Autonomous ADCP User's Manual

For the

JGOFS Arabian Sea Project

by

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Overview:

Vessel mounted Acoustic Doppler Current Profiler (ADCP) data is to be collected on the R/V T.G. THOMPSON throughout the Arabian Sea JGOFS project. To insure that the best possible data is obtained, while minimizing interference with other program components, we will use a modification to RD Instrument's data acquisition system, DAS 2.48, which enables autonomous operation developed previously in a collaboration between Brookhaven National Laboratory, the University of Rhode Island and RD Instruments. The program expands upon the standard DAS's capabilities making it possible to automatically start and stop the collection of the data and to change the configuration of the DAS depending upon the ship's location. The AutoADCP system is also designed to make back-up copies of the pingdata files and provides a means of restarting the system if for any reason the DAS locked-up.

The major component of the system is a "user exit" program called FLAG.EXE. This program, which is called up at the end of each ADCP ensemble, monitors the ship's position and compares it with pre-defined regions. When the ship leaves one region for another, the DAS's configuration file is updated, the computer reboots and starts pinging using the new configuration. Provision has also been made for a watchdog timer and automatic backup of pingdata files each time a file is filled. The utility of the AutoADCP DAS is that ensemble interval, number of bins, bin and pulse size, bottom tracking, and other configuration parameters can be controlled without an operator on board monitoring the DAS's performance. This makes for a more consistent and robust dataset.

In addition, the system includes the WOCE standard enhancements to the DAS with another "user-exit" program developed by the University of Hawaii, UE4.EXE, developed by Eric Firing's group at the University of Hawaii. This program was designed to improve on some features of RD Instruments' DAS software. The most important element is that UE4 records the position of the ship at the ends of the ensembles rather than as the average position during the ensemble. This allows for a more precise means of computing the ship's velocity during an ensemble. This program has been expanded recently so that it now interfaces with an Ashtech's attitude sensor which uses phase differential GPS to determine the ship's heading. The Ashtech heading data is not only more accurate than the ship's gyro compass, it is immune to the latitudinal, speed and turning errors that degrade gyros. However, because the Ashtech heading data can have gaps, the primary heading information for the ADCP remains the gyro compass. The recorded Ashtech heading data is used on a post-cruise basis to adjust the compass heading as needed.

A third user-exit program, AGCAVE.EX, modifies the way the DAS collects acoustic backscattered intensity data. Without the addition of this program, the DAS records the intensity (which used to be called amplitude) data as a single profile composed of the average of all four beams. This degrades the intensity data because without calibration, the beams produce slightly different profiles. To address this problem and to allow post-cruise calibration of the intensity data, AGCAVE was developed. The program forms ensemble averaged profiles for each beam and stores the results separately. We have used the program successfully for eight years and without experiencing any interference with the normal workings of the ADCP.

These are the main programs incorporated into the Autonomous ADCP DAS so that the system requires only an occasional check to insure that the hardware is still functioning. At the end of each cruise the pingdata files are to be copied to a SyQuest removeable hard disk and sent to Brookhaven National Laboratory for processing. The data will be made available to the program's PIs through the JGOFS data system with the usual provisions on its use.

If problems with the system arise, a reboot (Ctrl Alt Del) should restart the system. In fact, this is exactly what the "watch-dog" timer that is incorporated in the system does. The watch-dog will reboot the system if it has not been reset by the user-exit program FLAG.EXE within a specified time limit, usually set to 7.5 minutes for 5-minute ensembles. The only draw-back to this watch-dog is that it operates in software and can be disabled if the operating system itself crashes. Thus, some monitoring of the system is needed to make sure that neither the ADCP, the computer, nor ancillary equipment such as the GPS receivers has ceased to function. During the Shakedown and Calibration cruise the AutoADCP system stopped only once and we think this was caused by a momentary interruption in network service to the virtual disk. A reboot started the system again. If the network goes down for an extended period some reason, the system can be set up to record the data on its own disk with enough room for at least one cruise.

A last item that the chief scientist for each cruise should keep in mind is that to maintain and monitor the calibration of the ADCP, it is necessary to get an extended run in water depths shallower than 200 to 400 meters. The AutoADCP DAS is set up to turn on bottom-tracking for this purpose when ever the ship is over the continental shelf. The only place where the JGOFS cruises will routinely be over the shelf is during the run from Ras al Hadd to the beginning of the "main" JGOFS line. If it is possible, please maintain a steady course and speed while on this run.

