Washington Laboratories, Ltd.

FCC & ISED CANADA CERTIFICATION TEST REPORT

for the

MIRA HDR

FCC ID: QLA-MIRAHDR500

ISED ID: 25943-MIRAHDR500

REPORT# 16453-01 -01 REV 2

Prepared for:

Guideline Geo AB

Skolgatan 11

S-93070, Mala 29492 Sweden

Prepared By:

Washington Laboratories, Ltd.
7560 Lindbergh Drive
Gaithersburg, Maryland 20879

FCC & ISED Canada Certification Test Report

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MARCH 26, 2020

WLL REPORT# 16453-01 -01 REV 2

Prepared by:

Steve Koster

President

Reviewed by:

Michael Violette, P.E.

CEO

ABSTRACT

This report has been prepared on behalf of Guideline Geo AB to support the attached Application for Equipment Authorization. The test report and application are submitted for an Intentional Radiator under Part 15.509 and Part 15.521 of the FCC Rules and Regulations and Spectrum Management and Telecommunications Policy and under RSS-220 Issue 1, 3/2009, Amendment 1 7/2018 of Innovation, Science and Economic Development Canada (ISED). This Certification Test Report documents the test configuration and test results for the Guideline Geo AB MIRA HDR.

Testing was performed on an Open Area Test Site (OATS) of Washington Laboratories, Ltd, 4840 Winchester Blvd. Suite 5, 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. The ISED Canada OATS number is 3035A for Washington Laboratories, Ltd. Washington Laboratories, Ltd. has been accepted by the FCC and approved by ANAB under Certificate AT-1448 as an independent FCC test laboratory.

The Guideline Geo AB MIRA HDR complies with the limits for a Ground Penetrating Radar device under FCC Part 15.509 and 15.521 and RSS 220.

Revision History	Description of Change	Date
Rev 0	Initial Release	March 26, 2020
Rev 1	Respond to ACB Comments	April 7/2020
Rev 2	Corrected the frequency range in Table 1	April 9, 2020

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1 INTRODUCTION

1.1 COMPLIANCE STATEMENT

The Guideline Geo AB MIRA HDR complies with the limits for a Ground Penetrating Radar device under FCC Part 15.509 and 15.521 and ISED RSS 220.

1.2 TEST SCOPE

Tests for radiated emissions were performed. All measurements were performed in accordance with the 2013 version of ANSI C63.10. The measurement equipment conforms to ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation.

1.3 CONTRACT INFORMATION

Customer:	Guideline Geo AB
Address	Skolgatan 11
	S-93070, Mala 29492 Sweden
Purchase Order Number:	Int'l Wire - Advance deposit
Quotation Number:	71799

1.4 TEST DATES

Testing was performed on the following date(s): 3/23/2020 – 3/24/2020

1.5 TEST AND SUPPORT PERSONNEL

Washington Laboratories, LTD	Steve Koster
Customer Representative	Per Westholm

2 EQUIPMENT UNDER TEST

2.1 EUT IDENTIFICATION & DESCRIPTION

Table 1: Device Summary

Item	Ground Penetrating Radar
Manufacturer:	Guideline Geo AB
FCC ID:	QLA-MIRAHDR500
ISED ID:	25943-MIRAHDR500
Model:	MIRA HDR
Serial Number of Unit Tested	None
FCC Rule Parts:	§15.509 and 15.231
ISED Rule Parts:	RSS 220 Issue 1, Amendment 1
Frequency Range:	50.08 - 900.59 MHz
Maximum Output Power:	<-30dBm
Modulation:	Impulse excitation (UWB)
10 dB Bandwidth:	831.3 MHz
FCC Emission Designator:	NA
ISED Emissions Designators:	NA
Type of Information:	N/A
Number of Channels:	N/A
Power Output Level	Fixed
Highest TX Spurious Emission:	179uV/m @ 3 meters
Antenna Connector	None
Antenna Type	Resistively loaded bow-tie antenna. Guideline Geo 13-002329
Interface Cables:	Ethernet
Maximum Data Rate	N/A
Power Source & Voltage:	External battery, 12V nominal

The Guideline Geo AB MIRA HDR is a ground penetrating radar array system for detailed 3D mapping of the subsurface. Typical application areas include e.g., infrastructure and archaeology.

2.2 TEST CONFIGURATION

The MIRA HDR was configured to continuously transmit above a bed of anechoic material on a reference ground plane.

2.3 TESTING ALGORITHM

The MIRA HDR was tested while continuously transmitting.

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

2.5 MEASUREMENTS

2.5.1 References

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

ANSI C63.10 (Jun 2013) American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

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

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

Where u_c = standard uncertainty

a, b, c,.. = individual uncertainty elements

$Div_{a, b, c}$ = 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

$k \leq 2$ for 95% coverage (ANSI/NCSL Z540-2 Annex G)

u_c = 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 2 below.

Table 2: 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

4 GENERAL REQUIREMENTS

§15.509 Technical requirements for ground penetrating radars and wall imaging systems.

Requirement	Result
(a) The UWB bandwidth of an imaging system operating under the provisions of this section must be below 10.6 GHz.	Pass
(b) Operation under the provisions of this section is limited to GPRs and wall imaging systems operated for purposes associated with law enforcement, fire-fighting, emergency rescue, scientific research, commercial mining, or construction.	Pass
(1) Parties operating this equipment must be eligible for licensing under the provisions of part 90 of this chapter.	Managed by client
(2) The operation of imaging systems under this section requires coordination, as detailed in §15.525.	Managed by client
(c) A GPR that is designed to be operated while being hand held and a wall imaging system shall contain a manually operated switch that causes the transmitter to cease operation within 10 seconds of being released by the operator. In lieu of a switch located on the imaging system, it is permissible to operate an imaging system by remote control provided the imaging system ceases transmission within 10 seconds of the remote switch being released by the operator.	N/A

5 TEST EQUIPMENT

Table 3 shows a list of the test equipment used for measurements along with the calibration information.

Table 3: Test Equipment List

Radiated Emissions		Test Date:	**3/23/2020**
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
00382	SUNOL SCIENCES CORPORATION	JB1	5/1/2020
00558	HP	8447D	4/3/2020
00626	ARA	DRG-118/A	3/31/2020
00522	HP	8449B	4/4/2020
Borrowed	Keysight	MXA SA N9020B	4/4/2020

6 TEST RESULTS

6.1 RADIATED EMISSIONS: (FCC PART §15.509, §15.521 AND RSS 220)

The EUT must comply with the requirements for radiated emissions. Per the requirements of the rules. These emissions must meet the requirements specified in §15.509, §15.521 and RSS-220.

6.1.1 Test Procedure

The emissions from the EUT were measured continuously at every azimuth by rotating the turntable. Bi-conical and log periodic broadband antennas were mounted on an antenna mast to determine the height of maximum emissions. The height of the antenna was varied between 1 and 4 meters. The output of the antenna was connected to the input of the spectrum analyzer and the emissions in the frequency range of 30 MHz to 9 GHz were measured. Both the horizontal and vertical field components were measured.

