Chapter 11 Test Reports

Overview

This section contains the test reports and data that show that the FWAN PCS Base Station B1.8 is in compliance with all applicable technical standards and FCC Rules and Regulations.

Contents

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 2.1055 - 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 24.235 - 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 Mod**e: 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

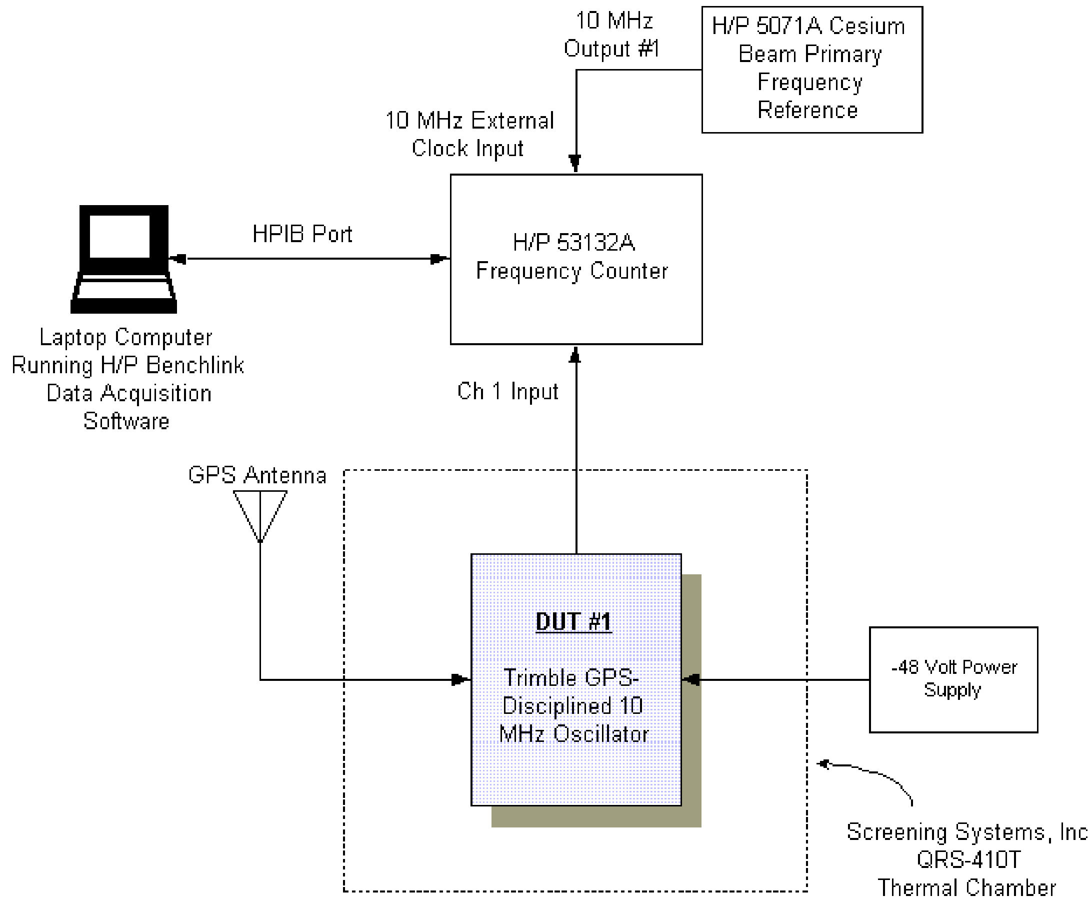
The Synchronization Card under test was placed into a Screening Systems, Inc. model QRS-410T thermal chamber (refer to Figure 11.1).

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 2.1055(d) - 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 24.235 - 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.

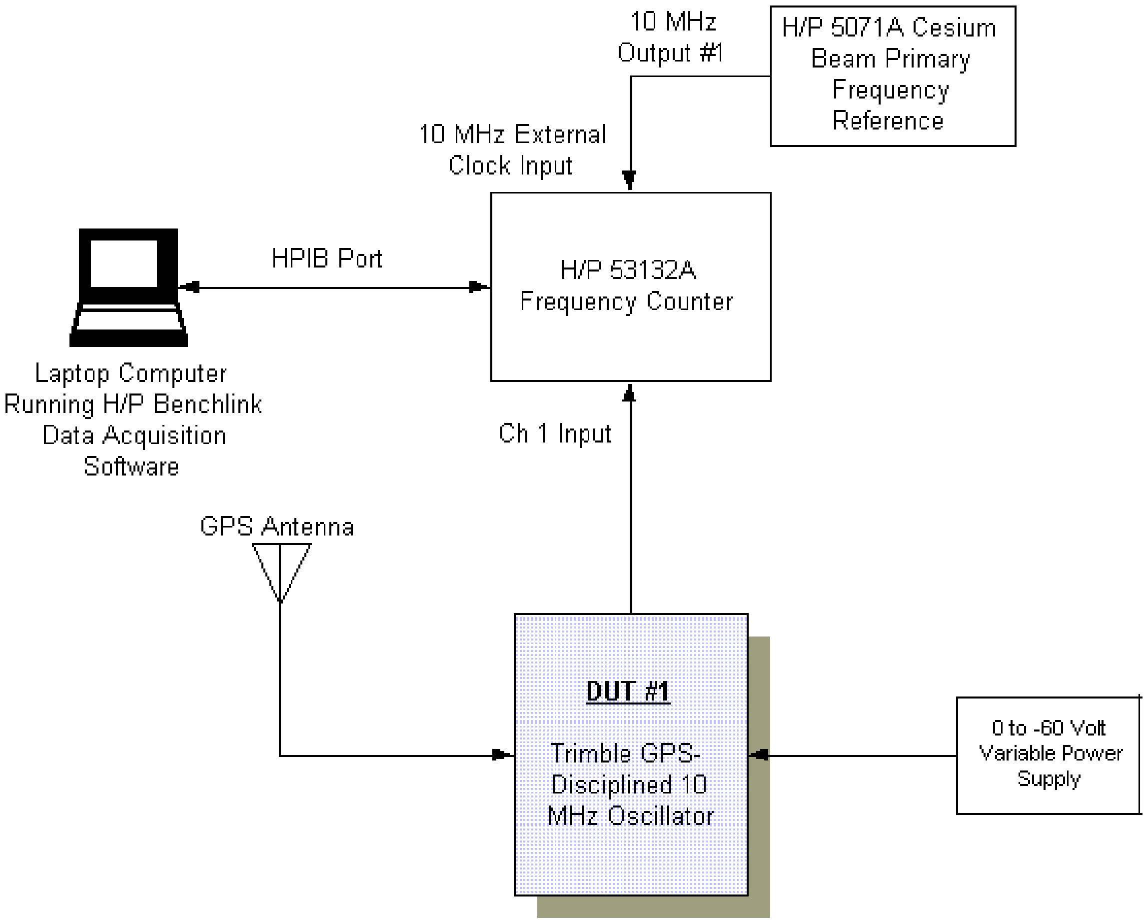
11.1.3.3 Test Methodology

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 2.049 - Occupied bandwidth is defined as 99% of the total mean power, measured according to Subpart 2.1049 (i), which requires full loading of the baseband, modulated such that the occupied bandwidth is consistent with that expected during normal operation.

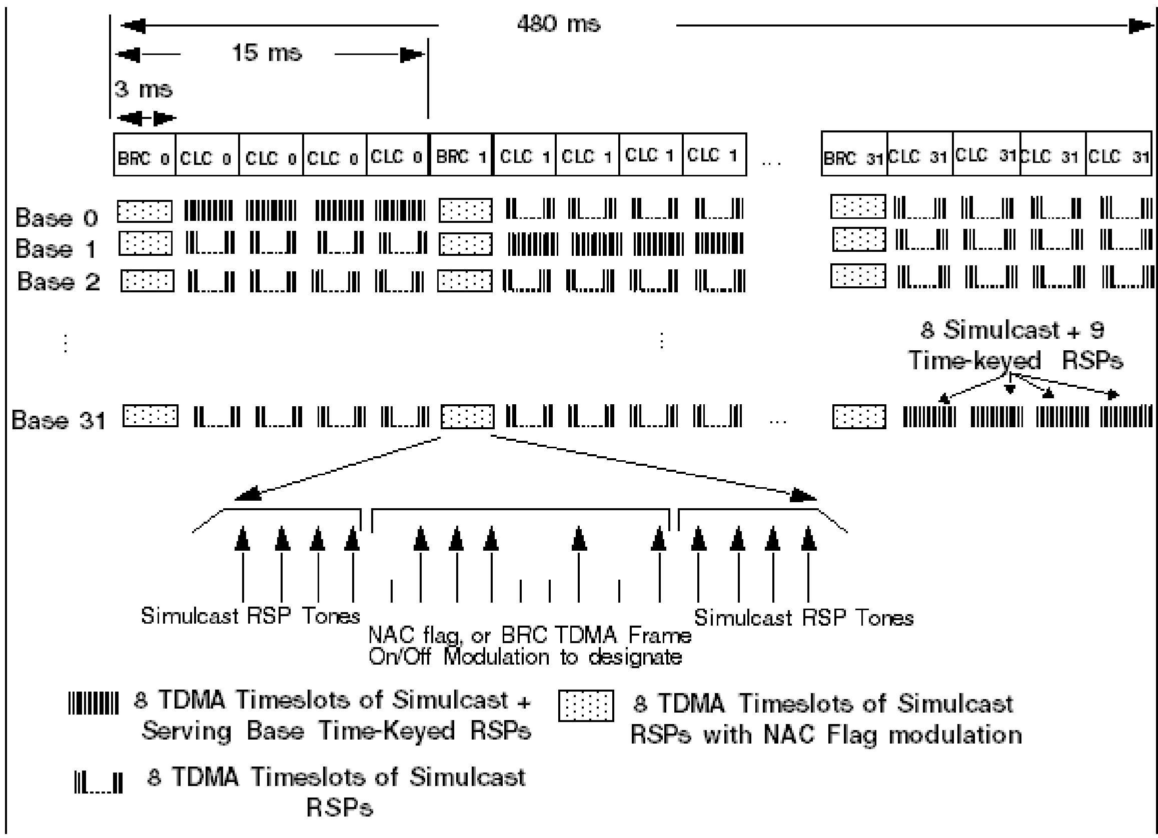
11.1.4.2 Overview

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

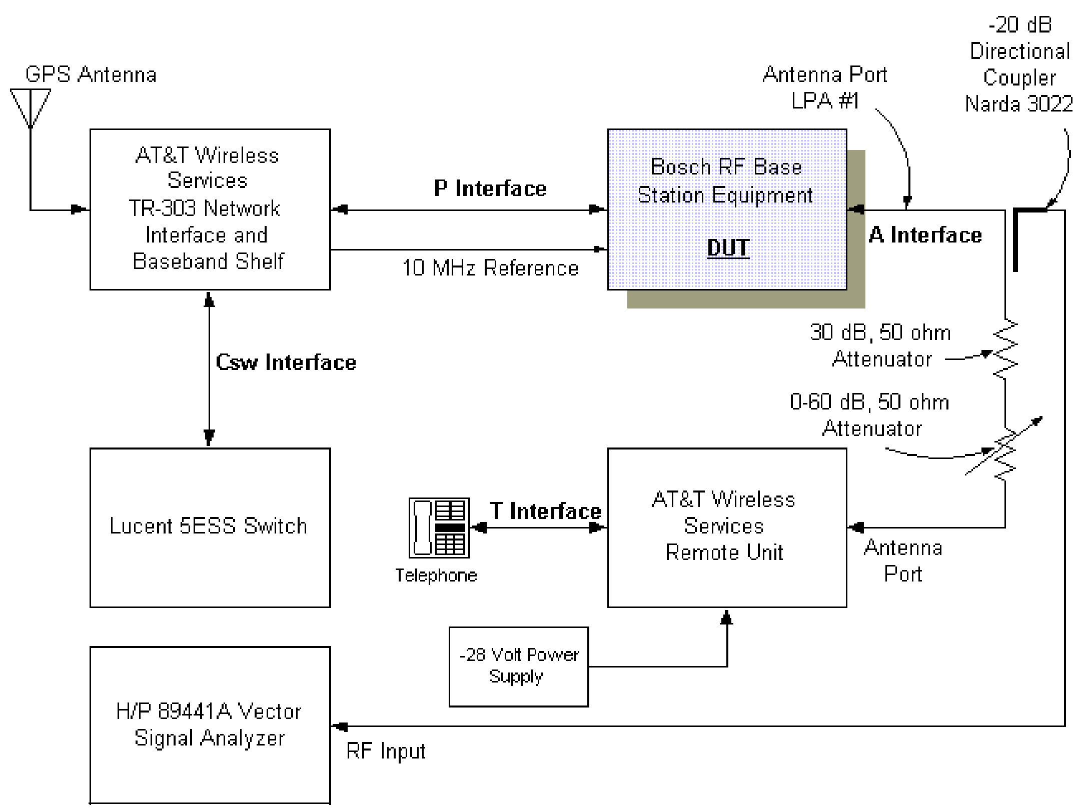


As Figure 11.3 indicates, each base will transmit eight RSPs continuously and five time-keyed RSPs every 15 ms. Every 480 ms, each base will transmit all 17 RSPs and a Broadcast Channel message. Because the Base Station's RSP activity is temporal (resulting in varying RF power per burst according to 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	1501
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 2.1047 - 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.

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)

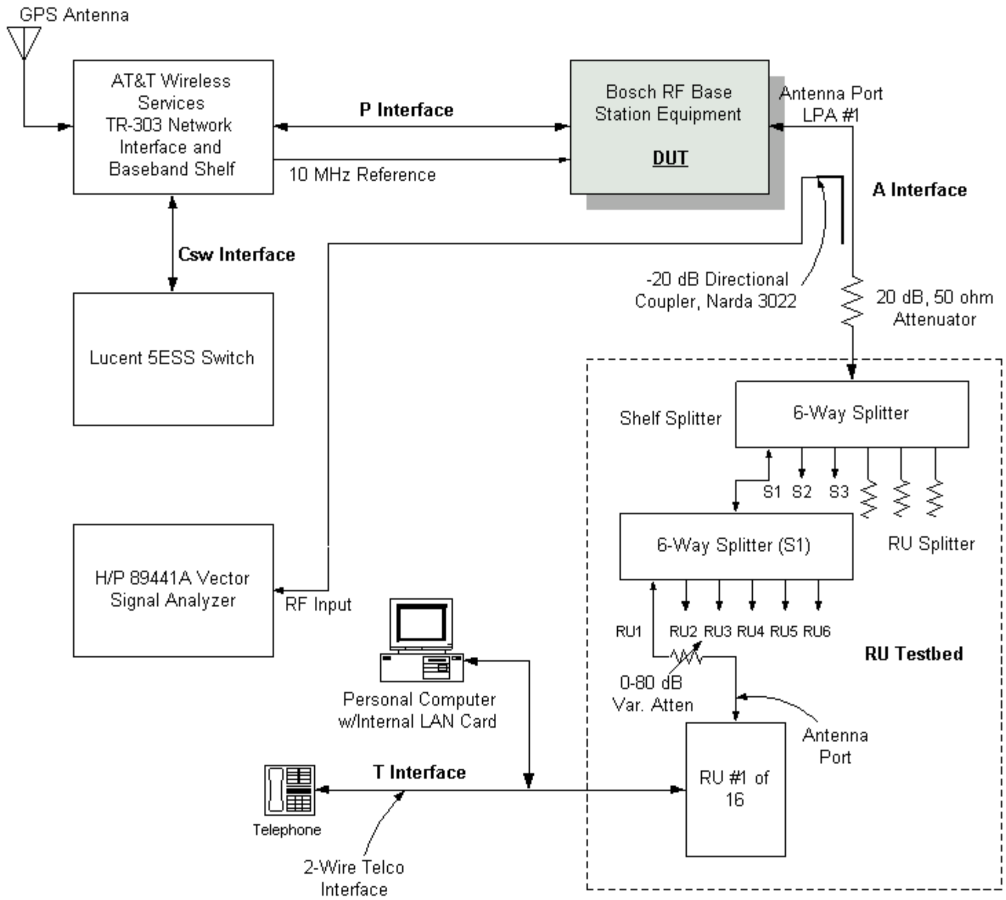
Parameter	Value
Center Frequency	1949.0 MHz
Span	2 MHz
Main Time Length	400 μs

Gate Time Length	320 μs
Gate Delay	50 μs
Trigger Type	IF Channel 1
Input Level	+25 dBm
External Attenuation	21.1 dB.
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	1501
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	1501
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 15 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 11.4.

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.13

11.1.6 RF Output Power

11.1.6.1 Applicable FCC Rules

- FCC Subpart 2.1046-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 §2.1033(c)(8). 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 15 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

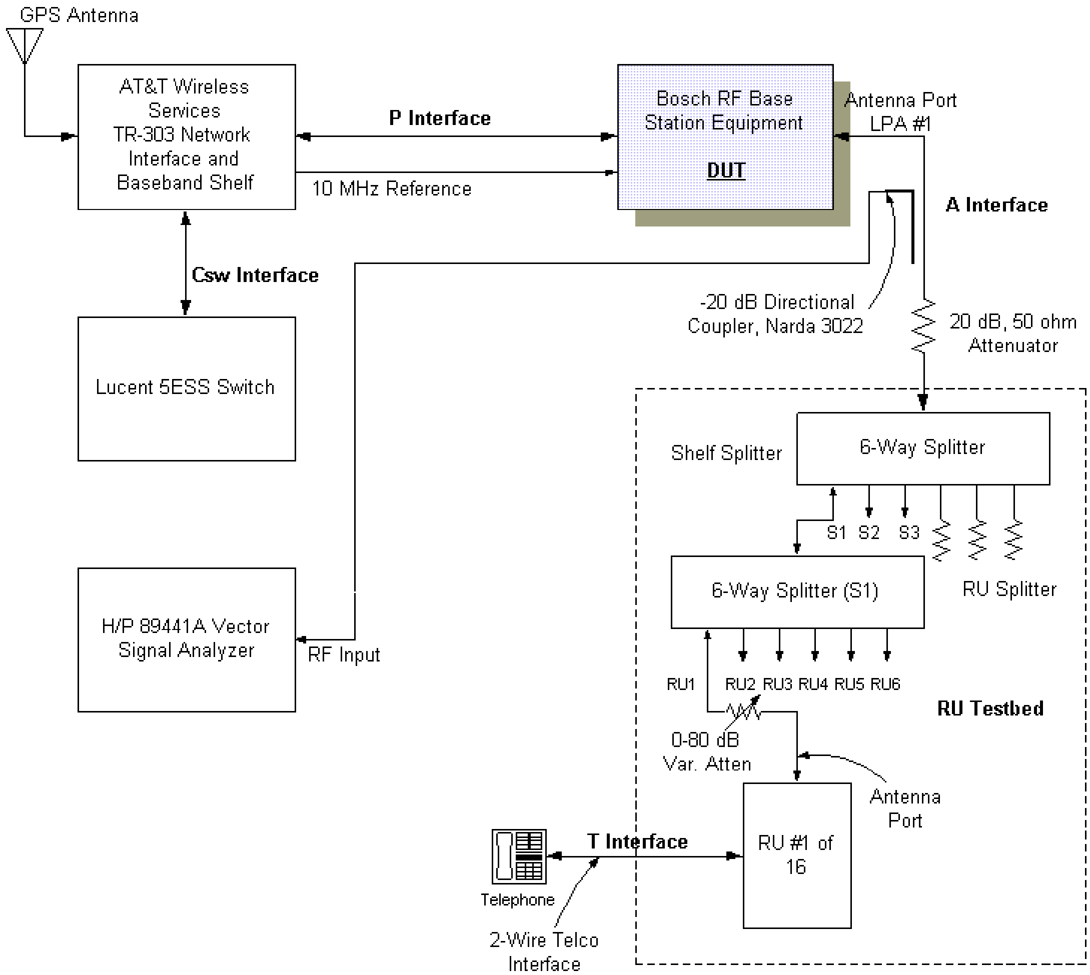
Parameter	Value
Center Frequency	1949.0 MHz
Span	2 MHz
Main Time Length	400 μs
Gate Time Length	320 μs
Gate Delay	50 μs
Input Level	+25 dBm
External Attenuation	21.1 dB
Peak/Average Metric	99.0%
Trigger Type	IF Channel 1
Trigger Delay	Selected to center 320 μs transmission bursts in time gate (typically -55 μs)

Trigger Holdoff	2300 μs
Frequency-Domain Averaging	20 Samples, RMS Exponential
FFT Window Type	Flat Top
FFT Freq. Points	1501
FFT Resolution BW	12 kHz.

