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Acoustic Doppler Profiler (ADP™)

Software Manual

Version 6.42

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INTRODUCTION

Thank you for buying an ADP from SonTek. Included with your ADP is Software Version 6.42 or later, which is designed to provide a powerful and flexible means to control instrument operation and access data. All software is written for DOS on PC-compatible computers. The software is intended to be easy to use, and it is our hope that the manual should be needed only as a reference.

This manual is divided into the following sections.

- **Section 1 Software Summary**

A listing of all programs supplied with Software Version 6.42 and their function.

- **Section 2 Real-Time Data Collection (ADPSA)**

This program collects ADP data when connected directly to a PC-compatible computer. It provides a menu driven format for selecting ADP operating parameters and a graphical display of ADP data.

- **Section 3 Binary Data Conversion (GADP___)**

These programs extract data from ADP binary data files into easily accessible ASCII files.

- **Section 4 Compass Calibration (COMPCAL)**

This program calibrates the internal compass/tilt sensor to eliminate contamination from ambient magnetic fields.

- **Section 5 Terminal Emulator (SONTERM)**

This program is for direct communication with the ADP.

- **Section 6 Recorded Data Extraction (SONREC)**

This program downloads ADP data files from the internal recorder.

- **Section 7 Additional Support**

This section provides contact information for additional customer support.

- **Appendix A Automatic File Naming Convention**

This appendix describes the file naming convention (based upon date and time) used when automatic file recording is specified in the real-time data collection software.

- **Appendix B Correcting for Vessel Motion Using GPS Position Data**

This appendix provides the algorithms to compensate ADP velocity data collected from a moving vessel by calculating vessel speed from GPS position data.

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SECTION 1. Software Summary

This section gives a summary of all programs provided with the ADP Software Version 6.42. The software includes programs for real-time data collection, data conversion, compass calibration, recorder data extraction, and direct communication with the ADP. A list of the files on the diskette, with a description of their basic function, is shown below.

- README ASCII text file containing a summary of the programs on the diskette.
- ADPSA.EXE Real-time data collection (see SECTION 2).
- COMPCAL.EXE Compass calibration (see SECTION 4).
- GADPAMP.EXE Data conversion programs. These extract different portions of
- GADPCTL.EXE ADP data from the binary files to an easily accessible ASCII
- GADPGPS.EXE format (see SECTION 3).
- GADPHDR.EXE
- GADPSNR.EXE
- GADPSTD.EXE
- GADPVEL.EXE

Extraction programs for using with ADP optional features:

- GADPBT.EXE (Described in Part 5)
- GADPCTD.EXE (Part 5)
- GADPPRES.EXE (Part 5)
- GADPWAVE.EXE (Part 5)

- MAGDEC A useful utility, which provides compass magnetic declination at a specified position and time (SECTION 7)
- SONREC.EXE Recorder data extraction (see SECTION 7).
- SONTERM.EXE Terminal emulator (see SECTION 5).

Additionally, the diskette includes a directory called SOURCE. This directory contains source code, written in C, for all ADP data conversion routines (the GADP____.EXE files). This code allows the user to easily write their own software to access the ADP binary data files. The code should be easily understandable to anyone with basic experience programming in C.

SECTION 2. Real-Time Data Collection (ADPSA)

This program collects data from an ADP in real time. The software must be run from DOS on a PC-compatible computer with a minimum 33-MHz 386 processor, 640K RAM, VGA graphics, and a hard disk. It provides a menu driven format to select ADP data collection parameters, real-time display of the velocity data, and writes the ADP data to binary files on the computer hard disk.

The program has two primary display screens: setup and data acquisition. The setup screen is for selecting ADP operating parameters. The data acquisition screen provides a graphical display of ADP data, as well as tabular information relating to data collection and recording. The description of the real-time data collection software is divided into the following sections.

- Section 2.1 gives an overview of program operation.
- Section 2.2 shows command line options to modify program operation.
- Section 2.3 describes the ADPSA setup screen.
- Section 2.4 describes the ADPSA data acquisition screen.
- Section 2.5 discusses using ADPSA to integrate GPS position data with ADP velocity data.
- Section 2.6 describes the contents of ADP binary data files.
- Section 2.7 describes configuration and log files used with ADPSA.

2.1. Program Overview

When run with no command line options, ADPSA will first try to communicate with the ADP on COM1 at 9600 baud (different communication parameters can be specified using command line options; see section 2.2). If communication is established, it downloads the current hardware and user parameters and enters the setup screen.

If communication cannot be established, ADPSA loads the hardware configuration file specified in the ASCII text file ADPSENS.DEF. ADPSENS.DEF is a text file with one line naming the hardware configuration file to be used. For example, if ADPSENS.DEF contains the following line:

```
ADP4050.SEN
```

this specifies the configuration file ADP4050.SEN for serial number 4050. The hardware configuration file allows the user to enter the setup screen without being connected to the ADP. When using these files, the program outputs a message that communications were not established and then enters the setup screen. The hardware configuration file and ADPSENS.DEF are included on the software diskette.

In the setup screen, the user can modify operating parameters, view hardware configuration and performance estimates, specify a recording file name, and start data collection. When data collection is started, the program sends all user settings to the ADP, enters the data acquisition screen, and begins collecting data. Within the data acquisition screen, the user can modify the graphical display without affecting data collection or recording.

IMPORTANT: At the start of data collection, the ADP internal clock is set to match the computer clock. This time standard is applied on all recorded data.

2.2. Command Line Options

Several command line options can alter the operation of ADPSA and change communication settings. Options designated by a single letter (c, f, g, p, w) change the operation of the data acquisition program; multiple-character options change how the program communicates with the ADP.

The table below gives the command line options that can modify the operation of ADPSA. Multiple command line options can be given in any combination. When more than one option is selected, all options should be given together (i.e. “ADPSA -cg” or “ADPSA -gp”).

ADPSA Command Line Options

Command	Function
ADPSA -c	Command file. This causes the program to send all commands in the user-generated ASCII text file USERCONF.CMD to the ADP prior to entering the setup screen. Thus, the parameters shown in the setup menu will reflect the settings given by commands in USERCONF.CMD.
ADPSA -f	Automatic file recording. This option causes the program to automatically select a file name for recording to the computer hard disk. See below for details on the file naming convention.
ADPSA -g	Automatically start data collection. This causes the program to skip the setup screen and immediately begin data collection. The ADP will use the data collection parameters stored in internal memory in the ADP. This option includes automatic file recording. This command can be put at the end of the AUTOEXEC.BAT file and collection will resume after a power failure.
ADPSA -p	Integrate GPS position data. This allows the program to read GPS position data from an available serial port and integrate the position data with the ADP data files. GPS position data can compute absolute velocity data when the ADP is installed on a moving vessel. See below for details on using the -p option; see sections 2.5 and 3.5 for more details on using integrated GPS position data.
ADPSA -w	Black and white display. This option is useful on portable computers being operated outdoors.

Automatic file recording

When using the automatic file-recording feature (-f or -g), the user must create the file ADPFILE.DEF to specify details relating to data file recording. This is a one-line ASCII text file, an example of which is shown below.

```
C:\ADP\AA  HOURLY
```

The first word specifies the path (“C:\ADP\”) for the data file and the first two characters (“AA”) in the file name. The remainder of the file name is generated using the date and time (see Appendix A). The second word on this line specifies the interval at which new data files are created. This is either done at the start of each hour (HOURLY) or when the file reaches a

particular size (SIZE <kBytes>). For example, "C:\ADP\AA SIZE 1400" will create a new file each time the data file reaches 1400 kBytes.

Integrated GPS position data

Using the -p command line option allows ADPSA to integrate GPS position data into the file. See sections 2.5 and 3.5 for more information about using GPS position data to correct ADP velocity data from a moving vessel. When using integrated GPS data, the user must create a one-line ASCII text file named "GPSPORT.DEF" to specify the format of the GPS data and the serial communication parameters used. The basic format of this file is shown below.

```
<Message Format> <com port> <baud rate> <parity> <data bits> <stop bits>
```

Where

- <Message Format> is the GPS message format being used. The ADP software will interpret three different types of GPS data formats: "\$GPGXP" and "\$GPGGA" \$GPGGK".
- <com port> is the serial port number to which the GPS receiver is connected (1 for COM1 or 2 for COM2). This must be different than the port to which the ADP is connected.

