COMMONWEALTH of VIRGINIA

Office of the Governor

Robert F. McDonnell
Governor

October 16, 2013

Royce Kincaid
FirstNet Campaign Director
Northrop Grumman
7555 Colshire Drive
McLean, VA 22102

Re: Consent for Special Temporary Authority
FCC File #0868-EX-ST-2013

Dear Mr. Kincaid,

The Commonwealth of Virginia, the sole guardian of the 'State' 700 MHz spectrum reference, WPTZ775, endorses the above-referenced application for Special Temporary Authority ("STA") filed by Northrop Grumman Systems Corporation ("Northrop Grumman") subject to the following terms and conditions which shall be made part of the documentation of this request:

- The resultant FCC license matches exactly to the application and resulting documentation that was supplied in good faith by Northrop Grumman to the Commonwealth of Virginia.

- Operations are strictly limited to ground floor indoor (in-building) operations at 7575 Colshire Drive, McLean, Virginia 22102, unless authorized by the Commonwealth of Virginia. The primary radiator coordinates (Latitude and Longitude) are as stated on the STA:

    - 38 55 17 North
    - 77 12 23 West

- The primary radiators under test shall not exceed 1 watt of power.

- It shall by further understood that in consideration of FirstNet's consent to this STA, and the FCC's grant of this STA, Northrop Grumman automatically agrees and consents to all terms and conditions as outlined by the Commonwealth of Virginia in this consent letter. Furthermore, Northrop Grumman assumes all causalities, risks, damages, and liabilities

that may result from the operations associated with this STA or any resultant STA associated with this request.

- Any deviation from this agreement will result in revocation of any and all STA's approved by the Commonwealth of Virginia. However, all causalities, risks, damages, and liabilities that may have resulted from the operations associated with any STA associated with this request will still be fully enforced to the maximum extent.

- The results from the radiators under test on October 10th performed by Comsearch shall be filed by Northrop Grumman with the FCC as part of the STA documentation. Absence of this document will nullify the endorsement of the Commonwealth of Virginia.

- Absence of these stated terms and conditions from the published STA documentation will null and void the STA endorsement from the Commonwealth of Virginia.

- Northrop Grumman will notify the Interoperability Coordinator, the Commonwealth Spectrum Manager, and the Virginia State Police if any upcoming test associated with this STA deviates from the operations authorized under the STA.

- Northrop Grumman shall notify the STARS NOC prior to commencing any test. Northrop Grumman shall not conduct any test authorized under the STA without the concurrence of the Virginia State Police.

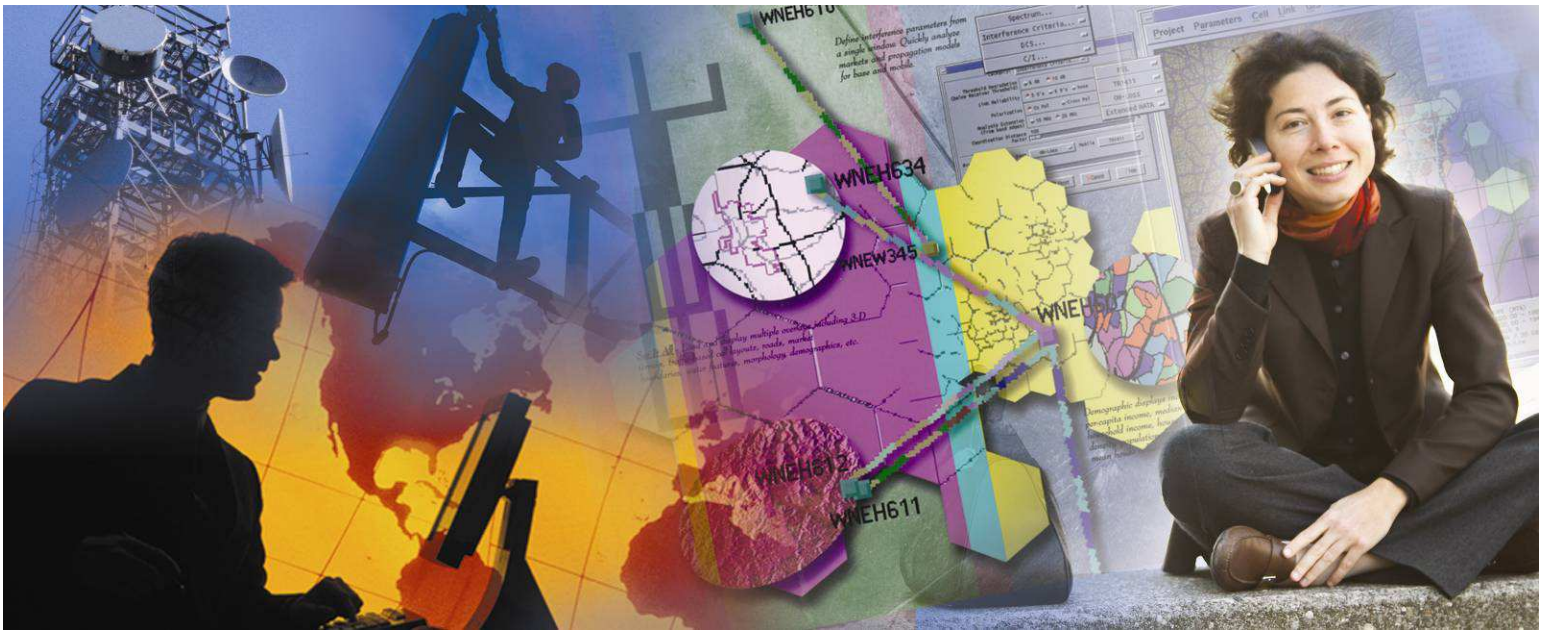
Should the Commonwealth experience any verifiable interference resulting from operations associated with this STA request, Northrop Grumman and any of its partners or associates will immediately discontinue all operations until the source of the interference is fully mitigated. In addition, Northrop Grumman will supply all equipment and personnel necessary to mitigate the interference to the satisfaction of the Commonwealth of Virginia.

In the event Northrop Grumman must discontinue operations twice because the Commonwealth has experienced verifiable interference from operations associated with the STA, the Commonwealth can revoke and nullify the STA at any time immediately upon notice. Moreover, the Commonwealth of Virginia or its employees will not be held liable for any ramifications that may be associated with an unplanned revocation to this STA.

Sincerely,

Chris McIntosh
Statewide Interoperability
and First Responder Network Coordinator
Office of Veterans Affairs and Homeland Security
Office of the Governor
Commonwealth of Virginia

COMSEARCH
A CommScope Company



RF MEASUREMENT REPORT

Band 14 – Upper 700 MHz Frequency Band

Prepared for

Northrop Grumman

October 2013

19700 Janelia Farm Boulevard. ● Ashburn, Virginia 20147, USA ● 703-726-5500 ● Fax 703.726.5600

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SECTION 1

INTRODUCTION AND BACKGROUND

1.1 Introduction

On-site Radio Frequency Band Sweeps measurements were performed on behalf of Northrop Grumman in Northern Virginia near their building at 7575 Colshire Blvd in McLean, Virginia. The measurements were performed starting on October 10, 2013 at ten (10) locations. The purpose of these measurements was to obtain RF signal level values for frequencies that Northrop Grumman is currently using to test out FirstNet network interoperability under an FCC Special Temporary Authority (STA). The purpose of this report is to document the results of these measurements and to present recommendations.

1.2 Background

Northrop Grumman is currently using frequencies in band fourteen (14) of the upper 700 MHz band to test interoperability of the FirstNet network. Band fourteen (14) is composed of two frequency ranges 758-768 MHz (downlink) and 788-798 MHz (uplink). The laboratory setup is a Nokia Siemens eNodeB radio unit located within an interior office area. The eNodeB is using a small omni directional antenna attached directly to a 30 dB attenuator on the TX port of the equipment. There is no other transmitting antenna system attached to the eNodeB. Northrop Grumman has designed this system for in building use. The system is currently operational and has been for some time. During this period of operation there have been no incidents of interference into other licensed systems.

Northrop Grumman has asked Comsearch to document their use of band fourteen (14) and whether or not there is risk for potential interference into other operators that could use the same frequency bands. Comsearch was assigned to measure the entire upper 700 MHz band (746-806 MHz) and both the downlink (758-768 MHz) and uplink (788-798 MHz) of band fourteen (14).

Northrop Grumman operates the eNodeB at the lowest power setting which is 8 watts (+39 dBm). To further reduce power there is a 30 dB attenuator attached directly to the Tx port on the radio. This effectively gives a total power to the antenna of +9 dBm (0.008 watts). The antenna (a small ¼ wave omni-directional) is connected directly to the 30 dB attenuator.

The measured sites are identified on a street map shown in Figure 1.2-1 and an aerial image shown Figure 1.2-2.

1.3 Constraints

The analysis in this report is based upon the following assumptions and constraints.

- Northrop Grumman's eNodeB was operational and transmitting during the entire measurement period.

- The measurement sites were selected randomly by Comsearch.

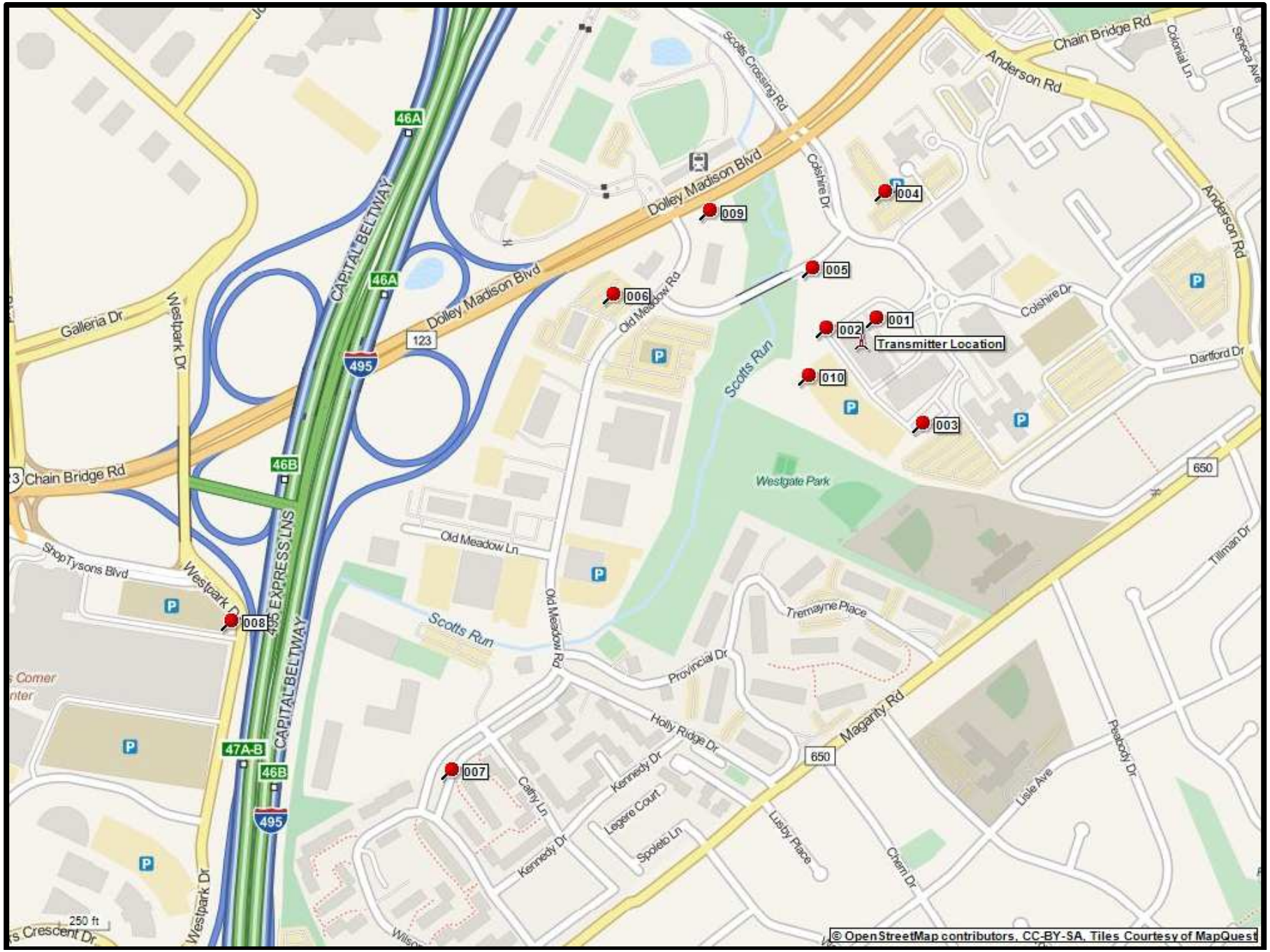


Figure 1.2-1 – Street map showing all measurement locations

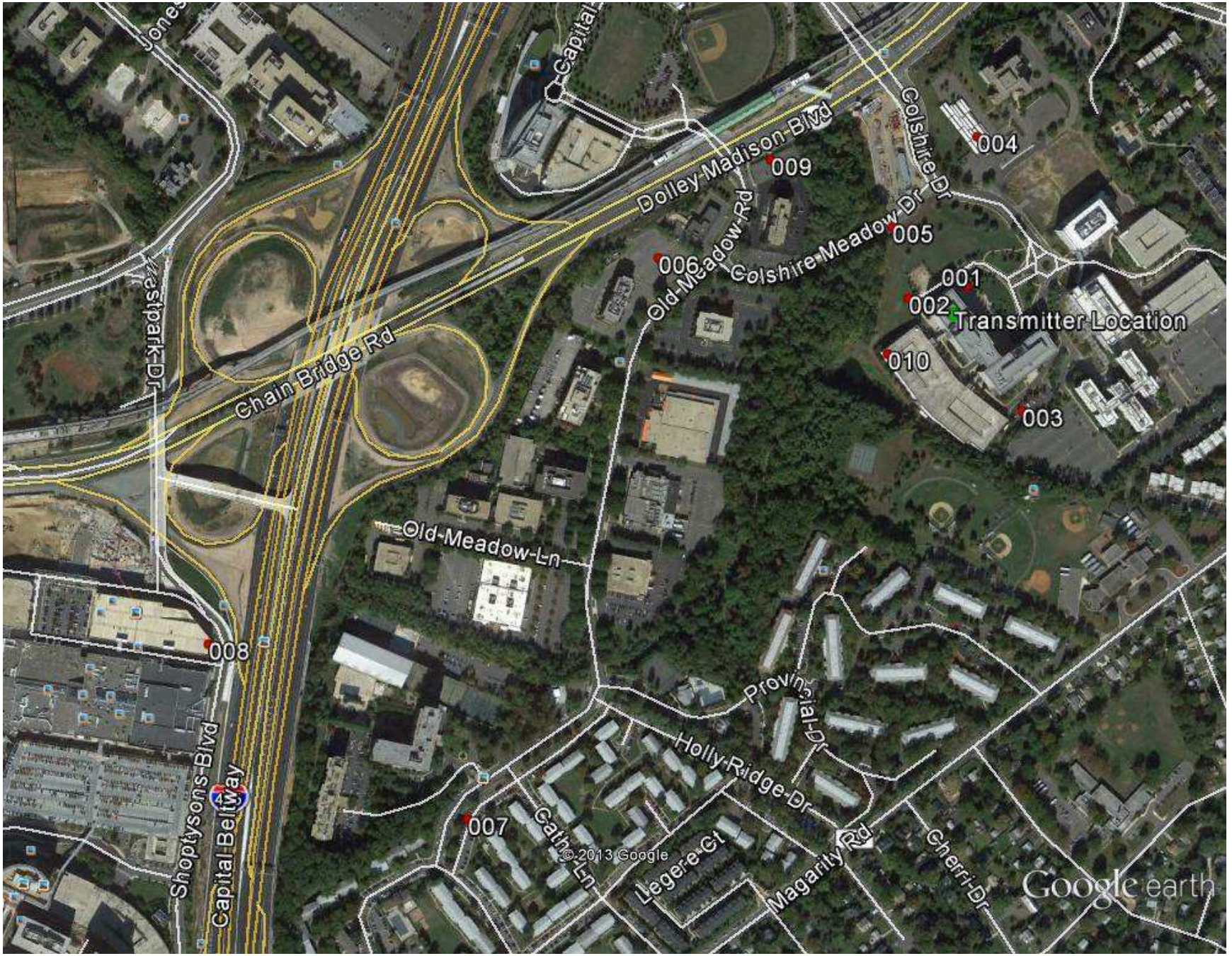


Figure 1.2-2 – Aerial image showing all measurement locations

SECTION

TWO

SECTION 2

TEST PROCEDURE

2.1 Calibration

Figure 2.1-1 is the block diagram of the band sweep test set. All test equipment used was allowed a proper warm-up period prior to calibration. The test set was calibrated by the signal substitution method, utilizing the HP Signal Generator signal source. The calibrated reference signal (-50 dBm) from the signal generator was then injected into the end of the coaxial cable of the test set at the point that normally connects to the test antenna. An Anritsu spectrum analyzer then measured the reference test signal level after passing through the test set. Upon completion of the calibration process, a known reference level was obtained for the measurements that correspond to a given set of spectrum analyzer display readings. Figure 2.1-2 displays the spectrum photograph of the described calibration procedure employed during the band sweep measurements.

The following formula is used to transform the injected signal level (dBm) into the spectrum analyzer display which is the isotropic reference signal level (dBm_I) as seen at the point of test:

$$dBm_I = LI - GA$$

Where: dBm_I = Isotropic level in dBW

LI = Level (dBm) of injected signal

GA = Test antenna gain

at 776 MHz: dBm_I = -50 dBm - 2 dB

= -52 dBm_I

In this instance, the spectrum analyzer displayed measured signal level of –50 dBm_I equates to an injected signal level of –50 dBm and represents a isotopic level of -52 dBm_I.

Figures 2.1-2 displays the spectrum photograph of the described calibration procedure employed during these measurements.

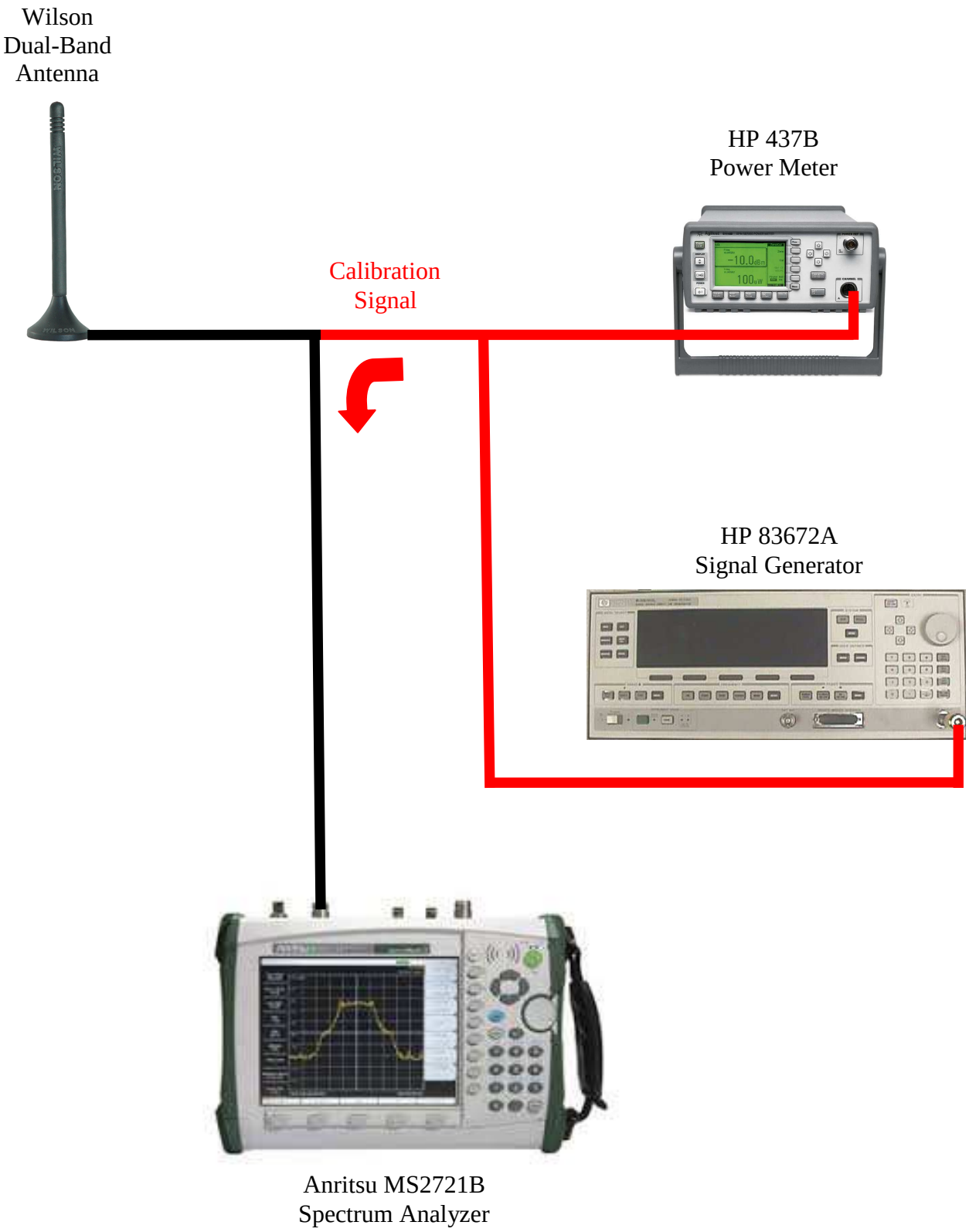
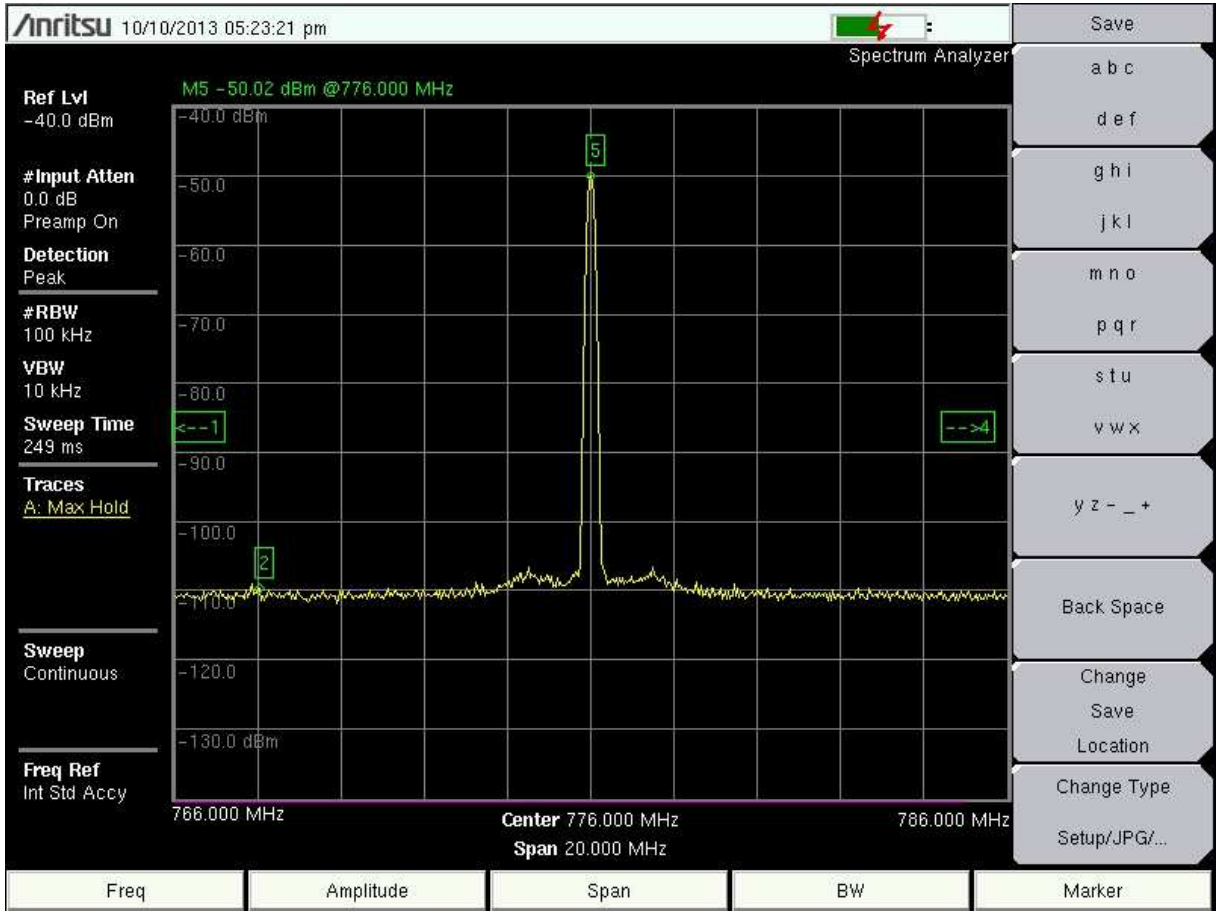


Figure 2.1-1 700 MHz Receive Test Equipment

Northrop Grumman

McLean, Virginia



Date: 10/10/2013

Time: 5:23 PM

RBW: 100 kHz

VBW: 10 kHz

-50 dBm, 776 MHz signal indication on the spectrum photograph represents a -50 dBm signal being injected at the point where the test cable connects to the output of the test antenna.

Displayed reference level equals:

-50 dBm injected signal
<u>-02 dBm antenna gain</u>
= -52 dBm_I signal level

Figure 2.1-2 RF Calibration Photograph

2.2 Methodology

RF Measurements were performed in the laboratory facility in Northrop Grumman to get baseline readings of the transmitting signal. RF measurements were taken by connecting a cable directly to a 30 dB attenuator which is directly connected to the Tx port on the eNodeB radio. RF measurements were then taken in the lab area not connected to the transmitter. More RF measurements were then performed in the lobby area of the Nortrop Grumman building. The transmitter was located behind two interior walls during this measurement.

RF measurements were then performed at ten (10) sites in and around the Northrop Grumman Building at 7575 Colshire Blvd in McLean, VA. Sites were selected that had at least a partial view of the Northrop Grumman Building. The test measurements were normally performed at a height of 5 feet above ground level (with the exception of sites 8 & 10 which were performed on top levels of parking garages).

Upon completion of the RF testing, the measured signal levels were transposed to isotropic levels after accounting for the test antenna gain. The results of the measured levels are presented in Section 3 of this report.

SECTION

THREE

SECTION 3

DATA PRESENTATION

The following section contains Street Maps, Aerial Maps and Spectrum Photographs pertaining to each site location measured in the Northern Virginia area.

3.1 Transmitter Site - Northrop Grumman Building - 7575 Colshire Blvd

- Figure 3.1-1 contains a street map of the transmitter location.
- Figures 3.1-2 contains an aerial photograph of the transmitter location.
- Figures 3.1-3 through 3.1-5 are the RF spectrum photographs depicting the transmitter signal.

3.2 Test Measurement Site 1

- Figure 3.2-1 contains a street map of the test measurement location.
- Figure 3.2-2 contains an aerial photograph of the test measurement location.
- Figures 3.2-3 through 3.2-8 are the RF spectrum photographs depicting the RF signal levels at the test site.

3.3 Test Measurement Site 2

- Figure 3.3-1 contains a street map of the test measurement location.
- Figure 3.3-2 contains an aerial photograph of the test measurement location.
- Figures 3.3-3 through 3.3-8 are the RF spectrum photographs depicting the RF signal levels at the test site.

3.4 Test Measurement Site 3

- Figure 3.4-1 contains a street map of the test measurement location.
- Figure 3.4-2 contains an aerial photograph of the test measurement location.
- Figures 3.4-3 through 3.4-8 are the RF spectrum photographs depicting the RF signal levels at the test site.

3.5 Test Measurement Site 4

- Figure 3.5-1 contains a street map of the test measurement location.
- Figure 3.5-2 contains an aerial photograph of the test measurement location.
- Figures 3.5-3 through 3.5-8 are the RF spectrum photographs depicting the RF signal levels at the test site.

3.6 Test Measurement Site 5

- Figure 3.6-1 contains a street map of the test measurement location.
- Figure 3.6-2 contains an aerial photograph of the test measurement location.
- Figures 3.6-3 through 3.6-8 are the RF spectrum photographs depicting the RF signal levels at the test site.

3.7 Test Measurement Site 6

- Figure 3.7-1 contains a street map of the test measurement location.
- Figure 3.7-2 contains an aerial photograph of the test measurement location.
- Figures 3.7-3 through 3.7-8 are the RF spectrum photographs depicting the RF signal levels at the test site.

3.8 Test Measurement Site 7

- Figure 3.8-1 contains a street map of the test measurement location.
- Figure 3.8-2 contains an aerial photograph of the test measurement location.
- Figures 3.8-3 through 3.8-8 are the RF spectrum photographs depicting the RF signal levels at the test site.

3.9 Test Measurement Site 8

- Figure 3.9-1 contains a street map of the test measurement location.
- Figure 3.9-2 contains an aerial photograph of the test measurement location.
- Figures 3.9-3 through 3.9-8 are the RF spectrum photographs depicting the RF signal levels at the test site.

3.10 Test Measurement Site 9

- Figure 3.10-1 contains a street map of the test measurement location.
- Figure 3.10-2 contains an aerial photograph of the test measurement location.
- Figures 3.10-3 through 3.10-8 are the RF spectrum photographs depicting the RF signal levels at the test site.

3.11 Test Measurement Site 10

- Figure 3.11-1 contains a street map of the test measurement location.
- Figure 3.11-2 contains an aerial photograph of the test measurement location.
- Figures 3.11-3 through 3.11-8 are the RF spectrum photographs depicting the RF signal levels at the test site.

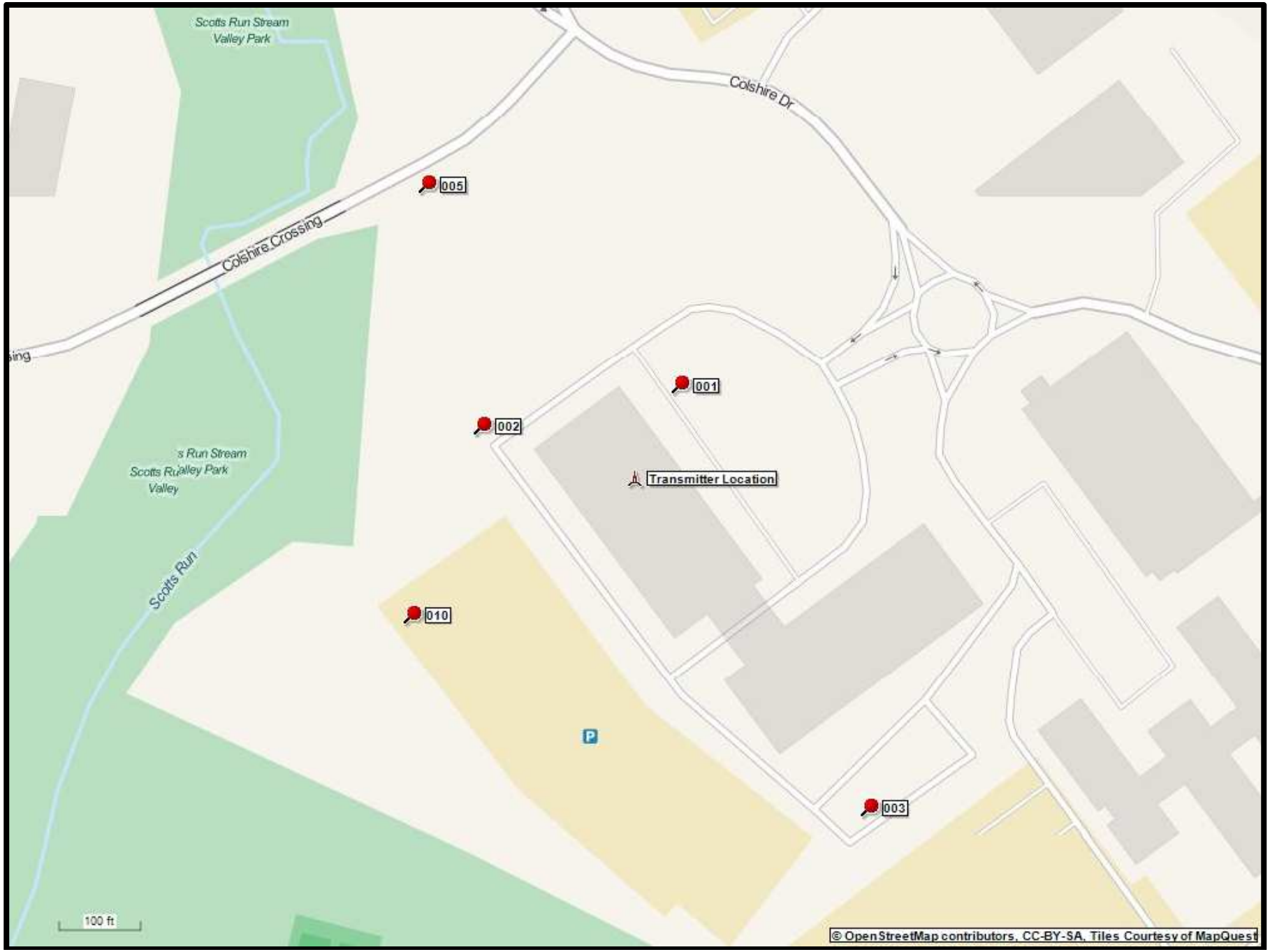


Figure 3.1-1 – Street Map Showing Transmitter Location

Figure 3.1-2 – Aerial Image Showing Transmitter Location

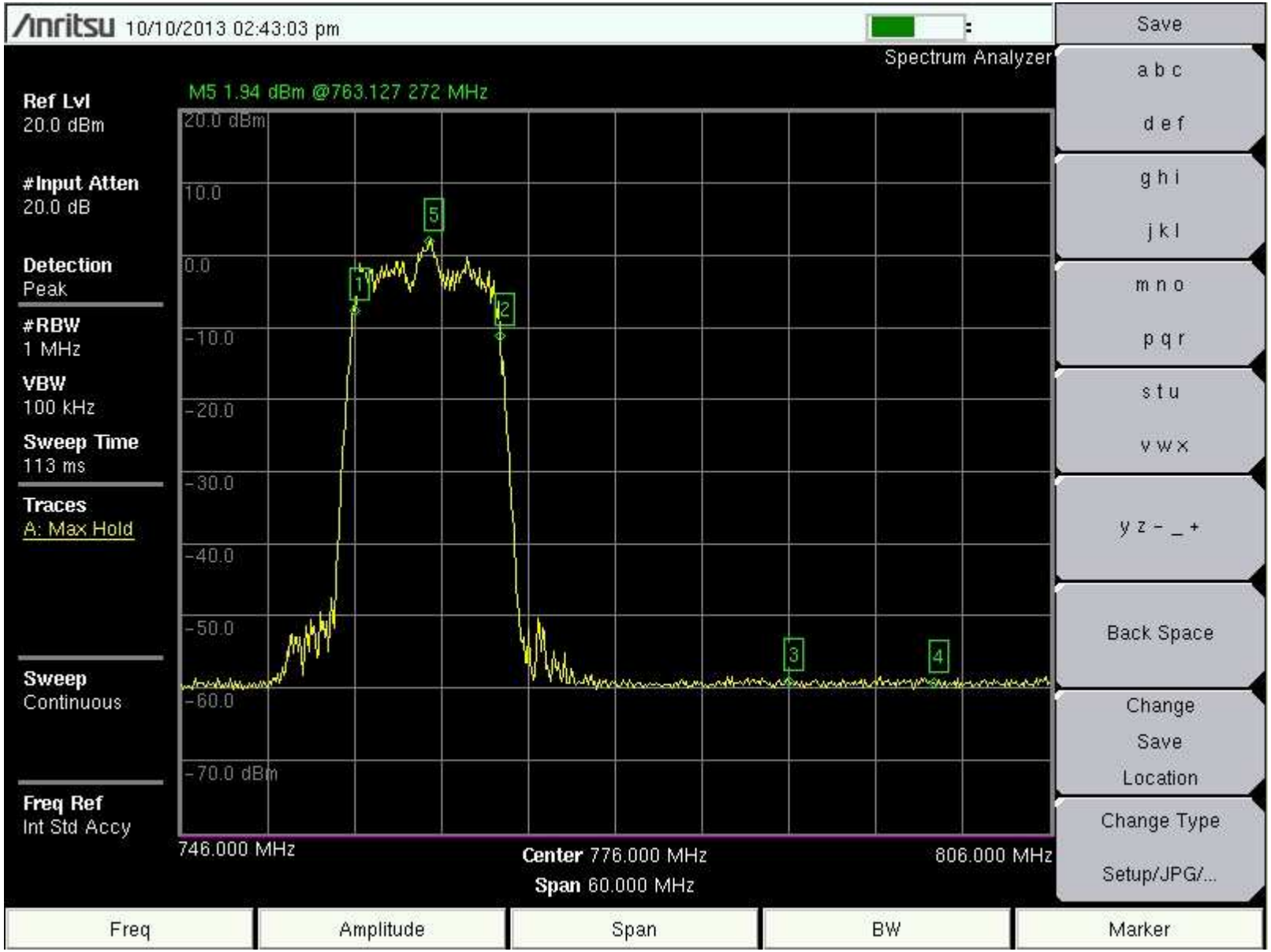


Figure 3.1-3 – Transmitter Location - Spectrum Analyzer Image @ 1 MHz RBW – Upper 700 MHz Band (746-806 MHz)
Spectrum Analyzer connected directly to eNodeB – This is the output power directly to the antenna
Band 14 Downlink – Recorded Signal Level 1.94 dBm (758-768 MHz) Markers 1 & 2
Band 14 Uplink - NO SIGNAL PRESENT (788-798 MHz) Markers 3 & 4
Transmit Signal level corrected for Digital Power is 1.94 + 10 dB (correction factor) = 11.94 dBm Tx power

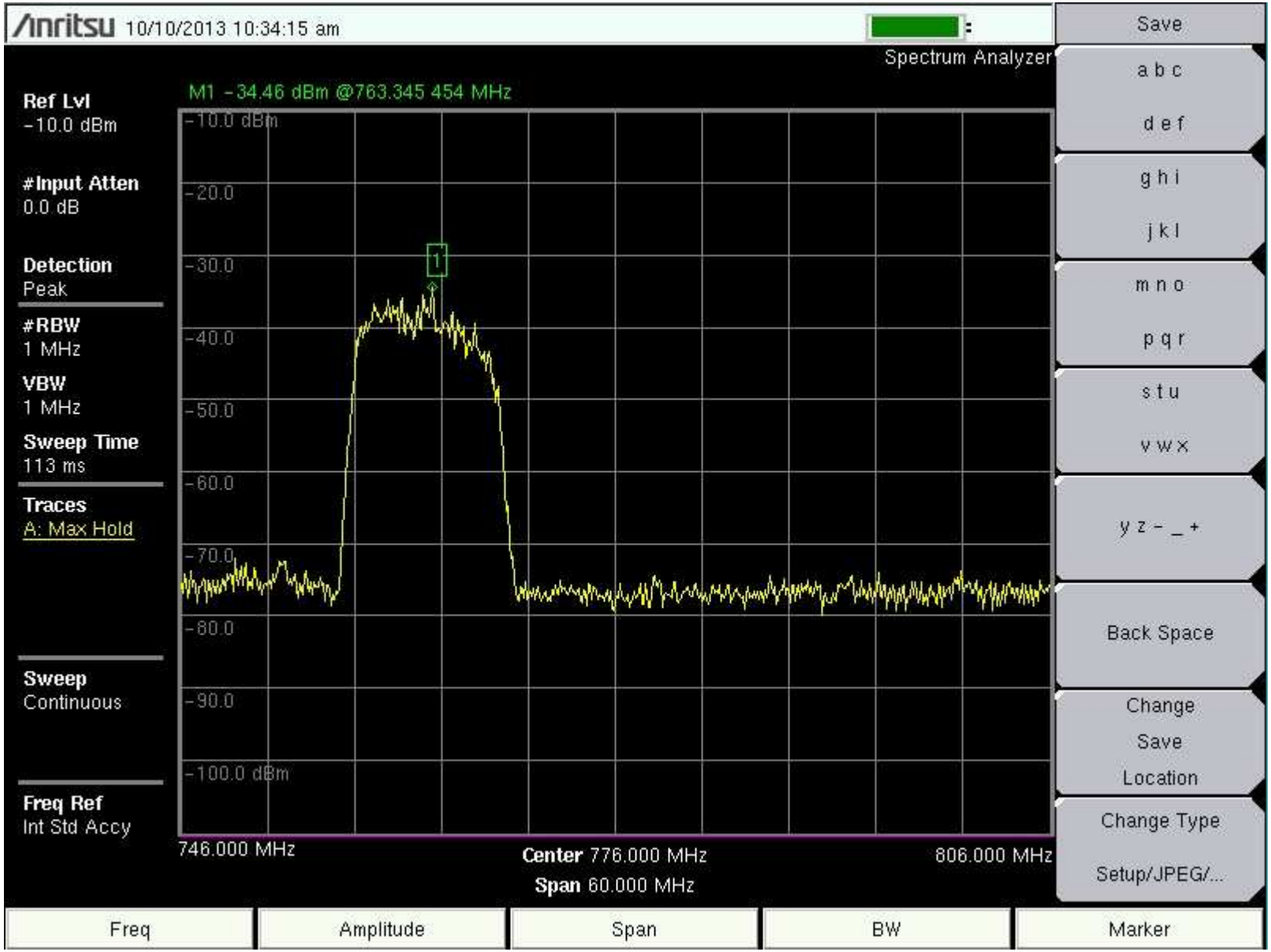


Figure 3.1-4 – Transmitter Location - Spectrum Analyzer Image @ 1 MHz RBW – Upper 700 MHz Band (746-806 MHz)
Spectrum Analyzer not connected to eNodeB – Receive antenna approx 10 ft from eNodeB Tx Antenna
Band 14 Downlink – Recorded Signal Level -34.46 dBm (758-768 MHz) Marker 1
Band 14 Uplink - NO SIGNAL PRESENT (788-798 MHz)

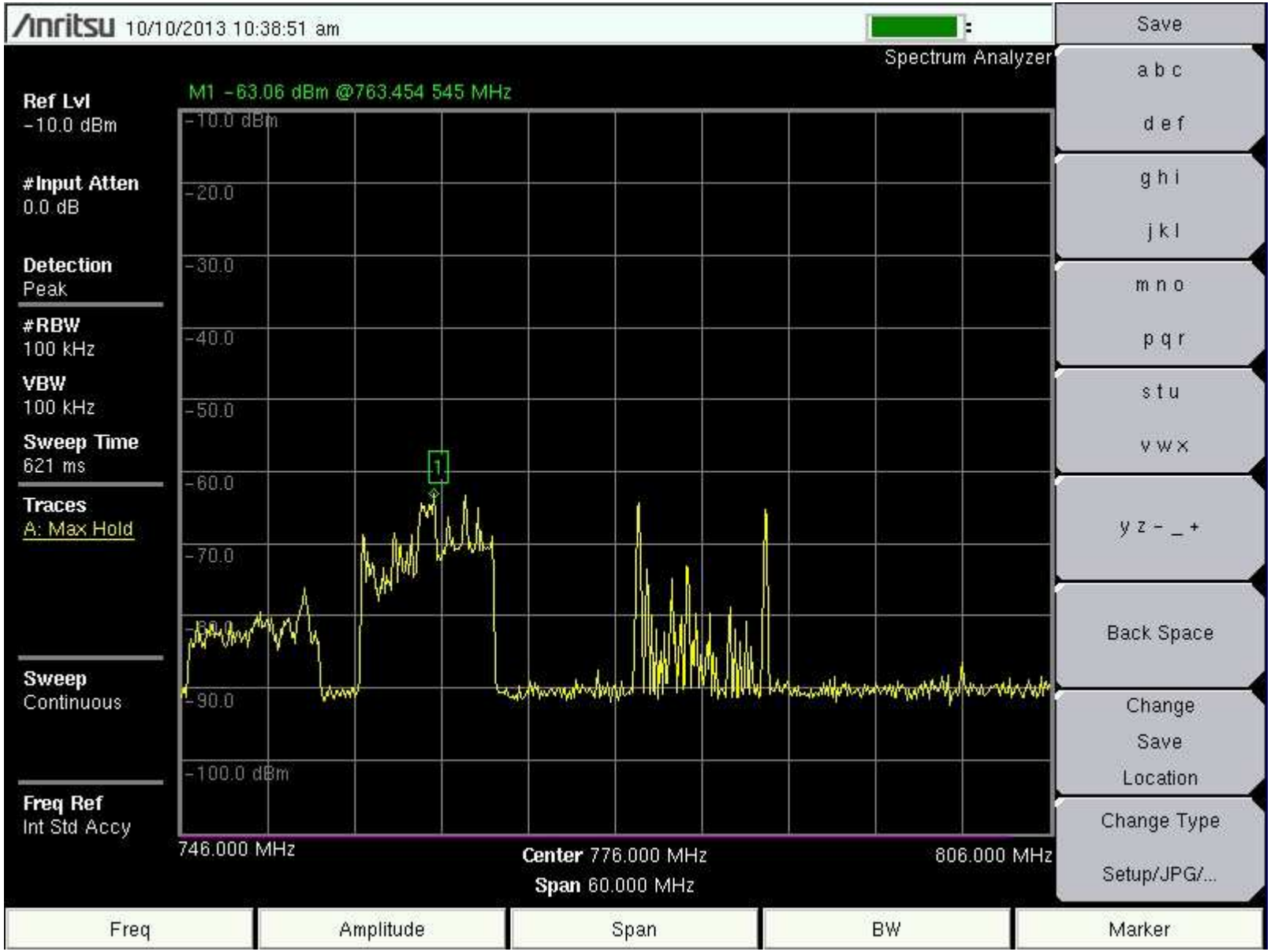


Figure 3.1-5 – Transmitter Location - Spectrum Analyzer Image @ 100 kHz RBW – Upper 700 MHz Band (746-806 MHz)
Measurement is in lobby of building – eNodeB is behind two interior walls from this location
Band 14 Downlink – Recorded Signal Level -63.06 dBm (758-768 MHz) Marker 1
Band 14 Uplink - NO SIGNAL PRESENT (788-798 MHz)

