



**FCC & ISED Certification Test Report**  
**For the**  
**SwipeSense Inc.**  
**Hygiene Sensor**

**FCC ID: 2AB5RSEN420**  
**ISED: TBD**

**WLL JOB# 14600-01 Rev 2**  
**Revised June 30, 2016**

Prepared for:

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**Testing Certificate AT-1448**

**FCC & ISED Certification Test Report**  
**for the**  
**SwipeSense Inc.**  
**Hygiene Sensor**  
**FCC ID: 2AB5RSEN420**  
**ISED: TBD**

**WLL JOB# 14600-01 Rev 2**  
**Revised June 22, 2016**

Prepared by:



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James Ritter  
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Reviewed by:



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Steven D. Koster  
President

## Abstract

This report has been prepared on behalf of SwipeSense Inc. to support the attached Application for Equipment Authorization. The test report and application are submitted for a Digital Transmission System (DTS) Transmitter under Part 15.247 (10/2014) of the FCC Rules and Regulations and Spectrum Management and Telecommunications Policy RSS-247 issue 1 of ISED. This Certification Test Report documents the test configuration and test results for the SwipeSense Inc. Hygiene Sensor.

Testing was performed on an Open Area Test Site (OATS) of Washington Laboratories, Ltd, 7560 Lindbergh Drive, Gaithersburg, MD 20879. 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 OATS numbers are 3035A-1 and 3035A-2 for Washington Laboratories, Ltd. Site 1 and Site 2, respectively. Washington Laboratories, Ltd. has been accepted by the FCC and approved by ANAB under Certificate AT-1448 as an independent FCC test laboratory.

The SwipeSense Inc. Hygiene Sensor complies with the limits for a Digital Transmission System (DTS) Transmitter device under FCC Part 15.247 and ISED RSS-247.

| Revision History | Description of Change  | Date          |
|------------------|--|---------------|
| Rev 0            | Initial Release  | June 15, 2016 |
| Rev 1            | Corrected various typographical errors   | June 22, 2016 |
| Rev 2            | Added Duty Cycle correction statement and added duty cycle correction to radiated emissions results. | June 30, 2016 |

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## **1 Introduction**

### **1.1 Compliance Statement**

The SwipeSense Inc. Hygiene Sensor complies with the limits for a Digital Transmission System (DTS) Transmitter device under FCC Part 15.247 (10/2014) and ISSED RSS-247 issue 1 May 2015.

### **1.2 Test Scope**

Tests for radiated emissions were performed. All measurements were performed in accordance with “C63.10 American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices”. The measurement equipment conforms to ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation.

### **1.3 Contract Information**

|           |   |
|-----------|---|
| Customer: | TEMS Consulting Inc.<br>140 River Road<br>Georgetown, TX, 78628 |
|-----------|---|

|               |  |
|---------------|--|
| On Behalf of: | SwipeSense Inc.<br>4619 N. Ravenswood Ave.<br>Suite 202<br>Chicago, IL 60640 |
|---------------|--|

|                   |       |
|-------------------|-------|
| Quotation Number: | 69498 |
|-------------------|-------|

### **1.4 Test Dates**

|   |                      |
|---|----------------------|
| Testing was performed on the following date(s): | 6/6/2016 to 6/9/2016 |
|---|----------------------|

### **1.5 Test and Support Personnel**

|                              |                |
|------------------------------|----------------|
| Washington Laboratories, LTD | James Ritter   |
| Customer Representative      | Stephen Berger |

## 1.6 Abbreviations

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



## 2 Equipment Under Test

### 2.1 EUT Identification & Description

The hygiene sensor is wall mounted behind a hand sanitizer. It senses the use of the sanitizer and forwards that information through the mesh network.

**Table 1: Device Summary**

| ITEM                    | DESCRIPTION                            |
|-------------------------|--|
| Manufacturer:           | SwipeSense Inc.                        |
| FCC ID:                 | 2AB5RSEN420                            |
| ISED:                   | TBD                                    |
| Model Number:           | SEN420                                 |
| Model Name:             | Hygiene Sensor                         |
| FCC Rule Parts:         | §15.247                                |
| ISED:                   | RSS-247                                |
| Frequency Range:        | 2402-2482MHz                           |
| Maximum Output Power:   | 2.49mW (3.97dBm) conducted             |
| Modulation:             | GFSK                                   |
| Occupied Bandwidth:     | 690kHz                                 |
| Keying:                 | Automatic                              |
| Type of Information:    | Data                                   |
| Number of Channels:     | Unit is preset to a single channel     |
| Power Output Level      | Fixed                                  |
| Antenna                 | integral                               |
| Antenna Type            | +0.27dBi Inverted 'F', laid out on PWB |
| Interface Cables:       | None                                   |
| Power Source & Voltage: | 4 "AA batteries"                       |
| Emission Designator     | 690KFXD                                |

### 2.2 Test Configuration

Six devices were submitted for testing, 3 units with the antenna replaced by a temporary antenna port and three with antennas for radiated testing. Each EUT was programmed to transmit at one of 3 frequencies (2402, 2440, & 2482MHz). All units were tested in a stand-alone configuration. All tests were performed in accordance with ANSI C63.10. Internal batteries were replaced by a lab power supply for testing.

### 2.3 Testing Algorithm

The Hygiene Sensor was programmed for DTS operation by the manufacturer. The EUT was set to transmit PRBS packets continuously at the desired transmit frequency. Worst case emission levels are provided in the test results data.

## 2.4 Test Location

All measurements herein were performed at Washington Laboratories, Ltd. test center in Gaithersburg, 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 OATS numbers are 3035A-1 and 3035A-2 for Washington Laboratories, Ltd. Site 1 and Site 2, respectively. 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 C63.10:2013 American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices
- ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation
- RSS-Gen Issue 4 — General Requirements for Compliance of Radio Apparatus
- RSS-247 issue 1 — Digital Transmission Systems (DTSs), Frequency Hopping Systems (FHSs) and Licence-Exempt Local Area Network (LE-LAN) 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

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

Where  $u_c$  = standard uncertainty

$a, b, c, \dots$  = individual uncertainty elements

$\text{Div}_{a, b, c}$  = 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

$$U = k u_c$$

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, CISPR14, FCC Part 15 | $\pm 2.63$ dB        |
| Radiated Emissions  | CISPR11, CISPR22, CISPR14, FCC Part 15 | $\pm 4.55$ dB        |

| Parameter  | Uncertainty            | Actual (+/-) | Unit  |
|--|------------------------|--------------|-------|
| Radio Frequency  | $\pm 1 \times 10^{-7}$ | 8.64E-08     | parts |
| RF Power conducted (up to 160 W)                       | $\pm 0.75$ dB          | 0.3          | dB    |
| Conducted RF Power variations using a test fixture     | $\pm 0.75$ dB          | 0.3          | dB    |
| Transmitter transient frequency (frequency difference) | $\pm 250$ Hz           | 160.7        | Hz    |
| Transmitter transient time                             | $\pm 20$ %             | 9.2          | %     |

### 3 Test Equipment

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

**Table 3: Test Equipment List**

| Test Name: <b>Radiated Emissions</b> |   | Test Date: <b>06/09/2016</b> |                 |
|--------------------------------------|---|------------------------------|-----------------|
| <b>Asset #</b>                       | <b>Manufacturer/Model</b>                     | <b>Description</b>           | <b>Cal. Due</b> |
| 823                                  | AGILENT - N9010A                              | EXA SPECTRUM ANALYZER        | 8/5/2016        |
| 559                                  | HP - 8447D                                    | AMPLIFIER                    | 07/30/2016      |
| 644                                  | SUNOL SCIENCES CORPORATION - JB1 925-833-9936 | BICONALOG ANTENNA            | 8/14/2017       |
| 4                                    | ARA - DRG-118/A                               | ANTENNA DRG 1-18GHZ          | 10/8/2016       |
| 627                                  | AGILENT - 8449B                               | AMPLIFIER 1-26GHZ            | 07/30/2016      |
| 453                                  | AH SYSTEMS - PAM1840                          | PRE-AMPLIFIER 18GHZ-40 GHZ   | 07/30/2016      |
| 209                                  | NARDA - V637                                  | HORN STANDARD GAIN           | CNR             |
| 210                                  | NARDA - V638                                  | HORN STANDARD GAIN           | CNR             |

| Test Name: <b>Bench Tests</b> |                           | Test Date: <b>6/6/2016</b>    |                 |
|-------------------------------|---------------------------|-------------------------------|-----------------|
| <b>Asset #</b>                | <b>Manufacturer/Model</b> | <b>Description</b>            | <b>Cal. Due</b> |
| 528                           | AGILENT - E4446A          | 3HZ - 44GHZ ANALYZER SPECTRUM | 7/15/2016       |
| 823                           | AGILENT - N9010A          | EXA Spectrum Analyze          | 8/5/2016        |

## 4 Test Summary

The Table Below shows the results of testing for compliance with a Digital Transmission System in accordance with FCC Part 15.247 10/2014 and RSS47 issue 1, 5/2015. Full results are shown in section 5.

**Table 4: Test Summary Table**

| <b>TX Test Summary<br/>(Digital Transmission System (DTS))</b> |                     |  |               |
|--|---------------------|--|---------------|
| <b>FCC Rule Part</b>   | <b>IC Rule Part</b> | <b>Description</b>   | <b>Result</b> |
| 15.247(a) (2)  | RSS-247 [5.2 (1)]   | 6dB Bandwidth  | Pass          |
| 15.247 (b)(3)  | RSS-247 [5.4 (4)]   | Transmit Output Power  | Pass          |
| 15.247 (e)   | RSS-247 [5.2 (2)]   | Power Spectral Density                                       | Pass          |
| 15.247 (d)   | RSS-247 [5.5]       | /Out-of-Band Emissions (Band Edge @ 20dB below)              | Pass          |
| 15.205<br>15.209   | RSS-Gen 7.2.2       | General Field Strength Limits (Restricted Bands & RE Limits) | Pass          |
| 15.207   | RSS-Gen [7.2.4]     | AC Conducted Emissions                                       | NA            |

## 5 Test Results

### 5.1 Occupied (DTS) Bandwidth:

Occupied bandwidth was performed by monitoring the output of the EUT antenna port with a spectrum analyzer corrected for any cable/attenuator losses.

For Direct Sequence Spread Spectrum Systems, FCC Part 15.247 requires the minimum 6 dB bandwidth be at least 500 kHz.

#### 5.1.1 Measurement Method:

Tests were performed as specified in ANSI C63.10 section 11.8 “DTS bandwidth” Option 1 (11.8.1).

**Table 5: Occupied Bandwidth Spectrum Analyzer Settings**

| Resolution Bandwidth | Video Bandwidth |
|----------------------|-----------------|
| 100kHz               | 1MHz            |

At full modulation, the occupied bandwidth was measured as shown in Figures 1-3.

Table 6 provides a summary of the Occupied Bandwidth Results.

**Table 6: Occupied Bandwidth Results**

| Frequency               | Bandwidth | Limit                | Pass/Fail |
|-------------------------|-----------|----------------------|-----------|
| Low Channel: 2402MHz    | 685kHz    | $\geq 500\text{kHz}$ | Pass      |
| Center Channel: 2440MHz | 686kHz    | $\geq 500\text{kHz}$ | Pass      |
| High Channel: 2480MHz   | 690kHz    | $\geq 500\text{kHz}$ | Pass      |

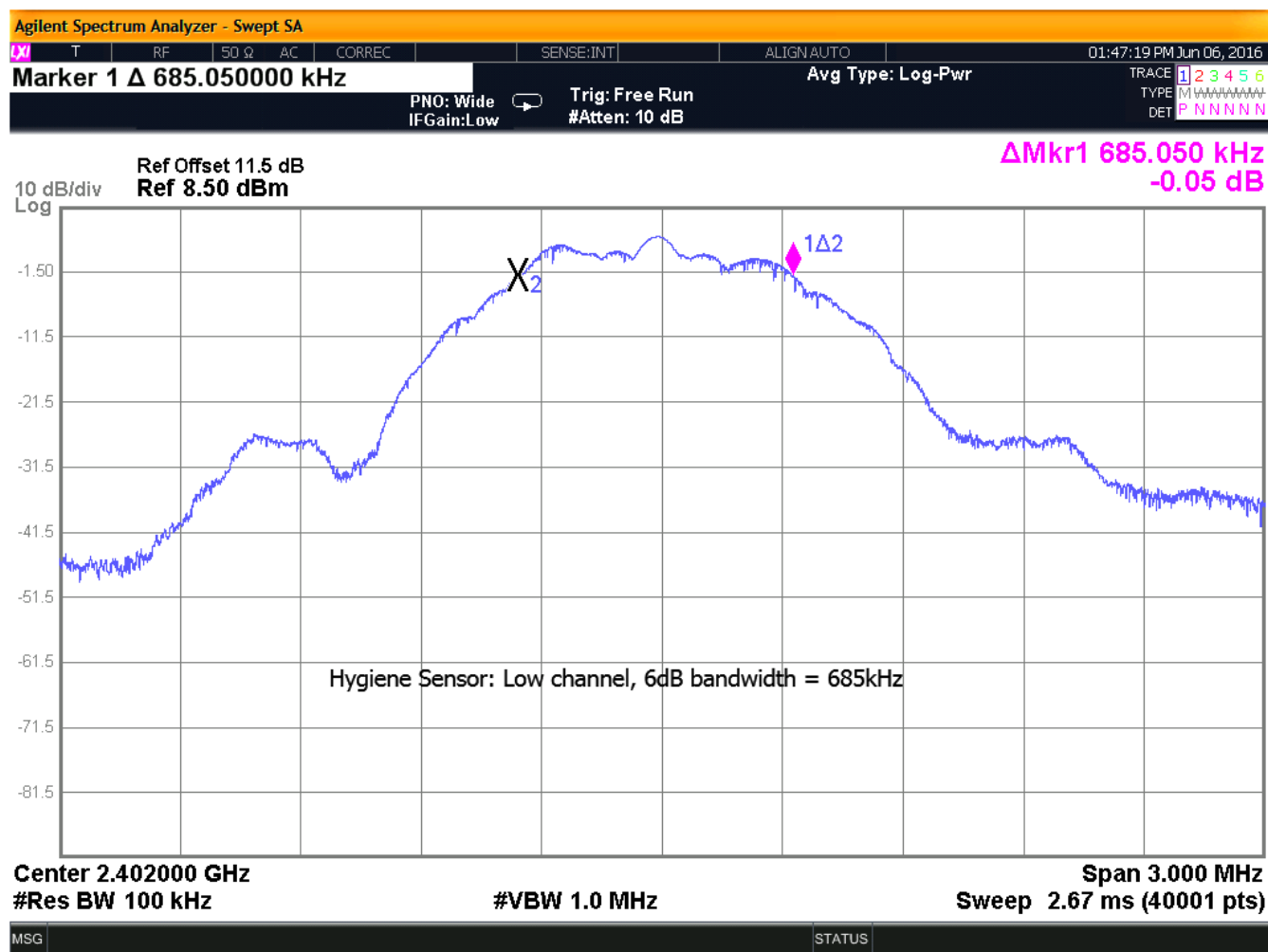


Figure 1: Occupied Bandwidth, Low Channel

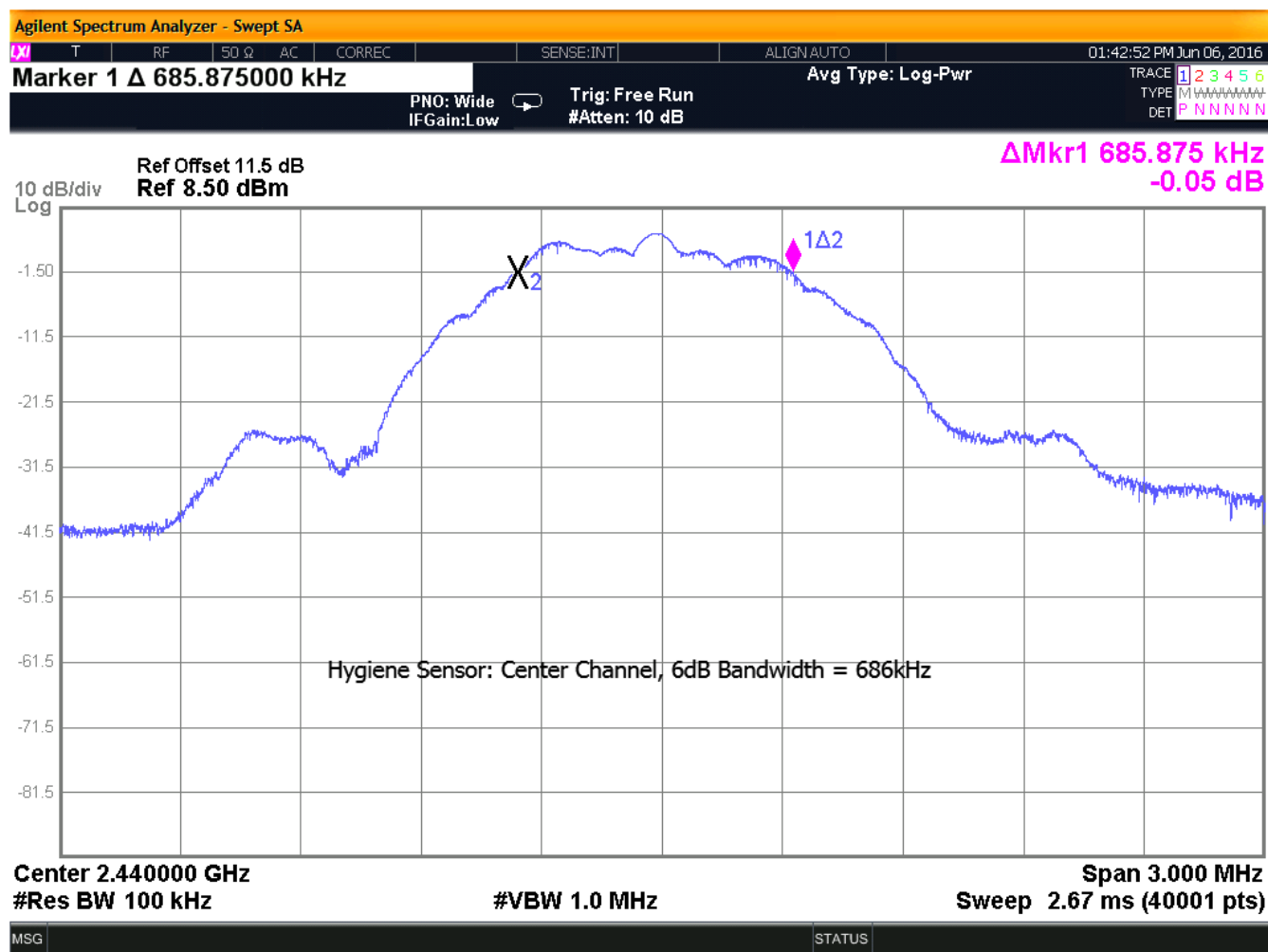


Figure 2: Occupied Bandwidth, Center Channel



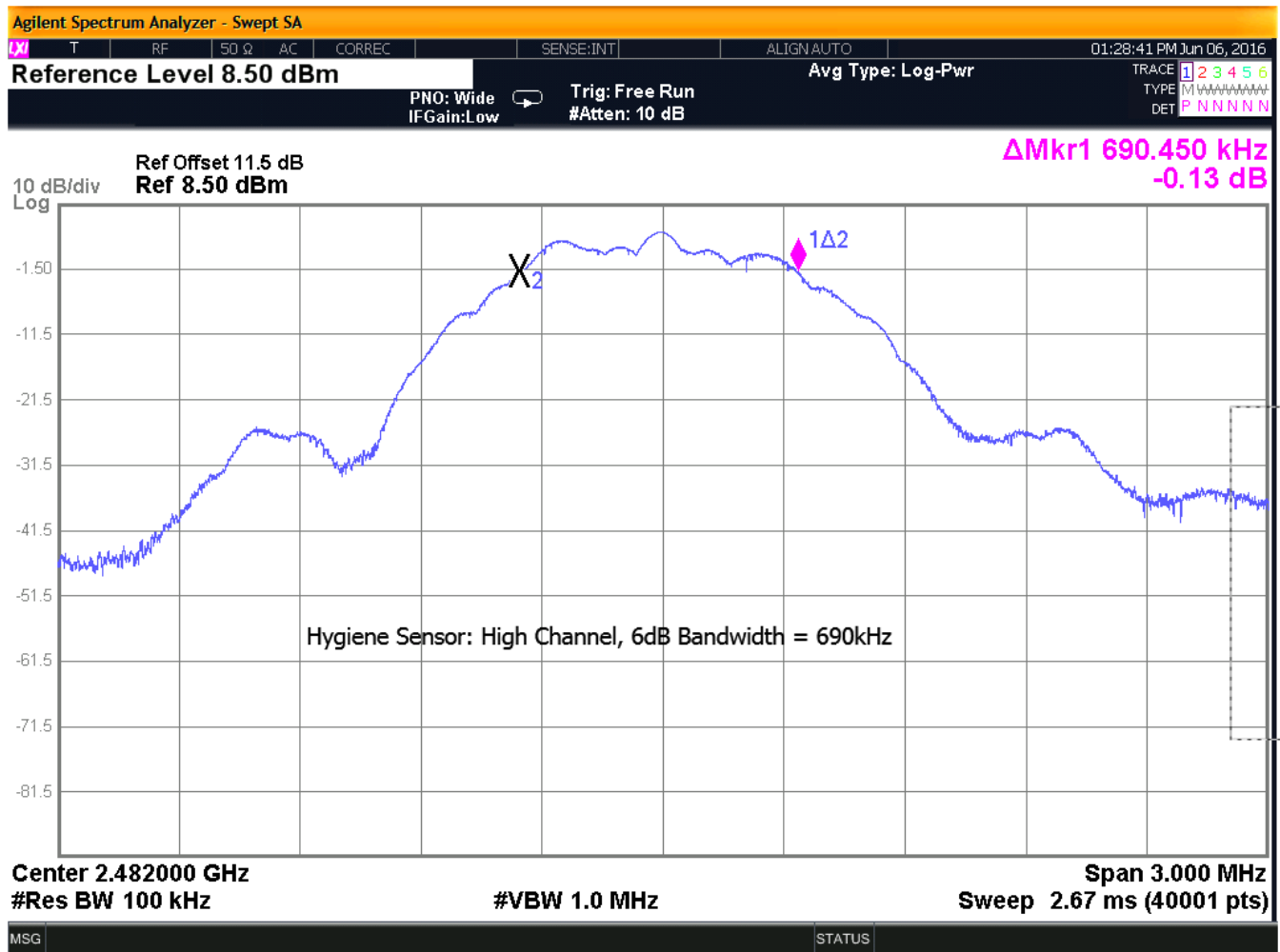


Figure 3: Occupied Bandwidth, High Channel

## 5.2 RF Power Output:

To measure the peak output power the unit was set to dwell on the low, high and middle channel. Testing was performed using the method from C63.10 section 11.9.1.1 “ $RBW \geq DTS$  bandwidth” at the antenna port as follows:

- a) Set the  $RBW \geq DTS$  bandwidth.
- b) Set  $VBW \geq [3 \times RBW]$ .
- c) Set  $span \geq [3 \times RBW]$ .
- d) Sweep time = auto couple.
- e) Detector = peak.
- f) Trace mode = max hold.
- g) Allow trace to fully stabilize.
- h) Use peak marker function to determine the peak amplitude level..

### 5.2.1 Measurement Method:

ANSI C63.10 section “11.9.1 Maximum peak conducted output power” subsection “11.9.1.1  $RBW > DTS$  bandwidth”

**Table 7: Spectrum Analyzer Settings**

| Resolution Bandwidth | Video Bandwidth |
|----------------------|-----------------|
| 1MHz                 | 3MHz            |

**Table 8: RF Power Output Summary**

| Frequency               | Level   | Limit  | Pass/Fail |
|-------------------------|---------|--------|-----------|
| Low Channel: 2402MHz    | 3.41dBm | 30 dBm | Pass      |
| Center Channel: 2440MHz | 3.97dBm | 30 dBm | Pass      |
| High Channel: 2480MHz   | 3.68dBm | 30 dBm | Pass      |

