The Eagle Series

CDMA PILOT SCANNERS

Manual Version 2.0

Eagle Manual Table of Contents

Introduction

Comprehensive CDMA Tools

The enormous growth of cellular telephone service has precipitated issues of spectrum capacity. This has resulted in a battle between digital proponents for both TDMA and CDMA formats. One of the potential advantages of Code Division Multiple Access (CDMA) is greater capacity. Unfortunately, it is also the most difficult attribute to optimize if the system parameters and configuration are not correctly implemented. "Pilot pollution", caused by excessive overlap of coverage contours, can rob CDMA designs of capacity. From a practical point of view, placement of the base stations is dependent on tower space availability, and particularly at high PCS frequencies, very terrain dependent. With CDMA modulation, many RF carriers share the channel, and digital codes are used to separate the voices. Sometimes, too many codes radiate in one area or sector of a cell and cause interference because it reduces the ratio of signal to noise ratio, often referred to as Ec/lo (energy in a correlated bit to that of total RF channel energy). CDMA designers have designed a sophisticated system of power control into each mobile telephone to minimize such interference. But controlling the power from each mobile so they look the same when they are received at the base station is no simple trick. Just a 3 dB difference between one RF carrier and another (as received at the base station) reduces the system capacity by one-half!

Propagation Analysis of CDMA Signals

Modulated signals sharing the same RF channel have unique characteristics when signal reflections are encountered. These reflections cause unphased additions of data symbols which can cause bit errors. Unmodulated signal strength measurements (using narrow bandwidth stimulus signals such as CW) are often misleading because the carrier strength of the signal appears to be strong, but there is often poor BER (Bit Error Rate) performance. The reason for this poor coverage is likely multipath reflections, better known as time dispersion of the RF carrier. Time dispersion or delay spreading is induced by reception of two or more signals of the same origin, with some components arriving later because they traveled a longer path; causing reflections and scattering of the signal. These distortions must be considered when planning and optimizing high-rate digitally-modulated radio systems.

The rational for advanced measurement tools

In almost all cases, short-term fading is caused by the environment, where two or more copies of the originally authored signal arrive at the receiver, but at different times. These radio waves are then known as multipath waves, and when they combine at the antenna, vary widely in both phase and amplitude. There are generally three properties that affect the character of the RF waves that arrive at the antenna. They are distance, propagation time and bandwidth of the transmitted signal. The signal strength has been the most traditional measurement for quality of the link. In an ideal environment, it has a predictable relationship to distance, and has been used to determine overall coverage in analog communication system designs.

The adverse effects of multipath reception are:

(i) rapid variations in the received RF amplitude

(ii) some FM of the original signal caused by the Doppler shifts on more than one path

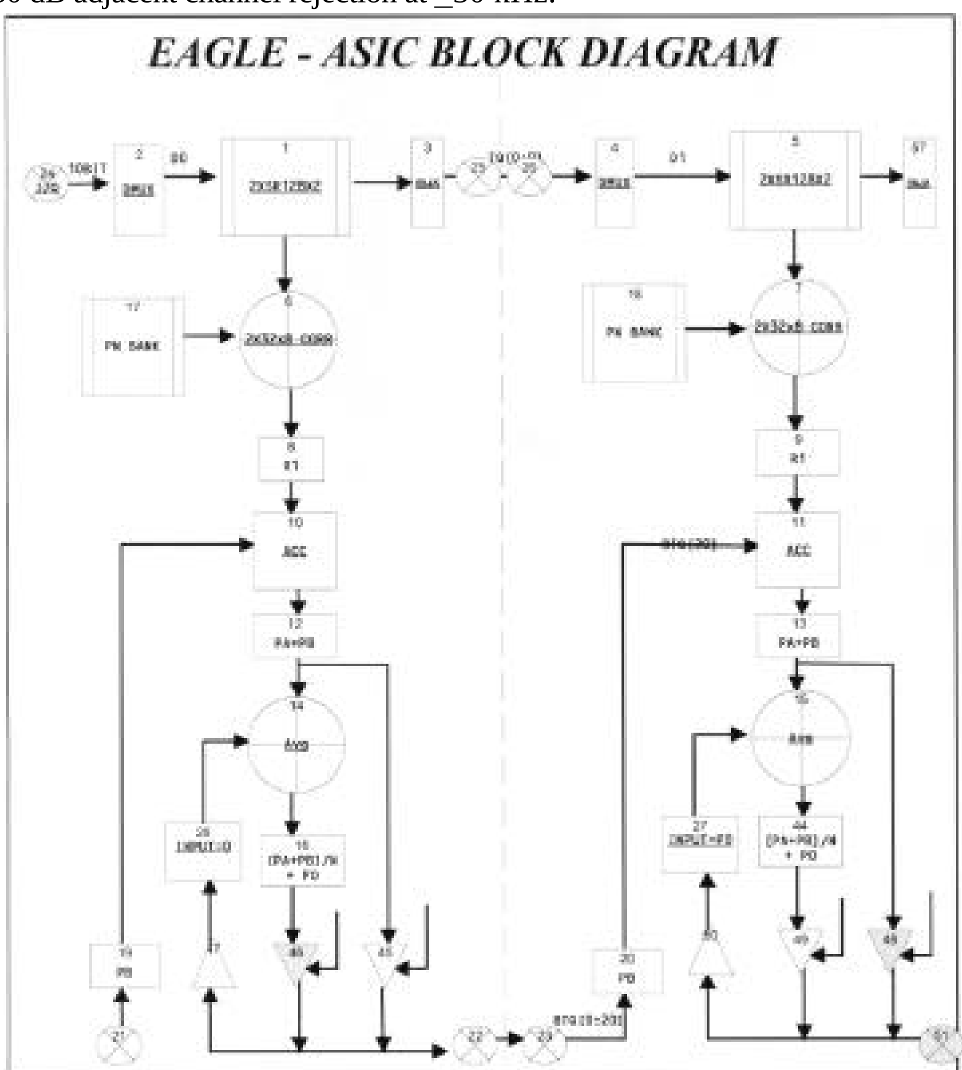
(iii) echoes (time dispersion) causing the carriers to add and subtract (vectorial in amplitude and phase) from each other causing data symbols to cancel

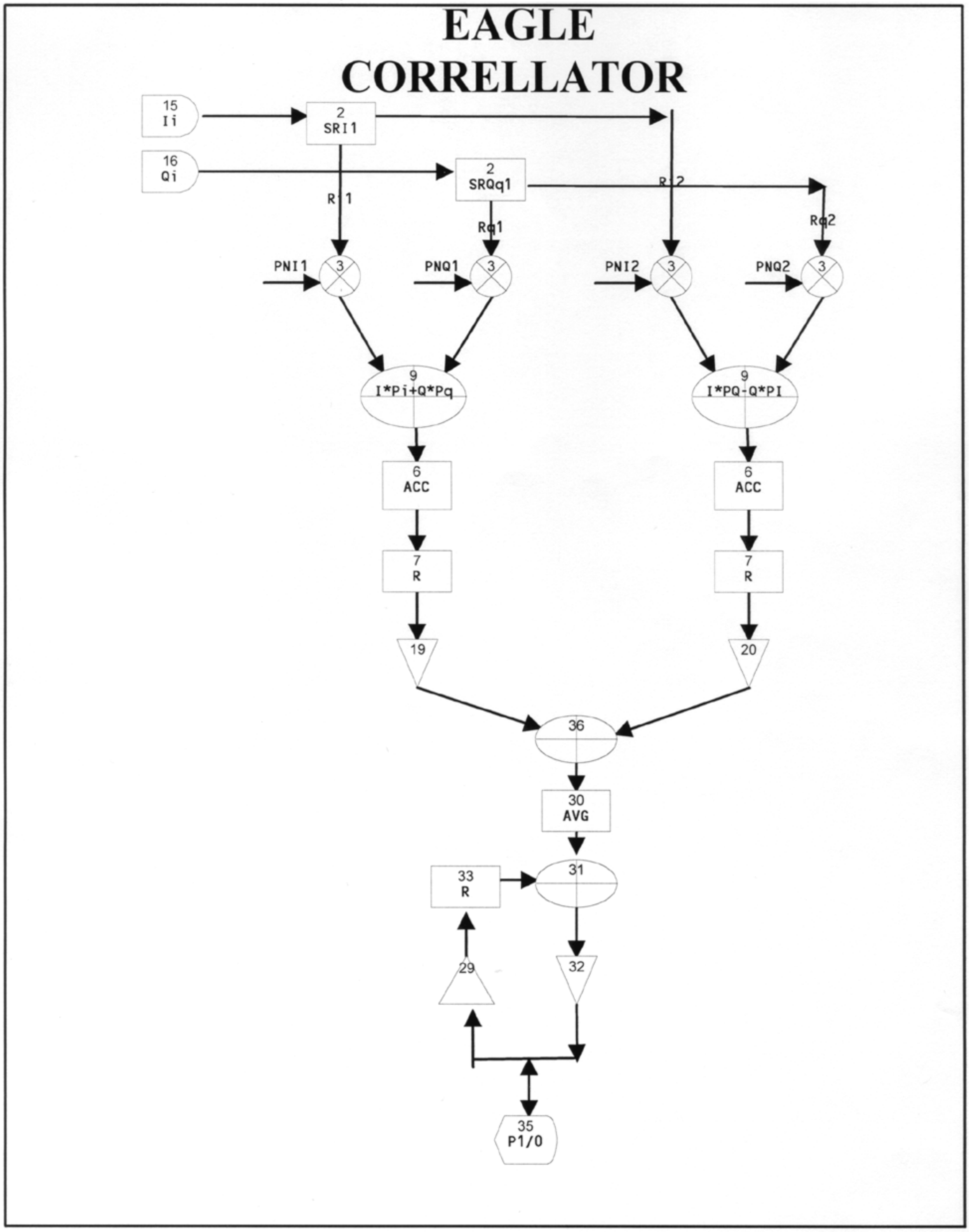
The BVS Eagle Series

The **Eagle** is a system-independent mobile measurement system which continuously surveys all

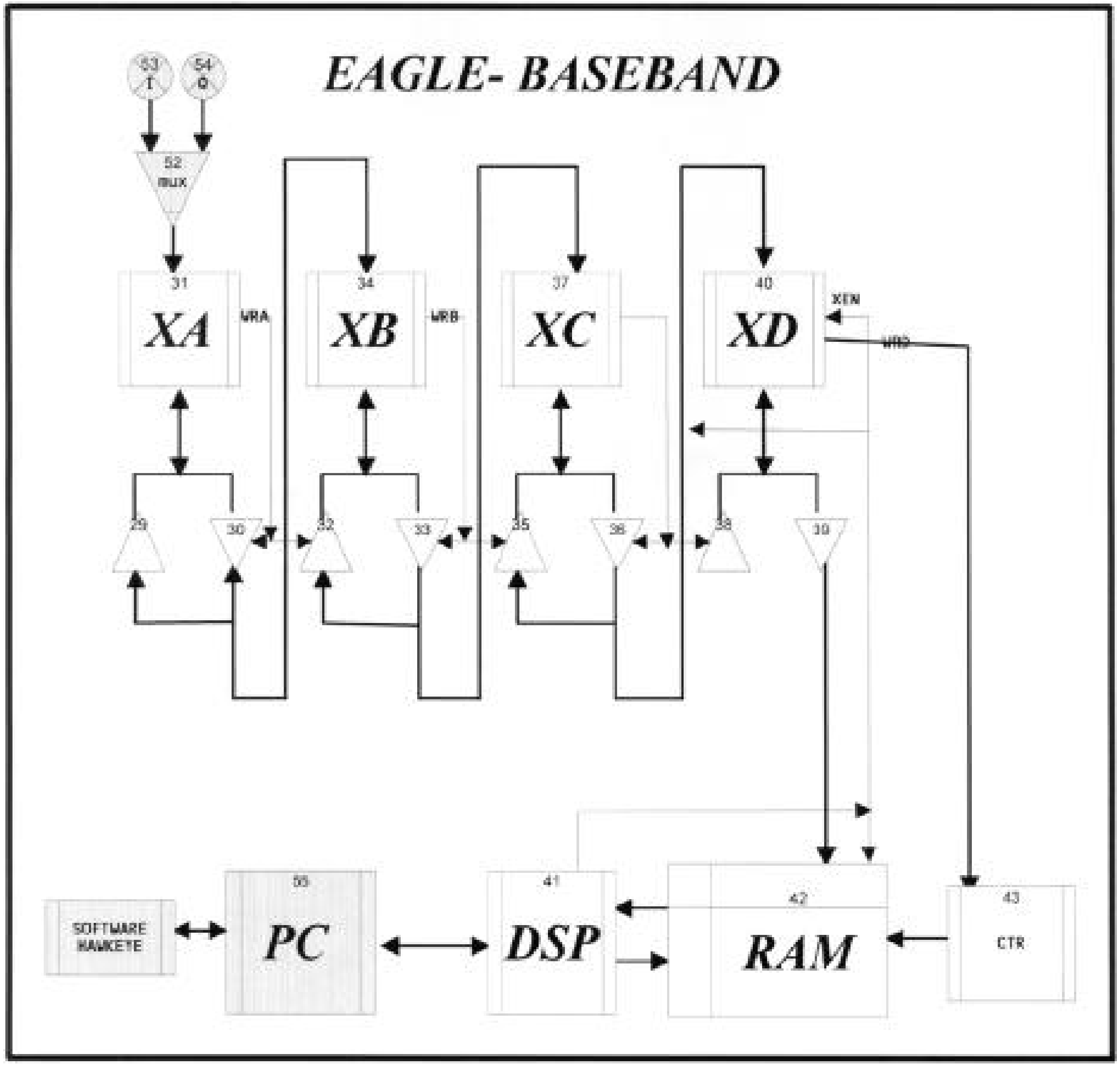
Cellular or PCS CDMA Pilot channel signals and reports their PN position and power profiles. Measured profiles indicate the distributions of interference and multipath components as a function of relative power and delay spread. The system employs a wide-band coherent (the clock and RF circuits of the Eagle are in-phase with the transmitter source by using the satellite as a common clock reference) receiver with an eight channel GPS system to synchronize and track the CDMA signals. The **Eagle** can be configured to survey continuously all or just specific base stations. The ability of the **Eagle** to scan all 512 base stations and the associated multipaths at each base station every frame 27 msec provides a fast "snap shot" of all the base stations for high-speed drive and fast fade analysis. The highly parallel, expandable time multiplexed architecture allows the **Eagle** to capture realtime co-channel interference and multipath analysis. The output of raw data from the **Eagle** is coupled to **Hawkeye** multipath fading analysis software. The standard equipment is configured to comply to IS-95/IS-97 and PCS JED008 standards.

