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Sensors and systems for Cumulus Surface Flux Measurement Programme

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ABSTRACT

Measurement systems on Ocean Weathership *Cumulus* were installed under the Surface Flux Programme for the James Rennell Centre meteorological team. This report details the technical contents of the systems which are deployed, highlighting aspects that are customised specifically for *Cumulus*.

Details included in the document are aimed at enabling a competent engineer to perform simple fault finding or enable diagnosis of 'the area' of more complex faults.

A brief description of the technology of each system and its dataset are included to enable the context of the systems to be understood.

KEYWORDS

"CUMULUS"
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SONIC ANEMOMETER

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1. SCOPE OF THIS MANUAL

Measurement systems on Ocean Weathership Cumulus were installed under the Surface flux programme for the James Rennell Centre Meteorological team. This report details the technical contents of the systems which are deployed, highlighting aspects that are customised specifically for Cumulus.

Details included in the document are aimed at enabling a competent engineer to perform simple fault finding or enable diagnosis of 'the area' of more complex faults.

A brief description of the technology of each system and its dataset are included to enable the context of the systems to be understood.

2. OVERVIEW OF SHIPBOARD SYSTEMS

Currently deployed are four separate recording systems, which are responsible for measurements of mean meteorological parameters, wind stress, surface wave field, and the ship's navigation. Each system is physically independent, but in the context of the scientific programme all systems must be simultaneously working to obtain a meaningful dataset.

The four hardware systems for measurement of these parameters are : -

MultiMet - mean meteorological parameters,

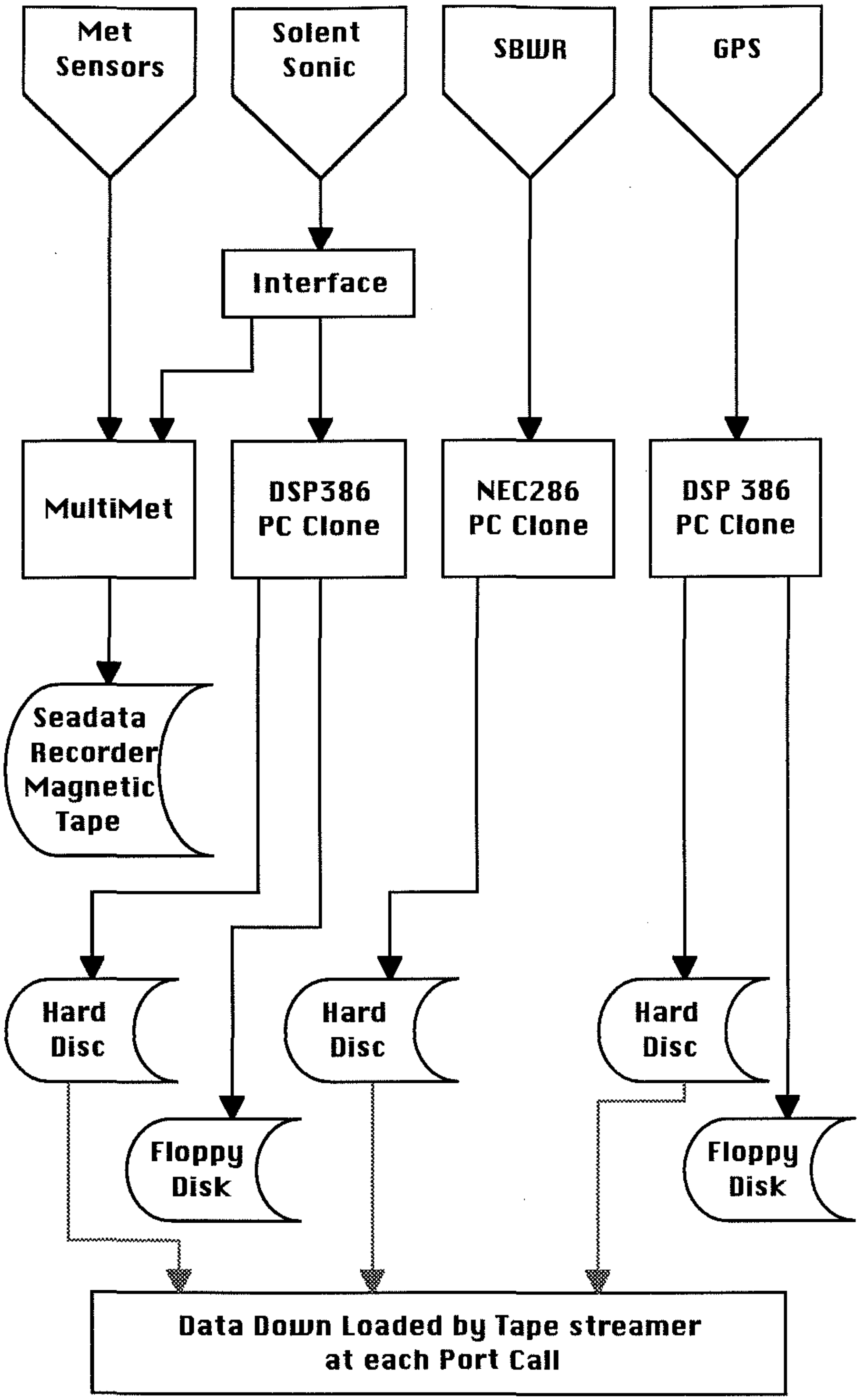
Sonic fast sampling - wind stress,

Shipborne wave recorder - surface wave field,

GPS & ship's head recording system - ship's navigation.