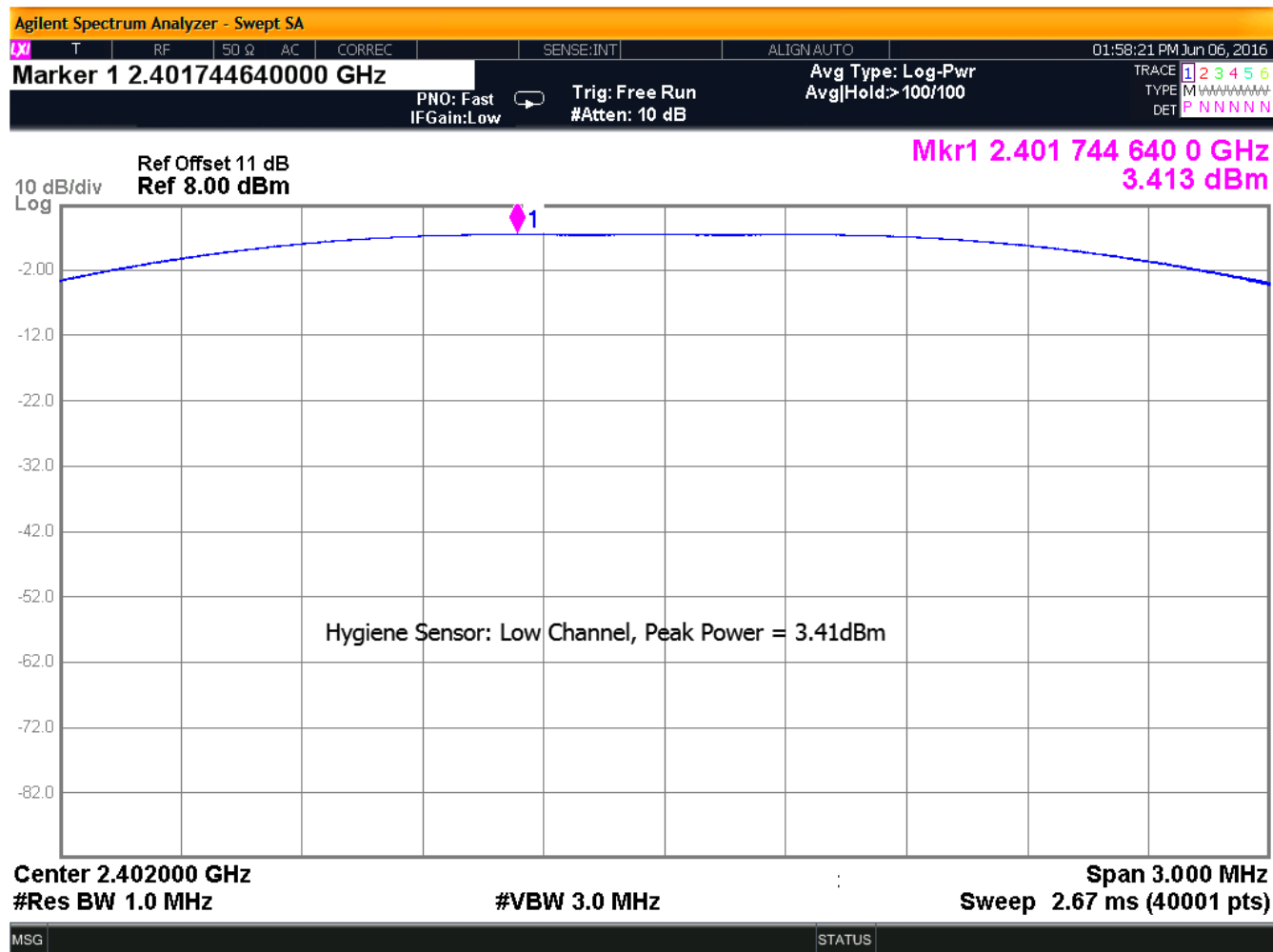


Figure 4: RF Peak Power, Low Channel

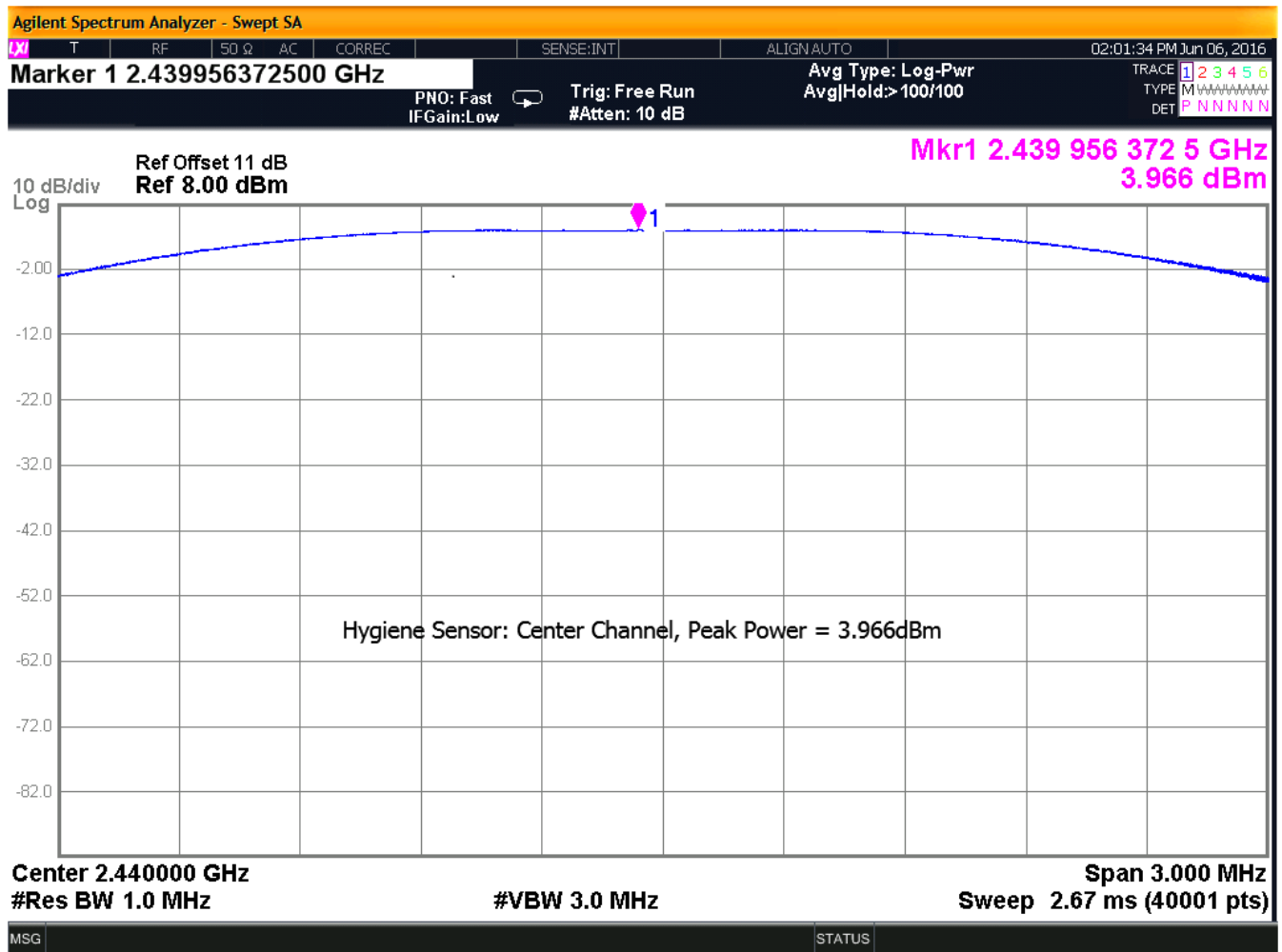


Figure 5: RF Peak Power, Center Channel

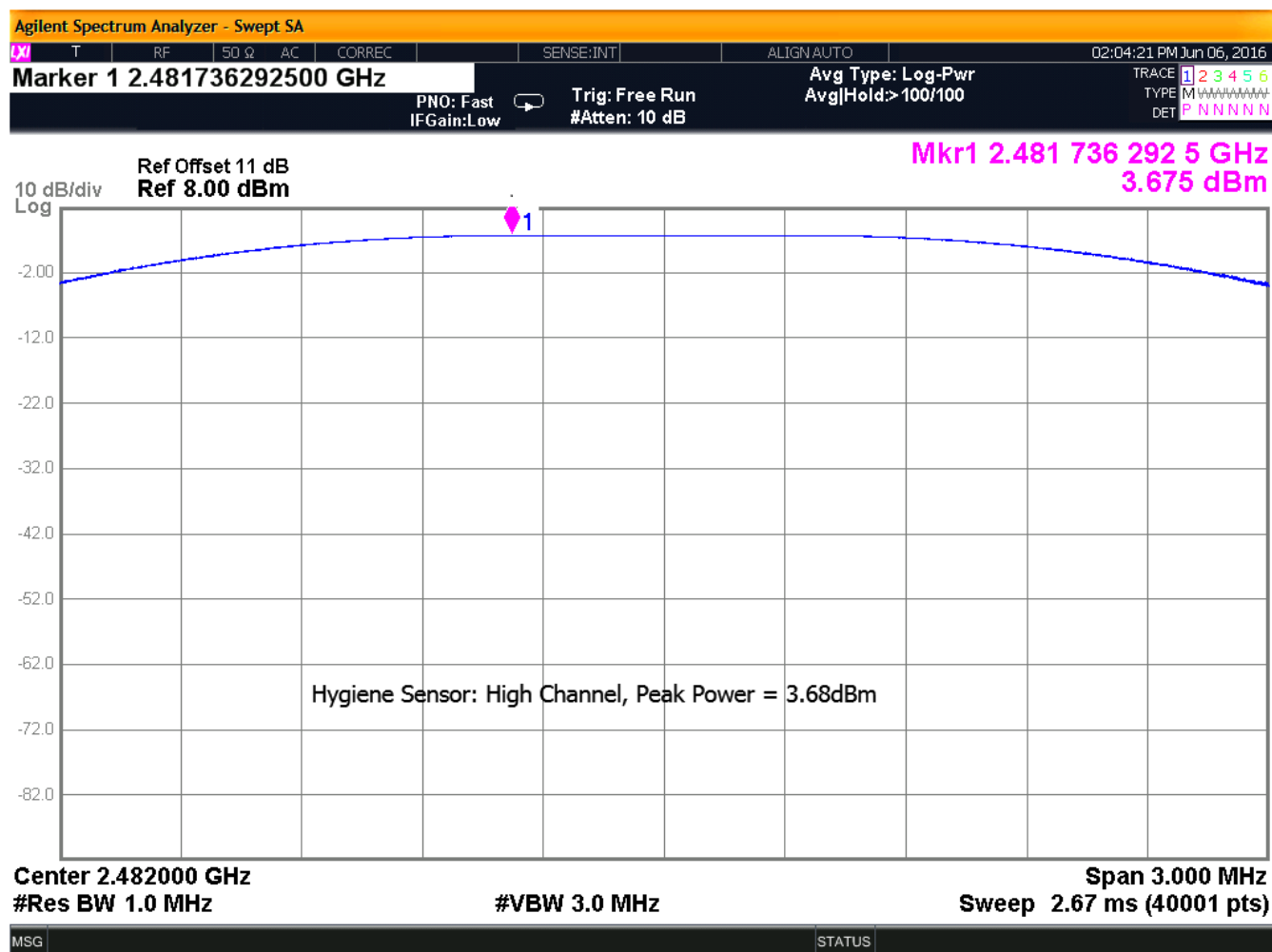


Figure 6: RF Peak Power, High Channel

### 5.3 Power Spectral Density

Measurements for power spectral density were taken at the antenna port in accordance with ANSI C63.10. The spectrum analyzer was set to peak detect mode with a RBW of 100kHz ,VBW of 300kHz across a span 1.5X the DTS bandwidth using an auto sweep time..

#### 5.3.1 Measurement Method:

ANSI C63.10 SECTION 11.10 “Maximum power spectral density level in the fundamental emission subsection 11.10.2 “Method PKPSD (peak PSD)”

The highest level detected across any 3 kHz band for continuous transmission was then recorded and compared to the limit 8dBm. The following table and plots give the results for power spectral density testing.

**Table 9: Power Spectral Density**

| Frequency               | Peak Level | Limit | Pass/Fail |
|-------------------------|------------|-------|-----------|
| Low Channel: 2402MHz    | 3.31dBm    | 8 dBm | Pass      |
| Center Channel: 2440MHz | 3.68dBm    | 8 dBm | Pass      |
| High Channel: 2480MHz   | 3.67dBm    | 8 dBm | Pass      |

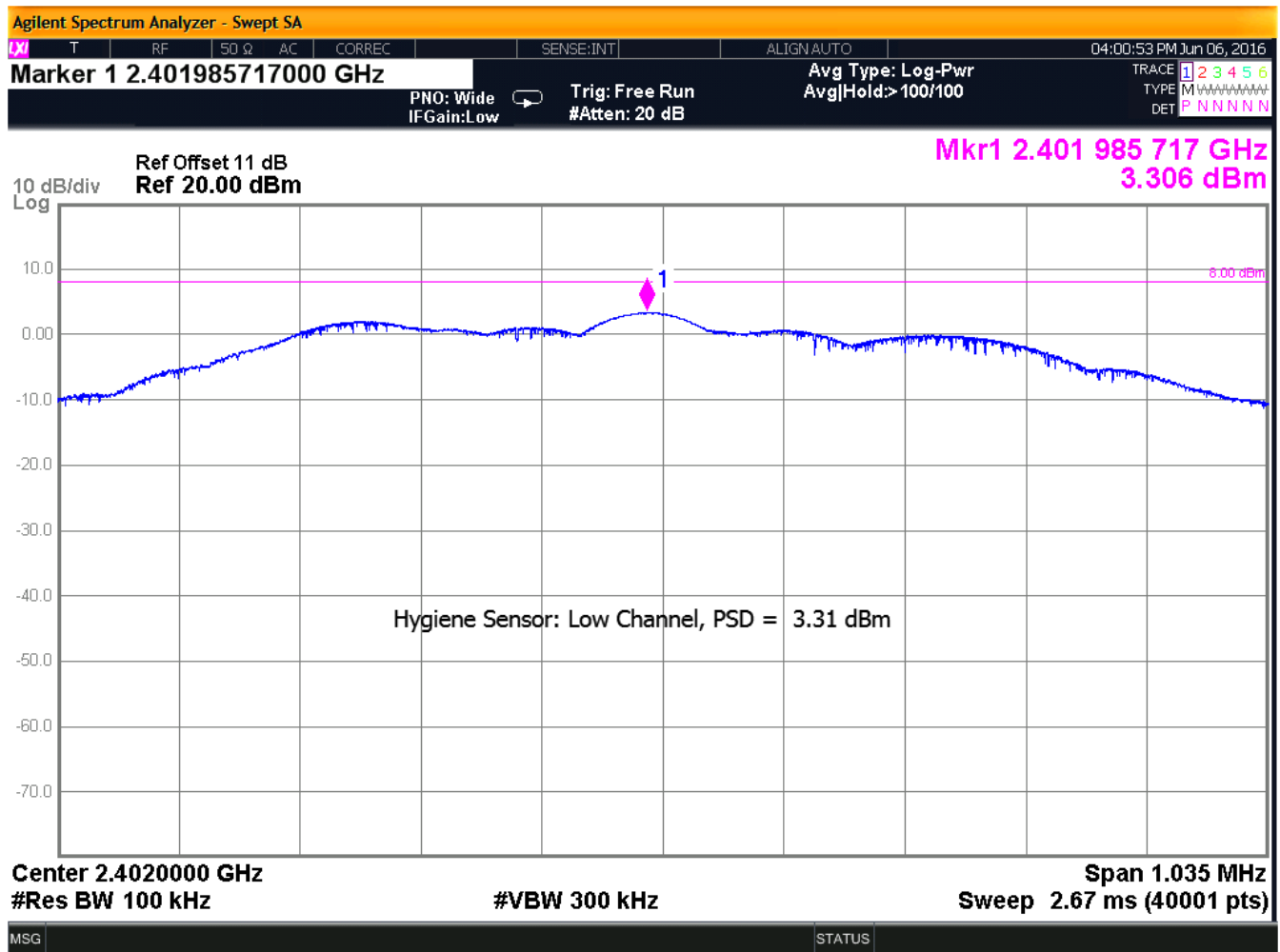


Figure 7: Power Spectral Density, Low Channel

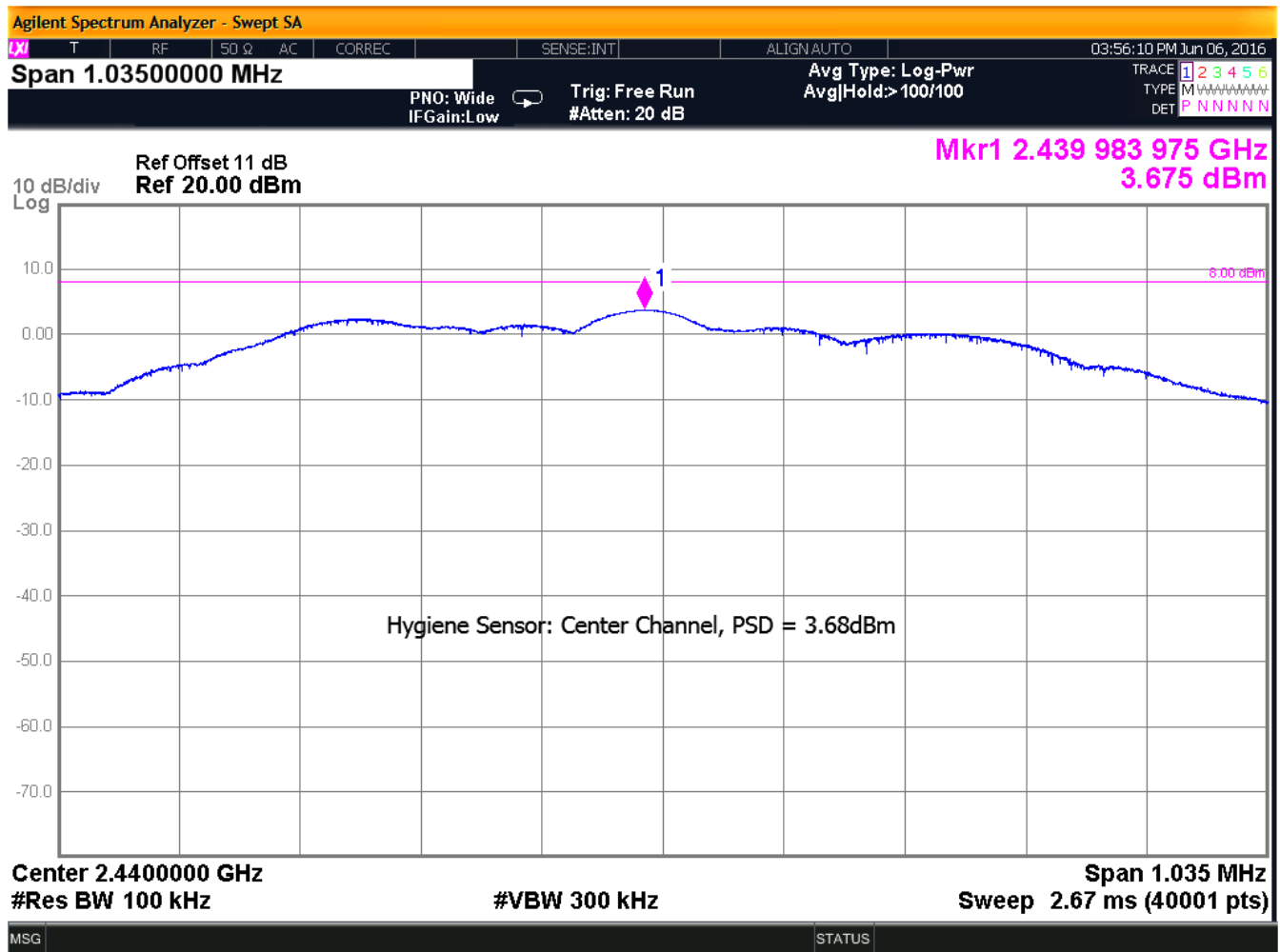


Figure 8: Power Spectral Density, Center Channel



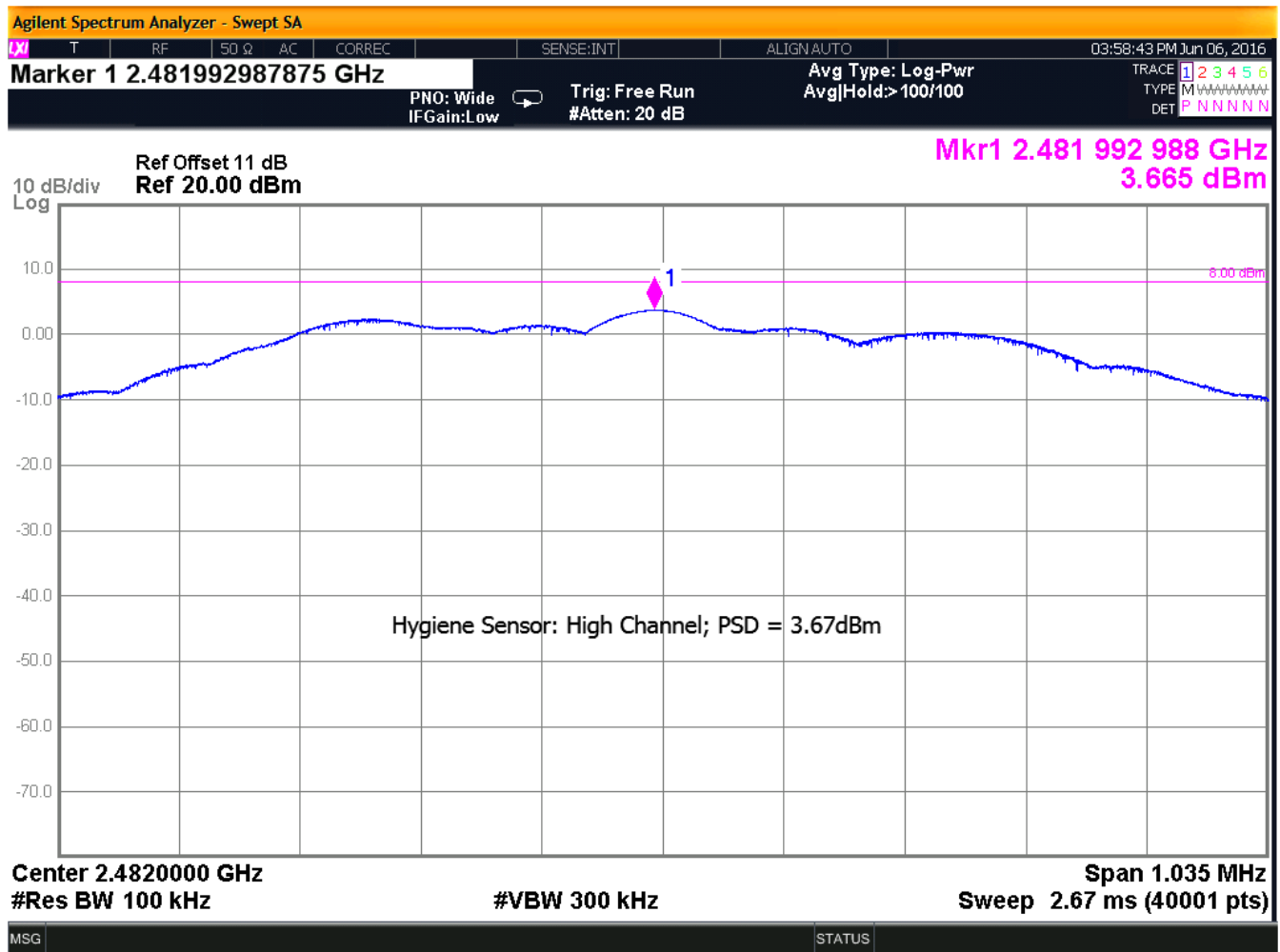


Figure 9: Power Spectral Density, High Channel

## 5.4 Conducted Spurious Emissions compliance

The EUT must comply with requirements for spurious emissions. Per §15.247(d) all spurious emissions in any 100 kHz bandwidth outside the frequency band in which the spread spectrum device is operating shall be attenuated 20 dB below the highest power level in a 100 kHz bandwidth within the band containing the highest level of the desired power.

Per ANSI C63.10 section 11.11 “Emissions in non-restricted frequency bands” this test may be performed in an antenna port conducted manner. The spectrum analyzer resolution bandwidth was set to 100 kHz and the video bandwidth was set to 300 kHz. The amplitude of the EUT carrier frequency was measured to determine the emissions limit (20 dB below the carrier frequency amplitude). The emissions outside of the allocated frequency band were then scanned from 30 MHz up to the tenth harmonic of the carrier.

As per ANSI C63.10 section 11.11.2 the Center channel has the highest PSD and the limit for all channels was based on this level.

The following table shows the spurious emissions data.

### 5.4.1 Test Summary

The EUT complied with the requirements for spurious emissions at the antenna port.

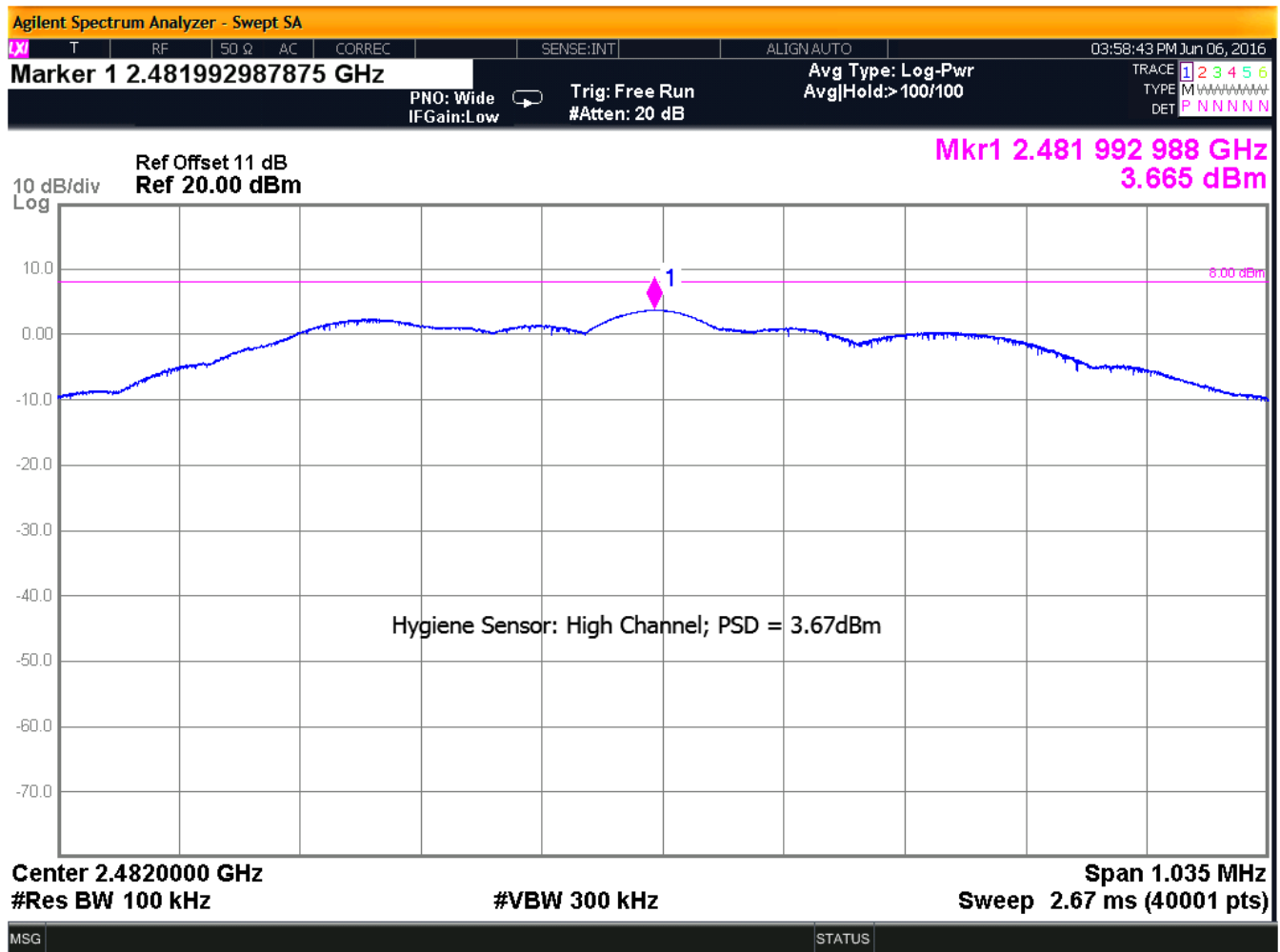


Figure 10: Highest PSD Level (center channel)

