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FCC Certification Test Report
For the
Mueller Systems
Mi.Hub 1.5XR

FCC ID: SM6-HUB15XR
IC ID: 9235A-HUB15XR

WLL JOB# **12452-01 Rev 3**
August 2, 2012
Re-issued October 26, 2012

Prepared for:

Mueller Systems
48 Leona Drive
Middleboro, MA, 02346 USA

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

Testing Certificate AT-1448

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Prepared by:

Steven Dovell
Compliance Engineer

Reviewed by:

Steven D. Koster
Vice President

Abstract

This report has been prepared on behalf of Mueller Systems to support the attached Application for Equipment Authorization. The test report and application are submitted for a Frequency Hopping Spread Spectrum Transmitter under Part 15.247 (10/2010) of the FCC Rules. This Certification Test Report documents the test configuration and test results for a Mueller Systems HUB15XR.

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 Mueller Systems Mi.Hub 1.5XR complies with the limits for a Frequency Hopping Spread Spectrum Transmitter device under FCC Part 15.247.

Revision History	Description of Change	Date
Rev 0	Initial Release	August 2, 2012
Rev 1	Addressed Client comments	August 16, 2012
Rev 2	Addressed additional comments	August 28, 2012
Rev 3	Addressed power and bandwidth discrepancies in Table 1	October 26,2012

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1 Introduction

1.1 Compliance Statement

The Mueller Systems Mi.Hub 1.5XR complies with the limits for a Frequency Hopping Spread Spectrum Transmitter device under FCC Part 15.247 (10/2010).

1.2 Test Scope

Tests for radiated and conducted (at antenna terminal) emissions were performed in the host device. All measurements were performed in accordance with FCC Public Notice DA 00-705, "Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems". The measurement equipment conforms to ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation.

1.3 Contract Information

Customer:	Mueller Systems 48 Leona Drive Middleboro, MA, 02346 USA
Quotation Number:	801661

1.4 Test Dates

Testing was performed on the following date(s):	2/29/2012 to 8/1/12

1.5 Test and Support Personnel

Washington Laboratories, LTD	Steven Dovell,
Client Representative	David Splitz

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 Mueller Systems Mi.Hub 1.5XR is a 902.5- 927.35MHz FHSS technology. The system uses 2 modes of operation data mode which uses 50 channels from 902.5 to 927MHz. The system also has a hailing mode to awaken units that are sleeping (these units go into a sleep mode when inactive). The hailing frequencies consist of 50 hailing channels from 902.65 to 927.35MHz. Both of these modes use FHSS technology. The characteristics (power & bandwidth) of the hailing channels are identical to the data channels and are produced from the same RF circuitry. For more detailed information refer to the theory of operation.

Table 1: Device Summary

ITEM	DESCRIPTION
Manufacturer:	Mueller Systems
FCC ID:	SM6-HUB15XR
IC ID:	9235A-HUB15XR
Model:	Mi.Hub 1.5XR
FCC Rule Parts:	§15.247
Frequency Range:	902.5-927.35MHz
Maximum Output Power: (conducted at antenna port)	30 dBm (1000mW)
Modulation:	FM
Occupied Bandwidth:	63.5878kHz
Keying:	Automatic
Type of Information:	Data
Number of Channels:	50 Hailing Channels and 50 Data Channels
Antenna Connector	N
Antenna Type	6dBi Omni
Interface:	N connector for 902.5-927 whip antenna,
Power Source & Voltage:	120VAC
Highest TX Spurious Emission	2707.5MHz @ 369.1uV/m
Highest RX Spurious Emission	73.34MHz @ 38.3uV/m

2.2 Modification

None.

2.3 Test Configuration

The Mi.Hub 1.5XR was operated as a standalone unit connected to 120VAC mains. Commands were sent to the Mi.Hub 1.5XR using a 3 pin to USB port connected to a support laptop using Windows HyperTerminal program.

2.4 Testing Algorithm

The Mi.Hub 1.5XR was programmed via an external 3 pin programming port on the EUT to a USB port on the support laptop. The support laptop used HyperTerminal to command the EUT to

transmit on the lowest, center, and highest channels. Commands were also sent to allow the unit to transmit in a hopping fashion. The unit was preloaded with a typical data payload to transmit.

Worst case emission levels are provided in the test results data.

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

2.6 Measurements

2.6.1 References

FCC Public Notice DA 00-705, Filing and Measurement Guidelines for Frequency Hopping Spread Spectrum Systems

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

2.7 Measurement Uncertainty

All results reported herein relate only to the equipment tested. The basis for uncertainty calculation uses ANSI/NCSL Z540-2-1997 with a type B evaluation of the standard uncertainty. Elements contributing to the standard uncertainty are combined using the method described in Equation 1 to arrive at the total standard uncertainty. The standard uncertainty is multiplied by the coverage factor to determine the expanded uncertainty which is generally accepted for use in commercial, industrial, and regulatory applications and when health and safety are concerned (see Equation 2). A coverage factor was selected to yield a 95% confidence in the uncertainty estimation.

Equation 1: Standard Uncertainty

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

Where u_c = standard uncertainty

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

$Div_{a, b, c}$ = the individual uncertainty element divisor based on the probability distribution

Divisor = 1.732 for rectangular distribution

Divisor = 2 for normal distribution

Divisor = 1.414 for trapezoid distribution

Equation 2: Expanded Uncertainty

$$U = ku_c$$

Where U = expanded uncertainty

k = coverage factor

k ≤ 2 for 95% coverage (ANSI/NCSL Z540-2 Annex G)

u_c = standard uncertainty

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

Table 2: Expanded Uncertainty List

Scope	Standard(s)	Expanded Uncertainty
Conducted Emissions	CISPR11, CISPR22, CISPR14, FCC Part 15	2.63 dB
Radiated Emissions	CISPR11, CISPR22, CISPR14, FCC Part 15	4.55 dB

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:	**Conducted Antenna Port**	Test Date:	**8/1/2012**
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
528	AGILENT - E4446A	ANALYZER SPECTRUM	8/30/2012
618	HP - 8563A	ANALYZER SPECTRUM	2/10/2013

Test Name:	**Radiated Emissions**	Test Date:	**07/19/2012**
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
528	AGILENT - E4446A	ANALYZER SPECTRUM	8/30/2012
4	ARA - DRG-118/A	ANTENNA DRG 1-18GHZ	2/15/2013
281	ITC - 21A-3A1	WAVEGUIDE 4.51-10.0GHZ	5/29/2014
742	PENN ENGINEERING - WR284	2.2-4.15GHZ BANDPASS FILTER	5/29/2014
627	AGILENT - 8449B	AMPLIFIER 1-26GHZ	5/24/2013
382	SUNOL SCIENCES CORPORATION - JB1	ANTENNA BICONLOG	12/27/2012
68	HP - 85650A	ADAPTER QP	7/1/2013
72	HP - 8568B	ANALYZER SPECTRUM	7/1/2013
70	HP - 85685A	PRESELECTOR RF W/OPT 8ZE	7/1/2013

Test Name:	**Conducted Emissions Voltage**	Test Date:	**07/20/2012**
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
68	HP - 85650A	ADAPTER QP	7/1/2013
72	HP - 8568B	ANALYZER SPECTRUM	7/1/2013
125	SOLAR - 8028-50-TS-24-BNC	LISN	6/28/2013
126	SOLAR - 8028-50-TS-24-BNC	LISN	6/28/2013
53	HP - 11947A	LIMITER TRANSIENT	3/28/2013

4 Test Summary

The Table Below shows the results of testing for compliance with a Frequency Hopping System in accordance with FCC Part 15.247 9:2010. Full results are shown in section 5.

Table 4: Test Summary Table

TX Test Summary (Frequency Hopping Spread Spectrum)			
FCC Rule Part	**IC Rule Part**	**Description**	**Result**
15.247 (a)(1)(i)	RSS-210 [A8. 1 (c)]	20dB Bandwidth	Pass
15.247 (b)(2)	RSS-210 [A8.4 (1)]	Transmit Output Power	Pass
15.247 (a)(1)	RSS-210 [A8.1 (b)]	Channel Separation	Pass
15.247 (a)(1)(i)	RSS-210 [A8. 1 (c)]	Number of Channels =50 minimum	Pass
15.247 (a)(1)(i)	RSS-210 [A8. 1 (c)]	Time of Occupancy	Pass
15.247 (d)	RSS-210 [A8. 5]	Occupied BW / Out-of-Band Emissions (Band Edge @ 20dB below)	Pass
15.205 15.209	RSS-210 Sect.2.2 RSS-Gen 7.2.2	General Field Strength Limits (Restricted Bands & RE Limits)	Pass
15.207	RSS-Gen [7.2.4]	AC Conducted Emissions	Pass
RX/Digital Test Summary (Frequency Hopping Spread Spectrum)			
FCC Rule Part	**IC Rule Part**	**Description**	**Result**
15.207	RSS-Gen [7.2.2]	AC Conducted Emissions	Pass
15.209	RSS-210 sect 2.5	General Field Strength Limits	Pass

5 Test Results

5.1 Duty Cycle and Time of Occupancy

In accordance with the FCC Public Notice the spurious radiated emissions measurements may be adjusted if using a duty cycle correction factor if the dwell time per channel of the hopping signal is less than 100 ms.

The duty cycle correction factor is calculated by:

20 x LOG (dwell time/100 ms)

5.1.1 Data Mode Timing

As the Maximum Dwell time of this device is approximately 200ms no duty cycle correction is allowed.

FCC part 15.247 requires that for hopping signals with an occupied bandwidth less than 250 kHz the limit is 0.4 seconds dwell time per 20 seconds

The following figures show the plot of the dwell time and time of occupancy for the transmitter. Based on this plot, the dwell time per hop is 200ms. As the unit is on a channel once in a 20 second period the time of occupancy is 200ms per 20 seconds, thus complying with the 0.4 second requirement.

Dwell time per hop =200ms; Limit 0.4sec

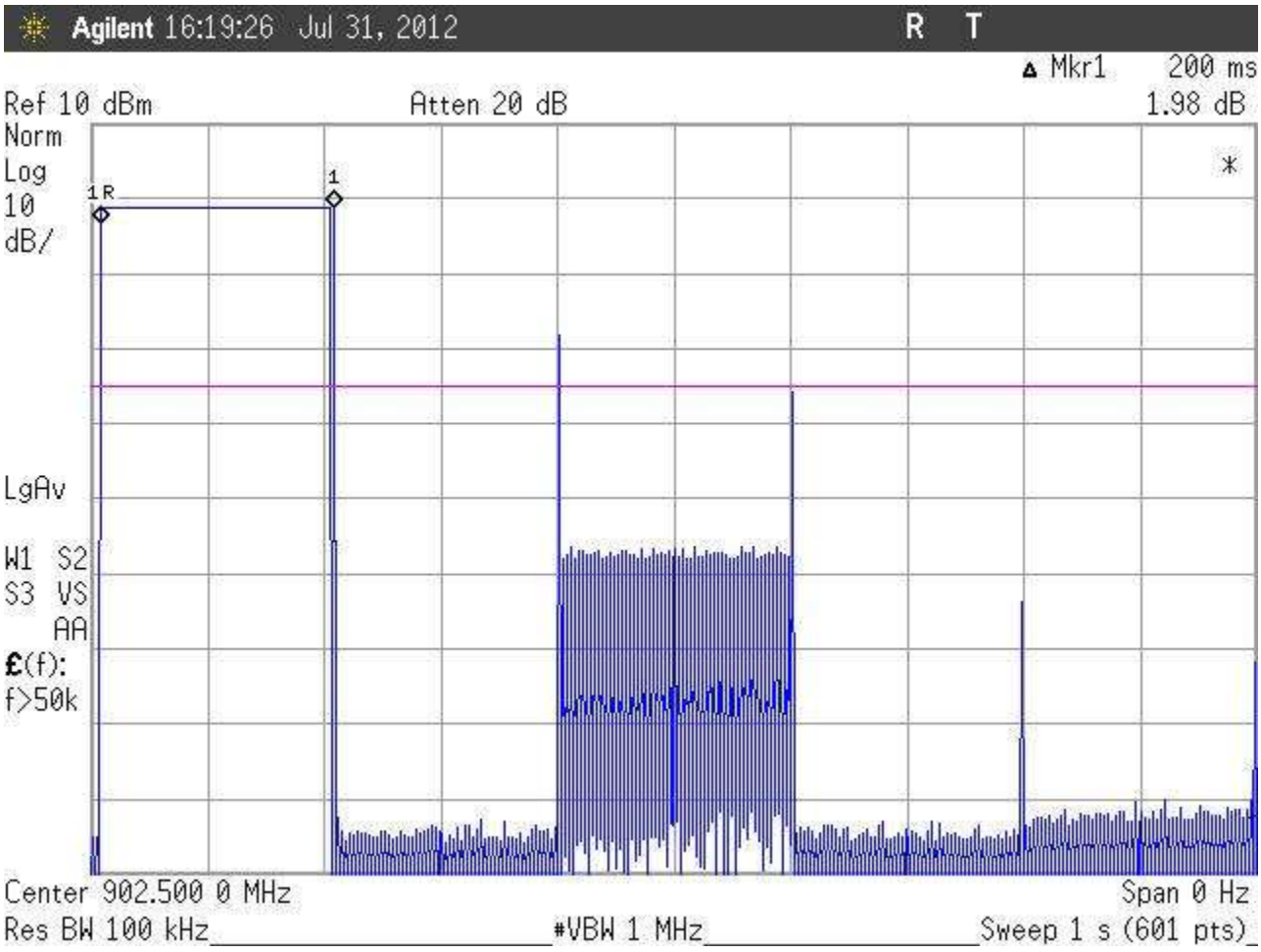

Figure 1: Duty Cycle Plot (Data Mode 9.6kbps)

Time of Occupancy per 20 seconds: 2 pulses of 200ms per 20 seconds = 400ms.

Limit = 0.4sec per 20 seconds maximum

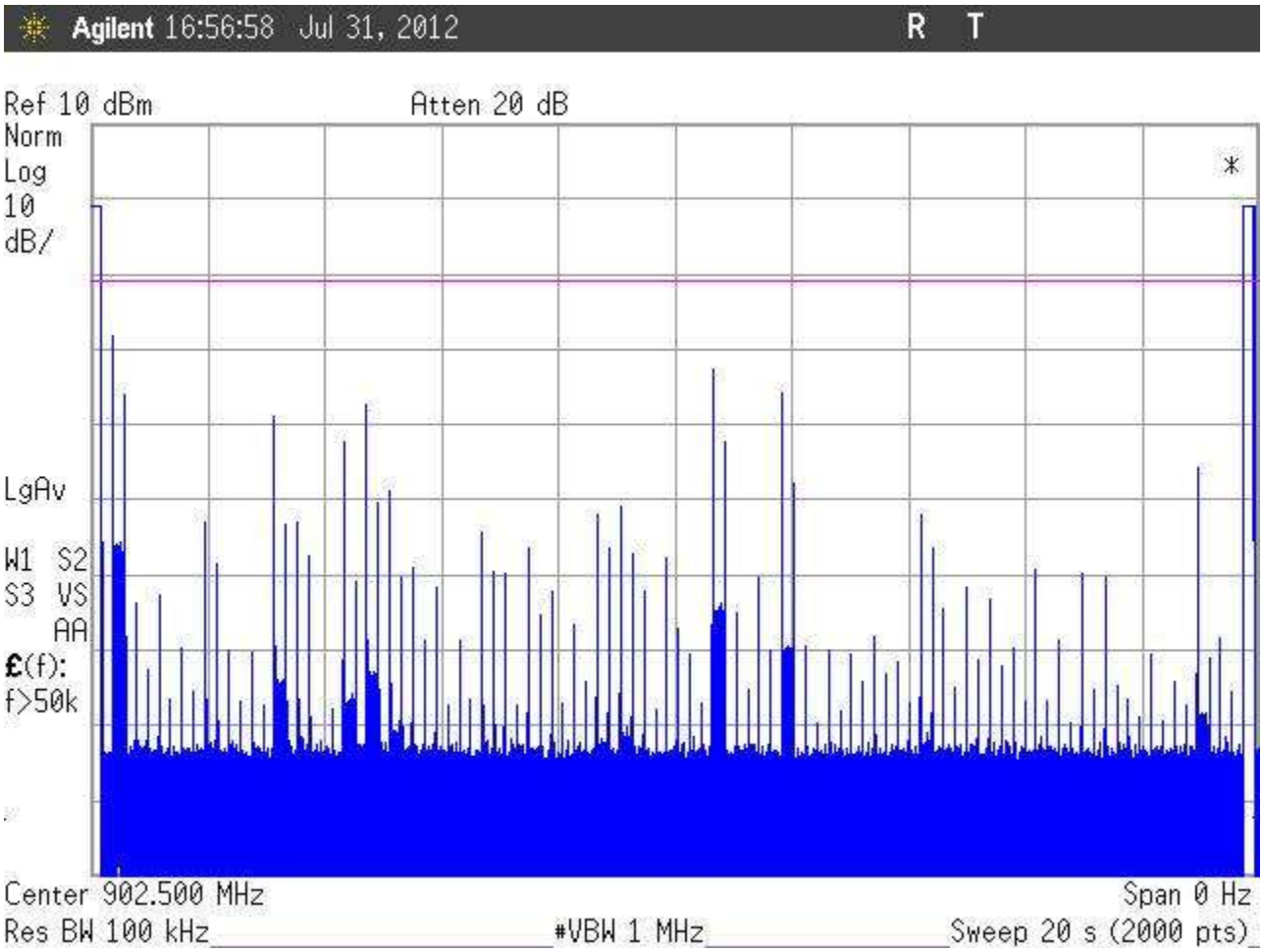

Figure 2: Time of Occupancy Plot (Data Mode 9.6kbps)

Dwell time per hop =65.24ms; Limit 0.4sec

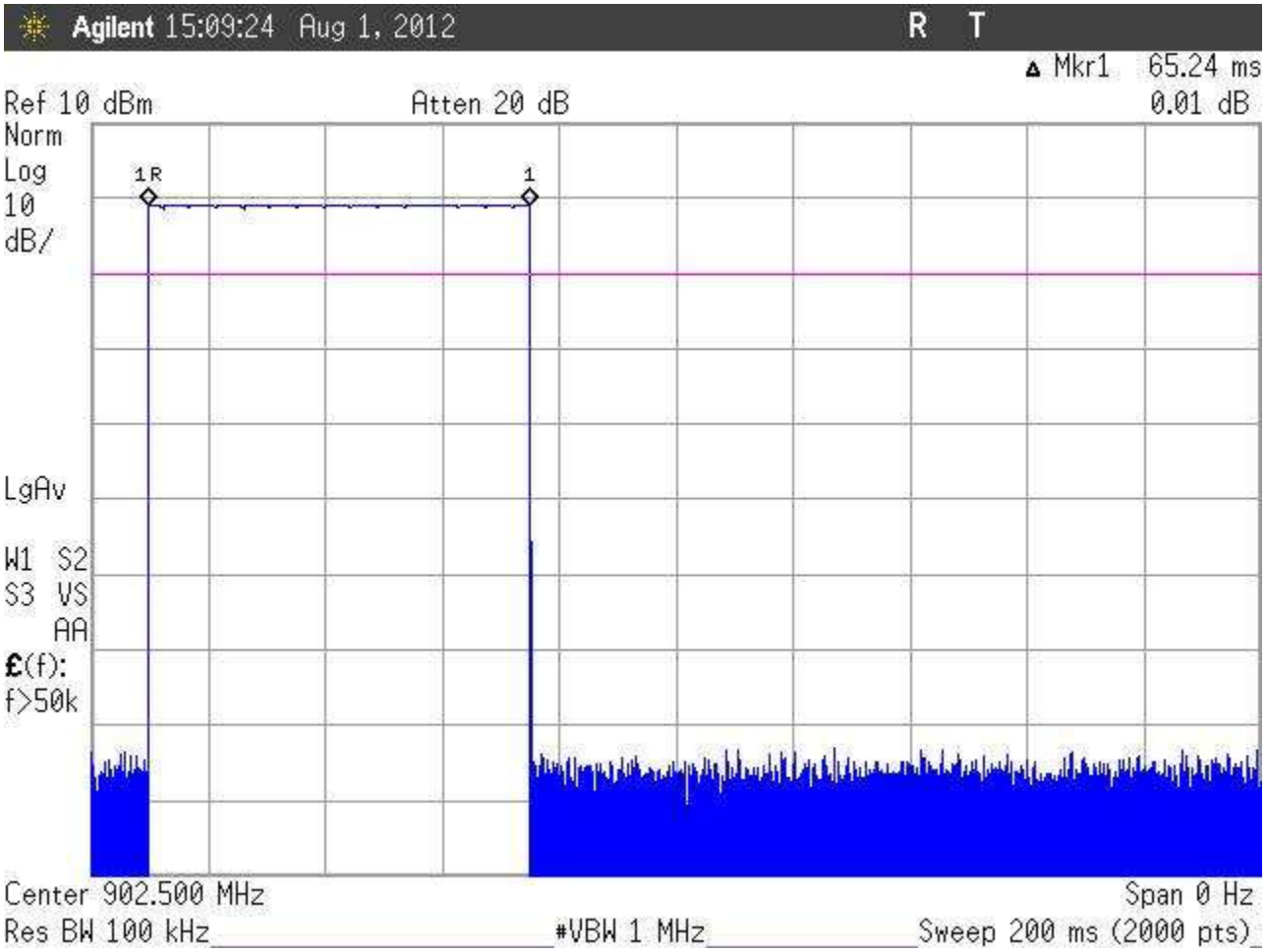

Figure 3: Duty Cycle Plot (Data Mode 28.8bps)

Time of Occupancy per 20 seconds: 2 pulses of 65.24ms per 20 seconds = 130.48ms.

Limit = 0.4sec per 20 seconds maximum

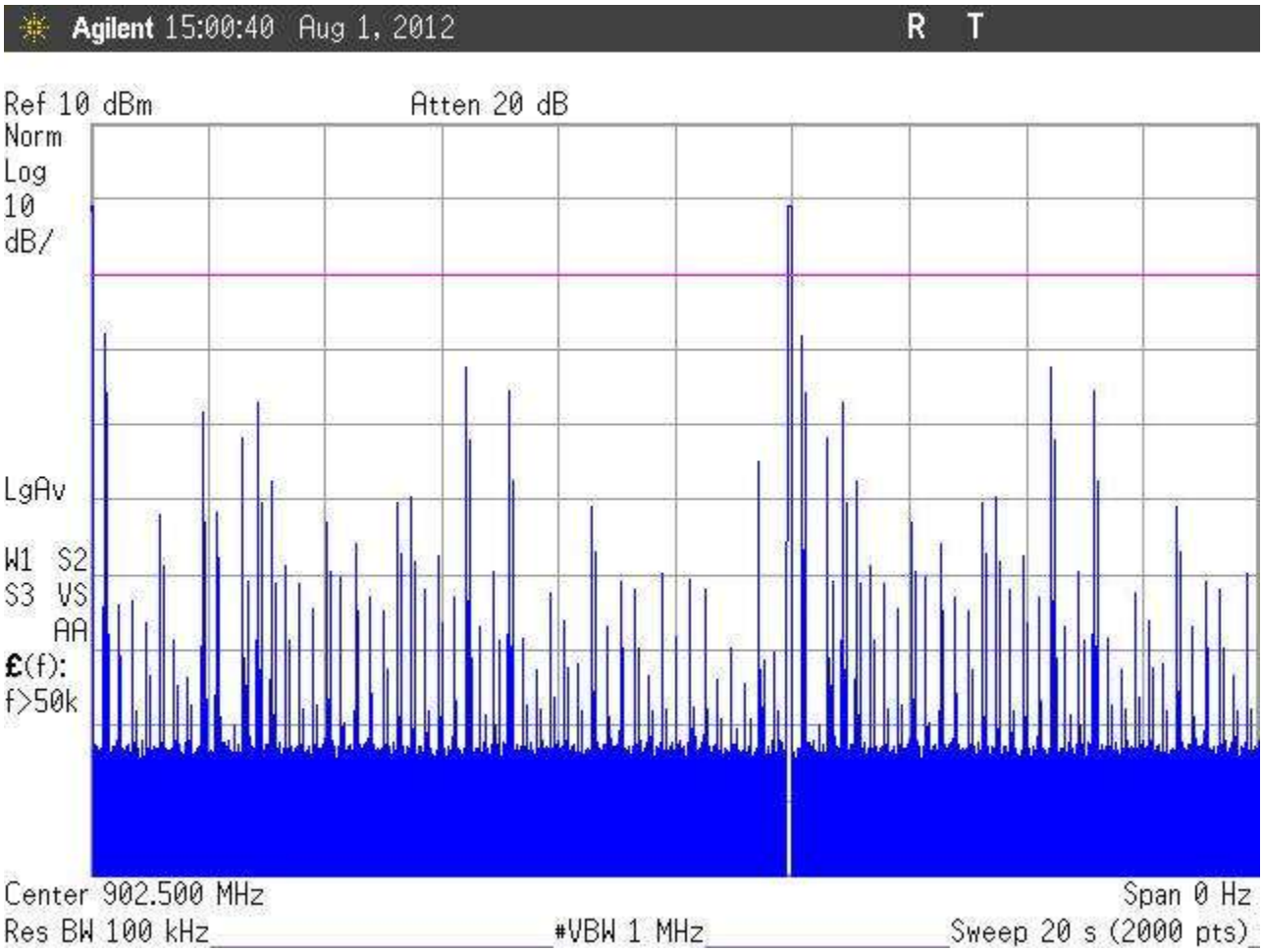

Figure 4: Time of Occupancy Plot (Data Mode 28.8kbps)

5.1.2 Hailing Mode Timing

As the Maximum Dwell time of this device in hailing 400ms no duty cycle correction is allowed.

FCC part 15.247 requires that for hopping signals with an occupied bandwidth less than 250 kHz the limit is 0.4 seconds dwell time per 20 seconds

The following figures show the plot of the dwell time and time of occupancy for the transmitter. Based on this plot, the dwell time per hop is 392.2ms. As the unit is on a hailing channel once in a 20 second period the time of occupancy is 392.2ms per 20 seconds, thus complying with the 0.4 second requirement.

Dwell time per hop =390ms; Limit 0.4sec

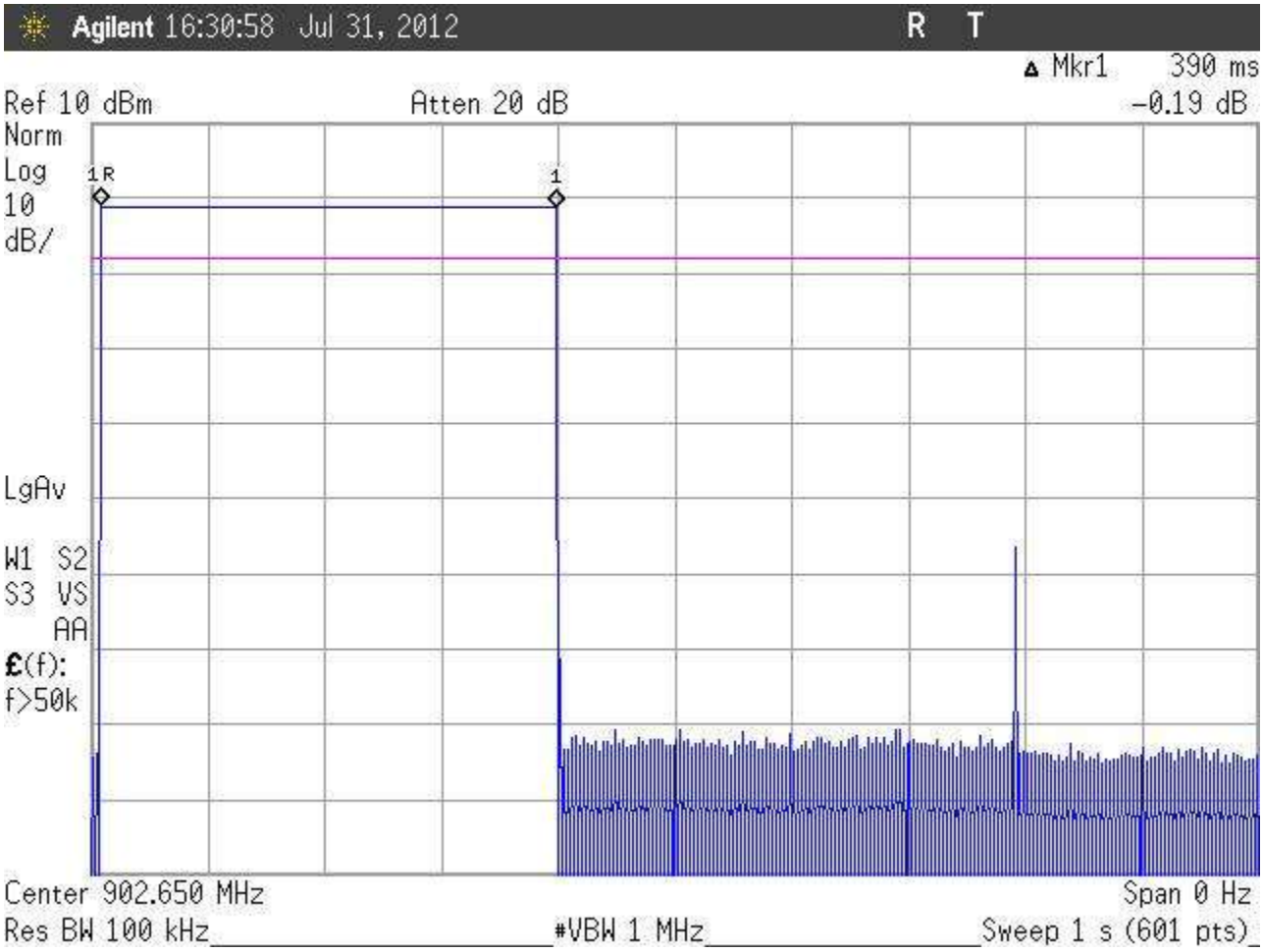

Figure 5 Hailing Channel Duty Cycle Plot

Time of Occupancy per 20 seconds: 1 pulse of 3900ms per 20 seconds = 390ms.

Limit = 0.4sec per 20 seconds maximum

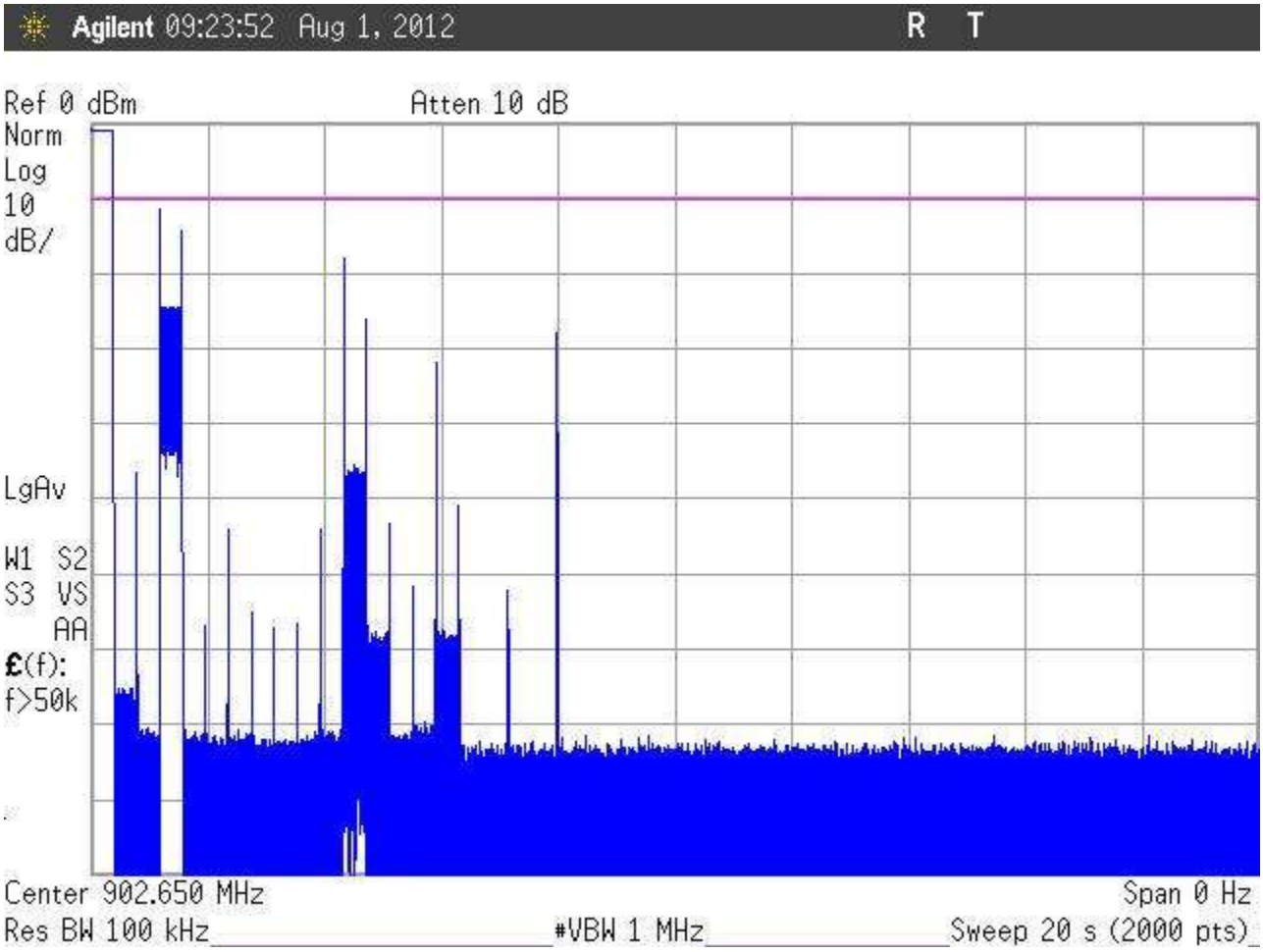

Figure 6 Hailing Channel Time of Occupancy Plot

5.2 RF Power Output: (FCC Part §2.1046)

To measure the output power the hopping sequence was stopped while the frequency dwelled on the lowest, middle and highest channel. The output from the transmitter was connected to an attenuator and then to the input of the RF Spectrum Analyzer. The analyzer offset was adjusted to compensate for the attenuator, cable, and other losses in the system. As the EUT has adjustable power settings the lowest and highest settings were measured.

