FCC ID: PHIAP100BS
ADDENDUM TO CONDUCTED MEASUREMENT REPORT

The following email response from the Technical Certification Body with regard to the initial FCC filing associated with the FCC ID number PHIAP100BS is presented for reference. This addendum addresses and resolves the action items presented in the correspondence that are related only to theory of operation, conducted measurements and RF Exposure. All other issues are to be addressed in a separate addendum to the radiated emissions report. The issues addressed in this addendum are underlined.

----- Original Message -----
From: Certification Manager
To: Jim Blaha
Sent: Thursday, March 29, 2001 12:38 PM
Subject: FCC ID: PHIAP100BS

Hi Jim,

We have conducted our review and have found the following issues:

1. We need an MPE calculation to prove that the device is safe at 20cm.

2. We need an RF exposure warning in the manual such as: ""IMPORTANT NOTE: To comply with FCC RF exposure compliance requirements, the following antenna installation and device operating configurations must be satisfied - The antenna(s) used for this transmitter must be installed to provide a separation distance of at least 20 cm from all persons and must not be co-located or operating in conjunction with any other antenna or transmitter."

3. For information only: We note that you did not think that RF Exposure concerns were an issue for this device. This is not the case. Please see attached FCC RF Exposure Procedure to determine when MPE calculations and warnings are required. For example this was a section F device (page 6). The Specific Procedures (SP) referenced are on page 13.

4. In table 18 of the test report only one type of detector data is shown. >From the text we conclude that it is average data. We need to confirm that the device complies with the peak limit of 15.35(b). This peak limit is 20dB above the average limit. Usually both average and peak data are reported to document compliance with both limits (alternatively, peak data which complies with the average limits is also acceptable). Please provide data to document compliance with the peak and average limits.

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5. The output power needs to be measured with a bandwidth which captures the full power of the signal. A power meter is the preferred measurement instrument. On page 11 of the test report the conducted power output measurements were made with a RBW of 100KHz. In the FCC procedure a RBW of greater than the 6dB bandwidth must be used. The 6dB bandwidth is about 1.5MHz. Please provide conducted power output data acquired using a bandwidth greater than 1.55MHz.

6. Please provide information on the length and shielding type of the two data cables attached to the product during radiated and conducted emissions. If shielded cables were used, then the manual must have a statement added instructing the user to utilize shielded cables on those ports so provisioned.

7. Please provide data responsive to the FCC 15.31 (e) requirements.

8. We need a better description of the spreading process to complete the evaluation of compliance with 15.247(e). Please discuss the available chip/symbol rate(s) and tell us the spreading rate and the data rate. If the spreading rate/data rate is less than 11:1, please provide a discussion of the theoretical processing gain of the system.

9. To comply with 2.925(a)(1) the FCC ID on the label must on a single line. Please supply a revised label exhibit. We have noted the label does include a Part 68 ID. How have you handled the Part 68 certification?

10. Please supply details of the label material so we confirm compliance with 2.925(d).

Best regards

Barry C. Quinlan
Certification & Telecom Manager

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Action Item resolution:

1. We need an MPE calculation to prove that the device is safe at 20cm.

The power density associated with a particular electric field intensity is:

$$W = \frac{|E|^2}{h} = \frac{|E|^2}{120p} = \frac{|E|^2}{377}; \frac{\left(V/m\right)^2}{Ohms} = \frac{Watts}{m^2}$$

The power density at a distance from an isotropic radiating source is:

$$W(r) = \frac{W_t}{4p\, r^2}; \frac{Watts}{m^2}$$

If identical isotropic transmitting and receiving antennas are used, the received power at a distance from an isotropic radiating source is:

$$P(r) = W(r) \cdot A = \frac{W_t \cdot A}{4pr^2} = \frac{P_t}{4pr^2} \quad ; \quad Watts$$

Solving for transmit power and expressing the received power in terms of received electric field intensity:

$$P_t = P(r) 4pr^2 = \frac{|E|^2}{120p} 4pr^2; \quad Watts$$

Since the electric field intensity is specified at a 3 meter distance and we are interested in the effective transmit power in dBm:

r = 3 meters

P (W)=P(mW) x 1000

E(V) = E(uV) x 10^{-6}

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$$P_t = 10\log_{10}\left(\frac{|E|^2}{30} 3^2 \cdot 1000\right) = 20\log_{10}(|E|) + 20\log_{10}(3) + 10\log_{10}(1000) - 10\log_{10}(30) \quad dBm$$

$$P_t = 20\log_{10}(|E_{mV}|) - 20\log_{10}(10^{-6}) + 20\log_{10}(3) + 10\log_{10}(1000) - 10\log_{10}(30) \quad dBm$$

