APPLICATION FOR

Certification

Sierra Wireless Inc.

FCC ID: N7NAB300A

MODEL: Air Blaster 300

Prepared by:
Sierra Wireless Inc.

#260 - 13151 Vanier Place
Richmond, B.C.
V6V 2J2

June 21, 1999

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Letter of Submittal and Compliance

SIERRA WIRELESS
HEART OF THE WIRELESS MACHINE™

June 23, 1999

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

Gentlemen:

Sierra Wireless Incorporated has tested this Cellular RF amplifier 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. We are unable to warrant against unpublished changes in requirements. The applicable rules are listed in the following test report.

The Open Area Test Site used for these measurements is located at Intertek Testing Services, Menlo Park, California.

Sincerely

Trent McKeen
RF Engineer

Applicant Introduction

Sierra Wireless, Inc, located in Richmond, B.C., Canada, designs and manufactures wireless data modems for use on Cellular networks.   The company was incorporated in May of 1993 around a core engineering staff with special expertise in development of products for use in commercial mobile data systems. The AB300, is a Cellular Tx/Rx amplifier for use with Sierra Wireless Inc. packet modems.

General Equipment Information

Receive Amplifier:

Frequency Range:	869 to 894 Mhz
Gain	8 dB
Noise Figure	6 dB
Designated Reception Mode and Bandwidth:	FM, 30kHz
Intermediate Frequencies:	None
Local Oscillator Frequencies:	None
Input Impedance:	50 ohms
Output Impedance:	50 ohm
Crystal Frequencies:	10.0 Mhz

Transmitter:

Frequency Range:	824 to 849 Mhz
Type of Emission:	FM, 30kHz
Input Impedance:	50 ohms
Output Impedance:	50 ohms
Crystal Frequencies:	10.0 Mhz
Input Power	+12dBm
Power Output:	36 dBm max, variable to 8 dBm in 4 dB steps

Expository Statement (2.983)

System Description

The booster is an optional add-on for selected 0.6Watt CDPD Radio Modems made by Sierra Wireless Inc. It provides 3 Watts of output power, improving the coverage area for the AirCard 300 for Notebooks and SB300 OEM device.

The booster is designed to be mounted into an automobile and wired into the car's electrical system. It connects to the 0.6Watt modem through an RF co-axial cable.   The intended application is for users who want the portability of a handheld device (either with an AirCard 300 PC Card plugged in or with an embedded SB300) when outside their car but require 3Watts of output power when in their automobile.

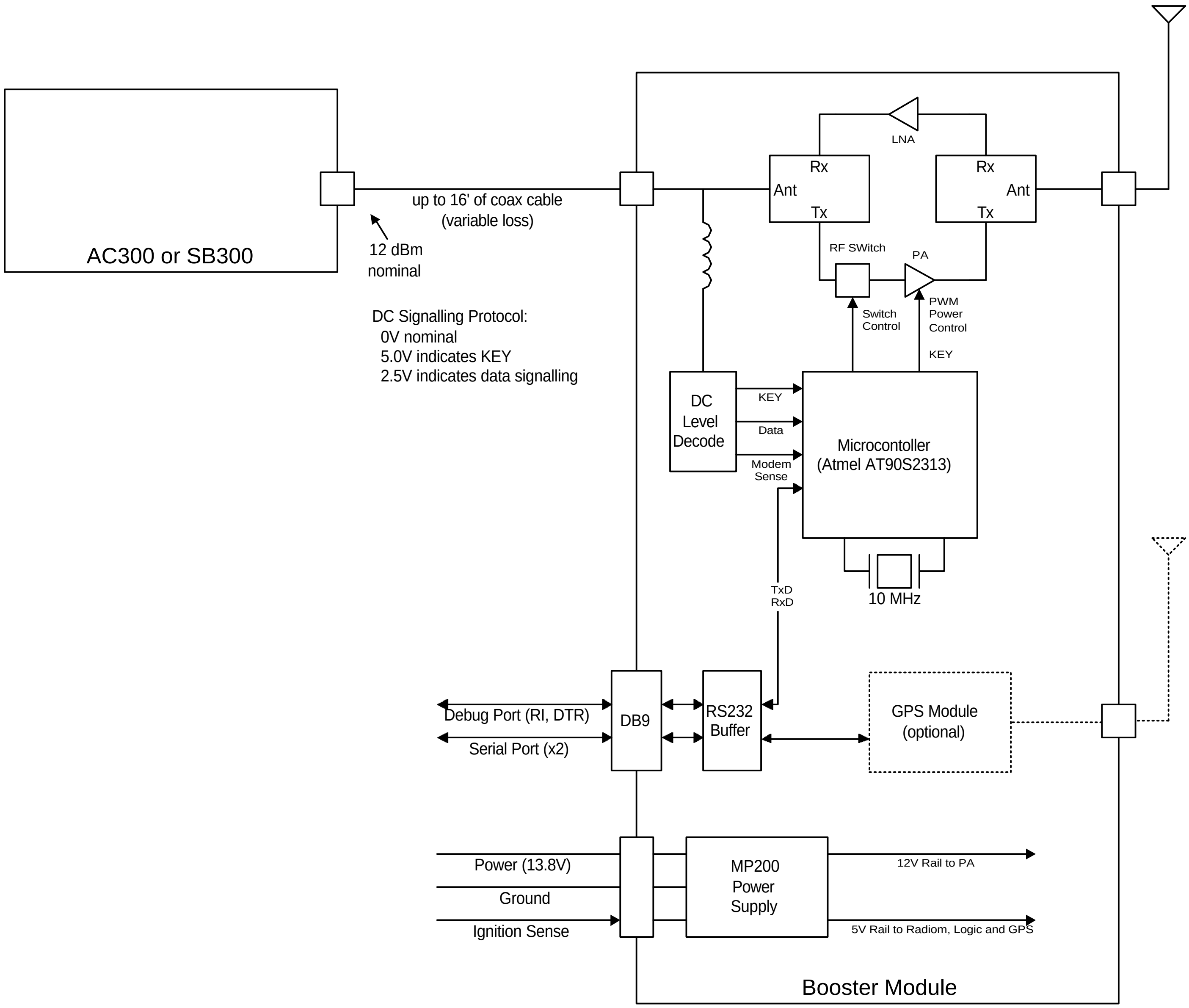
Although similar mechanically to the MP200, the booster will not be capable of stand-alone operation. Its primary purpose is to boost the output power up to a maximum of 3 Watts. Within the housing, the booster will allow an optional GPS module. Communication with the GPS module will be done through a dedicated serial port rather than over the RF link.

