

**APPLICATION FOR  
TYPE ACCEPTANCE**

**Sierra Wireless Inc.**

**FCC ID: N7NOEM3**

MODEL: SB320

Prepared by:  
**Sierra Wireless Inc.**

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Dec.7, 1998

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Letter of Submittal and Compliance



Dec.7, 1998

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

Gentlemen:

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. We are unable to warrant against unpublished changes in requirements. The applicable rules are listed in the following test report.

Sincerely

A handwritten signature in black ink, appearing to read "Trent McKeen", is written over a horizontal line.

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 SB320, is a multimode cellular data modem. It offers the capability of data communications using either CDPD (Cellular Digital Packet Data) or circuit switched cellular. It also has the capability of analog voice communication over AMPS cellular.

## **Operational Modes**

### **Data Over Circuit Switched Cellular:**

The modem is capable of data transmission over the standard AMPS voice channel. For establishing a conventional AMPS cellular call, cellular control channel FSK signaling is used at 10kbps per cellular system requirements. Once the call is established, computer modem signaling is sent over the “voice” channel along with SAT. This computer signaling varies in type depending on data rate used, but is filtered so that it always fits within a 300 to 3000Hz baseband bandwidth and the deviation is factory adjusted to be less than 12kHz peak. The spectrum occupancy of transmissions in this mode are characterized by testing at the highest data rate commonly achievable on the cellular infrastructure, 16.8kbps, to generate the worst case spectrum occupancy.

### **CDPD**

In addition to the analog cellular mode, the modem also can transmit using CDPD signaling. The modulation used in this case is GMSK at a single data rate of 19.2kbps. Deviation in this mode is factory adjusted to 4.8kHz peak  $\pm 5\%$ . Test results for all of these modulation types are included in this report.

## **Expository Statement 2.983 – Modem Detailed Circuit Description**

The SB320 modem is a wireless modem, which operates on both the AMPS and CDPD networks. The product operates as a stand alone modem which may connect to host device (such as a personal computer) through an available serial port.

The SB320 modem consists of 2 different subcircuits which are packaged together in a PCMCIA Type III housing. These circuits are

1. Modem Logic
2. Radio

Each subcircuit is discussed separately in the subsequent sections.

## **Description of Terminology**

|        |                                                     |
|--------|-----------------------------------------------------|
| CDPD   | Cellular Digital Packet Data                        |
| DSP    | Digital Signal Processor                            |
| EEPROM | Electrically Erasable Programmable Read Only Memory |
| MCU    | Micro Controller Unit                               |

## **SB320 Logic Detail Circuit Description**

The logic board can be divided into various subsystems: MCU, Memory, DSP, Radio Interface, Data Access Arrangement, Codec, and AMPS Data Processor. Figure 2-1 shows a block diagram of the whole system.

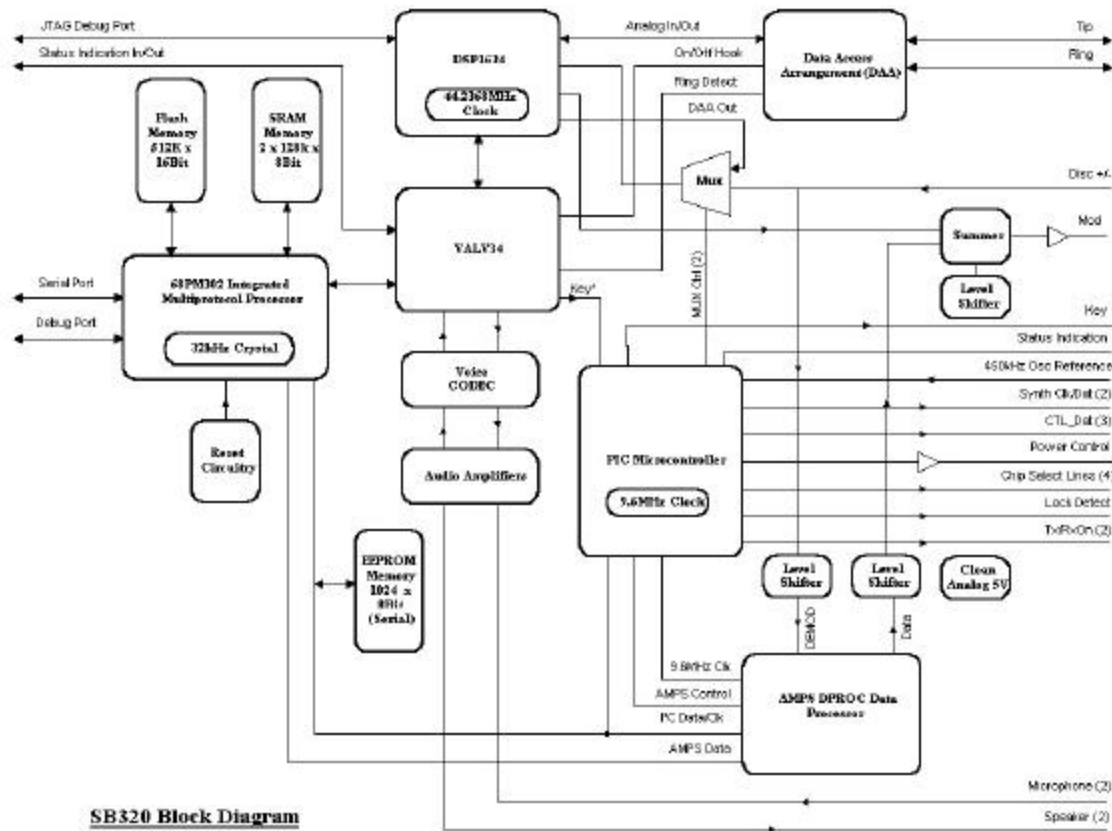


Figure 2-1: Logic Board Block Diagram

## MCU

The MCU subsystem is responsible for communicating with the host and running application and diagnostic software. It talks to the DSP through the VALV34 interface. The processor used is a MC68PM302 Integrated Multiprotocol MCU.

The MC68PM302 has an MC68000 core with two independent serial communication controllers (SCC) and various general parallel port pins. The first serial port is used as a debug port and the second is used for the host interface. The CPU has a 16-bit bus to access 16 bit flash memory and the 2 x 8 bit SRAM. The CPU has 20 address lines and 4 chip select lines that allow it to address up to 4 Mbytes. Address line A0 is used as WEH (Write Enable High) in 16 bit wide data bus mode.

The system clock is derived from a phase locked loop (PLL) circuit built into the MCU. The PLL utilizes a 32.768kHz external crystal. The PLL multiplies this frequency by a multiplication factor (MF) to obtain the system clock.

The MCU also monitors 4 status lines from the external connector monitored by software.

## **Memory**

The MCU accesses three types of memory: SRAM, FLASH, and EEPROM. The RAM and the FLASH memory are connected directly to the MCU bus while the EEPROM is connected to an I<sup>2</sup>C interface.

The SRAM is used to store program data variables. It consists of two 128k x 8-bit devices connected for high and low addressing to create a 16 bit address bus. The devices are addressed with !WEH and !WEL for high and low addresses respectively.

The FLASH memory allows for field reprogramming (upgrade) of system software. It is used to store the program code and constants. It is made up of one 512k x 16-bit device.

The EEPROM is used as non-volatile storage. The MCU communicates through two wires that make up the I<sup>2</sup>C interface. There are other devices on the I<sup>2</sup>C interface and each is identified with a unique address. Its size is 1024 x 8-bit.

## **DSP and VALV Chipset**

The DSP subsystem is responsible for performing all of the DSP functions. It consists of an AT&T DSP1634 DSP and a VALV34 interface device.

The DSP1634 has a DSP16A core with built in address decoding, wait states generator, baseband codec and JTAG port. The built in address decoding and wait states generator within the DSP 1634 simplifies memory interfacing.

The VALV34 is responsible for providing an interface between the MCU and the DSP. Internally, the VALV34 contains 8 mailboxes which is the primary means of communication between the MCU and DSP. It also provides serial ports and general purpose I/O for the radio interface.

The VALV also provides 2 status lines, one of which is available to the external connector, the other drives the on-board LED. The status lines are under the control of software.

## **Radio Interface**

The radio interface subsystem provides the hardware and software interface to the radio. A Microchip PIC microcontroller is the primary device used in this subsystem.

The PIC is programmed to perform housekeeping functions (such as monitor the KEY request line from the DSP and monitor the I<sup>2</sup>C interface lines) in the usual running mode but can also be controlled by the MCU via the I<sup>2</sup>C interface for other functions.

The clock source for the PIC is a 9.6MHz crystal which also supplies the clock for the AMPS data processor (DPROC) subsystem.

The PIC is one-time-programmable and is usually programmed before insertion into the board. Provision has been made however for in-circuit programming if desired.

Functions performed by the PIC/Radio Interface subsystem:

- Monitor the KEY request from the DSP, decide if appropriate, if so – Key the radio
- Control TXON (Transmitter subsystem) and RXON (Receiver subsystem) on the radio
- Interrogate the A/D converter on the radio and obtain RSSI and temperature readings
- Control the radio synthesizer
- Provide an adjustable power source for the transmitter which is also switchable through a RAMP control line.
- Detect if the radio is locked onto the desired frequency
- Control of a status line to reflect the status of the KEY line

### **Data Access Arrangement**

The Data Access Arrangement (DAA) subsystem is the wireline interface (conventional connection to the telephone line Tip and Ring). The DAA employed in this design is transformer based.

Analog data is sent and received through direct connection to the DSP. There is a control line called !OH\_VALV and is used to send the DAA on and off hook. There is a monitor line called !RING\_DET that signals that the line is ringing. The !RING\_DET line will monitor the ring status whether the modem is on or off hook.

!OH\_VALV is controlled by the VALV34 and the !RING\_DET can be monitored by either the VALV34 or the MCU (for wake up purposes).

### **Voice Codec**

The codec subsystem provides audio communication to/from the modem. The codec device is a Lucent T7527 High-Precision PCM Codec.

Communication is made through the VALV34/DSP chipset. A control line (SW\_VCODEC) is used to power down the device controlled by the VALV34.

The audio interface available on the 13pin ITT-Cannon connector consists of a differential microphone input and a differential microphone output.

Additional circuitry has been added for debug purposes to allow audible indication of AMPS signalling. This is achieved by a control line (SPKR\_CTL) switchable through the VALV34 which will feed either the DAA or DISC+ analog data to the speaker output.

The microphone input is a capacitively connected differential input with an input impedance greater than 10kohm. Microphone signals should be 90 mVp-p nominal. Software volume control is available. If a single-ended drive is desired, the MIC- input may be connected to ground.