Table 5: Data Channel RF Power Output

Frequency	High Power Level (Long Cable)	Low Power Level (Short Cable)	Limit	Pass/Fail
Low Channel: 902.5MHz	29.2	29.3	30dBm	Pass
Mid Channel: 915.0MHz	30.0	30.0	30dBm	Pass
High Channel: 927.0MHz	29.3	29.3	30dBm	Pass

Table 6 Hailing Channel RF Power Output

Frequency	High Power Level (Long Cable)	Low Power Level (Short Cable)	Limit	Pass/Fail
Low Channel: 902.65MHz	29.2	29.3	30dBm	Pass
Center Channel: 915.35MHz	30.0	30.0	30dBm	Pass
High Channel: 927.35MHz	29.2	29.2	30dBm	Pass

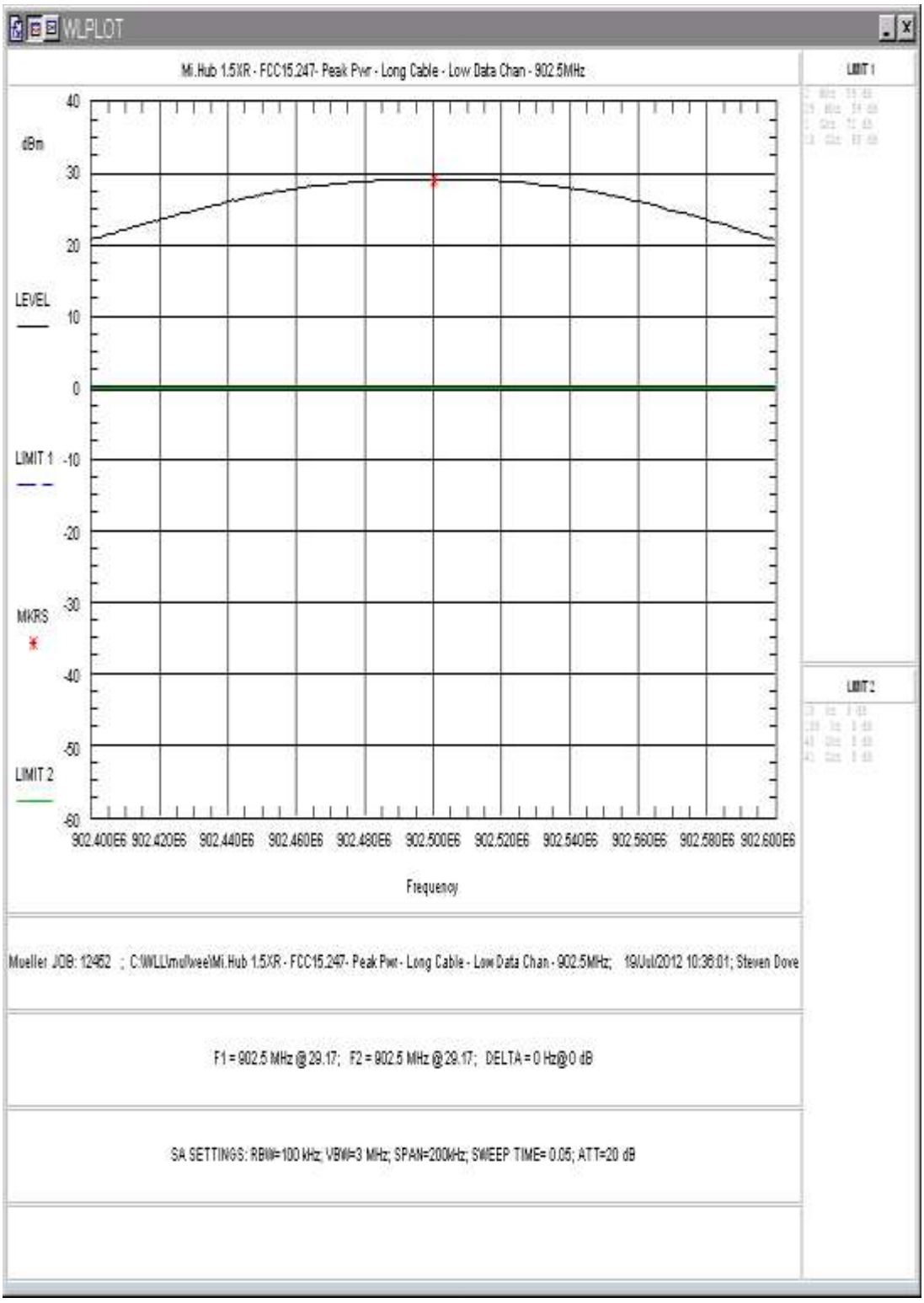

Figure 7: Data Channel RF Peak Power, Long Cable, Low Channel

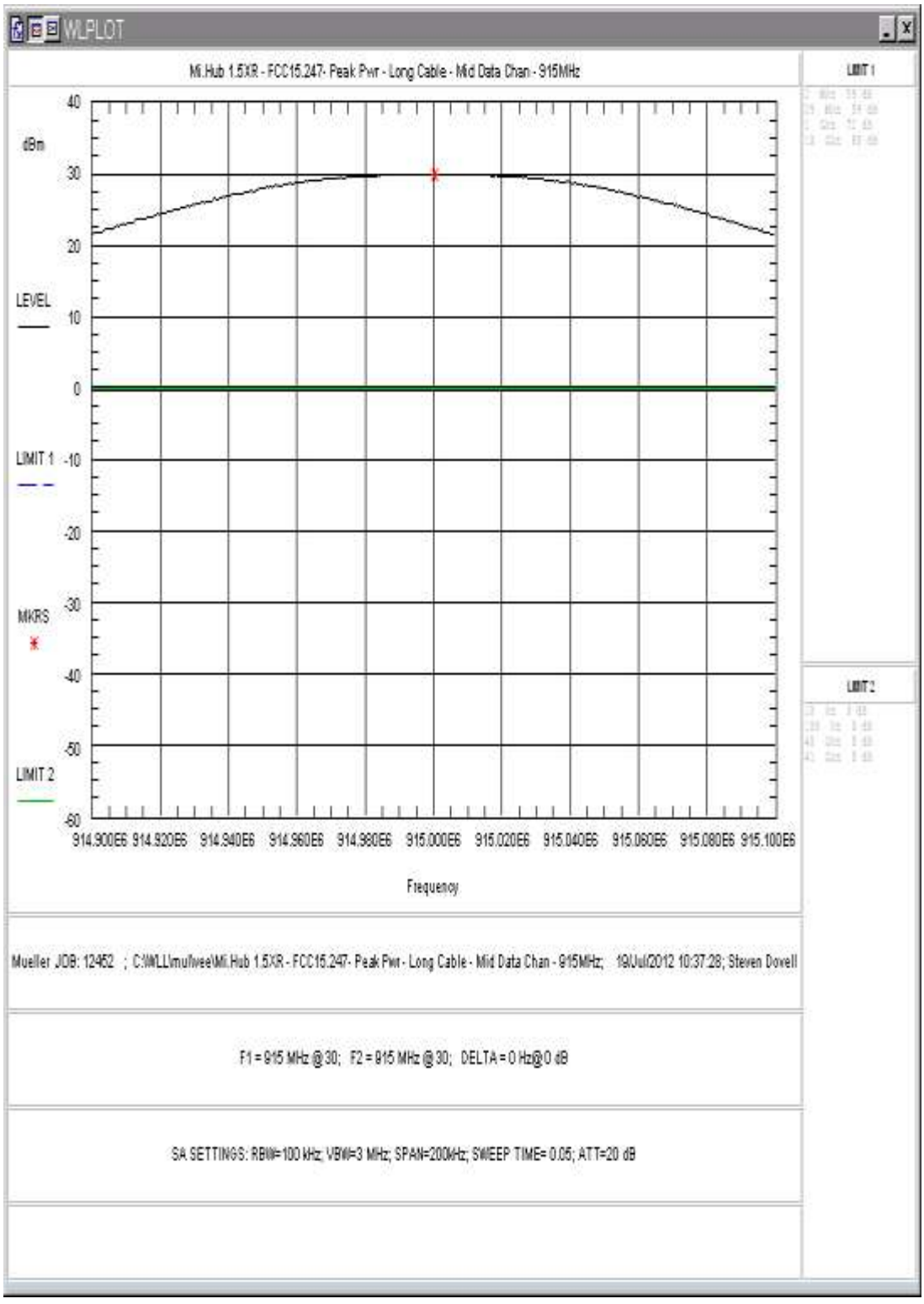

Figure 8: Data Channel RF Peak Power, Long Cable, Center Channel

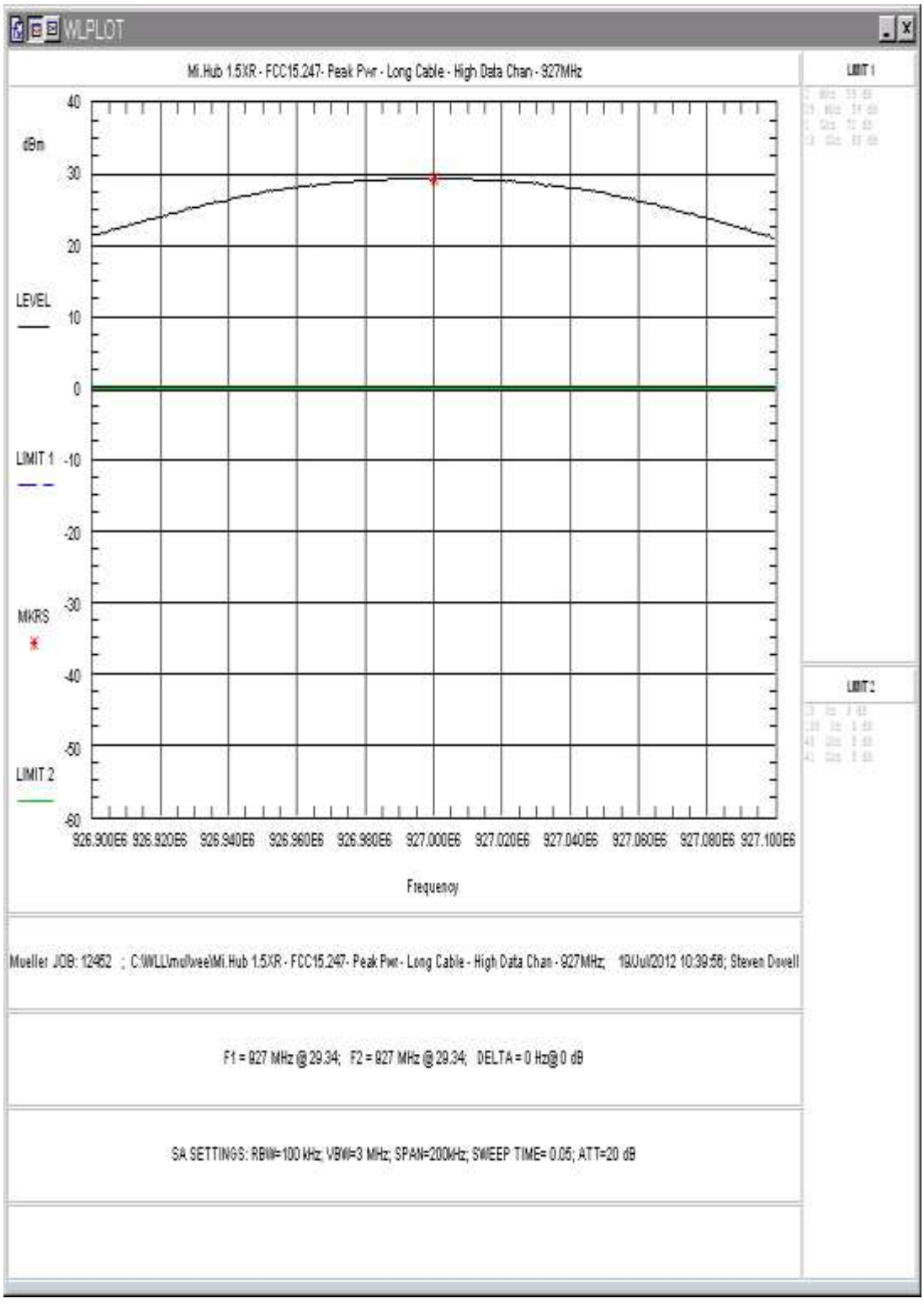

Figure 9: Data Channel RF Peak Power, Long Cable, High Channel

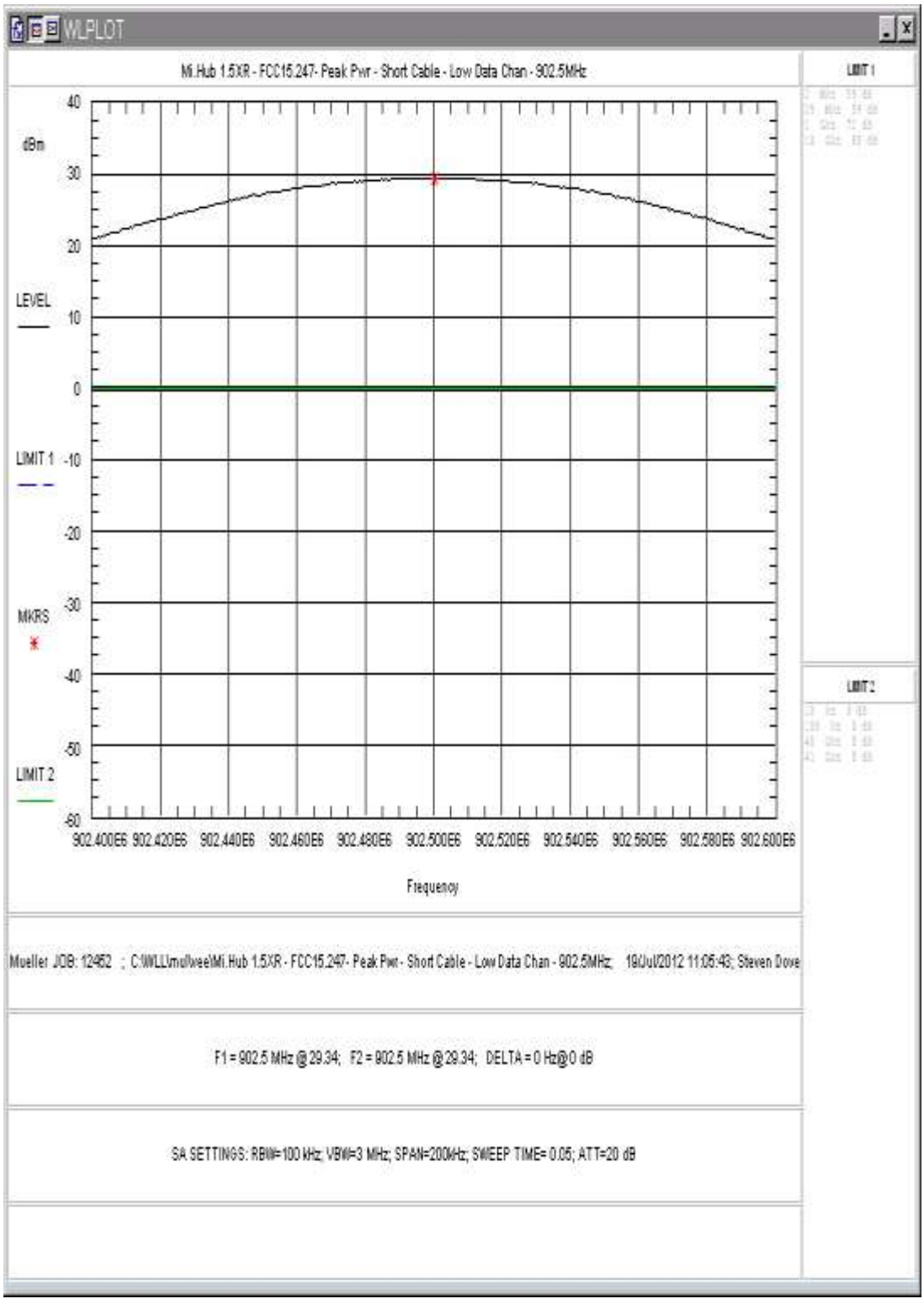

Figure 10: Data Channel RF Peak Power, Short Cable, Low Channel

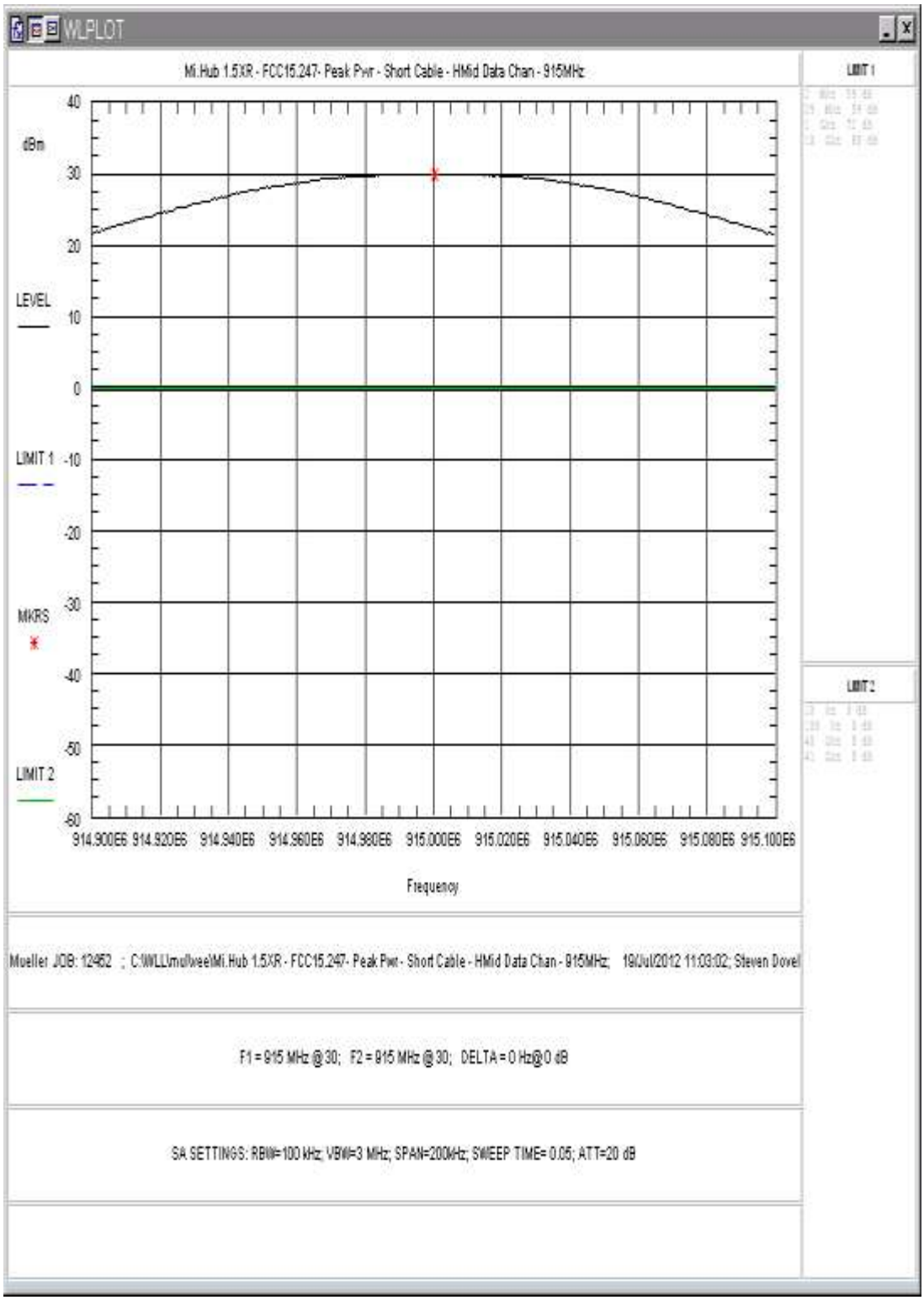

Figure 11: Data Channel RF Peak Power, Short Cable, Center Channel

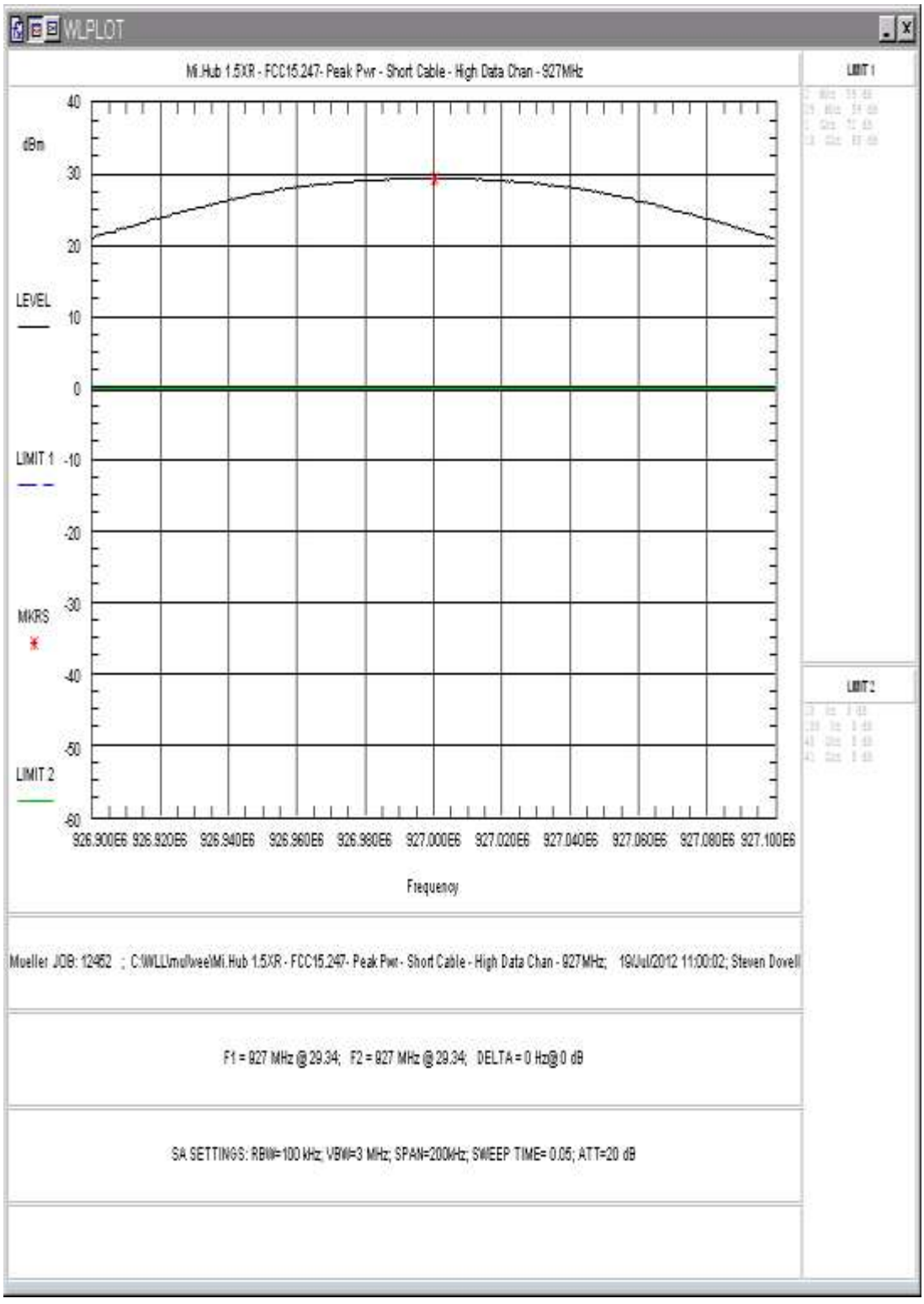

Figure 12: Data Channel RF Peak Power, Short Cable, High Channel

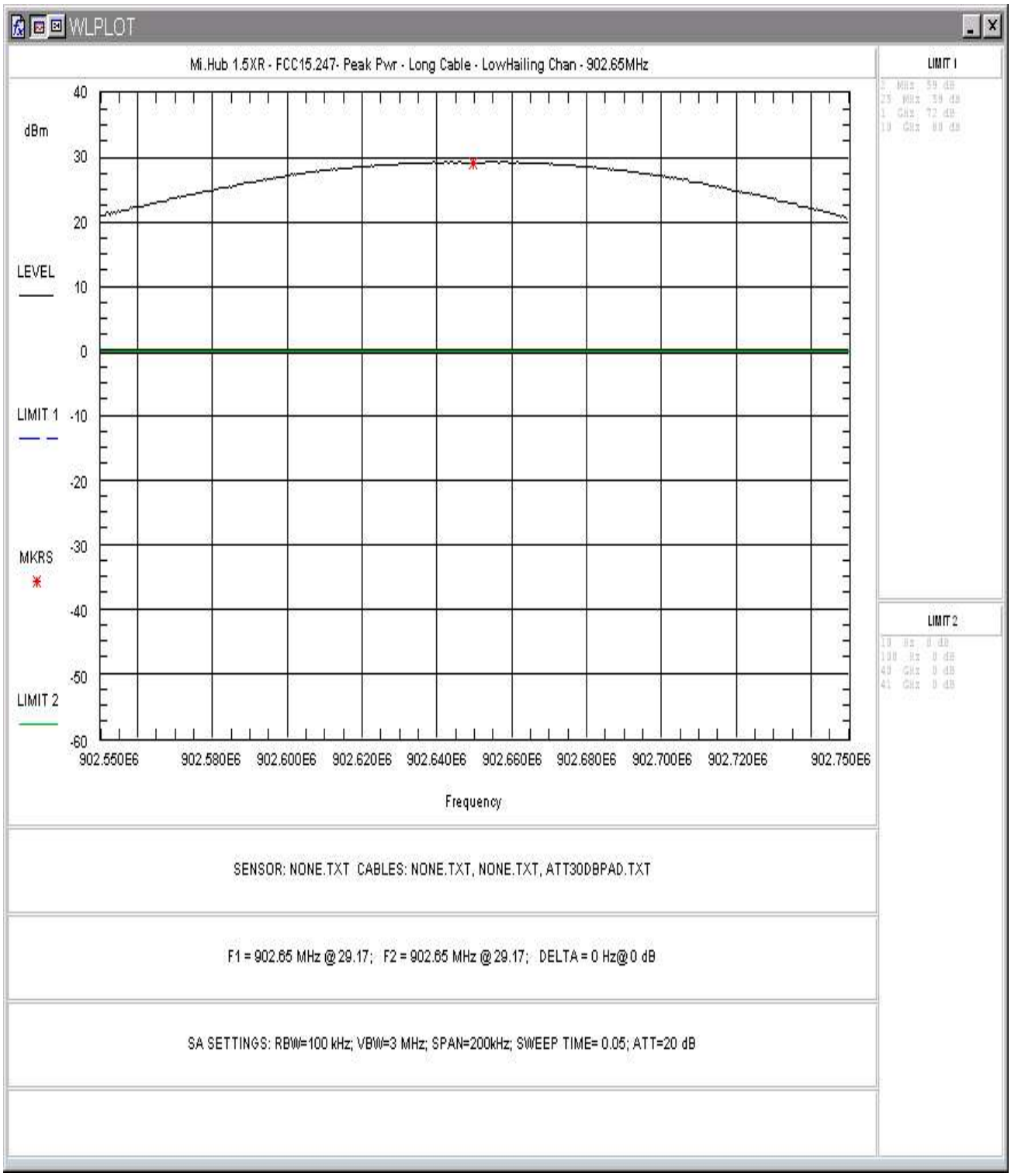

Figure 13 Hailing Channel RF Peak Power, Long Cable, Low Channel

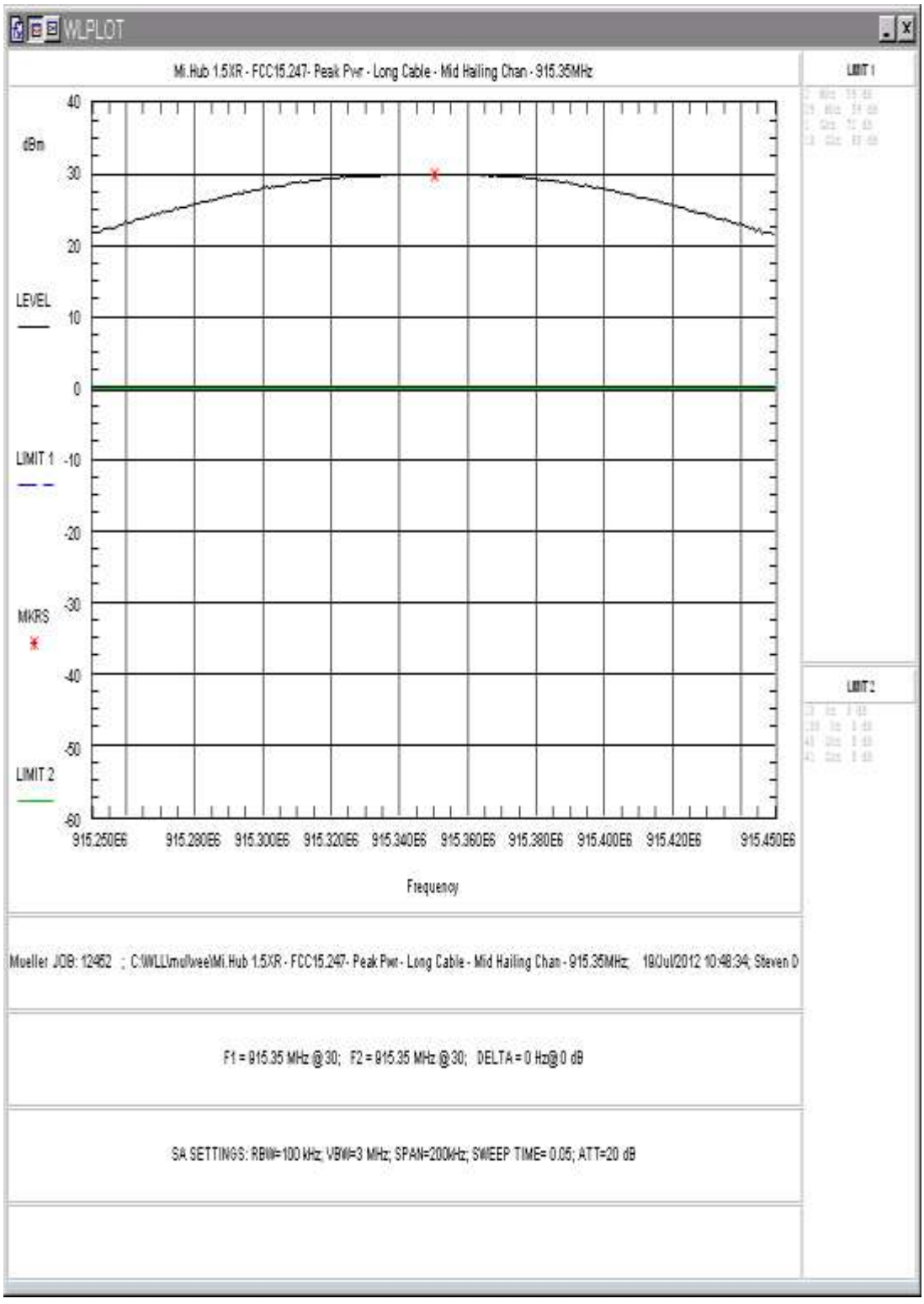

Figure 14 Hailing Channel RF Peak Power, Long Cable, Center Channel

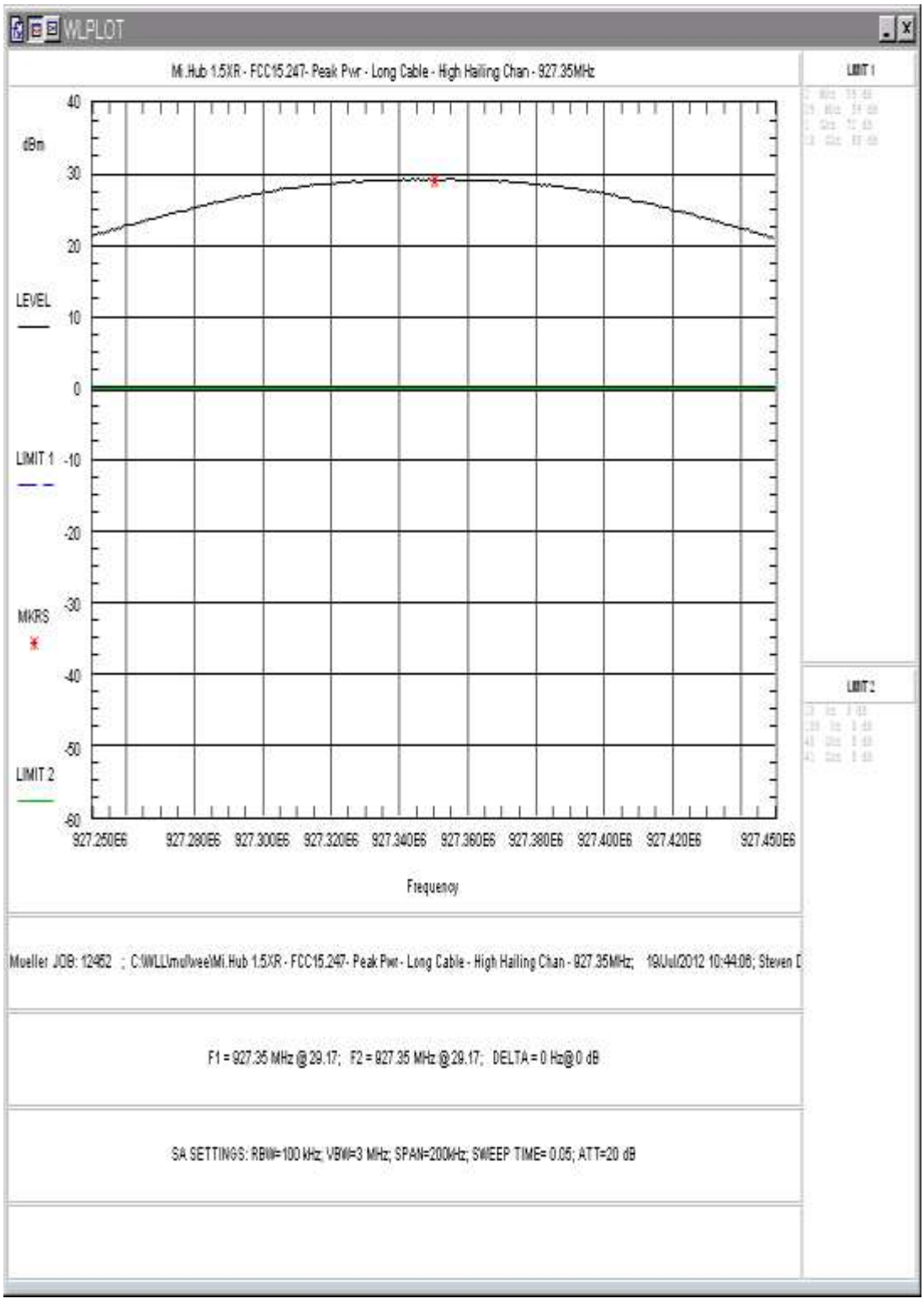

Figure 15 Hailing Channel RF Peak Power, Long Cable, High Channel

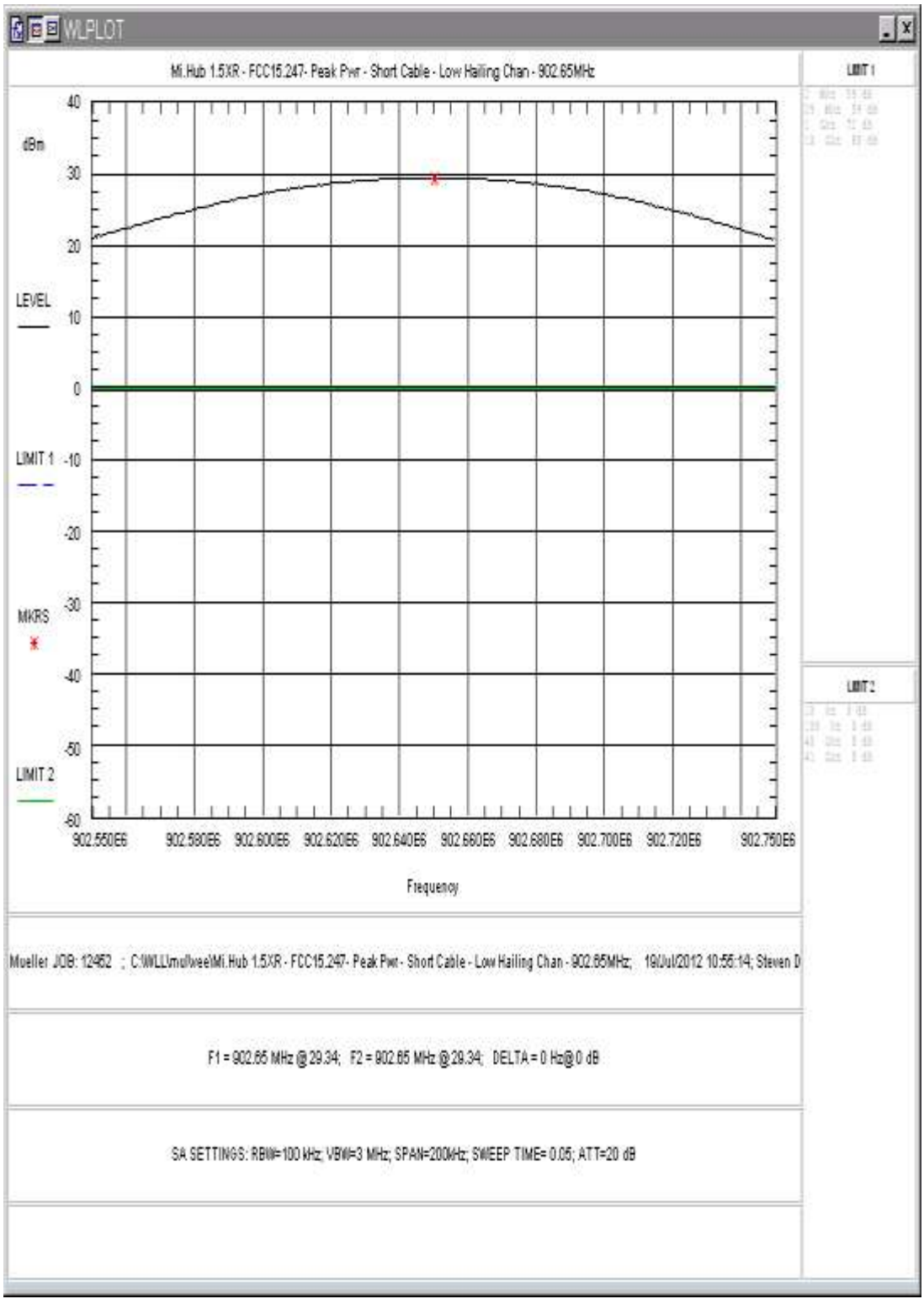

Figure 16 Hailing Channel RF Peak Power, Short Cable, Low Channel

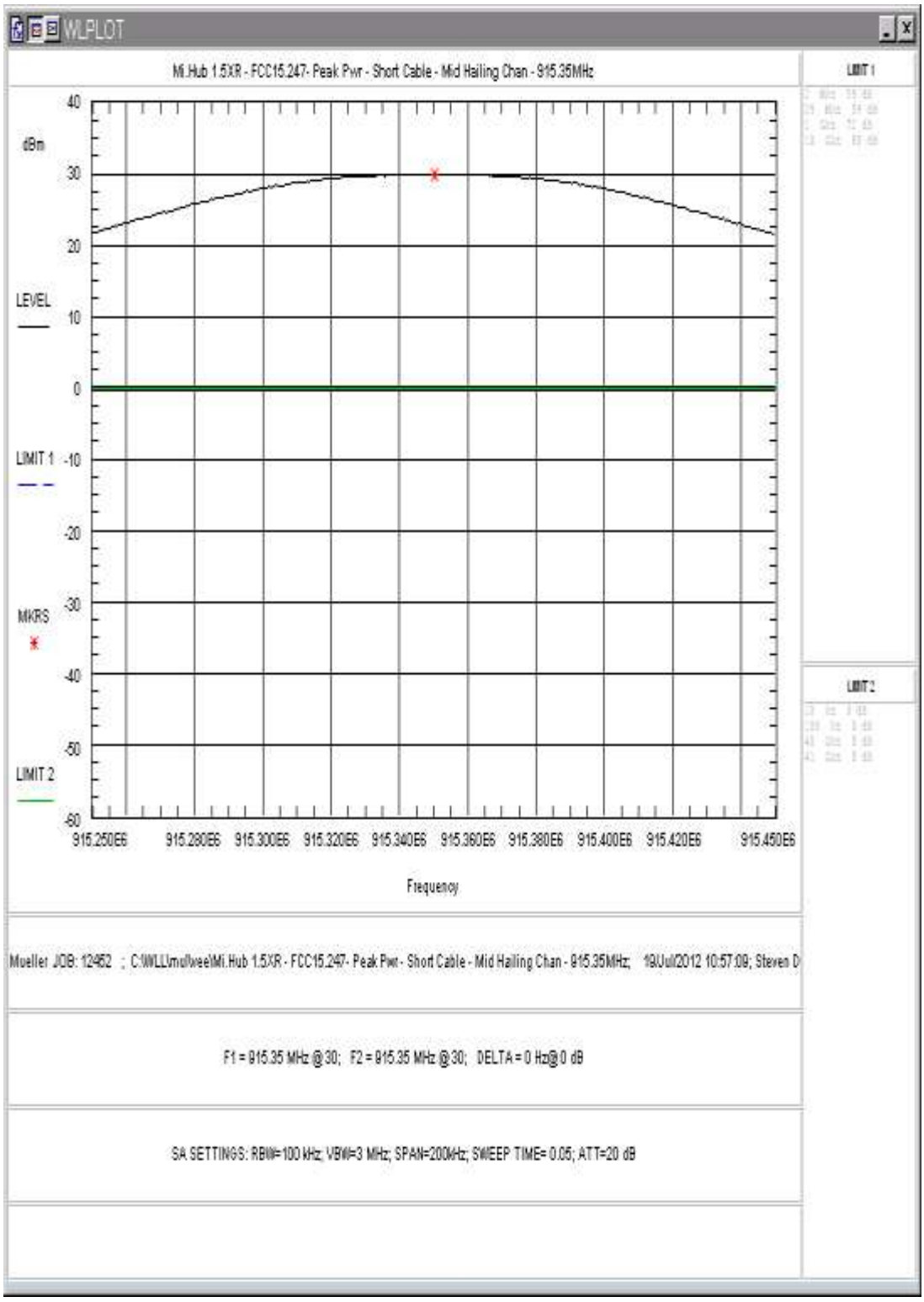

Figure 17 Hailing Channel RF Peak Power, Short Cable, Center Channel

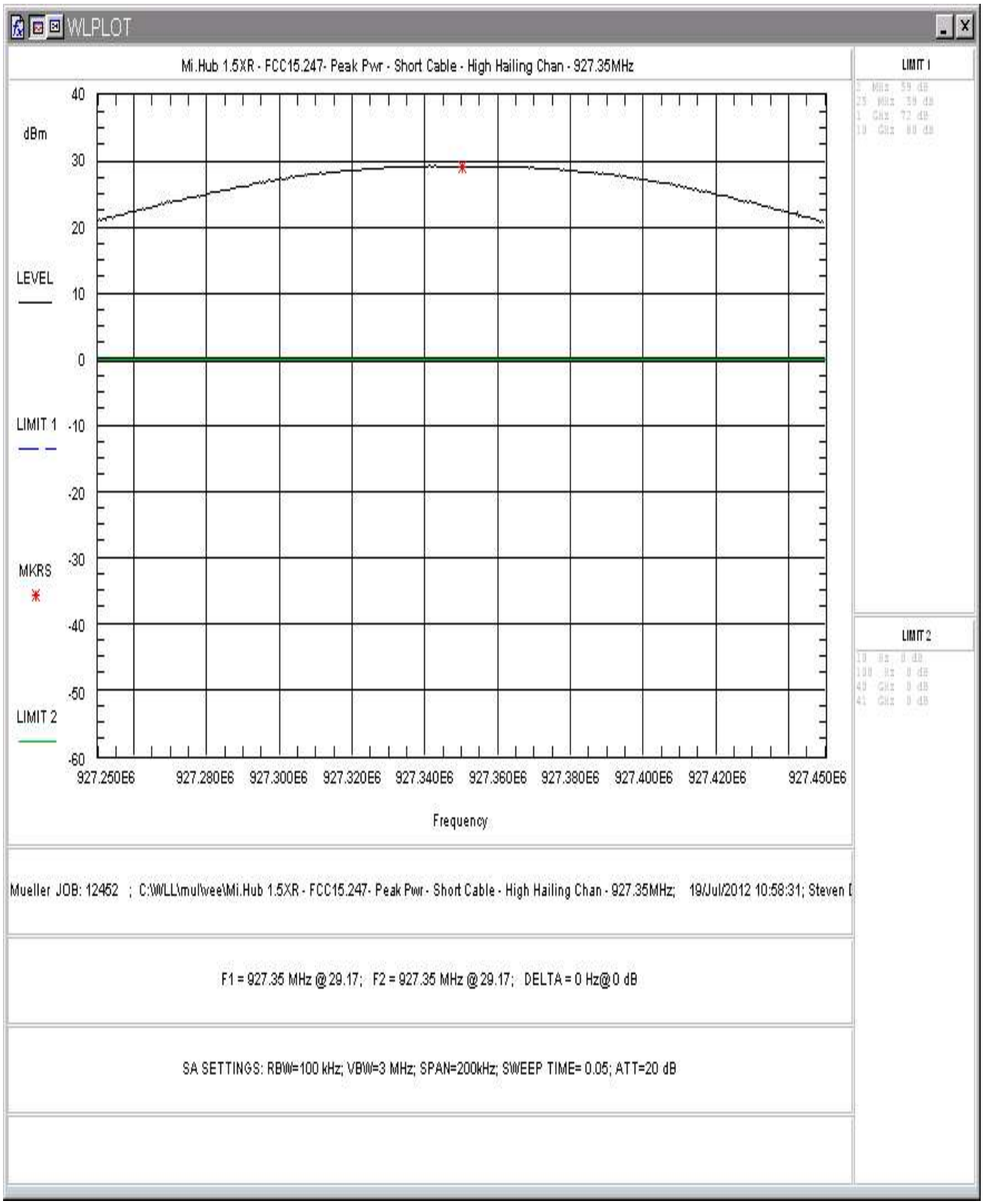

Figure 18 Hailing Channel RF Peak Power, Short Cable, High Channel

5.3 Occupied Bandwidth: (FCC Part §2.1049)

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

For Frequency Hopping Spread Spectrum Systems, operating in the 902-928MHz frequency range, FCC Part 15.247 requires that devices with occupied bandwidths less than 250kHz have a minimum of 50 hopping channels.