The end system consists of the following components:

- AirCard 300 or SB300.
- 3 Watt Booster.
- Power cable, identical to the one used on the MP200.
- Co-axial cable.
- Cellular antenna, typically 3dB gain.
- (Optional) Serial cable to communicate with the GPS module.
- (Optional) GPS antenna.

Block Diagram

A block diagram of the booster, focussing on the logic blocks, is shown below.



Microcontroller

All logic functions are controlled by the MCU, an Atmel AT90S2313. It is an 8-bit RISC micro running at 10MHz which includes an on-board 128 byte EEPROM and 128 bytes of RAM. Its ROM is Flash-based allowing the chip to be reprogrammed as required, though the board design does not allow In-Circuit reprogramming.

Crystal

X1 is a 10MHz crystal (+/- 100ppm tolerance, +/- 100ppm stability) which drives the MCU's built-in oscillator amplifier (along with capacitors C36 and C37).

Reset

The active low reset pin of the microcontroller is driven by the circuit formed by Q11, Q12, R34, R42, R44, R54, and C35. The purpose of the transistor circuit is to clamp the MCU in reset whenever the +12V power rail drops below 7V (set by the resistor divider formed by R44 and R54). The reason is that the Atmel micro has no built-in protection against low voltage situations. If the micro were allowed to operate when the +5V rail dropped below 4.0V, there would be a possibility of corrupting the EEPROM. In addition, a slowly rising or falling voltage rail may also corrupt memory. Therefore, the reset circuit is required to stop the micro from operating during power-on and power-off conditions, as well as during a brown-out.

During normal operation, Q11 is on forcing Q12 off: the ~Reset pin is then driven high and the MCU operates normally. Whenever the +12V rail drops below 7V (e.g., during power-on, power-off, or during a brownout), the transistor Q11 turns off allowing Q12 to turn on and the ~Reset pin is driven low.

LEDs

The booster has two LED's. One is driven by the power supply (see section 2.3) and the other is driven by the microcontroller. The function of this second LED (D8, labeled 'Status') is twofold:

1. Indicate the detection of the modem
2. Indicate transmitter on (KEY).

The LED will remain off when no modem is attached to the booster through the RF cable. It will immediately turn on when a modem is attached and powered on. During operation, the LED will blink off momentarily while KEYing.

Radio Interface

The micro controls radio operation through 3 signals:

1. TXKEY (active high) turns on the radio PA.
2. RF_OK (active high) closes the RF switch leading to the preamp.
3. PWR_CTRL is a PWM signal (20 kHz frequency) that sets the radio's output power. The MCU contains a built-in 8-bit PWM controller.

All three of these signals pass through a feed-thru capacitor block (C45).

Debug Port

The MCU contains a standard serial port interface, which is connected through the RS232 converter to the DB9 connector J5. This serial port is designed for manufacturing test and to provide debug information. It is not required for normal operation. The micro will respond to a small number of queries and commands through this port and will also dump out some logging information.

Signal Decoding

The information sent from the modem to the booster is carried along the RF coaxial cable. Two kinds of information are sent:

1. KEY (i.e., turn on the transmitter PA)
2. Power signaling to set the booster's output power

KEY is indicated by driving the DC level on the coax to 5V. Signaling is indicated by transitioning the DC level between 0V and 2.5V at a known frequency. This information is decoded by the booster using the comparator U6.

Before the signal is fed to the comparator circuit, the RF signal is stripped off using a low pass filter comprised of L2 and C40. The signal is then directed to two comparators, U6A and U6B. U6A is used to decode the KEY signal, and its reference voltage is set to 3.9V (through the resistor divider formed by R35, R36, and R38). Whenever the DC level on the RF cable is above 3.9V (i.e., during KEY) the comparator output is driven high. The micro then relays this signal to the radio through the TXKEY signal (see section 2.1.4 above). The second comparator, U6B, has a reference voltage of 1.6V and is used to decode the power control signaling. The micro uses this message to set the output power through its PWM (see section 2.1.3 above).

R45 is used to pull the DC level of the RF towards ground – this is the mechanism the modem uses to auto-detect the presence of the booster. Transistor Q10 allows the pull down to be switched out, but in practice the switch is always on as long as power has been applied to the booster.

In order for the booster to detect whether the modem is present or not, a comparator built into the MCU is used (pins 12 and 13). The reference voltage on pin 12 is set by the resistor divider R47 and R48. The other comparator input (pin 13) is fed by the RF DC level. When no modem is connected, the DC level is pulled close to ground through R45. When a modem is connected, the 20k pull up resistor on the modem pulls the DC level to approximately 500mV.

Power Supply

The power supply used on the booster is almost identical to that used on the MP200.

12V Regulator

The input voltage (on J3 pin 3) is a nominal 13.8V (typical automotive). The fuse (F1) and diode (D1) provide reverse polarity protection. C17, L1, C10, and C11 comprise the first stage of transient protection. The regulator, U5, and Q4 act together to regulate the 13.8V input to 12V. Q4 is there because U5 cannot handle the up to 2 Amps the booster will draw when transmitting. U5 starts to regulate current, but when the current draw grows large enough to forward bias Q4 across R17, the transistor is switched in parallel. C12 and C13 are the input and output capacitors for the regulator. The LED D5 turns on whenever the 12V rail is active.

The +12V supply to the radio (used by the PA) is switched using the power FET Q5. When the modem is not KEYing, the logic shuts off the PA’s power rail by pulling TXKEY low.

5V Regulator

The logic section of the booster, the GPS module, and much of the radio section run off of a +5V rail. This is provided by U7 which regulates the 12V rail down to 5V.   C14 and C15 are the input and output capacitors. The shutdown pin is not used, and is permanently pulled high through R26.

The +5V supply to the GPS module is switched using the power transistor Q3. In order to conserve current when the ignition sense is off (see below in section 2.3.3) and the modem is not connected, the logic shuts off the GPS module by pulling GPS_PWR high.

Ignition Sense

The ignition sense lead on the 4-pin power connector J3 is designed to be connected to the automobile’s ignition sense. This line goes high when the car’s ignition is turned to the on position. The transistor Q7 inverts the signal and translates it to 5V logic. C19, D3, R21 and R20 are all there to minimize the effect of transients on the signal. The ignition sense is used so the booster can determine whether or not to enter a low-power state (turning off the GPS module and putting the microcontroller to sleep).

