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FCC & Industry Canada Certification Test Report

For the

Broadcast Sports Inc.

HD Mini Transmitter

FCC ID: KTB-13281-9-005

WLL JOB# **11806-01 Rev 2**
March 30, 2011

Re-Issued July 12, 2011

Prepared for:

Broadcast Sports Inc.
7455 Race Road
Hanover, MD 21076

Prepared By:

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

ACCREDITED TESTING
Testing Certificate AT-1448

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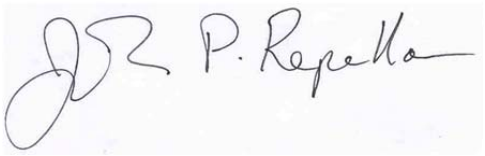

John P. Repella
Compliance Engineer

Reviewed by:

Steven D. Koster
EMC Operations Manager

Abstract

This report has been prepared on behalf of Broadcast Sports, Inc. 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, Inc. HD Mini-TX.

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 ACLASS under Certificate AT-1448 as an independent FCC test laboratory.

The Broadcast Sports, Inc. HD Mini-TX 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	March 30, 2011
Rev1	Administrative corrections, changed maximum antenna gain for unit	April 19, 2011
Rev 2	Retest to address specific frequency ranges for Part 74F requirements	July 12, 2011

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1 Introduction

1.1 Compliance Statement

The Broadcast Sports Inc. HD-Mini 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 2003 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, Inc. 7455 Race Road Hanover, MD, 21076
Purchase Order Number:	0015095
Quotation Number:	65813

1.4 Test Dates

Testing was performed on the following date(s): 1/17/2011-2/08/2011, Retest 6/24/2011& 6/27/2011

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 Mini Transmitter (TX) is intended to transmit audio and video from remote locations where size and weight are of concern, e.g. mounted on a race car or a belt pack.

The HD Mini TX is designed to accept two audio inputs and one video input, perform various processing and modulation functions on those signals, and output a DVB-T COFDM signal to an external antenna.

The unit's 2 audio inputs are balanced mic-level connectors with 5 Vdc phantom power. The single video input can be HD-SDI, SD-SDI, ASI (1080, 720, or 480 vertical lines of resolution) or SMPTE-170M, all of which the HD Mini TX will auto-detect and pre-process appropriately. Once the signal is 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 and 64QAM) and output to an attached antenna.

Table 1: Device Summary

ITEM	DESCRIPTION
Manufacturer:	Broadcast Sports Inc.
FCC ID:	KTB-13281-9-005
Model:	HD Mini Transmitter
FCC Rule Parts:	§74 Sub Part F
Industry Canada:	RSS-210
Frequency Range:	2025 - 2110MHz & 2450-2483.5MHz
Maximum Output Power:	302mW(24.80 dBm) @ 2483.5 MHz 296mW(24.71 dBm) @ 2025 MHz
Modulation:	QPSK,16QAM, 64QAM
Occupied Bandwidth:	8 MHz
Keying:	Automatic, Manual
Type of Information:	Audio/Video
Number of Channels:	16
Highest Power Output Level	302mW @ 2483.5 MHz, 296mW @ 2025 MHz
Antenna Connector	SMA
Antenna Type	Multiple up to, Max 5.1 dBi
Frequency Tolerance	2025 - 2110MHz >0.005 & 2450-2483.5MHz >0.001
Interface Cables:	See Interface Cables
Power Source & Voltage:	12-17Vdc

2.2 Test Configuration

With all equipment connected as shown in Figure 1 and the HD Mini TX transmitting, the MSK 200 (in "TV" mode, positioned across the room from the HD Mini TX) should indicate that it is "fully locked" and display the video feed from the TG700.

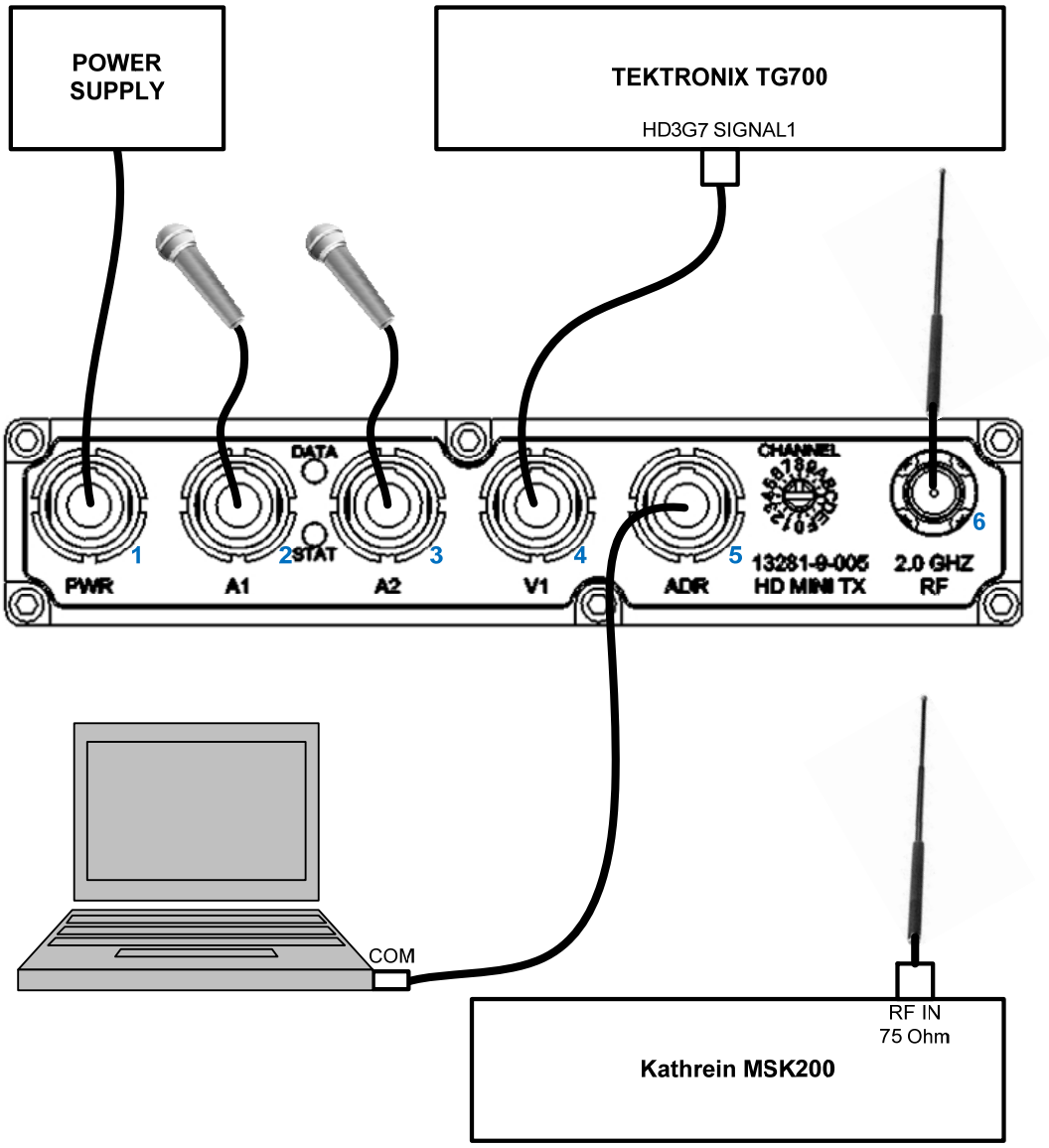

Figure 1: Test Configuration

2.3 Testing Algorithm

The HD Mini TX will a uto-detect input video in 4 formats – HD-SDI, SD-SDI, ASI, and analog NTSC. The carrier is selectab le in 250 kHz increm ents, from 2000 MHz to 2500 MHz. The FEC rate is selectable (½, ⅔, ¾, ⅚, ⅞) as is the modulation scheme (QPSK, 16QAM, and 64QAM).

2.4 Test Location

All measurements herein were p erformed at Washington Laboratories, Ltd. te st center in Gaithersburg, MD. Site description and site attenua tion data have been pl aced on f ile with th e FCC's Sampling and Measurements Branch at the FCC laboratory in Columbia, MD. The Industry Canada OATS numbers are 3035A-1 and 3035A-2 fo r Washington Laboratories, Ltd. Site 1 and Site 2, respectively. Washington Laboratories, Ltd. has been accepted by the FCC and approved by ACLASS under Certificate AT-1448 as an independent FCC test laboratory.

2.5 Measurements

2.5.1 References

Land Mobile FM or PM Communications Equipm ent Measurement and Perfor mance Standards (ANSI/TIA/EIA-603-93)

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

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

2.6 Measurement Uncertainty

All results reported herein relate only to th e equipment tested. For the pu rposes of the measurements performed by W ashington Laboratories, the measurement uncertainty is ±2.3 dB. This has been calculated for a *worst-case situation* (radiated emissions measurements performed on an open area test site).

The following measurement uncertainty calculation is provided:

$$\text{Total Uncertainty} = (A^2 + B^2 + C^2)^{1/2} / (n-1)$$

Where:

A = Antenna calibration uncertainty, in dB = 2 dB

B = Spectrum Analyzer uncertainty, in dB = 1 dB

C = Site uncertainty, in dB = 4 dB

n = number of factors in uncertainty calculation = 3

Thus, Total Uncertainty = $0.5\ (2^2 + 1^2 + 4^2)^{1/2} = \pm 2.3$ dB.

3 Test Equipment

Table 2 shows a list of the test equipment used for measurements along with the calibration information.

Table 2: Test Equipment List

Test Name:	**EIRP and Bench Conducted Emissions**	Test Date:	3/1/11
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
71	HP - 85685A	PRESELECTOR RF	7/1/2011
73	HP - 8568B	ANALYZER SPECTRUM	7/1/2011
69	HP - 85650A	ADAPTER QP	7/1/2011
382	SUNOL SCIENCES CORPORATION - JB1	ANTENNA BICONLOG	1/12/2012
644	SUNOL SCIENCES CORPORATION - JB1 925-833-9936	BICONALOG ANTENNA	12/20/2011
667	MEGAPHASE - EM18-S1NK5-600	TEST CABLE FOR OATS TESTING DC TO 18 GHZ SMA MALE	5/7/2011
528	AGILENT - E4446A	ANALYZER SPECTRUM	9/27/2011
522	HP - 8449B	PRE-AMPLIFIER 1-26.5GHZ	7/27/2011
4	ARA - DRG-118/A	ANTENNA DRG 1-18GHZ	2/15/2013
1	A.H. SYSTEMS - SAS-200/518	ANTENNA LP 1-18GHZ	4/29/2011
4000	R&S - SMR 40	SIG GEN 1-40GHZ	3/15/2012

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 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 3: RF Power Output (QPSK Modulation)

Channel/TX Frequency (MHz)	Measured Level (dBm)	Measured Level (Watts)	Limit (Watts)
2025	24.71	0.296	12
2110	24.22	0.264	12
2450	24.01	0.251	12
2483.5	24.80	0.302	12

Table 4: RF Power Output (16QAM Modulation)

Channel/TX Frequency (MHz)	Measured Level (dBm)	Measured Level (Watts)	Limit (Watts)
2025	24.64	0.291	12
2110	24.11	0.257	12
2450	23.69	0.234	12
2483.5	24.75	0.299	12

Table 5: RF Power Output (64QAM Modulation)

Channel/TX Frequency (MHz)	Measured Level (dBm)	Measured Level (Watts)	Limit (Watts)
2025	24.68	0.294	12
2110	24.21	0.264	12
2450	24.13	0.259	12
2483.5	24.80	0.302	12

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

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

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

Table 6: Occupied Bandwidth Results (QPSK)

Frequency(MHz)	Bandwidth(MHz)	Limit	Pass/Fail
2025	7.946	18 MHz	Pass
2110	8.045	18 MHz	Pass
2450	8.040	18 MHz	Pass
2483.5	8.168	18 MHz	Pass

Table 7: Occupied Bandwidth Results (16QAM)

Frequency(MHz)	Bandwidth(MHz)	Limit	Pass/Fail
2025	8.003	18 MHz	Pass
2110	8.016	18 MHz	Pass
2450	8.000	18 MHz	Pass
2483.5	8.147	18 MHz	Pass

Table 8: Occupied Bandwidth Results (64QAM)

Frequency(MHz)	Bandwidth(MHz)	Limit	Pass/Fail
2025	7.933	18 MHz	Pass
2110	8.080	18 MHz	Pass
2450	7.969	18 MHz	Pass
2483.5	8.134	18 MHz	Pass