$$P_t = 20\log_{10}(|E_{mV}|) - 120 + 9.54 + 30 - 14.77 \quad dBm$$

$$P_t = 20\log_{10}(|E_{mV}|) - 95.23 \quad dBm$$

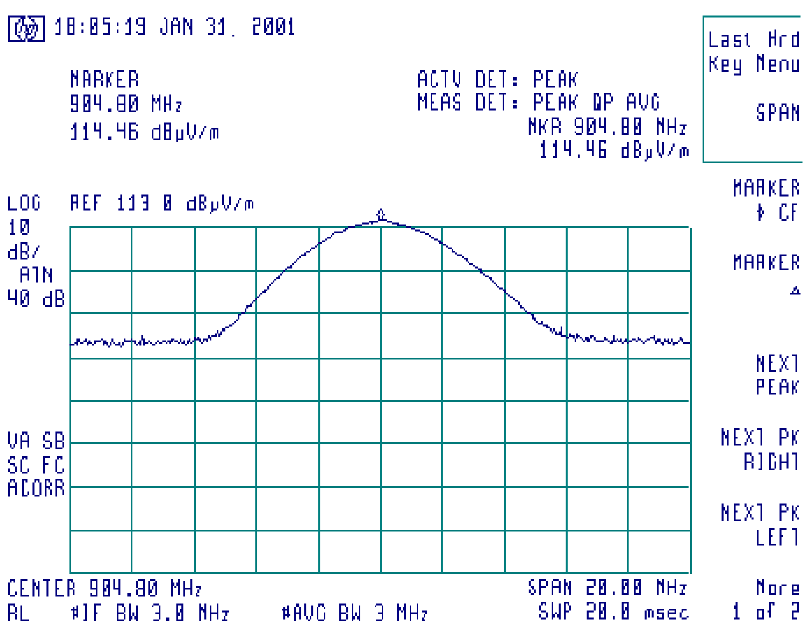
The conversion between effective radiated power and the magnitude of the electric field intensity at a 3 meter distance from the transmitting source are related by:

$$P_t = |E_{dBmV}| - 95.23 \quad dBm$$

The reported intentional emissions of the base-station are as follows.

```
channel 1        114.5 dBuV/m
channel 9        114.1 dBuV/m
channel 13      113.5 dBuV/m
```

The worst case is channel 1. A graph of the actual test indication is presented below for reference:



The effective radiated power for this worst case emission is:

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$$P_t = 114.5 \left. \frac{dBmV}{m} \right|_{r=3m} - 95.23 = 19.27 \quad dBm$$

The expected power density at a 20 centimeter distance is:

$$W(r) = \frac{W_t}{4p\, r^2} = \frac{10^{\left(\frac{19.27\, dBm}{10}\right)} \cdot \frac{10^{-3}\, mW}{W}}{4p\left(20 \times 10^{-2}\, m\right)^2} = 168.2\ \frac{mW}{m^2}$$

Re-normalizing this power density on a per square centimeter basis:

$$W(r) = 168.2\ \frac{mW}{m^2} \cdot \frac{10^{-4}\, m^2}{cm^2} = 16.82 \frac{mW}{cm^2}$$

The limit for Maximum Permissible Exposure (MPE) given in Table 1 of §1.1310 is given as

$$W_{\max}(r) = \frac{f\,(MHz)}{1500 \frac{MHz - cm^2}{mW}} = \frac{928 MHz}{1500 \frac{MHz - cm^2}{mW}} = 618.7 \frac{mW}{cm^2}$$

The base-station uses a Time-Division-Duplex Protocol where the transmitter has a constant duty factor of 50%. Section 2.1091 allows for time averaging of the transmit power for the purposes of the MPE calculations. This fact would reduce the average power to one-half the constantly transmitting value:

$$W(r) = 8.41 \frac{mW}{cm^2}$$

Since:

$$W(r) = 8.41 \frac{mW}{cm^2} < W_{\max}(r) = 618.7 \frac{mW}{cm^2}$$

Therefore, the device in question meets the MPE requirement.

5. The output power needs to be measured with a bandwidth which captures the full power of the signal. A power meter is the preferred