NOTE: Default DOS/WINDOWS serial port COM1 and COM2 configuration be used:

COM1 Interrupt request (IRQ)- 04, Input/output range 03F8-03FF

COM2 Interrupt request (IRQ)- 03, Input/output range 02F8-02FF

Communication ports configured using different settings (even though designated as COM1 or COM2) will not operate.

- <baud rate> is the baud rate setting of the GPS data. Acceptable baud rate settings are 4800, 9600 and 19200.
- <parity> is the parity setting: N for no parity, O for odd, and E for even.
- <data bits> is the number of data bits: 7 or 8.
- <stop bits> is the number of stop bits: 1 or 2.

The following line is an example of the GPSPORT.DEF file when inputting GPS data in the \$GPGXP format on COM 2 at 4800 baud, no parity, 8 data bits, and 1 stop bit.

```
$GPGXP 2 4800 N 8 1
```

Integrating GPS data with the ADP data file provides an additional option in the data acquisition screen of ADPSA. Velocity data can either be displayed relative to the ADP (without using the GPS data) or absolute currents subtracting the vessel speed based upon GPS position data. See Section 2.4 for more details.

Combinations of command line options

Many of the command line options shown above can be given in combination to increase the flexibility of the data collection software. For example, the command "ADPSA -cg" combines the command file and auto start options. When this command is selected, the program will send the commands specified in the ASCII file USERCONF.CMD to the ADP. It will then immediately begin data collection with a recording file named based upon date and time. The command "ADPSA -cgp" adds integrated GPS position data to the above operation. Placing one of these commands at the end of the AUTOEXEC.BAT file will automatically re-start data collection in the event of a power failure.

Communication settings

Using the default settings, ADPSA will communicate with the ADP on COM1 at 9600 baud. The following options can modify the communication port settings.

```
COM1, COM2  
BR1200, BR2400, BR4800, BR9600, BR19200, BR38400, BR57600, BR115200
```

For example, the following command will run ADPSA with automatic file recording using serial port COM2 at 4800 baud.

```
ADPSA -f -COM2 -BR4800
```

The communication settings can be used individually or in combination with any of the other command line options. Each communication option should be listed separately on the command line as shown above; the order in which command line options appear is not important.

2.3. Setting up Data Acquisition Parameters

Unless run with the -g command line option (automatic start), ADPSA enters the setup screen after loading hardware and user configuration parameters. An example of this screen is shown in Figure 1. The screen is divided into three areas. The top right corner shows the computer date and time. The center right portion of the screen presents ADP hardware configuration information and performance estimates based upon the current operating parameters. The left side of the screen has a number of active windows to select operating parameters for the ADP.

Computer date/time

The computer date and time are shown in the upper right hand corner of the screen. It is important to note that this is the date and time used for data collection by ADPSA. The ADP internal clock is set to match the computer clock, and all data has a time stamp that matches the computer clock.

Hardware configuration and performance estimate

Hardware configuration parameters are normally downloaded from the ADP. If the program is unable to establish communication with the ADP, it will load the hardware configuration from the file specified in the text file "ADPSENS.DEF" (see section 2.1). The first item under hardware configuration (ADP Status) reflects whether the program was able to establish communication with the ADP. Sensor serial number and system frequency are values that are factory set for each ADP. Sensor orientation (for UP / DOWN / SIDE profiling) is set by a hardware switch on the ADP electronics. Changing sensor orientation also requires the user to modify the installation of the compass/tilt sensor; see the ADP Operation Manual for details.

Three parameters relating to ADP performance are calculated based upon the current hardware and operating parameters. Upper and lower profile depths are calculated based upon cell size, blanking distance, number of cells, sensor orientation, and sensor mounting depth. They represent the lower edge of the lower cell and the upper edge of the upper cell, respectively. In the data acquisition screen, velocity data are plotted based upon the location of the center of each cell. Velocity precision is an estimate of the accuracy of the velocity measurements based upon

the cell size and averaging interval (the number of cells can also affect this value if it affects pinging rate).

2.3.2. User setup parameters

The left portion of the setup screen displays a number of parameters that can be set by the user for each deployment. To change these parameters, move through the items using the up/down arrow keys (or page up/page down). Information about the highlighted parameter is displayed at the bottom of the screen. The current item (highlighted) is changed or executed by pressing the ENTER key. After pressing the ENTER key on a highlighted item, the user is prompted to enter a new value for the parameter, or to choose from a set of acceptable values. If a parameter is accidentally selected the user may recover by pressing the ESC key, leaving the parameter unchanged.

A description of each item in the user setup menu is given below.

Water Temperature (°C): (Enter value)

Temperature is required for calculating the speed of sound, which converts Doppler shift to water velocity. The entered temperature may or may not be applied for sound speed calculations depending upon the temperature mode setting (see below).

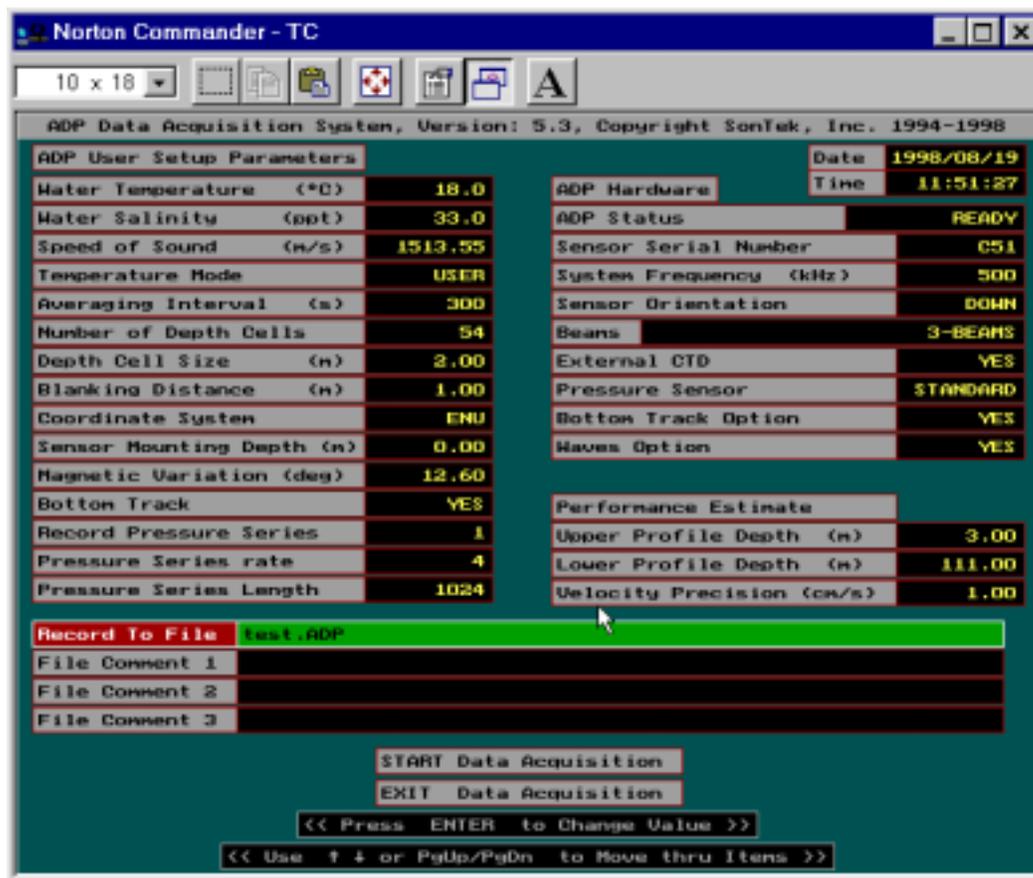


Figure 1 – ADPSA Setup Screen

Water Salinity (ppt): (Enter value)

Salinity is used to calculate the speed of sound, which converts Doppler shift to water velocity.

