# Chapter 11 Test Report

## Overview

This section includes the test report and data showing compliance with all applicable technical standards.

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## 11.1 Test Methodology

This section describes the test methodology used to validate the performance of the AT&T Wireless Services PWAN Base Station against the applicable requirements of FCC Part 2, 15, and Part 24.

### 11.1.1 Introduction

The purpose of this chapter is to present the test methodology used to verify FCC regulatory compliance of the PWAN Base Station.

Throughout this document, all depictions of test configurations utilize a common set of interfaces. These interfaces are described in detail in Chapter 7, "Operational Description" of this document. The name and purpose of each interface is summarized in Table 11.1— below:

*Table 11.1—PWAN Interface Definitions*

| Interface ID | Description |
|---|---|
| T Interface | Terminal interface to Remote Units |
| A Interface | Air interface between Remote Units and Base Station radio equipment |
| P Interface | Interface between Base Station radio equipment and Base Station control |
| Csw Interface | Interface that provides public switched telephone network (PSTN) connectivity for call processing |

### 11.1.2 Base Station Frequency Stability vs. Temperature

#### 11.1.2.1—Applicable FCC Rules Parts

FCC Subpart 2.995 - Measured over the temperature range of -30 to +50 C. Frequency measurements shall be made at the extremes and at intervals of not greater than 10 degrees C throughout the range. Only the frequency determining portions of the transmitter need be subjected to this test.

FCC Subpart 24.236 - The frequency stability shall be sufficient to ensure that the fundamental emission stays within the authorized frequency block.

#### 11.1.2.2—Overview

The PWAN Base Station obtains its frequency stability from GPS-disciplined 10 MHz ovenized oscillators located on the station's primary and redundant Synchronization Cards. Either Synchronization Card is capable of functioning in one of the following three operational modes:

**Oscillator operating in GPS Locked Mode**: During normal operation, the frequency of the 10 MHz oscillator is disciplined by GPS to an accuracy of approximately ±0.005 PPM.

**Oscillator operating in GPS Holdover Mode:** In the event that GPS signals are lost (due to an antenna or GPS receiver failure), the 10 MHz oscillator will utilize the most current correction data obtained from the on-board GPS receiver to maintain an accuracy of approximately ±0.02 PPM over a 24 hour period.

**Oscillator operating in GPS Free-Run mode:** In the event that GPS is completely unobtainable, the 10 MHz oscillator will free-run with an accuracy of approximately. ±0.2 PPM.

The 10 MHz disciplined oscillators on the primary and redundant Synchronization Cards serve as the main frequency-determining element in the Base Station. Any frequency error present in the 10 MHz output of the Synchronization Cards will create a corresponding frequency error in each transmitted OFDM tone at the Base Station operating frequency.

The Base Station also contains its own low stability (approx. 5 PPM) 10 MHz reference oscillator. This internal oscillator is phase-locked to the active Synchronization Card for the purpose of minimizing the effects of reference oscillator phase noise. The Base Station software is designed to disable RF output power in the event that both of the Synchronization Cards fail (or are not present). As a result, the Base Station will not transmit while using the internal oscillator as its 10 MHz reference.

#### 11.1.2.3—Test Methodology

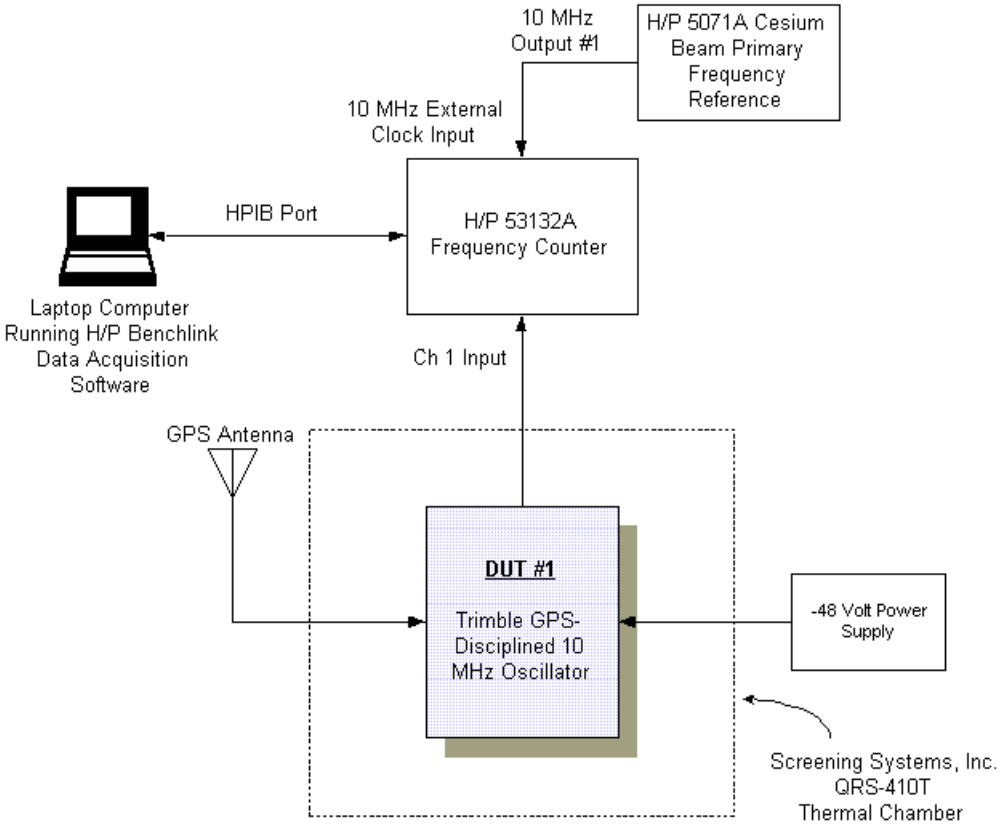
The Synchronization Card under test was placed into a Screening Systems, Inc. model QRS-410T thermal chamber (refer to Figure 11.1). A Hewlett/Packard 53132 frequency counter was used to monitor the

output frequency of the DUT. A Hewlett-Packard 5071A cesium beam primary standard was utilized as a precision frequency reference for the 53132A frequency counter. The frequency counter resolution was set to 0.001 Hz.

The frequency accuracy of the 10 MHz oscillator was tracked over the temperature range of -30 to +50 Celsius. During this test the thermal chamber "stair-stepped" from -40 to +60 degrees Celsius in temperature increments of 10 degrees Celsius. The thermal chamber's sensing thermocouple was attached to the Synchronization Card about 10 cm from the ovenized oscillator to assure that the DUT was kept to within ±5 degrees Celsius of each pre-determined thermal step. The chamber held each thermal step for 15 minutes. The total run time was three hours per test.

The frequency stability of the DUT was measured over temperature in each of the three operating modes.

*Figure 11.1 Base Station Synchronization Card Frequency Stability vs. Temperature Test Configuration*



### 11.1.3 Base Station Frequency Stability vs. Input Voltage

#### 11.1.3.1—Applicable FCC Rules Parts

FCC Subpart 2.995 - The frequency stability shall be measured with variation of primary supply voltage as follows: 1) Vary primary voltage from 85 to 115 percent of the nominal value for other than hand carried equipment. 3) The supply voltage shall be measured at the input to the cable provide with the equipment, or at the power supply terminals if cables are not normally provided. Effects on frequency of transmitter keying (except for broadcast transmitters) and any heating element cycling at the nominal supply voltage and at each extreme also shall be shown.

FCC Subpart 24.236 - The frequency stability shall be sufficient to ensure that the fundamental emission stays within the authorized frequency block.

#### 11.1.3.2—Overview

The PWAN Base Station obtains its frequency stability from GPS-disciplined 10 MHz ovenized oscillators located on the station's primary and redundant Synchronization Cards. Either Synchronization Card is capable of functioning in one of the following three operational modes:

Oscillator operating in GPS Locked Mode: During normal operation, the frequency of the 10 MHz oscillator is disciplined by GPS to an accuracy of approximately ±0.005 PPM.

Oscillator operating in GPS Holdover Mode: In the event that GPS signals are lost (due to an antenna or GPS receiver failure), the 10 MHz oscillator will utilize the most current correction data obtained from the on-board GPS receiver to maintain an accuracy of approximately ±0.02 PPM over a 24 hour period.

Oscillator operating in GPS Free-Run mode: In the event that GPS is completely unobtainable, the 10 MHz oscillator will free-run with an accuracy of approximately. ±0.2 PPM.

The 10 MHz disciplined oscillators on the primary and redundant Synchronization Cards serve as the main frequency-determining element in the Base Station. Any frequency error present in the 10 MHz

output of the Synchronization Cards will create a corresponding frequency error in each transmitted OFDM tone at the Base Station operating frequency.

The Base Station also contains its own low stability (approx. 5 PPM) 10 MHz reference oscillator. This internal oscillator is phase-locked to the active Synchronization Card for the purpose of minimizing the effects of reference oscillator phase noise. The Base Station software is designed to disable RF output power in the event that both of the Synchronization Cards fail (or are not present). As a result, the Base Station will not transmit while using the internal oscillator as its 10 MHz reference.

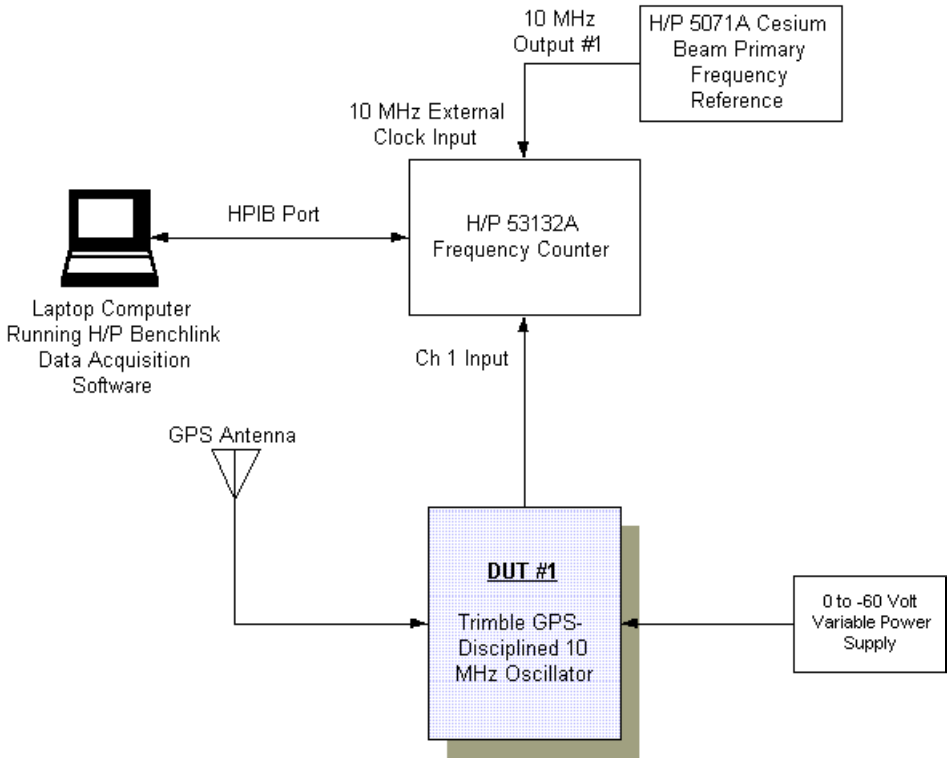
#### 11.1.3.3—Test Methodology

The Synchronization Card under test was connected to a variable DC power supply (refer to Figure 11.2). A Hewlett/Packard 53132 frequency counter was used to monitor the output frequency of the DUT. A Hewlett-Packard 5071A cesium beam primary standard was utilized as a precision frequency reference for the 53132A frequency counter. The frequency counter resolution was set to 0.001 Hz.

The frequency accuracy of the 10 MHz oscillator was tracked over the voltage range of -40.8 to -55.2 VDC (±15%) in 1.0 volt increments.

The output frequency stability of the DUT was measured over voltage in each of the three operating modes.

*Figure 11.2 Base Station Synchronization Card Frequency Stability vs. Input Voltage Test Configuration*




## 11.1.4 Base Station Occupied Bandwidth

### 11.1.4.1—Applicable FCC Rule Parts

FCC Subpart 2.989 - Occupied bandwidth is defined as 99% of the total mean power, measured according to Subpart 2.989 (i), which requires full loading of the baseband, modulated such that the occupied bandwidth is consistent with that expected during normal operation.

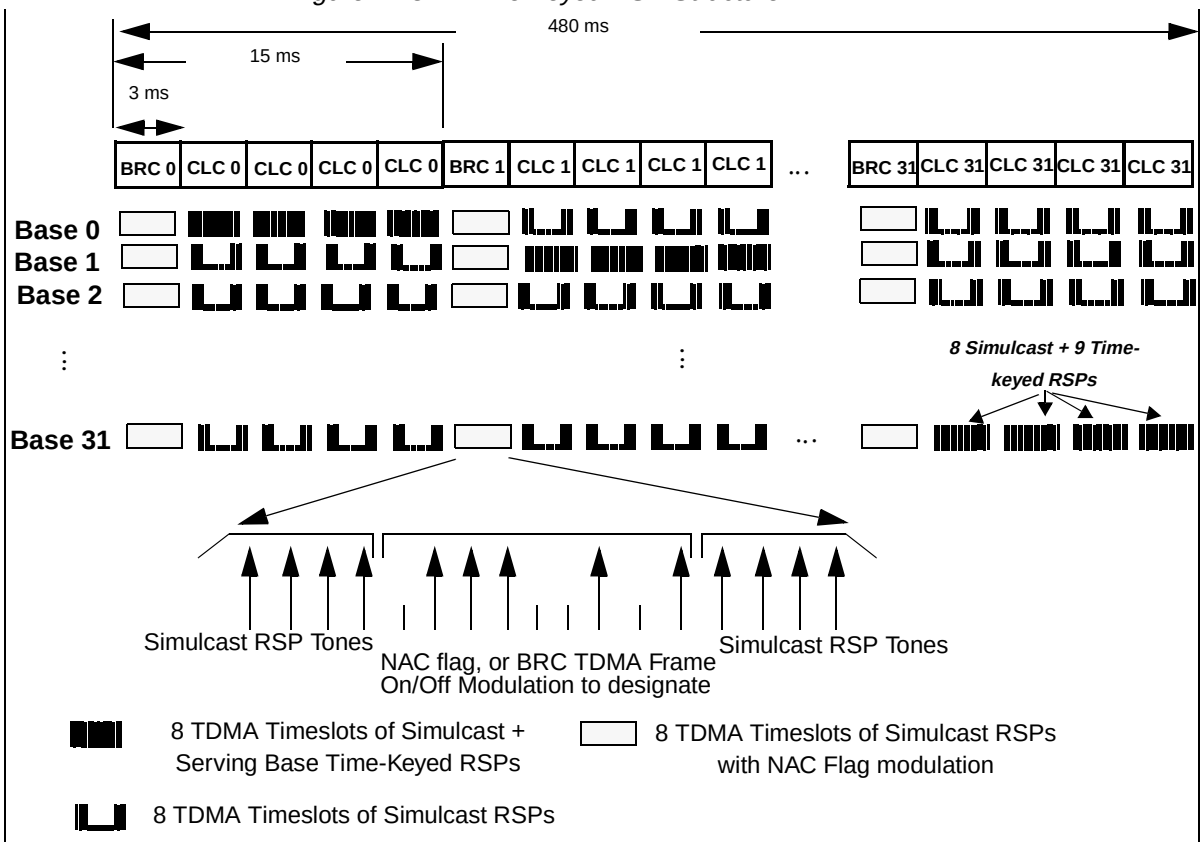
### 11.1.4.2—Overview

PWAN Base Station occupied bandwidth measurements do not differ substantially from any other system. The occupied bandwidth of a PWAN Base Station is maximized while transmitting eight simulcast Remote Synchronization Pilots (RSP's) without any voice or high-speed data traffic.

### 11.1.4.3—Test Methodology

The Base Station was allowed to operate in the idle mode (no call processing or data transfer).During normal operation, the number of RSP tones transmitted by the base varies according to the time slot associated with each transmission burst (refer to Figure 11.3).

*Figure 11.3 Time Keyed RSP Structure*

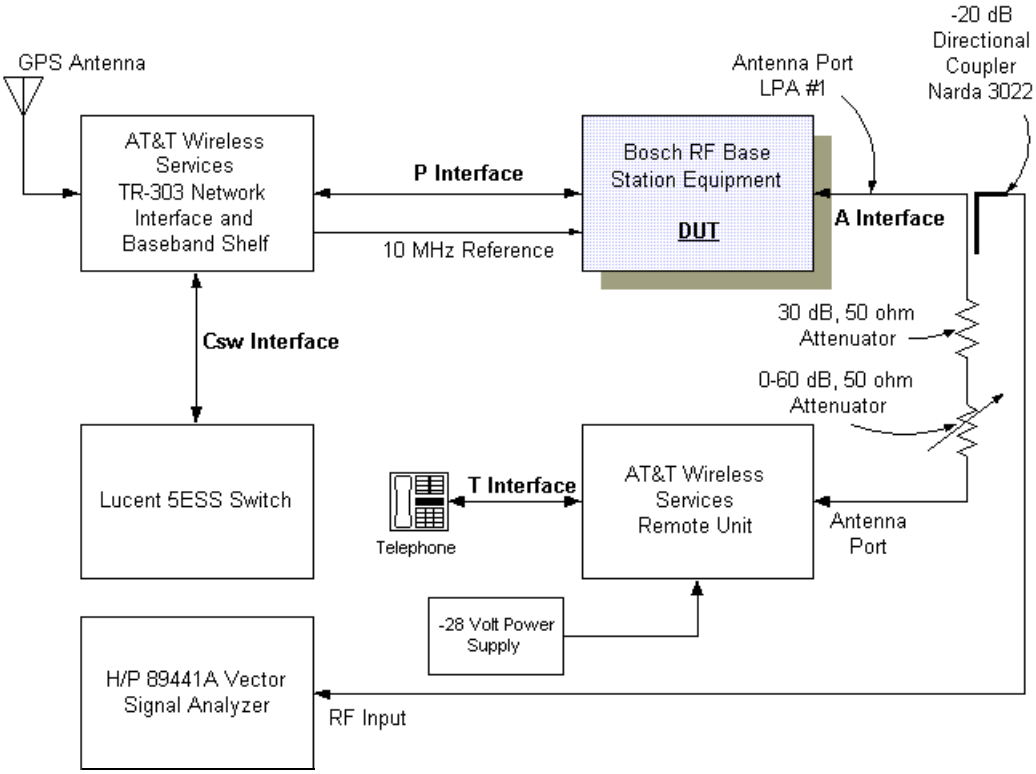


As Figure 11.3 indicates, each base will transmit eight RSPs continuously and five time-keyed RSPs every 15 ms. Every 480 ms, each base will transmit all 17 RSPs and a Broadcast Channel message. Because the Base Station's RSP activity is temporal (resulting in varying RF power per burst according to the number of active RSP tones in each TDMA slot), characterization of these pilots is difficult. Therefore, the Hewlett-Packard 89441A Vector Signal Analyzer and 89451A Digital Radio Personality option was configured to capture a 375 ms time record at the Base Station operating frequency (refer to Table 11.2 for configuration parameters). RF bursts contained in this time record were analyzed individually to obtain an occupied bandwidth measurement.

*Table 11.2—Hewlett-Packard Type 89451A Radio Personality Configuration Parameters (Time Capture Mode)*

| Parameter | Value |
|---|---|
| Center Frequency | 1949.0 MHz |
| Span | 2 MHz |
| Main Time Length | 400 µs |
| Gate Time Length | 320 µs |
| Gate Delay | 50 µs |
| Input Level | +25 dBm |
| Input Mode | Time Capture |
| External Attenuation | 21.1 dB |
| Frequency-Domain Averaging | Off |
| FFT Window Type | Flat Top |
| FFT Frequency Points | 1601 |
| FFT Resolution BW | 12 kHz |

*Figure 11.4 Base Station Occupied Bandwidth Test Configuration*




## 11.1.5 Modulation Characterization

### 11.1.5.1—Applicable FCC Rules

FCC Subpart 2.987 - Requires a curve or equivalent data which shows that the equipment will meet the requirements of the rules under which the equipment is to be licensed. Provide data showing that the modulation being employed does not cause the spectral purity to exceed the requirements of 2.985 and 24.238.

### 11.1.5.2—Overview

The modulation characteristics of the PWAN Base Station transmitter differ substantially from any other system. The OFDM time-domain waveform transmitted by the Base Station is a composite of several discrete logical “channels”. In this test, each logical “channel” was characterized individually in both the time and frequency domain. The channels characterized by this measurement include:

- Multiple Voice Traffic channel

- High-Speed Data Traffic channel
- High Speed Data Control channel
- Broadcast channel
- Time-Keyed Remote Synchronization channel
- Simulcast Remote Synchronization channel

These logical channels are described in detail in Chapter 7 “Operational Description” of this document.

A Hewlett-Packard 89441A Vector Signal Analyzer was used to characterize each of the discrete channels listed above. For each channel, the 89441A was used to obtain the following information:

- 99% occupied bandwidth in kHz
- Integrated power across the measured occupied bandwidth in dBm
- Power vs. frequency (in dBm) at a 12 kHz resolution bandwidth
- Time-domain average RF burst power
- Complimentary Cumulative Distribution Function (CCDF) of the peak to average ratio made up of $10^6$ samples of the time-domain RF bursts (this measurement was not possible for Remote Synchronization channel measurements).

The specific operating parameters of the Hewlett-Packard 89441A Vector Signal Analyzer are summarized in Table 11.3—

*Table 11.3—Hewlett-Packard 89441A Modulation Characterization Test Parameters (Real-Time Measurement Mode)*

| Parameter | Value |
|---|---|
| Center Frequency | 1949.0 MHz |
| Span | 2 MHz |
| Main Time Length | 400 us |
| Gate Time Length | 320 us |
| Gate Delay | 50 µs |
| Trigger Type | IF Channel 1 |
| Input Level | +25 dBm |
| External Attenuation | 21.1 dB |

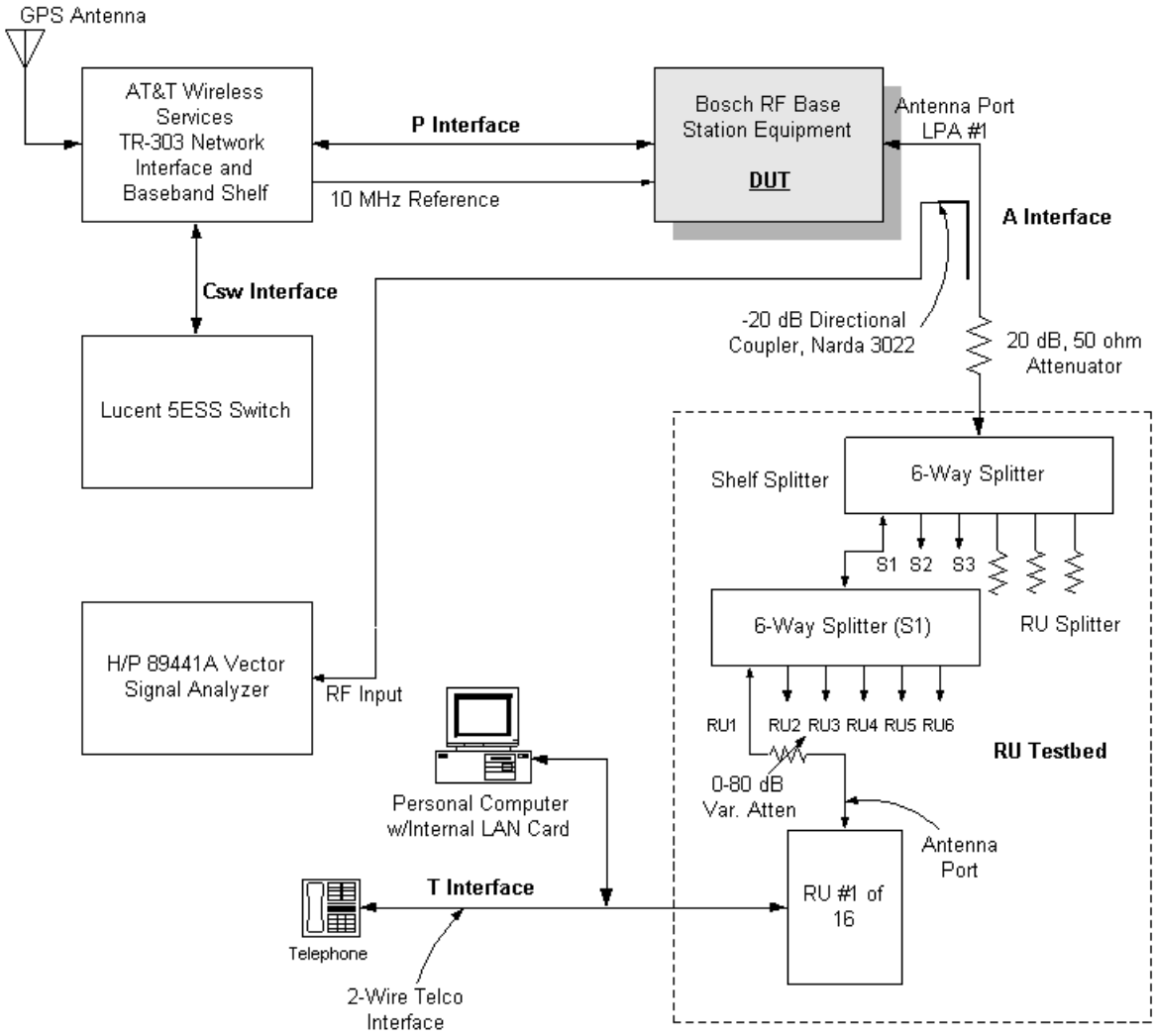
*Table 11.3—Hewlett-Packard 89441A Modulation Characterization Test Parameters (Real-Time Measurement Mode)*

| | |
|---|---|
| Peak/Average Metric | 99.0% |
| Trigger Delay | Selected to center 320 µs transmission bursts in time gate (typically -55 µs) |
| Trigger Holdoff | 2300 µs |
| Frequency-Domain Averaging | 20 Samples, RMS Exponential |
| FFT Window Type | Flat Top |
| FFT Freq. Points | 1601 |
| Resolution BW | 12 kHz |

*Table 11.4—Hewlett-Packard 89441A Modulation Characterization Test Parameters (Time Capture Mode)*

| Parameter | Value |
|---|---|
| Center Frequency | 1949.0 MHz |
| Span | 2 MHz |
| Main Time Length | 400 µs |
| Gate Time Length | 320 µs |
| Gate Delay | 50 µs |
| Input Level | +25 dBm |
| Input Mode | Time Capture |
| External Attenuation | 21.1 dB |
| Frequency-Domain Averaging | Off |
| FFT Window Type | Flat Top |
| FFT Freq Points | 1601 |
| FFT Resolution BW | 12 kHz |

*Figure 11.5 Modulation Characterization Test Configuration*




### 11.1.5.3—Test Methodology

#### 11.1.5.3.1—Voice Channel

A total of 16 telephone calls within a single TDMA slot were established between a pool of Remote Units and the Base Station under test using the configuration shown in Figure 11.5. A Hewlett-Packard 89441A Vector signal analyzer was configured according to the parameters shown in Table 11.3—. The random nature of the airlink data produced by the LD-CELP compression algorithm is sufficient to assure results representative of a normally operating system.

#### 11.1.5.3.2—High-Speed Data Channel

A High Speed Data (HSD) session was established between a single Remote Unit and the Base Station under test using the configuration shown in Figure 11.5. A Hewlett-Packard 89441A Vector Signal Analyzer was configured according the parameters shown in Table 11.3.

During this test, a text file was copied from an AWS network file server (using File Transfer Protocol) through the Base to a personal computer connected to a Remote Unit. The random nature of the data contained in this file was sufficient to assure results representative of a normally operating system.

#### 11.1.5.3.3—High Speed Data Control Channel

Characterization of the High Speed Data (HSD) Control channel took place utilizing the test configuration shown in Figure 11.5. A Hewlett-Packard Vector Signal Analyzer was configured according to the parameters shown in Table 11.3—.

During normal operation, the HSD Control channel is used to transmit a single pilot tone and two DSMA status flags during two TDMA slots in each TDMA frame (25% duty cycle). The HSD Control channel for the Base Under Test was characterized during a period of HSD Traffic Channel inactivity.

#### 11.1.5.3.4—Broadcast Channel

The Broadcast Channel was characterized using the test configuration shown in Figure 11.5. A Hewlett-Packard 89441A Vector Signal Analyzer was configured according to the parameters shown in Table 11.3.

#### 11.1.5.3.5—Time-Keyed Remote Synchronization Channel

During normal operation, the number of Remote Synchronization Pilot (RSP) tones transmitted by the base varies according to the time slot associated with each transmission burst. For example, of the 17 RSP tones available, eight are transmitted continuously and nine are time-keyed (refer to Figure 11.3). Every 480 ms, each base will transmit all 17 RSPs and a Broadcast Channel message.

Because the Base Station's RSP activity is temporal (resulting in varying RF power per burst according to the number of active RSP tones in each TDMA slot), characterization of these pilots is difficult. Therefore, the Hewlett-Packard 89441A Vector Signal Analyzer and 89451A Digital Radio Personality option was configured to capture a 375 ms time record at the Base Station operating frequency. Because bursts were analyzed manually, insufficient data points were available to produce a meaningful CCDF. Consequently, this parameter was excluded from the Time-Keyed Remote Synchronization channel characterization measurements.

#### 11.1.5.3.6—Simulcast Remote Synchronization Channel

During normal operation, the number of Remote Synchronization Pilot (RSP) tones transmitted by the base varies according to the time slot associated with each transmission burst (refer to Figure 11.3).

Because the Base Station's RSP activity is temporal (resulting in varying RF power per burst according to the number of active RSP tones in each TDMA slot), characterization of these pilots is difficult. Therefore, the Hewlett-Packard 89441A Vector Signal Analyzer and 89451A Digital Radio Personality option was configured to capture a 375 ms time record at the Base Station operating frequency. Because each burst was analyzed manually, insufficient data points were available to produce a meaningful CCDF. Consequently, this parameter was excluded from the Simulcast Remote Synchronization channel characterization measurements.

## 11.1.6 RF Output Power

### 11.1.6.1—Applicable FCC Rules

FCC Subpart 2.985-Power output shall be measured at the RF output terminals when the transmitter is adjusted in accordance with the tune-up procedure to give the values of current and voltage on the circuit elements specified in §2.983 (d)(5). The electrical characteristics of the radio frequency load attached to the output terminals when this test is made shall be stated.

FCC Subpart 24.232 - In no case may the peak output power of a base station transmitter exceed 100 watts. Peak transmitter power may be measured over any interval of continuous transmission using

instrumentation calibrated in terms of RMS equivalent voltage. The measurement results shall be properly adjusted for any instrument limitations, such as detector response times, limited resolution bandwidth capability when compared to the emission bandwidth, sensitivity, etc., so as to obtain a true peak measurement for the emission in question over the full bandwidth of the channel.

