Chapter 11 Test Reports

Overview

This section contains the test reports and data that show that the FWAN WCS Base Station B1.5 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 FWAN WCS Base Station B1.5 against the applicable requirements of the Code of Federal Regulations, FCC Rules - Parts 2, 15, and 27 and thus verify FCC regulatory compliance of the FWAN WCS 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." The name and purpose of each interface is summarized in Table 11.1 below:

Table 11.1 FWAN WCS 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

11.1.1 Frequency Stability vs. Temperature

11.1.1.1 Applicable FCC Rules

FCC Subpart 2.1055 - Measured over the temperature range of -30 to +50 degrees Celsius. Frequency measurements shall be made at the extremes and at intervals of not greater than 10 Celsius degrees throughout the range. Only the frequency-determining portions of the transmitter need be subjected to this test.

FCC Subpart 27.54 - The frequency stability shall be sufficient to ensure that the fundamental emission stays within the authorized frequency block.

11.1.1.2 Overview

The FWAN WCS 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 deviation.

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 deviation 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 deviation.

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 deviation) 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.

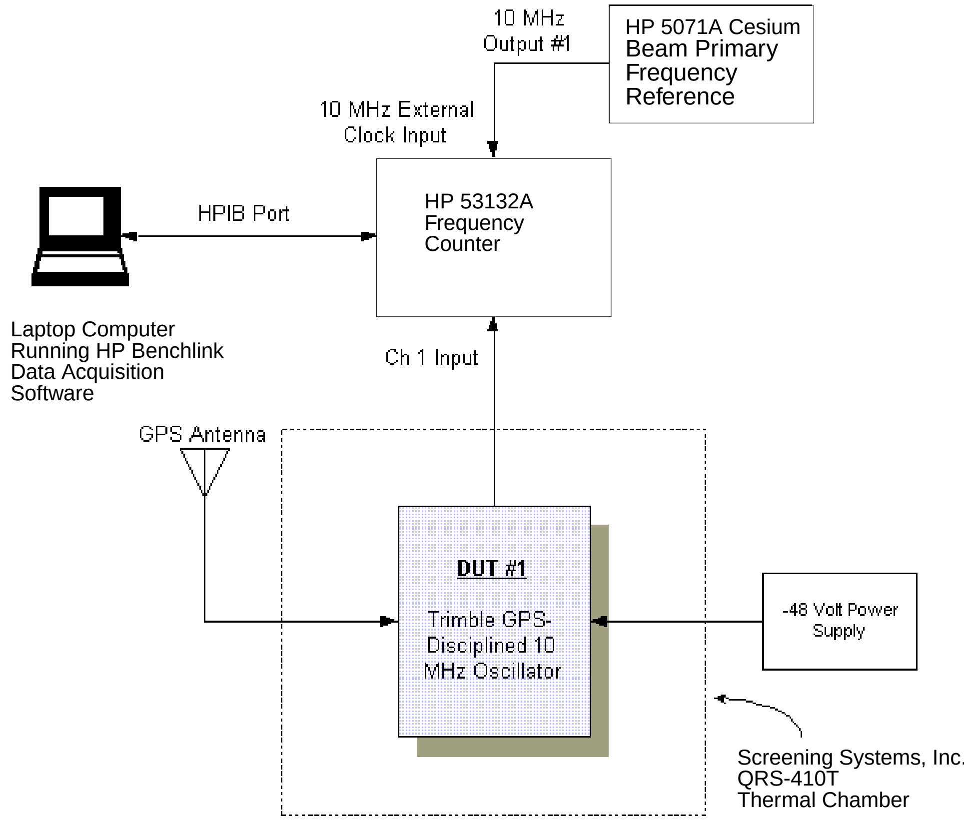
11.1.1.3 Test Methodology

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 degrees Celsius. During this test the thermal chamber “stair-stepped” from -40 to +60 degrees Celsius in temperature increments of 10 Celsius degrees. 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 predetermined 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 in relation to temperature in each of the three operating modes.

Figure 11.1 Frequency Stability vs. Temperature Test Configuration



11.1.2 Frequency Stability vs. Input Voltage

11.1.2.1 Applicable FCC Rules

FCC Subpart 2.1055 - 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 provided 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 27.5354 - The frequency stability shall be sufficient to ensure that the fundamental emission stays within the authorized frequency block.

11.1.2.2 Overview

The FWAN WCS 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 deviation.

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 deviation 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 deviation.

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 deviation) 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.

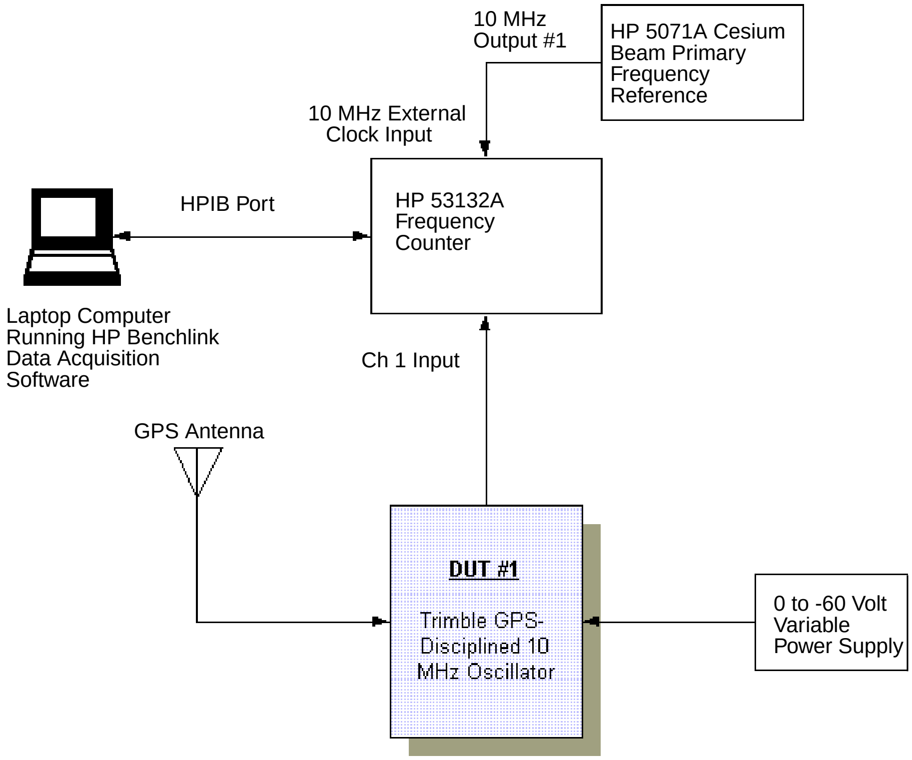
11.1.2.3 Test Methodology

The synchronization card under test was 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 in relation to voltage in each of the three operating modes.

Figure 11.2 Frequency Stability vs. Input Voltage Test Configuration



11.1.3 Base Station Occupied Bandwidth

11.1.3.1 Applicable FCC Rule

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.

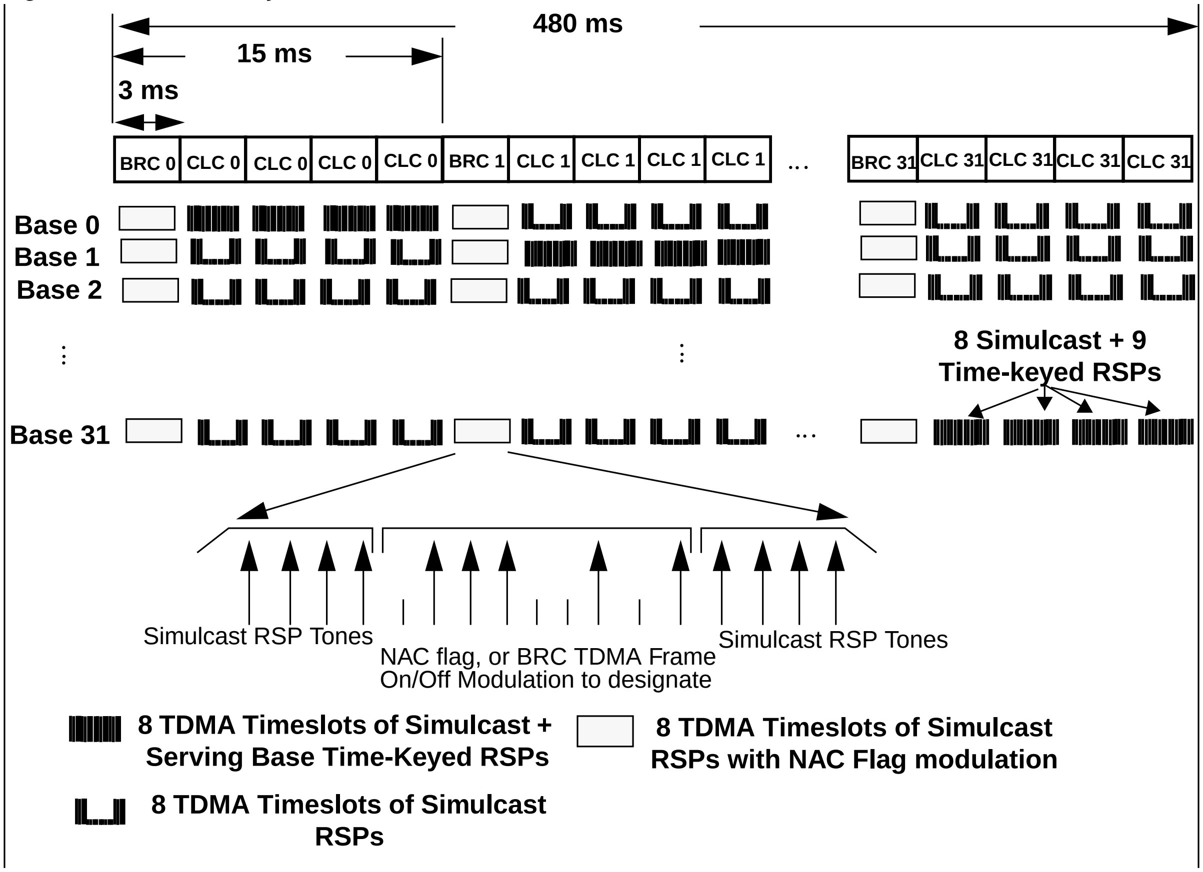
11.1.3.2 Overview

FWAN WCS Base Station occupied bandwidth measurements do not differ substantially from any other system. The occupied bandwidth of an FWAN WCS Base Station is maximized while transmitting eight simulcast remote synchronization pilots (RSPs) without any voice or high-speed-data (HSD) traffic.

11.1.3.3 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 Station 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 Station transmits eight RSPs continuously and five time-keyed RSPs every 15 ms. Every 480 ms, each Base Station transmits 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.

See Figure 11.4 for the full test configuration.

Figure 11.4 Occupied Bandwidth Test Configuration

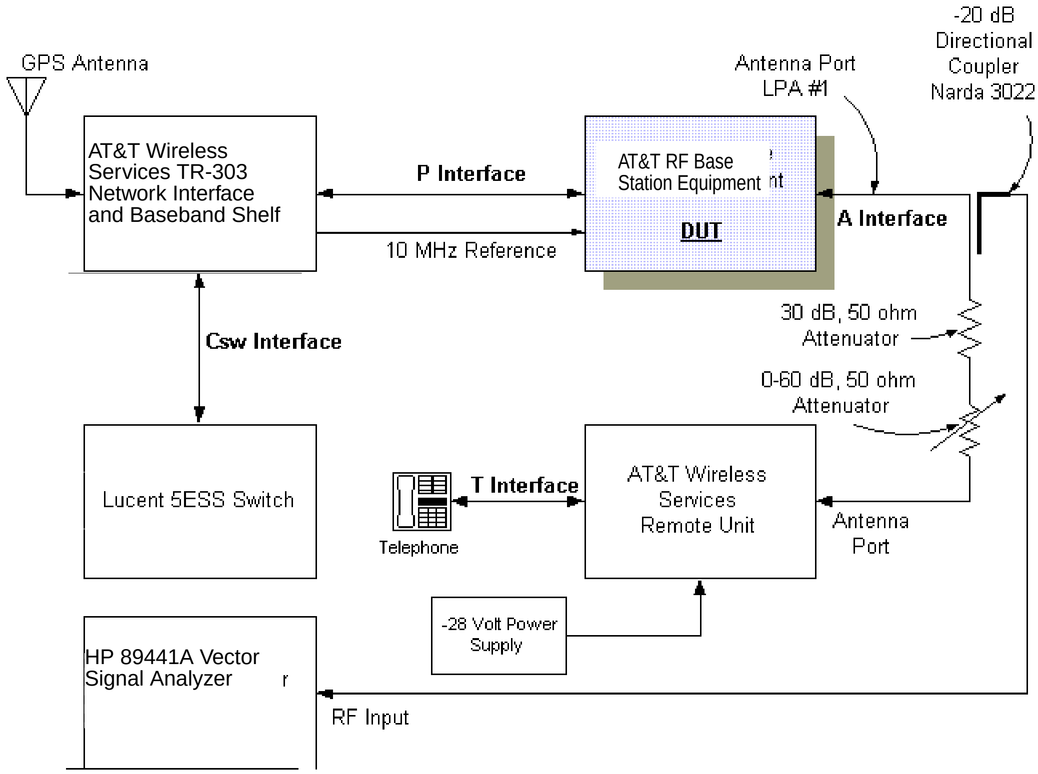


Table 11.2 Hewlett-Packard Type 89451A Radio Personality Configuration Parameters (Time Capture Mode)

Parameter	Value
Center Frequency	2306 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	52.9 dB
Frequency-Domain Averaging	Off
FFT Window Type	Flat Top
FFT Frequency Points	1601
FFT Resolution BW	12 kHz

11.1.4 Modulation Characterization

11.1.4.1 Applicable FCC Rules

FCC Subpart 2.1047 - Requires a curve or equivalent data that shows that the equipment will meet the requirements of the rules under which the equipment is to be licensed.

11.1.4.2 Overview

The modulation characteristics of the FWAN WCS 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
- Complementary 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 and Table 11.4.

See Figure 11.5 for the full test configuration.

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

Parameter	Value
Center Frequency	2306 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	52.9 dB
Peak/Average Metric	99.0%
Trigger Delay	Selected to center 320-µs transmission bursts in time gate (typically -55 µs)
Trigger Holdoff	1875 µsec (ts4)
Frequency-Domain Averaging	40 Samples, RMS Exponential
FFT Window Type	Flat Top
FFT Freq. Points	1601
Resolution BW	12 kHz

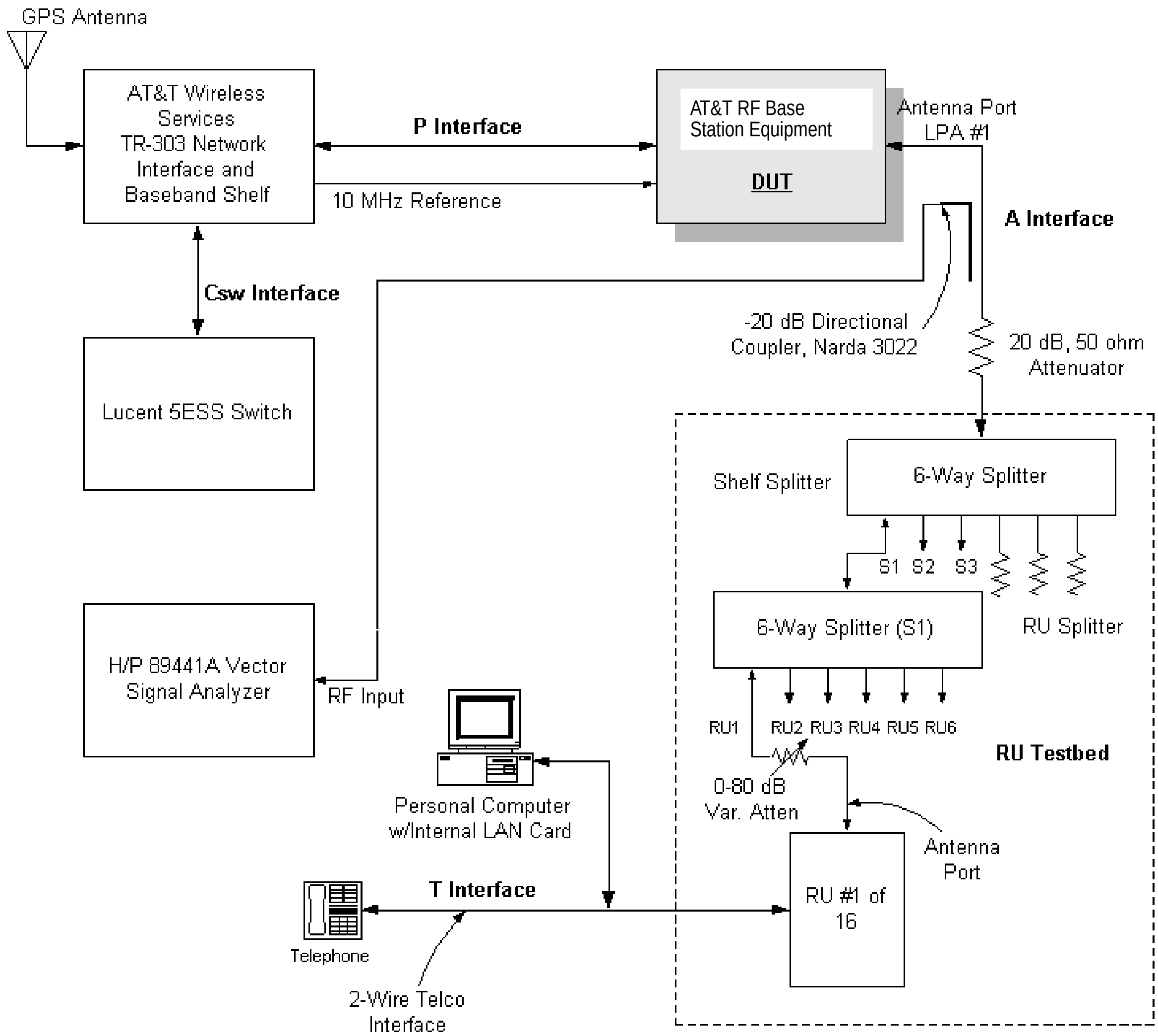
Table 11.4 Hewlett-Packard 89441A Modulation Characterization Test Parameters (Time Capture Mode)

Parameter	Value
Center Frequency	2306 MHz
Span	2 MHz
Main Time Length	400 µs
Gate Time Length	320 µs
Gate Delay	50 µs

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

Parameter	Value
Input Level	+25 dBm
Input Mode	Time Capture
External Attenuation	52.9 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



11.1.4.3 Test Methodology

11.1.4.3.1 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 11.4. 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.

11.1.4.3.2 High-Speed-Data Channel

An 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 .

During this test, a text file was copied from an AWS network file server (using File Transfer Protocol) through the Base Station 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.

11.1.4.3.3 High-Speed-Data Control Channel

Characterization of the 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 (50% duty cycle). The HSD Control channel for the Base Station under test was characterized during a period of HSD traffic channel inactivity.

11.1.4.3.4 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.

11.1.4.3.5 Time-Keyed Remote Synchronization Channel

During normal operation, the number of remote synchronization pilot (RSP) tones transmitted by the Base Station 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 Station transmits 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.

11.1.4.3.6 Simulcast Remote Synchronization Channel

During normal operation, the number of remote synchronization pilot (RSP) tones transmitted by the Base Station 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.

11.1.5 RF Output Power

11.1.5.1 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 27.50 - In no case may the peak output power of a Base Station transmitter exceed 2000 watts peak equivalent isotropically radiated power (EIRP). 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.

11.1.5.2 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.

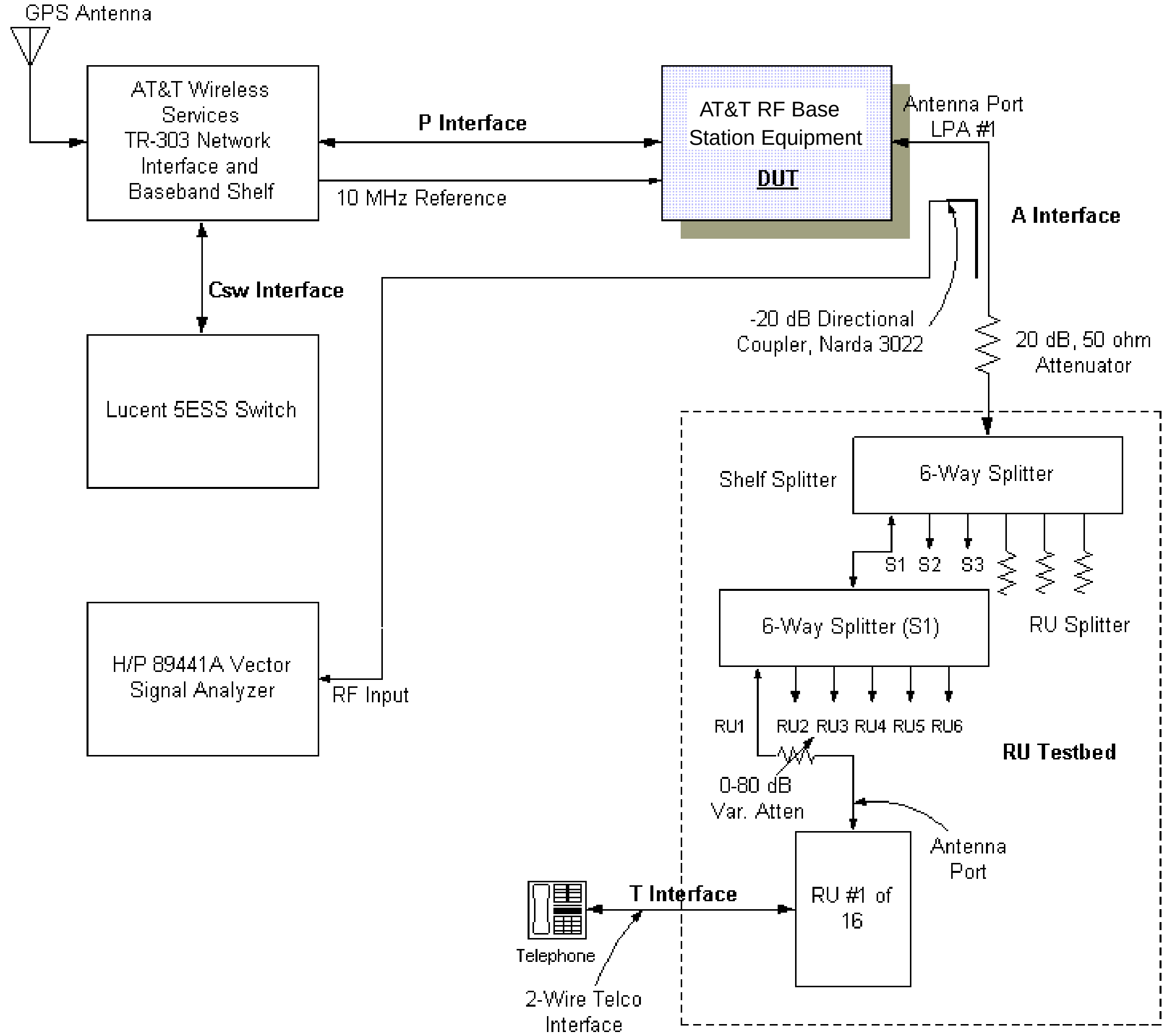
Table 11.5 Hewlett-Packard 89441A RF Power Test Parameters

Parameter	Value
Center Frequency	2306 MHz
Span	2 MHz
Main Time Length	400 µs
Gate Time Length	320 µs
Gate Delay	50 µs
Input Level	+25 dBm
External Attenuation	52.9 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	1875 µsec
Frequency-Domain Averaging	40 Samples, RMS Exponential
FFT Window Type	Flat Top
FFT Freq. Points	1601
FFT Resolution BW	12 kHz

11.1.5.3 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 Output Power Test Configuration



11.1.6 Spurious Emissions at the Antenna Terminal

11.1.6.1 Applicable FCC Rules

FFCC 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 27.53 - On any frequency outside a licensee's block, the power of any emission shall be attenuated below the transmitter power (P) by at least 80+10Log(P) dB on all frequencies between 2320 and 2345 MHz, by a factor not less than 70 + 10Log(P) dB on all frequencies below 2300 MHz and on all frequencies above 2370 MHz; and not less than 43 + 10Log(P) dB on all frequencies between 2300 and 2320 MHz and on all frequencies between 2345 MHz and 2370 MHz that are outside the licensed bands of operation. 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.

11.1.6.2 Overview

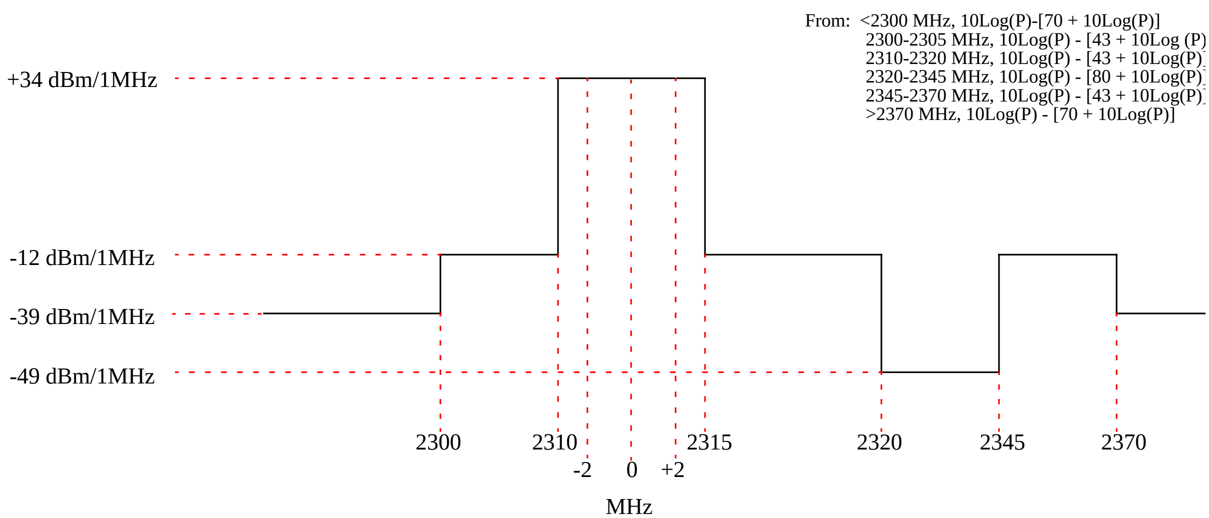
The RF spectral purity of the FWAN WCS Base Station transmitter does not differ substantially from a conventional TDMA transmitter, other than the characteristics of any intermodulation products that are produced. RF output power and out-of-band (OOB) emissions from the FWAN WCS Base Station are maximized 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 “A and B” WCS blocks. Any out-of-band (OOB) intermodulation and spurious signals are contributed by Base Stations operating in the exterior subbands. OOB spectral contributions from Base Stations operating within the two interior subbands are negligible.

Table 11.6 Hewlett-Packard 98441A 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	52.9 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	1875 µsec
Frequency-Domain Averaging	40 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



WCS Base Emission Mask

Note: Mask is based on the use of measurement instrumentation employing a resolution bandwith of 1 MHz or less, but at least 1% of the emission bandwidth of the fundamental emission of the transmitter, provided the measured energy is integrated over a 1 MHz-bandwidth.

11.1.6.3 Test Methodology

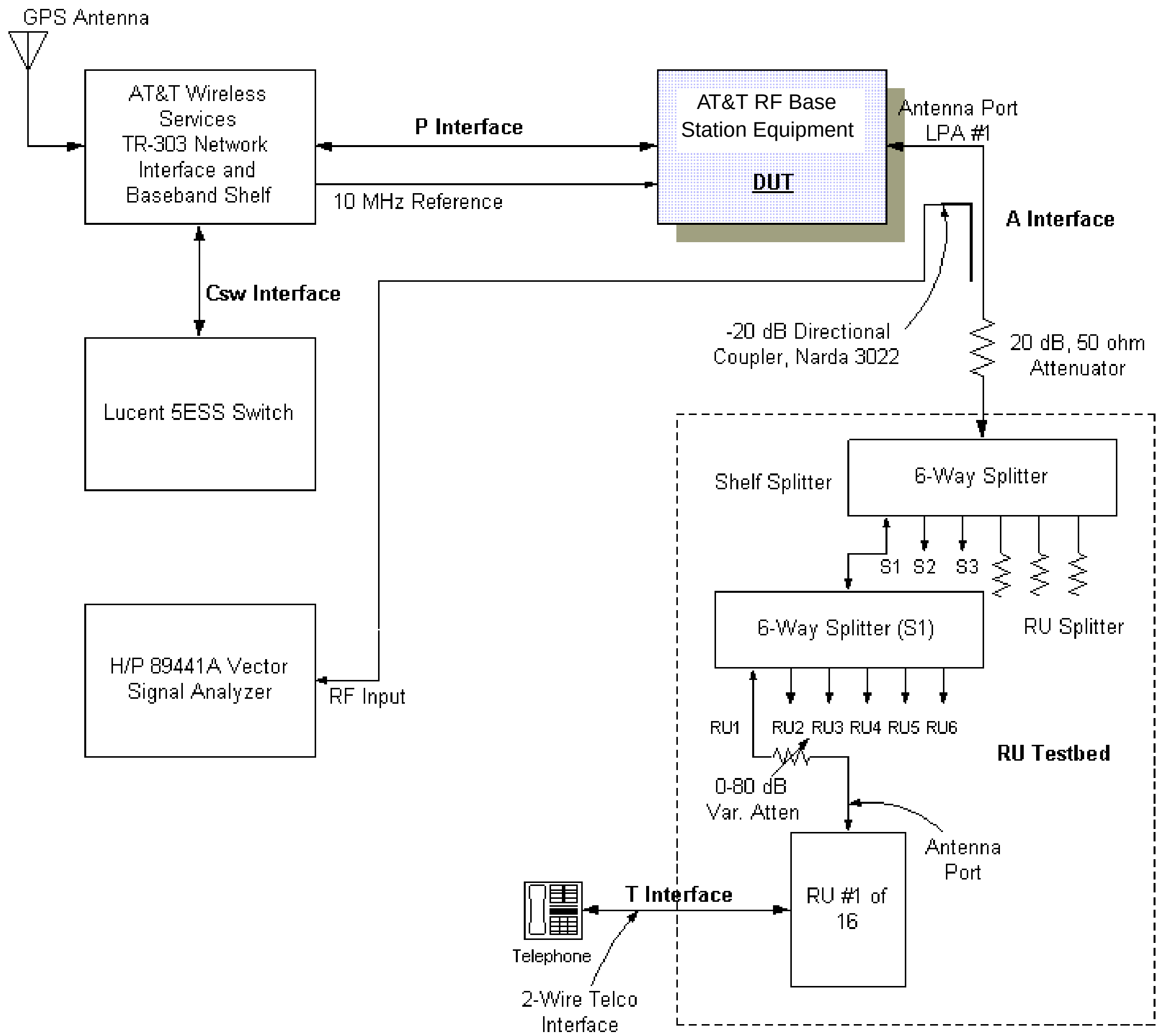
See Figure 11.8 for the test configuration.

FWAN WCS 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 a nominal 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 §2.1046 and §27.53. 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 2290 to 2375 MHz. Emissions at all applicable frequencies above and below this range have been documented in Section 11.3.5, “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.

Figure 11.8 Spectral Purity Test Configuration



11.1.7 Radiated Emissions

11.1.7.1 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.

11.1.7.2 Overview

The radiated emissions from the FWAN WCS 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.

11.1.7.3 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 WCS Base Station was set up in a typical field configuration, as shown in Figure 11.9. The FWAN WCS Base Station was placed inside two EMC cabinets with the digital shelves in one cabinet and the RF components in the other, as shown in Figure 12.2 through Figure 12.5. The cabinets, with the FWAN WCS Base Station shelves and components, were each grounded to an NEC-approved grounding method.

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

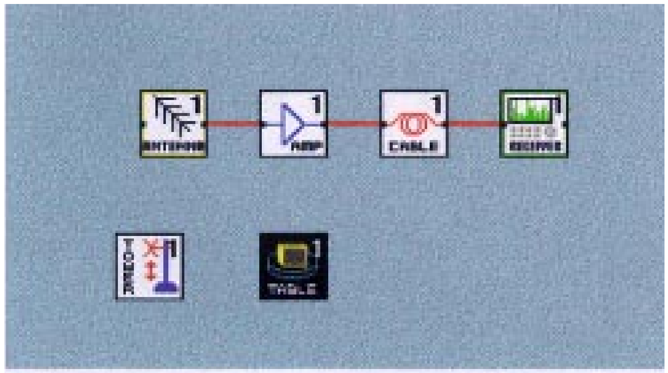
- Completely loaded baseband and network shelves (i.e., maximum number of TSP and NIF cards)
- 15 voice calls within the same time slot (maximum time slot capacity)
- 60 voice calls on a single sector
- 60 voice calls, 15 voice calls per sector with HSD operation within one sector
- DC power and NIF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

Testing was completed from 30 MHz to 26.5 GHz.

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

Figure 11.9 Test Equipment Configuration



11.1.7.4 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

11.1.7.5 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

11.1.7.6 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)	Amplitude (dB/m)
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
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

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

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

11.1.7.7 Cable Factors

The measurement system setup, as shown in Figure 11.9, is interconnected with 40 feet of Gore cable. The cable insertion loss was measured and documented for receiver data correction. Figure 11.4Table 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

Table 11.8 Cable Correction Factors

Frequency (MHz)	Amplitude (dB)
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
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

11.1.7.8 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

11.1.7.9 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

11.1.7.10Antenna 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 FWAN WCS Base Station against the applicable requirements of FCC Rules, Part 2 and Part 27.

11.2.1 Test Equipment Used

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
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	8665A	SDG005780	11/9/99	11/9/02
Power Meter	Hewlett-Packard	EPM-442A	GB37170550	2/4/00	2/4/01
Power Sensor	Hewlett-Packard	8482A	3318A26922	06/07/00	06/07/01
Cesium Beam Clock	Hewlett-Packard	5071A	3249A00701	N/A	N/A
Vector Signal Analyzer	Hewlett-Packard	89441A	3416A02243	8/31/00	8/31/01
Frequency Counter	Hewlett-Packard	53132A	3736A06180	2/7/00	2/7/01
Spectrum Analyzer	Hewlett-Packard	8563E	5317A03669	12/5/00	12/5/01
Network Analyzer	Hewlett-Packard	8753D	3410A05861	5/15/01	5/15/02

11.2.2 Frequency Stability vs. Temperature

The frequency stability of the DUT was measured in relation to temperature in each of the three operating modes (GPS Locked, GPS Holdover, and GPS Free-Run).