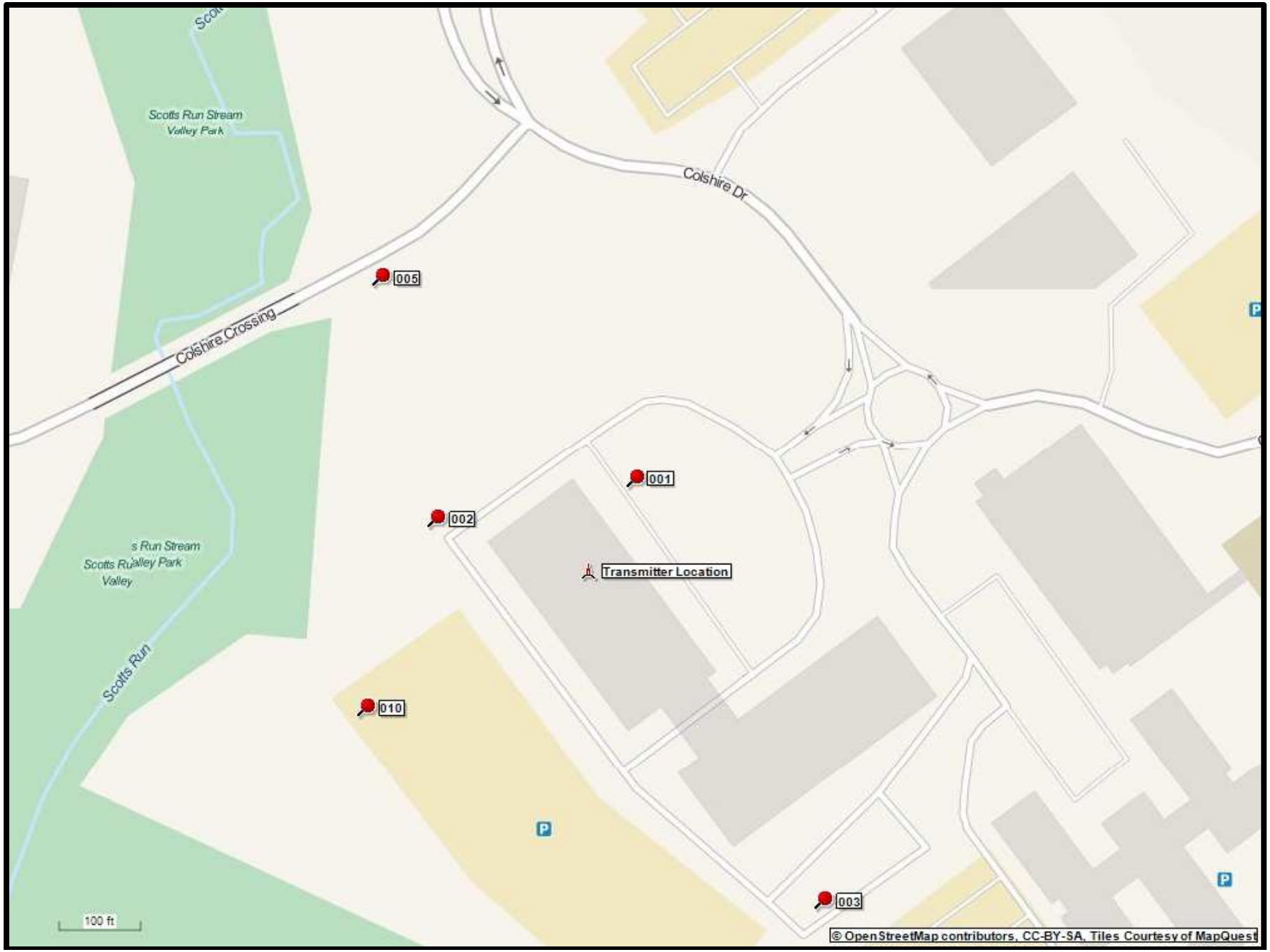


Figure 3.2-1 – Street Map Showing Measurement Location # 1

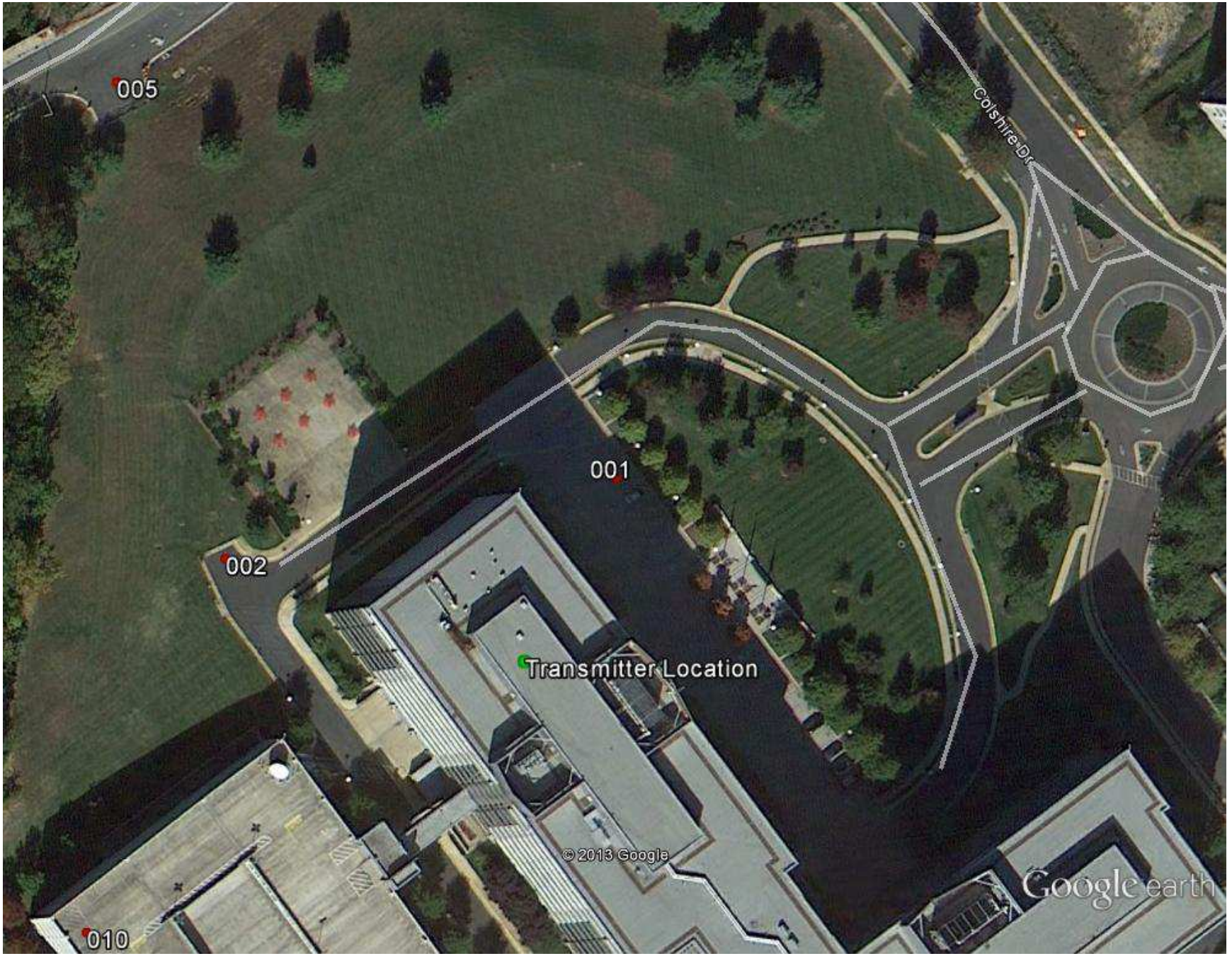


Figure 3.2-2 – Aerial Image Showing Measurement Location # 1

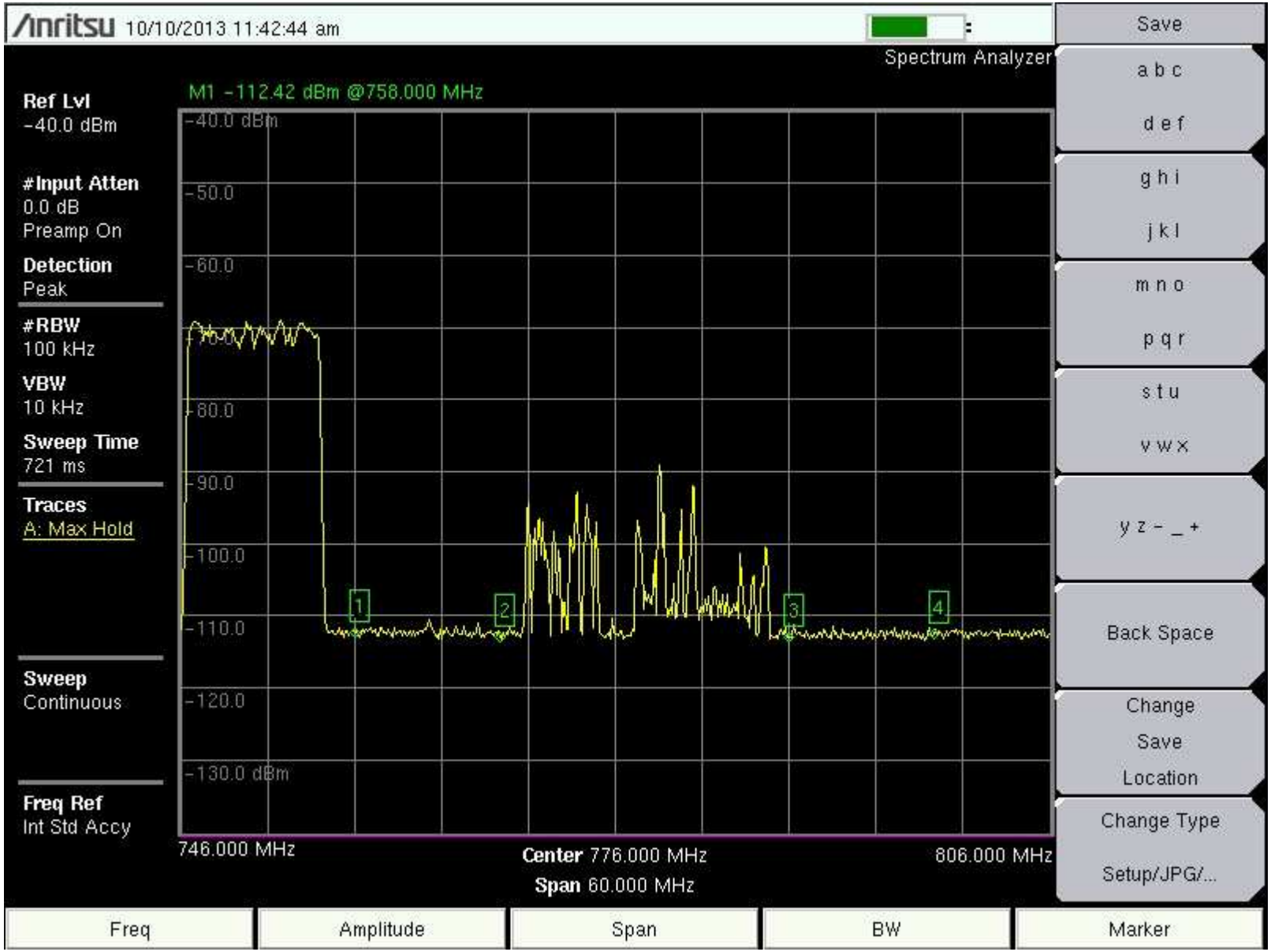


Figure 3.2-3 – Location # 1 - Spectrum Analyzer Image @ 100 kHz RBW – Upper 700 MHz Band (746-806 MHz)
Band 14 Downlink - NO SIGNAL PRESENT - Signal Level < -112 dBm (758-768 MHz) Markers 1 & 2
Band 14 Uplink - NO SIGNAL PRESENT - Signal Level < -112 dBm (788-798 MHz) Markers 3 & 4

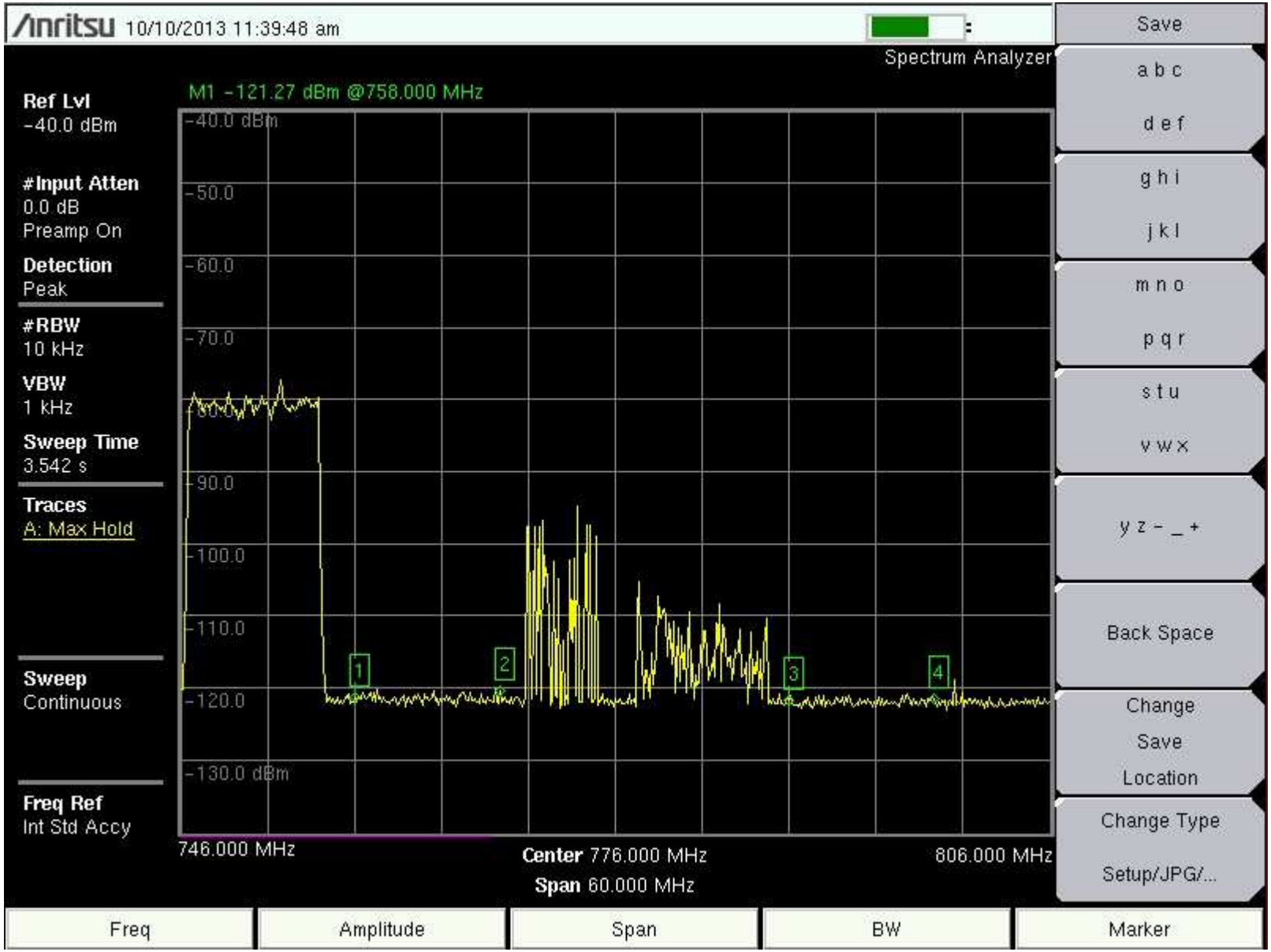


Figure 3.2-4 – Location # 1 - Spectrum Analyzer Image @ 10 kHz RBW – Upper 700 MHz Band (746-806 MHz)
Band 14 Downlink - NO SIGNAL PRESENT - Signal Level < -121 dBm (758-768 MHz) Markers 1 & 2
Band 14 Uplink - NO SIGNAL PRESENT - Signal Level < -121 dBm (788-798 MHz) Markers 3 & 4

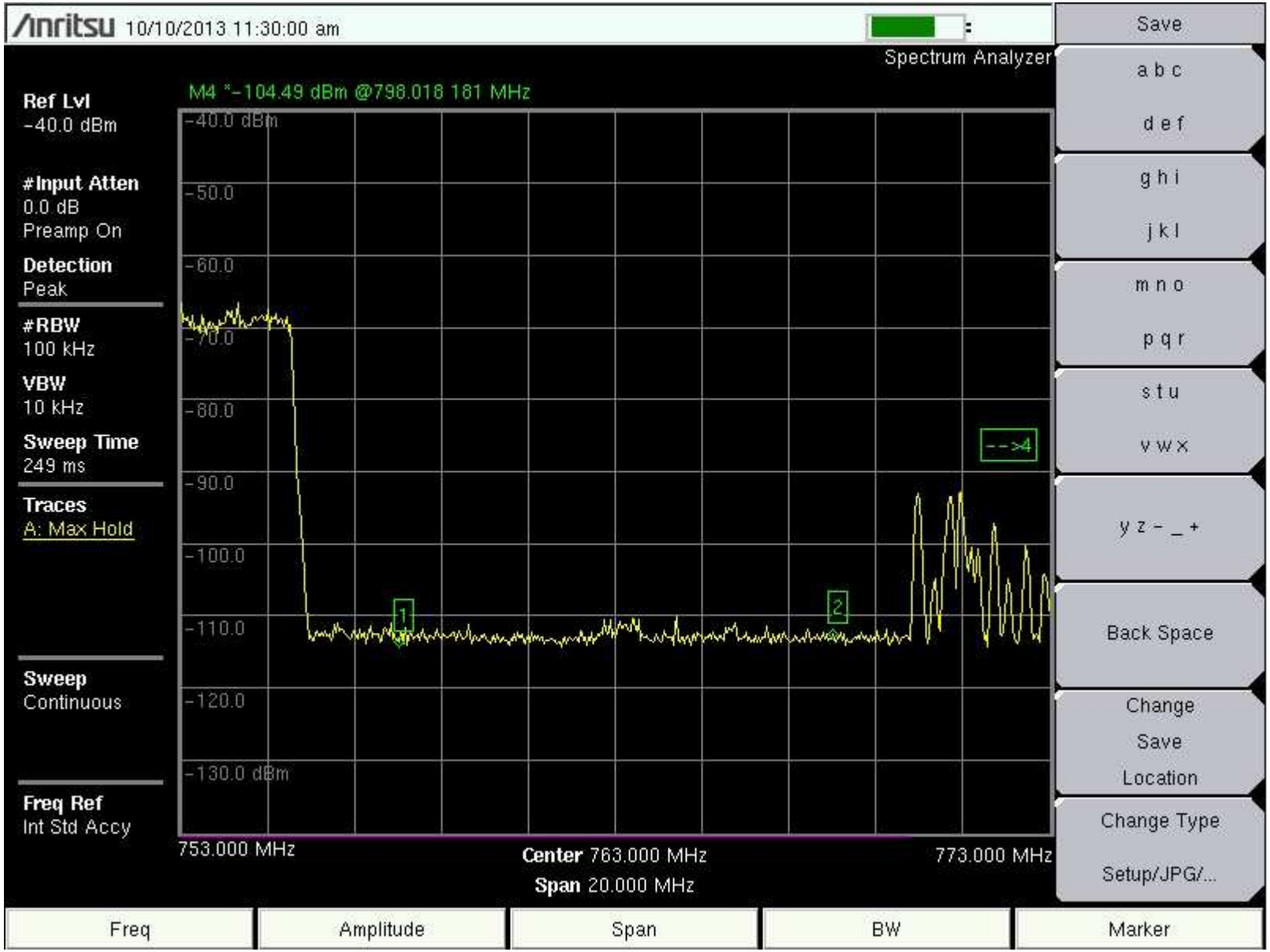


Figure 3.2-5 – Location # 1 - Spectrum Analyzer Image @ 100 kHz RBW
Band 14 Downlink - NO SIGNAL PRESENT - Signal Level < -110 dBm (758-768 MHz) Markers 1 & 2

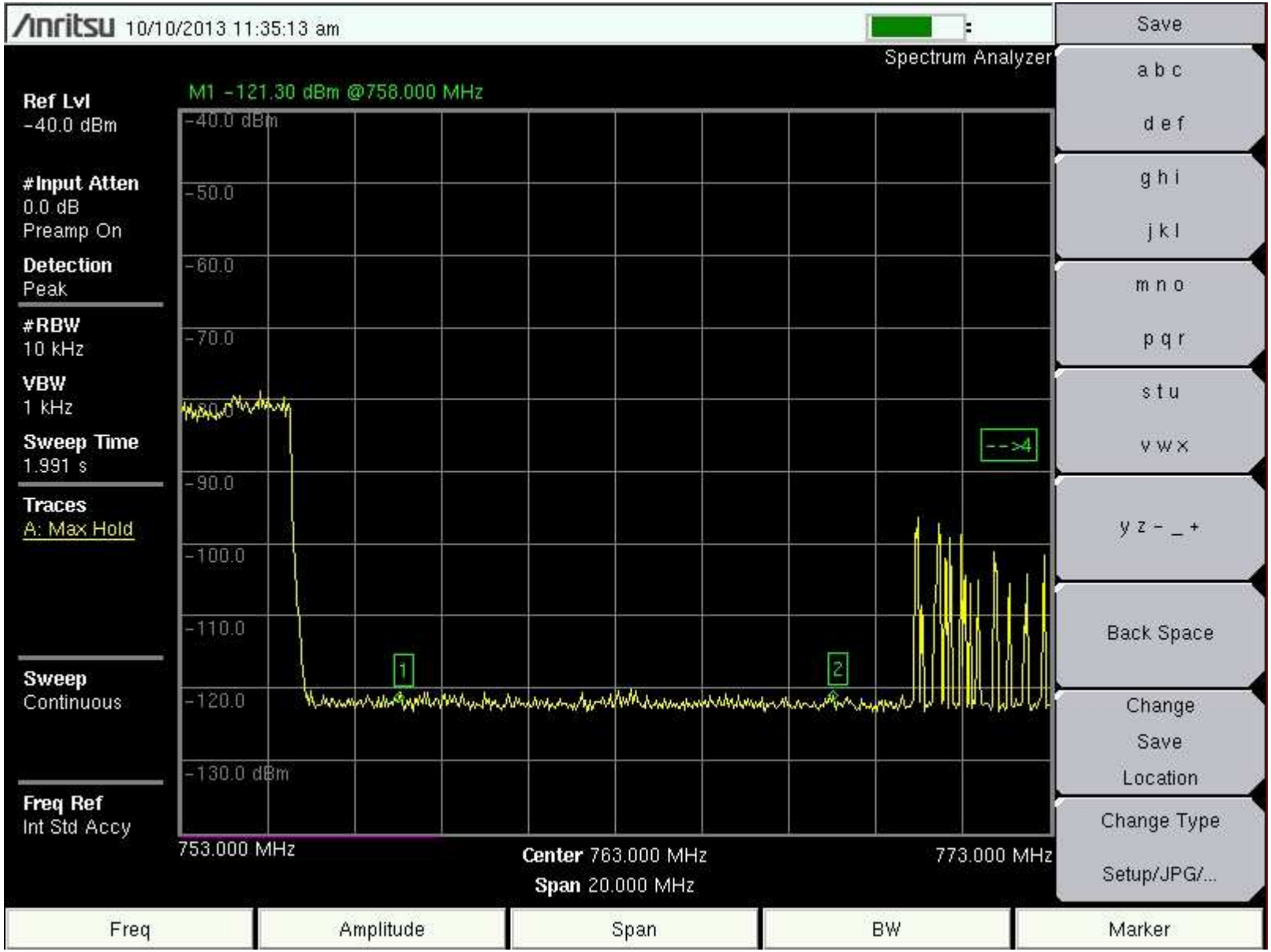


Figure 3.2-6 – Location # 1 - Spectrum Analyzer Image @ 10 kHz RBW
Band 14 Downlink - NO SIGNAL PRESENT - Signal Level < -120 dBm (758-768 MHz) Markers 1 & 2

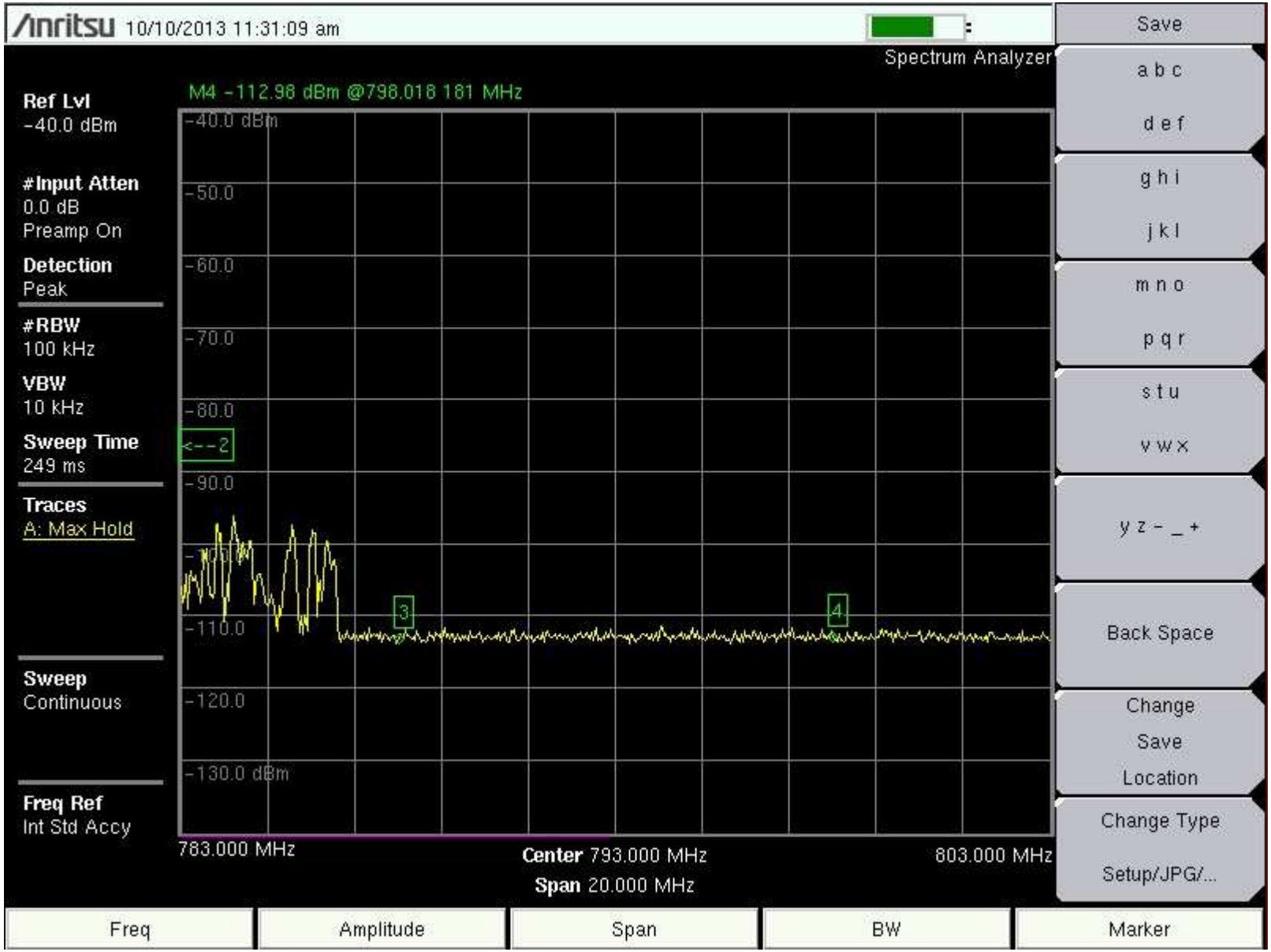


Figure 3.2-7 – Location # 1 - Spectrum Analyzer Image @ 100 kHz RBW
Band 14 Uplink - NO SIGNAL PRESENT - Signal Level < -112 dBm (788-798 MHz) Markers 3 & 4

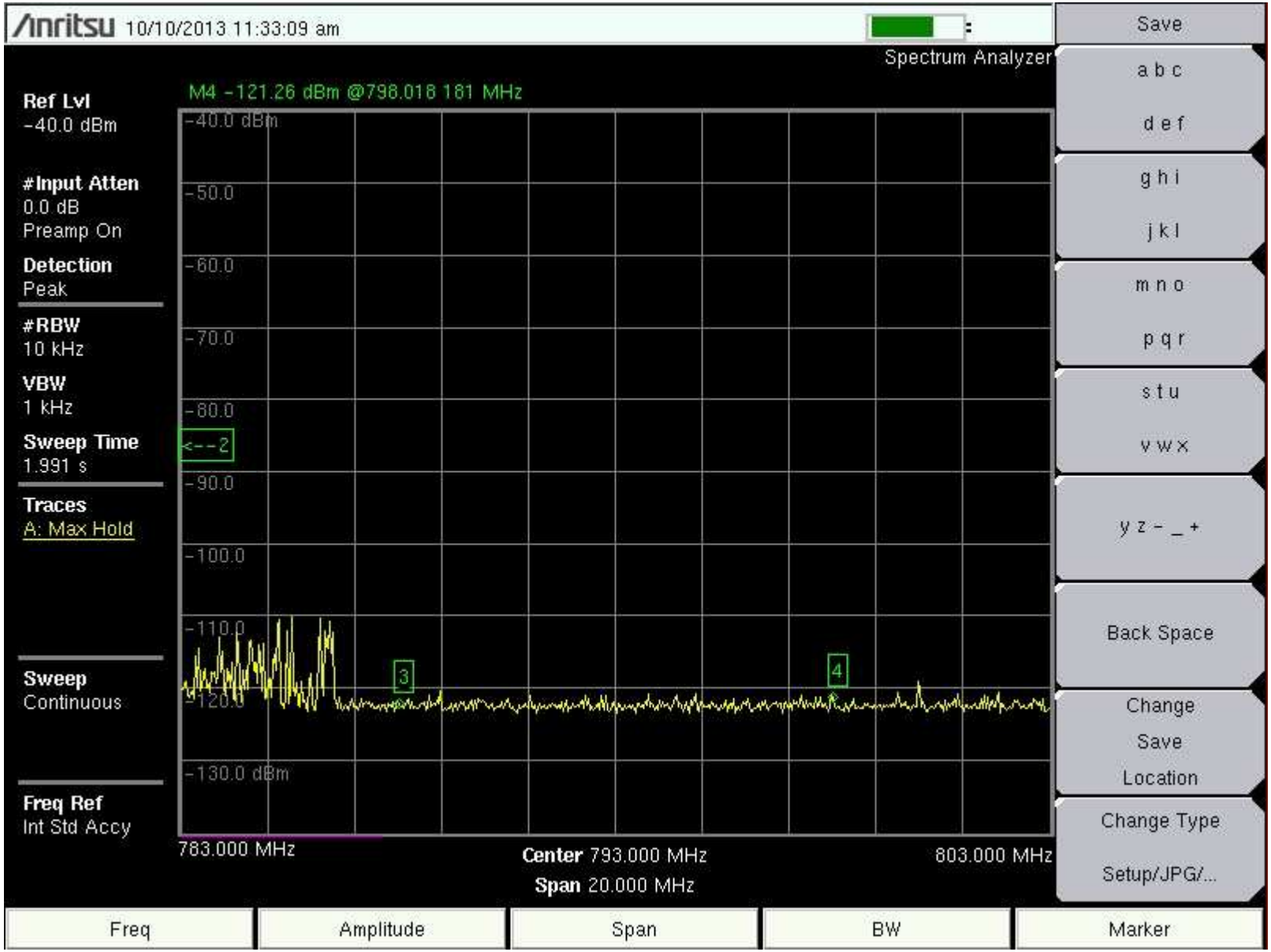


Figure 3.2-8 – Location # 1 - Spectrum Analyzer Image @ 10 kHz RBW
Band 14 Uplink - NO SIGNAL PRESENT - Signal Level < -121 dBm (788-798 MHz) Markers 3 & 4

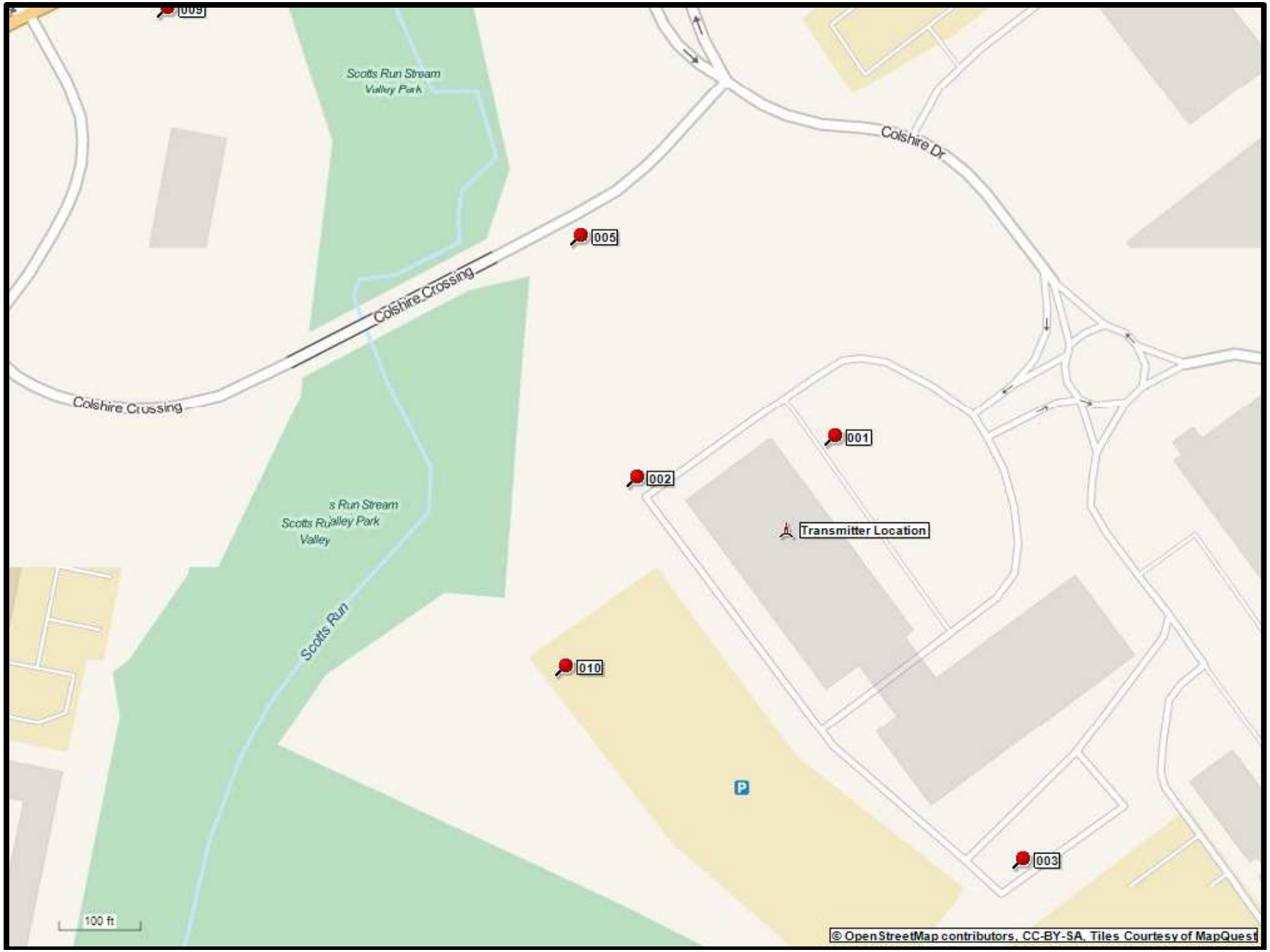


Figure 3.3-1 – Street Map Showing Measurement Location # 2

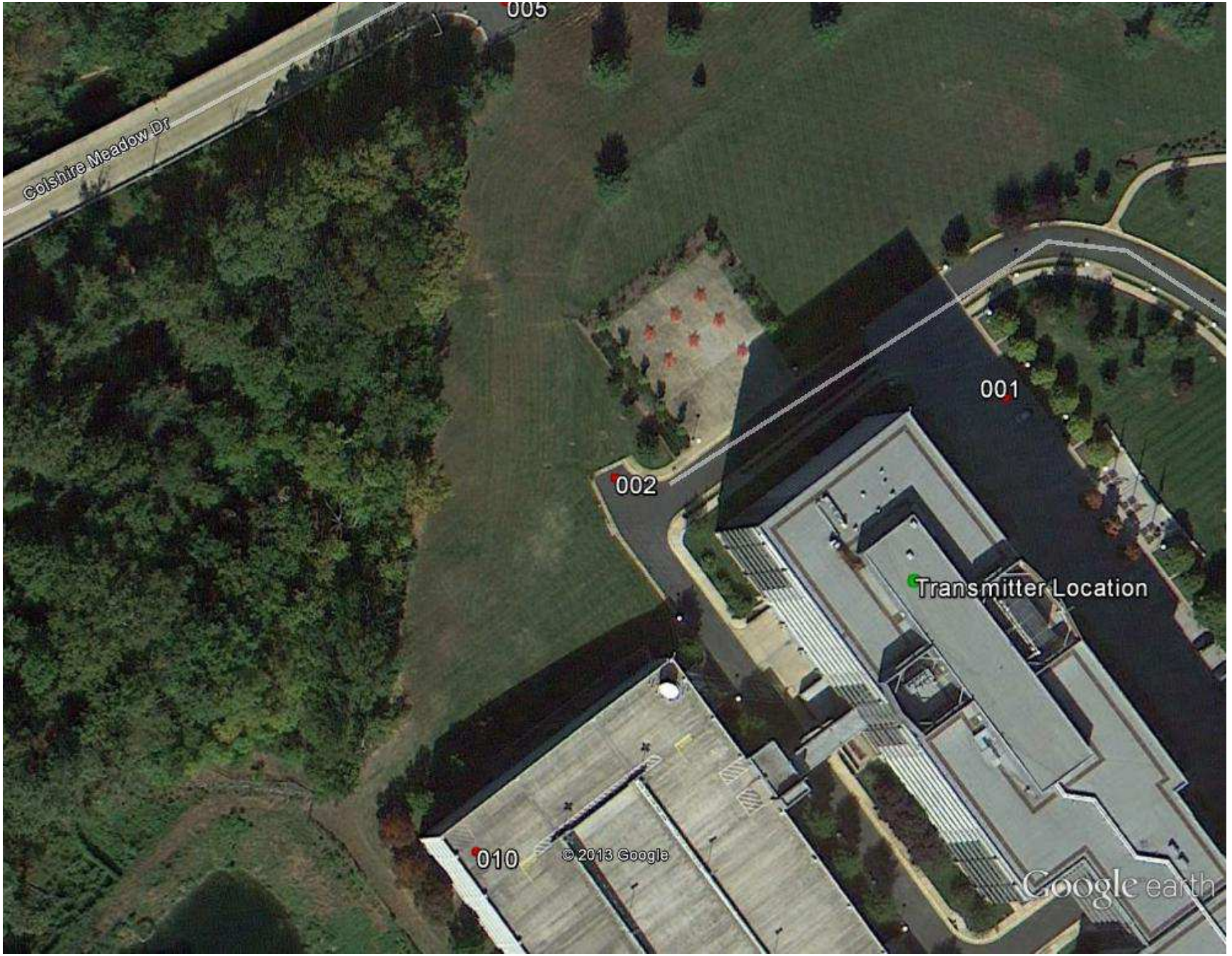


Figure 3.3-2 – Aerial Image Showing Measurement Location # 2

Figure 3.3-3 – Location # 2 - Spectrum Analyzer Image @ 100 kHz RBW – Upper 700 MHz Band (746-806 MHz)
Band 14 Downlink - NO SIGNAL PRESENT - Signal Level < -112 dBm (758-768 MHz) Markers 1 & 2
Band 14 Uplink - NO SIGNAL PRESENT - Signal Level < -112 dBm (788-798 MHz) Markers 3 & 4

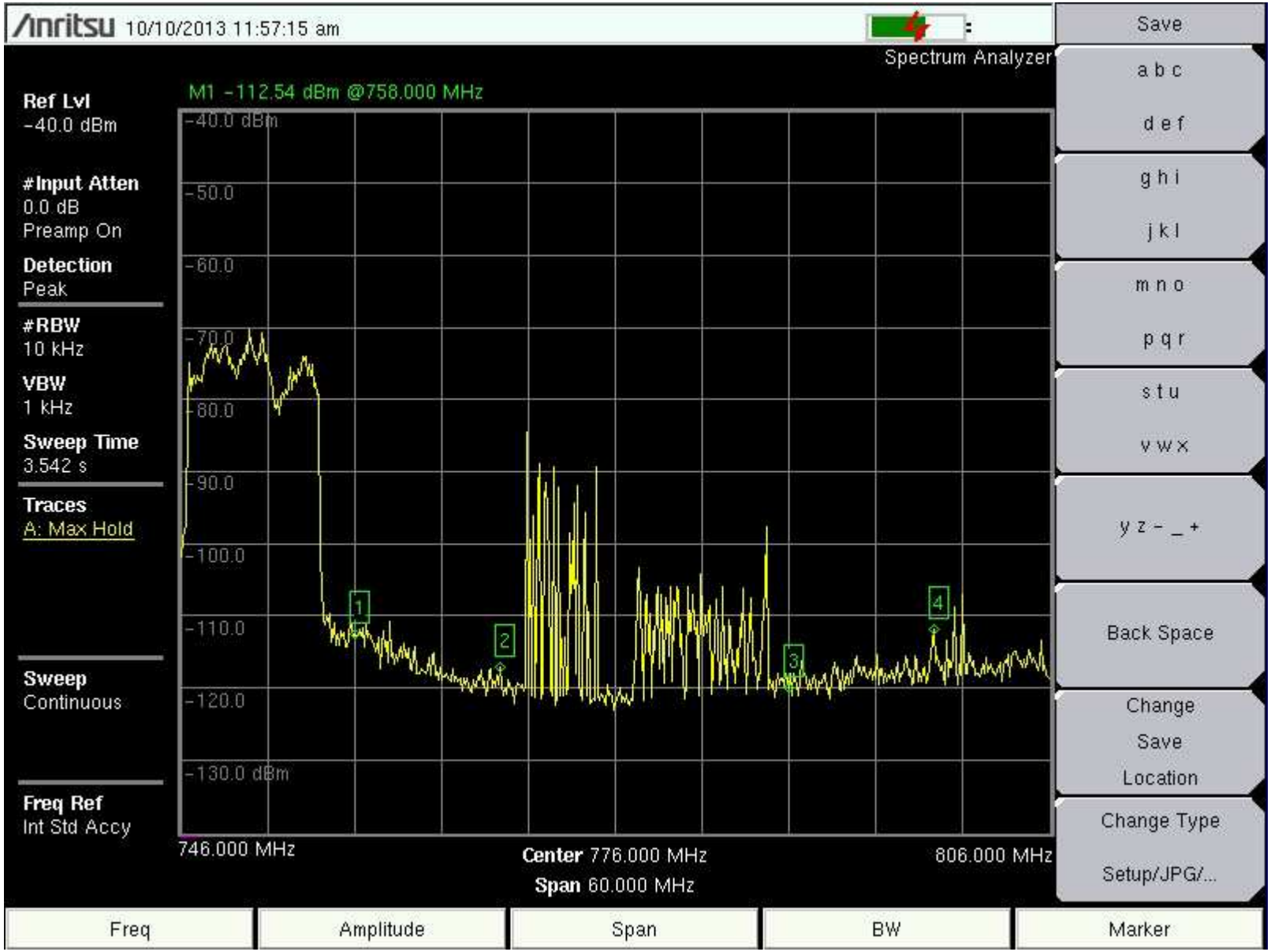


Figure 3.3-4 – Location # 2 - Spectrum Analyzer Image @ 10 kHz RBW – Upper 700 MHz Band (746-806 MHz)
Band 14 Downlink - NO SIGNAL PRESENT - Signal Level < -112 dBm (758-768 MHz) Markers 1 & 2
Band 14 Uplink - NO SIGNAL PRESENT - Signal Level < -112 dBm (788-798 MHz) Markers 3 & 4

