FCC Certification Test Report

Part §90F, Licensed Transmitter

for the

SRC, Inc.

R1410

FCC ID: 2APK5-R1410

WLL REPORT# 17363-01 REV 2

Prepared for:

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North Syracuse, New York 13212

Prepared By:

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Testing Certificate AT-1448

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FCC ID: 2APK5-R1410

February 25, 2022

WLL Report# 17363-01 Rev 2

Prepared by:

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Reviewed by:

Steven D. Koster
President

Abstract

This report has been prepared on behalf of SRC, Inc. to support the attached application for equipment authorizing of an intentional radiator under Part §90F of the FCC Rules. This Part §90 Test Report documents the test configuration and test results for the SRC, Inc. R1410. The information provided on this report is only applicable to device herein documented, as the EUT.

Radiated testing was performed on an Open Area Test Site (OATS) of Washington Laboratories, Ltd, 4340 Winchester Boulevard, Frederick, MD 21703. Site description and site attenuation data have been placed on file with the FCC's Sampling and Measurements Branch at the FCC laboratory in Columbia, MD. Washington Laboratories, Ltd. has been accepted by the FCC and approved by ANAB under Certificate AT-1448 as an independent FCC test laboratory.

These tests are accredited and meet the requirements of ISO/IEC 17025 as verified by the ANSI-ASQ National Accreditation Board/ANAB. Refer to certificate and scope of accreditation AT-1448.

The SRC, Inc. R1410 complies with the requirements for an intentional radiator, licensed device under FCC Part §90F.

Revision History	Description of Change	Date
Rev 0	Initial Release	February 25, 2022
Rev 1	ACB Comments Dated: 4/6/2022	April 8, 2022
Rev 2	Correction Factors Explained, per ACB.	July 5, 2022

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1 Introduction

1.1 Compliance Statement

The SRC, Inc. R1410 complies with the requirements for an intentional radiator, licensed device under FCC Part §90F.

1.2 Test Scope

Tests for radiated and conducted (at antenna terminal) emissions were performed. The measurement equipment conforms to ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation.

1.3 Contract Information

Customer:	SRC, Inc.
Purchase Order Number:	156245
Quotation Number:	72958

1.4 Test and Support Personnel

Washington Laboratories, LTD	Ryan Mascaro
Customer Representative	TJ Vitale

1.5 Test Dates

The R1410 was tested during the following dates: 11/9/2021 to 11/12/2021.

1.6 EUT Digital Emissions

Please know that the digital portion of the EUT is authorized under the SDoC procedure.

The applicant shall maintain the declaration of conformity as provided in Test Report # 17364-01.

The Class A SDoC was competed on 11/15/2021.

2 Equipment Under Test

2.1 EUT Identification & Description

Table 1: Device Summary

Manufacturer:	SRC, Inc.
EUT Name/Model:	R1410
FCC ID:	2APK5-R1410
FCC Rule Parts:	§90
TX Frequency Range:	9.3 GHz – 9.8 GHz (X-band)
Number of RF Channels:	5
Maximum Output Power:	54.0 dBm (251.5 W)
Modulation:	Pulsed-FM
20dB Occupied Bandwidth:	4.96 MHz *(rounded to 5.0 MHz)*
FCC Emission Designator:	5M00Q3N
Keying:	Automatic
Type of Information:	Radiolocation
Power Output Level:	Variable
Antenna Connector:	Waveguide
Antenna Type:	SRC, Inc.; Model: GS1003 (Panel Array) 30 dBi of Gain
Interface Cables:	Ethernet Cable
Maximum Data Rate:	N/A
Worst Case Spurious Emission:	78.2 dBuV/m at 3m
Power Source & Voltage:	120 VAC, 60 Hz (as tested)
Software/Firmware:	SW 1.9.0 with no special tune-up

The SRC, Inc. R1410 is a radar system designed to detect, track, and provide actionable information on targets on land, in the air, and on water. The primary missions are:

1) Commercial UAS Detect and Avoid (DAA)
2) UAS Surveillance
3) Bird Detection at Airports and Windfarms
4) Border surveillance
5) Harbor security
6) Fixed site security

2.2 Testing Algorithm

The R1410 was configured on each test site that produced the worst-case emissions, while facing the testing receive antennas. During each test, the transmitter was controlled by the applicant, via a LAN based interface which allowed for the tuning of each in-band frequencies. The transmitter was set to output the Pulsed-FM signal in a continuous mode, only halting upon user command. The duty cycle and transmitter timing, as outlined in Section 4.7 of this report, are representative of the EUT's use-case timing. All of the transmitter emissions provided throughout this report, are the worst-case emission levels.

2.3 Test Location

All measurements herein were performed at Washington Laboratories, Ltd. test center in Frederick, MD. Site description and site attenuation data have been placed on file with the FCC's Sampling and Measurements Branch at the FCC laboratory in Columbia, MD. The ISED Canada OATS number is 3035A-1 for Washington Laboratories, Ltd.

Washington Laboratories, Ltd. has been accepted by the FCC and approved by ANAB under Testing Certificate AT-1448 as an independent FCC test laboratory.

2.4 Test Configuration

The R1410 system was controlled with a laptop computer connected through the LAN port. The external power supply is considered to be part of the EUT configuration. As such, it was placed on the test site, in proximity to the radiating portion of the EUT. The primary input supply voltage comes from 120VAC, delivered through the final EUT interface, antenna controller, and to the RF package. For all measurements of radiated emissions, the height of the EUT transmitter (antenna) was set to a height of 1.5m. This height was fixed based on the manufacturer's outdoor mounting system.

Table 2: System Configuration List

Name / Description	Model Number	Part Number	Serial Number	Rev. #
Array Panel/RT Unit	GS1007	GS1007-14-01	020	0
Positioner/Pan	GS1009	GS1009-02	105	5
External Power Supply	GS1016	GS1016-WHTGV	002	9

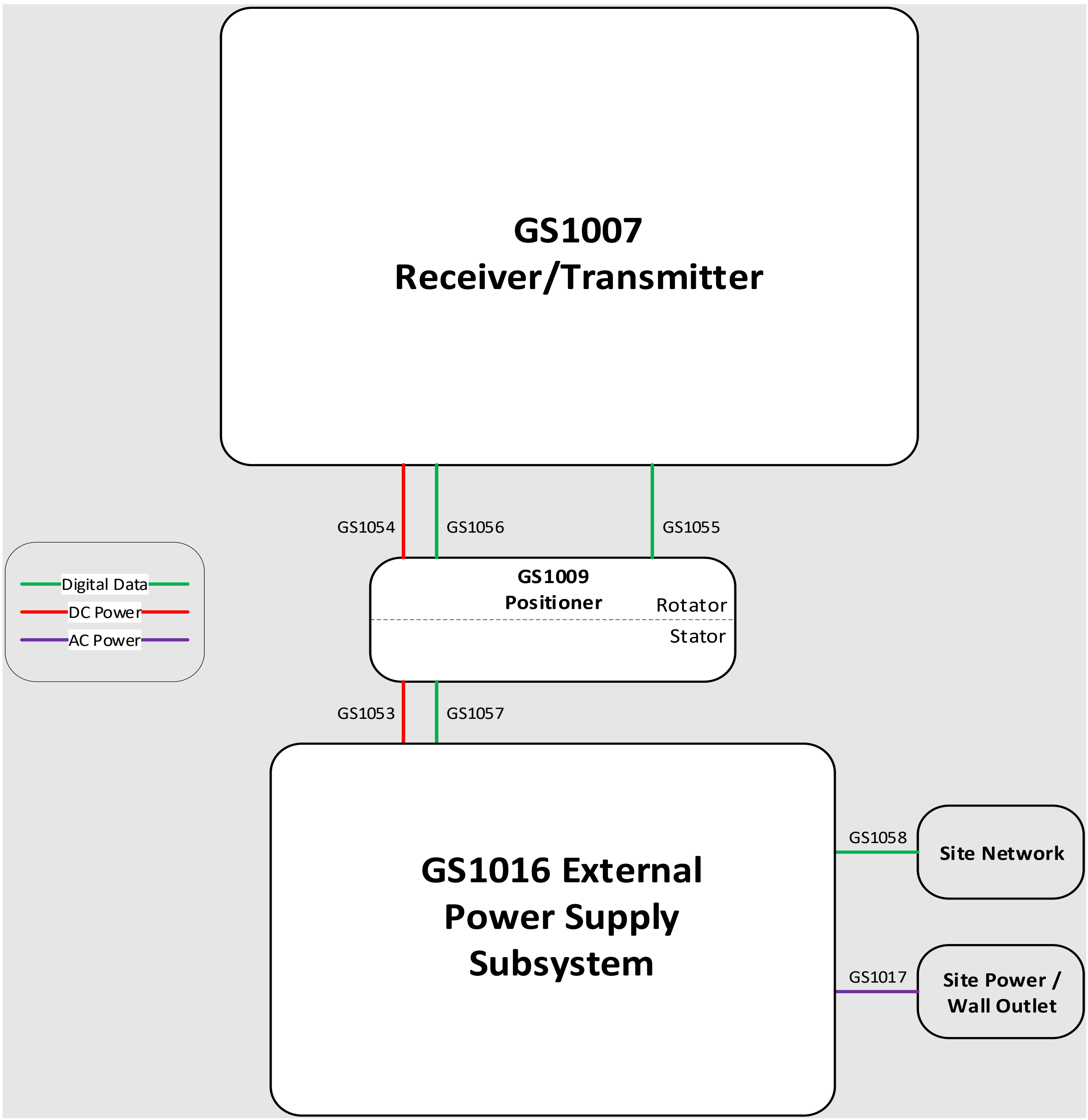
Table 3: Support Equipment

Name / Description	Manufacturer	Model	Calibration Data
Laptop	N/A	N/A	N/A
Ethernet Cable	N/A	N/A	N/A

Table 4: Cable Configuration

Ref. ID	Port Name on EUT	Cable Description	Qty.	Length (m)	Shielded	Termination Port ID
1	GS1007-J1	GS1054	1	0.56	Y	GS1009-J35
2	GS1007-J2	GS1055	1	0.56	Y	GS1009-J34
3	GS1007-J3	GS1056	1	0.56	Y	GS1009-J33
4	GS1009-J31	GS1053	1	3	Y	GS1016-J3
5	GS1009-J32	GS1057	1	9.1	Y	GS1016-J4
6	GS1016-J2	GS1058	1	15.2	Y	User
7	GS1016-J1	GS1017	1	9.1	Y	User

Figure 1: EUT Test Configuration (Diagram)



2.5 Measurements

2.5.1 References

ANSI C63.2 (Jan-2016) Specifications for Electromagnetic Noise and Field Strength Instrumentation

ANSI C63.4 (Jan 2014) American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz

ANSI C63.26 (Dec 2015) American National Standard for Compliance Testing of Transmitters Used in Licensed Radio Services

2.6 Measurement Uncertainty

All results reported herein relate only to the equipment tested. The basis for uncertainty calculation uses ANSI/NCSL Z540-2-1997 (R2002) with a type B evaluation of the standard uncertainty. Elements contributing to the standard uncertainty are combined using the method described in Equation 1 to arrive at the total standard uncertainty. The standard uncertainty is multiplied by the coverage factor to determine the expanded uncertainty which is generally accepted for use in commercial, industrial, and regulatory applications and when health and safety are concerned (see Equation 2). A coverage factor was selected to yield a 95% confidence in the uncertainty estimation.

Equation 1: Standard Uncertainty

$$u_c = \pm\sqrt{\frac{a^2}{{div_a}^2} + \frac{b^2}{{div_b}^2} + \frac{c^2}{{div_c}^2} + \ldots\ldots}$$

Where uc = standard uncertainty
a, b, c,.. = individual uncertainty elements
Diva, b, c = the individual uncertainty element divisor based on the probability distribution
Divisor = 1.732 for rectangular distribution
Divisor = 2 for normal distribution
Divisor = 1.414 for trapezoid distribution

Equation 2: Expanded Uncertainty

$$U = ku_c$$

Where:
U = expanded uncertainty
k = coverage factor
k ≤ 2 for 95% coverage (ANSI/NCSL Z540-2 Annex G)
uc = standard uncertainty

The measurement uncertainty complies with the maximum allowed uncertainty from CISPR 16-4-2. Measurement uncertainty is not used to adjust the measurements to determine compliance. The expanded uncertainty values for the various scopes in the WLL accreditation are provided in Table 5 below.

Table 5: Expanded Uncertainty List

Scope	Standard(s)	Expanded Uncertainty
Conducted Emissions	CISPR11, CISPR22, CISPR32, CISPR14, FCC Part 15	± 2.63 dB
Radiated Emissions	CISPR11, CISPR22, CISPR32, CISPR14, FCC Part 15	± 4.55 dB

3 Test Equipment

Table 6 shows a list of the test equipment used for measurements along with the calibration information.