### 11.1.6.2—Overview

Peak RF Output Power from the Base Station is maximized while supporting 16 simultaneously active FDMA slots. A Hewlett-Packard 89441A Vector Signal Analyzer was used to characterize the Base Stations's composite RF output signal according to the following criteria:

- Time-domain average burst power
- Time-domain peak envelope burst power at the 99.0% level
- Time-domain peak/average ratio at the 99.0% level

The specific operating parameters of the Hewlett-Packard 89441A Vector Signal Analyzer are summarized in Table 11.5—

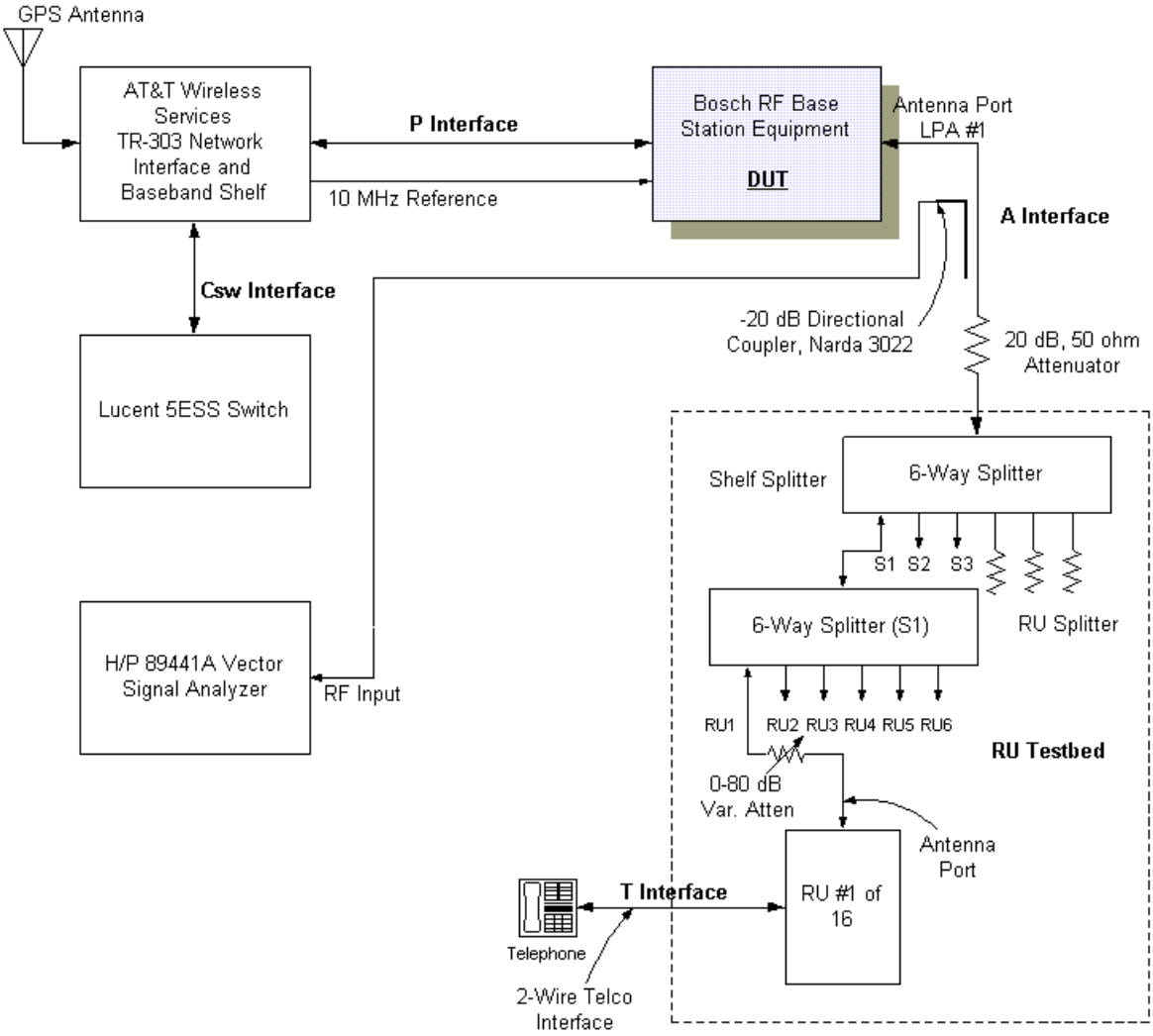
*Table 11.5—Hewlett-Packard 89441A RF Power Test Parameters*

| Parameter | Value |
|---|---|
| Center Frequency | 1949.0 MHz |
| Span | 2 MHz |
| Main Time Length | 400 µs |
| Gate Time Length | 320 µs |
| Gate Delay | 50 µs |
| Input Level | +25 dBm |
| External Attenuation | 21.1 dB |
| Peak/Average Metric | 99.0% |
| Trigger Type | IF Channel 1 |
| Trigger Delay | Selected to center 320 µs transmission bursts in time gate (typically -55 µs) |
| Trigger Holdoff | 2300 µs |
| Frequency-Domain Averaging | 20 Samples, RMS Exponential |
| FFT Window Type | Flat Top |
| FFT Freq. Points | 1601 |
| FFT Resolution BW | 12 kHz |

### 11.1.6.3—Test Methodology

Peak RF output power from the Base Station is maximized while supporting 16 simultaneously active FDMA slots. For this test, a total of 16 voice calls were established between multiple Remote Units and the Base Station under test using the equipment configuration shown in Figure 11.6. The Hewlett-Packard 89441A Vector Signal Analyzer was configured according the parameters shown in Table 11.5. The random nature of the data generated by the LD-CELP compression algorithm was sufficient to assure results representative of a normally operating system..

*Figure 11.6 Base Station Output Power Test Configuration*



### 11.1.7 Spurious Emissions at the Antenna Terminal

#### 11.1.7.1—Applicable FCC Rules

FCC Subpart 2.985 - Requires that the RF Output be measured at the antenna power terminals into a dummy load after the transmitter has been adjusted in accordance with the manufacturers tune up procedure. Requires documentation of measurement configuration. Transmitter spectral output shall not have any components that exceed the spectral mask applicable to the rule part under which the equipment shall be operated.

FCC Subpart 24.238 - On any frequency outside a licensee's block, the power of any emission shall be attenuated below the transmitter power (P) by at least 43+10Log(P) dB. Compliance is based on measurement within a 1 MHz resolution bandwidth. However, in the 1 MHz bands immediately adjacent to the frequency block a resolution bandwidth of at least 1 percent of the emission bandwidth may be employed. The emission bandwidth is defined as the width of the signal between two points, one above and one below the carrier frequency, outside of which all emissions are attenuated by at least 25 dB below the transmitter power.

#### 11.1.7.2—Overview

The RF spectral purity of the PWAN Base Station transmitter does not differ substantially from a conventional TDMA transmitter, other than the characteristics of any intermodulation products that are produced. RF Output Power and Out-Of-Band (OOB) emissions from the PWAN Base Station are maximized while transmitting 16 simultaneous FDMA slots within a TDMA slot.

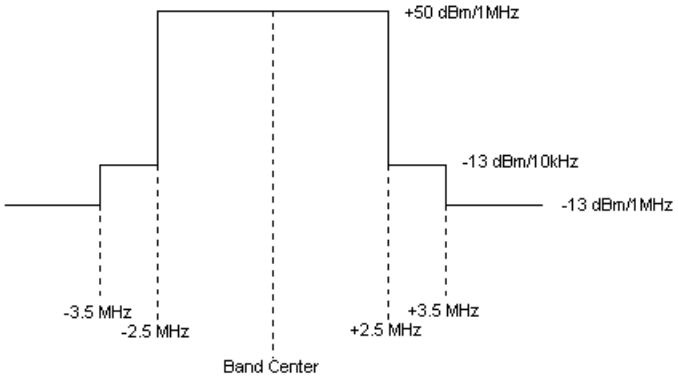
Spectral purity measurements were made with the Base Station operating in the lowest and highest subbands allocated in the "D" PCS block. Any Out-Of-Band (OOB) intermodulation and spurious signals will be contributed by Base Stations operating in the exterior subbands.

OOB spectral contributions from Base Stations operating within the two interior subbands will be negligible.

*Table 11.6—Hewlett-Packard 89441A Spectral Purity Test Configuration Parameters*

| Parameter | Value |
|---|---|
| Center Frequency | Varies with Measurement |
| Span | 4 MHz and 7 MHz |
| Main Time Length | 400 µs @ 4MHz Span, 229 µs @ 7 MHz Span |
| Gate Time Length | 320 µs @ 4 MHz Span, 0 µs @ 7 MHz Span |
| Gate Delay | 50 µs @ 4 MHz Span, 0 µs @ 7 MHz Span |
| Input Level | +25 dBm |
| External Attenuation | 21.1 dB |
| Trigger Type | IF Channel 1, Free Run for measurements with fundamental outside of span |
| Trigger Delay | -56 µs @ 4 MHz Span, 0 µS @ 7 MHz Span |
| Trigger Holdoff | 2300 µs |
| Frequency-Domain Averaging | 20 Samples, RMS Exponential |
| FFT Window Type | Flat Top |
| FFT Freq. Points | 1601 |
| Resolution BW | 12 kHz @ 4 MHz Span, 17 kHz @ 7 MHz Span |

*Figure 11.7 Base Station Conducted Power Spectral Mask*



### 11.1.7.3—Test Methodology

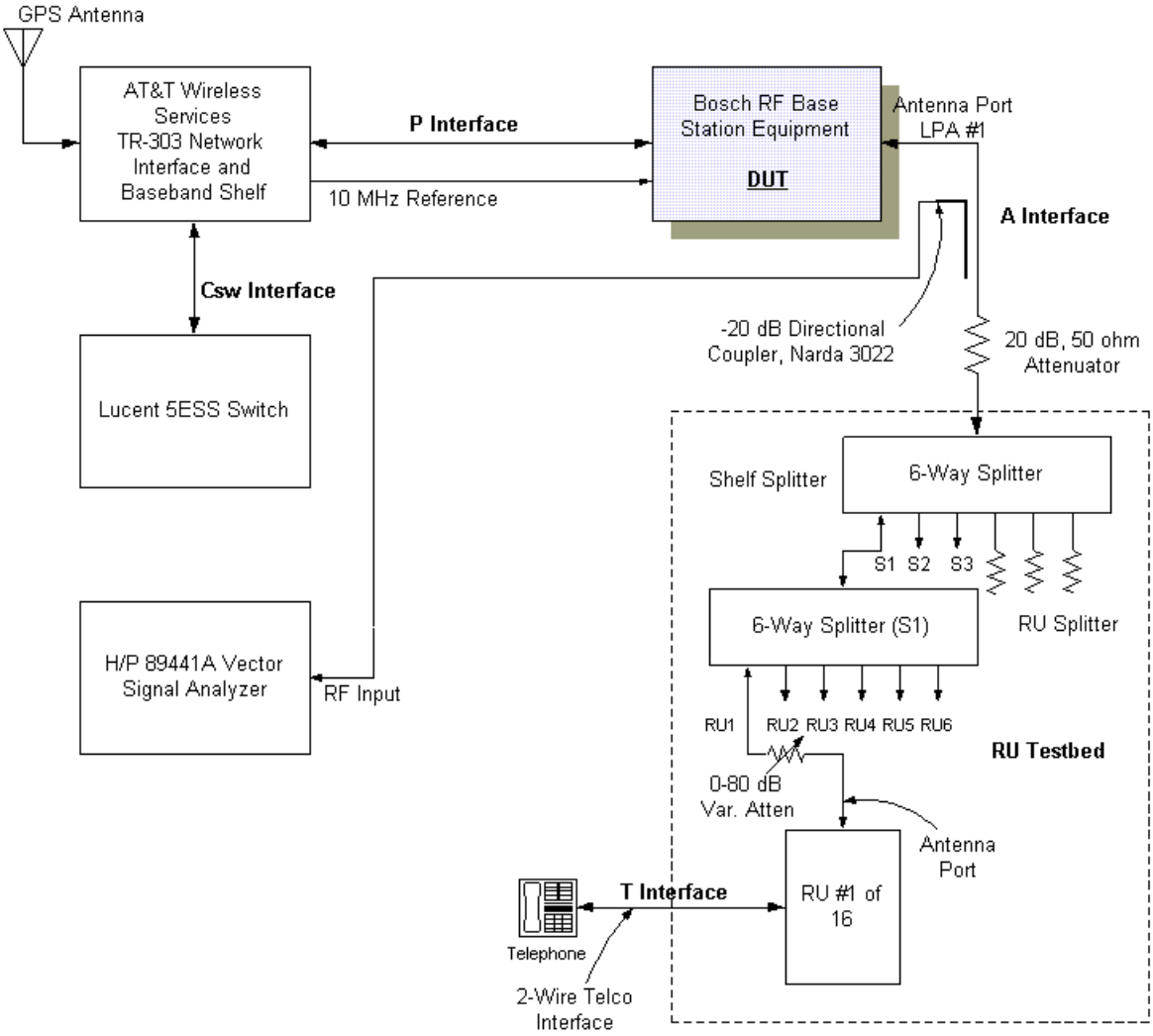
PWAN Base Station emissions measurements near the operating frequency must be synchronized to the transmitted bursts in order to be accurate. This implies the use of a receiver capable of performing an FFT which has been triggered by the presence of RF burst energy at a selected power level. This requirement is met by the Hewlett-Packard 89441A Vector Signal Analyzer, which was used to characterize the emissions from the Base Station transmitter while operating at full peak output power. For this test, a total of 16 voice calls were placed from a pool of Remote Units connected to the Base Station under test. The attenuators in the Base Station transmitter chain were set to produce a nominal average output power of 2.5 watts (+34 dBm) during the TDMA slot containing 16 simultaneous voice calls. The 89441A VSA was configured to trigger on the high level RF burst power present during this TDMA slot. When making measurements over spans that did not include the Base Station fundamental, the VSA trigger was disabled (trigger free-running). The specific operating parameters of the 89441A VSA are summarized in Table 11.6. The emission mask utilized through the course of this test is shown in Figure 11.7

The 89441A Vector Signal Analyzer design is optimized to provide highly accurate measurements in the frequency-domain with narrow resolution bandwidths. Conversely, the instrument does not perform well with the wide (1 MHz) resolution bandwidths required by §2.985 and §24.238. However, the 89441A is capable of making integrated power measurements across any desired bandwidth, the results of which are identical to using a corresponding resolution bandwidth in a conventional spectrum analyzer. All spectral purity measurements made with the 89441A utilized a 12 kHz resolution bandwidth for 4 MHz spans and a 17 kHz resolution bandwidth for 7 MHz spans. Band power markers (set to 1 MHz BW) were used to measure the total integrated power in 1 MHz segments at frequencies of concern across the range of 1933 to 1962 MHz. Emissions at all applicable frequencies above and below this range have been documented in Section 11.3.4.3, “Radiated to Conducted Spurious Emissions”.

Due to the amount of attenuation required to prevent overloading the VSA, noise contributed by the analyzer’s front-end diminished the resolution of low-level spurious products removed by greater than about ±2 MHz from the carrier center frequency. To improve the effective noise floor of the instrument during such measurements, mathematical subtraction of front-end noise in the frequency domain

was employed. For example, a 50-ohm termination was connected to the VSA's front-end RF input connector, and the instrument's intrinsic frequency-domain noise was averaged using the VSA parameters listed in Table 11.6. The resulting noise trace was saved into one of the instrument's data registers. The Base Station under test was then reconnected to the RF input through a -20 dB directional coupler as shown in Figure 11.8. By invoking a simple mathematical function, the VSA subtracted the instrument's front-end noise trace from the frequency-domain spectra of the DUT. This methodology results in approximately 20 dB of improvement in the instrument's noise floor.

*Figure 11.8 Base Station Spectral Purity Test Configuration*



## 11.1.8 Radiated Emissions

### 11.1.8.1—Applicable FCC Rules

FCC Subpart 15.209 - The level of any unwanted emissions from an intentional radiator operating under these general provisions shall not exceed the field strength levels specified in table 15.209 (a). Emission limits shown in the table below 1000 MHz are based on measurements employing a CISPR quasi-peak detector. Emission limits above 1000 MHz are based on measurements employing an average detector.

### 11.1.8.2—Overview

The radiated emissions from the PWAN Base Station must not exceed the levels as stated within the FCC Part 15, Class A requirements. The testing provides the necessary assurance that the Base Station when installed in a typical field environment will not interfere with other electronic devices. To make the appropriate measurements the Base Station must be setup in a typical installation configuration and made operational. Utilizing an EMI receiver, a peak, quasi-peak and average detectors, radiated measurements shall meet the FCC limits as specified in subpart 15.207.

### 11.1.8.3—Test Methodology

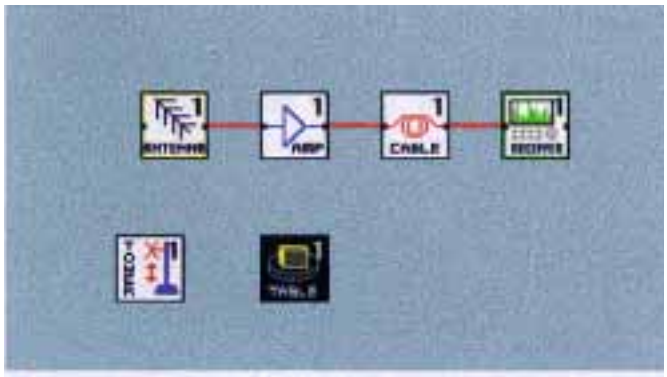
Radiated emissions measurements shall be made over the frequency range specified by the regulatory agency. In this case, per FCC Part 15, subpart 15.207. Measurements shall be made at the EUT azimuth and antenna height such that the maximum radiated emissions level will be detected. This was accomplished using both an automated 360 degree turntable and 1 to 4 meter height antenna positioners. Sixteen azimuth cuts at 22.5 degrees and 1 to 4 meter antenna scans in both polarizations were utilized. The PWAN Base Station was setup in a typical field configuration, as shown in Figure 12.3, consisting of the PWAN Base Station being placed inside two EMC cabinets with the digital shelves in one cabinet and the RF components in the other. The cabinets, PWAN Base Station were each grounded to an NEC-approved grounding method. A typical battery backup power supply was present, as well as sectored antennas atop a tower (Tower Top Amplifiers are ahead of the antenna). Various cable lengths were utilized to determine worse case configuration. All radiated emissions testing was completed in three configurations; 1) 16 voice calls within same time slot (maximum time slot capacity), 2) 32 voice calls on single sector, and 3)

32 voice calls with eight per sector. Testing was completed from 30 MHz to 26.5 GHz.

The PWAN Base Station test configuration and test setup photos can be found in Chapter 12, “Test Setup Photos.”

### 11.1.8.4—Radiated Emissions Equipment Configuration 30-1000 MHz

*Figure 11.9 Test Equipment Configuration*




#### 11.1.8.4.1—Equipment Settings

The following list details the individual pieces of equipment and their settings used to complete the 30 -1000 MHz radiated emission measurements, including antenna scan heights and turntable azimuth settings.

**Setting Details**

**Config. band: 30MHz - 1000 MHz**

Antenna 1: Horizontal and Vertical Polarizations

Cable 1: 53-foot RG-214

Tower 1: 1 to 4 meter scan

Turntable 1: 22.5 degree steps during scans

Amplifier 1: PREAMP OFF

Receiver I (Standard)

EMI BW (RBW): Default FCC

Average BW (VBW): Default FCC

Attenuation: Auto

Reference level: Auto
Sweep time: Auto
Input: Input #2 (20 MHz - 2.9 GHz)

Receiver I (Maximization)
EMI BW (RBW): Default FCC
Average BW (VBW): Default FCC
Attenuation: Auto
Reference level: Auto
Sweep time: Auto
Span: Auto
Single signal per segment: No
Amplitude resolution: 10 dB/div
Detector: Sample
Input: Input #2 (20 MHz - 2.9 GHz)
Maximization traces
Max. step-mode dwell: 1 sec / 1 sweeps
Video average: None
Remove impulses: No
Demodulation: Off

### 11.1.8.5—Measure Parameters

Measurements for radiated emissions were completed during the first pass with a peak detector, with the following settings:

#### Peak

- Auto settings: Yes
- Span 240 kHz, RBW 120 khz, VBW 1000 kHz
- Max dwell time: *5* seconds
- Max number of sweeps: *5* seconds

Measurements for radiated emissions were completed on all peak detected signals that exceeded the 6 dB limit line margin with a quasi-peak detector at the following settings:

### QP

- Auto settings: Yes
- Span 90 kHz, RBW 120 kHz, VBW 1000 kHz
- Max dwell time: *5* seconds
- Max number of sweeps: *5* seconds

The tune and listening settings were set to the following span, resolution, and video bandwiths:

### Tune/Listen setting

- Narrow span 100 kHz, RBW 30 kHz, VBW 10 kHz

### 11.1.8.6—Antenna Factors

The Chase, model CBL6111 EMI measurement antenna was used for radiated emissions measurements from 30 - 1000 MHz. The antenna correction factors are shown in Table 11.7.

*Table 11.7—Antenna Factors*

| Frequency (MHz) | Amplitude (db/m) |
|---|---|
| 30 | 18.4 |
| 35 | 16.4 |
| 40 | 13.7 |
| 45 | 11.1 |
| 50 | 8.6 |
| 60 | 6.4 |
| 70 | 6.8 |
| 80 | 7.4 |
| 90 | 8.5 |
| 100 | 9.5 |
| 120 | 11.8 |
| 125 | 12 |
| 140 | 11.6 |
| 150 | 11.1 |
| 160 | 10.5 |

*Table 11.7—Antenna Factors (continued)*

| Frequency (MHz) | Amplitude (db/m) |
|---|---|
| 175 | 9.4 |
| 180 | 9.2 |
| 200 | 9 |
| 250 | 12.1 |
| 300 | 13 |
| 400 | 15.4 |
| 500 | 17.5 |
| 600 | 19.3 |
| 700 | 20.6 |
| 800 | 21.2 |
| 900 | 22.1 |
| 1000 | 24.1 |

### 11.1.8.7—Cable Factors

The measurement system setup, as shown in Figure 11.9 is interconnected with 53 feet of RG214 coaxial cable. The cable insertion loss was measured and documented for receiver data correction. Table 11.8— outlines the measurement system's cable correction factors.

*Table 11.8—Cable Corrections*

| Frequency (MHz) | Amplitude (dB) |
|---|---|
| 30 | -0.74 |
| 40 | -0.85 |
| 50 | -0.95 |
| 60 | -1.05 |
| 70 | -1.16 |
| 80 | -1.23 |
| 90 | -1.31 |
| 100 | -1.39 |
| 120 | -1.52 |
| 140 | -1.7 |
| 160 | -1.81 |
| 180 | -1.93 |
| 200 | -2.05 |

*Table 11.8—Cable Corrections (continued)*

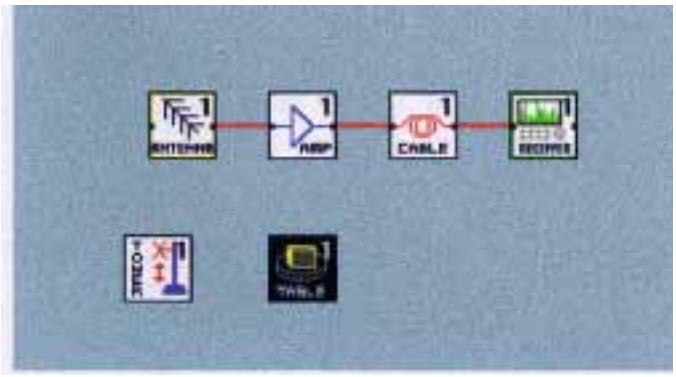
| Frequency (MHz) | Amplitude (dB) |
|---|---|
| 220 | -2.14 |
| 240 | -2.3 |
| 260 | -2.4 |
| 280 | -2.48 |
| 300 | -2.58 |
| 320 | -2.65 |
| 340 | -2.76 |
| 360 | -2.88 |
| 380 | -2.96 |
| 400 | -3.04 |
| 420 | -3.13 |
| 440 | -3.19 |
| 460 | -3.27 |
| 480 | -3.34 |
| 500 | -3.4253 |
| 520 | -3.5 |
| 540 | -3.59 |
| 560 | -3.66 |
| 580 | -3.72 |
| 600 | -3.79 |
| 620 | -3.87 |
| 640 | -3.97 |
| 660 | -4.03 |
| 680 | -4.1 |
| 700 | -4.16 |
| 720 | -4.25 |
| 740 | -4.33 |
| 760 | -4.41 |
| 780 | -4.47 |
| 800 | -4.5 |
| 820 | -4.55 |
| 840 | -4.67 |
| 860 | -4.75 |

*Table 11.8—Cable Corrections (continued)*

| Frequency (MHz) | Amplitude (dB) |
|---|---|
| 880 | -4.85 |
| 900 | -4.85 |
| 920 | -4.89 |
| 940 | -4.94 |
| 960 | -5 |
| 980 | -5.1 |
| 1000 | -5.1881 |

### 11.1.8.8—Radiated Emissions Equipment Configuration 1000-3500 MHz

*Figure 11.10 Test Equipment Configuration*



## Equipment Settings

The following list details the individual pieces of equipment and their settings used to complete the 1000 -3500 MHz radiated emissions measurement, including antenna scan heights and turntable azimuth settings

Config. band: 1000 MHz - 6000 MHz Antenna 1:
Cable 1: 53-foot RG-214

Tower 1: 1 to 4 meter scan

Turntable 1: 22.5 degree steps during scans

Amplifier 1: Preamp ON;

Receiver 1 (Standard)

EMI BW (RBW): 1000 kHz
Average BW (VBW): 1000 kHz
Attenuation: Auto
Reference level: Auto
Sweep time: Auto
Input: Input #2 (1 GHz - 3.5 GHz)

Receiver 1 (Maximization)
EMI BW (RBW): 1000 kHz
Average BW (VBW): 1000 kHz
Attenuation: Auto
Reference level: Auto
Sweep time: Auto
Span: Auto
Single signal per segment: No
Amplitude resolution: 10 dB/div
Detector: Sample
Input: Input #2 (1 GHz - 6.5 GHz)
Maximization traces
Max. step-mode dwell: 1 sec / 1 sweeps
Video average: None
Remove impulses: No
Demodulation: Off

#### 11.1.8.8.1—Measure Parameters

Measurements for radiated emissions were completed during the first pass with a peak detector, with the following settings:

### Peak

- Auto settings: Yes
- Span 240 Hz, RBW 1000 kHz, VBW 1000 kHz
- Max dwell time: 5 seconds
- Max number of sweeps: 5 seconds

Measurements for radiated emissions were completed on all peak detected signals that exceeded the 6dB limit line margin with an average detector at the following settings:

### Average

- Auto settings: Yes
- Span 90 kHz, RBW 1000 kHz, VBW 1000 kHz
- Max dwell time: *5* seconds
- Max number of sweeps: *5* seconds
- Auto selection of avg. VBW: Yes

The tune and listening settings were set to the following span, resolution, and video bandwisths:

### Tune/Listen setting

- Narrow span 100 kHz, RBW 30 kHz, VBW 10 kHz

#### 11.1.8.8.2—Antenna Factors

The EMCO, model 3115 EMI measurement horn antenna was used for radiated emissions measurements from 1000 - 3500 MHz. The antenna correction factors are shown in Table 11.9—.

*Table 11.9—Antenna Factors*

| Frequency (MHz) | Amplitude (dB/m) |
|---|---|
| 1000 | 24.8 |
| 1500 | 24.9 |
| 2000 | 27.1 |
| 2500 | 28.7 |
| 3000 | 30.9 |
| 3500 | 33 |
| 4000 | 32.2 |
| 4500 | 32.2 |
| 5000 | 33.7 |
| 5500 | 34.7 |
| 6000 | 35.2 |
| 6500 | 35.1 |

*Table 11.9—Antenna Factors*

| Frequency (MHz) | Amplitude (dB/m) |
|---|---|
| 7000 | 36 |
| 7500 | 37 |
| 8000 | 37.4 |
| 8500 | 38.6 |
| 9000 | 38.8 |
| 9500 | 38.6 |
| 10000 | 38.2 |
| 10500 | 38.4 |
| 11000 | 38.8 |
| 11500 | 39.2 |
| 12000 | 39.2 |
| 12500 | 39.5 |
| 13000 | 40.5 |
| 13500 | 41 |
| 14000 | 41.8 |
| 14500 | 40.8 |
| 15000 | 39 |
| 15500 | 37.9 |
| 16000 | 38.2 |
| 16500 | 40.6 |
| 17000 | 43.9 |
| 17500 | 45.6 |
| 18000 | 46.7 |

### 11.1.8.9—Cable Factors

The measurement system setup, as shown in Figure 11.10 is interconnected with 53 feet of RG-214 coaxial cable. The cable insertion loss was measured and documented for receiver data

correction. Table 11.10— outlines the measurement system's cable correction factors.

*Table 11.10—Cable Corrections*

| Frequency (MHz) | Amplitude (dB) |
|---|---|
| 1000 | -4.5 |
| 1100 | -4.8 |
| 1200 | -5 |
| 1300 | -5.2 |
| 1400 | -5.5 |
| 1500 | -5.7 |
| 1600 | -6 |
| 1700 | -6.2 |
| 1800 | -6.4 |
| 1900 | -6.6 |
| 2000 | -6.8 |
| 2100 | -7.2 |
| 2200 | -7.4 |
| 2300 | -7.8 |
| 2400 | -7.8 |
| 2500 | -7.8 |
| 2600 | -8.2 |
| 2700 | -8.4 |
| 2800 | -9 |
| 2900 | -9 |
| 3000 | -9.2 |
| 3100 | -9.7 |
| 3200 | -9.7 |
| 3300 | -10.5 |
| 3400 | -10.5 |
| 3500 | -10.6 |

## 11.2 RF Characterization Test Results

This section describes the test results obtained during the validation of the AT&T Wireless Services PWAN Base Station against the applicable requirements of FCC Part 2 and Part 24.

### 11.2.1 Test Equipment List

Test cases within this section were completed utilizing the equipment in the following table. Calibration of equipment, where required, was completed by Hewlett Packard and tracks to NIST.

*Table 11.11—Test Equipment*

| Instrument Name | Manufacturer | Model Number | Serial Number | Calibration Last Date | Calibration Due Date |
|---|---|---|---|---|---|
| Thermal Chamber | Screening Systems Inc. | QRS-410T | 9511-110 | N/A | N/A |
| Directional Coupler | Narda | 3022 | 76836 | N/A | N/A |
| Directional Coupler | Narda | 4012C-10 | 11626 | N/A | N/A |
| Signal Generator | Hewlett-Packard | 8657B | 2935U00456 | 5/11/98 | 5/11/99 |
| Power Meter | Hewlett-Packard | EPM-442A | GB37170555 | 5/14/98 | 5/14/99 |
| Power Sensor | Hewlett-Packard | 8482A | 3318A26922 | 5/27/98 | 5/27/99 |
| Cesium Beam Clock | Hewlett-Packard | 5071A | 3249A00701 | N/A | N/A |
| Vector Signal Analyzer | Hewlett-Packard | 89441A | 3416A01258 | 5/13/98 | 5/13/99 |
| Frequency Counter | Hewlett-Packard | 53132A | 3736A06180 | 08/21/98 | 08/21/99 |
| Spectrum Analyzer | Hewlett-Packard | 8563E | 5317A03669 | 5/1/97 | 5/1/99 |
| Network Analyzer | Hewlett-Packard | 8753E | US377390776 | 5/15/98 | 5/15/99 |

### 11.2.2 List of Equipment Under Test

Test cases within this section were executed using the equipment under test listed in Table 11.12.