The main blocks of the **Eagle** are the 1.25 MHz wide RF receiver, digital correlator bank, GPS module, reference generator, DSP module and communication control processor. The figure shows the functional block diagram of all these salient elements of the hardware design. In addition to the CDMA wideband receiver, a narrowband, high selectivity RF receiver covers the Cellular or PCS frequencies and supports a 20 to 60 MHz tuning range. The receiver scans 15ms per channel and measures Received Signal Strength Indicator [RSSI]. The dynamic range of the receiver is -115 to -30 dBm with a 30 kHz bandwidth and better than -50 dB adjacent channel rejection at ±30 kHz.





At the front end of the correlator bank, the demodulated in-phase and quad phase baseband signals from the RF modules are sampled by 10 bit ADCs at 4 times the chip rate of 1.2288 MHz. The correlator consists of four banks of ASICs to compute correlation power in parallel with a chip resolution. Each bank consists of two ASICs implementing a bank of 512, 10 bit shift registers to store the last 512 phases of the input, a 512 bit shift register to store PN phases and seventeen 16 bit accumulators and three 32 bit accumulators to compute correlated power every chip period. The correlators are initially synchronized to GPS. The input samples to correlators are software selectable. Hence, by selecting the first sample for the first chip bank and the third sample for second chip bank the correlation power resolution will be half chip. With optional add-on boards, resolution of the correlation power can be improved up to 1/4th of a chip. The Genlock board extracts the frequency reference for the correlator banks and time reference to DSP card from the 8 channel differential GPS. The DSP card consists of a high speed TI DSP (TMS 320C50 series with 30 nsec instruction time) and a dual UART to download power profile to the external device.



The DSP computes the optimum 256 PN phases and downloads to the PN shift register and continuously reads the correlation power from the ASICs and the timing reference from the genlock board. In a standard unit, the time tags and correlation power above a configurable threshold value are downloaded to a PC through an RS-232 port at up to 115 kbaud. The unit can be customized to interface to any external device for fast or synchronous download of raw data, without any threshold via its internal parallel port.

Hawkeye User Manual

(for use with version 2.0)

Contents

Requirements

- **Computer: IBM PC compatible required**
- **CPU/Speed: Intel 486 / 66MHZ minimum (Pentium preferred)**
- **RAM: 16MB minimum**
- **Disk Space: 10MB required**

- **Operating System: Windows 95**
- **Eagle Interface: 1 free serial port from COM1: to COM4:**

Introduction

Hawkeye is the companion application of the Eagle and Super Eagle CDMA Pilot Scanner and Profilers. Hawkeye uses the powerful features of the Eagle interface to display and log valuable information on the behavior of CDMA base stations. This data is typically logged as the Eagle is driven throughout a CDMA coverage area.

The data which is recorded by Hawkeye can be ASCII exported and then imported into post-processing applications for studying CDMA networks.

Hawkeye communicates with the Eagle through an available serial port between COM1: and COM4: at 115Kbps. Hawkeye stores binary information that is retrieved from the Eagle in a log file specified by the user. This binary data, which includes calibration and GPS location information, can be exported to different file formats for post-processing.

Hawkeye can also display RSSI information over the given frequency range of the Eagle unit (869.04-893.91 MHz for Cellular units, 1930-1990 MHz for PCS units). This RSSI information can be useful for a many reasons, including verification of signal bandwidth.

Hawkeye also has an option to display the top base stations at a certain frequency. The result of this scan is a bar chart that clearly labels the top base stations. These stations can be ordered by Ec/Io, Base Station number, or fixed position.

GPS Information is also available for date/time synchronization as well as scanner position and heading information. A screen which shows the plot of the drive pattern is also available.

The features mentioned above are discussed in further detail in the following sections.

Installation

The Hawkeye/Eagle team can be logging data in a matter of minutes. To install the Hawkeye application, place Disk 1 in an available 3.5" drive. On your Windows 95 task bar, click on START and then up to RUN. Choose SETUP.EXE from the drive which you have selected (e.g. For the A drive, type in A:\SETUP.EXE). After pressing OK, you will be taken through a series of screens explaining you options for directory placement etc. The entire installation process will only take a few minutes.

Getting Started

Two icons will be created in the folder which you selected for installation.One icon is for the Hawkeye application. The other is for the Eagle Loader utility,which is used for firmware upgrades. The Eagle Loader should ONLY be used if directed by a member of the Berkeley Varitronics staff or via explicit written instructions contained with a software upgrade.

Now plug in your Eagle unit and connect the GPS and RF antennas. Connect the Eagle to the PC via the serial cable supplied with the unit. Connect the cable to the Eagle port marked "SERIAL #1". Connect the cable to the PC on an available serial port between COM1: and COM4:.

Turn on the Eagle unit. You will see the "GENLOCK SYNC" and "MEASUREMENT IN PROGRESS" lights stay on for one or two seconds. This indicates that the internal firmware has booted up correctly. Now start the Hawkeye application by double-clicking on the icon created during installation.

You will now see the Hawkeye main screen maximized on the desktop as shown in Figure 1 below. This main screen encapsulates the four Eagle information screens. These screens are controlled through the main menu and the control panel, which can be found on the left side of the main screen.

Main Window

The main window of the Hawkeye system is the control center for retrieving data from the Eagle unit. All data screens are contained within this environment.

Status Bar

The status bar at the bottom of the main window contains information which pertains to the entire system and is updated real-time. The left-most panel contains the current latitude of the Eagle unit in decimal degrees. The second panel contains the current longitude in decimal degrees.

The next three panels report various Eagle conditions which are needed for Pilot Signal scanning. Panel 3 states whether or not GPS lock has been achieved. There are two values enclosed in parenthesis. The first is the number of satellites visible to the GPS receiver. The second number is the number of satellites which the Eagle is currently tracking. At least three satellites must be tracked in order for GPS lock to be achieved. The fourth panel states whether or not Gen Lock has been obtained. The fifth panel states whether or not the Eagle has been synchronized to GPS time. See the Eagle hardware documentation for a better understanding of how these statuses affect data recording.

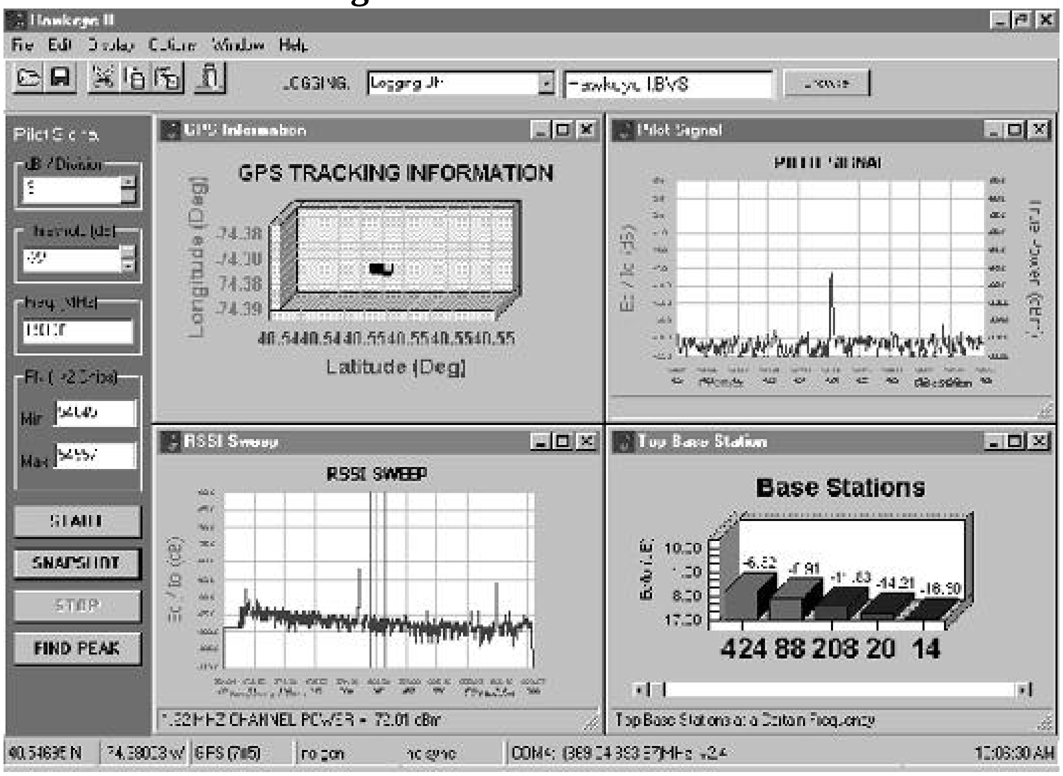


Figure 1 - Hawkeye Main Screen

The Pilot Signal and Top Base Station screens will not report accurate information until all of the lock and sync statuses have been achieved. However, if the user has already started scanning and the unit loses GPS, Gen Lock, or Sync, the scan information will still be accurate unless the three statuses do not re-lock/sync within a certain time period, typically 10-20 minutes. After this time period, the PN offsets of the acquired base stations may start to drift.

The sixth panel contains pertinent hardware and communications information. The communication port is displayed (COM4: in Figure 1). The frequency range of the unit is next (in MHz). The final piece of information is the Eagle internal firmware version number. If this version comes up as v0.0, the unit and Hawkeye must be restarted. This may occur due to a communications hiccup during transfer of hardware information.

The final panel is the current time as reported by the operating system.

Toolbar

The system toolbar is displayed underneath the main menu.The icons displayed are various shortcuts to menu items, including opening a log file and exiting the application. Moving the mouse cursor over an icon will display a hint explaining its purpose.

The remaining information on the toolbar concerns the data capture file. The first selection box allows the user to select whether or not to log the binary data to a file. The second entry field is the name of the file to which the pilot signal data is to be stored. If no path is specified, the file will be stored in the same directory as the application. Clicking on 'Browse' will assist the user in finding a suitable location for the log file.

Main Menu

The main menu is broken down into six different sections. The menu items are listed below, separated by section.

FILE

New	Select a new file for data logging.
Open	Select an existing file for data logging.
Delete	Delete the current log file.
Export	Export a binary data file into another format.
Print	Print the currently selected screen.
Print Setup	Setup printer characteristics.
Exit	Exit the application.

EDIT

Cut	Cut the selected item to the clipboard.
Copy	Copy the selected item to the clipboard.
Paste	Paste the clipboard item into selected entry field.

DISPLAY

Pilot Signal	Activate the Pilot Signal screen and update the control panel.
RSSI Sweep	Activate the RSSI Sweep screen and update the control panel.
Top Base Stations	Activate the Base Station screen and update the control panel.
GPS Information	Activate the GPS screen and display the GPS info panel.

OPTIONS

Correlation Length	Modify the correlation length used for scanning.
Channel Locator	Find possible CDMA channels at a given frequency.
Top Base Stations	Modify display characteristics of the Top BaseStation screen.
Performance	Toggle scan display on and off for faster data throughput.
Warning Beep	Toggle on and off GPS synchronization warning beep.
GPS Reset Delay	Choose a delay in synchronization reset after GPS loss.