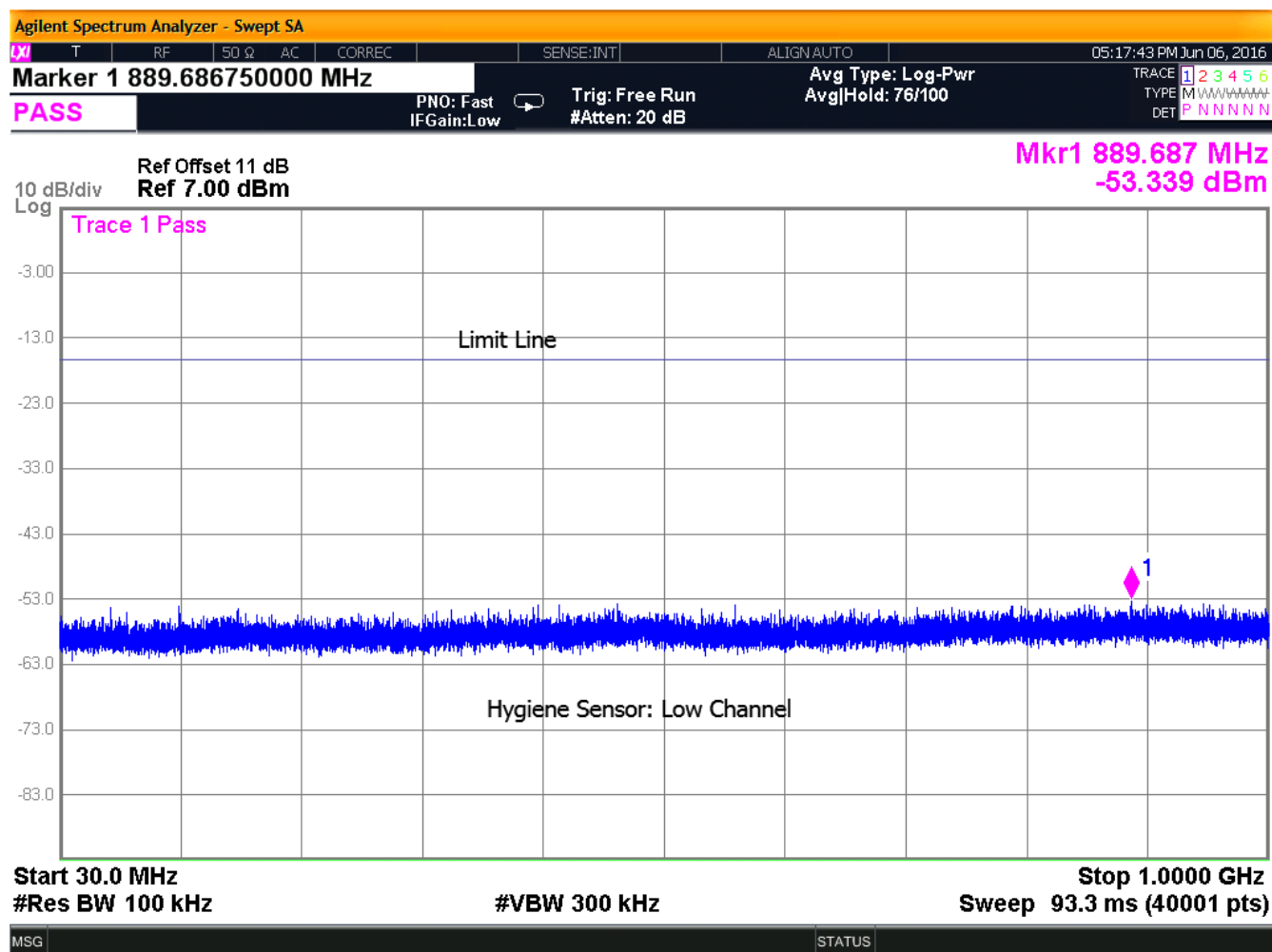


Figure 11: Low Channel Conducted Spurious Plot 1

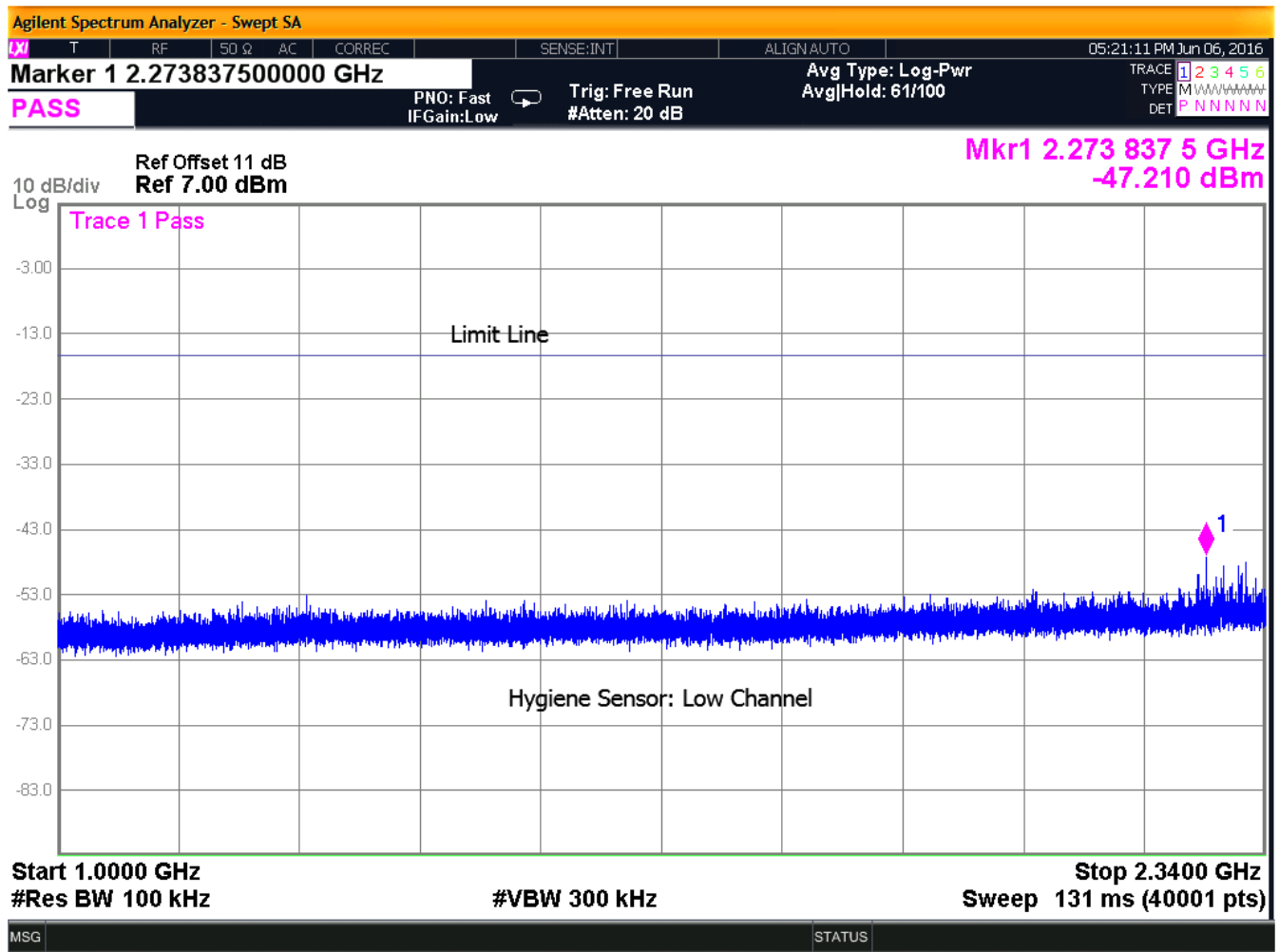


Figure 12: Low Channel Conducted Spurious Plot 2

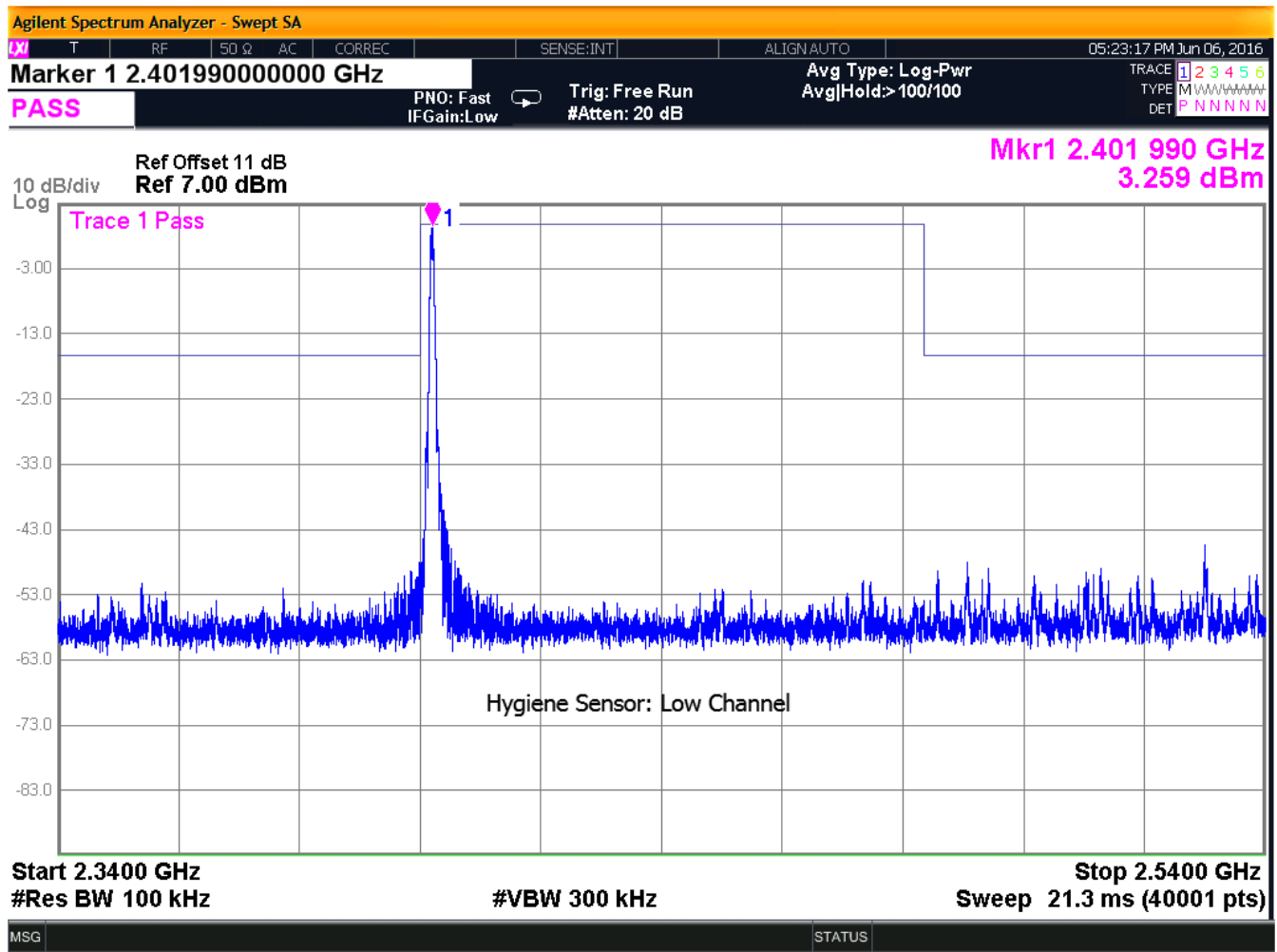


Figure 13: Low Channel Conducted Spurious Plot 3

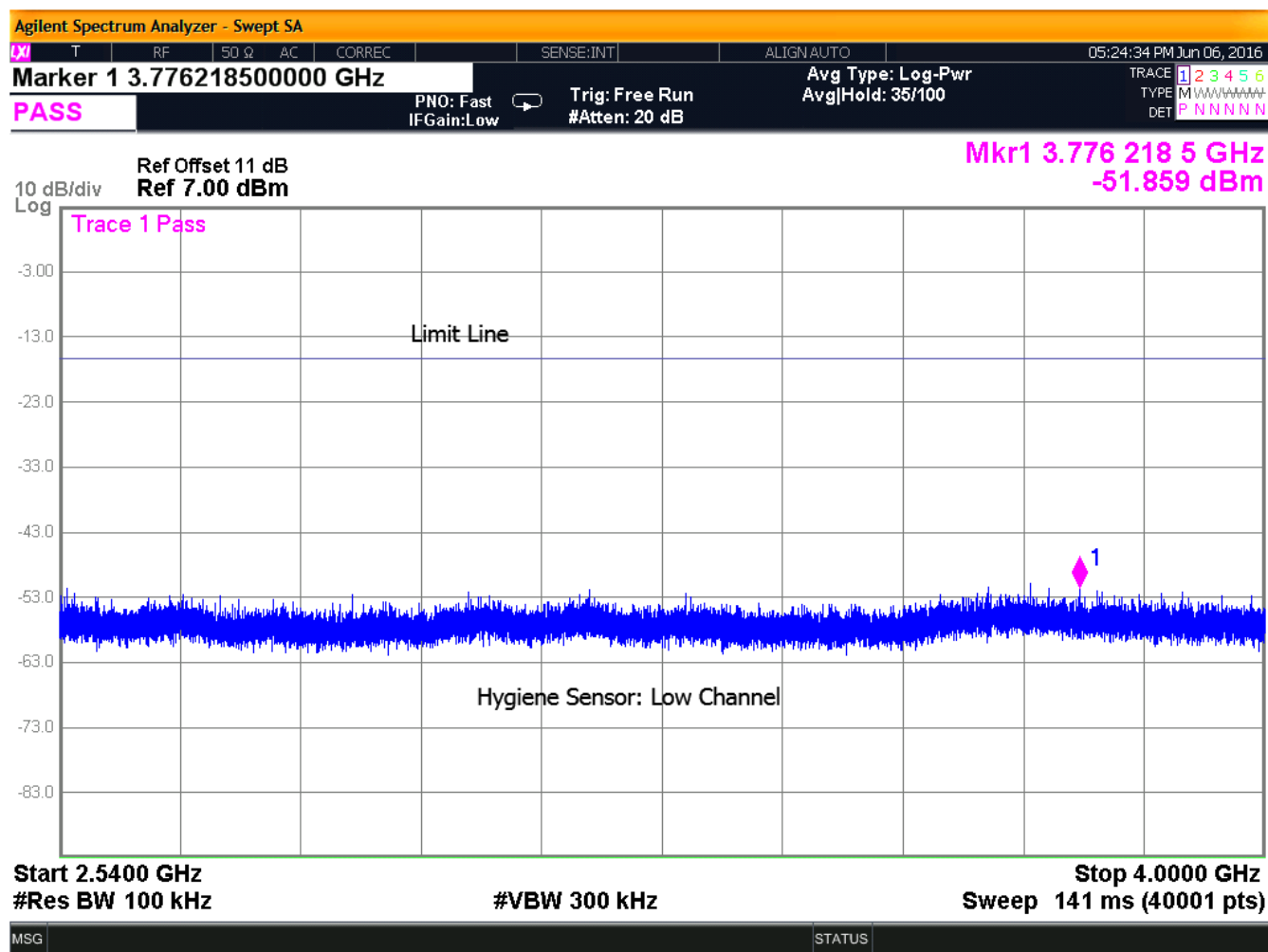


Figure 14: Low Channel Conducted Spurious Plot 4

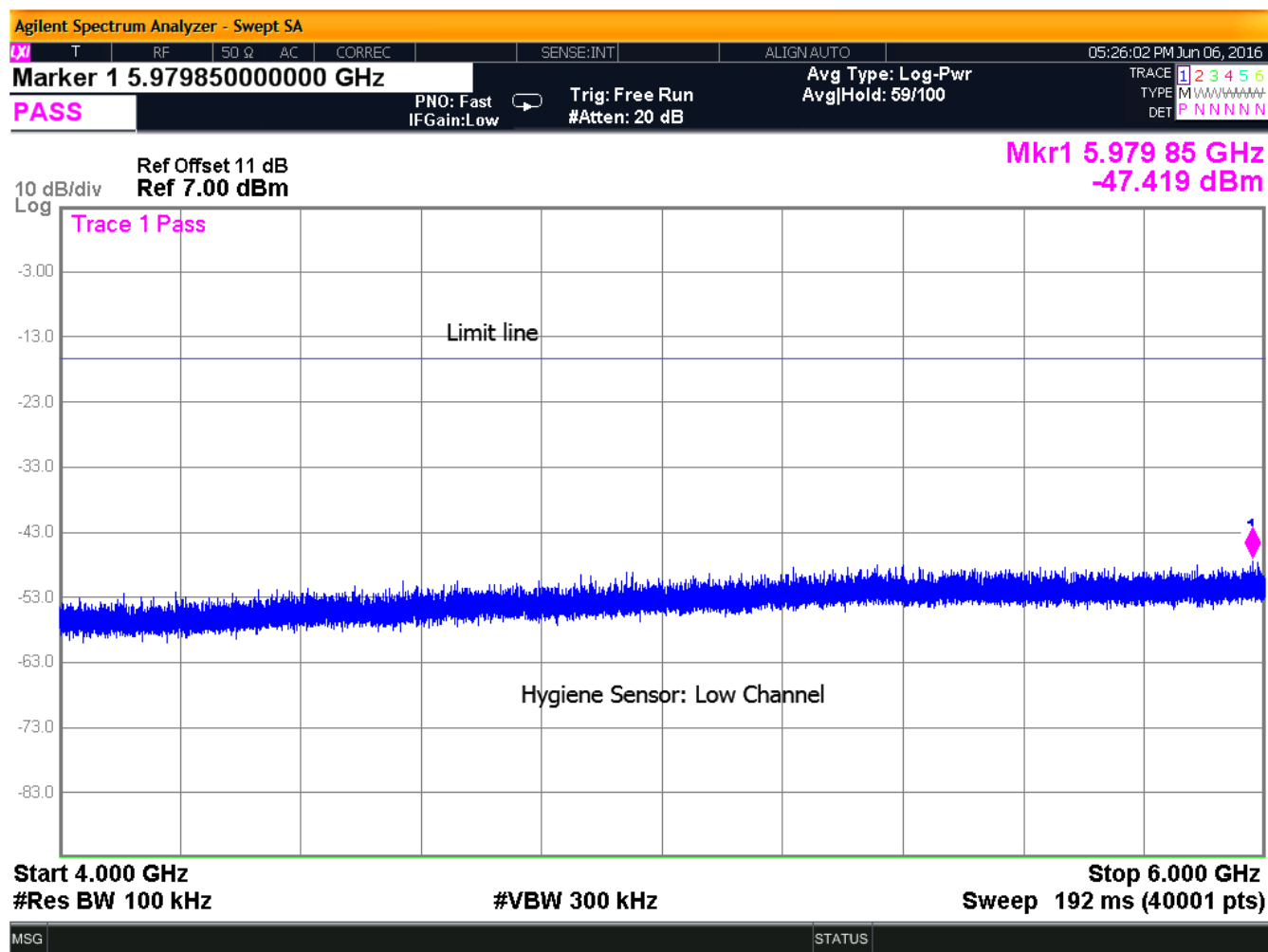


Figure 15: Low Channel Conducted Spurious Plot 5



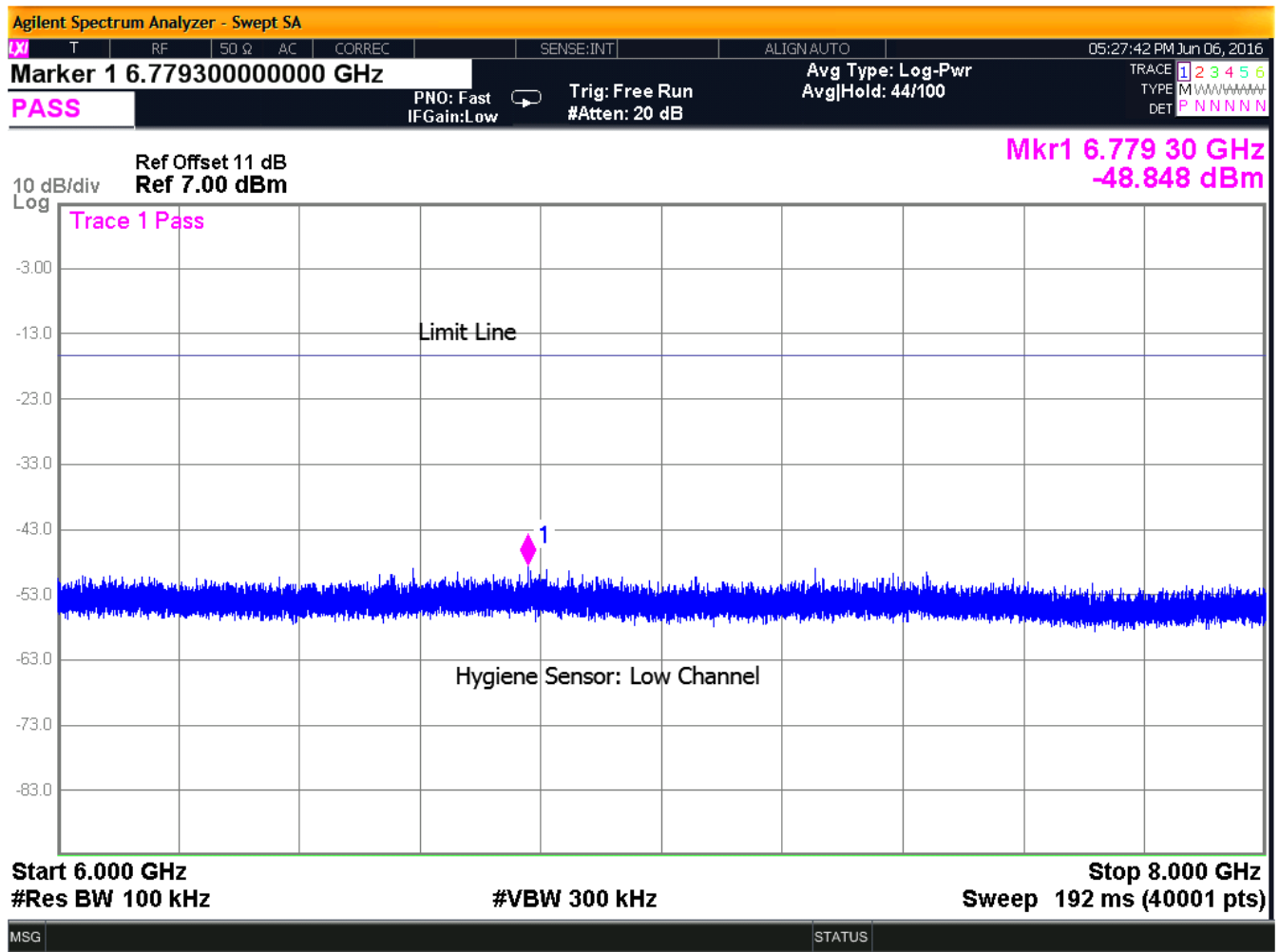


Figure 16: Low Channel Conducted Spurious Plot 6

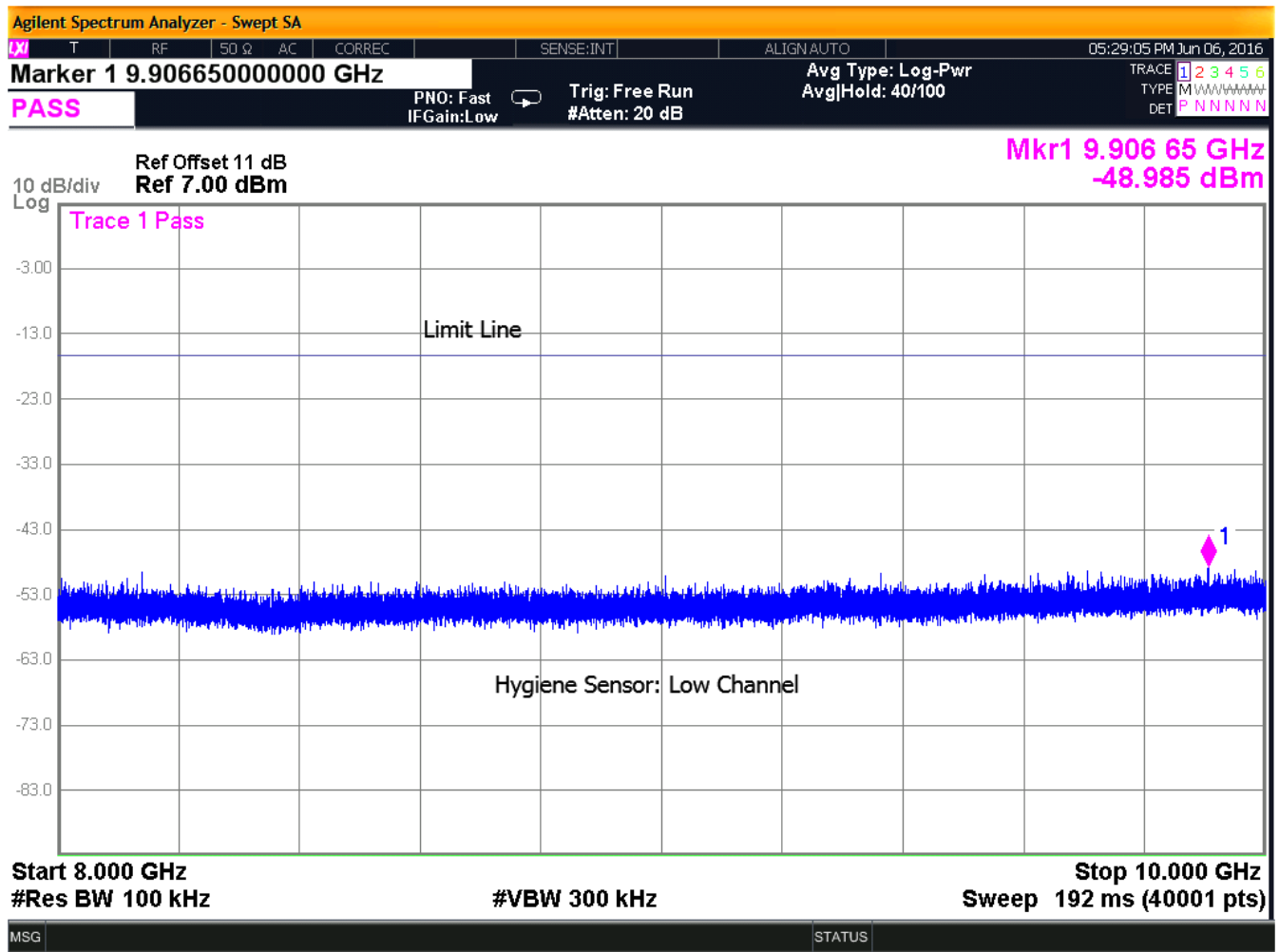


Figure 17: Low Channel Conducted Spurious Plot 7

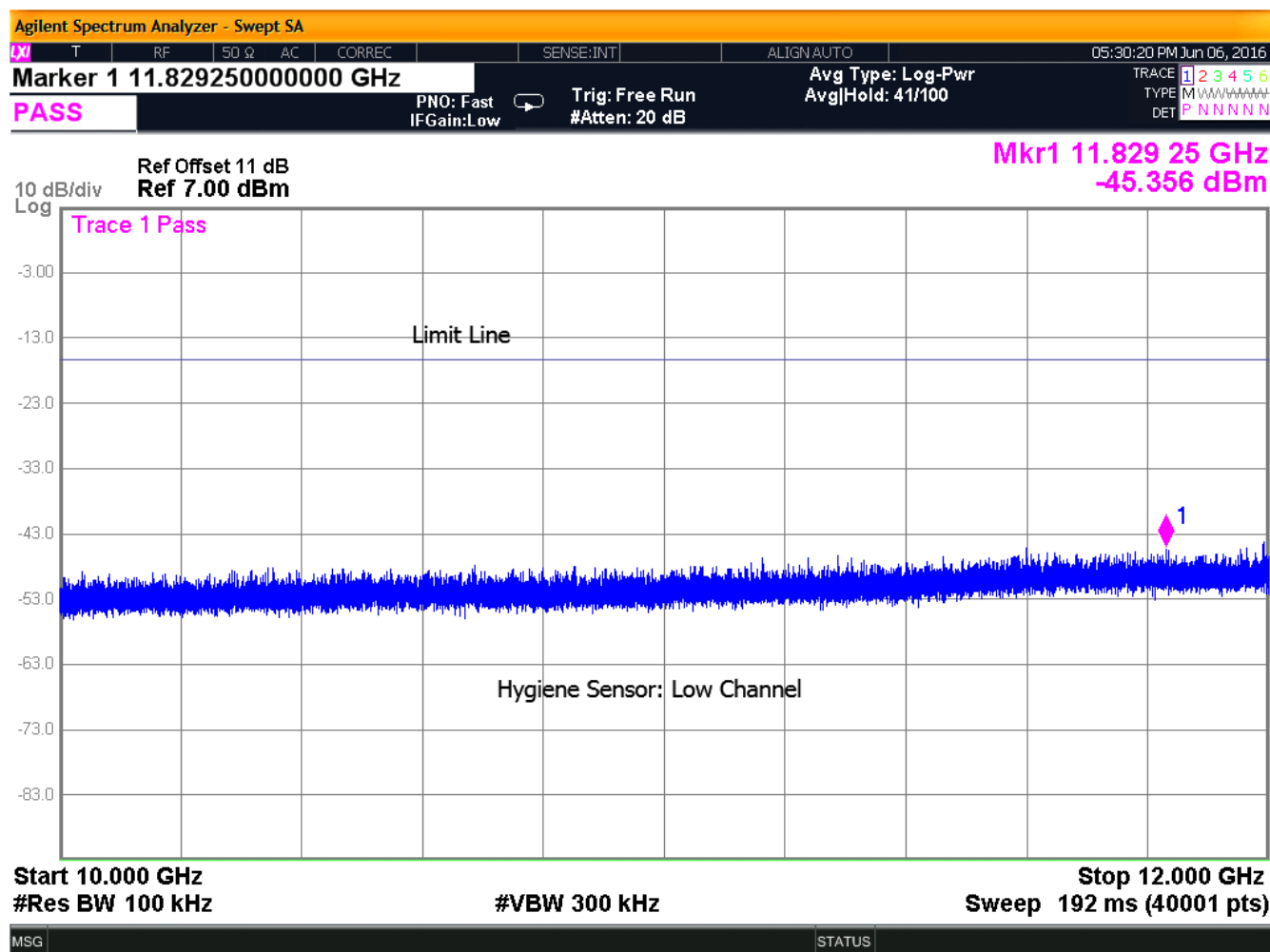


Figure 18: Low Channel Conducted Spurious Plot 8

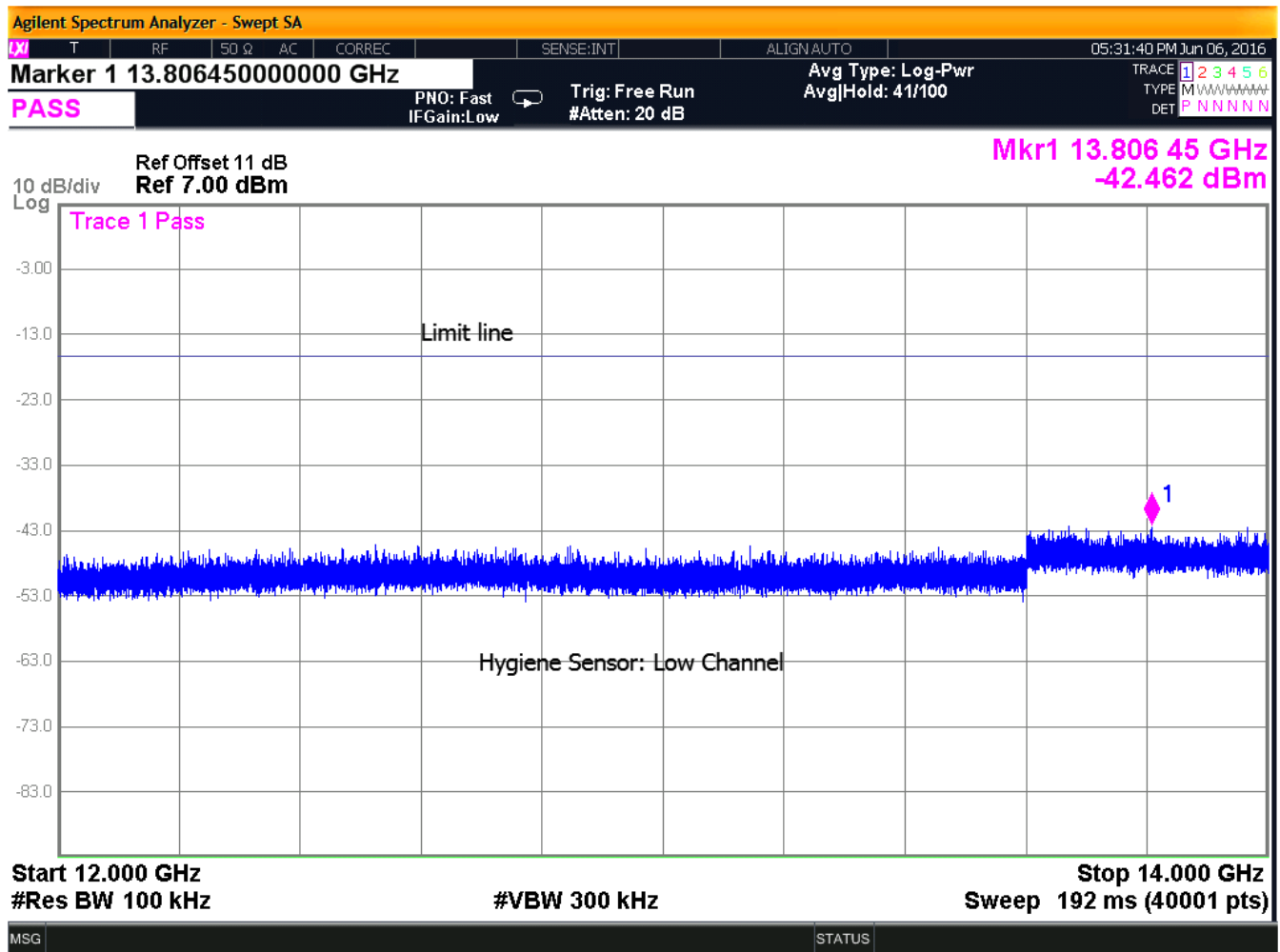


Figure 19: Low Channel Conducted Spurious Plot 9

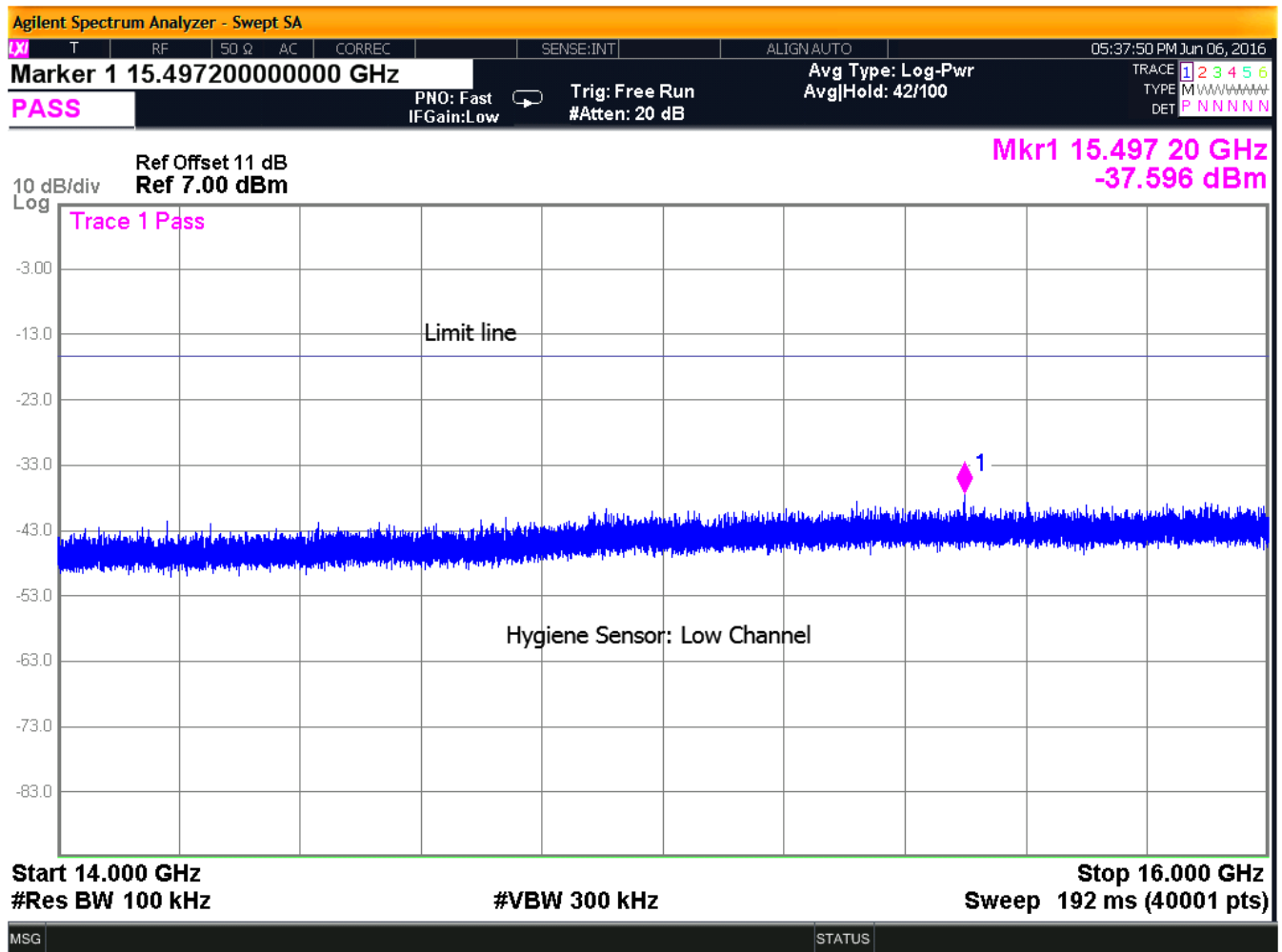


Figure 20: Low Channel Conducted Spurious Plot 10

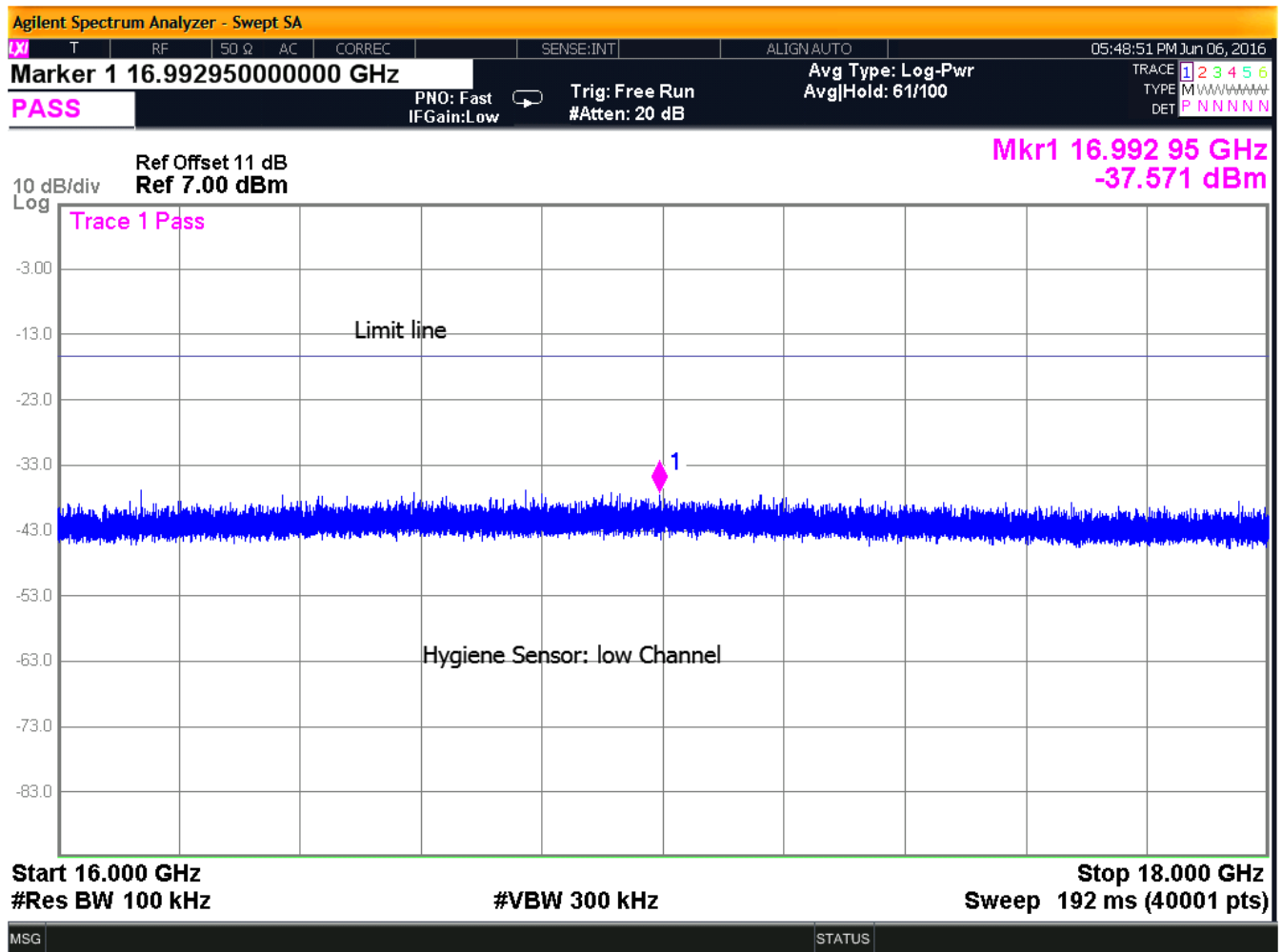


Figure 21: Low Channel Conducted Spurious Plot 11

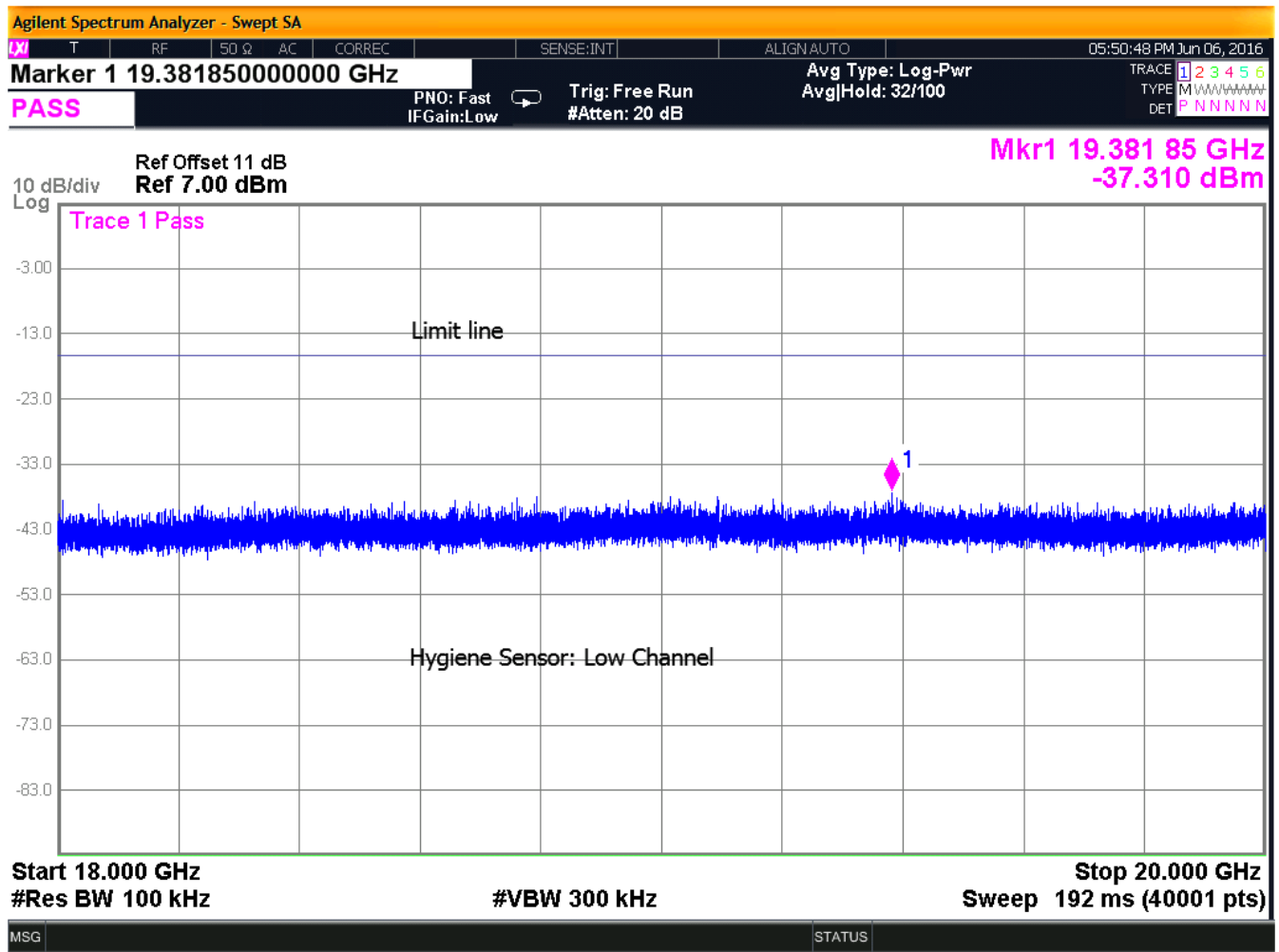


Figure 22: Low Channel Conducted Spurious Plot 12

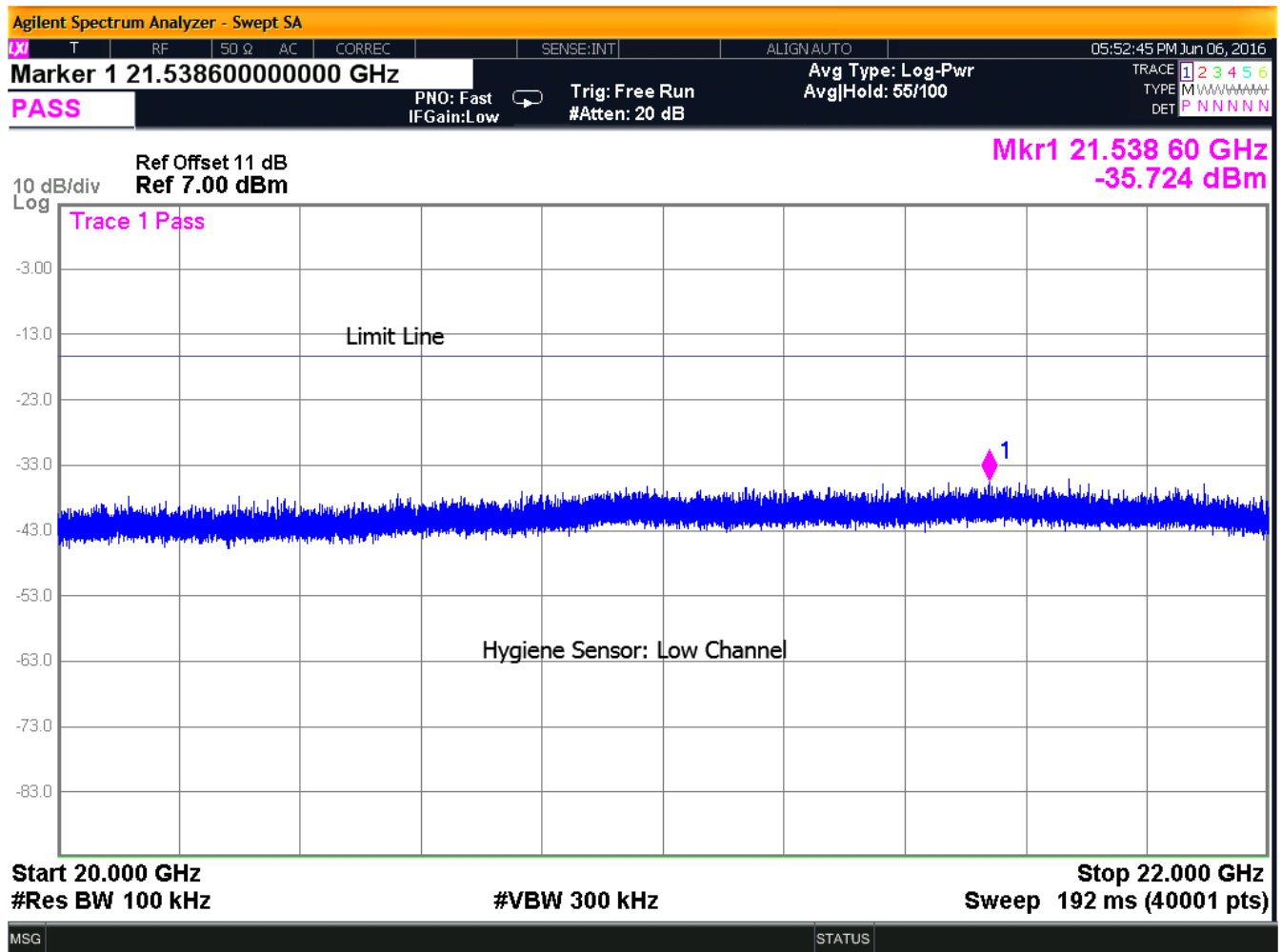


Figure 23: Low Channel Conducted Spurious Plot 13



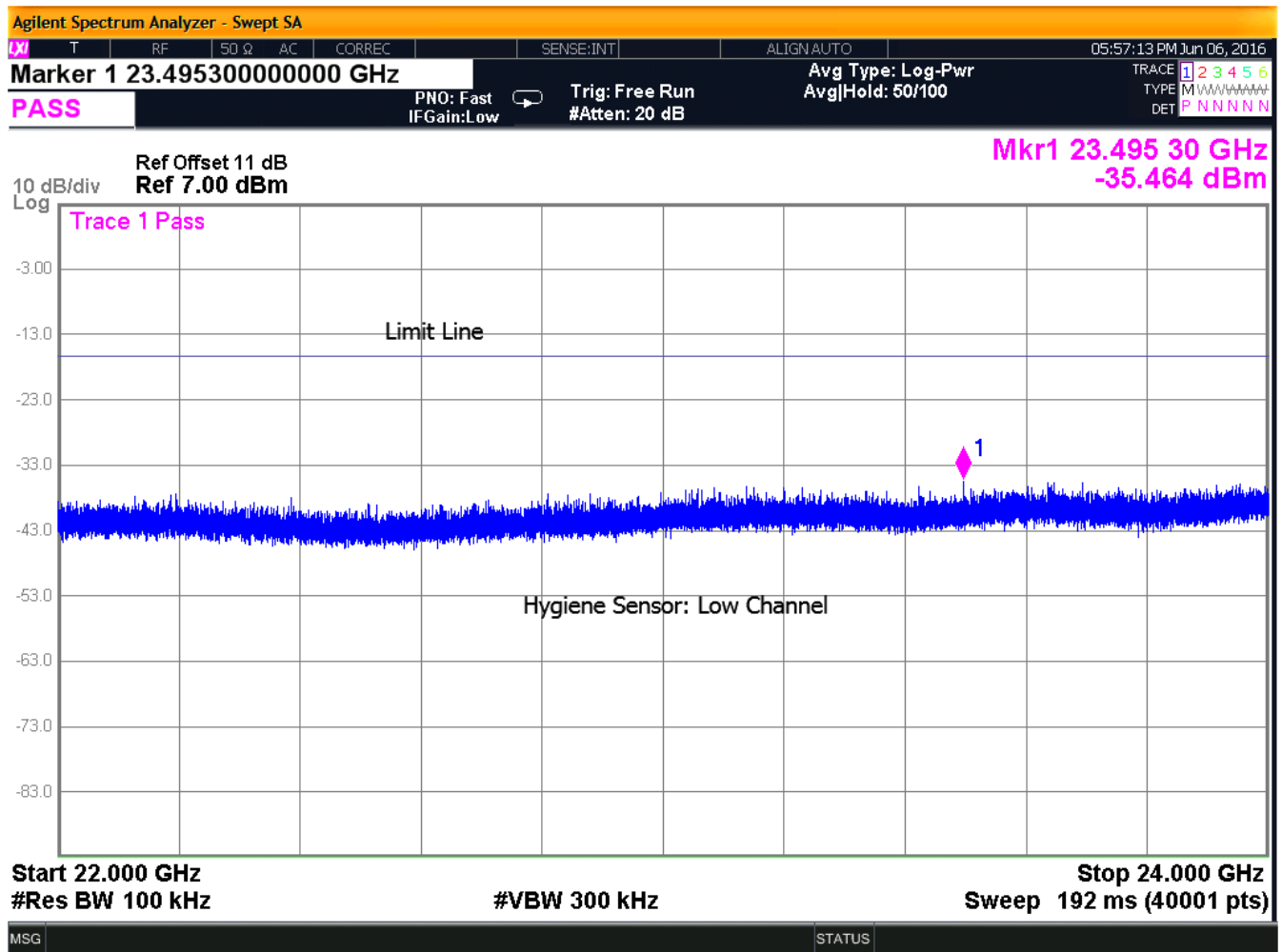


Figure 24: Low Channel Conducted Spurious Plot 14

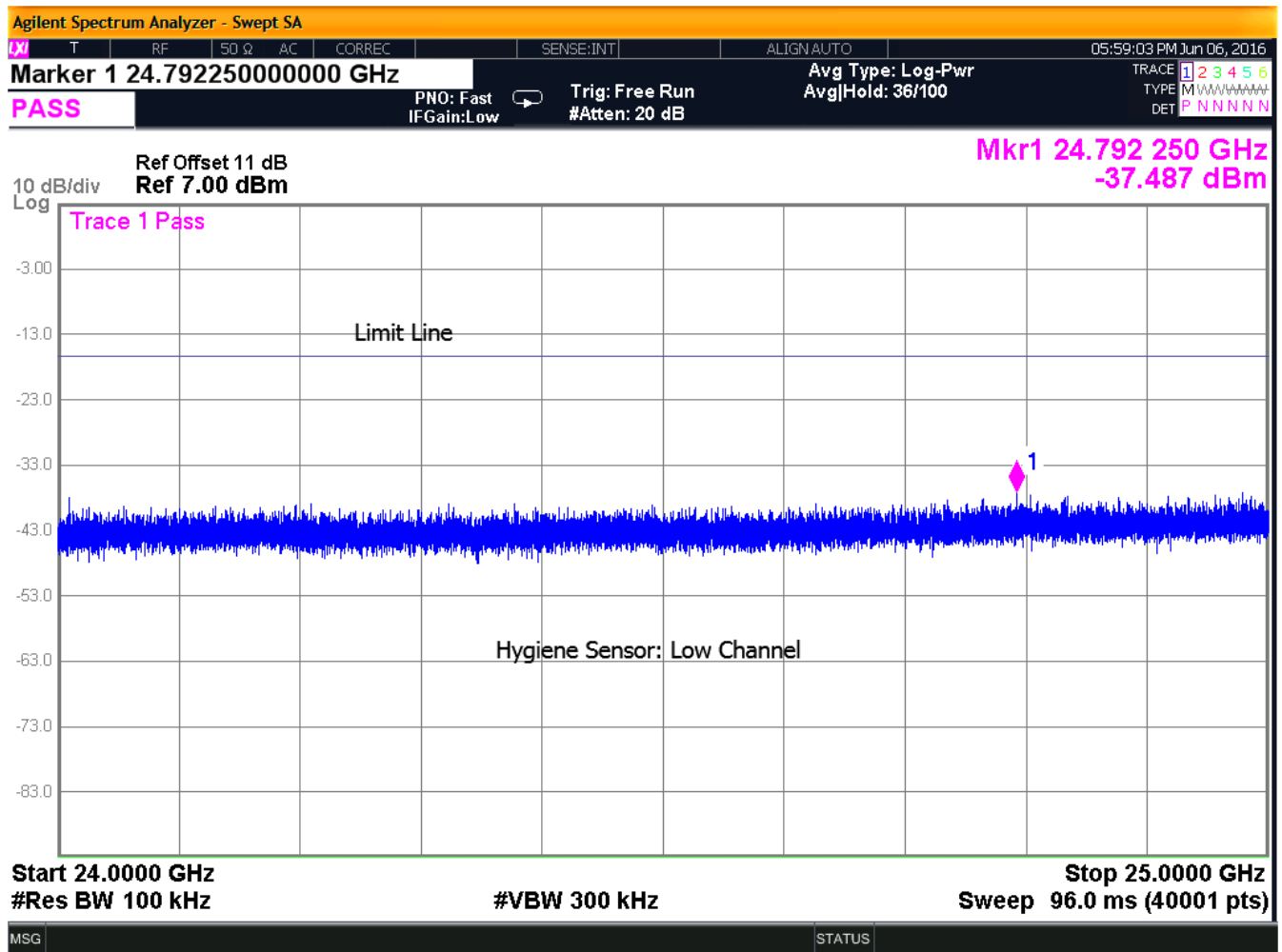


Figure 25: Low Channel Conducted Spurious Plot 15

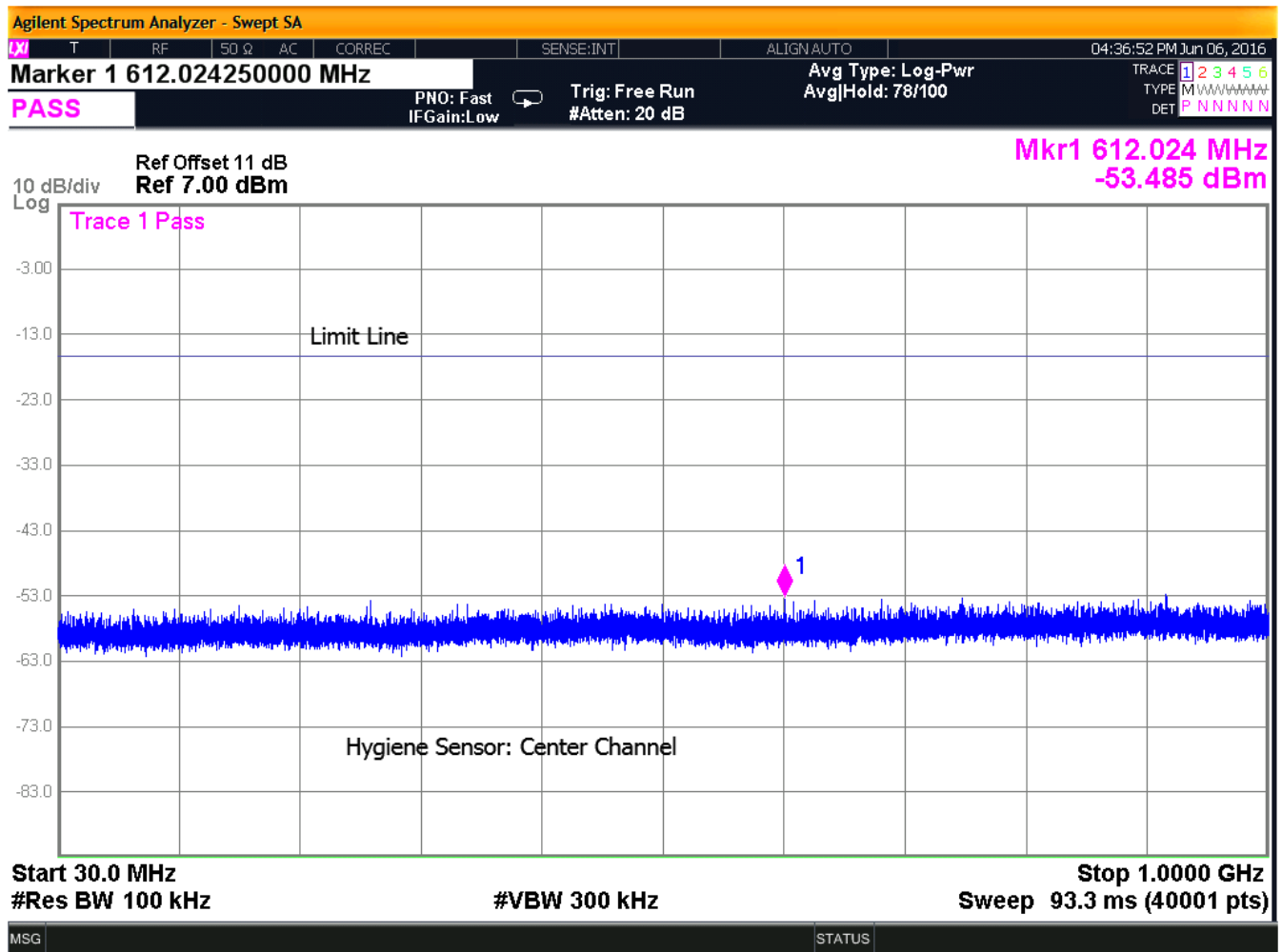


Figure 26: Center Channel Conducted Spurious Plot 1

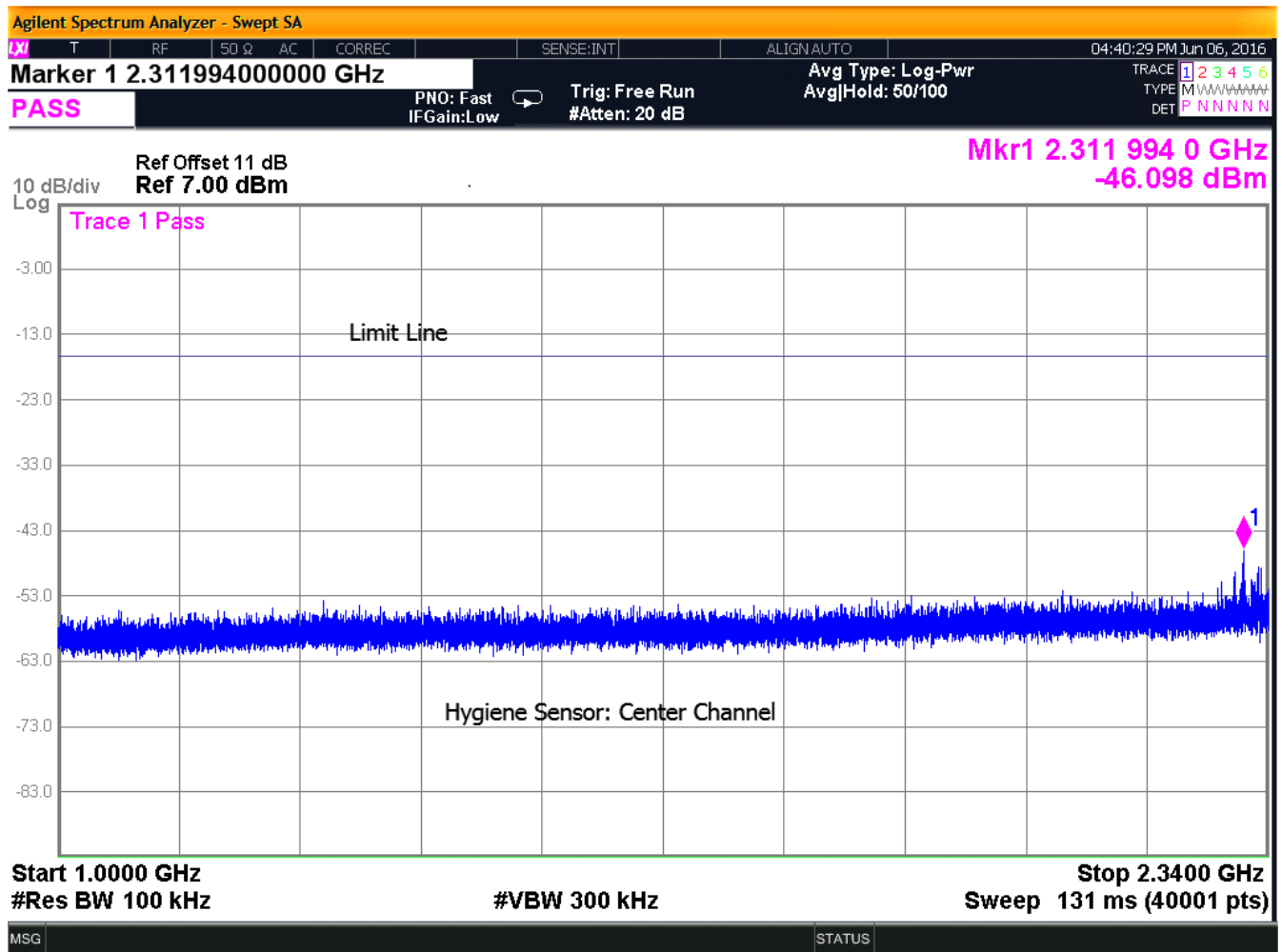


Figure 27: Center Channel Conducted Spurious Plot 2

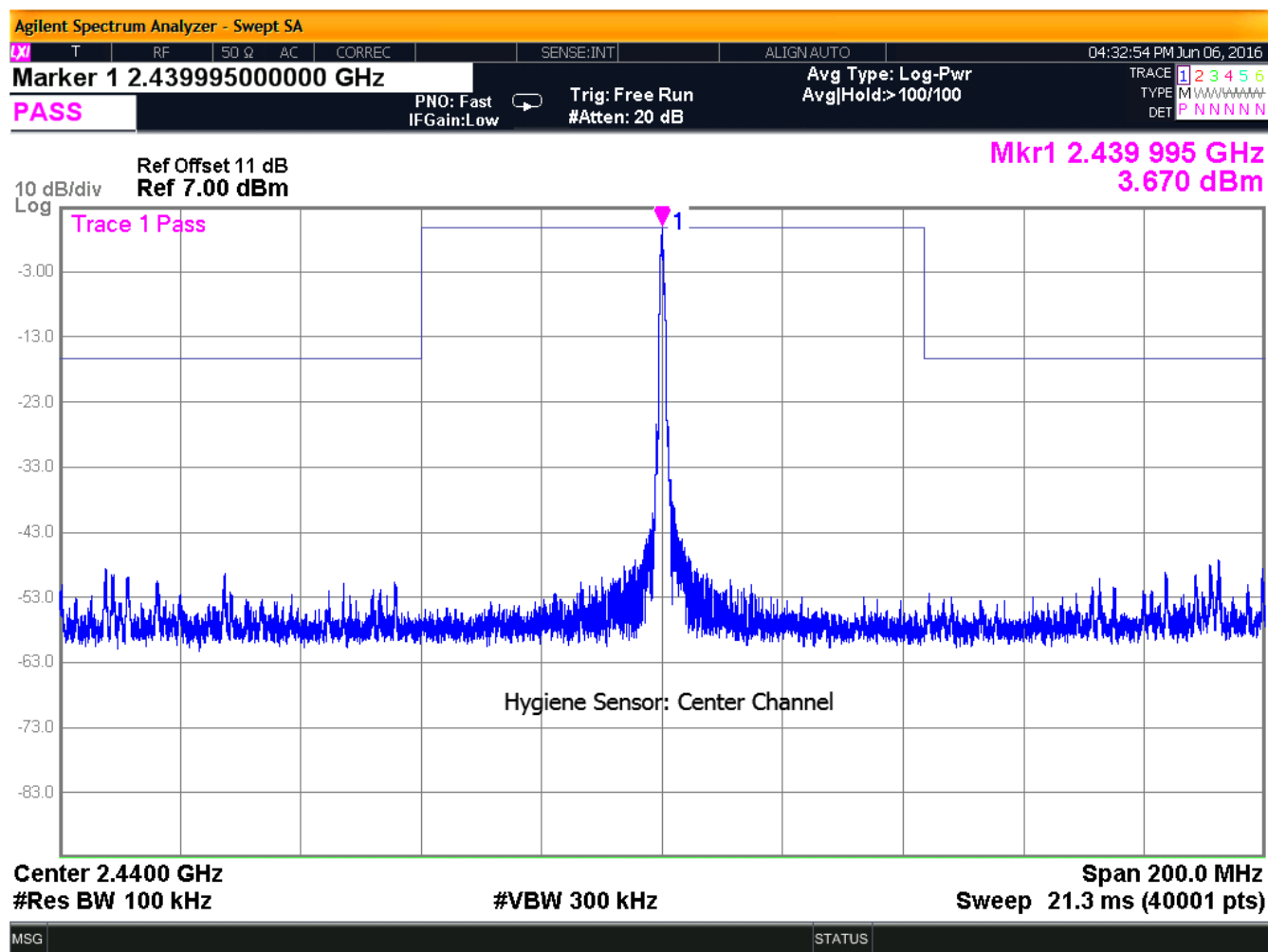


Figure 28: Center Channel Conducted Spurious Plot 3

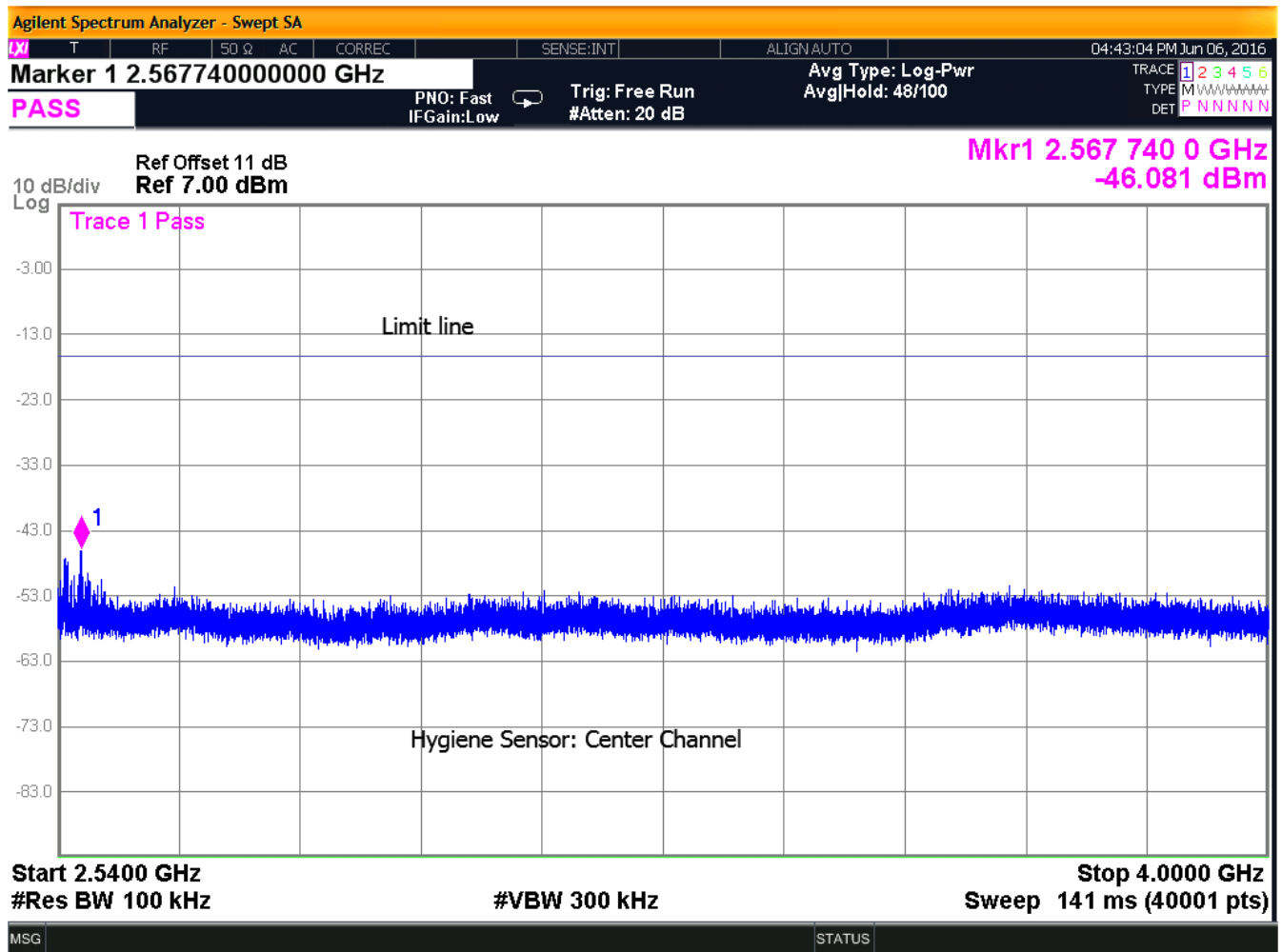


Figure 29: Center Channel Conducted Spurious Plot 4

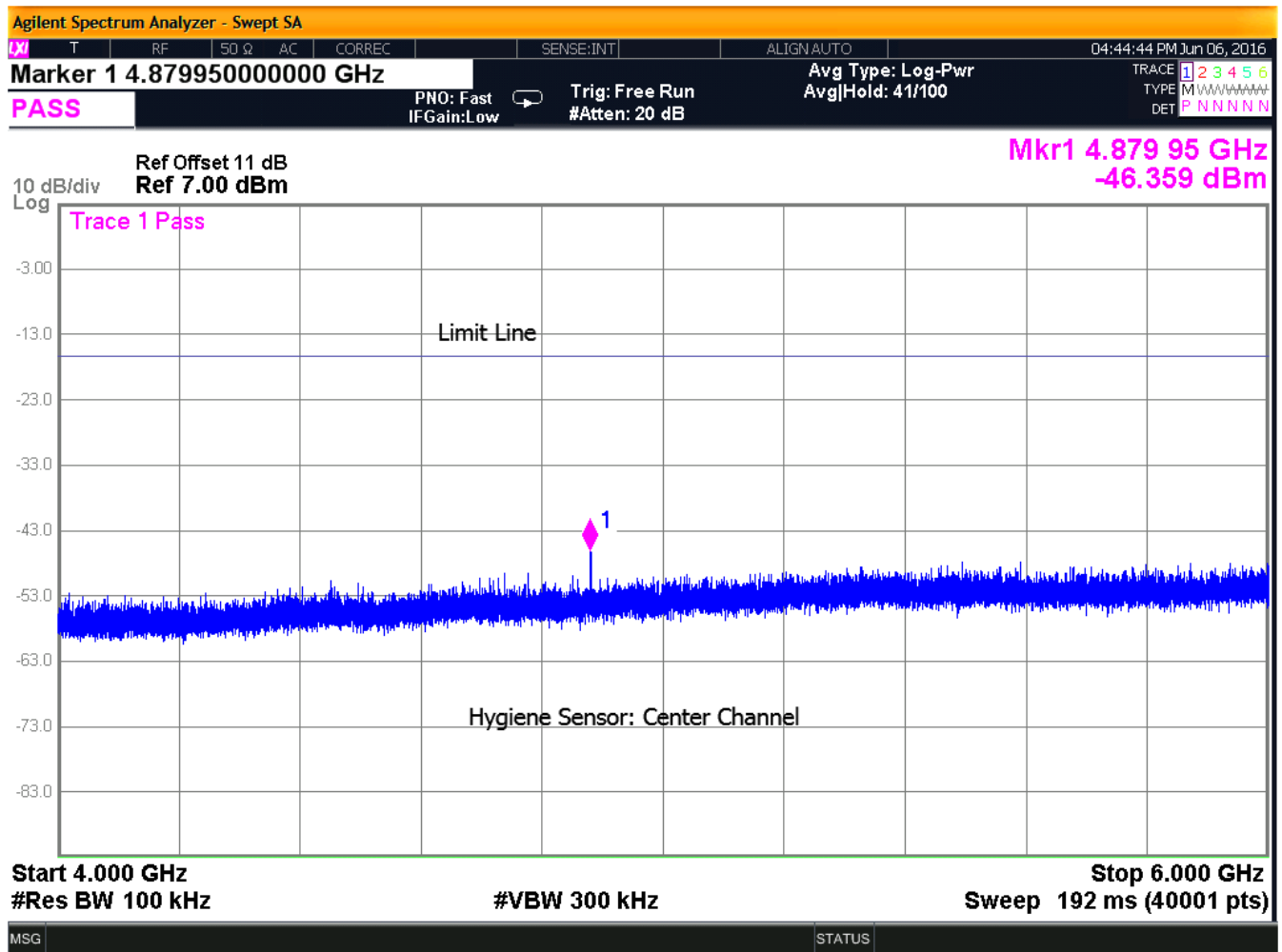


Figure 30: Center Channel Conducted Spurious Plot 5

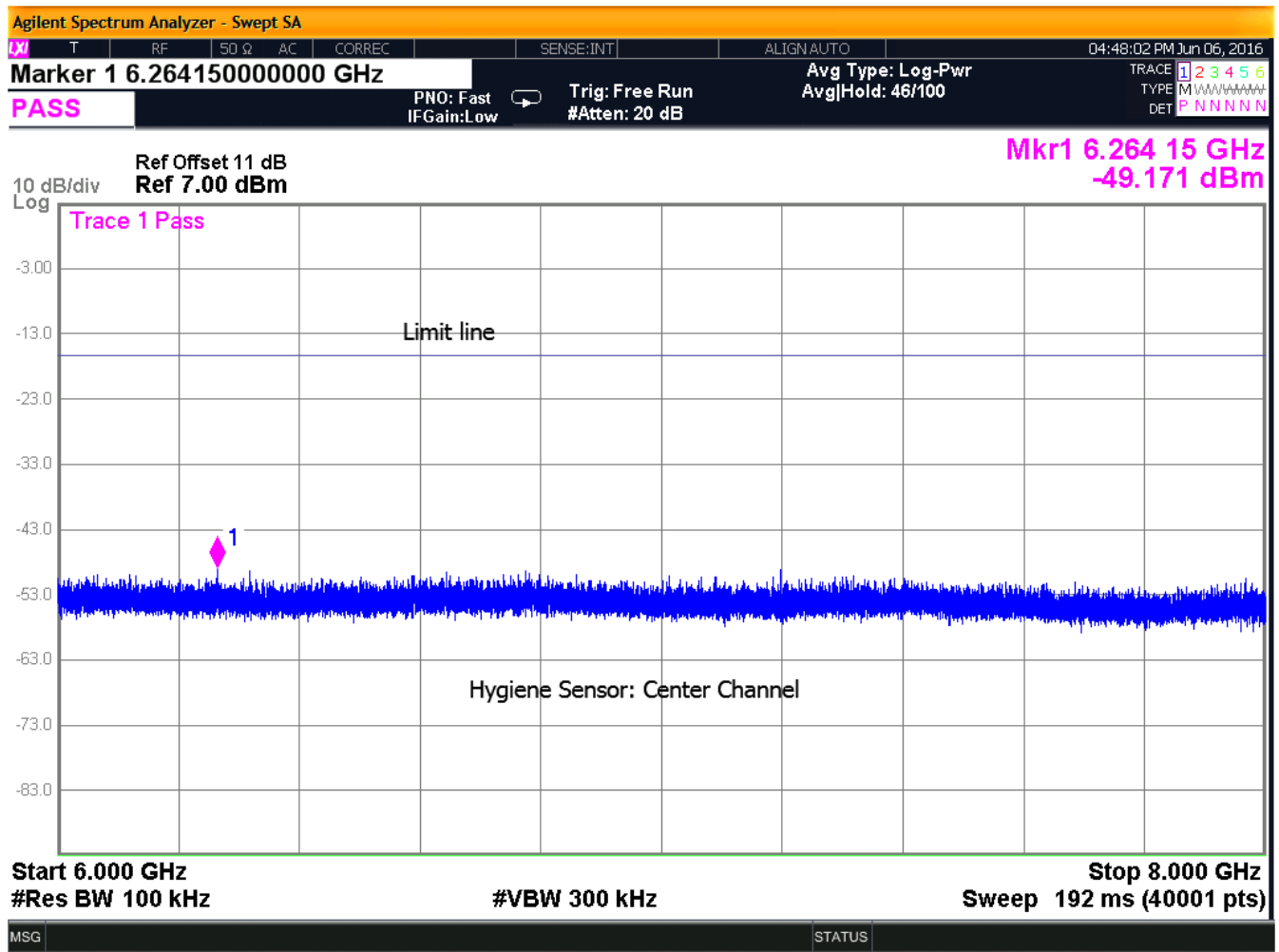


Figure 31: Center Channel Conducted Spurious Plot 6



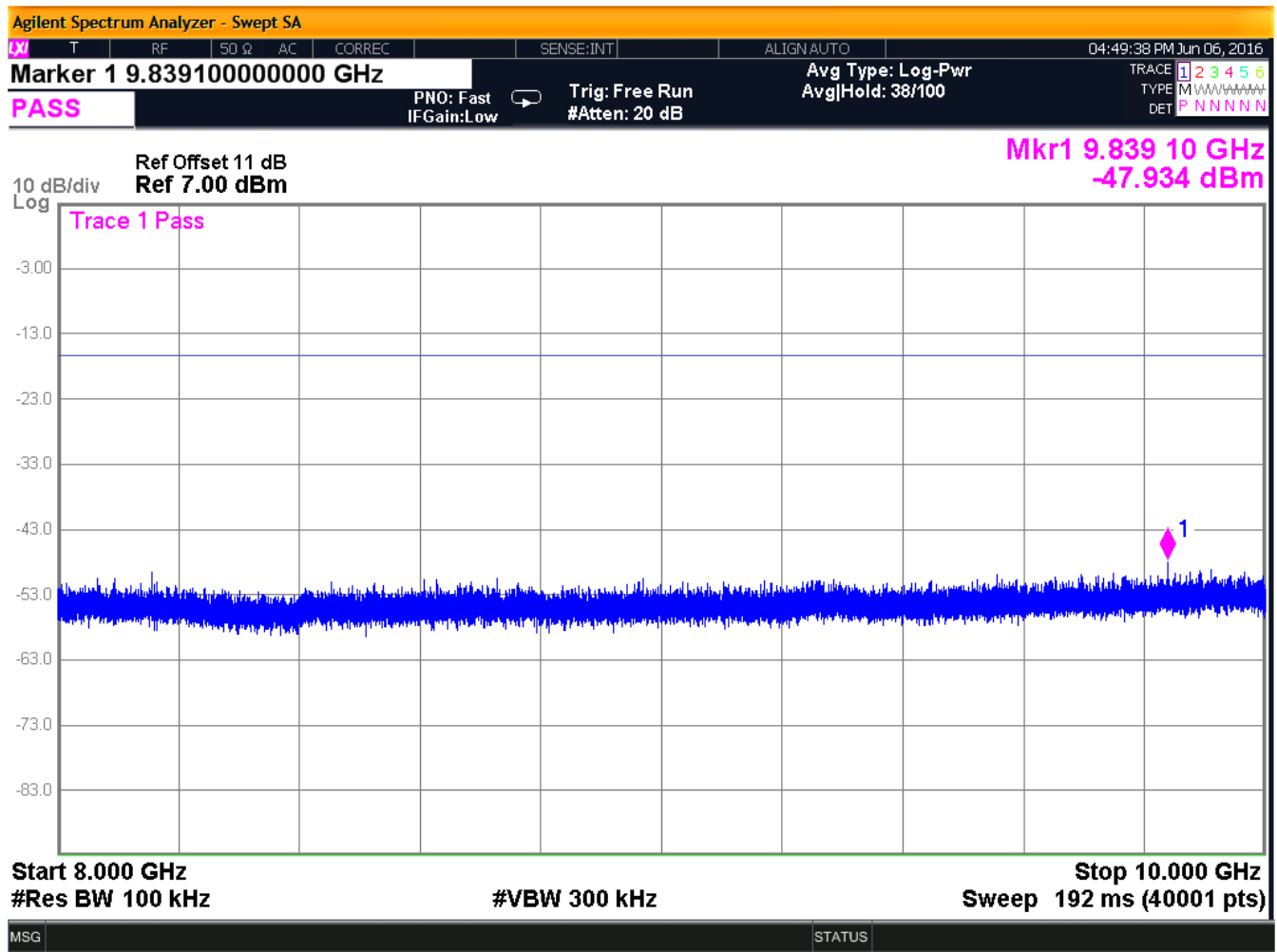


Figure 32: Center Channel Conducted Spurious Plot 7

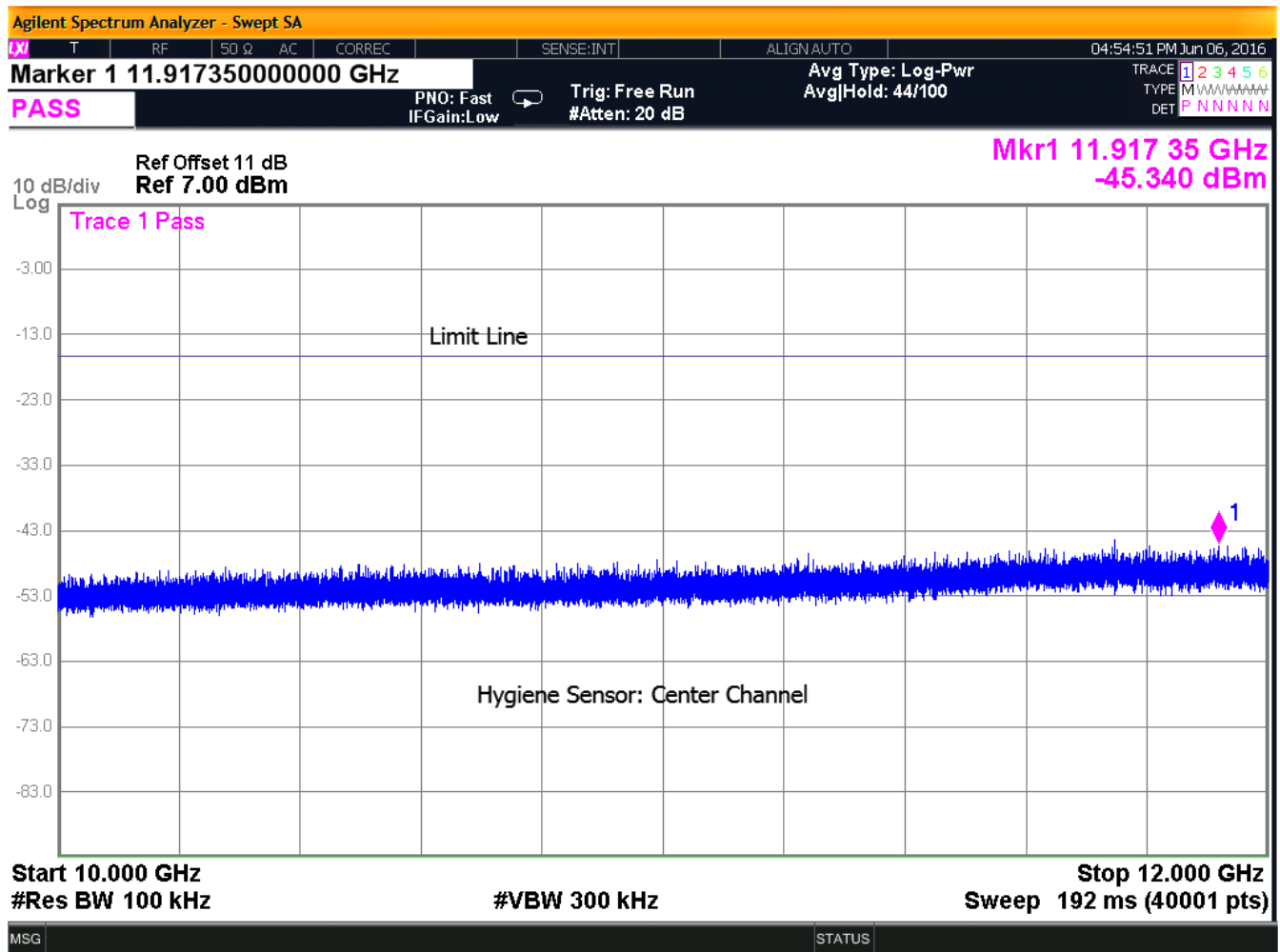


Figure 33: Center Channel Conducted Spurious Plot 8

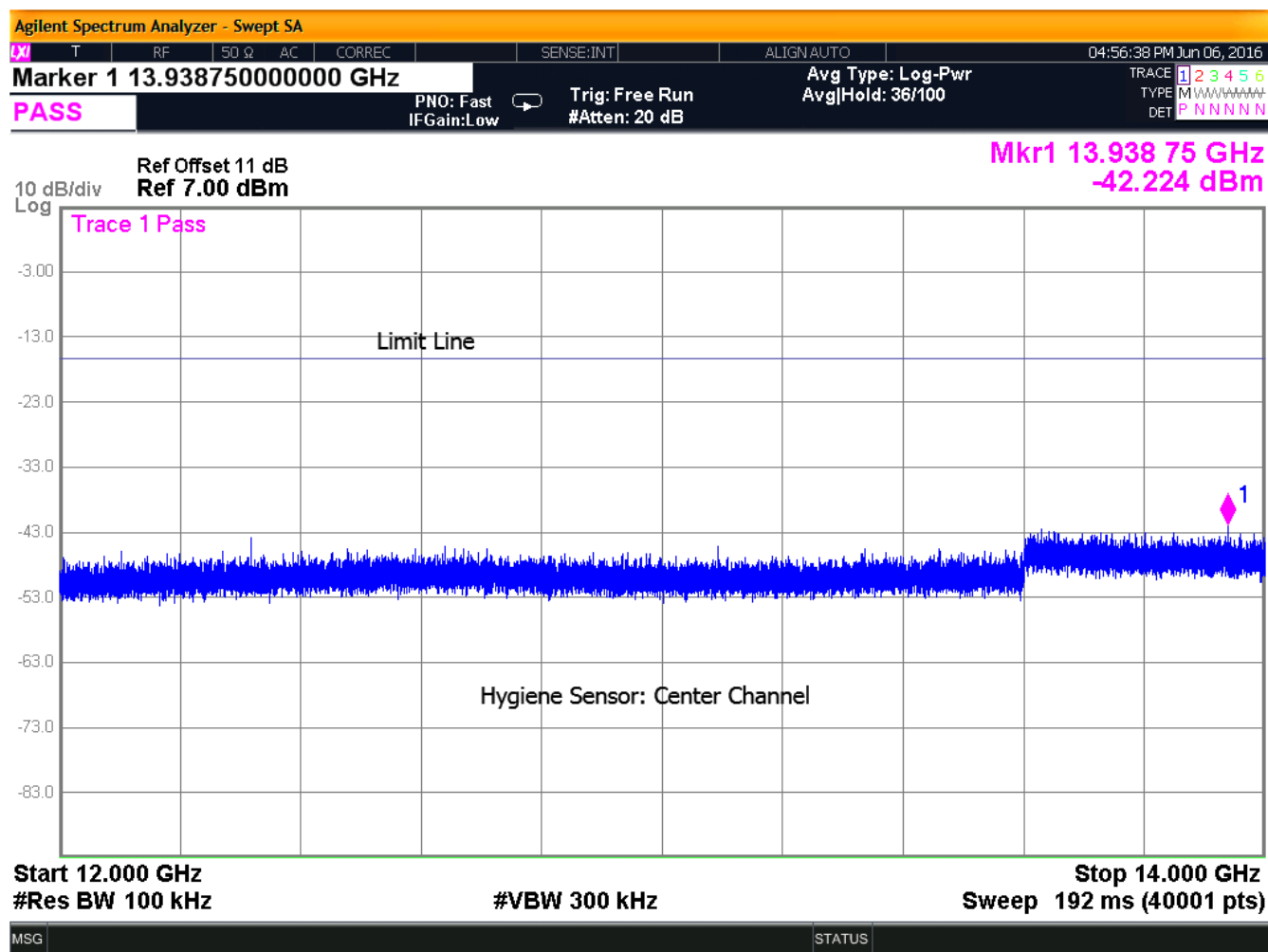


Figure 34: Center Channel Conducted Spurious Plot 9

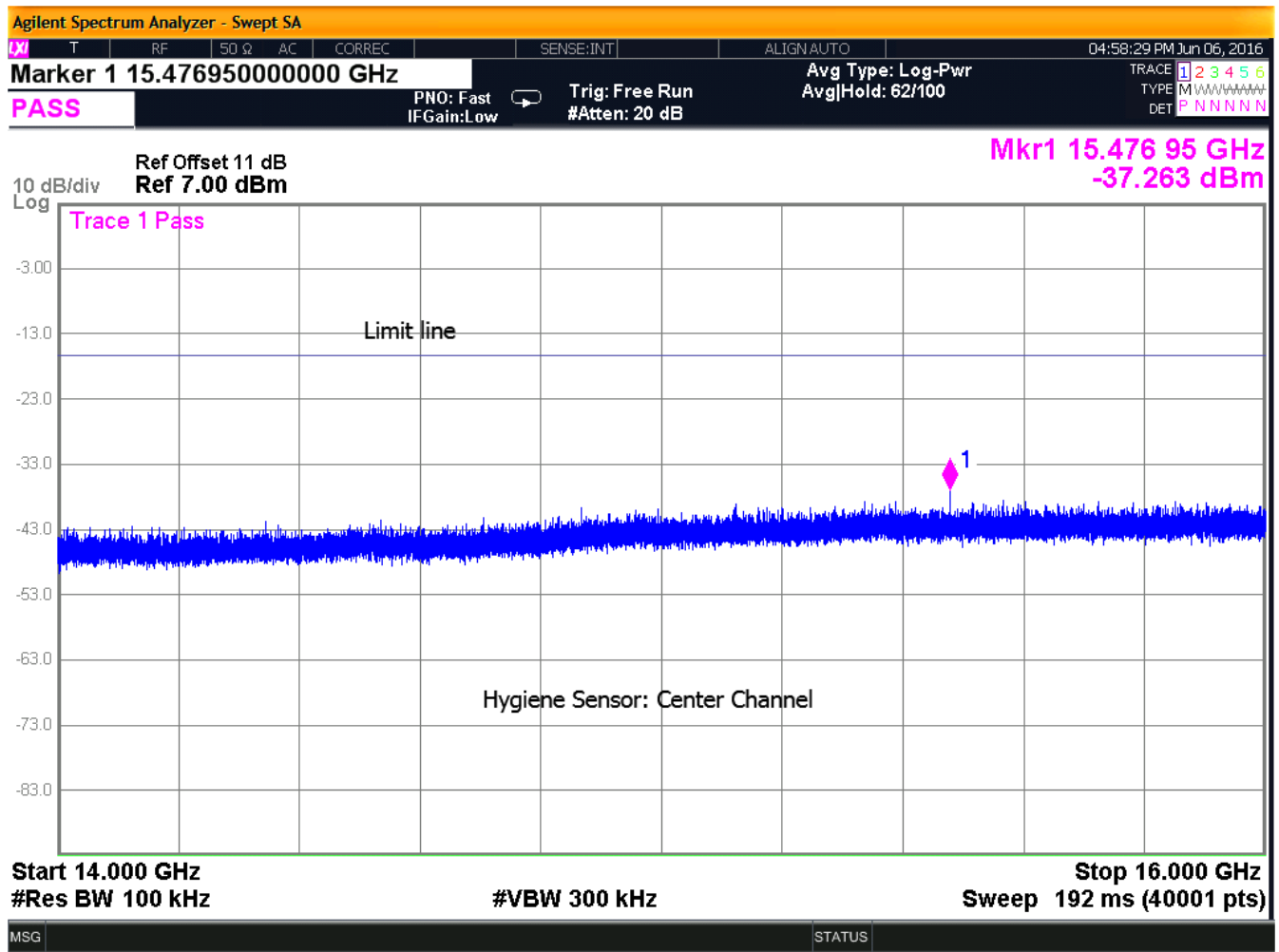


Figure 35: Center Channel Conducted Spurious Plot 10

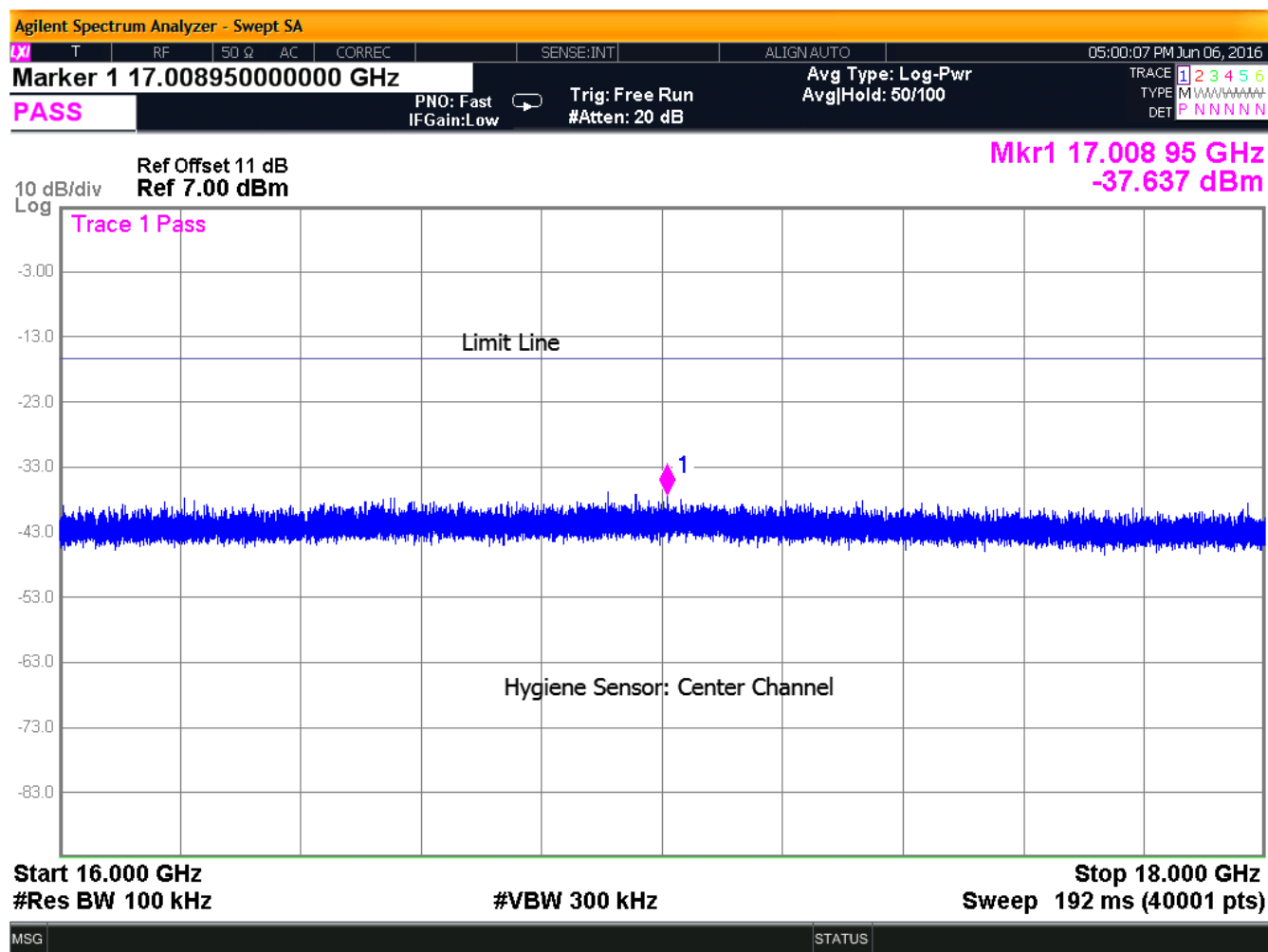


Figure 36: Center Channel Conducted Spurious Plot 11

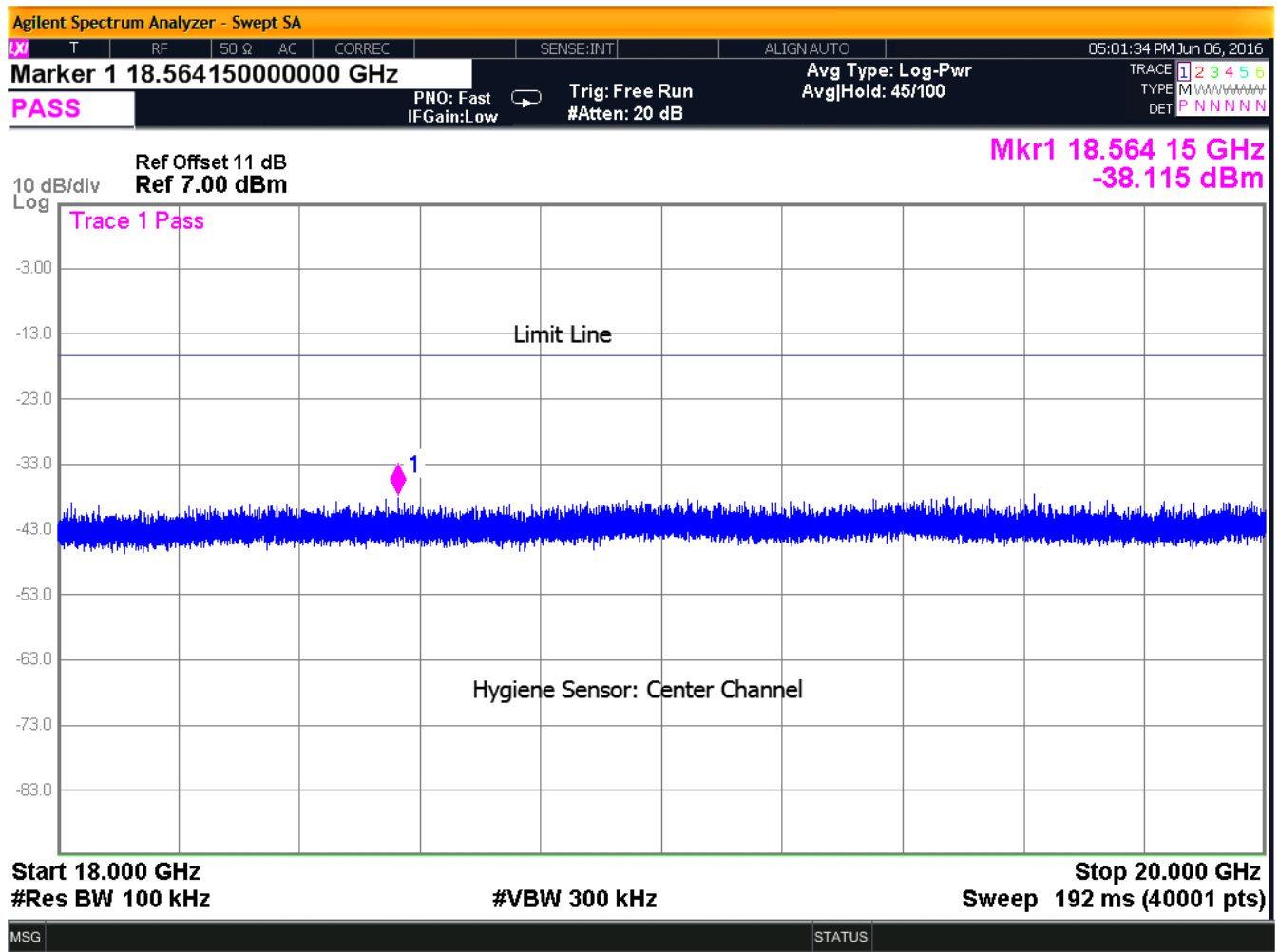


Figure 37: Center Channel Conducted Spurious Plot 12

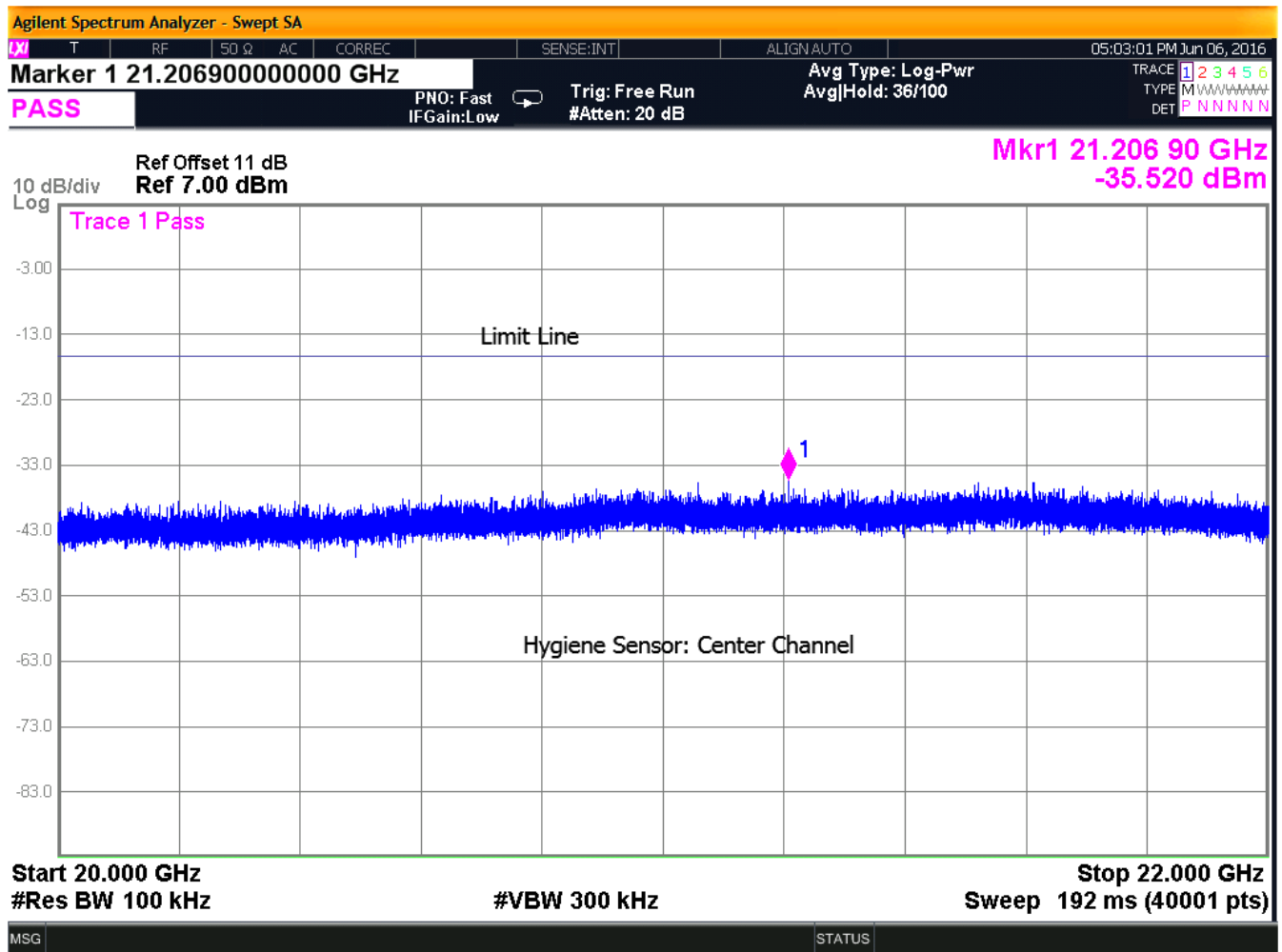


Figure 38: Center Channel Conducted Spurious Plot 13

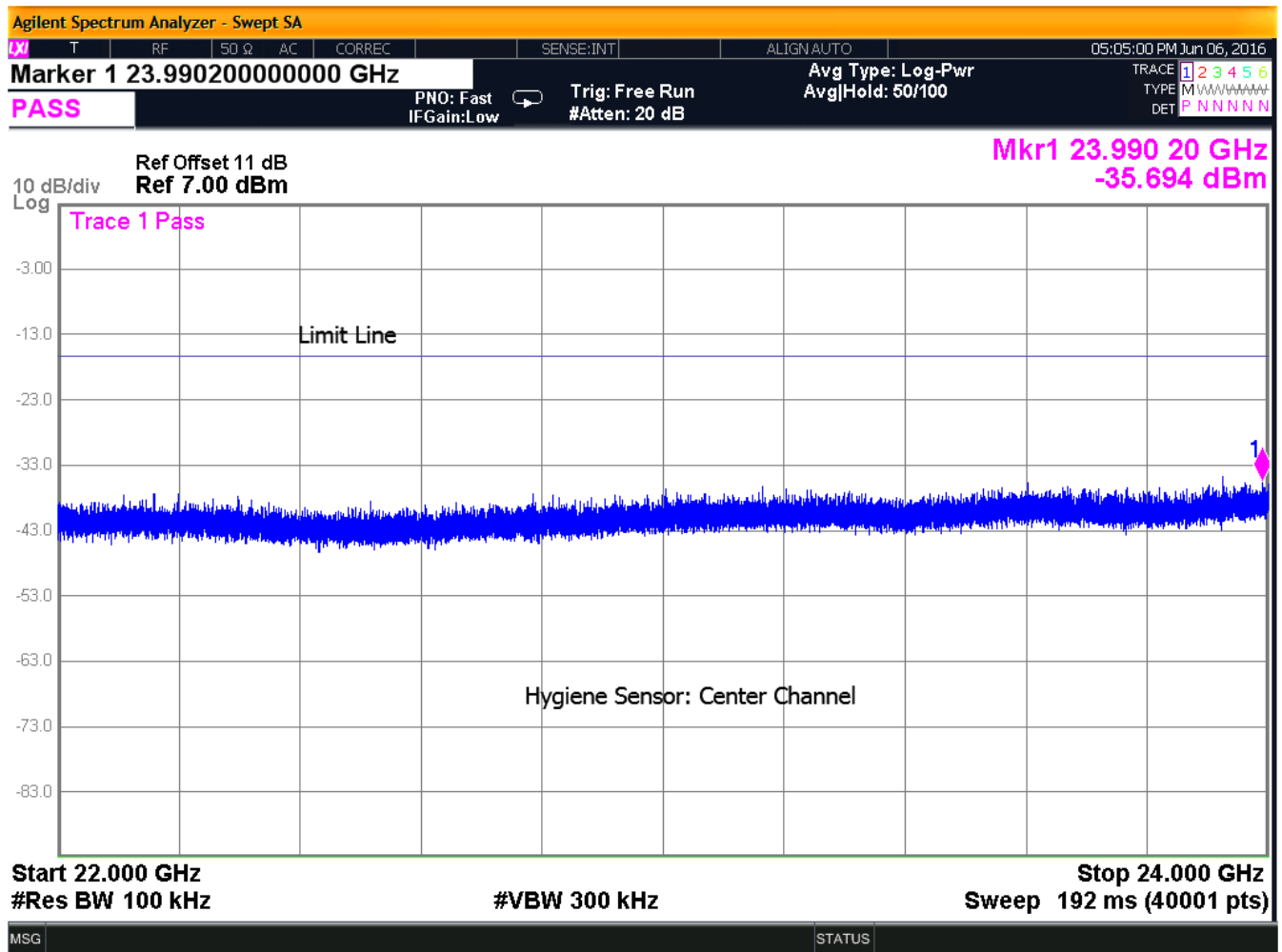


Figure 39: Center Channel Conducted Spurious Plot 14



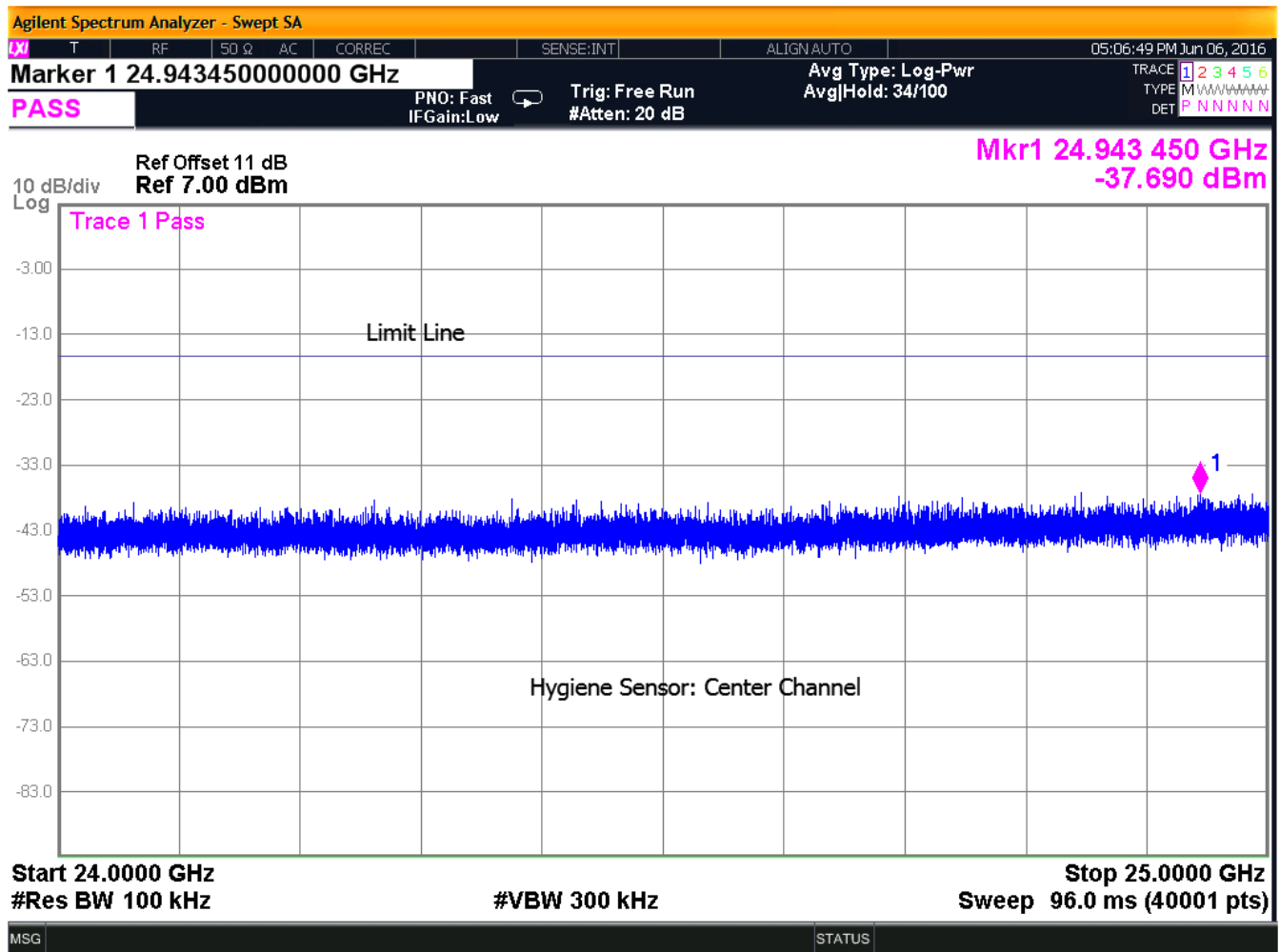


Figure 40: Center Channel Conducted Spurious Plot 15

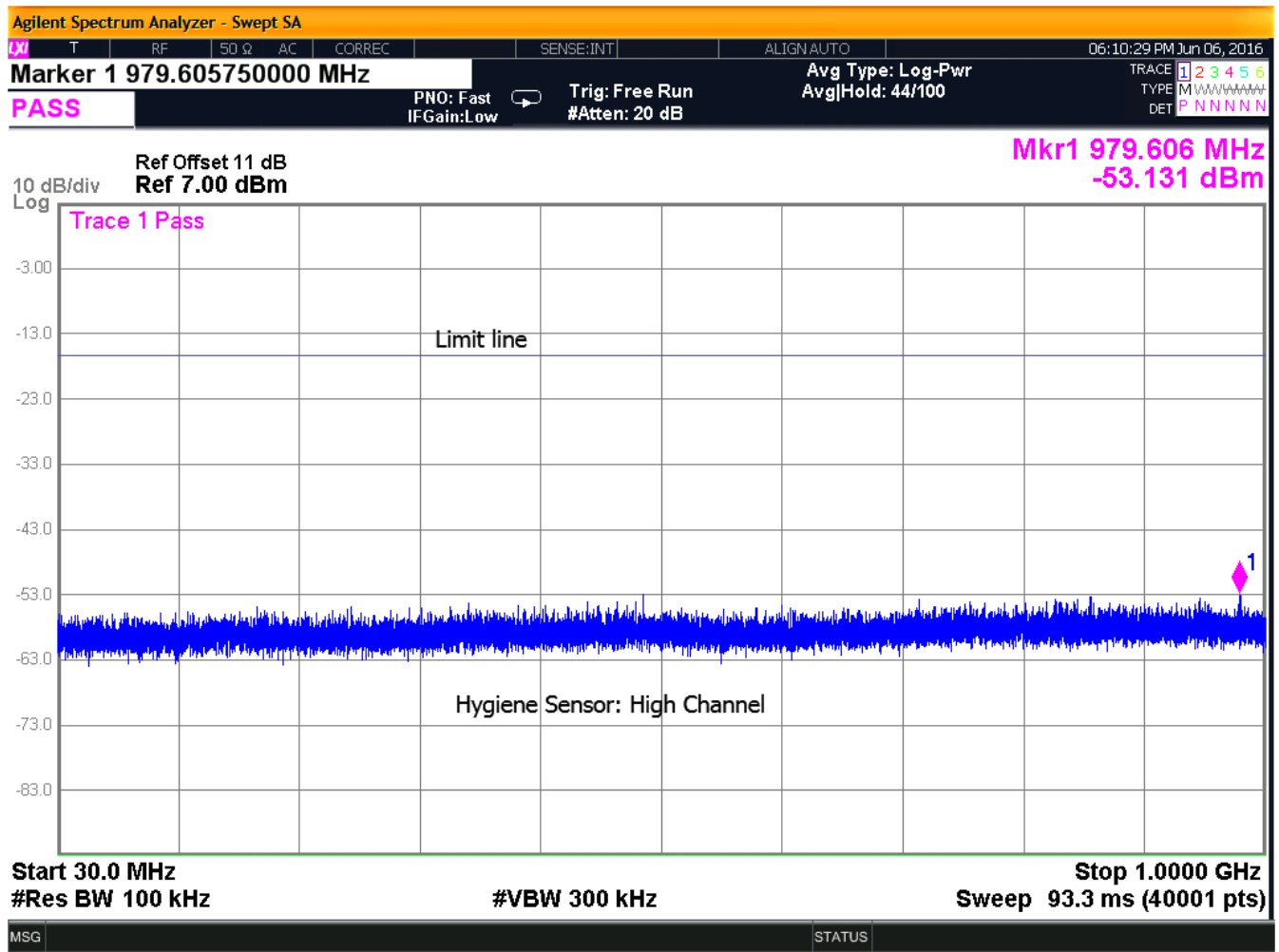


Figure 41: High Channel Conducted Spurious Plot 1

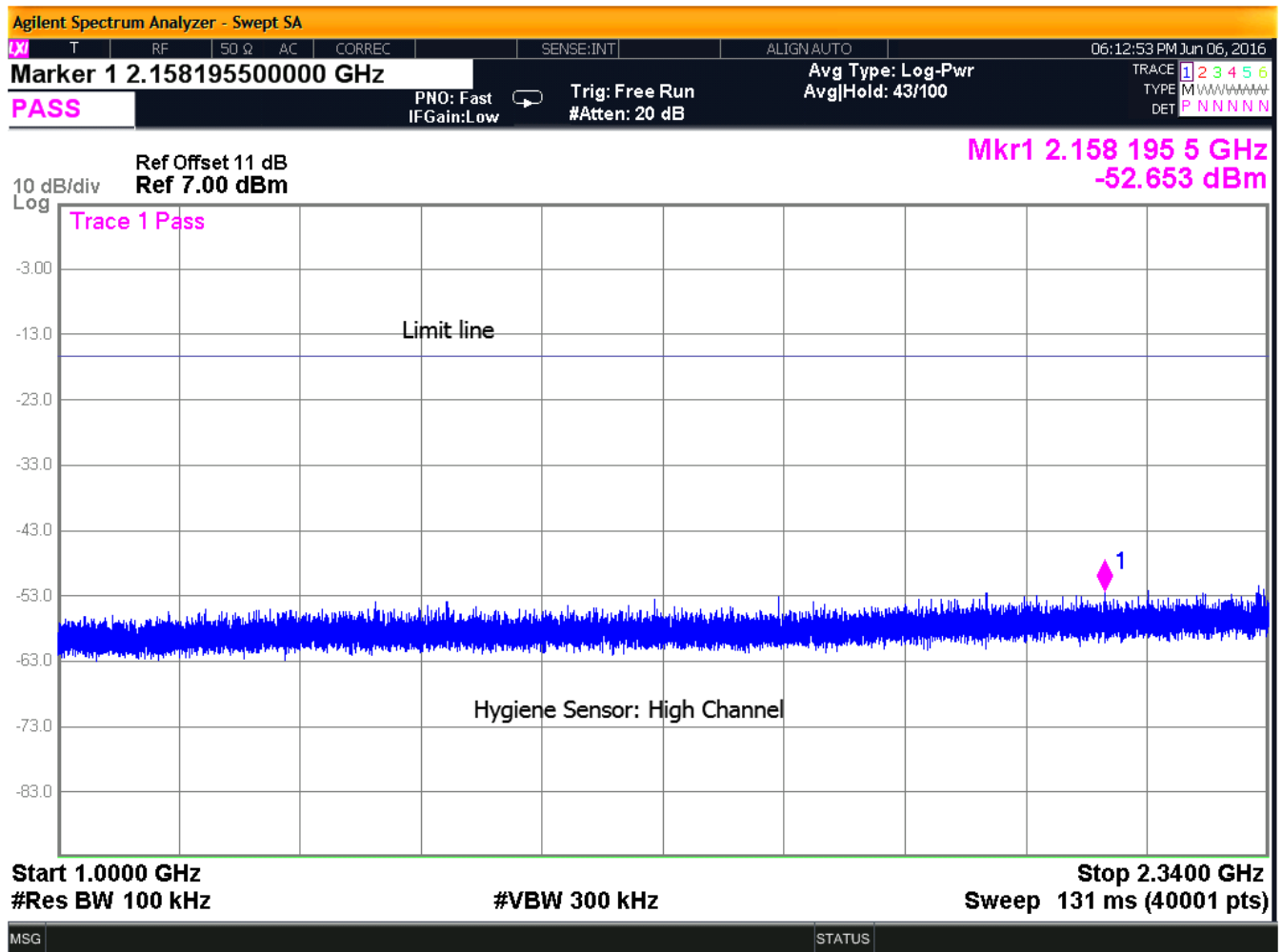


Figure 42: High Channel Conducted Spurious Plot 2

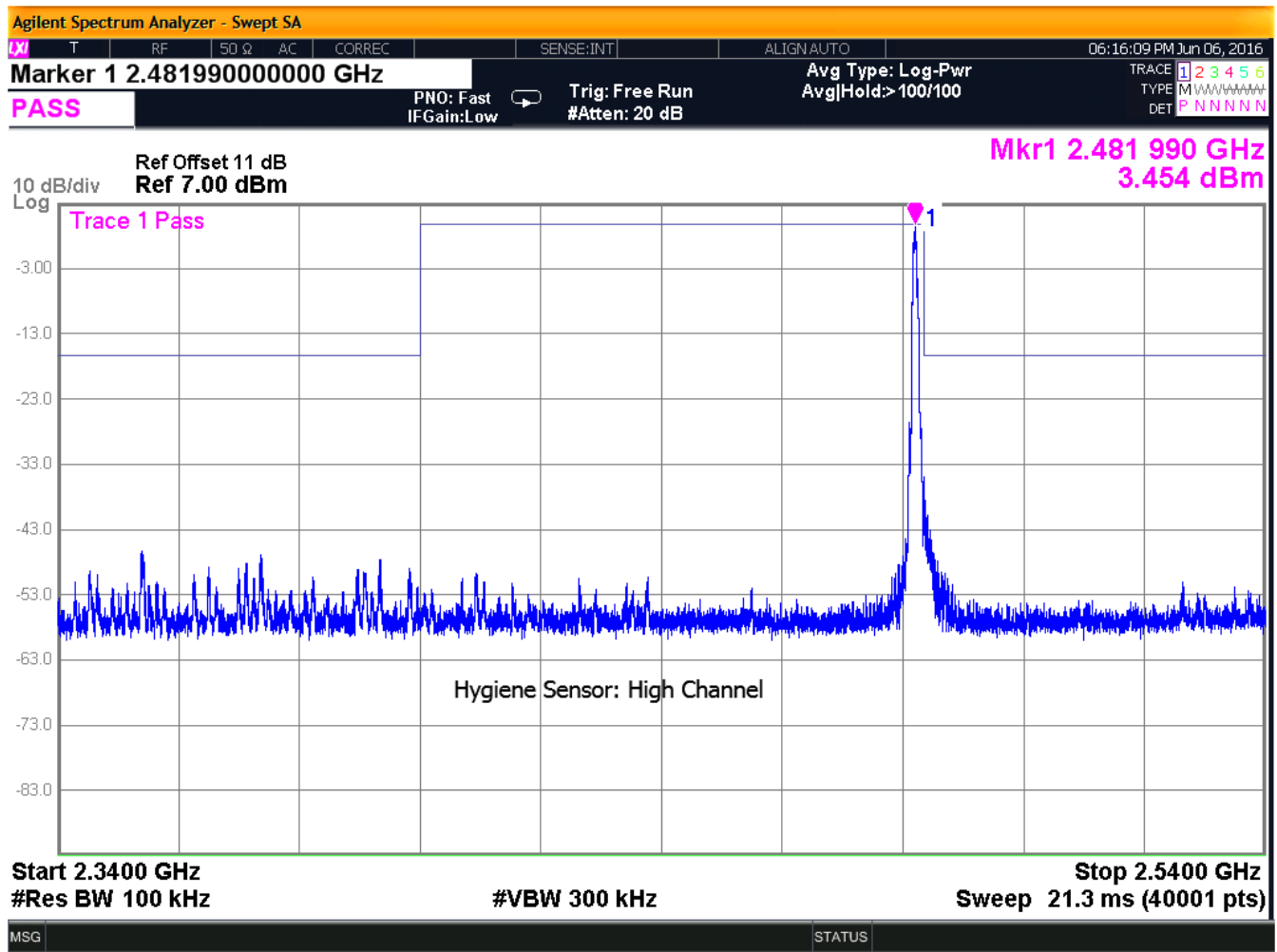


Figure 43: High Channel Conducted Spurious Plot 3

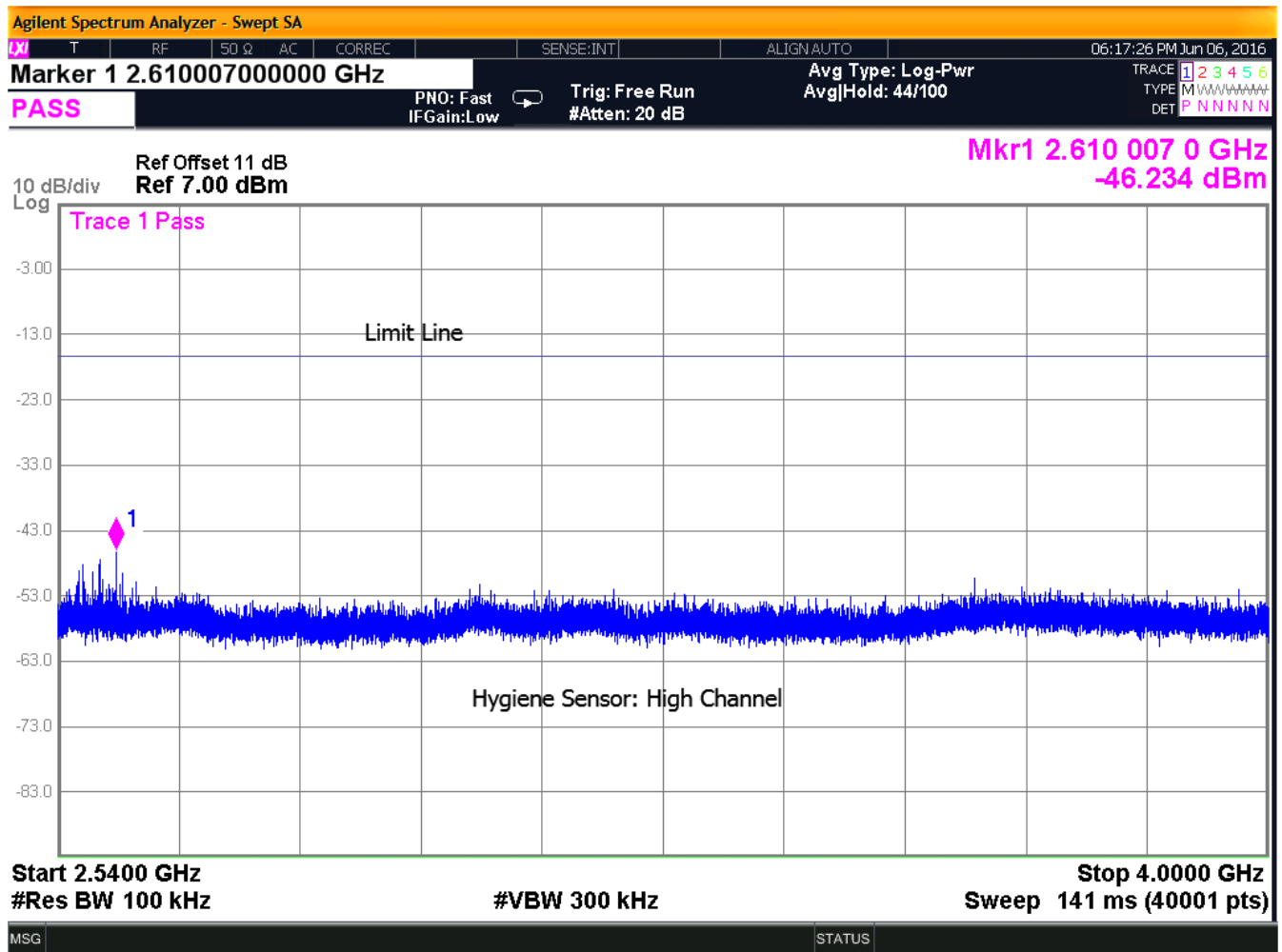


Figure 44: High Channel Conducted Spurious Plot 4

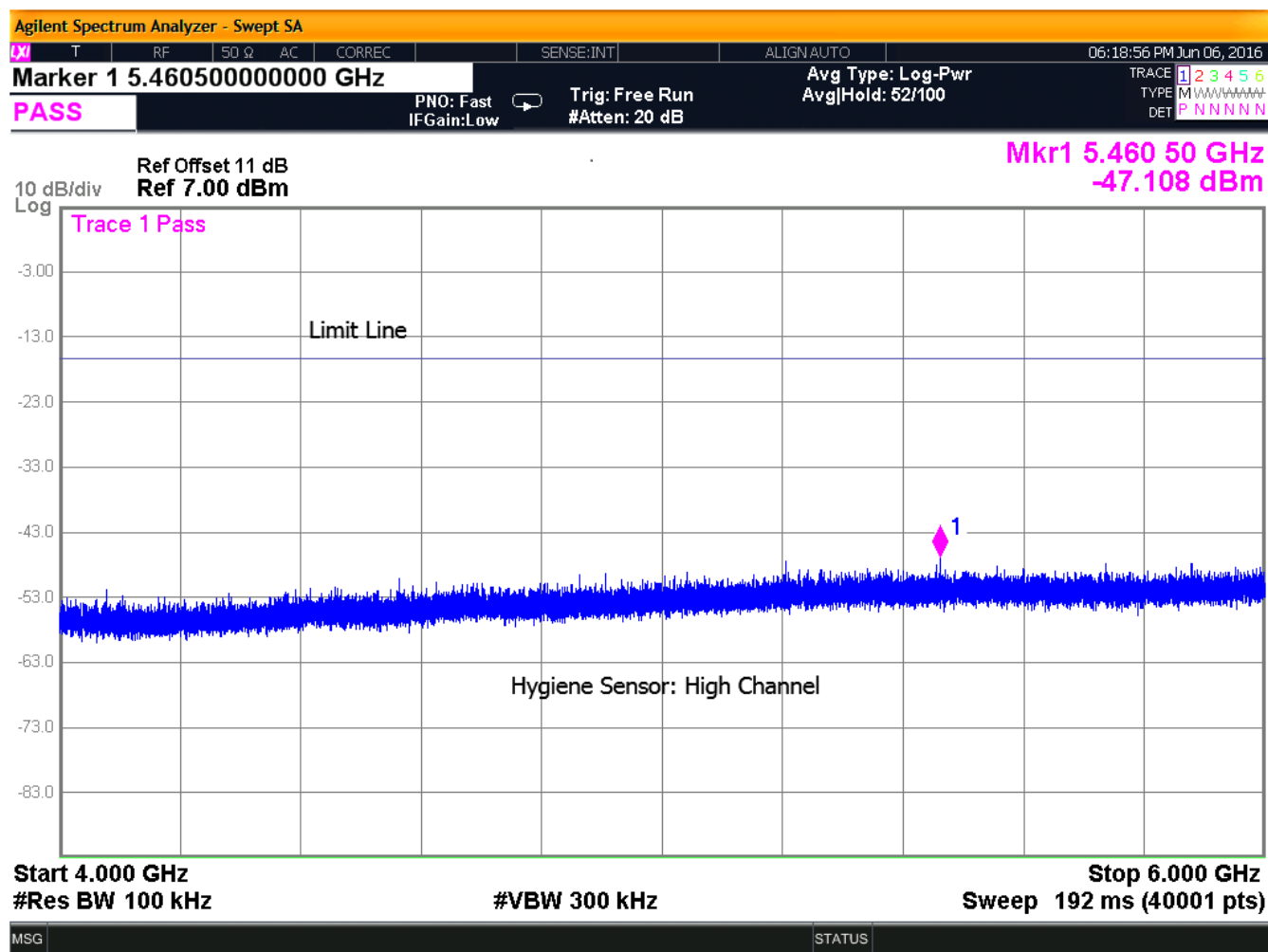


Figure 45: High Channel Conducted Spurious Plot 5

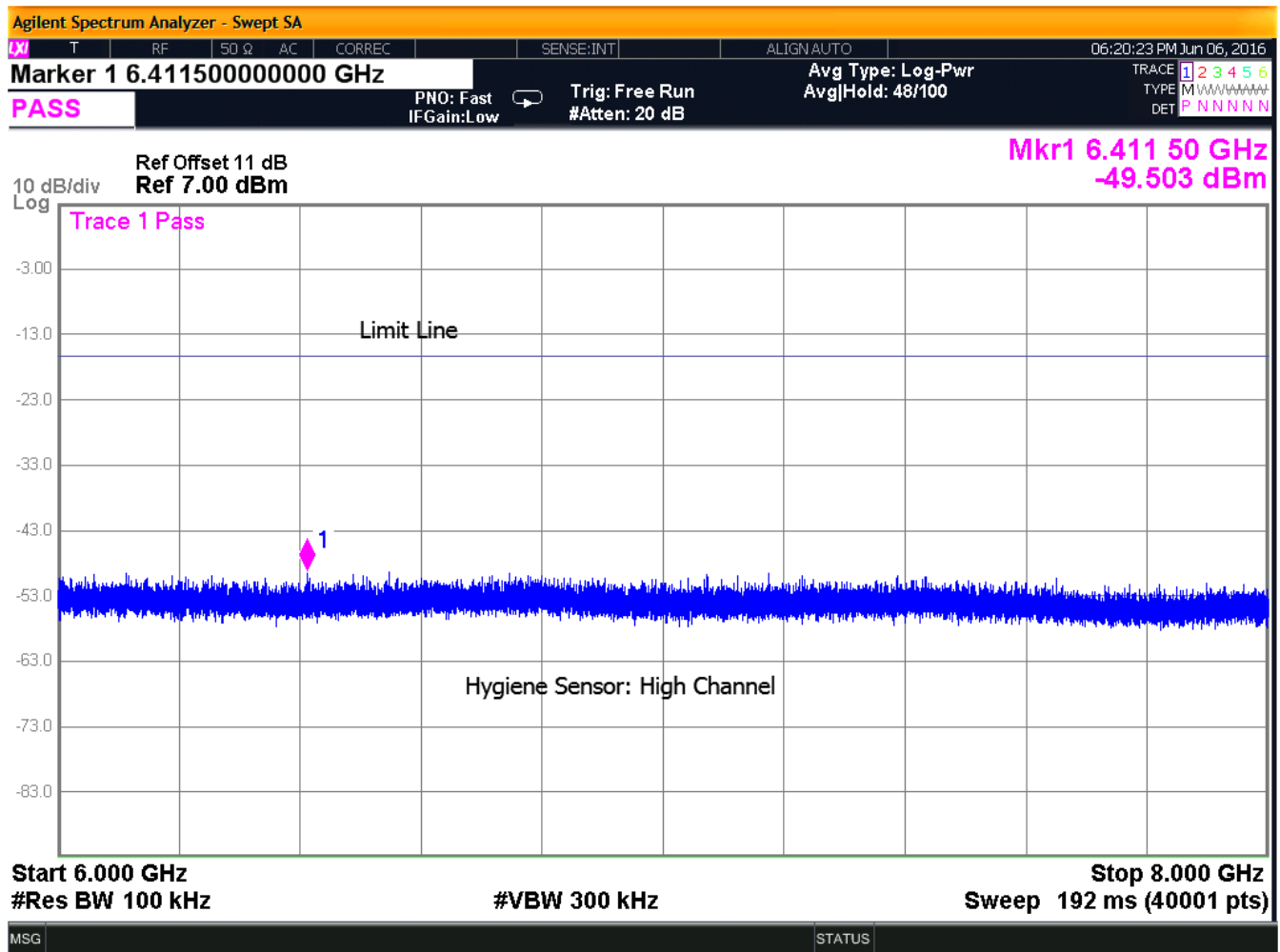