11.1.6.3 Test Methodology

Peak RF output power from the Base Station is maximized while supporting 15 simultaneously active FDMA slots. For this test, a total of 15 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 2.1051 - 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 26 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 15 simultaneous FDMA slots within a TDMA slot.

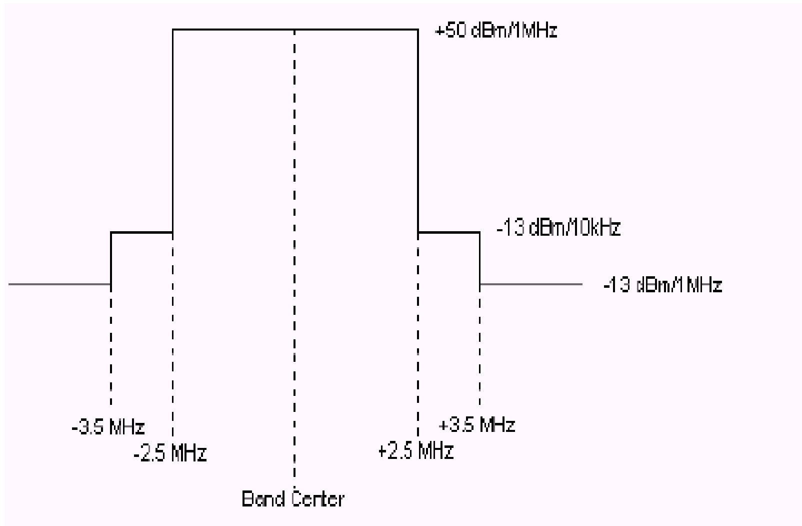
Spectral purity measurements were made with the Base Station operating in the lowest and highest subbands allocated in the “D” PCS block. Any Out-Of-Band (OOB) intermodulation and spurious signals will be contributed by Base Stations operating in the exterior subbands.

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	1501
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

See Figure 11.8 for the test configuration.

FWAN PCS 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 15 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 an average output power of 2.5 watts (+34 dBm) during the TDMA slot containing 15 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 §2.1051 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 1924 to 1965 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."

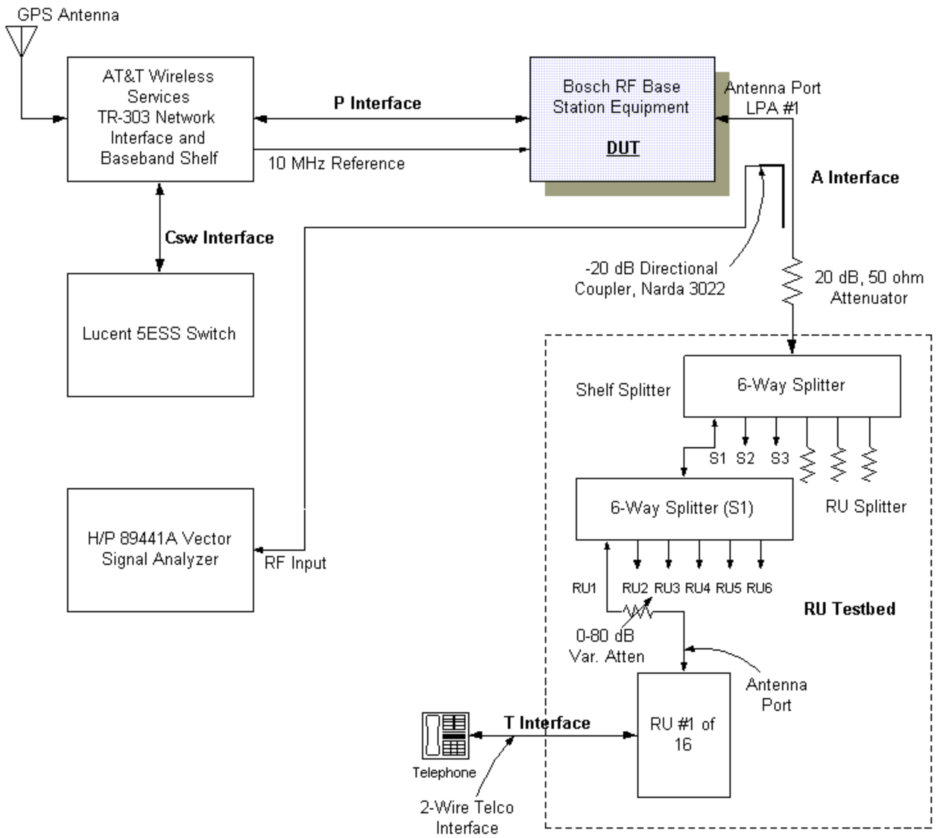
Due to the amount of attenuation required to prevent overloading the VSA, noise contributed by the analyzer's front-end diminished the resolution of low-level spurious products removed by greater than about ±2 MHz from the carrier center frequency. To improve the effective noise floor of the instrument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

Note

Note: **It was not possible to test 16 voice calls on the same time slot in the same sector because the NAC channel occupied one slot.**

The detailed FWAN PCS Base Station test configuration and test setup photos can be found in Chapter 12, "Test Setup Photos."

Figure 11.8 Spectral Purity Test Configuration



11.1.8 Radiated Emissions

11.1.8.1 Applicable FCC Rule

- 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 FWAN PCS 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 set up 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 were made over the frequency range specified by the regulatory agency. In this case, per FCC Rules, Part 15, subpart 15.207. Measurements were 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 FWAN PCS Base Station was set up in a typical field configuration, as shown in Figure 11.8. The FWAN PCS Base Station was placed inside an EMC cabinet, as shown in Figure 12.2 through Figure 12.5. The cabinet was grounded utilizing a NEC-approved grounding method.

During testing the Base Station was set up and tested in the following modes of operation:

- Completely loaded baseband and network shelves (i.e., maximum number of TSP and NIF cards)
- 15 voice calls within the same time slot (maximum time slot capacity)
- 60 voice calls on a single sector
- 60 voice calls, 15 voice calls per sector with HSD operation within one sector
- DC power and NIF cable interface lengths as close to 1 meter as possible

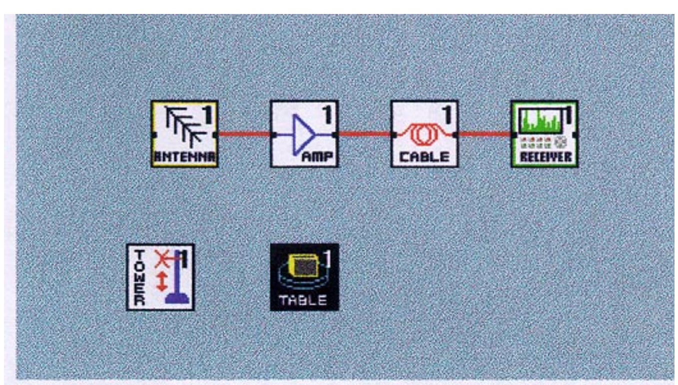
Testing was completed from 30 MHz to 26.5 GHz.

Note

***Note:* It was not possible to test 16 voice calls on the same time slot in the same sector because the NAC channel occupied one slot.**

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

Figure 11.9 Test Equipment Configuration



11.1.8.4 Equipment Settings for 30 - 1000 MHz Band

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.

- Antenna 1: Horizontal and Vertical Polarizations
- Gore Cable 1: 40-foot
- Tower 1: 1 to 4 meter scan
- Turntable 1: 22.5 degree steps during scans
- Amplifier 1: PREAMP ON
- 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 Measurement Parameters for 30 - 1000 MHz Band

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 bandwidths:

Tune/Listen setting

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

11.1.8.6 Antenna Factors for 30 - 1000 MHz Band

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 Correction Factors — 30 - 1000MHz

Frequency (MHz)	AF (dB)
30	19.9
40	14.2
50	8.9
60	6.3
70	6.8
80	8.0
90	9.0
100	10.4
110	11.6
120	12.3
130	12.5

Table 11.7 Antenna Correction Factors (continued)— 30 - 1000MHz

Frequency (MHz)	AF (dB)
140	12.3
150	11.8
160	10.2
170	10.0
180	9.4
190	9.4
200	9.9
225	10.8
250	12.8
275	13.2
300	14.0
325	14.4
350	15.6
375	15.7
400	16.6
425	17.2
450	17.2
475	17.9
500	18.1
525	18.4
550	20.3
575	19.8
600	20.1
625	20.6
650	20.9
675	20.8
700	21.1
725	21.9
750	22.1
775	22.2
800	22.2
825	23.0

Table 11.7 Antenna Correction Factors (continued)— 30 - 1000MHz

Frequency (MHz)	AF (dB)
850	23.5
875	23.2
900	23.2
925	24.1
950	24.7
975	25.1
1000	25.2

11.1.8.7 Cable Factors

The measurement system setup, as shown in Figure 11.8, is interconnected with 40 feet of Gore 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 Correction Factors

Frequency (MHz)	Amplitude (dB)
0.03	-0.090
300.00	-2.080
600.00	-2.650
1000.00	-3.220
1250.00	-3.560
1500.00	-3.820
1750.00	-4.130
2000.00	-4.420
2250.00	-4.580
2500.00	-4.840
2750.00	-5.060
3000.00	-5.310
3250.00	-5.560
3500.00	-5.900
3750.00	-6.320

Table 11.8 Cable Correction Factors

Frequency (MHz)	Amplitude (dB)
4000.00	-7.770
4100.00	-8.690
4250.00	-7.260
4500.00	-7.700
5000.00	-7.700
5500.00	-8.030
6000.00	-8.200

11.1.8.8 Equipment Settings for 1000 - 3500 MHz Band

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

- Antenna 1: Horizontal and Vertical Polarizations
- Gore Cable 1: 40 feet
- 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

11.1.8.9 Measurement Parameters for 1000 - 3500 MHz Band

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 6 dB 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 bandwidths:

Tune/Listen setting

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

11.1.8.10Antenna Factors for 1000 - 3500 MHz Band

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 Correction Factors — 1000 - 6000 MHz

Frequency (MHz)	Amplitude (dB/m)
1000	25.5
1500	26.9
2000	28.9
2500	30.6
3000	31.8
3500	32.8
4000	34.5
4500	33.9
5000	35.1
5500	36.1
6000	36.8

Note
Cable Correction Factors are shown in Table 11.8.

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 11.10 Test Equipment

Instrument Name	Manufacturer	Model Number	Serial Number	Calibration Last Date	Calibration Due Date
Directional Coupler	Narda	3022	76836	N/A	N/A
Vector Signal Analyzer	Hewlett-Packard	89410A	3415A02243	7/24/01	7/24/02
Spectrum Analyzer	Hewlett-Packard	8563E	3724A07272	12/8/00	12/8/01
Network Analyzer	Hewlett-Packard	8753D	3410A07599	7/17/01	7/17/02

11.2.2 Base Station RF Frequency Stability vs. Temperature

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

(Eq 11.1)

$$\mathrm{FrequencyError(PPM)} = \left(\left(\frac{\Delta f}{f}\right) \cdot 1 \times 10^6\right) = \left(\left(\frac{f(\mathrm{measured}) - 1\times10^7}{1\times10^7}\right) \cdot 1\times10^6\right.$$

11.2.2.1 Results Summary

The measured frequency stability vs. temperature is depicted in Figure11.11, Figure 11.12,and Figure 11.13.Theresultsofthesetests are summarized in Table11.12 below:

Figure 11.10 Base Station Synchronization Card Frequency Stability vs. Temperature, GPS Locked Mode

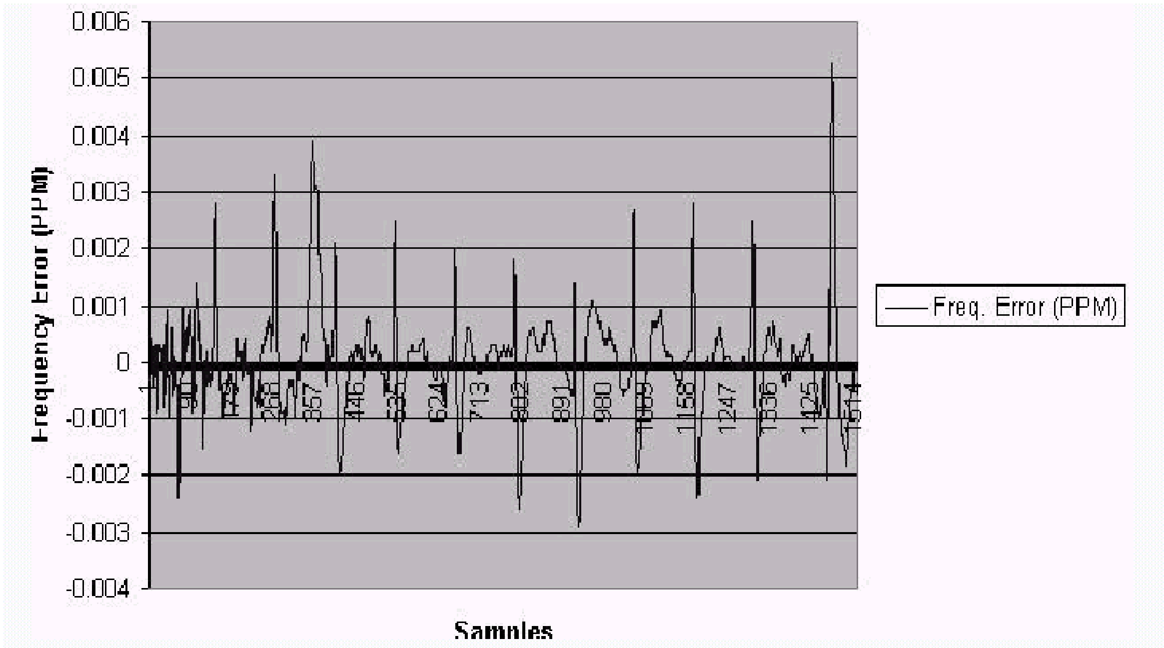


Figure 11.11 Base Station Synchronization Card Frequency Stability vs. Temperature, GPS Holdover Mode

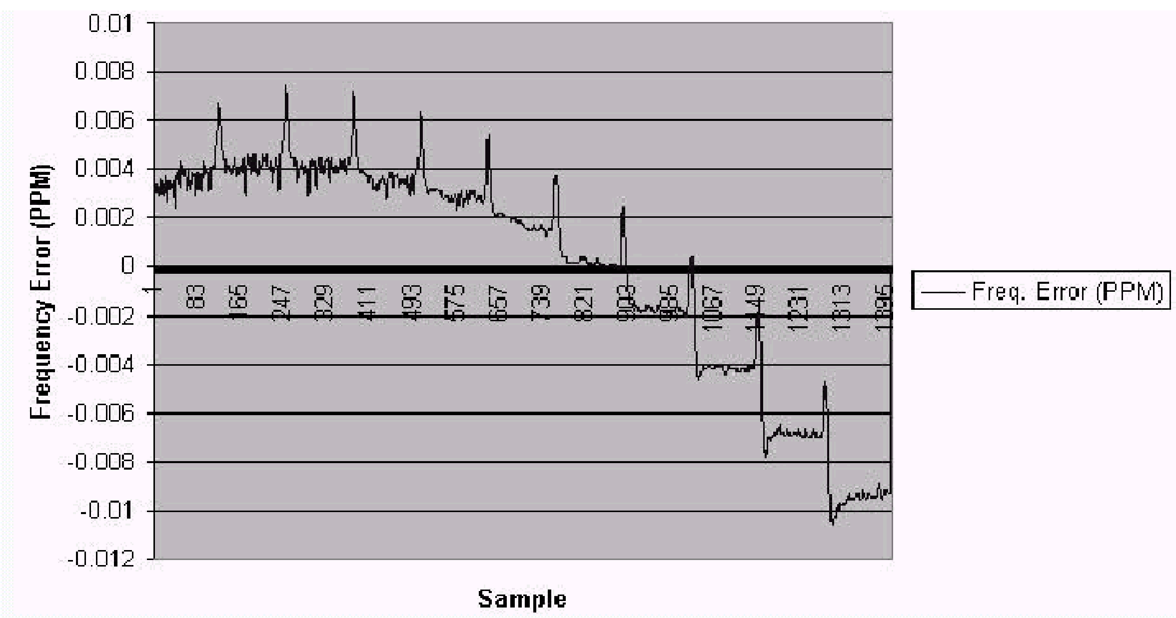


Figure 11.12 Base Station Synchronization Card Frequency Stability vs. Temperature, GPS Free-Run Mode

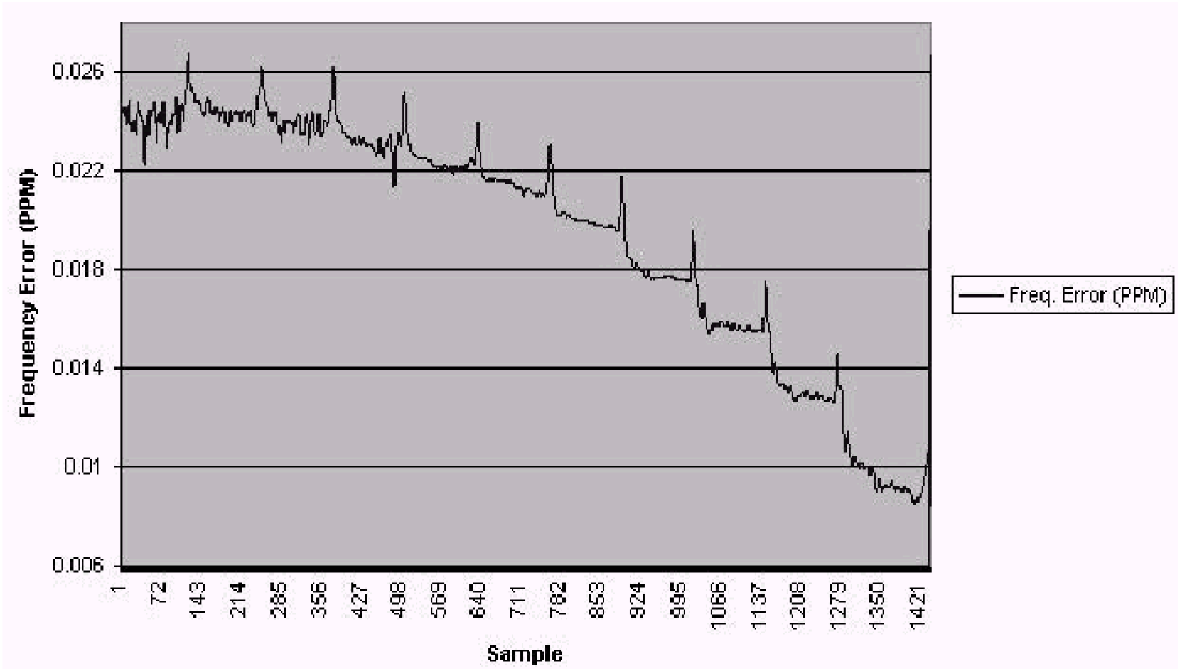


Table 11.11 Base Station Synchronization Card Frequency Stability vs. Temperature Summary