Table 6: Test Equipment List

Test Name:	**Conducted Emissions Voltage**	Test Date:	**11/10/2021**
Asset #	**Model/Manufacturer**	**Description**	**Cal. Due Date**
00528	AGILENT E4446A	SPECTRUM ANALYZER	3/18/2022
00125	SOLAR 8028-50-TS-24-BNC	LISN	9/14/2022
00126	SOLAR 8028-50-TS-24-BNC	LISN	9/14/2022
00330	WLL CE CABLE	BNC-BNC RF COAXIAL CABLE	5/12/2022
00895	HP 11947A	TRANSIENT LIMITER	2/18/2022

Test Name:	**Radiated Emissions**	Test Date:	**11/11/2021**
Asset #	**Model/Manufacturer**	**Description**	**Cal. Due Date**
00528	AGILENT E4446A	SPECTRUM ANALYZER	3/18/2022
00644	SUNOL SCIENCES CORP.	BICONALOG ANTENNA	11/9/2022
00425	ARA DRG-118/A	ANTENNA DRG 1-18GHZ	8/18/2022
00955	JUNKOSHA USA MWX322	18M HF COAXIAL CABLE	5/10/2022
00865	STORM 874-0101-036	HIGH FREQUENCY CABLE	6/17/2022
00885	UTIFLEX MICRO COAX	SMA RF COAXIAL CABLE	5/10/2022
00522	HP 8449B	PRE-AMPLIFIER 1-26.5GHZ	6/4/2022
00559	HP 8447D	AMPLIFIER	6/3/2022
00284	ITC, 22K-3A1	WAVEGUIDE BANDPASS	1/19/2022
00742	PENN ENG., WR284	BANDPASS FILTER	1/19/2022

4 Test Results

4.1 Transmitter Power, §90.205(r)

For a licensed device that operates in a frequency band outside of < 25 MHz – 5925 MHz, the requested transmitter power will be considered and authorized on a case-by-case basis. Applicants for licenses must request, and use, no more power than the actual power necessary for satisfactory operation. Although there is no power limit defined under FCC Part §90F, the measurement method outlined in ANSI C63.26, Section 5.2.3.3 has been employed.

The maximum transmitter radiated power was measured at a distance of 30m. The EUT was set to transmit at its maximum power, and the emissions from the device were recorded. The transmit signal was enabled in a Pulsed-FM (modulated) mode.

The power was tested at 30m because the transmitter beam does not form until 96-feet (29.2m).
This beam forming distance was declared by the applicant.

The plots provided below, are the uncorrected Field Strength levels. These levels only include the 45 dB offset, which accounts for the cable loss and attenuators used in the measurement path. The pre-amplifier gain and the antenna factor value(s) are mathematically accounted for in Table 7.
(e.g., 38.8($AF_{dBuV/m}$) – 30.4(G_{dB}) = 8.4(Corr. $Factors_{dB}$)).

The Field Strength to EIRP Conversion is: Power = dBuV/m + 20LOG(D_m) – 104.8 *(where D_m = 30m)*

The DCCF of 20 dB is explained in Section 4.8 of this report.

The final (corrected) power levels are provided in Table 7.

Table 7: RF Power Output Test Data – 30m Radiated Testing

Channel	Frequency (MHz)	SA Level (dBuV)	Corr Factors (dB)	DCCF (dB)	Corr. Level (dBuV/m)	EIRP (dBm)	Detector
Low	9300.0	139.65	8.4	20.0	127.75	52.8	Peak
Center	9550.0	140.83	8.4	20.0	129.03	54.0	Peak
High	9800.0	139.62	8.4	20.0	127.82	52.8	Peak

Figure 2: RF Peak Power – Low Channel (Uncorrected)

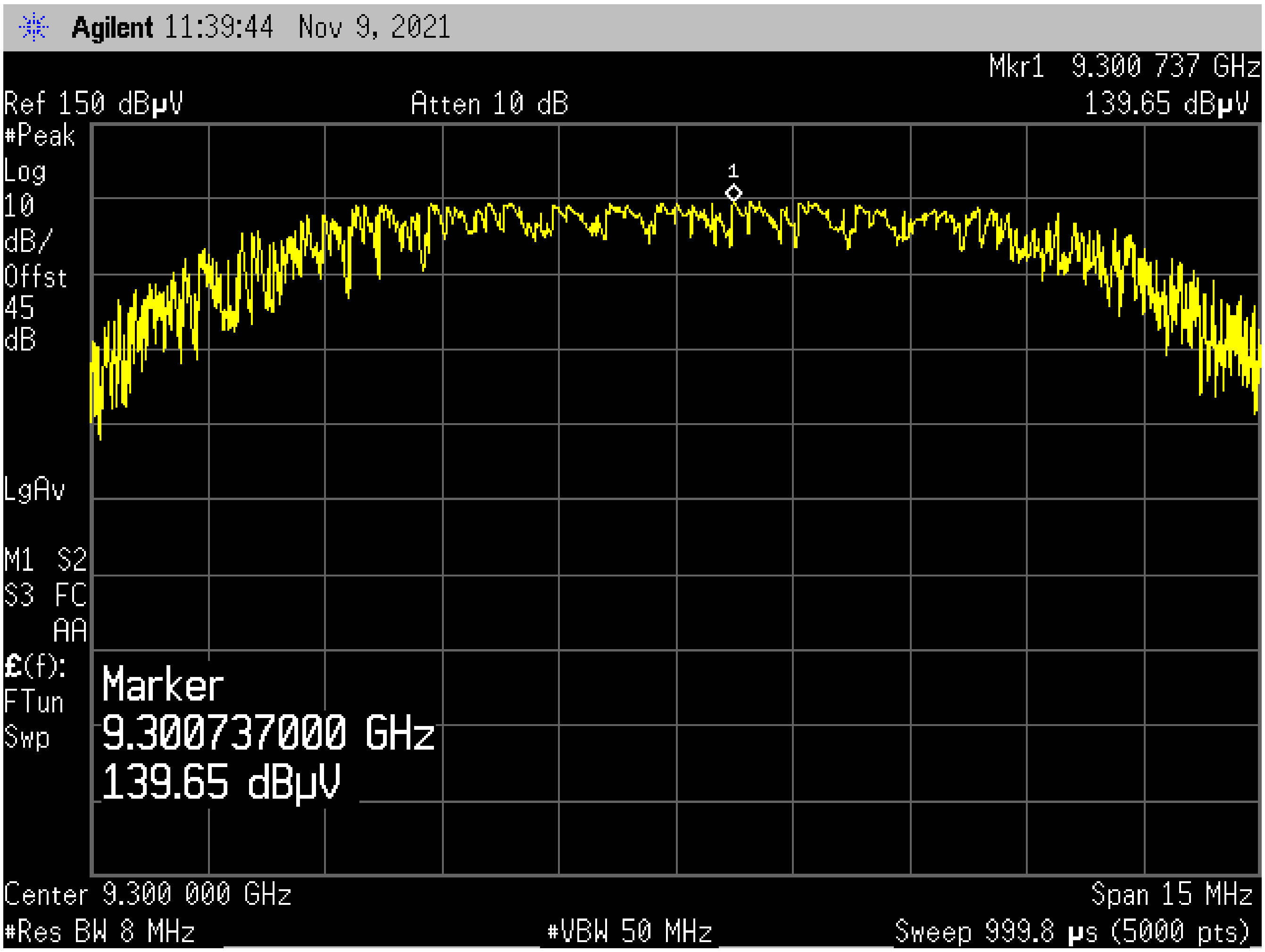


Figure 3: RF Peak Power – Center Channel (Uncorrected)

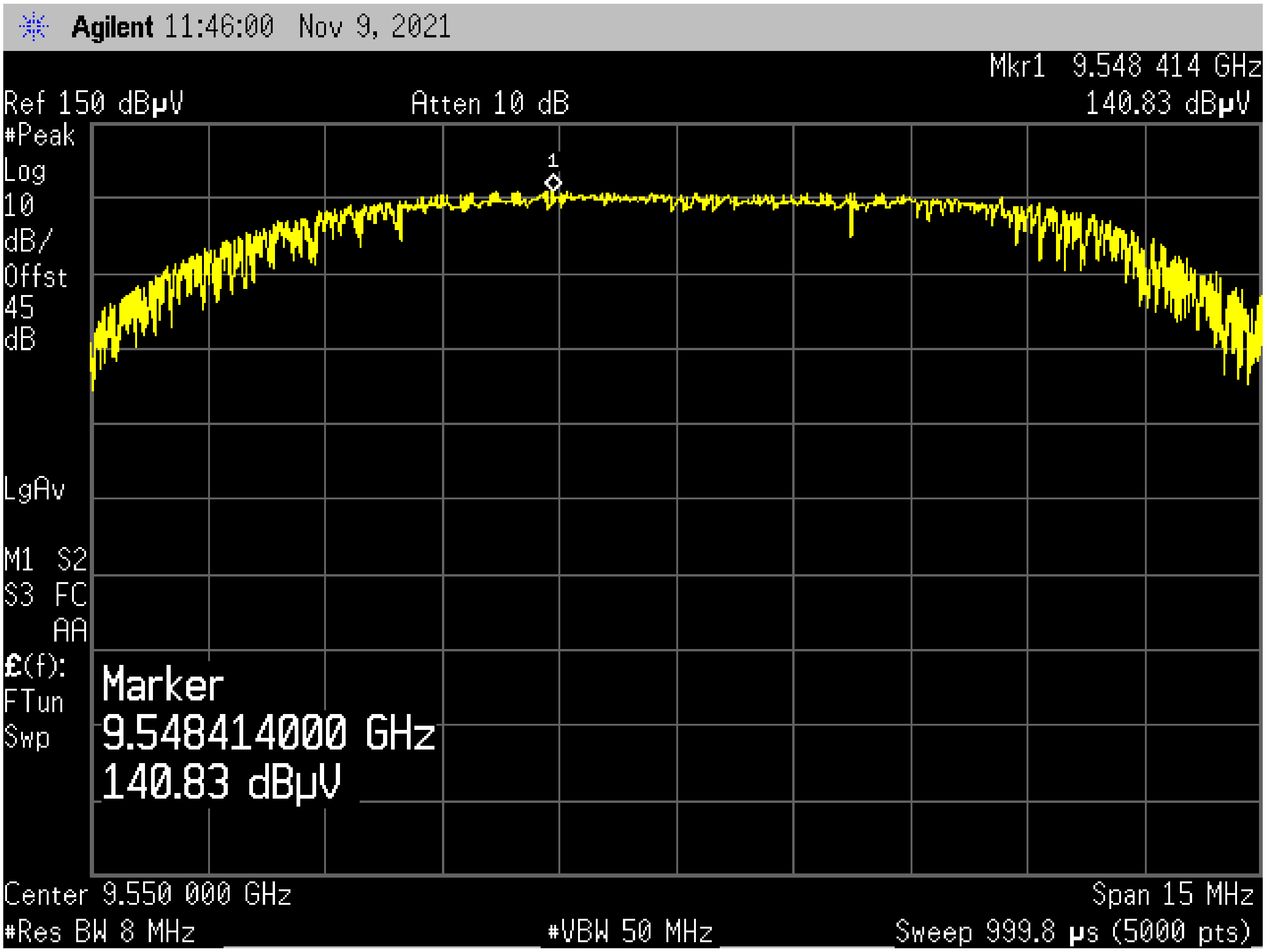
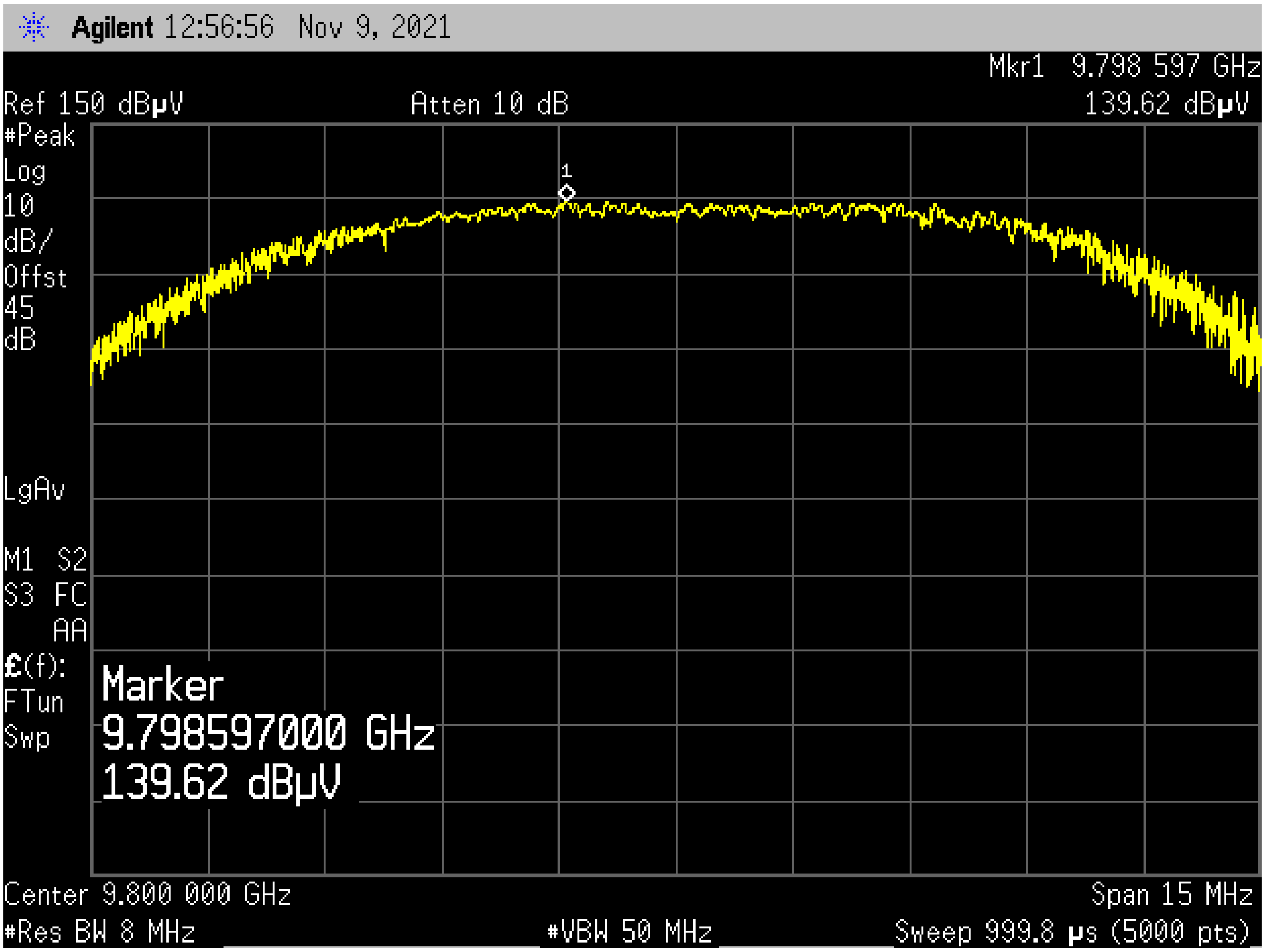


Figure 4: RF Peak Power – High Channel (Uncorrected)



4.2 Types of Emissions, §90.207(k)

Radiolocation operations may be authorized in accordance with subpart F, of Part §90.