Figure 46: High Channel Conducted Spurious Plot 6

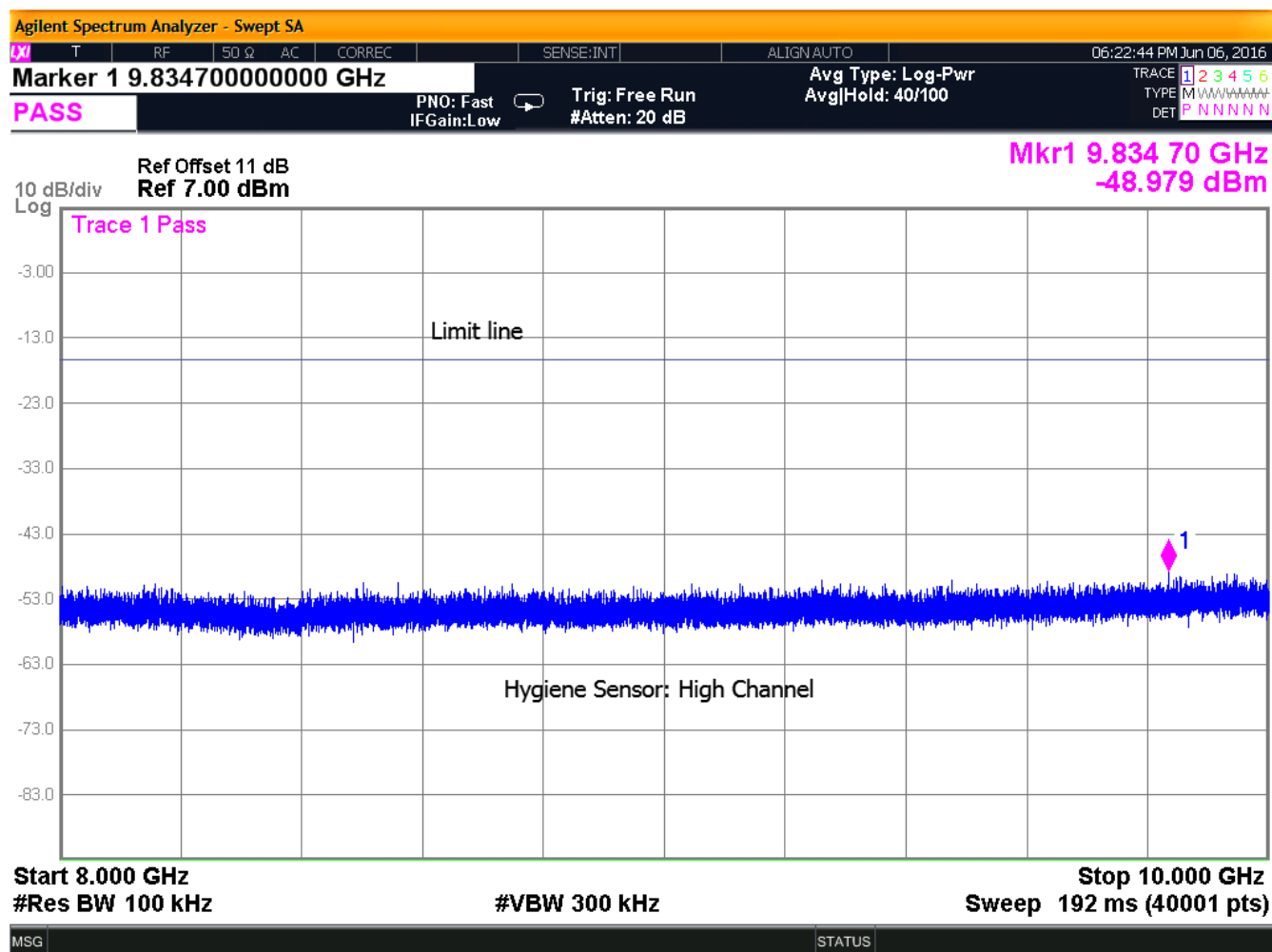


Figure 47: High Channel Conducted Spurious Plot 7



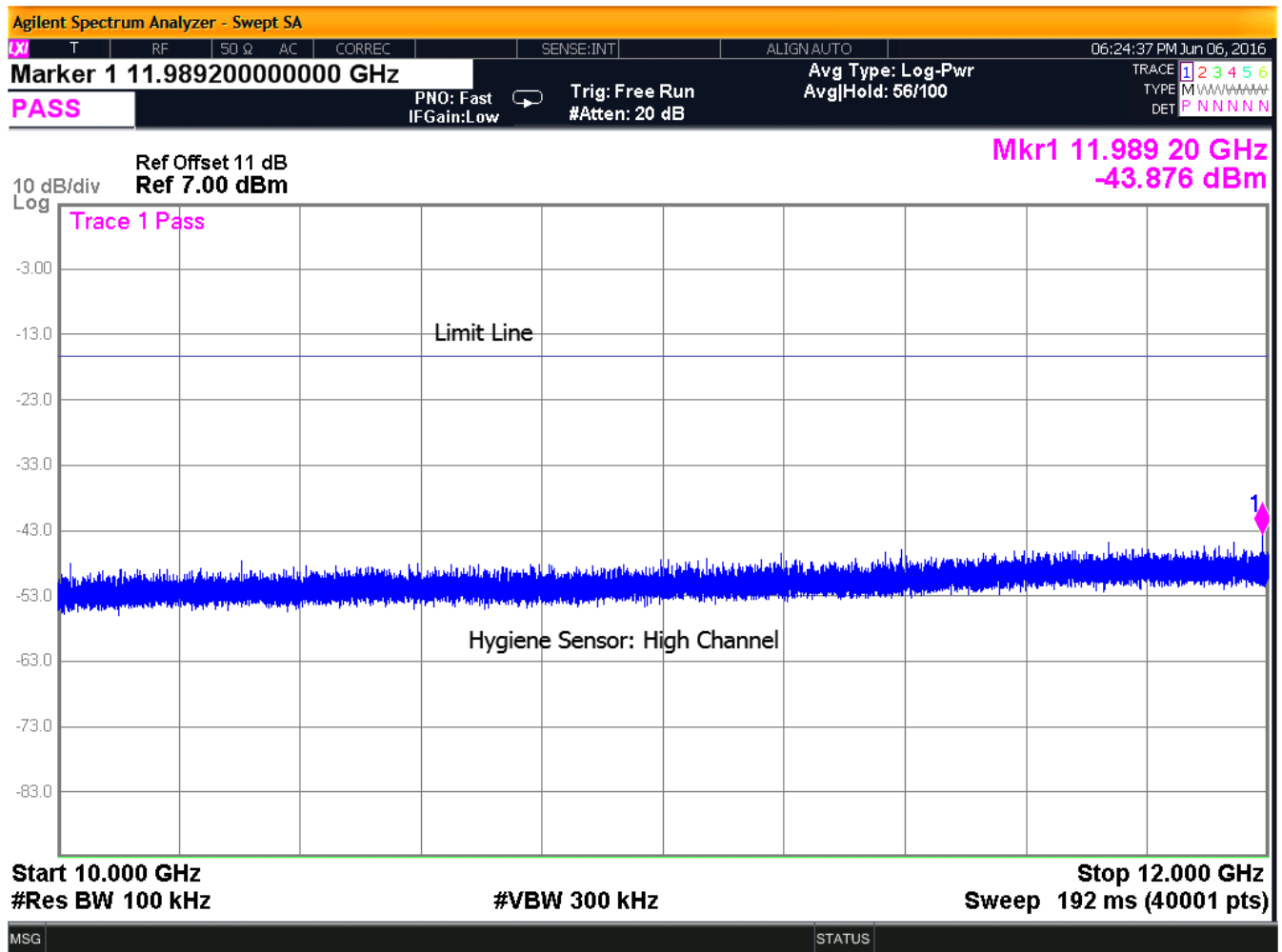


Figure 48: High Channel Conducted Spurious Plot 8

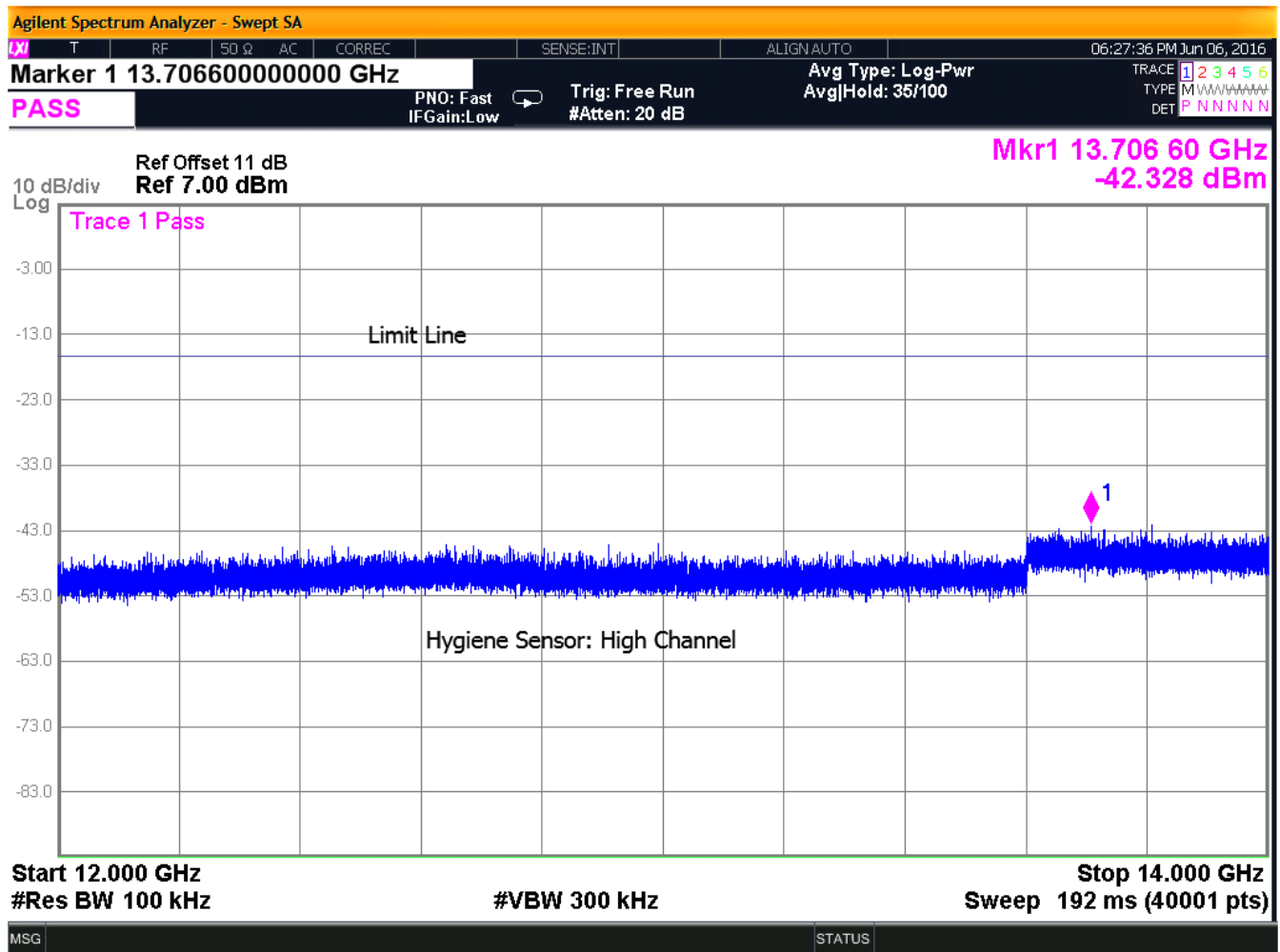


Figure 49: High Channel Conducted Spurious Plot 9

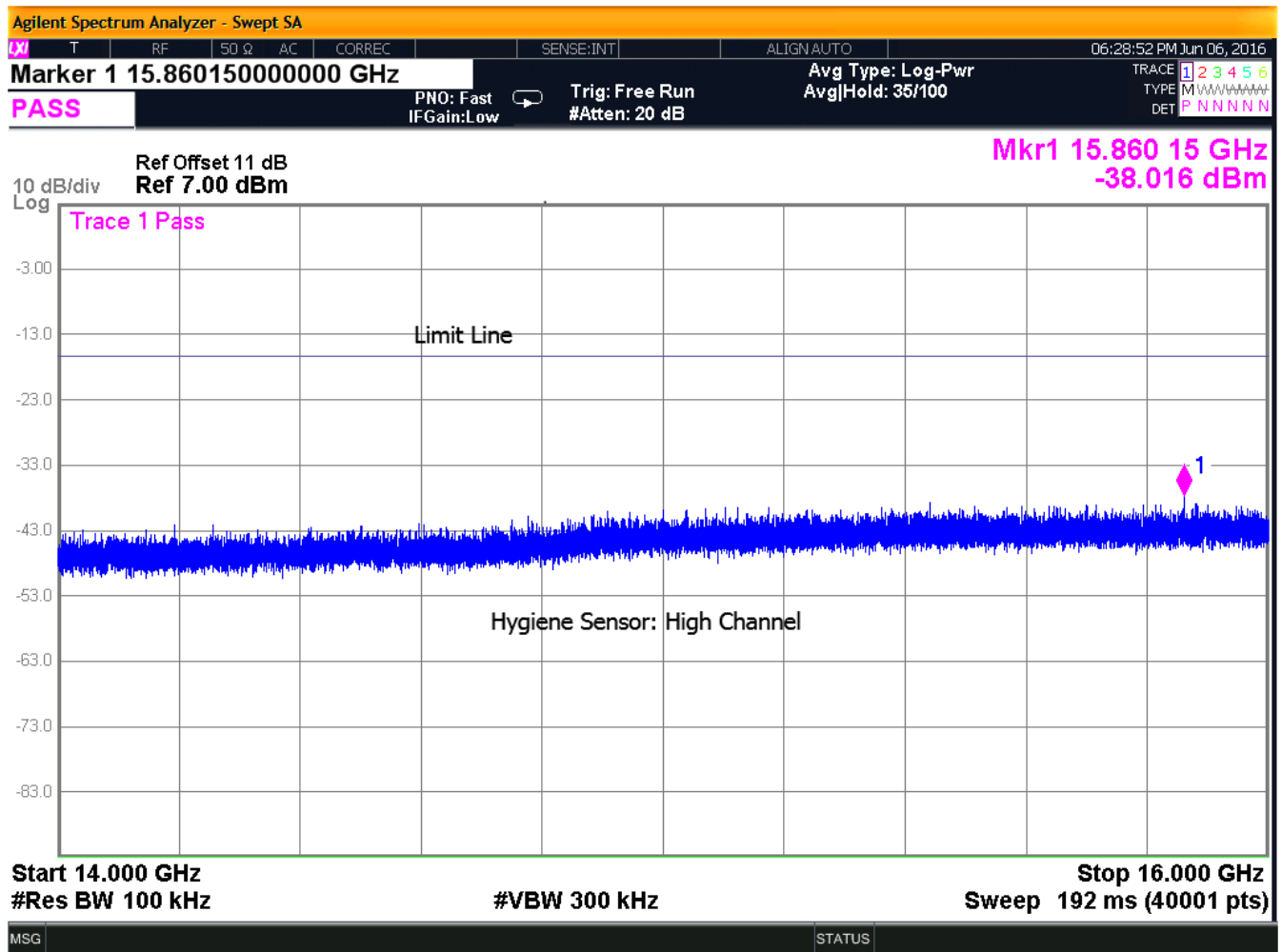


Figure 50: High Channel Conducted Spurious Plot 10

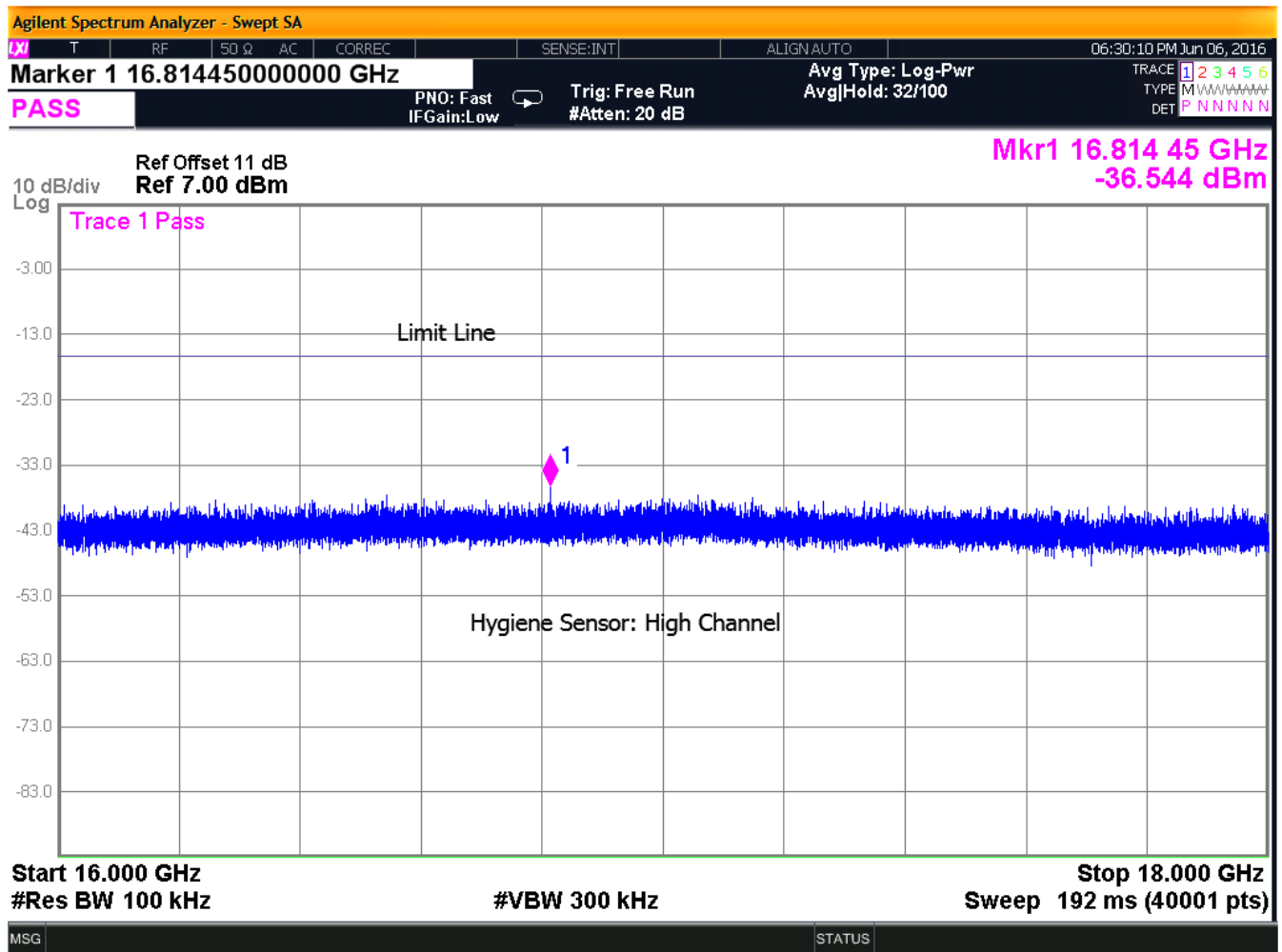


Figure 51: High Channel Conducted Spurious Plot 11

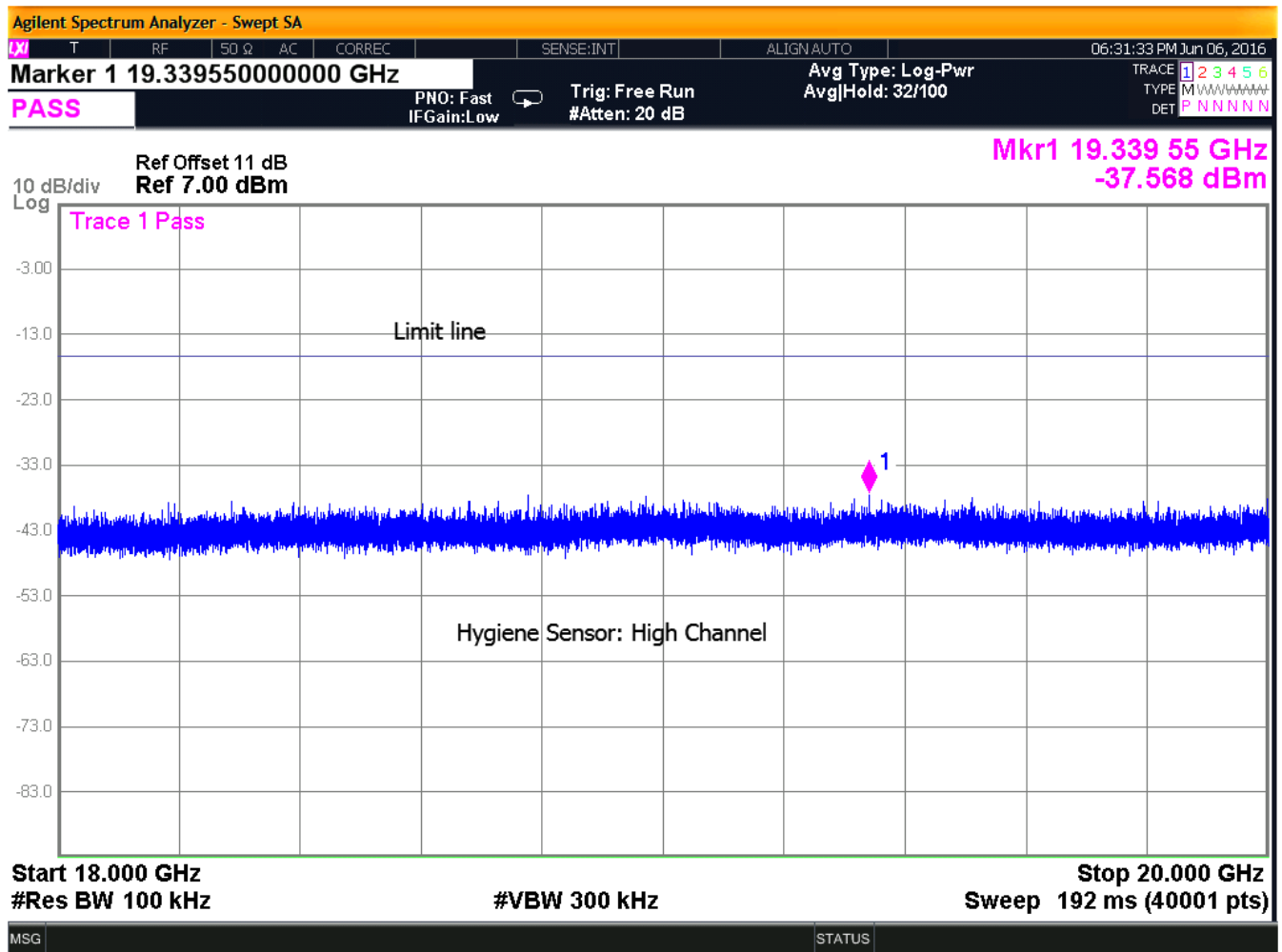


Figure 52: High Channel Conducted Spurious Plot 12

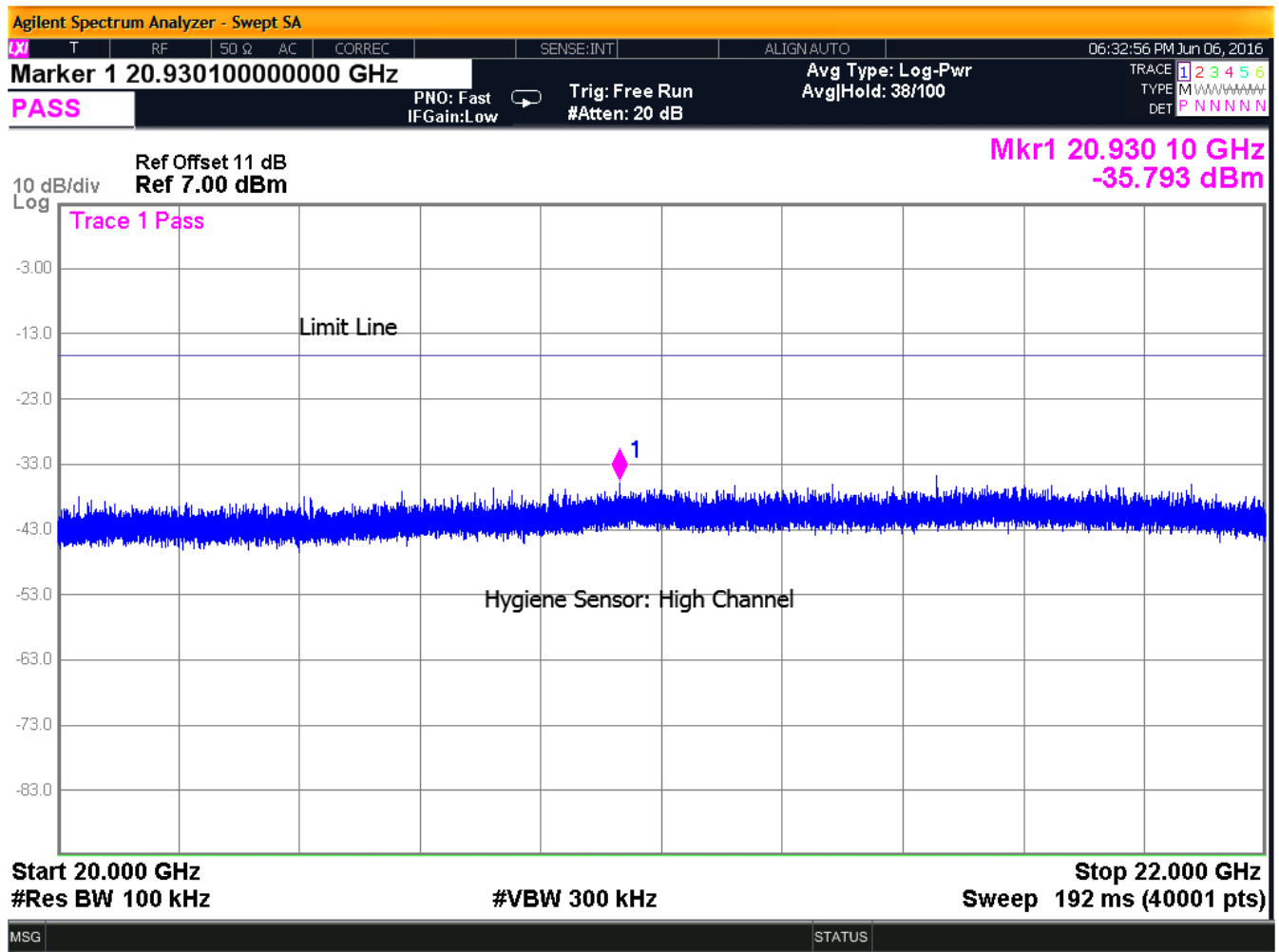


Figure 53: High Channel Conducted Spurious Plot 13

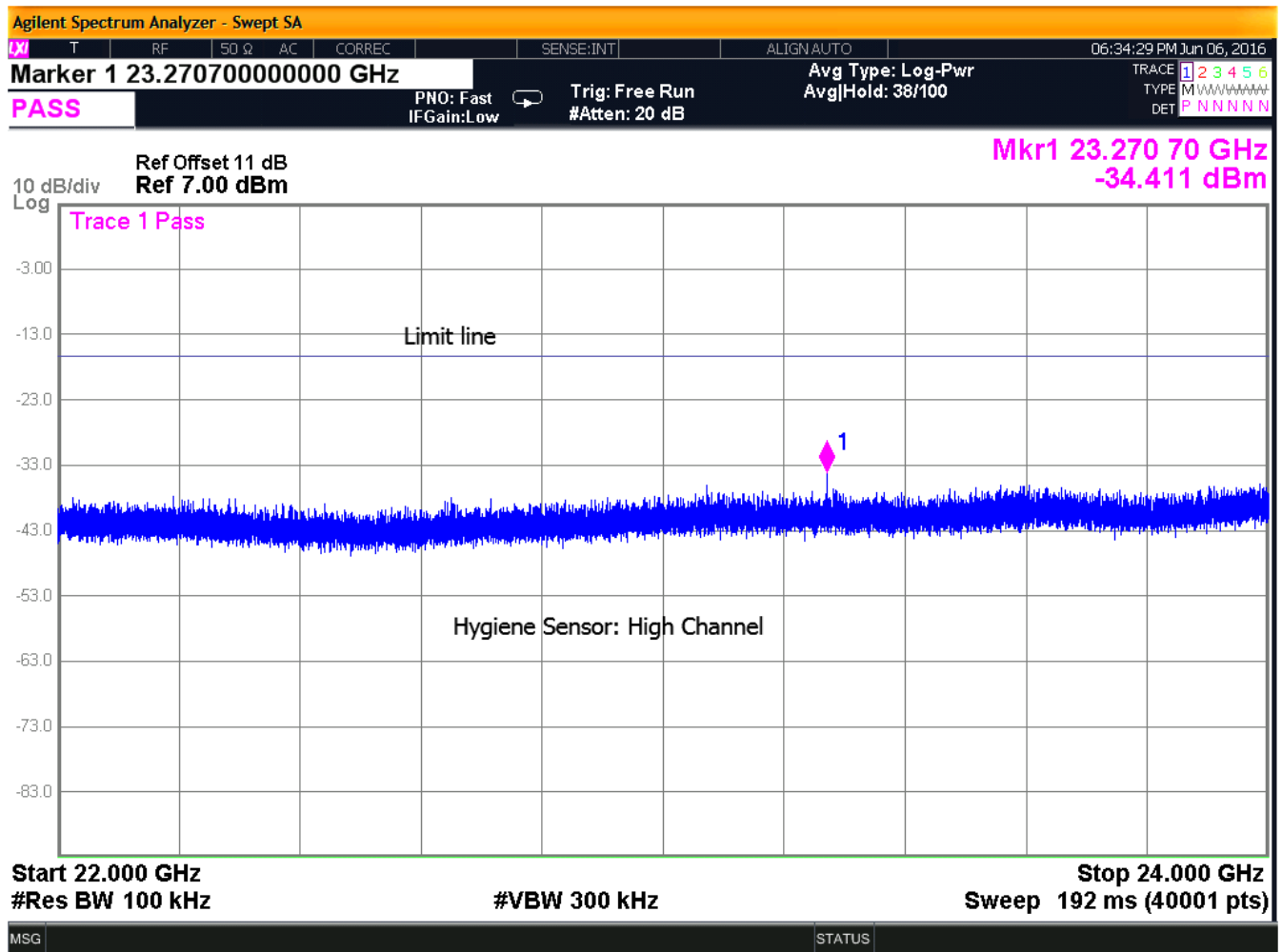


Figure 54: High Channel Conducted Spurious Plot 14

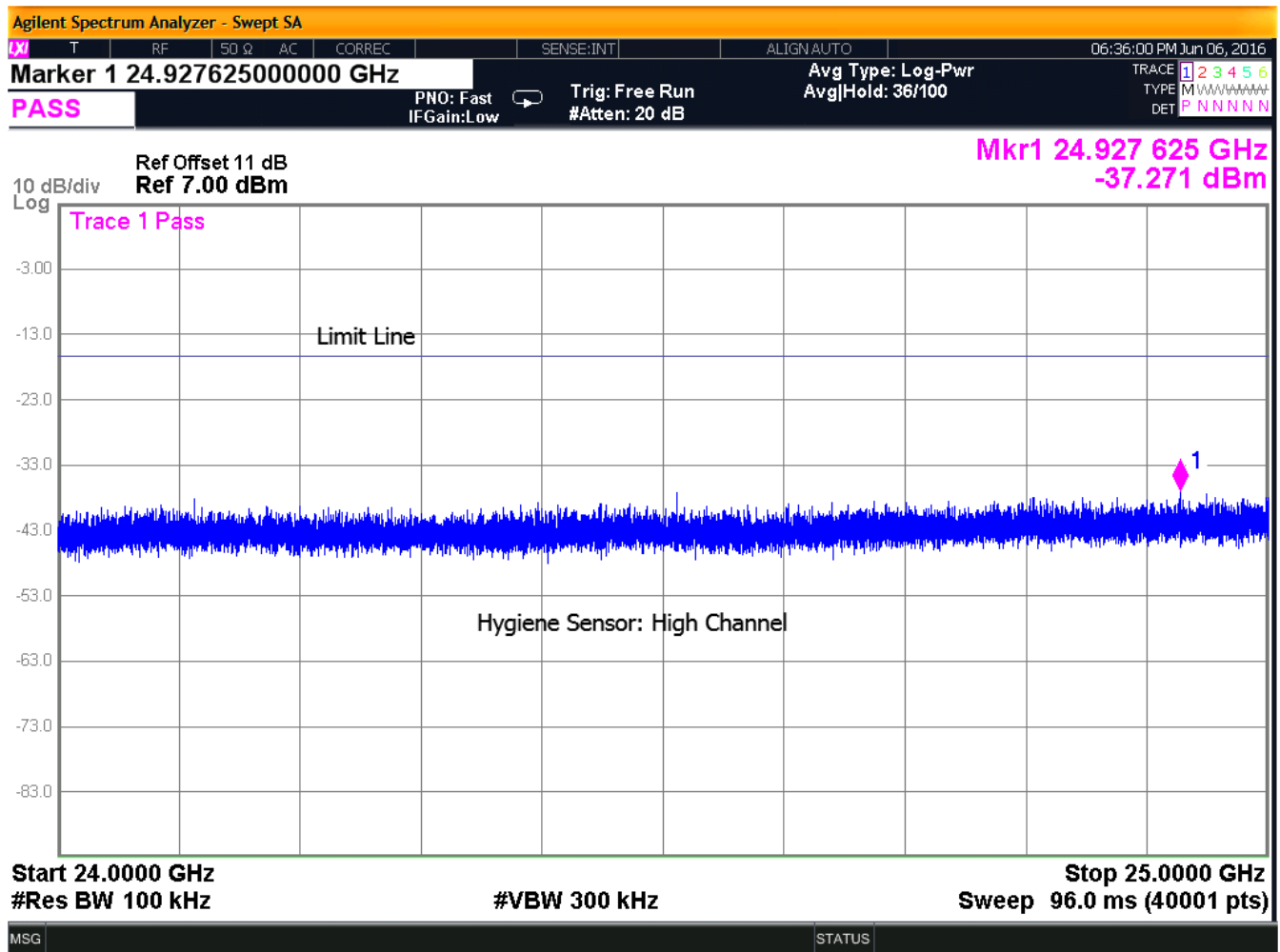


Figure 55: High Channel Conducted Spurious Plot 15



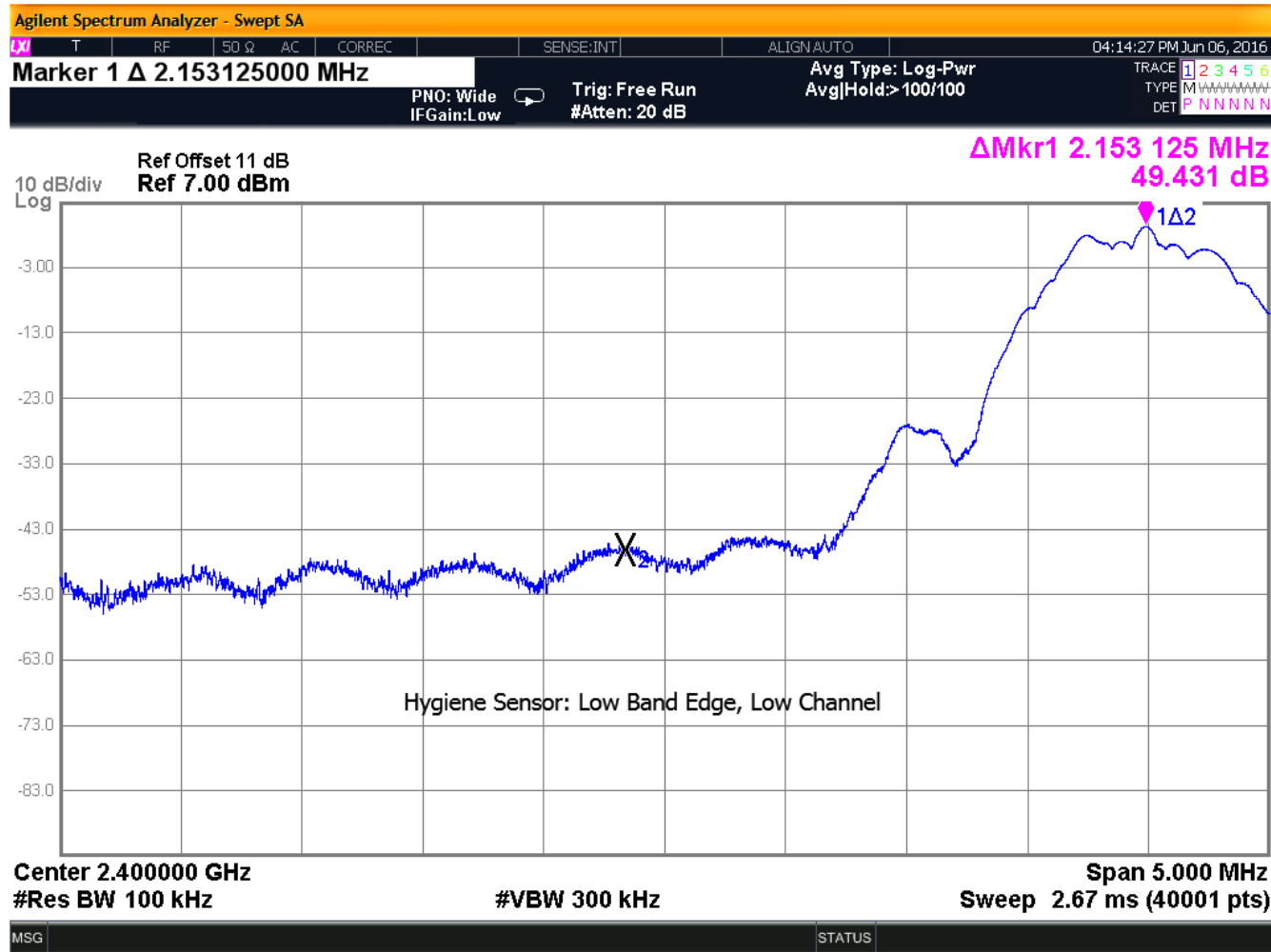


Figure 56: Lower Band Edge Low Channel

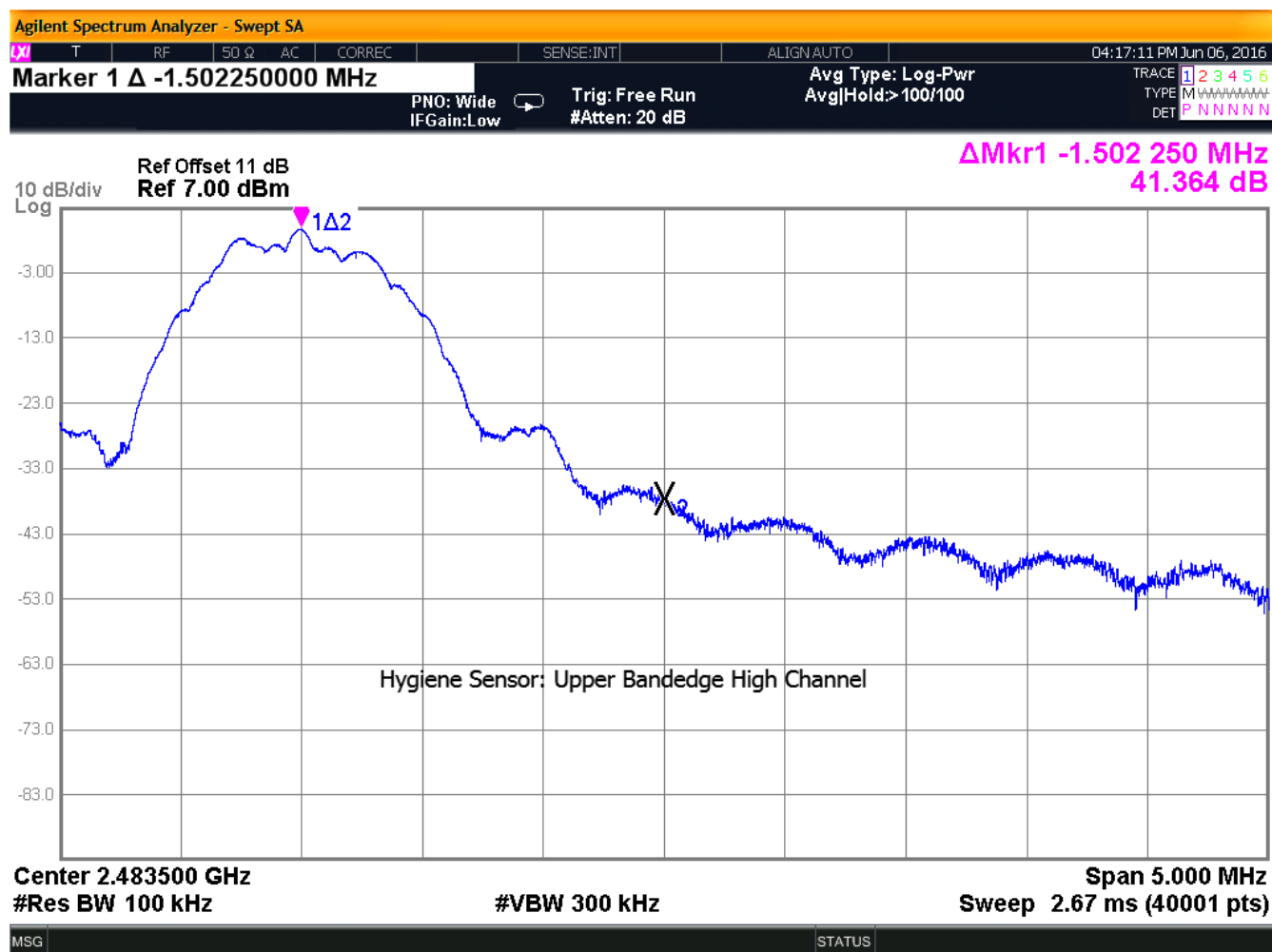


Figure 57: Upper Band Edge High Channel

## 5.5 Radiated Spurious Emissions:

The EUT must comply with the requirements for radiated spurious emissions that fall within the restricted bands. These emissions must meet the limits specified in §15.209 and §15.35(b) for peak measurements.

### 5.5.1 Test Procedure

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 height of the antenna was varied between 1 and 4 meters. Both the horizontal and vertical field components were measured.

The EUT was tested with the worst case readings reported.

Above 1GHz the EUT was placed on a 1.5meter table with RF absorber material between the EUT and Receive antenna.

The emissions were measured using the following resolution bandwidths:

**Table 10: Spectrum Analyzer Settings**

| Frequency Range | Resolution Bandwidth | Video Bandwidth |
|-----------------|----------------------|-----------------|
| 30MHz-1000 MHz  | 100kHz               | 300 kHz         |
| >1000 MHz       | 1 MHz                | 3MHz            |

Average measurements above 1GHz were made with the Spectrum analyzer set to RMS Average. Correction factors were then applied and the resulting value was compared to the limit.

#### 5.5.1.1 Duty Cycle Corrections

A duty cycle correction of 7dB was added to the RMS average readings to compensate for the on time of the EUT in accordance with C63.10 section 11.13.3.4.

Correction Calculation =  $10 \cdot \log(1/(\text{duty cycle})) = 10 \cdot \log(1/0.2) = 6.98$

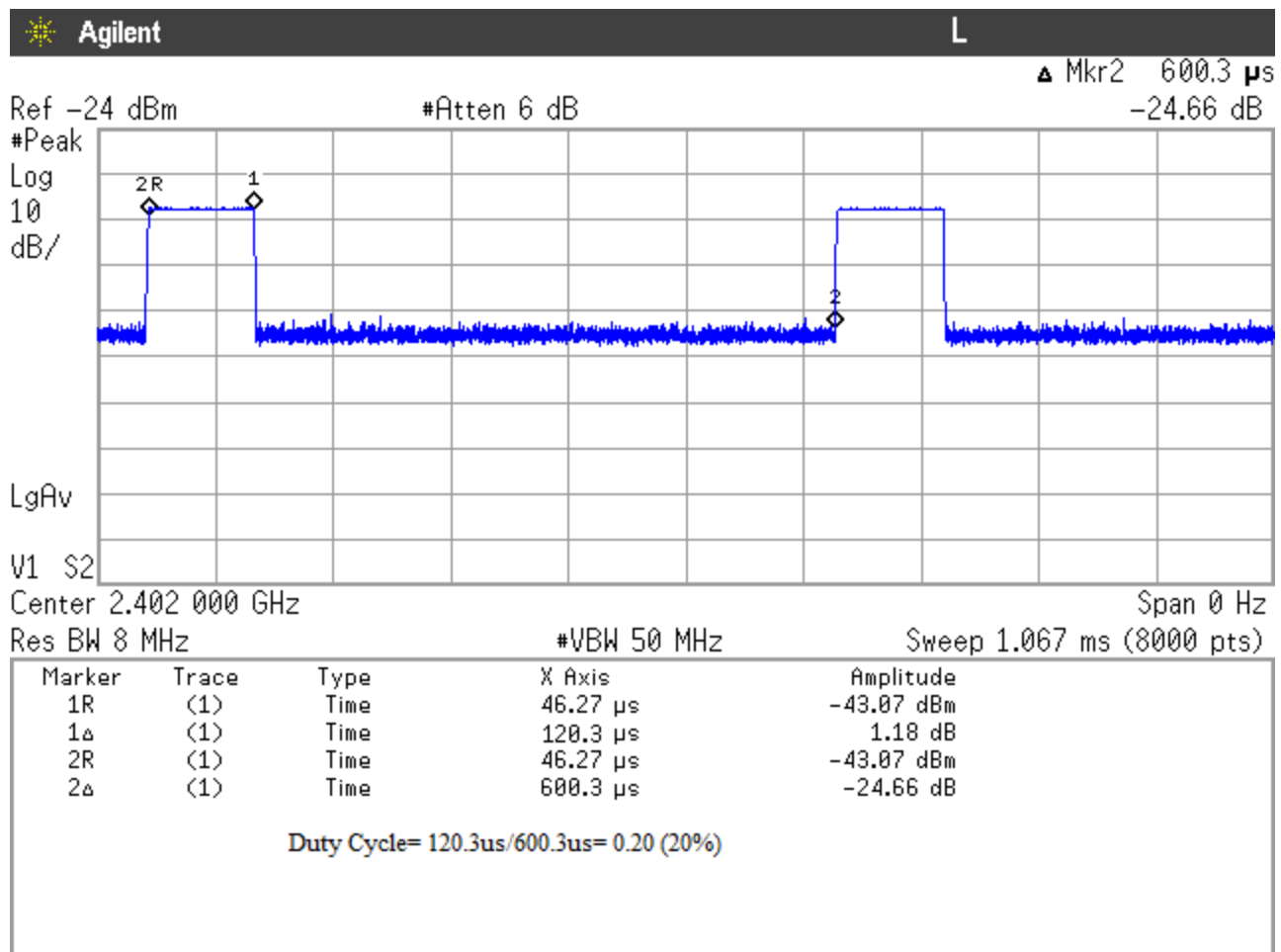


Figure 58: Duty Cycle Correction

### 5.5.2 Test Summary

The EUT complied with the requirements for radiated spurious emissions.

**Table 11: Radiated Emission Test Data (all Channels)**  
**(Restricted Bands)**

| 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) |
|-----------------|--------------|------------------|-----------------|-----------------|-------------------|--------------------|--------------|-------------|
| 114.26          | V            | 45.00            | 1.50            | 37.36           | -9.9              | 23.7               | 150.0        | -16.0       |
| 123.97          | V            | 90.00            | 1.50            | 33.82           | -9.1              | 17.3               | 150.0        | -18.8       |
| 127.60          | V            | 90.00            | 1.50            | 33.77           | -9.1              | 17.2               | 150.0        | -18.8       |