GPS

The optional GPS module is the same Trimble unit used in the MP200. Its pinout is as follows:

1. Serial Port 2 Output (with respect to the Trimble module) – this output carries NMEA data.
2. +5V supply rail.

3. Serial Port 1 Output – this is the primary serial port output and is used for host communications.
4. Battery Back Up – this pin is designed to be connected to a battery to allow the GPS receiver to retain its data during a prolonged power down. In the booster it is connected to the large capacitor C22 – C22 is charged through resistor R31 and D4 and will hold its charge while power to the booster is interrupted, slowly discharging into the GPS module.
5. Serial Port 1 Input – this is the primary serial port input and is used for host communications.
6. 1 Pulse Per Second – this output pulses once per second.
7. Serial Port 2 Input – this secondary serial port input is used for Differential GPS data.
8. Ground.

Both serial ports as well as the 1PPS output are brought out to the DB9 connector through the RS232 converter.

RS232

The RS232 converter, U9, is used to translate 5V logic signals into the +/- 9V used for standard RS232 communications. The four capacitors, C23-C26, are used by internal charge pumps to convert 5V into +/-9V. The DB9 serial connector, J5, contains the following signals (also mentioned in brackets are the standard definition for these signals):

1. 1 Pulse Per Second Output from the GPS module (DCD)
2. GPS Serial Port 1 Output (host RxD)
3. GPS Serial Port 1 Input (host TxD)
4. Microcontroller Debug Port Input (DTR)
5. Ground
6. Logic Low, also used during manufacturing test to output a derivative of the 10MHz clock (DSR)
7. GPS Serial Port 2 Input (RTS)
8. GPS Serial Port 2 Output (CTS)
9. Microcontroller Debug Port Output (Ring)

Calculation of Necessary Bandwidth for FCC ID: N7NAB300A

For CDPD 19.2Kbps Transmission (emission type FXW)

The data rate is 19200 bits per second.

Necessary Bandwidth = 2M + 2DK

M = 10 kHz
D = 4.8 kHz
K = 1.2

So necessary bandwidth = $2 \times 10 + 2 \times 4.8 \times 1.2 = 31.5$ kHz

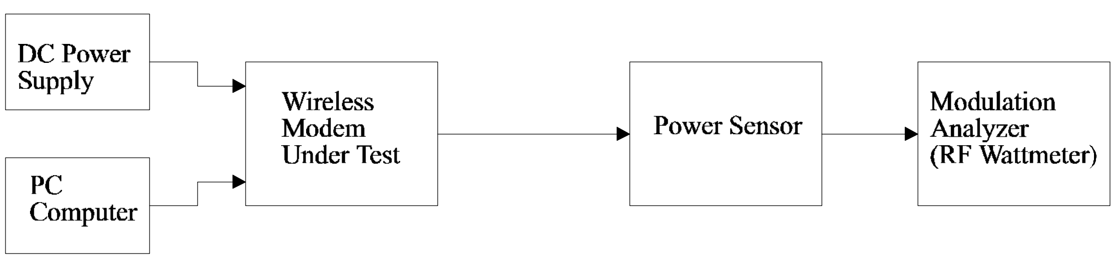
Performance Test Data

RF Output Power (2.985)

Name of Test:	RF Power Output
FCC ID:	N7NAB300A
Grantee:	Sierra Wireless
Serial No.:	206-00059265
Manufacturing Rating:	0.00631 to 4.0 Watt +8dBm to +36dBm in 4 dB steps (Controlled by Cell Base Station)
Equipment Authorization Procedure:	Para. 2.985(a)
Test Equipment:	HP8901A Modulation Analyzer HP8481H Power Sensor Astron VS20M DC power supply Zegna 486 PC Computer
Duty Cycle:	Portable (intermittent)

Block Diagram of Test Set-up

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



Final Radio Frequency Amplifying Device

PF0030	Hitachi PA Module	
	LOW POWER	**HIGH POWER**
Drain Current, (I_C) =	100 mA	1.2 A
Drain Voltage, (V_C)=	12.0 V	12.0 V
Total Transmitter Load	82 mA	1.05 A
DC Input Voltage	13.8 V	13.8 V
Power Input = (I_C)(V_C) = P_{in} =	1.13 W	14.5 W
Measured Power Output = P_{out} =	9.85 dBm	35.9 dBm
Rated Power Output	8.0 dBm	36.0 dBm

Modulation Characteristics (2.987)

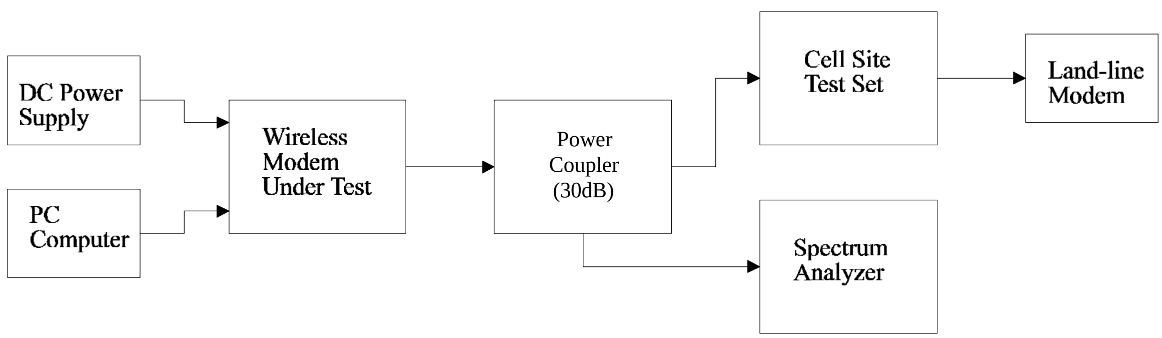
Name of Test:	Modulation Characteristics
FCC ID:	N7NAB300A
Grantee:	Sierra Wireless
Serial No.:	206-00059265
Minimum Standard Specified	Para. 22.907 (a)
Test Results	N/A
Equipment Authorization Procedure	Para 2.987 (a) and (b)
Test Equipment:	HP8921A Cell Site Test Set HP35665A Dynamic Signal Analyser Astron VS20M DC power supply Zegna 486 PC Computer

Note: These tests are not applicable as the device is only an RF amplifier. It has no baseband modulation circuitry.

