BumbleBee

Multi-Band Spectrum Analyzer

manual version 2.1

Contents

Unpacking Your BumbleBee

BumbleBee with accessories

BumbleBee user's manual and software

BumbleBee calibrated receiver

iPAQ (optional) inside iPAQ mounting case.

Direction Finding Antenna (optional)

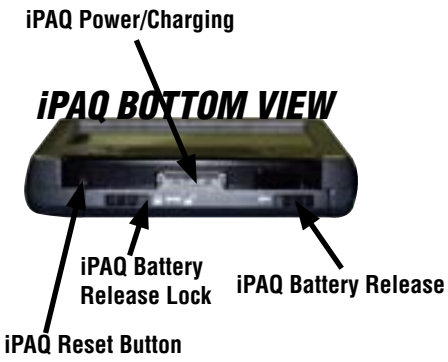
900 MHz antenna
2.4 GHz antenna
4.9/5 GHz antenna

iPAQ charging cradle.

eight AA Ni-MH batteries

BumbleBee AC power adapter with Y connector

Rayovac® Ni-MH fast charger with AC adapter and auto adapter



BumbleBee's serial connection is a removable lock-fit to the connector on the receiver side. This cable assembly (Billionton CF card) is replaceable.

Optional iPAQ 4700/4705 model shown with BumbleBee receiver

Optional iPAQ 2400/2700 model shown

Reset button located on bottom of iPAQ

Starting Up Your BumbleBee

Unpack and assemble your BumbleBee unit as shown. Slide the iPAQ case onto the BumbleBee spectrum analyzer and slide your iPAQ computer into the iPAQ case. Remove the Compact Flash cover and install the Compact Flash serial cable. The Compact Flash serial cable is the communication link between the BumbleBee spectrum analyzer and the iPAQ. Connect both the BumbleBee and iPAQ to external power as shown with the "Y" power cable.

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 male antenna input. iPAQs shipped by BVS are optimized for the BumbleBee. If you are using your own iPAQ, see the optimization section to set up your iPAQ.

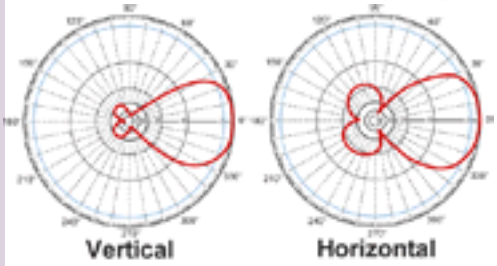
iPAQs supplied by BVS have the BumbleBee software pre-installed. If you need to install the BumbleBee software, see the software installation/re-installation section.

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.

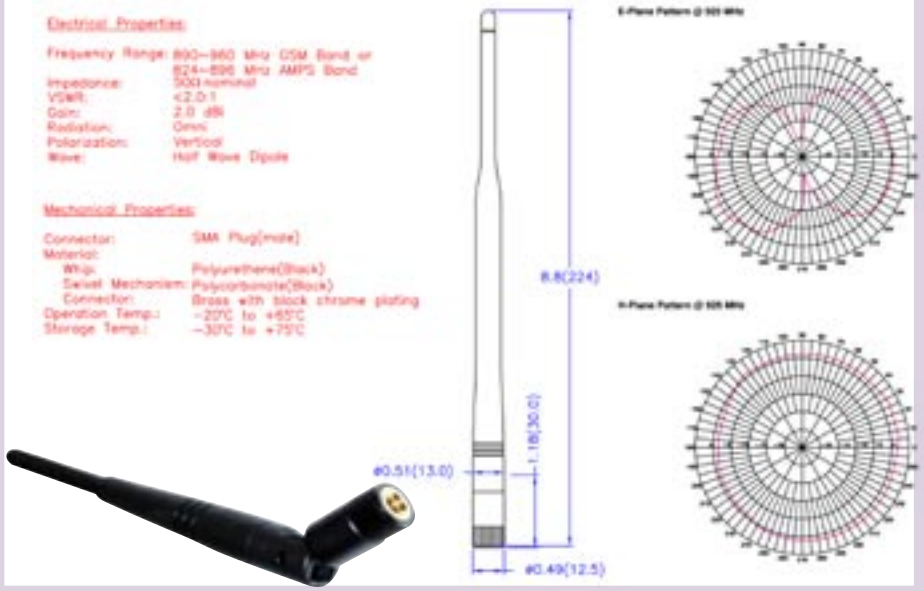
If the BumbleBee software loses communication with the BumbleBee, perform a soft reset by pressing the iPAQ's reset button. If communications problems persist, perform a hard reset by holding down the two outer buttons on the front of the iPAQ while holding in the soft reset button. Remember, hard resets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

900 MHz Direction Finding Yagi

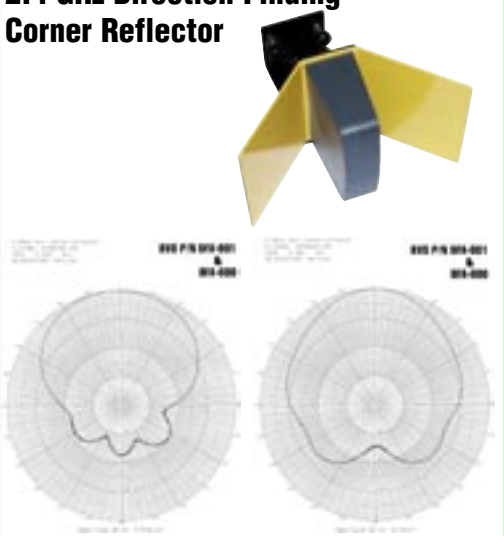


Frequency	890-960 MHz
Gain	9 dBi
Polarization	Horizontal or Vertical
Horizontal Beam Width	54°
Vertical Beam Width	48°
Front to Back Ratio	14 dB
Impedance	50 Ohm
Max. Input Power	100 Watts
VSWR	< 1.5:1 avg.
Elements	5
Weight	1.5 lbs. (0.7 kg)
Length	19.6 in. (0.5 m)
Mounting	2 in. (50.8 mm) diameter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

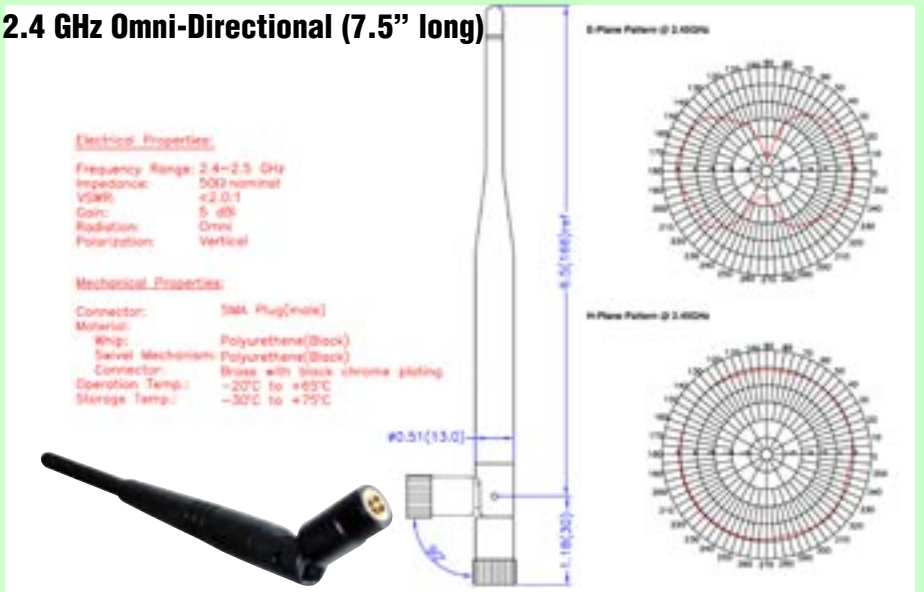
900 MHz Omni-Directional (9.5” long)



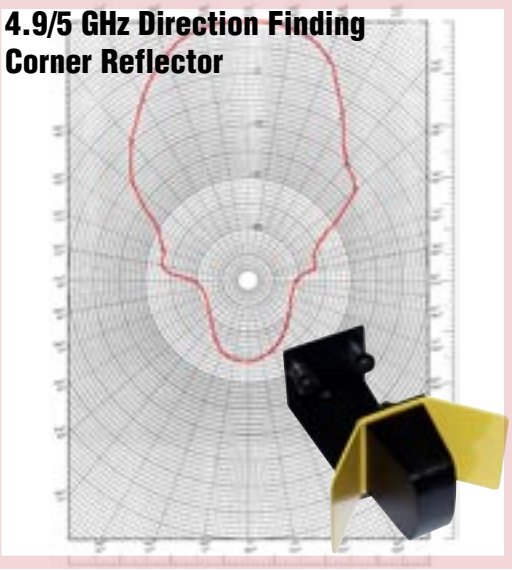
2.4 GHz Direction Finding Corner Reflector



2.4 GHz Omni-Directional (7.5” long)



4.9/5 GHz Direction Finding Corner Reflector



4.9/5 GHz Omni-Directional (5.5” long)

Accessories

Your BumbleBee includes the following accessories: 3 antennae, 2 sets of AA (Ni-MH) removable batteries (8 total) and an optional 12V car DC power inverter. Battery charging time for 4 Ni-MH batteries is just over one hour. Run time is over two hours. BVS supplies 2 battery sets (8 Ni-MH battery cells total) to get users working right out of the box. Ni-MH cells are recommended for best performance from your BumbleBee. **Batteries that are warm or hot to the touch (from constant usage or warm ambient temperatures) will take longer to charge than batteries of a normal temperature. Contact BVS for new Ni-MH battery packs. Expect over 500 cycles from each Ni-MH battery.**

Charging System

The BumbleBee has 2 independent power systems. The 4 AA Ni-MH receiver batteries may only be charged using the supplied fast charger or another comparable Ni-MH charger. The supplied AC power transformer powers both the iPAQ and BumbleBee receiver simultaneously. It will also charge the iPAQ's battery. BumbleBee receiver batteries must be removed and charged in the supplied Ni-MH AA battery charger. The iPAQ internal battery may be charged through either the supplied iPAQ power adapter or the iPAQ data/power/charging cradle power connector. The BumbleBee receiver may be continuously powered through the slimmer power connector.