The tasks involved in servicing these systems at a port call between voyages are documented in, Operational Procedures for Cumulus Surface Flux Measurement Programme, IOS Internal Document No.326.

The diagram on the next page shows an overview of the four systems together with their corresponding data paths.


Met Sensors
Solent Sonic
SBWR
GPS
Interface
MultiMet
DSP386 PC Clone
NEC286 PC Clone
DSP 386 PC Clone
Seadata Recorder Magnetic Tape
Hard Disc
Hard Disc
Hard Disc
Floppy Disk
Floppy Disk
Data Down Loaded by Tape streamer at each Port Call

2.1. MultiMet

MultiMet is a multi-channel system developed at IOS for the Meteorological Team. The logging system contains a RCA 1802 Microprocessor which collects the data from each individual sensor and calculates '1' minute mean values, recording the data to a Seadata cassette tape recorder. A single cassette tape is filled during each 35 day cruise, the tapes are fitted and removed by the Meteorological staff onboard the vessel. The logging system also supplies power to all sensors.

There is no visual data display unit connected to the logger, but the serial data output stream can be decoded with a BASIC programme on a Z88 portable computer for diagnostic purposes. This is only available at port calls and is not left on board.

A calibration and maintenance programme is continuously in progress. Sensors are replaced on a three month rotational basis, however replacement is staggered during the cycle to allow inter-comparison of deployed sensors.

The external sensor wiring is replaced annually at refit.

2.2. Sonic Fast Sampling

There have been significant improvements in anemometer technology and this has enabled the deployment of a second generation system on Cumulus. Based on a solid state ultrasonic anemometer and a single board PC, it is controlled by software written at IOS for acquisition, processing, time stamping and storage of the data.

The system implementation for data collection contains all the constituent parts packaged into an IOS designed 19"' rack. The main components are : -

Single Board PC, with 3.5" Floppy disc, a Hard disc drive, and

Solent sonic anemometer with interface and power supply.

At the conclusion of each cruise the data are manually copied from the Hard Disc onto a Tape Streamer cartridge and a replacement bootable floppy disc inserted into the disc drive.

2.3. Shipborne Wave Recorder

The Shipborne sensor system ,which was designed at IOS, was installed under the surface wave programme, by IOS Taunton. The demise of this programme coincided with the commencement of the surface flux programme and as such the meteorological team have assumed control. The maintenance and calibration of the sensor hardware is performed by an external contractor, with responsibility for the data collection being undertaken by IOS staff.

The Shipborne wave recorder analogue output signal is recorded, processed, time stamped and stored using a batch program with the commercial software Notebook. The wave field is sampled for 1024 seconds every 20 minutes, commencing at three minutes past the hour, twenty three minutes past, and seventeen minutes to the hour.

For the convenience of the meteorological staff on board the vessel a hard copy output of the significant wave height is available via a printer.

At the conclusion of each cruise the data is manually copied from the Hard Disc, to a tape streamer. Unlike any of the other three systems, there is no backup data stored to a second magnetic medium.

2.4. GPS & Ship's Head Recording System

Installed in the Observation area, at the rear of the vessel, this system records both Latitude and longitude from a GPS receiver and ship's head from a fluxgate compass. The system implementation for data collection contains all the constituent parts packaged into an IOS designed 19'" rack, these are : -

Single Board PC, with 3.5" Floppy disc and a Hard disc drive,

Magnavox GPS receiver,

Power supplies, and

KVH Fluxgate compass, mounted separately to minimise magnetic interference.

Software developed at IOS controls the collection, display, time stamping and recording of data to both hard and floppy disc units. The primary dataset is stored at '1' minute intervals to the hard disc with full ephemeris data, a sub-set of data is stored at '2' minute intervals to the floppy disc drive.

