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**GPS and ship head recording system:
installation and operators guide**

K G Birch, R W Pascal & A L Williams

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**INSTITUTE OF OCEANOGRAPHIC SCIENCES
DEACON LABORATORY**

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<p><i>ABSTRACT</i></p> <p>The advent of inexpensive Global Positioning System (GPS) receivers has allowed the development of a portable navigation system.</p> <p>The navigation system was developed to allow data to be collect on 'ships of opportunity'. The major component parts are GPS Receiver, Fluxgate Compass and a PC Clone. The PC both records and displays the data in 'real time'.</p> <p>The report details the recording system, also the GPS; and Compass configurations. The software menu's are explained together with the calibration techniques for the flux gate compass.</p>	
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1. SYSTEM OVERVIEW

The system described in this manual was developed in response to a requirement for navigational data on 'Vessels of Opportunity' where there are no data available from the ship's navigation system or where it is not possible to gain access to the navigation data.

The remit for the system is to acquire and record navigational data, with the secondary function to display the data for operational use. To be portable the system must rely on the vessel for only its basic requirements i.e. stowage and mains power. Independence from ship support means that the system must not require operator intervention, unless so desired, for the duration of deployment.

The major components of the system are :-

IBM Personnel Computer or Clone

GPS Receiver

Fluxgate Compass

with the PC acting as controller and data recording medium for the data from the GPS Receiver and Fluxgate Compass.

2. SYSTEM COMPONENTS

2.1 PC system

The PC is primarily responsible for data collection and storage with a secondary function as a data display. The primary screen displays, in digital format, the Latitude, Longitude, Ships Head, together with a analog compass rose. Logging status and file house keeping information is also displayed. Interactive software allows the user (on user supported cruises) to control the logging functions and also enables either of the raw data strings to be viewed for diagnostic purposes. The PC is upgraded with a Dual RS232 Serial data interface installed in the expansion bus, to allow simultaneous data collection of the two asynchronous data strings.

Data are stored on the PC's two magnetic media i.e. Hard and Floppy Disk. Dual media storage provides data security in event of failure by either of the disk drives. The primary storage of time, position and heading is on the Hard Disk together with full satellite empheris data. The secondary data set are stored on the Floppy disk and contains only the time, position and heading data. The file error checking will ensure that in the event of a single disk drive failure the data will continue to be logged to the alternate drive. In the event of both disk drives failing the program will continue to operate without data being recorded.

Primary data, stored on the Hard Disk, is written at approximately one minute intervals in files containing 360 data values. The file names are Time and Data stamped using the PC clock; each one minute data string is also time stamped based on the time of the GPS Fix. The stored data string contains the one minute values together with quality control empheris parameters for the GPS position fixes, which can be used to further filter the data at latter stages in the data processing. The secondary data files are written at half the primary data rate, i.e. approximately every two minutes

The formats of the file name and of the data string are of fixed length; a detailed description can be found in Sections 8 and 9. The data files are written in ASCII and can be read directly by a text editor or word processor, for example Microsoft Word.

2.2. Sensor Systems

The development of an industry interface standard for the pleasure boat market has led to many manufacturers bringing to the market place a large variety of relatively low cost navigational aids. This has allowed the development of this system from components which are an order of magnitude less expensive than the systems (currently fitted to NERC Research Ships (for example that manufactured by Trimble).

2.2.1. GPS System

The hardware chosen for acquiring GPS data is a Single Channel system manufactured by Magnavox, the MX4200. It is a two part system with a black box receiver and an Aerial containing a pre-amplifier. The aerial, which is connected to the receiver via a coax, lead must be mounted on a clear area of the ship's superstructure. Baccuse it is a single channel system, it must be able to

receive data from at least three satellites or more to be able to compute a positional fix. Hence the ability to give 'good' fixes is dependant on the aerial's field of view and the satellite orbits. For example, operation in port next to high buildings or cranes is far from ideal.

The receiver requires no operator actions, once power has been applied. The system collects all incoming signals, and performs quality checks on the data based on signal continuity and on the system configuration settings. The system configuration settings allow the user to set parameters which control the receivers quality checks of data by satellite constellation and by estimates of quality of position accuracy (DOP- Dilution of precision). Operational status can be monitored on the PC screen and also on the receiver front panel LED's. On the PC screen a text message shows one of six operational conditions ranging from 'Initial acquisition' through to 'Navigating'. On the receiver the green LED ,when flashing, indicates satellites being 'tracked' and when continuously illuminated indicates that the system has achieved 'navigating' mode. See Appendix A for the full GPS Specification and LED Code Diagnostics

2.2.2. Fluxgate Compass Unit

Magnetic measurements onboard ships fitted with or manufactured from steel have always given rise to many anomalies. The development of the self compensating fluxgate compass gives the opportunity to make these measurements with more accuracy, although it must always be carefully cross calibrated, preferably with a Gyro Compass.

The hardware chosen for acquiring ship's heading is the Azimuth 314AC compass manufactured by KVH Industries. The compass as used is fitted with a Universal Interface card providing NMEA, RS232 and Analog outputs. A handheld display can be used to monitor the compass signal simultaneously with the digital data output stream. It can also be used to configure the operational status of the compass and as a monitor of the Auto Compensation function. The Auto Compensation can be disabled, if required, when the user is convinced that the compensation is at an optimum setting. See Appendix B for the full Fluxgate Compass specification.

2.3. Interface/power Unit

2.3.1. Power Supplies

Both sensors require DC supplies which are provided by a custom made IOS unit. There are two encapsulated power supply units within the Unit, providing power to the systems units and the GPS serial signal interface.

2.3.2. Interface Circuitry

Compass data,in RS232 format, is passed straight through to the PC without any interface circuitry, however the GPS data stream is level shifted from NMEA (i.e. similar to RS422) to RS232. Unlike true RS422 the NMEA protocol requires data to be transmitted and received over two separate twisted pairs. Therefore there are two separate interface modules within the Unit. The circuitry requires no setting up procedure. A full circuit diagram and parts list can be found in Appendix E.