The Speaker output is a differential signal. This signal is used to interface to a speaker amplifier. Output signal is (AC-coupled) 2Vp-p nominal into a 150 ohm load.

Voice functionality is not a supported feature at this time.

### **AMPS Data Processor (DPROC)**

The AMPS data processor utilizes a UMA1002 Data processor for cellular radio (DPROC2) device. This device handles the front end data transceiving, data processing, and SAT functions for an AMPS circuit switched call. The 9.6MHz clock is supplied from the radio interface (PIC) clock. Control is achieved by the I<sup>2</sup>C interface under the control of the MCU. Additional control and status lines are also fed into the MCU.

Power for this device is supplied from the RXON (Radio receiver subsystem) line which is controlled by the radio interface (PIC). This means that the device will only be operational when the radio receiver is switched on. RESET/MUTE/TXCTRL control lines are also controlled by the radio interface (PIC).

The radio signal into the DPROC is derived from the DISC+ line which is DC coupled and then level shifted by a potential divider. The radio signal out of the DPROC is level shifted through the I<sup>2</sup>C control of a digital potentiometer and then summed with the DSP output. This resulting signal is further level shifted through a separate channel on the digital potentiometer and the result creates the MO

### **Electrical Specifications**

| <b>Parameter</b>            | <b>Specification</b>                     |
|-----------------------------|------------------------------------------|
| Power Supply                | +5 $\pm$ 5% VDC                          |
| Current Drain (Logic only)  | maximum noise DC to 100KHz 10mVpp        |
|                             | Wireline Inactive – 20mA                 |
|                             | Wireline Data/Fax Active – 220mA         |
|                             | Wireline Voice Active – 250mA            |
|                             | CSC Monitor – 60mA                       |
|                             | CSC Data/Fax Active – Full Power – 250mA |
|                             | CSC Voice Active – 250mA                 |
|                             | CDPD Sleep – 20mA                        |
| Operating Temperature Range | -30 to +60°C                             |
|                             | -40 to +85°C                             |
| Storage Temperature Range   | -40 to +85°C                             |
| Input High Voltage          | 2.5 V Min                                |
| Input Low Voltage           | 0.8 V Max                                |
| Output High Voltage         | 4.0 V Min                                |
| Output Low Voltage          | 0.5 V Max                                |
| MCU Frequency               | Min: DC Max: 22.1184 MHz                 |
| SRAM Speed                  | 70 ns                                    |
| FLASH Speed                 | 90 ns                                    |



## **SB320 Radio General Description**

The TAZ! radio architecture is a cost reduced, bear bones refinement of the AirCard (aka Tomcat) radio architecture (FCC ID LL9ACRD1). This new radio platform shares the same frequency plan and virtually the same level budget as AirCard.

Key features of this narrow band FM transceiver include:

- capable of full duplex operation in the North American 800MHz cellular band (forward 869 – 894MHz; reverse 824 – 849MHz),
- supports CDPD GMSK, V.34 AMPS, voice and wideband control data modulation and demodulation,
- 30kHz channel spacing with mixture of synthesized and crystal based frequency generation,
- 600mW transmit power with six programmable power output steps (28dBm, 24dBm, 20dBm, 16dBm, 12dBm, 8dBm),

We learned a great deal about making PCMCIA cellular radios during the AirCard development and were able to use this knowledge for another kick at the development can. The principal intent behind this design was to lower material and assembly cost and improve defect rates for high volume production. To achieve the lowest possible parts cost, we eliminated all custom components and selected only high volume stable parts that were well down on their cost curves. We also placed a restriction on the power supply requirements that eliminated four voltage regulators from the original AirCard DataPhone design.

So with this basic introduction, here we go. The following sections provide sufficient detail to understand this simple radio's architecture and operation.

## SB320 Radio Electrical Specifications

The TAZ! radio meets or exceeds all specification requirements of CDPD 1.1, RSS-128, and FCC Parts 15 & 22.

Table 1. Transceiver Specifications at standard temperature and pressure.

|                                                         |                                                                                                 |
|---------------------------------------------------------|-------------------------------------------------------------------------------------------------|
| Supply Requirements                                     | 5V $\pm$ 5%<br>10mVpp ripple DC to 100kHz                                                       |
| Current Consumption                                     | Sleep: 1mA<br>Receive: 45mA<br>Transmit: 700mA                                                  |
| Transmit Frequency                                      | 824 to 849MHz                                                                                   |
| Receive Frequency                                       | 869 to 894MHz                                                                                   |
| Channel Spacing & Number of Channels                    | 30kHz, 833 channels                                                                             |
| Modes                                                   | Sleep, Receive (Standby), Full duplex transmit                                                  |
| Modulation                                              | Direct FM, $\pm$ 14kHz maximum                                                                  |
| Modulation Frequency Response                           | Flat 10Hz to 10kHz ( $\pm$ 1dB)                                                                 |
| Performance Bandwidth                                   | 25MHz                                                                                           |
| Temperature Compensated Reference Frequency & Stability | 14.85MHz $\pm$ 2.5ppm                                                                           |
| Local Oscillator Frequency                              | 926MHz $\pm$ 12.5MHz                                                                            |
| TX Output Power (Conducted)                             | 28dBm to 8dBm in six programmable steps of 4dB                                                  |
| TX Spurious Outputs                                     | Per FCC Part 22                                                                                 |
| TX ramp up/down                                         | Per CDPD 1.1                                                                                    |
| TX Modulated LO                                         | 30MHz crystal oscillator, tripled to yield 90MHz                                                |
| RX Sensitivity (Conducted)                              | -108dBm (CDPD 5% BLER)<br>-116dBm (AMPS 12dB SINAD C-Message weighted, 750 $\mu$ s de-emphasis) |
| Receiver Intermediate Frequencies                       | 1 <sup>ST</sup> IF 45MHz<br>2 <sup>ND</sup> IF 450kHz                                           |
| Demodulation Frequency Response                         | Flat 10Hz to 10kHz ( $\pm$ 1dB)                                                                 |
| RX Adjacent Channel Selectivity                         | 16dB at $\pm$ 30kHz<br>60dB at $\pm$ 60kHz                                                      |
| RX Intermodulation Response                             | 57dB (per CDPD 1.1)                                                                             |
| Rejection                                               | 65dB (per EIA 19-B)                                                                             |
| RX Scan Time                                            | 60ms max band edge to band edge                                                                 |
| RX Spurious Emissions                                   | Per FCC Part 22                                                                                 |
| RX Unintended Emissions                                 | Per FCC Part 15                                                                                 |

## SB320 Radio Block Diagram

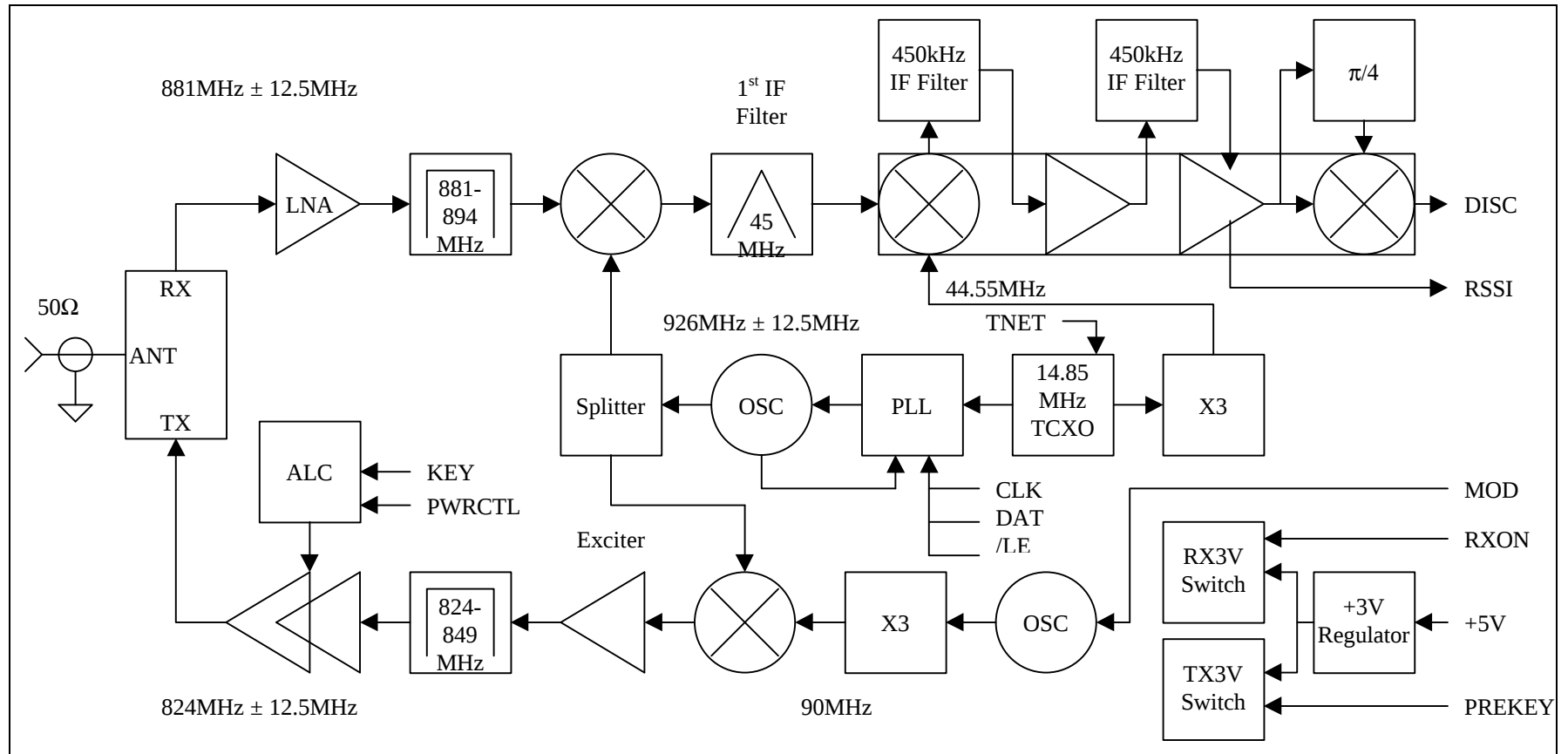


Figure 1. TAZ! Transceiver Block Diagram.

## **Power Supply**

Consists of a single 3V linear regulator (TOKO TK11230BM) and two current switches (Zetex FMMT717 and Motorola MMBT3906LT1).

With an active high control signal from the logic (RXON) the regulator applies RX3V to the receiver, FGU, ADC, and DAC.