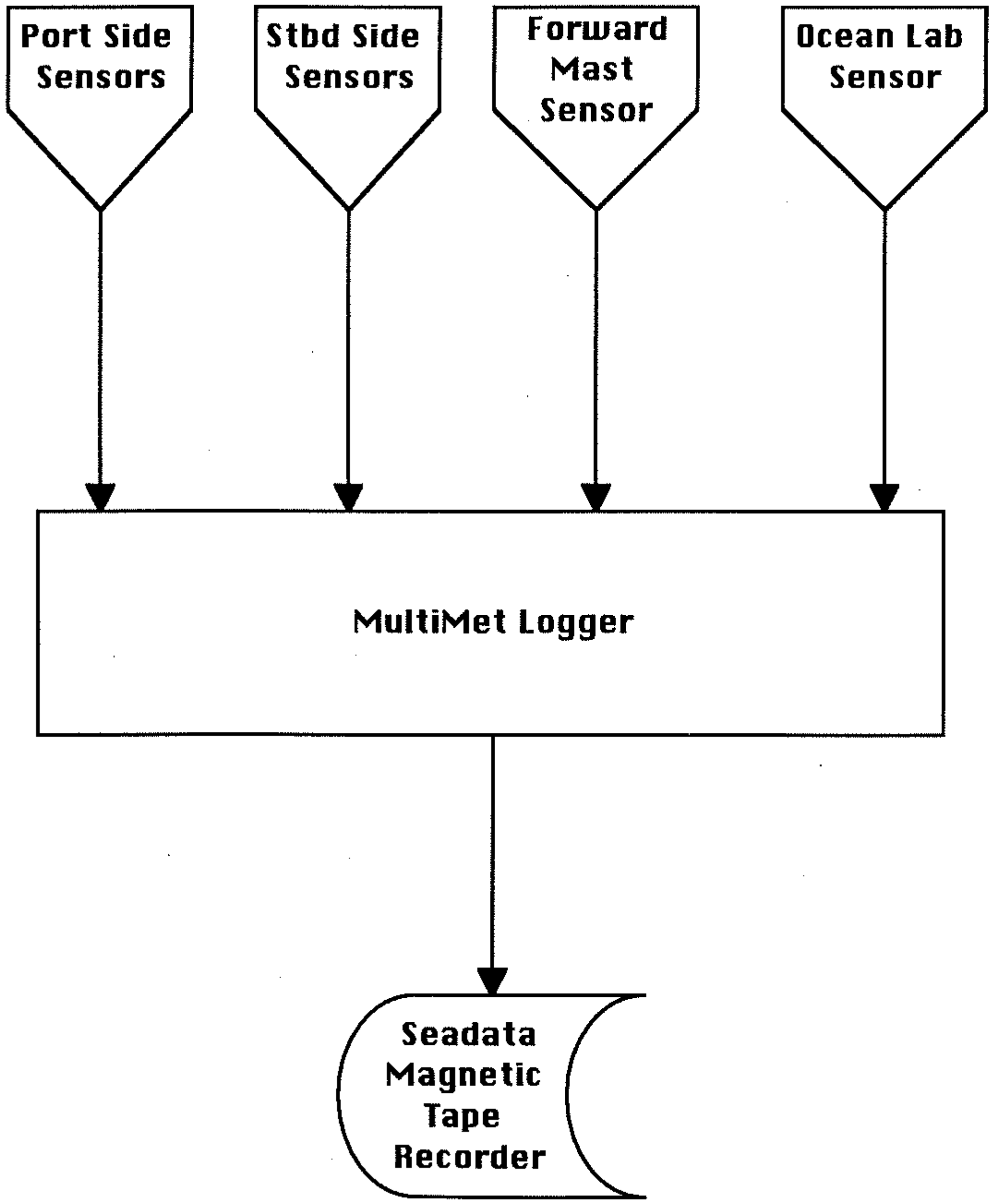
At the conclusion of each cruise the data are manually copied from the Hard Disc to a tape streamer and a replacement bootable floppy disc is exchanged with data disc from the previous cruise.

3. MULTIMET

A MultiMet anemometer and psychrometer are deployed on the port and starboard side wheelhouse top, also on the portside is a wind direction sensor. An air pressure sensor is deployed in the Oceanographic laboratory, however it is not connected to an external static head, and therefore measures the laboratory air pressure.

The MultiMet logger is 'rack mounted' in the Oceanographic Laboratory, which is amidship's on the portside. Although not strictly part of a MultiMet sensor suite, the analogue outputs from the Sonic anemometer X,Y,Z components and voltage reference are also sampled.

Appendix A indicates the positions of sensors and systems as deployed on Cumulus.



3.1. Logger

Current logger hardware, which was manufactured on Voyage 19, is unique in that it is the only logger system with 16 channels and a Seadata cassette recorder.

The MultiMet logger unit comprises of RCA 1802 Microboard Series cards together with specifically designed printed circuit cards. The Seadata logger cassette tape drive is externally mounted and the tape can easily be removed with the use of a screw driver. A nine pin 'D' Type socket is available for connection to the RS232 data stream to enable the data to be monitored for diagnostic purposes. This is not permanently connected but is only used at service visits for diagnostic checks.

The power supplies for both the sensors and logger are housed in a separate 19" frame under the MultiMet unit.

To enable fault diagnosis it is necessary to understand the format of the electrical signal types output from each sensor. There are three categories of sensors which are shown in the table below.

Signal type	Sensors
Frequency	Psychrometers i.e. wet & dry bulb temperatures Air Pressure Wind Speed
Analogue	Sonic Anemometer
Digital	Vector Wind Direction

3.1.1. Frequency Output sensors

The psychrometers can be considered as two parts, the sensing elements and the fan which aspirates the elements. Constant ventilation of the sensing elements is provided by the use of 12 V motor drawing air through the psychrometer housing. Fan motor efficiency must be monitored and the motor changed when performance degrades, however this is not time predictable, as it varies between motors, and the conditions during the time of deployment

Wiring modifications are carried out, when a new psychrometer is commissioned before calibration, which connect the sensing elements directly onto a flying lead. The flying lead is terminated with a environmentally sealed Lemo connector, and connects directly into the interface electronics circuit. Within the interface tube are two identical circuits, i.e. one for each thermometer element. The electronic interface is a sine wave oscillator whose frequency is modulated by the resistance changes in the platinum thermometer element.. The output frequency is in the range 1.4 to 2 KHz, however there is an offset in frequency between wet and dry, with the dry frequency about 50 to 100 Hz higher at an identical temperature. The difference between the temperatures of the two elements will vary according to the humidity, being maximum at 0% humidity and zero at 100% humidity.

