avg|Hold: 1/100
Trig: Free Run
1 Spectrum
Scale/Div 10 dB
Log
Ref Level 106.99 dBµV
Mkr1 76.140 3 GHz
80.42 dBµV
97.0
87.0
77.0
67.0
57.0
47.0
37.0
27.0
17.0
Center 76.5000 GHz
#Res BW 1.0 MHz
#Video BW 3.0 MHz
Span 1.000 GHz
#Sweep (SW Pre) ~70.0 s (500 pts)
Marker
Select Marker
Marker 1
Marker Frequency
76.140280561 GHz
Peak Search
Next Peak
Next Pk Right
Next Pk Left
Minimum Peak
Pk-Pk Search
Marker Delta
Mkr→CF
Mkr→Ref Lvl
Continuous Peak Search
On
Off
Settings
Peak Search
Pk Search Config
Properties
Marker Function
Marker→
Counter

7 FCC §95.3367(a) & ISEDC RSS-251 §8 - Average Fundamental Emission

7.1 Applicable Standards

According to FCC §95.3367(a): The maximum power (EIRP) within the 76-81 GHz band shall not exceed 50 dBm based on measurements employing a power averaging detector with a 1 MHz Resolution Bandwidth (RBW).

According to ISEDC RSS-251 §8.1: the average e.i.r.p measurement shall be performed using a power averaging detector with a 1 MHz resolution bandwidth (RBW). The power shall be integrated over the occupied bandwidth.

According to ISEDC RSS-251 §8.2: The radar device's total average e.i.r.p. shall not exceed 50 dBm over the occupied bandwidth.

7.2 Measurement Procedure

The Average Power was measured using the Channel Power function on the PSA

RBW = 1MHz, VBW = 3MHz

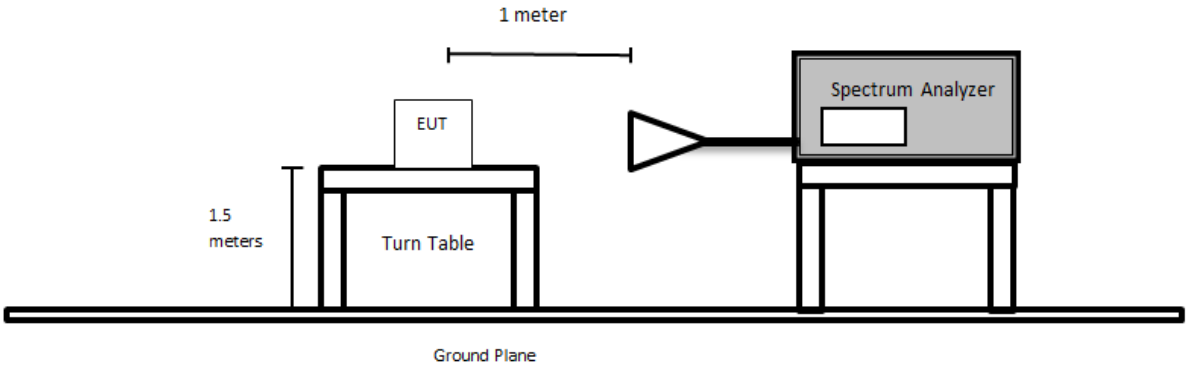
RMS detector

Maxhold trace

Sweep Time > EUT Cycle Time (67ms) * sweep points

Power is integrated over the occupied BW and value is recorded

7.3 Test Setup Block Diagram



7.4 Test Equipment List and Details

BACL No.	Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
-	Keysight	UXA Signal Analyzer	N9041B	US57220232	2021-12-08	1 year
861	OML Inc.	Horn Antenna	MR12H	17061501	N/R	N/A
-	-	RF cable	-	-	Each time[1]	N/A

Note[1]: cables included in the test set-up will be checked each time before testing.

Statement of Traceability: BACL Corp. *attests that all of the calibrations on the equipment items listed above were traceable to NIST or to another internationally recognized National Metrology Institute (NMI), and were compliant with the latest version of A2LA policy P102 "A2LA Policy on Metrological Traceability".*

7.5 Test Environmental Conditions

Temperature:	23º C
Relative Humidity:	42 %
ATM Pressure:	102.7 KPa

The testing was performed by Christian McCaig on 2022-05-09in 5 meter chamber 3.

7.6 Test Results

Measurements were taken at 1 meter

*The "**Margin**" column of the following data tables indicates the degree of compliance within the applicable limit. For example, a margin of -7 dB means the emission is 7 dB below the maximum limit. The equation for margin calculation is as follows:*

Margin = Corrected Amplitude – Limit

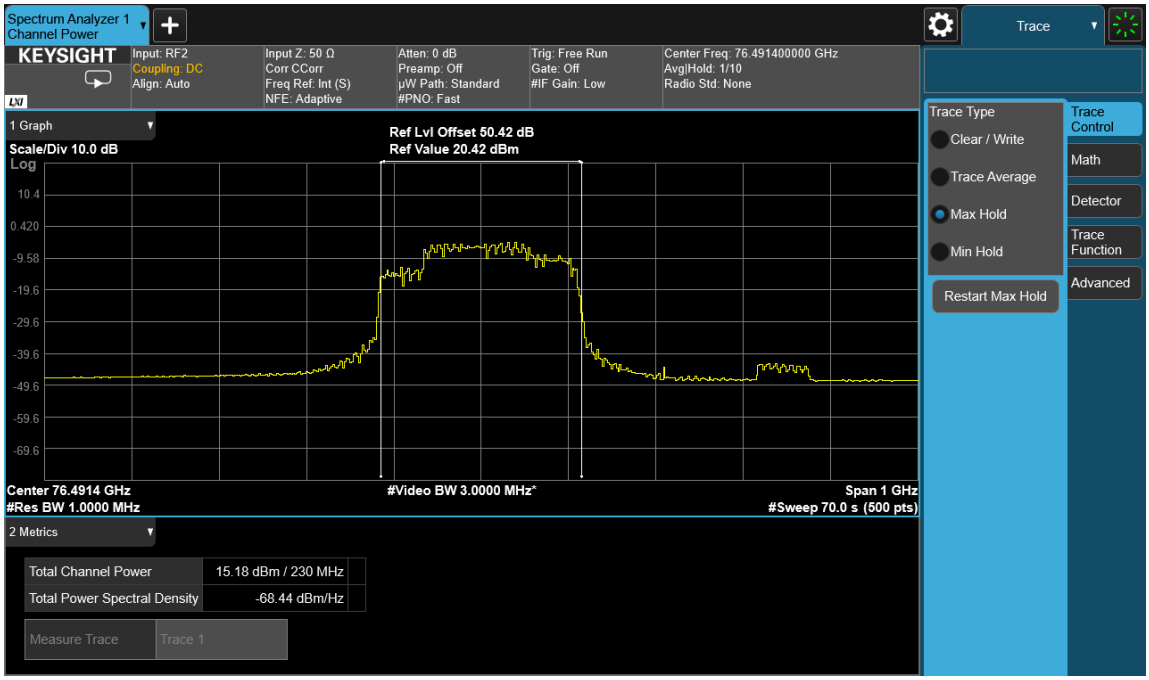
Average Power

Mode	PSA Reading (dBm)	Duty Cycle Correction Factor (dB)	Average Power (dBm)	Limit (dBm)	Margin (dB)
3	15.18	3.4	18.58	50	-31.42
4	16.88	3.4	20.28	50	-29.72
5	19.09	3.4	22.49	50	-27.51

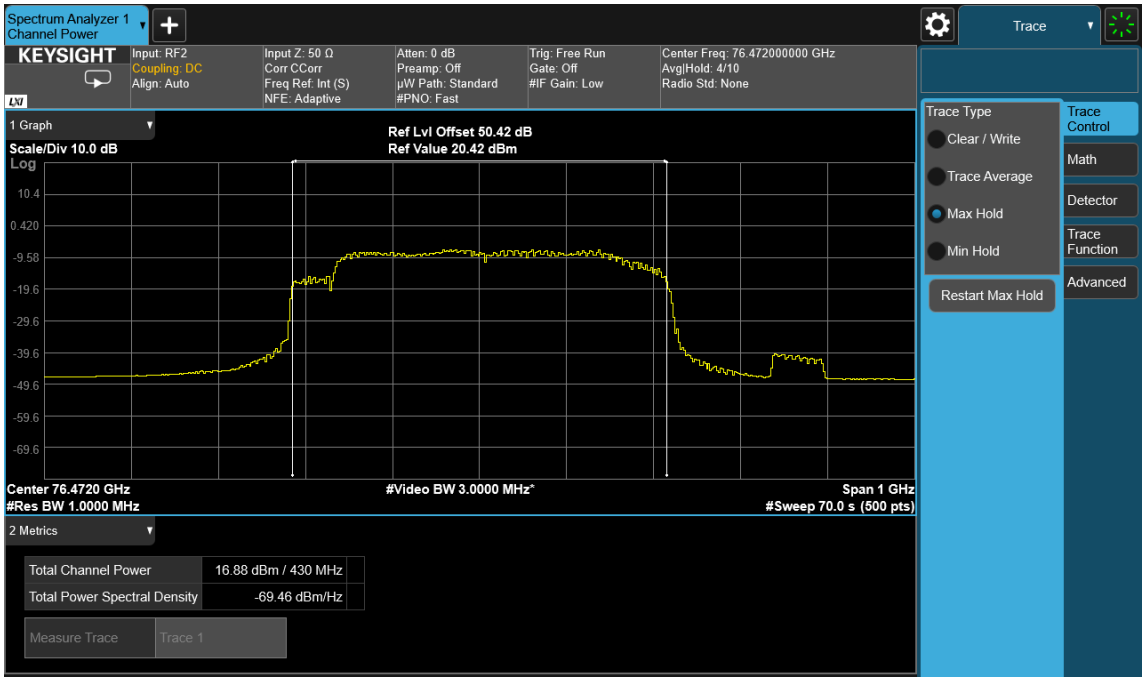
Note: The correction factors have been considered in the reference level offset as shown in the following measurement screenshots.

Please refer to the following plots.

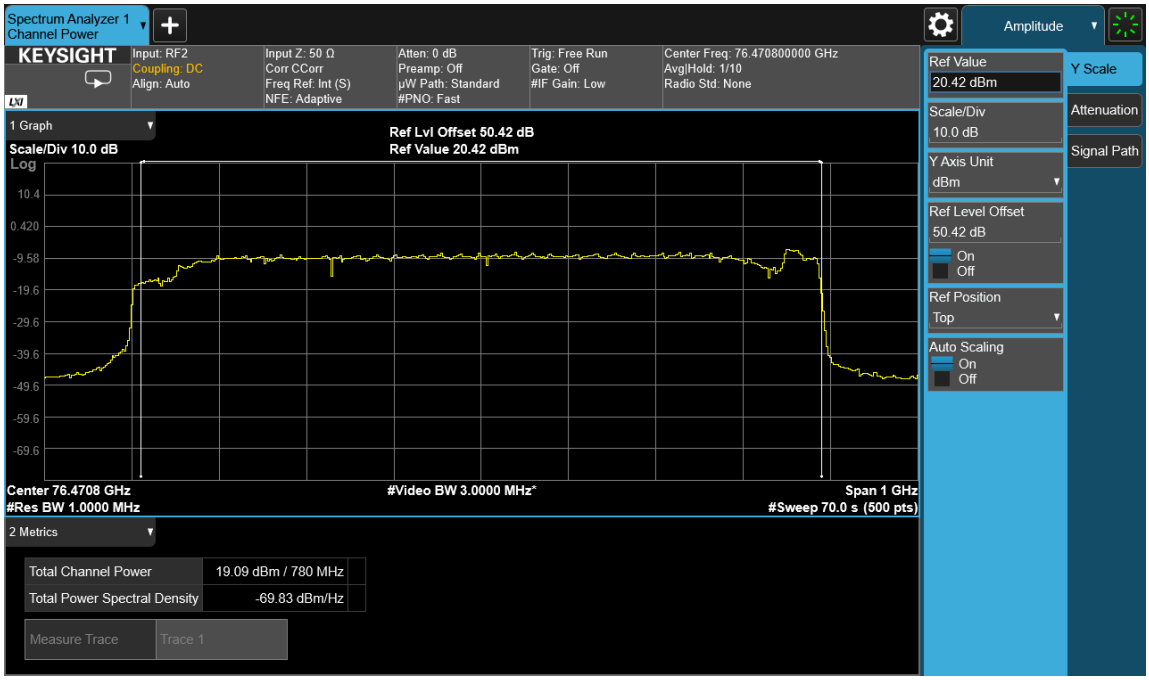
Mode 3


Spectrum Analyzer 1
Channel Power
KEYSIGHT
Input: RF2
Coupling: DC
Align: Auto
Input Z: 50 Ω
Corr CCorr
Freq Ref: Int (S)
NFE: Adaptive
Atten: 0 dB
Preamp: Off
µW Path: Standard
#PNO: Fast
Trig: Free Run
Gate: Off
#IF Gain: Low
Center Freq: 76.491400000 GHz
Avg|Hold: 1/10
Radio Std: None
Trace
1 Graph
Scale/Div 10.0 dB
Log
Ref Lvl Offset 50.42 dB
Ref Value 20.42 dBm
10.4
0.420
-9.58
-19.6
-29.6
-39.6
-49.6
-59.6
-69.6
Center 76.4914 GHz
#Res BW 1.0000 MHz
#Video BW 3.0000 MHz*
Span 1 GHz
#Sweep 70.0 s (500 pts)
2 Metrics
Total Channel Power
15.18 dBm / 230 MHz
Total Power Spectral Density
-68.44 dBm/Hz
Measure Trace
Trace 1
Trace Type
Clear / Write
Trace Average
Max Hold
Min Hold
Restart Max Hold
Trace Control
Math
Detector
Trace Function
Advanced

Mode 4


Spectrum Analyzer 1
Channel Power
KEYSIGHT
Input: RF2
Coupling: DC
Align: Auto
Input Z: 50 Ω
Corr CCorr
Freq Ref: Int (S)
NFE: Adaptive
Atten: 0 dB
Preamp: Off
µW Path: Standard
#PNO: Fast
Trig: Free Run
Gate: Off
#IF Gain: Low
Center Freq: 76.472000000 GHz
Avg|Hold: 4/10
Radio Std: None
Trace
1 Graph
Scale/Div 10.0 dB
Log
Ref Lvl Offset 50.42 dB
Ref Value 20.42 dBm
10.4
0.420
-9.58
-19.6
-29.6
-39.6
-49.6
-59.6
-69.6
Center 76.4720 GHz
#Res BW 1.0000 MHz
#Video BW 3.0000 MHz*
Span 1 GHz
#Sweep 70.0 s (500 pts)
2 Metrics
Total Channel Power
16.88 dBm / 430 MHz
Total Power Spectral Density
-69.46 dBm/Hz
Measure Trace
Trace 1
Trace Type
Clear / Write
Trace Average
Max Hold
Min Hold
Restart Max Hold
Trace Control
Math
Detector
Trace Function
Advanced

Mode 5


Spectrum Analyzer 1
Channel Power
KEYSIGHT
Input: RF2
Coupling: DC
Align: Auto
Input Z: 50 Ω
Corr CCorr
Freq Ref: Int (S)
NFE: Adaptive
Atten: 0 dB
Preamp: Off
µW Path: Standard
#PNO: Fast
Trig: Free Run
Gate: Off
#IF Gain: Low
Center Freq: 76.470800000 GHz
Avg|Hold: 1/10
Radio Std: None
Amplitude
Ref Value
20.42 dBm
Y Scale
Scale/Div
10.0 dB
Attenuation
Y Axis Unit
dBm
Signal Path
Ref Level Offset
50.42 dB
On
Off
Ref Position
Top
Auto Scaling
On
Off
1 Graph
Ref Lvl Offset 50.42 dB
Ref Value 20.42 dBm
Scale/Div 10.0 dB
Log
10.4
0.420
-9.58
-19.6
-29.6
-39.6
-49.6
-59.6
-69.6
Center 76.4708 GHz
#Res BW 1.0000 MHz
#Video BW 3.0000 MHz*
Span 1 GHz
#Sweep 70.0 s (500 pts)
2 Metrics
Total Channel Power
19.09 dBm / 780 MHz
Total Power Spectral Density
-69.83 dBm/Hz
Measure Trace
Trace 1

8 FCC §95.3379(a), ISEDC RSS-251 §10 & RSS-Gen §8.1, §8.9, §8.10 - Radiated Emissions

8.1 Applicable Standards

As per FCC §95.3379(a): The power density of any emission outside the 76-81 GHz band shall consist solely of spurious emissions and shall not exceed the following:

(1): Radiated emissions below 40 GHz shall not exceed the field strength as shown in the following emissions table.

Frequency (MHz)	Field Strength (micro volts/meter)	Measurement Distance (meters)
0.009 - 0.490	2400/F(kHz)	300
0.490 - 1.705	24000/F(kHz)	30
1.705 - 30.0	30	30
30 - 88	100**	3
88 - 216	150**	3
216 - 960	200**	3
Above 960	500	3

(i): In the emissions table in paragraph (a)(1) of this section, the tighter limit applies at the band edges.

(ii): The limits in the table in paragraph (a)(1) of this section are based on the frequency of the unwanted emission and not the fundamental frequency. However, the level of any unwanted emissions shall not exceed the level of the fundamental frequency.

(iii): The emissions limits shown in the table in paragraph (a)(1) of the section are based on measurements employing a CISPR quasi-peak detector except for the frequency bands 9.0-90.0 kHz, 110.0-490.0 kHz, and above 1000 MHz. Radiated emissions limits in these three bands are based on measurements employing an average detector with a 1 MHz RBW.

(2): The power density of radiated emissions outside the 76-81 GHz band above 40.0 GHz shall not exceed the following, based on measurements employing an average detector with a 1 MHz RBW:

(i): For radiated emissions outside the 76-81 GHz band between 40 GHz and 200 GHz from field disturbance sensors and radar systems operating in the 76-81 GHz band: 600 pW/cm^2 at a distance of 3 meters from the exterior surface of the radiating structure.

(ii): For radiated emissions above 200 GHz from field disturbance sensors and radar systems operating in the 76-81 GHz band: 1000 pW/cm^2 at a distance of 3 meters from the exterior surface of the radiating structure.

(3): For field disturbance sensors and radar systems operating in the 76-81 GHz band, the spectrum shall be investigated up to 231.0 GHz.

As per ISEDC RSS-251 §10.2, The radar device's unwanted emissions outside the 76-81 GHz frequency band shall comply with the limits in table 1, below.

Table 1: Unwanted emissions limits outside the 76-81 GHz frequency band

Emission frequency range	Limit	Applicable detector
Below 40 GHz	RSS-Gen general field strength limits for licence-exempt radio apparatus	RSS-Gen requirements
40-162 GHz *	-30 dBm/MHz (e.i.r.p.)	RMS detector

Note:
* For radar devices that operate solely in the 76-77 GHz band (i.e. the occupied bandwidth is entirely contained in the 76-77 GHz band), an unwanted emissions limit of 0 dBm/MHz shall apply for the unwanted emission that fall in the 73.5-76 GHz band. Outside of the 73.5-76 GHz band, the unwanted emission limits prescribed in table 1 shall apply.

As per ISEDC RSS-Gen §8.9, except where otherwise indicated in the applicable RSS, radiated emissions shall comply with the field strength limits shown in the table below. Additionally, the level of any transmitter unwanted emission shall not exceed the level of the transmitter's fundamental emission.

