

# BumbleBee-EX/LX/RFID

Multi-Band Spectrum Analyzer

manual version 1.1 for all EX, LX & RFID models



## Contents

### BumbleBee/iPAQ Interface Hardware

Unpacking Your BumbleBee.....	2
Starting Up Your BumbleBee.....	3
Antenna Specifications.....	4
Accessories.....	5
BumbleBee Power System.....	5
Troubleshooting.....	6
Hardware Connection Issues.....	6
Software Installation / Re-Installation.....	7
Operational Tips.....	8
Battery Life.....	8
Surveying.....	8
Optimization.....	8
BumbleBee Accessories Sheet.....	10
Honeycomb RF Interference Mapping Software.....	11
Nectar RF Spectrum Analysis PC Software.....	12

### BumbleBee/iPAQ Interface Software

Introduction.....	13
Getting Started.....	13
Main Measurement Screen.....	15
Quick Tour.....	16
Making a Measurement.....	16
Measurement Screens.....	16
Analyzer Display.....	17
Numerical Data Entry.....	19
Band Presets.....	20
Reference Level.....	21
Resolution Bandwidth.....	22
Traces.....	23
Factory Preset.....	24
Zoom In.....	24
Zoom Out.....	25
Marker Functions.....	26
Channel Shadowing.....	27
User Presets.....	27
Interference ID Assist.....	28
Trigger.....	29
Video Smoothing.....	30
Screen Averaging.....	31
Time Markers.....	32
Persistence Display.....	33
Histogram Display.....	34
Spectrogram Display.....	35
Trigger Mode Example to Measure Off-Air Signals.....	36

### Chameleon (BumbleBee Edition) User Manual

Introduction.....	38
Spectrum Data.....	38
Triggered Spectrum Data.....	38
Other Fields.....	39
Conversion Instructions.....	39

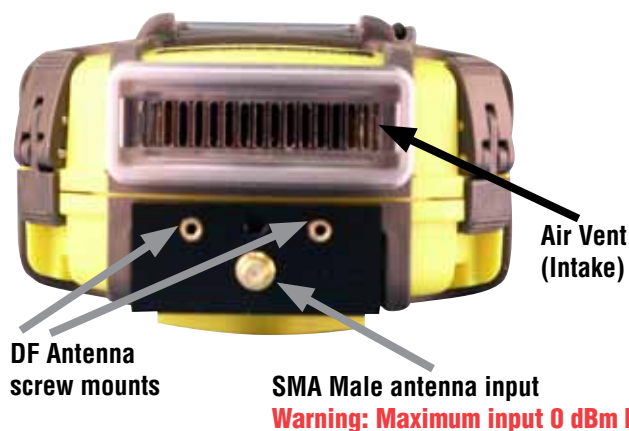
## Unpacking Your BumbleBee



### BumbleBee BOTTOM VIEW



### BumbleBee TOP VIEW



SMA Male antenna input  
**Warning: Maximum input 0 dBm NO DC Input**



## About Your BumbleBee

Unpack and assemble your BumbleBee unit as shown. Your BumbleBee is a self-contained spectrum analyzer. The user interface (iPAQ), antenna and power connections are all accessible, but there is usually no need to open the protective, yellow hard case. If you should need to open the case to remove the iPAQ or address the internal connections, simply unhook all 4 latches on the case. Remove top cover to reveal iPAQ, cooling fan and power/data connector. The BumbleBee receiver and battery system are below these components. The iPAQ may be disconnected and removed by users but the other components should only be accessed by Berkeley technicians. Removing such components will void your hardware warranty.

Power up the iPAQ by pushing the **power button** in the upper right corner of the iPAQ. Connect the appropriate frequency antenna to the SMA antenna input. iPAQs shipped by BVS are optimized for the BumbleBee.

iPAQs supplied by BVS have the BumbleBee software pre-installed. If you need to install the BumbleBee software, see the software installation/re-installation section.

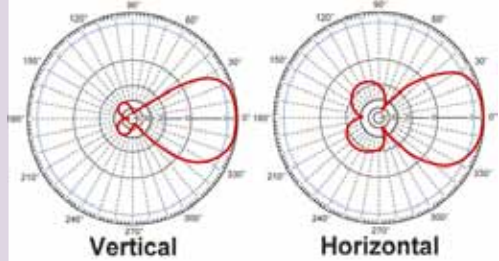
Tap the **windows Start icon** in the upper left corner and then choose BumbleBee in the pulldown menu. If the BumbleBee does not appear in the pulldown menu, tap on the "Programs" folder. Tap on the BumbleBee icon.

Running the BumbleBee software will power the BumbleBee spectrum analyzer.

If the BumbleBee software loses communication with the BumbleBee, perform a soft reset by pressing the iPAQ's reset button. If communications problems persist, perform a hard reset by holding down the **two outer buttons** on the front of the iPAQ while holding in the soft reset button. Remember, hard resets erase all data collected and software installed so backup all data and see software re-installation for details.



## 900 MHz Direction Finding Yagi



Frequency	890-960 MHz
Gain	9 dBi
Polarization	Horizontal or Vertical
Horizontal Beam Width	54°
Vertical Beam Width	48°
Front to Back Ratio	14 dB
Impedance	50 Ohm
Max. Input Power	100 Watts
VSWR	< 1.5:1 avg.
Elements	5
Weight	1.5 lbs. (0.7 kg)
Length	19.6 in. (0.5 m)
Mounting	2 in. (50.8 mm) diameter mast max.
Operating Temperature	-40°C to +85°C (-40°F to 185°F)
Lightning Protection	DC Short
Connector	N-Female

## 900 MHz Omni-Directional (9.5" long)

### Electrical Properties:

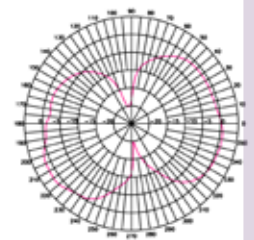
Frequency Range: 890~960 MHz GSM Band or  
824~896 MHz AMPS Band  
Impedance: 50Ω nominal  
VSWR: <2.0:1  
Gain: 2.0 dBi  
Radiation: Omni  
Polarization: Vertical  
Wave: Half Wave Dipole

### Mechanical Properties:

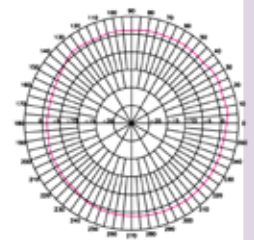
Connector: SMA Plug(male)  
Material: Polyurethane(Black)  
Whip: Polycarbonate(Black)  
Swivel Mechanism: Brass with black chrome plating  
Operation Temp.: -20°C to +65°C  
Storage Temp.: -30°C to +75°C



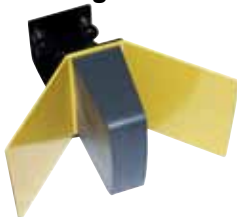
E-Plane Pattern @ 925 MHz



H-Plane Pattern @ 925 MHz



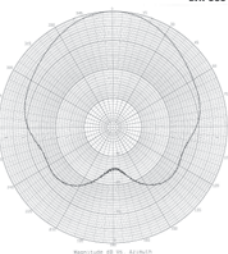
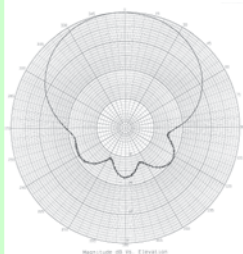
## 2.4 GHz Direction Finding Corner Reflector



2.4GHz 100% CORNER REFLECTOR  
FOLDER: CORNER REF  
SIZE: 1.00" x 0.50"  
POLARIZATION: HORIZONTAL

BVS P/N DFA-001  
&  
DFA-000

BVS P/N DFA-001  
&  
DFA-000



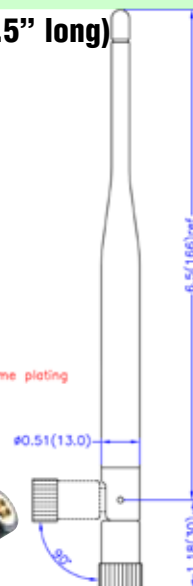
## 2.4 GHz Omni-Directional (7.5" long)

### Electrical Properties:

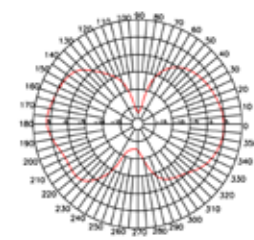
Frequency Range: 2.4~2.5 GHz  
Impedance: 50Ω nominal  
VSWR: <2.0:1  
Gain: 5 dBi  
Radiation: Omni  
Polarization: Vertical

### Mechanical Properties:

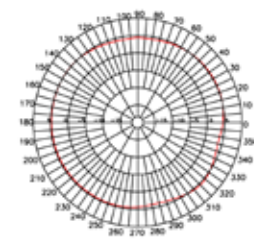
Connector: SMA Plug(male)  
Material: Polyurethane(Black)  
Whip: Polyurethane(Black)  
Swivel Mechanism: Polyurethane(Black)  
Connector: Brass with black chrome plating  
Operation Temp.: -20°C to +65°C  
Storage Temp.: -30°C to +75°C



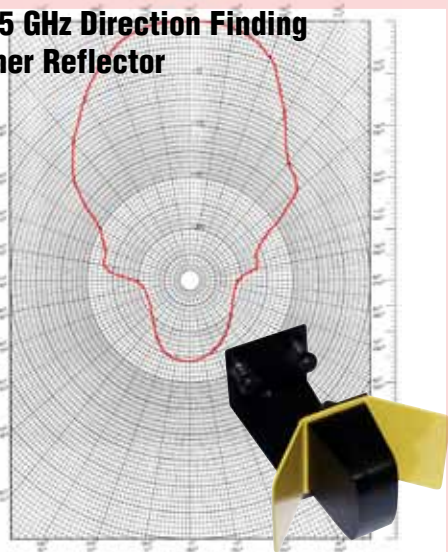
E-Plane Pattern @ 2.45GHz



H-Plane Pattern @ 2.45GHz



## 4.9/5 GHz Direction Finding Corner Reflector



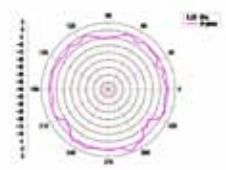
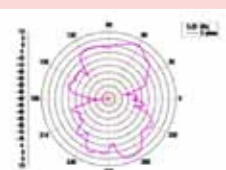
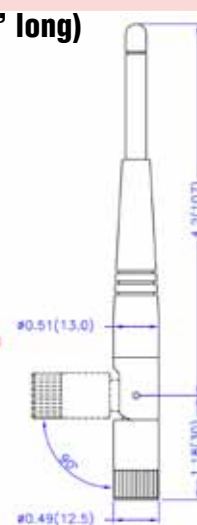
## 4.9/5 GHz Omni-Directional (5.5" long)

### Electrical Properties:

Frequency Range: 5.15~5.35 GHz  
Impedance: 50Ω nominal  
VSWR: <2.0:1  
Gain: 5 dBi  
Radiation: Omni  
Polarization: Vertical

### Mechanical Properties:

Connector: SMA Plug(male)  
Material: Polyurethane(Black)  
Whip: Polyurethane(Black)  
Swivel Mechanism: Polycarbonate(Black)  
Connector: Brass with black chrome plating  
Operation Temp.: -20°C to +65°C  
Storage Temp.: -30°C to +75°C



## Accessories

Your BumbleBee includes the following accessories: 3 antennae, spare data/power cable (for IPAQ), larger case grip with hex key tools, an AC power/charging adapter, user's manual, SD software install card and CD-ROM software installer.



## BumbleBee Power System

BumbleBee offers three choices of powering: internal Li-PO battery, external 12VDC (11-15 V) power supply or external auxiliary battery. The power smoothly transitions from one source to another providing uninterrupted functionality while plugging or unplugging the external supplies. The IPAQ runs from the built-in battery or from an internal regulated 5VDC supply when the external 12VDC is applied. Both batteries – the IPAQ built-in battery and the system Li-PO battery – are charged when the external 12VDC is applied. The charge time is 3 to 4 hours depending on the depth of discharge and the ambient temperature. The run time exceeds 3 hours when the batteries are completely charged.



