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FCC Certification Test Report

For the

MARINE INSTRUMENTS, S.A.

M3P BUOY HEAD

FCC ID: 2AEES-MPTR

WLL REPORT# **14489-01 Rev 0**
December 13, 2016

Prepared for:

Marine Instruments, S.A.
Rúa dos Padróns No 4 (Vial 3)
Parque Empresarial Porto do Molle
Nigrán, Pontevedra 36350 Spain

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Prepared By:
Washington Laboratories, Ltd.
7560 Lindbergh Drive
Gaithersburg, Maryland 20879

Testing Certificate AT-1448

FCC Certification Test Report

For the

MARINE INSTRUMENTS, S.A.

M3P BUOY HEAD

WLL REPORT# **14489-01 Rev 1**
December 13, 2016

Prepared by:

James Ritter
EMC Compliance Engineer

Reviewed by:

Steven D. Koster
President

Abstract

This report has been prepared on behalf of Marine Instruments, S.A. to support the attached Application for Equipment Authorization. The test report and application are submitted for a Licensed Transmitter under Part 80. This was authorized by the FCC by waiver DA 16-219 granting a waiver of section 80.373(c) to permit use of frequencies 26.145, 26.150, 26.155, 26.160, 26.165, 26.170, and 26.175 MHz to transmit position and related information pertaining to equipment used in fishing operations

Testing was performed at Washington Laboratories, Ltd, 7560 Lindbergh Drive, Gaithersburg, MD 20879.

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 Marine Instruments M3P Buoy Head complies with the limits for a Licensed Transmitter device under FCC Part 80.

Revision History	Reason	Date
Rev 0	Initial Release	December 13, 2016

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1 Introduction

1.1 Compliance Statement

The Marine Instruments, S.A. M3P Buoy Head complied with the requirements of Part 80 as modified by waiver DA 16-219 granting a waiver of section 80.373(c) to permit use of frequencies 26.145, 26.150, 26.155, 26.160, 26.165, 26.170, and 26.175 MHz to transmit position and related information pertaining to equipment used in fishing operations and FCC inquiry Tracking Number 847377

1.2 Test Scope Summary

The following tests were performed to show compliance with Part 80E of the FCC rules:

Total Power	limited to 6W Per FCC waiver DA 16-219
Emission Bandwidth	80.205 (F1D, authorized Bandwidth 20kHz per FCC Inquiry Tracking Number 847377)
Emission Limitations	FCC Part 80.211 (f)
Frequency Tolerance	FCC Part 80.209
Modulation Characteristics	FCC Part 80.213 (Duty cycle Limitations)

1.3 Contract Information

Customer:	Marine Instruments, S.A. Rúa dos Padróns No 4 (Vial 3); Parque Empresarial Porto do Molle Nigrán, Pontevedra 36350 Spain
Quotation Number:	68638B

1.4 Test Dates

Testing was performed on the following date(s):	8/29/2016 to 12/9/2016

1.5 Test and Support Personnel

Washington Laboratories, Ltd.	James Ritter
Client Representative	Gregory Hammann

1.6 Abbreviations

A	**A**mpere
ac	**a**lternating **c**urrent
AM	Amplitude Modulation
Amps	**Amp**ere**s**
b/s	**b**its per **s**econd
BW	**B**and**W**idth
CE	**C**onducted **E**mission
cm	**c**enti**m**eter
CW	**C**ontinuous **W**ave
dB	**d**eci**B**el
dc	**d**irect **c**urrent
EMI	**E**lectro**m**agnetic **I**nterference
EUT	**E**quipment **U**nder **T**est
FM	**F**requency **M**odulation
G	**g**iga - prefix for 10^9 multiplier
Hz	**H**ertz
IF	**I**ntermediate **F**requency
k	**k**ilo - prefix for 10^3 multiplier
LISN	**L**ine **I**mpedance **S**tabilization **N**etwork
M	**M**ega - prefix for 10^6 multiplier
m	**m**eter
µ	**m**icro - prefix for 10^{-6} multiplier
NB	**N**arrow**b**and
QP	**Q**uasi-**P**eak
RE	**R**adiated **E**missions
RF	**R**adio **F**requency
rms	**r**oot-**m**ean-**s**quare
SN	**S**erial **N**umber
S/A	**S**pectrum **A**nalyzer
V	**V**olt

2 Equipment Under Test

2.1 EUT Identification

The results obtained relate only to the item(s) tested.

Table 1: Overview of M3P Buoy Head, Equipment Under Test

ITEM	DESCRIPTION
Manufacturer:	Marine Instruments, S.A.
EUT Name	Recon Scout Operator Control Unit
FCC ID:	2AEES-MPTR
Model:	M3P Buoy Head
Model covered:	M3P, M3P-T, M3P-R
FCC Rule Parts:	Part 80
Frequency Range:	26.145 - 26.175 MHz
Measured Output Power:	28.5dBm (0.7W) conducted total power
Modulation:	FSK
Emission Bandwidth:	526Hz
Keying:	Automatic
Type of Information:	Data
Number of Channels:	7 channels available- units fixed at factory for single channel
Antenna Connector	N Type
Antenna Type	Omni Whip
Antenna Gain	2dBi
Frequency Tolerance:	<10Hz
Emission Designator:	526HF1D
Interface Cables:	None
Power Source & Voltage:	Rechargeable Battery, Ni-MH Batteries / 12 V

2.2 EUT Description

HF Radio buoy for monitoring longline fishing gear or any other fishing gear or drifting assets. The buoy provides GPS position, battery level and optionally sea surface temperature. These buoys permit the vessel captain to monitor the gear's drift and current location using proprietary software specially designed for that purpose. The devices are pre-configured with the transmit frequency (not user changeable)

2.3 Test Configuration

The Marine Instruments, S.A. M3P Buoy Head, Equipment Under Test (EUT), was operated from a Lab power supply. The channels were preprogrammed and switchable via an external switch for lab testing. As the frequency range of programmable channels is less than 1 MHz only the center channel at 26.16MHz was tested. The unit was a stand-alone device.

2.4 Equipment Configuration

The EUT was comprised of the following equipment. (All Modules, PCBs, etc. listed were considered as part of the EUT, as tested.)

Table 2: Equipment Configuration

Name / Description	Model Number	Part Number	Serial Number	Revision
PCB M3P	P-1912	--	--	03

2.5 Support Equipment

The following support equipment was used during testing:

Table 3: Support Equipment

Item	Model/Part Number	Serial Number
AC/DC Transformer	CPE45-120800/9 (with female DC jack adapter and VHR-2N)	----

2.6 Interface Cables

Table 4: Interface Cables

Ref. ID	Port name on EUT	Cable Description or reason for no cable	Qty.	Length (m)	Shielded?	Termination Box ID & Port ID
1	DC IN (from Power Supply) Only for charging battery	Red/black cable with banana jacks on one end, various DC jacks on other	1	1	No	Port 1

2.7 EUT Modifications

None.

2.8 Test Location

All measurements herein were performed at Washington Laboratories, Ltd. test center in Gaithersburg, MD. Washington Laboratories, Ltd. has been accepted by the FCC and approved by ANAB under Certificate AT-1448 as an independent FCC test laboratory.

2.9 Measurement Uncertainty

All results reported herein relate only to the equipment tested. The basis for uncertainty calculation uses ANSI/NCSL Z540-2-1997 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 ≤ 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 5 below.

Table 5: Expanded Uncertainty List

Scope	Standard(s)	Expanded Uncertainty
Conducted Emissions	FCC Part 15	2.63 dB
Radiated Emissions	FCC Part 15	4.55 dB

3 Test Summary

The Table Below shows the results of testing for compliance with a M3P Buoy transmitter.

Table 6: Test Summary Table

FCC Rule Part	Description	Result
80.207, FCC Inquiry	Classes of Emission	Pass
80.205, 2.1049	Emission Bandwidth (Occupied Bandwidth)	Pass
80.215, 2.1046	Maximum Transmitter Power (RF Power)	Pass
80.211(f), 2.1051	Unwanted Radiation (at antenna terminal)	Pass
80.211(f), 2.1053	Unwanted Radiation (Radiated Emissions)	Pass
95.637, 2.1047	Modulation Standards (Duty Cycle)	Attested to by Manufacturer
80.205 2.1055	Frequency Stability	Pass

4 Test Equipment

Test Name: **Temperature Stability**		Test Date: **12/9/2016**	
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
Rental	AGILENT -EXA N9010B	ANALYZER SPECTRUM Ser#MY55460673	10/17/2017
00776	TENNY - TJR-A-WS4	1.22 CUFT	05/22/2017
00641	HQ power PS5005U	DC Power Supply	CNR
685	Fluke 115	True RMS Voltmeter	12/30/2016

Test Name: **Radiated Emissions**		Test Date: **9/1/2016**	
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
856	EMCO - 6507	ACTIVE LOOP 1KHZ - 30MHZ	11/12/2017
644	SUNOL SCIENCES CORPORATION - JB1 925-833-9936	BICONALOG ANTENNA	8/14/2017
559	HP - 8447D	AMPLIFIER	9/30/2016
823	AGILENT - N9010A	EXA SPECTRUM ANALYZER	9/30/2016
734	HEWLET PACKARD - 8647A	SIGNAL GENERATOR - 250KHZ - 1GHZ OPT 1E5 -HIGH STABILITY TIMEBASE	9/9/2016
428	EMCO - 3109	ANTENNA BICONICAL	9/30/2016

Test Name: **Conducted Antenna PortEmissions**		Test Date: **9/1/2016**	
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
823	AGILENT - N9010A	EXA SPECTRUM ANALYZER	9/30/2016

5 FCC Additional Requirements

5.1 FCC Waiver DA 16-219

5.1.1 Waiver Specifications

1. Grant a waiver of section 80.373(c) to permit use of frequencies 26.145, 26.150, 26.155, 26.160, 26.165, 26.170, and 26.175 MHz to transmit position and related information pertaining to equipment used in fishing operations.
2. Output power is limited to 6 watts.
3. Duty cycle is limited to a 3.9-second transmission every 5 to 15 minutes.
4. The technical requirements in part 80 Subpart E – General Technical Standards of the rules must be met.
5. Use is permitted only by fishing vessels with a ship station license issued under section 80.13(b) or 80.55 of the Commission's rules

5.1.2 FCC Inquiry Response

The FCC approved the following test methods per FCC inquiry Tracking Number 847377:

1. Authorized bandwidth (80.205) for the F1D transmission is authorized a 20kHz BW.
2. Then power is limited to 6 Watts peak conducted power.
3. The emission limit to be used is mask under section 802.11 (f).
4. The class of emission is radio determination.