On the RV T.G. Thompson, the AutoADCP programs have been installed on two PC computers, both of which are connected via a Pathworks network to virtual disks on a DEC 5000-200 Unix workstation. At the moment, September 1994, we are using one of the Thompson's PCs to collect the data, and a PC supplied by Brookhaven (a Dell 310) for real-time presentation of the results. Since the AutoADCP programs have been installed on both computers, the collection of the data can be switched to the Brookhaven PC if the primary PC suffers a failure.

On the Thompson's Delphi 286, the standard ADCP data is displayed. This consists of 5 minute ensemble averaged profiles of U (zonal) and V (meridional) velocity, AGC (automatic gain control) and percent good pings. In addition to the data gathering performed by the AutoADCP system, another set of programs have been written in MATLAB to present ADCP data in real-time. These programs run on the second computer, the Dell 386, and make use of the networked virtual disk that is common with the AutoADCP system computer to access the most recent pingdata files. The real-time displays include vertical sections of U (zonal) velocity, (top panel), V (meridional) velocity (center panel) and range corrected backscatter intensity (bottom panel). The usual setup we have used displays the last 12 hours of ADCP data, updating the display every 15 minutes. On the Calibration and Training Cruise, this display proved extremely useful in tracking the currents, vertical shears and vertical migration of the scattering layers. The real-time data presentation is accomplished by opening MATLAB from WINDOWS and running a script file called "realtime".

Stopping the Autnomous DAS and Copying Files to the SyQuest Disks

Unloading the data at the end of the cruise is a fairly simple task. The critical part is to exit the DAS and turn off the watch-dog timer before it grabs the system and reboots the computer. Using either capital or lower-case letters, first interrupt the DAS by pushing the space-bar, then type "A" followed by RETURN, and "QQ" , RETURN. This gets you out of the DAS and should get you to the "C:\AUTOADCP>" DOS prompt. To turn off the watch-dog timer (and to disable a CPU slow-down program on the Dell), a simple batch file called STOP.BAT should be run by typing "STOP", RETURN.

The AutoADCP system stores pingdata files in two places, on the usual primary disk identified in the DAS configuration, and on a backup disk and sub-directory identified in the FLAGEXEC.BAT batch file. Both PCs are setup to use the same network disk as the primary storage area. The primary network disk is "F:\" on the Thompson's PC, and "J:\" on the Dell. Despite of the different disk names, the network disks on the PCs point to the same disk area on the workstation's hard disk. The disks for each system, and their intended use, are shown in Table 1.

Regardless of which computer was used to collect the ADCP data, you have to use the Dell to transfer the data to a SyQuest disk to send the data back to Brookhaven for processing. Put a SyQuest disk in the drive and wait for the green light to come on. Then from the AutoADCP sub-directory, run the batch file called COPY2SYQ.BAT from the DOS prompt with a command that looks like:

C:\AUTOADCP>COPY2SYQ <dir-name>.

This batch file creates a sub-directory on the SyQuest disk and copies <u>all</u> the pingdata files on the primary network drive to this sub-directory. The command line variable, dir-name, should be the cruise number, i.e. TN039. An alternative to using the batch file is to use a file manager to copy just those pingdata files that correspond to a specific cruise. This will be mandatory after first three or four cruises because the SyQuest disks will only hold about 130 pingdata files and each cruise will generate about 40 to 50 files.

There appears to be enough room on the primary network disk to contain about six months' worth of pingdata files. Therefore, for the first few months of the program, it would be less confusing if you left the pingdata files on the disks. At some point, we will erase all the pingdata files and start anew. The ADCP loads the data into the lowest numbered pingdata file it can find and if there are gaps in the numbering system, the DAS will fill in the gaps causing no-end of confusion for processing.

When the disk copying is complete, remove the SyQuest disk from the drive by pushing the button on the drive, **wait** until the light goes off, then push the lever to the right to eject the disk. After removing the Syquest disk, reboot the computer by simultaneously typing: Ctrl - Alt - Del. After rebooting ,the DAS will start-up, begin pinging and will show the usual display after the second ensemble. (The first ensemble will be okay but will not have the position and ship speeds displayed. The UE4 program causes extra items to show-up on the display.)

The remainder of this manual gives a detailed description of each of the hardware and software components of the Autonomous ADCP DAS. It is assumed that the user is already reasonably familiar with the operation of the DAS in its usual interactive mode and that other manuals are available as needed to deal with the ADCP hardware itself. One final note, it is important that all dealings with the ADCP be carried out in Greenwich Mean Time (**GMT** or **UTC**). The UE4 user-exit program will automatically allign the PC-clock to the GPS satellite if the PC clock starts out within a day of the actual GMT time.