3. SYSTEM OPERATION

3.1. Deployment

Each deployment will vary to suit each individual vessel but it must be remembered that it is not a quick task to fit the external parts of the system. Some of the external parts may need to be mounted on the vessel's mast, which at the extreme may require the use of a crane or possibly some careful climbing. Deployment will require either detailed consideration before commissioning, or being equipped to cope with several methods of aerial attachment. At least a day should be allowed to commission the system.

3.2. Compass location

Finding a 'good' site for the compass is not a straight forward task and it may be that several attempts will need to be made before a suitable site can be determined.

There are however two operating modes that will result in different considerations :-

3.2.1. Where data from the ship's compass is not available

Choosing a suitable site will be difficult, initially a handheld magnetic compass may be a useful guide. However a method of quantifying the compass accuracy requires 'Swinging the Vessel'. At completion of 'Swinging the Vessel' the hand held monitor will display a parameter indicating the quality of the compensation and the site suitability. Hence, if this technique is carried out several times with the compass in different locations, it may be possible to determine a 'good' location.

3.2.2. Where the ship's compass data is available

The fluxgate compass data can be correlated against that of the ship's compass (Gyro Compass preferably) by 'Swinging the Vessel'. A 'look up' table can then be constructed to allow the recorded data to be corrected. See Appendix C for details of Calibration Procedures.

3.3. GPS Aerial Position

Position of the aerial is critical both with respect to good signal reception and cabling distance from the receiver. To receive the best available signals the aerial requires to have an unobstructed view to the horizon; blocking any sector of this view can reduce the receiver's ability to compute fixes by limiting the number of satellites it can track. Whilst it is seldom possible to achieve the perfect aerial mounting solution, care should be taken to minimise superstructure shadowing. By mounting the aerial above the upper deck of the superstructure and as far away as practical from masts, ship funnels, cranes etc., a 'best' solution will be obtained.

The deployment position of the aerial has a direct effect on the receiver location on the

vessel. The maximum cable length permissible between aerial and receiver is 30 m. If possible it is better to reduce this length to 15 m to minimise signal losses down the coax cable.

These two conditions of deployment will usually require the receiver, computer etc to be located on the upper deck of the vessel.

4. SOFTWARE

4.1 Overview

The GPS software has been written in GWBASIC for an IBM PC or compatible, and requires the PC to have two serial COMS ports. Data is received at 4800 baud at a sample rate of 1 hz from both the MX4200 GPS Receiver and the KVH Fluxgate Compass, merged, and then written to disk. Both the GPS receiver and the Compass transmit their data under the NMEA 0183 interface standard. Each record has a five character address which labels it as a GPS message i.e. PMVXG=GPS and HCHDM=Compass. The GPS receiver outputs many different types of records, each record type containing different navigation parameters. The first data field after the record address is an index code which identifies the specific type and format of the record. The software identifies the index code and then processes the record according to the data format within that record. In this way the navigational data logged by the program is continuously updated as the various record types are detected. Once a minute the data file is updated by the program with the current values for the navigational information. The file name for the data file is determined by the date and time at which the file was originally opened, each file is then appended to for 6 hours where upon that file is closed and a new file opened.

4.2. Software operation

When the PC is powered up or re-booted, commands in the AUTOEXEC.BAT configure the PC and load the software in the required manner. The software requires the NUMLOCK, and CAPSLOCK keys to be set OFF on the keyboard, and for a number of GWBasic environment conditions to be set. On some PC's the keyboard can be configured by commands in AUTOEXEC.BAT such as :-

```
SETKBD NUMLOCK = OFF
```

```
SETKBD CAPSLOCK = OFF
```

When GWBasic is loaded by the PC, certain switch parameters need to be set to enable the program to operate correctly. This is achieved by using the following command to load GWBasic and the program in the AUTOEXEC.BAT.

```
GWBASIC GPS12 /C:32767 /F:4
```

GPS12 loads the current version of the GPS program.

C:32767 allocates 32767 bytes to the receive buffer and 128 bytes to the transmit buffer for the RS-232 communications.

F:4 sets the maximum number of files that may be opened simultaneously during the execution of the program to 4.

4.3. Program Overview

When the program is first executed it runs through a number of routines and statements, which initialises and prepares the system for operation. These include, programming the control keys, opening the communication lines, initialising the GPS receiver, and opening files on both the hard and floppy disk's. When all these processes have been completed, the program operates within a loop which reads in both the GPS and Compass data, and displays it on the screen. This loop can only be interrupted in two ways, an interrupt driven timer, and control keys effected by an operator from the keyboard. The timer is set to produce an interrupt every 60 seconds. The interrupt redirects the program to the "Write a Record" routine, from which the current values for the GPS and Compass parameters are written to disk..

4.3. User Commands - Logging Control

4.3.1. Commence Logging - <Alt><F1>.

This key is employed to initiate the logging of data to disk at 1 minute intervals. On pressing the key, a call is made to the routine that opens a file for logging data. At the start of the program the key is enabled, but on entry into the routine, the key is immediately disabled. The key is re-enabled once the open file has been closed. The routine initially checks whether a new disk has been inserted. If this is the case, then a call is made to the routine that checks the amount of space available on the disk. This routine evaluates the number of bytes free on the disk, and calculates how much time would elapse before the disk would be full. This is displayed to the user, who has the option of continuing, or inserting a new disk and repeating the process. On completion, control is passed to the original data logging routine.

A dummy file is opened, so as to write six hours of records to it. This establishes whether there is enough room on the disk for the actual data file. If a disk full error is encountered by the error trapping routine, then the user is requested to insert a new disk, otherwise the dummy file is deleted. The routine then builds up the correct filename, and opens that file for sequential output. A flag (LOGGING) is set to indicate that logging has commenced, and a timer interrupt is initialised to activate every 60 seconds - the purpose of this being to write the records to disk. Control is then passed back to the point at which the program was interrupted.

4.3.2. Stop Logging - <Alt><F2>)

At the start of the program, this key is disabled, and performs no action. The key is only enabled when a data file has been opened for logging. On pressing the key combination the routine closes the data file.

4.3.3. Escape to Command Menu - <Alt><Esc>.

Program control is passed to the routine which displays additional commands. A new screen is shown to the user and a new set of function keys (F1,F2,F5,F6) is enabled for use in this command screen.

The screen remains displayed, until an <Alt><Enter> is detected.