General Field Strength Limits at Frequencies above 30 MHz

Frequency (MHz)	Field Strength (µv/m at 3 meters)
30-88	100
88-216	150
216-960	200
Above 960	500

As per ISEDC RSS-Gen §8.10,

Restricted frequency bands, identified in table 7, are designated primarily for safety-of-life services (distress calling and certain aeronautical activities), certain satellite downlinks, radio astronomy and some government uses. Except where otherwise indicated, the following conditions related to the restricted frequency bands apply:

a. The transmit frequency, including fundamental components of modulation, of licence-exempt radio apparatus shall not fall within the restricted frequency bands listed in table 7 except for apparatus compliant with RSS-287, *Emergency Position Indicating Radio Beacons (EPIRB), Emergency Locator Transmitters (ELT), Personal Locator Beacons (PLB), and Maritime Survivor Locator Devices (MSLD)*.
b. Unwanted emissions that fall into restricted frequency bands listed in table 7 shall comply with the limits specified in table 5 and table 6.
c. Unwanted emissions that do not fall within the restricted frequency bands listed in table 7 shall comply either with the limits specified in the applicable RSS or with those specified in table 5 and table 6.

Table 7 – Restricted frequency bands[Note 1]		
MHz	MHz	GHz
0.090 - 0.110	149.9 - 150.05	9.0 - 9.2
0.495 - 0.505	156.52475 - 156.52525	9.3 - 9.5
2.1735 - 2.1905	156.7 - 156.9	10.6 - 12.7
3.020 - 3.026	162.0125 - 167.17	13.25 - 13.4
4.125 - 4.128	167.72 - 173.2	14.47 - 14.5
4.17725 - 4.17775	240 – 285	15.35 - 16.2
4.20725 - 4.20775	322 - 335.4	17.7 - 21.4
5.677 - 5.683	399.9 - 410	22.01 - 23.12
6.215 - 6.218	608 - 614	23.6 - 24.0
6.26775 - 6.26825	960 - 1427	31.2 - 31.8
6.31175 - 6.31225	1435 - 1626.5	36.43 - 36.5
8.291 - 8.294	1645.5 - 1646.5	Above 38.6
8.362 - 8.366	1660 - 1710	
8.37625 - 8.38675	1718.8 - 1722.2	
8.41425 - 8.41475	2200 - 2300	
12.29 - 12.293	2310 - 2390	
12.51975 - 12.52025	2483.5 - 2500	
12.57675 - 12.57725	2655 - 2900	
13.36 - 13.41	3260 – 3267	
16.42 - 16.423	3332 - 3339	
16.69475 - 16.69525	3345.8 - 3358	
16.80425 - 16.80475	3500 - 4400	
25.5 - 25.67	4500 - 5150	
37.5 - 38.25	5350 - 5460	
73 - 74.6	7250 - 7750	
74.8 - 75.2	8025 – 8500	
108 – 138		

Note 1: Certain frequency bands listed in table 7 and in bands above 38.6 GHz are designated for licence-exempt applications. These frequency bands and the requirements that apply to related devices are set out in the 200 and 300 series of RSSs.

As per ISEDC RSS-Gen §8.1, Unless otherwise specified, for all frequencies equal to or less than 1 GHz, the emission limits for licence-exempt radio apparatus stated in applicable RSSs (including RSS-Gen) are based on measurements using a CISPR quasi-peak detector function, with the exception of the frequency ranges 9-90 kHz and 110-490 kHz, where the emission limits are based on measurements employing a linear average detector. The measurement bandwidth to be used depends on the measured frequency and shall be as specified in CAN/CSA-CISPR 16-1-1:15 for the required type of detector to be used for measurements.

If an average limit is specified for the EUT, then the peak emission shall also be measured with instrumentation properly adjusted for factors such as pulse desensitization to ensure that the peak emission is less than 20 dB above the average limit.

If an average measurement is specified for wanted emissions, a linear average detector having a bandwidth equal to or greater than the occupied bandwidth shall be used to make the measurement.

8.2 Test Setup

The radiated emissions tests were performed in the 5-meter Chamber, using the setup in accordance with ANSI C63.10-2013 and ANSI C63.26-2015. The specification used was the FCC 95 Subpart M and ISEDC RSS-251 limits.

The spacing between the peripherals was 10 centimeters.

External I/O cables were draped along the edge of the test table and bundle when necessary.

8.3 Measurement Procedure

The EUT host, and all support equipment power cords were connected to the AC floor outlet.

Maximizing procedure was performed on the highest emissions to ensure that the EUT complied with all installation combinations.

For radiated testing the EUT was set 1 meter away from the testing antenna, which was varied from 1-4 meter, and the EUT was placed on a turntable, which was 0.8 meter and 1.5 meter above the ground plane for below and above 960 MHz measurements, the table shall be rotated for 360 degrees to find out the highest emission. The receiving antenna's polarity should be changed between horizontal and vertical.

The spectrum analyzer or receiver was set as:

Below 960 MHz:

RBW = 100 kHz / VBW = 300 kHz / Sweep = Auto

Above 960 MHz:

The measurements were based on ANSI C63.10-2013, American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices and ANSI C63.26-2015, American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services.

8.4 Corrected Amplitude and Margin Calculation

For emissions below 1 GHz,

The Corrected Amplitude (CA) is calculated by adding the Correction Factor to the S.A. Reading. The basic equation is as follows:

CA = S.A. Reading + Correction Factor

For example, a corrected amplitude of 40.3 dBuV/m = S.A. Reading (32.5 dBuV) + Correction Factor (7.8 dB/m)

The Correction Factor is calculated by adding the Antenna Factor (AF), the Cable Loss (CL), the Attenuator Factor (Atten) and subtracting the Amplifier Gain (Ga) together. This calculation is done in the measurement software, and reported in the test result section. The basic equation is as follows:

Correction Factor = AF + CL + Atten – Ga

For emission above 1 GHz,

The Corrected Amplitude (CA) is calculated by adding the Antenna Factor (AF), the Cable Loss (CL), the Attenuator Factor (Atten) and subtracting the Amplifier Gain (Ga) to indicated Amplitude (Ai) reading. The basic equation is as follows:

CA = Ai + AF + CL + Atten – Ga

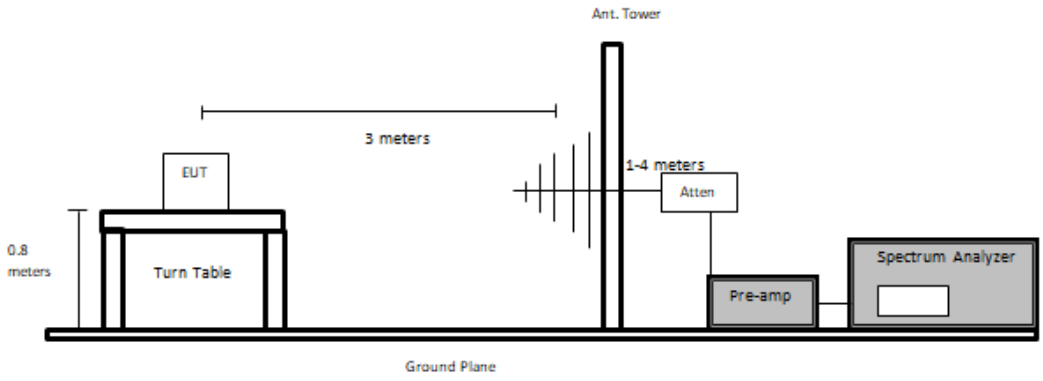
For example, a corrected amplitude of 40.3 dBuV/m = Indicated Reading (32.5 dBuV) + Antenna Factor (+23.5dB) + Cable Loss (3.7 dB) + Attenuator (10 dB) - Amplifier Gain (29.4 dB)

The "**Margin**" column of the following data tables indicates the degree of compliance within the applicable limit. For example, a margin of -7 dB means the emission is 7 dB below the maximum limit. The equation for margin calculation is as follows:

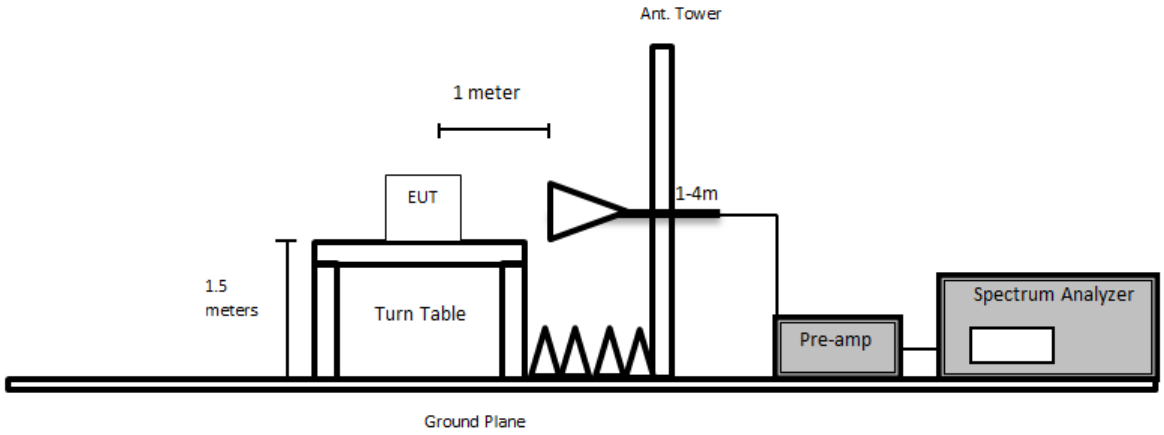
Margin = Corrected Amplitude – Limit

8.5 Test Setup Block Diagram

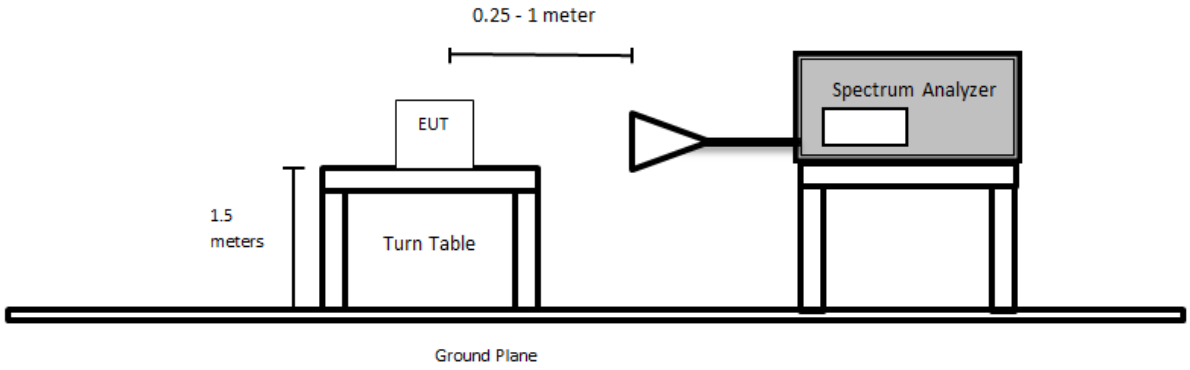
Below 1GHz:



1-40 GHz:



Above 40 GHz:



8.6 Test Equipment List and Details

BACL No.	Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
-	Keysight	UXA Signal Analyzer	N9041B	MY60100113	2021-10-22	1 year
124	Rohde & Schwarz	EMI Test Receiver	ESCI 1166.5950 K03	10 0044	2021-05-14	2 years
287	Agilent	Spectrum Analyzer	E4446A	US44300386	2021-04-27	13 months
-	Sunol Sciences Corp	System Controller	SC110V	122303-1	N/R	N/A
459	HP	Preamplifier	8447D	2443A04374	2021-11-02	1 year
658	HP/Agilent	Preamplifier	8449B OPT HO2	3008A0113	2021-05-06	1 year
827	AH Systems	Preamplifier	PAM 1840 VH	170	2021-08-03	1 year
1101	IW Incorporated	157 Series Cable Armored with 2.92mm Male Plugs on Both Sides	KPS-1571AN-2400	DC 1922	2021-07-06	1 year
1081	MDP Digital	Times Microwave LMR 400 UltraFex Coaxial Cable 35'	FMC0101405-420	BACL1904161	2021-06-18	1 year
321	Sunol Sciences Corp	Biconilog Antenna	JB3	A020106-2	2019-11-20	2 years
1192	ETS Lindgren	Horn Antenna	3117	00218973	2021-09-14	2 years
91	Wisewave	Horn Antenna	ARH-4223-02	10555-02	2020-02-05	2 years
92	Wisewave	Horn Antenna	ARH-2823-02	10555-01	2020-02-05	2 years
861	OML Inc.	Mixer and Horn Antenna set	M03HWA, M05HWA M08HWA M012HWA M19HWA	170615-1	N/R	N/A
-	-	RF cable	-	-	Each time[1]	N/A
-	Vasona	Test software	V6.0 build 11	10400213	N/R	N/R

Note[1]: cables included in the test set-up will be checked each time before testing.

Statement of Traceability: BACL Corp. *attests that all of the calibrations on the equipment items listed above were traceable to NIST or to another internationally recognized National Metrology Institute (NMI), and were compliant with the latest version of A2LA policy P102 "A2LA Policy on Metrological Traceability".*

The equipment above was used for testing performed by Christian McCaig and Deepak Mishra from 2021-09-30 to 2021-11-05 in 5 meter chamber 3.

BACL No.	Manufacturer	Description	Model No.	Serial No.	Calibration Date	Calibration Interval
-	Keysight	UXA Signal Analyzer	N9041B	US57220232	2021-12-08	1 year
124	Rohde & Schwarz	EMI Test Receiver	ESCI 1166.5950 K03	10 0044	2021-05-14	2 years
287	Agilent	Spectrum Analyzer	E4446A	US44300386	2021-04-27	13 months
-	Sunol Sciences Corp	System Controller	SC110V	122303-1	N/R	N/A
459	HP	Preamplifier	8447D	2443A04374	2021-11-02	1 year
658	HP/Agilent	Preamplifier	8449B OPT HO2	3008A0113	2021-05-06	1 year
827	AH Systems	Preamplifier	PAM 1840 VH	170	2021-08-03	1 year
1101	IW Incorporated	157 Series Cable Armored with 2.92mm Male Plugs on Both Sides	KPS-1571AN-2400	DC 1922	2021-07-06	1 year
1081	MDP Digital	Times Microwave LMR 400 UltraFex Coaxial Cable 35'	FMC0101405-420	BACL1904161	2021-06-18	1 year
321	Sunol Sciences Corp	Biconilog Antenna	JB3	A020106-2	2021-11-22	2 years
1192	ETS Lindgren	Horn Antenna	3117	00218973	2021-09-14	2 years
91	Wisewave	Horn Antenna	ARH-4223-02	10555-02	2022-03-08	2 years
92	Wisewave	Horn Antenna	ARH-2823-02	10555-01	2022-03-17	2 years
861	OML Inc.	Mixer and Horn Antenna set	M03HWA, M05HWA M08HWA M012HWA M19HWA	170615-1	N/R	N/A
-	-	RF cable	-	-	Each time[1]	N/A
-	Vasona	Test software	V6.0 build 11	10400213	N/R	N/R

Note[1]: cables included in the test set-up will be checked each time before testing.

Statement of Traceability: BACL Corp. *attests that all of the calibrations on the equipment items listed above were traceable to NIST or to another internationally recognized National Metrology Institute (NMI), and were compliant with the latest version of A2LA policy P102 "A2LA Policy on Metrological Traceability".*

The equipment above was used for testing performed by Christian McCaig and Deepak Mishra from 2022-04-04 to 2022-05-05 in 5 meter chamber 3.

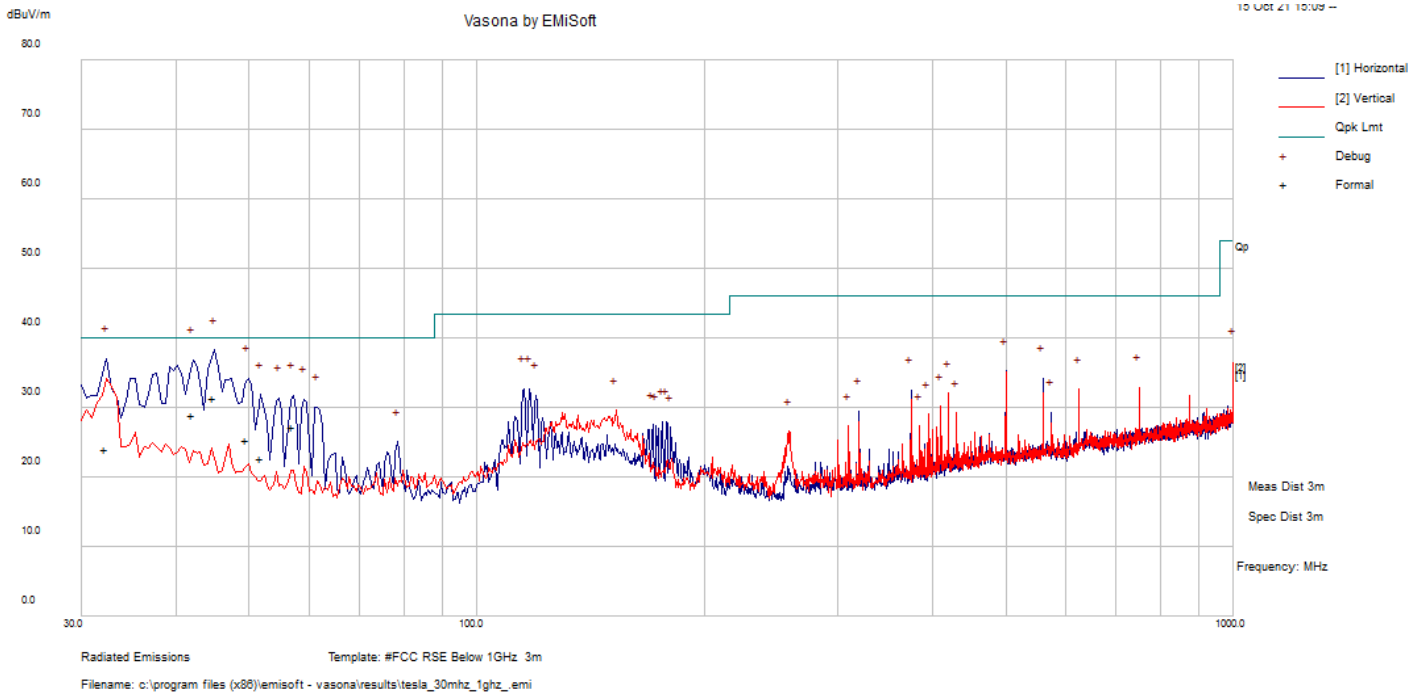
8.7 Test Environmental Conditions

Temperature:	20-22 ºC
Relative Humidity:	42-50 %
ATM Pressure:	102.7 kPa

The testing was performed by Christian McCaig and Deepak Mishra from 2021-09-30 to 2022-05-05 in 5 meter chamber 3.