6 Test Results

6.1 Classes of Emission (80.207, FCC Inquiry)

Pursuant to FCC waiver DA-16-219 and FCC inquiry Tracking Number 847377 the Class of emission shall be Radio Determination with a F1D designator and 20kHz authorized bandwidth. The frequency is waived. As the unit uses a FSK modulation with an occupied bandwidth of 526.1Hz these conditions are met.

6.2 Emission Bandwidth [FCC Part 80.205, 2.1049]

1.1.1 Test Method

The emission bandwidth test was performed as an occupied bandwidth measurement. The EUT antenna was disconnected from its antenna port and replaced with a calibrated cable connected to a spectrum analyzer through appropriate attenuators. A spectrum analyzer was tuned to the transmit frequency. The span of the analyzer was the reduced to approximately 2 to 3 times the span of the Tx signal. The resolution bandwidth of the device was lowered to approximately 1-5% of the estimated occupied bandwidth.. The span between points on each side of the Tx signal corresponding to 26dB below the peak were then recorded as the emission bandwidth.

1.1.2 Test Limit

FCC inquiry Tracking Number 847377 states that the authorized bandwidth is 20kHz.

1.1.3 Test Results

Figure 1 shows the plot of the occupied bandwidth. The recorded level is 526.1 Hz

1.1.4 Test Summary

The EUT complied with the requirements. Figure 1 through Figure 3 show the Occupied bandwidth Plots.

Table 7 provides a summary of the Occupied Bandwidth Results.

Table 7: Occupied Bandwidth results

Frequency	Bandwidth	Limit	Pass/Fail
26.145MHz	525Hz	20kHz	Pass
26.160MHz	525Hz	20kHz	Pass
26.175MHz	526Hz	20kHz	Pass