The Hailing channels operate at a single transmission rate 9.6kbps, the data channels can operate at either 9.6 or 28.8kbps (negotiated by network). The Occupied bandwidth was verified in all available data rates.

Table 7 and Table 8 provide a summary of the Occupied Bandwidth Results.

Table 7 Data Channel Occupied Bandwidth Results

Frequency	9.6kbps Bandwidth	28.8kbps Bandwidth
Low Channel: 902.5MHz	40.83kHz	62.5kHz
Mid Channel: 915.0MHz	41.864kHz	62.6779kHz
High Channel: 927.0MHz	42.418kHz	63.5878kHz

Table 8: Hailing Channel Occupied Bandwidth Results

Frequency	9.6kbps Bandwidth
Low Channel: 902.65MHz	41.4844kHz
Mid Channel: 915.35MHz	41.8405kHz
High Channel: 927.35MHz	42.4785kHz

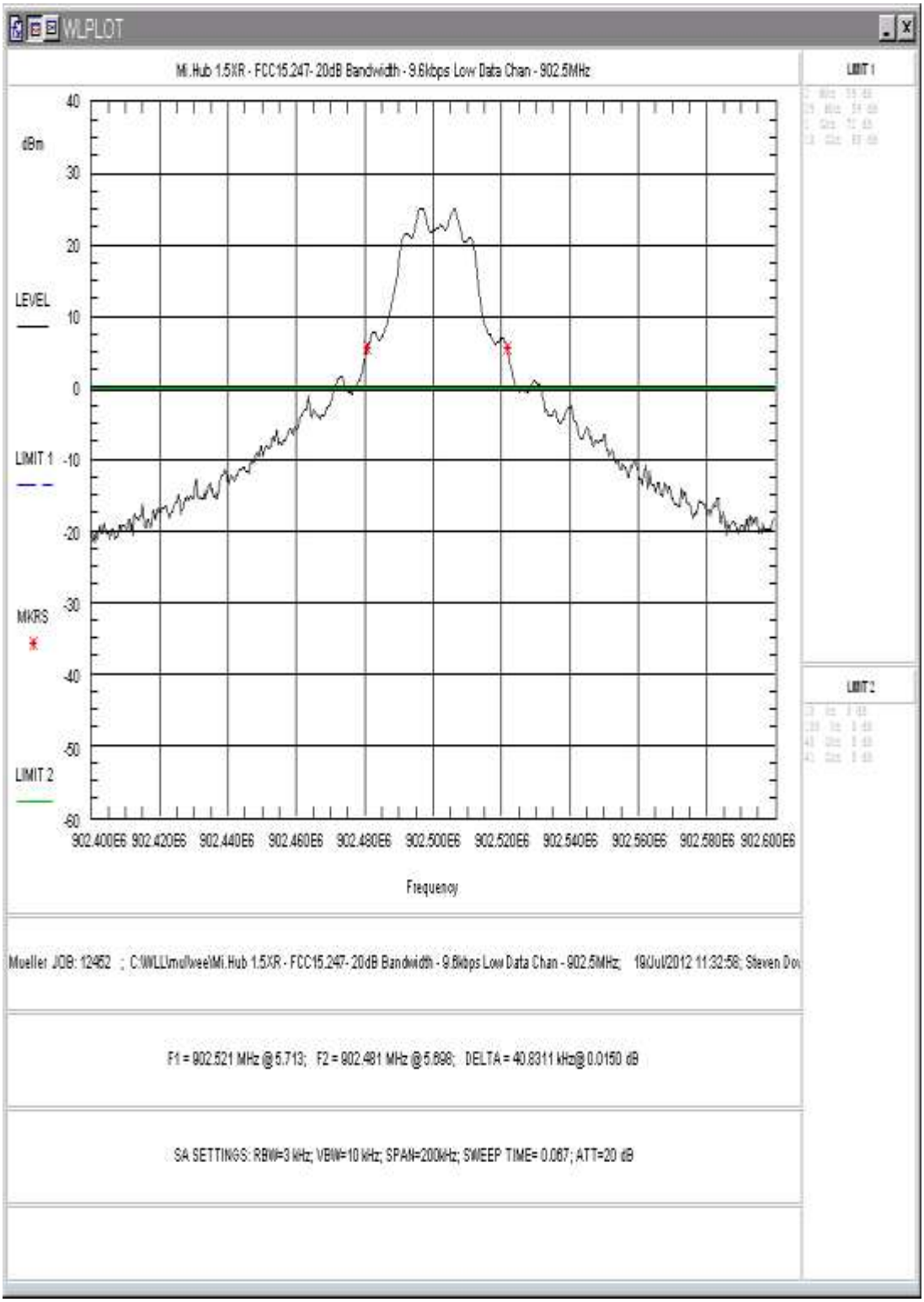

Figure 19: Data Channel Occupied Bandwidth, 9.6kbps, Low Channel

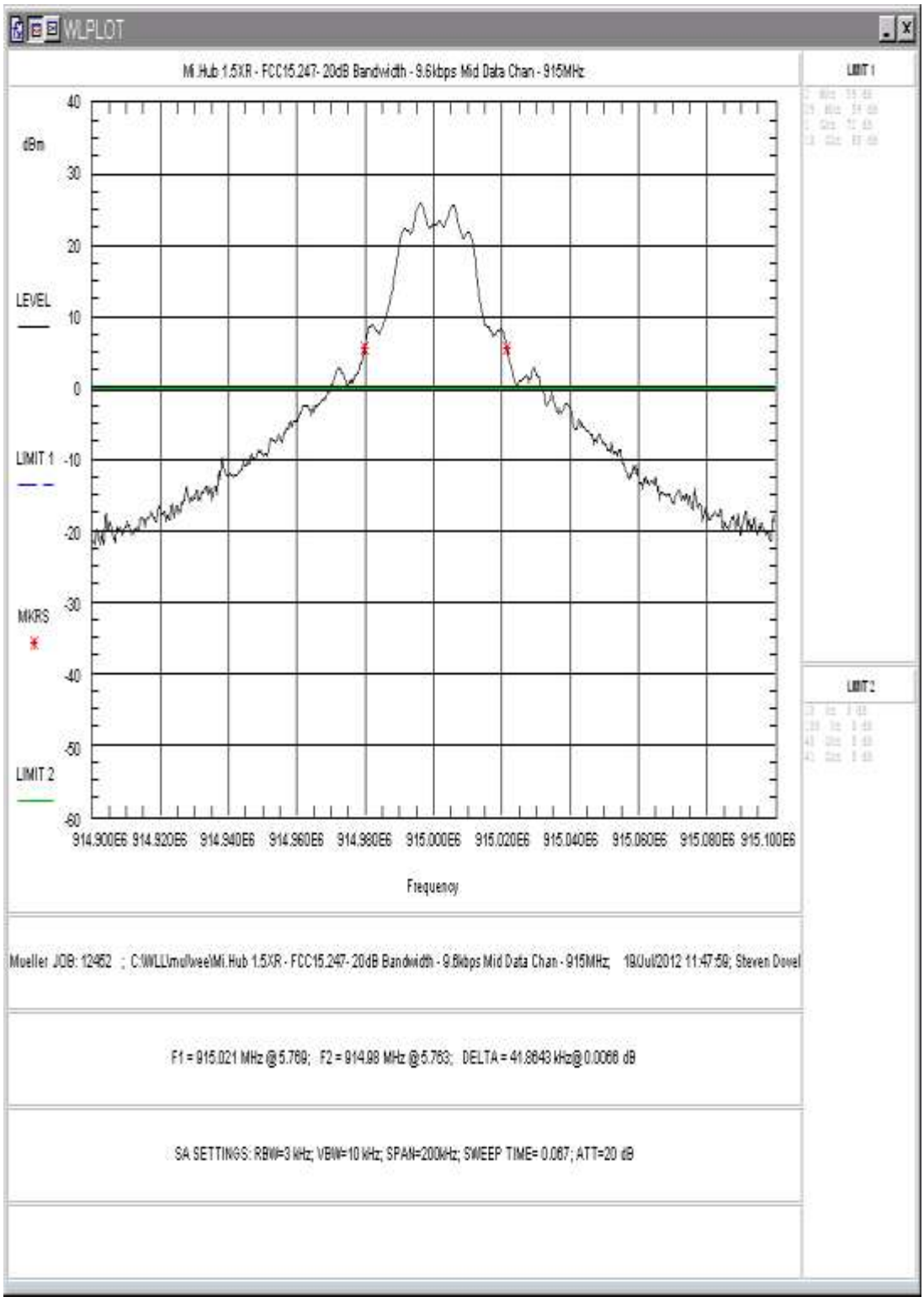

Figure 20: Data Channel Occupied Bandwidth, 9.6kbps, Center Channel

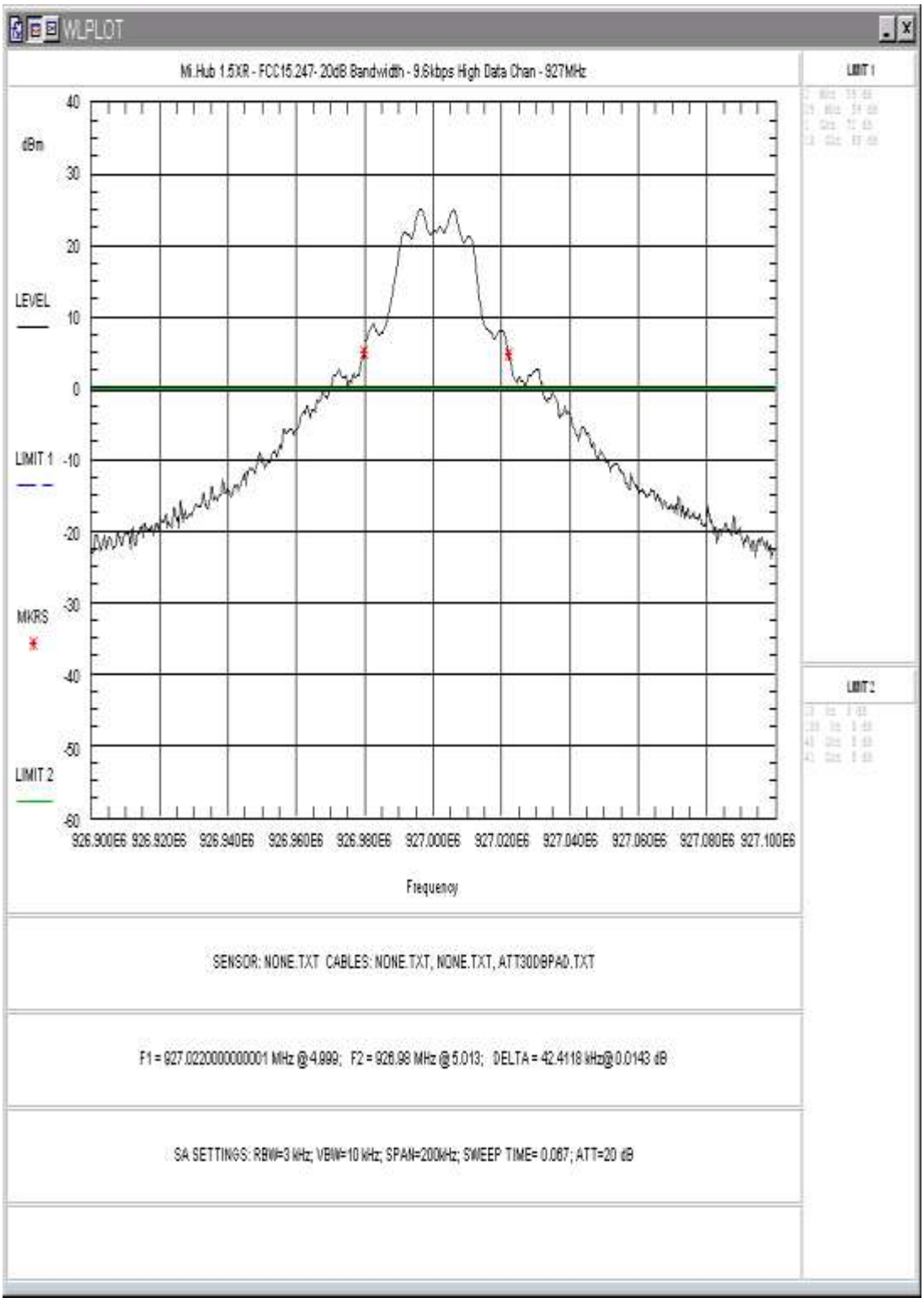

Figure 21: Data Channel Occupied Bandwidth, 9.6kbps, High Channel

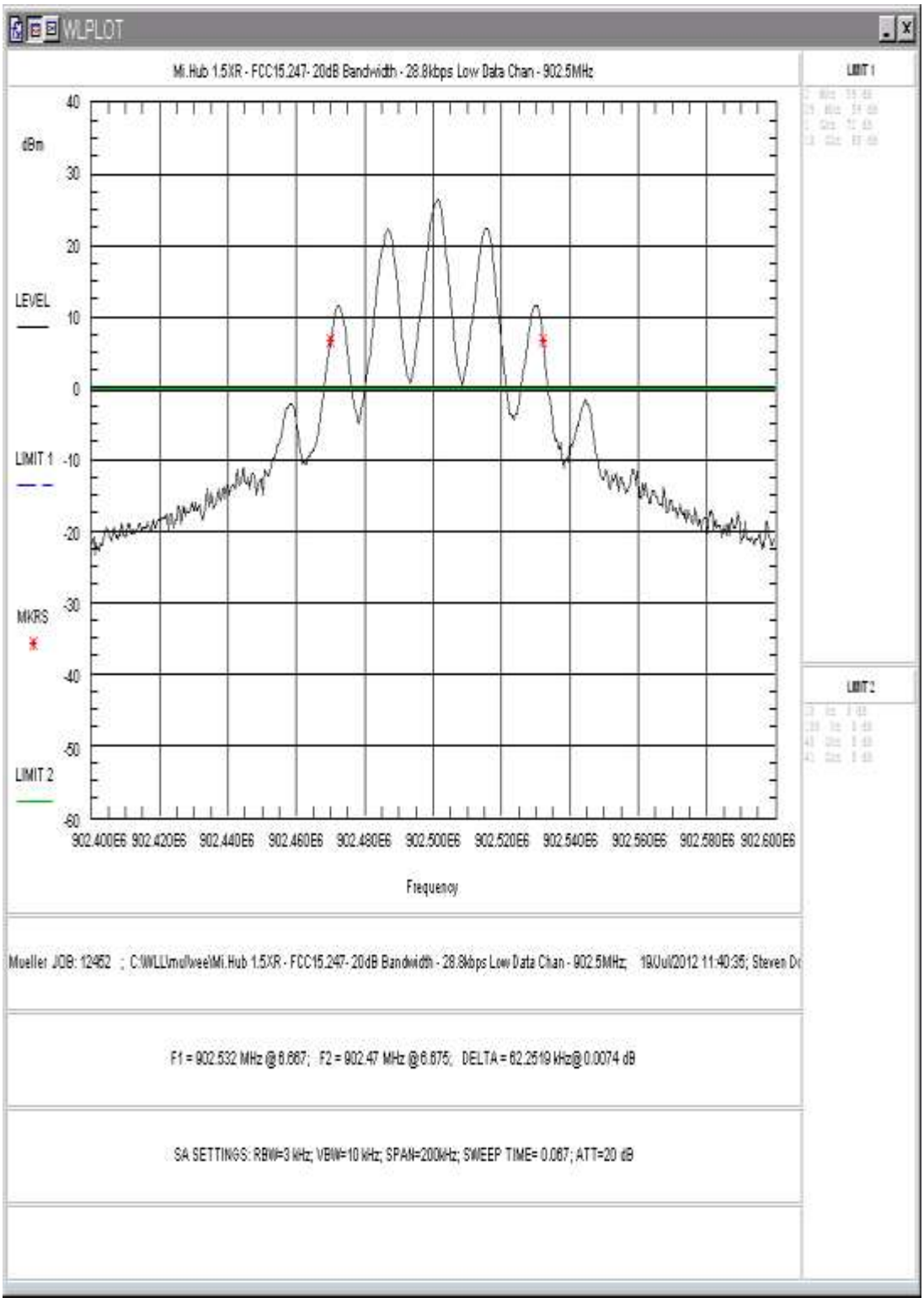

Figure 22: Data Channel Occupied Bandwidth, 28.8kbps, Low Channel

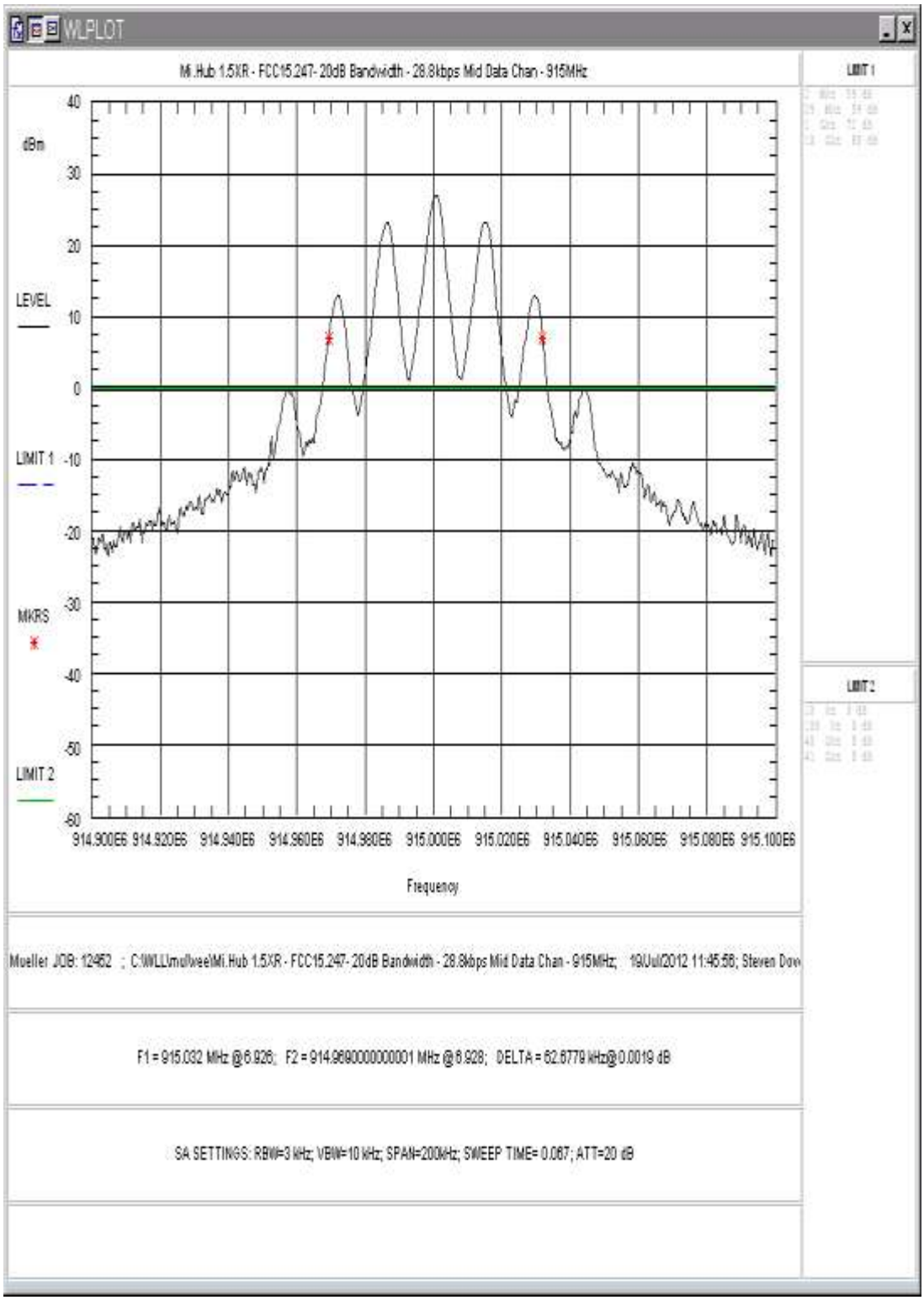

Figure 23: Data Channel Occupied Bandwidth, 28.8kbps, Center Channel

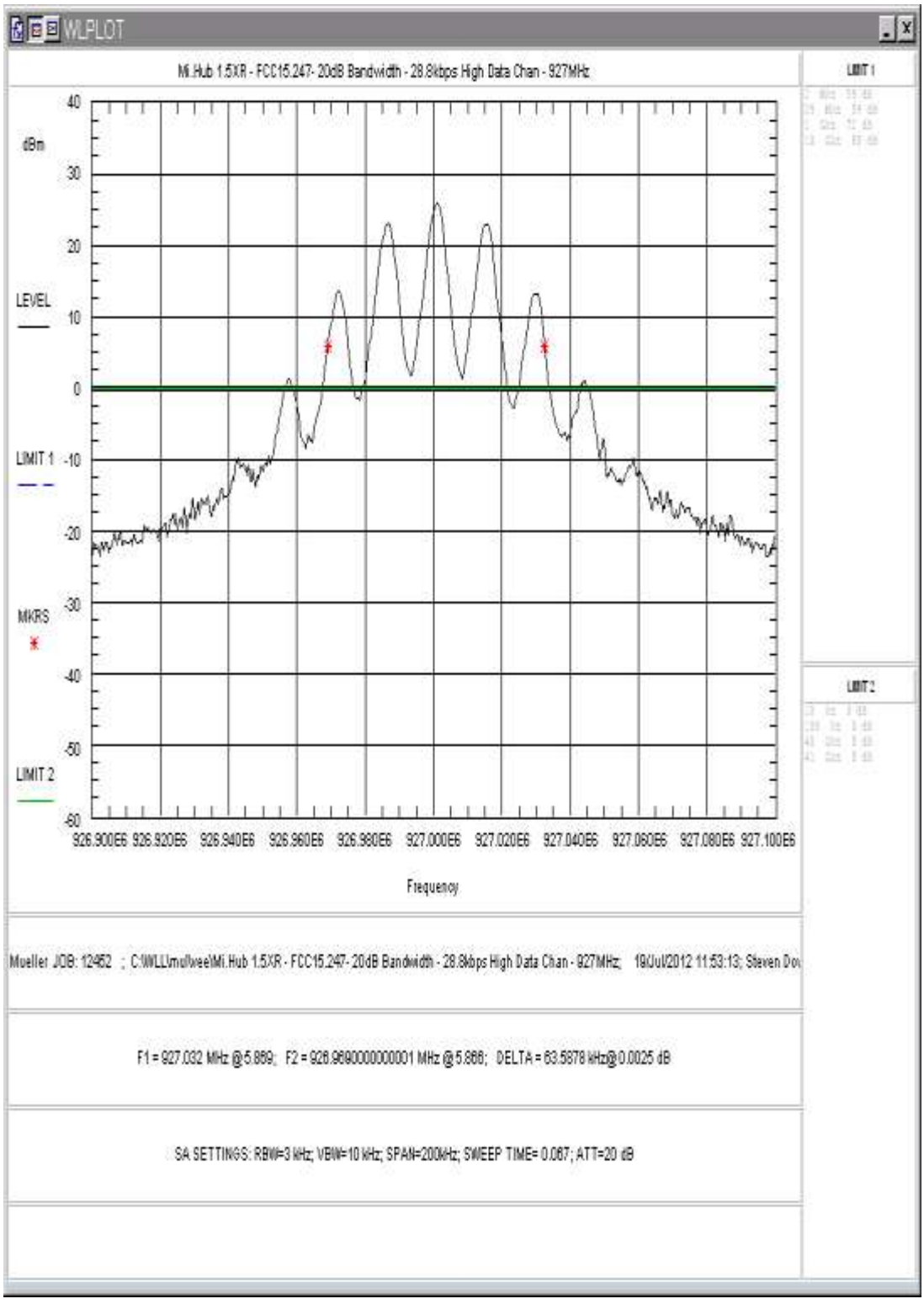

Figure 24: Data Channel Occupied Bandwidth, 28.8kbps, High Channel

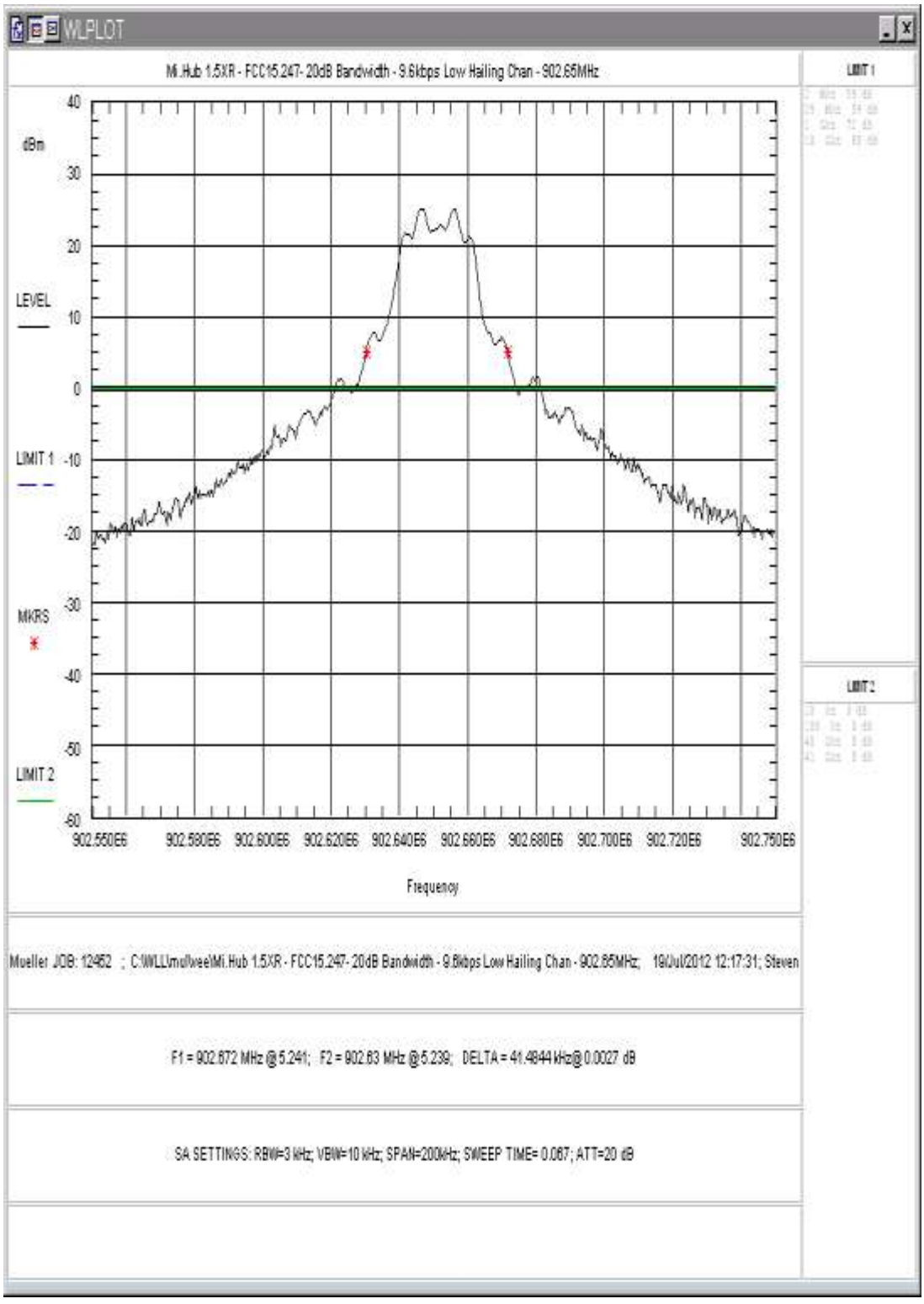

Figure 25 Hailing Channel Occupied Bandwidth, Low Channel

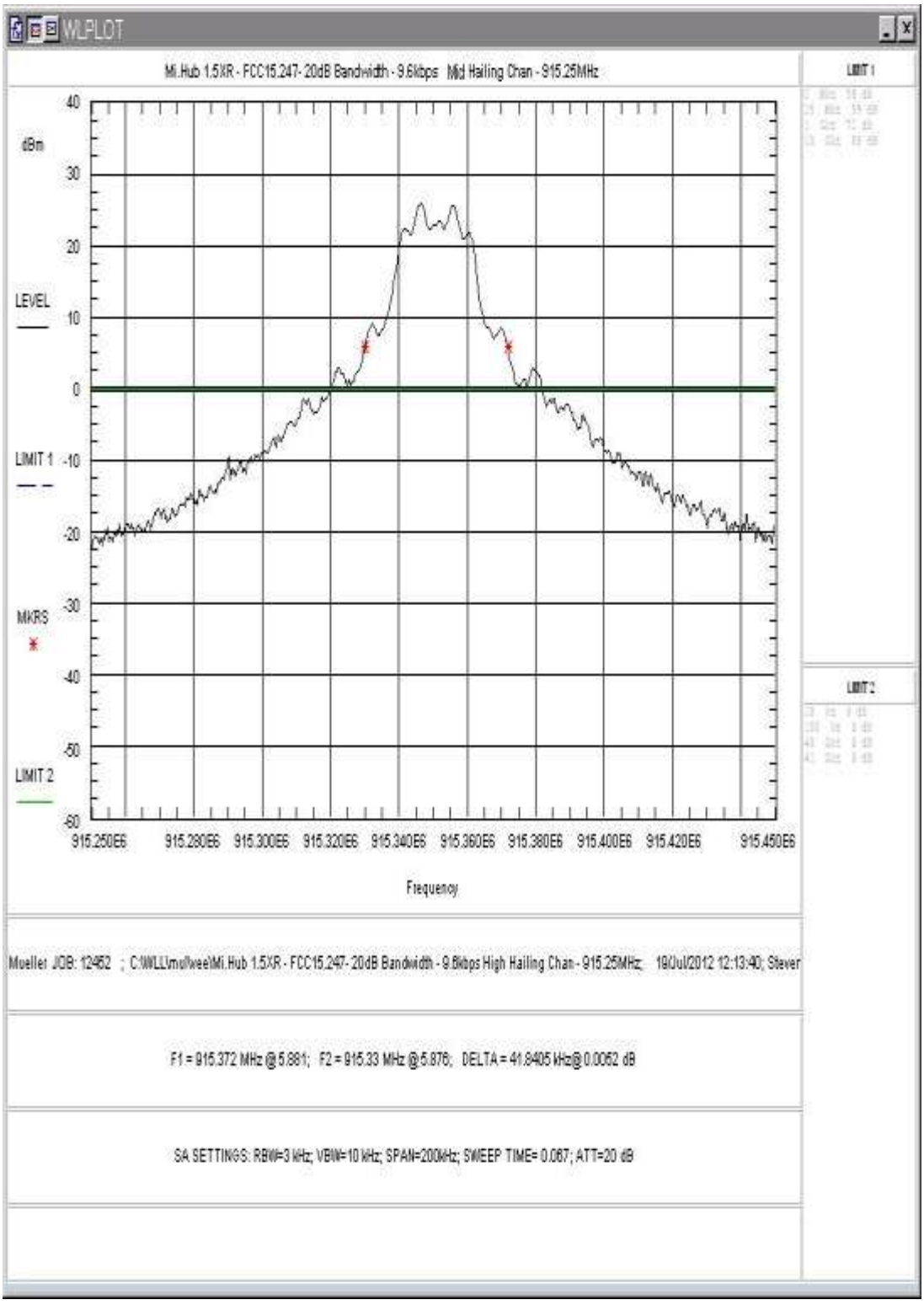

Figure 26 Hailing Channel Occupied Bandwidth, Center Channel

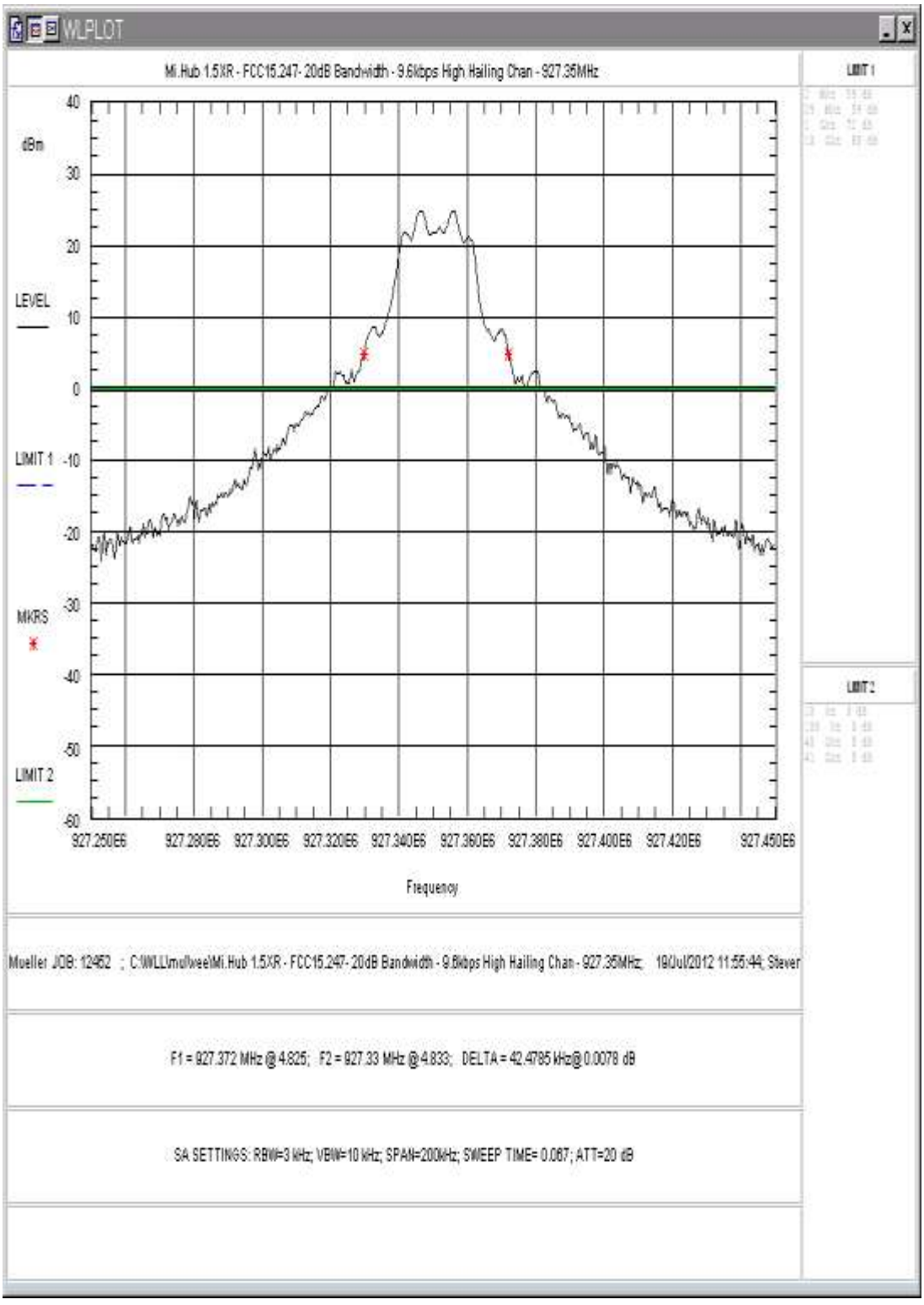

Figure 27 Hailing Channel Occupied Bandwidth, High Channel

5.4 Channel Spacing and Number of Hop Channels (FCC Part §15.247(a)(1)

Per the FCC requirements, frequency hopping systems operating in the 902-928MHz shall have hopping channel carrier frequencies separated by a minimum of 25kHz or the 20 dB bandwidth, whichever is greater. The maximum 20dB bandwidth measured is 63.5878 kHz for Data channels (28.8kbps mode) and 42.4785kHz for hailing mode. The channel spacing must be more than 63.5878 kHz for Data mode and 42.478 kHz for Hailing mode. In addition, Part 15.247 requires that devices with occupied bandwidths less than 250kHz have a minimum of 50 hopping channels.

The EUT antenna was removed and the cable was connected directly into a spectrum analyzer through a calibrated cable and attenuator. An offset was programmed into the spectrum analyzer to compensate for the loss of the external attenuator/cable. The spectrum analyzer resolution bandwidth was set to 100 kHz and the video bandwidth was set to 300 kHz. The channel spacing of 2 adjacent channels was measured using a spectrum analyzer span setting of 2MHz. Also, the number of hopping channels was measured within the 902-928MHz frequency range.

The following are plots of the channel spacing and number of hopping channels data. The channel spacing was measured to be 250kHz (minimum) for Data channels and 150kHz (minimum) for Hailing channels and the number of hopping channels is 50 for each mode of operation.

Note: The Data channel plan for this unit has a typical channel spacing of 500kHz between channels, however, 2 channels have been removed at 909MHz and 921MHz. These channels have been replaced with 2 channels at 902.25MHz and 908.25MHz thus giving a 250kHz channel spacing between 904MHz -904.5MHz and 908MHz-908.5MHz. This still remains in compliance.

In addition the hailing channels are not evenly dispersed within the band with the closest hailing channels spaced 150 kHz apart. Worst case spacings are shown in plots below.

