# TEST REPORT OF A 2.4 GHZ LOW POWER WLAN INTEGRATED PCMCIA CARD, BRAND AGERE, TYPE PC24-11-FC/R, IN CONFORMITY WITH 47 CFR PART 15 (2001-12-18).

**TNO Electronic Products & Services (EPS) B.V.**
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# MEASUREMENT/TECHNICAL REPORT

## Agere Systems Nederland B.V.

## Model : PC24-11-FC/R

## FCC ID: IMRWLPC2411R

April 29, 2002

| | | |
|---|---|---|
| This report concerns: | Original grant/certification ~~Class 2 change~~ ~~Verification~~ | |
| Equipment type: | Direct Sequence Spread Spectrum Transceiver | |
| Deferred grant requested per 47 CFR 0.457(d)(1)(ii) ? | ~~Yes~~ | No |
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The data taken for this test and report herein was done in accordance with 47 CFR Part 15.247 and the measurement procedures of ANSI C63.4-1992. TNO Electronic Products & Services (EPS) B.V. at Niekerk, The Netherlands, certifies that the data is accurate and contains a true representation of the emission profile of the Equipment Under Test (EUT) on the date of the test as noted in the test report. I have reviewed the test report and find it to be an accurate description of the test(s) performed and the EUT so tested.

Date: April 29, 2002 Signature:

P. de Beer
TNO Electronic Products & Services (EPS) B.V.

## Description of test item

| | | |
|---|---|---|
| Test item | : | 2.4 GHz low power WLAN integrated PCMCIA card |
| Manufacturer | : | Agere Systems Nederland B.V. |
| Brand | : | Agere |
| Type | : | PC24-11-FC/R |
| Serial number | : | 02UT03640001 |
| Revision | : | n.a. |
| Receipt number | : | 2 |
| Receipt date | : | March 25, 2002 |

## Applicant information

| | | |
|---|---|---|
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## Test(s) performed

| | | |
|---|---|---|
| Location | : | Niekerk |
| Test(s) started | : | March 25, 2002 |
| Test(s) completed | : | April 29, 2002 |
| Purpose of test(s) | : | Type approval / certification |
| Test specification(s) | : | 47 CFR Part 15 (2001-12-18) |

Test engineer : O.H. Hoekstra

Report written by : P.A.J.M. Robben, B.Sc.E.E.

Project leader : P.A.J.M. Robben, B.Sc.E.E.

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**The test results relate only to the item(s) tested.**

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# 1 General information

## 1.1 Product description

The 2.4 GHz low power WLAN integrated PCMCIA card, brand Agere, type PC24-11-FC/R, is designed to operate in the 2.4 GHz ISM frequency band, channels 1 to 11 (2412 MHz to 2462 MHz), as specified by the Federal Communications Commission in the USA.

The 2.4 GHz low power WLAN integrated PCMCIA card, brand Agere, type PC24-11-FC/R, utilizes Direct Sequence Spread Spectrum (DSSS) technology.

The 2.4 GHz low power WLAN integrated PCMCIA card, brand Agere, type PC24-11-FC/R, is intended for use with external antennas which are to be connected to the (unique) antenna connector(s). Only antennas, which have been certified by the Federal Communications Commission for use with this specific 2.4 GHz low power WLAN integrated PCMCIA card, may be connected to the antenna connector(s) of this device.

## 1.2 Related submittal(s) and/or Grant(s)

Not applicable.

## 1.3 Tested system details

### 1.3.1 System configuration.

Details and an overview of the system and all its components, as it has been tested, can be found in table 1 below. FCC ID's are stated in this overview where applicable. The EUT is listed in the first row of this table 1.

| Description | Type number | Serial number | FCC ID | Cable descriptions |
|---|---|---|---|---|
| 2.4 GHz low power WLAN integrated PCMCIA card | PC24-11-FC/R | 02UT03640001 | IMRWLPC2411R | Connected to coaxial cable. |
| Directional Yagi antenna having a maximum antenna gain of 11.5 dBi (including all cable losses of the coaxial cable, surge arrestor and RF IEEE cable) | AOU24-YA-1414 | n.a. | n.a. | Connected to 2.4 GHz low power WLAN integrated PCMCIA card. |
| Notebook computer, manufacturer Dell Computer Corporation | Latitude C600 | DS/N TW-0791UH-12800-0BR-0635<br>DP/N 0791UH C/O TW Rev A05 | n.a. (DoC) | Unshielded DC power cord to AC/DC adapter.<br>Shielded parallel cable to printer. |
| Dell AC/DC power adapter<br><br>100-240 VAC/1.5 Amps to +20 VDC/3.5 Amps | AA20031, PA-6 family | DS/N CN-09364U-12761-0C4-007R<br>DP/N 09361U\C/O CN/Rev A00 | n.a. (DoC) | Unshielded DC power cord to notebook computer.<br>Unshielded power cord to AC mains. |
| HP DeskJet 895Cxi | C6410A | ES8B42307H | n.a. (DoC) | Unshielded DC power cord to AC/DC adapter.<br>Shielded parallel cable to notebook computer. |
| HP AC/DC power adapter<br><br>100-240 VAC/1 Amps to +18 VDC/1.1 Amps | C6409-60014 | n.a. | n.a. (DoC) | Unshielded DC power cord to printer.<br>Unshielded power cord to AC mains. |

Table 1 - Tested system configuration.

## 1.4 Test methodology

The test methodology used is based on the requirements of 47 CFR Part 15 (2001-12-18).

The test methods, which have been used, are based on ANSI C63.4: 1992.

Radiated emission tests above 30 MHz were performed at a measurement distance of 3 meters. Below 30 MHz the radiated emission tests were carried out at measurement distances of 3 and 10 meters. The test results regarding the radiated emission tests on frequencies below 30 MHz have been extrapolated in order to determine the field strength of the measured values at measurement distances of 30 and 300 meters (as required by 47 CFR Part 15).

The bandwidth of the receiver is switching automatically to the right bandwidth in accordance with CISPR 16. This is implemented in the receiver. The antenna factors are programmed in the test receiver. The receiver automatically calculates the appropriate correction factor for the utilized antenna and also the appropriate antenna factor for the cable loss. The total correction is automatically added to the measured value.

Radiated emission tests on frequencies above 1 GHz were performed with appropriate pre-amplifiers, antennas and a spectrum analyzer. At frequencies on which radiated emissions were found the level at the input of the pre-amplifier was reproduced by means of a RF signal generator. The output level of the signal generator was then increased with the antenna factor in order to obtain the actual field strength value for each individual frequency on which radiated emissions were found.

## 1.5 Test facility

The Federal Communications Commission has reviewed the technical characteristics of the test facilities at TNO Electronic Products & Services (EPS) B.V., located in Niekerk, 9822 TL Smidshornerweg 18, The Netherlands, and has found these test facilities to be in compliance with the requirements of 47 CFR Part 15, section 2.948, per October 23, 2000.

The description of the test facilities has been filed under registration number 90828 at the Office of the Federal Communications Commission. The facility has been added to the list of laboratories performing these test services for the public on a fee basis.

The list of all public test facilities is available on the Internet at http://www.fcc.gov.

## 1.6 Product labeling

In accordance with 47 CFR Part 15.19 (a)(3) the following text shall be placed on a label, which is attached to the EUT:

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

In accordance with 47 CFR Part 2.925 (a)(1), the FCC ID shall be placed on a label, which is attached to the EUT.

For further details about the labeling requirements (size, legibility, etc.) as set by the Federal Communications Commission see 47 CFR Part 15.19 (a)(3), 47 CFR Part 15.19 (b)(2), 47 CFR Part 15.19 (b)(4), 47 CFR Part 2.925 and 47 CFR Part 2.926.

## 1.7 System test configuration

### 1.7.1 Justification

The system was configured for testing in a typical fashion (as a customer would normally use it).

The justification and manipulation of cables and equipment in order to simulate a worst-case behavior of the test setup has been carried out as prescribed in ANSI C63.4: 1992.

Tests were performed at the lowest operating frequency (channel 1: 2412 MHz), the operating frequency in the middle of the specified frequency band (channel 6: 2437 MHz) and the highest operating frequency (channel 11: 2462 MHz). Further details may be found in table 2 below.

| Channel | Operating frequencies (MHz) | Rated output power (dBm) | Test performed |
|---|---|---|---|
| 1 | 2412 | +18 | ***yes*** |
| 2 | 2417 | +18 | no |
| 3 | 2422 | +18 | no |
| 4 | 2427 | +18 | no |
| 5 | 2432 | +18 | no |
| 6 | 2437 | +18 | ***yes*** |
| 7 | 2442 | +18 | no |
| 8 | 2447 | +18 | no |
| 9 | 2452 | +18 | no |
| 10 | 2457 | +18 | no |
| 11 | 2462 | +18 | ***yes*** |

Table 2 - Specification of channels and rated maximum output power (excluding antenna gain).

The EUT was tested in a notebook computer with an external antenna connected to the unique antenna connector of the EUT. The antenna, which has been used during all tests, is connected to a coaxial cable, surge arrestor and a RF IEEE coaxial cable which is fitted with a unique type of coaxial connector and which is manufactured solely for the manufacturer of the 2.4 GHz low power WLAN integrated PCMCIA card, as listed in this test report. This antenna can only be attached to those 2.4 GHz low power WLAN cards which are fitted with the same unique type of antenna connector.

### 1.7.2 EUT exercise software

The EUT could be enabled to transmit or receive continuously on channels 1 (2412 MHz), 6 (2437 MHz) and 11 (2462 MHz) by means of test software, which was supplied by the manufacturer of the EUT. Furthermore, the utilized test software also enables various transmission bit-rate settings in the range of 1 Mbit/s, 2 Mbit/s, 5.5 Mbit/s and 11 Mbit/s.

## 1.8 Special accessories

No special accessories are used and/or needed to achieve compliance with the appropriate sections of 47 CFR Part 15.

## 1.9 Equipment modifications

No modifications have been made to the equipment in order to achieve compliance with the appropriate sections of 47 CFR Part 15.

## 1.10 Configuration of the tested system

Not applicable. See table 1 in section 1.3 of this test report.

## 1.11 Block diagram(s) of the EUT

The block diagram is available as part of the documentation which is to be submitted to the FCC/TCB.

# 2 Radiated emission data

## 2.1 Test results with EUT operating in receive mode on channel 1

The results of the radiated emission tests, carried out in accordance with 47 CFR Part 15.109 and 47 CFR Part 15.209 with the EUT operating in receive mode on channel 1 (2412 MHz), are depicted in table 3.

| Frequency (MHz) | Test results quasi peak (dBµV/m) | | Test results average (dBµV/m) | | Test results peak (dBµV/m) | | Resolution bandwidth (kHz) | Quasi peak limits (dBµV/m) | Average limits (dBµV/m) | Peak limits (dBµV/m) |
|---|---|---|---|---|---|---|---|---|---|---|
| | V | H | V | H | V | H | | | | |
| 30.0-88.0 | <20.0 | <20.0 | - | - | - | - | 120 | 40.0 | - | - |
| 88.0-216.0 | <23.5 | <23.5 | - | - | - | - | 120 | 43.5 | - | - |
| 216.0-960.0 | <26.0 | <26.0 | - | - | - | - | 120 | 46.0 | - | - |
| 960.0-1000.0 | <34.0 | <34.0 | - | - | - | - | 120 | 54.0 | - | - |
| 1100.00 | - | - | n.t. | n.t. | 40.3 | 41.2 | 1000 | - | 54.0 | 74.0 |
| 1504.00 | - | - | n.t. | n.t. | 42.1 | 40.7 | 1000 | - | 54.0 | 74.0 |
| 1708.00 | - | - | n.t. | n.t. | 43.2 | 42.1 | 1000 | - | 54.0 | 74.0 |
| 4824.00 | - | - | n.t. | n.t. | 43.1 | 42.6 | 1000 | - | 54.0 | 74.0 |

Table 3 - Test results with the EUT operating in receive mode on channel 1 (2412 MHz).