**NOTE: BVS recommends charging the unit once every 2 weeks (once a month at an absolute minimum). Failure to do so may damage the battery and/or reduce battery run time. Not following these instructions may void warranty coverage on the battery.**

The IPAQ battery is usually depleted at the same time as the system Li-PO battery. However, if the IPAQ battery is low while the system is still running, the equalizing mode of operation is provided. In this mode the IPAQ is powered from the system Li-PO battery. To enter this mode, set the IPAQ to “USB Charge” ON. This may prolong the total system run time. **Do not keep the “USB Charge” setting ON all the time since it will drain the system battery faster, eventually reducing the system run time.**

It is recommended to keep the IPAQ and/or the application software OFF while charging. The system supports a simultaneous charge and run though the charge time may substantially increase due to increased internal temperature.

When the internal temperature exceeds the maximum allowed for the Li-PO batteries the system automatically interrupts the charge. The red LED that can be seen through the bottom transparent hatch will be blinking. The same LED is solid ON when the charge is going and turns OFF completely when the charge is finished.

# **TROUBLESHOOTING**

## **IPAQ AND BumbleBee POWER ISSUES**

Your BumbleBee Spectrum Analyzer and your HP iPAQ are both charged and/or powered through the 4 pin power port at the bottom of the BumbleBee. Both the receiver and iPAQ have their own internal batteries but both of these batteries are maintained and charged through the 4 pin power port. Here are some tips for prolonging the life of your hardware and data:

- The iPAQ's internal batteries are discharged when the iPAQ is "off" to maintain its memory. Keep the iPAQ charged! Charge it at least once a week!
- If the iPAQ's batteries are completely discharged, it will need several hours of charging before it can be powered on or even flash the charging (yellow) LED. Once the iPAQ is charged it may need to be soft or hard reset before powering on. The BumbleBee software must be re-installed from an SD card or downloaded via ActiveSync. In order to install software using the SD card, the iPAQ must be removed.

1. Unhook all 4 latches and remove the top cover.
2. Remove the (optional) DF antenna by loosening the 2 thumb screws and unscrewing the antenna connection.
3. Be sure not to touch the air intake cooling fan while it is spinning. This fan spins to regulate the temperature of the receiver and batteries so be sure to keep all obstructions and objects from the fan's air path.
4. Remove the power/data connector at the bottom of the iPAQ. This connector provides communication and charging/battery power to the iPAQ.

You may now remove the iPAQ from its holder for other uses.

**NOTE: If unit is not being charged occasionally, the Lithium-Ion battery pack will completely discharge which permanently damages it. This is true for any Lithium-Ion powered device. BVS recommends charging the unit once every 2 weeks (once a month at an absolute minimum). Failure to do so may damage the battery and/or reduce battery run time. Not following these instructions may void warranty coverage on the battery.**



## **HARDWARE CONNECTION ISSUES**

When the BumbleBee software is started, the following screen will appear if the software was unable to detect the hardware. The following may cause this:

1. Loose connection to iPAQ serial cable. The serial cable may not be fully seated in the power/data slot on the bottom of the iPAQ. Check the connection. A soft boot of the iPAQ may be required. Soft booting is accomplished by pressing the recessed reset button on the iPAQ with the stylus.
2. Low batteries. Test this by running off of A/C power using the supplied 4 pin power connection to the BumbleBee and the iPAQ. The charge (Yellow) LED on the iPAQ should be flashing if the cable is connected correctly and the BumbleBee red power LED should be on.
3. COM port is held open. Soft boot the iPAQ to clear out the possibility that the serial port is being held open by a previously running copy of the BumbleBee software.

**NOTE:** Your BumbleBee receiver will only support one spectrum analyzer model. Please note the frequency that your model covers:

**BumbleBee-EX (2.0-4.0 & 4.9-5.9 GHz)**

**BumbleBee-LX (750-2000 MHz)**

**BumbleBee-RFID (860-960 MHz & 2.4-2.5 GHz)**

## **SOFTWARE INSTALLATION/RE-INSTALLATION**

The BumbleBee software can be installed/re-installed in three ways.

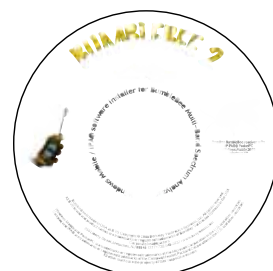
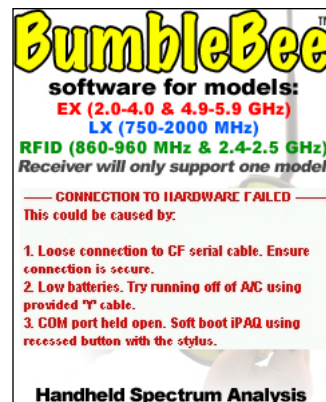
### **CD installation**

1. Connect the iPAQ to the PC by connecting through ActiveSync. Note that ActiveSync needs to be installed on the PC. It is preinstalled on the iPAQ.
2. Insert the CD. If the installation program does not appear after a few seconds, run autorun.exe from the root directory of the CD.
3. Choose the BumbleBee software button.
4. Follow the installation instructions.
5. Software is now installed on the user's iPAQ.

### **SD (secure digital) card installation**

(The iPAQ must be removed in order to access the SD card slot. Be careful not to touch the cooling fan while it is spinning)

1. The BumbleBee shipped with an SD card that contains a copy of the BumbleBee software.
2. Insert the SD card into the SD slot on the iPAQ.
3. Go to File Explorer on the iPAQ. Proceed to the SD Card folder off of the root directory ("My Device").
4. Run install.exe.
5. Choose the model of your iPAQ and press the install button.



**BUMBLEBEE-EX/LX/RFID**

**SD Card Installer**  
**WMV demos included!**

- Insert card into SD slot on top of iPAQ
- Tap on "Start" icon on top left of screen
- Tap on "Programs" in menu
- Tap on the "File Explorer" folder
- Choose "My Device"
- Tap on "SD Card" or "Storage Card"
- Tap on "Install" executable
- Choose Yellowjacket receiver & iPAQ model for installation and tap on that "install" button

- Tap on Windows Media Viewer applications or WMV files to play included video demos.

**DATE:** \_\_\_\_\_





6. Software should now be installed on your iPAQ.

## **OPERATIONAL TIPS**

### **SURVEYING**

While surveying, BumbleBee achieves the most accuracy when antenna is at a vertical 90 degree angle and completely perpendicular to the ground or floor.

### **OPTIMIZATION**

Remember that your iPAQ comes from the BVS factory optimized for powerful spectrum analysis right out of the box, but sometimes these optimized settings can be lost (back to HP's factory defaults) when the iPAQ's battery completely drains. The following are procedures for:

#### **Disabling Bluetooth and 802.11 on an iPAQ**

It is essential when running your BumbleBee software that you do not have either 802.11b or Bluetooth running on the same iPAQ. This will interfere with BumbleBee measurements in the 2.4 GHz band.

#### **Turning Off Bluetooth**

HP iPAQ 27xx series:

From the main screen on the iPAQ, select the antenna icon in the lower right-hand portion of the screen. Then choose the Bluetooth button to turn off Bluetooth.

The blue LED on the iPAQ should not be flashing when the radio is off.

#### **Turning Off 802.11b**

HP iPAQ 27xx series:

From the main screen on the iPAQ, select the antenna icon in the lower right-hand portion of the screen. Then choose the Wi-Fi button to turn off 802.11b.

## Battery Settings

**NOTE:** In order to prevent the Ipaq from freezing when running BumbleBee software, make sure to:

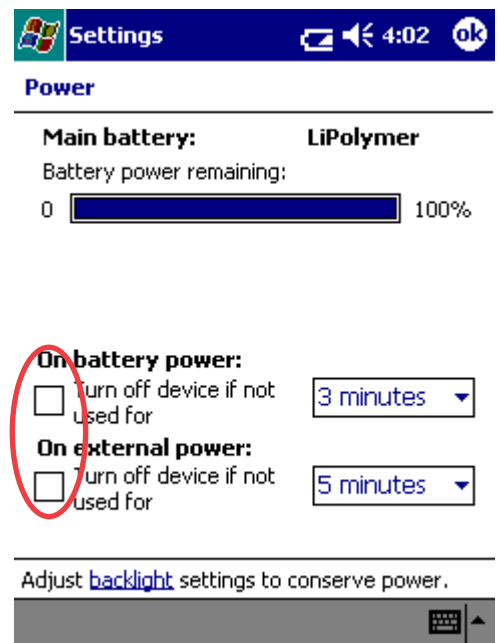
1. ALWAYS leave the checkboxes in the SETTINGS/SYSTEM/POWER screen unchecked. Power-save mode will lock up the application due to the fact that the application is stopped while communicating with the hardware..
2. Make sure that the battery level on the Ipaq remains above 40%. The serial card interface may cease to operate when the battery level is under 40%.

To resolve the freeze, simply press the soft reset button on the iPAQ with the stylus.

## Disabling Screen Saver on an iPAQ

DockWare (by default) runs a screen saver with a calendar on any new iPAQ (47xx series). This could interfere with the operation of BumbleBee software. To disable:

1. Tap on the Windows icon in the upper-left corner of the iPAQ screen.
2. Tap “Programs” in the menu.
3. Tap on “DockWare”.
4. Once running, tap-and-hold on the screen.
5. Uncheck “Start Automatically”.
6. Now tap the upper right corner of the screen to terminate DockWare (where the ‘X’ would usually be).
7. DockWare is now disabled. It will need to be disabled again if the batteries completely discharge on the iPAQ.



Choose Settings and then choose System settings at the bottom. Select battery icon for Power Settings to access this screen. These power settings come unchecked from the BVS factory to ensure BumbleBee-EX software runs optimally.

# Accessories for your **Bumble Bee**

12VDC to 110VAC car cigarette  
lighter power inverter  
75 Watts output  
P/N BB-12V  
\$ 35.00 **OPTIONAL**



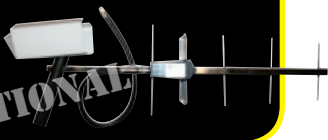
**STANDARD**

Ni-MH Fast-Charger  
4 AA 6 V  
P/N NIMH-001  
\$ 55.00



Rugged Carrying Case  
ABS Plastic  
P/N P-CASE  
\$ 100.00 **STANDARD**

900 MHz Direction Finding Yagi  
Antenna with mounting bracket,  
cable & SMA male  
9 dBi gain  
P/N HG909Y  
\$ 125.00 **OPTIONAL**



4.9/5 GHz Direction Finding Antenna  
with mounting bracket, cable & SMA  
male  
9 dBi gain  
P/N 5NE  
\$ 250.00 **OPTIONAL**



Data Playback Windows PC  
Software  
\$ 250.00 **OPTIONAL**



Nectar  
PC Spectrum Analysis Software  
Ask for a Quote **OPTIONAL**



Honeycomb  
Interference Mapping Software  
Ask for a Quote **OPTIONAL**



30 dB attenuator pad for use with  
directional antennas (between  
DF antenna & BumbleBee) SMA  
male to female  
P/N bbpad30  
\$ 30.00 **OPTIONAL**



2.4 GHz Omni Antenna  
SMA male swivel  
P/N S151AM-2450S  
\$ 25.00 **STANDARD**



900 MHz Omni Antenna  
SMA male swivel  
P/N C191AM-925  
\$ 25.00 **STANDARD**



2.4 GHz Direction Finding  
Antenna with mounting brack-  
et, cable & SMA male  
9 dBi gain  
P/N 2ND  
\$ 250.00 **OPTIONAL**



4.9/5 GHz Omni Antenna  
SMA male swivel  
Co-Linear Dipole 5 dBi VSWR 1.8:1  
P/N K181AM-5250S  
\$ 25.00 **STANDARD**



# HONEYCOMB™

## RF INTERFERENCE-MAPPING SITE SURVEYS



### 1 Create Survey Maps: HONEYCOMB PROJECTOR (PC)

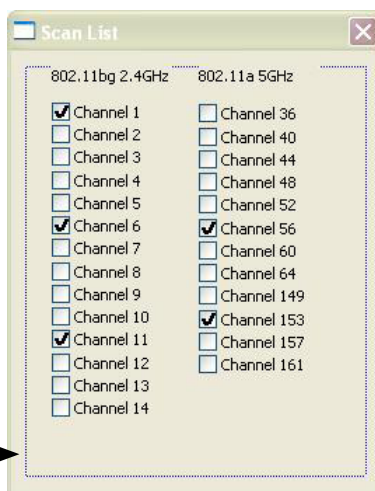
- Import any image file of a floorplan or site
- Create a distance projection
- Add simple objects to image
- Add custom objects to floorplan
- Scale and crop image
- Save for use in Collector and Analyzer



Honeycomb™ allows users to take measurements at anytime in the field using your iPAQ and Berkeley's calibrated receiver technology.

