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# FCC Part 74F Certification Test Report
# For the
# Broadcast Sports International
# HD In-Car Transmitter

## FCC ID: KTB-13418-9-001

WLL JOB# **14329-01 Rev 2**
**January 05, 2016**

**Re-Issued**
**June 7, 2016**

Prepared for:

**Broadcast Sports International**
**7455 Race Road**
**Hanover, MD 21076**

Prepared By:

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

ANAB ACCREDITED ISO/IEC 17025 TESTING LABORATORY

Testing Certificate AT-1448

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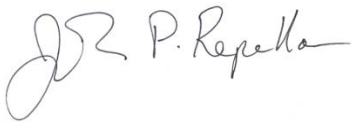

John P. Repella
Compliance Engineer

Reviewed by:

Steven D. Koster
President

 

# Abstract

This report has been prepared on behalf of Broadcast Sports International to support the attached Application for Equipment Authorization. The test report and application are submitted for a Licensed Non-Broadcast Station Transmitter under Part 74 F of the FCC Rules and Regulations. This Federal Communication Commission (FCC) Certification Test Report documents the test configuration and test results for a Broadcast Sports International HD In-Car Transmitter.

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 Industry Canada 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 Broadcast Sports International HD In-Car Transmitter complies with the limits for a Licensed Non-Broadcast Station Transmitter device under Part 74 F of the FCC Rules and Regulations.

| Revision History | Reason | Date |
|---|---|---|
| Rev 0 | Initial Release | January 05, 2016 |
| Rev 1 | Updated to reflect correct device name and customer name | May 18, 2016 |
| Rev 2 | Update the report to reflect the correct frequency tolerances for the device | June 7, 2016 |

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# 1 Introduction

## 1.1 Compliance Statement

The Broadcast Sports International HD In-Car Transmitter complies with the limits for a Licensed Non-Broadcast Station Transmitter device under Part 74F of the FCC Rules and Regulations.

## 1.2 Test Scope

Tests for radiated and conducted (at antenna terminal) emissions were performed. All measurements were performed in accordance with the 2014 version of ANSI C63.4 and EIA/TIA 603. The measurement equipment conforms to ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation.

## 1.3 Contract Information

| | |
|---|---|
| Customer: | Broadcast Sports International<br>7455 Race Road<br>Hanover, MD, 21076 |
| Purchase Order Number: | 24920 |
| Quotation Number: | 68605C |

## 1.4 Test Dates

| | |
|---|---|
| Testing was performed on the following date(s): | 11/11/2015-12/3/2015 |

## 1.5 Test and Support Personnel

| | |
|---|---|
| Washington Laboratories, LTD | John P. Repella |
| Customer Representative | Dave Starsoneck |

## 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 & Description

The HD In-Car Transmitter (TX) is intended to transmit audio and video from remote locations, e.g. mounted in a race car. It can transmit 1 or 2 videos simultaneously.

The TX is designed to accept four pairs of audio and video inputs. The user selects up to 2 A/V inputs upon which the TX performs various processing and modulation functions, and outputs a DVB-T COFDM signal to an external antenna.

The unit's audio inputs are balanced mic-level connectors with T-power. The video inputs can be HD-SDI, SD-SDI, or NTSC, all of which the TX will auto-detect and pre-process appropriately. Once pre-processed, the audio and video are encoded (LPCM, MPEG-2 Layer I&II, or Dolby for audio and H.264 for the video) and mux'ed into a transport stream (TS). The resulting TS is modulated (QPSK, 16QAM, or 64QAM) and output to an attached antenna.

**Table 1: Device Summary**

| ITEM | DESCRIPTION |
|---|---|
| Manufacturer: | Broadcast Sports International |
| FCC ID: | KTB-13418-9-001 |
| Model: | HD Mini Transmitter |
| FCC Rule Parts: | §74 Sub Part F |
| Industry Canada: | N/A |
| Frequency Range: | 2033 – 2101.5MHz & 2458.5MHz |
| Maximum Output Power: | (Calibrated & configured by Manufacturer for consumer to be no greater than +25dBm) |
| Modulation: | QPSK,16QAM, 64QAM |
| Occupied Bandwidth: | 8 MHz |
| Keying: | Automatic, Manual |
| Type of Information: | Audio/Video |
| Number of Channels: | 16 |
| Power Output Level | 248mW(23.95dBm) |
| Antenna Connector | SMA |
| Antenna Type | Multiple up to, Max 5.1 dBi |
| Frequency Tolerance | 2033 - 2067.5MHz >0.005 & 2101.5-2458.5MHz >0.001 |
| Interface Cables: | See Interface Cables |
| Power Source & Voltage: | 12Vdc Nominal |

**Table 2: Equipment Configuration**

| Name / Description | Model Number | Part Number | Serial Number | Rev. # |
|---|---|---|---|---|
| HD In-Car Transmitter | - | 13418-9-001 | 12530 | N/A |

## 2.2 Port and Cabling

The following port and cabling were identified on the EUT

**Table 3: Ports & Cabling**

| Ref. ID | EUT Port | Cable Description or reason for no cable | Qty. | Length (m) | Shielded? |
|---|---|---|---|---|---|
| 1 | V1 | 7-pin LEMO to BNC | 1 | | Y |
| 2 | V2 | 7-pin LEMO to BNC | 1 | | Y |
| 3 | V3 | None – 2 video output max | - | | N/A |
| 4 | V4 | None – 2 video output max | - | | N/A |
| 5 | A1 | None – audio not needed | - | | N/A |
| 6 | A2 | None – audio not needed | - | | N/A |
| 7 | A3 | None – audio not needed | - | | N/A |
| 8 | A4 | None – audio not needed | - | | N/A |
| 9 | RF | SMA-M to SMA-M | 1 | | Y |
| 10 | DATA | Configuration Only | - | | N/A |
| 11 | UHF | 5-pin LEMO to DB-9 | 1 | | Y |
| 12 | PWR | 2-pin LEMO to 4-pin XLR | 1 | | Y |

## 2.3 Support Equipment

The following support equipment was used during testing:

**Table 4: Support Equipment**

| Name / Description | Manufacturer | Model Number | *Customer Supplied Calibration Data |
|---|---|---|---|
| Video Generator | Leader | LT 443D | N/A |
| Down Converter | BSI | - | N/A |
| Receiver/Decoder | BSI | - | N/A |
| SDI Monitor | Marshall | V-R10420P-TE4U | N/A |
| RS232-RS485 Converter | B&B | 485SD9R | N/A |
| Laptop | Dell | E4310 | N/A |
| USB-RS232 Converter | Assmann | Digitus | N/A |

## 2.4 Test Configuration

With all equipment connected as shown in Figure 1 and the HD In-Car TX transmitting. With all equipment connected as shown in the block diagram and the TX transmitting, the decoder status "GOOD" LED should be green and the monitor should display the test pattern being fed to the TX.

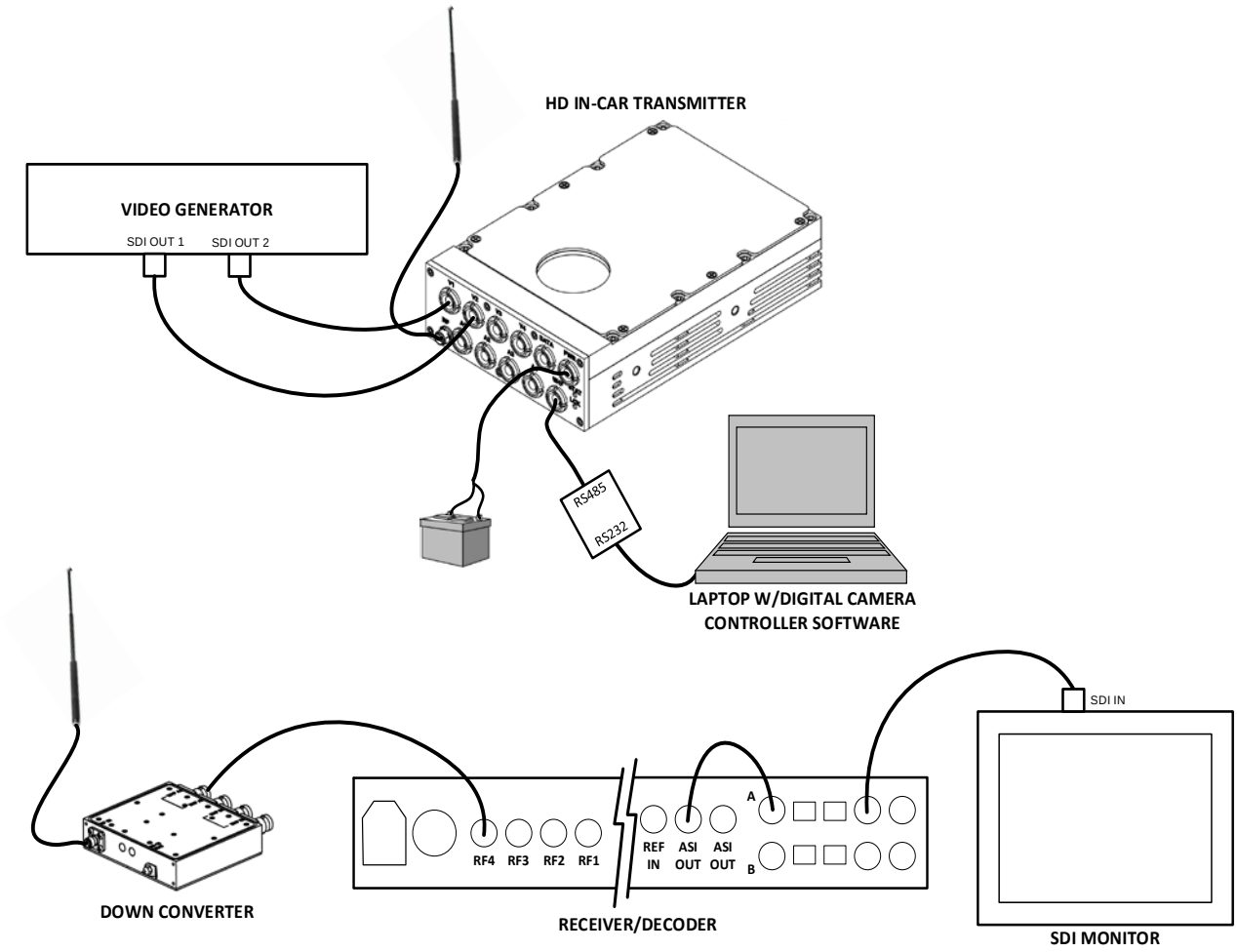


**Figure 1: Test Configuration**

 

## 2.5 Testing Algorithm

The HD In-Car TX will auto-detect input video the following formats – HD-SDI, SD-SDI, and NTSC. The carrier is selectable in 250 kHz increments, from 1435MHz to 2600MHz. The frequency range is restricted to the applicable requirements for the region that it is distributed. The FEC rate is selectable (1⁄2, 2⁄3, 3⁄4, 5⁄6, 7⁄8) as is the modulation scheme (QPSK or QAM16). In dual stream mode, the two videos are modulated onto two adjacent COFDM pedestals.

## 2.6 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 Industry Canada 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.

## 2.7 Measurements

### 2.7.1 References

ANSI/TIA/EIA-603 Land Mobile FM or PM Communications Equipment Measurement and Performance Standards

ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation

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

## 2.8 Measurement Uncertainty

All results reported herein relate only to the equipment tested. The basis for uncertainty calculation uses ANSI/NCSL Z540-2-1997 (2002) 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 Equation1 and 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 uc = standard uncertainty

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

diva, b, c = the individual uncertainty element divisor based on the probability distribution

Divisor = 1.732 for rectangular distribution

Divisor = 2 for normal distribution

Divisor = 1.414 for trapezoid distribution

**Equation 2: Expanded Uncertainty**

$$U = ku_c$$

Where U = expanded uncertainty

k = coverage factor

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

uc = standard uncertainty

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

**Table 5: Expanded Uncertainty List**

| Scope | Standard(s) | Expanded Uncertainty |
|---|---|---|
| Bench Conducted Emissions | ANSI/NCSL Z540-2/CISPR 16-4-2 | ±2.30 dB |
| Radiated Emissions | ANSI/NCSL Z540-2/CISPR 16-4-2 | +4.55 dB |

 

# 3 Test Equipment

The test equipment used for test measurements along with the calibration information is shown in Table 6 below.

**Table 6: Test Equipment List**

| Test Name: | **Radiated Emissions** | Test Date: | **11/15/2015** |
|---|---|---|---|
| **Asset #** | **Manufacturer/Model** | **Description** | **Cal. Due** |
| 382 | SUNOL SCIENCES CORPORATION - JB1 | ANTENNA BICONLOG | 8/31/2017 |
| 644 | SUNOL SCIENCES CORPORATION - JB1 925-833-9936 | BICONALOG ANTENNA | 8/14/2017 |
| 849 | AH SYSTEMS - SAC-18G-16 | 16 METER CABLE | 8/22/2016 |
| 528 | AGILENT - E4446A | 3HZ - 44GHZ ANALYZER SPECTRUM | 7/15/2016 |
| 522 | HP - 8449B | PRE-AMPLIFIER 1-26.5GHZ | 12/24/2015 |
| 4 | ARA - DRG-118/A | ANTENNA DRG 1-18GHZ | 10/8/2016 |
| 425 | ARA - DRG-118/A | ANTENNA DRG 1-18GHZ | 11/23/2017 |
| 803 | R&S - SMR 40 | SIGNAL GENERATOR 1 - 40GHZ | 7/15/2017 |
| 558 | HP - 8447D | AMPLIFIER | 2/20/2016 |
| 558 | HP - 8447D | AMPLIFIER | 2/20/2016 |

 

# 4 Test Results

## 4.1 RF Power Output (FCC Part §2.1046 & §74.636)

The output from the transmitter was connected to a broadband power meter and the output power was measured.

The output power shall be measured when the transmitter is operating at the manufacturer's rated power and modulated with signals representative (i.e. typical) of those encountered in a real system operation.

**Table 7: RF Power Output (QPSK Modulation)**

| Channel/TX Frequency (MHz) | Measured Level (dBm) | Measured Level (Watts) | Limit (Watts) |
|---|---|---|---|
| 2033.0 | 23.20 | 0.209 | 12 |
| 2067.5 | 23.05 | 0.202 | 12 |
| 2101.5 | 23.81 | 0.240 | 12 |
| 2458.5 | 23.06 | 0.202 | 12 |

**Table 8: RF Power Output (16QAM Modulation)**

| Channel/TX Frequency (MHz) | Measured Level (dBm) | Measured Level (Watts) | Limit (Watts) |
|---|---|---|---|
| 2033.0 | 23.25 | 0.211 | 12 |
| 2067.5 | 23.05 | 0.202 | 12 |
| 2101.5 | 23.87 | 0.244 | 12 |
| 2458.5 | 23.10 | 0.204 | 12 |

**Table 9: RF Power Output (64QAM Modulation)**

| Channel/TX Frequency (MHz) | Measured Level (dBm) | Measured Level (Watts) | Limit (Watts) |
|---|---|---|---|
| 2033.0 | 23.23 | 0.210 | 12 |
| 2067.5 | 23.04 | 0.201 | 12 |
| 2101.5 | 23.95 | 0.248 | 12 |
| 2458.5 | 23.06 | 0.202 | 12 |

## 4.2 Occupied Bandwidth: (FCC Part §2.1049 & §74.637)

Occupied bandwidth was performed by coupling the output of the EUT via cable to the input of a spectrum analyzer.

At full modulation, the occupied bandwidth was measured as shown:

**Table 10: Occupied Bandwidth Results (QPSK)**

| Frequency(MHz) | Bandwidth(MHz) | Limit | Pass/Fail |
|---|---|---|---|
| 2033.0 | 8.053 | 18 MHz | Pass |
| 2067.5 | 8.003 | 18 MHz | Pass |
| 2101.5 | 8.034 | 18 MHz | Pass |
| 2458.5 | 8.142 | 18 MHz | Pass |

**Table 11: Occupied Bandwidth Results (16QAM)**

| Frequency(MHz) | Bandwidth(MHz) | Limit | Pass/Fail |
|---|---|---|---|
| 2033.0 | 8.062 | 18 MHz | Pass |
| 2067.5 | 8.038 | 18 MHz | Pass |
| 2101.5 | 8.021 | 18 MHz | Pass |
| 2458.5 | 8.101 | 18 MHz | Pass |

**Table 12: Occupied Bandwidth Results (64QAM)**

| Frequency(MHz) | Bandwidth(MHz) | Limit | Pass/Fail |
|---|---|---|---|
| 2033.0 | 8.069 | 18 MHz | Pass |
| 2067.5 | 8.134 | 18 MHz | Pass |
| 2101.5 | 8.123 | 18 MHz | Pass |
| 2458.5 | 8.089 | 18 MHz | Pass |

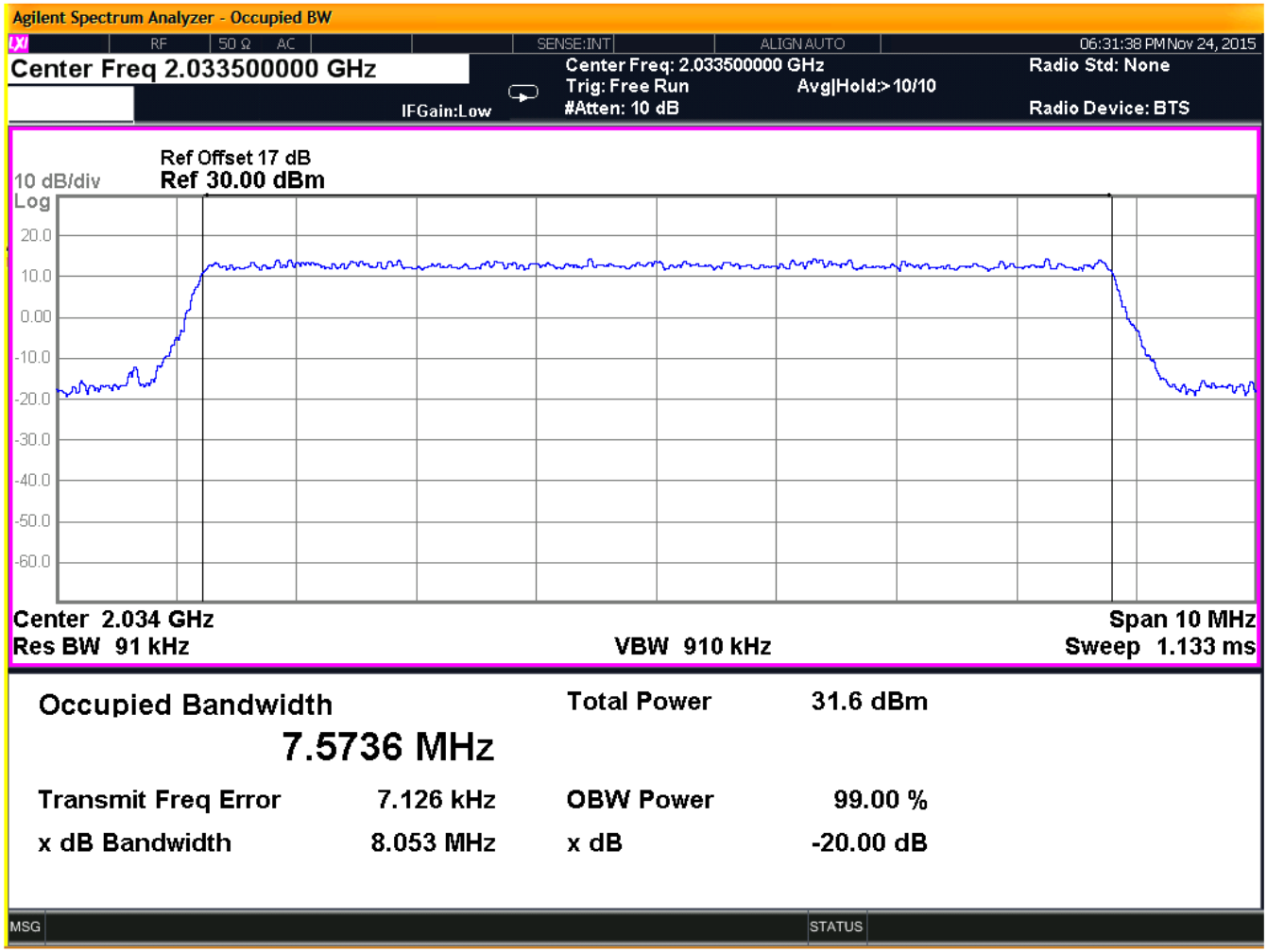


**Figure 1: Occupied Bandwidth, QPSK Modulation, TX @ 2033MHz**

 

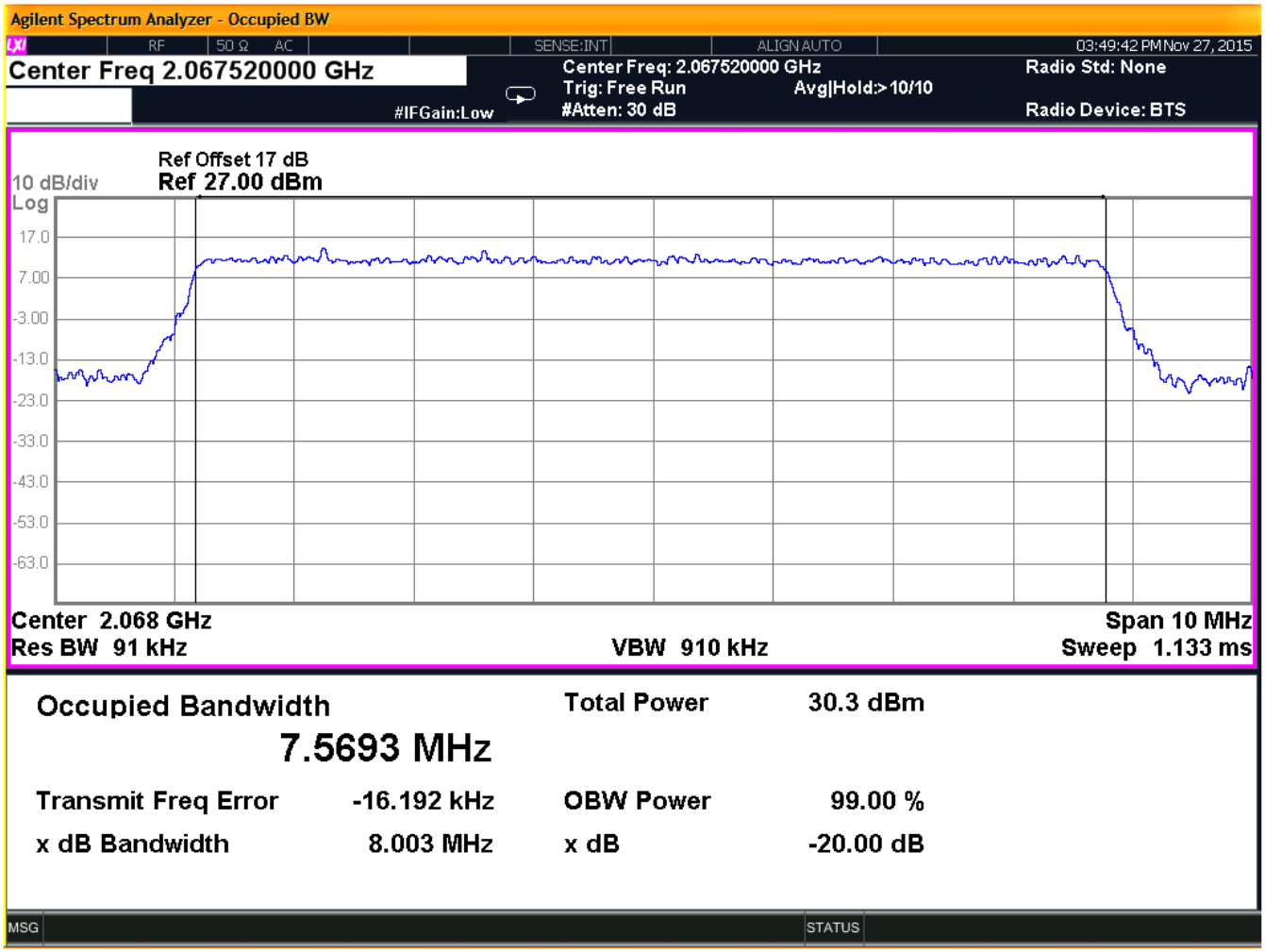


**Figure 2: Occupied Bandwidth, QPSK Modulation, TX @ 2067.5MHz**

 

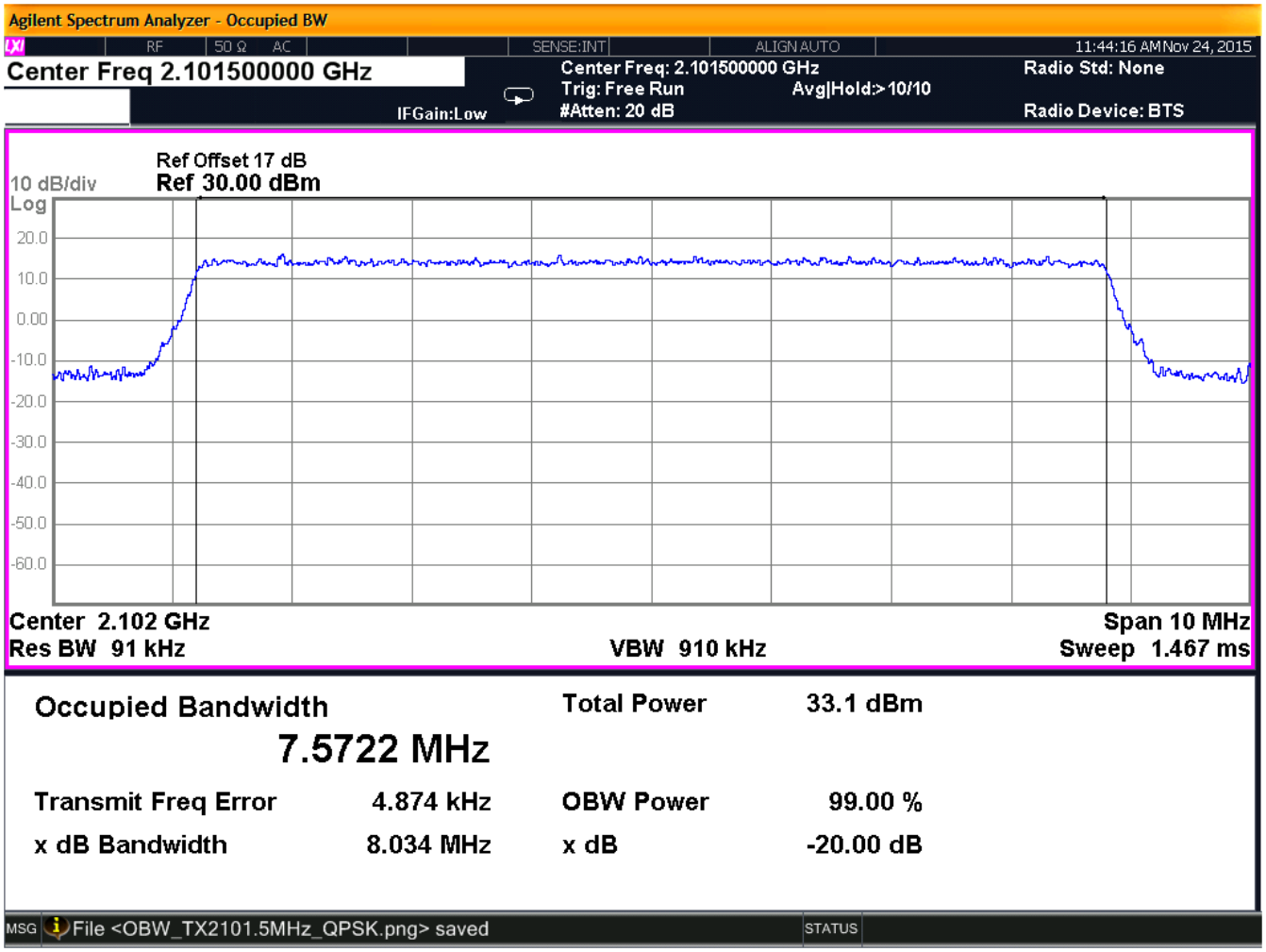


**Figure 3: Occupied Bandwidth, QPSK Modulation, TX @ 2101.5MHz**

 

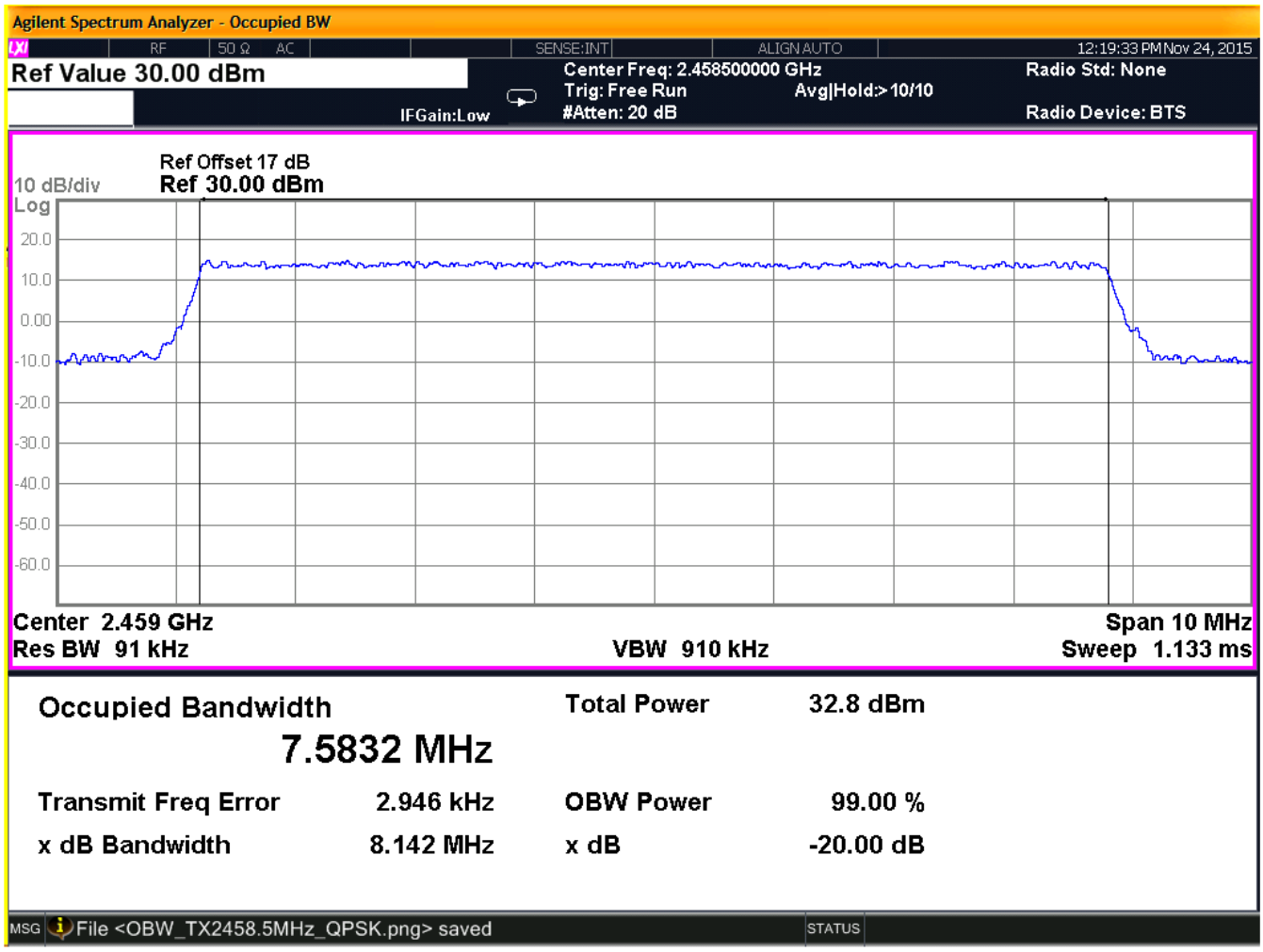


**Figure 4: Occupied Bandwidth, QPSK Modulation, TX @ 2458.5MHz**

 

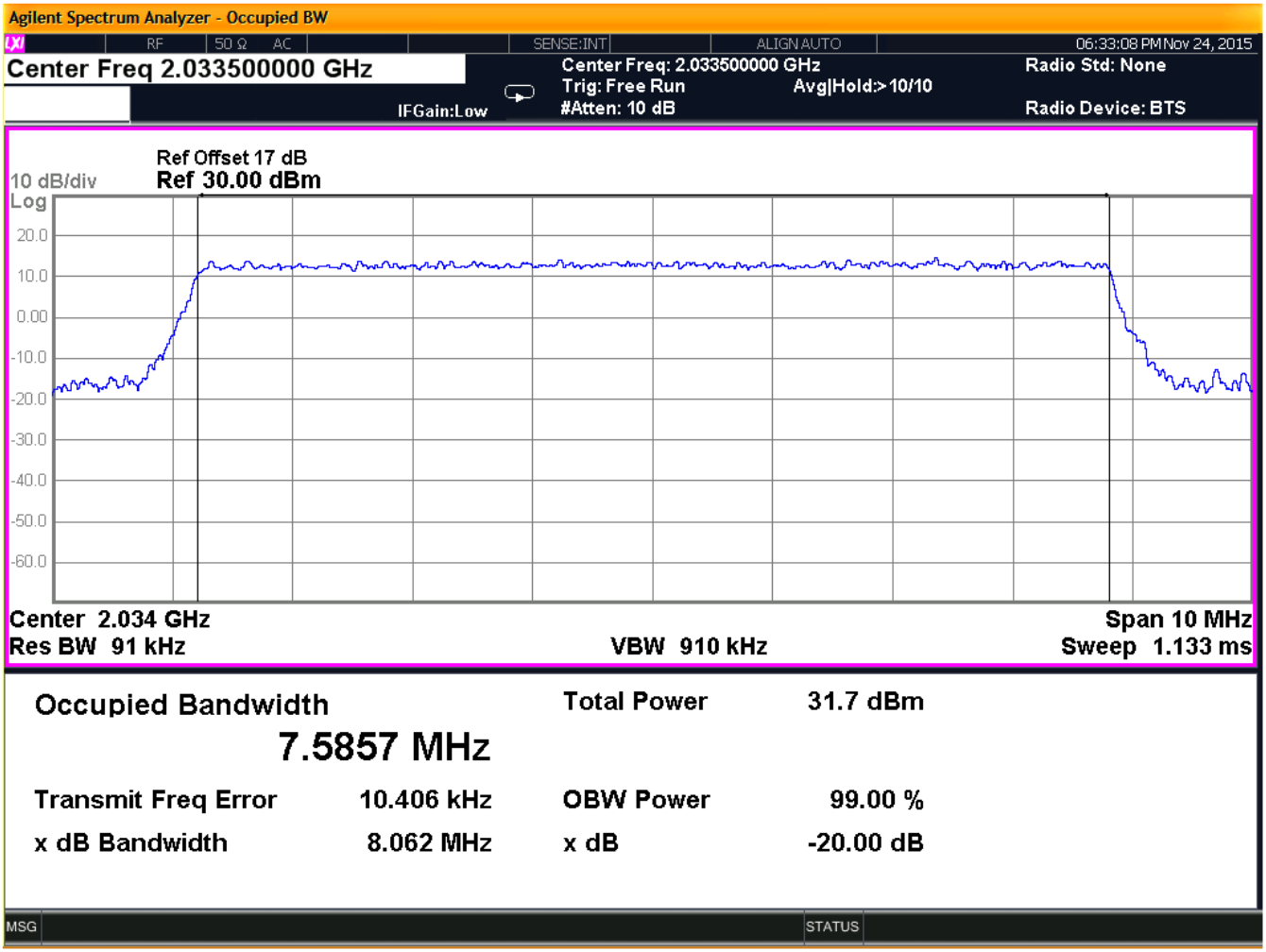


**Figure 5: Occupied Bandwidth, 16QAM Modulation, TX @ 2033MHz**

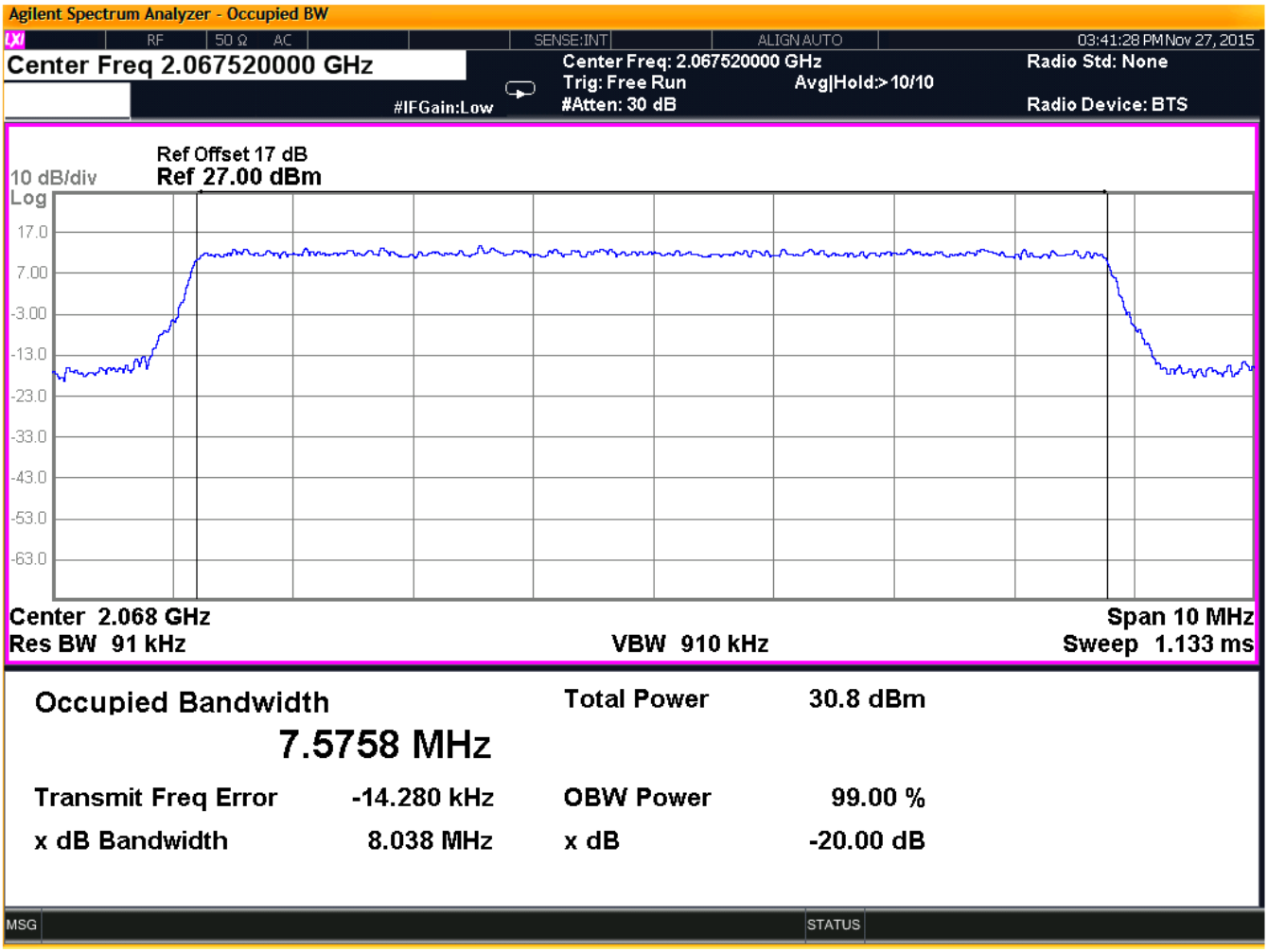


**Figure 6: Occupied Bandwidth, 16QAM Modulation, TX @ 2067.5MHz**

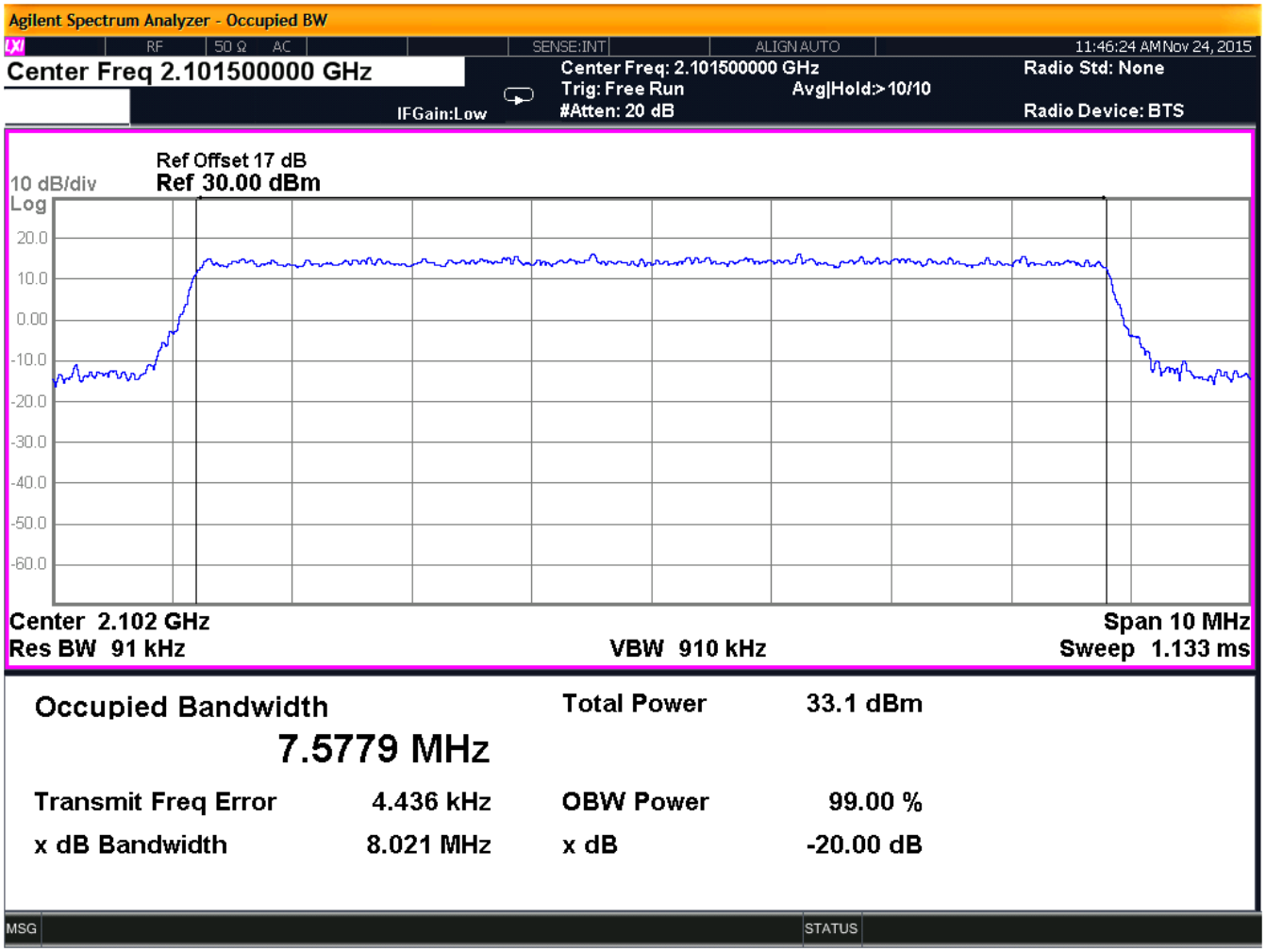


**Figure 7: Occupied Bandwidth, 16QAM Modulation, TX @ 2101.5MHz**

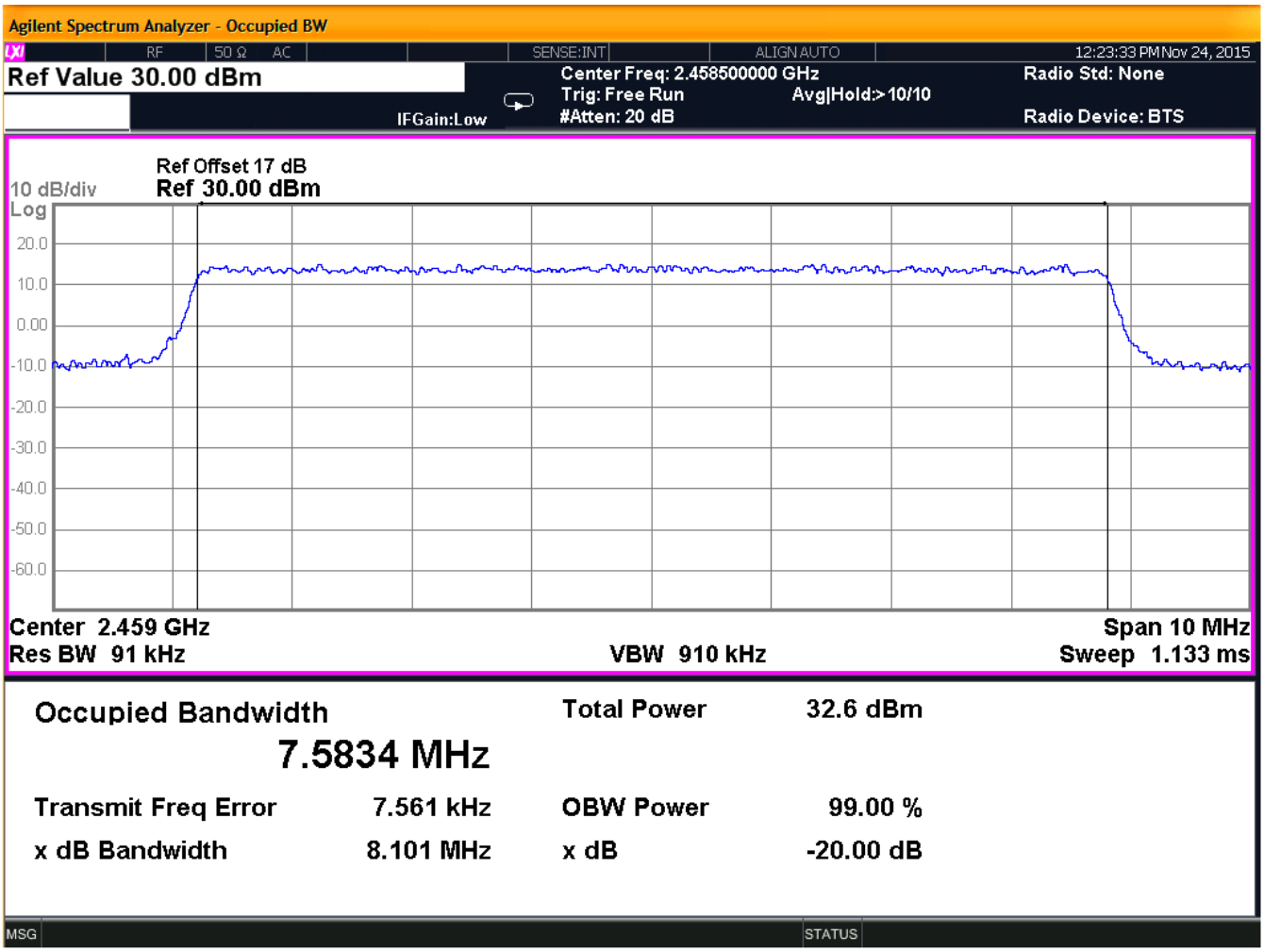


**Figure 8: Occupied Bandwidth, 16QAM Modulation, TX @ 2458.5MHz**

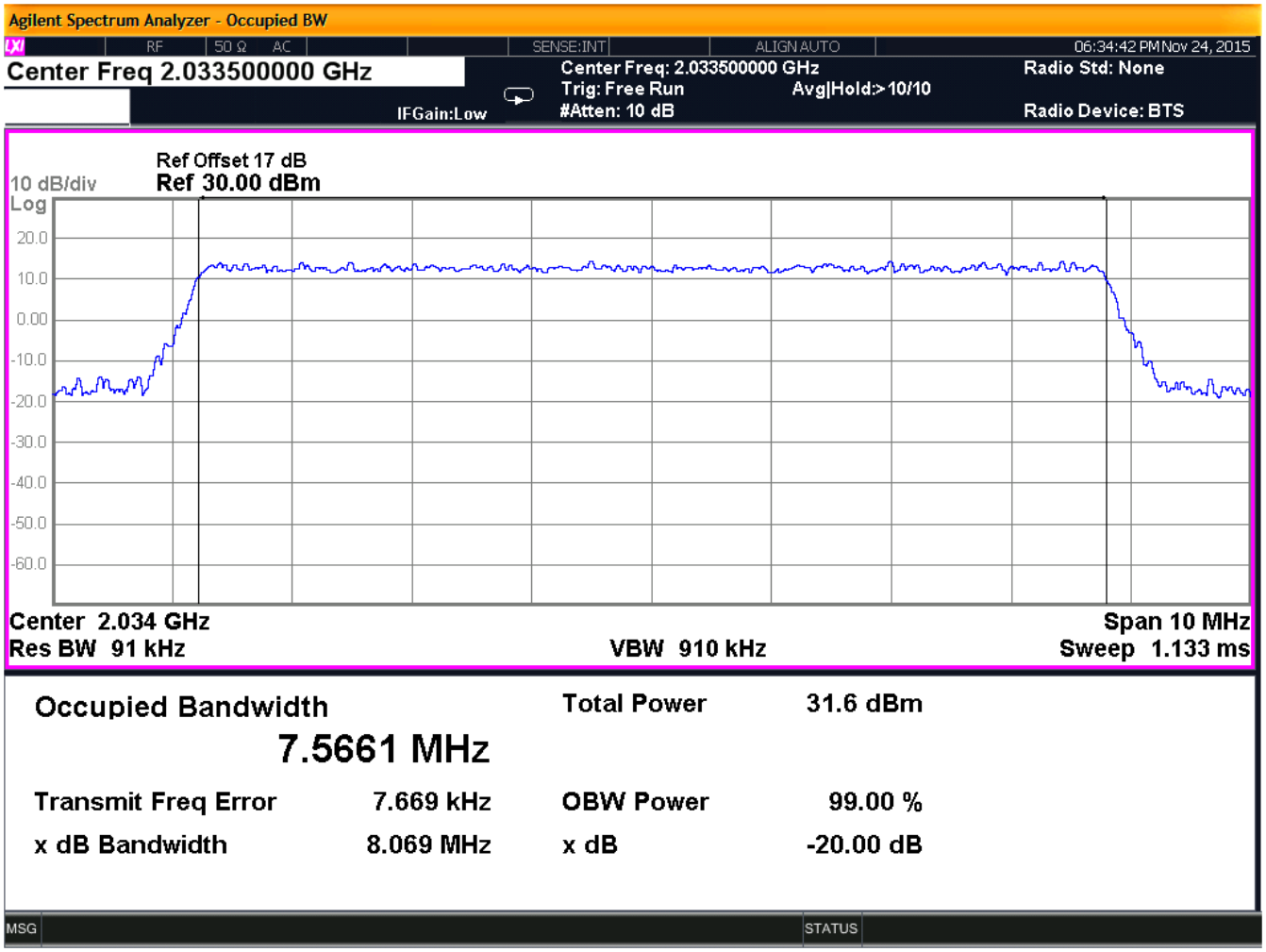


**Figure 9: Occupied Bandwidth, 64QAM Modulation, TX @ 2033MHz**

 