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

11.2.3 Base Station Frequency Stability vs. Input Voltage

11.2.3.1 Results Summary

Themeasuredfrequencystabilityvs.inputvoltagefortheBaseStation under test is depicted in Figure11.14, Figure11.15, Figure11.16. The results of these tests are summarized in Table11.13 below:

Figure 11.13 Base Station Synchronization Card Frequency Stability vs. Input Voltage, GPS Locked Mode

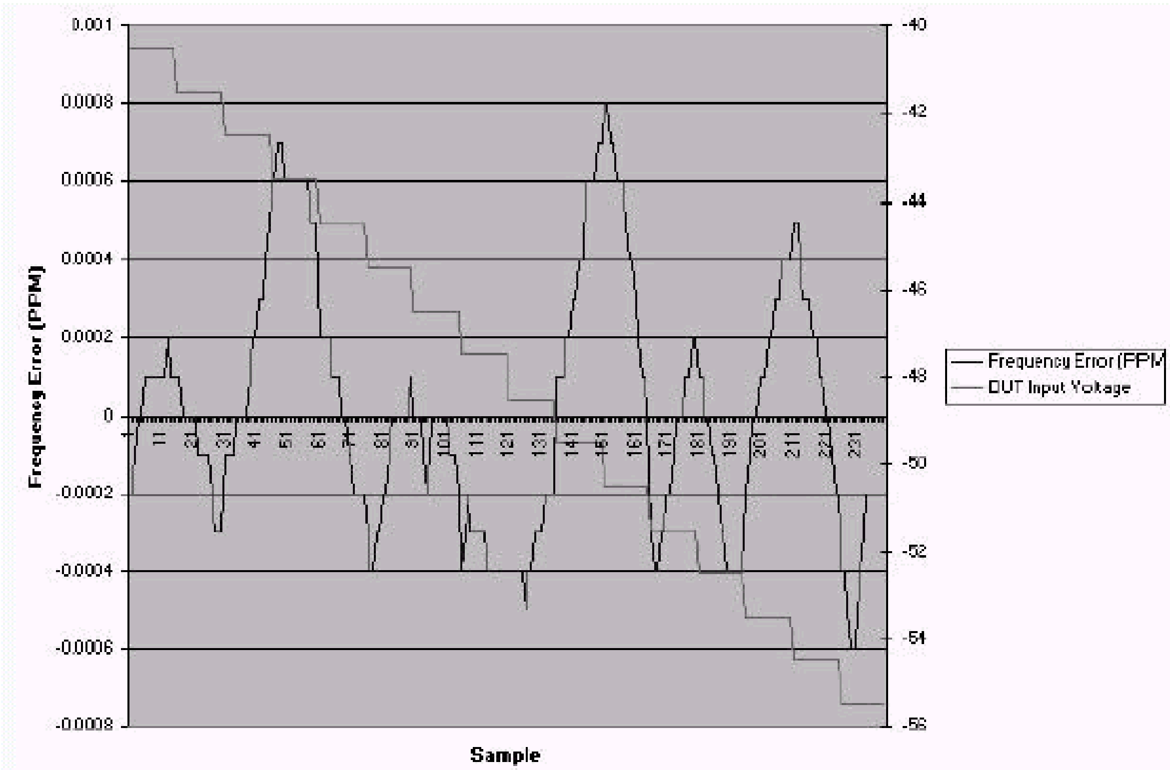


Figure 11.14 Base Station Synchronization Card Frequency Stability vs. Input Voltage, GPS Holdover Mode

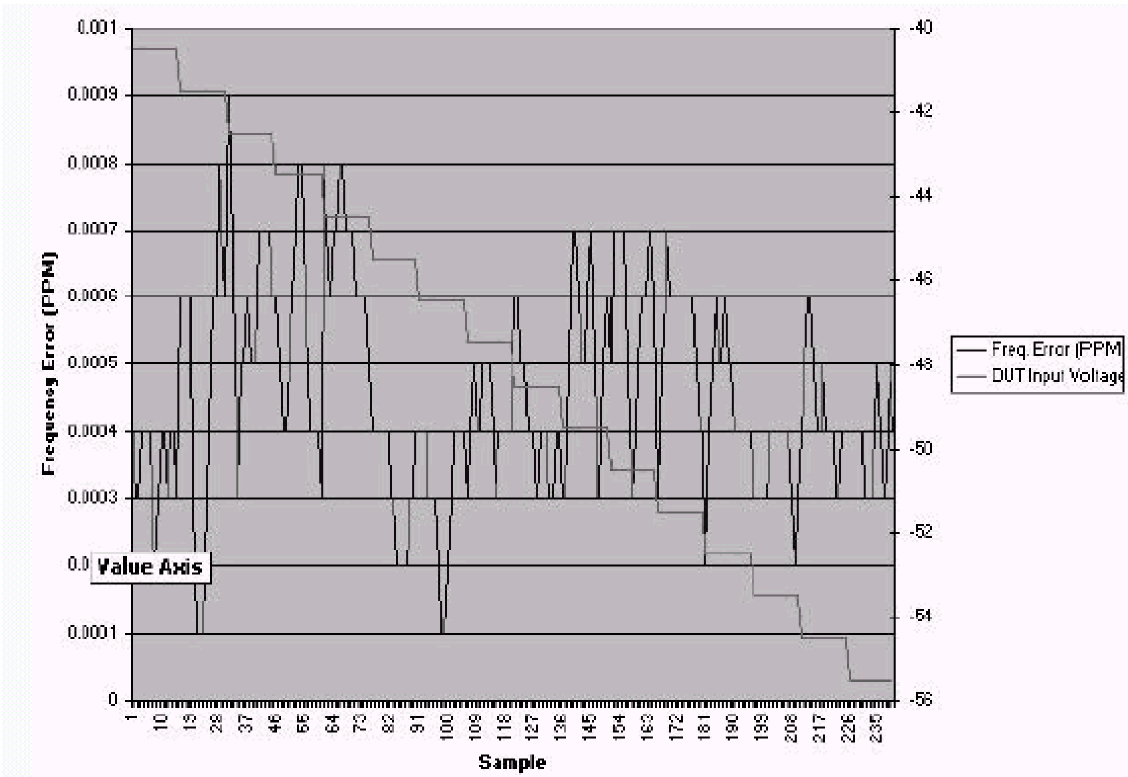


Figure 11.15 Base Station Synchronization Card Frequency Stability vs. Input Voltage, GPS Free-Run Mode

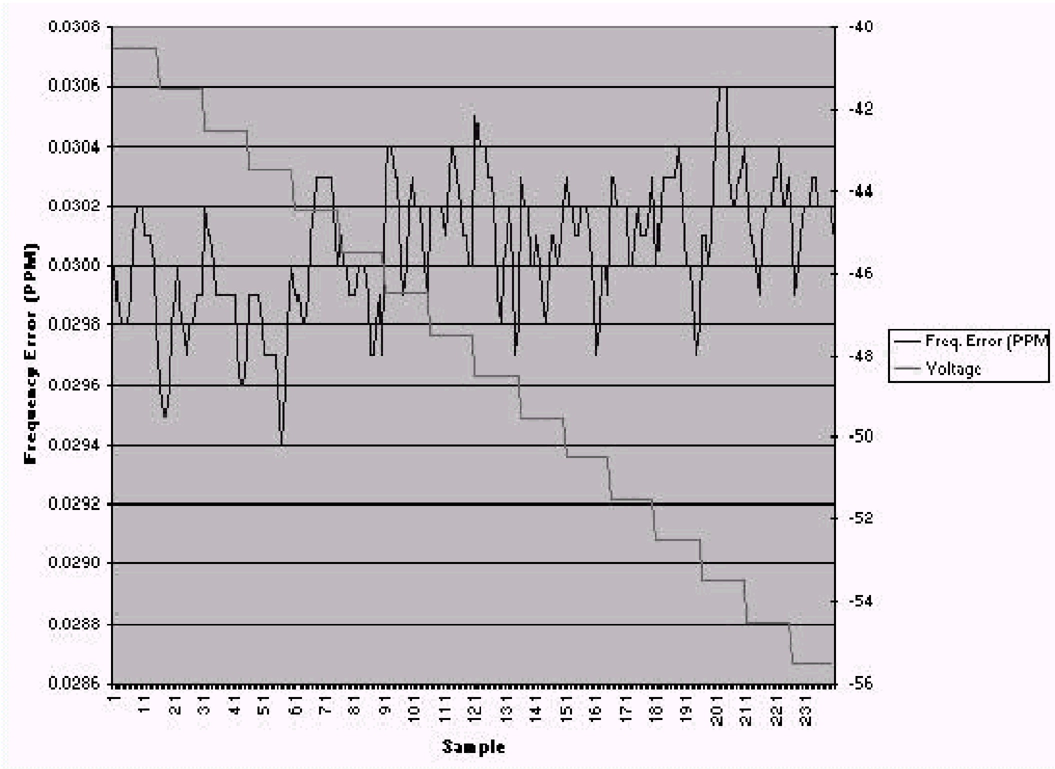


Table 11.12 Base Station Synchronization Card Frequency Stability vs. Input Voltage Summary

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

11.2.4 Base Station Occupied Bandwidth

11.2.4.1 Applicable FCC Rule Parts

- FCC Subpart 2.1049 - Occupied bandwidth is defined as 99% of the total mean power, measured according to Subpart 2.1049 (i), which requires full loading of the baseband, modulated such that the occupied bandwidth is consistent with that expected during normal operation.

11.2.4.2 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 Figure11.4). 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 Table11.2.

11.2.4.3 Test Summary

The 99% Occupied Bandwidth for the Base Station is depicted in Figure11.16. The test results are summarized in Table 11.13.

Figure 11.16 Base Station 99% Occupied Bandwidth While Transmitting Simulcast Remote Synchronization Pilots

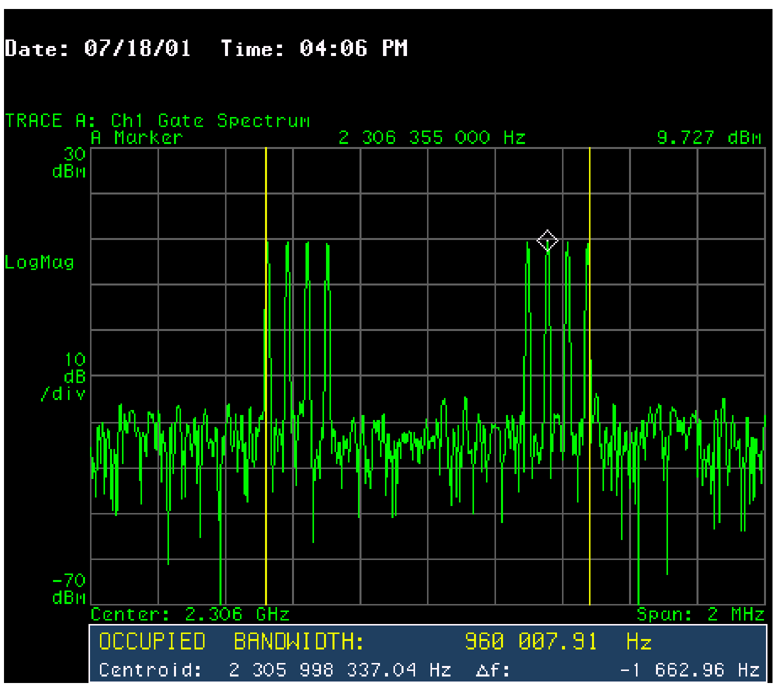


Table 11.13 Occupied Bandwidth Test Result Summary

Parameter	Measured Value
99% Occupied Bandwidth While Transmitting Remote Synchronization Pilots	=960 kHz.

11.2.5 Modulation Characterization

11.2.5.1 Applicable FCC Rules

- FCC Subpart 2.1047 - 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.

11.2.5.2 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
- NAC 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)

11.2.5.3 Results Summary

11.2.5.3.1 Multiple Call Voice Traffic Channel

A total of 15 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 11.17 and Figure 11.18. The results of these tests are summarized in Table 11.14.

Figure 11.17 Voice Channel Power vs. Frequency, 99.0% Occupied BW, and Time-Domain Average Burst Power

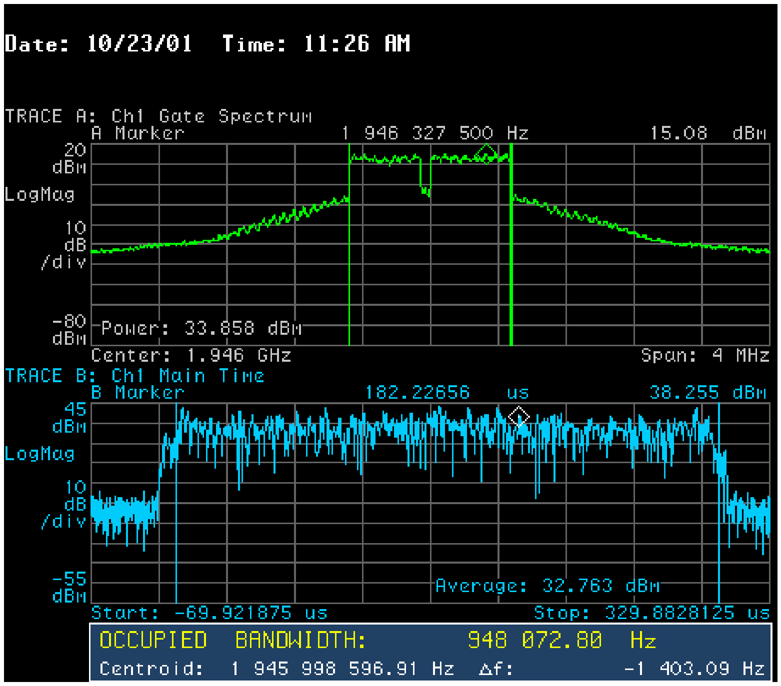
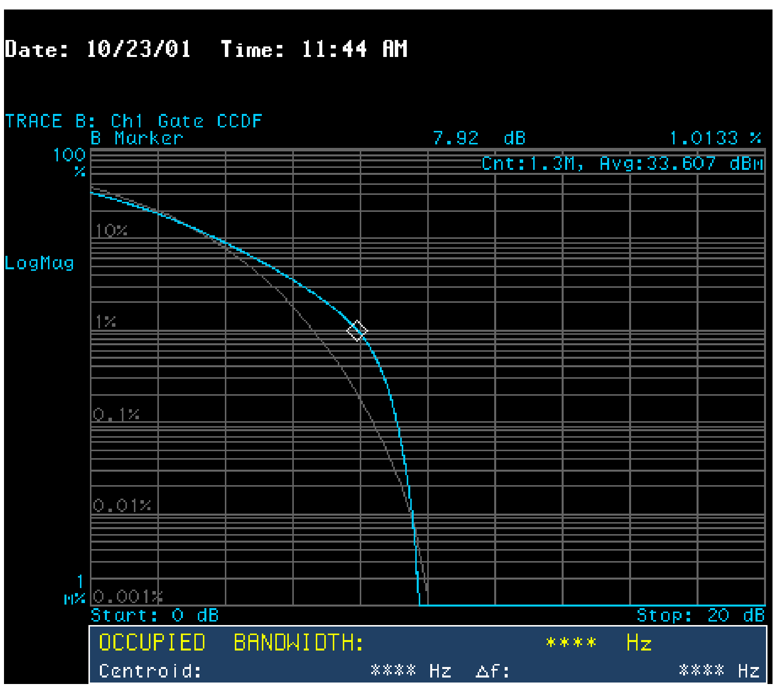


Figure 11.18 Voice Channel CCDF.



11.2.5.3.2 High-Speed Data Traffic Channel

A single High-Speed Data Traffic 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.

11.2.5.3.3 Results Summary

The measured characteristics of the High-Speed Data Traffic channel are depicted in Figure 11.19 and Figure 11.20. The results of these tests are summarized in Table 11.14.

Figure 11.19 High-Speed Data Traffic Channel Power vs. Frequency, 99.0% Occupied BW, and Time-Domain Average Burst Power.

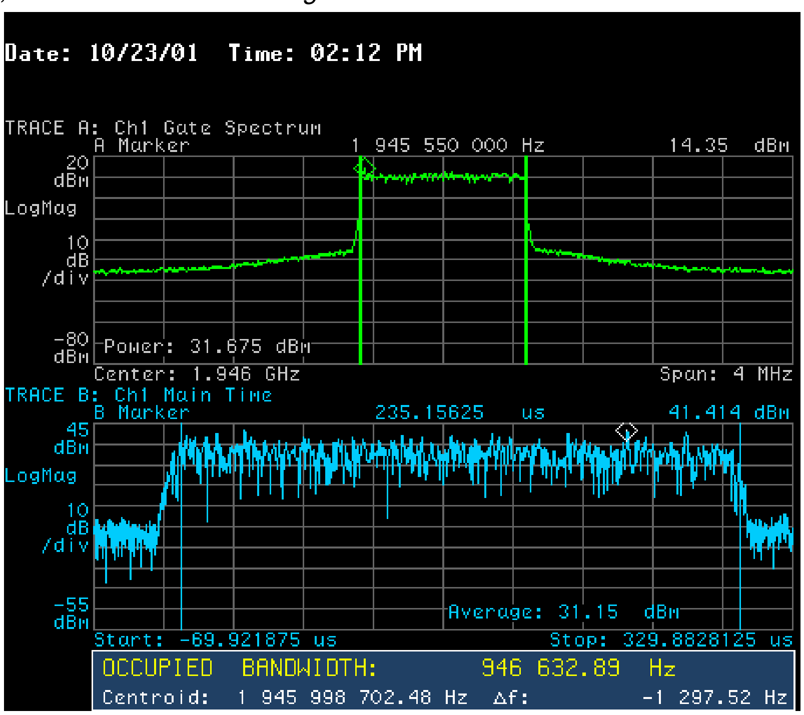
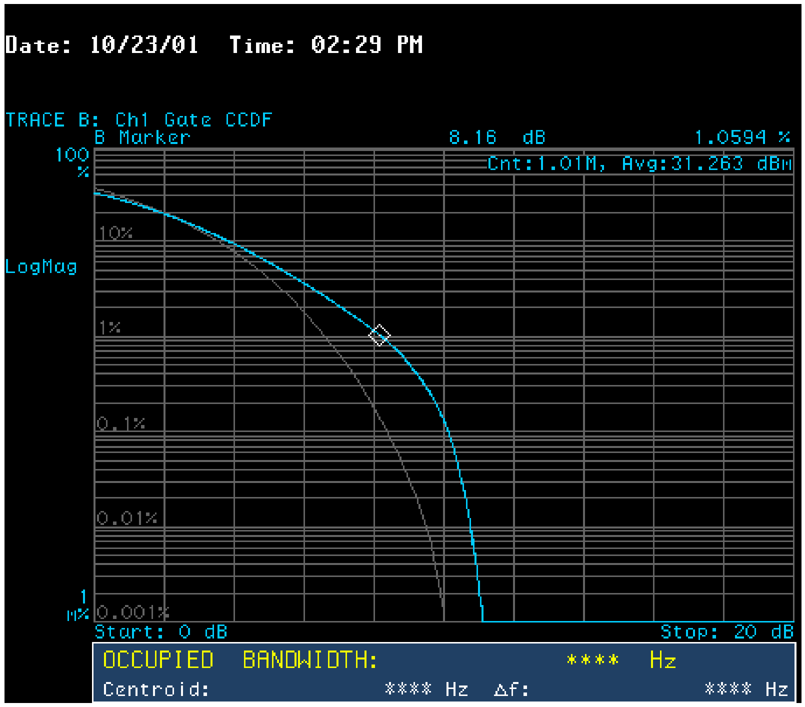


Figure 11.20   High-Speed Data Traffic Channel CCDF



11.2.5.3.4   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.

11.2.5.3.5   Results Summary

The measured characteristics of the High-Speed Data Control channel are depicted in Figure 11.21 and Figure 11.22. The results of these tests are summarized in Table 11.14.