Occupied Bandwidth (2.989)

Name of Test:	Occupied Bandwidth
FCC ID:	N7NAB300A
Grantee:	Sierra Wireless
Serial No.:	206-00059265
Minimum Standard Specified	Para. 22.907 (b) and (d)
Test Results	Equipment is Compliant with Standard
Equipment Authorization Procedure	Para 2.989 (c)(1)
Test Equipment:	HP8594E Spectrum Analyzer HP8921A Cell Site Test Set Astron VS20M DC Power Supply Zegna 486 PC Computer Mini-Circuits splitter, model ZA3PD-1.5 Land-line modem: shop built (unit # 1) RF attenuators, model PE7016-30, and CAT-3

Test Setup Block Diagram



Measurement Data

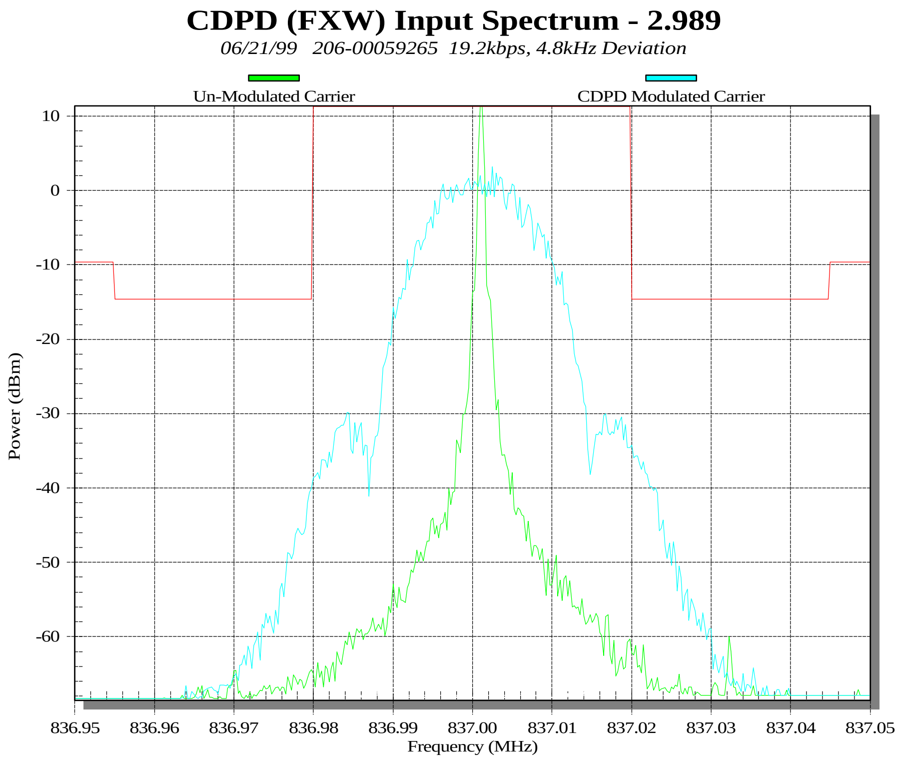
Spectrum Analyzer:	Hewlett Packard 8593E	
Settings:	Resolution Bandwidth	300 Hz
	Video Filter	300 Hz
	Scan Time	3.33 sec
	Scan Width	100 kHz
	Center Frequency	837.0 MHz

Data Or Signaling Type	**Tx Deviation**	**Emission Designator**
1) CDPD, Cellular Digital Packet Data (19.2 kbaud)	4.8 kHz	31K5FXW

CDPD Cellular Digital Packet Data (19.2kbaud)