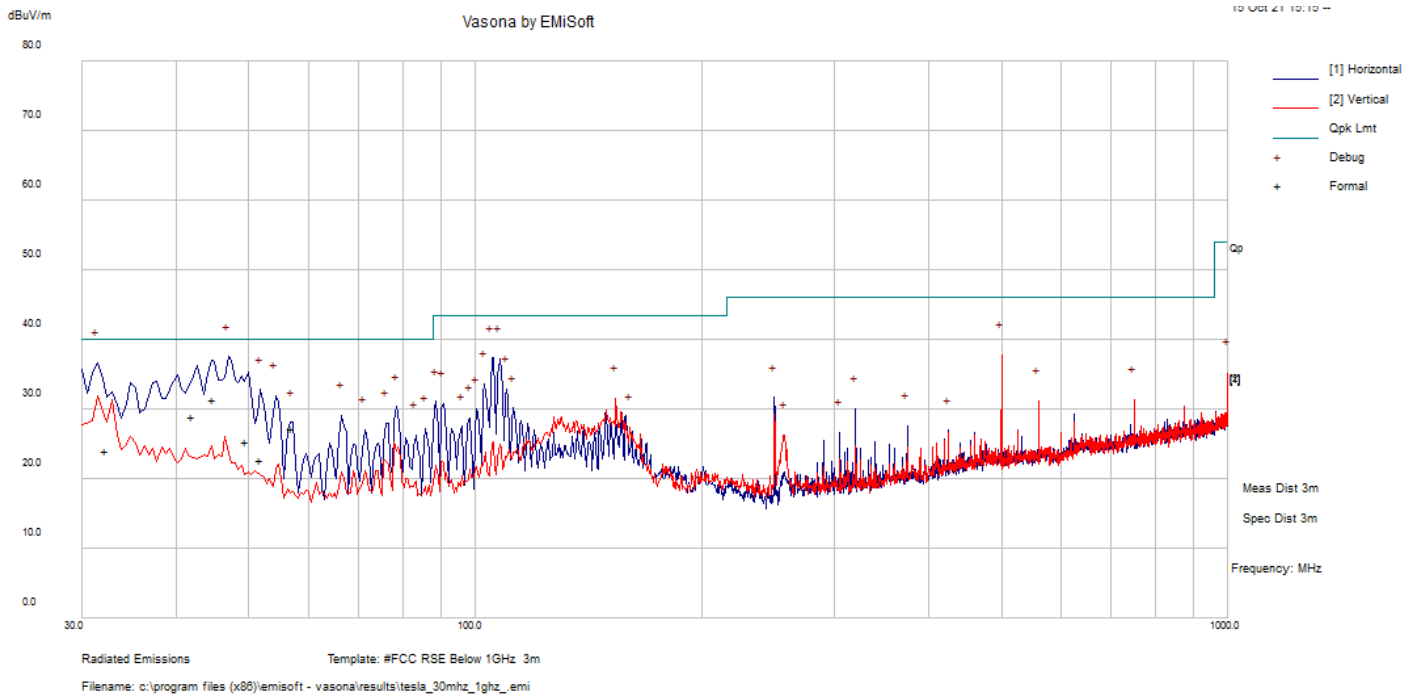
8.8 Test Results below 1 GHz measured at 3 meters

Mode 3



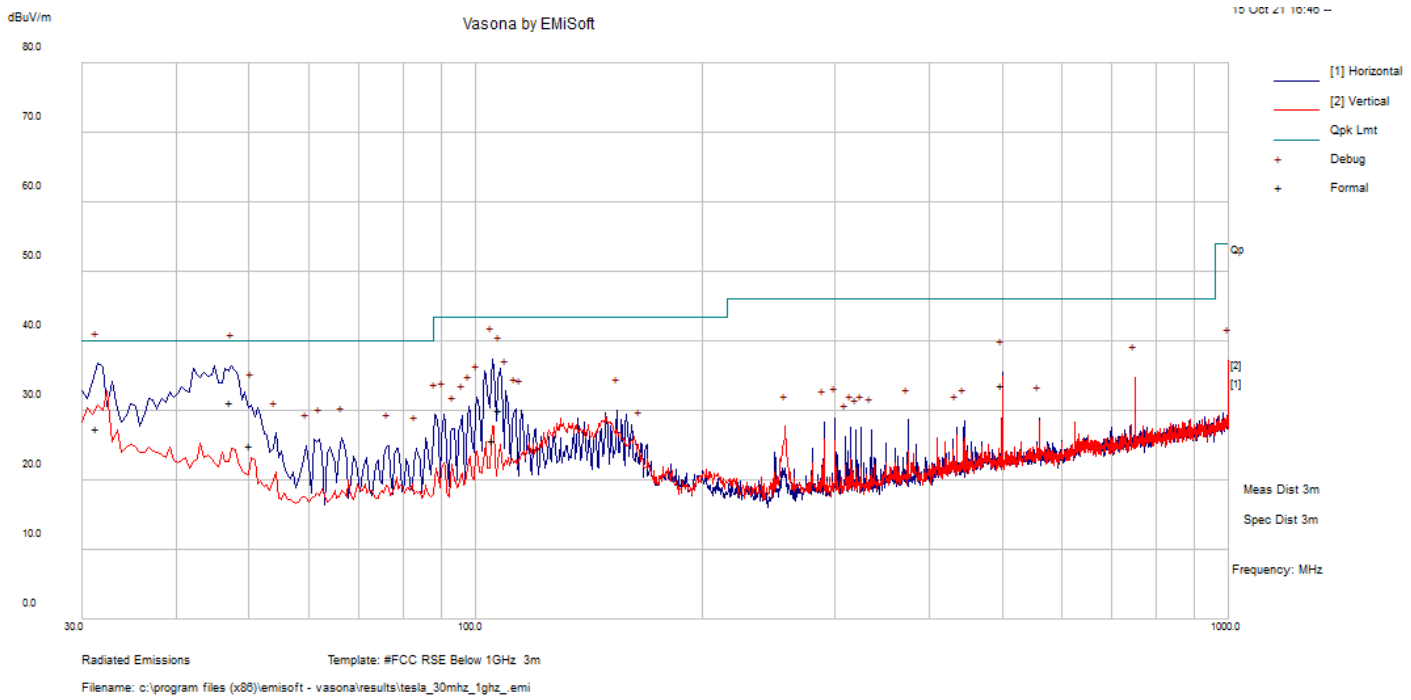
Freq. (MHz)	S.A. Reading (dBµV)	Corr. Factor (dB/m)	Corrected Amp. (dBµV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBµV/m)	Margin (dB)	Comment
44.91875	39.86	-8.51	31.35	101	H	126	40	-8.65	QP
32.2455	23.31	0.69	24	236	H	177	40	-16	QP
42.1355	35.63	-6.75	28.88	156	H	352	40	-11.12	QP
49.671	36	-10.63	25.37	198	H	343	40	-14.63	QP
51.932	33.75	-11.1	22.65	139	H	194	40	-17.35	QP
57.003	38.55	-11.37	27.18	122	H	7	40	-12.82	QP

Mode 4



Freq. (MHz)	S.A. Reading (dBµV)	Corr. Factor (dB/m)	Corrected Amp. (dBµV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBµV/m)	Margin (dB)	Comment
47.136	39.42	-9.7	29.72	198	H	36	40	-10.28	QP
47.165	39.57	-9.71	29.86	197	H	17	40	-10.14	QP
31.679	23.64	1.15	24.79	151	H	205	40	-15.21	QP
31.686	25.02	1.14	26.16	109	H	124	40	-13.84	QP
105.423	39.72	-6.38	33.34	106	H	195	43.5	-10.16	QP
105.298	38.49	-6.4	32.09	109	H	228	43.5	-11.41	QP

Mode 5



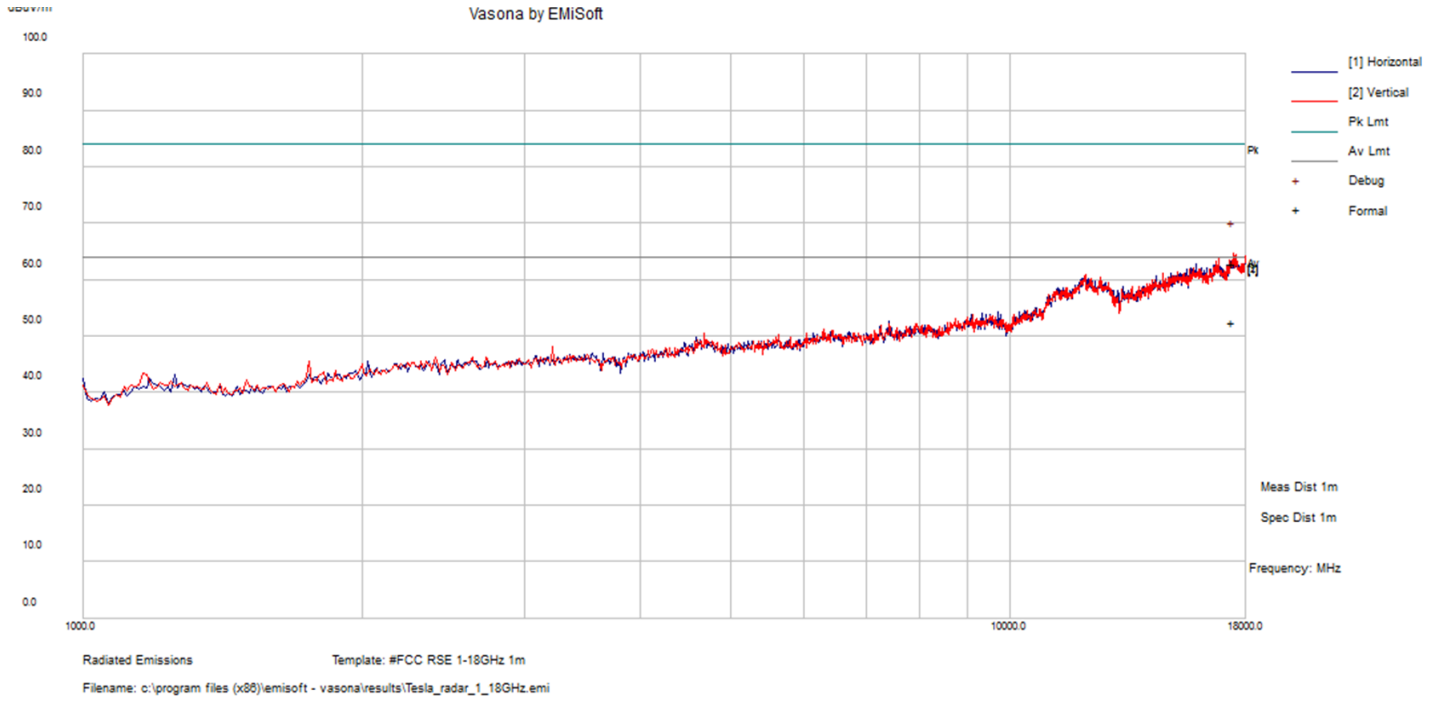
Freq. (MHz)	S.A. Reading (dBµV)	Corr. Factor (dB/m)	Corrected Amp. (dBµV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBµV/m)	Margin (dB)	Comment
31.45	26.12	1.35	27.47	111	H	7	40	-12.53	QP
47.22	40.93	-9.73	31.2	101	H	53	40	-8.8	QP
105.37	32.14	-6.38	25.76	248	H	122	43.5	-17.74	QP
107.65	35.91	-5.92	29.99	126	H	186	43.5	-13.51	QP
50.13	35.66	-10.75	24.91	132	H	29	40	-15.09	QP
499.99	33.91	-0.25	33.66	122	H	177	46	-12.34	QP

8.9 Test Results above 1 GHz to 40 GHz measured at 1 meter

Note: For below spurious emissions, a peak detector was used in comparison to peak and average limits in order to show compliance. Where such a pre-scan exceeds the average limit, a formal measurement was performed.

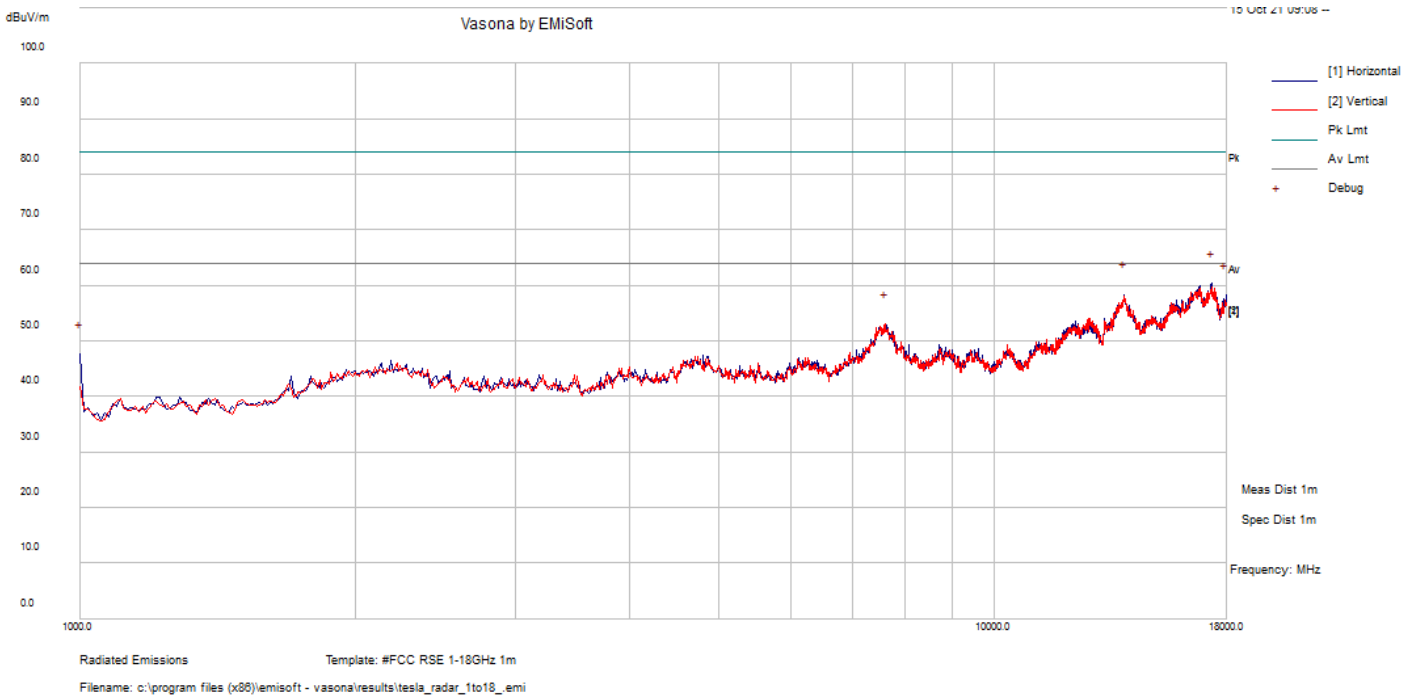
1 – 18 GHz, measured at 1 meter:

Mode 3



Frequency (MHz)	S.A. Reading (dBuV)	Correction Factor (dB/m)	Corrected Amplitude (dBµV/m)	Ant. Polarity (H/V)	Ant. Height (cm)	Turntable Azimuth (degrees)	Limit (dBµV/m)	Margin (dB)	Detector (Peak /Ave.)
17424.928	45.08	17.88	62.96	V	117	93	84	-21.04	Peak
17424.928	34.67	17.88	52.55	V	117	93	64	-11.45	Ave.

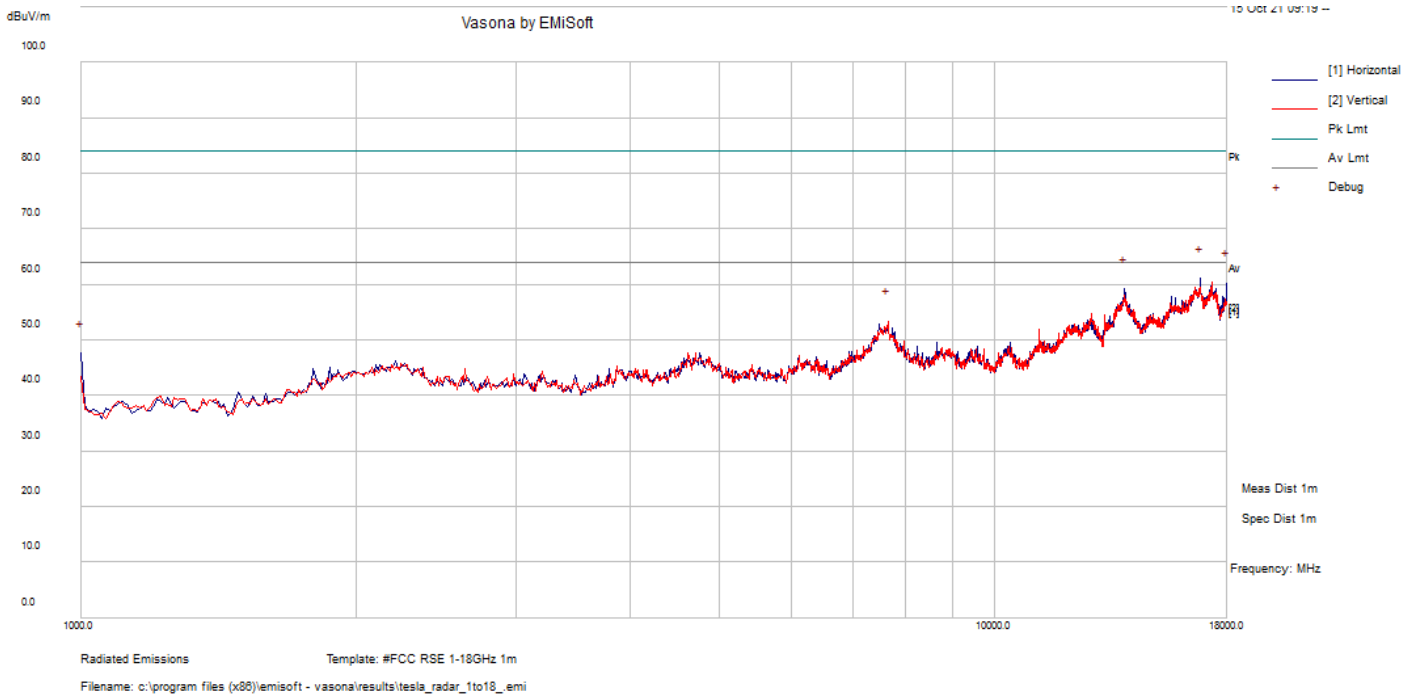
Mode 4



Frequency (MHz)	S.A. Reading (dBuV)	Correction Factor (dB/m)	Corrected Amplitude (dBµV/m)	Ant. Polarity (H/V)	Ant. Height (cm)	Turntable Azimuth (degrees)	Limit (dBµV/m)	Margin (dB)	Detector (Peak /Ave.)
17420.015	44.29	17.23	61.52	V	200	360	64	-2.48	Peak.

Note: Peak measurement was made on worst case emission and compared to average limit.

Mode 5

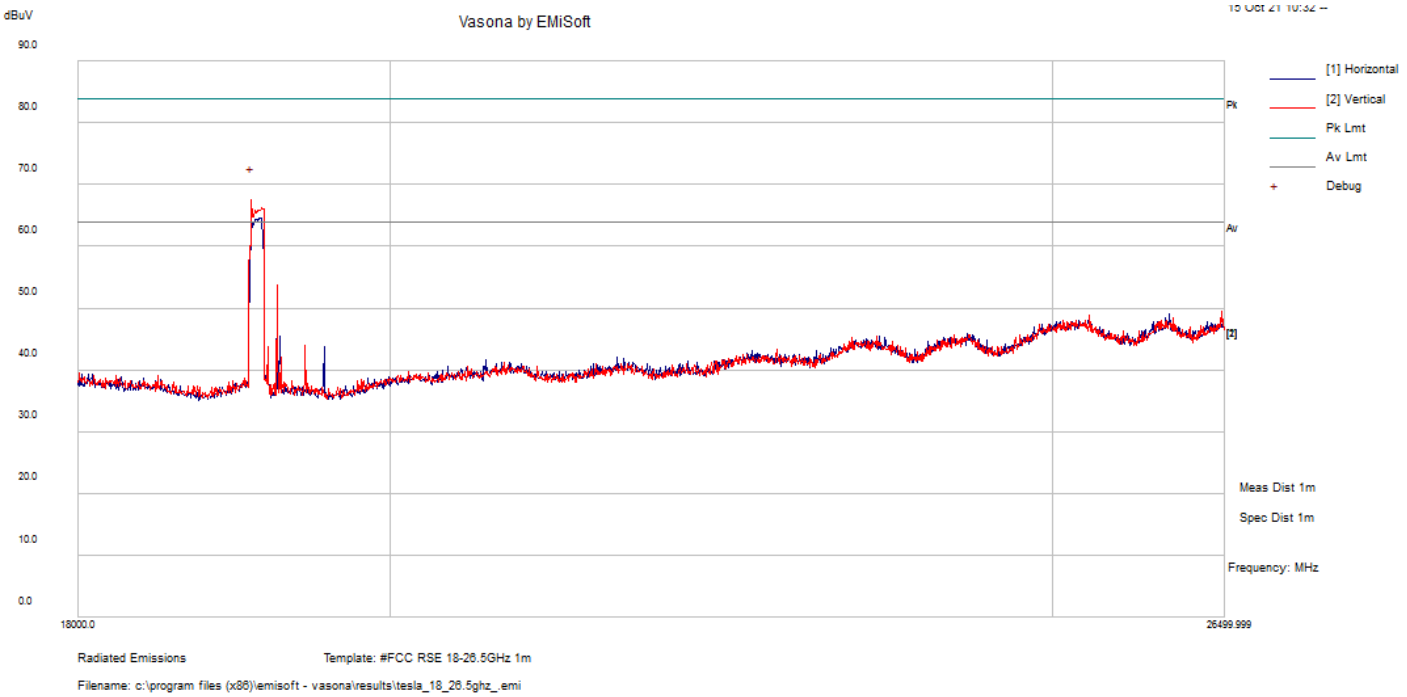


Frequency (MHz)	S.A. Reading (dBuV)	Correction Factor (dB/m)	Corrected Amplitude (dBµV/m)	Ant. Polarity (H/V)	Ant. Height (cm)	Turntable Azimuth (degrees)	Limit (dBµV/m)	Margin (dB)	Detector (Peak /Ave.)
17300.647	45.81	16.56	62.37	V	200	360	64	-1.63	Peak

Note: Peak measurement was made on worst case emission and compared to average limit.

