Interference Mitigation & Avoidance Methodolgy for Compliance with the 47 CFR 15 US Federal Communications Commission (FCC) Rules and Regulations for Broadband over Power Line (BPL)

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Revision 1.0

Date: October 10, 2006

Introduction

On January 7, 2005 the Federal Communication Commission 47 CFR Part 15 Rules for Broadband Power Lines Systems were published in the Federal Register. These rules as adopted and published went into effect on July 7, 2006. The Rules among other things define Broadband Power Line systems and establish requirements for emissions limits, reporting, certification, interference mitigation and excluded frequencies and exclude deployment zones.

As part of the these rules the FCC has added defined Broadband over Power Line (BPL) thereby differentiating it from Power Line Carrier (PLC) and creating a new class of Part 15 product. The FCC further differetiated BPL products creating definitions for Access BPL and In-Home BPL devices recognizing the distintly different function the products serve and the different environments where the products shall be applied. itions for these products which were not present prior to the rules changes. The definitions can be found in 47 CFR §15.3(ff) and 47 CFR §15.3(gg). The rules for interference mitigation apply to Access BPL products.

Specifically any Access BPL equipment that is manufactured, sold, distributed or installed from July 7, 2006 onward must meet the new rules. These rules require that:

- Access BPL equipment be certified compliant with the FCC rules[1];
- Access BPL equipment when applied to overhead electric distributionlines have a set of pre-set notches where no carrier frequencies are placed[2,3]

[1] 47 CFR §15.101(a)

[2] 47 CFR §15.516(f)(1)

[3] The FCC Office of Engineering and Technology (OET) provided clarification regarding the reference in 47 CFR §15.516f to no carriers in the excluded bands. The communication is presented below:

Inquiry: Section 15.615(f) states ....system does not operate on any frequencies designated as excluded bands or on identified frequencies within any designated exclusion zones. What are the limits for spurious emissions within the excluded bands?

Response: Section 15.611(c) "Interference Mitigation and Avoidance" addresses the limits for excluded bands. The signal shall be attenuated by 20 dB below the Part 15 limit for frequencies below 30 MHz and 10 dB below the applicable limit for frequencies above 30 MHz.

At frequencies above 30 MHz Class A limits are permissible on medium-voltage lines with justification. Justification includes marketing requirements and usage requirements. Generally these devices are sold and used by public utility companies so class A limits are applicable for the medium-voltage lines. The application must provide a paragraph on this justification. Otherwise Class B limits can be used on medium-voltage lines.

BPL devices used on low-voltage lines and operating above 30 MHz must use Class B limits. Class A limits are not permissible on low-voltage lines.

There is no test procedure for the 20 dB or 10 dB notch. This is due to the dangers inherent in moving a measurement antenna close to the power line. However, the application must describe what frequencies or bands are notched and how this is implemented to meet the requirements. This can be done in the operational Description or a Letter Exhibit of compliance can be submitted by the applicant.

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- The equipment has the capability to remotely places notches or filters that will reduce radiated emissions to 20 dB below the Part 15 limits for frequencies below 30 MHz and 10 dB below the Part 15 limits for frequencies above 30 MHz[4];
- The equipment has the ability to automatically restore system settings following a power interruption[5]; and,
- The equipment has the capability to be shut-down remotely[6].

This paper describes MainNet's methodolgy for meeting specifically the interference mitigation requirements as adopted by these rules.

Definitions

From 47 CFR §15.3,

(ff) Access Broadband over Power Line (Access BPL). A carrier current system installed and operated on an electric utility service as an unintentional radiator that sends radio frequency energy on frequencies between 1.705 MHz and 80 MHz over medium voltage lines or over low voltage lines to provide broadband communications and is located on the supply side of the utility service's points of interconnection with customer premises. Access BPL does not include power line carrier systems as defined in Section 15.3(t) of this part or In-House BPL as defined in Section 15.3(gg) of this part.

(gg) In-House Broadband over power line (In-House BPL). A carrier current system, operating as an unintentional radiator, that sends radio frequency energy by conduction over electric power lines that are not owned, operated or controlled by an electric service provider. The electric power lines may be aerial (overhead), underground, or inside the walls, floors or ceilings of user premises. In-House BPL devices may establish closed networks within a user's premises or provide connections to Access BPL networks, or both.

Interference Mitigation Avoidance Requirements

47 CFR §15.611(c) defines the interference mitigation technical requirements. "*Interference Mitigation Avoidance* (1) Access BPL systems shall incorporate adaptive interference mitigation techniques to remotely reduce power and adjust operating frequencies, in order to avoid site specific, local use of same spectrum by licensed services. These techniques may

[4] 47 CFR §15.611(c)(1)

[5] 47 CFR §15.611(c)(2)

[6] 47 CFR §15.611(c)(3)

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include adaptive or “notch” filtering, or complete avoidance of frequencies, or bands of frequencies, locally used by licensed radio operators.

(i) For frequencies below 30 MHz, when a notch filter is used to avoid interference to a specific frequency band, the Access BPL system shall be capable of attenuting emissions within the band to a level of at least 20 dB below the applicable part 15 limits.

(ii) For frequencies above 30 MHz when a notch filter is used to avoid interference to a specific frequency band, the Access BPL system shall be capable of attenuating emmissions within that band to a level level of at least 10 dB below the applicable part 15 limits.

(2) Access BPL systems shall comply with applicable radiated emmissions limits upon power-up following a fault condition, or during start-up operation after a shut-off procedure, by the use of some non-volatile memory, or some other method, to immediately restore previous settings with programmed notches and excluded bands, to avoid time delay caused by the need for manual reprogramming during which protected services may be vunerable.

(3) Access BPL systems shall incorporate a remote-controlled shut-down feature to deactivate, from a central location, any unit found to cause harmful interference, if other interference mitigation techniques do not resolve the interference problem.

MainNet’s Interfernce Mtigation Methodolgy for Compliance

MainNet meets the technical requirements as defined in 47 CFR §15.611 for interference mitigation. The PLUS units are all remotely accessable via Layer 3 IP, with each device having a unique IP address. Through this remote access and via the on-board management and configuration software an indivdual PLUS device’s power level can be adjust down or the unit can be permantely shut-down. Access to the PLUS unit can be done remotely through MainNet’s NmPLUS PLUS Network Management Station which allows acces to an individual device virtually from any Internet connection throughout the world.

MainNet’s PLUS devices’ OFDM spread spectrum modulation, having 80 separate tones in its tone map across the 4 – 21 MHz operating band, dynamically adjust the tone utilization based on the ambient noise environment. Tones where noise is high are dynamically dropped.

MainNet’s PLUS devices also have an embedded Tone Map and Tone Mask. The Tone Map and Tone Mask are Layer 2 controlled via MainNet’s MACPLUS™. The Tone Map and Tone Mask are defined for each MainNet system cell. All PLUS devices under an aggregation device operate under the same Tone Map & Tone Mask which specifies which carriers (tones) are used (and by definition which tones are not used) by the system cell. The MainNet PLUS aggregation device holds the defined Tone Map and Tone Mask.

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When a unit is introduced into the system cell, the PLUS aggregation device pushes the configuration down to the unit. This method insures that during network build and/or maintenance the Tone Map and Tone Mask integrity is maintained.