With an active low control signal from the logic (/PREKEY) TX3V is applied to the transmit modulator, upconverter, negative voltage generator, and PA automatic level control circuits.

## **Programming Interface**

This is a dumb radio – there is no onboard microcontroller or memory. The radio is programmed for a desired channel through a three line SPI (Serial Peripheral Interface) port to the PLL (Phase Locked Loop).

Transmit power output is selected by a calibrated DC voltage applied to the PWRCTL line.

The RAMP signal prevents excess transient signal splatter during transmit state change. This feature is not required by any North American specification but is designed by Sierra Wireless to protect the congested electromagnetic spectrum.

Transceiver temperature and RSSI (Receiver Signal Strength Indicator) are measured by the ADC (Analog to Digital Converter; Burr-Brown ADS7841). This is also a three wire SPI programmable device.

The receiver discriminator quadrature circuit (QTUNE) and PLL reference oscillator (TNET) are both tuned by the DAC (Digital to Analog Converter, Micro Linear ML2330). This is also a three wire SPI programmable device

## **Frequency Generation Unit**

Consists of a PLL (Phase Locked Loop, National LM1511 + Fujitsu Towa VC-3R0A20-0926-B VCO + Motorola Components KXN1398A TCXO) which generates the Receive and Transmit Local Oscillator signals (RXLO & TXLO) and a tripler circuit which generates the Receive 2<sup>ND</sup> LO from the reference oscillator (TCXO).

The PLL produces an LO at 926MHz  $\pm$  12.5MHz. This signal is fed directly to the first down converter to produce a 45MHz 1<sup>ST</sup> IF (Intermediate Frequency). The LO is also fed to the TX mixer which when mixed with the 90MHz modulator output produces the reverse channel signal (836MHz  $\pm$  12.5MHz).

The desired channel is selected by programming the PLL with the correct reference and main loop integer dividers. This one loop produces channel select signals for both receive and transmit paths simultaneously.

To simplify the architecture, we eliminated a 2<sup>ND</sup> LO synthesizer and generated this signal by tripling the 14.85MHz TCXO to produce 44.55MHz.

**Receiver**

Consists of half the duplex filter (Taiyo Yuden CFU7BA08360881 or equivalent), an LNA/MIXER GaAs front end (TriQuint TQ9223C), image filter (Murata SAFC881N5MA70N), 1<sup>st</sup> IF 45MHz crystal filter (Motorola KFN6121), and backend IF strip (Philips SA676DK).

Outputs from the receiver include: DISC+ & DISC-; and RSSI.

**Transmitter**

The desired reverse channel signal is produced by mixing the TXLO with a tripled output of a 30MHz crystal modulator. The crystal is modulated by the MOD signal. By its very nature a crystal has flat audio modulation response from near DC to well above 10kHz. Careful selection of this crystal was necessary to ensure both wide pullability and tight temperature stability.

The modulated sub-carrier is converted to the desired reverse channel through the upmixer (NEC UPC8106TB). The PA consists of an exciter (NEC UPC2710), noise limiter (Murata SAFC836N5MA70N), power amplifier (ITT GaAsTEK ITT3102BD), and the other half of the duplex filter.

## User Manual Pages With FCC Disclaimers

### Important Notice

Because of the nature of wireless communications, transmission and reception of data can never be guaranteed. Data may be delayed, corrupted (i.e., have errors) or be totally lost. Although significant delays or losses of data are rare when wireless devices such as the Sierra Wireless modem are used in a normal manner with a well-constructed network, the Sierra Wireless modem should not be used in situations where failure to transmit or receive data could result in damage of any kind to the user or any other party, including but not limited to personal injury, death, or loss of property. Sierra Wireless, Inc., accepts no responsibility for damages of any kind resulting from delays or errors in data transmitted or received using the Sierra Wireless modem, or for failure of the Sierra Wireless modem to transmit or receive such data.

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### Patents

"Portions of this product are covered by some or all of the following US patents: D367062; D372248; D372701; 5515013; 5617106; 5629960; other patents pending"

### Regulatory Information

The equipment certifications appropriate to your device are marked on the device and the accompanying product specific information. Where appropriate, the use of the equipment is subject to the following conditions:

#### Caution

Unauthorized modifications or changes not expressly approved by Sierra Wireless, Inc. could void compliance with regulatory rules, and thereby your authority to use this equipment.

#### Warning (EMI) - United States

This equipment has been tested and found to comply with the limits pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in an appropriate installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communication. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

#### Warning (EMI) - Canada

This digital apparatus does not exceed the limits for radio noise emissions from digital apparatus set out in the radio interference regulations of the Canadian Department of Communications.

"Cet appareil numérique respecte les limites de bruits radioélectriques applicables aux appareils numériques de Classe B prescrites dans la norme sur le matériel brouilleur: 'Appareils Numériques', NHB-003 édictée par le ministre des Communications."

#### RSA Licensee



If you have purchased this product under a United States Government contract, it shall be subject to restrictions as set forth in subparagraph (c)(1)(ii) of Defense Federal Acquisitions Regulations (DFARs) Section 252.227-7013 for Department of Defense contracts and as set forth in Federal Acquisitions Regulations (FARs) Section 52.227-19 for civilian agency contracts or any successor regulations. If further government regulations apply, it is your responsibility to ensure compliance with such regulations.

### **Safety and Hazards**

Do not operate the Sierra Wireless modem in areas where blasting is in progress, where explosive atmospheres may be present, near medical equipment, near life support equipment, or any equipment which may be susceptible to any form of radio interference. In such areas, the Sierra Wireless modem **MUST BE TURNED OFF**. The Sierra Wireless modem can transmit signals, which could interfere with this equipment.

Do not operate the Sierra Wireless modem in any aircraft, whether the aircraft is on the ground or in flight. In aircraft, the Sierra Wireless modem **MUST BE TURNED OFF**. The reason for this is that when operating in the CDPD or cellular circuit switched mode, the Sierra Wireless modem can transmit signals that could interfere with various onboard equipment systems.

The driver or operator of any vehicle should not operate the Sierra Wireless modem while in control of a vehicle. Doing so will detract from the driver or operator's control and operation of that vehicle. In some states and provinces, operating such communications devices while in control of a vehicle is an offence.

## Calculation of Necessary Bandwidth for FCC ID: N7NOEM3

### For CDPD 19.2Kbps Transmission (emission type FXW)

The data rate is 19200 bits per second.

Necessary Bandwidth =  $2M + 2DK$

$M = 10 \text{ kHz}$

$D = 4.8 \text{ kHz}$

$K = 1.2$

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

### For AMPS Wideband Data Mode (emission type F1D)

The data rate is 10,000 bits per second.

Necessary Bandwidth =  $2M + 2DK$

$M = 10.4 \text{ kHz}$

$D = 8.0 \text{ kHz}$

$K = 1.2$

So necessary bandwidth =  $2 \times 10.4 + 2 \times 8 \times 1.2 = 40 \text{ kHz}$

### For AMPS Voice Channel Transmission for Modem Signaling (emission type F9W)

The data rate is 14,400 bits per second. This is the highest data rate achievable in this mode of operation.

Necessary Bandwidth =  $2M + 2DK$

$M = 6.0 \text{ kHz}$  (includes 300Hz to 3000Hz information bandwidth + SAT tone at 6kHz)

$D = 14.0 \text{ kHz}$  (12kHz for voice band information + 2kHz for SAT)

$K = 1$  (per 2.202(g) III 2)

So necessary bandwidth =  $2 \times 6 + 2 \times 14 \times 1 = 40 \text{ kHz}$

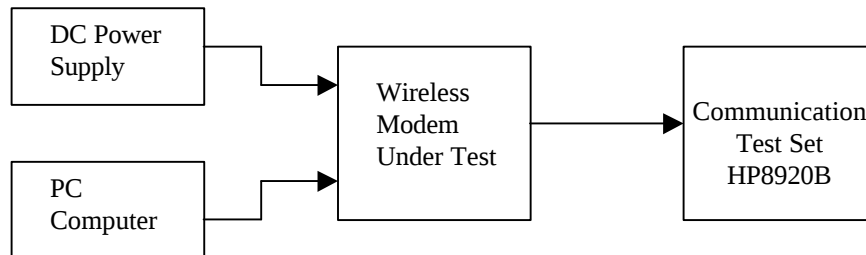
## Performance Test Data

### RF Output Power (2.985)

|                                           |                                                                                             |
|-------------------------------------------|---------------------------------------------------------------------------------------------|
| <b>Name of Test:</b>                      | RF Power Output                                                                             |
| <b>FCC ID:</b>                            | N7NOEM3                                                                                     |
| <b>Grantee:</b>                           | Sierra Wireless                                                                             |
| <b>Serial No.:</b>                        | 20600052674                                                                                 |
| <b>Manufacturing Rating:</b>              | 0.00631 to 0.631 Watt<br>+8dBm to +28dBm in 4 dB steps<br>(Controlled by Cell Base Station) |
| <b>Equipment Authorization Procedure:</b> | Para. 2.985(a)                                                                              |
| <b>Test Equipment:</b>                    | HP8920B Communications Test Set<br>HP3631A DC power supply<br>Zegna 486 PC Computer         |
| <b>Duty Cycle:</b>                        | 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

ITT333102BD

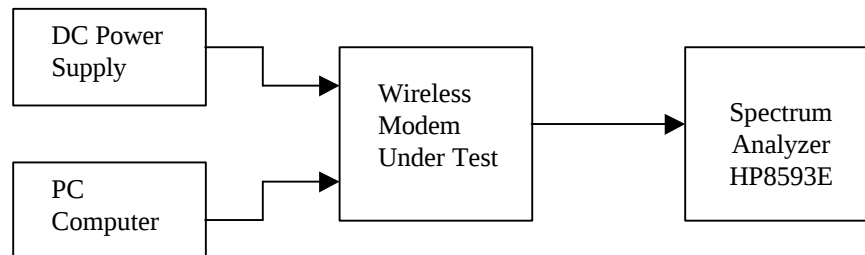
ITT PA Module

|                                                                        | LOW POWER | HIGH POWER |
|------------------------------------------------------------------------|-----------|------------|
| <b>Drain Current, (I<sub>C</sub>) =</b>                                | 85 mA     | 445 mA     |
| <b>Drain Voltage, (V<sub>C</sub>)=</b>                                 | 4.8 V     | 4.8 V      |
| <b>Total Transmitter Load</b>                                          | 105 mA    | 465 mA     |
| <b>DC Input Voltage</b>                                                | 5.0 V     | 5.0 V      |
| <b>Power Input = (I<sub>C</sub>)(V<sub>C</sub>) = P<sub>in</sub> =</b> | 0.408 W   | 2.14 W     |
| <b>Measured Power Output = P<sub>out</sub> =</b>                       | 7.95 dBm  | 27.3 dBm   |
| <b>Rated Power Output</b>                                              | 8.0 dBm   | 28.0 dBm   |