Autonomous ADCP Hardware and Programs

This section presents the programs and configuration files that are needed to make the Autonomous ADCP system function. It is organized as though one were installing the system from scratch. If that is not the case, then skip to the part or program that seems to be of immediate concern. The documentation that describes the Autonomous ADCP program FLAG.EXE and its ancillary files is contained in Appendix I.

COMPUTERS

The Brookhaven computer that we are using in the Arabian Sea project is a 386 computer, a Dell Model 310. This has a 80386DX CPU running at 20 MHz, 4 MBytes of memory, and a VGA video controller. There are two COM ports, one serial port, and a video port. The machine is equipped with two hard-disk drives, two floppy drives, a 44 MByte SyQuest removable hard-disk drive, and a National Instrument's GPIB-PCIIA interface card. The two hard-disk drives are Western Digital drives, one each of 340 and 430 MBytes. The brain dead BIOS (Rev A14) in the Dell Model 310, however, cannot handle drives this large, so in the computer's setup, the disks have been defined as 321 MByte drives (Type 45). The machine is using the DOS 6.2 operating system simplifing memory configuration which is fairly critical for the Autonomous DAS. Occasionally, something happens to PCs that make it necessary to change or reset the hardware configuration which is stored in ROM (Read-Only-Memory). If for some reason you need to do this, you can do so on the Dell 310, accessing the "setup" utility by pressing Ctrl-Alt-Enter.

On the Dell, the initial intent was that the two hard drives would simply be C: and D: and each would have the ability to hold the entire ADCP data set from the program. A problem arose, however, because the ADCP DAS is an old program that apparently cannot deal with large disk drives. As a result, the two disk drives have been partitioned into smaller primary and secondary sectors. The first drive has a 121 MByte primary sector and two 100 MByte extended sectors while the second drive also has a 121 MByte primary sector but with a single 200 MByte extended sector. The operating system assigns letters to the primary sectors before letters are assigned to the extended sectors. As a result, the two primary sectors are C: and D: while the secondary sectors on the first physical drive are E: and F:, and G: on the second drive. This lettering scheme has taken a simple system and created something of a monster but there are no alternatives at the moment. An attempt will be made to have RDI remove the limitation to the DAS but that will be sometime in the future. The SyQuest removable hard disk drive is H: and we have assigned a network virtual drive to the letter J:\.

If the Dell computer is used as the ADCP data acquisition computer, the C:\-disk will be the normal drive where the system will be operating and the

200 MByte G:-disk will be the backup repository used by FLAG.EXE (which is not limited by the 100 MByte ceiling). The complete set of programs needed to run the Autonomous has been copied to the second hard disk, the D:\ drive, so if the main disk drive (C:, E:, and F:) crashes at some point, the system can be resurrected by physically disconnecting the first drive and substituting the second drive. If a disk swap was necessary, the virtual drive would remain as J:\, but the SyQuest drive would change from H:\ to E:\.

The Thompson's Delphi 286 computer is configured to be the primary AutoADCP computer. The reason for using this machine as the primary data collection device rather than the Dell is that its hardware is simpler than the Dell's, while the Dell has all the software and disk space to process and display the ping data if someone knows how, has the time, and wants to do it. The Delphi that is connected to the ADCP runs at 20 MHz and uses DOS 5.3. RD Instrument suggests that this speed should cause problems with the GPIB driver compiled with the DAS 2.48 software. However, experience with the machine on the Thompson indicates that problems with the GPIB do not occur with this particular machine. (The other Delphi computers on the counter run at 40 MHz which would certainly cause problems.) The 20 MHz Delphi has a single 80 MByte hard-disk and 5 1/4 inch (A:\) and 3 1/2 inch (B:\) floppy disk drives. The computer is attached via the network to several virtual disk drives described in Table 1. The main network drive that will be used for storing pingdata files is F:\ on this machine. (This is the same disk area as virtual disk J:\ on the Dell.

SyQuest Removeable Hard-Disks

The Dell computer is equipped with SyQuest removeable hard-disks for transporting data and programs to and from the ship. SyQuest drives have been used for several years in the NOAA volunteer observing ship program with reasonable success. In the initial autonomous ADCP setup on the OLEANDER that runs between New York and Bermuda, the SyQuest ran all the time and was used as the backup disk. In general this worked well but we experienced a couple of drive failure under those high vibration conditions. As a result, in the Arabian Sea program we will be using a standard hard-disk as the backup disk and the SyQuest disk solely as a transport medium.