*Table 11.12—EUT Equipment Under Test List*

| Shelf | Board Type | Serial No. | Revision Level | Test |
|---|---|---|---|---|
| **BaseBand Shelf 1** | | | | |
| | BBC | 15077 | C | 11.2.3 only |
| | NSP | 115115 | D | 11.2.3 only |
| | TSP 1 | 215154981204 | C | All other tests |
| | TSP 2 | 215155981204 | C | All other tests |
| | TSP 3 | 215317 | A | All other tests |
| | TSP 4 | 215270 | A | All other tests |
| | TSP 5 | 215246 | A | All other tests |
| | TSP 6 | 215372 | A | All other tests |
| | Modem | 85006 | A | All other tests |
| **BaseBand Shelf 2** | | | | All other tests |
| | BBC | 15018 | B | All other tests |
| | NSP | 115035 | B | All other tests |
| | TSP | 215125981104 | C | All other tests |
| | Modem | 85010 | A | All other tests |
| **BaseBand Shelf Redundant** | | | | All other tests |
| | BBCR | 15030 | C | All other tests |
| | NSP | 115237 | D | All other tests |
| | TSP | 215328 | A | All other tests |
| | Modem | 85008 | A | All other tests |
| **Network Shelf** | | | | All other tests |
| | Sync-P | 1999900030 | Osc S/N 958 | All other tests |
| | Sync-R | 1999900056 | Osc S/N 1858 | All other tests |
| | TSI-P | 205023 | B | All other tests |
| | TSI-R | 205015 | A | All other tests |
| | NIF-1 | 95222 | B | All other tests |
| | NIF-3 | 95223 | B | All other tests |
| | NIF-6 | 95224 | B | All other tests |
| | NMP | 105012 | C | All other tests |
| | ICP-P | 75023 | C | All other tests |

*Table 11.12—EUT Equipment Under Test List*

| | | | | |
|---|---|---|---|---|
| | ICP-R | 75024 | C | All other tests |
| **RF Cabinet** | | | | All other tests |
| | FE Unit 1 | 250135 | N/A | All other tests |
| | FE Unit 2 | 250138 | N/A | All other tests |
| | FE Unit 3 | 250136 | N/A | All other tests |
| | FE Unit 4 | 250137 | N/A | All other tests |
| | FE Unit 5 | 250131 | N/A | All other tests |
| | FE Unit 6 | 250132 | N/A | All other tests |
| | FE Unit 6 | 250132 | N/A | All other tests |
| | FE Unit 7 | 250134 | N/A | All other tests |
| | FE Unit 8 | 250133 | N/A | All other tests |
| | FES-RS Unit | 250228 | N/A | All other tests |
| | TRS Shelf 1 | 250248 | N/A | All other tests |
| | TRS Shelf 2 | 250247 | N/A | All other tests |
| | TRS Shelf 3 | 250246 | N/A | All other tests |

## 11.2.3 Base Station RF Frequency Stability vs. Temperature

### 11.2.3.1—Applicable FCC Rules Parts

FCC Subpart 2.995 - Measured over the temperature range of -30 to +50 C. Frequency measurements shall be made at the extremes and at intervals of not greater than 10 degrees C throughout the range. Only the frequency determining portions of the transmitter need be subjected to this test.

FCC Subpart 24.236 - The frequency stability shall be sufficient to ensure that the fundamental emission stays within the authorized frequency block.

### 11.2.3.2—Test Configuration

The Synchronization Card under test was placed into a Screening Systems, Inc. model QRS-410T thermal chamber (refer to Figure 11.1). A Hewlett/Packard 53132 frequency counter was used to monitor the output frequency of the DUT. A Hewlett-Packard 5071A cesium beam primary standard was utilized as a precision frequency reference for the 53132A frequency counter. The frequency counter resolution was set to 0.001 Hz.

The frequency accuracy of the 10 MHz oscillator was tracked over the temperature range of -30 to +50 Celsius. During this test the thermal chamber “stair-stepped” from -40 to +60 degrees Celsius in temperature increments of 10 degrees Celsius. The thermal chamber’s sensing thermocouple was attached to the Synchronization Card about 10 cm from the ovenized oscillator to assure that the DUT was kept to within ±5 degrees Celsius of each pre-determined thermal step. The chamber held each thermal step for 15 minutes. The total run time was three hours per test.

The frequency stability of the DUT was measured over temperature in each of the three operating modes.

The frequency error was calculated for each temperature step using the formula in Equation 11.1:

**(Eq 11.1)**

$$\text{FrequencyError(PPM)} = \left(\left(\frac{\Delta f}{f}\right) \cdot 1\times10^{6}\right) = \left(\left(\frac{f(\text{measured}) - 1\times10^{7}}{1\times10^{7}}\right) \cdot 1\times10^{6}\right)$$

### 11.2.3.3—Results Summary

The measured frequency stability vs. temperature is depicted in Figure 11.11, Figure 11.12, and Figure 11.13. The results of these tests are summarized in Table 11.13— below:

*Figure 11.11 Base Station Synchronization Card Frequency Stability vs. Temperature, GPS Locked Mode*

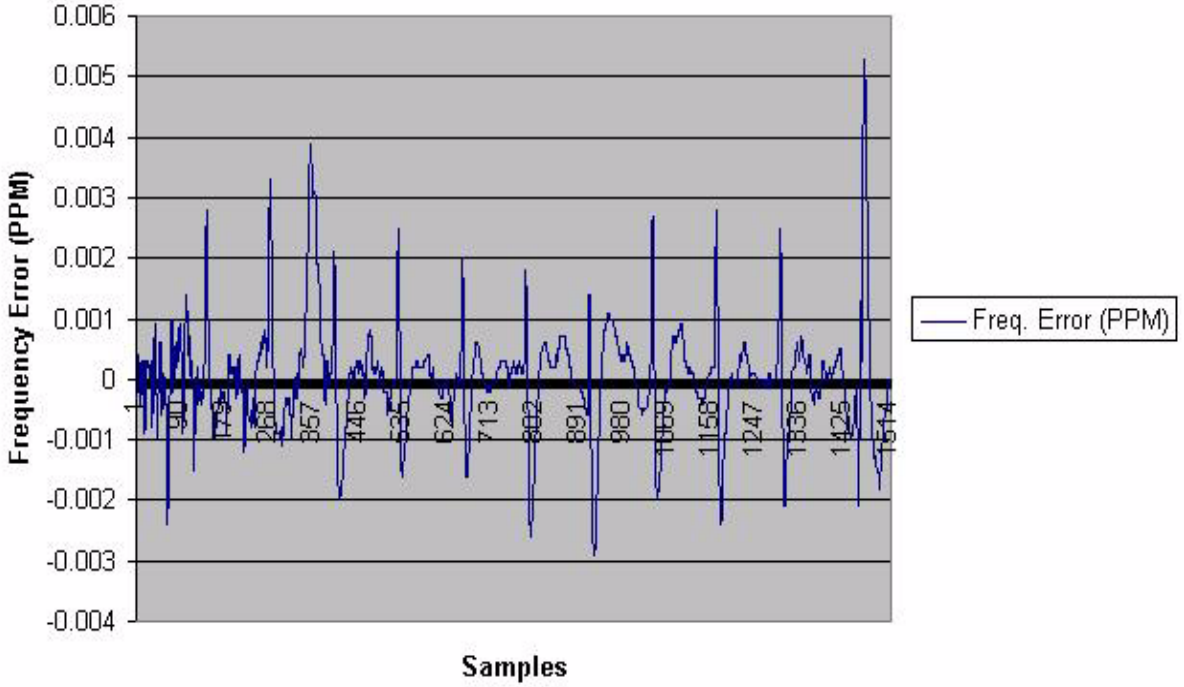



*Figure 11.12 Base Station Synchronization Card Frequency Stability vs. Temperature, GPS Holdover Mode*

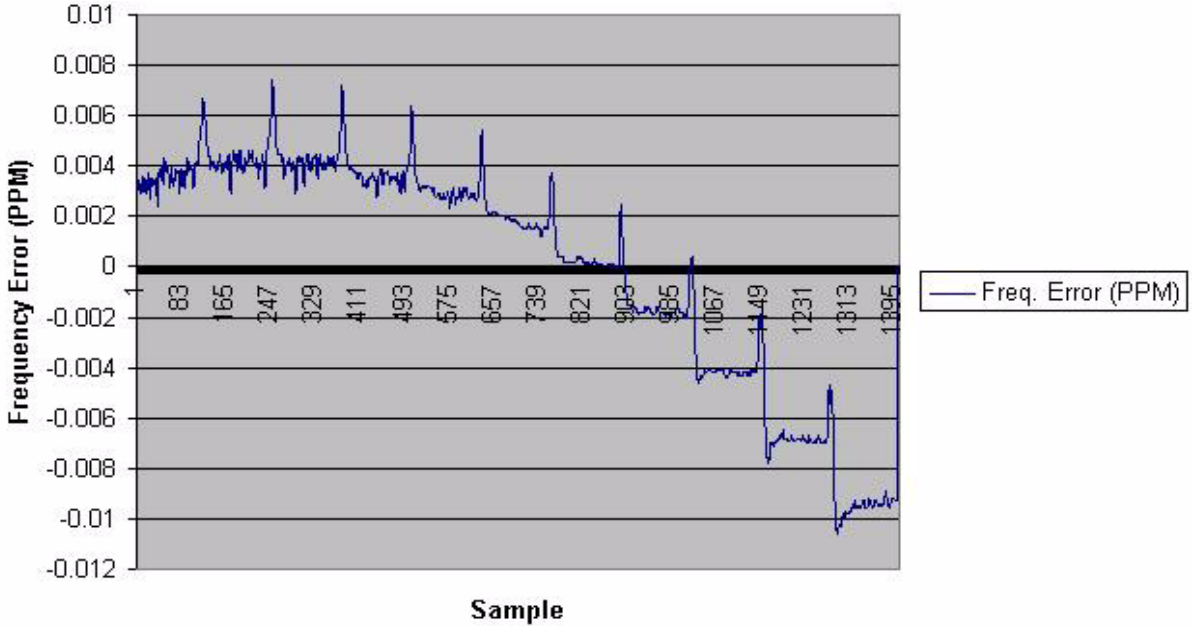


*Figure 11.13 Base Station Synchronization Card Frequency Stability vs. Temperature, GPS Free-Run Mode*

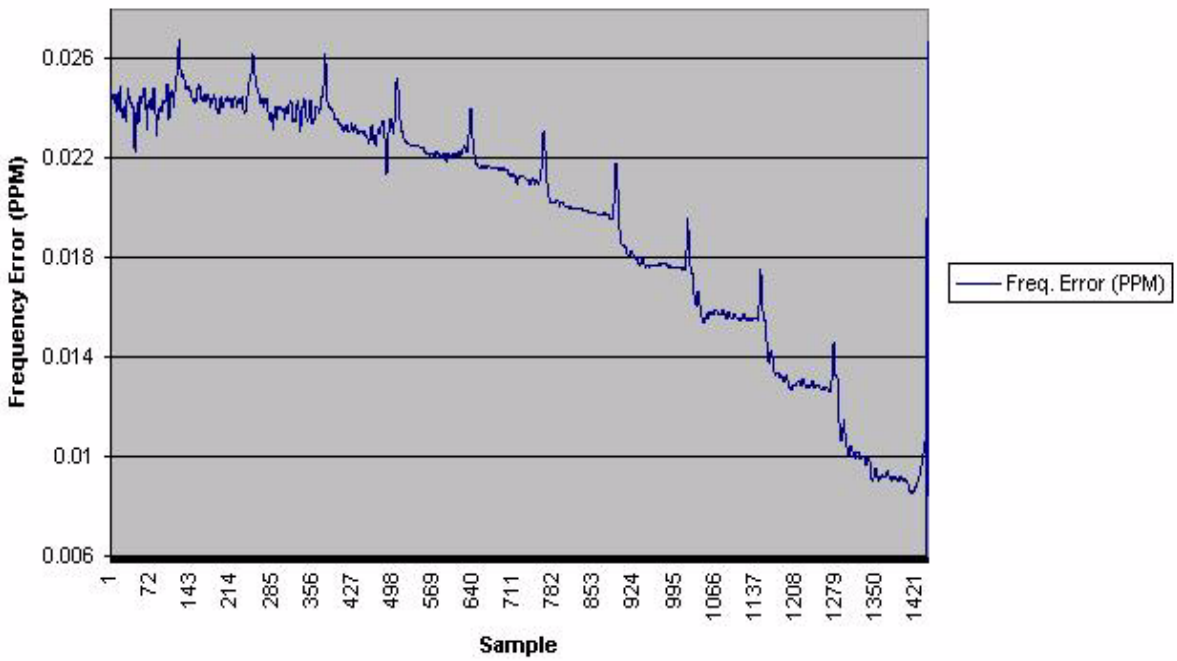



*Table 11.13—Base Station Synchronization Card Frequency Stability vs. Temperature Summary*

| Parameter | Measured Value |
|---|---|
| Frequency stability at 10.0 MHz Synchronization Card between -40 Deg. Celsius and +60 Deg. Celsius in GPS Locked Mode | Frequency change of ≤ 0.009 PPM @ 10 MHz |
| Frequency stability at 10.0 MHz Synchronization Card between -40 Deg. Celsius and +60 Deg. Celsius in GPS Holdover Mode | Frequency change of ≤ 0.02PPM @ 10 MHz |
| Frequency stability at 10.0 MHz Synchronization Card between -40 Deg. Celsius and +60 Deg. Celsius in GPS Free-Run Mode | Frequency change of ≤ 0.02 PPM @ 10 MHz |

## 11.2.4 Base Station Frequency Stability vs. Input Voltage

### 11.2.4.1—Applicable FCC Rule Parts

FCC Subpart 2.995 - The frequency stability shall be measured with variation of primary supply voltage as follows: 1) Vary primary voltage

from 85 to 115 percent of the nominal value for other than hand carried equipment. 3) The supply voltage shall be measured at the input to the cable provide with the equipment, or at the power supply terminals if cables are not normally provided. Effects on frequency of transmitter keying (except for broadcast transmitters) and any heating element cycling at the nominal supply voltage and at each extreme also shall be shown.

FCC Subpart 24.236 - The frequency stability shall be sufficient to ensure that the fundamental emission stays within the authorized frequency block.

### 11.2.4.2—Test Configuration

The Synchronization Card under test was connected to a variable DC power supply (refer to Figure 11.2). A Hewlett/Packard 53132 frequency counter was used to monitor the output frequency of the DUT. A Hewlett-Packard 5071A cesium beam primary standard was utilized as a precision frequency reference for the 53132A frequency counter. The frequency counter resolution was set to 0.001 Hz.

The frequency accuracy of the 10 MHz oscillator was tracked over the voltage range of -40.8 to -55.2 VDC (±15%) in 1.0 volt increments.

The output frequency stability of the DUT was measured over voltage in each of the three operating modes.

The frequency error was calculated for each temperature step using the formula in Equation 11.2:

**(Eq 11.2)**

$$\text{FrequencyError(PPM)} = \left(\left(\frac{\Delta f}{f}\right) \cdot 1\times10^{6}\right) = \left(\left(\frac{f(\text{measured}) - 1\times10^{7}}{1\times10^{7}}\right) \cdot 1\times10^{6}\right)$$

### 11.2.4.3—Results Summary

The measured frequency stability vs. input voltage for the Base Station under test is depicted in Figure 11.14, Figure 11.15, Figure 11.16. The results of these tests are summarized in Table 11.14— below:

*Figure 11.14 Base Station Synchronization Card Frequency Stability vs. Input Voltage, GPS Locked Mode,*

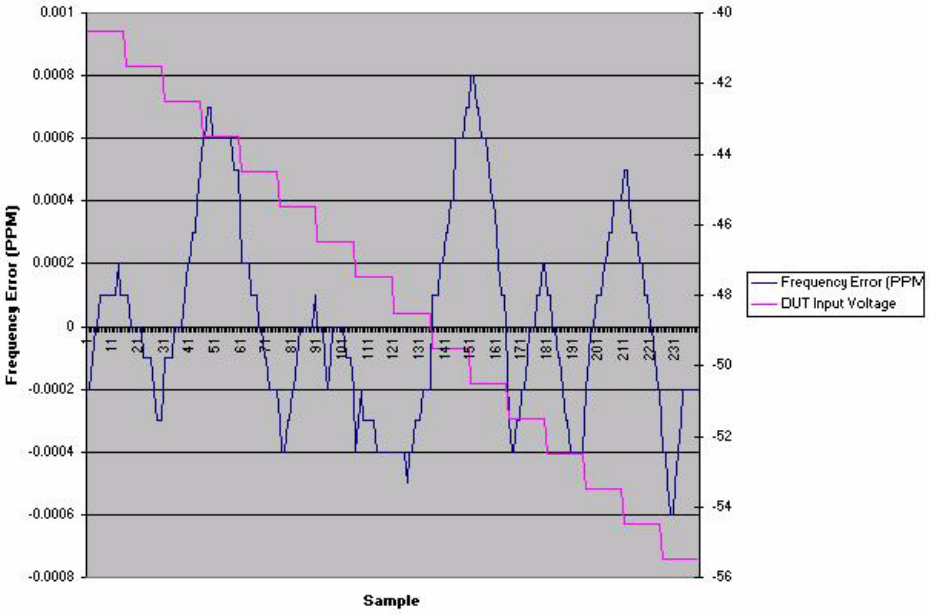



*Figure 11.15 Base Station Synchronization Card Frequency Stability vs. Input Voltage, GPS Holdover Mode*

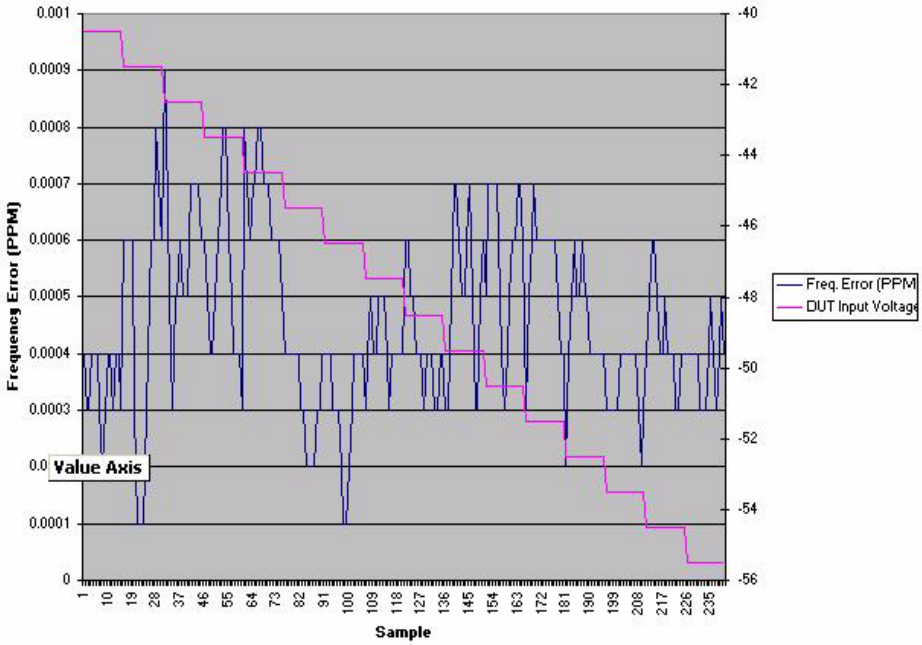


*Figure 11.16 Base Station Synchronization Card Frequency Stability vs. Input Voltage, GPS Free-Run Mode*

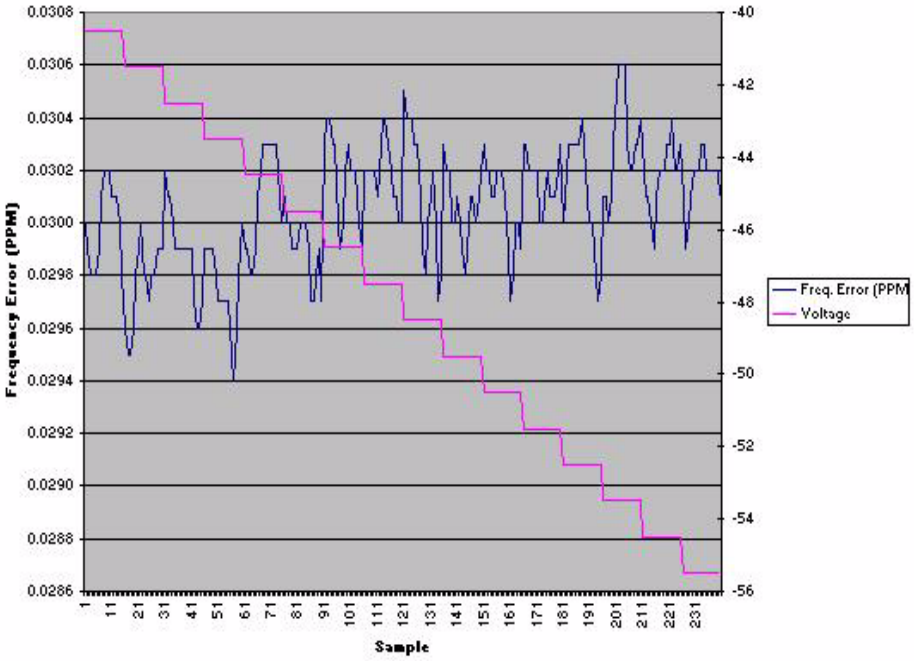



*Table 11.14—Base Station Synchronization Card Frequency Stability vs. Input Voltage Summary*

| Parameter | Measured Value |
|---|---|
| *Base Station Synchronization Card Frequency Stability vs. Input Voltage, GPS Locked Mode* | Total frequency change of ≤ 0.0015 PPM |
| *Base Station Synchronization Card Frequency Stability vs. Input Voltage, GPS Holdover Mode* | Total frequency change of ≤ 0.001 PPM |
| *Base Station Synchronization Card Frequency Stability vs. Input Voltage, GPS Free-Run Mode* | Total frequency change of ≤ 0.0015 PPM |

## 11.2.5 Base Station Occupied Bandwidth

### 11.2.5.1—Applicable FCC Rule Parts

FCC Subpart 2.989 - Occupied bandwidth is defined as 99% of the total mean power, measured according to Subpart 2.989 (i), which requires full loading of the baseband, modulated such that the occupied bandwidth is consistent with that expected during normal operation.

### 11.2.5.2—Test Configuration

The occupied bandwidth of a PWAN Base Station is maximized while transmitting eight simulcast Remote Synchronization Pilots (RSPs) without any voice or high-speed data traffic. The Base Station was allowed to operate in the idle mode (no call processing or data transfer).

The transmitter was sampled through a -20 dB directional coupler and viewed with a Hewlett-Packard 89441A Vector Signal Analyzer and 89451A Digital Radio Personality option, set up to measure 99% Occupied Bandwidth (refer to Figure 11.4). A 375 ms time record was captured to obtain the measurement data included in this report. The configuration parameters of the 89451A are listed in Table 11.2.

### 11.2.5.3—Test Summary

The 99% Occupied Bandwidth for the Base Station is depicted in Figure 11.17. The test results are summarized in Table 11.15

*Figure 11.17 Base Station 99% Occupied Bandwidth While Transmitting Simulcast Remote Synchronization Pilots*

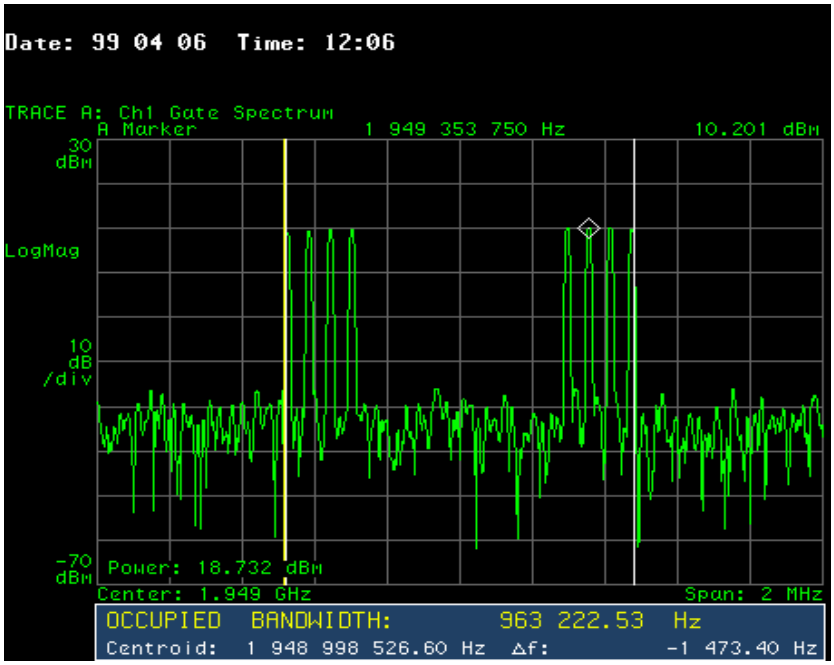



*Table 11.15—Occupied Bandwidth Test Result Summary*

| Parameter | Measured Value |
|---|---|
| 99% Occupied Bandwidth While Transmitting Remote Synchronization Pilots | ≤964 kHz |

## 11.2.6 Modulation Characterization

### 11.2.6.1—Applicable FCC Rules

FCC Subpart 2.987 - Requires a curve or equivalent data which shows that the equipment will meet the requirements of the rules under which the equipment is to be licensed. Provide data showing that the modulation being employed does not cause the spectral purity to exceed the requirements of 2.985 and 24.238.

### 11.2.6.2—Test Configuration

A Hewlett-Packard 89441A Vector Signal Analyzer was used to characterize each of the following discrete logical channels:

- Multiple Call Voice Traffic channel
- High-Speed Data Traffic channel
- High Speed Data Control channel
- Broadcast channel
- Time-Keyed Remote Synchronization channel
- Simulcast Remote Synchronization channel

For each logical channel, the 89441A Vector Signal Analyzer was used to obtain the following information:

- 99% occupied bandwidth in kHz
- Integrated power across the measured occupied bandwidth in dBm
- Power vs. frequency (in dBm) in a 12 kHz resolution bandwidth
- Time-domain average RF burst power
- Complimentary Cumulative Distribution Function (CCDF) of the peak to average ratio made up of *x* samples of the time-domain RF bursts (this measurement was not possible for Remote Synchronization channel measurements)

### 11.2.6.3—Results Summary

#### 11.2.6.3.1—Multiple Call Voice Traffic Channel

A total of 16 telephone calls were established between a pool of Remote Units and the Base Station under test using the test configuration shown in Figure 11.5. The Hewlett-Packard 89441A Vector signal analyzer was configured according to the parameters shown in Table 11.3. The measured characteristics of a fully occupied voice TDMA slot are depicted in Figure 11.18 and Figure 11.19. The results of these tests are summarized in Table 11.16 below:

*Figure 11.18 Voice Channel Power vs. Frequency, 99.0% Occupied BW, and Time-Domain Average Burst Power*

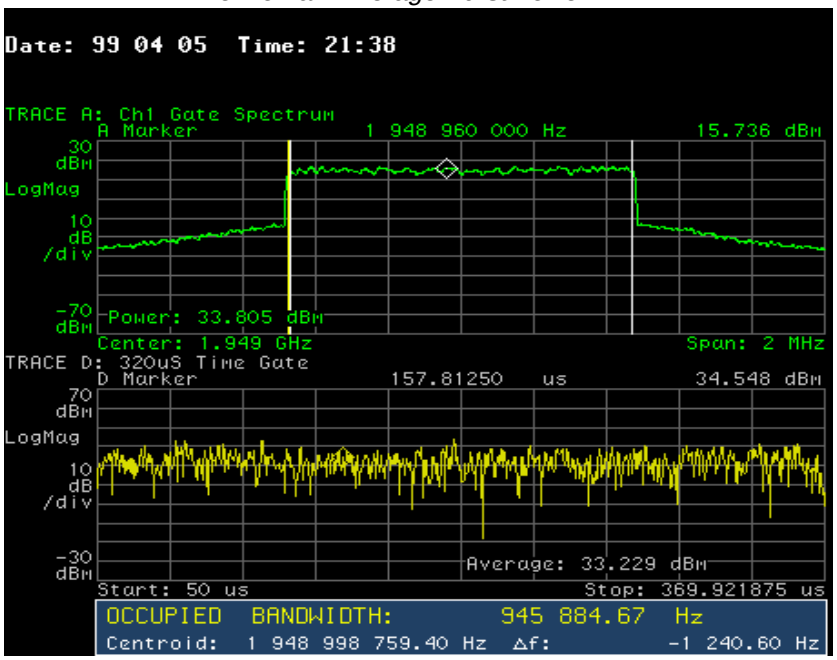
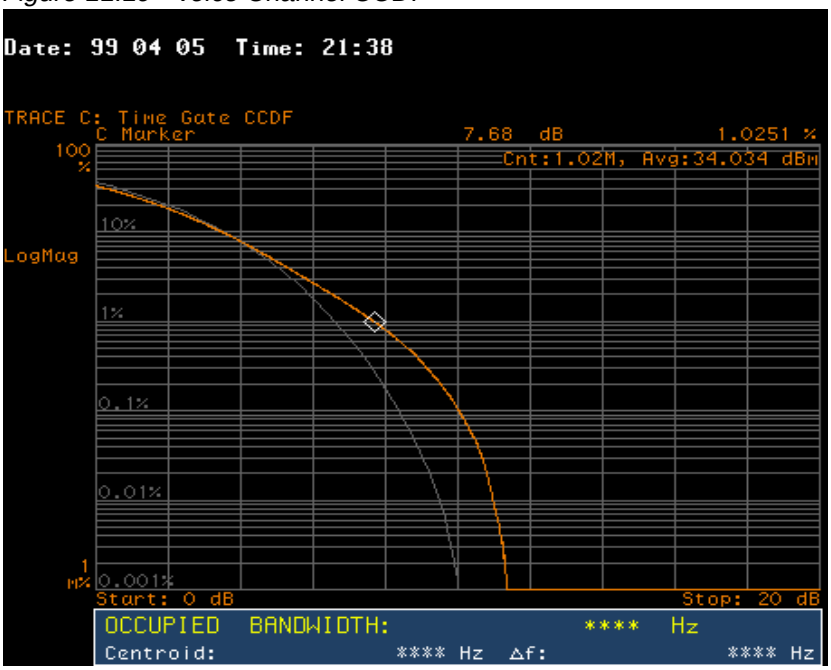



*Figure 11.19 Voice Channel CCDF*



#### 11.2.6.3.2—High-Speed Data Channel

A single High-Speed Data session was established between the Base Station under test and the Base using the test configuration shown in Figure 11.5. The Hewlett-Packard 89441A Vector Signal Analyzer was configured according the parameters shown in Table 11.3. During this test, a 20 MB text file was transferred from the Base Station to an FTP server on the AWS network. The random nature of the data contained in this file is sufficient to assure results representative of a normally operating system.