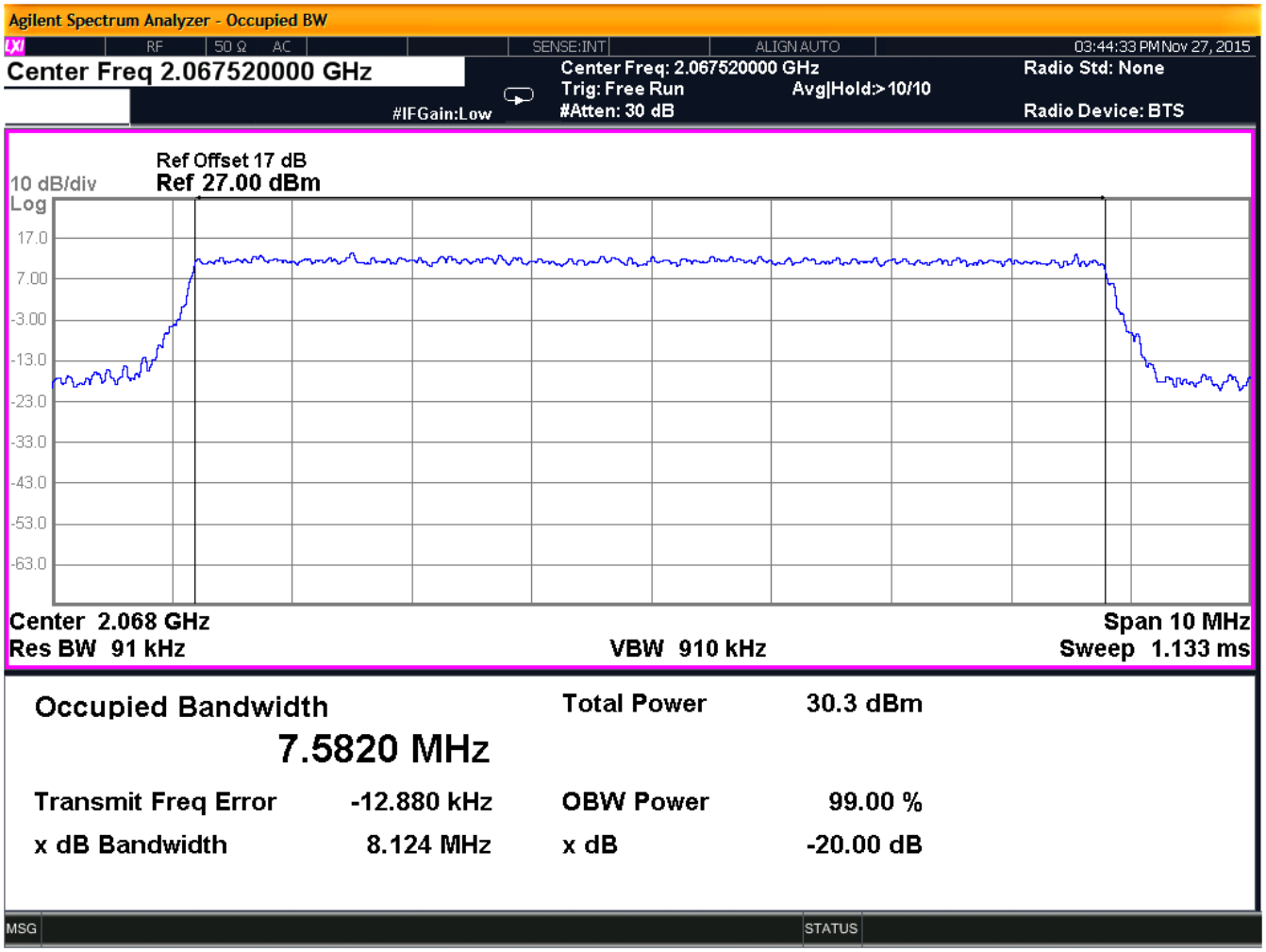


**Figure 10: Occupied Bandwidth, 64QAM Modulation, TX @ 2067.5MHz**

 

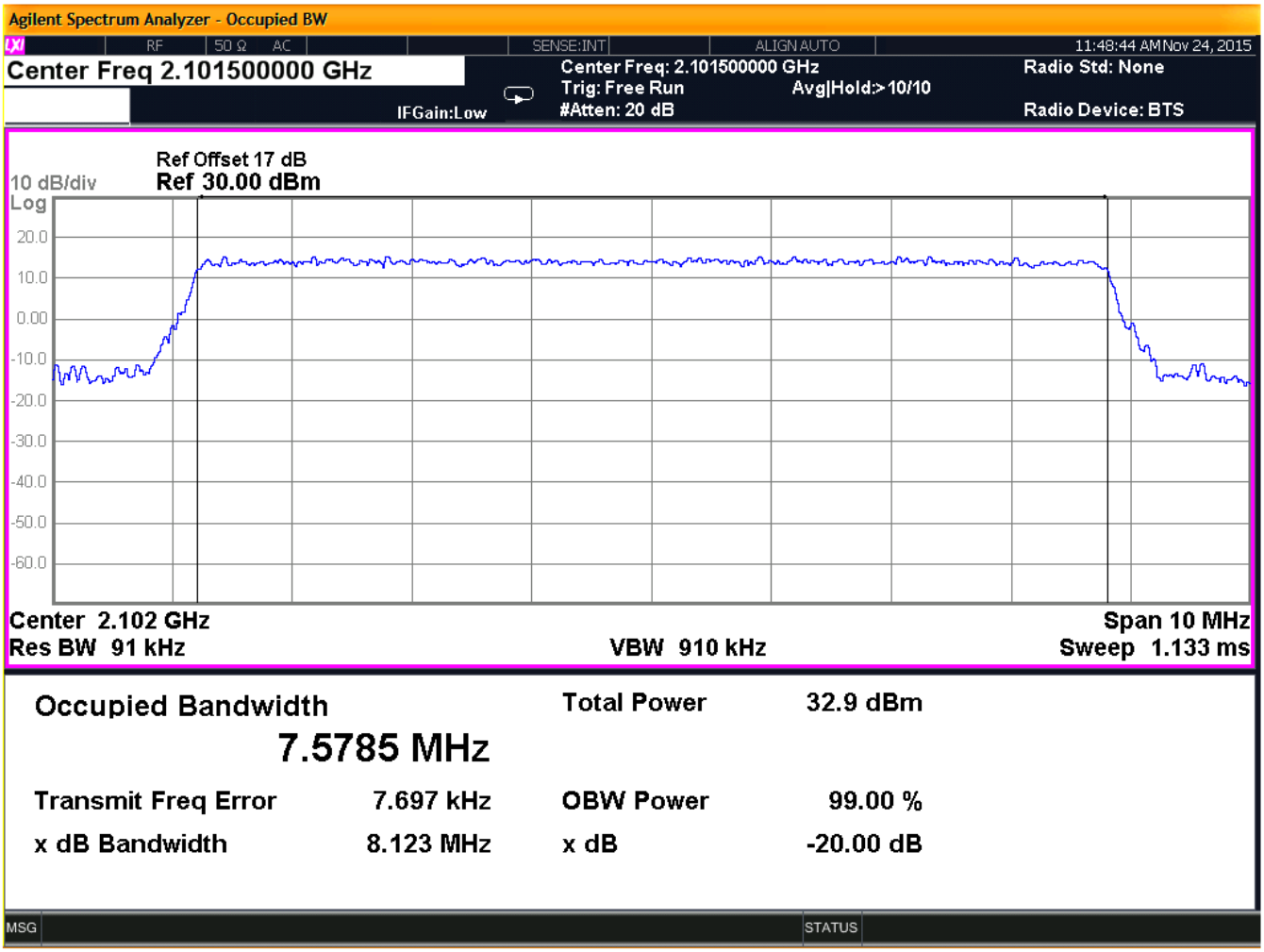


**Figure 11: Occupied Bandwidth, 64QAM Modulation, TX @ 2101.5MHz**

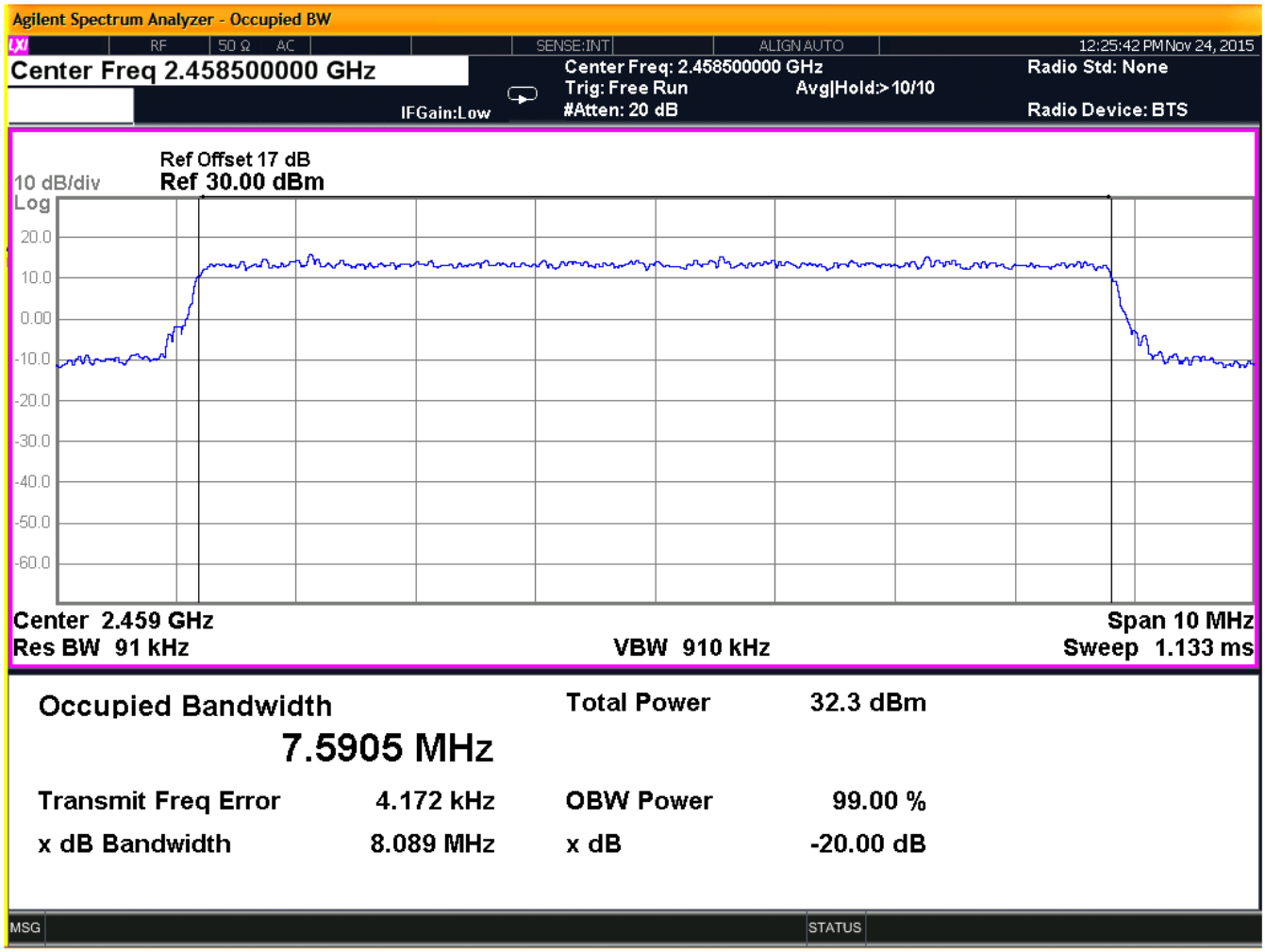


**Figure 12: Occupied Bandwidth, 64QAM Modulation, TX @ 2458.5MHz**

 

## 4.3 Emission Limitations per FCC Part § 74.637 (Emission Masks & Spurious Emissions)

Emissions limitations are specified in §74.637 (a) 2 (i) for digitally modulated transmissions.

### 4.3.1 Test Procedure

The emissions from 30 MHz to the tenth harmonic of the operating frequency were measured. The EUT antenna was removed and the cable was connected directly into a spectrum analyzer through a 10 dB attenuator. An offset was programmed into the spectrum analyzer to compensate for the loss of the external attenuator. The spectrum analyzer resolution bandwidth was set to 100 kHz and the video bandwidth was set to 3MHz. 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. Each of the available modulation schemes was tested.

### 4.3.2 Test Results

The following plots detail the emissions measured.

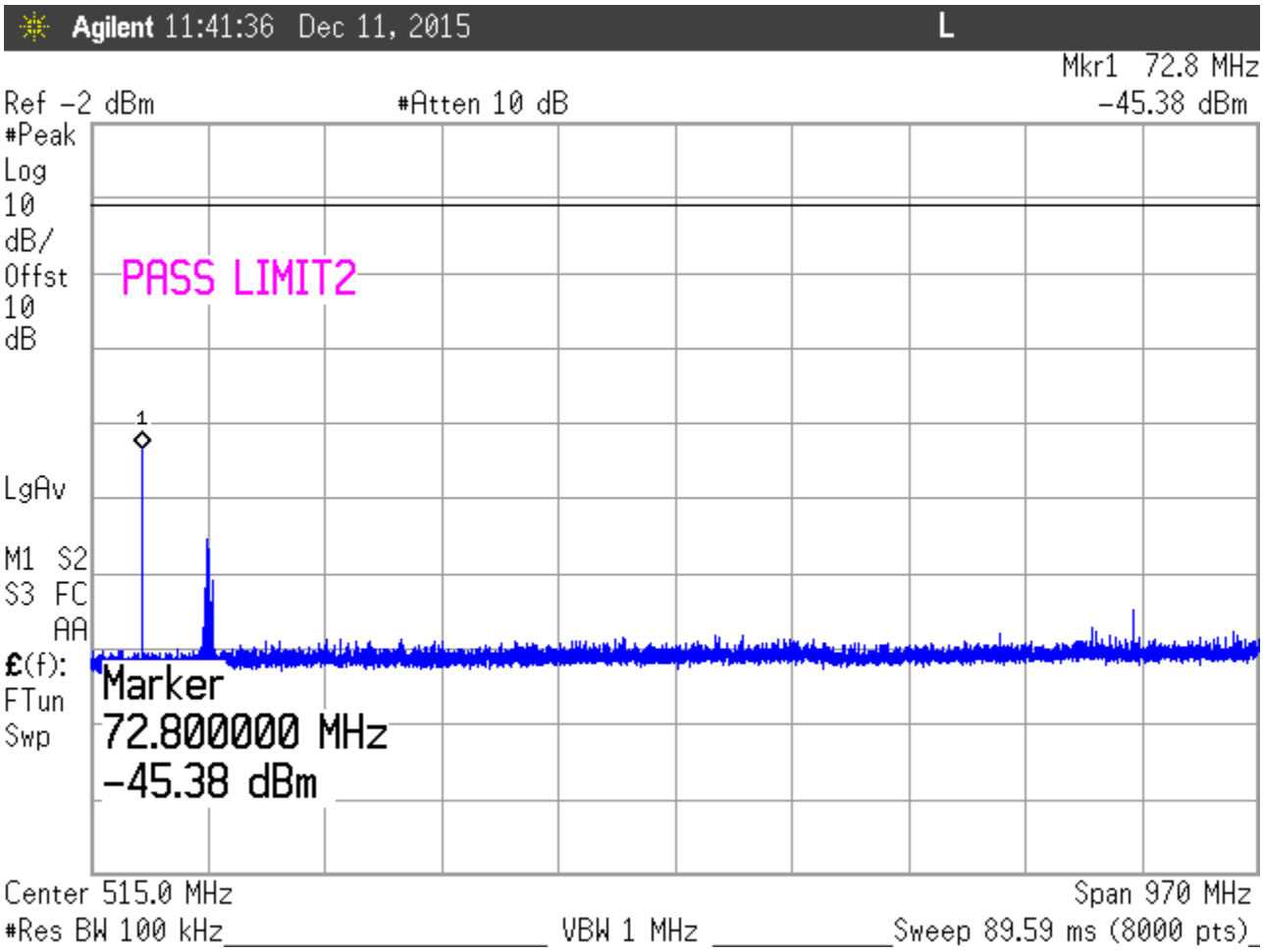


**Figure 13: Spurious Emissions, QPSK Modulation, TX @ 2033MHz, 30MHz-1000MHz**

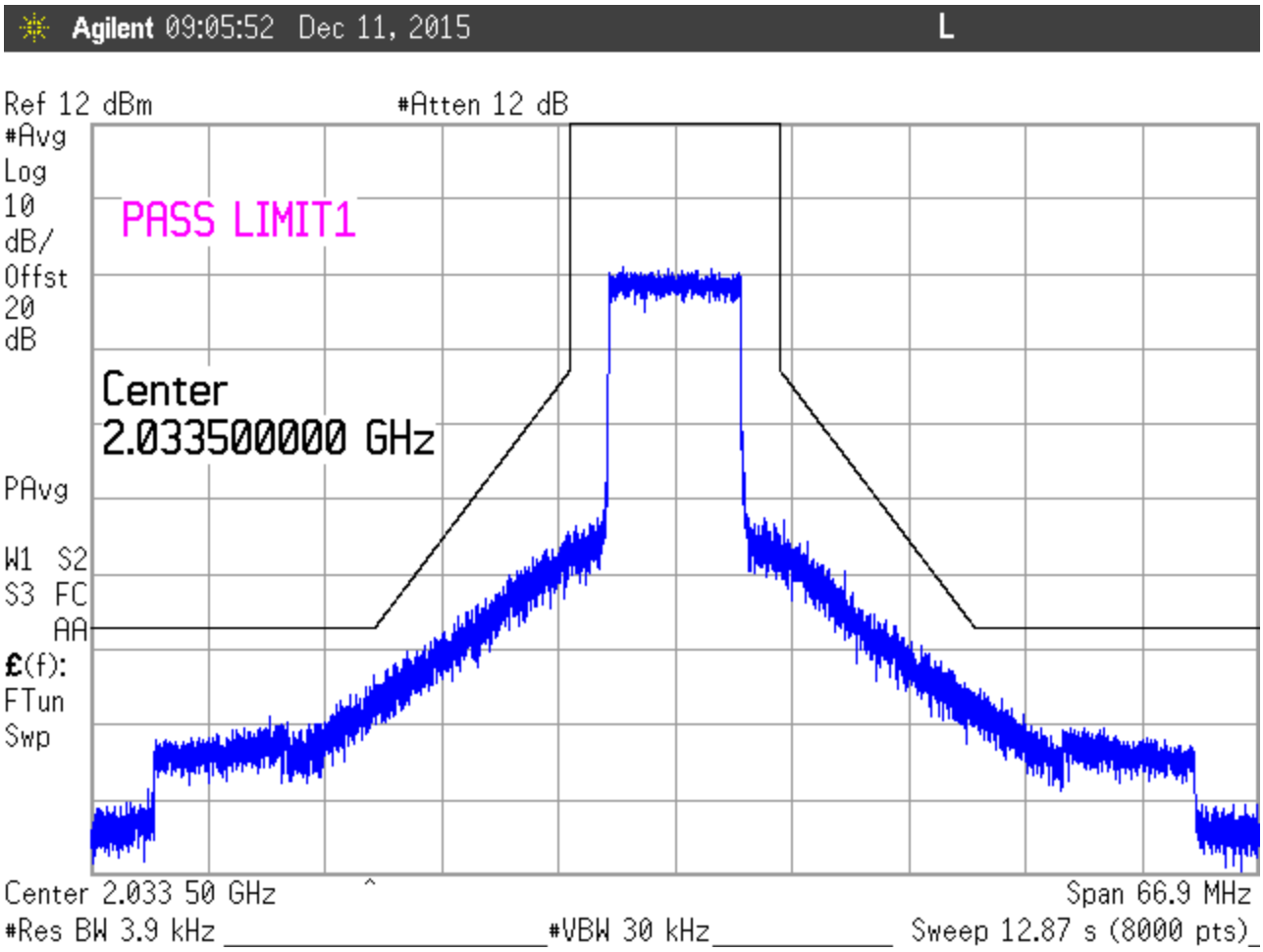


**Figure 14: Spurious Emissions, QPSK Modulation, TX @ 2033MHz, Emission Mask**

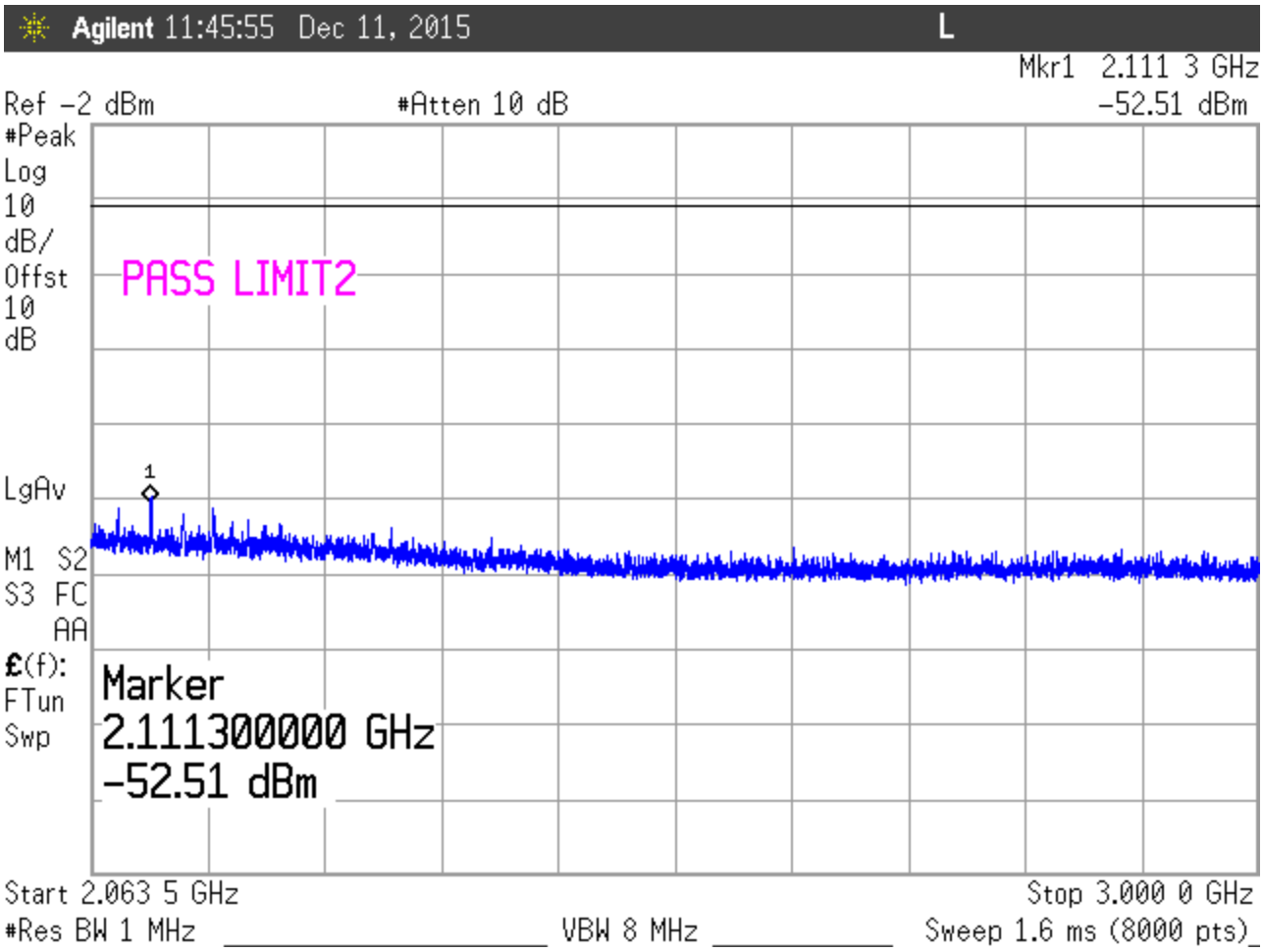


**Figure 15: Spurious Emissions, QPSK Modulation, TX @ 2033MHz, 2063MHz-3000MHz**

 

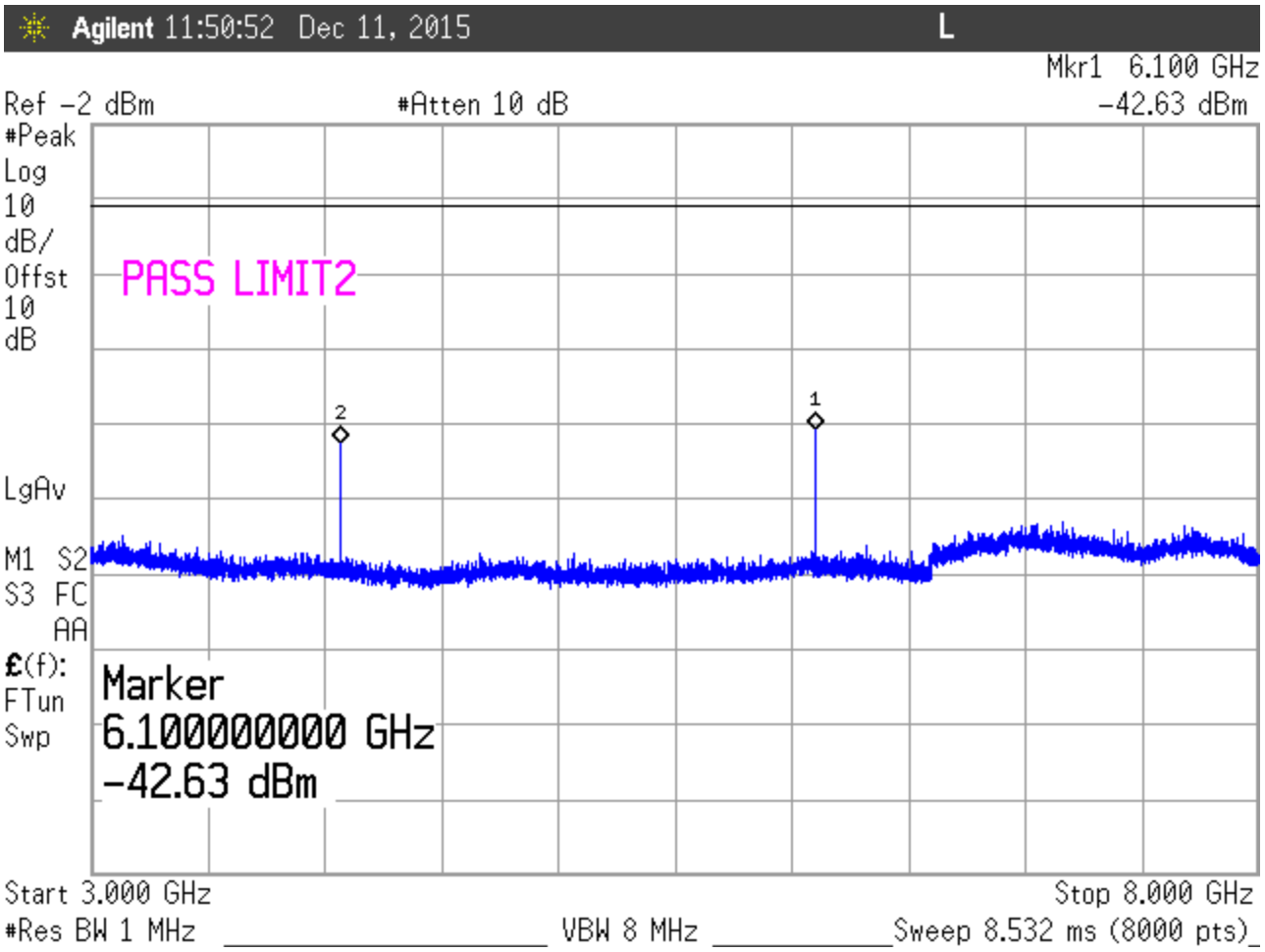


**Figure 16: Spurious Emissions, QPSK Modulation, TX @ 2033MHz, 3GHz-8GHz**

 

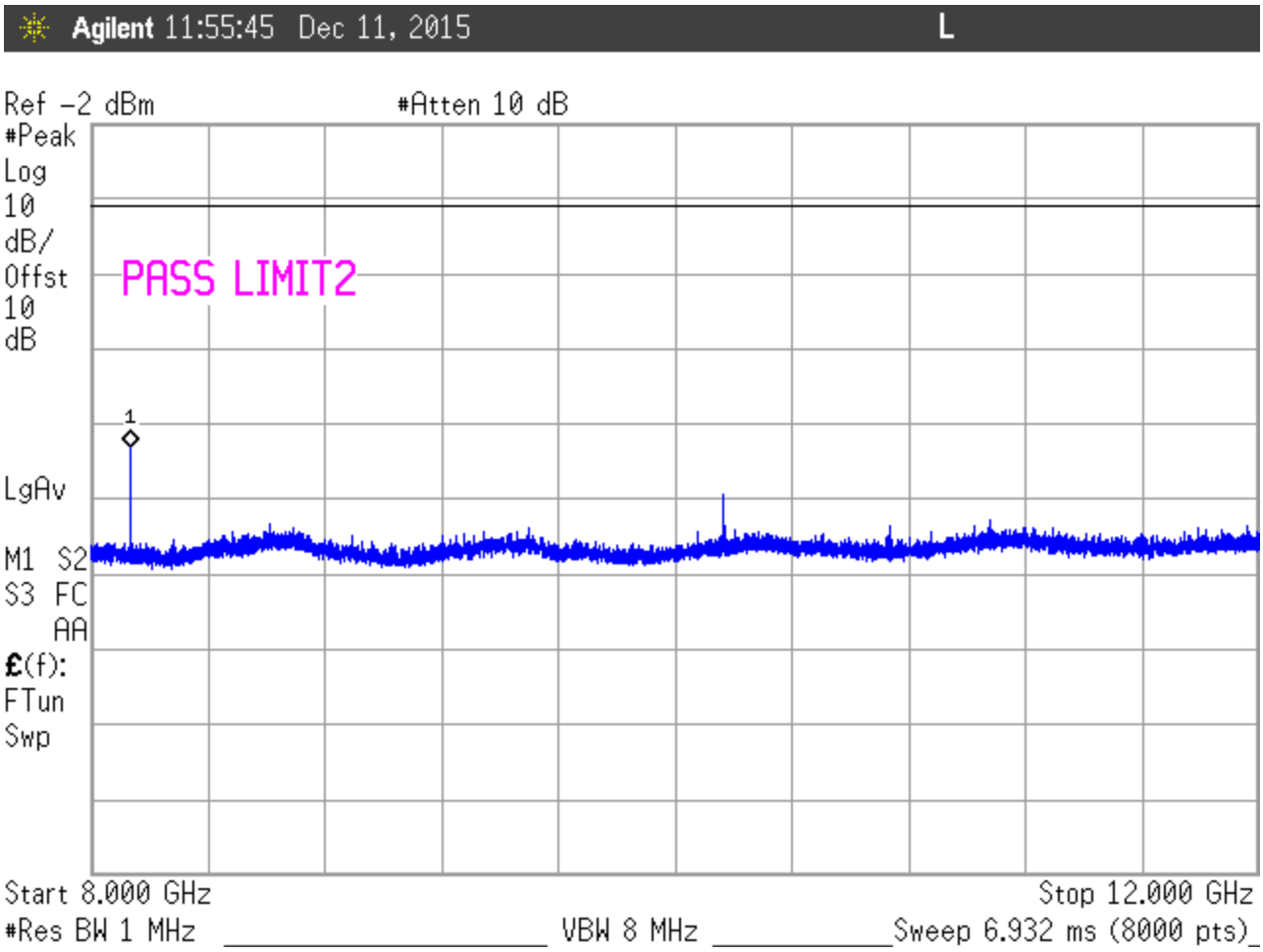


**Figure 17: Spurious Emissions, QPSK Modulation, TX @ 2033MHz, 8GHz-12GHz**

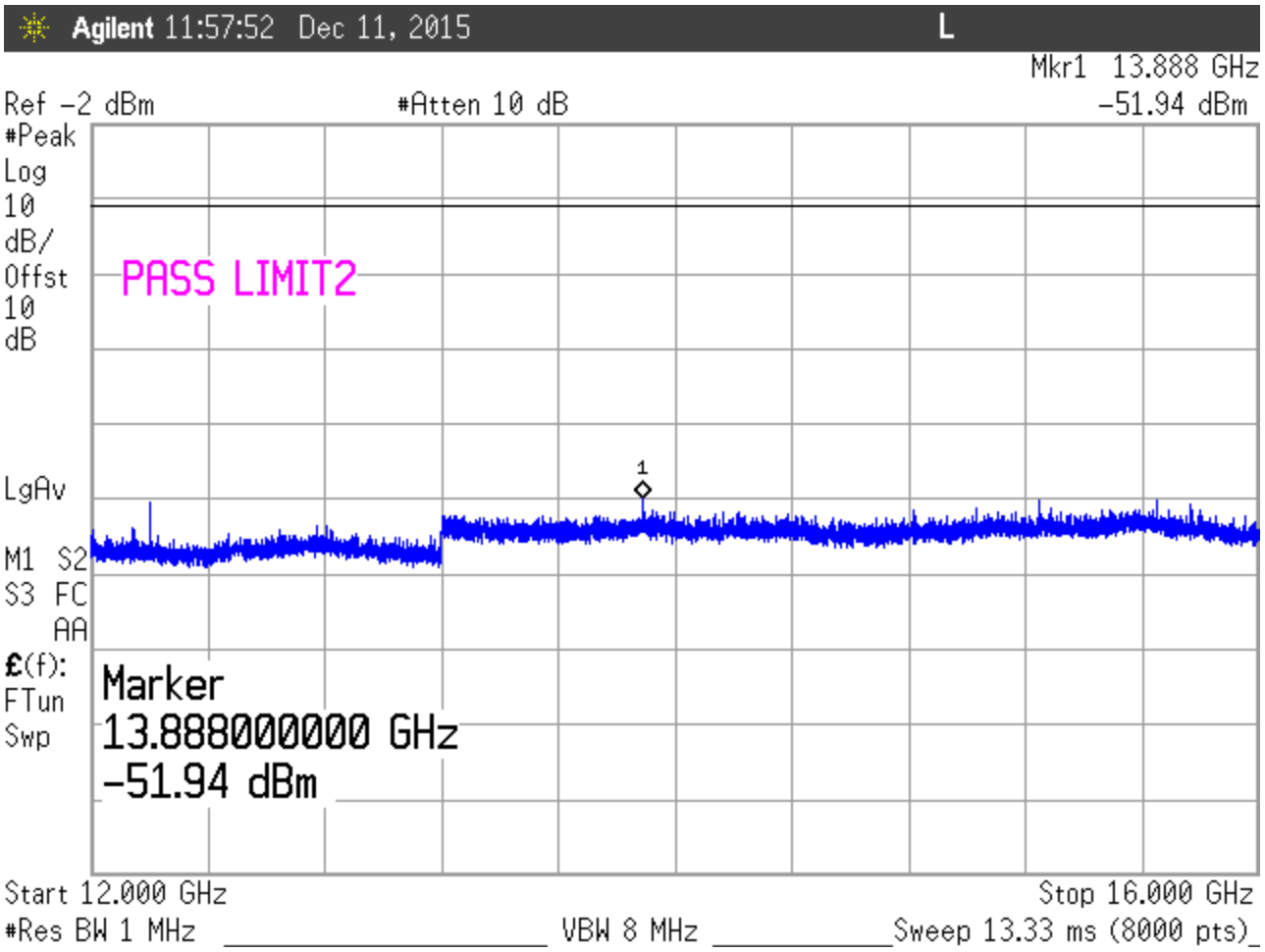


**Figure 18: Spurious Emissions, QPSK Modulation, TX @ 2033MHz, 12GHz-16GHz**

 

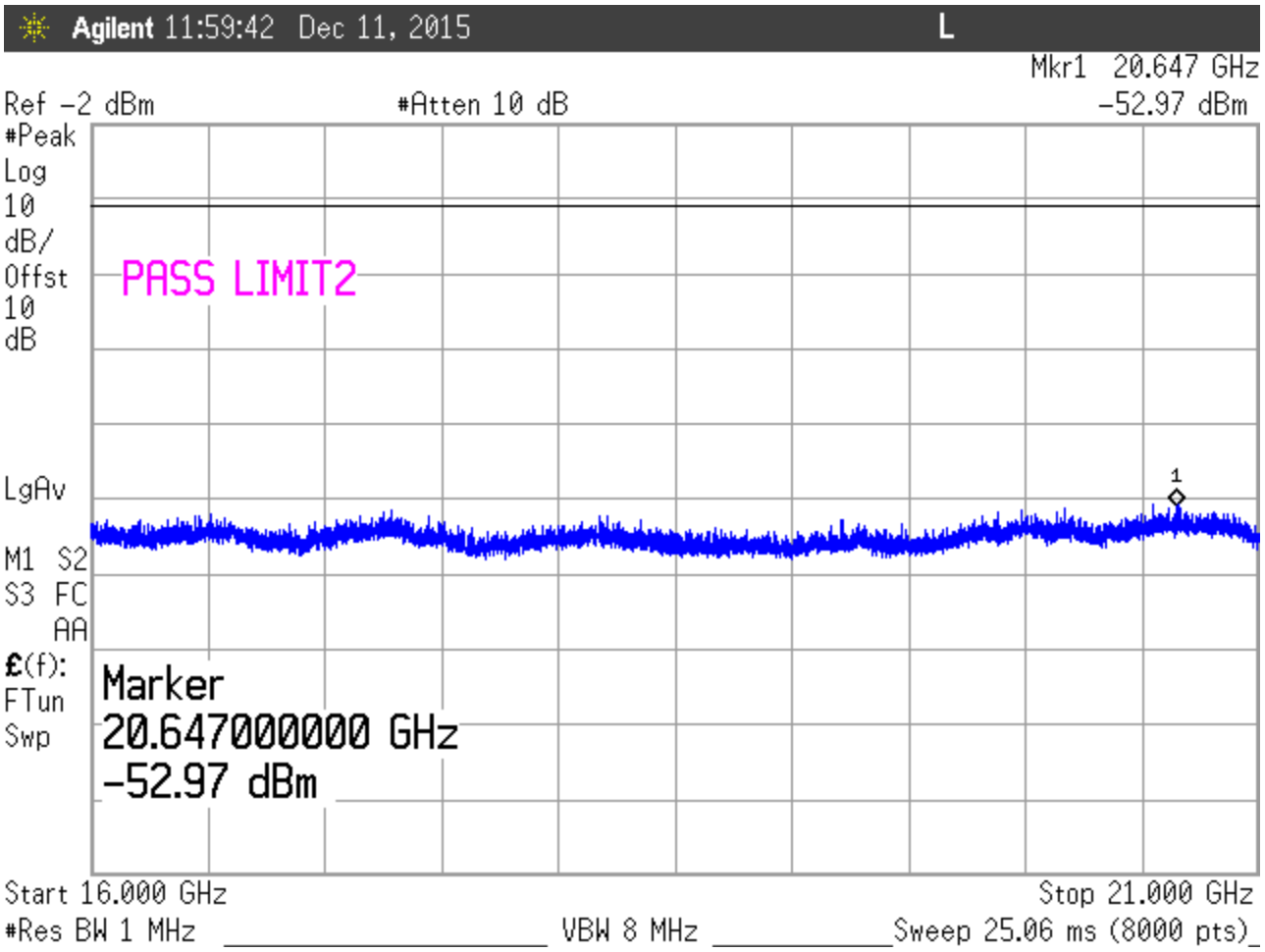


**Figure 19: Spurious Emissions, QPSK Modulation, TX @ 2033MHz, 16GHz-21GHz**

 