Speed of Sound (m/s): (Derived value)

The speed of sound in water is given in the menu for information only, and cannot be changed by the user. It is computed from the values of temperature and salinity. Sound speed shown in this menu is based upon the entered values of temperature and salinity; if temperature mode is set to MEASURED, the sound speed will be based upon the value from the ADP temperature sensor. See the ADP Principles of Operation for details on the effect of sound speed on ADP operation.

Temperature Mode: (Multiple-choice)

Temperature mode refers to the source of temperature data for sound speed calculations. USER indicates that the value input in the setup menu (see above) should be used; MEASURED indicates that the value from the ADP temperature sensor should be used. The ADP temperature sensor is considered sufficiently reliable and accurate ($\pm 0.2^\circ\text{C}$) for sound speed calculations, thus MEASURED is the common choice. The USER setting is occasionally selected to simplify post-processing corrections using data from an external temperature / salinity sensor. Sound speed is recorded with each profile, so post-processing corrections can be made using data from either temperature mode.

Averaging Interval (s): (Enter value)

The ADP will accumulate samples internally for this period of time and then display and store the mean current profile. The standard deviation (accuracy) of the velocity data is inversely proportional to the square root of the averaging interval (longer averaging times give lower standard deviations).

Number of Depth Cells: (Enter value)

Number of depth cells to collect per profile.

Depth Cell Size (m): (Enter value)

Vertical length of each depth cell. Standard deviation (accuracy) of the velocity measurements is inversely proportional to the depth cell size (larger depth cells give lower standard deviations).

Blanking Distance (m): (Enter value)

The vertical distance from the transducers to the start of the first depth cell. A minimum value is required for each frequency to avoid contamination. Except for specialized applications, the blanking distance should be left at the minimum setting and not changed by the user. Minimum values for each frequency are shown in the table below.

ADP Minimum Blanking Distances

Frequency	Minimum Blanking Distance
3000 kHz	0.2 m
1500 kHz	0.4 m
1000 kHz	0.5 m
750 kHz	0.8 m
500 kHz	1.0 m
250 kHz	1.5 m

Coordinate system: (Multiple-choice)

This determines the coordinate system in which velocity data are displayed and stored. BEAM gives velocity data as along-beam velocities (not common). XYZ gives velocity data in a Cartesian coordinate system relative to ADP orientation (see the ADP Operation Manual). ENU (for East-North-Up) reports data in an instrument independent Earth coordinate system; this option requires that the ADP have the optional compass/tilt sensor installed. When configuring the ADP, be certain that “Sensor Orientation” is correctly set in the hardware configuration, as this will affect the reporting of velocity data in either the XYZ or ENU coordinate system. For most applications, the ENU coordinate system is preferred.

Sensor Mounting Depth (m): (Enter value)

This sets the depth at which the ADP is mounted (at the level of the transducer faces). This value is for display purposes to determine the depth of each cell.

Magnetic Variation (deg): (Enter value)

The difference between magnetic north and true north, expressed as degrees east of true. Thus a value of 10.0 indicates magnetic north is 10° east of true north, where as a value of -10.0 indicates that magnetic north is 10° west of true north. This value is for display purposes only when using the ENU (East-North-Up) coordinate system; display velocities are rotated to represent true north. The data stored in binary files are always referenced to magnetic north when using the ENU coordinate system.

NOTE: in order to obtain up to date magnetic variation (declination) for your specific location use utility MAGDECL (see SECTION 7) provided with the ADP software package.

Bottom Track (Yes or No):

Enables/disables the Bottom Tracking mode.

Record Pressure Series (value) (Enter value)

Controls Collection/Recording of the Pressure Series data. When RPS=N (N>0) is entered the pressure data will be collected every N profiles (note, that the time between successive pressure records will be N×PRI, where PRI is profiling interval in s). If N=0 is specified, no pressure data is collected.

Pressure Series Length (samples) (Enter value)

Sets the length of the pressure time series (in samples). The PSL should fall in the range between 1 and 8192 samples. The length of the pressure series in seconds equals PSL/PSR.). Because the wave extraction software uses 256-second data segments it is recommended that the PSL is a multiple of that number. For more accurate wave parameter estimation we also recommend the minimum pressure series length of 1024 seconds. However the user may choose smaller values if desired.

Pressure Series Rate (Hz) (Enter value)

Specifies the sampling rate for the pressure time series collection (can be set to only 1, 2 or 4 Hz).

Record To File: (Enter filename)

This item assigns a file for recording ADP data. Several checks have been incorporated to insure that a valid filename is given, the file can be created, and that an existing file is not accidentally overwritten.

File Comment 1/2/3: (Enter text)

These items permit the user to enter up to three 60-character lines of text for the purpose of documenting the data set.

START Data Acquisition: (Enter)

Once the user is satisfied with the setup, data acquisition can be started by pressing Enter on this item. The program will initialize the ADP and enter the data acquisition mode.

EXIT Data Acquisition: (Enter)

Pressing Enter causes the program to terminate and return to DOS.

2.4. Data Acquisition Display

After selecting "Start Data Acquisition" in the setup screen, the program displays the command sequence for initializing the ADP, and then switches to the real-time display and the ADP begins collecting data. Figure 2 shows an example of the data acquisition screen. The top of the screen displays information on the status of data acquisition. The main portion of the screen provides a graphical data display of ADP data. The bottom of the screen shows which keys are active during data acquisition and the function of each.

2.4.1. Status Information

The status portion of the screen is updated with each profile; each block is described below.

Recording To File

This displays the path and name of the ADP data file. If recording is disabled, the words NOT RECORDING are displayed.

File Size (kb) / Disk Space (kb) / Recording Time Left (h)

These fields will display information only if recording is enabled. "File Size" gives the current size of the data file in kilobytes. "Disk Space" gives the amount of space left on the disk on which the data file resides (also in kilobytes). "Recording Time Left" tells the user how many hours of data can be collected at the present rate before the disk becomes full.

Start Time

This time is obtained from the computer clock (note that the ADP clock is set to match the PC clock at the start of data collection) and represents the start of the first averaging interval.

Profile Time

This represents the time of the profile currently displayed on the screen (start of the averaging interval).

Secs to Average

Indicates the time remaining (in seconds) in the current averaging interval.

Profile Number

This is the number of the last velocity profile collected and currently displayed.

Heading / Pitch / Roll

These fields present data from the optional compass/tilt sensor.

Temp (°C)

Displays the most-recent data from the ADP temperature sensor.

Pressure (dB)

Displays the most-recent data from the optional ADP pressure sensor, in dBar. This field will show 0 if the pressure sensor is not installed.

Bottom Track Display (if enabled)

Displays the most-recent bottom-track data: averaged depth (m), Veast and Vnorth (cm/s).

GPS Navigation Display (if present)

Displays the most-recent position (Lat & Long) and vessel spees (Veast and Vnorth (cm/s)).

Waves Display (if enabled)

Displays the most-recent wave data: Significant wave height (H_{mo} , cm) and wave peak period (T_p , s).

External CTD Display (if present)

Displays the most-recent data acquired from an external CTD: temperature (°C), conductivity {Siemens), pressure {dbar) and salinity, (ppt).).