18-26.5 GHz, Measured at 1 meter

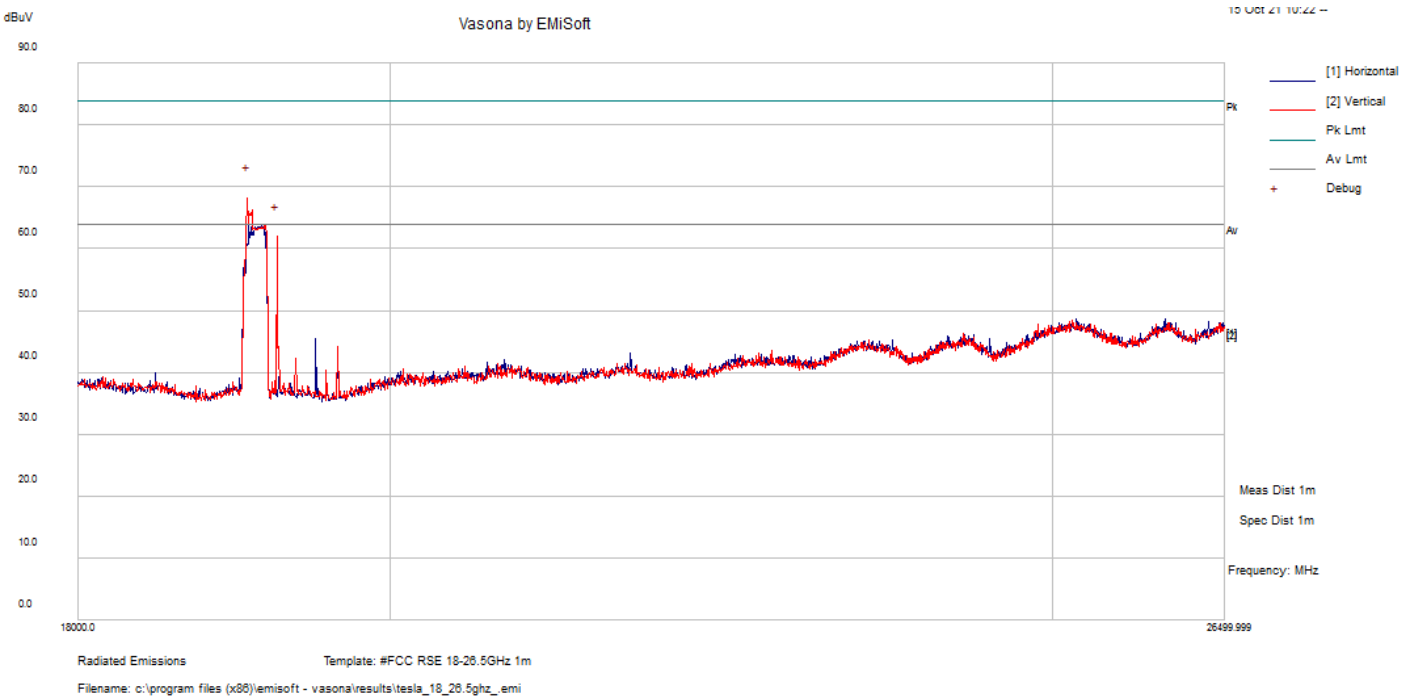
Mode 3



Radiated Emissions Template: #FCC RSE 18-26.5GHz 1m

Filename: c:\program files (x86)\emisoft - vasona\results\tesla_18_26.5ghz_.emi

Mode 4



Radiated Emissions Template: #FCC RSE 18-26.5GHz 1m

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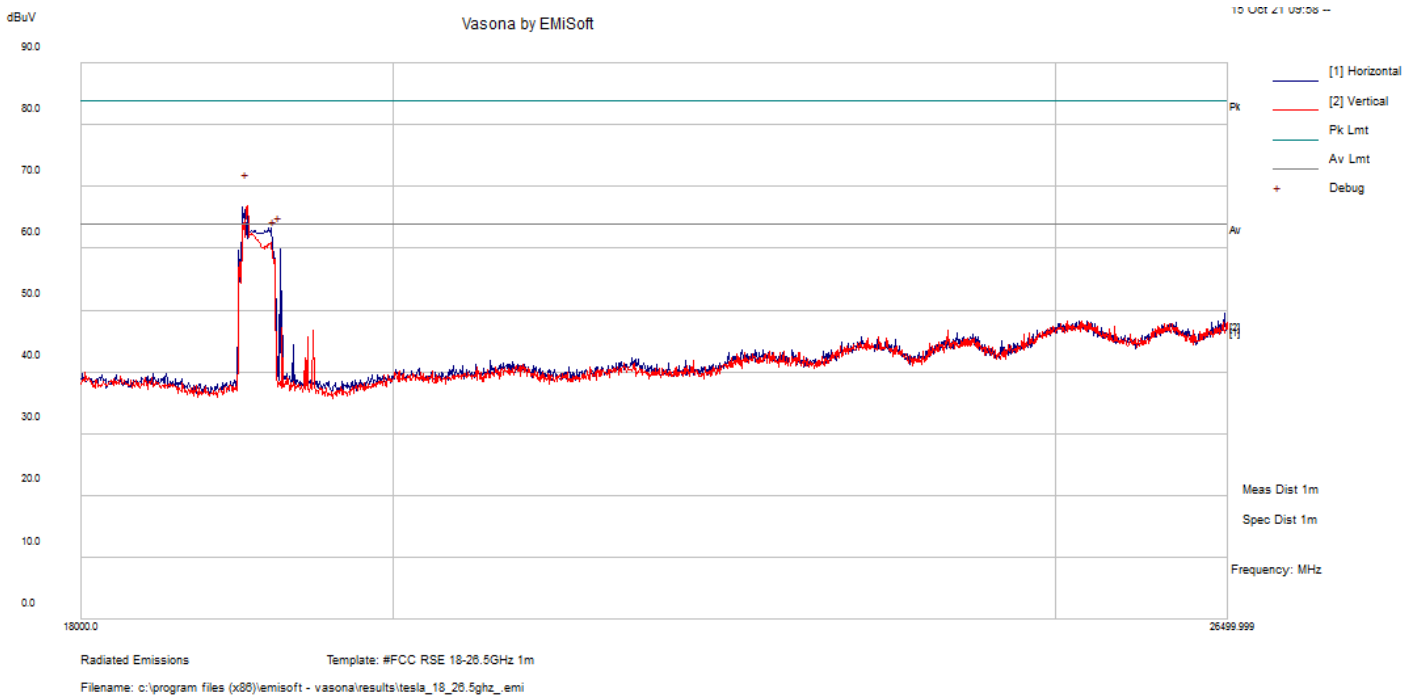
Mode 5



Peak Measurements:

Mode	Emission Frequency (GHz)	PSA Reading (dBuV)	Equipment Factors (dB/m)	Peak Desensitization Factor* (dB)	Corrected Field Strength (dBµV/m at 3m)	Limit (dBµV/m at 1m)	Margin (dB)
3	19.1	67.84	11.857	0	79.697	84	-4.303
4	19.1	69.22	11.857	0	81.077	84	-2.923
5	19.0	69.53	11.857	0	81.387	84	-2.613

Note: customer declares the emission characteristic at sub-harmonic frequencies is not exactly the same as the emission characteristic at the fundamental frequency, and the Peak Desensitization Factor should not be applied to the spurious emissions. Fundamental signal consists of chirps through the entire chirp width. However, at the beginning of each one of the three sub-frames within the chirp width, sub-harmonic emissions do not have an idle period (chirp repetition interval – chirp time). The peaks shown at the beginning of the spectrum at the sub-harmonic frequency are the result of continuous transmission but not sweeping. Therefore, Peak Desensitization Factor is not applicable for the measured amplitude from these peaks.*

Note: Equipment Factors(dB/m) = Antenna Factor (dB/m) + Cable Loss (dB) – Pre-amplifier Gain (dB).

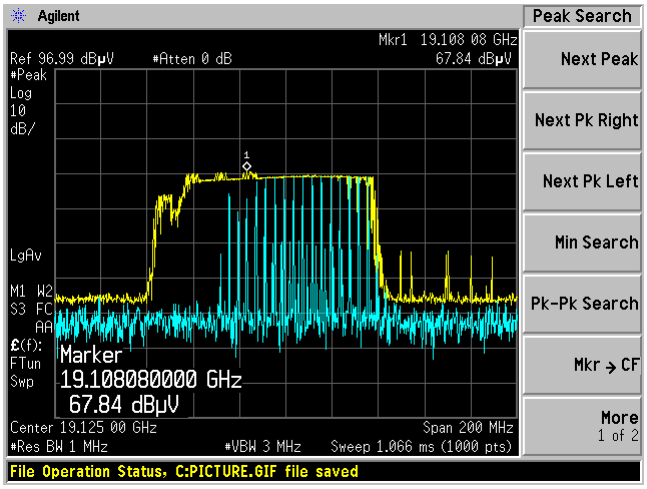
Average Measurements:

Mode	Emission Frequency (GHz)	PSA Reading (dBuV)	Equipment Factors (dB)	Duty Cycle Correction Factor (dB)	Corrected Field Strength (dBµV/m at 3m)	Limit (dBµV/m at 1m)	Margin (dB)
3	19.1	47.84	11.857	3.4	63.097	64	-0.903
4	19.1	47.34	11.857	3.4	62.597	64	-1.403
5	19.0	47.57	11.857	3.4	62.827	64	-1.173

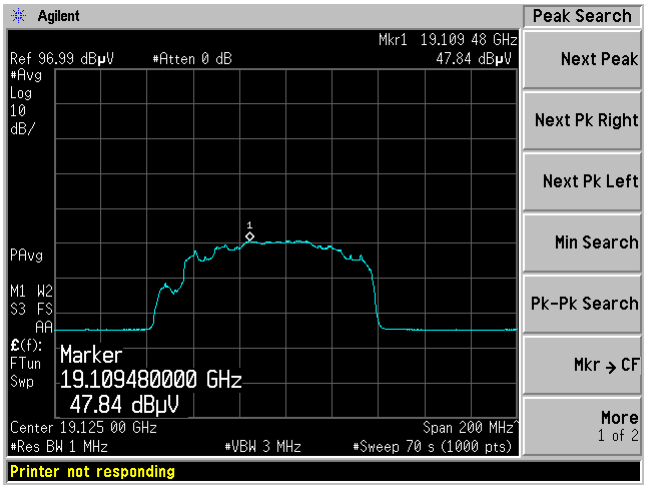
Note: Equipment Factors(dB/m) = Antenna Factor (dB/m) + Cable Loss (dB) – Pre-amplifier Gain (dB).