4.3.4. Return to Main Screen - <Alt><Enter>.

This causes the program to return to the original display screen. The function keys that were enabled in the command screen are disabled.

4.3.5. View GPS or Compass Raw Data<F1> & <F2>.

These function keys are only enabled when in the command screen. They cause control to be passed to the routine which displays the contents of COM1, or the routine which displays the contents of COM2, whichever the case may be. A continuous loop is set up that reads the content of the COM port; this is done by successive calls to the routine which reads a GPS data record.

4.3.6. Re-Start GPS Receiver - <F5>.

This causes a call to the routine to restart the GPS. The program simply sends a restart message to the GPS system and waits a second or two. Again, the key is only enabled while in the command screen.

4.3.7. Re-Initialise GPS Parameters - <F6>.

Pressing <F6> causes the routine to initialise the GPS parameters, and as in the above case, the key is only enabled while in the command screen. The routine prompts the user to enter values for Time, Date, Lat, Lon, and altitude of the antenna, and assigns them to the GPS receiver. When all values have been input, the routine prompts the user for their correctness, and subsequently calls the routine builds up a properly formatted message from the user input, and transmits it to the GPS. Control is passed back to the original routine.

4.4. User Commands during logging

4.4.1. Main display

Once the program is up and running, the user is confronted with the main display screen as shown in Figure 4.1.

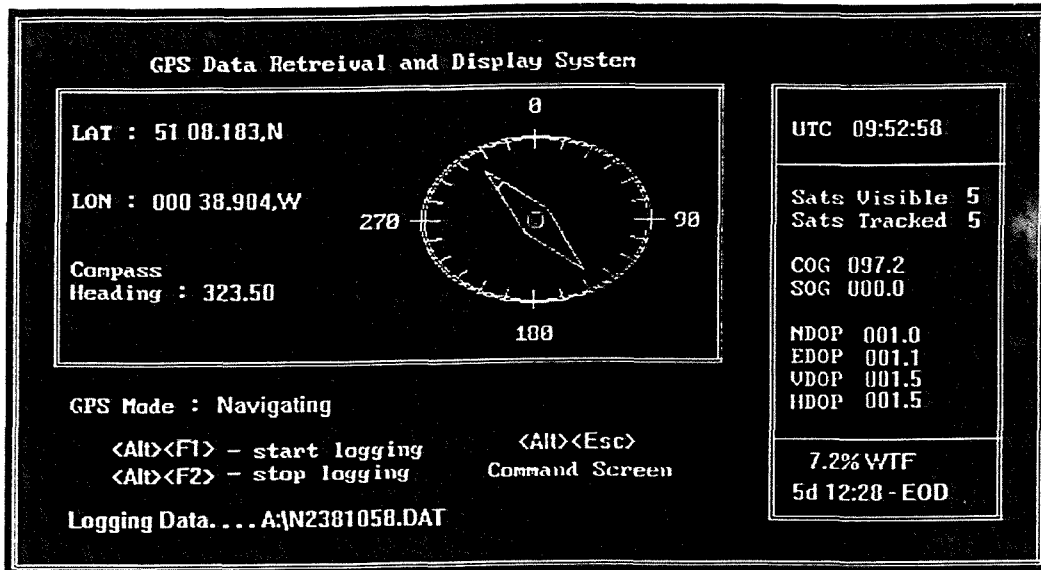


Figure 4.1 Main display screen during program operation

The main display shows the main navigational information provided by the GPS receiver to the user. Included is the latitude, longitude (of the antenna) and compass heading. Also included are values concerning the number of satellites visible to the system, as well as the number of satellites being tracked.

The COG and SOG fields show the current values of Course Over Ground (in degrees), and Speed Over Ground (in knots).

The DOP fields are estimates of the Dilution Of Precision in the position solution. This part of the display is broken down into North, East, Vertical, and Horizontal components. The lower these values, the better the potential accuracy of the solution. The UTC field displays the Universal Coordinated Time based on the UTC standard.

The GPS mode field displays the current mode of the MX4200 GPS receiver. The possible mode indicators and their meanings are as follows :

GPS mode	Meaning
Initial Acquisition	GPS attempts to acquire a satellite during system startup
Searching the Sky	GPS is searching for visible satellites
Tracking Satellite	GPS is tracking satellite but does not have enough satellites to navigate
Navigating	GPS is navigating
No Satellite Visible	GPS cannot locate any satellites
Satellite Re-acquisition	GPS attempts to re-acquire satellites for tracking

The display also shows that the system is logging data, and the file name is shown. Two other fields also give information about data logging; WTF shows the percentage of data written to the current file, and, directly underneath, the time in days, hours and minutes before the end of disk is shown. Note that these fields will only be displayed when data logging has been initiated by pressing <Alt><F1>.

4.4.2. The Command Screen.

Entry to the command screen is made by pressing <Alt><Esc> from the display screen. Initially, the display will appear as follows :

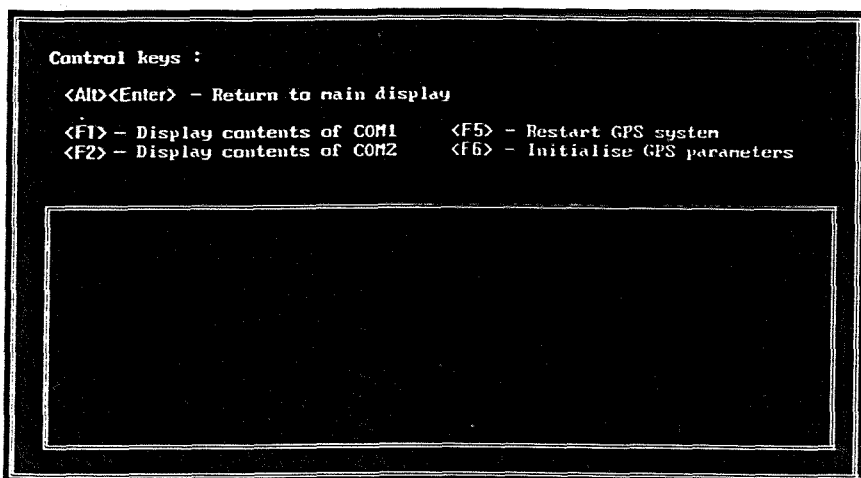


Figure 4.2 Illustration of initial command screen.