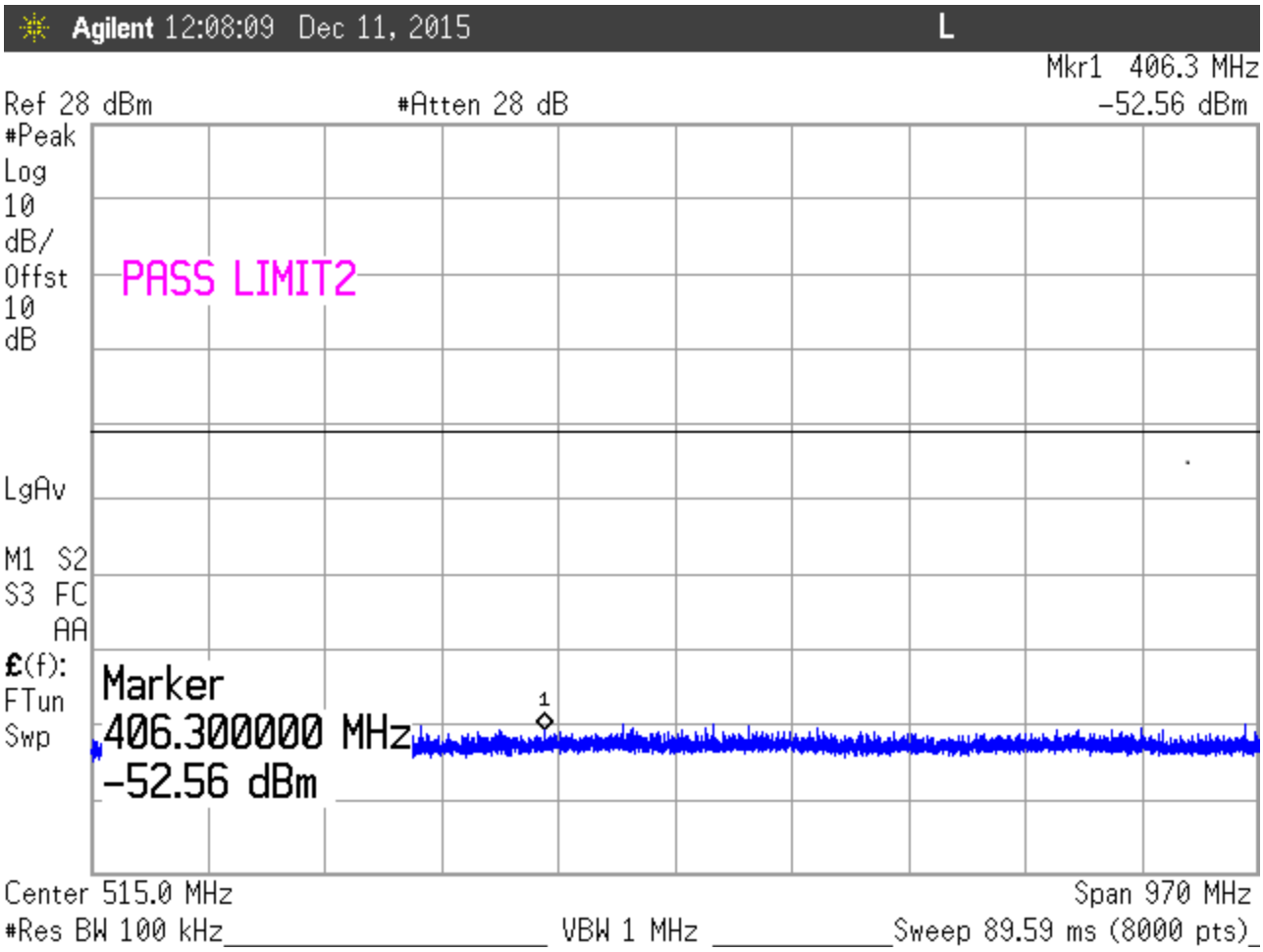


**Figure 20: Spurious Emissions, 16QAM Modulation, TX @ 2033MHz, 30MHz-1000MHz**

 

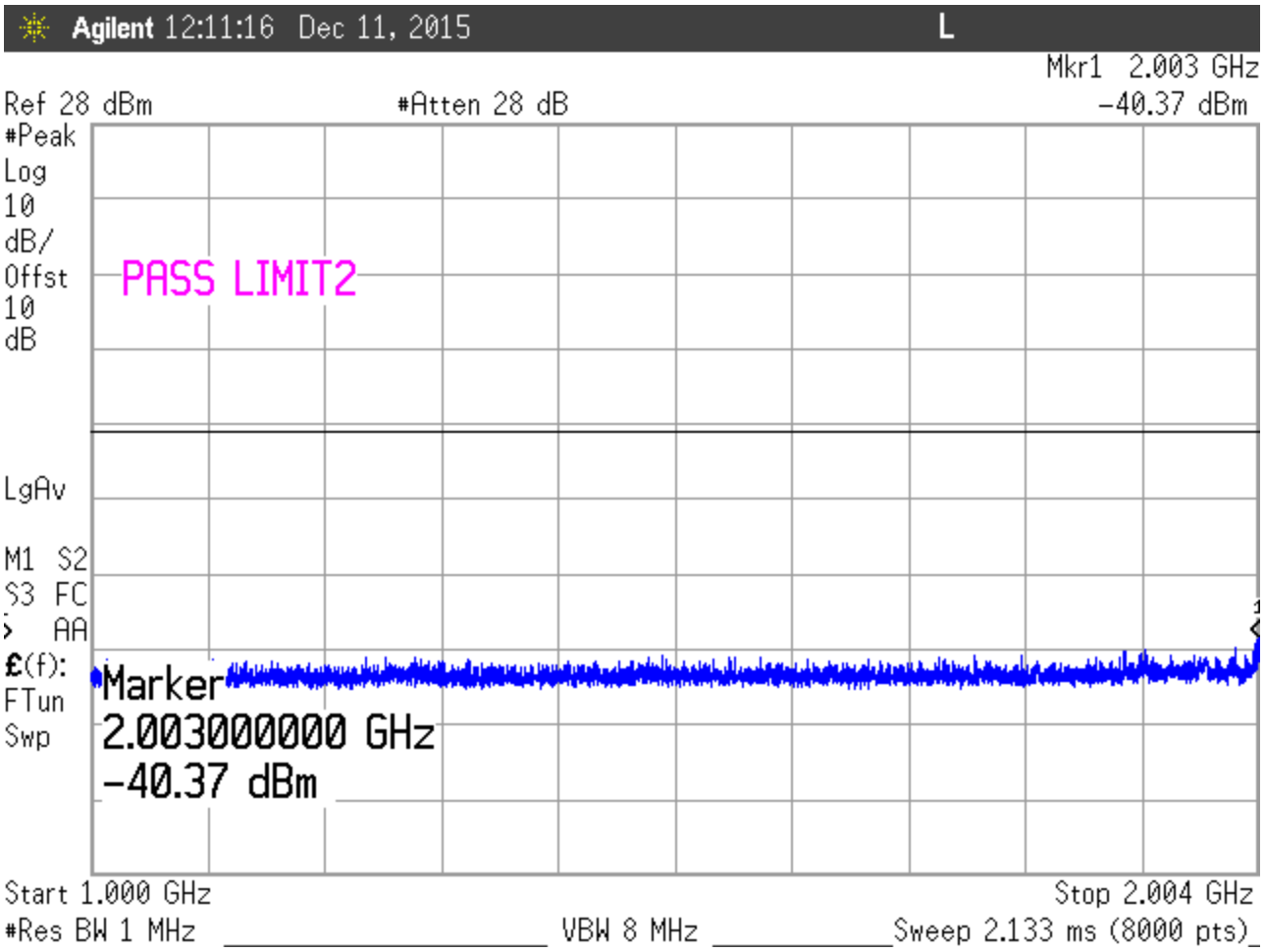


**Figure 21: Spurious Emissions, 16QAM Modulation, TX @ 2033MHz, 1000MHz-2004MHz**

 

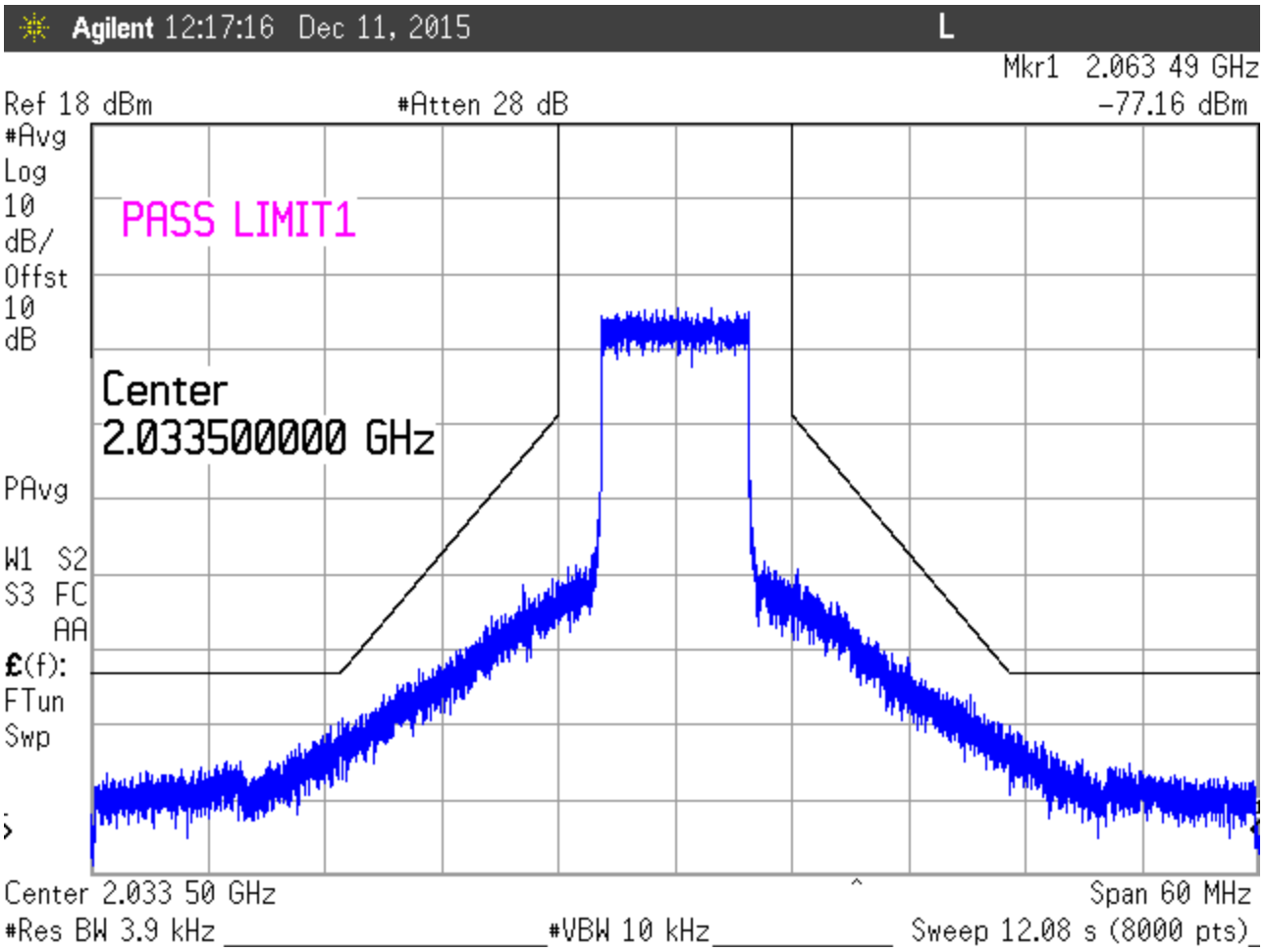


**Figure 22: Spurious Emissions, 16QAM Modulation, TX @ 2033MHz, Emission Mask**

 

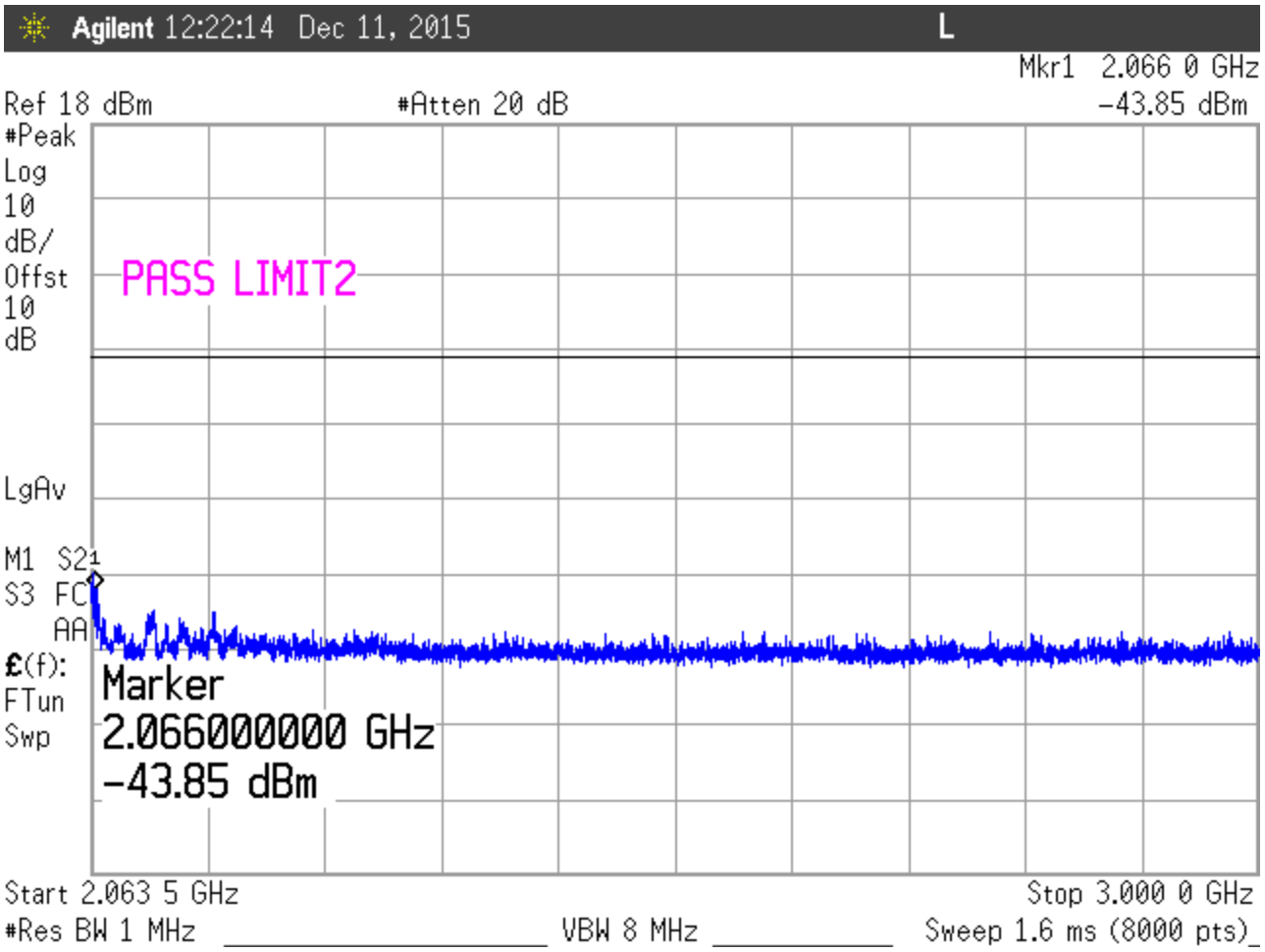


**Figure 23: Spurious Emissions, 16QAM Modulation, TX @ 2033MHz, 2063.5MHz-3GHz**

 

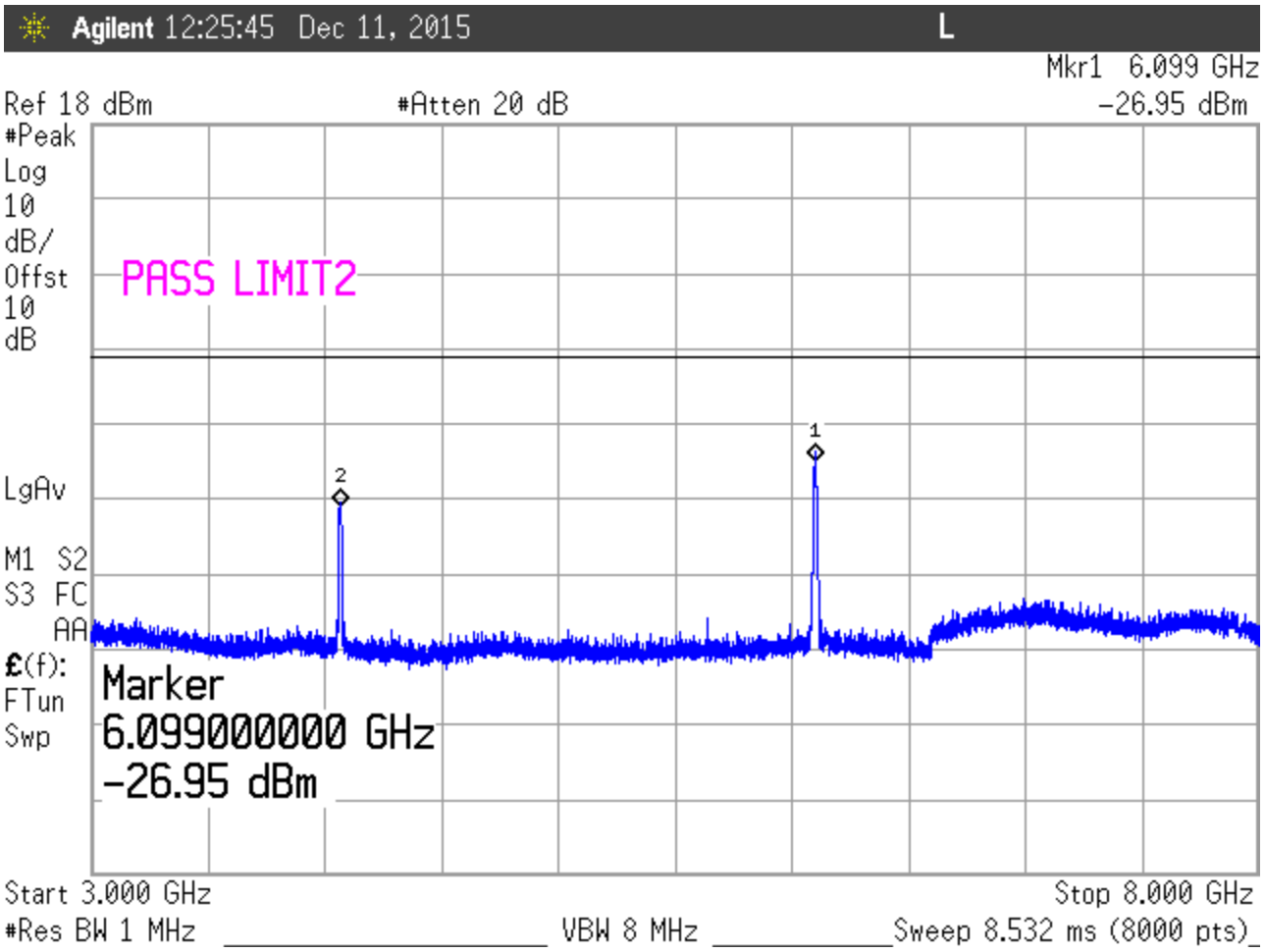


**Figure 24: Spurious Emissions, 16QAM Modulation, TX @ 2033MHz, 3GHz-8GHz**

 

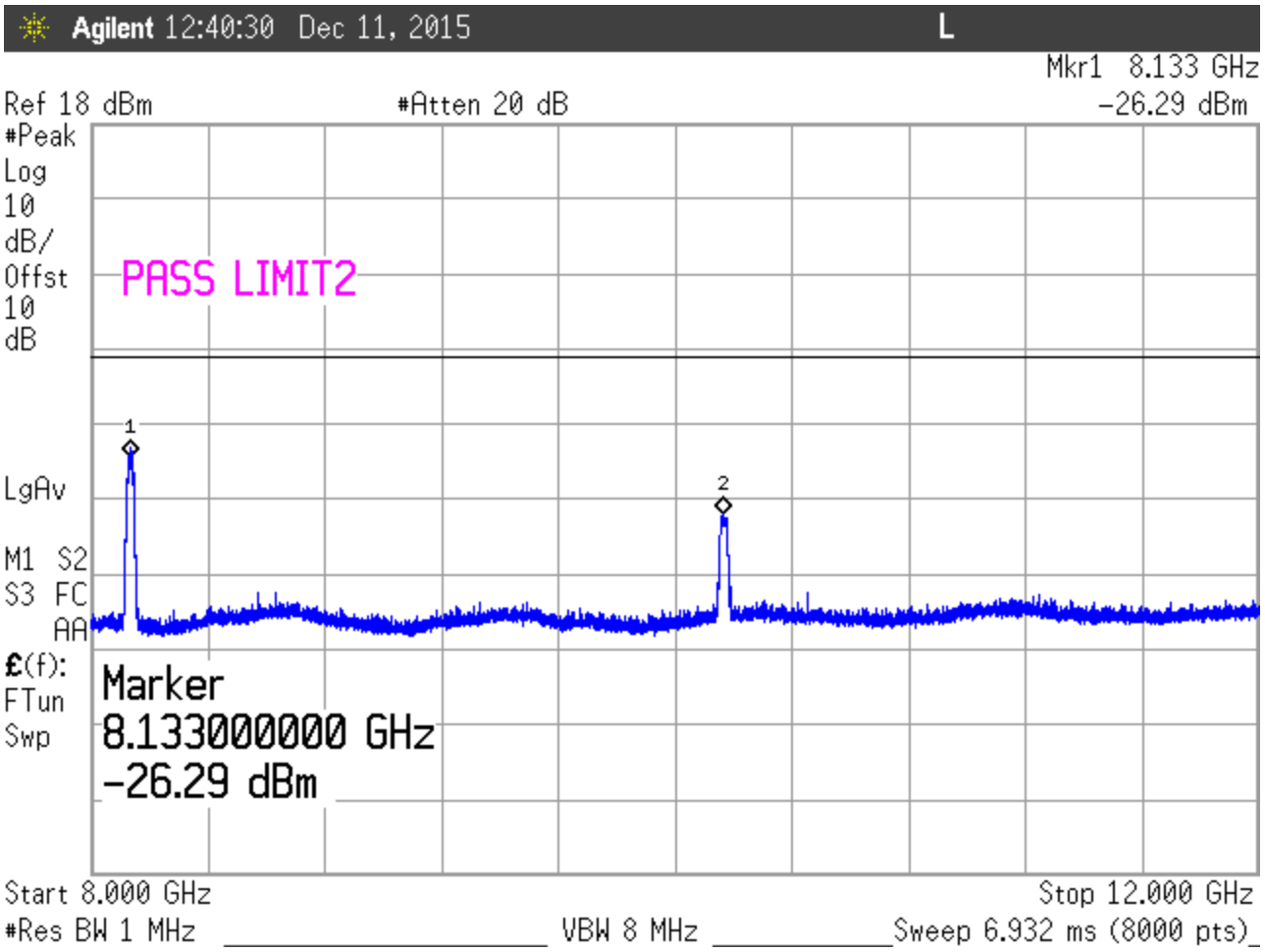


**Figure 25: Spurious Emissions, 16QAM Modulation, TX @ 2033MHz, 8GHz-12GHz**

 

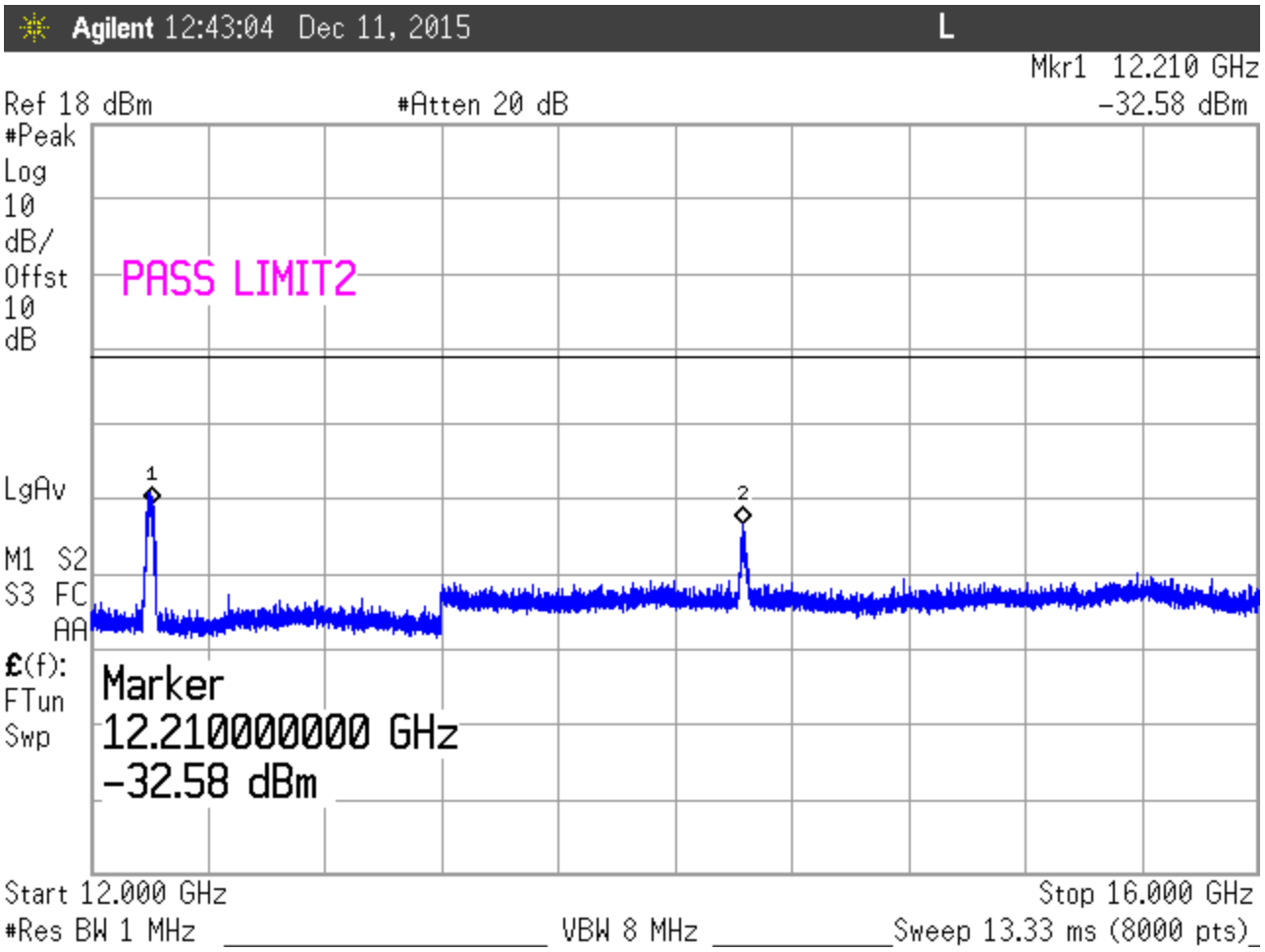


**Figure 26: Spurious Emissions, 16QAM Modulation, TX @ 2033MHz, 12GHz-16GHz**

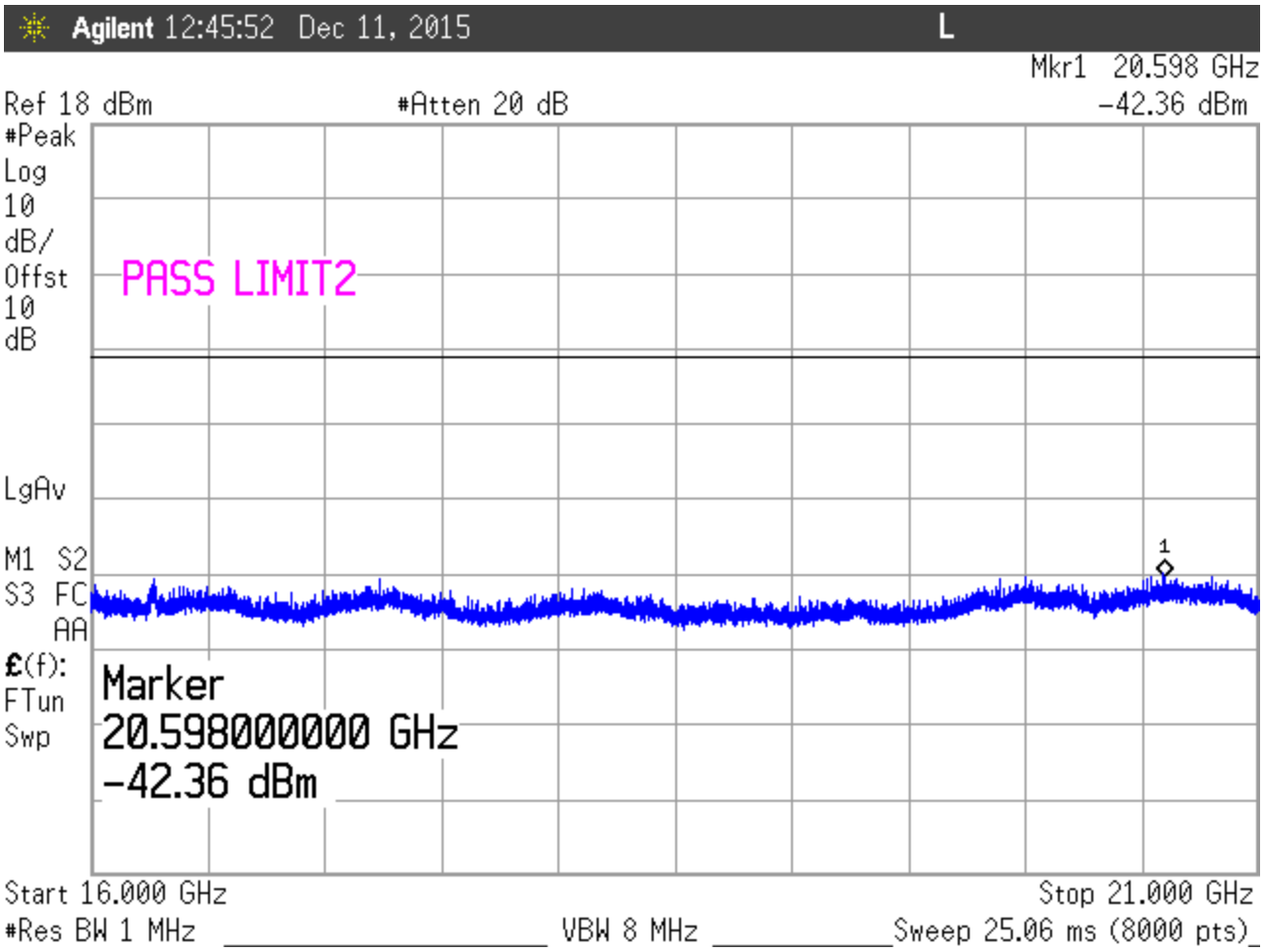


**Figure 27: Spurious Emissions, 16QAM Modulation, TX @ 2033MHz, 16GHz-21GHz**

 

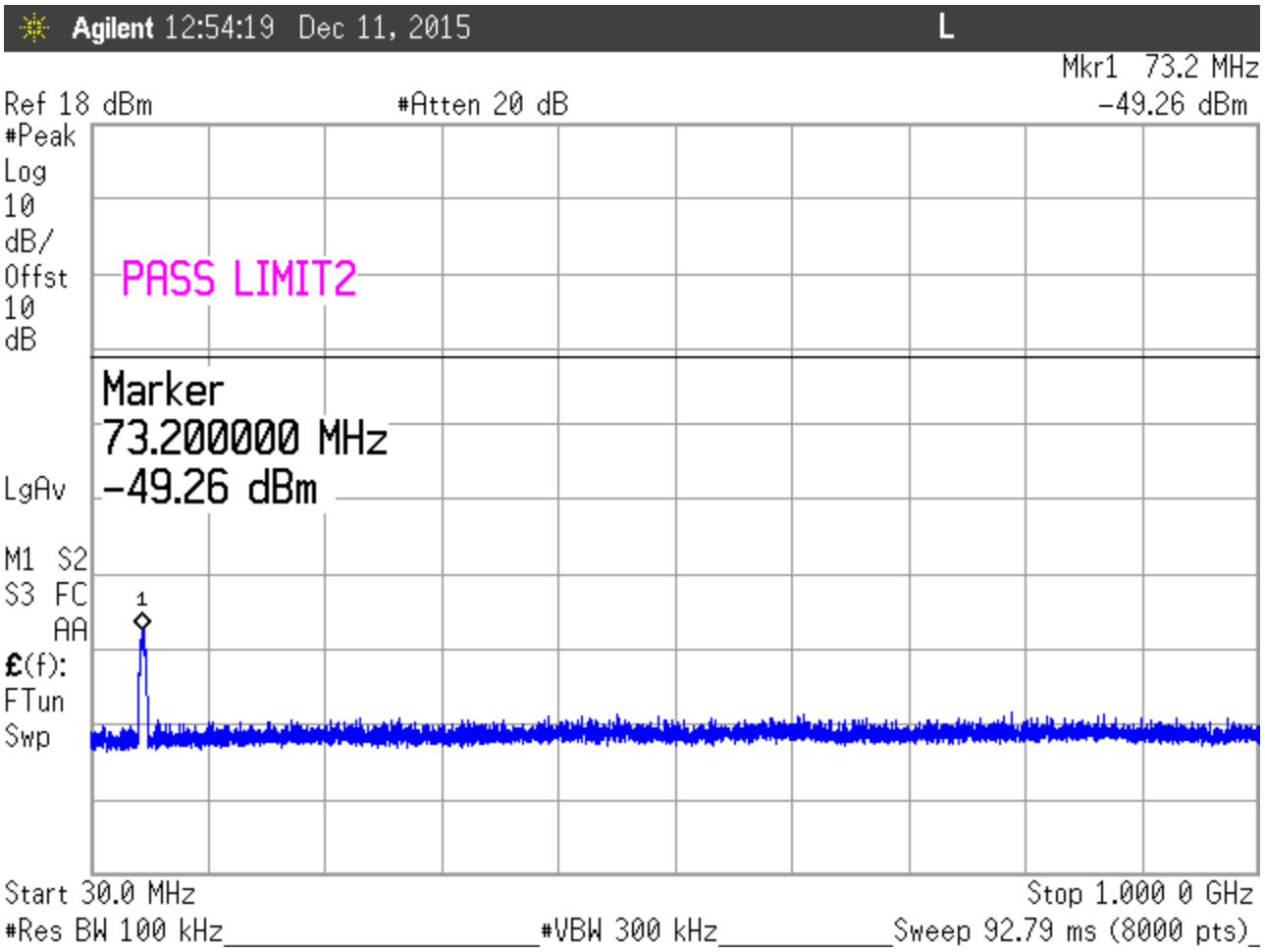


**Figure 28: Spurious Emissions, 64QAM Modulation, TX @ 2033MHz, 30MHz-1000MHz**

 

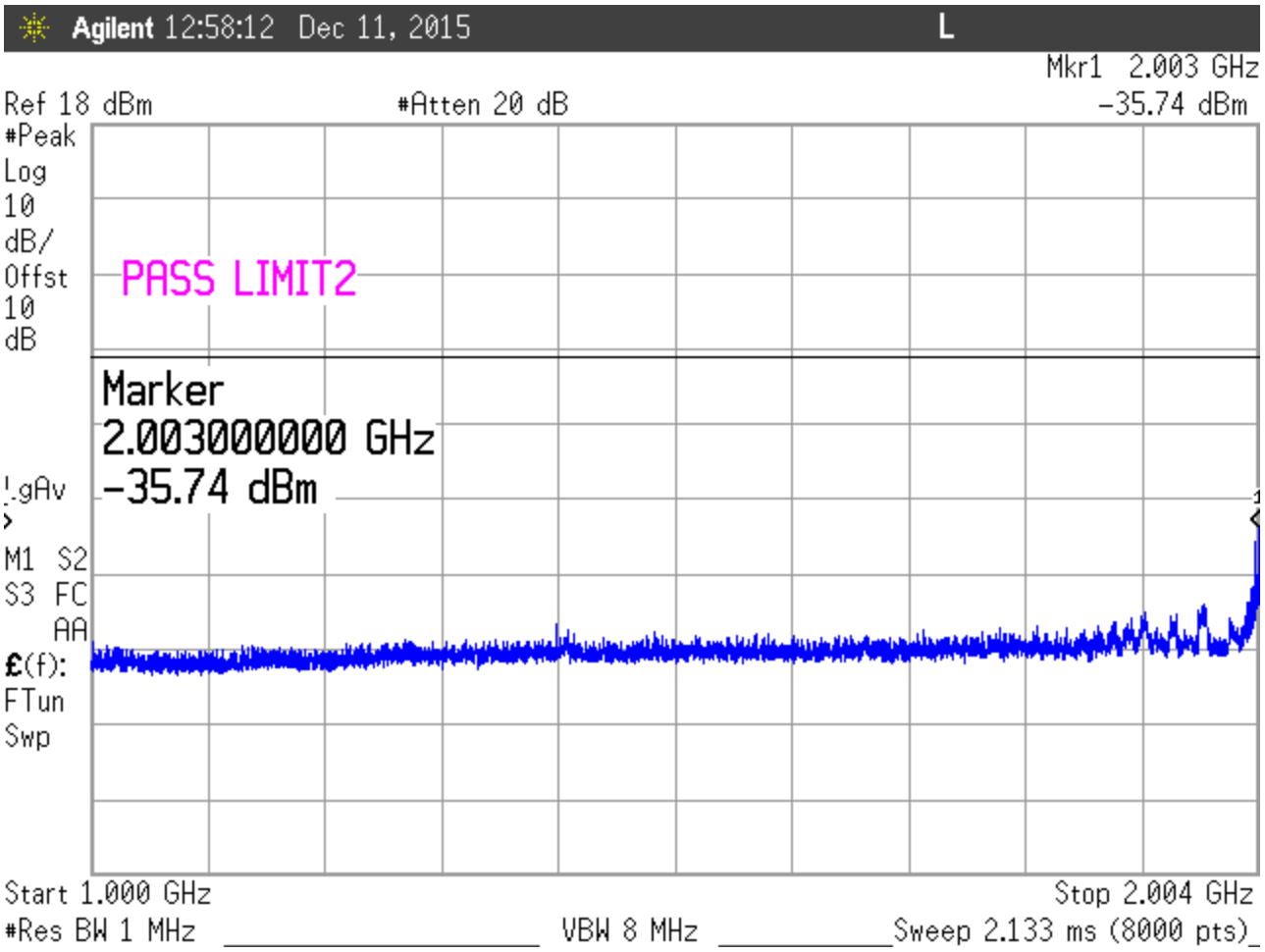


**Figure 29: Spurious Emissions, 64QAM Modulation, TX @ 2033MHz, 1000MHz-2004MHz**

 

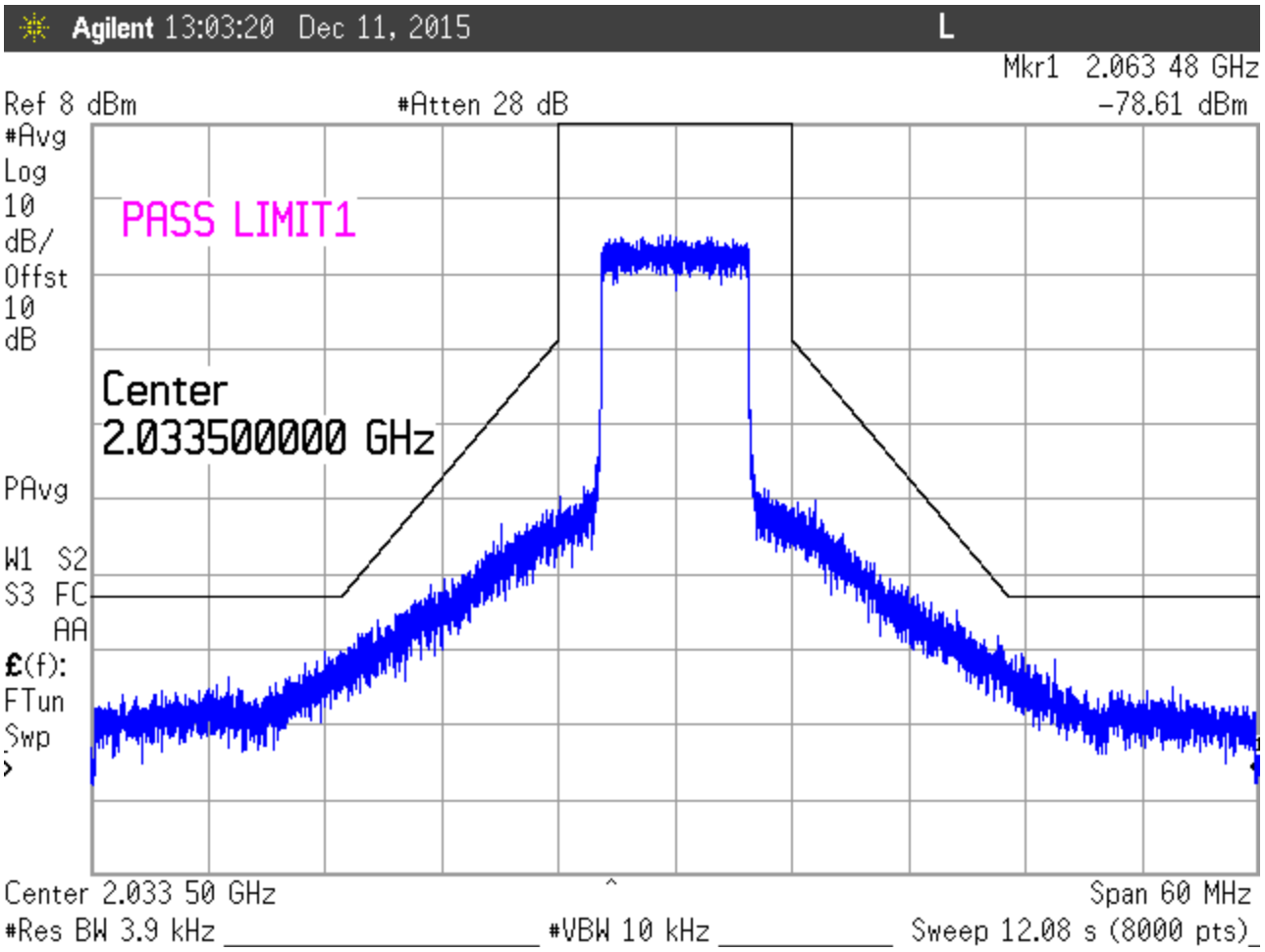


**Figure 30: Spurious Emissions, 64QAM Modulation, TX @ 2033MHz, Emission Mask**

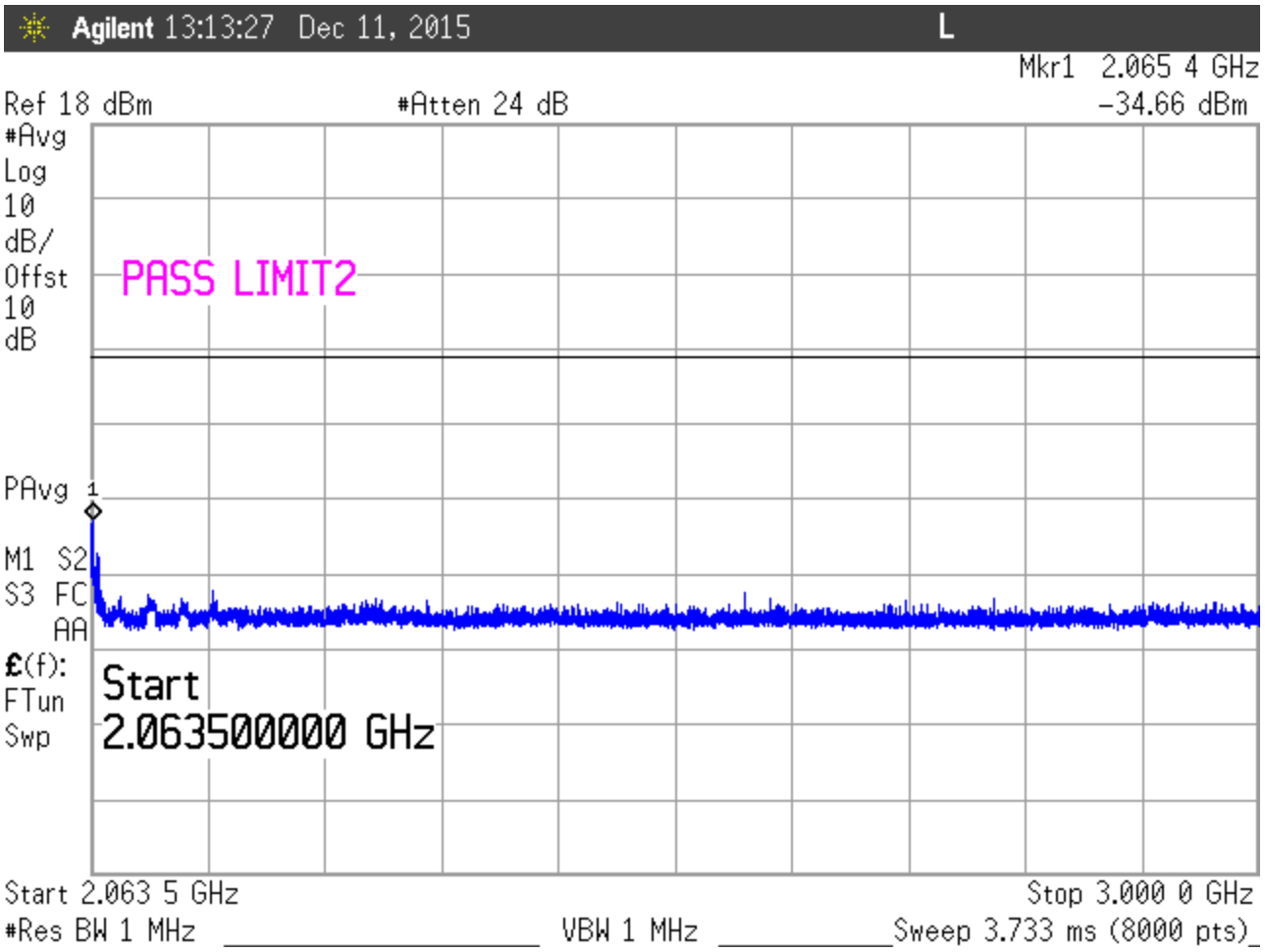


**Figure 31: Spurious Emissions, 64QAM Modulation, TX @ 2033MHz, 2063.5MHz-3GHz**

 