| 242.50          | V            | 45.00            | 2.70            | 33.84           | -11.4             | 13.2               | 200.0        | -23.6       |
|                 | V            |                  |                 |                 |                   |                    |              |             |
| 73.50           | H            | 0.00             | 4.00            | 45.30           | -15.4             | 31.3               | 100.0        | -10.1       |
| 109.25          | H            | 180.00           | 3.66            | 42.25           | -10.7             | 37.6               | 150.0        | -12.0       |
| 134.95          | H            | 0.00             | 3.17            | 40.59           | -9.6              | 35.3               | 150.0        | -12.6       |
| 242.60          | H            | 0.00             | 2.66            | 38.80           | -11.8             | 22.4               | 200.0        | -19.0       |
| 266.99          | H            | 90.00            | 2.40            | 36.30           | -10.1             | 20.4               | 200.0        | -19.8       |
| 285.98          | H            | 90.00            | 2.20            | 37.06           | -9.4              | 24.1               | 200.0        | -18.4       |

**Table 12: Radiated Emission Test Data, Low Channel**

Low Channel @ 2402MHz

| Frequency (MHz) | Polarity H/V | Azimuth (Degree) | Ant. Height (m) | SA Level (dBuV) | Corr Factors (dB) | Duty Cycle Correction (dB) | Corr. Level (uV/m) | Limit (uV/m) | Margin (dB) | Comments |
|-----------------|--------------|------------------|-----------------|-----------------|-------------------|----------------------------|--------------------|--------------|-------------|----------|
| 2402.00         | V            | 0.00             | 2.80            | 93.30           | -1.8              | 0.0                        | 37483.4            | NA           | NA          | Fund Pk  |
|                 |              |                  |                 |                 |                   |                            |                    |              |             |          |
| 2930.00         | V            | 0.00             | 2.89            | 50.26           | -0.9              | 0.0                        | 292.9              | 5000.0       | -24.6       | pk       |
| 2930.00         | V            | 0.00             | 2.80            | 39.40           | -0.9              | 7.0                        | 187.7              | 500.0        | -8.5        | av       |
|                 |              |                  |                 |                 |                   |                            |                    |              |             |          |
| 4804.00         | V            | 10.00            | 2.20            | 47.80           | 5.1               | 0.0                        | 441.2              | 5000.0       | -21.1       | pk       |
| 4804.00         | V            | 10.00            | 2.20            | 38.20           | 5.1               | 7.0                        | 327.1              | 500.0        | -3.7        | av       |
|                 |              |                  |                 |                 |                   |                            |                    |              |             |          |