In accordance with FCC Rule Part §2.201(a) *Emission, modulation, and transmission characteristics*, the EUT shall be classified as: “Q3N”

Q = where the carrier is angle-modulated during the period of the pulse

3 = a single RF carrier channel, containing analog signals

N = no data/information is transmitted on the carrier

4.3 Bandwidth Limitations, §90.209(b)(5)

The transmitter occupied channel bandwidth was measured at a distance of 30m. The EUT was set to transmit at its maximum power, and the emissions from the device were recorded.

The transmit signal was enabled in a Pulsed-FM (modulated) mode.

In accordance with FCC Table of §90.209(b)(5), there are no bandwidth requirements for radiolocation stations that transmit above 2500 MHz

Although there is no limit defined for this §90F device, the measurement method outlined in ANSI C63.26, Section 5.4.3 has been employed.

Table 8: Occupied Bandwidth Test Data

Channel	Frequency (MHz)	20dB OBW
Low	9300.0	4.96 MHz
Center	9550.0	4.68 MHz
High	9800.0	4.82 MHz

Figure 5: 20dB Occupied Bandwidth – Low Channel

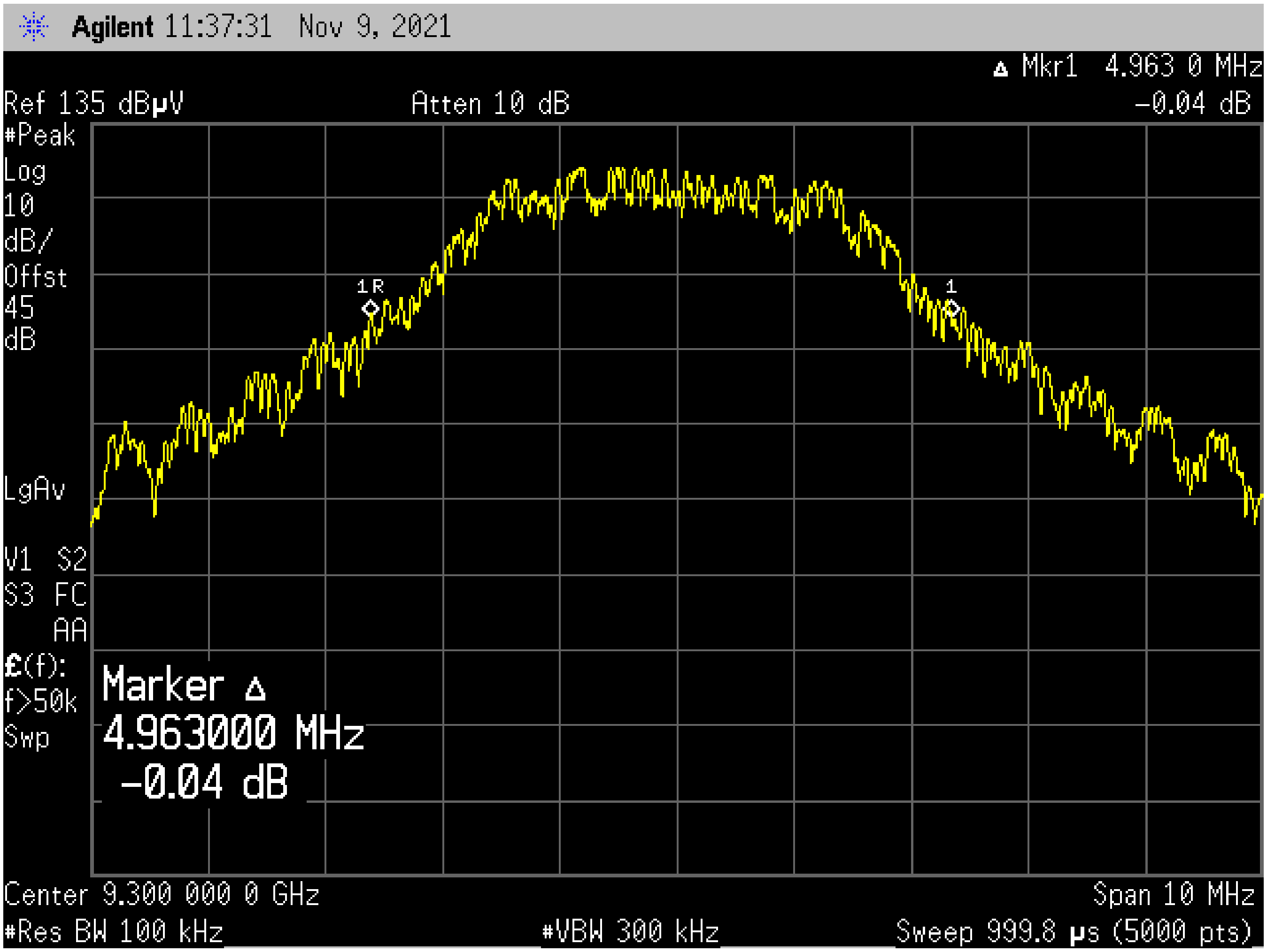


Figure 6: 20dB Occupied Bandwidth – Center Channel

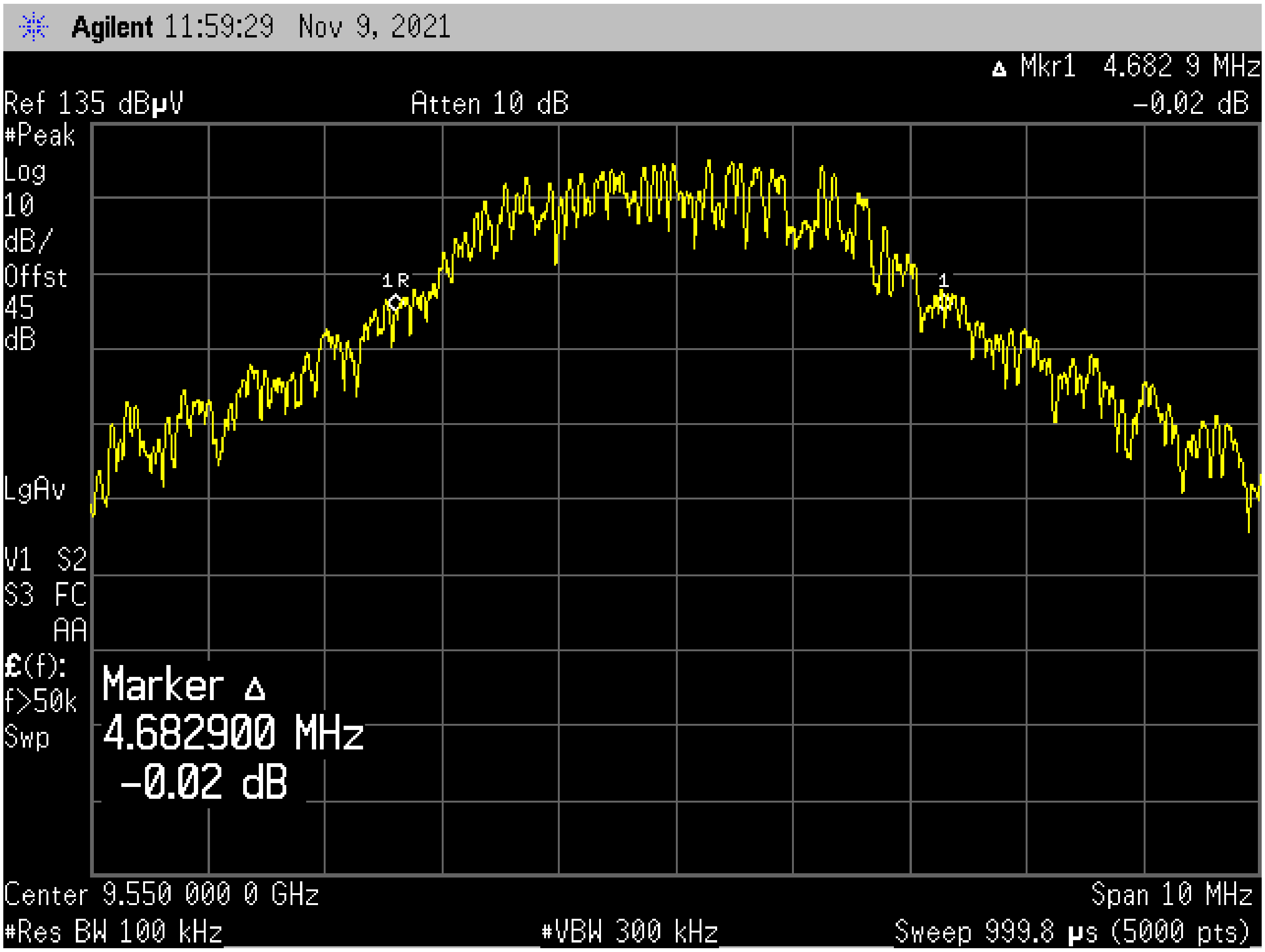
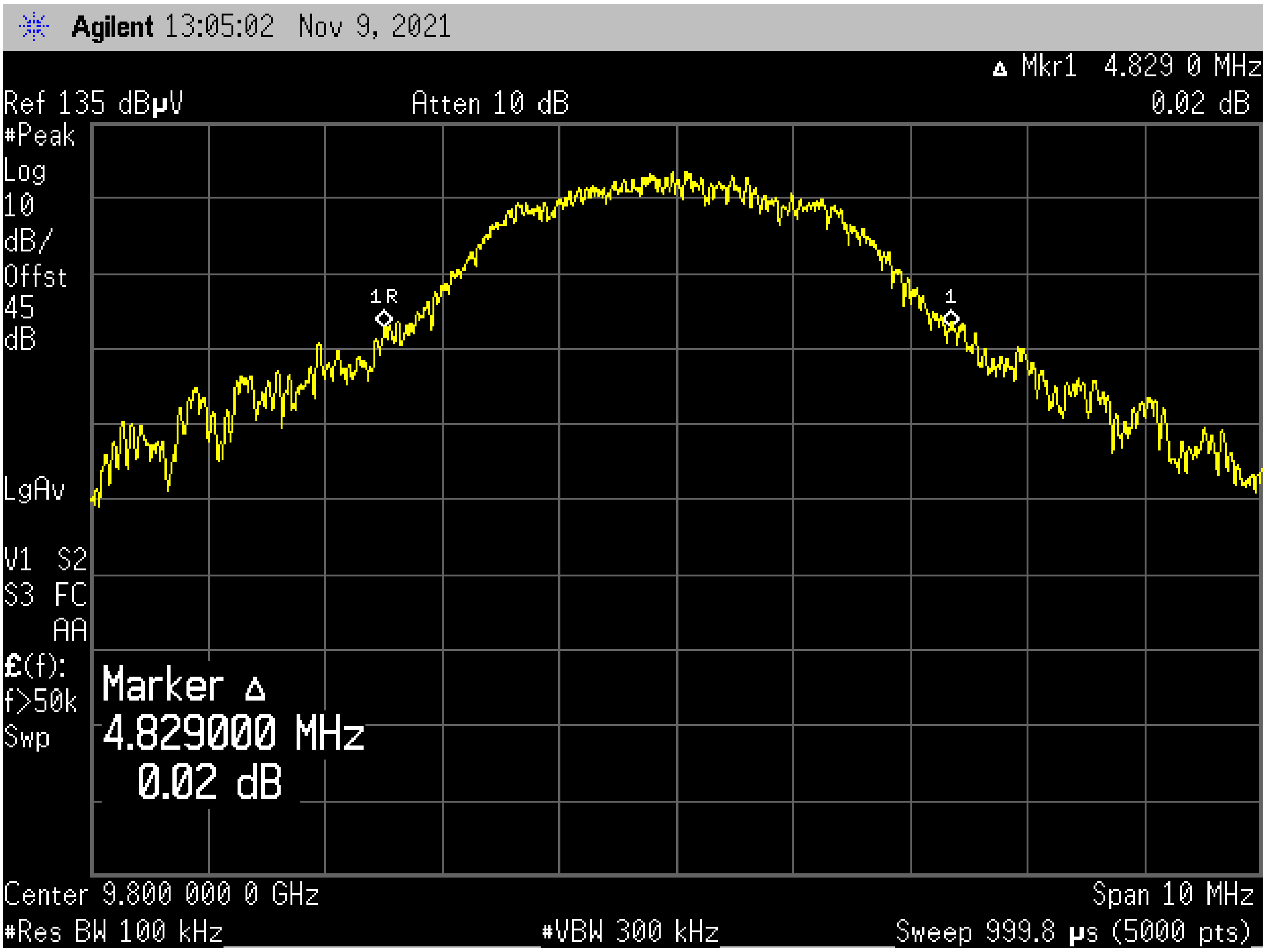


Figure 7: 20dB Occupied Bandwidth – High Channel



4.4 Transmitter Emissions Masks, §90.210(b)

Transmitter in-band spectral components and all spurious emissions must comply with the requirements of FCC Part §90.210(b). Measurements of emission power can be expressed in either peak or average values, provided that emission powers are expressed with the same parameters used to specify the unmodulated transmitter carrier power. For transmitters that do not produce a full power unmodulated carrier, reference to the unmodulated transmitter carrier power refers to the total power contained in the channel bandwidth.