Generally, the SyQuest disks will come to the ship already formated, but in case they don't or you run into problems, here is the procedure for formating the disks. Check to make sure that the disk is write-enabled by toggling the switch on the back. Insert the disk all the way into the drive and make sure that the ejection lever is closed all the way. When the lever is closed, first the orange light and then the green lights will come on as the disk reaches operating speed. At this point, go to the SYQUEST sub-directory and run the program SYPREP. Choose the format disk item from the menu. This will bring you to another menu which should show <u>both</u> your hard-disk drive <u>and</u> the SyQuest disk. Use the arrow keys to highlight the SyQuest disk. **Make sure you choose the SyQuest disk or you will reformat your entire hard-disk - bad news!** (In the event that you commit this error, there is a SyQuest disk with the entire system backed up on it.) With the SyQuest disk highlighted and the LED lit on the disk-drive, proceed with formating the disk. A formated SyQuest disk can be treated as any other disk and it has access times that are comparable with regular hard disks.

One final note on dealing with the SyQuest drive. To remove a disk from the drive, first push the button in the middle of the drive then <u>wait</u> for the orange light to go off before moving the ejection lever. Forcing the lever too early could injure both the disk and the drive.

AUTOEXEC.BAT

The AUTOEXEC.BAT file contains a series of DOS commands that are executed in order when the computer is booted up. These commands set up some memory allocations, define the sub-directory path, load needed programs that run in the background and start the Autonmous ADCP system. The memory requirement for the entire Autonomous DAS is about 550K, so it necessary to keep the extraneous programs to a minimum. One thing that we have run into already with this is that network software, unless it is carefully loaded, does not leave enough memory for the DAS. This has not been a problem on the Thompson as we've been able to load most of the network programs into high memory and actually have plenty of room for DAS. Copies of the AUTOEXEC batch files for both the Dell and the Delphi computers are listed in Appendix C.

The following is a listing of an AUTOEXEC.BAT file that has worked during tests in the lab. On the Dell, we started with a generic version of the Autoexec that had all the items needed and then ran MEMMAKER, a DOS 6 memory optimizer which reordered the file and changed some of the parameters.

```
LH /L:0;2,45488  /S  C:\DOS\SMARTDRV.EXE /X
@ECHO OFF
PROMPT $P$G
PATH  C:\DOS;C:\BORLANDC\BIN;C:\ADCP248\AT-SLOW;C:\MATLAB40\BIN;C:\TCPIP
SET TEMP=C:\DOS
LH /L:0;1,1776;2,36256  /S  COMMAND  /E:1024  /CC:\TCPIP\TGT.BAT
AT-SLOW  /C16
CD  C:\AUTOADCP
CALL  FLAGEXEC
```

The first line loads a disk caching routine into high-memory. The next three lines turn off the echoing of the batch file to the screen, set up the DOS prompt, e.g.. "C:\>", and the path. The path indicates directories where the computer can find needed files that are not in a local directory. Some programs need the "environment" variable "TEMP" set equal to the DOS sub-directory. The next line connects the PC to the network which makes virtual disks and printers available. The batch file TGT.BAT in the TCPIP sub-directory controls which devices are made available and defines the virtual disk used by the ADCP DAS for storage as J:\. We are using a 20 MHz computer which may be too fast for the antique GPIB interface drivers compiled with the DAS. As a precaution, we can slow the computer's effective speed down to about 16 MHz using a shareware program called AT-SLOW. The line "AT-SLOW /c16" runs the program specifying the desired degree of slow-down, Appendix A. The next line changes the local sub-directory from the root directory to the sub-directory with the Autonomous ADCP programs. The last line calls a batch-file, FLAGEXEC.BAT, which sets some parameters and starts the ADCP. The AUTOEXEC,BAT file for the Thompson's Delphi is similar to the above file and is listed in Appendix C.

A note on AT-SLOW: It appears that AT-SLOW adversely effects the Dell computer's access to floppy drives A: and B:. To access these drives it is necessary to disable the CPU slow-down and this can be done by typing :

AT-SLOW /D

at the DOS prompt. AT-SLOW will also be disabled if you run the batch program, STOP.BAT, when exiting the DAS. To restart the Autonomous DAS, simply reboot the computer and that will get everything back in order.

You can add things to the AUTOEXEC batch-file, but do it carefully and one step at a time. When installing the system on an existing computer system, it will save you <u>a lot of grief</u> if you replace the existing AUTOEXEC.BAT file with something like this one and then slowly reinstall features as needed.