The user has now the option of performing several tasks by pressing the keys quoted on the menu. The display will remain as long as <Alt><Enter> is not pressed.

4.4.3. Display the contents of COM1/COM2.

To display the contents of COM1 - i.e. view the GPS data as it is received by the PC, simply press <F1>. The lower window will then display the contents of the communications port (see Figure 4.3). Similarly, to display the contents of COM2 - i.e. view the compass data, simply press <F2>. The lower window will then display the contents of that communications port (see Figure 4.4).

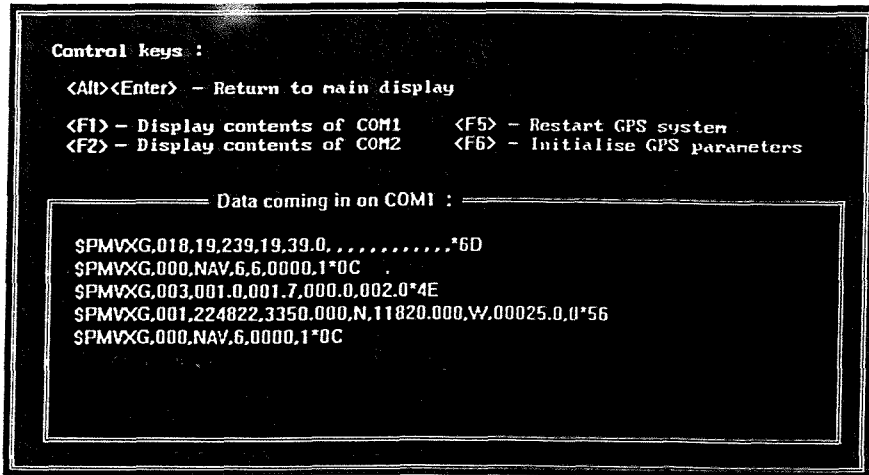


Figure 4.3 Illustration of the command screen after pressing <F1>.

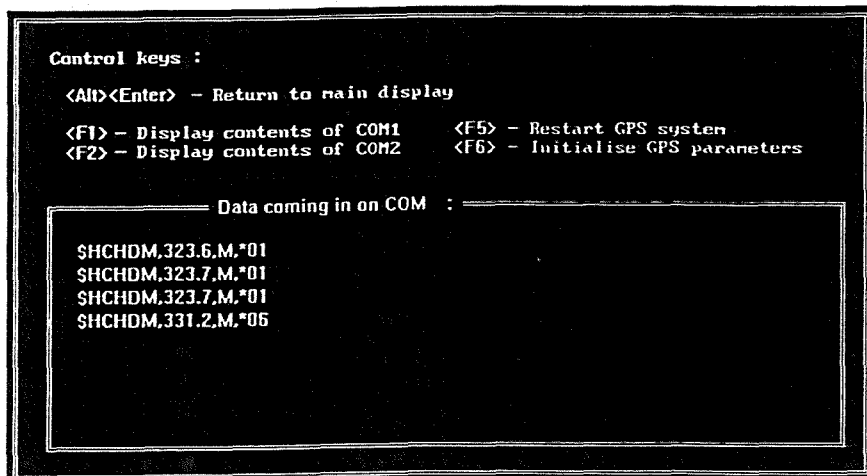


Figure 4.4 Illustration of the command screen after pressing <F2>.

4.4.3. Restarting the GPS system.

Pressing <F5> will send a message to the GPS causing the unit to terminate operations and restart. All parameters that have been previously set will be preserved.

4.4.4. Initialising GPS parameters.

Pressing <F6> will cause the software to initialise the GPS parameters. The user is prompted for five items of information - namely, the current time and date, and the approximate antenna latitude, longitude and height. Default values are given within the square brackets, and are selected by pressing <Enter>. Once all values have been input, their correctness have to be confirmed by pressing "Y" or "N". If "N" is selected, then all values have to be re-input, otherwise, the message is sent to the GPS.

Figure 4.5 shows the command screen when initialising the GPS parameters :

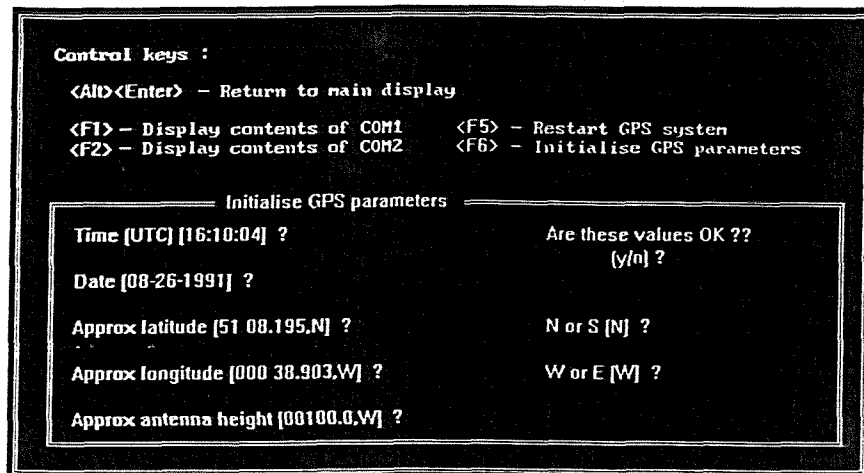


Figure 4.5 Illustration of the command screen display when initialising the GPS parameters.

The display screen will also show the percentage of the current file written to disk, as well as the time remaining before the disk will be full. After 6 hours, the current file is automatically closed, and a new file opened. The file can also be closed at any time by pressing <F2>.

4.5. File Structure.

Once data logging has commenced, sequential fixed length records are written to file at the rate of one per minute. Files are made up of 360 records; i.e. 6 hours worth of data. There are a total of 21 fields.

The different fields within each record are shown in Figure 4.5.1.