In this case, the maximum reported transmitter power (53.3 dBm) is a corrected average level, due to the nature of the transmitter pulse-timing. Because the modulated carrier power was mathematically averaged using a DCCF, the same principles shall apply to the emission mask of this section, and for the case-radiated spurious emissions testing of Section 4.5 of this report.

For this section, the power envelope within the emissions mask of §90.210(b) shall be demonstrated as an average value, through the use of an Average detector function setting withing the spectrum analyzer.

4.4.1 Requirements

The limits for emissions, under this rule part, are as follows –

The average power of emissions shall be attenuated below the mean output power of the transmitter in accordance with the following schedule:

(1) On any frequency removed from the assigned frequency by more than 50 percent, but not more than 100 percent of the authorized bandwidth: At least 25 dB.

(2) On any frequency removed from the assigned frequency by more than 100 percent, but not more than 250 percent of the authorized bandwidth: At least 35 dB.

(3) On any frequency removed from the assigned frequency by more than 250 percent of the authorized bandwidth: At least 43 + 10LOG(P) dB.

where authorized bandwidth is a declared frequency band, specified in kilohertz and centered on the carrier frequency containing those frequencies upon which a total of 99% of the radiated power appears, extended to include any discrete frequency upon which the power is at least 0.25% of the total radiated power. (ANSI 63.26).

The authorized bandwidth, as defined above, shall be derived from a measurement that encapsulates the transmitter bandwidth, and the power spectral components of the signal, calculated from the following formula:

10LOG(.0025) = –26.02

This power (0.25% of the total power) represents the 26dB bandwidth.

As such, the 26dB bandwidth shall be equal to the authorized bandwidth that is utilized for this section.

The authorized bandwidth for this test is: 9.15 MHz *(rounded to 9.20 MHz)*

4.4.2 Test Procedure

This test was performed via a radiated method, at a measurement distance of 10m. The EUT was set to transmit at its maximum power, and the emissions from the device were recorded. The transmit signal was enabled in a Pulsed-FM (modulated) mode. The plots provided below, are not a corrected representation of field strength levels. The data presented in this section is a relative representation of power and emission performance. The conformity of the transmit signals within the mask, are based on the amplitude of the modulated fundamental carrier, as measured on the 10m test site.

As a worst-case measurement, the RBW was set to 1 MHz, and the VBW was set to 3 MHz. The spectrum analyzer detector function was set to Average mode.

The Y-axis of the spectrum analyzer was set to units of dBuV, as this was a radiated test. Please know that 94 dBuV is equal to –13 dBm. The plots that depict the spurious domain data, have a marker placed at, or near, 94 dBuV to indicate that the level of the emissions mask is built to –13 dBm in the frequency range removed from the assigned frequency by more than 250 percent of the authorized bandwidth.

There are two ways to confirm that 94 dBuV is equal to –13 dBm. The formulas are as follows:

Formula 1	Formula 2
dBuV – 10LOG(*Z*) – 90 = dBm	dBuV – 107dB = dBm
94 – 10LOG(50) – 90 = –13	94 – 107 = –13

The center channel has the highest recorded power, from Section 4.1 of this report, measuring 213.8W; as such, this channel was used to establish the in-band authorized bandwidth, as denoted in Figure 8.

The EUT was tested at the low, center, and high channels, from 9 GHz to 10 GHz. This frequency range covers the in-band, out-of-band, and spurious domains, as the test range is removed from the assigned carrier frequency in accordance with Section 4.4.1 of this report.

4.4.3 Test Results

The EUT complies with the emission requirements of this section.

Figure 8 provides the authorized bandwidth plot.

Figure 9 through 17 provide the final test data for all three channels.

Figure 8: Authorized Bandwidth (All Channels)