Honeycomb™ scan list allows users to search all Wi-Fi channel allocations for 802.11b/a/g while still in the field.

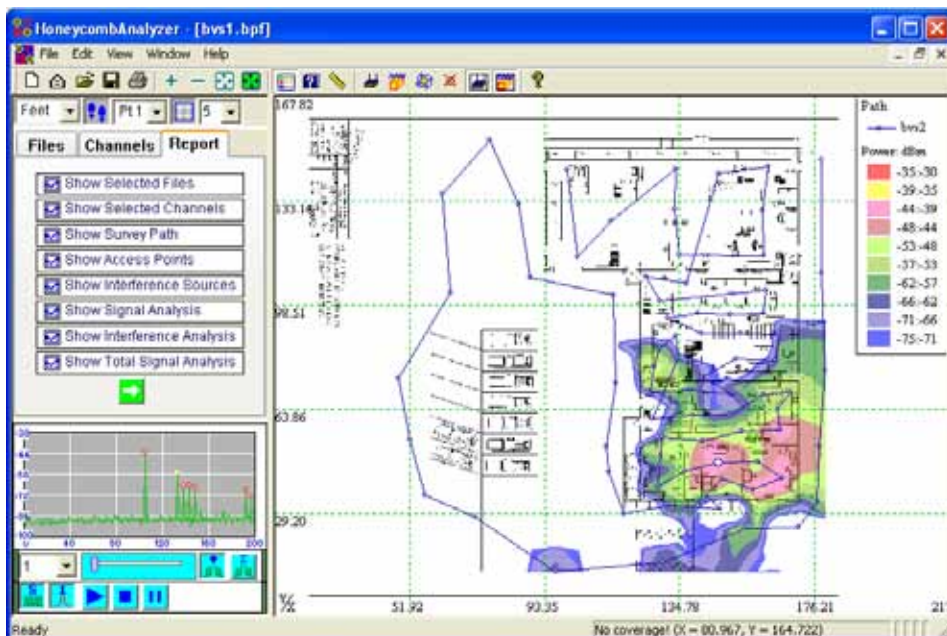
HoneyComb™ is Windows XP and Mobile 5.0 interference-mapping software designed for use with of BVS Bumble Bee™ spectrum analyzer system. It consists of three parts: Projector, Collector, and Analyzer. Sources of interference can be separated from 802.11 WLAN signals, allowing the user to graph severity of interference, percentage of channel capacity remaining and other significant interference related quantities. HoneyComb™ aids in locating jamming interference, unintentional interference and network intrusion as well as channel verification.



HoneyComb™ will also map all likely signal sources and strengths for helping to clear "RF free zones." Floorplans or site maps can be used as a reference to collect data leaving the resulting interference maps to be overlayed onto floorplans for easy identification of interference prone areas.

### 2 Instant RF Surveys: HONEYCOMB COLLECTOR (iPAQ)

- Save multiple data files while using same projection file
- Ability to choose up to 26 802.11b/a/g channels
- Adjust duration of scan
- Adjust period of scan for each channel
- Automatically saves data to file
- Take screen snapshots of any site
- Saves data for further analysis in HoneyComb™ Analyzer
- Shows walk/drive path
- Access information on any point at any time



### 3 Plot Interference Analysis: HONEYCOMB ANALYZER (PC)

- Imports data from other Honeycomb applications
- Detect/Separate interference from Wi-Fi signals
- Interference severity and channel
- Plot and view interference-related problems
- Wi-Fi channel capacity for intrusion detection
- Plot and view "RF free zones"
- Print and export plots into bmp files
- Create a HTML report for any survey area

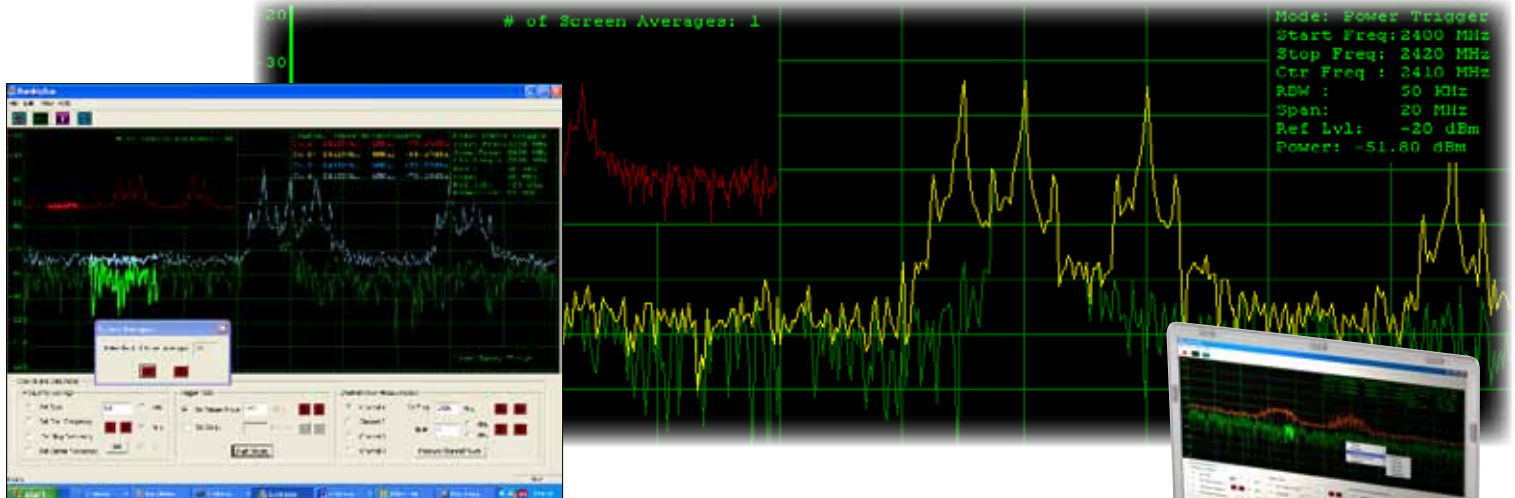
OPTIONAL SOFTWARE AVAILABLE FOR YOUR BUMBLEBEE



# NECTAR™

## RF Spectrum Analysis Software On Your PC

**Nectar™** is a Windows® XP software application that scans and monitors a variety of wireless networks. **Nectar™** utilizes the **BumbleBee™** Receiver Module to continuously scan **BumbleBee™** frequency bands **900 MHz, 2.4 GHz and 5 GHz, 2.4, 4.9 and 5 GHz** or (**BumbleBee Wi-MAX frequencies**). Users must specify the desired RF frequency models when ordering. Current **BumbleBee™** customers may use their receivers with the **Pollenator™** PC interface with **Nectar™** software. User selectable channel, preset and log settings ensure that **Nectar™** software is able to distinguish your network's signal strength from other networks and sources of RF interference. Laptop or PC control via USB and ethernet creates customized, time-stamped log files for true 24/7 monitoring. In addition, JPEG/BMP snapshot features allow users to instant capture waveforms at key moments for later analysis. **Nectar™** software features up to 5 distinct waveform traces (1 live and 4 peak), screen averaging, video smoothing and packet/interference triggering.



- ✓ Full Spectrum Analysis using BumbleBee™ calibrated receiver technology
- ✓ Channel Power Measurements (up to 4 user selectable channels)
- ✓ Adjacent Channel Power Measurements
- ✓ Presets for different frequency bands
- ✓ Choose Between 3 Different Models: (900 MHz, 2.4 & 5 GHz) (2.4, 4.9 & 5 GHz) (BumbleBee Wi-MAX frequencies)
- ✓ Interfaces to BumbleBee receiver via USB & Ethernet (using Pollenator™)
- ✓ Power Trigger Modes (with measurement delay)
- ✓ 5 Waveform Traces (1 live & 4 peak traces)
- ✓ Screen Averaging (up to 100 traces)
- ✓ Video Smoothing (VBW : 50 kHz)
- ✓ JPEG/BMP Snapshots of the screen

Use BumbleBee™ hardware on your desktop or laptop for spectrum analysis monitoring 24/7.



Use your BumbleBee™ receiver and Pollenator™ to interface with your PC via the USB or Ethernet port.

## OPTIONAL SOFTWARE AVAILABLE FOR YOUR BUMBLEBEE

# **BumbleBee-EX/LX/RFID Spectrum Analyzer**

## **iPAQ Interface Software**

### **Introduction**

The BumbleBee is a precision hand-held spectrum analyzer. Spectrum analysis data is displayed by BumbleBee software running on an iPAQ. This iPAQ is connected to the BumbleBee via a serial/power cable. The BumbleBee has several features to detect signals and interference. Many of these transmissions are bursty; they transmit and then turn-off. These types of transmissions can be difficult to detect with a spectrum analyzer. The BumbleBee features Trace Peak Hold, Persistence Display and Channel Power Trigger to detect and measure bursty signals and bursty interference. See each feature's section in this manual.

### **BumbleBee models:**

**BumbleBee-EX (2.0-4.0 & 4.9-5.9 GHz)**

**BumbleBee-LX (750-2000 MHz)**

**BumbleBee-RFID (860-960 MHz & 2.4-2.5 GHz)**

**Note:** Your BumbleBee receiver will only support one of these models and their respective frequencies. Some screen examples in this manual do not necessarily reflect your unit's functionality.

### **Installation of Software**

The BumbleBee software is pre-installed on iPAQ computers purchased from BVS. A completely depleted iPAQ battery will erase the software. See re-installation of software in the troubleshooting section of this manual.

For users who are using their own iPAQ, follow the CD or SD card installation instructions in the troubleshooting section of this manual to install the BumbleBee software.

### **Getting Started**

- 1. Power your BumbleBee receiver and iPAQ as described in the "starting-up your BumbleBee" section of the manual.**
- 2. Connect the serial/power cable from the BumbleBee Receiver to the iPAQ.**
- 3. Tap the Start button on the iPAQ.**
- 4. Tap on the "Programs" folder.**
- 5. Tap on the "BumbleBee" icon.**
- 6. Tap anywhere on the screen when the splash screen appears as shown below.**

# BumbleBee™

**software for models:**

**EX (2.0-4.0 & 4.9-5.9 GHz)**

**LX (750-2000 MHz)**

**RFID (860-960 MHz & 2.4-2.5 GHz)**

*Receiver will only support one model.*

## Handheld Spectrum Analysis

### BUMBLEBEE SPLASH SCREEN

This startup screen will display the frequency bands your BumbleBee is capable of scanning. If the error screen is displayed (as shown below), the software was not able to connect to the BumbleBee receiver. See 'Hardware Connection Issues' in the troubleshooting section of this manual.