WINDOW

Cascade	Order non-minimized windows in a cascade fashion.
Tile	Display all non-minimized windows in a tile fashion.
Arrange Icons	Arranges Icons.
Minimize All	Minimize all display windows.
Screen List	Lists all display windows, same effect as in the 'Display' menu.

HELP

User Manual	This manual.
Version Info	Information on all versions of Hawkeye.

About Displays application information.

Control Panel

The control panel is used to set parameters for the currently active display screen. These parameters are then used to regulate the information being provided by the Eagle unit.The following table outlines each of the parameters.

Pilot Signal / Base Stations

-dB / Division	Number of dB's per each grid division.
Threshold (dB)	Minimum Ec / lo value allowed for this scan.
Frequency (MHz)	Pilot Signal Frequency
Minimum	Minimum reported PN value in 1/2chips for this scan.
Maximum	Maximum reported PN value in 1/2chips for this scan.
START button	Begin a continuous scan using given parameters.
SNAPSHOT button	Perform a single scan using given parameters.
STOP button	Immediately terminate a continuous scan.
FIND PEAK button	(Pilot only) Find the strongest base station and display.

RSSI Sweep

dB / Division	Number of dB's per each grid division.
Threshold (dB)	Minimum Ec / lo value allowed for this scan.
Center Frequency (MHz)	Center of channel to record power.
Minimum	Minimum frequency for this scan.
Maximum	Maximum frequency for this scan.
START button	Begin a continuous scan using given parameters.
SNAPSHOT button	Perform a single scan using given parameters.
STOP button	Immediately terminate a continuous scan.

GPS Information

Date / Time	Current Date and Time (Greenwich Mean Time)
Latitude	Current latitude position of Eagle in decimal degrees.
Longitude	Current longitude position of Eagle in decimal degrees.
Height	Currently reported height relative to sea level in meters.
Speed / Heading	Current speed in meters/sec and heading in degrees relative to due North.

Pilot Signal Scanning

To begin scanning pilot signals, choose the Display/Pilot Signal selection of the main menu.

When Hawkeye is started, it attempts to find control panel values which have been stored from a previous session. If there are no previous values, such as when the system is used for the first time, application defaults will be used. Since Hawkeye is unaware of the frequency range of the unit until after communication has been established, default values may be cellular frequencies.

Scanning

There are three types of scans which may be started from this screen. These are 'Snapshot', 'Continuous', and 'Find Peak' scans. The snapshot scan will display information on a single sweep of the PN range selected. The continuous scan repeatedly retrieves information returned from sweeps of the PN range. A continuous scan is terminated by pressing the "STOP" button. If logging is activated, binary data retrieved from the Eagle is stored in the filename specified. The dB/division and threshold values may be changed during scanning.

Finding a Peak

The third method of scanning is the 'Find Peak' scan. This feature is useful in eliminating test scans over the entire PN range (0-65535 in 1/2 chips) to locate the strongest base station. If selected, the resultant display will show the signal centered in a range of 128 PN chips.

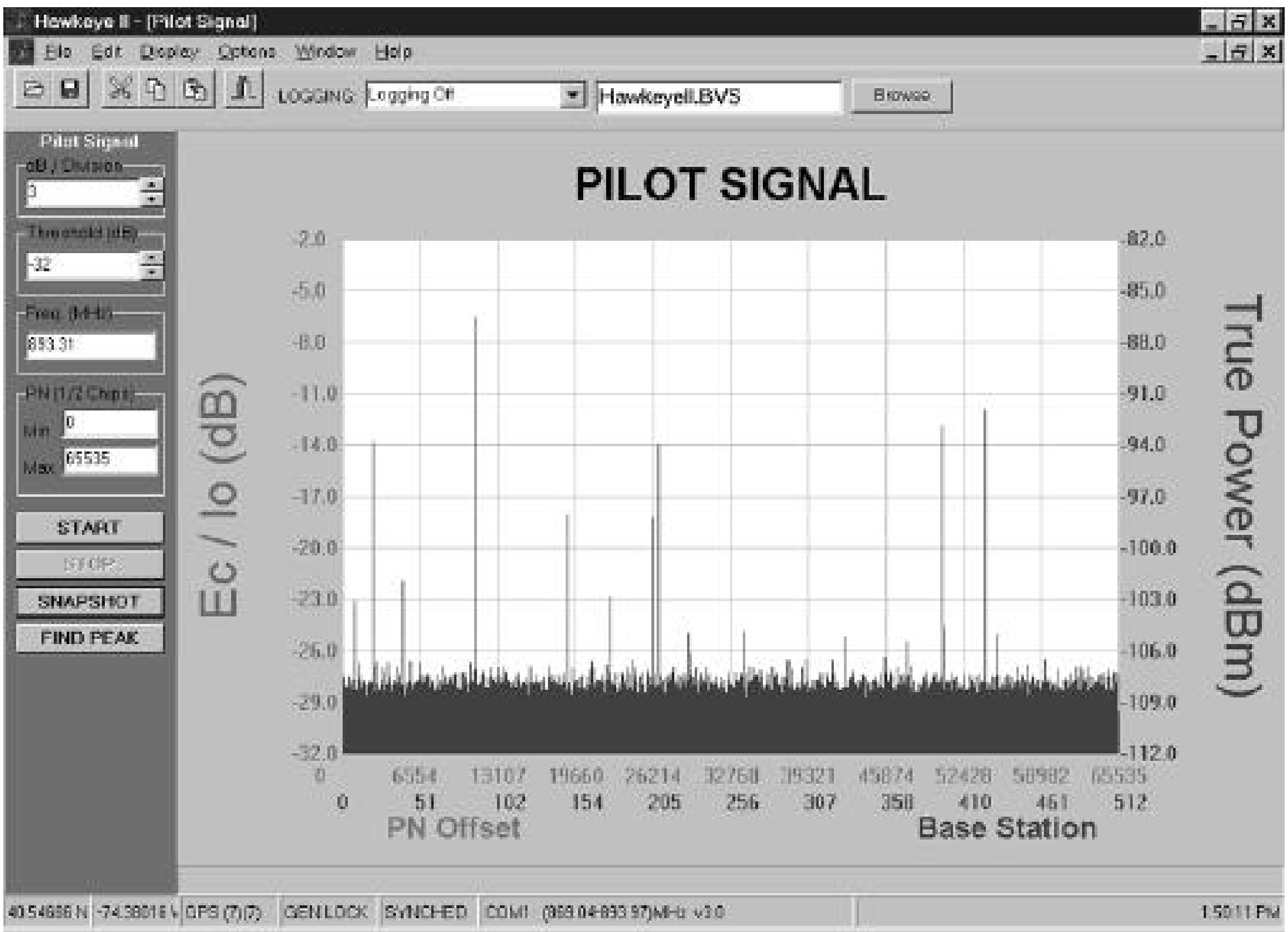


Figure 2 - Hawkeye Pilot Signal Display Window

Display Screen Characteristics

The display area is a 10x10 block grid. The horizontal axis marks divisions by PN location (1/2 chips from 0-65535) and Base Station (0-512). The values are determined by entries in the PN group box for Min and Max. The BaseStation number is calculated by dividing the PN offset by 128. As you can see from Figure 2, the Pilot Signal is at Base Station 208.

The vertical axis contains two different measurements. The leftmost set of numbers is the Ec/Io value of the signal at the PN locations in dB. These values are fixed to the grid and are set by the Threshold and dB/Division entry fields. The dB/Division field can be changed during a scan to vertically zoom in or out of the display.

The Threshold field is set to limit the number of data points returned by the unit. The Eagle unit will only return data in the PN range specified which rises above the threshold set by the user. Setting a threshold allows the user to eliminate unwanted data which is in the noise floor. Eliminating these points allows for greater scan throughput on the data which is most useful to the user. Changes to the threshold during a scan will be reflected on the following scan.

The rightmost set of values on the vertical axis represent the true signal power in dBm. This is a floating set of values and is updated during every complete sweep of the PN range selected.

Zoom Feature

The user may Zoom In and Out of the display grid for both the Pilot Signal scan and the RSSI Sweep. The min/max range of the grid is increased/decreased by a factor of 2 during a Zoom. The user may Zoom out to the limits of the Eagle (e.g. 0-65535 for the PN offset) and Zoom in to the smallest unit (e.g. 10000-10001).

To Zoom in, click once on the left mouse button. The data will reflect the change during the next scan sweep.

To Zoom out, click once on the right mouse button. Again, the data will reflect the change during the next scan sweep.

RSSI Scanning

To plot the RSSI strength of a frequency range, the Display/RSSI Scan menu option must be chosen. The display screen for this option is shown in Figure 3 below. The horizontal axis shows the frequencies, as well as the corresponding RF Channel number. The vertical axis shows RSSI strength. The points between the two red bars are used to calculate the Channel Power. This channel is set at a constant 1.22MHZ. The center of the channel may be set by modifying the 'Center Frequency' entry field.

The frequency range is set using the Min and Max entry fields. The threshold and dB/Division entry fields have the same meaning as in the Pilot Signal screen. In the display of Figure 3, the spikes most likely represent AMPS signals, while the bow towards the right is Bell Atlantic CDMA RF Channel 777.

The RSSI screen gives a good indication on whether or not the sought after signals are present. This display does not require the presence of GPS lock and therefore can be used immediately after Hawkeye makes contact with the Eagle unit.

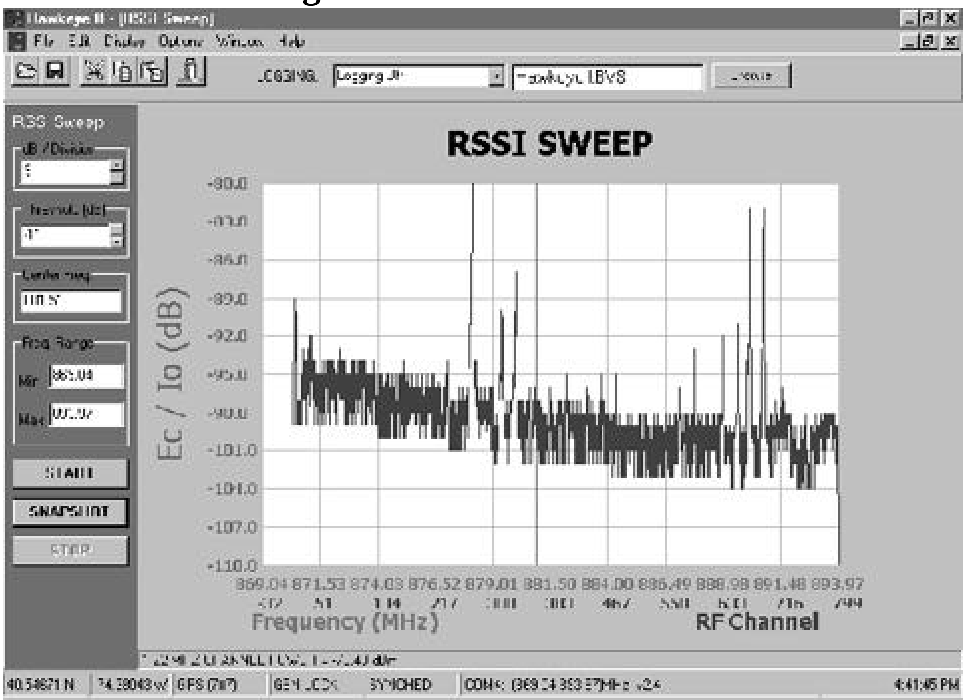


Figure 3 - Hawkeye RSSI Display

Top Base Stations

A user may find out which Base Station signals are the strongest by choosing the Display/Top Base Stations menu option. The Control Panel is the same as it was for a Pilot Signal Scan. After setting the appropriate parameters, selecting Snapshot will display a list of the strongest base stations. The display plots base stations versus Ec/Io. A sample of the results is shown in Figure 4 below. Selecting 'Start' will continuously scan for base stations.

As can be seen from Figure 4, there are boundary lines which represent TAdd and TDrop. These vales can be set by the user by selecting OPTIONS/TOP BASE STATIONS from the main menu. Any bar above the TAdd value will be shown in green. Any bar between TAdd and TDrop will be displayed in blue. Any bars which fall below TDrop will be shown in red.

The number of base stations to view on this display can be modified from the options screen under the main menu option OPTIONS/TOP BASE STATIONS.