The output from the antenna was connected, via a preamplifier, to the input of the spectrum analyzer. The detector function was set to quasi-peak or peak, as appropriate. Above 1GHz average measurement are recorded. 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. Frequencies above 1GHz were performed using a measurement bandwidth of 1MHz with a video bandwidth setting of 10 Hz for the average measurement.

6.1.2 Limits

For the FCC Part 15.509 the radiated emissions at or below 960 MHz from a device operating under the provisions of this section shall not exceed the emission levels in §15.209. The radiated emissions above 960 MHz from a device operating under the provisions of this section shall not exceed the following average limits when measured using a resolution bandwidth of 1 MHz:

Frequency in MHz	EIRP in dBm
960-1610	-65.3
1610-1990	-53.3
1990-3100	-51.3
3100-10600	-41.3
Above 10600	-51.3

For RSS 220 Radiated emissions at or below 960 MHz for all subclasses of UWB device shall not exceed the following limits. Measurements of radiated emissions at and below 960 MHz are to be made using a CISPR quasi-peak detector. CISPR measurement bandwidth specifications are to be used.

Frequency (MHz)	Field Strength (Microvolts/m)	Measurement Distance (Metres)	EIEP (dBmW)
0.009-0.490	2,400/F (F in kHz)	300	10 log(17.28/F^2) (F in kHz)
0.490-1.705	24,000/F (F in kHz)	30	10 log(17.28/F2) (F in kHz)
1.705-30	30	30	-45.7
30-88	100	3	-55.2
88-216	150	3	-51.7
216-960	200	3	-49.2

6.1.3 Results Summary

The EUT complies with the radiated emission requirements.

6.1.4 Test Data

Above 1 GHz, measurements were collected as field strength. To convert the data to compare against the EIRP limit, the following common formula was used for converting field strength to EIRP at a distance of 3 meters.

$$EIRP = EdBuV/m – 95.2$$

Data are shown in the following table.

Table 4: Radiated Emission Test Data, Low Frequency Data (<960 MHz)

Frequency (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)	Comments
200.00	V	45.0	1.0	44.9	-11.8	45.3	150.0	-10.4	QP
229.00	V	22.5	1.0	46.2	-12.8	46.8	200.0	-12.6	QP
230.00	V	22.5	1.0	45.2	-12.7	42.0	200.0	-13.6	QP
263.00	V	315.0	1.0	45.4	-11.1	51.7	200.0	-11.8	QP
300.00	V	0.0	1.0	45.9	-9.9	62.6	200.0	-10.1	QP
320.00	V	0.0	1.0	53.3	-9.3	158.5	200.0	-2.0	Clock
340.00	V	180.0	1.0	45.4	-9.0	65.4	200.0	-9.7	QP
450.00	V	180.0	1.0	43.6	-5.7	78.5	200.0	-8.1	QP
500.00	V	225.0	1.0	45.6	-4.5	114.2	200.0	-4.9	QP
550.00	V	225.0	1.0	46.6	-3.2	148.5	200.0	-2.6	QP
650.00	V	225.0	1.0	45.1	-1.4	152.3	200.0	-2.4	QP
700.00	V	180.0	1.0	40.0	-1.3	86.0	200.0	-7.3	QP
800.00	V	225.0	1.0	37.9	0.6	84.0	200.0	-7.5	QP
900.00	V	237.5	1.0	36.5	1.9	83.3	200.0	-7.6	QP
950.00	V	0.0	1.0	36.1	2.9	89.1	200.0	-7.0	QP
960.00	V	0.0	1.0	35.7	2.4	79.9	200.0	-8.0	QP
960.00	V	0.0	1.0	25.4	2.4	24.5	29.9	-2.0	Ave
200.00	H	270.0	1.4	51.4	-11.8	96.0	150.0	-3.9	QP
229.00	H	270.0	1.4	52.8	-12.8	99.2	200.0	-6.1	QP
230.00	H	270.0	1.4	52.9	-12.7	101.6	200.0	-5.9	QP
263.00	H	270.0	1.4	51.9	-11.1	109.6	200.0	-5.2	QP
300.00	H	270.0	1.0	42.4	-9.9	41.9	200.0	-13.6	QP
320.00	H	270.0	1.0	54.4	-9.3	179.8	200.0	-0.9	QP
340.00	H	270.0	1.0	54.1	-9.0	179.0	200.0	-1.0	QP
450.00	H	270.0	1.0	49.9	-5.7	162.0	200.0	-1.8	QP
500.00	H	270.0	1.0	44.8	-4.5	104.3	200.0	-5.7	QP
550.00	H	225.0	1.0	39.5	-3.2	65.3	200.0	-9.7	QP
650.00	H	315.0	1.0	41.2	-1.4	97.6	200.0	-6.2	QP
700.00	H	270.0	1.0	42.7	-1.3	117.6	200.0	-4.6	QP
900.00	H	270.0	1.0	35.3	1.9	72.6	200.0	-8.8	QP
950.00	H	270.0	1.0	35.4	2.9	81.5	200.0	-7.8	QP
960.00	H	270.0	1.0	34.0	2.4	66.3	200.0	-9.6	QP

960	H	270	1.0	24.0	2.4	21.4	29.9	-2.9	Ave.

Above 1 GHz, measurements were collected as field strength. The measurements were average measurements with a 1 MHz resolution bandwidth and a 10 Hz video bandwidth. To convert the data to compare against the EIRP limit, the following common formula was used for converting field strength to EIRP at a distance of 3 meters.

EIRP = EdBuV/m – 95.2

Data are shown in the following table.

Table 5: Radiated Emission Test Data, High Frequency Data >960 MHz

Frequency (MHz)	**Polarity H/V**	**Azimuth (Degree)**	**Ant. Height (m)**	**SA Level (dBuV)**	**Corr Factors (dB)**	**Corr. Level (dBuV/m)**	**EIRP**	**Limit EIRP**	**Margin (dB)**
1000.00	V	45.0	1.0	27.4	-2.4	25.0	-70.2	-65.3	-4.9
1250.00	V	0.0	1.0	28.6	-0.7	27.9	-67.3	-65.3	-2.1
1500.00	V	0.0	1.0	26.5	-0.2	26.3	-68.9	-65.3	-3.6
1750.00	V	45.0	1.0	35.0	0.8	35.8	-59.4	-51.3	-8.1
2000.00	V	45.0	1.0	32.7	3.5	36.2	-59.0	-51.3	-7.7
2250.00	V	0.0	1.0	31.6	4.1	35.7	-59.5	-51.3	-8.2
7000.00	V	0.0	1.0	24.7	15.6	40.3	-54.9	-41.3	-13.6
1000.00	H	45.0	1.0	25.8	-2.4	23.4	-71.8	-65.3	-6.5
1250.00	H	90.0	1.0	24.8	-0.7	24.1	-71.1	-65.3	-5.8
1500.00	H	67.5	1.0	25.1	-0.2	24.9	-70.3	-65.3	-5.0
1750.00	H	135.0	1.0	35.5	0.8	36.3	-58.9	-51.3	-7.6
2000.00	H	135.0	1.0	32.2	3.5	35.7	-59.5	-51.3	-8.2

Peak EIRP

Peak emissions were collected per RSS-220)6.2.1g). The maximum field strength was measured with a resolution bandwidth of 50 MHz. The conversion from field strength to EIRP is:

EIRP = FS – 95.2

In addition, a bandwidth correction factor (20Log(50) = 34 was applied to the result.