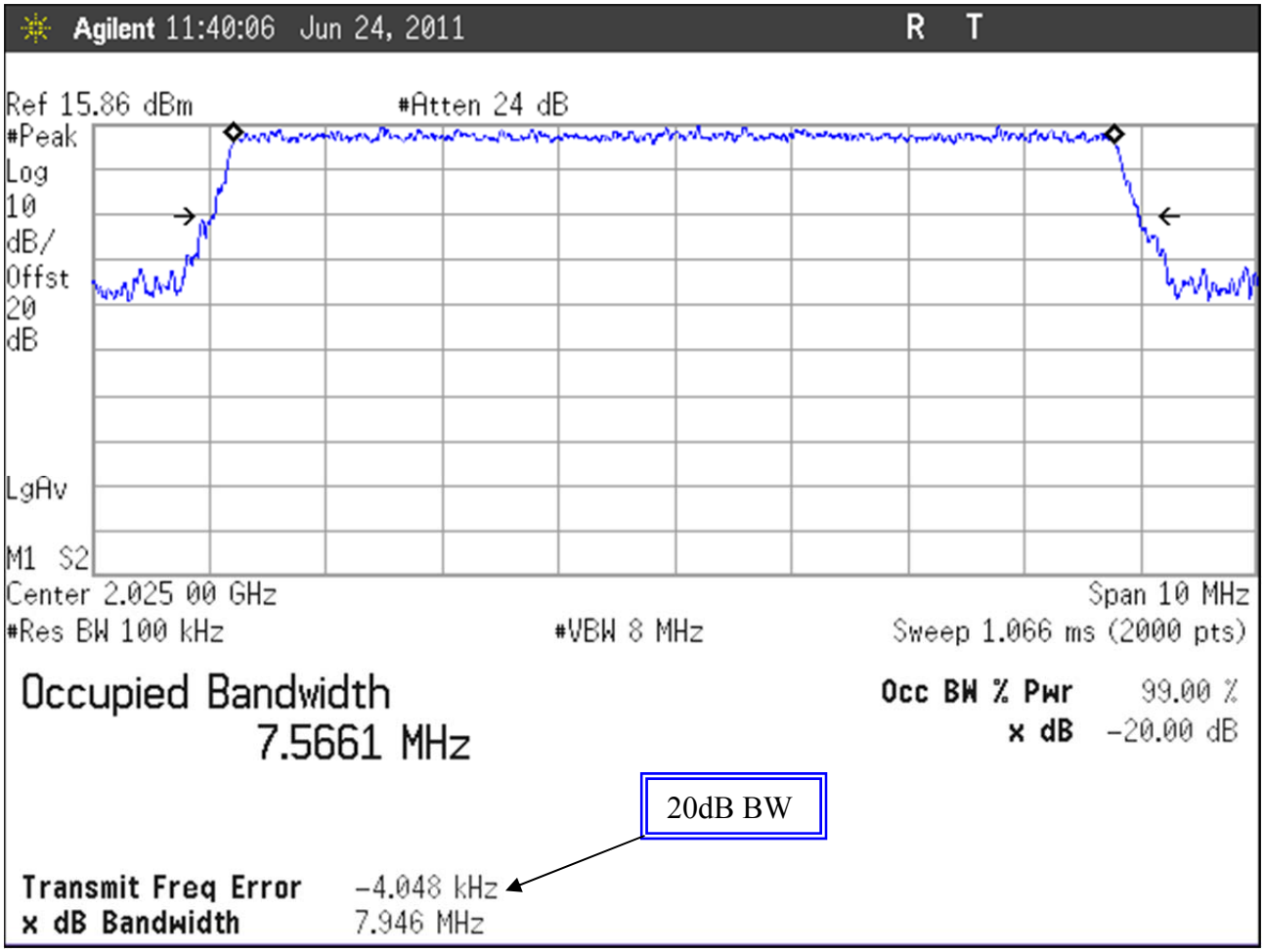

Figure 1: Occupied Bandwidth, QPSK Modulation, TX @ 2025MHz

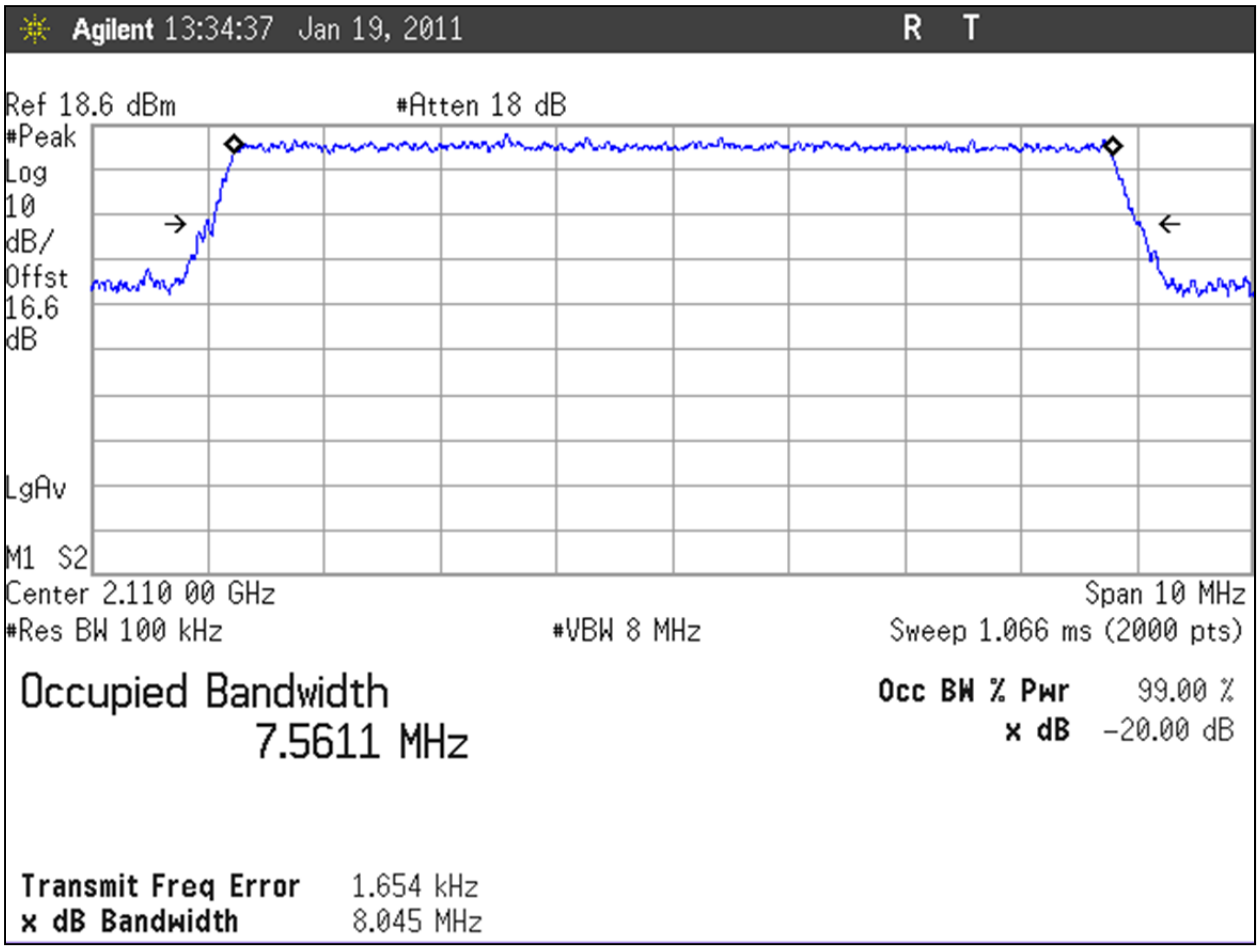

Figure 2: Occupied Bandwidth, QPSK Modulation, TX @ 2110MHz

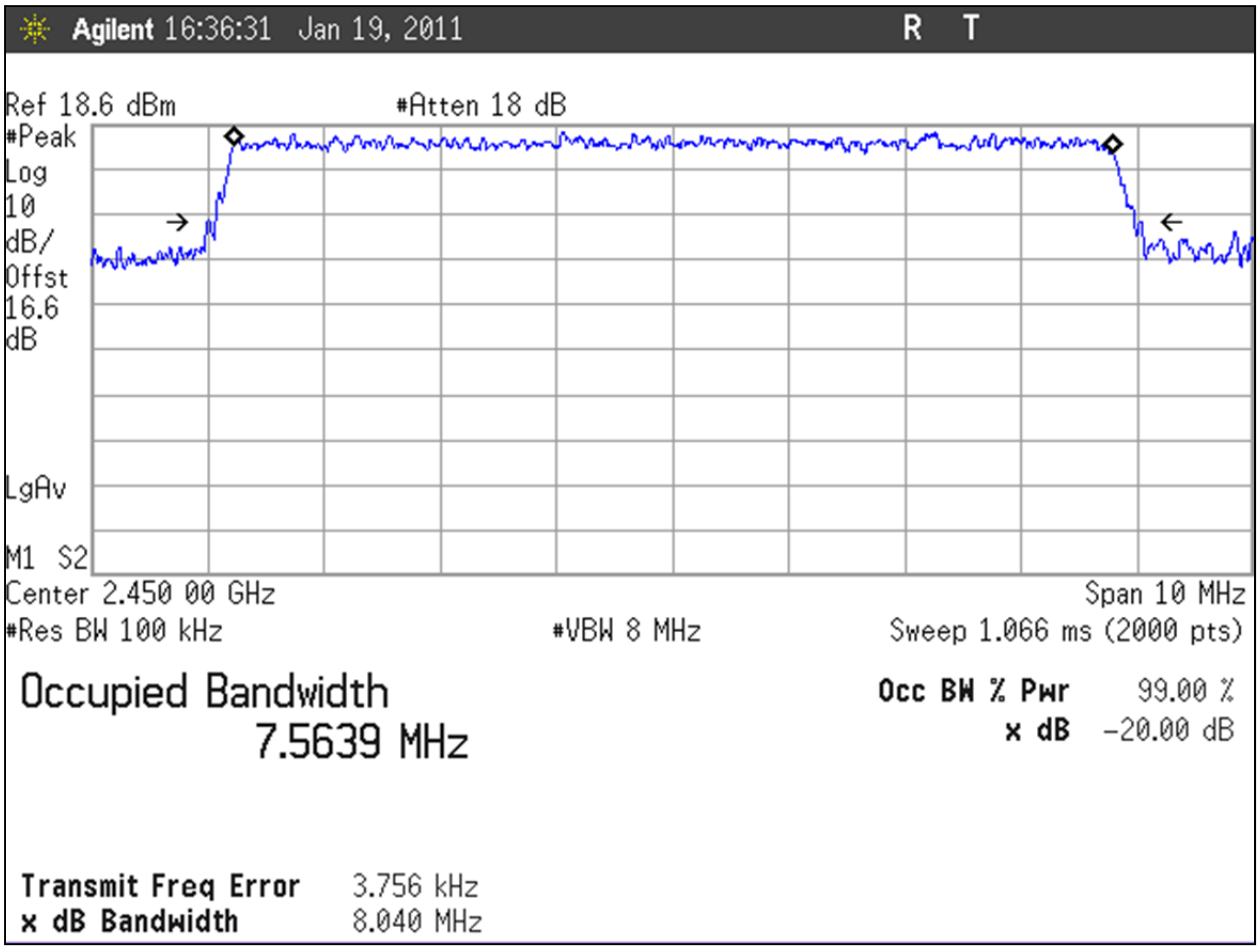

Figure 3: Occupied Bandwidth, QPSK Modulation, TX @ 2450MHz

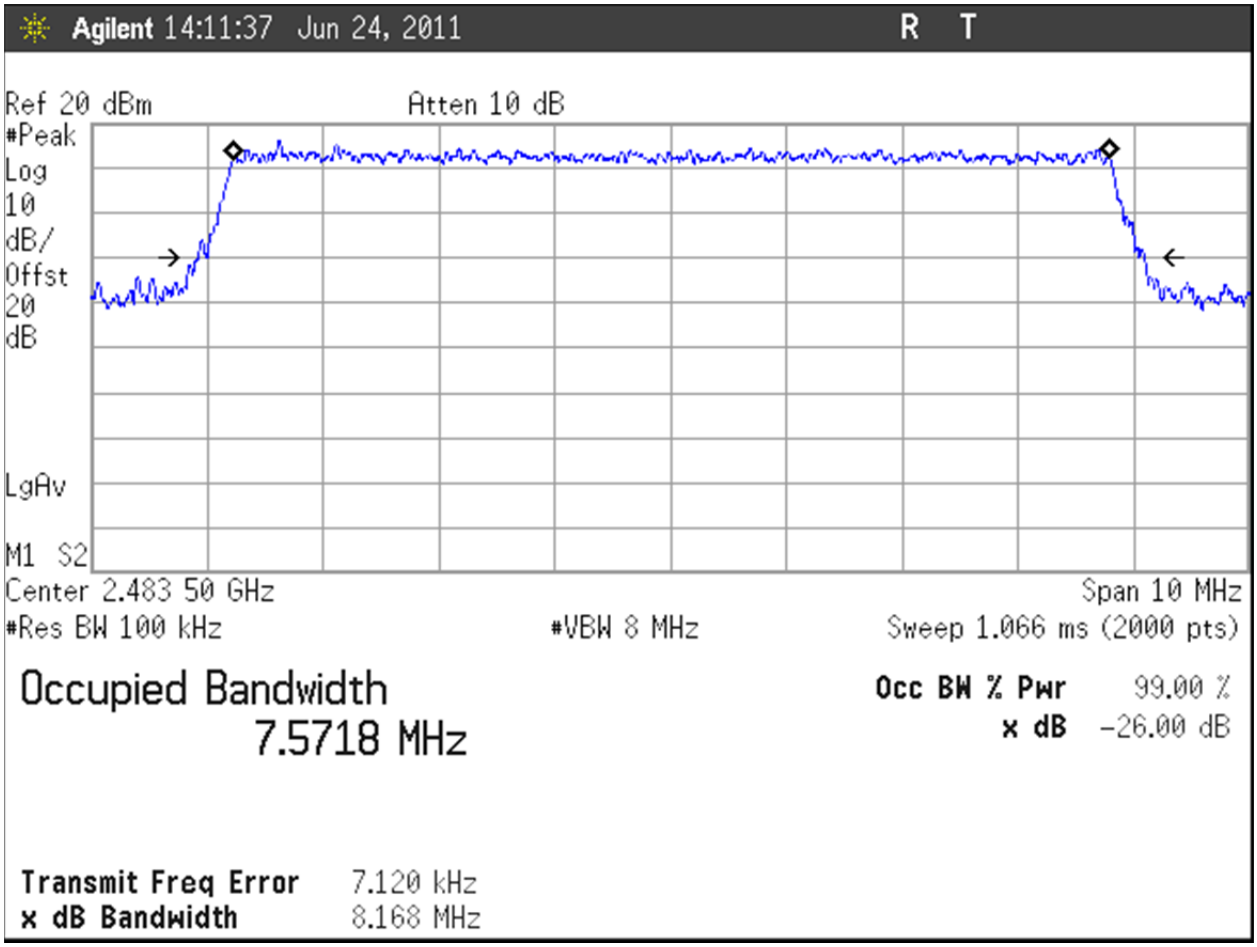

Figure 4: Occupied Bandwidth, QPSK Modulation, TX @ 2483.5MHz

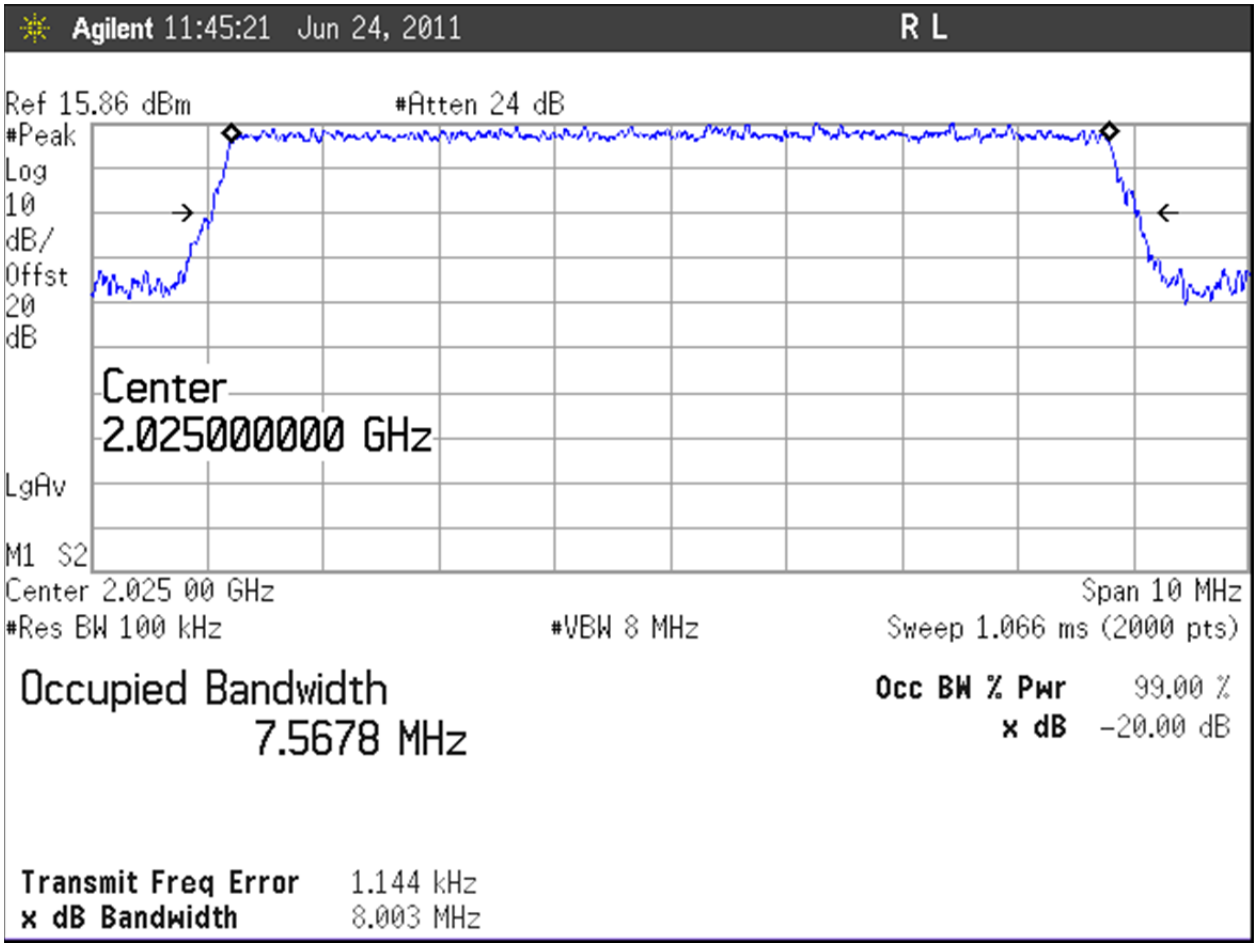