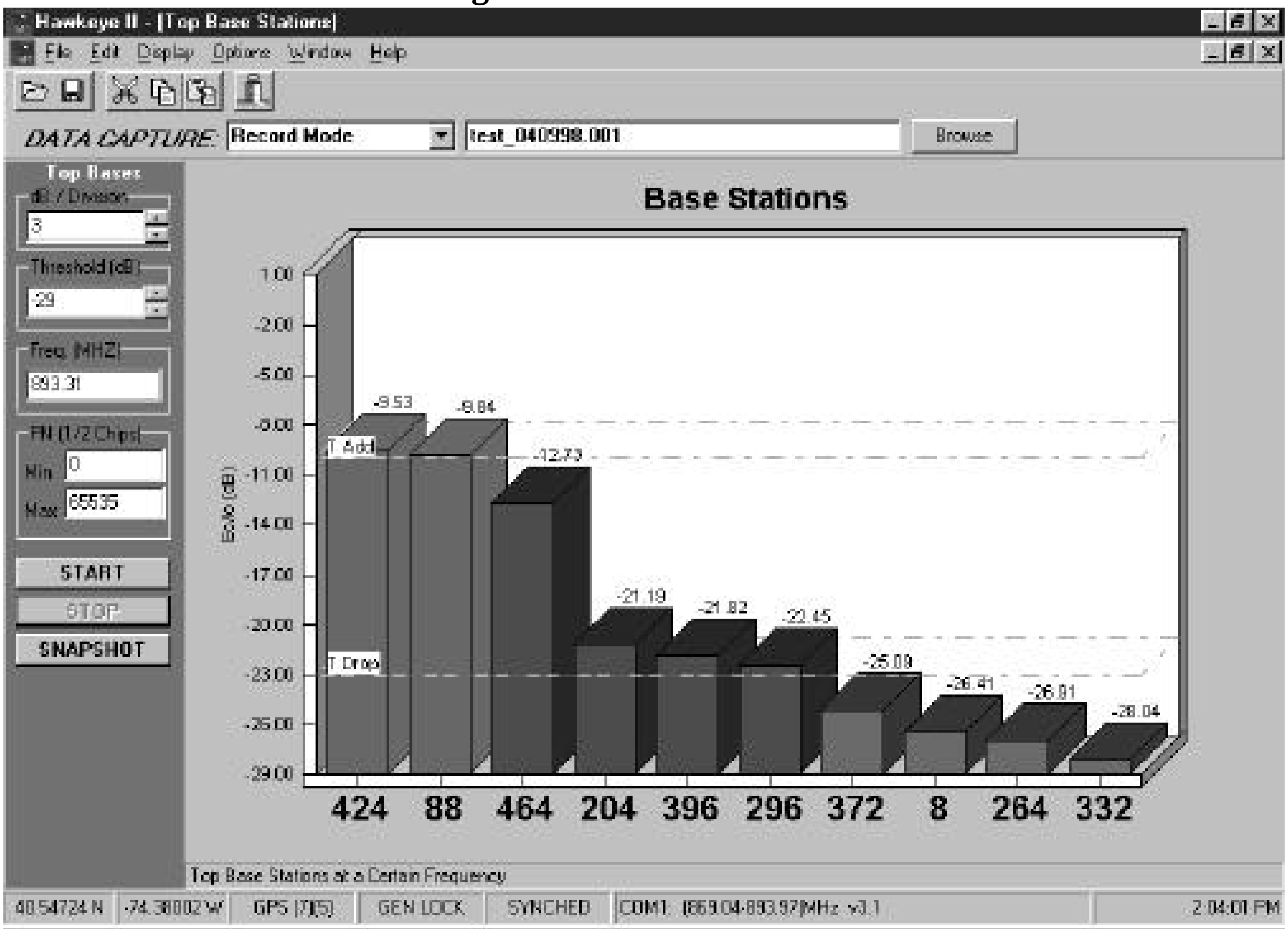


Figure 4 - Hawkeye Top Base Station Display

Correlation Length

The OPTIONS/CORRELATION LENGTH menu option from the Main Window allows the user to increase or decrease the amount of PN chips used to perform the correlation during a scan. The greater the number selected, the better the signal to noise ratio. The trade-off is in scan frequency. The higher the correlation length, the longer it takes to perform a single scan. The default setting is the maximum amount shown on the screen shown in Figure 5 below.

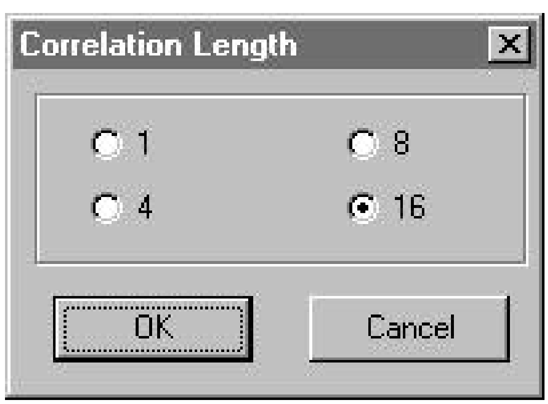


Figure 5 - Correlation Length Selection Screen

Scan Data

The data which is recorded by Hawkeye from the Eagle is stored in a binary file format. The binary file can then be exported into an ASCII format from within Hawkeye. This exported data can then be imported into a variety of post-processing software packages for studying the CDMA hetwor6k.Below are the formats for each of these files.

When scanning, if the log file already exists, the new data is appended to the file. If the file does not exist, it is created.

Opening a Log File

To set a file for being used as a data log, the user may perform one of three actions. The first is to enter the fully qualified path name in the entry field on the Main Window. The second is to use the browse button to locate the file. The final option is to use the File/Open menu option. This brings up the same dialog as the browse button. If no path is specified, the file will reside in the same directory as the Hawkeye application.

Clearing a Log File

As mentioned previously, scan data is continuously appended to the specified log file. To erase the contents of the log file, choose the File/Clear menu option. This option will verify that the user really wishes to erase the contents of the file. If this is verified, then the file is erased.

Binary File Format

The binary data file is a series of scan records which are stored one after the other. The order of the data blocks are as follows: Playback Data (PD), Calibration Data (CD), Scan Data (SD), and GPS Data (GD). The file header (FH) is always the first 3 bytes of the file. Therefore, the blocks would be stored in the file as:

```
 FH PD CD SD SD SD SD SD ... GD PD CD SD SD SD SD ... SD GD
```

The number of Scan Data blocks would depend on the amount of data being reported above the threshold selected in Hawkeye and the PN Range.

Below are the formats for each of the different data blocks. Multiple byte values are stored MSB first.

```
File Header (FH) (3 bytes) "BV#" where # is the file version number. (e.g. 'BV2')

Playback Data (PD)
-----------------------------------------------------------
      ID Byte                = 0xA5
      Threshold              = (2 bytes)
      Frequency              = (4 bytes) in KHz
      Minimum PN             = (2 bytes)
      Maximum PN             = (2 bytes)
      Cal Adjust (Ca)        = (1 byte)
```

```
where
  ID Byte          : is the ID which identifies this block as a playback data
                     block.
  Threshold        : is the EcIo value set which restricts any data below this
                     value from being reported in this scan.
  Frequency        : is the frequency at which the Super Eagle was set at for this
                     scan.
  Minimum PN       : is the minimum PN offset which may be reported for this scan.
  Maximum PN       : is the maximum PN offset which may be reported for this scan.
  Cal Adjust (Ca)  : is a calibration factor which is used in the calculation of
                     Ec/Io and True Power (see NOTES).
```

Calibration Data (CD)

```
ID Byte               = 0x82
Item Reference        = 0x11
Data Type             = 0x83
Number of Words       = 0x04
Si Factor             = (2 bytes)
Ei Factor             = (2 bytes)
Frame Number          = (2 bytes)
Eagle Status          = (2 bytes)

where
  ID Byte        : is the ID which states that this block is a data block.
  Item Reference : is the ID which states that this is a calibration data block.
  Data Type      : another calibration ID byte.
  Number of Words: Number of words which are in this data block.

  Si Factor      : is a calibration constant. See NOTE 1 below.
  Ei Factor      : is a calibration constant. See NOTE 2 below.
  Frame Number   : is the frame count since the start of the even second
                   mark. The range is between 0 and 74.
  Eagle Status   : identifies GPS, Gen Lock, and Sync. See NOTE 3 below.
```

Scan Data (SD)

```
ID Byte           = 0x82
Item Reference    = 0x01
Data Type         = 0x02
Number of Words   = (1 byte)
PN Location       = (2 bytes) *
Correlation Power = (2 bytes) *
* Repeated for the number of words in the data block.

where
  ID Byte           : is the ID which states that this block is a data block.
  Item Reference    : is the ID which states the search item towhich this block
                      refers.
  Data Type         : states that this is a threshold restricted search.
  Number of Words   : Number of words which are in this data block.
  PN Location       : is the PN offset of the following correlation power.
  Correlation Power: measured data used to calculate true power and EcIo
                      based on the formulas given in NOTES 1 & 2.
```

GPS Data (GD)

```
Scan Data ID Byte = 0x83
GPS Data          = (70 bytes)
```

```
      Reserved          = (1 byte)

      where
        ID Byte          : is the ID which states that this is a GPS information block.
        GPS Data         : is the trailing 70 bytes of GPS information received from
                           the Motorola GPS receiver block.
        Reserved         : BVS Internal Use Only

NOTES:

1. The Si Factor is used to calculate true power from the correlated power
   output in the data records as in the following formula.

   P = 20log(Nc) + Si/Ca
   where P is true power,
         Nc is the correlated power,
         Ca is the calibration adjustment.

2. The Ei Factor is used to determine Ec/Io power as follows:

   Ec/Io = 20log(Nc) + Ei/Ca
   where Nc is the correlated power,
         Ca is the calibration adjustment.

3. The Hawkeye Status is returned by set bits: 1=valid, 0=not valid

   Bit              Status
    0                GPS lock.
    1                Gen Lock.
    2                Synchronization to the even second of GPS time.
```

ASCII Export

Binary data files may be exported to an ASCII format, with comma delimeters. This will allow the recorded data to be imported into many post-processing applications for data analysis. To export a binary file, the File/Export option should be chosen. As shown in Figure 6, the user will be prompted to enter the binary filename as well as the new ASCII filename. If the ASCII filename exists, the data will be overwritten. After pressing the Export button, the conversion will begin. A message box stating that the export has completed will then appear.

The binary data may also be filtered by either sampling the data or averaging the data. The default values for these filters is 1. At these values, all data will be exported. If a sampling rate is chosen which is greater than 1, then only certain records will be exported. For example, if a sampling rate of 3 is chosen, then only every third record will be exported.

If averaging is selected and the value is greater than 1, then every X number of records will be averaged. For example, if 10 is selected for averaging, then every10 records will be summed and averaged (Ec/Io and True Power).

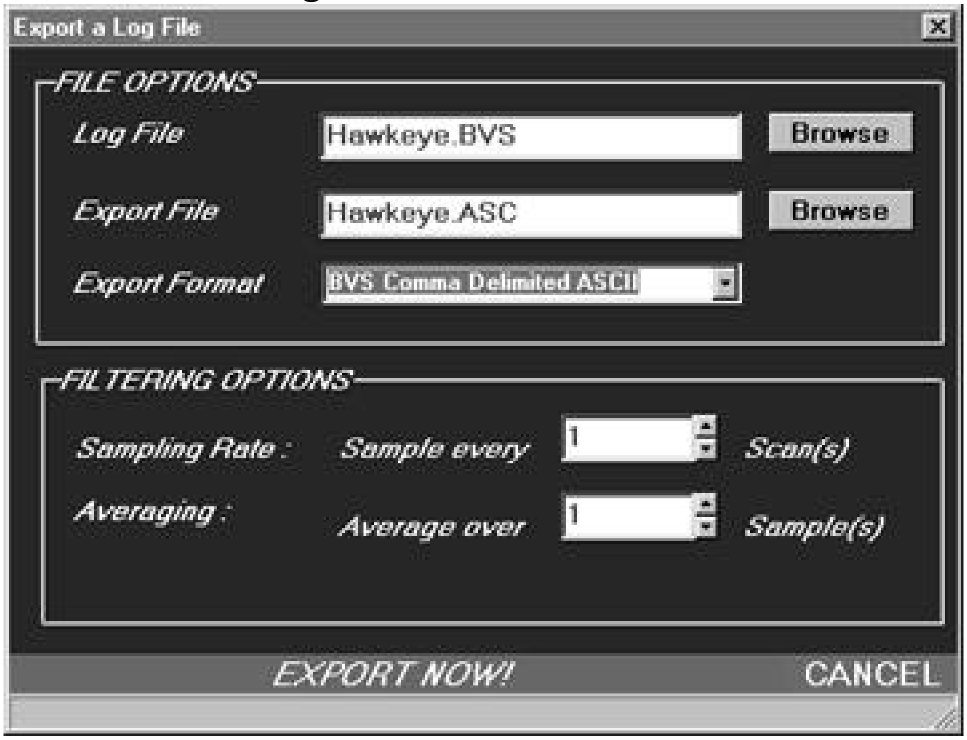


Figure 6 - Hawkeye Export Screen

```
The format of the ASCII exported file is as shown below:

PN1,Ec/Io1,Power1,...,PN#,Ec/Io#,Power#,MM/DD/YYYY,HH:MM:SS.FFFFFF,Long,Lat(CR/LF)

where :

PN             : is the PN offset in 1/2 chips (Range 0-65535)
Ec/Io          : is the Ec/Io recorded value in (dB).
Power          : is the true power in (dBm)
MM/DD/YYYY     : is the GPS recorded date
HH:MM:SS.FFFFFF: is the GPS recorded time including fractional seconds
Long           : is the longitude in milliarcseconds (mas).*
Lat            : is the latitude in milliarcseconds (mas).*
(CR/LF)        : is a carriage return and line feed.

* 1 degree = 3,600,000 milliarcseconds (mas).
```

GPS Reset Option

This feature, which is found in the options menu, allows the user to control the restart of the Gen Lock and Sync'ng process when GPS lock has been regained. This delay is measured in seconds. The default value is 0. At this default value, Gen Lock and Sync process will be restarted the instant that GPS lock has been regained.