Mode 3

Peak

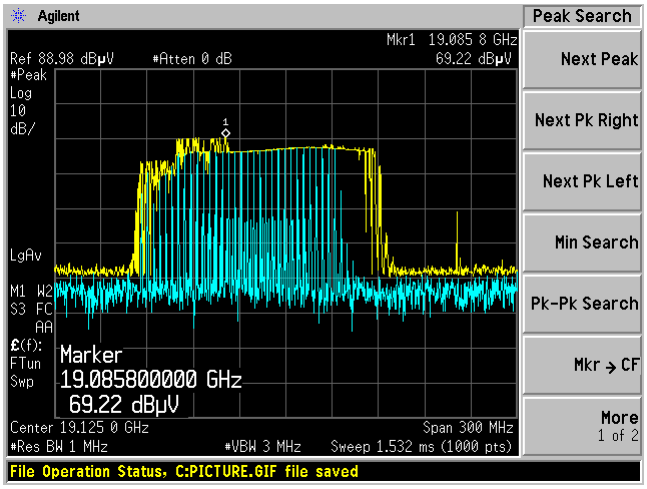


Average

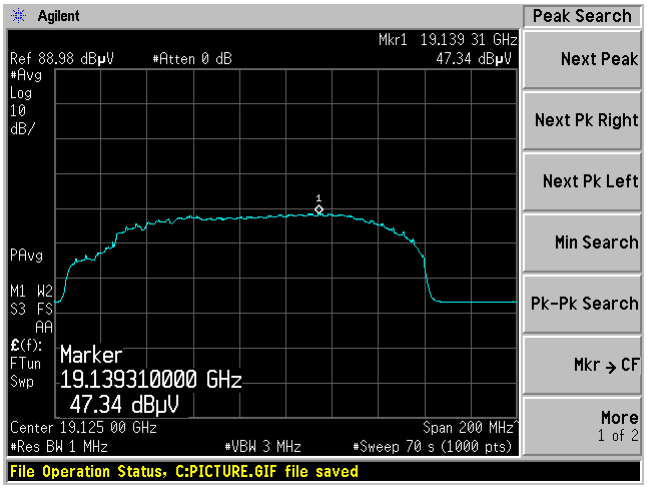


Mode 4

Peak

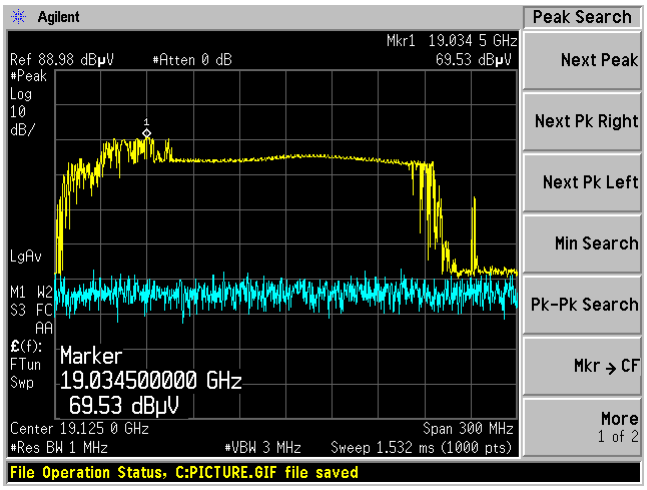


Average

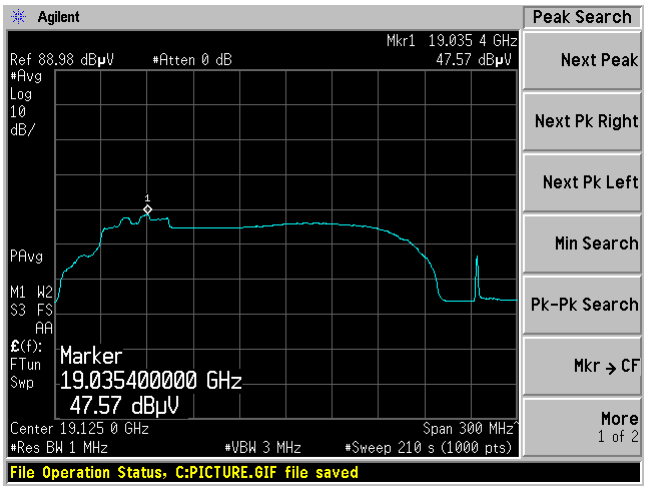


Mode 5

Peak

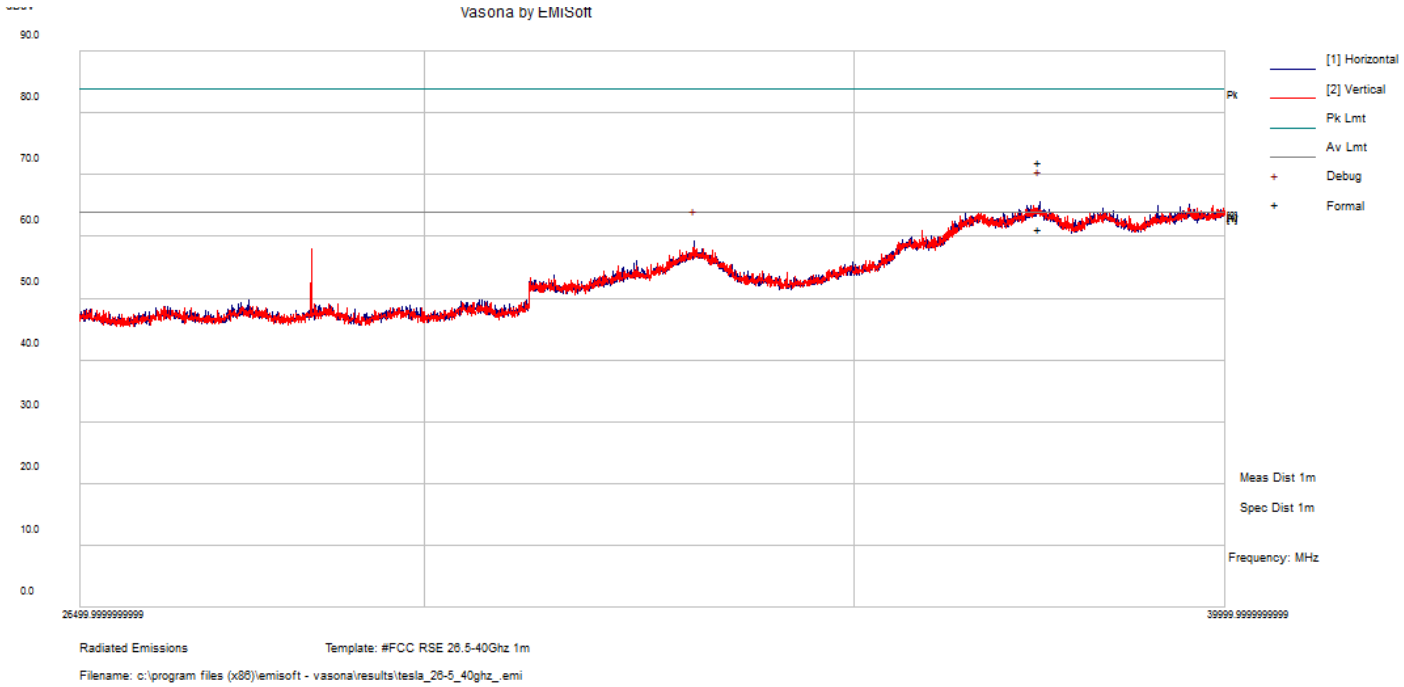


Average



26.5-40 GHz Worst Case, Measured at 1 meter

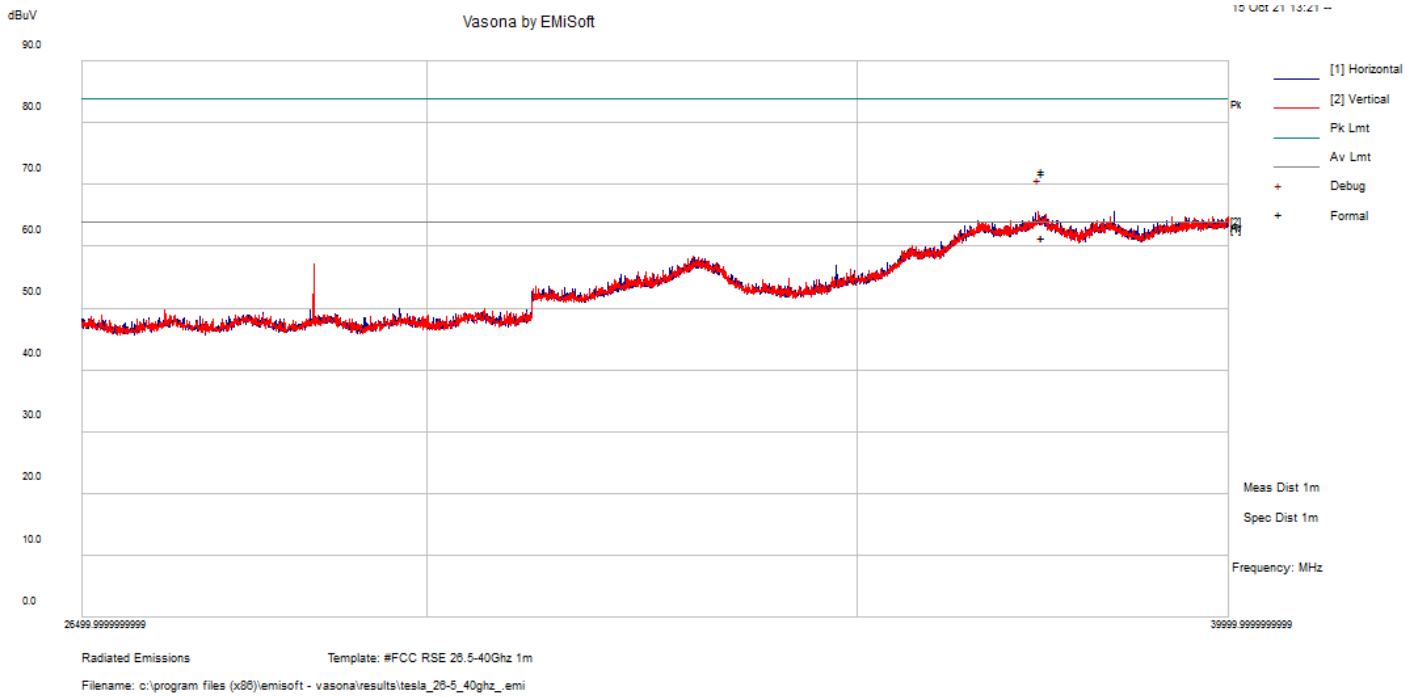
Mode 3



Freq. (MHz)	S.A. Reading (dBµV)	Corr. Factor (dB/m)	Corrected Amp. (dBµV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBµV/m)	Margin (dB)	Comment
37418.51	55.04	17.08	72.12	112	H	55	84	-11.88	Peak
37418.51	44.23	17.08	61.31	112	H	55	64	-2.69	Avg.

Note: Higher end of 26.5 – 40 GHz span was verified to be noise floor. Peak and average formal measurements were made on the highest amplitude noise floor frequency to show compliance with relevant limits.

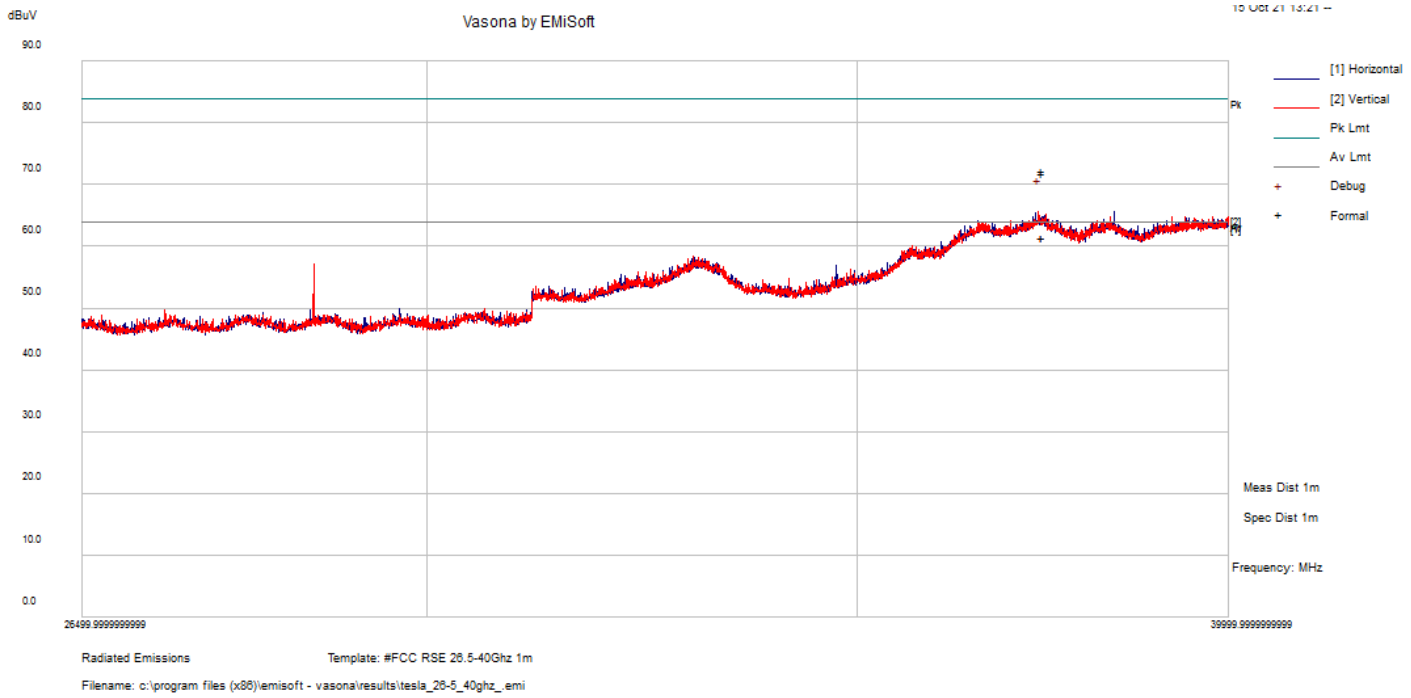
Mode 4



Freq. (MHz)	S.A. Reading (dBµV)	Corr. Factor (dB/m)	Corrected Amp. (dBµV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBµV/m)	Margin (dB)	Comment
37418.46	55.19	17.08	72.27	104	H	290	84	-11.73	Peak
37418.46	44.29	17.08	61.37	104	H	290	64	-2.63	Avg.

Note: Higher end of 26.5 – 40 GHz span was verified to be noise floor. Peak and average formal measurements were made on the highest amplitude noise floor frequency to show compliance with relevant limits.

Mode 5



Freq. (MHz)	S.A. Reading (dBµV)	Corr. Factor (dB/m)	Corrected Amp. (dBµV/m)	Antenna Height (cm)	Antenna Polarity (H/V)	Turntable Azimuth (degrees)	Limit (dBµV/m)	Margin (dB)	Comment
37375.75	55.33	16.99	72.31	146	H	352	84	-11.69	Peak
37375.75	44.48	16.99	61.47	146	H	352	64	-2.53	Avg.

Note: Higher end of 26.5 – 40 GHz span was verified to be noise floor. Peak and average formal measurements were made on the highest amplitude noise floor frequency to show compliance with relevant limits.

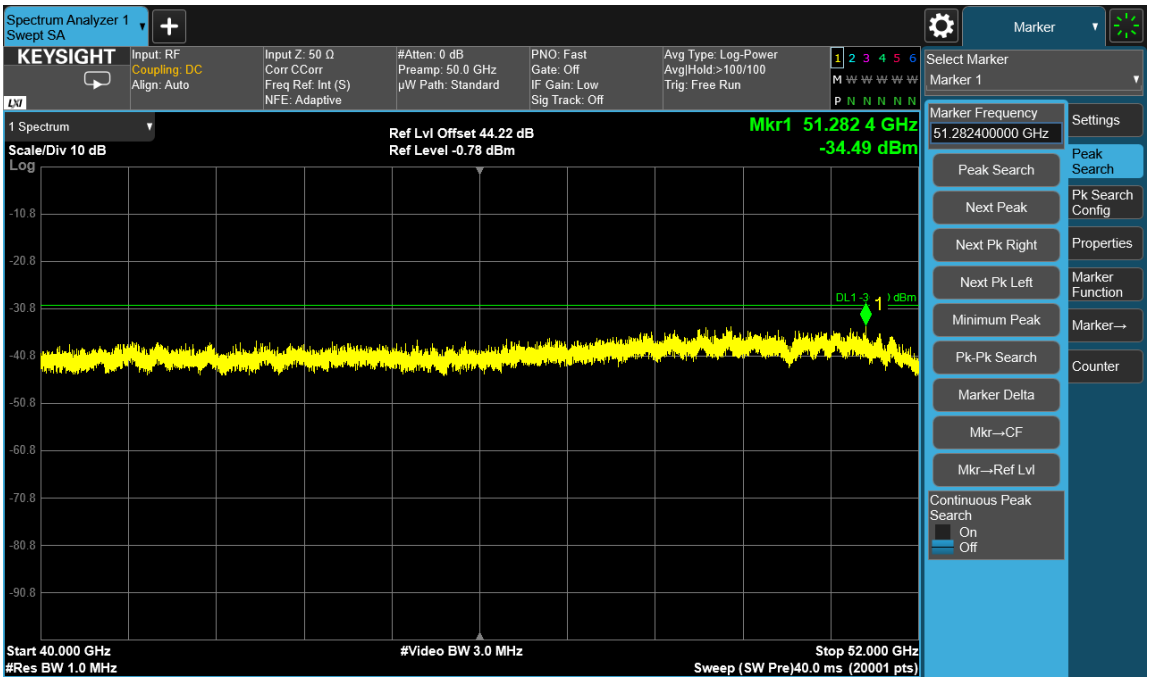
8.10 Test Results 40 GHz to 231 GHz

Frequency Range (GHz)	FCC Limit		ISED Limit (dBm)
	(pW/cm^2) @ 3m	(dBm)	
40-76	600	-1.69	-30
81-162	600	-1.69	-30
162-200	600	-1.69	-
200-231	1000	0.53	-

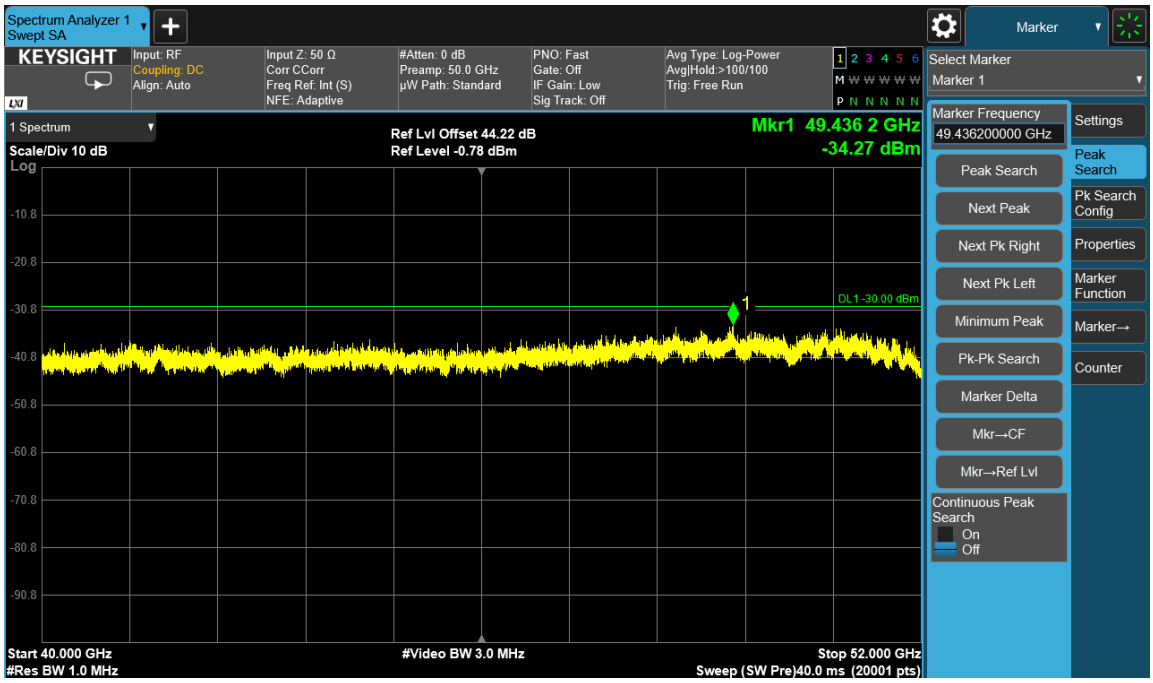
Note: For below spurious emissions, a peak detector was used in comparison to average limits in order to show compliance.
Note: The correction factors have been considered in the reference level offset as shown in the following measurement screenshots.

40-52 GHz, Measured at 1 meter

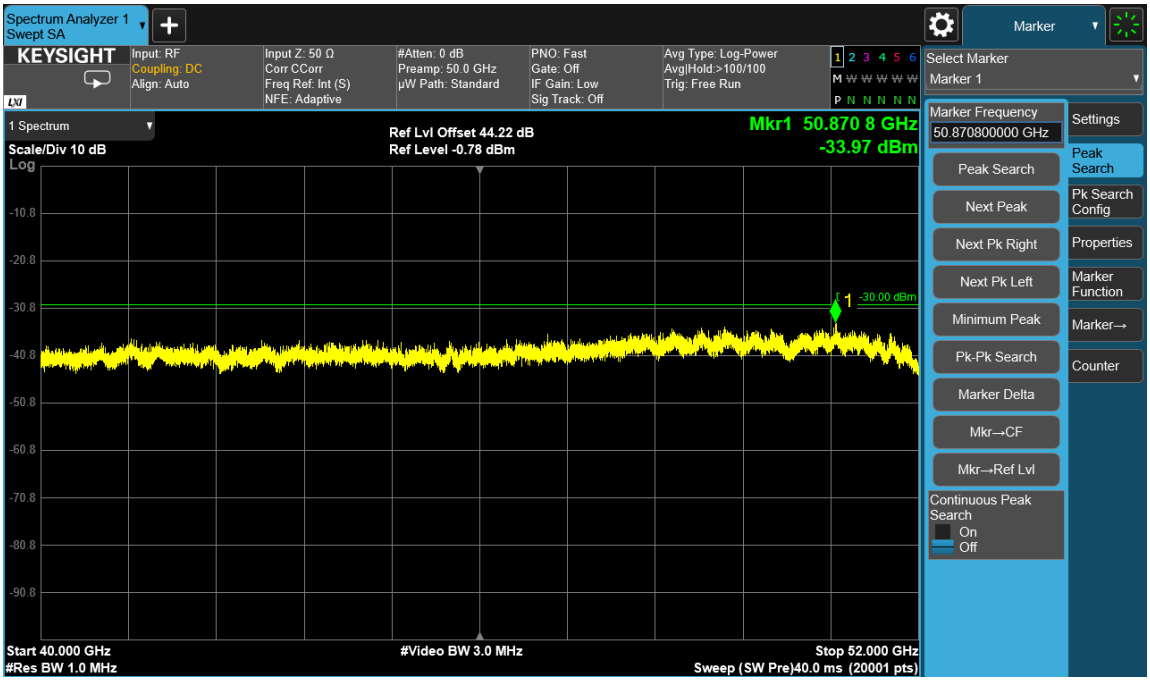
Mode 3



Mode 4

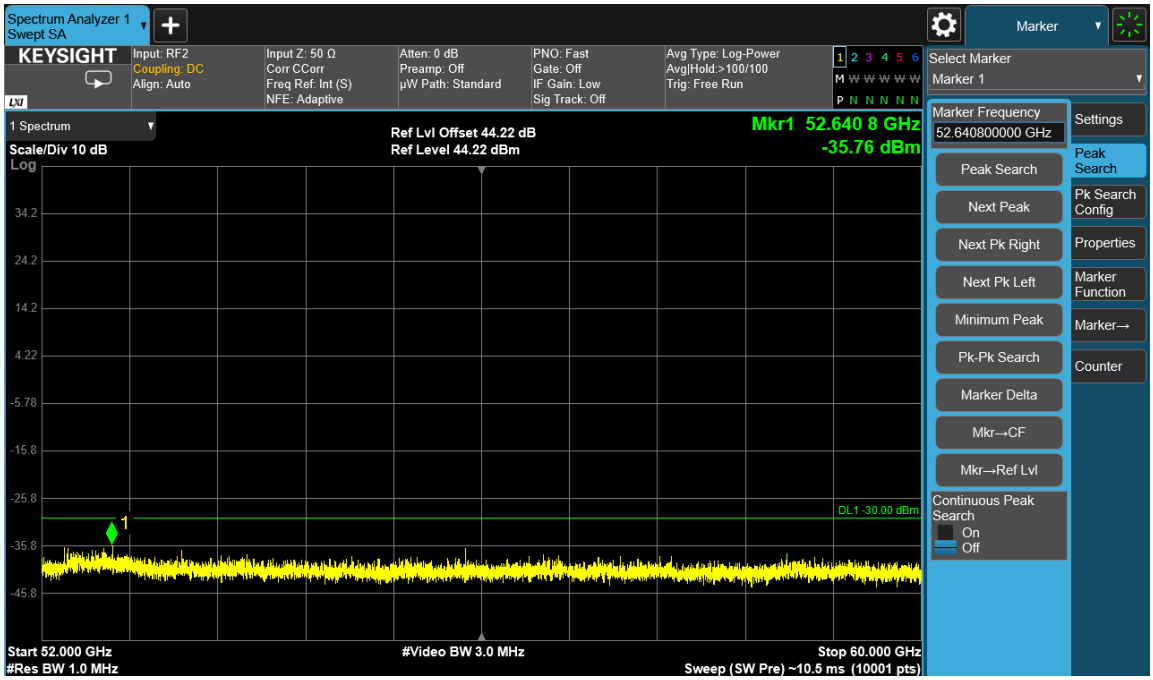

Spectrum Analyzer 1
Swept SA
KEYSIGHT
Input: RF
Coupling: DC
Align: Auto
Input Z: 50 Ω
Corr CCorr
Freq Ref: Int (S)
NFE: Adaptive
#Atten: 0 dB
Preamp: 50.0 GHz
µW Path: Standard
PNO: Fast
Gate: Off
IF Gain: Low
Sig Track: Off
Avg Type: Log-Power
Avg|Hold:>100/100
Trig: Free Run
Marker
Select Marker
Marker 1
1 Spectrum
Scale/Div 10 dB
Log
Ref Lvl Offset 44.22 dB
Ref Level -0.78 dBm
Mkr1 49.436 2 GHz
-34.27 dBm
DL1 -30.00 dBm
Start 40.000 GHz
#Res BW 1.0 MHz
#Video BW 3.0 MHz
Stop 52.000 GHz
Sweep (SW Pre)40.0 ms (20001 pts)
Marker Frequency
49.436200000 GHz
Peak Search
Next Peak
Next Pk Right
Next Pk Left
Minimum Peak
Pk-Pk Search
Marker Delta
Mkr→CF
Mkr→Ref Lvl
Continuous Peak Search
On
Off
Settings
Peak Search
Pk Search Config
Properties
Marker Function
Marker→
Counter