Note: Above 1 GHz, all measured values of the spurious emissions with the detector in peak mode, are below the applicable limits, which are valid when using an average detector. Therefore, all spurious emissions above 1 GHz have been measured with the peak detector only (n.t. = not tested).

Note: Field strength values of radiated emissions at frequencies not listed in table 3 are more than 20 dB below the applicable limit.

Test engineer

Signature :

Name : Onno H. Hoekstra

Date : April 29, 2002

## 2.2 Test results with EUT operating in receive mode on channel 6

The results of the radiated emission tests, carried out in accordance with 47 CFR Part 15.109 and 47 CFR Part 15.209 with the EUT operating in receive mode on channel 6 (2437 MHz), are depicted in table 4.

| Frequency (MHz) | Test results quasi peak (dBµV/m) | | Test results average (dBµV/m) | | Test results peak (dBµV/m) | | Resolution bandwidth (kHz) | Quasi peak limits (dBµV/m) | Average limits (dBµV/m) | Peak limits (dBµV/m) |
|---|---|---|---|---|---|---|---|---|---|---|
| | V | H | V | H | V | H | | | | |
| 30.0-88.0 | <20.0 | <20.0 | - | - | - | - | 120 | 40.0 | - | - |
| 88.0-216.0 | <23.5 | <23.5 | - | - | - | - | 120 | 43.5 | - | - |
| 216.0-960.0 | <26.0 | <26.0 | - | - | - | - | 120 | 46.0 | - | - |
| 960.0-1000.0 | <34.0 | <34.0 | - | - | - | - | 120 | 54.0 | - | - |
| 1100.00 | - | - | n.t. | n.t. | 40.7 | 42.3 | 1000 | - | 54.0 | 74.0 |
| 1504.00 | - | - | n.t. | n.t. | 43.0 | 41.4 | 1000 | - | 54.0 | 74.0 |
| 1708.00 | - | - | n.t. | n.t. | 43.8 | 43.5 | 1000 | - | 54.0 | 74.0 |
| 4874.00 | - | - | n.t. | n.t. | 44.1 | 43.9 | 1000 | - | 54.0 | 74.0 |

Table 4 - Test results with the EUT operating in receive mode on channel 6 (2437 MHz).

Note: Above 1 GHz, all measured values of the spurious emissions with the detector in peak mode, are below the applicable limits, which are valid when using an average detector. Therefore, all spurious emissions above 1 GHz have been measured with the peak detector only (n.t. = not tested).

Note: Field strength values of radiated emissions at frequencies not listed in table 4 are more than 20 dB below the applicable limit.

Test engineer

Signature :

Name : Onno H. Hoekstra

Date : April 29, 2002

## 2.3 Test results with EUT operating in receive mode on channel 11

The results of the radiated emission tests, carried out in accordance with 47 CFR Part 15.109 and 47 CFR Part 15.209 with the EUT operating in receive mode on channel 11 (2462 MHz), are depicted in table 5.

| Frequency (MHz) | Test results quasi peak (dBµV/m) | | Test results average (dBµV/m) | | Test results peak (dBµV/m) | | Resolution bandwidth (kHz) | Quasi peak limits (dBµV/m) | Average limits (dBµV/m) | Peak limits (dBµV/m) |
|---|---|---|---|---|---|---|---|---|---|---|
| | V | H | V | H | V | H | | | | |
| 30.0-88.0 | <20.0 | <20.0 | - | - | - | - | 120 | 40.0 | - | - |
| 88.0-216.0 | <23.5 | <23.5 | - | - | - | - | 120 | 43.5 | - | - |
| 216.0-960.0 | <26.0 | <26.0 | - | - | - | - | 120 | 46.0 | - | - |
| 960.0-1000.0 | <34.0 | <34.0 | - | - | - | - | 120 | 54.0 | - | - |
| 1100.00 | - | - | n.t. | n.t. | 42.3 | 44.1 | 1000 | - | 54.0 | 74.0 |
| 1504.00 | - | - | n.t. | n.t. | 45.6 | 44.5 | 1000 | - | 54.0 | 74.0 |
| 1708.00 | - | - | n.t. | n.t. | 44.1 | 43.1 | 1000 | - | 54.0 | 74.0 |
| 4944.00 | - | - | n.t. | n.t. | 45.3 | 45.0 | 1000 | - | 54.0 | 74.0 |

Table 5 - Test results with the EUT operating in receive mode on channel 11 (2462 MHz).

Note: Above 1 GHz, all measured values of the spurious emissions with the detector in peak mode, are below the applicable limits, which are valid when using an average detector. Therefore, all spurious emissions above 1 GHz have been measured with the peak detector only (n.t. = not tested).

Note: Field strength values of radiated emissions at frequencies not listed in table 5 are more than 20 dB below the applicable limit.

Test engineer

Signature :

Name : Onno H. Hoekstra

Date : April 29, 2002

## 2.4 Test results with EUT operating in transmit mode on channel 1.

The results of the radiated emission tests, carried out in accordance with 47 CFR Part 15.205 (restricted bands of operation) with the EUT operating in transmit mode on channel 1 (2412 MHz), are depicted in table 6.

| Frequency (MHz) | Test results quasi peak (dBµV/m) | | Test results average (dBµV/m) | | Test results peak (dBµV/m) | | Resolution bandwidth (kHz) | Quasi peak limits (dBµV/m) | Average limits (dBµV/m) | Peak limits (dBµV/m) |
|---|---|---|---|---|---|---|---|---|---|---|
| | V | H | V | H | V | H | | | | |
| 30.0-88.0 | <20.0 | <20.0 | - | - | - | - | 120 | 40.0 | - | - |
| 88.0-216.0 | <23.5 | <23.5 | - | - | - | - | 120 | 43.5 | - | - |
| 216.0-960.0 | <26.0 | <26.0 | - | - | - | - | 120 | 46.0 | - | - |
| 960.0-1000.0 | <34.0 | <34.0 | - | - | - | - | 120 | 54.0 | - | - |
| 1100.00 | - | - | n.t. | n.t. | 42.1 | 40.1 | 1000 | - | 54.0 | 74.0 |
| 1499.00 | - | - | n.t. | n.t. | 41.3 | 38.9 | 1000 | - | 54.0 | 74.0 |
| 1713.00 | - | - | n.t. | n.t. | 43.5 | 43.1 | 1000 | - | 54.0 | 74.0 |
| 4824.00 | - | - | n.t. | n.t. | 49.0 | 48.7 | 1000 | - | 54.0 | 74.0 |
| 7236.00 | - | - | n.t. | n.t. | 52.0 | 50.5 | 1000 | - | 54.0 | 74.0 |

Table 6 - Test results with the EUT operating in transmit mode on channel 1 (2412 MHz).

Note: Radiated emission tests have been performed with all possible transmission bit-rates (1 Mbit/s, 2 Mbit/s, 5.5 Mbit/s and 11 Mbit/s) in transmit mode. The highest values measured of the spurious emission components are reported by means of table 6.

Note: Above 1 GHz, all measured values of the spurious emissions with the detector in peak mode are below the applicable limits which are valid when using an average detector. Therefore, all spurious emissions above 1 GHz have been measured with the peak detector only (n.t. = not tested).

Note: Field strength values of radiated emissions at frequencies not listed in table 6 are more than 20 dB below the applicable limit.

Test engineer

Signature :

Name : Onno H. Hoekstra

Date : April 29, 2002

## 2.5 Test results with EUT operating in transmit mode on channel 6.

The results of the radiated emission tests, carried out in accordance with 47 CFR Part 15.205 (restricted bands of operation) with the EUT operating in transmit mode on channel 6 (2437 MHz), are depicted in table 7.

| Frequency (MHz) | Test results quasi peak (dBµV/m) | | Test results average (dBµV/m) | | Test results peak (dBµV/m) | | Resolution bandwidth (kHz) | Quasi peak limits (dBµV/m) | Average limits (dBµV/m) | Peak limits (dBµV/m) |
|---|---|---|---|---|---|---|---|---|---|---|
| | V | H | V | H | V | H | | | | |
| 30.0-88.0 | <20.0 | <20.0 | - | - | - | - | 120 | 40.0 | - | - |
| 88.0-216.0 | <23.5 | <23.5 | - | - | - | - | 120 | 43.5 | - | - |
| 216.0-960.0 | <26.0 | <26.0 | - | - | - | - | 120 | 46.0 | - | - |
| 960.0-1000.0 | <34.0 | <34.0 | - | - | - | - | 120 | 54.0 | - | - |
| 1100.00 | - | - | n.t. | n.t. | 42.6 | 42.3 | 1000 | - | 54.0 | 74.0 |
| 1499.00 | - | - | n.t. | n.t. | 42.0 | 40.1 | 1000 | - | 54.0 | 74.0 |
| 1713.00 | - | - | n.t. | n.t. | 44.1 | 44.6 | 1000 | - | 54.0 | 74.0 |
| 4874.00 | - | - | n.t. | n.t. | 51.1 | 50.7 | 1000 | - | 54.0 | 74.0 |
| 7311.00 | - | - | n.t. | n.t. | 53.5 | 52.6 | 1000 | - | 54.0 | 74.0 |

Table 7 - Test results with the EUT operating in transmit mode on channel 6 (2437 MHz).

Note: Radiated emission tests have been performed with all possible transmission bit-rates (1 Mbit/s, 2 Mbit/s, 5.5 Mbit/s and 11 Mbit/s) in transmit mode. The highest values measured of the spurious emission components are reported by means of table 7.

Note: Above 1 GHz, all measured values of the spurious emissions with the detector in peak mode are below the applicable limits which are valid when using an average detector. Therefore, all spurious emissions above 1 GHz have been measured with the peak detector only (n.t. = not tested).

Note: Field strength values of radiated emissions at frequencies not listed in table 7 are more than 20 dB below the applicable limit.

Test engineer

Signature :

Name : Onno H. Hoekstra

Date : April 29, 2002

## 2.6 Test results with EUT operating in transmit mode on channel 11.

The results of the radiated emission tests, carried out in accordance with 47 CFR Part 15.205 (restricted bands of operation) with the EUT operating in transmit mode on channel 11 (2462 MHz), are depicted in table 8.

| Frequency (MHz) | Test results quasi peak (dBµV/m) | | Test results average (dBµV/m) | | Test results peak (dBµV/m) | | Resolution bandwidth (kHz) | Quasi peak limits (dBµV/m) | Average limits (dBµV/m) | Peak limits (dBµV/m) |
|---|---|---|---|---|---|---|---|---|---|---|
| | V | H | V | H | V | H | | | | |
| 30.0-88.0 | <20.0 | <20.0 | - | - | - | - | 120 | 40.0 | - | - |
| 88.0-216.0 | <23.5 | <23.5 | - | - | - | - | 120 | 43.5 | - | - |
| 216.0-960.0 | <26.0 | <26.0 | - | - | - | - | 120 | 46.0 | - | - |
| 960.0-1000.0 | <34.0 | <34.0 | - | - | - | - | 120 | 54.0 | - | - |
| 1100.00 | - | - | n.t. | n.t. | 43.0 | 42.0 | 1000 | - | 54.0 | 74.0 |
| 1499.00 | - | - | n.t. | n.t. | 42.1 | 41.3 | 1000 | - | 54.0 | 74.0 |
| 1713.00 | - | - | n.t. | n.t. | 44.0 | 46.1 | 1000 | - | 54.0 | 74.0 |
| 4944.00 | - | - | n.t. | n.t. | 52.4 | 52.1 | 1000 | - | 54.0 | 74.0 |
| 7386.00 | - | - | n.t. | n.t. | 53.8 | 53.3 | 1000 | - | 54.0 | 74.0 |

Table 8 - Test results with the EUT operating in transmit mode on channel 11 (2462 MHz).

Note: Radiated emission tests have been performed with all possible transmission bit-rates (1 Mbit/s, 2 Mbit/s, 5.5 Mbit/s and 11 Mbit/s) in transmit mode. The highest values measured of the spurious emission components are reported by means of table 8.