Once a device has had its Tone Map and Tone Mask set by the PLUS aggregation device the Tone Map and Tone Mask is stored along with the other changeable configuration settings such as IP Address, Power Level Setting, IP Gateway, etc., in on board non-volatile memory. In this way, following a shut-down event all previous settings will be restored upon re-boot.

MainNet has the ability to create a unique Tone Map and Tone Mask to match site specific requirements. Once a frequency has been identified that requires "notching", MainNet will create the Tone Map and Tone Mask which would then be remotely uploaded to the PLUS aggregation unit which would then drive this configuration down to the PLUS devices under its management.

MainNet has created three standard Tone Map and Tone Mask schemes which include the frequencies defined in 47 CFR §15.615 (f) (1) *Excluded Bands* for Access BPL using overhead medium voltage power lines, the Amateur Radio Bands, and the combination of the two sets of frequencies.

Therefore MainNet complies with the technical requirements for interference mitigation as defined in 47 CFR §15.611(c).

Specifically:

1. 47 CFR §15.611(c)(1) – MainNet utilizes notch filtering creating notches that are at least 20dB below the applicable part 15 limits for operations below 30MHz. MainNet does not operate above 30MHz.
2. 47 CFR §15.611(c)(2) – MainNet utilizes non-volatile memory which stores the PLUS device configuration so that upon power-up following a fault condition, or during start-up operation after a shut-off procedure, the previous settings with programmed notches, excluded bands and power level are immediately restored.
3. 47 CFR §15.611(c)(3) – MainNet has incorporated remote-controlled shut-down feature to deactivate, from a central location, any unit found to cause harmful interference, if other interference mitigation techniques do not resolve the interference problem.