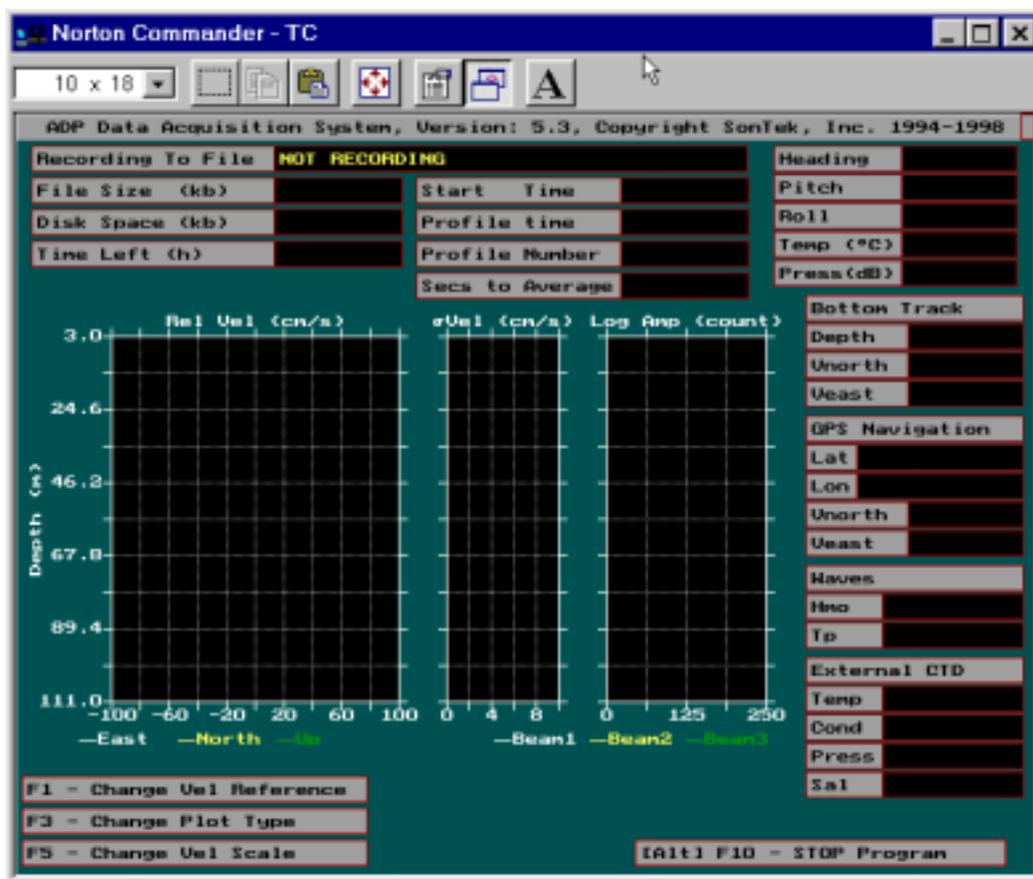


Figure 2 – ADPSA Real-Time Data Acquisition Display

2.4.2. Velocity Profile Data

The data acquisition mode has two graphical displays: one presents velocity component data in BEAM, XYZ, or ENU coordinates, and the other gives current speed and direction. The plots associated with each display type are described below.

Velocity component plots: (shown in Figure 2)

The first plot (“Vel (cm/s)”) displays the most-recent velocity profile with separate lines for each velocity component (either Beam 1/2/3, X/Y/Z, or East/North/Up). The second plot (“ σ Vel (cm/s)”) displays the standard deviation of each velocity component. For all plots, the (Beam 1/X/East) component is shown in white, (Beam 2/Y/North) in yellow, and (Beam 3/Z/Up) in green.

The third plot (“Log Amp (count)”) displays the acoustic signal strength as a function of depth for each of the three acoustic beams. Signal strength is the magnitude of the return signal from the water, and is a function of the frequency of the ADP, the amount of scattering material in the water, and the range from the instrument. Signal strength is plotted using internal units called counts; one count equals 0.43 dB. See the ADP Principles of Operation for more information about interpreting ADP velocity, standard deviation, and signal strength.

Current speed and direction plots:

The first plot (“Speed (cm/s)”) displays the most-recent profile of water speed, and the second plot (“Direction”) displays the most-recent profile of water velocity direction. Only horizontal velocity data are used for the calculation of speed and direction (X and Y, or East and North, depending upon the coordinate system selected). The units for direction are degrees clockwise from north for the ENU coordinate system, or degrees clockwise from the positive Y-axis for the XYZ coordinate system. The third plot (“Log Amp (counts)”) displays the acoustic signal strength, as described above. This display type is not allowed if the BEAM coordinate system is selected.

2.4.3. Control Keys

Three active keys may be used during data collection. The first two keys (F3 and F5) affect only the graphical display and do not alter or interrupt data collection. The third key (ALT+F10) stops data collection (it prompts you to confirm before stopping). Pressing the ESC key will remove the pop up window if any key is pressed unintentionally.

F3 - Change Plot Type: (Multiple-choice)

Pressing the F3 key permits the user to select the type of graphical display.

“Beam, XYZ or ENU” plots the velocity data as individual components. “Speed / Dir” plots the velocity data as current speed and direction.

F5 - Change Vel Scale: (Multiple-choice)

Pressing the F5 key permits the user to select the full scale of the velocity profile plot. Velocity scale options are: ± 10 cm/s, ± 20 cm/s, ± 50 cm/s, ± 100 cm/s, ± 200 cm/s, ± 300 cm/s, and ± 500 cm/s. Note that this setting affects both types of graphical displays (velocity component and current speed), but does not affect recorded data.

[ALT] F10 - Stop Program: (Yes/No)

To stop data acquisition, the user must press the ALT and F10 keys simultaneously. After this is done, the user is presented with a prompt (a Yes/No multiple-choice window) to confirm the intention to stop the program. Data collection/recording proceeds normally until the confirmation is given. Upon selecting “Yes”, the program returns to the setup screen. If the program was run with the automatic start option (“ADPSA -g”), confirmation after ALT-F10 returns to the DOS prompt.

F1 – Change Vel Reference: (Multiple-choice)

This allows the user to select how ADP velocity data are displayed. “Relative to ADP” gives the raw velocity relative to the instrument. “Relative to GPS” uses the GPS calculated vessel speed and the magnetic variation (from the setup menu) to determine the absolute water velocity, independent of vessel motion.

If ADPSA has been run with the –p option for integrated GPS data, there will be several minor changes in the data acquisition screen. Several additional fields will be present in the status portion of the screen, and one additional active key is enabled. Each of these is described below.

2.4.4. Integrated GPS Data

If ADPSA has been run with the –p option for integrated GPS data, there will be several minor changes in the data acquisition screen. Several additional fields will be present in the status portion of the screen, and one additional active key is enabled. Each of these is described below.

Latitude / Longitude

These fields display the most-recent position information from the incoming GPS data.

Vessel Speed (knots)

These fields give the north-south and east-west vessel speed from the last profile, calculated based upon GPS position data.

F1 – Change Vel Reference: (Multiple-choice)

This allows the user to select how ADP velocity data are displayed.

“Relative to ADP” gives the raw velocity relative to the instrument.

“Relative to GPS (if present)” uses the GPS calculated vessel speed and the magnetic variation (from the setup menu) to determine the absolute water velocity, independent of vessel motion.

“Relative to Bottom (if enabled)” uses the Bottom Track speed and the magnetic variation (from the setup menu) to determine the absolute water velocity, independent of vessel motion.

2.5. Considerations When Collecting GPS Data

Integration of GPS position with ADP velocity data allows the instrument to measure absolute current profiles from a moving vessel. This is a very powerful capability, particularly for performing rapid current surveys over a wide area. However, the user must be aware that collecting data from a moving vessel is inherently more complex than from a stationary system. Extra precautions are required to ensure good quality data. Several areas of concern are described below.

Positioning Data

The accuracy of the positioning data is an essential key to the success of moving boat data collection. A good quality GPS receiver with accurate differential corrections should be used. The accuracy of the positioning data directly determines the accuracy of the absolute velocity profiles. For example, if the positioning data has an uncertainty of ± 2 m and an averaging interval of 60 seconds is entered, the uncertainty of the vessel speed for each profile is about ± 6 cm/s. This uncertainty is reflected directly in the absolute current speed.

Compass Data

The quality of heading, pitch, and roll data is equally critical. The importance of accurate heading is magnified because of the vessel motion. For example, if data are being collected from a boat moving at 5 knots, a heading error of 2° translates into a cross-track velocity error of $(5 \text{ knots} * \sin(2^\circ) = 8 \text{ cm/s})$. Before starting data collection, perform a compass calibration with the ADP mounted in the exact location and orientation that it will be in during data collection. Additionally, limit vessel speed to reduce the effect of any heading errors.

Magnetic Variation

The value for magnetic variation entered in the setup menu rotates ADP velocity data from magnetic East-North-Up coordinates to geographic East-North-Up. This is required since GPS data yield vessel speed in geographic coordinates. The accuracy of magnetic variation therefore affects the accuracy of absolute velocity data, with the same sensitivity as heading data discussed above. In order to obtain up to date magnetic variation (declination) for your specific location use utility MAGDECL provided with the ADP software package.