Note: Above 1 GHz, all measured values of the spurious emissions with the detector in peak mode are below the applicable limits which are valid when using an average detector. Therefore, all spurious emissions above 1 GHz have been measured with the peak detector only (n.t. = not tested).

Note: Field strength values of radiated emissions at frequencies not listed in table 8 are more than 20 dB below the applicable limit.

Test engineer

Signature :

Name : Onno H. Hoekstra

Date : April 29, 2002

# 3 Conducted emission data

The (worst-case) results of the conducted emission tests at the 110 Volts AC mains connection terminals of the notebook computer in which the EUT is built-in, carried out in accordance with 47 CFR Part 15.107 and 47 CFR Part 15.207 with the EUT operating in transmit and/or receive mode on channels 1 (2412 MHz), 6 (2437 MHz) and 11 (2462 MHz) while utilizing all possible transmission bit-rates (1 Mbit/s, 2 Mbit/s, 5.5 Mbit/s and 11 Mbit/s), are depicted in table 9.

| Frequency (MHz) | Measurement results dB(µV) Neutral | Measurement results dB(µV) Line 1 | Limits dB(µV) | Margin (dB) Neutral | Margin (dB) Line 1 | Result |
|---|---|---|---|---|---|---|
| | QP | QP | QP | QP | QP | |
| 0.46 | 32.4 | 31.5 | 48.0 | -15.6 | -16.5 | PASS |
| 0.67 | 32.9 | 32.0 | 48.0 | -15.1 | -16.0 | PASS |
| 0.92 | 32.7 | 31.3 | 48.0 | -15.3 | -16.7 | PASS |
| 1.46 | 32.4 | 31.6 | 48.0 | -15.6 | -16.4 | PASS |
| 1.96 | 33.5 | 32.9 | 48.0 | -14.5 | -15.1 | PASS |
| 2.57 | 36.1 | 35.4 | 48.0 | -11.9 | -12.6 | PASS |
| 2.97 | 35.0 | 34.7 | 48.0 | -13.0 | -13.3 | PASS |
| 5.49 | 35.2 | 34.9 | 48.0 | -12.8 | -13.1 | PASS |
| 8.82 | 32.1 | 31.8 | 48.0 | -15.9 | -16.2 | PASS |
| 24.00 | 28.4 | 29.2 | 48.0 | -19.6 | -18.8 | PASS |

Table 9 - Test results with the EUT operating in transmit/receive mode.

Note: Disturbance voltage values of conducted emissions at frequencies not listed in table 9 are more than 20 dB below the applicable limit.

Test engineer

Signature :

Name : Onno H. Hoekstra

Date : April 29, 2002

## 3.1 Emission in restricted bands nearest to the band 2400 - 2483.5 MHz

The results of the conducted emission tests, carried out in accordance with 47 CFR Part 15.205 (restricted bands of operation, with the emphasis on the emission in restricted bands nearest to the band 2400-2483.5 MHz) with the EUT operating in transmit mode, are depicted in table 10.

| Frequency (MHz) | Test results quasi peak (dBµV/m) | Test results average (dBµV/m) | Test results peak (dBµV/m) | Resolution bandwidth (kHz) | Quasi peak limits (dBµV/m) | Average limits (dBµV/m) | Peak limits (dBµV/m) |
|---|---|---|---|---|---|---|---|
| 2390.00 | - | 51.5 | n.a. | 1000 | - | 54.0 | 74.0 |
| 2383.60 | - | n.a. | 66.6 | 1000 | - | 54.0 | 74.0 |
| 2483.50 | - | 52.5 | 65.6 | 1000 | - | 54.0 | 74.0 |

Table 10 - Test results with the EUT operating in transmit mode.

Note: Conducted emission tests have been performed with all possible transmission bit-rates (1 Mbit/s, 2 Mbit/s, 5.5 Mbit/s and 11 Mbit/s) in transmit mode. The highest values measured of the spurious emission components are reported by means of table 10.

Note: Field strength values of conducted emissions at frequencies not listed in table 10 are more than 20 dB below the applicable limit.

Test engineer

Signature :

Name : Onno H. Hoekstra

Date : April 29, 2002

# 4 Test results of measurements in conformity with 47 CFR Part 15.247

## 4.1 Minimum 6 dB bandwidth

The results of tests on the EUT, carried out in accordance with 47 CFR Part 15.247 (a)(2), are depicted in table 11.

| Transmission bitrate (Mbit/s) | Minimum 6 dB bandwidth (kHz) | | | Limit (kHz) |
|---|---|---|---|---|
| | Channel 1 (2412 MHz) | Channel 6 (2437 MHz) | Channel 11 (2462 MHz) | |
| 1 | 11100 | 10200 | 10200 | >500 |
| 2 | 10200 | 10200 | 10200 | >500 |
| 5.5 | 11180 | 11480 | 10650 | >500 |
| 11 | 11550 | 11480 | 11480 | >500 |

Table 11 - Minimum 6 dB bandwidth.

Test engineer

Signature :

Name : Onno H. Hoekstra

Date : April 29, 2002

## 4.2 Maximum peak output power

### 4.2.1 Test results for fixed point-to-point operation.

The results of tests on the EUT, carried out in accordance with 47 CFR Part 15.247 (b)(1), are depicted in table 12a.

As the maximum effective antenna gain exceeds 6 dBi, the limit of 30 dBm has been corrected to 28.2 dBm in accordance with 47 CFR Part 15.247 (b)(3)(i). The correction to the limit of 30 dBm can be calculated by the following formula:

30 dBm – (1 dB * ((Effective antenna gain – 6 dBi) / 3 dBi)) =

30 dBm – (1 dB * ((11.5 dBi – 6 dBi) / 3 dBi)) =

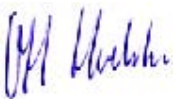
30 dBm – 1.8 dB = 28.2 dBm

| Transmission bitrate (Mbit/s) | Maximum peak output power (dBm) | | | Limit (dBm) Effective antenna gain <=11.5 dBi |
|---|---|---|---|---|
| | Channel 1 (2412 MHz) | Channel 6 (2437 MHz) | Channel 11 (2462 MHz) | |
| 1 | 18.4 | 18.3 | 18.4 | 28.2 |
| 2 | 18.5 | 18.4 | 18.4 | 28.2 |
| 5.5 | 17.9 | 17.9 | 17.9 | 28.2 |
| 11 | 18.3 | 18.2 | 18.3 | 28.2 |

Table 12a - Maximum peak output power for antennas having a maximum effective gain of 11.5 dBi.

Note: During the measurements, the AC mains supply voltage of the notebook PC in which the EUT was built-in was varied between 85% and 115% of the nominal value. The maximum measured values are depicted in table 12a. No differences in measurement results, due to the AC mains voltage variations between 85% and 115% from the nominal value, have been observed.

Test engineer

Signature : 

Name : Onno H. Hoekstra

Date : April 29, 2002

### 4.2.2 Test results for point-to-multipoint and other types of operation.

The results of tests on the EUT, carried out in accordance with 47 CFR Part 15.247 (b)(1), are depicted in table 12b.

As the maximum effective antenna gain exceeds 6 dBi, the limit of 30 dBm has been corrected to 24.5 dBm in accordance with 47 CFR Part 15.247 (b)(3). The correction to the limit of 30 dBm can be calculated by the following formula:

30 dBm – (Effective antenna gain – 6 dBi) =

30 dBm – (11.5 dBi – 6 dBi) =

30 dBm – 5.5 dB = 24.5 dBm

| Transmission bitrate (Mbit/s) | Maximum peak output power (dBm) | | | Limit (dBm) |
|---|---|---|---|---|
| | Channel 1 (2412 MHz) | Channel 6 (2437 MHz) | Channel 11 (2462 MHz) | Effective antenna gain <=11.5 dBi |
| 1 | 18.4 | 18.3 | 18.4 | 24.5 |
| 2 | 18.5 | 18.4 | 18.4 | 24.5 |
| 5.5 | 17.9 | 17.9 | 17.9 | 24.5 |
| 11 | 18.3 | 18.2 | 18.3 | 24.5 |

Table 12b - Maximum peak output power for antennas having a maximum effective gain of 11.5 dBi.

Note: During the measurements, the AC mains supply voltage of the notebook PC in which the EUT was built-in was varied between 85% and 115% of the nominal value. The maximum measured values are depicted in table 12b. No differences in measurement results, due to the AC mains voltage variations between 85% and 115% from the nominal value, have been observed.

Test engineer

Signature :

Name : Onno H. Hoekstra

Date : April 29, 2002

## 4.3 Radiated emission data outside restricted bands

The results of tests on the EUT, carried out in accordance with 47 CFR Part 15.247 (c), are depicted in table 13.

Radiated emission data outside restricted bands in a 100 kHz bandwidth shall be at least 20 dB below the highest level in a 100 kHz bandwidth within the band.

| Frequency (MHz) | Level below working channel based on field strength (dB) | Limit (dB) |
|---|---|---|
| 2398.53 | -35.6 | < -20.0 |
| 2400.00 | -37.9 | < -20.0 |
| all frequencies | <40.0 | < -20.0 |

Table 13 - Radiated emission data outside restricted bands.

Note: Worst case measurement values for transmissions with all possible transmission bit-rates (1 Mbit/s, 2 Mbit/s, 5.5 Mbit/s and 11 Mbit/s) and channel (channel 1 (2412 MHz), channel 6 (2437 MHz) and channel 11 (2462 MHz)) combinations.

Test engineer

Signature :

Name : Onno H. Hoekstra

Date : April 29, 2002

## 4.4 Conducted emission data outside restricted bands

The results of tests on the EUT, carried out in accordance with 47 CFR Part 15.247 (c), are depicted in table 14.

Conducted emission data outside restricted bands in a 100 kHz bandwidth shall be at least 20 dB below the highest level in a 100 kHz bandwidth within the band.

| Frequency (MHz) | Level below working channel based on field strength (dB) | Limit (dB) |
|---|---|---|
| 2398.53 | -35.6 | < -20.0 |
| 2400.00 | -37.9 | < -20.0 |
| other frequencies | < -40.0 | < -20.0 |

Table 14 - Conducted emission data outside restricted bands.

Note: Worst case measurement values for transmissions with all possible transmission bit-rates (1 Mbit/s, 2 Mbit/s, 5.5 Mbit/s and 11 Mbit/s) and channel (channel 1 (2412 MHz), channel 6 (2437 MHz) and channel 11 (2462 MHz)) combinations.

Test engineer

Signature :

Name : Onno H. Hoekstra

Date : April 29, 2002

## 4.5 Peak power spectral density

The results of the tests on the EUT, carried out in accordance with 47 CFR Part 15.247 (d), are depicted in table 15.

| Transmission bitrate (Mbit/s) | Peak power spectral density (conducted) in any 3 kHz band (dBm) | | | Limit (dBm) |
|---|---|---|---|---|
| | Channel 1 (2412 MHz) | Channel 6 (2437 MHz) | Channel 11 (2462 MHz) | |
| 1 | -9.3 | -9.6 | -9.5 | <8.0 |
| 2 | -9.3 | -9.6 | -9.6 | <8.0 |
| 5.5 | -10.5 | -10.5 | -10.6 | <8.0 |
| 11 | -7.5 | -7.4 | -7.4 | <8.0 |

Table 15 - Peak power spectral density.

Test engineer

Signature :

Name : Onno H. Hoekstra

Date : April 29, 2002

## 4.6 Processing gain

The results of the processing gain tests, carried out in accordance with 47 CFR Part 15.247 (e), are available in a separate test report with reference number 02060302.r00, dated April 29, 2002, issued by TNO Electronic Products & Services (EPS) B.V.

Test engineer

Signature :

Name : Onno H. Hoekstra

Date : April 29, 2002

# 5 Plots of measurement data

For reference purposes and visualization of spectrum analyzer settings during the measurements, a selection of plots of measurement data is included in this test report.