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

(Eq 11.1)

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

11.2.2.1 Results and Summary

The measured frequency stability vs. temperature is depicted in Figure 11.10, Figure 11.11, and Figure 11.12. The results of these tests are summarized in Table 11.11 below:

Figure 11.10 Frequency Stability vs. Temperature, GPS Locked Mode

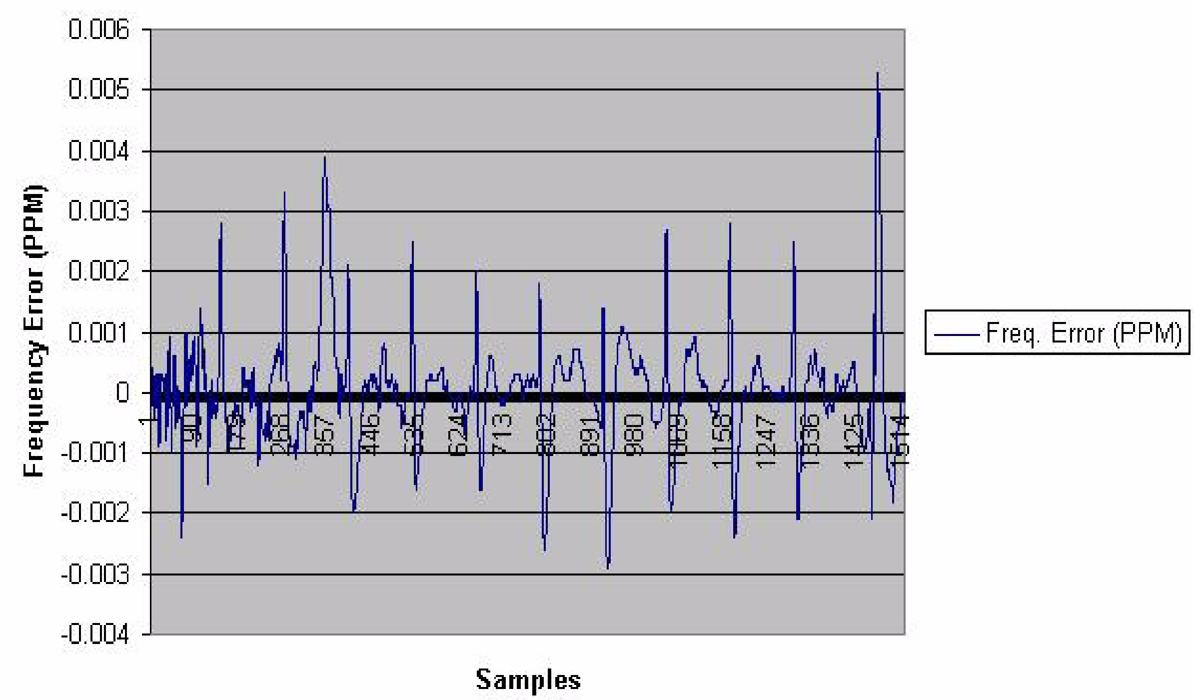


Figure 11.11 Frequency Stability vs. Temperature, GPS Holdover Mode

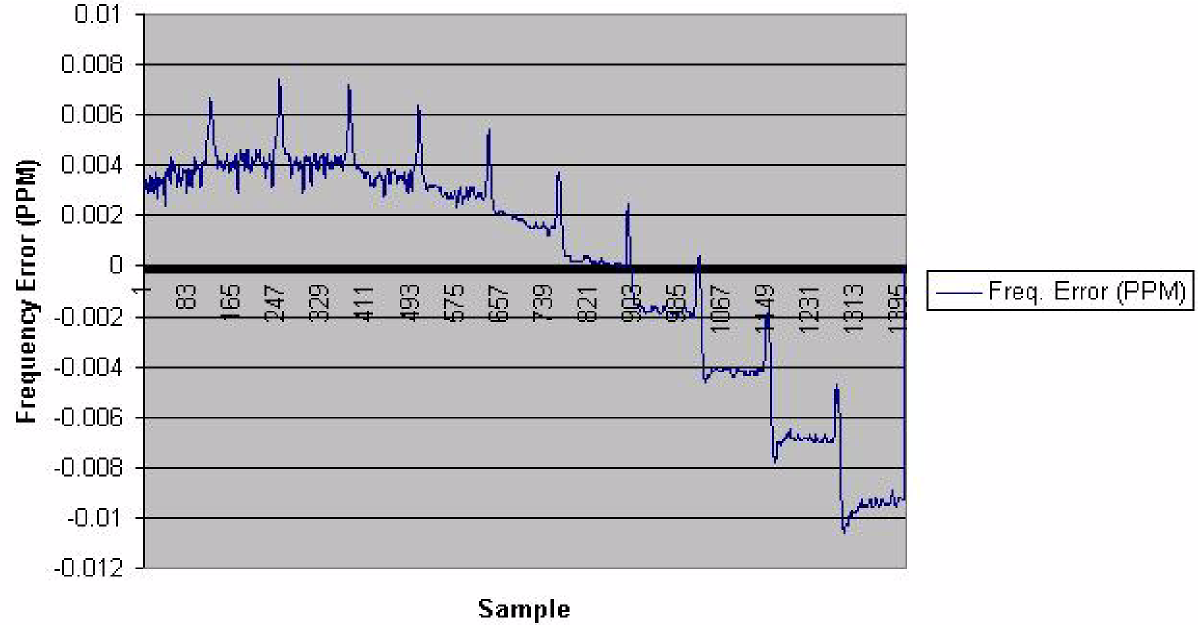


Figure 11.12 Frequency Stability vs. Temperature, GPS Free-Run Mode

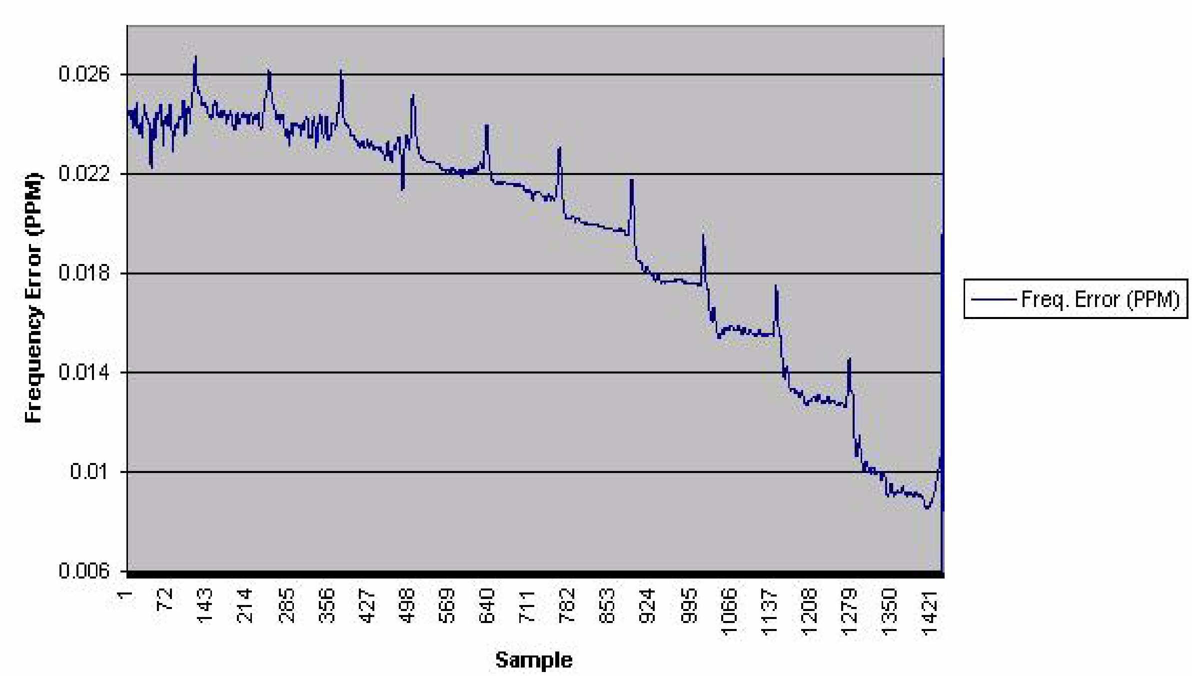


Table 11.11 Summary of Frequency Stability vs. Temperature Test Results

Parameters	Measured Value
Synchronization Card between -40 degrees Celsius and +60 degrees Celsius in GPS Locked Mode	Frequency change of ≤ 0.009 PPM @ 10 MHz
Synchronization Card between -40 degrees Celsius and +60 degrees Celsius in GPS Holdover Mode	Frequency change of ≤ 0.02PPM @ 10 MHz
Synchronization Card between -40 degrees Celsius and +60 degrees Celsius in GPS Free-Run Mode	Frequency change of ≤ 0.02 PPM @ 10 MHz

11.2.3 Frequency Stability vs. Input Voltage

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 in relation to voltage in each of the three operating modes.

The frequency error was calculated for each input voltage using the formula in Equation 11.1.

11.2.3.1 Results and Summary

The measured frequency stability vs. input voltage for the Base Station under test is depicted in Figure 11.13, Figure 11.14, Figure 11.15. The results of these tests are summarized in Table 11.12:

Figure 11.13 Frequency Stability vs. Input Voltage, GPS Locked Mode

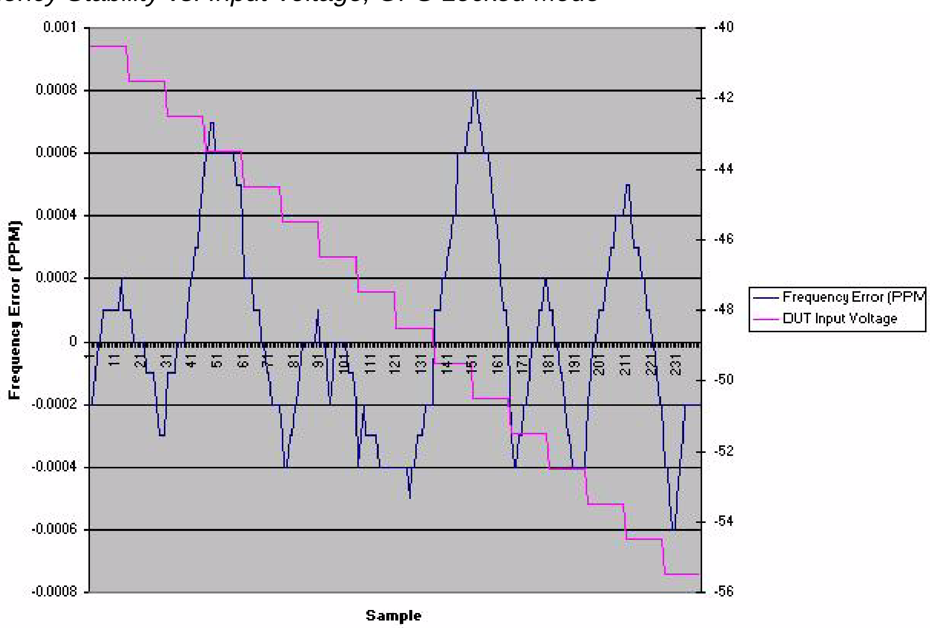


Figure 11.14 Frequency Stability vs. Input Voltage, GPS Holdover Mode

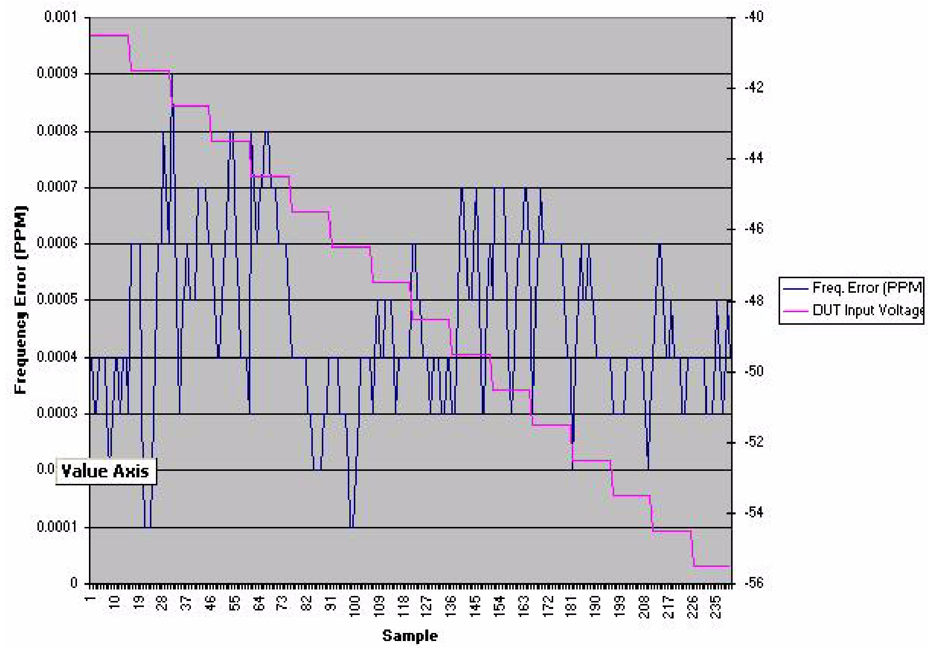


Figure 11.15 Frequency Stability vs. Input Voltage, GPS Free-Run Mode

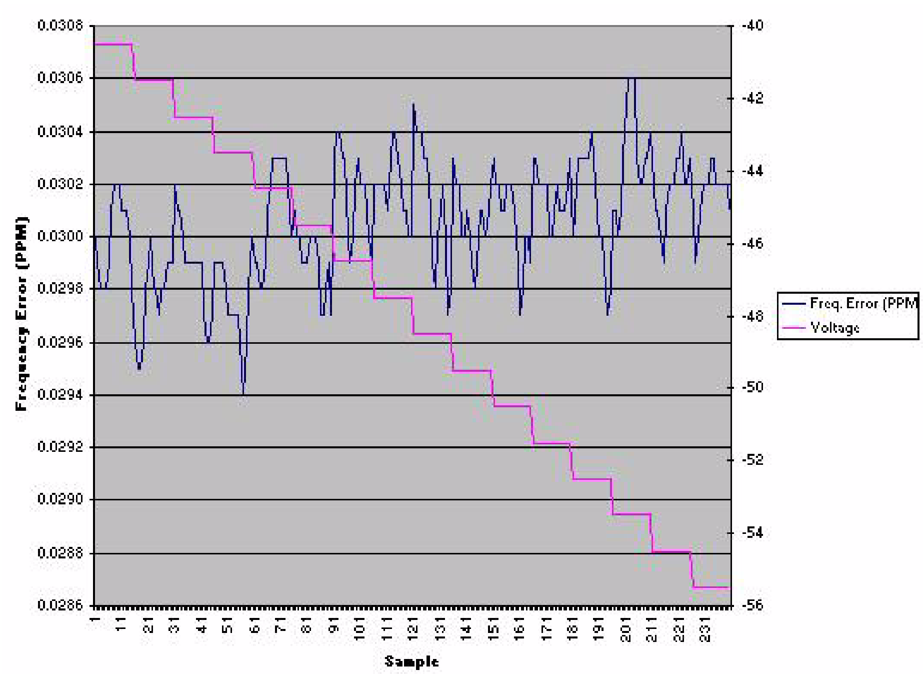


Table 11.12 Summary of Frequency Stability vs. Input Voltage Tests

Parameter	Measured Value
GPS Locked Mode	Total frequency change of ≤ 0.0015 PPM
GPS Holdover Mode	Total frequency change of ≤ 0.001 PPM
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 an FWAN WCS 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 Figure 11.4 and Table 11.2.

11.2.4.3 Test Results and Summary — WCS Block A

Block A refers to the 5-MHz-wide spectrum between 2305 MHz and 2310 MHz.

The 99% Occupied Bandwidth for the Base Station is depicted in Figure 11.16 for Sector A and in Figure 11.17 for Sector D. The test results are summarized in .

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

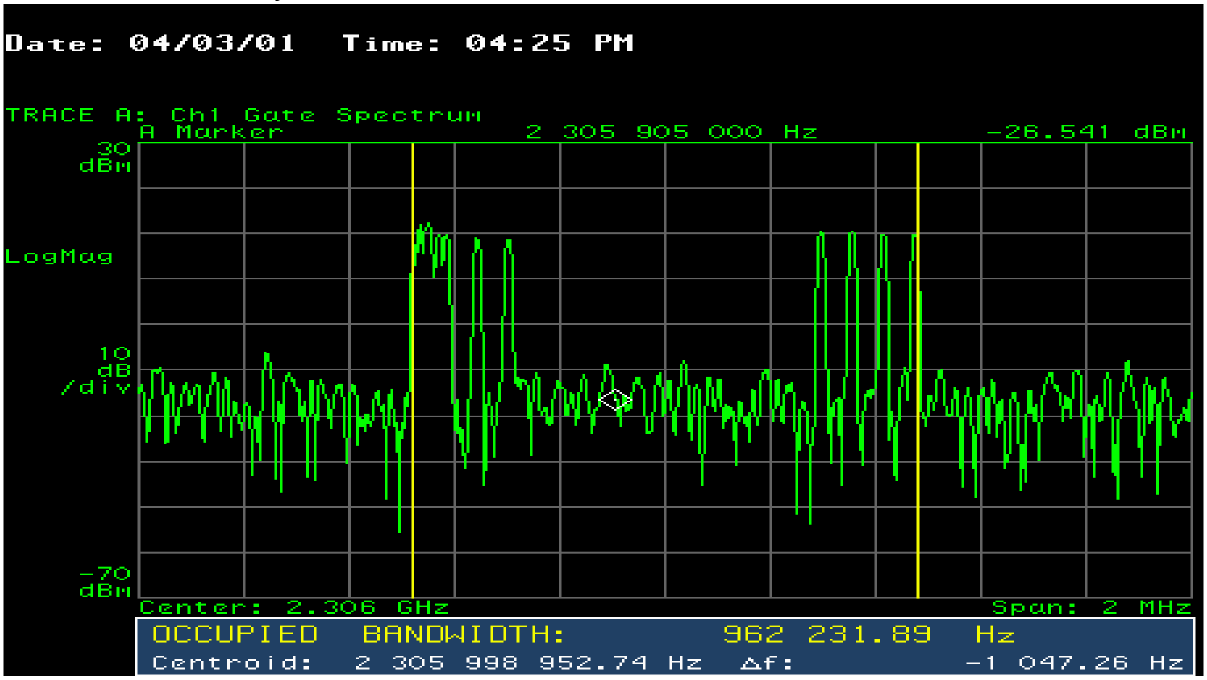


Figure 11.17 Base Station 99% Occupied Bandwidth While Transmitting Simulcast Remote Synchronization Pilots — Sector D

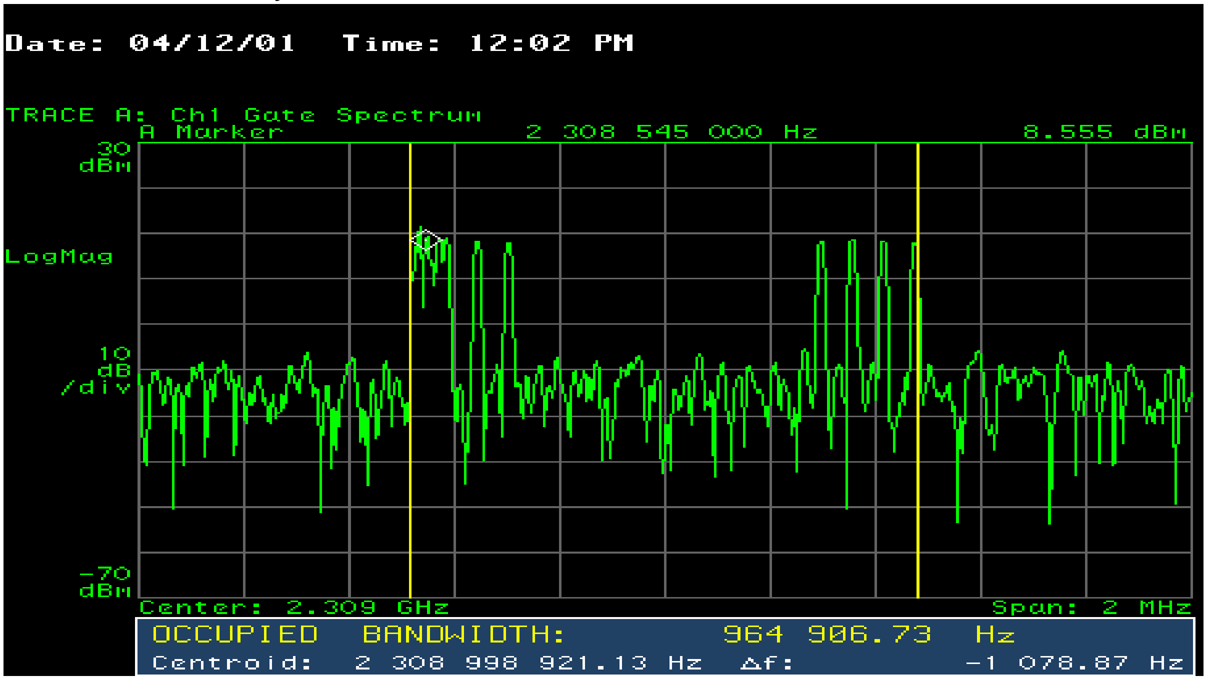


Table 11.13 Occupied Bandwidth Test Result - WCS Block A

Parameter	Measured Value	FCC Reqm't.	Compiles Y/N
99% Occupied Bandwidth while Transmitting Remote Synchronization Pilots	≤ 964 kHz	1 Mhz	Y

11.2.4.4 Test Results and Summary — WCS Block B

Block B refers to the 5-Mhz-wide spectrum between 2310 MHz and 2315 MHz.

The 99% Occupied Bandwidth for the Base Station is depicted in Figure 11.18 for Sector A and in Figure 11.19 for Sector D. The test results are summarized in Table 11.14

Figure 11.18 Base Station 99% Occupied Bandwidth While Transmitting Simulcast Remote Synchronization Pilots — Sector A

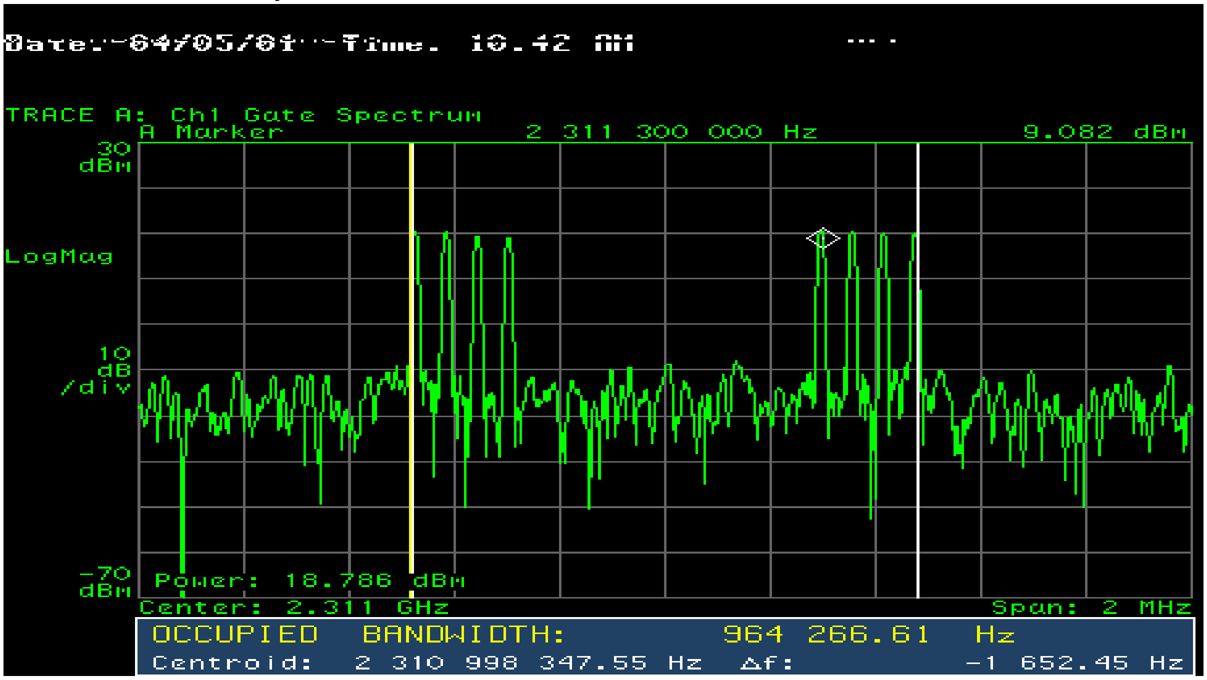


Figure 11.19 Base Station 99% Occupied Bandwidth While Transmitting Simulcast Remote Synchronization Pilots — Sector D

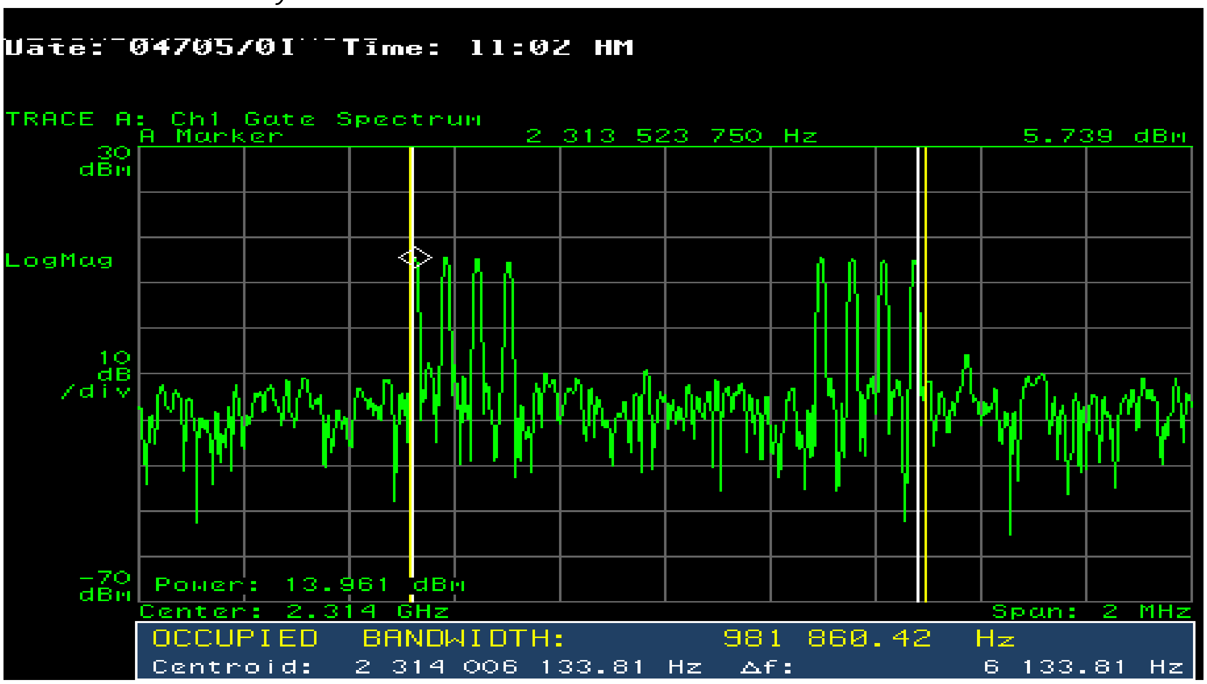


Table 11.14 Occupied Bandwidth Test Result — WCS Block B

Parameter	Measured Value	FCC Reqm't.	Complies Y/N
99% Occupied Bandwidth While Transmitting Remote Synchronization Pilots	≤982 kHz	1 MHz	**Y**

11.2.5 Modulation Characterization — Block A

Block A refers to the 5-MHz-wide spectrum between 2305 MHz and 2310 MHz.

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)

11.2.5.2.1 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 11.20 and Figure 11.21. The results of these tests are summarized in Table 11.15.

Figure 11.20 Fifteen Simultaneous — Voice Channel Power vs. Frequency, 99.0% Occupied BW, and Time-Domain Average Burst Power — Block A

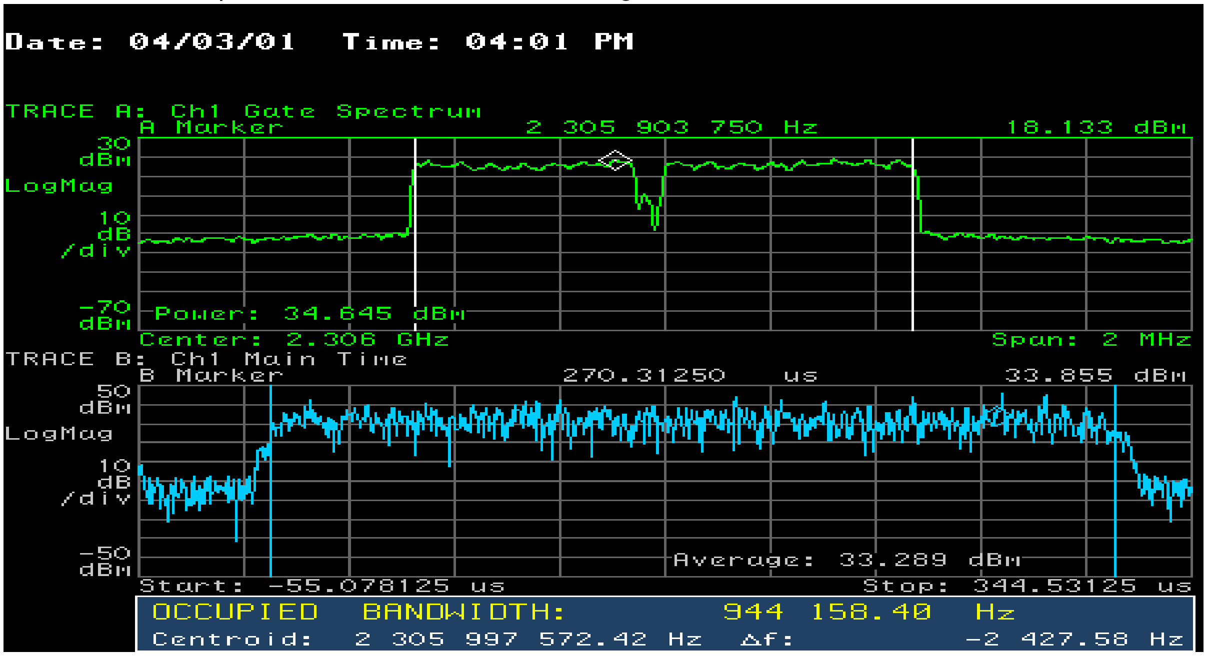
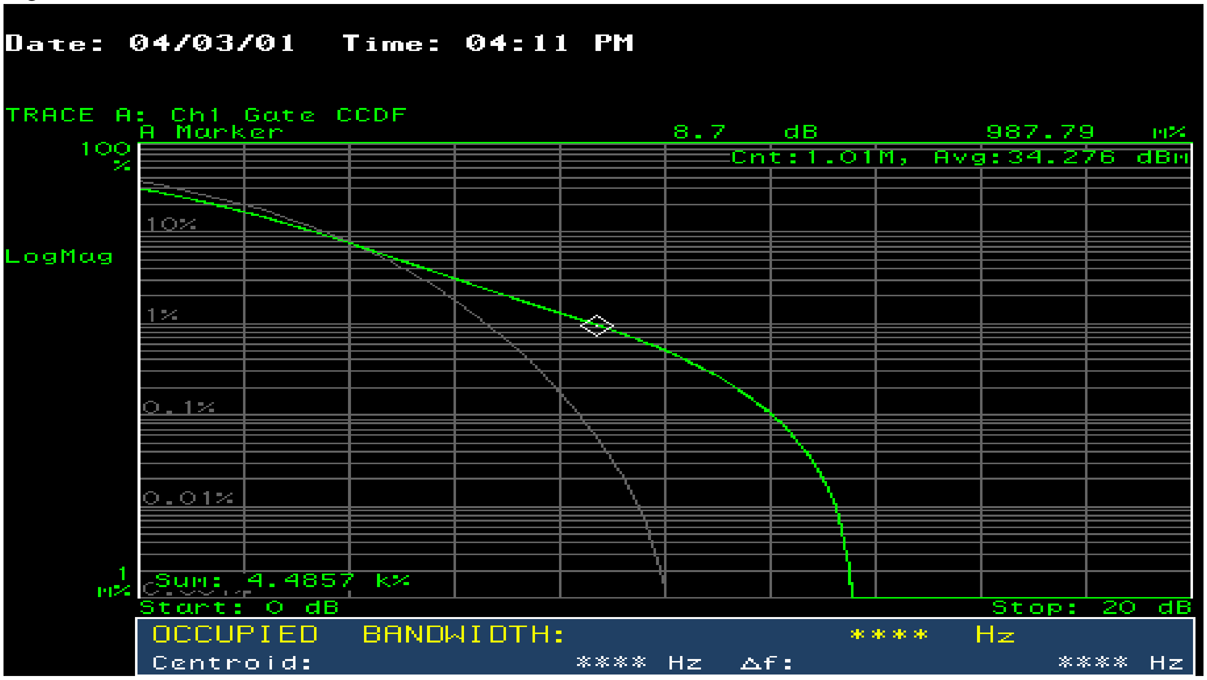


Figure 11.21 Voice Channel CCDF — Block A



11.2.5.2.2 High-speed Data Channel

A single HSD session was established between the Base Station under test and the Base Station using the test configuration shown in Figure 11.5. The Hewlett-Packard 89441A Vector Signal Analyzer was configured according the parameters shown in Table 11.4. 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.

The measured characteristics of the HSD channel are depicted in Figure 11.22 and Figure 11.23. The results of these tests are summarized in Table 11.15.

Figure 11.22 High-Speed Data Channel Power vs. Frequency, 99% Occupied BW, and Time-Domain Average Burst Power — Block A

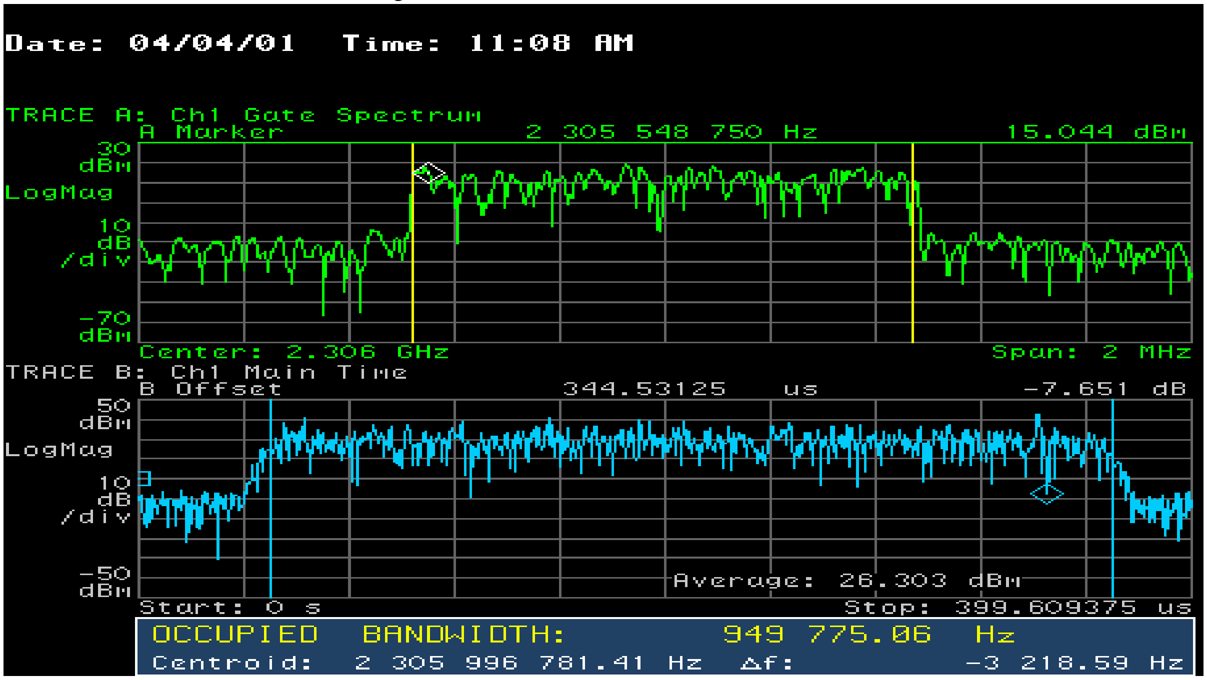
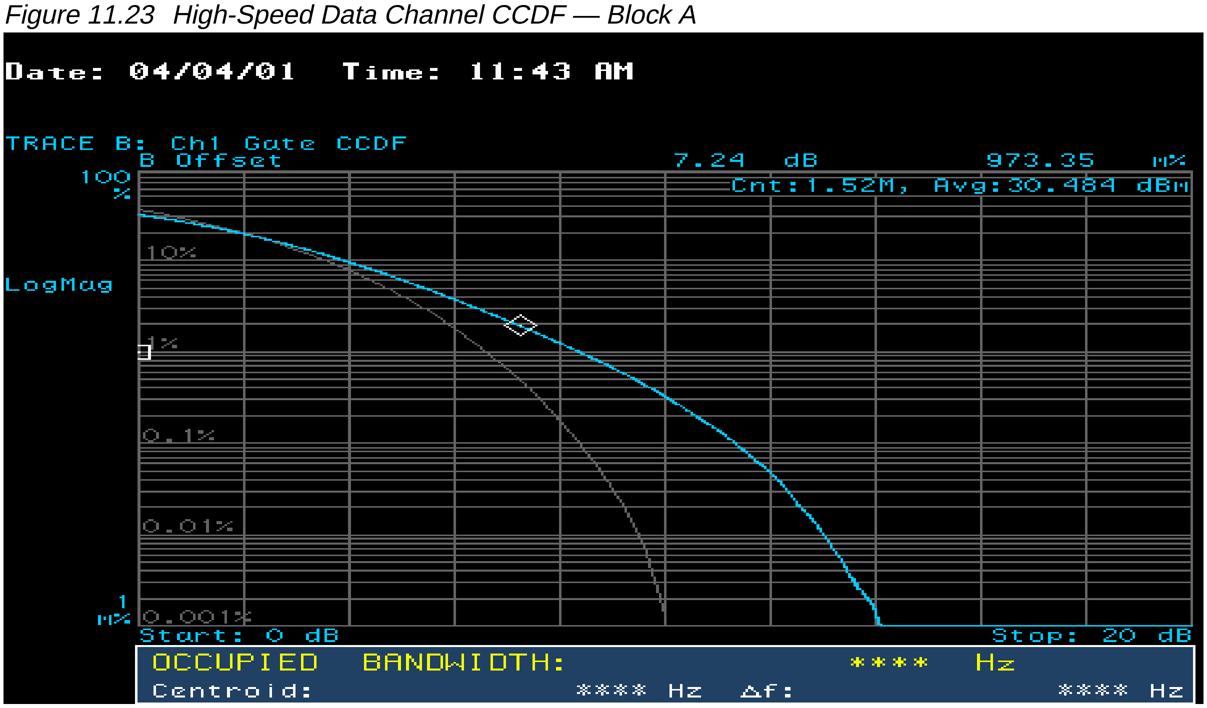


Figure 11.23 High-Speed Data Channel CCDF — Block A



11.2.5.2.3 High-speed Data Control Channel

Characterization of the HSD 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.

The measured characteristics of the HSD Control channel are depicted in Figure 11.24 and Figure 11.25. The results of these tests are summarized in Table 11.15.