| 2402.00         | H            | 200.00           | 2.51            | 96.70           | -1.8              | 0.0                        | 55442.1            | NA           | NA          | Fund Pk  |
|                 |              |                  |                 |                 |                   |                            |                    |              |             |          |
| 2930.00         | H            | 200.00           | 2.51            | 51.20           | -0.9              | 0.0                        | 326.1              | 5000.0       | -23.7       | pk       |
| 2930.00         | H            | 200.00           | 2.51            | 38.42           | -0.9              | 7.0                        | 167.7              | 500.0        | -9.5        | av       |
|                 |              |                  |                 |                 |                   |                            |                    |              |             |          |
| 4804.00         | H            | 45.00            | 2.80            | 47.89           | 5.1               | 0.0                        | 445.8              | 5000.0       | -21.0       | pk       |
| 4804.00         | H            | 45.00            | 2.80            | 35.35           | 5.1               | 7.0                        | 235.6              | 500.0        | -6.5        | av       |

**Table 13: Radiated Emission Test Data, Center Channel**

Center Channel @ 2440 MHz

| Frequency (MHz) | Polarity H/V | Azimuth (Degree) | Ant. Height (m) | SA Level (dBuV) | Corr Factors (dB) | Duty Cycle Correction (dB) | Corr. Level (uV/m) | Limit (uV/m) | Margin (dB) | Comments |
|-----------------|--------------|------------------|-----------------|-----------------|-------------------|----------------------------|--------------------|--------------|-------------|----------|
| 2440.00         | V            | 0.00             | 3.50            | 96.80           | -1.8              | 0.0                        | 56356.0            | NA           | NA          | Fund Pk  |
|                 |              |                  |                 |                 |                   |                            |                    |              |             |          |
| 4880.00         | V            | 190.00           | 3.48            | 45.91           | 5.1               | 0.0                        | 354.9              | 5000.0       | -23.0       | pk       |
| 4880.00         | V            | 190.00           | 3.48            | 35.17           | 5.1               | 7.0                        | 230.7              | 500.0        | -6.7        | av       |
|                 |              |                  |                 |                 |                   |                            |                    |              |             |          |
| 7320.00         | V            | 90.00            | 2.91            | 37.80           | 12.9              | 0.0                        | 341.1              | 5000.0       | -23.3       | pk       |
| 7320.00         | V            | 90.00            | 2.91            | 27.30           | 12.9              | 7.0                        | 227.9              | 500.0        | -6.8        | av       |
