APPLICATION FOR

CLASS II Permissive Change on Type Accepted Equipment

Sierra Wireless Inc.

FCC ID: LL9MP200V

MODEL: MP210V-GPS

Prepared by:
Sierra Wireless Inc.

13575 Commerce Parkway
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Richmond, British Columbia
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December 22, 1999

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SIERRA WIRELESS
HEART OF THE WIRELESS MACHINE™

Letter of Submittal and Compliance

December 22, 1999

Federal Communications Commission
Authorization and Standards Division
7435 Oakland Mills Rd.
Columbia, M.D. 21046

RE: FCC ID: LL9MP200V Grantee: Sierra Wireless Inc.
Equipment Class: Non-Broadcast Transmitter
Application for Class II Permissive Change dated December 21, 1999

Dear Madam/Sir:

The following information is submitted in support of a Class II Permissive Change to the certification of the LL9MP200V transmitter. There are no physical or electrical changes exceeding those allowed in Section 2.1001a. The following section explains the changes that make the application for permissive change necessary. Along with the updated schematic (Appendix A), the updated Bill of Material (Appendix B) and the detailed circuit description currently on file at FCC for this type, this section outlines the modifications and the circuits that are affected.

The conducted tests that are required for part 22 type acceptance have been performed in-house on a representative upgraded unit. Sierra Wireless Incorporated has tested this transmitter in accordance with the requirements contained in the appropriate Commission Regulations. To the best of my knowledge, these tests were performed using measurement procedures consistent with the Industry or Commission standards and demonstrates that the equipment complies with the published standard. The results are presented in this document.

Radiated tests for unintentional radiators (15.109), radiated spurious emission (2.993), and maximum permissible emission (2.1091) have been performed at an FCC certified site, Intertek Testing Services, in Menlo Park, California. We enclose their reports that show the device is compliant with the Commission standards.

Sierra Wireless wishes to establish the acceptability of a category of antennas (instead of specific models) as defined below for purposes of satisfying MPE compliance for 2.1091 of the FCC rules with the MP210V-GPS (FCC ID LL9MP200V). To qualify this category of antenna we have provided test results (see MPE report by ITS) using five examples within the category and that, we believe, represent the extremes of radiation levels that might be seen in this category.

These examples include the longest, shortest and nominal lengths of antennas of similar configuration and are intended to demonstrate the worst case and nominal performance for this category.

We refer to this category as the "3dB gain Cellular Mobile" whip antenna. This category is defined by these attributes:

- rated gain of 3 dBd
- the radiator is a collinear array of two vertical elements. A base fed lower element of length 85 mm +/-30 mm, connected at its highest point to a matching coil. The top of the coil is, in turn, connected to an upper vertical element of length 200 mm +/- 35 mm. The matching coil may be an open-air type or encapsulated.
- Intended for mounting on a horizontal metallic surface of vehicle body using either a through-hole or magnetic base.
- Cable loss of more than 0.5 dB

The five example antennas tested include open coil types, encapsulated coil types, magnetic mount and through-hole mount.

We ask that the Grant condition referring to antenna type be worded to include this category.

Sincerely

Ron Vanderhelm
Director, RF Development

Expository Changes (2.1001(b)(2))

This section describes the changes made on the MP210V-GPS.

The reference oscillators (TCXO or temperature compensated crystal oscillators) provide the frequency references for the two synthesizers used to generate the transmit carrier. The parts that had been used until now for this reference oscillator function have been discontinued by its manufacturer. These old oscillator modules included an internal microprocessor to provide temperature compensation and a serial digital interface for zeroing the frequency error. The part that we will be replacing them with do not support this digital interface. Our new circuitry adds a small microprocessor to serve as a translator between the old interface and the new.

Two TCXOs are affected. One (formerly U16, now U19) is used as the reference for the transmit IF signal at 81.75 MHz. The second (formerly U17, now U16) is used as the reference for the transmitter LO at 755 MHz +/-12.5 MHz. The oscillator frequencies do not change; the IF reference is 14.4 MHz, and the LO reference is 16.8 MHz, as it was in the old design.

The new oscillators are functionally equivalent to the old discontinued ones once our new interface circuitry is added to provide DC voltage for trimming frequency error to zero. The circuitry to provide temperature stabilization remains within the crystal oscillator module and is not part of our added circuitry. The following circuit descriptions provide more detail.

Other changes are made including minor upgrades in part type to four other components including the synthesizer prescalers (U12 and U14), the AMPS modem IC (U27) and the DSP (U22). These upgrades are minor in that, in each case, the new chip is a manufacturing upgrade from the old, from the same manufacturer. Their functionality and performance do not change significantly. These changes are listed in detail in a later section of this statement.

Reference Oscillators

The RX and TX Temperature Voltage Controlled Crystal Oscillators (TCXOs) have been replaced. Figure 1 shows the circuitry newly implemented.

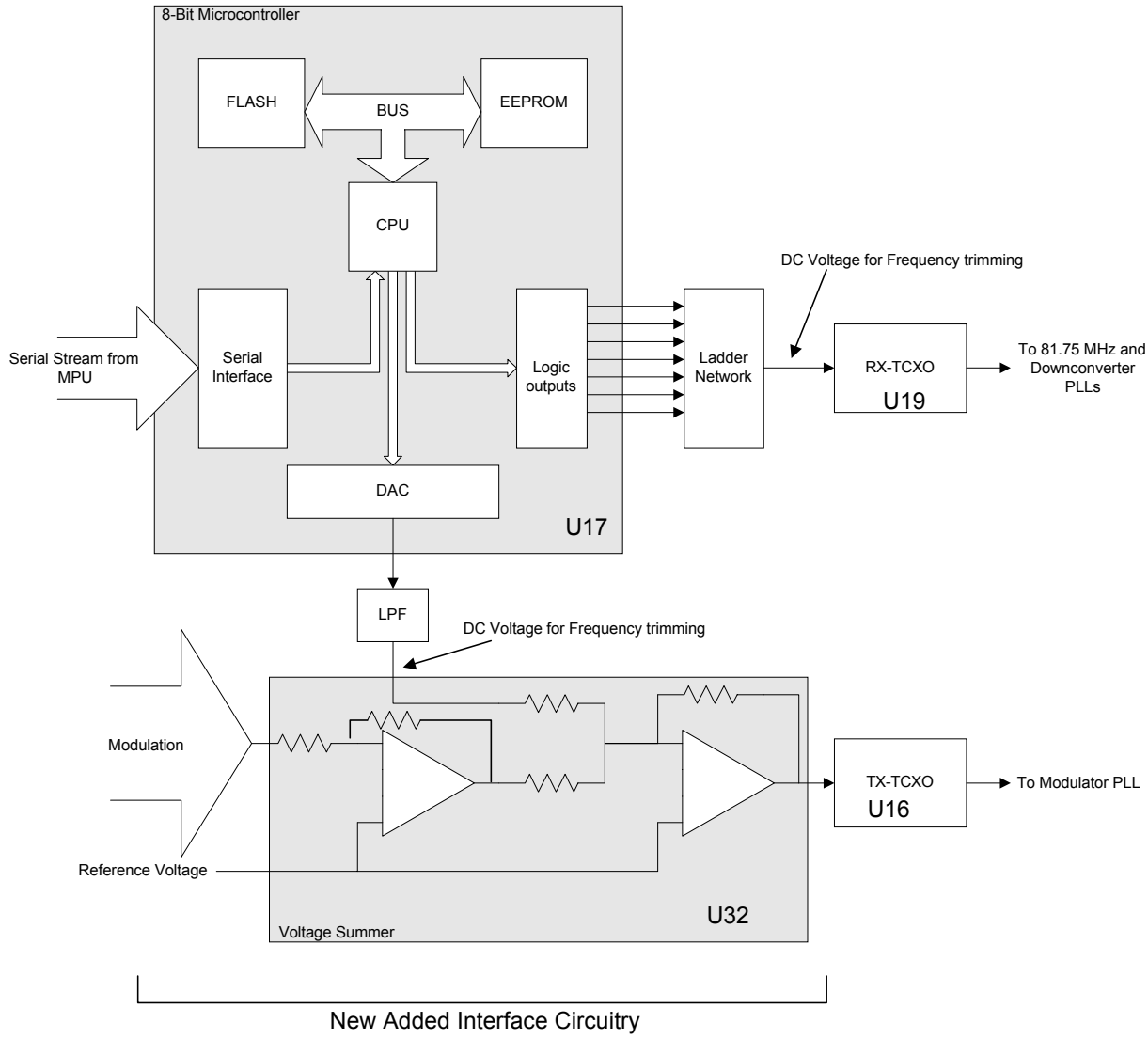


Figure 1: TCXO Interface Circuits

The RX oscillator (RX-TCXO) signal, at 14.4 MHz, is the reference of the two PLLs used to generate the first LO and second LO of the dual conversion, superheterodyne receiver. The first LO signal (F_{LO}= RF_{RX}+82.2 MHz) is only used on the receiver side whereas the second LO (81.75 MHz) signal is also used in the transmitter as its IF signal.

The TX LO oscillator is modulated using a two port approach. Basically, it is a PLL that uses classic FM modulation (baseband signal directly FM modulates the VCO) with a slight variation. Because our digital

modulation signal has significant low frequency components, the reference crystal is also FM modulated to extend modulation bandwidth to DC. High frequency components of the baseband GMSK signal are passed on to the RF by the VCO whereas the low frequency ones are tracked up by the PLL.