Figure 11.24 High Speed Data Control Channel Power vs. Frequency, 99% Occupied Bandwidth, and Time-Domain Average Power — Block A

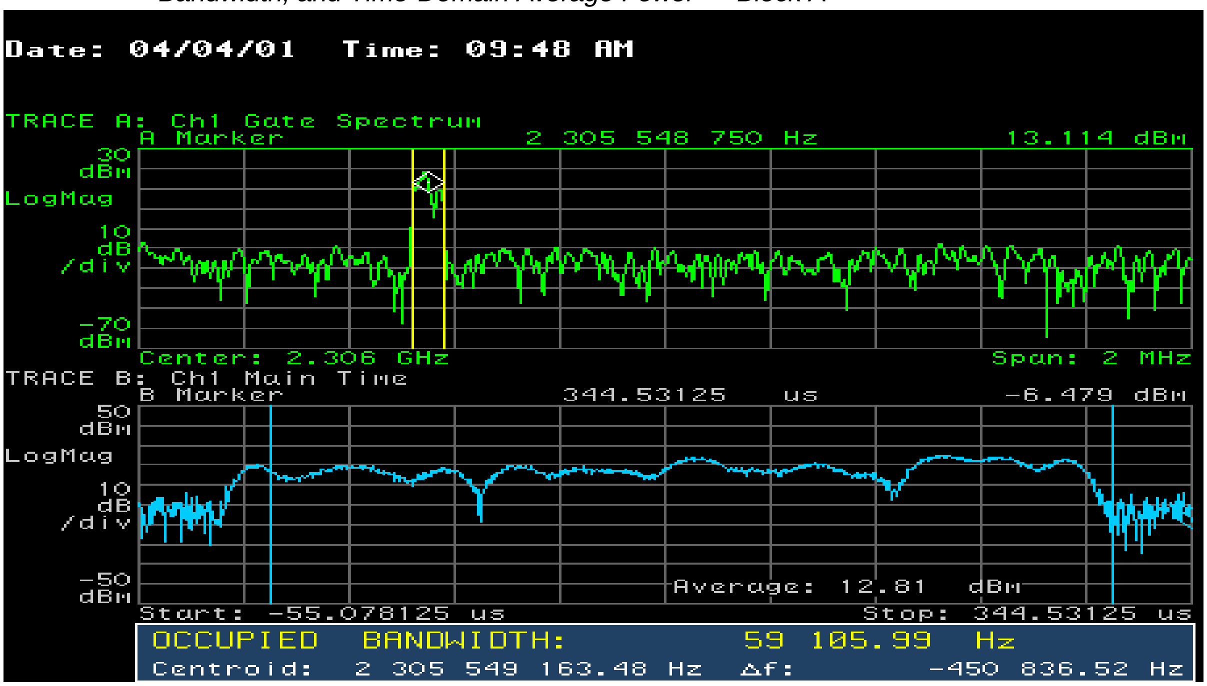
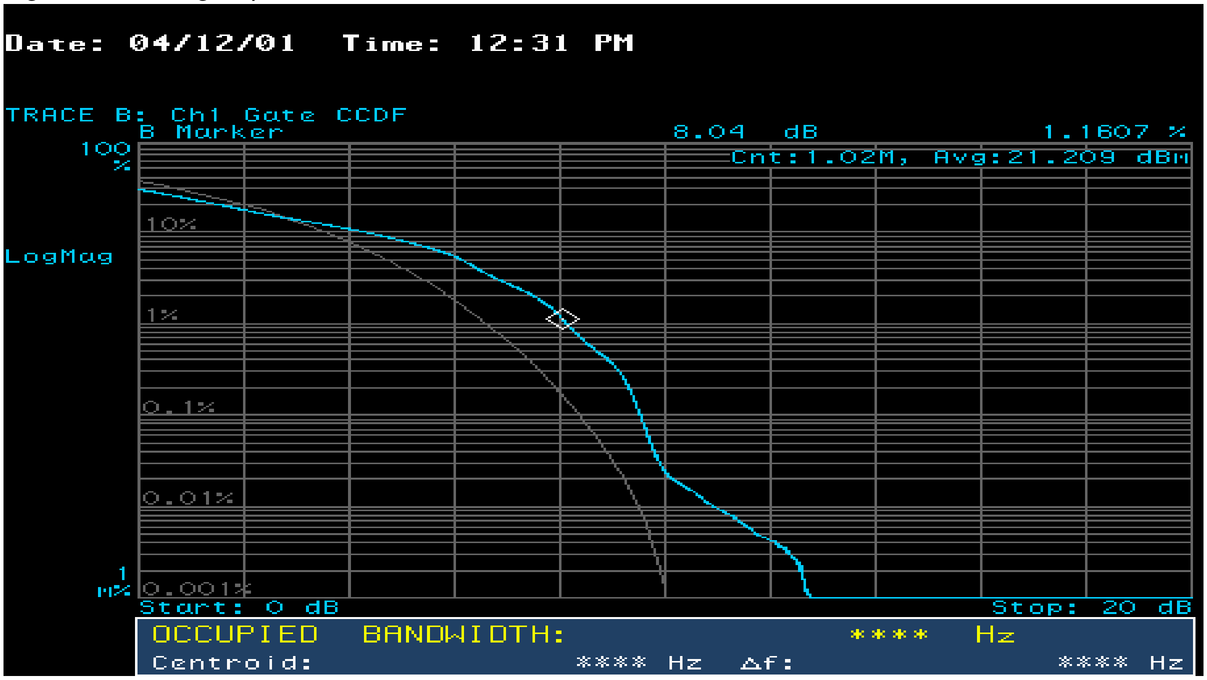


Figure 11.25 High Speed Data Control Channel CCDF — Block A



11.2.5.2.4 Network Access Channel (NAC)

The Base Station NAC 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.

The measured characteristics of the Network Access channel are depicted in Figure 11.26 and Figure 11.27. The results of these tests are summarized in Table 11.15.

Figure 11.26 NAC Channel Power vs. Frequency, 99% Occupied BW, and Time-Domain Average Power — Block A

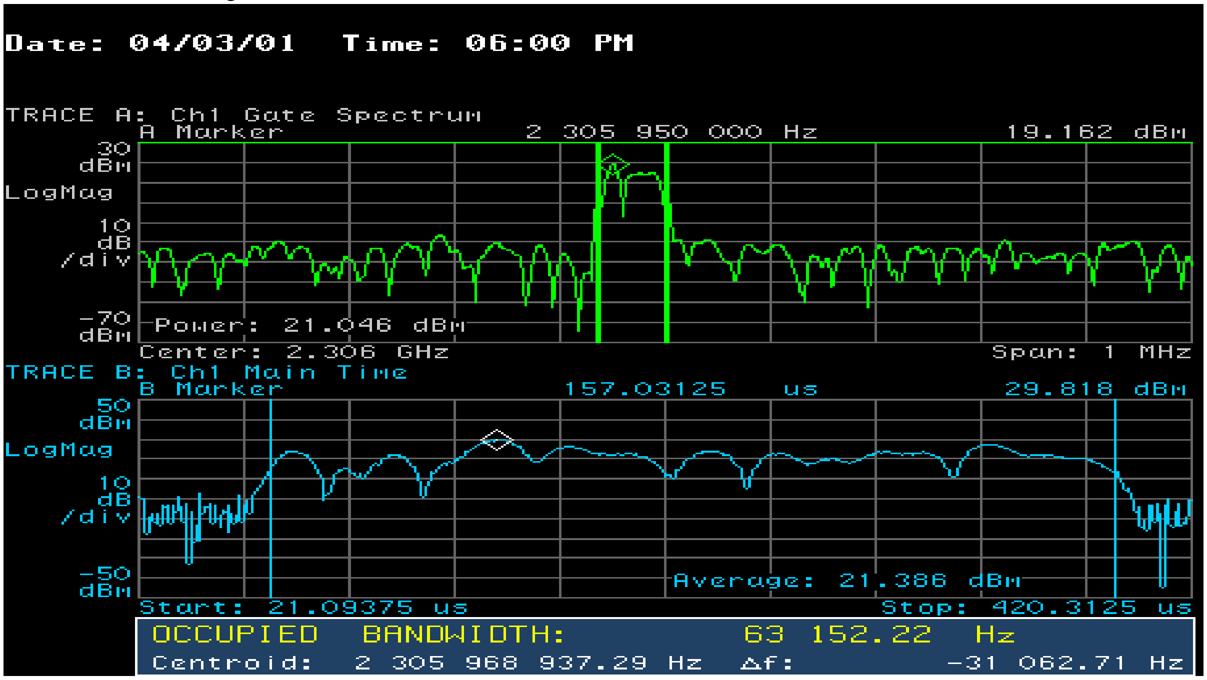
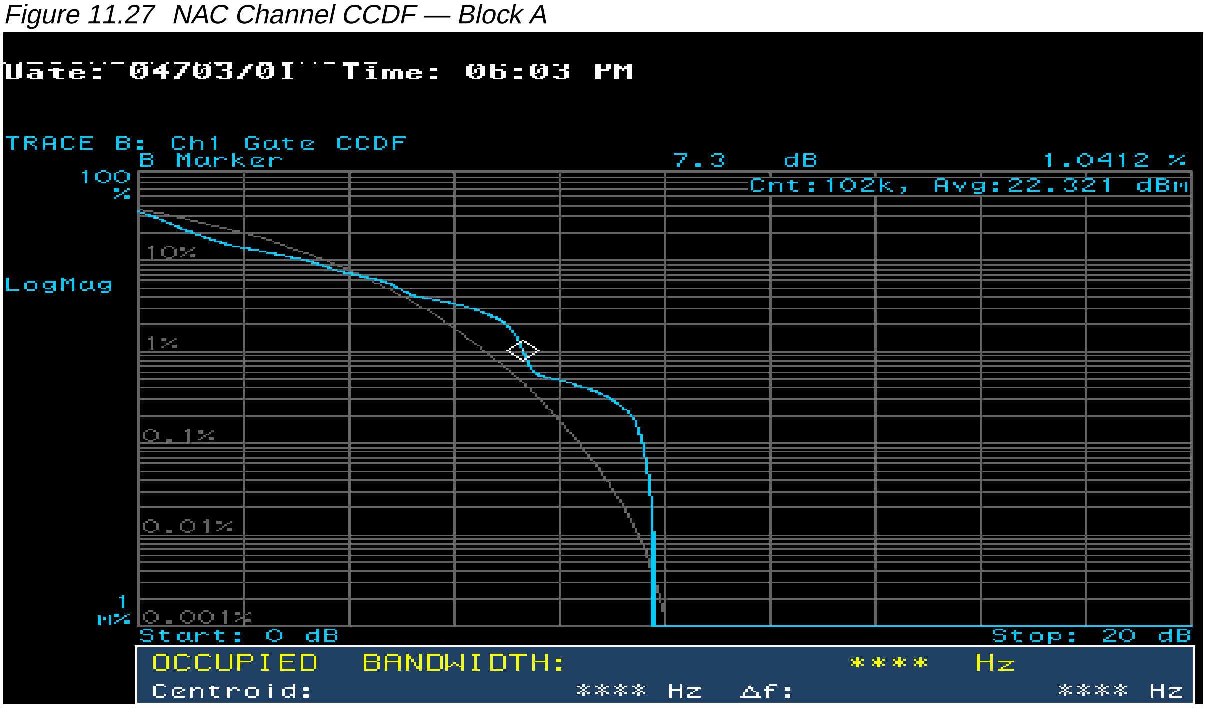


Figure 11.27 NAC Channel CCDF — Block A



11.2.5.2.5 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 11.3.

The measured characteristics of the Time-Keyed Remote Synchronization channel are depicted in Figure 11.28 and Figure 11.29. The results of these tests are summarized in Table 11.15.

Figure 11.28 Time-Keyed Remote Synchronization Pilots Power vs. Frequency, 99.0% Occupied Bandwidth, and Time-Domain Average Burst Power During Broadcast TDMA Frames — Block A

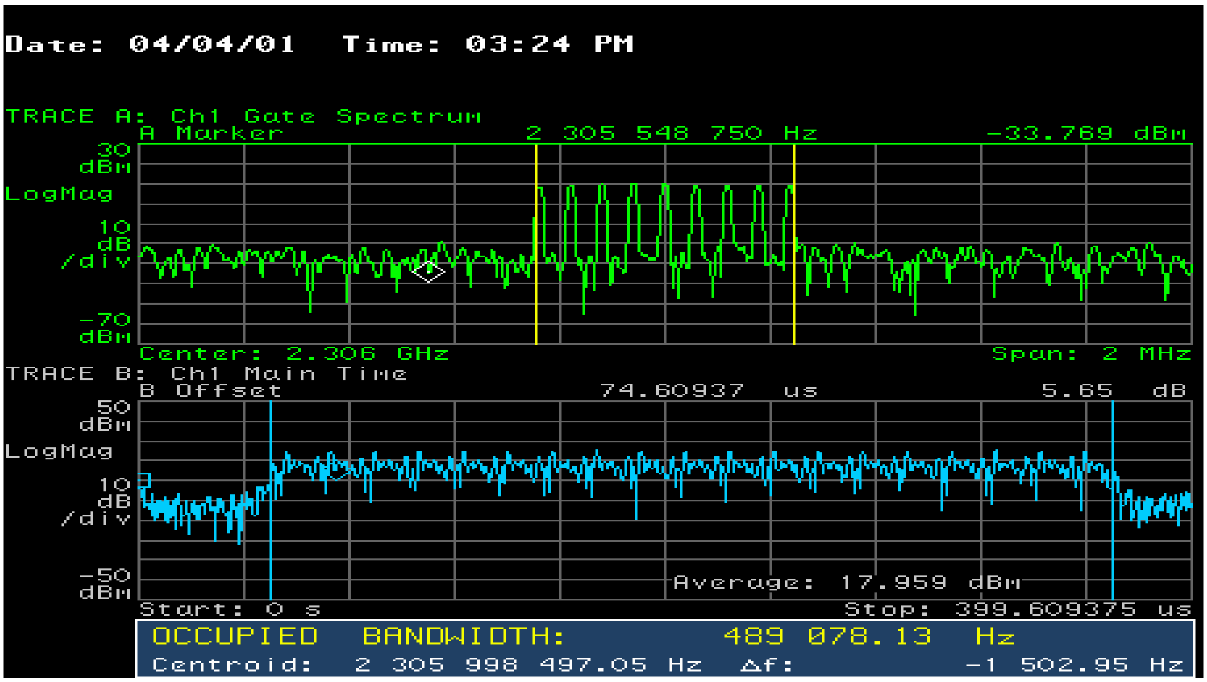
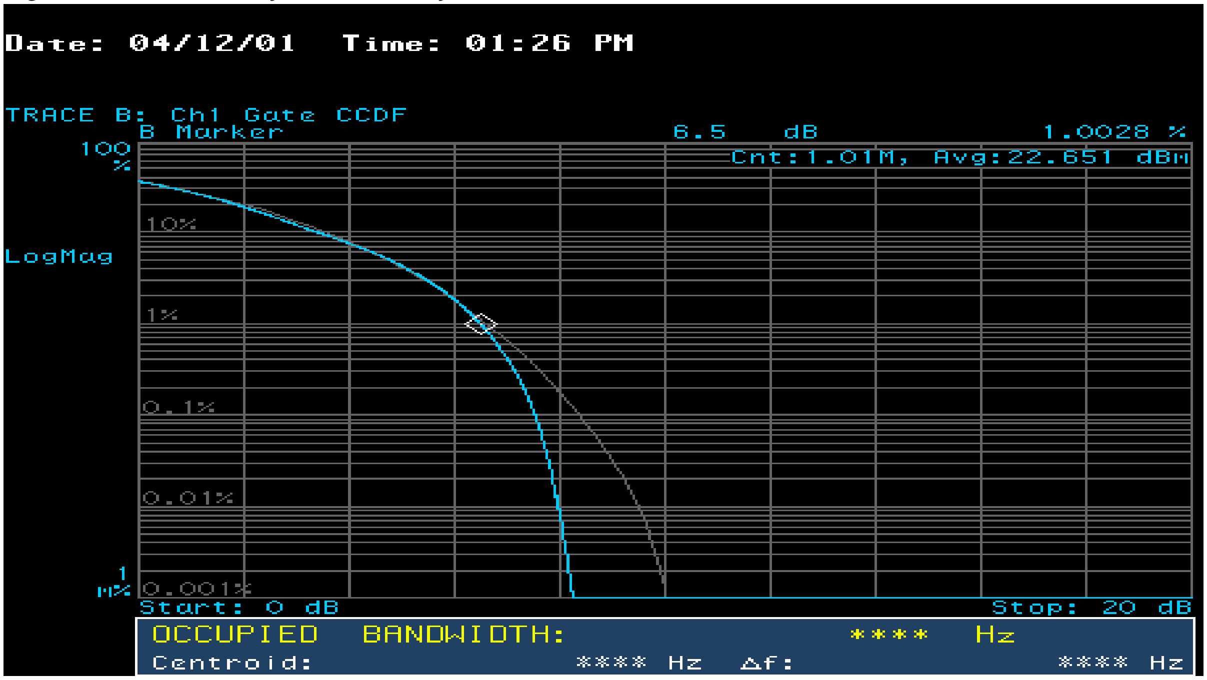


Figure 11.29 Time-Keyed Remote Synchronization Pilots Channel CCDF — Block A



11.2.5.2.6 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 11.3.

The measured characteristics of the Remote Synchronization channel are depicted in Figure 11.30 and Figure 11.31. The results of these tests are summarized in Table 11.15.

Figure 11.30 Simulcast Remote Synchronization Pilots Power vs. Frequency, 99.0% Occupied Bandwidth, and Time-Domain Average Burst — Block A

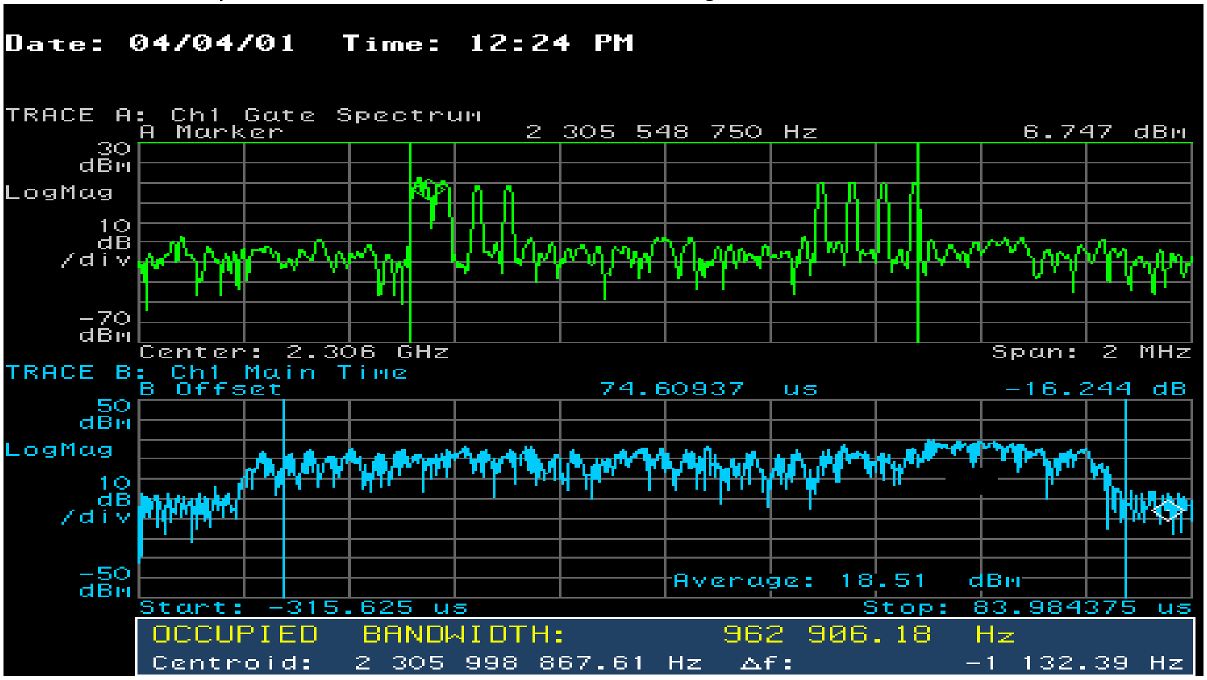
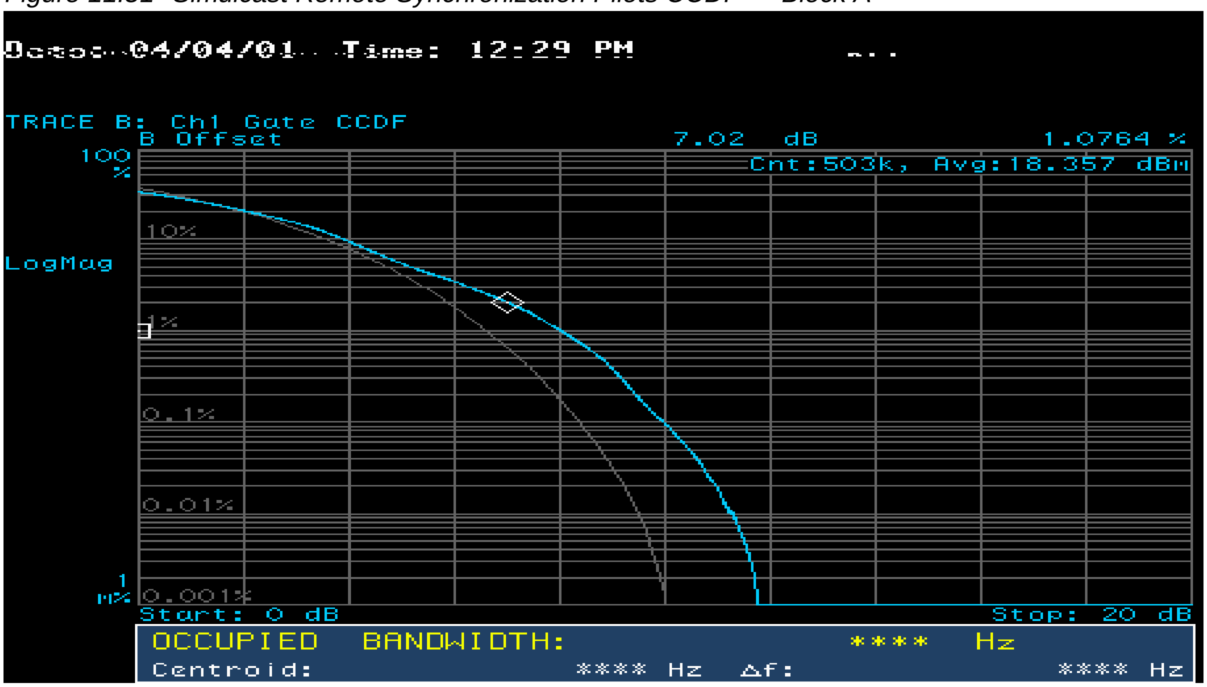


Figure 11.31 Simulcast Remote Synchronization Pilots CCDF — Block A



11.2.5.3 Test Results and Summary — WCS Block A

Table 11.15 Summary of Logical Channel Characterization Test Results — Block A

Parameter	Measured Value	FCC Reqm't.	Complies Y/N
Fifteen Voice Channel 99% Occupied Bandwidth	≤ 946 kHz	1 MHz	**Y**
Fifteen Voice Channel Average Power	+34.07 dBm	*<35 dBm	**Y**
Voice Channel Peak/Average Ratio at ≤ 99.0% occurrence after $1x10^6$ samples	13.1 dB	N/A	
High-Speed Data Channel 99% Occupied Bandwidth	≤ 950 kHz	1 MHz	**Y**
High-Speed Data Channel Average Power	+32.01 dBm	*<35 dBm	**Y**
High-Speed Data Control Channel 99% Occupied Bandwidth	≤ 60 kHz	1 MHz	**Y**
High-Speed Data Control Channel Average Power	+17.0 dBm	*<35 dBm	**Y**
NAC Channel 99% Occupied Bandwidth	≤ 68 kHz	1 MHz	**Y**
NAC Channel Average Power	+20.83 dBm	*<35 dBm	**Y**
Time-Keyed Remote Synchronization Channel 99% Occupied Bandwidth	≤ 500 kHz	1 MHz	**Y**
Time-Keyed Remote Synchronization Channel Average Power	+19.36 dBm	*<35 dBm	**Y**
Remote Synchronization Channel 99% Occupied Bandwidth	≤ 963 kHz	1 MHz	**Y**

Note: Power levels listed are for each state of the time-keyed RSPs documented in Section 11.1.4.3.5, "Time-Keyed Remote Synchronization Channel."

* Transmit power limited by design.

11.2.6 Modulation Characterization — Block B

Block B refers to the 5-Mhz-wide spectrum between 2310 MHz and 2315 MHz.

11.2.6.1 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.

11.2.6.2 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
- 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)

11.2.6.2.1 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 11.32 and Figure 11.33. The results of these tests are summarized in Table 11.15.

Figure 11.32 Fifteen Simultaneous — Voice Channel Power vs. Frequency, 99.0% Occupied BW, and Time-Domain Average Burst Power — Block B

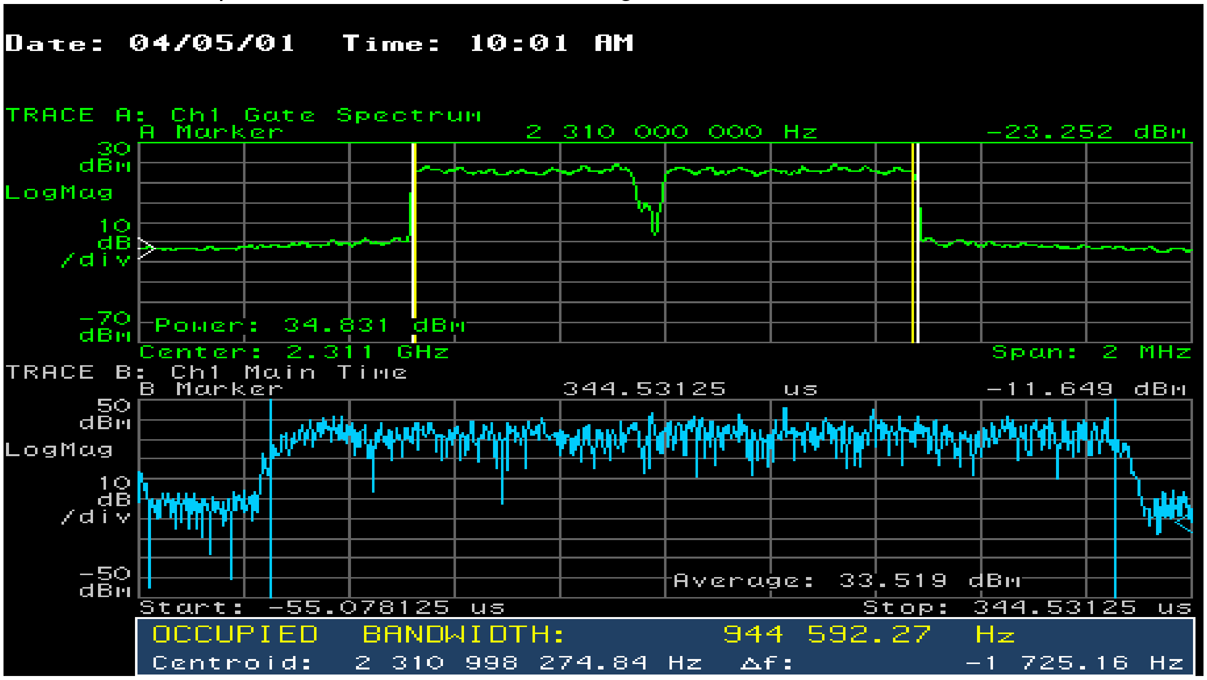
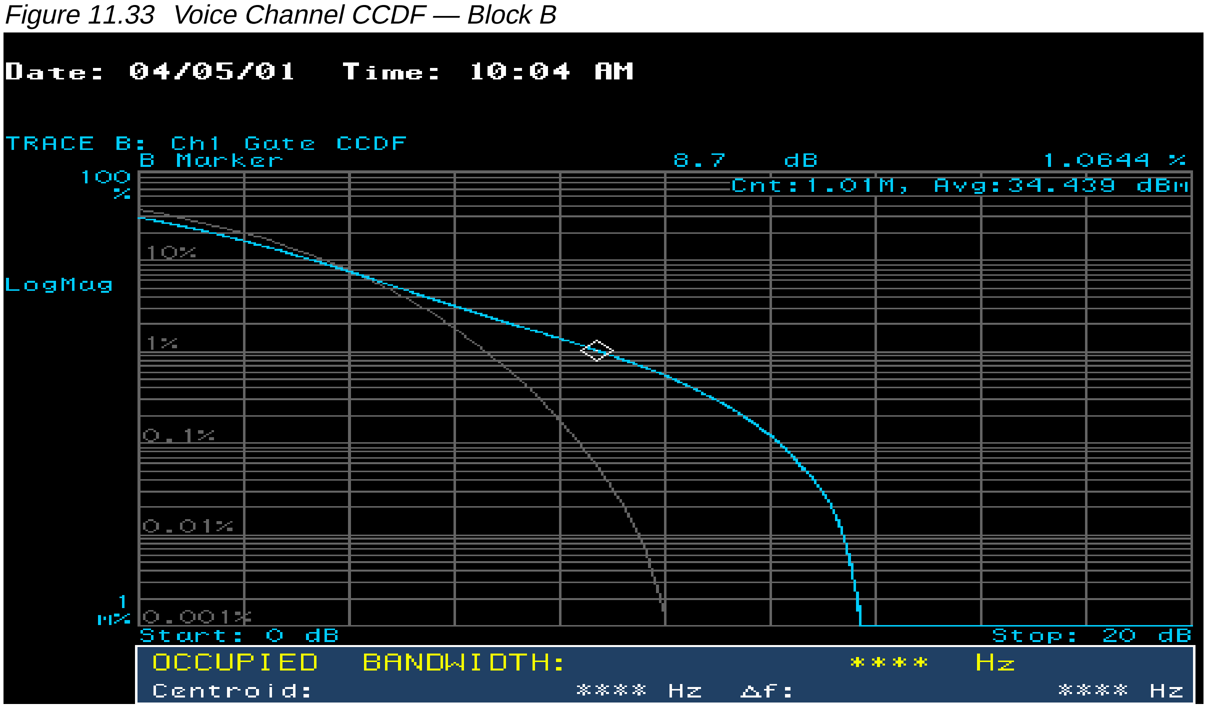


Figure 11.33 Voice Channel CCDF — Block B



11.2.6.2.2 High-Speed-Data Channel

A single HSD session was established between the Base Station under test and the Base Station 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.

The measured characteristics of the HSD channel are depicted in Figure 11.34 and Figure 11.35. The results of these tests are summarized in Figure 11.43.

Figure 11.34 High-Speed Data Channel Power vs. Frequency, 99% Occupied BW, and Time-Domain Average Burst Power — Block B

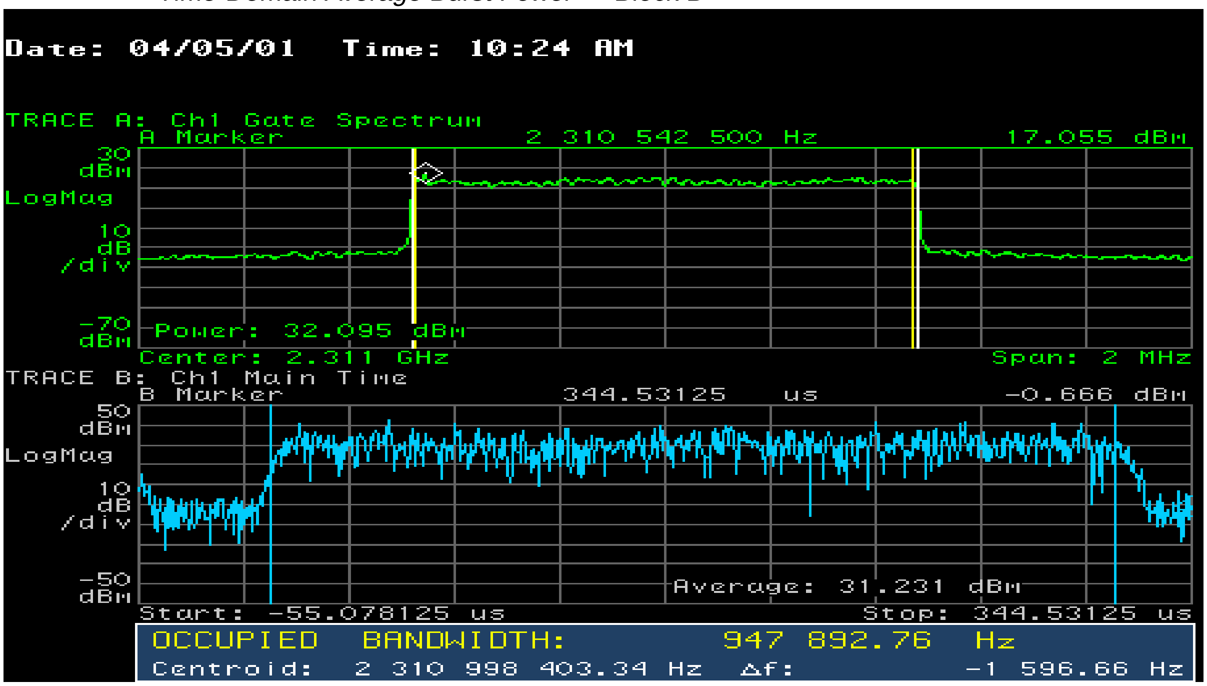
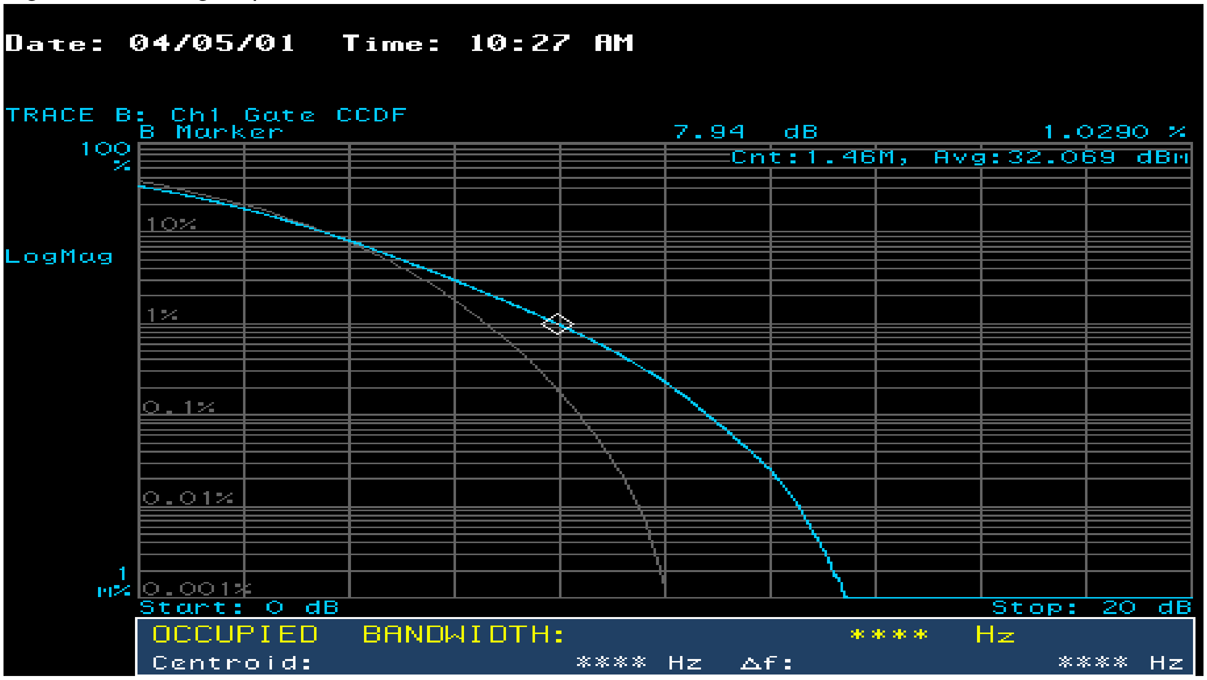


Figure 11.35 High-Speed Data Channel CCDF — Block B



11.2.6.2.3 High-speed Data Control Channel

Characterization of the HSD 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.

The measured characteristics of the HSD Control channel are depicted in Figure 11.36 and Figure 11.37. The results of these tests are summarized in Figure 11.43.