Table 9: Channel spacing and number of hopping channels summary

Test	Result	Limit	Pass/Fail
Data Channel spacing	250kHz channel spacing between 904MHz - 904.5MHz and 908MHz-908.5MHz. 500kHz between other channels	63.5878kHz Minimum	Pass
Number of Channels	50 channels	50 channels minimum	Pass
Hailing Channel Spacing	The closest channels are spaced 150kHz	42.4785kHz Minimum	Pass
Number of Hailing Channels	50 channels	50 channels minimum	Pass

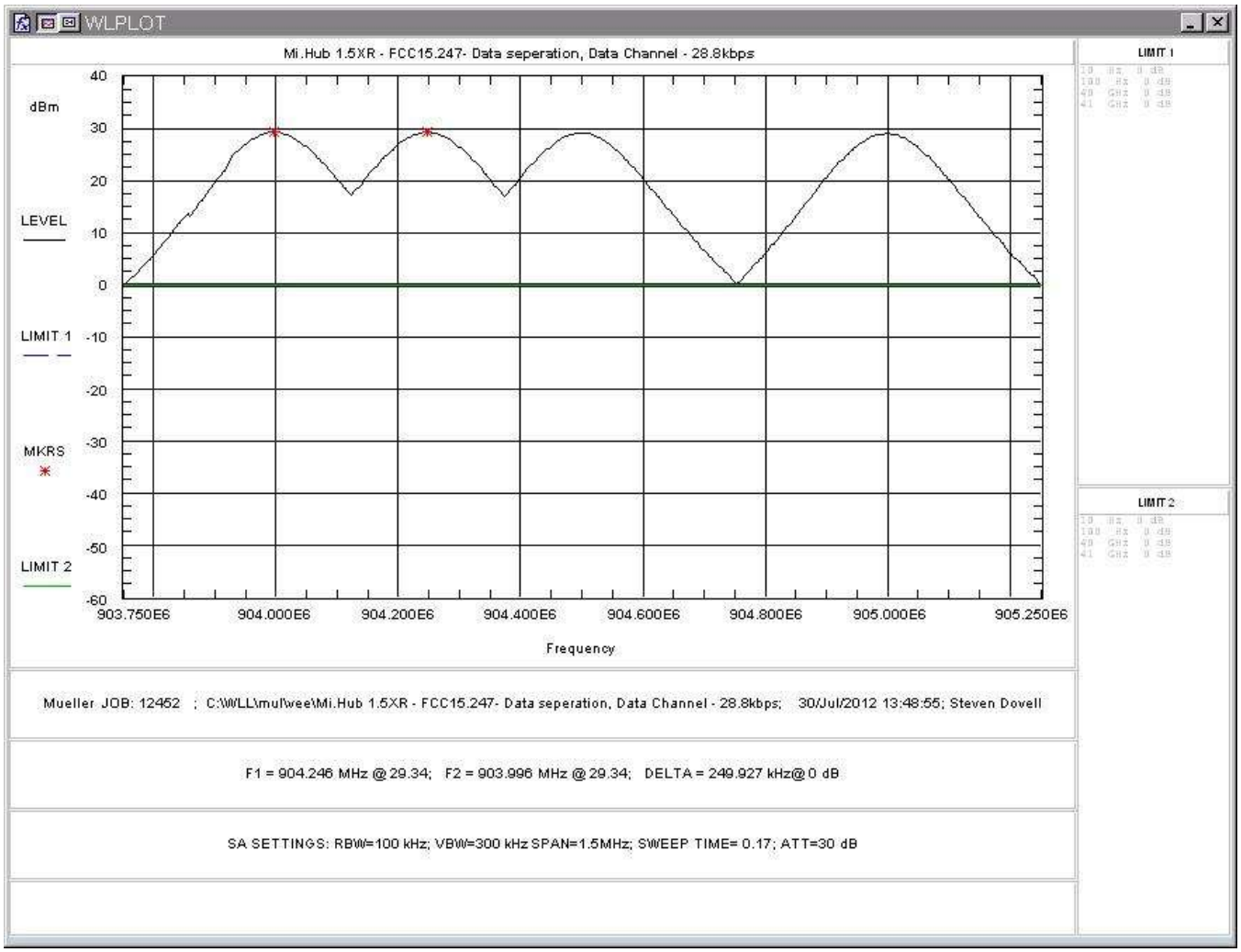

Figure 28: Data Channel Spacing, 250 kHz

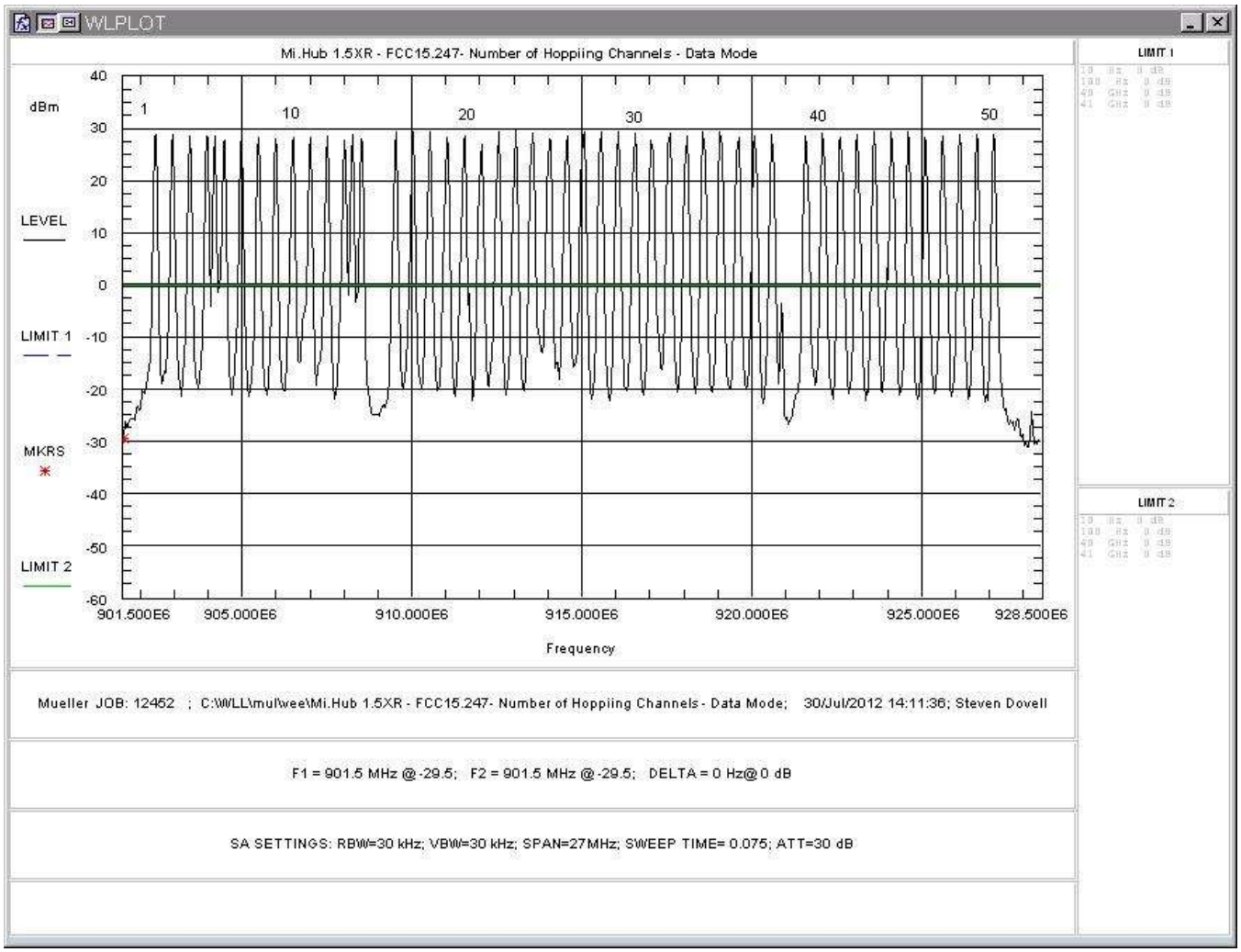

Figure 29: Data Channel Number of Channels

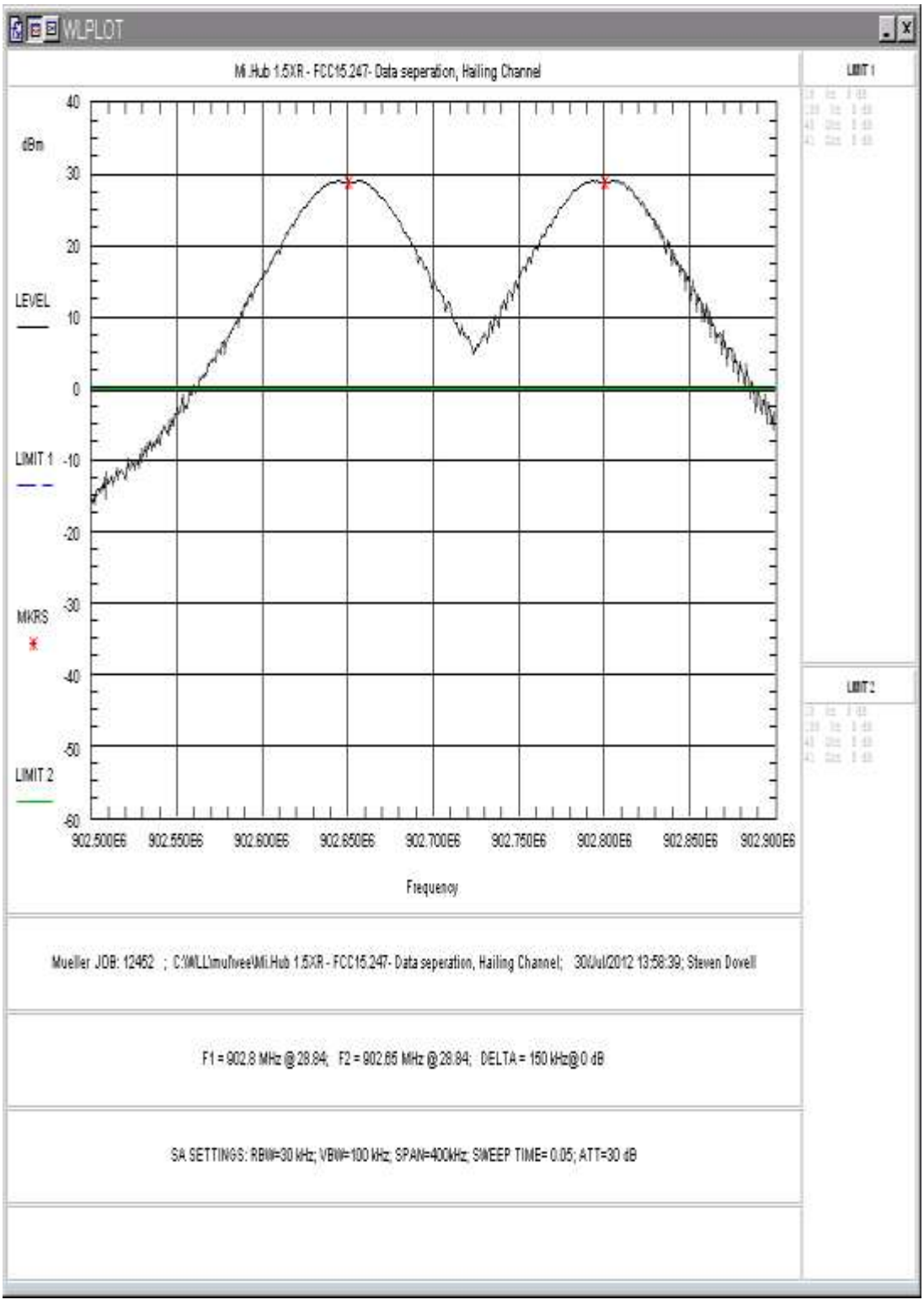

Figure 30: Hailing Channel Spacing

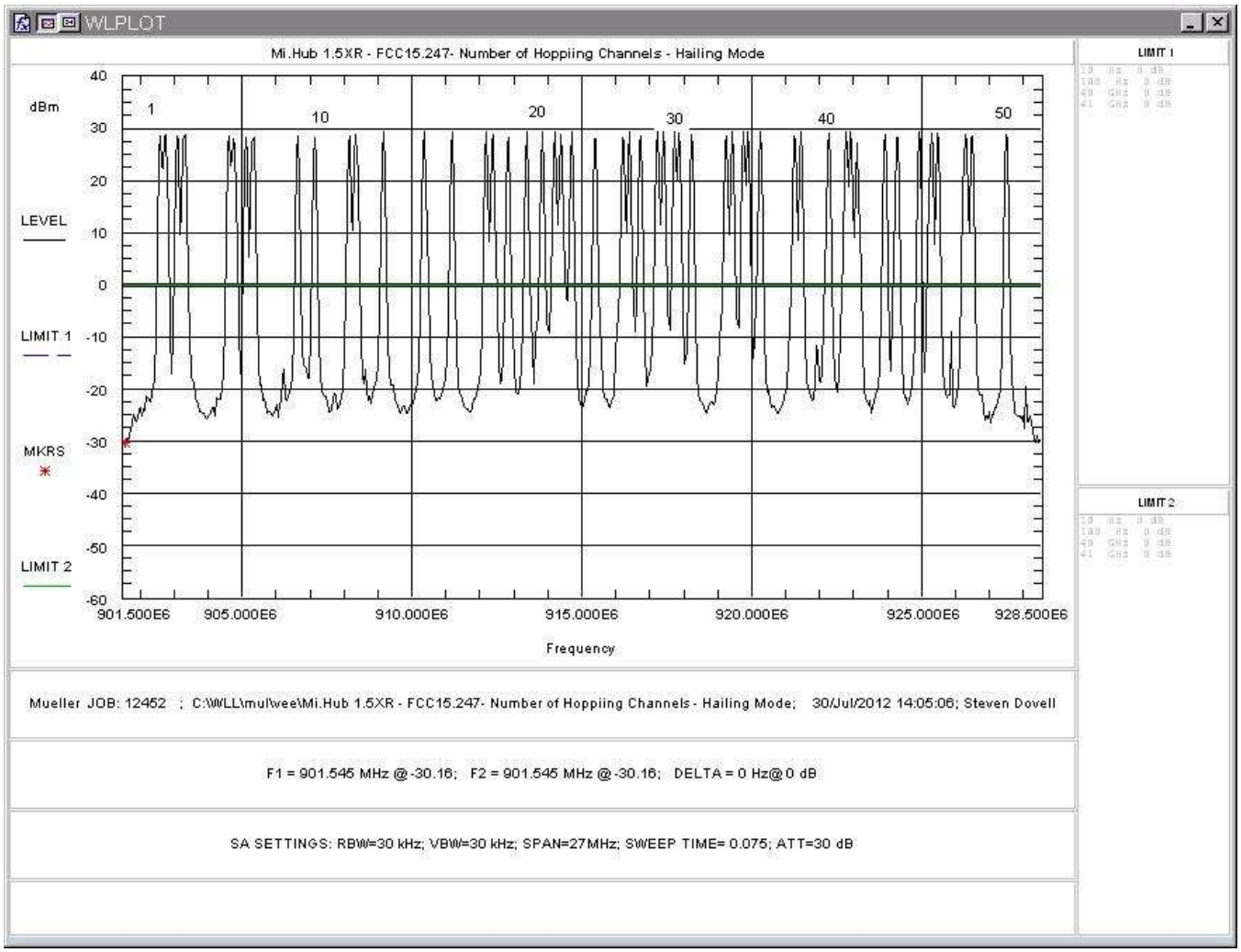

Figure 31: Number of Hailing Channels

5.5 Conducted Spurious Emissions at Antenna Terminals (FCC Part §2.1051)

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

The EUT antenna was removed and the cable was connected directly into a spectrum analyzer through a suitable 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 300 kHz. The amplitude of the EUT carrier frequency was measured to determine the emissions limit (20 dB below the maximum modulated transmit frequency amplitude). The emissions outside of the allocated frequency band were then scanned from 30 MHz up to the tenth harmonic of the carrier.

Close-up plots of the 902-928MHz band edges are provided in both the hopping and non-hopping modes for all modes of operation to show compliance at both of these points.

Based on the results of the previous tests & band-edge tests plus the fact that both the hailing & data channels have the same power and share the same RF circuitry the full conducted tests will be performed as follows:

Low Channel Testing: 902.5MHz –Long and Short cables, 9.6kbps

Center Channel Testing: 915 MHz - Long and Short cables, 9.6kbps

High Channel Testing: 927.35MHz - Long and Short cables, 9.6kbps

(this is the low, center & highest channels of both modes combined)

The EUT complied with all requirements of FCC Part15.247 for the conducted spurious measurements performed in sections 5.5.1 and 5.5.2 of this test report.