The obsolete crystal oscillators have integrated logic and EEPROM that support a serial link with the Main Processing Unit (MPU) of the modem, two Digital to Analog Converters (DACs) as well as a calibration look-up table. During the initial factory calibration process, the CPU sends serial streams to the RX and TX TCXOs with incrementing calibration values. When the generated RF frequency error is minimum, the MPU sends a command so the current calibration value is written onto the EEPROM. Because the replacing parts doe not integrate logic circuits, we have added an 8-Bit microcontroller. Figure 1 shows the diagram of the circuitry newly implemented. The microcontroller's main functions are to read calibration values on EEPROM, to receive and process the commands going to the serial interface, to implement a DAC, and to control logic outputs, these one being part of a ladder network DAC. The DAC and Ladder Network are two DACs that allow control of the DC voltage at the voltage control input of the two TCXOs. Since the baseband signal modulates the TX-TCXO, a summer made of operational amplifiers combines the frequency adjust DAC voltage output and the information signal.

All the circuitry presented in this sub-section is viewable on page sheet #3 of the schematic diagram (see Appendix)

Signal Path

As is explained in the previous sub-section, the modulation signal path is slightly changed. Indeed, the op-amp configuration replaces the internal circuitry that was implemented in the previous TX-TCXO (see figure 1). However, the high port path remains unchanged. Changes affect only the low frequency range (below 300Hz of the signal, which is the approximate cutoff frequency of the loop filter).

On the receiver side, the signal path is affected by the upgrade of the DSP IC (DSP1634AE, U22 on sheet #6 of Schematic in Appendix) and the obsolescence of a the voice compander IC (SA577, U29 on sheet #8 of Schematic), that was previously used for its expander capability . This feature is now integrated to the new DSP; U29 is therefore no longer populated.

Other Secondary Changes

Other minor changes include:

- Upgrade of the prescalers (U12 sheet #1 and U14 sheet #2).
- Upgrade of the DPROC (AMPS modem) IC (U27 sheet#7). 100% compatibility with the obsolete part, the UMA1000.

Performance Test Data

RF Output Power (2.985)

Name of Test:	RF Power Output
FCC ID:	LLP9MP200V
Grantee:	Sierra Wireless
Serial No.:	206-00094808
Manufacturing Rating:	0.00631 to 4 Watts +8dBm to +36dBm in 4 dB steps (Controlled by Cell Base Station)
Equipment Authorization Procedure:	Para. 2.985(a)
Test Equipment:	HP8920B Cell Site Test Set Circuit-Test DC power supply Pentium PC Computer
Duty Cycle:	Continuous

Block Diagram of Test Set-up

The computer is used to select the channel and key the transmitter.

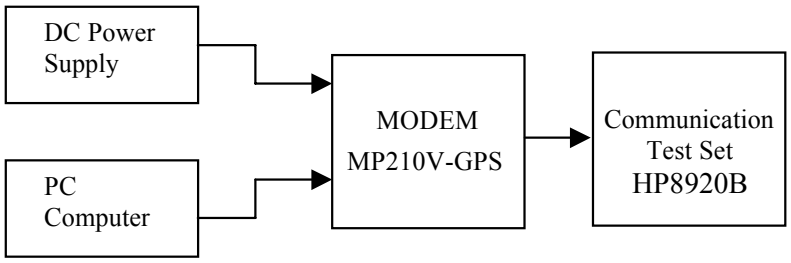


Figure 2: RF Power Test Set up

Final Radio Frequency Amplifying Device

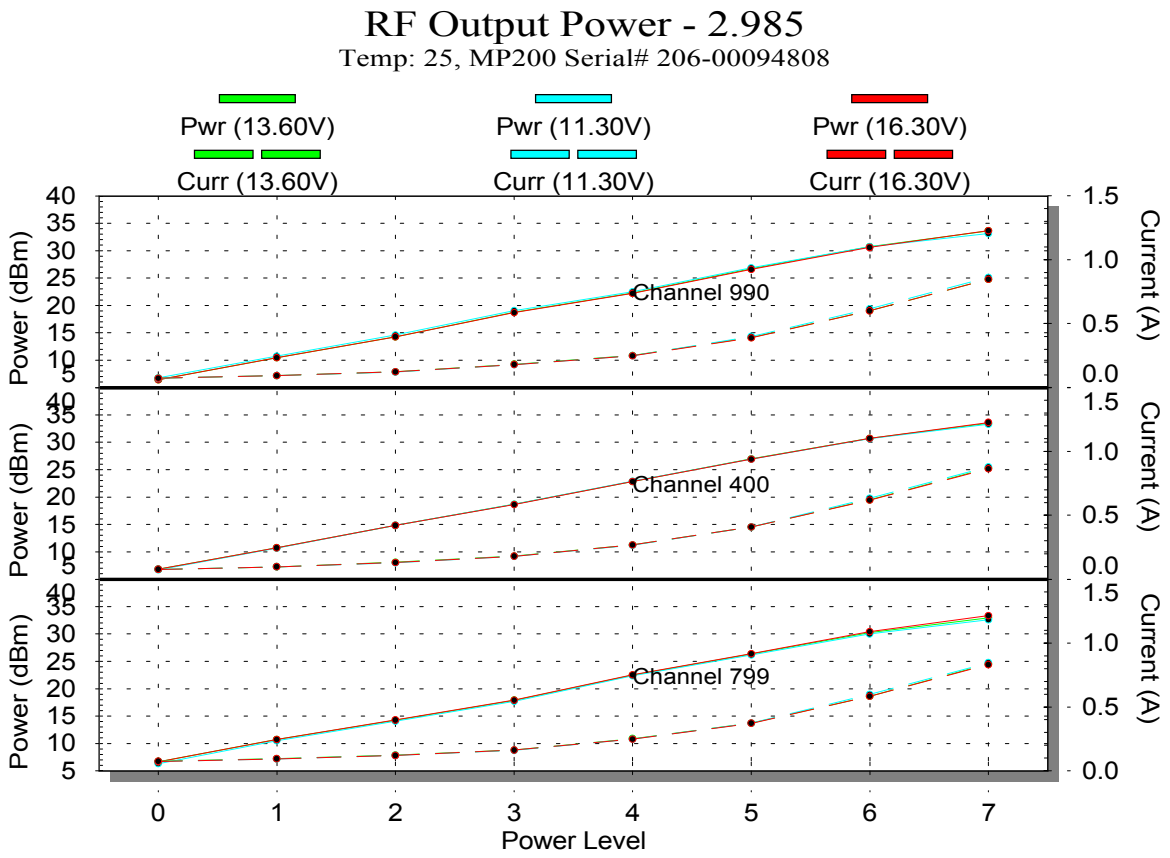
PF0030 Hitachi Power module

	LOW POWER	**HIGH POWER**
Drain Current, (Ic)=	Unable to measure physically	Unable to measure physically
Drain Voltage, (Vc)=	Unable to measure physically	Unable to measure physically
Total Transmitter Load	0.11 A	1.27 A
DC Input Voltage	13.6 V	13.6 V
Power Input = (Ic)(Vc)= Pin =	1.50 W	17.3 W
Measured Power Output[1] =	7.4 dBm	36.1 dBm
Rated Power Output	8.0 dBm	35.0 dBm

Note: it is not physically possible to access the components to measure collector current and voltage.

[1] Because the device is calibrated to 35 +/- 1 dBm in high power mode, we wish to demonstrate the maximum level available, so the power was set by manually changing (through test software) the power control.

This graph is provided to show transmitter power and overall system current drain at the eight calibrated power levels used.



*Calibrated Power Levels:

0: 8 (+/-2) dBm
1: 12 (+1/-2) dBm
2: 16 (+1/-2) dBm
3: 20 (+1/-2) dBm
4: 24 (+1/-2) dBm
5: 28 (+1/-2) dBm
6: 32 (+1/-2) dBm
7: 35 (+/-1) dBm

Modulation Characteristics (2.987)

There are six types of modulation used in this device.

The primary mode is CDPD mode, where the only modulation used is **CDPD** (GMSK digital mode), 31K5FXW, where modulation level is fixed by factory calibration to +/- 4.8 kHz deviation.

In AMPS system mode, we use the standard signaling types:

ST (10KHz)
fixed deviation of +/-8.0 kHz, factory calibrated, 40K0F9W

SAT
fixed deviation of +/-2.0 kHz, factory calibrated, 40K0F9W

Control Channel Wideband Data
fixed deviation of +/-8 kHz, factory calibrated, 40K0F1D

Voice
maximum deviation of +/- 12KHz, limiter used, 40K0F3E

Also in AMPS mode we use the non-standard signaling type:

Voice Channel Modem signaling
Maximum deviation of 12.0 kHz, level factory calibrated to fixed level of nominal 8 kHz, 40K0F9W

For all of these modes, we demonstrate compliance with FCC rules using Occupied Bandwidth Measurements (see following section). For voice, we choose to demonstrate compliance as provided under 22.917c, using an emissions mask as seen in the following section "Occupied Bandwidth", in place of measuring the audio low pass filter and limiter characteristics.

The emissions mask used for the AMPS Voice channel, 2.5 kHz tone (plots 5a and 5b) complies with the requirements of 22.917c. In that test, the 2.5 kHz tone is set to an increased level of 16 dB over nominal. Spectral lines normally seen at 2.5 kHz increments from the carrier are not seen in this case due to the nature of the DSP used for voice processing. The microphone audio processing subsystem uses a digital signal processor to implement the limiter and the bandwidth controlling filters. The microphone preamp does not quite accommodate the 16 dB step in level, but limits, causing distortion. The distortion causes the audio spectrum to expand beyond the usual Nyquist limit for the particular sampling rate used in the A-to-D converter and so aliasing occurs. When this occurs, the audio spectrum "fills in", obscuring the discrete 2.5 kHz lines. Note that this distortion of the input signal occurs before the deviation limiter and bandwidth limiting filter and so does not cause widening of the occupied bandwidth. This characteristic tends to add some additional distortion to the heavily limited voice, but intelligibility is not degraded much more than is usual in a cellular phone that is being shouted into.

In the Voice Channel Modem Signaling mode of operation we demonstrate compliance using the maximum rate of 14.4 kbps signaling which demonstrates the worst case spectrum occupancy.