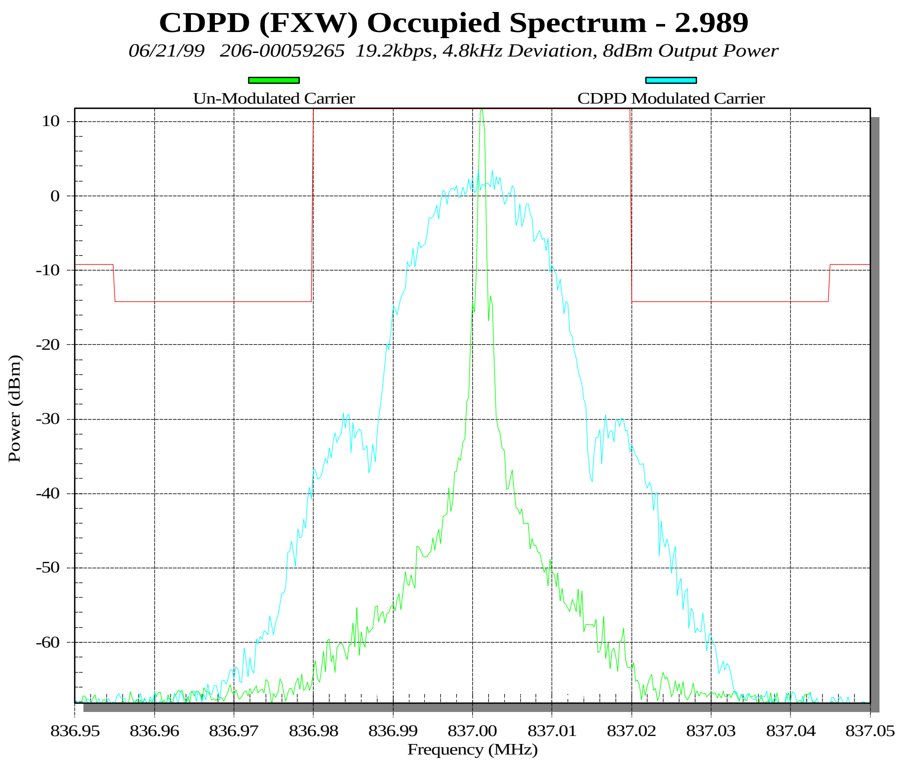
Input Spectrum

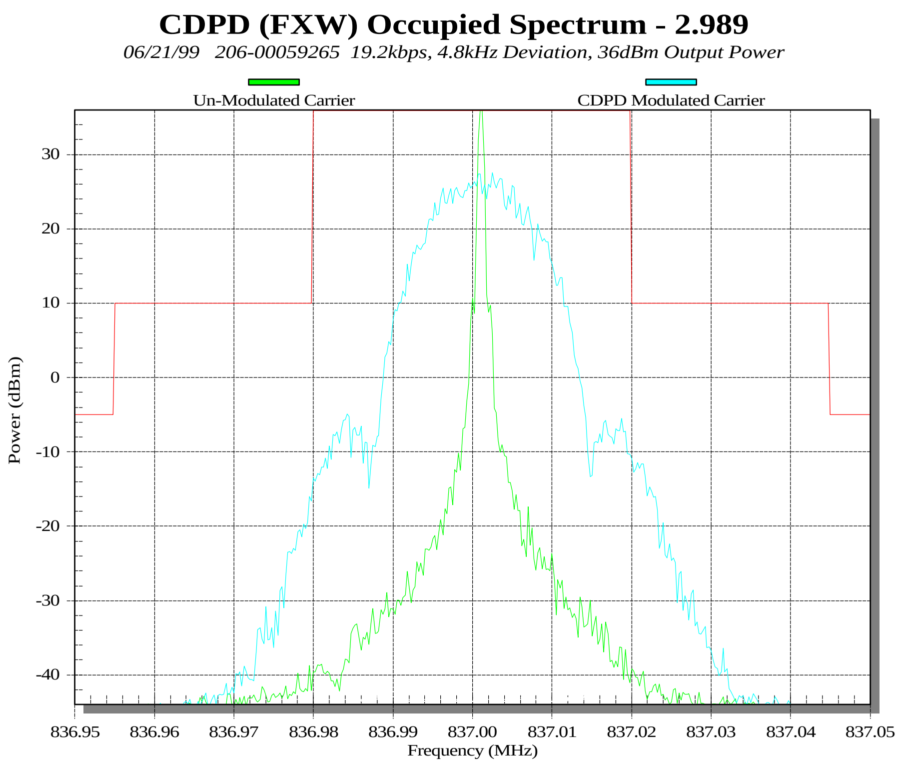
This is a plot the the spectrum input to the AB300 amplifier at a nominal 12dBm.



AB300 Output Spectrum

The following 2 plots show the resulting output spectrum at the min (8dBm) and max (36dBm) output powers.

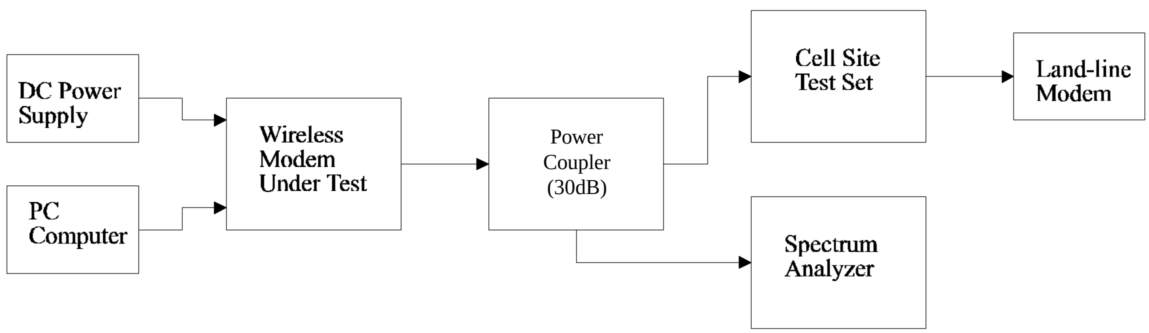




Spurious Emissions at Antenna Terminals (2.991)

Name of Test:	Spurious Emissions at Antenna Terminals
FCC ID:	N7NAB300A
Grantee:	Sierra Wireless
Serial No.:	206-00059265
Minimum Standard Specified	Para. 22.106
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	14.85 MHz TCXO
Power Output	0.00631 to 4.0 Watt (8 to 36 dBm) in 4 dB steps
Spurious Limit = 43dB + 10Log$_{10}$ (P_O) =	-21 to -49 dBm

Test Setup Block Diagram



Measurement Data

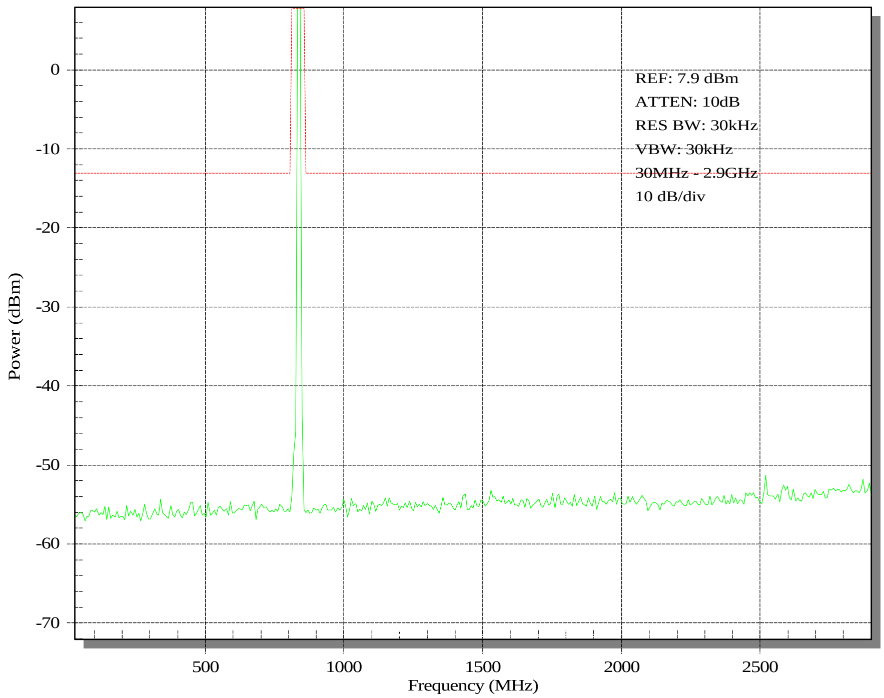
Formula	Frequency (MHz)	Level (dB below carrier)	
		Low Power	High Power
f_o	837.0	- 0 -	- 0 -
$2f_o$	1647.0	-	-64 dBc
$3f_o$	2511.0	-	-68 dBc
$4f_o$	3348.0	-	-
$7f_o$	5859.0	-	-
$8f_o$	6696.0	-	-

Note: All other emissions were greater than 20dB below the spurious limit. Plots of the spurs reported in the table can be seen on the following 2 pages.