Figure 11.21 High Speed Data Control Channel Power vs. Frequency, 99.0% Occupied Bandwidth, and Time-Domain Average Power

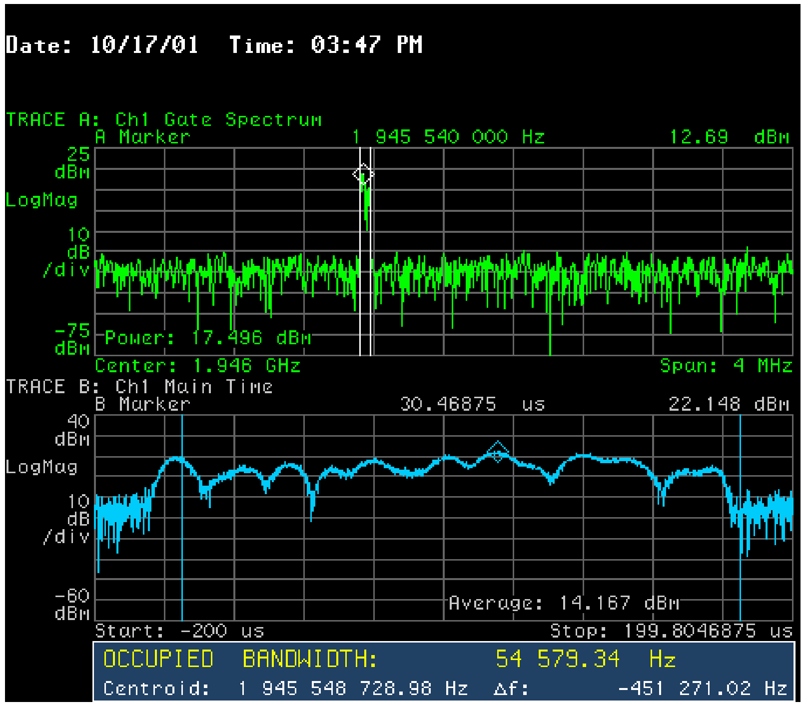
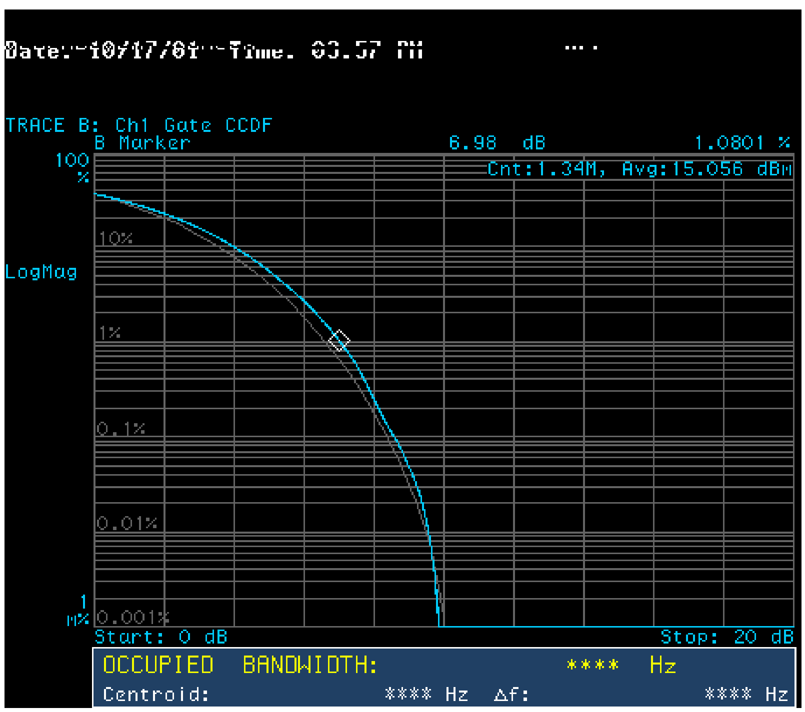


Figure 11.22 High Speed Data Control Channel CCDF.



11.2.5.3.6 NAC (Network Access Control) Channel

The Base Station NAC channel was characterized using the test configuration shown inFigure 11.5. The Hewlett-Packard Vector Signal Analyzer was configured according to the parameters shown in Table 11.3.

11.2.5.3.7 Results Summary

The measured characteristics of the NAC channel are depicted in Figure 11.23 and Figure 11.24. The results of these tests are summarized in Table 11.14.

Figure 11.23 NAC Channel Power vs. Frequency, 99.0% Occupied BW, and Time-Domain Average Power.

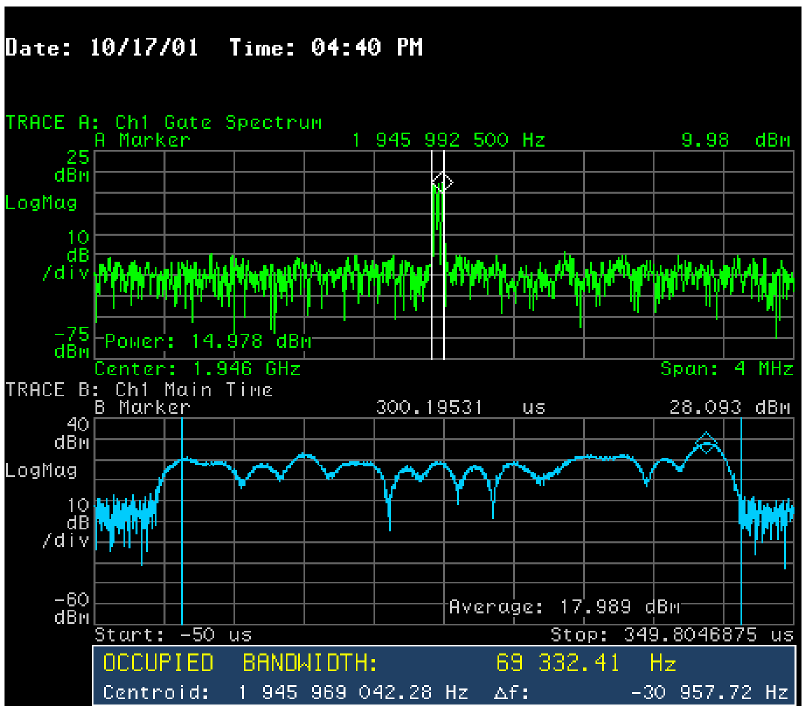
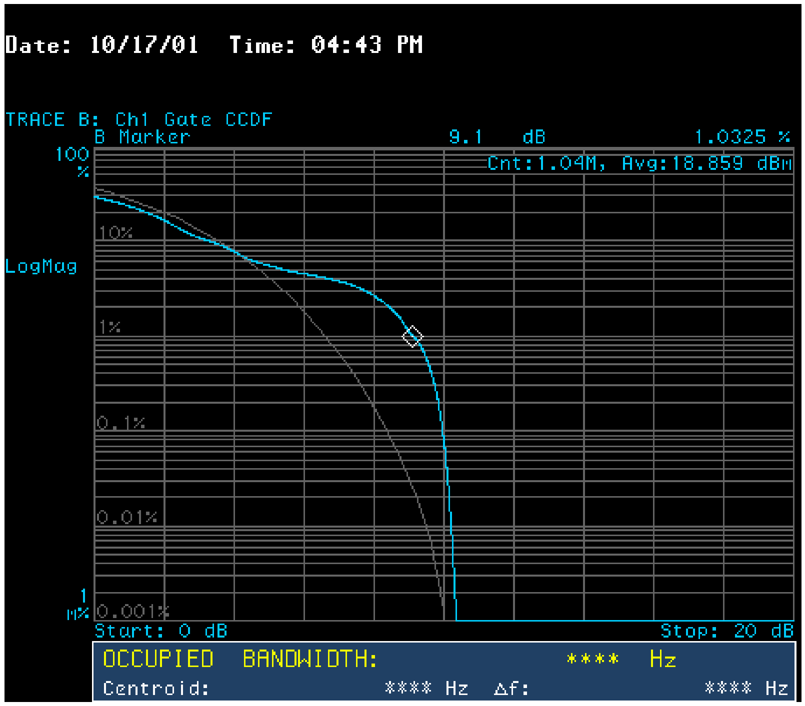


Figure 11.24 NAC Channel CCDF



11.2.5.3.8 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.

11.2.5.3.9 Results Summary

The measured characteristics of the Time-Keyed Remote Synchronization channel are depicted in Figure 11.25 and Figure 11.26. The results of these tests are summarized in Table 11.14.

Figure 11.25 Time-Keyed Remote Synchronization Pilots Power vs. Frequency, 99.0% Occupied Bandwidth, and Time-Domain Average Burst Power

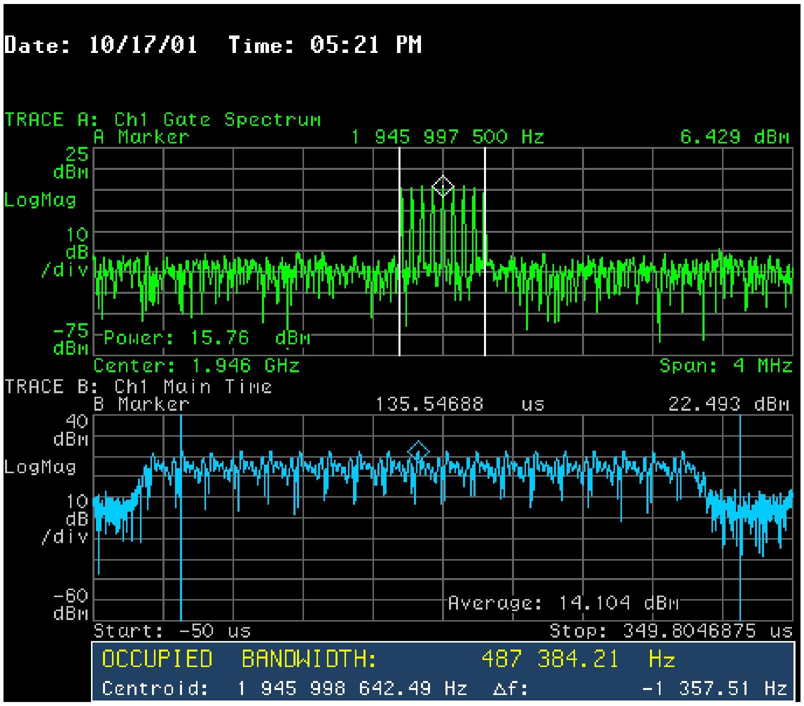
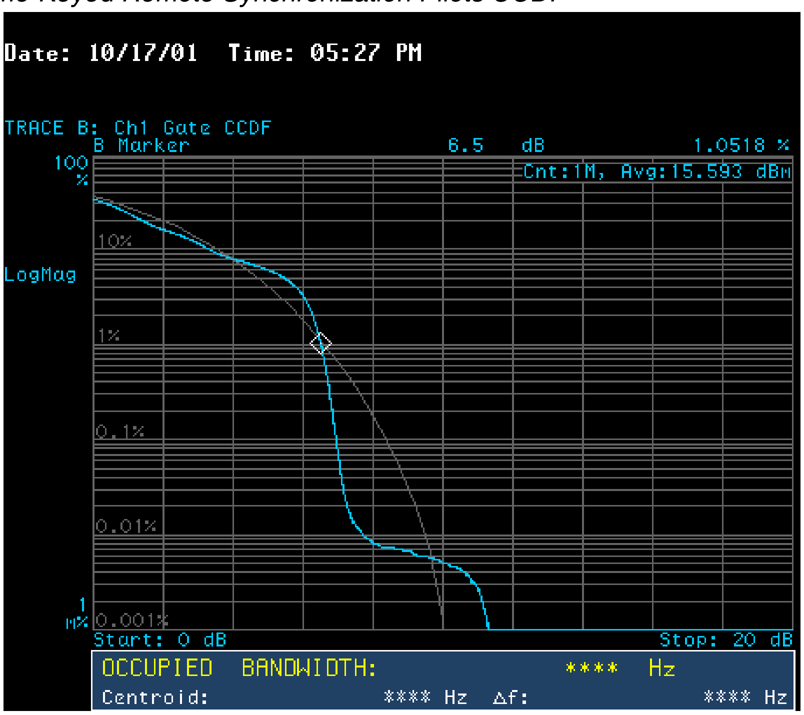


Figure 11.26 Time-Keyed Remote Synchronization Pilots CCDF



11.2.5.3.10 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.

11.2.5.3.11 Results Summary

The measured characteristics of the Remote Synchronization channel are depicted in Figure 11.27 and Figure 11.28. The results of these tests are summarized in Table 11.14.

Figure 11.27 Simulcast Remote Synchronization Pilots Power vs. Frequency, 99.0% Occupied Bandwidth, and Time-Domain Average Burst Power.

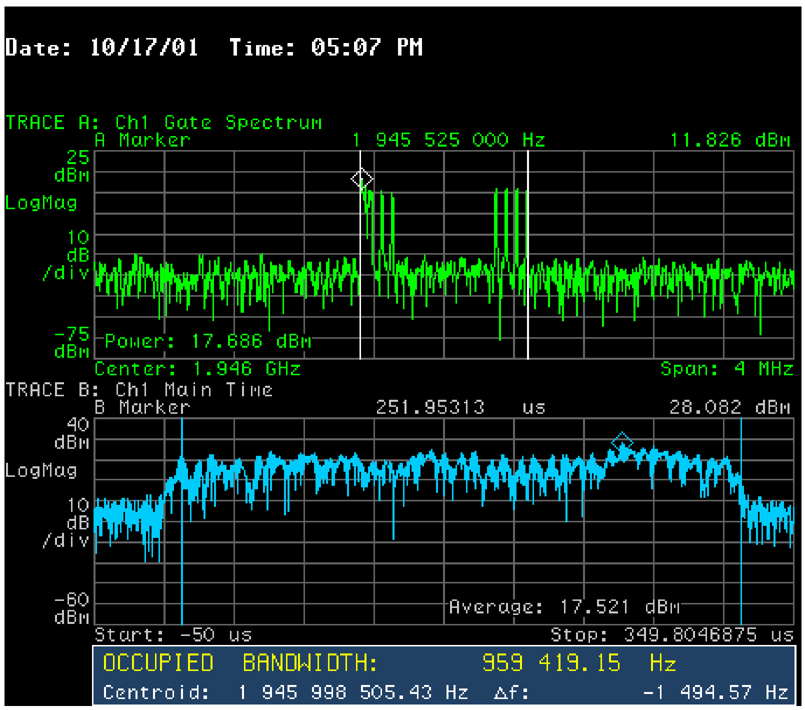


Figure 11.28 Simulcast Remote Synchronization Pilots CCDF.

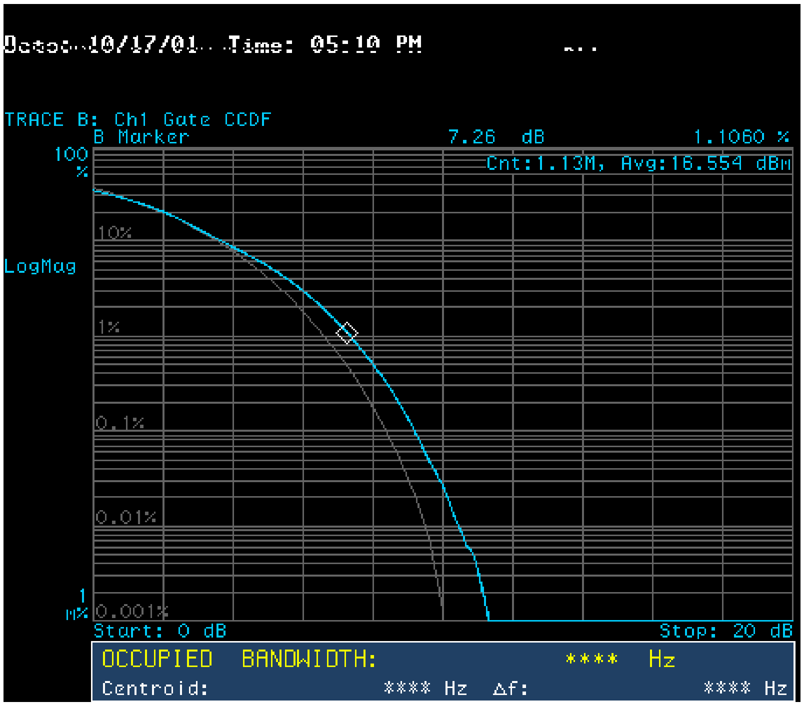


Table 11.14 Logical Channel Characterization Test Results Summary

Parameter	Measured Value
Multiple Voice Channel 99% Occupied Bandwidth	948 kHz
Multiple Voice Channel Average Power	33.86 dBm/1MHz
Voice Channel Peak/Average Ratio at =99.0% occurrence after 1x10^6 samples	7.92 dB
High-Speed Data Channel 99% Occupied Bandwidth	946.6 kHz
High-Speed Data Channel Average Power	31.7 dBm/1 MHz
High-Speed Data Peak/Average Ratio at =99.0% occurrence after 1x10^6 samples	8.16 dB
High-Speed Data Control Channel 99% Occupied Bandwidth	54.6 kHz
High-Speed Data Control Channel Average Power	17.5 dBm
High-Speed Data Control Channel Peak/Average Ratio at =99.0% after 1x10^6 samples	6.98 dB
NAC Channel 99% Occupied Bandwidth	69.3 kHz
NAC Channel Average Power	14.9 dBm
NAC Channel Peak/Average Ratio at =99.0% occurrence after 1x10^6 samples	9.1 dB
Time-Keyed Remote Synchronization Channel 99% Occupied Bandwidth	487 kHz
Time-Keyed Remote Synchronization Channel Average Power	15.76 dBm
Time-keyed Remote synchronization Channel Peak/Average Ration at =99.0% occurrence after 1x10^6 samples	6.5 dB

Simulcast Remote Synchronization Channel 99% Occupied Bandwidth	959.4 kHz
Simulcast Remote Synchronization Channel Average Power	17.7 dBm
Simulcast Remote Synchronization Channel Peak/Average Ratting at =99.0% occurrence after $1x10^6$ samples	7.3 dB

11.2.6 RF Output Power

11.2.6.1 Applicable FCC Rules

- FCC Subpart 2.1046 - 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 §2.1033(c)(8). 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.

11.2.6.2 Test Configuration

Peak RF Output Power from the Base Station is maximized while supporting 15 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 15 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.

11.2.6.3 Results Summary

The measured RF output power of the Base Station while supporting 15 simultaneous voice calls in a single TDMA slot is depicted in Figure 11.29 through Figure 11.31. The results of these tests are summarized in Table 11.15.

Figure 11.29 Time-Domain Power Envelope, Average Power.

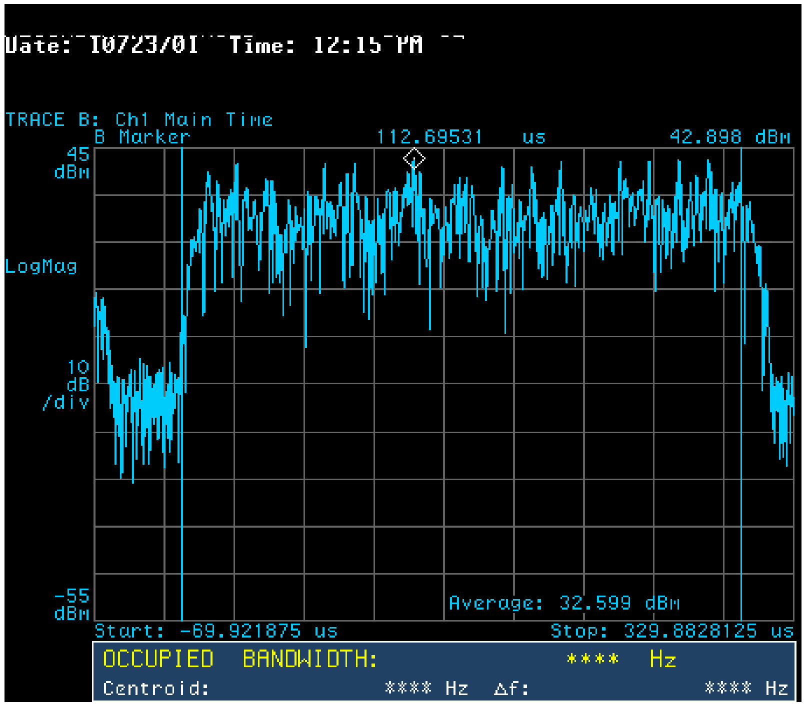


Figure 11.30 Time-Domain Power Envelope, Peak Power at <_99.0% Occurrence.