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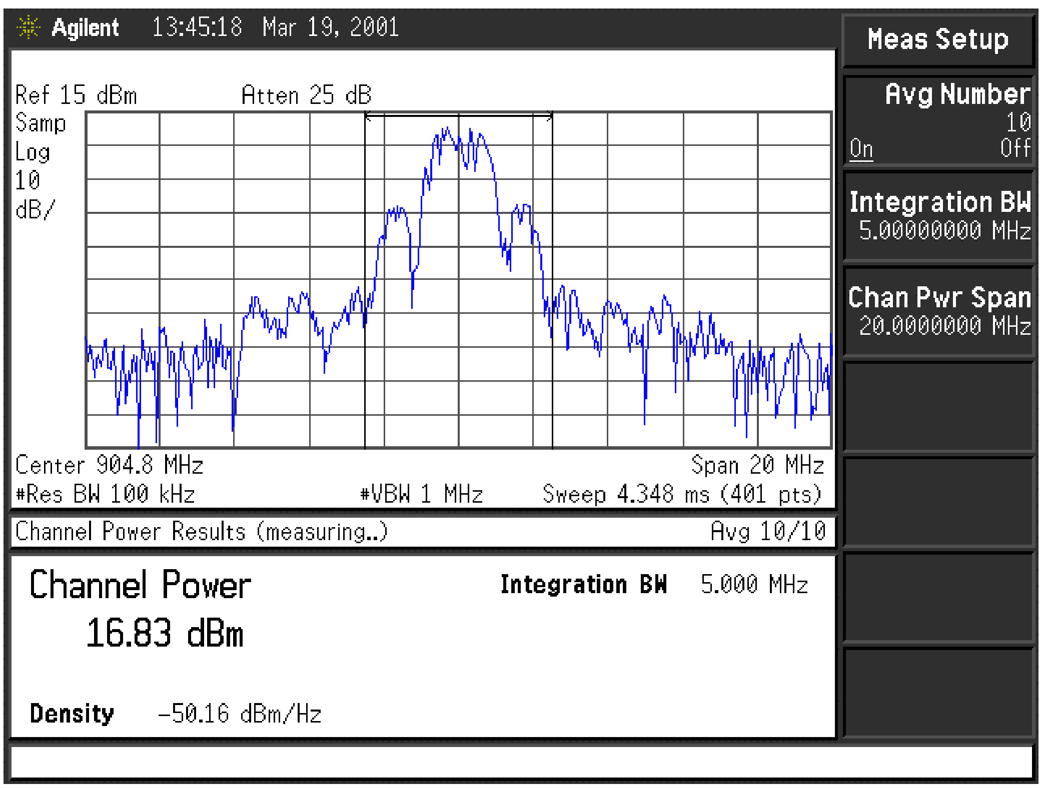
measurement instrument. On page 11 of the test report the conducted power output measurements were made with a RBW of 100KHz. In the FCC procedure a RBW of greater than the 6dB bandwidth must be used. The 6dB bandwidth is about 1.5MHz. Please provide conducted power output data acquired using a bandwidth greater than 1.55MHz.

Presented on pages 10-13 are measurements of integrated channel power. The spectrum analyzer automatically selects the resolution bandwidth and video bandwidth for the measurements. The power contained within the 100 kHz bandwidth shown is measured with a sampling detector. Each of the power spectral density samples across the defined channel width is summed and the value of the integrated power spectral density is indicated. Further, this process is carried out 10 times and the average value of that ensemble is presented as the test indication. The test indication is defined as the total average power contained within the limit lines.

This measurement has good agreement with a power meter. An excerpt from an Agilent Technologies application note is reproduced below for more details on the measurement process [1]:



Channel-power measurements

Most modern spectrum analyzers allow the measurement of the power within a frequency range, called the channel bandwidth. The displayed result comes from the computation:

$$P_{ch} = \left(\frac{B_s}{B_n}\right)\left(\frac{1}{N}\right)\sum_{i=n1}^{n2} 10^{(P_i/10)}$$

Pch is the power in the channel, *Bs* is the specified bandwidth (also known as the channel bandwidth), *Bn* is the equivalent noise bandwidth of the RBW used, *N* is the number of data points in the summation, *pi* is the sample of the power in measurement cell *i* in dB units (if *pi* is in dBm, *Pch* is in milliwatts). *n1* and *n2* are the end-points for the index *i* within the channel bandwidth, thus $N=(n2 - n1) + 1$.

The computation works well for CW signals, such as from sinusoidal modulation. The computation is a power-summing computation. Because the computation changes the input data points to a power scale before summing, there is no need to compensate for the difference between the log of the average and the average of the log as explained in Part I, even if the signal has a noise-like PDF (probability density function). But, if the signal starts with noise-like statistics and is averaged in decibel form (typically with a VBW filter on the log scale) before the power summation, some 2.51 dB under-response, as explained in Part I, will be incurred. If we are certain that the signal is of noise-like statistics, and we fully average the signal before performing the summation, we can add 2.51 dB to the result and have an accurate measurement. Furthermore, the averaging reduces the variance of the result.

But if we don't know the statistics of the signal, the best measurement technique is to do no averaging before power summation. Using a VBW ≥ 3RBW is required for insignificant averaging, and is thus recommended. But the bandwidth of the video signal is not as obvious as it appears. In order to not peak-bias the measurement, the *sample* detector must be used. Spectrum analyzers have lower effective video bandwidths in sample detection than they do in peak detection mode, because of the limitations of the sample-and-hold circuit that precedes the A/D converter. Examples include the Agilent 8560E-Series spectrum analyzer family with 450 kHz effective sample-mode video bandwidth, and a substantially wider bandwidth (over 2 MHz) in the Agilent ESA-E Series spectrum analyzer family.

Figure 9 shows the experimentally determined relationship between the VBW:RBW ratio and the under-response of the partially averaged logarithmically processed noise signal.

However, the Agilent PSA is an exception to the relationship illustrated by Figure 9. The Agilent PSA allows us to directly average the signal on a power scale. Therefore, if we are not certain that our signal is of noise-like statistics, we are no longer prohibited from averaging before power summation. The measurement may be taken by either using VBW filtering on a power scale, or using the average detector on a power scale.