Low Power (8dBm Nominal)

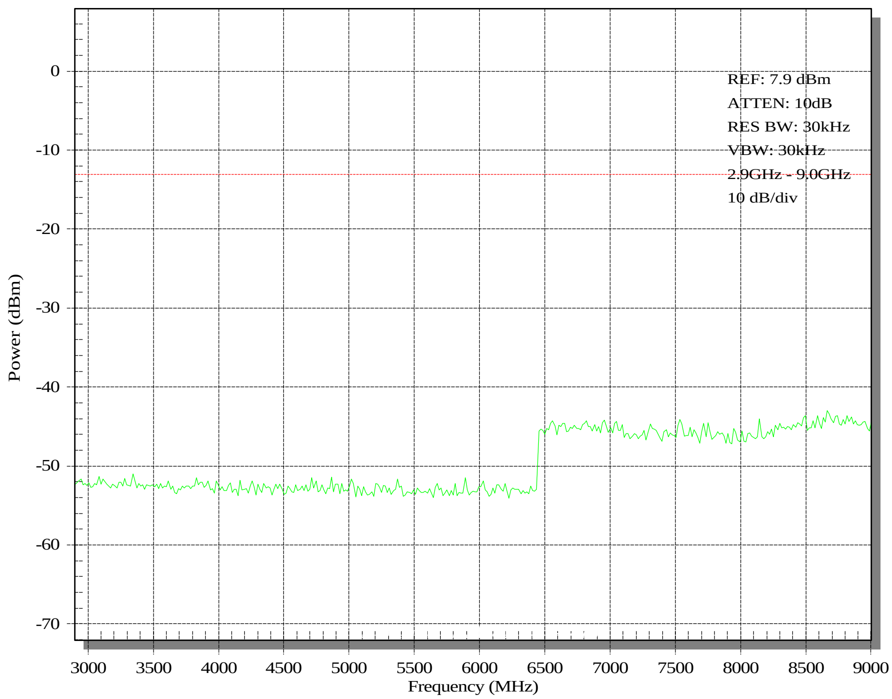
Conducted Tx Spurious Emissions - 2.991

06/21/99   206-00059265 19.2kbps, 4.8kHz Deviation, 8dBm Output Power, 25.0C

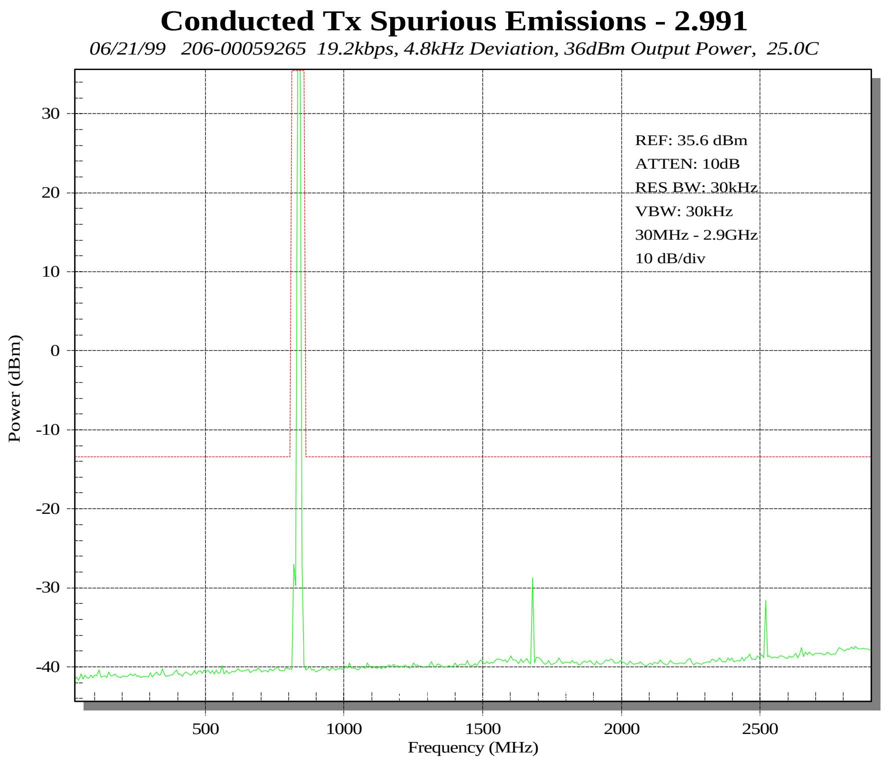


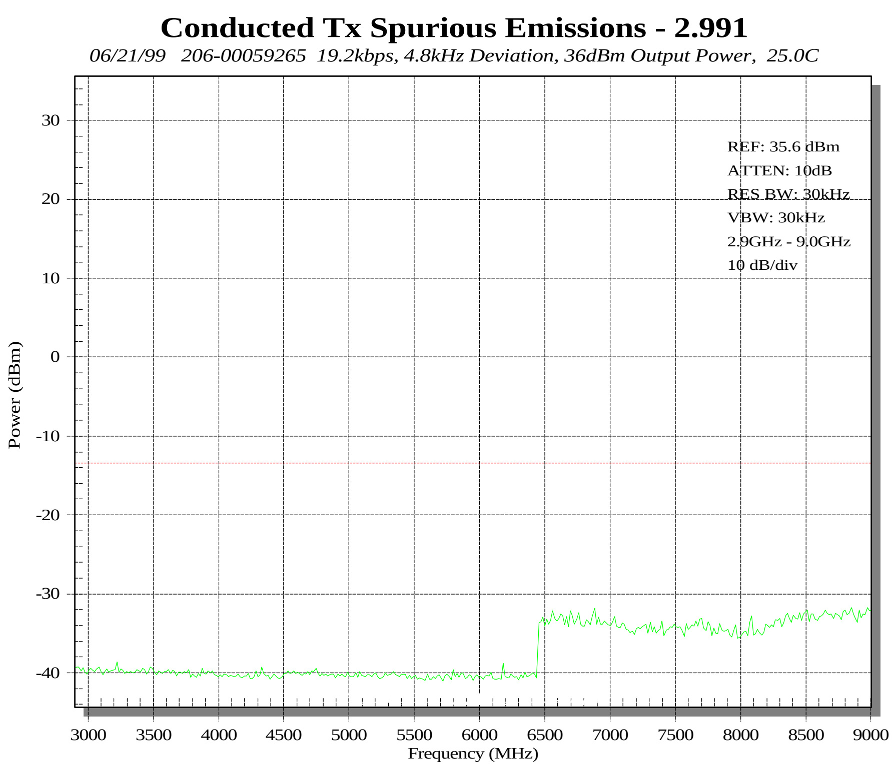
Conducted Tx Spurious Emissions - 2.991

06/21/99   206-00059265 19.2kbps, 4.8kHz Deviation, 8dBm Output Power, 25.0C



High Power (36dBm Nominal)