Figure 5: Occupied Bandwidth, 16QAM Modulation, TX @ 2025MHz

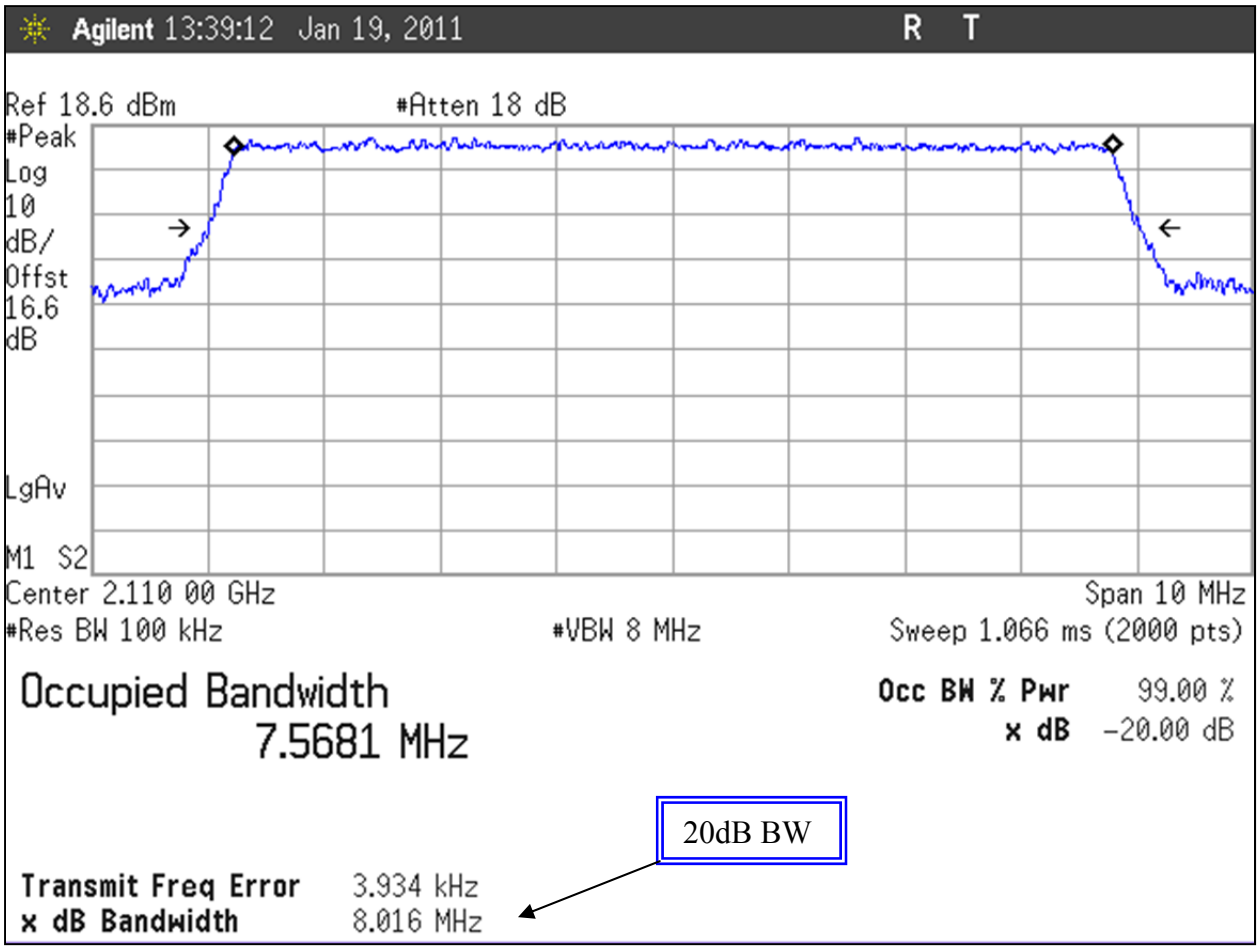

Figure 6: Occupied Bandwidth, 16QAM Modulation, TX @ 2110MHz

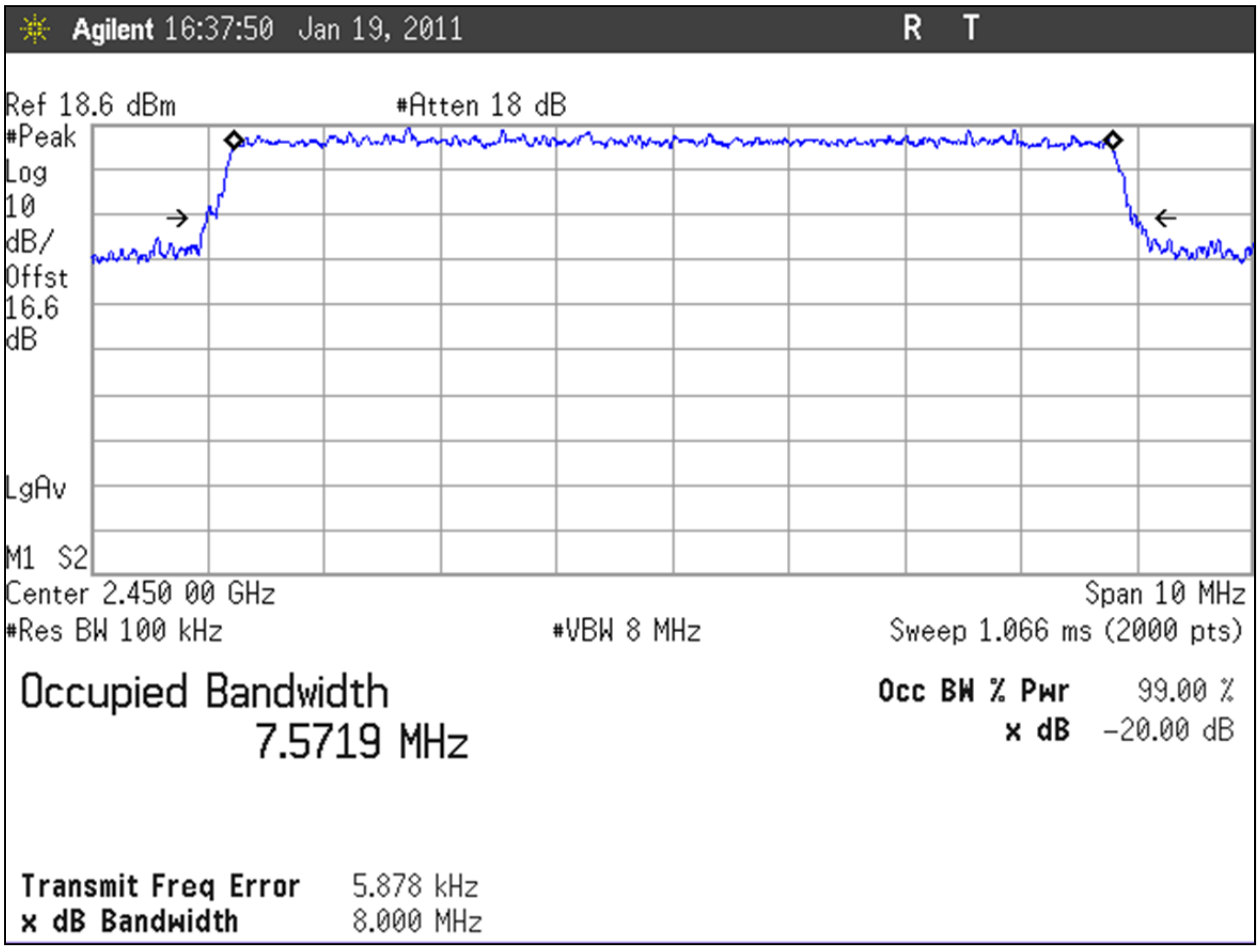

Figure 7: Occupied Bandwidth, 16QAM Modulation, TX @ 2450MHz

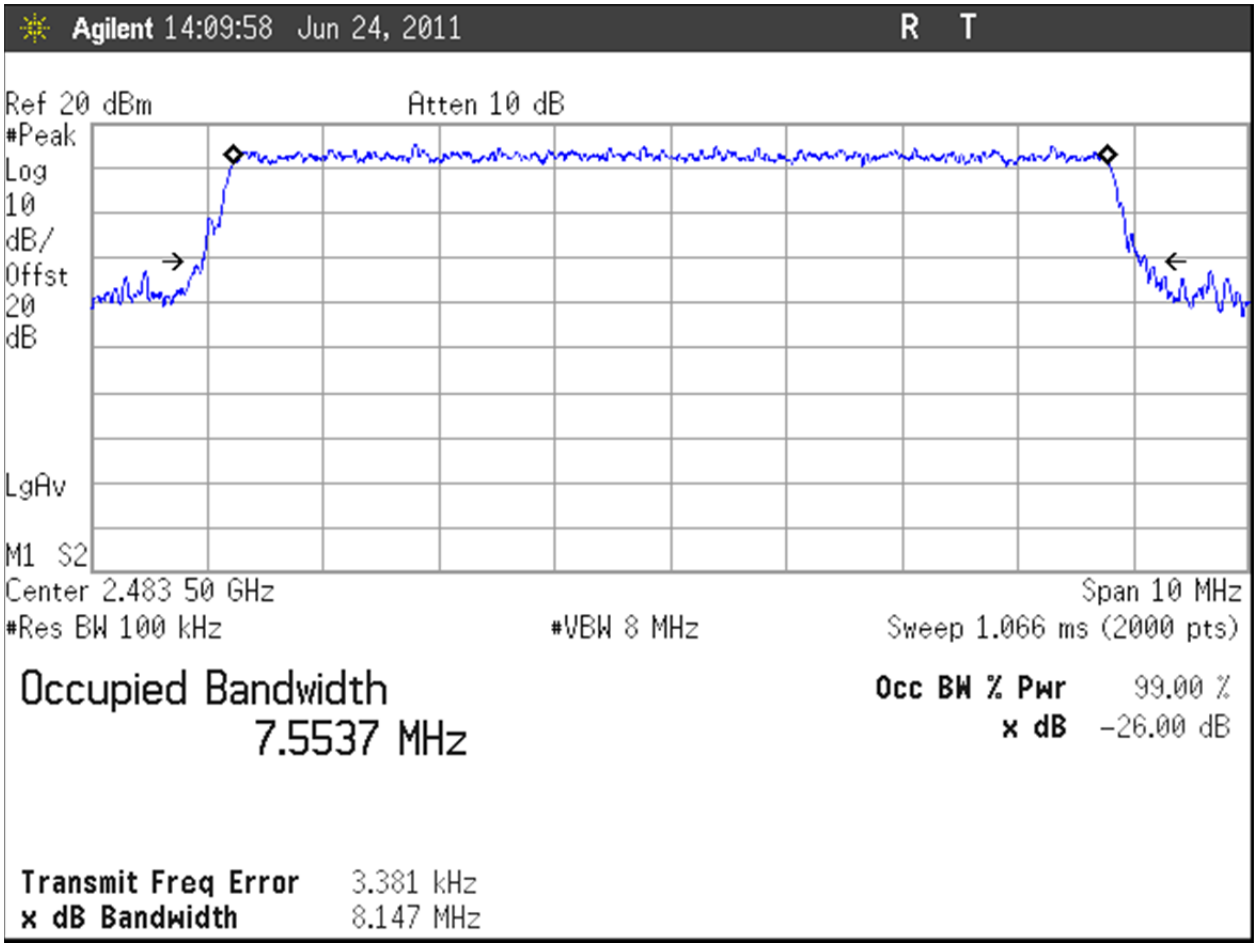

Figure 8: Occupied Bandwidth, 16QAM Modulation, TX @ 2483.5MHz

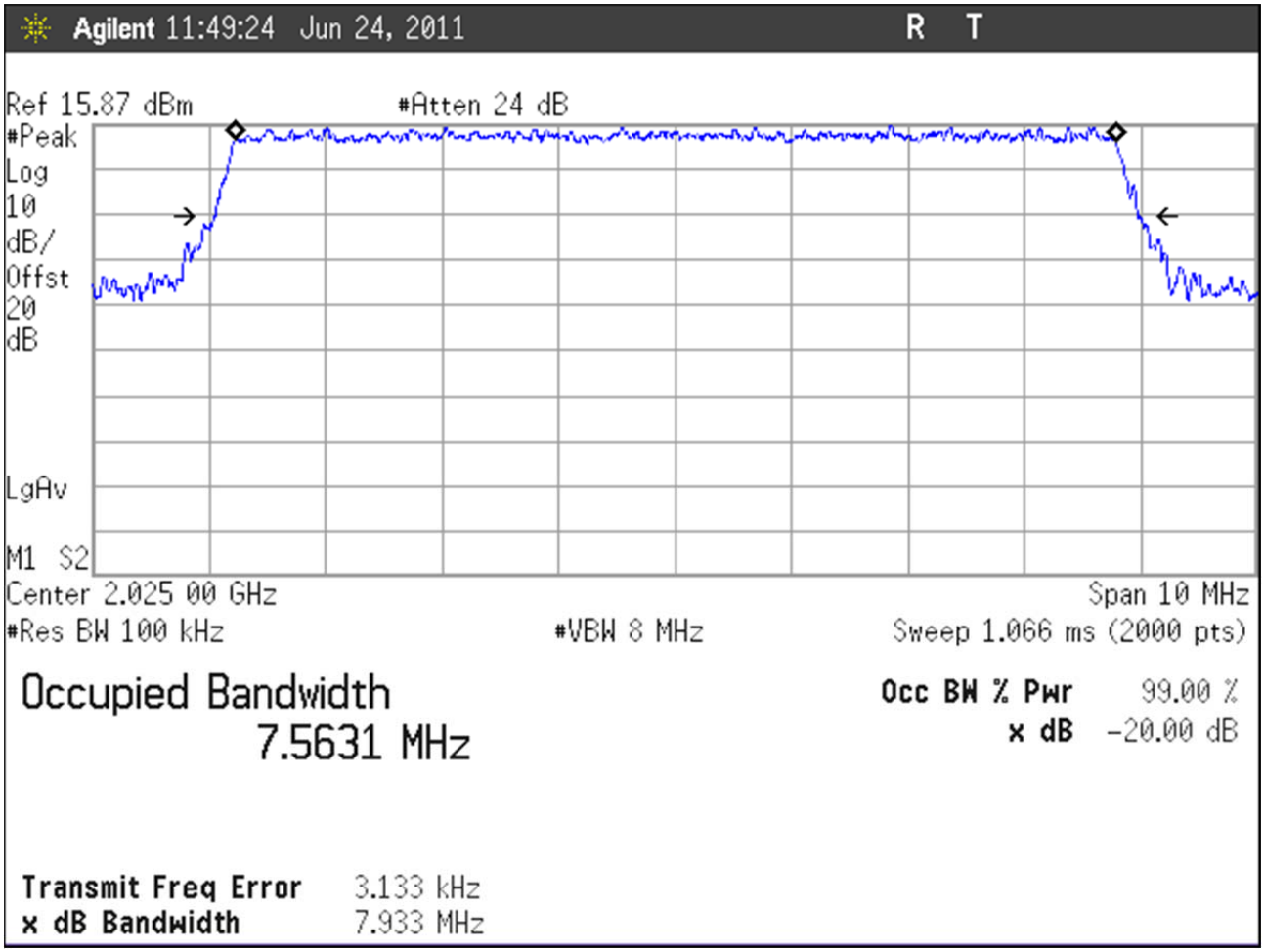