# BumbleBee™

**software for models:**

**EX (2.0-4.0 & 4.9-5.9 GHz)**

**LX (750-2000 MHz)**

**RFID (860-960 MHz & 2.4-2.5 GHz)**

**— CONNECTION TO HARDWARE FAILED —**

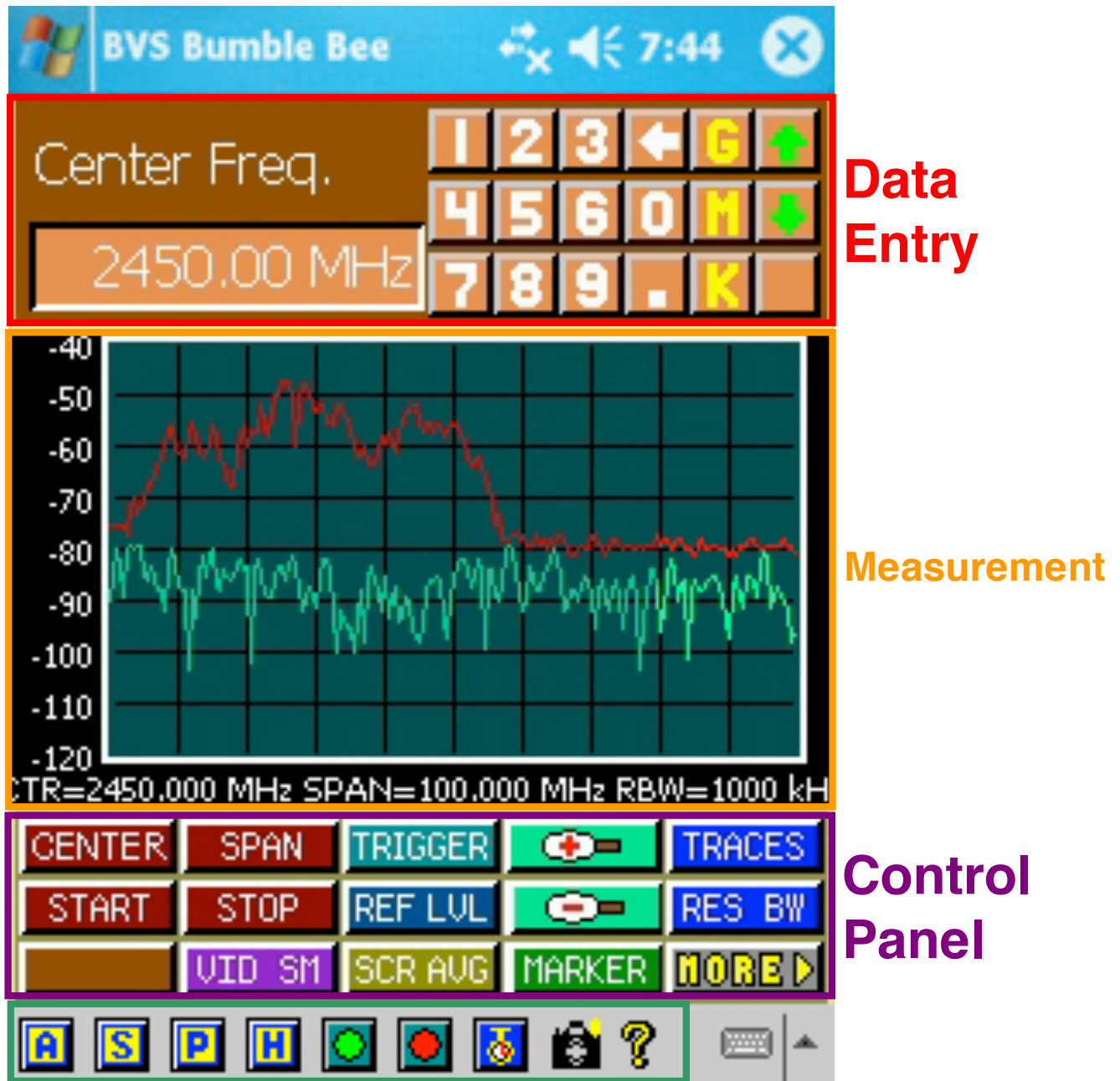
**This could be caused by:**

- 1. Loose connection to CF serial cable. Ensure connection is secure.**
- 2. Low batteries. Try running off of A/C using provided "Y" cable.**
- 3. COM port held open. Soft boot iPAQ using recessed button with the stylus.**

## Handheld Spectrum Analysis

### BUMBLEBEE ERROR SCREEN WHEN THE SOFTWARE CANNOT CONNECT TO THE BUMBLEBEE

## BumbleBee Main Measurement Screen



## Toolbar

### Quick Tour

The BumbleBee application is broken up into four display sections. From top to bottom they are:

1. **Data Entry** - This is the area where different information is entered such as the center frequency, trigger information, and reference level. The data entry screen is selected by using the control panel.
2. **Measurement** - This is the area where data from the BumbleBee receiver is displayed.
3. **Control Panel** - This is the area where data entry blocks are selected. Use the "MORE>" and "<BACK" buttons to switch between control panel pages.



4. **Toolbar** - Other options such as switching displays, snapshots, and logging are chosen here.

## **Making a Measurement**

This section describes the basic procedure to measure off-air signals in the 2.4 – 2.5 GHz band.

1. **Start your BumbleBee**, if it is not already, as described in the Getting Started section.
2. **Connect the 2.4 GHz omnidirectional antenna** to the BumbleBee.
3. **Initialize the BumbleBee**: Tap the “MORE>” button on the control panel. Tap the “FACTORY” button on the control panel.
4. **Set the frequency range to scan**: Tap “PSET 2.4” on the control panel. Tap “BAND” on the data entry portion of the screen.
5. **Set the Reference Level**: Tap the “<BACK” button on the control panel. Tap “REF LVL” on the control panel. Verify that the reference level is set to –40 dBm.
6. **Set the Trace options**: Tap the “TRACES” button on the control panel. Tap the “PEAK” button on the data entry portion of the screen for trace 1.
7. **Adjust the Reference Level**: If signals are captured and displayed OK (the trace is not drawn off the top of the display and signal(s) are drawn) make no adjustment to the Reference Level.

7a. If the peak of the trace is clipped by the top of the screen, tap the “TRACES” button on the data entry portion of the screen. Tap the “Live” button on the data entry portion of the screen for trace 1. Continue with step 5, but raise the Reference Level 10 dB by tapping the “↑” button in the data entry portion of the screen. Continue with step 6.

7b. If the Trace does not display any signals after a minute or two, tap the “TRACES” button on the data entry portion of the screen. Tap the “Live” button on the data entry portion of the screen for trace 1. Continue with step 5, but lower the Reference Level 10 dB by tapping the “↓” button in the data entry portion of the screen. Continue with step 6.



**Toolbar Options**

From left to right, the toolbar buttons perform the following functions:

### **BUMBLEBEE TOOLBAR**

#### **ANALYZER DISPLAY**

This button will change the data entry block to the center frequency option and will change the display to show analyzer data.

#### **SPECTROGRAM DISPLAY**

This button sets the data entry block to the spectrogram option and will change the display to show

**spectrogram data.**

#### **PERSISTENCE DISPLAY**

**This button sets the data entry block to the persistence option and will change the display to show persistence data.**

#### **HISTOGRAM DISPLAY**

**This button sets the data entry block to the histogram option and will change the display to show histogram data.**

#### **LOG FILE RECORD**

**This button will display a file selection screen to choose a log file name. After the name is chosen, the program will begin to log spectrum data to the log file.**

#### **LOG FILE STOP**

**This button will stop the recording of data to a log file.**

#### **TIME MARKER**

**This button will increment the internal time marker. This time marker is used to mark places in a log file of interest. The display of the current value of the time marker is accomplished by choosing the “time marker” button from the control panel.**

#### **SNAPSHOT**

**When the camera icon is pressed from the toolbar at the bottom of the screen, a snapshot of the currently viewable display is taken. The snapshot is saved as a JPEG format picture (just like a digital camera) for viewing at a later time or for importing into documents and reports. As an example, the images of the BumbleBee screens shown in this section of the manual were saved using this option.**

#### **ABOUT BOX**

**This button will display a dialog box which shows the version for the BumbleBee software.**

#### **Measurement Screens**

**The following paragraphs outline the measurement and control panel options on the BumbleBee software. They are arranged from basic to some of the more advanced measurement techniques.**

## BASIC Measurement Screens and Control Panel Options

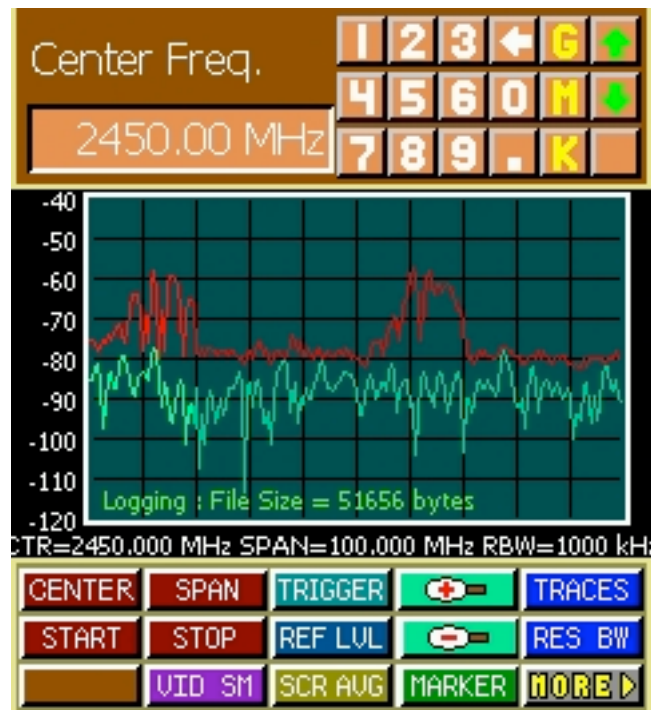
### ANALYZER DISPLAY

Tapping on the splash screen will bring you to the analyzer screen. This is one of four separate displays of data available on the BumbleBee.

The analyzer display screen shows the current signal in a frequency vs. power spectrum waveform. The range of power values on the Y-axis will change depending on the current reference level.

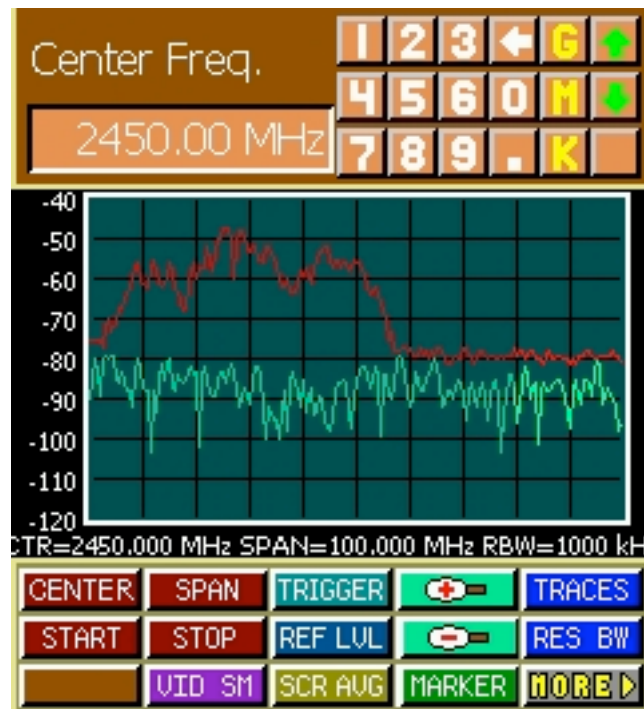
The values on the X-axis change according to the current frequency settings. The number of points displayed depends on the frequency settings and the resolution bandwidth selected.

Data logging is currently active and is shown with file size in bytes.



**ANALYZER DISPLAY**

## **1. Numerical Data Entry**



**NUMERICAL DATA ENTRY – CENTER FREQUENCY**

The numerical data entry pad (NDE) is displayed when the center, start, stop, or span frequencies are chosen from the bottom menu. The NDE is composed of a textual information area, a data entry field, and a keypad. The information area details what data is being entered (i.e. “Center Freq.”). The data entry field will show the actual data being entered. After a value has been finalized, the units of the data will also show up in this area.

The keypad consists of the following:

**0 thru 9**

**decimal point**

**<- (backarrow) = used to clear the current entry**

**G = sets to GHz and finalizes the entry**

**M = sets to MHz and finalizes the entry**

**K = sets to kHz and finalizes the entry**

**When the units are displayed in the data entry field:**

**(uparrow) = increments the value and resends to the receiver**

**(downarrow) = decrements the value and resends to the receiver**

**Center Frequency**

This menu option allows the user to set the center frequency to be displayed. The value, along with



the current span, must not be outside the valid receiver bands.