TROUBLESHOOTING

IPAQ AND BUMBLE BEE POWER ISSUES

Your Bumble Bee Spectrum Analyzer and your HP iPAQ have independent power systems. Each system is described below:

Bumble Bee Spectrum Analyzer Power System

1. May be powered via the 4 internal NiMH batteries or external power.

2. Internal NiMH batteries must be removed and charged with the separate NiMH Charger.

3. The Bumble Bee's internal batteries are not discharged when the Bumble Bee software is not running on the iPAQ.

4. A "Battery Low" message will be displayed by the Bumble Bee Software when the Bumble Bee's internal batteries are low.

5. The Bumble Bee may be powered by an external +5v source supplied with your Bumble Bee. Always close the Bumble Bee software before changing between internal or external power sources.

iPAQ Power System

1. The iPAQ may be powered via its internal batteries or external power.

2. The internal iPAQ batteries are charged internally when the iPAQ is powered externally.

3. 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!

4. An "iPAQ Battery Low" message is will be displayed by operating system when the iPAQ's internal batteries are low.

5. 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 Bumble Bee software must be re-installed from: The folder stored on the iPAQ (iPAQ File Store\Bumble Bee), SD card or download via ActiveSync.

HARDWARE CONNECTION ISSUES

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

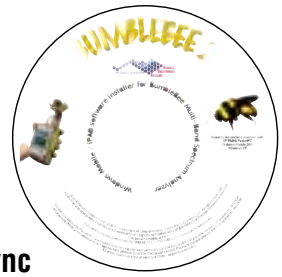
1. Loose connection to CF serial cable. The serial cable may not be fully seated in the CF slot on the iPAQ. Check the connection. A soft boot of the iPAQ may be required. Soft booting is accomplished by pressing the recessed reset button on the iPAQ with the stylus.

2. Low batteries. Test this by running off of A/C power using the supplied 'Y' cable to connect power to both the Bumble Bee and the iPAQ. The charge (Yellow) LED on the iPAQ should be flashing if the cable is connected correctly and the Bumble Bee green 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 Bumble Bee software.

BUMBLE BEE HARDWARE INITIALIZATION FAILURE

SOFTWARE INSTALLATION/RE-INSTALLATION



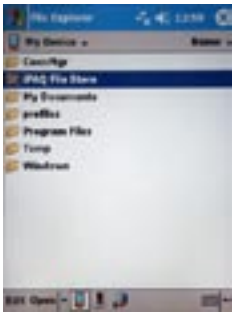
The Bumble Bee software can be installed/re-installed in three ways.

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 Bumble Bee software button.
4. Follow the installation instructions.
5. Software is now installed on the user's iPAQ.

SD (secure digital) card installation

1. The Bumble Bee shipped with an SD card that contains a copy of the Bumble Bee 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.
6. Software should now be installed on your iPAQ.



iPAQ File Store reinstallation

1. A copy of the Bumble Bee software is stored on the iPAQ after original CD installation.
2. Using File Explorer on the iPAQ, go to the 'iPAQ File Store' folder off of the root direc-

tory (“My Device”)
3. There will be a Bumble Bee folder. Open the folder.
4. Run the reinstall program. This will reinstall the application.

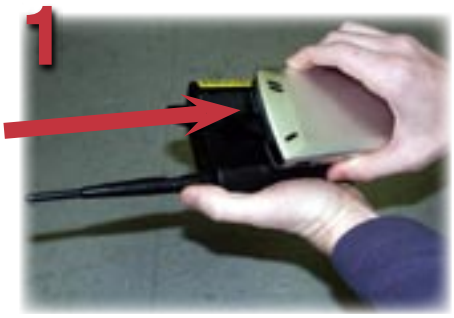
DRIVER INSTALLATION/RE-INSTALLATION

The 24xx model iPAQ needs an updated driver for the Quatech serial card which interfaces to your BVS product. The driver installation program can be found in the “driver” directory of your product CD. Run this executable from your PC while the iPAQ is connected via ActiveSync. After installation, soft boot the iPAQ. Your product should be ready to go. Symptoms of an iPAQ needing this driver include loss of communication in a high-speed data transfer mode (such as spectrum on YellowJackets and Bumble Bee).

Replacing Batteries

If your BumbleBee has difficulty connecting or collecting data and you have verified the iPAQ is fully charged, then you may need to change your AA Ni-MH batteries out for fresh ones. To access batteries under iPAQ:

1. Slide iPAQ back and away from antenna end of receiver. Be sure not to pull too hard on the cable in any way. NEVER remove the Compact Flash connector from the iPAQ sled unless troubleshooting for connectivity issues.



2. Flip over iPAQ exposing the battery compartment on the top of the BumbleBee receiver.

3. Change 4 Ni-MH AA batteries for fresh Ni-MH batteries and repeat steps above in reverse order.

4. When troubleshooting connectivity issues, be sure to GENTLY remove the Compact Flash serial adapter card from the iPAQ. Slowly slide the card out holding it by the very top of the card and NOT the cable. Be sure it is seated properly and slowly slide it back into the iPAQ’s CF housing.

OPERATIONAL TIPS

BATTERY LIFE

1. Ni-MH batteries do not charge to full capacity the first time they are charged.
2. Ni-MH batteries do not charge to full capacity the first time they are charged after a long period of inactivity, or after a long period of non-use.

Cause:

When charging Ni-MH batteries for the first time after long-term storage, deactivation of reactants may lead to increased battery voltage and decreased capacity, (which causes premature termination of charging). Because batteries are chemical products involving internal chemical reactions, performance deteriorates with prolonged storage. This is normal in Ni-MH batteries.

Resolution:

Ni-MH batteries may not charge to full capacity the first time they are charged, or after a long period of inactivity. The first-time charge of the Ni-MH Rechargeable Battery Pack should take approximately 2 hours. If the charger indicates a full charge, in less than 2 hours, repeat the charge cycle as follows:

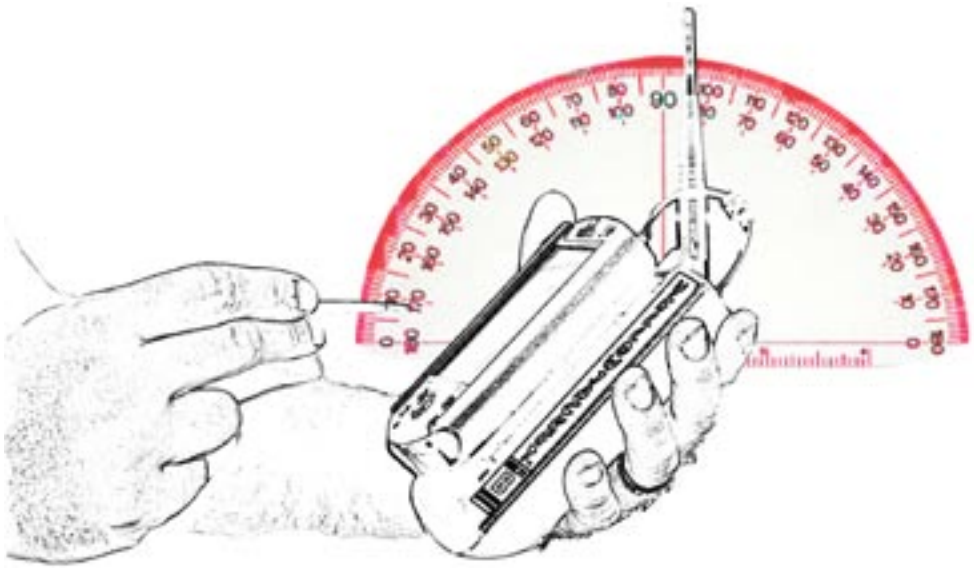
First-time Charge:

1. To begin charging, provide power to charger and insert NI-MH batteries.
2. When the charge is complete, remove the batteries from charger and place back in after several seconds.
3. Repeat steps 1 and 2 three or four times or until the **combined** charge time is 2 hours.

Subsequent charges of the W-LAN Ni-MH Battery Pack will not require multiple charging cycles unless left uncharged for a long period of time (greater than 2 months).

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 as shown below.



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 22xx series:
From the main screen on the iPAQ, select the Bluetooth icon in the lower right-hand portion of the screen. Then choose "Turn Bluetooth Off" from the menu.

HP iPAQ 47xx 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

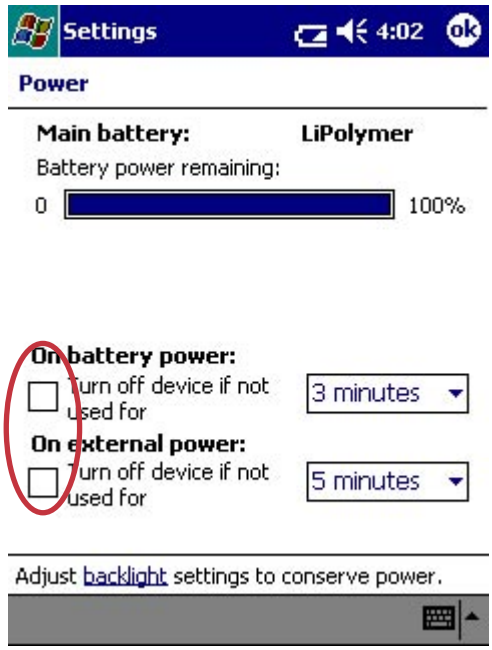
HP iPAQ 47xx series:
From the main screen on the iPAQ, select the antenna icon in the lower right-hand portion of the screen. Then choose the Wi-Fi button to turn off 802.11b.