5.5.1 Conducted Band Edge Plots

5.5.1.1 Hailing Mode-Long Cable

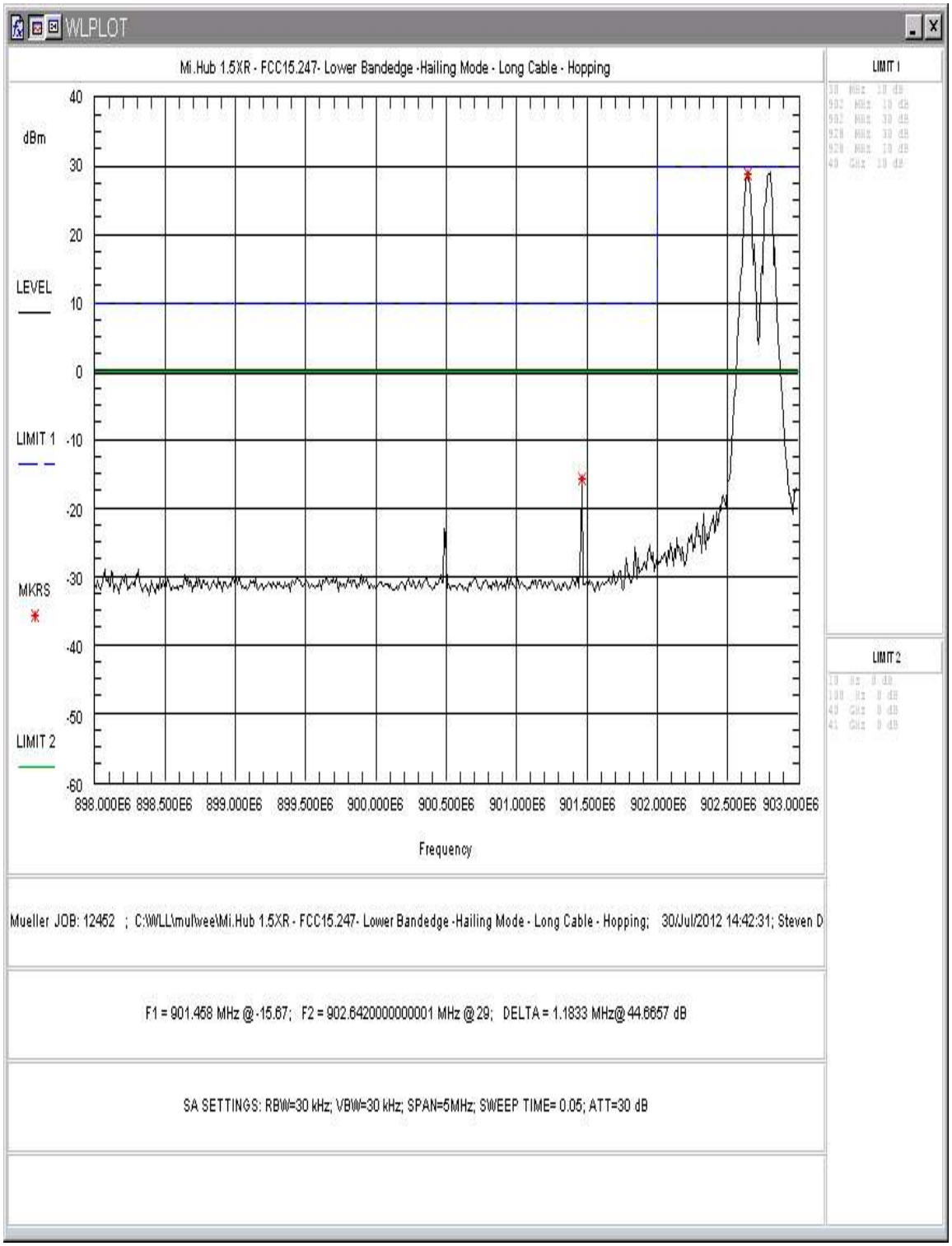

Figure 32: Lower Band-edge, Hailing, Long Cable, 9.6kbps, TX-902.65MHz

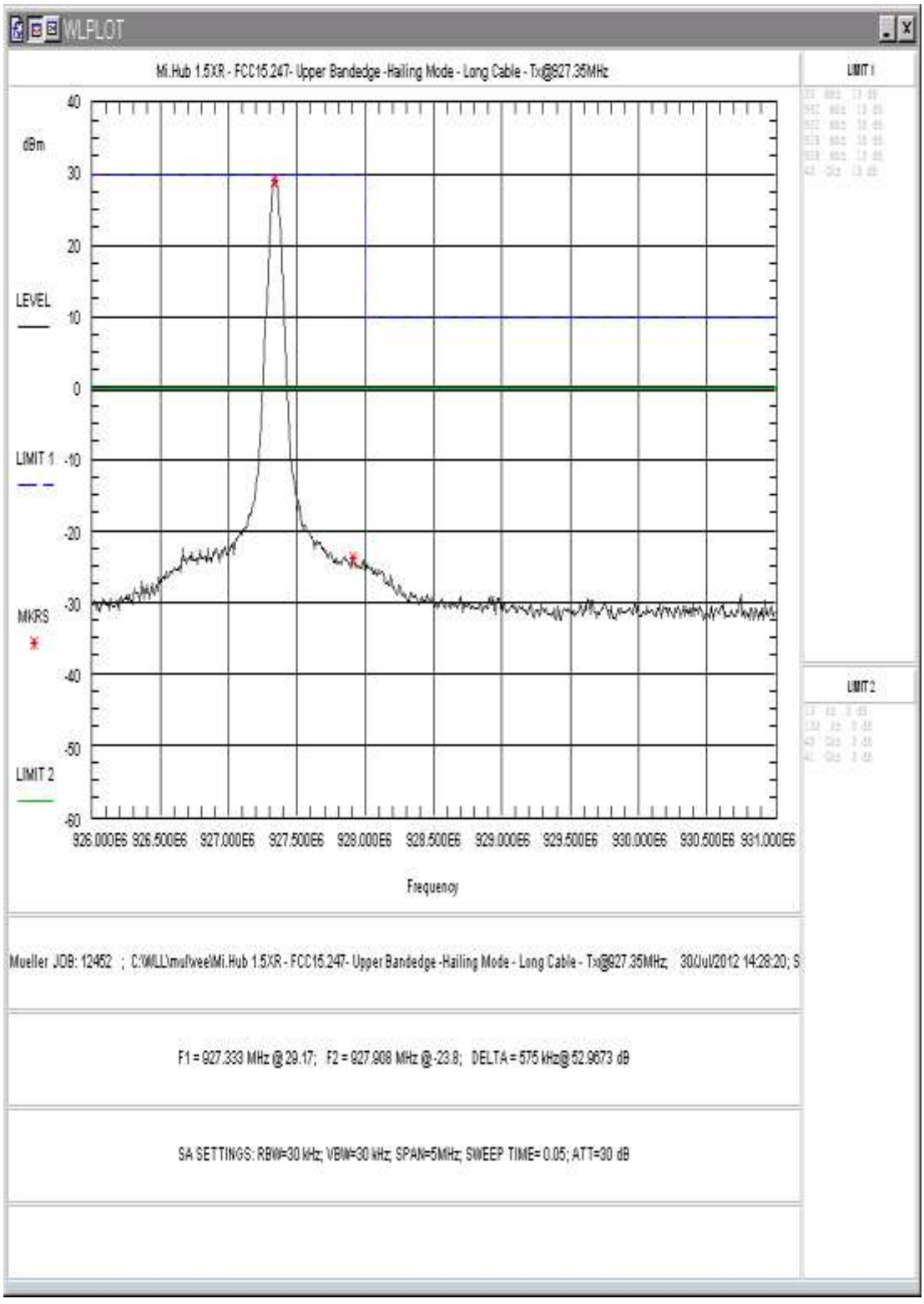

Figure 33: Upper Band-edge, Hailing, Long Cable, 9.6kbps, TX-927.35MHz

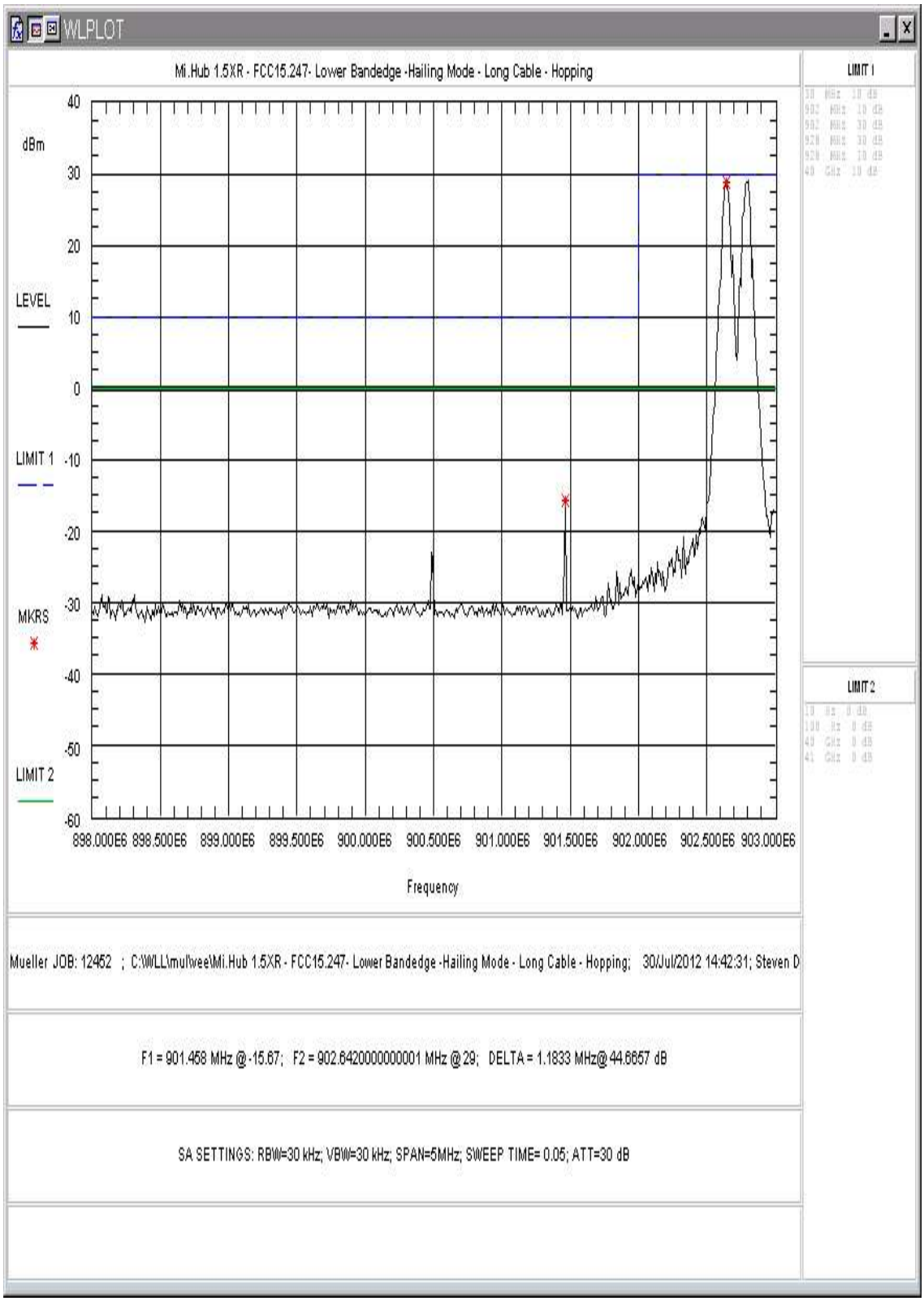

Figure 34: Lower Band-edge, Hailing, Long Cable, 9.6kbps, Hopping

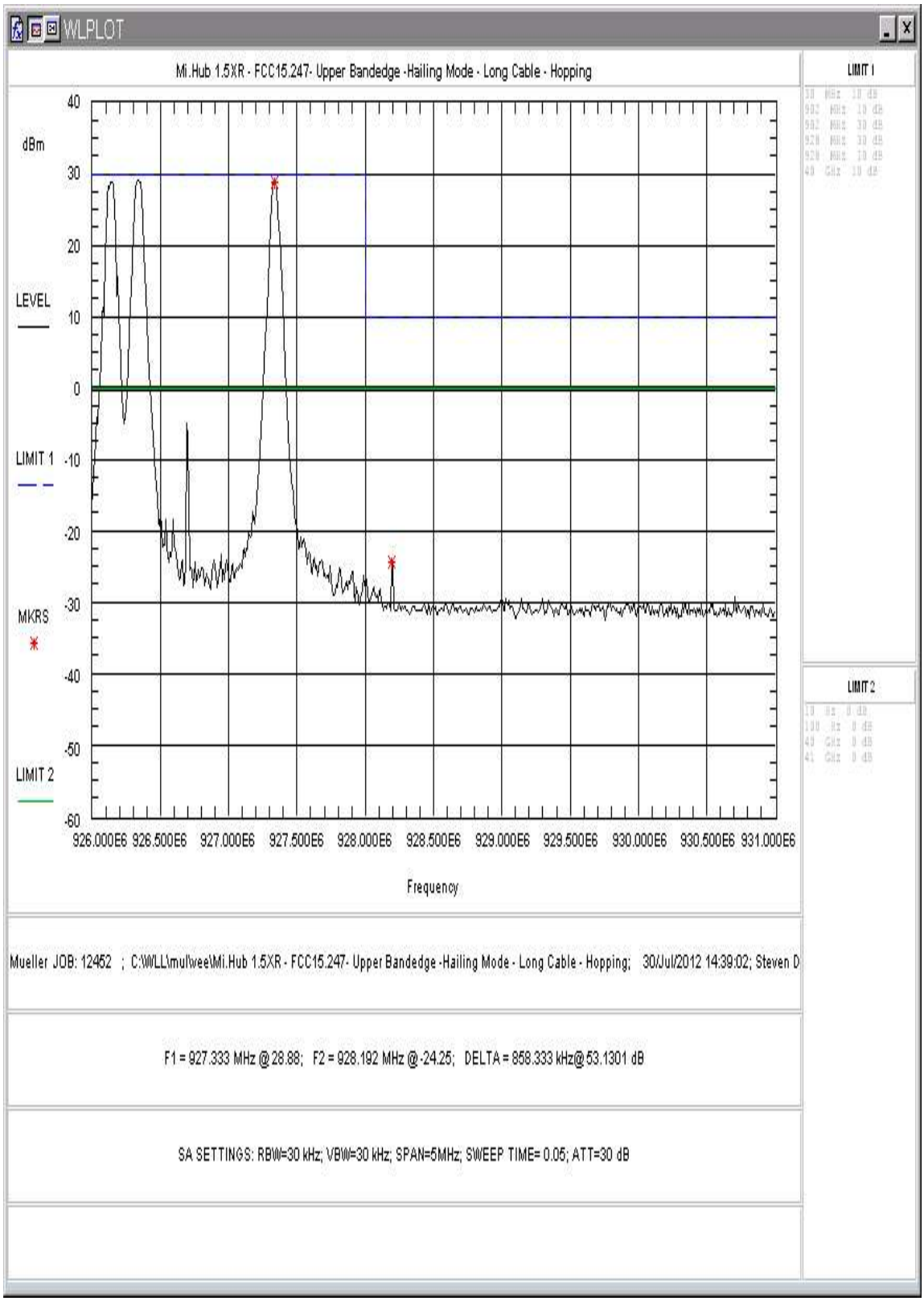

Figure 35: Upper Band-edge, Hailing, Long Cable, 9.6kbps, Hopping

5.5.1.2 Hailing Mode- Short Cable

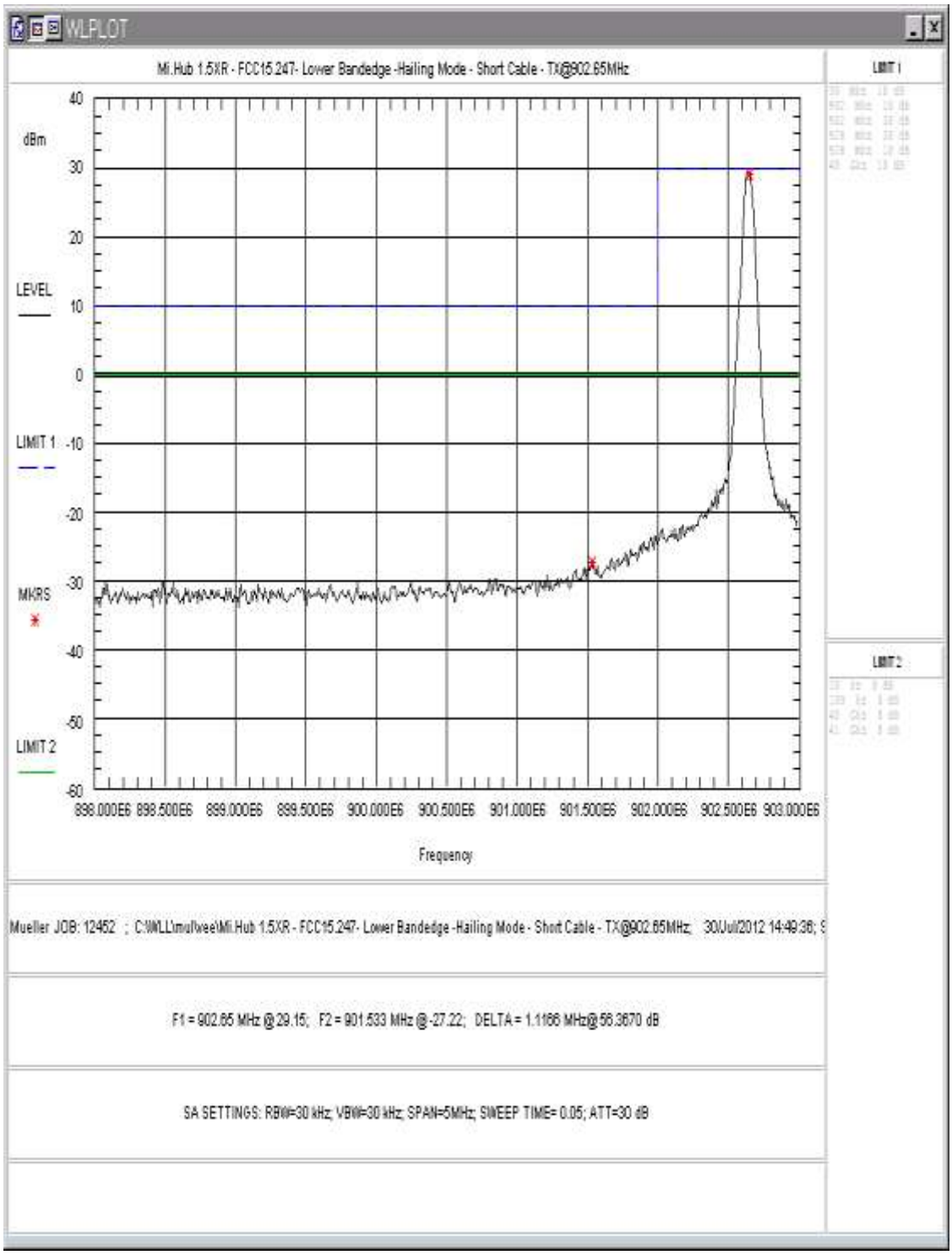

Figure 36: Lower Band-edge, Hailing, Short Cable, 9.6kbps, TX-902.65MHz

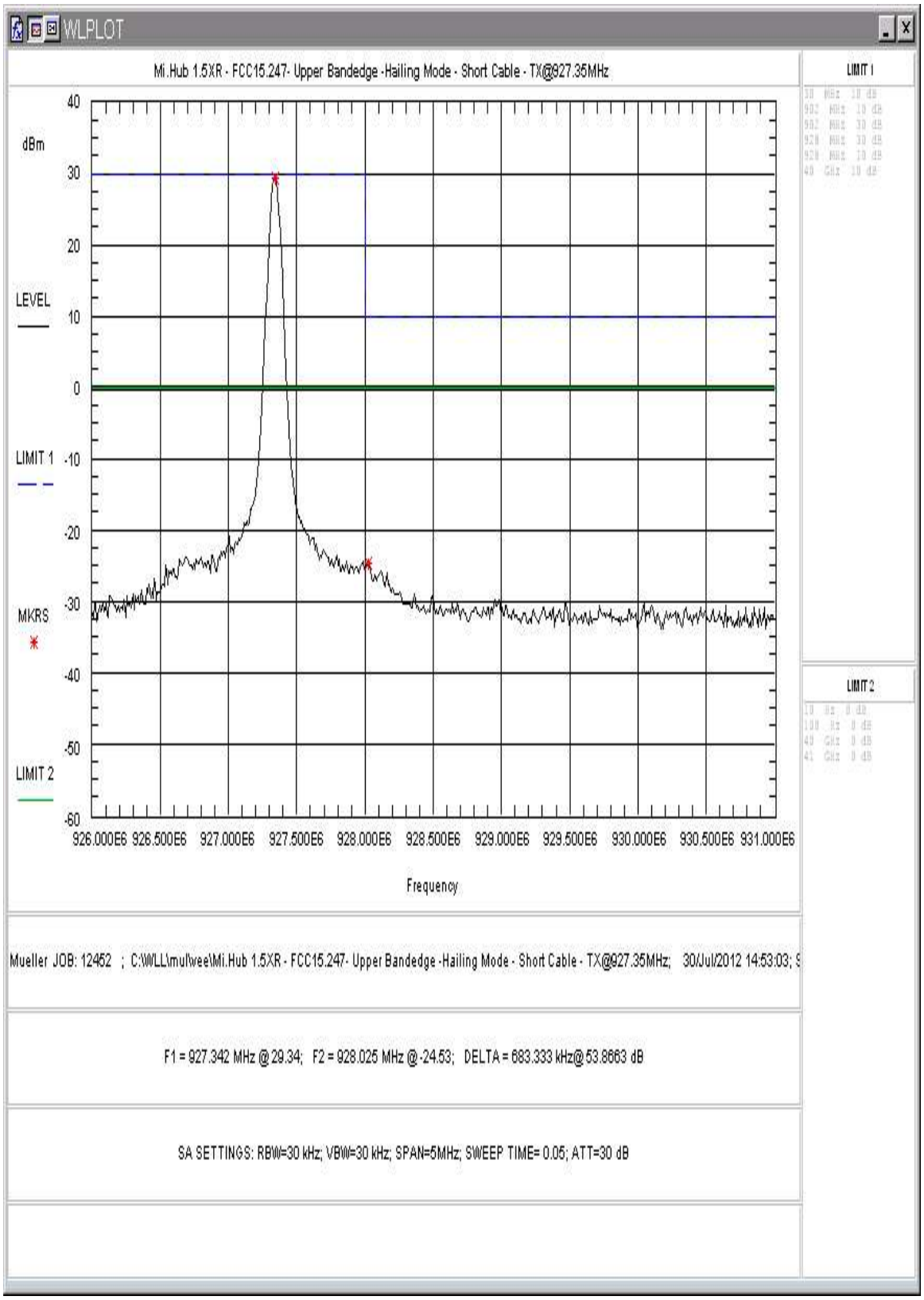

Figure 37: Upper Band-edge, Hailing, Short Cable, 9.6kbps, TX-927.35MHz

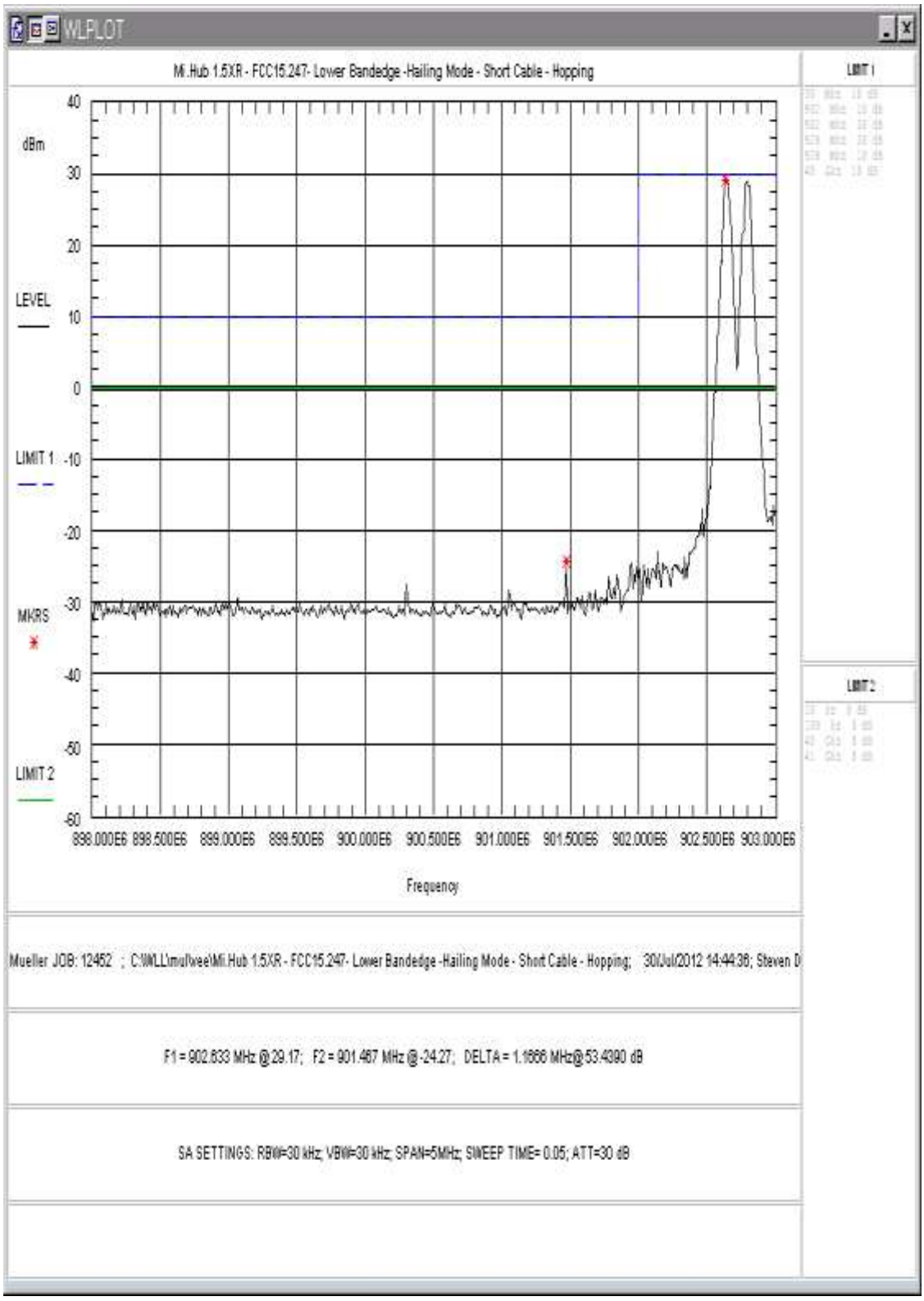

Figure 38: Lower Band-edge, Hailing, Short Cable, 9.6kbps, Hopping

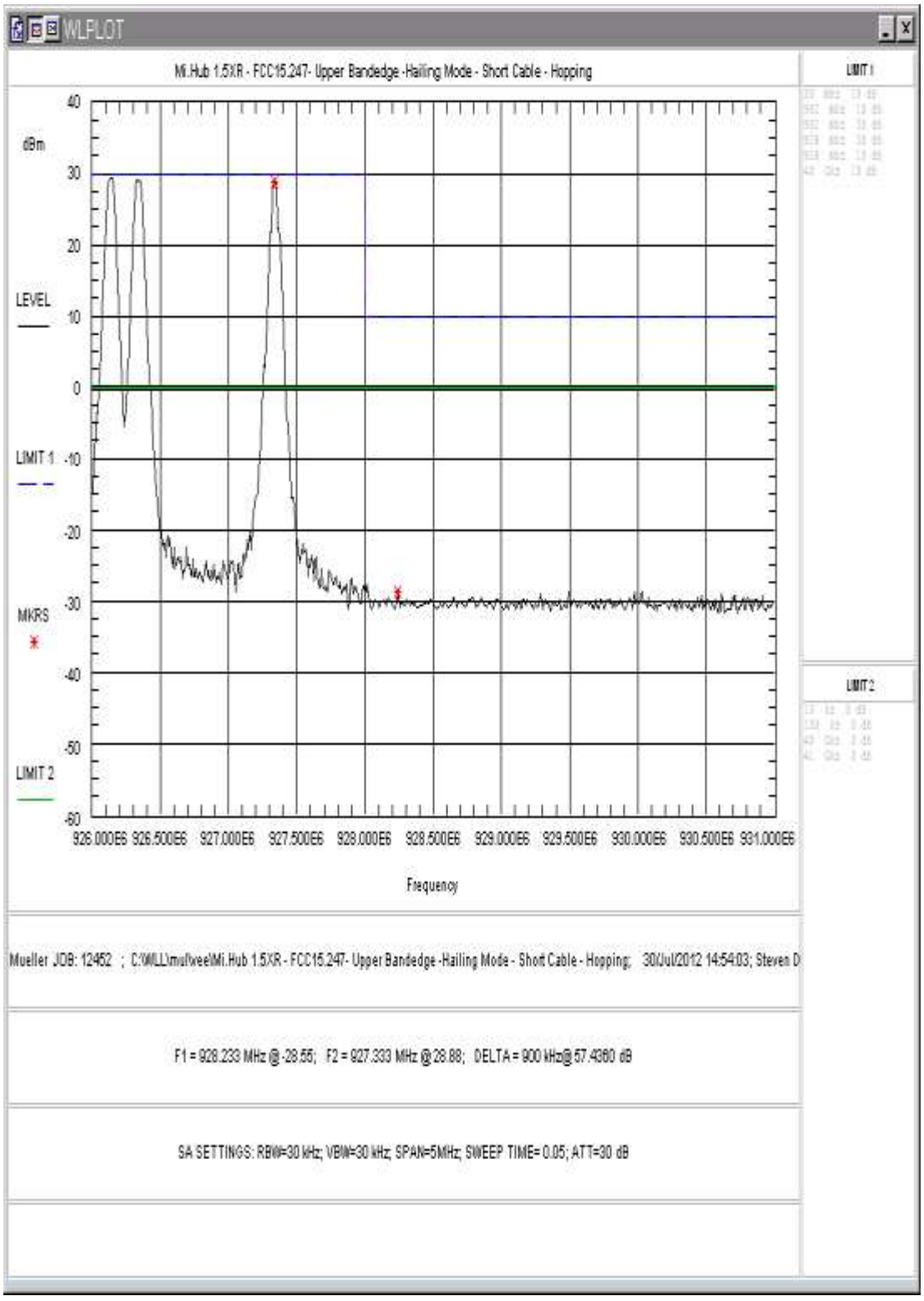

Figure 39: Upper Band-edge, Hailing, Short Cable, 9.6kbps, Hopping

5.5.1.3 Data Mode-9.6kbps-Long Cable

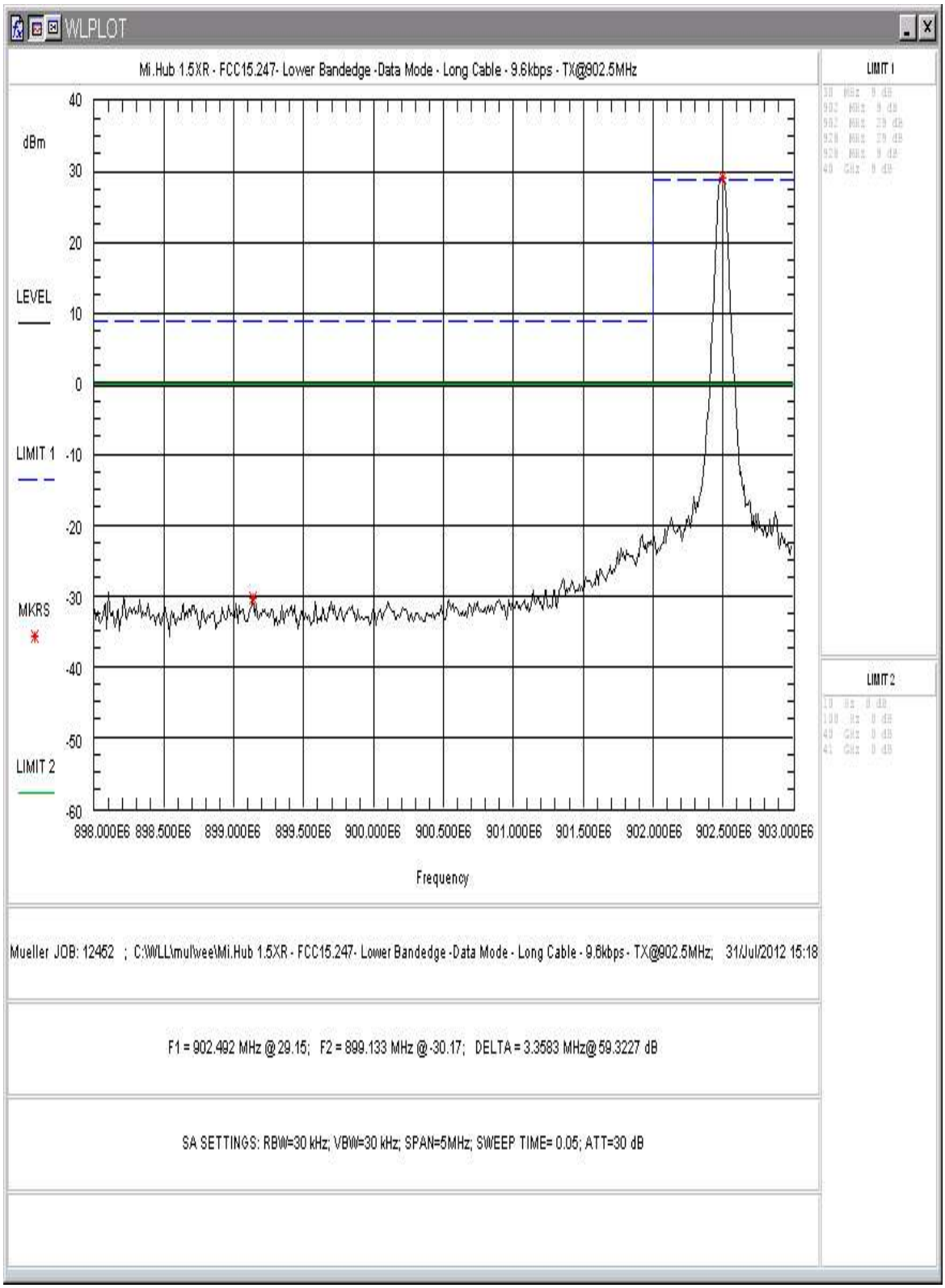

Figure 40: Lower Band-edge, Data, Long Cable, 9.6kbps, TX-902.5MHz

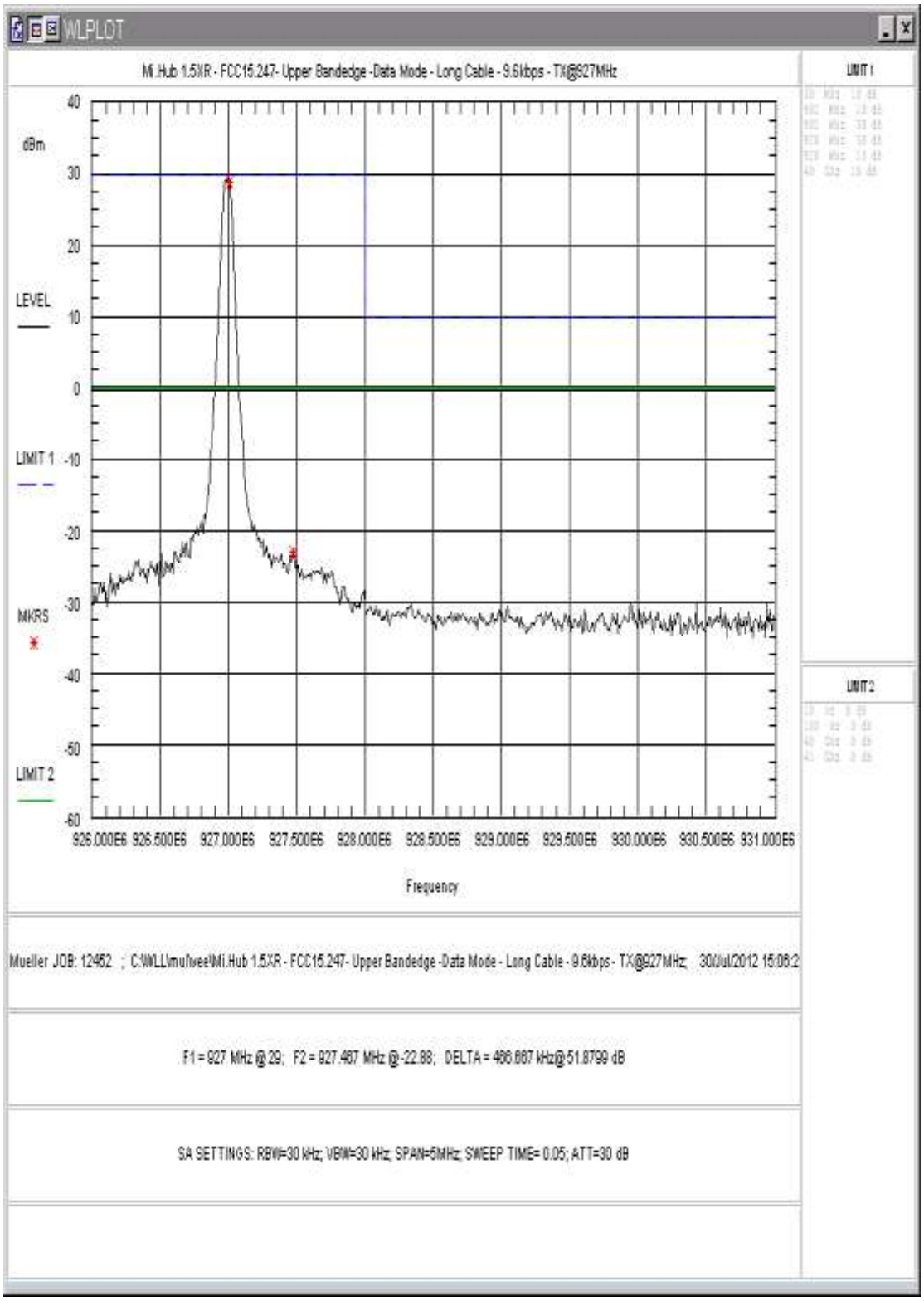

Figure 41: Upper Band-edge, Data, Long Cable, 9.6kbps, TX-927MHz

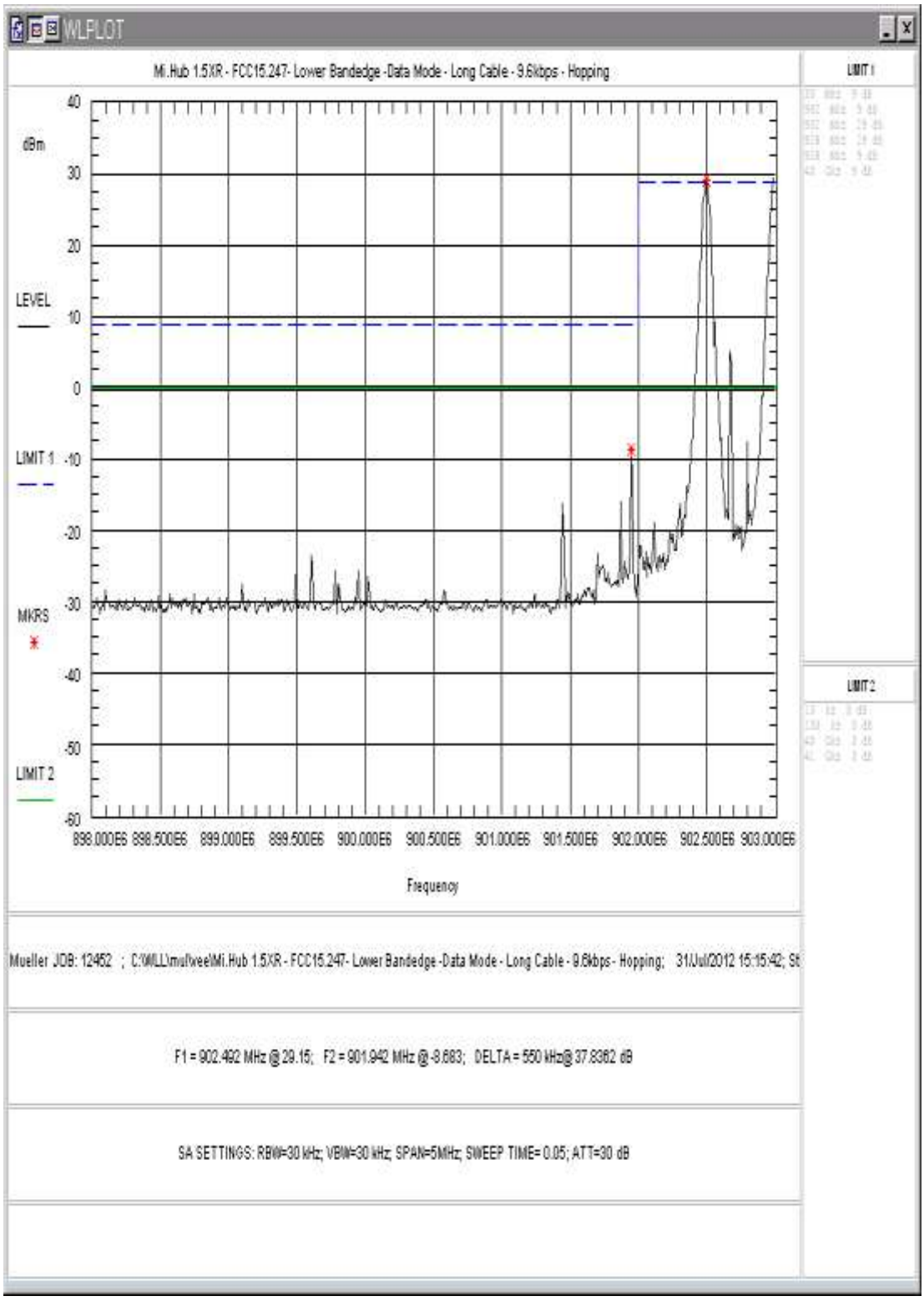

Figure 42: Lower Band-edge, Data, Long Cable, 9.6kbps, Hopping

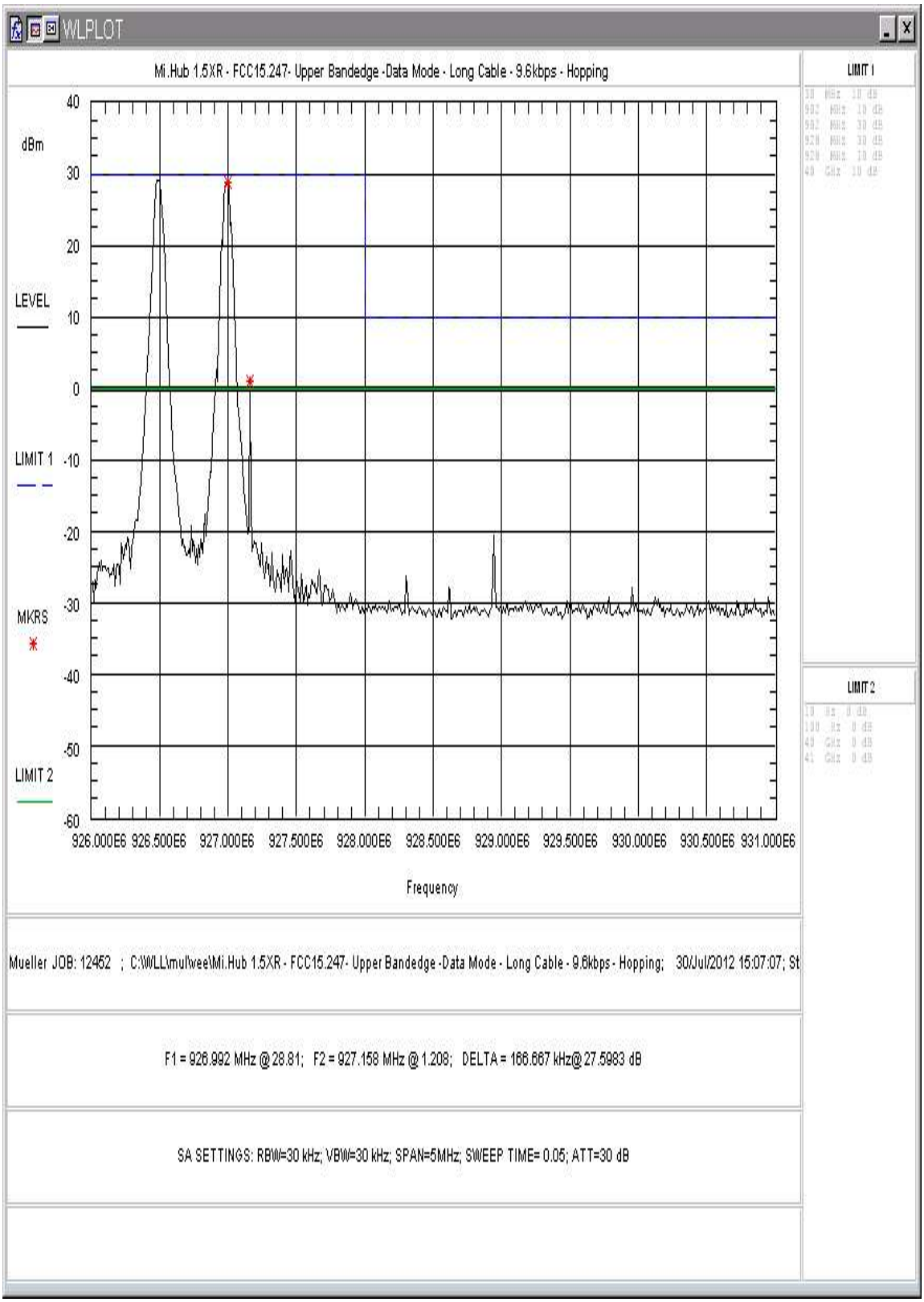

Figure 43: Upper Band-edge, Data, Long Cable, 9.6kbps, Hopping

Data Mode-9.6kbps-Short Cable

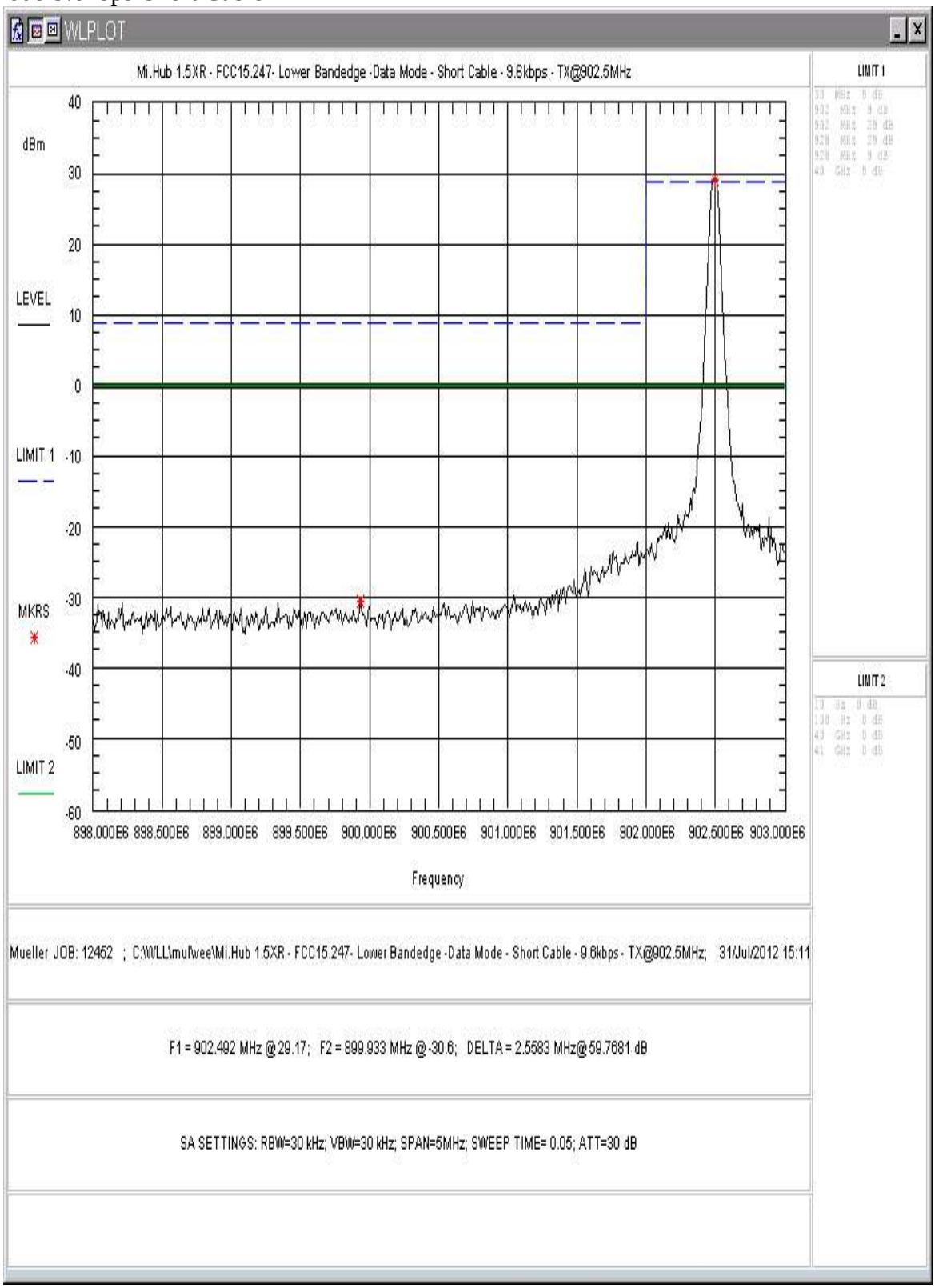

Figure 44: Lower Band-edge, Data, Short Cable, 9.6kbps, TX-902.5MHz

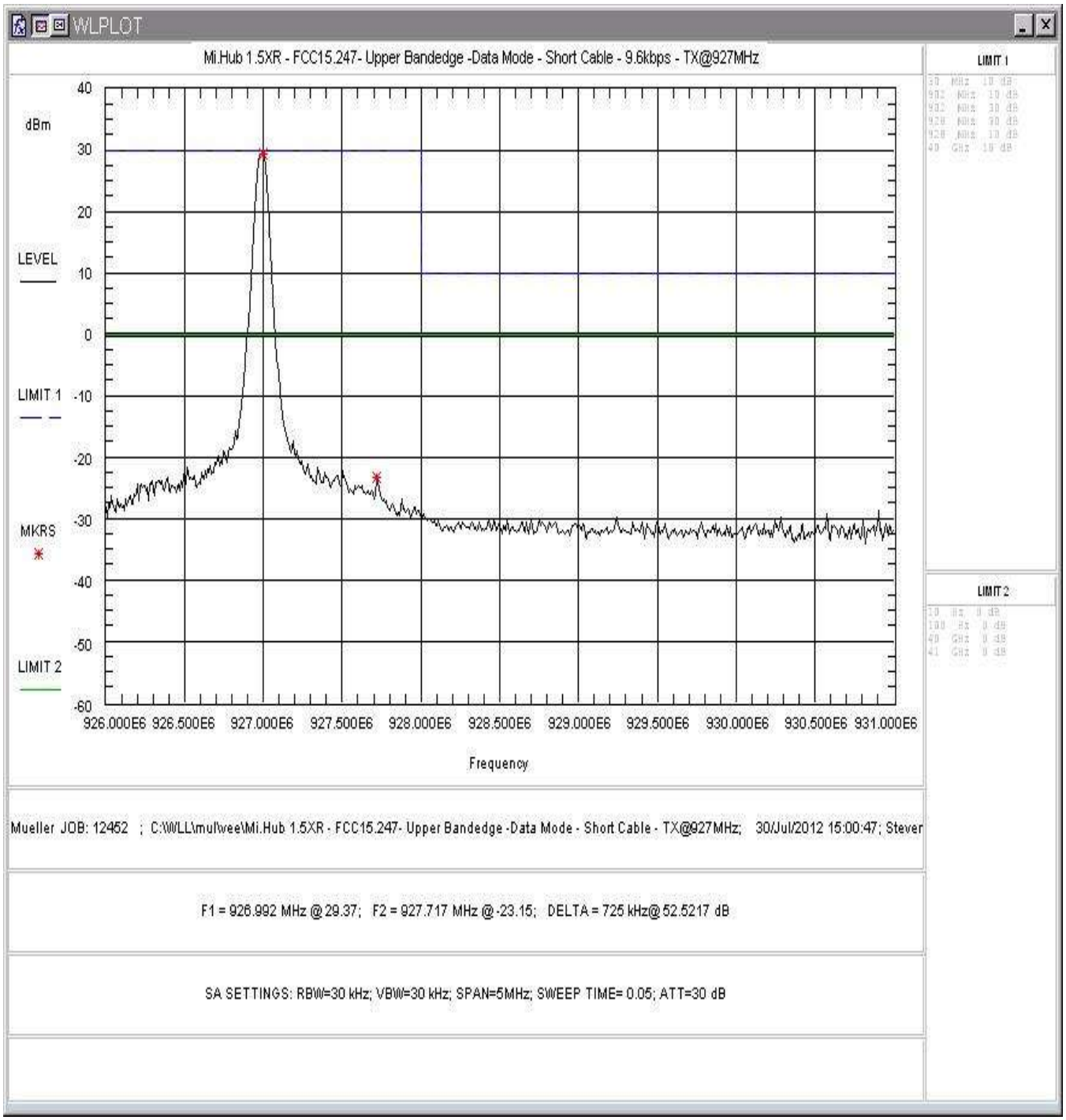

Figure 45: Upper Band-edge, Data, Short Cable, 9.6kbps, TX-927MHz

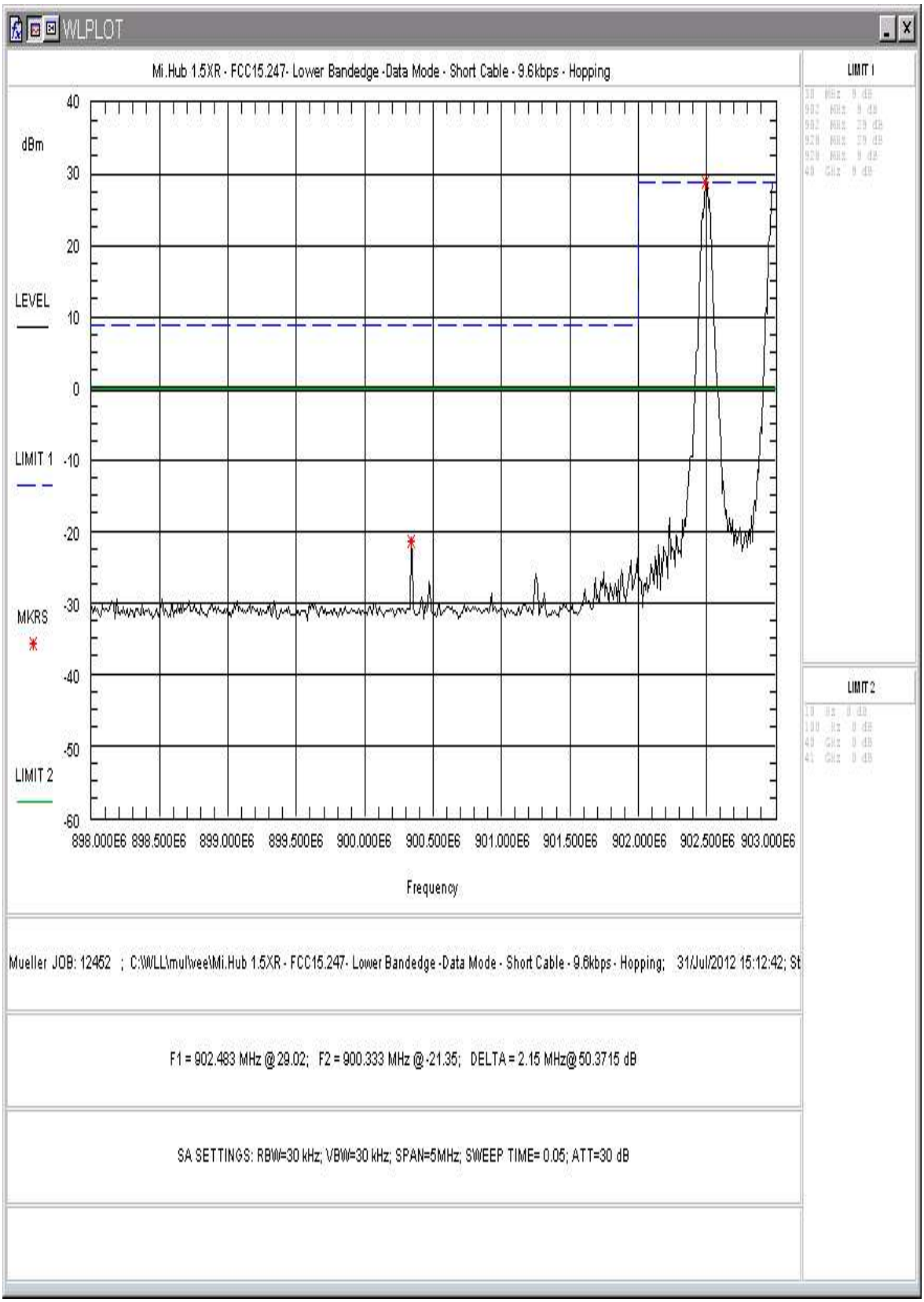

Figure 46: Lower Band-edge, Data, Short Cable, 9.6kbps, Hopping

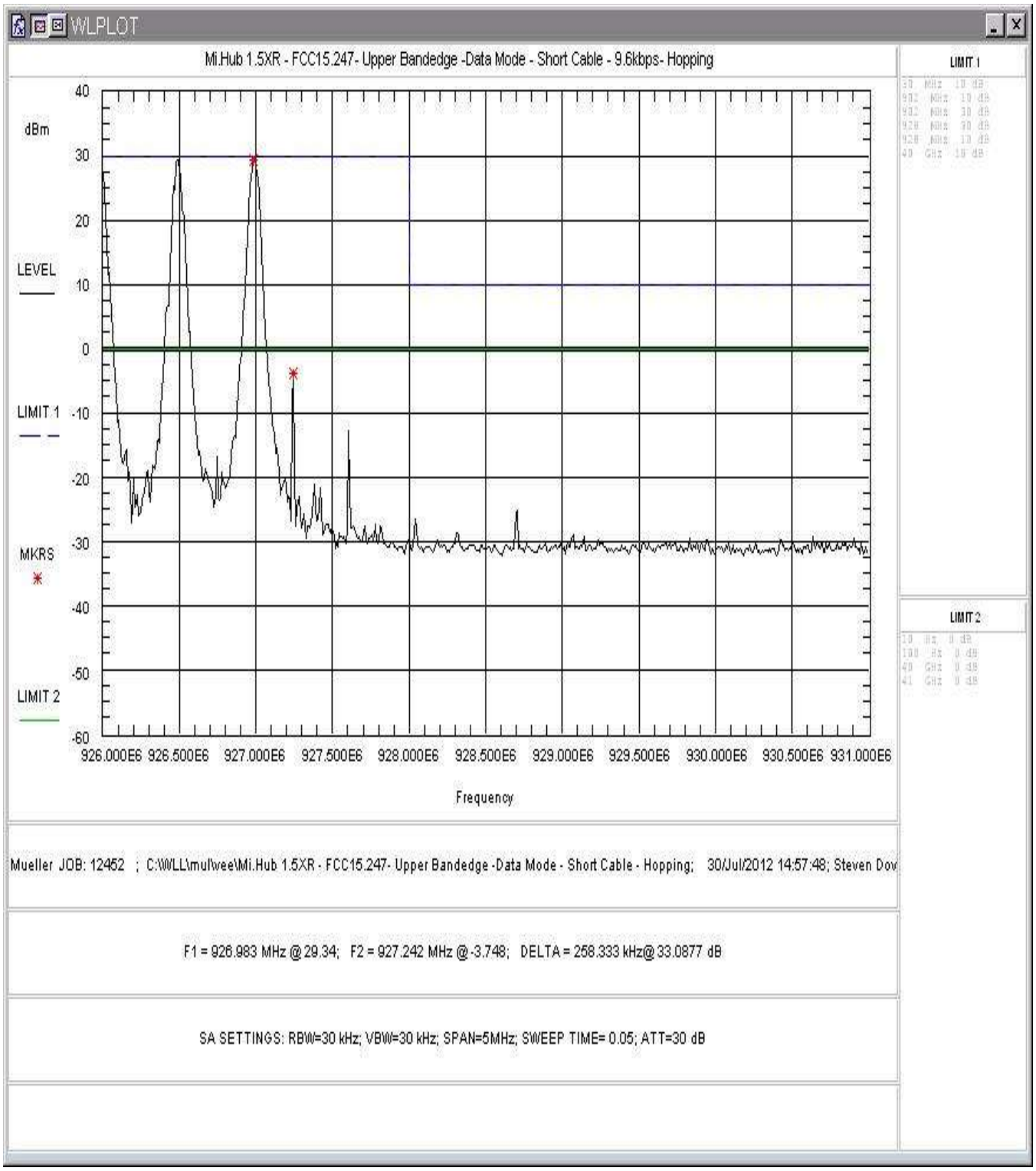

Figure 47: Upper Band-edge, Data, Short Cable, 9.6kbps, Hopping

Data Mode-28.8kbps-Long Cable

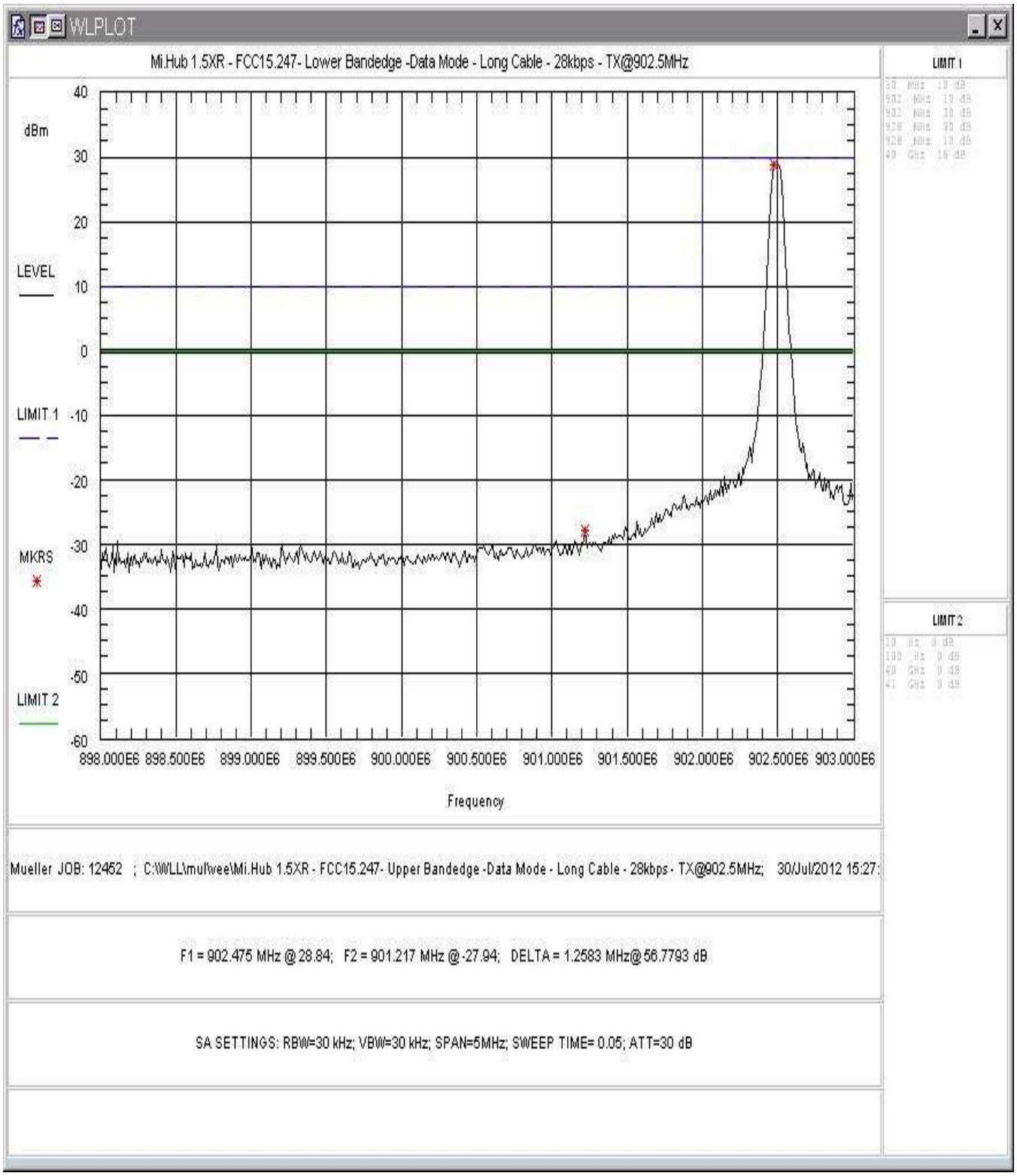

Figure 48: Lower Band-edge, Data, Long Cable, 28.8kbps, TX-902.5MHz

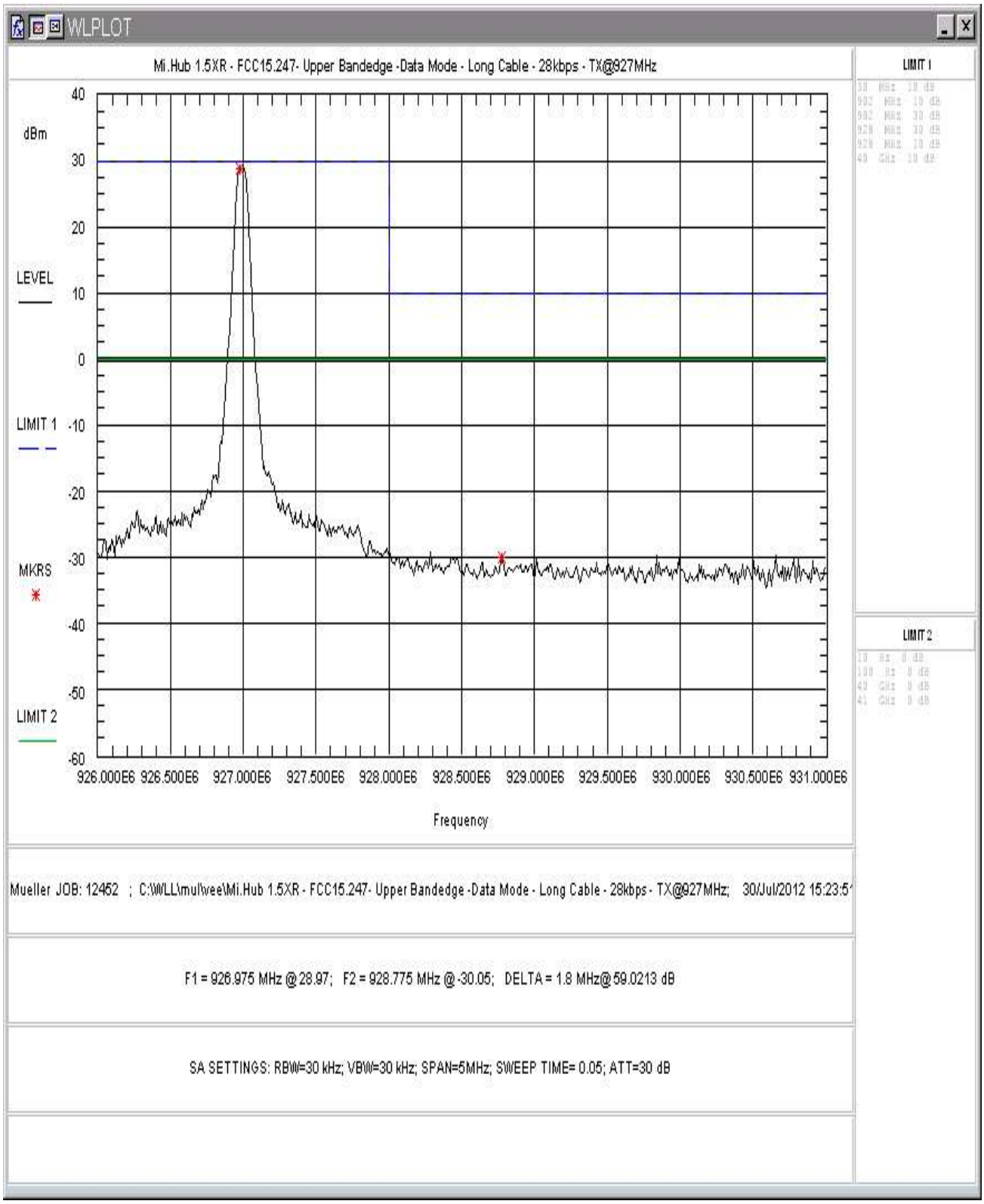

Figure 49: Upper Band-edge, Data, Long Cable, 28.8kbps, TX-927MHz

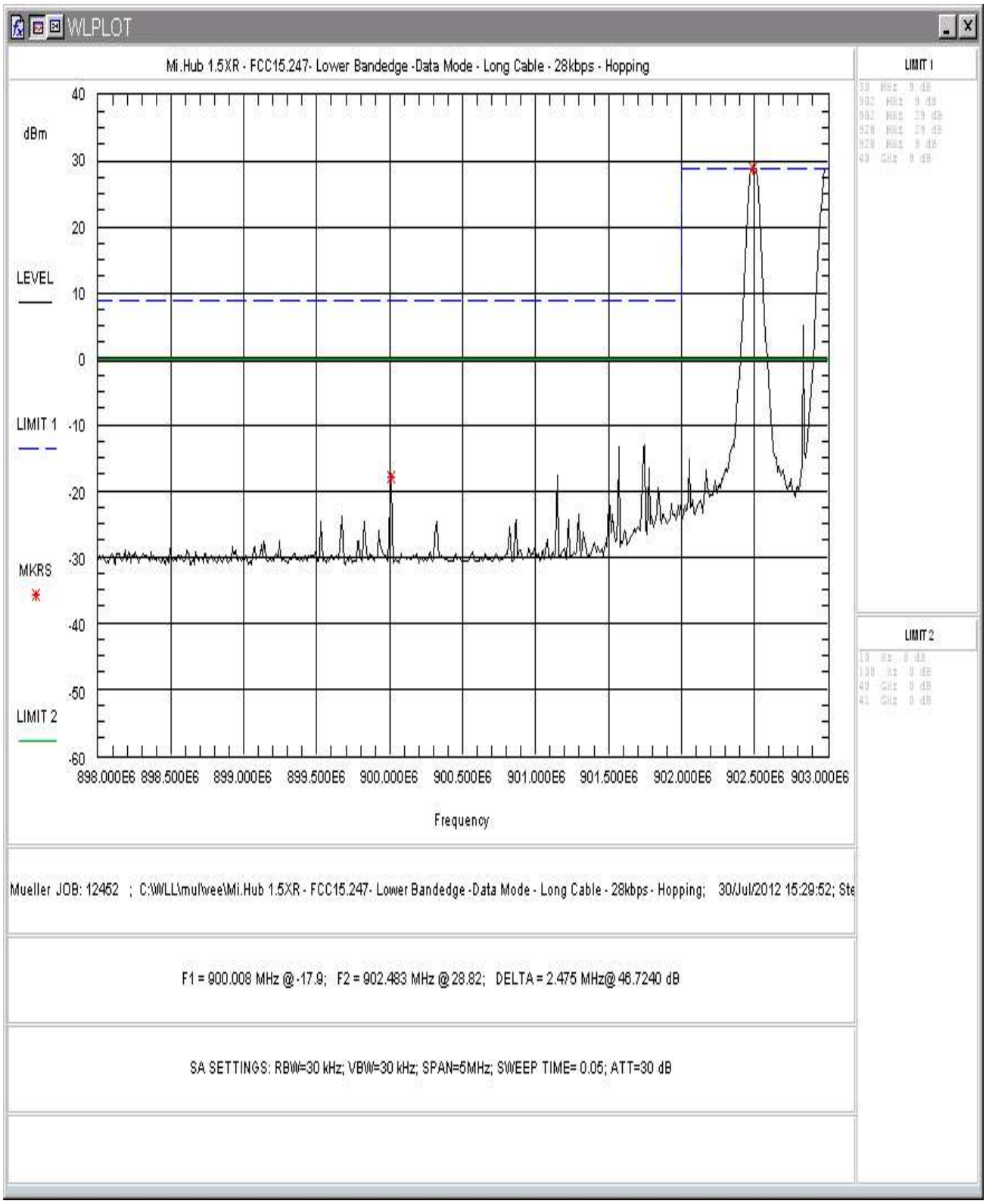

Figure 50: Lower Band-edge, Data, Long Cable, 28.8kbps, Hopping

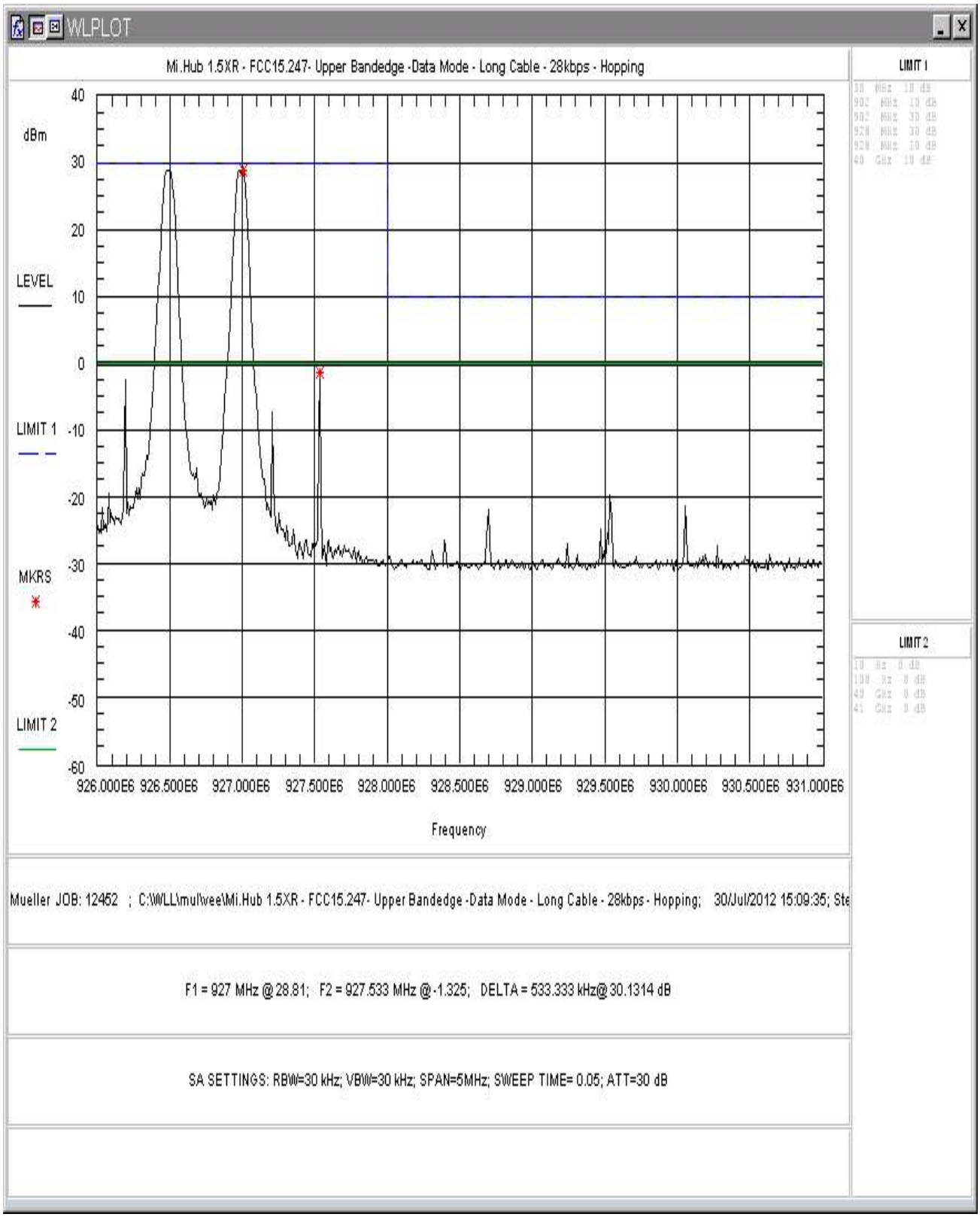

Figure 51: Upper Band-edge, Data, Long Cable, 28.8kbps, Hopping

Data Mode-28.8kbps-Short Cable

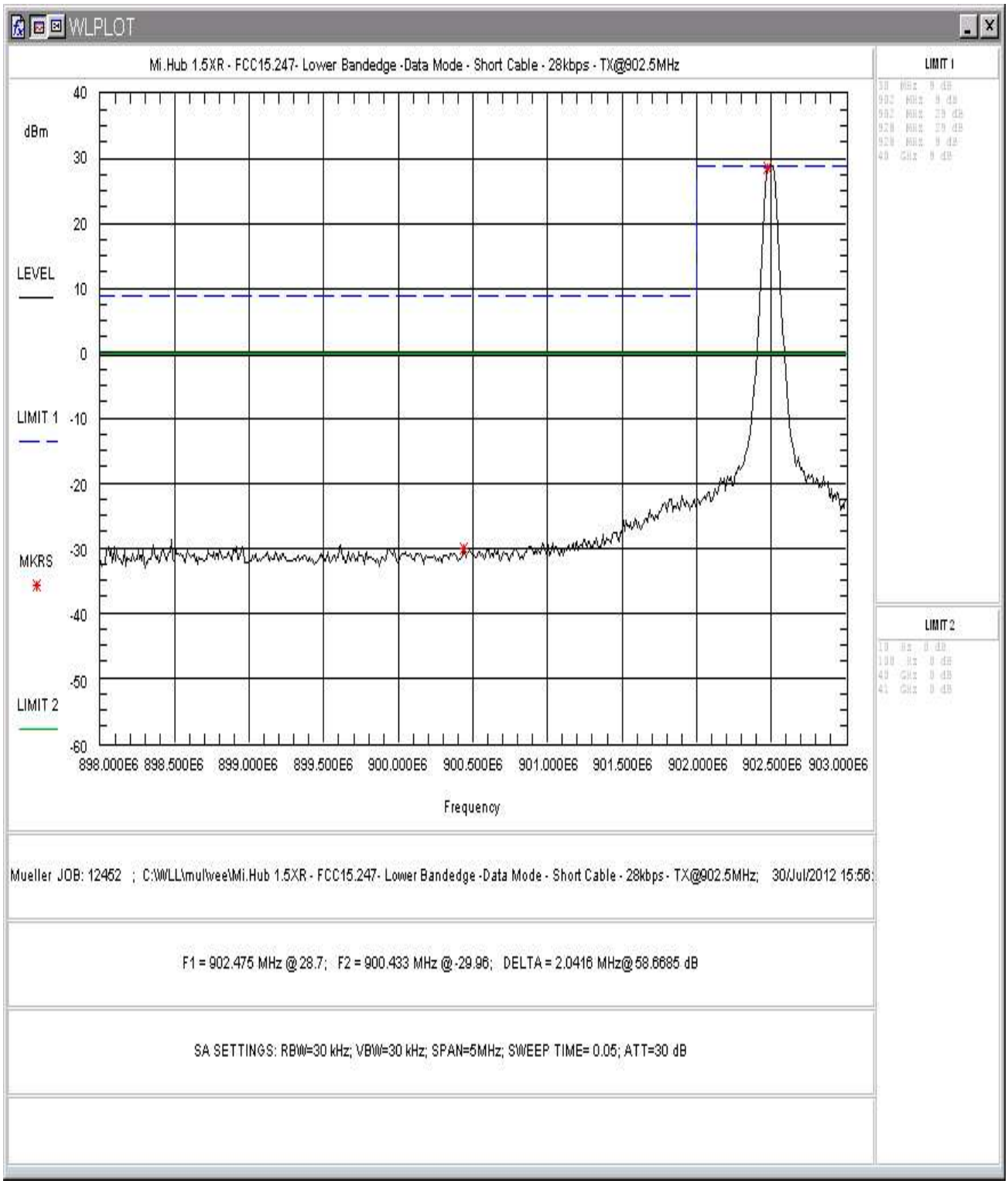

Figure 52: Lower Band-edge, Data, Short Cable, 28.8kbps, TX-902.5MHz

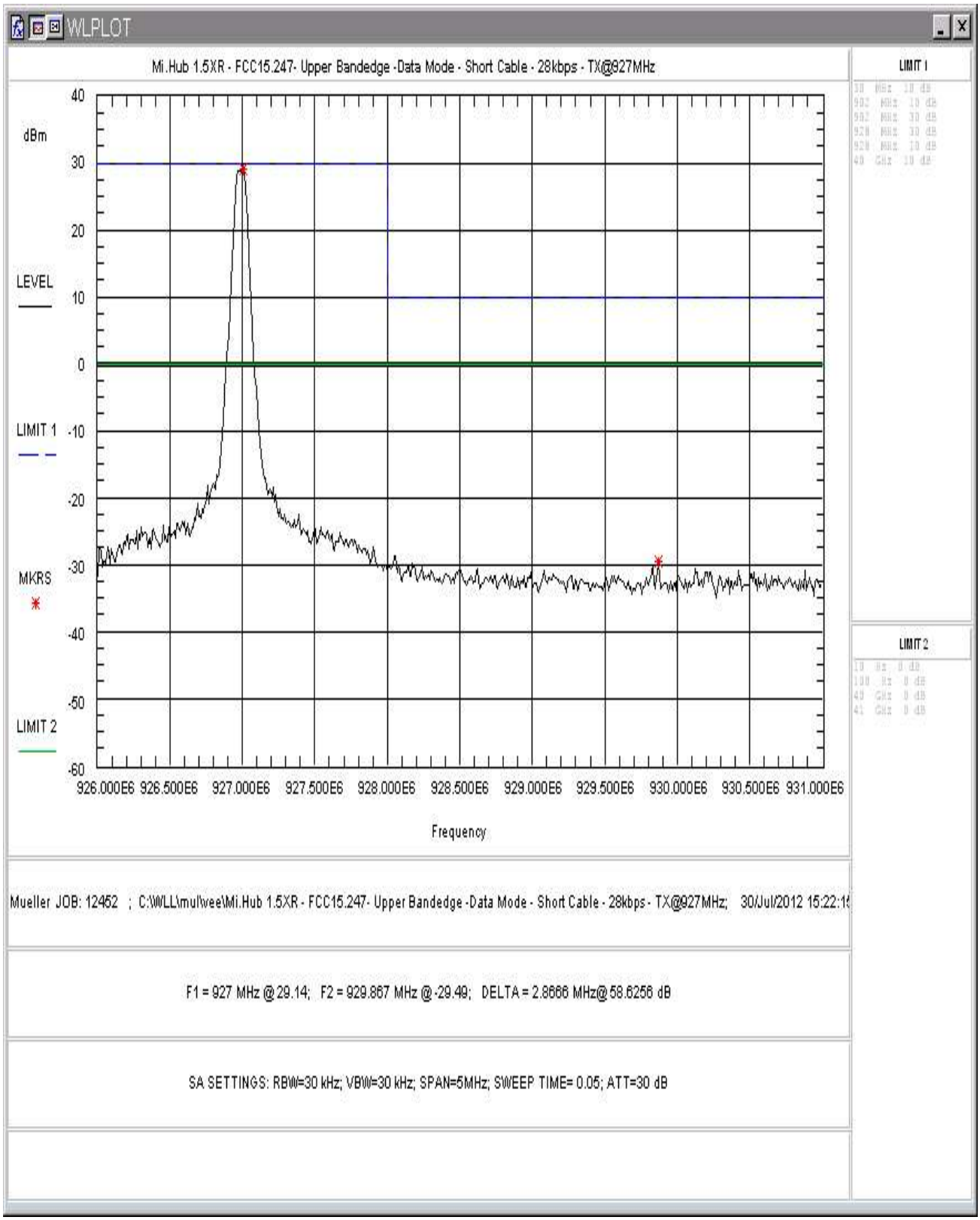

Figure 53: Upper Band-edge, Data, Short Cable, 28.8kbps, TX-927MHz

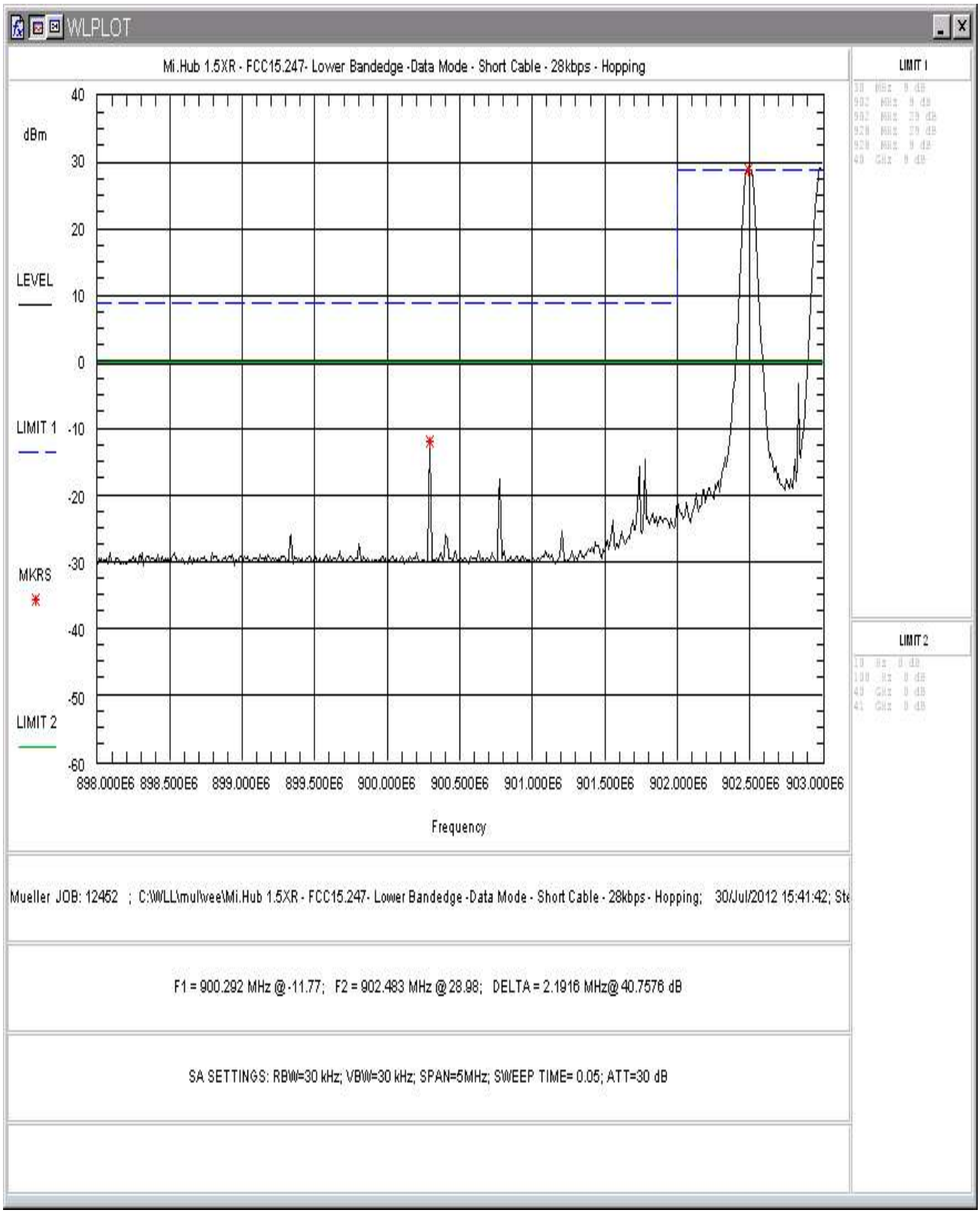

Figure 54: Lower Band-edge, Data, Short Cable, 28.8kbps, Hopping

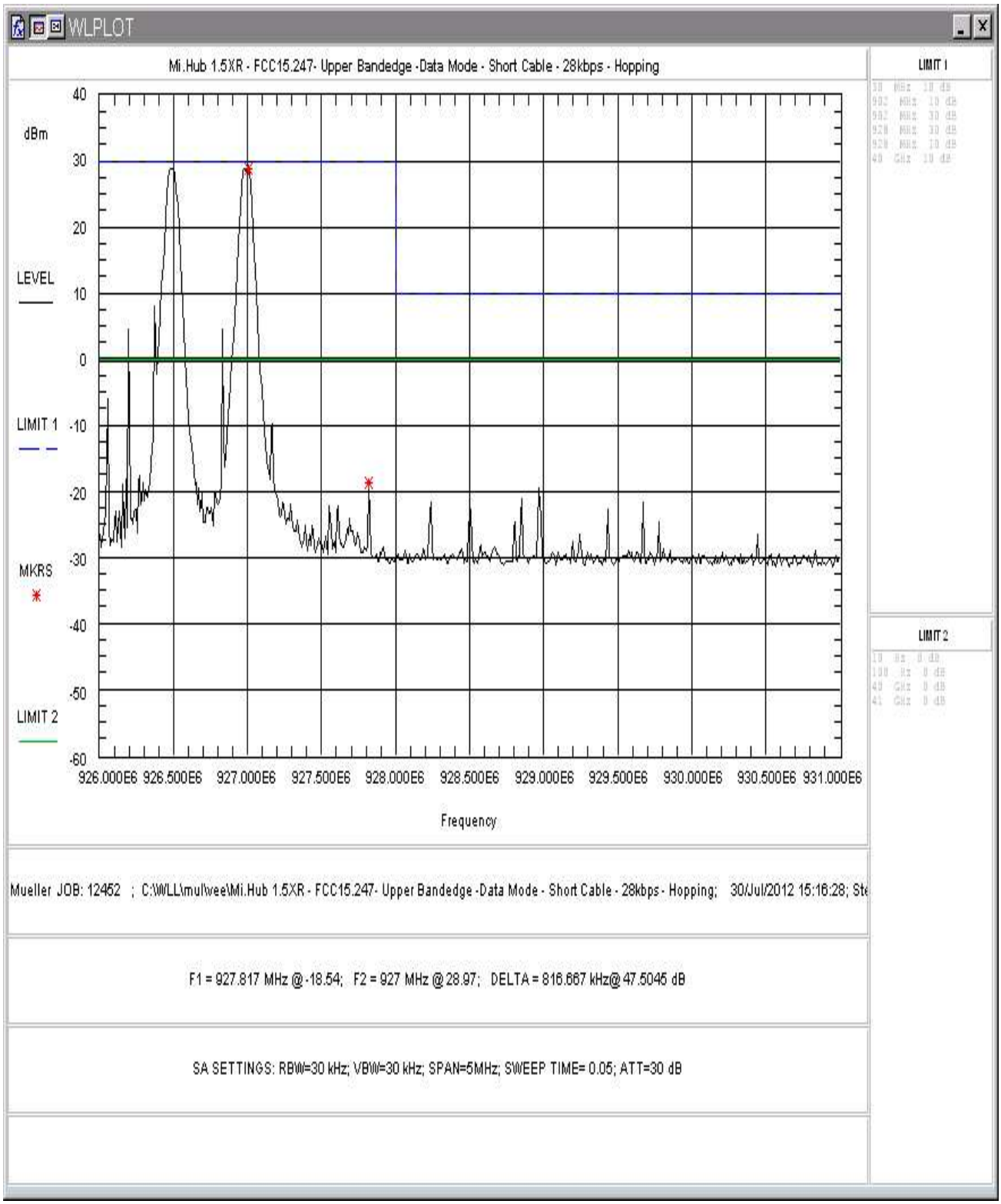

Figure 55: Upper Band-edge, Data, Short Cable, 28.8kbps, Hopping

5.5.2 Full-Band Conducted Spurious Emissions

5.5.2.1 Low Channel 902.5MHz- Long Cable

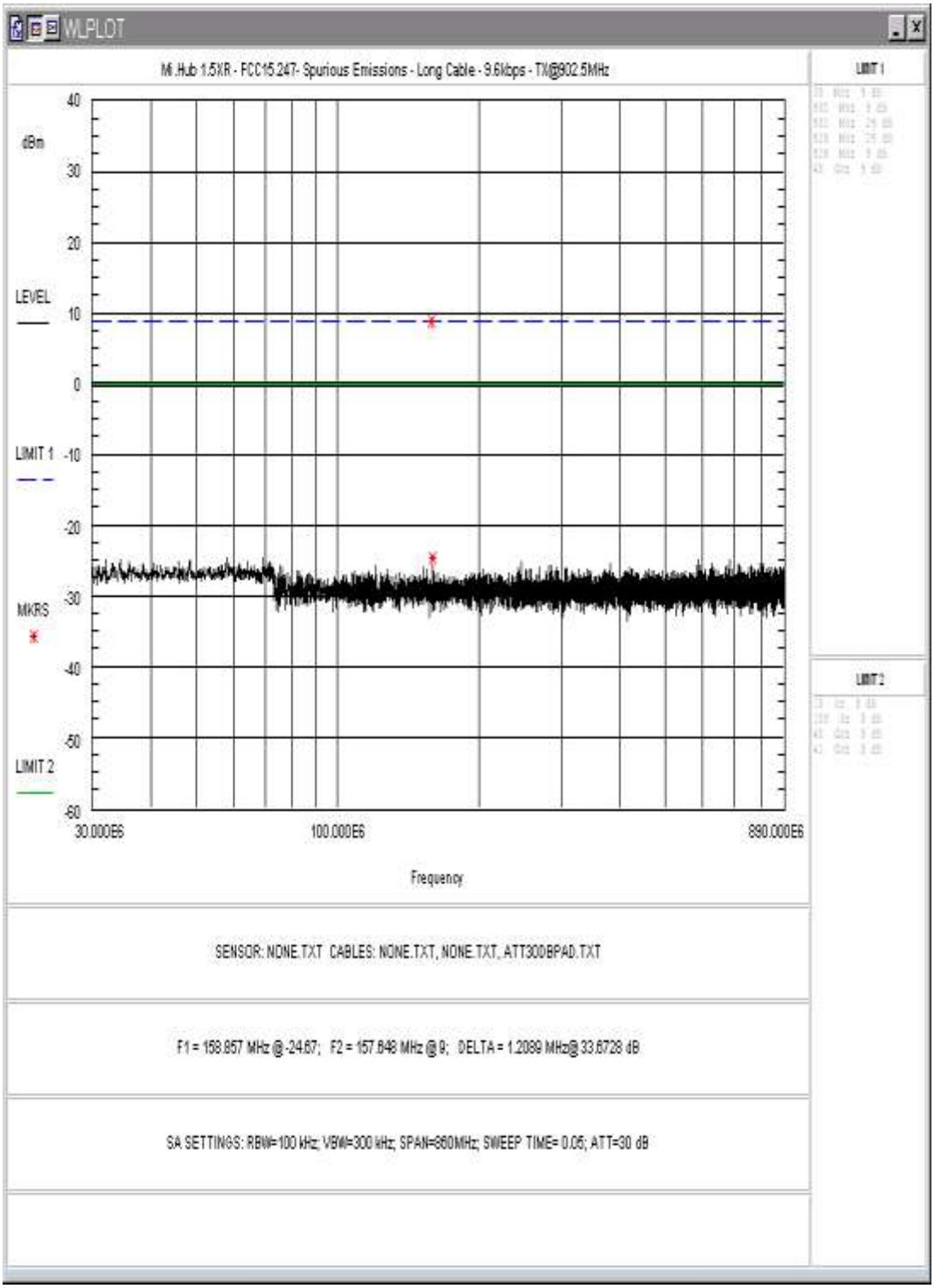

Figure 56: Spurious Emissions, Long Cable, TX-902.5MHz, 30-890MHz

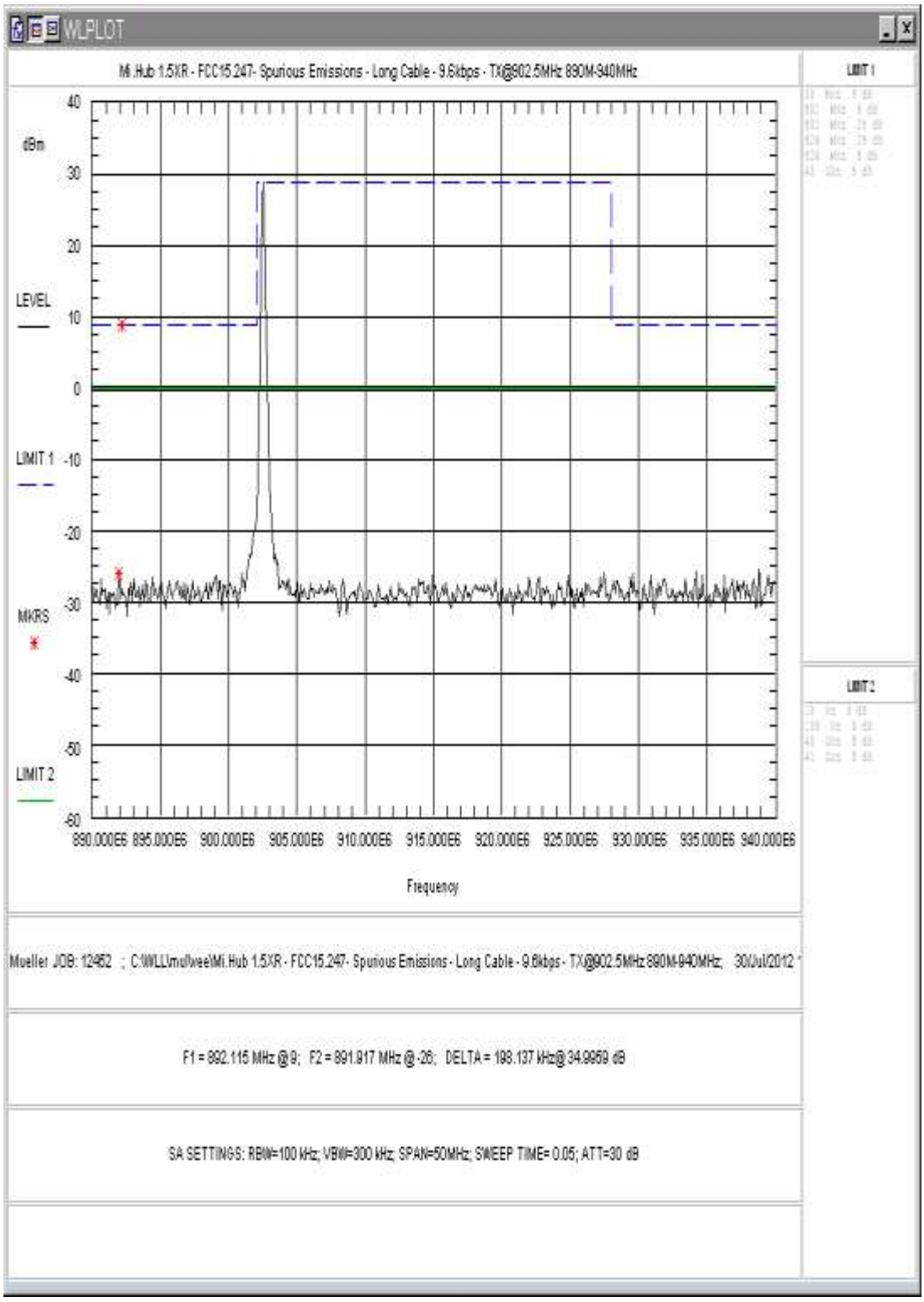

Figure 57: Spurious Emissions, Long Cable, TX-902.5MHz, 890-940MHz

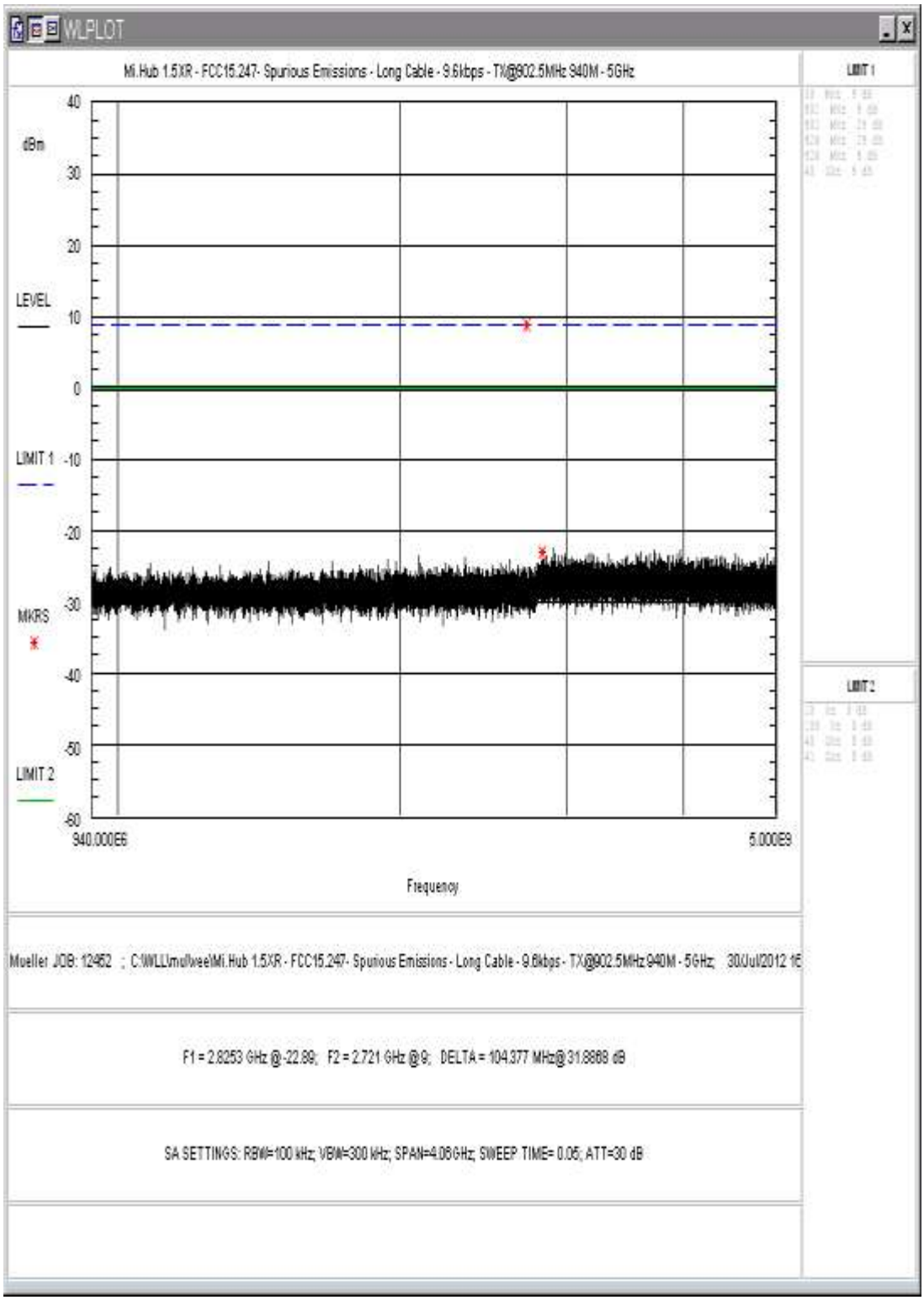

Figure 58: Spurious Emissions, Long Cable, TX-902.5MHz, 940-5000MHz

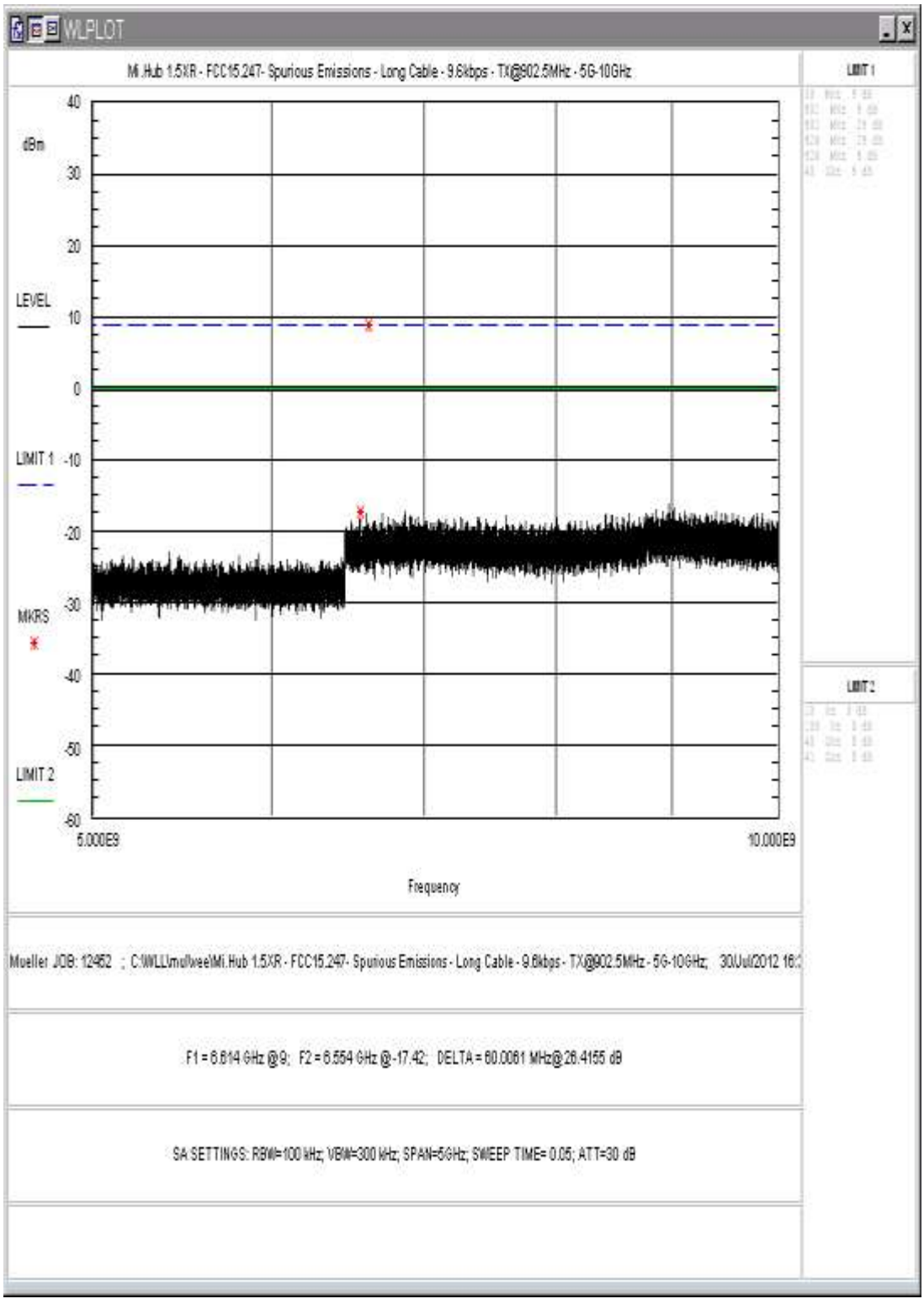

Figure 59: Spurious Emissions, Long Cable, TX-902.5MHz, 5 – 10GHz

5.5.2.2 Low Channel 902.5MHz- Short Cable

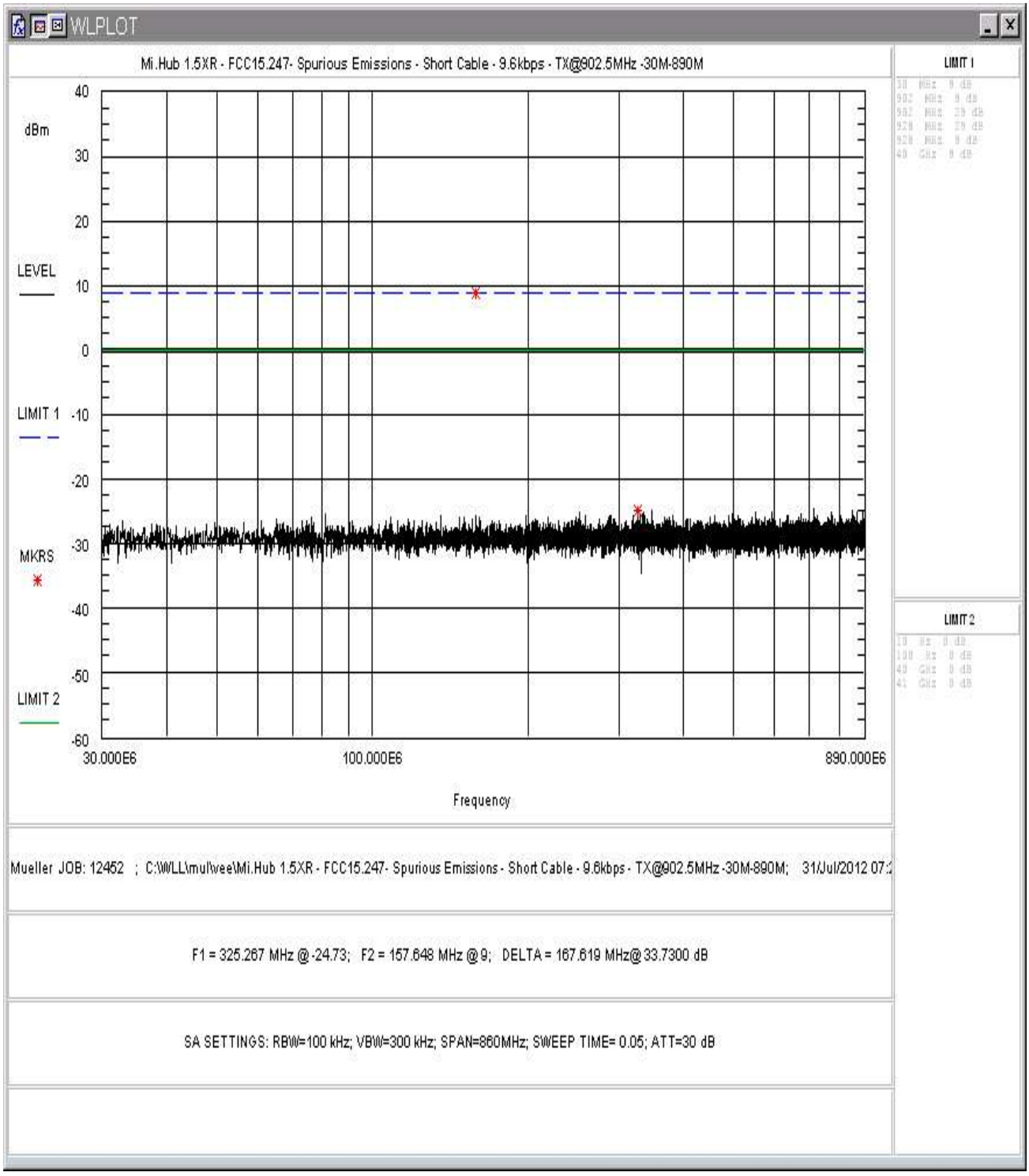

Figure 60: Spurious Emissions, Short Cable, TX-902.5MHz, 30-890MHz

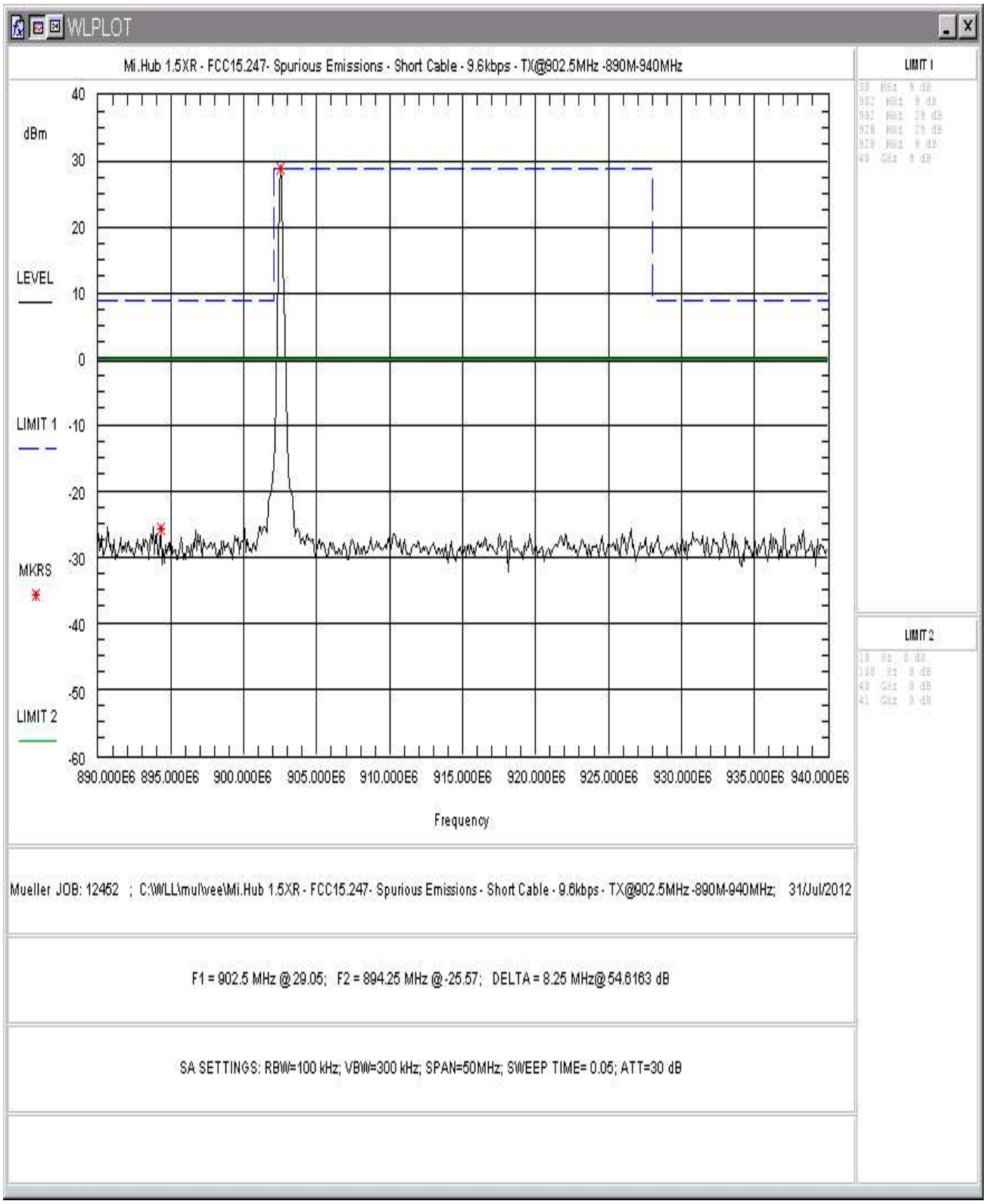

Figure 61: Spurious Emissions, Short Cable, TX-902.5MHz, 890-940MHz

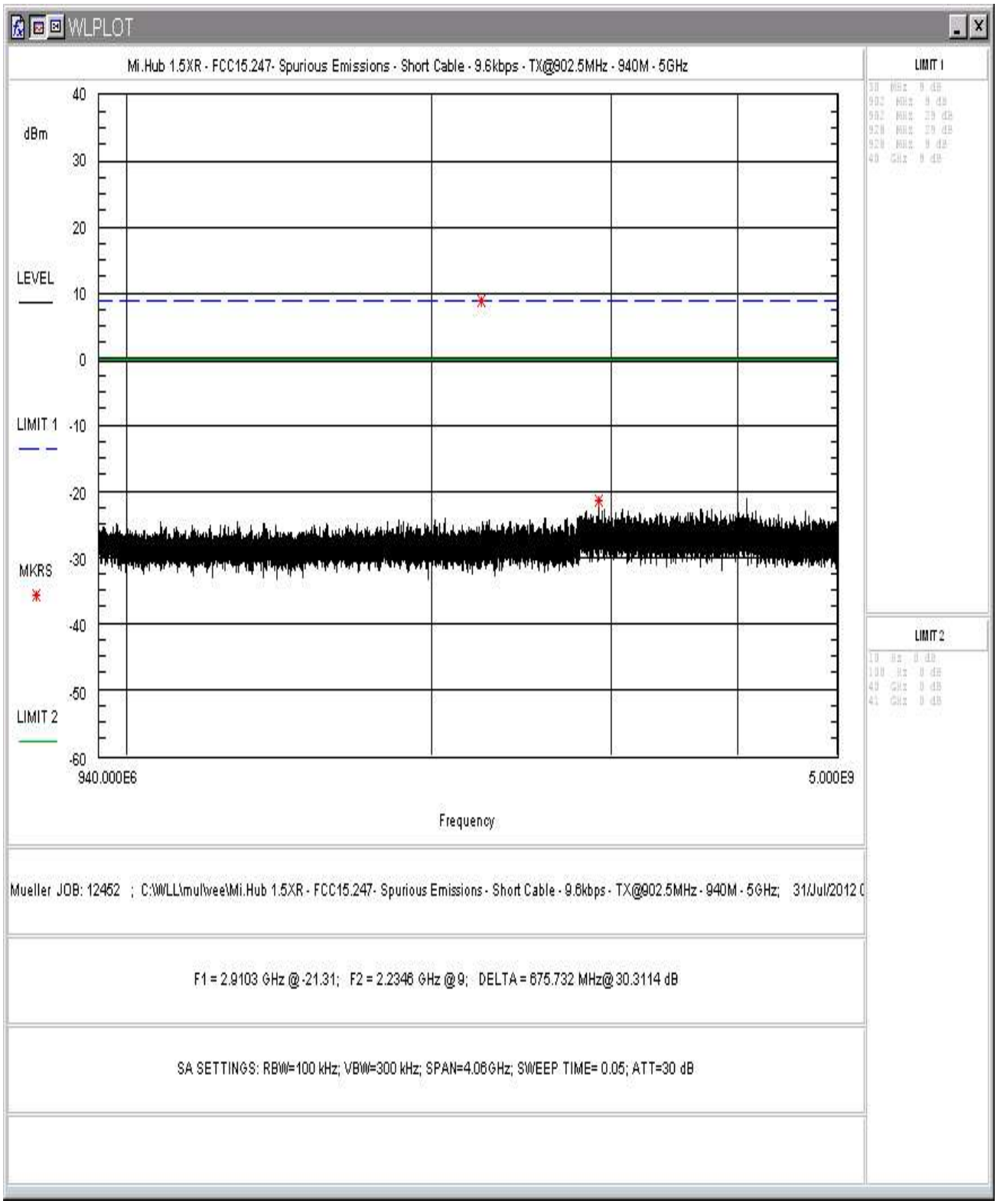

Figure 62: Spurious Emissions, Short Cable, TX-902.5MHz, 940-5000MHz

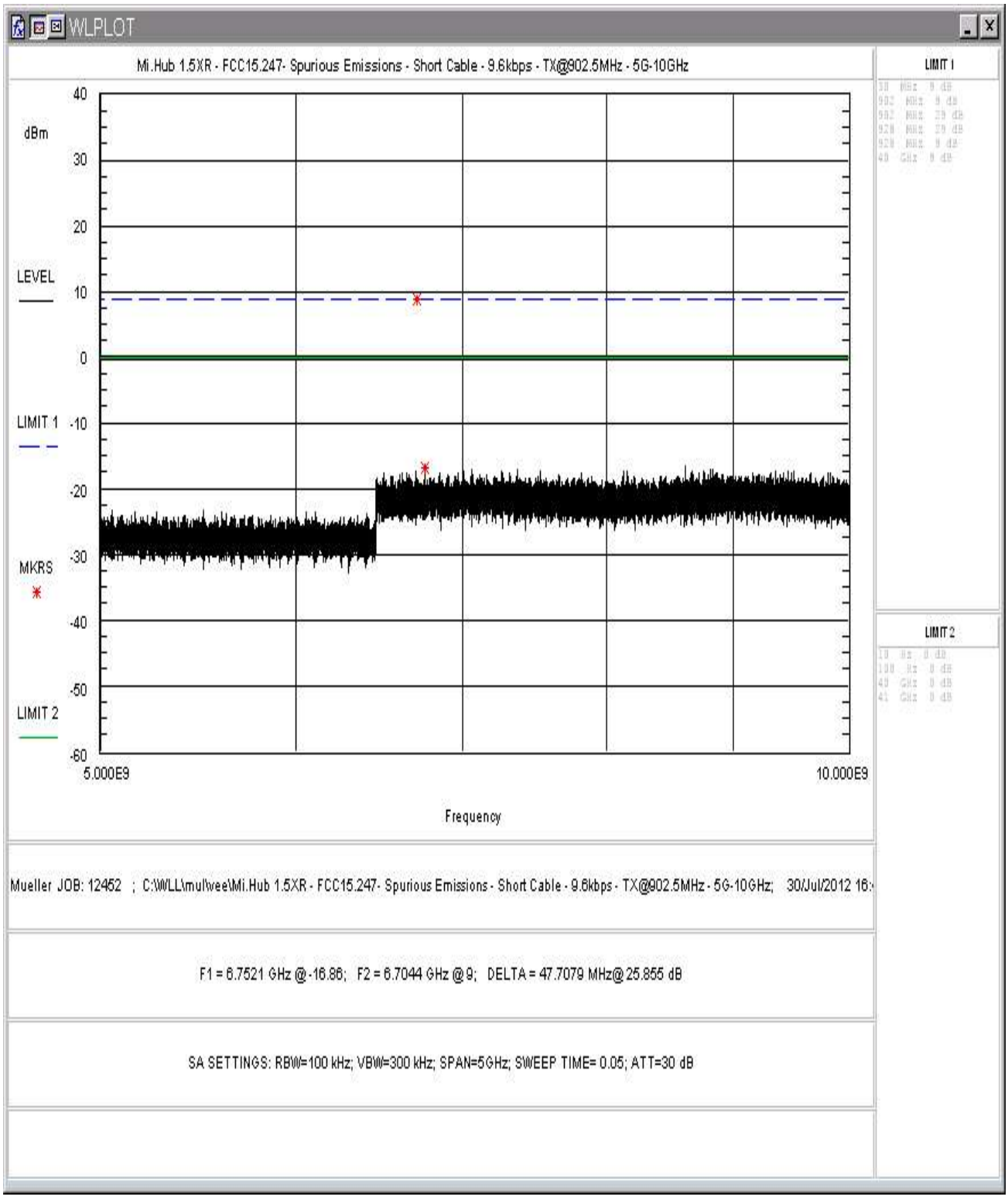

Figure 63: Spurious Emissions, Short Cable, TX-902.5MHz, 5-10GHz

5.5.2.3 Center Channel 915MHz- Long Cable

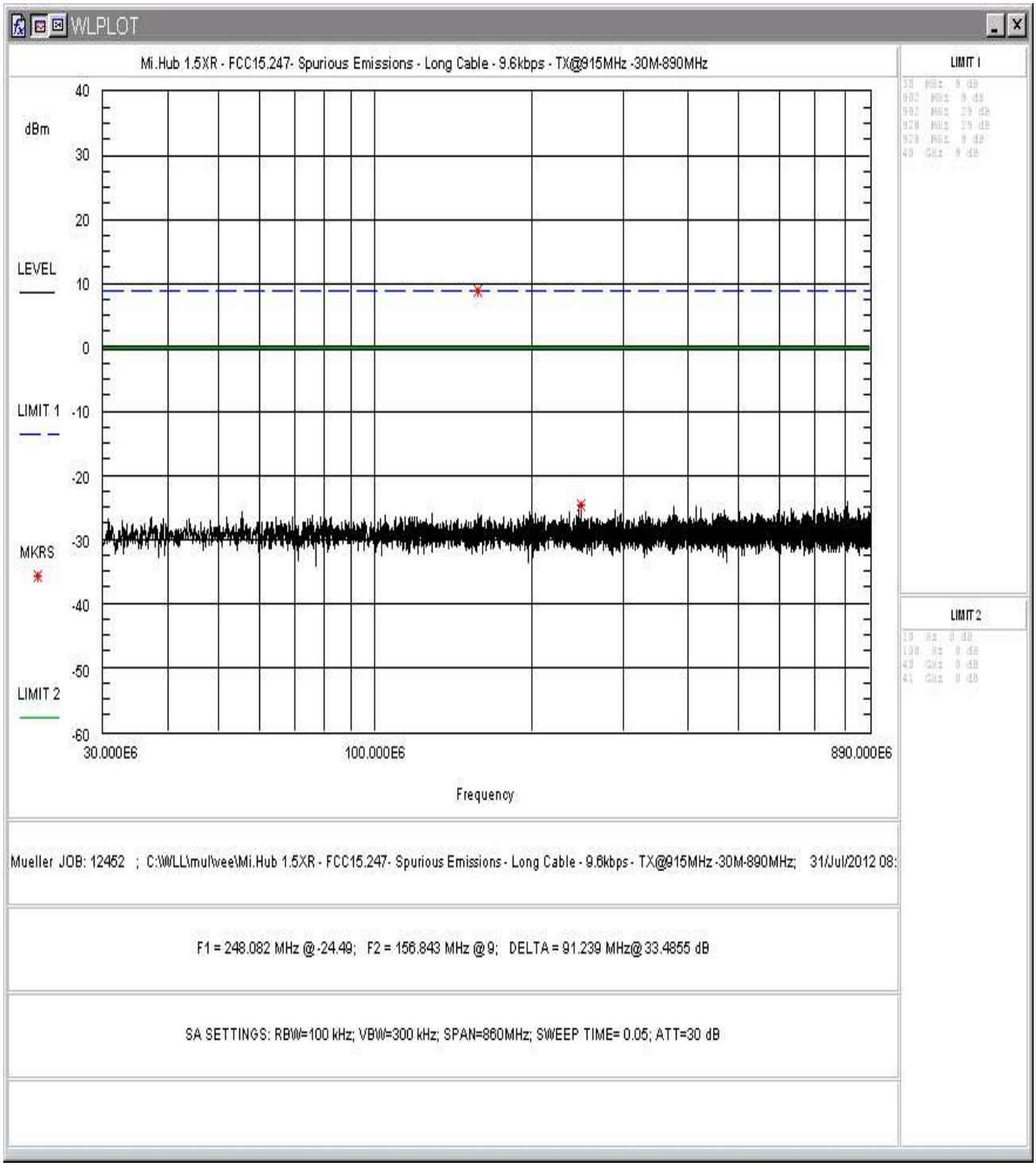

Figure 64: Spurious Emissions, Long Cable, TX-915MHz, 30-890MHz

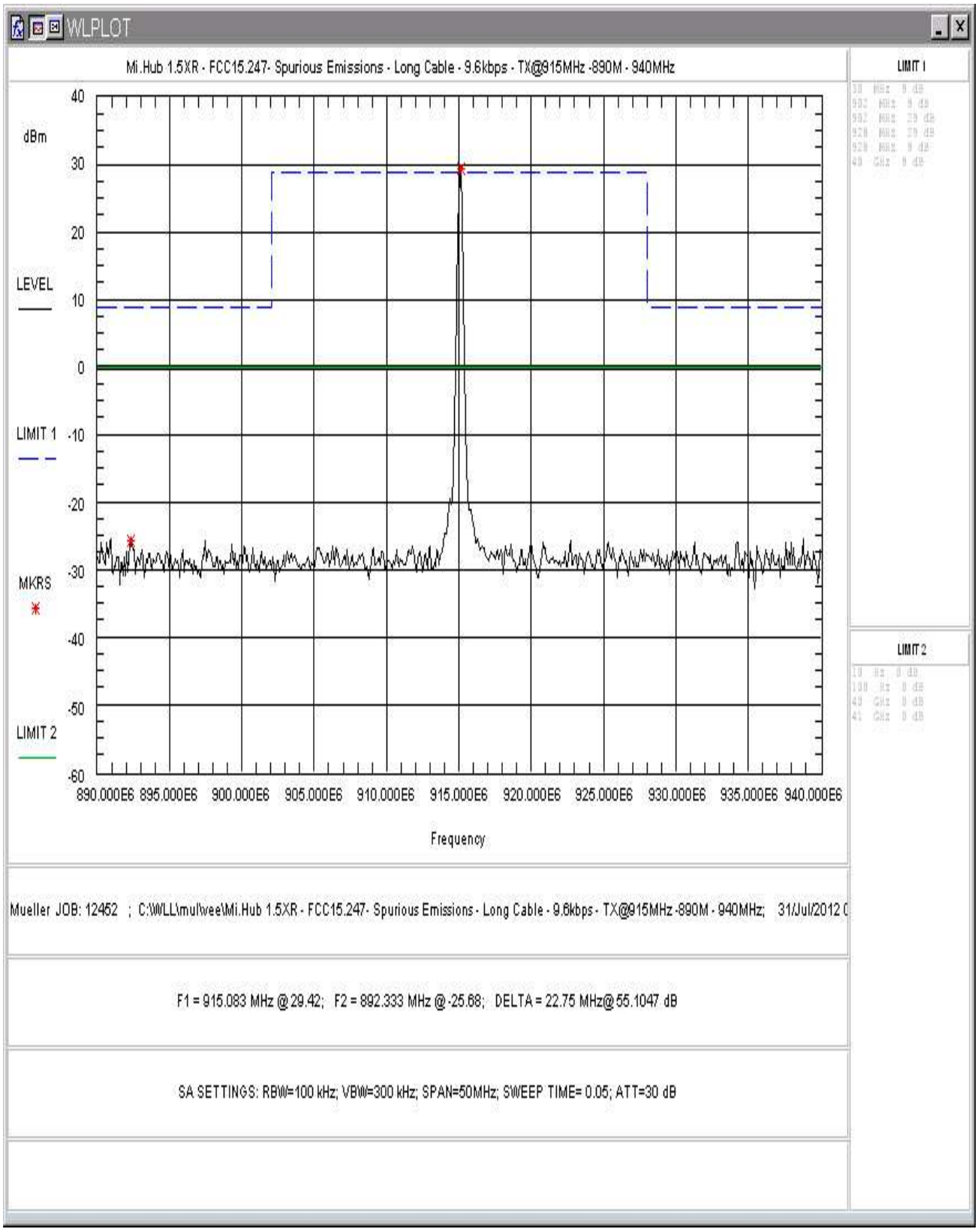

Figure 65: Spurious Emissions, Long Cable, TX-915MHz, 890-940MHz

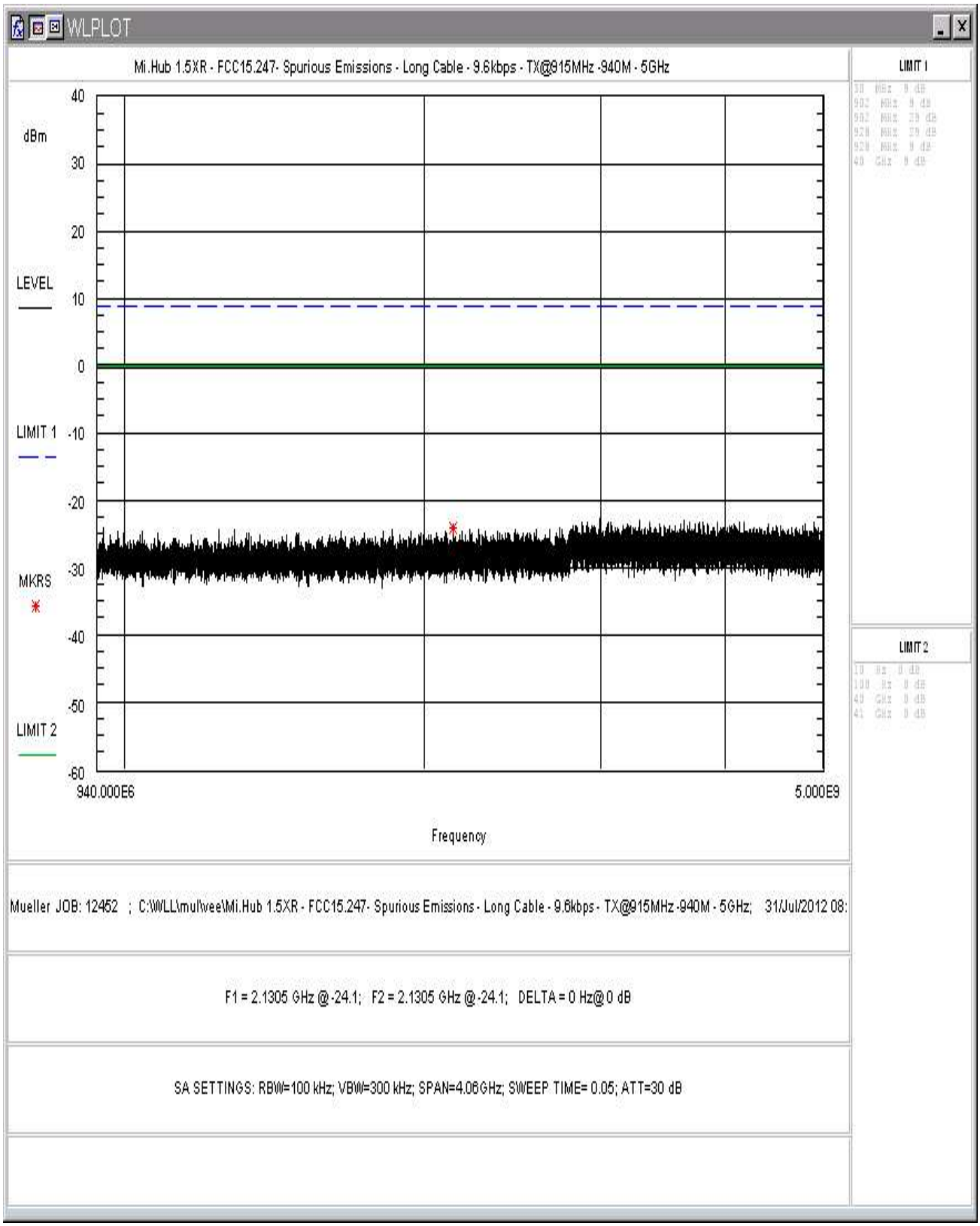

Figure 66: Spurious Emissions, Long Cable, TX-915MHz, 940-5000MHz

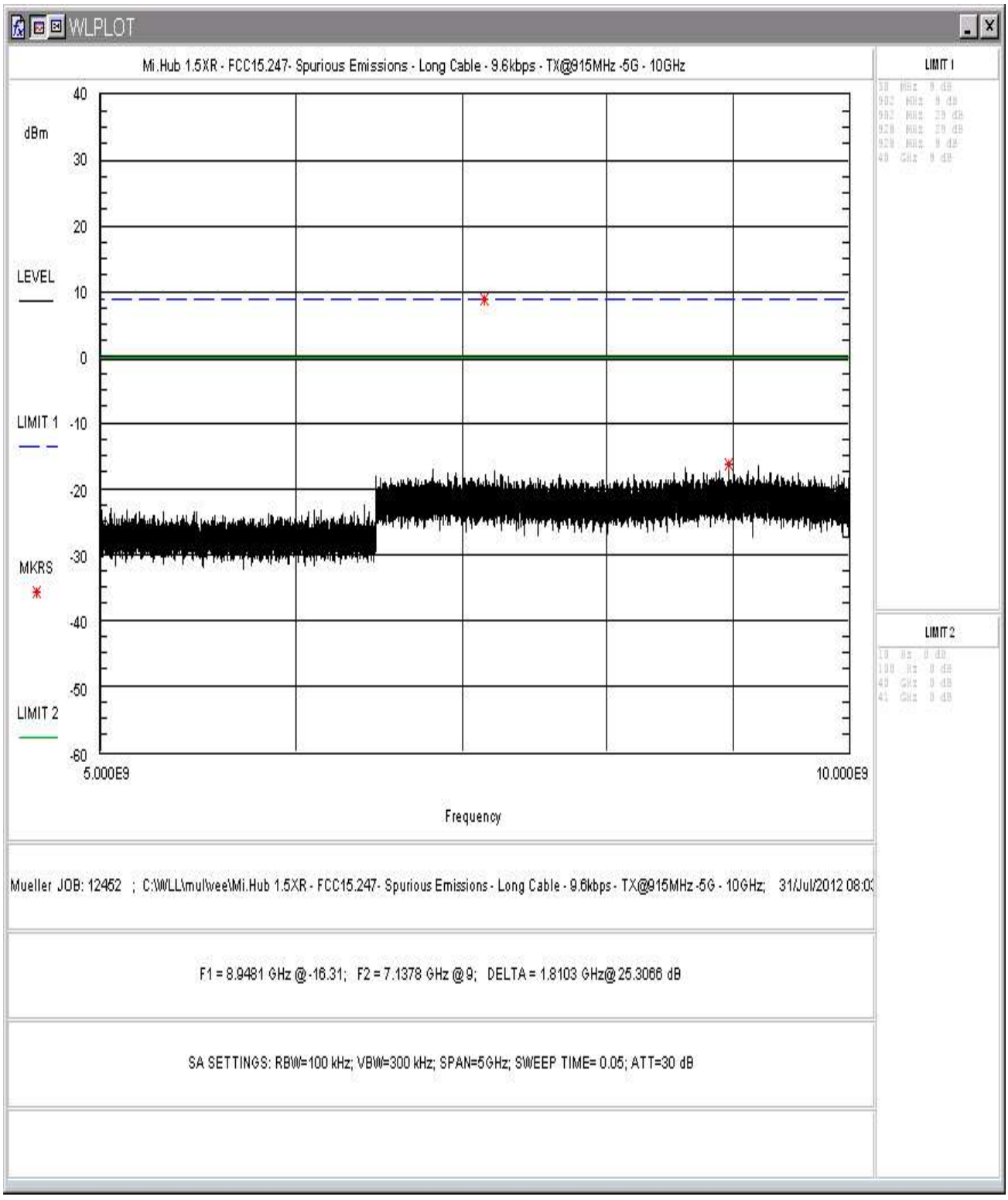

Figure 67: Spurious Emissions, Long Cable, TX-915MHz, 5-10GHz

5.5.2.4 High Channel 927.35MHz- Long Cable

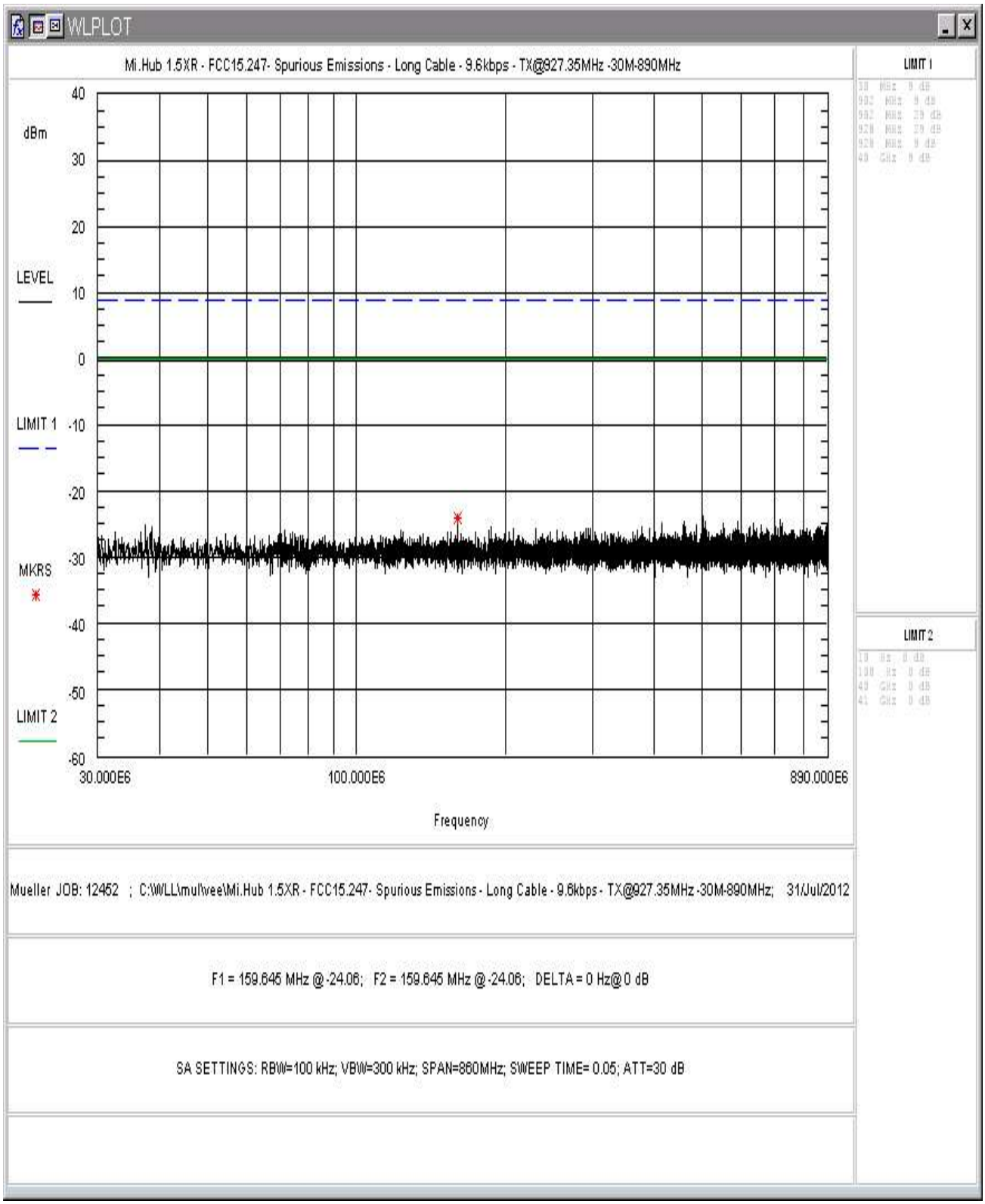

Figure 68: Spurious Emissions, Long Cable, TX-927.35MHz, 30-890MHz

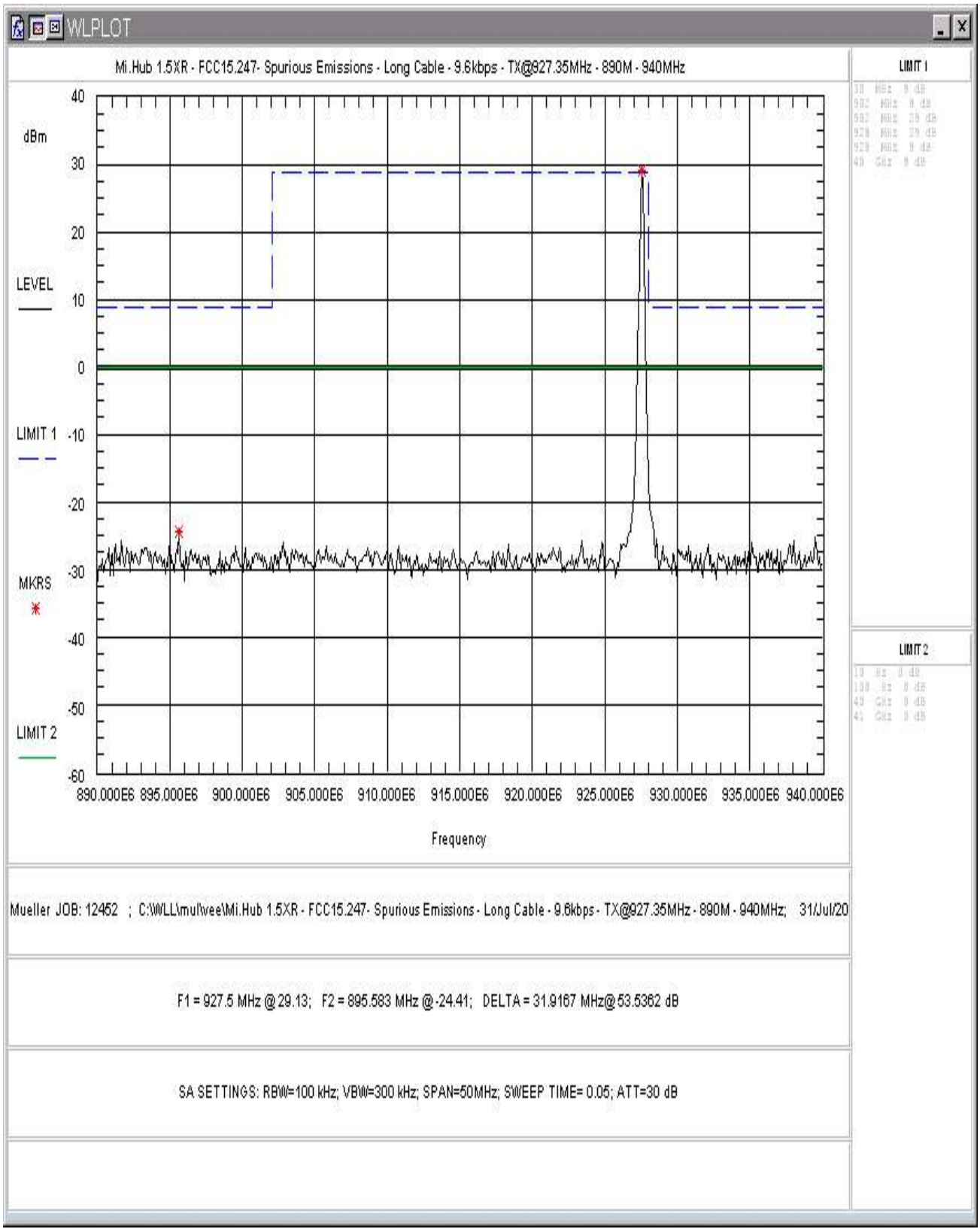

Figure 69: Spurious Emissions, Short Cable, TX-927.35MHz, 890-940MHz