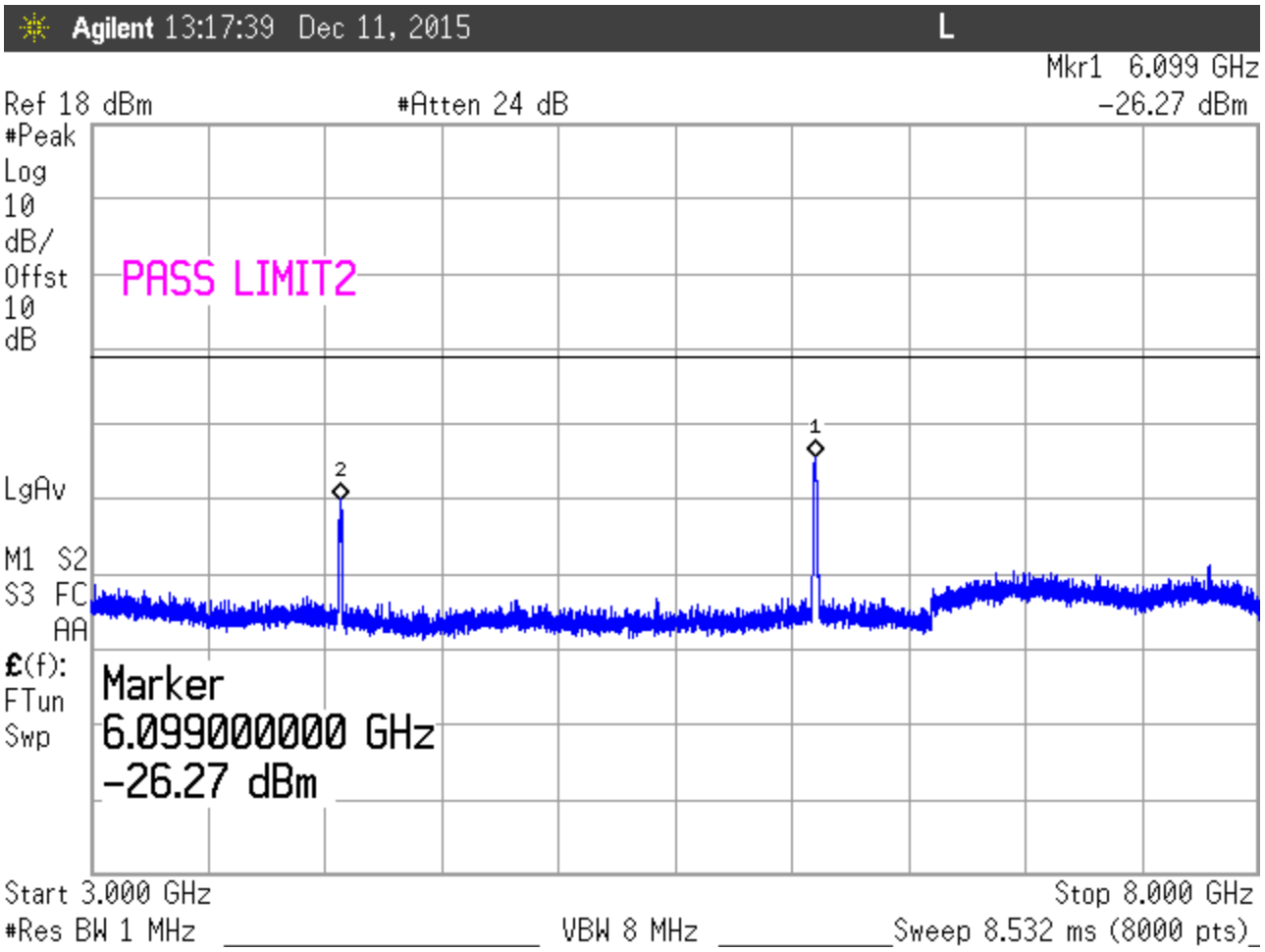


**Figure 32: Spurious Emissions, 64QAM Modulation, TX @ 2033MHz, 3GHz-8GHz**

 

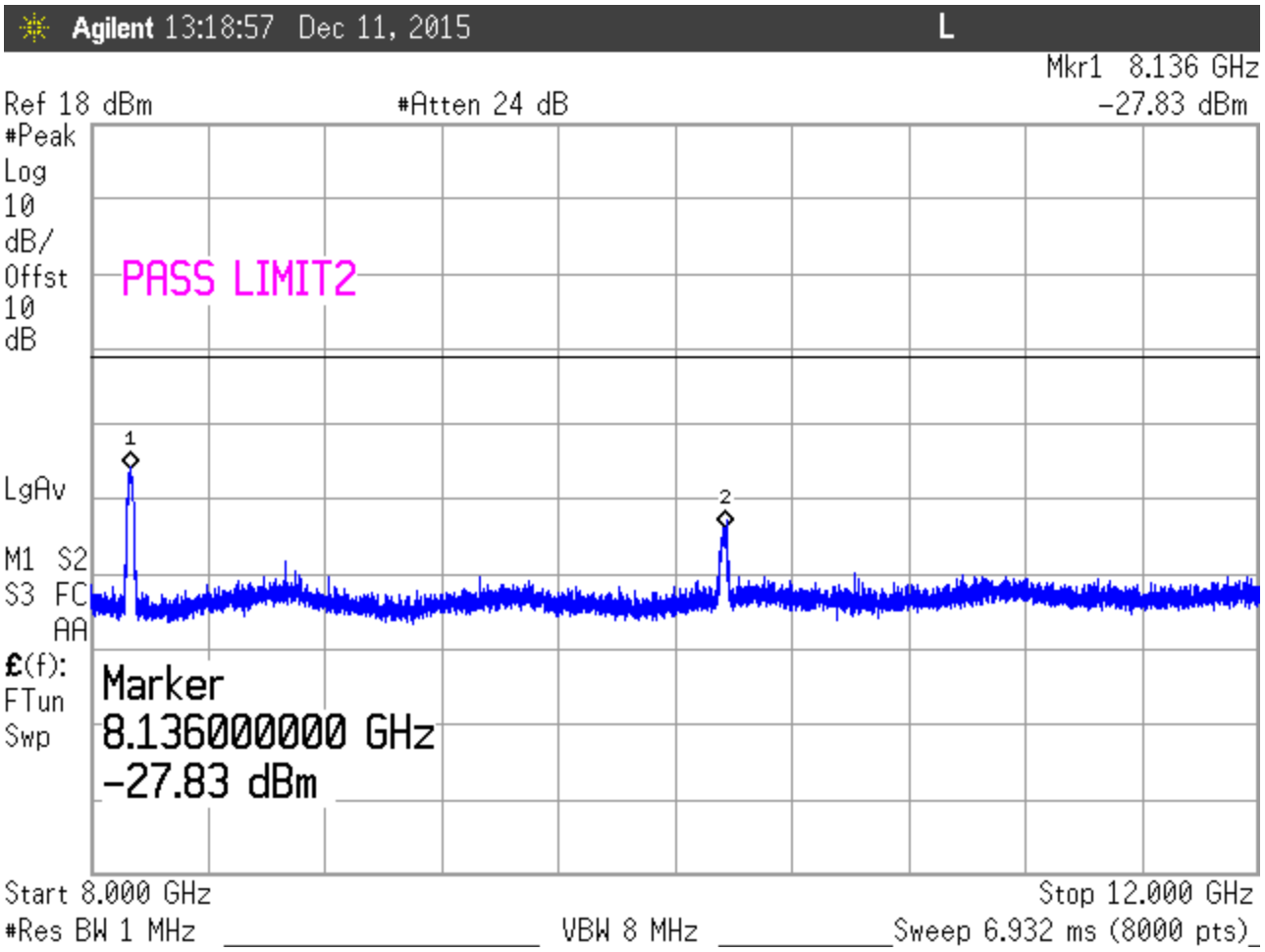


**Figure 33: Spurious Emissions, 64QAM Modulation, TX @ 2033MHz, 8GHz-12GHz**

 

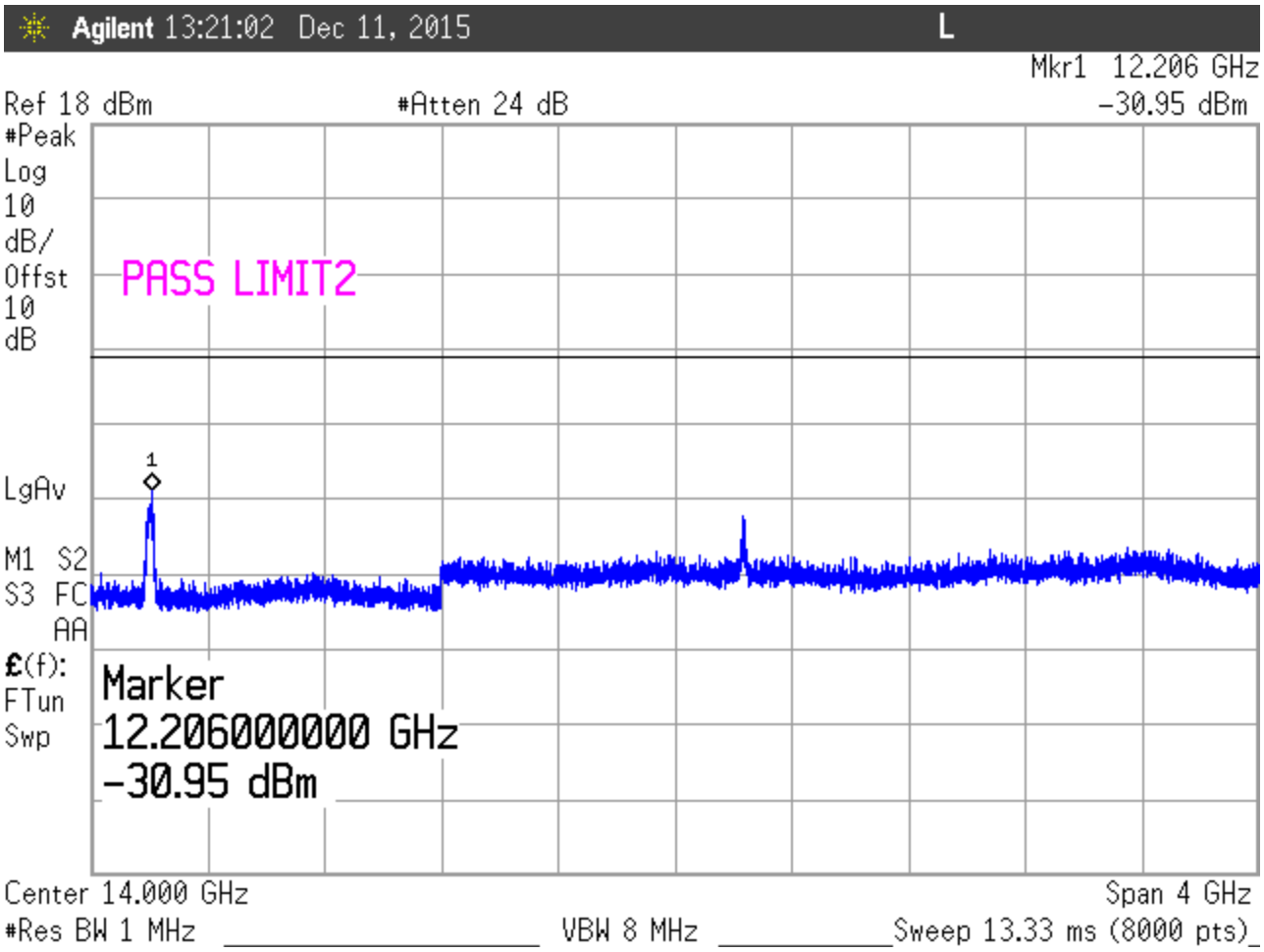


**Figure 34: Spurious Emissions, 64QAM Modulation, TX @ 2033MHz, 12GHz-16GHz**

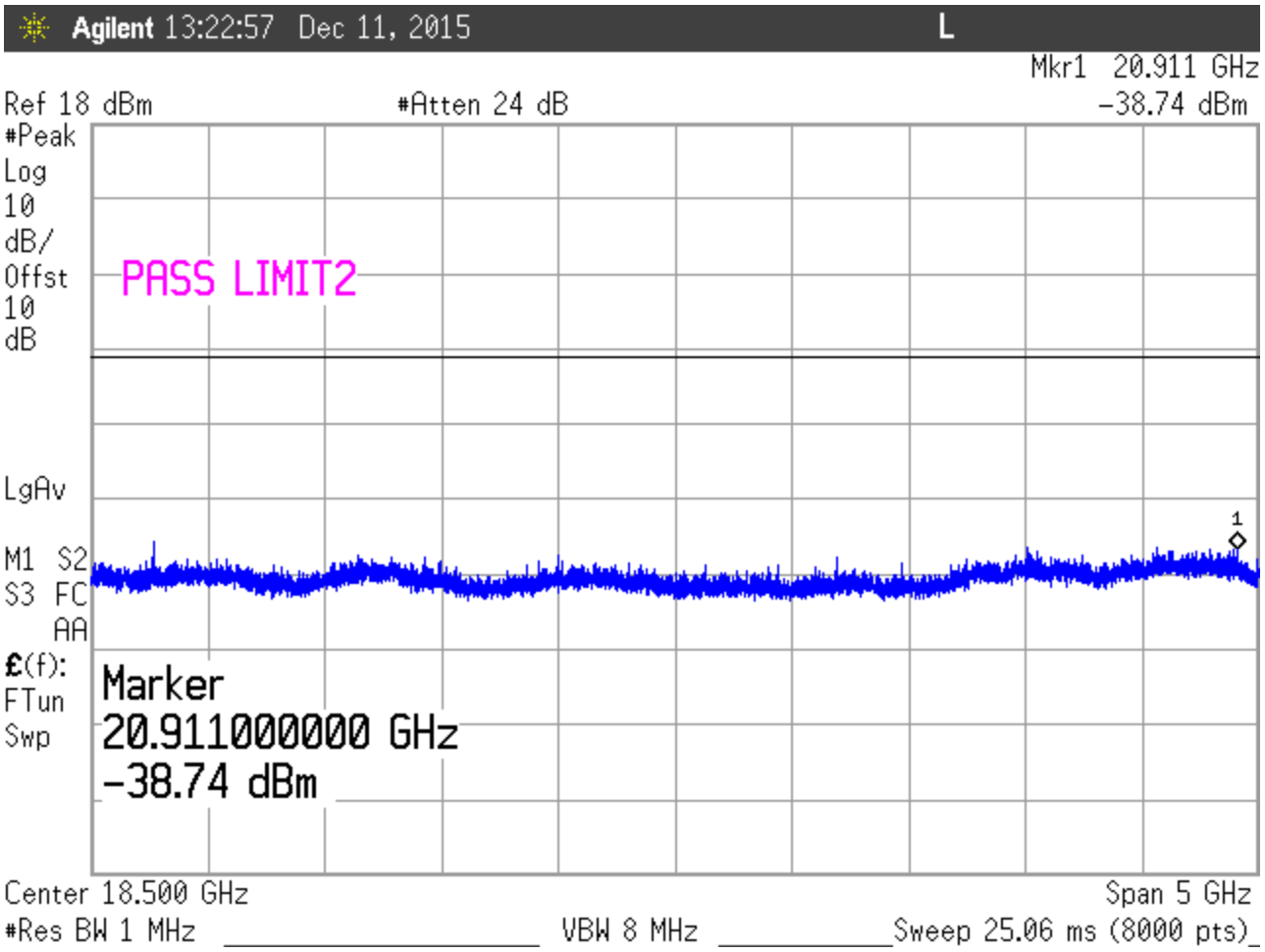


**Figure 35: Spurious Emissions, 64QAM Modulation, TX @ 2033MHz, 16GHz-21GHz**

 

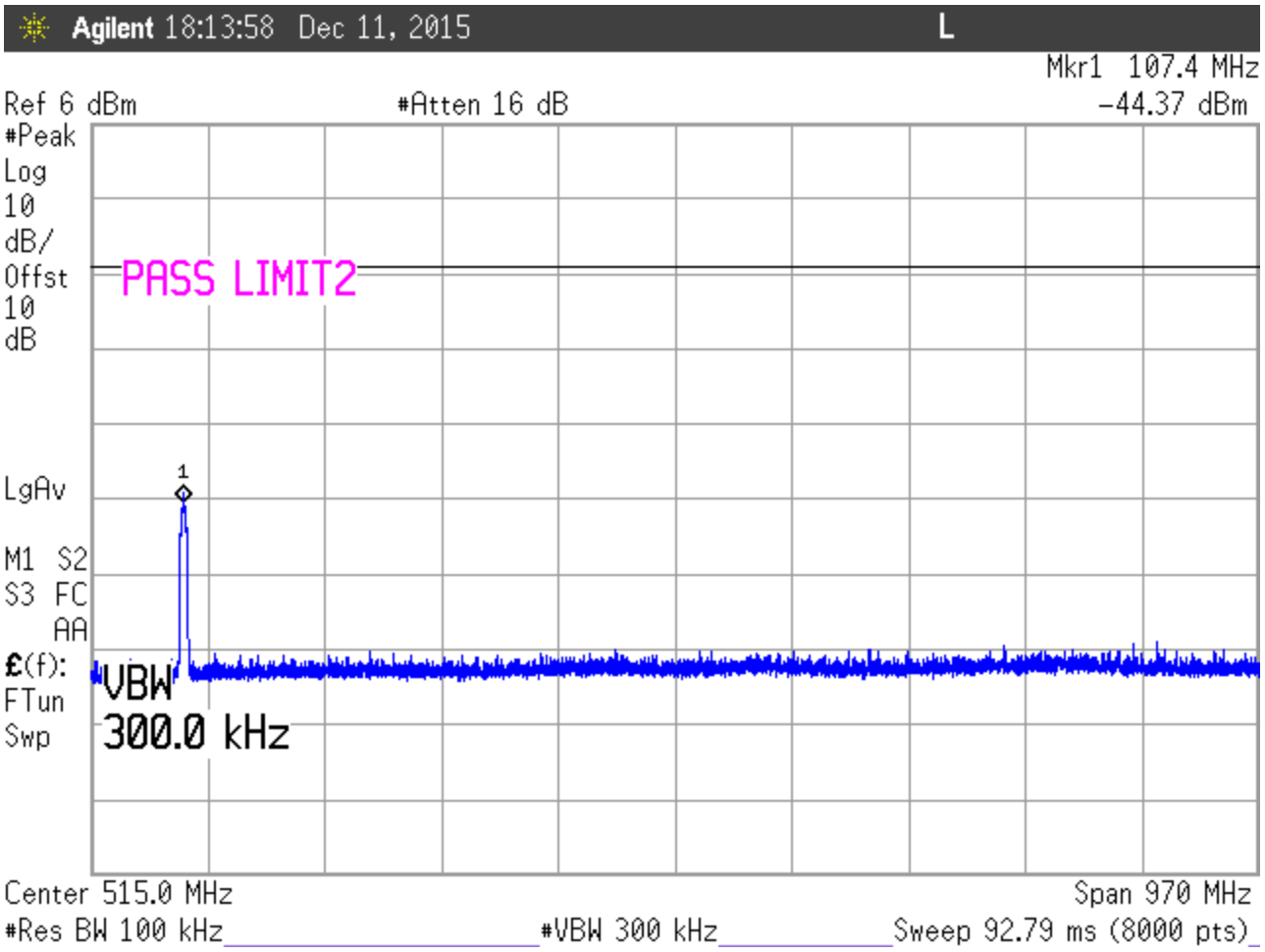


**Figure 36: Spurious Emissions, QPSK Modulation, TX @ 2067.5MHz, 30MHz-1000MHz**

 

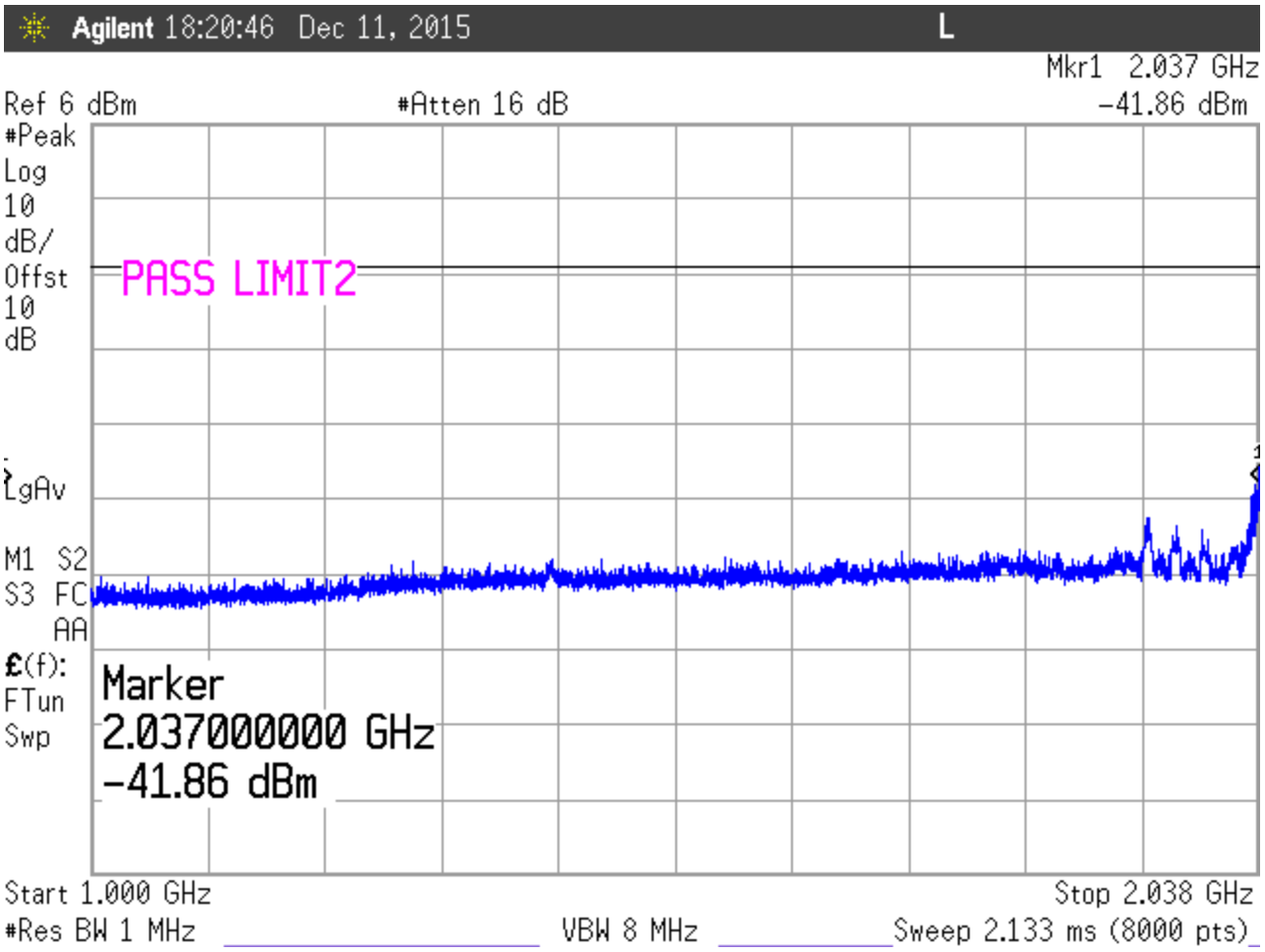


**Figure 37: Spurious Emissions, QPSK Modulation, TX @ 2067.5MHz, 1000MHz -2038MHz**

 

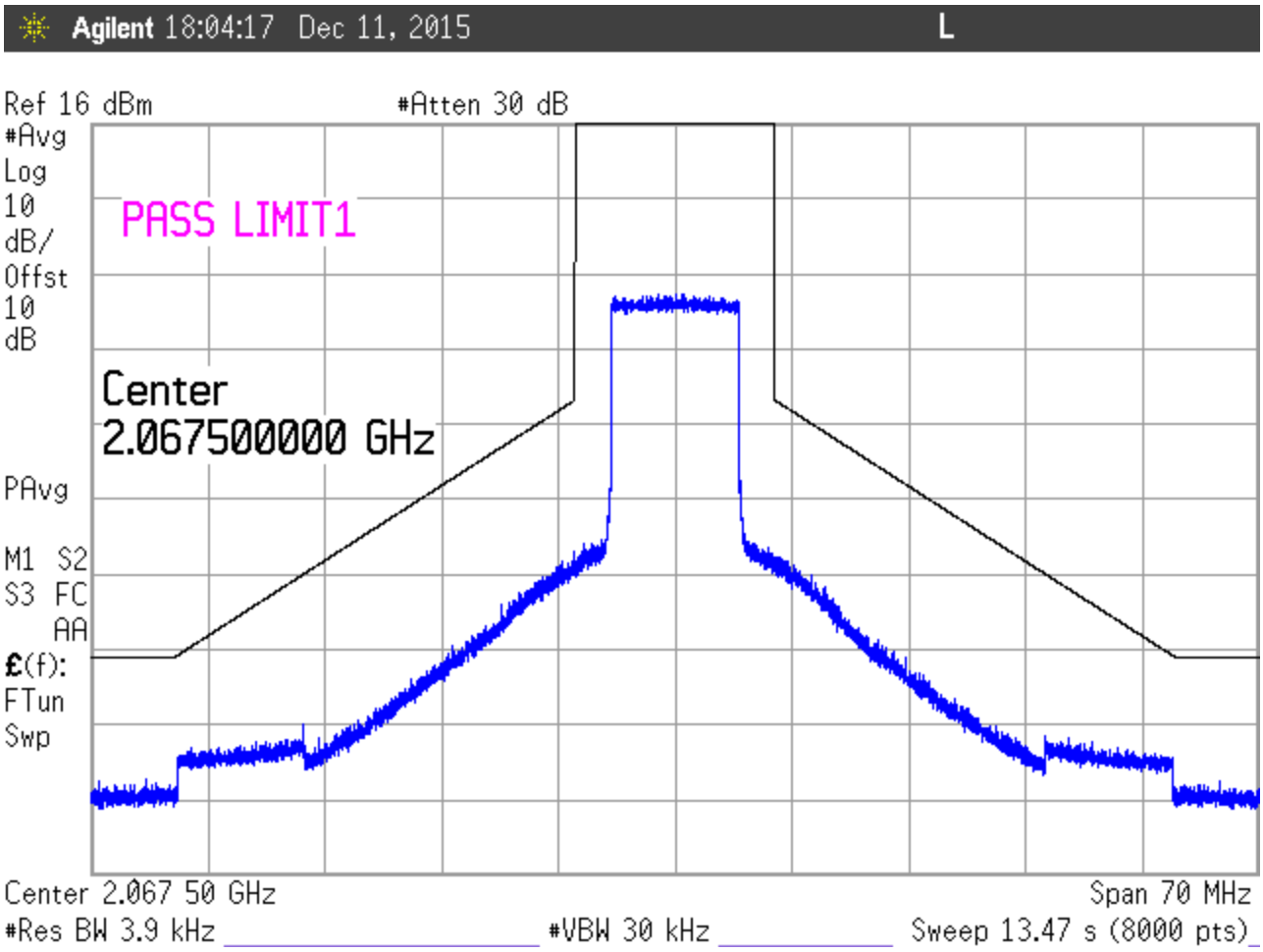


**Figure 38: Spurious Emissions, QPSK Modulation, TX @ 2067.5MHz, Emission Mask**

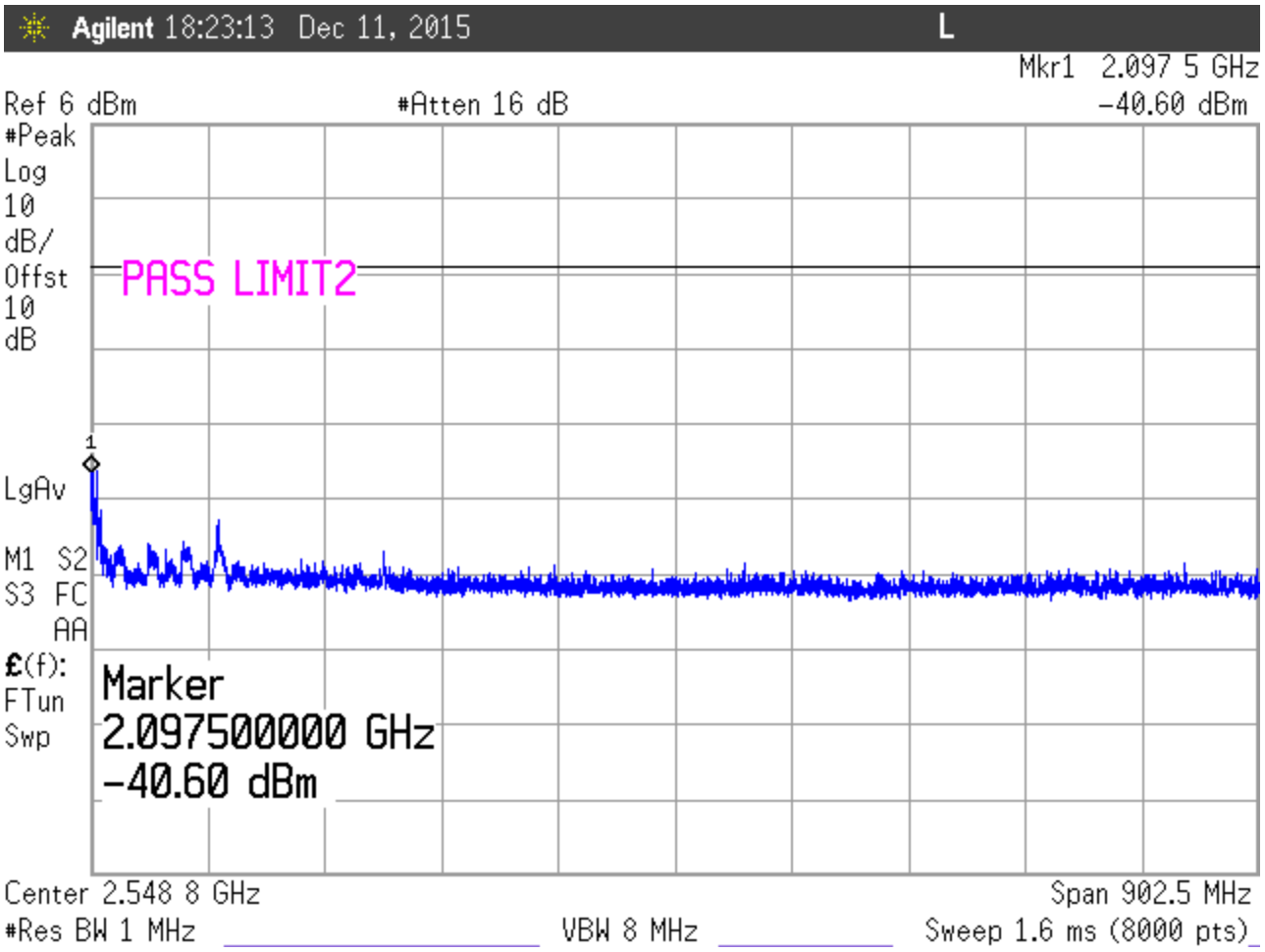


**Figure 39: Spurious Emissions, QPSK Modulation, TX @ 2067.5MHz, 2140MHz-10GHz**

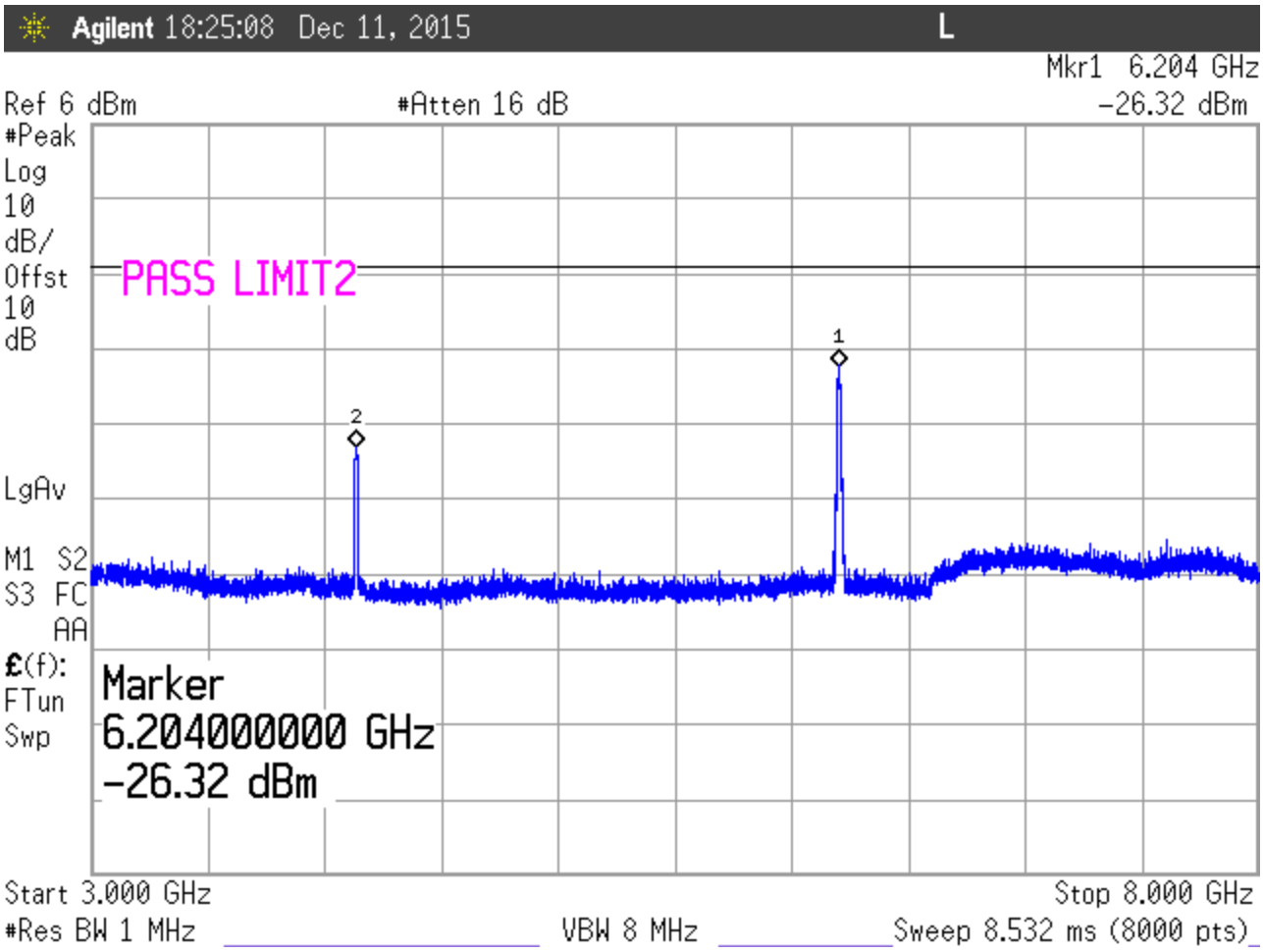


**Figure 40: Spurious Emissions, QPSK Modulation, TX @ 2067.5MHz, 3GHz-8GHz**

 

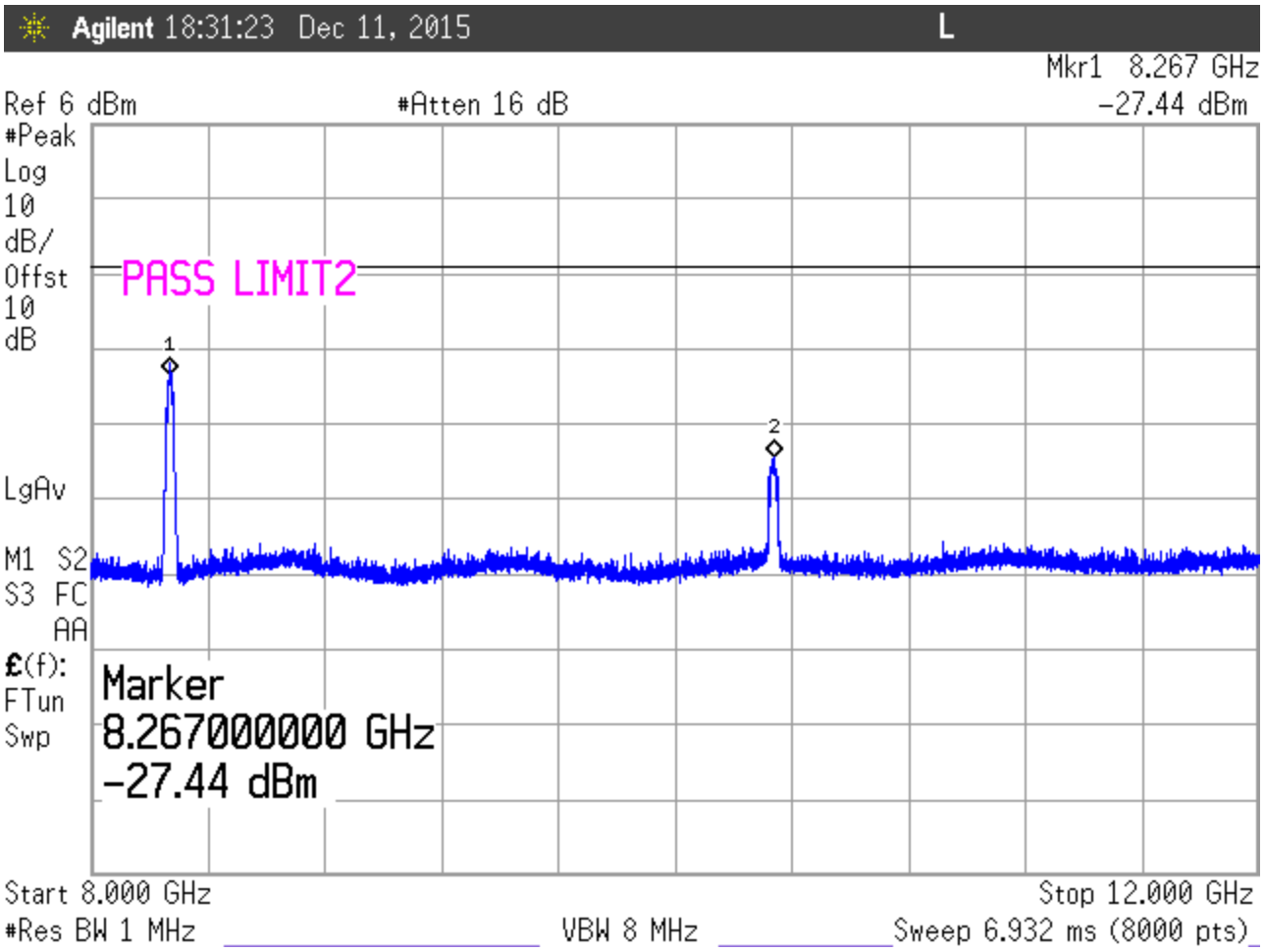


**Figure 41: Spurious Emissions, QPSK Modulation, TX @ 2067.5MHz, 8GHz-12GHz**

 

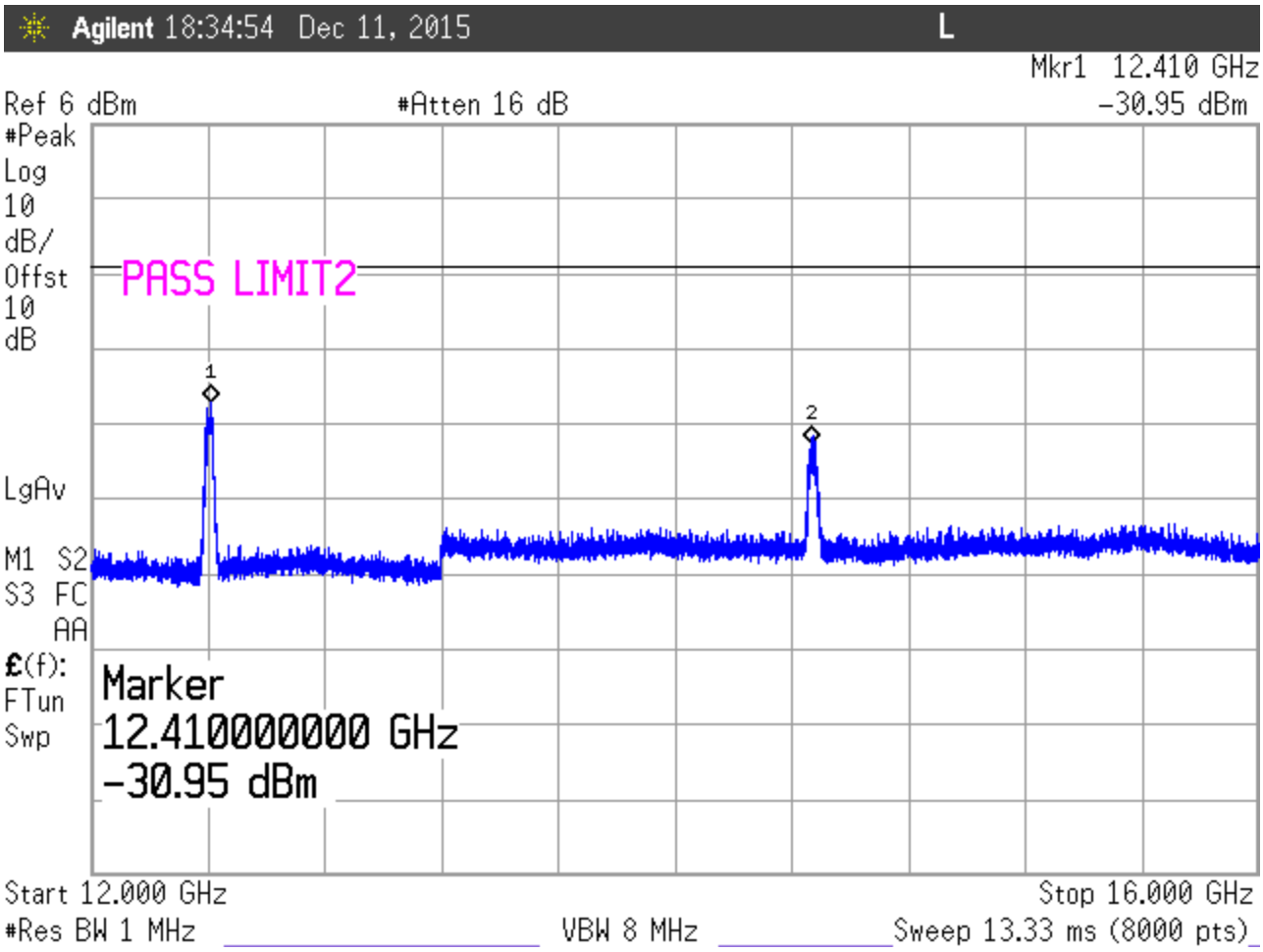


**Figure 42: Spurious Emissions, QPSK Modulation, TX @ 2067.5MHz, 12GHz-16GHz**

 

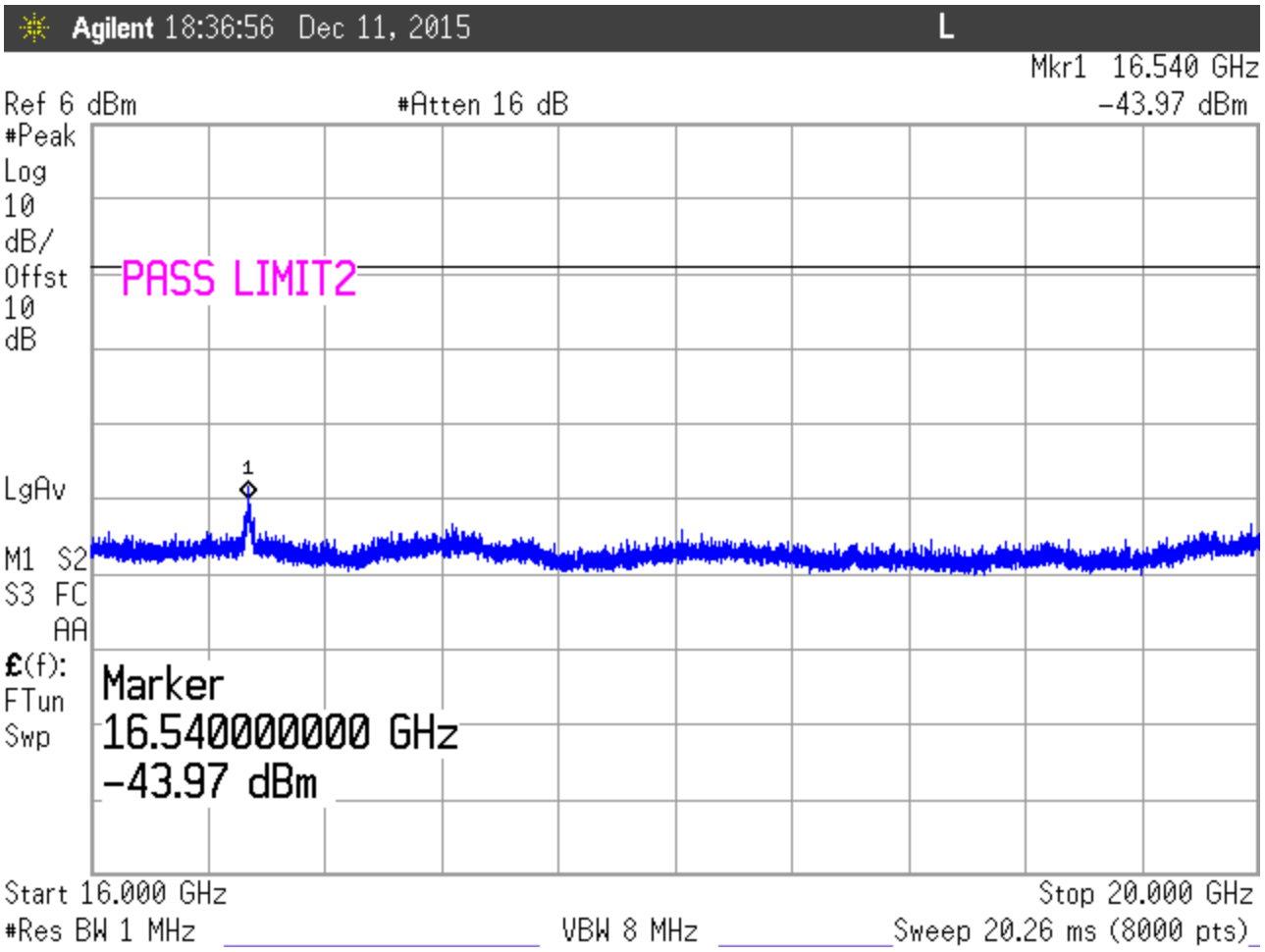


**Figure 43: Spurious Emissions, QPSK Modulation, TX @ 2067.5MHz, 16GHz-20GHz**

 