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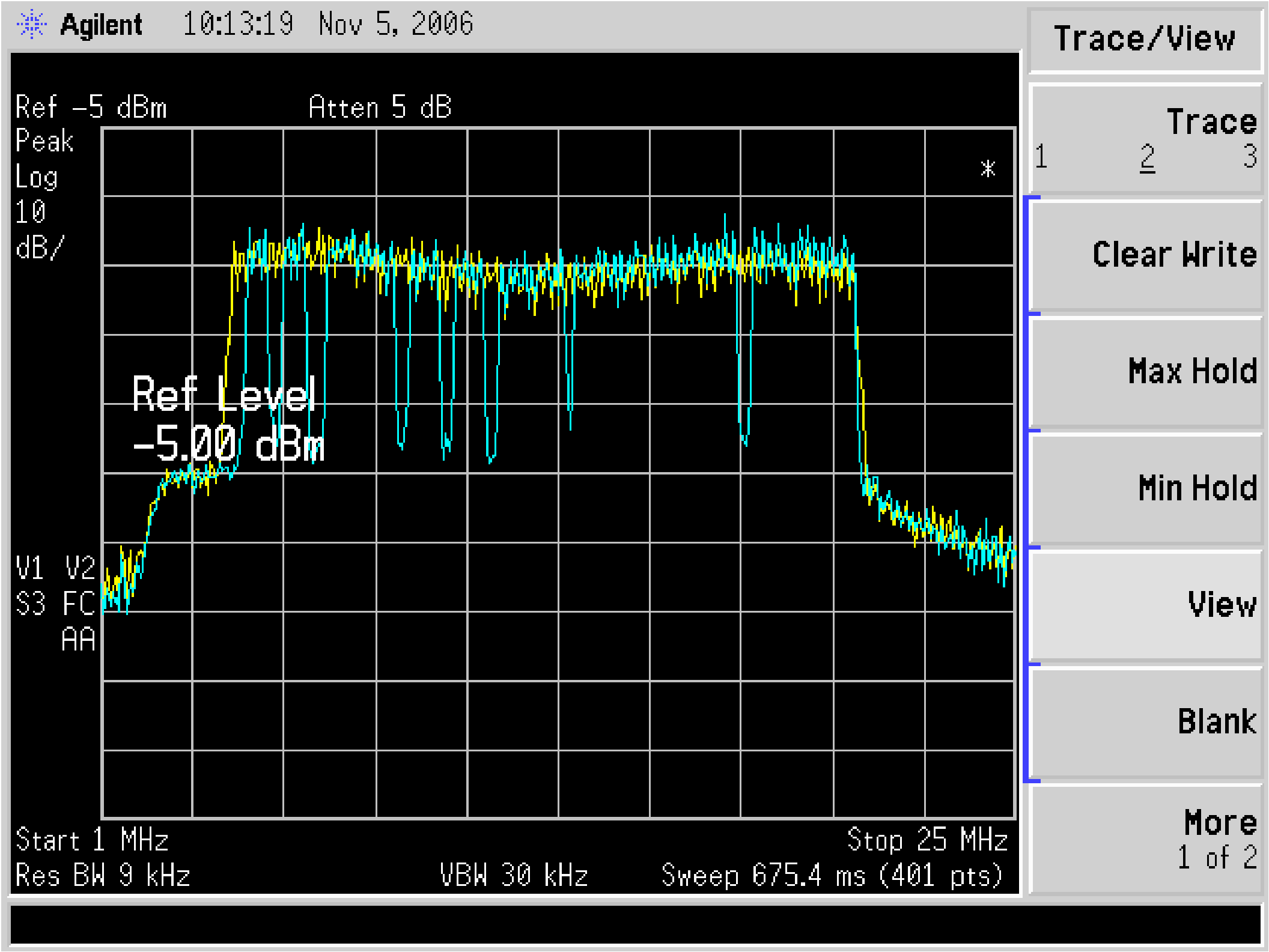
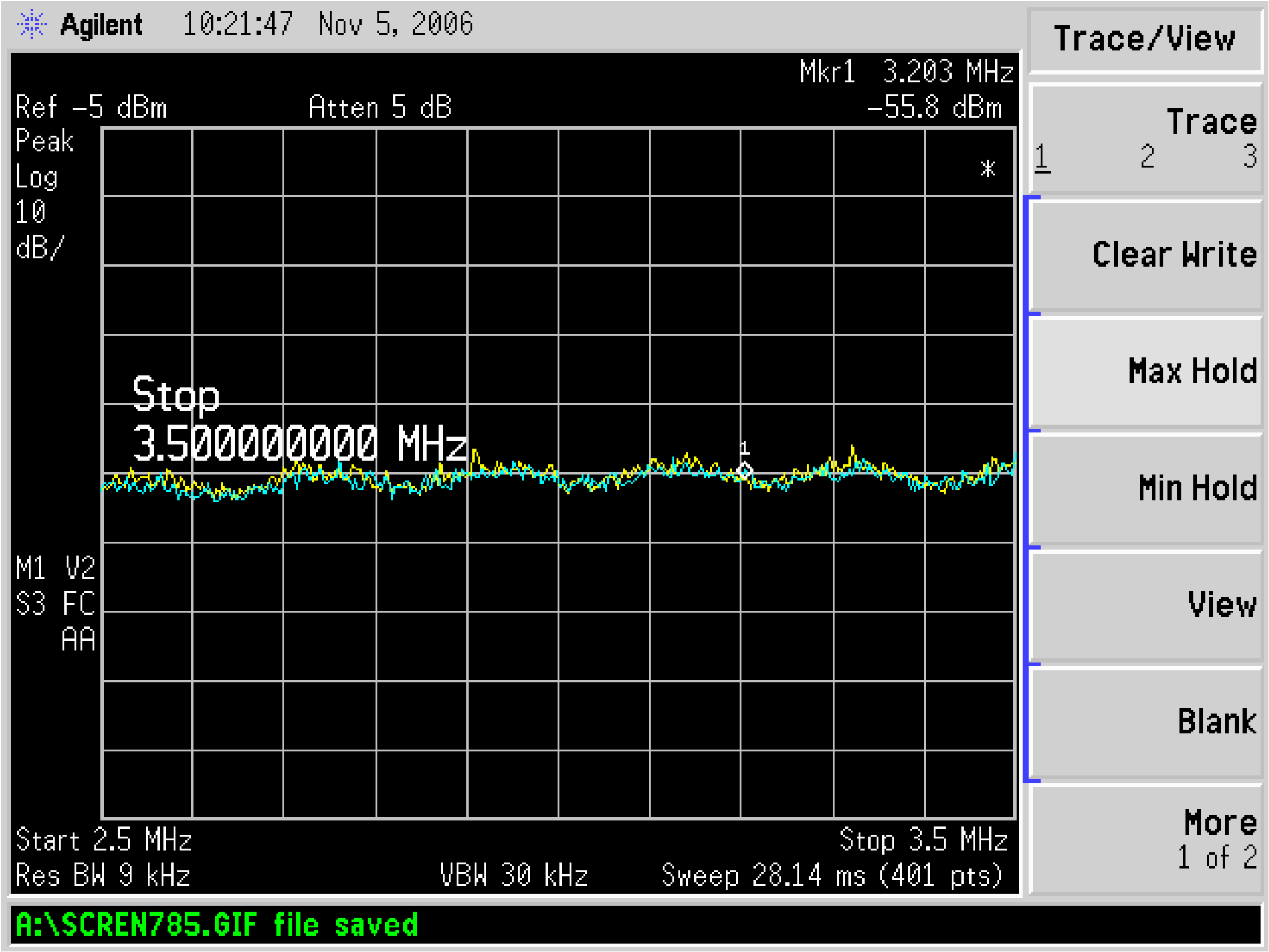