Within the air pressure sensor interface the circuitry is identical to the temperature sensors, producing a sinusoidal output signal, with frequency proportional to pressure.

The Vector wind speed sensors produce an output a pulse for each revolution of the cups, hence high wind speeds produce a higher pulse rate, in the range 0 - 60 Hz for 0 -50 m/sec.

The logger interface for the frequency category of sensors is on the Isolator Divider card. Each sensor signal has an opto isolator followed by CD40103 divider, which is 'hard wired' to divide by eight. However because of low output frequency from the Vector wind speed sensors the dividers are replaced by wire links. The sensor output signal is then latched asynchronously by a bistable, with one bistable for each channel. Under software command the bistable output status is monitored, with a 'set' bistable resulting in a software counter being incremented. This process is carried in sequence over all ten input channels, and then all bistables are reset simultaneously.

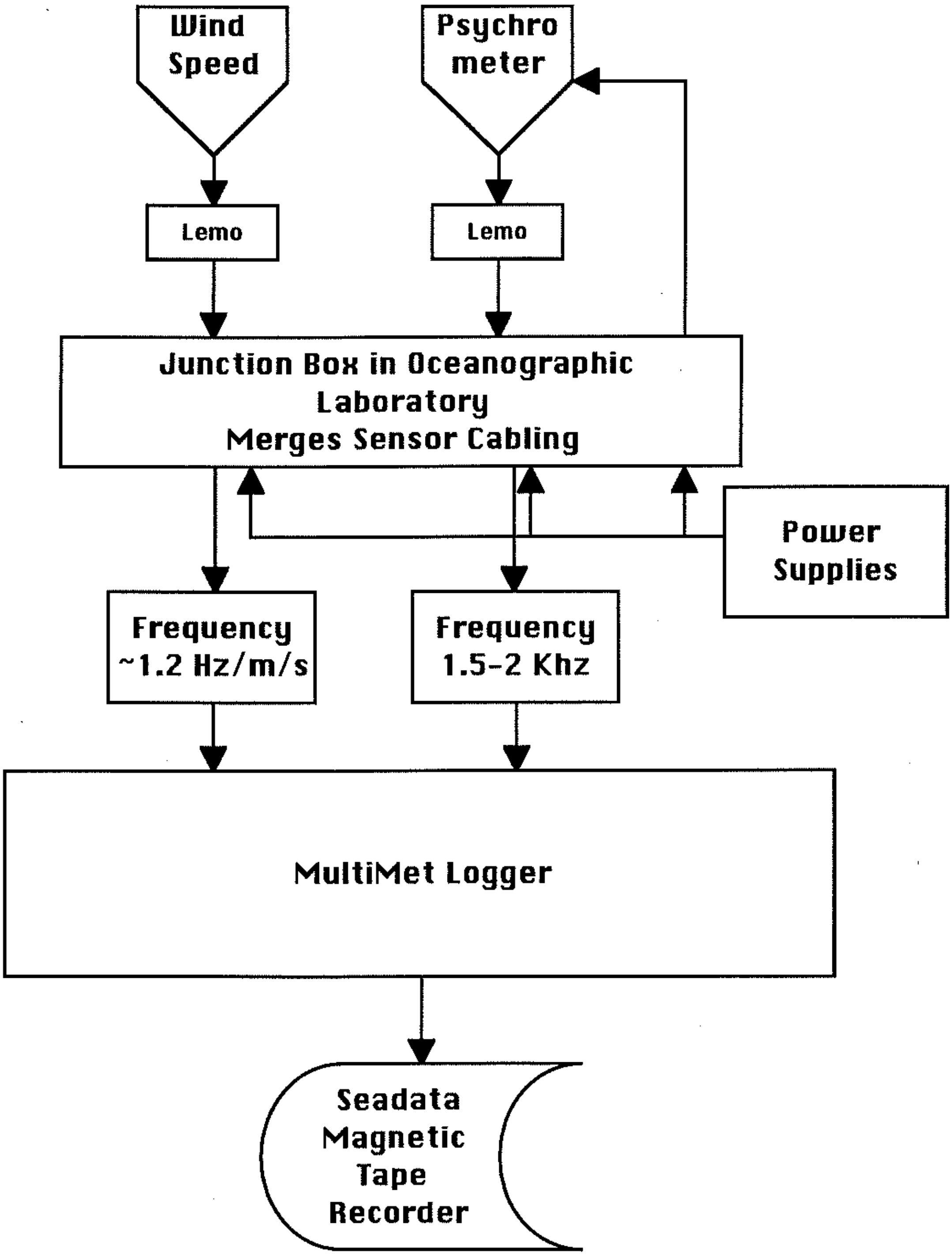
The opto isolators are driven directly from the sensor signals and require a drive current of 0.5 mA . A series resistor is available to set the current level and may be different on each channel to accommodate signal amplitude variations.