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%.



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 software runs optimally.

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.

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

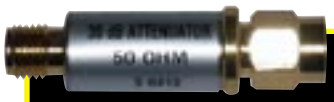
900 MHz Direction Finding Yagi Antenna with mounting bracket, cable & SMA male
9 dBi gain
P/N HG909Y
$ 125.00 OPTIONAL

Data Playback Windows PC Software
$ 250.00 OPTIONAL

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

2.4 GHz Direction Finding Antenna with mounting bracket, cable & SMA male
9 dBi gain
P/N 2ND
$ 250.00 OPTIONAL

OPTIONAL

Soft Field Case
8” x 8” x 3”
P/N BB-SFC
$ 75.00

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

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

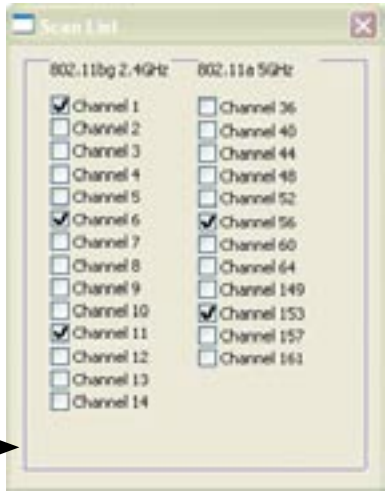
HONEYCOMB™

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.

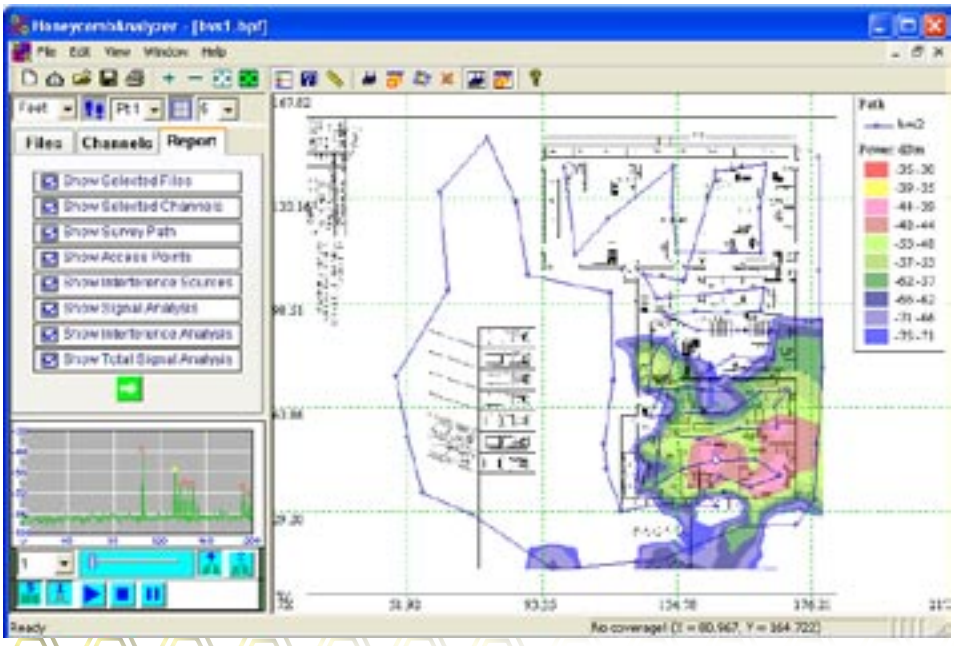


Honeycomb™ scan list allows users to search all Wi-Fi channel allocations for 802.11b/a/g while still in the field.

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)

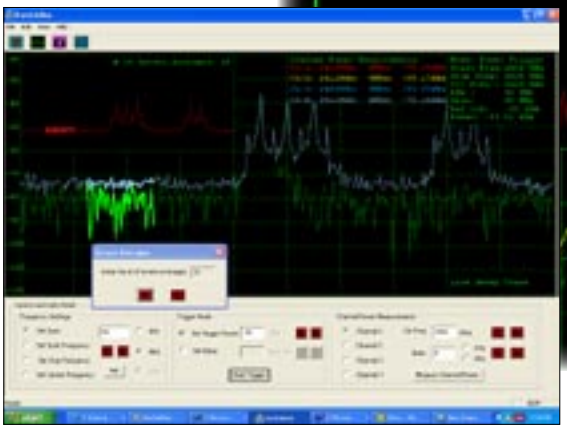
- Imports data from other Honeycomb applications
- Detect/Separate interference from Wi-Fi signals
- Interference severity and channel
- Plot and view interference-related problems
- Wi-Fi channel capacity for intrusion detection
- Plot and view "RF free zones"
- Print and export plots into bmp files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

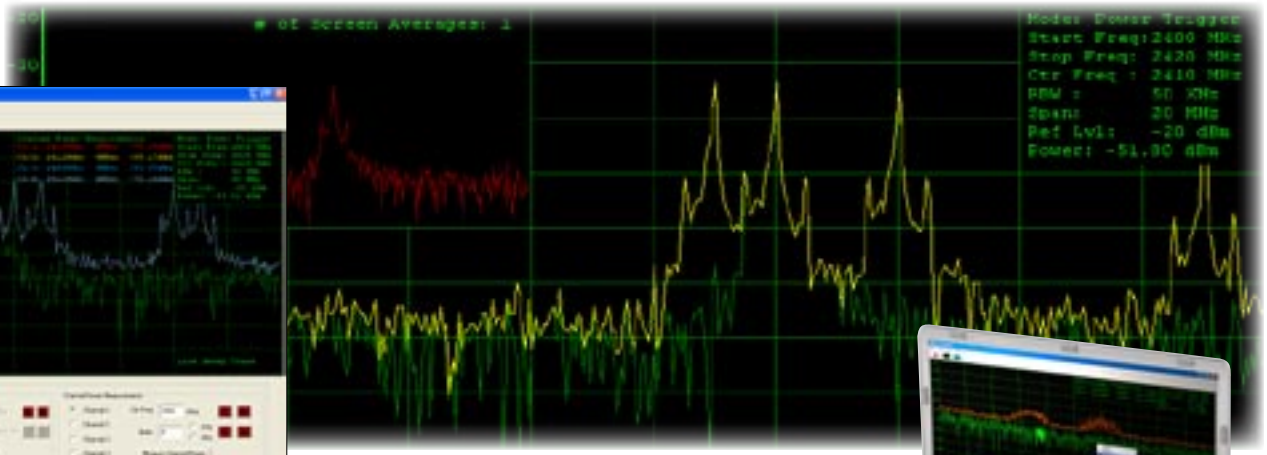
OPTIONAL SOFTWARE AVAILABLE FOR YOUR BUMBLEBEE

NECTAR™

RF Spectrum Analysis Software On Your PC

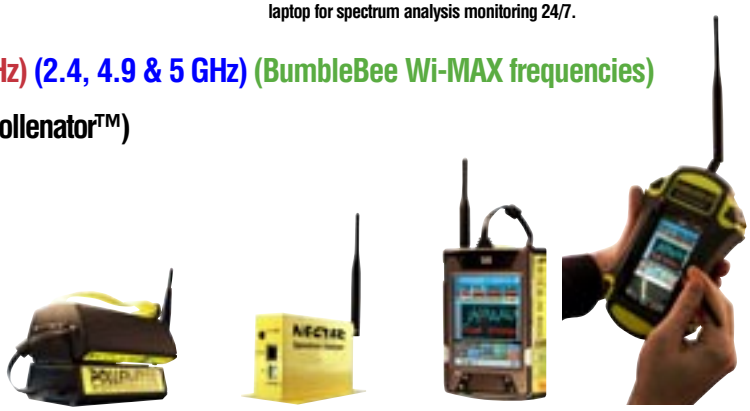
Nectar™ is a Windows® XP software application that scans and monitors a variety of wireless networks. ***Nectar***™ utilizes the **BumbleBee**™ Receiver Module to continuously scan **BumbleBee**™ frequency bands **900 MHz, 2.4 GHz and 5 GHz**, **2.4, 4.9 and 5 GHz** or **(BumbleBee Wi-MAX frequencies)**. 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.





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

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

OPTIONAL SOFTWARE AVAILABLE FOR YOUR BUMBLEBEE

Bumble Bee™

Handheld Multi-Band Spectrum Analyzer

SPOT RFID TAGS

DETECT 802.11 APs

PUBLIC SAFETY BAND

IDENTIFY VoIP SIGNALS

NOW SUPPORTS
4.9 GHz (specify model)
Wi-MAX (specify model)

900 MHz
2.4 GHz
4.9 GHz
5 GHz

BumbleBee™ is a precision calibrated Wi-Fi spectrum analyzer that interfaces with HP's iPAQ® PocketPC®. The handheld receiver measures popular wireless bands: 900 MHz, 2.4 GHz, 4.9 Ghz and 5 GHz. BumbleBee™ allows the user to capture, display and record each of these bands for network installation, coverage and interference analysis. The iPAQ's touch screen allows field engineers to tap on points of interest in the waveform and "zoom" in for further analysis. Advanced spectrum analysis features include 3 WAVEFORM TRACES, PEAK HOLD, PEAK SEARCH, SPECTROGRAM, HISTOGRAM and user selectable PACKET / INTERFERENCE TRIGGERS. BumbleBee™ allows for on-the-fly switching of bands for realtime spectral analysis of many wireless standards including RFID, VoIP, 802.11(b,a,g & Bluetooth) and cordless phones/video. BumbleBee™ is the only true handheld Wi-Fi spectrum analyzer.