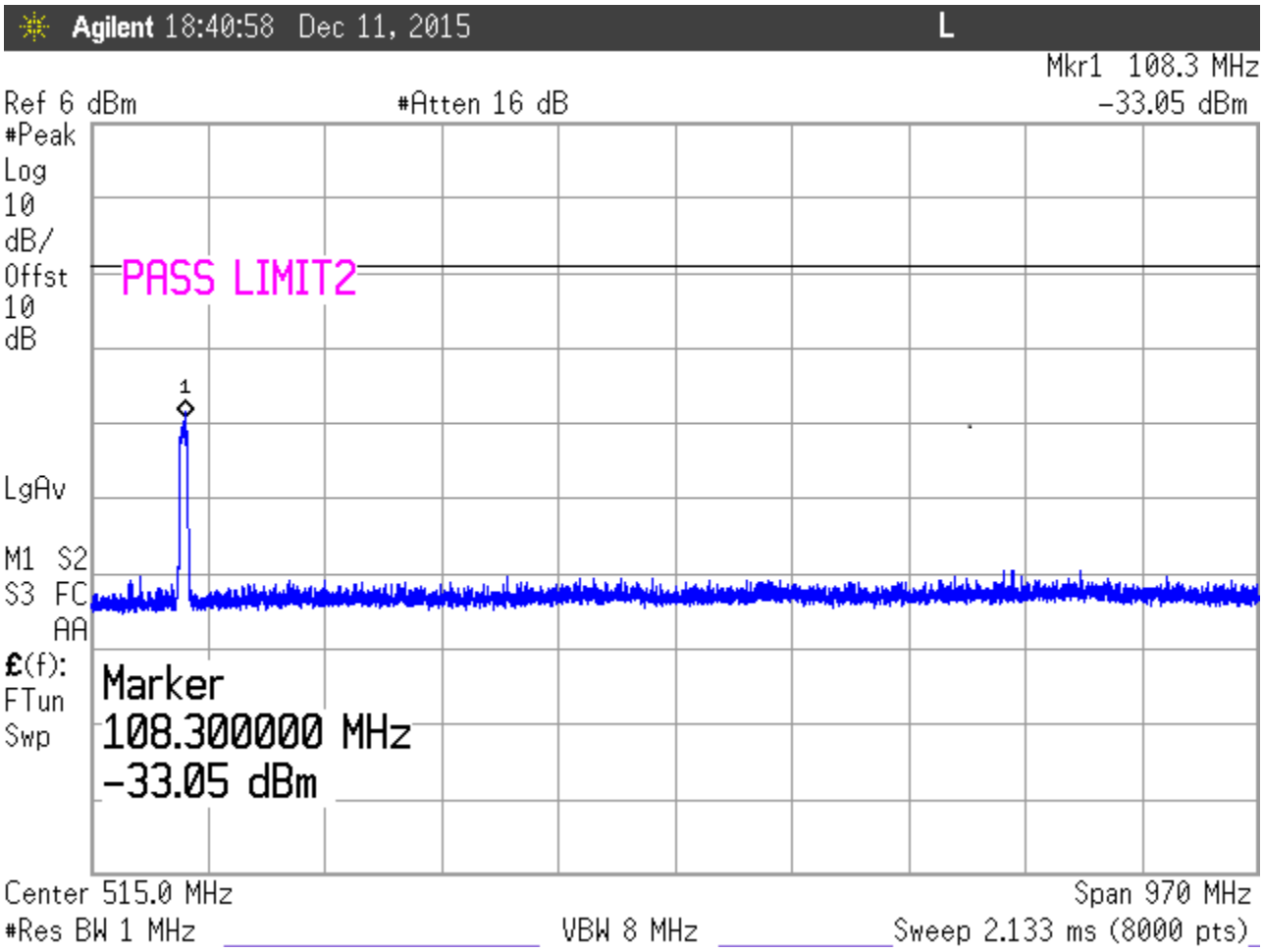


**Figure 44: Spurious Emissions, 16QAM Modulation, TX @ 2067.5MHz, 30MHz-1000MHz**

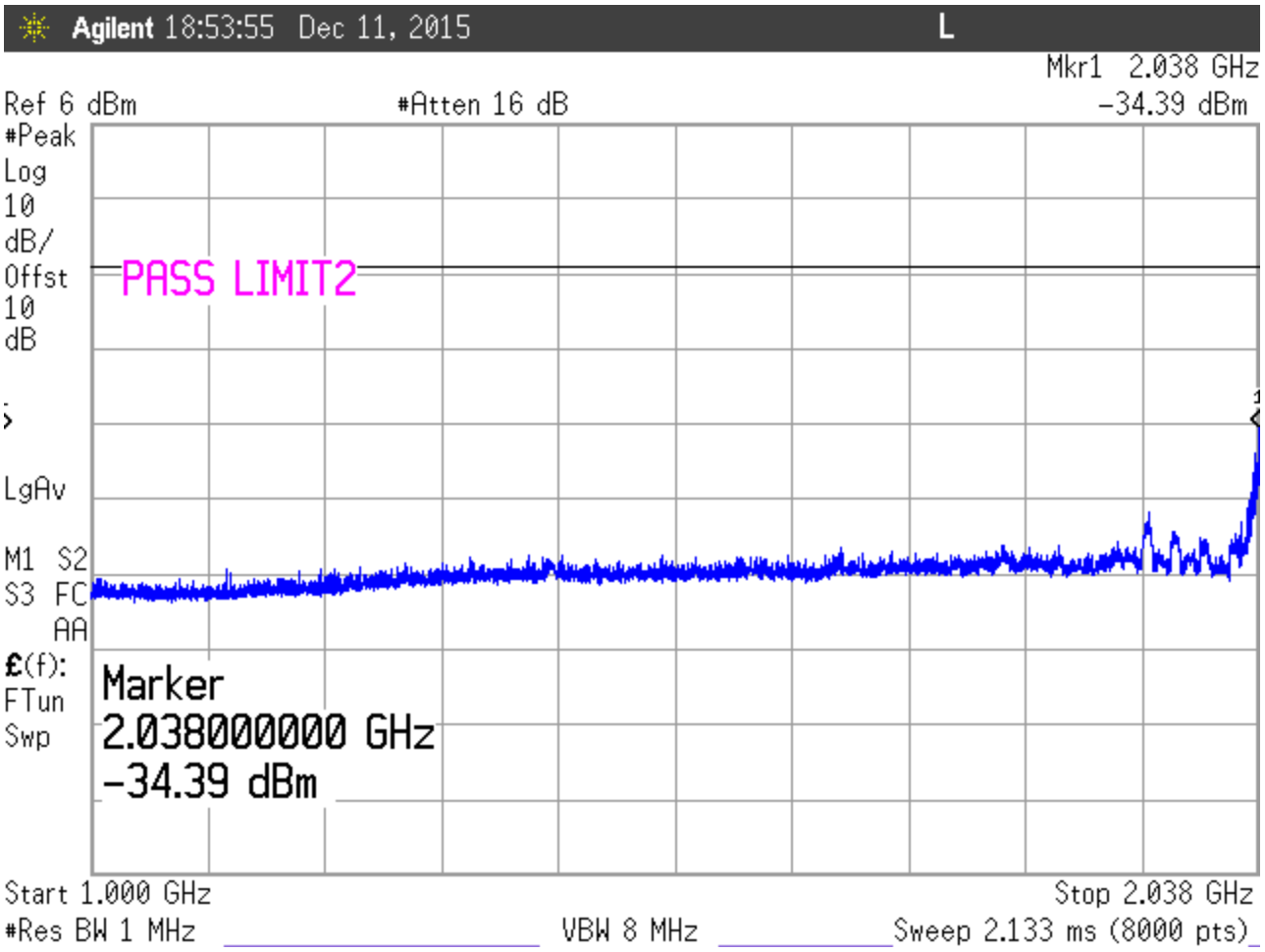


**Figure 45: Spurious Emissions, 16QAM Modulation, TX @ 2067.5MHz, 1000MHz-2038MHz**

 

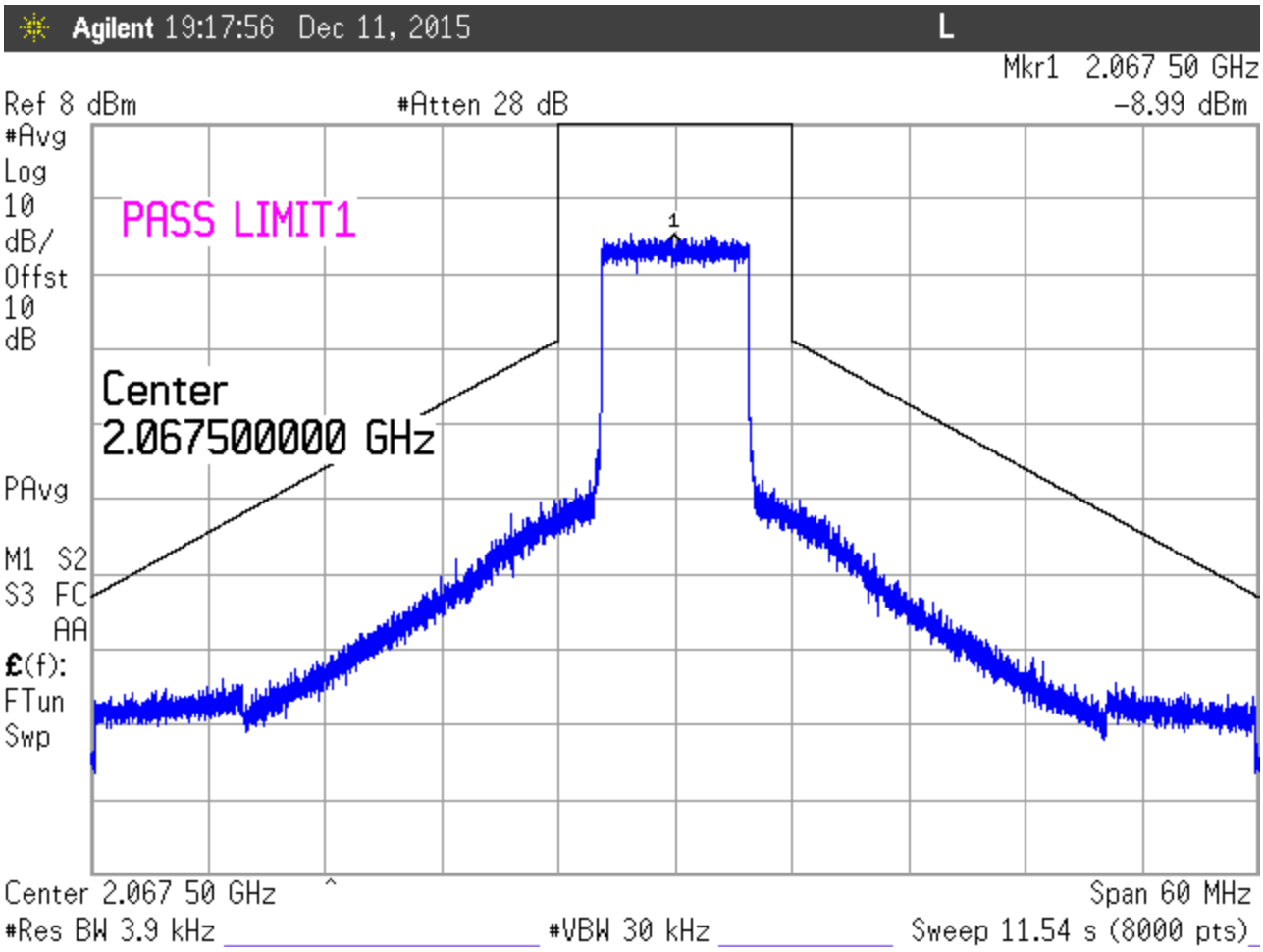


**Figure 46: Spurious Emissions, 16QAM Modulation, TX @ 2067.5MHz, Emission Mask**

 

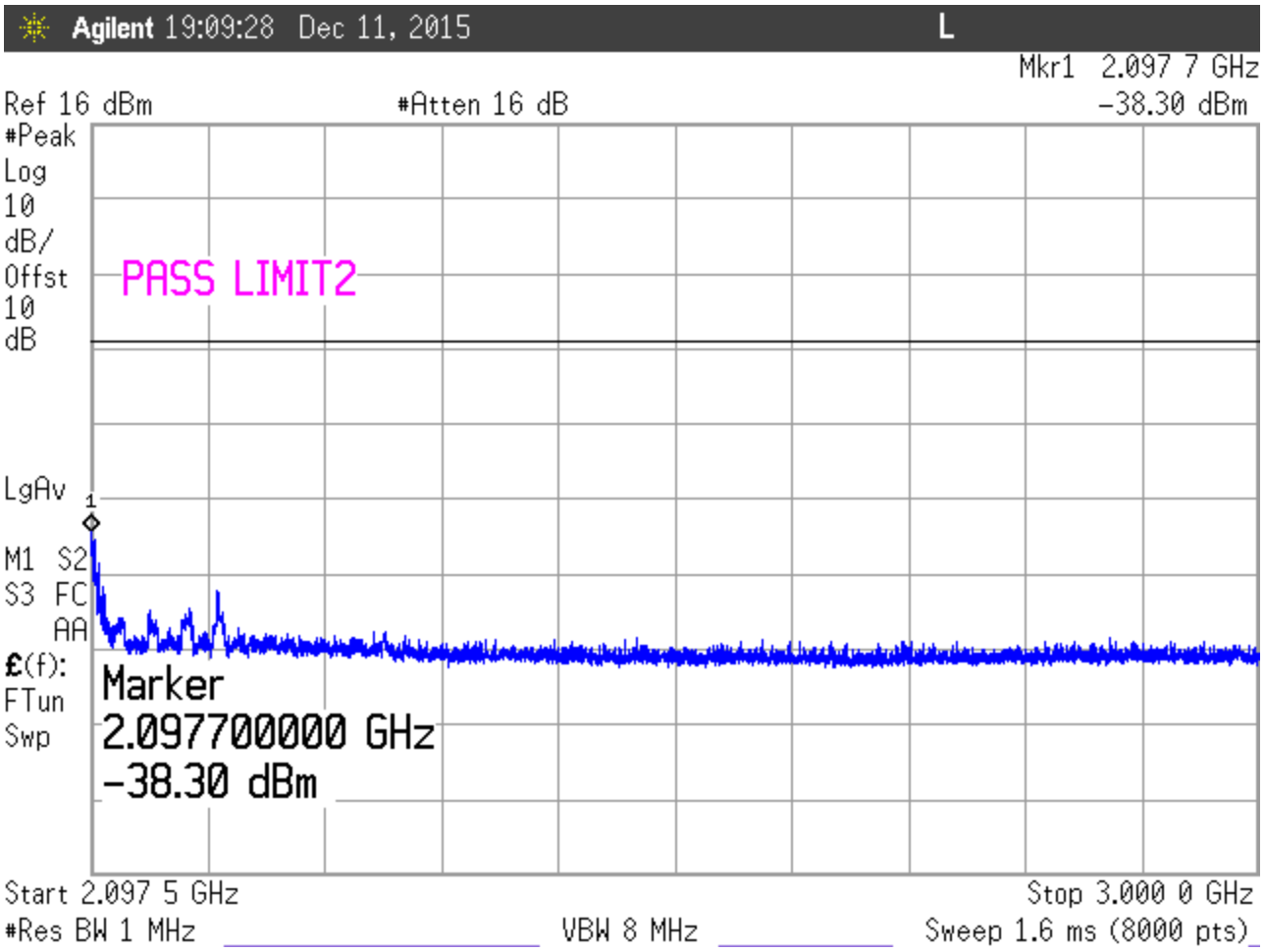


**Figure 47: Spurious Emissions, 16QAM Modulation, TX @ 2067.5MHz, 2097.5MHz-3GHz**

 

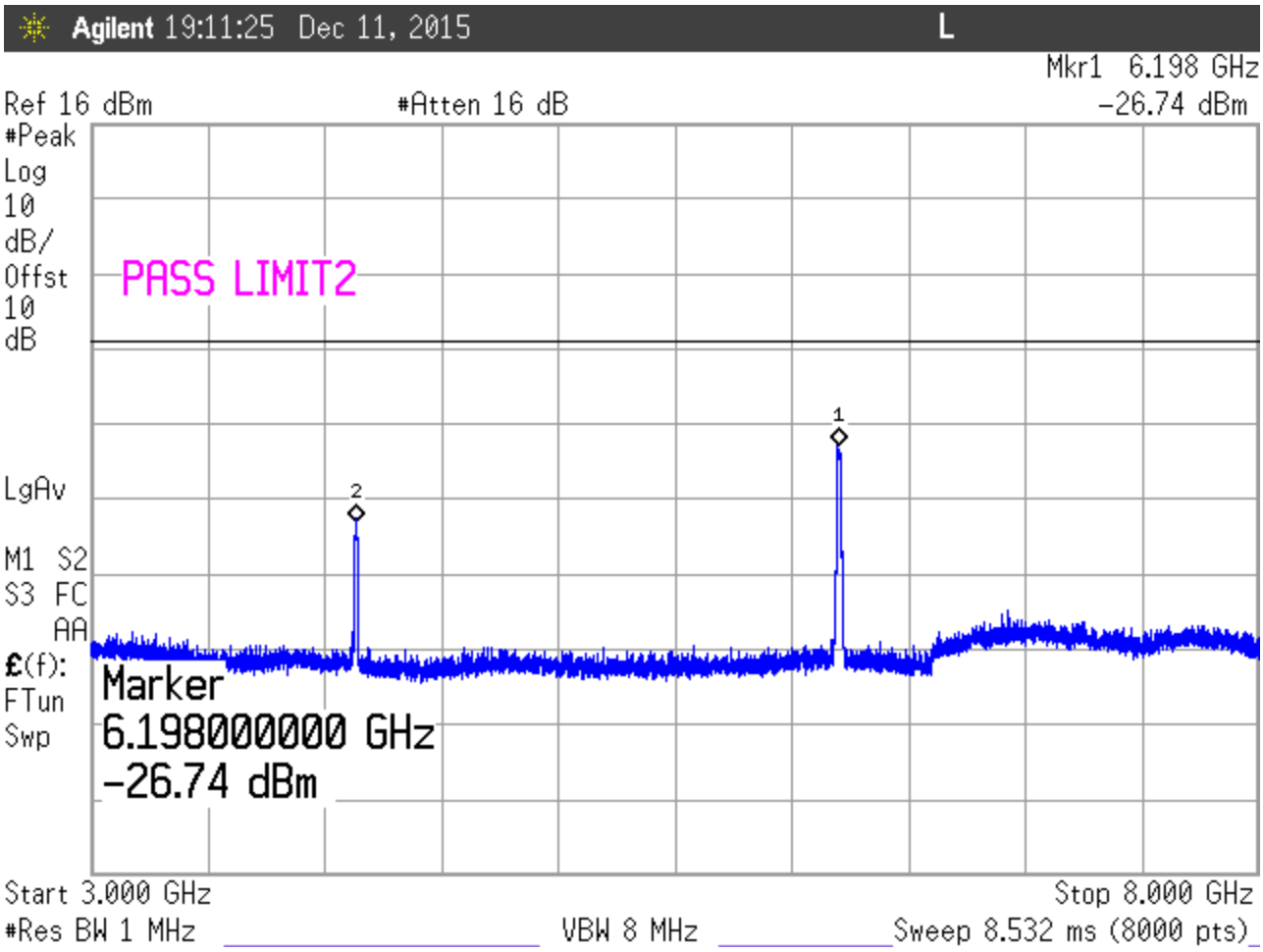


**Figure 48: Spurious Emissions, 16QAM Modulation, TX @ 2067.5MHz, 3GHz-8GHz**

 

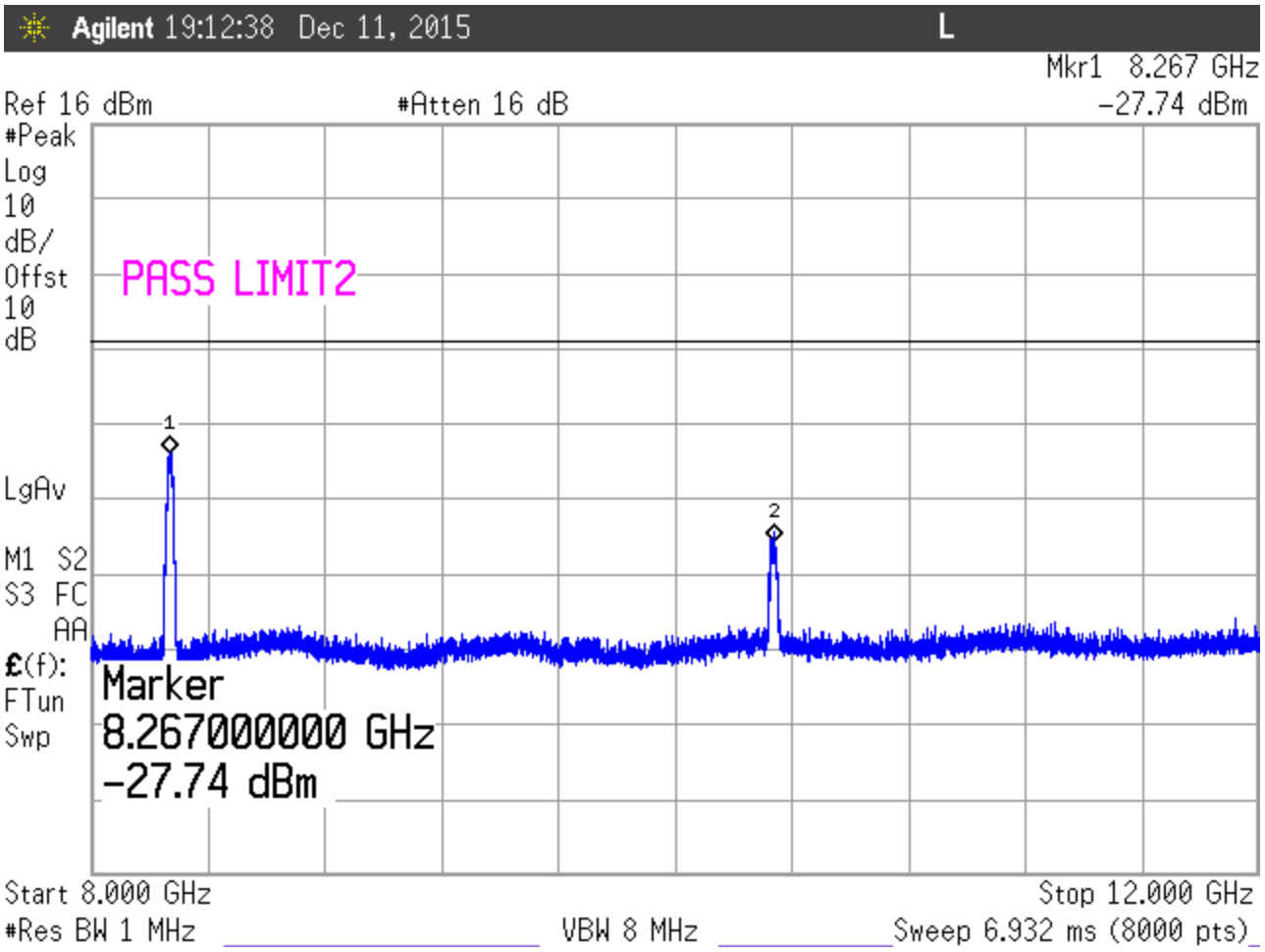


**Figure 49: Spurious Emissions, 16QAM Modulation, TX @ 2067.5MHz, 8GHz-12GHz**

 

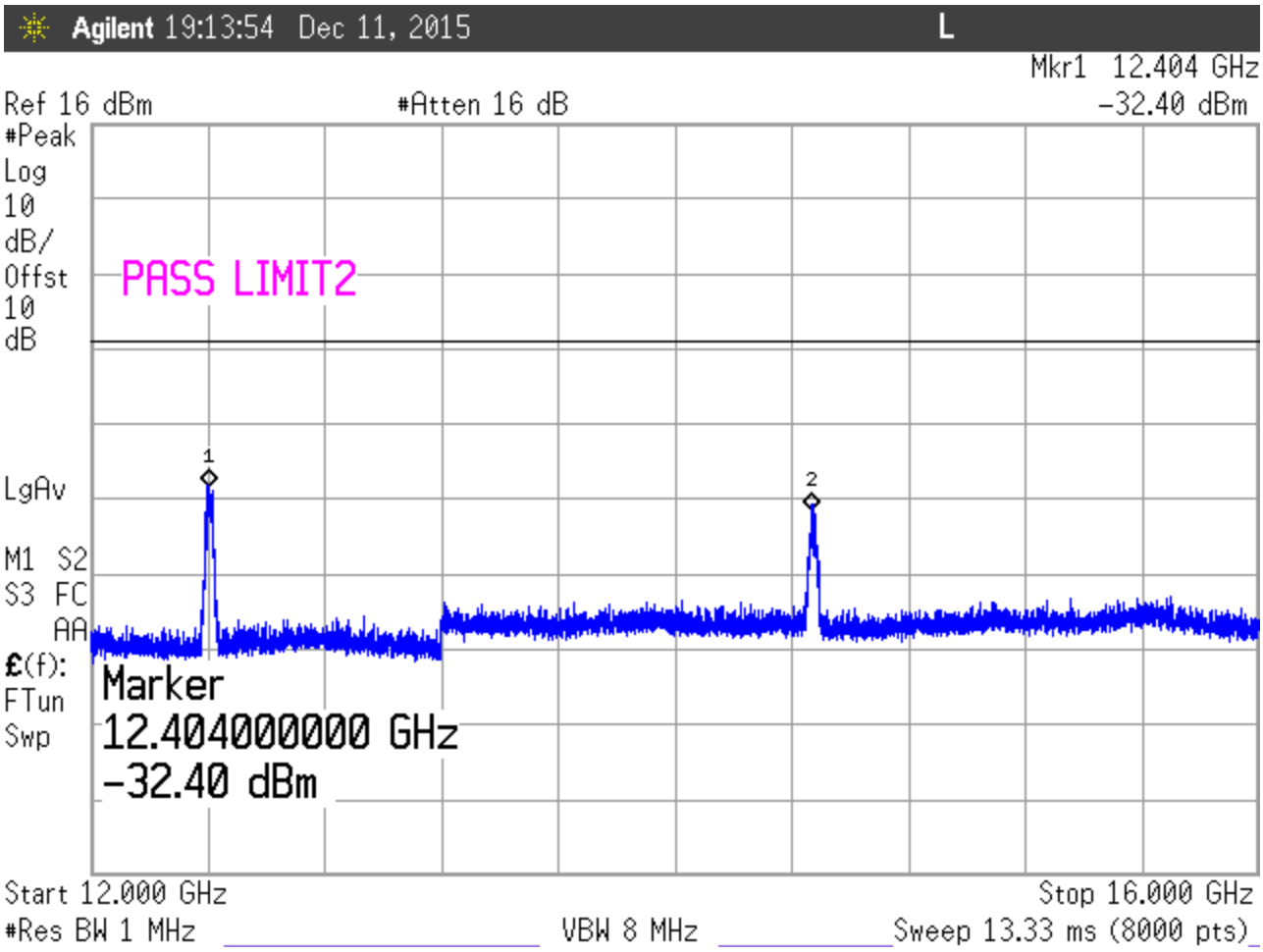


**Figure 50: Spurious Emissions, 16QAM Modulation, TX @ 2067.5MHz, 12GHz-16GHz**

 

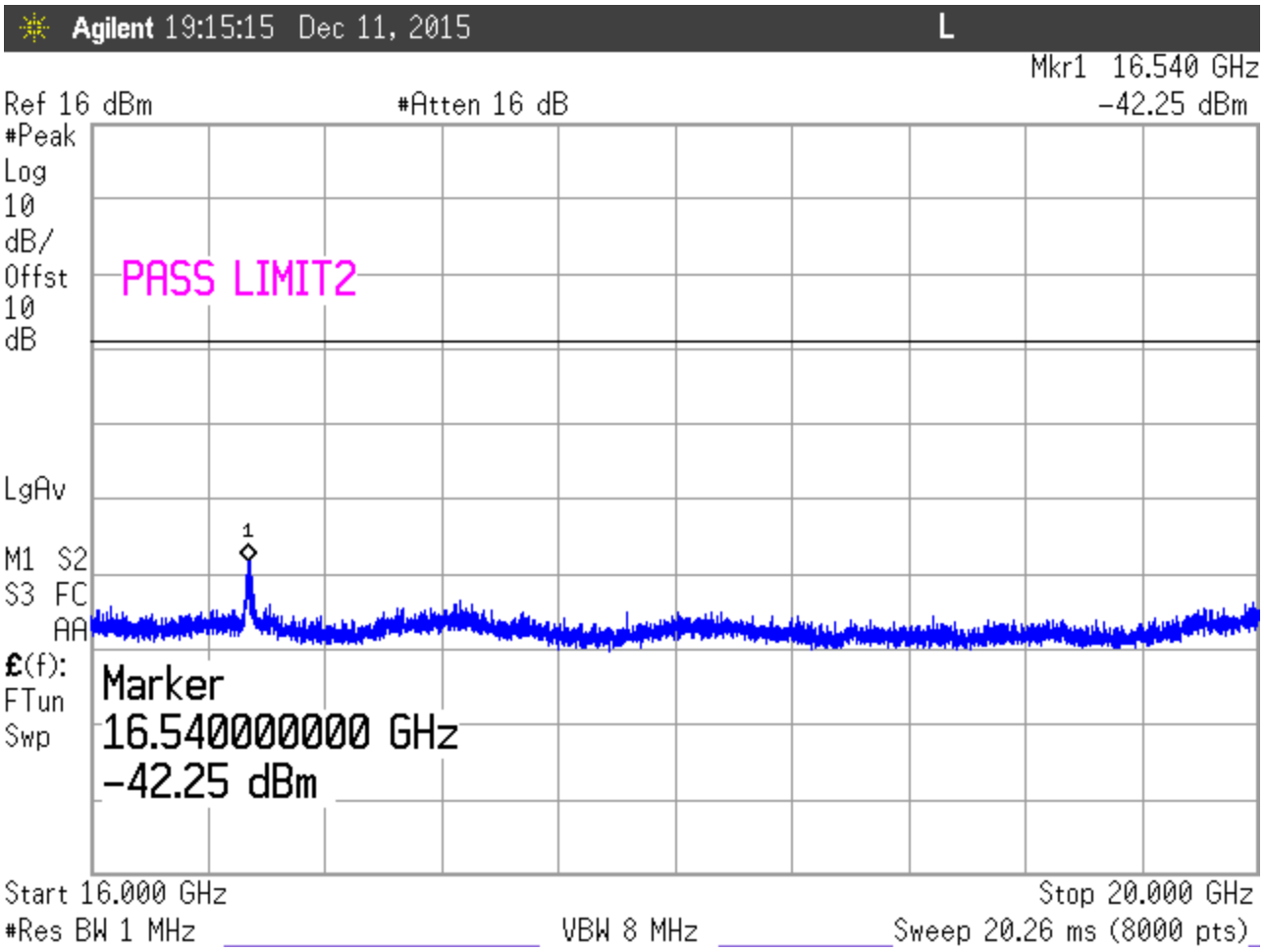


**Figure 51: Spurious Emissions, 16QAM Modulation, TX @ 2067.5MHz, 16GHz-20GHz**

 

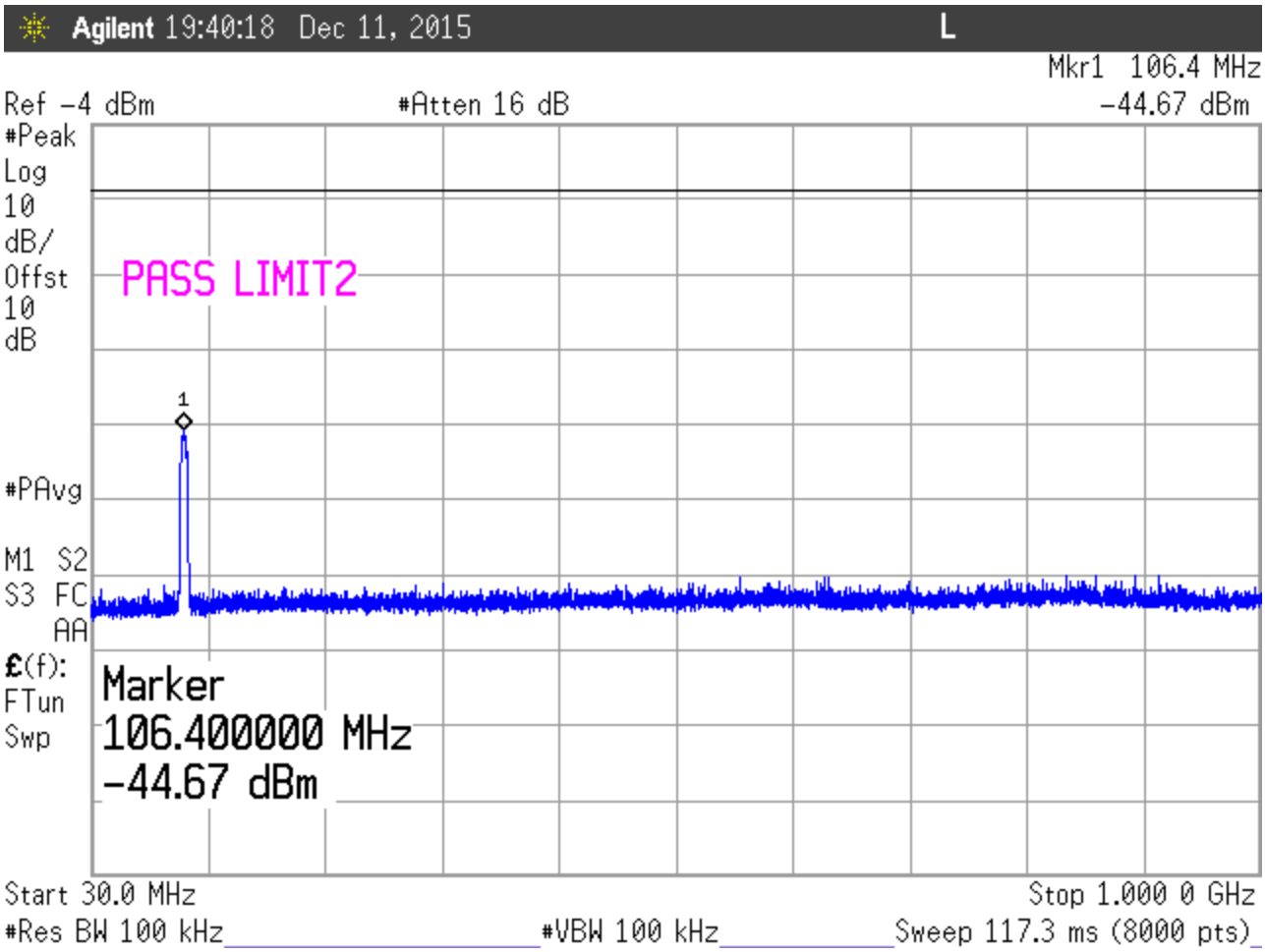


**Figure 52: Spurious Emissions, 64QAM Modulation, TX @ 2067.5MHz, 30MHz-1000MHz**

 

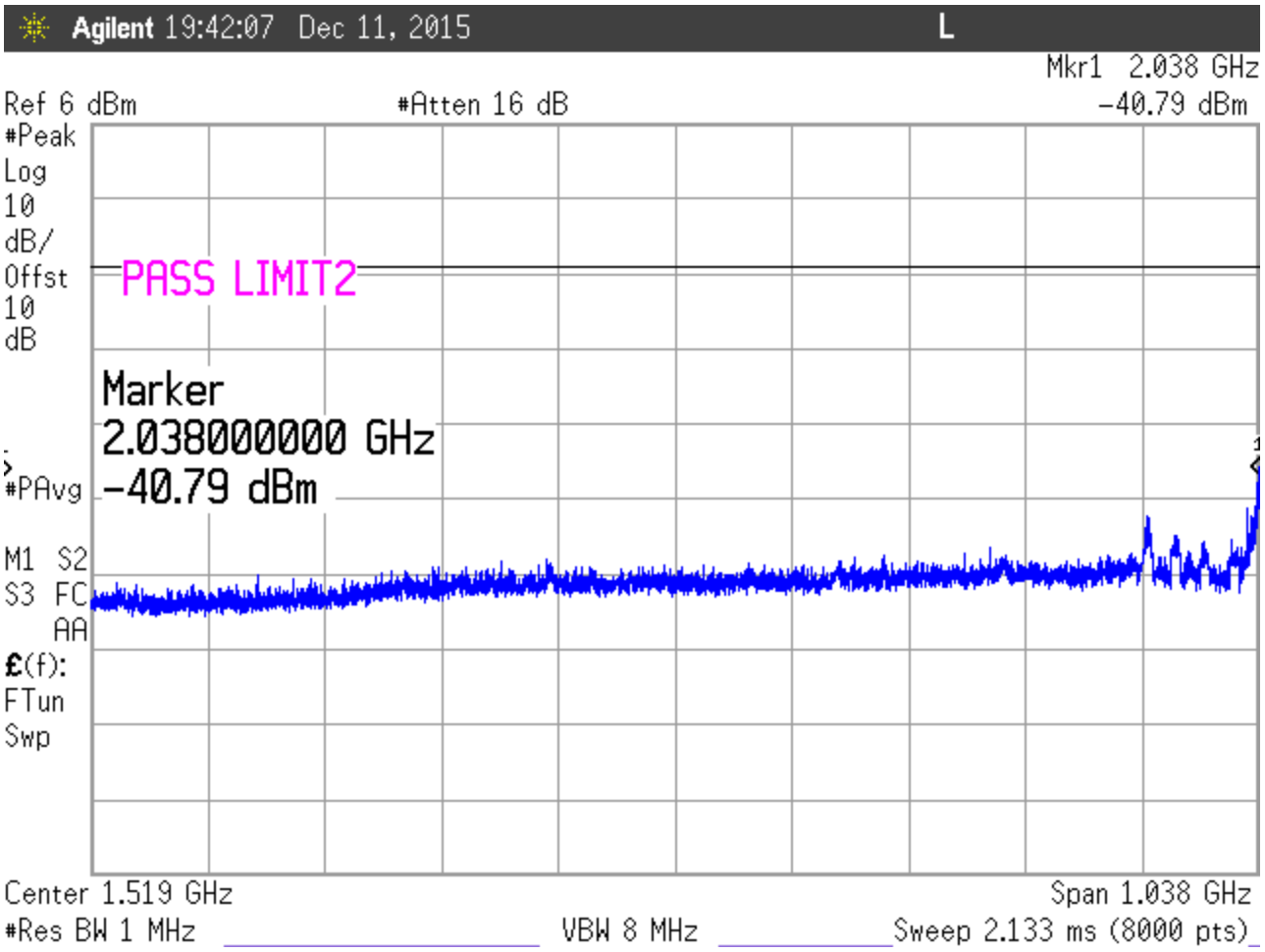


**Figure 53: Spurious Emissions, 64QAM Modulation, TX @ 2067.5MHz, 1000MHz-2038MHz**

 

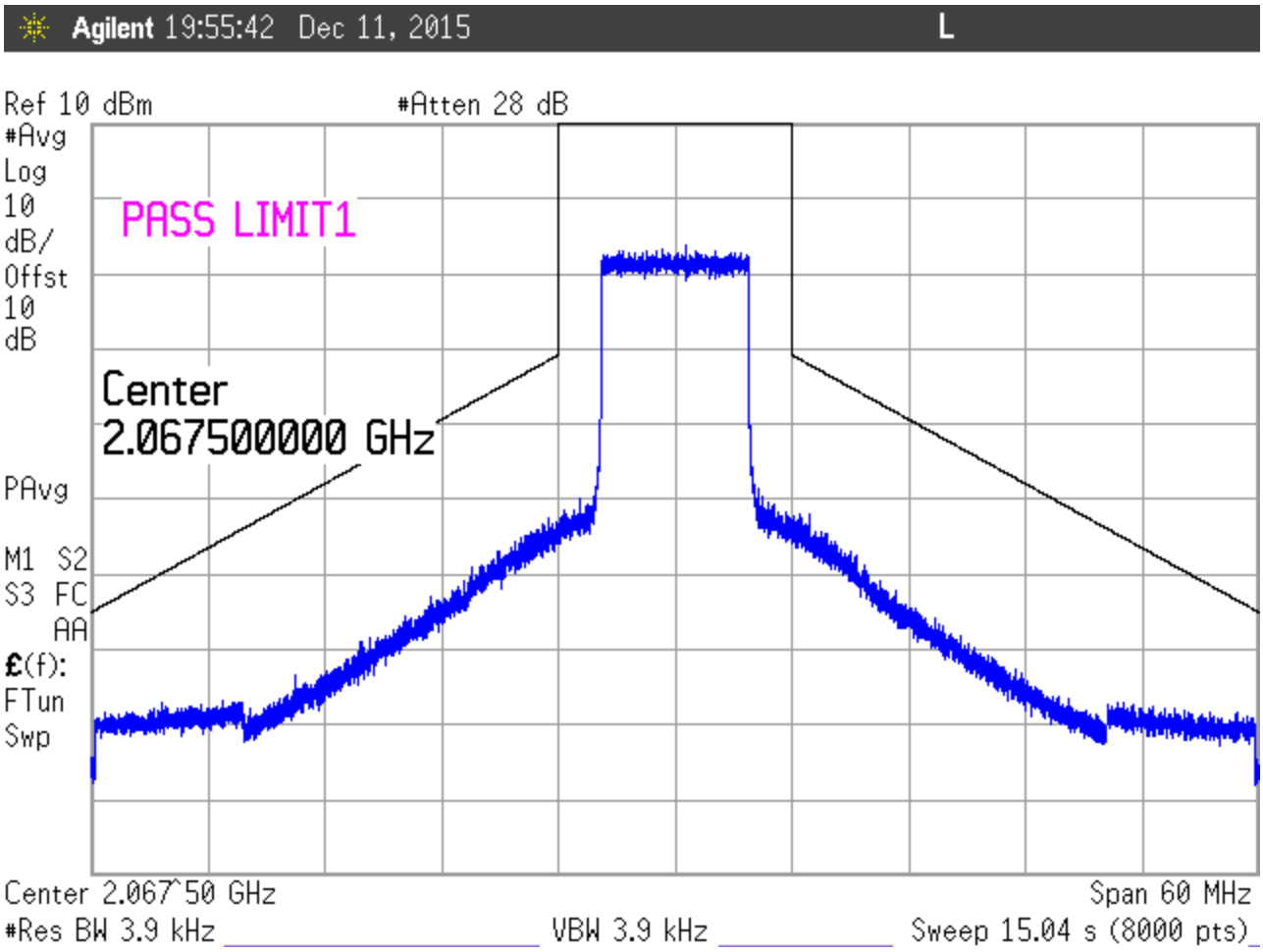


**Figure 54: Spurious Emissions, 64QAM Modulation, TX @ 2067.5MHz, Emission Mask**

 