Figure 11.36 High Speed Data Control Channel Power vs. Frequency, 99% Occupied Bandwidth, and Time-Domain Average Power — Block B

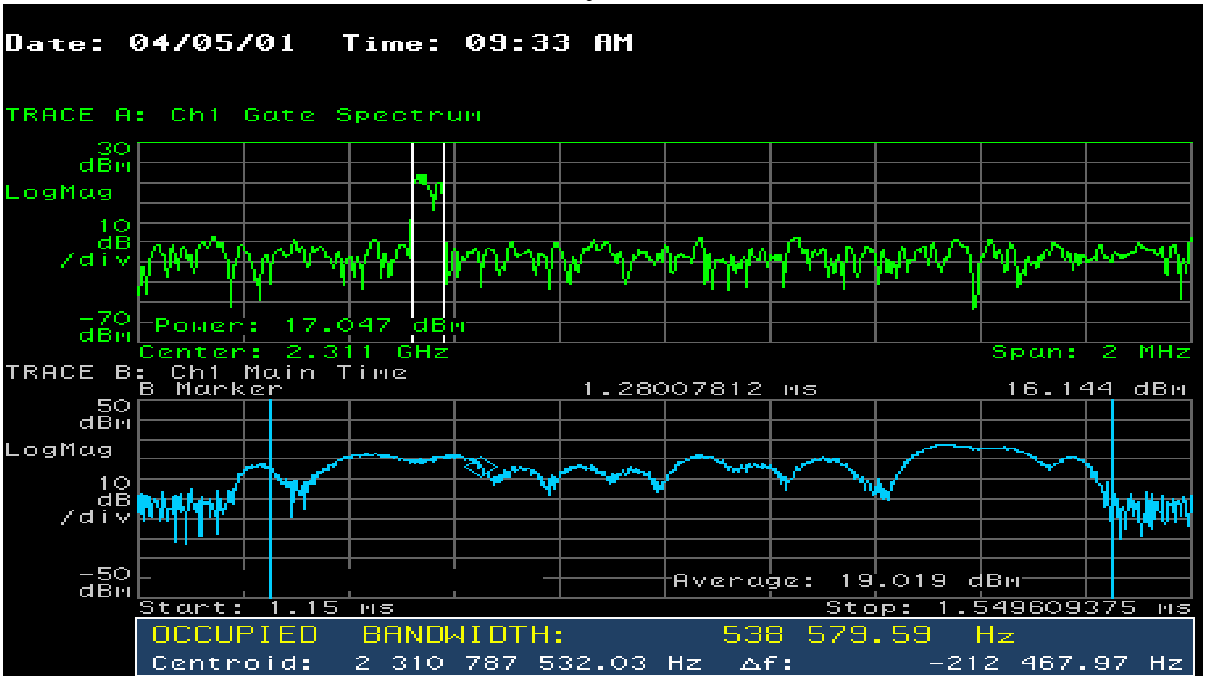
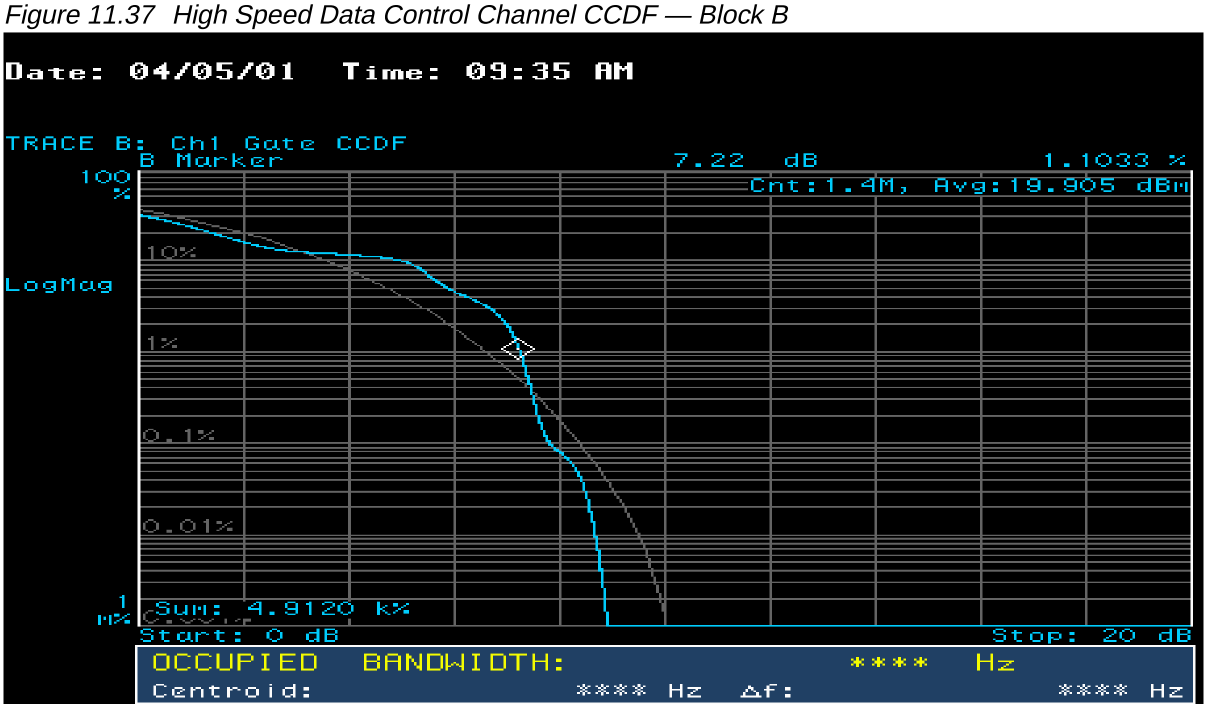


Figure 11.37 High Speed Data Control Channel CCDF — Block B



11.2.6.2.4 Network Access Channel (NAC)

The Base Station NAC 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. The measured characteristics of the Network Access channel are depicted in Figure 11.38 and Figure 11.39. The results of these tests are summarized in Figure 11.43.

Figure 11.38 NAC Channel Power vs. Frequency, 99% Occupied BW, and Time-Domain Average Power — Block B

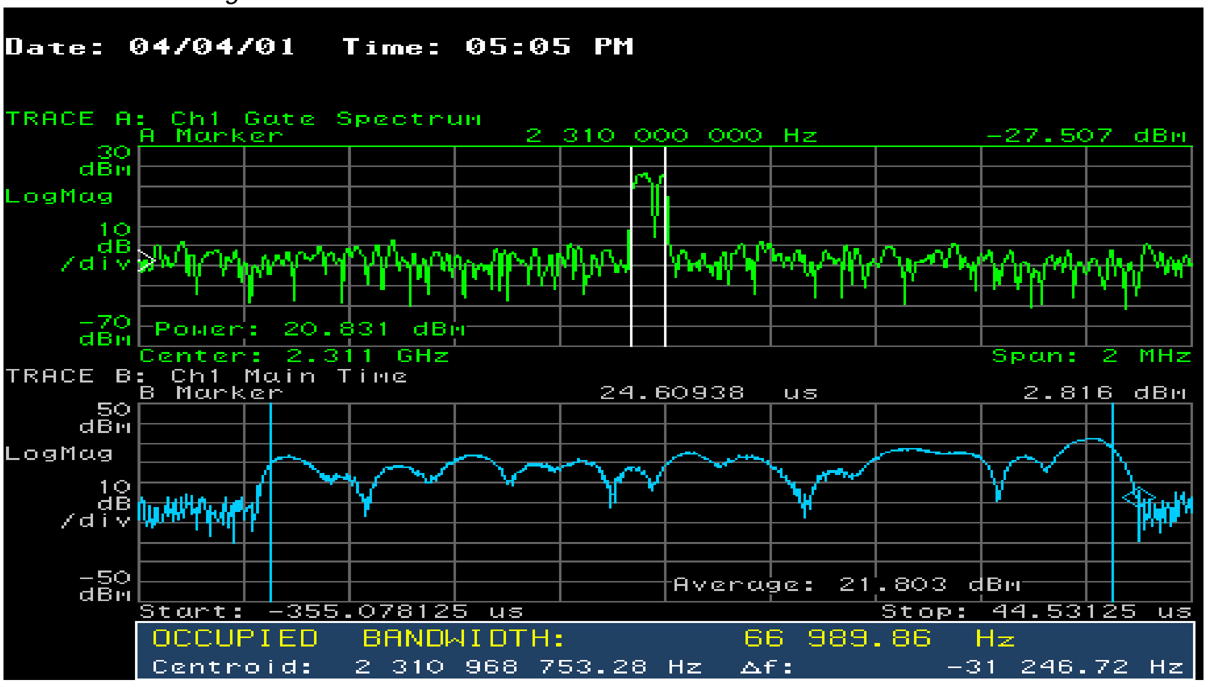
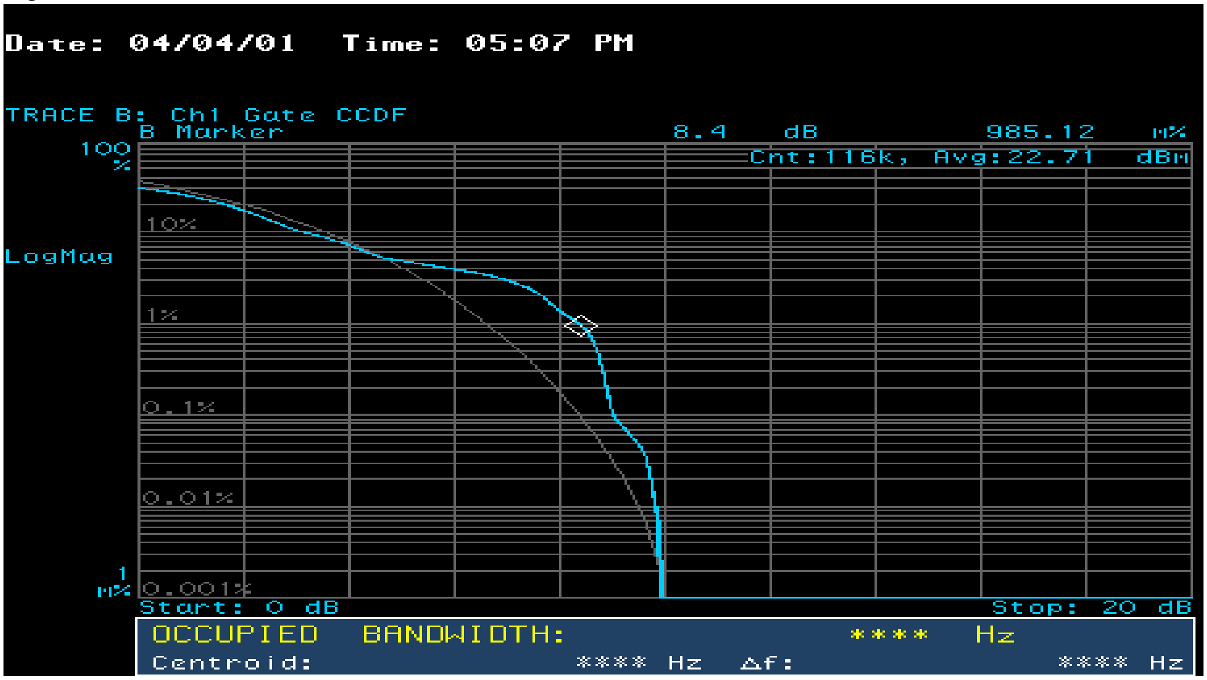


Figure 11.39 NAC Channel CCDF — Block B



11.2.6.2.5 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.

The measured characteristics of the Time-Keyed Remote Synchronization channel are depicted in Figure 11.40 and Figure 11.41. The results of these tests are summarized in Figure 11.43.

Figure 11.40 Time-Keyed Remote Synchronization Pilots Power vs. Frequency, 99.0% Occupied Bandwidth, and Time-Domain Average Burst Power During Broadcast TDMA Frames — Block B

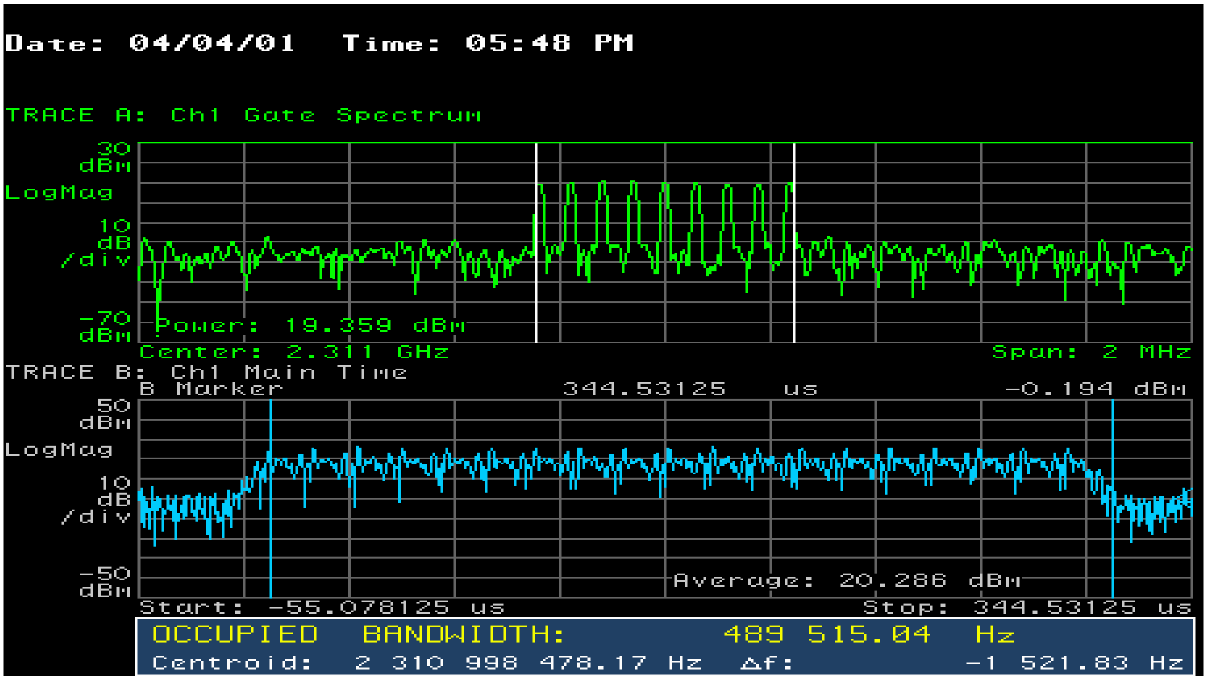
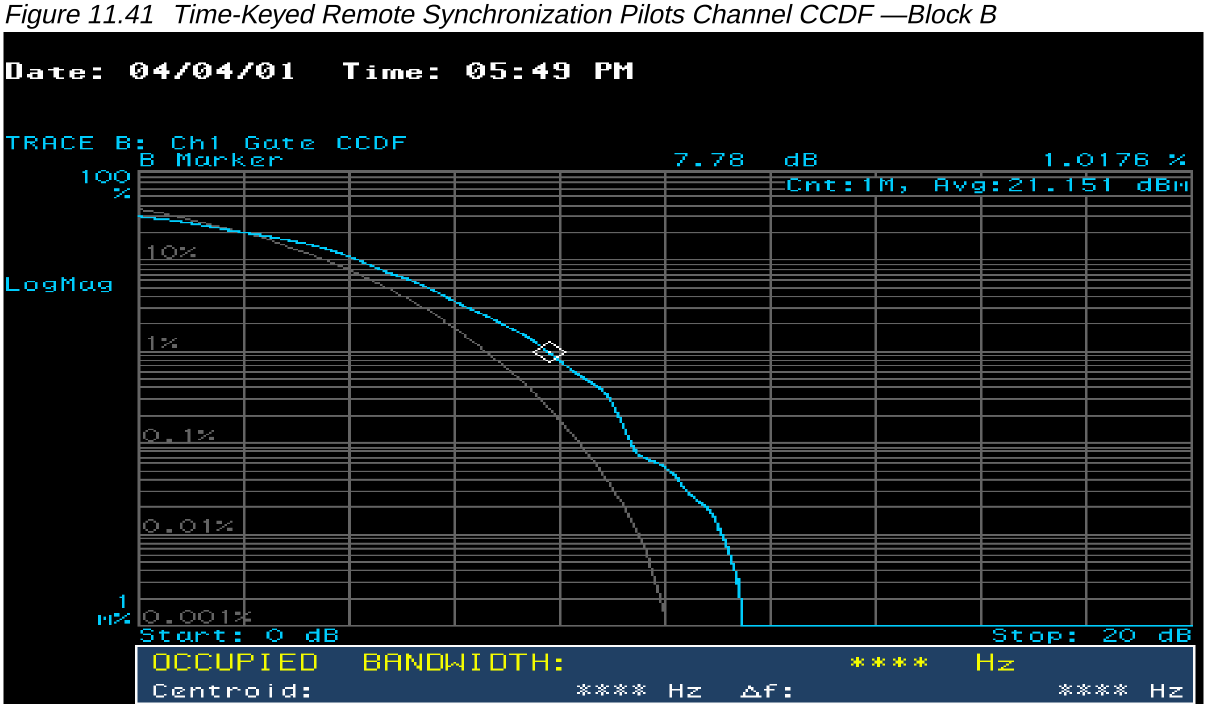


Figure 11.41 Time-Keyed Remote Synchronization Pilots Channel CCDF —Block B



11.2.6.2.6 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.

The measured characteristics of the Remote Synchronization channel are depicted in Figure 11.42 and Figure 11.43. The results of these tests are summarized in Figure 11.43.

Figure 11.42 Simulcast Remote Synchronization Pilots Power vs. Frequency, 99.0% Occupied Bandwidth, and Time-Domain Average Burst — Block B

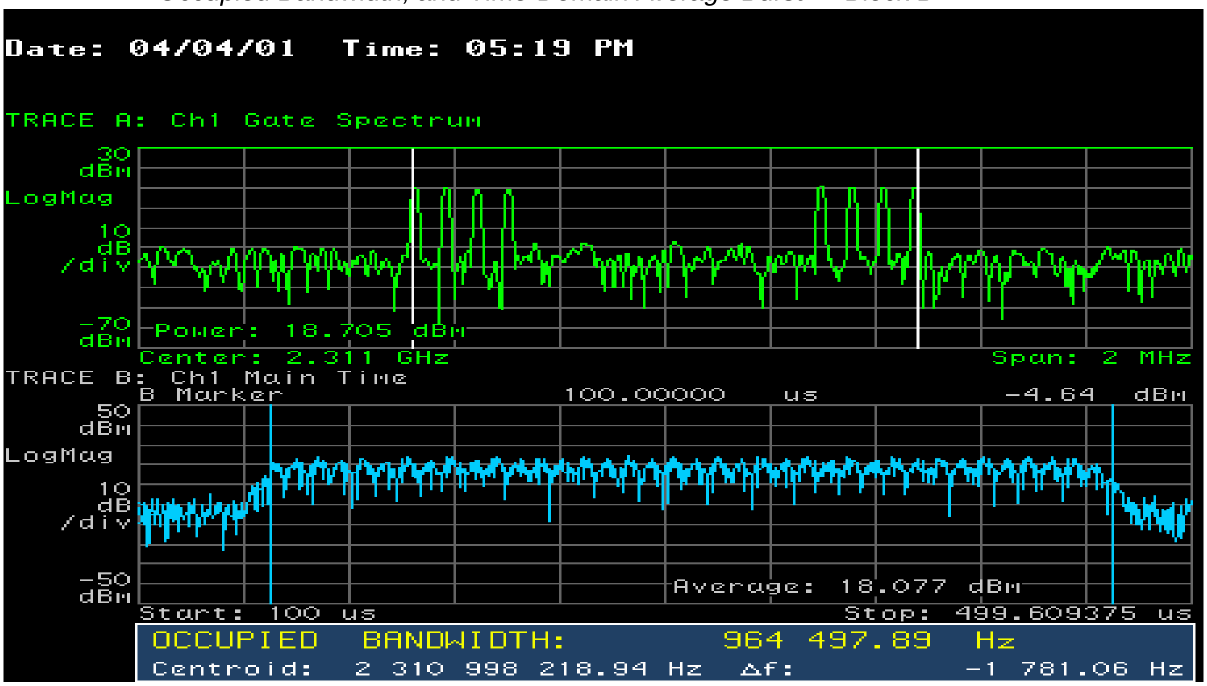
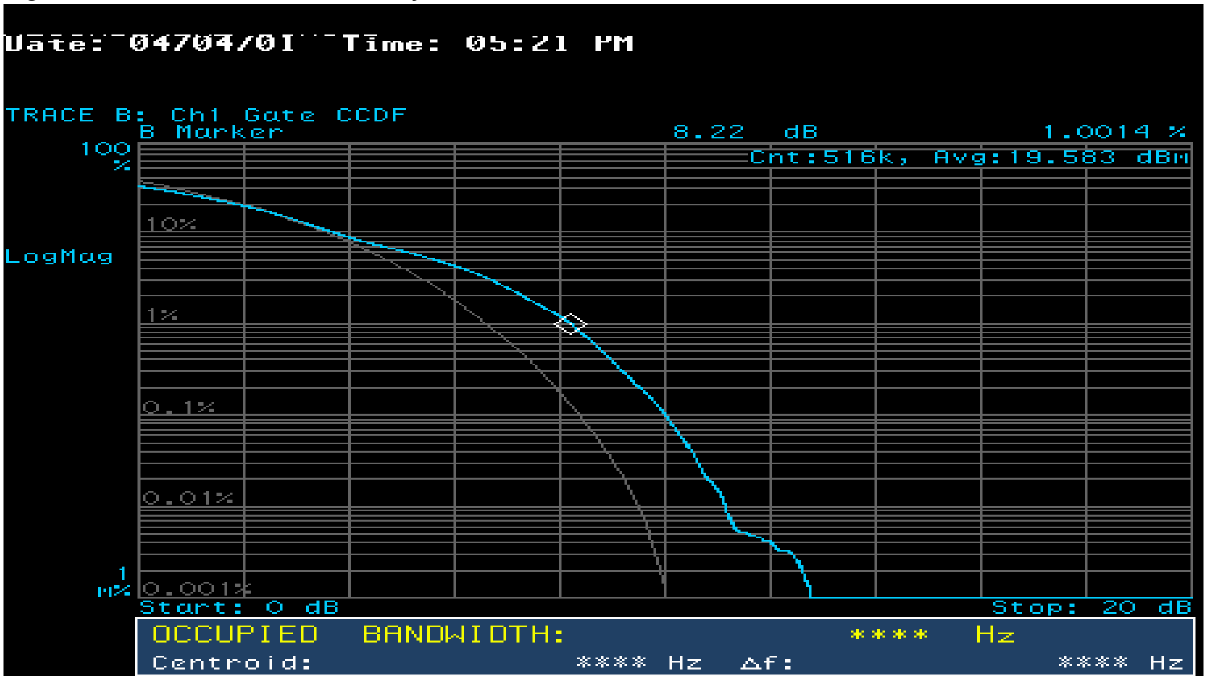


Figure 11.43 Simulcast Remote Synchronization Pilots CCDF — Block B



11.2.6.3 Test Results and Summary — WCS Block B

Table 11.16 Summary of Logical Channel Characterization Test Results — Block B

Parameter	Measured Value	FCC Reqm't.	Complies Y/N
Fifteen Voice Channel 99% Occupied Bandwidth	≤ 945 kHz	1 MHz	**Y**
Fifteen Voice Channel Average Power	+34.03 dBm	*<35 dBm	**Y**
Fifteen Voice Channel Peak/Average Ratio at ≤ 99.0% occurrence after $1x10^6$ samples	14.32 dB	N/A	
High-Speed Data Channel 99% Occupied Bandwidth	≤ 948 kHz	1 MHz	**Y**
High-Speed Data Channel Average Power	+32.01 dBm	*<35 dBm	**Y**
High-Speed Data Control Channel 99% Occupied Bandwidth	≤ 539 kHz	1 MHz	**Y**
High-Speed Data Control Channel Average Power	+17.05 dBm	*<35 dBm	**Y**
NAC Channel 99% Occupied Bandwidth	≤ 67 kHz	1 MHz	**Y**
NAC Channel Average Power	+20.8 dBm	*<35 dBm	**Y**
Time-Keyed Remote Synchronization Channel 99% Occupied Bandwidth	≤ 500 kHz	1 MHz	**Y**
Time-Keyed Remote Synchronization Channel Average Power	+19.35 dBm	*<35 dBm	**Y**
Remote Synchronization Channel 99% Occupied Bandwidth	≤ 965 kHz	1 MHz	**Y**
Remote Synchronization Channel Average Power	+18.7 dBm	*<35 dBm	**Y**

Power levels listed are for each state of the time-keyed RSPs documented in *Section 11.1.4.3.5, "Time-Keyed Remote Synchronization Channel*."

* Transmit power limited by design.

11.2.7 RF Output Power

11.2.7.1 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 27.50 - In no case may the peak output power of a base station transmitter exceed 2000 watts peak equivalent isotropically radiated power (EIRP). 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 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 11.20.

The Hewlett-Packard 89441A Vector Signal Analyzer was configured according to the parameters noted. 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.

11.2.7.3 Results and Summary — Block A

Block A refers to the 5-MHz-wide spectrum between 2305 MHz and 2310 MHz.

The measured RF output power of the Base Station while supporting 15 simultaneous voice calls in a single TDMA slot is depicted in Figure 11.44, Figure 11.45 and Figure 11.46. The results of these tests are summarized in 11.2.8.4.

Figure 11.44 Time-Domain Power Envelope, Average Power — Block A

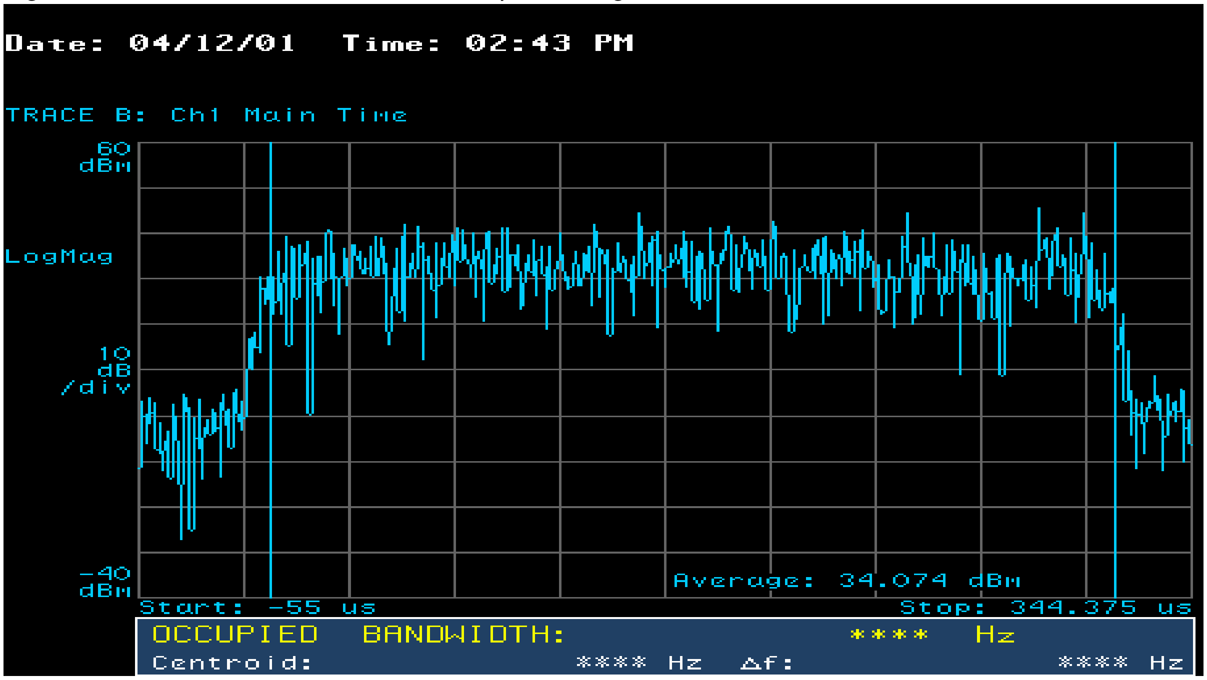


Figure 11.45 Time-Domain Power Envelope, Peak Power at ≤ 99.0% Occurrence —Block A

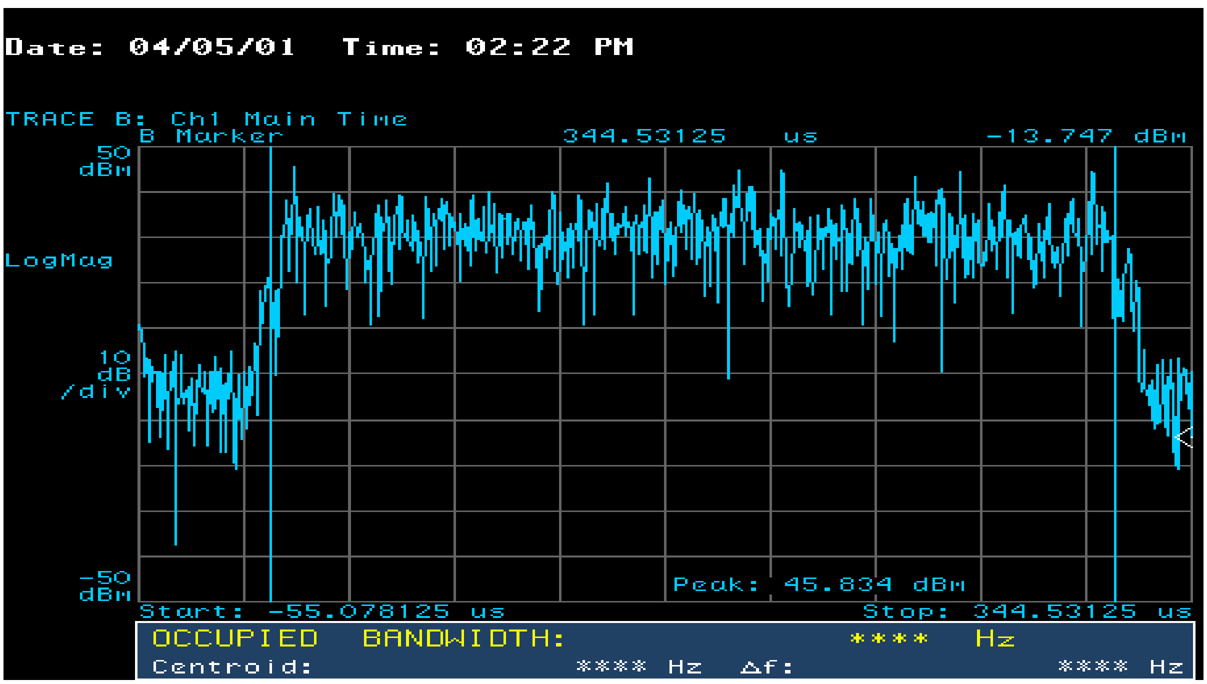


Figure 11.46 Time-Domain Power Envelope, Peak/Average Ratio at ≤ 99.0% Occurrence — Block A

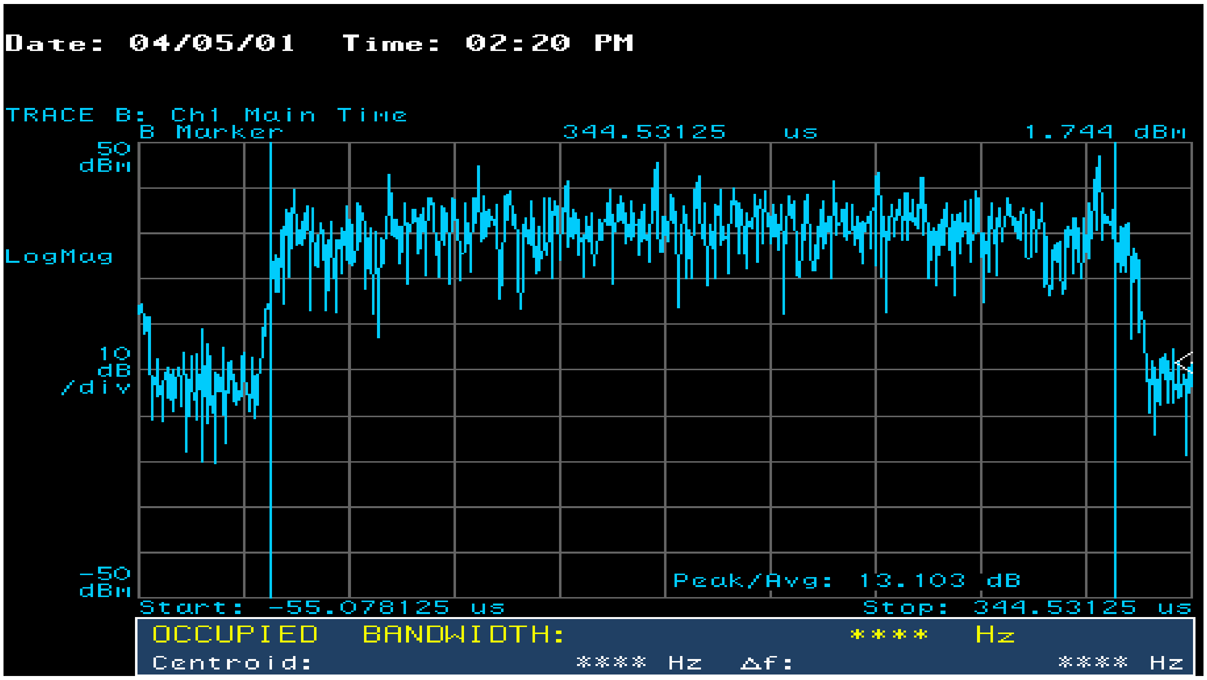


Table 11.17 RF Output Power Characteristics

Parameter	Measured Value	FCC Part 27 Limit
Time-Domain Average Power	+34.1 dBm/1 MHz	N/A
Time-Domain Peak Power at ≤ 99.0% Occurrence	+45.8 dBm/1 MHz RBW	+50.0 dBm/1 MHz RBW
Time-Domain Peak/Average Ratio at ≤ 99.0% Occurrence	13.1 dB	N/A

11.2.7.4 Results and Summary — Block B

Block B refers to the 5-Mhz-wide spectrum between 2310 MHz and 2315 MHz.

The measured RF output power of the Base Station while supporting 15 simultaneous voice calls in a single TDMA slot is depicted in Figure 11.47, Figure 11.48 and Figure 11.49. The results of these tests are summarized in 11.2.8.4.