3.1.2. Analogue Output sensors

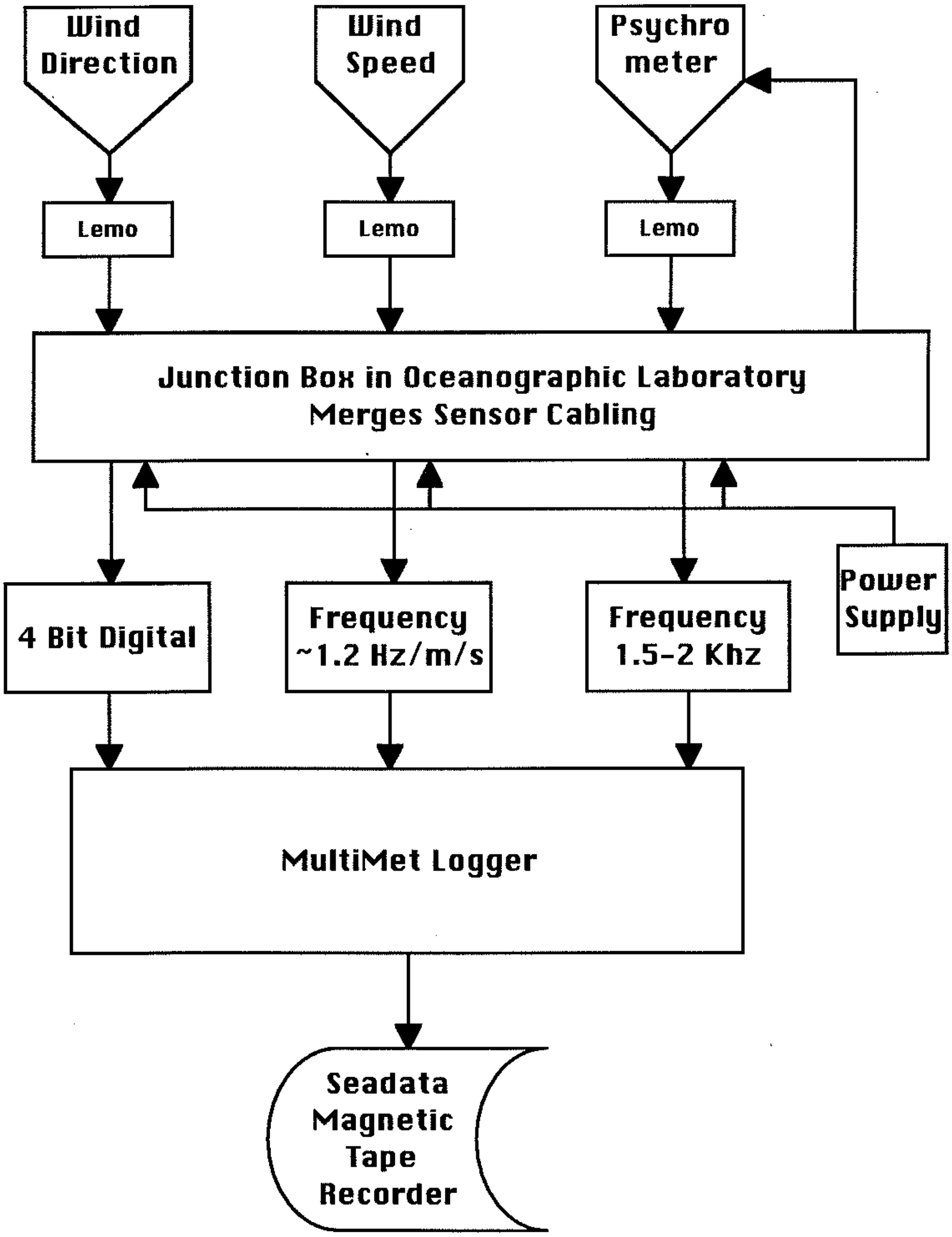
Within the Sonic anemometer a digital to analogue converter produces analogue voltages proportional to the X, Y, Z wind vectors , and voltage reference. The anemometer analogue signals are connected to the Logger via the same long cable that is used to provide power to the anemometer and for the serial data communications. These analogue signals are interfaced via DC isolators, active filters, and a multiplexor onto the analogue bus before being sampled by the logger 12 Bit analogue to digital converter .