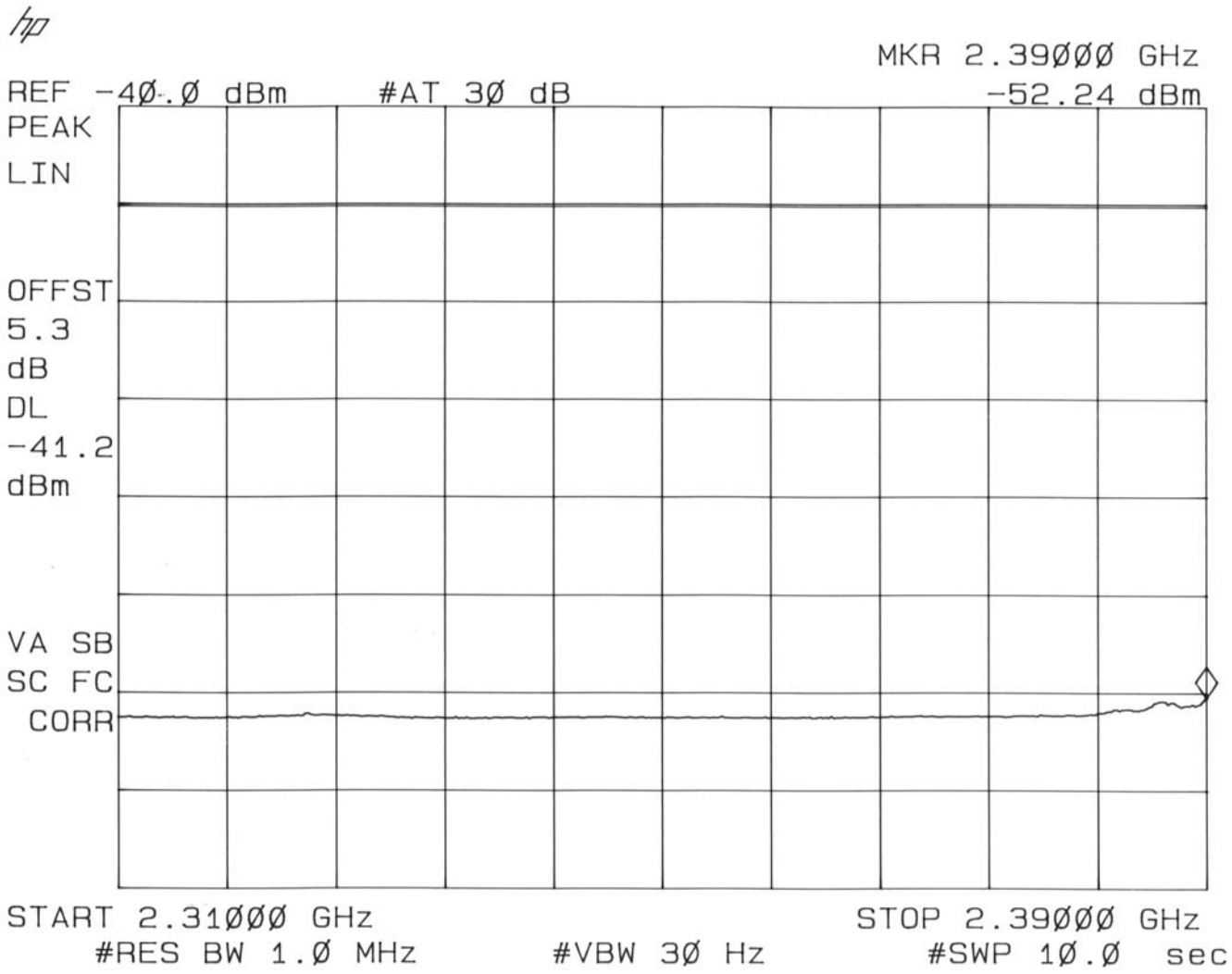
Test engineer

Signature :

Name : Onno H. Hoekstra

Date : April 29, 2002

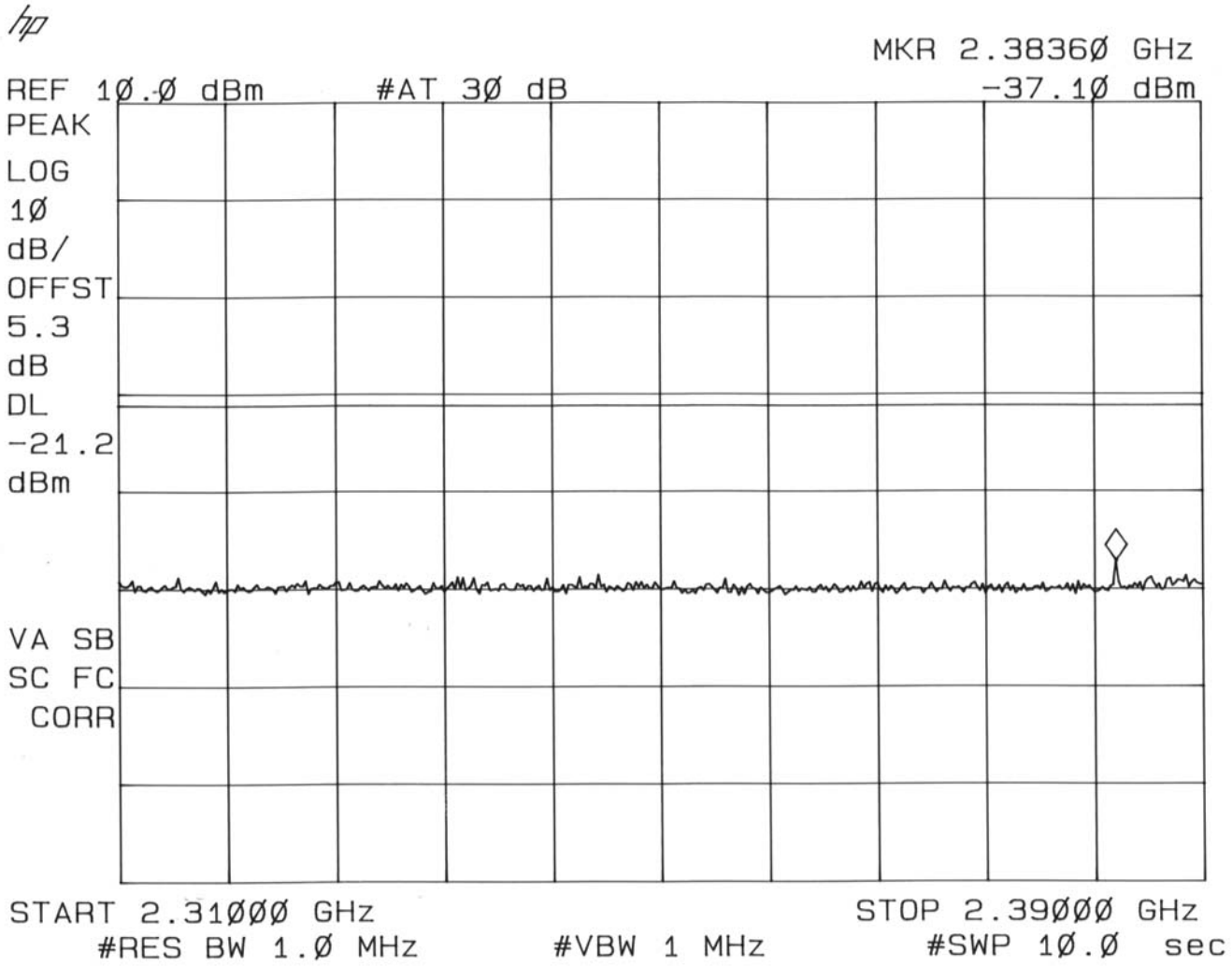
## 5.1 Emission in restricted bands nearest to the band 2400 - 2483.5 MHz




Plot 1 - Average measurement values in restricted band 2310 - 2390 MHz.

Average measurement values in restricted band. All possible transmission bit-rates (1 Mbit/s, 2 Mbit/s, 5.5 Mbit/s and 11 Mbit/s), conducted measurement, corrected for 3 dBi antenna gain (including antenna cable losses) and 2.3 dB cable losses (measurement cable).

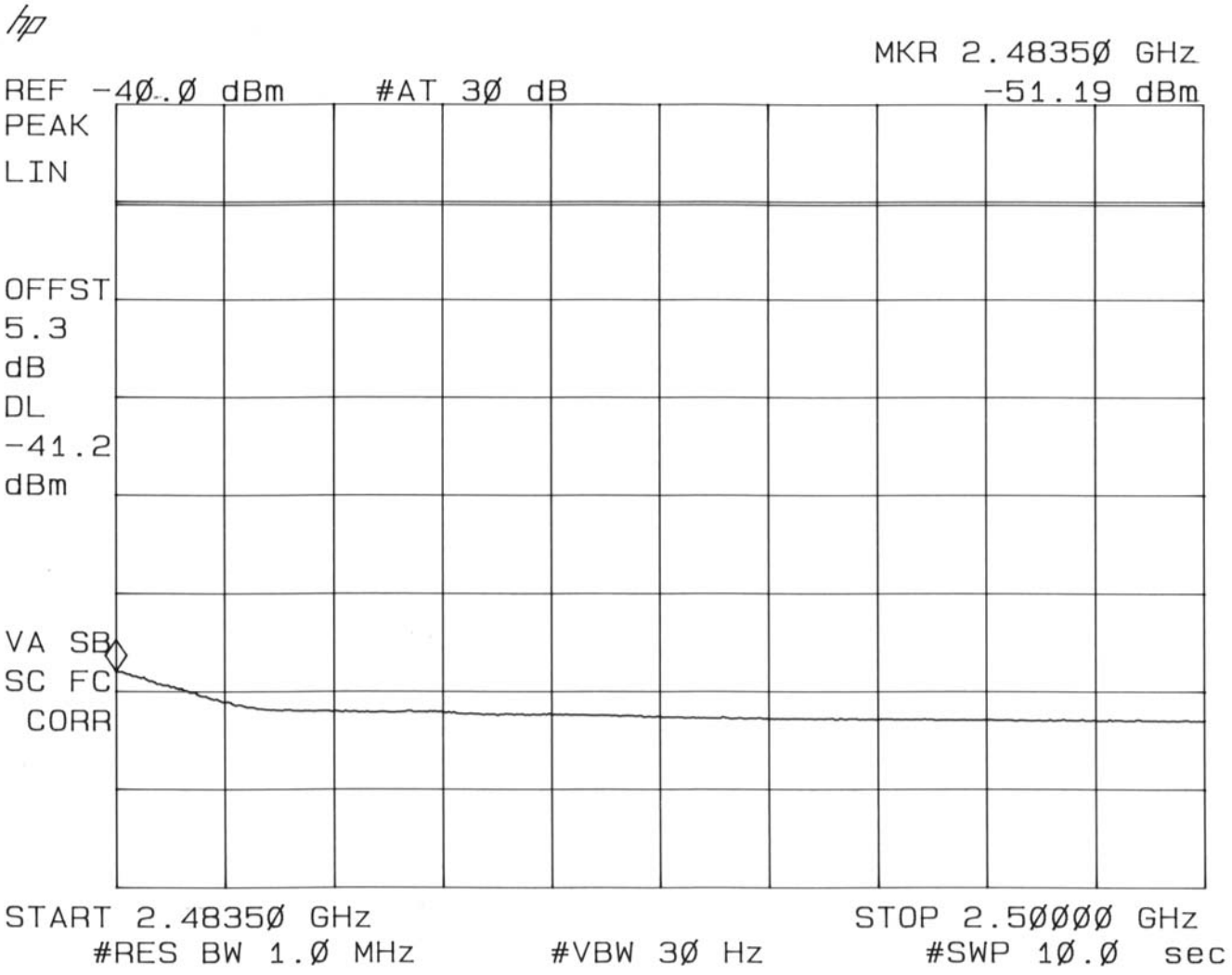
Note: 54 dBµV/m :: -41.2 dBm display line setting.




Plot 2 - Peak measurement values in restricted band 2310 - 2390 MHz.