Bumble Bee Features:

- 900 MHz, 2.4 GHz, 4.9 GHz, 5 GHz SPECTRUM ANALYSIS (4.9 GHz only available in Public Safety Model)
- IDENTIFY RFID, VoIP, 802.11 & OTHER ISM RF SPECTRUMS
- HP iPAQ POCKETPC INTERFACE
- 3 WAVEFORM TRACES
- RF SPECTROGRAM & HISTOGRAM
- PEAK HOLD / SEARCH
- PACKET / INTEREFERENCE TRIGGERS
- 802.11 CHANNEL PRESETS
- WAVEFORM JPEG SNAPSHOTS

IDENTIFY INTERFERENCE

Berkeley Varitronics Systems
255 Liberty Street, Metuchen, NJ 08840
(732) 548-3737 / Fax: (732) 548-3404
www.bvsystems.com

wireless products
Berkeley Varitronics Systems

Bumble Bee™

Handheld Multi-Band Spectrum Analyzer

Frequency:

Ranges:	902-928 MHz	ISM Band	
	2400 – 2500 MHz	ISM Band	(802.11/802.11b/g standard)
	4940 – 4990 MHz	(Public Safety Band)	*only available in public saftey model
	5150 – 5500 MHz	U-NII	(802.11a standard)
	5500 – 5900 MHz	U-NII	(802.11a standard)

Span:	50 kHz to 800 MHz
Resolution bandwidth:	50 kHz – 1 MHz (50, 100, 300, 500, 1 MHz) Automatic 802.11 preset bandwidths
Video bandwidth (smoothing):	100 kHz – 1 MHz (50 kHz steps)
Screen Averaging:	1 – 100 Averages
Reference Stability:	± 2.5 PPM
Sweep Time:	800 mSec (20 MHz span, 50 kHz resolution bandwidth)

Amplitude:

Average Noise Floor (No input):	< -100 dBm (reference level -70 dBm)
Dynamic Range:	> 40 dB
Level Accuracy:	± 1.5 dB (25 deg. C)
Max input (safe):	+ 0 dBm
Max input (no saturation)	- 20 dB
Reference level:	-20 to -70 dBm (10 dB steps)

Display/Operating System/Memory:

Number of traces:	3 colors
Trace settings:	Peak hold, screen average
Marker functions:	Peak search, center frequency, left, right, delta Screen shots saved to .jpg file
Display (iPAQ):	see HP4700 or HP2200 specifications
Operating system (iPAQ):	Pocket PC™ 2003

Triggering:

Auto or Manual:	
Packet/Interference Trigger:	Trigger analyzer when input power meets or exceeds threshold (20 MHz span)
Trigger threshold:	user settable in dBm.
Trigger delay:	user settable in mS.

Input Connector: SMA Female, 50Ω

Power:

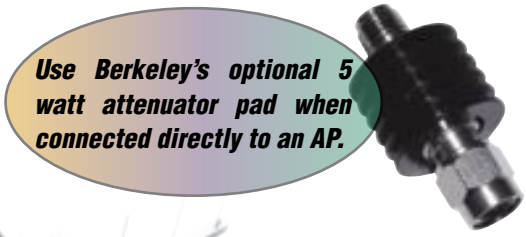
Internal battery:	(4 AA Ni-MH), AC or DC
Run time (internal battery):	> 3 hours
Re-charge time:	< 1 hour

Physical Specifications:

Weight:	3 lbs.
Dimensions:	4”H x 4”W x 6”L

Accessories:
900 MHz Antenna
2400 MHz Antenna
5 GHz Antenna

Optional Accessories:
HX4700 or HX2400 series iPAQ
12V Car Adapter
900 MHz Yagi Antenna
2.4 GHz Directional Antenna
5 GHz Directional Antenna
5 Watt dB attenuator pad



Use Berkeley’s optional 5 watt attenuator pad when connected directly to an AP.

Use Berkeley’s optional 900 MHz, 2.4 GHz, 4.9 GHz or 5 GHz directional antenna to locate and pin-point various sources of interference or hackers.

Berkeley Varitronics Systems, Liberty Corporate Park, 255 Liberty Street, Metuchen, NJ 08840
Phone 732-548-3737 • Fax 732-548-3404 • www.bvsystems.com • E-mail: info@bvsystems.com

Bumble Bee Spectrum Analyzer

iPAQ Interface Software (Version 2)

Introduction

The Bumble Bee is a precision hand-held spectrum analyzer. Spectrum analysis data is displayed by Bumble Bee software running on an iPAQ. This iPAQ is connected to the Bumble Bee via a CF serial cable. The Bumble Bee 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 Bumble Bee 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.

Installation of Software

The Bumble Bee 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 Bumble Bee software.

Getting Started

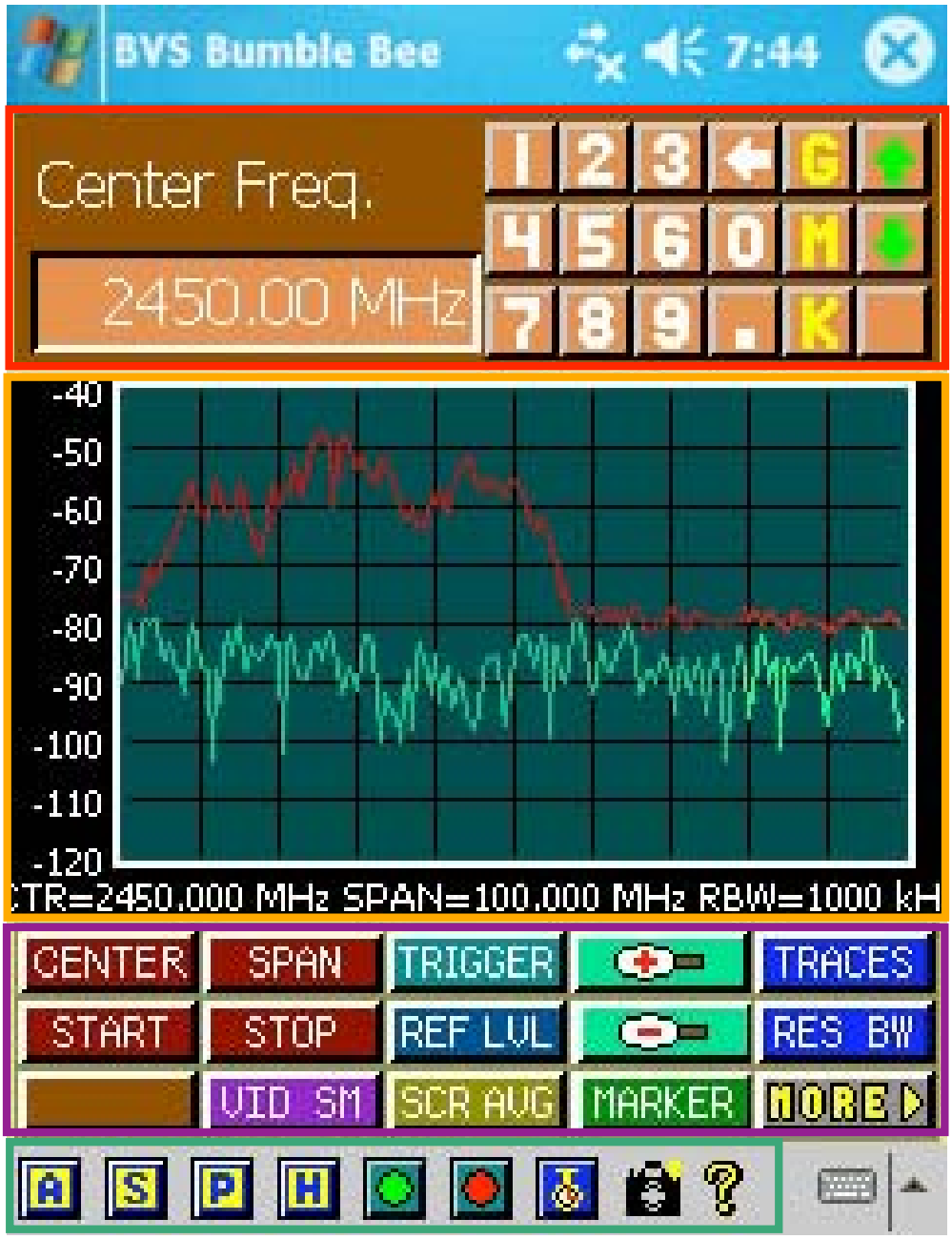
1. Power your Bumble Bee receiver and iPAQ as described in the "starting-up your Bumble Bee" section of the manual.
2. Connect the CF serial cable from the Bumble Bee Receiver to the iPAQ.
3. Tap the Start button on the iPAQ.
4. Tap on the "Programs" folder.
5. Tap on the "Bumble Bee" icon.
6. Tap anywhere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

BUMBLE BEE SPLASH SCREEN

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

BUMBLE BEE ERROR SCREEN WHEN THE SOFTWARE CANNOT CONNECT TO THE BUMBLE BEE

BumbleBee Main Measurement Screen



Data Entry

Measurement

Control Panel

Toolbar

Quick Tour

The Bumble Bee 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 Bumble Bee 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.