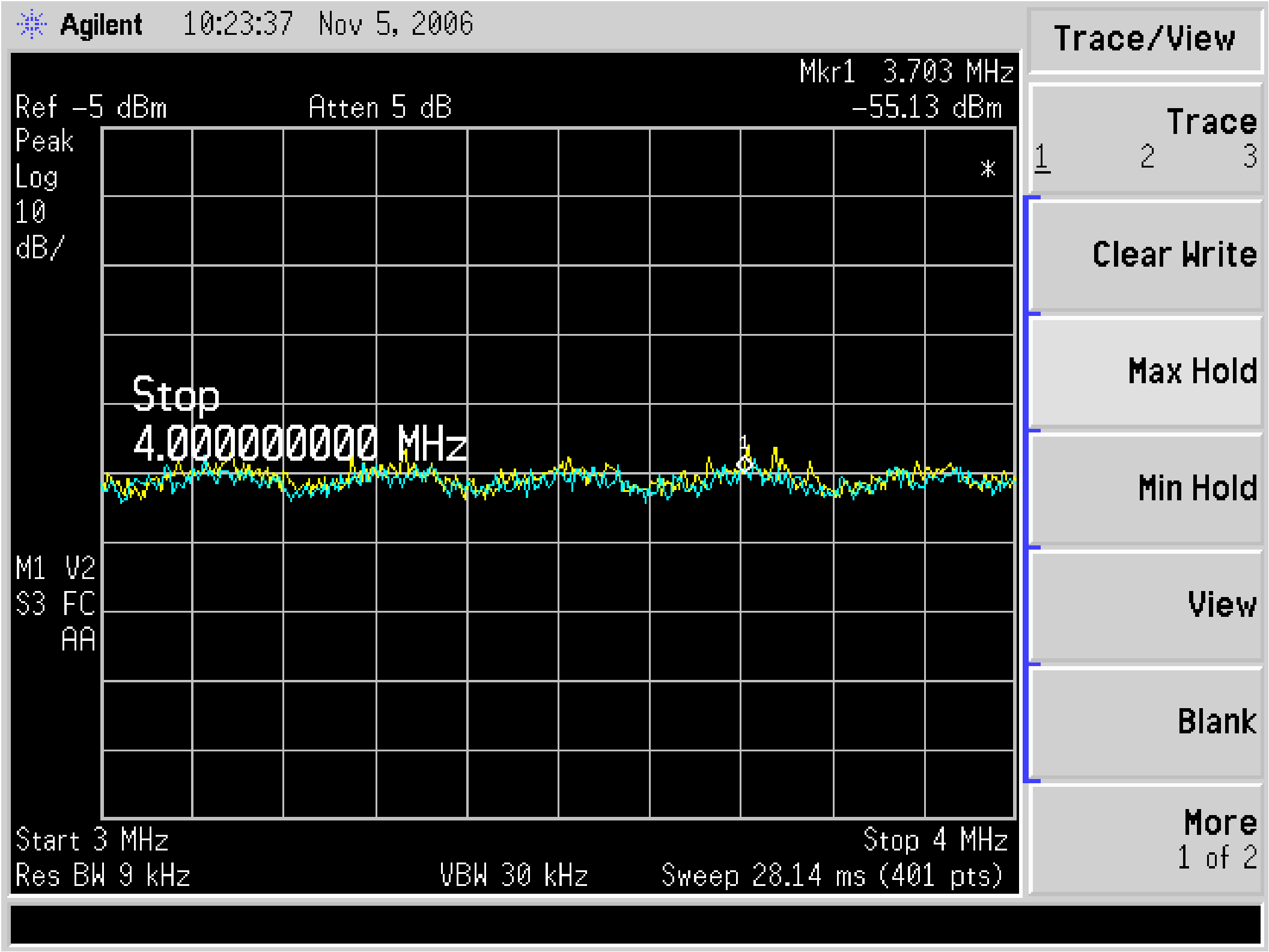
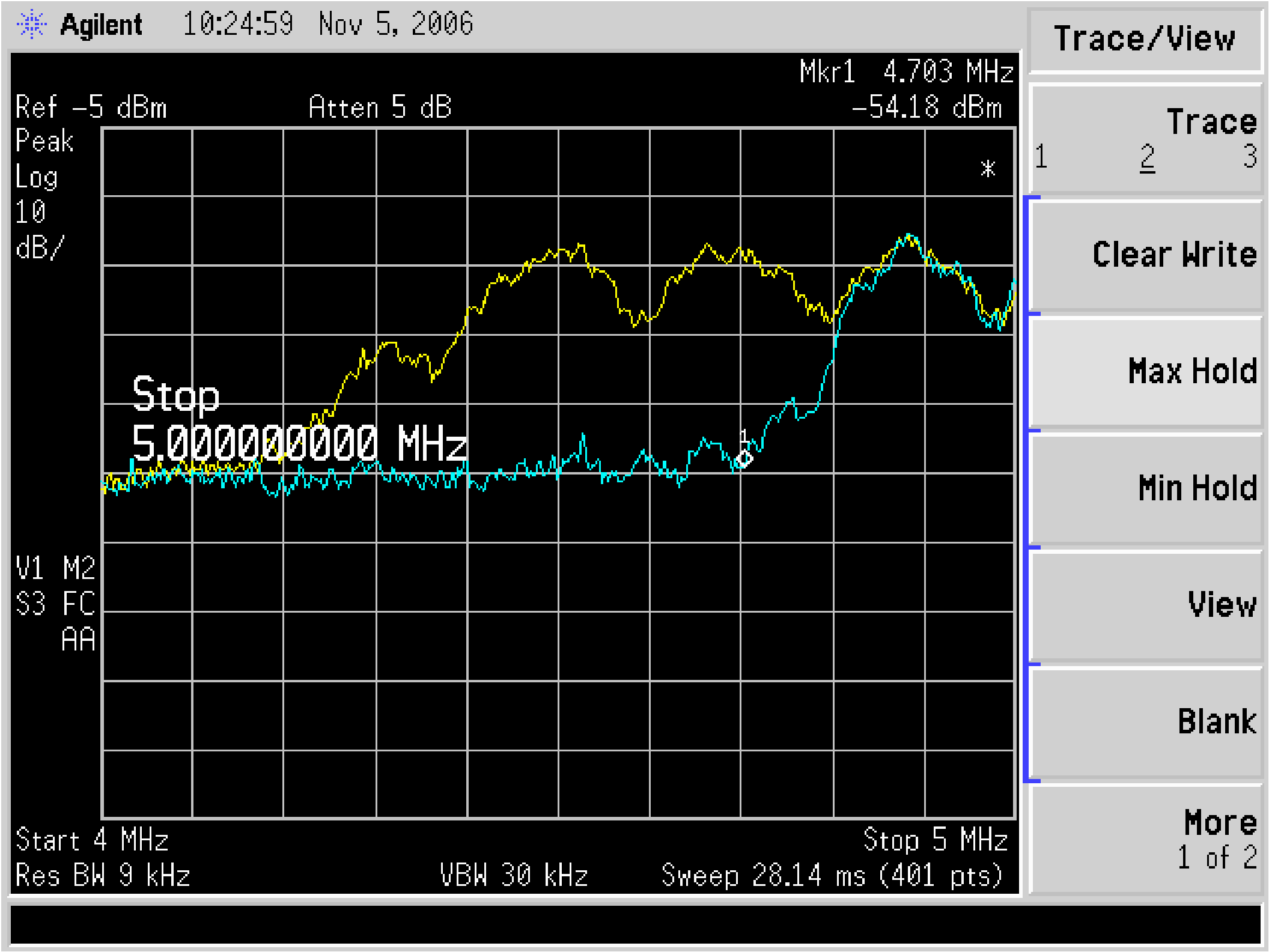
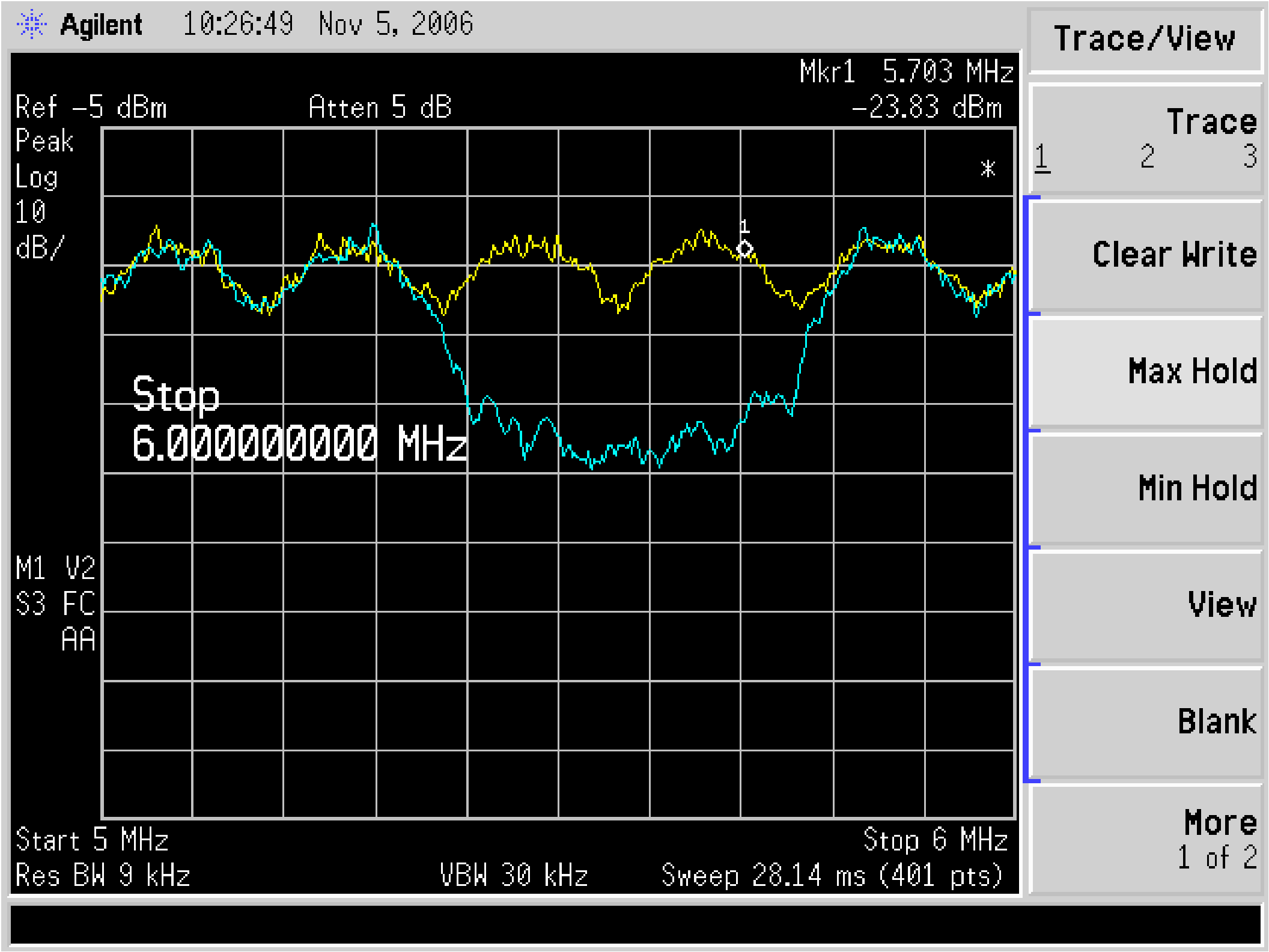
EXCLUDED FREQUENCY BANDS