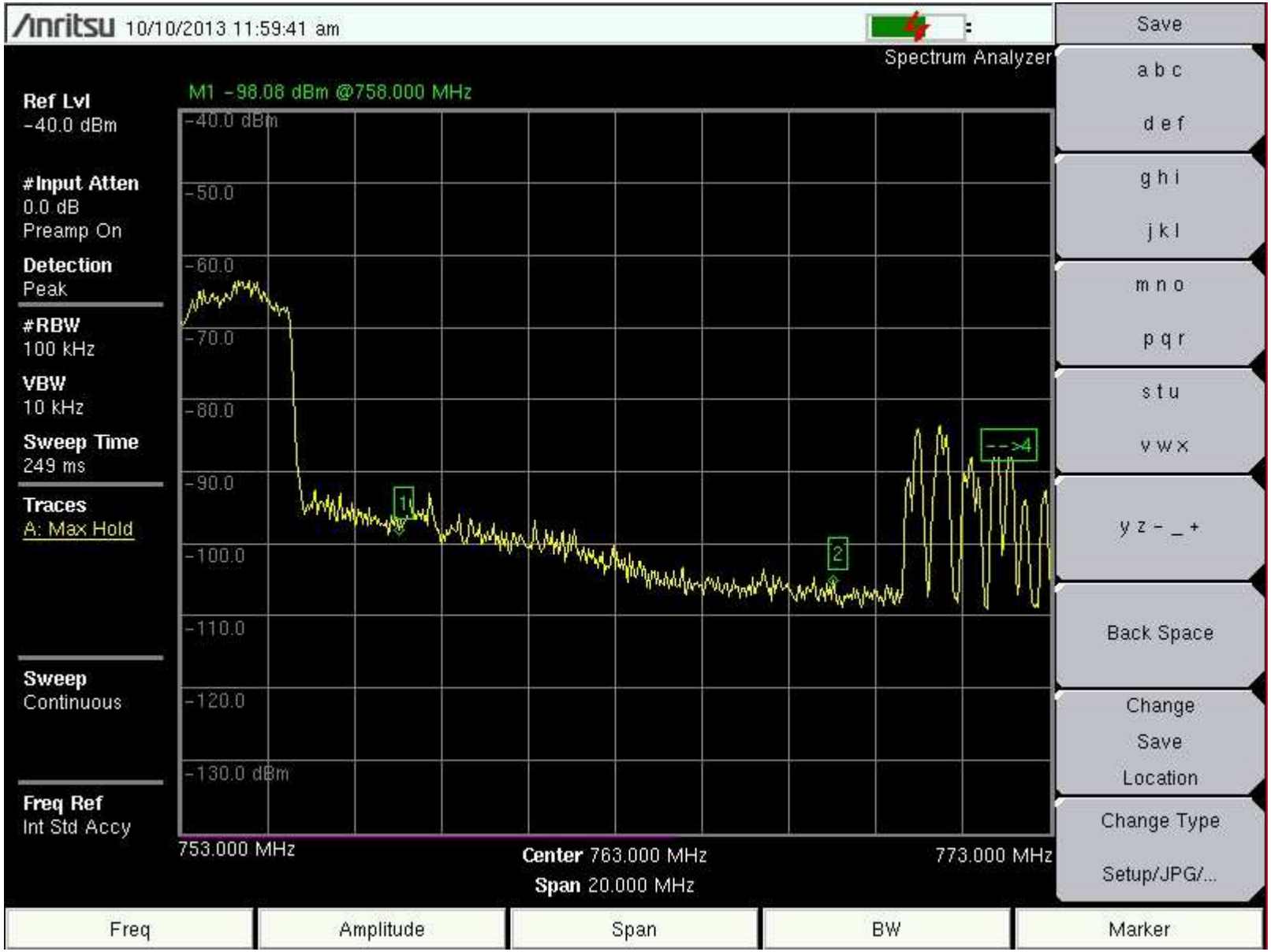


Figure 3.3-5 – Location # 2 - Spectrum Analyzer Image @ 100 kHz RBW
Band 14 Downlink - NO SIGNAL PRESENT - Signal Level < -95 dBm (758-768 MHz) Markers 1 & 2

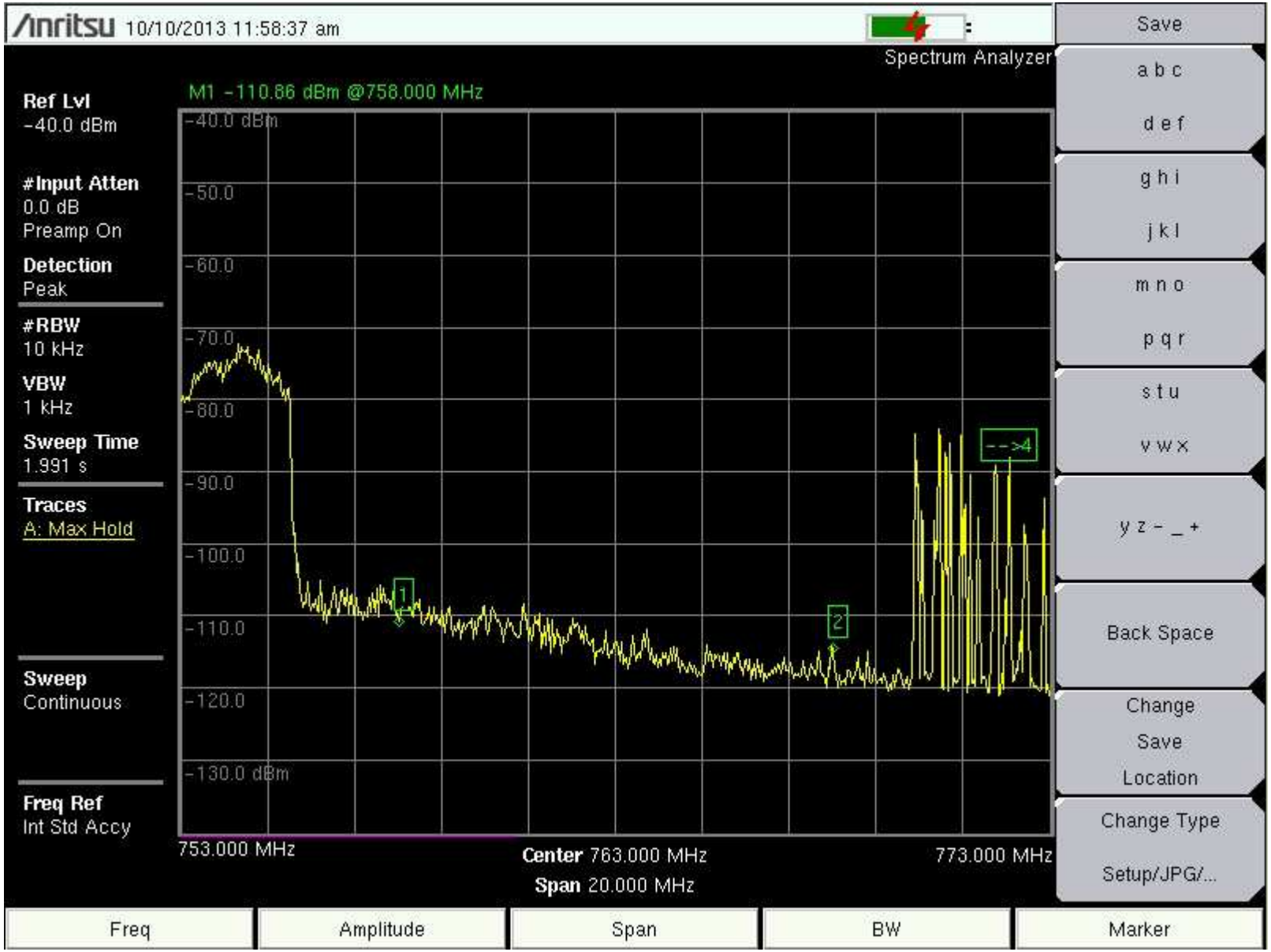


Figure 3.3-6 – Location # 2 - Spectrum Analyzer Image @ 10 kHz RBW
Band 14 Downlink - NO SIGNAL PRESENT - Signal Level < -95 dBm (758-768 MHz) Markers 1 & 2

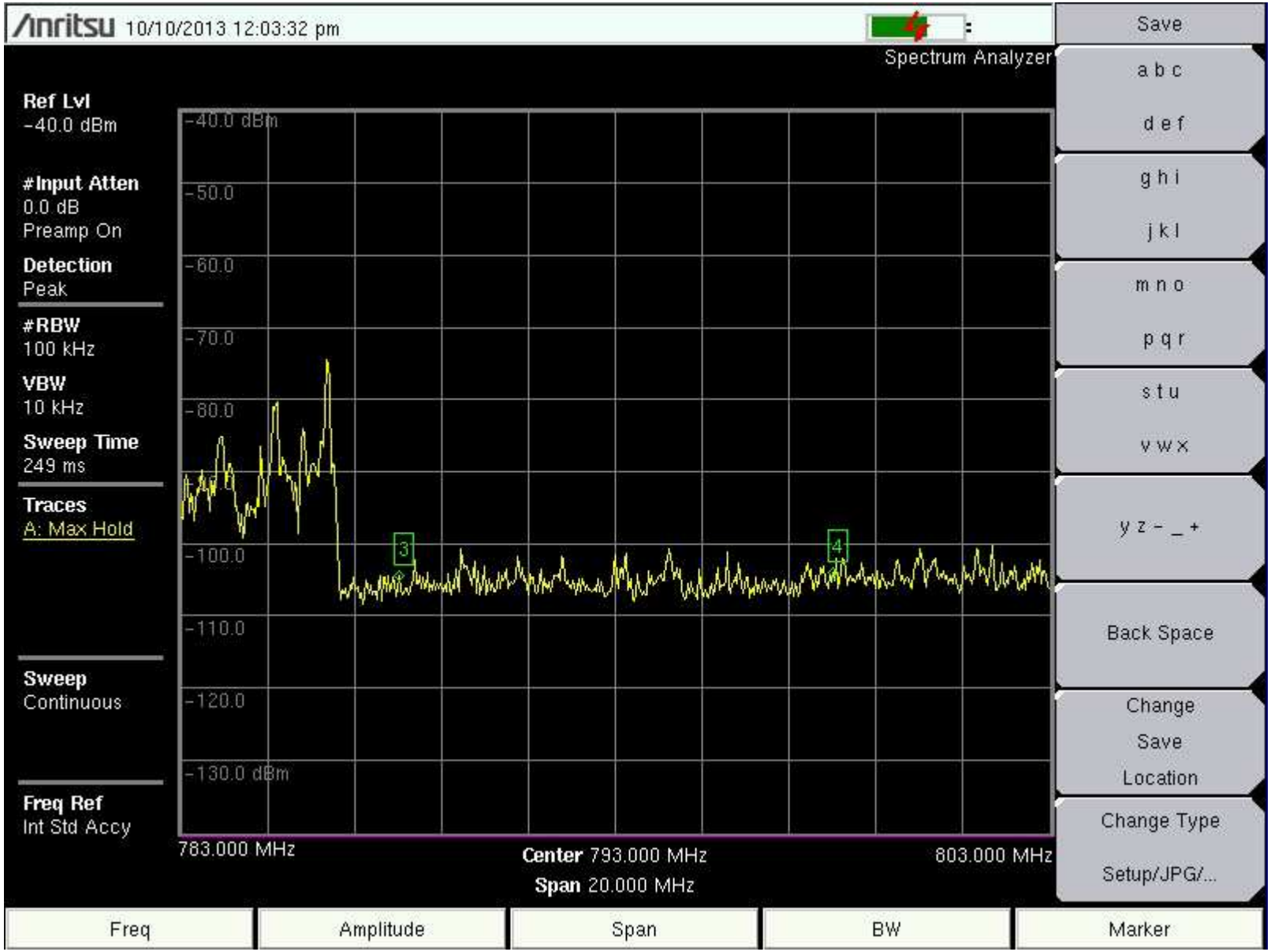


Figure 3.3-7 – Location # 2 - Spectrum Analyzer Image @ 100 kHz RBW
Band 14 Uplink - NO SIGNAL PRESENT - Signal Level < -112 dBm (788-798 MHz) Markers 3 & 4

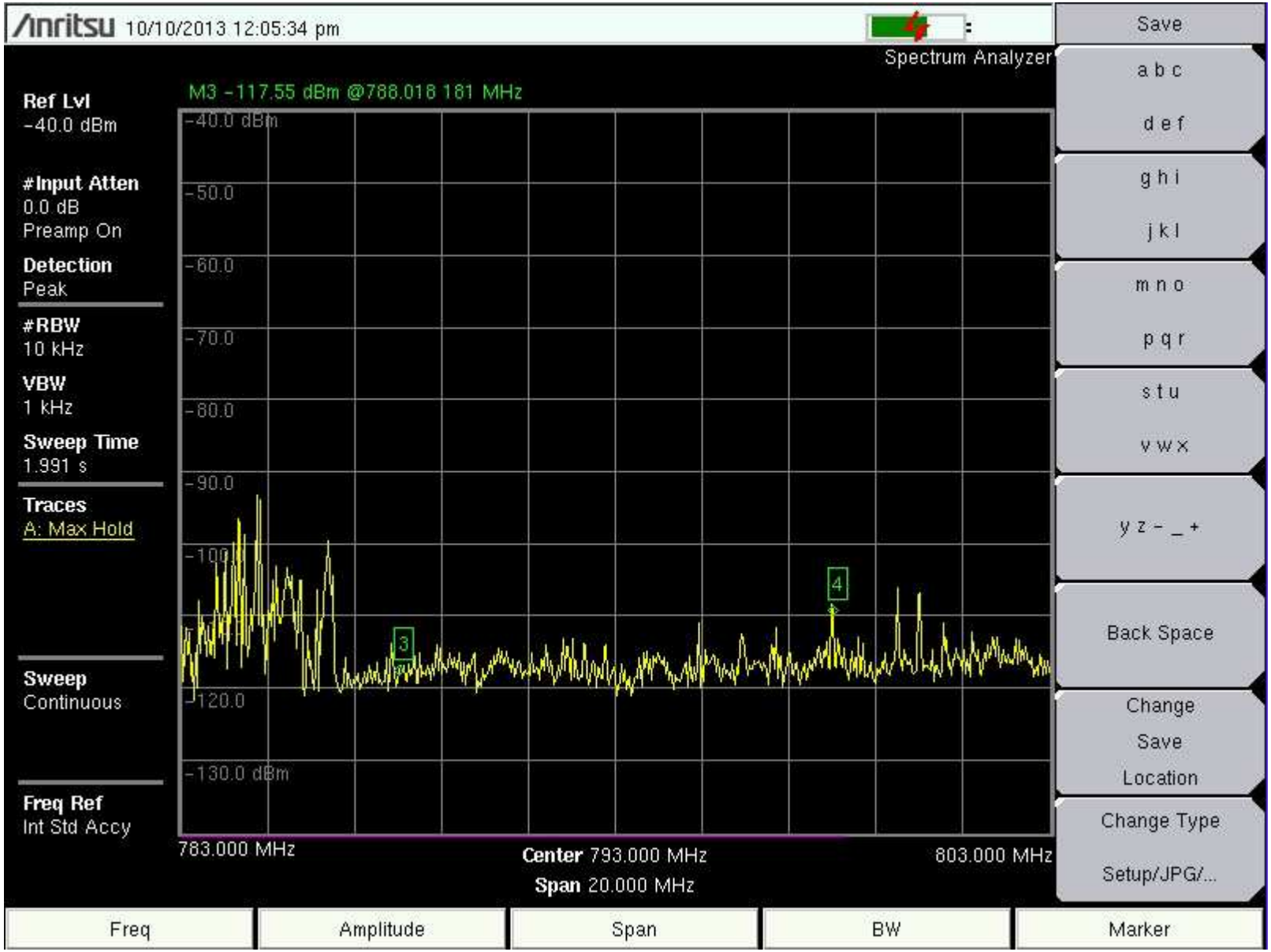


Figure 3.3-8 – Location # 2 - Spectrum Analyzer Image @ 10 kHz RBW
Band 14 Uplink - NO SIGNAL PRESENT - Signal Level < -110 dBm (788-798 MHz) Markers 3 & 4

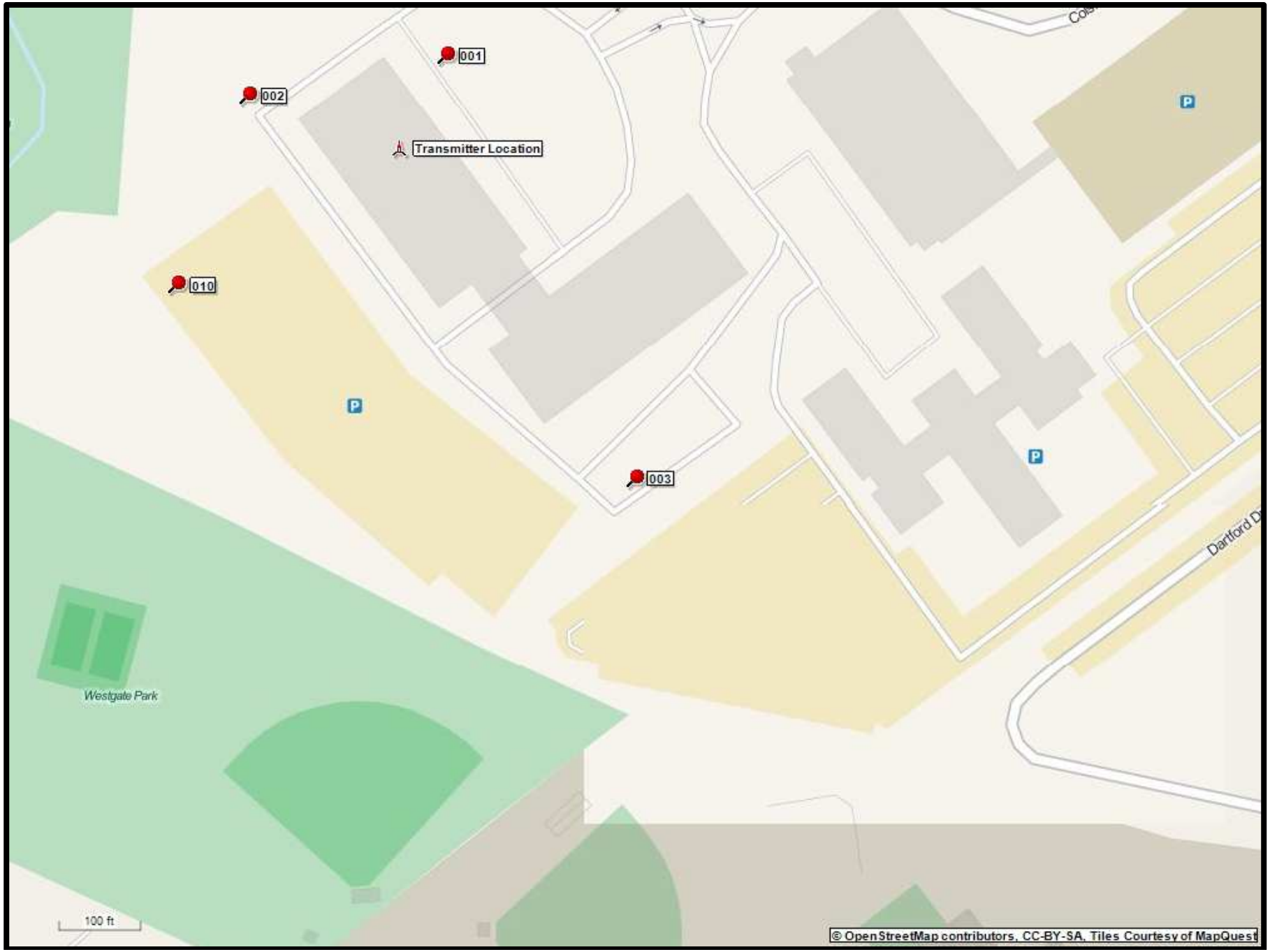


Figure 3.4-1 – Street Map Showing Measurement Location # 3

Figure 3.4-2 – Aerial Image Showing Measurement Location # 3

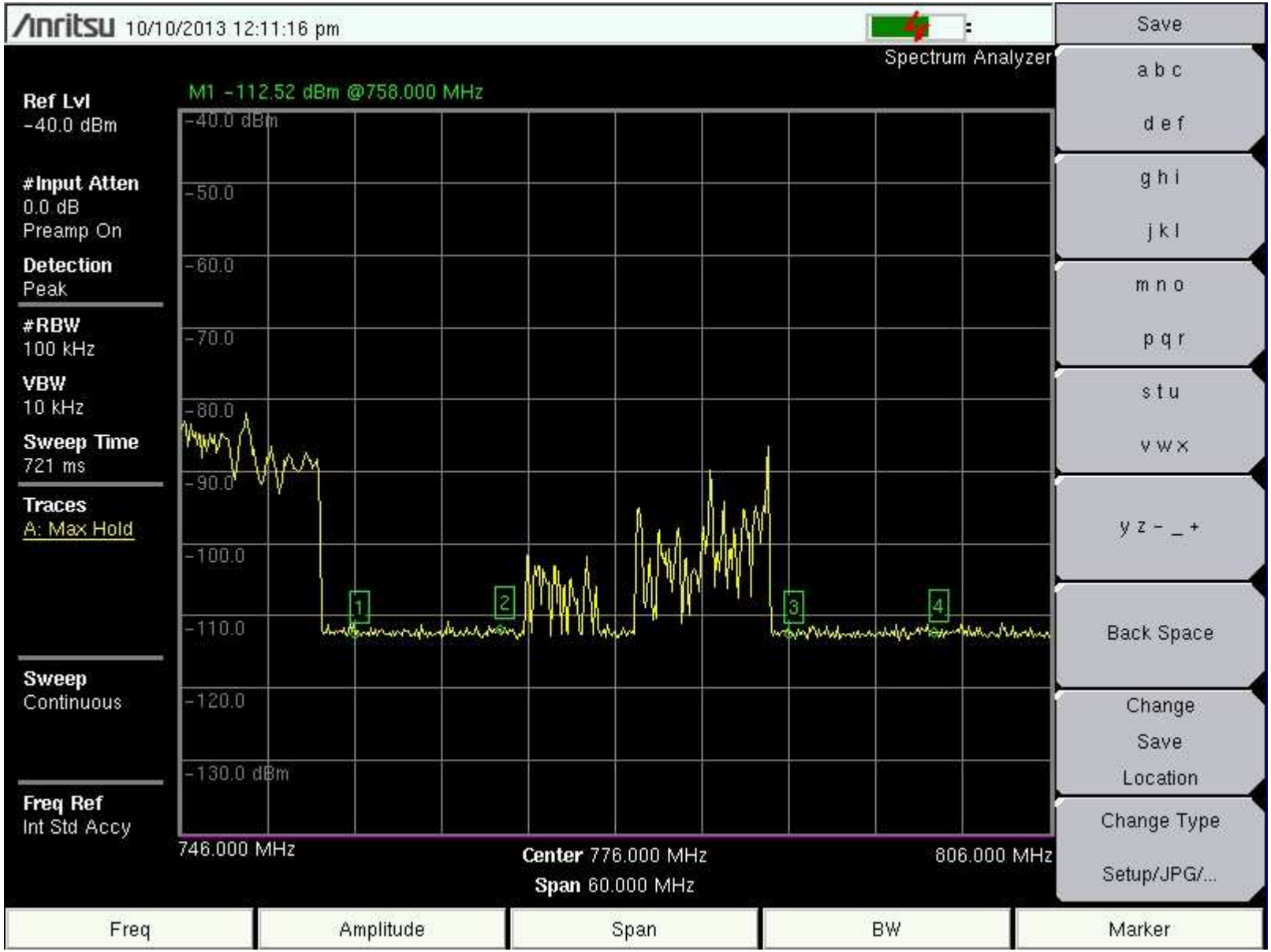


Figure 3.4-3 – Location # 3 - Spectrum Analyzer Image @ 100 kHz RBW – Upper 700 MHz Band (746-806 MHz)
Band 14 Downlink - NO SIGNAL PRESENT - Signal Level < -112 dBm (758-768 MHz) Markers 1 & 2
Band 14 Uplink - NO SIGNAL PRESENT - Signal Level < -112 dBm (788-798 MHz) Markers 3 & 4

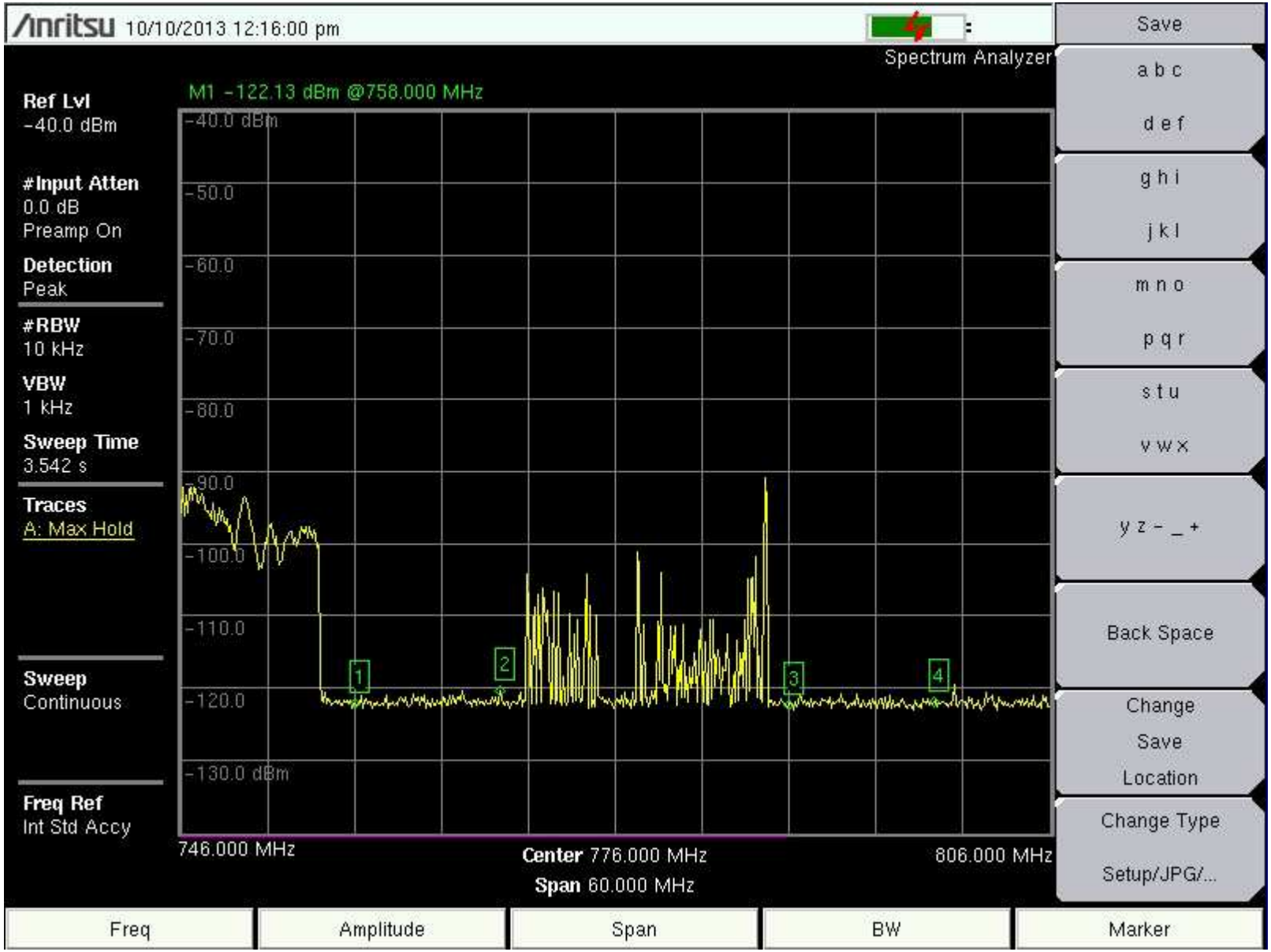


Figure 3.4-4 – Location # 3 - Spectrum Analyzer Image @ 10 kHz RBW – Upper 700 MHz Band (746-806 MHz)
Band 14 Downlink - NO SIGNAL PRESENT - Signal Level < -121 dBm (758-768 MHz) Markers 1 & 2
Band 14 Uplink - NO SIGNAL PRESENT - Signal Level < -121 dBm (788-798 MHz) Markers 3 & 4

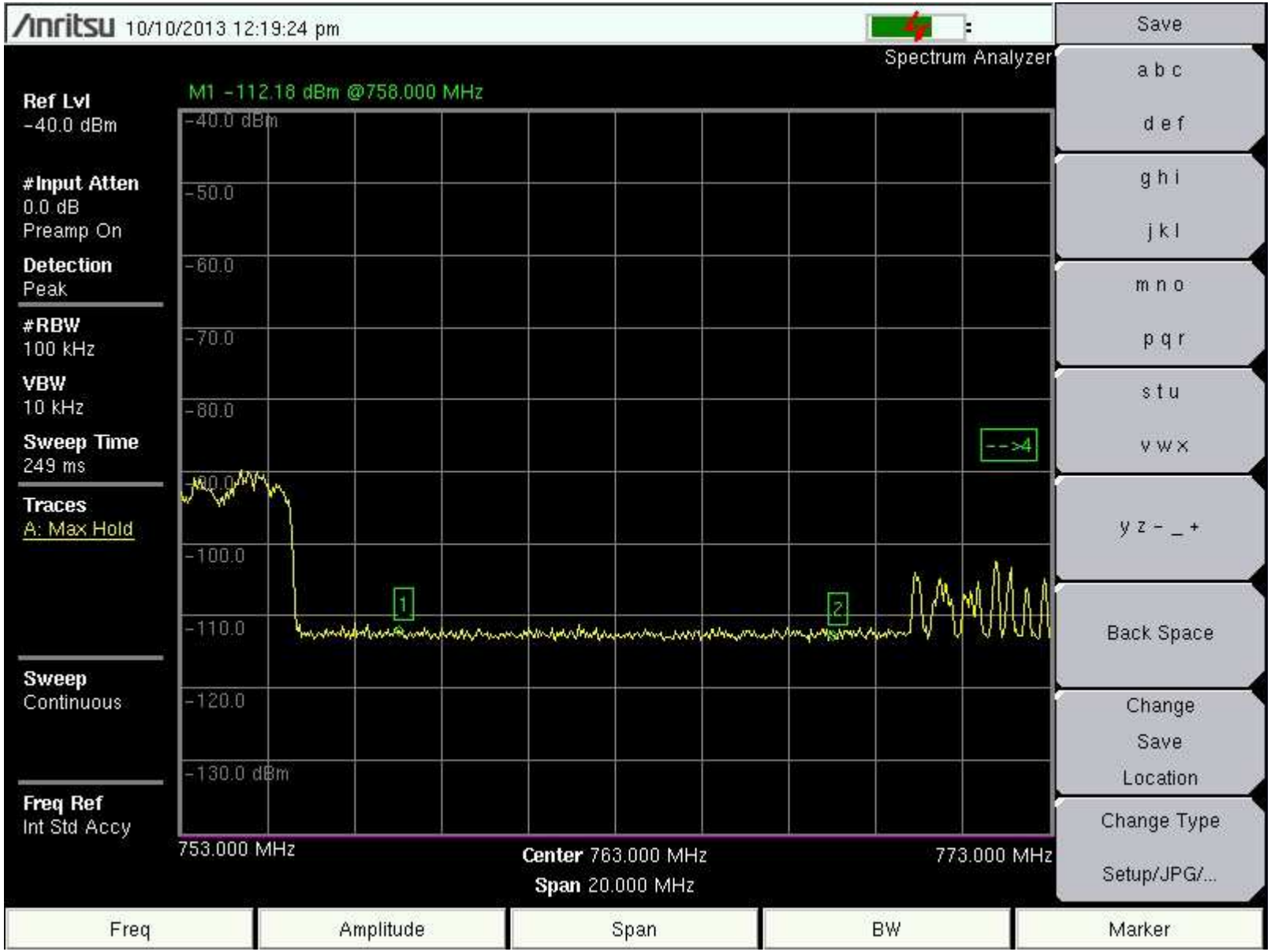


Figure 3.4-5 – Location # 3 - Spectrum Analyzer Image @ 100 kHz RBW
Band 14 Downlink - NO SIGNAL PRESENT - Signal Level < -112 dBm (758-768 MHz) Markers 1 & 2

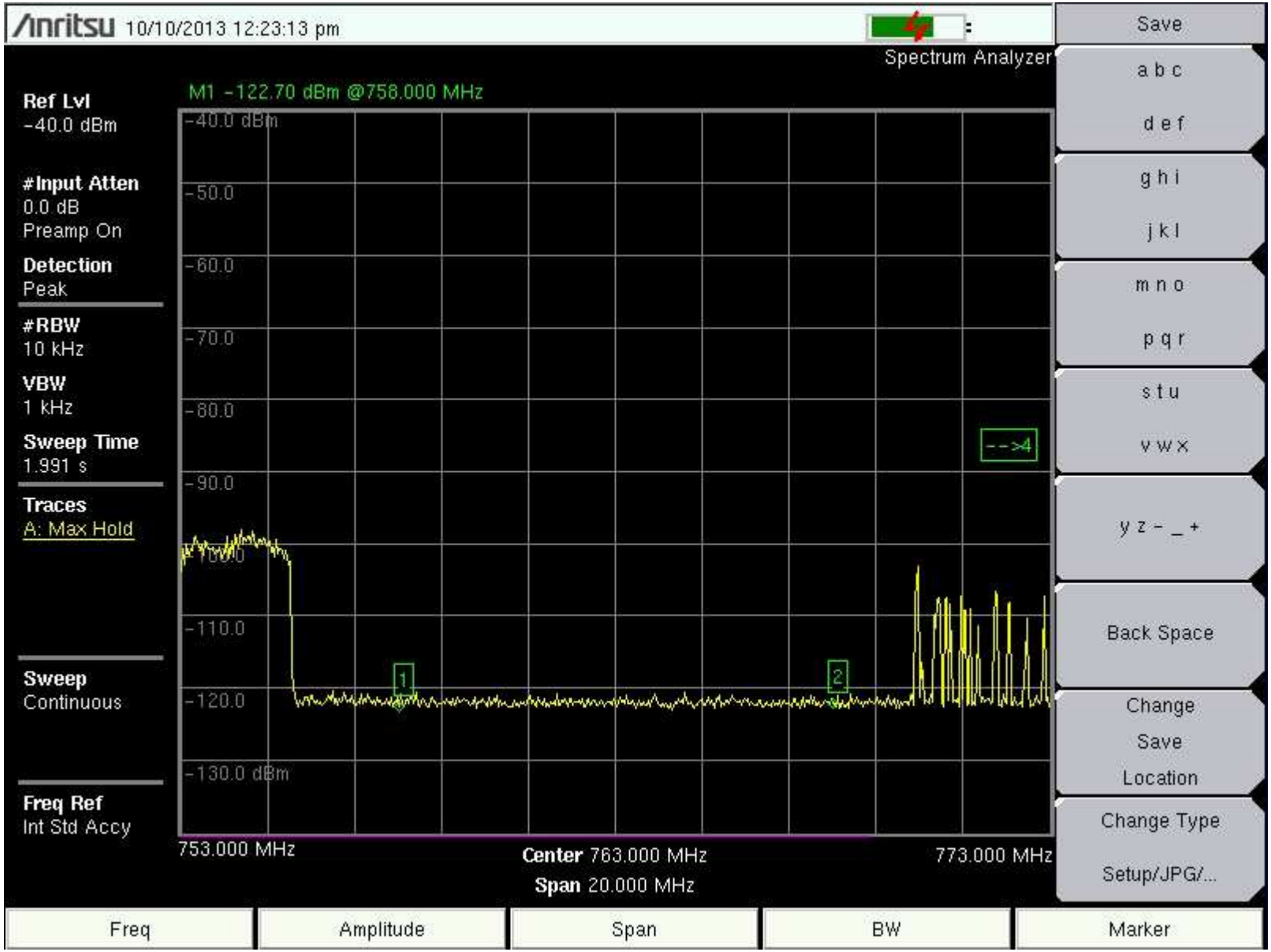


Figure 3.4-6 – Location # 3 - Spectrum Analyzer Image @ 10 kHz RBW
Band 14 Downlink - NO SIGNAL PRESENT - Signal Level < -121 dBm (758-768 MHz) Markers 1 & 2

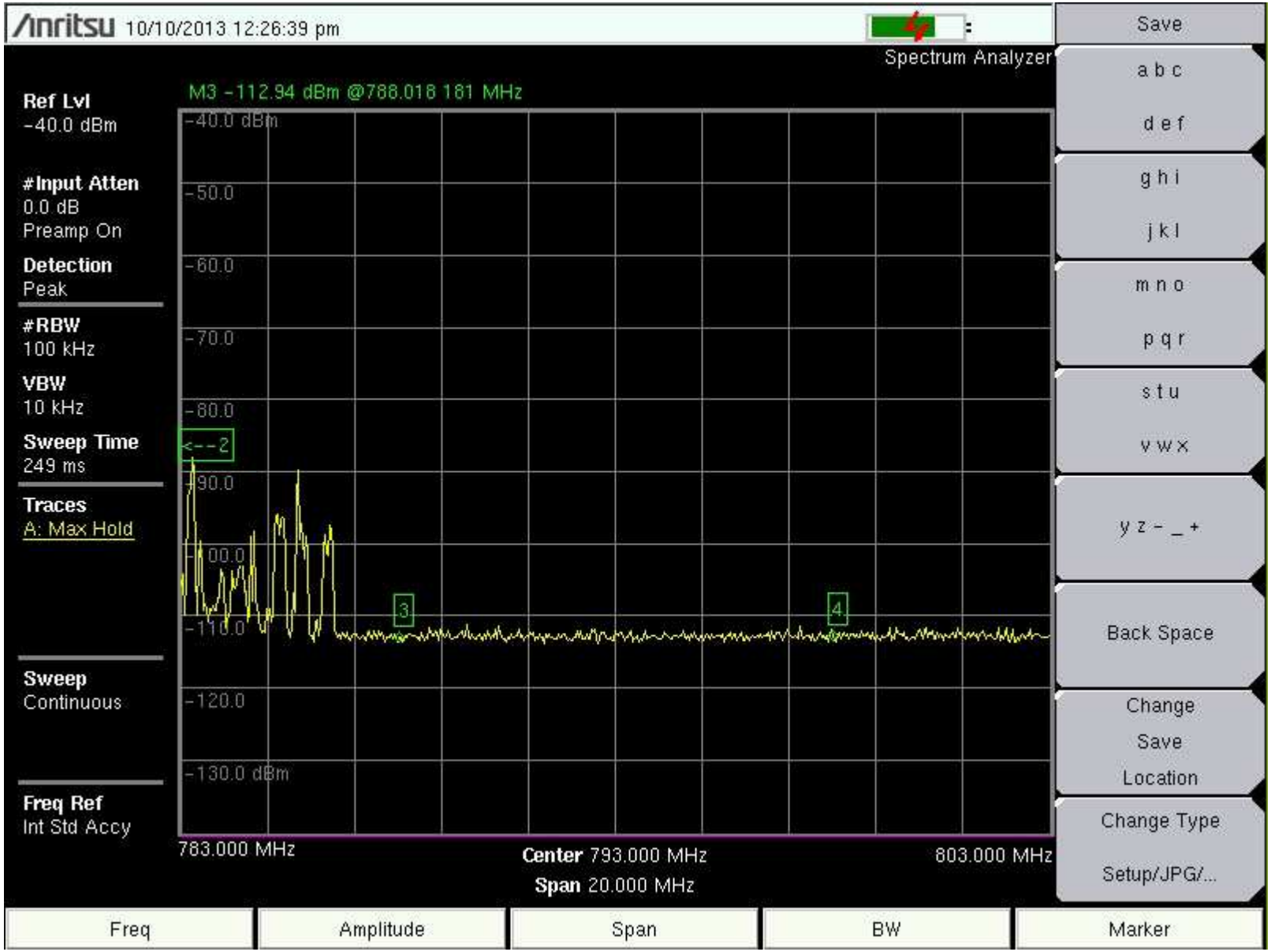


Figure 3.4-7 – Location # 3 - Spectrum Analyzer Image @ 100 kHz RBW
Band 14 Uplink - NO SIGNAL PRESENT - Signal Level < -112 dBm (788-798 MHz) Markers 3 & 4

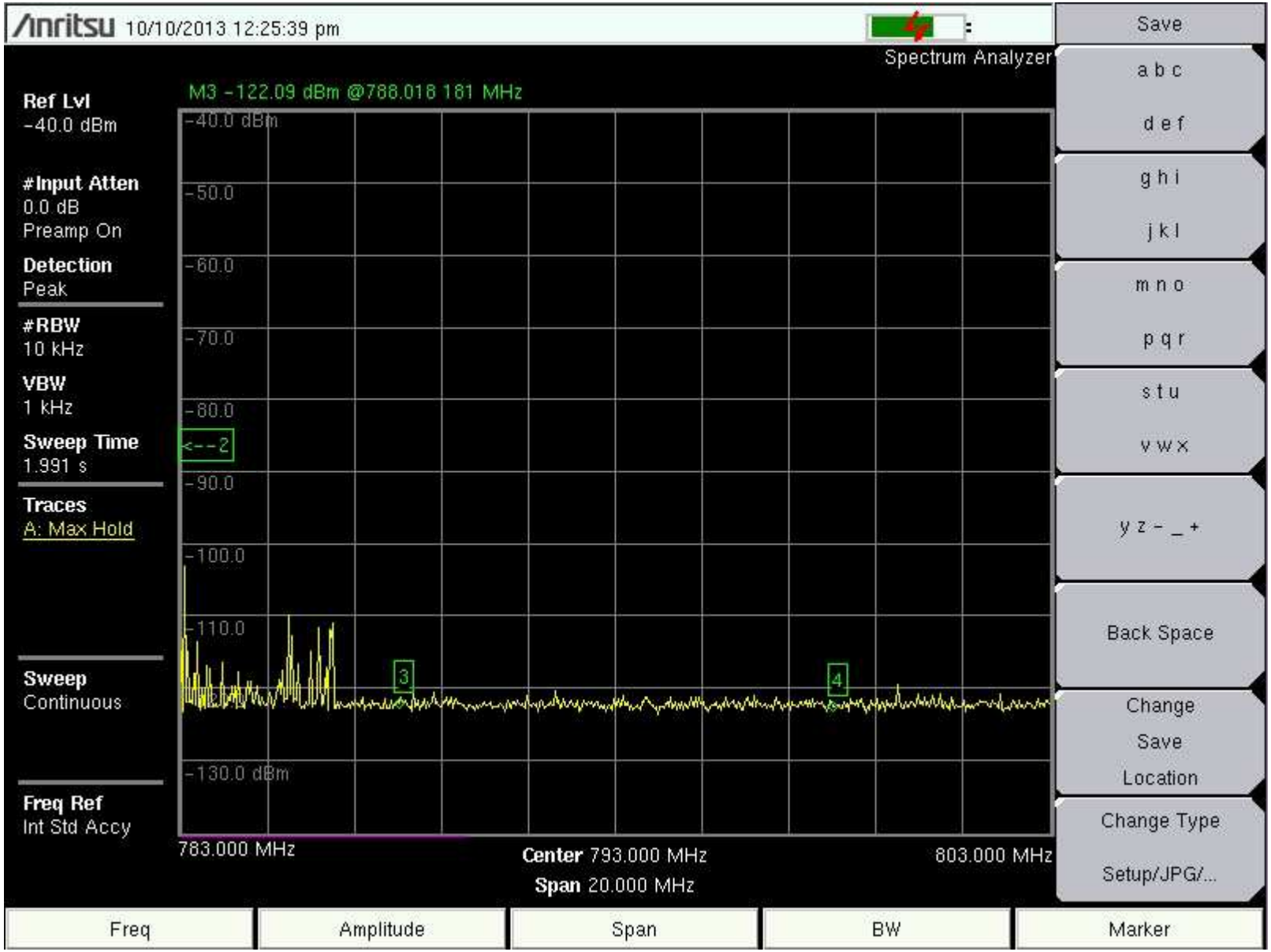


Figure 3.4-8 – Location # 3 - Spectrum Analyzer Image @ 10 kHz RBW
Band 14 Uplink - NO SIGNAL PRESENT - Signal Level < -121 dBm (788-798 MHz) Markers 3 & 4