#### 11.2.6.3.3—Results Summary

The measured characteristics of the High-Speed Data channel are depicted in Figure 11.20 and Figure 11.21. The results of these tests are summarized in Table 11.16 below:

*Figure 11.20 High-Speed Data Channel Power vs. Frequency, 99% Occupied BW, and Time-Domain Average Burst Power*

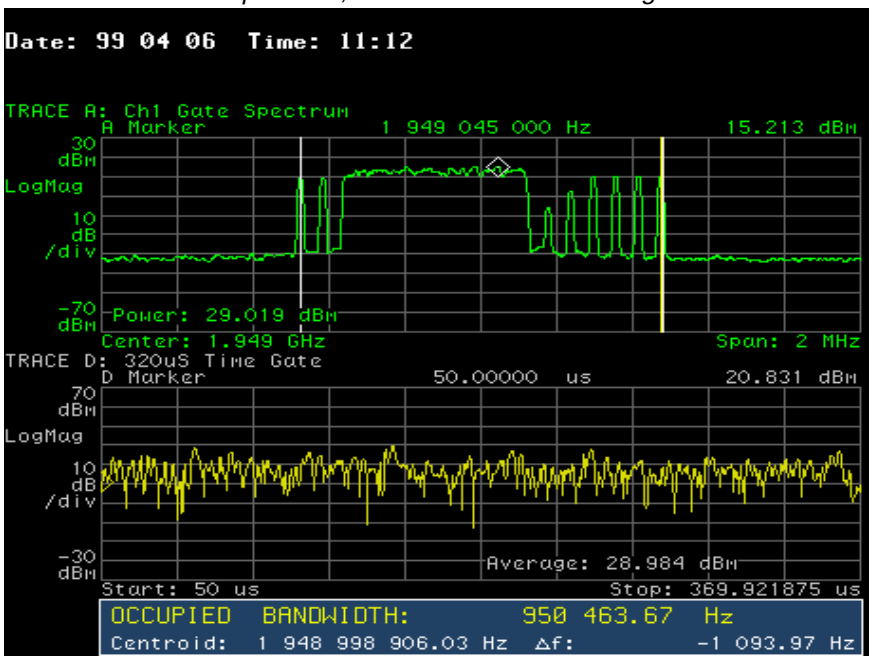
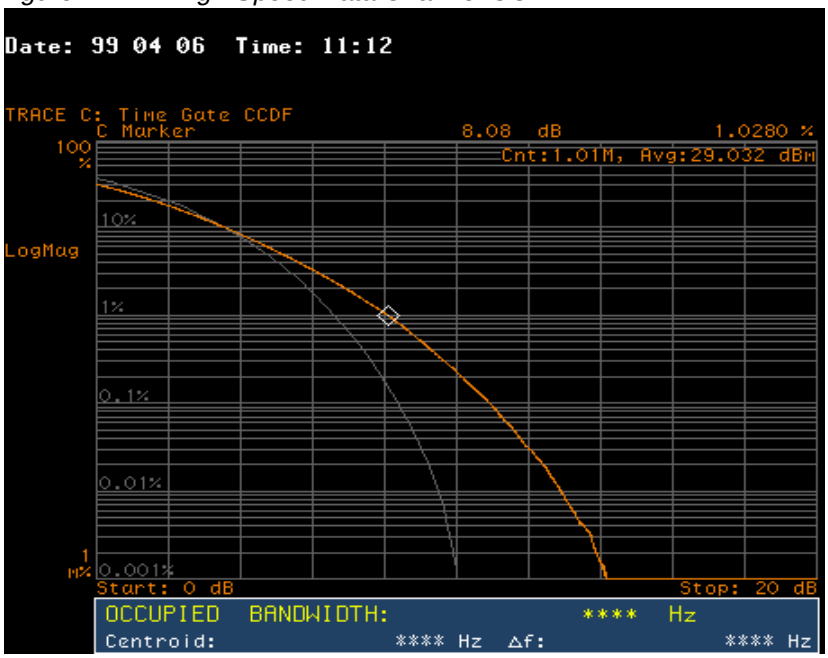


*Figure 11.21 High-Speed Data Channel CCDF*




#### 11.2.6.3.4—High Speed Data Control Channel

Characterization of the High-Speed Data Control channel took place utilizing the test configuration shown in Figure 11.5. The Hewlett-Packard Vector Signal Analyzer was configured according to the parameters shown in Table 11.3.

#### 11.2.6.3.5—Results Summary

The measured characteristics of the High-Speed Data Control channel are depicted in Figure 11.22 and Figure 11.23. The results of these tests are summarized in Table 11.16 below:

*Figure 11.22 High Speed Data Control Channel Power vs. Frequency, 99% Occupied Bandwidth, and Time-Domain Average Power*

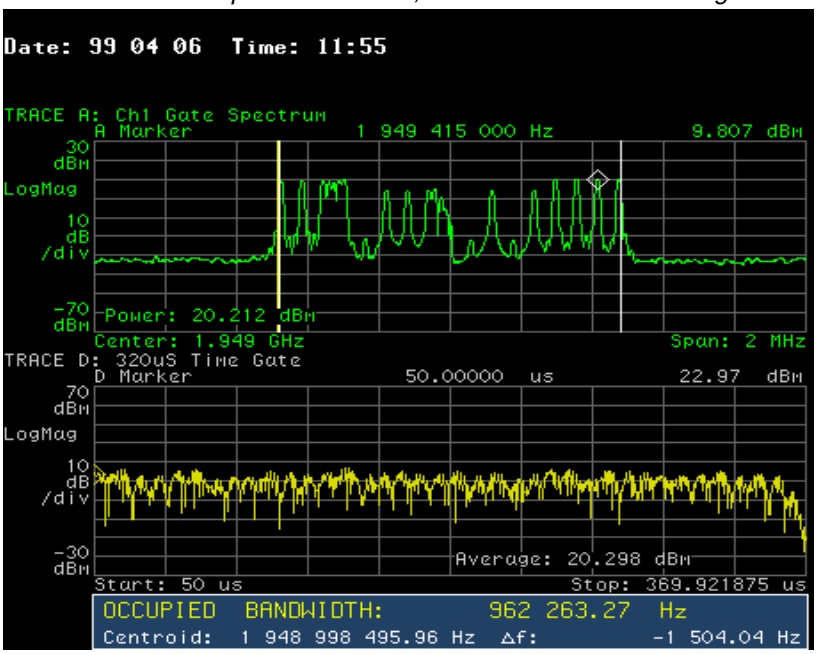
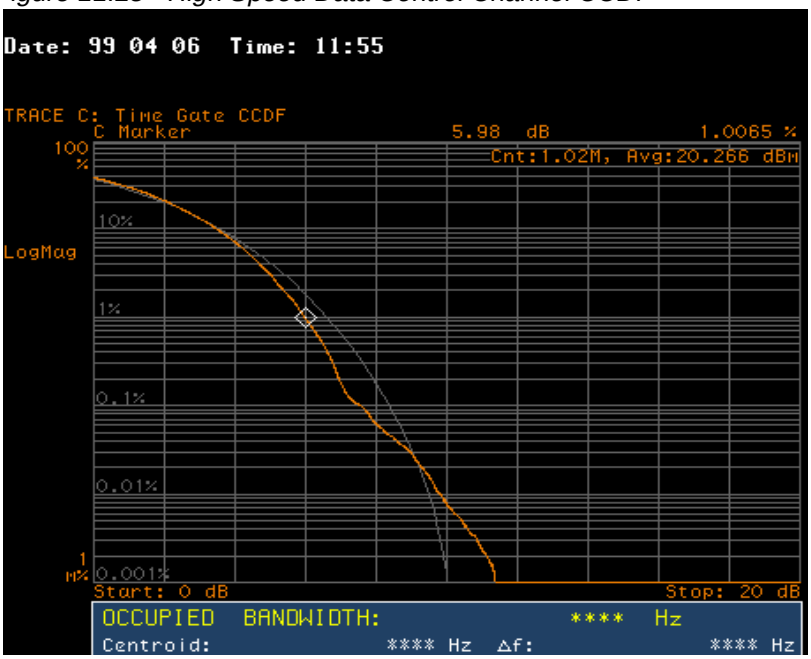



*Figure 11.23 High Speed Data Control Channel CCDF*




### 11.2.6.3.6—Broadcast Channel

The Base Station Broadcast channel was characterized using the test configuration shown in Figure 11.5. The Hewlett-Packard Vector

Signal Analyzer was configured according to the parameters shown in Table 11.3.

#### 11.2.6.3.7—Results Summary

The measured characteristics of the Remote Synchronization channel are depicted in Figure 11.24 and Figure 11.25. The results of these tests are summarized in Table 11.16 below:

*Figure 11.24 Remote Synchronization and Broadcast Channel Power vs. Frequency, 99% Occupied BW, and Time-Domain Average Power*

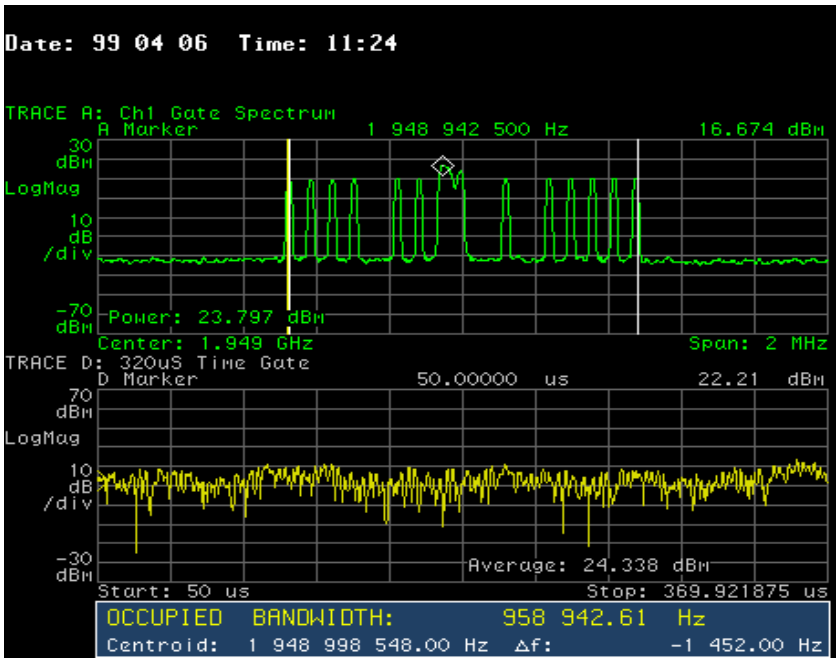
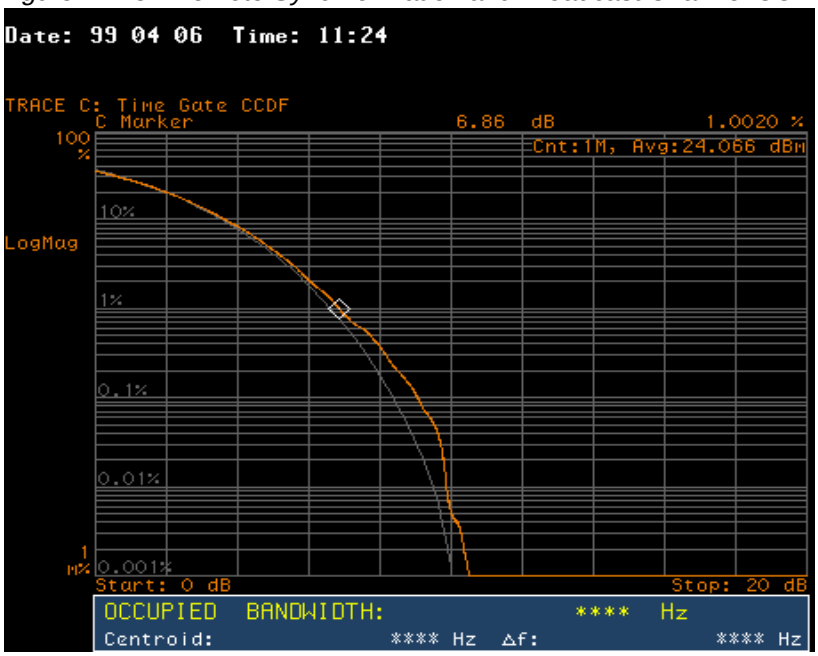


*Figure 11.25 Remote Synchronization and Broadcast Channel CCDF*




#### 11.2.6.3.8—Time-Keyed Remote Synchronization Channel

Time-Keyed Remote Synchronization Pilots (RSPs) were characterized using the test configuration shown in Figure 11.5. The Hewlett-Packard Vector Signal Analyzer was configured according to the parameters shown in Table 11.4.

#### 11.2.6.3.9—Results Summary

The measured characteristics of the Time-Keyed Remote Synchronization channel are depicted in Figure 11.26 and Figure 11.27. The results of these tests are summarized in Table 11.16 below:

*Figure 11.26 Time-Keyed Remote Synchronization Pilots Power vs. Frequency, 99.0% Occupied Bandwidth, and Time-Domain Average Burst Power During Broadcast TDMA Frames Other Than That Associated With DUT*

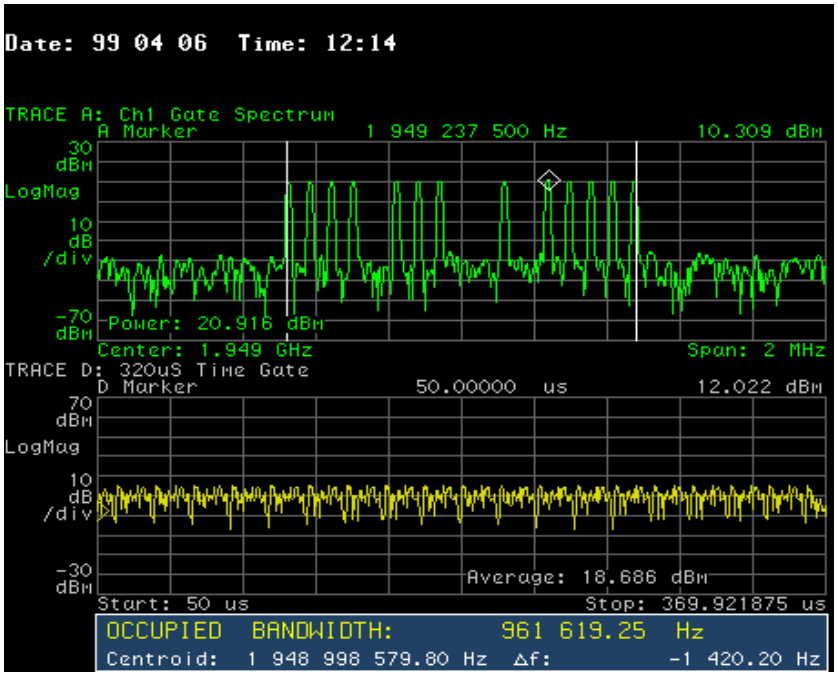
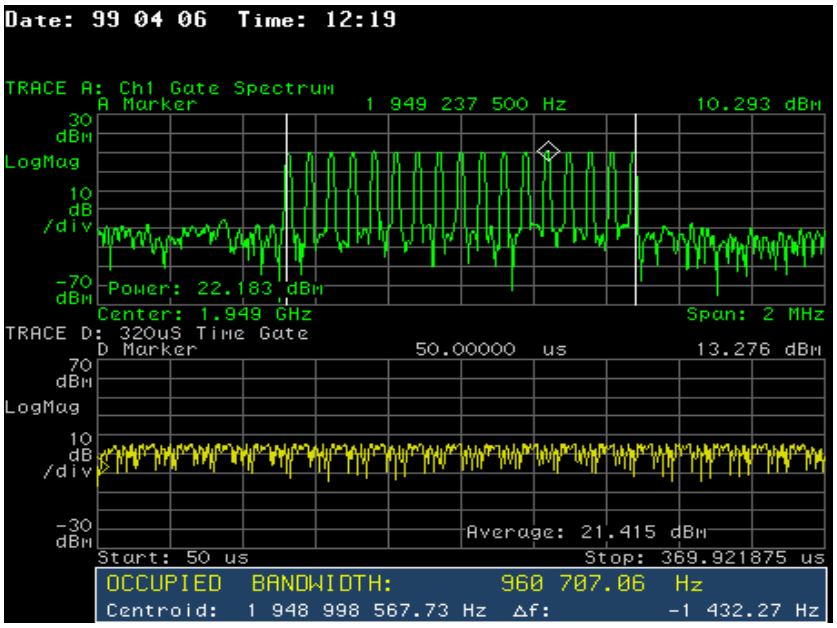



*Figure 11.27 Time-Keyed Remote Synchronization Pilots Power vs. Frequency, 99.0% Occupied Bandwidth, and Time-Domain Average Burst Power During Broadcast TDMA Frame Associated With DUT*



#### 11.2.6.3.10—Simulcast Remote Synchronization Channel

Simulcast Remote Synchronization Pilots (RSPs) were characterized using the test configuration shown in Figure 11.5. The Hewlett-Packard Vector Signal Analyzer was configured according to the parameters shown in Table 11.4.

#### 11.2.6.3.11—Results Summary

The measured characteristics of the Remote Synchronization channel are depicted in Figure 11.28. The results of these tests are summarized in Table 11.16 below:

*Figure 11.28 Simulcast Remote Synchronization Pilots Power vs. Frequency, 99.0% Occupied Bandwidth, and Time-Domain Average Burst*

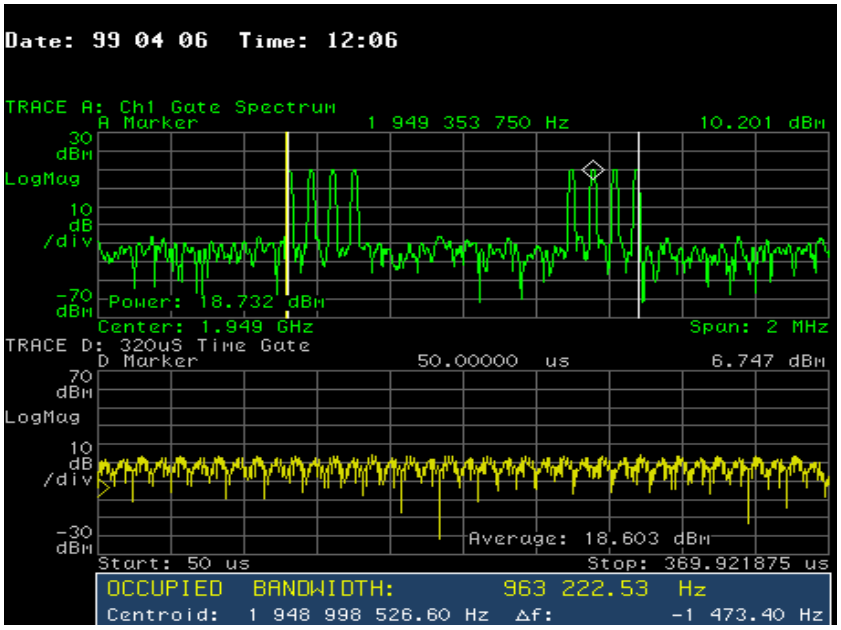


*Table 11.16 Logical Channel Characterization Test Results Summary*

| Parameter | Measured Value |
|---|---|
| Single Voice Channel 99% Occupied Bandwidth | ≤ 946 kHz |
| Single Voice Channel Average Power | +33.3 dBm |
| Voice Channel Peak/Average Ratio at ≤ 99.0% occurrence after $1x10^6$ samples | 7.7 dB |
| High-Speed Data Channel 99% Occupied Bandwidth | ≤ 951 kHz |
| High-Speed Data Channel Average Power | +29.0 dBm |
| High-Speed Data Peak/Average Ratio at ≤ 99.0% occurrence after $1x10^6$ samples | 8.1 dB |
| High-Speed Data Control Channel 99% Occupied Bandwidth | ≤ 963 kHz |
| High-Speed Data Control Channel Average Power | +20.3 dBm |
| High-Speed Data Control Channel Peak/Average Ratio at ≤ 99.0% after $1x10^6$ samples | 6.0 dB |
| Broadcast Channel 99% Occupied Bandwidth | ≤ 959 kHz |
| Broadcast Channel Average Power | +24.3 dBm |
| Broadcast Channel Peak/Average Ratio at ≤ 99.0% occurrence after $1x10^6$ samples | 6.9 dB |
| Time-Keyed Remote Synchronization Channel 99% Occupied Bandwidth | ≤ 962 kHz |
| Time-Keyed Remote Synchronization Channel Average Power | 18.7/21.4 dBm (see Note 1) |
| Remote Synchronization Channel 99% Occupied Bandwidth | ≤ 964 kHz |
| Remote Synchronization Channel Average Power | +18.6 dBm |

***Note 1:*** Power levels listed are for each state of the time-keyed RSPs documented in 11.2.6.3.8, "Time-Keyed Remote Synchronization Channel."

## 11.2.7 RF Output Power

### 11.2.7.1—Applicable FCC Rules

FCC Subpart 2.985-Power output shall be measured at the RF output terminals when the transmitter is adjusted in accordance with the tune-

up procedure to give the values of current and voltage on the circuit elements specified in §2.983 (d)(5). The electrical characteristics of the radio frequency load attached to the output terminals when this test is made shall be stated.

FCC Subpart 24.232 - In no case may the peak output power of a base station transmitter exceed 100 watts. Peak transmitter power may be measured over any interval of continuous transmission using instrumentation calibrated in terms of RMS equivalent voltage. The measurement results shall be properly adjusted for any instrument limitations, such as detector response times, limited resolution bandwidth capability when compared to the emission bandwidth, sensitivity, etc., so as to obtain a true peak measurement for the emission in question over the full bandwidth of the channel.

### 11.2.7.2—Test Configuration

Peak RF Output Power from the Base Station is maximized while supporting 16 simultaneously active FDMA slots.

A Hewlett-Packard 89441A Vector Signal Analyzer was used to characterize the Base Station's composite RF output signal according to the following criteria:

- Time-domain average burst power
- Time-domain peak envelope burst power at the 99.0% level
- Time-domain peak/average ratio at the 99.0% level

For this test, a total of 16 voice calls were established between multiple Remote Units and the Base Station under test using the equipment configuration shown in Figure 11.18.

The Hewlett-Packard 89441A Vector Signal Analyzer was configured according the parameters shown in Table 11.17. The random nature of the data generated by the LD-CELP compression algorithm was sufficient to assure results representative of a normally operating system. A -20 dB directional coupler provided the required RF sample for measurement.

#### 11.2.7.2.1—Results Summary

The measured RF output power of the Base Station while supporting 16 simultaneous voice calls in a single TDMA slot is depicted in

Figure 11.29, Figure 11.30 and Figure 11.31. The results of these tests are summarized in Table 11.17— below:

*Figure 11.29 Time-Domain Power Envelope, Average Power*

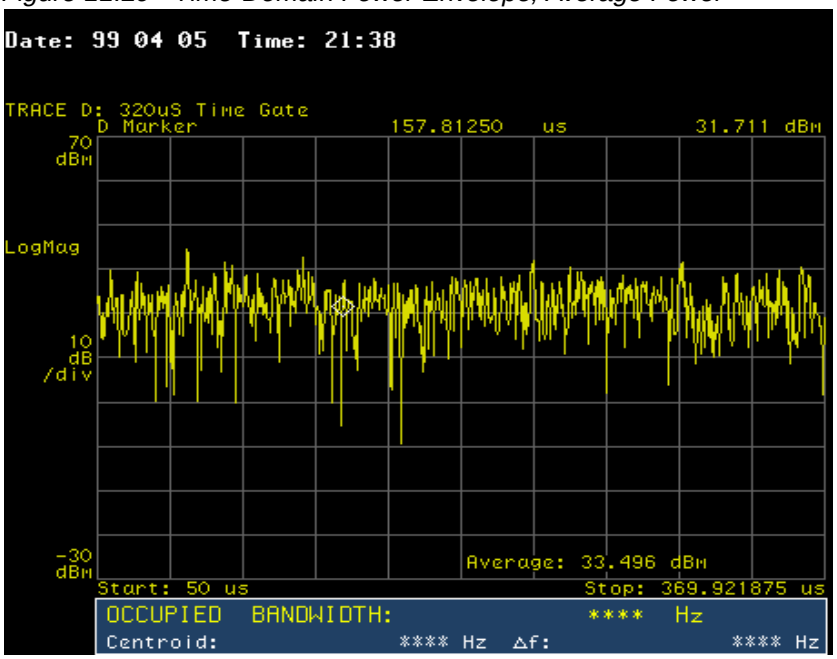



*Figure 11.30 Time-Domain Power Envelope, Peak Power at ≤ 99.0% Occurrence*

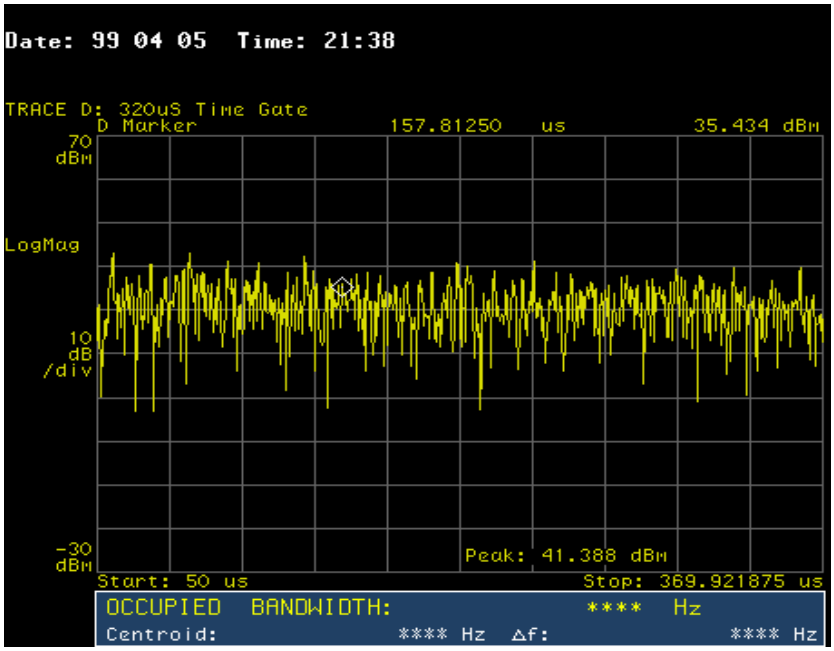


*Figure 11.31 Time-Domain Power Envelope, Peak/Average Ratio at ≤ 99.0% Occurrence*

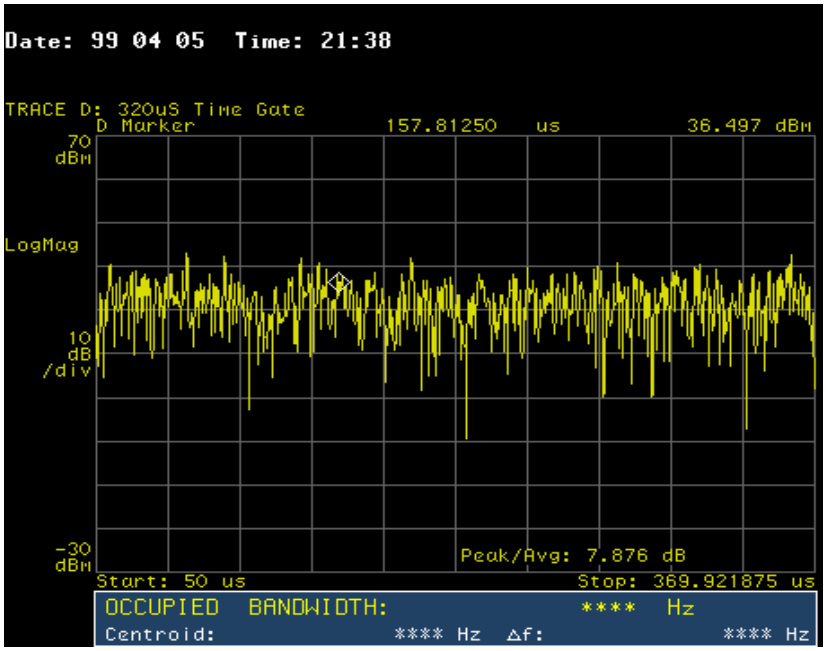



*Table 11.17—RF Output Power Characteristics*

| Parameter | Measured Value | FCC Part 24 Limit |
|---|---|---|
| Time-Domain Average Power | +33.5 dBm/1 MHz | N/A |
| Time-Domain Peak Power at ≤ 99.0% Occurrence | +41.4 dBm/1 MHz RBW | +50.0 dBm/1 MHz RBW |
| Time-Domain Peak/Average Ratio at ≤ 99.0% Occurrence | 7.9 dB | N/A |

## 11.2.8 Spurious Emissions at the Antenna Terminal

### 11.2.8.1—Applicable FCC Rules

FCC Subpart 2.985 - Requires that the RF Output be measured at the antenna power terminals into a dummy load after the transmitter has been adjusted in accordance with the manufacturers tune up procedure. Requires documentation of measurement configuration. Transmitter spectral output shall not have any components that exceed the spectral mask applicable to the rule part under which the equipment shall be operated.

FCC Subpart 24.238 - On any frequency outside a licensee's block, the power of any emission shall be attenuated below the transmitter power

(P) by at least 43+10Log(P) dB. Compliance is based on measurement within a 1 MHz resolution bandwidth. However, in the 1 MHz bands immediately adjacent to the frequency block a resolution bandwidth of at least 1 percent of the emission bandwidth may be employed. The emission bandwidth is defined as the width of the signal between two points, one above and one below the carrier frequency, outside of which all emissions are attenuated by at least 25 dB below the transmitter power.

#### 11.2.8.2—Test Configuration

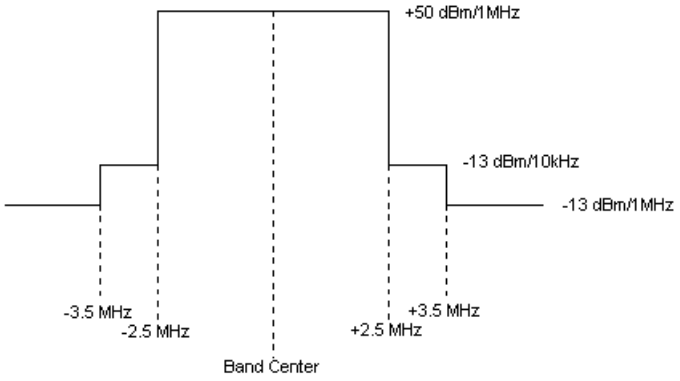
RF Output Power and Out-Of-Band (OOB) emissions from the Base Station are maximized while transmitting 16 simultaneous FDMA slots within a TDMA slot. For this test, 16 Remote Units were used to set up 16 voice calls within a single TDMA slot from the base. The Base Station under test was configured to produce a nominal average output power of 2.5 watts (+34 dBm) during the TDMA slot containing 16 simultaneous voice calls.