If a delay is set (say 10 seconds), then the Gen Lock and Sync'ng process will not be restarted as soon as GPS lock has been regained. If GPS lock has been reacquired during this time frame, then the Gen lock and Sync'ng process would not be forced to be restart at all. If the 10 seconds has elapsed, however, then the process would be restarted when GPS lock returned.

This delay factor is useful if there are short periods of GPS lock loss. The drift of Pilot Signal measurements is negligible over short periods of time. This delay factor will prevent the constant resetting of Gen lock and Sync if GPS goes in and out a large number of times during a drive study.

The GPS circuitry in the Eagle is a module produced by Motorola which reports a positive lock status whenever enough satellites can be tracked through the GPS antenna to record accurate time and position data.

The Eagle Gen Lock circuitry synchronizes time against the GPS information, which in turn produces synchronization with CDMA base stations. When the GPS lock has been lost, the Gen Lock circuitry continues to sync using the last known information from the GPS module.

EXAMPLES:

no gps (6)(1) no gen lock : There is no GPS or internal time synchronization . 6 satellites are visible, 1 is being tracked.

GPS (7)(4) no gen lock : GPS lock has been achieved with 7 visible satellites and 4 being tracked. Internal synchronization has not been achieved.

GPS(7)(4) GEN LOCK : GPS and Internal synchronization has been achieved. Unit will now be synched with CDMA base stations.

no gps(6)(1) GEN LOCK :GPS lock has been lost, Internal synchronization is using last known GPS information.

Warning Beep Shutoff

There is now an option to shut off the audible warning for lock loss. During normal operation, the audible warning is heard whenever GPS lock, Gen lock, or Sync is lost. Choosing the Warning Beep option from the Options menu will toggle the sound on and off.

CDMA Channel Locator

In the case wherethe RF Channel for the CDMA stations is unknown, the Channel Locator option off the options menu provides an alternative. Pressing the locate button attempts to find a CDMA channel. Candidates will be listed in the list box provided. After completion of the search, simply double-click on the frequency you wish to use. The Pilot Signal parameters will be automatically updated and a single scan will be performed on the strongest peak.

Performance Option

In order to provide maximum throughput into a log file, the user may turn off the display of information on the scan grid by deselecting the checkbox under the OPTIONS/PERFORMANCE. This eliminates the time necessary to perform display operations. Depending on the display type and memory, this can make a wide variety of differences in scan time.

Troubleshooting

Following are some typical user questions which may be encountered along with some troubleshooting suggestions.

Q: When I start up Hawkeye, I get a message "Eagle Is Not Responding". What's happening?

A: Hawkeye cannot locate the Eagle unit and receive system information from COM1:, COM2:, COM3:, or COM4:. Make sure that the serial cable is connected to "SERIAL #1" on the Eagle unit. Make sure that the other end of the cable is securely connected to an available COM port. Verify that Windows acknowledges the serial port as a device in the Device Manager.

Verify that the Eagle unit has been turned on and that only the power light remains lit. If connected to a power supply, verify that the supply can output at least 4 amps.

Q: None of the statuses are becoming locked/synched. Why is this happening?

A: You are not obtaining GPS lock. The GPS antenna must be in full view of at least 3 orbiting global positioning satellites. Make sure your GPS antenna is securely connected and that it has a clear view of a good portion of the sky. If one area of the sky is blocked (by a building etc.), GPS lock might be difficult at certain times of the day.

If this is the first time you have turned on the unit since it arrived at your location, GPS lock might take at least 30 minutes. This is because the last time the Eagle unit may have been powered up could have been hundreds or thousands of miles away. The GPS hardware remembers its previous location and must lock to a new location. For instance, if you have just received a brand new unit and you are loocated in California, the last time the unit was powered up was during testing at Berkeley's New Jersey location.

The Eag1e unit is now over 3,000 miles away from the last time it was GPS locked. After achieving a lock for the first time, the user should see locks happen in a much shorter time period.

Q: When I start a Pilot Signal Scan, I see a blue line across the bottom of the grid. What should I do?

A: All data for the PN range selected is below the threshold set. Lower the threshold value until you begin to see data appear.

Q: When I start a Pilot Signal Scan, I only see noise at levels close to 0dB. What's wrong?

A: The most likely cause for this is that there is no RF input. Make sure that the RF antenna is securely connected to the Eagle unit.

Q: I keep losing GPS lock and then reacquire it. This takes on average about 20 seconds. Is there any way to prevent Gen Lock and Sync from being reset when I lose GPS???

A: By setting the GPS Reset value to between 20 and 30 seconds, Gen Lock and Sync will not be reset during most of your outages. The reset will occur if the delay is longer than the GPS Reset value.

Output Data File Format

The output generated by a Single Scan from the Hawkeye Data Recorder is as follows

File Header (3 bytes) IIBVS"

Calibration Data

Scan Data ID Byte	= 0x82
Item Reference	= 0x11
Data Type	= 0x83
Number of Words	= 0x04
Si Factor	= (2 bytes)
Ei Factor	= (2 bytes)
Frame Number	= (2 bytes)
Scout Status	= (2 bytes)

Check Sum (XOR of all bytes in data block) = (1 byte)

Scan Data - repeated until all PN positions are reported.

Scan Data ID Byte	= 0x82
Item Reference	= 0X01
Data Type	= 0X01
Number of Words	= (1 byte)
Correlation Power	= (2 bytes)

Correlation Power is repeated for the number of words in the data block.
Check Sum (XOR of all bytes in data block) = (1 byte)

GPS Data

Scan Data ID Byte = Ox83

Check Sum (XOR of all bytes in data block) = (1 byte)

TECH NOTES:

1. The Si Factor is used to calculate true power from the correlated power outp

   P = 20log(Nc) + Si
   where P is true power and Nc is the correlated power.

2. The Ei Factor is used to determine Ec/Io power as follows:

   Ec/Io = 20log(Nc) + Ei

3. The frame number is the frame count since the start of the even second mark.

4. The Eagle Status is returned by set bits: 1=valid, 0=not valid

Bit	Status
0	GPS lock.
1	Gen Lock.
2	Synchronization to the even second of GPS time.

APPLICATION NOTES:

1. If the filename specified exists, data will be appended to the existing file.

Tips

1. If the Eagle is disconnected and then reconnected while the Hawkeye Data Recorder is operating, the application might not reestablish connection. Please stop and restart the Data Recorder.

2. If a checksum error appears during a scan, retry using "GO". This error may occur from noise on the serial cable.

Eagle Commands List

A brief description of all commands.

Command	Value	Description
Initialize	0x01	For future compatability.
DefineSearchItem	0x02	Defines one (1) of a possible (16) search types and parameters.
SelectSearchItems	0x03	Choose search items that are active.
StartScan	0x04	Begins a continuous or single scan.
EndContinuousScan	0x05	Ends a continuous scan.
RFInfo	0x06	Get information about the frequency range of the unit.
RFSetFreq	0x07	Sets the RF Frequency of the unit.
GetStatus	0x08	Get Status byte.
GetVersionInfo	0x09	Get software version information.
RESERVED	0x0A-0x0B	Reserved commands; do not issue.
SetRSSIParam	0x0C	Set frequency parameters for RSSI scan.
StartRSSIScan	0x0D	Begin a continuous or single RSSI scan.
SetCorrLength	0x10	Select the averages used in the correlation.

Response	Value	Description
ResponseOK	0x80 <CMD>	General good response for many commands. Echoes the command.
ResponseError	0x81 <ERR>	Something is wrong with the last command. Returns error code.
ScanData	0x82	Block of Scan data. Includes type and length (Max. length predefined).
GPSData	0x83	GPS Data Block
RFData	0x84	RF Data Block
Status	0x85	Various flags indicating unit operating status.
VersionInfo	0x86	Software version information.

All multi-byte values are sent MSB first.

Error Code	Value	Description
StatusError	0x01	Read Status byte to determine error.
CheckSum	0x02	Bad Check sum on command.
UnknownCommand	0x03	Not a recognized command.
InvalidParam	0x04	Parameter out of range.
InvalidCommand	0x05	Command not excepted at this time.

Command Descriptions

Initialize

format.-
<Initialize> <Check Sum>
Description:

Presently, it is not necessary to issue this command for proper operation of the Eagle. However, for future compatibility, this command should be sent to the Eagle as the first command during each session. The *Check Sum* is the command itself.

Response.-

Valid responses are *ResponseOK and ResponseError*.

DefineSearchitem

format:
<DefineSearchltem><item number><item type><param 1 ><param 2><param 3> <Check Sum>
Description:

There are sixteen stored items which can be used as search criteria. This changes one of them, selected by *item number* which is between zero (0) and fifteen (15). The parameters (param n) are dependent on the *item type* and may not be used for some values of *item type*. Parameters are word (two byte) values.

item type	Value	Param 1	Param 2	Param3
NULL_SEARCH	0x00			
PN_SEARCH	0x01	Start PN	End PN	
THRESHOLD_SEARCH	0x02	Start PN	End PN	Threshold
Reserved	0x03			
CALIBRATION_DATA*	0x83			
RSSI_SCAN*	0x04			

* These type values are returned by ScanData, and are not valid item types for DefineSearchitem. They are included here for completeness.

The *Check Sum* is the XOR of all of the data bytes.

Response:

Valid responses are *ResponseOK and ResponseError*.

SelectSearchitems

format:

<SelectSearchitems><number of items><item 1 > ... <item n> <Check Sum>

Description:

Selects which search items will be used in the next search. The search results are applied and reported in the order sent. The item numbers are between zero (0) and fifteen (15).

The *Check Sum* is the XOR of all of the data bytes.

Response:

Valid responses are *ResponseOK and ResponseError*.

StartScan

format:

<StartScan><Continuous I Single><Check Sum>

Description:

Begins scanning with the criteria chosen with the SelectSearchitems command. The data for a scan is returned with multiple ScanData responses.

Identifier	Value
Continuous	0x01
Single	0x02

The *Check Sum* is the XOR of all of the data bytes.

Response:

A response of *ResponseOK or ResponseError* is sent immediately. A *ResponseOK will* be followed by *DataScan* responses to transfer the data.

EndContinuousScan

format.

<EndContinuousScan><Check Sum>

Description:

Stops continuous scan mode after all of the data from the present scan has been transferred.

The Check Sum is the Command.

Response:

Responds with *ResponseOK* after transmitting any remaining ScanData responses. Therefore, this response may not be next response from the Eagle.

ScanData (response)

format.-

<ScanData><item reference><type><number of words><word 1 > .... <word **N>** <Check Sum>

Description:

The *item reference* indicates which search item the data pertains to. The actual data returned by ScanData depends on the type field (See Define Search item for a list of type values). The *check sum* is the XOR of all data bytes.

CALIBRATION_DATA

A ScanData response of this type is sent for every scan. It contains the Calibrated reference to convert the correlation counts into either **Ec/Io** or true power, P. The ScanData response has the following format for the word data.

<Si factor><Ei factor><Frame Number><Status>

The two factors are signed 16 bit numbers that are used to calculate **Ec/Io** and true power, P1 from the correlation counts, Nc. These values are determined in dB (or dBm for true power) as follows:

$$P = 20 \log(Nc) + Si$$

$$\frac{Ec}{Io} = 20\log(Nc)+Ei$$

The *frame number* is the frame count since the start of the even second mark. frames are between 0 and 74. For information on Status, see Status Response. The item reference for this ScanData record is 0x11.

THRESHOLD_SEARCH

For a *type* of value THRESHOLD_SEARCH, the data is returned in word pairs, as follows.

<PN Location><Power>

The PN location is in half chips. The Power is in Correlation counts and can be converted to **Ec/Io** or true power. The end of data is marked by a *Power* value of zero (the *PN Location* will also be set equal to zero).

PN SEARCH

For type values of PN-SEARCH, the word data format follows:

<Power 1 ><Power 2> .... <Power N>

The powers are in correlation counts and can be converted to **Ec/Io** or true power.
There is one power value for each half chip in the PN range specified in the associated search item. The end of data can be determined by the number of words returned or by following the PN_SEARCH search item by a NULL_SEARCH search item.