Occupied Bandwidth (2.989)

Name of Test:	Occupied Bandwidth
FCC ID:	LLP9MP200V
Grantee:	Sierra Wireless
Serial No.:	206-00094808
Minimum Standard Specified	Para. 22.917 c, d
Test Results	Equipment is Compliant with Standard
Equipment Authorization Procedure	Para 2.989 (c)(1)
Test Equipment:	HP4407B Spectrum Analyzer HP89441A Spectrum Analyzer 2 (for F1D measurement) HP8920B Cell Site Test Set Circuit-Test DC Power Supply Pentium PC Computer Mini-Circuits splitter, model ZFSC-2-2 Land-line modem: shop built (unit # 1) RF attenuators, model 6N5W-10dB

Test Setup Block Diagram

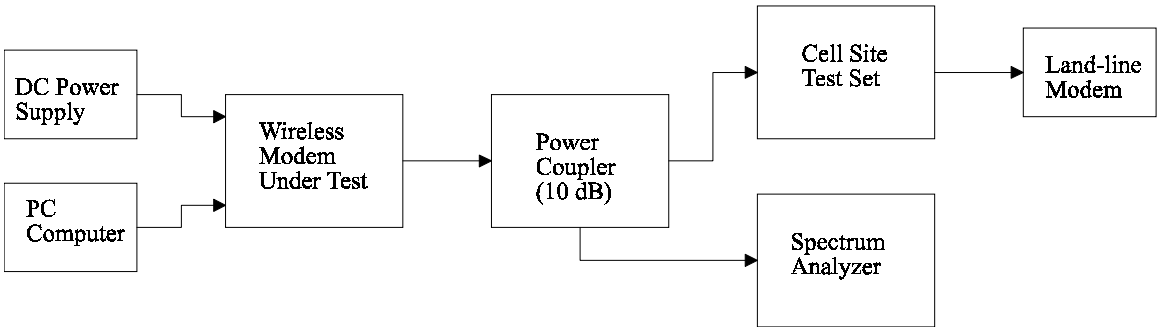


Figure 3: Occupied Bandwidth Test Setup

Measurement Data

Spectrum Analyzer: Hewlett Packard 4407B

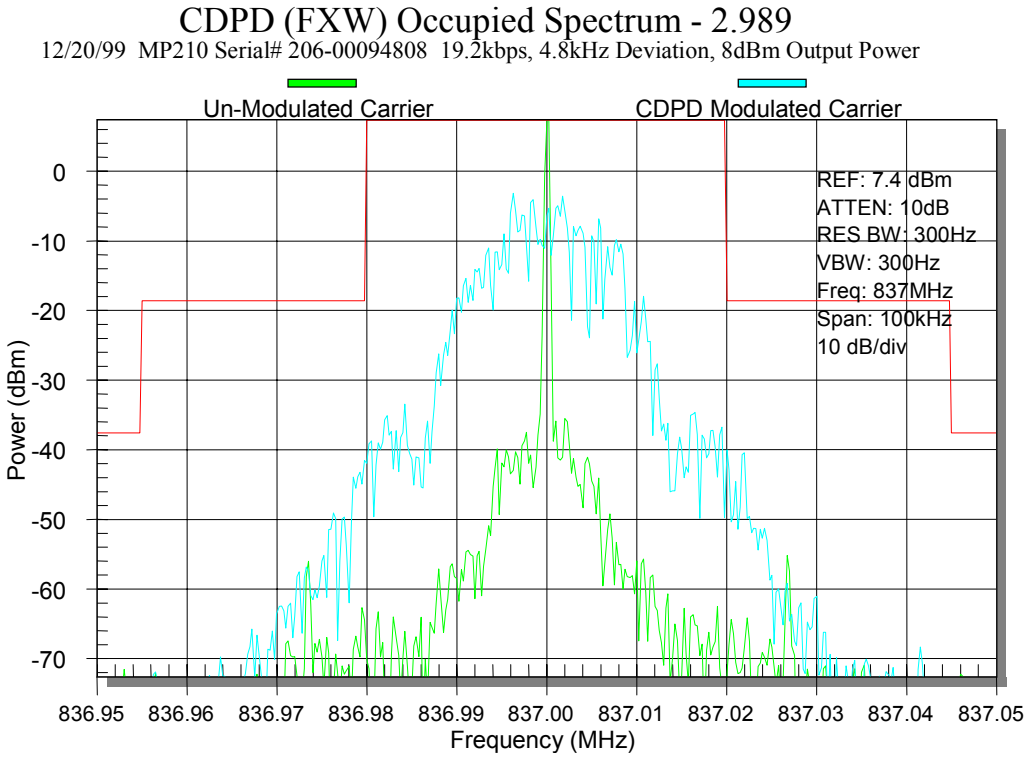
Settings:

Resolution Bandwidth	300 Hz
Video Filter	300 Hz
Scan Time	3.33 sec
Scan Width	100 kHz
Center Frequency	837 MHz

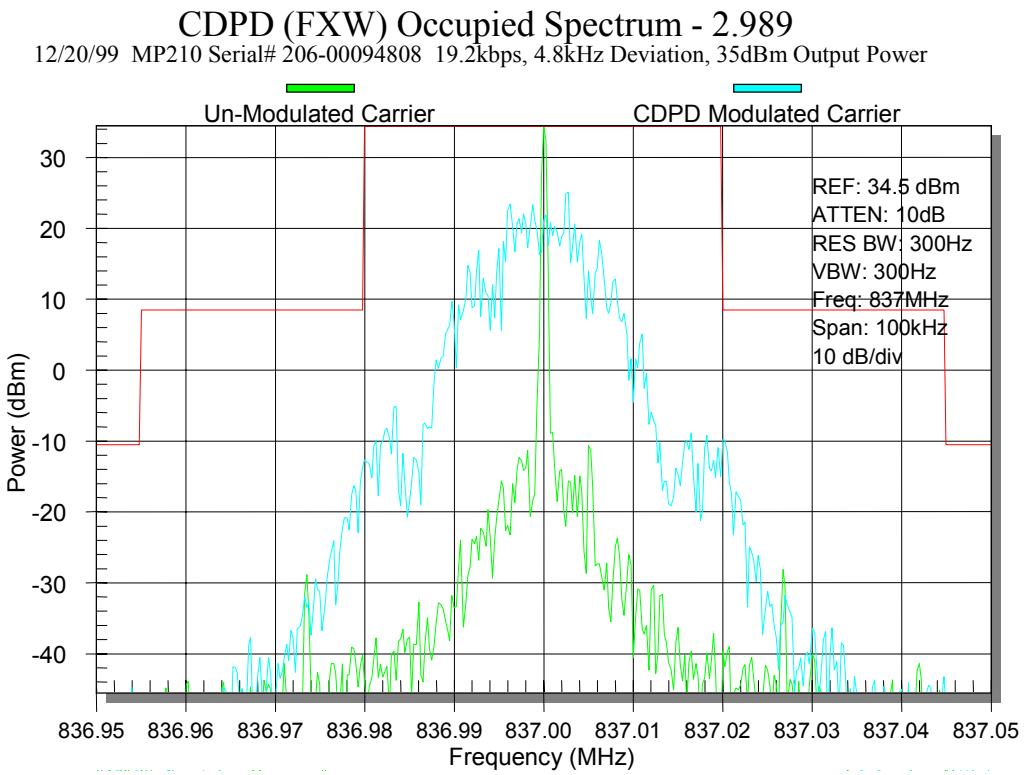
Data Or Signaling Type	**Tx Deviation**	**Emission Designator**
1) CDPD, Cellular Digital Packet Data (19.2 kbaud)	4.8 kHz	31K5FXW
2) SAT, Supervisory Audio Tone (6 kHz)	2.0 kHz	40K0F9W
3) ST (10 kHz)	8.0 kHz	40K0F9W
4) Control Channel Wide Band Data	8.0 kHz	40K0F1D
5) Voice Channel, 2.5 kHz tone	12.0 kHz	40K0F3E
6) Voice Channel/Modem Signaling (14.4 baud)	12.0 kHz	40K0F9W

Explanation of these modes is given in the previous section “Modulation Characteristics”.

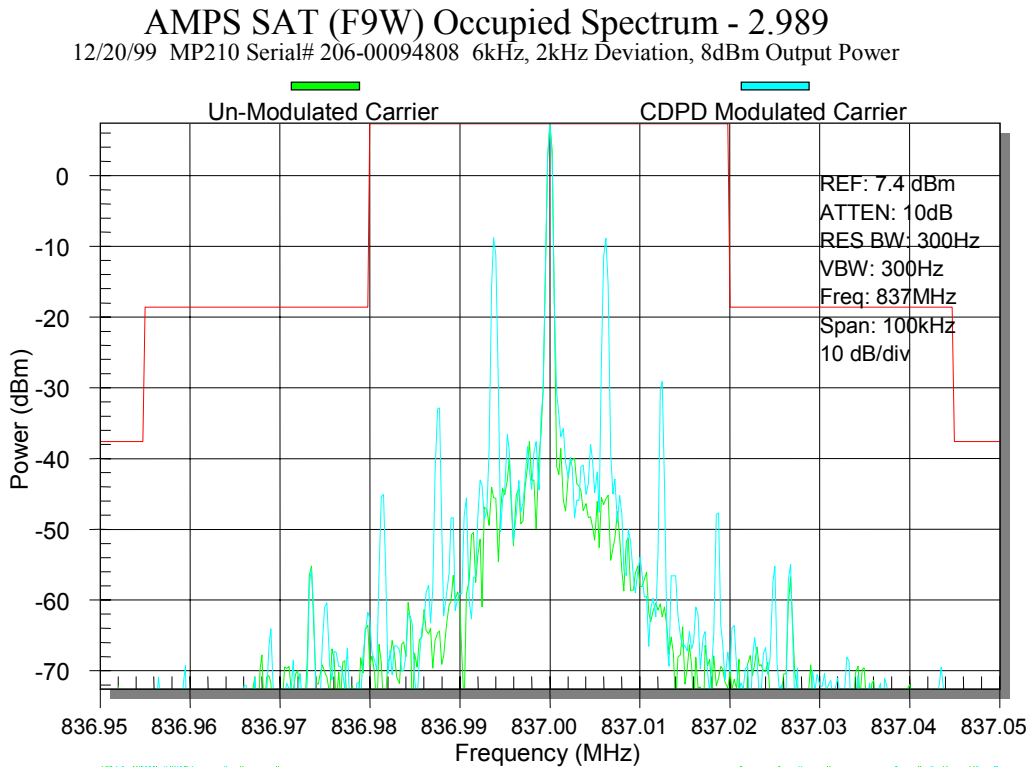
1)a) CDPD, Cellular Digital Packet Data (19.2 kbaud), 8dBm



