RAPTOR

manual version 1.2

Contents

Raptor Hardware Introduction

Raptor Power

The Transmitter is powered from a 12VDC external power supply. Raptor accessories include Astron AC switching power supply model SS-12.

The Receiver is powered from a 12V battery in the measurement mode of operation, if portability is required. In the training mode of operation or in the measurement mode if portability is not required, the Receiver is powered from a 12VDC external power supply. Raptor accessories include a battery belt and Astron power supply model SS-10.

Raptor Rx and Tx use Rubidium oscillators as primary clock sources. The rubidium oscillators require three times more power when turned-on. This is why the option to power the receiver from an external power supply is provided. It is recommended to power the receiver from the battery only when portability is required. Plugging the battery connector and unplugging the power supply connector and otherwise can be done without interruption of the receiver operation as long as a "make before brake" sequence is preserved. A circuit that provides a smooth transition is built into the receiver.

Raptor Training

Rubidium oscillators have excellent short- term stability. Over time however their frequency can drift. For example, a difference in Tx and Rx frequency of 1E-10 may cause a phase shift or slide of the correlation peak 10ns/s. Raptor uses PN length of 255 chips at the rate of 25 Mchips/s. This means that the range of multiple path ambiguity is 10.2 _s. Such range will be covered in only about 20 min at a slide rate of 10ns/s.

The training mode allows for a substantial increase of this time by means of equalizing the Tx and Rx rubidium oscillator frequencies.

While in the training mode the Raptor Rx input must be connected to the Raptor Tx output using a coaxial cable through a RF attenuator.

***CAUTION! : The power setting on the transmitter and the attenuator should be such that the power does not exceed the level of –30dBm at the receiver input*.**

Operating frequency of the Tx and Rx must be the same. The Tx must be ON.

In the training mode the Tx and Rx rubidium oscillators warm up and stabilize. In addition, the receiver automatically drives its rubidium oscillator to match the frequency of the Tx rubidium oscillator. Depending on the application, higher or lower accuracy of matching can be satisfactory. For example, resulting accuracy of training to 10E-12 provides a slide of the correlation peak of about 10 ns per 20 min of measurement.

Raptor Transmitter Operation (Version 1.1)

Figure 1

Top Panel LED:

UNLOCK: When lit, indicates that the RF is not locked to frequency. The Raptor will NOT transmit if this led is lit.

XMIT: When lit, this led indicates that the Raptor is transmitting.

Rubidium Lock: When lit, this led indicates that the internal Rubidium Oscillator is locked to frequency. The Raptor will not transmit until the Rubidium Oscillator is lacked.

GPS: When lit, this led indicates that the optional GPS receiver is locked.

MAIN POWER: This led is lit when the Raptor transmitter is switched on.

MAIN SCREEN

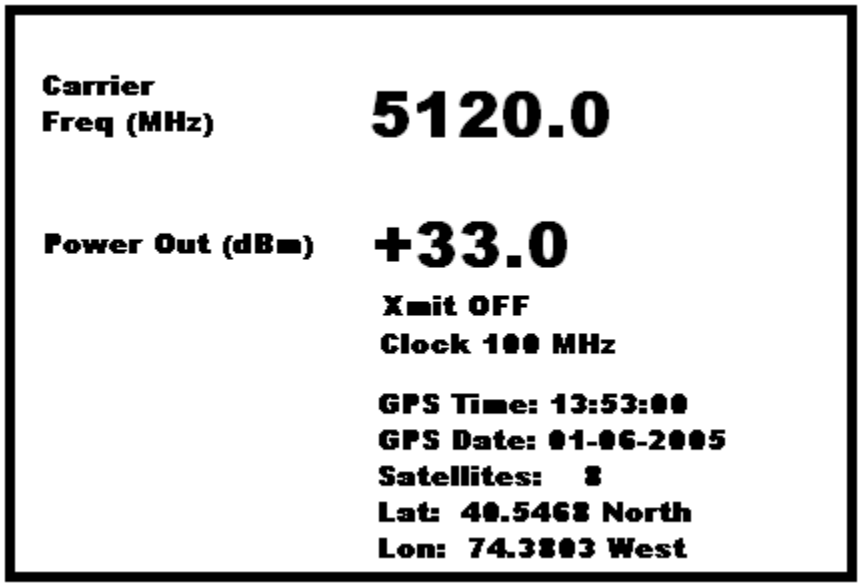


Figure 2

Changing transmitter frequency or power:

The current parameter that can be entered or controlled by the knob is indicated by its text being highlighted, "Carrier" or "Power Out". To move the highlight between the two, press the ENTER key. Note that the above Main Screen display (Figure 2) is an example of the Output Power text being highlighted. To enter a parameter, use the digit keys. The backspace key (left arrow) can be used to move back to correct an incorrect digit. Once the entry is correctly entered, press the ENTER key. The

transmitter must be OFF in order to change frequency or output power level. Pressing the ESC key during entry aborts the current entry sequence and Raptor reverts to the previous values.

Special KEYS:

XMIT: Press this key to turn the transmitter on and off. The current status of the transmitter is indicated on the main screen.

CHAN/FREQ: Press this key to change between frequency display and channel number display.

SAVE: Use this key to save the current frequency/output power combination. Up to 8 frequency and power levels can be saved for later recall.

When the save key is pressed, a special entry screen is displayed that indicates the current frequency and power level and a table of 8 previously saved combinations. To save the current combination of frequency and power in one of the 8 positions in the displayed save table, press the digit that corresponds to the position where the combination should be saved (1-8 key).

RECALL: Use this key to recall any of the 8 saved frequency/power level combinations that had been previously saved.

When the recall key is pressed, the save table is displayed. To make any of the 8 saved combinations of frequency and power current, press the digit that corresponds to its table entry (1-8 key).

Special KEYS (continued):

ESC: This key is used to abort the current entry sequence. If this key is pressed while not in an entry sequence, the SETUP menu is displayed.