Operating Parameters: Cell Size and Averaging Interval

In moving boat applications, you will typically use a larger cell size than stationary applications. There are several reasons for this: higher vertical resolution is not meaningful because of motion of the vessel (heave, pitch, roll, and translation), larger cell sizes achieve lower instrument noise in a short period of time, and the maximum profiling range of the system is typically important. Recommended cell sizes for the different ADP frequencies are 0.5 m, 1.0 m, 1.0 m, 2.0 m, 4.0 m, and 4.0 m for the 3000 kHz, 1500 kHz, 1000 kHz, 750 kHz, 500 kHz, and 250 kHz, respectively.

Moving boat velocity data typically require relatively large averaging times (5-10 minutes) to reduce the effects of boat motion. However, for flexible post processing we recommend recording data with a shorter averaging interval (1 minute) and performing the additional averaging in post processing. This allows you to precisely define different segments of the data (i.e. on station versus in motion) and gives the greatest flexibility in data analysis.

General Data Processing Concerns

As mentioned before, the user should be aware of the increased complexity of moving boat data collection. SonTek is willing to provide support, guidance, and software to assist in collecting and analyzing moving vessel ADP data. However, the user will also need to invest time in understanding the different aspects of moving boat data collection and in developing the tools needed for effective data analysis.

2.6. Data Recording

ADP data are recorded in a standard binary file format; the same format is used whether data are recorded using ADPSA or on the internal recorder. When data collection is started, the hardware configuration and user operating parameters are stored in a file header structure. With each profile, the system stores a binary record containing velocity, signal strength, standard deviation, heading, pitch, roll, profile time, and a number of other parameters. All of the data contained in these files can be accessed by the data conversion programs discussed in SECTION 3. The binary file format is described in detail in the ADP Operation Manual.

When using ADPSA to collect data, the user has the option to also store data internally on the ADP recorder. ADPSA does not affect any ADP settings that relate to the internal recorder; these are left in the same state during data collection, as they were when ADPSA was started. The most common reason to use the internal recorder while collecting data with ADPSA is for a backup in case of computer malfunction or power loss. To do this, the user should use a terminal emulator (i.e. SONTERM.EXE) to set the ADP recorder to ON and the recorder mode to BUFFER. In BUFFER mode, the internal recorder will overwrite the oldest data currently on the recorder once all available space has been filled.

2.7. Associated Configuration and Log Files

There are several configuration and log files associated with the operation of ADPSA.

ADPSA Associated Configuration and Log Files

File Name	Function
ADPSA.LOG	Records all communication between computer and ADP in an ASCII text file; this file is overwritten each time ADPSA is run. Information recorded here can be useful when looking for errors in data collection.
ADPUSER.SET	Records settings for all user parameters; overwritten each time ADPSA is exited. This binary file is only used if the computer is unable to communicate with the ADP upon start up.
DISPLAY.SET	This binary file records the most-recent graphics settings from data acquisition mode.
ADPSENS.DEF	This text file specifies which hardware configuration file is used if needed (see section 2.1).
*.SEN	Hardware configuration file (see section 2.1).
USERCONF.CMD	This ASCII text file is used with the -c command line option (see section 2.2).
ADPFILE.DEF	This ASCII text file is for automatic file recording with the -f or -g command line options (see section 2.2).
GPSPORT.DEF	This ASCII text file is used with the -p command line option (see sections 2.2 and 2.5)

SECTION 3. Binary Data Conversion (GADP___)

All binary data files generated by the ADP, whether collected using the real-time data collection software ADPSA or recorded internally in ADP memory, use the same format. The exact format of the binary data files is given in the ADP Operation Manual. The data conversion software discussed in this section extract various portions of the data from the binary file to an easily manipulated ASCII format. The following list summarizes these programs and their functions. These programs can be run on any PC-compatible computer.

- GADPAMP Extracts raw signal strength data.
- GADPCTL Extracts configuration and setup information.
- GADPHDR Extracts profile header information (heading, pitch, roll, temperature, and pressure) recorded with each velocity profile.
- GADPSNR Extracts Signal-to-Noise Ratio (SNR) data.
- GADPSTD Extracts velocity standard deviation data.
- GADPVEL Extracts velocity data as individual components (BEAM, XYZ, or ENU).

The following program is used only if the ADP data files contain GPS position data collected using the real-time data acquisition software (see section 2.5).

- GADPGPS Extracts GPS position data.

The following programs are used only if the ADP data files contain corresponding optional data collected using the real-time data acquisition software (see corresponding sections of Section 8 in Operations Manual).

- GADPCTD Extracts CTD data.
- GADPBT Extracts Bottom Track data.
- GADPPRESS Extracts Pressure Time Series.
- GADPWAVE Extracts wave spectra.

If the name of any of these programs is entered by itself, the program will display information on its usage and a description of the parameters that can be specified on the command line.

3.1. Control File Conversion: GADPCTL

GADPCTL extracts configuration and setup information from the binary data files. This includes all header data recorded only once with each file. It is selected by entering either of the commands below.

```
GADPCTL <ADP data file>
GADPCTL <ADP data file> <output file>
```

File names must be given without extension. The program assumes that the ADP data file has extension .ADP and assigns the output data file the extension .CTL. For example,

```
GADPCTL TEST HEADER
```

will extract the configuration information from ADP binary data file TEST.ADP and place it into an ASCII file named HEADER.CTL. If <output file> is not specified, the program will create an

output file with the same name as the ADP data file (i.e. TEST.CTL). The information in the .CTL file is in a self-explanatory ASCII text format.

3.2. Profile Header Conversion: GADPHDR

This program extracts the header information that is recorded with each velocity profile. This information includes time, heading, pitch, roll, temperature, pressure, and sound speed. The file will show 0 for any data where the optional sensor is not installed (i.e. compass or pressure sensor). The command format is as follows.

```
GADPHDR <ADP file>
GADPHDR <ADP file> <output file>
GADPHDR <ADP file> <output file> <first profile> <last profile>
```

File names must be given without extension. GADPHDR generates an ASCII output file with the extension .HDR. The program assumes that the ADP data file has extension .ADP. If no output file name is specified, the program uses the same name as the binary data file. First profile and last profile permit the user to extract a subset of the data. If they are not specified the program extracts all profiles in the file.

The ASCII tabular output file has one line per profile. There are no headers so that commercial processing programs (Lotus, Quattro Pro, Matlab, etc.) can easily access the data. There are 20 columns of data output in the header file; the table below shows the contents and units of each column.

GADPHDR Tabular Data Output Format

Column	Contents	Units
1	Profile number in file	
2	Profile time (start of averaging interval) - Year	
3	Profile time (start of averaging interval) - Month	
4	Profile time (start of averaging interval) - Day	
5	Profile time (start of averaging interval) - Hour	
6	Profile time (start of averaging interval) - Minute	
7	Profile time (start of averaging interval) - Second	
8	Number of samples averaged for this profile	
9	Sound speed to calculate velocity	m/s
10	Mean heading	degrees
11	Mean pitch (rotation about the Y axis)	degrees
12	Mean roll (rotation about the X axis)	degrees
13	Mean temperature	°C
14	Mean pressure	dBar
15	Standard deviation of heading	degrees
16	Standard deviation of pitch	degrees
17	Standard deviation of roll	degrees
18	Standard deviation of temperature	°C
19	Standard deviation of pressure	dBar
20	Instrument power supply voltage level	V

3.3. Profile Data Conversion: GADPAMP / SNR / STD

These five programs extract different portions of the ADP profile data from the binary files: signal strength (as the log of the return signal amplitude), signal to noise ratio (SNR), current speed and direction, standard deviation, and velocity. Each program operates using under the same command protocol.

```
GADP___ <ADP file>
GADP___ <ADP file> <output file>
GADP___ <ADP file> <output file> <first profile> <last profile>
```

File names must be given without extension. The programs assume that the ADP data file has extension .ADP. If no output file name is specified, the programs use the same name as the binary data file. Specifying the first and last profile permits the user to extract a subset of the data. If they are not specified, the programs extract all profiles in the file.