The data are shown in the following table.

Table 6. Peak EIRP Measurements

F MHz	SA dBuV	AF	Pgain	E field dBuV/m	EIRP	Corr factor	EIRP dBm	Limit dBm
425.0	58.0	16.0	-26.0	48.0	-47.2	34.0	-13.2	0

6.1.5 Emissions in the GPS Bands

UWB transmitters operating under the provisions of this section shall not exceed the following average limits when measured using a resolution bandwidth of no less than 1 kHz:

Frequency in MHz	EIRP in dBm
1164-1240	-75.3
1559-1610	-75.3

Above 1 GHz, measurements were collected as field strength. To convert the data to compare against the EIRP limit, the following common formula was used:

EIRP = EdBuV/m – 95.2

Data are shown in the following table.

Table 7: Radiated Emission Test Data, GPS Band

Frequency (MHz)	Polarity (H/V)	Azimuth (Degree)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (dBuV/m)	EIRP	Limit EIRP	Margin (dB)	Comments
1174.13	V	225.0	1.0	11.0	-1.0	11.9	-83.3	-75.3	-8.0	1kHz
1569.30	V	180.0	1.0	7.5	-0.1	7.4	-87.7	-75.3	-12.4	1kHz
1178.07	H	135.0	1.0	12.1	-1.0	11.1	-84.1	-75.3	-8.5	1kHz
1590.10	H	90.0	1.0	11.2	0.0	11.2	-84.0	-75.3	-8.7	1kHz