Figure 11.47 Time-Domain Power Envelope, Average Power— Block B

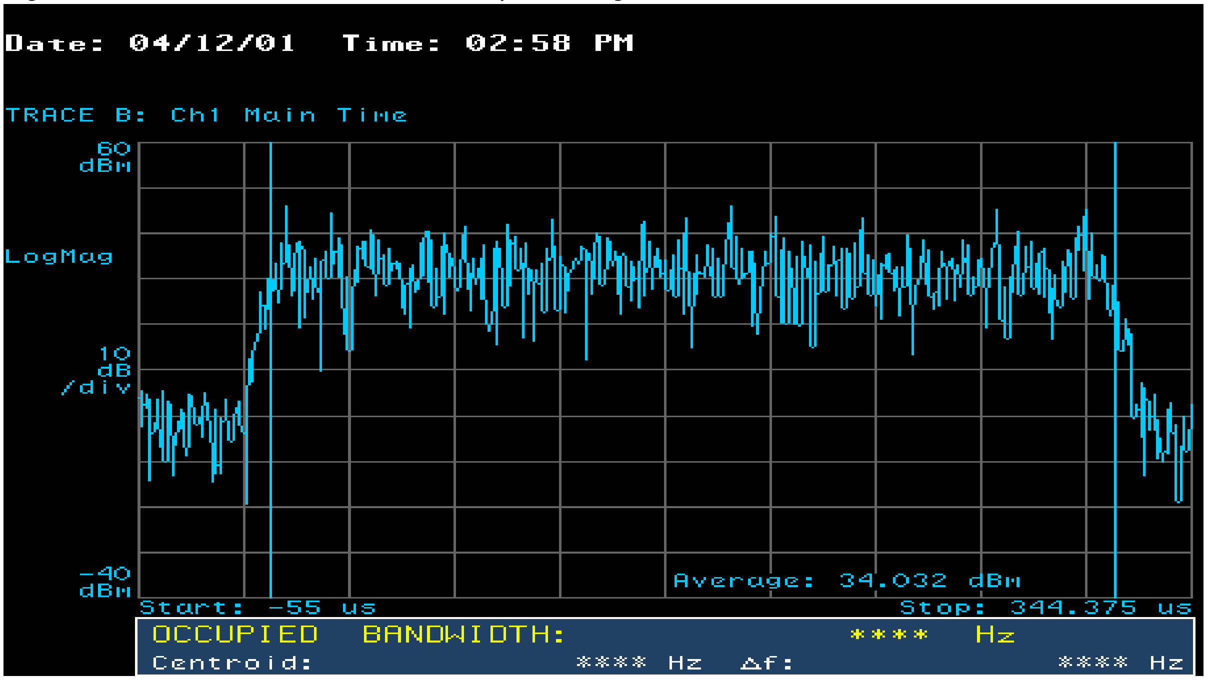


Figure 11.48 Time-Domain Power Envelope, Peak Power at ≤ 99.0% Occurrence — Block B

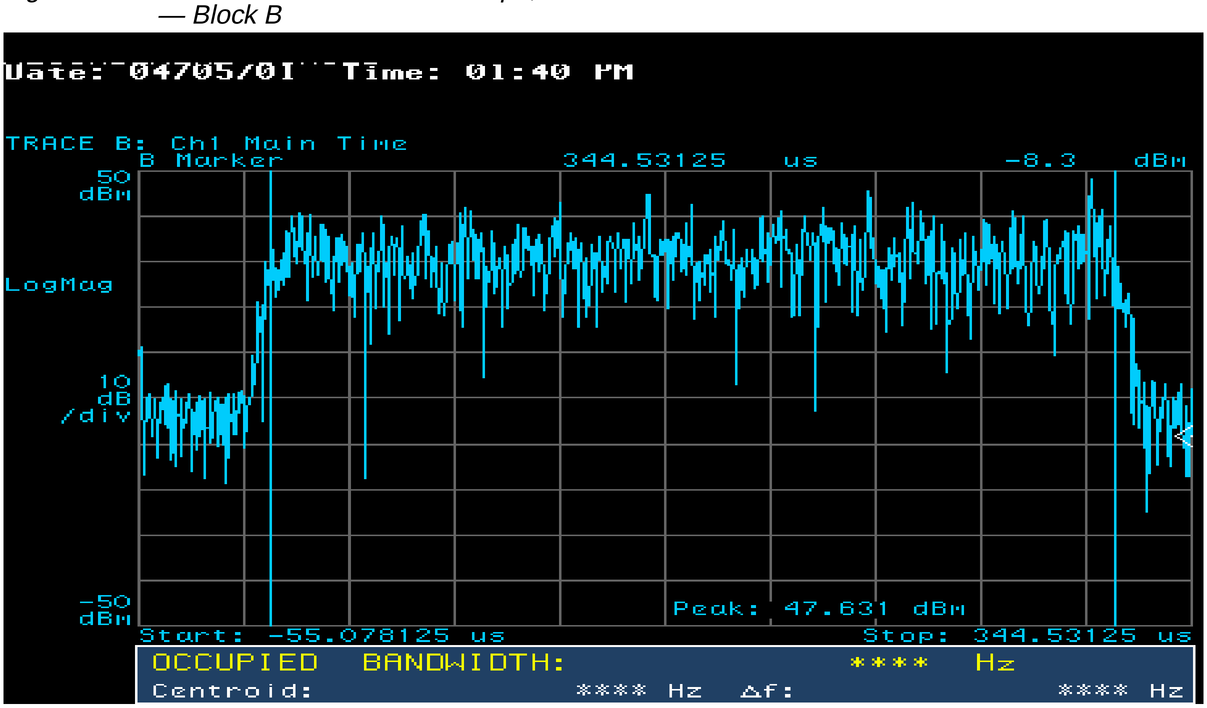


Figure 11.49 Time-Domain Power Envelope, Peak/Average Ratio at ≤ 99.0% Occurrence — Block B

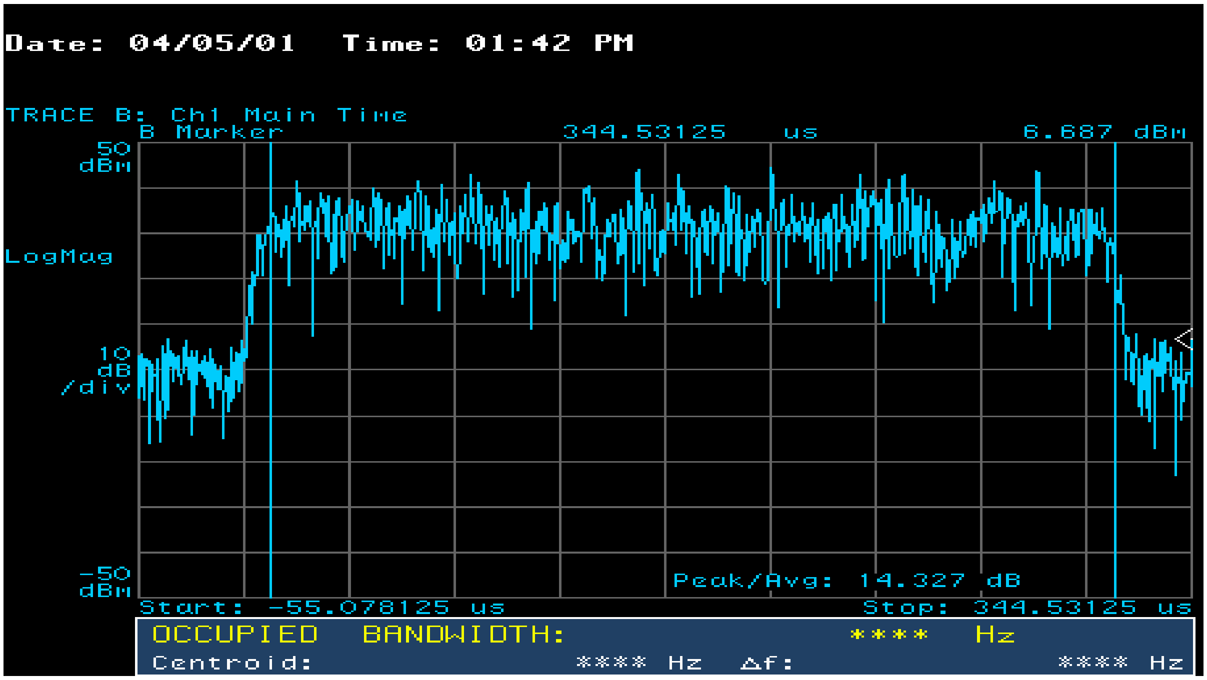


Table 11.18 RF Power Characteristics

Parameter	Measured Value	FCC Part 24 Limit
Time-Domain Average Power	+34.0 dBm/1 MHz	N/A
Time-Domain Peak Power at ≤ 99.0% Occurrence	+47.6 dBm/1 MHz RBW	+50.0 dBm/1 MHz RBW
Time-Domain Peak/Average Ratio at ≤ 99.0% Occurrence	14.3 dB	N/A

11.2.8 Spurious Emissions at the Antenna Terminal

11.2.8.1 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 27.53 - On any frequency outside a licensee's block, the power of any emission shall be attenuated below the transmitter power (P) by at least 80+10Log(P) dB on all frequencies between

2320 and 2345 MHz, by a factor not less than 70 + 10Log(P) dB on all frequencies below 2300 MHz and on all frequencies above 2370 MHz; and not less than 43 + 10Log(P) dB on all frequencies between 2300 and 2320 MHz and on all frequencies between 2345 MHz and 2370 MHz that are outside the licensed bands of operation. 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 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 “A and B” WCS blocks. 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 11.59. The Hewlett-Packard 89441A Vector Signal Analyzer was configured according the parameters shown in Figure 11.12.

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 2290 to 2375 MHz.

11.2.8.3 Results and Summary — Block A

Block A refers to the 5-MHz-wide spectrum between 2305 MHz and 2310 MHz.

11.2.8.3.1 Sector A

The measured spectral purity of the Base Station while transmitting 15 simultaneous voice calls in a single TDMA slot is depicted in Figure 11.50 through Figure 11.54 for Sector A. The results of these tests are summarized in 11.2.8.4.

Figure 11.50 1 MHz Band-Power Between 2305.5 and 2306.5 MHz — Sector A

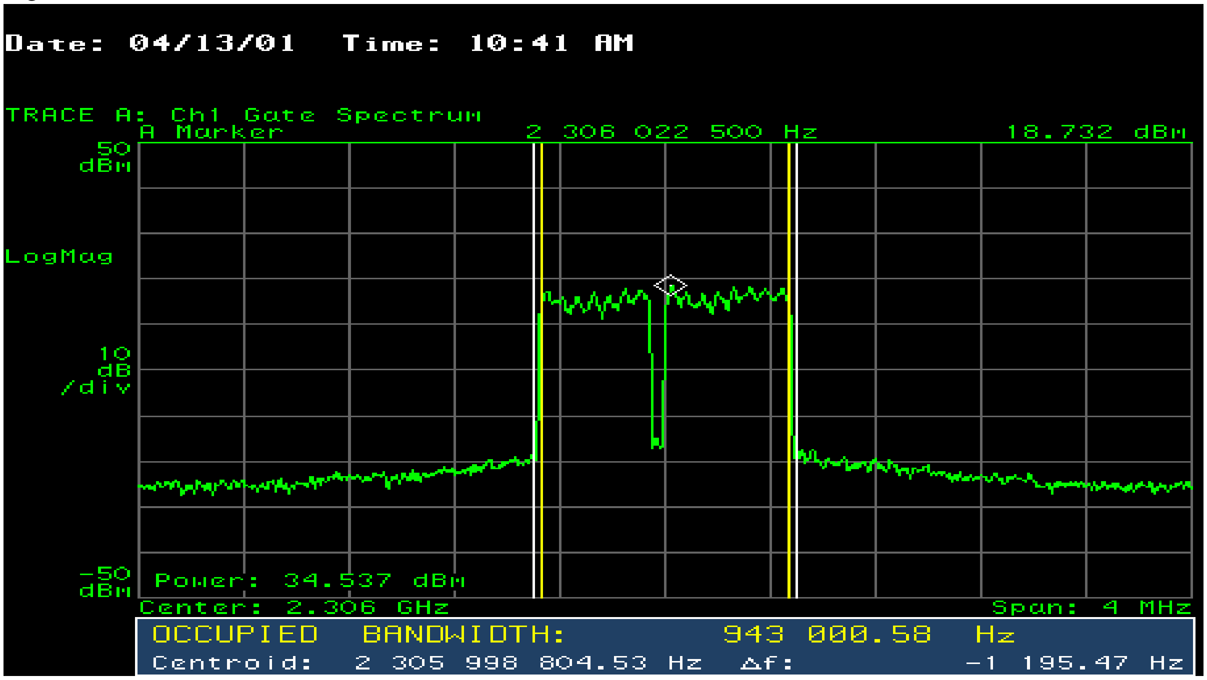


Figure 11.51 1 MHz Band Power Between 2306.5 and 2307.5 MHz — Sector A

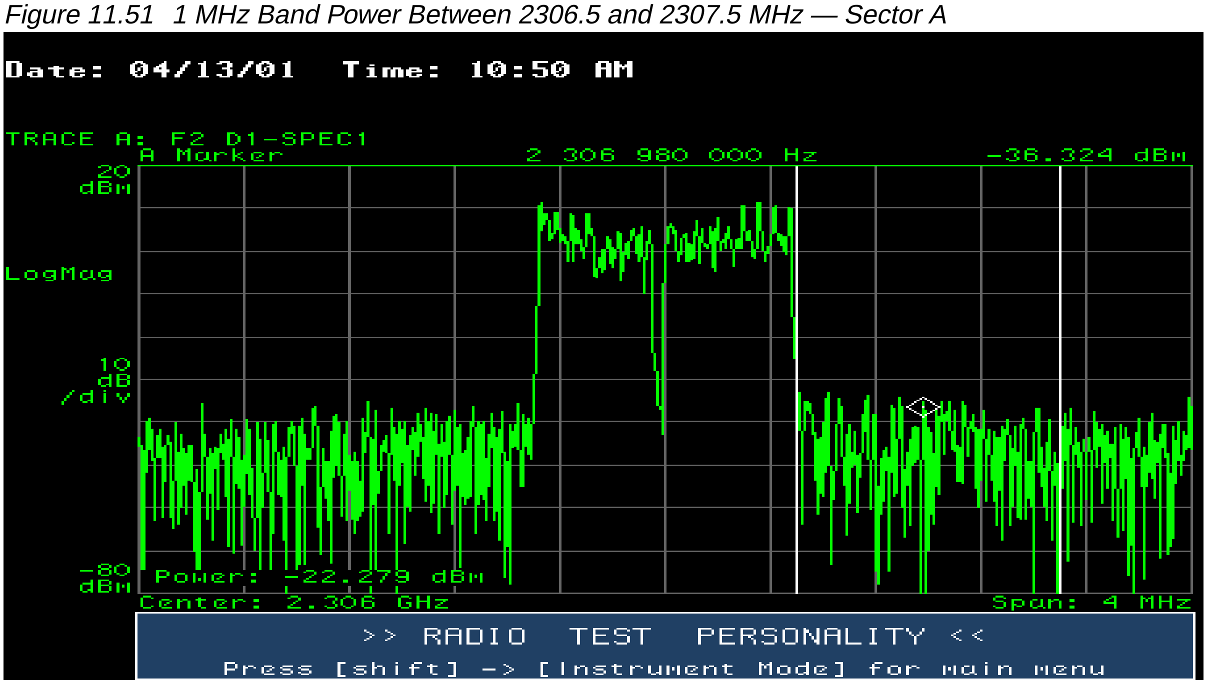


Figure 11.52 7 MHz Lower Guard Band Between 2299 and 2306 MHz — Sector A

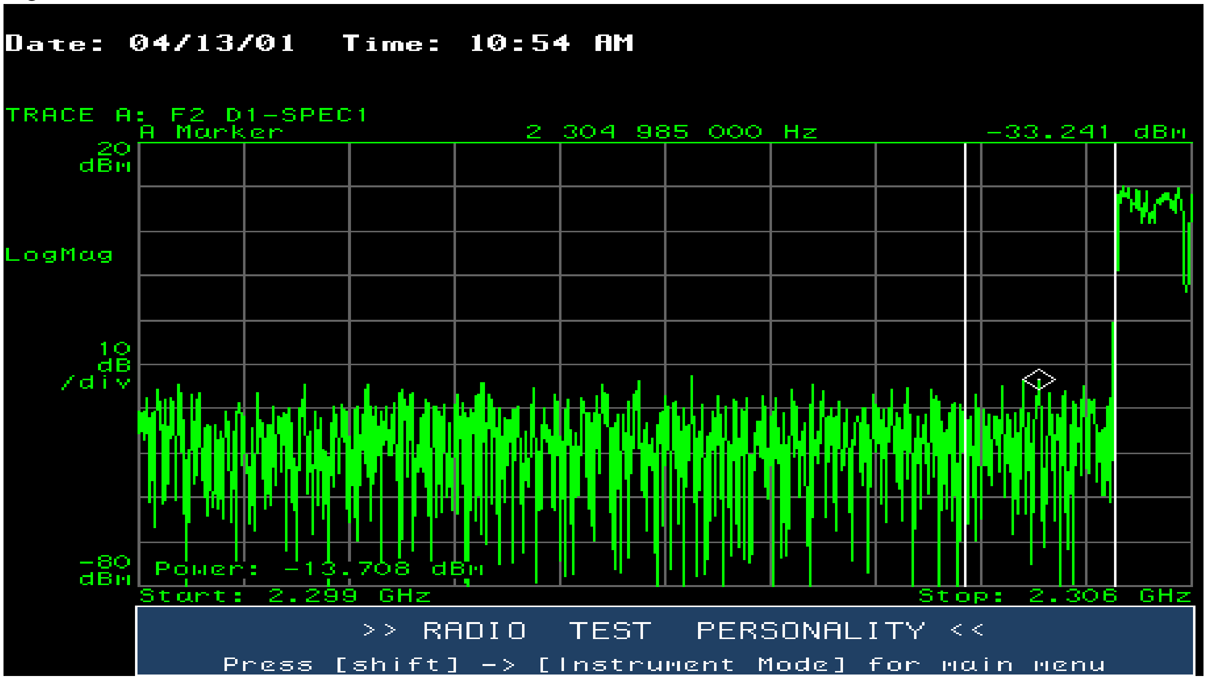


Figure 11.53 7 MHz Lower Guard Band Between 2292 MHz and 2299 MHz — Sector A

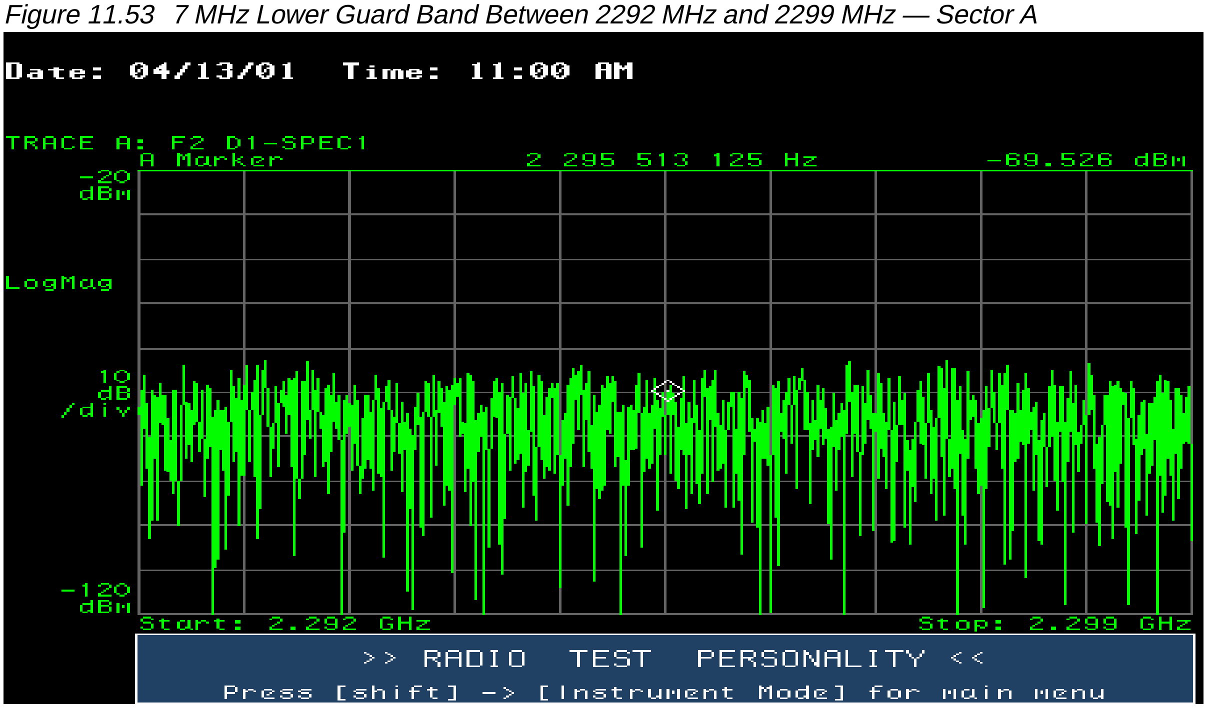
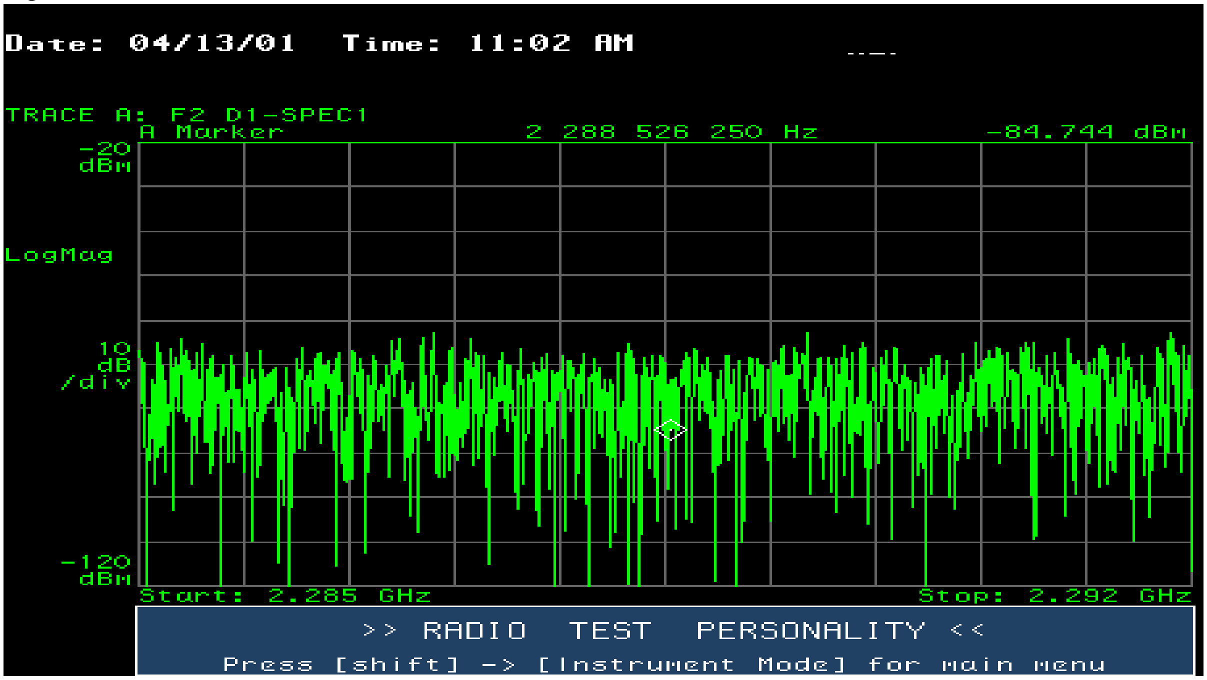


Figure 11.54 7 MHz Lower Guard Band Between 2285 MHz and 2292 MHz — Sector A



11.2.8.3.2 Sector D

The measured spectral purity of the Base Station while transmitting 15 simultaneous voice calls in a single TDMA slot is depicted in Figure 11.55 through Figure 11.65 for Sector D. The results of these tests are summarized in 11.2.8.4.