3.1.3. Digital Output sensors

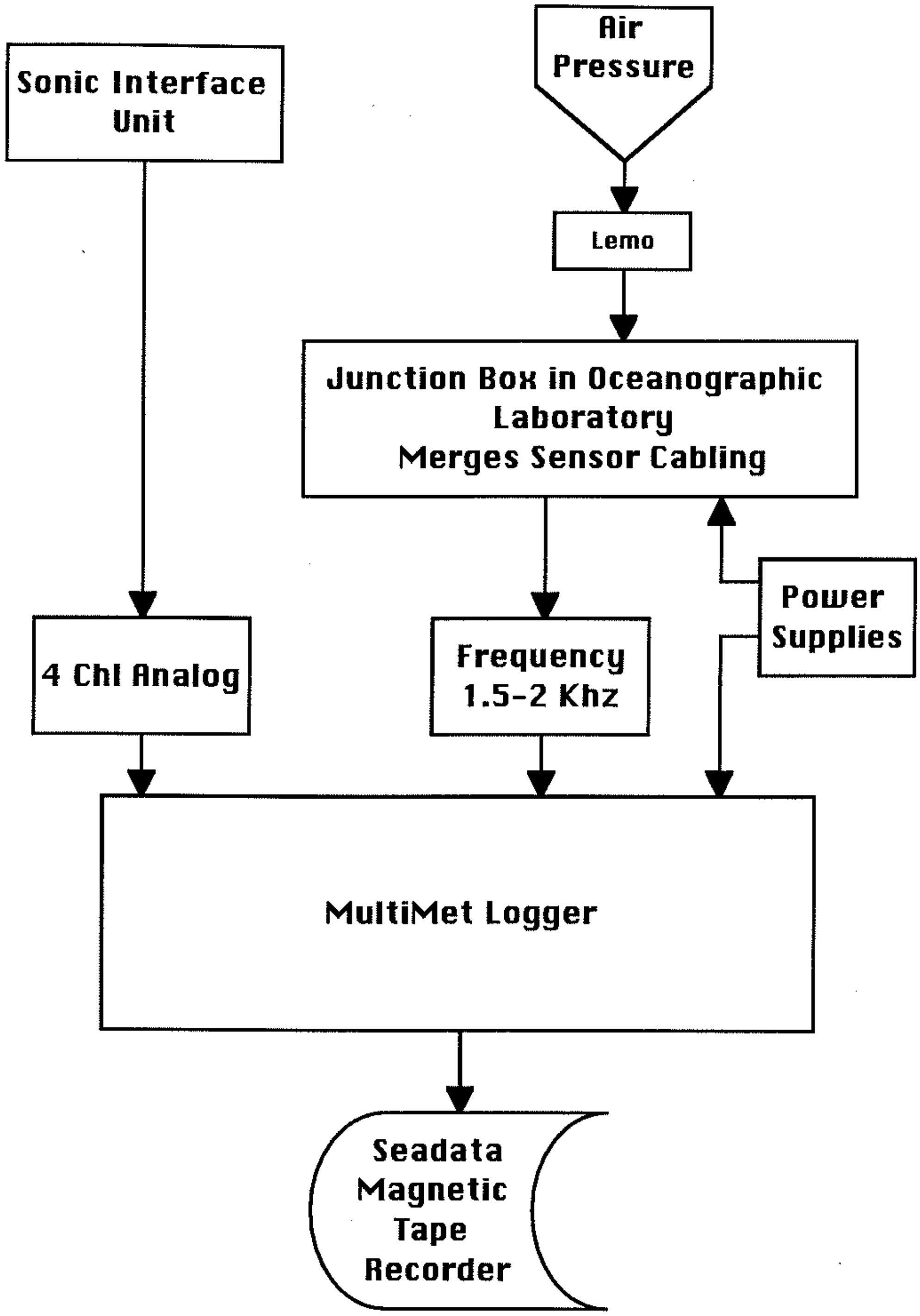
This interface latches 8 bit digital parallel data, under command of a common strobe. The Vector wind direction sensor has a 4 bit grey code output format. Therefore a customised software module has been written to read the 8 bit data port , manipulate into an 4 bit format and convert to decimal value. As directional data has a step function, i.e. the transition 0°-360°-0°, this would lead to aliasing when averaged using a simple summation technique, therefore a special routine has been written to take care of this event.



Wheelhouse top starboard side sensors



Wheelhouse top port side sensors



Oceanographic Laboratory sensors

3.2. Output Data Stream Format

The character format is fixed and independent of the number of sensors actually connected to the logger. The data format is unique to the Cumulus MultiMet logger because of the 16 channel limitation, but is constructed as follows : -

time word + 16 data channels.

The format of the complete data string is : -

S00yymmddhhnnss00xxxx.....xxxx....... xxxxT

Therefore the total number of bytes 18 bytes (time, terminators & fillers) + 16 * 4 bytes (data) = 82 bytes

the characters have the following representation : -

S	start character
yy	year number i.e.94
mm	month number
dd	day number
hh	hours
nn	minutes
ss	seconds
xxxx	single channel data, in hexadecimal format for all except wind direction
0	filler characters
T	termination character

3.3. Junction Box

A purpose made junction box was fabricated to allow the connection of the sensor cables to the logger cables. The layout of the terminal junctions is grouped by sensor signal types i.e. analogue, frequency, and digital.

The junction box contains 'push on' crimp terminals which allow for up to six connectors to be made at each terminal post .

Each sensor has a separate cable from the junction box which contains both the sensor's supplies and sensor signals

The psychrometer signals are floating relative to the logger ground and therefore have 10K resistors, to tie the signals to logger zero volts. This is also true for the Air Pressure sensor. Each of the individual 10 K resistor for the sensor signals are applied between the junction box terminals.

A complete list of the junction box wiring is supplied in Appendix B

3.4. Sensors

3.4.1. Wind Speed

3.4.1.1. Sonic

The Gill Solent Sonic anemometer provides the analogue outputs for MultiMet, and also provides the digital serial data for the Wind Stress system. Command of the anemometer is by the Wind Stress system and only when the anemometer operating in Mode 1 will it provide calibrated analogue signals of X, Y, Z wind vectors. Both analogue and digital signals use a common cable from the anemometer to the interface/ power supply box supplied as part of the anemometer package. The analogue signals are then connected straight to the analogue inputs of the logger, without passing through the Junction Box.