Agilent 10:13:19 Nov 5, 2006
Ref -5 dBm
Atten 5 dB
Peak
Log
10
dB/
Ref Level
-5.00 dBm
V1 V2
S3 FC
AA
Start 1 MHz
Res BW 9 kHz
VBW 30 kHz
Stop 25 MHz
Sweep 675.4 ms (401 pts)
Trace/View
Trace
1 2 3
Clear Write
Max Hold
Min Hold
View
Blank
More
1 of 2


Agilent 10:21:47 Nov 5, 2006
Mkr1 3.203 MHz
Ref -5 dBm
Atten 5 dB
-55.8 dBm
Peak
Log
10
dB/
Stop
3.500000000 MHz
M1 V2
S3 FC
AA
Start 2.5 MHz
Res BW 9 kHz
VBW 30 kHz
Stop 3.5 MHz
Sweep 28.14 ms (401 pts)
Trace/View
Trace
1 2 3
Clear Write
Max Hold
Min Hold
View
Blank
More
1 of 2
A:\SCREN785.GIF file saved


Agilent 10:23:37 Nov 5, 2006
Mkr1 3.703 MHz
Ref -5 dBm
Atten 5 dB
-55.13 dBm
Peak
Log
10
dB/
Stop
4.000000000 MHz
M1 V2
S3 FC
AA
Start 3 MHz
Res BW 9 kHz
VBW 30 kHz
Stop 4 MHz
Sweep 28.14 ms (401 pts)
Trace/View
Trace
1 2 3
Clear Write
Max Hold
Min Hold
View
Blank
More
1 of 2