Figure 11.55 1 MHz Channel Power Between 2308.5 and 2309.5 MHz — Sector D

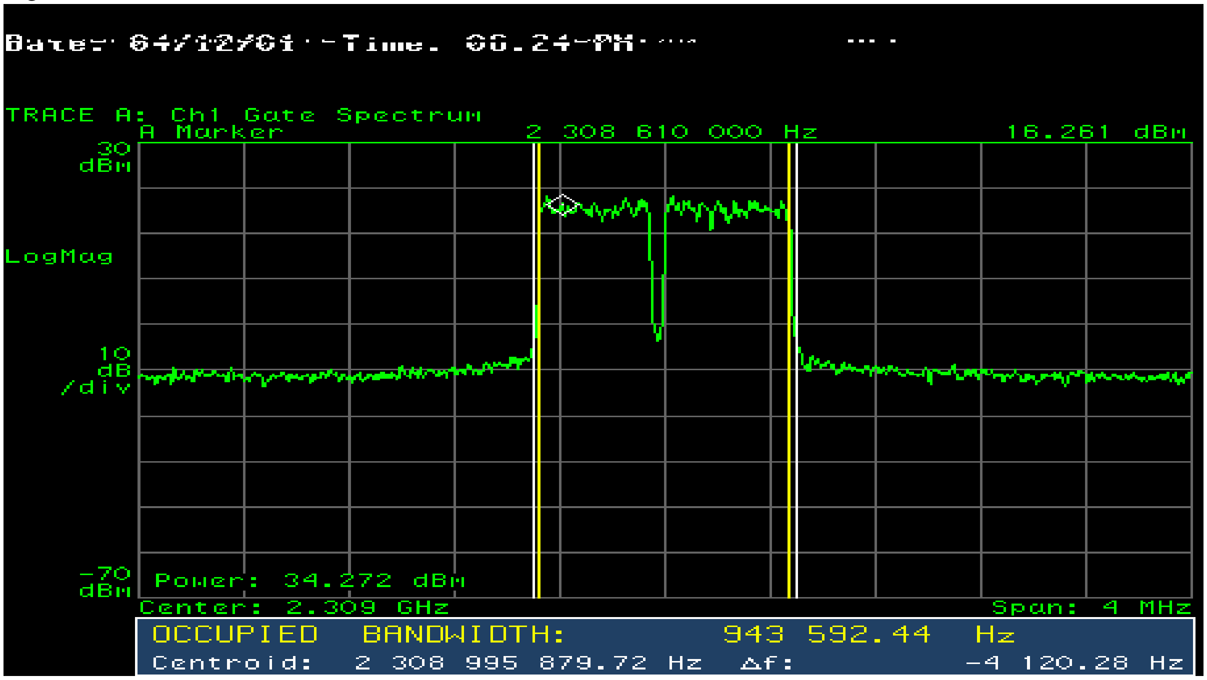


Figure 11.56 1 MHz Band Power Between 2307.5 and 2308.5 MHz — Sector D

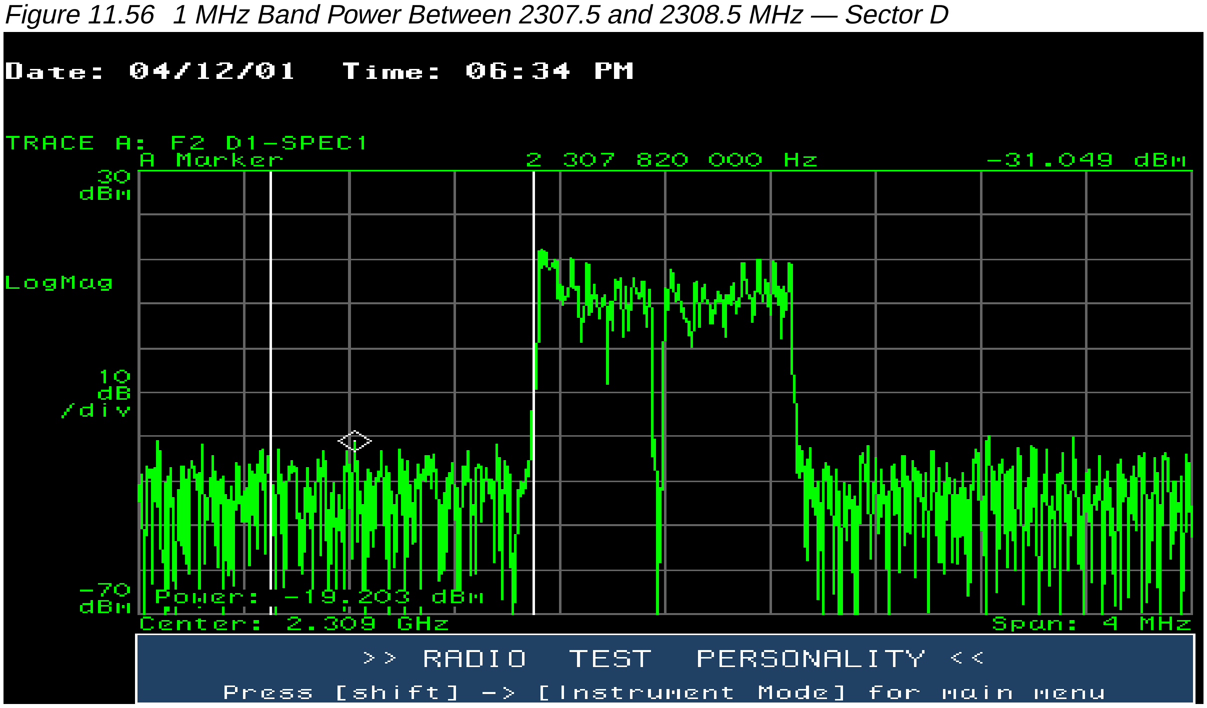


Figure 11.57 1 MHz Band Power Between 2309.5 and 2310.5 MHz — Sector D

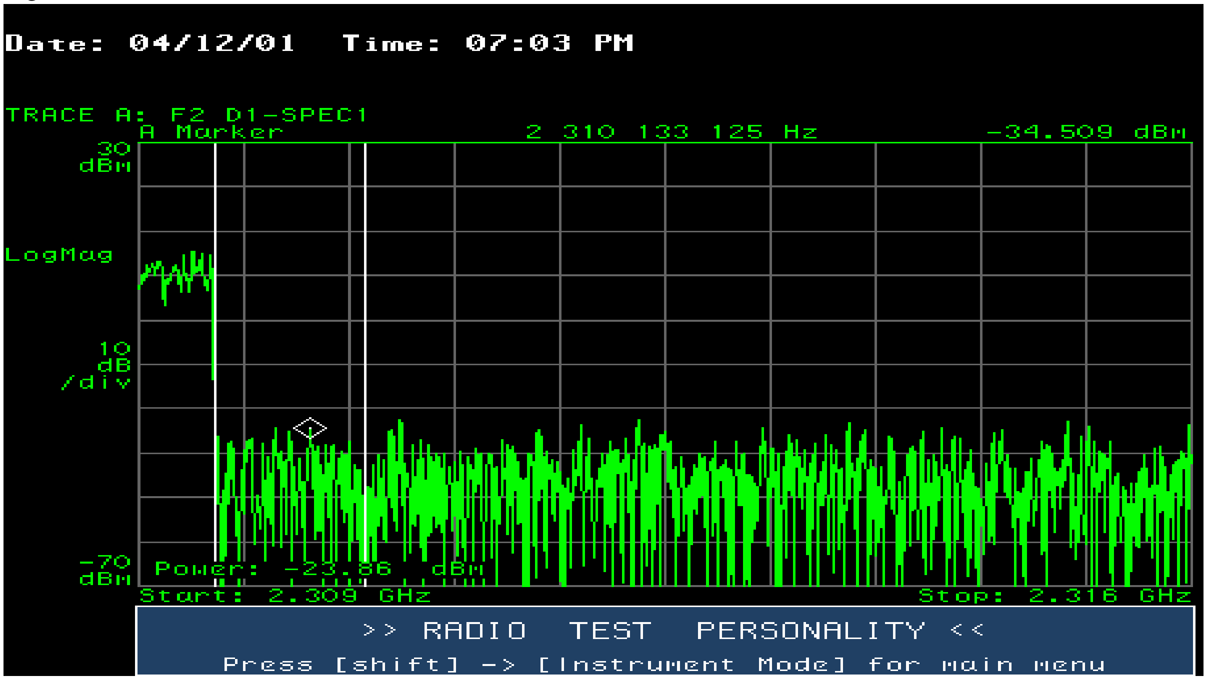


Figure 11.58 7 MHz Upper Guard Band Between 2316 MHz and 2323 MHz — Sector D

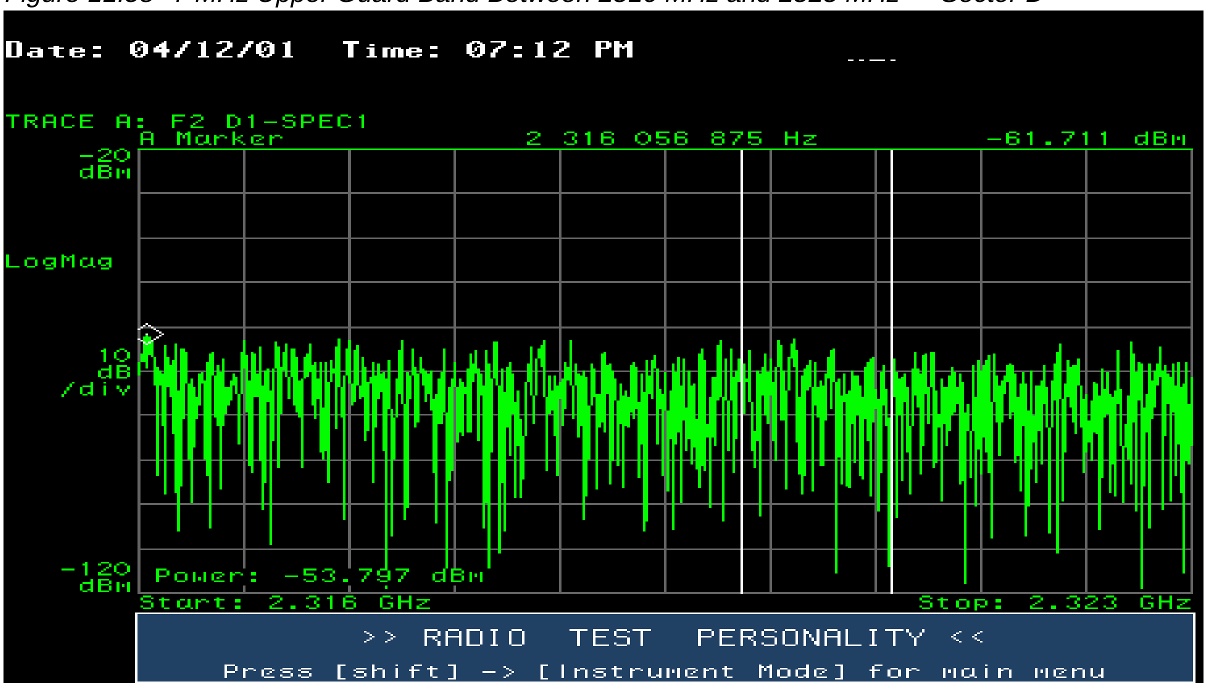


Figure 11.59 7 MHz Upper Guard Band Between 2323 MHz and 2330 MHz — Sector D

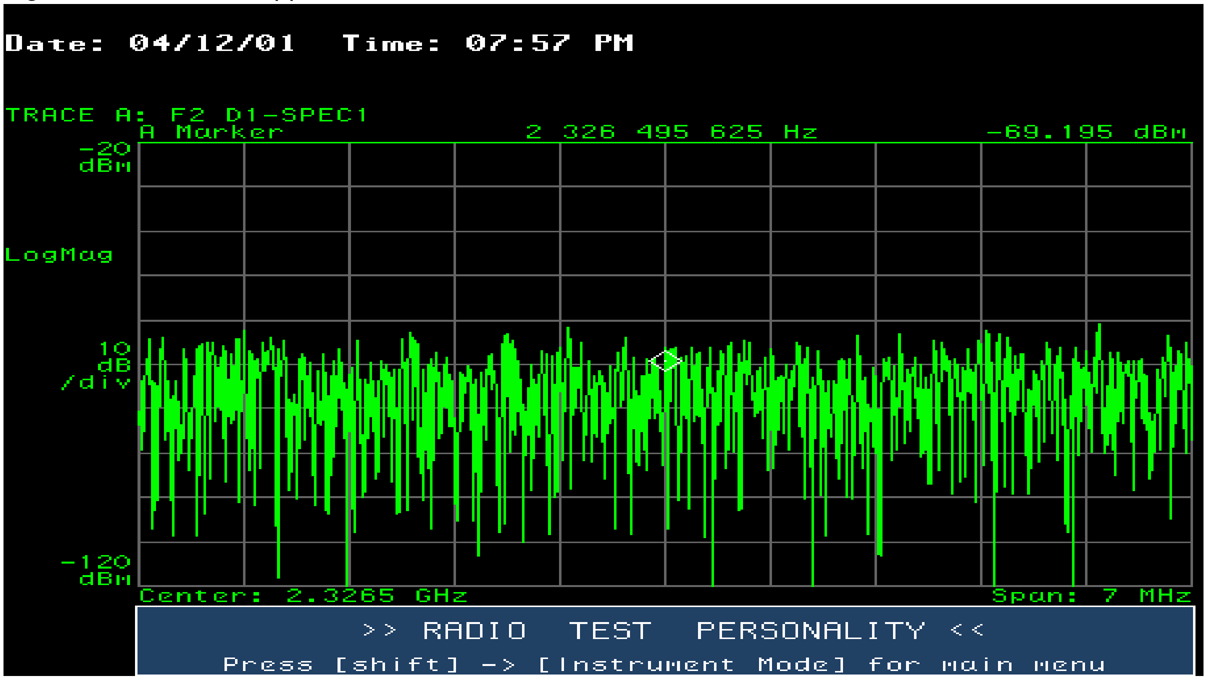


Figure 11.60 7 MHz Upper Guard Band Between 2330 MHz and 2337 MHz — Sector D

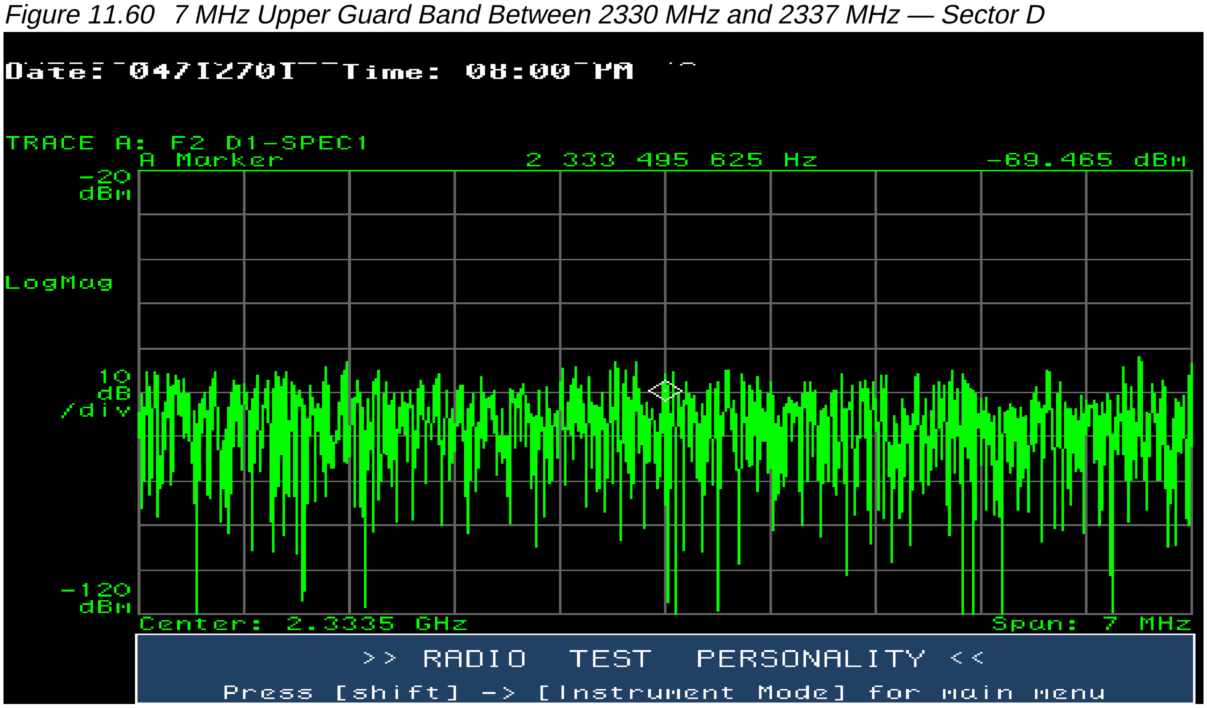


Figure 11.61 7 MHz Upper Guard Band Between 2337 MHz and 2344 MHz — Sector D

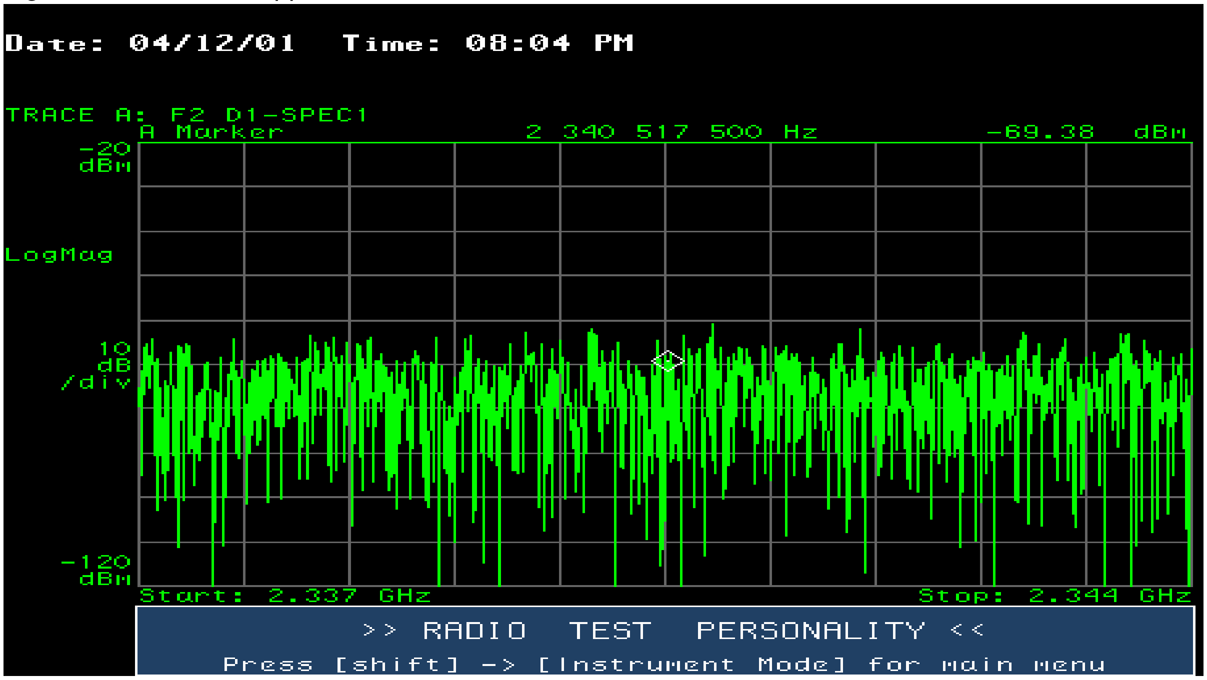


Figure 11.62 7 MHz Upper Guard Band Between 2344 MHz and 2351 MHz — Sector D

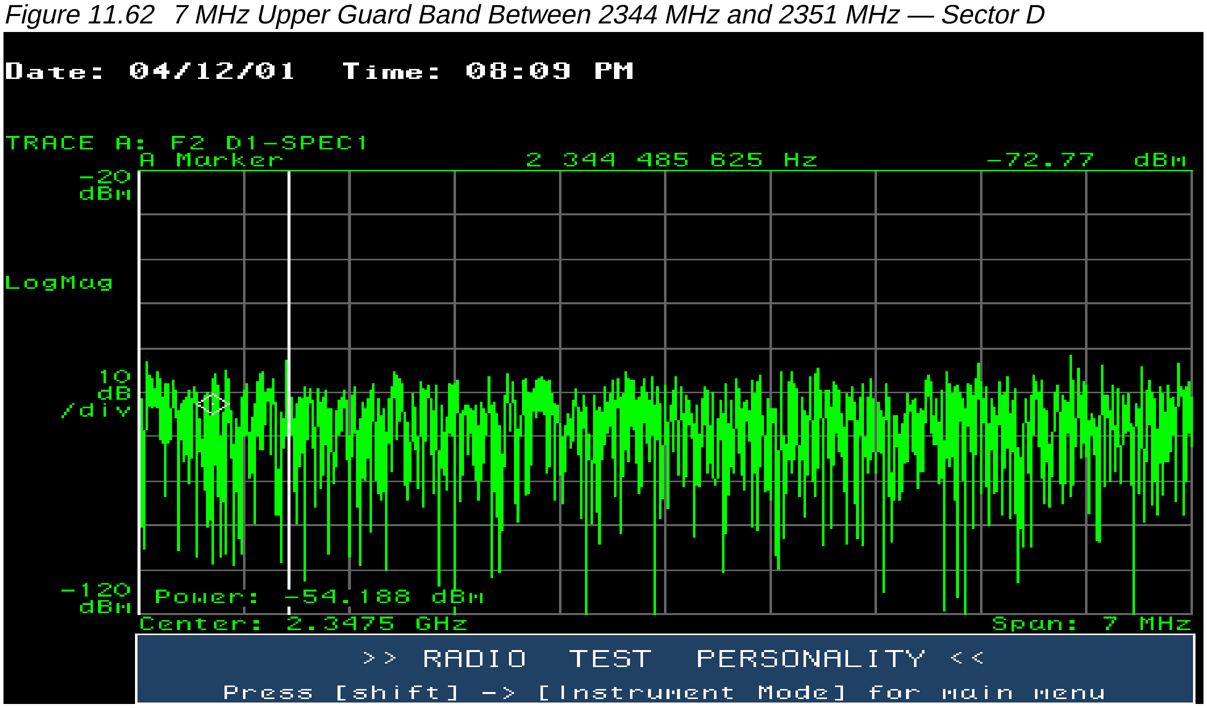


Figure 11.63 7 MHz Upper Guard Band Between 2351 MHz and 2358 MHz — Sector D

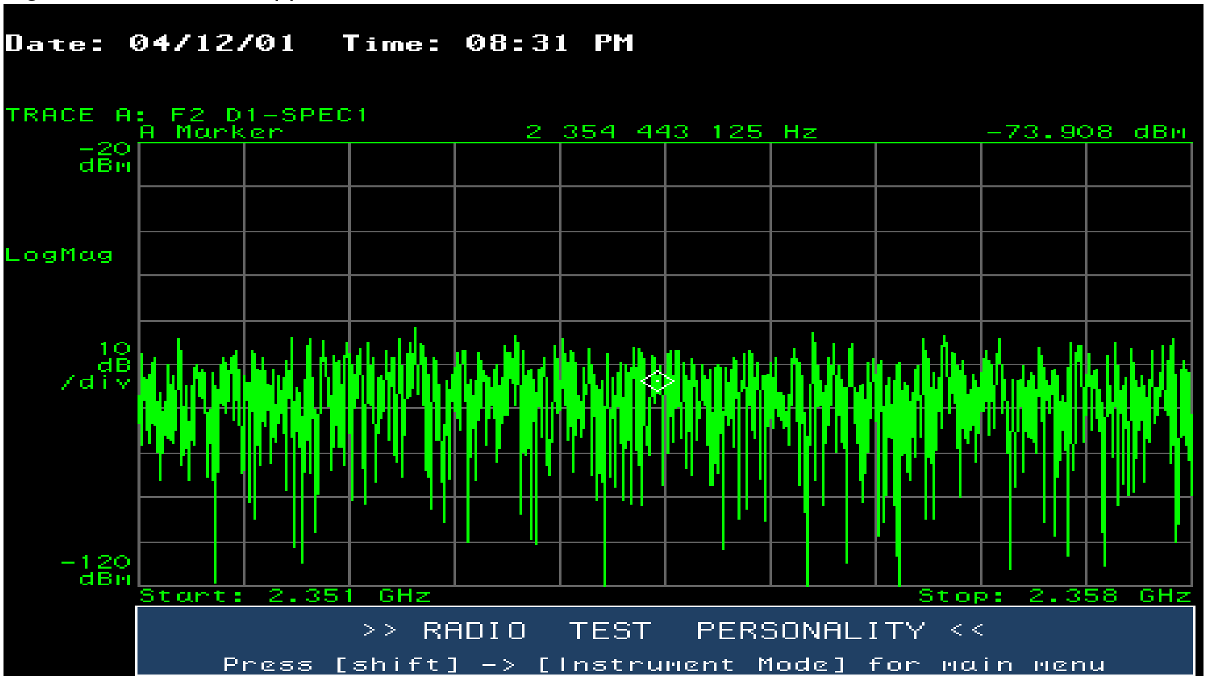


Figure 11.64 7 MHz Upper Guard Band Between 2358 MHz and 2365 MHz — Sector D

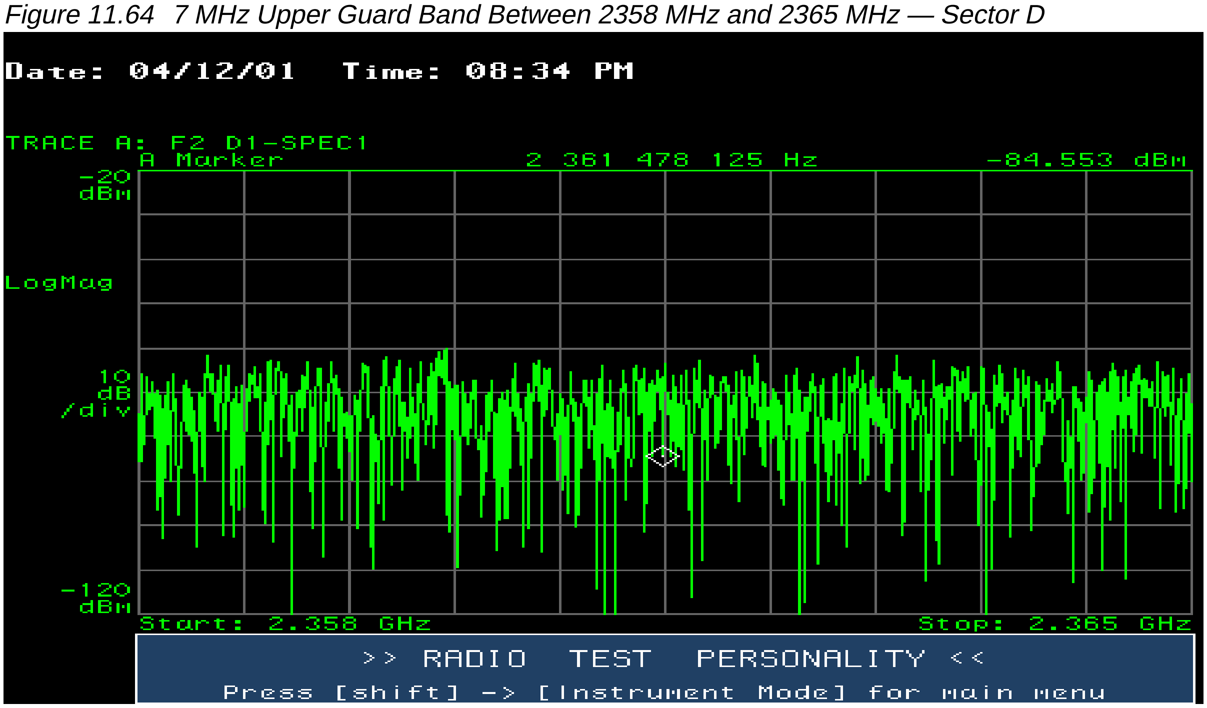
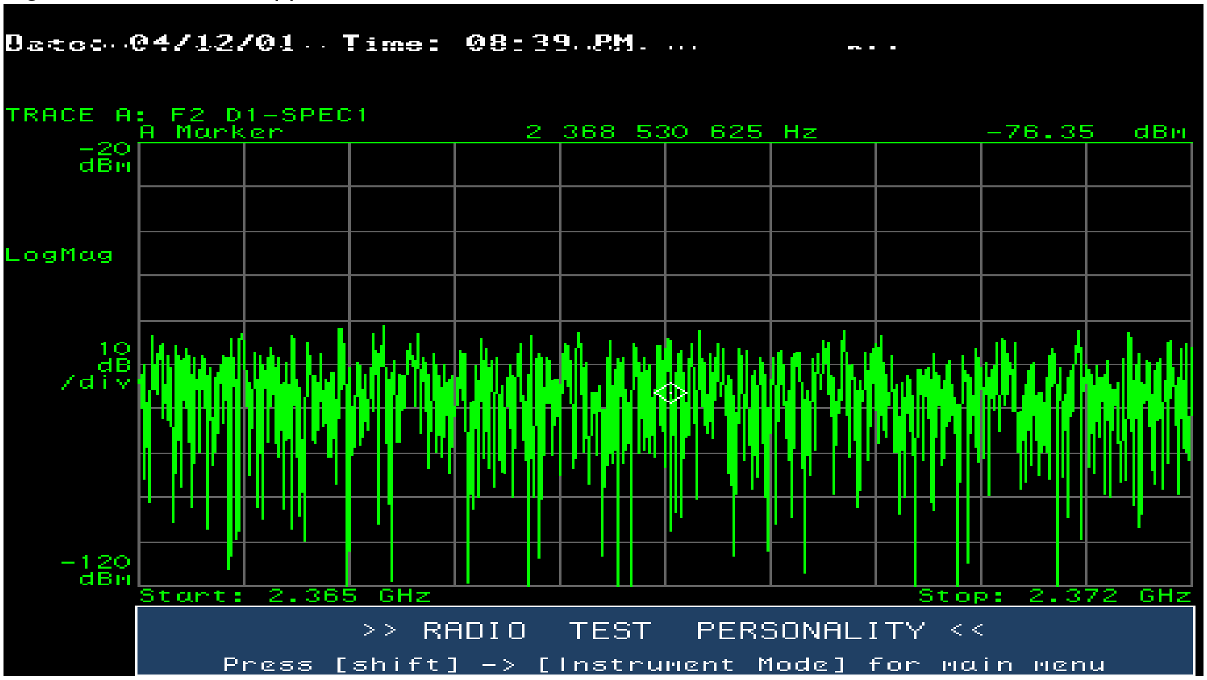


Figure 11.65 7 MHz Upper Guard Band Between 2365 MHz and 2372 MHz — Sector D



11.2.8.4 Test Results and Summary — Block A, Sector A and D

Table 11.19 In-Band and Out-of-Band Power Summary — Block A, Sector A and D

Parameter	Measured Value	FCC Part 27 Limit	Complies Y/N
Total power centered @ 2306 MHz	+34.5 dBm in a 1 MHz BW	*<35 dBm/ 1 MHz RBW	**Y**
Total power centered @ 2307 MHz	-32.0 dBm in a 1 MHz BW	*<35 dBm/ 1 MHz RBW	**Y**
Total power centered @ 2308 MHz	-19.2 dBm in a 1 MHz BW	*<35 dBm/ 1 MHz RBW	**Y**
Total power centered @ 2309 MHz	+34.27 dBm in a 1 MHz BW	*<35 dBm/ 1 MHz RBW	**Y**
Max. guard band spurious power between 2304.5 and 2305.5 MHz	-13.7 dBm in a 12 kHz RBW	-12 dBm/ 1 MHz RBW	**Y**
Maximum spurious power between 2292 and 2299 MHz	<-65 dBm in a 12 kHz RBW	-59 dBm/ 10 kHz RBW	**Y**
Maximum spurious power between 2285 and 2292 MHz	<-65 dBm in a 12 kHz RBW	-59 dBm/ 10 kHz RBW	**Y**
Maximum spurious power between 2316 and 2323 MHz	<-65 dBm in a 12 kHz RBW	-59 dBm/ 10 kHz RBW	**Y**
Maximum spurious power between 2323 and 2330 MHz	<-69 dBm in a 12 kHz RBW	-69 dBm/ 10 kHz RBW	**Y**
Maximum spurious power between 2330 and 2337 MHz	<-69 dBm in a 12 kHz RBW	-69 dBm/ 10 kHz RBW	**Y**
Maximum spurious power between 2337 and 2344 MHz	<-69 dBm in a 12 kHz RBW	-69 dBm/ 10 kHz RBW	**Y**
Maximum spurious power between 2344 and 2351 MHz	<-69 dBm in a 12 kHz RBW	-69 dBm/ 10 kHz RBW	**Y**
Maximum spurious power between 2351 and 2358 MHz	<-69 dBm in a 12 kHz RBW	-30 dBm/ 17 kHz RBW	**Y**
Maximum spurious power between 2358 and 2365 MHz	<-69 dBm in a 12 kHz RBW	-30 dBm/ 17 kHz RBW	**Y**
Maximum spurious power between 2365 and 2372 MHz	<-69 dBm in a 12 kHz RBW	-30 dBm/ 17 kHz RBW	**Y**

* Transmit power limited by design.

11.2.8.5 Results and Summary — Block B

Block B refers to the 5-Mhz-wide spectrum between 2310 MHz and 2315 MHz.

The measured spectral purity of the Base Station while transmitting 15 simultaneous voice calls in a single TDMA slot is depicted in Figure 11.66 through Figure 11.71 for Sector A, and Figure 11.72 through Figure 11.82 for Sector D. The results of these tests are summarized in Table 11.20.

11.2.8.5.1 Sector A

Figure 11.66 1 MHz Band-Power Between 2310.5 and 2311.5 MHz — Sector A

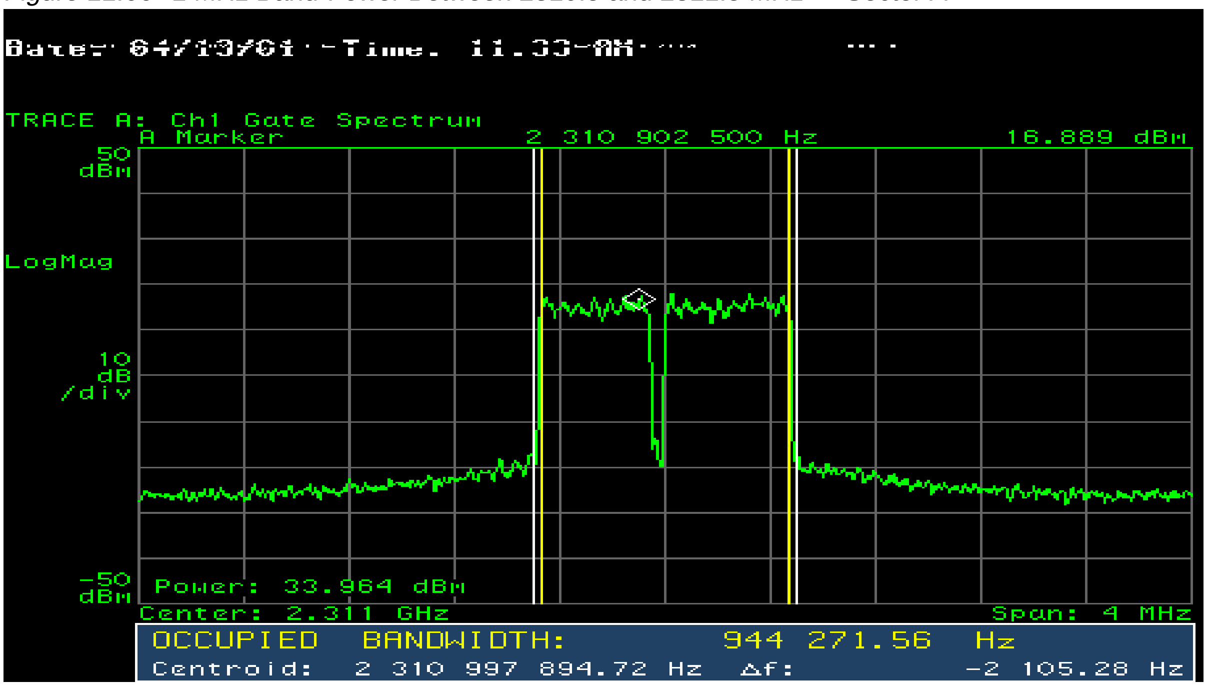


Figure 11.67 1 MHz Band Power Between 2311.5 and 2312.5 MHz — Sector A

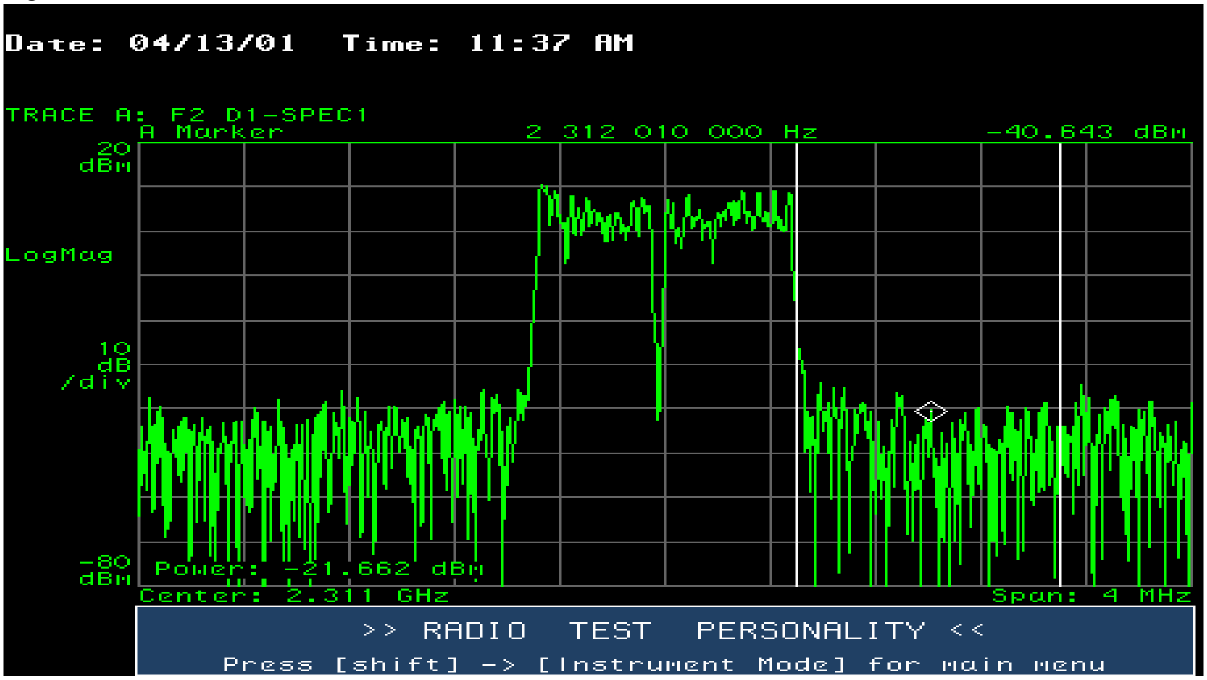


Figure 11.68 7 MHz Lower Guard Band Between 2309.5 MHz and 2310.5 MHz — Sector A

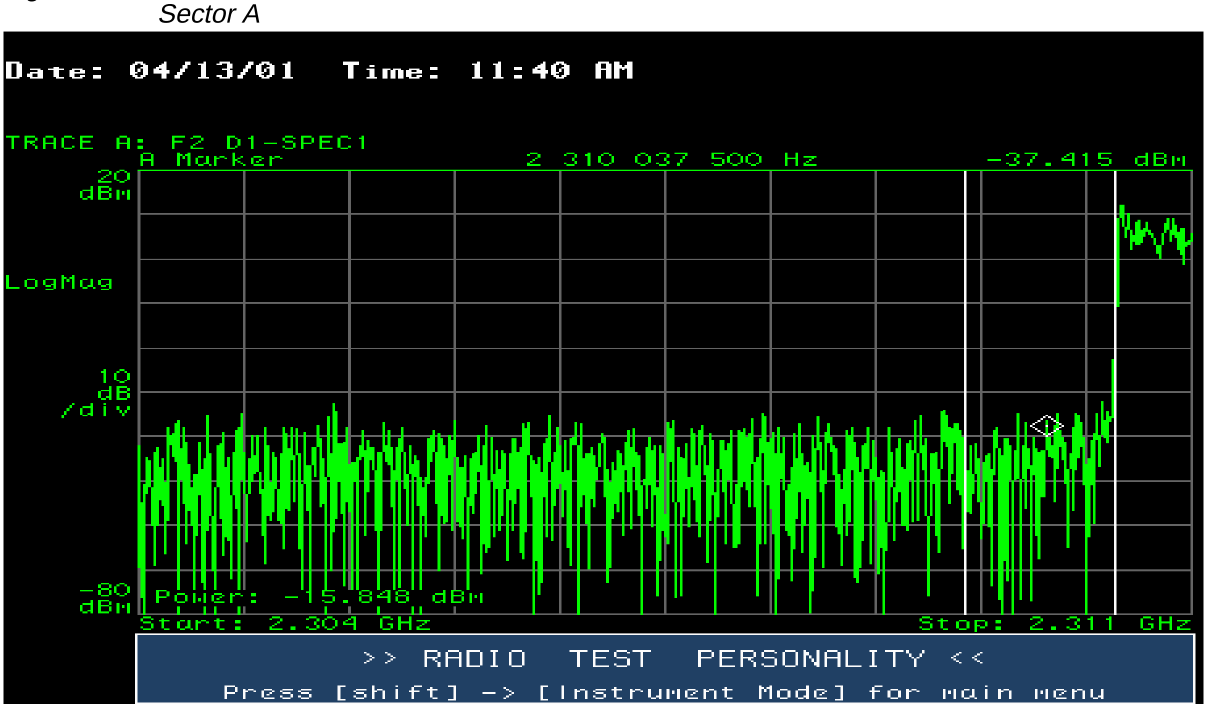


Figure 11.69 7 MHz Lower Guard Band Between 2300 MHz and 2304 MHz — Sector A

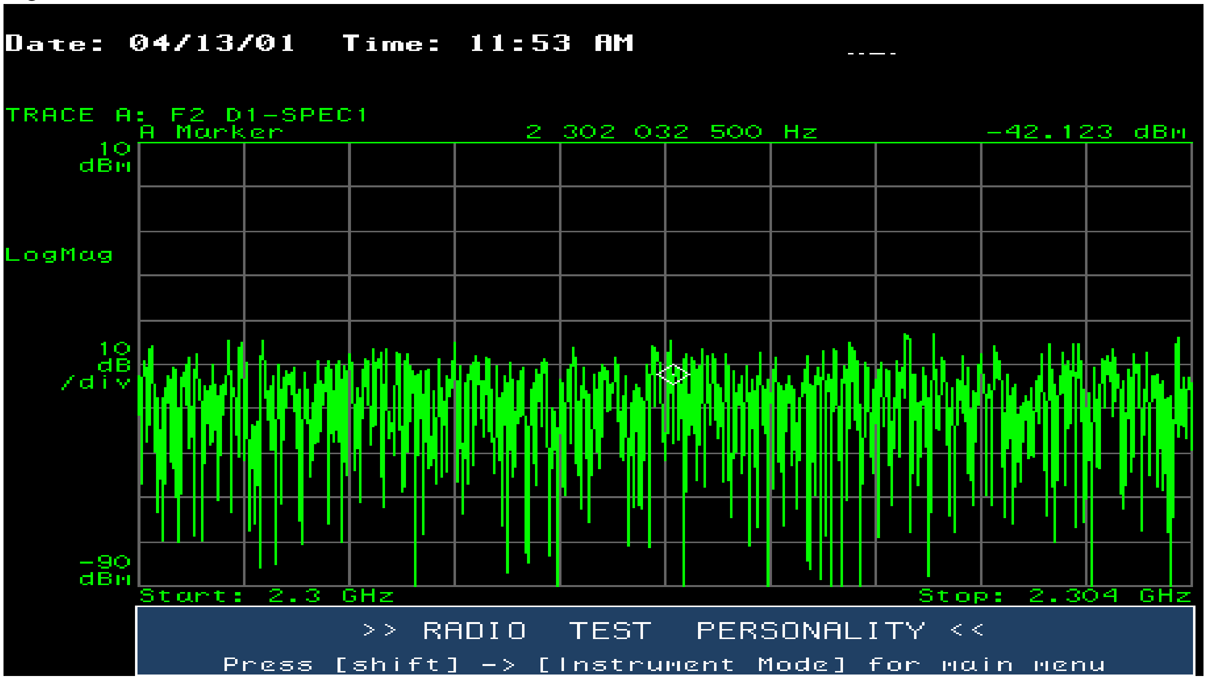


Figure 11.70 7 MHz Lower Guard Band Between 2293 MHz and 2300 MHz — Sector A

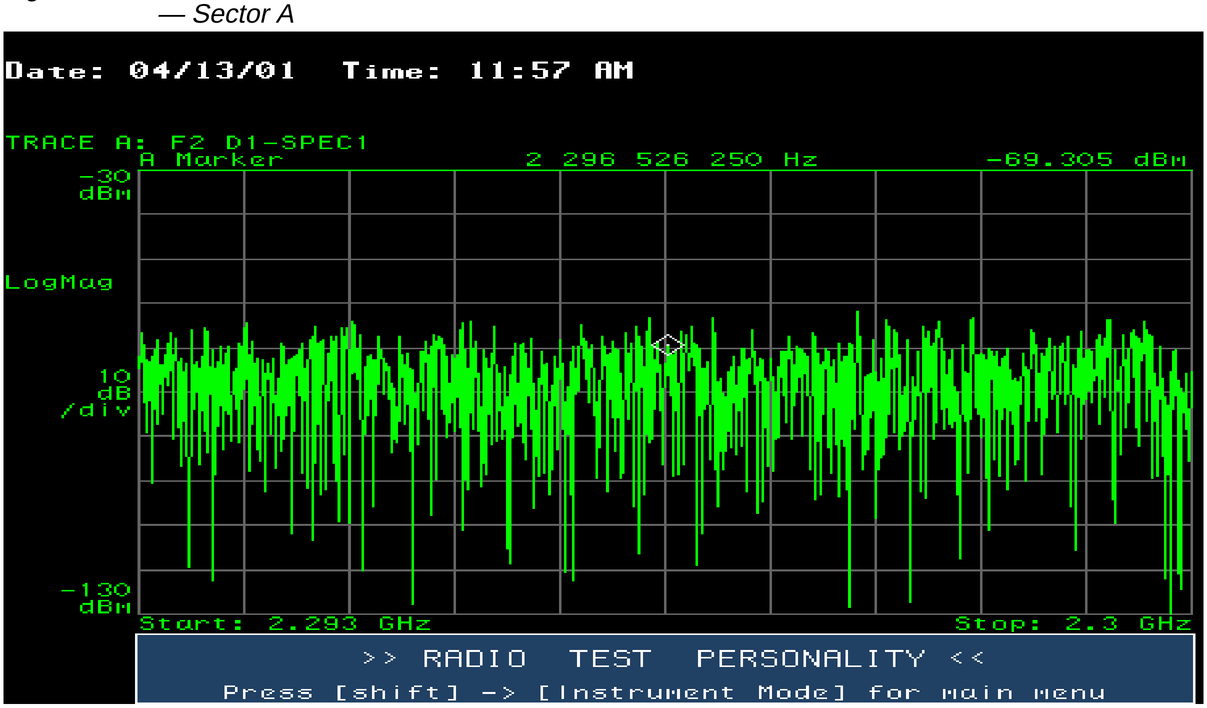
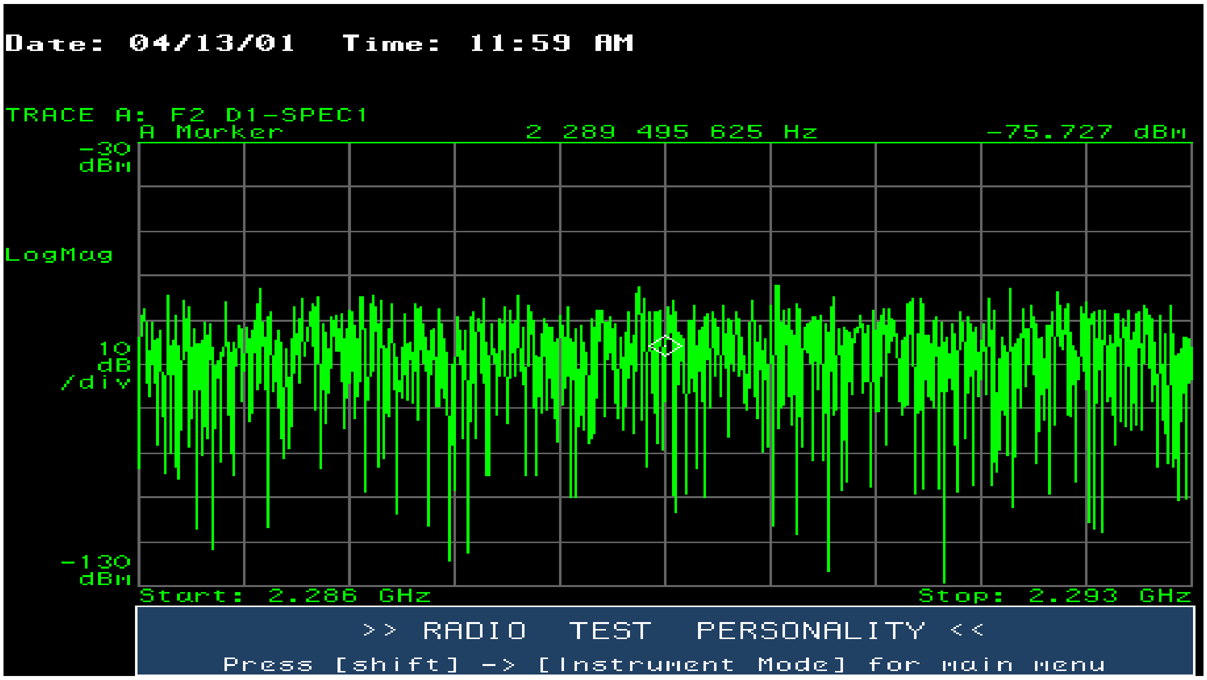