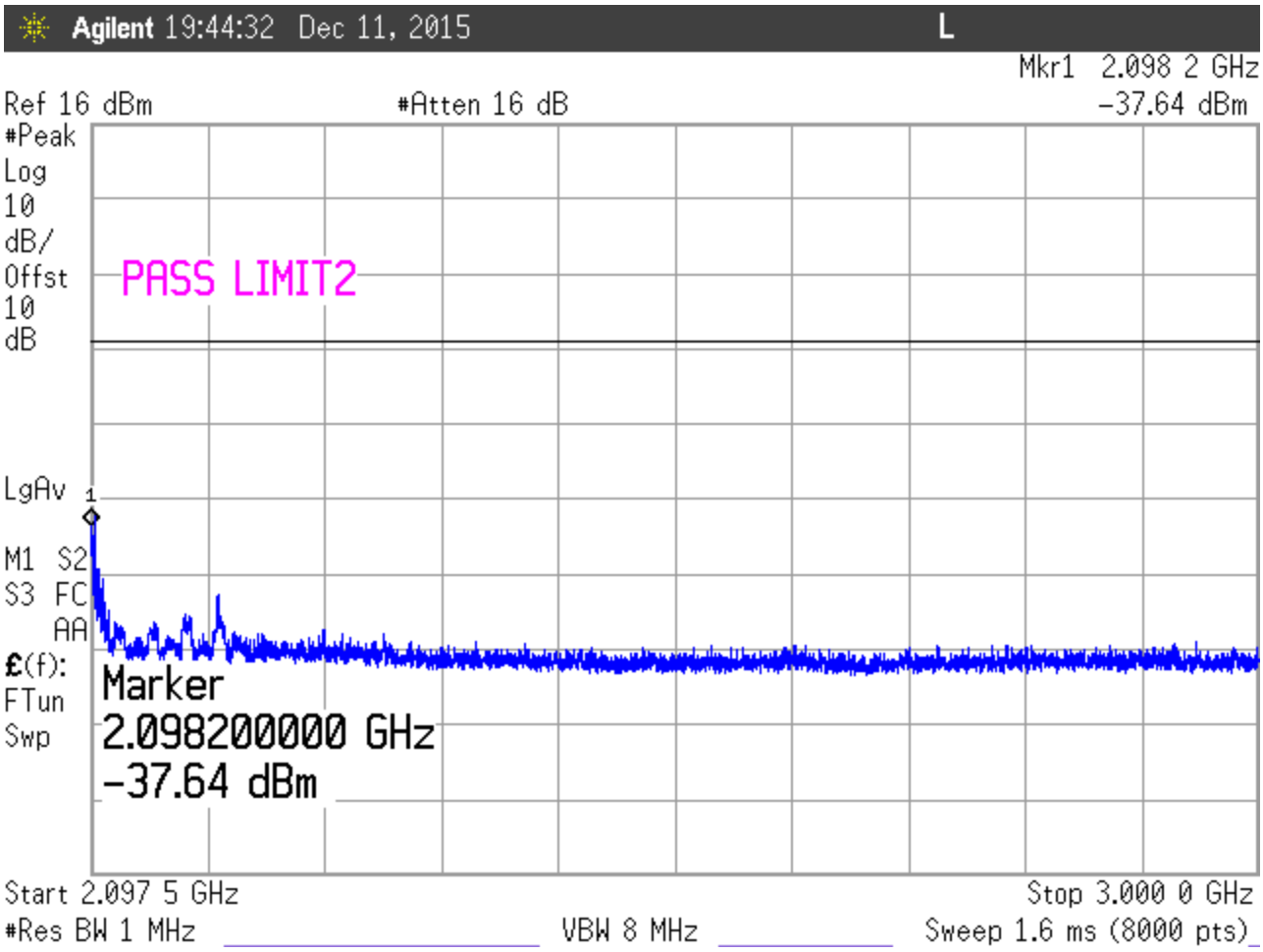


**Figure 55: Spurious Emissions, 64QAM Modulation, TX @ 2067.5MHz, 2097.5MHz-3GHz**

 

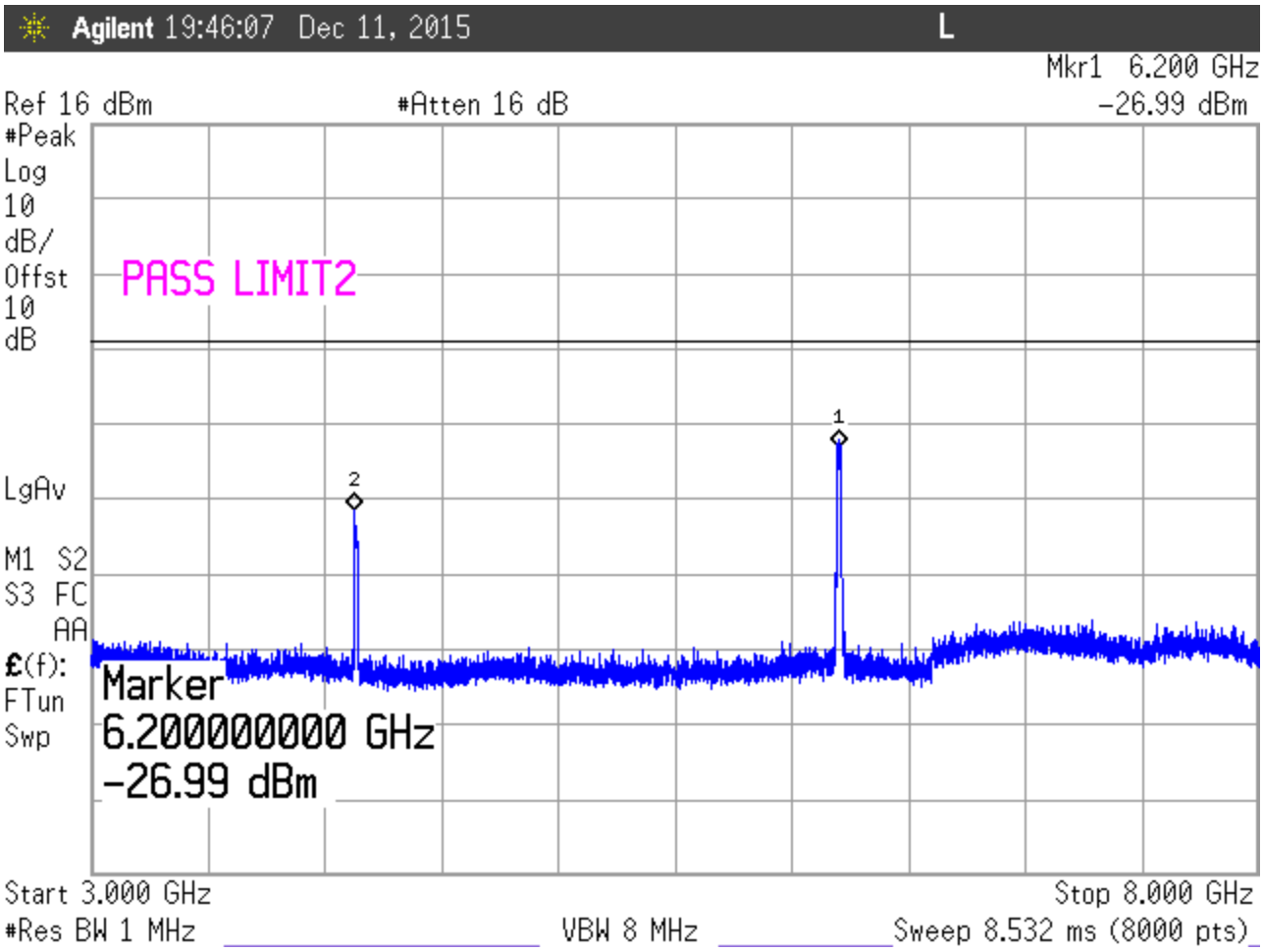


**Figure 56: Spurious Emissions, 64QAM Modulation, TX @ 2067.5MHz, 3GHz-8GHz**

 

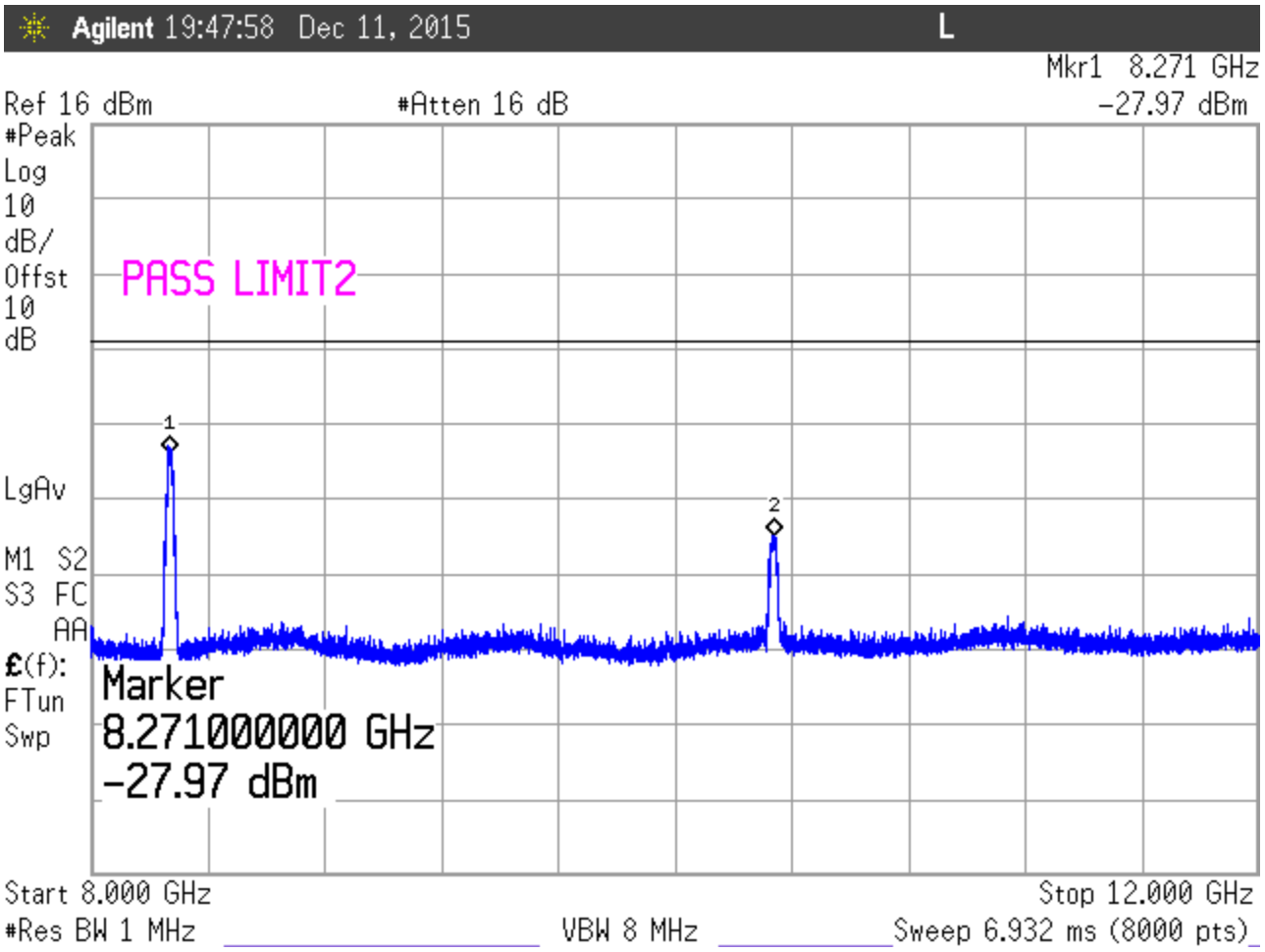


**Figure 57: Spurious Emissions, 64QAM Modulation, TX @ 2067.5MHz, 8GHz-12GHz**

 

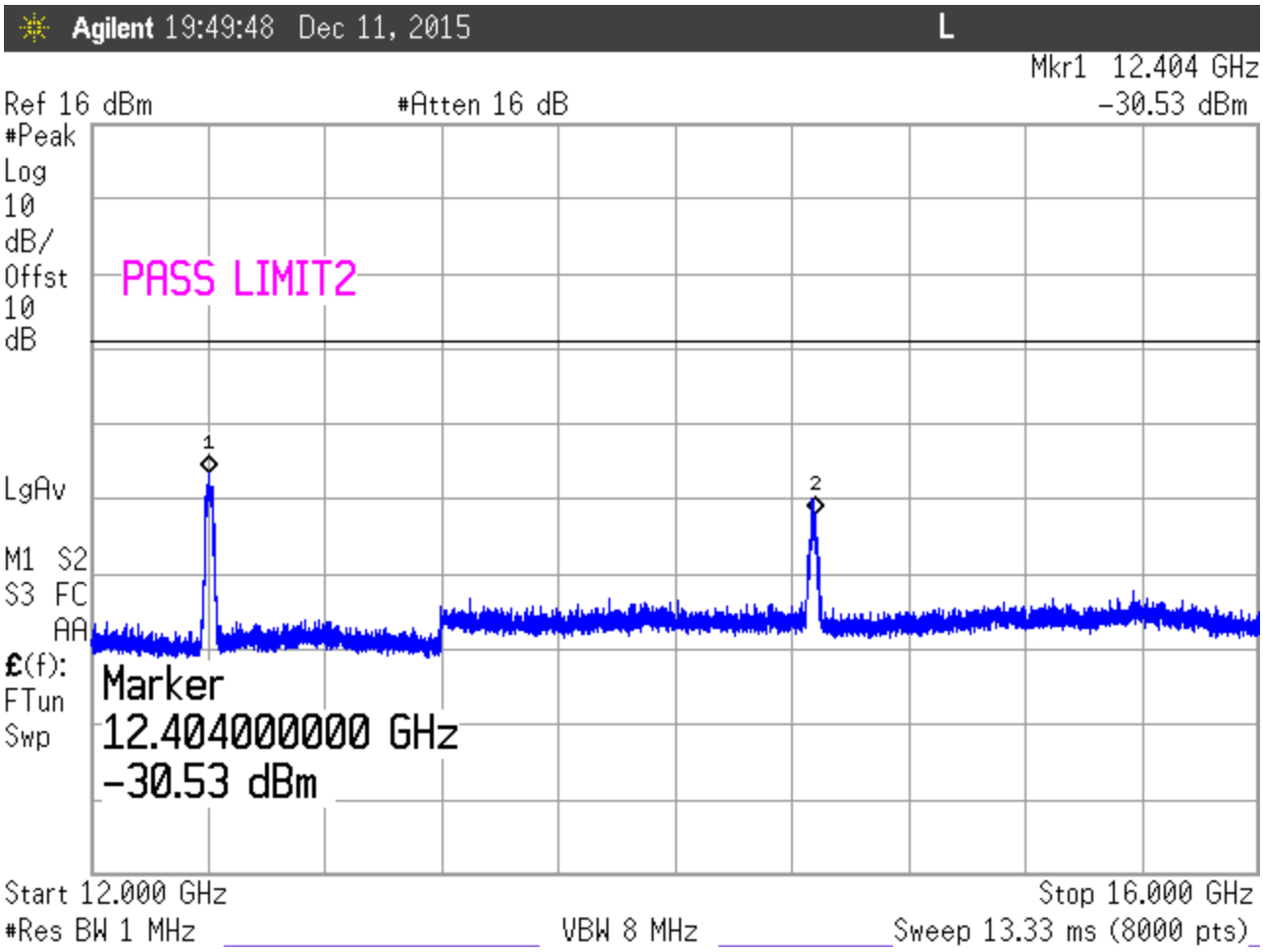


**Figure 58: Spurious Emissions, 64QAM Modulation, TX @ 2067.5MHz, 12GHz-16GHz**

 

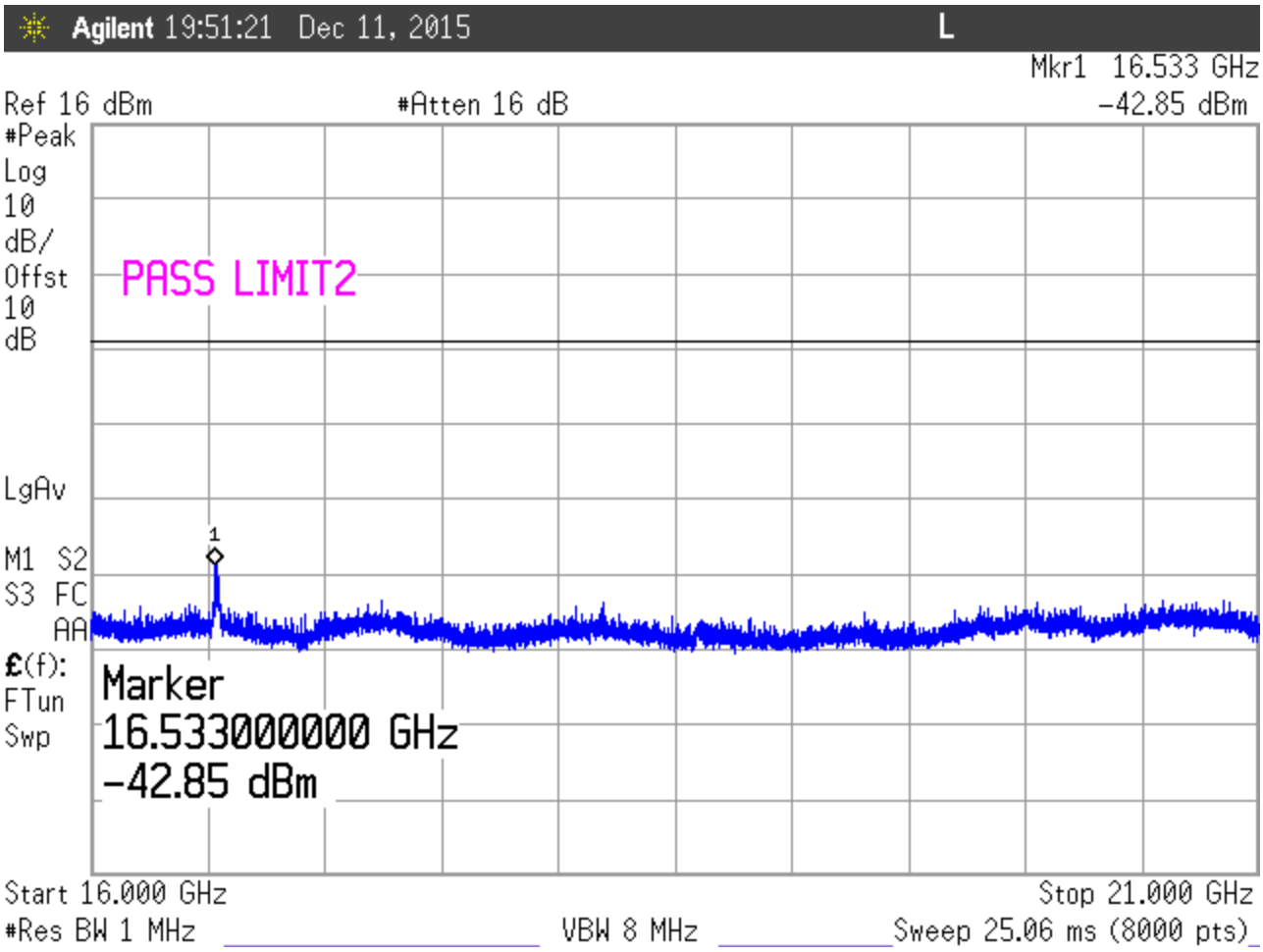


**Figure 59: Spurious Emissions, 64QAM Modulation, TX @ 2067.5MHz, 16GHz-21GHz**

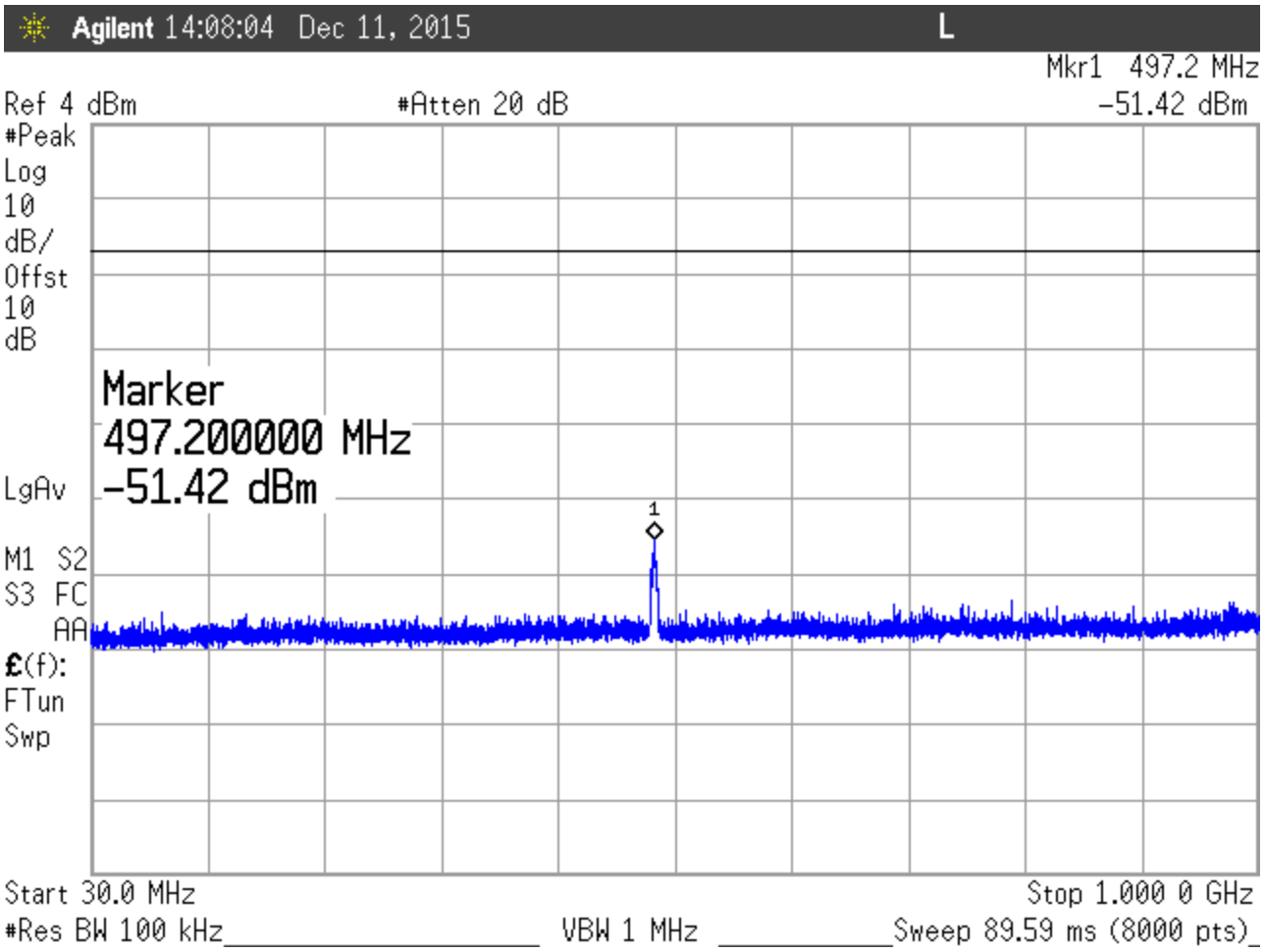


**Figure 60: Spurious Emissions, QPSK Modulation, TX @ 2458.5MHz, 30MHz-1000MHz**

 

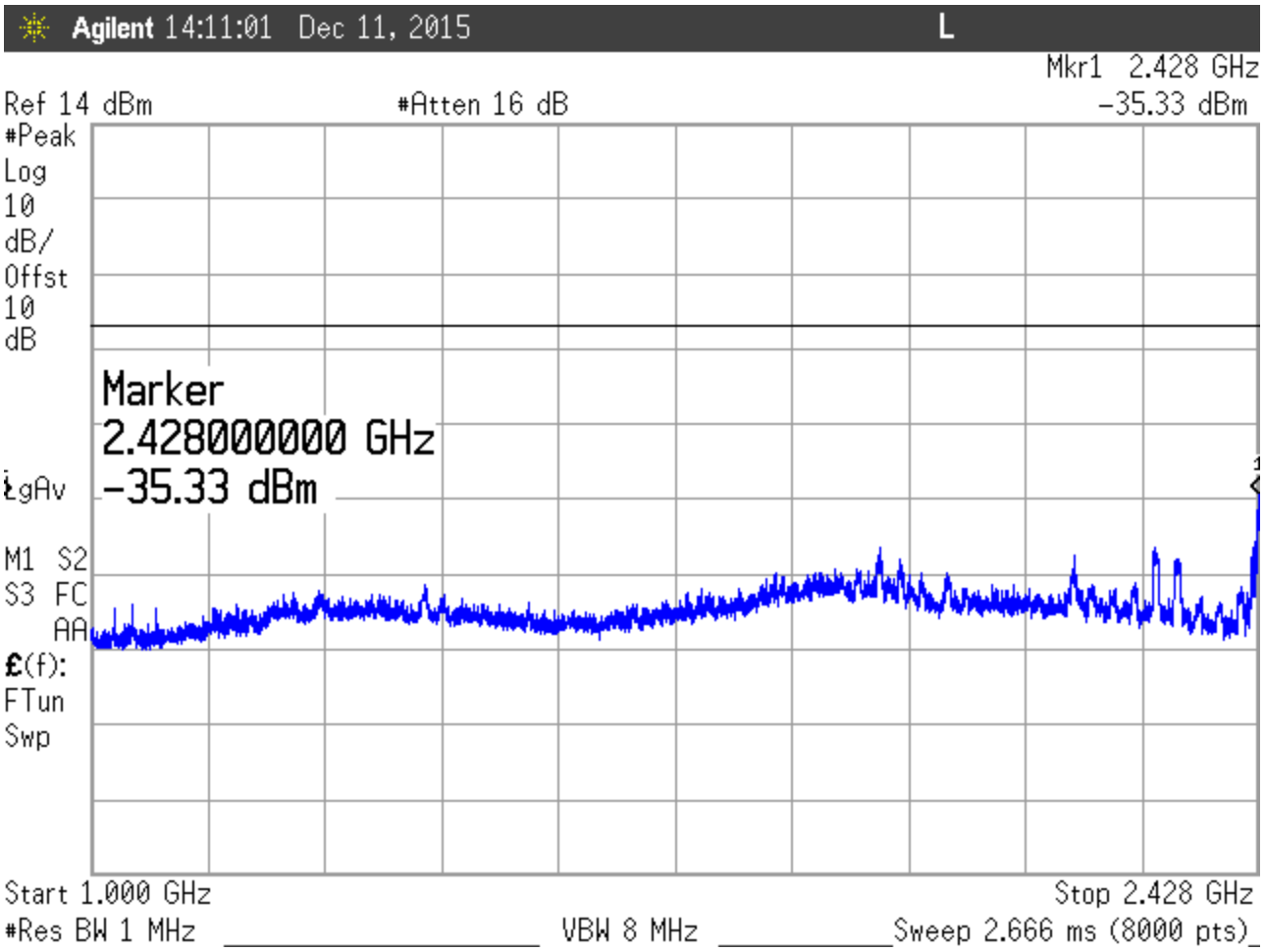


**Figure 61: Spurious Emissions, QPSK Modulation, TX @ 2458.5MHz, 1000MHz-2428MHz**

 

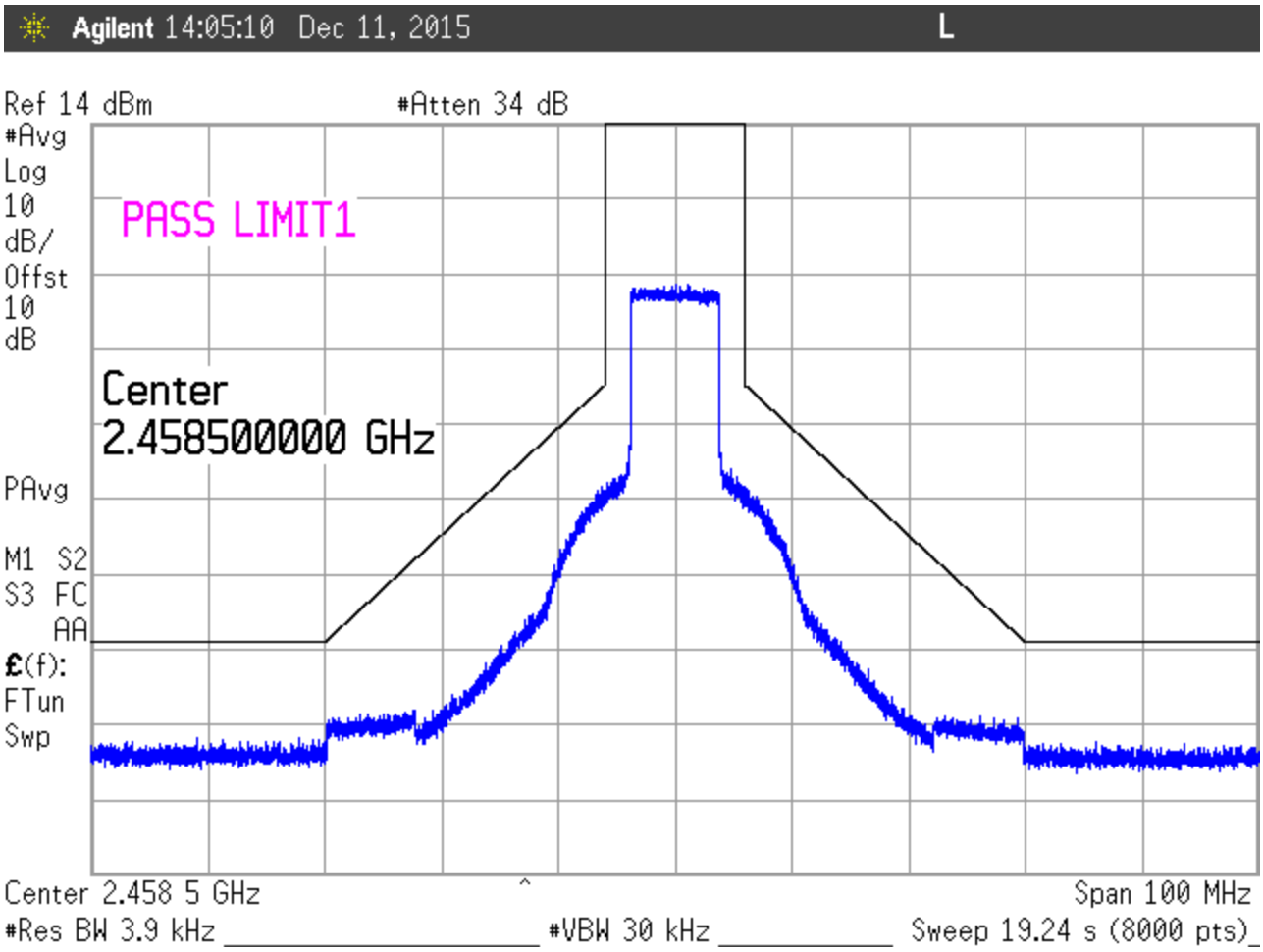


**Figure 62: Spurious Emissions, QPSK Modulation, TX @ 2458.5MHz, Emission Mask**

 

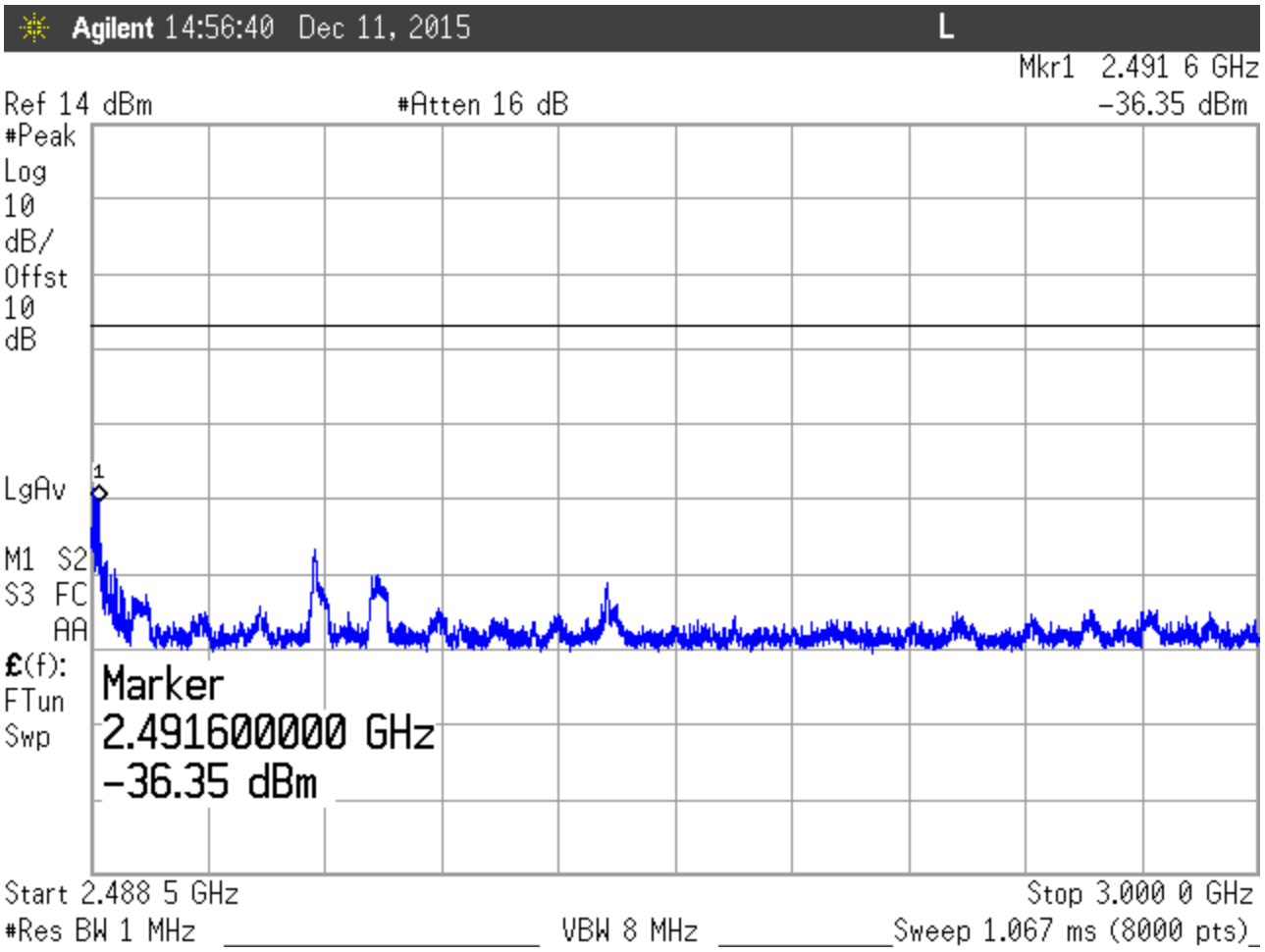


**Figure 63: Spurious Emissions, QPSK Modulation, TX @ 2458.5MHz, 2488.5MHz-3GHz**

 

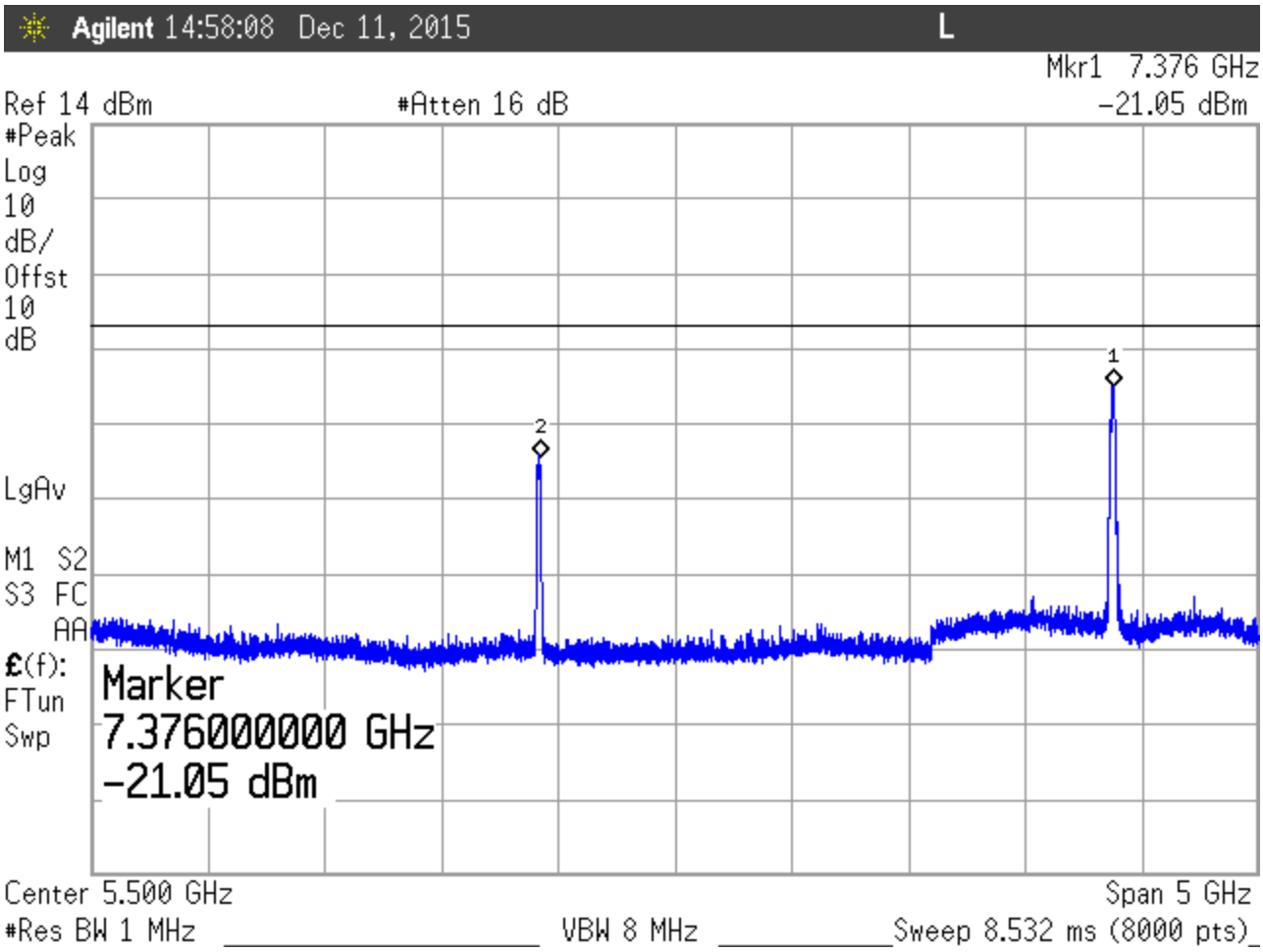


**Figure 64: Spurious Emissions, QPSK Modulation, TX @ 2458.5MHz, 3GHz-8GHz**

 

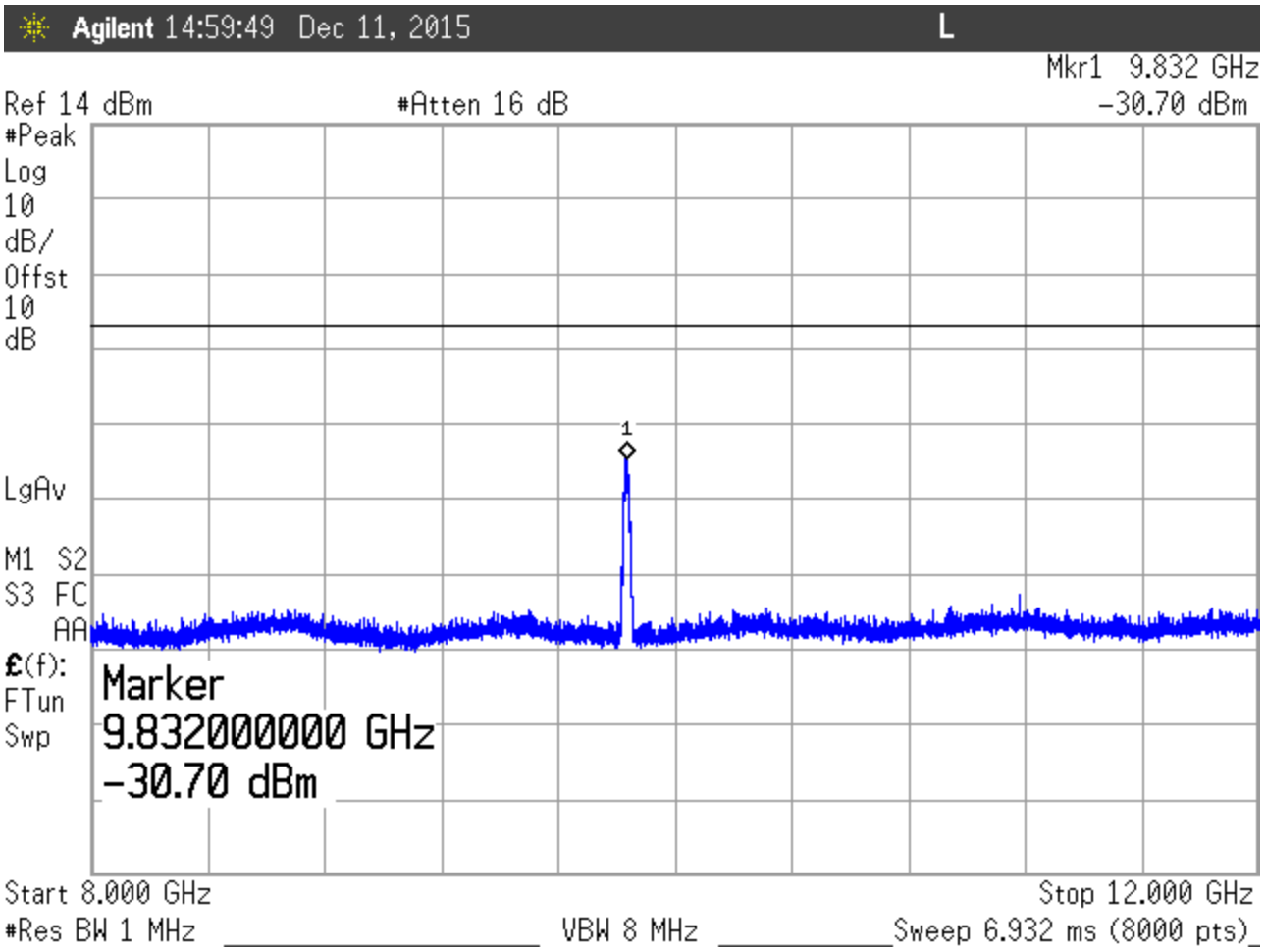


**Figure 65: Spurious Emissions, QPSK Modulation, TX @ 2458.5MHz, 8GHz-12GHz**

 

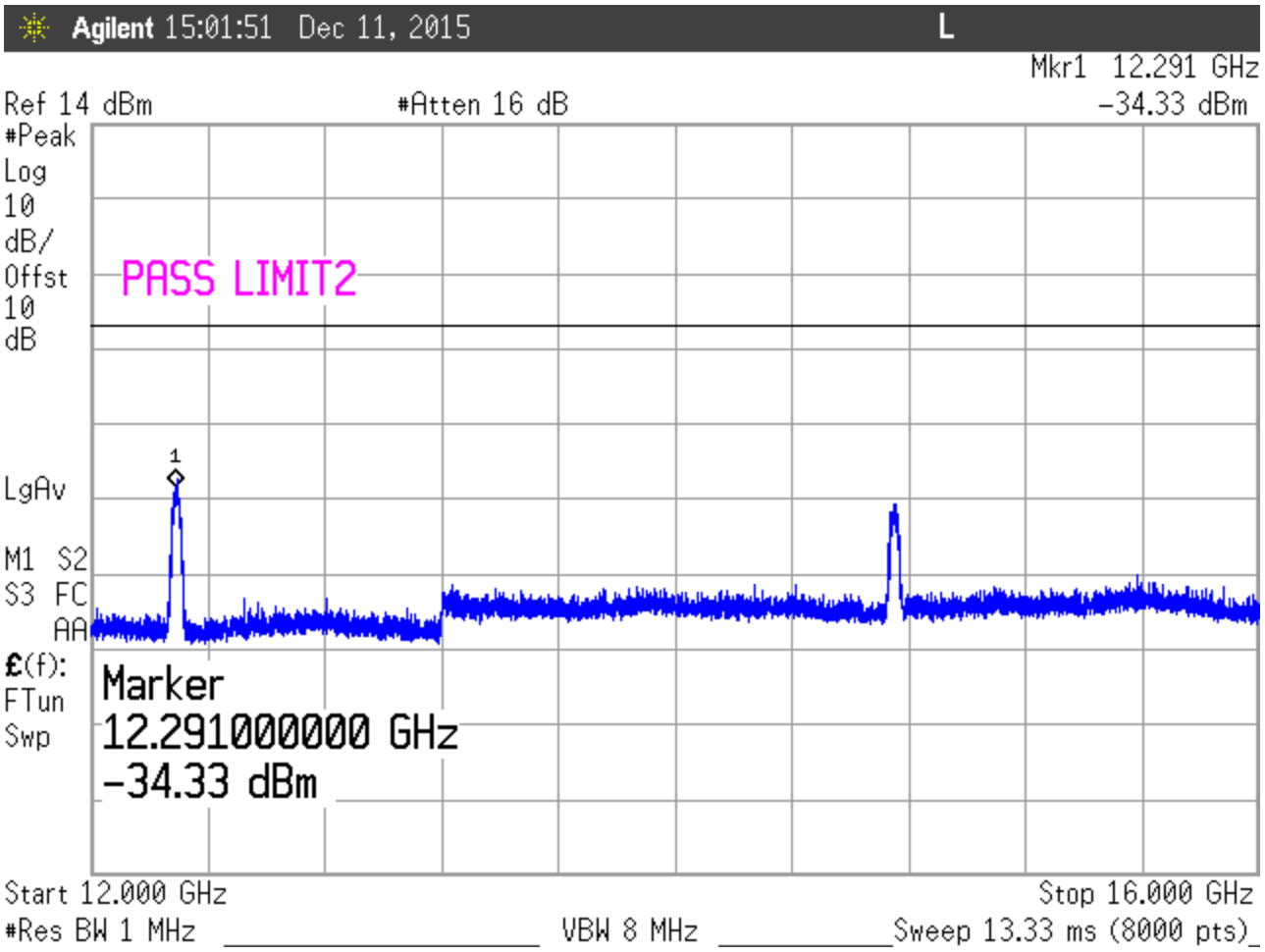


**Figure 66: Spurious Emissions, QPSK Modulation, TX @ 2458.5MHz, 12GHz-16GHz**

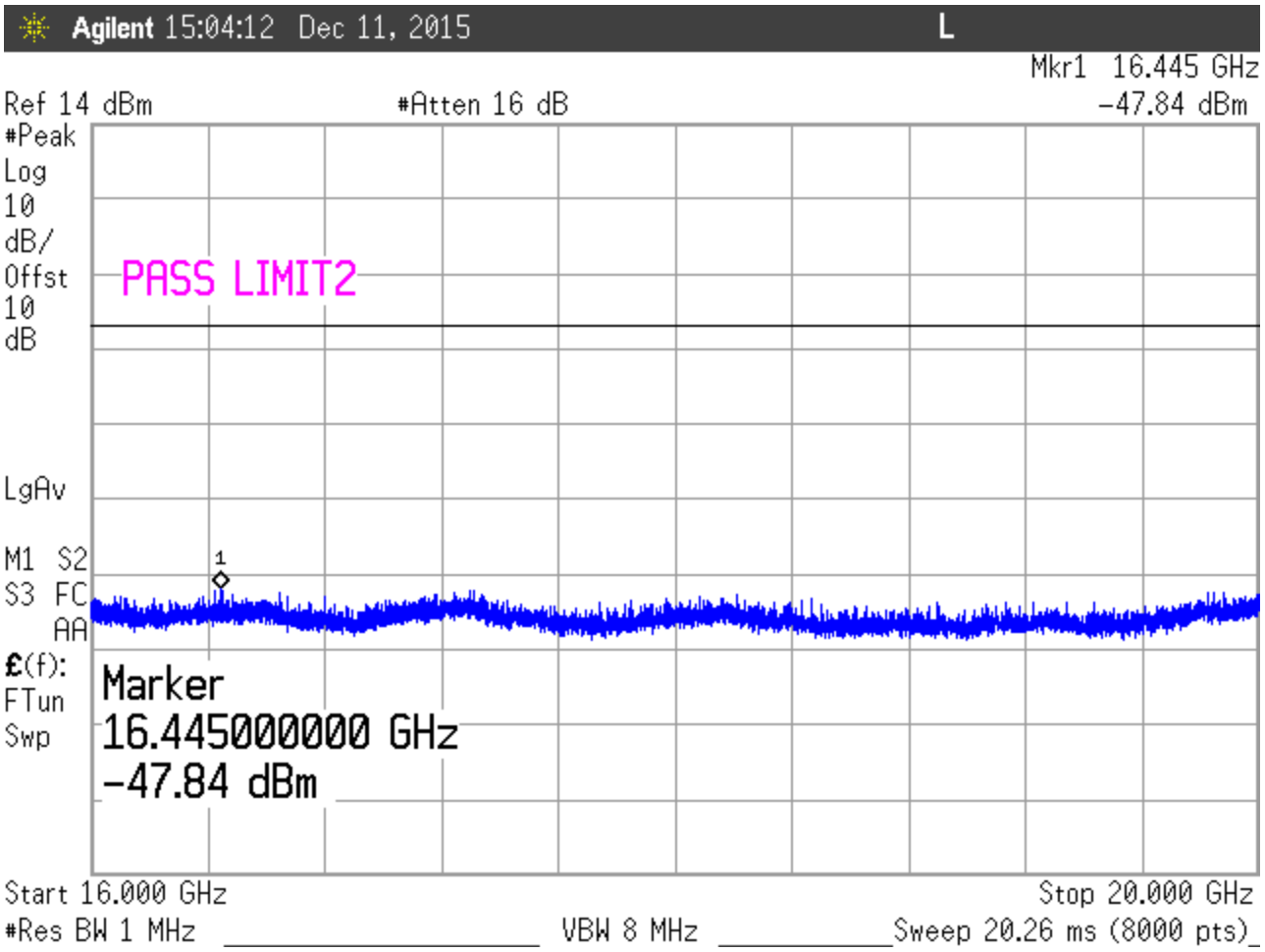


**Figure 67: Spurious Emissions, QPSK Modulation, TX @ 2458.5MHz, 16GHz-20GHz**

 