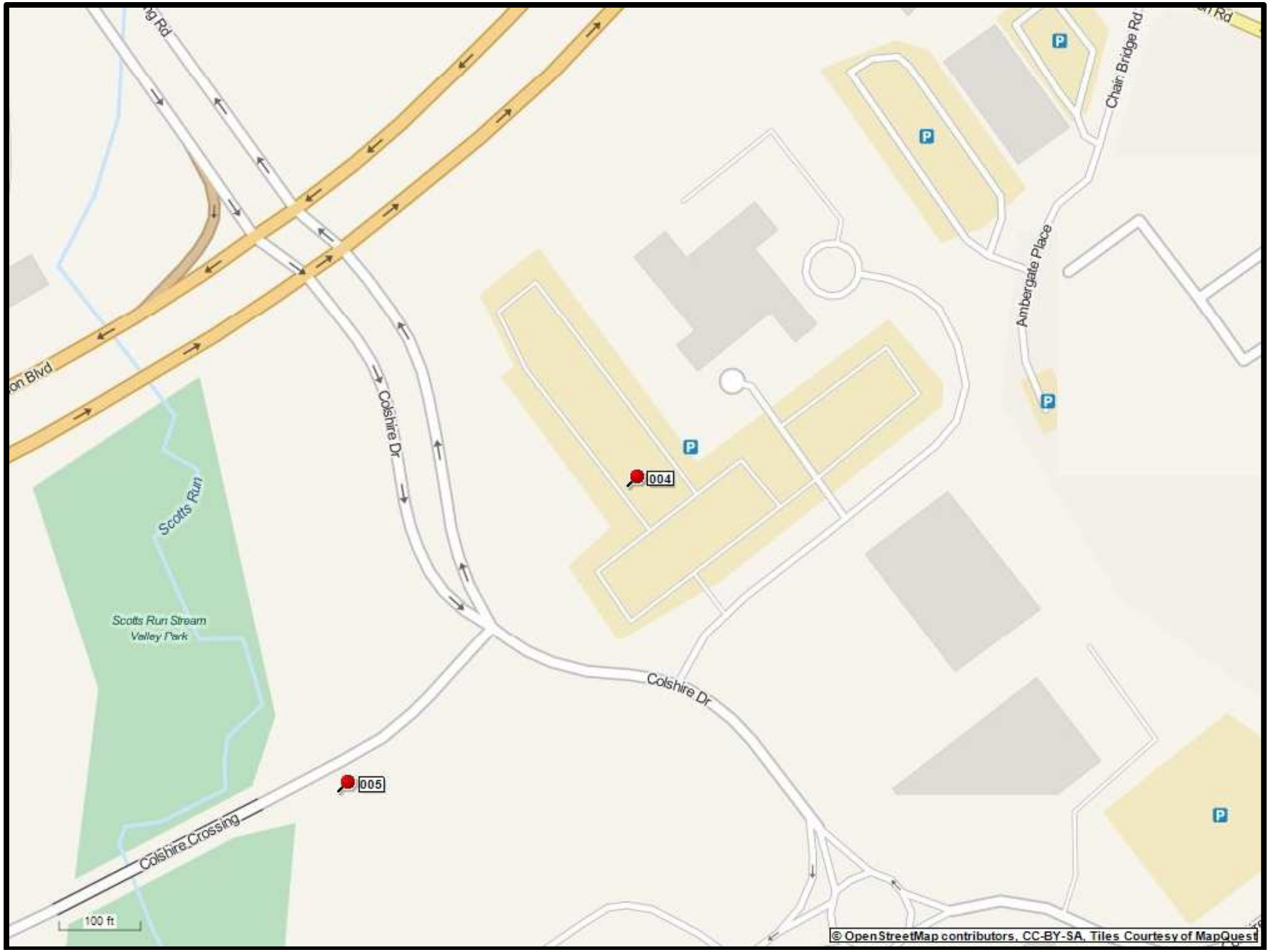


Figure 3.5-1 – Street Map Showing Measurement Location # 4

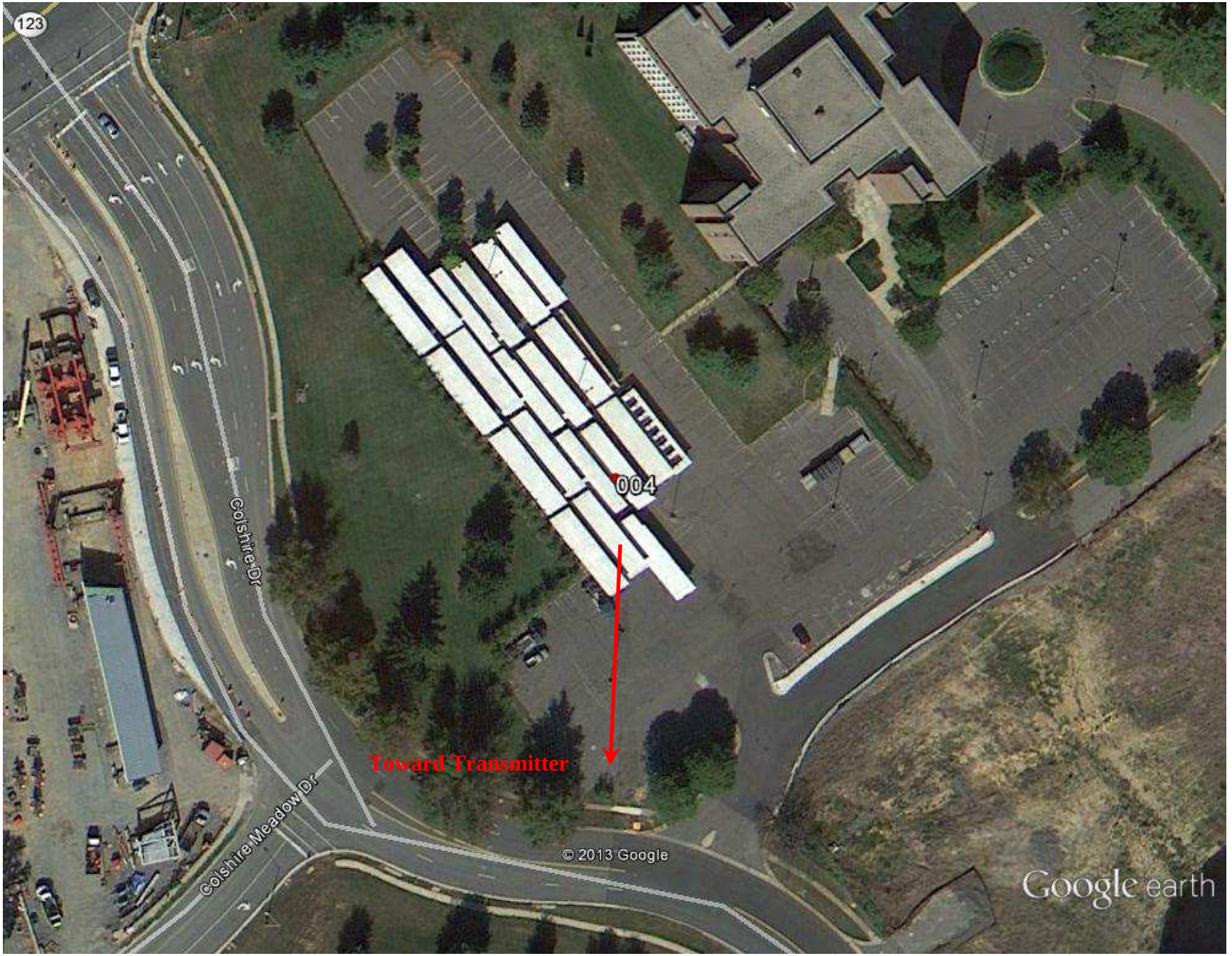


Figure 3.5-2 – Aerial Image Showing Measurement Location # 4

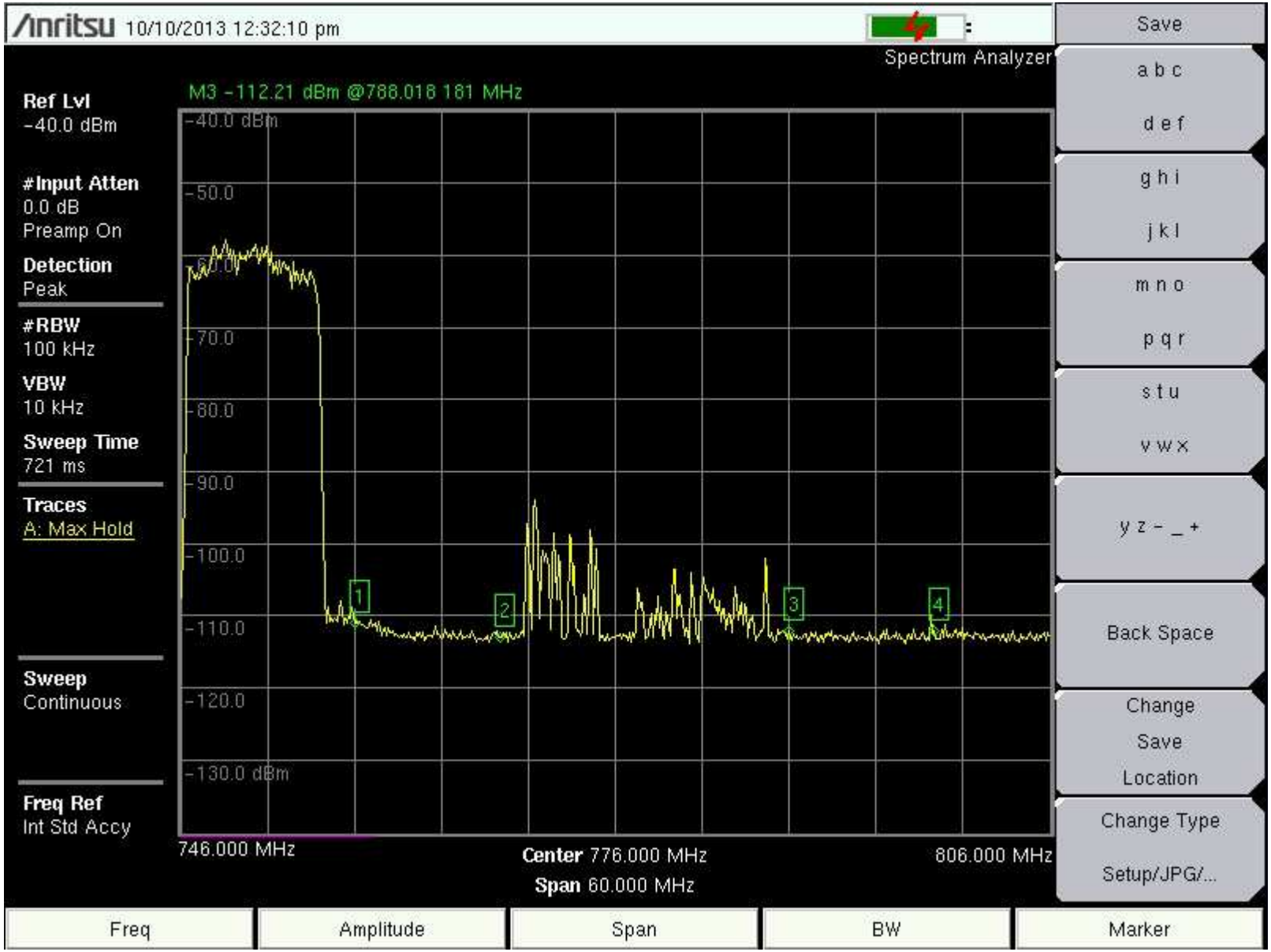


Figure 3.5-3 – Location # 4 - Spectrum Analyzer Image @ 100 kHz RBW – Upper 700 MHz Band (746-806 MHz)
Band 14 Downlink - NO SIGNAL PRESENT - Signal Level < -110 dBm (758-768 MHz) Markers 1 & 2
Band 14 Uplink - NO SIGNAL PRESENT - Signal Level < -112 dBm (788-798 MHz) Markers 3 & 4

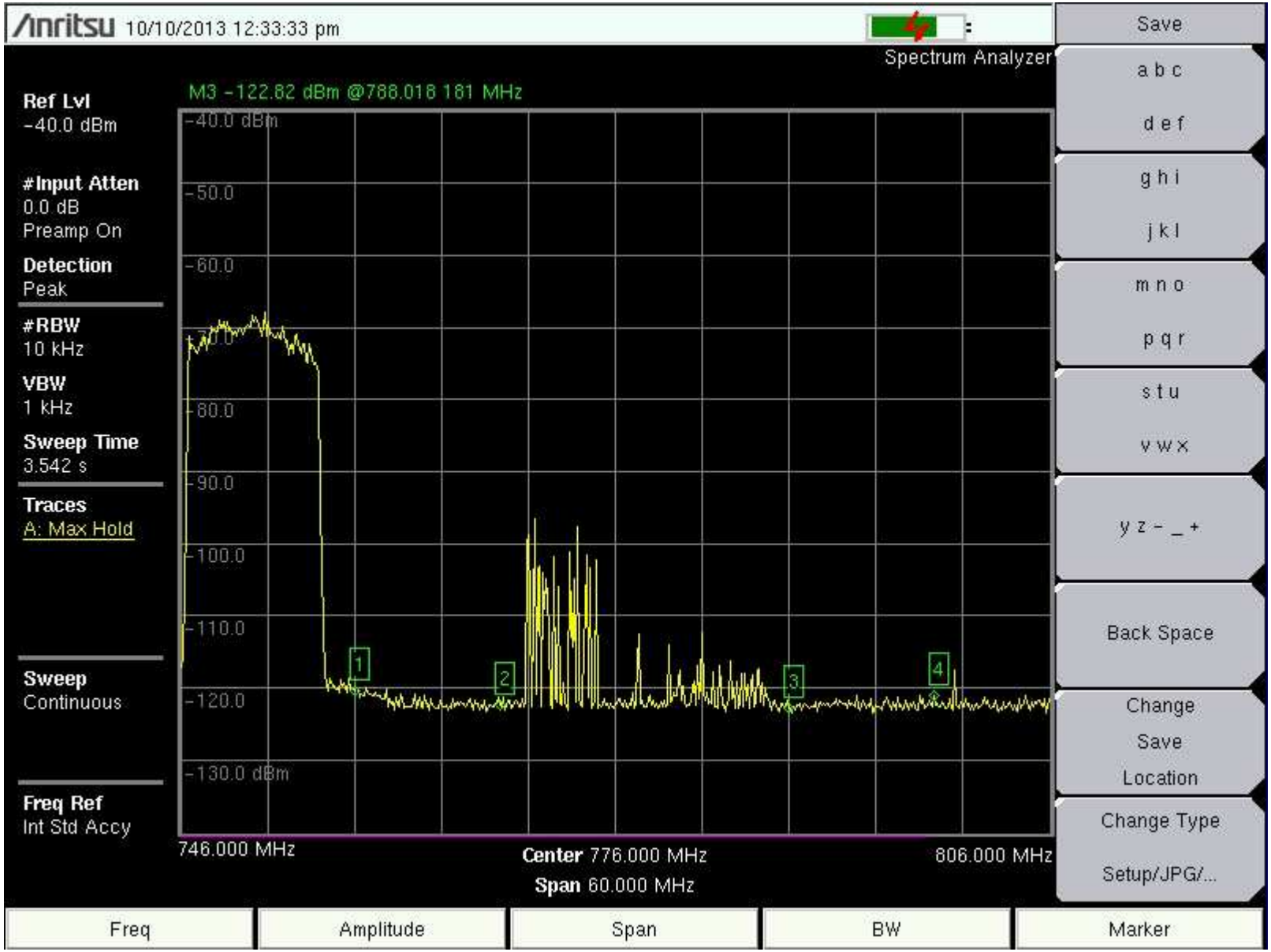


Figure 3.5-4 – Location # 4 - Spectrum Analyzer Image @ 10 kHz RBW – Upper 700 MHz Band (746-806 MHz)
Band 14 Downlink - NO SIGNAL PRESENT - Signal Level < -120 dBm (758-768 MHz) Markers 1 & 2
Band 14 Uplink - NO SIGNAL PRESENT - Signal Level < -121 dBm (788-798 MHz) Markers 3 & 4

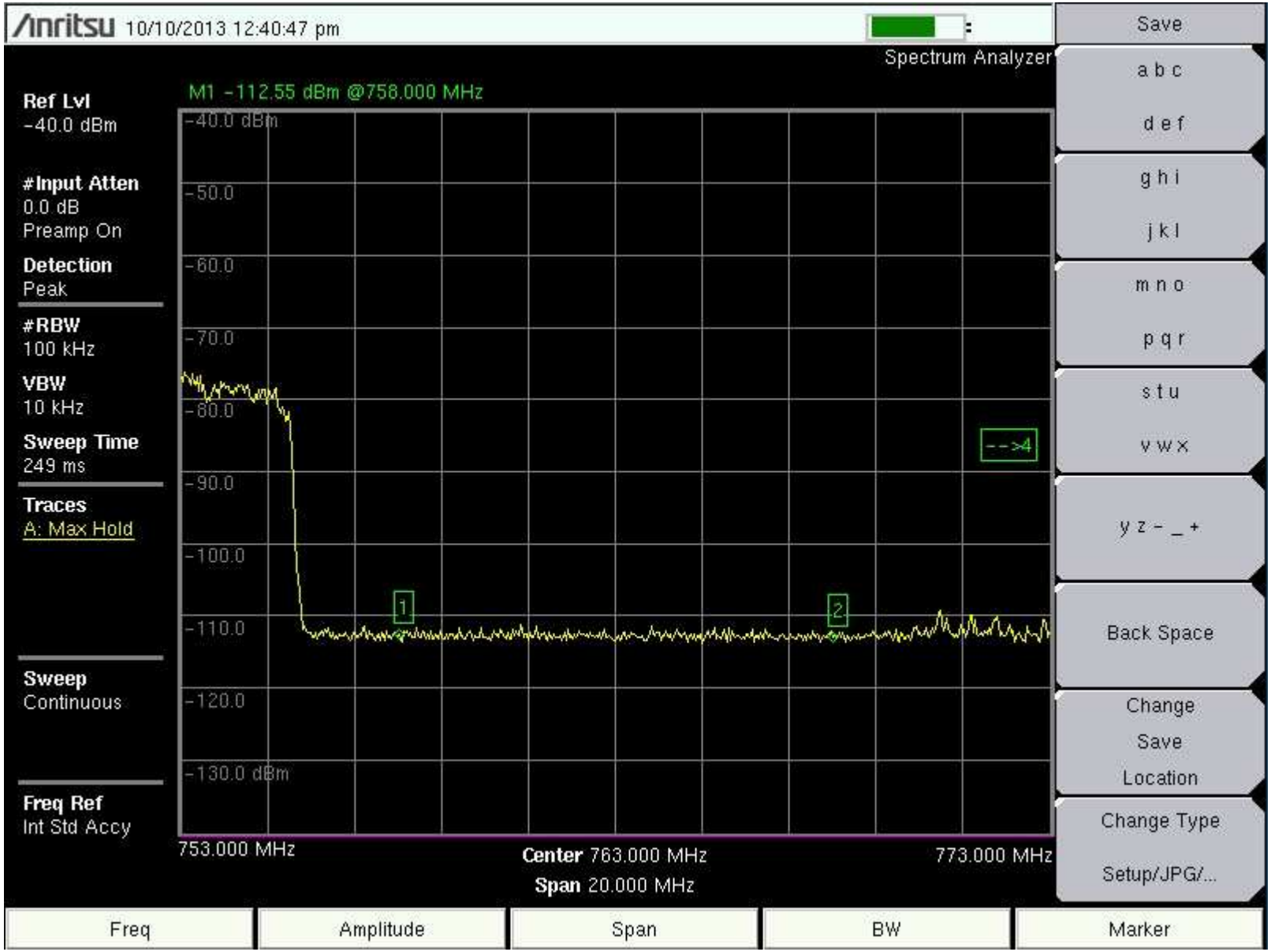


Figure 3.5-5 – Location # 4 - Spectrum Analyzer Image @ 100 kHz RBW
Band 14 Downlink - NO SIGNAL PRESENT - Signal Level < -112 dBm (758-768 MHz) Markers 1 & 2

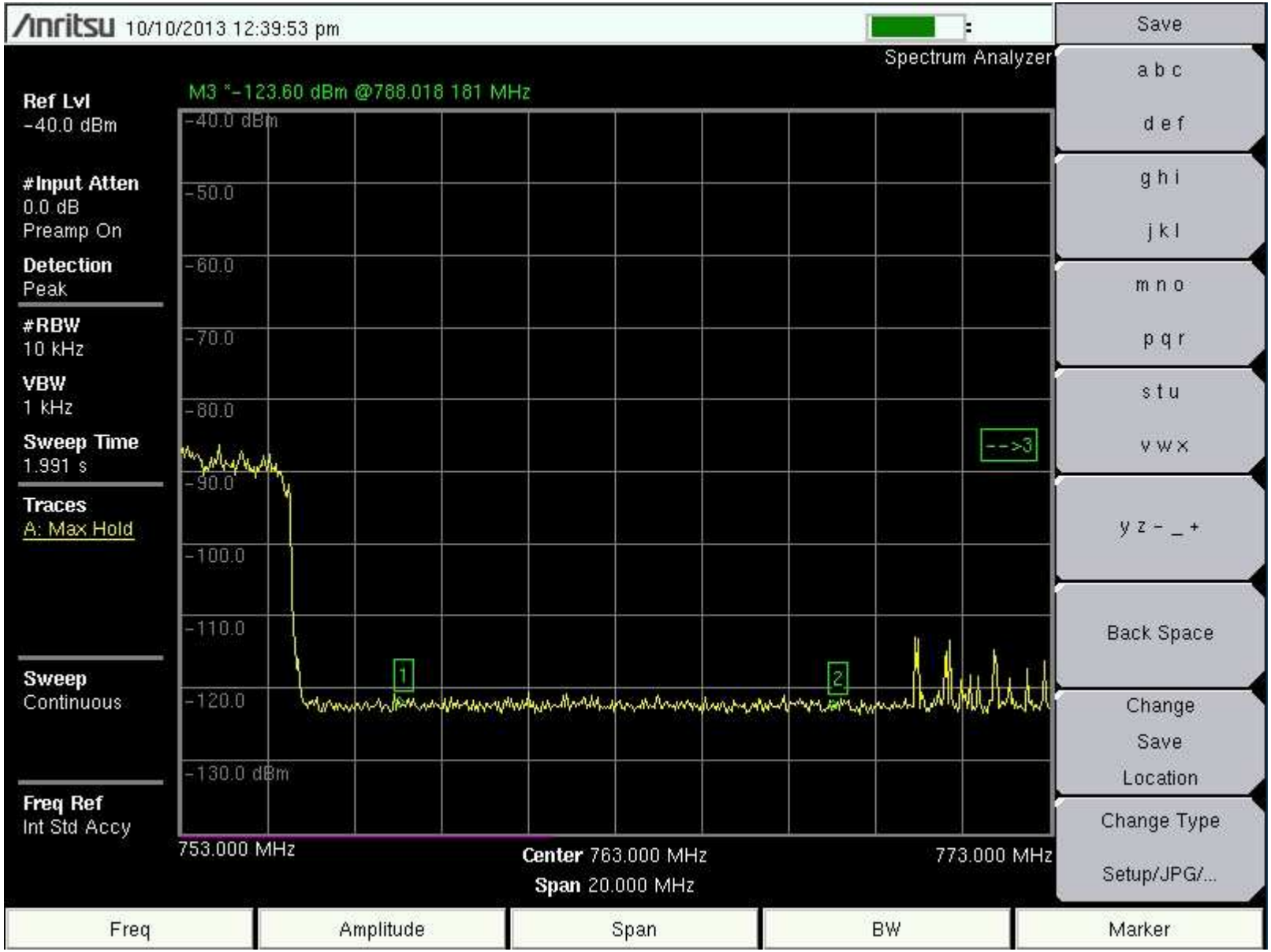


Figure 3.5-6 – Location # 4 - Spectrum Analyzer Image @ 10 kHz RBW
Band 14 Downlink - NO SIGNAL PRESENT - Signal Level < -122 dBm (758-768 MHz) Markers 1 & 2

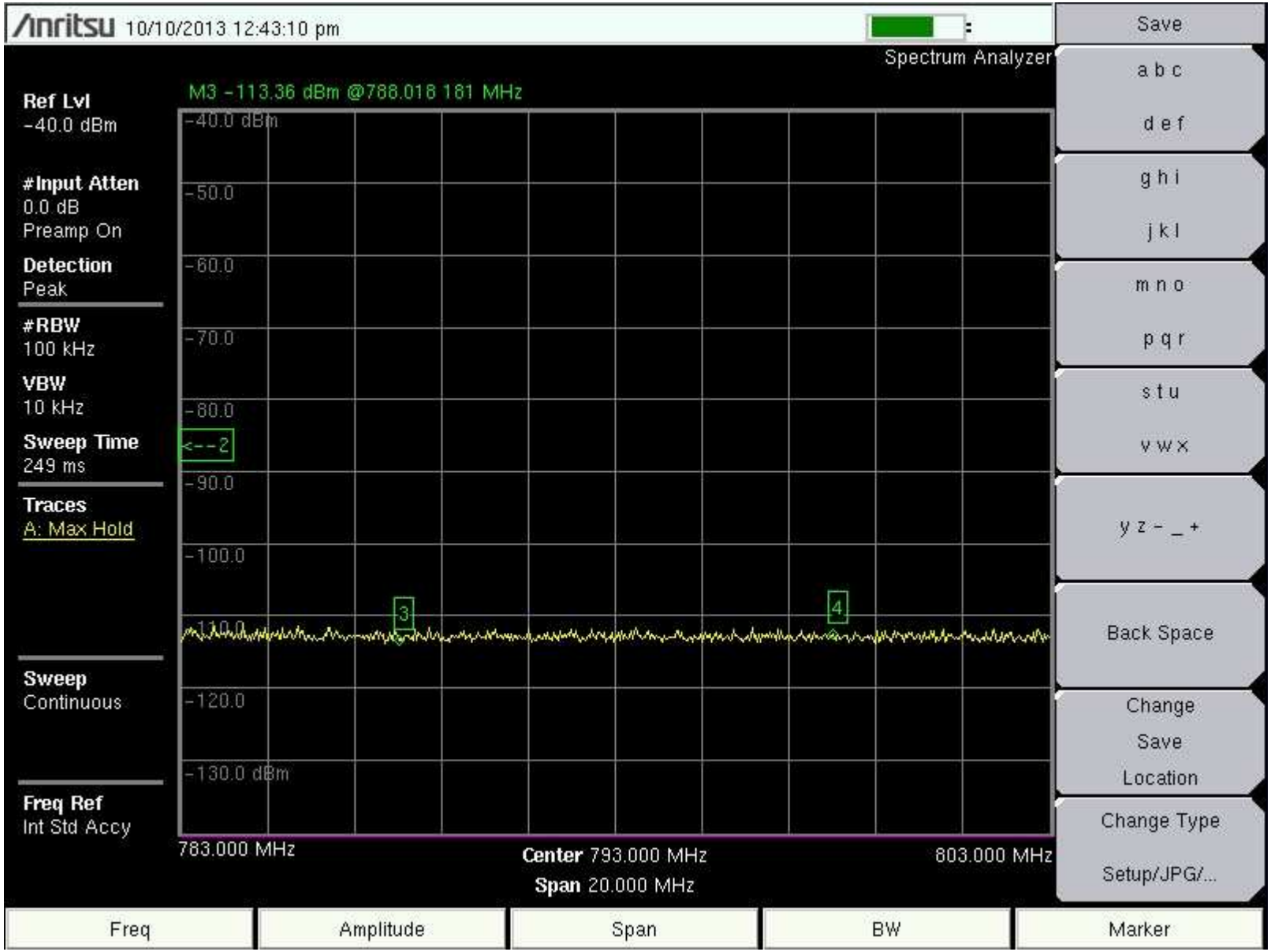


Figure 3.5-7 – Location # 4 - Spectrum Analyzer Image @ 100 kHz RBW
Band 14 Uplink - NO SIGNAL PRESENT - Signal Level < -113 dBm (788-798 MHz) Markers 3 & 4

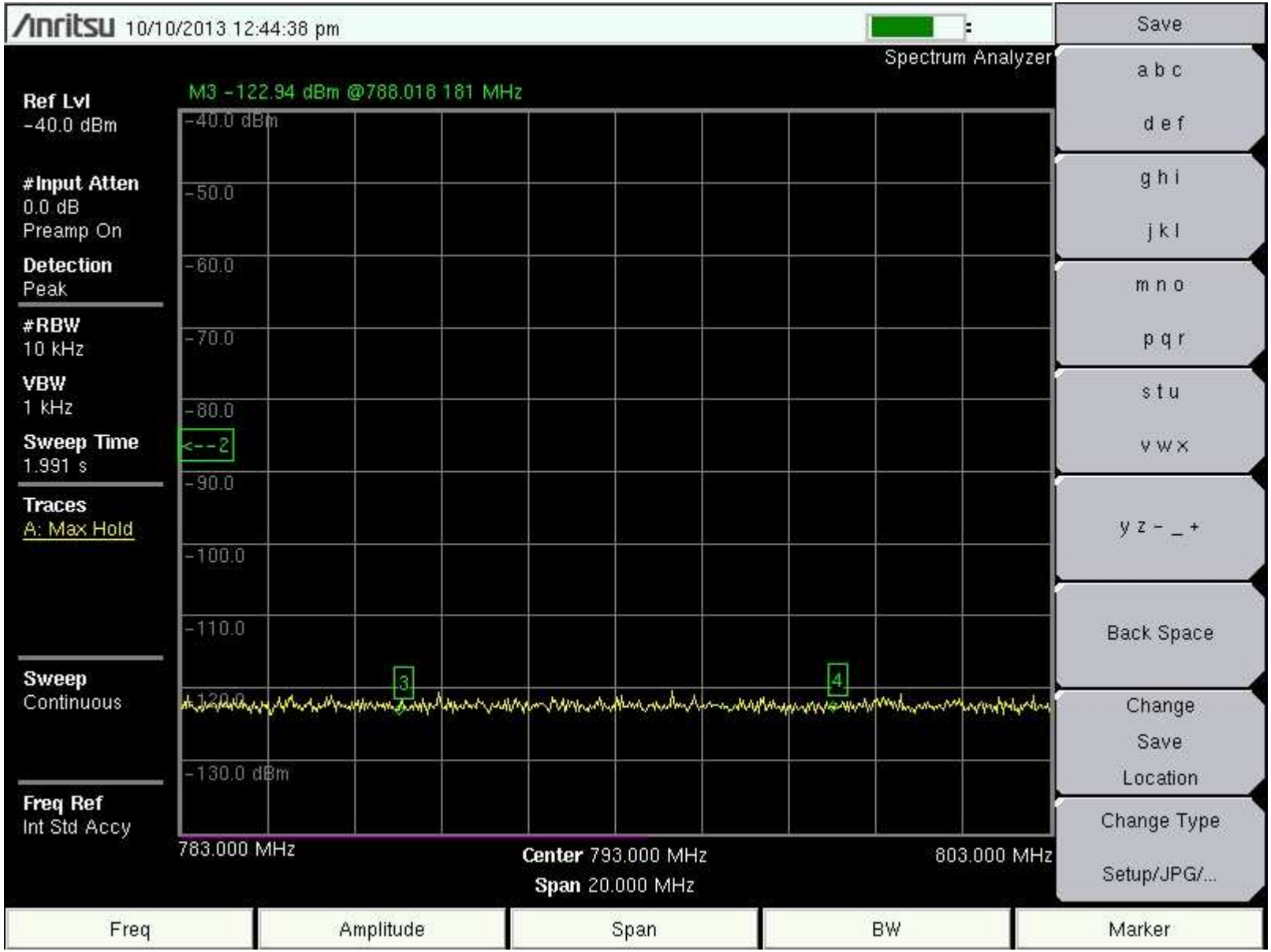


Figure 3.5-8 – Location # 4 - Spectrum Analyzer Image @ 10 kHz RBW
Band 14 Uplink - NO SIGNAL PRESENT - Signal Level < -121 dBm (788-798 MHz) Markers 3 & 4

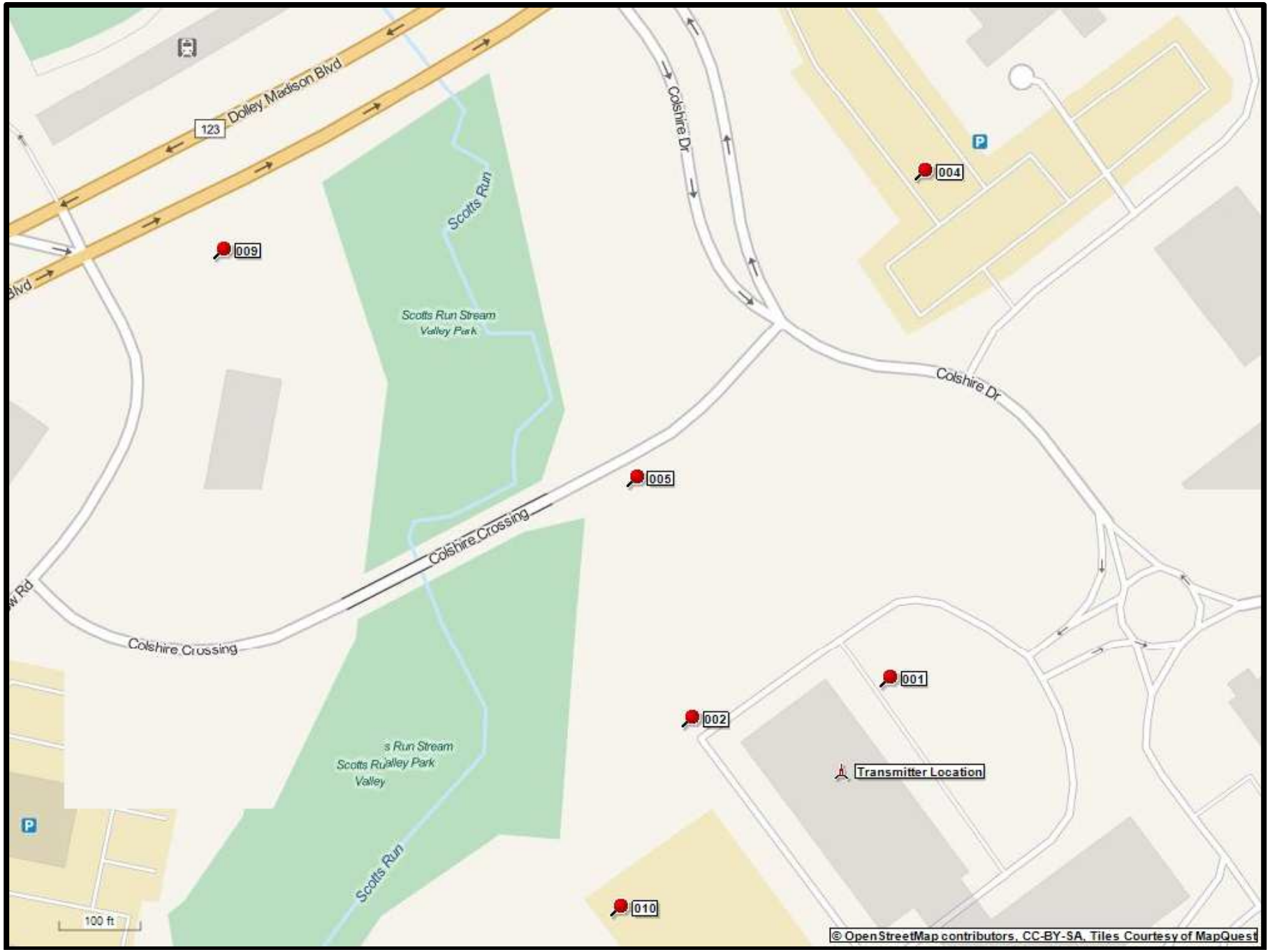


Figure 3.6-1 – Street Map Showing Measurement Location # 5

Figure 3.6-2 – Aerial Image Showing Measurement Location # 5

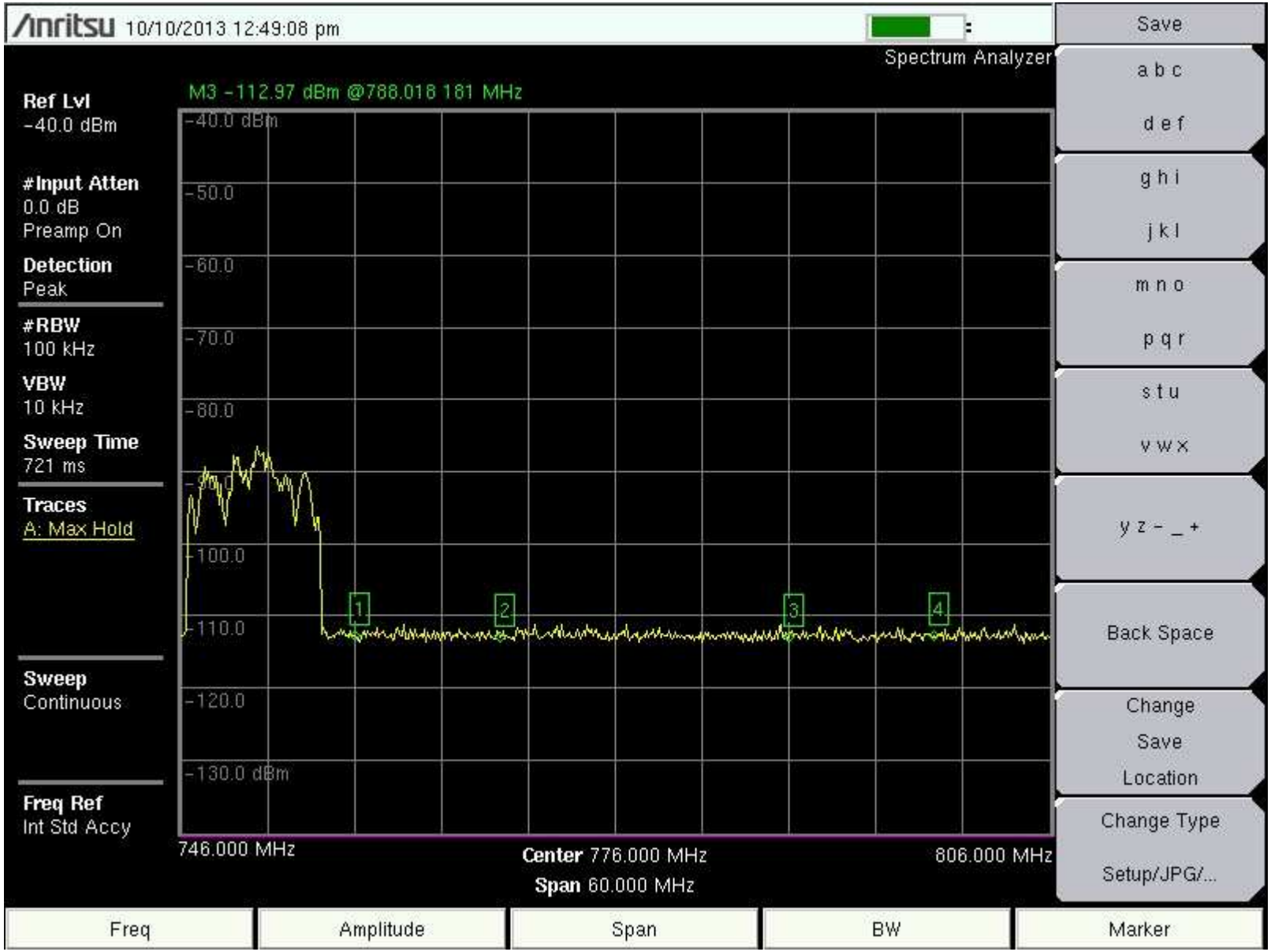


Figure 3.6-3 – Location # 5 - Spectrum Analyzer Image @ 100 kHz RBW – Upper 700 MHz Band (746-806 MHz)
Band 14 Downlink - NO SIGNAL PRESENT - Signal Level < -112 dBm (758-768 MHz) Markers 1 & 2
Band 14 Uplink - NO SIGNAL PRESENT - Signal Level < -112 dBm (788-798 MHz) Markers 3 & 4

Figure 3.6-4 – Location # 5 - Spectrum Analyzer Image @ 10 kHz RBW – Upper 700 MHz Band (746-806 MHz)
Band 14 Downlink - NO SIGNAL PRESENT - Signal Level < -121 dBm (758-768 MHz) Markers 1 & 2
Band 14 Uplink - NO SIGNAL PRESENT - Signal Level < -121 dBm (788-798 MHz) Markers 3 & 4

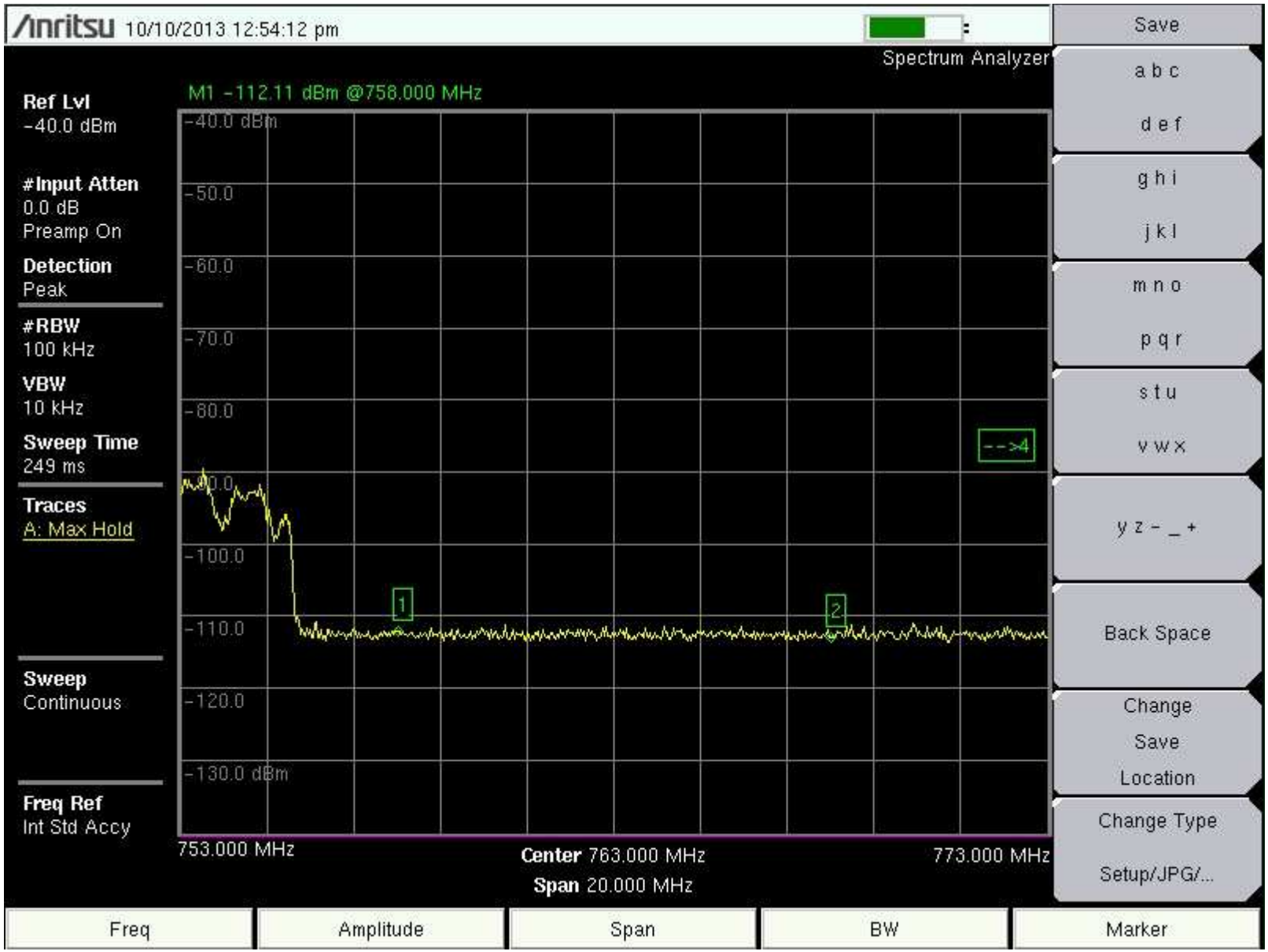


Figure 3.6-5 – Location # 5 - Spectrum Analyzer Image @ 100 kHz RBW
Band 14 Downlink - NO SIGNAL PRESENT - Signal Level < -112 dBm (758-768 MHz) Markers 1 & 2