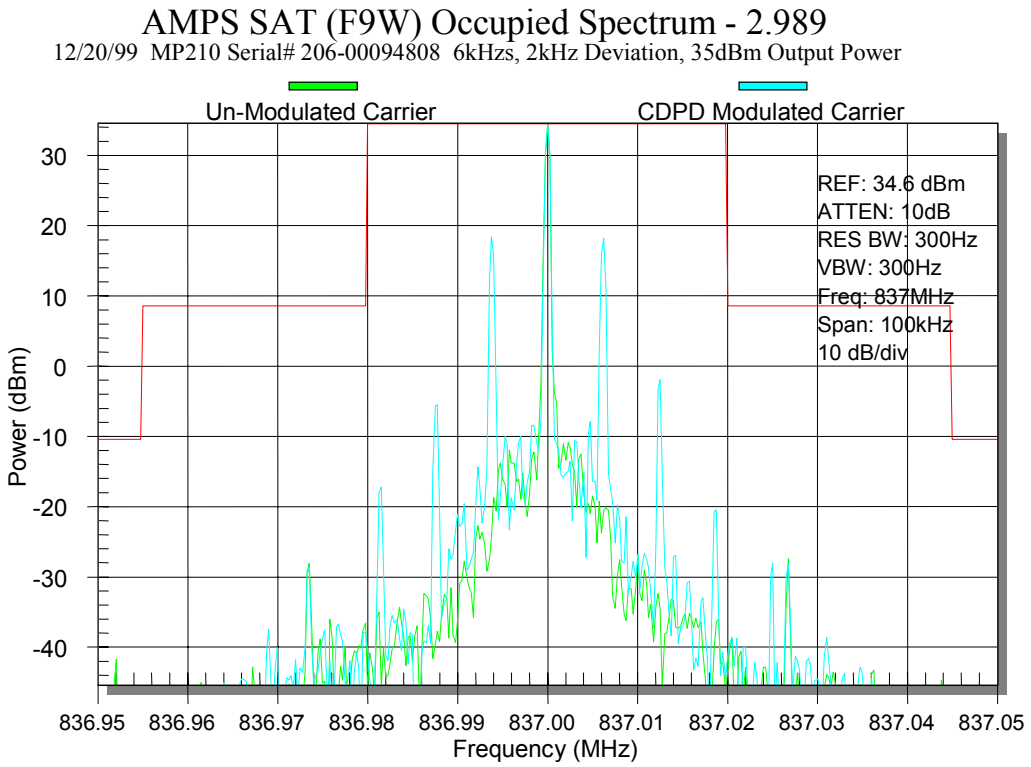
1)b) CDPD, Cellular Digital Packet Data (19.2 kbaud), 35dBm



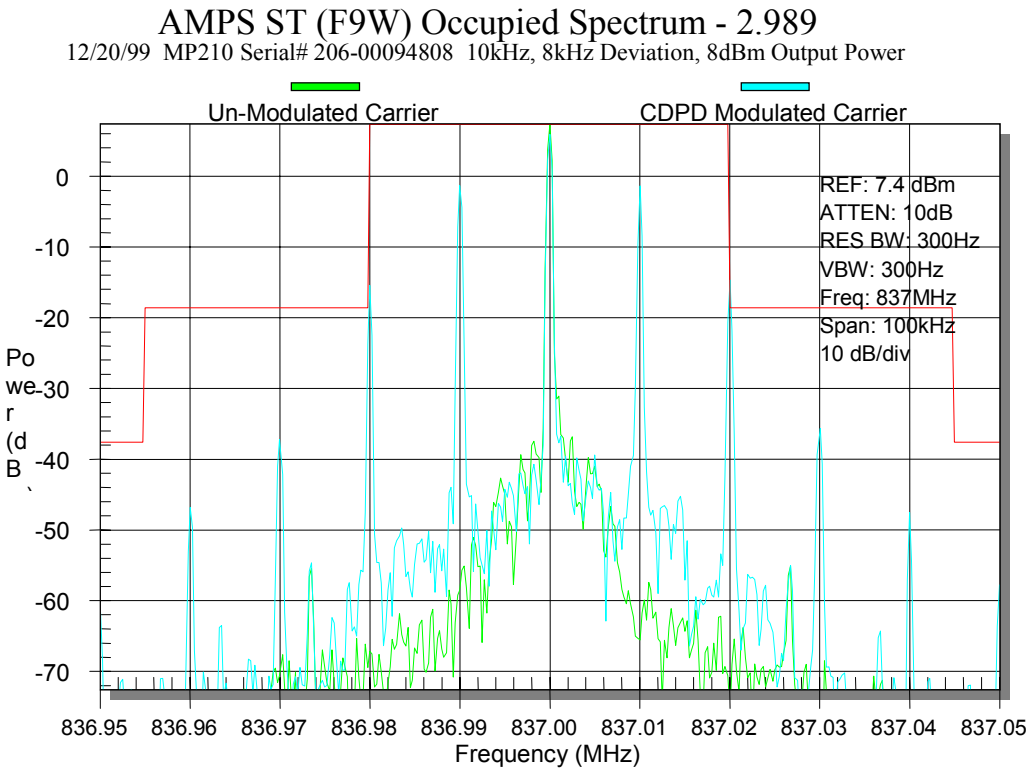
2)a) SAT, Supervisory Audio Tone, 8 dBm



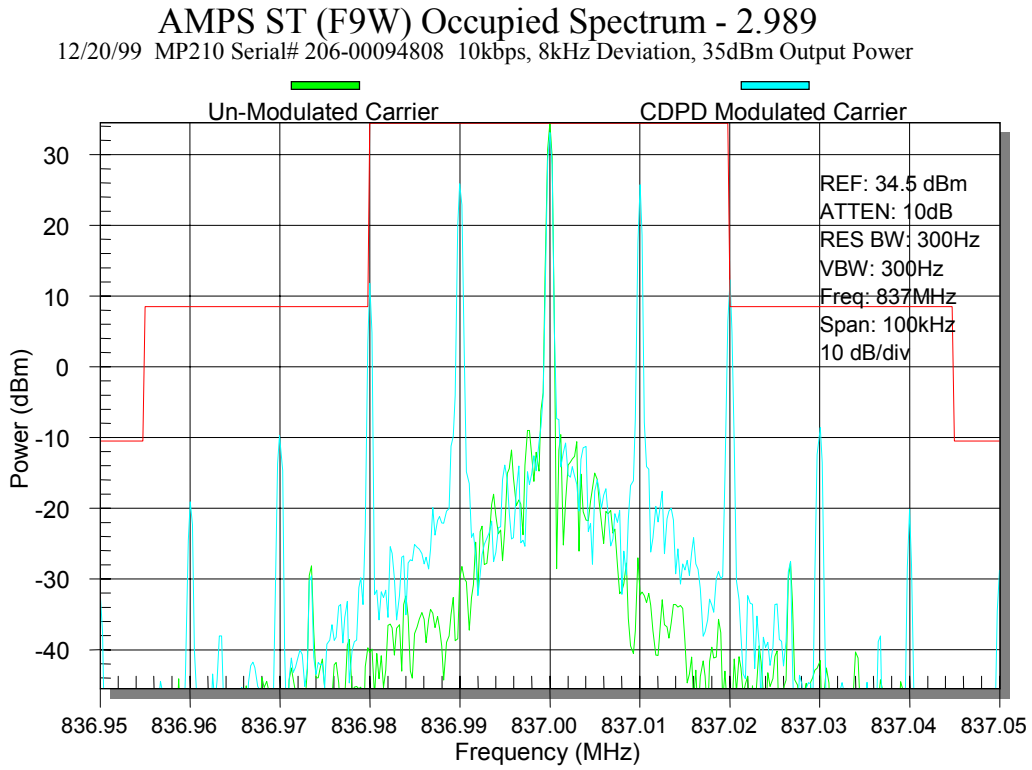
2)b) SAT, Supervisory Audio Tone, 35 dBm