## Occupied Bandwidth (2.989)

|                                          |                                                                               |
|------------------------------------------|-------------------------------------------------------------------------------|
| <b>Name of Test:</b>                     | Occupied Bandwidth                                                            |
| <b>FCC ID:</b>                           | N7NOEM3                                                                       |
| <b>Grantee:</b>                          | Sierra Wireless                                                               |
| <b>Serial No.:</b>                       | 20600052674                                                                   |
| <b>Minimum Standard Specified</b>        | Para. 22.907 (b) and (d)                                                      |
| <b>Test Results</b>                      | Equipment is Compliant with Standard                                          |
| <b>Equipment Authorization Procedure</b> | Para 2.989 (c)(1)                                                             |
| <b>Test Equipment:</b>                   | HP8593E Spectrum Analyzer<br>HP3631A DC power supply<br>Zegna 486 PC Computer |

### Test Setup Block Diagram



### Measurement Data

**Spectrum Analyzer:**  
**Settings:**

Hewlett Packard 8593E  
Resolution Bandwidth 300 Hz  
Video Filter 300 Hz  
Scan Time 3.33 sec  
Scan Width 100 kHz  
Center Frequency 837.00 MHz

#### **Data Or Signaling Type**

- 1) CDPD, Cellular Digital Packet Data (19.2 baud)
- 2) SAT, Supervisory Audio tone (6 kHz Tone)
- 3) ST, (10 kHz Tone)
- 4) Control Channel Wide Band Data
- 5) Voice Channel/Modem Signaling (14.4 baud)