Figure 9: Occupied Bandwidth, 64QAM Modulation, TX @ 2025MHz

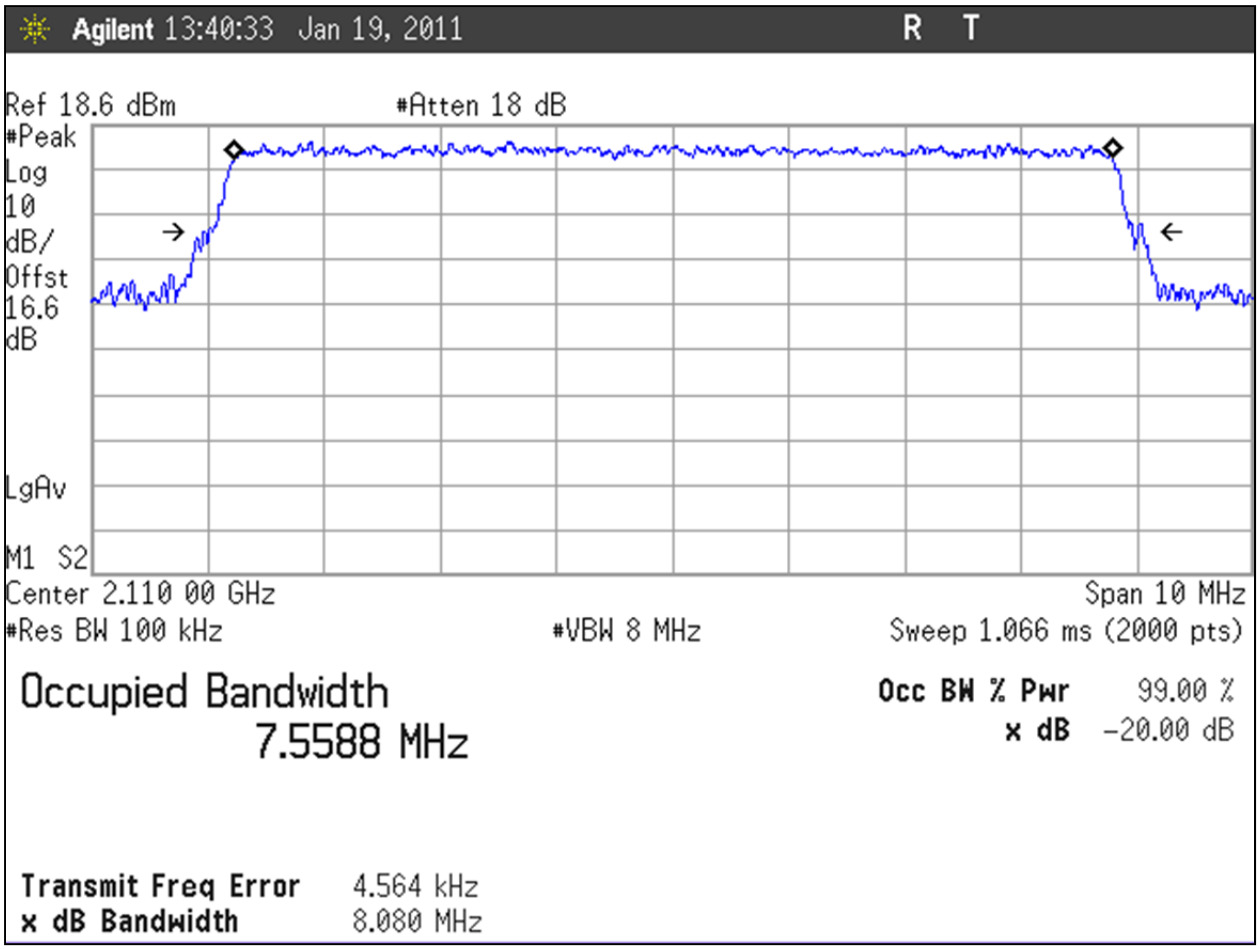

Figure 10: Occupied Bandwidth, 64QAM Modulation, TX @ 2110MHz

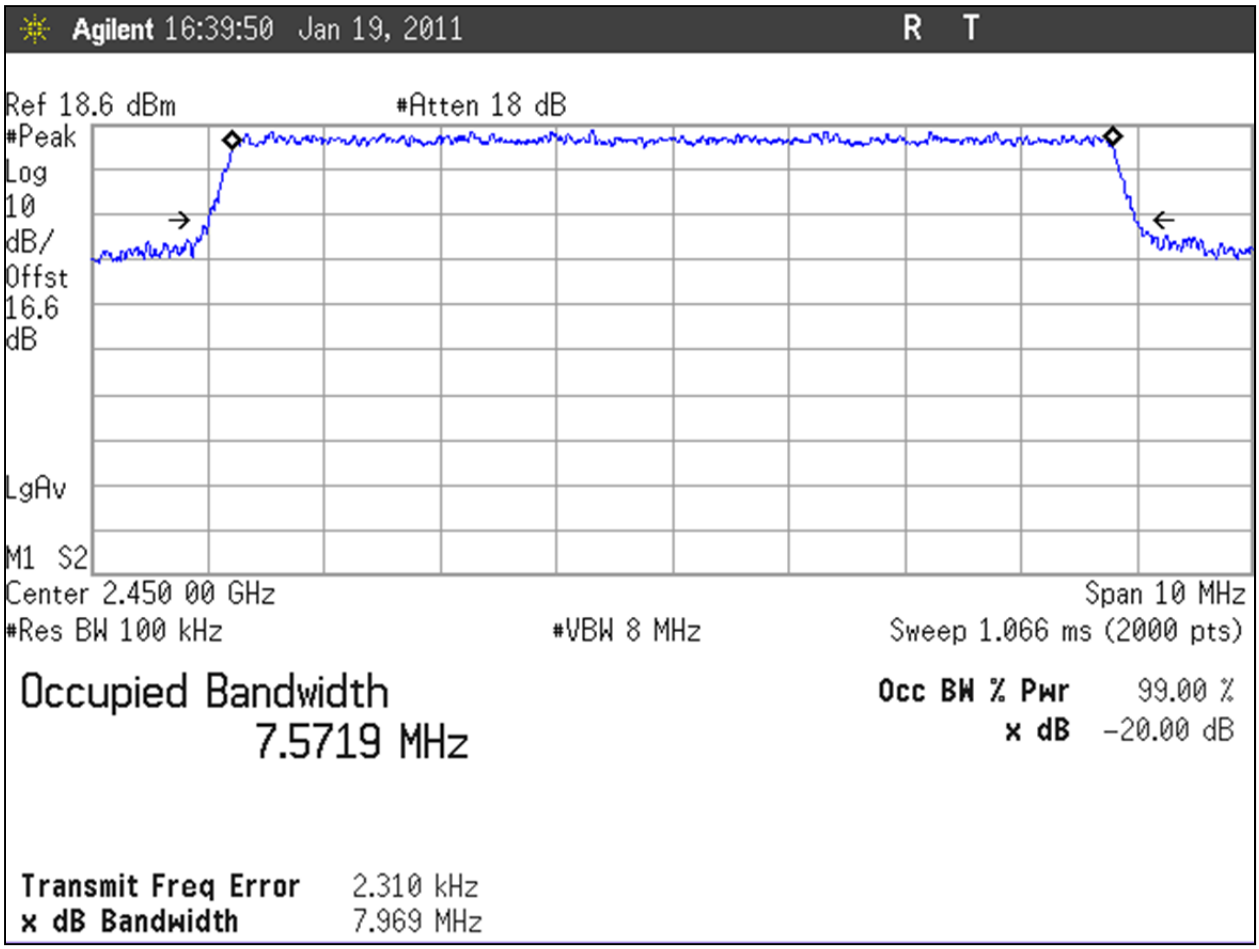

Figure 11: Occupied Bandwidth, 64QAM Modulation, TX @ 2450MHz

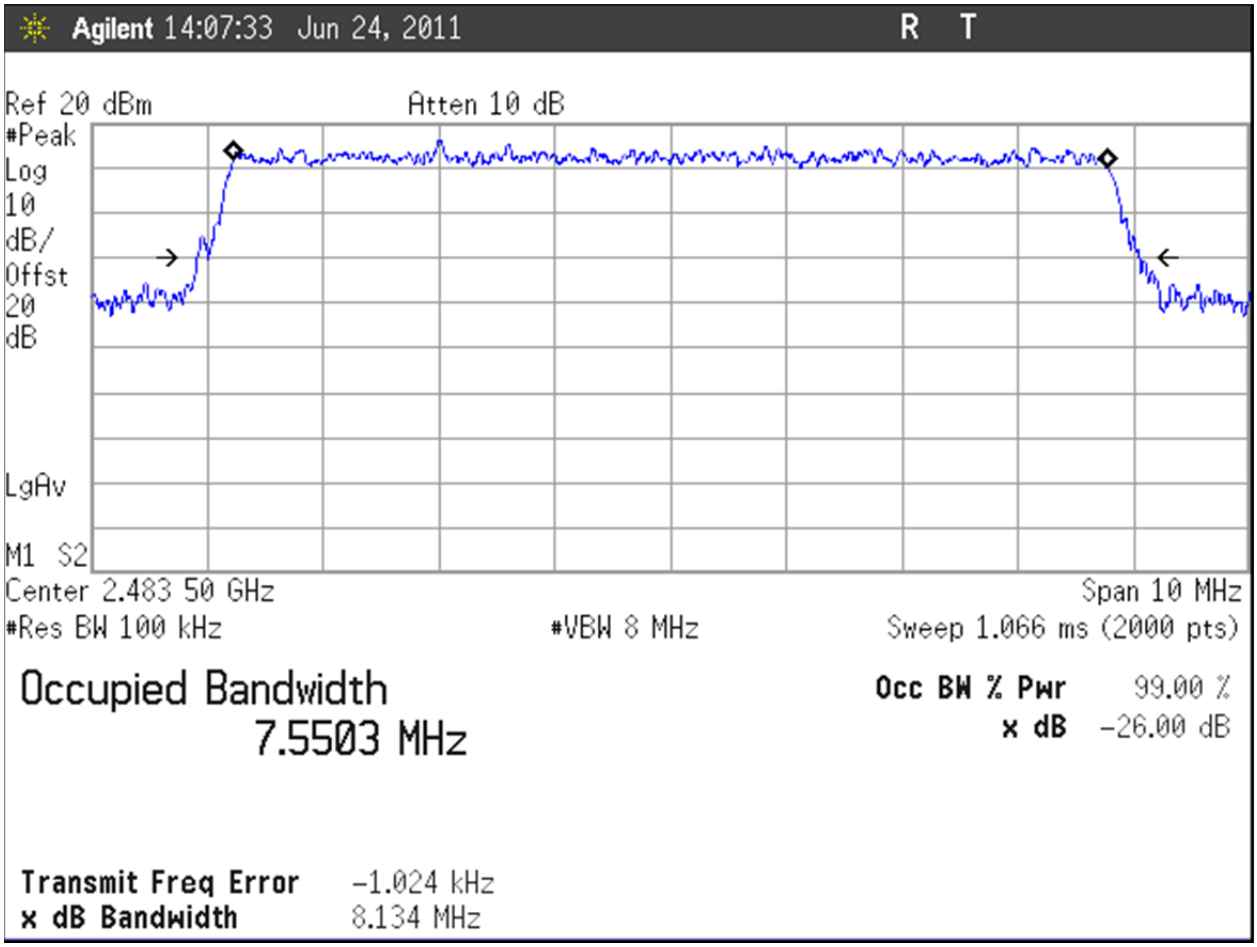

Figure 12: Occupied Bandwidth, 64QAM Modulation, TX @ 2483.5MHz

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.