Mode 5

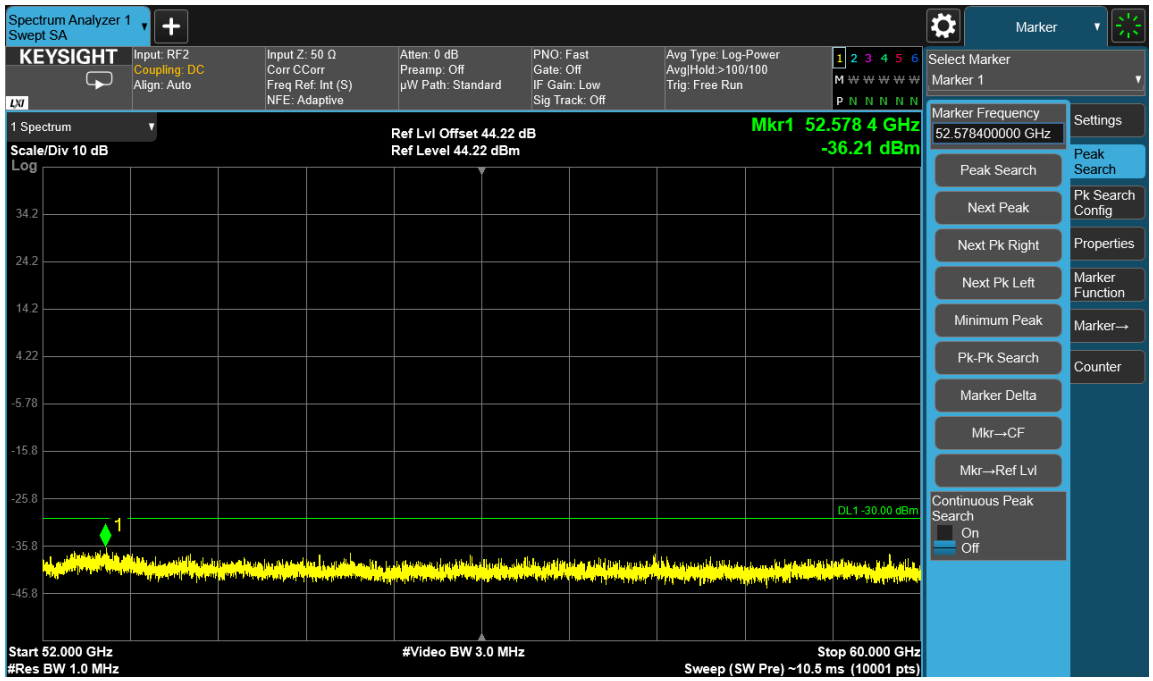

Spectrum Analyzer 1
Swept SA
KEYSIGHT
Input: RF
Coupling: DC
Align: Auto
Input Z: 50 Ω
Corr CCorr
Freq Ref: Int (S)
NFE: Adaptive
#Atten: 0 dB
Preamp: 50.0 GHz
µW Path: Standard
PNO: Fast
Gate: Off
IF Gain: Low
Sig Track: Off
Avg Type: Log-Power
Avg|Hold:>100/100
Trig: Free Run
Marker
Select Marker
Marker 1
1 Spectrum
Scale/Div 10 dB
Log
Ref Lvl Offset 44.22 dB
Ref Level -0.78 dBm
Mkr1 50.870 8 GHz
-33.97 dBm
-30.00 dBm
Start 40.000 GHz
#Res BW 1.0 MHz
#Video BW 3.0 MHz
Stop 52.000 GHz
Sweep (SW Pre)40.0 ms (20001 pts)
Marker Frequency
50.870800000 GHz
Peak Search
Next Peak
Next Pk Right
Next Pk Left
Minimum Peak
Pk-Pk Search
Marker Delta
Mkr→CF
Mkr→Ref Lvl
Continuous Peak Search
On
Off
Settings
Peak Search
Pk Search Config
Properties
Marker Function
Marker→
Counter

52-60 GHz, Measured at 1 meter

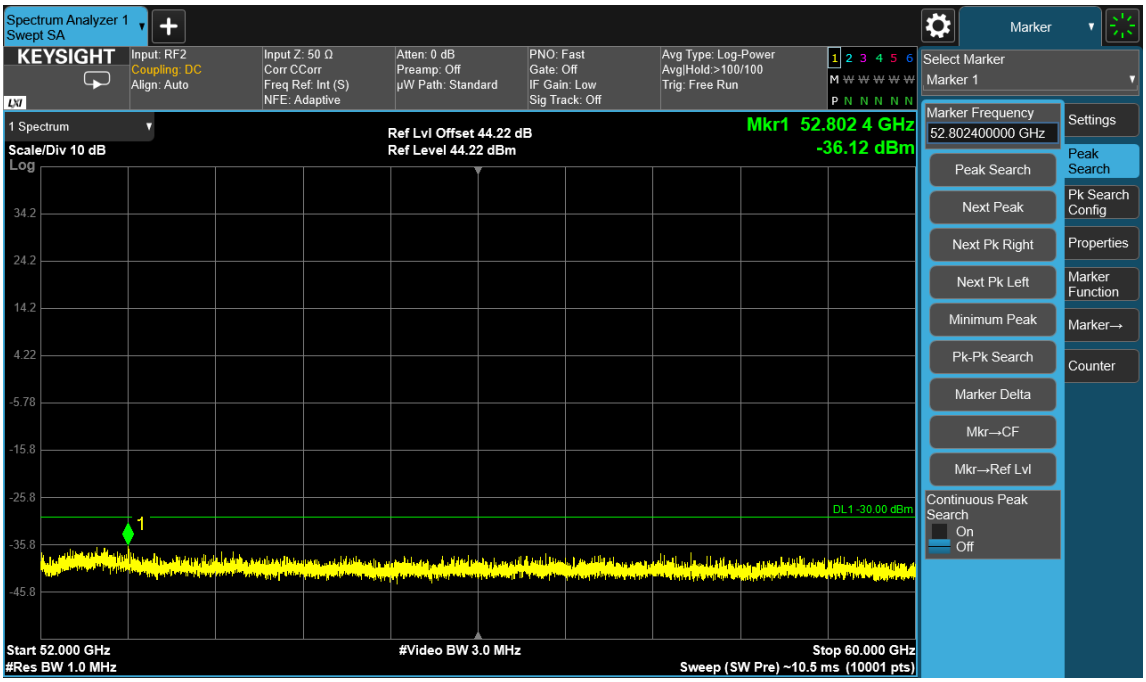
Mode 3



Mode 4

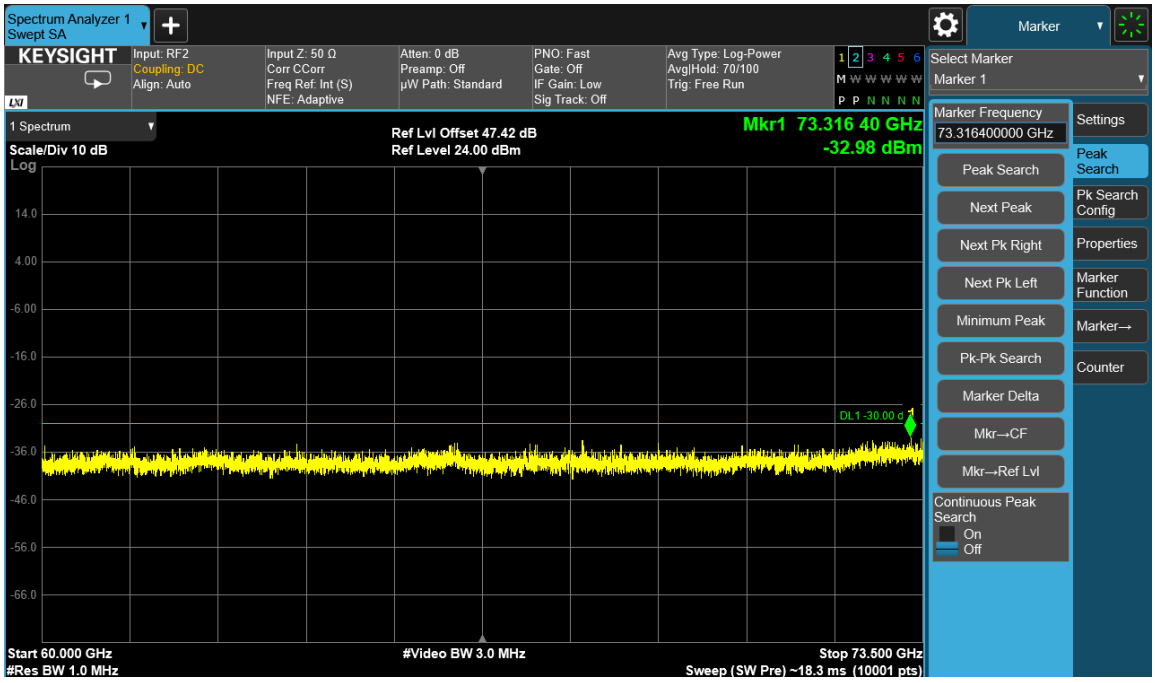


Mode 5

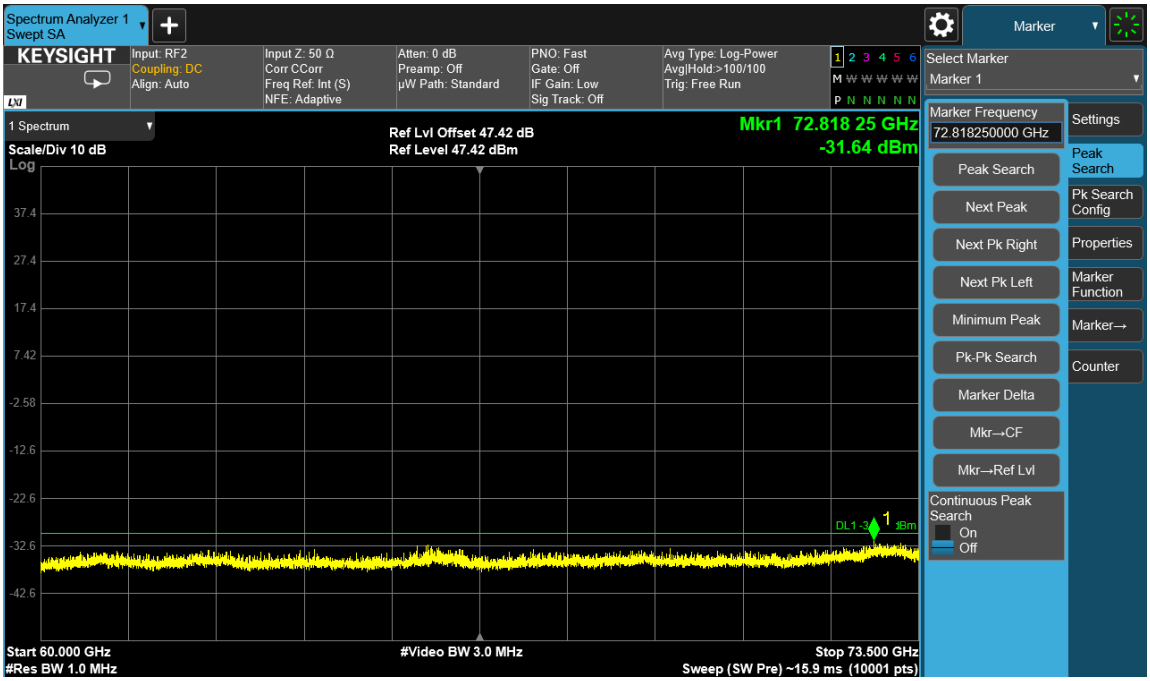

Spectrum Analyzer 1
Swept SA
KEYSIGHT
Input: RF2
Coupling: DC
Align: Auto
Input Z: 50 Ω
Corr CCorr
Freq Ref: Int (S)
NFE: Adaptive
Atten: 0 dB
Preamp: Off
µW Path: Standard
PNO: Fast
Gate: Off
IF Gain: Low
Sig Track: Off
Avg Type: Log-Power
Avg|Hold:>100/100
Trig: Free Run
Marker
Select Marker
Marker 1
Marker Frequency
52.802400000 GHz
Settings
Peak Search
Next Peak
Next Pk Right
Next Pk Left
Minimum Peak
Pk-Pk Search
Marker Delta
Mkr→CF
Mkr→Ref Lvl
Continuous Peak Search
On
Off
Pk Search Config
Properties
Marker Function
Marker→
Counter
1 Spectrum
Scale/Div 10 dB
Log
Ref Lvl Offset 44.22 dB
Ref Level 44.22 dBm
Mkr1 52.802 4 GHz
-36.12 dBm
34.2
24.2
14.2
4.22
-5.78
-15.8
-25.8
-35.8
-45.8
DL1 -30.00 dBm
Start 52.000 GHz
#Res BW 1.0 MHz
#Video BW 3.0 MHz
Stop 60.000 GHz
Sweep (SW Pre) ~10.5 ms (10001 pts)

60- 73.5 GHz, Measured at 1 meter

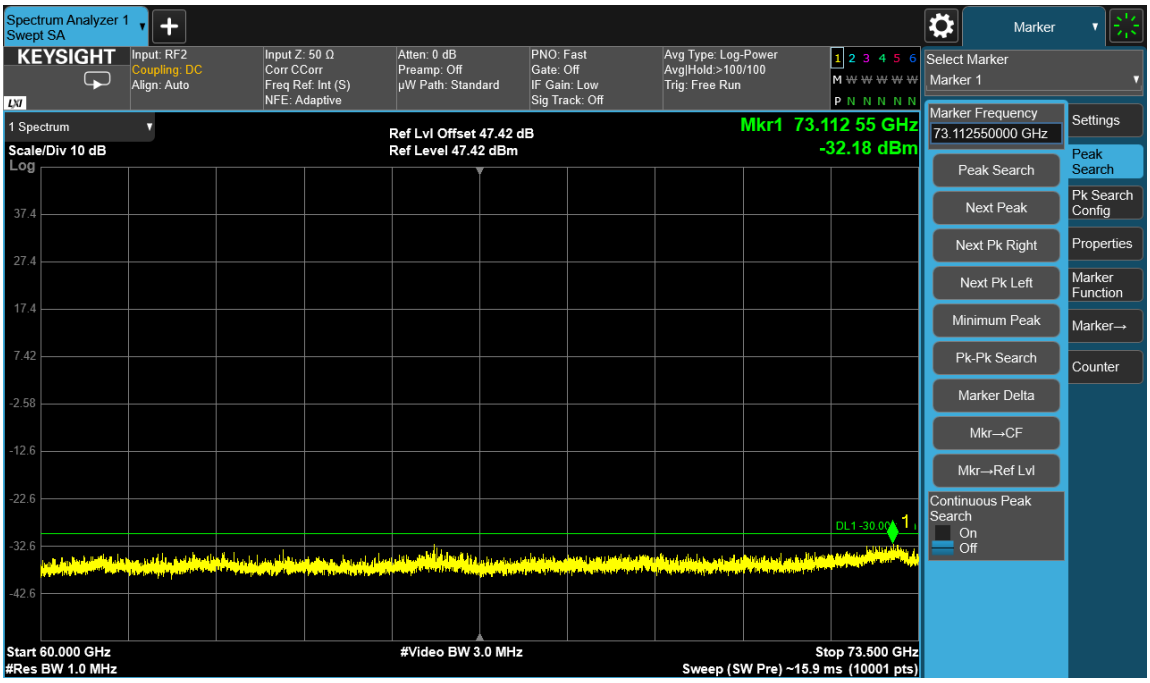
Mode 3



Mode 4

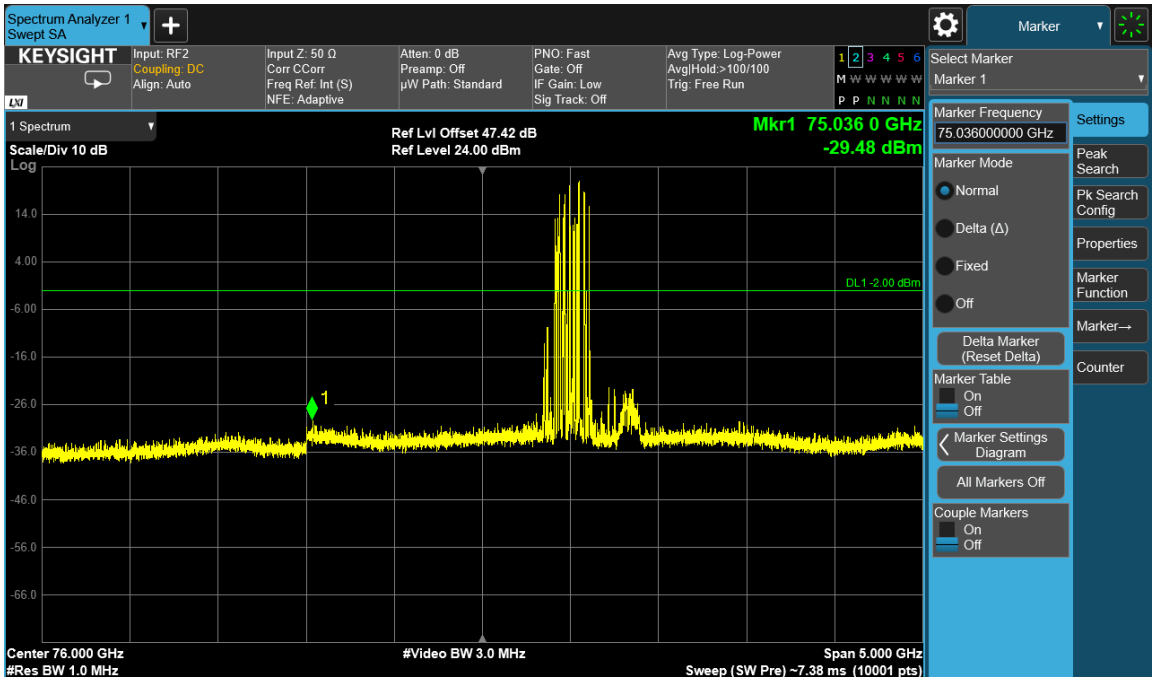


Mode 5

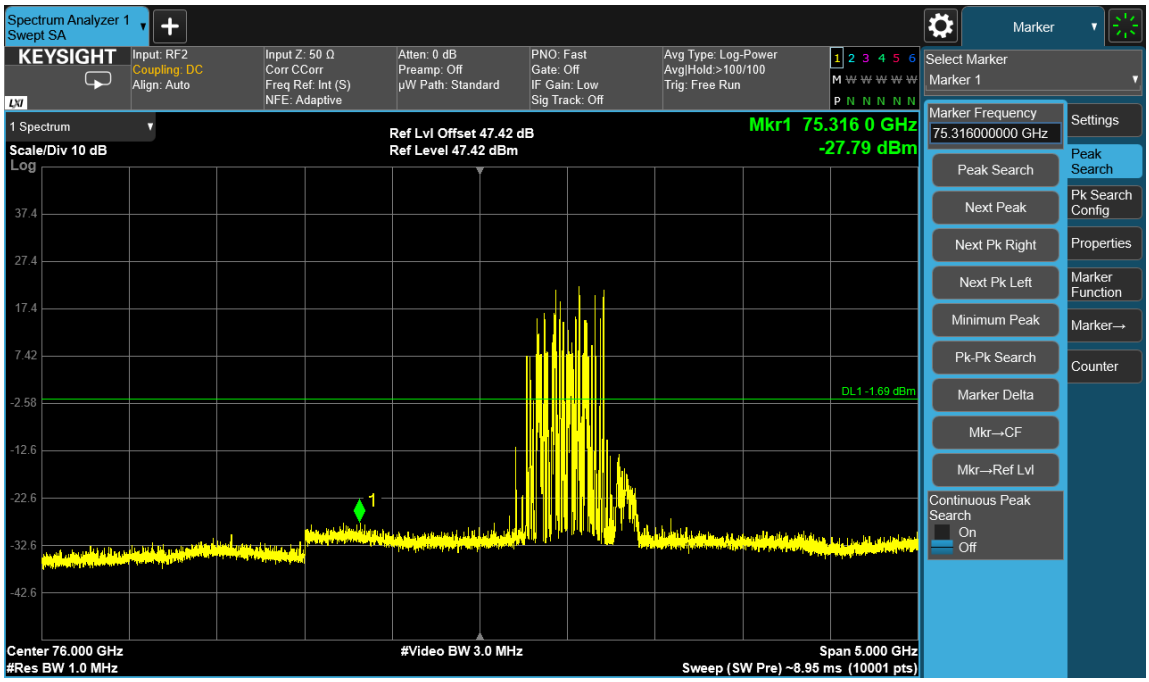

Spectrum Analyzer 1
Swept SA
KEYSIGHT
Input: RF2
Coupling: DC
Align: Auto
Input Z: 50 Ω
Corr CCorr
Freq Ref: Int (S)
NFE: Adaptive
Atten: 0 dB
Preamp: Off
µW Path: Standard
PNO: Fast
Gate: Off
IF Gain: Low
Sig Track: Off
Avg Type: Log-Power
Avg|Hold:>100/100
Trig: Free Run
Marker
Select Marker
Marker 1
Marker Frequency
73.112550000 GHz
Settings
Peak Search
Next Peak
Next Pk Right
Next Pk Left
Minimum Peak
Pk-Pk Search
Marker Delta
Mkr→CF
Mkr→Ref Lvl
Pk Search Config
Properties
Marker Function
Marker→
Counter
Continuous Peak Search
On
Off
1 Spectrum
Scale/Div 10 dB
Log
Ref Lvl Offset 47.42 dB
Ref Level 47.42 dBm
Mkr1 73.112 55 GHz
-32.18 dBm
37.4
27.4
17.4
7.42
-2.58
-12.6
-22.6
-32.6
-42.6
DL1 -30.00
Start 60.000 GHz
#Res BW 1.0 MHz
#Video BW 3.0 MHz
Stop 73.500 GHz
Sweep (SW Pre) ~15.9 ms (10001 pts)