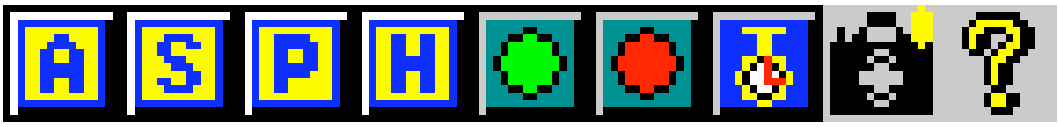
Making a Measurement

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 Bumble Bee: 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:

BUMBLE BEE 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 Bumble Bee 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 Bumble Bee software.

Measurement Screens

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

BASIC Measurement Screens and Control Panel Options

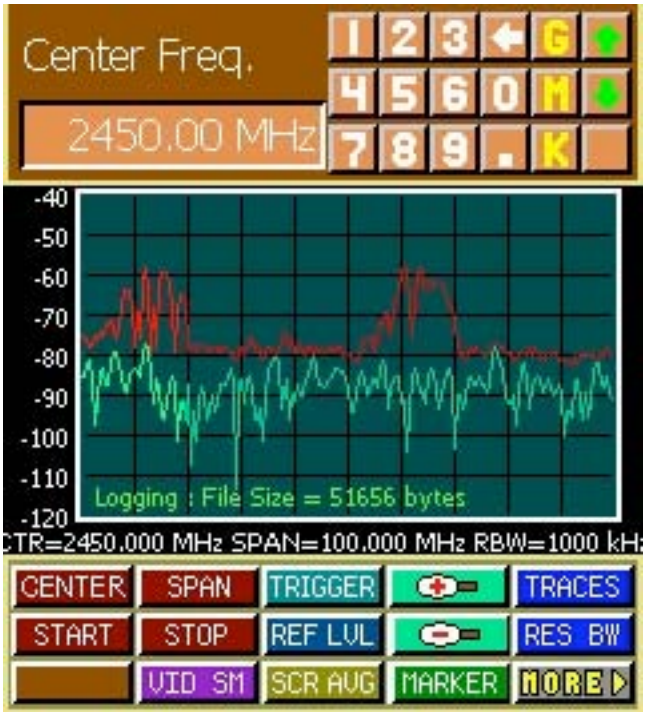
ANALYZER DISPLAY

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

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

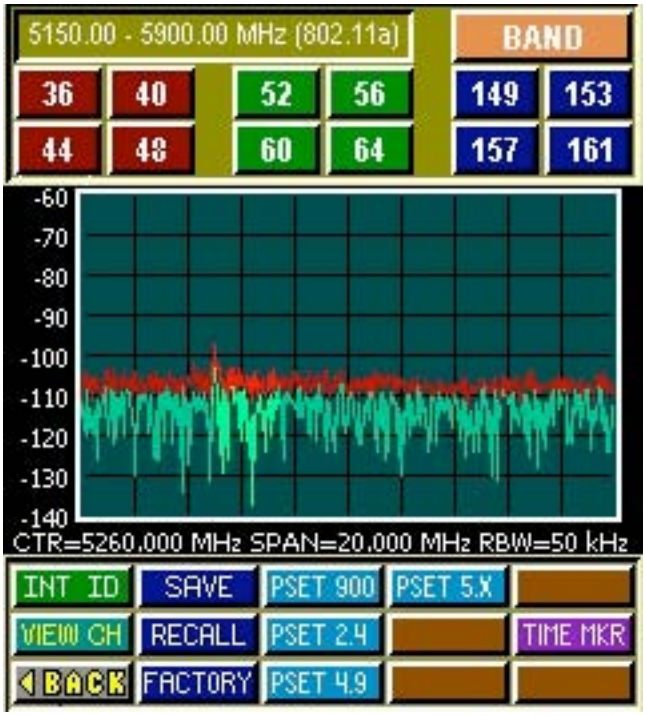
Center Frequency
This menu option allows the user to set the center frequency to be displayed. The value, along with the current span, must not be outside the valid receiver bands.

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

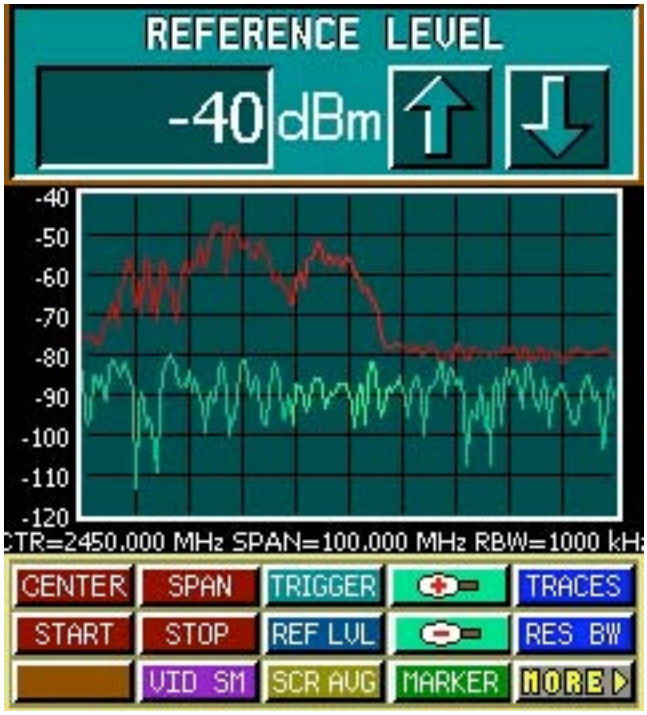
WHAT IS IT?
Presets automatically tune all of the Bumble Bee's settings to appropriate values for a variety of measurement tasks. Each "PSET" button tunes a different band.

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 Bumble Bee's settings. However, the Bumble Bee 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

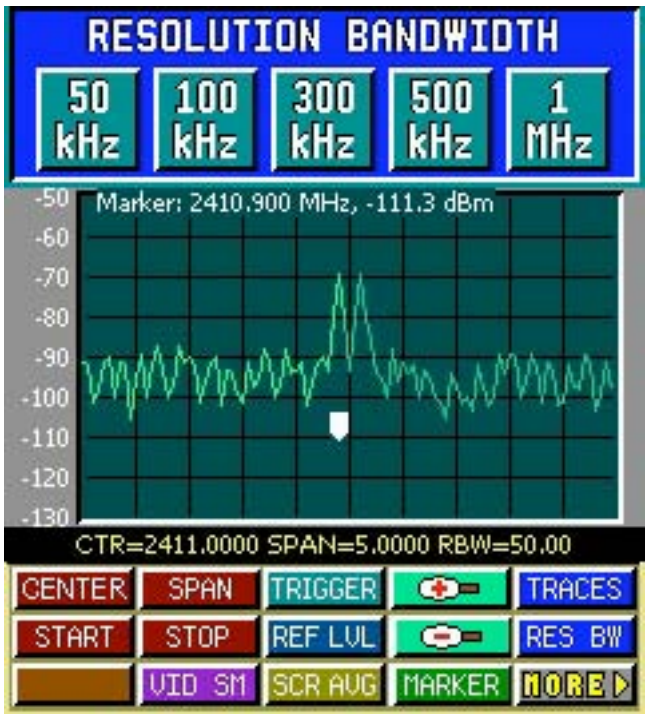
WHAT IS IT?

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.

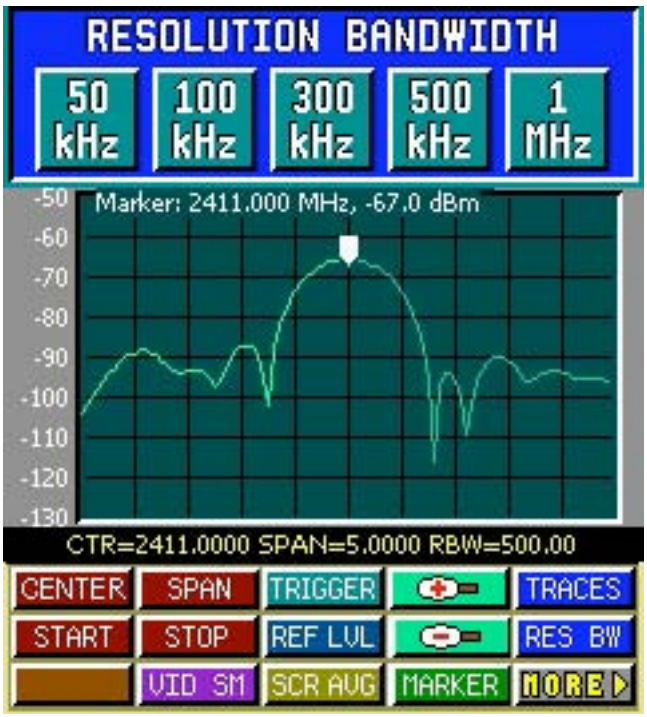
HOW TO USE IT?

The level indicated by the Bumble Bee 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 Bumble Bee 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.

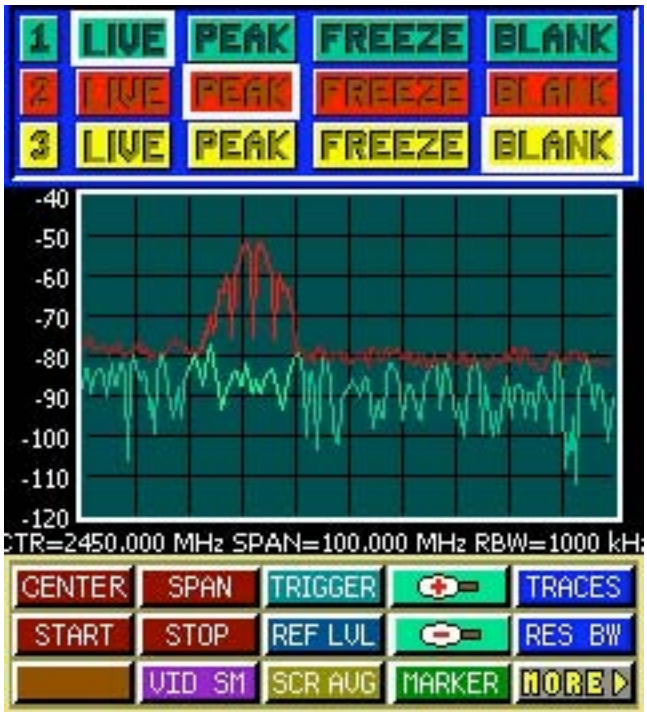
WHY TO USE IT?