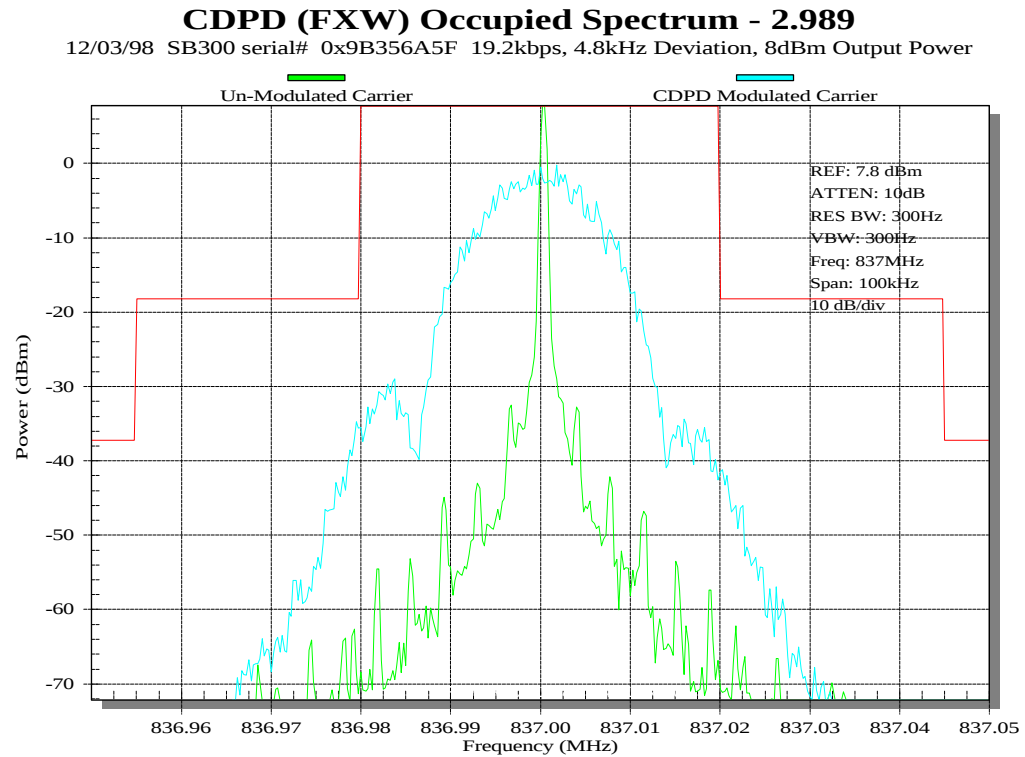
#### **Tx Deviation**

4.8 kHz  
2.0 kHz  
8.0 kHz  
8.0 kHz  
14.0 kHz

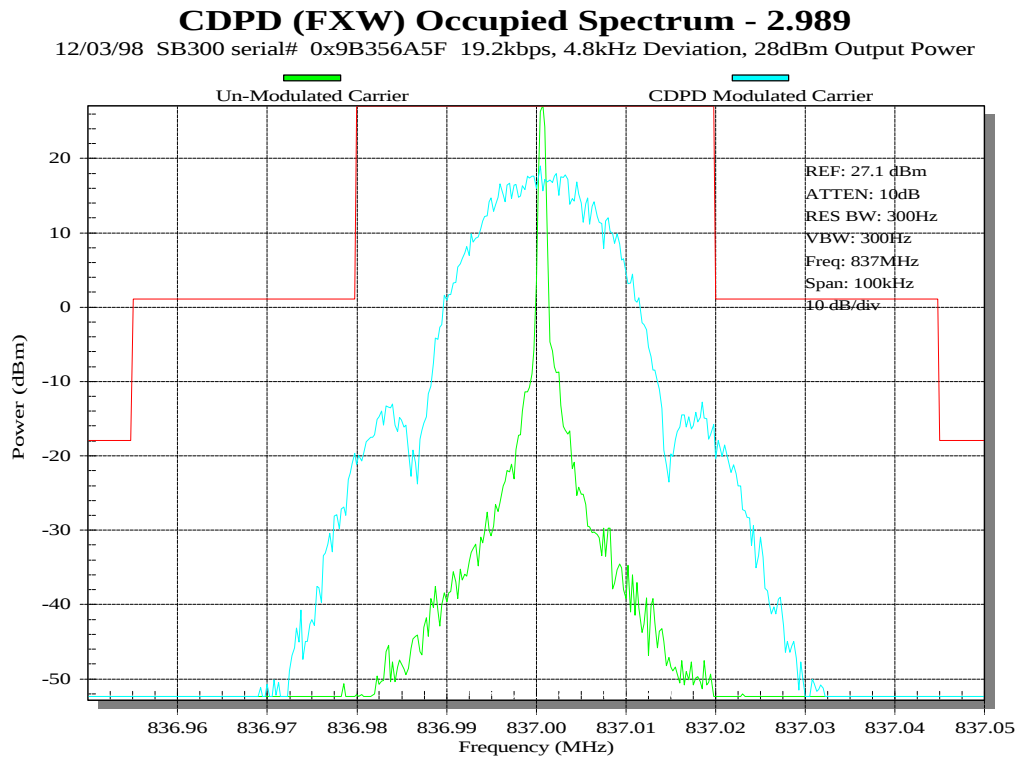
#### **Emission Designator**

31K5FXW  
40K0F9W  
40K0F9W  
40K0F1D  
40K0F9W

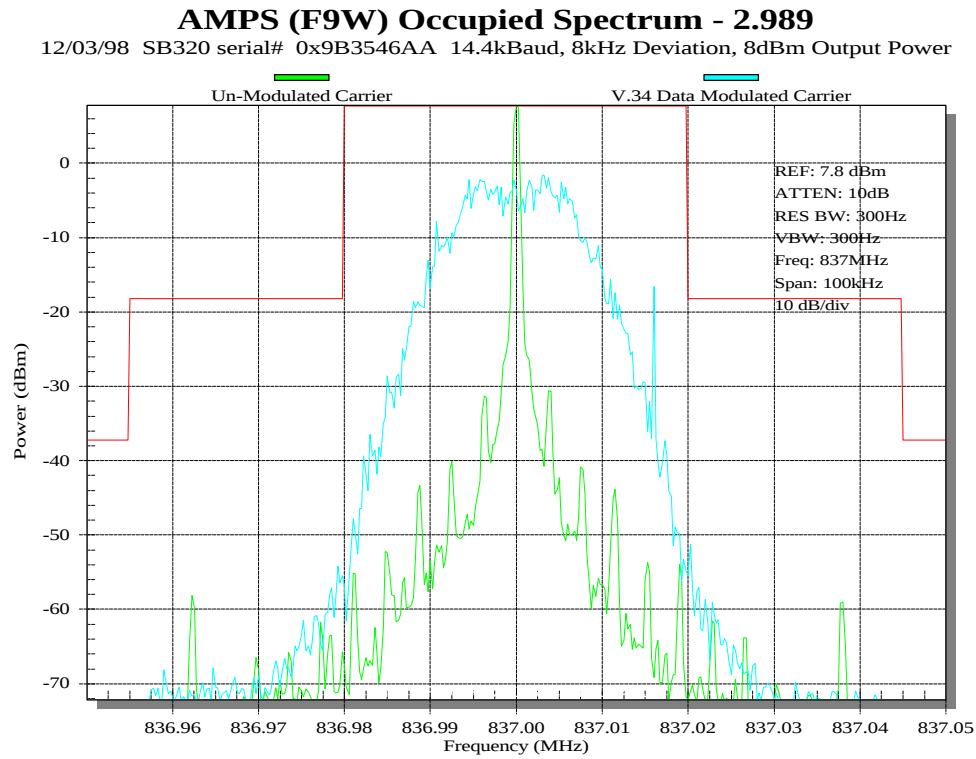
## CDPD - Low Power



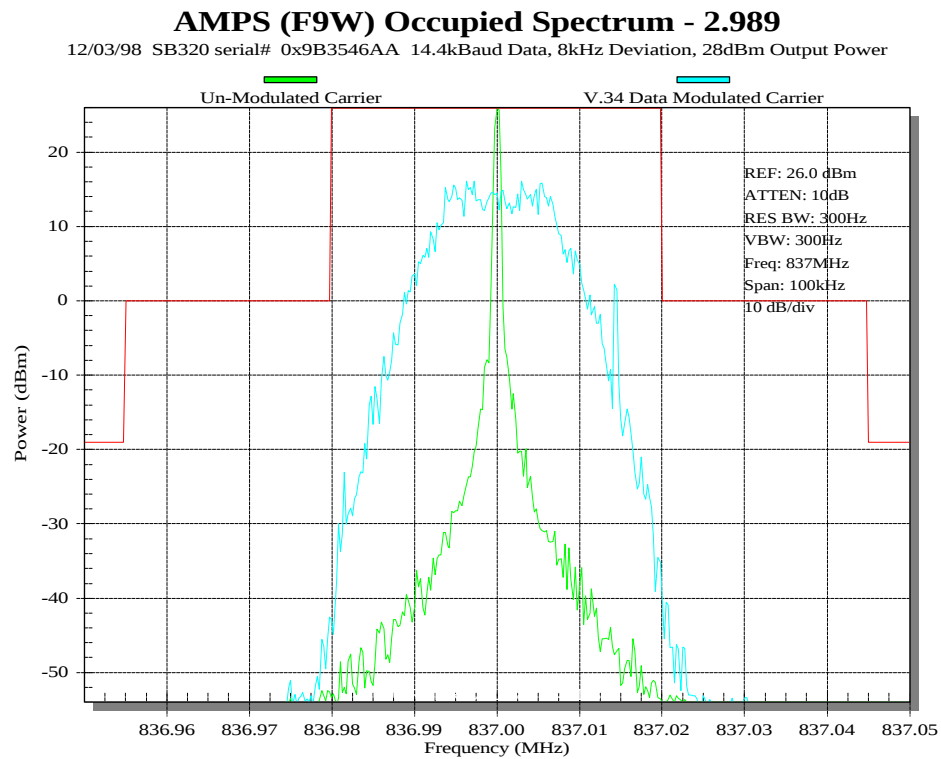
## CDPD - High Power



## AMPS Voice - Low Power

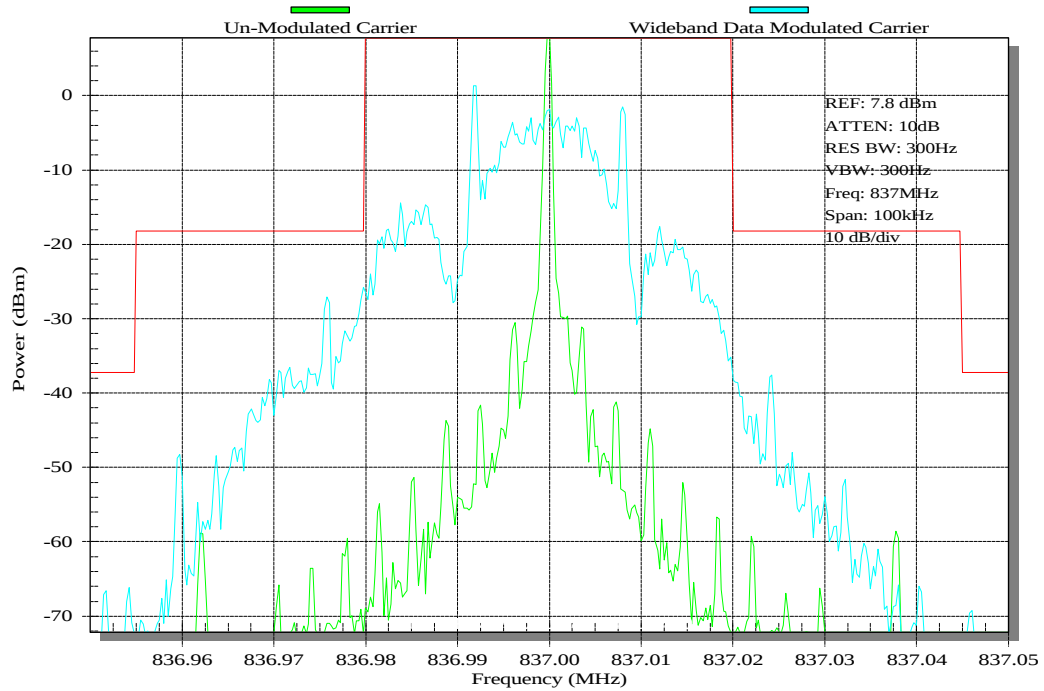


## AMPS Voice - High Power



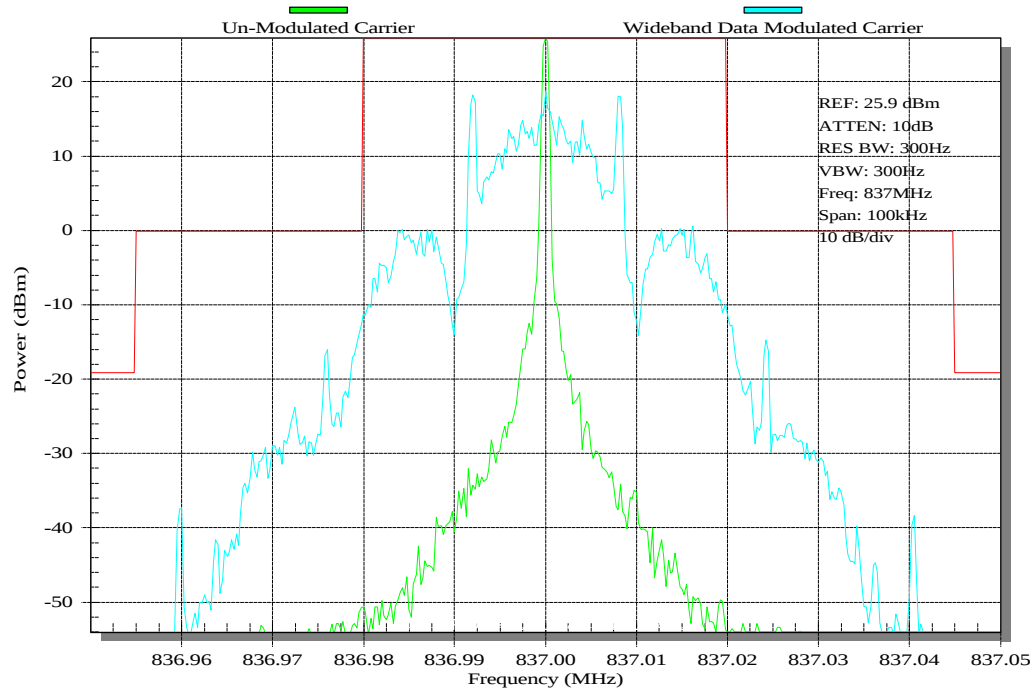
## AMPS Signaling - Low Power

**AMPS (F1D) Occupied Spectrum - 2.989**  
12/03/98 SB320 serial# 0x9B3546AA 10kBaud Data, 8kHz Deviation, 8dBm Output Power

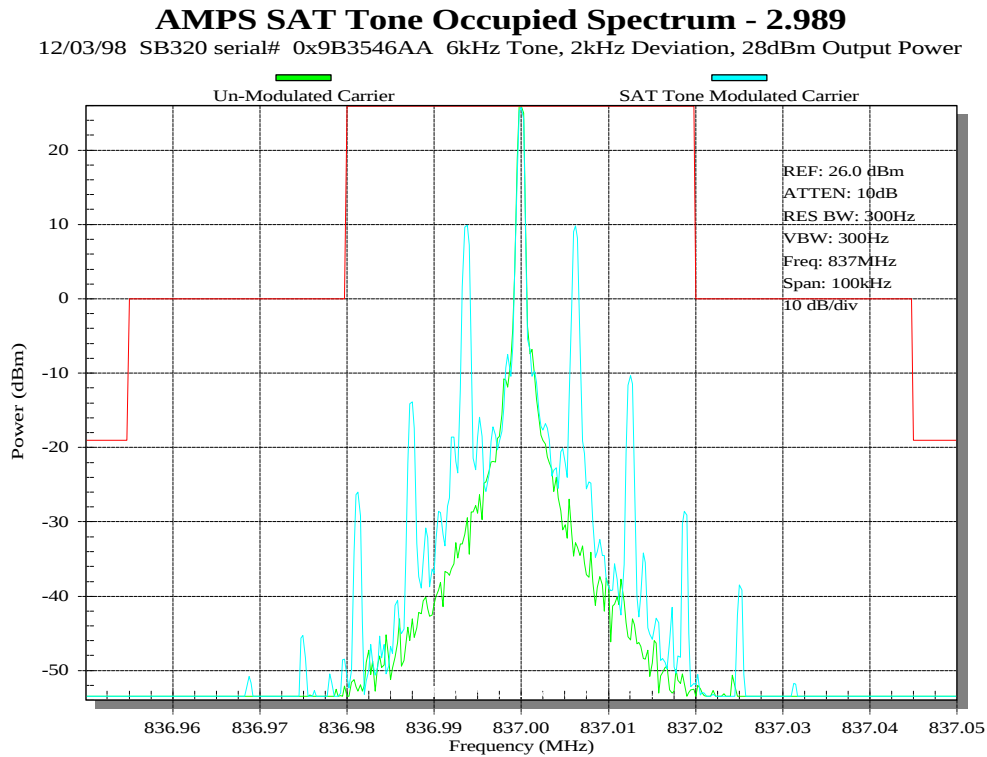


## AMPS Signaling - High Power

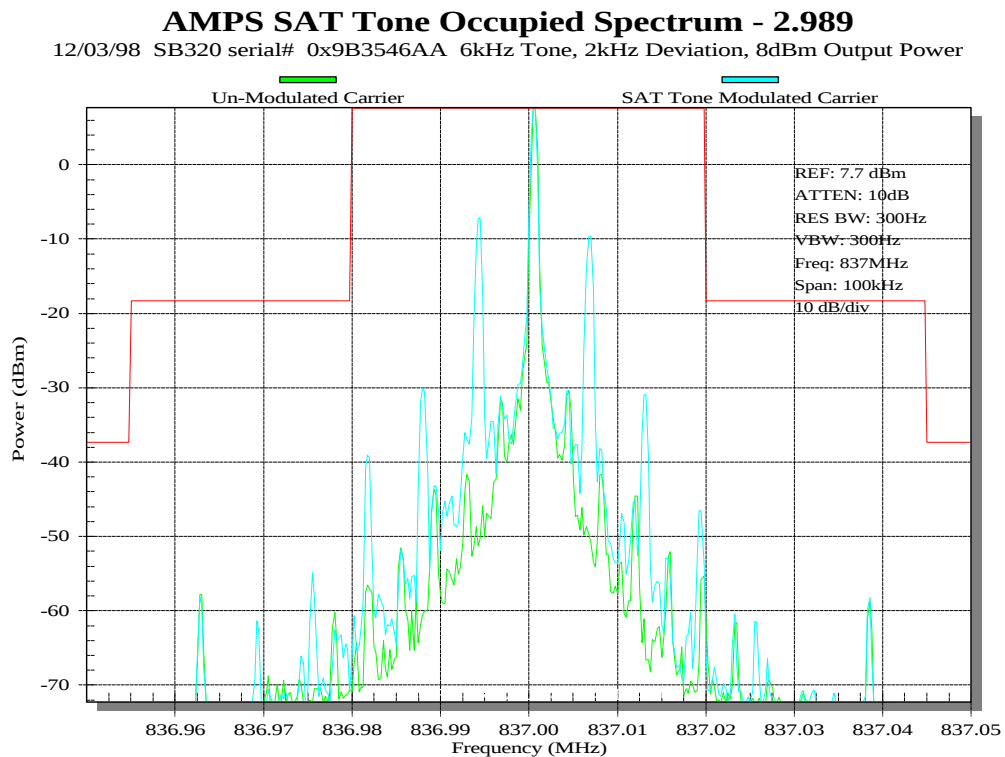
**AMPS (F1D) Occupied Spectrum - 2.989**  
12/03/98 SB320 serial# 0x9B3546AA 10kBaud Data, 8kHz Deviation, 28dBm Output Power