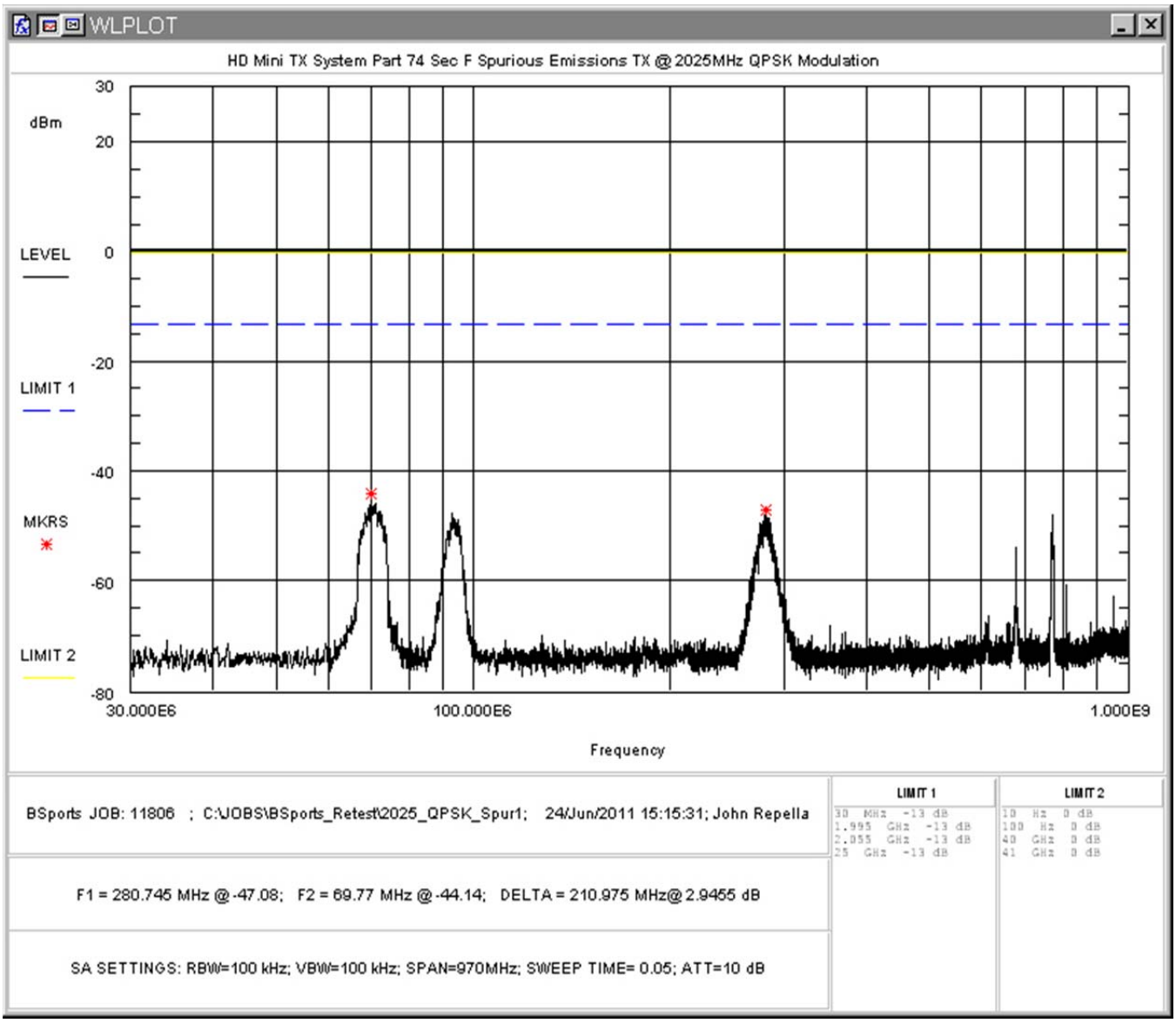

Figure 13: Spurious Emissions, QPSK Modulation, TX @ 2025MHz, 30MHz-1000MHz

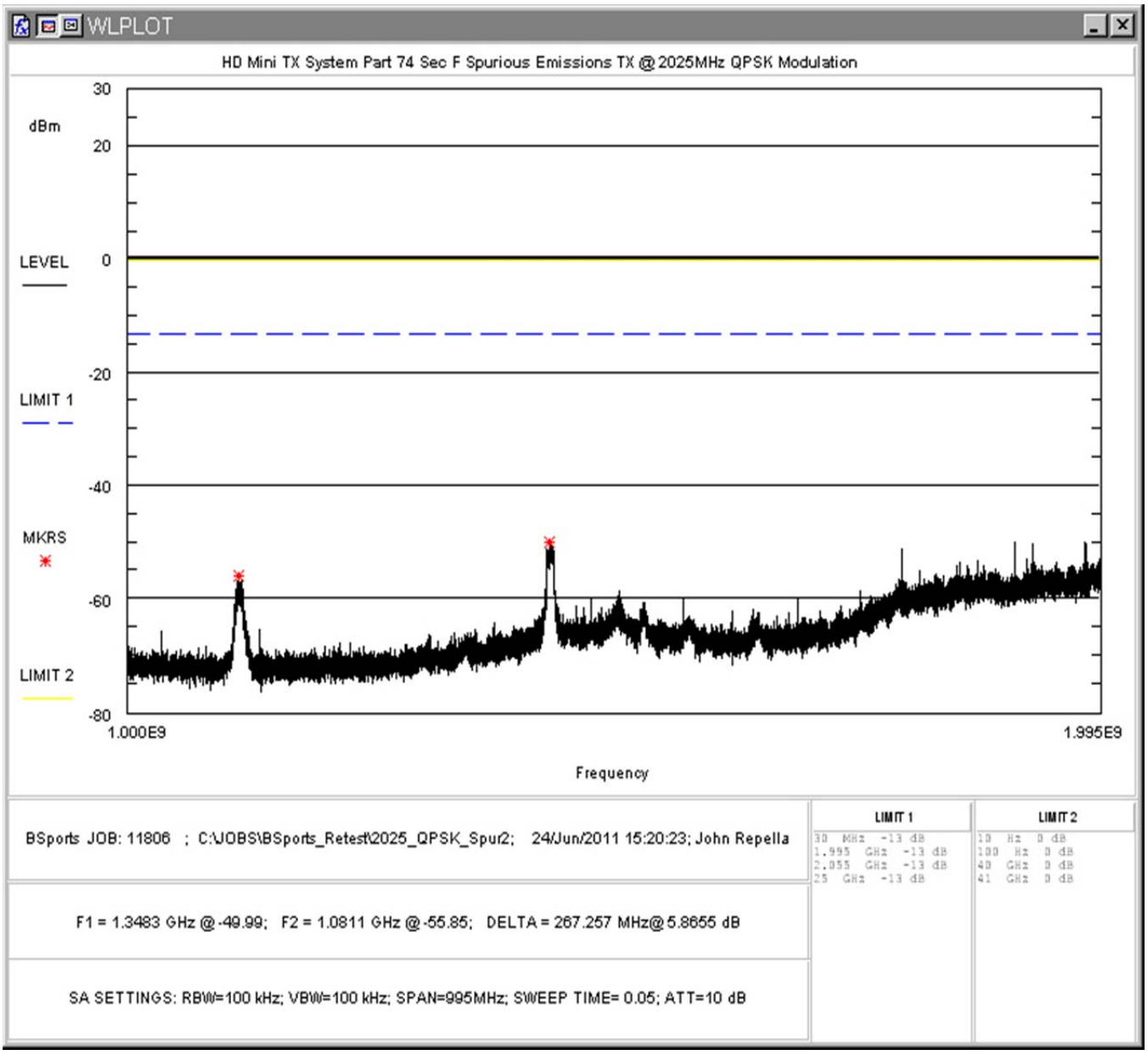

Figure 14: Spurious Emissions, QPSK Modulation, TX @ 2025MHz, 1000-1995MHz

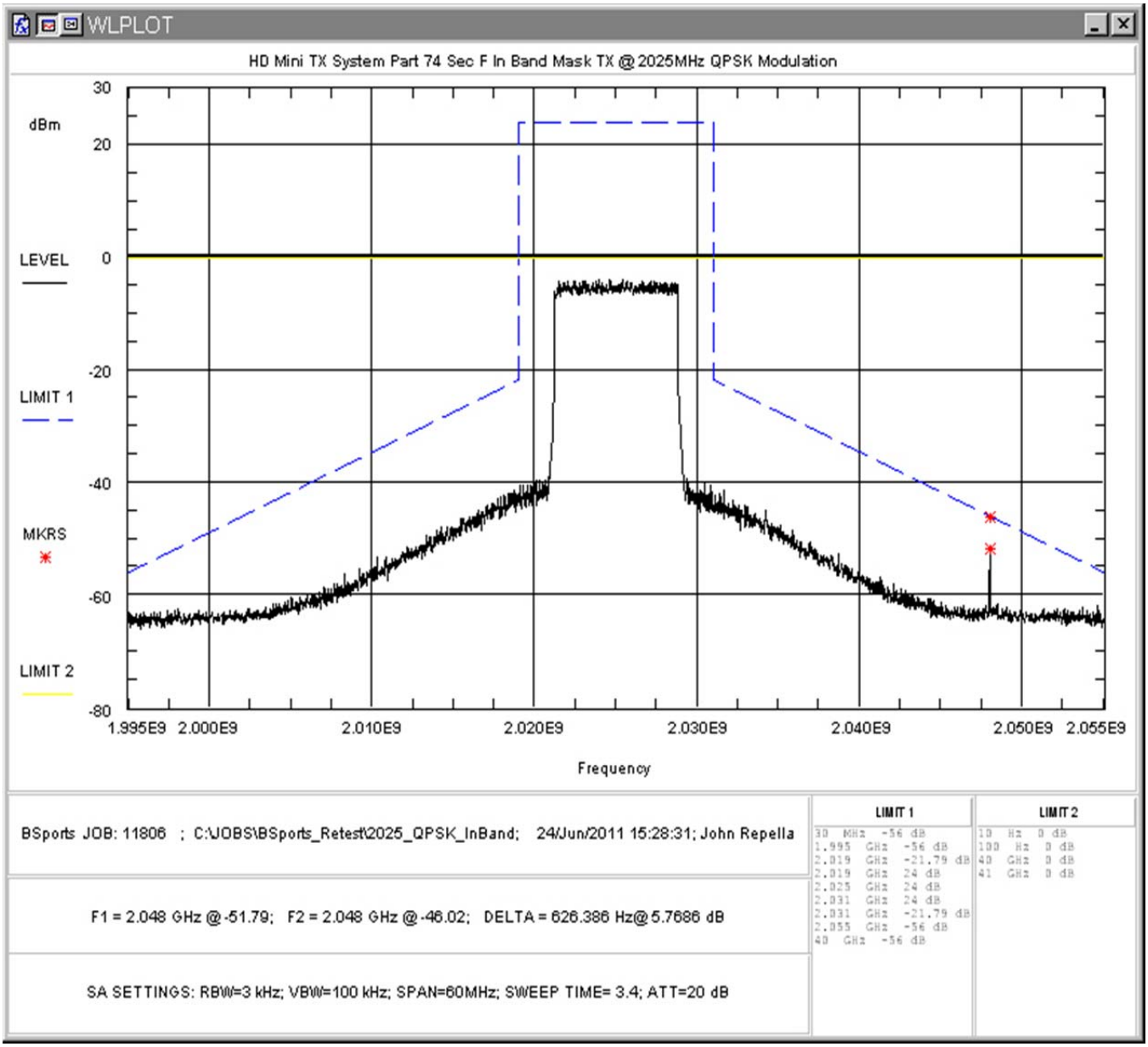

Figure 15: Spurious Emissions, QPSK Modulation, TX @ 2025MHz, Emission Mask