The figure depicts how setting the resolution bandwidth can "change" the Bumble Bee'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 Bumble Bee 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.

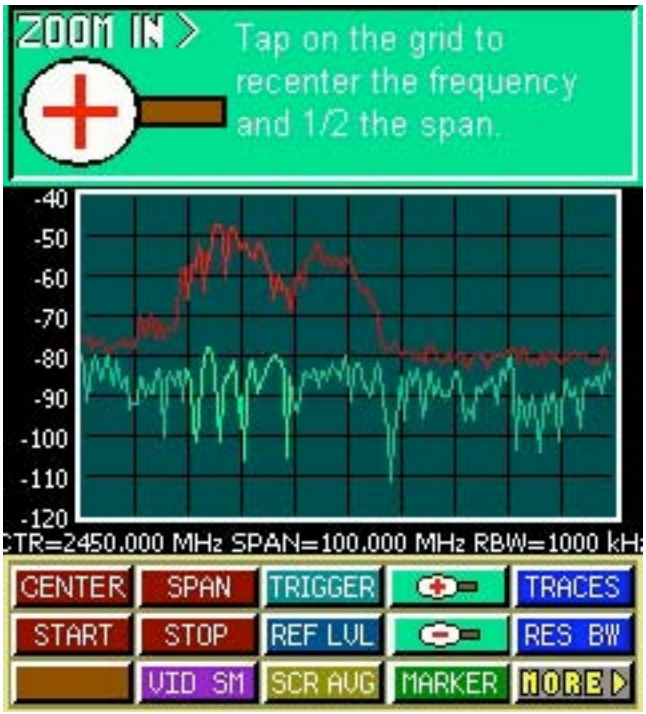
TIP: Periodically clear "PEAK" hold data by setting the Trace to "LIVE" and then resetting it to "PEAK" hold.

6. Factory Preset

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

More Basic Control Panel Options:

7. Zoom In



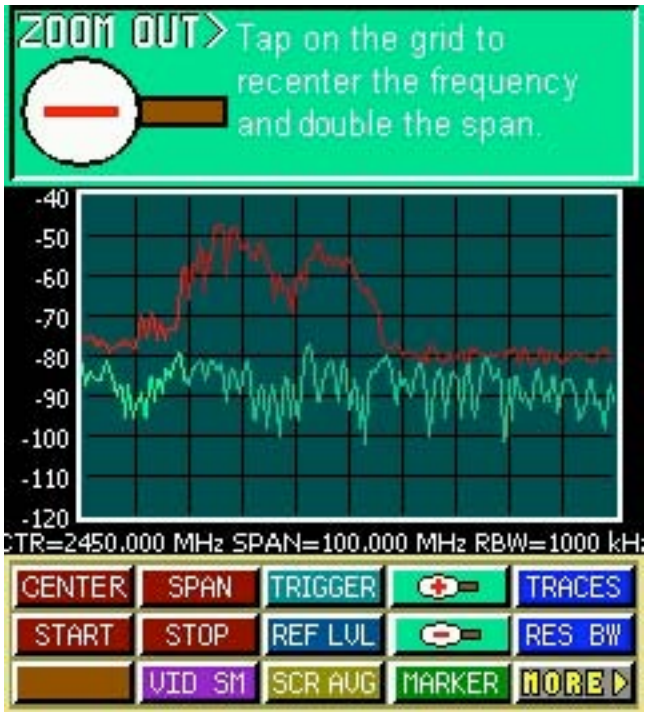
ZOOM IN MODE

WHAT IS IT?
Zoom In will reduce the span shown on the display and re-center the frequency on the stylist 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?

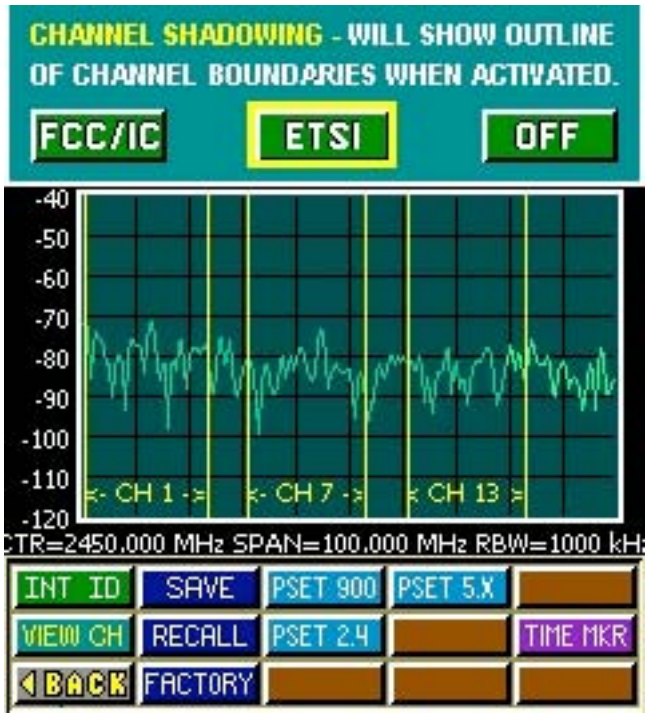
The marker menu option allows the user to place a marker at a certain frequency. The frequency and power values are shown at the marker position. It also allows a delta marker. This delta marker shows the difference in frequency and power from the marker.

HOW TO SET IT?

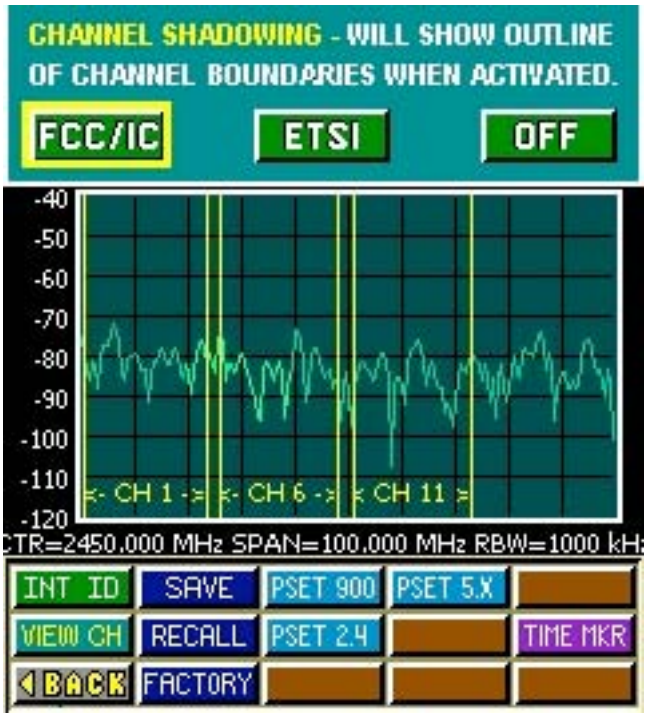
To turn on the marker value and/or the delta marker value, simply tap the 'ON' button for either value. A yellow rectangular box will highlight the 'ON' button. Use the arrows to move the marker or delta value left or right across the screen. Use the double-arrows to move faster. To center the marker 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 Bumble Bee 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 Bumble Bee units.

12. Interference ID Assist

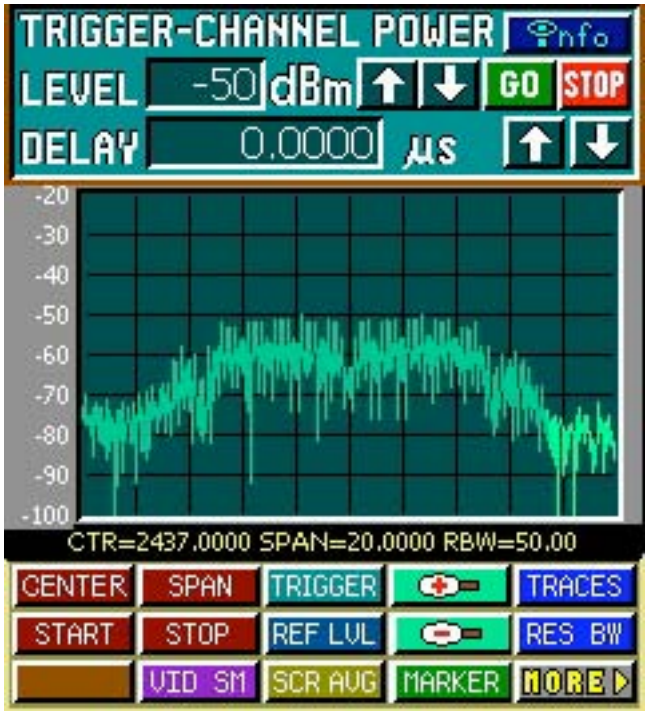
The Interference ID assist option provides a number of example screen shots of spectrum data with associated pictures of equipment which may cause the resulting spectrum display.

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



DELAY

NO DELAY

SIGNAL TRIGGERING

WHAT IS IT?