Figure 1: Low GPS Band Horizontal

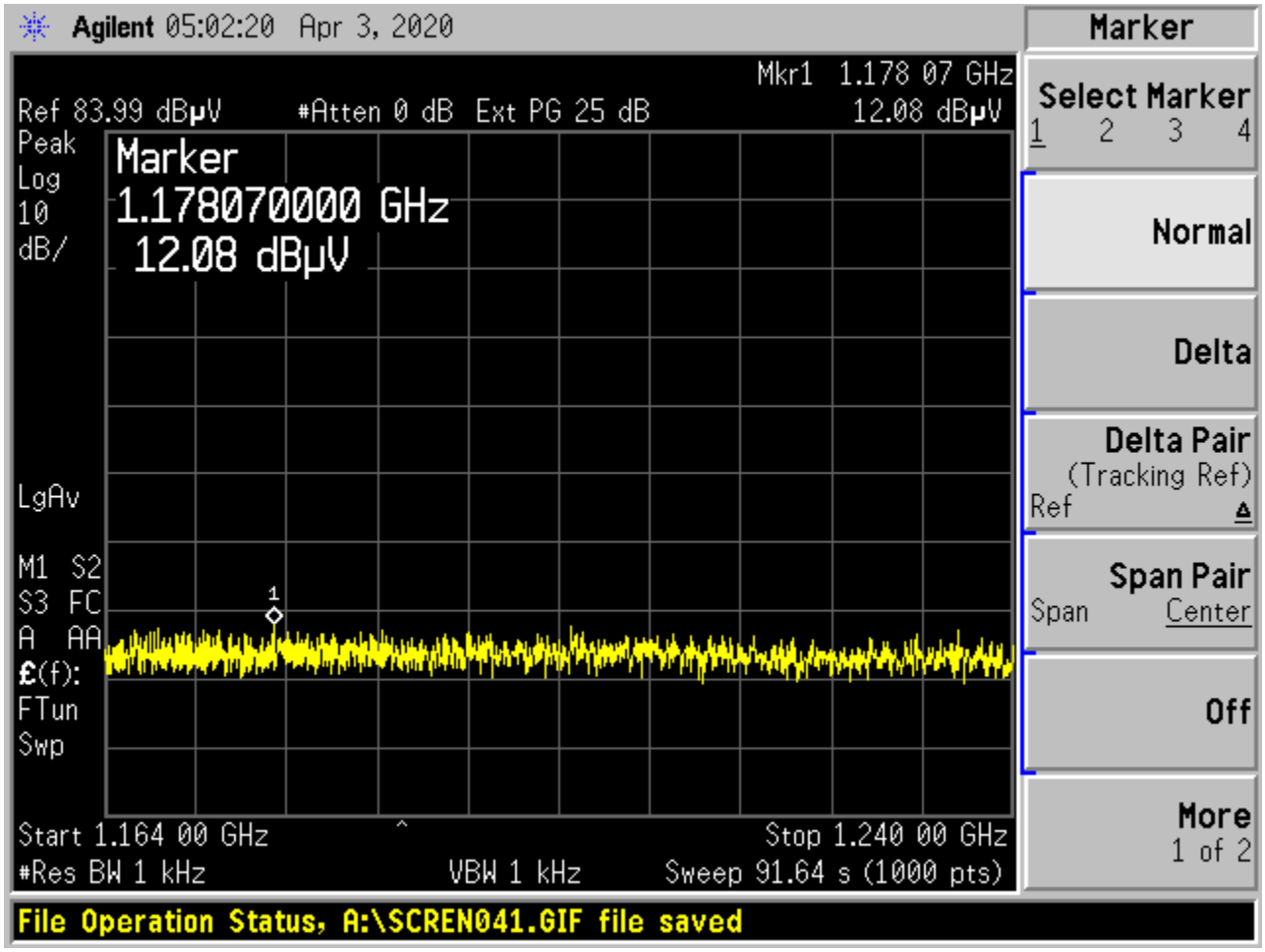


Figure 2: Low GPS Band Vertical

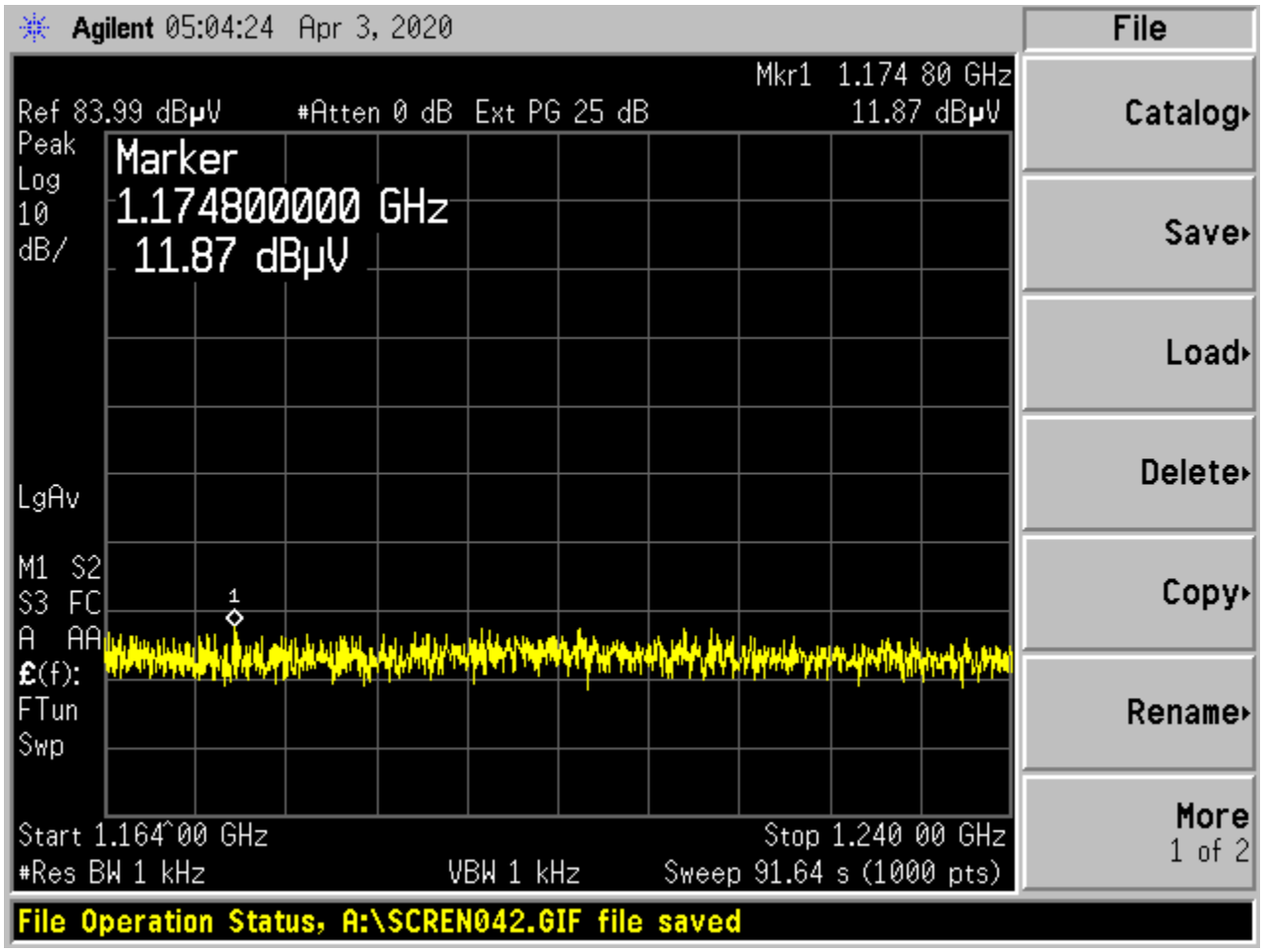