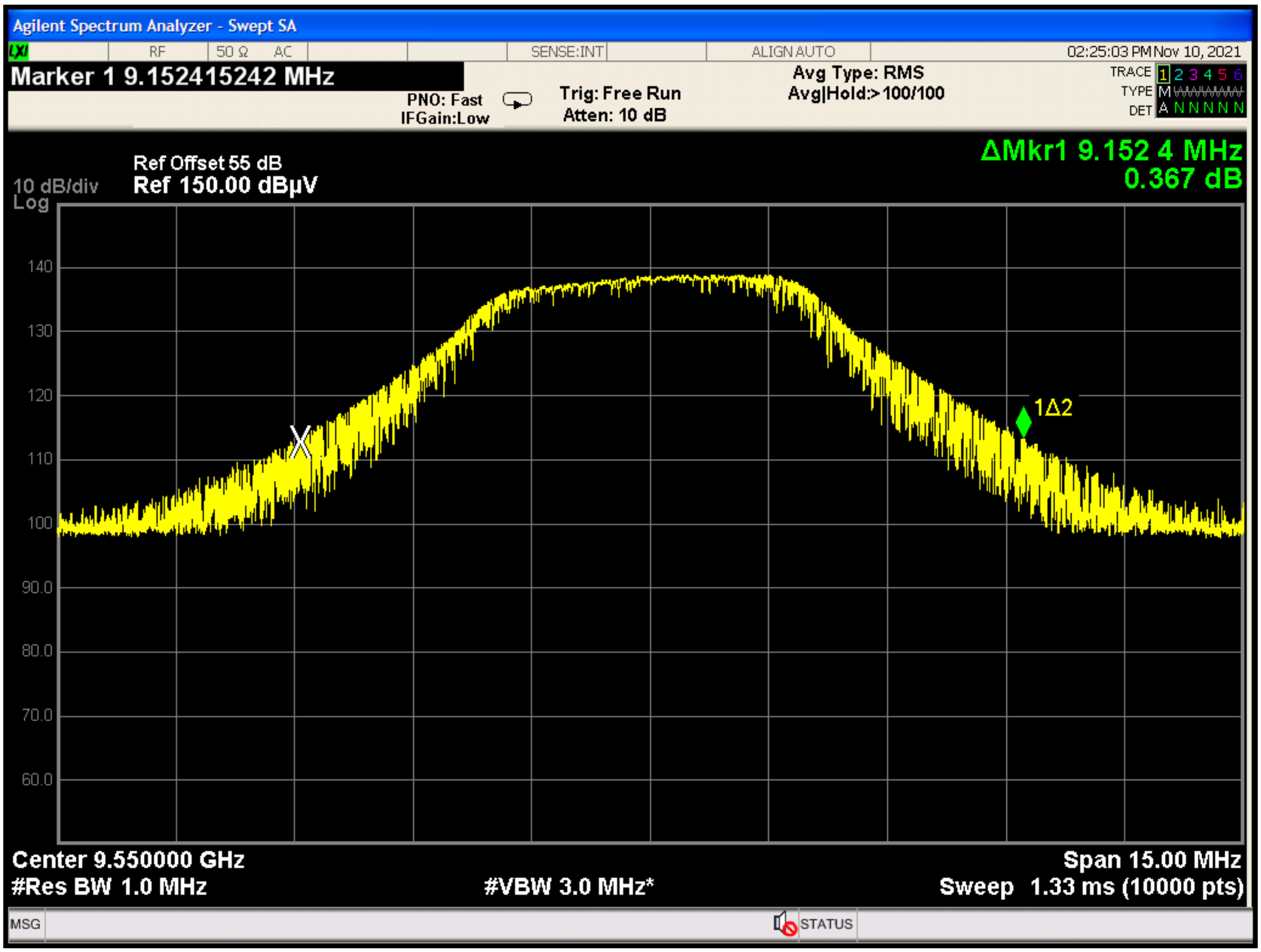


Figure 9: Emissions Mask, Low Channel – Plot 1

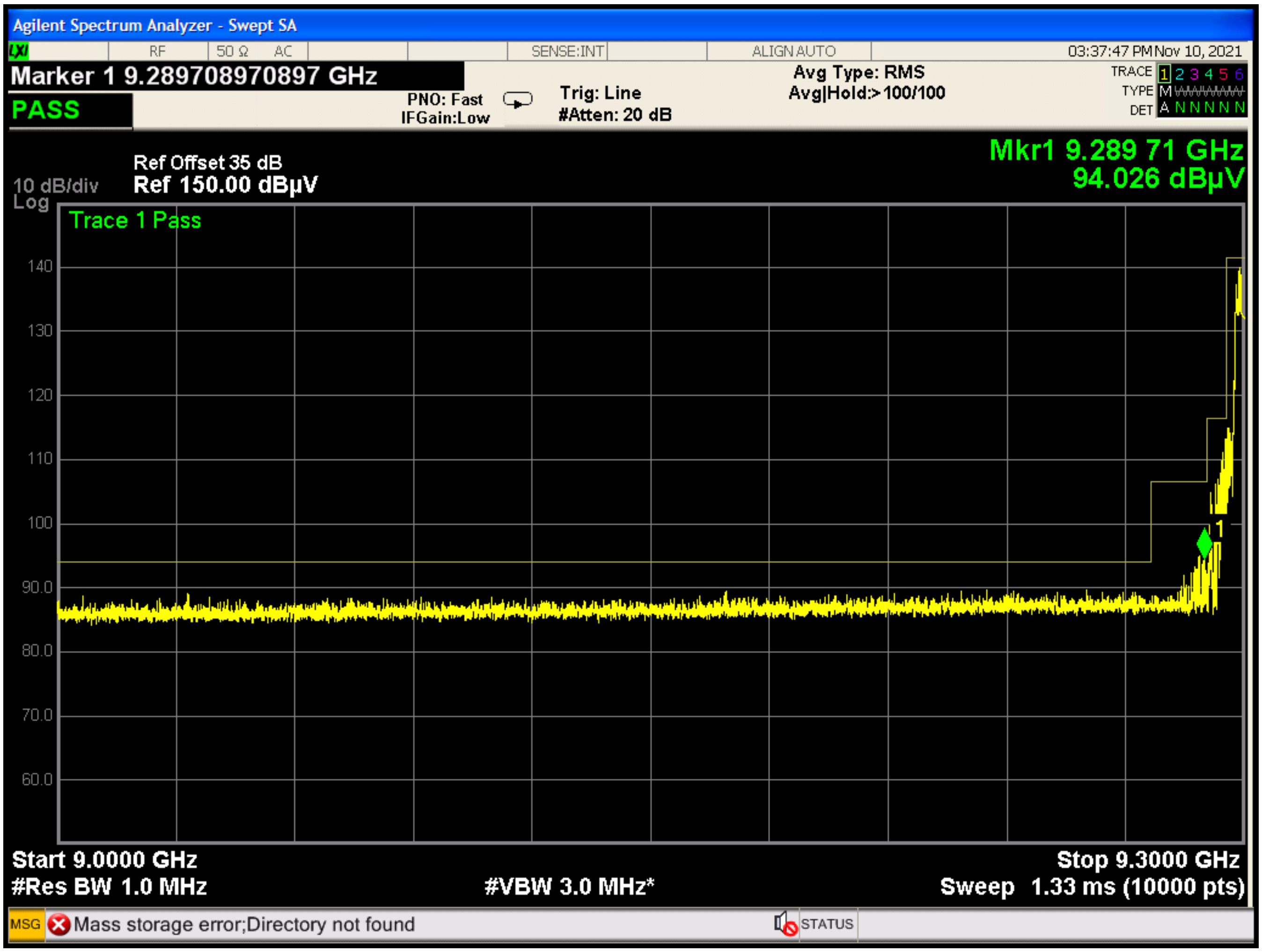


Figure 10: Emissions Mask, Low Channel – Plot 2

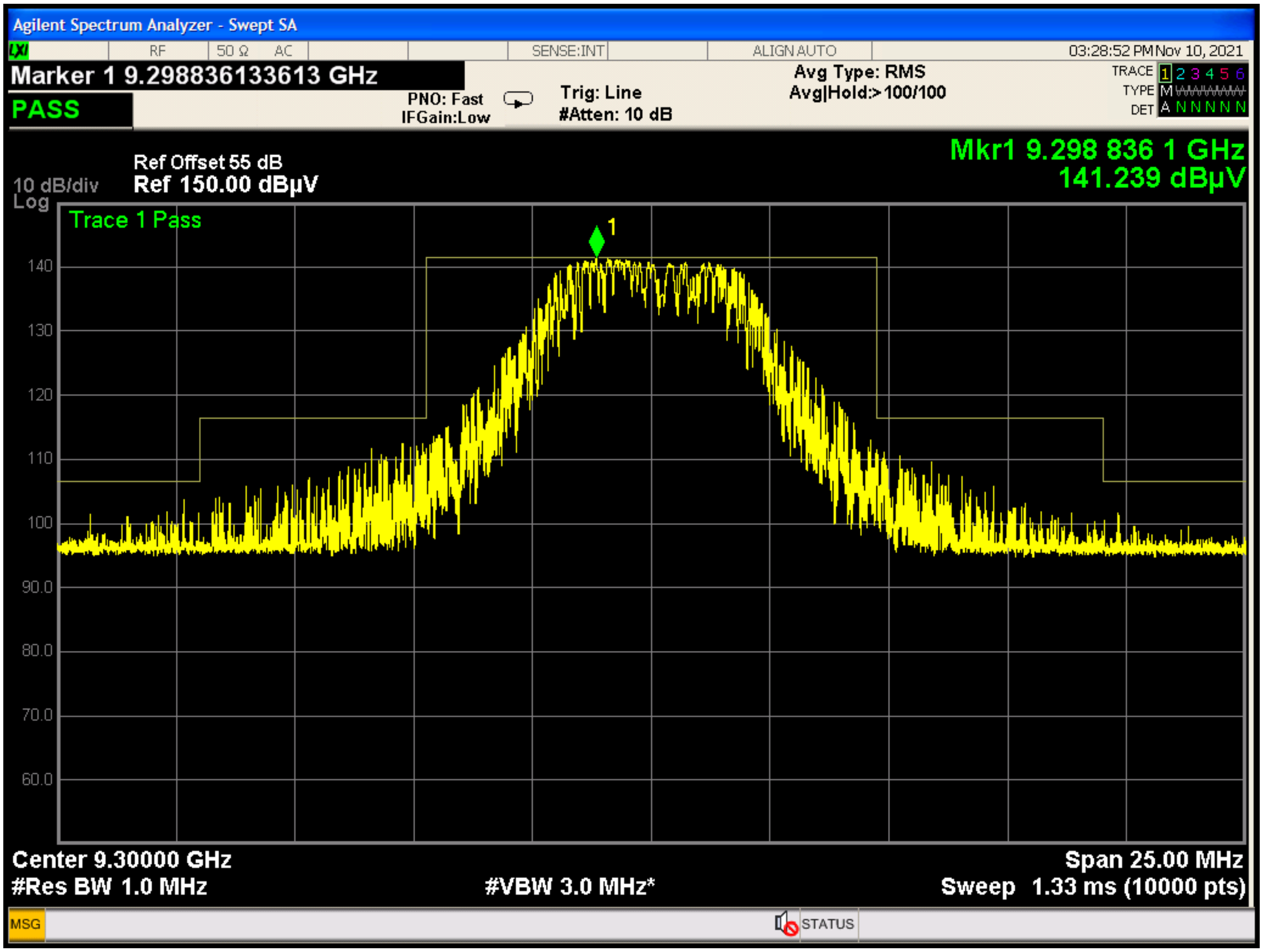


Figure 11: Emissions Mask, Low Channel – Plot 3

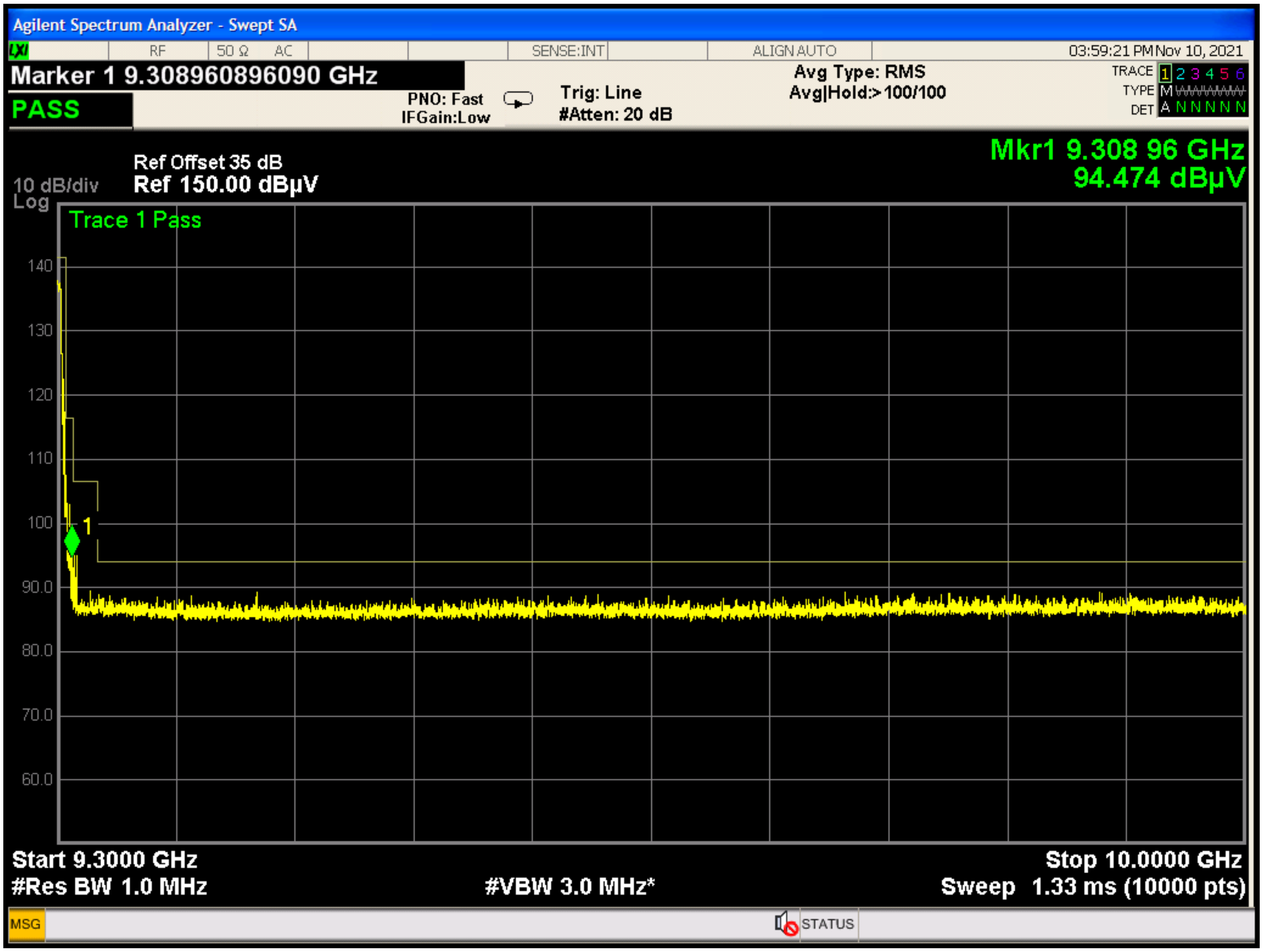


Figure 12: Emissions Mask, Center Channel – Plot 1

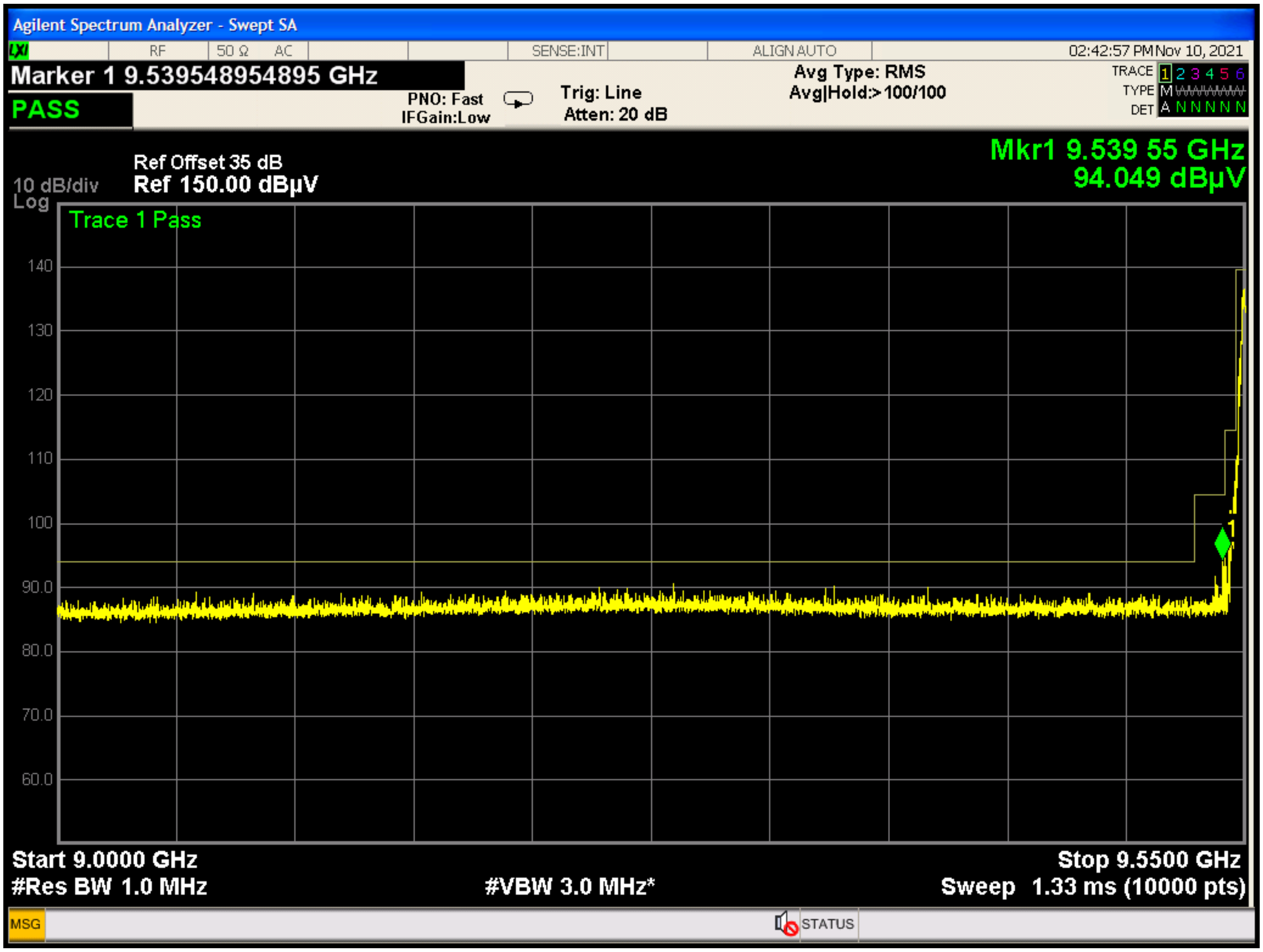


Figure 13: Emissions Mask, Center Channel – Plot 2

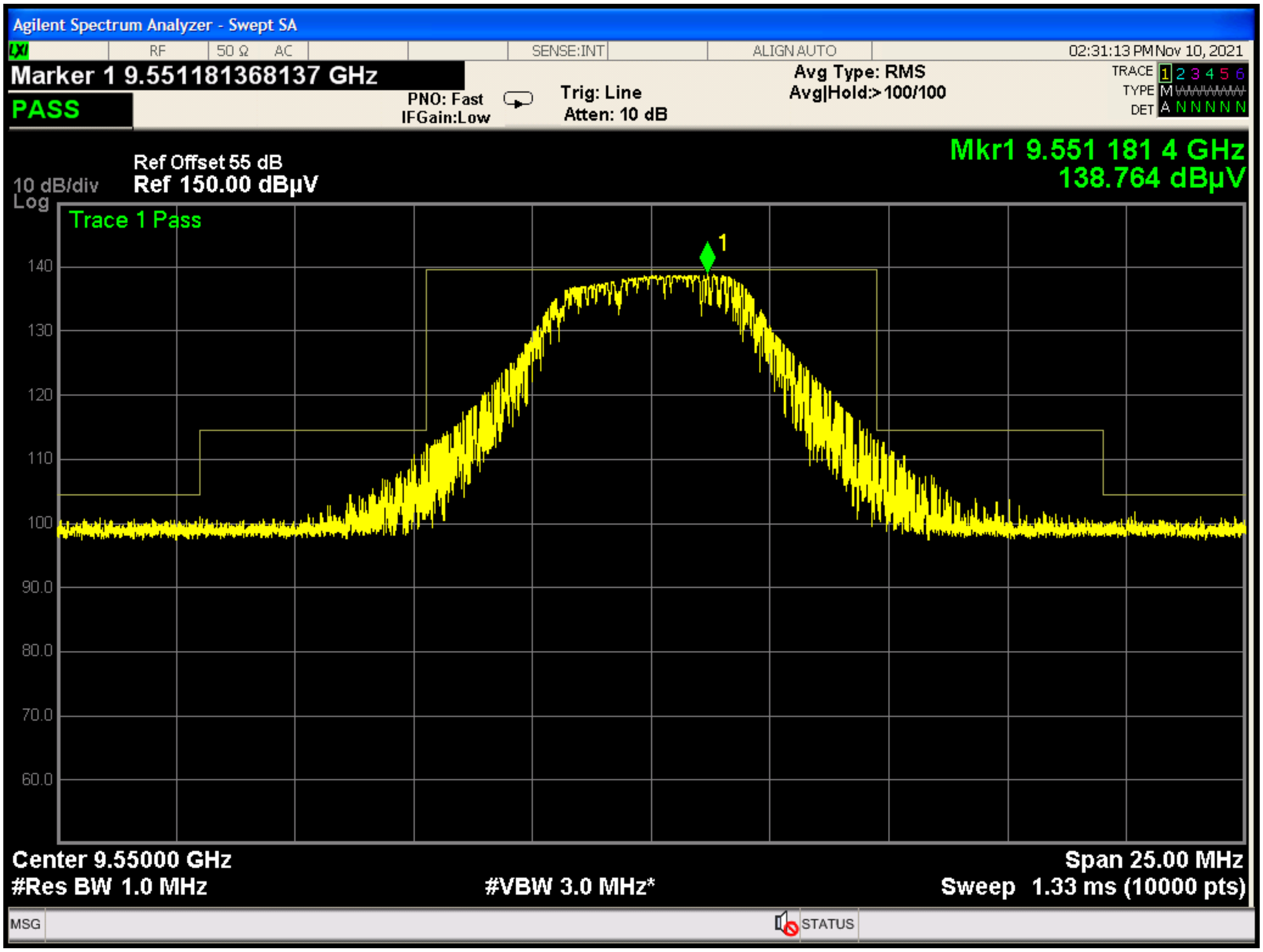


Figure 14: Emissions Mask, Center Channel – Plot 3

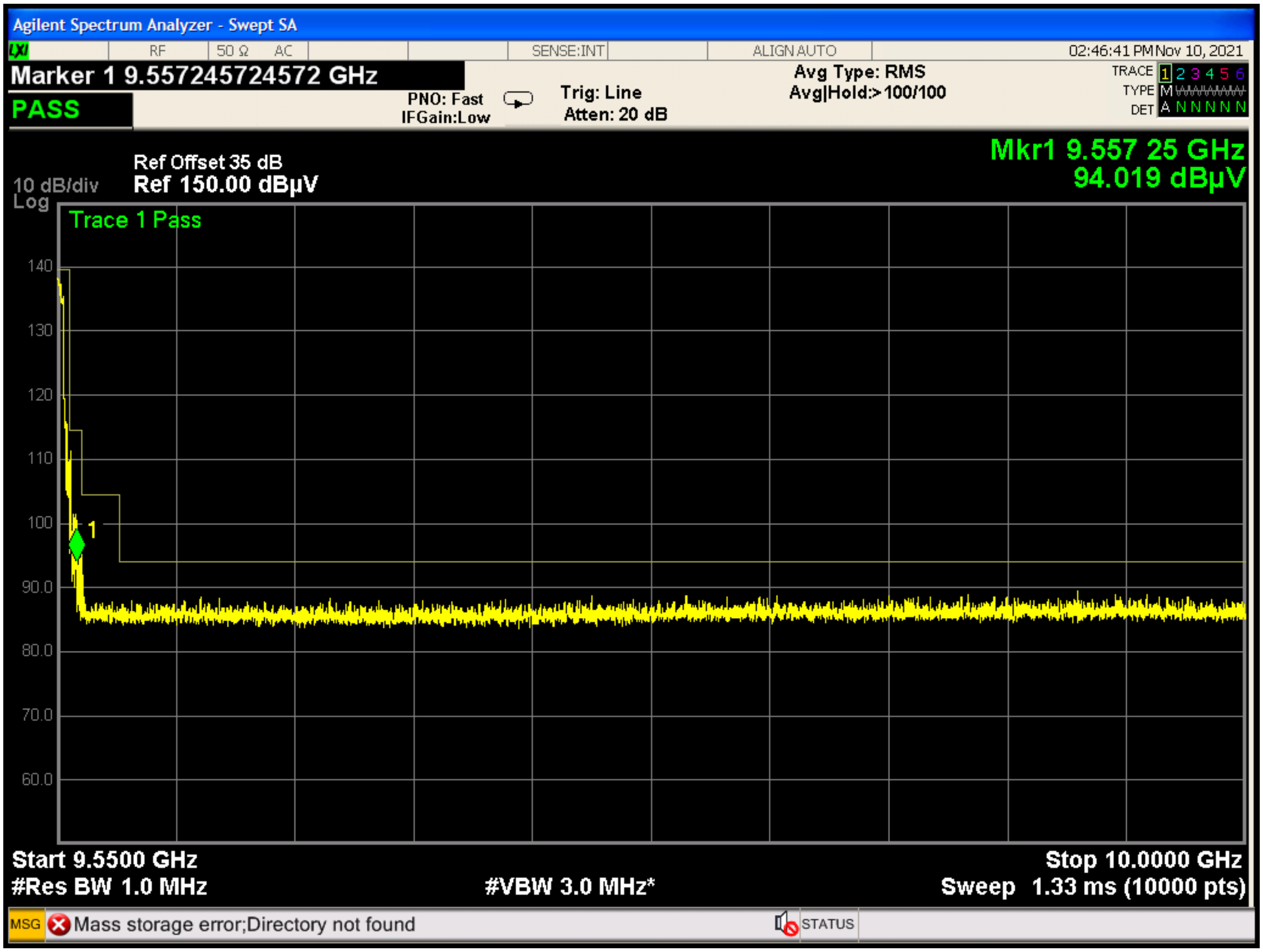


Figure 15: Emissions Mask, High Channel – Plot 1

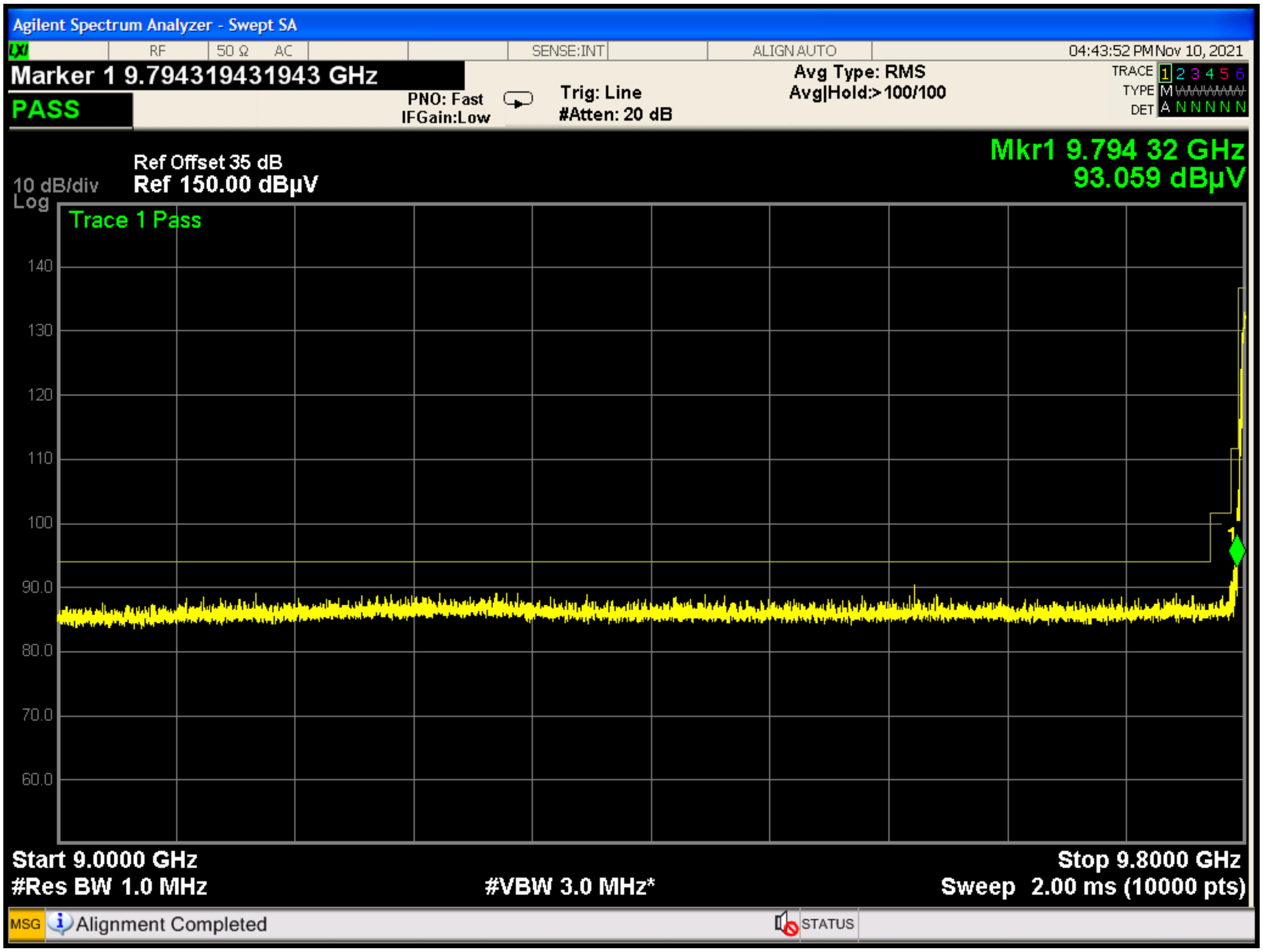