NULL_SEARCH

In response to a NULL-SEARCH search item, a ScanData response with the *number of words* set equal to zero is returned. This can be used as an alternate method of determining the end of search data returned from different search items.

RSSI_SCAN
This type of ScanData record is only returned during an RSSI scan. The item reference is set to 0xl 2. Each data word returned corresponds to an RSSI value (in dB) for the frequency step.

<RSSI 1 > <RSSI 2> .... <RSS1 n>

GPS_Data (Response)

format.-
<GPS_Data> <70 bytes> <Check Sum>

Description:

This Data block is sent once a scan and contains the binary data from the GPS receiver. The *check sum* is the XOR of all data bytes.

RFinfo
format:
<RFinfo> <Check Sum>
Description:
Requests the RFData block to be returned.

Retums:
RFData is returned in response to this command.

RFSetFreq
format:
<RFSetFrequency> <Frequency>
Description:
Sets the RF frequency. *Frequency* is a four byte value equal to the actual RF frequency divided by the StepSize (from the RFInfo command).

Returns:
OKResponse.

RFData (Response)
format:
<RFData> <Min RF frequency> <Max RF frequency> <Stepsize> <Check Sum>
Description:
The *Min RF frequency* and the *Max RF frequency* are two word integers expressed in kilohertz. The *Stepsize* is in kilohertz and is a one word value.

GetStatus
format:
<GetStatus><Check Sum>

Get the status byte from the unit.

Retums:
Status response.

Status (Response)
format:
<Status><Status byte><Check Sum>

Description:
The status byte contains several flags and is cleared by the Initialize command.

bit	Meaning	
0	GenLocked	This is "l " when the system has GPS Lock
1	Synched	This is "l " when the system is Genlocked.

2	Synched	This is "1" when the system is synchronized to the even second of GPS time.

SetRSSIParam
format:
<SetRSSIParam><Start Frequency><Step><Count><Check Sum>
Description:

Set the parameters associated with an RSSI scan. The *Start Frequency* is four bytes (MSB first) in the same units as the frequency in the RFSetFreq command. The Step is a word representing the frequency increment between samples (in the same units as the start frequency). *Count* is a word representing the number of steps to make.

Returns:
OKResponse.

StartRSSIScan
format:
<StartRSSIScan><Continuous | Single><Check Sum>
Description:

Begins scanning with the criteria chosen with the SetRSSIScan command. The data for a scan is returned with multiple ScanData responses.

Identifier	Value
Continuous	0x01
Single	0x02

The *Check Sum* is the XOR of all of the data bytes. A continuous RSSI scan must be ended in the same way as a continuous scan, with a EndContinousScan command.

Response:

A response of *ResponseOK or ResponseError* is sent immediately. A *ResponseOK* will be followed by *DataScan* responses to transfer the data.

GetVersionInfo
format:
<GetVersionInfo><Check Sum>
Description:

Requests the current software version number.

Response:

Returns a VersionInfo Response.

VersionInfo (Response)
format:
<VersionInfo><Major Version><Minor Version><reserved - 4 bytes>
<Check Sum>
Description:

Provides the current software version number. The major and minor version numbers are bytes.

Response:

Returns a VersionInfo Response.

SetCorrLength

format:

<SetCorrLength><length><Check Sum>

Description:

Selects the amount of averaging following the correlation. The correlation length of 256 is averaged the number of times given in the table below.

Length value	Number of Averages
1	1
2	4
4	8
8	16

Response:

Returns a *ResponseOK.*

Guidelines for direct software interface to the Eagle receiver

By writing software, the end user can directly issue low level commands to the Eagle receiver via an RS232 serial port. The ability to directly control the Eagle provides user with the ability to perform specialized tests and automated testing.

The primary purpose of the Eagle is to scan PN phase offsets and report correlated power for those offsets. An IS-95 base station produces a PN pilot code that is 215 chips long. There are, therefore, 32768 different PN offsets. The Eagle samples twice per chip, so there are 65536 locations that are scanned by the Eagle. All references to PN locations refer to a number between 0 and 65535 (representing PN position in half chips).

For each scan, the Eagle calculates all 65536 locations, processes the data, and returns the requested information to the controlling device (usually a PC). The scan time is one IS-95 pilot frame (the period of the pilot code), which is approximately 27 ms. All searches defined by the user are then performed, and the data for each search is returned to the PC.

Binary Data Output Format

File Header

42 56 32 ← 'BV2'

Playback Data

A5 FF E2 00 1D F2 04 0D B3 0E B3 01

- FF E2: Threshold= -29
- 00 1D F2 04: Frequency= 1962.5 MHz
- 0D B3: Minimum PN= 3507
- 0E B3: Maximum PN= 3763
- 01: Cal Adjust= 1

Calibration Data

82 11 83 04 FF 52 FF B3 00 37 00 07

- 04: 4 Words
- FF 52: Si Constant -173
- FF B3: Ei Constant -76
- 00 37: Frame # 37
- 00 07: Eagle Status

Scan Data

82 01 02 20 0D B3 02 45 0D B4 02 67 0D B5 01 E1 0D B6 01 E3
0D B7 01 E8 0D B8 02 4C 0D B9 02 39 0D BA 02 A9
0D BB 01 F4 0D BC 02 4C 0D BD 02 BE 0D BE 02 82
0D BF 01 DE 0D C0 02 5A 0D C1 02 66 0D C2 02 85

- 20: 32 Words
- 0D B3: PN Offset= 3507
- 02 45: Correlated Power= 581
  For PN= 3507
  Power= 20 log10 (581) + -173/1= -117.72 dBm
  Ec/Io= 20 log10 (581) + -76/1= -20.72 dB

...
82 01 02 02 0E B3 02 63

GPS Data
83 04 03 07 CE 16 22 3B 00 0B 42
72 08 B3 51 91 F0 0A 2A 09 FF
FF F5 91 00 00 02 DA 00 26 05
21 00 14 00 08 08 0A 08 46 A8
07 08 54 A8 1E 08 3A A8 05 08
60 A8 10 08 48 A8 18 08 57 A8
04 08 8C A8 12 08 5E A8 20 7B
A7

Next Playback Data Record
A5 FF E2 00 1D F2 04 0D B3 0E B3 01
...

Typical Eagle Command Session

A typical Eagle session might consist of the following commands and responses.

(Commands to the Eagle are in Bold. Responses in Italics. Comments in plain text.)

Initialized()	
ResponseError (Status Error)	If the Eagle has just been turned on the and has not yet locked to GPS time, this error will be returned. It is not necessary to initialize the Eagle again.
GetStatus()	Check the status, and wait until the Eagle has GPS Lock, Gen Lock, and Sync.
Status	
GetStatus()	
Status	Once Sync. is achieved, the Eagle is ready to measure data.
RFinfo()	Get information about the frequency range of this Eagle.
RFData(info)	
RFSetFreq(Frequency)	Set the RF frequency for the receiver.
ResponseOK	
DefineSearchitem(Search Item)	Define Searches that could be used. Several of these commands maybe sent.
ResponseOK	
SelectSearchitems(items)	Select which of the defined search items will actually be used.
ResponseOK	
StartScan(Continuous)	Start continuously scanning.
ResponseOK	
ScanData(Calibration_Data)	The Calibration data is returned each scan
ScanData	The data for each of the searches is returned possibly multiply ScanData blocks per search.
ScanData	
ScanData(GPS Data)	GPS-Data is returned at the end of every scan.
ScanData(Calibration_Data)	For a continuous scanning, the next scan is made and the data is sent back in ScanData blocks.

EndContinousScan()	This command ends a continuous scan.
ScanData	The remainder of the ScanData blocks for this scan will be sent (if there are anymore).
ScanData	
ResponseOK	When all of the Scan data blocks have been transmitted. The EndContinuousScan is acknowledged.

Eagle Drive Test Sample Data

12/17/1997
Metuchen,Edison,Woodbridge *NJ*
Threshold set at -15dB
PN Range from 0 to 65535
Frequency 893.31 MHZ (RF Channel 777)

Data format
PN1,Ec/Iol,Powerl.... PN#,Ec/Io#,Power#,Date,Time,Lonqitude.,Latitude

where PN is the PN offset in 1/2 chips.
Ec/Io is the Ec/Io reading in dB.
Power is the true signal power in dBm.
Date is in MM/DD/YYYY
Time is in HH:MM:SS.FFFFFF where F is a fractional second.
Longitude/Latitude is in milliarcseconds
where 3,600,000mas = 1 degree.

Pilot Signal Scan Data
26131,-12.76,-71.76,
26135,-9.05,-68.05,
26136,-3.71,-62.71,
26137,-4.76,-63.76,
26138,-12.10,-71.10,
26144,-15.67,-74.67,
47639,-11.00,-70.00,
47640,-7.43,-66.43,
47641,-8.57,-67.57,
47642,-14.48,-73.48,
12/17/1997,18:45:20.572460,145981324,-267559860

5166,-14.78,-92.78,
26150,-14.34,-92.34,
26151,-9.95,-87.95,
26152,-10.81,-88.81,
26670,-11.82,-89.82,
26671,-12.63,-90.63,
27689,-12.36,-90.36,
27690,-9.07,-87.07,
27691,-11.99,-89.99,
47654,-13.75,-91.75,
47655,-11.20,-89.20,
47656,-12.79,-90.79,
47658,-12.61,-90.61
47659,-9.80,-87.80,
47660,-12.79,-90.79,
49194,-13.40,-91.40
50721,-15.43,-93.43,
12/17/1997,18:52:59.904043,145999851,-267635758

Eagle Q & A

While the Eagle and the accompanying Hawkeye software represent the simplest of hardware and software interfaces, CDMA technology is a technically complicated science. In response to a variety of questions, Dr. James Bush has prepared this brief summary:

The apparent level of the Ec/Io noise floor is a function of received pilot strength, if a signal is present. The IS-95 pilot code is a very long PN sequence. When correlating against this code across even a fairly large subsection of this code, there is a correlation noise floor. In the Eagle, which uses a 256 chip correlation length, this value is 15 dB down from inphase correlation. What this means is that Ec/Io measurement has a noise floor that is about 15 dB down from the pilot Ec/Io. Suppose an active base station has a pilot Ec/Io of -9 dB, then the noise floor at that moment would be -24 dB. If on the other hand, no signal is present, the gain in the Eagle increases until the noise is brought to full scale. Uncorrelated noise does have a small gain through a correlator, in the Eagle this produces an Ec/Io noise floor of -7 dB (the true correlated power for these "peaks" will be very low). This high noise floor, of course, is due to the high sensitivity of the Eagle receiver.

It is important to remember that the Ec/Io of a signal is unrelated to the signal strength, in so much as without interferers, the Ec/Io of a base station would remain constant regardless of signal level until the thermal noise floor was approached (just below -100 dBm). The Eagle can receive pilot signals with signal strengths well below -100 dBm. However, a much stronger base station will cover a weak signal (see previous paragraph). These signals will also be hidden to a CDMA telephone and all CDMA sounding equipment. When close to a base station, a CDMA phone only knows who the neighboring cells are, because it is told by the base station (it cannot hand-off to them at this point since it cannot "see" them). A neighbor list must be built by examining the fringe areas of a cell that do permit hand-offs.

Often, when using an Eagle, other momentary peaks bounce around the peak corresponding to a base station. These peaks are not noise but really exist and are most likely multipath reflections from moving objects. The presence of such peaks tell you a great deal about CDMA environments. If the user is interested in integrating these peaks out, this can be done in post-processing. Also, the VGA screen is updated slowly as compared to the rate of captured and recorded data. I hope this eliminates some of the confusion as to the interpretation of the Eagle CDMA sounder's measurements.

The following are some of the more common questions that the BVS technical support staff receives:

Questions

1. What is the maximum difference between the weakest and the strongest Ec/Io in the same measurement, that can be measured?

2. What is the minimum Ec/Io that can be measured?

3. Can a user calibrate the Eagle without assistance from Berkeley?

4. What is the Eagle's RF sensitivity?

5. What is the processing gain and how does BVS compute it?

6. A threshold scan on the Eagle seems to result in either no data points or data for every half-chip regardless of whether it is above or below the requested threshold. What is the proper way to send a threshold on the Eagle?

7. How is the output format of Eagle compatible to various post-processing packages?

8. Is it correct to assume that for PN scanning, the RFSeqFreq command should be set to the center frequency of the target CDMA signal?