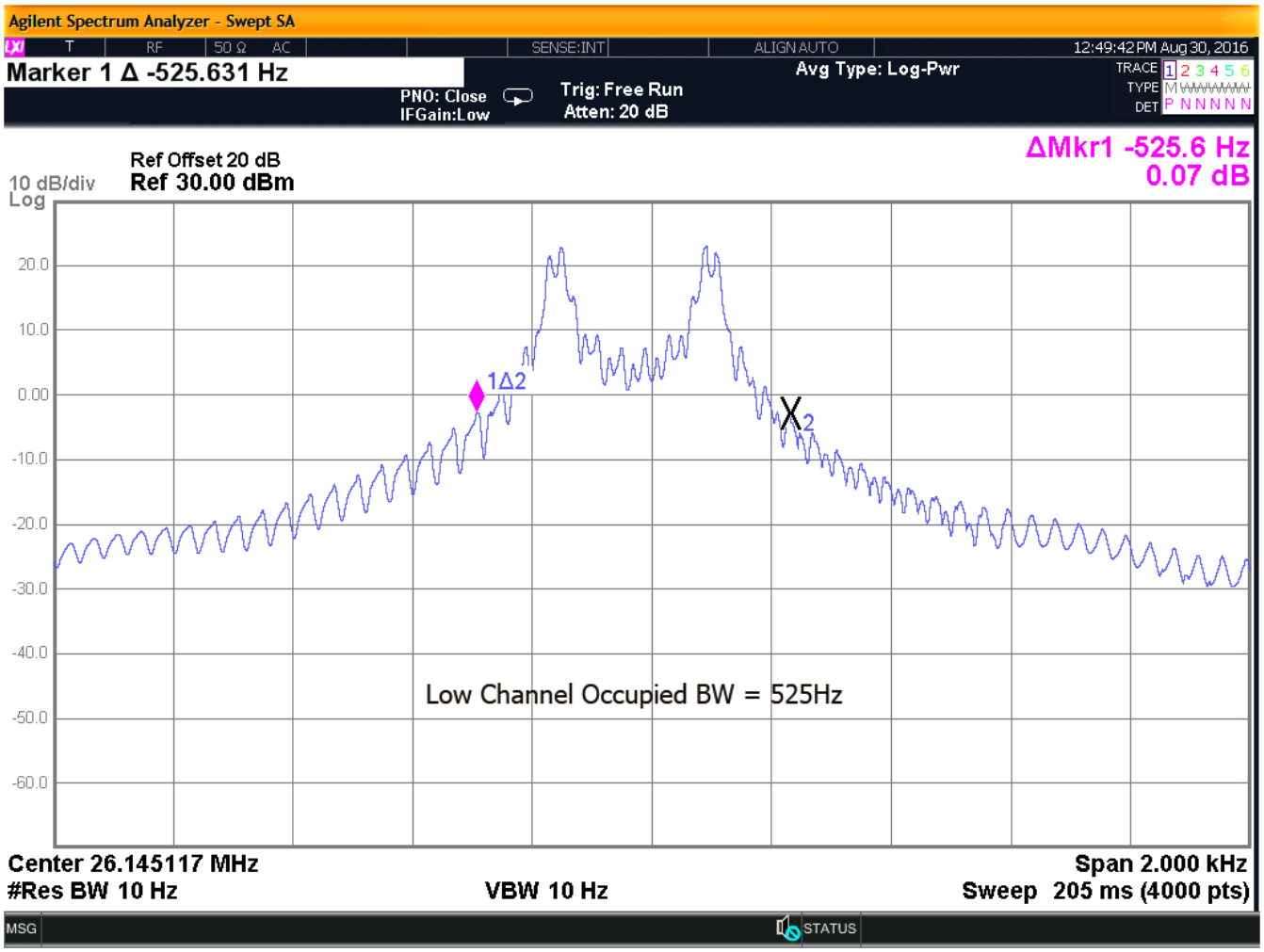

Figure 1: Low Channel Occupied Bandwidth

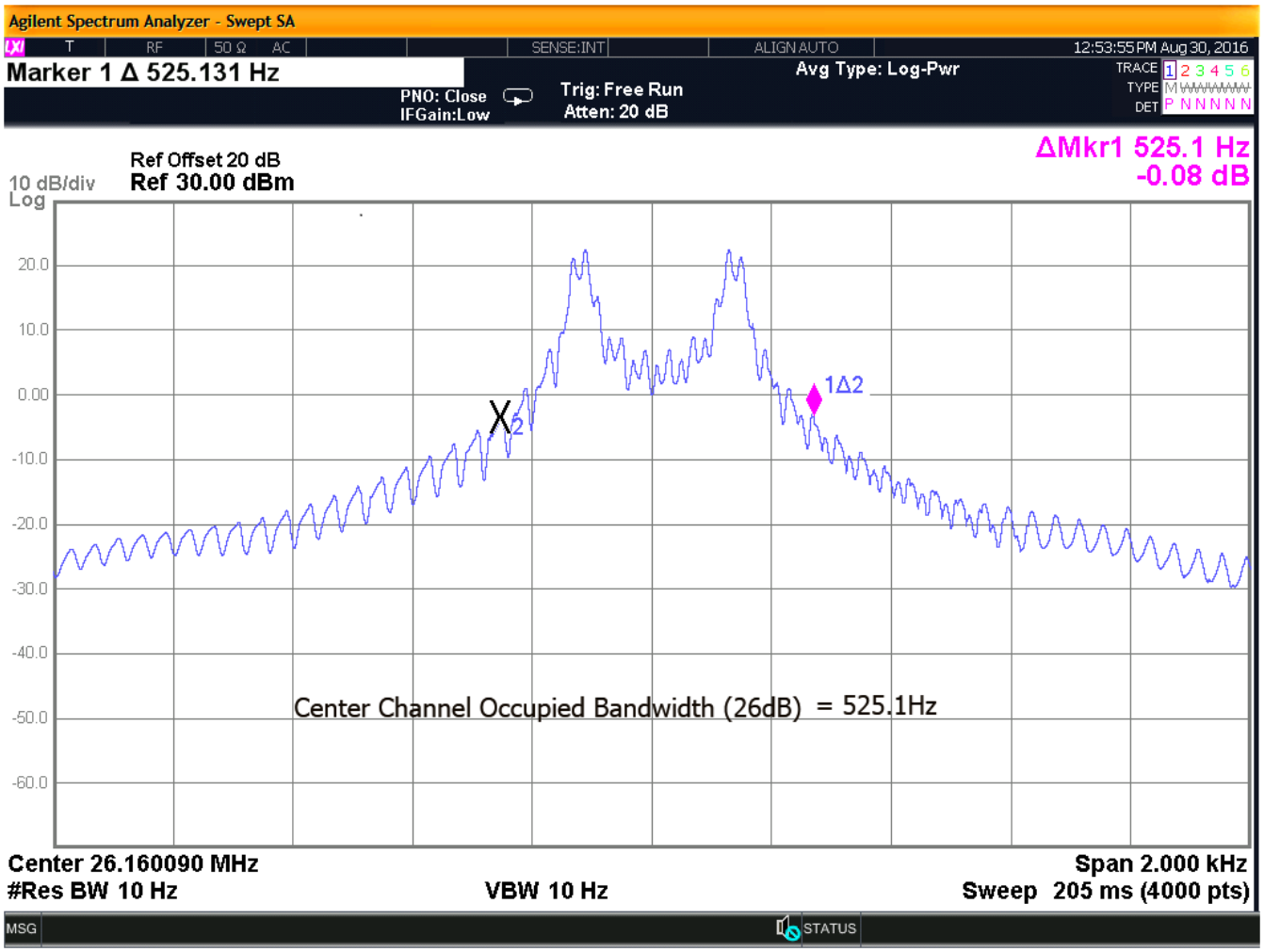

Figure 2: Center Channel Occupied Bandwidth

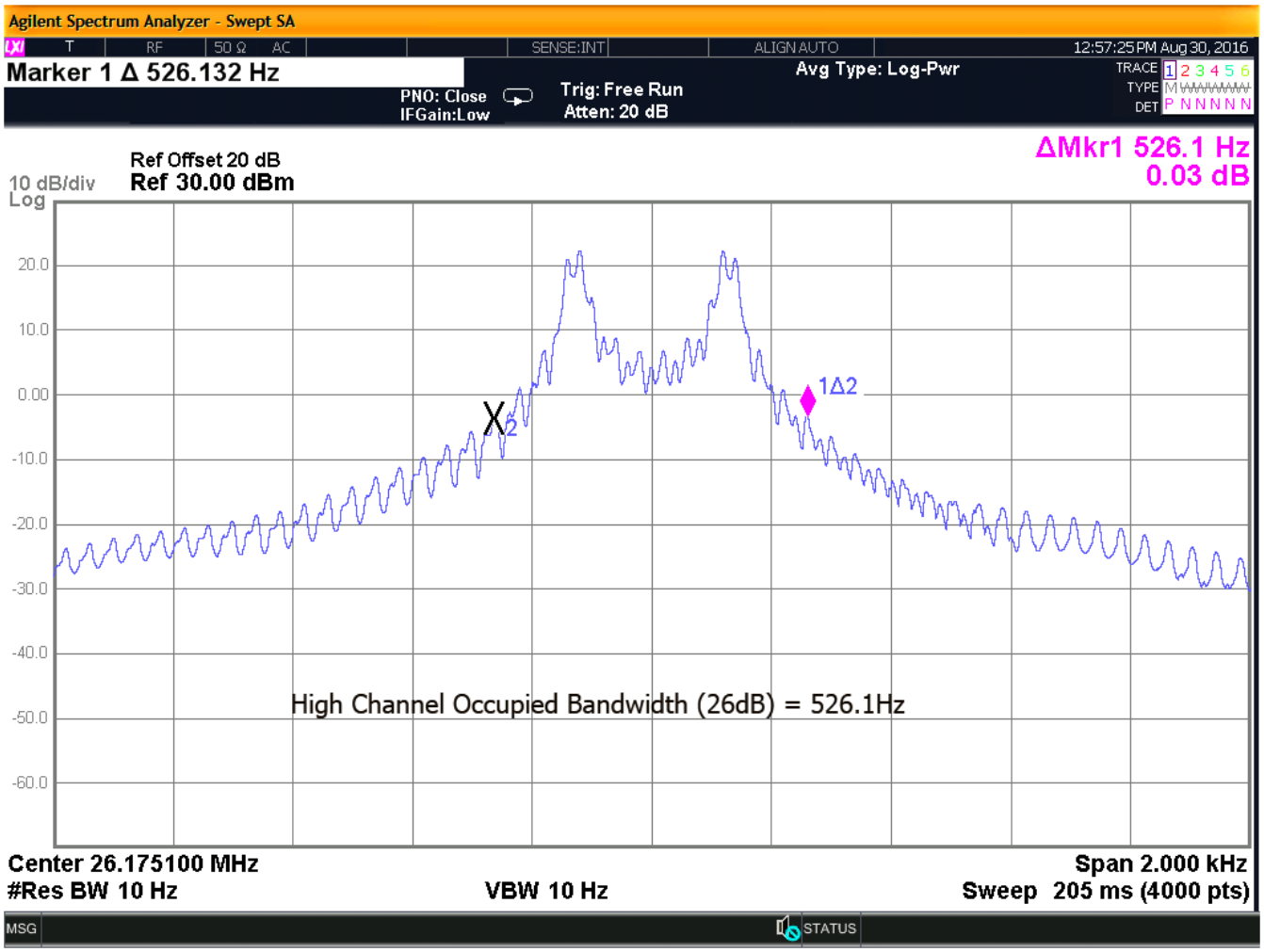

Figure 3: High Channel Occupied Bandwidth

6.3 RF Power [FCC Part 80.215, 2.1046]

6.3.1 Test Method

To measure the total power the EUT antenna was disconnected from its antenna port and replaced with a calibrated cable connected to a spectrum analyzer through appropriate attenuators. The EUT was the set to transmit with its modulation enabled. The resolution bandwidth was set larger than the occupied bandwidth with the video bandwidth set to greater than 3 times the RBW. A peak hold captured the highest peak power. This level was recorded for the conducted power.

6.3.2 Test Limit

Per FCC Waiver DA-16-219 the conducted power is limited to 6 Watts.

6.3.3 Test Results

Table 8 provides a summary of the RF Power Results.

Table 8: RF Power Results

Frequency	Power	Limit	Pass/Fail
26.145MHz	28.0dBm	37.8dBm (6W)	Pass
26.160MHz	27.9dBm	37.8dBm (6W)	Pass
26.175MHz	28.5dBm	37.8dBm (6W)	Pass

6.3.4 Test Summary

The RF Conducted power complies with the 6W limit.