SETUP MENU

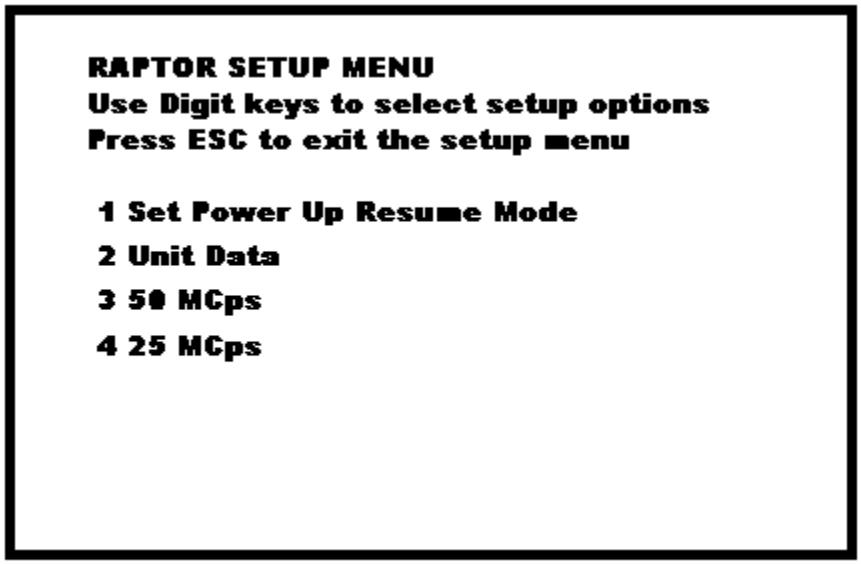


Figure 3

Setup option selections:

Press 1 to control the **Transmit Resume** feature.

When TX resume is ON, the transmitter will resume transmitting when the unit power is restored AND the following conditions as met:

a) The transmitter was ON when unit power was removed.
b) The RF is locked.
c) The Rubidium Oscillator is warmed up and locked.

Press 2 to display the Unit Information screen.

UNIT INFORMATION SCREEN:

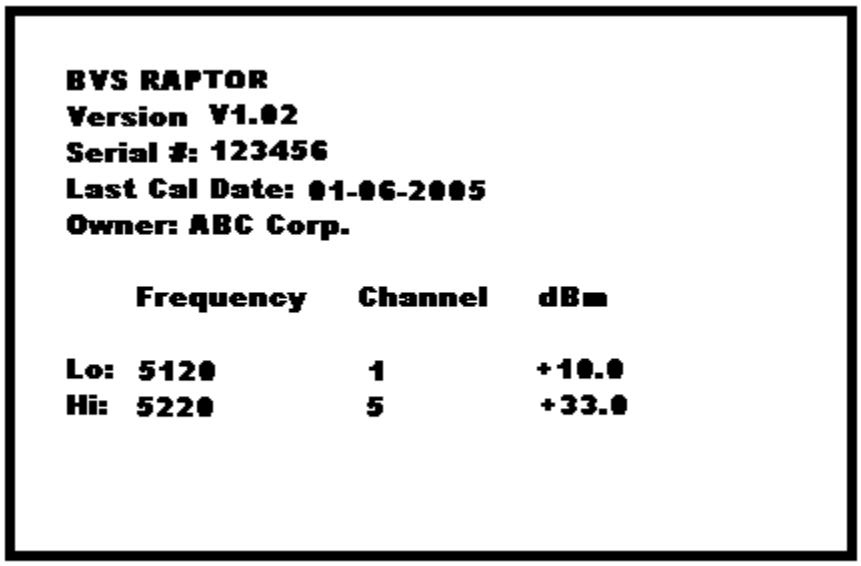


Figure 4

The Unit Information screen displays all of the data required to describe the instrument in the event that it is necessary to contact the manufacturer. In addition, the frequency (MHz) to channel number relationship is displayed along with the power range.

Press 3 for 50 MHz channel bandwidth (50 M Chip/second).

Press 4 for 25 MHz channel bandwidth (25 M Chip/second).

Press 5 to display the Self Test screen.

It should never be required to use any of these options.

a) Keypad test is used to test each key.
b) LED test lights up the status led's in sequence.
c) Reset – reset the instrument.

GENERAL INFORMATION:

The Raptor transmitter holds all programmed parameters in a battery backed up ram that is checksumed so that no setting is lost when the power is removed.

POWER ON SEQUENCE

When power is applied to the Raptor, the following sequence is executed by the instrument:

a) All data required by the instrument saved in the battery backed ram is restored if the checksum is valid. If the checksum is not valid, default values are used.
b) The RF hardware is initialized.
c) The instrument waits for the Rubidium Oscillator to lock and warm up. The warm up time is 3 minutes.
d) If TX resume is on AND the instrument was transmitting when power was last removed, the instrument will resume transmitting after a 10 second count down. Pressing any key during this count down period will abort the re-transmit.
e) The main screen is displayed (Figure 2).

TRANSMIT ON SEQUENCE:

When the XMIT key is pressed and the transmitter is not transmitting, the following sequence is executed:

a) Calibration Parameters are restored for the current frequency and power level on the main screen (Figure 2).
b) RF Lock and Rubidium Lock are checked. Transmit is aborted if either are not locked.

c) The transmitter section is turned on and the output is brought up to the calibration level.

d) When the required level has been reached, the instrument enters a monitor mode where it checks that the output is at the correct level once every second. The instrument remains in this mode until the XMIT key is again pressed (transmit OFF) or the power from the unit is removed.

e) When the transmitter is ON, additional icons are displayed so that it is easy to determine at a glance if the RAPTOR is transmitting (Figure 5).