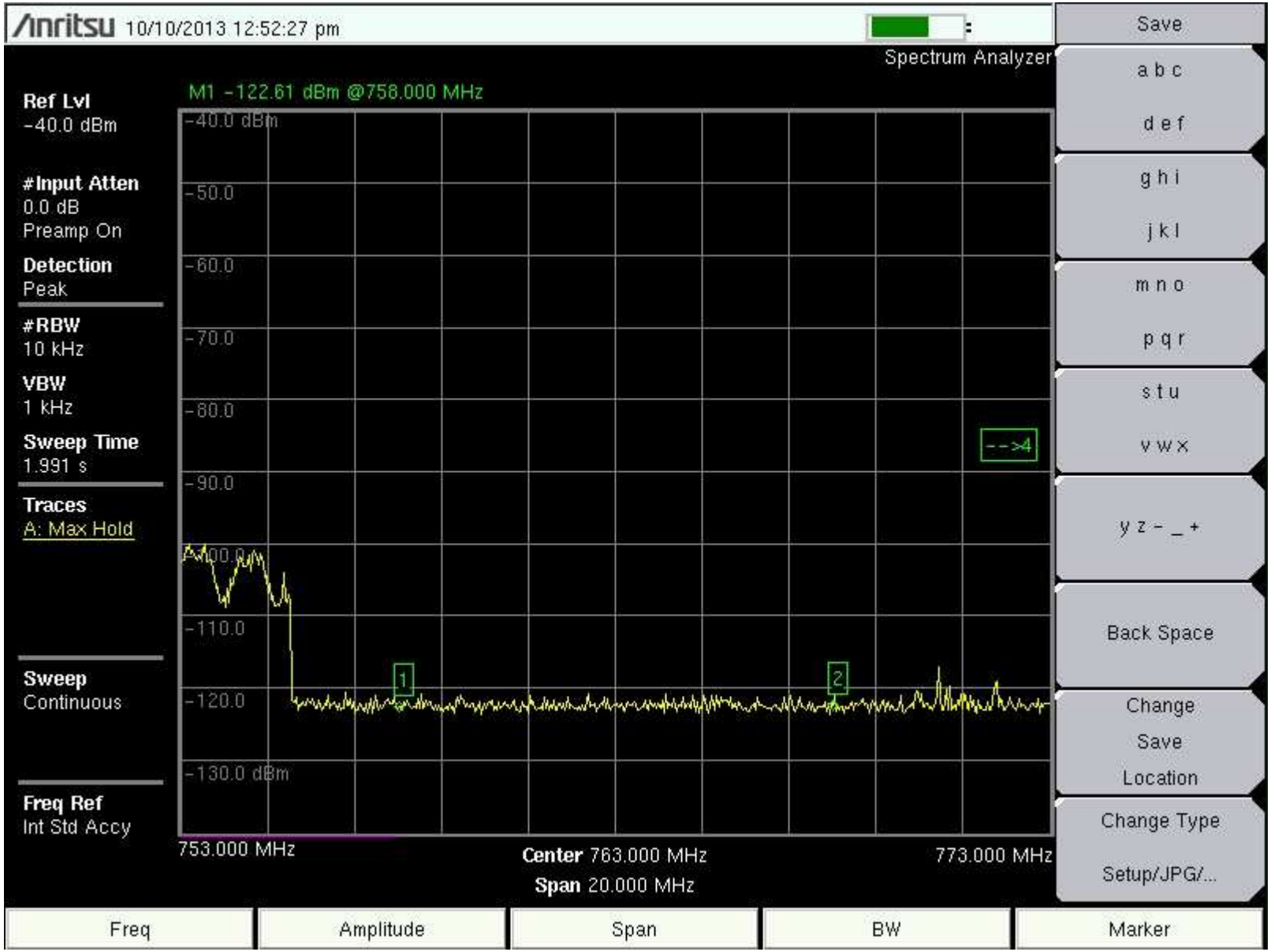


Figure 3.6-6 – Location # 5 - Spectrum Analyzer Image @ 10 kHz RBW
Band 14 Downlink - NO SIGNAL PRESENT - Signal Level < -121 dBm (758-768 MHz) Markers 1 & 2

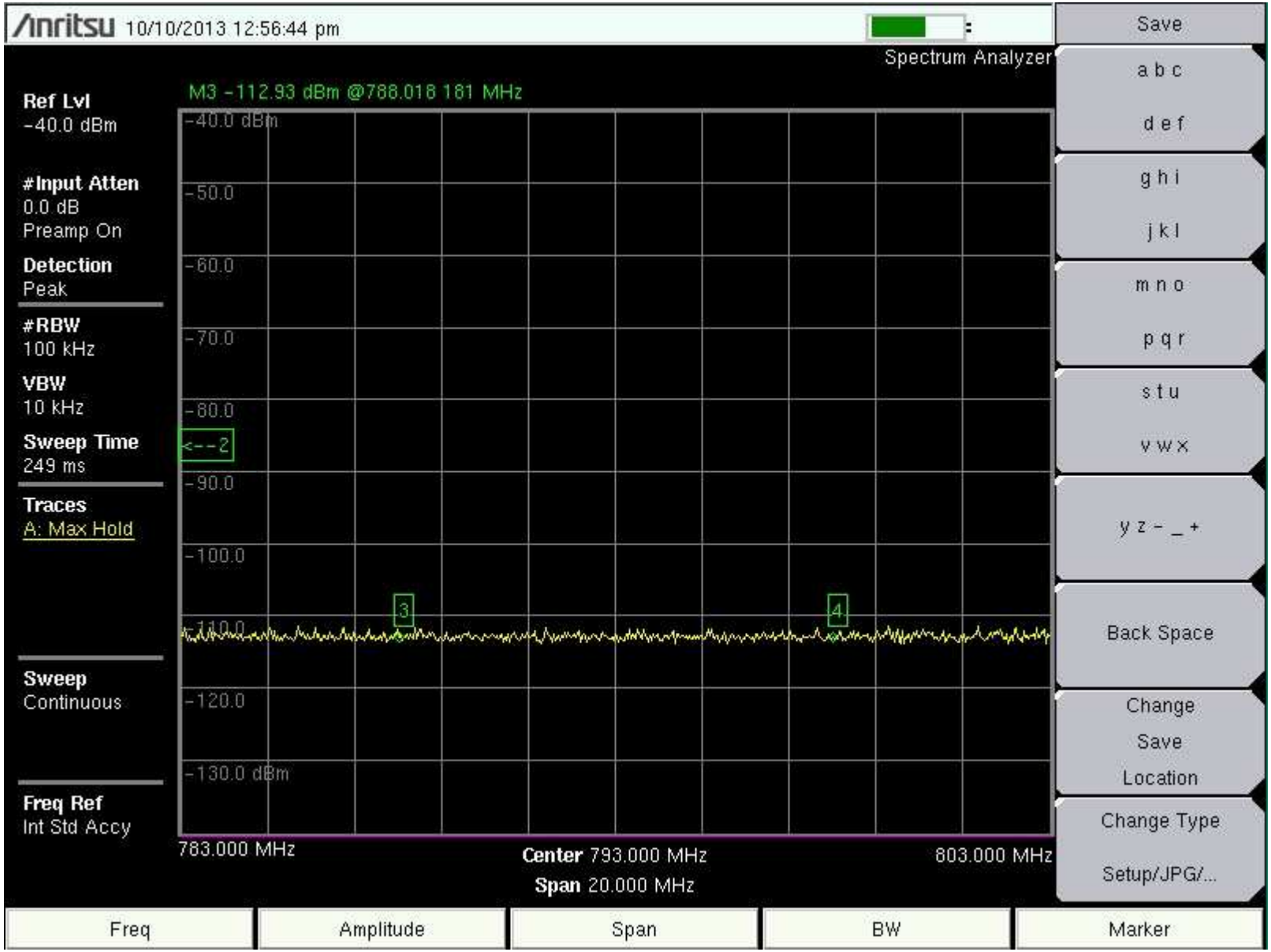


Figure 3.6-7 – Location # 5 - Spectrum Analyzer Image @ 100 kHz RBW
Band 14 Uplink - NO SIGNAL PRESENT - Signal Level < -112 dBm (788-798 MHz) Markers 3 & 4

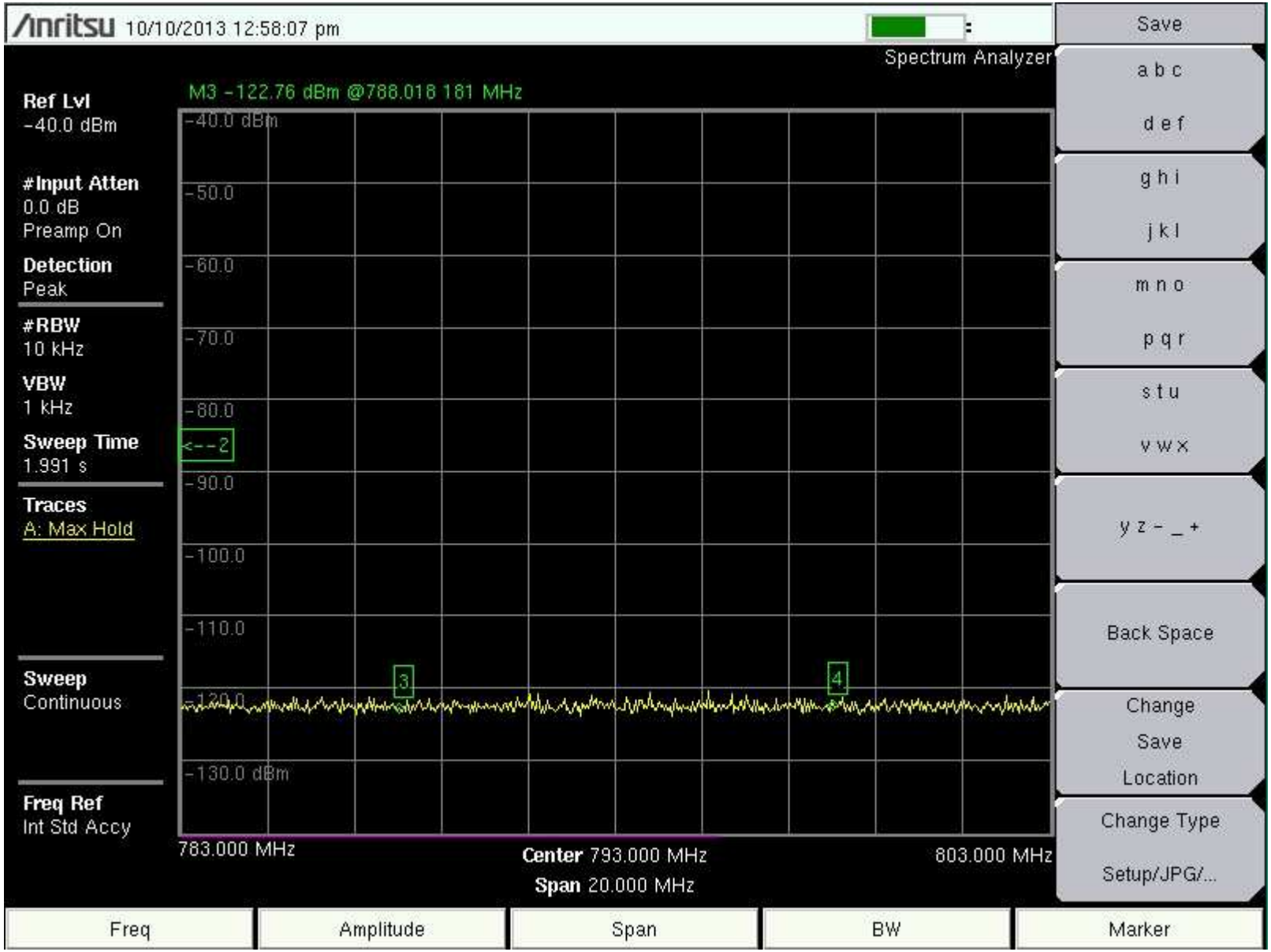


Figure 3.6-8 – Location # 5 - Spectrum Analyzer Image @ 10 kHz RBW
Band 14 Uplink - NO SIGNAL PRESENT - Signal Level < -122 dBm (788-798 MHz) Markers 3 & 4

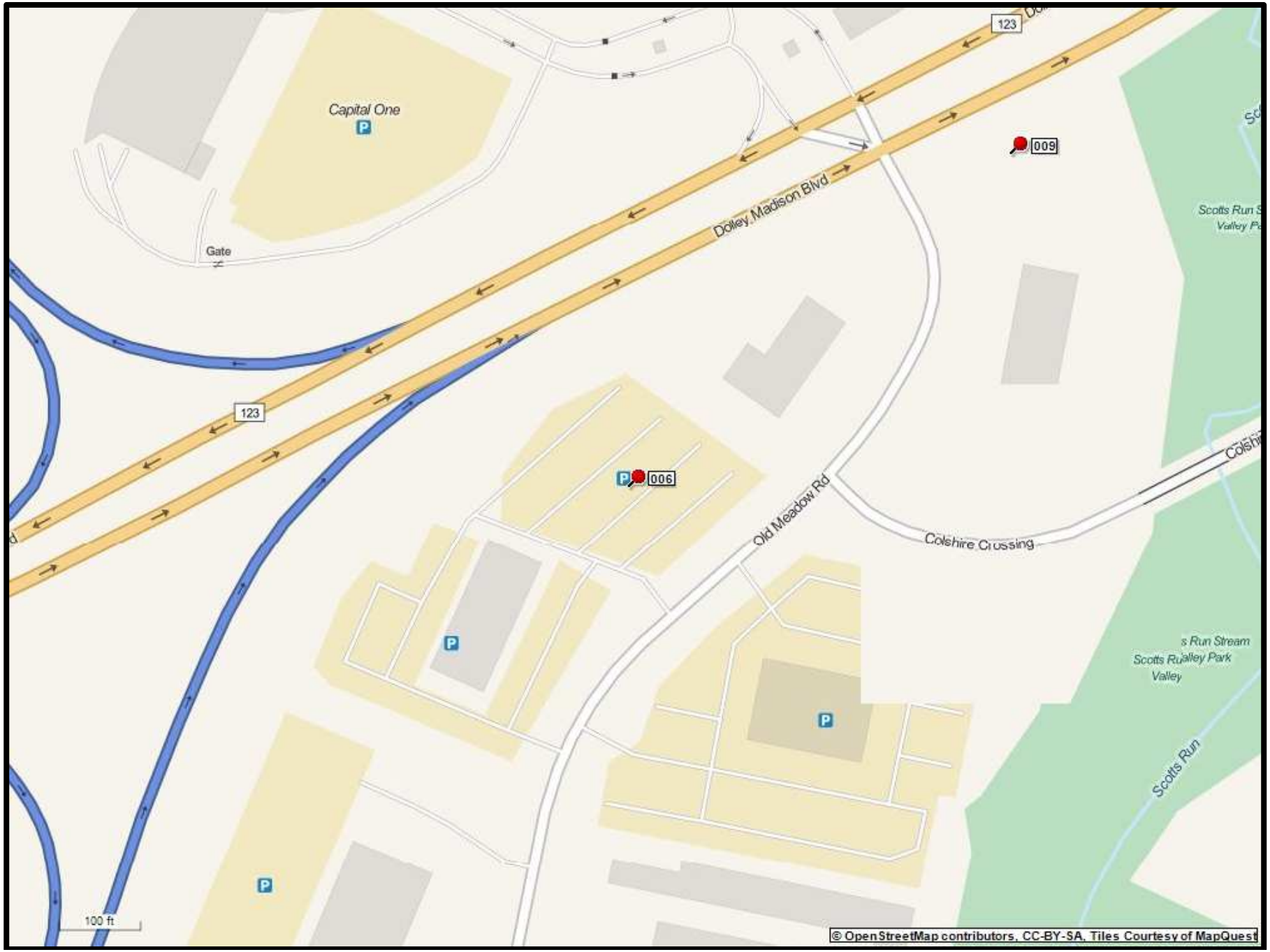


Figure 3.7-1 – Street Map Showing Measurement Location # 6

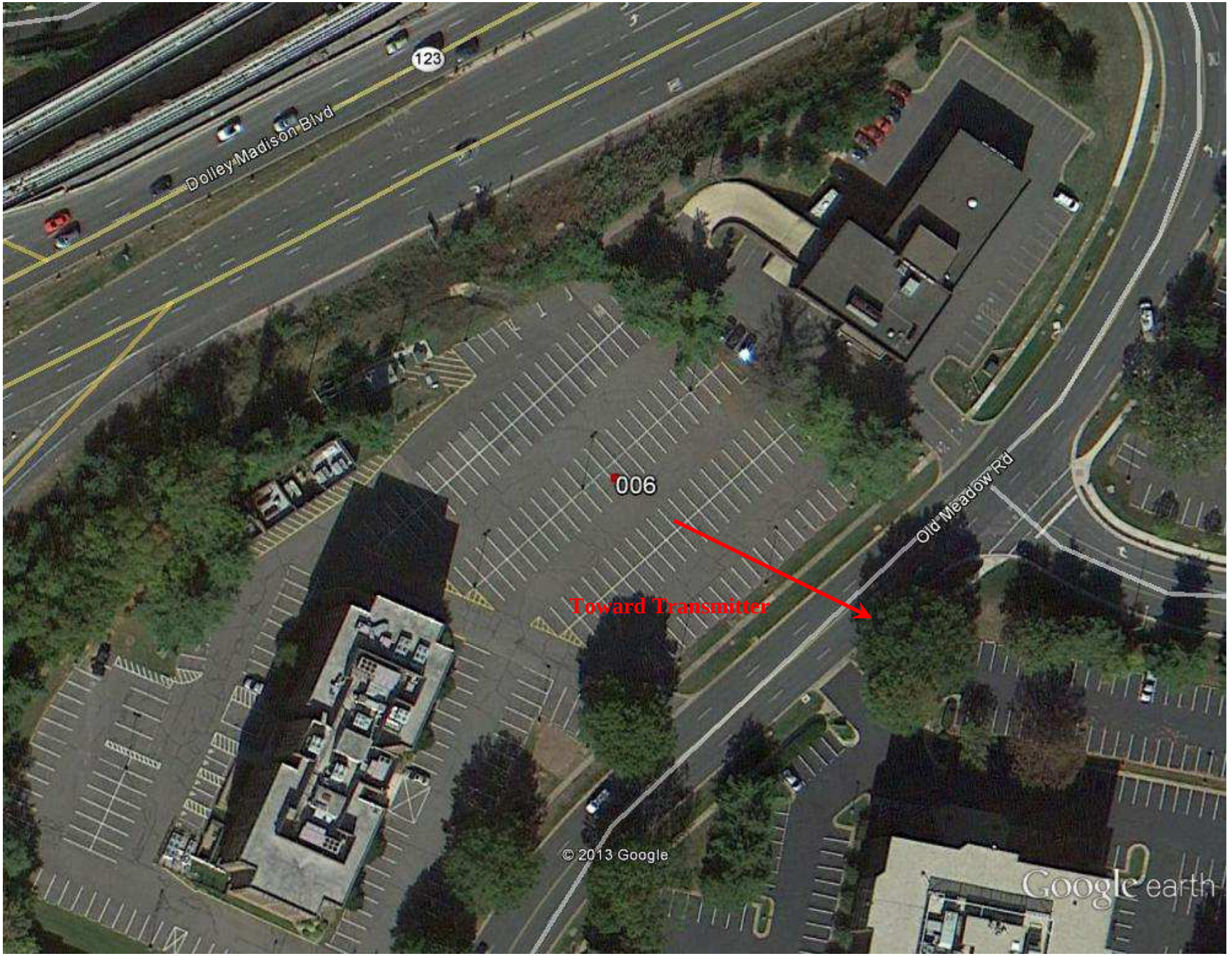


Figure 3.7-2 – Aerial Image Showing Measurement Location # 6

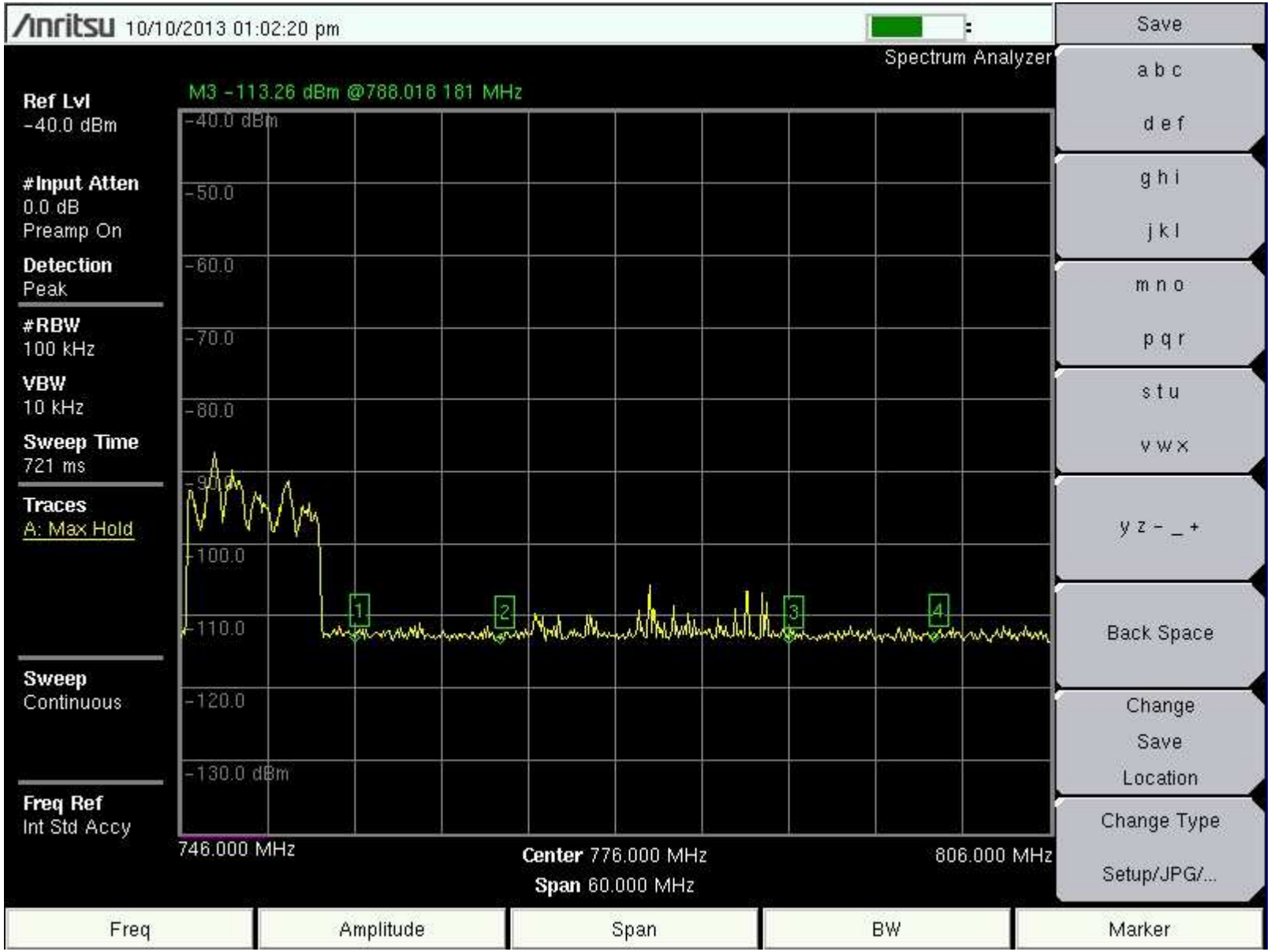


Figure 3.7-3 – Location # 6 - Spectrum Analyzer Image @ 100 kHz RBW – Upper 700 MHz Band (746-806 MHz)
Band 14 Downlink - NO SIGNAL PRESENT - Signal Level < -113 dBm (758-768 MHz) Markers 1 & 2
Band 14 Uplink - NO SIGNAL PRESENT - Signal Level < -113 dBm (788-798 MHz) Markers 3 & 4

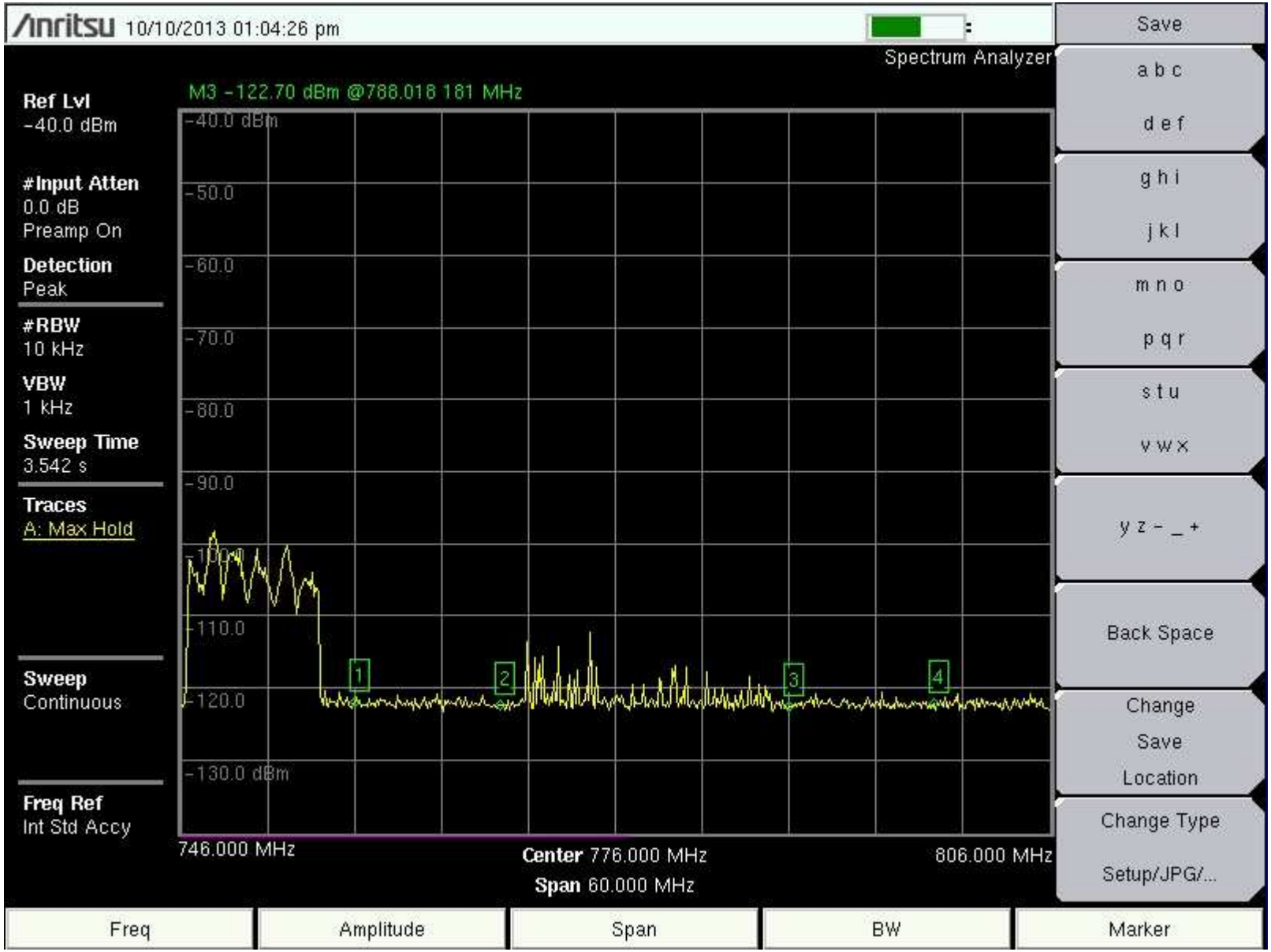


Figure 3.7-4 – Location # 6 - Spectrum Analyzer Image @ 10 kHz RBW – Upper 700 MHz Band (746-806 MHz)
Band 14 Downlink - NO SIGNAL PRESENT - Signal Level < -121 dBm (758-768 MHz) Markers 1 & 2
Band 14 Uplink - NO SIGNAL PRESENT - Signal Level < -121 dBm (788-798 MHz) Markers 3 & 4

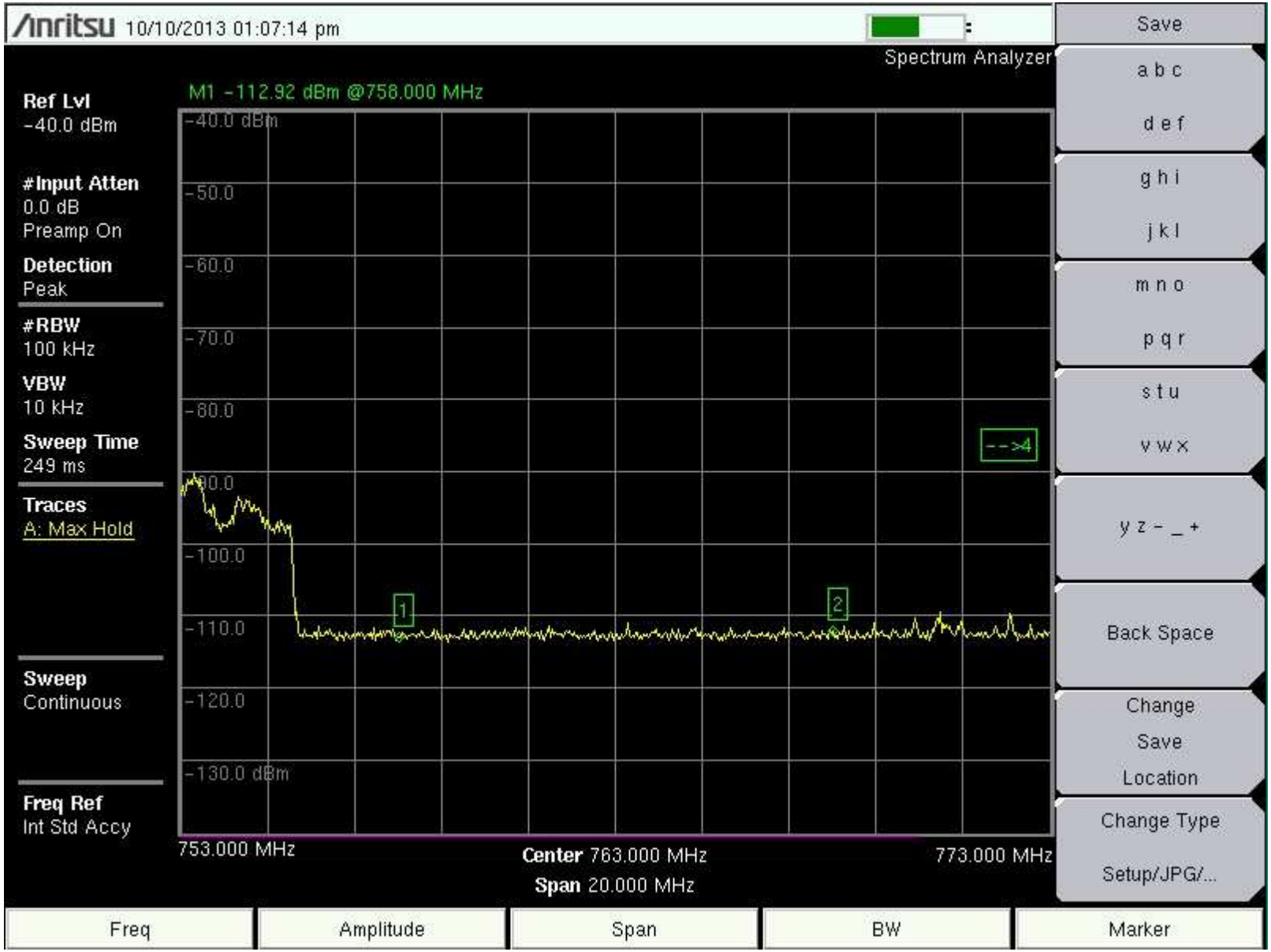


Figure 3.7-5 – Location # 6 - Spectrum Analyzer Image @ 100 kHz RBW
Band 14 Downlink - NO SIGNAL PRESENT - Signal Level < -112 dBm (758-768 MHz) Markers 1 & 2

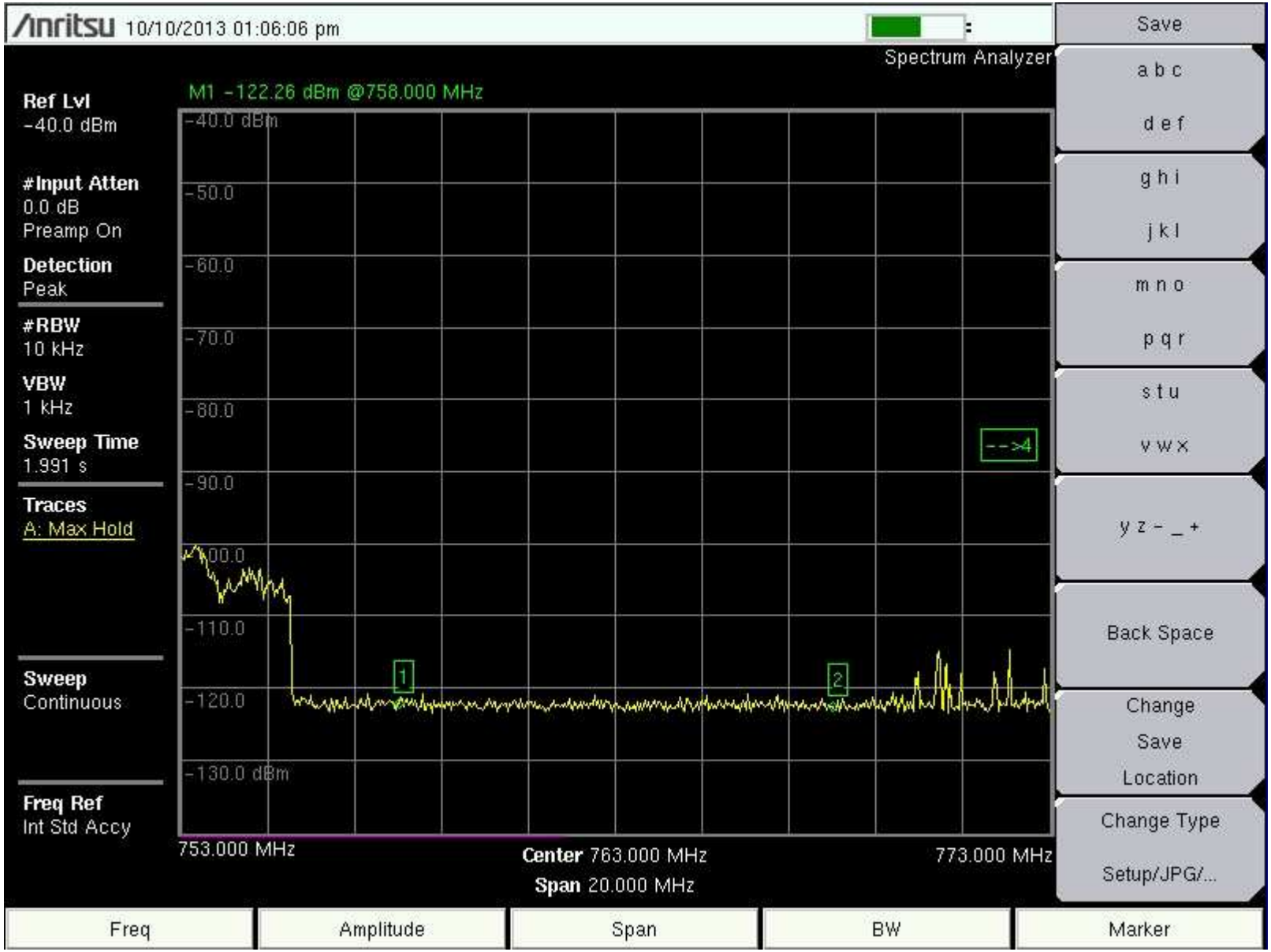


Figure 3.7-6 – Location # 6 - Spectrum Analyzer Image @ 10 kHz RBW
Band 14 Downlink - NO SIGNAL PRESENT - Signal Level < -121 dBm (758-768 MHz) Markers 1 & 2

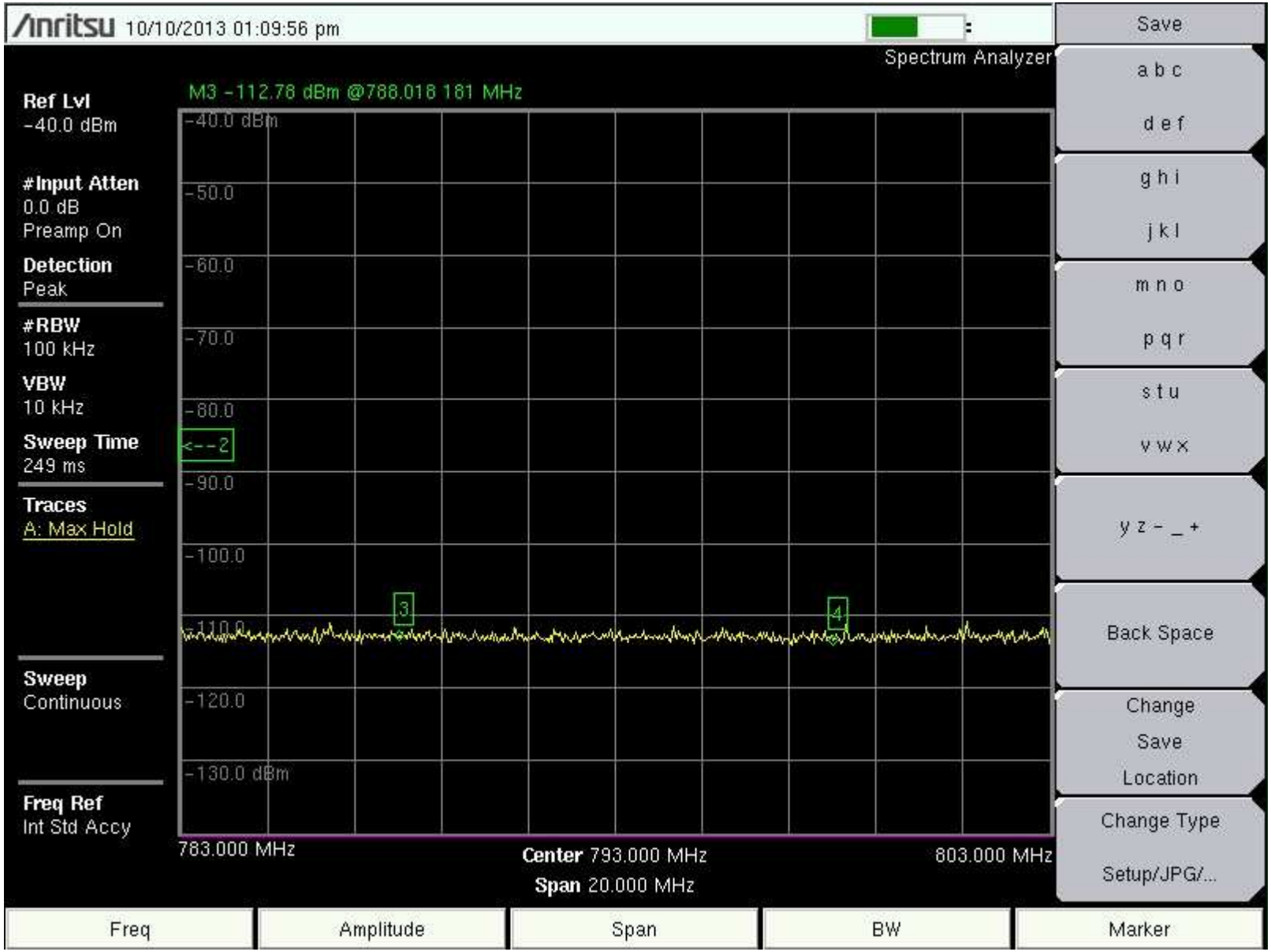


Figure 3.7-7 – Location # 6 - Spectrum Analyzer Image @ 100 kHz RBW
Band 14 Uplink - NO SIGNAL PRESENT - Signal Level < -112 dBm (788-798 MHz) Markers 3 & 4

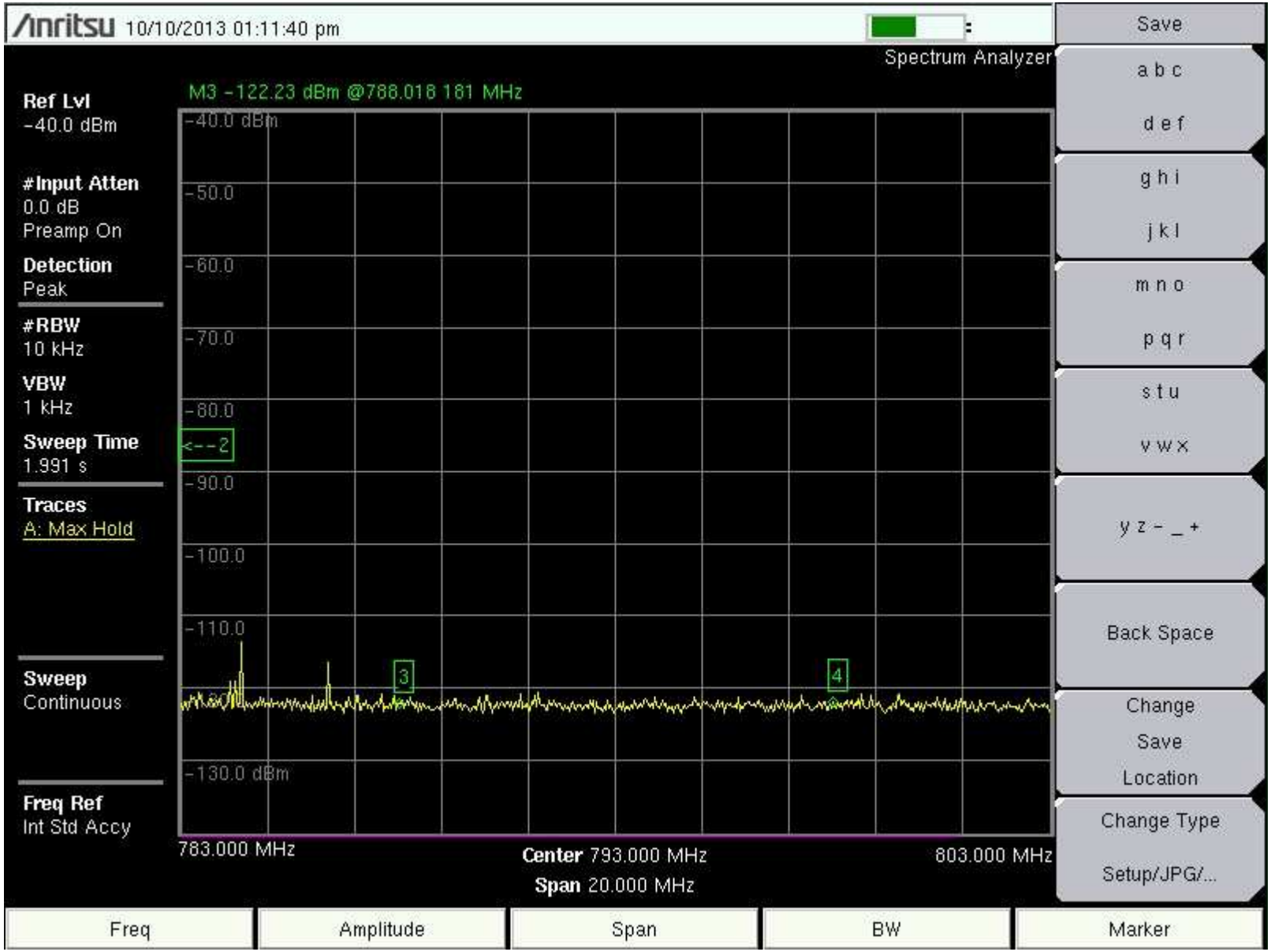


Figure 3.7-8 – Location # 6 - Spectrum Analyzer Image @ 10 kHz RBW
Band 14 Uplink - NO SIGNAL PRESENT - Signal Level < -121 dBm (788-798 MHz) Markers 3 & 4