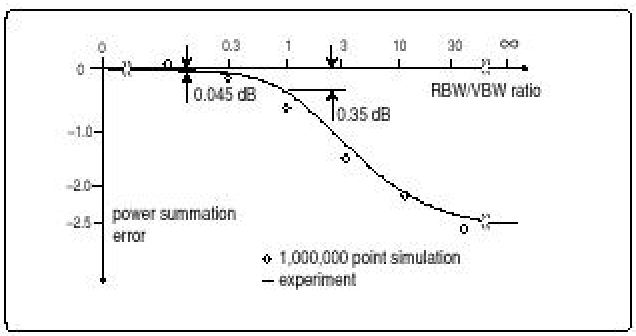


Figure 9. For VBW ≥ 3 RBW, the averaging effect of the VBW filter does not significantly affect power-detection accuracy.

[1] "Agilent Technologies AN 1303 – Spectrum Analyzer Measurements and Noise", Published January 21, 2001.

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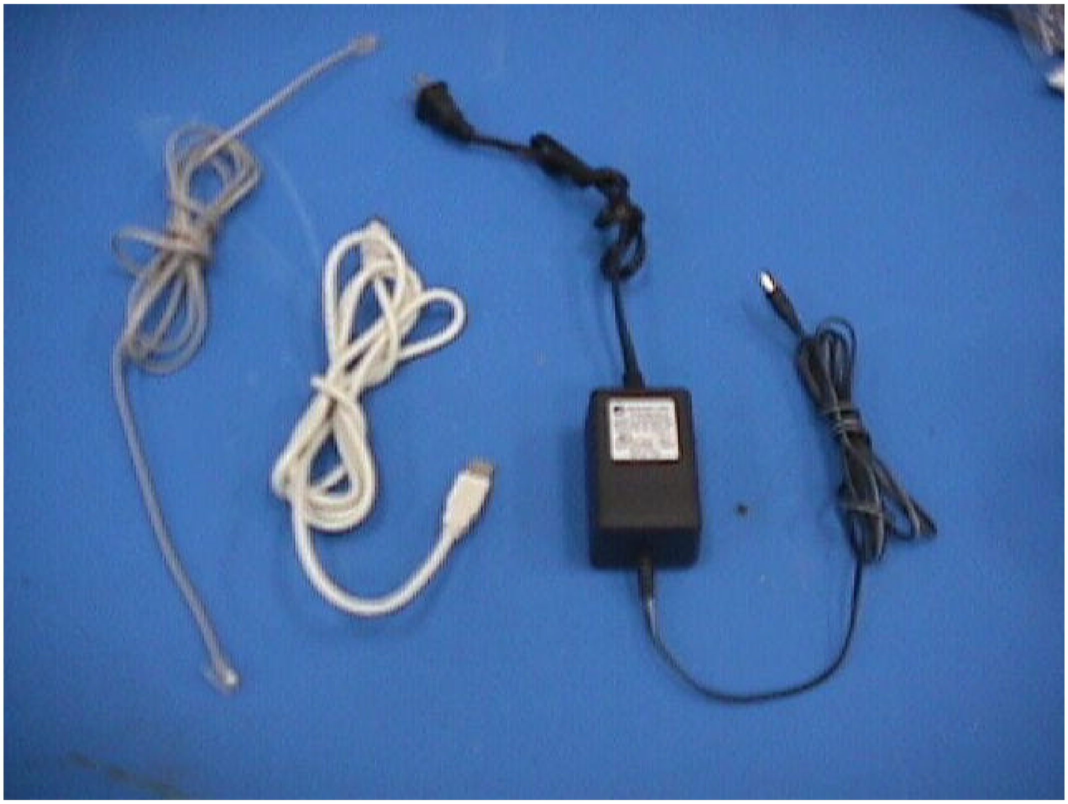
6. Please provide information on the length and shielding type of the two data cables attached to the product during radiated and conducted emissions. If shielded cables were used, then the manual must have a statement added instructing the user to utilize shielded cables on those ports so provisioned.

The base-station has three external cables. The cables are described as:

1. Telephone Cable: 6 ft. two-conductor phone cable terminated with RJ11 connectors.
2. Universal Serial Bus (USB) Cable: 6 ft. shielded USB patch cable.
3. AC/DC Power Unit/Cable: 2 ft. two-conductor AC Mains, 6 ft. DC Cable.

The three cables are presented in a photograph shown below:



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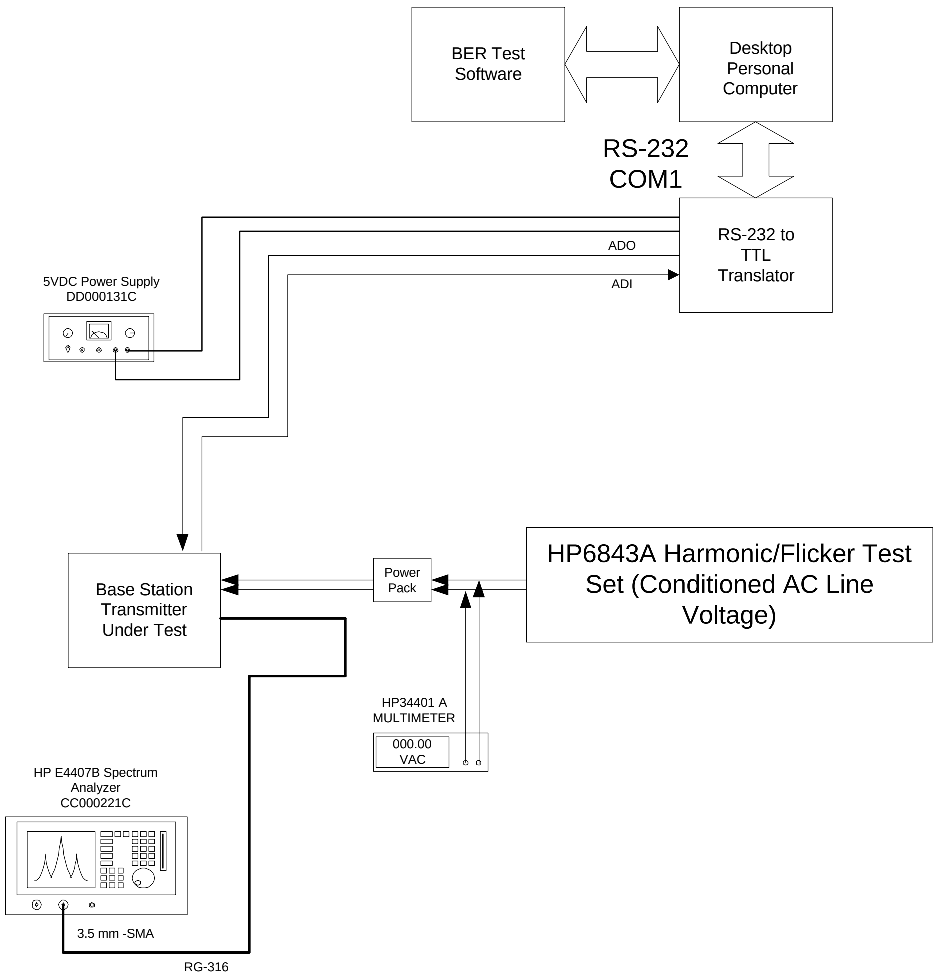
7. Please provide data responsive to the FCC 15.31 (e) requirements.

The base-station was tested with respect to the requirements dictated by FCC 15.31. The integrated channel power was measured at the center channel of 914.5 MHz over a line voltage variation of 120 VAC +/- 15 % (102 VAC minimum, 120 VAC nominal, 138 VAC). The test configuration is shown below:



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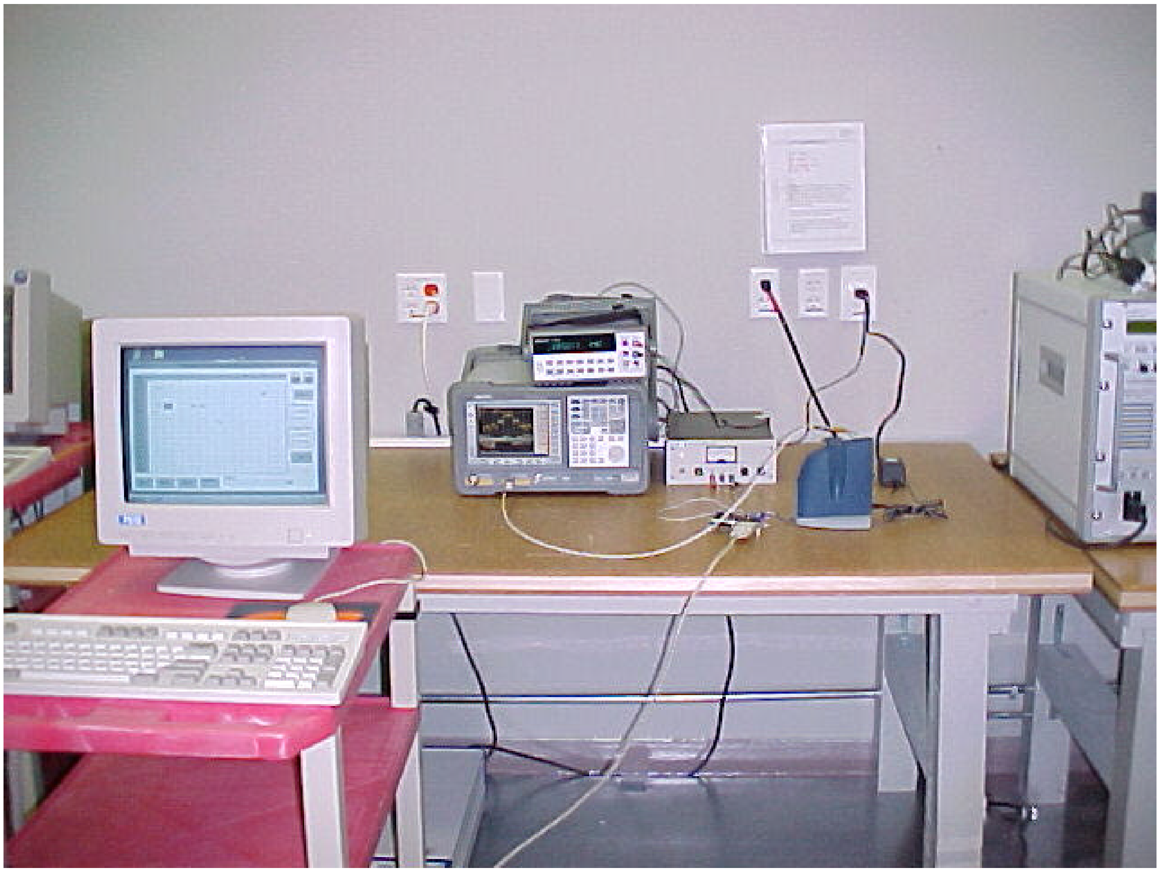
Photographs of the test configuration are presented below:



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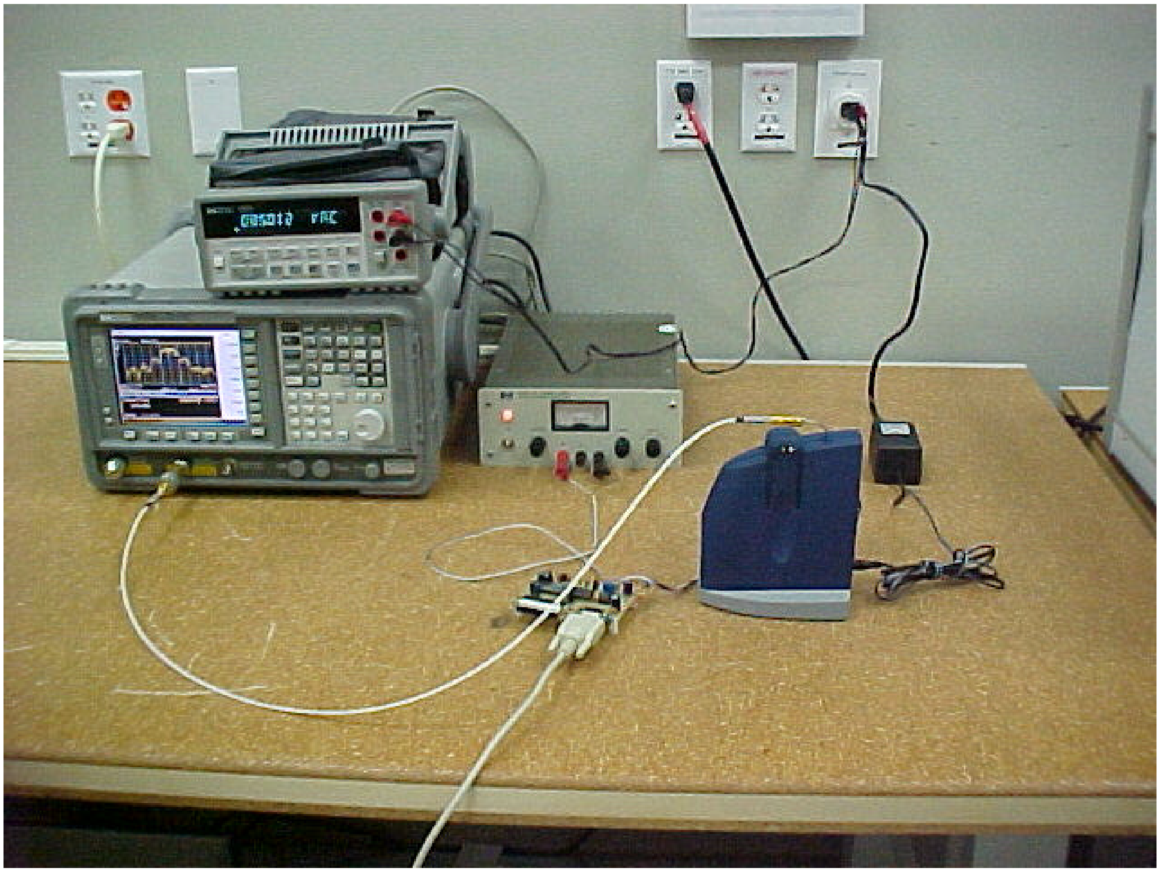