Figure 11.71 7 MHz Lower Guard Band Between 2288 MHz and 2293 MHz — Sector A



11.2.8.5.2 Sector D

Figure 11.72 1 MHz Channel Power Between 2313.5 MHz and 2314.5 MHz — Sector D

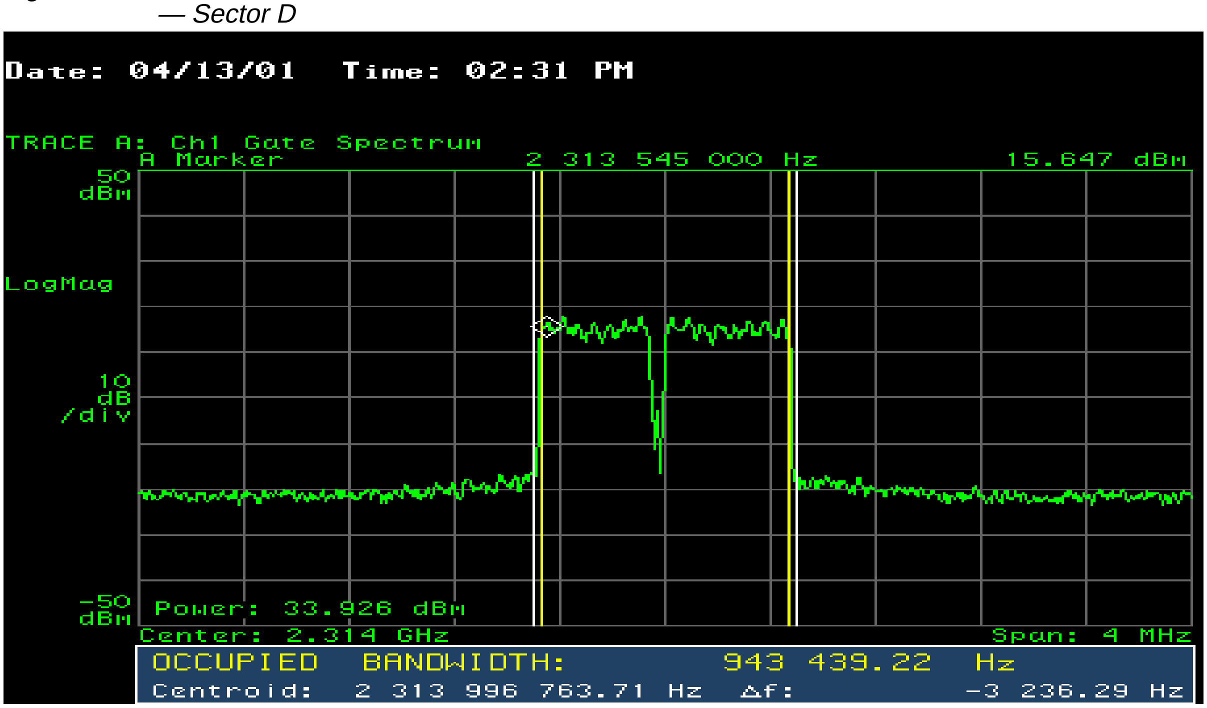


Figure 11.73 1 MHz Channel Power Between 2312.5 MHz and 2313.5 MHz — Sector D

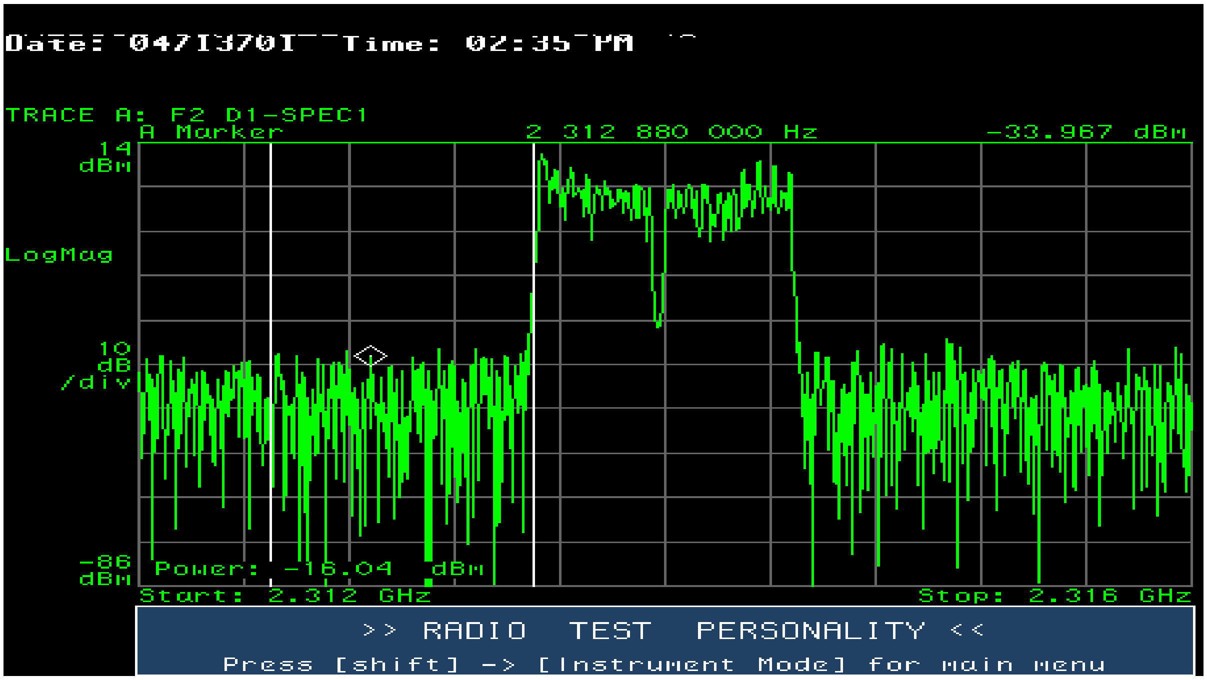


Figure 11.74 1 MHz Channel Power Between 2313.5 MHz and 2314.5 MHz — Sector D

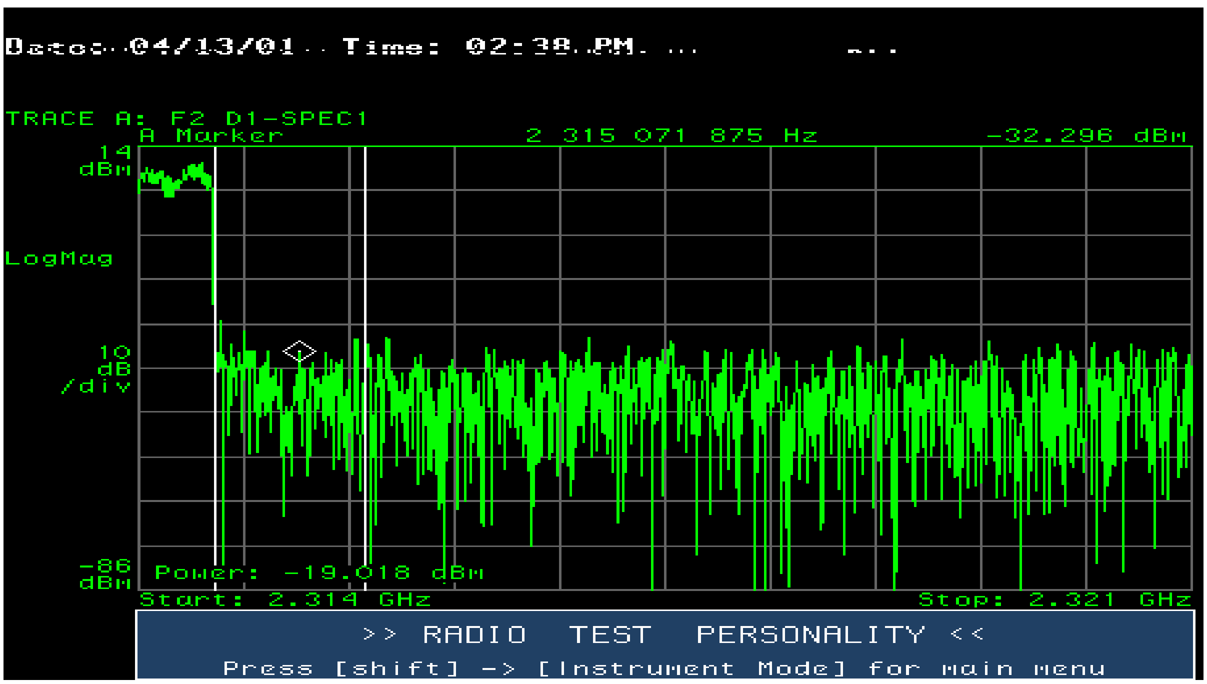


Figure 11.75 7 MHz Upper Guard Band Between 2320 MHz and 2327 MHz — Sector D

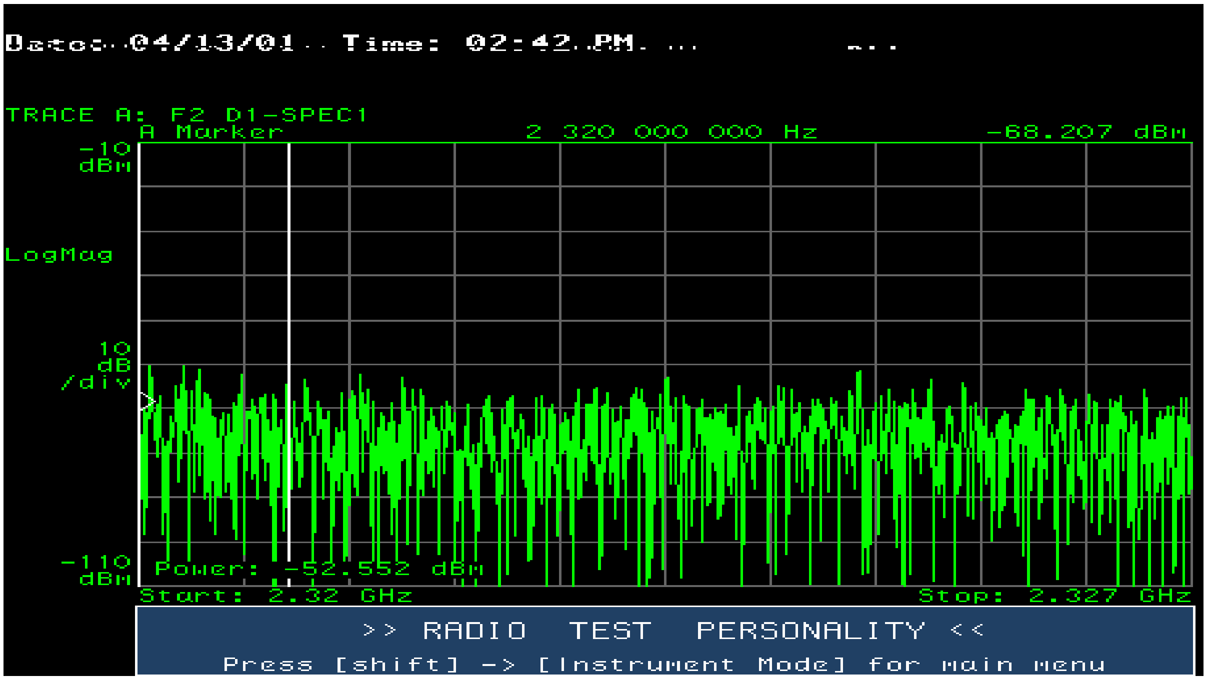


Figure 11.76 7 MHz Upper Guard Band Between 2327 MHz and 2334 MHz — Sector D

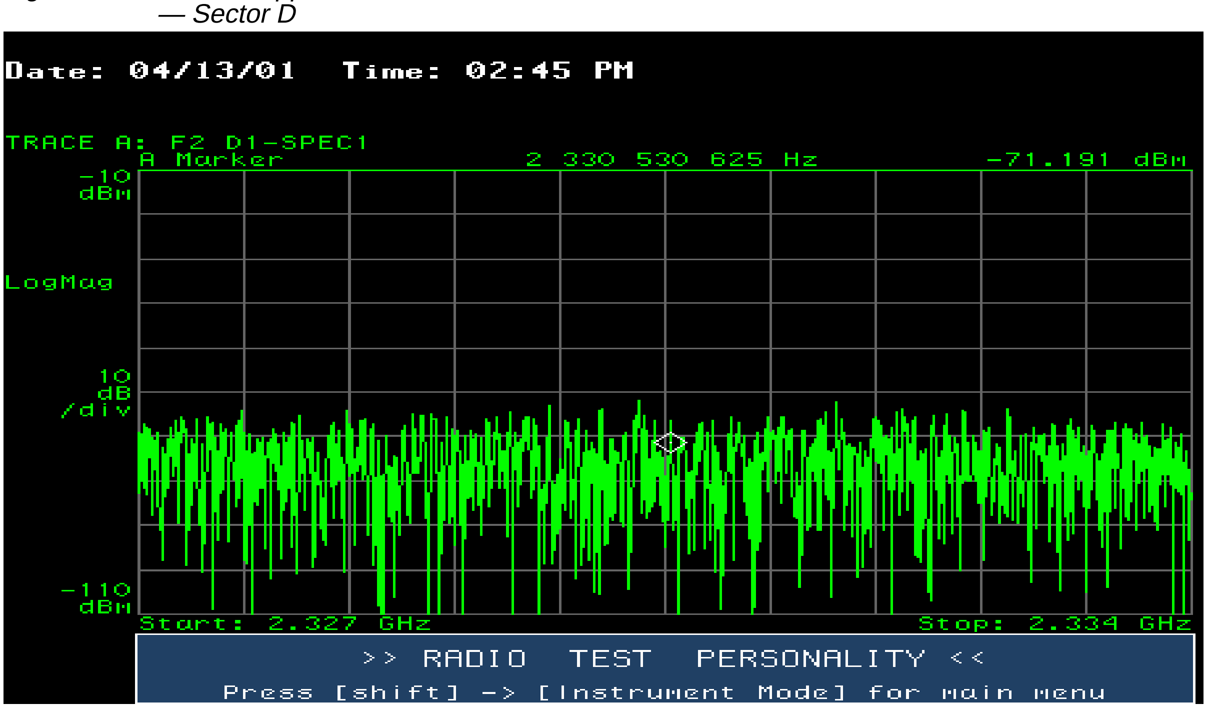


Figure 11.77 7 MHz Upper Guard Band Between 2334 MHz and 2341 MHz — Sector D

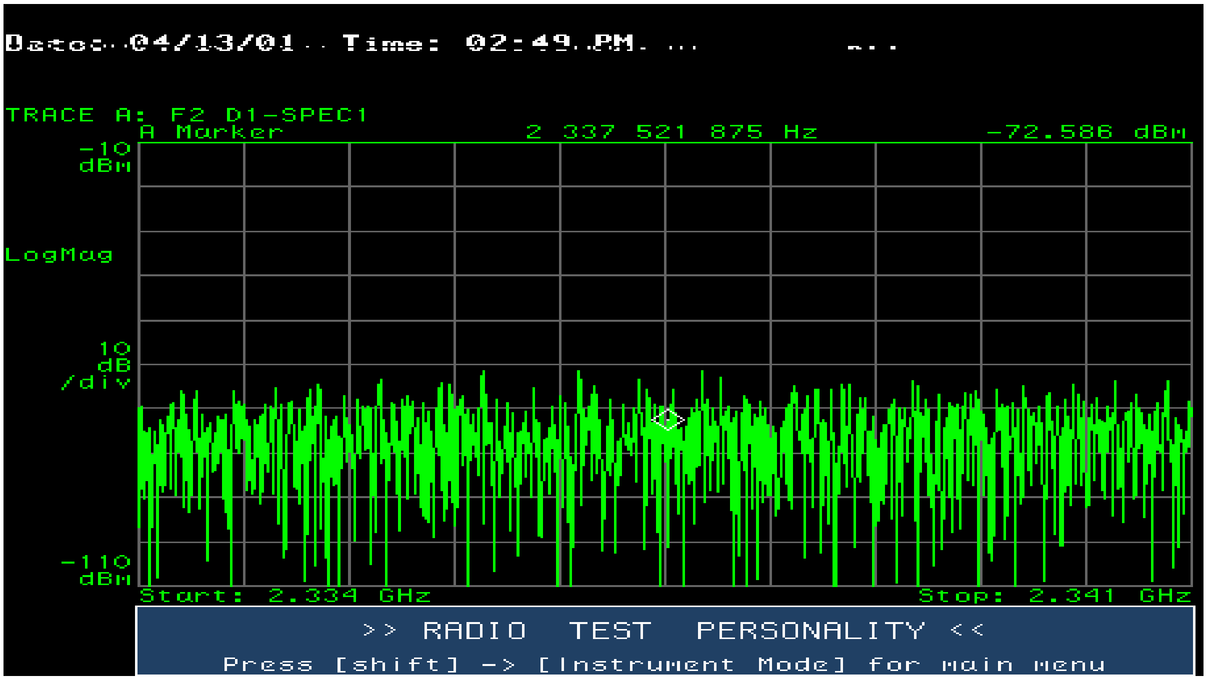


Figure 11.78 7 MHz Upper Guard Band Between 2341 MHz and 2348 MHz — Sector D

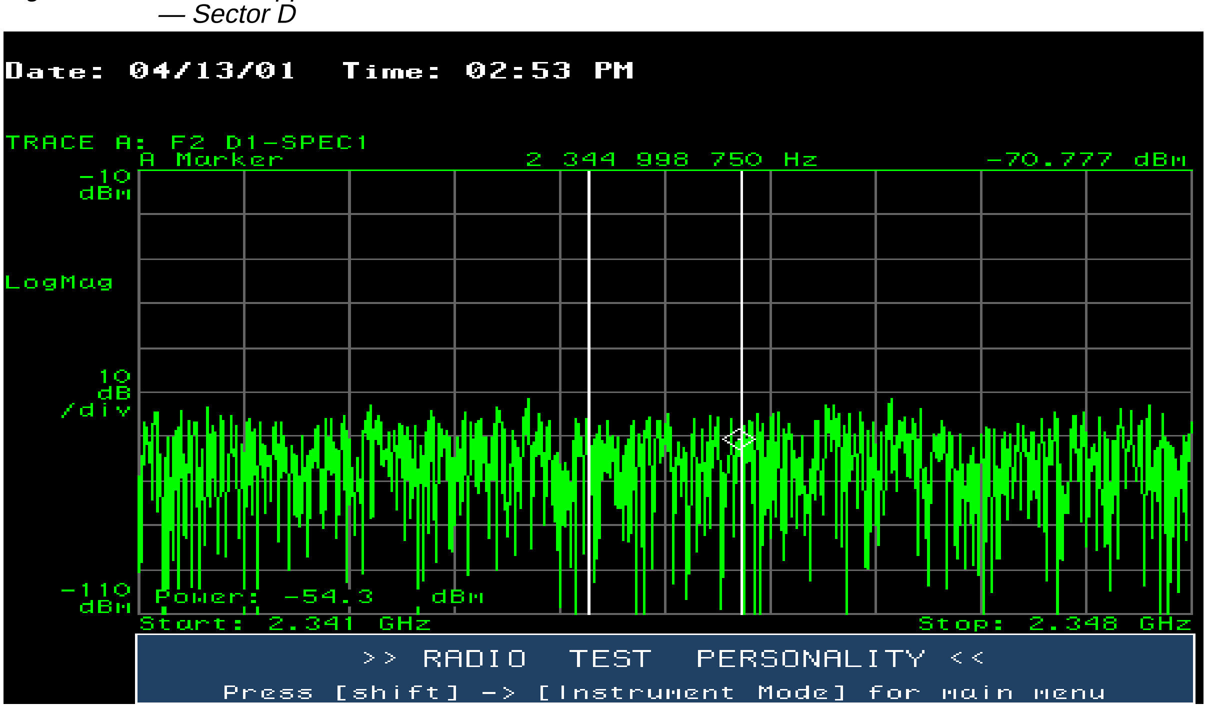


Figure 11.79
7 MHz Upper Guard Band Between 2348 MHz and 2355 MHz — Sector D

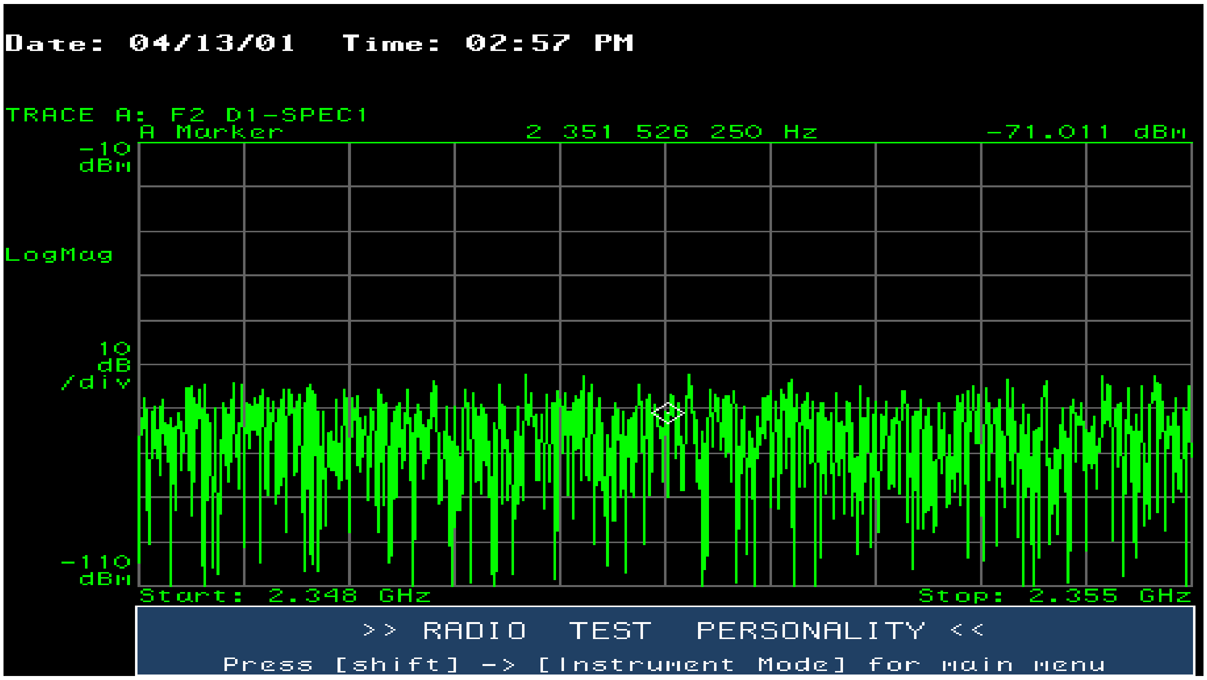


Figure 11.80 7 MHz Upper Guard Band Between 2355 MHz and 2362 MHz — Sector D

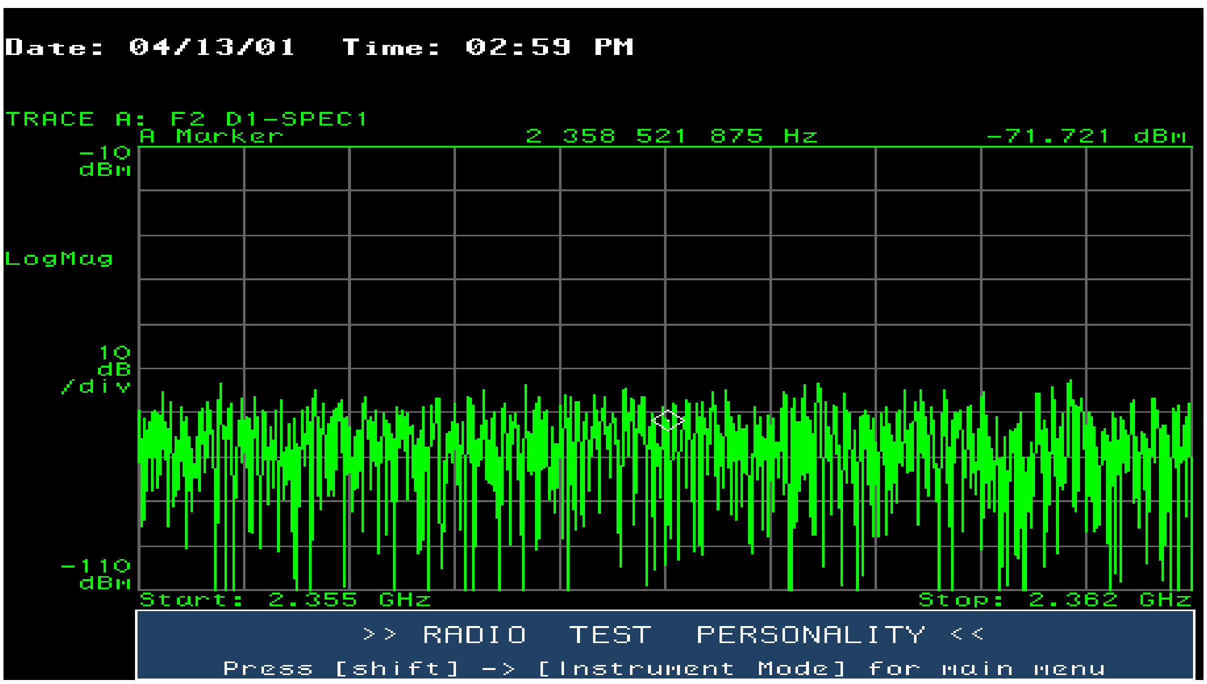


Figure 11.81 7 MHz Upper Guard Band Between 2362 MHz and 2369 MHz — Sector D

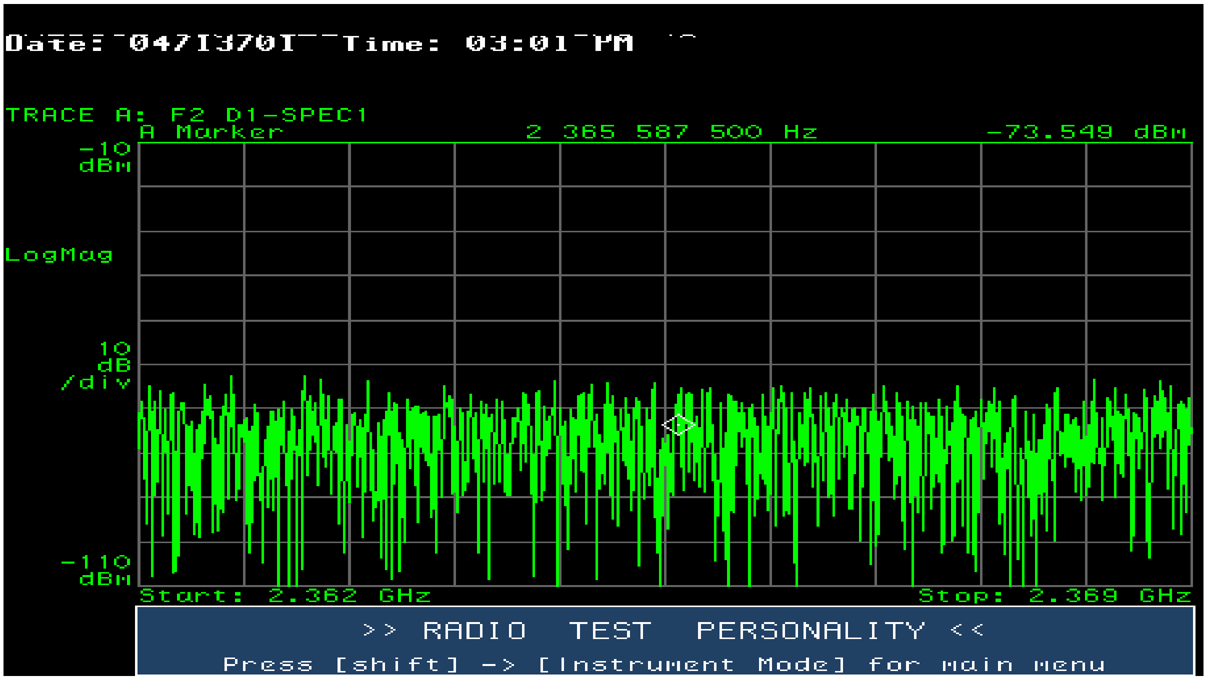
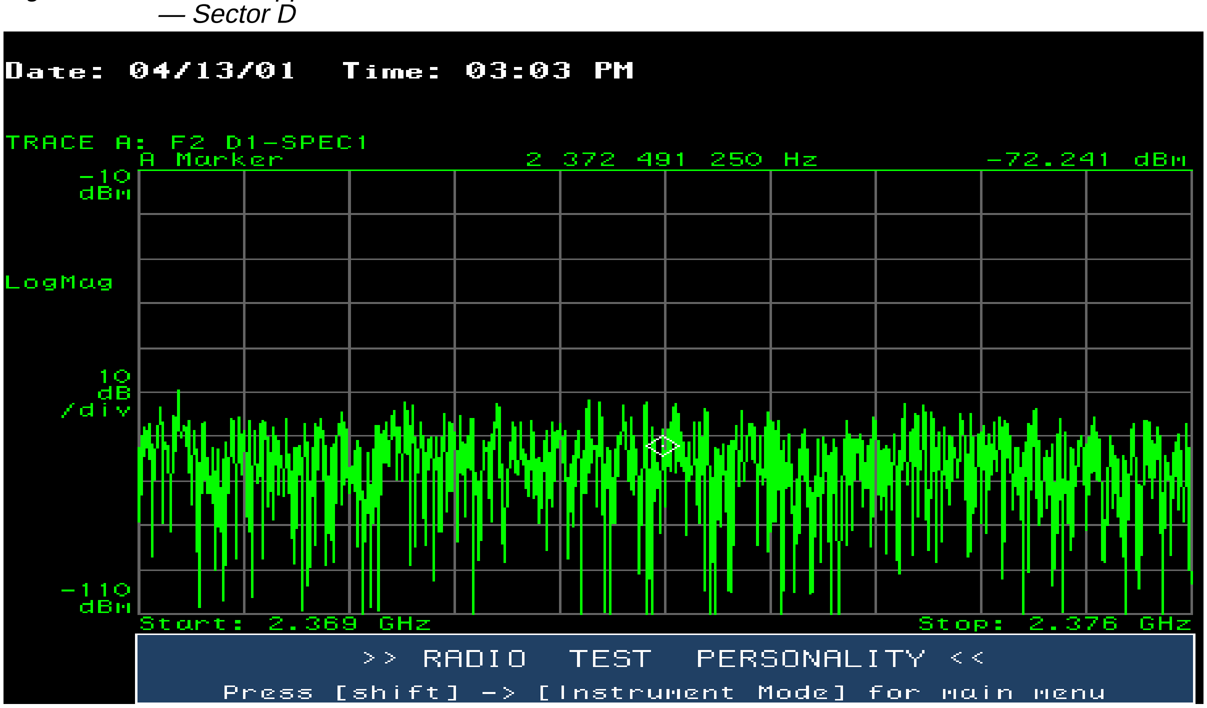


Figure 11.82 7 MHz Upper Guard Band Between 2369 MHz and 2376 MHz — Sector D



11.2.8.6 Test Results and Summary — Block B, Sector A and D

Table 11.20 In-Band and Out-of-Band Power Summary — Block B, Sector A and D

Parameter	Measured Value	FCC Part 27 Limit	Complies Y/N
Total power centered @ 2311 MHz	+33.96 dBm in a 1 MHz BW	*<35 dBm/ 1 MHz RBW	**Y**
Total power centered @ 2312 MHz	-21.66 dBm in a 1 MHz BW	*<35 dBm/ 1 MHz RBW	**Y**
Total power centered @ 2310 MHz	-15.85 dBm in a 1 MHz BW	-*<35 dBm/ 1 MHz RBW	**Y**
Maximum spurious power centered @ 2314 MHz	+33.93 dBm in a 1 MHz BW	*<35 dBm—/ 1 MHz RBW	**Y**
Max. guard band spurious power between 2300 and 2304 MHz	<-31 dBm in a 12 kHz RBW	-31 dBm/ 12 kHz RBW	**Y**
Max. guard band spurious power between 2293 and 2300 MHz	<-57 dBm in a 17 kHz RBW	-57 dBm/ 17 kHz RBW	**Y**
Max. guard band spurious power between 2288 and 2293 MHz	<-57 dBm in a 12 kHz RBW	-57 dBm/ 17 kHz RBW	**Y**
Maximum spurious power between 2312.5 and 2313.5 MHz	-16.04 dBm in a 1 MHz BW	*<35 dBm/ 1 MHz RBW	**Y**
Maximum spurious power between 2313.5 and 2314.5 MHz	-19.0 dBm in a 1 MHz BW	*<35 dBm/ 1 MHz RBW	**Y**
Maximum spurious power between 2320 and 2327 MHz	<-67 dBm in a 17 kHz RBW	-69 dBm/ 10 kHz RBW	**Y**
Maximum spurious power between 2327 and 2334 MHz	<-67 dBm in a 17 kHz RBW	-69 dBm/ 10 kHz RBW	**Y**
Maximum spurious power between 2334 and 2341 MHz	<-67 dBm in a 17 kHz RBW	-69 dBm/ 10 kHz RBW	**Y**
Maximum spurious power between 2341 and 2348 MHz	<-67 dBm in a 17 kHz RBW	-69 dBm/ 10 kHz RBW	**Y**
Maximum spurious power between 2348 and 2355 MHz	<-67 dBm in a 17 kHz RBW	-30 dBm/ 17 kHz RBW	**Y**
Maximum spurious power between 2355 and 2362 MHz	<-67 dBm in a 17 kHz RBW	-30 dBm/ 17 kHz RBW	**Y**
Maximum spurious power between 2362and 2369 MHz	<-67 dBm in a 17 kHz RBW	-30 dBm/ 17 kHz RBW	**Y**
Maximum spurious power between 2369 and 2376 MHz	<-67 dBm in a 17 kHz RBW	-57 dBm/ 17 kHz RBW	**Y**

* 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 FWAN WCS Base Station against the applicable requirements of FCC Rules, Parts 15 and 27 (Spurious Emissions 5 MHz outside fundamental).

11.3.1 Introduction

The purpose of this section is to present the test results used to verify compliance of the FWAN WCS Base Station with FCC regulations. The data presented in this section are the test results obtained from applying FCC Rules, Part 15, Radiated and Conducted Emissions. Additional data obtained to comply with FCC Rules, Part 27, Spurious Emissions 5 MHz Outside the Fundamental Frequency are also presented. Testing was completed within the FCC regulatory guidelines, including the utilization of ANSI C63.4-1992 standard, “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 three-meter Anechoic Chamber. This chamber has been shown to meet FCC requirements as outlined within subpart 2.948 of FCC Rules, Part 15, as referenced in FCC memo 31040/SIT 1300F2.

During testing, the FWAN WCS Base Station was set up and configured as close as possible to actual field installation specifications. The EUT was configured in a worst case mode of operation. The following mode was tested per FCC regulatory standards:

- Completely loaded sector, (i.e. maximum number of TSP and NIF cards)
- 15 voice calls within the same time slot (maximum time slot capacity)
- Power and NIF cable interface lengths as close to 1 meter as possible

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 11.21. These limits were extrapolated to establish the radiated emission limits for Class A devices.

Table 11.21 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 - 216	53.5	3
216 - 960	56.5	3
Above 960	60	3

11.3.2 Test Equipment Used

Test cases pertinent to this section were completed utilizing the test equipment outlined in Table 11.22. 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 documentation is stored in both hard copy and electronic form, tracking to NIST standards.

Table 11.22 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	8/6/00	8/6/01
Antenna 1	EMCO	3115	5514-9807	3/11/00	3/11/01
Cable 1	Gore	53 ft.	00195373, 00195374, 00195375	10/23/00	10/23/01
Analyzer	Hewlett-Packard	8546A	3520A00260	06/06/00	06/06/01
Preselector	Hewlett-Packard	8546A internal	3330A0010	06/06/00	06/06/01
QPeak Adapter	Hewlett-Packard	internal to RF section	internal	06/06/00	06/06/01
Pre-Amplifier	Hewlett-Packard	8546A internal	internal	06/06/00	06/06/01
Tower 1	EMCO	1050	1123	N/A	N/A
Turntable 1	EMCO	1060	1049	N/A	N/A
Antenna	Chase	CBL6111 A	1704	08/10/00	08/10/01
Positioner Controller	EMCO	2090	9601-1101	N/A	N/A
EMI Measurement System	Hewlett-Packard	84125C	4536439012	11/20/00	11/20/01

11.3.3 FWAN WCS Base Station Equipment Under Test

Testing was performed on the equipment listed in Table 11.23.

Table 11.23 Equipment Under Test

Card Name	Serial Number	Revision
Baseband Shelf 1 Components		
BBC	15448 000627	D
NCP	116985 000614	G
TSP 1	0998 000993 000614	A
TSP 2	0000216042000310	C
TSP 3	0000215656991021	A
TSP 4	0000216116000310	C
TSP 5	0000216063000310	C
TSP 6	0000216059000310	C
TSP 7	0000216308000330	C
MODEM	0000086217000614	L
Baseband Shelf 2 Components		
BBC	0000016070 000614	D
NCP	0000116962 000614	G
TSP 1	0998001063 000601	A
TSP 2	0000215659 991021	A
TSP 3	0000216298 000330	C
TSP 4	0000216061 000310	C
TSP 5	0000216040 000310	C
TSP 6	0000216285 000330	C
TSP 7	0000215282 000309	A
MODEM	0000086149 000614	L
Baseband Shelf Redundant Components		
BBC	0000016073 000614	D
NCP	0000117061 000614	G
TSP 1	0000216341 000407	C
TSP 2	0000216210 000323	C
TSP 3	0000216055 000310	C
TSP 4	0000216314 000330	C
TSP 5	0998028959 001130	H
TSP 6	0998029055 001130	H
TSP 7	0998029015 001130	H

Table 11.23 Equipment Under Test

Card Name	Serial Number	Revision
MODEM	0000086237 000614	L
Network Shelf Components		
Sync-P	1999901134DC0025	1
Sync-R	1999901014DC0017	1
TSI-P	0000205877 000614	D
TSI-R	0000205855 000614	D
NIF-1	0998001306 000601	A
NIF-2	95807 991007	H
NIF-3	0998001309 000601	A
NIF-4	000009550 990903	F
DNIF-5	0000095559 990903	F
DNIF-6	0000095501 000627	E
DNIF-7	0000095527 000627	E
NMP	0000105531 000614	B
ICP-P	0000075251 000627	D
ICP-R	0000075188 000627	D

11.3.4 EMC Test Results

A measurement of the three-meter shielded chamber was conducted previous to FCC measurements to establish the chamber ambients. Figure 11.83 shows a plot of the chamber's ambient measurement.