Spectral purity measurements were made with the Base Station operating in the lowest and highest subbands allocated in the “D” PCS block. Any Out-Of-Band (OOB) intermodulation and spurious signals will be contributed by Base Stations operating in the exterior subbands. OOB spectral contributions from Base Stations operating within the two interior subbands will be negligible.

A Hewlett-Packard 89441A Vector Signal Analyzer was used to evaluate the spectral purity of the Base Station. The test configuration is shown in Figure 11.33. The Hewlett-Packard 89441A Vector Signal Analyzer was configured according the parameters shown in Table 11.21.

All spectral purity measurements made with the 89441A utilized a 12 kHz resolution bandwidth for 4 MHz spans and a 17 kHz resolution bandwidth for 7 MHz spans. Band power markers (set to 1 MHz BW) were used to measure the total integrated power in 1 MHz segments at frequencies of concern across the range of 1933 to 1962 MHz. Emissions at all applicable frequencies above and below this range have been documented in Section 5.4.3, “Radiated to Conducted Spurious Emissions.

*Figure 11.32 Base Station Conducted Power Spectral Mask*




### 11.2.8.3—Results Summary

The measured spectral purity of the Base Station while transmitting 16 simultaneous voice calls in a single TDMA slot is depicted in Figure 11.33, through Figure 11.42. The results of these tests are summarized in Table 11.18— below:

*Figure 11.33 1-MHz Band-Power Between 1945.5 and 1946.5 MHz*

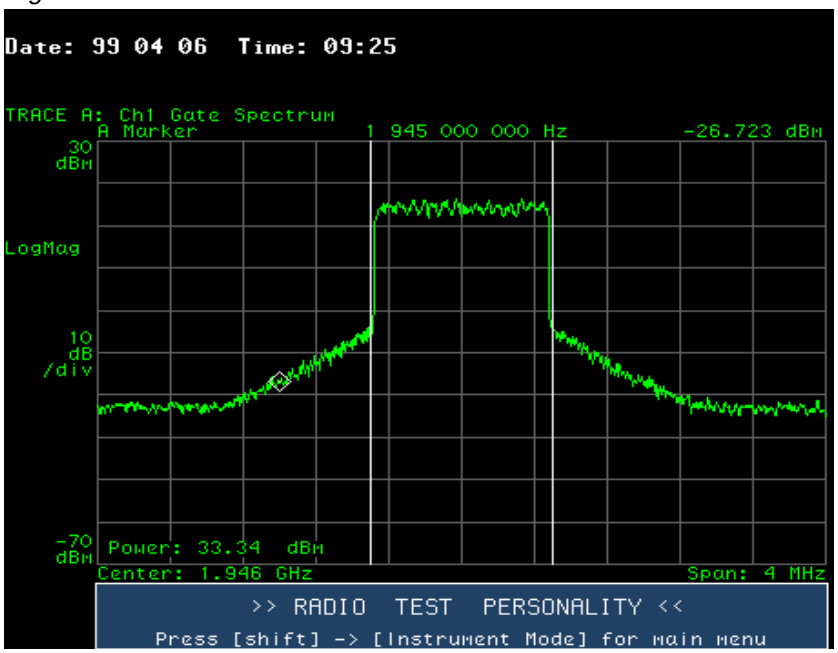


*Figure 11.34 1-MHz Band Power Between 1946.5 and 1947.5 MHz*

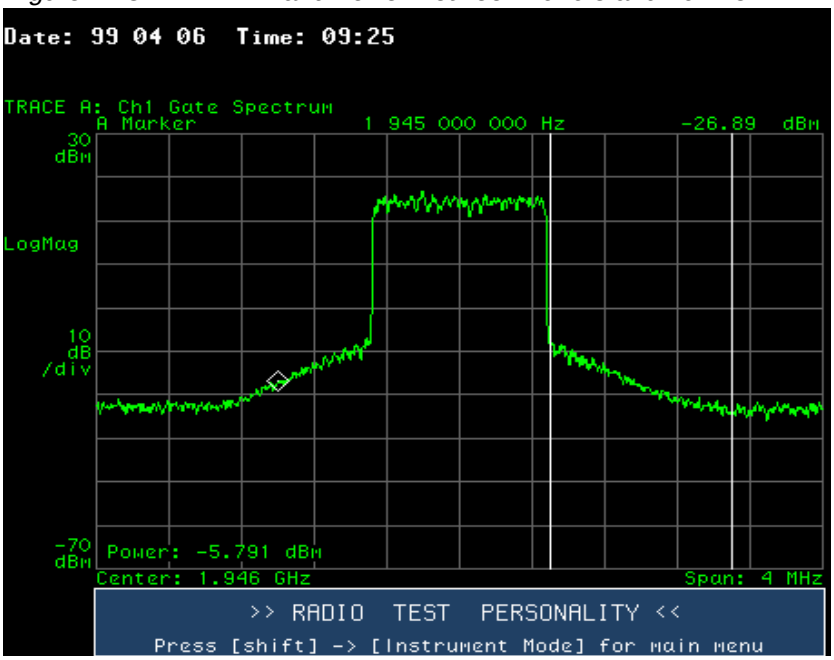



*Figure 11.35 1 MHz Channel Power Between 1947.5 and 1948.5 MHz*

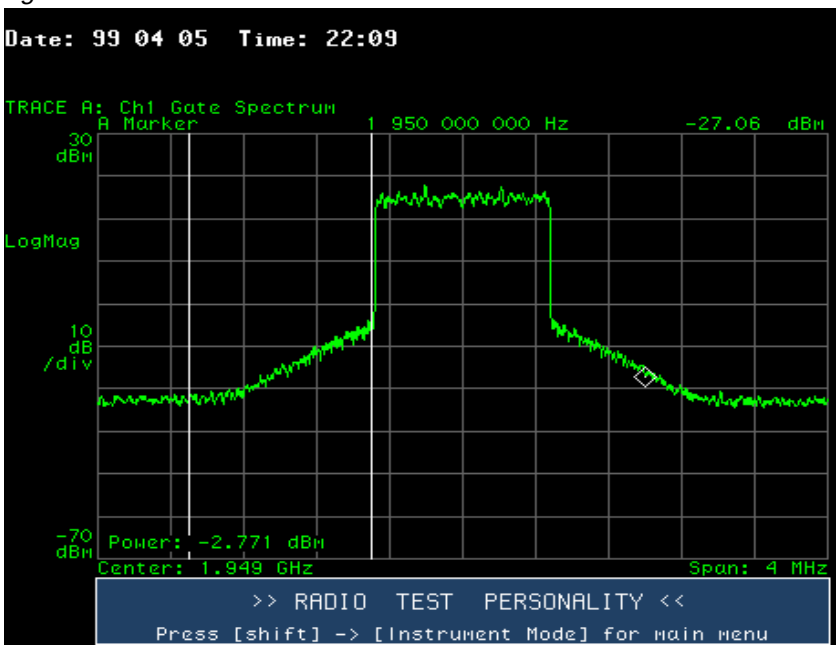


*Figure 11.36 1 MHz Channel Power Between 1948.5 and 1949.5 MHz*

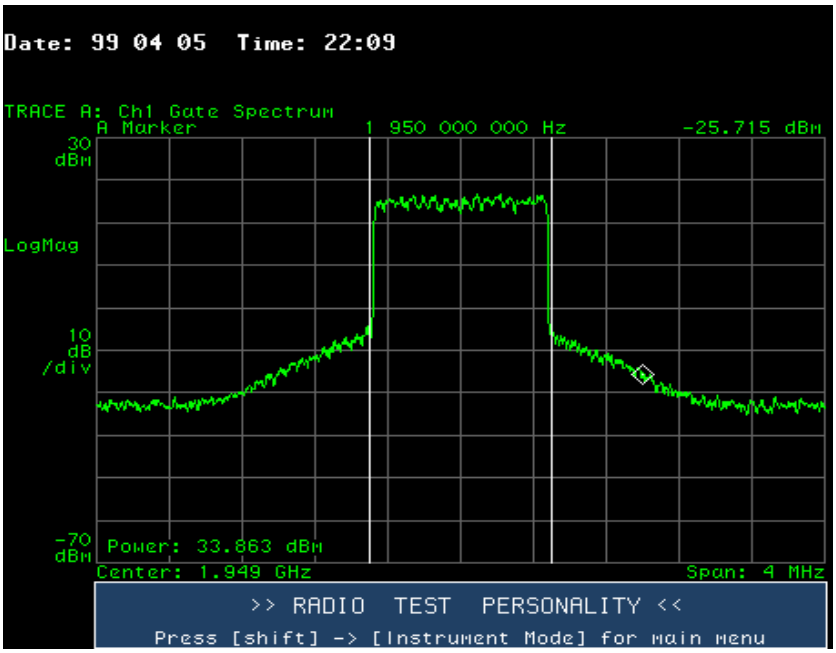



*Figure 11.37 Maximum Lower Guard Band Spurious Power, Measured in a 12 kHz Resolution BW (Marker Indicates Edge of Subband)*

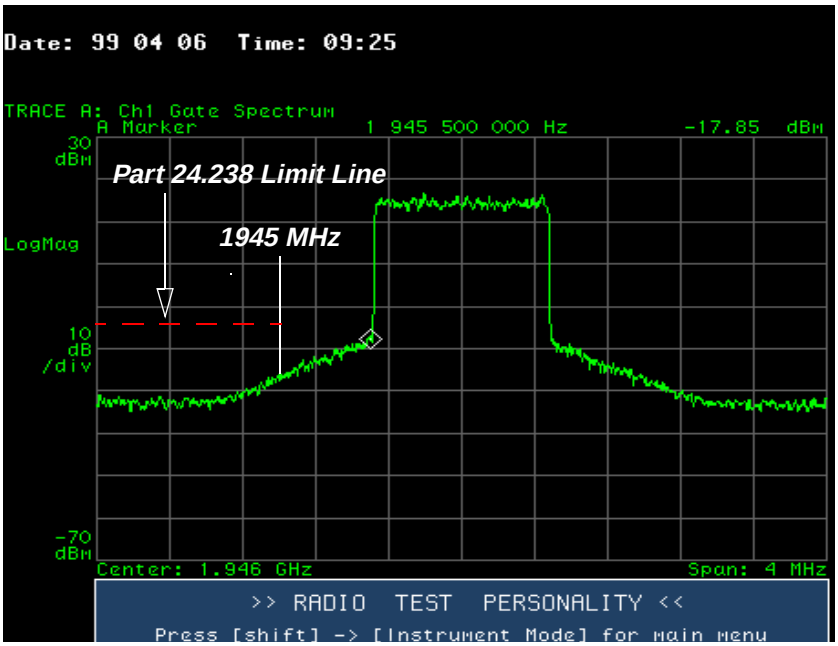


*Figure 11.38 Maximum Upper Guard Band Spurious Power Measured in a 12 kHz Resolution BW (Marker Indicates Edge of Subband)*

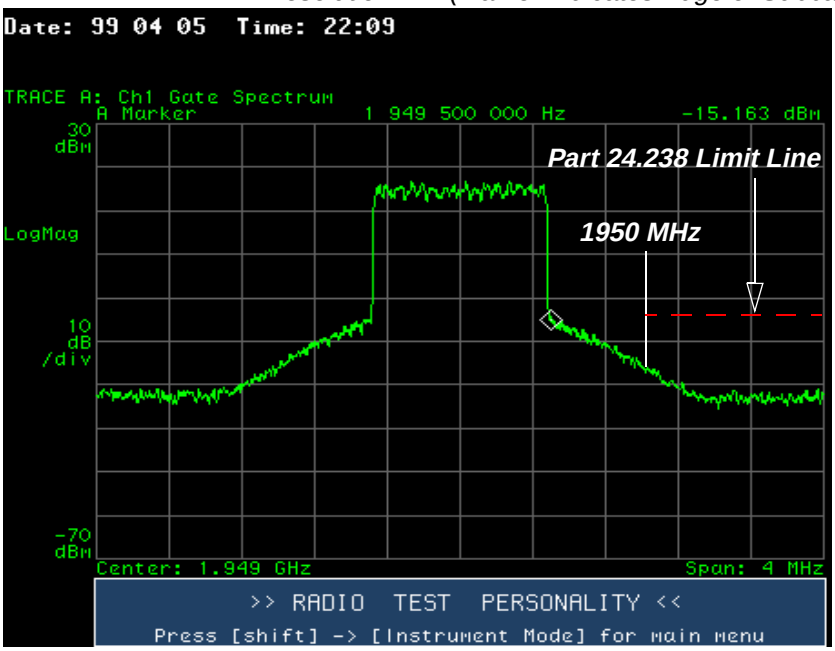



*Figure 11.39 Spectral Purity from 1939.5 MHz to 1946.5 MHz, with Spurious Power Between 1941.5 and 1942.5 MHz Measured in a 1 MHz Bandwidth*

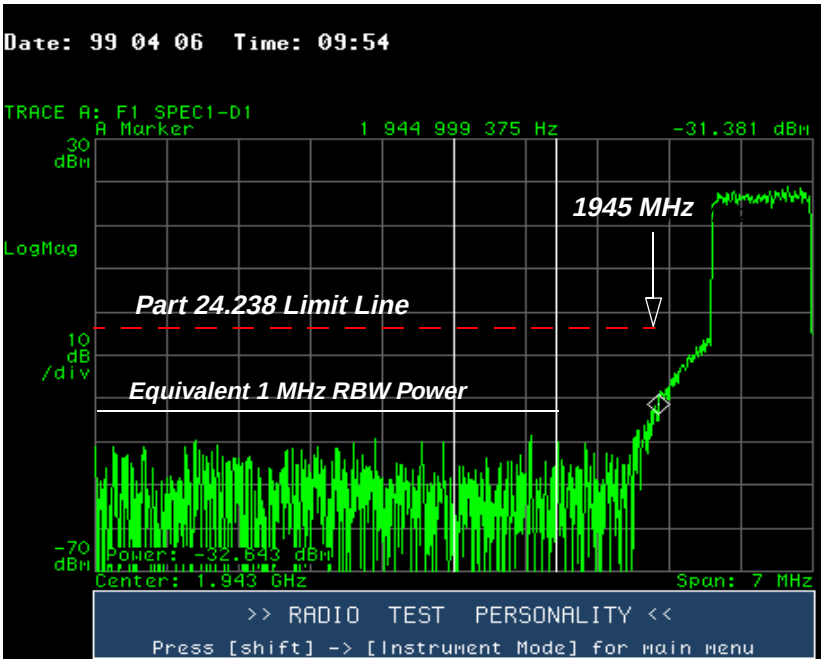


*Figure 11.40 Spectral Purity from 1933 to 1940 MHz, with Spurious Power Measured in a 1 MHz Band-Power Marker Centered on 1937 MHz*

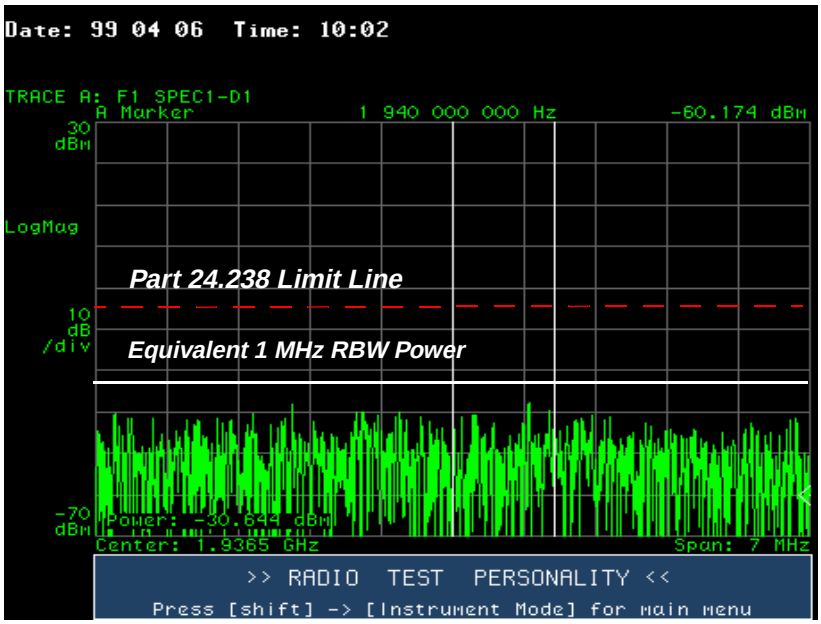



*Figure 11.41 Spectral Purity from 1948.5 MHz to 1855.5 MHz with 1 MHz Band-Power Reference Between 1951 and 1952 MHz*

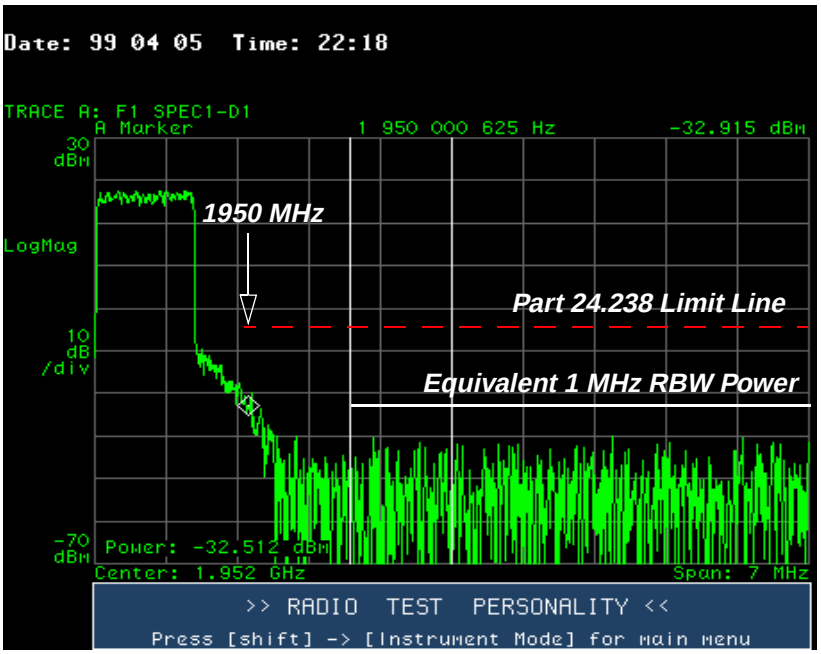
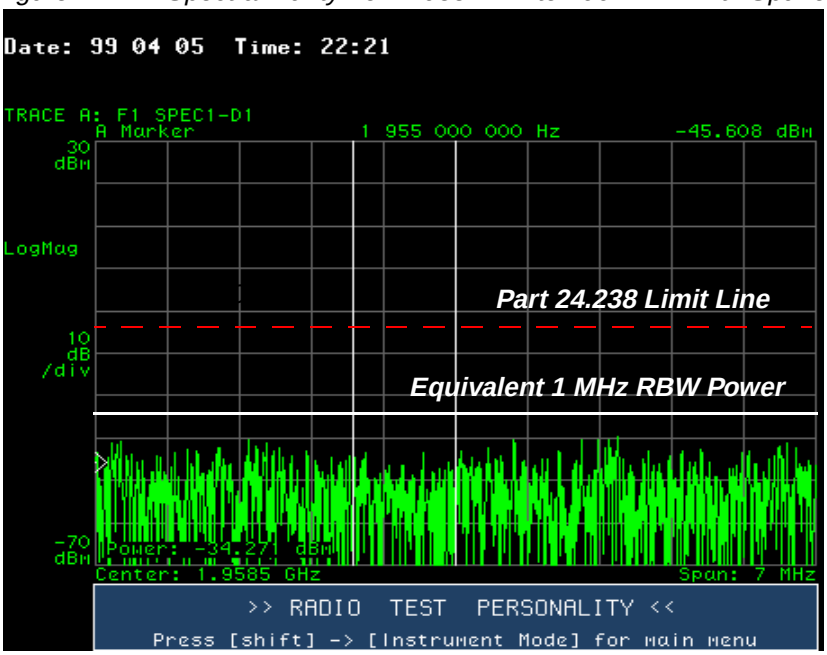


*Figure 11.42 Spectral Purity from 1955 MHz to 1962 MHz with Spurious*




*Power Between 1955.5 and 1956.6 MHz Measured in a 1 MHz Bandwidth*

*Table 11.18—Base Station In-Band and Out-Of-Band Power Summary*

| Parameter | Measured Value | FCC Part 24 Limit |
|---|---|---|
| Total power centered @ 1946 MHz | +33.3 dBm in a 1 MHz BW (+41.0 peak) | +50.0 dBm/ 1MHz RBW |
| Total power centered @ 1947 MHz | -5.8 dBm in a 1 MHz BW | +50.0 dBm/1 MHz RBW |
| Total power centered @ 1948 MHz | -2.8 dBm in a 1 MHz BW | +50.0 dBm/1 MHz RBW |
| Total power centered @ 1949 MHz | +33.9 dBm in a 1 MHz BW (+41.6 peak) | +50.0 dBm/1 MHz RBW |
| Max. guard band spurious power between 1945 and 1945.5 MHz | -17.8 dBm in a 12 kHz RBW @ 1945.5 MHz | +50.0 dBm/1 MHz RBW |
| Max. guard band spurious power between 1949.5 and 1950 MHz | -15.2 dBm in a 12 kHz RBW @ 1949.5 MHz | +50.0 dBm/1 MHz RBW |
| Maximum spurious power between 1944 and 1945 MHz | -31.4 dBm in a 12 kHz RBW @ 1945.0 MHz | -13 dBm/10 kHz RBW |
| Maximum spurious power between 1950 and 1951 MHz | -32.9 dBm in a 12 kHz RBW @ 1950.0 | -13 dBm/10 kHz RBW |
| Maximum spurious power between 1933 and 1940 MHz | -30.6 dBm in a 1 MHz BW | -13 dBm/1 MHz RBW |
| Maximum spurious power between 1939.5 and 1944 MHz | -32.6 dBm in a 1 MHz BW | -13 dBm/1 MHz RBW |
| Maximum spurious power between 1951 and 1956.5 MHz | -32.5 dBm in a 1 MHz BW | -13 dBm/1 MHz RBW |
| Maximum spurious power between 1956 and 1962 MHz | -34.2 dBm in a 1 MHz BW | -13 dBm/1 MHz RBW |

## 11.3 Electromagnetic Compatibility Test Results

This section describes the test results obtained during the validation of the AT&T Wireless Services PWAN Base Station against the applicable requirements of FCC Parts 15 and 24 (Spurious Emissions 5 MHz outside fundamental).

### 11.3.1 Introduction

The purpose of this chapter is to present the test results used to verify FCC regulatory compliance of the PWAN Base Station. The data presented in this chapter are the test results obtained from completing FCC Part 15, radiated and conducted emissions. Additional data representing FCC Part 24 spurious emissions 5 MHz outside the fundamental frequency is also presented. Testing was completed within the FCC regulatory guidelines, including the utilization of ANSI C63.4-1992 standard entitled “American National Standard for Methods of Measurements of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz. Per these standards, all Part 15 emission testing was performed within the FCC accredited 3-meter Anechoic Chamber shown to meet FCC requirements as outlined within subpart 2.948 as referenced in FCC memo 31040/SIT 1300F2.

During testing, the PWAN Base Station was setup and configured as close to actual field installation as possible. The EUT was configured in multiple modes of operation. The following modes were tested per FCC Regulatory Standards:

- Completely loaded sector, (ie. maximum number of TSP and NIF cards)
- 16 voice calls within same time slot (maximum time slot capacity)
- 32 voice calls on single sector
- 32 voice calls, eight voice calls per sector with HSD operation within one sector
- Redundant sector switch
- Various power and NIF cable interface lengths

### 11.3.2 Equipment List

Test cases within this section were completed utilizing the test equipment outlined in Table 11.19. Equipment calibration is completed on a bi-yearly schedule by the Hewlett Packard Company and is monitored by both HP and AT&T Wireless. All calibration material is stored in both hard copy and electronic form, tracking to NIST standards.

*Table 11.19—Emissions Test Equipment*

| Instrument Name | Manufacturer | Model Number | Serial Number | Calibration Last Date | Calibration Due Date |
|---|---|---|---|---|---|
| Semi-anechoic Chamber | Rantec Test Systems | 3-meter semi anechoic | N/A | Shield Test NSA 8/6/99 | 8/6/00 |
| Antenna 1 | EMCO | 3115 | 5515 | 7/2/98 | 7/2/99 |
| Cable 1 | Belden | RG-214/ U, 3 cables (6,14,33) | 1-6-1, 1-14-1, 1-33-1 | 8/6/98 | 8/6/99 |
| Analyzer | Hewlett Packard | 8546A | 3520A00260 | 3/6/99 | 3/6/00 |
| Preselector | Hewlett Packard | 8546A internal | 3330A0010 | 3/6/99 | 3/6/00 |
| QPeak Adapter | Hewlett Packard | internal to RF section | internal | 3/6/99 | 3/6/00 |
| Pre-Amplifier | Hewlett Packard | 8546A internal | internal | 3/6/99 | 3/6/00 |
| Tower 1 | EMCO | 1050 | 1123 | 11/19/98 | 11/19/99 |
| Turntable 1 | EMCO | 1060 | 1049 | 11/19/98 | 11/19/99 |
| Amplifier 1 | HP | 8546A | Internal | 3/6/99 | 3/6/00 |
| Turnable Notch Filter | K & L | 3TNF-1000/2000 -0/0 | 0007 | 11/5/98 | 11/5/99 |
| Cable 2 | Belden | RG-214 | 2-2-2 | 12/2/98 | 12/2/99 |
| Antenna | Chase | CBL6111 A | 1704 | 4/28/99 | 4/28/00 |

*Table 11.19—Emissions Test Equipment (continued)*

| Instrument Name | Manufacturer | Model Number | Serial Number | Calibration Last Date | Calibration Due Date |
|---|---|---|---|---|---|
| Positioner Controller | EMCO | 2090 | 9601-1101 | N/A | N/A |
| EMI Measurement System | Hewlett Packard | 84125C | 4536439012 | 6/15/99 | 6/15/00 |

### 11.3.3 List of Equipment Under Test

Test cases within this section were executed using the equipment under test listed in Table 11.20—.

*Table 11.20—EUT Equipment Under Test*

| Card Name | Serial Number | Revision |
|---|---|---|
| Sync-P | 1999900050 | 1 |
| Sync-R | 1999900056 | 1 |
| TSI-P | 205023 | B |
| TSI-R | 205015 | A |
| NIF-1 | 95222 | B |
| NIF-3 | 95223 | B |
| NIF-6 | 95224 | B |
| NMP | 105012 | C |
| ICP-P | 75023 | C |
| ICP-R | 75024 | C |
| BBC | 15077 | C |

*Table 11.20—EUT Equipment Under Test*

| Card Name | Serial Number | Revision |
|---|---|---|
| NSP | 115115 | D |
| TSP-1 | 215154981204 | C |
| TSP-2 | 215155981204 | C |
| TSP-3 | 215317 | A |
| TSP-4 | 215270 | A |
| TSP-5 | 215246 | A |
| TSP-6 | 215372 | A |
| MODEM | 85006 | A |
| BBC | 15018 | B |
| NSP | 115035 | B |
| TSP | 215123981104 | C |
| MODEM | 85010 | A |
| BBC-R | 15030 | C |
| NSP | 115237 | D |
| TSP | 215328 | A |
| MODEM | 85008 | A |

## 11.3.4 Test Results

### 11.3.4.1—Radiated Emissions

*Table 11.21—FCC Radiated Emission Limits for Class B at 3 Meters*

| Frequency (MHz) | Field Strength (MicroVolts/meter) | Measurement Distance (Meters) |
|---|---|---|
| 30 - 88 | 90 | 10 |
| 88 - 216 | 150 | 10 |
| 216 - 960 | 210 | 10 |
| Above 960 | 300 | 10 |

An FCC approved three meter room was utilized to complete the necessary Part 15, Class A testing. To accomplish this, the radiated emission limits for Class B devices, as shown in Table 11.21, at a three meter distance were extrapolated, proving the Class A three meter

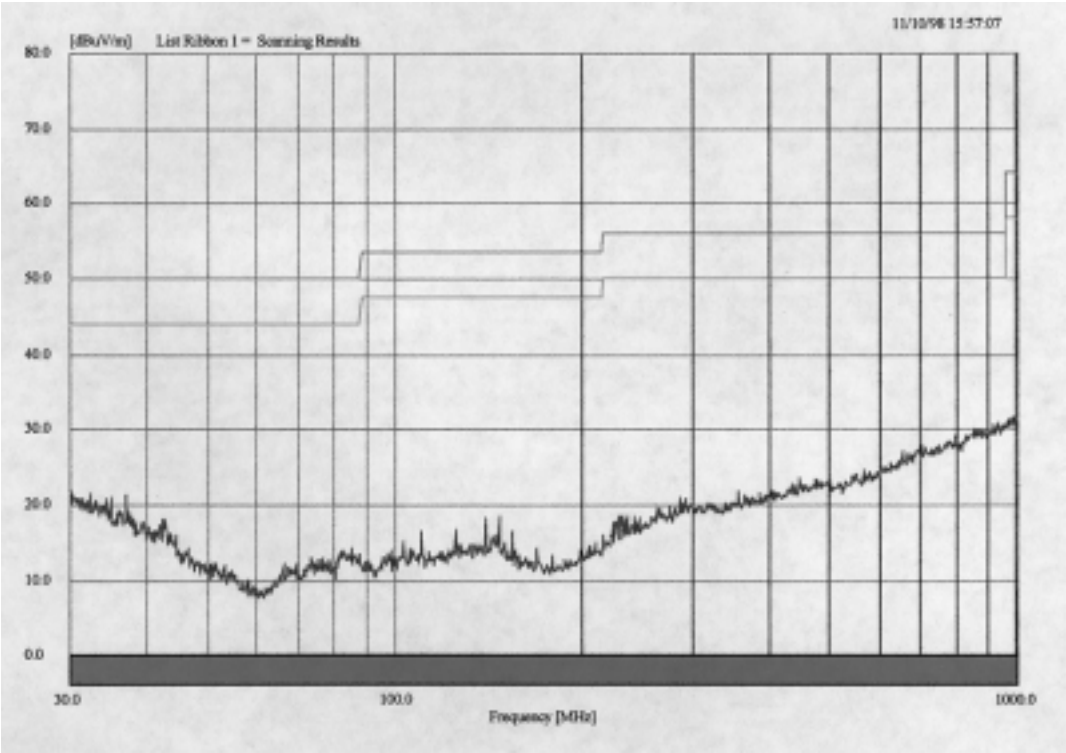
limits as outlined in Table 11.22..