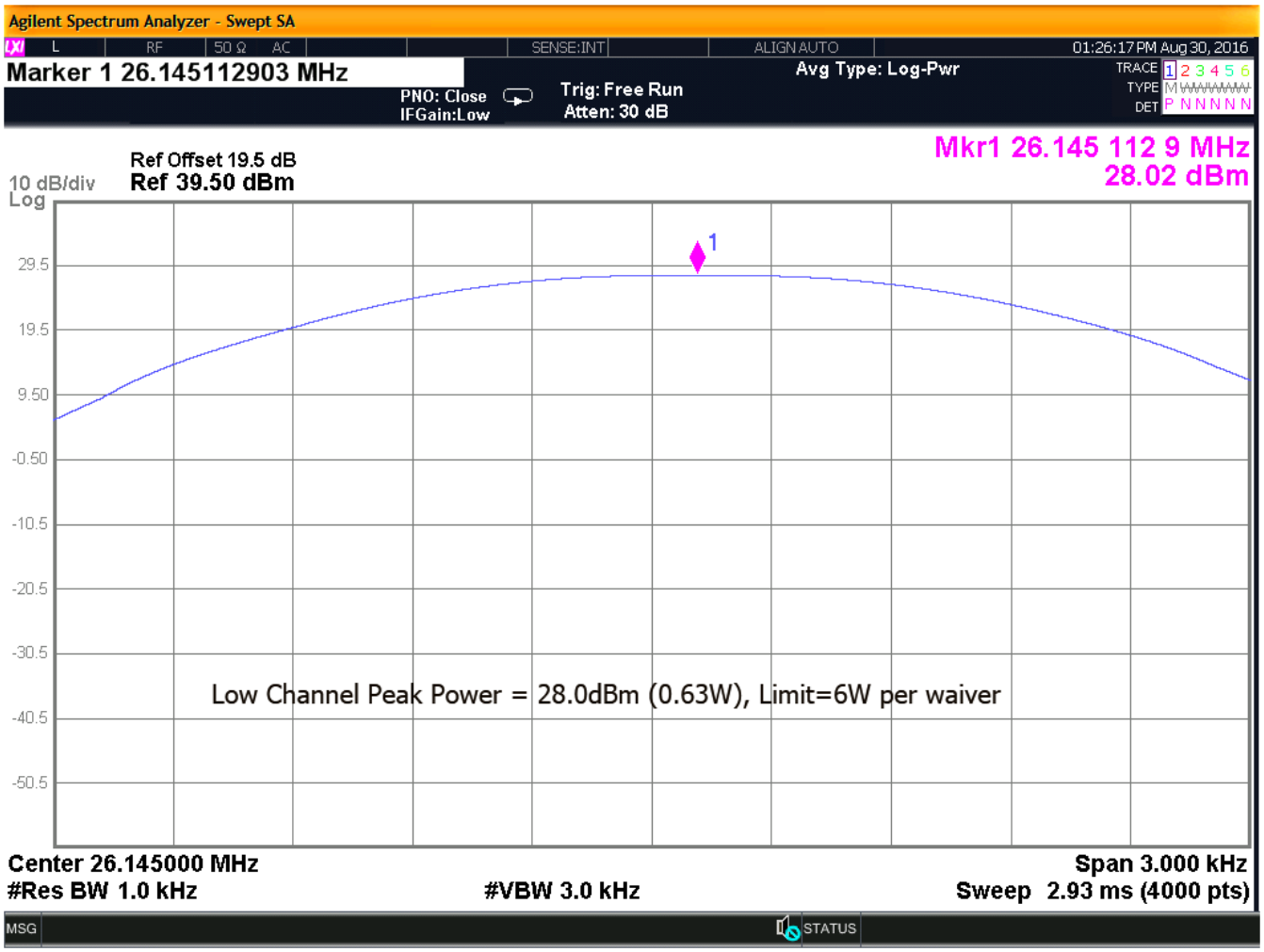

Figure 4: RF Power, Low Channel

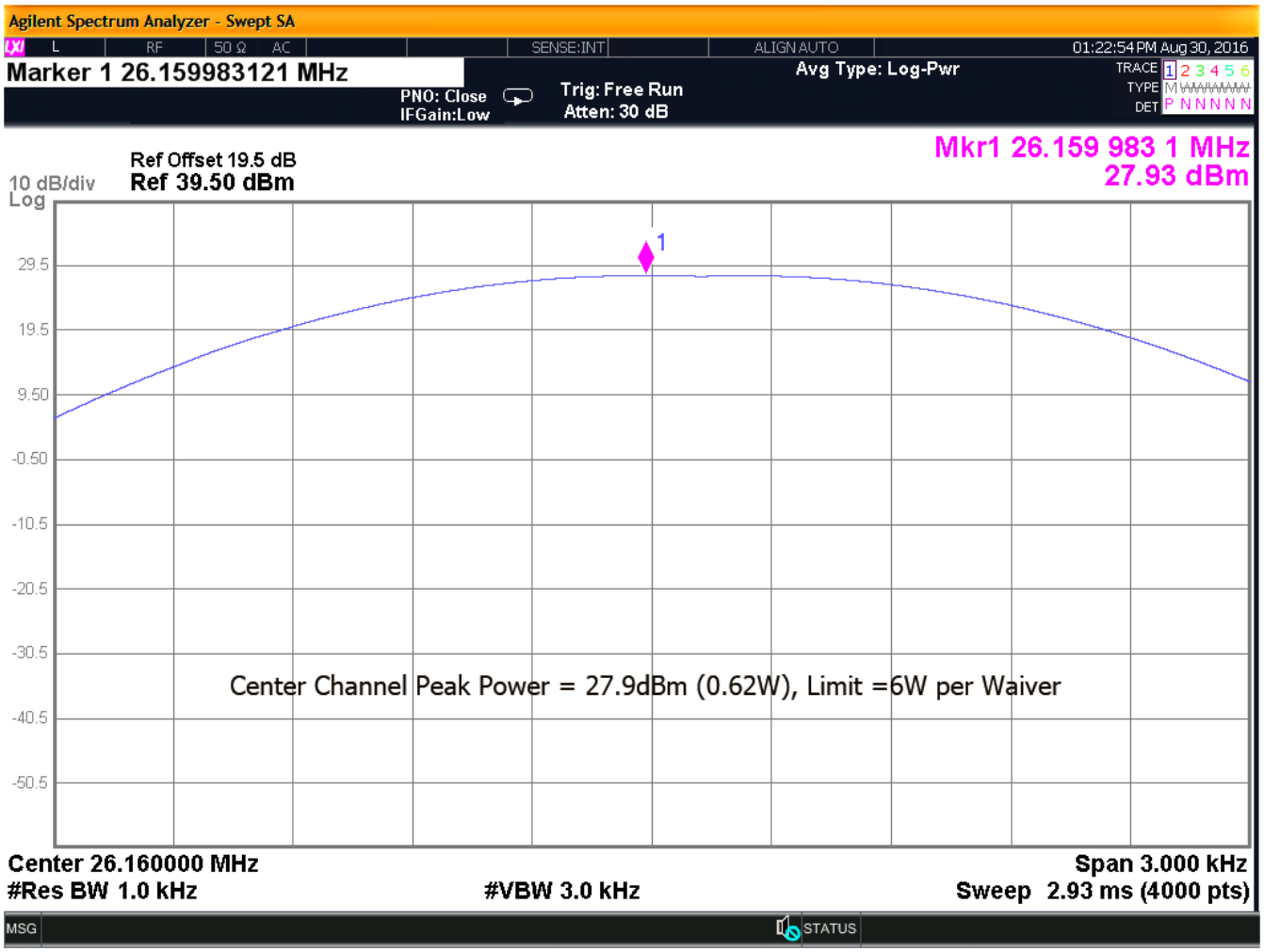

Figure 5: RF Power, Center Channel

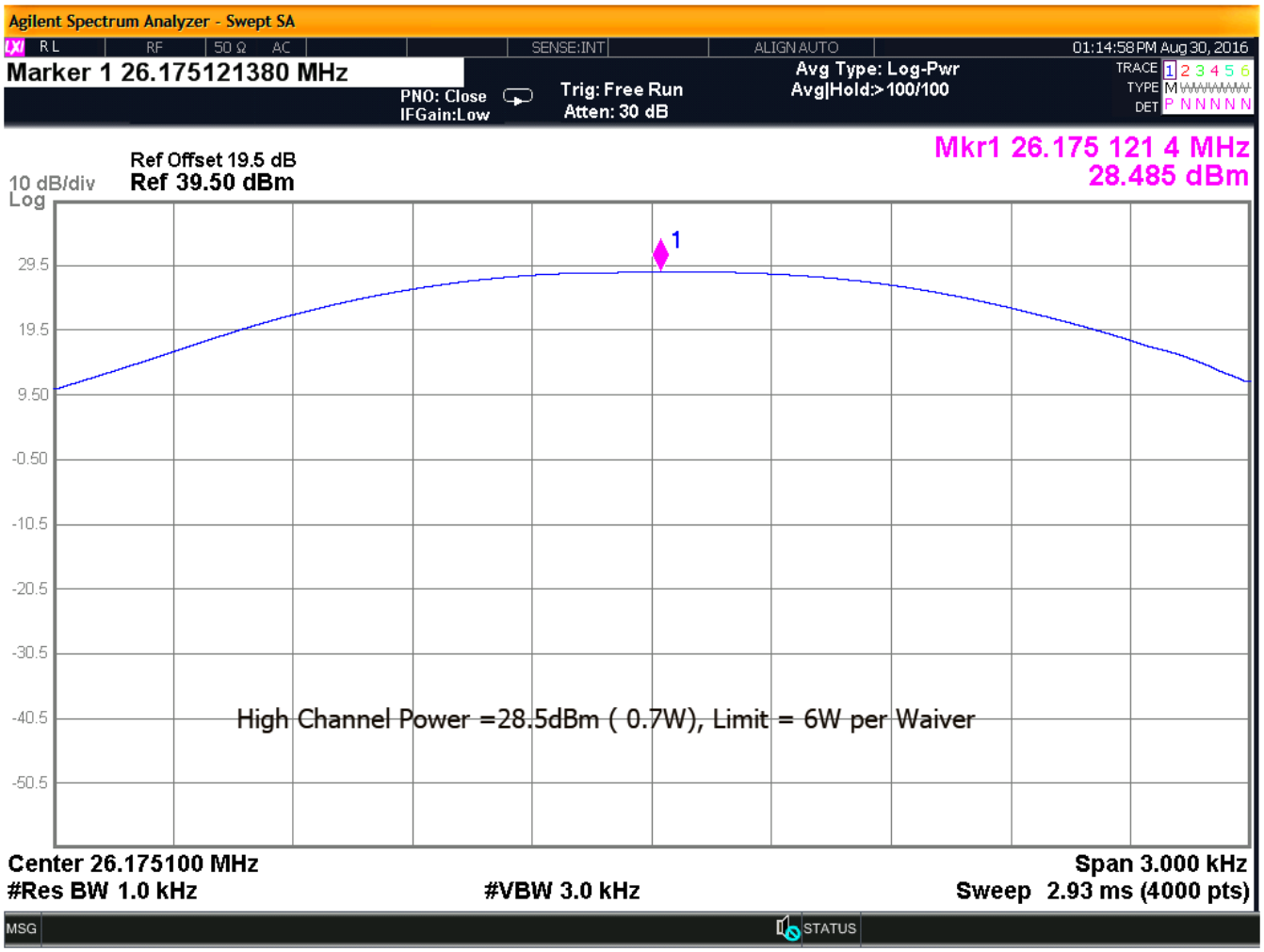

Figure 6: RF Power, High Channel

6.4 Emissions Limitations (spurious emissions) [FCC Part 80.211 (f), 2.1051, 2.1053]

6.4.1 Test Method

The unwanted radiation tests were tested via 2 methods using the limits set for in FCC Part 80.211(f) . The first method was a conducted method connecting the internal antenna connector to a spectrum analyzer. A resolution bandwidth of 30Hz was used inband. Larger resolution bandwidths were used out of band where possible to reduce the plots required to test the EUT (larger RBW's provide a worst case reading).