|                 |              |                  |                 |                 |                   |                            |                    |              |             |          |
| 2440.00         | H            | 22.00            | 2.59            | 96.75           | -1.8              | 0.0                        | 56013.2            | NA           | NA          | Fund Pk  |
|                 |              |                  |                 |                 |                   |                            |                    |              |             |          |
| 4880.00         | H            | 10.00            | 3.36            | 47.81           | 5.1               | 0.0                        | 441.7              | 5000.0       | -21.1       | pk       |
| 4880.00         | H            | 10.00            | 3.36            | 36.50           | 5.1               | 7.0                        | 268.9              | 500.0        | -5.4        | av       |
|                 |              |                  |                 |                 |                   |                            |                    |              |             |          |
| 7320.00         | H            | 20.00            | 3.00            | 39.20           | 12.9              | 0.0                        | 400.7              | 5000.0       | -21.9       | pk       |
| 7320.00         | H            | 20.00            | 3.00            | 28.50           | 12.9              | 7.0                        | 261.7              | 500.0        | -5.6        | av       |

**Table 14: Radiated Emission Test Data, High Channel**

High Channel @ 2480MHz

| Frequency (MHz) | Polarity H/V | Azimuth (Degree) | Ant. Height (m) | SA Level (dBuV) | Corr Factors (dB) | Duty Cycle Correction (dB) | Corr. Level (uV/m) | Limit (uV/m) | Margin (dB) | Comments                          |
|-----------------|--------------|------------------|-----------------|-----------------|-------------------|----------------------------|--------------------|--------------|-------------|-----------------------------------|
| 2482.00         | V            | 45.00            | 2.55            | 94.01           | -1.7              | 0.0                        | 41065.2            | NA           | NA          | Fund Pk                           |
|                 |              |                  |                 |                 |                   |                            |                    |              |             |                                   |
| 2483.50         | V            | 45.00            | 2.60            | 51.30           | -1.7              | 0.0                        | 300.7              | 5000.0       | -24.4       | Marker Delta Method Band Edge -Pk |
| 2483.50         | V            | 45.00            | 2.60            | 37.45           | -1.7              | 7.0                        | 136.7              | 500.0        | -11.3       | Marker Delta Method Band Edge -Av |
|                 |              |                  |                 |                 |                   |                            |                    |              |             |                                   |
| 4964.00         | V            | 350.00           | 2.65            | 46.29           | 5.2               | 0.0                        | 377.6              | 5000.0       | -22.4       | pk                                |