Each program generates several multiple ASCII tabular data files. The output files generated by each program are listed below.

- GADPAMP creates files with extension ".A1", ".A2", and ".A3" corresponding to signal strength for beams 1, 2, and 3, respectively.
- GADPSNR creates files with extension ".SN1", ".SN2", and ".SN3" corresponding to SNR for beams 1, 2, and 3, respectively.
- GADPSTD creates files with extensions ".SD1", ".SD2", and ".SD3" corresponding to the standard deviation of velocity components based upon the coordinate system selected (Beams 1, 2, and 3 / Vx, Vy, and Vz / VEast, VNorth, and VUp).

These programs generate tabular data files with one line per profile. The first value in each line is the profile number within the data file. This is followed by the measurement at each depth cell in the profile, starting with cell 1 (closest to the transducer). The range from the instrument to the center of each cell is given in the ASCII file generated by GADPCTL. This range can also be calculated by the following formula.

$$\text{Range} = \text{Blanking_Distance} + (\text{Cell_Number} * \text{Cell_Size})$$

The units for each of these programs are shown in the table below.

Profile Data Units

Program	Units
GADPAMP	counts (see explanation below)
GADPSNR	decibels (dB) (see explanation below)
GADPSTD	cm/s
GADPVEL	cm/s (degrees clockwise from Y-axis (XYZ coordinates)) or (degrees from magnetic north (ENU coordinates)) for direction

For signal strength data, GADPAMP uses internal ADP units called counts; one count equals 0.43 dB. GADPSNR extracts the signal to noise ratio of the ADP. This is the signal strength minus the system noise level, converted to dB. SNR (Signal-to-noise ratio) data determines maximum profiling range (see ADP Principles of Operation).

If ADP signal strength is being used to estimate sediment concentration, raw signal strength data from GADPAMP should be used rather than SNR, since the latter includes information about the instrument noise level, which may change with time. Further references on the use of ADP data for monitoring sediment concentration are available upon request.

For more information about how to use each type of ADP data, see the ADP Principles of Operation.

3.4. Velocity Data Conversion: GADPVEL

This program extracts velocity data from an ADP data file and writes them to an ASCII file in tabular format. GADPVEL creates files with extensions ".V1", ".V2", and ".V3" corresponding to velocity components based upon the coordinate system selected (Beams 1, 2, and 3 / V_x , V_y , and V_z / V_{East} , V_{North} , and V_{Up}). The command syntax is as follows.

```
GADPGPS <ADP file> [options]
```

where:

- <ADP data file> is the name of an ADP binary data file (no extension).
- [options] is one or more of the following optional parameters:
- <-Oname> Name of output file (no extension). Defaults to input file name.
 - <-Nj:k> Extracts profiles numbered j to k. Default is all profiles.
 - <-Mddd.d> Magnetic declination. Default is MagDecl stored with data. (Note: only the real-time program allows the inclusion of magnetic declination).
 - <-Ccoordsys> Change output coordinates to XYZ (-CXYZ) or ENU (-CENU). Default is to output data in whatever coordinates they were collected.
 - <-AAbsVel> Convert to absolute velocities relative to GPS (-AGPS) or to bottom (-ABOT). Default is to output velocities relative to ADP. Note: Absolute velocities relative to GPS can only be used in the ENU system.
 - <-SPDR> Output velocities as magnitude and direction.

File names must be given without extension. The program assumes that the ADP data file has extension .ADP. If no output file name is specified, the program uses the same name as the ADP data file. Specifying the first and last profile permits the user to extract a subset of the data. If they are not specified, the program extracts all profiles in the file.

Example:

```
GADPVEL test1 -O\data\test1 -M11.3 -N1:200 -CENU -AGPS
```

will extract velocity profiles 1 to 200, from file test1 and output velocity relative to GPS into a file \data\test1 using magnetic variation of 11.3°, in ENU coordinates.

3.5. GPS Data Conversion: GADPGPS

The program provide access to the GPS position data recorded when the real-time data collection software is run with the “ADPSA -p” option (see sections 2.2 and 2.5 for details). Each record extracted contains the profile number, and the universal time, latitude and longitude for the first and last GPS message during an averaging interval. This program can only be used if GPS position data are included in the file. The command format is as follows.

```
GADPGPS <ADP file> [options]
```

where:

- <ADP File> is the name of an ADP binary data file (no extension).
- [options] is one or more of the following optional parameters:
 - <-Oname> Name of output file (no extension). Defaults to input file name.
 - <-Nj:k> Extracts profiles numbered j to k. Default is all profiles.

File names must be given without extension. The program assumes that the ADP data file has extension .ADP. If no output file name is specified, the program uses the same name as the ADP data file. Specifying the first and last profile permits the user to extract a subset of the data. If they are not specified, the program extracts all profiles in the file.

Example:

```
GADPGPS test1 -O\data\test1 -N1:200
```

Will extract GPS data for the profiles 1 to 200, from file test1 and output data into a file \data\test1.

GADPGPS generates one ASCII output file with the extension .GPS. The ASCII tabular output file has one line per profile with 7 columns of data as described in the table below.

GADPGPS Tabular Data Output Format

Column	Contents
1	Profile number in file
2	UTC time from start of profile (seconds from January 1, 1980, 00:00:00)
3	GPS Latitude from start of profile (positive for degrees North)
4	GPS Longitude from start of profile (positive for degrees East)
5	UTC time from end of profile (seconds from January 1, 1980, 00:00:00)
6	GPS Latitude from end of profile (positive for degrees North)
7	GPS Longitude from end of profile (positive for degrees East)
8	GPS East Velocity
9	GPS West Velocity
10	GPS Velocity Magnitude
11	GPS Velocity Direction

SECTION 4. Compass Calibration (COMPCAL)

This program is provided with the ADP software to allow the user to calibrate the internal compass/tilt sensor. Calibration minimizes the effects of ambient magnetic fields on compass data. We recommend that a compass calibration be performed before each deployment.

This program gives a graphical display of instrument orientation that can insure the compass/tilt sensor is functioning correctly. The program is intended to be self-explanatory; simply type “COMPCAL” at the DOS prompt for operating instructions. To run the calibration program, make sure that the instrument is powered up and connected to a computer serial port and type one of the following commands:

```
COMPCAL <com port>  
COMPCAL <com port> <baud rate>
```

where

- <com port> is the serial port number to which the ADP is connected (1 for COM1 or 2 for COM2).
- <baud rate> is the communication baud rate setting of the ADP; if no value is given, the program assumes the default setting of 9600 baud. Acceptable baud rate settings are 1200, 2400, 4800, 9600, 19200, 38400, 57600, and 115200.

Once started, the program shows a graphical display of compass orientation. At this point, the compass is not in calibration mode; it is in a monitoring mode where orientation data is output in real time. The graphical display provides three perspectives. To the right is a compass that indicates the direction the X-axis is pointing. To the left are tabular and graphical displays of pitch and roll. In the center is a 3D box with an X on the side corresponding to north. When this side is facing into the screen, the instrument X-axis is facing north.

To begin the calibration, press the F1 key. The program will pause to put the compass in calibration mode; following this, the display will resume and the program provides instructions for instrument rotation at the bottom of the screen. Rotate the instrument slowly through two complete circles, while varying the pitch and roll as much as possible. Each turn should take about one minute; the exact starting and ending orientations are not important.

To end the calibration, either press the F1 key again (to remain in the graphical display) or press the ESC key to exit with the calibration results. Pressing ESC at any time during this program will exit the program and display the results of the most-recent calibration. Refer to the ADP Operation Manual for more information about compass calibration and for information on how to interpret the calibration score.

SECTION 5. Obtaining Correct Magnetic Variation (MAGDECL)

In order to facilitate correct measurements of velocity direction SonTek supplies utility MAGDECL.EXE which provides access to a magnetic variation database MAGDATA.GRD.