Trigger Mode enables the Bumble Bee 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 Bumble Bee 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?

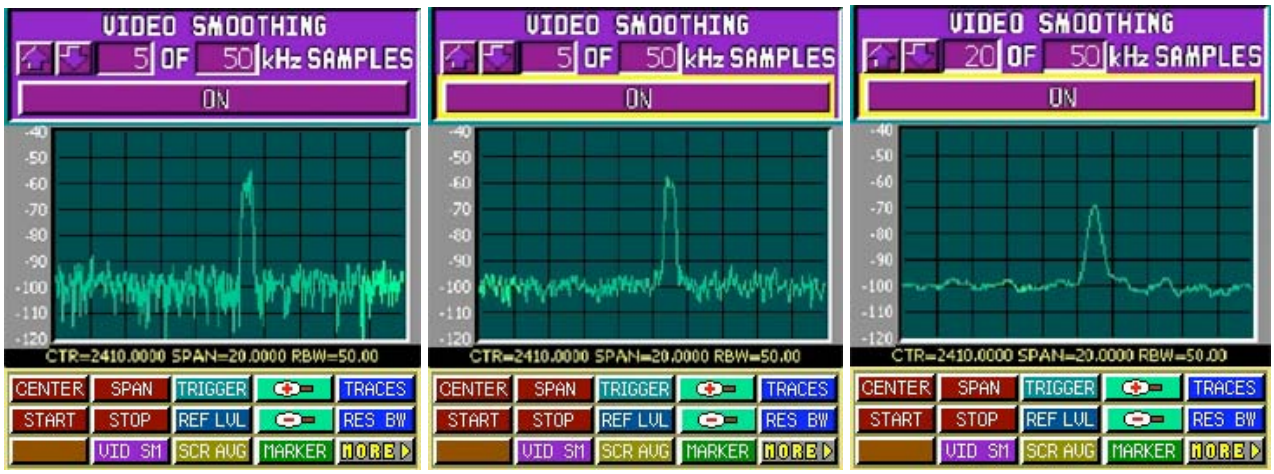
The trigger threshold is set by the user in dBm, and its range is from the current Reference Level to 20dB below the current Reference Level.

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.

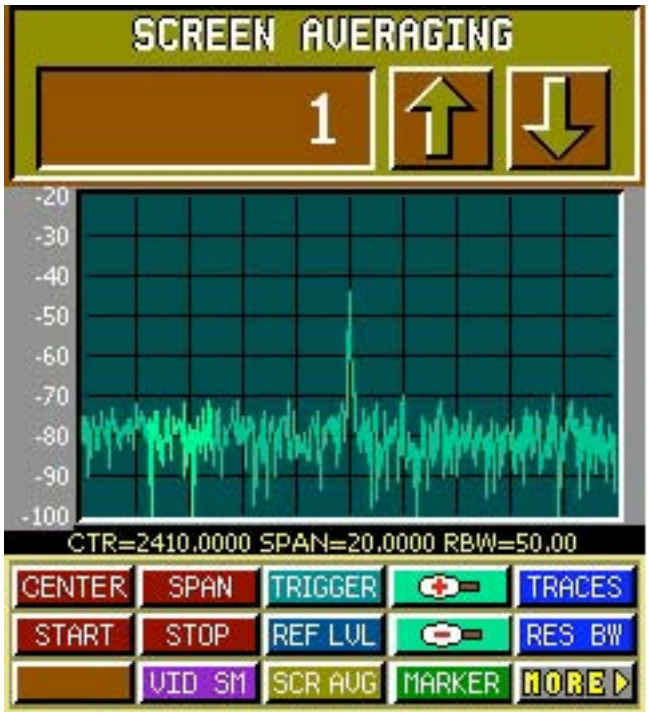
HOW TO SET IT?

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.

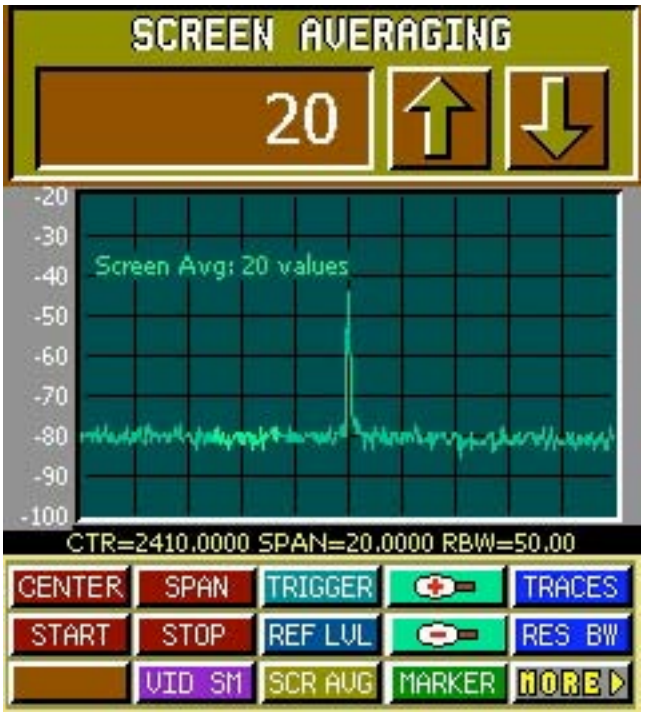
WHY TO USE IT?

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



1 average



20 averages

SCREEN AVERAGING

WHAT IS IT?

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

HOW TO SET IT?

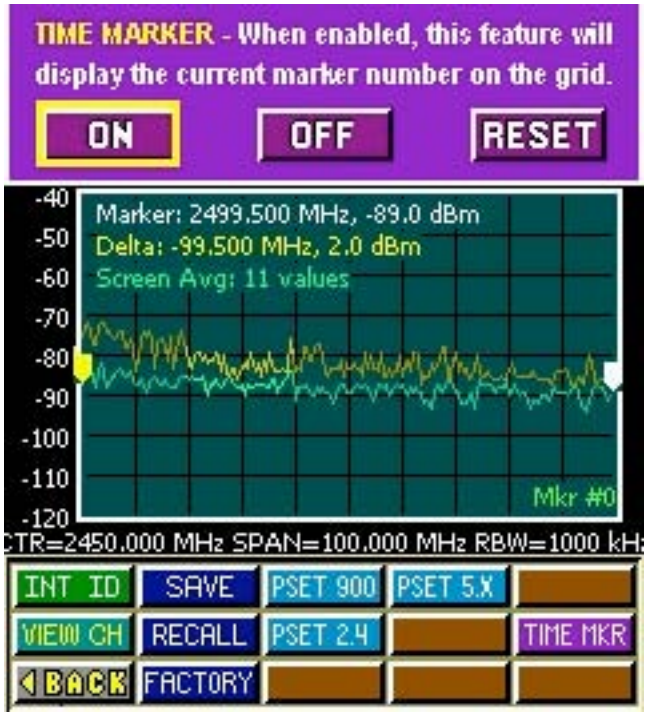
Use the up and down arrows to set this value between 1 and 100. 1 is no averaging. Any value over 1 will take the last N traces and display the average value for each frequency.

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.