Figure 3: High GPS Band Horizontal

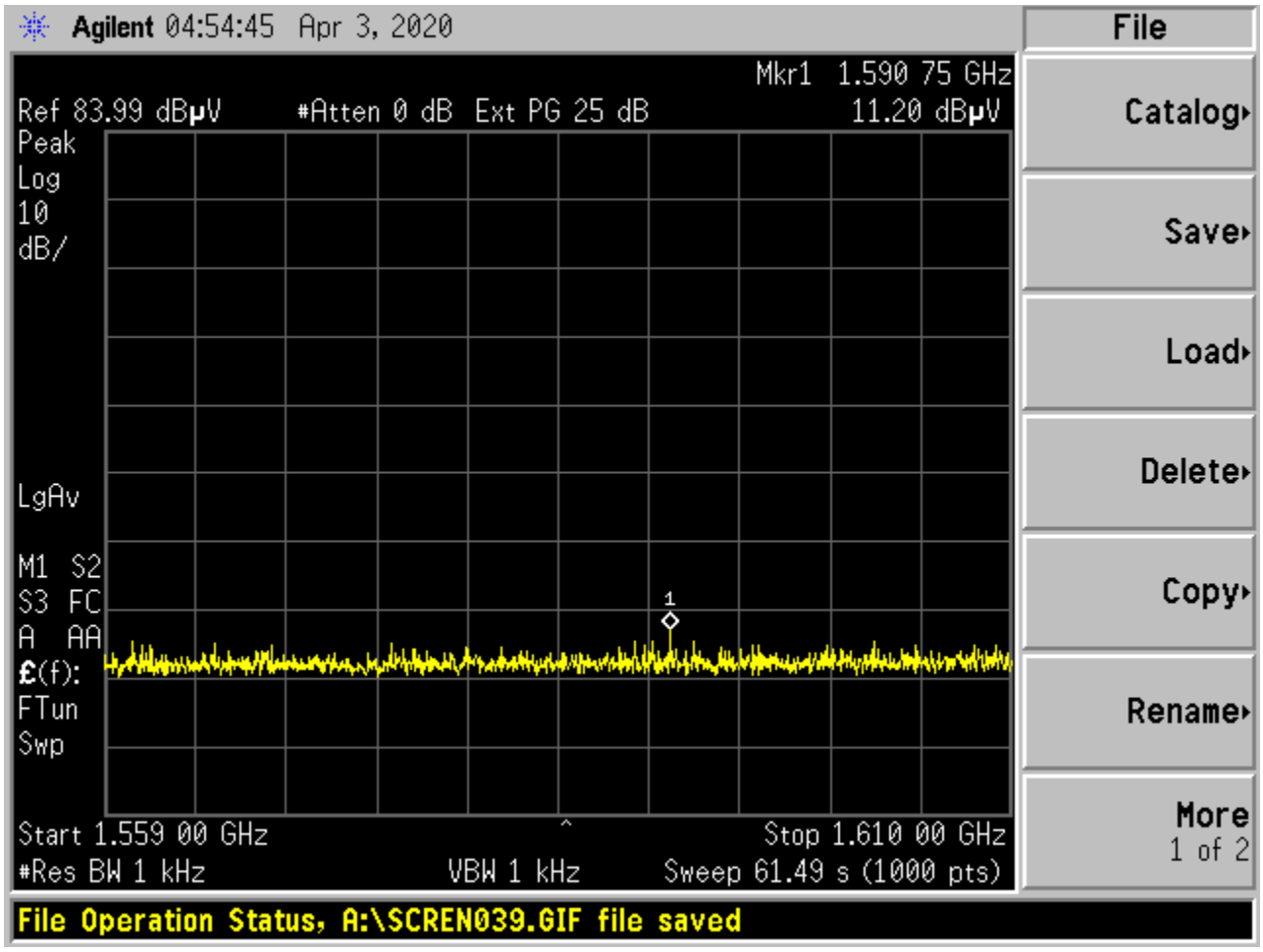
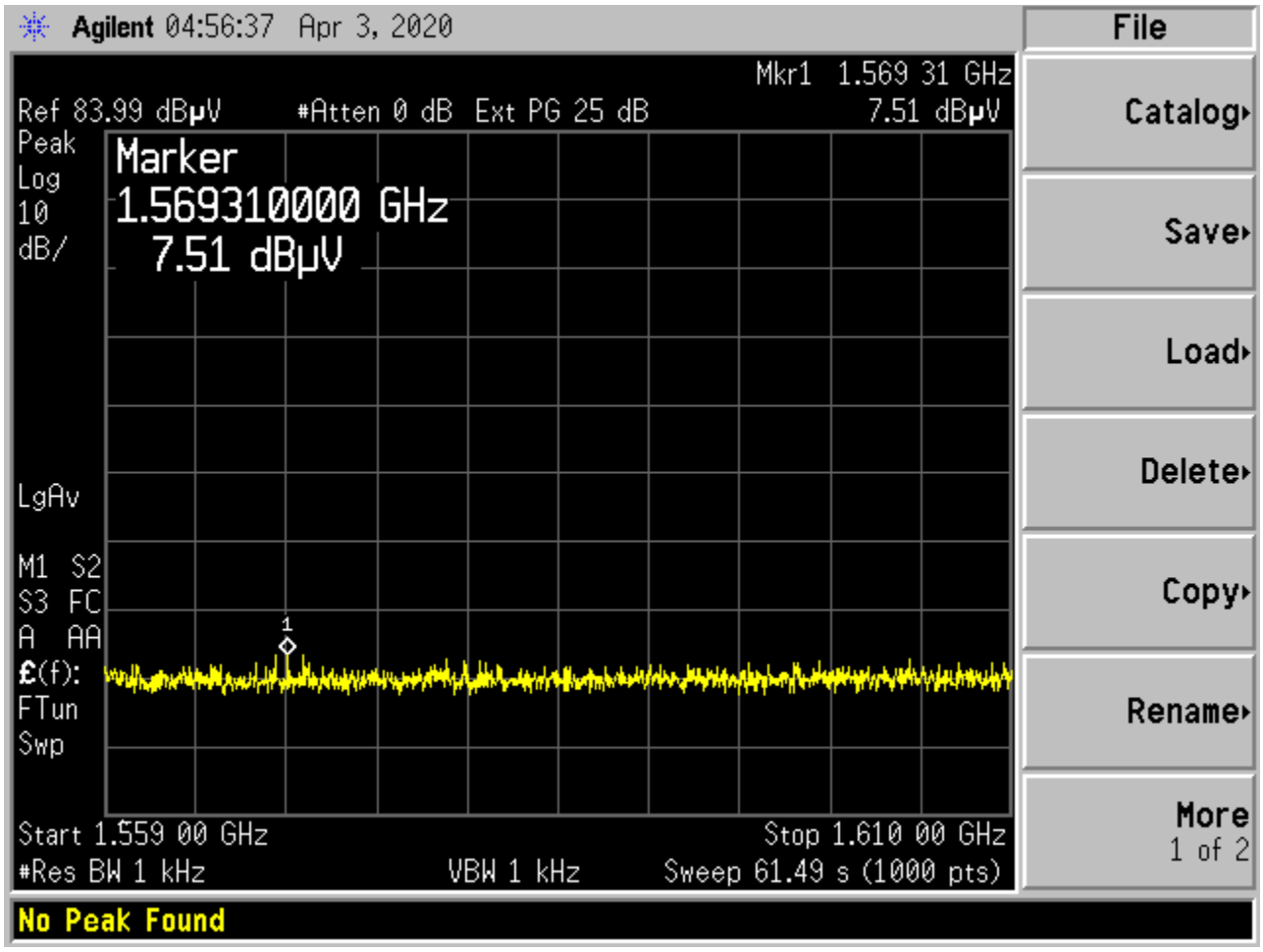