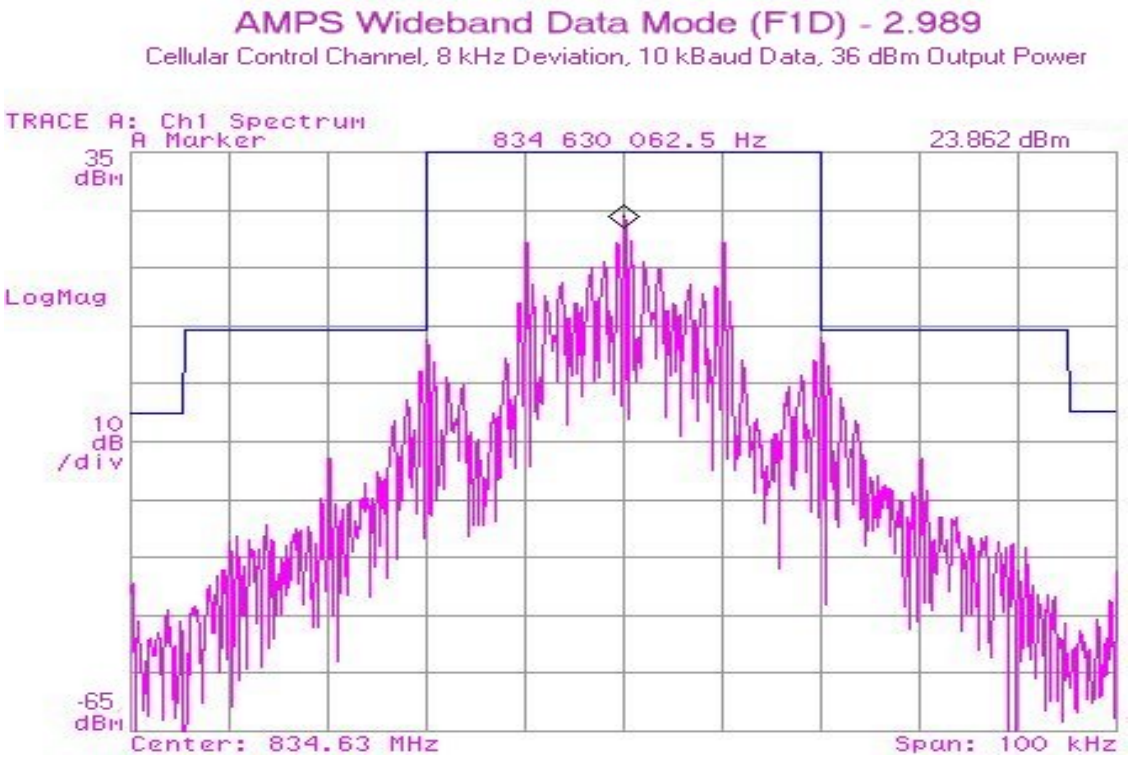
3)a) ST (10 kHz), 8dBm



3)b) ST (10 kHz), 35dBm

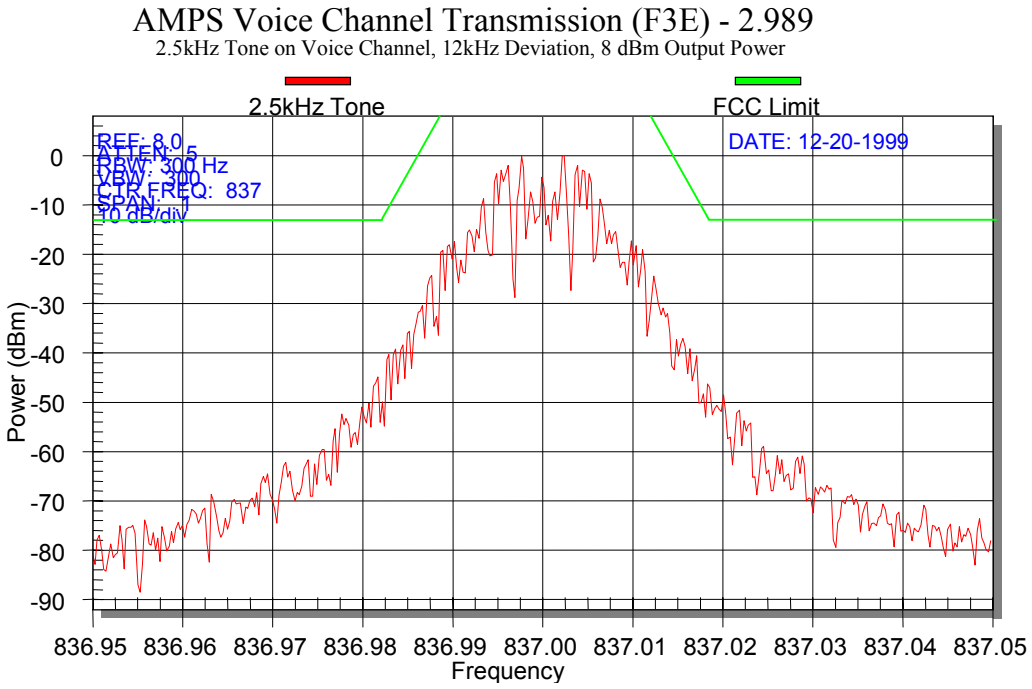


4) Control Channel Wide Band Data
Note that Spectrum Analyzer 2 was used for this measurement. Model HP89441A.

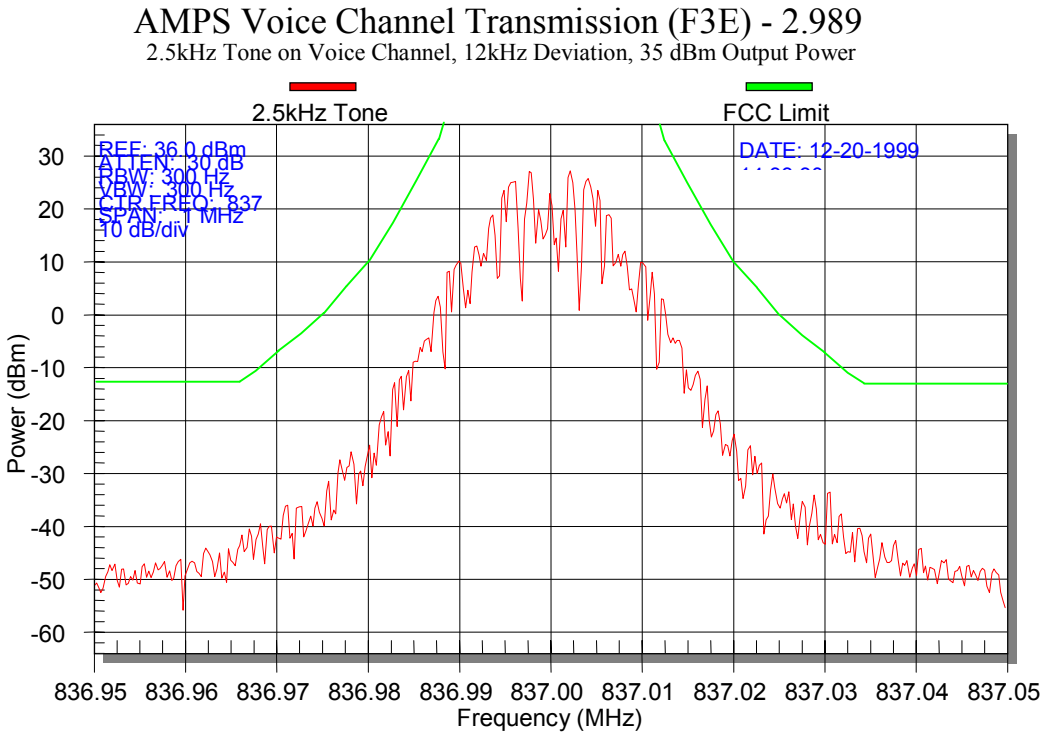


In this plot, the unmodulated carrier level is the same as the top horizontal line, the reference line at 35 dBm.

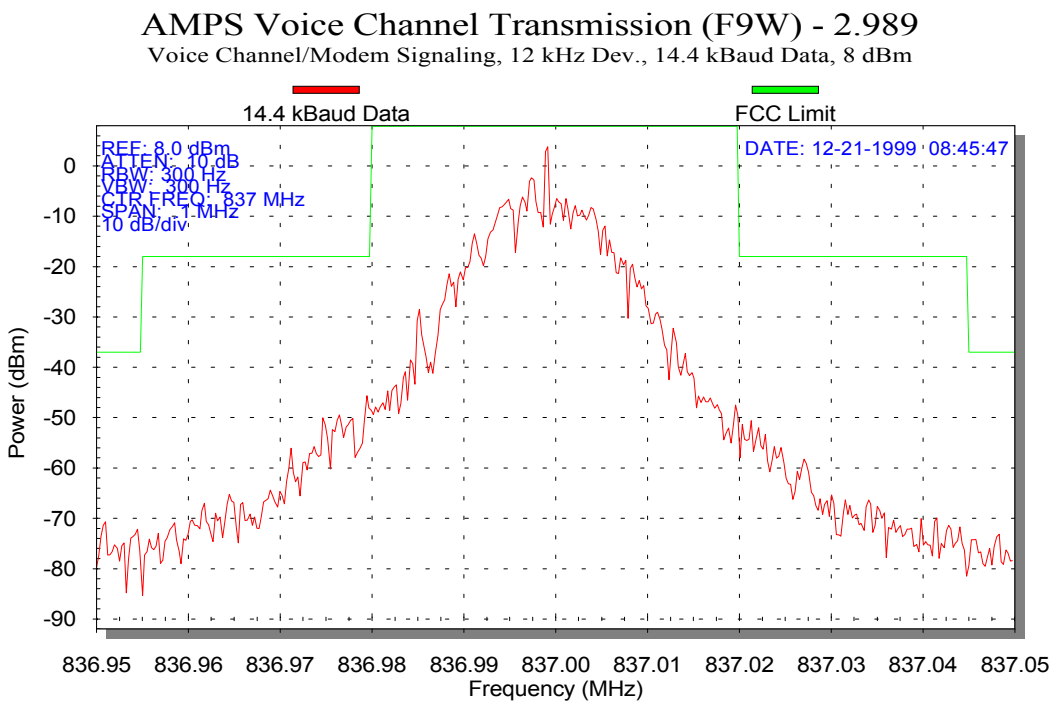
5)a) Voice Channel, 2.5 kHz tone
Unmodulated Carrier power is the top horizontal line (the reference line) of the graph.