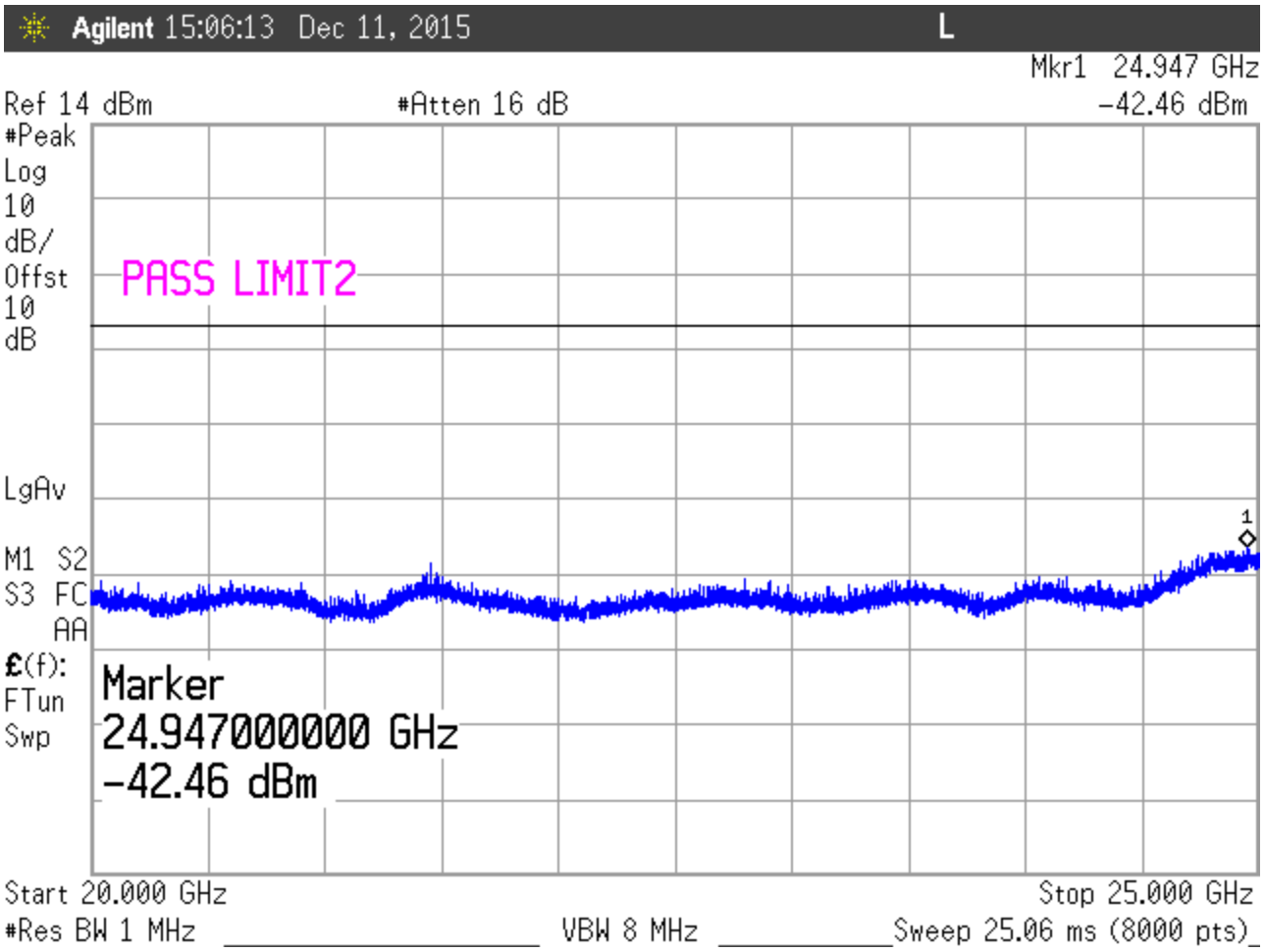


**Figure 68: Spurious Emissions, QPSK Modulation, TX @ 2458.5MHz, 20GHz-25GHz**

 

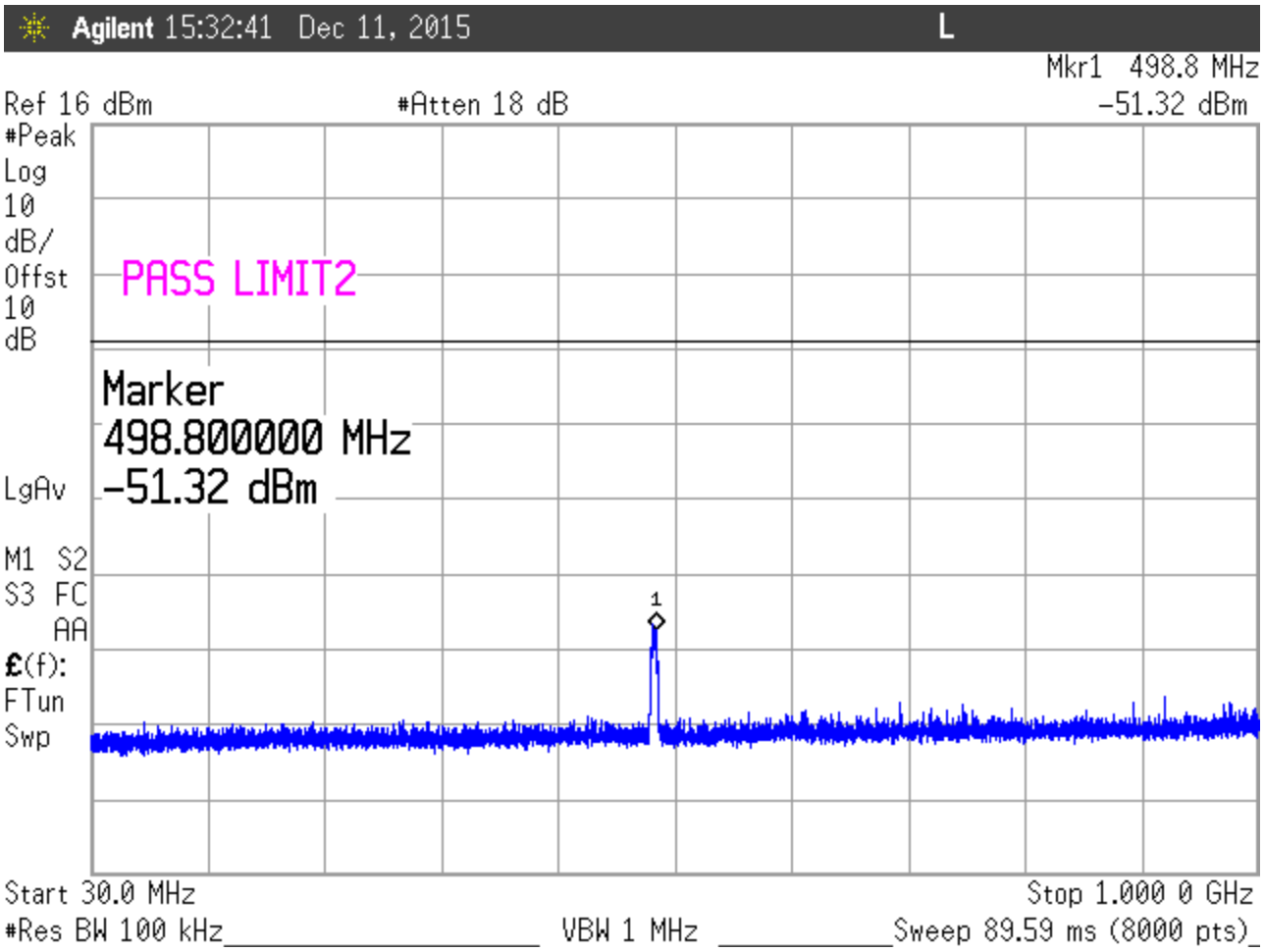


**Figure 69: Spurious Emissions, 16QAM Modulation, TX @ 2458.5MHz, 30MHz-1000MHz**

 

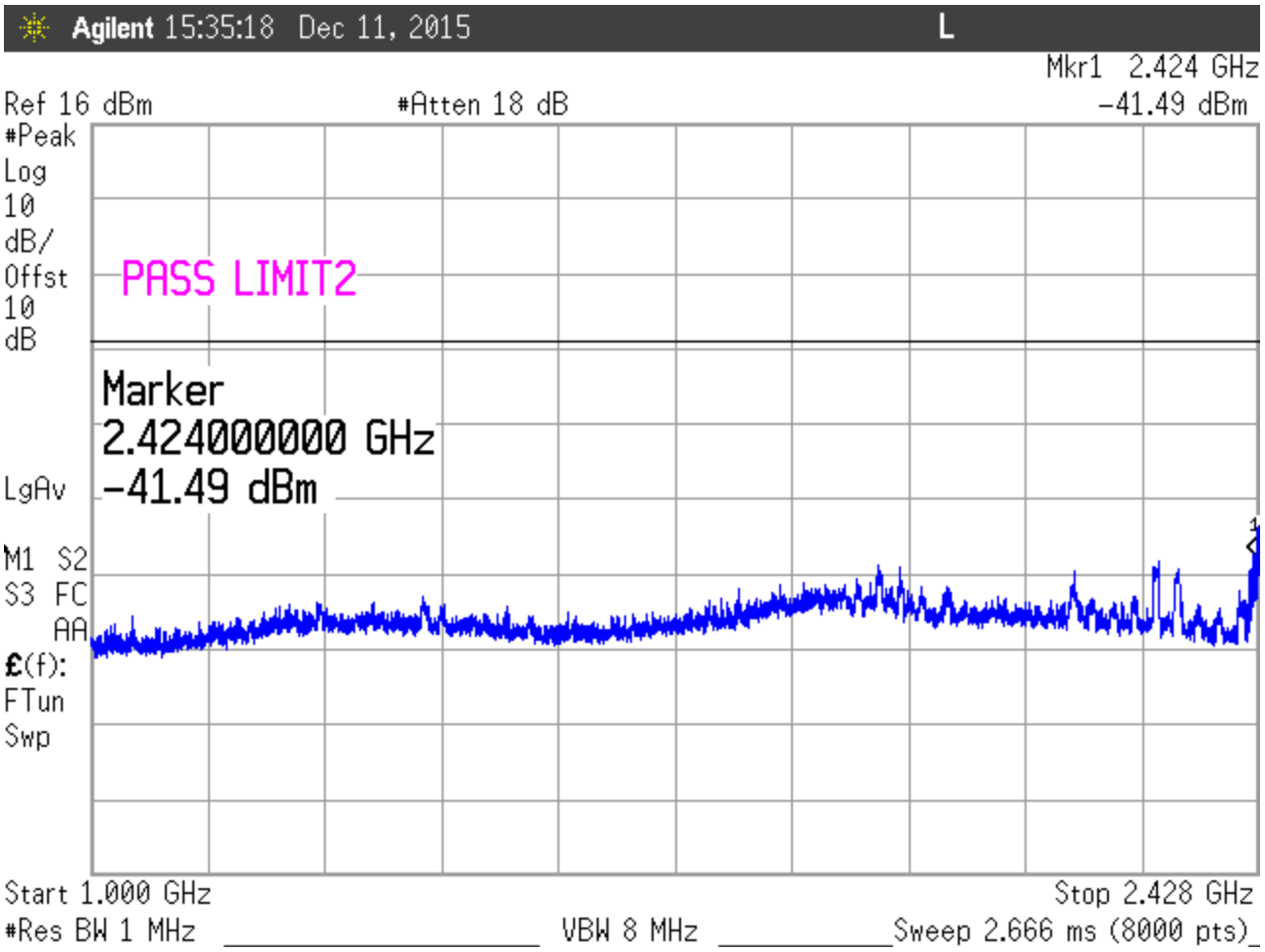


**Figure 70: Spurious Emissions, 16QAM Modulation, TX @ 2458.5MHz, 1000MHz-2428MHz**

 

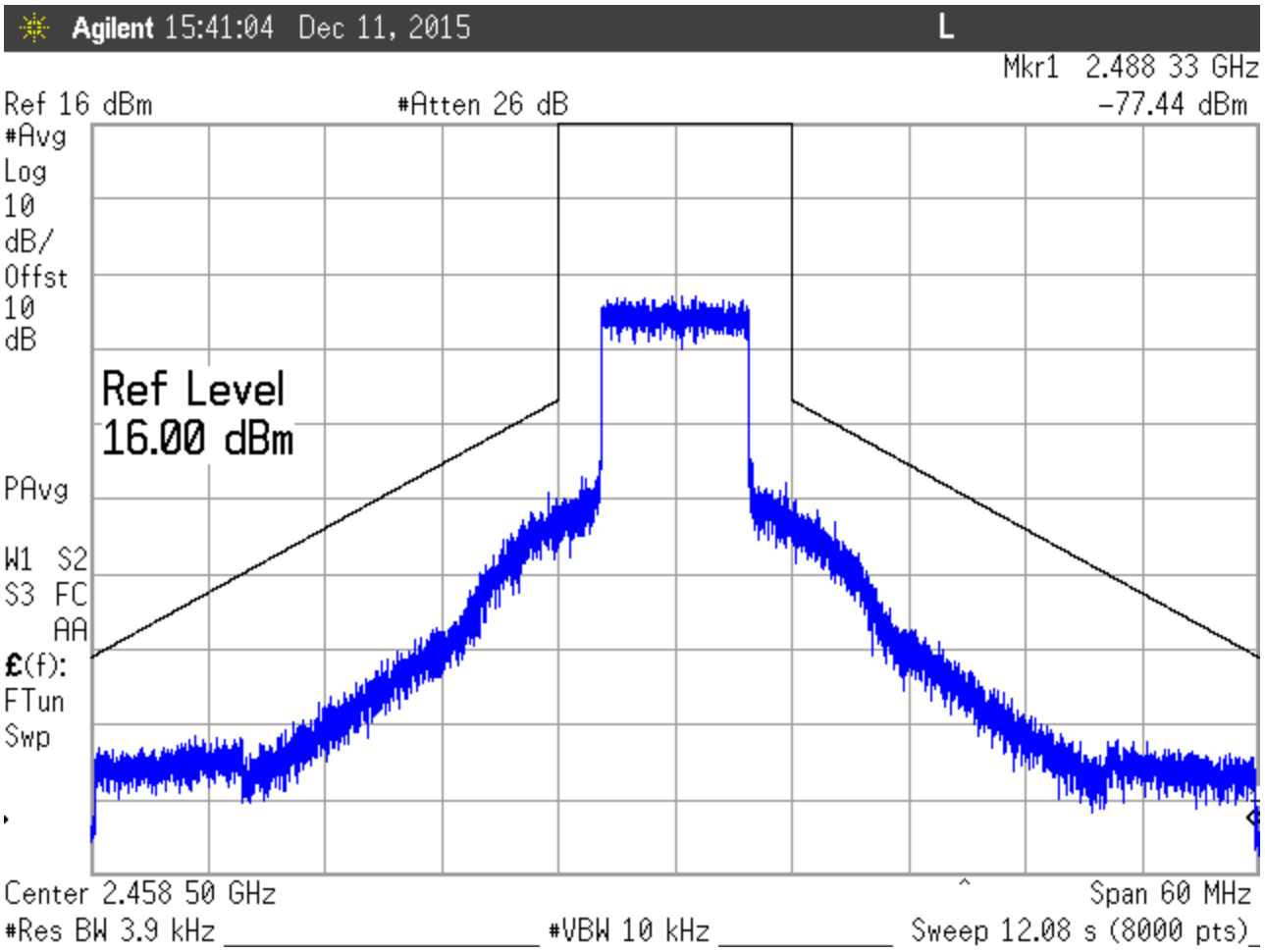


**Figure 71: Spurious Emissions, 16QAM Modulation, TX @ 2458.5MHz, Emission Mask**

 

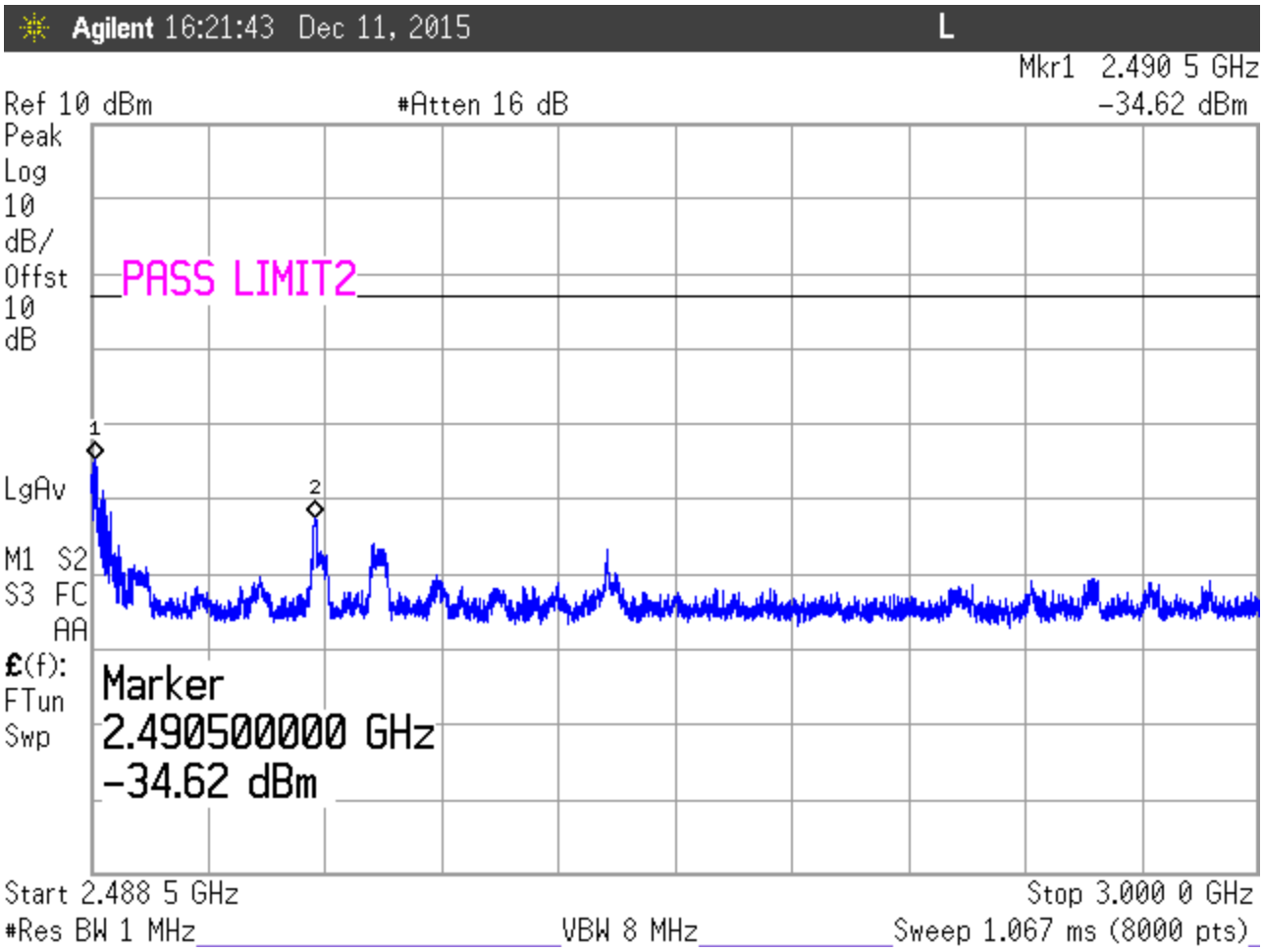


**Figure 72: Spurious Emissions, 16QAM Modulation, TX @ 2458.5MHz, 2438MHz-3GHz**

 

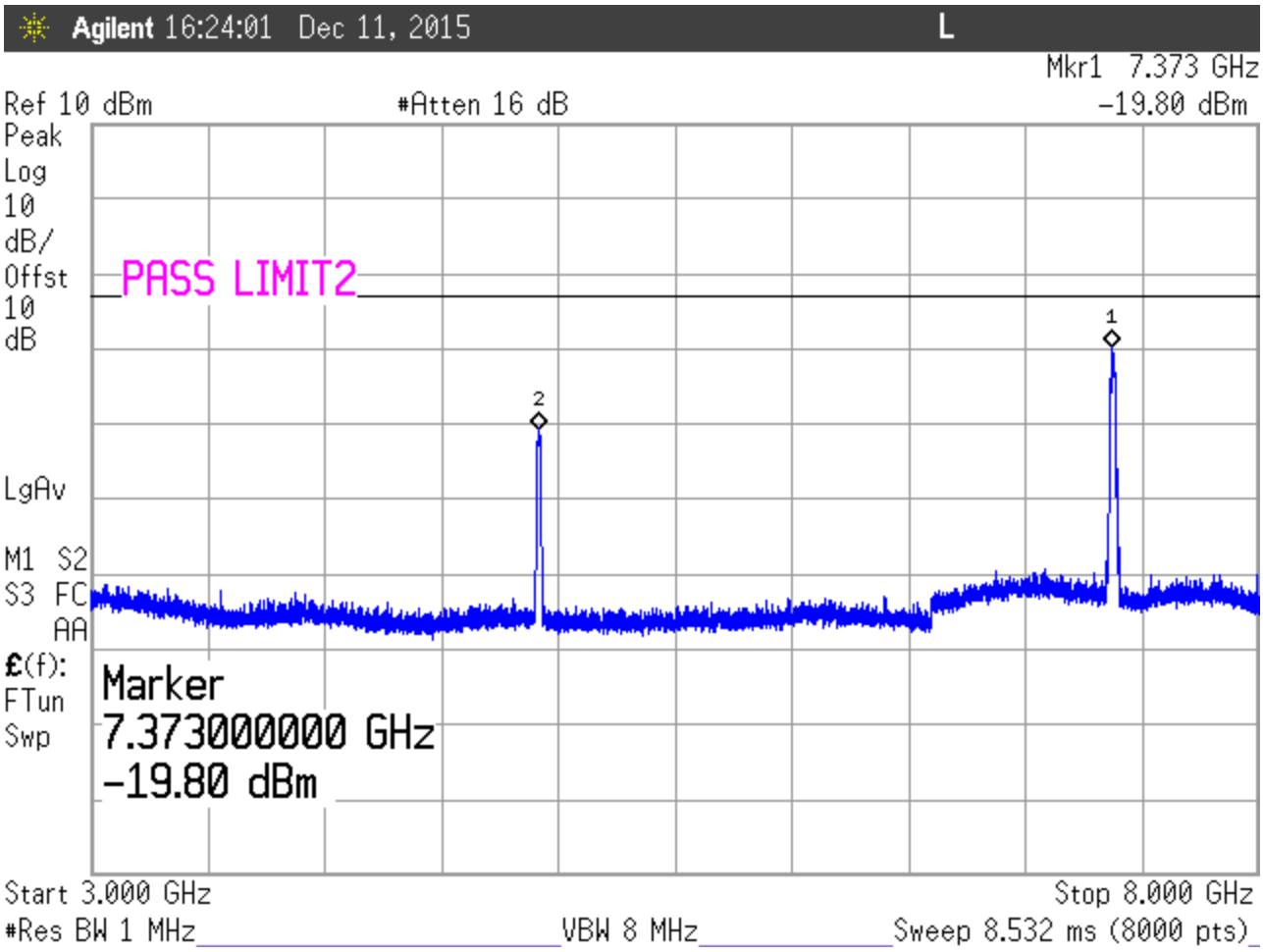


**Figure 73: Spurious Emissions, 16QAM Modulation, TX @ 2458.5MHz, 3GHz-8GHz**

 

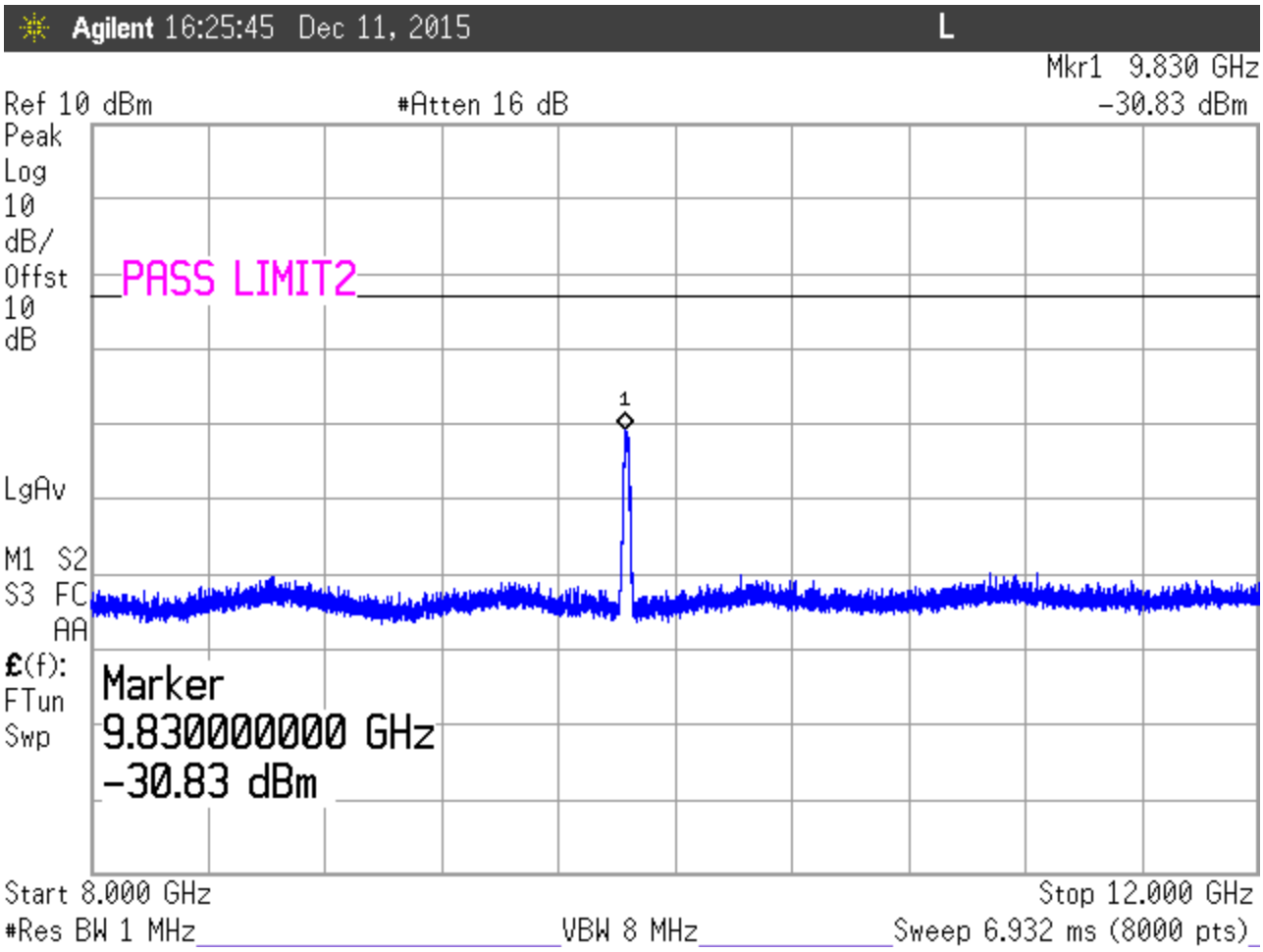


**Figure 74: Spurious Emissions, 16QAM Modulation, TX @ 2458.5MHz, 8GHz-12GHz**

 

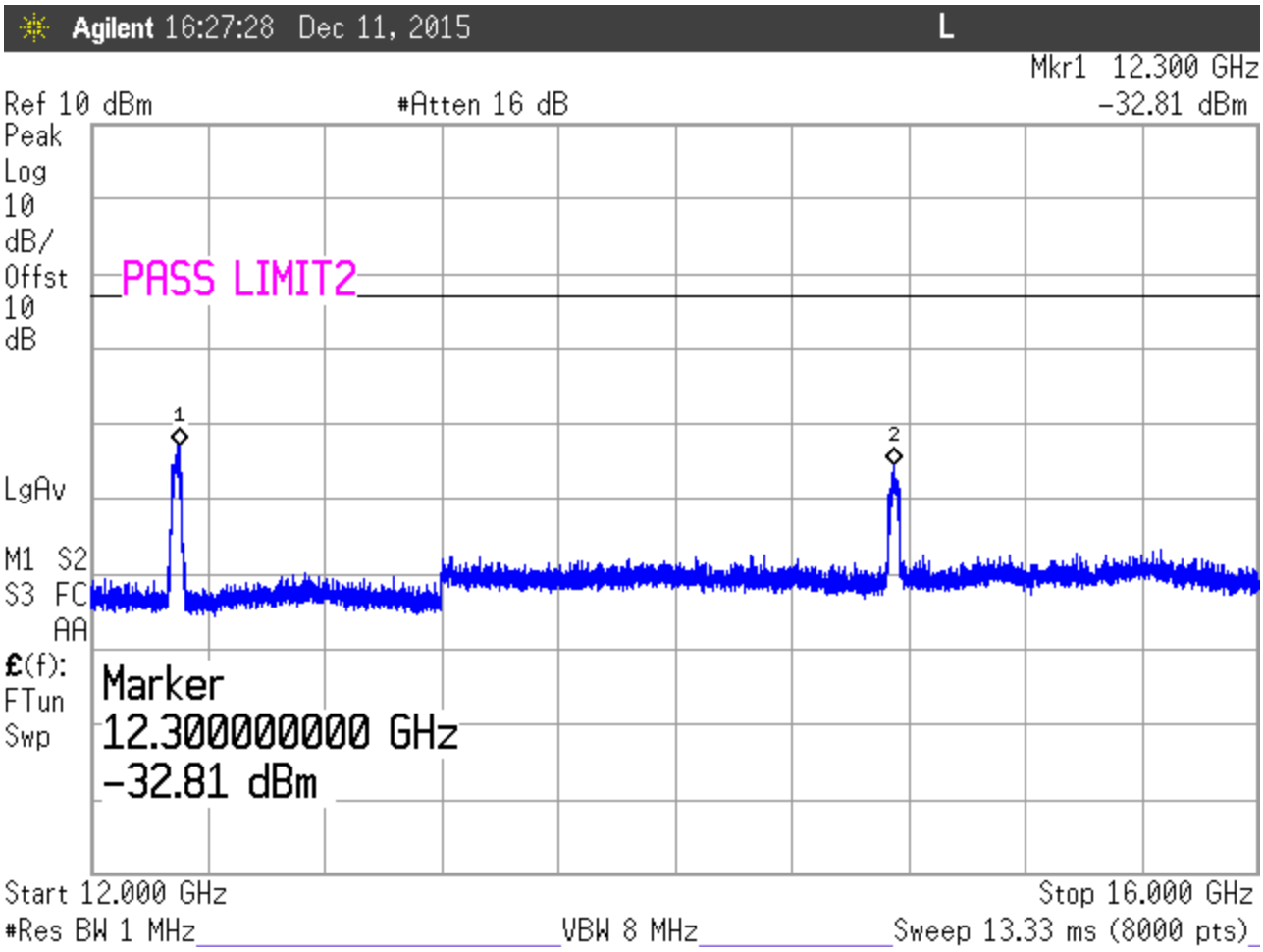


**Figure 75: Spurious Emissions, 16QAM Modulation, TX @ 2458.5MHz, 12GHz-16GHz**

 

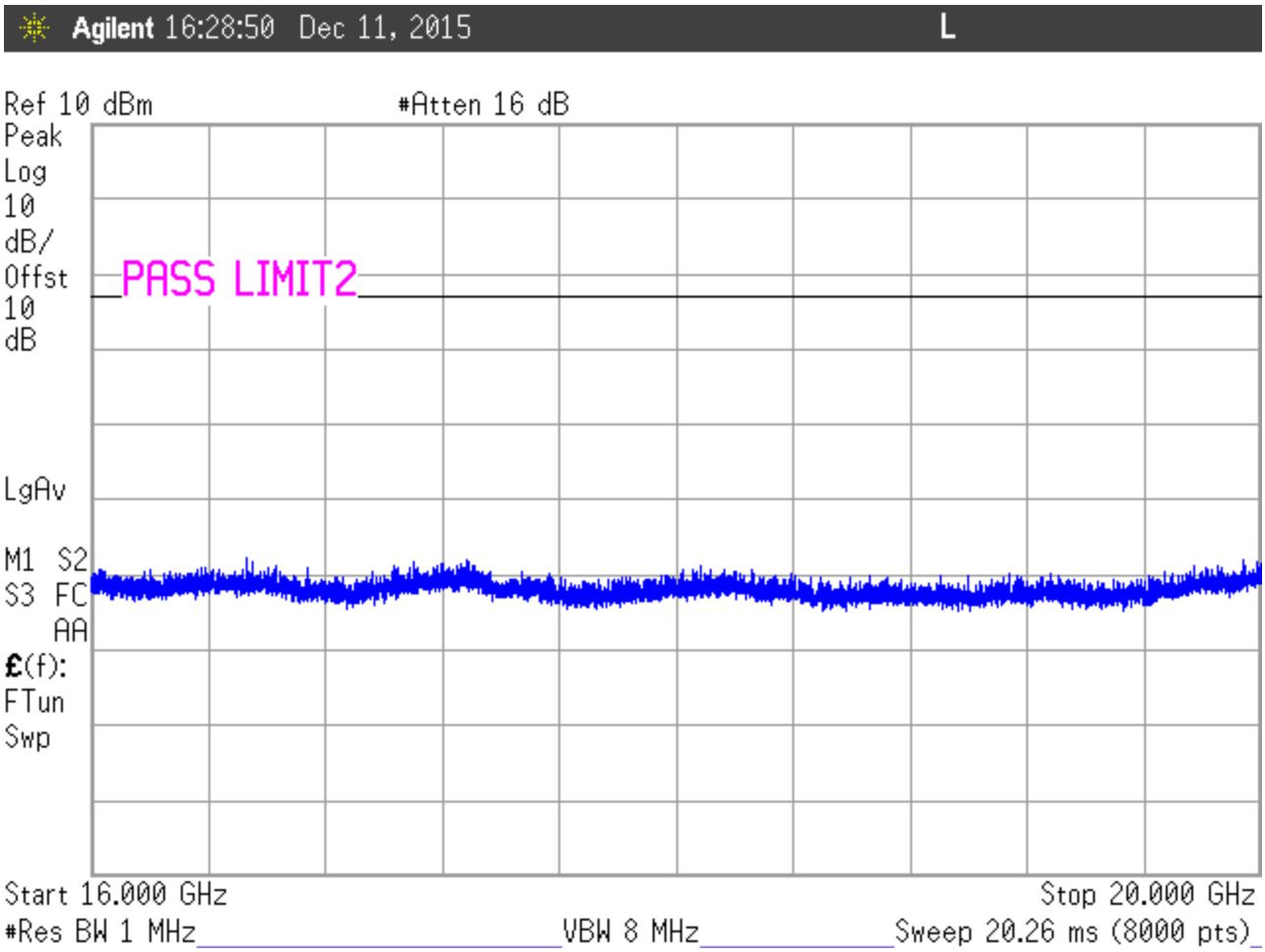


**Figure 76: Spurious Emissions, 16QAM Modulation, TX @ 2458.5MHz, 16GHz-20GHz**

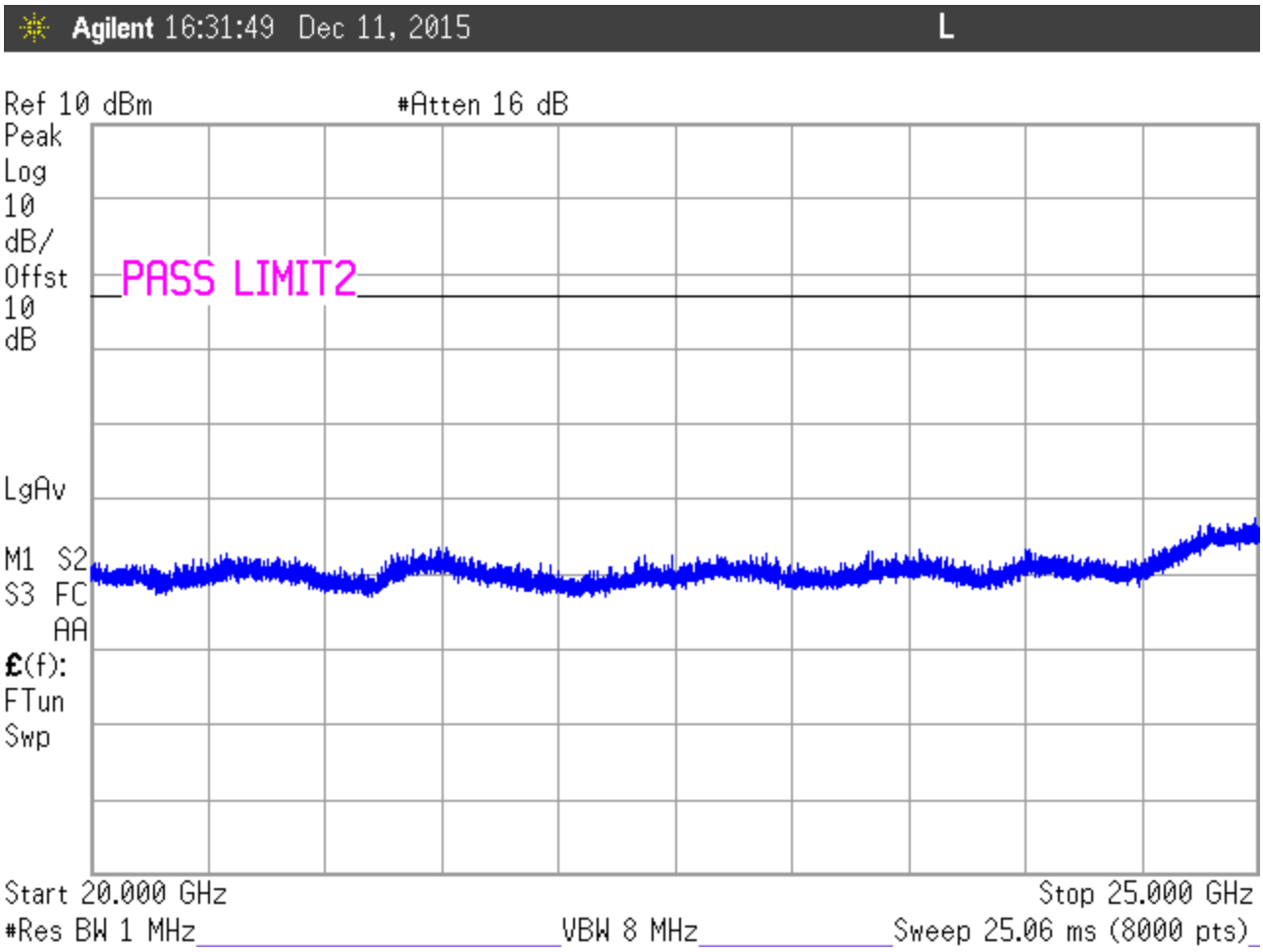


**Figure 77: Spurious Emissions, 16QAM Modulation, TX @ 2458.5MHz, 20GHz-25GHz**

 