Figure 4: High GPS Band Vertical



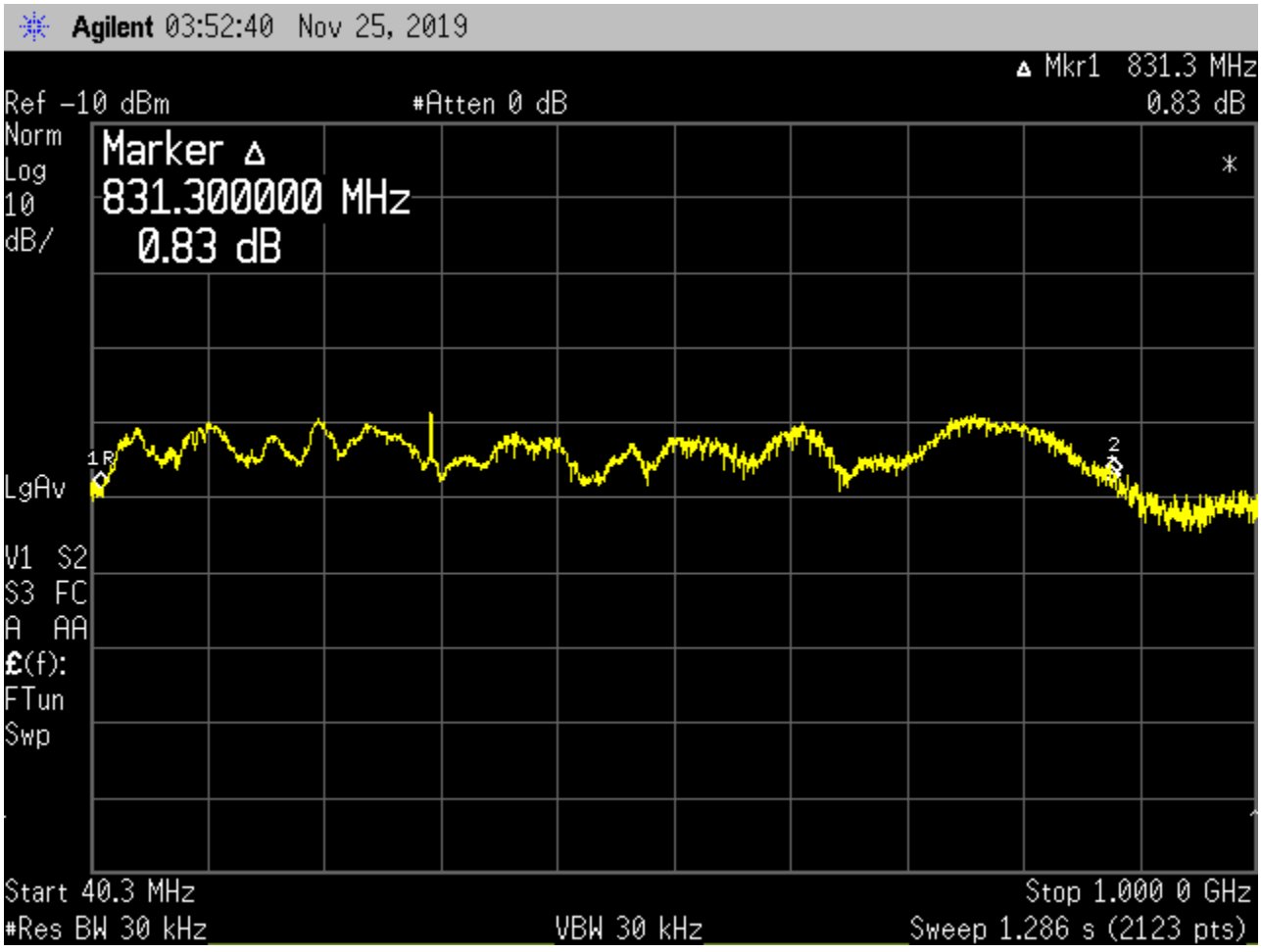
6.2 GPR PARAMETERS

6.2.1 Bandwidth

The UWB bandwidth of an imaging system operating under the provisions of this section must be below 10.6 GHz. *UWB bandwidth.* For the purpose of this subpart, the UWB bandwidth is the frequency band bounded by the points that are 10 dB below the highest radiated emission, as based on the complete transmission system including the antenna. The upper boundary is designated f_H and the lower boundary is designated f_L. The frequency at which the highest radiated emission occurs is designated f_M. *Ultra-wideband (UWB)* transmitter is an intentional radiator that, at any point in time, has a bandwidth equal to or greater than 500 MHz.

The 10 dB Bandwidth for this device is 831.3 MHz.

Figure 5: UWB Bandwidth



6.2.2 Frequency Points

The UWB device has frequency points that are spelled out. They at $F_{L,}$ $F_{M,}$ $F_{H\ and}$ $F_{C.}$