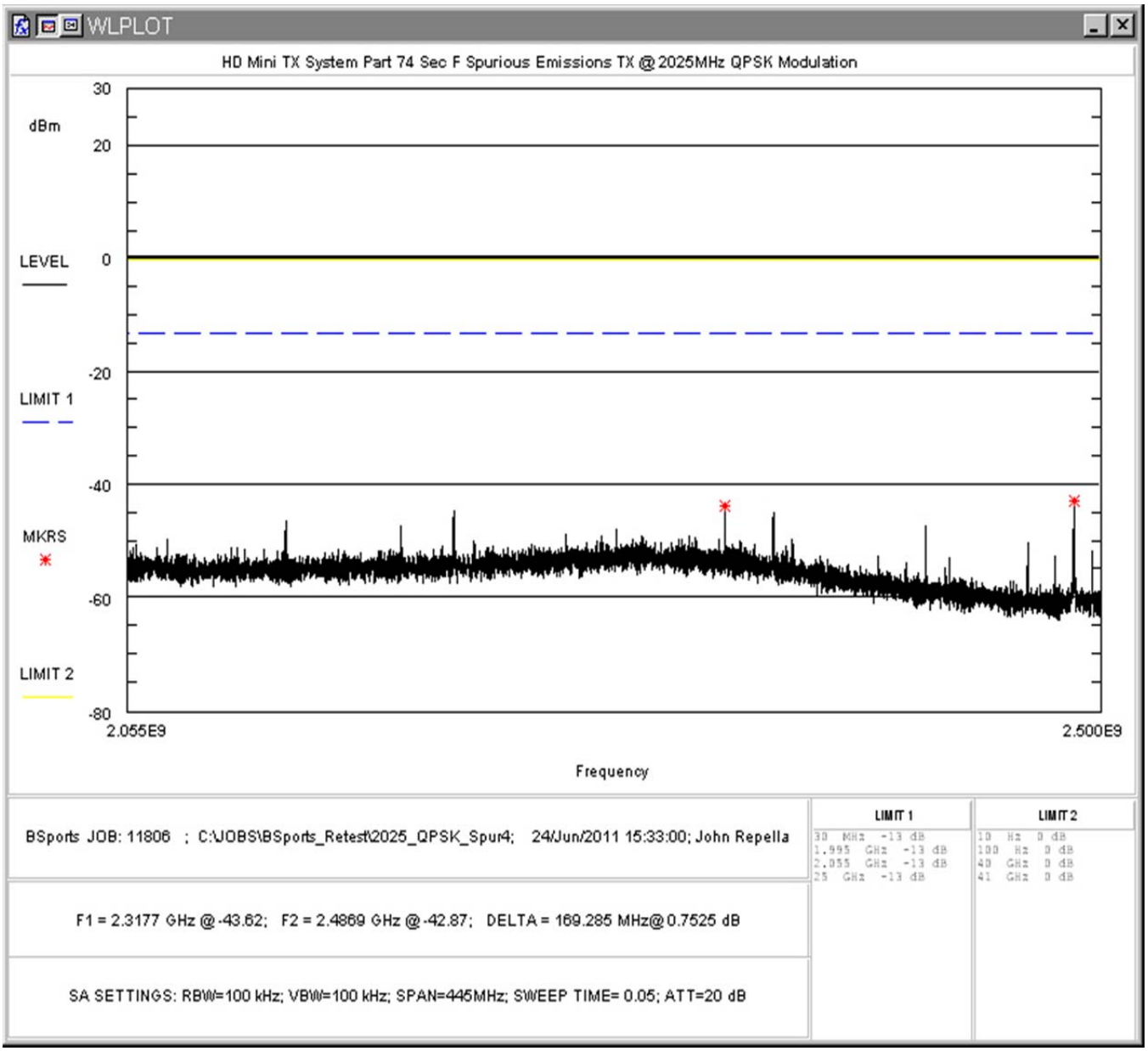

Figure 16: Spurious Emissions, QPSK Modulation, TX @ 2025MHz, 2055MHz-2500MHz

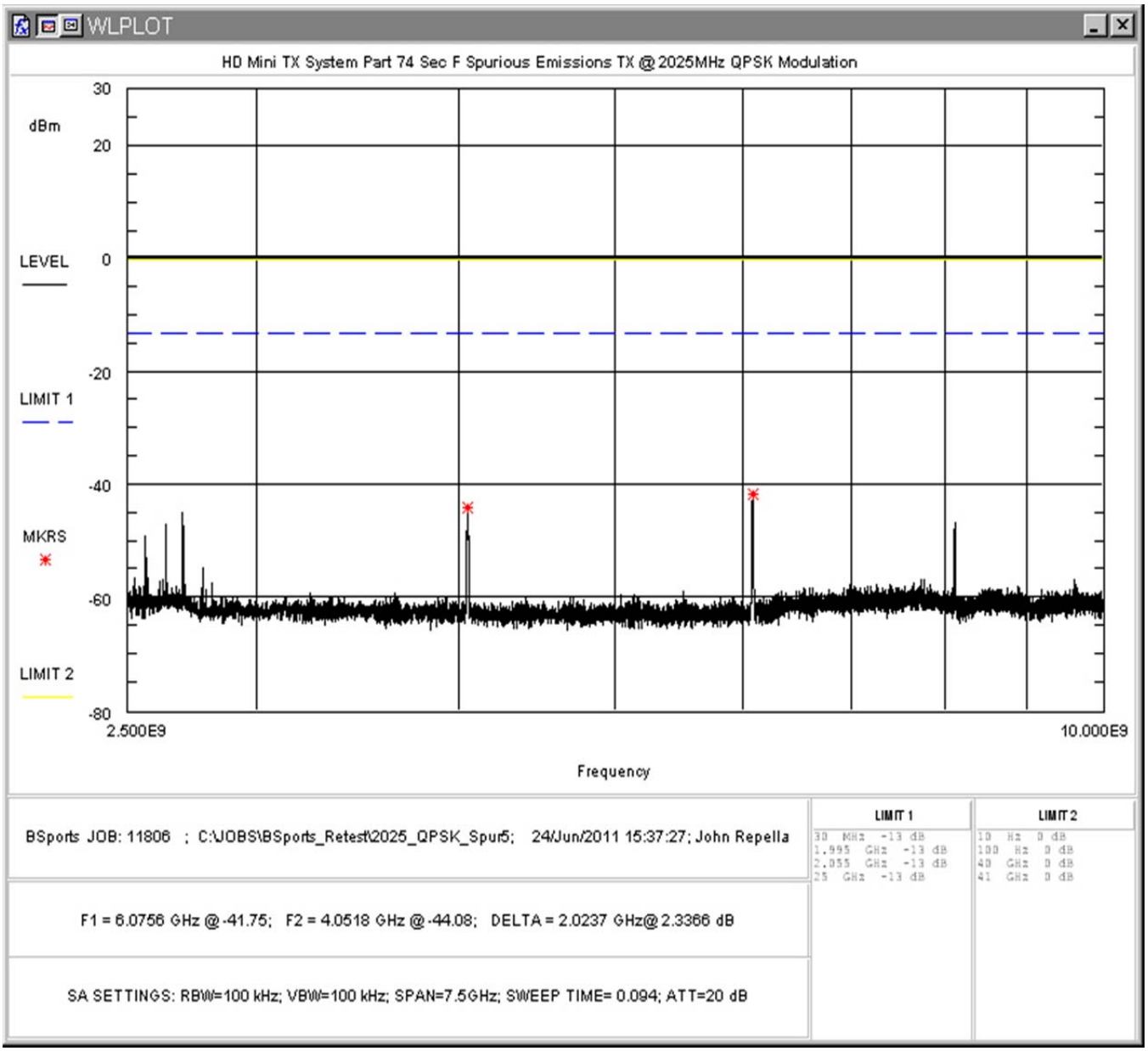

Figure 17: Spurious Emissions, QPSK Modulation, TX @ 2025MHz, 2500MHz-10GHz

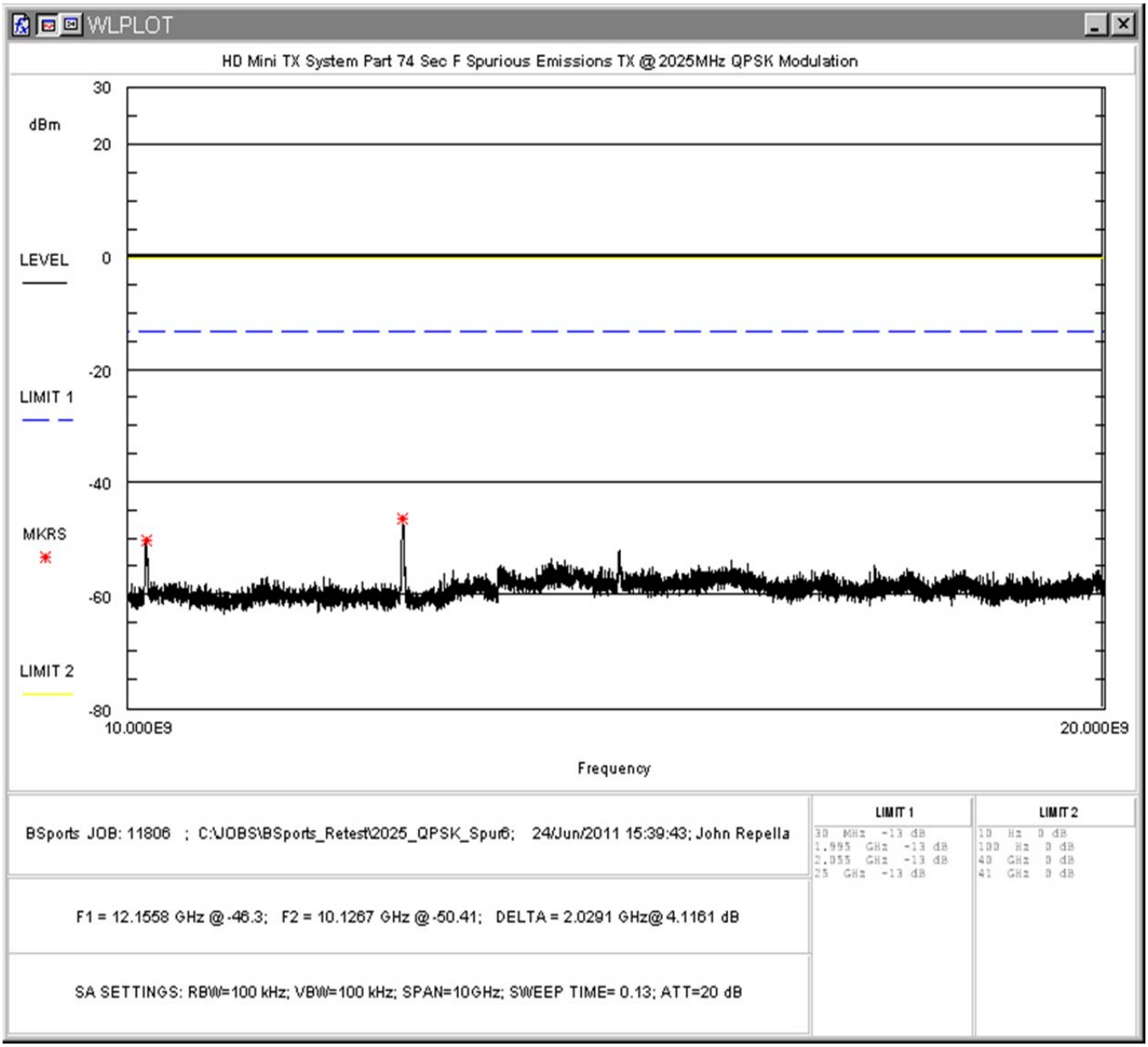

Figure 18: Spurious Emissions, QPSK Modulation, TX @ 2025MHz, 10GHz-20GHz