### Start Frequency

This menu option allows the user to set a new start frequency. The value, along with the current span, must not be outside the valid receiver bands.

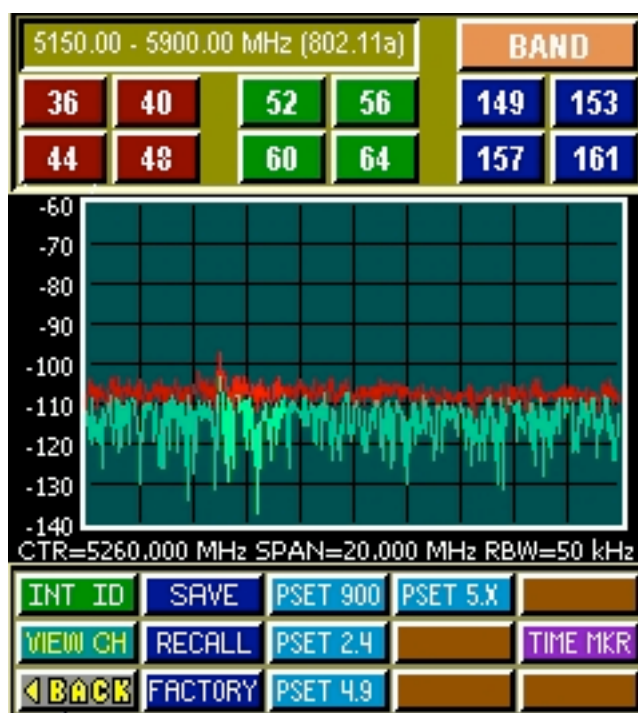
### Stop Frequency

This menu option allows the user to set a new stop frequency. The value, along with the current span, must not be outside the valid receiver bands.

### Frequency Span

This menu option allows the user to set the span. The value, along with the center frequency, must not be outside the valid receiver bands. Use the numerical data entry instructions to set the value.

## 2. Band Presets



**802.11a PRESET BLOCK**

### WHAT IS IT?

Presets automatically tune all of the BumbleBee's settings to appropriate values for a variety of measurement tasks. Each "PSET" button tunes a different band.

### HOW TO SET IT?

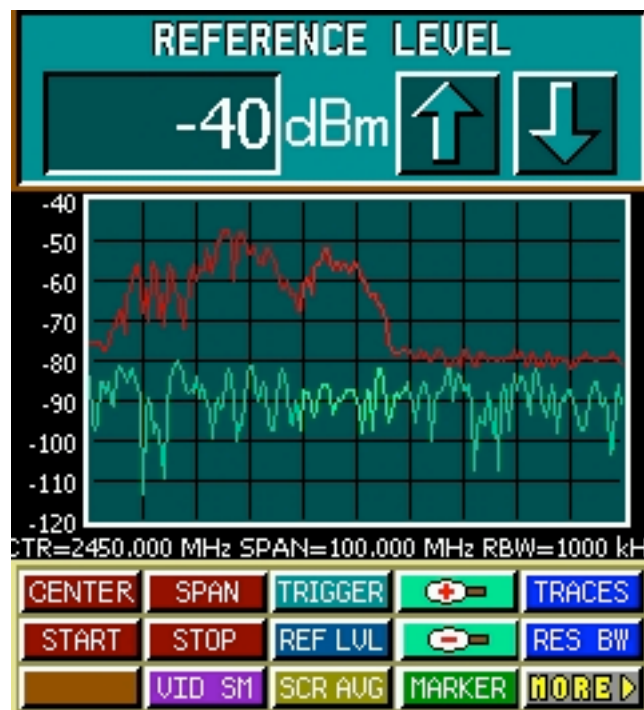
Press on the appropriate band or channel to set the frequency, span and resolution bandwidth. For example, pressing the '2' button on the "2.4 PSET" display will set the receiver to channel 2 for

802.11bg networks. Pressing the “BAND” button will set the receiver to the entire 802.11bg band, including all channels (1-14).

### WHY TO USE IT?

Presets can save time and don’t require a detailed knowledge of the BumbleBee’s settings. However, the BumbleBee is a general-purpose instrument and requires the user to set the instrument appropriately for their application. Presets that measure the entire 802.11 2.4 GHz band or the entire 802.11 5 GHz band use a High Resolution Bandwidth to detect which channels have activity. A sweep of each channel with activity can be set via the Presets to measure the signals with a small Resolution Bandwidth. See the Resolution Bandwidth section.

### 3. Reference Level



REFERENCE LEVEL – SET TO -40 dBm

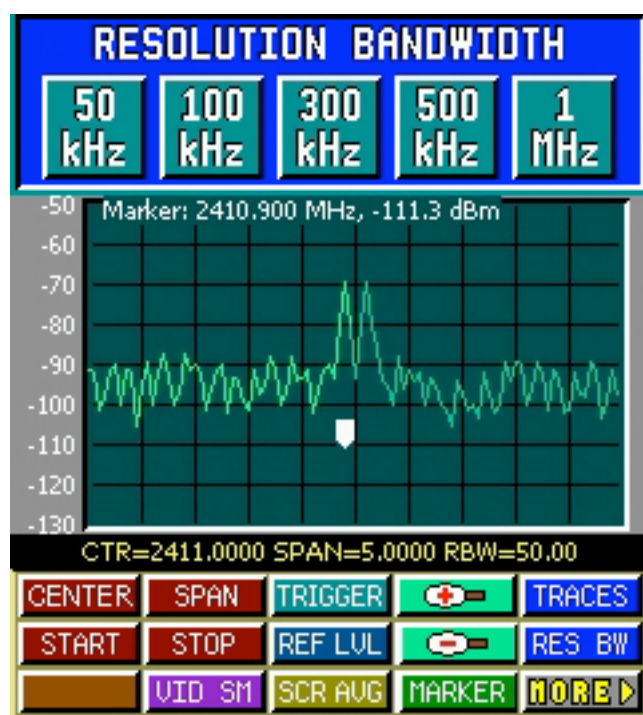
### WHAT IS IT?

This menu option allows the user to set the current reference level of the receiver. The valid choices are between -20 and -70 dBm, in 10 dBm increments.

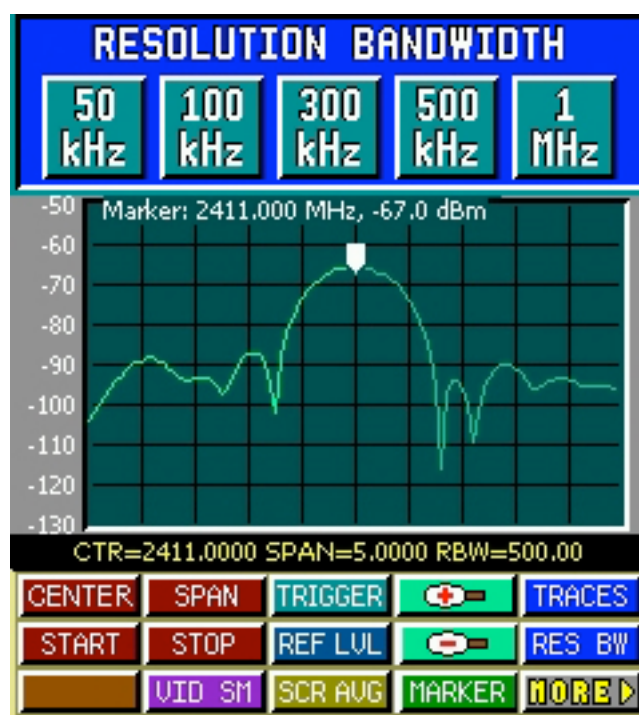
### HOW TO USE IT?

The level indicated by the BumbleBee at the top of the measurement display is the reference level. The Reference Level should be adjusted to obtain the greatest dynamic range. The Reference Level should be set so that the strongest signal on the display is about 10 dB down from the top of the measurement display. If a signal is drawn off the top of the measurement display or the message “clipped” is displayed, lower the Reference Level. The highest Reference Level is -20dBm. The lowest Reference Level is -70dBm.

#### 4. Resolution Bandwidth



50 kHz



500 kHz

#### RESOLUTION BANDWIDTH

##### WHAT IS IT?

The BumbleBee measures the energy present in different frequency bins, each bin's width is equal to the resolution bandwidth.

##### HOW TO SET IT?

The resolution bandwidth is set by pressing the appropriate button for the resolution bandwidth desired.

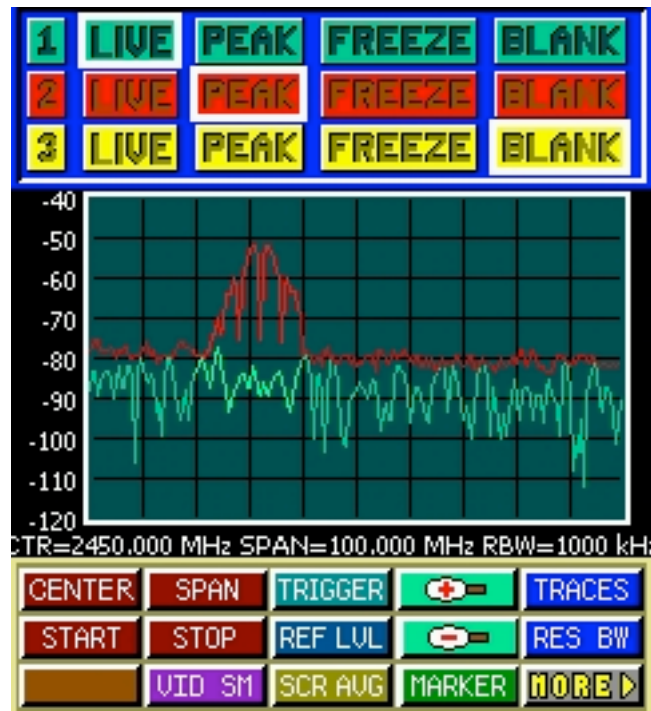
##### WHY TO USE IT?

The figure depicts how setting the resolution bandwidth can “change” the BumbleBee’s displayed spectrum with the same input. The first figure to the left (50 kHz resolution bandwidth) clearly shows that the input signal contains 2 frequencies. Each signal is in a different frequency bin and each has the same power. The second figure to the right (500 kHz) shows only 1 frequency bin with signal power; both signals are in the same bin! Both displays are correct! The first figure (50 kHz resolution bandwidth) is useful to analyze the signal’s frequency components and the power in each component. The second figure (500 kHz resolution bandwidth) is appropriate to measure the total power in the signal.