Figure 16: Emissions Mask, High Channel – Plot 2

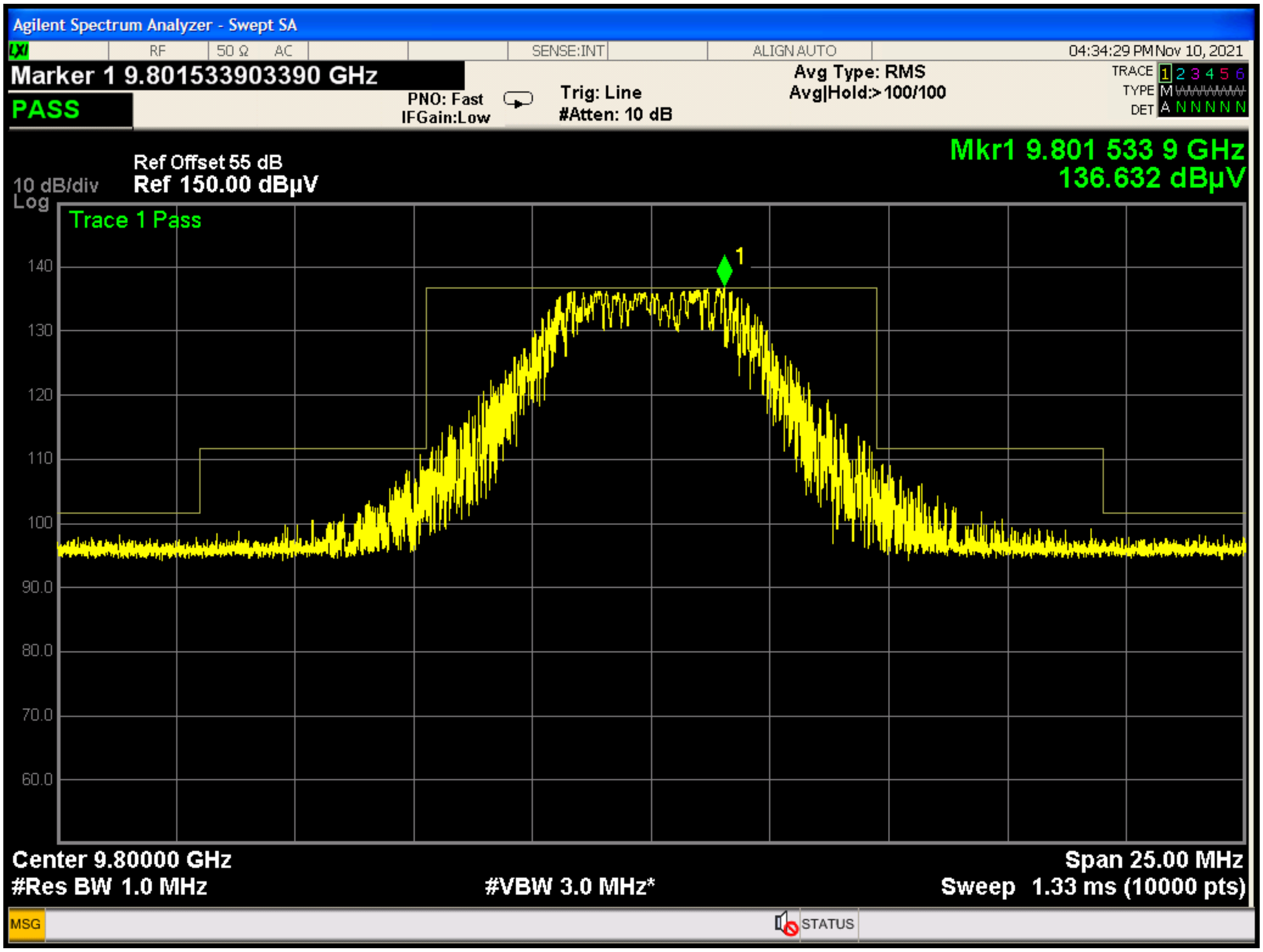
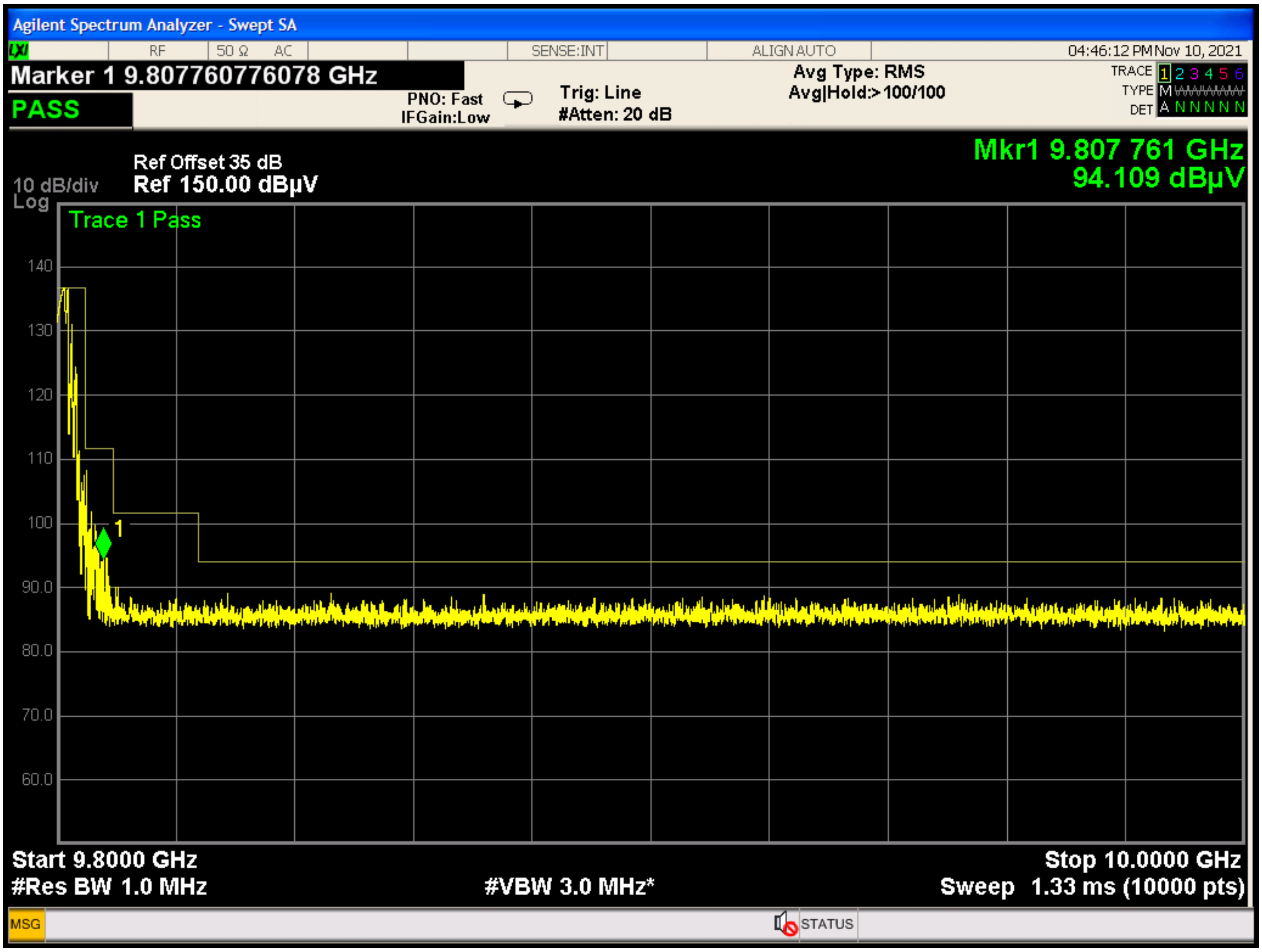


Figure 17: Emissions Mask, High Channel – Plot 3



4.5 Transmitter Limitations/Case Radiated, §90.210(b)

The requirements of this section shall follow the rules outlined in FCC Part §90.210(b). This section shall focus on the case-radiated unwanted emissions, that are detectable in the frequency range of frequencies which are removed from the assigned frequency by more than 250 percent of the authorized bandwidth. That is, traditionally recognized as 30 MHz to the tenth harmonic of the highest fundamental frequency, or to 40 GHz (whichever is lower); in accordance with FCC Part §2.1057(3).