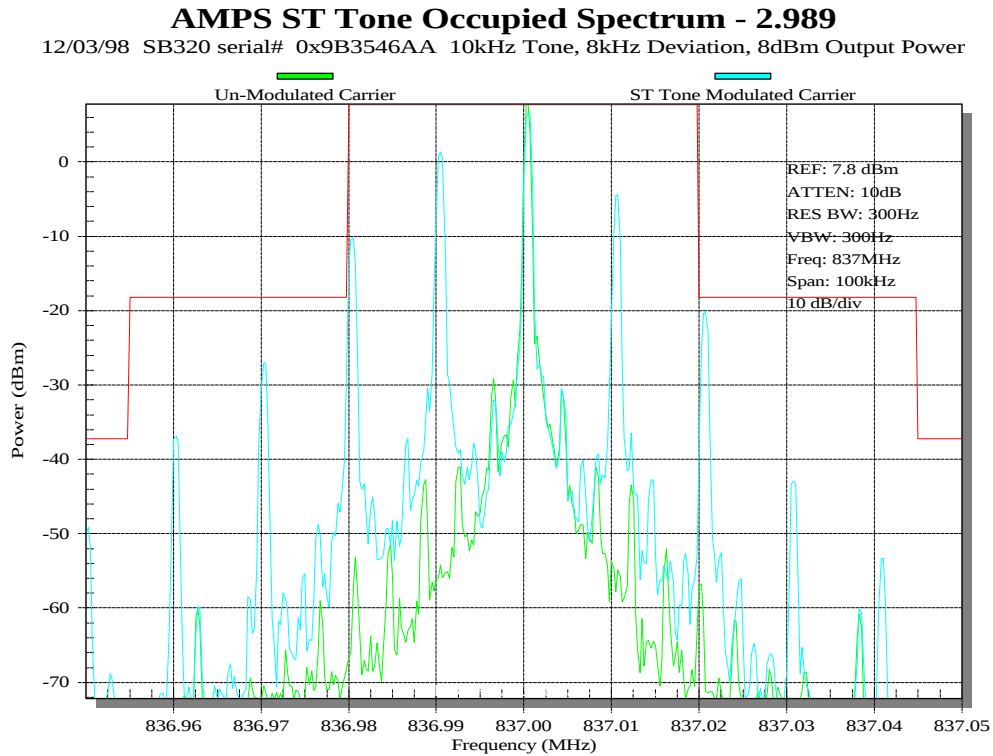
## AMPS SAT - Low Power



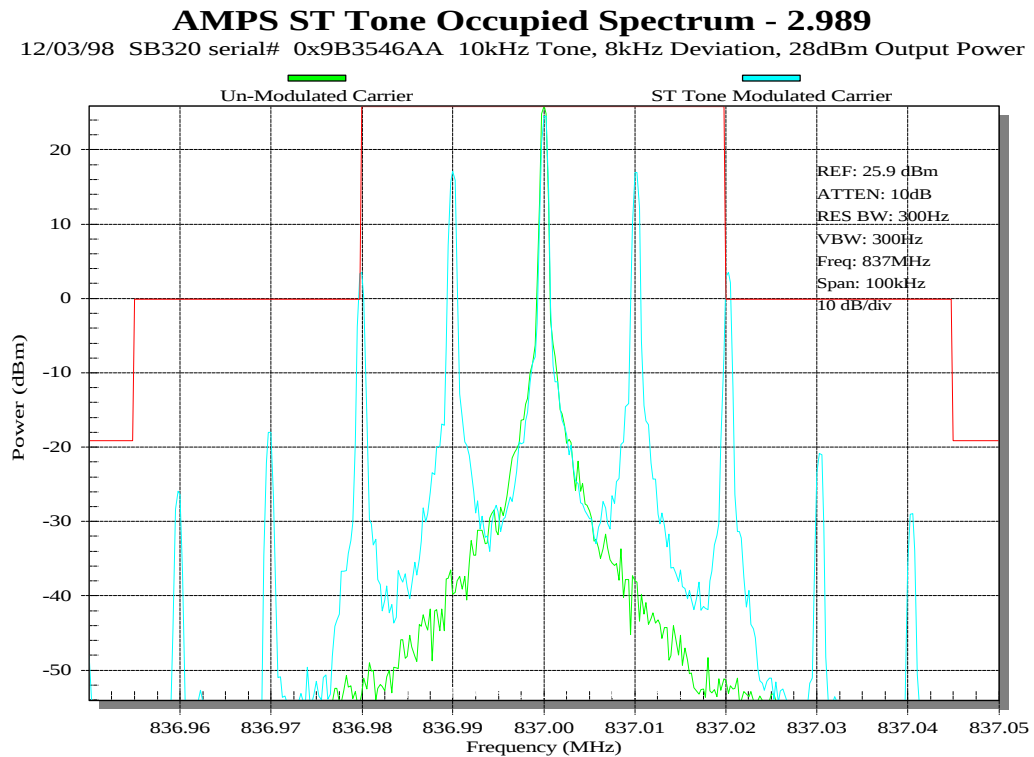
## AMPS SAT – High Power



## ST Tone – Low Power



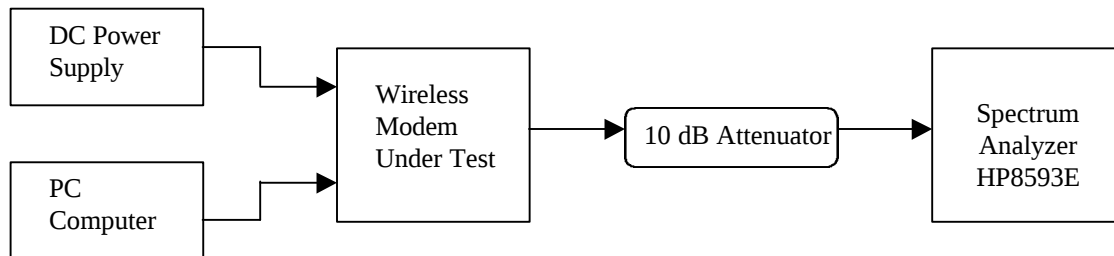
## ST Tone – High Power



## Spurious Emissions at Antenna Terminals (2.991)

|                                                                            |                                                 |
|----------------------------------------------------------------------------|-------------------------------------------------|
| <b>Name of Test:</b>                                                       | Spurious Emissions at Antenna Terminals         |
| <b>FCC ID:</b>                                                             | N7NOEM3                                         |
| <b>Grantee:</b>                                                            | Sierra Wireless                                 |
| <b>Serial No.:</b>                                                         | 20600052674                                     |
| <b>Minimum Standard Specified</b>                                          | Para. 22.106                                    |
| <b>Test Results</b>                                                        | Equipment Compliant with Standard               |
| <b>Equipment Authorization Procedure</b>                                   | Para. 2.993                                     |
| <b>Frequency Range Observed</b>                                            | 0 to 9 GHz                                      |
| <b>Operating Frequency</b>                                                 | 837.000 MHz                                     |
| <b>Crystal Frequency</b>                                                   | 14.85 MHz TCXO                                  |
| <b>Power Output</b>                                                        | 0.00631 to 4.0 Watt (8 to 36 dBm) in 4 dB steps |
| <b>Spurious Limit = <math>43\text{dB} + 10\text{Log}_{10} (P_o)</math></b> | -21 to -41 dBm                                  |
| <b>=</b>                                                                   |                                                 |