Agilent 10:24:59 Nov 5, 2006
Mkr1 4.703 MHz
Ref -5 dBm
Atten 5 dB
-54.18 dBm
Peak
Log
10
dB/
Stop
5.000000000 MHz
V1 M2
S3 FC
AA
Start 4 MHz
Res BW 9 kHz
VBW 30 kHz
Stop 5 MHz
Sweep 28.14 ms (401 pts)
Trace/View
Trace
1 2 3
Clear Write
Max Hold
Min Hold
View
Blank
More
1 of 2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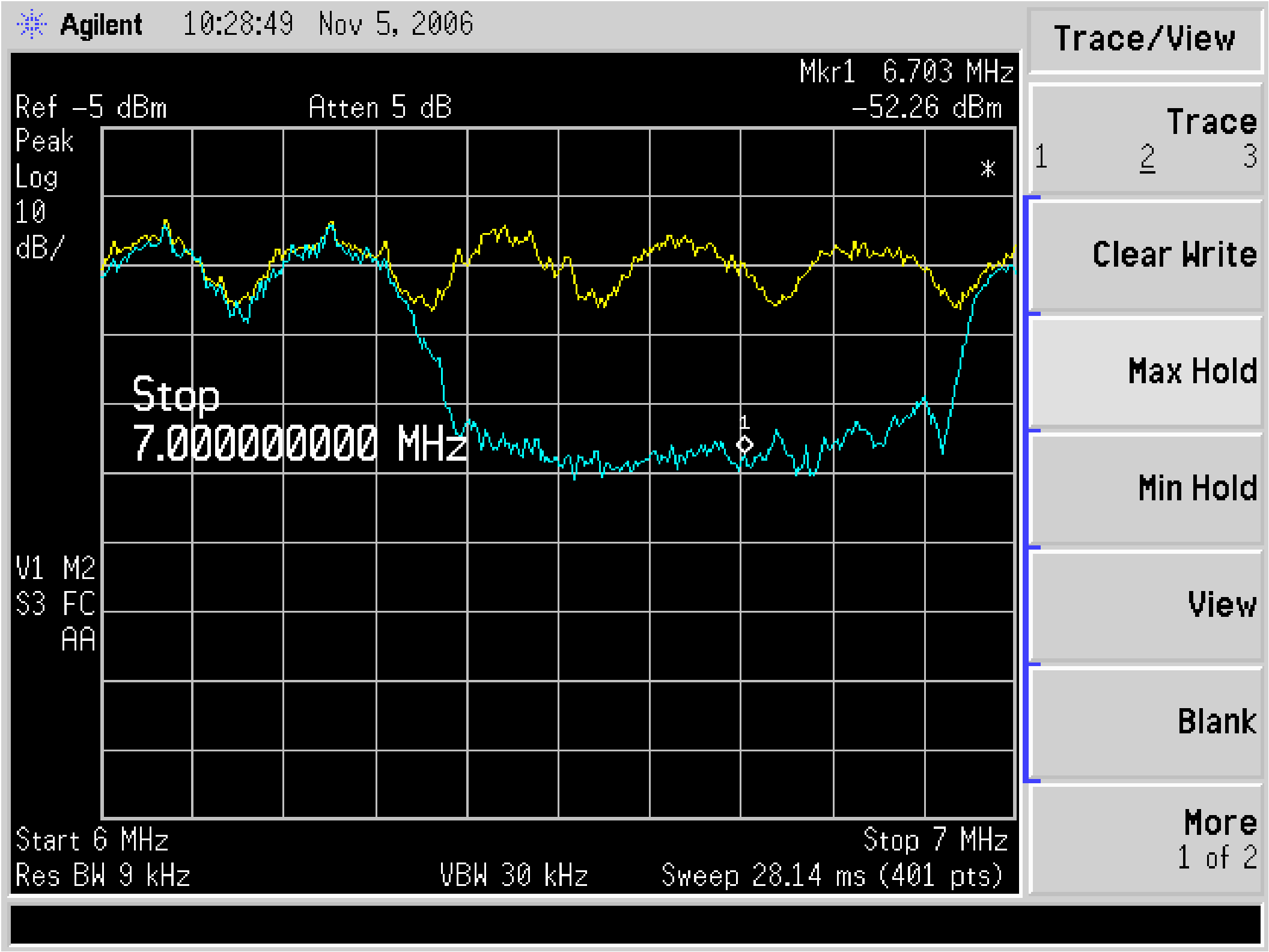
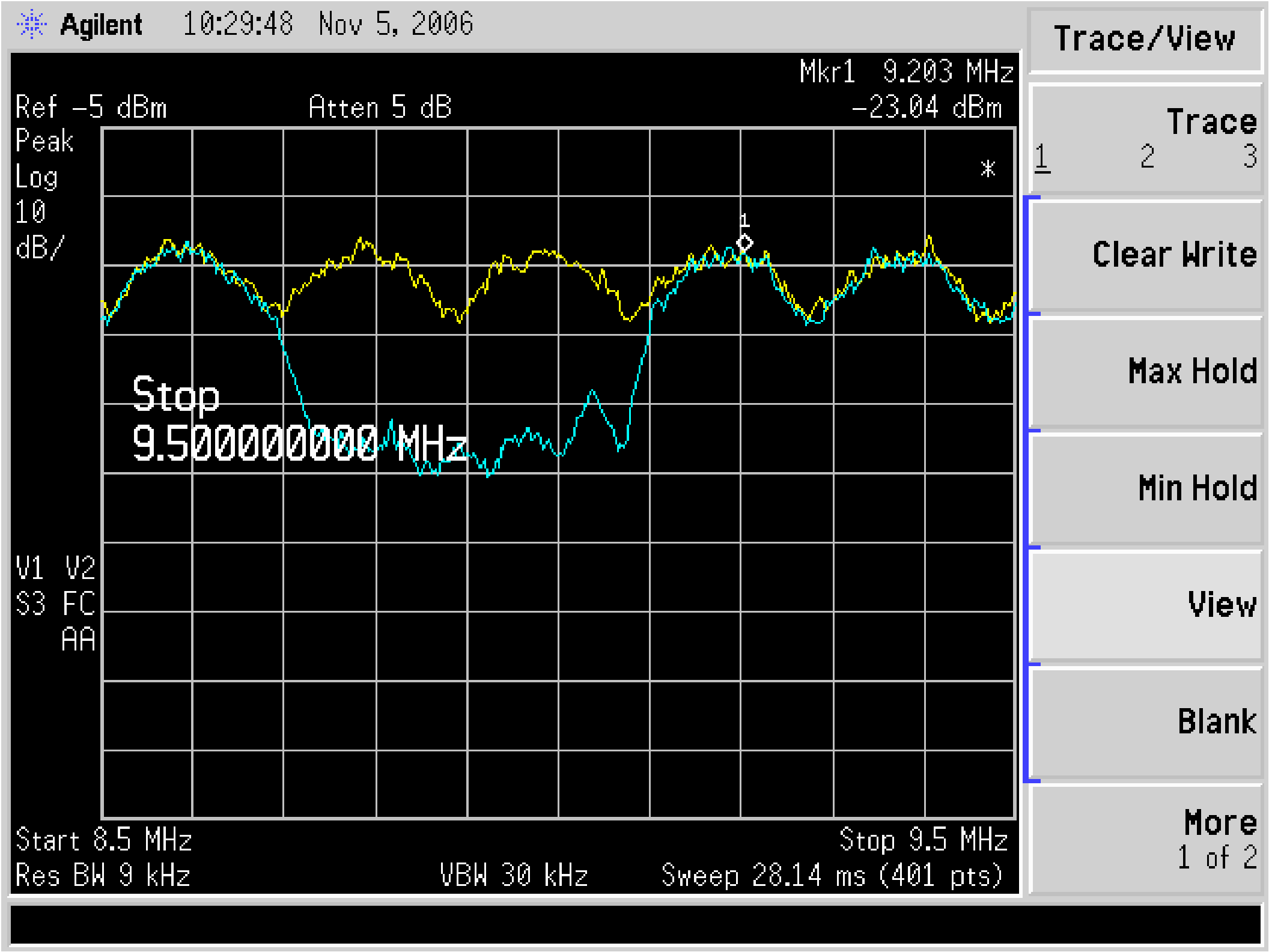