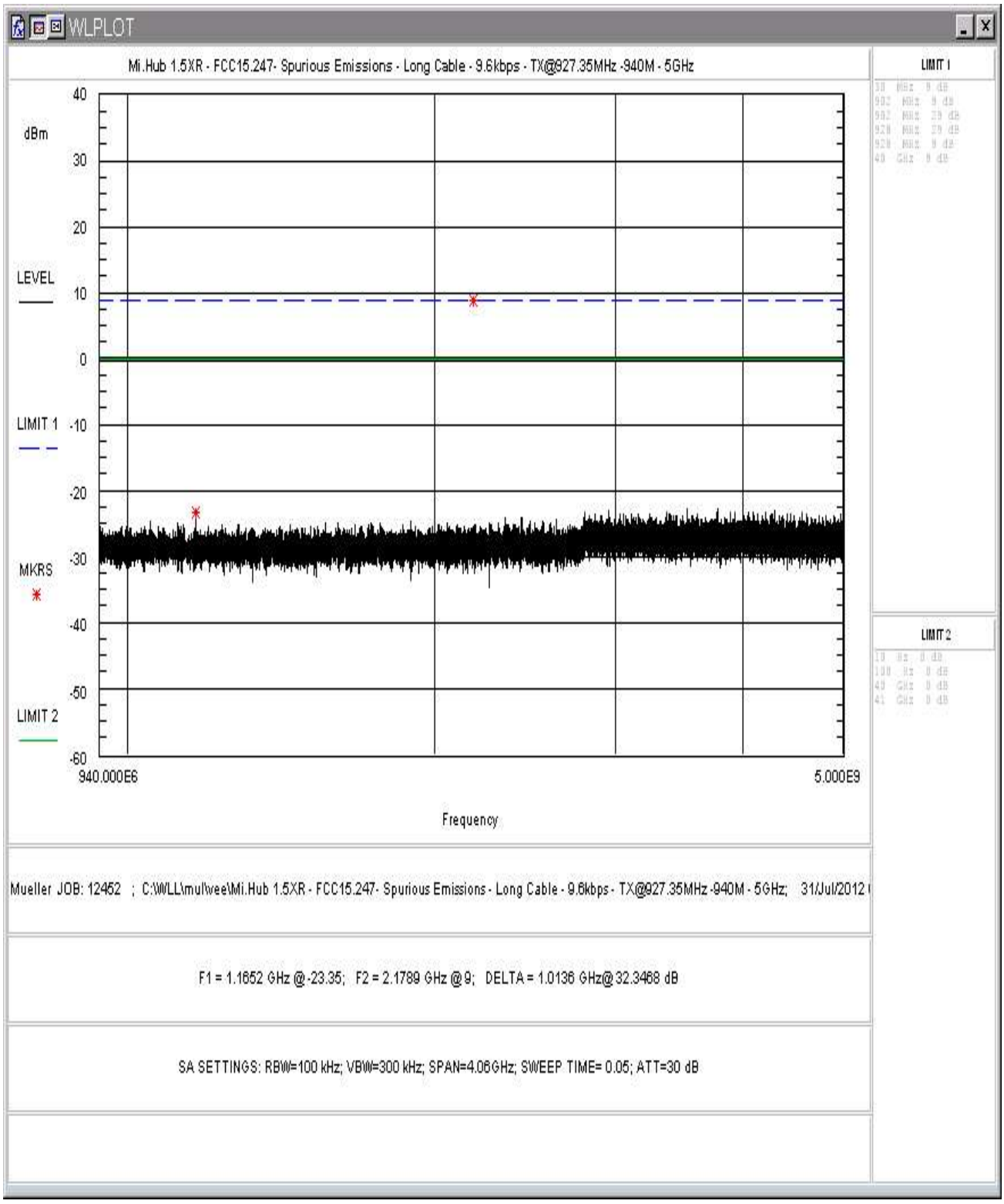

Figure 70: Spurious Emissions, Short Cable, TX-927.35MHz, 940-5000MHz

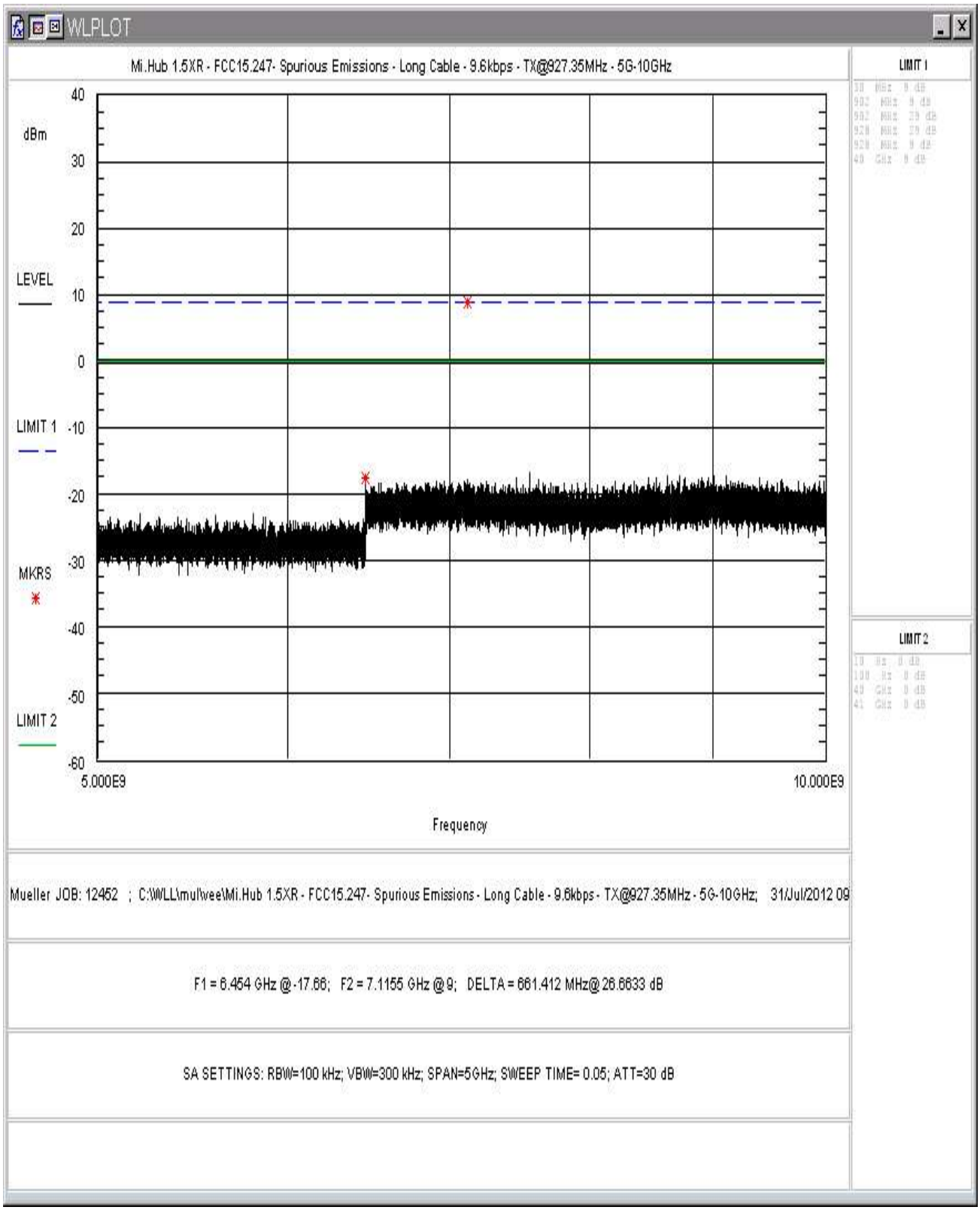

Figure 71: Spurious Emissions, Short Cable, TX-927.35MHz, 5-10GHz

5.5.2.5 High Channel 927.35MHz- Short Cable

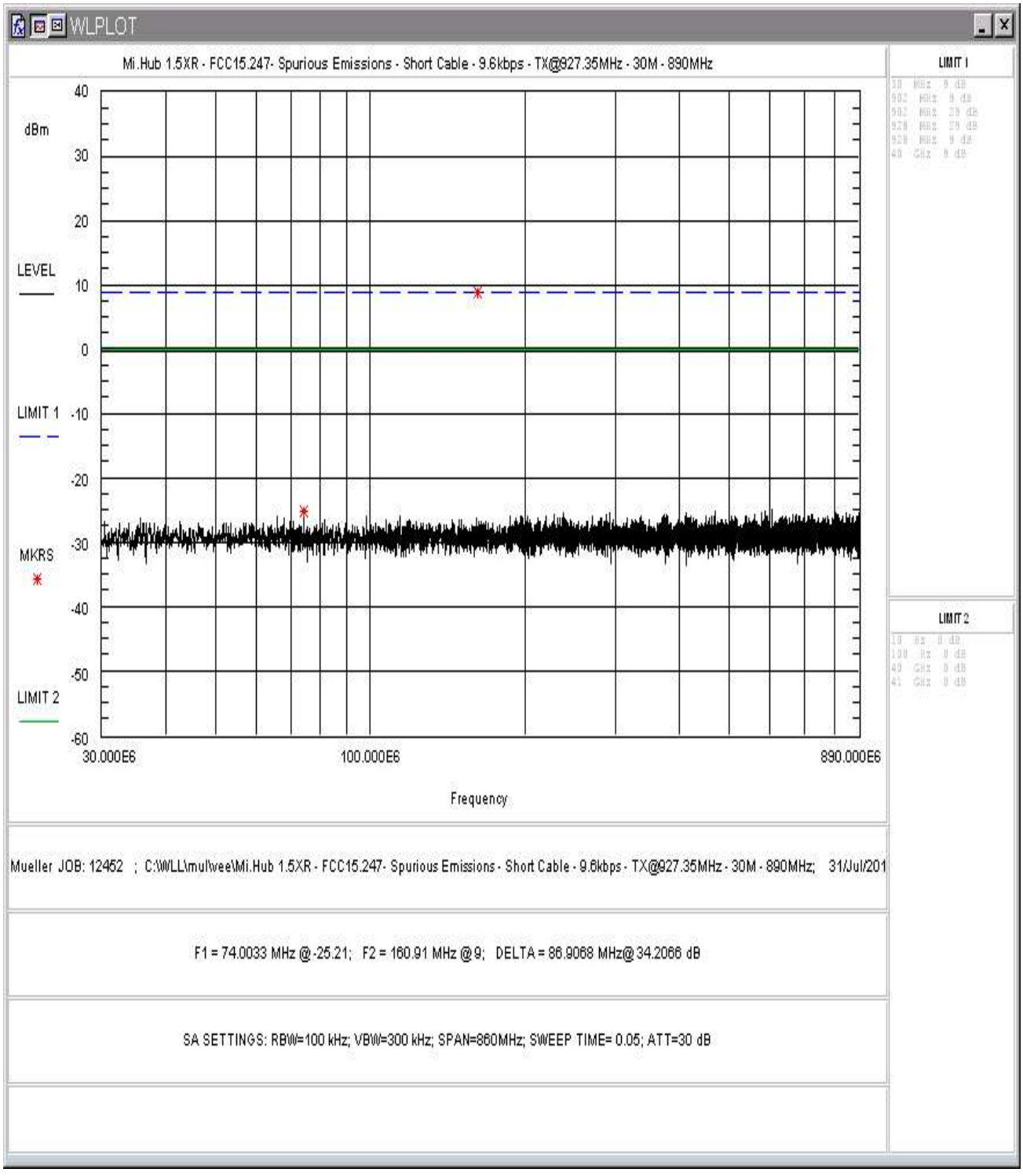

Figure 72: Spurious Emissions, Short Cable, TX-927.35MHz, 30-890MHz

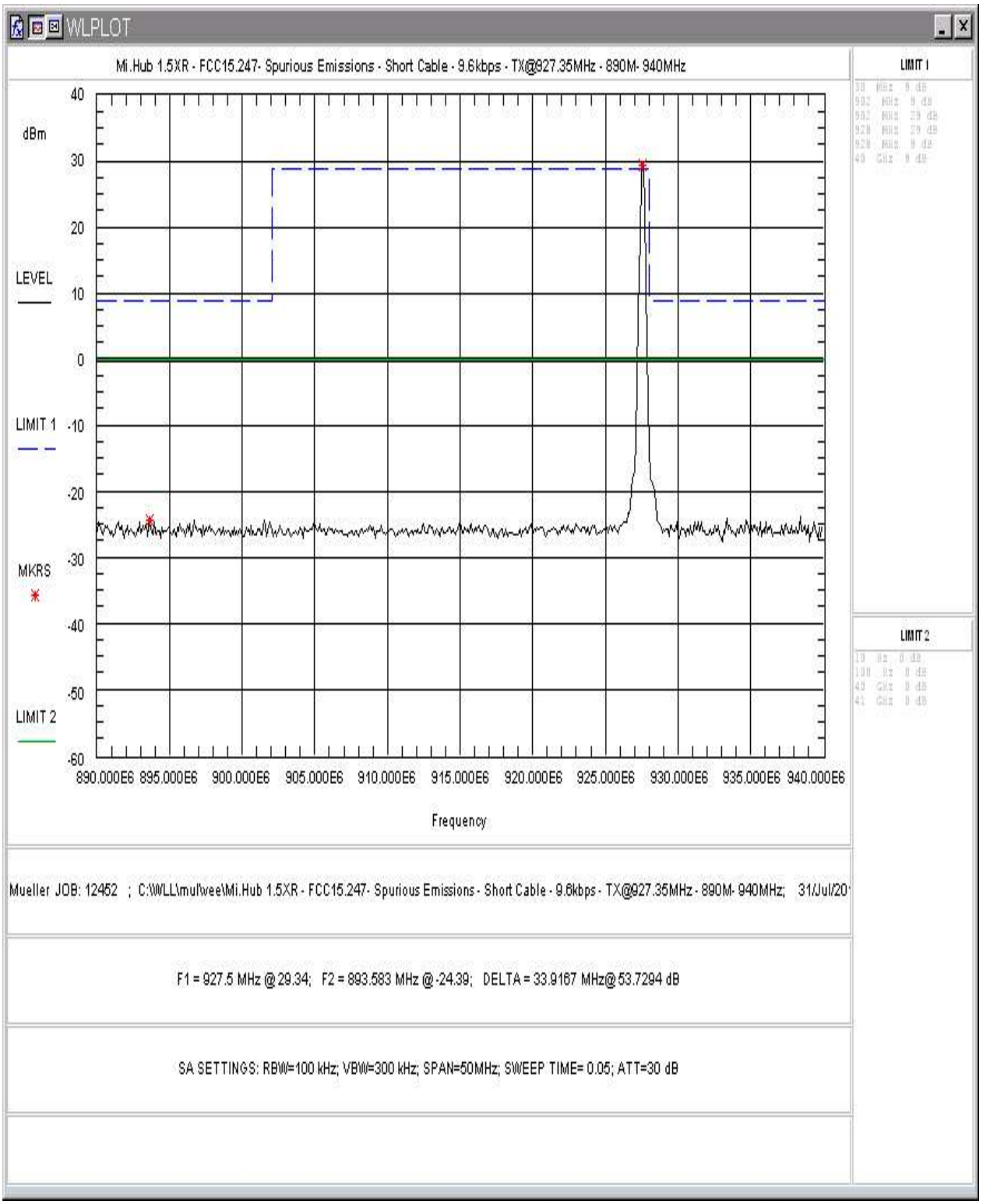

Figure 73: Spurious Emissions, Short Cable, TX-927.35MHz, 890-940MHz

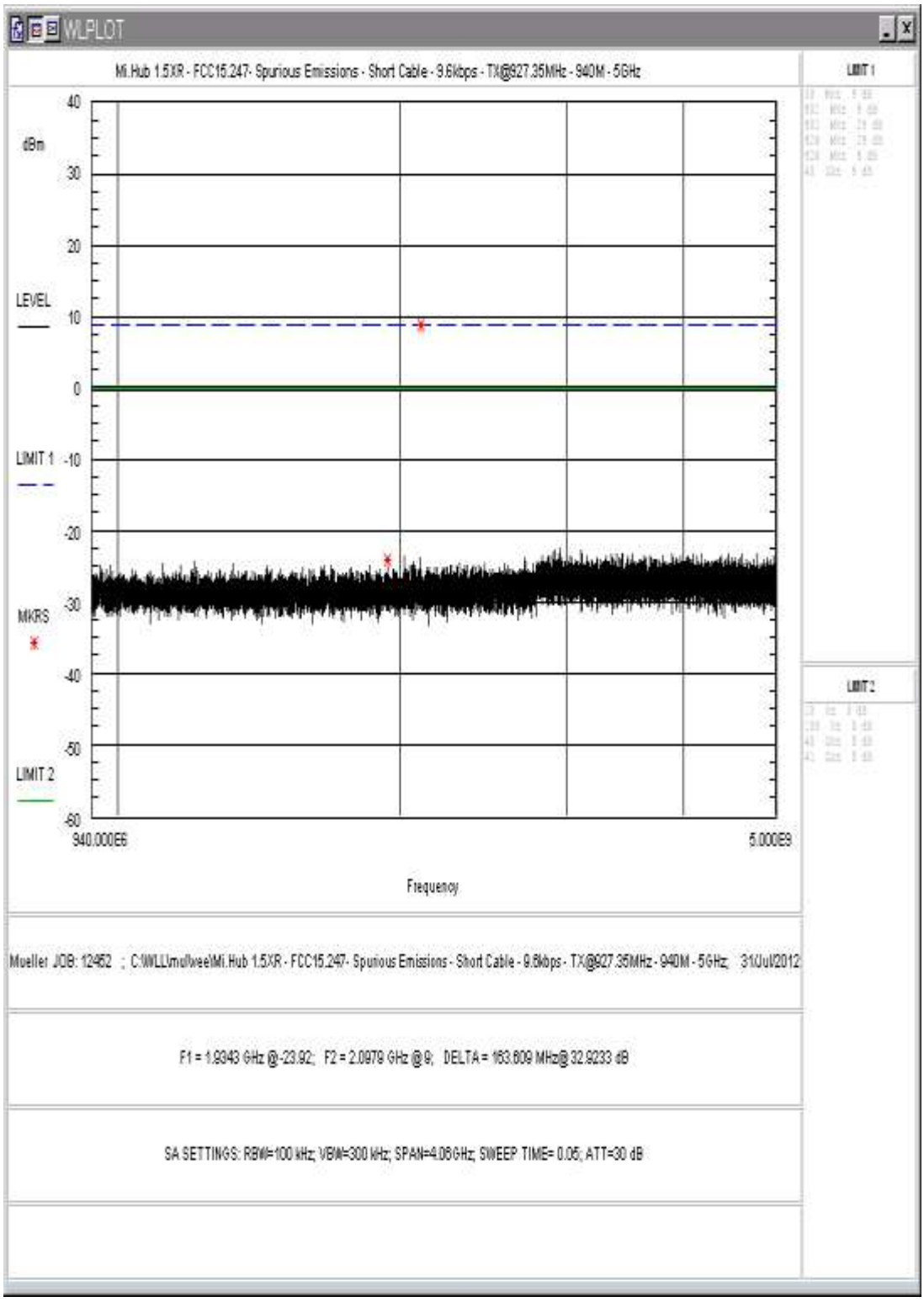

Figure 74: Spurious Emissions, Short Cable, TX-927.35MHz, 940-5000MHz

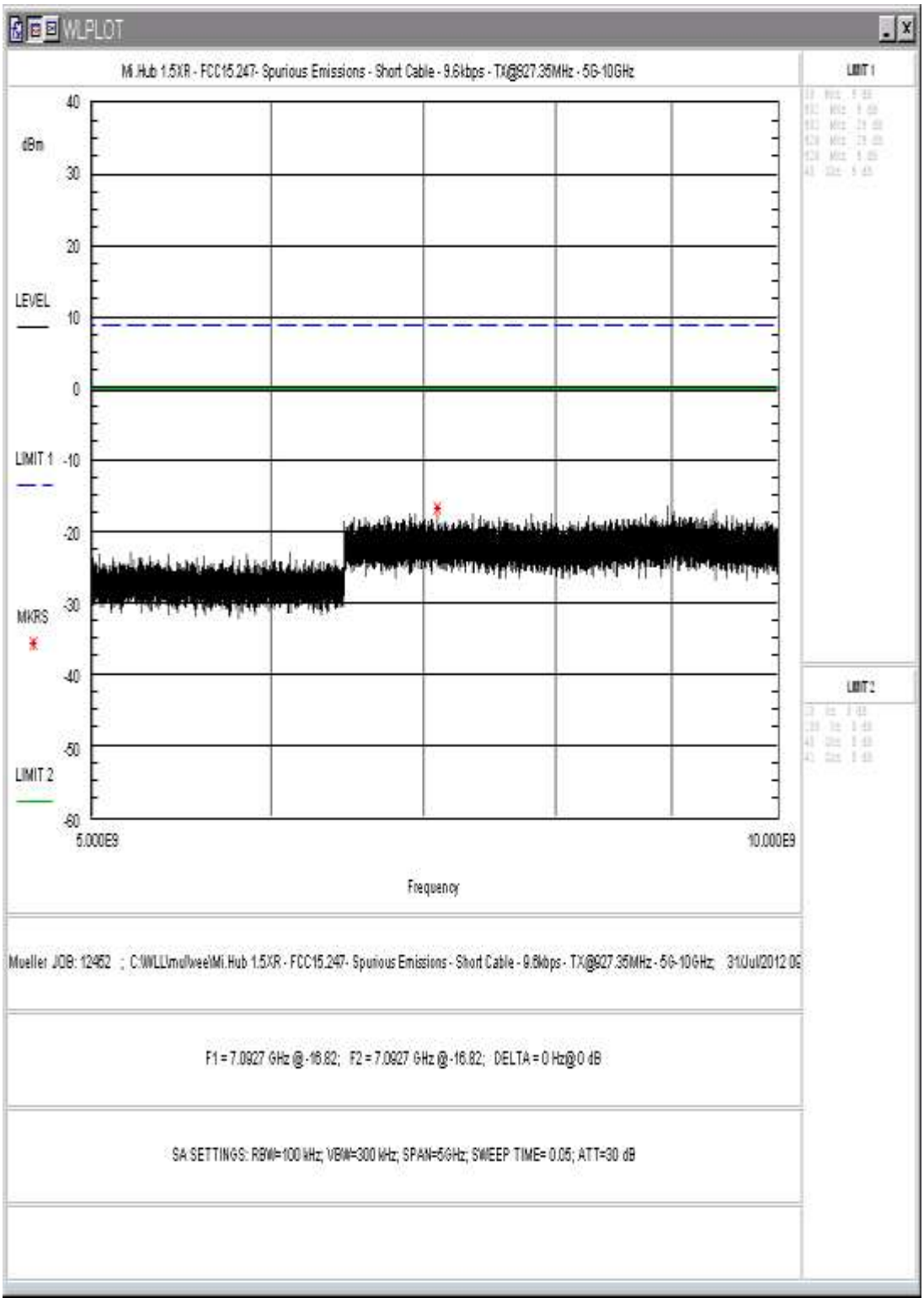

Figure 75: Spurious Emissions, Short Cable, TX-927.35MHz, 5-10GHz

5.6 Radiated Spurious Emissions: (FCC Part §2.1053)

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.

5.6.1 Test Procedure

The EUT was placed on a 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 EUT was tested in 3 orthogonals with the worst case readings provided. Both the horizontal and vertical field components were measured. Measurements below 1 GHz include both restricted and non-restricted bands.

The emissions were measured using the following resolution bandwidths:

Frequency Range	Resolution Bandwidth	Video Bandwidth
30MHz-1000 MHz	120kHz	>100 kHz
>1000 MHz	1 MHz	10 Hz (Avg.) 1MHz (Peak)

5.6.2 Areas of concern

None

Table 10: Radiated Emission Test Data, Low Frequency Data (<1GHz)

(Restricted bands only, same for all Channels)

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)
37.51	V	180.00	1.00	11.00	15.5	21.2	100.0	-13.5
73.34	V	90.00	1.00	22.10	9.6	38.3	100.0	-8.3
74.83	V	75.00	1.00	20.10	9.5	30.2	100.0	-10.4
117.89	V	95.00	1.00	17.60	16.3	49.8	150.0	-9.6
332.40	V	85.00	1.93	14.50	17.9	41.7	200.0	-13.6
401.56	V	100.00	1.63	5.80	20.4	20.4	200.0	-19.8
73.72	H	185.00	4.00	11.60	9.6	11.4	100.0	-18.8
75.08	H	190.00	4.00	11.80	9.5	11.6	100.0	-18.7
117.81	H	300.00	3.38	13.70	16.4	31.8	150.0	-13.5
132.51	H	280.00	3.85	15.50	15.3	34.6	150.0	-12.7
149.93	H	20.00	2.76	12.20	14.4	21.4	150.0	-16.9
156.76	H	275.00	1.96	7.50	14.6	12.7	150.0	-21.4
247.20	H	180.00	1.87	11.90	14.5	21.0	200.0	-19.6
332.65	H	175.00	1.32	11.60	17.9	29.9	200.0	-16.5

Note: Emissions were common to all tested channels. The frequencies listed are the highest emitted restricted bands.

Table 11: Radiated Emission Test Data, Short Cable, High Frequency Data (>1GHz) (6dBi Whip antenna) (Restricted Bands)

Low Channel-902.5MHz

Frequency (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)	Comments
2707.50	V	180.00	2.35	55.48	-1.9	479.9	5000.0	-20.4	Peak
2707.50	V	180.00	2.35	53.20	-1.9	369.1	500.0	-2.6	Average
3610.00	V	185.00	2.12	43.40	-0.3	143.1	5000.0	-30.9	Peak
3610.00	V	185.00	2.12	31.70	-0.3	37.2	500.0	-22.6	Average
4512.50	V	180.00	2.15	43.20	1.7	176.4	5000.0	-29.0	Peak
4512.50	V	180.00	2.15	36.70	1.7	83.5	500.0	-15.5	Average
2707.50	H	125.00	2.57	52.24	-1.9	330.5	5000.0	-23.6	Peak
2707.50	H	125.00	2.57	47.50	-1.9	191.5	500.0	-8.3	Average
3610.00	H	270.00	2.45	44.20	-0.3	156.9	5000.0	-30.1	Peak
3610.00	H	270.00	2.45	35.90	-0.3	60.3	500.0	-18.4	Average
4512.50	H	180.00	2.40	42.40	1.7	160.9	5000.0	-29.8	Peak
4512.50	H	180.00	2.40	34.28	1.7	63.2	500.0	-18.0	Average

Center Channel – 915MHz

Frequency (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)	Comments
2745.00	V	125.00	2.44	52.73	-1.8	350.4	5000.0	-23.1	Peak
2745.00	V	125.00	2.44	49.30	-1.8	236.1	500.0	-6.5	Average
3660.00	V	275.00	2.40	44.50	0.0	168.2	5000.0	-29.5	Peak
3660.00	V	275.00	2.40	36.24	0.0	65.0	500.0	-17.7	Average
4575.00	V	187.00	2.38	43.40	1.8	181.3	5000.0	-28.8	Peak
4575.00	V	187.00	2.38	36.67	1.8	83.5	500.0	-15.5	Average
2745.00	H	95.00	2.26	50.90	-1.8	283.8	5000.0	-24.9	Peak
2745.00	H	95.00	2.26	47.20	-1.8	185.4	500.0	-8.6	Average
3660.00	H	200.00	2.20	42.40	0.0	132.1	5000.0	-31.6	Peak
3660.00	H	200.00	2.20	32.80	0.0	43.7	500.0	-21.2	Average
4575.00	H	185.00	2.15	44.60	1.8	208.1	5000.0	-27.6	Peak
4575.00	H	185.00	2.15	37.50	1.8	91.9	500.0	-14.7	Average

High Hailing Channel-927.35MHz

Frequency (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)	Comments
2782.50	V	180.00	1.84	53.50	-1.8	383.6	5000.0	-22.3	Peak
2782.05	V	180.00	1.84	51.12	-1.8	291.6	500.0	-4.7	Average
3709.40	V	185.00	1.80	43.70	0.3	158.9	5000.0	-30.0	Peak
3709.40	V	185.00	1.80	32.09	0.3	41.7	500.0	-21.6	Average
4636.75	V	85.00	1.93	44.90	1.9	218.1	5000.0	-27.2	Peak
4636.75	V	85.00	1.93	33.30	1.9	57.4	500.0	-18.8	Average
2782.50	H	200.00	1.63	53.10	-1.8	366.3	5000.0	-22.7	Peak
2782.05	H	200.00	1.63	49.70	-1.8	247.6	500.0	-6.1	Average
3709.40	H	185.00	1.92	44.70	0.3	178.3	5000.0	-29.0	Peak