**Why use a small Resolution Bandwidth? A small Resolution Bandwidth is appropriate to measure frequency components and signal characteristics. Smaller Resolution Bandwidths increases the Sweep Time (number of traces displayed per second) for a given frequency Span.**

**Why use a large Resolution Bandwidth? A large Resolution Bandwidth is appropriate to measure large Spans of frequencies quickly. A Resolution Bandwidth larger than the signal's bandwidth can measure channel power. The BumbleBee may be set to a larger Resolution Bandwidth and a larger Span to quickly sweep and identify frequencies of interest. The Span and Center can then be decreased to measure frequency components and the signal's characteristics.**

## **5. Traces**



**TRACES (1 is LIVE)(2 is on PEAK)(3 is frozen)**

### **WHAT IS IT?**

**The Traces menu item allows the user to display three different traces in different ways. Each trace can be set to live, peak, freeze, or blank.**

### **HOW TO SET IT?**

**Each trace has a different color. Assign the action for the trace based on the same color buttons. To make a trace report 'live' data, press the 'LIVE' button. Only one trace can be live at a time. To make a trace hold the peak value at each point, press the 'PEAK' button. The reported value will be the highest power at each frequency. Only one trace can be in peak mode at any time. To freeze the current report of a trace, press the 'FREEZE' button. This will display the last report for each frequency.**

**To remove the trace from the screen, press the 'BLANK' button.**



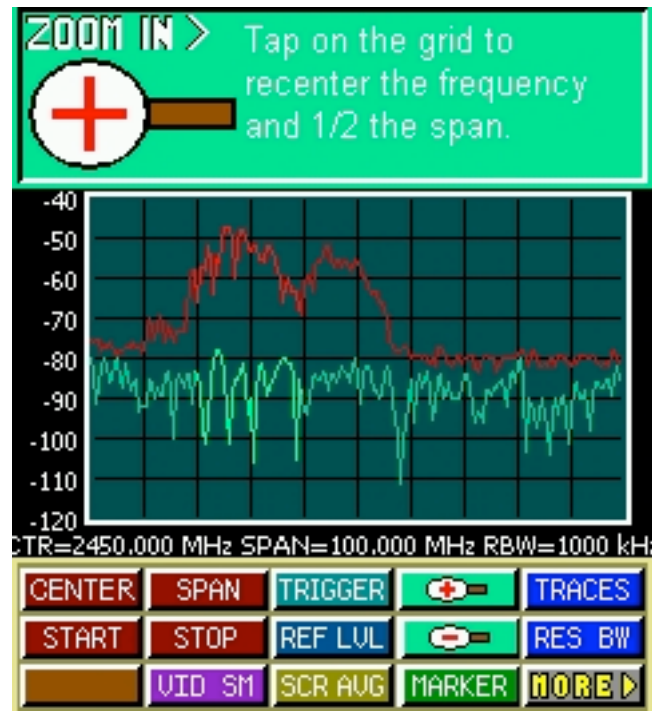
**TIP: Periodically clear “PEAK” hold data by setting the Trace to “LIVE” and then resetting it to “PEAK” hold.**

## **6. Factory Preset**

**The factory option will reset the all settings to the factory default.**

**More Basic Control Panel Options:**

## **7. Zoom In**



**ZOOM IN MODE**

### **WHAT IS IT?**

**Zoom In will reduce the span shown on the display and re-center the frequency on the stylus tap.**

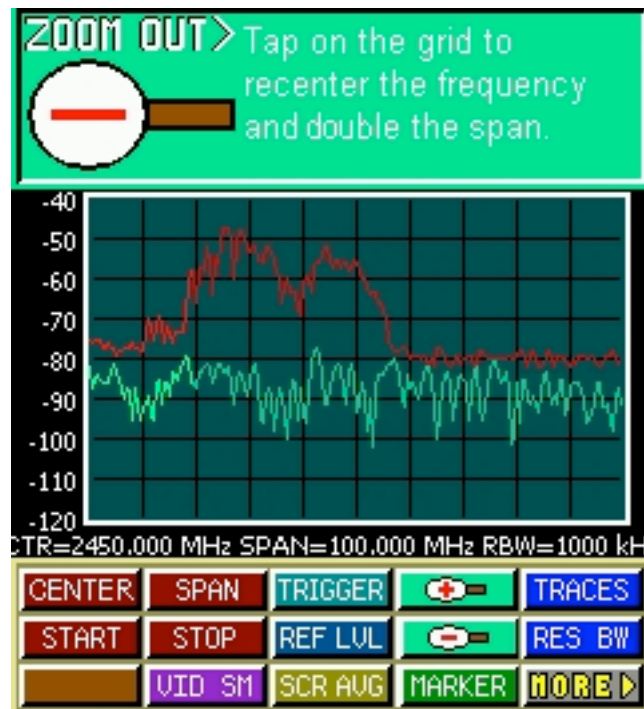
### **HOW TO SET IT?**

**Simply tap on the frequency of interest. The screen will be re-centered on the tapped frequency and will cut the span in half.**

### **WHY TO USE IT?**

**Zooming in on a signal is used to get a clearer picture of a signal by reducing the span.**

## 8. Zoom Out



**ZOOM OUT MODE**

### WHAT IS IT?

Zoom Out will double the span shown on the display and recenter the center frequency.

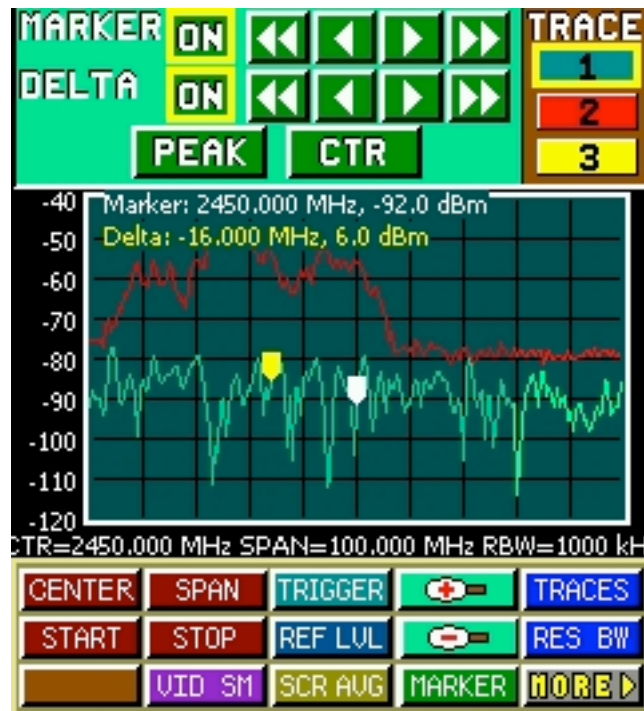
### HOW TO SET IT?

Simply tap on the frequency of interest. The screen will be recentered on the tapped frequency and will double the span.

### WHY TO USE IT?

Zooming out from a signal is used to get a broader picture of a signal by increasing the span.

## 9. Marker Functions



**MARKER ENABLED ON TRACE 1**

### WHAT IS IT?

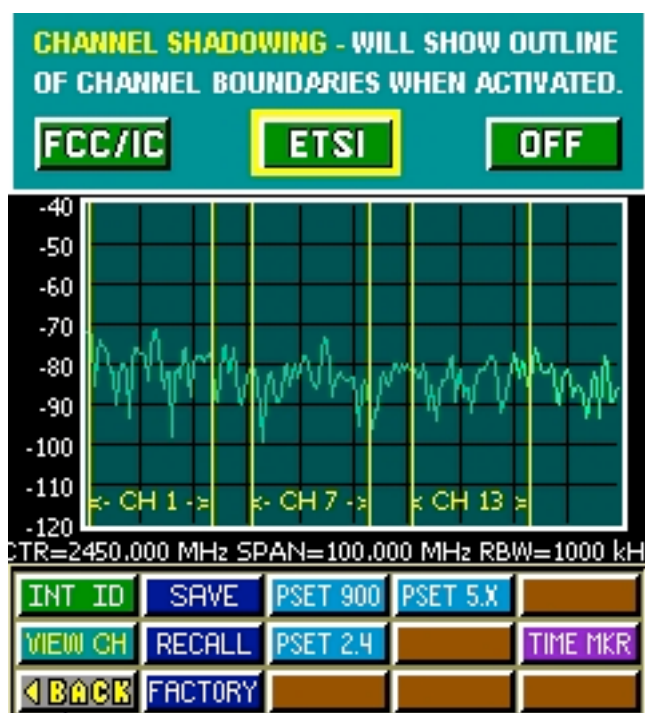
The marker menu option allows the user to place a marker at a certain frequency. The frequency and power values are shown at the marker position. It also allows a delta marker. This delta marker shows the difference in frequency and power from the marker.

### HOW TO SET IT?

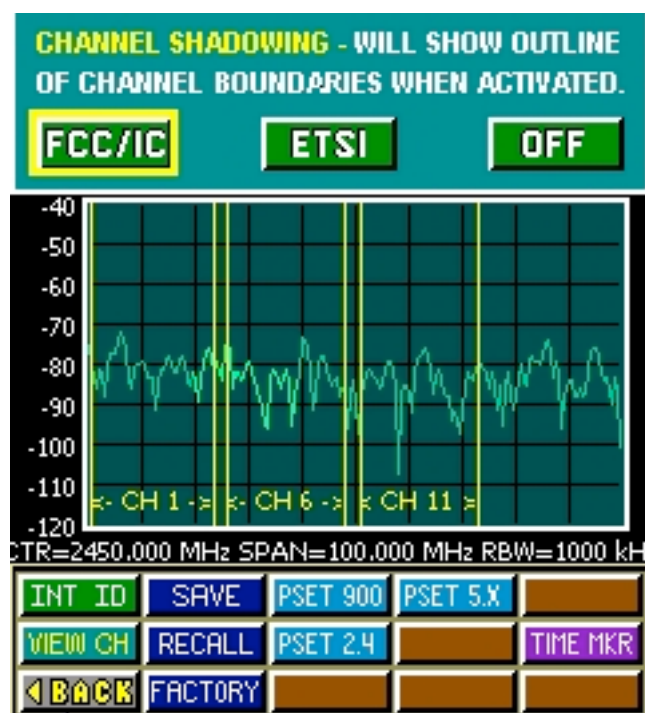
To turn on the marker value and/or the delta marker value, simply tap the 'ON' button for either value. A yellow rectangular box will highlight the 'ON' button. Use the arrows to move the marker or delta value left or right across the screen. Use the double-arrows to move faster. To center the marker on the screen, press the 'CENTER' button. To place the marker on the highest power value, press the 'X PEAK' button. Choose which trace the marker will follow by selecting 1, 2 or 3 from the menu on the right of the marker selections.

## 10. View Channel (Shadowing)

The “view channel” option, when turned “on”, will display boundary markers for either 802.11bg (channels 1,6, and 11) or 802.11a (lower, mid and center U-NII band) whenever the “BAND” preset button is selected in the analyzer screen. Choose ETSI for Europe and FCC/IC for U.S. and Canada.



ETSI channel boundaries



FCC/IC channel boundaries

## CHANNEL SHADOWING

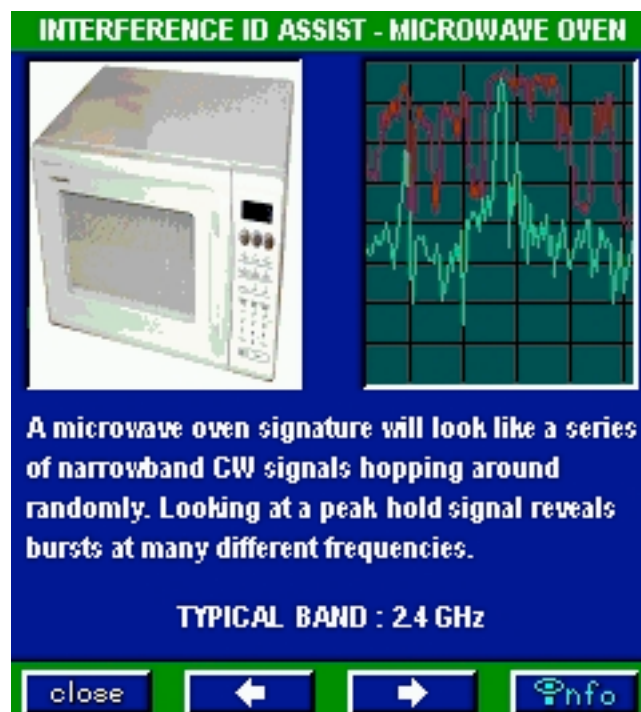
## 11. User Presets

The Save and Recall options allow for saving and restoring current settings on the BumbleBee receiver. File names will be asked for so that the settings files can be moved to other iPAQ's or stored on a PC for loading settings for other BumbleBee units.

## 12. Interference ID Assist

The Interference ID assist option provides a number of example screen shots of spectrum data with associated pictures of equipment which may cause the resulting spectrum display.

A textual comment will appear under the pictures as well as the typical bands for the signal.