4.5.1 Requirements

The limits for radiated spurious emissions that are detected in a band that is more than 250% removed from the authorized bandwidth, containing the assigned fundamental frequency, is calculated from the following formula, which is based on the EUT power measurement from Section 4.1 of this report:

$Limit_{(dBm)} = Peak\ Power_{(dBm)} - (43 + 10 * LOG(Peak\ Power_{[Watts]})$

Limit = 53.3 – (43 + 10LOG(213.8))

Limit = –13.0 dBm

4.5.2 Test Procedure

The requirements for a floor standing EUT, call for the device to be placed on a natural ground plane, isolated from it by a distance not to exceed 15cm. During testing, the EUT shall be rotated to expose the maximum radiated emissions, at measured at a distance of 3m, at an open area test site. Measurements shall be performed while the test antenna is oriented toward the front-facing field components of the EUT. The maximum emissions shall be recorded.

The output of the measurement antenna was connected, via a preamplifier, to the input of the spectrum analyzer, through an appropriate filter, and the emissions in the frequency range of 30 MHz to 40 GHz were measured. The system under test was examined for emissions with both horizontal and vertical antenna polarizations.

The detector function was set to quasi-peak for measurements below 1 GHz. The measurement bandwidth of the spectrum analyzer system was set to at least 120 kHz, with all post-detector filtering no less than 10 times the measurement bandwidth. For measurements above 1 GHz, both the peak and average levels are recorded, using a measurement bandwidth of 1 MHz with a video bandwidth setting of 10 Hz for the average measurement.

Please note that any spurious emission that is a product of the transmitter shall be mathematically averaged through the use of a DCCF. In the case of an ambient condition, that is reported, or a digital unwanted emission [not correlating to the transmitter], a DCCF shall not apply.

4.5.3 Radiated Data Reduction and Reporting

To convert the raw spectrum analyzer radiated data into a form that can be compared with the FCC limits, it is necessary to account for various calibration factors that are supplied with the antennas and other measurement accessories. These factors are included into the antenna factor (AF) column of the table and in the cable factor (CF) column of the table. The AF (in dB/m) and the CF (in dB) is algebraically added to the raw Spectrum Analyzer Voltage in dBμV to obtain the Radiated Electric Field in dBμV/m. This logarithm amplitude is converted to a linear amplitude, then compared to the FCC limit.

Example:

Spectrum Analyzer Voltage:	VdBμV
Antenna Correction Factor:	AFdB/m
Cable Correction Factor:	CFdB
Pre-Amplifier Gain (if applicable):	GdB
Electric Field: EdBμV/m =	V dBμV + AFdB/m + CFdB - GdB
Convert to linear units of measure:	EdBμV/m/20 Inv log

The measured field strength values, of radiated emissions, shall be converted to EIRP via the following formulas:

Frequency range of 1 GHz to 20 GHz: Power = dBuV/m + 20LOG(D_m) – 104.8 *(where D_m = 3m)*

Frequency range of 20 GHz to 40 GHz: Power = dBuV/m + 20LOG(D_m) – 104.8 *(where D_m = 2m)*

4.5.4 Test Results

The EUT complies with the emission requirements of this section.

For testing in the frequency range of 30 MHz to 1000 MHz, the EUT was set to transmit at the center channel. No emissions from the EUT were detected in the frequency range below 1000 MHz; as such, a Quasi-Peak Detector was used to make ambient measurements.

The transmitter low, center, and high channels were scanned for spurious unwanted emissions from 30 MHz to 40 GHz. Only the first and second harmonic of the fundamental were detectable. No other emissions were noted.

AMB indicates that the measurement was taken at the noise floor.

Spur indicates that an emission was detected on the OATS.

Table 9: Case Radiated Emissions Test Data, 30 MHz – 1000 MHz

Frequency (MHz)	Polarity (H/V)	Azimuth (Degree)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (dBuV/m)	EIRP (dBm)	Limit (dBm)	Margin (dB)	Detector	Comments
58.86	V	0.0	1.9	57.00	-17.0	40.00	-55.3	-13.0	-42.3	QP	AMB
65.93	V	0.0	1.9	58.30	-16.2	42.10	-53.2	-13.0	-40.2	QP	AMB
100.00	V	0.0	1.6	44.80	-14.2	30.60	-64.7	-13.0	-51.7	QP	AMB
250.00	V	0.0	1.7	32.90	-11.9	21.00	-74.3	-13.0	-61.3	QP	AMB
336.70	V	0.0	1.5	36.60	-9.2	27.40	-67.9	-13.0	-54.9	QP	AMB
400.00	V	0.0	1.6	36.60	-7.5	29.10	-66.2	-13.0	-53.2	QP	AMB
813.59	V	0.0	1.5	32.90	-0.8	32.10	-63.2	-13.0	-50.2	QP	AMB
58.86	H	0.0	1.8	55.10	-17.0	38.10	-57.2	-13.0	-44.2	QP	AMB
65.93	H	0.0	1.7	56.70	-16.2	40.50	-54.8	-13.0	-41.8	QP	AMB
100.00	H	0.0	1.8	41.90	-14.2	27.70	-67.6	-13.0	-54.6	QP	AMB
250.00	H	0.0	1.4	30.00	-11.9	18.10	-77.2	-13.0	-64.2	QP	AMB
336.70	H	0.0	1.4	34.70	-9.2	25.50	-69.8	-13.0	-56.8	QP	AMB
400.00	H	0.0	1.6	32.30	-7.5	24.80	-70.5	-13.0	-57.5	QP	AMB
813.59	H	0.0	1.5	30.10	-0.8	29.30	-66.0	-13.0	-53.0	QP	AMB

Table 10: Case Radiated Emissions Test Data, 1 GHz – 40 GHz

Frequency (MHz)	Polarity (H/V)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	DCCF (dB)	Corr. Level (dBuV/m)	EIRP (dBm)	Limit (dBm)	Margin (dB)	Detector	Comment
1100.0	V	1.5	41.2	-1.8	0.0	39.4	-55.9	-13.0	-42.9	AVG	AMB
2600.0	V	1.5	42.7	4.8	0.0	47.5	-47.8	-13.0	-34.8	AVG	AMB
5200.0	V	1.5	32.4	13.5	0.0	45.9	-49.4	-13.0	-36.4	AVG	AMB
18600.0	V	1.5	60.5	37.7	20.0	78.2	-17.1	-13.0	-4.1	Peak	Spur
19100.0	V	1.5	56.7	37.0	20.0	73.7	-21.6	-13.0	-8.6	Peak	Spur
19600.0	V	1.5	55.0	37.7	20.0	77.7	-17.6	-13.0	-4.6	Peak	Spur
27900.0	V	1.4	51.2	47.6	20.0	78.8	-20.0	-13.0	-7.0	Peak	Spur
28650.0	V	1.4	50.0	47.6	20.0	77.6	-21.2	-13.0	-8.2	Peak	Spur
29400.0	V	1.4	29.9	47.6	0.0	47.6	-51.2	-13.0	-38.2	AVG	AMB
1100.00	H	1.5	41.9	-1.8	0.0	40.1	-55.2	-13.0	-42.2	AVG	AMB
2600.00	H	1.5	41.7	4.8	0.0	46.5	-48.8	-13.0	-35.8	AVG	AMB
5200.00	H	1.5	29.9	13.5	0.0	43.4	-51.9	-13.0	-38.9	AVG	AMB
18600.00	H	1.5	58.2	37.7	20.0	75.9	-19.4	-13.0	-6.4	Peak	Spur
19100.00	H	1.5	50.0	37.0	20.0	67.0	-28.3	-13.0	-15.3	Peak	Spur
19600.00	H	1.5	52.6	37.7	20.0	70.3	-25.0	-13.0	-12.0	Peak	Spur
27900.00	H	1.5	51.2	47.6	20.0	78.8	-20.0	-13.0	-7.0	Peak	Spur
28650.00	H	1.5	50.0	47.6	20.0	77.6	-21.2	-13.0	-8.2	Peak	Spur
29400.00	H	1.5	29.9	47.6	0.0	77.5	-21.3	-13.0	-8.3	AVG	AMB

* The measurement distance for frequencies below 20 GHz was 3m; while the measurement distance for frequencies above 20 GHz was 2m. This accounts for the shift in the math at the transition frequency.

Frequency range of 1 GHz to 20 GHz: Power = dBuV/m + 20LOG(3) – 104.8

Frequency range of 20 GHz to 40 GHz: Power = dBuV/m + 20LOG(2) – 104.8

4.6 AC Voltage Conducted Emissions

4.6.1 Requirements

FCC Compliance Limits				
Frequency Range	Class A Digital Device		Class B Digital Device	
	Quasi-peak	Average	Quasi-peak	Average
0.15 – 0.5 MHz	79 dBμV	66 dBμV	66 to 56 dBμV	56 to 46 dBμV
0.5 – 5 MHz	79 dBμV	66 dBμV	56 dBμV	46 dBμV
0.5 – 30 MHz	73 dBμV	60 dBμV	60 dBμV	50 dBμV

4.6.2 Test Procedure

The requirements of this test call for a floor standing EUT to be placed on a metallic horizontal ground plane, which extends beyond the boundaries of the EUT on all sides. Power to the EUT was provided through a Solar Corporation 50 Ω/50 µH Line Impedance Stabilization Network bonded to a 3 X 2-meter ground plane. The LISN has its AC input supplied from a filtered AC power source. Power and data cables were moved about to obtain maximum emissions.

The 50 Ω output of the LISN was connected to the input of the spectrum analyzer and the emissions in the frequency range of 150 kHz to 30 MHz were measured. The detector function was set to quasi-peak, peak, or average as appropriate, and the resolution bandwidth during testing was at least 9 kHz, with all post-detector filtering no less than 10 times the resolution bandwidth. For average measurements, the post-detector filter was set to 10 Hz.

Environmental Conditions during Conducted Emissions Testing

Ambient Temperature:	19 °C
Relative Humidity:	31 %

4.6.3 Conducted Data Reduction and Reporting

The comparison between the Conducted emissions level and the FCC limit is calculated as shown in the following example:

Spectrum Analyzer Voltage: VdBμV

LISN Correction Factor: LISN dB

Cable Correction Factor: CF dB

Electric Field: EdBμV = V dBμV + LISN dB + CF dB

4.6.4 Test Data

The EUT complies with the Class A Conducted Emissions requirements.

The Conducted Emissions test data is provided in the tables below.

This data is provided for informational purposes only.

Table 11: Conducted Emission Test Data – 120 VAC Input Supply

Frequency (MHz)	Level QP (dBμV)	Level AVG (dBμV)	Cable Loss (dB)	LISN Corr (dB)	Level QP Corr (dBμV)	Level Corr Avg (dBμV)	Limit QP (dBμV)	Limit AVG (dBμV)	Margin QP (dB)	Margin AVG (dB)
NEUTRAL										
0.157	66.8	38.3	10.2	0.6	77.6	49.1	79.0	66.0	-1.4	-16.9
0.253	61.0	32.0	10.2	0.4	71.6	42.6	79.0	66.0	-7.4	-23.4
0.476	46.4	22.2	10.2	0.3	56.9	32.7	79.0	66.0	-22.1	-33.3
1.000	28.3	12.5	10.3	0.3	38.9	23.1	73.0	60.0	-34.1	-36.9
1.665	33.0	27.5	10.2	0.3	43.5	38.0	73.0	60.0	-29.5	-22.0
2.996	26.3	22.0	10.3	0.4	36.9	32.6	73.0	60.0	-36.1	-27.4
3.504	27.7	20.2	10.4	0.4	38.4	31.0	73.0	60.0	-34.6	-29.0
20.769	46.8	37.5	11.5	1.3	59.6	50.3	73.0	60.0	-13.4	-9.7
PHASE										
0.153	66.5	50.0	10.2	0.5	77.1	60.6	79.0	66.0	-1.9	-5.4
0.170	64.6	47.5	10.2	0.4	75.2	58.1	79.0	66.0	-3.8	-7.9
0.282	57.0	39.0	10.2	0.3	67.5	49.5	79.0	66.0	-11.5	-16.5
0.495	45.9	30.0	10.2	0.3	56.4	40.5	79.0	66.0	-22.6	-25.5
1.113	25.5	27.4	10.3	0.3	36.0	37.9	73.0	60.0	-37.0	-22.1
3.431	24.5	28.0	10.4	0.4	35.2	38.7	73.0	60.0	-37.8	-21.3
20.766	49.2	44.0	11.5	1.0	61.8	56.5	73.0	60.0	-11.2	-3.5

4.7 Transmitter Duty Cycle

4.7.1 Requirements

Overall, the transmitter power demonstrated throughout this report is a mathematically averaged value. Because the EUT has a pulsed transmit signal, for calibrated measurements of field strength and/or power, the Peak emission was recorded and then corrected with a Duty Cycle Correction Factor (DCCF).