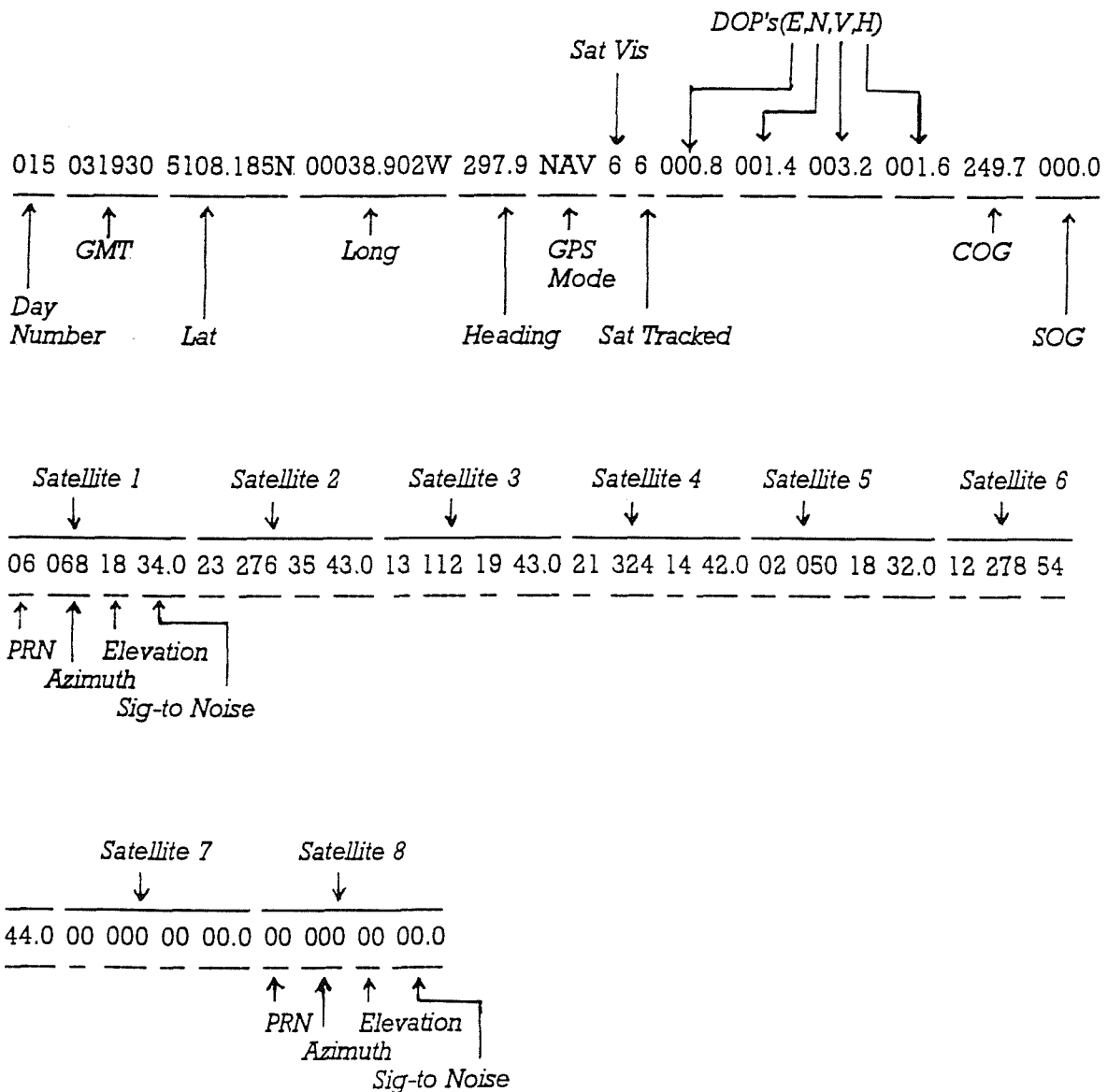


Figure 4.5.1 Diagram showing record structures.

The data message is a composite of the GPS and Compass data with Julian day number from the PC clock.

To ensure that the records are of fixed length, certain fields are filled up with "x"s. This is particularly the case when writing the specific information concerning the satellites being tracked (fields 14 to 21), as it is rarely the case for 8 satellites to be tracked at any one time.

Each record is 160 bytes long i.e. message length plus 4 extra characters, these are carriage return+line feed+carriage return+line feed

Thus, an extract from a typical data file might look as follows :

```
0150319305108.185N00038.902W297.9NAV66000.8001.4003.2001.6249.7000.0060681834.023
2763543.0131121943.0213241442.0020501832.0122785444.0000000000.0000000000.0
```

```
0150320305108.184N00038.903W297.9NAV66000.8001.4003.2001.6216.6000.0060681738.023
2763541.0131121942.0213231440.0020501735.0122785442.0000000000.0000000000.0
```

```
0150321305108.184N00038.903W297.9NAV66000.8001.4003.2001.6337.3000.0060681738.023
2763542.0131121941.0213231438.0020501733.0122785441.0000000000.0000000000.0
```

```
0150322305108.184N00038.903W297.9NAV66000.8001.4003.2001.6219.8000.0060681735.023
2763543.0131121942.0213231438.0020501733.0122785443.0000000000.0000000000.0
```

```
0150323295108.184N00038.903W297.9NAV66000.8001.4003.2001.6226.6000.0060681735.023
2763542.0131121942.0213231435.0020501733.0122785443.0000000000.0000000000.0
```

```
0150324295108.183N00038.903W297.9NAV66000.8001.4003.2001.6225.5000.0060681736.023
2763541.0131121939.0213231432.0020501735.0122785443.0000000000.0000000000.0
```

4.6. Troubleshooting

Error Condition	Action
Function keys have no effect.	Ensure that CAPS LOCK and NUM LOCK are both off.
Data from GPS contains zero's only.	Restart GPS and initialise the system parameters.
GPS will not respond to parameter initialisation.	Ensure that there are no spaces in user input, and that the correct format has been used.
Display screen shows text that should not be present.	(when returning to display screen from command screen) Press <Alt><Esc> followed by <Alt><Ent>.