CONFIG.SYS

The CONFIG.SYS file is another file read by the computer at boot-up time. The CONFIG.SYS file lets you change the default configuration of the computer such as how memory is allocated, how many files can be opened simultaneously, how large is the internal buffering, and installs device drivers for extra hardware such as GPIB boards, SYQUEST drives and disk drives. The following is a configuration file that has been used successfully; it also was rearranged by the MAMMAKER memory utility:

```
DEVICE=C:\DOS\HIMEM.SYS
DEVICE=C:\DOS\EMM386.EXE NOEMS 512 FRAME=E000
BUFFERS=15,0
```

```
FILES=50
DOS=UMB
LASTDRIVE=Z
FCBS=30,0
DEVICEHIGH /L:2,12048 =C:\DOS\SETVER.EXE
DOS=HIGH
STACKS=10,512
SHELL = C:\DOS50\COMMAND.COM  C:\DOS\ /E:1024  /P
DEVICEHIGH /L:1,2720 =C:\TCPIP\NEMM.DOS
DEVICE=C:\TCPIP\PROTMAN.SYS /I:C:\TCPIP
DEVICEHIGH /L:2,14416 = C:TCPIP\ELNK3.DOS
DEVICEHIGH /L:1,4080 =C:\TCPIP\TCPDRV.DOS /I:C:\TCPIP
DEVICEHIGH /L:1,9072 =C:\DOS\ANSI.SYS
DEVICEHIGH /L:2,23680 =C:\SYDRIVER.SYS
DEVICEHIGH /L:2,10864 = C:\ADCP248\GPIB.COM
```

The first two lines set up the controllers for high-memory management. These options are for 80386 and higher computers. The order of these instructions is important. The DOS routines are stored in the DOS sub-directory. Lines 3, 4, 7 and 10 setup various memory stacks and buffers to speed-up the processor. The DOS=UMB line provides the "upper memory blocks" into which the system and device drivers will be loaded. The DEVICEHIGH command loads the device drivers into high memory, if there is room available. The parameters after the "/L" specify the memory location and amount of memory required for the driver. The shell command specifies the location of the command interperter that will be used when shelling out of a program. The "/E:" switch sets the environment size and I don't know what the "/P" does. Setver is a DOS utility that allows a program written for an earlier version of DOS to run under the current version. Lines 12 thru 15 setup the drivers for the network allowing virtual disks and other network services. The ANSI driver allows the use of ANSI escape sequences which are necessary for the ADCP DAS and UE4 routines. The SYQ55 driver allows the removable SyQuest drives to be accessed like a normal hard-disk. The GPIB device driver controls the GPIB board that is used between the ADCP deck unit and DAS computer. The GPIB driver must be the one supplied by RD Instruments with the latest version of the DAS.

POSITION.DAT

This file contains the listing of the ADCP regions and the vertices that define the various regional polygons. An example of this file for the Arabian Sea is given in Appendix B. At the end of each ensemble, the user-exit program FLAG.EXE gets the latest position from the DAS and compares it with the polygons defined in POSITION.DAT. If the position is within the currently defined region, the ADCP DAS continues. Note, the DAS will continues with the latest configuration if the position is outside <u>all</u> the regions. However, if the ship is within a new polygon, FLAG.EXE copies the DAS configuration file that corresponds to the new region to the default configuration file, START.CNF, copies the name of the new region into START.DAT, and causes the computer to reboot. The names of the regions in the POSITION.DAT file match the names of the ADCP configuration files. Since the ADCP DAS can be set to start pinging at start-up, this procedure will automatically change the ADCP's configuration as the ship passes from one region to another.

There is nothing tricky about setting up the regional polygons. Each polygon has a unique name (up to eight characters) followed by a listing of latitude/longitude pairs that define the vertices. North latitude and east longitude are <u>positive</u>. There is no need to close the polygons, i.e. the first and last vertex do not need to be the same and a square requires but four vertices. The only requirement is that the vertices follow around the polygon in order - I usually follow around in a counter-clockwise fashion. The order in which the polygons appear in the list has an effect because FLAG.EXE stops looking for the correct region at the first instance when the ship's position falls within a polygon. This allows the definition of small regions that within larger regions which can be useful if there are isolated regions within the study area, such as ports or islands. To do this, arrange the order of the regions such that the small interior regions are listed first.

START.DAT

This is a very short file that simply contains the name of the region currently being used. This file is generated and updated by FLAG.EXE. The region name matches one given in the POSITION.DAT file. FLAG.EXE checks the name within this file after finding which region the ship is in at the end of each ensemble. If the regions match, the program continues, otherwise the program copies the appropriate configuration to the default ADCP configuration file and reboots.