F_L	50.08 MHz
F_M	759.89 MHz
F_H	900.59 MHz
F_C	425.00 MHz

Figure 6: UWB F_L

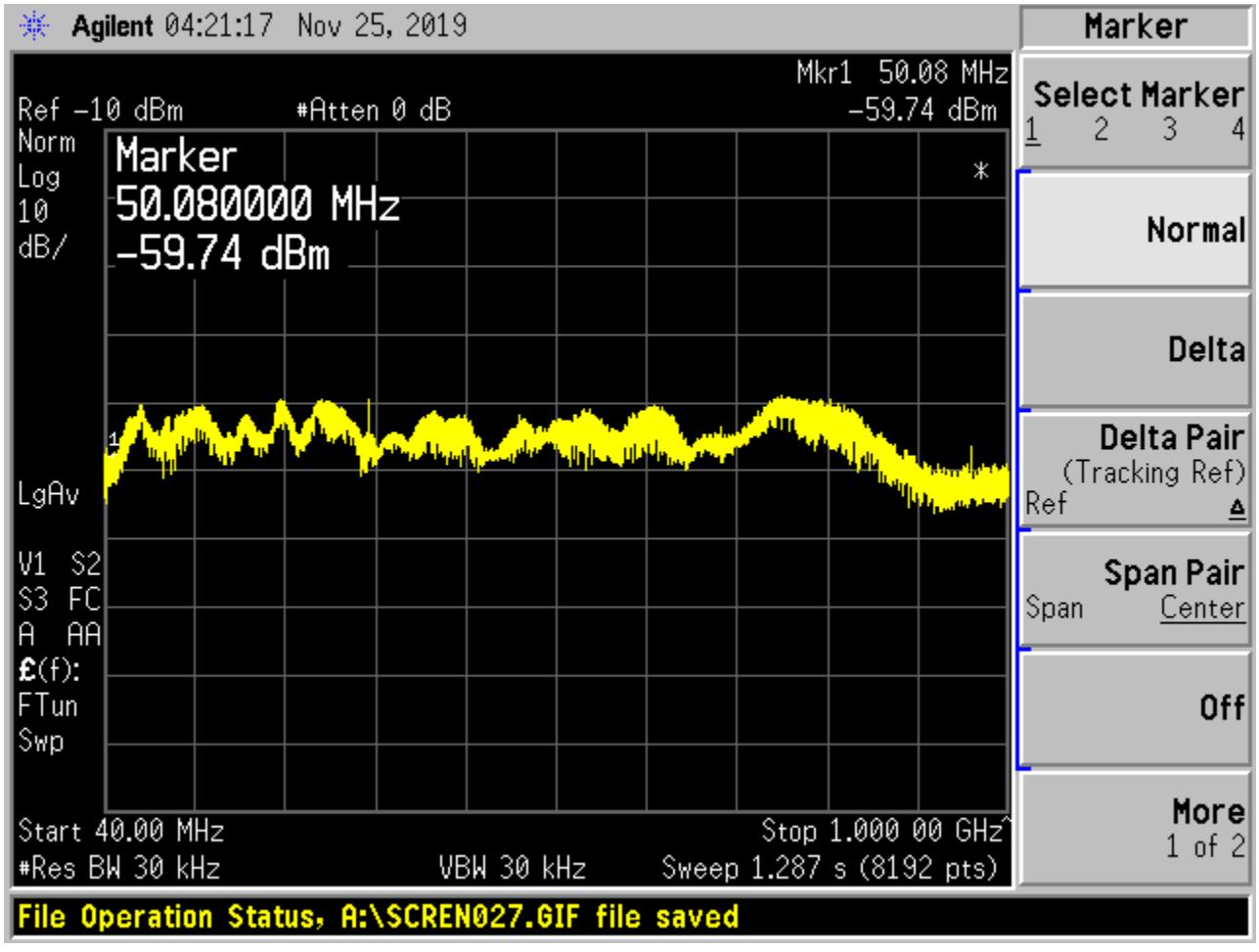


Figure 7: UWB F_H

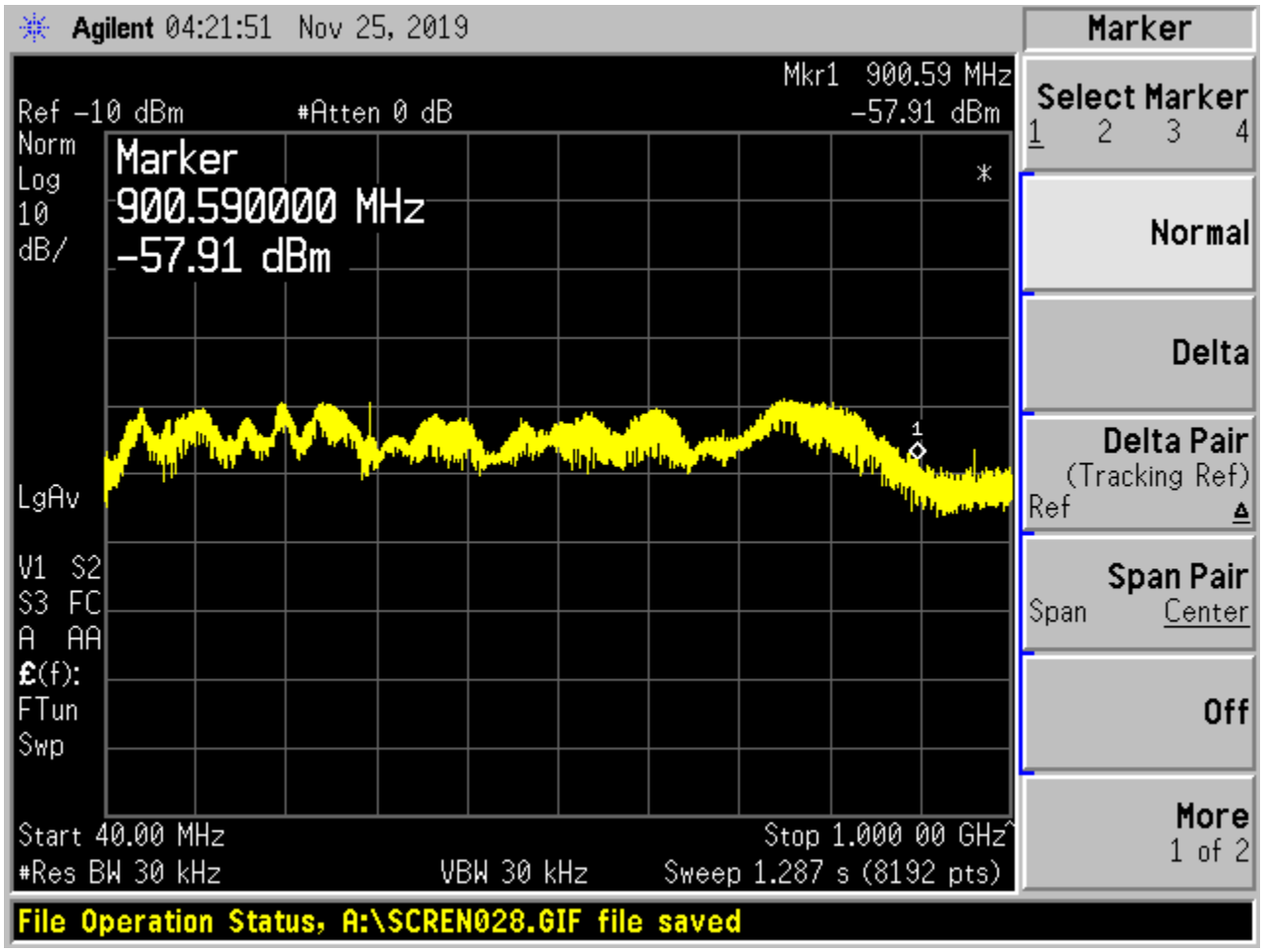


Figure 8: UWB F_C

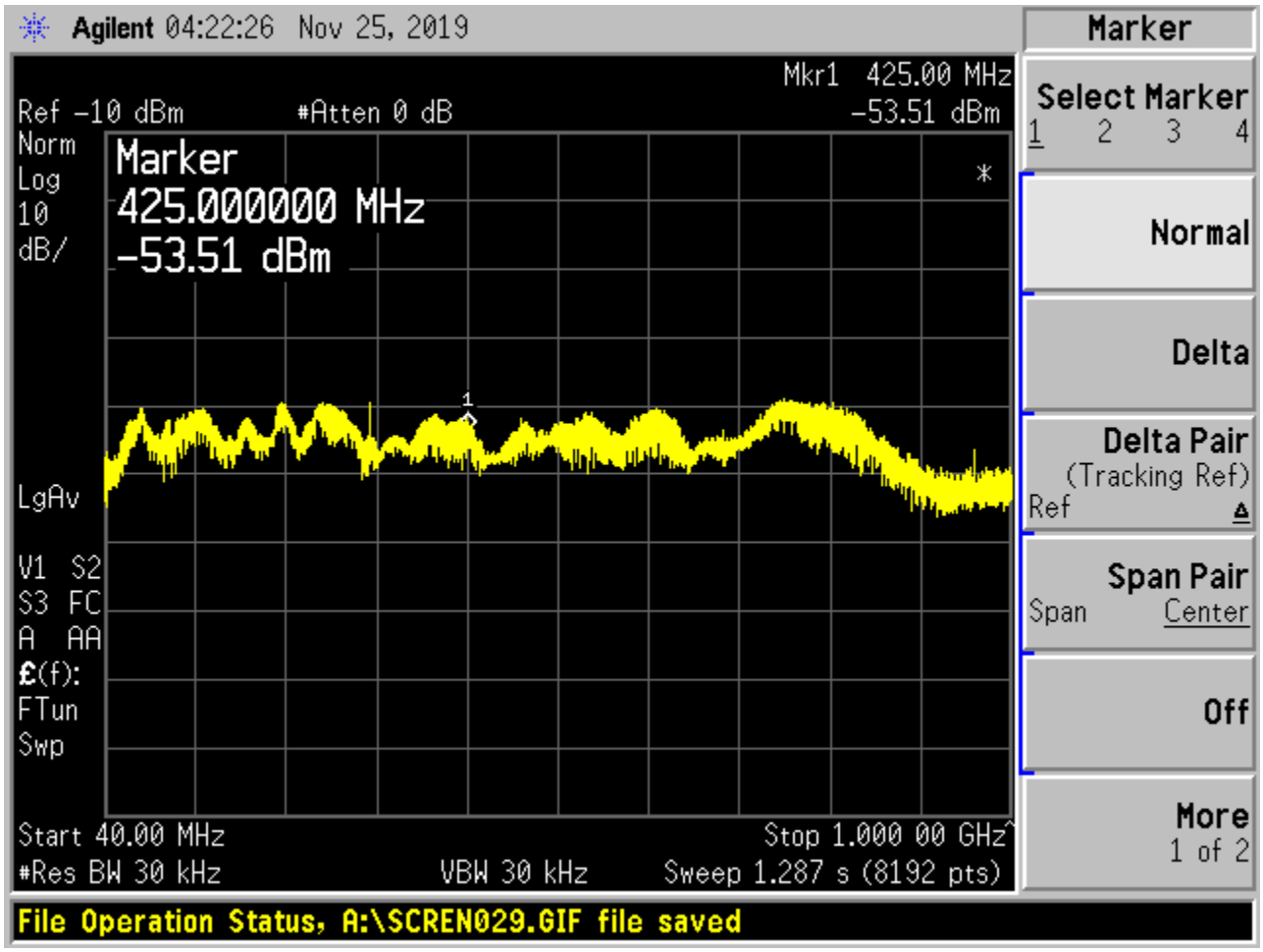