APPENDIX A - GPS SYSTEM SPECIFICATION

A.1. GPS System

A.1.1. Operating Modes

Dimensional Navigation

Altitude hold(3 satellites visible)

Altitude hold(less than 3 satellites visible)

Altitude aided(NMEA input)

Dead reckoning (NMEA input)

Automatic cold start (no time or position input required)

A.1.2. Position Update Rate

Once per second (unless set by an external controller i.e. a PC)

A.1.3. Time to first Fix

one minute(typical)

A.1.4. Accuracy

Position (with SA implemented)	100 meters, 2 drms
Position (with no SA implemented)	30 meters, 2 drms
Velocity	0.1 knot
Time Recovery(optional)	1pps 100 nanoseconds

A.1.5. Self-Test Coverage

Antenna, antenna cable, digital sections of the circuit card assemblies, and analog section of RF/power supply circuit card assembly

A.1.6. Remote Control Sources

IBM-PC with control software or Magnavox MX4102GPS unit.

A.1.7. Power input requirement

10-32 Vdc, 5 Watts typical

Fuse Rating and type: 1 Amp, 3AG3 fast blow

Chassis isolated from electrical ground

A.1.8. Physical Data

A.1.8.1. Receiver

Height	1.8 inches
Width	5.5 inches
Depth	6.9 inches

A.1.8.2. Antenna

Height	7.5 inches
Diameter	3.25 inches
Weight (including 15M cable)	2.5 pounds (1.1 Kg)

A.2. Status Indicator Analysis

STATUS	Red	Yellow	Green
NORMAL SEQUENCE			
Power OFF or processor CCA failure, see Table A3	OFF	OFF	OFF
Power first turned ON	ON	OFF	OFF
Initial receiver test OK	ON	ON	OFF
Communicating with controlling (attached) device established, but not tracking	OFF	ON	OFF
First satellite being tracked but not navigating	OFF	OFF	FLASHING
Navigating and communicating with attached device	OFF	OFF	ON
ERROR STATUS			
Receiver memory failure	ON	ON	ON
Communication with attached device failed, not tracking satellites	OFF	FLASHING	OFF
Communications with attached device failed, tracking satellites	OFF	FLASHING	FLASHING
RF Self-Test Failed	FLASHING	OFF	OFF
Antenna cable Self-Test Failed	FLASHING	FLASHING	OFF
Antenna Self-Test Failed	FLASHING	OFF	FLASHING
Oscillator SELF-TEST Failed	FLASHING	FLASHING	FLASHING

A.3. MX4200 Trouble Shooting Table

STATUS INDICATORS			POSSIBLE CAUSE	RECOMMENDED ACTION
RED	YELLOW	GREEN		
OFF	OFF	OFF	Fuse Blown	Replace fuse
ON	ON	ON	Receiver memory failure	Replace CCA
OFF	FLASHING	OFF	Receiver Processor/navigation processor failure	Replace CCA
FLASHING	OFF	OFF	RF self-test failed	Replace RF/power supply CCA
FLASHING	FLASHING	OFF	Antenna cable problem	1.Tighten cable connections 2.Replace antenna
FLASHING	OFF	FLASHING	Antenna problem	Replace antenna
FLASHING	FLASHING	FLASHING	Reference oscillator problem	Replace RF/power supply CCA

APPENDIX B - FLUXGATE SPECIFICATION

B.1. Performance

Accuracy	±5 %
Op. Temp. Range	0 to 70 °C
Humidity Range	1-100 %
Field Strength Sensitivity	2.5-65 micro Tesla
Range Horizontal Component	3 degrees Magnetic Incl or dip
Number of Repeaters	4 maximum
Alarm	ON/OFF
Alarm Range Selections	± 5 degrees to ±60 degrees
Damping Levels	Select Range 0-9

B.2. Interface capability

Standard output	NMEA 0183
Universal Interface RS232	used by GPS & ships recording system
Universal Interface Analog	

B.3. Power Supply

Voltage requirements	5 V dc
Current Consumption	6 mA (light off)
light ON - 3 Levels	78/85/95 mA

B.4. Dimensions

Remote Sensor	4.75 inches cylinder by 4.0" high
Display Unit	6.5 inches by 4.75" by 0.97"

B.5. Weight

Remote Sensor with cables	9 pounds
Display Unit	10 ounces
Shipping Weight	11 pounds

APPENDIX C - COMPASS

C.1. Compass Calibration

C.1.1. Auto Compensation

The auto - compensation capability automatically measures the surrounding magnetic field distortion and compensates it out. However if the level of compensation cannot be improved because of too high distortion of the magnetic field then the current level of compensation is retained. To compensate the Azimuth 314 a calm day is required to reduce the ship motion during the calibration exercise of 'Swinging the Vessel'.

Before starting ensure that the compass is in the Auto - compensation mode :-

On the display unit briefly push down the 'crs'+ 'damp'+ 'nav' buttons and release. The display will now continuously roll through "CAL", "on" and "****".

"CAL" - indicates that you are in the Compensation display

"on" - indicates that the auto-compensation is enabled

"oFF" indicates that the auto-compensation is disabled

"****" - compensation status information ("000" indicates the system has not been auto-compensated)

C.1.2. Changing Autocompensation Mode between "on" and "oFF"

If the auto-compensation is flagged as "oFF" this must be turned to "on" before "Swinging the Vessel". Having entered the Compensation display(depressing all three buttons) hold down the "damp button". This will cause the mode to toggle between "on" and "oFF". Release the button when in the required mode and exit from the Compensation Display by applying two short pushes to the "crs" button.

C.1.3. Swinging the Ship

The vessel should be turned through a full 360 degree circle at a slow speed (certainly not quicker than 2 minutes) either clockwise or anti clockwise. The boat should continue in a circle until the display emits 4 short beeps. If it does not beep after a full circle, do not stop but continue circling, try slowing down and concentrate on keeping the vessel steady and smooth throughout the 360 degree turn.

Once the turn is completed and the display has beeped your compass is compensated. You should now enter the Compensation Display to review how successfully the compensation has been achieved. Make sure that a full circle has been completed. Do not stop even if multiple beeps occur, multiple beeping is an indication that the sensor is rapidly receiving better and better

information.

To check the auto-compensation enter the Compensation Display (press 'crs'+ 'damp'+ 'nav' buttons and release).

The display will now continuously roll through "CAL", "on" and "****". The digits "****" will display the auto-compensation data. The digits indicate :-

Lefthand Digit - the quality of the compensation (1-9 with 9 being the best).