Peak measurement values in restricted band. All possible transmission bit-rates (1 Mbit/s, 2 Mbit/s, 5.5 Mbit/s and 11 Mbit/s), conducted measurement, corrected for 3 dBi antenna gain (including antenna cable losses) and 2.3 dB cable losses (measurement cable).

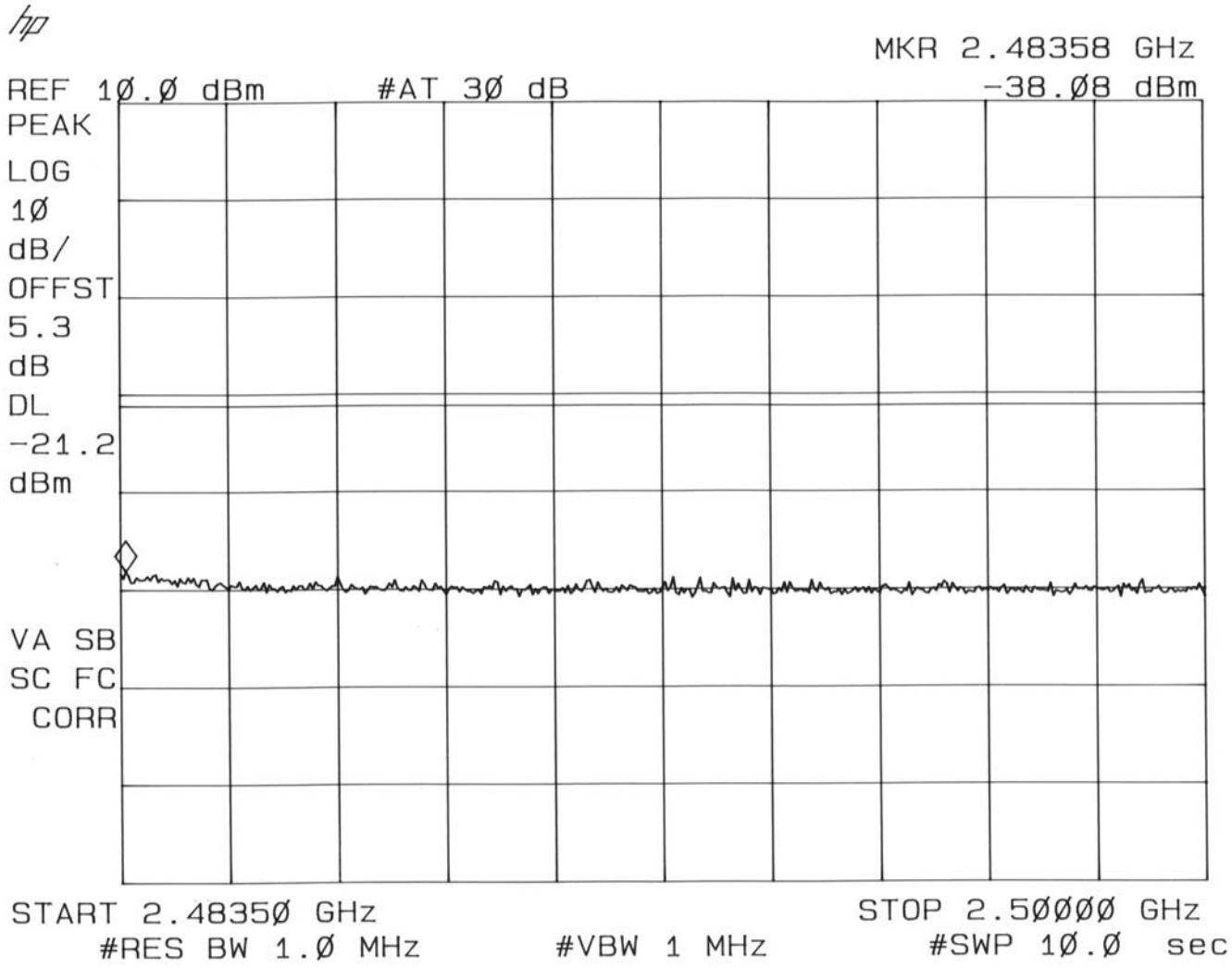
Note: 74 dBµV/m :: -21.2 dBm display line setting.




Plot 3 - Average measurement values in restricted band 2483.5 - 2500 MHz.

Average measurement values in restricted band. All possible transmission bit-rates (1 Mbit/s, 2 Mbit/s, 5.5 Mbit/s and 11 Mbit/s), conducted measurement, corrected for 3 dBi antenna gain (including antenna cable losses) and 2.3 dB cable losses (measurement cable).

Note: 54 dBµV/m :: -41.2 dBm display line setting.

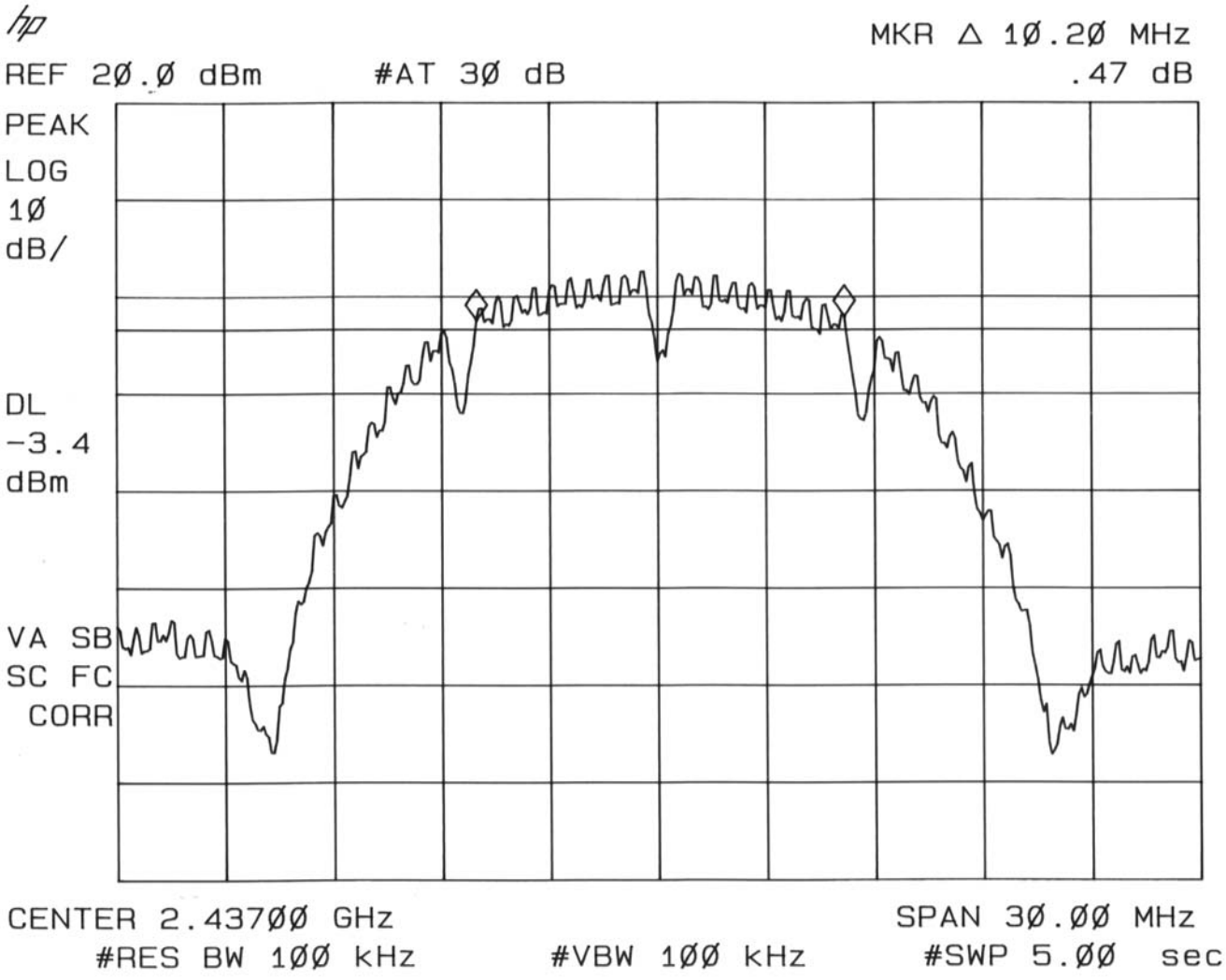



Plot 4 - Peak measurement values in restricted band 2483.5 - 2500 MHz.

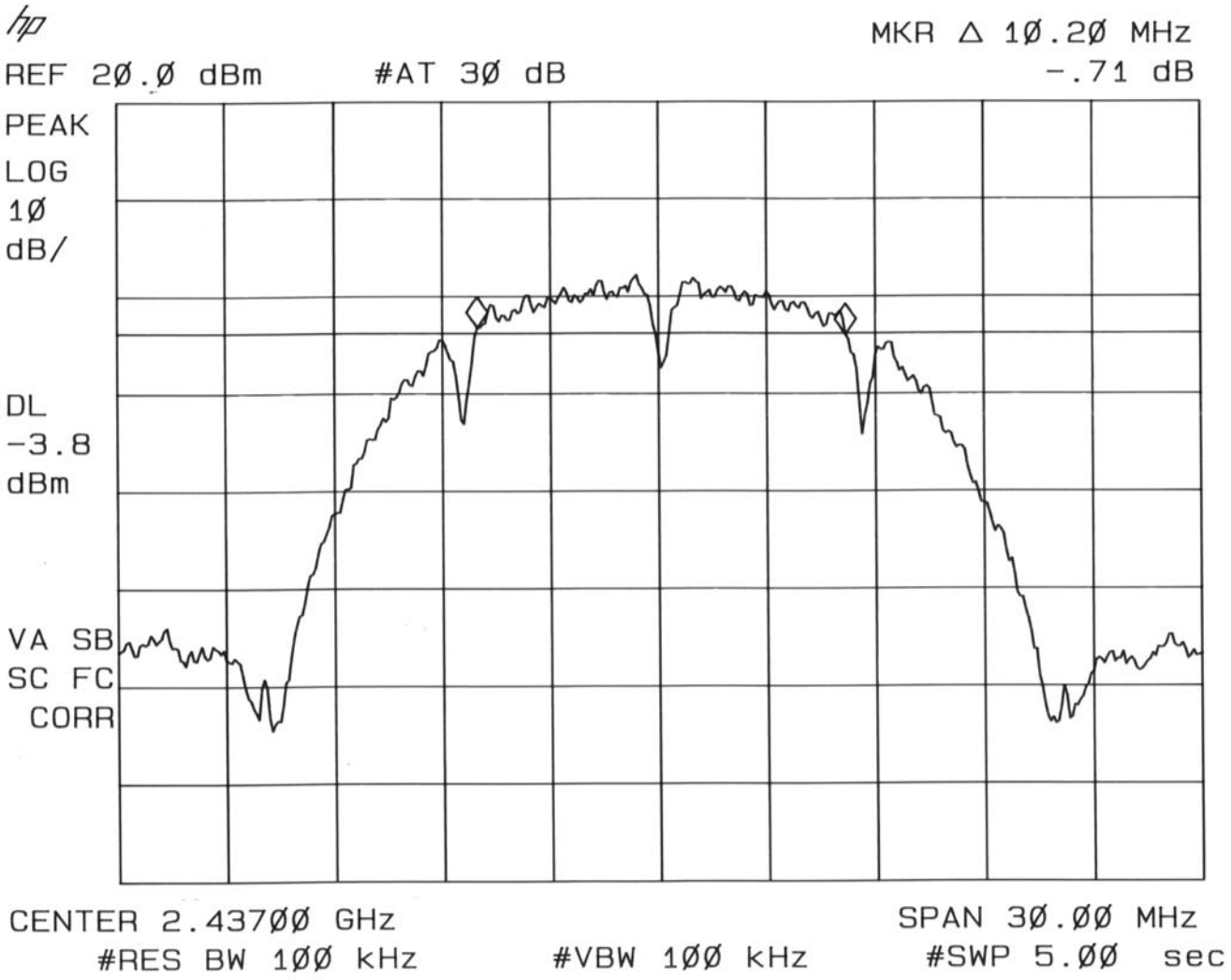
Peak measurement values in restricted band. All possible transmission bit-rates (1 Mbit/s, 2 Mbit/s, 5.5 Mbit/s and 11 Mbit/s), conducted measurement, corrected for 3 dBi antenna gain (including antenna cable losses) and 2.3 dB cable losses (measurement cable).