### Test Setup Block Diagram



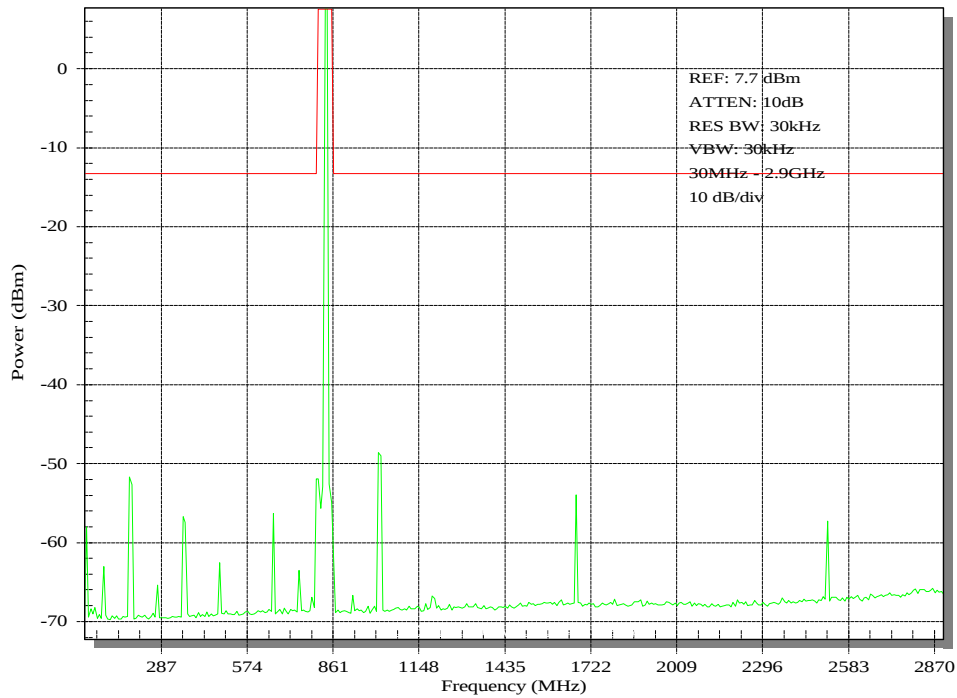
### Measurement Data

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

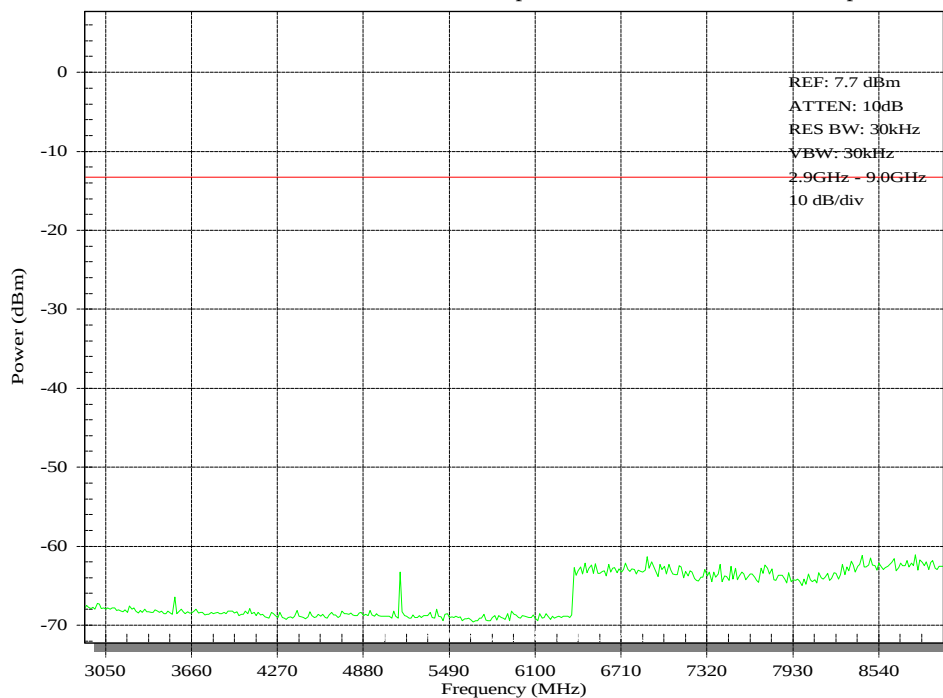
Note: All emissions were greater than 20dB below the spurious limit. Plots of the spurs reported in the table can be seen on the following 2 pages.

**Low Power (8dBm Nominal)****Spurious Emissions at Antenna Terminals - 2.991**

12/03/98 SB320 serial# 0x9B3546AA 19.2kbps, 4.8kHz Deviation, 8dBm Output Power

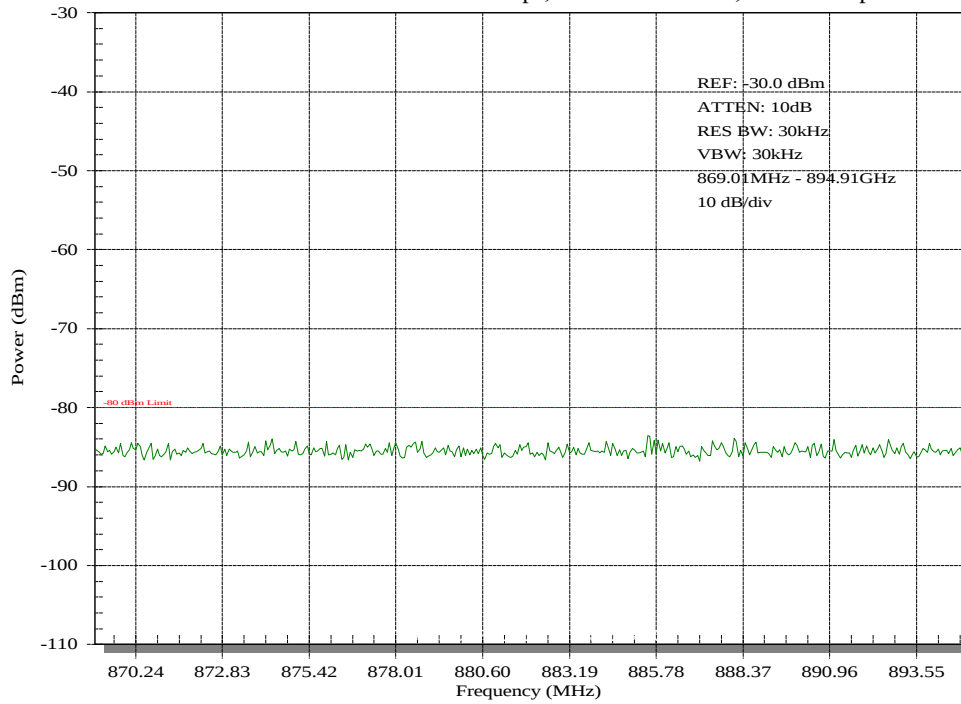
**Spurious Emissions at Antenna Terminals - 2.991**

12/03/98 SB320 serial# 0x9B3546AA 19.2kbps, 4.8kHz Deviation, 8dBm Output Power

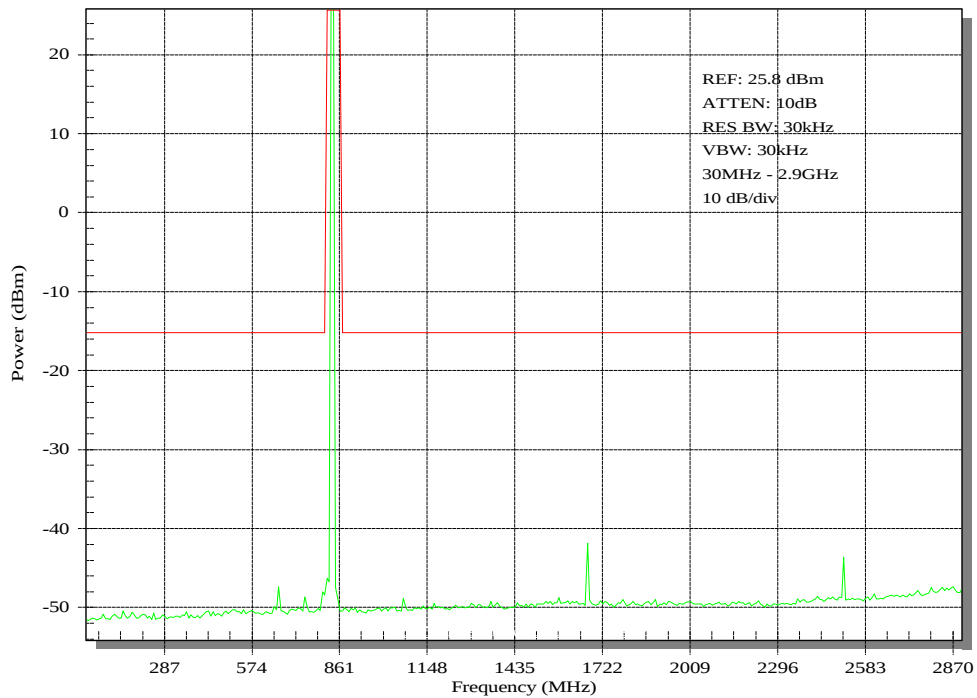


**Spurious Emissions at Antenna Terminals - 2.991**

12/08/98 SB320 serial# 0x9B3546AA 19.2kbps, 4.8kHz Deviation, 8dBm Output Power

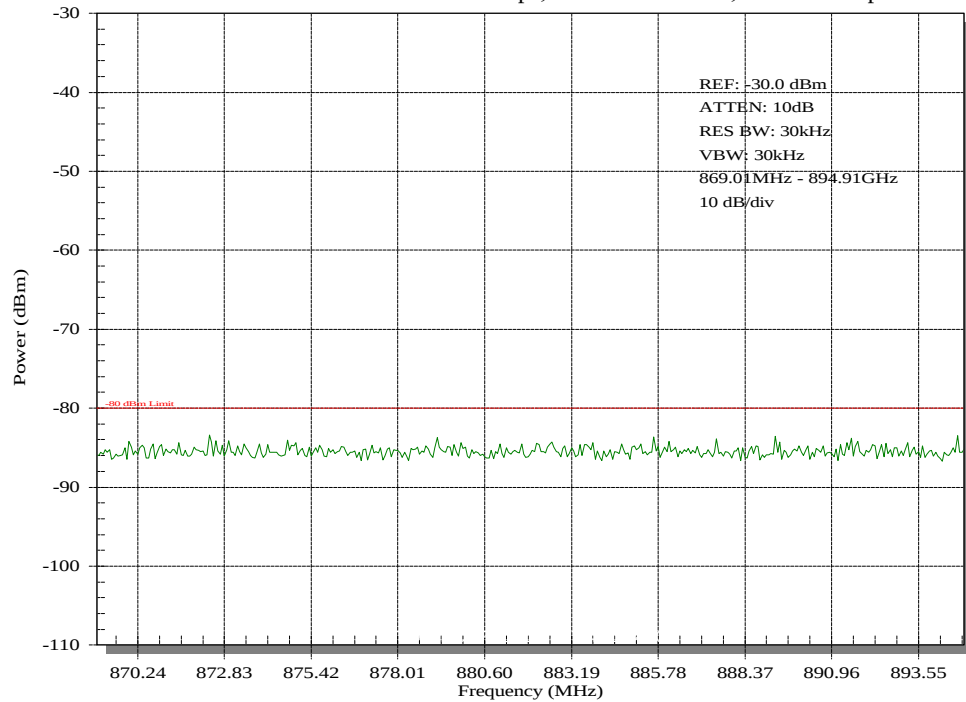
**High Power (28dBm Nominal)****Spurious Emissions at Antenna Terminals - 2.991**