In addition the EUT was tested out of band (>250 % of authorized bandwidth) for radiated emissions on an open air test site (OATS) using the substitution method specified in TIA-603-D

A sample from the substitution tables is provided below to clarify them.

Frequency (MHz)	Polarity	Azimuth	Ant. Height (m)	Spurious Level (dBuV)	Sub. Sig. Gen. Level (dBm)	Sub. Power Level (dBm)	Sub. Ant. Factor (dB)	Sub. Ant. Gain (dB)	EIRP Level (dBm)	Limit (dBm)	Margin (dB)
151.42(a)	V(b)	0.0(b)	1.5(b)	25.69(c)	-54.2(d)	-58.0(e)	8.8(f)	5.0(g)	-52.9(h)	-26(j)	-27.1(k)

Columns:

a= Frequency of detected emission
b=Position of EUT and height/ polarization of receive antenna at maximum emission level
c= maximum field strength level of EUT emission on receiver without any corrections
d=Level of Signal Generator attached to a substitution antenna (replacing EUT) that produced a field strength identical to the EUT emission.
e=Signal Generator level at Substitution antenna (d minus any cable/connector losses)
f=Antenna Factor of substitution antenna used to get Antenna Gain
g=Substitution Antenna Gain
h=EIRP level of emission per TIA-603-D (column e plus column g) Note : numbers may have fractional differences
j= EIRP limit as specified in FCC part 80
k=Level of EUT EIRP (column i) compared to EIRP limit (Column j). Minus numbers indicate level below limit.

The EUT was placed on motorized turntable for radiated testing on a 3-meter open field test site. The emissions from the EUT were measured continuously at every azimuth by rotating the turntable. Receiving antennas were mounted on an antenna mast to determine the height of maximum emissions. The EUT was tested in 3 orthogonal positions for compliance. The EUT was then replaced with a substitution antenna of known gain and the levels of the initial emissions re-created with a signal generator feeding the substitution antenna. The signal generator reading was then converted to EIRP as shown in the above table explanation. A resolution bandwidth of 100kHz was used for radiated measurements. The EUT antenna was replaced by a dummy load for these readings.

Both tests were performed from 30MHz to the tenth harmonic of the fundamental frequency.

6.4.2 Test Limit

Per FCC Part 80.2119(f):

The attenuation from the mean peak power is as follows:

On any frequency removed from the assigned frequency by more than 50 percent up to and including 100 percent of the authorized bandwidth: At least 25 dB;

On any frequency removed from the assigned frequency by more than 100 percent up to and including 250 percent of the authorized bandwidth: At least 35 dB; and

On any frequency removed from the assigned frequency by more than 250 percent of the authorized bandwidth: At least 43 plus $10\log^{10}$ (mean power in watts) dB.

6.4.3 Test Results

The conducted tests are shown in Figure 7 to Figure 12. Radiated results are shown in Table 9 to Table 11.

6.4.4 Test Summary

The EUT complied with the requirements of FCC Part 80.211 mask f.