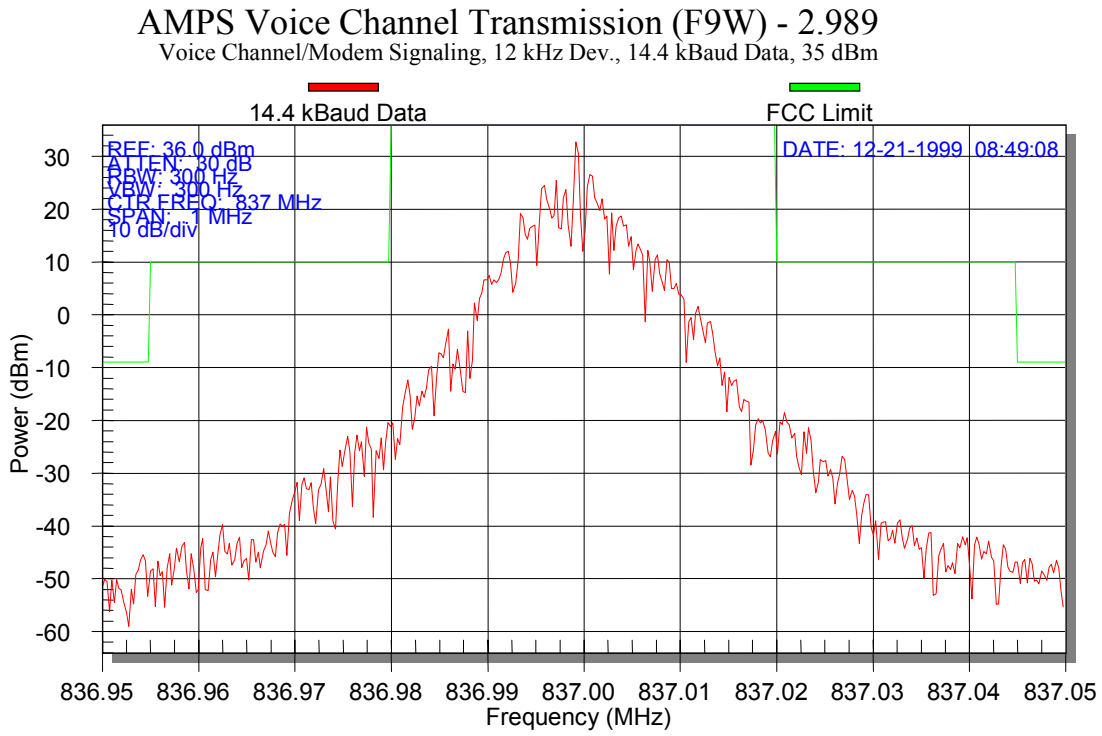
5)b) Voice Channel, 2.5 kHz tone, 35 dBm
Unmodulated Carrier power is the top horizontal line (the reference line) of the graph.



6)a) Voice Channel/Modem Signaling (14.4 kbaud), 8 dBm
Unmodulated Carrier power is the reference line of the graph.



6)b) Voice Channel/Modem Signaling (14.4 kbaud), 35 dBm
Unmodulated Carrier power is the top reference line of the graph.



Spurious Emissions at Antenna Terminals (2.991)

Name of Test:	Spurious Emissions at Antenna Terminals
FCC ID:	LL9MP200V
Grantee:	Sierra Wireless
Serial No.:	206-00094808
Minimum Standard Specified	Para. 22.917 e
Test Results	Equipment Compliant with Standard
Equipment Authorization Procedure	Para. 2.993
Frequency Range Observed	0 to 9 GHz
Operating Frequency	837.000 MHz
Crystal Frequency	16.8 MHz TCXO
Power Output	0.00631 to 4.0 Watt (8 to 36 dBm) in 4 dB steps
Spurious Limit	-13 dBm

Test Setup Block Diagram

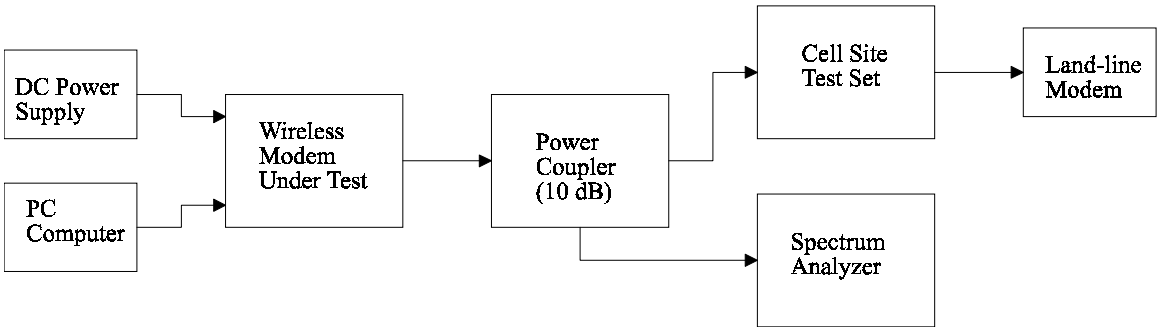
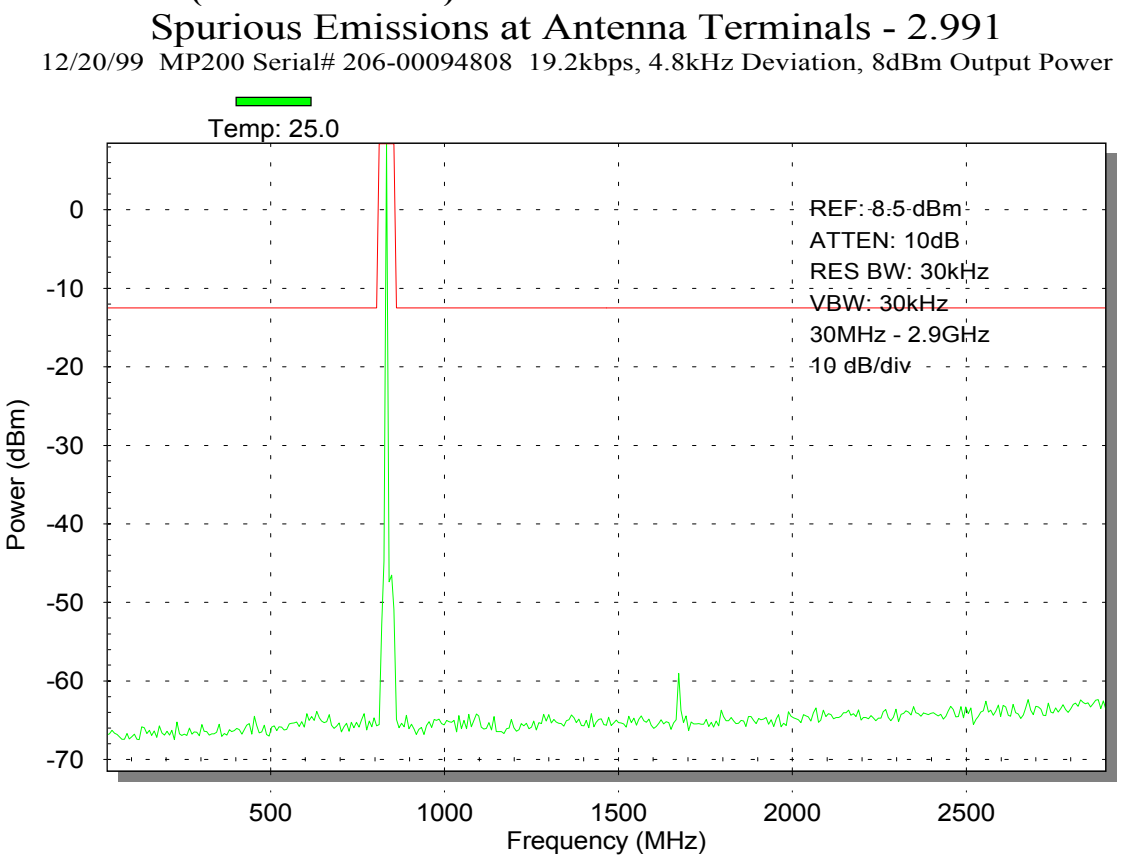
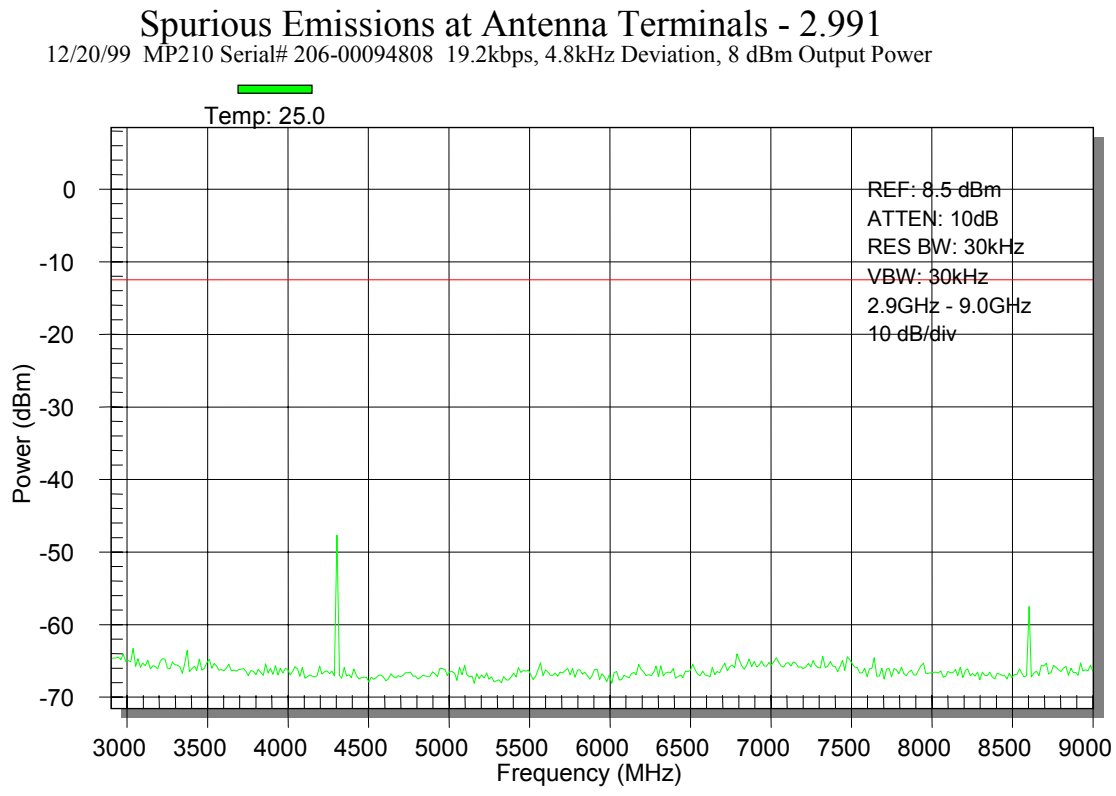