*Table 11.22—FCC Radiated Emission Limits for Class A at 3 Meters*

| Frequency (MHz) | Field Strength (MicroVolts/Meter) | Measurement Distance (Meters) |
|---|---|---|
| 30-88 | 50 | 10 |
| 88-216 | 53.5 | 10 |
| 216-960 | 56.5 | 10 |
| >960 | 60 | 10 |

A measurement of the 3-meter shielded chamber was conducted previous to FCC measurements to establish the chamber ambients. A plot of the chamber's ambient measurement is shown in Figure 11.43.

*Figure 11.43 3-meter Chamber Ambient*



#### 11.3.4.1.1—Applicable FCC Rules

FCC Subpart 15.209 - The level of any unwanted emissions from an intentional radiator operating under these general provisions shall not exceed the field strength levels specified in table 15.209 (a). Emission limits shown in the table below 1000 MHz are based on measurements employing a CISPR quasi-peak detector. Emission limits above 1000 MHz are based on measurements employing an average detector.

#### 11.3.4.1.2—Test Configuration

The radiated emissions testing was performed within an FCC certified 3 Meter semi-anechoic chamber located at 9461 Willows Rd., Redmond, WA within an AT&T Wireless Services facility. Figures 11.44 through Figure 11.83 correspond to the emissions profile of the PWAN Base Station, measured from 30MHz – 26.5GHz in three modes of operation within the following configuration setup: the PWAN Base Station was located within an EMC shield cabinet, with all interface cabling (power, T1's, GPS, RF, etc) entering and exiting through the bottom of the digital cabinet as seen in the typical field configuration. Both cabinets making up the PWAN Base Station (digital and RF) were grounded via a 2 inch wide braid at the outer corners. To accomplish the worst case digital configuration of 16 voice calls located within the same TDMA slot, the upper digital Baseband shelf, sector A, was fully loaded with six TSP cards in order to fully populate the PWAN Base Station.

### 11.3.4.2—Test Results - Configuration 1: 16 Voice Calls on single TDMA Slot

The top horizontal line shown in Figure 11.44 depicts the FCC Class A limit line extrapolated to a 3 Meter test distance. The lower horizontal line indicates the 6 dB margin used during all radiated emission testing. The two peak signals that exceed the 6 dB margin, as shown in Figure 11.44, were further investigated using a quasi-peak detector. The quasi-peak amplitutes are indentified in Table 11.23 and shown in Figure 11.44, denoted by a sideways "X" symbol. As shown on the data plot, the amplitutes of the two signals investigated with a quasi-peak detector, dropped below the 6 dB margin.

*Figure 11.44 30 - 1000 MHz, 16 Calls on Single TDMA Slot*

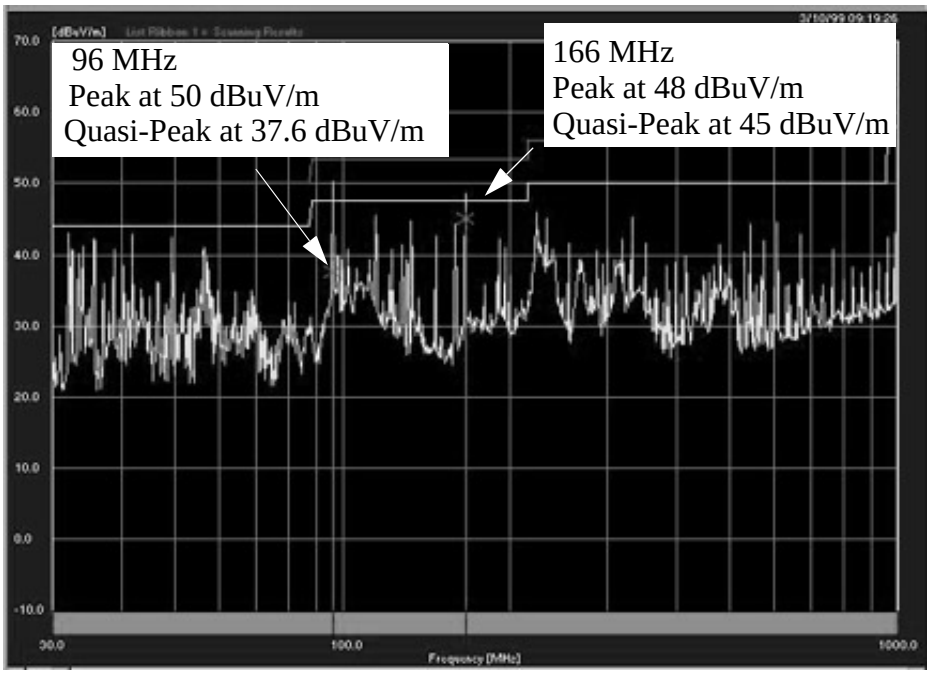



Table 11.23 lists all frequencies that lie above the FCC Class A 6dB margin and is in the following column order: Frequency (in MHz), Peak (the peak amplitude in dBuV/m), Peak Lmt (the peak limit line as compared to the 6dB margin in dBuV/m), DelLim-Pk (delta between the peak reading and the 6-dB margin in dB), QP (quasi-peak reading in dBuV/m), QP Lmt (quasi-peak limit line in dBuV/m), DelLim-QP (delta between the quasi-peak reading and the quasi-peak limit line in dB), Hgt (height of the antenna in cm), Angle (angle of the turntable in degrees), and the Pol (polarity of the antenna at the time of the measurement). As shown in Table 11.23, both frequencies fell below the FCC Class A limit line by –15.90dB and –8.40dB respectively, as shown in the DelLim-QP Column of Table 11.23.

*Table 11.23—30MHz – 1000MHz emissions scan, 16 calls on single TDMA slot*

| Frequency MHz | Peak dBuV/m | Peak LmtDelLim-Pk dBuV/m dB | QP dBuV/m | QP LmtDelLim-QP dBuV/m dB | Hgt cm | Angle deg | Pol |
|---|---|---|---|---|---|---|---|
| 96.014504 | 39.36 | 47.50 -8.14 | 37.60 | 53.50 -15.90 | 135 | 315 | Horz |
| 166.683493 | 46.08 | 47.50 -1.42 | 45.10 | 53.50 -8.40 | 218 | 90 | Horz |

Figure 11.45 corresponds to the emissions profile of the PWAN Base Station (1000MHz – 3500MHz) in the following configuration: the PWAN Base Station is located within the EMC cabinet, all cables (PWR,T1's, GPS, and four RF) exiting through the bottom of the cabinet, two sides grounded with two-inch braid, as well as a fully loaded Baseband A shelf (six TSP cards were necessary) in order to fully populate the base with 16 calls on the same TDMA slot.

The first group of signals shown in Figure 11.45 corresponds to the Radio Transciever Shelf's local oscillators, as shown in Figure 11.47. The second set of signals in Figure 11.45 corresponds to the PWAN Base authorized transmit frequencies, and the third group corresponds to time variant noise for the PWAN Base. The time variant noise within the Base were within the noise floor of the receiver during average detector measurements.

*Figure 11.45 1000MHz – 3500MHz emissions scan, 16 calls on single TDMA slot*

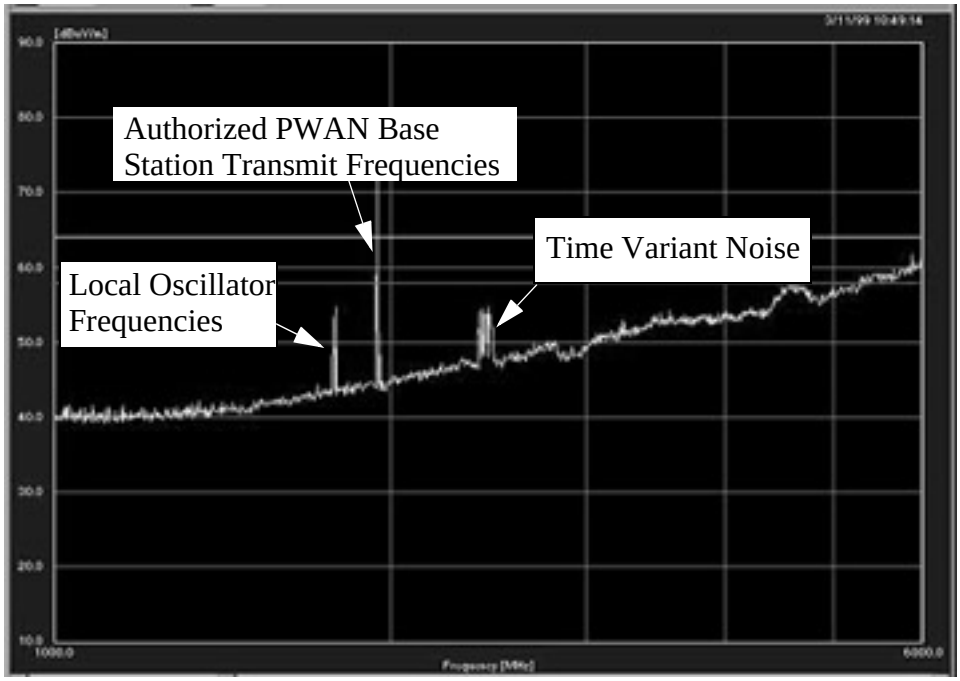



Figure 11.46 is the average emissions scan (as indicated with dashes) of the PWAN Base Station in the same configuration as Figure 11.45. Note that all groups of signals (except for the Base Transmit frequencies) drop well below the FCC Class A limit line.

*Figure 11.46 1000MHz – 3500MHz average emissions scan, 16 calls on single time slot*

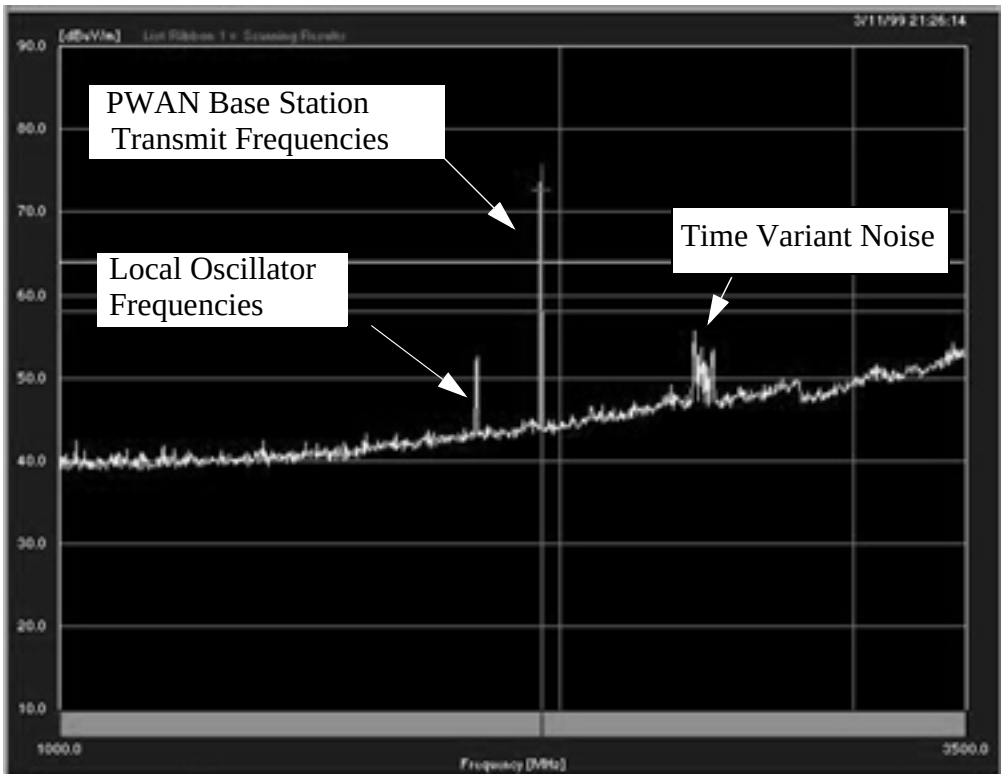



Figure 11.47 is a narrow span of the first set of signals shown in Figures 11.44 – 11.46. Note that the PWAN Base Station is still in the same configuration (16 calls on the same TDMA slot) and that the fourth peak (1.783MHz) out of the three corresponds to the particular LO of sector A being loaded by the 16 calls. Also note that all four frequencies lie below the FCC Class A 6dB margin of the limit line.

*Figure 11.47 7MHz span of the local oscillators shown in Fig 11.46*

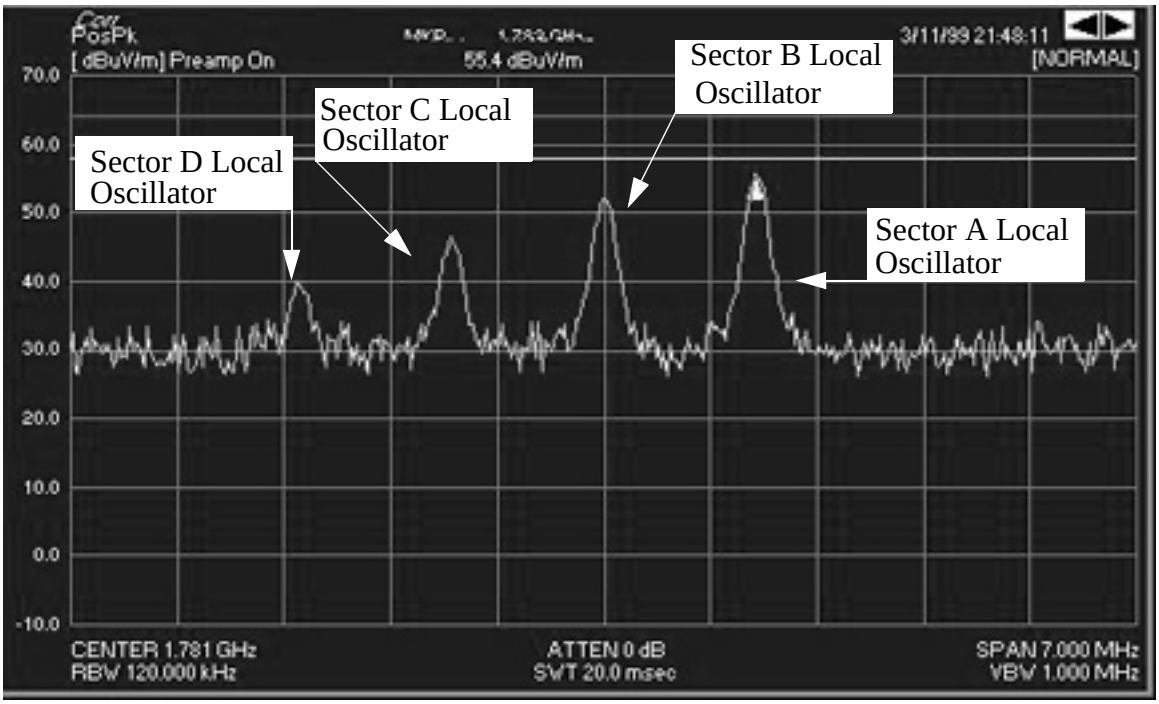



Figure 11.48 is the PWAN Base Station radiated emissions scan (3.5GHz – 18GHz) in the vertical polarization at a 1 meter antenna height. The PWAN Base Station was loaded with 16 calls on the same TDMA slot continuously throughout the duration of the test. The marker at 3.55GHz (61.17dBuV/m) is investigated as shown in Figure 11.49.

*Figure 11.48 3.5GHz – 18GHz @1m antenna height emissions scan, Vertical polarization, 16 calls, same TDMA slot*

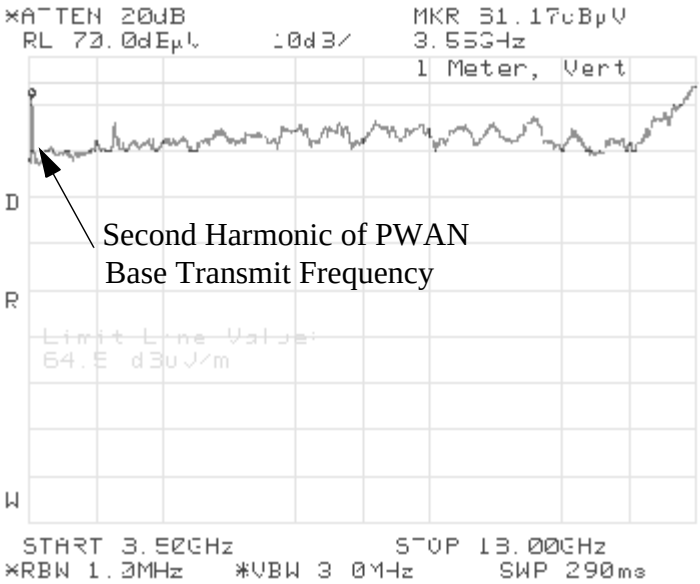



Figure 11.49 is a narrow band radiated emissions scan of the marked frequency in Figure 11.48. Note that the amplitude of 60.50 dBuV/m falls below the FCC Class A radiated emissions limit line. Furthermore, an average measurement was taken but proved to change the amplitude of the signal very little (not shown).

*Figure 11.49 1 MHz span at 3.56GHz @1m antenna height, Vertical polarization*

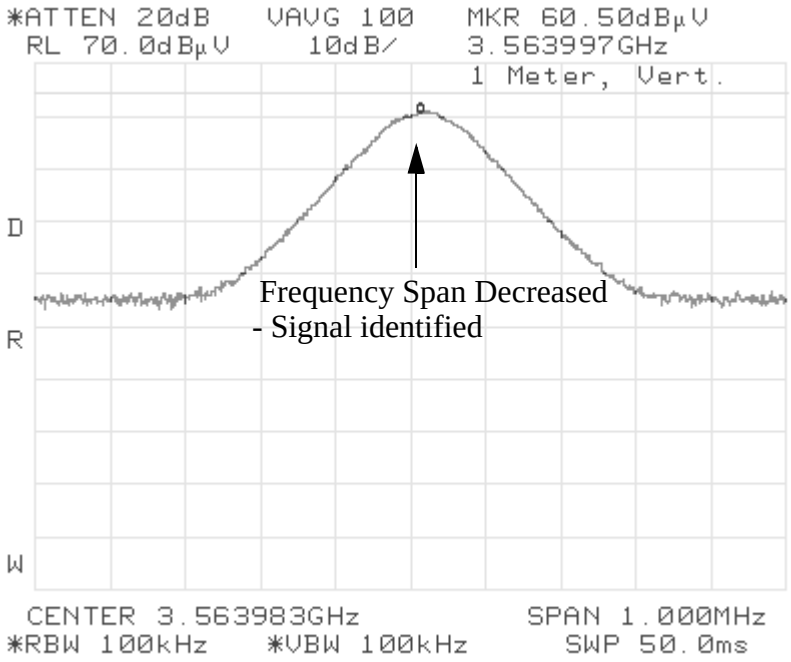



Figure 11.50 identifies the PWAN Base Station radiated emissions data (3.5 GHz - 18 GHz) in the horizontal polarization at a 1 meter antenna height. The PWAN Base Station was loaded with 16 calls on the same TDMA slot continuously throughout the duration of the test.

*Figure 11.50 3.5GHz – 18GHz @1m antenna height emissions scan, Horizontal polarization,16 calls, same TDMA slot*

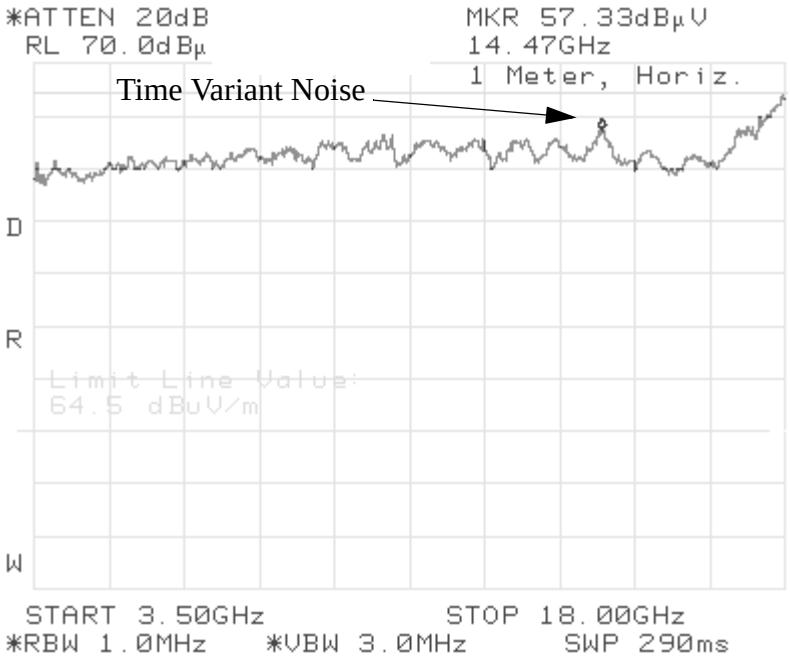



Figure 11.51 identifies the PWAN Base Station radiated emissions data (3.5 GHz - 18 GHz) in the vertical polarization at a 1.4 meter antenna measurement height. The PWAN Base Station was loaded with 16 calls on the same TDMA slot continuously throughout the duration of the test.

*Figure 11.51 3.5GHz – 18GHz @1.4m antenna height emissions scan, Vertical polarization, 16 calls, same TDMA slot*

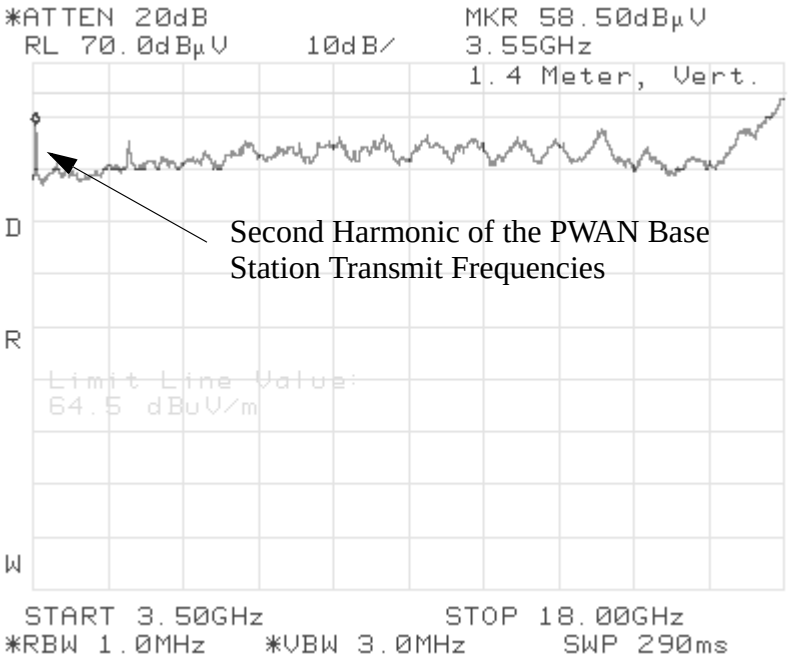



Figure 11.52 is a narrow band radiated emissions scan of the marked frequency in Figure 11.51. Note that the amplitude of 54.67dBuV/m falls below the FCC Class A radiated emissions limit line. Furthermore, an average measurement was taken but proved to change the amplitude of the signal very little (not shown).

*Figure 11.52 2 MHz span at 3.56GHz @1.4m antenna height, Vertical polarization, 16 calls, same TDMA slot*

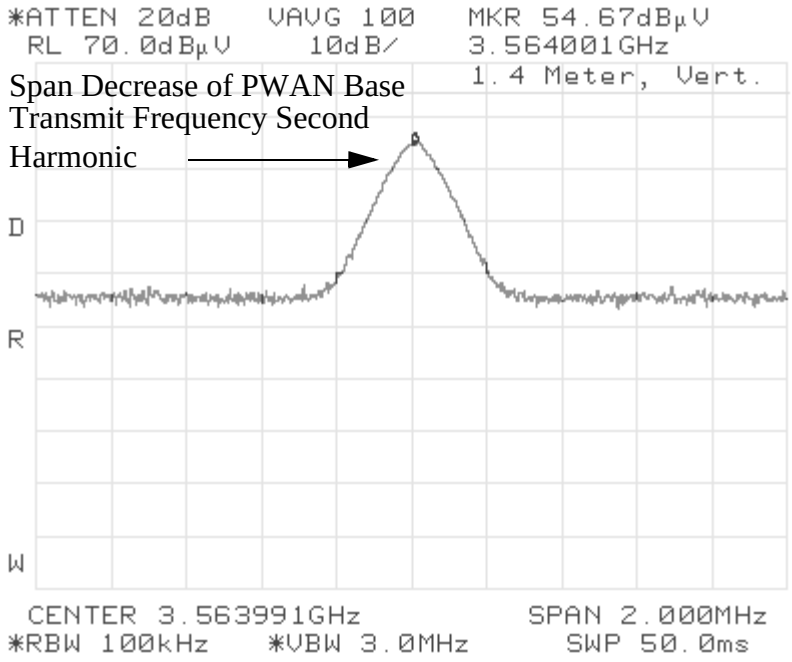



Figure 11.53 is a narrow band radiated emissions scan of the second highest frequency in Figure 11.51. Note that the amplitude of 47.50dBuV/m falls below the FCC Class A radiated emissions limit line. Furthermore, an average measurement was taken but proved to change the amplitude of the signal very little (not shown).

*Figure 11.53 1 MHz span at 5.38GHz @1.4m antenna height, Vertical polarization, 16 calls, same TDMA slot*

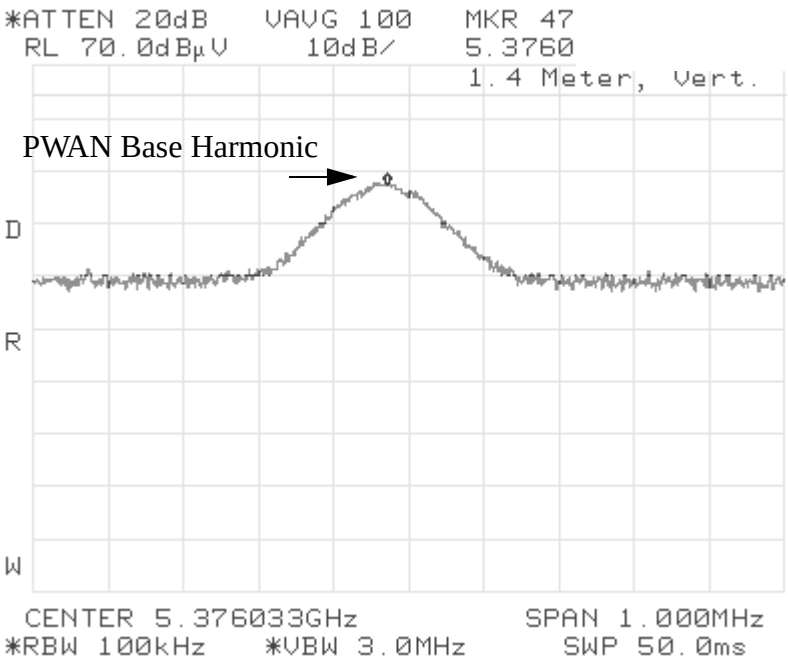



Figure 11.54 identifies the PWAN Base Station radiated emissions data from 3.5 GHz to 18 GHz in the horizontal polarization at an antenna hieght of 1.4 meters. The PWAN Base Station was loaded with 16 calls on the same TDMA slot continuously throughout the duration of the test.

*Figure 11.54 3.5GHz – 18GHz @1.4m antenna height emissions scan, Horizontal polarization, 16 calls, same TDMA slot*

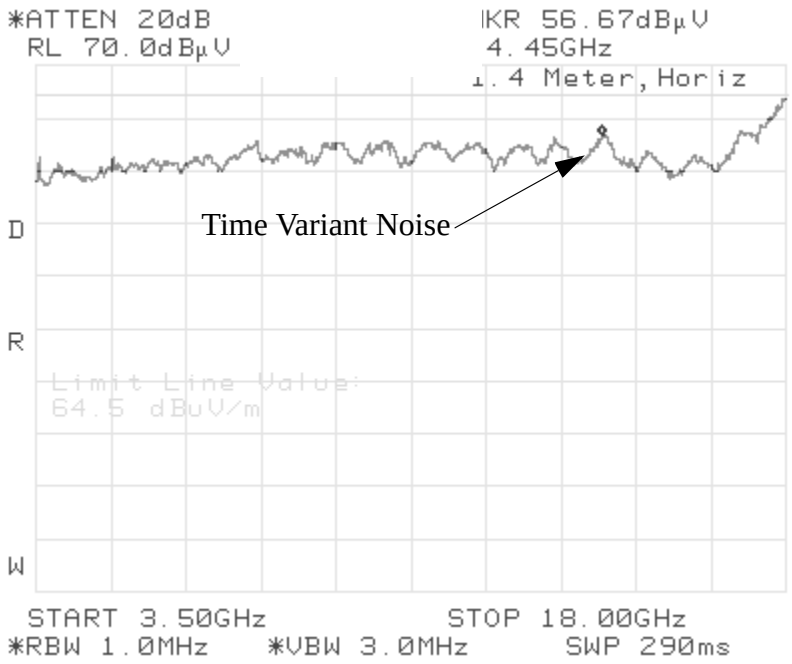



Figure 11.55 identifies the PWAN Base Station radiated emissions data from 3.5 GHz to 18 GHz in the vertical polarization at an antenna hieght of 1.8 meters. The PWAN Base Station was loaded with 16 calls on the same TDMA slot continuously throughout the duration of the test. The marked signal at 3.57GHz (54.17dBuV/m) is investigated in Figure 11.56.

*Figure 11.55 3.5GHz – 18GHz @1.8m antenna height emissions scan, Vertical polarization, 16 calls, same TDMA slot*

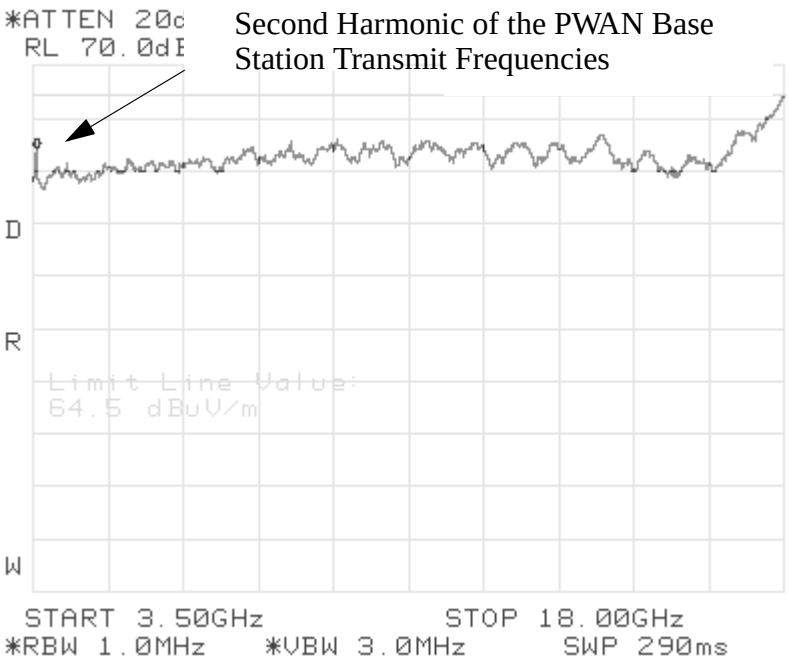



Figure 11.56 is a narrow band radiated emissions scan of the marked frequency in Figure 11.55. Note that the amplitude of 52.17dBuV/m falls below the FCC Class A radiated emissions limit line. Furthermore, an average measurement was taken but proved to change the amplitude of the signal very little (not shown).