TRANSMIT ON SCREEN

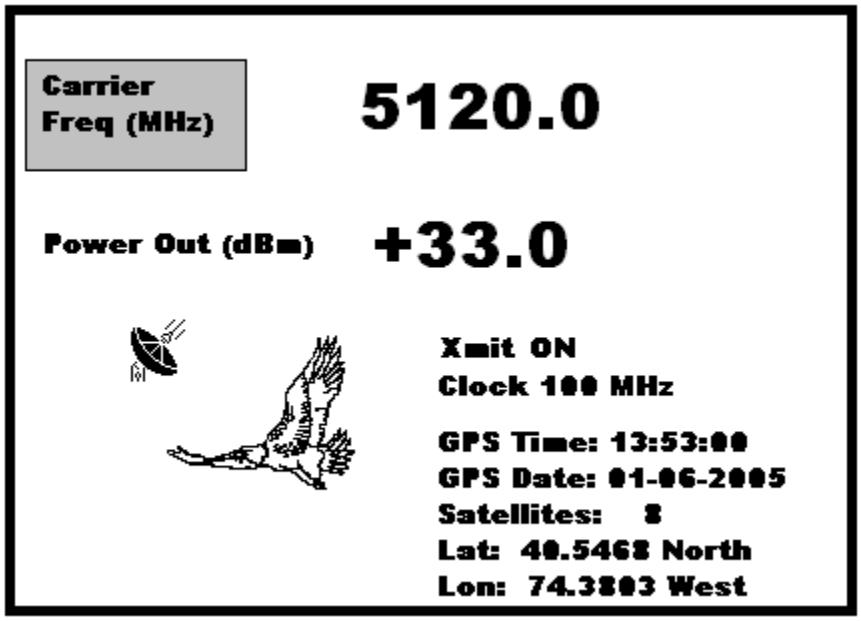


Figure 5

GPS Option:
GPS Data Display

When the Raptor Transmitter is equipped with the GPS option, the data in Figure 6 is displayed on the main screen when the GPS is locked. In order to be locked, the GPS antenna must be connected to the transmitter. At least 3 satellites are required to be visible to the GPS receiver in order for lock to occur. Whenever the transmitter is moved a good distance, it will take longer to lock than normal which is in less than 5 minutes. Use the number of satellites displayed to determine the best position for the antenna. The more satellites tracked, the better. The optional GPS receiver can track up to 12 satellites.

Figure 6

Figure 7 indicates the data displayed when the GPS receiver is not locked.

Figure 7

Raptor Receiver Interface

PC Application

Getting Started

Connect the serial cable from the Raptor Receiver to the PC.

Start the “Raptor Receiver Interface” application.
You should now see a valid firmware version on the screen (not 0.0).

TOOLBAR

The first icon represents the ‘snapshot’ option. A snapshot is taken of the current screen for later viewing.

The second icon is for the measurement screen. This screen shows the correlated data at a particular frequency.

You may choose system setup (the third icon), which enters a screen that will train the receiver reference clock to match the transmitter clock.

The fourth icon is the GPS button. This screen shows current GPS information.

The fifth icon represents frequency/PN and will open a dialog box for setting the frequency of the receiver as well as the PN.

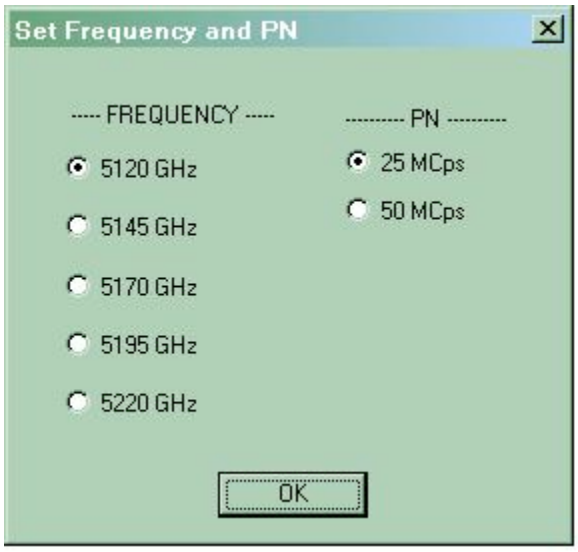
The marker button sets a date/time marker in a log file.

The “record” button is for logging a data file.

The “stop” button is for terminating the logging of data.

Setting the Frequency/PN

After pressing the frequency button on the toolbar, a dialog displays for the user to select a frequency/PN. Select a frequency and PN. Then press the SET FREQUENCY/PN button.



System Setup Screen

NOTE: Please read the section on training in the hardware section of the manual. This will explain what is accomplished during the training process.

TRAINING STARTUP NOTE: Follow these steps before starting training mode:

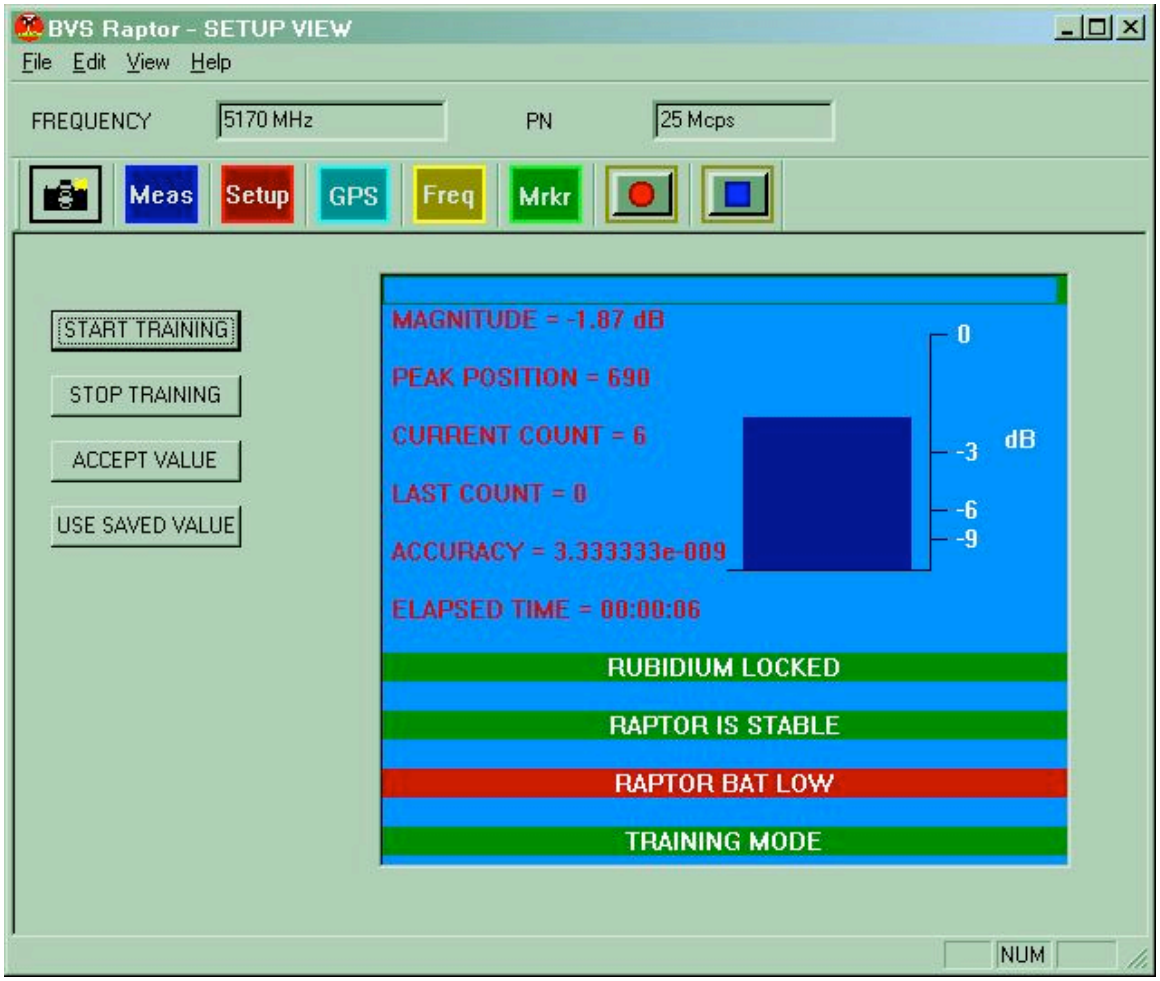
1. Connect the RF output of the transmitter to the RF input of the receiver using a cable and at least 40 dB of attenuation.
2. Go into the System Setup screen.
3. Wait for a strong signal (above –3 dB).
4. Wait for the “RAPTOR IS STABLE” indicator. Do not train when indicator states “Raptor is unstable”.
5. Now press “TRAIN”.

The System Setup screen (as shown below) is where the receiver is trained to the transmitter. It displays the current magnitude (as a value and as a bar graph). It also displays the current peak position.

There are indicators for whether or not the rubidium is warm (locked) and if the receiver is stable (the peak position has stabilized). There is also a low battery indicator.

The final indicator states whether or not training mode has started. The accuracy and count data will be discussed in the TRAINING section below.

NOTE: The “ACCEPT VAL” and “USE SAVED” buttons are only available when NOT in training mode.



NON-TRAINING MODE

In “NOT TRAINING” mode, the training data is received through the serial port but the receiver is not training. This is the mode where you can accept the frequency control value that has been calculated during training mode. This is accomplished by pressing the “ACCEPT VAL” button. If you wish to use the value that had been saved in the receiver previously, press the “USE SAVED” value.

TRAINING MODE

Pressing the “TRAIN” button starts “TRAINING MODE”. Pressing the “STOP” button stops training mode.

During training mode, an elapsed time indicator shows the time in hours, minutes, and seconds since the training mode was started. The accuracy value is calculated using the following formula:

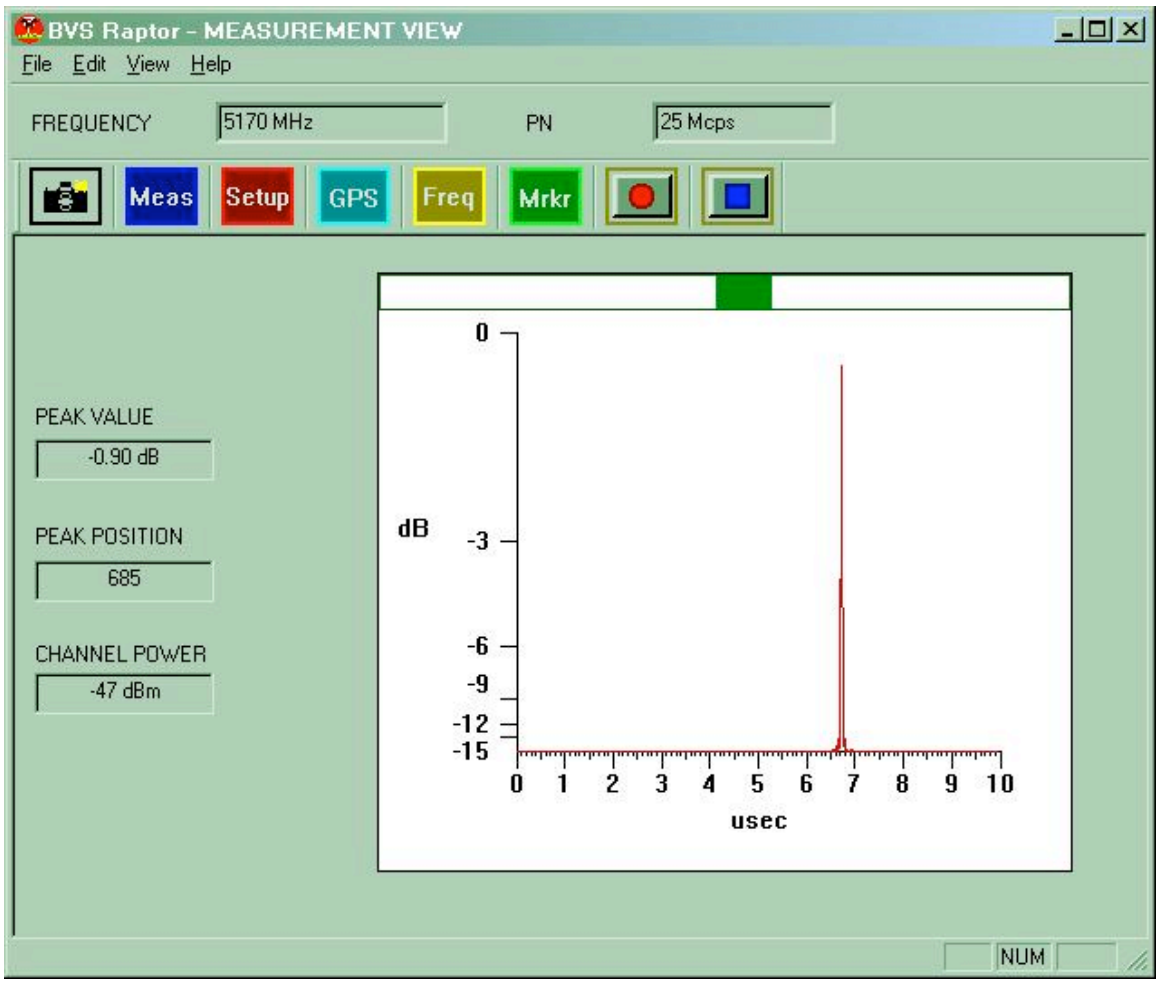
Accuracy = (20ns)/max(Current Count, Last Count)