Note: 74 dBµV/m :: -21.2 dBm display line setting.

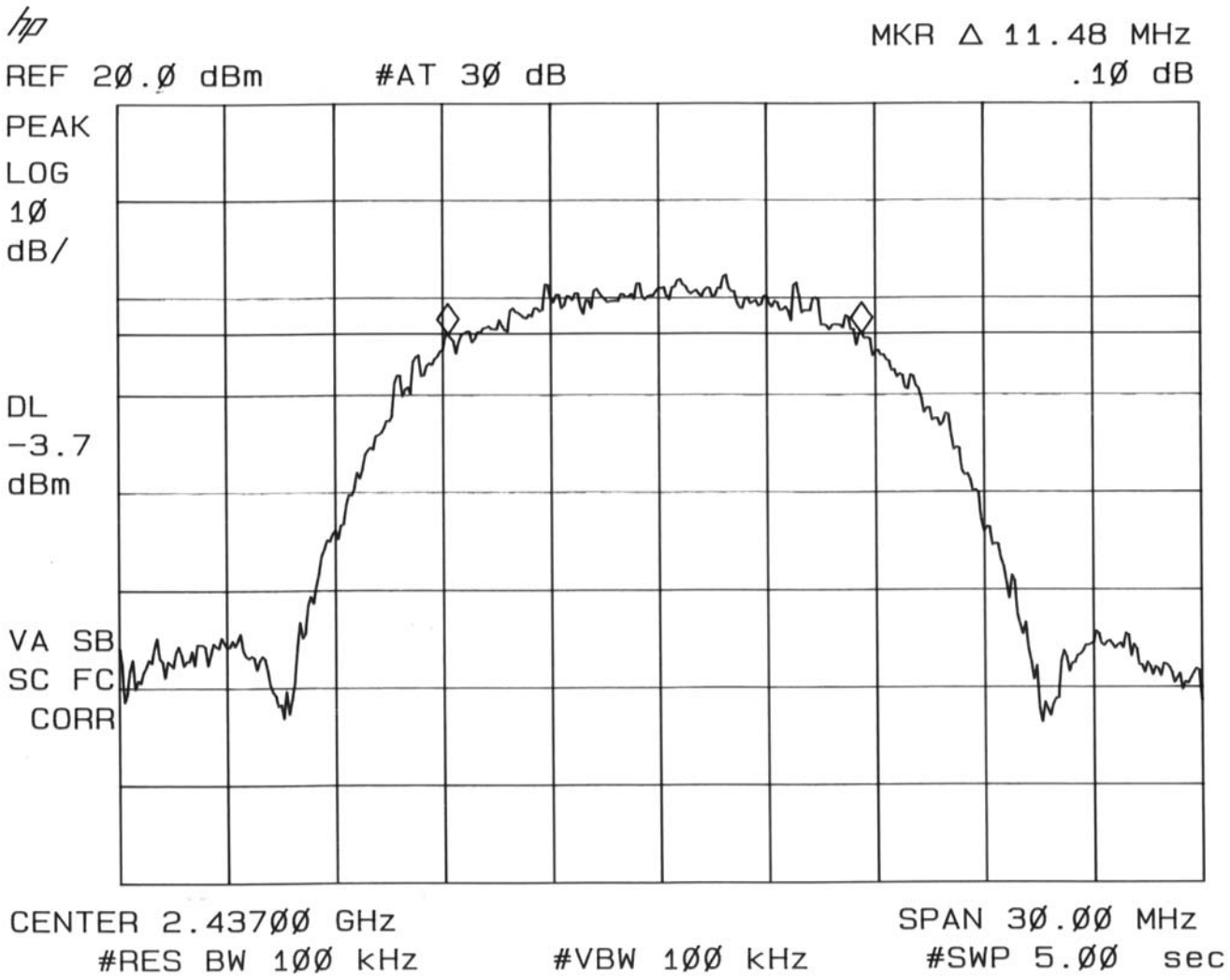
## 5.2 Minimum 6 dB bandwidth



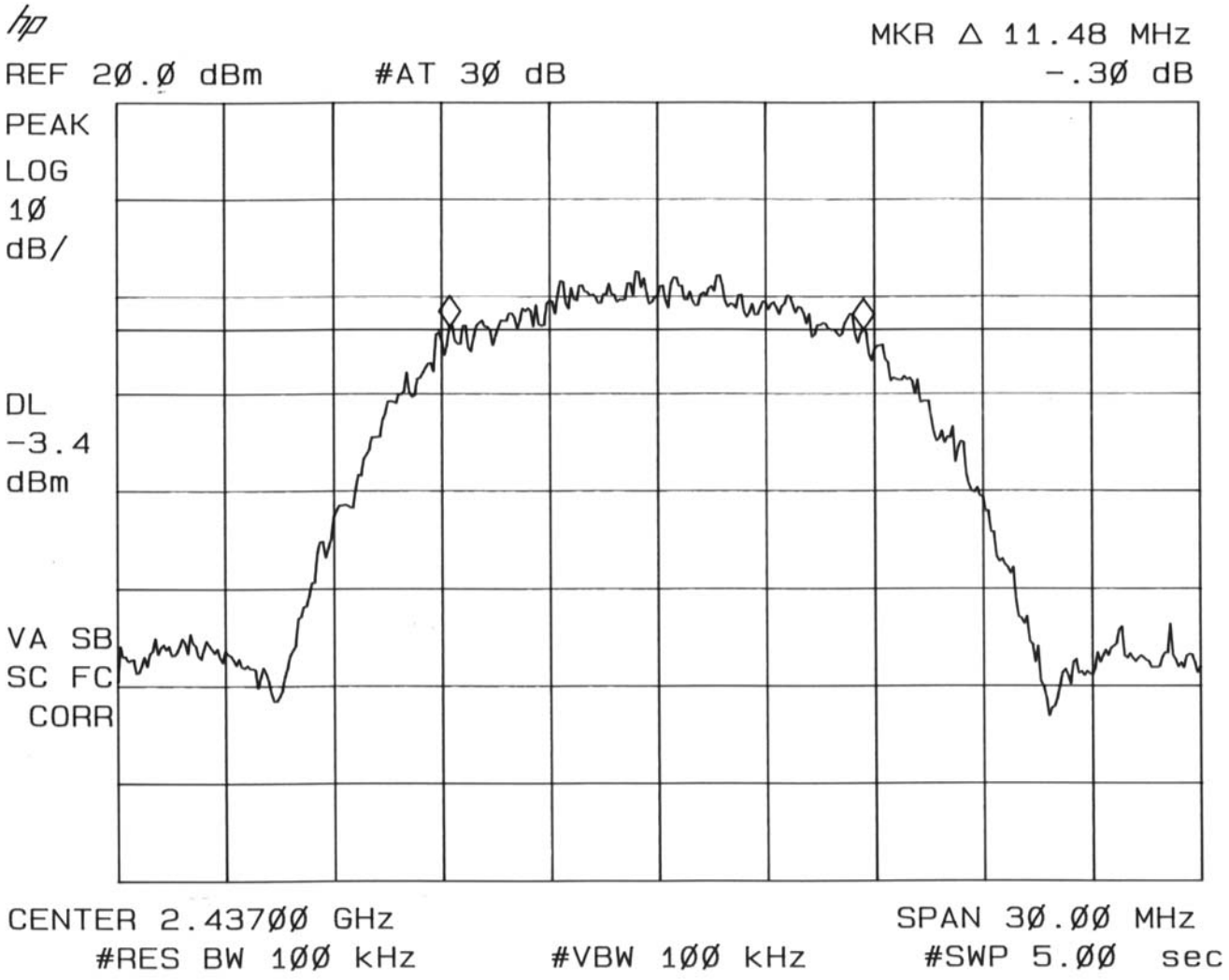

Plot 5 - Minimum 6 dB bandwidth at a transmission bit-rate of 1 Mbit/s.




Plot 6 - Minimum 6 dB bandwidth at a transmission bit-rate of 2 Mbit/s.

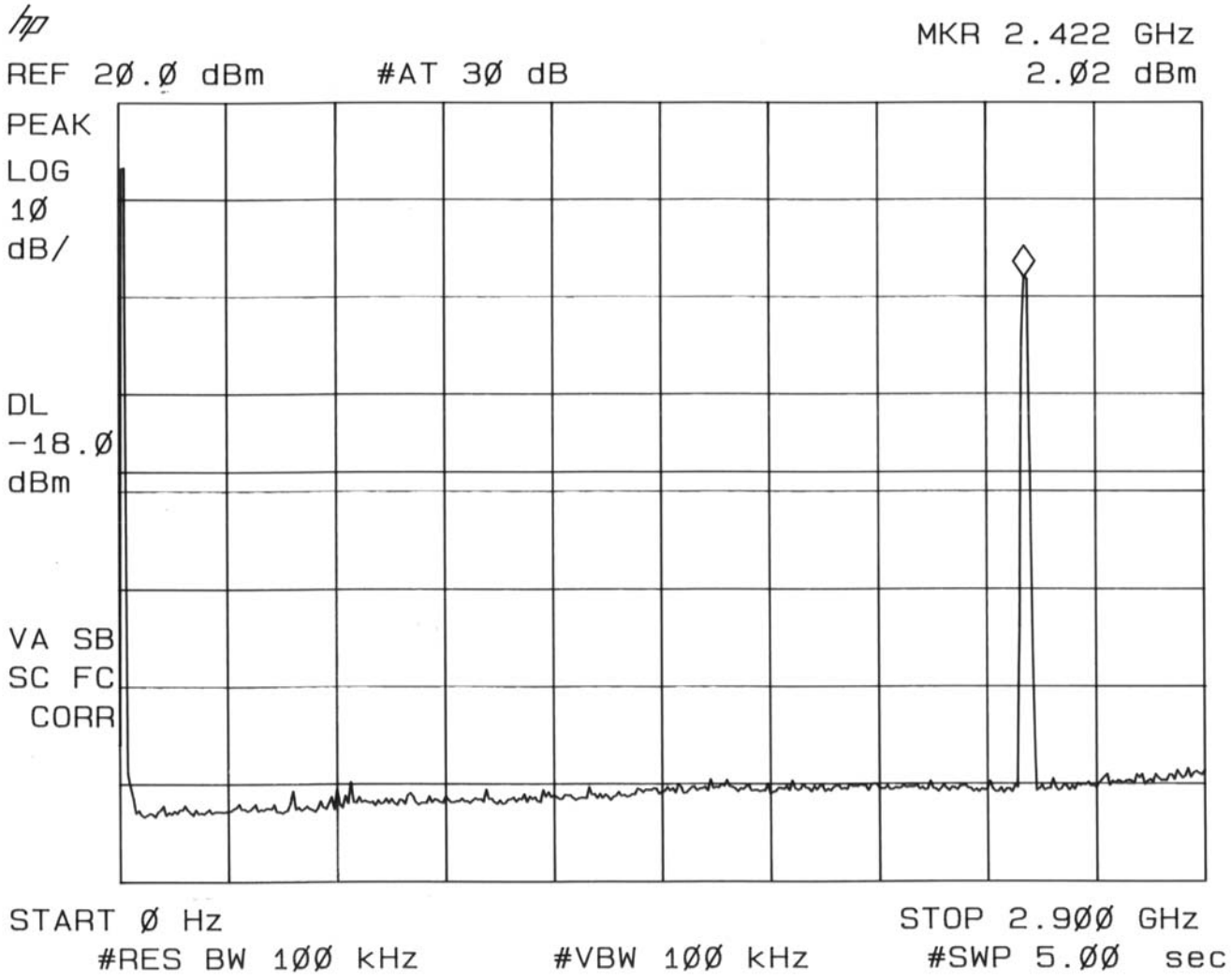



Plot 7 - Minimum 6 dB bandwidth at a transmission bit-rate of 5.5 Mbit/s.