3709.40	H	185.00	1.92	31.90	0.3	40.8	500.0	-21.8	Average
4636.75	H	175.00	2.20	45.00	1.9	220.6	5000.0	-27.1	Peak
4636.75	H	175.00	2.20	37.00	1.9	87.8	500.0	-15.1	Average

Table 12: Radiated Emission Test Data, Long Cable, High Frequency Data (>1GHz) (6dBi Whip antenna) (Restricted Bands)

Low Channel-902.5MHz

Frequency (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)	Comments
2707.50	V	180.00	1.88	54.05	-1.9	407.1	5000.0	-21.8	Peak
2707.50	V	180.00	1.88	51.80	-1.9	314.2	500.0	-4.0	Average
3610.00	V	115.00	1.65	41.80	-0.3	119.0	5000.0	-32.5	Peak
3610.00	V	115.00	1.65	31.90	-0.3	38.1	500.0	-22.4	Average
4512.50	V	180.00	1.80	41.50	1.7	145.1	5000.0	-30.7	Peak
4512.50	V	180.00	1.80	30.74	1.7	42.0	500.0	-21.5	Average
2707.50	H	95.00	2.82	50.20	-1.9	261.3	5000.0	-25.6	Peak
2707.50	H	95.00	2.82	46.40	-1.9	168.7	500.0	-9.4	Average
3610.00	H	275.00	2.78	44.30	-0.3	158.7	5000.0	-30.0	Peak
3610.00	H	275.00	2.78	34.98	-0.3	54.3	500.0	-19.3	Average
4512.50	H	180.00	2.70	40.70	1.7	132.3	5000.0	-31.5	Peak
4512.50	H	180.00	2.70	30.60	1.7	41.4	500.0	-21.6	Average

Center Channel – 915MHz

Frequency (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)	Comments
2745.00	V	265.00	2.02	49.00	-1.8	228.0	5000.0	-26.8	Peak
2745.00	V	265.00	2.02	44.06	-1.8	129.1	500.0	-11.8	Average
3660.00	V	45.00	2.06	43.80	0.0	155.2	5000.0	-30.2	Peak
3660.00	V	45.00	2.06	32.60	0.0	42.7	500.0	-21.4	Average
4575.00	V	165.00	2.08	43.30	1.8	179.2	5000.0	-28.9	Peak
4575.00	V	165.00	2.08	35.40	1.8	72.2	500.0	-16.8	Average
2745.00	H	280.00	2.86	50.00	-1.8	255.9	5000.0	-25.8	Peak
2745.00	H	280.00	2.86	46.60	-1.8	173.0	500.0	-9.2	Average
3660.00	H	265.00	2.70	43.50	0.0	149.9	5000.0	-30.5	Peak
3660.00	H	265.00	2.70	33.00	0.0	44.8	500.0	-21.0	Average
4575.00	H	270.00	2.70	43.10	1.8	175.1	5000.0	-29.1	Peak
4575.00	H	270.00	2.70	32.50	1.8	51.7	500.0	-19.7	Average

High Hailing Channel-927.35MHz

Frequency (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)	Comments
2782.50	V	275.00	2.06	51.30	-1.8	297.7	5000.0	-24.5	Peak
2782.05	V	275.00	2.06	48.70	-1.8	220.7	500.0	-7.1	Average
3709.40	V	125.00	2.02	43.64	0.3	157.8	5000.0	-30.0	Peak
3709.40	V	125.00	2.02	32.40	0.3	43.3	500.0	-21.3	Average
4636.75	V	185.00	2.20	46.60	1.9	265.3	5000.0	-25.5	Peak
4636.75	V	185.00	2.20	42.20	1.9	159.8	500.0	-9.9	Average
2782.50	H	270.00	2.21	54.27	-1.8	419.1	5000.0	-21.5	Peak
2782.05	H	270.00	2.21	51.25	-1.8	296.0	500.0	-4.6	Average
3709.40	H	90.00	2.17	41.86	0.3	128.6	5000.0	-31.8	Peak
3709.40	H	90.00	2.17	32.30	0.3	42.8	500.0	-21.4	Average
4636.75	H	125.00	2.20	44.00	1.9	196.6	5000.0	-28.1	Peak
4636.75	H	125.00	2.20	33.90	1.9	61.5	500.0	-18.2	Average

5.7 AC Conducted Emissions (FCC Pt.15.207)

5.7.1 Requirements

Test Arrangement: Table Top

Compliance Standard: FCC Class B

FCC Compliance Limits		
Frequency	**Quasi-peak**	**Average**
0.15 - 0.5MHz	66 to 56dBµV	56 to 46dBµV
0.5 - 5MHz	56dBµV	46dBµV
5 - 30MHz	60dBµV	50dBµV

5.7.2 Test Procedure

The EUT was placed on an 80 cm high 1 X 1.5 m non-conductive table above a ground plane. Power to the EUT was provided through a Solar Corporation 50 Ω/50 µH Line Impedance Stabilization Network bonded to a 3 X 2 meter ground plane. The LISN has its AC input supplied from a filtered AC power source. Power was supplied to the peripherals through a second LISN. The peripherals were placed on the table in accordance with ANSI C63.4-2003. Power and data cables were moved about to obtain maximum emissions.

The 50 Ω output of the LISN was connected to the input of the spectrum analyzer and the emissions in the frequency range of 150 kHz to 30 MHz were measured. The detector function was set to quasi-peak, peak, or average as appropriate, and the resolution bandwidth during testing was at least 9 kHz, with all post-detector filtering no less than 10 times the resolution bandwidth. For average measurements the post-detector filter was set to 10 Hz.

At frequencies where quasi-peak or peak measurements comply with the average limit, no average measurements need be performed.

At frequencies where quasi-peak or peak measurements comply with the average limit, no average measurements need be performed. The Conducted emissions level to be compared to the FCC limit is calculated as shown in the following example.

Example:

Spectrum Analyzer Voltage: VdBµV

LISN Correction Factor: LISN dB

Cable Correction Factor: CF dB

Electric Field: EdBµV = V dBµV + LISN dB + CF dB

5.7.3 Test Data

The EUT complied with the Class B Conducted Emissions requirements. Table 10-11 provide the test results for phase and neutral line power line conducted emissions.