This program computes the magnetic declination of Earth's magnetic North as a function of Date, Latitude and Longitude. Magnetic Declination is the horizontal angle between the Magnetic North and TRUE North. For example, a declination of +10 deg means that Magnetic North is 10 deg to the East of TRUE North. SonTek's ADP, ADV, and ARGONAUT systems use a

magnetic compass to measure the direction of North, which results in velocities referenced to magnetic North instead of TRUE North. Magnetic Declinations permit to correct these velocities so that they are referred to TRUE North.

The program usage is as follows:

```
MAGDECL <Date> <Latitude> <Longitude>
```

where:

- <Date> is in the format yy/mm/dd.
- <Latitude> is in decimal degrees (from -90 to 90)
- <Longitude> is in decimal degrees (from -180 to 180)

Example:

```
MAGDECL 97/10/24 32.7 -117.2
```

Since magnetic variation is not only a function of the exact position but also the time it is advised that the user obtains an up to date magnetic variation before setting up a deployment. Although the Earth magnetic field slowly changes, for most latitudes (away from poles) the rate of change is very small so a few days, or even months, only cause a fraction of a degree change.

SECTION 6. Terminal Emulator (SONTERM)

This program is for direct communication with the ADP over a computer serial port. To run the program type “SONTERM” at the DOS prompt. Direct communication with the ADP is used for a variety of functions including system diagnostics, autonomous deployment, manual recorder-data retrieval, and placing the system in sleep mode. Refer to the ADP Operation Manual for more details about the direct command interface.

To establish direct communication with the ADP, simply connect the cable from the instrument to COM1 of your computer, supply power to the ADP, and run SONTERM. Press “ALT+B” to send a BREAK and establish communication. The ADP will respond with a message similar to “SonTek ADP, Copyright 1997...” and will then return a command prompt (“>”).

SONTERM displays user commands in yellow type and instrument output in blue type. There are several active keys for special functions within SONTERM, as shown in the first table below. One function, ALT+S, enables the user to change communications settings; details of this are shown in the second table. The default settings match the default communication parameters of the ADP.

SONTERM Function Keys

Key	Function
ALT+B	Sends a BREAK over the serial port. This involves holding the computer transmit data line high for a period of 500 milliseconds. The BREAK causes the ADP to terminate any operations (or exit the sleep mode) and enter the command mode.
ALT+F	Open or close a log file. If no log file is currently open, the program prompts the user to enter a file name; everything that appears on the screen will be written to this file. If a log file is currently open, this function closes the file. When SONTERM is first started, no log file is used. Confirmation is required before the program will overwrite an existing log file.
ALT+C	Loads commands from an ASCII file. The user is prompted to enter the file name. The file specified should be an ASCII text file with each line containing one command for the ADP. The program reads the commands from the specified file and sends them in order to the ADP. This is useful to ensure that a precise series of commands are sent to the ADP.
ALT+S	Set communication parameters, such as serial port number and baud rate. Refer to the table below for details.
ALT+X	Exit the program.

To change communication parameters within SONTERM, press “ALT+S”. This gives a menu with a number of active keys to set the communication port, baud rate, parity, number of data bits, and number of stop bits. The default baud rate is 9600 baud; this can be changed using hardware switches in the ADP processor (refer to the ADP Operation Manual). The fixed communication parameters are no parity, 8 data bits, and 2 stop bits; these are the default settings in SONTERM. The table below shows the active keys to set all available values for these

parameters. When the desired parameters have been set, press ESC to return to normal SONTERM operation. The most-recent parameter settings are saved to the computer hard disk and used when running SONTERM.

Changing Communication Parameters (ALT+S)

Parameter	Keystroke and Function		
Communication port	F1 - COM1	F2 - COM2	
Baud rate	1 - 300 2 - 1200 3 - 2400	4 - 4800 5 - 9600 6 - 19200	7 - 38400 8 - 57600 9 - 115200
Parity	N - none E - even	O - odd H - high	L - low
Data bits	Alt+F7 - 7	Alt+F8 - 8	
Stop bits	Alt+F1 - 1	Alt+F2 - 2	
Defaults	D - Return all settings to default values (COM1, 9600 baud, no parity, 8 data bits, 2 stop bits)		

SECTION 7. Recorder Data Extraction (SONREC)

This program extracts data from the optional ADP internal recorder. To learn about its operation, type “SONREC” at the DOS prompt.

IMPORTANT: This program should be run from a dedicated DOS environment, not from a DOS prompt within Windows. Memory resident features of Windows interfere with serial port operation. Running this program from within Windows will at the very least slow down data retrieval, and can potentially cause the retrieval to fail.

To run from the DOS prompt, use one of the following commands.

```
SONREC <com port>
SONREC <com port> <baud rate>
SONREC <com port> <baud rate> <extraction rate>
```

where

- <com port> is the serial port number to which the ADP is connected (1 for COM1 or 2 for COM2).
- <baud rate> is the communication baud rate setting of the ADP; if no value is given, the program assumes the default setting of 9600 baud. Acceptable baud rate settings are 1200, 2400, 4800, 9600, 19200, 38400, 57600, and 115200.
- <extraction rate> is the baud rate at which data files will be retrieved from the recorder; if no value is given, it uses the default setting of 115200 baud. Acceptable extraction rate values are 1200, 2400, 4800, 9600, 19200, 38400, 57600, and 115200.

For example, the command “SONREC 1 9600 38400” will establish communication with the ADP on COM1 at 9600 baud and download data files using 38400 baud.

For short cables (less than 30 m), the default extraction rate of 115200 baud provides the fastest downloading time. For longer cables, a slower baud rate may be needed to ensure reliable communication (if you are regularly downloading large files on a long cable, it may be worthwhile to switch the ADP to RS422 serial communication). If SONREC encounters a large number of communication errors while retrieving data, it will terminate the retrieval. Note that some computers (particularly older laptop computers) do not operate reliably at high baud rates and may not be able to work using the default setting of 115200. If you encounter problems with SONREC, run the program using a lower extraction rate.

The table below shows the typical download rates achieved with different baud rate settings. Extraction rates slower than 9600 baud are rarely needed and are not shown here.

SONREC Data Retrieval Rates

Extraction rate	Effective retrieval rate	Download time for 1 MB
115200	4800 bytes per second	3.6 minutes
57600	3400 bytes per second	5.1 minutes
38400	2600 bytes per second	6.7 minutes
19200	1500 bytes per second	11.5 minutes
9600	850 bytes per second	20.5 minutes

Upon execution, SONREC wakes the ADP and establishes a direct link to the recorder at the specified extraction rate. The program then downloads the directory of files stored on the recorder and displays this information on the screen. The directory screen shows the following information.

- Number of files on recorder
- List of files including name, size, and date/time of creation.
- Recorder size (bytes)
- Recorder free space (bytes)
- Extraction baud rate
- Active keys and their function, as listed below
 - ESC - exit program
 - SPACE BAR - mark and unmark files for extraction
 - F3 - retrieve all marked files
 - DEL - format the recorder and erase all data

Within SONREC, move between files in the directory using the up/down arrow and page up/down keys. The SPACE BAR will mark and unmark one or more files for retrieval. Pressing F3 retrieves all currently marked files. The program prompts you to enter a destination path for the files; if no path is given, the current directory is selected. While retrieving data files, the program provides ongoing information about progress with each file.

SONREC transmits data from the recorder in blocks, each of which includes a checksum for reliable data transmission. If the checksum fails, the program will attempt to transmit the same block again. If the program encounters a large number of errors during retrieval, it will abort the process. Try running the program again at a lower data extraction rate.

Pressing the DEL key will format the recorder and delete all data files. Before the files are deleted, the user is prompted to enter the complete word “Yes” for confirmation. Be certain that all data are backed up before erasing the recorder. Data cannot be recovered after formatting the recorder. Pressing ESC will exit the program.

Data files extracted from the ADP recorder are assigned the extension .ADP.

SECTION 8. Additional Support

Any additional questions can be directed to SonTek by phone, FAX, or e-mail. Regular business hours are 8:00 am to 5:00 p.m., Pacific Standard Time, Monday through Friday.