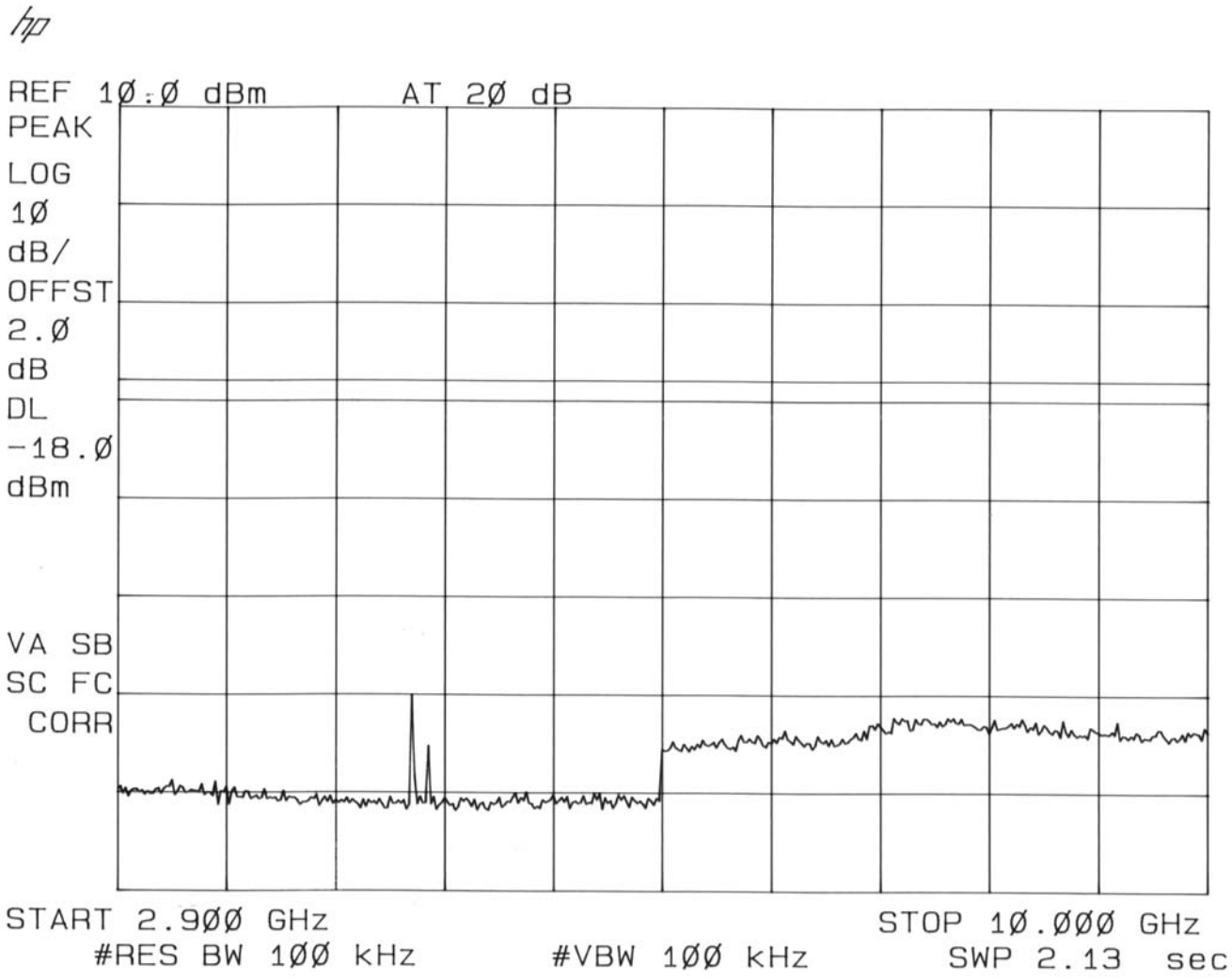

Plot 8 - Minimum 6 dB bandwidth at a transmission bit-rate of 11 Mbit/s.

## 5.3 Conducted emission data outside restricted bands




Plot 9 - Conducted emission outside restricted bands.

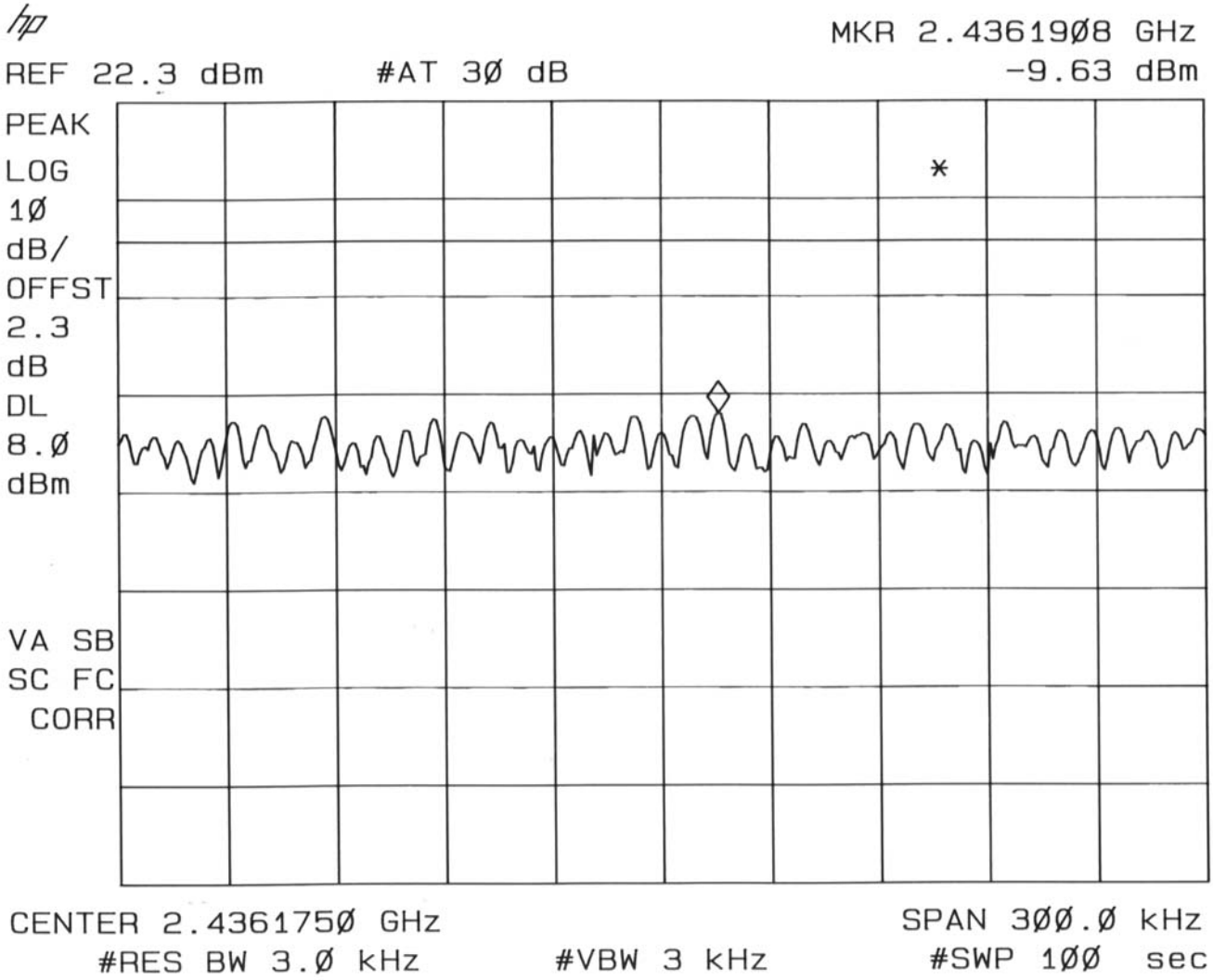
Conducted emission data outside restricted bands in a 100 kHz bandwidth shall be at least 20 dB below the highest level in a 100 kHz bandwidth within the band. Display line :: -20 dB limit line. Corrected (offset) for cable losses.




Plot 10 - Conducted emission outside restricted band.

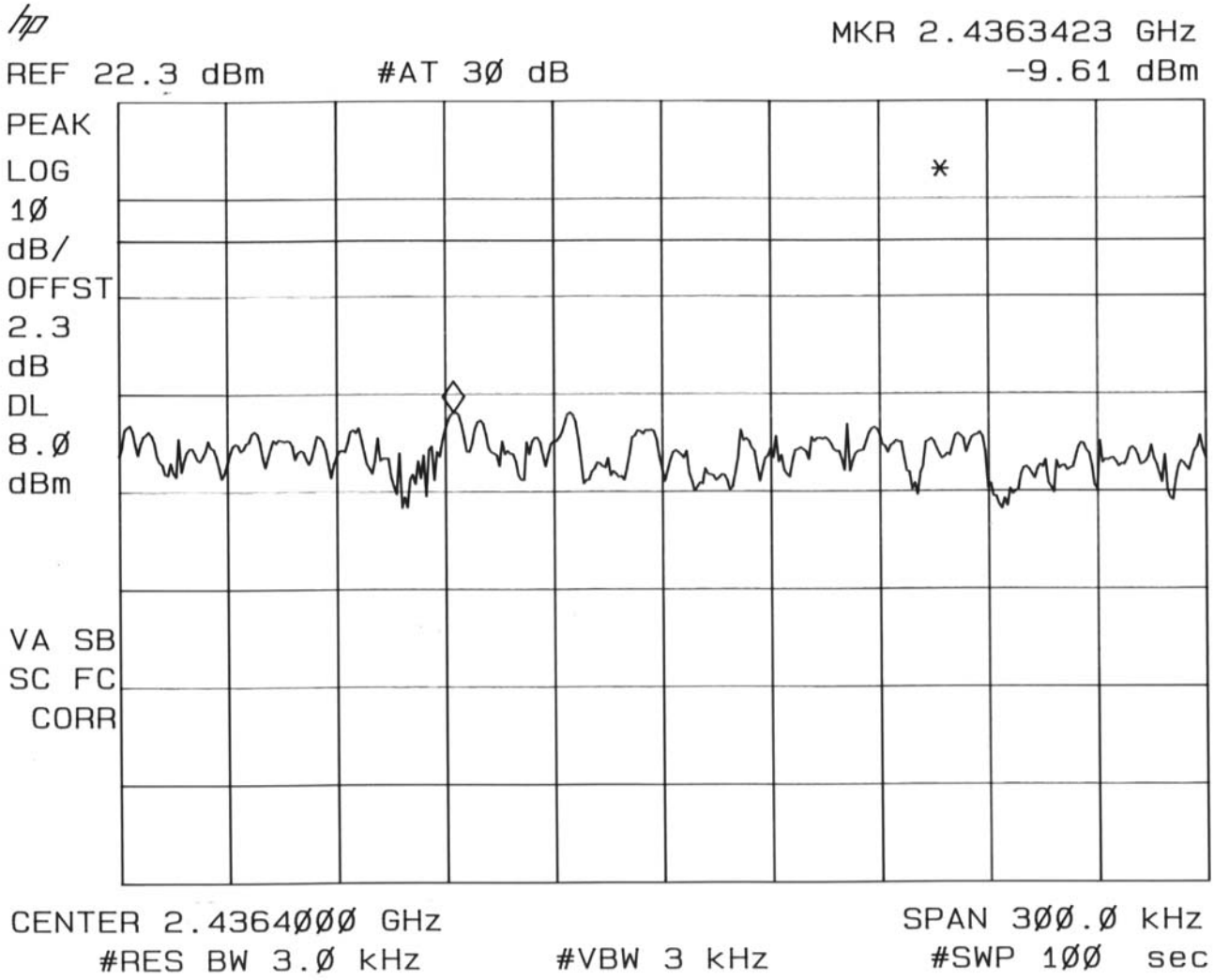
Conducted emission data outside restricted bands in a 100 kHz bandwidth shall be at least 20 dB below the highest level in a 100 kHz bandwidth within the band. Display line :: -20 dB limit line. Corrected (offset) for cable losses.