Middle Digit - quality of the sensors magnetic location

Righthand Digit - is a rollover counter increasing by 1 digit each time the compass has accepted a new compensation. This will roll over to "1" after 9 compensations.

For instance ,a "991" indicates that you had a good compensation, good location and this is your first try. If the lefthand digit is lower than "5", you may want to try another 360 turn to get better compensation. If the middle digit is lower than "4" then you may consider moving the sensor, although if the lefthand digit is a "5" or better than you will have $\pm 1^\circ$ accuracy. To exit from the Compensation Display press the "crs" button twice and the display will return to the Compass mode

C.2. Compass Damping

The factory setting for the 'damping level' is "d-2", this should be set to "d-4" for ship (as opposed to aircraft) applications.

To change the compass damping hold down the "damping button" on the compass display and the unit will scroll through the various 'damping levels'. When the desired level is reached release the button and the value will be loaded into memory. The last setting is stored in memory even after the power is removed from the unit.

C.3. Compass Wiring.

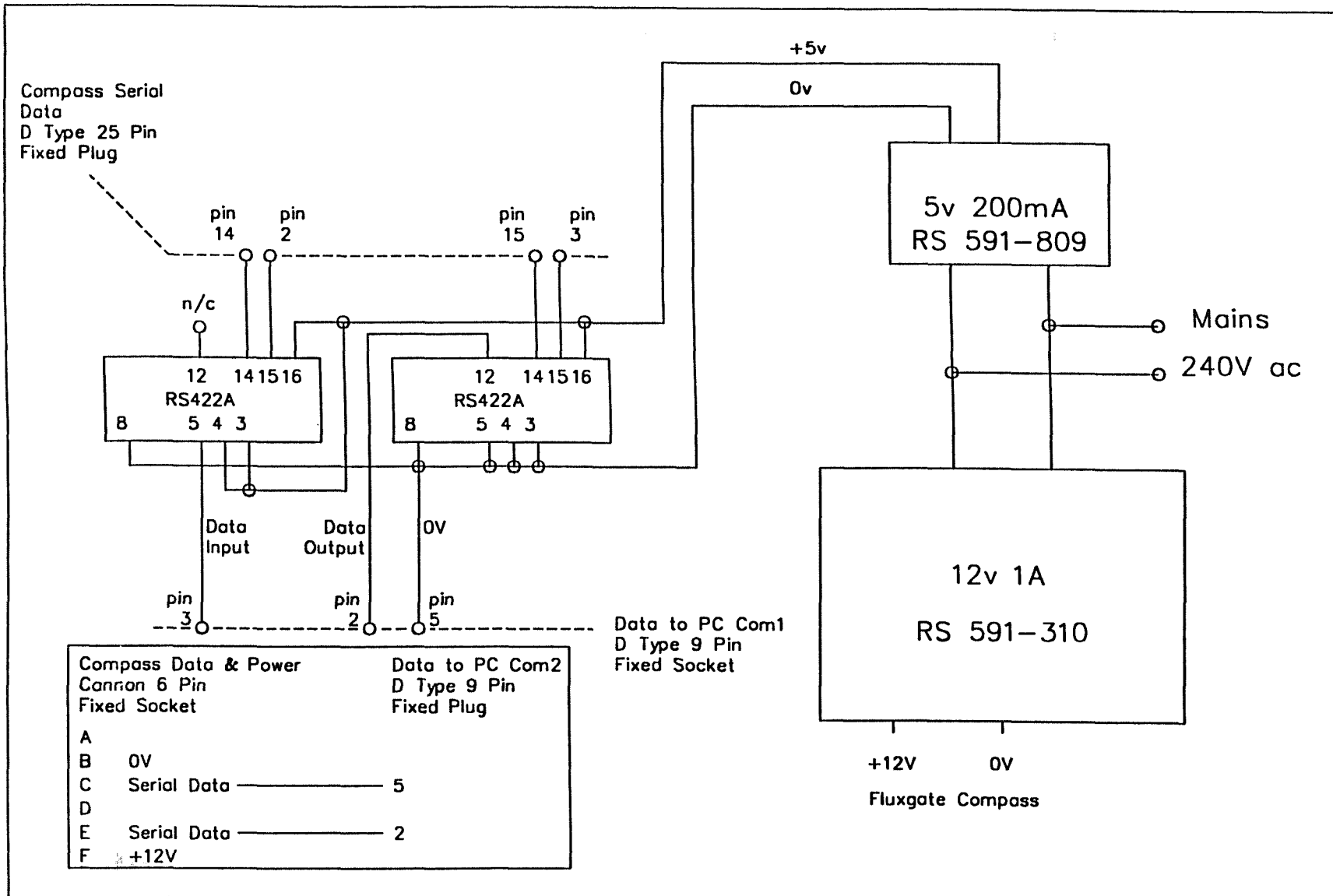
The compass as used in GAFERS is not wired as the handbook. A Universal Interface Card is fitted to the unit providing RS232,NMEA0183 and Sine/Cosine Analog outputs . The connector wiring is detailed in Appendix E.2.

Output Cable Wire Colour	Function
Red	+12V;power input , 12Vdc
White /Red	N=1;output line for N+1 signal
Violet	NMEA 0183 OUT (+); sensor output
White/Violet	NMEA 0183 OUT (-); reference ground for output
Black	PGround; power ground input from ship's ground
Black/White	TxD; RS232 transmit data output (no handshaking)
Green	NMEA 0183 In (+); data input stream
White/Green	NMEA In(-); data input stream
Blue	Sin 2; sine output for 2nd sin/cos channel
White/Blue	Cos 2; cosine output for 2nd sin/cos channel
Yellow	Sin 1(+); sine output for 1st sin/cos channel
Yellow/Yellow	Sin 1(+); inverted sine output for 1st sin/cos channel
White	Vref 1; voltage reference output for 2nd sin/cos channel
White/Black	Vref 2; voltage reference output for 2nd sin/cos channel
Brown	Cos 1(+); cosine output for 1st sin/cos channel
White/Brown	Cos 1(+); inverted cosine output for 1st sin/cos channel
Orange	Damp Out 0; control input; Ground to reduce damping
White/Orange	Damp Out 1; control input; Ground to reduce damping