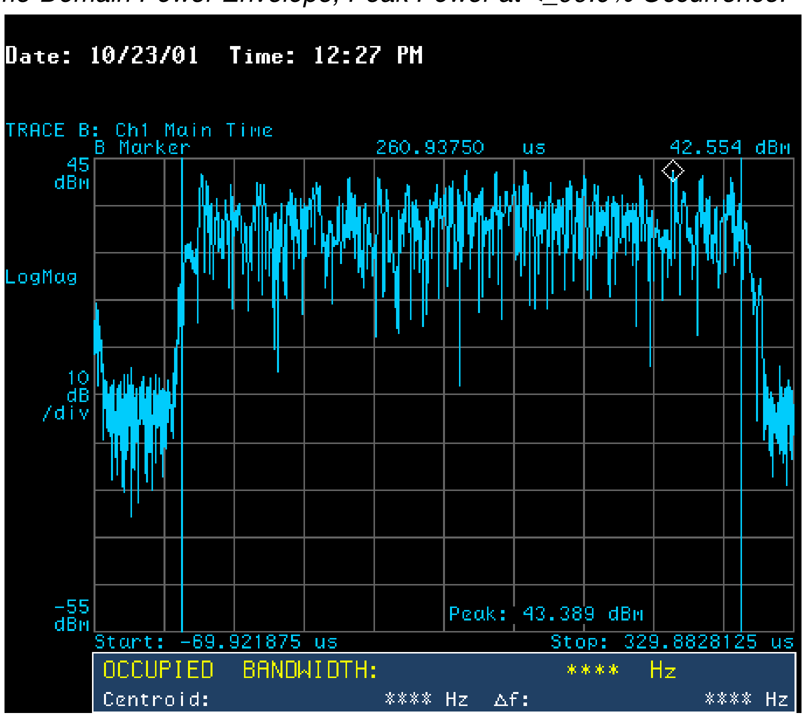


Figure 11.31 Time-Domain Power Envelope, Peak/Average Ratio at <_99.0% Occurrence

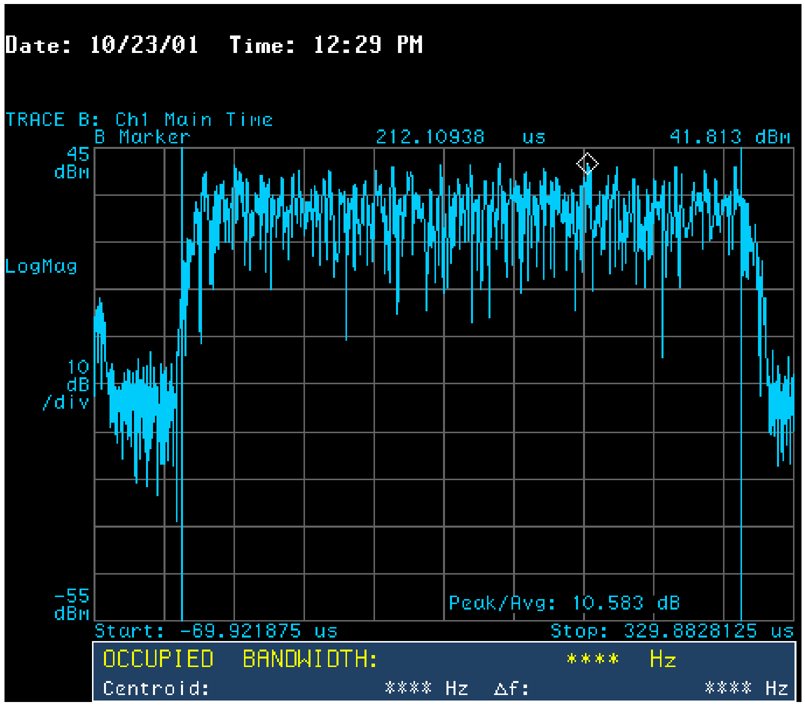


Table 11.15 RF Output Power Characteristics

Parameter	Measured Value	FCC Part 24 Limit
Time-Domain Average Power	32.6 dBm	N/A
Time-Domain Peak Power at =99.0% Occurrence	43.4 dBm	+50.0 dBm/1 MHz RBW
Time-Domain Peak/Average Ratio at =99.0% Occurrence	10.6 dB	N/A.

11.2.7 Spurious Emissions at the Antenna Terminal

11.2.7.1 Applicable FCC Rules

- FCC Subpart 2.1046 - 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 26 dB below the transmitter power.

11.2.7.2 Test Configuration

RF Output Power and Out-Of-Band (OOB) emissions from the Base Station are maximized while transmitting 15 simultaneous FDMA slots within a TDMA slot. For this test, 15 Remote Units were used to set up 15 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 15 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 11.8. The Hewlett-Packard 89441A Vector Signal Analyzer was configured according the parameters shown in Table 11.6.

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 1924 to 1965 MHz. Emissions at all applicable frequencies above and below this range have been documented in “Radiated to Conducted Spurious Emissions”.

11.2.7.3 Results Summary

The measured spectral purity of the Base Station while transmitting 15 simultaneous voice calls in a single TDMA slot is depicted in Figure 11.32 through Figure 11.42. The results of these tests are summarized in Table 11.16.

Figure 11.32 1MHz Band-Power Between 1945.5 and 1946.5 MHz.

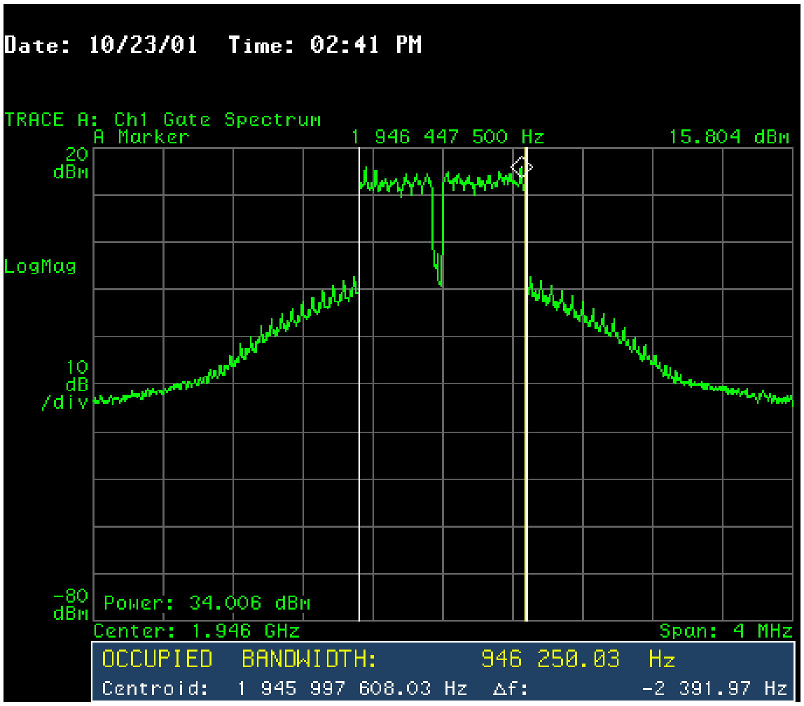


Figure 11.33 Maximum Lower Guard Band Spurious Power, Measured in a 1MHz Resolution BW. Marker Indicates Edge of Subband

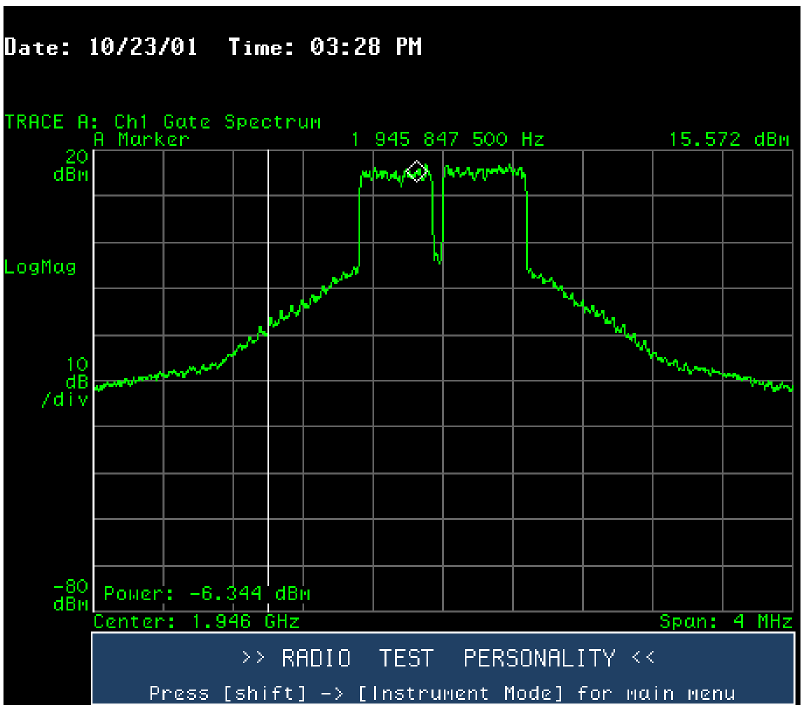


Figure 11.34 Spectral Purity from 1937MHz to 1944MHz, with Spurious Power Measured in a 1MHz Band-Power, Marker Centered on 1938.8MHz Denoting Spurious Emissions.

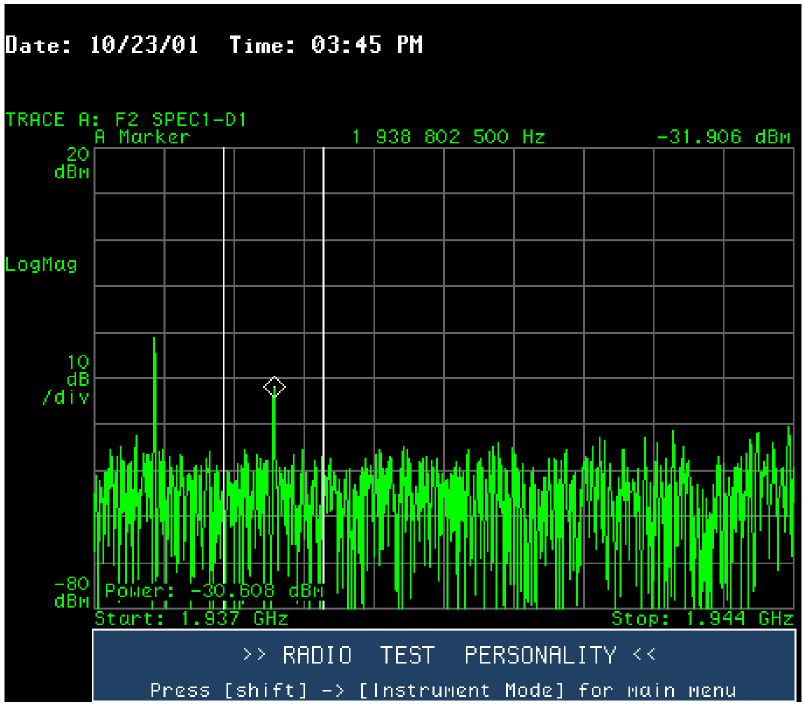


Figure 11.35 Spectral Purity from 1937MHz to 1944MHz, with Spurious Power Measured in a 1MHz Band-Power, Marker Centered on 1937.6MHz Denoting Spurious Emissions

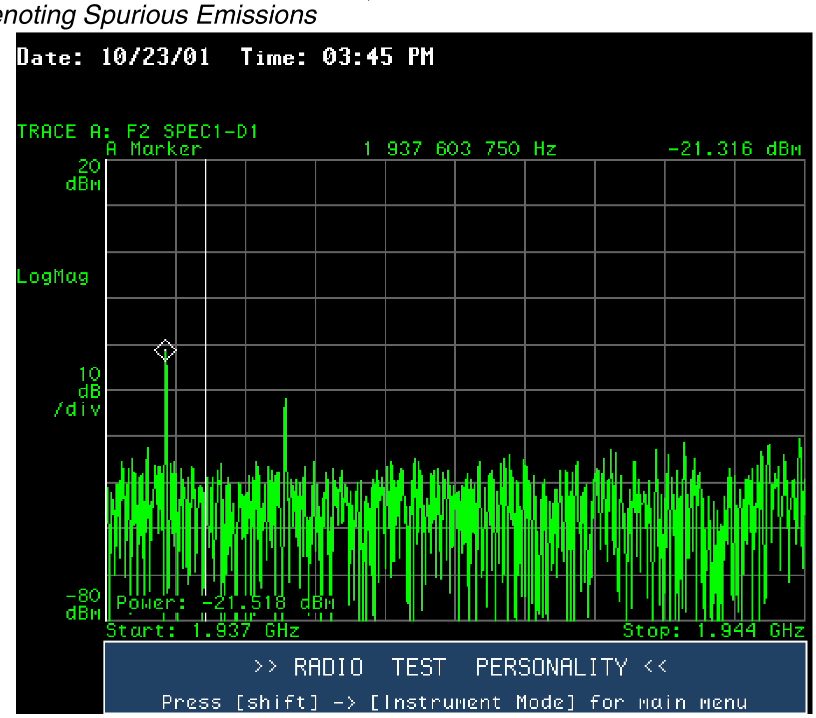


Figure 11.36 Spectral Purity from 1930MHz to 1937MHz, with Spurious Power Measured in a 1MHz Band-Power.

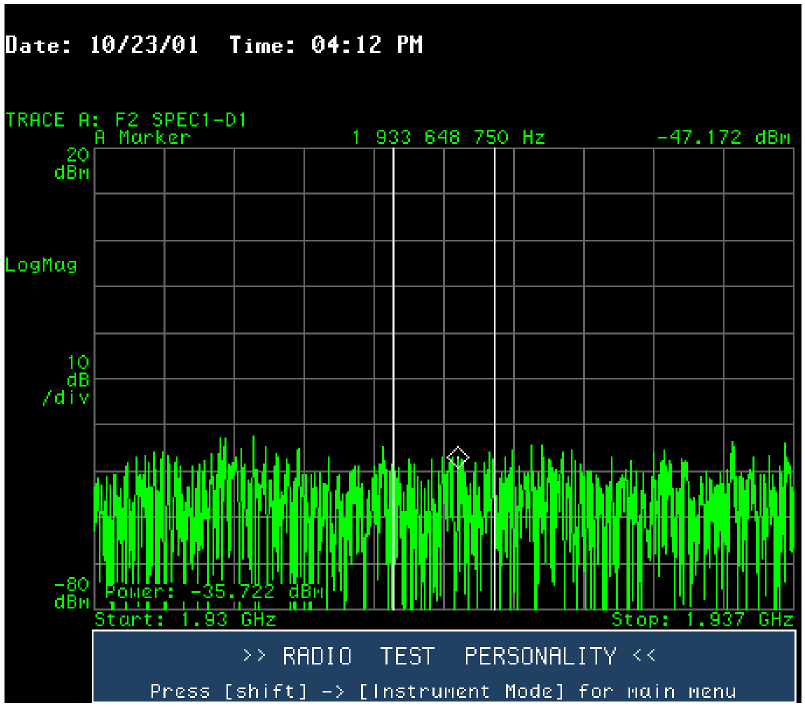


Figure 11.37 Spectral Purity from 1924MHz to 1931MHz, with Spurious Power Measured in a 1MHz Band-Power, Marker Centered on 1930MHz Denoting Spurious Emissions

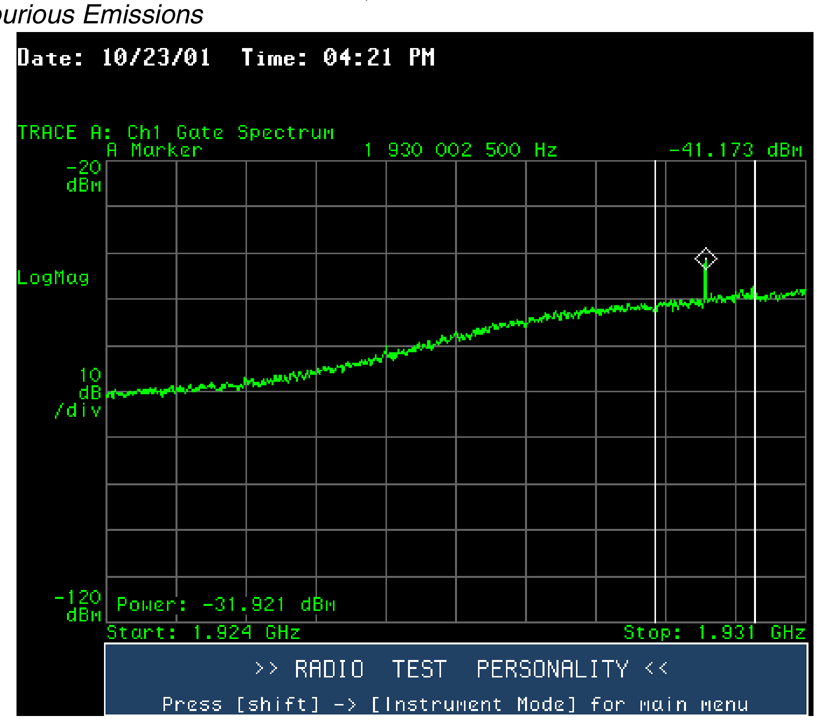


Figure 11.38   1MHz Band-Power Between 1948.5 and 1949.5MHz.