## 5.4 Peak power spectral density



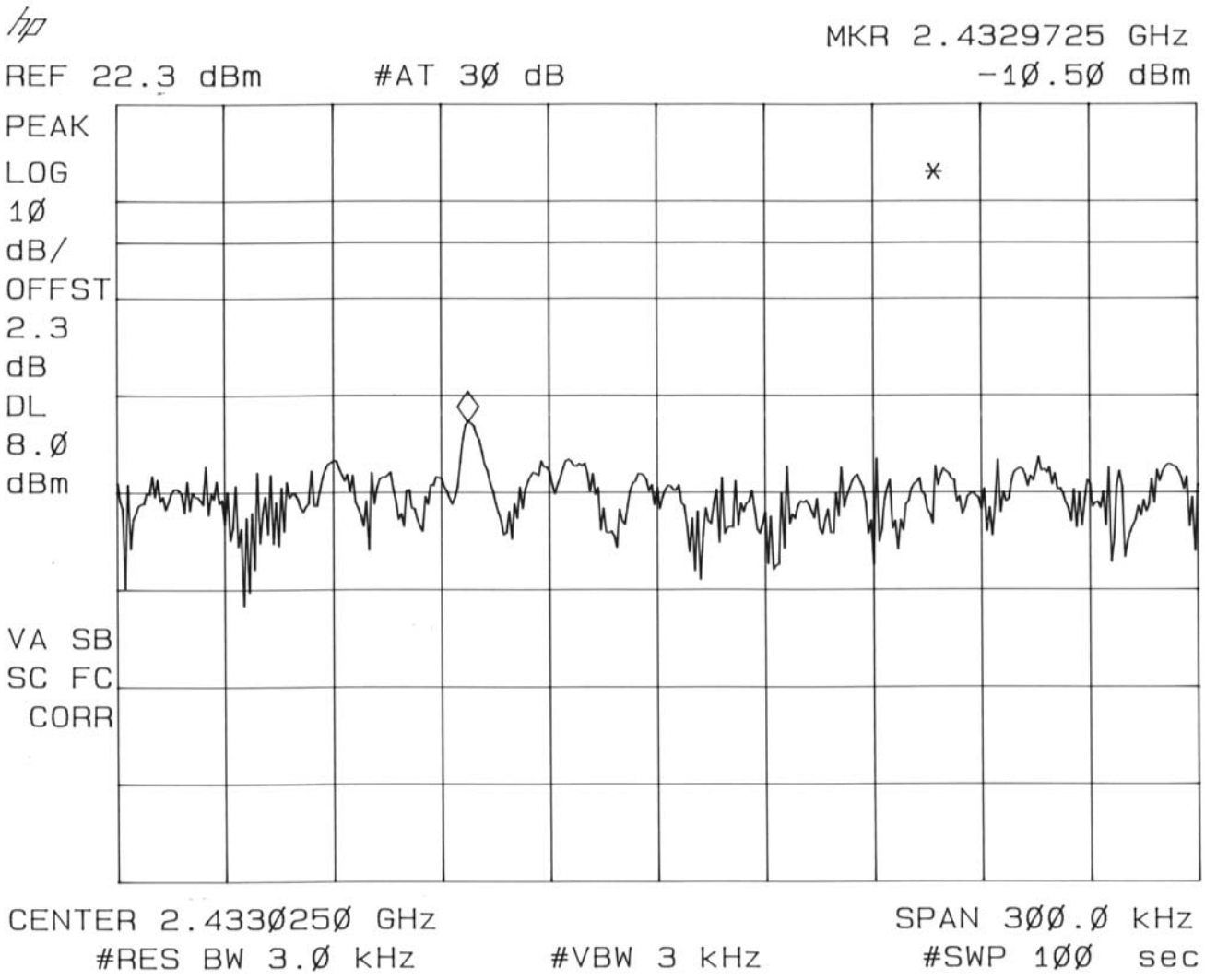

Plot 11 - Peak power spectral density (conducted) from the intentional radiator in any 3 kHz band.

Peak power spectral density (conducted) in a 3 kHz bandwidth at a transmission bit-rate of 1 Mbit/s. Corrected (offset) for cable losses.



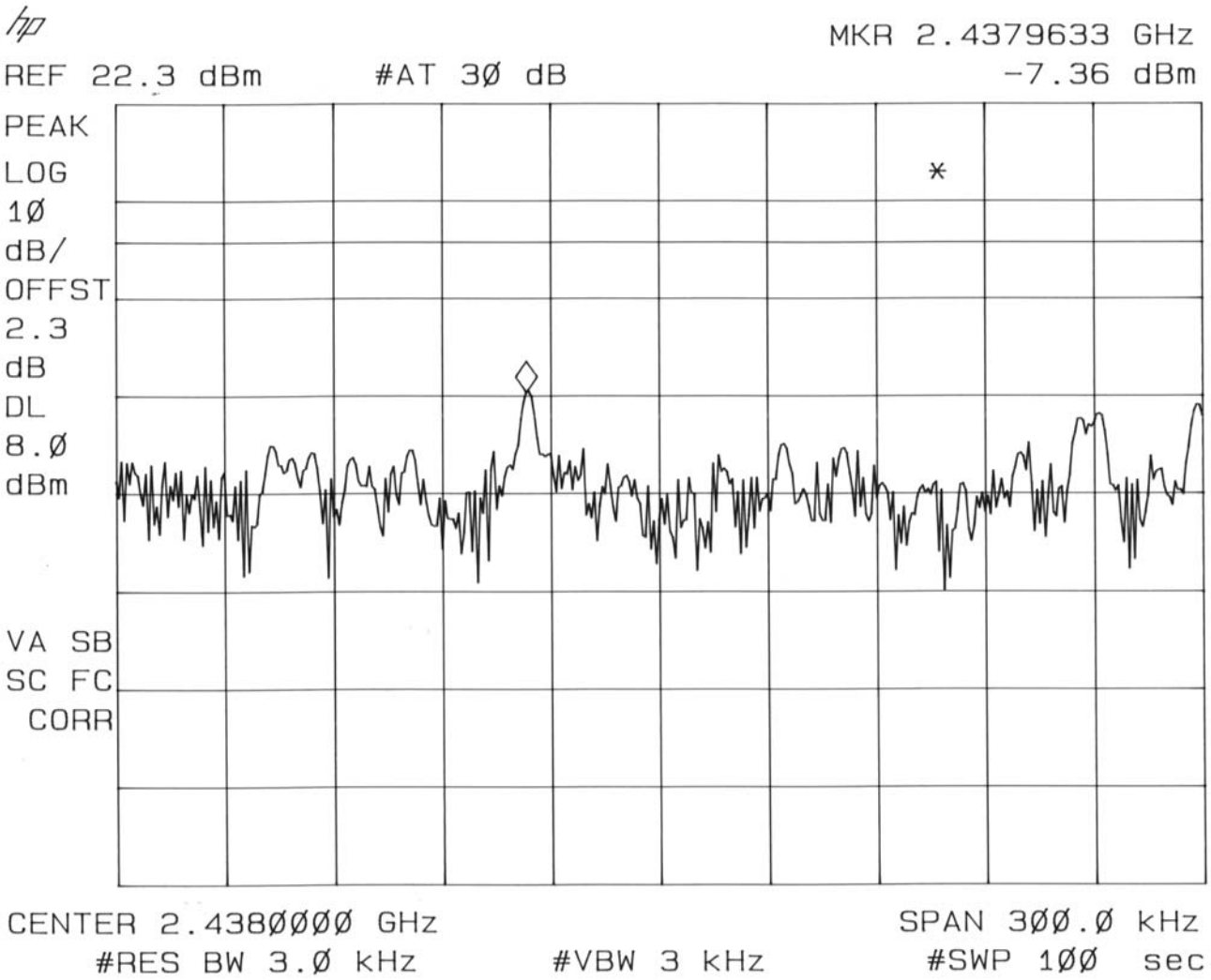

Plot 12 - Peak power spectral density (conducted) from the intentional radiator in any 3 kHz band.

Peak power spectral density (conducted) in a 3 kHz bandwidth at a transmission bit-rate of 2 Mbit/s. Corrected (offset) for cable losses.




Plot 13 - Peak power spectral density (conducted) from the intentional radiator in any 3 kHz band.

Peak power spectral density (conducted) in a 3 kHz bandwidth at a transmission bit-rate of 5.5 Mbit/s. Corrected (offset) for cable losses.




Plot 14 - Peak power spectral density (conducted) from the intentional radiator in any 3 kHz band.

Peak power spectral density (conducted) in a 3 kHz bandwidth at a transmission bit-rate of 11 Mbit/s. Corrected (offset) for cable losses.

# 6 List of utilized test equipment

| Inventory number | Description | Brand | Type |
|---|---|---|---|
| 12471 | Biconical antenna 20MHz-200MHz | EATON | 94455-1 |
| 12473 | Log-per antenna 200-1000MHz | EATON | 96005 |
| 12476 | Antenna mast | EMCO | TR3 |
| 12477 | Antenna mast 1-4 mtr | Poelstra | -- |
| 12482 | Loop antenna | EMCO | 6507 |
| 12483 | Guidehorn | EMCO | 3115 |
| 12484 | Guidehorn | EMCO | 3115 |
| 12488 | Guidehorn 18 - 26.5 GHz | EMCO | RA42-K-F-4B-C |
| 12533 | Signalgenerator | MARCONI | 2032 |
| 12559 | Digital storage oscilloscope | Le Croy | 9310M |
| 12561 | DC Power Supply 20A/70V | DELTA | SM7020D |
| 12567 | Plotter | HP | 7440A |
| 12605 | calibrated dipole 28MHz-1GHz | Emco | 3121c |
| 12608 | HF milliwattmeter | Hewlett Packard | HP435a |
| 12609 | Power sensor 10MHz-18GHz | Hewlett Packard | HP8481A |
| 12636 | Polyester chamber | Polyforce | -- |
| 12640 | Temperature chamber | Heraeus | VEM03/500 |
| 13664 | Spectrum analyzer | HP | HP8593E |
| 13078 | Preamplifier 0.1 GHz - 12 GHz | Miteq | AMF-3D-001120-35-14p |
| 13452 | Digital multi meter | HP | 34401A |
| 13526 | Signalgenerator 20 GHz | Hewlett & Packard | 83620A |
| 13594 | Preamplifier 10 GHz - 25 GHz | Miteq | AMF-6D-100250-10p |
| 13886 | Open Area testsite | Comtest | -- |
| 14051 | Anechoic room | Comtest | -- |
| 14450 | 2.4 GHz bandrejectfilter | BSC | XN-1783 |
| 15633 | Biconilog Testantenna | Chase | CBL 6111B |
| 15667 | Measuring receiver | R&S | ESCS 30 |
| 99045 | DC Power Supply 3A/30V | DELTA | E030/3 |
| 99055 | Non-conducting support | NMi | -- |
| 99061 | Non-conducting support 150cm | NMi | -- |
| 99068 | Detector N-F/BNC-F | Radiall | R451576000 |
| 99069 | Cable 5m RG214 | NMi | -- |
| 99071 | Cable 10m RG214 | NMi | -- |
| 99076 | Bandpassfilter 4 - 10 GHz | Reactel | 7AS-7G-6G-511 |
| 99077 | Regulating trafo | RFT | LTS006 |
| 99112 | Tripod | Chase | -- |
| 99136 | Bandpassfilter 10 - 26.5 GHz | Reactel | 9HS-10G/26.5G-S11 |