C.4. Compass Interface Damping Chart

Damping Level	Update	Connect to ground
Damping 1	3 seconds	Damp Out 0 & Damp Out 1
Damping 2	9 seconds	Damp Out 1 only
Damping 3	17 seconds	Damp Out 0 only
Damping 4	Variable **	Do not ground either wire

** same level as selected (0-9) on Azimuth 314AC display



Electronic Component Description					Identification						
Circuit Diagram Symbol	Name	Rating	Grade	Type	Trade or Suppliers Name	Reference Number	Alternatives or Remarks				
IC 1	Intergrated Circuit			RS422A	RS Components	RS 633-098					
IC 2	Intergrated Circuit			RS422A	RS Components	RS 633-098					
PSU 1	Power Regulator				RS Components	RS 691-809					
PSU 2	Power Regulator				RS Components	RS 691-310					
Case					RS Components	RS 501-238					
Con 1	Connector Cir			6 Pin Fixed Skt	RS Components	RS 466-646					
Con 2	Connector Cir			3 Pin Fixed Skt	RS Components	RS 478-707					
Con 3	Connector 'D'			28 Pin Fixed Plug	RS Components	RS 466-191					
Con 4	Connector 'D'			9 Pin Fixed Skt	RS Components	RS 472-843					
Con 5	Connector 'D'			9 Pin Fixed Plug	RS Components	RS 472-437					
Con 6	Connector IEC			3 Pin Fixed Plug	RS Components	RS 488-191					
Boot 1	Saftey Boot			IEC Saftey Boot	RS Components	RS 644-112	5 per Packet				
Remarks		Issue	Date	Remarks		Issue	Date	Remarks		Issue	Date
Case and Components		1	11.2.92								
GPS and Fluxgate Interface Unit						Electronics Comps Drg No. I.O.S./					
Institute Of Oceanographic Sciences						Compiled By : K.Birch					
						Sheet Number : 1					
						Date					

D.2. Connector Wiring to Sensors

COMPASS DATA & POWER CONNECTOR

Pin	Function
A	12
B	0v Power
C	Data 0v
D	13
E	Serial Data from Compass
F	+12V Power

GPS POWER CONNECTOR

Pin	Function
A	+5V Power
B	14
C	0V Power

GPS SERIAL DATA CONNECTOR

Pin	Function
15	16
17	NMEA Port2 B Input A
18	NMEA Port2 B Output A
19	20
21	NMEA Port2 B Input B
22	NMEA Port2 B Output B
23	24

D.3. Serial Data Connectors to Computer

GPS OUTPUT TO COM1

Pin	Function
25	26
27	Serial data output from GPS
28	Serial data input to GPS
29	30
31	0V
32	33

COMPASS OUTPUT TO COM2

Pin	Function
34	35
36	Serial Data output from Compass
37	38
39	Data 0V
40	41

COMPASS WIRING TO INTERFACE UNIT

Compass		Compass Data & Power Connector
Wire Colour	Function	Pin
Red	+12V	F
Black	0V	B
Violet	NMEA Sensor (+)	E
White/Violet	NMEA Sensor (-)	C

APPENDIX E - DOWN LOADING DATA FROM GPS SYSTEM

E.1. Format for Floppy Disk

Data is recorded to both hard disk and floppy disk, where a condensed data set is stored on the floppy as back-up. On PC's such as the NEC Portable, the presence of a disk in the floppy drive is detected during power up and the system is booted up from that disk. It is therefore imperative that for PC's of this type, the back up data disk has been formatted as a bootable disk with DOS and contains the following files:-

CONFIG.SYS

AUTOEXEC.BAT

GWBASIC.EXE

GPS.BAS (CURRENT VERSION TO DATE IS GPS12.BAS)

This enables the PC to boot the software off the floppy and will insure that the back-up data is still collected even if the hard disk should fail.

E.2. Procedures for down loading gps data

Before interrupting the software, first check that the system is working correctly, and that it is giving the correct position and status. Read from the display:-

Number of satellites visible

Number of satellites tracked (3 or more to navigate)

Current status i.e.NAVIGATING

UTC time

Position IOSDL is approx N 51 08.16 W 0 38.91

Once satisfied that all is well with the system, the software must be exited and the data down loaded. The procedure for this is as follows:-

- (1) Interrupt software and exit GWBASIC to the DOS prompt.

To interrupt software press CTRL/PAUSE

To exit GWBASIC type SYSYTEM <cr>

To load the directory scanner type DS <cr> at the DOS prompt

- (2) Remove back up disk from the floppy drive and note the first and last file on disk

- (3) Change to drive D and down load data

Change drive to D: by pressing "D" then type D <cr>

Insert blank formatted disk into the floppy drive (high density).

Select the first 26 files by pressing "T" and highlight each file required

Then copy to the floppy by pressing "K" and typing B: <cr>

- (4) When all data files have been transferred to floppy erase files from hard disk.

Press ALT/T to select all files

press ALT/D to select delete files

Press "Y" <cr> to delete files

Insert a new back-up disk in the floppy drive

Exit DS

Press the F9 key

Restart system by pressing CTRL/ALT & DEL.

The Software should now boot up off the floppy drive, and before opening files on the disk's it will scan each disk in turn and display the amount of disk space available in terms of bytes and DAYS. This is displayed for approximately 10 sec before the next drive is scanned. CHECK that there is enough space on both disk's for the next voyage.

APPENDIX F - SOFTWARE UPDATES

When software updates are provided, they must be installed on to the hard disk and be present on the new back-up disk. Usually the new back-up disk will be the source for updating the hard disk. The programs for the GPS system reside in the C:\GWBASIC directory, and therefore the new version must be copied to this directory from the floppy disk.

The current program name is GPS12.BAS. If this name is changed, then the AUTOEXEC.BAT in the PC's root directory must also be modified to include the new filename.

Procedure to copy updated software from the floppy to the hard disk:-

Load the directory scanner DS.

At the DOS prompt type DS <cr>

Change to drive B:

press "D" then type B <cr>

Select file and copy

Use cursor keys to move pointer to the required file (GPS12.BAS) and press "T"

Press "K" and then type C:\GWBASIC <cr>

Exit DS

Press the F9 key

Restart GPS system

Press CTRL/ALT & DEL