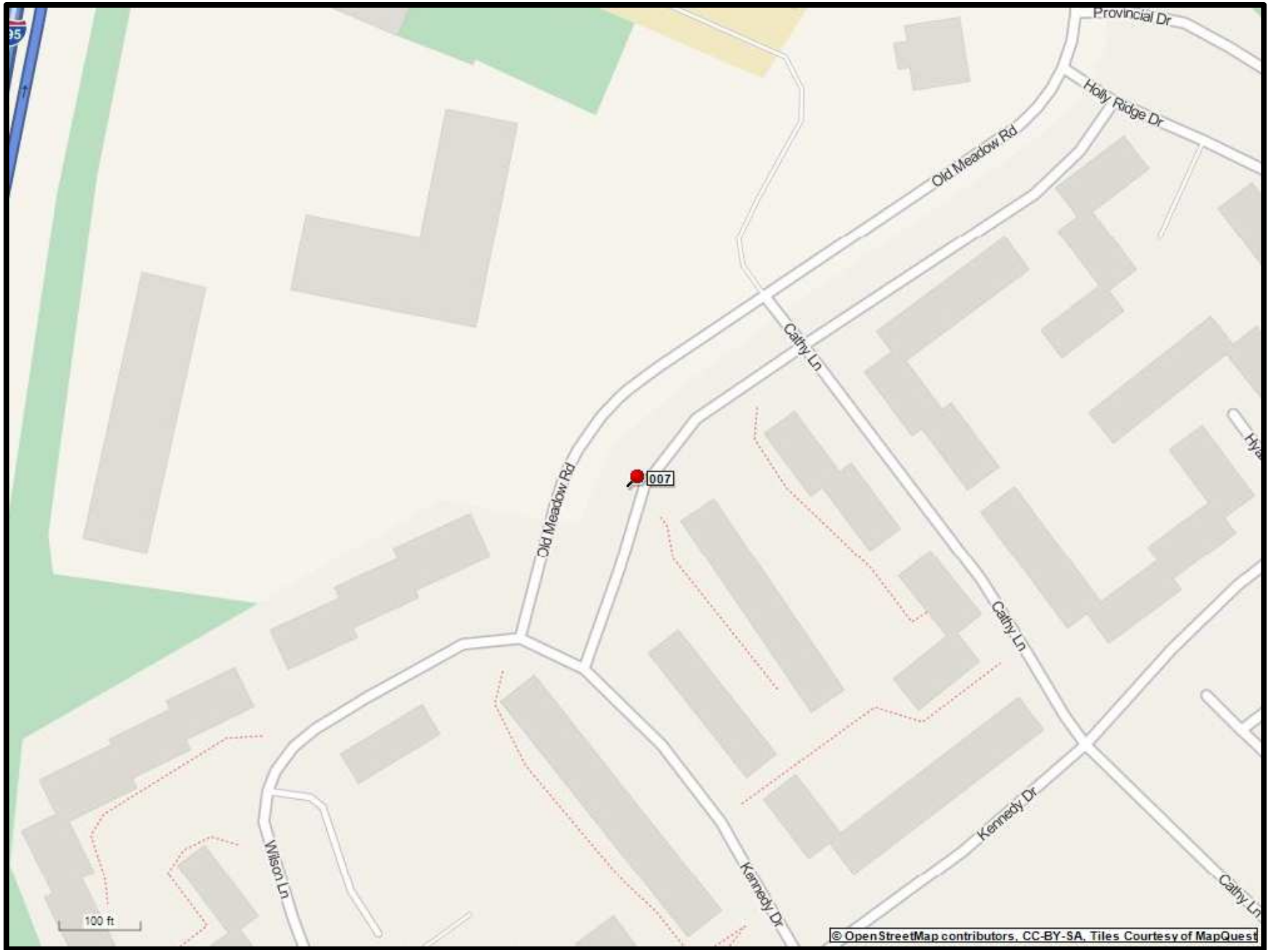


Figure 3.8-1 – Street Map Showing Measurement Location # 7

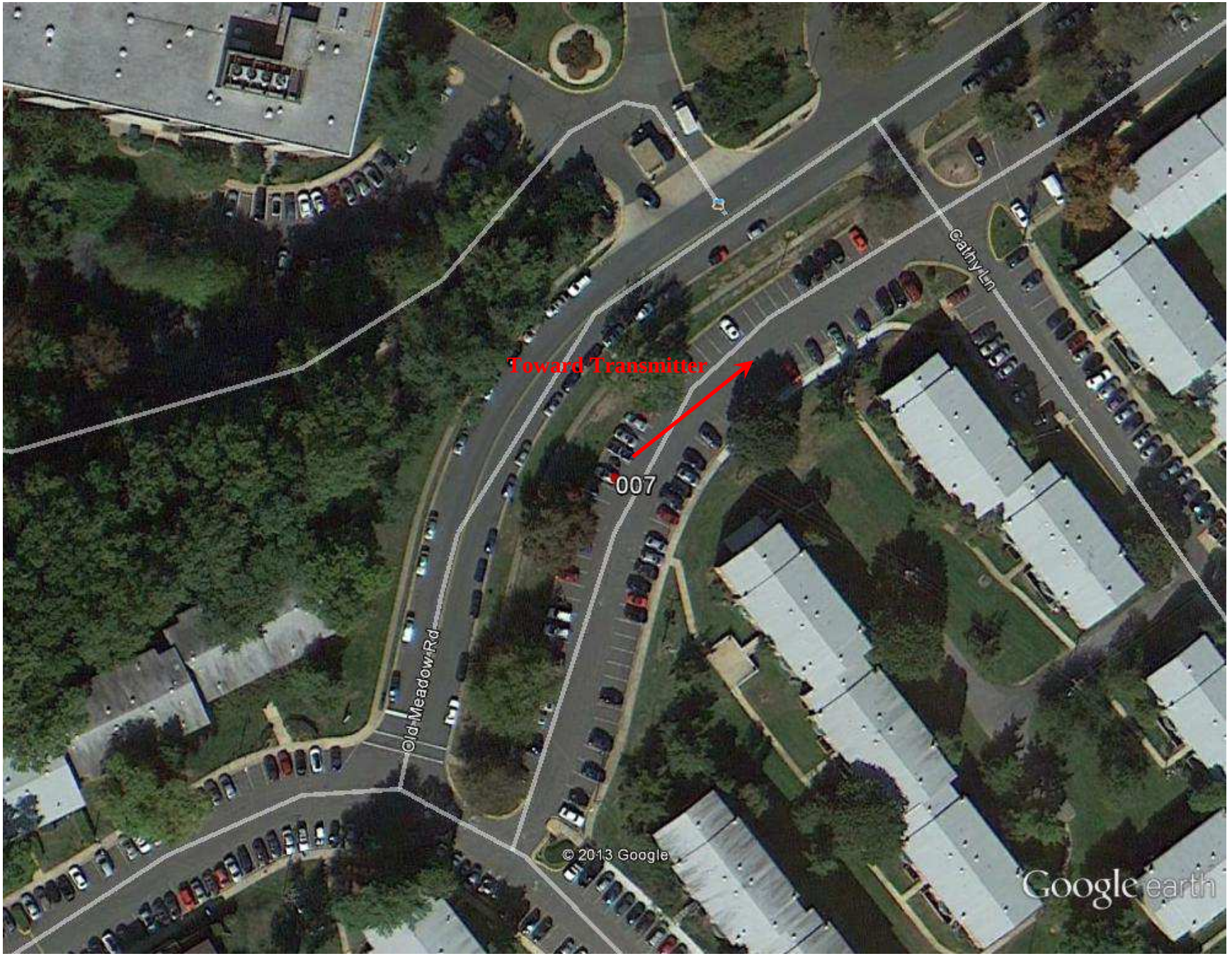


Figure 3.8-2 – Aerial Image Showing Measurement Location # 7

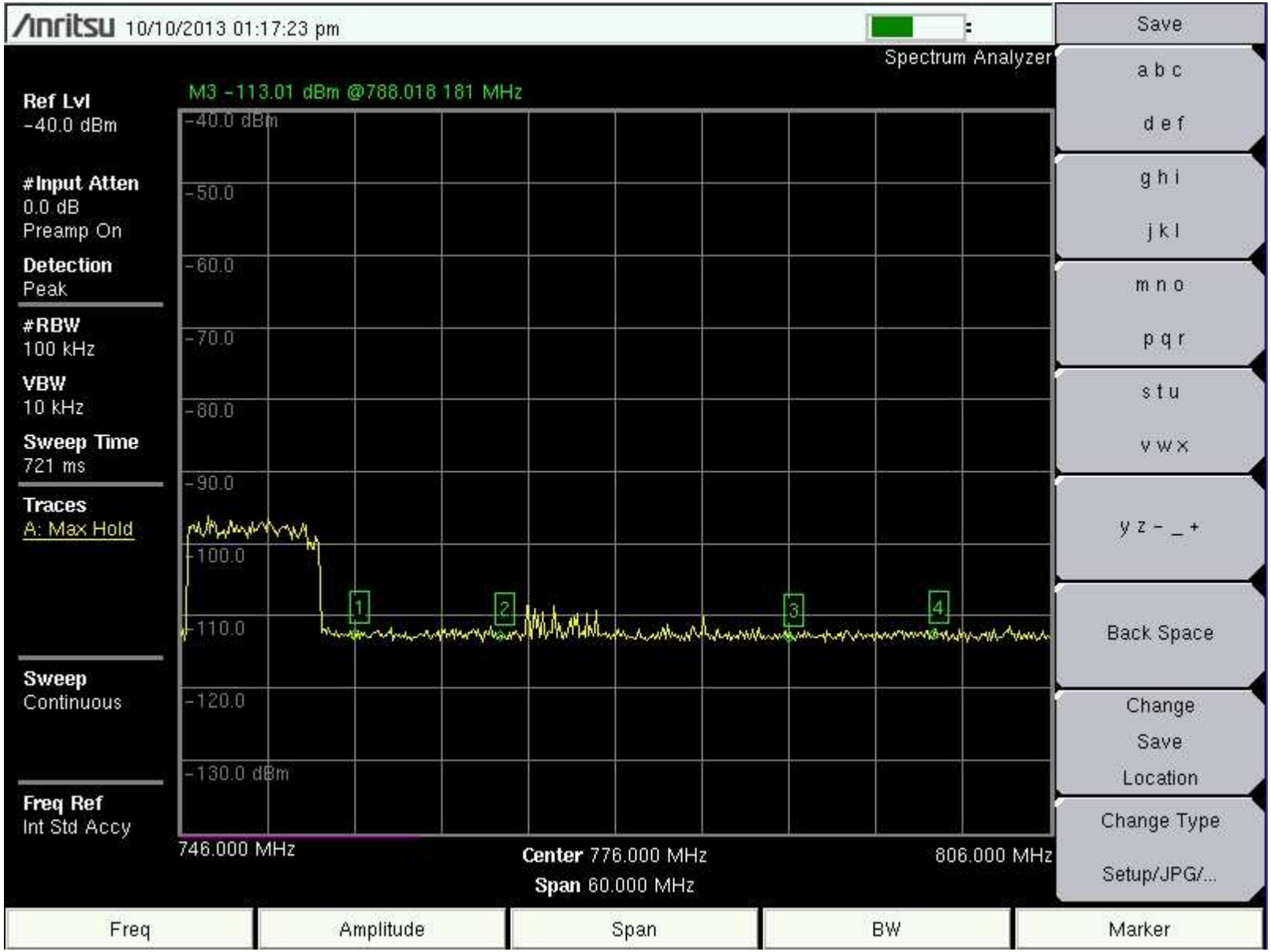


Figure 3.8-3 – Location # 7 - Spectrum Analyzer Image @ 100 kHz RBW – Upper 700 MHz Band (746-806 MHz)
Band 14 Downlink - NO SIGNAL PRESENT - Signal Level < -112 dBm (758-768 MHz) Markers 1 & 2
Band 14 Uplink - NO SIGNAL PRESENT - Signal Level < -112 dBm (788-798 MHz) Markers 3 & 4

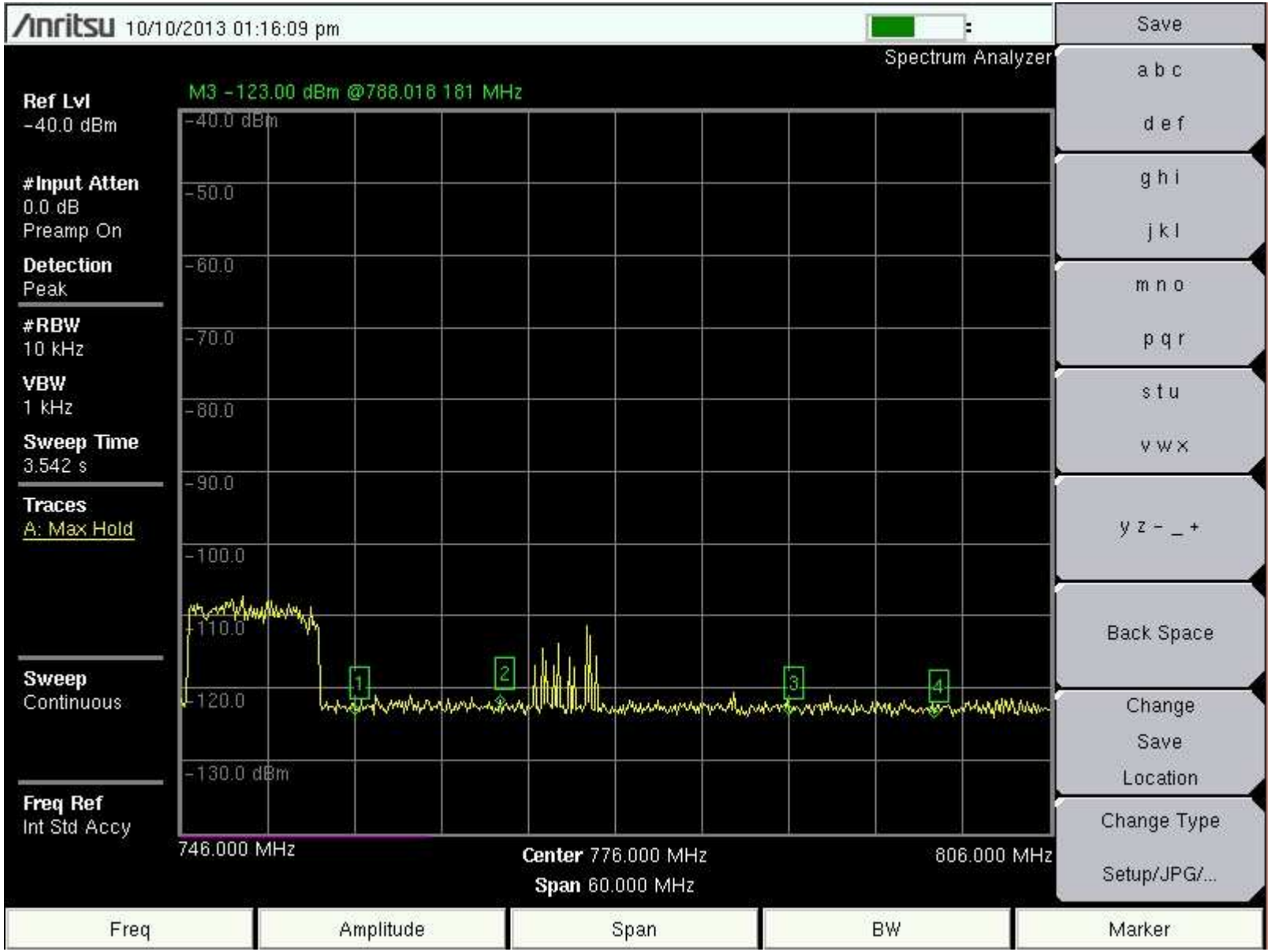


Figure 3.8-4 – Location # 7 - Spectrum Analyzer Image @ 10 kHz RBW – Upper 700 MHz Band (746-806 MHz)
Band 14 Downlink - NO SIGNAL PRESENT - Signal Level < -122 dBm (758-768 MHz) Markers 1 & 2
Band 14 Uplink - NO SIGNAL PRESENT - Signal Level < -122 dBm (788-798 MHz) Markers 3 & 4

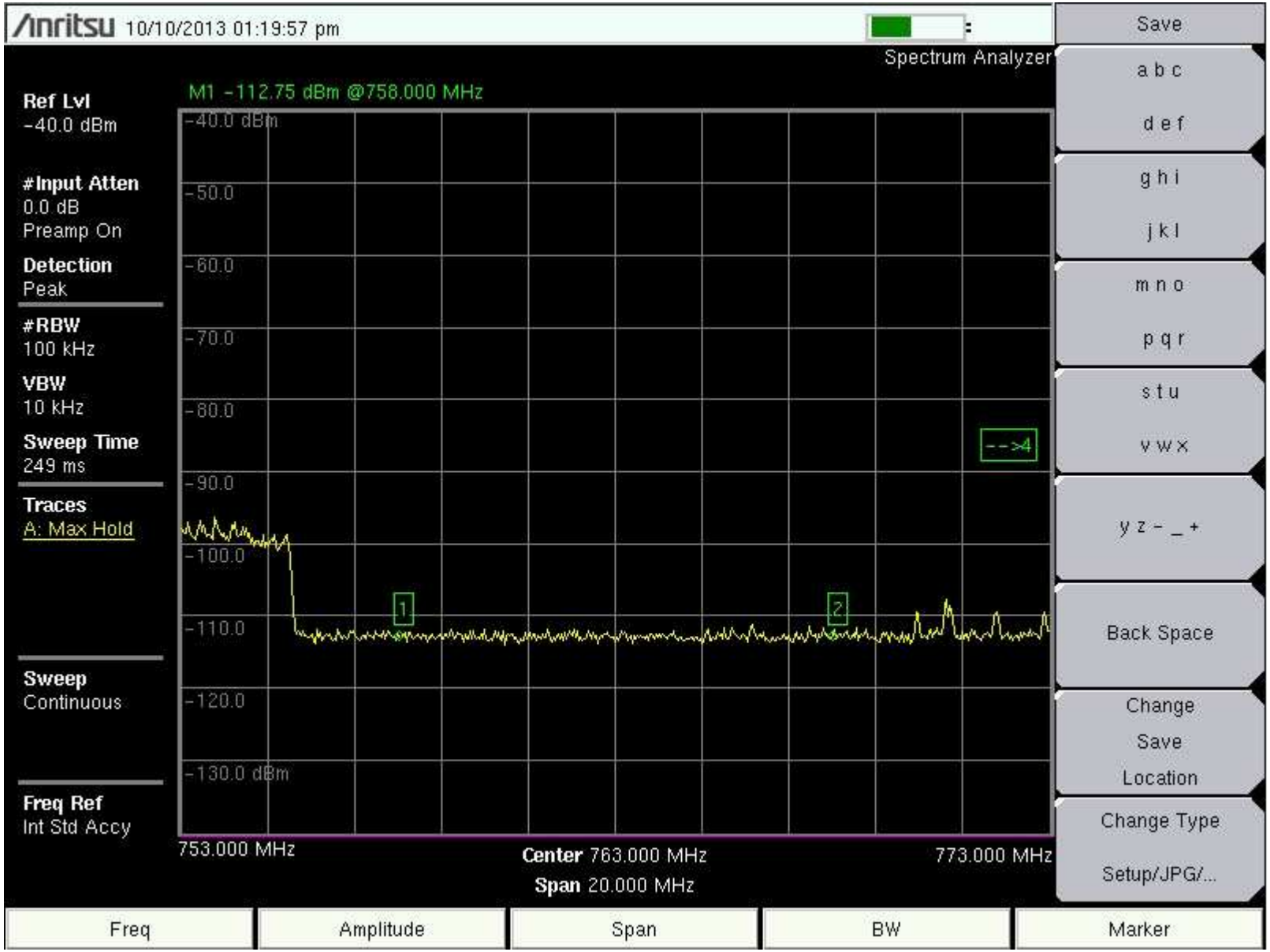


Figure 3.8-5 – Location # 7 - Spectrum Analyzer Image @ 100 kHz RBW
Band 14 Downlink - NO SIGNAL PRESENT - Signal Level < -112 dBm (758-768 MHz) Markers 1 & 2

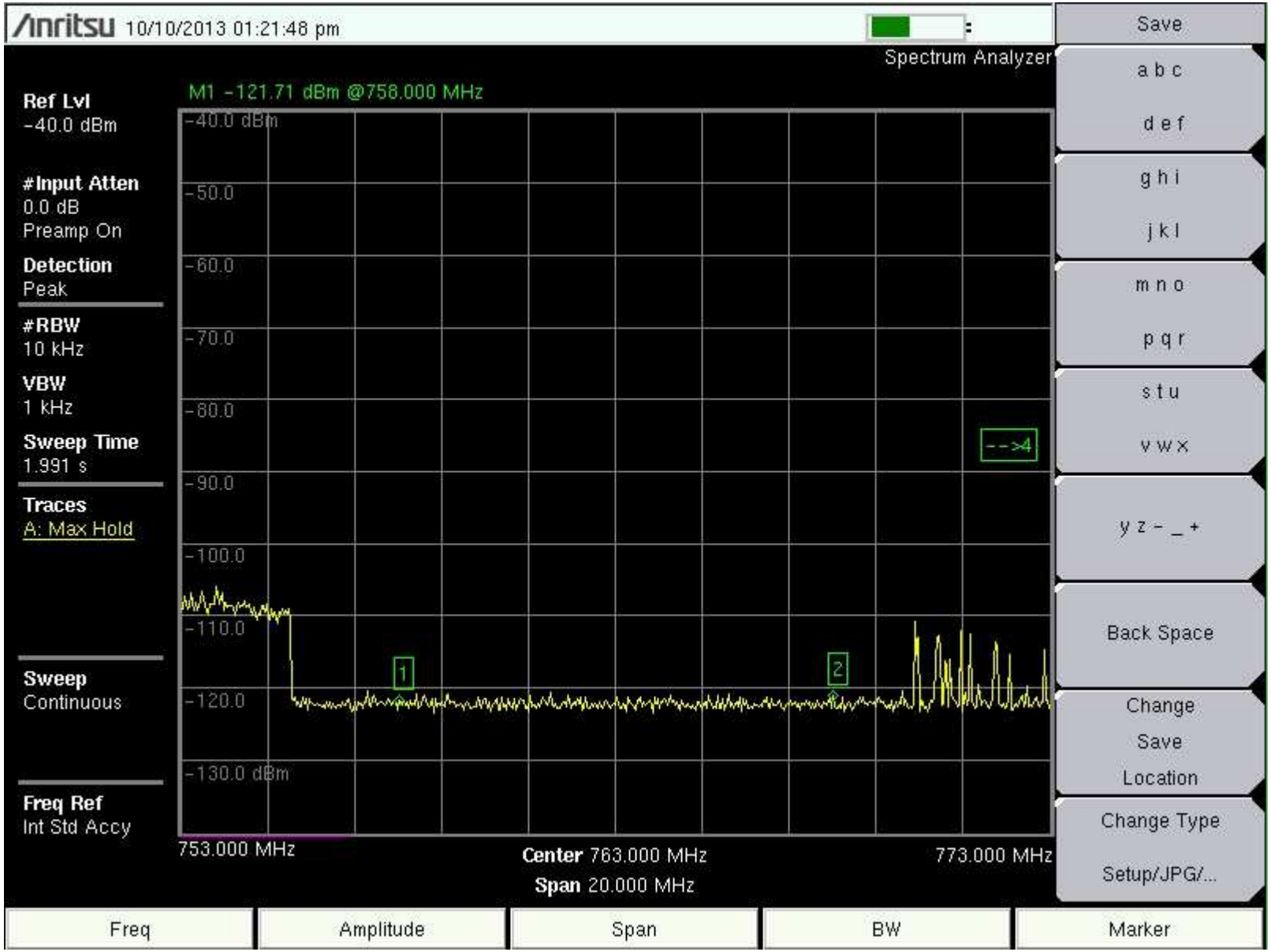


Figure 3.8-6 – Location # 7 - Spectrum Analyzer Image @ 10 kHz RBW
Band 14 Downlink - NO SIGNAL PRESENT - Signal Level < -121 dBm (758-768 MHz) Markers 1 & 2

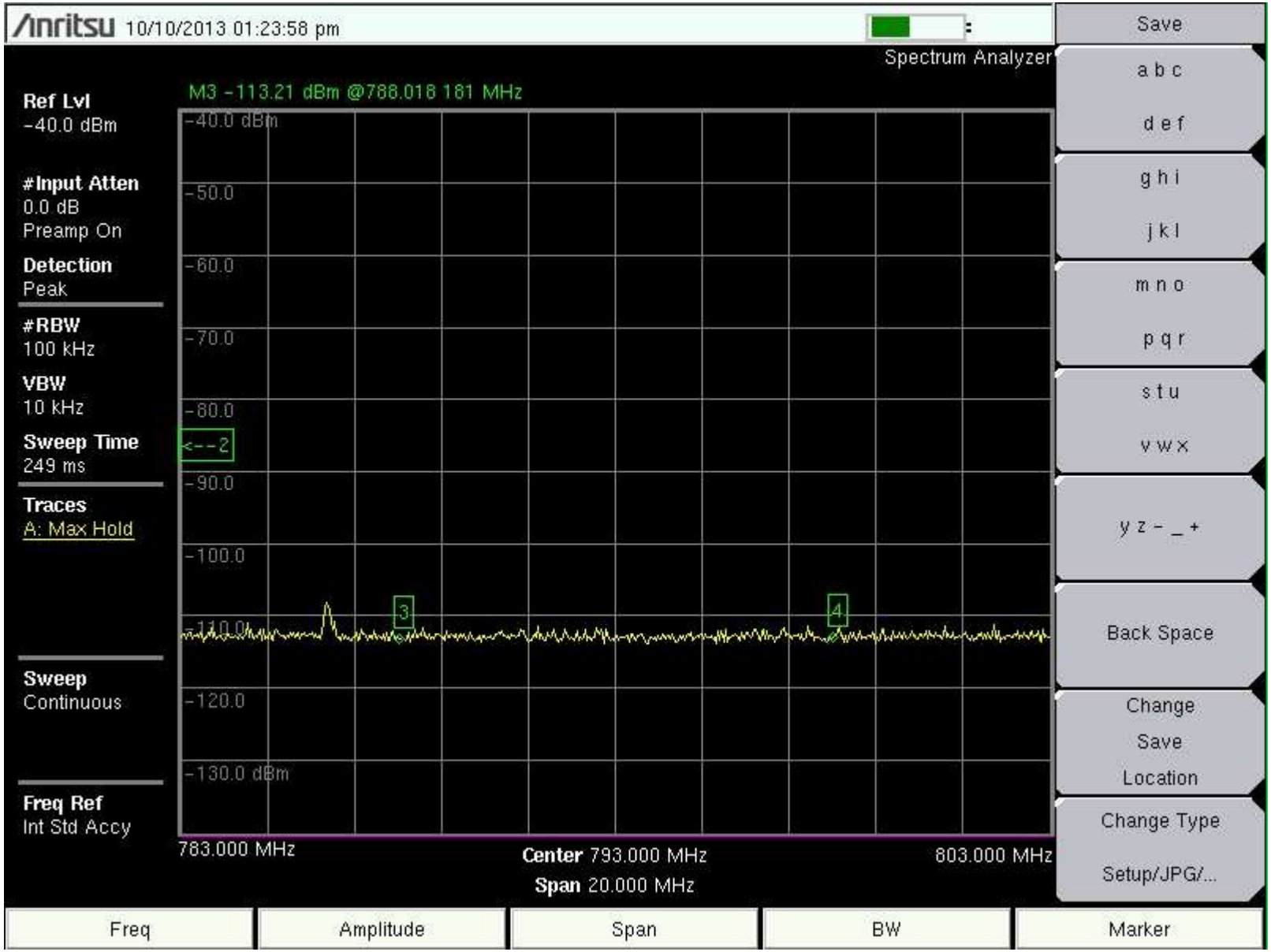


Figure 3.8-7 – Location # 7 - Spectrum Analyzer Image @ 100 kHz RBW
Band 14 Uplink - NO SIGNAL PRESENT - Signal Level < -112 dBm (788-798 MHz) Markers 3 & 4

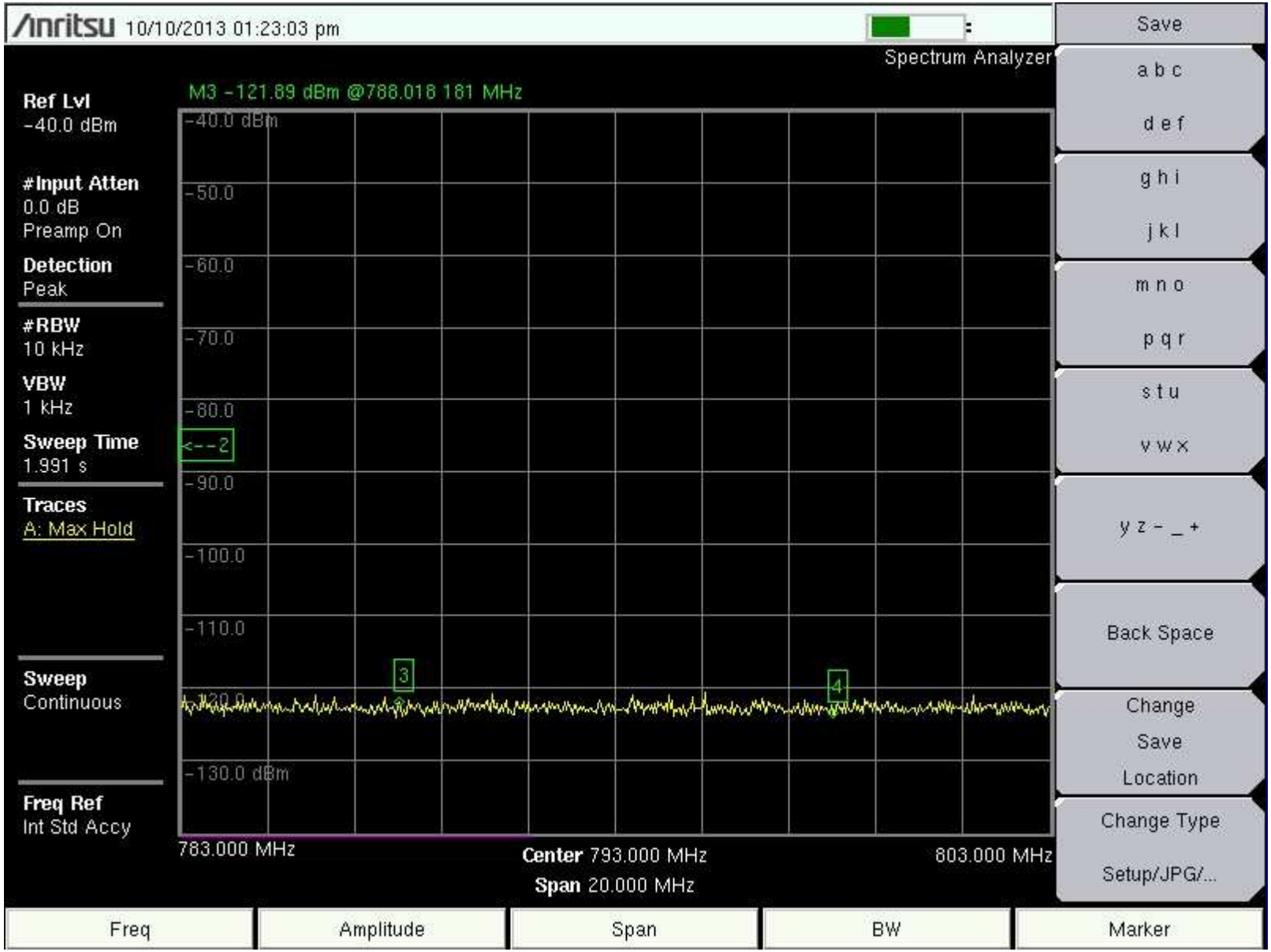


Figure 3.8-8 – Location # 7 - Spectrum Analyzer Image @ 10 kHz RBW
Band 14 Uplink - NO SIGNAL PRESENT - Signal Level < -121 dBm (788-798 MHz) Markers 3 & 4

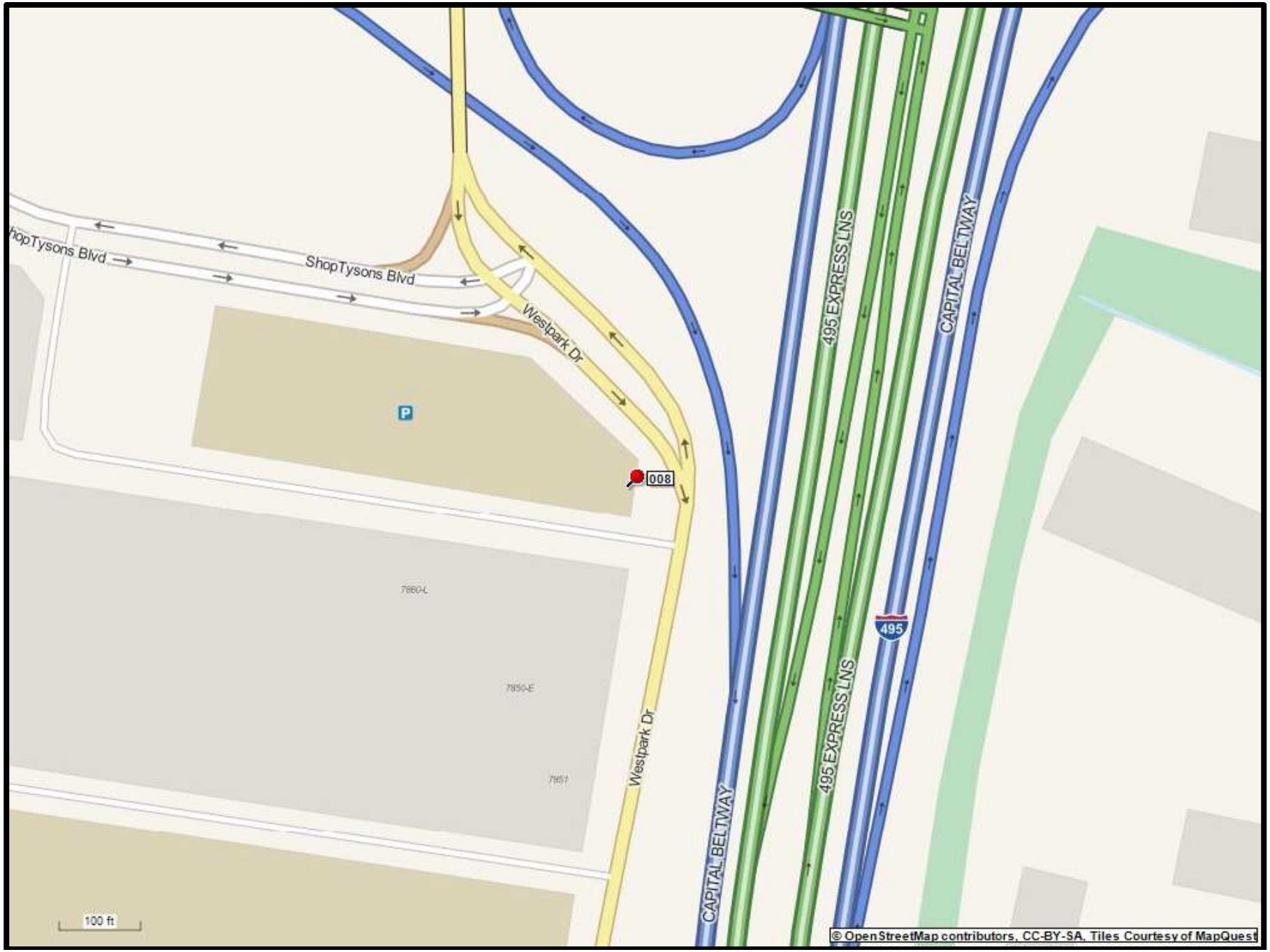


Figure 3.9-1 – Street Map Showing Measurement Location # 8

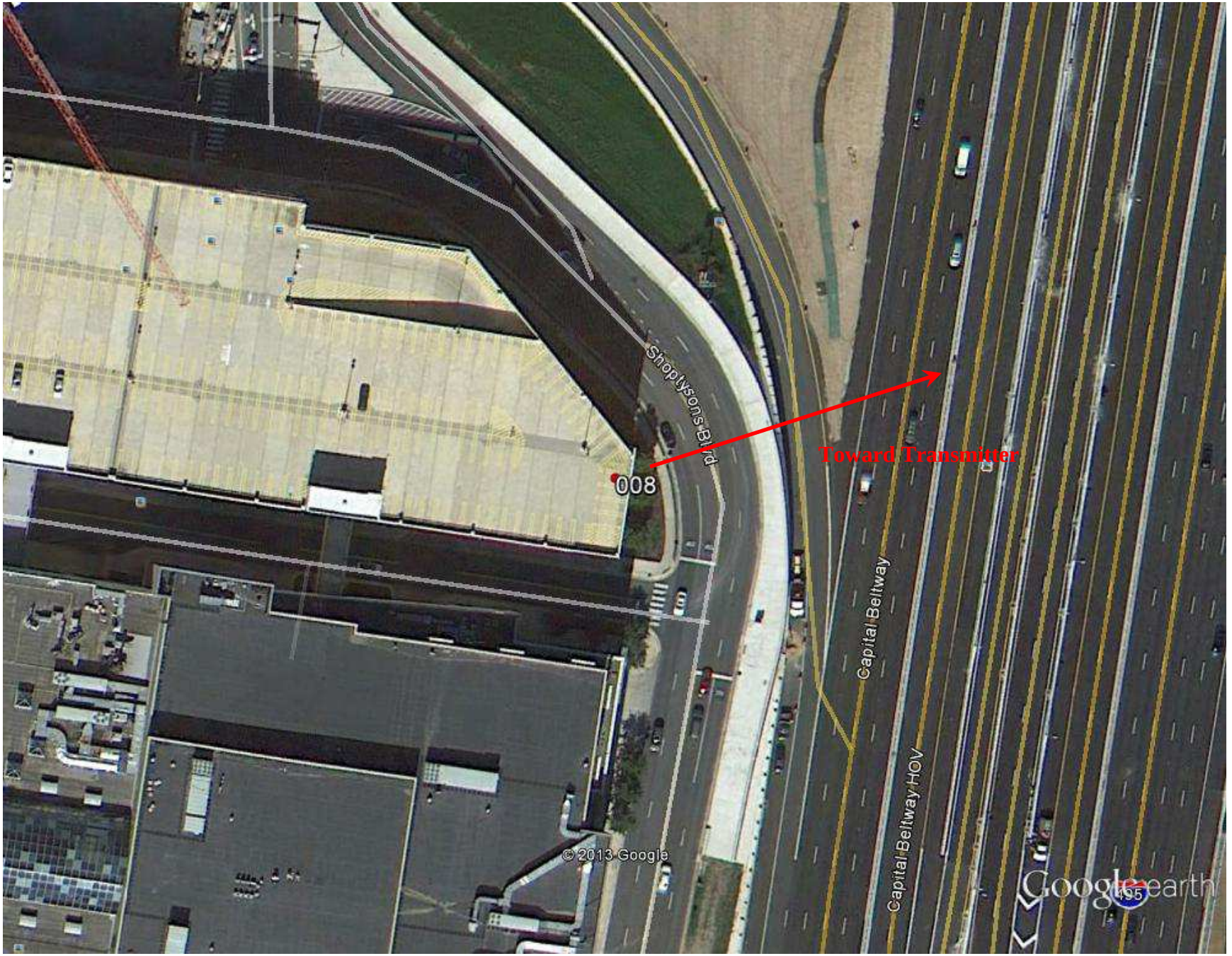


Figure 3.9-2 – Aerial Image Showing Measurement Location # 8

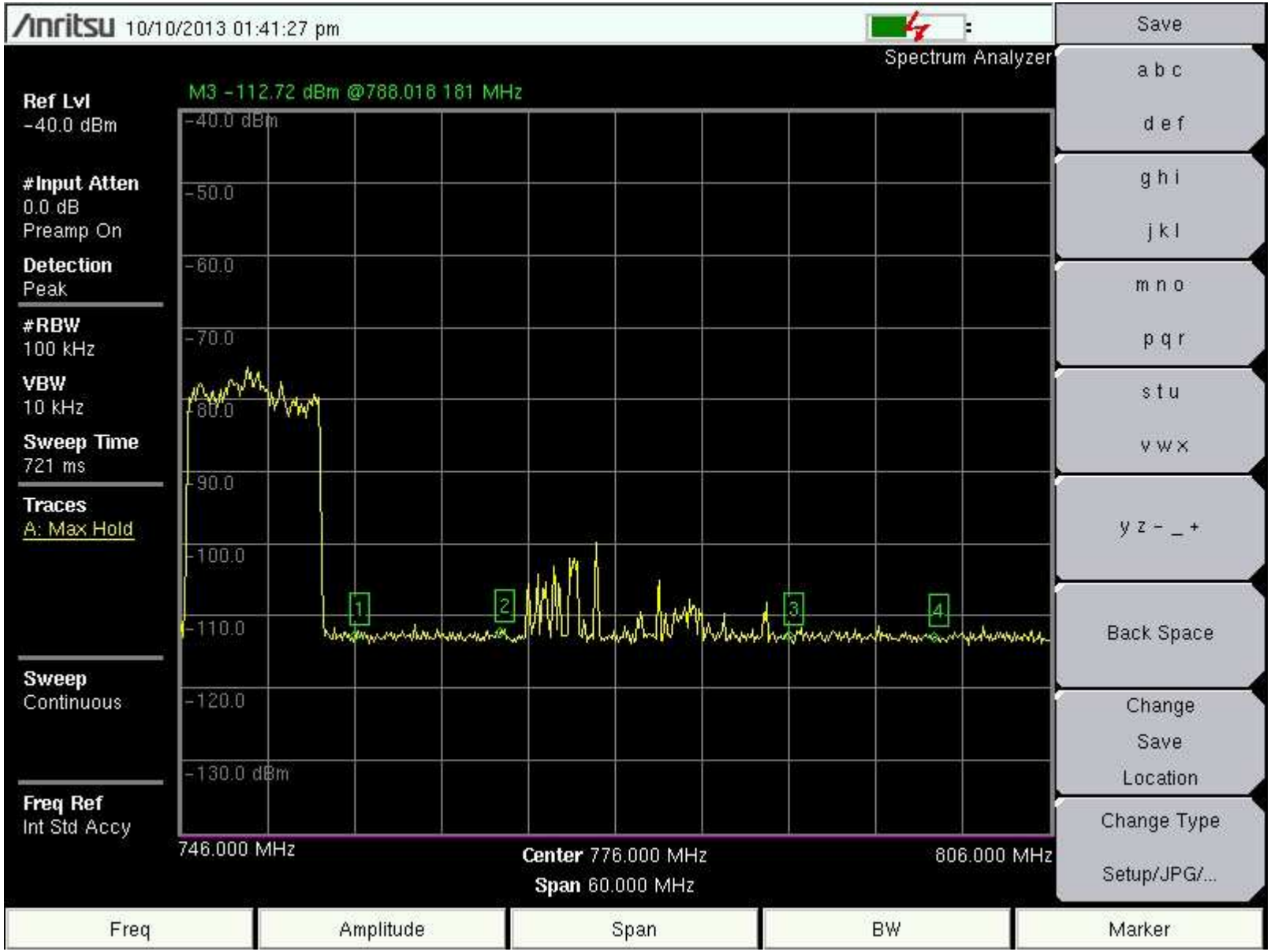


Figure 3.9-3 – Location # 8 - Spectrum Analyzer Image @ 100 kHz RBW – Upper 700 MHz Band (746-806 MHz)
Band 14 Downlink - NO SIGNAL PRESENT - Signal Level < -112 dBm (758-768 MHz) Markers 1 & 2
Band 14 Uplink - NO SIGNAL PRESENT - Signal Level < -112 dBm (788-798 MHz) Markers 3 & 4