| 4964.00         | V            | 350.00           | 2.65            | 34.15           | 5.2               | 7.0                        | 208.9              | 500.0        | -7.6        | av                                |
|                 |              |                  |                 |                 |                   |                            |                    |              |             |                                   |
| 7446.00         | V            | 0.00             | 2.89            | 38.31           | 12.6              | 0.0                        | 350.4              | 5000.0       | -23.1       | pk                                |
| 7446.00         | V            | 0.00             | 2.89            | 27.54           | 12.6              |                            | 101.4              | 500.0        | -13.9       | av                                |
|                 |              |                  |                 |                 |                   |                            |                    |              |             |                                   |
| 2482.00         | H            | 90.00            | 3.20            | 92.25           | -1.7              | 7.0                        | 75114.6            | NA           | NA          | Fund Pk                           |
|                 |              |                  |                 |                 |                   |                            |                    |              |             |                                   |
| 2483.50         | H            | 90.00            | 3.20            | 49.04           | -1.7              | 0.0                        | 232.0              | 5000.0       | -26.7       | Marker Delta Method Band Edge -Pk |
| 2483.50         | H            | 90.00            | 3.20            | 37.20           | -1.7              | 7.0                        | 132.8              | 500.0        | -11.5       | Marker Delta Method Band Edge -Av |
|                 |              |                  |                 |                 |                   |                            |                    |              |             |                                   |
| 4964.00         | H            | 260.00           | 3.40            | 46.22           | 5.2               | 0.0                        | 374.6              | 5000.0       | -22.5       | pk                                |
| 4964.00         | H            | 260.00           | 3.40            | 34.25           | 5.2               | 7.0                        | 211.3              | 500.0        | -7.5        | av                                |
|                 |              |                  |                 |                 |                   |                            |                    |              |             |                                   |
| 7446.00         | H            | 45.00            | 2.87            | 35.90           | 12.6              | 0.0                        | 265.5              | 5000.0       | -25.5       | pk                                |
| 7446.00         | H            | 45.00            | 2.80            | 27.66           | 12.6              | 7.0                        | 230.1              | 500.0        | -6.7        | av                                |