*Figure 11.56 1 MHz span at 3.58GHz @1.8m antenna height, Vertical polarization, 16 calls, same TDMA slot*

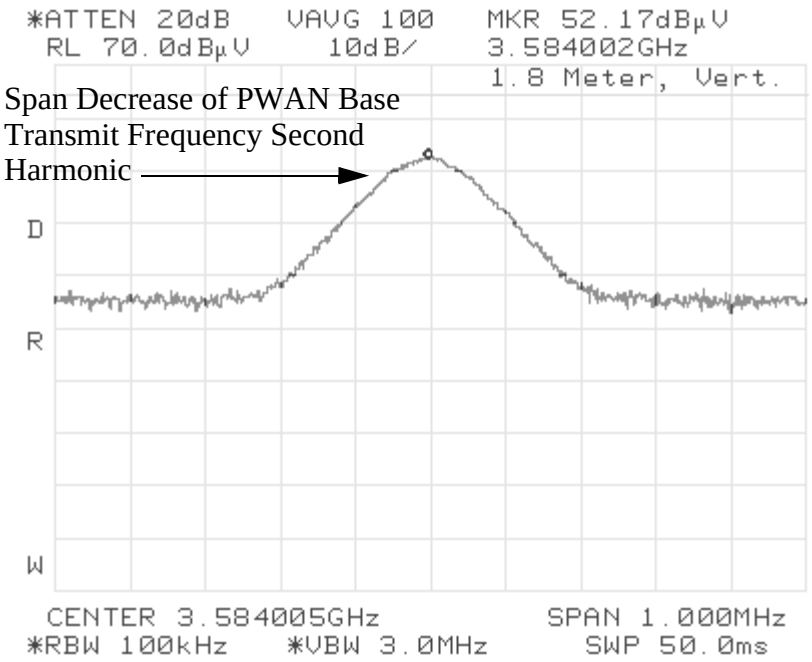



Figure 11.57 is the PWAN Base Station radiated emissions data from 3.5 GHz to 18 GHz in the horizontal polarization at an antenna hieght of 1.8 meters.. The PWAN Base Station was loaded with 16 calls on the same TDMA slot continuously throughout the duration of the test.

*Figure 11.57 3.5GHz – 18GHz @1.8m antenna height emissions scan, Horizontal polarization, 16 calls, same TDMA slot*

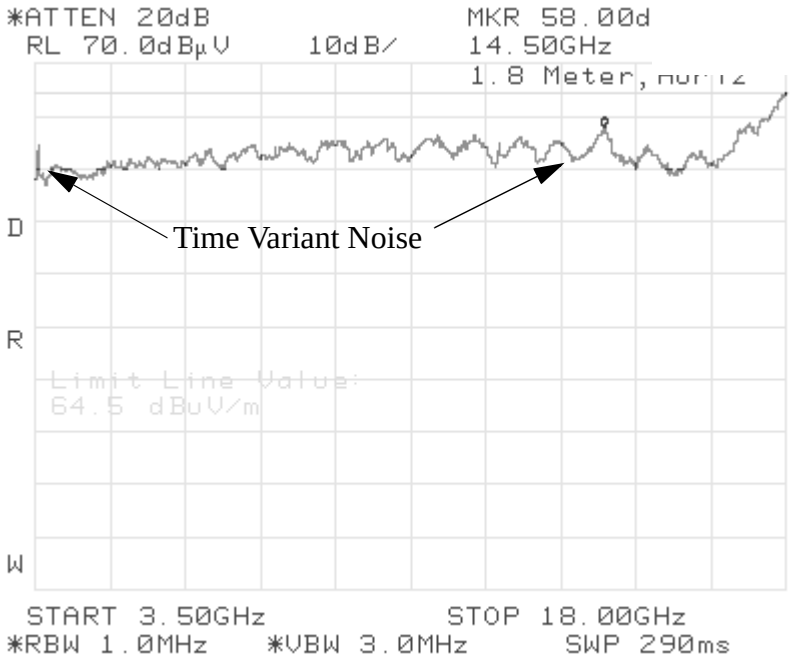



Figure 11.58 indentifies the PWAN Base Station radiated emissions data from 18 GHz to 26.5 GHz in the vertical polarization at an antenna hieght of 1 meter. The PWAN Base Station was loaded with 16 calls on the same TDMA slot continuously throughout the duration of the test.

The marker at 25.027GHz (59.50dBuV/m) is the noise floor of the HP 84300A E62 Microwave EMI test system

*Figure 11.58 18.00GHz – 26.50GHz @1m antenna height emissions scan, Vertical polarization, 16 calls, same TDMA slot*

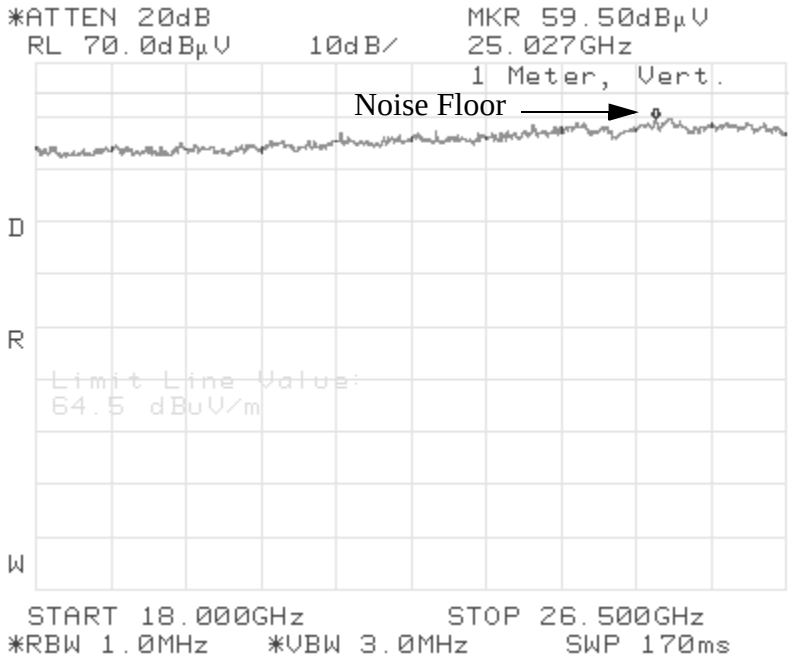



FIgure 11.59 identifies the PWAN Base Station radiated emissions data from 18 GHz to 26.5 GHz in the horizontal polarization at an antenna hieght of 1 meter. The PWAN Base Station was loaded with 16 calls on the same TDMA slot continuously throughout the duration of the test.

The marker at 25.296GHz (60.17dBuV/m) is the noise floor of the HP 84300A E62 Microwave EMI test system.

*Figure 11.59 18.00GHz – 26.50GHz @1m antenna height emissions scan, Horizontal polarization, 16 calls, same TDMA slot*

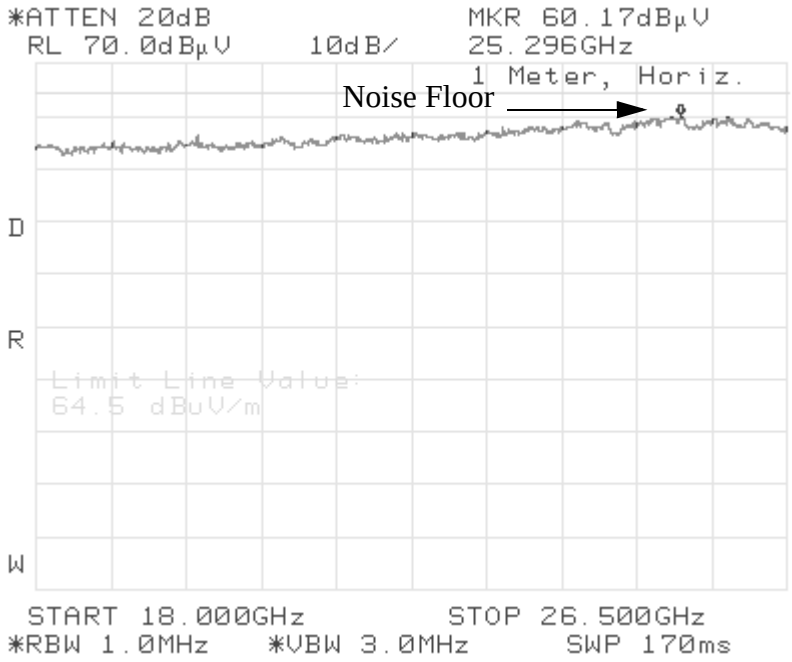



FIgure 11.60 identifies the PWAN Base Station radiated emissions data from 18 GHz to 26.5 GHz in the vertical polarization at an antenna hieght of 1.4 meter. The PWAN Base Station was loaded with 16 calls

on the same TDMA slot continuously throughout the duration of the test. The marker at 25.565GHz (57.50dBuV/m) is the noise floor of the HP 84300A E62 Microwave EMI test system.

*Figure 11.60 18.00GHz – 26.50GHz @1.4m antenna height emissions scan, Vertical polarization, 16 calls, same TDMA slot*

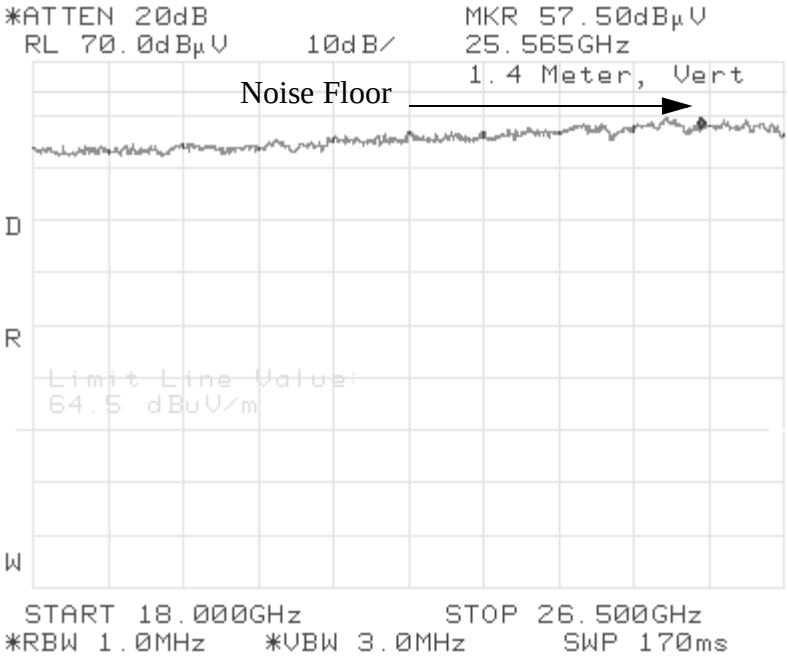



Figure 11.61 identifies the PWAN Base Station radiated emissions data from 18.00GHz – 26.50GHz in the horizontal polarization at an

antenna height of 1.4 meters. The PWAN Base Station was loaded with 16 calls on the same TDMA slot continuously throughout the duration of the test. The marker at 25.565GHz (59.50dBuV/m) is the noise floor of the HP 84300A E62 Microwave EMI test system.

*Figure 11.61 18.00GHz – 26.50GHz @1.4m antenna height emissions scan, Horizontal polarization, 16 calls, same TDMA slot*

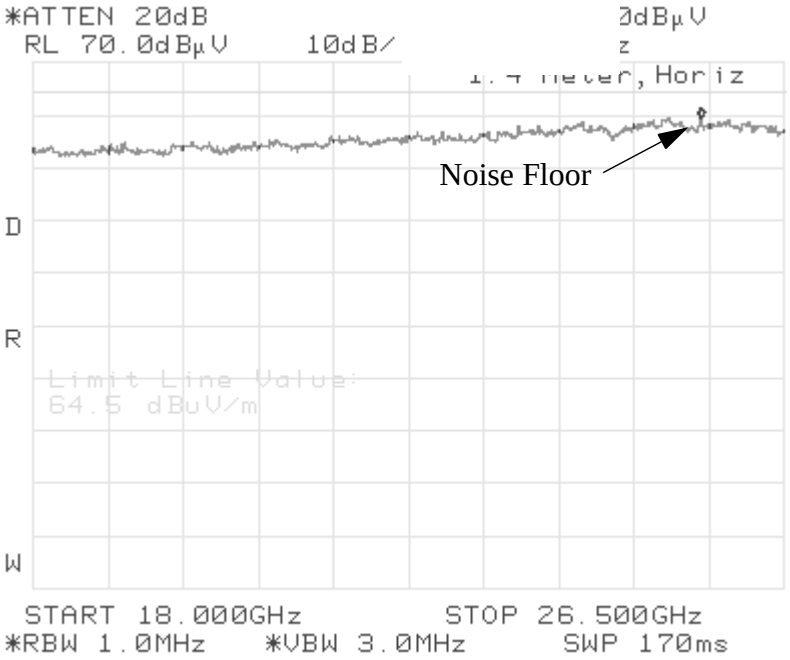


FIgure 11.62 identifies the PWAN Base Station radiated emissions data from 18 GHz to 26.5 GHz in the vertical polarization at an antenna hieght of 1.8 meters. The PWAN Base Station was loaded with 16 calls on the same TDMA slot continuously throughout the duration of the test. The marker at 25.14GHz (58.83dBuV/m) is the noise floor of the HP 84300A E62 Microwave EMI test system.

*Figure 11.62 18.00GHz – 26.50GHz @1.8m antenna height emissions scan, Vertical polarization, 16 calls, same TDMA slot*

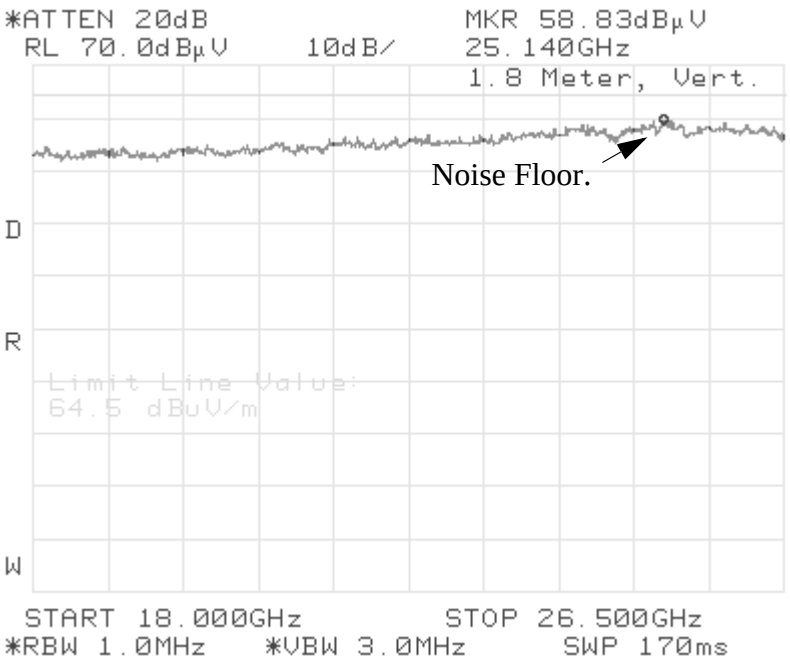
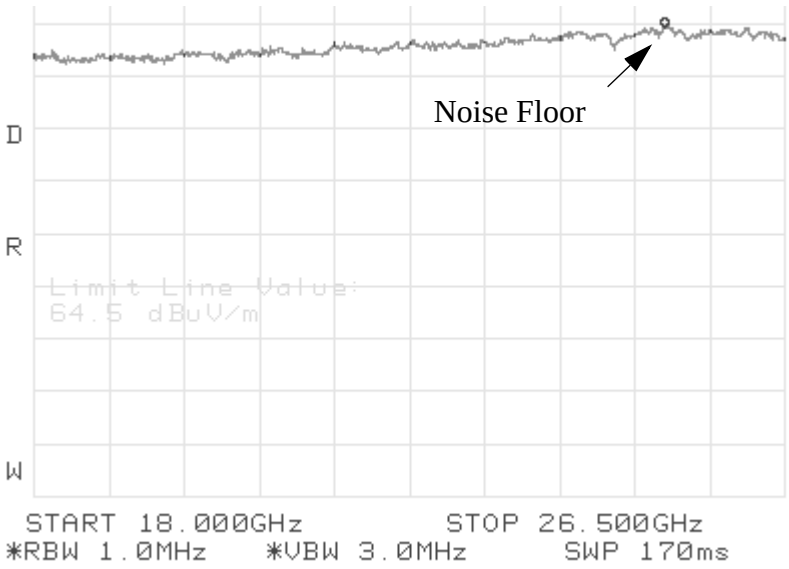


FIgure 11.63 identifies the PWAN Base Station radiated emissions data from 18 GHz to 26.5 GHz in the horizontal polarization at an antenna hieght of 1.8 meters. The PWAN Base Station was loaded with 16 calls on the same TDMA slot continuously throughout the duration of the test. The marker at 25.14GHz (59.17dBuV/m) is the noise floor of the HP 84300A E62 Microwave EMI test system.

*Figure 11.63 18.00GHz – 26.50GHz @1.8m antenna height emissions scan, Horizontal polarization, 16 calls, same TDMA slot*



### 11.3.4.3—Test Results—Configuration 2: Eight Voice Calls on each of four sectors

The radiated emissions testing was performed within an FCC certified 3 Meter chamber located at 9461 Willows Rd., Redmond, WA within an AT&T Wireless Facility. Figures 11.64 through 11.82 corresponds to the radiated emissions profile of the PWAN Base Station (30MHz – 26.5 GHz) in the following configuration: the PWAN Base Station is located within the EMC cabinet, all cables (PWR, T1's, GPS, and four RF) exiting through the bottom of the cabinet, two sides grounded with two-inch braid, eight calls per sector are loading the PWAN Base Station throughout the duration of the test.

The top horizontal line shown in Figure 11.64 depicts the FCC Class A limit line extrapolated to a 3 meter test distance. The lower horizontal line indicates the 6dB margin used during emissions testing. Five peak signals that exceeded the 6dB margin, as shown in Figure 11.64, were further investigated using a quasi-peak detector and are labeled in Table 11.24. The quasi-peak amplitudes are identified in table 11.24 and shown in Figure 11.64 denoted by a sideways <X> symbol. As shown in Figure 11.64 the amplitudes of the five investigated signals were below the FCC 6dB limit line.

*Figure 11.64 30MHz – 1000MHz emissions scan, 8 calls per sector*

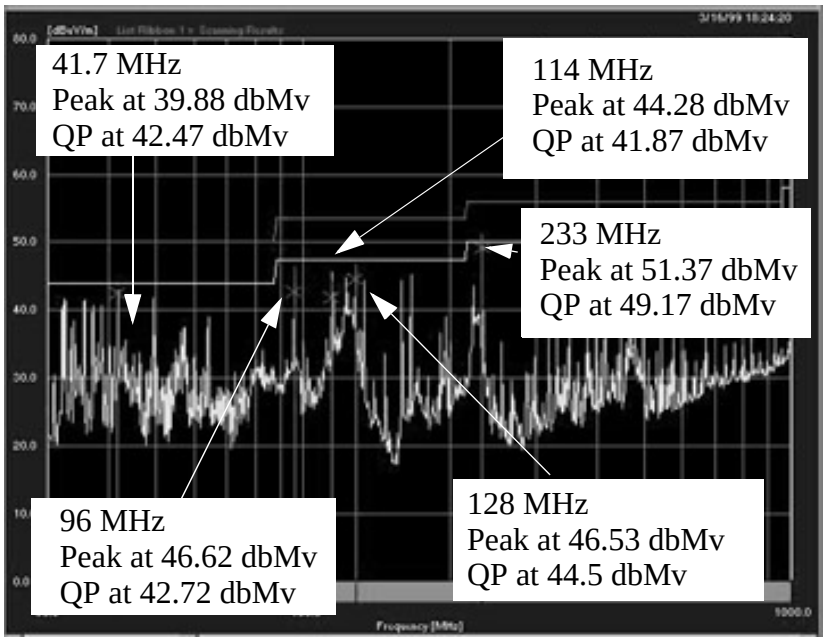


Table 11.24 lists all detected signal above the FCC class A 6 dB margin and, as shown, all frequencies fell below the FCC Class A limit.

*Table 11.24—30MHz – 1000MHz emissions scan, 8 calls per sector*

| Frequency (MHZ) | Peak (dBuV/m | DelLim-Pk (dB) | QP (dBuV/m) | Hgt (cm) | Angle (deg) | Pol |
|---|---|---|---|---|---|---|
| 41.702917 | 39.88 | -10.12 | 42.47 | 100 | 203 | Vert |
| 96.017296 | 46.62 | -6.88 | 42.72 | 160 | 111 | Vert |
| 114.708080 | 44.28 | -9.22 | 41.87 | 185 | 60 | Vert |
| 128.005863 | 46.53 | -6.97 | 44.50 | 100 | 88 | Vert |
| 233.351248 | 51.37 | -4.63 | 49.17 | 104 | 90 | Vert |

Figure 11.65 is the radiated emissions scan from 1000MHz -3500 MHz. The first detected peak signal shown in Figure 11.65 corresponds to the PWAN Base Station's RF Transceiver shelf's local oscillators (see Fig. 11.66). The second detected peak signal corresponds to the PWAN Base Stations transmit frequencies, and the third group of peak signals corresponds to time variant noise from the PWAN Base Station.

*Figure 11.65 1000MHz – 3500MHz emissions scan, 8 calls per sector*

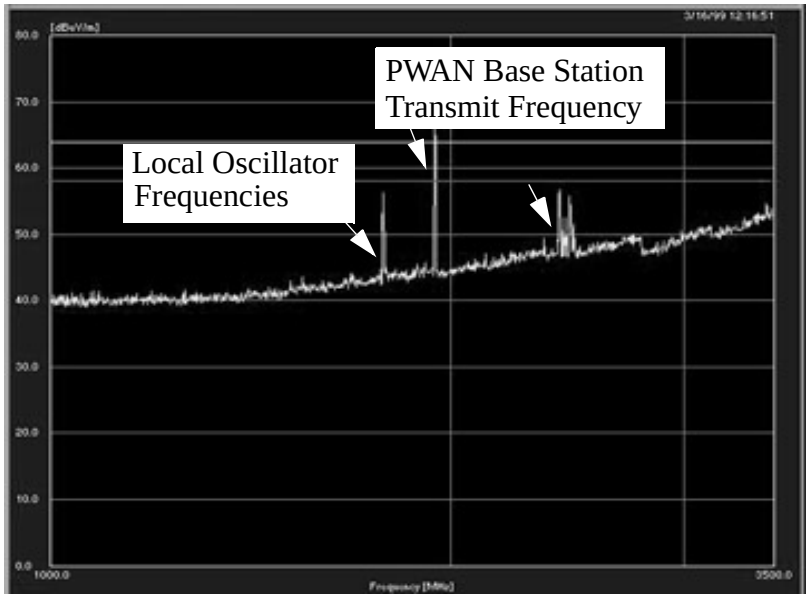


Figure 11.66 is a narrow span of the first peak detected signal shown in Figure 11.65. Note that all four frequencies lie below the FCC Class A 6dB limit line.

*Figure 11.66 7MHz span of the first peak detected shown in Fig. 11.65*

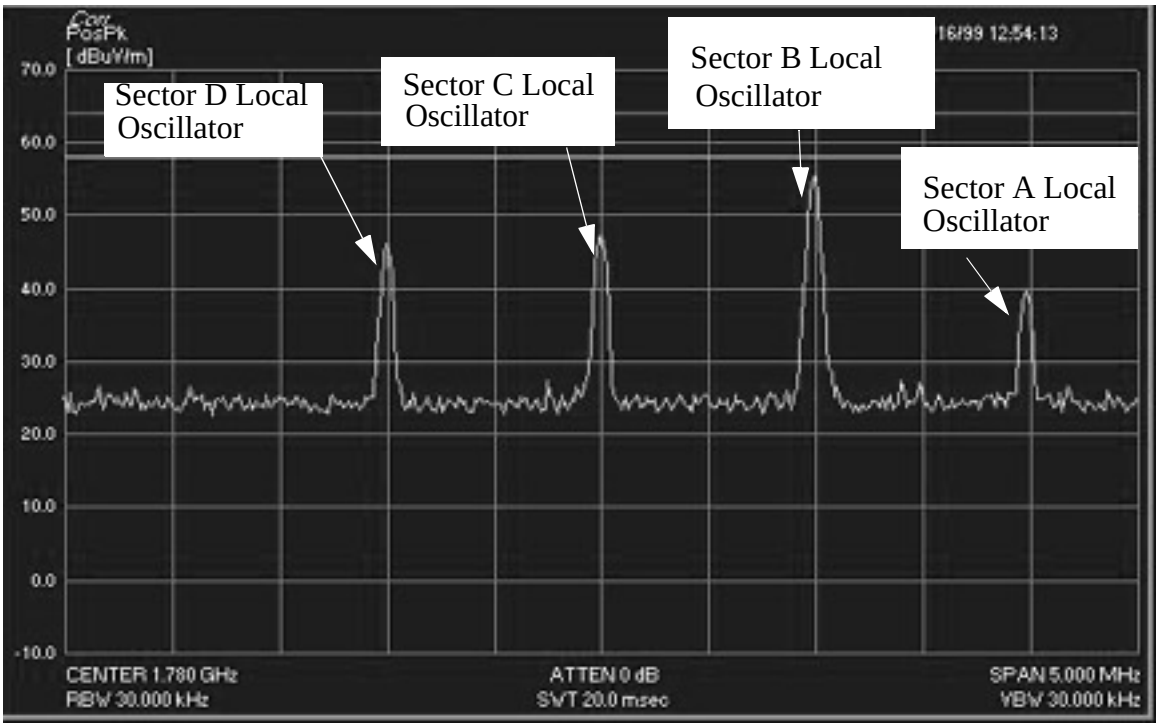


Figure 11.67 identifies the PWAN Base Station radiated emissions scan 3.5GHz – 18GHz in the vertical polarization at 1 meter. The PWAN Base Station was loaded with eight calls per sector continuously throughout the duration of the test. The marker at 3.55GHz (63.50dBuV/m) is investigated as shown in Figure 11.68.

*Figure 11.67 3.5GHz – 18GHz @1m antenna height emissions scan, Vertical polarization, 8 calls per sector*

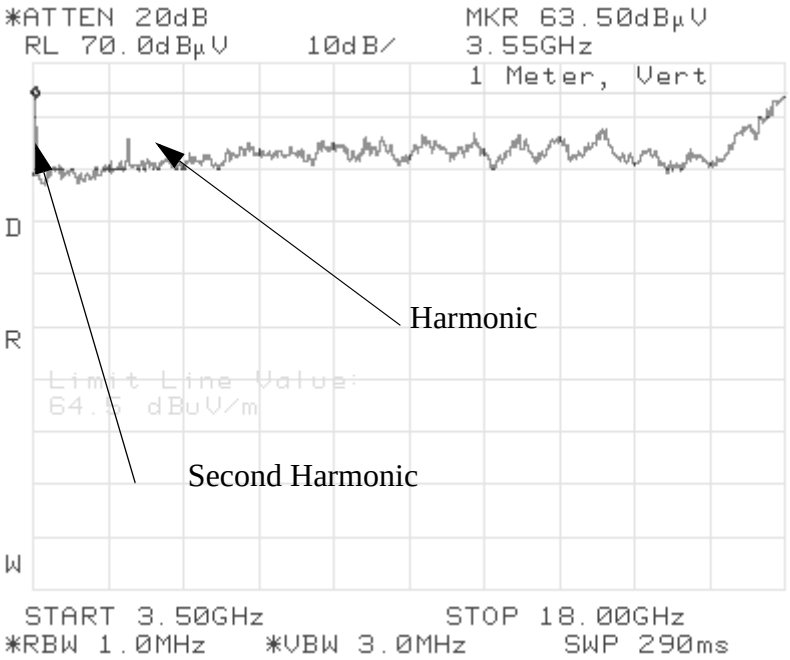


Figure 11.68 is a narrow band emissions scan of the marked frequency in Figure 11.67. Note that the amplitude of 64.11 dBuV/m falls below the FCC Class A emissions limit line. An average measurement was taken and shown in Figure 11.69.

*Figure 11.68 10MHz span at 3.56GHz @1m antenna height, Vertical polarization*

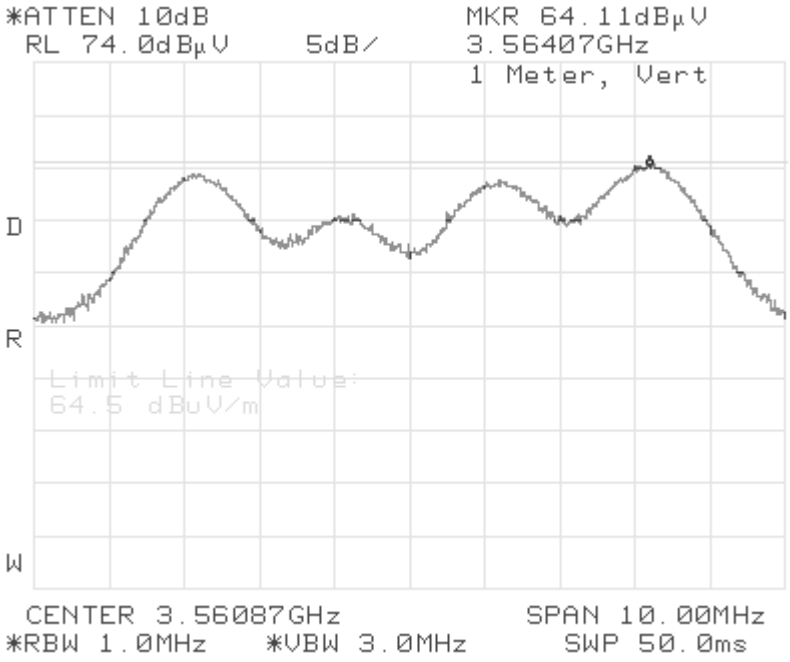


Figure 11.69 is the average measurement of the marked frequency in Figure 11.67, in the horizontal polarization. The PWAN Base Station was loaded with eight calls per sector continuously throughout the duration of the test.