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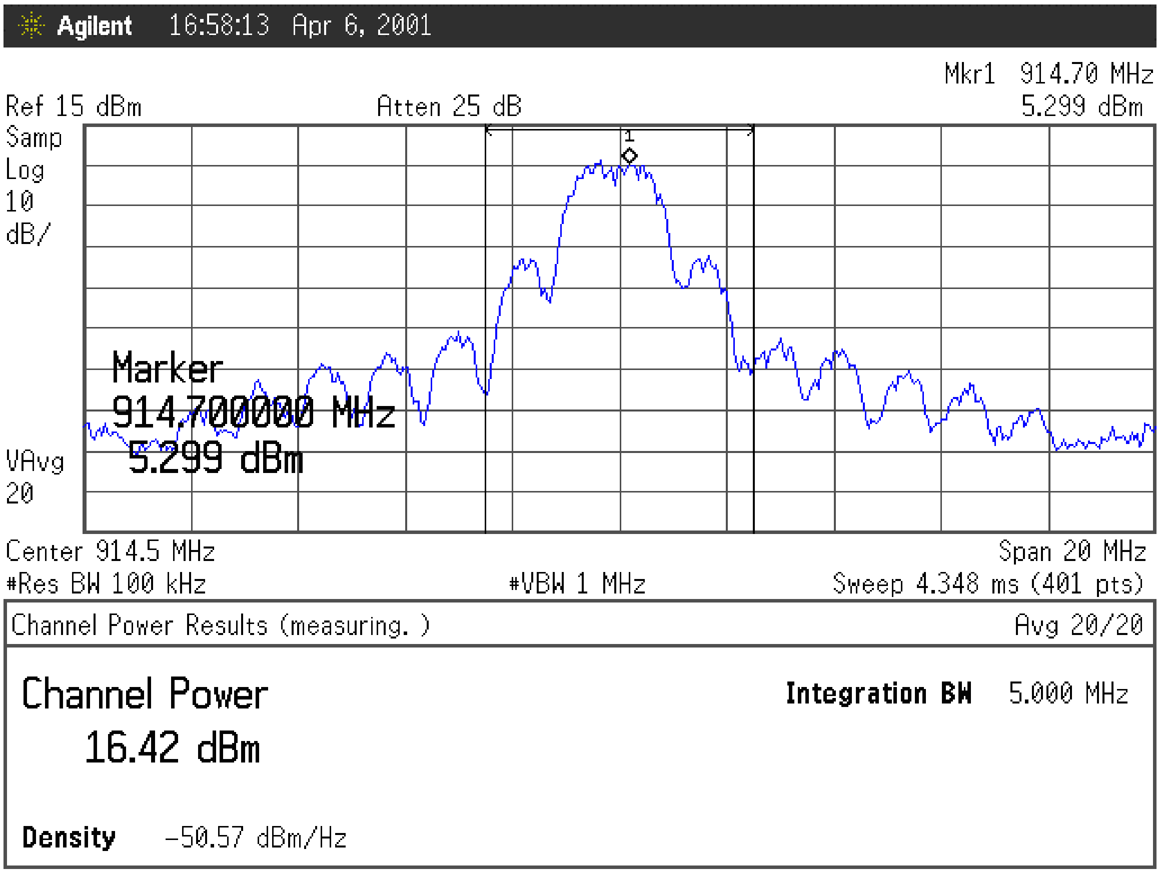
The test indications are presented below:



Test Indication for Line Voltage at 85% of Nominal: 102 VAC

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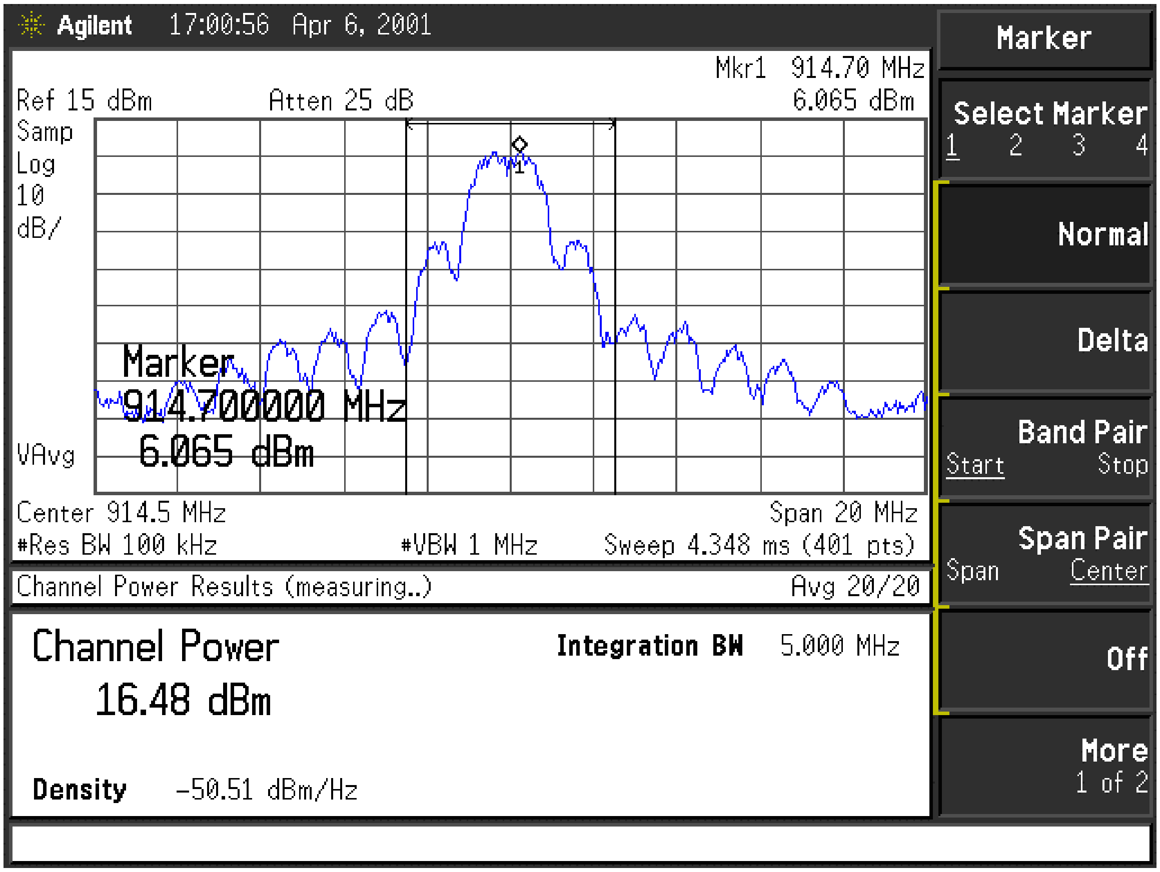