Figure 11.83 Three-Meter Chamber Ambient

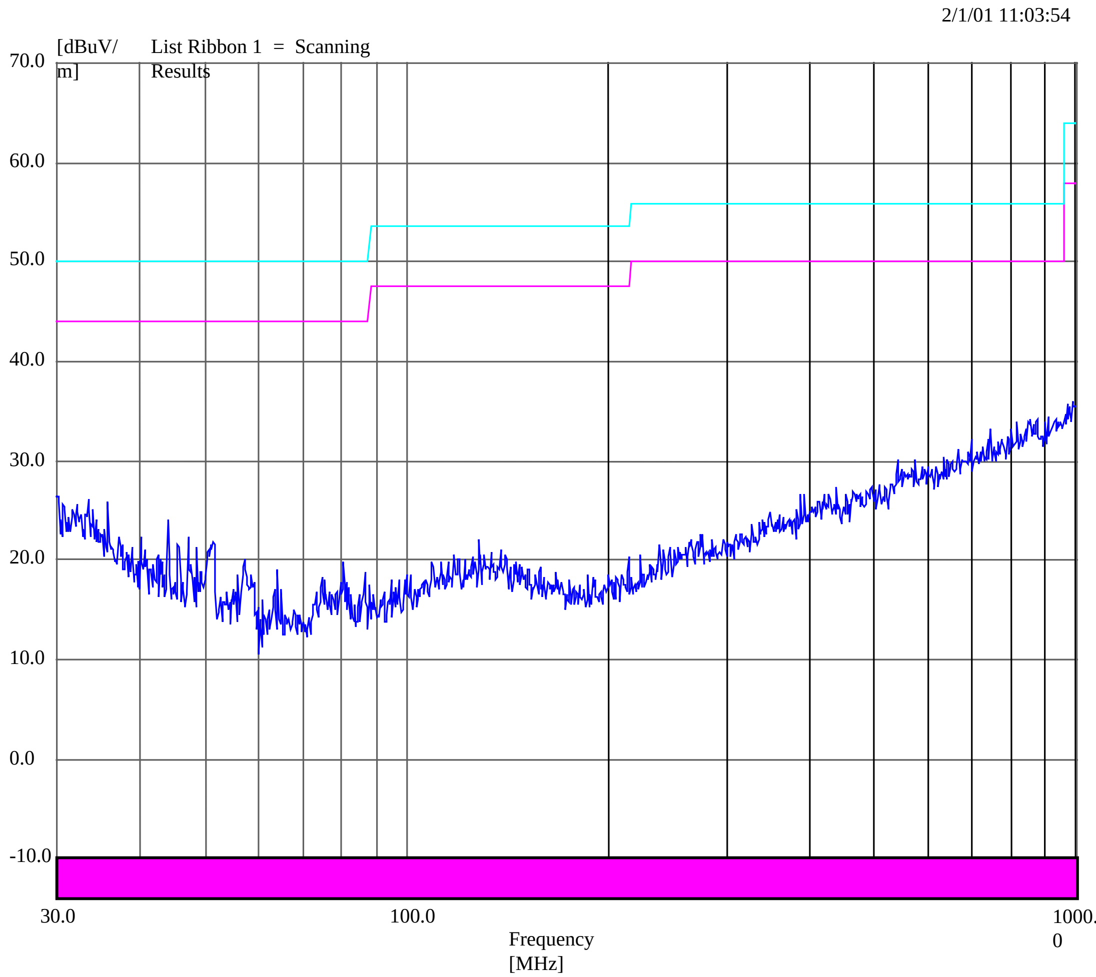
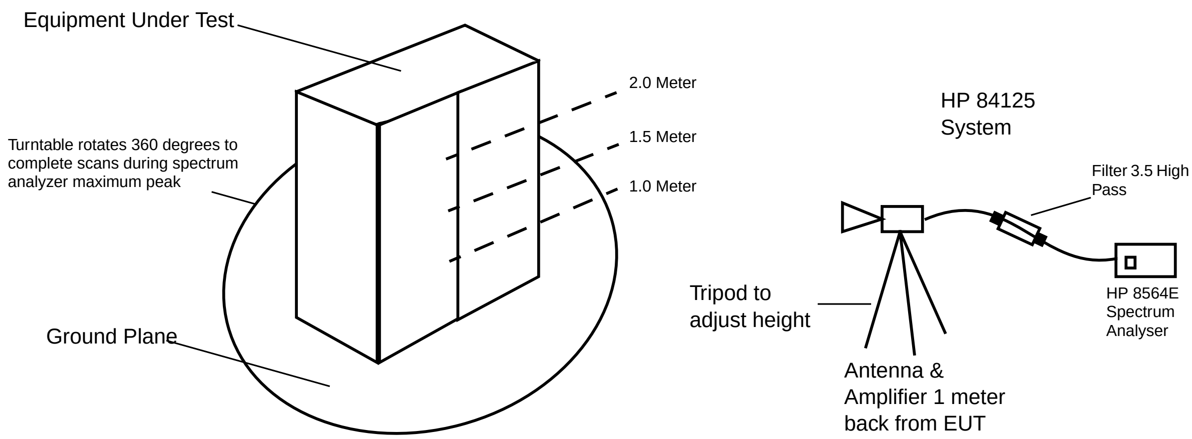


Figure 11.84 Radiated Emissions Testing



11.3.4.1 Worst-Case Configuration

The top horizontal line shown in Figure 11.85 depicts the FCC Class A limit line extrapolated to a three-meter test distance. The lower horizontal line indicates the 6-dB margin used during all radiated emission testing. The 24 peak signals that exceed the 6-dB margin, as shown in Figure 11.85, were further investigated using a quasi-peak detector. The quasi-peak amplitudes are identified in Table 11.24 and shown in Figure 11.85, denoted by a sideways "X" symbol. As shown on the data plot, the amplitudes of the 24 signals investigated with a quasi-peak detector, dropped below the 6 dB margin.

Figure 11.85 30 MHz - 1000 MHz, Worst-Case Configuration

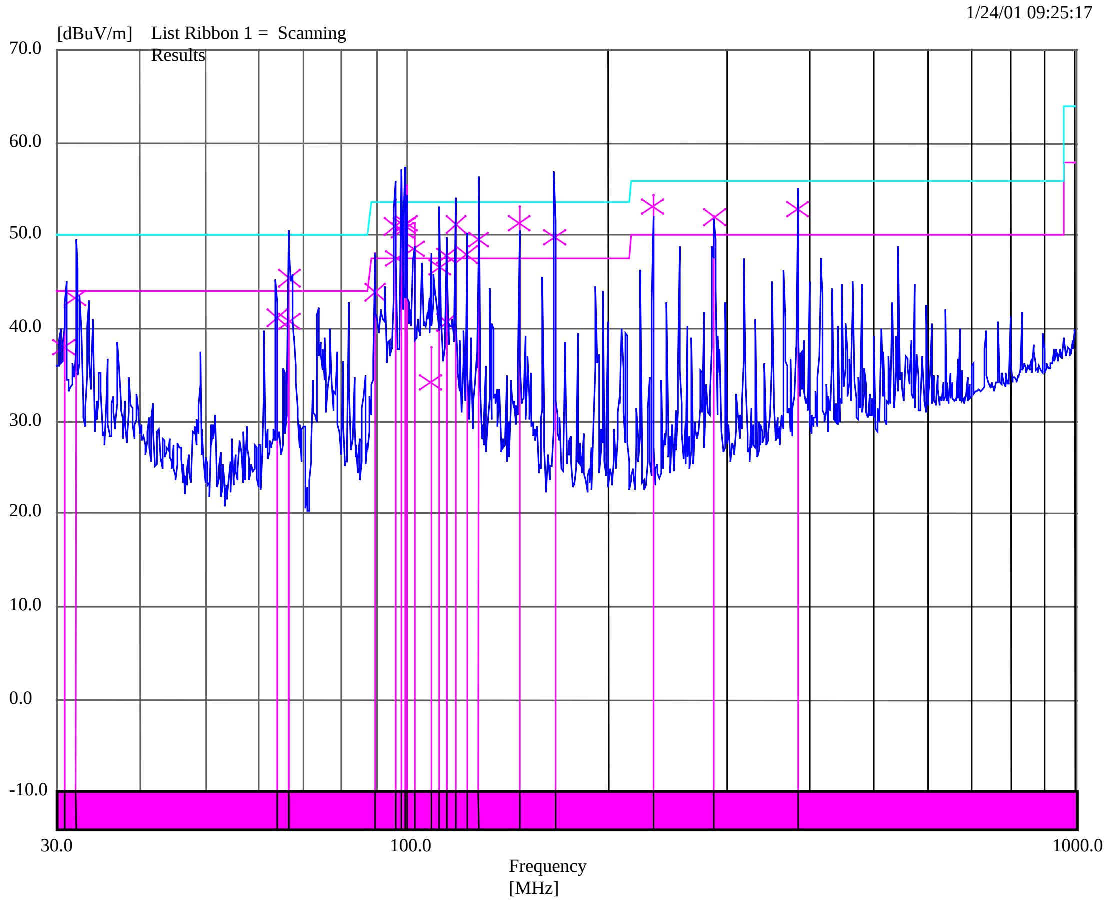


Figure 11.85 shows the B1.5 WCS FCC emissions scan in the 3-meter chamber. It represents a fully loaded digital cabinet, with all eight FEs being operational. (Diversity FEs are loaded inside the cabinet; primary FEs lead to the patch panel through RG-214.)

Table 11.24 Signals Investigated During Testing

Frequency (MHz)	Peak (dBuV/m)	Peak Lmt (dBuV/m)	DelLim-Pk (dB)	QP (dBuV/m)	QP Lmt (dBuV/m)	DelLmt-QP (dB)	Height (cm)	Angle Pol (deg)
30.7228163	42.28	44.00	-1.72	38.06	50.00	-11.94	107	90 Vert
31.971761	43.26	44.00	-0.74	43.29	50.00	-6.71	111	261 Vert
63.975188	41.13	44.00	-2.87	41.11	50.00	-8.89	270	225 Vert
66.637177	40.29	44.00	-3.71	40.77	50.00	-9.23	325	268 Vert
66.676769	45.51	44.00	1.51	45.39	50.00	-4.61	166	219 Vert
89.585159	48.10	47.50	0.60	43.89	53.50	-9.61	233	47 Vert
95.988051	53.83	47.50	6.33	50.94	53.50	-2.56	169	89 Vert
96.458671	51.61	47.50	4.11	47.62	53.50	-5.88	166	133 Vert
98.268596	50.43	47.50	2.93	50.67	53.50	-2.83	102	98 Vert
99.158081	54.29	47.50	6.79	51.17	53.50	-2.33	107	134 Vert
99.970749	55.30	47.50	7.80	51.34	53.50	-2.16	119	132 Vert
102.375832	51.31	47.50	3.81	48.59	53.50	-4.91	213	134 Vert
108.509965	38.00	47.50	-9.50	34.17	53.50	-19.33	216	46 Vert
111.973730	48.62	47.50	1.12	46.49	53.50	-7.01	240	311 Vert
114.653697	42.76	47.50	-4.74	40.67	53.50	-12.83	167	311 Vert
114.660377	48.04	47.50	0.54	47.85	53.50	-5.65	193	91 Vert
118.375305	52.46	47.50	4.96	51.27	53.50	-2.23	297	311 Vert
122.852730	48.36	47.50	0.86	47.99	53.50	-5.51	229	314 Vert
127.970898	49.68	47.50	2.18	49.55	53.50	-3.95	273	94 Vert
147.425842	53.23	47.50	5.73	51.31	53.50	-2.19	258	46 Vert
166.634388	50.14	47.50	2.64	49.90	53.50	-3.60	239	310 Horz
233.301851	54.31	50.00	4.31	53.05	56.00	-2.95	193	313 Vert
287.975596	51.99	50.00	1.99	51.97	56.00	-4.03	100	264 Vert
383.975170	52.49	50.00	2.49	52.78	56.00	-3.22	173	222 Vert

Figure 11.86 1000 MHz - 3500 MHz, Worst-Case Configuration

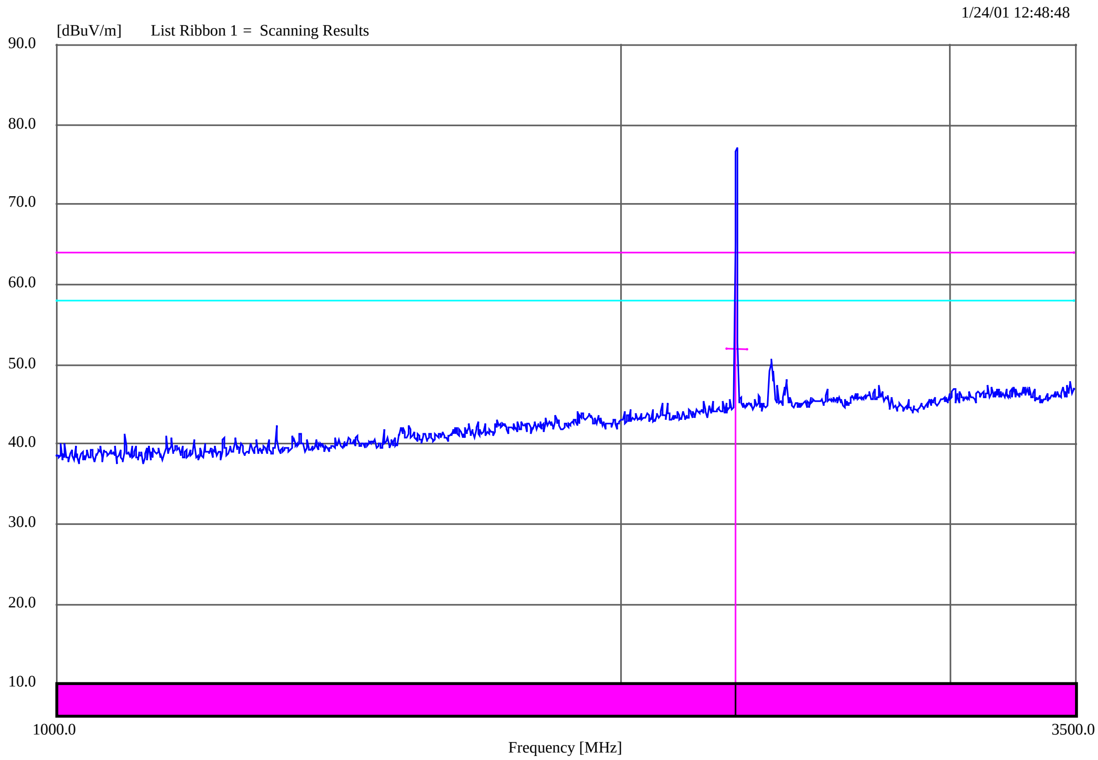


Figure 11.86 corresponds to the emissions profile of the FWAN WCS Base Station (1000MHz – 3500MHz) in the following configuration: the FWAN WCS Base Station is located within the EMC cabinet, all cables (PWR,T1s, GPS, and four RF) exiting through the bottom of the cabinet, two sides grounded with two-inch braid, as well as fully loaded Baseband and Network shelves (seven TSP cards were necessary) in order to fully populate the Base Station with 15 calls on the same TDMA slot. As shown in Figure 11.86, all frequencies fell below the FCC Class A limit line.

The group of signals shown in Figure 11.86 corresponds to the FWAN WCS Base Station authorized transmit frequencies.

Figure 11.87 3.5 GHz – 18 GHz @1-m Antenna Height Emissions Scan, Horizontal Polarization

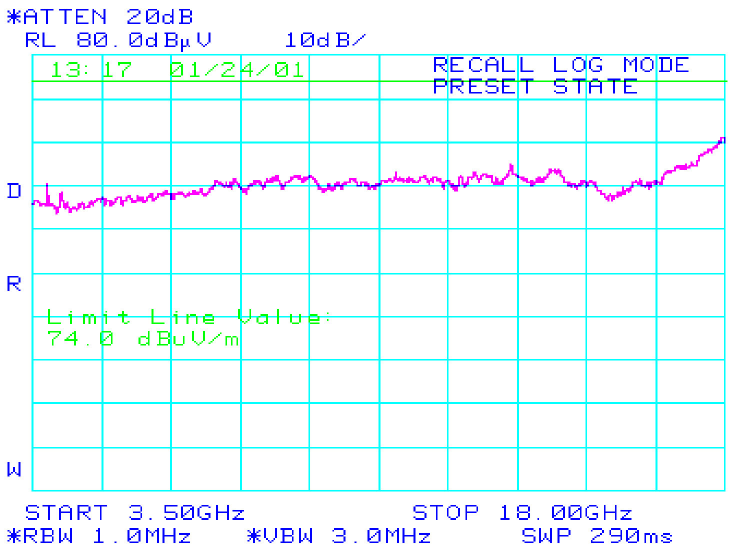


Figure 11.87 is the FWAN WCS Base Station radiated emissions scan (3.50-18GHz) in the horizontal polarization at a 1-m antenna height. During testing, the FWAN WCS Base Station was set up and tested in the following modes of operation:

- 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

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 baseband and network shelves without phone calls.

Figure 11.88 3.5 GHz – 18 GHz @ 1.5-m Antenna Height Emissions Scan, Horizontal Polarization

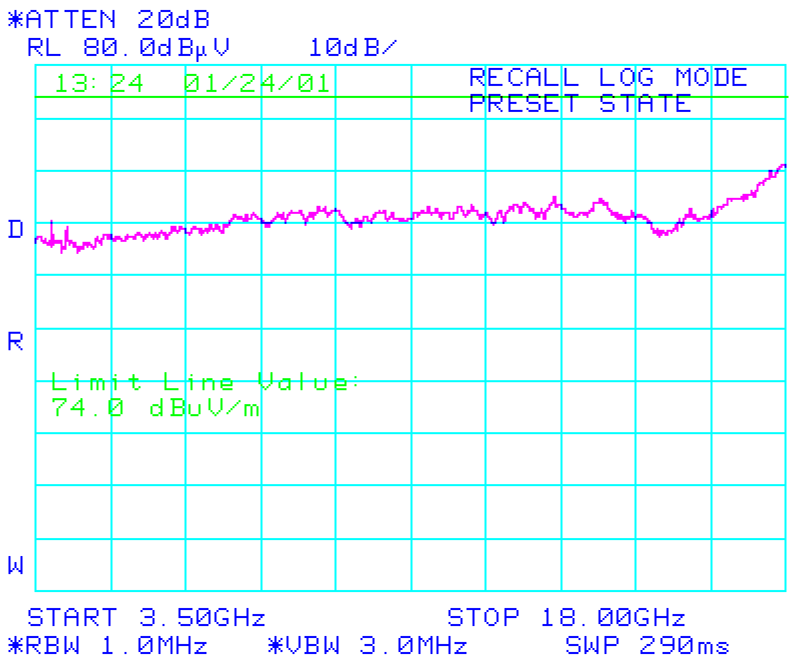


Figure 11.88 is the FWAN WCS Base Station radiated emissions scan (3.50-18GHz) in the horizontal polarization at a 1.5-m antenna height. During testing, the FWAN WCS Base Station was set up and tested in the following modes of operation:

- 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

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 baseband and network shelves without phone calls.

Figure 11.89 3.50GHz – 18GHz @ 2-m Antenna Height Emissions Scan, Horizontal Polarization

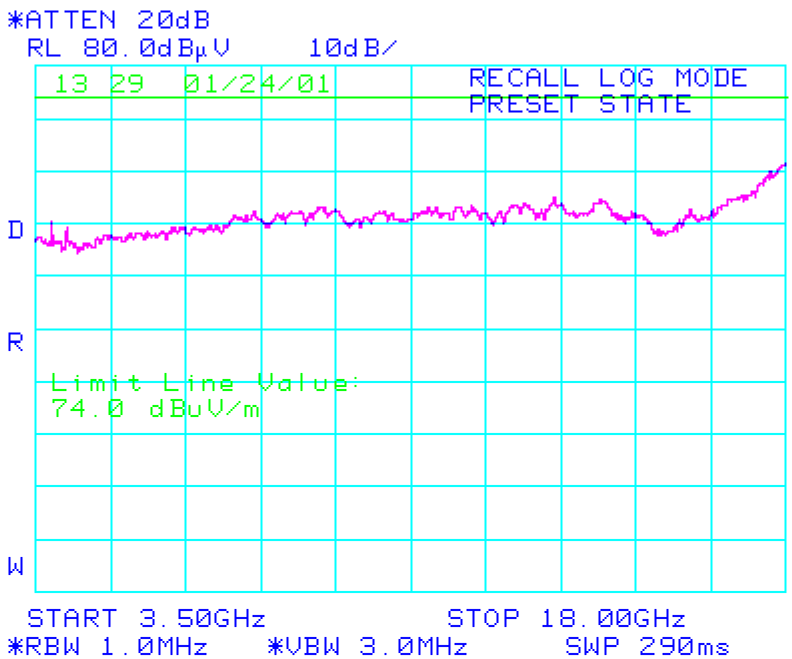


Figure 11.89 is the FWAN WCS Base Station radiated emissions scan (3.50-18GHz) in the horizontal polarization at a 2-m antenna height. During testing, the FWAN WCS Base Station was set up and tested in the following modes of operation:

- 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

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 baseband and network shelves without phone calls.

Figure 11.90 3.50GHz – 18GHz @1-m Antenna Height Emissions Scan, Vertical Polarization

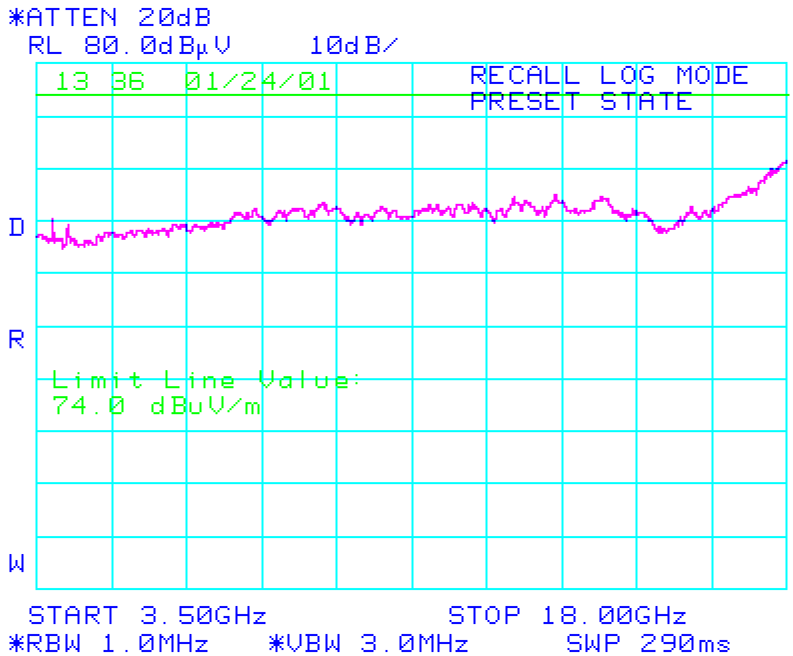


Figure 11.90 is the FWAN WCS Base Station radiated emissions scan (3.50-18GHz) in the vertical polarization at a 1-m antenna height. During testing, the FWAN WCS Base Station was set up and tested in the following modes of operation:

- 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

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 baseband and network shelves without phone calls.

Figure 11.91 3.50GHz – 18GHz @1.5-m Antenna Height Emissions Scan, Vertical Polarization

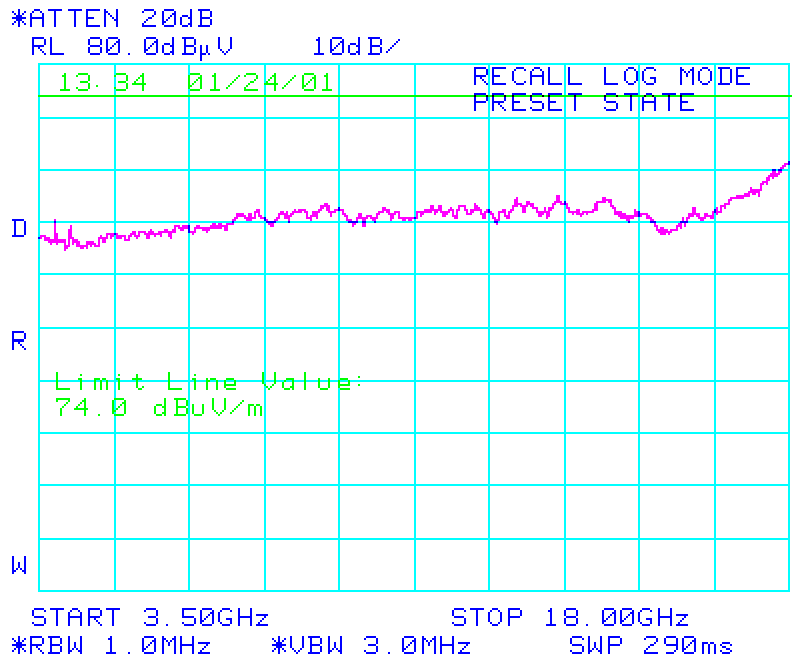


Figure 11.91 is the FWAN WCS Base Station radiated emissions scan (3.50-18GHz) in the vertical polarization at a 1.5-m antenna height. During testing, the FWAN WCS Base Station was set up and tested in the following modes of operation:

- 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

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 baseband and network shelves without phone calls.

Figure 11.92 3.50GHz – 18GHz @ 2-m Antenna Height Emissions Scan, Vertical Polarization

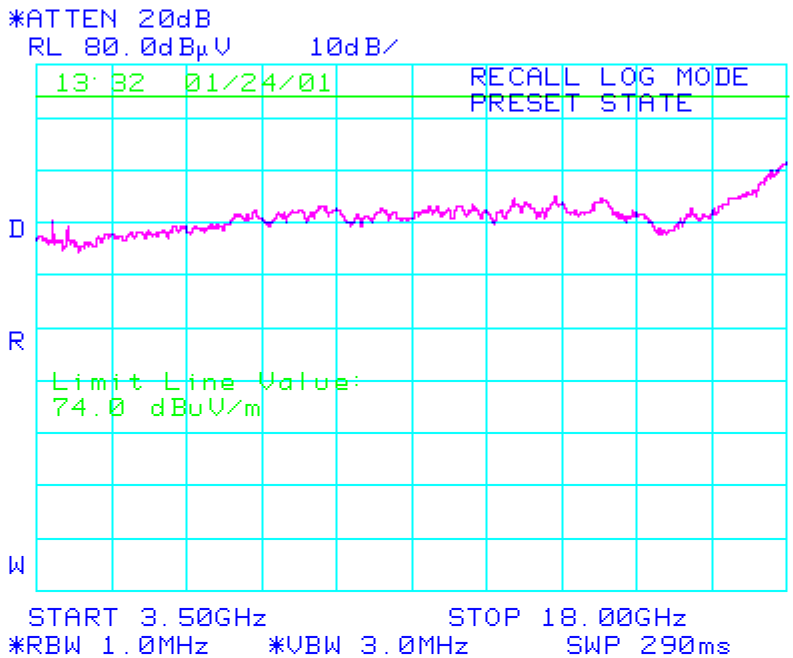


Figure 11.92 is the FWAN WCS Base Station radiated emissions scan (3.50-18GHz) in the vertical polarization at a 2-m antenna height. During testing, the FWAN WCS Base Station was set up and tested in the following modes of operation:

- 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

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 baseband and network shelves without phone calls.

Figure 11.93 18.0 GHz – 26.5GHz @ 1.5-m Antenna Height Emissions Scan, Vertical Polarization

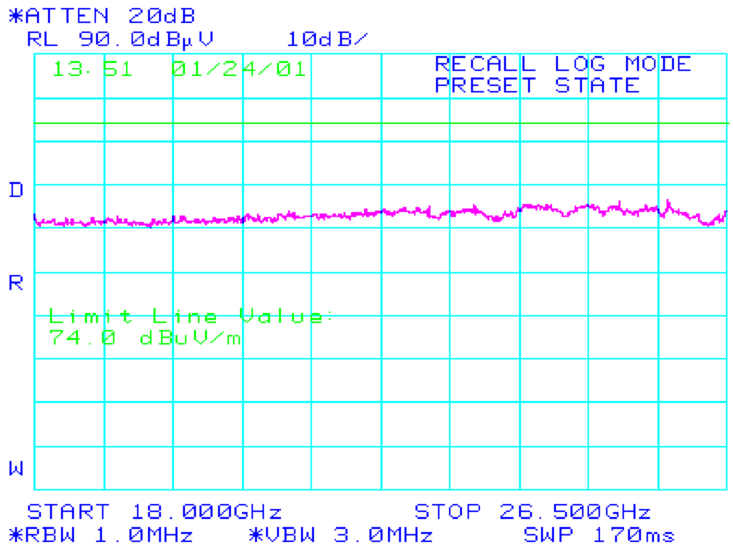


Figure 11.93 is the FWAN WCS Base Station radiated emissions scan (18.0-26.5GHz) in the vertical polarization at a 1-m antenna height. During testing, the FWAN WCS Base Station was set up and tested in the following modes of operation:

- 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

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 baseband and network shelves without phone calls.

Figure 11.94 18.0 GHz – 26.5GHz @ 1-m Antenna Height Emissions Scan, Vertical Polarization

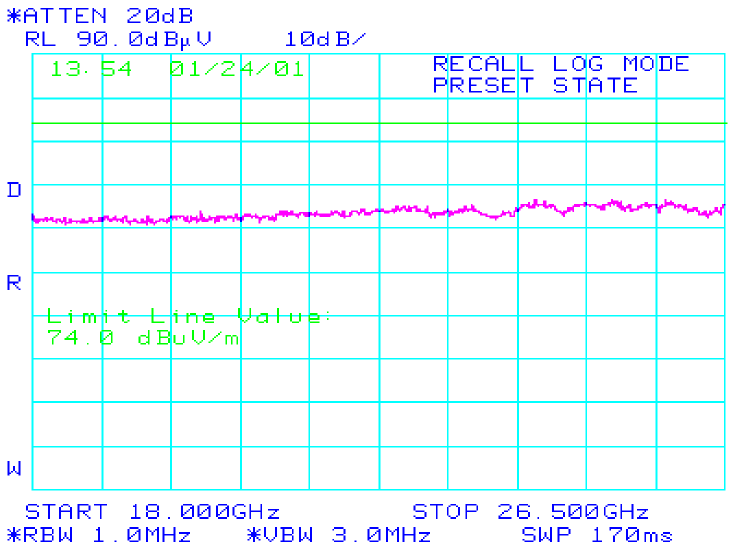


Figure 11.94 is the FWAN WCS Base Station radiated emissions scan (18.0-26.5GHz) in the vertical polarization at a 1.5-m antenna height. During testing, the FWAN WCS Base Station was set up and tested in the following modes of operation:

- 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

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 baseband and network shelves without phone calls.

Figure 11.95 18.0 GHz – 26.5GHz @ 2-m Antenna Height Emissions Scan, Vertical Polarization

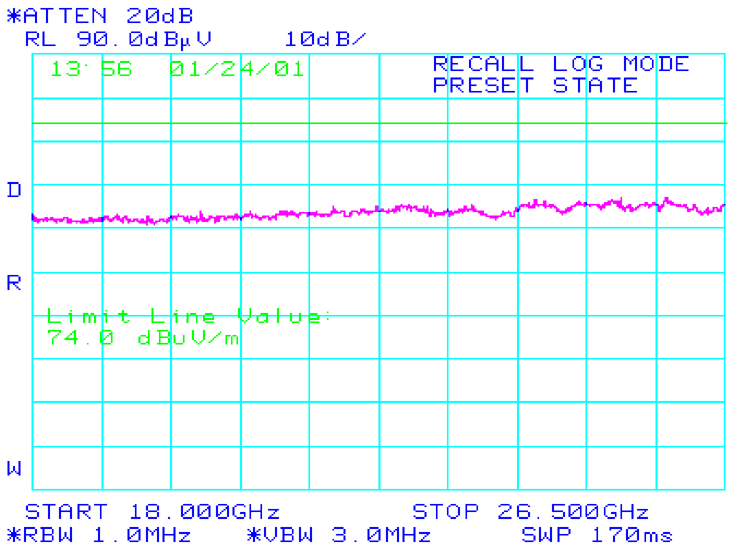


Figure 11.95 is the FWAN WCS Base Station radiated emissions scan (18.0-26.5GHz) in the vertical polarization at a 2-m antenna height. During testing, the FWAN WCS Base Station was set up and tested in the following modes of operation:

- 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

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 baseband and network shelves without phone calls.

Figure 11.96 18.0 GHz – 26.5GHz @ 1-m Antenna Height Emissions Scan, Horizontal Polarization

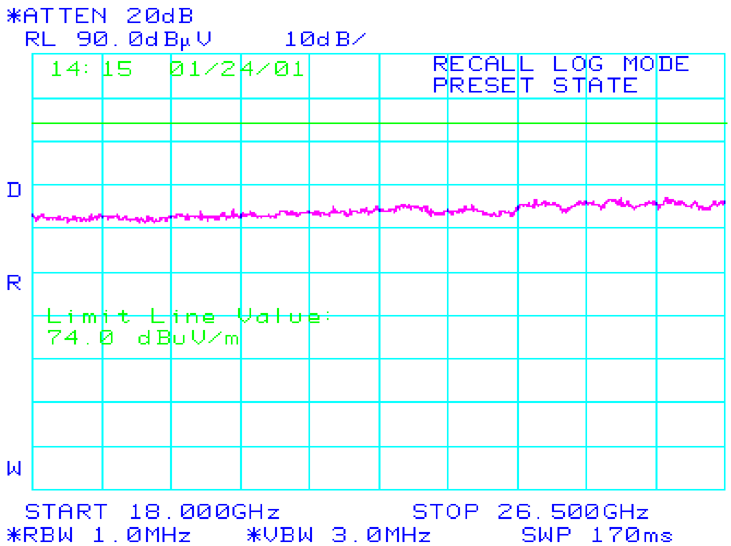


Figure 11.96 is the FWAN WCS Base Station radiated emissions scan (18.0-26.5GHz) in the horizontal polarization at a 1-m antenna height. During testing, the FWAN WCS Base Station was set up and tested in the following modes of operation:

- 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

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 baseband and network shelves without phone calls.

Figure 11.97 18.0 GHz – 26.5GHz @ 1.5-m Antenna Height Emissions Scan, Horizontal Polarization

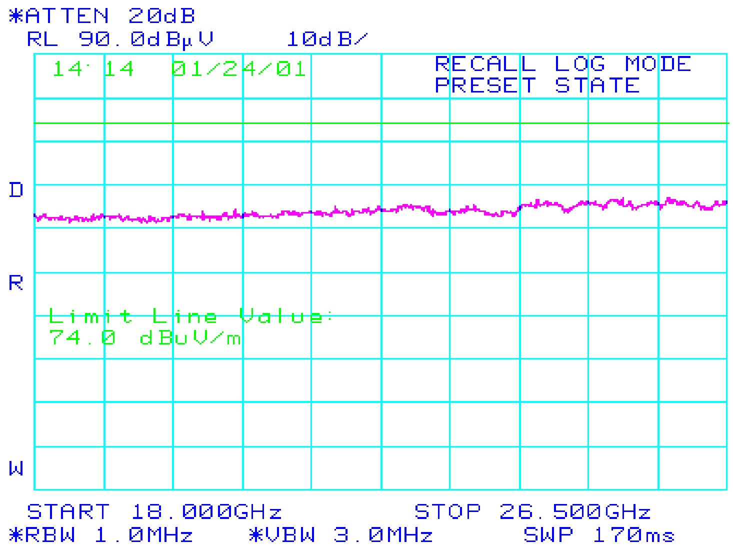


Figure 11.97 is the FWAN WCS Base Station radiated emissions scan (18.0-26.5GHz) in the horizontal polarization at a 1.5-m antenna height. During testing, the FWAN WCS Base Station was set up and tested in the following modes of operation:

- 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

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 baseband and network shelves without phone calls.

Figure 11.98 18.0 GHz – 26.5GHz @ 2-m Antenna Height Emissions Scan, Horizontal Polarization

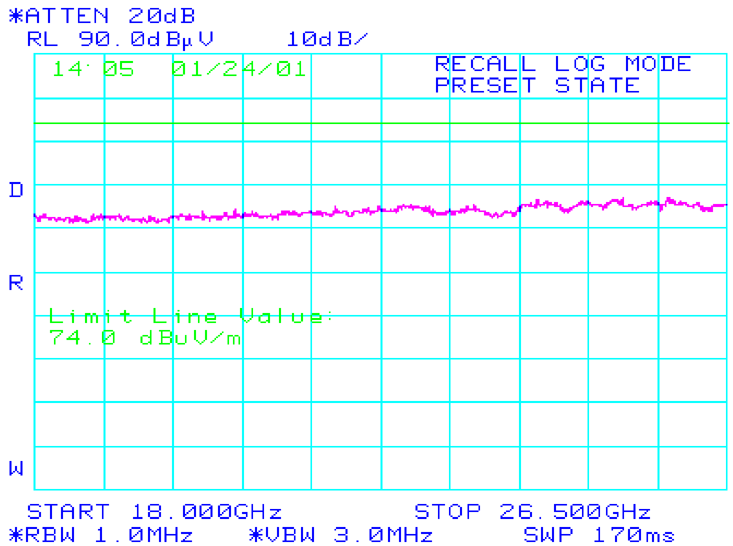


Figure 11.98 is the FWAN WCS Base Station radiated emissions scan (18.0-26.5GHz) in the horizontal polarization at a 2-m antenna height. During testing, the FWAN WCS Base Station was set up and tested in the following modes of operation:

- 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

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 baseband and network shelves without phone calls.

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. Figure 11.85 through Figure 11.98 correspond to the radiated emissions profile of the FWAN WCS Base Station (30MHz – 26.5 MHz) in the following configuration: the FWAN WCS Base Station is located within the EMC cabinet, all cables (PWR, T1s, GPS, and four RF) exiting through the bottom of the cabinet, two sides grounded with two-inch braid, two RUs per sector are loading the FWAN WCS Base Station throughout the duration of the test.

The top horizontal line shown in Figure 11.85 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 emissions testing. Twenty-four peak signals exceeded the 6 dB margin, as shown in Figure 11.85, and was further investigated using a quasi-peak detector and labeled in Table 11.24. The quasi-peak amplitudes are identified in Table 11.24 and shown in Figure 11.85 denoted by a sideways <X> symbol. As shown in Figure 11.85 the amplitudes of the twenty-four investigated signals were below the FCC Class A limit line.

11.3.5 Radiated to Conducted Spurious Emissions

11.3.5.1 Applicable FCC rules

FCC Subpart 2.1046 -This rule 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 manufacturer's tune-up procedure. The rule requires documentation of the measurement configuration. The transmitter's spectral output shall not have any components that exceed the spectral mask that applies to the rule/ subpart under which the equipment shall be operated.

FCC Subpart 27 - On any frequency outside a licensee's block, the power of any emission shall be attenuated below the transmitter power (P) by at least 80+10Log(P) dB on all frequencies between 2320 and 2345 MHz, by a factor not less than 70 + 10Log(P) dB on all frequencies below 2300 MHz and on all frequencies above 2370 MHz; and not less than 43 + 10Log(P) dB on all frequencies between 2300 and 2320 MHz and on all frequencies between 2345 MHz and 2370 MHz that are outside the licensed bands of operation. Compliance is based on measurement within a resolution bandwidth of 1 MHz. However, in the 1 MHz bands immediately adjacent to the licensee's 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.

11.3.5.2 Test Results

The data presented here is in addition to the results presented in Section 11.1.7. After completion of the radiated emission scans, Figure 11.85 through Figure 11.98, show that no spurious emissions were detected.