Figure 4: Spurious Emissions Test Setup

Low Power (8dBm Nominal)

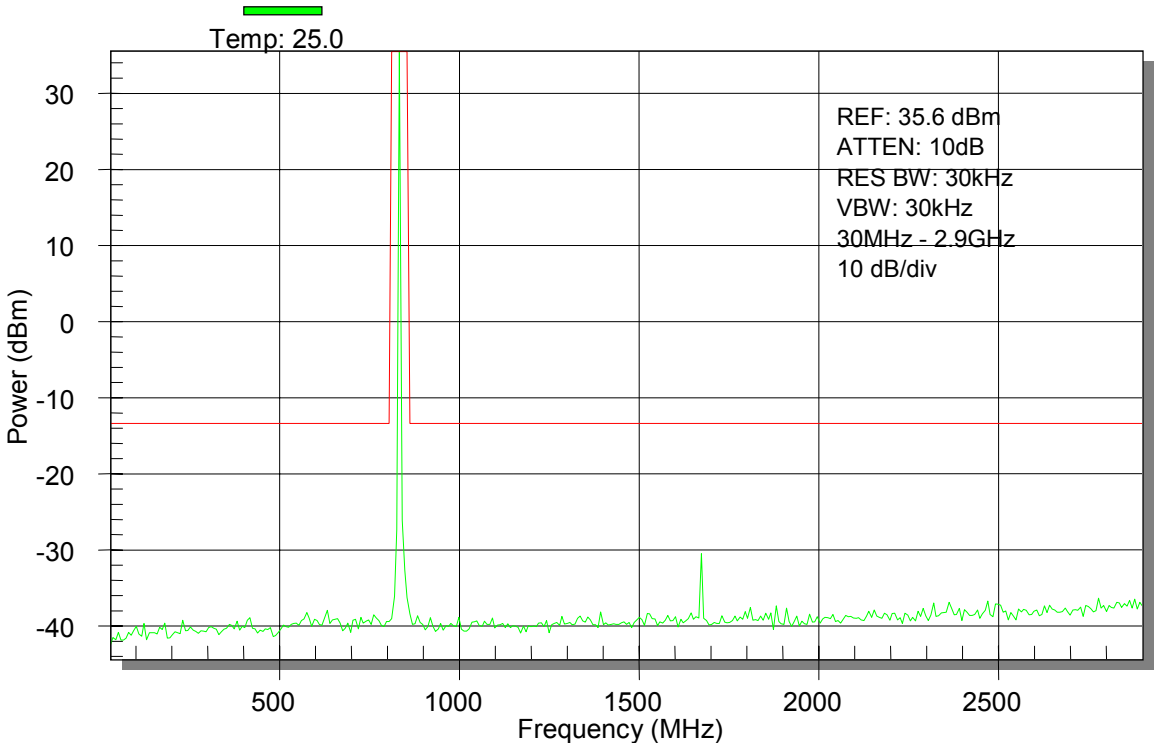




High Power (35 dBm Nominal)

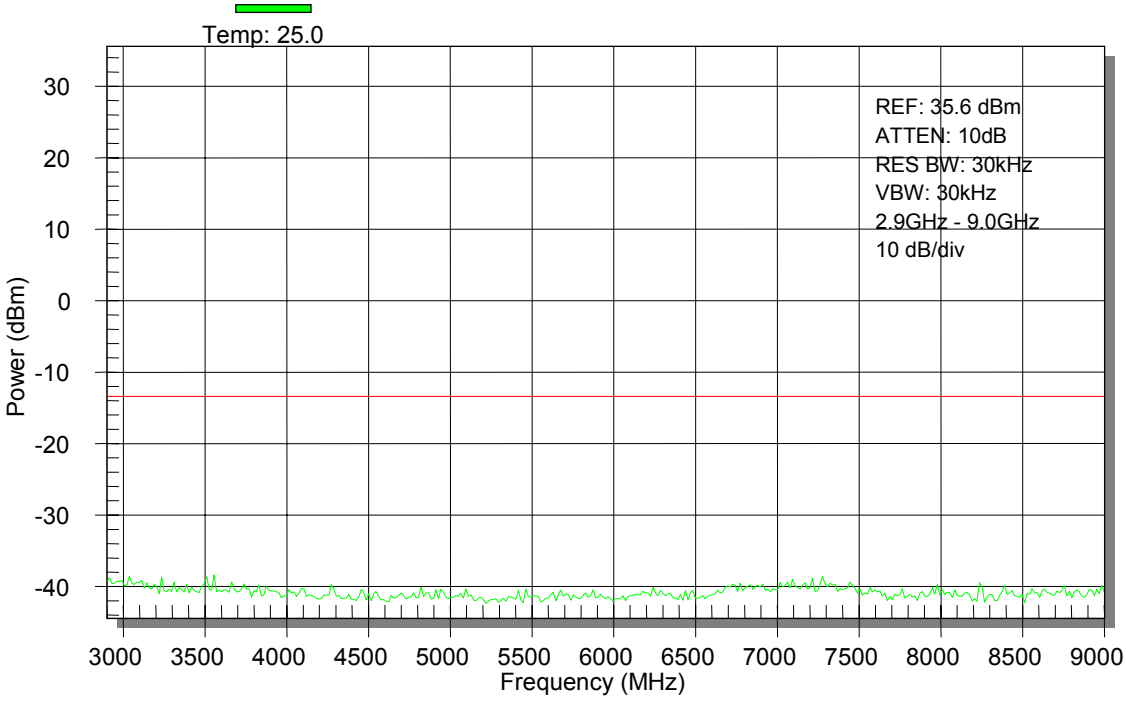
Spurious Emissions at Antenna Terminals - 2.991

12/20/99 MP210 Serial# 206-00094808 19.2kbps, 4.8kHz Deviation, 35dBm Output Power



Spurious Emissions at Antenna Terminals - 2.991

12/20/99 MP210 Serial# 206-00094808 19.2kbps, 4.8kHz Deviation, 35 dBm Output Power



Spurious Emissions in the Base Station Frequency Band (22.917f)

Name of Test:	Spurious Emissions In the Base Station Frequency Band
FCC ID:	LL9MP200V
Grantee:	Sierra Wireless
Serial No.:	206-00094808
Minimum Standard Specified	Para. 22.917 f
Test Results	Equipment Compliant with Standard
Equipment Authorization Procedure	Para. 2.993
Frequency Range Observed	850 to 900 MHz
Operating Frequency	837.000 MHz
Crystal Frequency	16.8 MHz TCXO
Power Output	35 dBm
Spurious Limit	-80 dBm

Test Setup Block Diagram

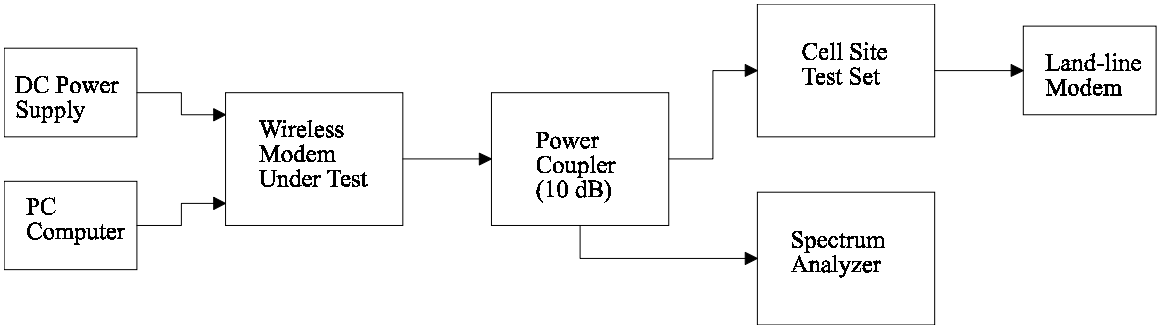
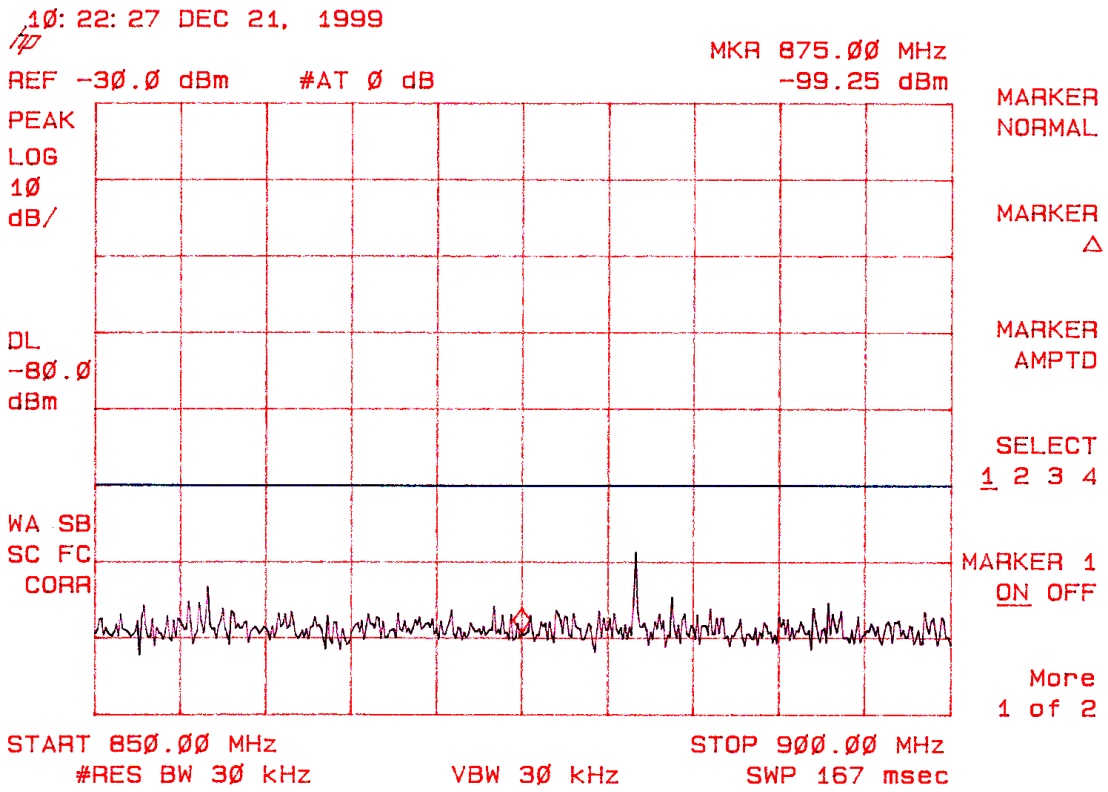