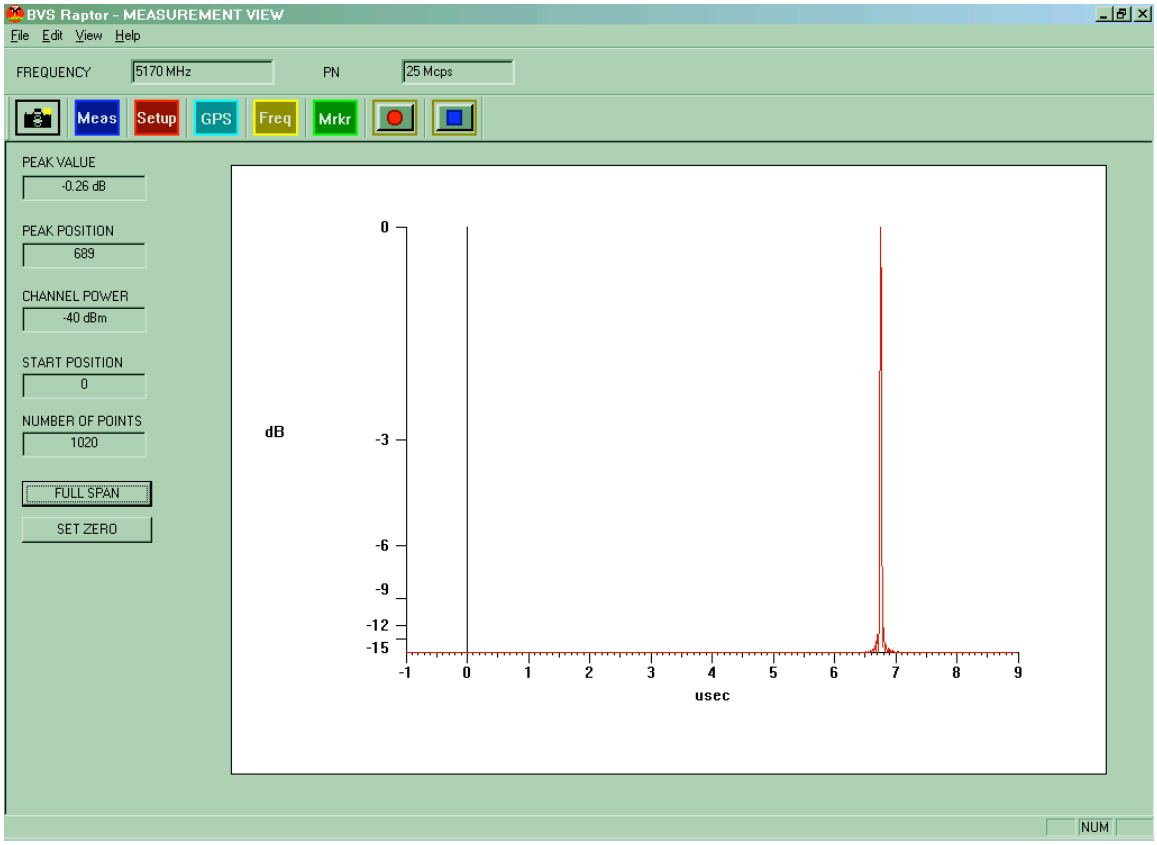
The current count is the number of seconds since the peak value shifted 1 sample. This value is placed in the last count when a change does occur. Then the current count is set back to 0.

When the desired accuracy is achieved, turn training mode off and then press the “ACCEPT VAL” button.

Measurement Screen

The measurement screen displays the correlated data as it is received through the serial port from the receiver. The screen below shows the screen in the 1us Zoom mode. When entering the screen, normally 1020 points over a span of just over 10us is displayed. The vertical axis represents the portion of channel power in each multi-path component. The horizontal axis represents time of arrival of each signal component.


BVS Raptor – MEASUREMENT VIEW
File Edit View Help
FREQUENCY
5170 MHz
PN
25 Mcps
Meas
Setup
GPS
Freq
Mrkr
PEAK VALUE
-0.90 dB
PEAK POSITION
685
CHANNEL POWER
-47 dBm
0
dB
-3
-6
-9
-12
-15
0 1 2 3 4 5 6 7 8 9 10
usec
NUM



The peak value and position are displayed in the lower left-hand portion of the screen. Underneath these values is the channel power in dBm.