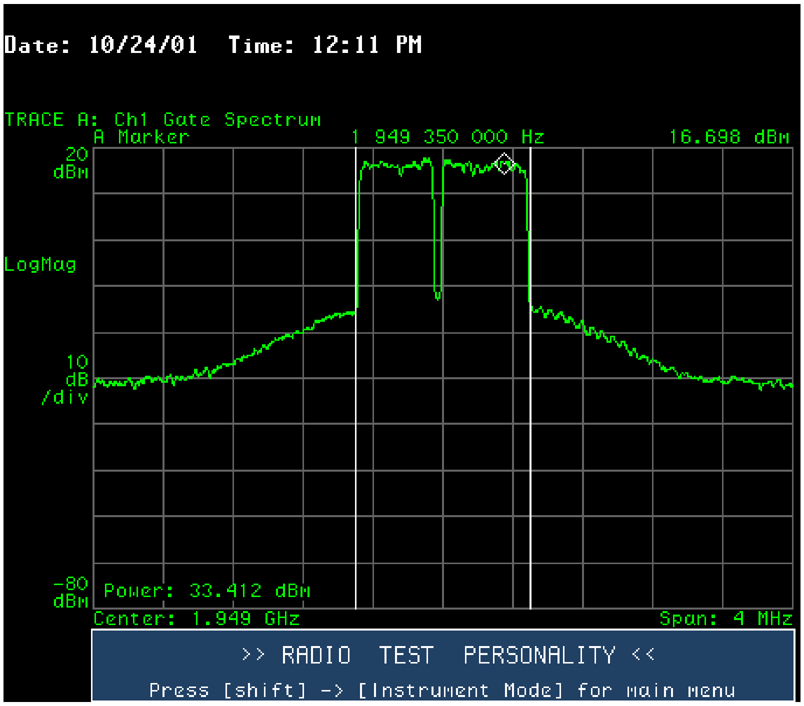


Figure 11.39   Maximum Upper Guard Band Spurious Power with Band Power Markers Centered on 1950.5 MHz Indicating Guard Band

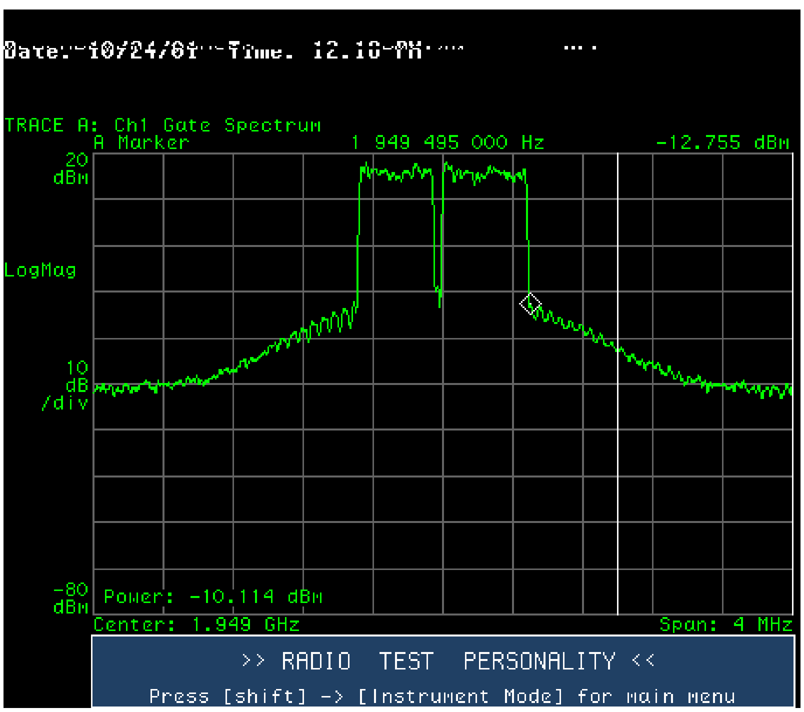


Figure 11.40 Spectral Purity from 1951MHz to 1958MHz, with Spurious Power Measured in a 1MHz Band-Power, Marker Centered on 1952.2 MHz Denoting Spurious Emissions.

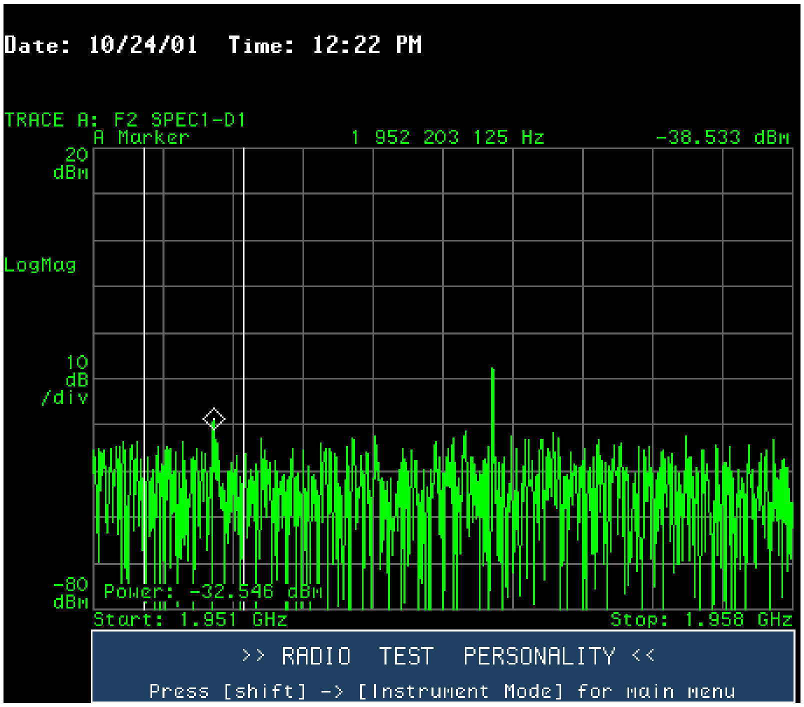


Figure 11.41 Spectral Purity from 1951MHz to 1958MHz, with Spurious Power Measured in a 1MHz Band-Power, Marker Centered on 1955 MHz Denoting Spurious Emissions

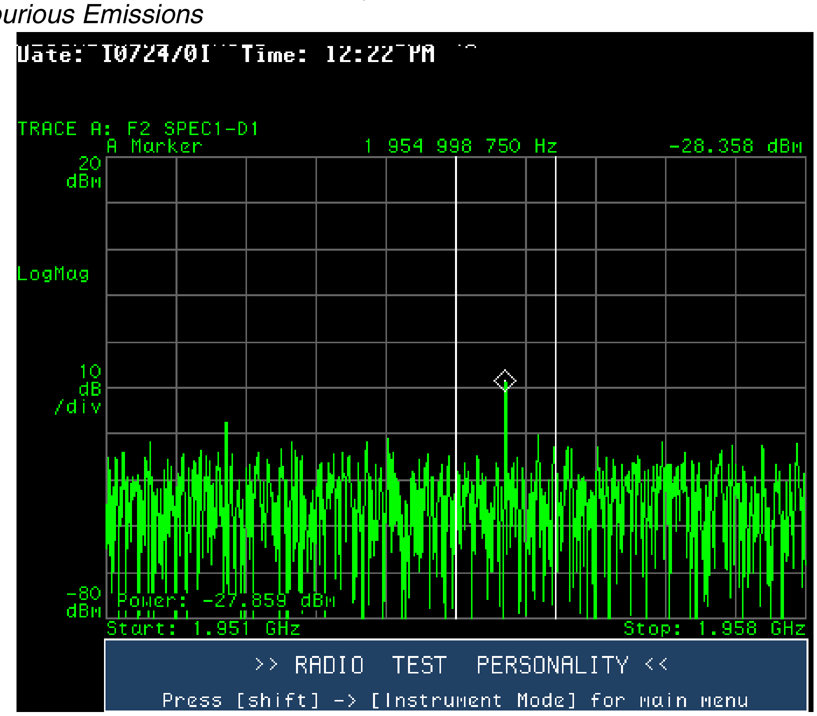


Figure 11.42 Spectral Purity from 1958MHz to 1965MHz, with Spurious Power Measured in a 1MHz Band-Power, Marker Centered on 1961.8 MHz Denoting Spurious Emissions

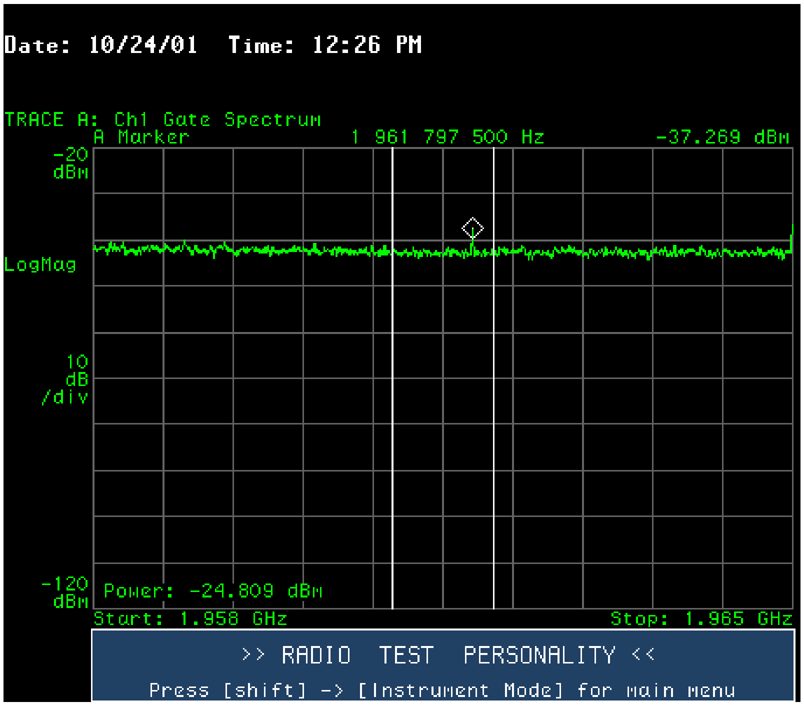


Table 11.16 Base Station In-Band and Out-Of-Band Power Summary

Parameter	Measured Value	FCC Part 24 Limit
Total power centered @ 1946 MHz	34 dBm/1 MHz RBW	* <35 dBm/1 MHz RBW
Max Spurious Power between 1944 and 1945 MHz	-6.3 dBm/1 MHz RBW	+7 dBm/1 MHz RBW
Max Spurious Power between 1937 and 1944 MHz	-30.6 dBm/1 MHz RBW	-13 dBm/1 MHz RBW
Max Spurious Power between 1930 and 1937 MHz	-35.7 dBm/1 MHz RBW	-13 dBm/1 MHz RBW
Max Spurious Power between 1924 and 1931 MHz	-31.9 dBm/1 MHz RBW	-13 dBm/1 MHz RBW
Total Power Centered @1949 MHz	33.4 dBm/1 MHz RBW	* <35 dBm/1 MHz RBW
Maximum spurious power between 1950 and 1951 MHz	-10.1 dBm/1 MHz RBW	+7 dBm/1 MHz RBW

Maximum spurious power between 1951 and 1958 MHz	-32.5 dBm/1 MHz RBW	-13 dBm/1 MHz RBW
Maximum spurious power between 1958 and 1965 MHz	-24.8 dBm/1 MHz RBW	-13 dBm/1 MHz RBW.

*Transmit power limited by design.

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 15 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 15 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 a worst-case scenario. The following modes were tested per FCC Regulatory Standards:

- Completely loaded digital shelf
- 15 voice calls within same time slot (maximum time slot capacity-worst case scenario)
- 60 voice calls on a single sector
- 60 voice calls, 15 voice calls per sector with HAD operation within one sector

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 11.17 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	8/6/01	8/6/02
Antenna 1	EMCO	3115	5514-9807	5/27/01	5/27/02

Cable 1	Gore	53 ft.	00195373, 00195374, 00195375	10/23/00	10/23/01
Analyzer	Hewlett-Packard	8546A	3520A00260	6/12/01	6/12/02
Preselector	Hewlett-Packard	8546A internal	3330A0010	6/12/01	6/12/02
QPeak Adapter	Hewlett-Packard	internal to RF section	internal	6/12/01	6/12/02
Pre-Amplifier	Hewlett-Packard	8546Ainternal	internal	6/12/01	6/12/02
Tower 1	EMCO	1050	1123	N/A	N/A
Turntable 1	EMCO	1060	1049	N/A	N/A
Antenna	Chase	CBL6111 A	1704	9/26/01	9/26/02
Positioner Controller	EMCO	2090	9601-1101	N/A	N/A
EMI Measurement System	Hewlett-Packard	84125C	4536439011	12/14/00	12/14/01

11.3.3 List of Equipment Under Test

Test cases within this section were executed using the equipment under test listed in the following tables.

Table 11.18 Network Components

Card Name	Serial Number	Revision
SYNC	1999903560DC0052	D8
NIC	0000380047-010402	2
NIC	0000380049-010402	4
WP	0001025493-001026	6
WP	0001025707-010129	6
WP	0001027685-010416	7
WP	0001025476-001026	6
BCP	0001027759-010417	4
BCP	0001027756-010417	4
SBC	0001027746-010417	5
SBC	0001027738-010417	5
SBC	0001027743-010417	5
SBC	0001027741-010417	5
SMP	0001029272-010530	4

11.3.4 EMC Test Results

11.3.4.1 Radiated Emissions

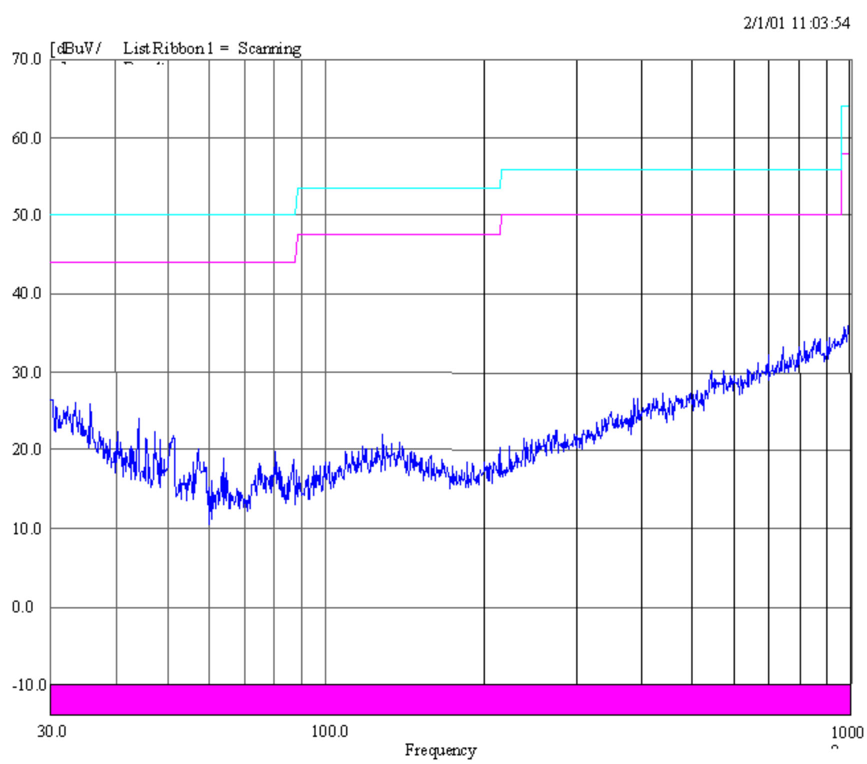
An FCC approved three-meter room was utilized to complete the necessary Part 15, Class A testing. Class A three-meter limits are outlined in Table 11.19. These limits were extrapolated to establish the radiated emission limits for Class A devices.

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 11.48.

Table 11.19 FCC Radiated Emission Limits for Class A Devices at Three Meters

Frequency (MHz)	Field Strength dB(MicroVolts/ meter)	Measurement Distance (Meters)
30 - 88	50	3
88 - 215	53.5	3
215 - 960	56.5	3
Above 960	60	3

Figure 11.43 Three-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.

Figure 11.44 through Figure 11.53 correspond to the emissions profile of the PWAN Base Station, measured from 30MHz – 26.5GHz 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 top EMC filtered patch panel. The cabinet housing the PWAN Base Station was grounded via a 2 inch wide braid at the outer corners. To accomplish the worst case digital configuration of 15 voice calls located within the same TDMA slot, the digital shelf was fully loaded in order to fully populate the PWAN Base Station.

11.3.4.2 Test Results

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. As shown in Figure 11.44, no signals exceeded the Class A FCC limit line.

Figure 11.44   30-1000MHz, 15 Calls on Single TDMA Slot.

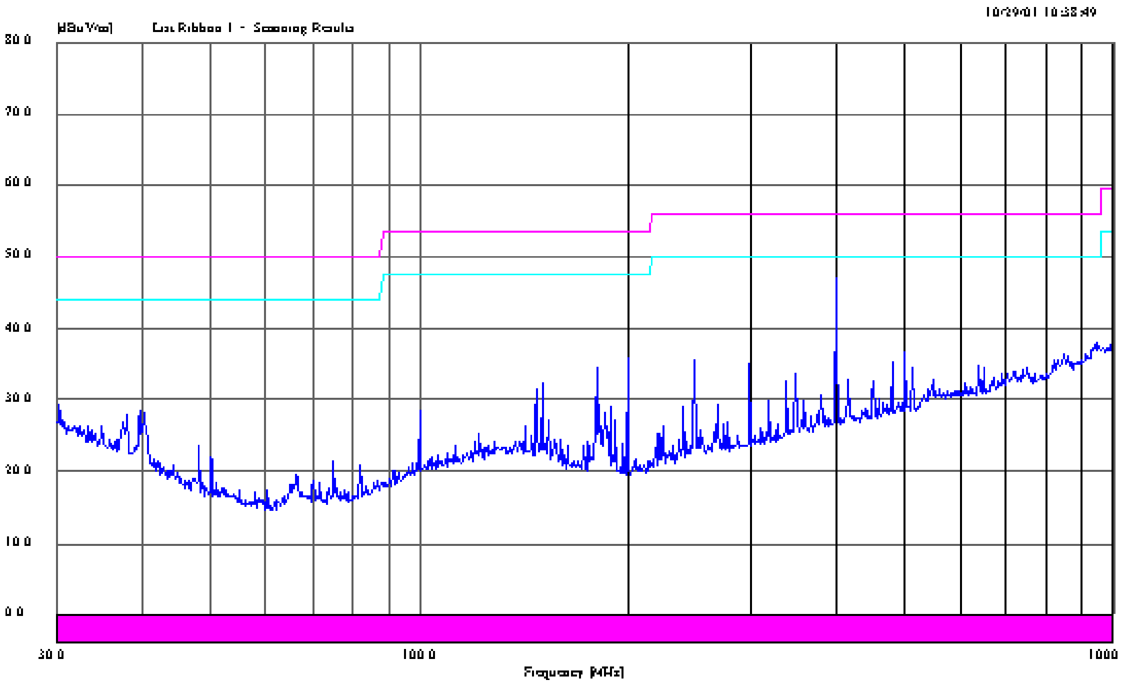
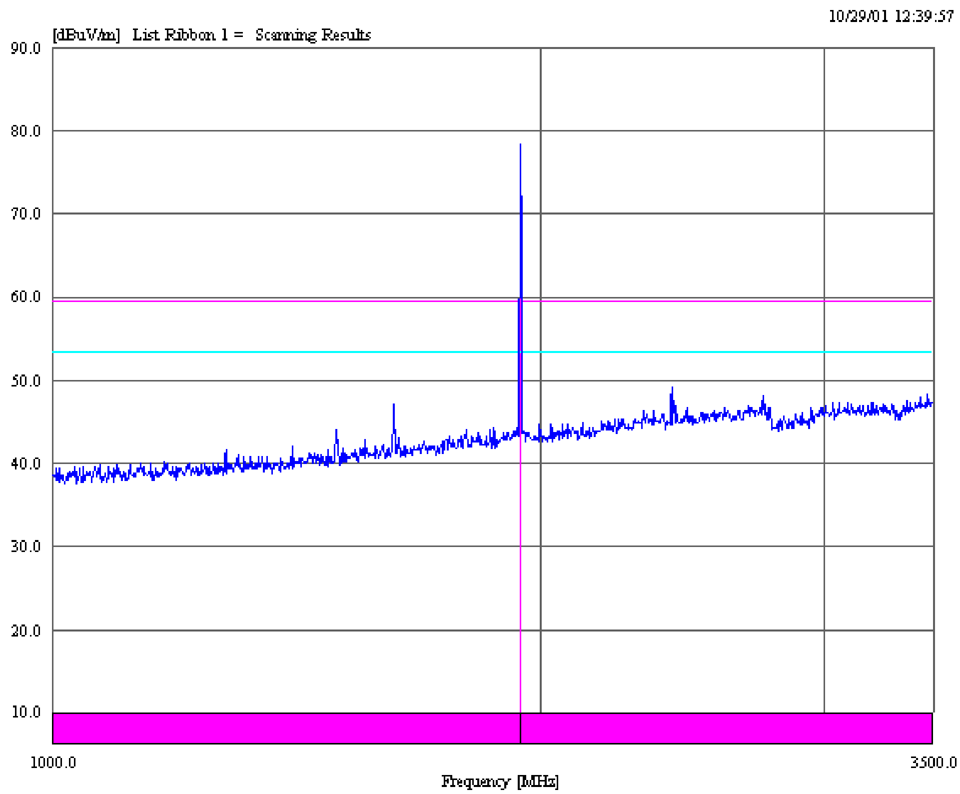


Figure 11.45 1000MHz-35000MHz Emissions Scan, 15 Calls on Single TDMA Slot



The group of signals shown in Figure 11.45 corresponds to the PWAN Base authorized transmit frequencies. The time variant noise within the Base were within the noise floor of the receiver during peak detector measurements.