9. What are some of the up and coming features in store for the Hawkeye software?

Answers

1. The Eagle can be setup to use 4 different correlation lengths, 256 chips, 512 chips, 1024 chips and

2048 chips. Each of these settings has a different minimum Ec/Io and a different weakest-to-strongest ratio. The theoretical values are given in the following table:

Corr Length	Min Ec/Io	Weakest to Strongest
256	-24 dB	-11 dB
512	-27 dB	-14 dB
1024	-30 dB	-16 dB
2048	-33 dB	-19 dB

It should be noted that the report rate at 2048 chips is approximately 1/3 not 1/8 of the report rate at 256 chips. Our reliance on hardware correlation allows a faster update rate even at long correlation lengths.

2. The Min Ec/Io specified in the table above is based on processing gain. The weakest to strongest values were produced by computer simulation.

3. It is not advisable for an Eagle user to attempt calibration by themselves. This is because the HP 8924C is really a base station simulator and has a rather inaccurate power control, limited to -30 dBm because it was not intended to accurately measure or control power, just to simulate a high-level radiated signal. More importantly, it would be an "apples to oranges" calibration, since the HP and even the Tektronix / Rodie base station simulators include all CDMA channels, and not just Pilot, as in the Eagle. The Rodie / Tektronix CDMA unit is much more accurate and extends 18 dB further, but still not advisable.
The calibration process of an Eagle is rather tedious and extensive. We are automating it here but it still is too complex to detail to customers. It requires some hardware fixtures and can be treacherous because the calibration tables must be exact or the unit will be way off. The process itself uses a calibrated CDMA source (right now an HP-4000A signal generator externally modulated or a Duet PN) and fed into a series of automated step attenuators.
BVS provides free calibration to all of our Eagles customers that are within the warrantee period of 180 days. The process takes one day and serves as a quick "RF sanity check" for the Eagle when compared to a good spectrum analyzer such as an HP 8563 or equivalent.

4. The receiver has an RF sensitivity down to approximately -95 dBm. This is the point at which the AGC stops responding to decreases in RF level.

5. The pilot correlation length is 256 chips. The gain of the signal is through this process is 20 log(256)=48 dB. However, the gain through the correlator for Gaussian noise would be 10 log(256)=24 dB. Therefore, the processing gain above Gaussian noise is 24 dB.
It should be noted that this cannot be used to determine the maximum difference between strongest and weakest base stations that can be measured simultaneously. The real limitation is the correlation noise floor. Correlating across the IS-95 PN code with a correlation length of 256 chips, the maximum non-aligned correlation is -15 dB down from the aligned value. Base stations 15 dB below the strongest base station will be hidden in the correlation noise of the stronger PN. It is important to realize that this property of short correlations on very long PN codes. All IS-95 phones and test equipment suffer the same limitation.

6. The threshold is always in Ec/Io and must be sent as a negative number. A threshold of -30 dB for example would be sent as FF E2.

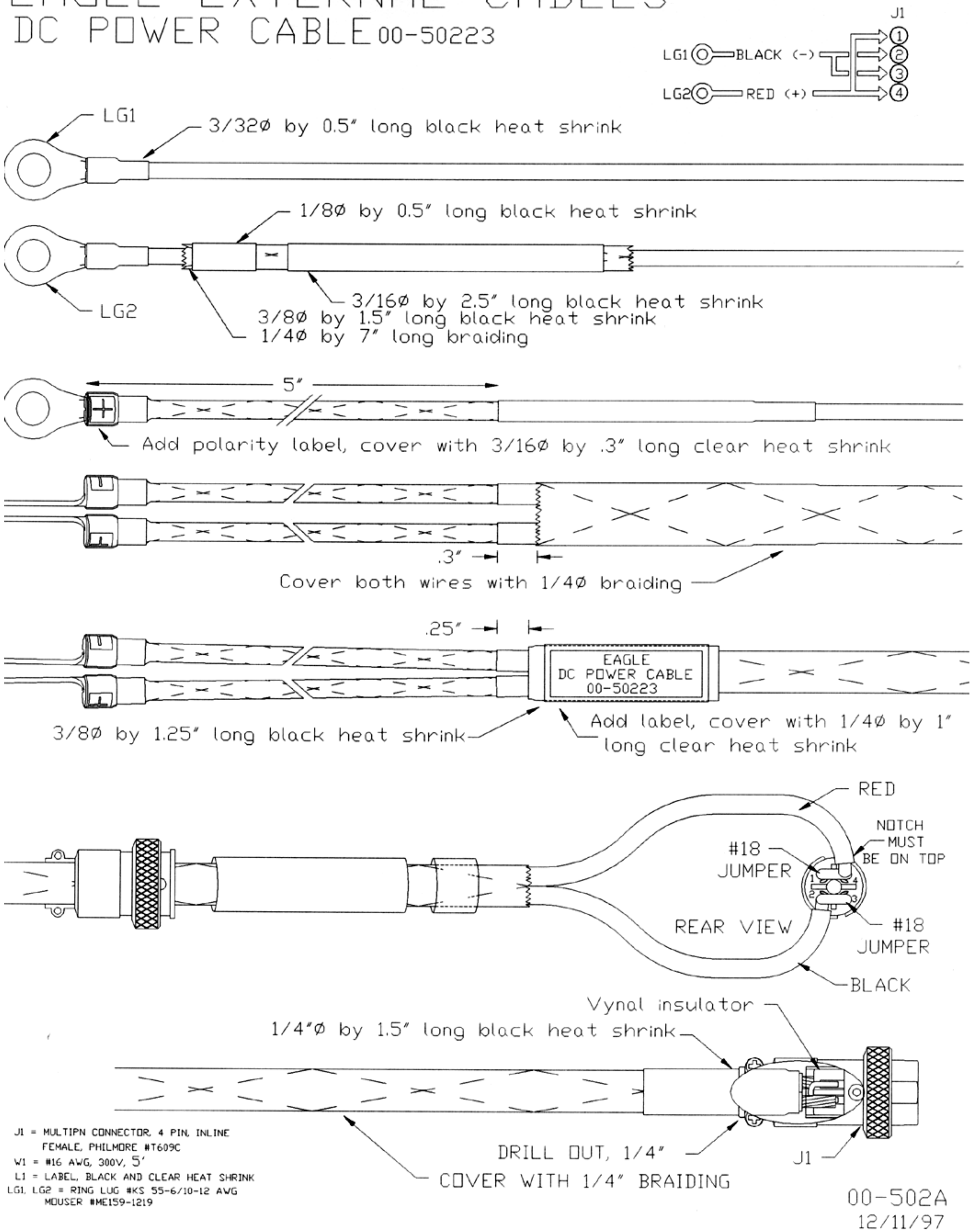
7. This is handled most simply in a custom post-processing data converter. The export feature is part of the Hawkeye software package. This application can run on any PC. The user does not need to be connected to an Eagle in order to perform an export.

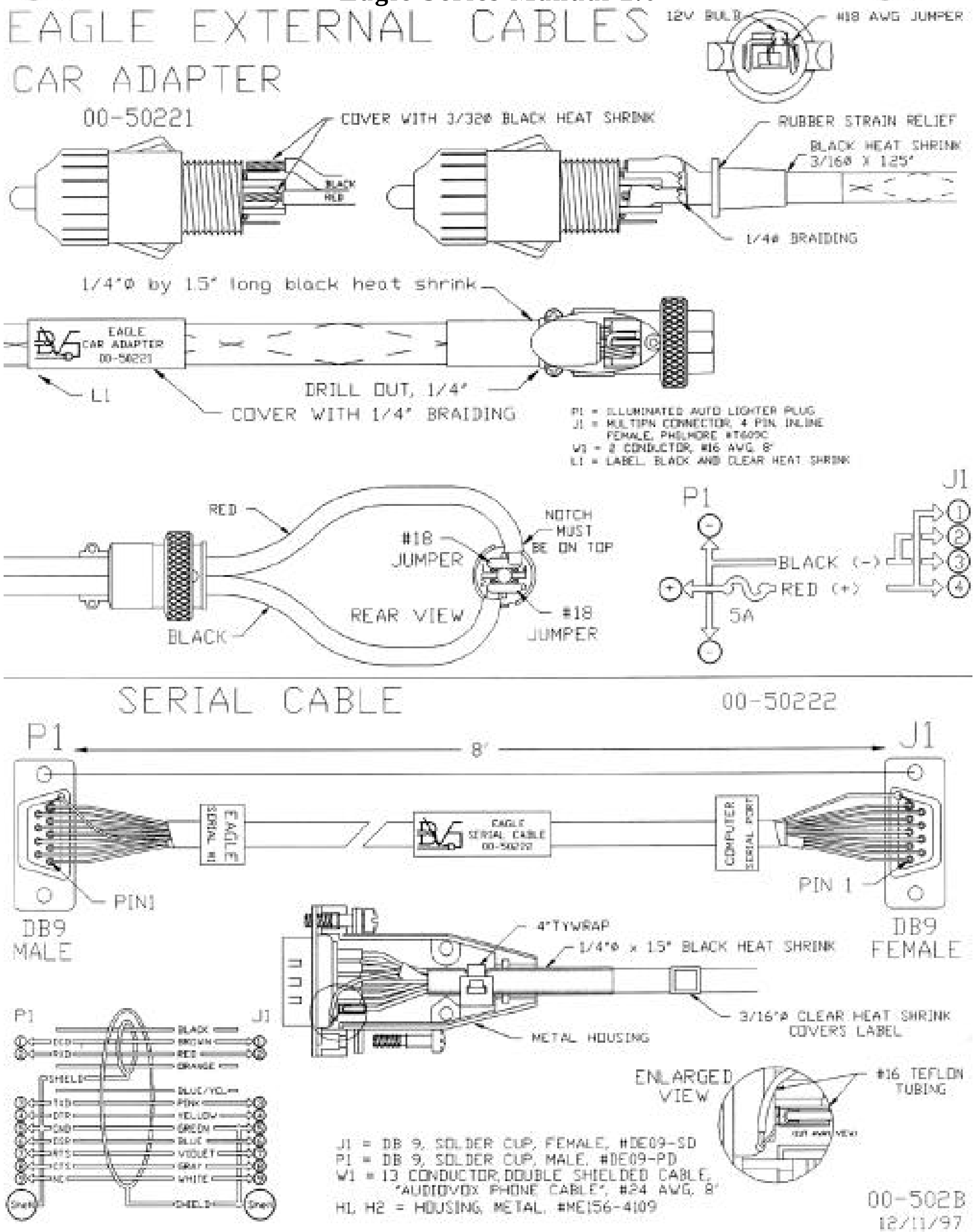
8. Yes, the RF frequency should be set to the center of the channel. The Min and Max frequencies are actually in units of StepSize and the StepSize is in kHz. In order for your software to work with an Eagle receiver in a different frequency range. You should get the RF Info and calculate the frequencies sent to the Eagle using the StepSize.

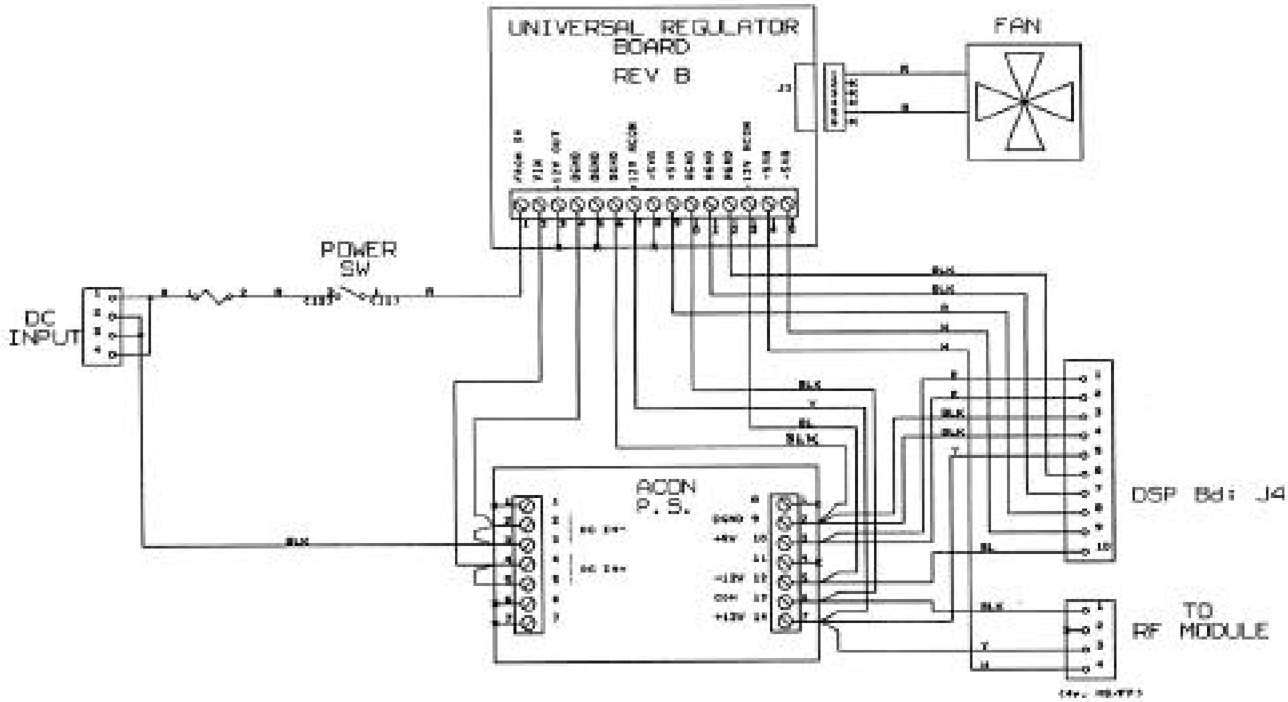
9. The next versions of Hawkeye (1.4 and greater) will support sampling and averaging of the PN measurements. The sampling rate is an input parameter for the user to set but averaging will be done on sector PN on time base through filtered data after it is exported.