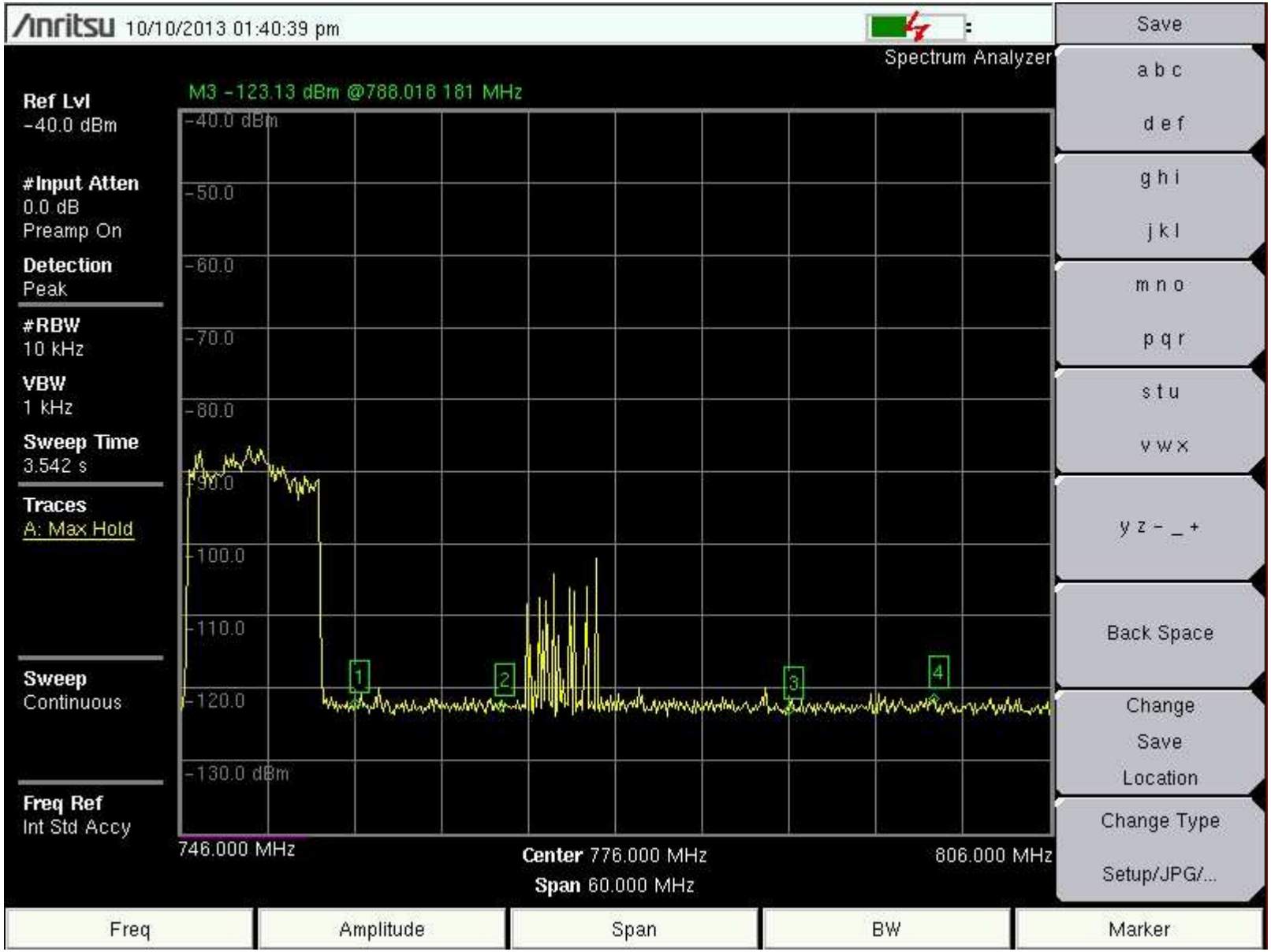


Figure 3.9-4 – Location # 8 - Spectrum Analyzer Image @ 10 kHz RBW – Upper 700 MHz Band (746-806 MHz)
Band 14 Downlink - NO SIGNAL PRESENT - Signal Level < -122 dBm (758-768 MHz) Markers 1 & 2
Band 14 Uplink - NO SIGNAL PRESENT - Signal Level < -122 dBm (788-798 MHz) Markers 3 & 4

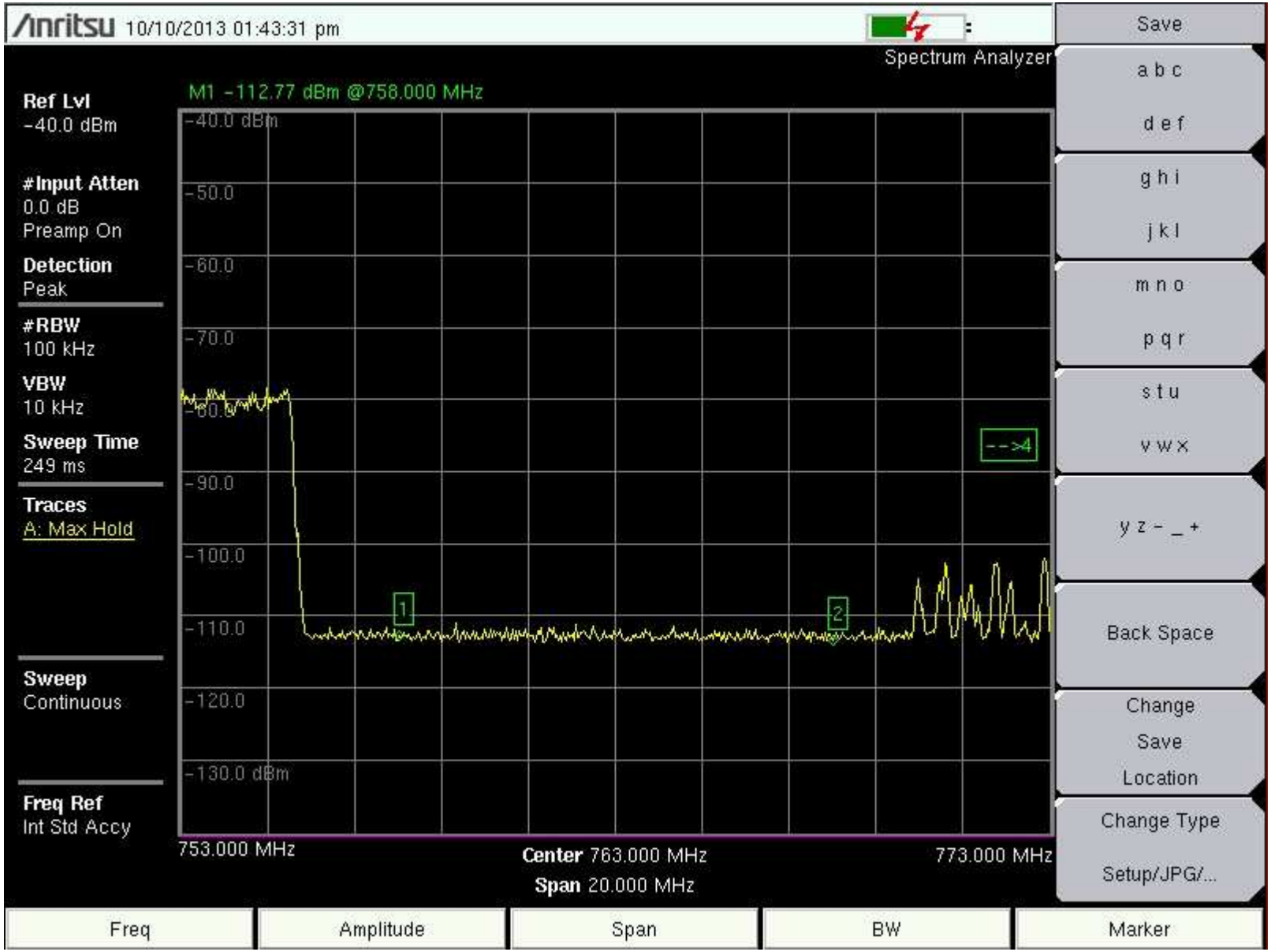


Figure 3.9-5 – Location # 8 - Spectrum Analyzer Image @ 100 kHz RBW
Band 14 Downlink - NO SIGNAL PRESENT - Signal Level < -112 dBm (758-768 MHz) Markers 1 & 2

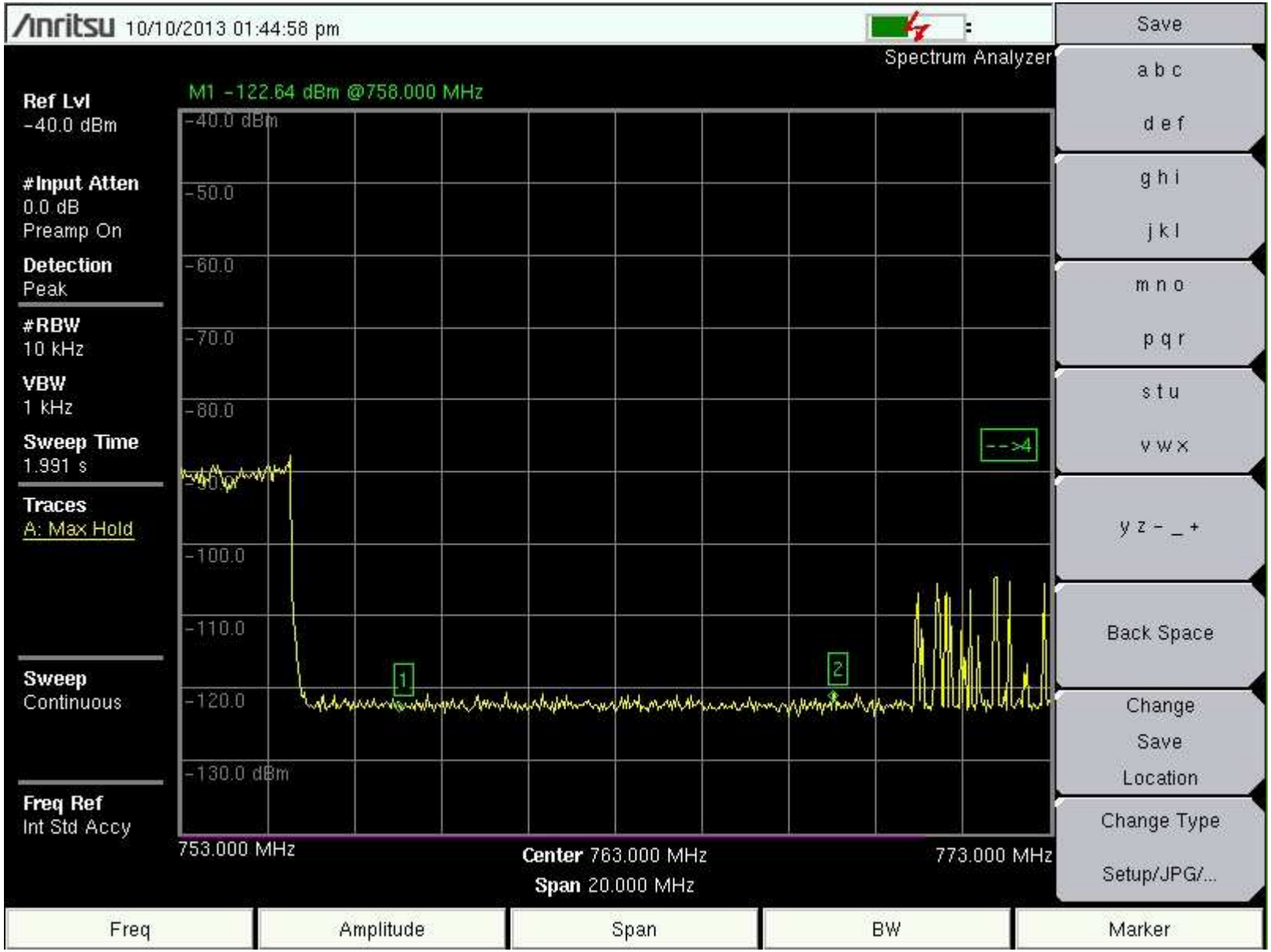


Figure 3.9-6 – Location # 8 - Spectrum Analyzer Image @ 10 kHz RBW
Band 14 Downlink - NO SIGNAL PRESENT - Signal Level < -121 dBm (758-768 MHz) Markers 1 & 2

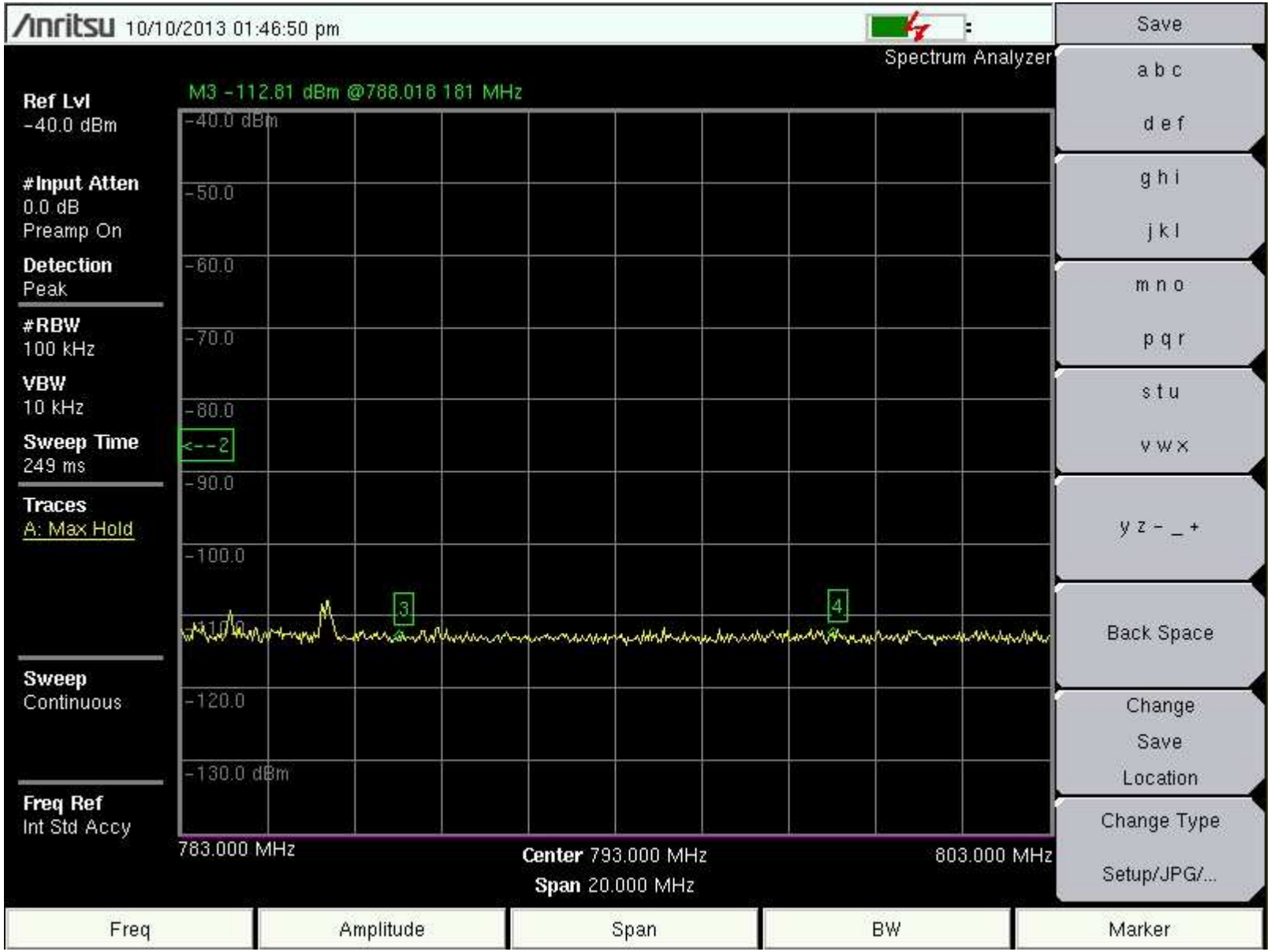


Figure 3.9-7 – Location # 8 - Spectrum Analyzer Image @ 100 kHz RBW
Band 14 Uplink - NO SIGNAL PRESENT - Signal Level < -112 dBm (788-798 MHz) Markers 3 & 4

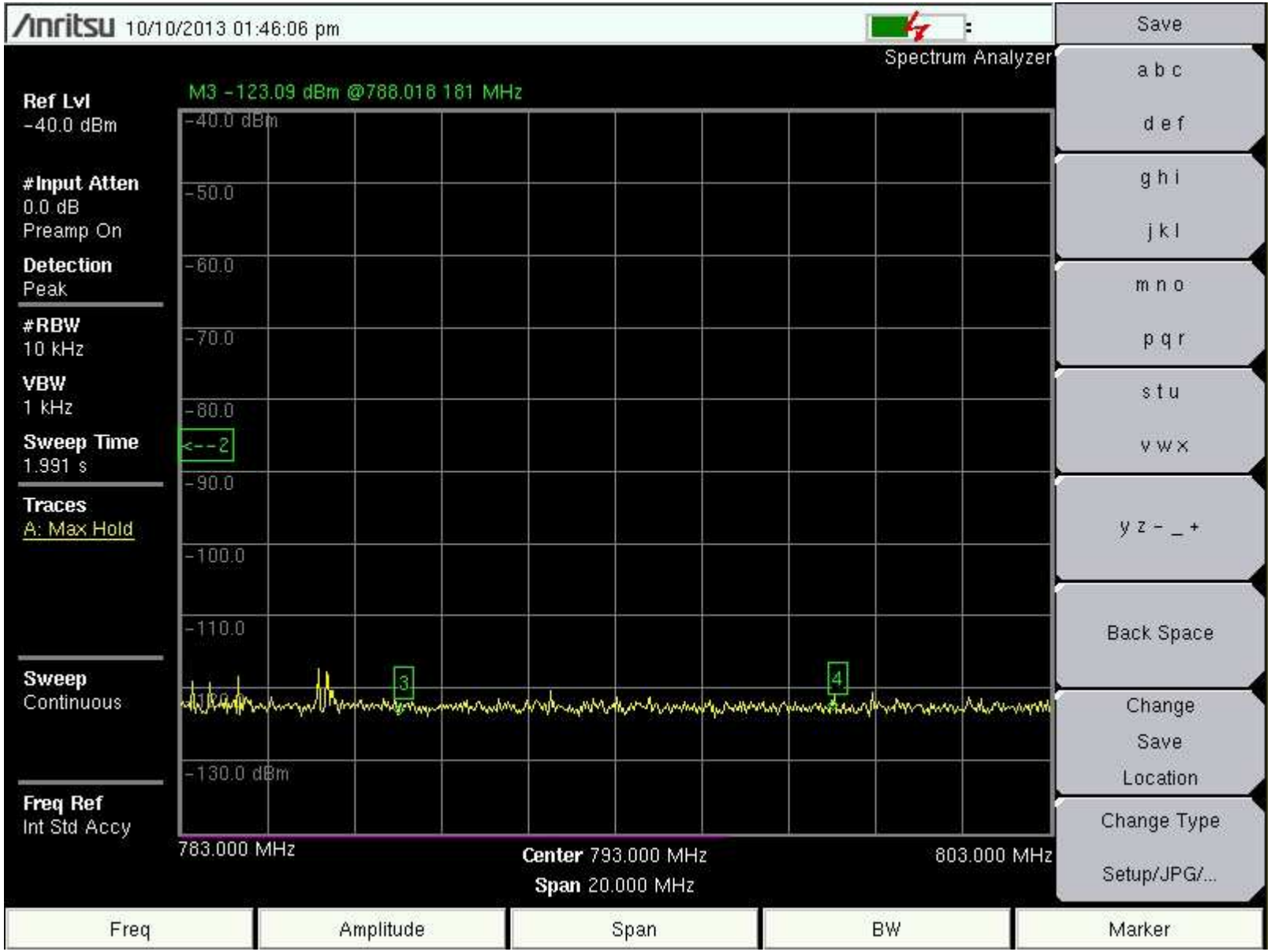


Figure 3.9-8 – Location # 8 - Spectrum Analyzer Image @ 10 kHz RBW
Band 14 Uplink - NO SIGNAL PRESENT - Signal Level < -121 dBm (788-798 MHz) Markers 3 & 4

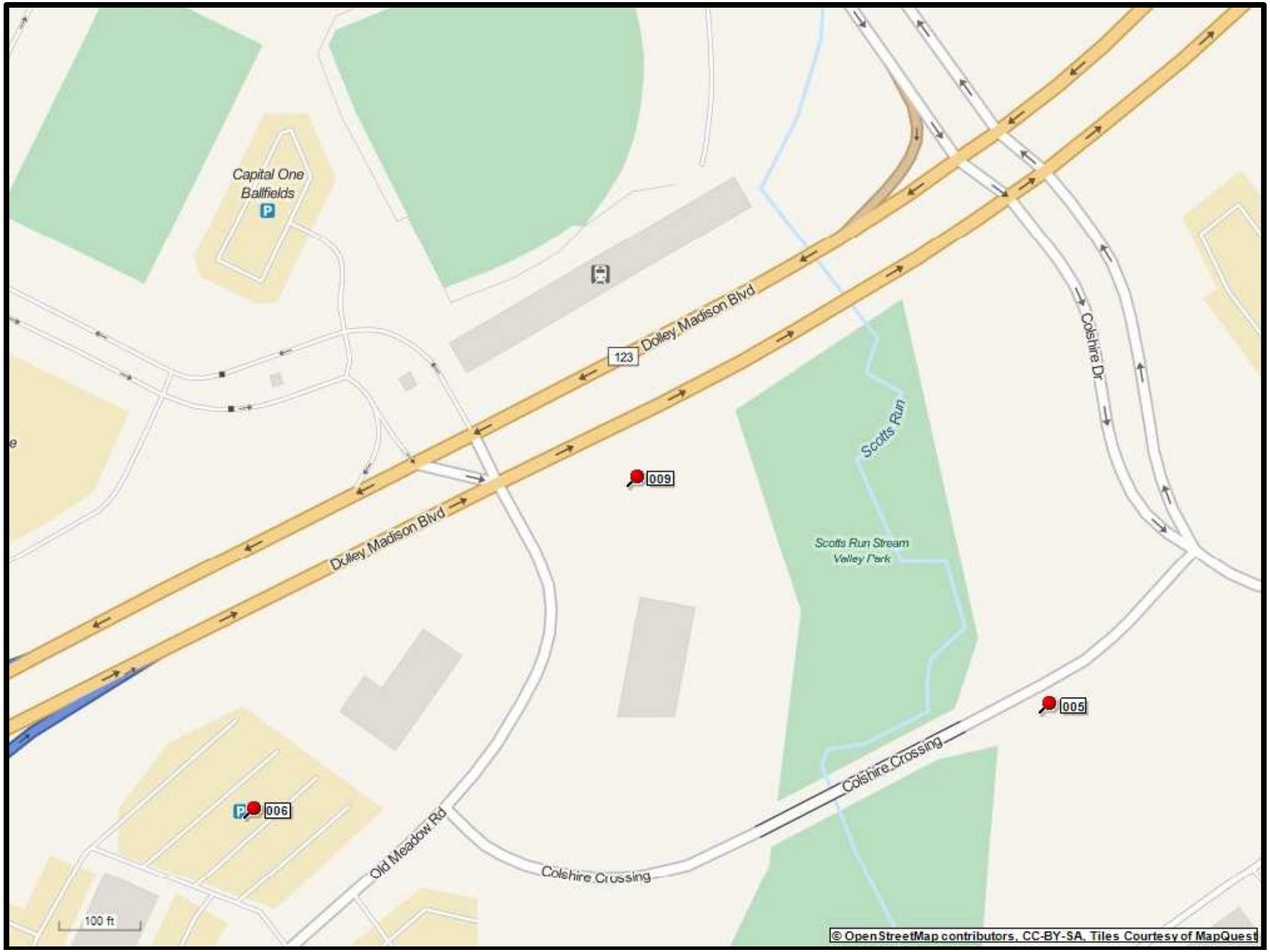


Figure 3.10-1 – Street Map Showing Measurement Location # 9

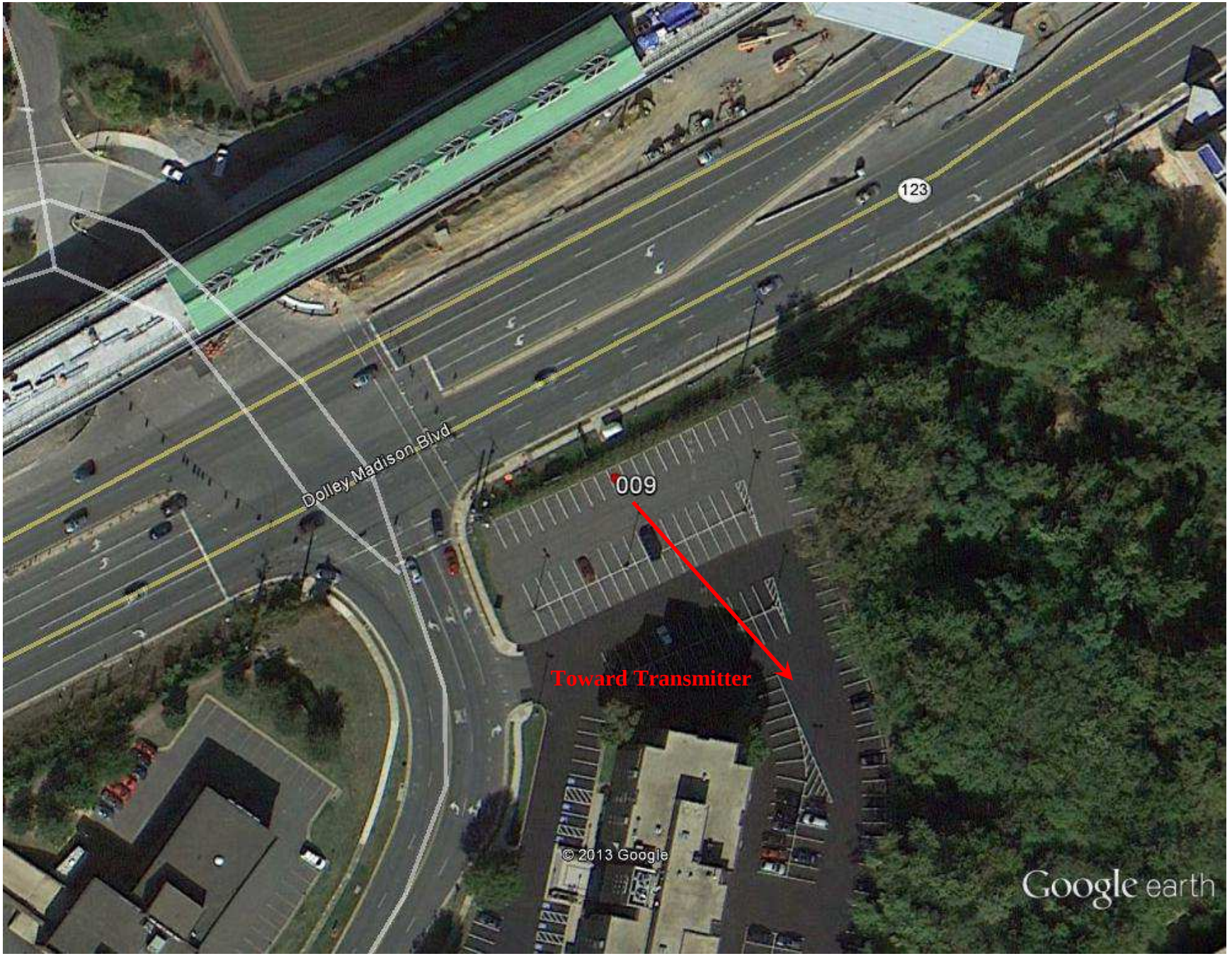


Figure 3.10-2 – Aerial Image Showing Measurement Location # 9

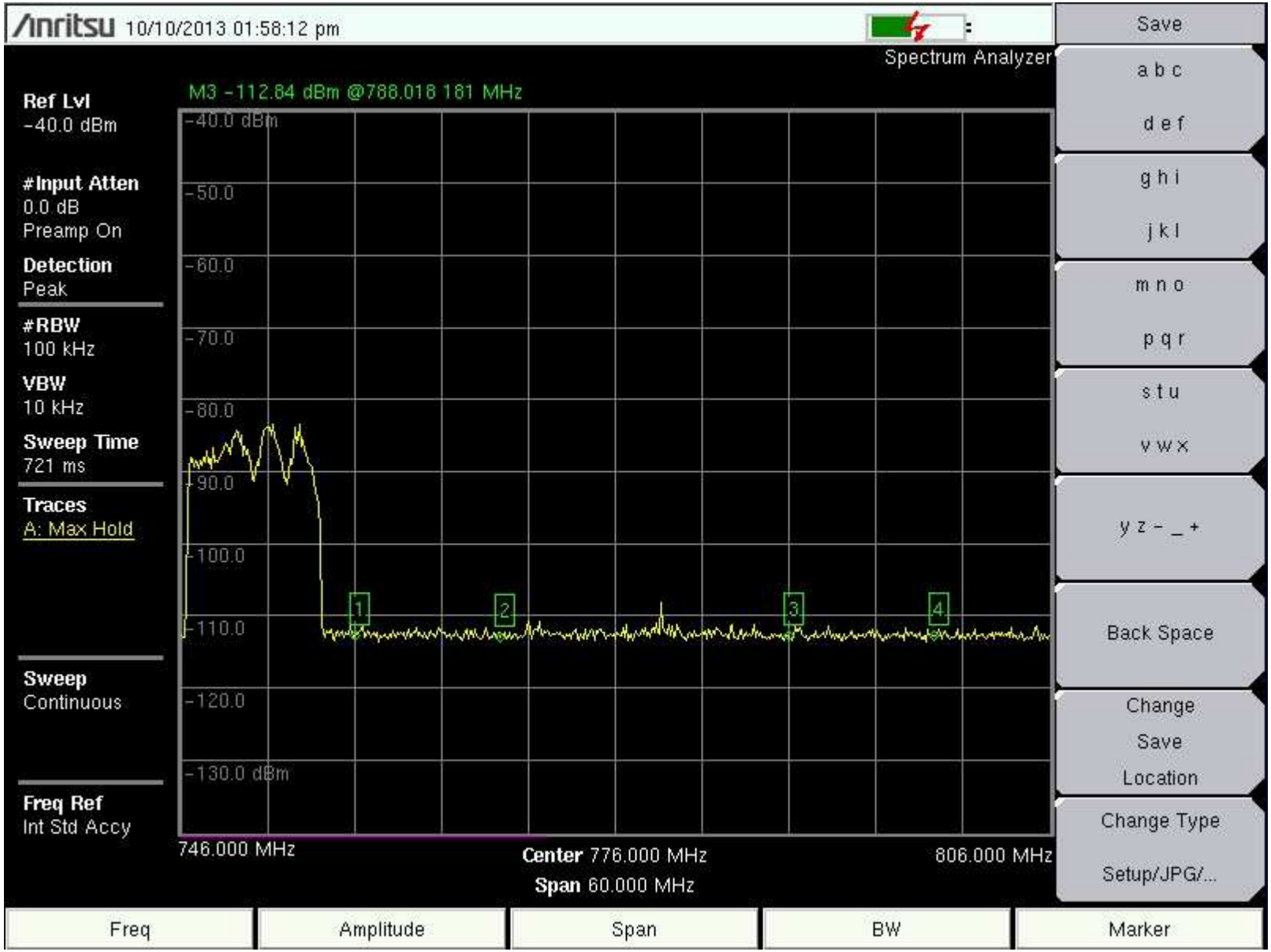


Figure 3.10-3 – Location # 9 - Spectrum Analyzer Image @ 100 kHz RBW – Upper 700 MHz Band (746-806 MHz)
Band 14 Downlink - NO SIGNAL PRESENT - Signal Level < -112 dBm (758-768 MHz) Markers 1 & 2
Band 14 Uplink - NO SIGNAL PRESENT - Signal Level < -112 dBm (788-798 MHz) Markers 3 & 4

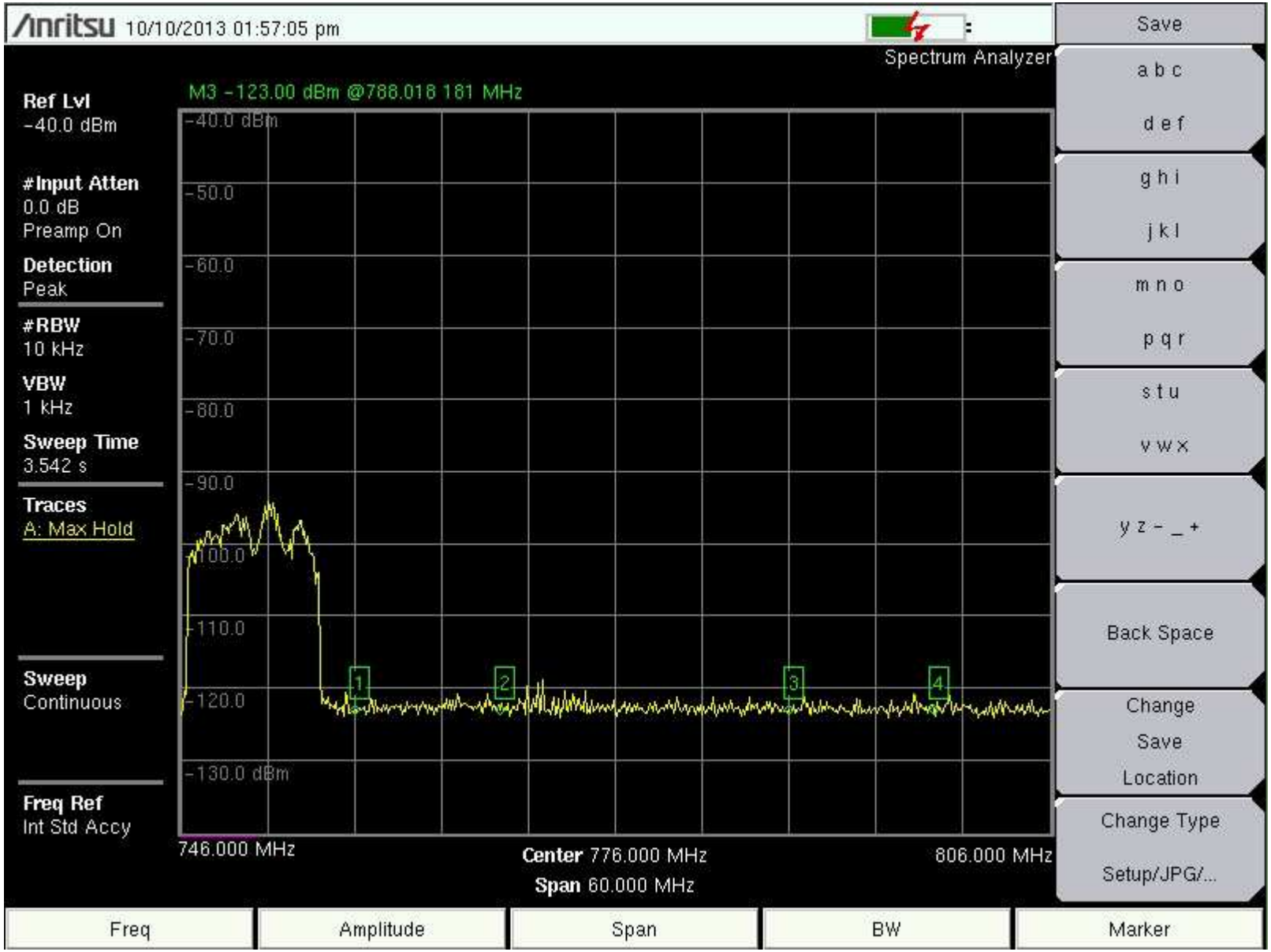


Figure 3.10-4 – Location # 9 - Spectrum Analyzer Image @ 10 kHz RBW – Upper 700 MHz Band (746-806 MHz)
Band 14 Downlink - NO SIGNAL PRESENT - Signal Level < -122 dBm (758-768 MHz) Markers 1 & 2
Band 14 Uplink - NO SIGNAL PRESENT - Signal Level < -122 dBm (788-798 MHz) Markers 3 & 4

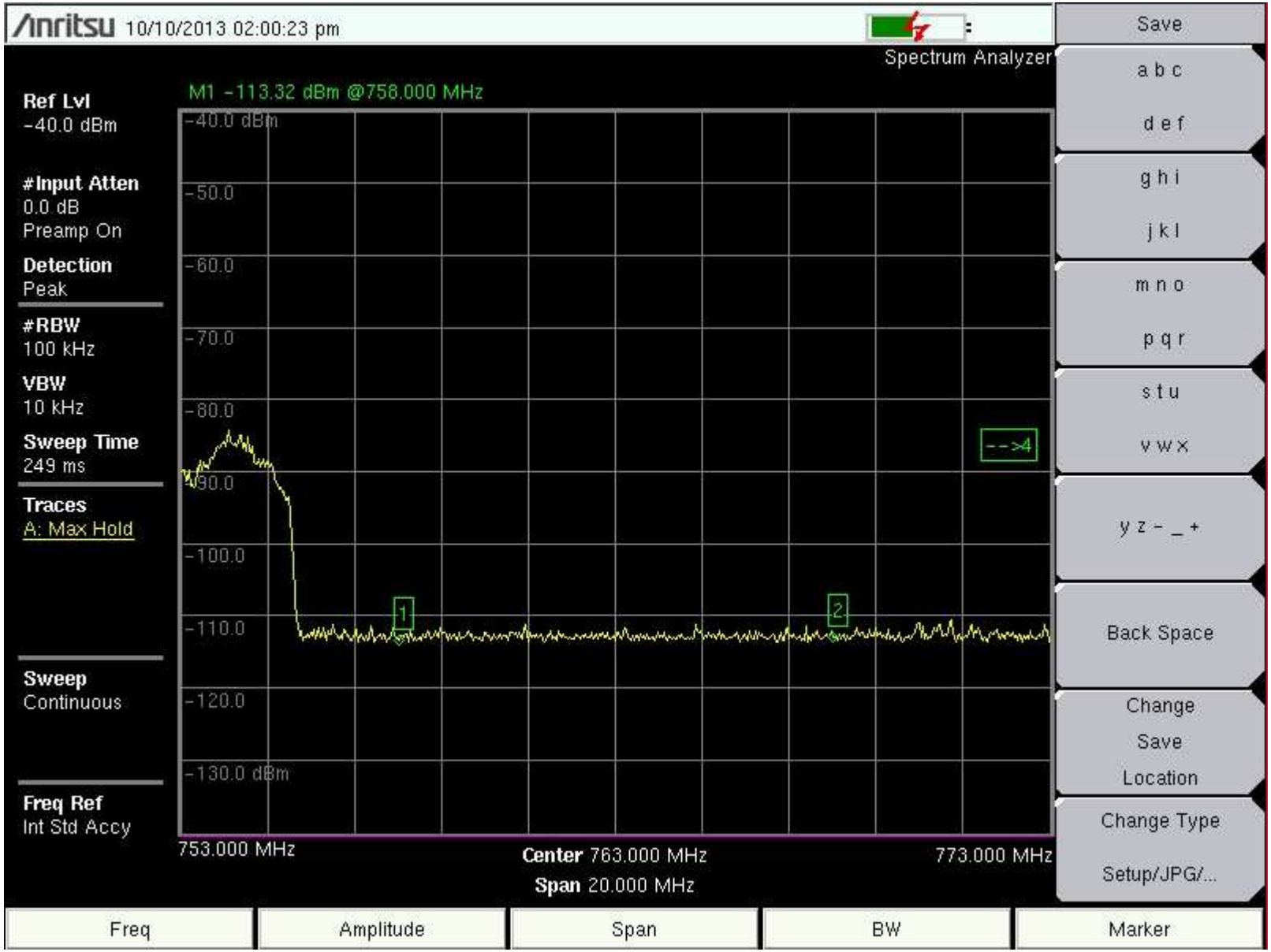


Figure 3.10-5 – Location # 9 - Spectrum Analyzer Image @ 100 kHz RBW
Band 14 Downlink - NO SIGNAL PRESENT - Signal Level < -112 dBm (758-768 MHz) Markers 1 & 2

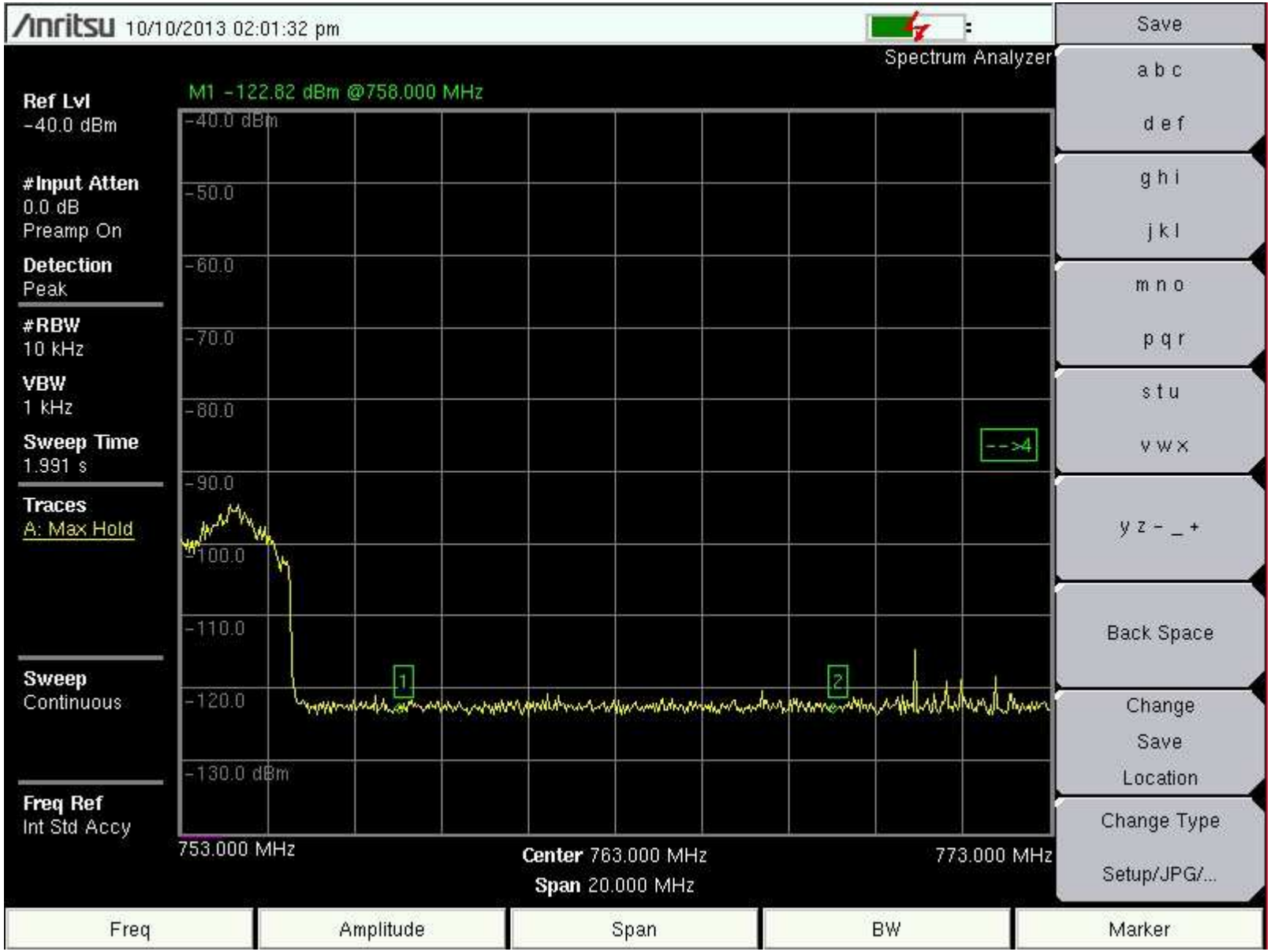


Figure 3.10-6 – Location # 9 - Spectrum Analyzer Image @ 10 kHz RBW
Band 14 Downlink - NO SIGNAL PRESENT - Signal Level < -121 dBm (758-768 MHz) Markers 1 & 2