Figure 11.46 3.5GHz-18.0GHz @1m Antenna Height Emissions Scan, Vertical Polarization, 15 Calls Same TDMA

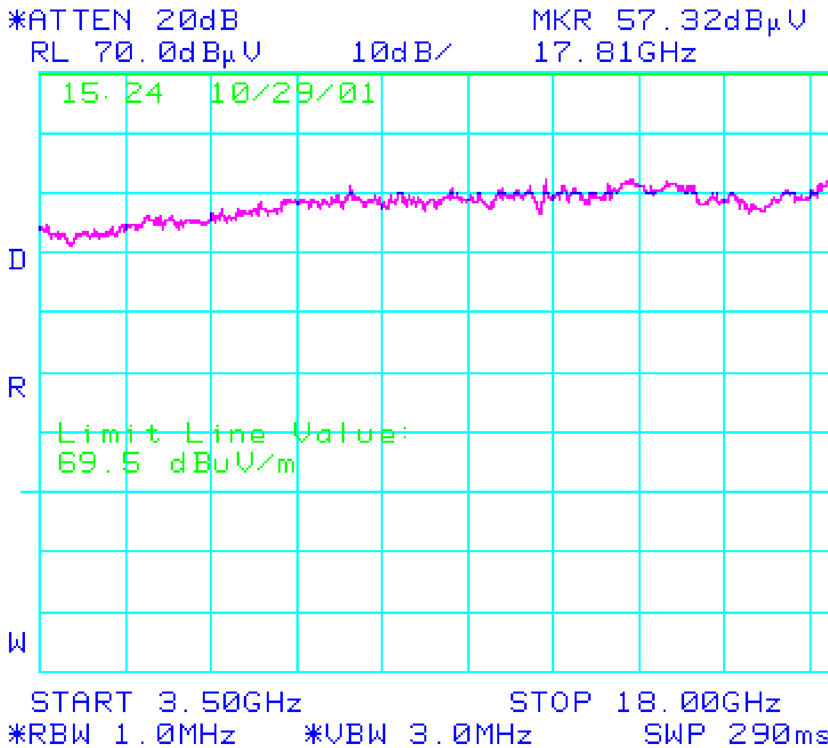


Figure 11.46 is the PWAN Base Station radiated emissions scan (3.5GHz – 18GHz) in the vertical polarization at a 1 meter antenna height.

During testing, the PWAN PCS Base Station was set up and tested in the following modes of operation:

- Completely loaded digital shelf
- 15 voice calls within the same time slot (maximum time slot capacity)
- 60 voice calls on a single sector
- 60 voice calls, 15 voice calls per sector with HSD operation within one sector

While testing the above-mentioned modes of operation, no measurable differences in FCC part 15 emissions were detected. Hence, all following test data was gathered using fully loaded digital shelf with 15 voice calls within the same time slot.

Figure 11.47 3.5 GHz-18.0 GHz @1m Antenna Height Emissions Scan, Horizontal Polarization, 15 Calls Same TDMA

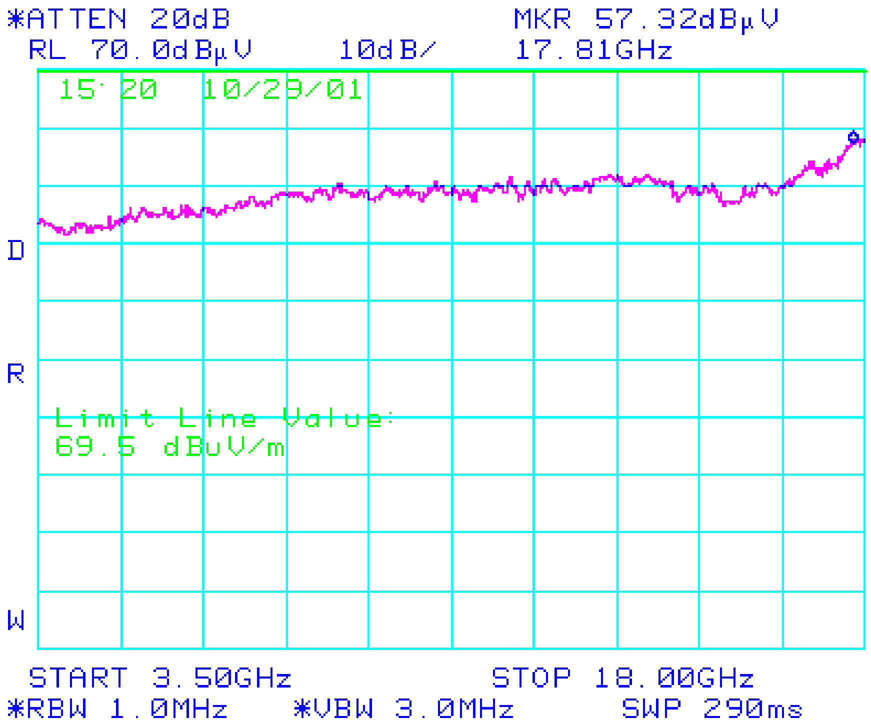


Figure 11.47 is the PWAN Base Station radiated emissions scan (3.5 GHz – 18.0 GHz) in the horizontal polarization at a 1 meter antenna height.

During testing, the PWAN PCS Base Station was set up and tested in the following modes of operation:

- Completely loaded digital shelf
- 15 voice calls within the same time slot (maximum time slot capacity)
- 60 voice calls on a single sector
- 60 voice calls, 15 voice calls per sector with HSD operation within one sector

While testing the above-mentioned modes of operation, no measurable differences in FCC part 15 emissions were detected. Hence, all following test data was gathered using fully loaded digital shelf with 15 voice calls within the same time slot.

Figure 11.48 3.5 GHz- 18.0 GHz @1.5m Antenna Height Emissions Scan, Vertical Polarization, 15 Calls, Same TDMA Slot

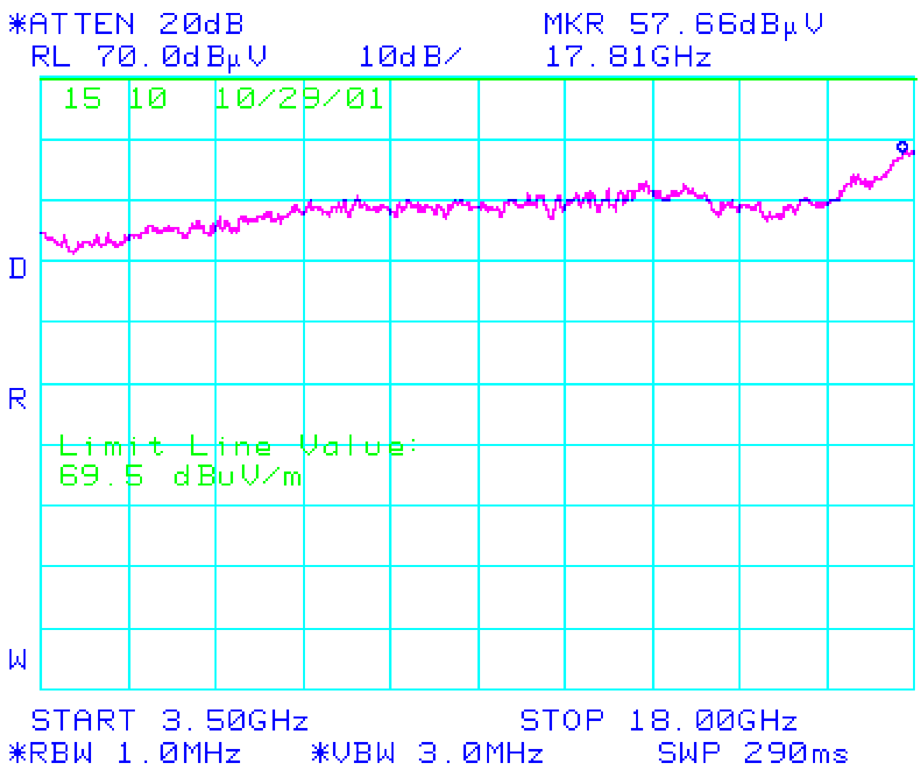


Figure 11.48 identifies the PWAN Base Station radiated emissions data (3.5 GHz - 18.0 GHz) in the vertical polarization at a 1.5-m measurement height.

During testing, the PWAN PCS Base Station was set up and tested in the following modes of operation:

- Completely loaded digital shelf
- 15 voice calls within the same time slot (maximum time slot capacity)
- 60 voice calls on a single sector
- 60 voice calls, 15 voice calls per sector with HSD operation within one sector

While testing the above-mentioned modes of operation, no measurable differences in FCC part 15 emissions were detected. Hence, all following test data was gathered using fully loaded digital shelf with 15 voice calls within the same time slot.

Figure 11.49 3.5 GHz-18.0 GHz @ 1.5m Antenna Height Emissions Scan, Horizontal Polarization, 15 Calls Same TDMA

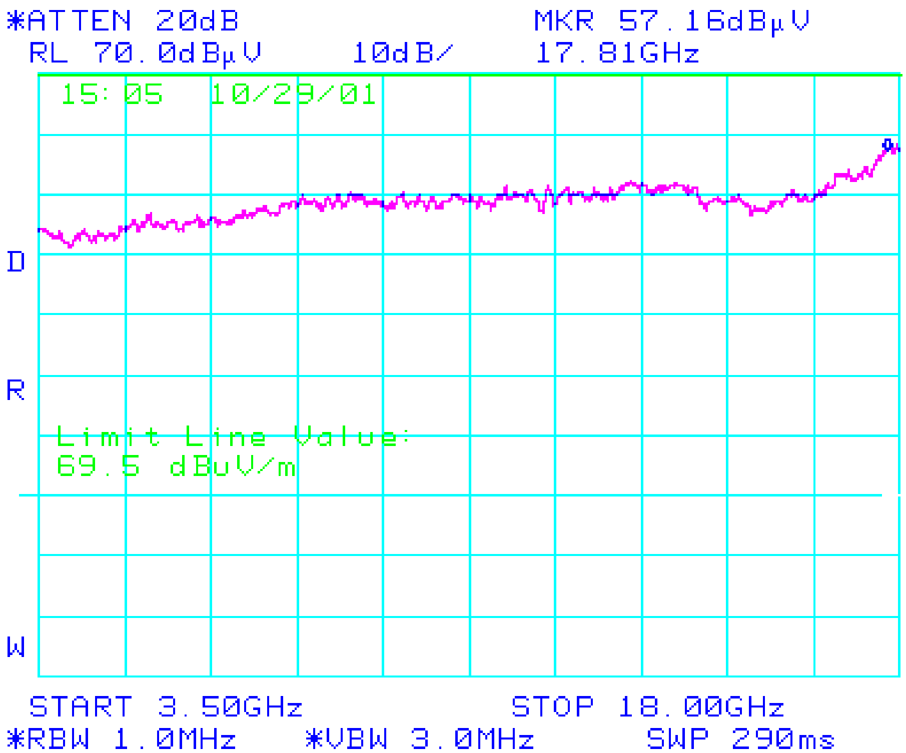


Figure 11.49 identifies the PWAN Base Station radiated emissions data (3.5 GHz - 18.0 GHz) in the horizontal polarization at a 1.5 meter antenna measurement height.

During testing, the PWAN PCS Base Station was set up and tested in the following modes of operation:

- Completely loaded digital shelf
- 15 voice calls within the same time slot (maximum time slot capacity)
- 60 voice calls on a single sector
- 60 voice calls, 15 voice calls per sector with HSD operation within one sector

While testing the above-mentioned modes of operation, no measurable differences in FCC part 15 emissions were detected. Hence, all following test data was gathered using fully loaded digital shelf with 15 voice calls within the same time slot.

Figure 11.50 18 GHz-26.5 GHz @ 1 m Antenna Height Emissions Scan, Vertical Polarization, 15 Calls Same TDMA

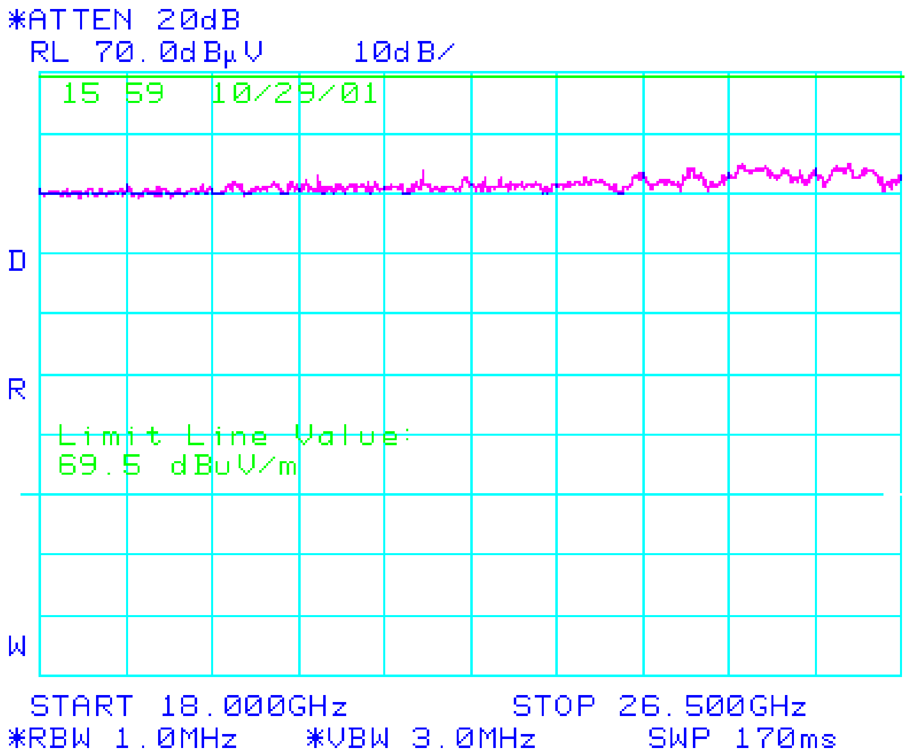


Figure 11.50 is the PWAN PCS Base Station radiated emissions scan (18-26.5 GHz) in the vertical polarization at a 1-m antenna height. During testing, the PWAN PCS Base Station was set up and tested in the following modes of operation:

- Completely loaded digital shelf
- 15 voice calls within the same time slot (maximum time slot capacity)
- 60 voice calls on a single sector
- 60 voice calls, 15 voice calls per sector with HSD operation within one sector

While testing the above-mentioned modes of operation, no measurable differences in FCC part 15 emissions were detected. Hence, all following test data was gathered using fully loaded digital shelf with 15 voice calls within the same time slot.

Figure 11.51 18 GHz-26.5 GHz @ 1 m Antenna Height Emissions Scan, Horizontal Polarization, 15 Calls Same TDMA

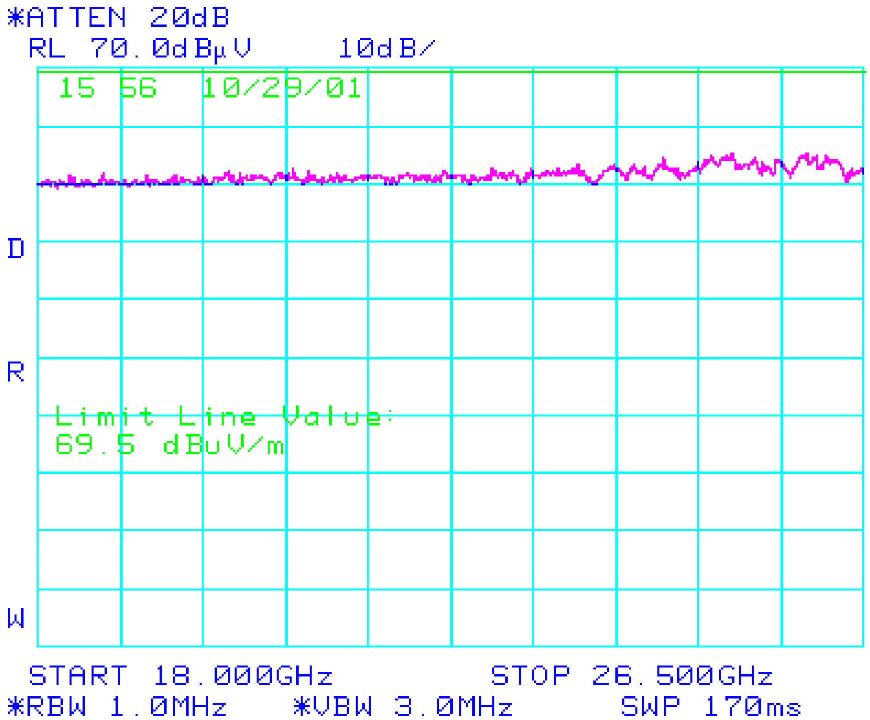


Figure 11.51 is the PWAN PCS Base Station radiated emissions scan (18-26.5 GHz) in the horizontal polarization at a 1-m antenna height. During testing, the PWAN PCS Base Station was set up and tested in the following modes of operation:

- Completely loaded digital shelf
- 15 voice calls within the same time slot (maximum time slot capacity)
- 60 voice calls on a single sector
- 60 voice calls, 15 voice calls per sector with HSD operation within one sector

While testing the above-mentioned modes of operation, no measurable differences in FCC part 15 emissions were detected. Hence, all following test data was gathered using fully loaded digital shelf with 15 voice calls within the same time slot.

Figure 11.52 18 GHz-26.5 GHz @ 1.5 m Antenna Height Emissions Scan, Vertical Polarization, 15 Calls Same TDMA

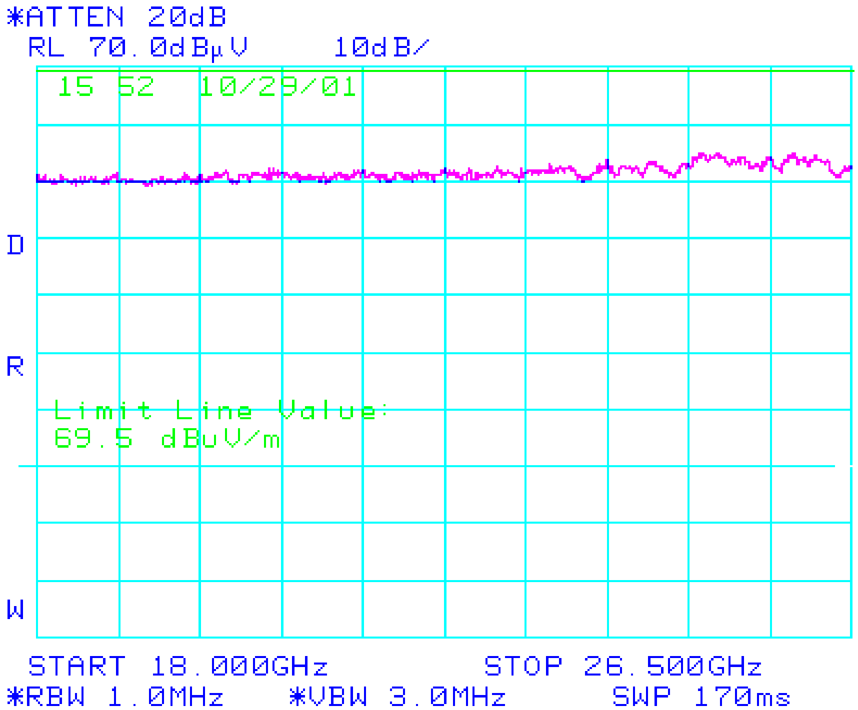


Figure 11.52 is the PWAN PCS Base Station radiated emissions scan (18-26.5 GHz) in the vertical polarization at a 1.5-m antenna height. During testing, the PWAN PCS Base Station was set up and tested in the following modes of operation:

- Completely loaded digital shelf
- 15 voice calls within the same time slot (maximum time slot capacity)
- 60 voice calls on a single sector
- 60 voice calls, 15 voice calls per sector with HSD operation within one sector

While testing the above-mentioned modes of operation, no measurable differences in FCC part 15 emissions were detected. Hence, all following test data was gathered using fully loaded digital shelf with 15 voice calls within the same time slot.