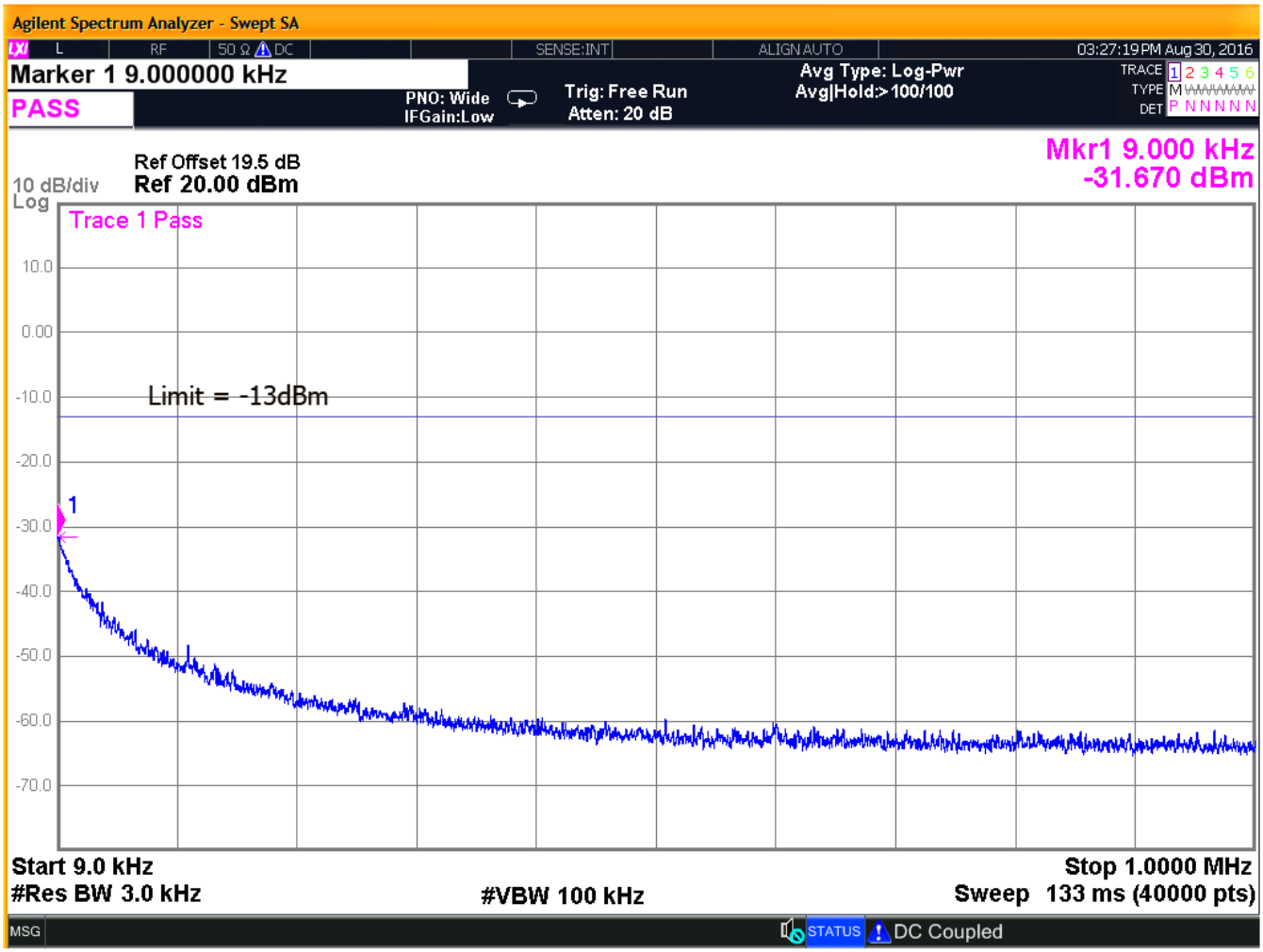

Figure 7: Spurious Emissions, 9kHz -1MHz

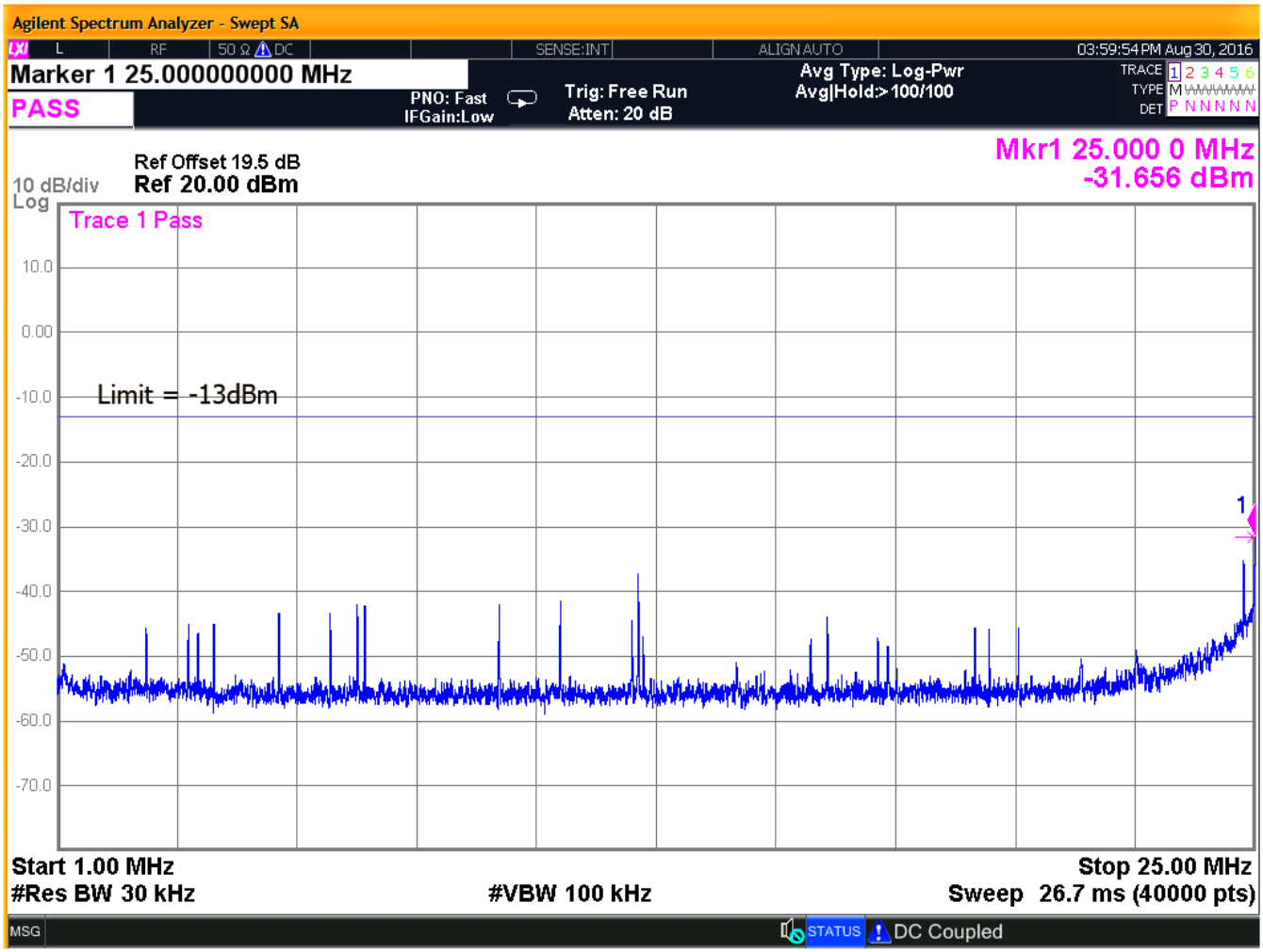

Figure 8: Spurious Emissions, 1-25MHz

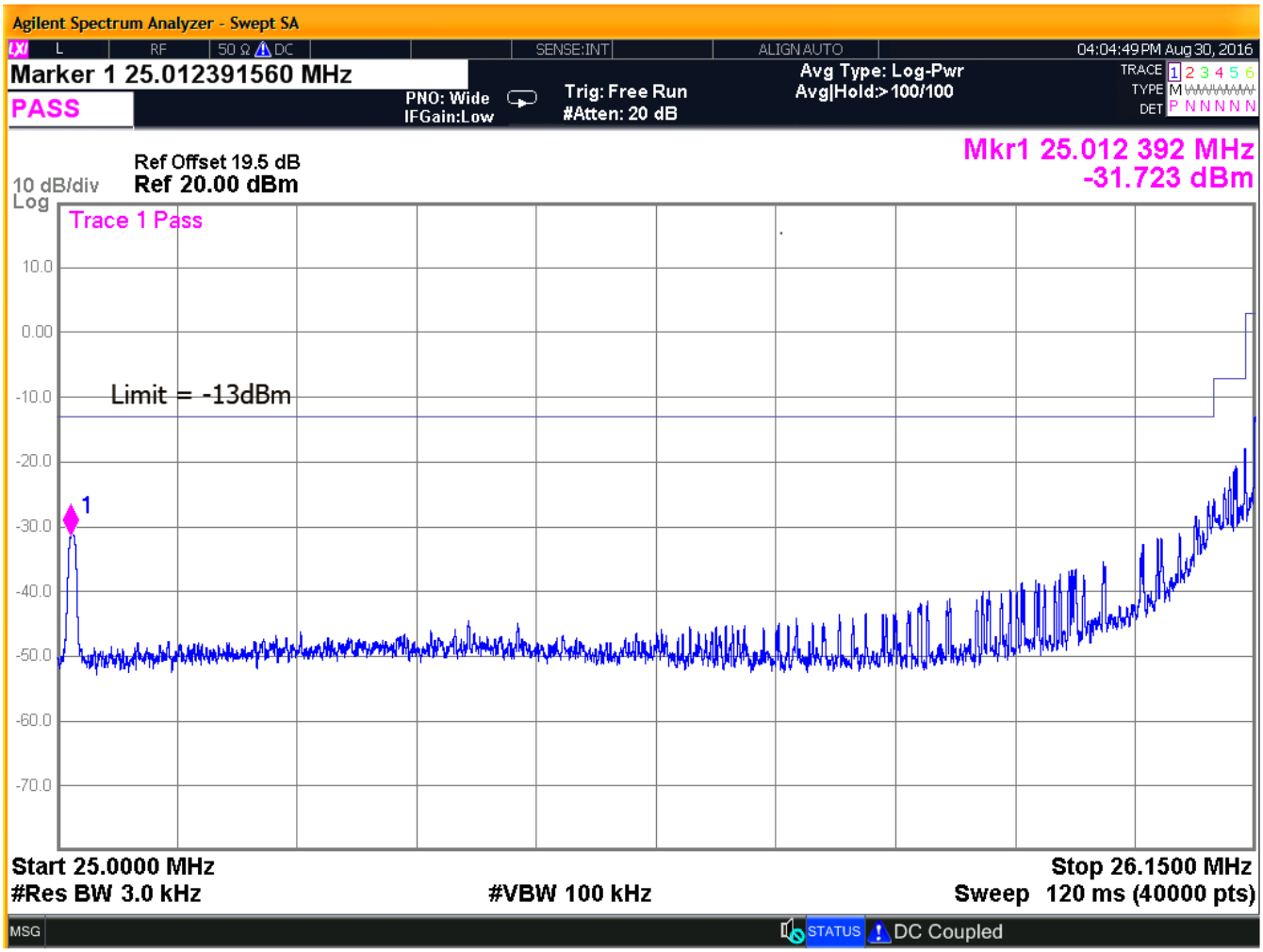

Figure 9: Spurious Emissions, 25 – 26.15MHz

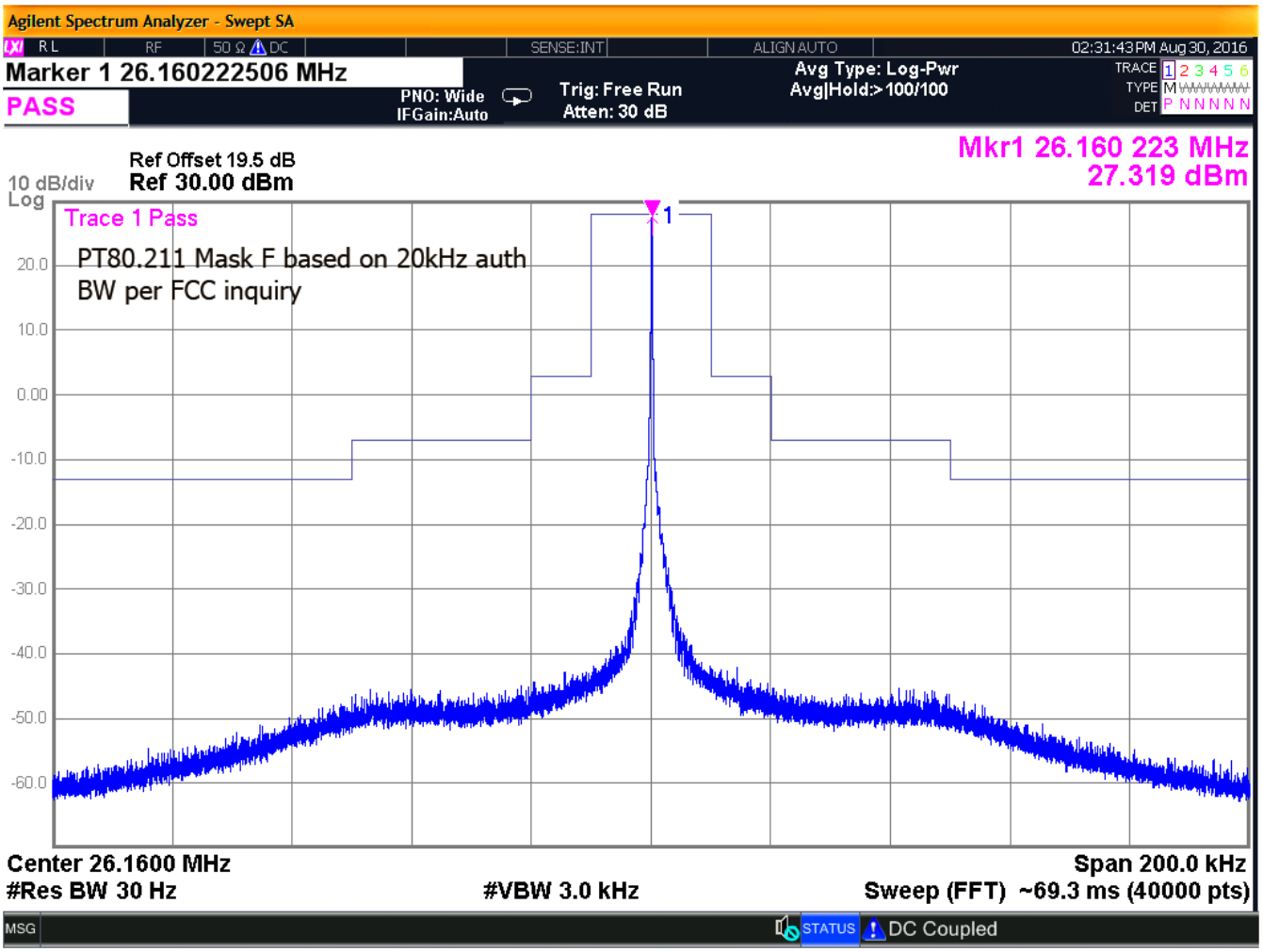

Figure 10: Spurious Emissions, 26.06 – 26.26MHz

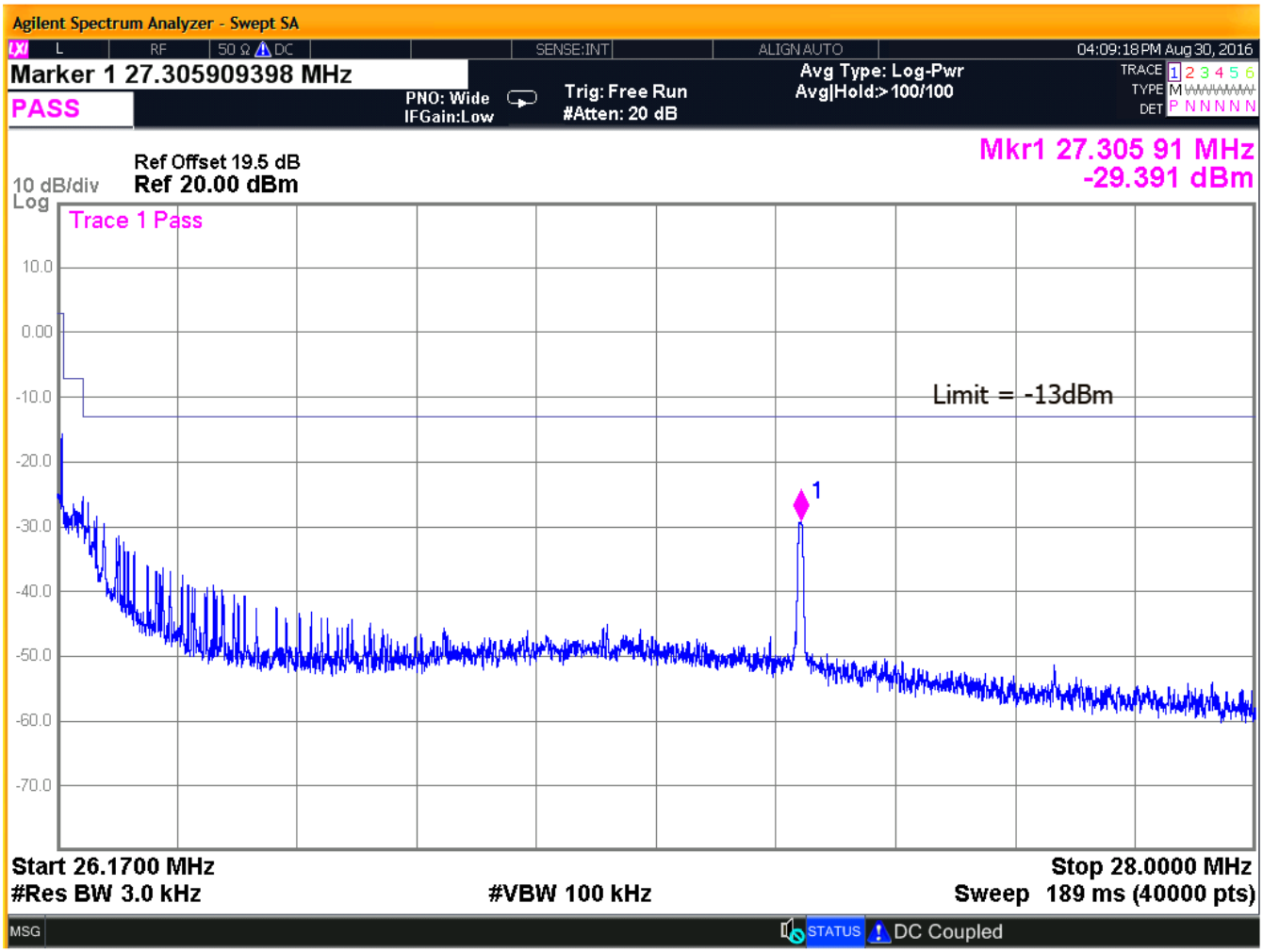

Figure 11: Spurious Emissions, 26.17 - 28MHz

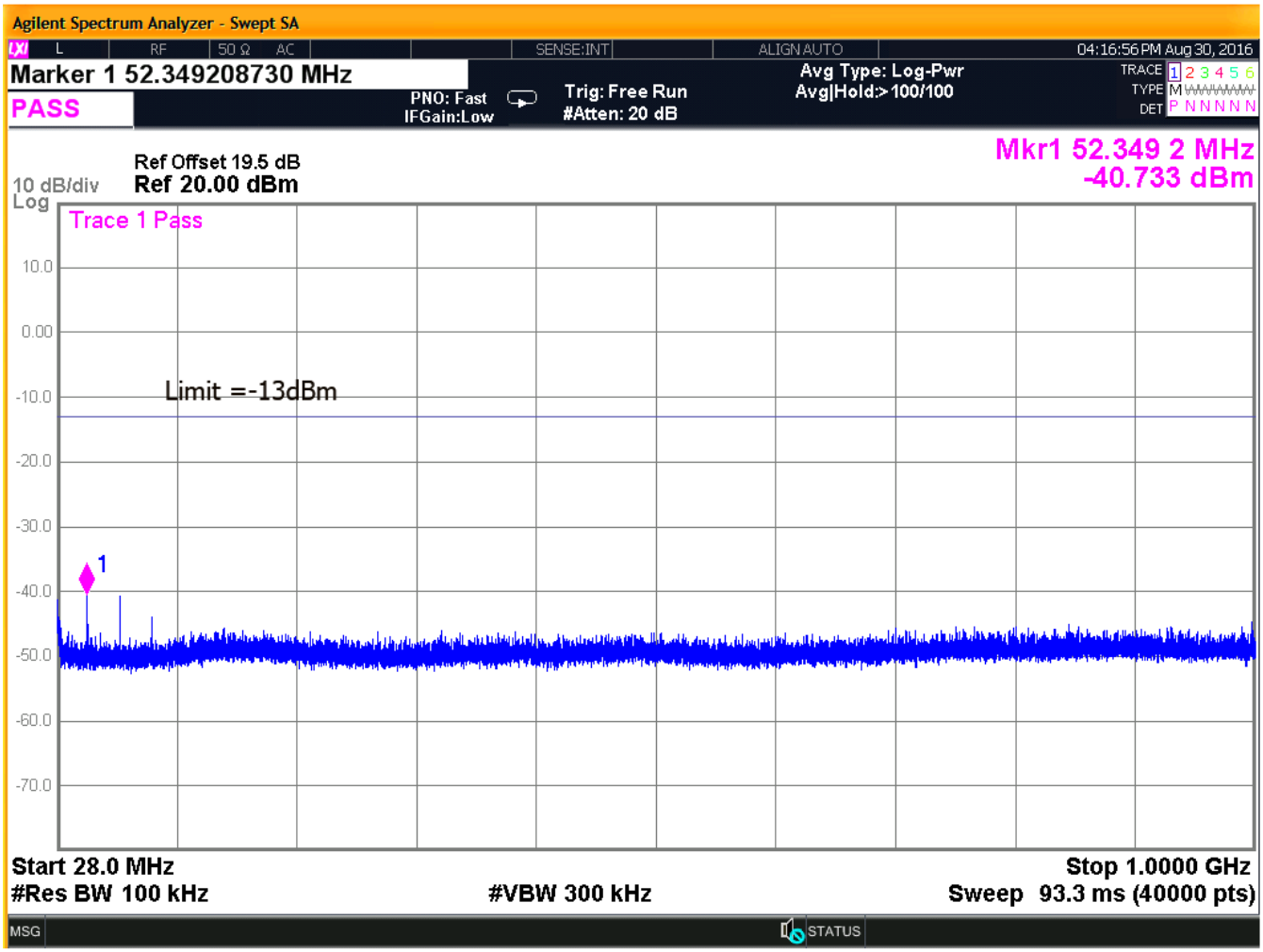

Figure 12: Spurious Emissions, 28 – 1000MHz

Table 9: Unwanted Emissions, Radiated emissions, Unit Upright

Frequency (MHz)	Polarity	Azimuth	Ant. Height (m)	Spurious Level (dBuV)	Sub. Sig. Gen. Level (dBm)	Sub. Power Level (dBm)	Sub. Ant. Factor (dB)	Sub. Ant. Gain (dB)	EIRP Level (dBm)	Limit (dBm)	Margin (dB)
52.32	V	180.0	1.0	39.1	-72.3	-74.7	12.4	-7.8	-82.5	-13	-69.5
78.49	V	90.0	1.0	44.1	-56.9	-59.7	8.6	-0.4	-60.2	-13	-47.2
130.80	V	190.0	1.0	36.1	-67.4	-71.1	12.8	-0.2	-71.3	-13	-58.3