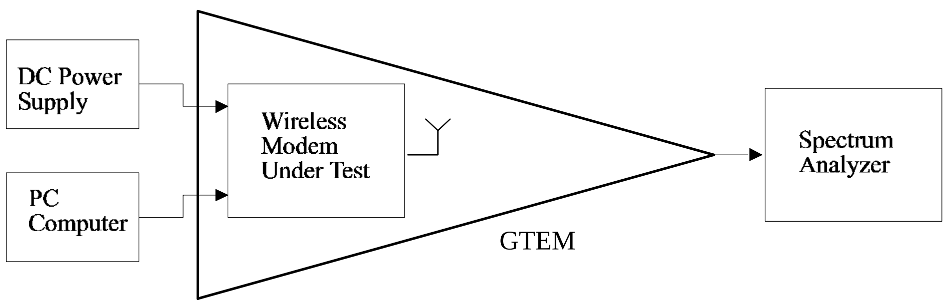




Field Intensity Measurements of Spurious Radiation (2.993)

Name of Test:	Field Intensity Measurements of Spurious Radiation
FCC ID:	N7NAB300A
Grantee:	Sierra Wireless
Serial No.:	206-00059265
Minimum Standard Specified	Para. 22.106
Test Results	Equipment is Compliant with Standard
Equipment Authorization Procedure	Para. 2.993
Frequency Range Observed	0 MHz to 9 GHz
Spurious Limit = 43dB + 10Log$_{10}$ P$_O$=	-21 to -49 dB

Test Setup Block Diagram



Measurement Data

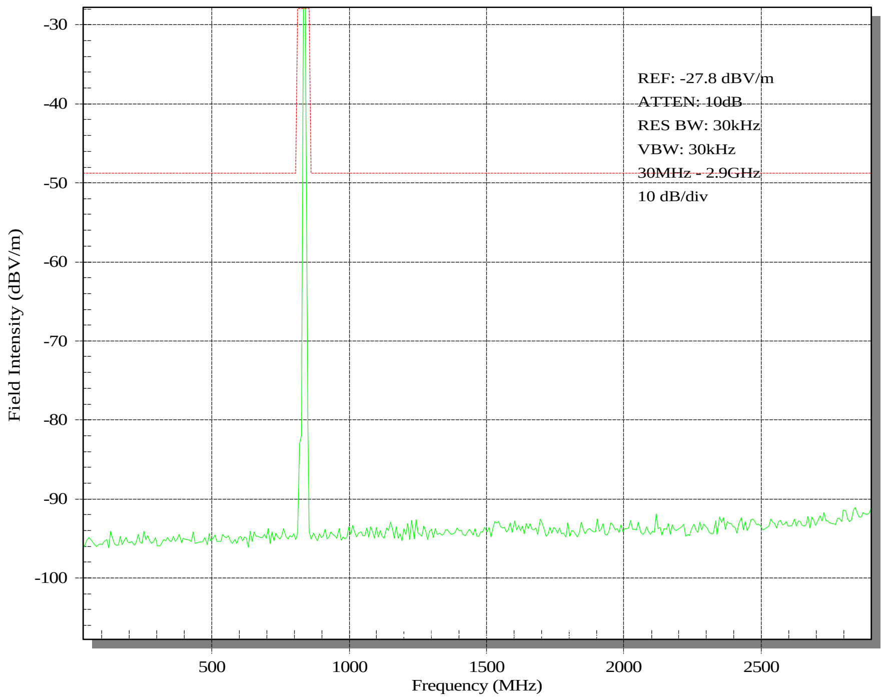
Formula	Frequency (MHz)	Level (dB below carrier)	
		Low Power	High Power
f_o	837.0	- 0 -	- 0 -
$2f_o$	1647.0	-	-59 dBc
$3f_o$	2511.0	-	-60 dBc
$4f_o$	3348.0	-	-
$7f_o$	5859.0	-	-
$8f_o$	6696.0	-	-

Note: All other emissions were greater than 20dB below the spurious limit. Plots of the spurs reported in the table can be seen on the following 2 pages.

Low Power (8dBm Nominal)

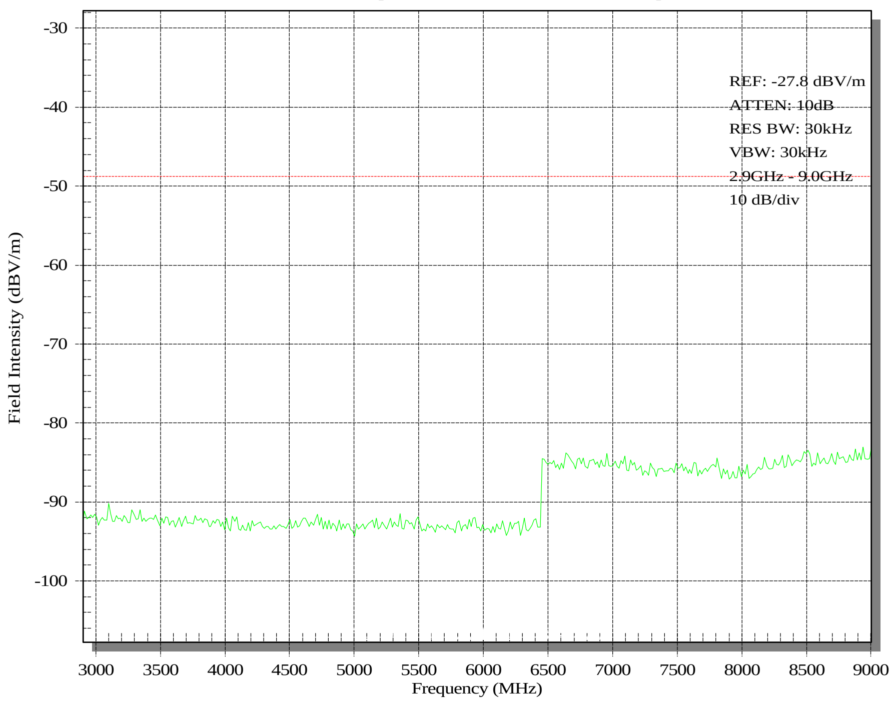
Field Intensity of Spurious Radiation - 2.993