Figure 11.53 18 GHz-26.5 GHz @ 1.5 m Antenna Height Emissions Scan, Horizontal Polarization, 15 Calls Same TDMA

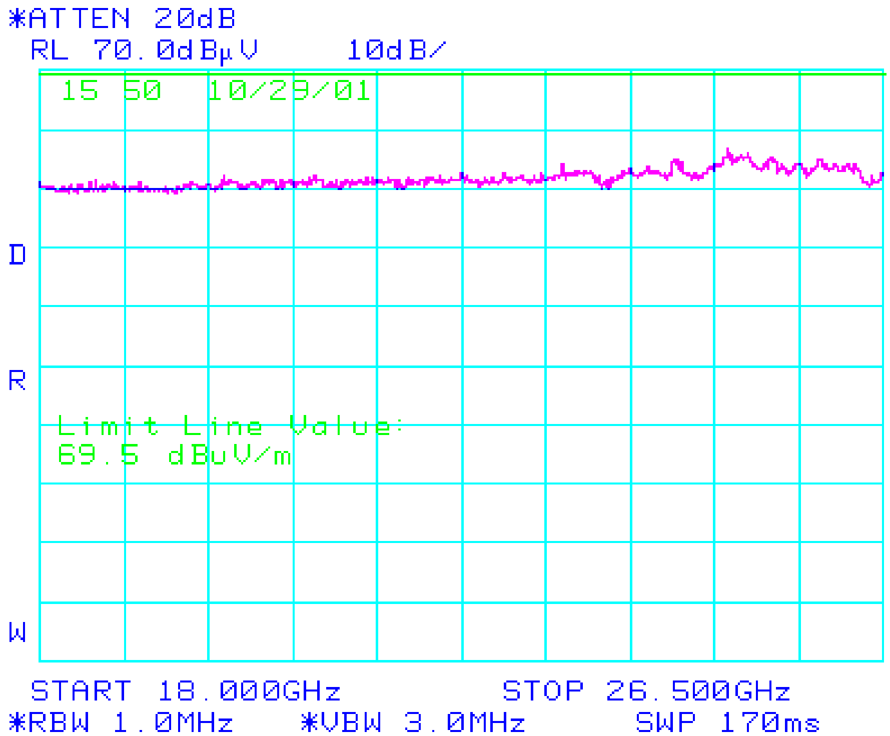


Figure 11.53 is the PWAN PCS Base Station radiated emissions scan (18-26.5 GHz) in the horizontal polarization at a 1.5-m antenna height. During testing, the PWAN PCS Base Station was set up and tested in the following modes of operation:

- Completely loaded digital shelf
- 15 voice calls within the same time slot (maximum time slot capacity)
- 60 voice calls on a single sector
- 60 voice calls, 15 voice calls per sector with HSD operation within one sector

While testing the above-mentioned modes of operation, no measurable differences in FCC part 15 emissions were detected. Hence, all following test data was gathered using fully loaded digital shelf with 15 voice calls within the same time slot.

11.3.4.3 Radiated to Conducted Spurious Emissions

11.3.4.3.1 Applicable FCC Rules

- FCC Subpart 2.1046 -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.

11.3.4.3.2 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.

Figure 11.44 through Figure 11.53 correspond to the emissions profile of the PWAN Base Station, measured from 30MHz – 26.5GHz 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 top EMC filtered patch panel. The cabinet housing the PWAN Base Station was grounded via a 2 inch wide braid at the outer corners. To accomplish the worst case digital configuration of 15 voice calls located within the same TDMA slot, the digital shelf was fully loaded in order to fully populate the PWAN Base Station.

11.3.4.3.3 Test Results

After completion of the radiated emission scans, Figure 11.43 through Figure 11.53 indicate no spurious emissions other than the authorized PCS PWAN Base Station transmit frequencies.

Chapter 12 Test Setup Photos

Overview

This section contains test setup photos.

Contents

12.1 Radiated Emissions Test Setup

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 FWAN PCS Base Station was set up in a typical field configuration, as shown in Figure 12.1, with the FWAN PCS Base Station being in the center of the turntable. Proper interconnecting cable was utilized from the FWAN PCS Base Station to the system power supply.

All radiated emissions testing was completed in the following modes of operation:

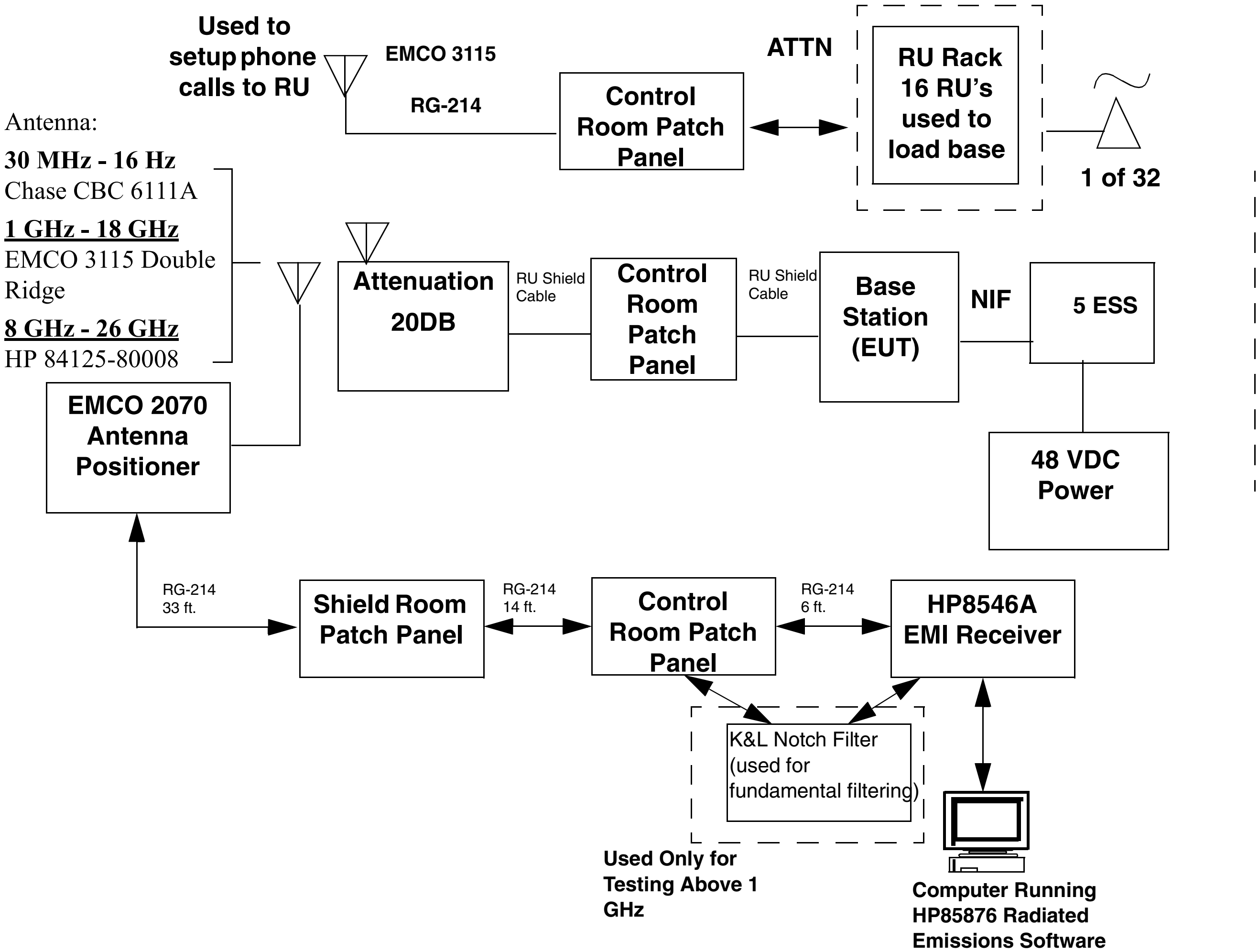
- Completely loaded digital shelf
- 15 voice calls within the same time slot (maximum time slot capacity)
- 60 voice calls on a single sector
- 60 voice calls, 15 voice calls per sector with HSD operation within one sector

While testing the above-mentioned modes of operation, no measurable differences in FCC part 15 emissions were detected. Hence, all following test data was gathered using fully loaded digital shelf with 15 voice calls within the same time slot.

Testing was completed from 30 MHz to 26.5 GHz.

To complete the calls, a test fixture utilizing a rack of sixteen (16) Remote Units (RUs) with four telephones per RU was established. Figure 12.10 shows the RU test rack used to load the Base Station. The rack was designed to hold up to 16 remote units together with all power, RF, and telco connections. This design was necessary in order to load the Base Station with the maximum number of calls on the same time slot and sector. That is, we used 16 remote units, four lines each, for a total of 64 calls.

Figure 12.1 Radiated Emissions Test Setup



12.2 Parts Comprising Equipment Under Test (EUT)

12.2.1 List of Equipment Under Test

Table 12.1 EUT List

Card Name	Serial Number	Revision
SYNC	1999903560DC0052	D8
NIC	0000380047-010402	2
NIC	0000380049-010402	4
WP	0001025493-001026	6
WP	0001025707-010129	6
WP	0001027685-010416	7
WP	0001025476-001026	6
BCP	0001027759-010417	4
BCP	0001027756-010417	4
SBC	0001027746-010417	5
SBC	0001027738-010417	5
SBC	0001027743-010417	5
SBC	0001027741-010417	5
SMP	0001029272-010530	4

12.3 EUT Test Configuration Photos

Figure 12.2 Base, Configuration, Doors Open—Front View

Figure 12.3 Base Configuration, Doors Closed—Side View

Figure 12.4 Base Configuration, Doors Closed—Rear Side View

Figure 12.5 Base Configuration, Rear Panels Removed—Rear View

12.4 Testing Facility and Location

During the month of October, 2001, a series of radio frequency interference measurements were performed on the AT&T Base Station Version B1.8 PCS.

For Class A digital devices/intentional radiator, the tests were performed according to the procedures of the FCC as stated in the "Methods of Measurement of Radio-Noise Emissions from Low – Voltage Electrical and Electronic Equipment in the range of 9kHz to 40 GHz" found in the American National Standards Institute, ANSI C63.4-1992 (Revision of the ANSI C63.4-1988). These tests were performed by personnel of AT&T WIRELESS SERVICES EMC Laboratory at 9461 Willows Road Redmond, Washington. Additionally FCC Part 15 radiated emissions testing was completed at the same location within an FCC certified 3 meter semi-anechoic shield room.

Figure 12.6 shows the overall control room setup used to acquire test data during radiated and conducted emissions testing. From left to right, the control room is set up as follows: HP8546A receiver, EMCO 2090 dual device controller (turntable and tower), CCTV and controller used to monitor the device under test, and HP Vectra computer, monitor, and printer used to control the EMC measurement software and data acquisition processes.

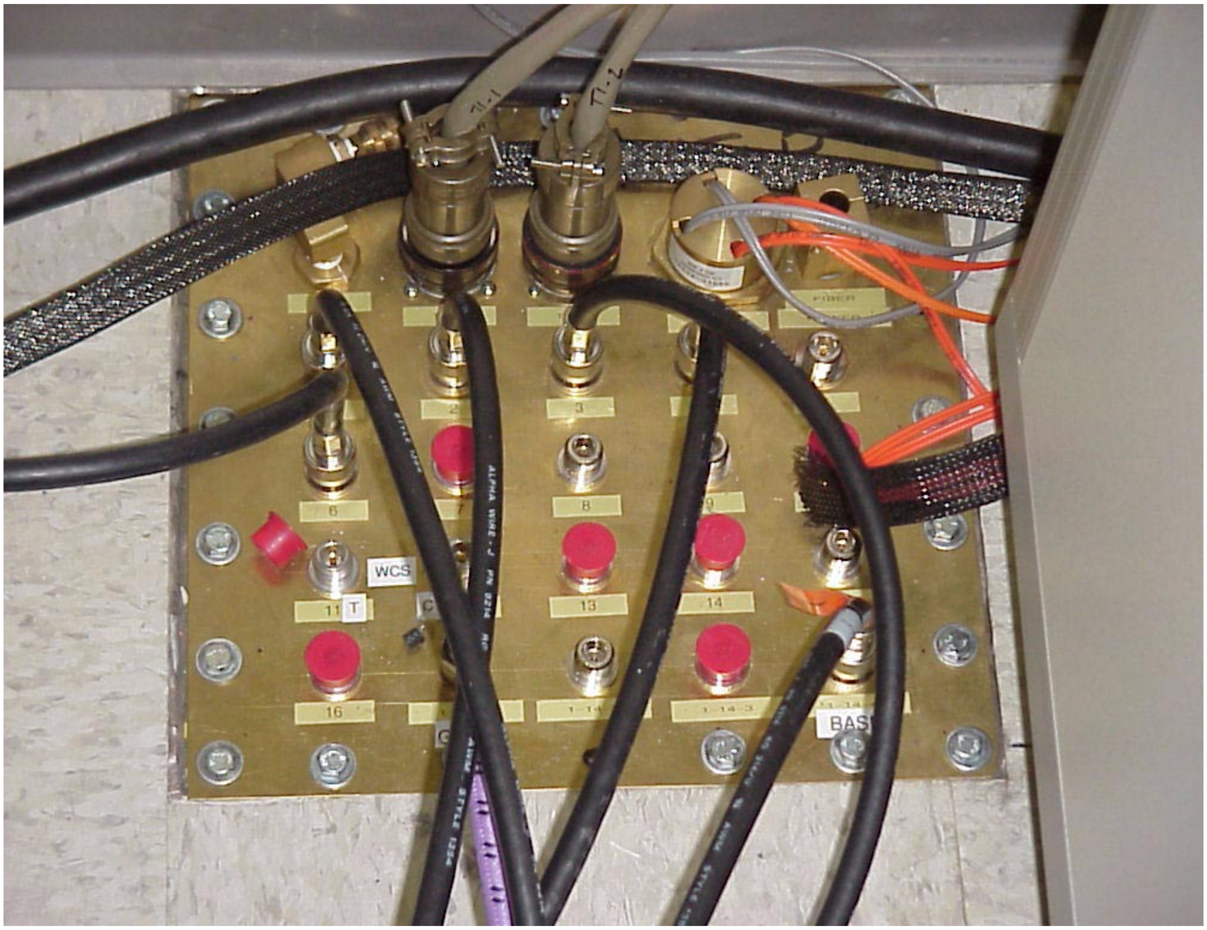
Figure 12.6 3-Meter Shield Room Control Room

All radiated emission measurements were taken in an isolated /shielded control room using a Hewlett Packard 8546A EMI receiver system 12.7

Figure 12.7 3-Meter Control Room

All data/telco and RF enters and exits shield room from this panel

Figure 12.8 3-Meter Control Chamber Access Panel Penetration.



Fiber carries telecom lines into control room and then converts into copper wire.

Figure 12.9 T1 Fiber Optic Lines

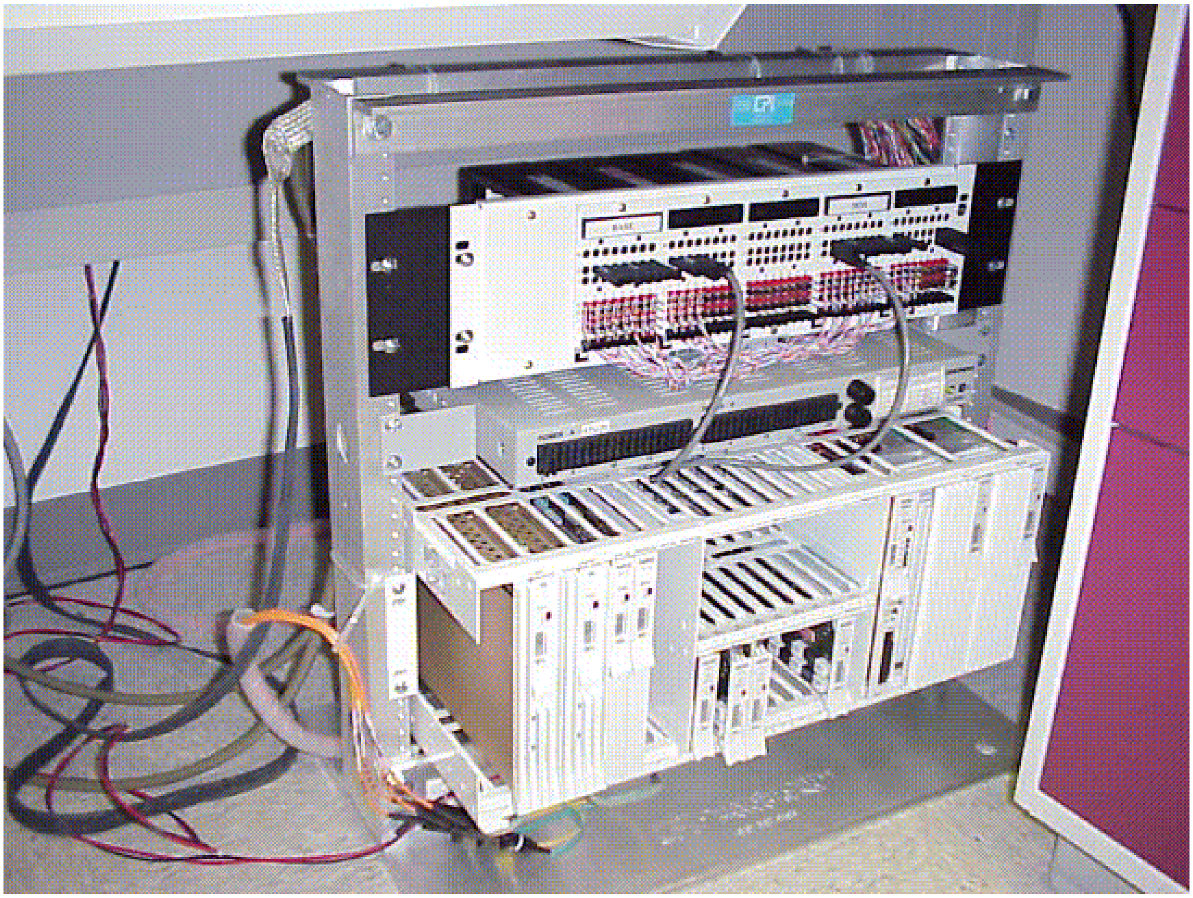


Figure 12.10RU Test Rack

Figure 12.11 shows a close-up view of the setup shown in Figure 12.10.

Figure 12.11Setup of the 16 Remote Units

Figure 12.12 shows the test setup for radiated emissions testing in the range from 1GHz - 26GHz. An EMCO 3115 horn antenna is shown here during the 1GHz - 3.5GHz testing phase, horizontal polarization (additional high frequency waveguide antennas were used for testing above 3.5GHz). Also shown is the HP 84300A E62 microwave intentional radiator system in the background, with a portable laptop serving as the software control and data capturing system.

Figure 12.12HP 84300A E62 Microwave Intentional Radiator System

Figure 12.13 shows the 3 Meter Chamber EMCO Antenna Tower which was controlled with the EMCO 2090 to vary the receive antenna height from one to four meters. Also shown is the Chase CBL6111A 30MHz to 1000MHz Biconical - Log Periodic receive antenna, used for radiated emissions testing at a distance of three meters from the device under test.

Figure 12.13Radiated Emission 30MHz - 1GHz Test Setup

Chapter 13 Users Manuals

A users manual has not been included within this Type Acceptance Application. The FWAN PCS Base Station is delivered, installed, and maintained by AT&T and/or authorized personnel.