3.4.1.2. Vector

At each rotation of the cups a magnet momentarily closes the contacts on a reed switch within the sensor. The contact closure signal pass through opto-isolators before being counted by the logger software.

The opto-isolator for each channel has a series 'current limiting' resistor. This resistor connects the cathode of the LED to zero volts. When the reed relay contacts close, the anode of LED is 'pulled up' to the positive supply, changing the output signal level of the opto-isolator on pin 6 of the 6N139.

Note. The supply voltage of 5 Volts is common to all of the Vector sensors, both wind speed and direction sensors.

3.4.2. Wind Direction

3.4.2.1. Vector

The Vector sensor has a 4 bit grey code output, which provides a resolution of 22.5 degrees. Diagnosis of sensor performance is difficult as only one bit changes at a time when moving between sectors. Checking the sensor, whilst connected, can be achieved by securing the vane in a constant direction and monitoring the MultiMet data string. The data string output has converted the grey code to degrees, but as this is only available at '1' minute intervals, a full 360 degree check will take an appreciable time i.e. several tens of minutes.

A test box is available which can used to test the sensors and also can generate a grey code format to check wiring to the logger.

Note. The supply voltage of 5 Volts is common to all of the Vector sensors, both wind speed and direction sensors.

3.4.3. Psychrometers

3.4.3.1.. Vector

Each psychrometer has a dedicated electronics interface tube, with calibrations for this combination only, therefore these cannot be interchanged without re-calibration.

The temperature elements are aspirated by a fan motor driven from a 12V power supply . This is connected via 3 pin Cannon connector , which plugs directly into the psychrometer die cast housing. The connector type is prone to corrosion, and therefore must be maintained regularly.

The sensor elements are directly soldered to a flying lead which is terminated by a Lemo connector. The collet on the Lemo must be of the correct size otherwise water can penetrate into the connector along the exterior of the cable into the area of the soldered connections. Not only will this cause corrosion, but in the early stages of water ingress this can result in offsets and/or noisy signals.

The interface tube has Lemo connectors at both ends, with an 8 pin connector for the psychrometer elements and at the opposite end a 4 pin connector for 24V power input and signal outputs for dry and wet sensors.

3.5. Sensor Connections

3.5.1. Vector Anemometer - Lemo Series 2 - 4 way

Pin	Function	Wire Colour
1	Signal	Yellow(Red)
2	0V	Green(Blue)
3-4	n/c	

3.5.1.1. Vector Wind Vane - Lemo series 3 - 6 way

Pin	Function	Wire Colour
1	+V Supply	Red
2	Grey Code Bit 1 lsb	Green
3	Grey Code Bit 2	Blue
4	Grey Code Bit 3	Yellow
5	Grey Code Bit 4 msb	White
6	0V Supply	Black

3.5.1.2. Vector Psychrometer Lemo Series 3 - 8 way

Pin	Function	Wire Colour
1	Dry PRT White	Red
2	Dry PRT White	Green
3	Dry PRT Black	Blue
4	Dry PRT Black	Yellow
5	Wet PRT White	White
6	Wet PRT White	Brown
7	Wet PRT Black	Black
8	Wet PRT Black	Mauve

3.5.1.3. Air Pressure - Lemo Series 3 - 3 way

Pin	Function	Wire Colour
1	+V supply	Red
2	Air Pressure Freq.	Blue
3	0V Supply	Black

3.5.2. Psychrometer Electronic Interface Tube

3.5.2.1. Internal wiring - Power & Signals - Lemo 4 way fixed

Pin	Function	Wire Colour
1	+V Supply	Red
2	Dry Frequency	Blue
3	Wet Frequency	Green
4	0V	Yellow

3.5.2.2. Internal wiring - Sensor Elements - Lemo 8 way fixed

Pin	Function	Wire Colour
1-2	Dry PRT White	Red
3-4	Dry PRT Black	Blue
5-6	Wet PRT White	White
7-8	Wet PRT Black	Black

3.5.3. Psychrometer Motor - Cannon 3 Pin

Pin	Function	Wire Colour
1	+12V Motor	Red
2	0V Motor	Black
3		

4. SHIPBORNE WAVE RECORDER - SBWR

The Shipborne wave recorder has four constituent parts, two hull mounted sensor packages, a 19" rack unit, and the data processing computer. In each of the hull sensor packages are an accelerometer and pressure sensor. These measure the vertical acceleration of the ship as it rides over a wave and water level relative to the ship. The hull sensors are mounted amidship's on both port and starboard sides of the ship and are located in the depths of the engine room. The signals are hard wired, with individual cables from the port and starboard sensors, to the ship's meteorological office, and after passing through the main junction box these are connected to the SBWR 19" rack unit. Within the SBWR rack unit the signals are filtered and summed together to provide an analogue output signal proportional to wave height.