*Figure 11.69 Average measurement of the marked frequency in Figure 11.68, 1m antenna height, Horizontal polarization, eight calls per sector.*

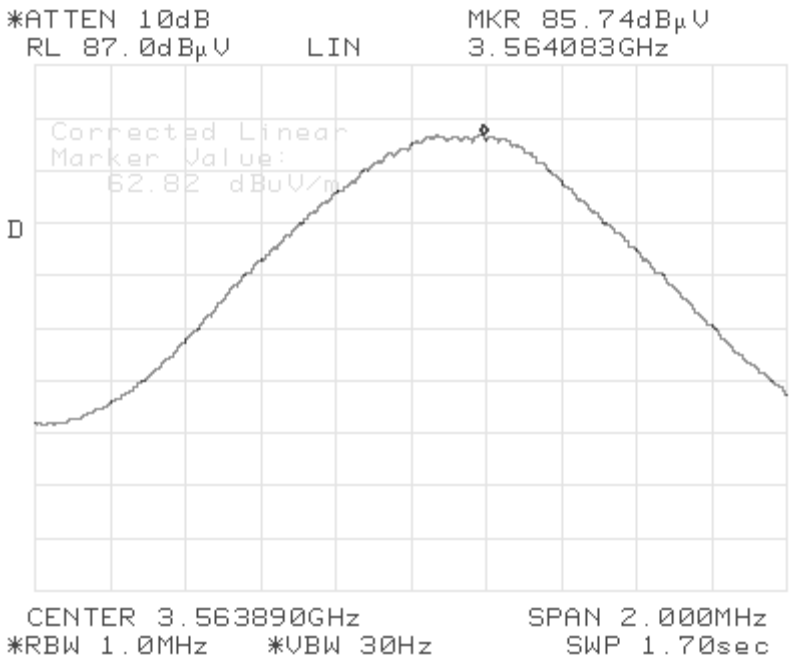


Figure 11.70 is a narrow band emissions scan of the second highest frequency in Figure 11.67. Note that the amplitude of 58.42 dBuV/m falls below the FCC Class A emissions limit line.

*Figure 11.70 10MHz span at 5.343GHz, @1m antenna height, Vertical polarization*

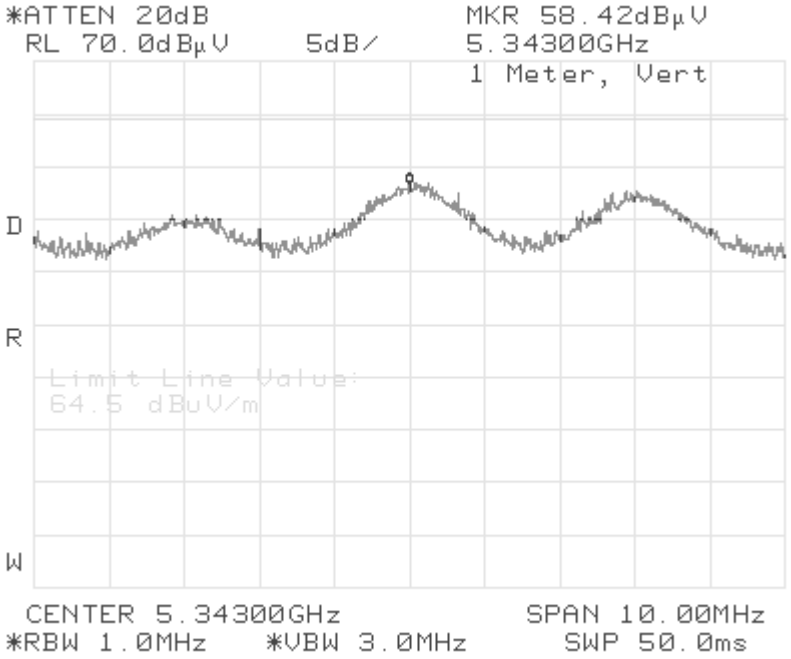


Figure 11.71 identifies the PWAN Base Station radiated emissions scan 3.5GHz – 18GHz in the horizontal polarization. The PWAN Base Station was loaded with eight calls per sector throughout the duration of the test. The marker at 3.55GHz (54.83dBuV/m) is investigated as shown in Figure 11.72.

*Figure 11.71 3.5GHz – 18GHz @1m antenna height emissions scan, Horizontal polarization, eight calls per sector.*

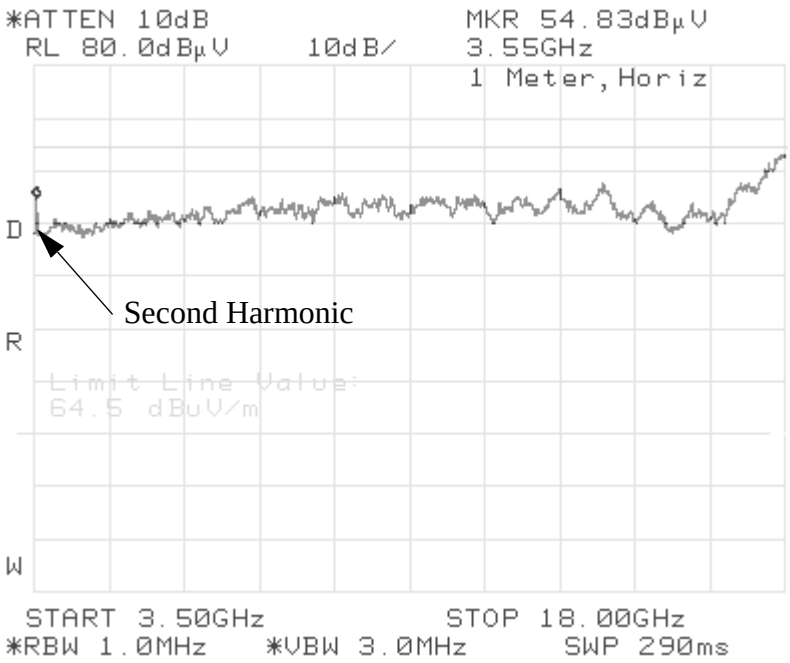


Figure 11.72 is a narrow band emissions scan of the marked frequency in Figure 11.71. Note that the amplitude of 55.53 dBuV/m falls below the FCC Class A emissions limit line. An average measurement was taken but proved to change the amplitude of the signal very little (not shown).

*Figure 11.72 10MHz span at 3.56GHz @1m antenna height, Horizontal polarization, eight calls per sector*

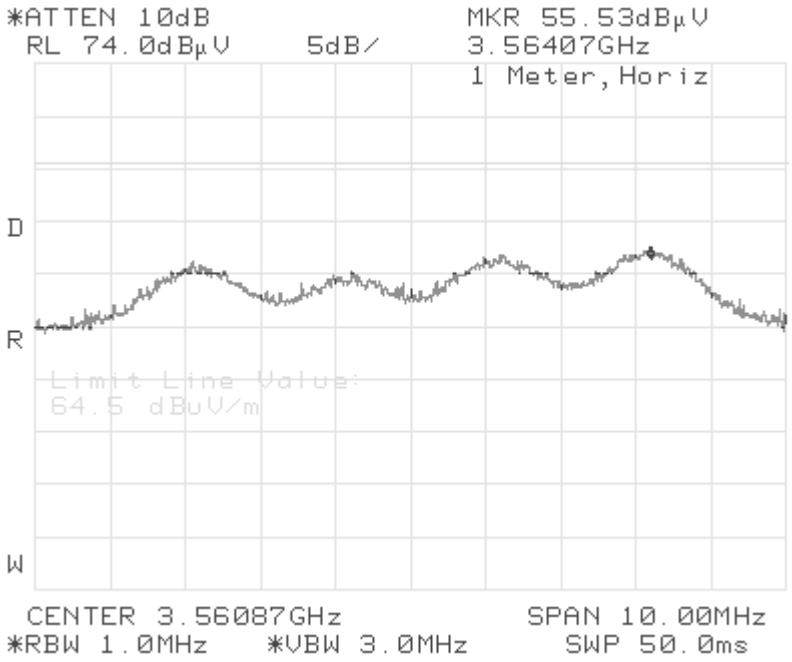


Figure 11.73 identifiess the PWAN Base Station radiated emissions scan 3.5GHz – 18GHz in the vertical polarization at an antenna height of 1.4 meters. The PWAN Base Station was loaded with eight calls per sector continuously throughout the duration of the test.

*Figure 11.73 3.5GHz – 18GHz @1.4m antenna height emissions scan, Vertical polarization, eight calls per sector*

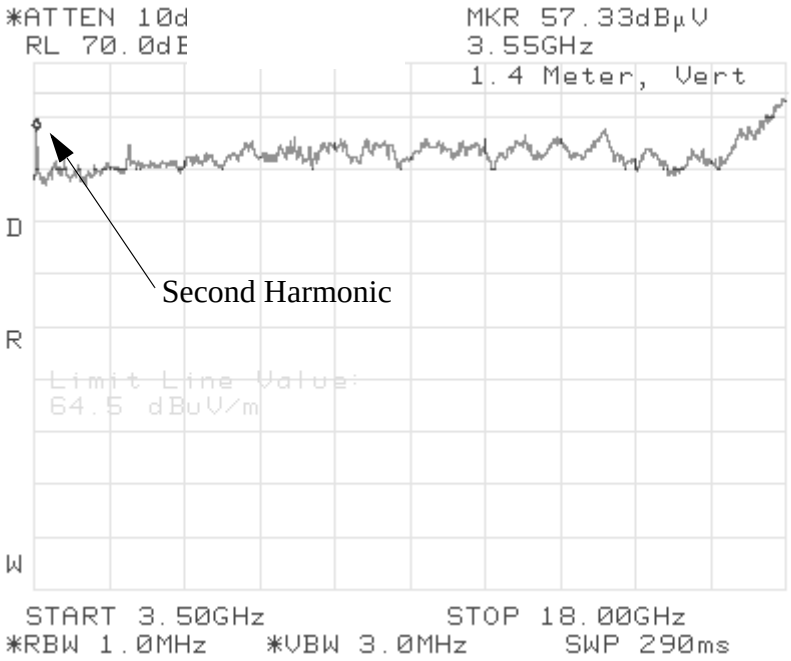


Figure 11.74 identifies the PWAN Base Station radiated emissions scan 3.5GHz – 18GHz in the horizontal polarization at an antenna height of 1.4 meters. The PWAN Base Station was loaded with eight calls per sector continuously throughout the duration of the test.

*Figure 11.74 3.5GHz – 18GHz @1.4m antenna height emissions scan, Horizontal polarization, eight calls per sector*

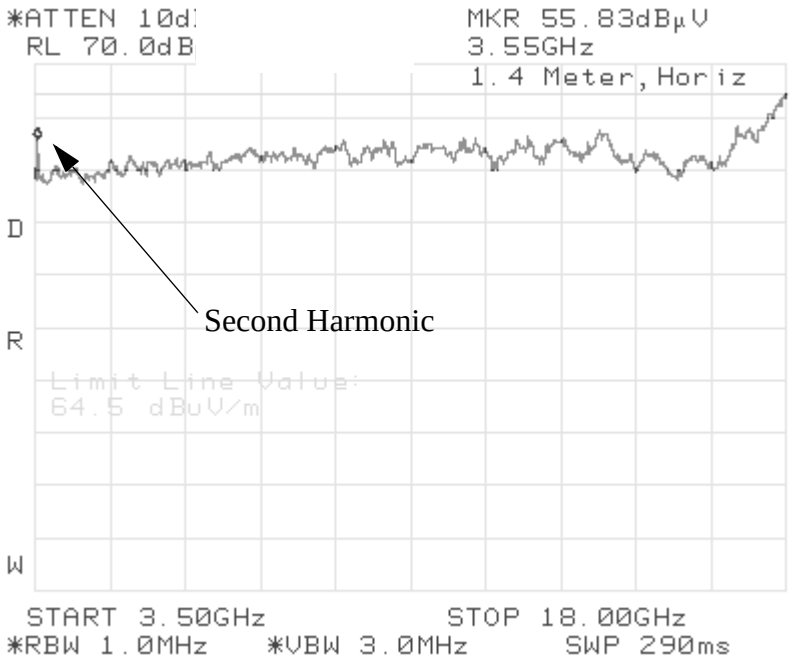


Figure 11.75 identifies the PWAN Base Station radiated emissions scan 3.5GHz – 18GHz in the vertical polarization at an antenna height of 1.8 meters. The PWAN Base Station was loaded with eight calls per sector continuously throughout the duration of the test. The marked signal at 3.55GHz (57.33 dBuV/m) is shown to be below the FCC Class A 1.4 meter limit line.

*Figure 11.75 3.5GHz – 18GHz @1.8m antenna height emissions scan, Vertical polarization, eight calls per sector*

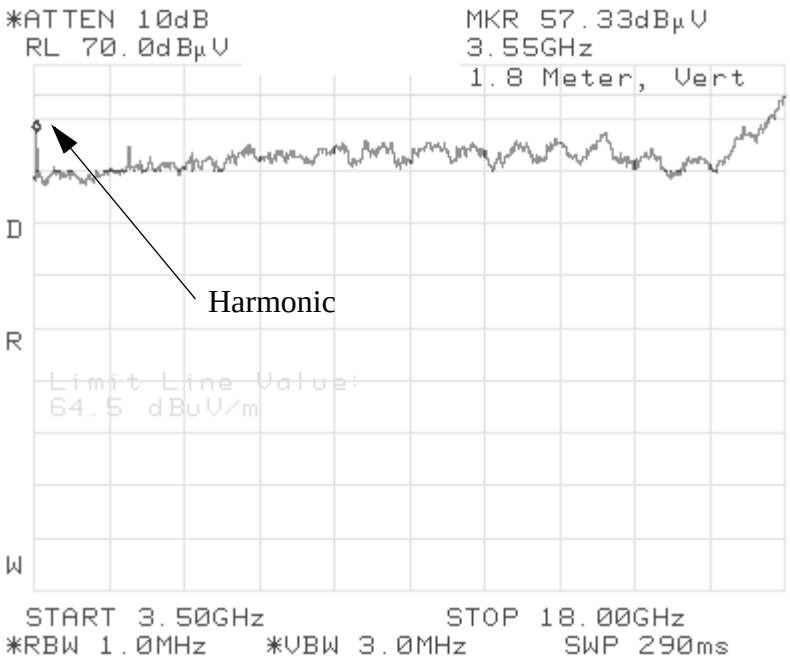


Figure 11.76 identifies the PWAN Base Station radiated emissions scan 3.5GHz – 18GHz in the horizontal polarization at an antenna height of 1.8 meters. The PWAN Base Station was loaded with eight calls per sector continuously throughout the duration of the test. The marked signal at 3.55GHz (51.00 dBuV/m) is shown to be below the FCC Class A limit line.

*Figure 11.76 3.5GHz – 18GHz @1.8m antenna height emissions scan, Horizontal polarization, eight calls per sector*

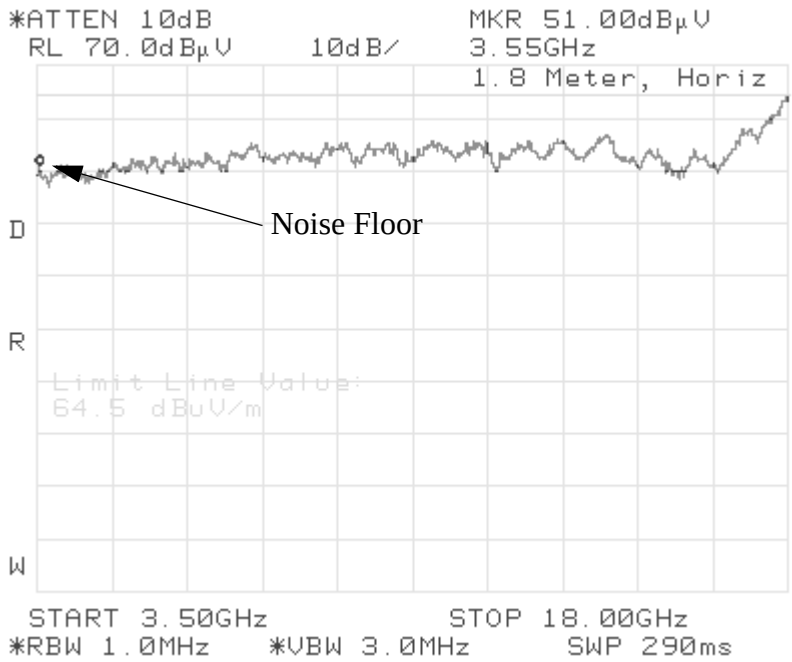


Figure 11.77 identifies the PWAN Base Station radiated emissions scan 18.00GHz – 26.50GHz in the vertical polarization at an antenna height of 1 meter. The PWAN Base Station was loaded with eight calls per sector continuously throughout the duration of the test.

*Figure 11.77 18.00GHz – 26.50GHz @1m antenna height emissions scan, Vertical polarization, eight calls per sector*

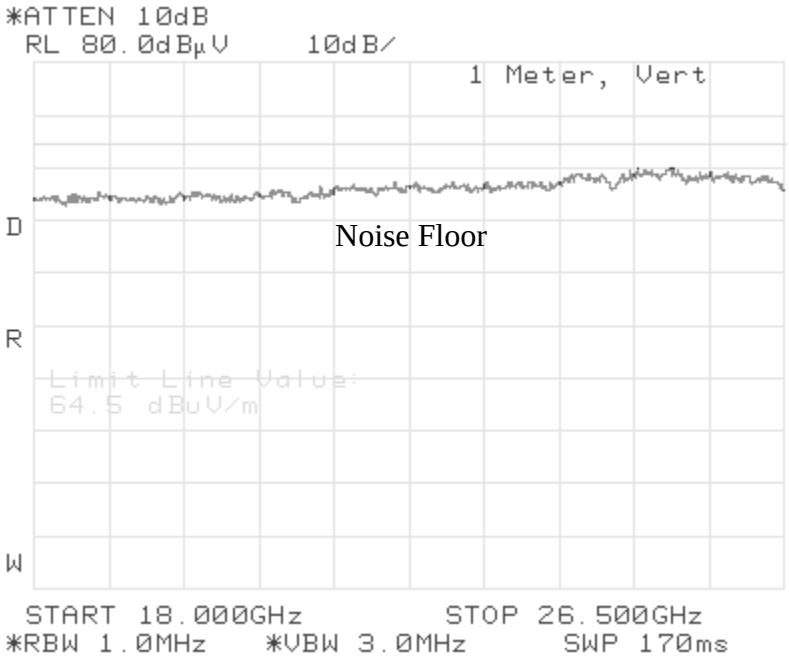


Figure 11.78 identifies the PWAN Base Station radiated emissions scan 18.00GHz – 26.50GHz in the horizontal polarization at an antenna height of 1 meter. The PWAN Base Station was loaded with eight calls per sector continuously throughout the duration of the test.

*Figure 11.78 18.00GHz – 26.50GHz @1m antenna height emissions scan, Horizontal polarization, eight calls per sector*

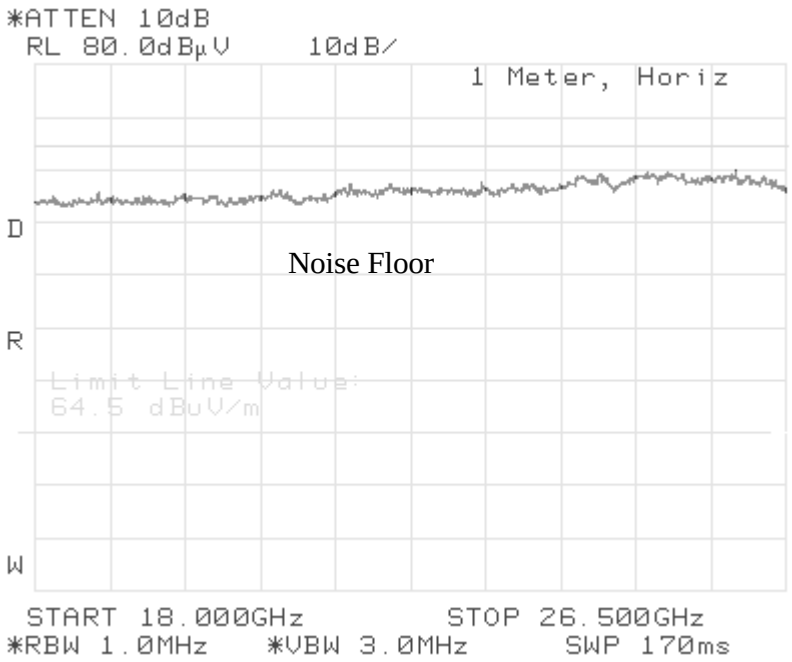


Figure 11.79 identifies the PWAN Base Station radiated emissions scan 18.00GHz – 26.50GHz in the vertical polarization at an antenna height of 1.4 meters. The PWAN Base Station was loaded with eight calls per sector continuously throughout the duration of the test.

*Figure 11.79 18.00GHz – 26.50GHz @1.4m antenna height emissions scan, Vertical polarization, eight calls per sector*

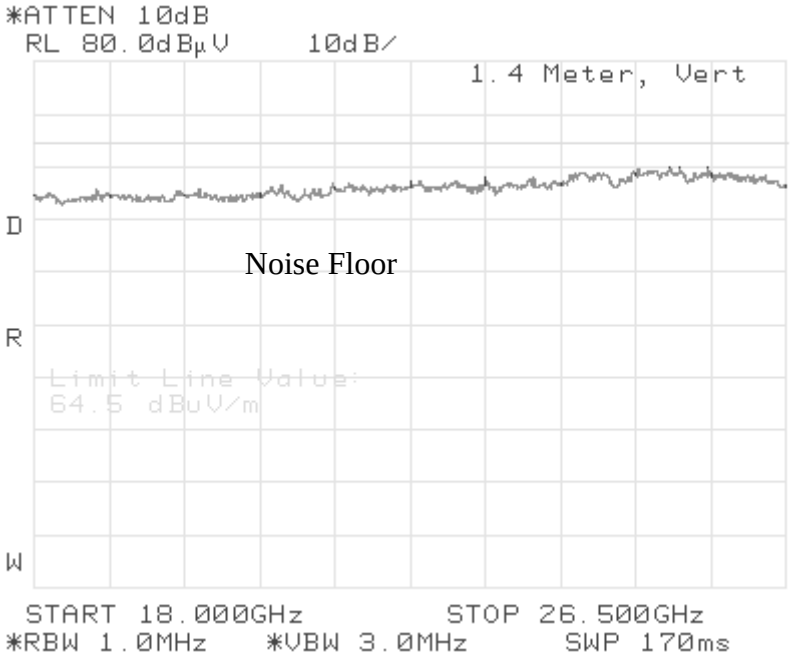


Figure 11.80 identifies the PWAN Base Station radiated emissions scan 18.00GHz – 26.50GHz in the horizontal polarization at an antenna height of 1.4 meters. The PWAN Base Station was loaded with eight calls per sector continuously throughout the duration of the test.

*Figure 11.80 18.00GHz – 26.50GHz @1.4m antenna height emissions scan, Horizontal polarization, eight calls per sector*

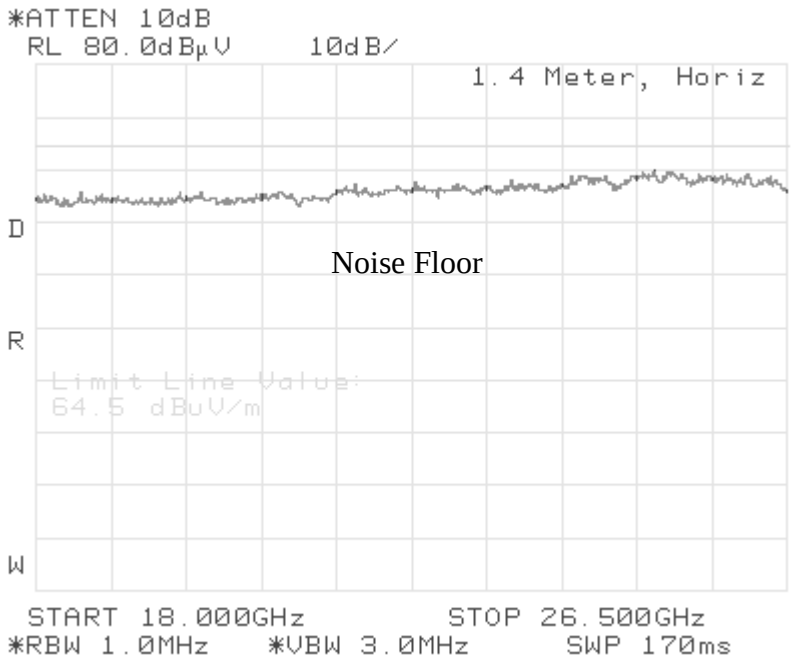


Figure 11.81 identifies the PWAN Base Station radiated emissions scan 18.00GHz – 26.50GHz in the vertical polarization at an antenna height of 1.8 meters. The PWAN Base Station was loaded with eight voice calls continuously throughout the duration of the test.

*Figure 11.81 18.00GHz – 26.50GHz @1.8m antenna height emissions scan, Vertical polarization, eight calls per sector*

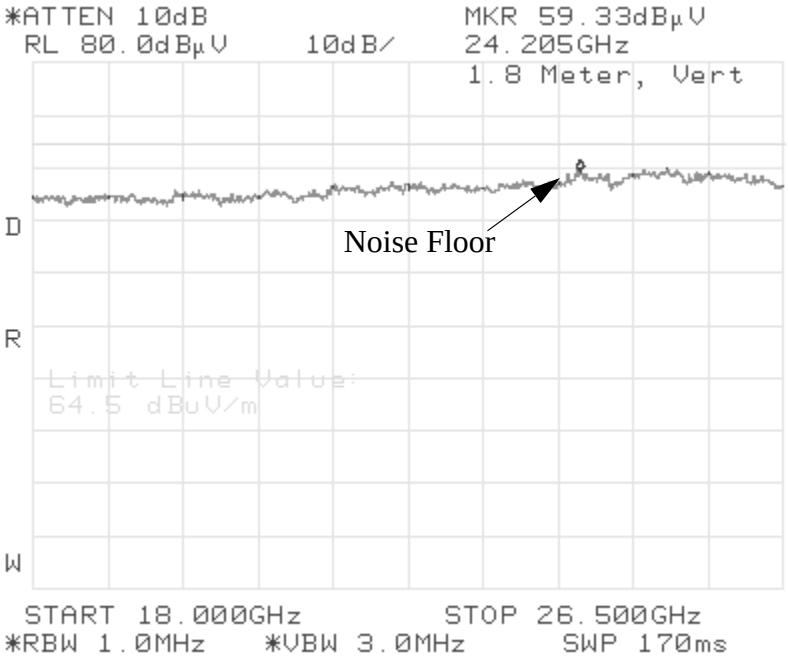
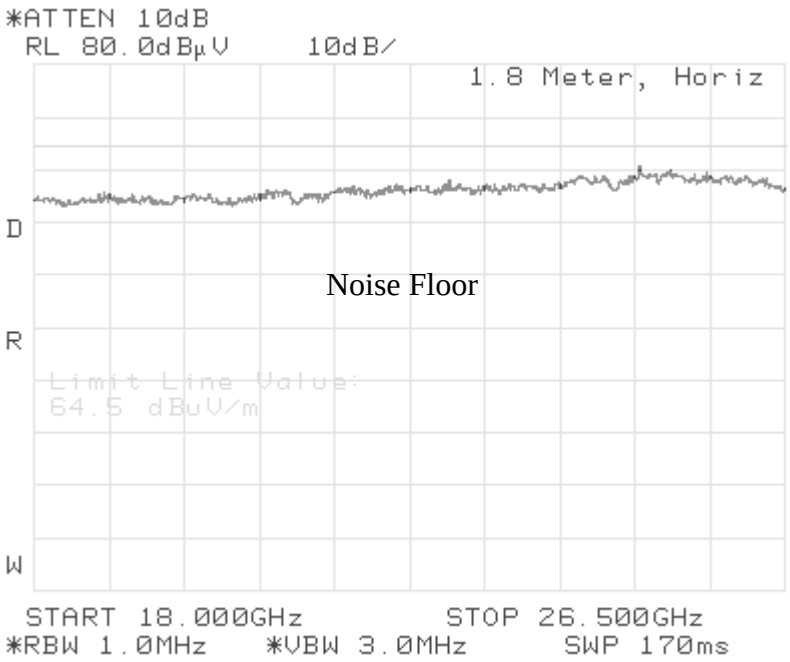


Figure 11.82 identifies the PWAN Base Station radiated emissions scan 18.00GHz – 26.50GHz in the horizontal polarization at an antenna height of 1.8 meters. The PWAN Base Station was loaded with eight calls per sector continuously throughout the duration of the test.

*Figure 11.82 18.00GHz – 26.50GHz @1.8m antenna height emissions scan, Horizontal polarization, eight calls per sector*




### 11.3.4.4—Test Results - Configuration 3: 32 Voice Calls on a Single Sector

Testing in this configuration was completed with 32 voice calls occupying various and random frequency and time slots. The data amplitudes within the entire tested spectrum was found to be lower than the first configuration, i.e. 16 calls on the same time slot. Simutaneuos high speed data and voice calls were also completed in various sectors with random frequency and time slots, also found to be quite lower than the first configuration.

### 11.3.4.5—Radiated to Conducted Spurious Emissions

#### 11.3.4.5.1—Applicable FCC rules

FCC Subpart 2.985 -This requires that the RF output be measured at the antenna power terminals into a dummy load after the transmitter has been adjusted in accordance with the manufacturers tune up procedure. Requires documentation of measurement configuration. Transmitter spectral output shall not have any components that exceed the spectral mask applicable to the rule part under which the equipment shall be operated.

FCC Subpart 24.238 - On any frequency outside a licensee's block, the power of any emission shall be attenuated below the transmitter power (P) by at least 43+10Log(P) dB. Compliance is based on measurement within a 1 MHz resolution bandwidth. However, in the 1 MHz bands immediately adjacent to the frequency block a resolution bandwidth of at least 1 percent of the emission bandwidth may be employed. The emission bandwidth is defined as the width of the signal between two points, one above and one below the carrier frequency, outside of which all emissions are attenuated by at least 25 dB below the transmitter power.

#### 11.3.4.5.2—Test Configuration

#### 11.3.4.5.3—Test Results

The data presented here is in addition to the results presented in Section 11.1.8. After completion of the radiated emission scans, Figure 11.44 through Figure 11.81, the highest five signals closest to the fundamental frequency were evaluated to the spurious emission spectrum as shown in Figure 11.32. These frequencies were converted from dBµV to dBm and compares to the FCC Part 24 spurious emissions limit. Testing was completed with a resolution and video bandwidth of 1000 MHz. Table 11.25 provides the data and comparison to both the dBuV and dBm FCC limits. It should be noted that the frequencies within the following table have been evaluated and found to be non-spurious occurrences.

*Table 11.25—Part 24 Spurious Emissions Limits*

| Frequency (GHz) | Part 15 Average Level (dBuv) | Avg dbm | dB Below -13 dbm limit line |
|---|---|---|---|
| 1.780 | 46.8 | -60.12 | 47.12 |
| 1.781 | 51.3 | -55.69 | 42.69 |
| 1.782 | 55.4 | -51.6 | 38.6 |
| 3.55 | 60.5 | -46.49 | 33.49 |
| 5.34 | 58.4 | -48.59 | 35.59 |