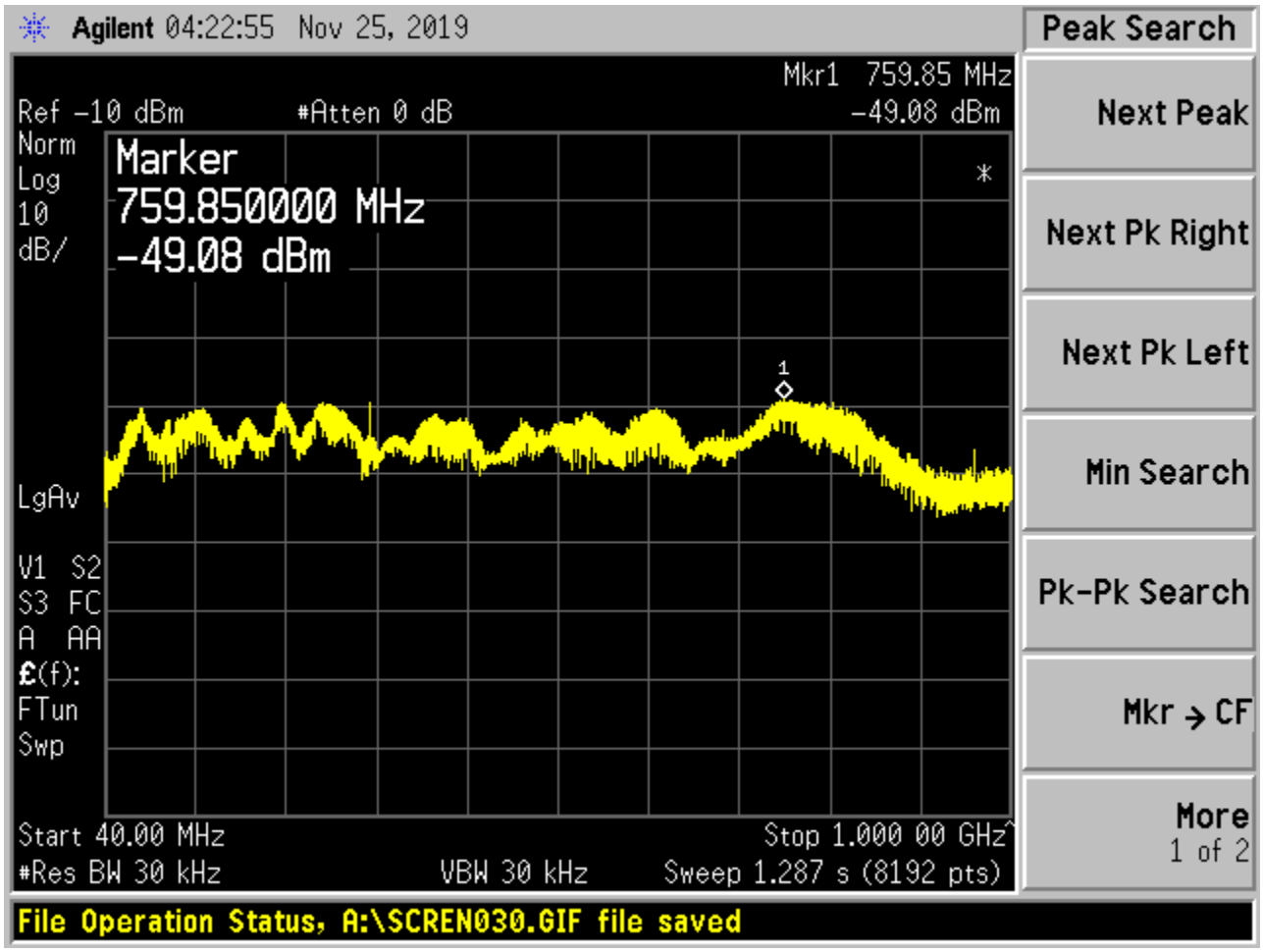
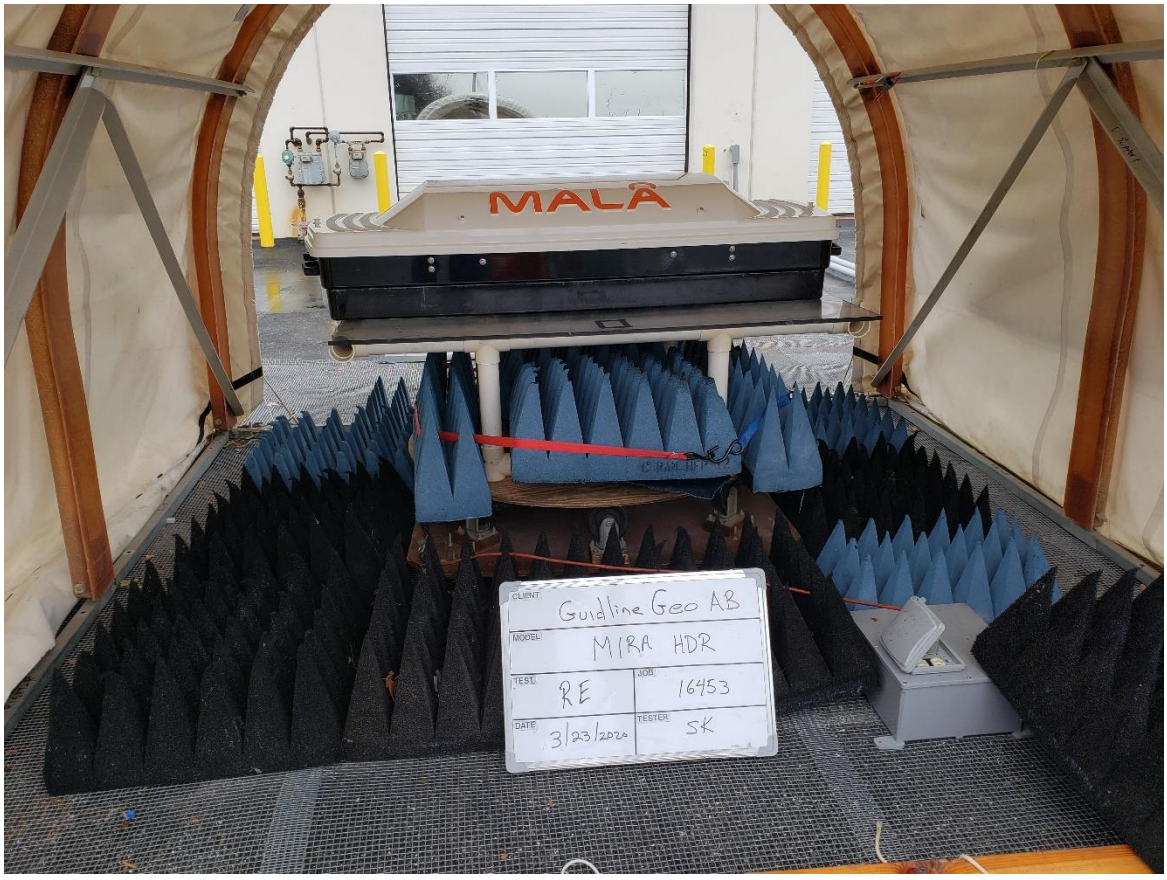


Figure 9: UWB F_M



Photograph 1: Radiated Emissions Test Configuration - Front



Photograph 2: Radiated Emissions Test Configuration - Back