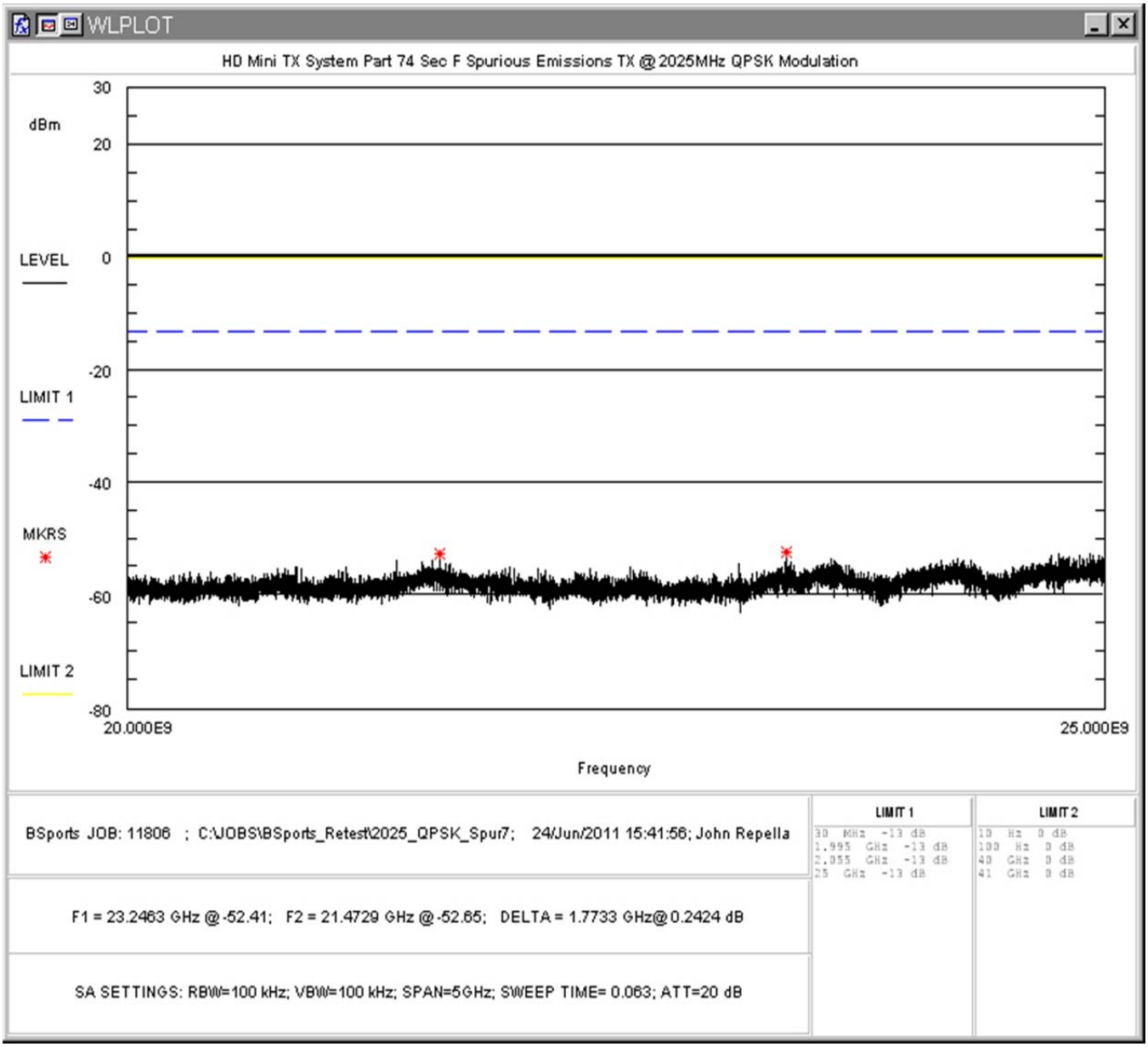

Figure 19: Spurious Emissions, QPSK Modulation, TX @ 2025MHz, 20GHz-25GHz

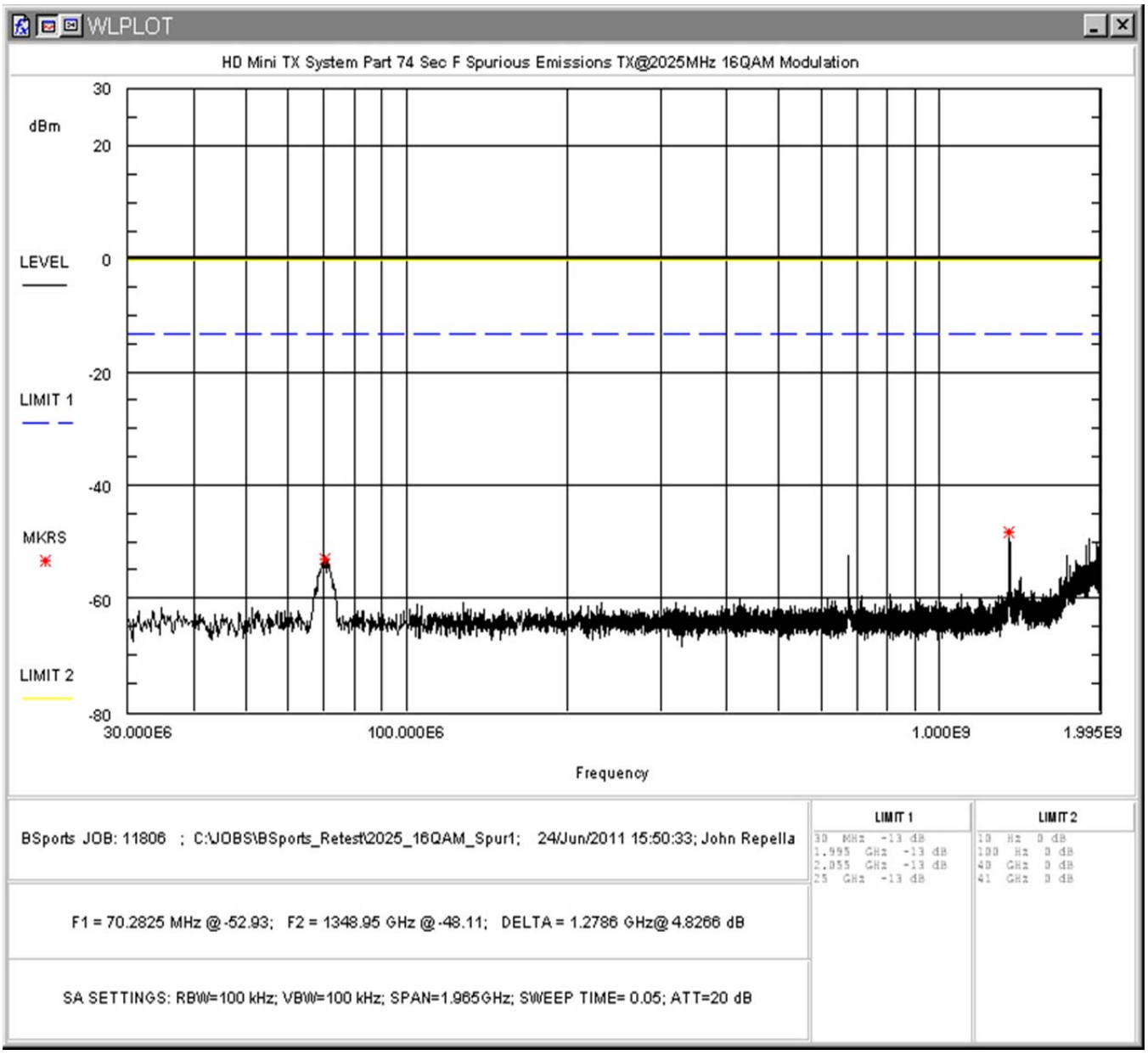

Figure 20: Spurious Emissions, 16QAM Modulation, TX @ 2025MHz, 30MHz-1995MHz

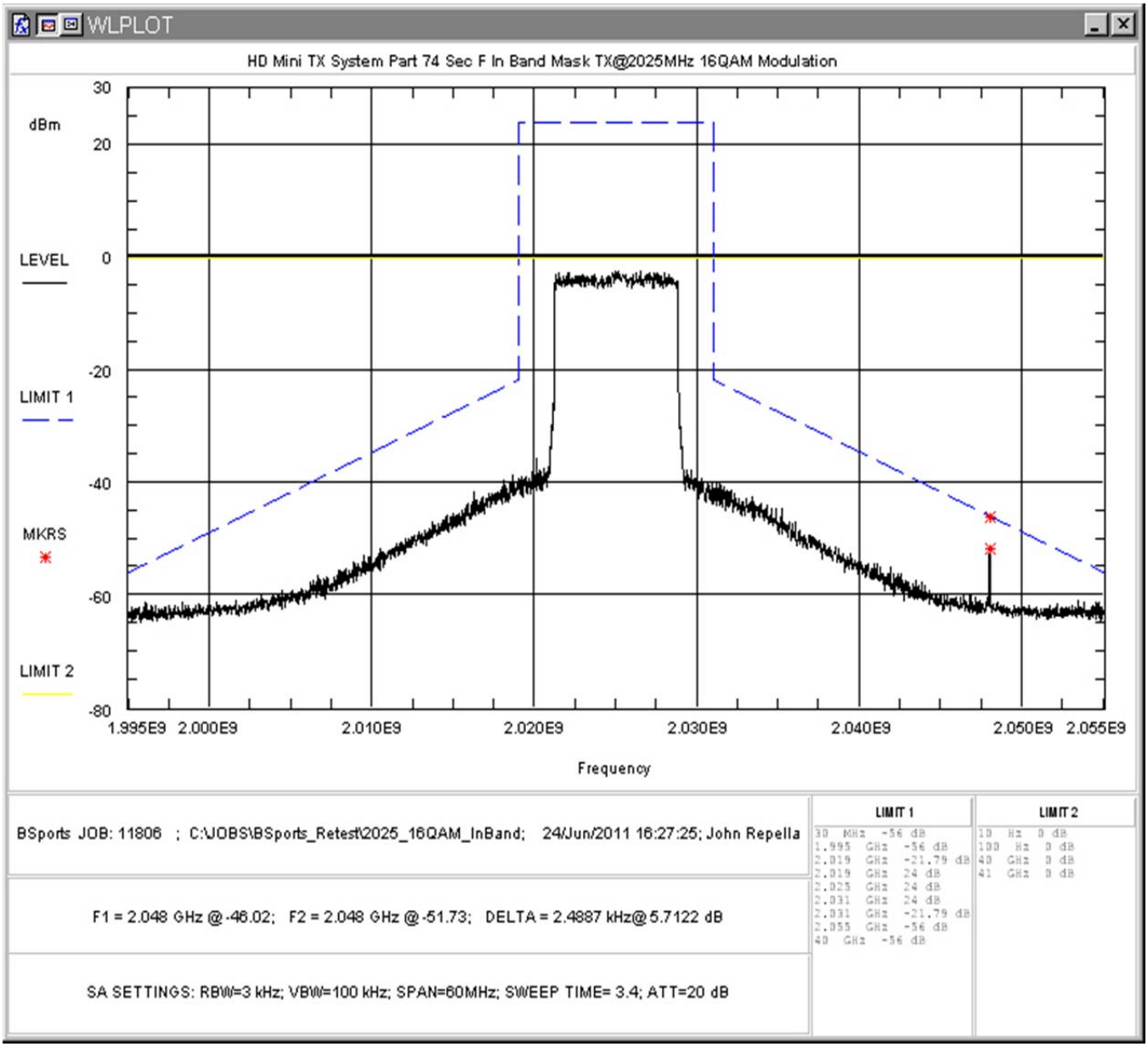

Figure 21: Spurious Emissions, 16QAM Modulation, TX @ 2025MHz, Emission Mask