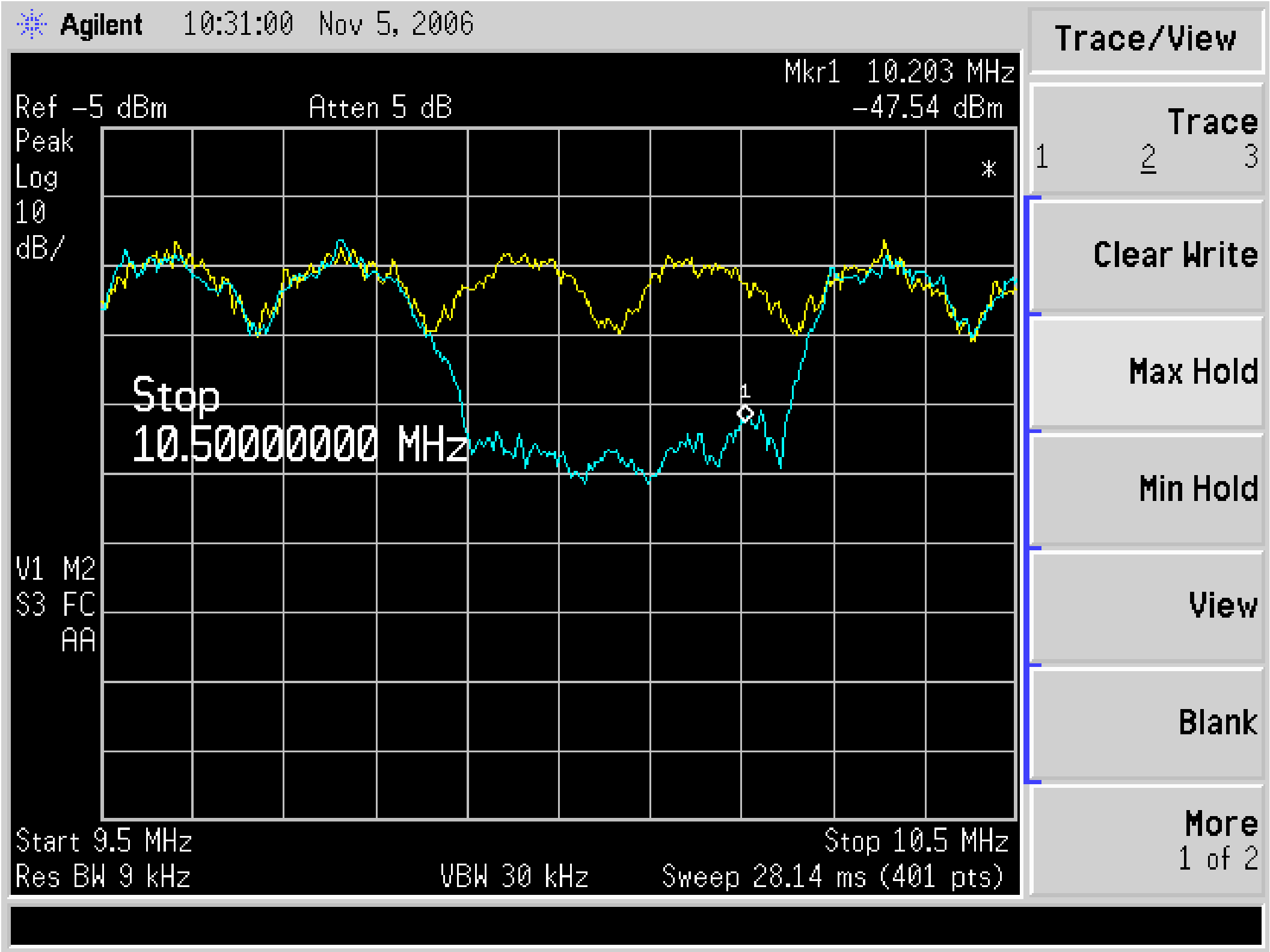
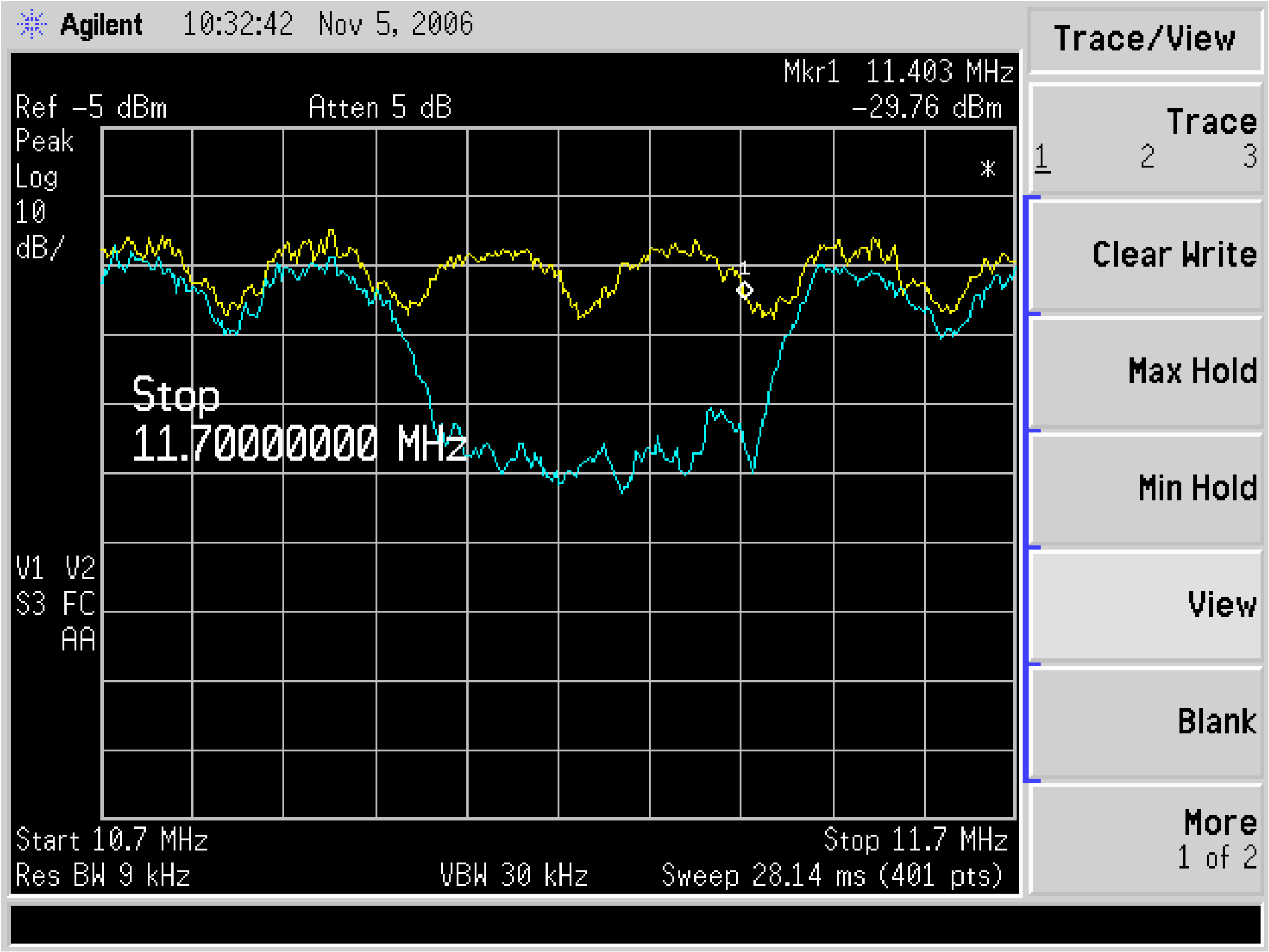
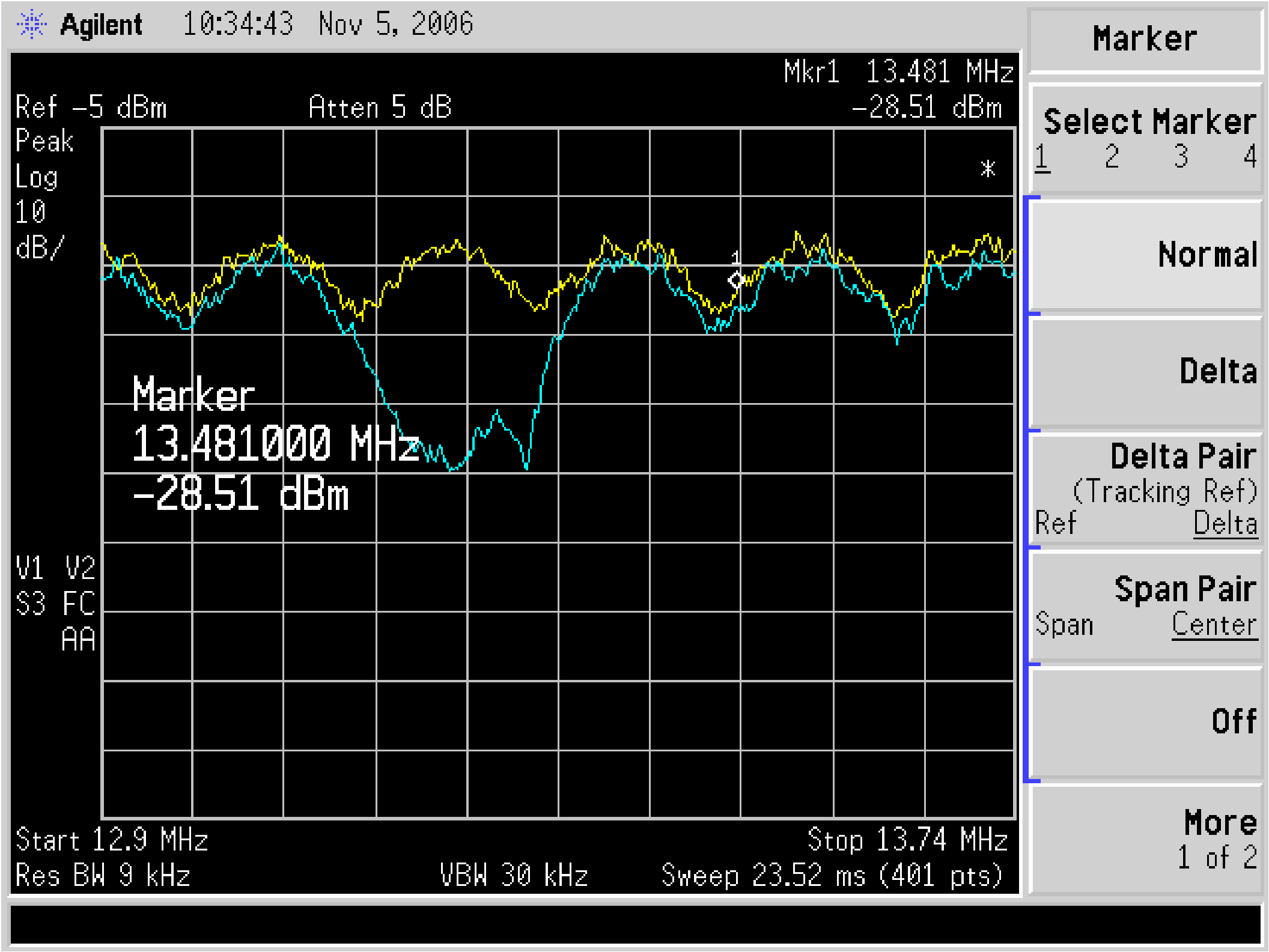
Mkr1 5.703 MHz
Ref -5 dBm
Atten 5 dB
-23.83 dBm
Peak
Log
10
dB/
Stop
6.000000000 MHz
M1 V2
S3 FC
AA
Start 5 MHz
Res BW 9 kHz
VBW 30 kHz
Stop 6 MHz
Sweep 28.14 ms (401 pts)
Trace/View
Trace
1 2 3
Clear Write
Max Hold
Min Hold
View
Blank
More
1 of 2