FLAGEXEC.BAT

This batch file initializes parameters used by FLAG.EXE. The batch file identifies the backup disk drive and sub-directory, the names and directories for the BOOT.LOG and DASLOG.LOG files, appends the reboot/start-up time to the BOOT.LOG file, sets the watch-dog timer interval, typically 7.5 minutes, turns on the watch-dog timer, and starts the ADCP DAS program. The FLAGEXEC.BAT file should be called from the AUTOEXEC.BAT file after setting the default directory to the one with the AutoADCP DAS programs (see above). An example of FLAGEXEC.BAT that should be close to the version used for the Arabian Sea program is included in Appendix D.

BOOT.LOG and DASLOG.LOG Files

The log files are produced by the Autonomous system at various stages and provide a record of what the DAS was doing and when. The BOOT.LOG file is simply a list of times when the FLAGEXEC.BAT file was called. Since this batch file is only called up when the system is started initially or when it reboots itself, the file provides important bench-marks for deciphering what was happening to the system. The DASLOG.LOG file is written to by the user-exit program FLAG.EXE whenever one of a number of things happen. Under normal conditions, the only entries to the DASLOG file will be when the ship passes into a new region or when a pingdata file is filled and copied onto the backup disk. The messages signalling these events includes the time and location of the ship. If an error condition is encountered by FLAG.EXE, a message to the DASLOG file is also sent indicating the time and type of error. The error messages are generated relatively infrequently but they will occur if the navigation devices cease to send the expected GGA or ATT messages. If the GPS systems fail, an error message can be generated at each ping which will quickly produce and enormous file. The failure of the navigation system will cause errors or blanks in the display which should alert the crew that something is wrong and needs to be fixed. If the DASLOG file gets too big, probably the only reasonable thing to do is erase it once the problem has been dealt with.

User-Exit Programs

The user-exit facility of the ADCP DAS makes possible added capabilities that were not included, or not thought of, in the original program. User-exit programs are like subroutines that can be run at various points throughout the data collection and processing. There are three main user-exit programs that we use and they are explained below.

FLAG.EXE

This program is the heart of the autonomous ADCP system. As explained earlier, its main purpose is to determine whether the ship has moved from one regional polygon to another and change the ADCP configuration if it has. It also resets the watch-dog timer each time it is run so it must run at least once before the watch-dog timer interval, defined in FLAGEXEC.BAT expires, or else the computer will reboot and start again. Lastly, when a pingdata file is filled to capacity, which is about 360K bytes, the program will copy the pingdata file to the backup disk and directory defined in FLAGEXEC.BAT. Each time FLAG.EXE takes control of the DAS, such as when moving into a new region, backing up a pingdata file, or if it encounters and error, a message is sent to a log file called "DASLOG.LOG".

To install the program as a user exit program, first enter the UX sub-menu from the main DAS menu. There should be several blank places in which to install the program. Type in the number for the appropriate blank line and then type in the path and name of the program:

FLAG.EXE.

Toggle the enable switch to YES using the space-bar, then enter 9 as the entry point. FLAG.EXE is a non-resident program, that is, it has to be loaded into memory each time it is run. Therefore, do not enter an interrupt number. After entering the user-exit information, the DAS will attempt to load the program into memory, If there are any problems, there will be a "not loaded" notation on the appropriate user-exit line. Usually the problem, if there is one, is that the path is incorrect.

UE4.EXE

This user-exit program replaces the navigation user-exit program (usually NAVSOFT.EXE) and is the result of considerable experience with shipboard ADCPs gained by Eric Firing and the other WOCE users of the ADCP. This program is not necessary for the operation of the Autonomous ADCP DAS, but it significantly improves the quality of the resulting data. There is a complete explanation of the program in Appendix E, but the most important features are that the program changes the way navigation data is obtained and it has recently been expanded to process phase-differential GPS heading data provided by an Ashtech 3DF GPS receiver.

The conventional ADCP DAS records a position for each ensemble that is the average position of the ship during the ensemble. The velocity of the ship is then determined by differencing the average position between successive ensembles. The ADCP, however, measures the average relative water velocity during an ensemble, not between ensembles. To get absolute water velocity from the relative water velocity, it is necessary to have the ship's average velocity over the ground during the ensemble. This is done in UE4 by recording the ship's position, together with the time, at the end of each ensemble in the "user buffer". The UE4 routine reads "GGA" GPS messages through a COM port after each ping as well as at the end of each ensemble. Post-processing of the data merges the correct ship's velocity with the relative water velocity.