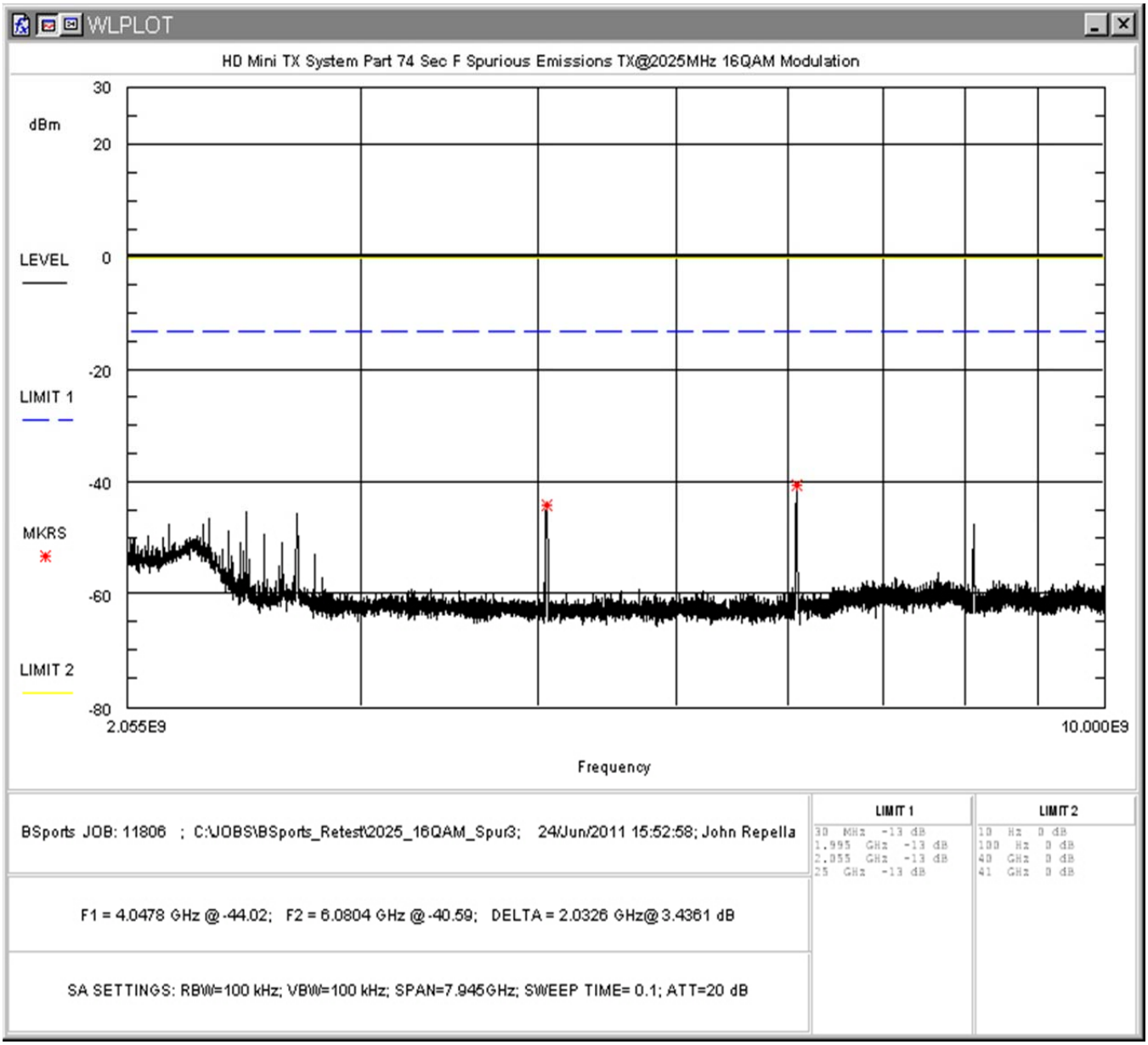

Figure 22: Spurious Emissions, 16QAM Modulation, TX @ 2025MHz, 2055MHz-10GHz

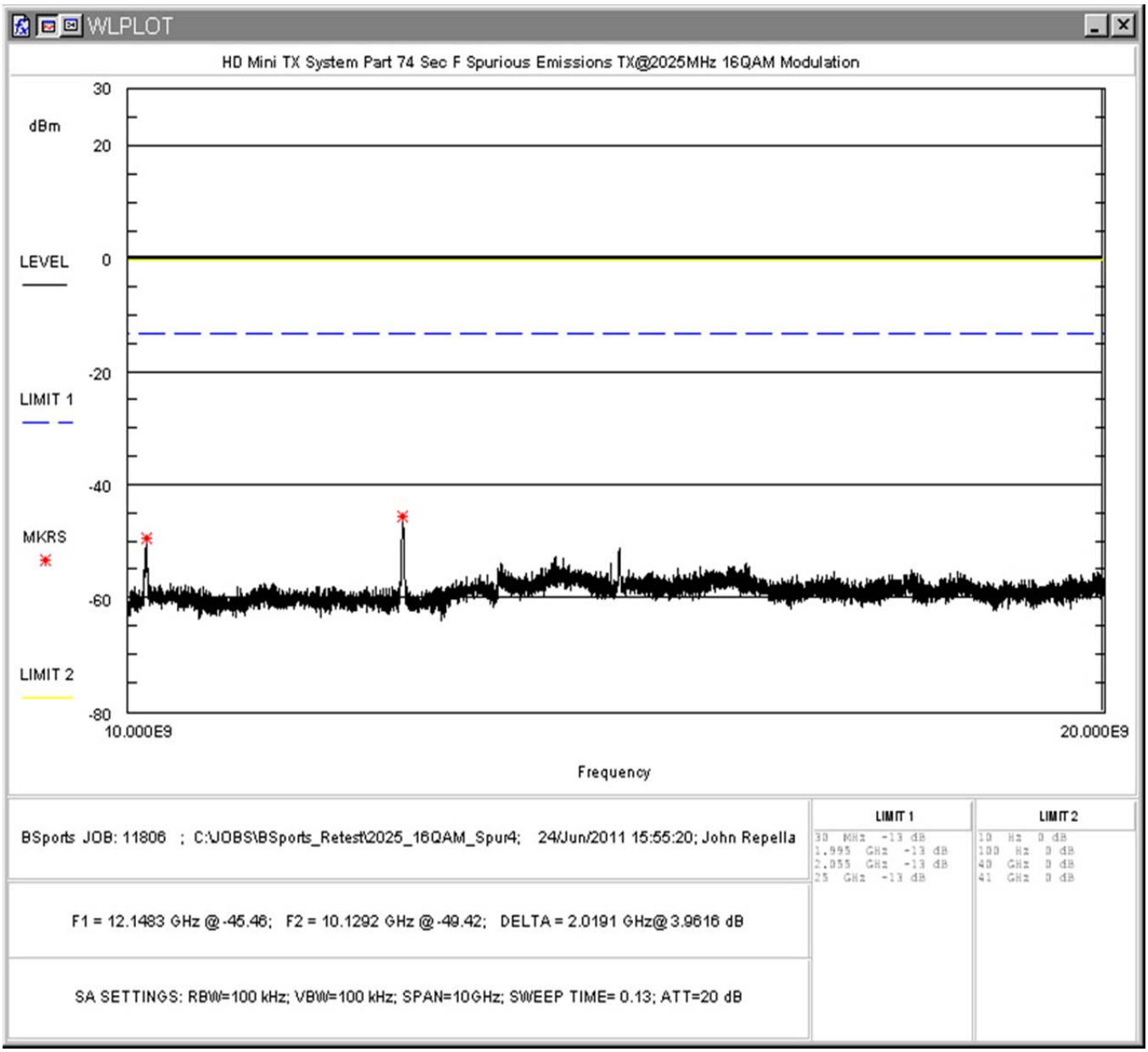

Figure 23: Spurious Emissions, 16QAM Modulation, TX @ 2025MHz, 10GHz-20GHz

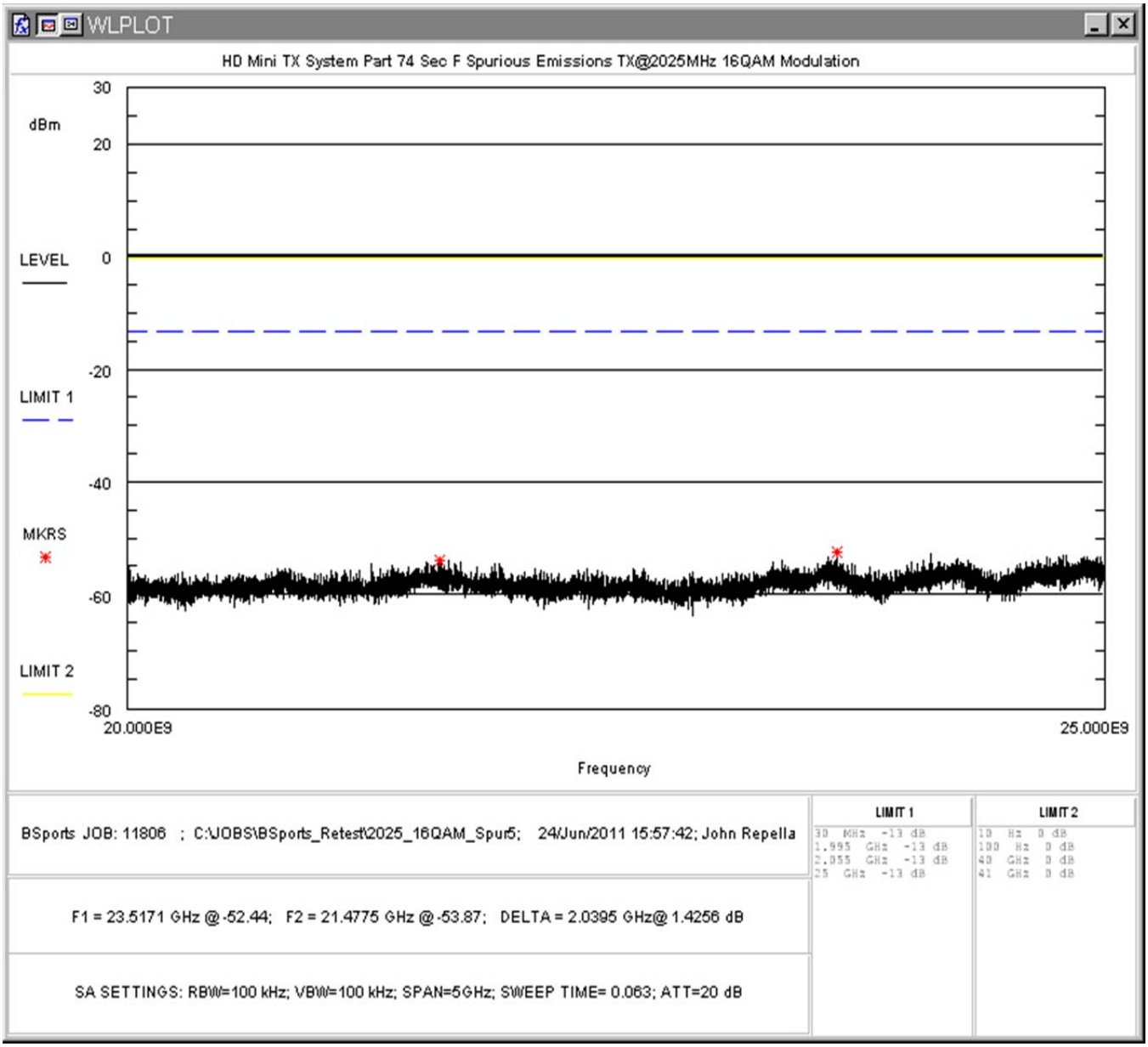

Figure 24: Spurious Emissions, 16QAM Modulation, TX @ 2025MHz, 20GHz-25GHz