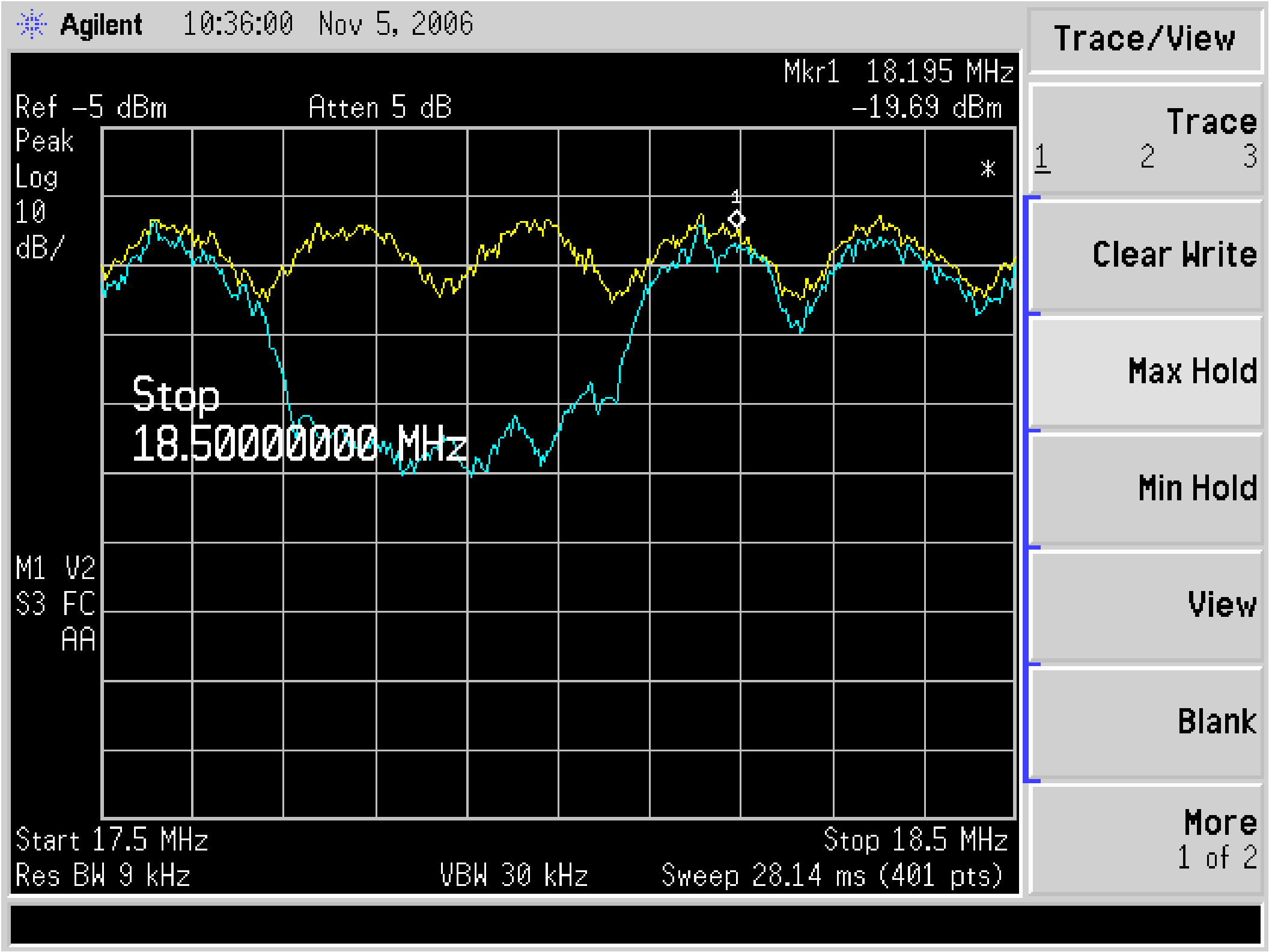

Agilent 10:28:49 Nov 5, 2006
Mkr1 6.703 MHz
Ref -5 dBm
Atten 5 dB
-52.26 dBm
Peak
Log
10
dB/
Stop
7.000000000 MHz
V1 M2
S3 FC
AA
Start 6 MHz
Res BW 9 kHz
VBW 30 kHz
Stop 7 MHz
Sweep 28.14 ms (401 pts)
Trace/View
Trace
1 2 3
Clear Write
Max Hold
Min Hold
View
Blank
More
1 of 2


Agilent 10:29:48 Nov 5, 2006
Mkr1 9.203 MHz
Ref -5 dBm
Atten 5 dB
-23.04 dBm
Peak
Log
10
dB/
Stop
9.500000000 MHz
V1 V2
S3 FC
AA
Start 8.5 MHz
Res BW 9 kHz
VBW 30 kHz
Stop 9.5 MHz
Sweep 28.14 ms (401 pts)
Trace/View
Trace
1 2 3
Clear Write
Max Hold
Min Hold
View
Blank
More
1 of 2


Agilent 10:31:00 Nov 5, 2006
Mkr1 10.203 MHz
Ref -5 dBm
Atten 5 dB
-47.54 dBm
Peak
Log
10
dB/
Stop
10.50000000 MHz
V1 M2
S3 FC
AA
Start 9.5 MHz
Res BW 9 kHz
VBW 30 kHz
Stop 10.5 MHz
Sweep 28.14 ms (401 pts)
Trace/View
Trace
1 2 3
Clear Write
Max Hold
Min Hold
View
Blank
More
1 of 2


Agilent 10:32:42 Nov 5, 2006
Mkr1 11.403 MHz
Ref -5 dBm
Atten 5 dB
-29.76 dBm
Peak
Log
10
dB/
Stop
11.70000000 MHz
V1 V2
S3 FC
AA
Start 10.7 MHz
Stop 11.7 MHz
Res BW 9 kHz
VBW 30 kHz
Sweep 28.14 ms (401 pts)
Trace/View
Trace
1 2 3
Clear Write
Max Hold
Min Hold
View
Blank
More
1 of 2


Agilent 10:34:43 Nov 5, 2006
Mkr1 13.481 MHz
Ref -5 dBm
Atten 5 dB
-28.51 dBm
Peak
Log
10
dB/
Marker
13.481000 MHz
-28.51 dBm
V1 V2
S3 FC
AA
Start 12.9 MHz
Stop 13.74 MHz
Res BW 9 kHz
VBW 30 kHz
Sweep 23.52 ms (401 pts)
Marker
Select Marker
1 2 3 4
Normal
Delta
Delta Pair
(Tracking Ref)
Ref Delta
Span Pair
Span Center
Off
More
1 of 2


Agilent 10:36:00 Nov 5, 2006
Mkr1 18.195 MHz
Ref -5 dBm
Atten 5 dB
-19.69 dBm
Peak
Log
10
dB/
Stop
18.50000000 MHz
M1 V2
S3 FC
AA
Start 17.5 MHz
Res BW 9 kHz
VBW 30 kHz
Stop 18.5 MHz
Sweep 28.14 ms (401 pts)
Trace/View
Trace
1 2 3
Clear Write
Max Hold
Min Hold
View
Blank
More
1 of 2