06/22/99 206-00059265 19.2kbps, 4.8kHz Deviation, 8dBm Output Power, 25.0C



Field Intensity of Spurious Radiation - 2.993

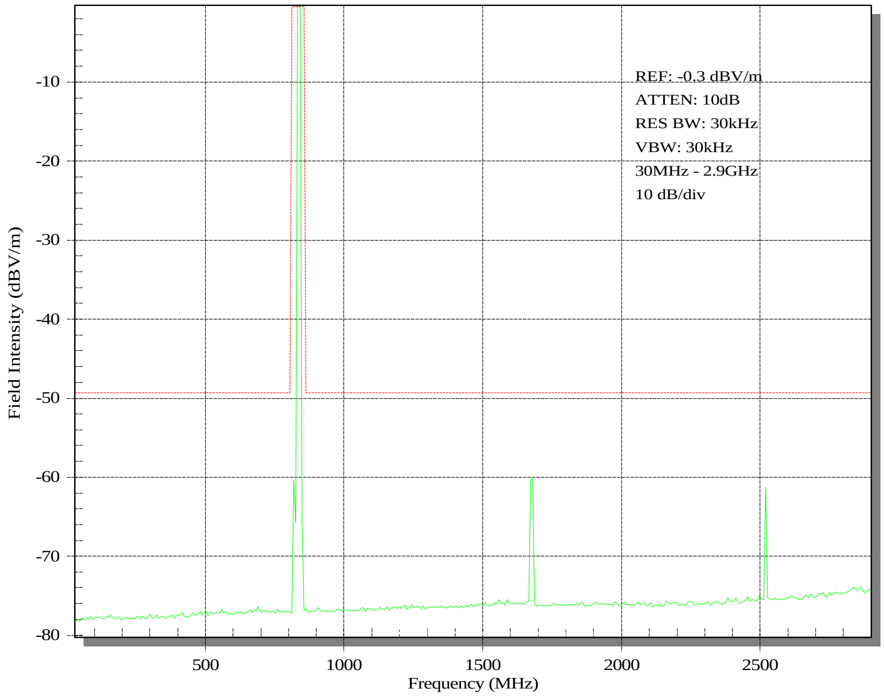
06/22/99 206-00059265 19.2kbps, 4.8kHz Deviation, 8dBm Output Power, 25.0C



High Power (36dBm Nominal)

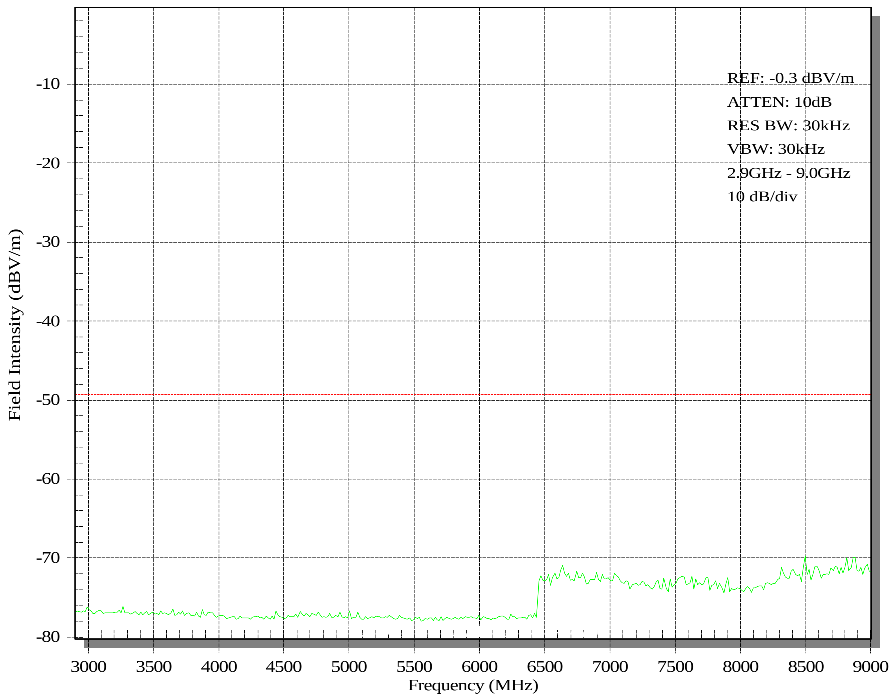
Field Intensity of Spurious Radiation - 2.993

06/22/99   206-00059265 19.2kbps, 4.8kHz Deviation, 36dBm Output Power, 25.0C



Field Intensity of Spurious Radiation - 2.993

06/22/99   206-00059265 19.2kbps, 4.8kHz Deviation, 36dBm Output Power, 25.0C



Operation Stability Performance (2.995)

Name of Test:	Operational Stability Performance
FCC ID:	N7NAB300A
Grantee:	Sierra Wireless
Serial No.:	206-00059265
Minimum Standard Specified	Para. 22.101 (a)
Equipment Authorization Procedure	Para. 2.995
Test Results	Equipment is Compliant with Standard
Test Equipment	HP8921A Cell Site Test Set Tenney Jr environmental chamber Astron VS20M DC power supply Zegna 486 PC Computer
Standard Test Frequency	837.0 MHz

Note: These tests are not applicable as the device is only an RF amplifier. No RF frequency determining circuitry is present.

Test Equipment List

Sierra Wireless, Inc.

Type	Manufacturer and Model No.	Serial no.	Accuracy
Spectrum Analyzer	Hewlett Packard HP8593E	3801A03362	
Pre-Amp	Mini-Circuits ZFL-1000LN	N020596	
Power Supply	Hewlett Packard E3632A	KR75301364	
Cellular Test Set	Hewlett Packard HP8924C	US35360321	
RF Termination	Bird 8135	10004	1.1 VSWR
Attenuators	Texscan FP45-20 Texscan FP45-10 Weinshel 40-10-33 Mini-Circuits CAT30 Pomona 4108-10	 CZ682 8419 01	 +/-1% to 1.5 GHz
Thermometer	Fluke 52	3965185	+/-(0.1% reading +/-0.7 deg C)
GTEM	EMCO 5407	9903-1305	