Test Indication for Line Voltage at 100% of Nominal: 120 VAC

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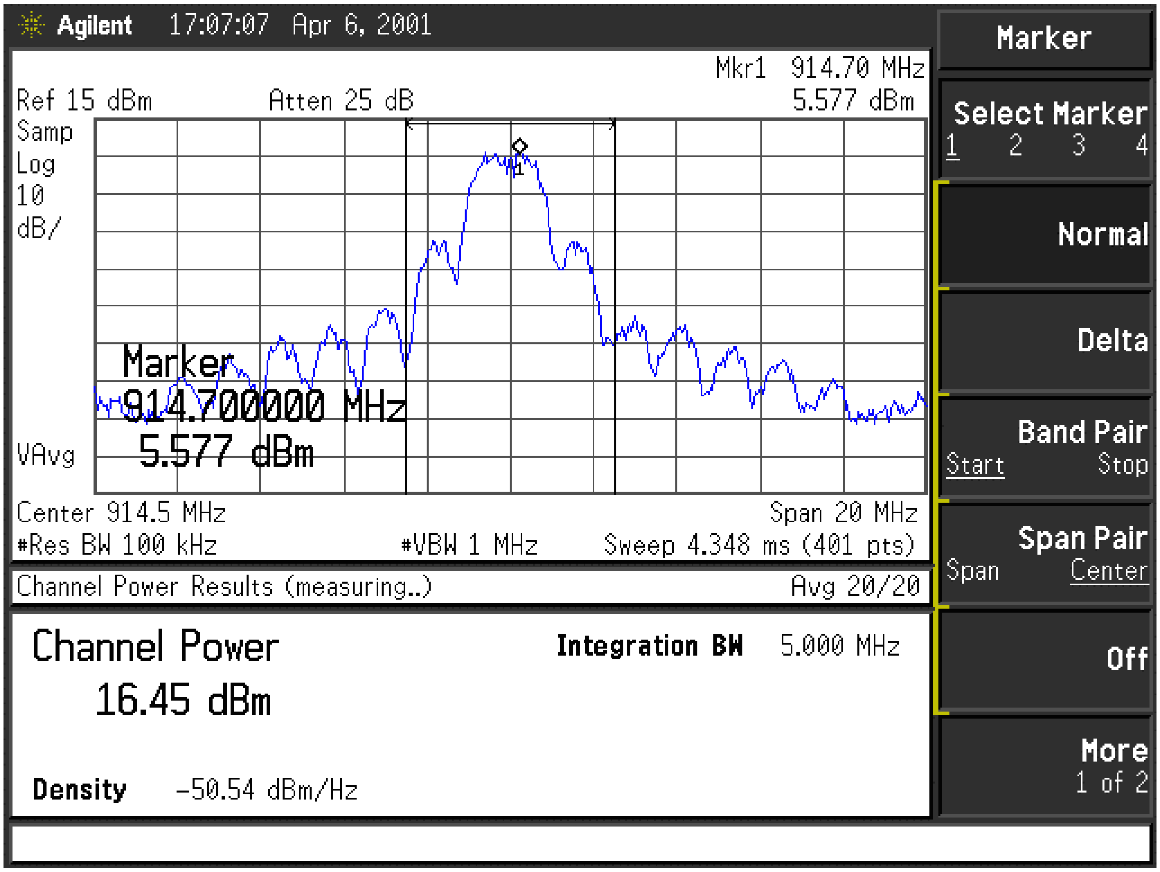

Test Indication for Line Voltage at 115% of Nominal: 138 VAC

8. We need a better description of the spreading process to complete the evaluation of compliance with 15.247(e). Please discuss the available chip/symbol rate(s) and tell us the spreading rate and the data rate. If the spreading rate/data rate is less than 11:1, please provide a discussion of the theoretical processing gain of the system.

Each transmitted bit is multiplied by a 12-chip spreading code. The spread data stream is used to bi-phase modulate the carrier. At the receiver, the signal is demodulated by a complex I-Q demodulator with AFC, and I-Q matched filters. The spreading rate would be declared to be 12:1 and has a theoretical processing gain of :

$$G_p = 10\log_{10}\left(\frac{R_c}{R_b}\right) = 10\log_{10}\left(\frac{12\,R_b}{R_b}\right) = 10\log_{10}(12) = 10.79\ dB$$

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