73.5-76 GHz (Band Edge), Measured at 1 meter

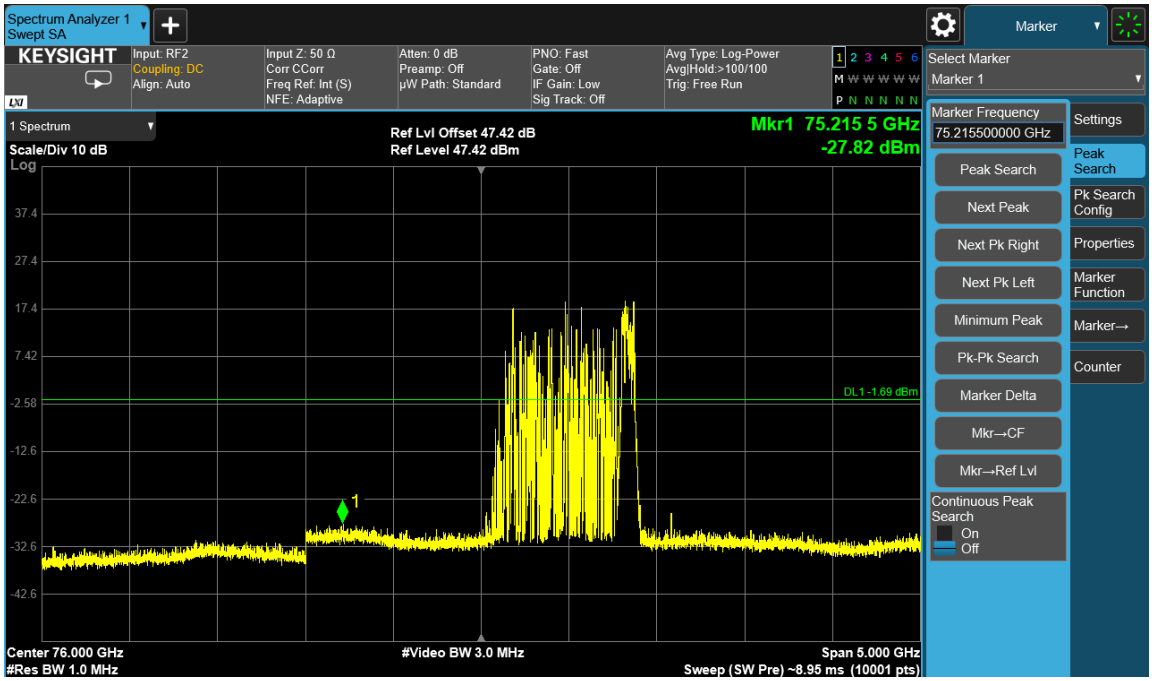
Mode 3



Mode 4

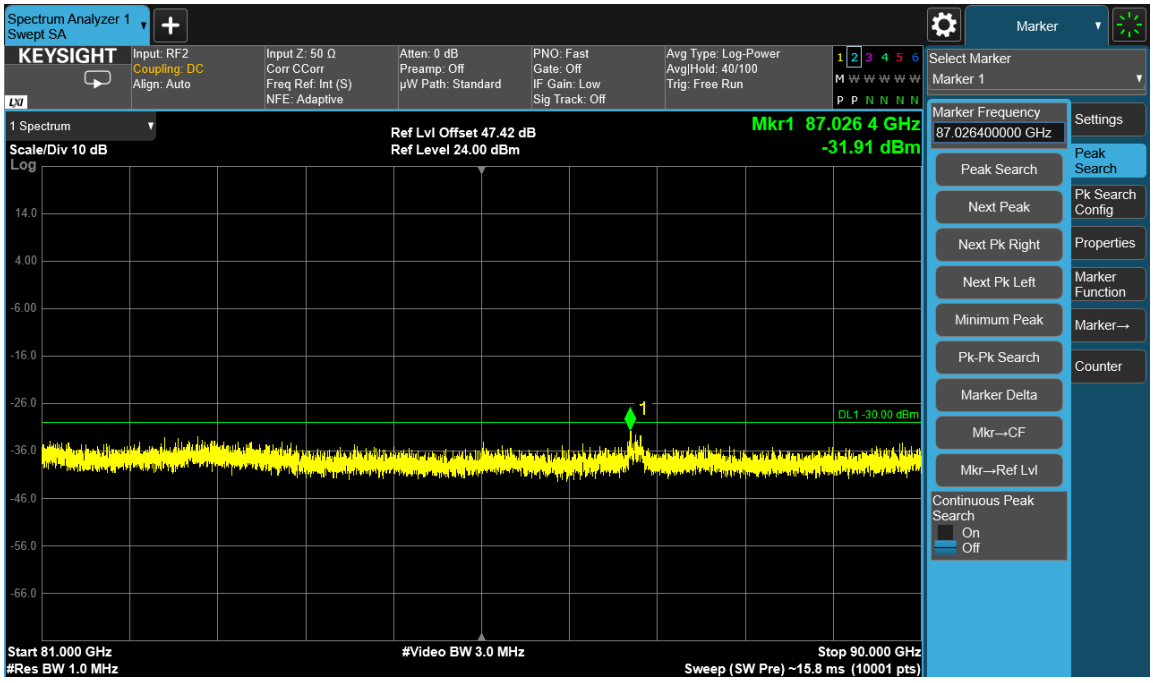


Mode 5

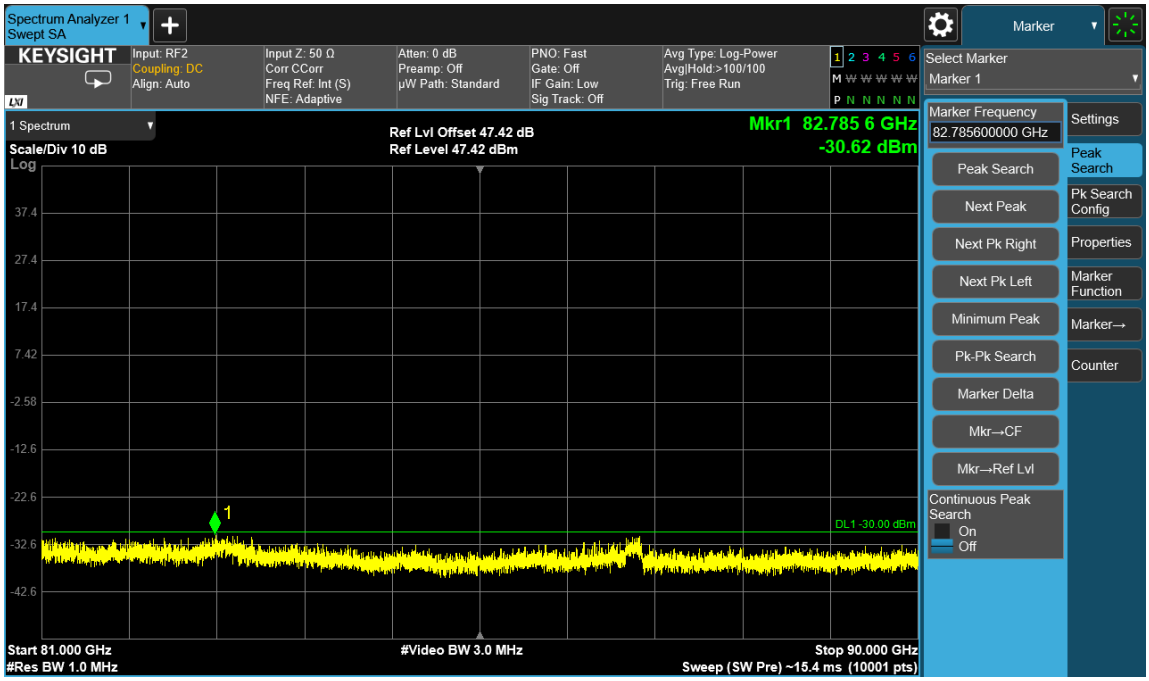

Spectrum Analyzer 1
Swept SA
KEYSIGHT
Input: RF2
Coupling: DC
Align: Auto
Input Z: 50 Ω
Corr CCorr
Freq Ref: Int (S)
NFE: Adaptive
Atten: 0 dB
Preamp: Off
µW Path: Standard
PNO: Fast
Gate: Off
IF Gain: Low
Sig Track: Off
Avg Type: Log-Power
Avg|Hold:>100/100
Trig: Free Run
1 Spectrum
Scale/Div 10 dB
Log
Ref Lvl Offset 47.42 dB
Ref Level 47.42 dBm
Mkr1 75.215 5 GHz
-27.82 dBm
37.4
27.4
17.4
7.42
-2.58
-12.6
-22.6
-32.6
-42.6
DL1 -1.69 dBm
Center 76.000 GHz
#Res BW 1.0 MHz
#Video BW 3.0 MHz
Span 5.000 GHz
Sweep (SW Pre) ~8.95 ms (10001 pts)
Marker
Select Marker
Marker 1
Marker Frequency
75.215500000 GHz
Peak Search
Next Peak
Next Pk Right
Next Pk Left
Minimum Peak
Pk-Pk Search
Marker Delta
Mkr→CF
Mkr→Ref Lvl
Continuous Peak Search
On
Off
Settings
Peak Search
Pk Search Config
Properties
Marker Function
Marker→
Counter

81-90 GHz, Measured at 1 meter

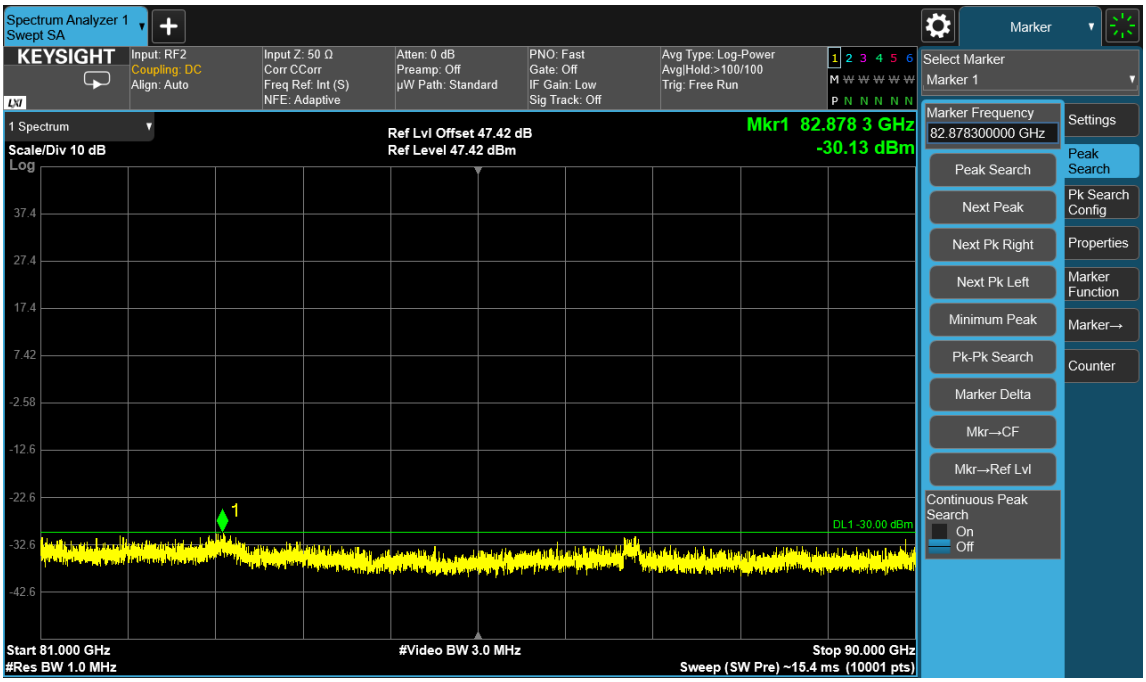
Mode 3



Mode 4

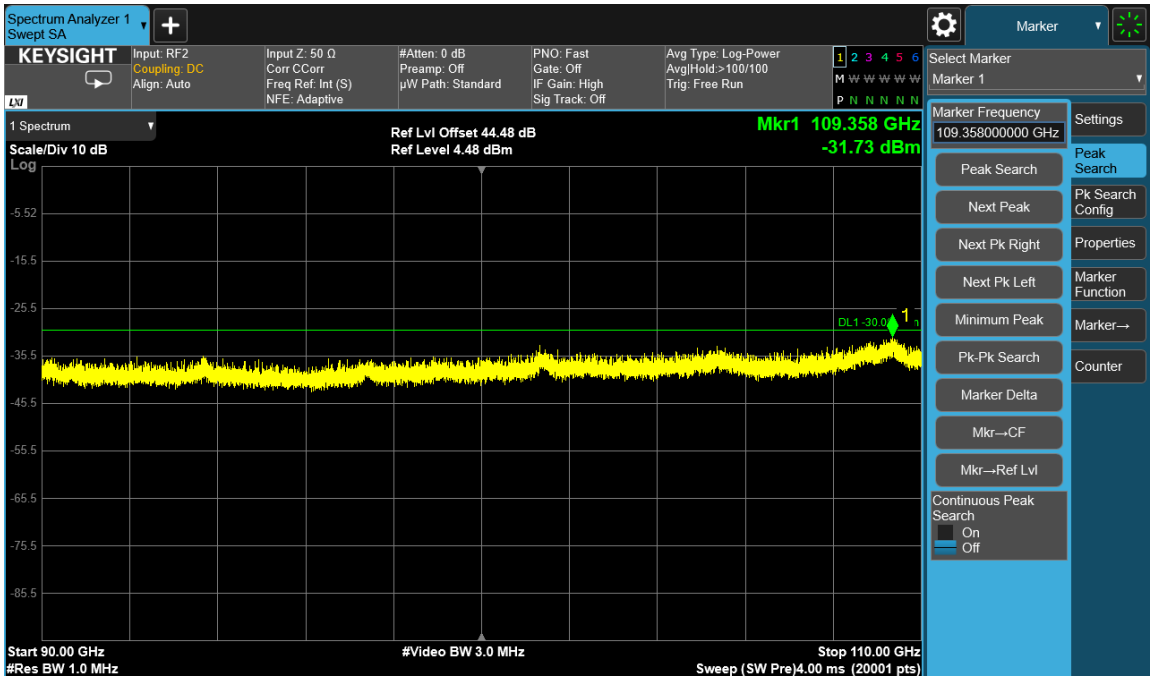


Mode 5

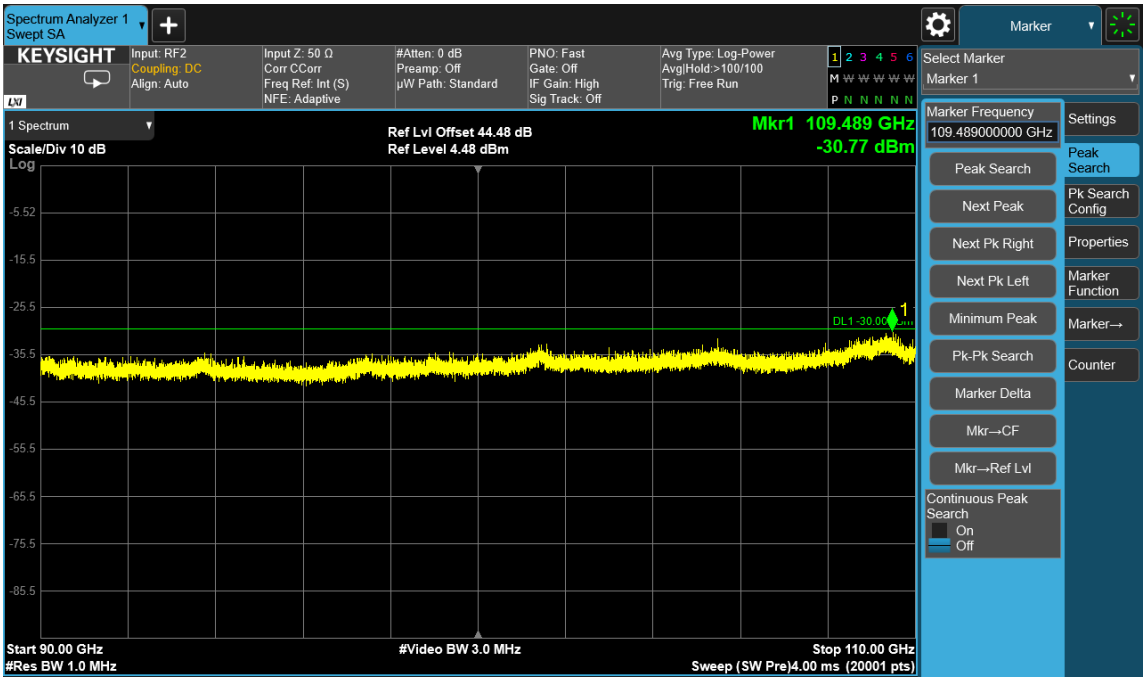

Spectrum Analyzer 1
Swept SA
KEYSIGHT
Input: RF2
Coupling: DC
Align: Auto
Input Z: 50 Ω
Corr CCorr
Freq Ref: Int (S)
NFE: Adaptive
Atten: 0 dB
Preamp: Off
µW Path: Standard
PNO: Fast
Gate: Off
IF Gain: Low
Sig Track: Off
Avg Type: Log-Power
Avg|Hold:>100/100
Trig: Free Run
1 Spectrum
Scale/Div 10 dB
Log
Ref Lvl Offset 47.42 dB
Ref Level 47.42 dBm
Mkr1 82.878 3 GHz
-30.13 dBm
37.4
27.4
17.4
7.42
-2.58
-12.6
-22.6
-32.6
-42.6
DL1 -30.00 dBm
Start 81.000 GHz
#Res BW 1.0 MHz
#Video BW 3.0 MHz
Stop 90.000 GHz
Sweep (SW Pre) ~15.4 ms (10001 pts)
Marker
Select Marker
Marker 1
Marker Frequency
82.878300000 GHz
Peak Search
Next Peak
Next Pk Right
Next Pk Left
Minimum Peak
Pk-Pk Search
Marker Delta
Mkr→CF
Mkr→Ref Lvl
Continuous Peak Search
On
Off
Settings
Peak Search
Pk Search Config
Properties
Marker Function
Marker→
Counter