Phone	(858) 546-8327
Fax	(858) 546-8150
Email	inquiry@sontek.com
World Wide Web	http://www.sontek.com

See our web page for information concerning new products and software / firmware upgrades. SonTek also maintains an FTP site for software upgrades and data exchanges. To access the FTP site, login anonymously to *ftp.sontek.com*, use your e-mail address as a password, and use the path */pub*.

The FTP site includes a directory called “incoming”, which has external write privileges and will accept incoming files. Note that there are no external read privileges for this directory, so you will not be able to view this file after sending it to this directory. After sending the file, notify us by phone, fax, or e-mail and we will look at the data as soon as possible.

There are a number of other directories on the FTP site providing upgrades, demonstration software, and a variety of other information. In each directory there is a file called “0README” that provides information on what information is available and where to find it.

APPENDIX A. Automatic File Naming Convention

When automatically generating data file names in the real-time software (running ADPSA with the -f or -g command line options), the ADP uses a file naming convention based upon the date and time at which the file was created. Unless the clock has been reset such that two files are started within the same minute, the file name cannot be repeated. An example of this convention is shown below.

AA7ADM23.ADP

where

AA = starting two characters as specified in the file ADPFILE.DEF (see section 2.2).

7 = last digit of year (1997)

A = month (i.e. A = 10 = October)

D = day (i.e. D = 13)

M = hour (i.e. M = 22)

23 = minute

.ADP = all ADP data files use the same extension

The above file name is for a file started at 22:23 on October 13, 1997. Several tables showing the abbreviation for month, day and hour are shown below.

Month

1 = January	4 = April	7 = July	A = October
2 = February	5 = May	8 = August	B = November
3 = March	6 = June	9 = September	C = December

Day

1 = 1	5 = 5	9 = 9	D = 13	H = 17	L = 21	P = 25	T = 29
2 = 2	6 = 6	A = 10	E = 14	I = 18	M = 22	Q = 26	U = 30
3 = 3	7 = 7	B = 11	F = 15	J = 19	N = 23	R = 27	V = 31
4 = 4	8 = 8	C = 12	G = 16	K = 20	O = 24	S = 28	

Hour

0 = 0	3 = 3	6 = 6	9 = 9	C = 12	F = 15	I = 18	L = 21
1 = 1	4 = 4	7 = 7	A = 10	D = 13	G = 16	J = 19	M = 22
2 = 2	5 = 5	8 = 8	B = 11	E = 14	H = 17	K = 20	N = 23

APPENDIX B. Correcting for Vessel Motion Using GPS Position Data

The ADP real-time data collection, when run with the “ADPSA -p” command line option, allows integration of GPS position with ADP velocity data. Good quality differential GPS position data can be used to compensate velocity data measured from a moving vessel to compute the absolute current.

This appendix provides the algorithms to calculate vessel motion from GPS data, and to remove vessel motion from ADP velocity data. These algorithms are used for the display of absolute velocity data in the real-time software (see sections 2.4 and 2.5), and for the output of absolute velocity data in ASCII format using the data conversion software (see SECTION 3).

GPS position and time data is recorded at the beginning and end of each profile. Calculating vessel motion based upon GPS data is done using the following steps.

- Convert latitude, longitude, and height (assumed to be 0) to an earth-centered, earth-fixed XYZ coordinate system.
- Calculate the position change in the XYZ coordinate system from position data at the beginning and end of the profile.
- Convert the change in the XYZ coordinate system to a position change in the local ENU (East-North-Up) coordinate system based on latitude and longitude.
- Calculate vessel motion (east and north components) from the change in ENU position and the change in GPS time.

ADP velocity data (relative to the instrument) is compensated for vessel speed using the following steps.

- Rotate ADP velocity data from magnetic East-North to geographic East-North using the magnetic variation.
- Subtract vessel speed from ADP velocity.

The following C language code performs these steps. This is included (in a slightly different format) with the ADP software as part of the data conversion software source code.

```
typedef struct
{
    long    Utc;      /* Universal time of position fix (GPS sec) */
    double  Lat;     /* In degrees */
    double  Lon;     /* In degrees */
} GpsPosType;

GpsPosType  StartGpsPos;
GpsPosType  EndGpsPos;
float       GpsVnorth;
float       GpsVeast;

/*=====*/
/* LlhXyz */
/* Given the lat, lon and height of point on earth this */
/* function computes the earth centered coordinates for */
/* that point. */
/* Notes: Heights must be in m. x,y,z are returned in m */
/* */
#define dtr    0.1745329251994330E-1 /* Degrees to radians */
```

```

#define Ae      6378137.0          /* Earth's semi-major axis */
#define Flat    0.0033528107      /* Earth's flattening      */

void LlhXYZ(double Lat, double Lon, double Height, double xyz[])
{
    double rlat, rlon, clat, slat, clon, slon, g1, g2, g3;

    rlat = dtr*Lat;
    rlon = dtr*Lon;
    clat = cos(rlat);
    slat = sin(rlat);
    clon = cos(rlon);
    slon = sin(rlon);
    g1 = Ae/sqrt(1 - (2 - Flat)*Flat*slat*slat);
    g2 = g1*(1 - Flat)*(1 - Flat) + Height;
    g3 = (g1 + Height)*clat;

    xyz[0] = g3*clon;
    xyz[1] = g3*slon;
    xyz[2] = g2*slat;
}
/*=====*/
/*   XyzToEnu                               */
/*   Given a vector in the earth centered, earth fixed          */
/*   coordinate system, and a position lat/lon on the surface   */
/*   of the Earth, this function will compute the components    */
/*   of that vector in the local East/North/Up system.         */
/*=====*/
void XyzToEnu(double Lat, double Lon, double xyz[], double Enu[])
{
    double rlat, rlon, clat, slat, clon, slon;

    rlat = DegToRad(Lat);
    rlon = DegToRad(Lon);
    clat = cos(rlat);
    slat = sin(rlat);
    clon = cos(rlon);
    slon = sin(rlon);
    Enu[0] = -xyz[0]*slon + xyz[1]*clon;
    Enu[1] = -xyz[0]*slat*clon - xyz[1]*slat*slon + xyz[2]*clat;
    Enu[2] = xyz[0]*clat*clon + xyz[1]*clat*slon + xyz[2]*slat;
}
/*=====*/
void ComputeGpsVel( void )
{
    int i,j,k,l,m,n;
    double dxyz[3], denu[3], dt;
    double xyz0[3], xyz1[3];

    LlhXYZ(StartGpsPos.Lat, StartGpsPos.Lon, 0.0, xyz0 );
    LlhXYZ(EndGpsPos.Lat, EndGpsPos.Lon, 0.0, xyz1 );

    for(i=0;i<3;i++) dxyz[i] = xyz1[i] - xyz0[i];

    XyzToEnu(StartGpsPos.Lat, StartGpsPos.Lon, dxyz, denu);

    dt = EndGpsPos.Utc - StartGpsPos.Utc;
    if(dt < 0) dt += 604800.0; /* correct for week crossover */

    if(dt >= 1)
    {
        GpsVeast = denu[0] / dt;
    }
}

```

```
        GpsVnorth = denu[1] / dt;
    }
}

/*=====*/
void ComputeAbsVelocities(void)
{
    int i,j,k,l,m;
    float ar, ca, sa;
    int nbins = AdpUser.Ncells;

    /* convert magnetic variation (east of north) to radians */
    ar = DegToRad(DisplaySetup.MagneticVariation);
    ca = cos(ar);
    sa = sin(ar);

    /* correct velocity in all bins */
    for(i=0; i < nbins; i++)
    {
        /* ADP velocity is rotated for magnetic variation */
        /* Prf.Vel[0][i] is magnetic east, Prf.Vel[1][i] is north*/
        /* vertical velocity (Prf.Vel[2][i]) is not affected */
        /* recall that velocity is stored as mm/s */
        AbsVel[i][0] = ca*Prf.Vel[0][i] + sa*Prf.Vel[1][i] + 1000*GpsVeast;
        AbsVel[i][1] = -sa*Prf.Vel[0][i] + ca*Prf.Vel[1][i] + 1000*GpsVnorth;
        AbsVel[i][2] = Prf.Vel[2][i];
    }
}
```