Emissions were tested in the "transmit on" state with the EUT tuned to 915MHz.

Table 13: Conducted Emissions Data 120VAC, Transmit On

NEUTRAL

Frequency (MHz)	Level QP (dBµV)	Level AVG (dBµV)	Cable Loss (dB)	LISN Corr (dB)	Level QP Corr (dBµV)	Level Corr Avg (dBµV)	Limit QP (dBµV)	Limit AVG (dBµV)	Margin QP (dB)	Margin AVG (dB)
0.175	47.6	25.9	10.2	0.5	58.3	36.6	64.7	54.7	-6.4	-18.1
3.133	37.4	32.6	10.3	0.9	48.6	43.8	56.0	46.0	-7.4	-2.2
5.310	38.0	32.5	10.7	0.8	49.6	44.1	60.0	50.0	-10.4	-5.9
10.480	31.9	25.4	11.1	1.0	44.0	37.5	60.0	50.0	-16.0	-12.5
15.080	25.4	19.0	11.3	0.8	37.6	31.2	60.0	50.0	-22.4	-18.8
18.870	27.0	19.9	11.5	0.7	39.2	32.1	60.0	50.0	-20.8	-17.9
22.780	29.9	21.4	11.6	1.5	42.9	34.4	60.0	50.0	-17.1	-15.6
29.580	24.1	10.9	12.0	3.0	39.1	25.9	60.0	50.0	-20.9	-24.1

PHASE

Frequency (MHz)	Level QP (dBµV)	Level AVG (dBµV)	Cable Loss (dB)	LISN Corr (dB)	Level QP Corr (dBµV)	Level Corr Avg (dBµV)	Limit QP (dBµV)	Limit AVG (dBµV)	Margin QP (dB)	Margin AVG (dB)
0.180	47.1	30.2	10.2	0.9	58.2	41.3	64.5	54.5	-6.3	-13.2
0.465	38.7	33.8	10.2	0.6	49.5	44.6	56.6	46.6	-7.1	-2.0
4.835	37.9	32.3	10.7	1.2	49.7	44.1	56.0	46.0	-6.3	-1.9
5.250	38.4	33.0	10.7	1.2	50.3	44.9	60.0	50.0	-9.7	-5.1
10.660	32.0	25.1	11.1	1.1	44.3	37.4	60.0	50.0	-15.7	-12.6
18.840	27.7	20.0	11.5	0.8	40.0	32.3	60.0	50.0	-20.0	-17.7
22.840	30.2	22.5	11.6	1.6	43.4	35.7	60.0	50.0	-16.6	-14.3
29.580	23.9	11.9	12.0	3.1	39.0	27.0	60.0	50.0	-21.0	-23.0

5.8 Receiver Radiated Emissions

5.8.1 *Requirements*

Test Arrangement: Table Top

RSS210 Compliance Limits for Receivers	
Frequency	**Limits**
30-88 MHz	100 µV/m
88-216 MHz	150 µV/m
216-960 MHz	200 µV/m
>960MHz	500 µV/m

5.8.2 *Test Procedure*

The requirements of call for the EUT to be placed on an 80 cm high 1 X 1.5 meters non-conductive 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. Biconical and log periodic broadband antennas were mounted on an antenna mast to determine the height of maximum emissions. The height of the antenna was varied between 1 and 4 meters. The output of the antenna was connected to the input of the spectrum analyzer and the emissions in the frequency range of 30 MHz to 3 GHz were measured. The peripherals were placed on the table in accordance with ANSI C63.4-2003. Cables were varied in position to produce maximum emissions. Both the horizontal and vertical field components were measured.

The output from the antenna was connected, via a preamplifier, to the input of the spectrum analyzer. The detector function was set to quasi-peak, peak, or average as appropriate. The measurement bandwidth of the spectrum analyzer system was set to at least 120 kHz, with all post-detector filtering no less than 10 times the measurement bandwidth.

All measurements above 1GHz were made at a distance of 3m with a Resolution Bandwidth of 1MHz and a Video bandwidth of 10Hz.

5.8.3 *Test Data*

The EUT complied with the Receiver Radiated Emissions requirements. Table 9 provides the test results for radiated emissions.

5.8.4 *Radiated Data Reduction and Reporting*

To convert the raw spectrum analyzer radiated data into a form that can be compared with the FCC limits, it is necessary to account for various calibration factors that are supplied with the antennas and other measurement accessories. These factors are included into the antenna factor (AF) column of the table and in the cable factor (CF) column of the table. The AF (in dB/m) and the CF (in dB) is algebraically added to the raw Spectrum Analyzer Voltage in dBµV to obtain the Radiated Electric Field in dBµV/m. This logarithm amplitude is converted to a linear amplitude, then compared to the Industry Canada limit.

Example:

Spectrum Analyzer Voltage: VdBµV

Antenna Correction Factor: AFdB/m

Cable Correction Factor: CFdB

Electric Field: EdBV/m = V dBµV + AFdB/m + CFdB

To convert to linear units of measure: EdBV/m/20 Inv log

Table 14: Receiver Radiated Emission Test Data

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)
37.51	V	180.00	1.00	11.00	15.5	21.2	100.0	-13.5
73.34	V	90.00	1.00	22.10	9.6	38.3	100.0	-8.3
74.83	V	75.00	1.00	20.10	9.5	30.2	100.0	-10.4
117.89	V	95.00	1.00	17.60	16.3	49.8	150.0	-9.6
332.40	V	85.00	1.93	14.50	17.9	41.7	200.0	-13.6
401.56	V	100.00	1.63	5.80	20.4	20.4	200.0	-19.8
73.72	H	185.00	4.00	11.60	9.6	11.4	100.0	-18.8
75.08	H	190.00	4.00	11.80	9.5	11.6	100.0	-18.7
117.81	H	300.00	3.38	13.70	16.4	31.8	150.0	-13.5
132.51	H	280.00	3.85	15.50	15.3	34.6	150.0	-12.7
149.93	H	20.00	2.76	12.20	14.4	21.4	150.0	-16.9
156.76	H	275.00	1.96	7.50	14.6	12.7	150.0	-21.4
247.20	H	180.00	1.87	11.90	14.5	21.0	200.0	-19.6
332.65	H	175.00	1.32	11.60	17.9	29.9	200.0	-16.5