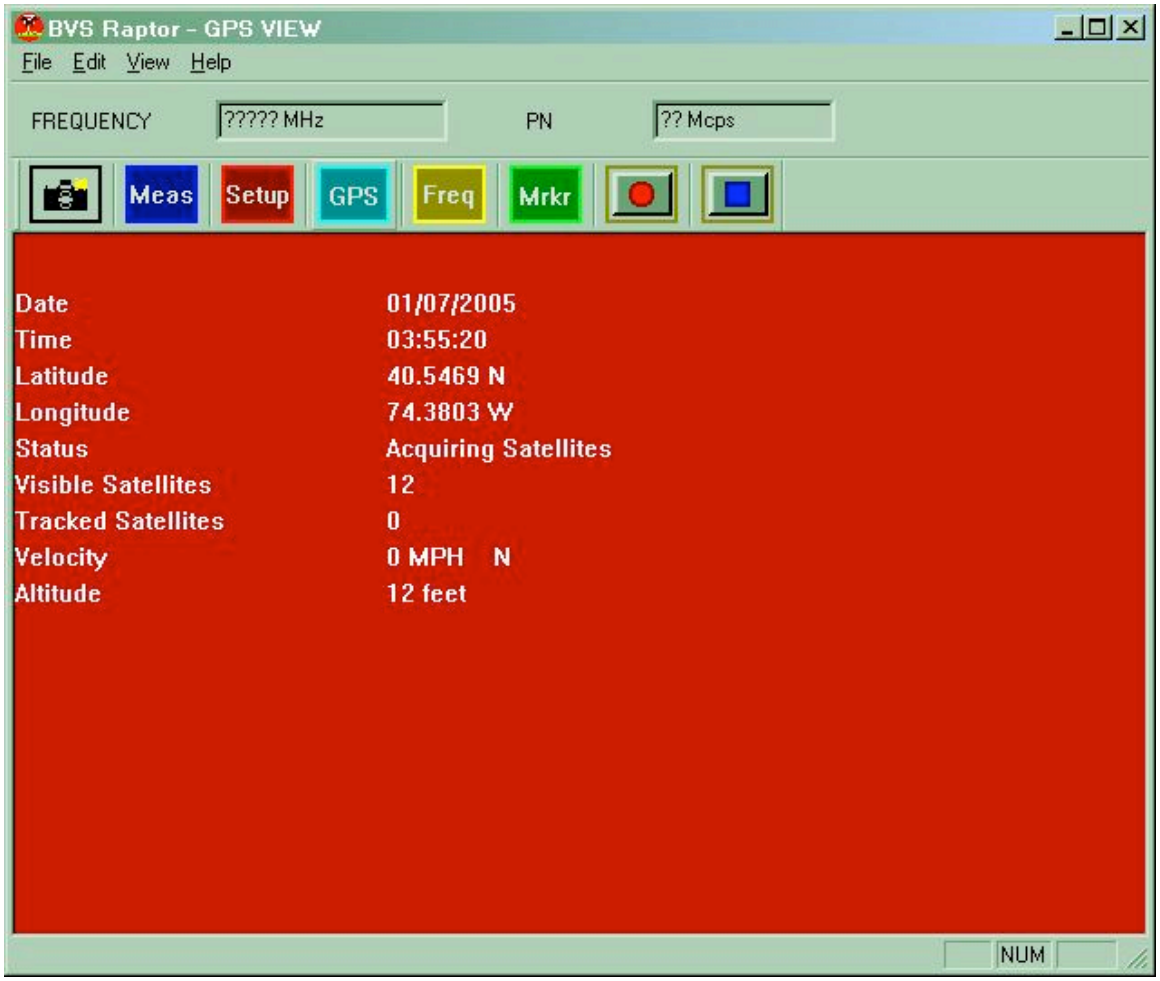
A message stating whether or not the rubidium has been warmed up is also displayed. The status of the battery powering the Raptor is displayed as either OK or LOW.

WARNING!!! If the battery low indication is on, immediately save logged data by pressing the “STOP” button.

To change the frequency/PN of the receiver, press the frequency icon.

GPS Screen

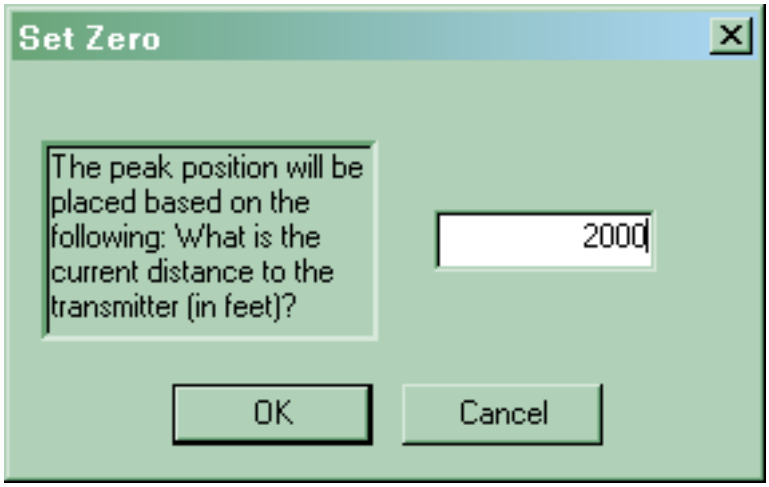
The GPS screen shows current information from the internal GPS receiver. Date, time, latitude and longitude are all shown. The GPS data stream can be turned on and off by pressing the appropriate buttons on this screen.



Absolute Delay Measurement

To make absolute delay measurements from the transmitter, the known distance to the transmitter can be set. Press the “SET ZERO” button on the measurement screen. You will be prompted to enter the distance that the receiver is known to be from the transmitter. Enter this number in feet. The peak signal will now align itself with the zero usec reading.

At 0 feet, the peak would show up on 0 usec. The peak will show up further out in time as the distance increases. The absolute delay will drift based on the training done on the system. An accuracy of 10^{-11} would take 1000 seconds to drift one sample, as an example.