156.96	V	10.0	1.2	31.6	-73.7	-77.6	13.0	1.1	-76.5	-13	-63.5
183.12	V	0.0	1.4	39.3	-66.6	-70.9	13.6	1.9	-69.0	-13	-56.0
209.28	V	180.0	1.3	41.7	-63.3	-67.9	15.3	1.3	-66.6	-13	-53.6
235.44	V	10.0	1.6	40.2	-64.7	-69.5	15.9	1.7	-67.8	-13	-54.8
261.61	V	180.0	2.0	39.9	-61.5	-66.5	18.7	-0.1	-66.6	-13	-53.6
287.76	V	90.0	2.0	39.0	-55.7	-60.9	23.4	-4.0	-65.0	-13	-52.0
52.32	H	180.0	3.4	33.4	-69.3	-71.7	12.4	-7.8	-79.5	-13	-66.5
78.48	H	180.0	2.5	33.9	-75.5	-78.3	8.6	-0.4	-78.8	-13	-65.8
130.80	H	180.0	2.5	30.3	-75.1	-78.8	12.8	-0.2	-79.0	-13	-66.0
156.96	H	270.0	2.5	29.5	-79.0	-82.9	13.0	1.1	-81.8	-13	-68.8
183.12	H	90.0	3.0	40.4	-71.1	-75.4	13.6	1.9	-73.5	-13	-60.5
209.28	H	270.0	2.4	31.4	-79.3	-83.9	15.3	1.3	-82.6	-13	-69.6
235.44	H	0.0	1.7	44.3	-64.1	-68.9	15.9	1.7	-67.2	-13	-54.2
261.60	H	270.0	1.4	38.8	-68.1	-73.1	18.7	-0.1	-73.2	-13	-60.2
287.75	H	10.0	1.0	41.0	-63.4	-68.6	23.4	-4.0	-72.7	-13	-59.7