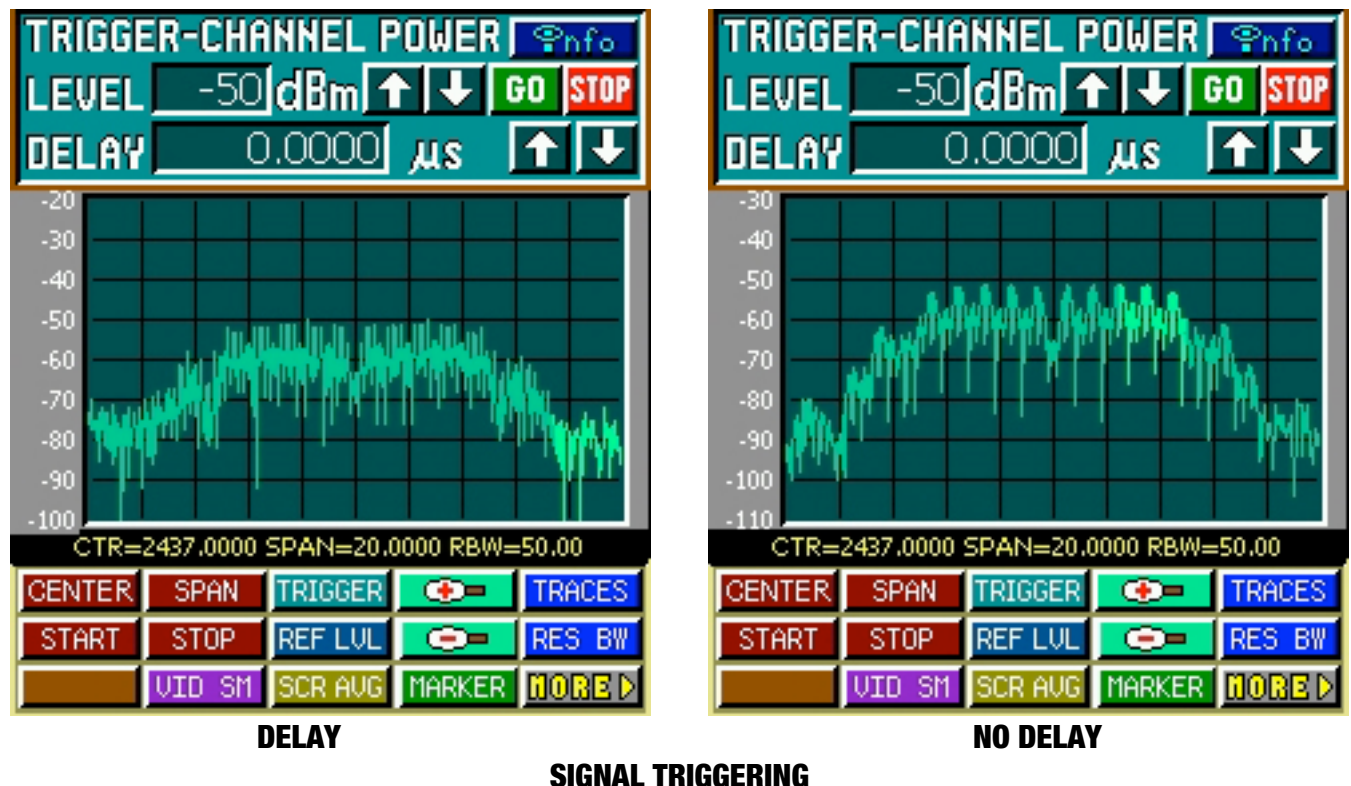


**INTERFERENCE ID EXAMPLE**



## ADVANCED Measurement Screens and Control Panel options:

### 13. Trigger



#### WHAT IS IT?

Trigger Mode enables the BumbleBee to quickly capture the spectrum from sources that are not continuously transmitting. The trigger threshold represents the amount of CHANNEL POWER that when exceeded will trigger the BumbleBee to measure the spectrum. The trigger delay sets a delay between the trigger threshold being exceeded and the measurement of the spectrum. The figures show the spectrum from two different sections of an 802.11b packet using trigger delay.

#### HOW TO SET IT?

The trigger threshold is set by the user in dBm, and its range is from the current Reference Level to 20dB below the current Reference Level.

**NOTE: Span MUST be set to 20 MHz.**

### WHY USE IT?

Trigger Mode is very useful to capture the spectrum from any source that is not continually transmitting on the same frequency. This includes 802.11 a,b,g devices and Frequency Hoppers.

## 14. Video Smoothing



OFF

GOOD

TOO MUCH

VIDEO SMOOTHING (for the same signal)

### WHAT IS IT?

Video Smoothing uses adjacent bin averaging to reduce the amount of fluctuation in the measured trace due to noise. This is different from Screen Averaging, which averages the same frequency bin from different traces.

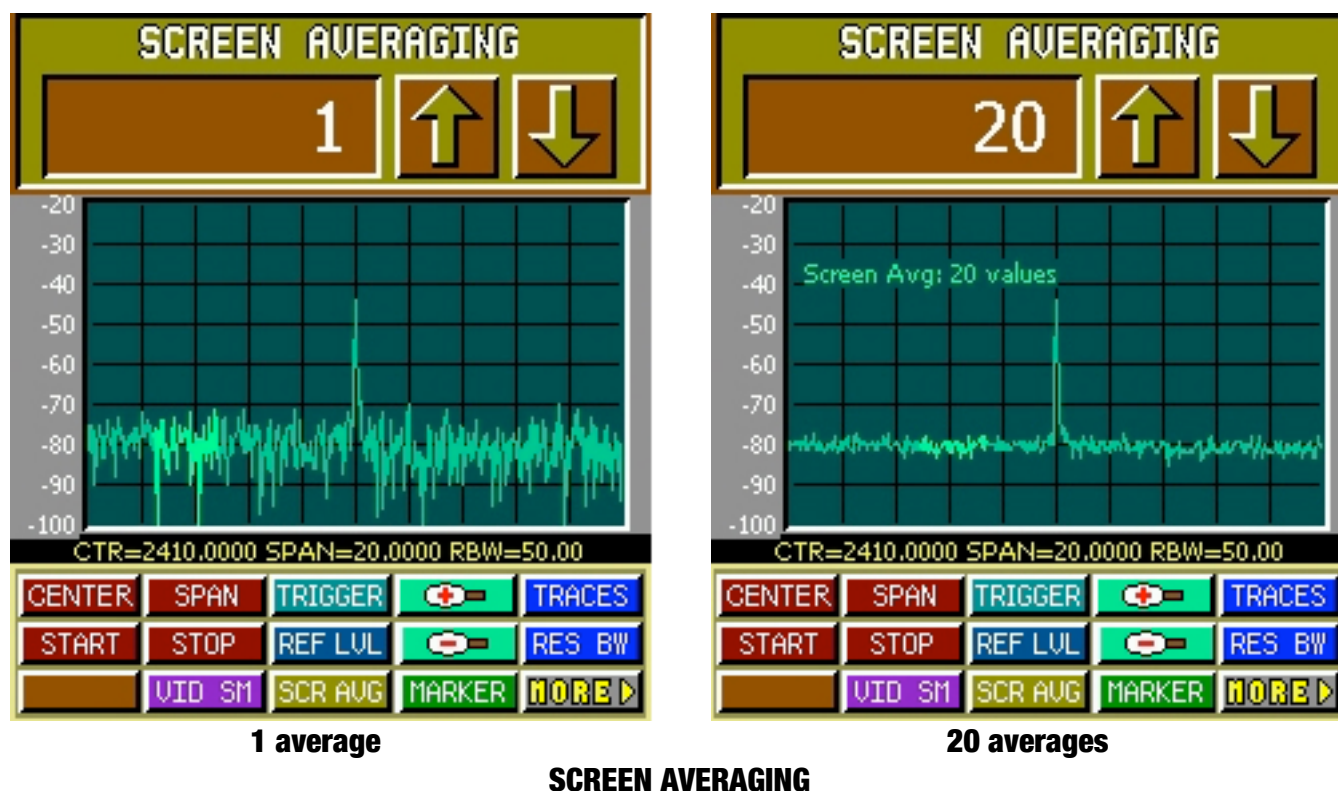
### HOW TO SET IT?

Tap the “ON” button to enable video smoothing. Use the arrows to increase or decrease the number of samples which are averaged for the smoothing. When properly set, Video Smoothing can reduce the variation of the trace due to noise without distorting the trace. It is especially useful for smoothing signals that are not continuous or repetitive.

### WHY TO USE IT?

The user must use good judgment when applying Video Smoothing. It is possible to smooth the trace too much so that the trace no longer represents the spectrum of the signal.

## 15. Screen Averaging



### WHAT IS IT?

The screen averaging option provides an average of data points over the last N traces.

### HOW TO SET IT?

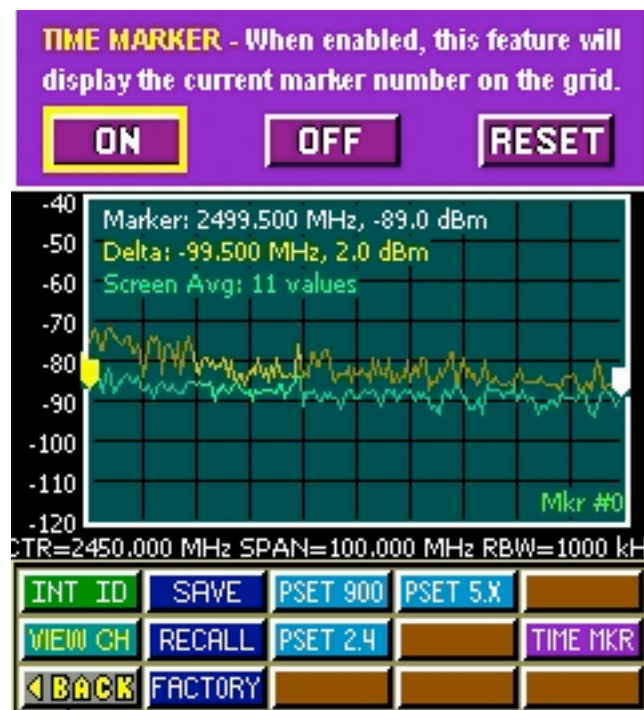
Use the up and down arrows to set this value between 1 and 100. 1 is no averaging. Any value over 1 will take the last N traces and display the average value for each frequency.

### WHY TO USE IT?

Screen averaging is used as another method of smoothing the signal to average noise fluctuations.

## 17. Time Markers

The time marker option, when turned on, will display the current time marker value when in the analyzer screen. The changing of this value results in a change in the time marker stored in any currently recording log file. The reset button sets the marker back to 0.



**TIME MARKER OPTION**

## **PERSISTENCE DISPLAY**

The persistence display holds the peak value of each point in the spectrum sweep for N number of sweeps. The number of sweeps is determined by adjusting the value in the data entry block for persistence. Tap on the “P” icon located in the toolbar to actuate this feature.

The X-axis is the current frequency range. The Y-axis displays the power values.



**PERSISTENCE DISPLAY**



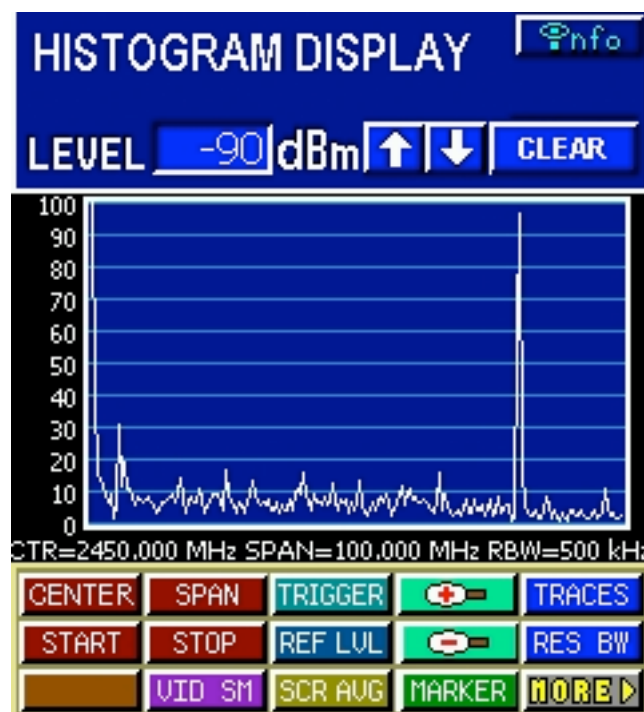
## **HISTOGRAM DISPLAY**

The histogram display shows the percentage, over the last 100 sweeps, of power values at each frequency that is above the user set level.