EAGLE EXTERNAL CABLES

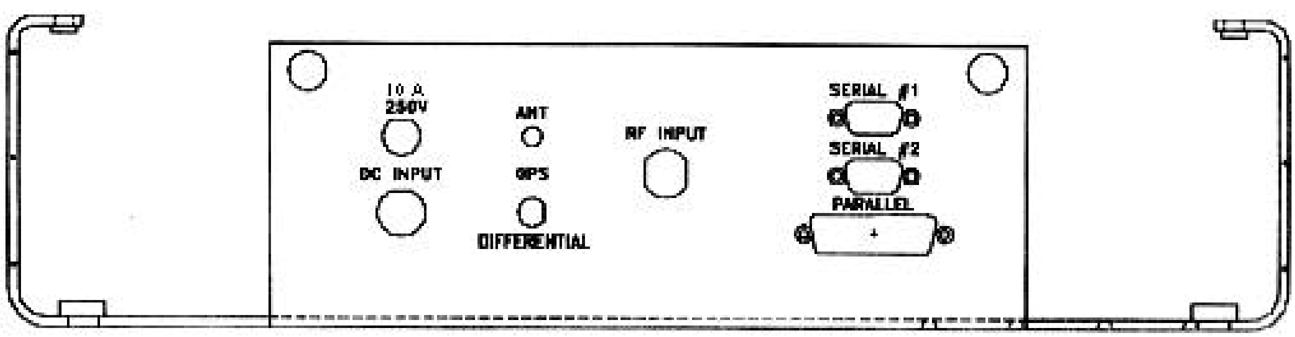
DC POWER CABLE 00-50223



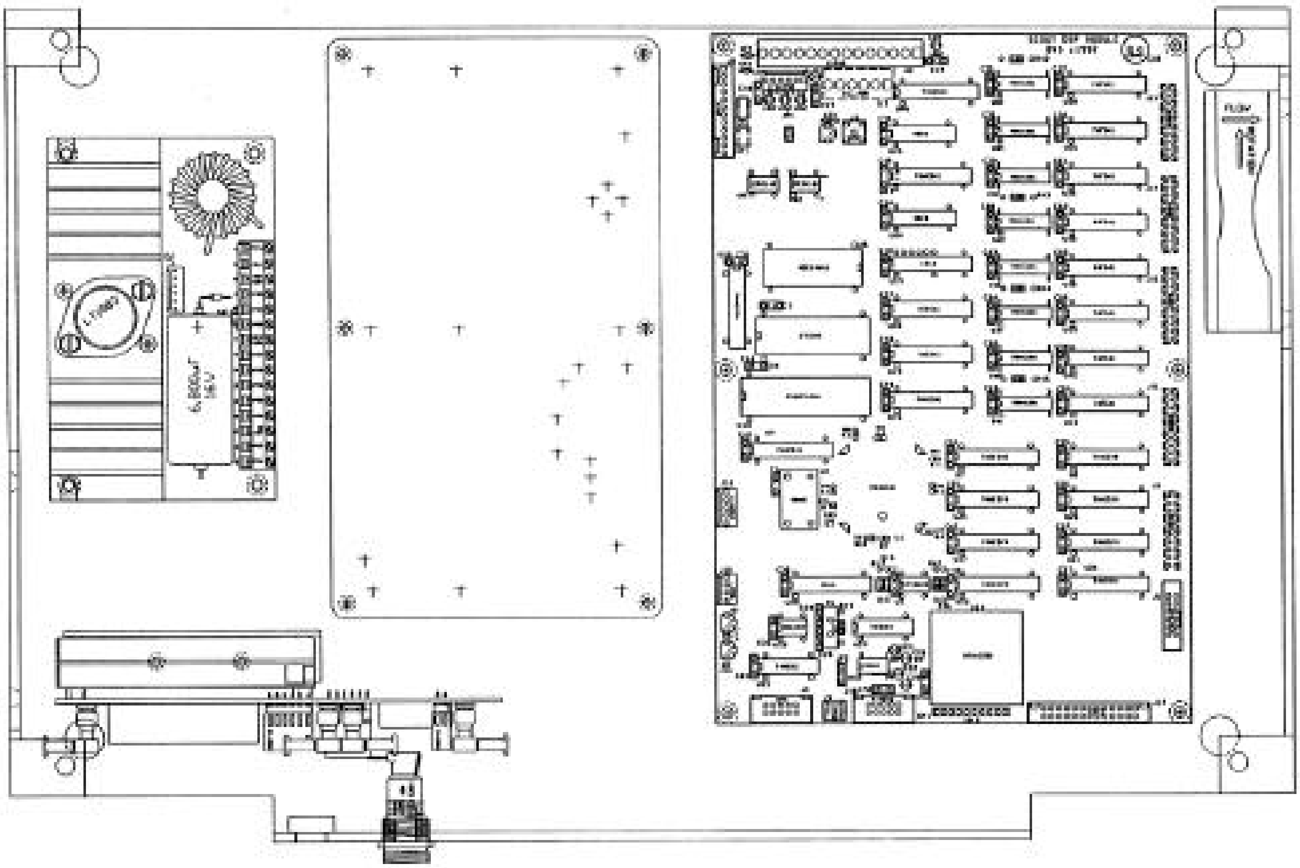

EAGLE EXTERNAL CABLES
CAR ADAPTER
00-50221
12V BULB
#18 AWG JUMPER
COVER WITH 3/32Ø BLACK HEAT SHRINK
BLACK
RED
RUBBER STRAIN RELIEF
BLACK HEAT SHRINK 3/16Ø X 1.25"
1/4Ø BRAIDING
1/4"Ø by 1.5" long black heat shrink
EAGLE CAR ADAPTER 00-50221
L1
DRILL OUT, 1/4"
COVER WITH 1/4" BRAIDING
P1 = ILLUMINATED AUTO LIGHTER PLUG
J1 = MULTIPIN CONNECTOR, 4 PIN, INLINE FEMALE, PHILMORE #T605C
W1 = 2 CONDUCTOR, #16 AWG, 8'
L1 = LABEL, BLACK AND CLEAR HEAT SHRINK
RED
BLACK
#18 JUMPER
NOTCH MUST BE ON TOP
REAR VIEW
#18 JUMPER
P1
J1
BLACK (-)
RED (+)
5A
SERIAL CABLE
00-50222
P1
8'
J1
EAGLE SERIAL #1
EAGLE SERIAL CABLE 00-50222
COMPUTER SERIAL PORT
PIN1
PIN 1
DB9 MALE
DB9 FEMALE
4"TYWRAP
1/4"Ø x 1.5" BLACK HEAT SHRINK
3/16"Ø CLEAR HEAT SHRINK COVERS LABEL
METAL HOUSING
ENLARGED VIEW
#16 TEFLON TUBING
J1 = DB 9, SOLDER CUP, FEMALE, #DE09-SD
P1 = DB 9, SOLDER CUP, MALE, #DE09-PD
W1 = 13 CONDUCTOR, DOUBLE SHIELDED CABLE, "AUDIOVOX PHONE CABLE", #24 AWG, 8'
H1, H2 = HOUSING, METAL, #ME156-4109
00-502B
12/11/97



Eagle/Super Eagle Universal Regulator Board



Eagle/Super Eagle Back Panel



Eagle/Super Eagle Layout (top view)

SPECIFICATIONS for laptop PC as provided with Super Eagle

CPU, Memory, and Architecture:

Intel Pentium(r) processor: 233mhz MMX or 166mhz. Supplies correct dual voltages for MMX processors. 128MB maximum EDO RAM. PCI Bus architecture. 256K Level 2 Synchronous Pipelined burst-mode Cache.

Display:

12.1" 800 x 600 Dual-Scan Passive (256 color) or TFT Active Matrix Color display supporting 480,000 simultaneous colors from a 16 million color pallet. Trident video chip features 2MB EDO display memory, acceleration, and a 64-bit PCI Bus interface, and supports simultaneous display on LCD (internal) and external VGA or NTSC/PAL monitor or TV/VCR. Up to 1280 x 1024 resolution in 256 colors when used with external monitor. Internal MPEG available.

Input Devices:

PS/2 Glidepad (centered under keyboard). 86-key detachable Win95 keyboard with A4 size keys and an embedded numeric keypad.

Ports:

1 DB9 serial (high-speed 16550 UART) and 1 parallel (EPP/ECP) port. External VGA, microphone, speaker, keyboard/mouse (ps/2), game/MIDI, and infrared file transfer (IrDA / FIR compliant) ports.

Integrated Multimedia:

Built-in CD-ROM Drive, using an IDE interface for best compatibility. Internal 16-bit Soundblaster Pro 3.01 compatible sound card with 1MB ROM wavetable for high quality sounds. Built-in mic and stereo speakers.

PCMCIA:

Two stacked PCMCIA type II expansion slots (these also accept one type III card in the place of 2 type II cards).

PLUS one additional, separate type II only slot with support for Zoomed Video (a direct bus to the video display).

Physical:

11.8" x 8.9" x 2". Weighs 7.5 lbs. with one battery and floppy in place.

Power:

110V - 240V, 47-63hz auto-sensing external AC adapter. Built-in Intelligent Power Management (IPM) hardware. Removable lithium ion battery. Primary battery alone lasts 1 to 1.3 hours depending on use. Primary and secondary battery used together last 2 to 2.6 hours depending on use. (Suspend feature further extends battery life when system is idle). Suspend to hard disk feature saves all memory to the hard drive before a low battery condition shutdown occurs.

Removable drives:

1.3GB (13ms) or 2.1GB (12ms) hard drive options. Enhanced PCI IDE hard disk interface supports PIO mode 3 operation. 3.5" 1.44MB Floppy Diskette Drive (removes for insertion of second battery).

110 Watt internal power supply, accepts 100-240V AC power in. One 5.25" and one 3/5" drive bay (SCSI devices recommended). One special bay accepts the 6200/mint floppy drive. Three PCI slots accept two-thirds height PCI cards. One parallel port, two serial ports, one 15-pin VGA/SVGA port, one external ps/2 keyboard/mouse port, headphone jack, TV out RCA jack, one game/midi port. Two internal speakers. Dimensions: 381mm x 405.5mm x 113mm. Weight: 2.5kg (5.5lbs).

Glossary of Acronyms

AC	alternating current
A/D	analog to digital converter
AGC	automatic gain control
BER	bit error rate
BPSK	binary phase shift keying
BW	band width
CDMA	Code Division Multiple Access (spread spectrum modulation)
DC	direct current
D/A	digital to analog
dB	decibel
dBm	decibels referenced to 1 milliwatt
DOS	digital operating system
DSP	digital signal processing
FIR	finite impulse response
GHz	gigahertz
GPS	geographical positioning system (satellite based)
GPS diff.	GPS error correction signal which enhances GPS accuracy
IF	intermediate frequency
I and Q	In phase and Quadrature
kHz	kilohertz
LCD	liquid crystal display
LO	local oscillator
Mbits	megabits
MHz	megahertz
modem	acronym for modulator/demodulator
PCMCIA	personal computer memory card international association
PC	personal computer
PCS	personal communications service (1.8 to 2.1 GHz)
PN	pseudo noise
QPSK	quaternary phase shift keying, 4-level PSK
RF	radio frequency
RSSI	receiver signal strength indicator
UTC	universal coordinated time
VAC	volts alternating current
VGA	video graphic

Technical Support

- Up-to-date information is available on our web site at **http://www.bvsystems.com**
- The latest version of Hawkeye is also available on our web site for download..
- If you wish to contact technical support, mail to **info@bvsystems.com**

Acknowledgements

Notice

Information in this document is subject to change without notice.

If you require technical assistance, or service to your Eagle or Super Eagle CDMA Scanner, contact:

Eagle/Super Eagle Technical Support
Liberty Corporate Park
Berkeley Varitronics Systems, Inc.
255 Liberty Street
Metuchen, NJ 08840
Tel: (732) 548-3737
Fax: (732) 548-3404
8:00am - 6:00pm Eastern Time
www.bvsystems.com E-mail: info@bvsystems.com