Zoom Feature

The user may zoom in on a part of the data stream. A minimum of 10 points can be reported, the maximum being 1020. To zoom in, hold down the left mouse button at the leftmost part of the graph desired. Drag the mouse to the rightmost part of the graph wanted while holding down the left mouse button. Then release the mouse button. The number of points will now be reduced to this area.

GPS should be turned off while zooming. The reduction in the number of points means that the data will be streaming at a faster rate.

Turn the GPS off by pressing the OFF button from the GPS screen.

To return to streaming all 1020 points, press the "FULL SPAN" button on the measurement screen.

Time Markers

Pressing the "MRKR" button will place a marker in a log file containing the current time and an incrementing marker number (starts with 0 when the application opens). A dialog box will appear when the marker button has been pressed and a log file is currently open.

This button has no effect when there is no current log file open and should not be pressed in this case.

Data Recording

(NOTE: Only record data from the Measurement screen!)

When the "record" button icon is pressed from the toolbar at the bottom of the screen, the user will be prompted for a filename. This filename will be used to store collected data for later conversion by Chameleon.

The data is stored in a compact proprietary binary format. The RRI will store correlation data as it is received from the hardware.

To save the collected data, press the "stop" button icon.

WARNING! : Make sure that the "stop" button is pressed to avoid the loss of data saved.

Snapshots

When the camera icon is pressed, a snapshot of the currently viewable display is taken. The snapshot is saved as a BMP format picture (just like a digital camera) for viewing at a later time or for importing into documents and reports.

Data Conversion (using Chameleon (Raptor Edition)

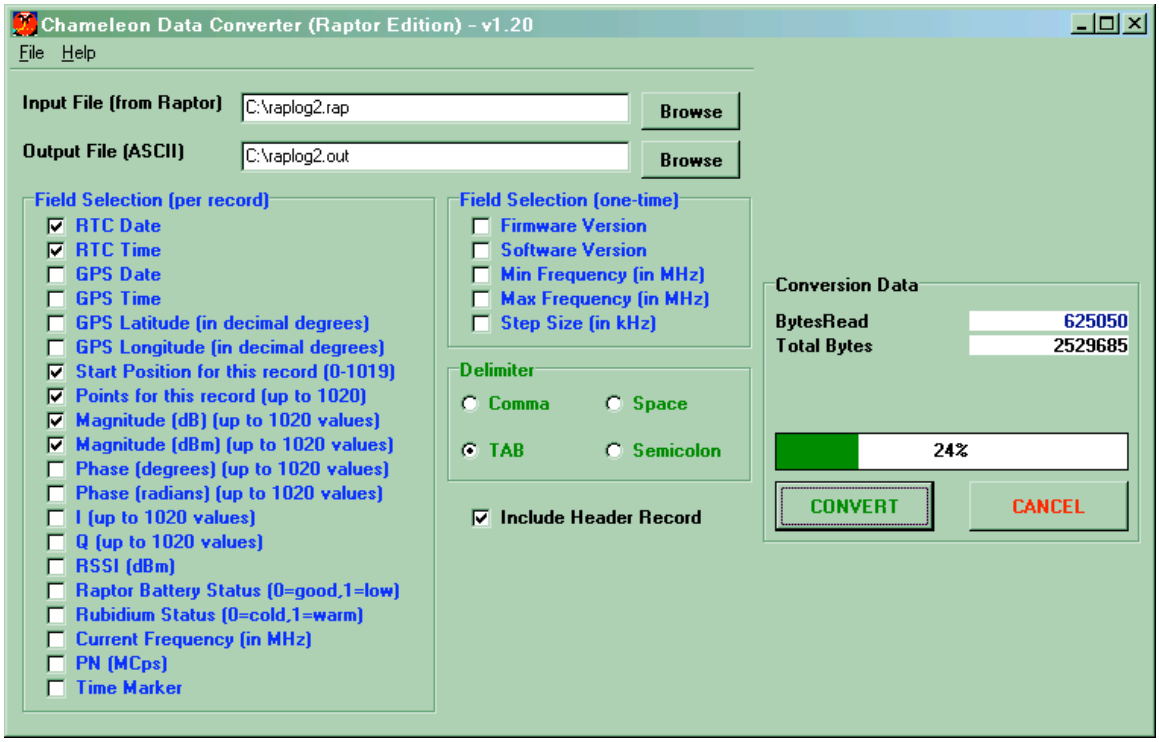
Data that has been logged by the Raptor is stored in a proprietary binary format. The Chameleon utility application can be used to convert the binary data into an ASCII-readable format that can be imported into spreadsheet applications such as MS Excel or other applications that accept ASCII-delimited data.

CHAMELEON SOFTWARE

SEQ CHAPTER \h \r 1The Chameleon application converts data logged by the Raptor into an ASCII delimited file for use in post-processing. The data converted is based on correlation records collected in the measurement mode of the Raptor Receiver Interface. To convert a file, use the following steps:

Copy the log file onto your desktop or laptop.

Run the Chameleon application.
Click BROWSE on the Input File line to choose a file to convert.
A default output filename will be created. Change if needed.
Choose which fields you wish to have in the output file.
Choose the delimiter to place between fields.
Choose whether or not you would like a header record with titles for each column.
Press the CONVERT button.



The progress bar will monitor the progress of the conversion.

These fields will be output for every correlation record that is processed. The fields will alternate across the output record.
(i.e. A#1,B#1,A#2,B#2, …A#1020,B#1020)

These fields will be outputte19 once at the beginning of the output file.

The Raptor™

CDMA INDOOR MULTIPATH SYSTEM

The Raptor™ is a high-resolution channel sounder system sutiable for indoor propagation studies as well as for outdoor RF sounding. The system consists of two units- a portable, battery-powered correlating receiver Rx and a 3-watt transmitter Tx. The transmitter outputs a BPSK modulated signal that is a 4x over-sampled PN sequence of 255 chips in length. The sampling frequency is up to 100 MHz. The correlating receiver also samples the demodulated baseband signal at 100 MHz. This allows the resolution of multiple RF paths down to 40-50 ns. The highest delay spread that can be monitored at the same time without ambiguity of reflections is up to 10.2 µs. RF sensitivity with this bandwidth will be greater than 85 dBm.