Figure 4: Spurious Emissions Test Setup



In this plot, the blue line is the specification limit of –80 dBm. Transmitter power is set to 35 dBm, the maximum calibrated power level.

Operational Stability Performance (2.995)

Name of Test:	Operational Stability Performance
FCC ID:	LL9MP200V
Grantee:	Sierra Wireless
Serial No.:	206-00094808
Minimum Standard Specified	22.355 +/- 2.5 ppm freq. stability
Equipment Authorization Procedure	Para. 2.995
Test Results	Equipment is Compliant with Standard
Test Equipment	HP8920B Cell Site Test Set Tenney Jr environmental chamber Circuit Test DC power supply Pentium PC Computer
Standard Test Frequency	837.0 MHz

Notes : Tolerance =+/- 2091 Hz or 2.5 ppm

Block Diagram of Test Set-up

Measurements were performed using an automated test facility, which includes a switch matrix to route transmitter power to the test set. Path loss is accounted for automatically in our test software.

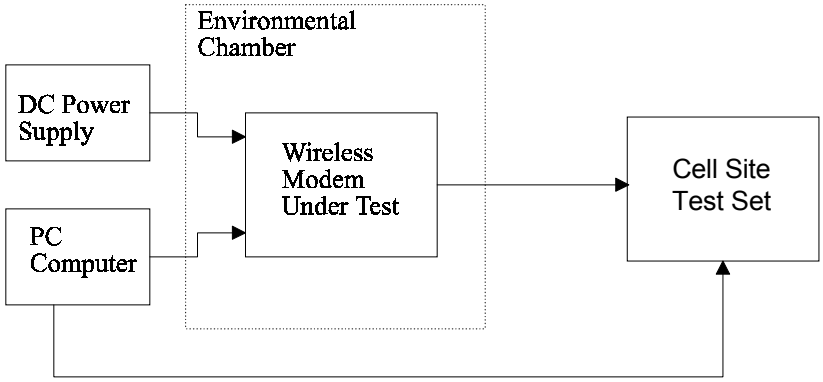
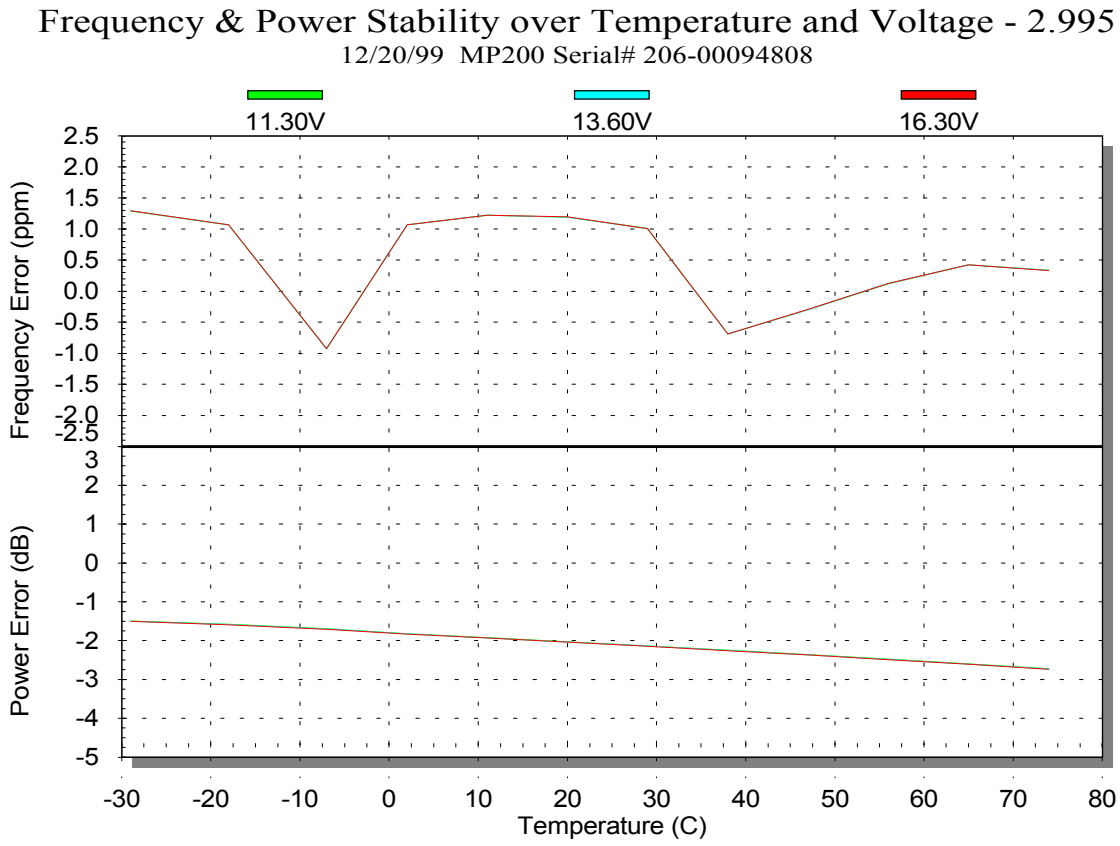


Figure 5: Operational Stability Test Setup

EUT set up in test chamber with temperature probe located adjacent to EUT in chamber center to observe ambient.

This graph shows the frequency stability vs. temperature for this device. Our automated test system includes the power error plot, but it can be ignored.

The plots of frequency error at three voltages are indeed all shown, however, they are so alike that the red line overlays and obscures the green and blue lines.



Field Intensity Measurements of Spurious Radiation (2.993)

This test was performed by Intertek Testing Services (ITS) at Menlo Park California. Their test report, Report No J990032362a, containing the results of their tests is attached to this submission.

Their report shows that the device meets the FCC rules.

Radio Frequency Radiation Exposure Limit (2.1091)

This test was performed by Intertek Testing Services (ITS) at Menlo Park California. Their test report, Report No J99032362, containing the results of their tests is attached to this submission.

Their report shows that the device meets the FCC rules with all five sample antennas.

As explained in the Letter of Submittal and Compliance, Sierra Wireless wishes to establish the acceptability of a category of antennas (instead of specific models) as defined below for purposes of satisfying MPE compliance for 2.1091 of the FCC rules with the MP210V-GPS (FCC ID LL9MP200V). To qualify this category of antenna we have provided test results (see MPE report by ITS) using five examples within the category and that, we believe, represent the extremes of radiation levels that might be seen in this category.

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We refer to this category as the "3dB gain Cellular Mobile" whip antenna. This category is defined by these attributes:

- rated gain of 3 dBd
- the radiator is a collinear array of two vertical elements. A base fed lower element of length 85 mm +/-30 mm, connected at its highest point to a matching coil. The top of the coil is, in turn, connected to an upper vertical element of length 200 mm +/- 35 mm. The matching coil may be an open-air type or encapsulated.
- Intended for mounting on a horizontal metallic surface of vehicle body using either a through-hole or magnetic base.
- Cable loss of more than 0.5 dB

The five example antennas tested include open coil types, encapsulated coil types, magnetic mount and through-hole mount. Photographs of the antennas are included in the ITS report. As shown in the data of that report, all five antennas demonstrate similar performance and all meet FCC requirements.

We ask that the Grant condition referring to antenna type be worded to include this category.

Test Equipment List

Sierra Wireless, Inc.

Type	Manufacturer and Model No.	Serial no.	Accuracy
Spectrum Analyzer	Hewlett Packard HP4407B Opt. 1D5, 1D6, 1DR, A4H, AYX, BAA	US39160286	
Spectrum Analyzer(2)	Hewlett Packard HP89441A	3416A03323	
Cell Site Test Site	Hewlett Packard HP8920B Opt. 001, 004, 006, 013, 102	US37423715	0.05PPM +/-1Hz, +/- 5% +/-0.01mW
Power Splitter	Mini-Circuits ZFSC-2-2	943705	
RF Attenuator	Mini-Circuits 6N5W-10dB		
Power Supply	Circuit-Test PS-3230	A143988	
Environmental Chamber	Tenney TJR	26393.07	
Pentium PC Computer			