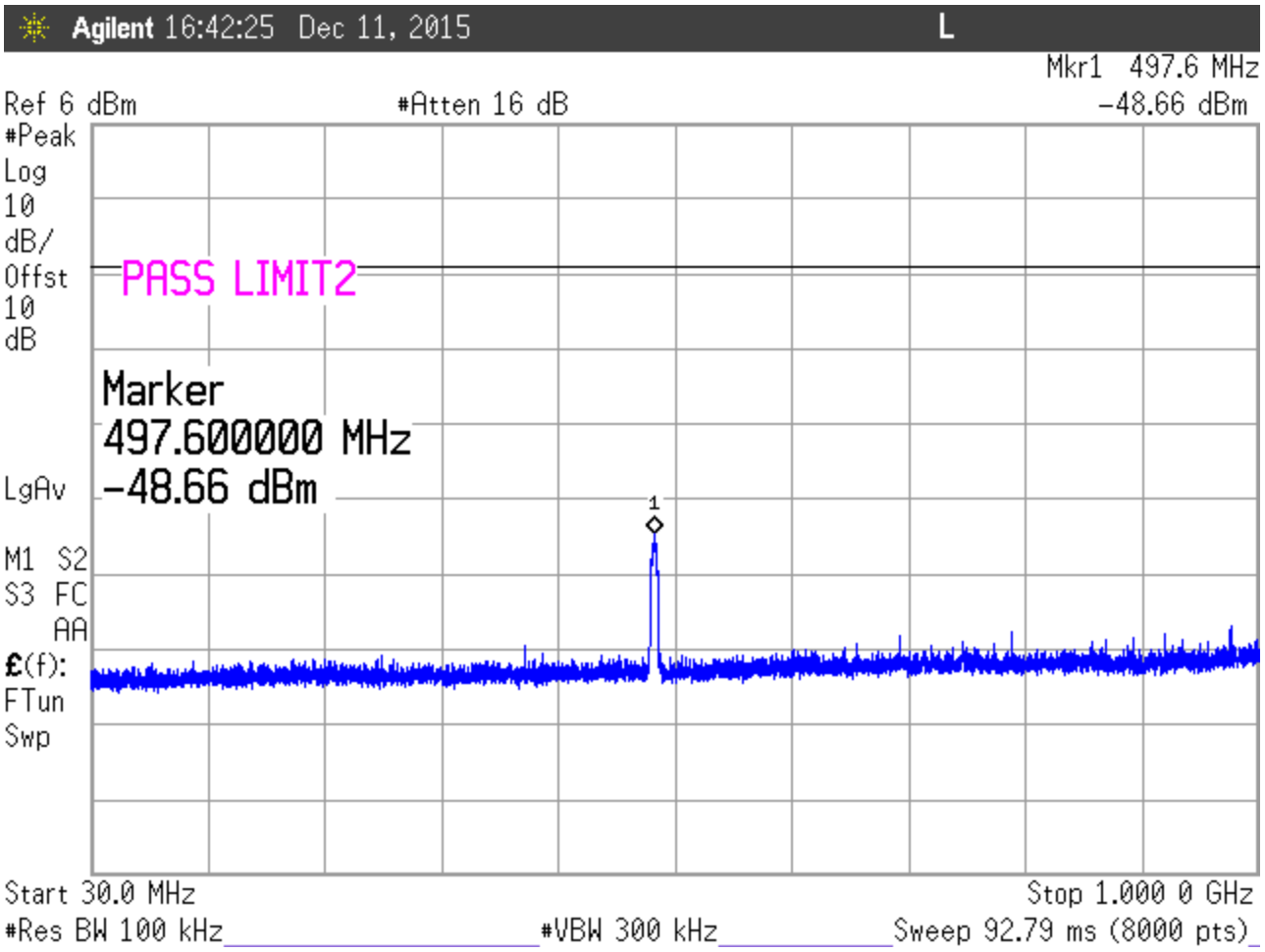


**Figure 78: Spurious Emissions, 64QAM Modulation, TX @ 2458.5MHz, 30MHz-1000MHz**

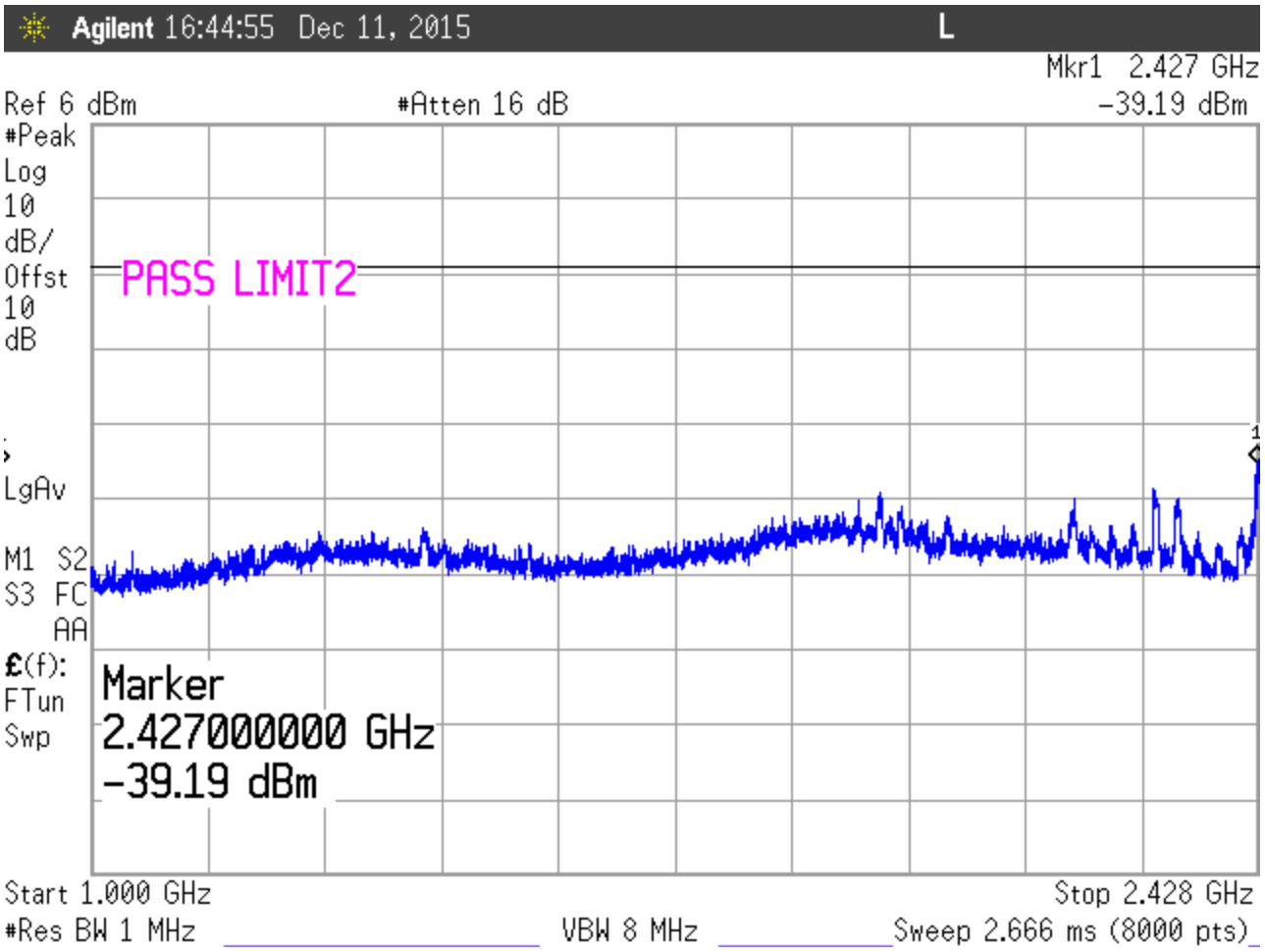


**Figure 79: Spurious Emissions, 64QAM Modulation, TX @ 2458.5MHz, 1000MHz-2428MHz**

 

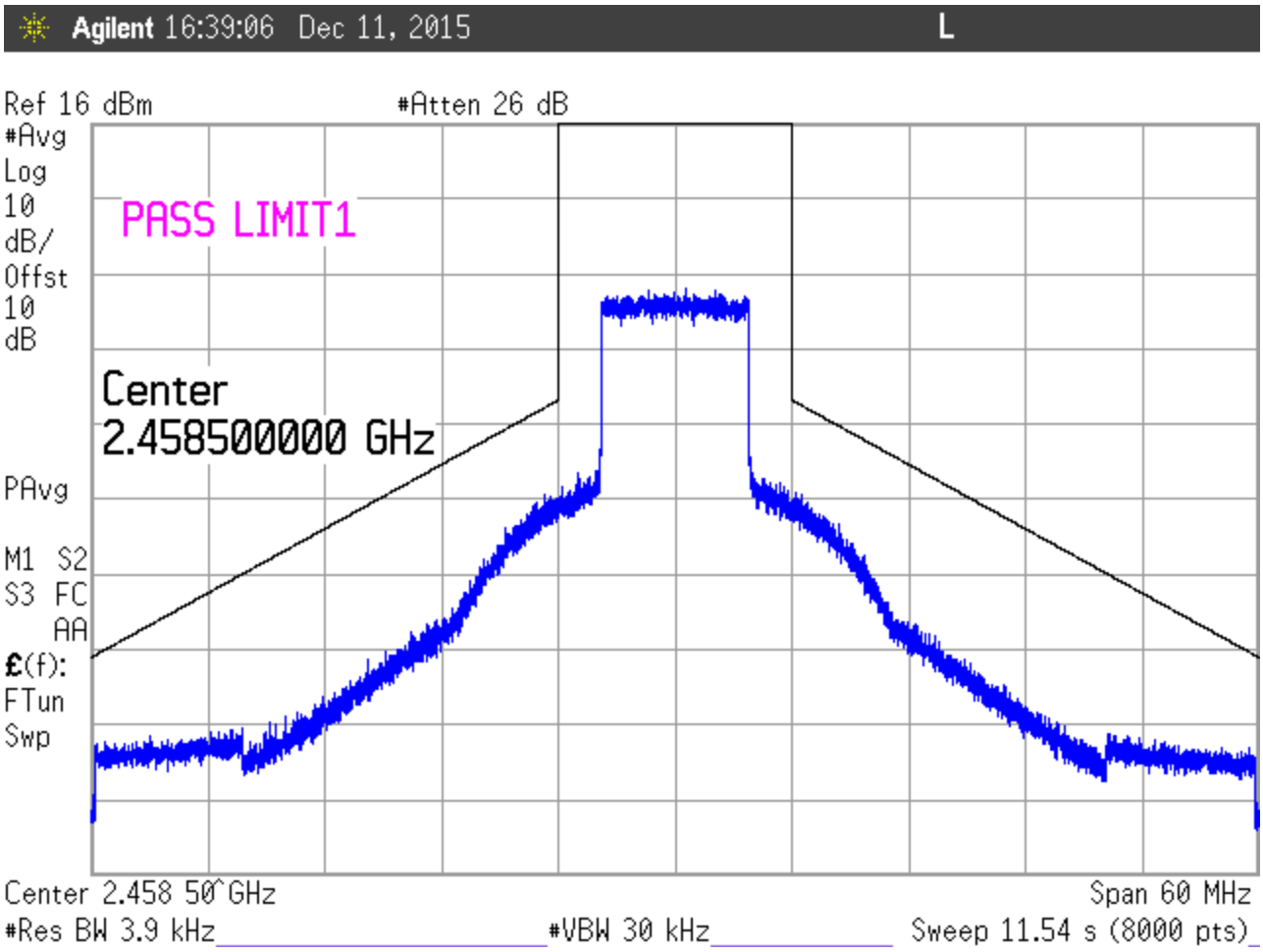


**Figure 80: Spurious Emissions, 64QAM Modulation, TX @ 2458.5MHz, Emission Mask**

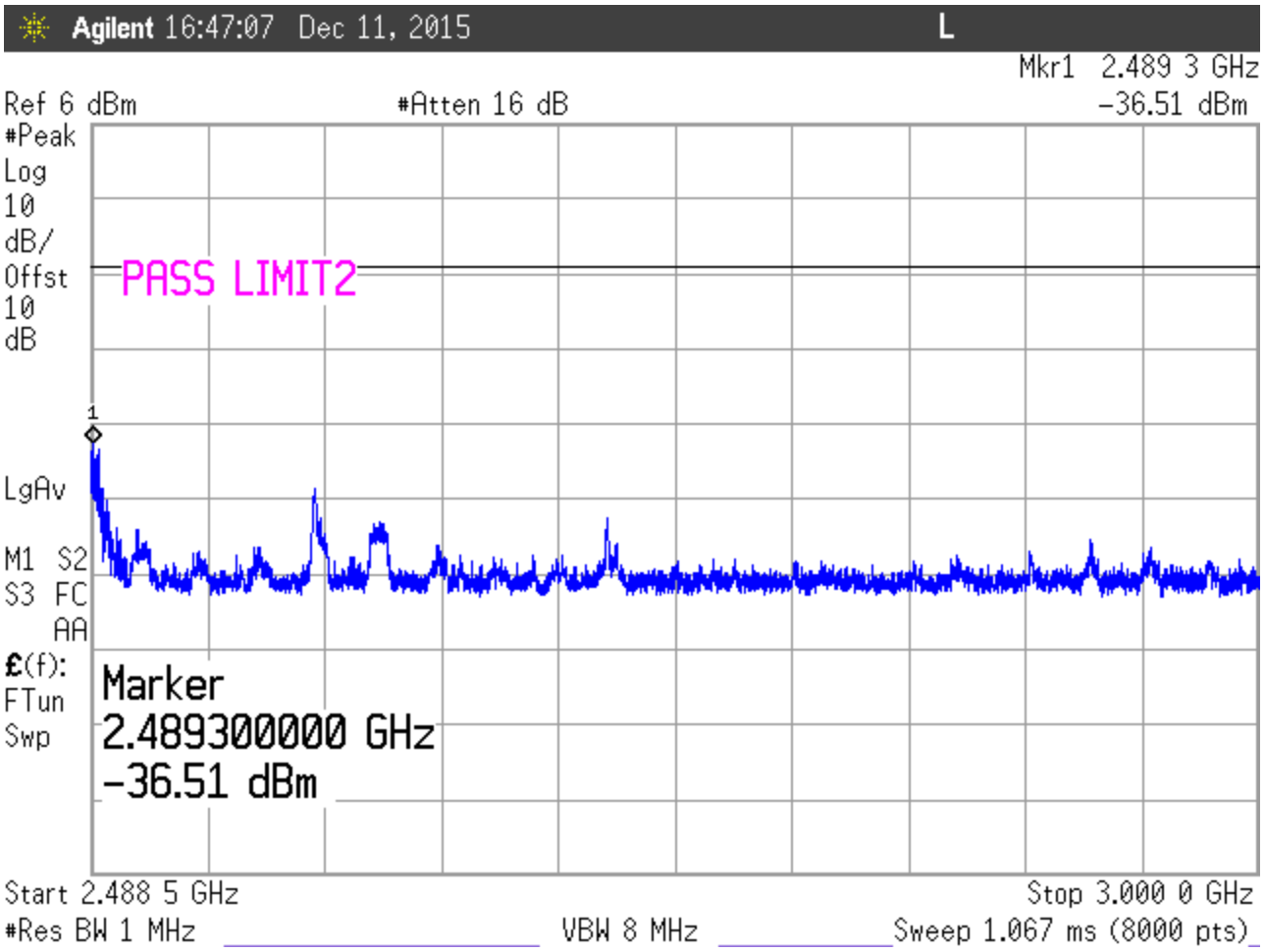


**Figure 81: Spurious Emissions, 64QAM Modulation, TX @ 2458.5MHz, 2488MHz-3GHz**

 

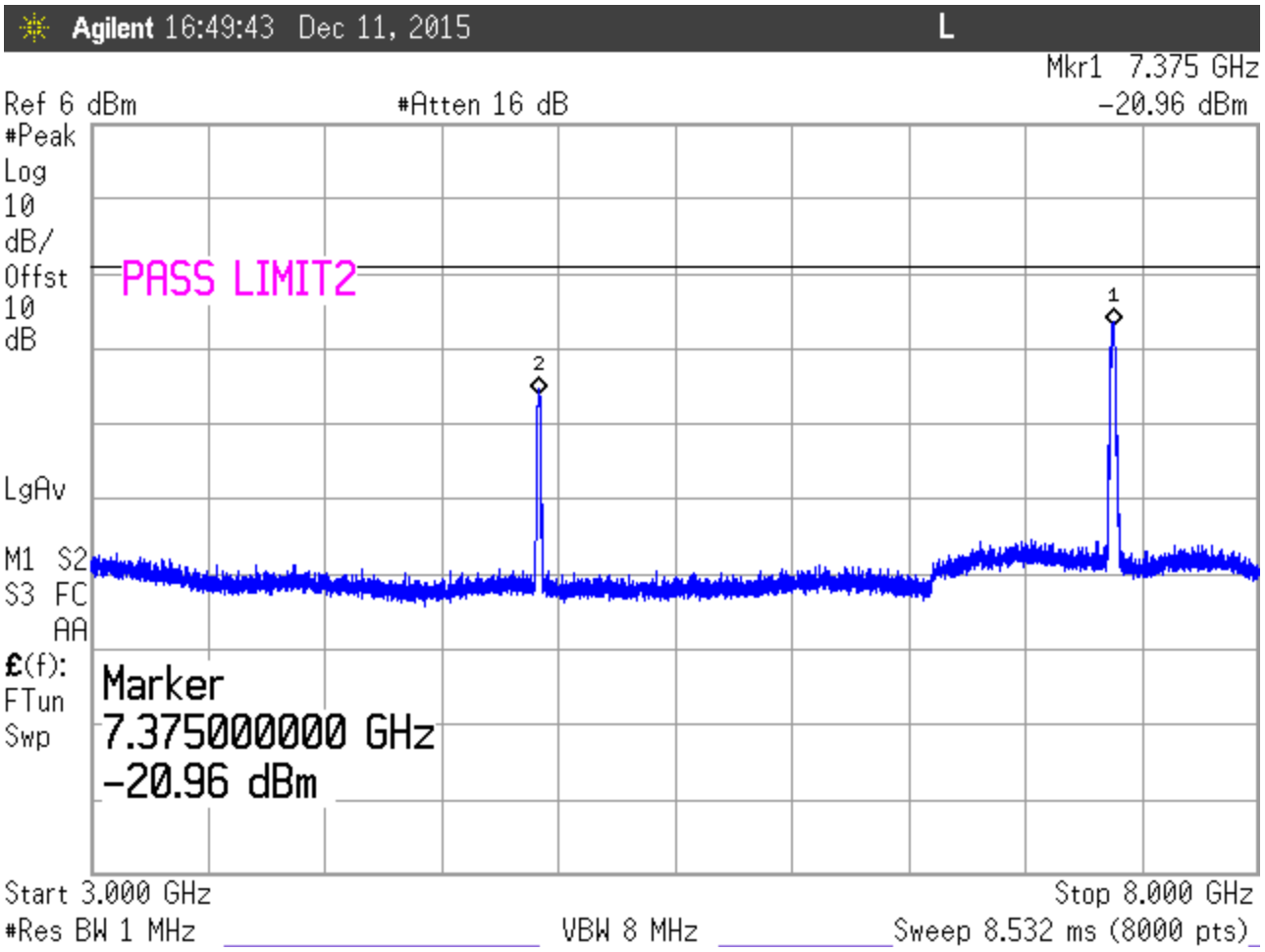


**Figure 82: Spurious Emissions, 64QAM Modulation, TX @ 2458.5MHz, 3GHz-8GHz**

 

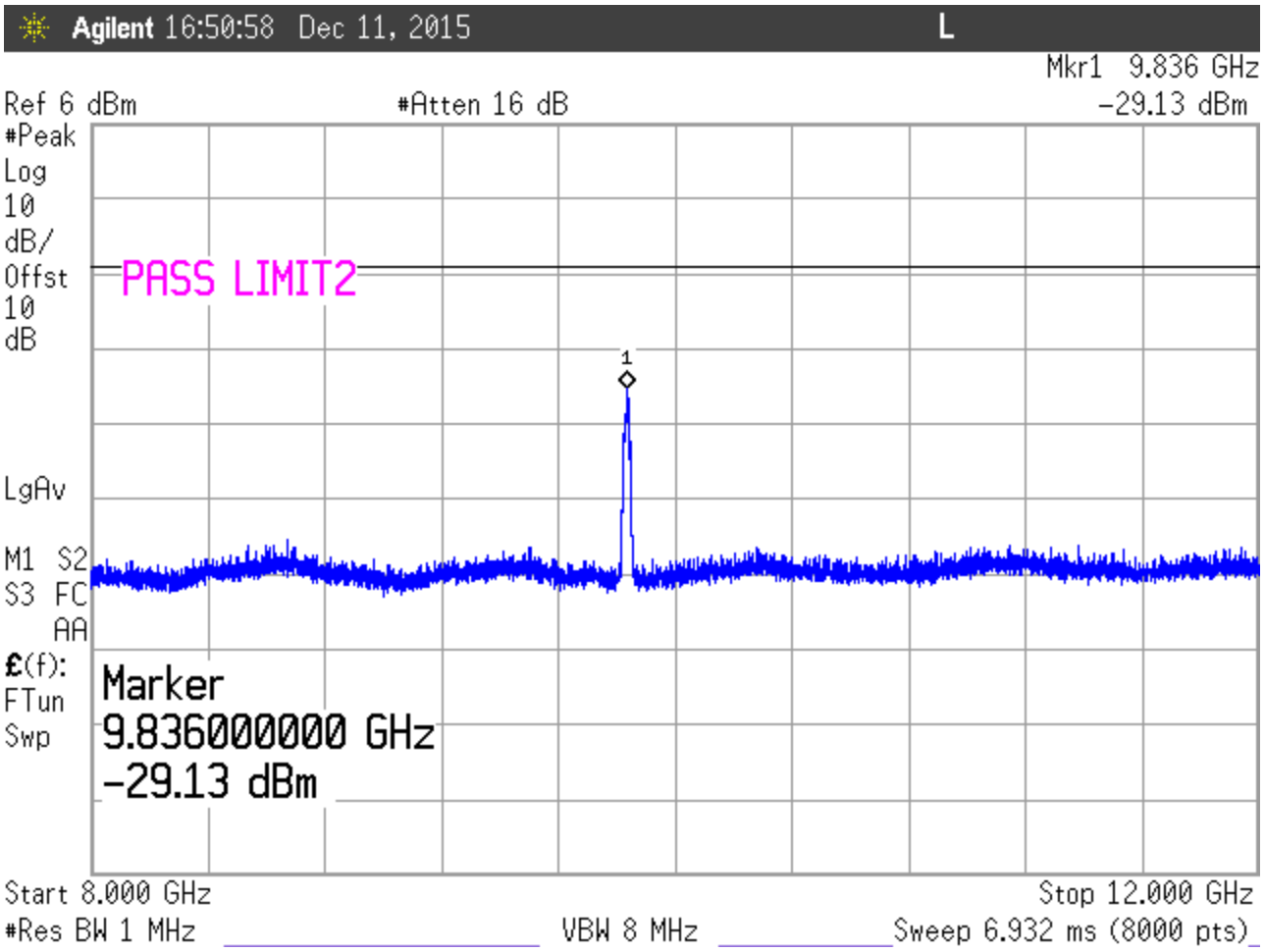


**Figure 83: Spurious Emissions, 64QAM Modulation, TX @ 2458.5MHz, 8GHz-12GHz**

 

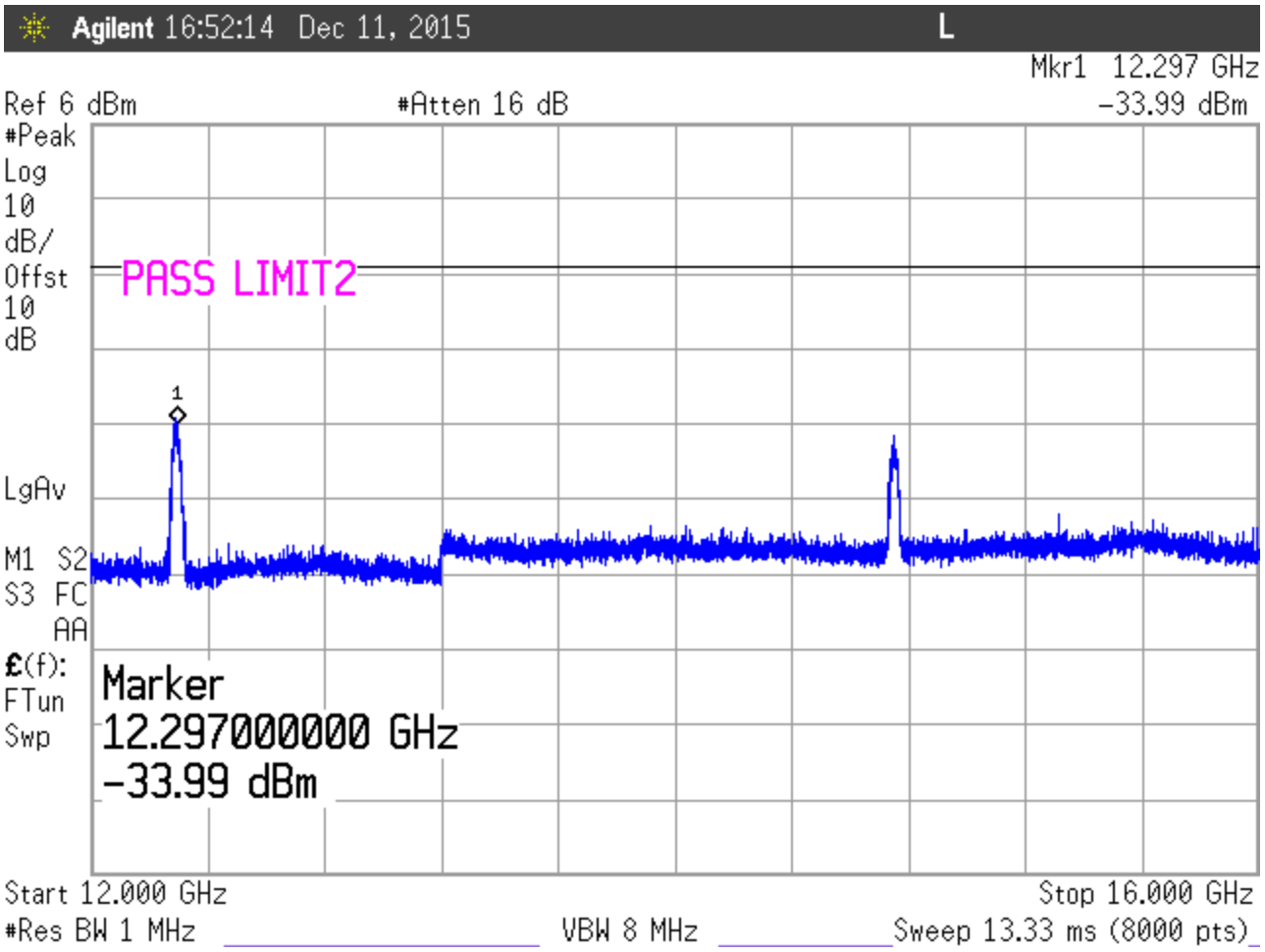


**Figure 84: Spurious Emissions, 64QAM Modulation, TX @ 2458.5MHz, 12GHz-16GHz**

 

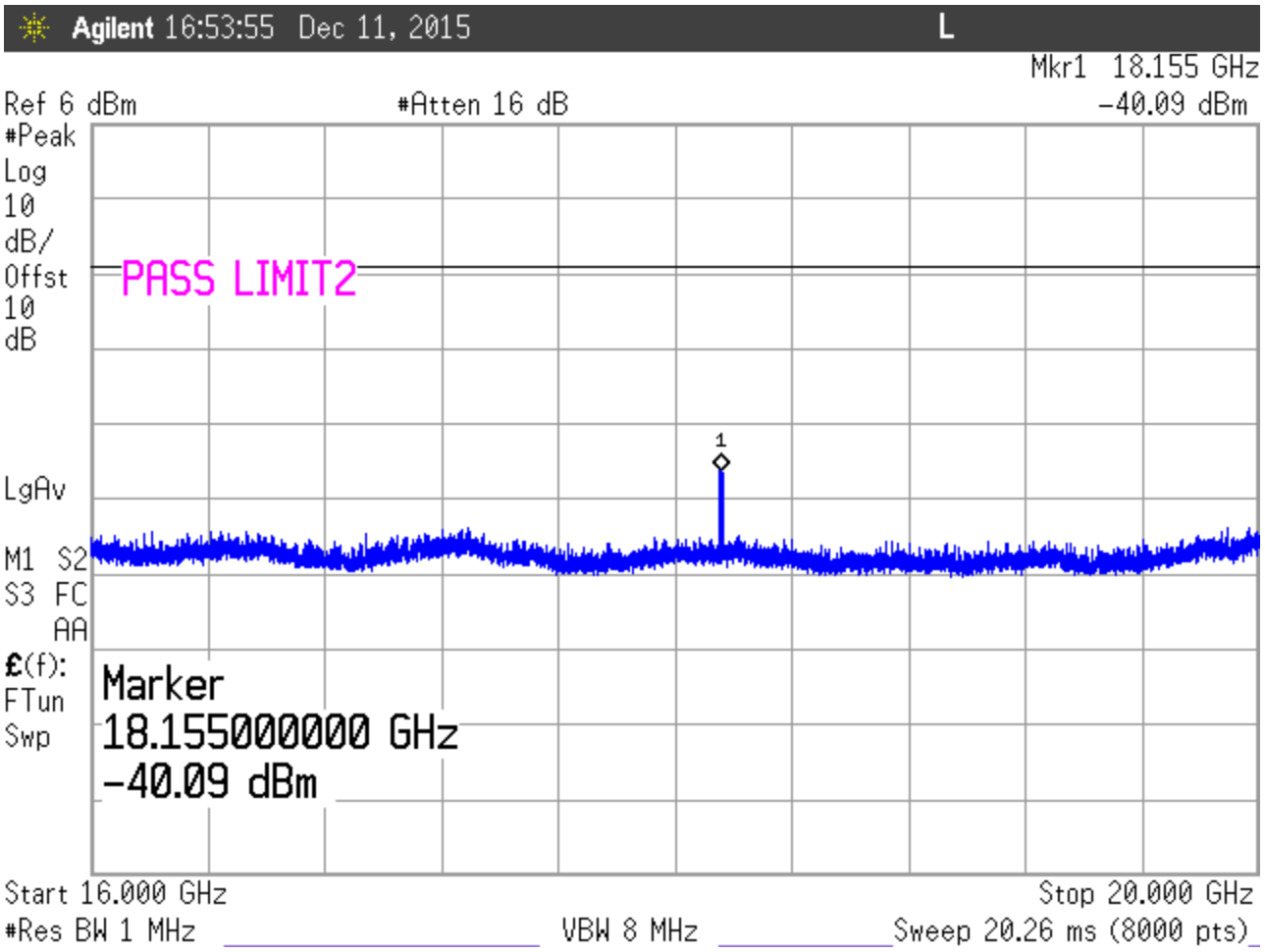


**Figure 85: Spurious Emissions, 64QAM Modulation, TX @ 2458.5MHz, 16GHz-20GHz**

 

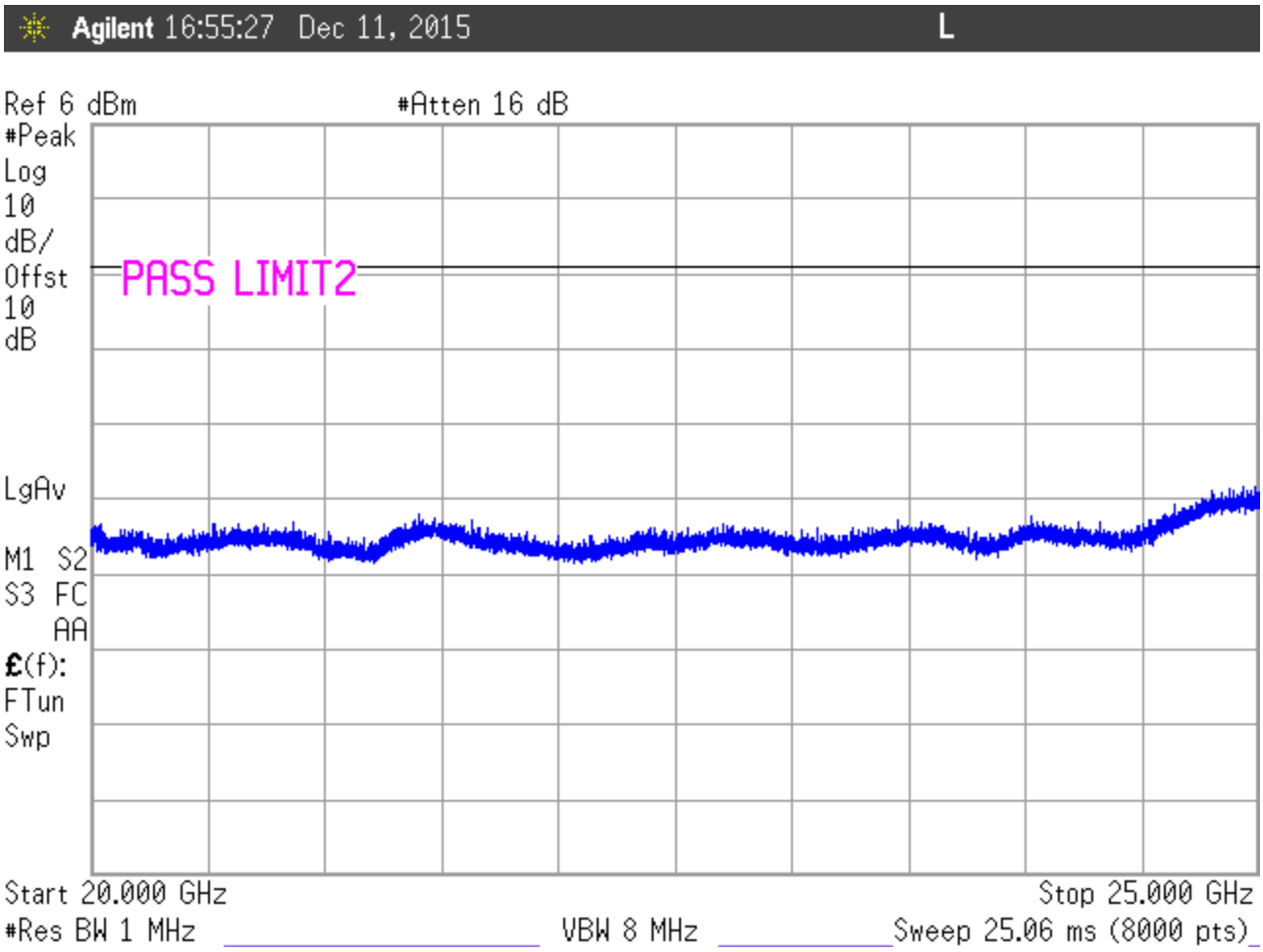


**Figure 86: Spurious Emissions, 64QAM Modulation, TX @ 2458.5MHz, 20GHz-25GHz**

## 4.4 Radiated Spurious Emissions (EIRP): (FCC Part §2.1053)

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. The peripherals were placed on the table in accordance with ANSI C63.4-2014. Cables were varied in position to produce maximum emissions. Both the horizontal and vertical field components were measured.

The Effective Isotropic Radiated Power (EIRP) levels were measured and were compared with the limit of –13dBm per FCC Part 74. The limit of -13dB is derived from the formula of 43+10 log (P) dB per §74.637(a)(3).

Emissions were measured for a Low Channel 2033MHz, a middle channel 2067.5MHz and a high channel 2458.5MHz representing channels across the operating band and falling within the specific frequency range of Part 74F. Emissions were scanned up to the $10^{th}$ harmonic of the fundamental. Worst case measurements are reported. The signal substitution method was used to obtain EIRP levels.

### 4.4.1 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. The peripherals were placed on the table in accordance with ANSI C63.4-2014. Cables were varied in position to produce maximum emissions. Both the horizontal and vertical field components were measured.

Where emissions were detected, the EIRP levels were determined using the method of signal substitution. The measurement bandwidth used was set to 4 kHz. The actual EIRP level was calculated as follows.

EIRP (dBm) = Signal generator substitution level (dBm) + Antenna Gain (dBi)

 

### 4.4.2 Test Results

**Table 13: Radiated Emission Test Data**

| Frequency (MHz) | Polarity (H/V) | Azimuth (Degree) | Ant. Height (m) | SA Level (dBuV) | Corr Factors (dB) | Corr. Level (dBuV/m) | EIRP Calc (dBm) | Limit (dBm) | Margin (dB) | Peak or Average | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 38.18 | V | 90.00 | 1.00 | 32.91 | -8.7 | 24.2 | -71.0 | -13.0 | -58.0 | Peak | |
| 43.08 | V | 0.0 | 1.00 | 33.5 | -12.3 | 21.2 | -74.1 | -13.0 | -61.1 | Peak | |
| 47.66 | V | 180.0 | 1.10 | 34.2 | -15.1 | 19.2 | -76.1 | -13.0 | -63.1 | Peak | |
| 73.25 | V | 0.00 | 1.20 | 31.20 | -15.5 | 15.7 | -79.5 | -13.0 | -66.5 | Peak | |
| 112.95 | V | 165.00 | 1.20 | 27.77 | -9.9 | 17.9 | -77.4 | -13.0 | -64.4 | Peak | |
| 133.50 | V | 10.00 | 1.20 | 32.17 | -9.4 | 22.8 | -72.5 | -13.0 | -59.5 | Peak | |
| 255.56 | V | 270.00 | 2.73 | 37.91 | -11.4 | 26.5 | -68.7 | -13.0 | -55.7 | Peak | |
| 38.18 | H | 90.0 | 3.9 | 29.1 | -8.7 | 20.4 | -74.8 | -13.0 | -61.8 | Peak | |
| 47.66 | H | 270.0 | 3.9 | 34.0 | -15.1 | 19.0 | -76.3 | -13.0 | -63.3 | Peak | |
| 48.48 | H | 90.0 | 3.9 | 33.6 | -15.4 | 18.2 | -77.1 | -13.0 | -64.1 | Peak | |
| 73.25 | H | 0.0 | 3.8 | 33.7 | -15.5 | 18.3 | -77.0 | -13.0 | -64.0 | Peak | |
| 112.95 | H | 10.0 | 3.8 | 32.3 | -9.9 | 22.4 | -72.9 | -13.0 | -59.9 | Peak | |
| 133.50 | H | 190.0 | 3.5 | 30.1 | -9.4 | 20.7 | -74.6 | -13.0 | -61.6 | Peak | |
| 255.56 | H | 170.0 | 2.3 | 30.3 | -11.4 | 18.9 | -76.3 | -13.0 | -63.3 | Peak | |

**Table 14: Radiated Emission Test Data, TX @ 2.033GHz**

| 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) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2033.50 | | | | | | | | | | | |
| 4067.00 | V | 45.0 | 2.2 | 63.50 | -39.2 | -41.8 | 36.8 | 5.5 | -36.2 | -13 | -23.2 |
| 6100.50 | V | 45.0 | 2.2 | 59.67 | -43.2 | -46.7 | 39.1 | 6.8 | -39.9 | -13 | -26.9 |
| 8134.00 | V | 45.0 | 2.2 | 52.00 | -48.8 | -54.0 | 42.5 | 5.8 | -48.1 | -13 | -35.1 |
| 10167.50 | V | 45.0 | 2.2 | 47.50 | -44.5 | -51.0 | 45.8 | 4.6 | -46.4 | -13 | -33.4 |
| 2033.50 | | | | | | | | | | | |
| 4067.00 | H | 0.0 | 2.6 | 62 | -41.3 | -43.9 | 36.8 | 5.5 | -38.3 | -13 | -25.3 |
| 6100.50 | H | 0.0 | 2.6 | 58.2 | -43.5 | -47.0 | 39.1 | 6.8 | -40.2 | -13 | -27.2 |
| 8134.00 | H | 0.0 | 2.6 | 50.5 | -46.3 | -51.5 | 42.5 | 5.8 | -45.6 | -13 | -32.6 |
| 10167.50 | H | 0.0 | 2.6 | 44.7 | -47.8 | -54.3 | 45.8 | 4.6 | -49.7 | -13 | -36.7 |

 

## Table 15: Radiated Emission Test Data, TX @ 2.0675GHz

| 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) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 4135.00 | V | 45.0 | 2.2 | 64.88 | -38.2 | -40.8 | 36.6 | 5.7 | -35.1 | -13 | -22.1 |
| 6202.50 | V | 45.0 | 2.2 | 59.91 | -43.2 | -46.6 | 39.5 | 6.3 | -40.3 | -13 | -27.3 |
| 8270.00 | V | 45.0 | 2.2 | 51.81 | -49.5 | -54.6 | 42.4 | 5.8 | -48.7 | -13 | -35.7 |
| 10337.50 | V | 45.0 | 2.2 | 47.50 | -44.5 | -50.9 | 44.5 | 5.7 | -45.2 | -13 | -32.2 |
| 2067.50 | | | | | | | | | | | |
| 4135.00 | H | 0.0 | 2.6 | 60.3 | -42.1 | -44.7 | 36.6 | 5.7 | -39.0 | -13 | -26.0 |
| 6202.50 | H | 0.0 | 2.6 | 55.2 | -45.4 | -48.8 | 39.5 | 6.3 | -42.5 | -13 | -29.5 |
| 8270.00 | H | 0.0 | 2.6 | 45.6 | -51.2 | -56.3 | 42.4 | 5.8 | -50.4 | -13 | -37.4 |
| 10337.50 | H | 0.0 | 2.6 | 44.7 | -47.8 | -54.2 | 44.5 | 5.7 | -48.5 | -13 | -35.5 |

## Table 16: Radiated Emission Test Data, TX @ 2.1015GHz

| 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) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2101.50 | | | | | | | | | | | |
| 4203.00 | V | 45.0 | 2.1 | 47.3 | -48.5 | -51.1 | 36.5 | 6.3 | -44.8 | -13 | -31.8 |
| 6304.50 | V | 45.0 | 2.1 | 49.8 | -44.6 | -48.3 | 39.3 | 7.0 | -41.3 | -13 | -28.3 |
| 8406.00 | V | 45.0 | 2.1 | 53.2 | -36.4 | -41.8 | 43.6 | 5.1 | -36.7 | -13 | -23.7 |
| 10507.50 | V | 45.0 | 2.1 | 48.4 | -38.2 | -44.9 | 45.3 | 5.4 | -39.5 | -13 | -26.5 |
| 2101.50 | | | | | | | | | | | |
| 4203.00 | H | 0.0 | 2.6 | 45.3 | -49.5 | -52.1 | 36.5 | 6.3 | -45.8 | -13 | -32.8 |
| 6304.50 | H | 0.0 | 2.6 | 47.2 | -41.3 | -45.0 | 39.3 | 7.0 | -38.0 | -13 | -25.0 |
| 8406.00 | H | 0.0 | 2.6 | 50.8 | -31.6 | -37.0 | 43.7 | 5.1 | -31.9 | -13 | -18.9 |
| 10507.50 | H | 0.0 | 2.6 | 44.2 | -41.4 | -48.1 | 45.3 | 5.4 | -42.7 | -13 | -29.7 |

 

## Table 17: Radiated Emission Test Data, TX @ 2.4585GHz

| 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) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 2458.50 | | | | | | | | | | | |
| 4917.00 | V | 45.0 | 2.2 | 62.83 | -35 | -37.8 | 37.2 | 6.9 | -30.9 | -13 | -17.9 |
| 7375.50 | V | 45.0 | 2.2 | 56.7 | -35.4 | -40.1 | 41.0 | 6.6 | -33.5 | -13 | -20.5 |
| 9834.00 | V | 45.0 | 2.2 | 54.67 | -38.15 | -44.5 | 45.0 | 5.1 | -39.4 | -13 | -26.4 |
| 12292.50 | V | 45.0 | 2.2 | 61.83 | -27.15 | -34.8 | 47.5 | 4.6 | -30.2 | -13 | -17.2 |
| 2458.50 | | | | | | | | | | | |
| 4917.00 | H | 0.0 | 2.6 | 60.33 | -36.5 | -39.3 | 37.2 | 6.9 | -32.4 | -13 | -19.4 |
| 7375.50 | H | 0.0 | 2.6 | 51.8 | -42.5 | -47.2 | 41.0 | 6.6 | -40.6 | -13 | -27.6 |
| 9834.00 | H | 0.0 | 2.6 | 50.67 | -42.5 | -48.9 | 45.0 | 5.1 | -43.7 | -13 | -30.7 |
| 12292.50 | H | 0.0 | 2.6 | 56.33 | -28.4 | -36.1 | 47.5 | 4.6 | -31.5 | -13 | -18.5 |

 

## 4.5 Frequency Stability: (FCC Part §2.1055 & FCC Part §74.661)

Frequency as a function of temperature and voltage variation shall be maintained within the FCC-prescribed tolerances.

The temperature stability was measured with the unit in an environmental chamber used to vary the temperature of the sample. The sample was held at each temperature step to allow the temperature of the sample to stabilize.

The EUT is powered by DC voltage supplied externally. The manufacturer's power requirements for the EUT include the following:

Low DC Voltage of 10 VDC (manufacturer's specification)

High DC Voltage of 13.8VDC (manufacturer's specifications)

The frequency stability of the transmitter was examined at the voltage extremes and for the temperature range of -30°C to +50°C. The carrier frequency was measured while the EUT was in the temperature chamber. The reference frequency of the EUT was measured at the ambient room temperature with the frequency counter.

Two limits were evaluated which are dependent on the frequency band of operation. In the frequency range 2.025-2.11GHz a frequency tolerance of 0.005% must be maintained. In the frequency range 2.45-2.4835GHz a frequency tolerance of 0.001% must be maintained.

### 4.5.1 Test Procedure

The temperature stability was measured with the unit in an environmental chamber used to vary the temperature of the sample. The sample was held at each temperature step to allow the temperature of the sample to stabilize.

The frequency stability of the transmitter was examined at the voltage extremes and for the temperature range of -30°C to +50°C. The carrier frequency was measured while the EUT was in the temperature chamber. The reference frequency of the EUT was measured at the ambient room temperature with the frequency counter.

### 4.5.2 Test Results

The EUT complies with the temperature stability requirements of FCC Part §2.1055 & Part §74.661. Test results are given in Tables 12-15.

 

## Table 18: Frequency Stability Test Data TX @ 2101.5MHz

| Temperature (Centigrade) | Frequency (MHz) | Difference (Hz) | Deviation (%) |
|---|---|---|---|
| Ambient | 2101.499791 | 0.0 | 0 |
| -30 | 2101.500711 | 920.0 | 0.000044 |
| -20 | 2101.500660 | 869.0 | 0.000041 |
| -10 | 2101.500555 | 764.0 | 0.000036 |
| 0 | 2101.499917 | 126.0 | 0.000006 |
| 10 | 2101.499916 | 125.0 | 0.000006 |
| 20 | 2101.499851 | 60.0 | 0.000003 |
| 30 | 2101.499624 | -167.0 | 0.000008 |
| 40 | 2101.499441 | -350.0 | 0.000017 |
| 50 | 2101.499840 | 49.0 | 0.000002 |

## Table 19: Frequency Stability Test Data TX @ 2458.5MHz

| Temperature (Centigrade) | Frequency (MHz) | Difference (Hz) | Deviation (%) |
|---|---|---|---|
| Ambient | 2458.499435 | 0.0 | 0 |
| -30 | 2458.500665 | 1230.0 | 0.000050 |
| -20 | 2458.500695 | 1260.0 | 0.000051 |
| -10 | 2458.500554 | 1119.0 | 0.000046 |
| 0 | 2458.499857 | 422.0 | 0.000017 |
| 10 | 2458.499777 | 342.0 | 0.000014 |
| 20 | 2458.499672 | 237.0 | 0.000010 |
| 30 | 2458.499364 | -71.0 | 0.000003 |
| 40 | 2458.499242 | -193.0 | 0.000008 |
| 50 | 2458.499844 | 409.0 | 0.000017 |

## Table 20: Frequency Stability Test Data (Voltage Variation) TX @2101.5MHz

| Voltage (Volts) | Frequency (MHz) | Difference (Hz) | Deviation (%) | Voltage (Volts) |
|---|---|---|---|---|
| At rated | 2101.499791 | 0 | 0.0 | 12VDC |
| At 85% | 2101.499651 | 140 | 0.000007 | 10.9VDC |
| At 115% | 2101.500562 | -771 | 0.000037 | 13.8VDC |

## Table 21: Frequency Stability Test Data (Voltage Variation) TX @2458.5MHz

| Voltage (Volts) | Frequency (MHz) | Difference (Hz) | Deviation (%) | Voltage (Volts) |
|---|---|---|---|---|
| At rated | 2458.499435 | 0 | 0.0 | 12VDC |
| At 85% | 2458.499132 | 303 | 0.000012 | 10.9VDC |
| At 115% | 2458.500265 | -830 | 0.000034 | 13.8VDC |