12/03/98 SB320 serial# 0x9B3546AA 19.2kbps, 4.8kHz Deviation, 28dBm Output Power



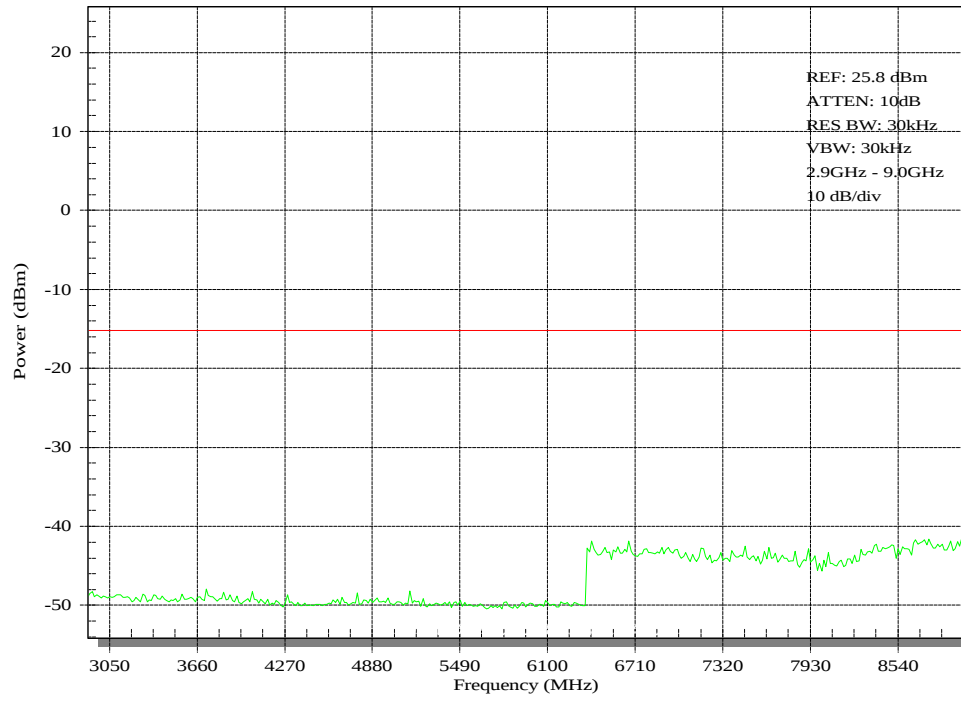
**Spurious Emissions at Antenna Terminals - 2.991**

12/08/98 SB320 serial# 0x9B3546AA 19.2kbps, 4.8kHz Deviation, 28dBm Output Power



**Spurious Emissions at Antenna Terminals - 2.991**

12/03/98 SB320 serial# 0x9B3546AA 19.2kbps, 4.8kHz Deviation, 28dBm Output Power



**Field Intensity Measurements of Spurious Radiation (2.993)**

|                                                                          |                                                    |
|--------------------------------------------------------------------------|----------------------------------------------------|
| <b>Name of Test:</b>                                                     | Field Intensity Measurements of Spurious Radiation |
| <b>FCC ID:</b>                                                           | N7NOEM3                                            |
| <b>Grantee:</b>                                                          | Sierra Wireless                                    |
| <b>Serial No.:</b>                                                       | 20600052674                                        |
| <b>Minimum Standard Specified</b>                                        | Para. 22.106                                       |
| <b>Test Results</b>                                                      | Equipment is Compliant with Standard               |
| <b>Equipment Authorization Procedure</b>                                 | Para. 2.993                                        |
| <b>Frequency Range Observed</b>                                          | 0 MHz to 9 GHz                                     |
| <b>Spurious Limit = <math>43\text{dB} + 10\text{Log}_{10} P_O</math></b> | -21 to -49 dB                                      |

**Note:** This test was performed at:

**Intertek Testing Services NA Inc.  
1365 Adams Court  
Menlo Park, CA 94025**

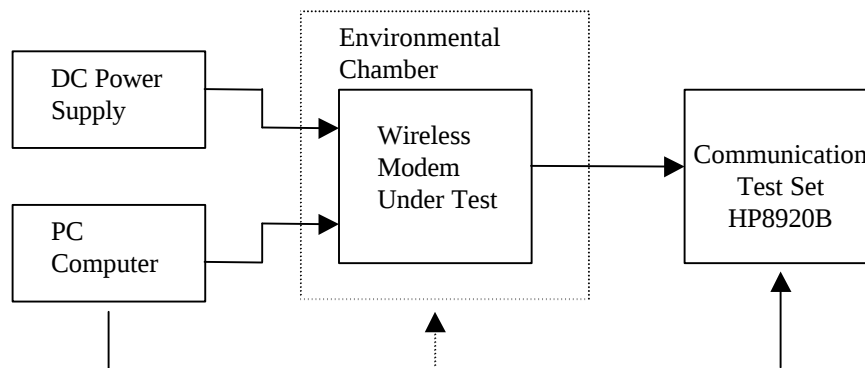
## Operation Stability Performance (2.995)

|                                          |                                                                                                                   |
|------------------------------------------|-------------------------------------------------------------------------------------------------------------------|
| <b>Name of Test:</b>                     | Operational Stability Performance                                                                                 |
| <b>FCC ID:</b>                           | N7NOEM3                                                                                                           |
| <b>Grantee:</b>                          | Sierra Wireless                                                                                                   |
| <b>Serial No.:</b>                       | 20600052674                                                                                                       |
| <b>Minimum Standard Specified</b>        | Para. 22.101 (a)                                                                                                  |
| <b>Equipment Authorization Procedure</b> | Para. 2.995                                                                                                       |
| <b>Test Results</b>                      | Equipment is Compliant with Standard                                                                              |
| <b>Test Equipment</b>                    | HP8920B Cell Site Test Set<br>Tenney Jr environmental chamber<br>HP3631A DC power supply<br>Zegna 486 PC Computer |
| <b>Standard Test Frequency</b>           | 837.00 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.



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

**NOTE: The EUT has an internal voltage detector which disables the modem if power supply deviates more the 0.25V from nominal. Testing was therefore performed at nominal voltage (5.0V) and the upper and lower threshold of operability permitted by the voltage supervisor, 5.25V and 4.75V respectively.**

## Measurement Data

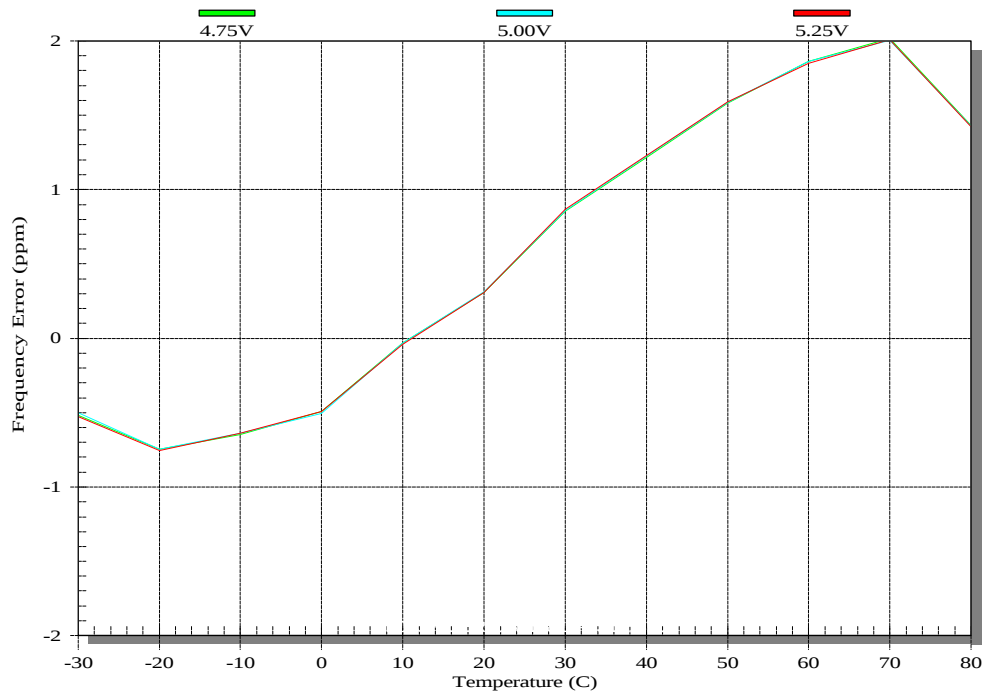
**Table 1: Tx Stability Varying +5V Supply**

| Temp (°C) | Freq. Stability<br>(rated voltage 5.0V)<br>(ppm) | Freq. Stability<br>(max voltage 5.25V)<br>(ppm) | Freq. Stability<br>(min. voltage 4.75V)<br>(ppm) | Worst Case Relative to Rated<br>Freq. Stability<br>(ppm) |
|-----------|--------------------------------------------------|-------------------------------------------------|--------------------------------------------------|----------------------------------------------------------|
| -30       | -0.50                                            | -0.53                                           | -0.52                                            | -0.53                                                    |
| -20       | -0.75                                            | -0.76                                           | -0.75                                            | -0.76                                                    |
| -10       | -0.64                                            | -0.64                                           | -0.65                                            | -0.65                                                    |
| 0         | -0.51                                            | -0.49                                           | -0.49                                            | -0.51                                                    |
| 10        | -0.03                                            | -0.04                                           | -0.03                                            | -0.04                                                    |
| 20        | 0.31                                             | 0.31                                            | 0.31                                             | 0.31                                                     |
| 30        | 0.86                                             | 0.87                                            | 0.86                                             | 0.87                                                     |
| 40        | 1.22                                             | 1.23                                            | 1.22                                             | 1.23                                                     |
| 50        | 1.59                                             | 1.59                                            | 1.58                                             | 1.59                                                     |
| 60        | 1.86                                             | 1.85                                            | 1.86                                             | 1.86                                                     |
| 70        | 2.00                                             | 2.01                                            | 2.01                                             | 2.01                                                     |
| 80        | 1.43                                             | 1.43                                            | 1.43                                             | 1.43                                                     |

Worst case frequency error found was 2.01 ppm which falls within the minimum standard of +/- 2.5 ppm.

### Frequency Stability over Temperature and Voltage - 2.995

12/10/98 SB320 serial# 0x9B3546AA



## Test Equipment List

### Sierra Wireless, Inc.

| <u>Type</u>        | <u>Manufacturer and Model No.</u>                       | <u>Serial no.</u> | <u>Accuracy</u>                  |
|--------------------|---------------------------------------------------------|-------------------|----------------------------------|
| Spectrum Analyzer  | Hewlett Packard HP8593E<br>Opt. 041, 101, 130           | 3801A03362        |                                  |
| Cell Site Test Set | Hewlett Packard HP8920B<br>Opt. 001, 004, 006, 013, 102 | US37423716        | 0.05PPM +/-1Hz, +/- 5% +/-0.01mW |
| Power Supply       | Hewlett Packard HP3631A                                 | KR53600263        | DCV +/- 0.1% +5mV                |
| Multimeter         | Hewlett Packard HP3457A                                 | 3114A14978        |                                  |
| Attenuators        | Mini-Circuits CAT-10                                    | 9406 13           |                                  |
| Thermometer        | Fluke 52                                                | 3965185           | +/(0.1% reading +/-0.7 deg C)    |

## **FCC Sample Label**

### **Finished Product Label:**

See the photos accompanying this report for the layout and positioning of the FCC label.

### **Finished Product Label Location:**

See the photos accompanying this report for the layout and positioning of the FCC label.