The DCCF was calculated from the data obtained from the transmitter timing and pulse width plots, as denoted in the below provided images.

Figure 18 provides the pulse width of a single radar pulse. As shown, this timing is 13.78μs, which shall be rounded to 14.0μs. As such, T_{on} = 14.0 μs

The full pulse train was evaluated several times, and the most accurate representation of the cycle timing is provided in Figure 19 and Figure 20. As shown, this timing is 156.0μs. As such, T_{cycle} = 156.0μs

The duty cycle can be calculated from the following formula:

$T_{on} \div T_{cycle} = \Delta$

$14 \div 156 = 0.09$

$\Delta = 9\ \%$

Where Δ is the final duty cycle.

The duty cycle correction factor can be calculated from the following formula:

$20LOG(\Delta) = \delta$

20LOG(0.09) = –20.9 *(rounded down to –20.0)*

$\delta = 20.0$ dB

Where δ is the final DCCF

Figure 18: Single Pulse Width Timing

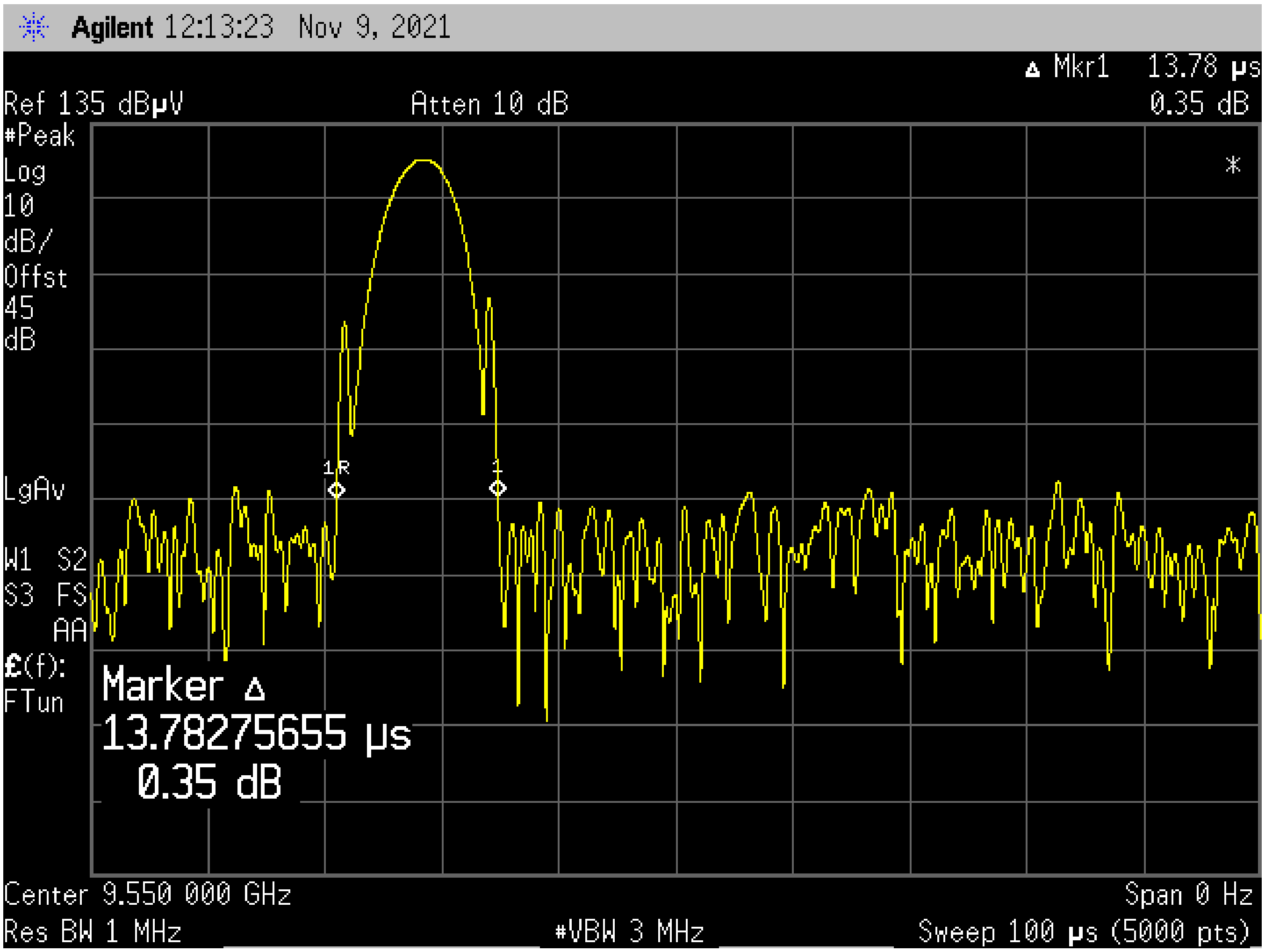


Figure 19: Cycle Period Timing

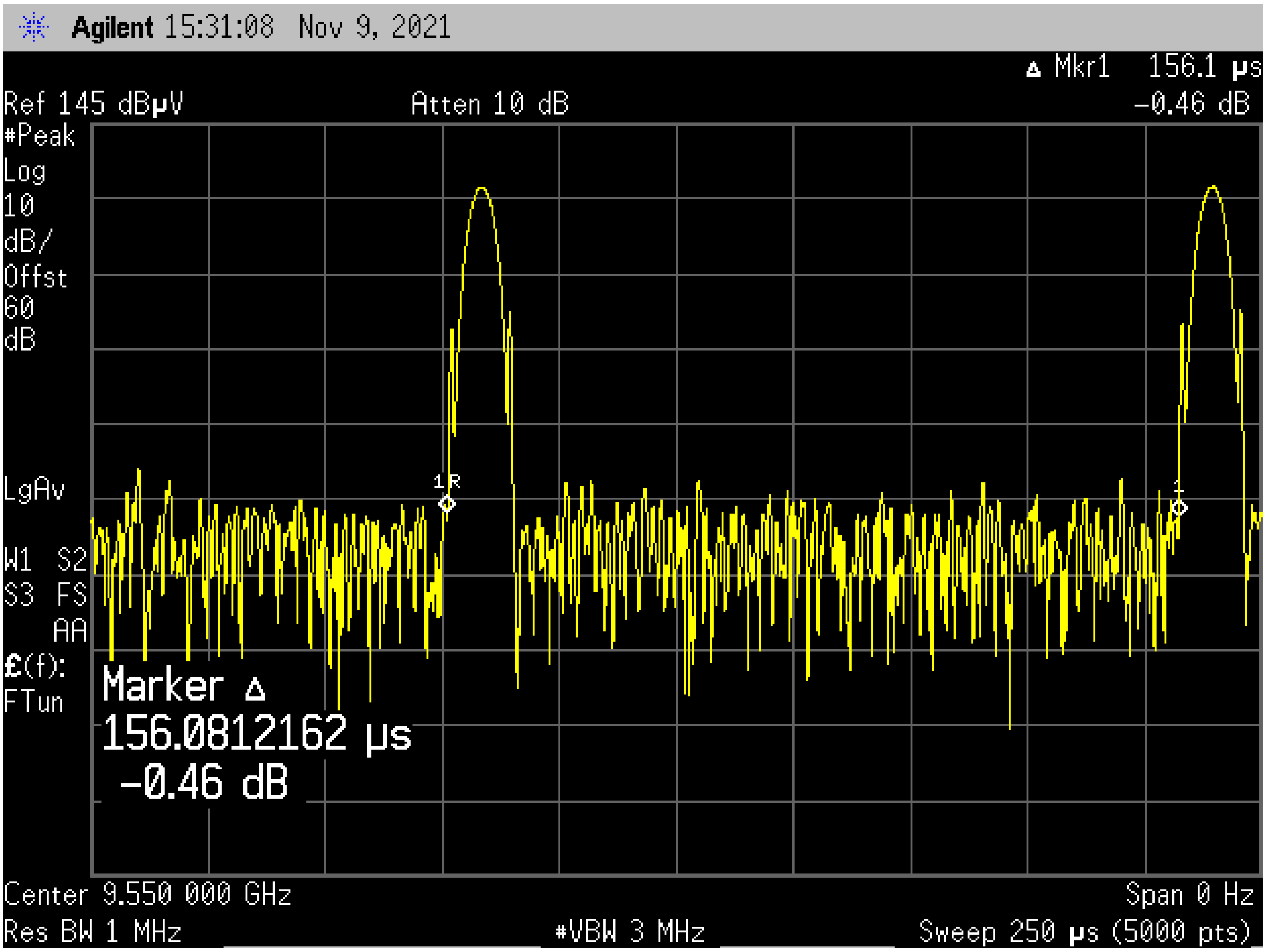
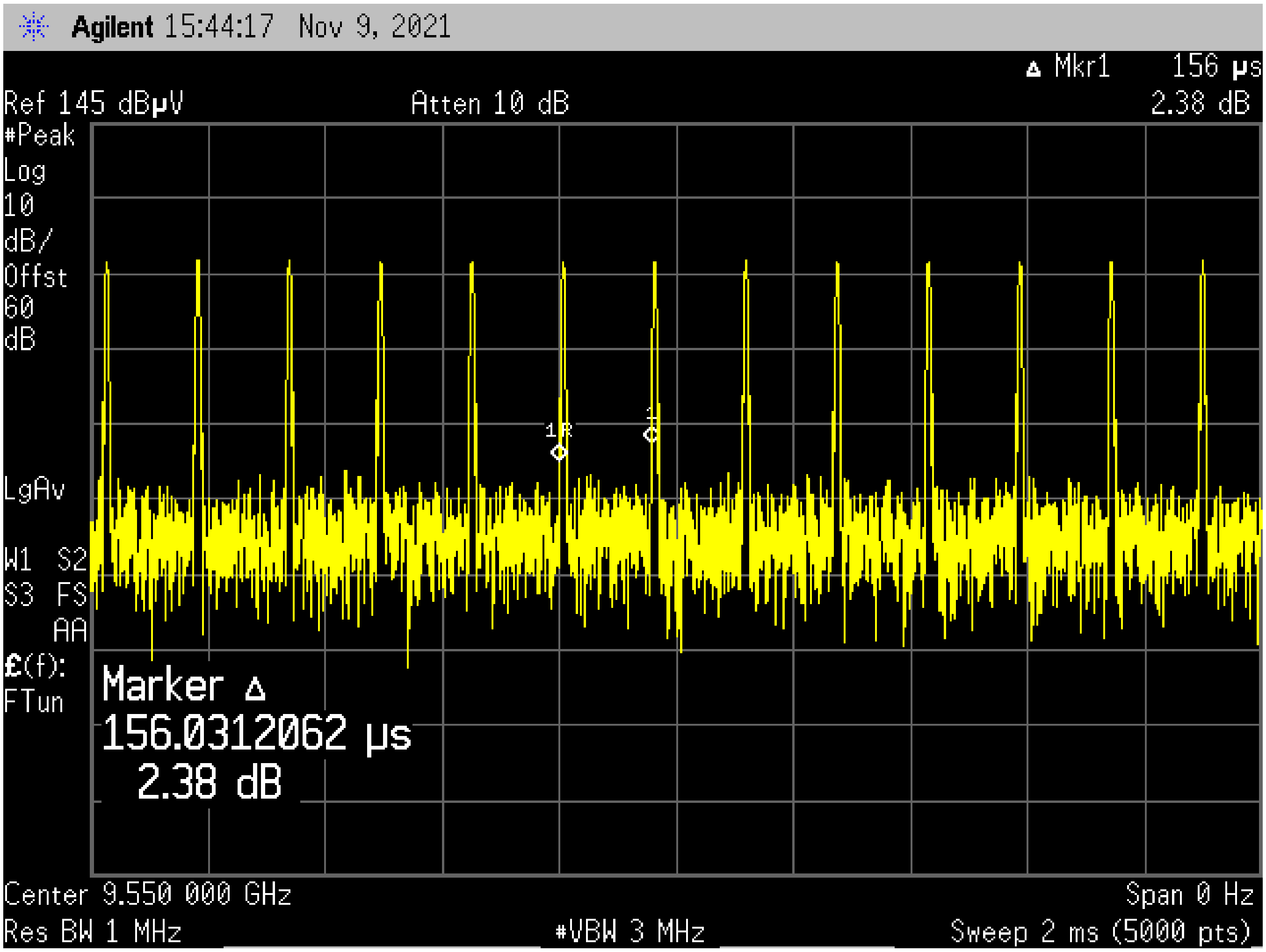


Figure 20: Transmitter PRF



* note: this plot also provides the Pulse Repetition Frequency (PRF). Over the measurement period of 2ms, the radar pulses 13 times. The final PRF is calculated to be 6500 Hz via the following work-up:

13 cycles per 2ms

1000ms ÷ 2ms = 500

500 x 13 = 6500

6500 cycles per 1000ms = 6500 Hz