One of the last problems with ADCP data is associated with biases and oscillations of the ship's gyro-compass. The advent of short-baseline, phase-differential GPS attitude receivers makes it possible to determine a ship's true heading with an accuracy of about 0.1 degrees, regardless of the ship's latitude, speed, or course. One such receiver is the Ashtech 3DF, and one of these has been installed on the RV T.G. Thompson. There has not been enough experience with the units nor is the output of the devices sufficiently reliable for them to replace the gyro-compass. Therefore, the ADCP will continue to use the gyro-compass data and we use the GPS data to correct for gyro-compass error during post-processing. The UE4 program is setup to read two messages from the Ashtech units, the "GGA" message, which gives position, followed by the "ATT" message, which contains the attitude data. UE4 reads the Ashtech data through a second COM port, processing the data throughout the ensemble, and writes summary statistics at the end of the ensemble to the "user-buffer" output area.

The operation of the UE4 user-exit program is controlled by a configuration file which must be in the same directory as the ADCP.EXE program. The configuration file, UE4.CNF, controls which COM ports will be used for which GPS receiver, the baud rates, parity, etc., and the format of the incoming data. The UE4 program can also write intermediate data to the COM ports, the transmit line of which can be routed to other computers. One of the purposes of this capability is to allow real-time transfer of data to another computer for real-time presentation of ADCP results. See the discussion of the UE4 program in the appendix for more information on these options. An example of the UE4.CNF file is included in the Appendix E, as well.

UE4.EXE is installed as a resident user-exit program. The procedure is to enter the "UX" sub-menu from the main ADCP DAS menu and load UE4 into the navigation user-exit slot. Therefore, type an "N" to indicate the navigation user-exit slot, followed by UE4.EXE. Toggle the space-bar to enable the program. Enter "4 5 9" as the entry points and choose an interrupt that has not been allocated to another program, usually 2 or 3. Make sure all the user exit routines have been enabled by typing "EE", as necessary. Lastly, in the "DR" ADCP DAS sub-menu toggle on the user-buffer by typing "RB" and use 192 bytes.

AGCAVE.COM

This routine, written by RD Instruments, changes the way backscatter intensity data is recorded in the DAS and makes it possible to use intensity data for estimating zooplankton concentrations. If left to its own devices, the ADCP DAS averages the backscatter intensity data from all four beams to form a single ensemble averaged profile. The problem is that the beams, while nominally the same, are not calibrated and give slightly different results for the same target strengths. The calibration of the beams has to be done as a post-processing step and therefore it is necessary to record the ensemble averaged profiles of the four beam separately. This is what AGCAVE.COM was designed to do. The routine grabs the intensity profiles for each beam after each ping, forms the four ensemble averaged profiles, and stores the result in the storage location in the pingdata files reserved for the "LAST AGC". RD Instruments took this route because people rarely used that feature and they did not want to create a new data type. This program is small and has been working successfully since about 1988. The details of the program are given in Appendix F.

To use AGCAVE.COM, enter the user-exit sub-menu by typing "UX". Choose one of the blank lines for the user-exit program and type the line number. Enter AGCAVE.COM, use the space-bar to toggle the enable, and enter exit points 5 and 9. AGCAVE.COM is a resident program, so choose an unused interrupt number, typically 3. Make sure that the all the user exit programs have been enabled.

COMMAND.COM

When working with the ADCP DAS and setting up the system it is often convenient to be able to switch back and forth between the DOS environment and the DAS. This can be easily done by setting up a shell using COMMAND.COM as a non-resident, non-active user-exit program. To do this, enter in COMMAND.COM as a user-exit program including the path which will probably be either "C:\" or "C:\DOS\". Enable the program with the space-bar but do not enter any entry points or interrupts. To shell out of the DAS back to DOS, type "EM" from the user-exit sub-menu and type the line number of the COMMAND.COM program. This will result in a DOS prompt and any <u>small</u> DOS program can be executed. To return to the DAS, type "exit" at the DOS prompt.

SETTING UP THE ADCP DAS AND ITS CONFIGURATION FILES

The last step, and perhaps the trickiest, is setting up the ADCP DAS configuration. It is very easy to change the configuration and it is fairly time consuming to check all the parameters. This, combined with the fact that some parameters control vital processing or recording functions, means that care should be taken when modifying the DAS. It is often best to start from a configuration file that you know gives satisfactory results and make the desired modifications.

The configuration of the DAS is contained in two files, EXIT.CNF and either the default, START.CNF, or a user defined configuration file. The EXIT.CNF file contains some of the basic DAS setup parameters that should not change, in particular, the user-exit programs. The EXIT.CNF file is stored in binary format. The START.CNF, or some other configuration file, controls things like the number of bins, pulse length, bin length, what and whether data is being recorded, what kind of graphical output is desired, etc. These configuration files are in ASCII and a copy of one of these files is given in Appendix G.