Table 10: Unwanted Emissions, Radiated emissions, Unit on side 1

Frequency (MHz)	Polarity	Azimuth	Ant. Height (m)	Spurious Level (dBuV)	Sub. Sig. Gen. Level (dBm)	Sub. Power Level (dBm)	Sub. Ant. Factor (dB)	Sub. Ant. Gain (dB)	EIRP Level (dBm)	Limit (dBm)	Margin (dB)
52.32	V	0.0	1.0	36.8	-75.0	-77.4	12.4	-7.8	-85.2	-13	-72.2
78.49	V	0.0	1.0	38.5	-62.2	-65.0	8.6	-0.4	-65.5	-13	-52.5
130.80	V	180.0	1.2	33.1	-70.0	-73.7	12.8	-0.2	-73.9	-13	-60.9
156.96	V	270.0	1.4	28.4	-76.9	-80.8	13.0	1.1	-79.7	-13	-66.7
183.12	V	270.0	1.3	38.6	-67.4	-71.7	13.6	1.9	-69.8	-13	-56.8
209.28	V	0.0	1.4	33.9	-71.5	-76.1	15.3	1.3	-74.8	-13	-61.8
235.44	V	90.0	1.5	37.5	-67.4	-72.2	15.9	1.7	-70.5	-13	-57.5
261.61	V	90.0	2.0	39.1	-62.3	-67.3	18.7	-0.1	-67.4	-13	-54.4
287.76	V	0.0	2.2	37.2	-57.7	-62.9	23.4	-4.0	-67.0	-13	-54.0
52.32	H	10.0	3.2	33.8	-68.9	-71.3	12.4	-7.8	-79.1	-13	-66.1
78.48	H	180.0	2.6	38.2	-71.1	-73.9	8.6	-0.4	-74.4	-13	-61.4
130.80	H	10.0	2.5	30.1	-75.3	-79.0	12.8	-0.2	-79.2	-13	-66.2
156.96	H	180.0	2.5	30.8	-77.8	-81.7	13.0	1.1	-80.6	-13	-67.6
183.12	H	270.0	2.5	39.2	-72.3	-76.6	13.6	1.9	-74.7	-13	-61.7
209.28	H	180.0	2.5	37.1	-73.7	-78.3	15.3	1.3	-77.0	-13	-64.0
235.44	H	180.0	1.5	41.1	-67.2	-72.0	15.9	1.7	-70.3	-13	-57.3
261.60	H	180.0	1.2	41.2	-65.6	-70.6	18.7	-0.1	-70.7	-13	-57.7
287.75	H	190.0	1.2	41.6	-62.8	-68.0	23.4	-4.0	-72.1	-13	-59.1

Table 11: Unwanted Emissions, Radiated emissions, Unit Side 2

Frequency (MHz)	Polarity	Azimuth	Ant. Height (m)	Spurious Level (dBuV)	Sub. Sig. Gen. Level (dBm)	Sub. Power Level (dBm)	Sub. Ant. Factor (dB)	Sub. Ant. Gain (dB)	EIRP Level (dBm)	Limit (dBm)	Margin (dB)
52.32	V	180.0	1.0	37.7	-74.4	-76.8	12.4	-7.8	-84.6	-13	-71.6
78.49	V	10.0	1.0	37.8	-63.2	-66.0	8.6	-0.4	-66.5	-13	-53.5
130.80	V	10.0	1.0	32.2	-71.4	-75.1	12.8	-0.2	-75.3	-13	-62.3
156.96	V	90.0	1.3	29.7	-75.4	-79.3	13.0	1.1	-78.2	-13	-65.2
183.12	V	90.0	1.3	39.5	-66.7	-71.0	13.6	1.9	-69.1	-13	-56.1
209.28	V	45.0	1.5	35.6	-69.3	-73.9	15.3	1.3	-72.6	-13	-59.6
235.44	V	90.0	1.6	37.5	-67.3	-72.1	15.9	1.7	-70.4	-13	-57.4
261.61	V	90.0	2.5	38.6	-62.8	-67.8	18.7	-0.1	-67.9	-13	-54.9
287.76	V	10.0	2.5	36.3	-58.5	-63.7	23.4	-4.0	-67.8	-13	-54.8
52.32	H	0.0	3.0	34.0	-68.5	-70.9	12.4	-7.8	-78.7	-13	-65.7
78.48	H	180.0	2.8	39.8	-69.5	-72.3	8.6	-0.4	-72.8	-13	-59.8
130.80	H	0.0	2.5	29.4	-76.2	-79.9	12.8	-0.2	-80.1	-13	-67.1
156.96	H	90.0	2.4	31.2	-77.4	-81.3	13.0	1.1	-80.2	-13	-67.2
183.12	H	90.0	2.5	42.0	-69.5	-73.8	13.6	1.9	-71.9	-13	-58.9
209.28	H	180.0	2.4	39.4	-71.4	-76.0	15.3	1.3	-74.7	-13	-61.7
235.44	H	180.0	1.6	45.0	-63.8	-68.6	15.9	1.7	-66.9	-13	-53.9
261.60	H	0.0	1.3	47.7	-59.3	-64.3	18.7	-0.1	-64.4	-13	-51.4
287.75	H	190.0	1.3	40.1	-64.2	-69.4	23.4	-4.0	-73.5	-13	-60.5

6.5 Frequency Tolerance [FCC Part 80.209,2 1055]

6.5.1 Test Method

The EUT was placed in a calibrated temperature chamber. A receive antenna was placed in the temperature chamber with the device connected to a frequency counter outside the chamber. The EUT was set to transmit at 26.160MHz with an unmodulated carrier. A frequency reading was taken with the temperature at ambient (26C). The EUT was turned off and the temperature chamber set to -30 Celsius after 1 hour at this temperature the unit was turned on and a frequency reading was taken. The unit was turned back off and the temperature changed to -20 C. This process was repeated in 10 degree increments up to 50 Degrees Celsius allowing the unit to stabilize for 1 hour at each level before turning on the unit and recording the frequency. At each level the frequency recorded was compared to the ambient reading with the amount of deviation in Hz compared to the part 80 limit.

6.5.2 Test Limit

As the is no direct equivalent in the table in section 80.209 for Buoy devices the level of 10Hz maximum deviation from the table in FCC 80.209 used in the range of 4000-27500 kHz.

6.5.3 Test Results

The test results are show in Table 12 and Table 13.

6.5.4 Test Summary

The EUT complied with the requirements of Part 80 per the FCC.

Table 12: Frequency Tolerance vs. Temperature

Limit: 10Hz% Most stringent level for frequency range in FCC 80.209

Freq=26.160MHz

Temperature Variations

Temperature (Centigrade)	Frequency (MHz)	Deviation (Hz)	Limit (Hz)	Pass/Fail
23 (ambient)	26.159990	0	NA	NA
-30	26.159993	3	10	Pass
-20	26.159995	5	10	Pass
-10	26.159995	5	10	Pass
0	26.159995	5	10	Pass
10	26.159991	1	10	Pass
20	26.159990	0	10	Pass
30	26.159990	0	10	Pass
40	26.159991	1	10	Pass
50	26.159990	0	10	Pass

Table 13: Frequency Tolerance vs. Battery Voltage

Nominal voltage Level = 12VDC

Voltage Variations

Voltage (Volts)	Frequency (MHz)	Deviation (Hz)	Limit (Hz)	Pass/Fail
Nominal Voltage 12VDC	26.159990	0	NA	Pass
Battery ENDPOINT (7.5vdc)	26.159990	0	10	Pass

6.6 Modulation Characteristics [FCC 2.1047]

6.6.1 Test Method

Per waiver DA-16-219 the duty cycle requirements for a digital signal are modified as follows:

'Duty cycle is limited to a 3.9-second transmission every 5 to 15 minutes'

6.6.2 Transmission Attestation

Marine Instruments states that transmissions are 3.9 seconds in duration and occur every five, ten, or fifteen minutes, depending on how it is configured by the user.

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