90-110 GHz, Measured at 0.5 meter

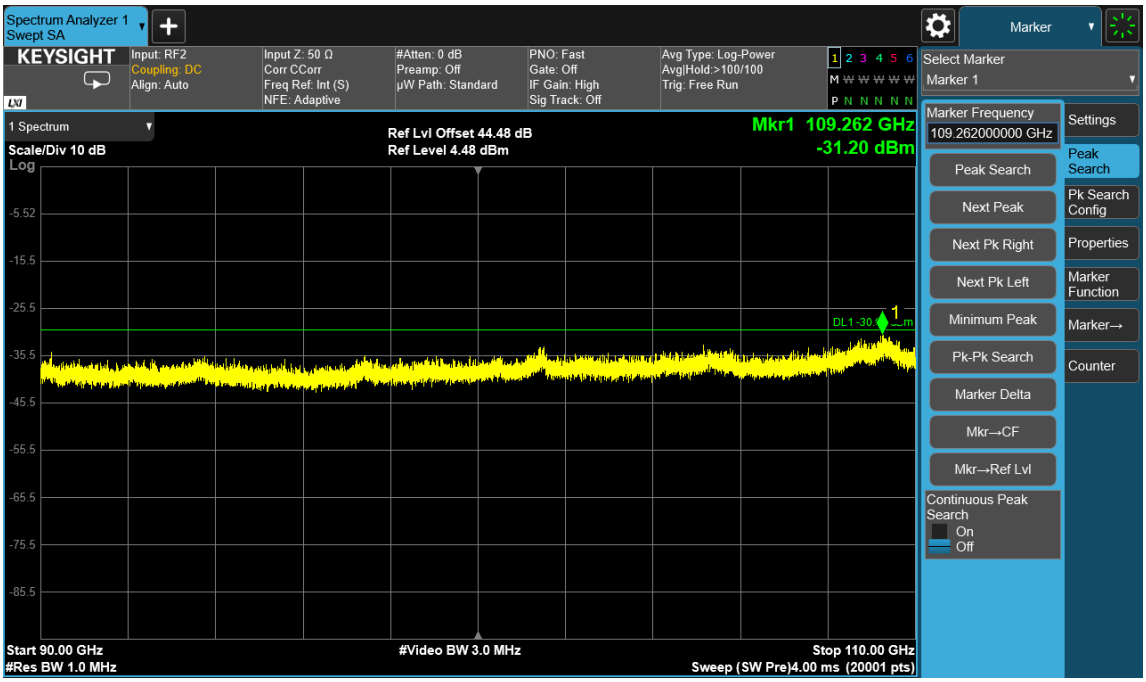
Mode 3



Mode 4

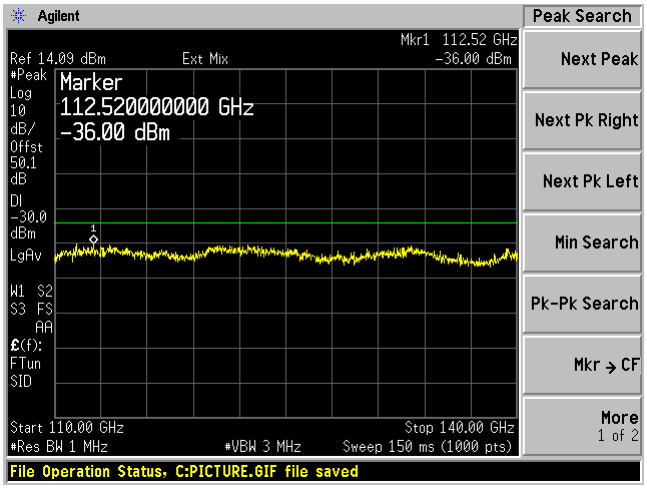


Mode 5

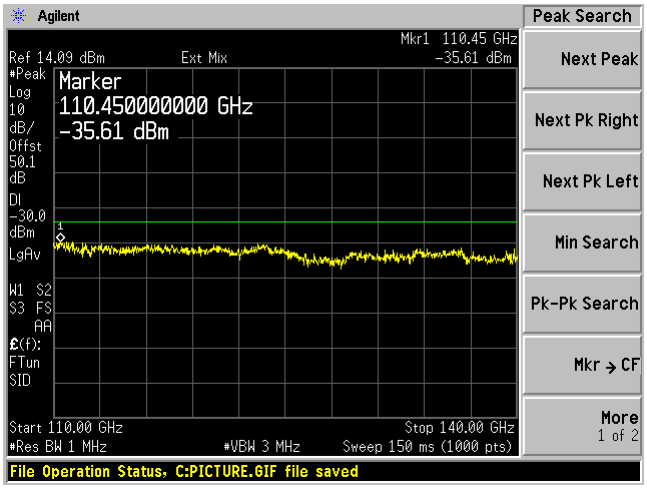

Spectrum Analyzer 1
Swept SA
KEYSIGHT
Input: RF2
Coupling: DC
Align: Auto
Input Z: 50 Ω
Corr CCorr
Freq Ref: Int (S)
NFE: Adaptive
#Atten: 0 dB
Preamp: Off
µW Path: Standard
PNO: Fast
Gate: Off
IF Gain: High
Sig Track: Off
Avg Type: Log-Power
Avg|Hold:>100/100
Trig: Free Run
Marker
Select Marker
Marker 1
Marker Frequency
109.262000000 GHz
1 Spectrum
Scale/Div 10 dB
Log
Ref Lvl Offset 44.48 dB
Ref Level 4.48 dBm
Mkr1 109.262 GHz
-31.20 dBm
-5.52
-15.5
-25.5
-35.5
-45.5
-55.5
-65.5
-75.5
-85.5
Start 90.00 GHz
#Res BW 1.0 MHz
#Video BW 3.0 MHz
Stop 110.00 GHz
Sweep (SW Pre)4.00 ms (20001 pts)
Settings
Peak Search
Next Peak
Next Pk Right
Next Pk Left
Minimum Peak
Pk-Pk Search
Marker Delta
Mkr→CF
Mkr→Ref Lvl
Continuous Peak Search
On
Off
Peak Search
Pk Search Config
Properties
Marker Function
Marker→
Counter

110-140 GHz, Measured at 0.5 meter

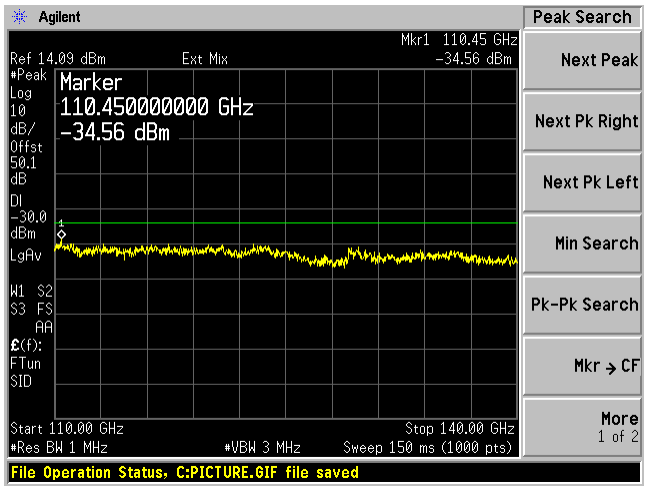
Mode 3



Mode 4

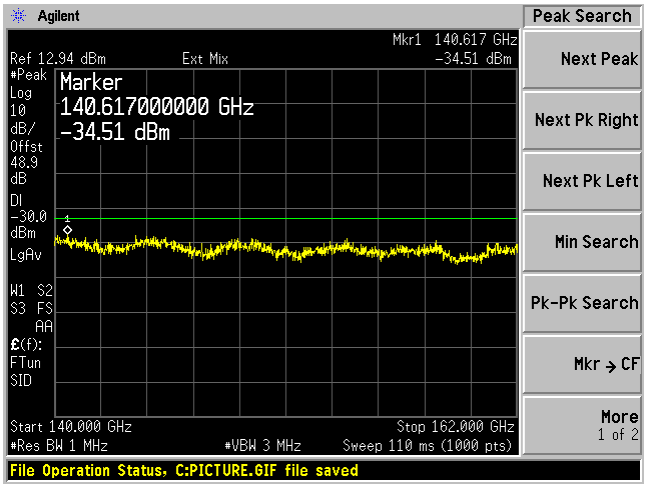


Mode 5

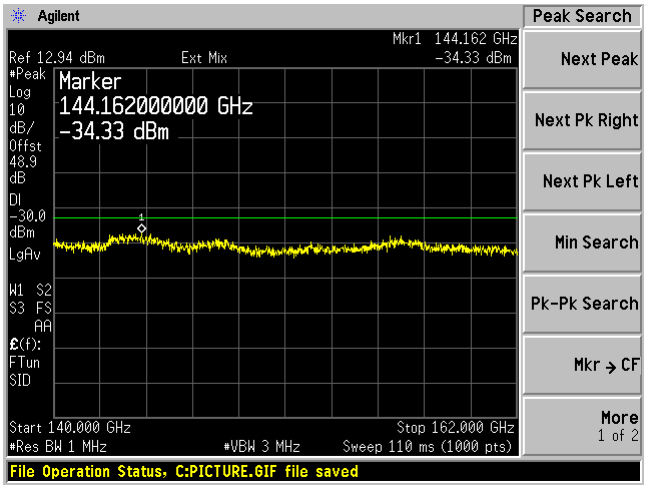


140-162 GHz, Measured at 0.25 meter

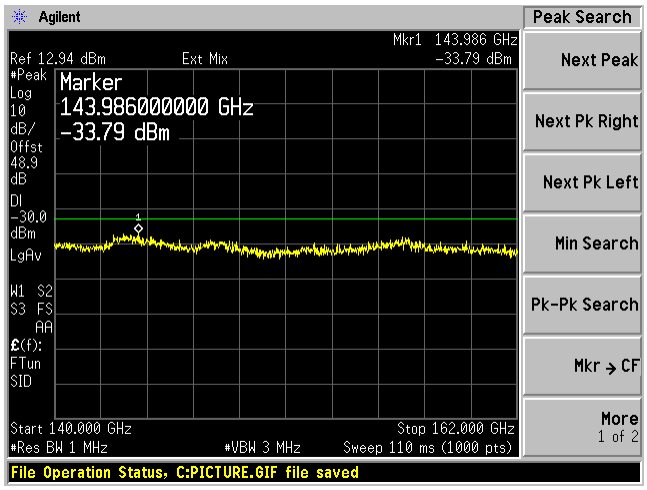
Mode 3



Mode 4

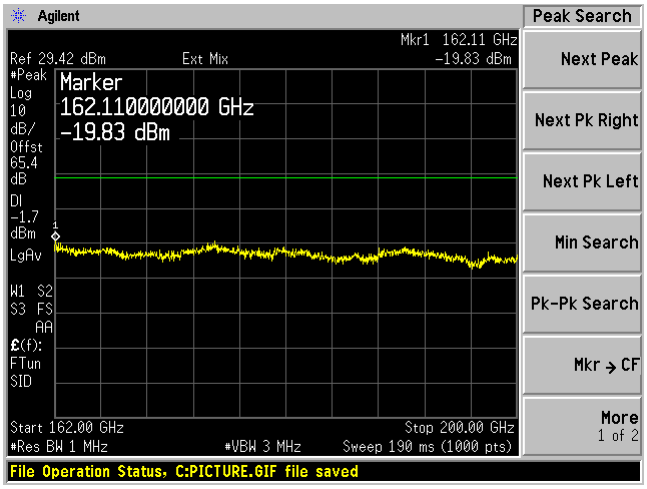


Mode 5

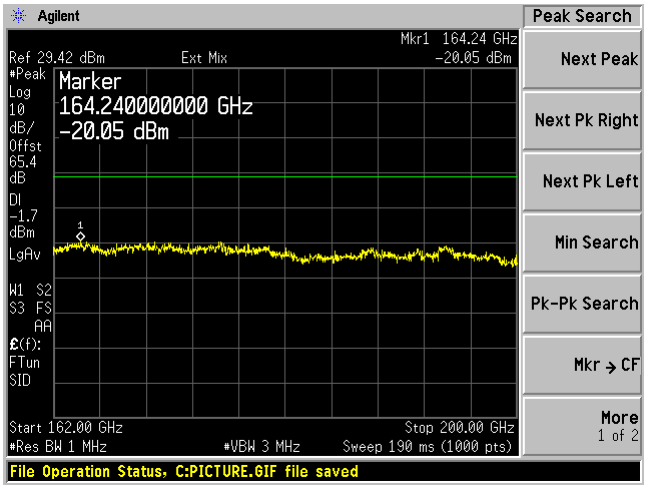


162-200 GHz, Measured at 1 meter

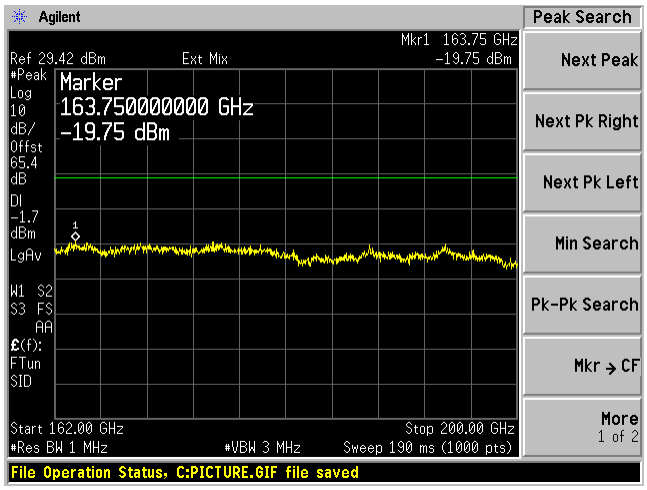
Mode 3



Mode 4

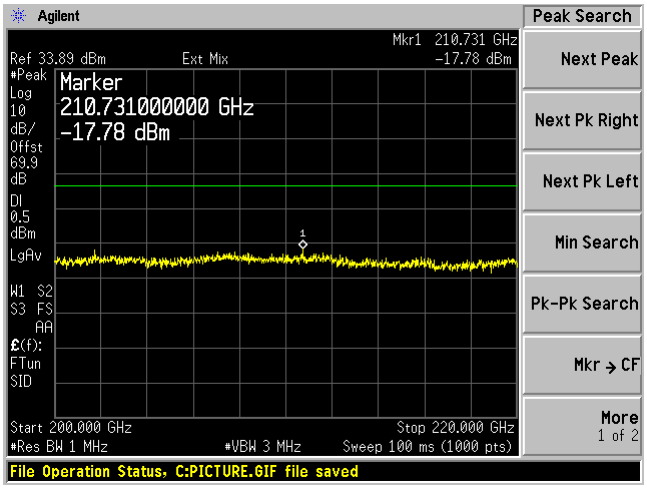


Mode 5

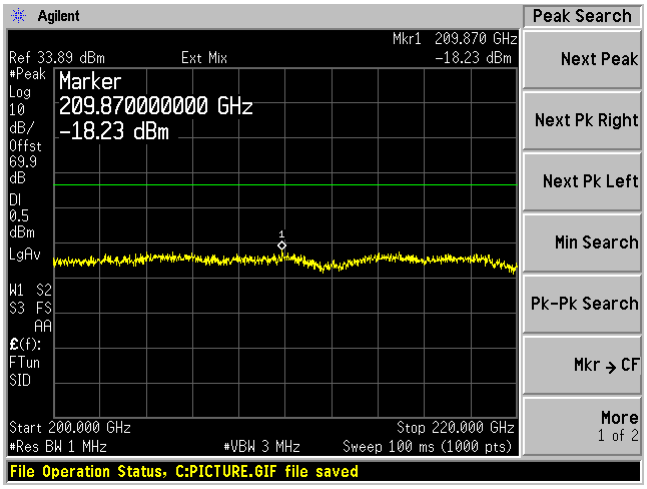


200-220 GHz, Measured at 1 meter

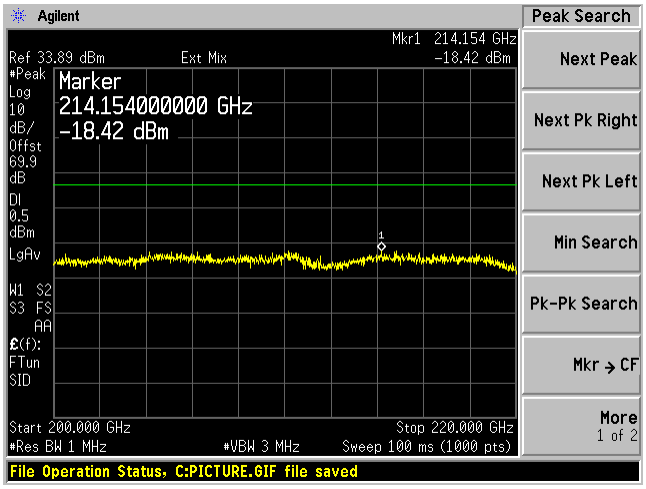
Mode 3



Mode 4

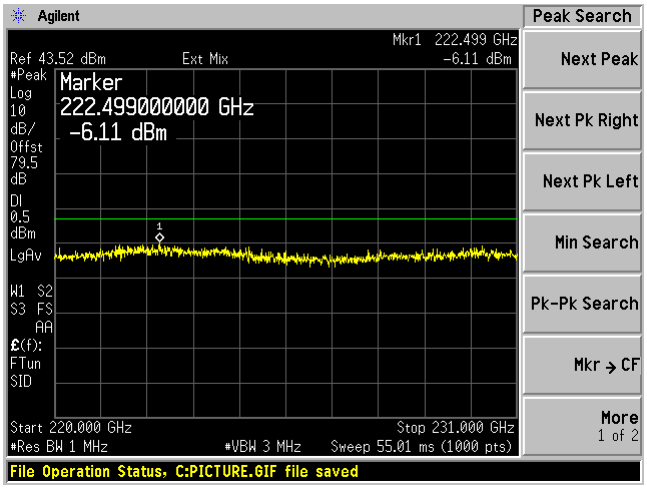


Mode 5

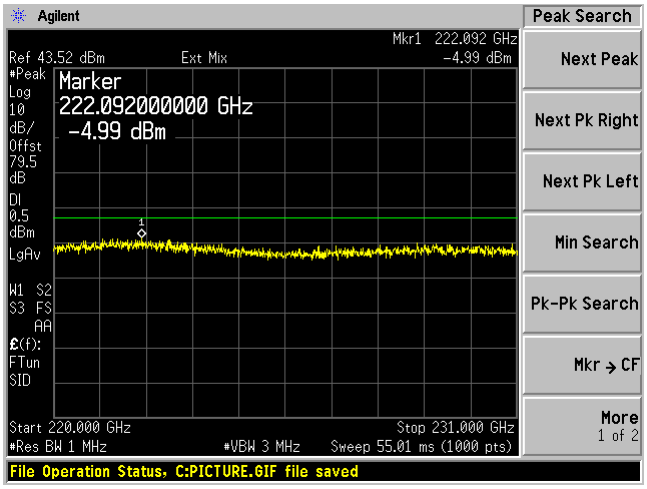


220-231 GHz, Measured at 1 meter

Mode 3



Mode 4



Mode 5