Raptor's high speed architecture and light weight make Raptor ideal for indoor CDMA multipath and propagation analysis studies.

KEY APPLICATIONS:

- Powerful multipath analysis that verifies reflections
- True RF channel sounding, magnitude & phase measurement
- Optimization of symbol rates
- Analysis of coverage areas
- Verification of equalizing algorithms

FEATURES:

- RF sensitivity of greater than 85 dBm
- "Sliding correlator" measures CDMA correlated signal strength (Ec/Io) ±1.0 dB
- Modulating signal is 4X over-sampled PN sequence of 255 chips length (up to 50 Megachips per second)
- 100 mW to 3 Watts of CDMA output controllable in 1.0 dB steps
- Infinite VSWR protection for power amplifier
- Complete data output via RS-232 to laptop PC
- Fast Fade analysis supports up to 100 measurements per second

Raptor is just one of many exceptional design solutions from Berkeley Varitronics Systems. Call us today for more information:

(732) 548-3737 / Fax: (732) 548-3404
Internet: www.bvsystems.com
Email: info@bvsystems.com

wireless products
Berkeley Varitronics Systems

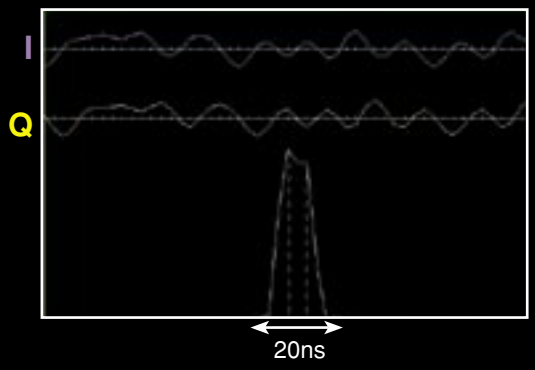
The Raptor™

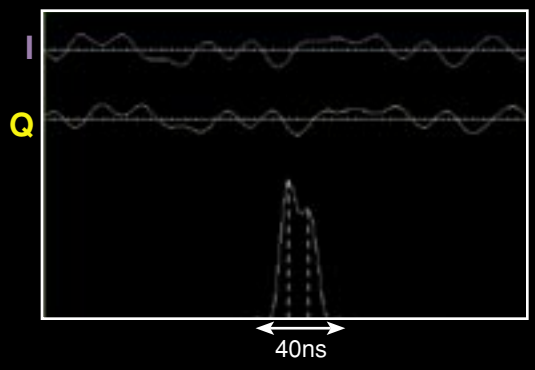
TRANSMITTER SPECIFICATIONS

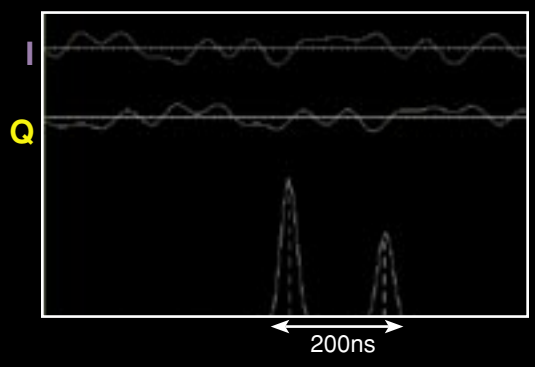
TUNING RANGE	2.4-2.85 GHz (up to 250 MHz tuning range in 1 MHz steps)
OUTPUT POWER RANGE	+20 to +35 dBm in 1 dB steps
MODULATION	BPSK (demodulator uses both I and Q quadrature signal components)
CODE RATE	25 to 50 megachips/second
OUTPUT FILTERING	Multistage (128 stages) FIR filter
OUTPUT MONITORING	6:1 VSWR monitoring
VSWR MONITORING	-20 dB
DIMENSIONS	W=14" L=11" D=6"
WEIGHT	7 pounds
POWER	12 VDC @ 3A

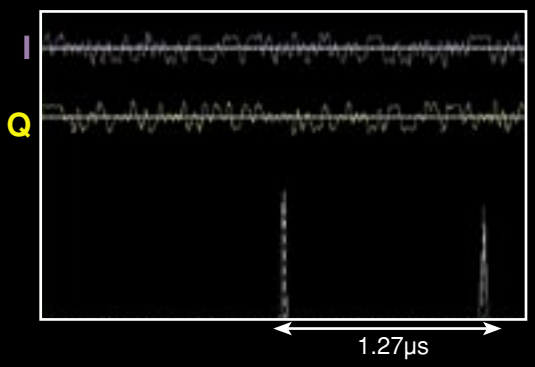
RECEIVER SPECIFICATIONS

TUNING RANGE	2.4-2.85 GHz (1 MHz steps)
TIME RESOLUTION	40ns
MAXIMUM DELAY	10µs
CODE RATE	25 megachips/second
SENSITIVITY	-85 dBm
DYNAMIC RANGE	-30 dBm to -85 dBm (max. input without damage to LNA is +13 dBm)
NORMAL PROCESSING GAIN	21 dB
STABILITY	± 0.1 ppm 0° to 50° C
PHASE NOISE	<100 Hz out 1 kHz from carrier
REMOTE CONTROL	Control of receiver functions through RS-232 port
DIMENSIONS	W=8" L=6" D=4"
WEIGHT	6 pounds
POWER	12 VDC @ 1A









The four graphs on the left illustrate the Raptor's ability to transmit, receive and correlate a variety of time delay spreads from as little as 20 ns (maximum is 10 µs). The two dashed, vertical lines represent both correlation peaks, one is the input and the other is the delay. The top horizontal waveform (Input phase) is the analog signal input while the one below it represents the delayed signal (Quadrature phase)

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