The usual way that the configuration is changed is by setting parameters using the main DAS menu and then saving the setup using the save/restore, "SR" functions. The saving and restoring can be to or from default configuration files, using "SV" or "RD", or to or from "work" files using the "SN" or "RN" commands. In either case, the setup of the user-exit programs is saved in the EXIT.CNF configuration file while the rest of the parameters are stored in the default or work configuration file. For the Autonomous ADCP system, a separate configuration file is needed for each of the regional polygons and therefore, it will be necessary to use the "work" file option. To construct a work file, one first goes through the "AD", "DP", and "DR" sub-menus as needed to set the parameters and then uses the commands in the "SR" sub-menu to save the configurations. In the "SR" sub-menu, enter a "work file" name and a cruise ID. The cruise ID should be unique to each regional polygon so that you can tell whether the correct configuration file is installed. Save the configuration file with the "SN" command. Use the "RN" command to call back configuration files for further editing. The ASCII configuration files can also be edited using the DOS editor. Although it is faster to use the DOS editor, there is less helpful (?) information available.

There are some vital parameters for the Autonomous ADCP system and there are some that are just plain critical. There is a good discussion of the parameter setup in Eric Firing's write-up for WOCE, Appendix H. Below is a list of some of the parameters to check before saving a configuration file:

Sub-Menu	Command	Parameter	Explanation
AD	US	Yes	Use Direct Commands on Start Up
AD	PS	No	Yes=Serial/No=Parallel Profiler Link
AD	BK	4.0	Blank after transmit, m
DP	TH	Yes	Toggle Heading Compensation
DP	UR	Yes	Use Reference Layer
DP	VS	Yes	Calc. Speed of Sound from Temp/Sal
DP	BT	Yes or No	Turn-on Bottom-Track in shallow water, turn-off otherwise
DR	RD	Yes	Recording on Disk
DR	RB	192	Bytes of user program buffer, needed for UE4
DR	AP	Yes	**Auto-ping on start-up**
DR	RN	YES	Record Ancillary Data (bottom track <u>and</u> navigation data)
DR	RRA	Yes	Record last raw AGC (w/ AGCAVE, this actually records ensemble-averaged beam intensities)
UX	EE	Yes	Enable Exits to External Programs
SS	OD	nn	Transducer depth, m
SS	OH	$\pm$nn.nn	Heading offset, degrees
SS	OT	45.00	Offset for temperature
SS	ST	50.00	Scale for temperature
SS	SL	ss.sss	Regional salinity in psu
DC	1	FH00001	Bottom Track pings/Water track ping
DC	2	E0004020099	Ping-to-Ping 1st bin tracking control
DC	3	CF64	Turns off fish finder
DC	4	B009001	Bin-to-bin acquisition and filter control

The "Auto-Ping on Start Up" is crucial for the Autonomous ADCP system.

In addition to these parameters, you should also check that the sampling interval, number of bins, bin size, and pulse length are correct for the region that is being defined. In deep water, the bin length should be 8 meters and the pulse length 8 to 16 meters. While the DAS can record 128 bins of data, the range of the device is typically no more than about 400 meters, so 50 or 60 meters should be the maximum number of bins to record. In shallow water, set both the bin size and pulse length to 4 meters. Sampling interval is a matter of preference -- I prefer 5 minute intervals as this usually gives adequate spatial resolution while minimizing the statistical velocity errors . Using a reference layer can significantly improve the velocity data under variable conditions. The top one or two bins can be effected by the flow around/under the ship and it is preferable not to use them as part of the reference layer. In deep water, the usual procedure is to use bins 5 to 20 as the reference layer. In shallow water, the issue becomes trickier. If the top bin is set too deep, i.e. in the mud, you can lose data. In the past out of necessity, I have used bins 2 to 5 as the reference layer under shallow conditions. As a final word, and to allay fears, the setting of parameters to control the graphical presentation does not effect how the data is recorded.

Appendix A AT-SLOW.DOC

Appendix B. POSITION.DAT file

Appendix C. AUTOEXEC.BAT and CONFIG.SYS files

Appendix D FLAGEXEC.BAT file

Appendix E UE4 Documentation

Appendix F AGCAVE Documentation

Appendix G ADCP Configuration File

Appendix H Eric Firing's WOCE ADCP Procedures Document

Appendix I FLAG.EXE User-Exit Program Documentation

Appendix J GPIB PC-IIA Documentation