Tap on the “H” button in the toolbar to activate this feature.

The level is selected by adjusting the value contained in the histogram data entry block. The X-axis is the current frequency range. The Y-axis is the percentage of time (from 0 to 100) when the power value at each frequency was above the set level.

The current percentage values displayed can be cleared by pressing the “clear” button on the histogram data entry block.



**HISTOGRAM DISPLAY**

## **SPECTROGRAM DISPLAY**

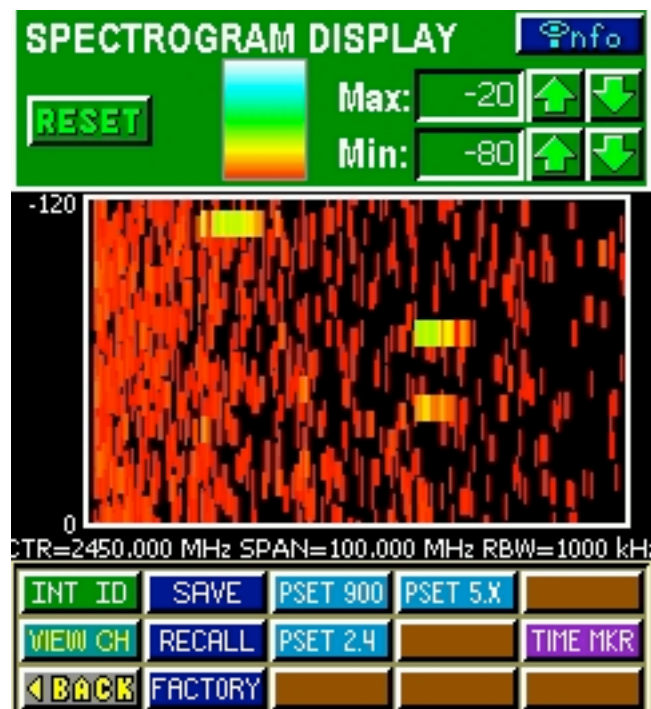
The spectrogram display screen shows the previous 100 sweeps in time. The X-axis is the current frequency range. The Y-axis progresses from the current sweep on the bottom row to the oldest sweep on the top row.

Tap on the “S” button in the toolbar to activate this feature.

The power values are represented by the colors on the color chart shown in the data entry block for the spectrogram display. The minimum and maximum values for the color range can be adjusted. Any value below the minimum power will appear as black. Any value above the maximum power will appear white.

As shown on the image below, DSSS transmission bursts are visible as well as a CW signal that appears constantly on the right part of the current spectrum.

The reset button in the upper left will clear all data from the screen and start from sweep 0.



**SPECTROGRAM DISPLAY**

### **Trigger Mode Example to Measure off-air signals.**

**This section describes how to use the BumbleBee's advanced Trigger Mode to measure off-air signals. This example will measure signals on 802.11 b/g channel 1, but the center frequency may be changed to any that your BumbleBee can tune.**

**A Reference Level Setting of –40 dBm is appropriate for most off-air measurements, and is recommended to start off-air measurements. Changing the Reference Level to –30 dBm will decrease the BumbleBee's sensitivity for stronger signals, and lowering the Reference Level to –50 will increase the BumbleBee's sensitivity for weaker signals.**

**The Trigger Threshold represents the amount of channel power in a 20 MHz channel that must be exceeded to trigger the BumbleBee to measure the spectrum. The Trigger mode requires the span to be set to 20 MHz.**

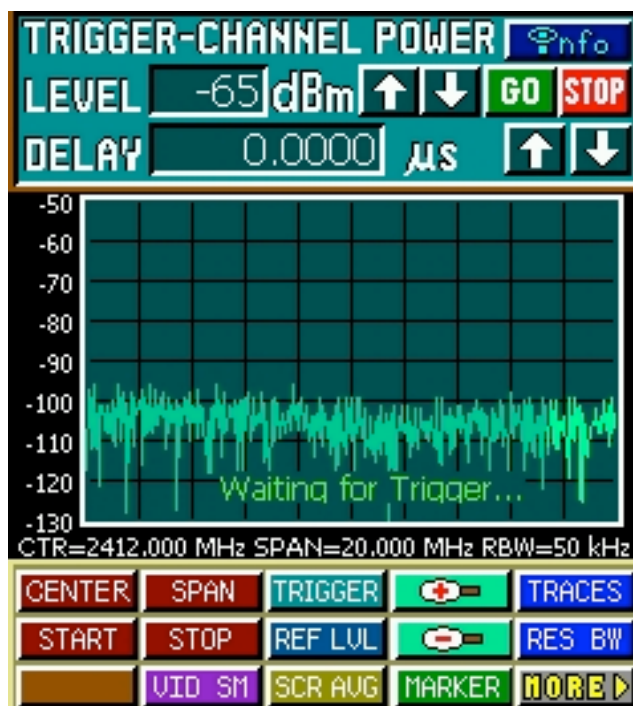
**The Trigger Delay is not typically used for off-air testing and can be left at 0.**

- 1. Start your BumbleBee, if it is not already, as described in the Getting Started section.**
- 2. Connect the 2.4 GHz omni-directional antenna to the BumbleBee.**
- 3. Initialize the BumbleBee: Tap the "MORE>" button on the control panel. Tap the "FACTORY" button on the control panel.**
- 4. Set the frequency range to scan: Tap "PSET 2.4" on the control panel. Tap "1" on the data entry portion of the screen. This will set the center frequency.**
- 5. Set the Span: Tap the "<BACK" button on the control panel. Tap the "SPAN" button and set the Span to 20 MHz.**
- 6. Set the Reference Level: Tap "REF LVL" on the control panel. Change the reference level to –30 dBm.**
- 7. Set Trigger options: Tap the "TRIGGER" button on the control panel. Change the Threshold to –45 dBm.**
- 8. Start the Trigger: Tap the "GO" button on the data entry portion of the screen**
- 9. Check for relatively Strong Signals: The BumbleBee will now trigger and display the spectrum of any signals that have a channel power greater than –45 dBm. If the BumbleBee does not trigger and display a spectrum, no signals are present with a channel power above –45 dBm.**
- 10. Stop the Trigger: Tap the "STOP" button on the data entry portion of the screen.**
- 11. Set the Reference Level: Tap "REF LVL" on the control panel. Change the reference level to –40 dBm.**
- 12. Set Trigger options: Tap the "TRIGGER" button on the control panel. Lower the Threshold to –55 dBm.**
- 13. Start the Trigger: Tap the "GO" button on the data entry portion of the screen**

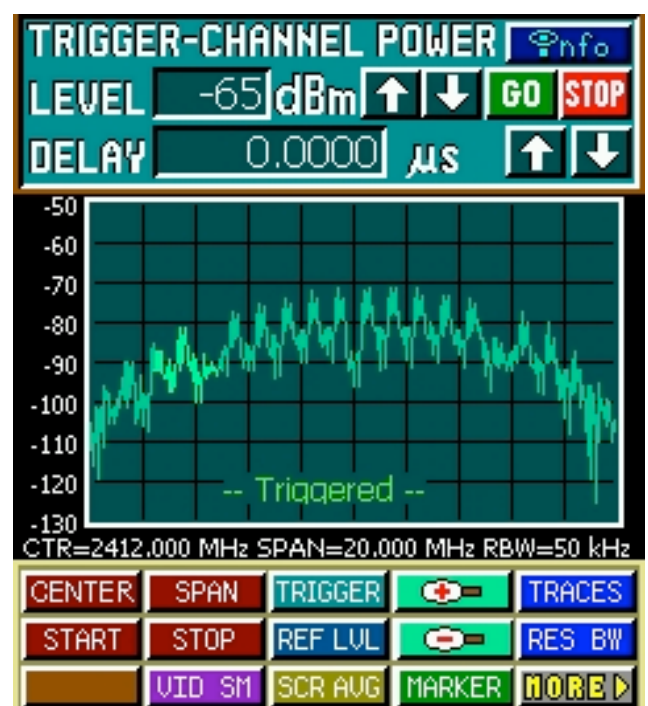
14. Check for Signals: The BumbleBee will now trigger and display the spectrum of any signals that have a channel power greater than  $-55$  dBm. If the BumbleBee does not trigger and display a spectrum, no signals are present with a channel power above  $-55$  dBm.
15. Stop the Trigger: Tap the “STOP” button on the data entry portion of the screen.
16. Set the Reference Level: Tap “REF LVL” on the control panel. Change the reference level to  $-50$  dBm.
17. Set Trigger options: Tap the “TRIGGER” button on the control panel. Lower the Threshold to  $-65$  dBm.
18. Start the Trigger: Tap the “GO” button on the data entry portion of the screen
19. Check for Relatively Weak Signals: The BumbleBee will now trigger and display the spectrum of any signals that have a channel power greater than  $-65$  dBm. If the BumbleBee does not trigger and display a spectrum, no signals are present with a channel power above  $-65$  dBm.
20. Stop the Trigger: Tap the “STOP” button on the data entry portion of the screen to exit the Trigger Mode.

The Reference Level and Trigger Level can be further lowered to check for weaker signals.

Stronger signals may “clip” the display when checking for weaker signals, but weaker signals will not “clip”.



Waiting for Trigger



Triggered

#### TRIGGERING EXAMPLE

# **BVS Chameleon (BumbleBee Edition) User Manual**

## **(for use with BumbleBee controller software version 2)**

### **Introduction**

**Chameleon is a Windows XP application that converts data logged by the BumbleBee into an ASCII delimited file for use in post-processing. The data converted is based on spectrum and triggered spectrum records collected from the BumbleBee using the BumbleBee controller application.**

**BVS Chameleon (BumbleBee Edition)**

File Help

Bumble Bee / Converted Filenames

Input File: C:\Documents and Settings\Owner\My Documents\wimax\_world\Wimax world 2005 show.bb

Output File: C:\Documents and Settings\Owner\My Documents\wimax\_world\Wimax world 2005 show.out

Choose per Record fields

☒ RTC Date ☐ Time Marker

☒ RTC Time ☐ Reference Level

☒ Spectrum Data ☐ Resolution Bandwidth

☐ Triggered Spectrum Data ☐ 'Clipped' (yes/no)

Field Delimiter

☐ Comma ☒ Tab ☐ Semicolon ☐ Space

☒ Include Header Record

Convert Cancel

**CHAMELEON MAIN SCREEN**

### **Spectrum Data**

**Converted spectrum data consists of a complete sweep in every record. The start and stop frequencies are reported. The step frequency between power values is also converted.**



**The power values are then converted from the start to stop frequency.**

### **Triggered Spectrum Data**

**The triggered spectrum data output is the same as the spectrum with the following exceptions:**

- 1. Trigger power level is reported in dBm.**
- 2. Trigger delay setting is reported in nanoseconds.**

**The triggered data appears in the log file only when the triggered power value has been reached. If the power value is not reached, no data will be output.**

### **Other Fields**

**Other fields which may be put into the output file include:**

- 1. The current reference level (in dBm).**
- 2. The current resolution bandwidth (in kHz).**
- 3. The RTC Date (mm/dd/yyyy).**
- 4. The RTC Time (hh:mm:ss).**
- 5. The Time Marker value.**
- 6. Whether or not the sweep peak was clipped (yes/no)**

### **Conversion Instructions**

**To convert a file, use the following steps:**

- 1. Copy the log file off of the iPAQ and onto your desktop or laptop.**
- 2. Run the Chameleon application.**
- 3. Click File/Open to choose a file to convert.**
- 4. A default output filename will be created. Change if needed.**
- 5. Choose which fields you wish to have in the output file.**
- 6. Choose the delimiter to place between fields.**
- 7. Choose whether or not you would like a header record with titles for each column.**
- 8. Press the CONVERT button.**

**The progress bar will monitor the progress of the conversion.**