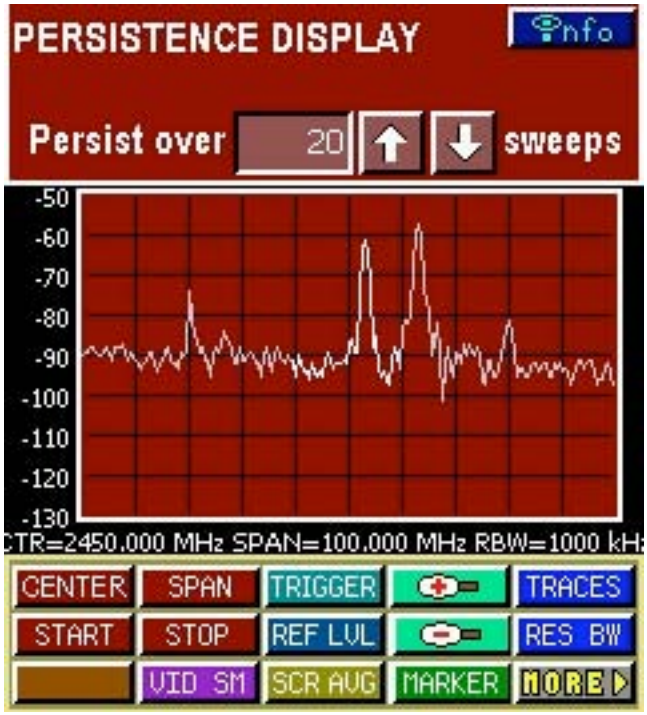


TIME MARKER OPTION

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

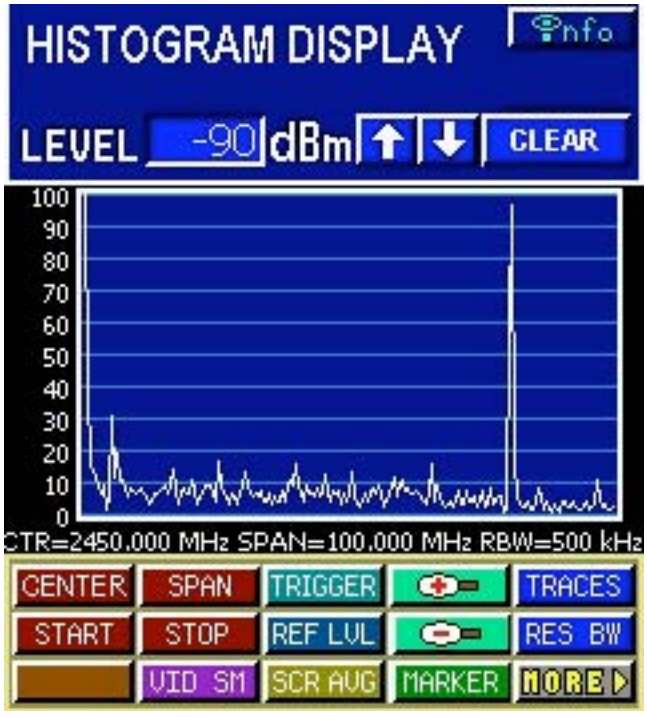
HISTOGRAM DISPLAY

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

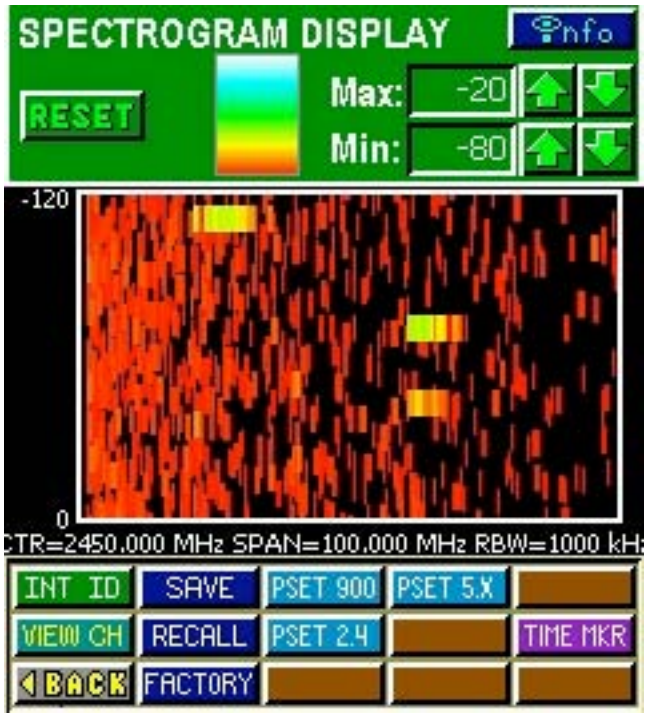
The spectrogram display screen shows the previous 100 sweeps in time. The X-axis is the current frequency range. The Y-axis progresses from the current sweep on the bottom row to the oldest sweep on the top row.

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

The power values are represented by the colors on to 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.

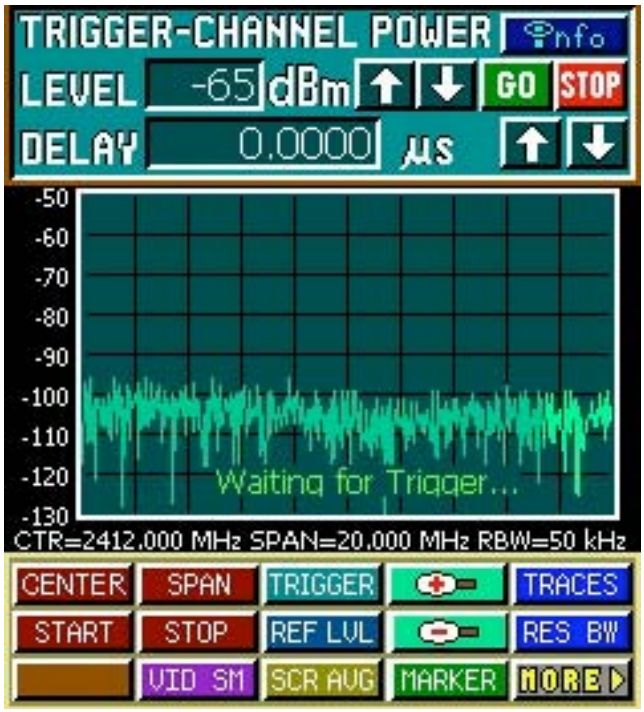
The Trigger Delay is not typically used for off-air testing and can be left at 0.

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**

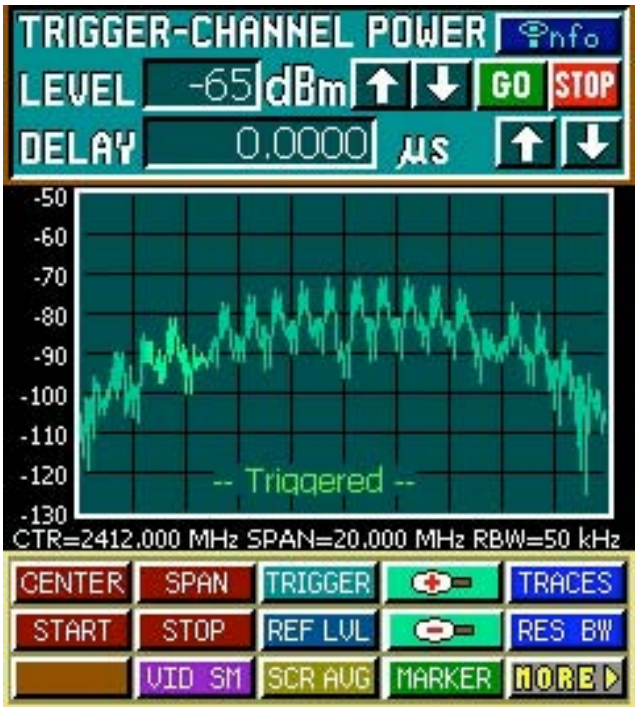
14. **Check for Signals: The BumbleBee will now trigger and display the spectrum of any signals that have a channel power greater than –55 dBm. If the BumbleBee does not trigger and display a spectrum, no signals are present with a channel power above –55 dBm.**
15. **Stop the Trigger: Tap the "STOP" 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

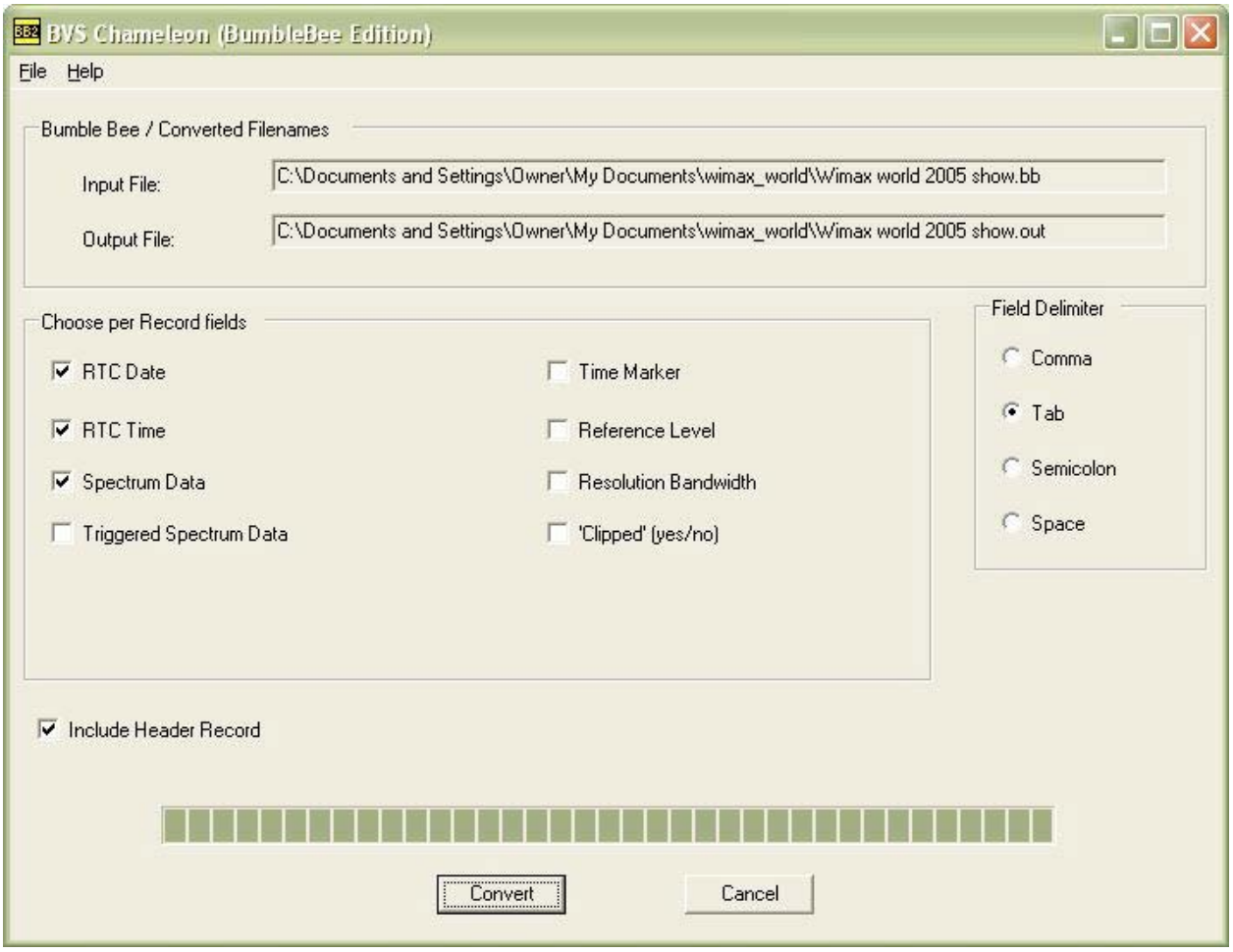
TRIGGERING EXAMPLE

BVS Chameleon (Bumble Bee Edition) User Manual

(for use with Bumble Bee controller software version 2)

Introduction

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



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.