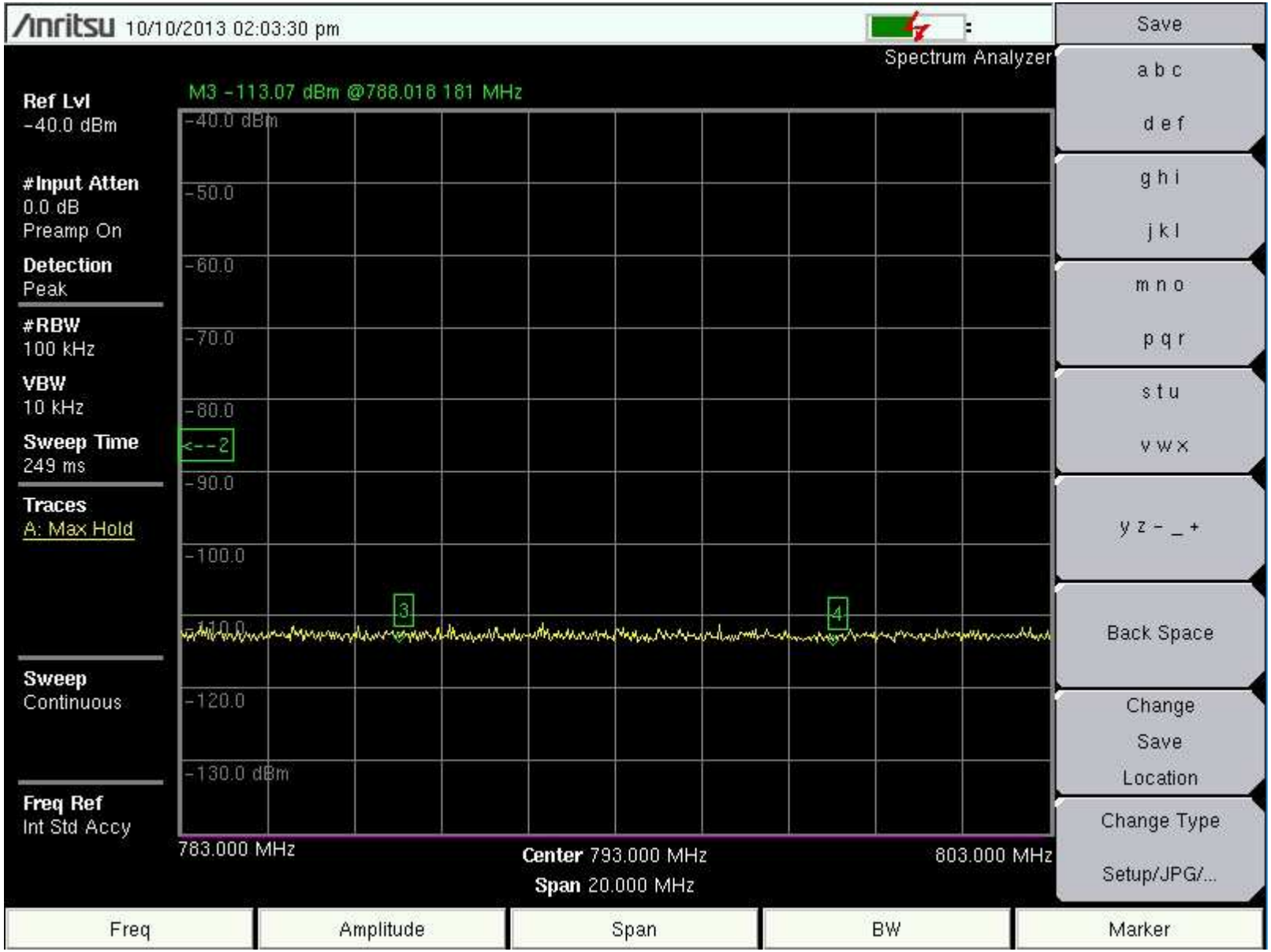


Figure 3.10-7 – Location # 9 - Spectrum Analyzer Image @ 100 kHz RBW
Band 14 Uplink - NO SIGNAL PRESENT - Signal Level < -112 dBm (788-798 MHz) Markers 3 & 4

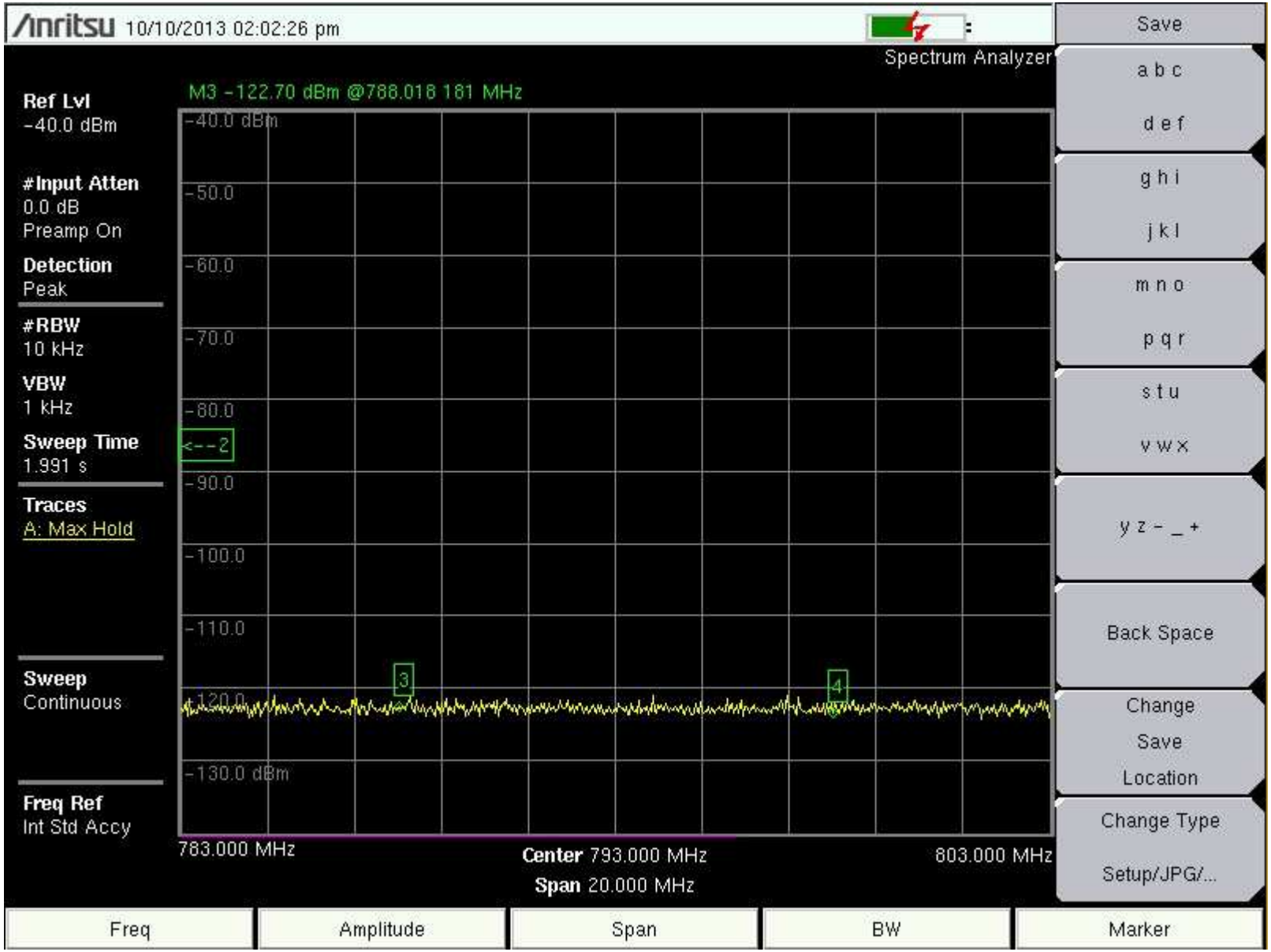


Figure 3.10-8 – Location # 9 - Spectrum Analyzer Image @ 10 kHz RBW
Band 14 Uplink - NO SIGNAL PRESENT - Signal Level < -121 dBm (788-798 MHz) Markers 3 & 4

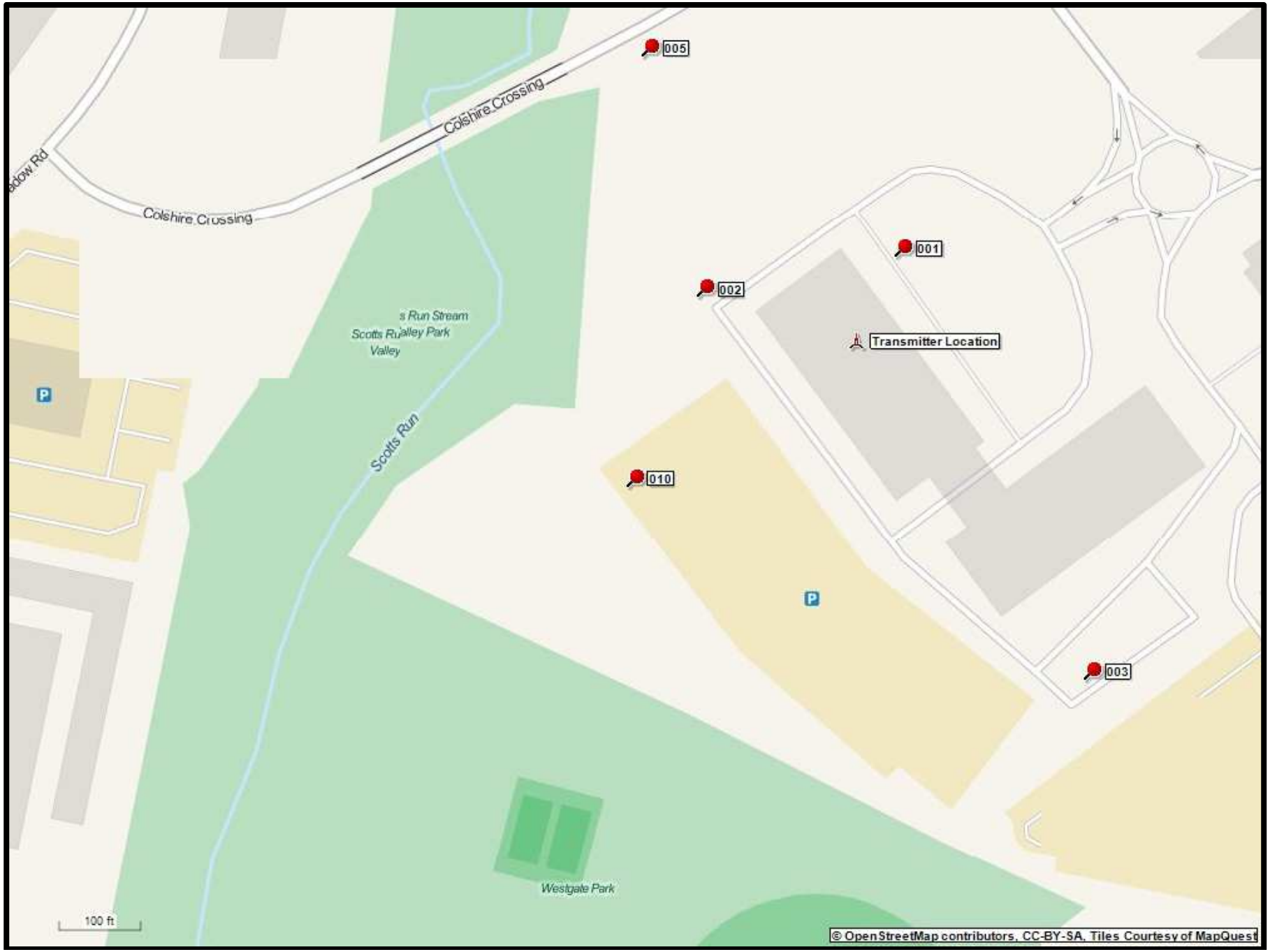


Figure 3.11-1 – Street Map Showing Measurement Location # 10

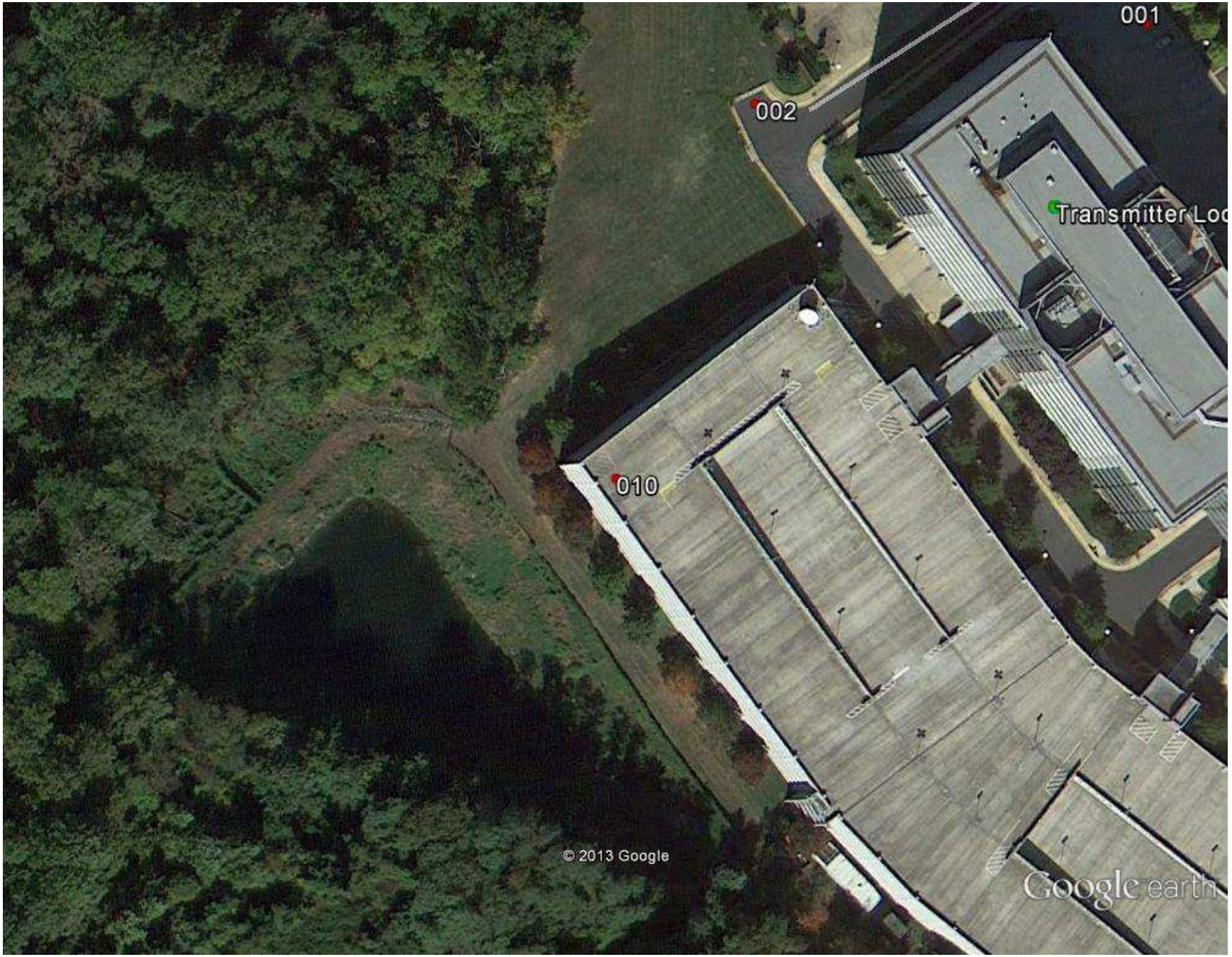


Figure 3.11-2 – Aerial Image Showing Measurement Location # 10

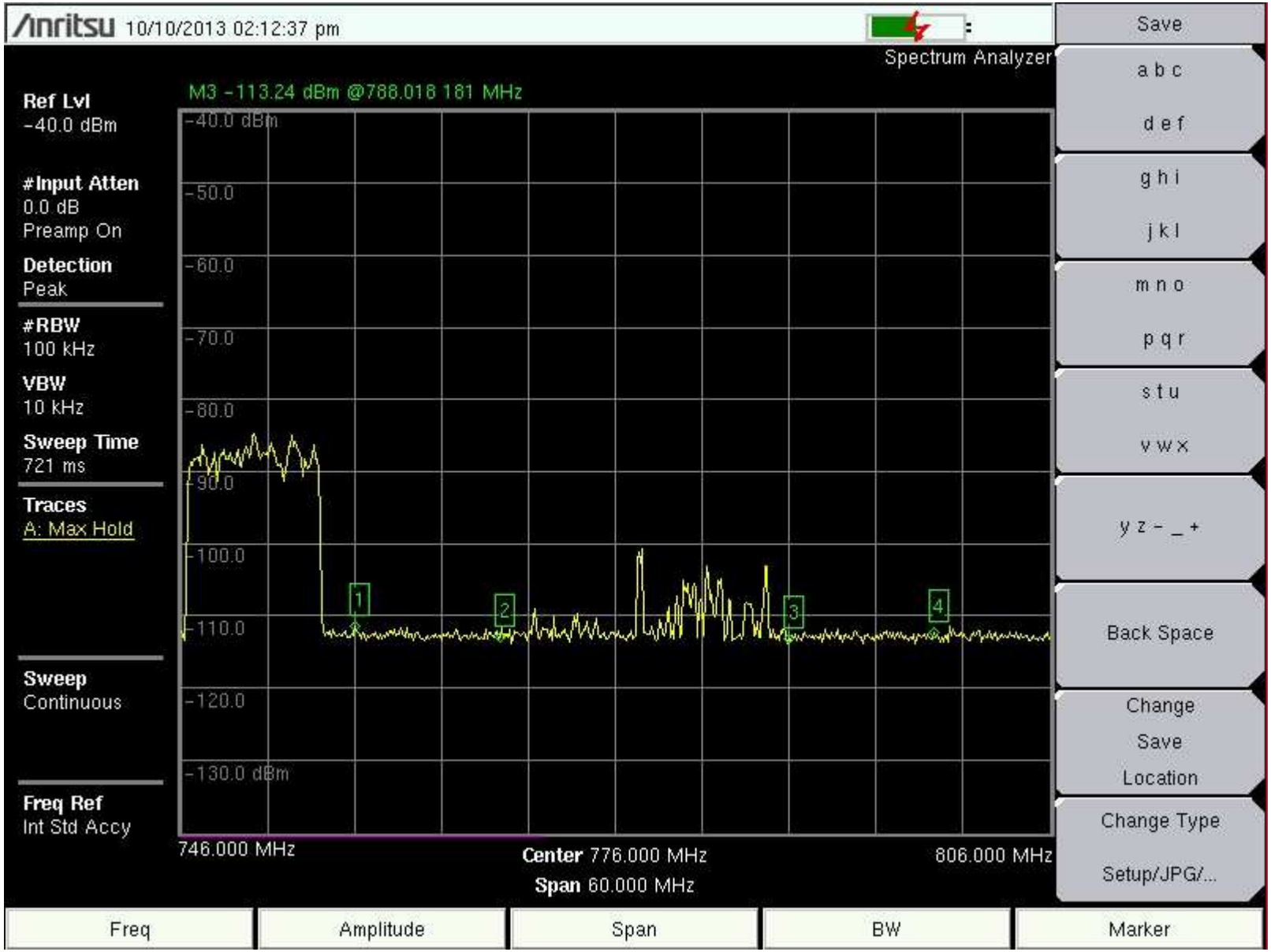


Figure 3.11-3 – Location # 10 - Spectrum Analyzer Image @ 100 kHz RBW – Upper 700 MHz Band (746-806 MHz)
Band 14 Downlink - NO SIGNAL PRESENT - Signal Level < -112 dBm (758-768 MHz) Markers 1 & 2
Band 14 Uplink - NO SIGNAL PRESENT - Signal Level < -112 dBm (788-798 MHz) Markers 3 & 4

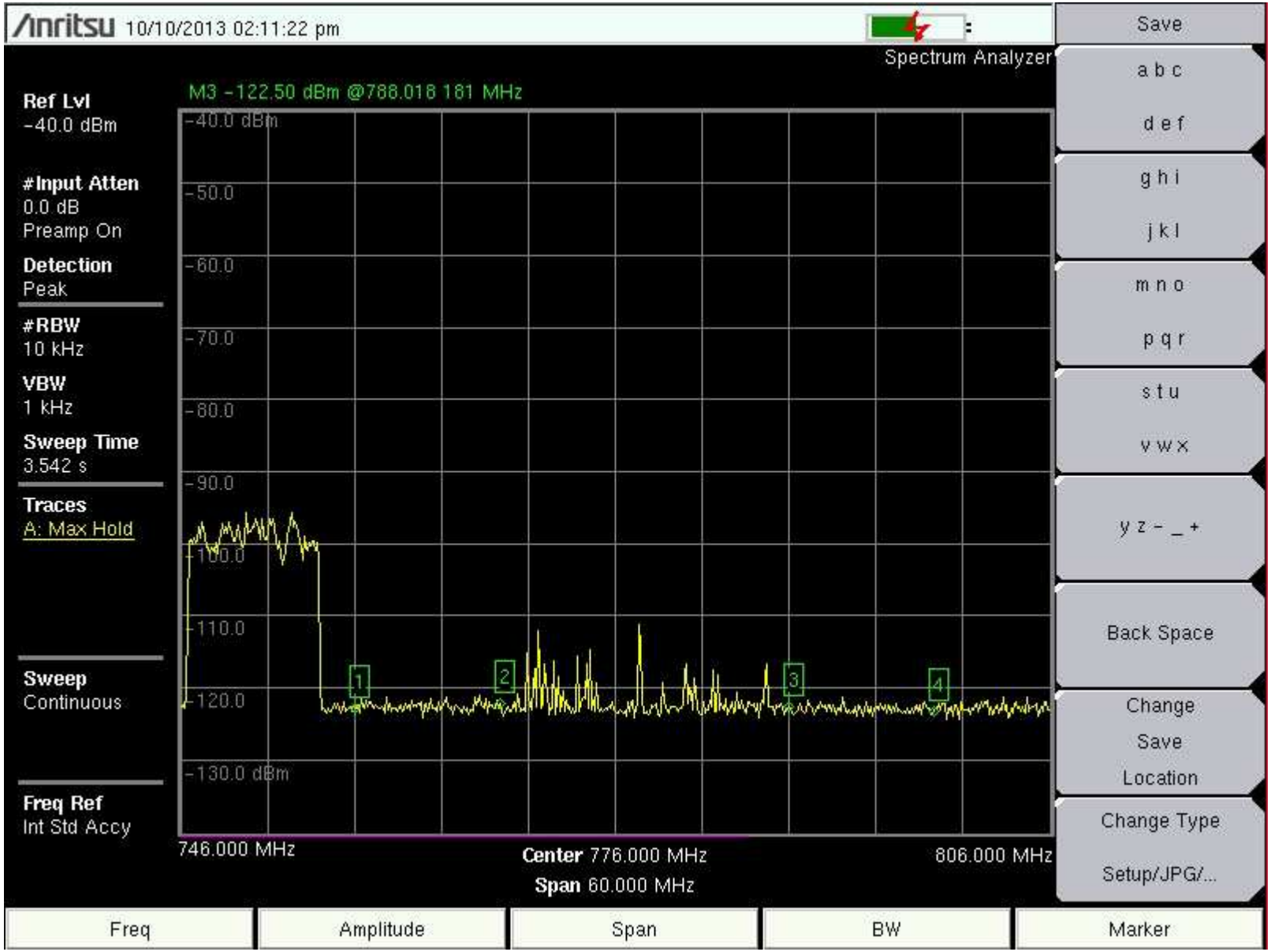


Figure 3.11-4 – Location # 10 - Spectrum Analyzer Image @ 10 kHz RBW – Upper 700 MHz Band (746-806 MHz)
Band 14 Downlink - NO SIGNAL PRESENT - Signal Level < -121 dBm (758-768 MHz) Markers 1 & 2
Band 14 Uplink - NO SIGNAL PRESENT - Signal Level < -121 dBm (788-798 MHz) Markers 3 & 4

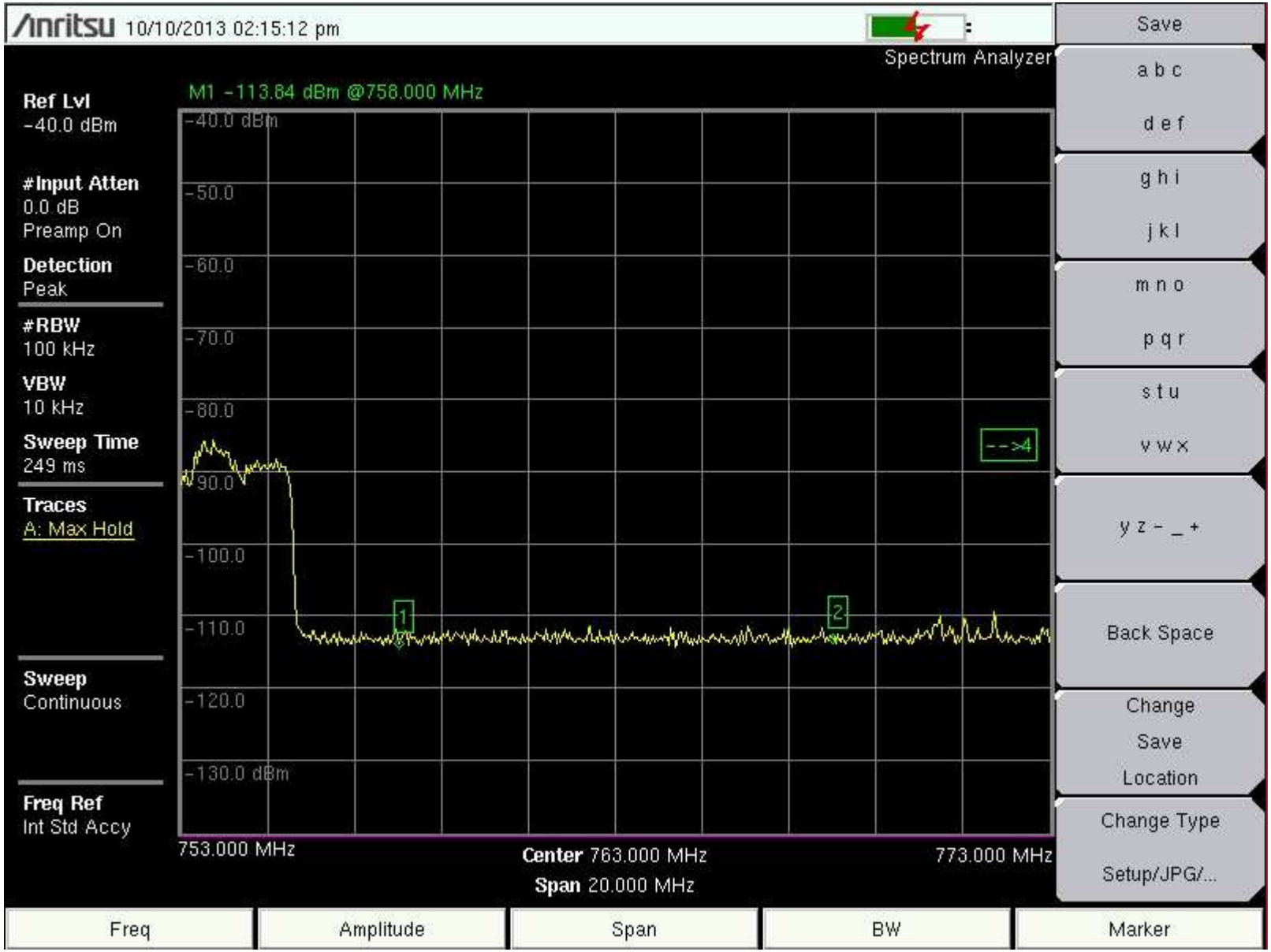


Figure 3.11-5 – Location # 10 - Spectrum Analyzer Image @ 100 kHz RBW
Band 14 Downlink - NO SIGNAL PRESENT - Signal Level < -112 dBm (758-768 MHz) Markers 1 & 2

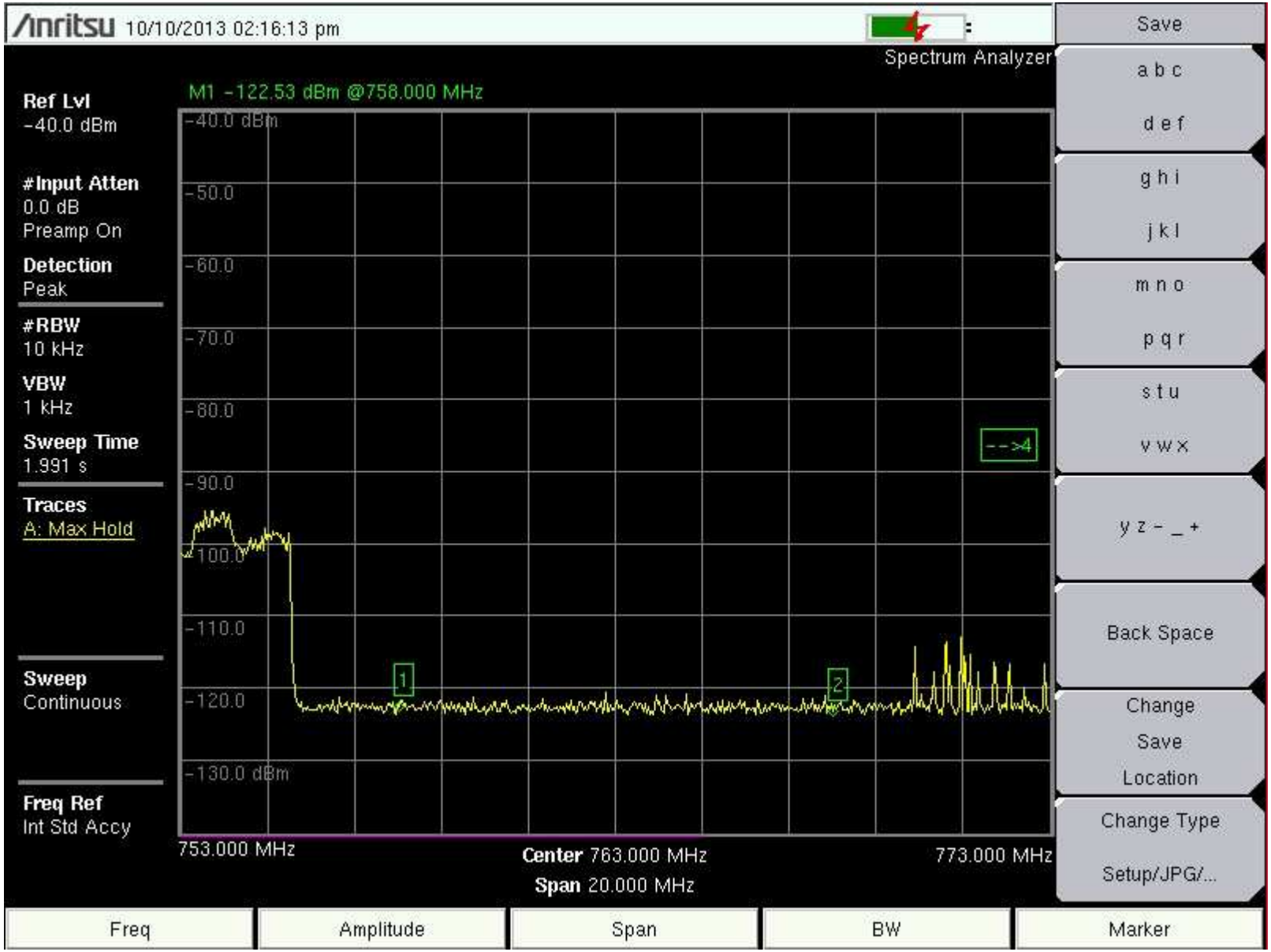


Figure 3.11-6 – Location # 10 - Spectrum Analyzer Image @ 10 kHz RBW
Band 14 Downlink - NO SIGNAL PRESENT - Signal Level < -121 dBm (758-768 MHz) Markers 1 & 2

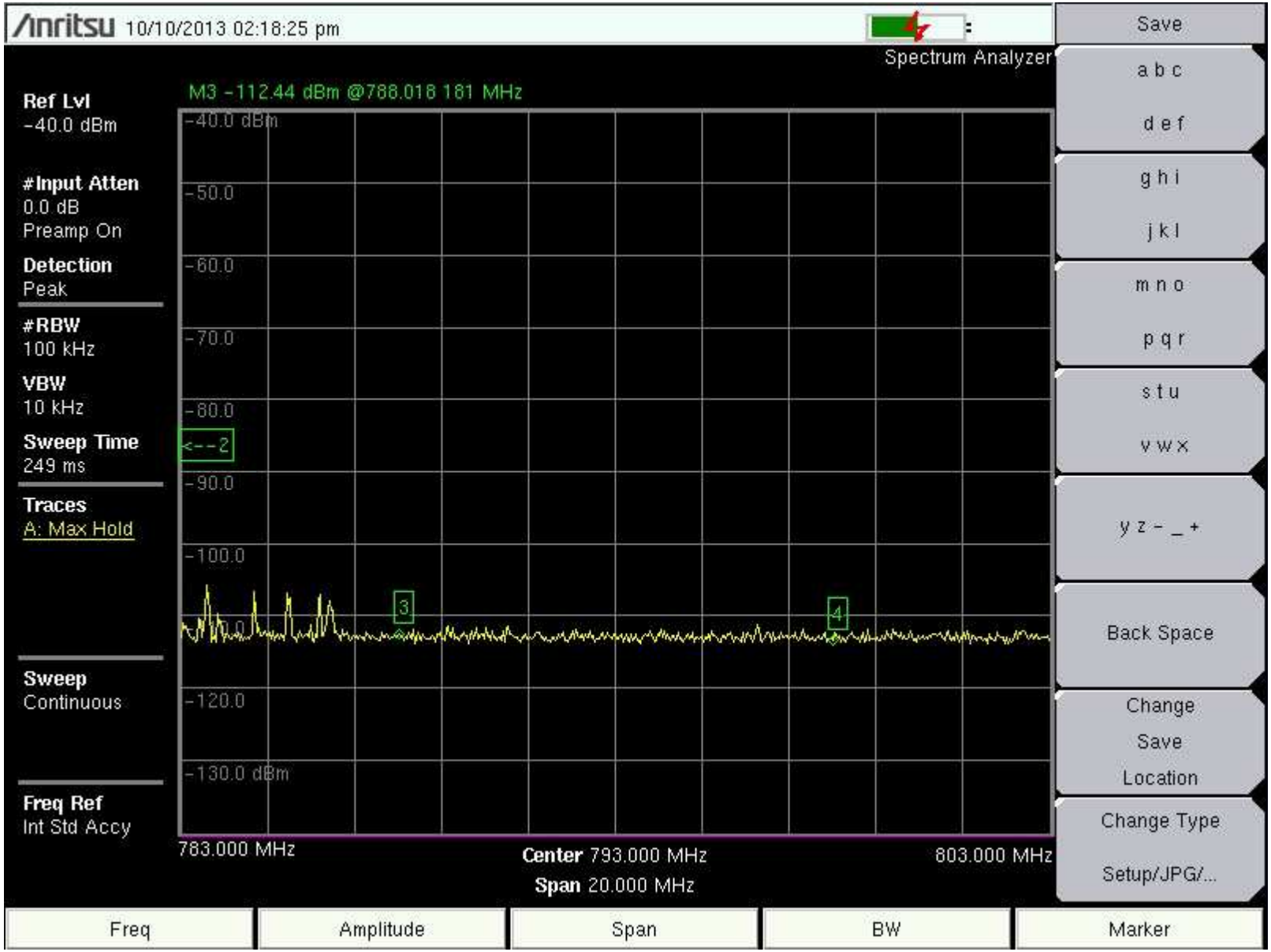


Figure 3.11-7 – Location # 10 - Spectrum Analyzer Image @ 100 kHz RBW
Band 14 Uplink - NO SIGNAL PRESENT - Signal Level < -112 dBm (788-798 MHz) Markers 3 & 4

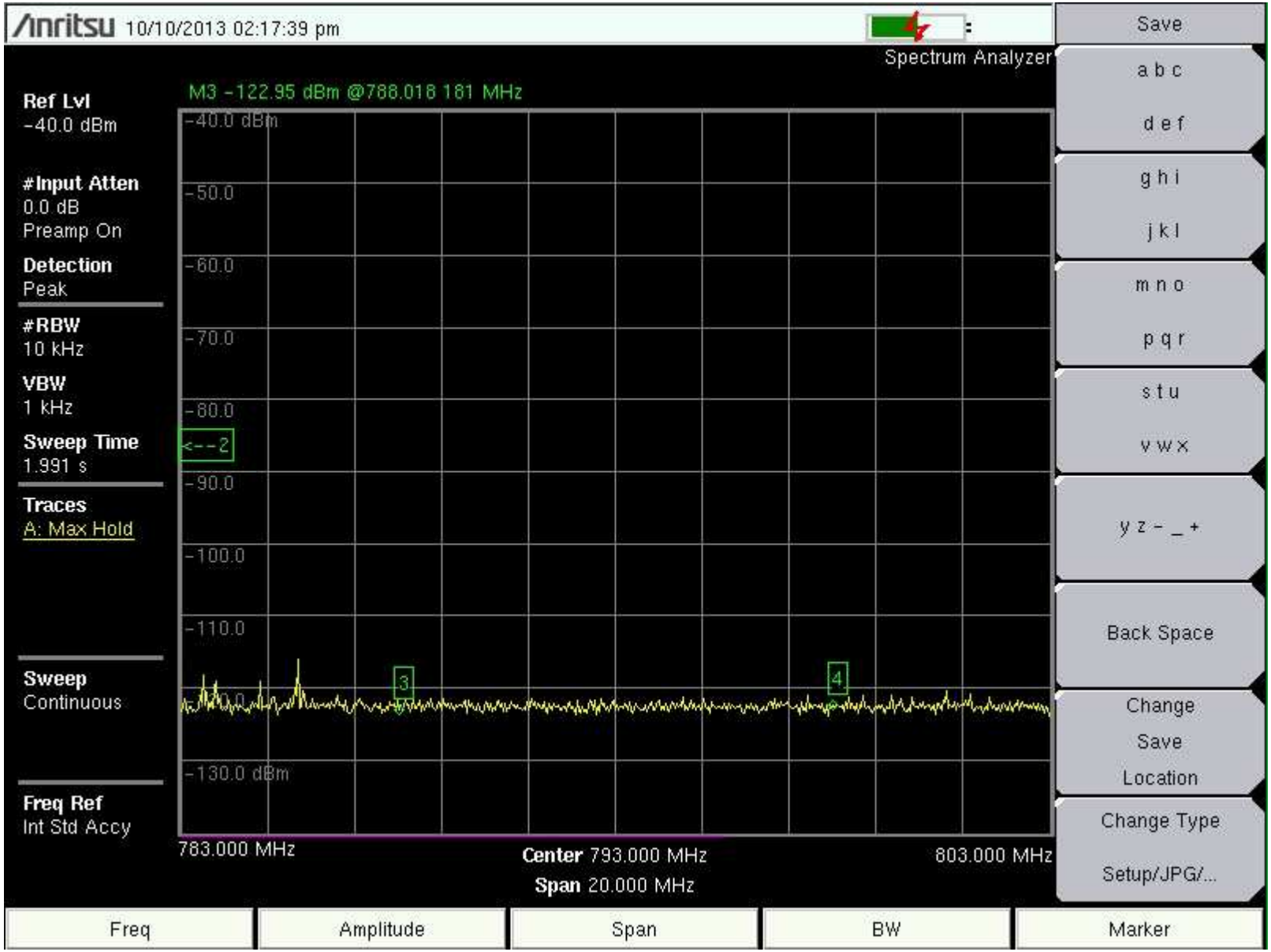


Figure 3.11-8 – Location # 10 - Spectrum Analyzer Image @ 10 kHz RBW
Band 14 Uplink - NO SIGNAL PRESENT - Signal Level < -122 dBm (788-798 MHz) Markers 3 & 4

SECTION

FOUR

SECTION 4

SUMMARY OF RESULTS

The results of the measurements performed at each site location measured in the Northern Virginia area is presented in this section.

4.1 RF Measurements

- There were measurements made in ten locations near the Northrop Grumman building at 7575 Colshire Blvd. RF Signals were not seen in Band 14, only noise floor was noted at all locations.

- There were signals observed in Band 13 at all locations and these can been seen in the spectrum images in Section 3. These signals are from other operators in the area and are not the interest of this study.

- At site 2, RF signals became erratic due to Line of Sight (LOS) conditions to a commercial wireless operator's monopole tower. This caused power fluctuations on the equipment used to perform the measurements. Other than the power fluctuations at site 2 nothing else of interest to report.

- Table 4.1-1 presents the data for these measurements

Table 4.1-1

RF Measurement Site Data

	Transmitter Location	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10
Latitude	38 55 19.74 N	38 55 20.86 N	38 55 20.37 N	38 55 15.76 N	38 55 26.96 N	38 55 23.27 N	38 55 22.01 N	38 54 59.09 N	38 55 06.24 N	38 55 26.01 N	38 55 18.09 N
Longitude	77 12 25.96 W	77 12 25.25 W	77 12 28.30 W	77 12 22.34 W	77 12 24.69 W	77 12 29.15 W	77 12 41.42 W	77 12 51.42 W	77 13 05.01 W	77 12 35.52 W	77 12 29.39 W
Ground Elevation (ft)	382	382	360	374	319	335	345	396	400	317	334
Distance to Transmitter (mi)	N/A	0.024	0.037	0.094	0.14	0.083	0.236	0.549	0.639	0.187	0.06
Azimuth to Transmitter (deg)	N/A	206	109	324	188	145	101	44	66	130	58
Height Above Ground (ft)	N/A	5	5	5	5	5	5	5	70	5	45
Downlink Highest Signal Level @ 100 kHz RBW* (dBm)	N/A	-112	-97	-114	-114	-114	-114	-114	-114	-114	-114
Downlink Highest Signal Level @ 10 kHz RBW* (dBm)	N/A	-122	-97	-123	-124	-123	-123	-123	-123	-123	-123
Uplink Highest Signal Level @ 100 kHz RBW* (dBm)	N/A	-114	-114	-114	-115	-114	-114	-114	-114	-114	-114
Uplink Highest Signal Level @ 10 kHz RBW* (dBm)	N/A	-123	-112	-123	-123	-124	-123	-123	-123	-123	-124

* Isotropic Value

SECTION

FIVE

SECTION 5

CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

Based on the results of the on-site measurements, there **DOES NOT** seem to be a potential for interference in Band Fourteen (14) of the upper 700 MHz frequency band into other operators from the eNodeB transmitter at the Northrop Grumman building in McLean, VA. Based upon the location and configuration in the interior of the building it appears significant signal attenuation is provided by the exterior walls of the building. No signal was observed above -123 dBm (noise floor of measurement device) in Band 14 at sites further than 0.04 miles (192 ft) away. Signal levels should be well below the operational levels of other operator's devices.

It should be noted that this conclusion is for sites outside the Northrop Grumman building. There is a strong case for interference inside the building at 7575 Colshire Blvd.

5.2 Recommendations

If Northrop Grumman continues to operate their eNodeB in the current location and configuration there should not be any issues to other operators in the same band. Any changes to location of eNodeB, the attenuator, antenna, or transmit power could affect potential interference. Care should be taken to ensure no changes are made.

Northrop Grumman should provide an emergency contact to any operators concerned about potential interference so if any interference occurs the transmitter can be shut down.