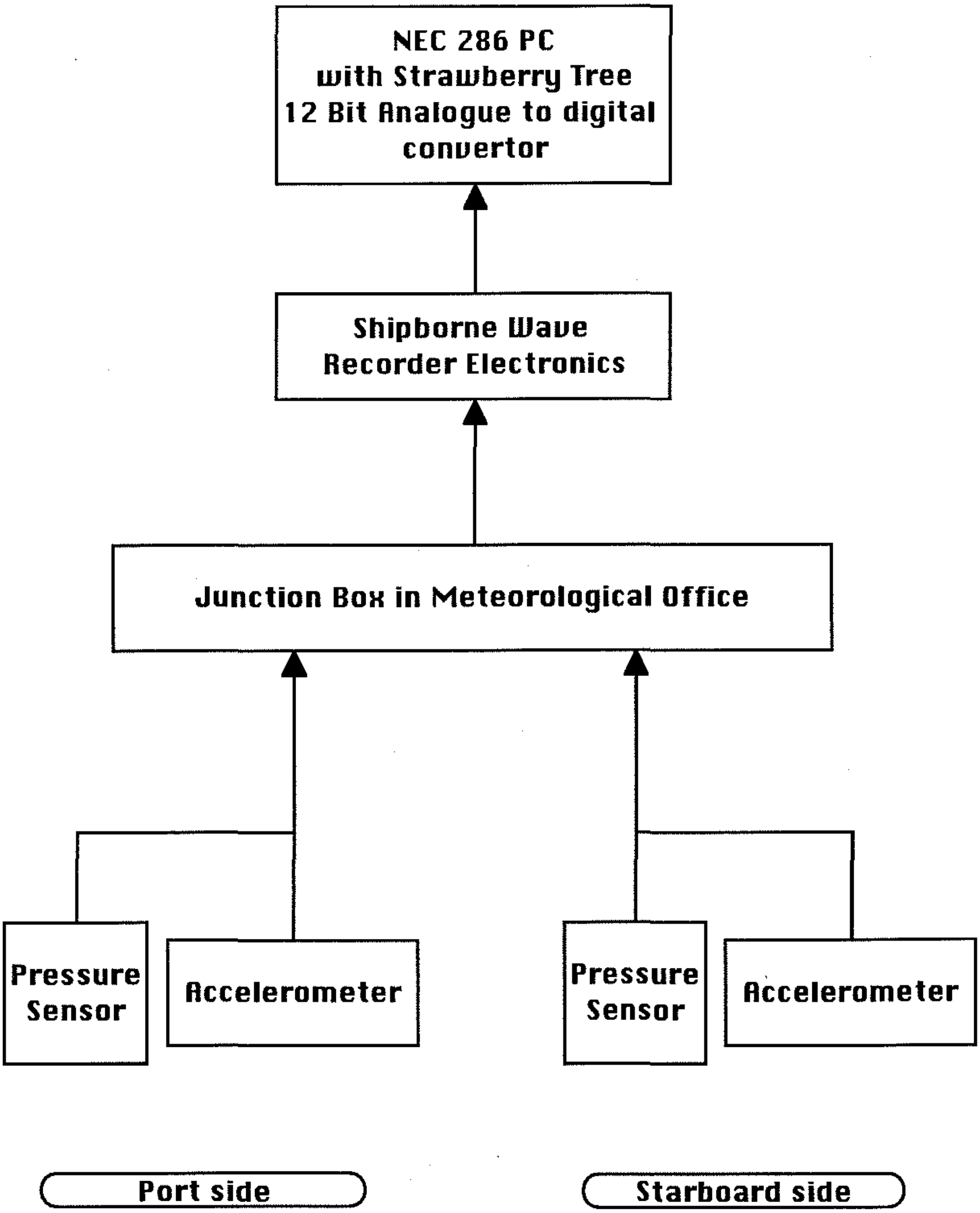
The output signal is sampled via an analogue to digital converter with the processing PC, under control by Notebook software. The three stages within the acquisition and spectral processing are all carried out by Notebook routines which are called from a BASIC program. This control software has been developed at IOS.

Whilst in port the functionality of the system is difficult to check without a portable calibrator unit, and also because the sensor signal will be limited due to limited motion of the ship whilst it is in port. However signal offsets from the mean should be clearly visible and would enable diagnosis of a sensor fault. During each cruise test records are made to check the functionality of each sensor, and by brief examination of this record an assessment can usually diagnose problems. As this system is maintained under external contract all fault repairs are instigated by contact with the contractor i.e. JSD Seawave Services.

The system will start itself when the PC is powered up or rebooted by CTRL+ALT+DEL. The first display after rebooting will be that of 'waiting for the start time' for the first record at the next twenty minute increment. During operation the screen will show plots corresponding to the stage which is currently being executed. This might be analogue trace of the data collection, replay prior to processing or a spectral plot.. At conclusion of data collection and processing there will be a gap before the data cycle re-commences.

To exit the software and close all open files depress SHIFT+} keys simultaneously. However it is best to wait until the software is the waiting state between records and exit by depressing CTRL+BREAK, care must be taken because any open files must then be closed by entering CLOSE.

The PC will still however be in the graphics mode which can be left from by pressing F10 key. To exit from BASIC to the DOS prompt, enter SYSTEM.



Shipborne wave Recorder System

5. GPS & SHIP'S HEAD RECORDING SYSTEM

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 or where it is not possible to gain access to the data.

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

The major components of the system are :-

IBM Personal 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.

The PC clone is primarily responsible for data collection and storage with a secondary function as a data display. The primary screen display in numerical format, the Latitude, Longitude, Ship's Head, together with a analogue compass rose. Logging status and file house keeping information are 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.

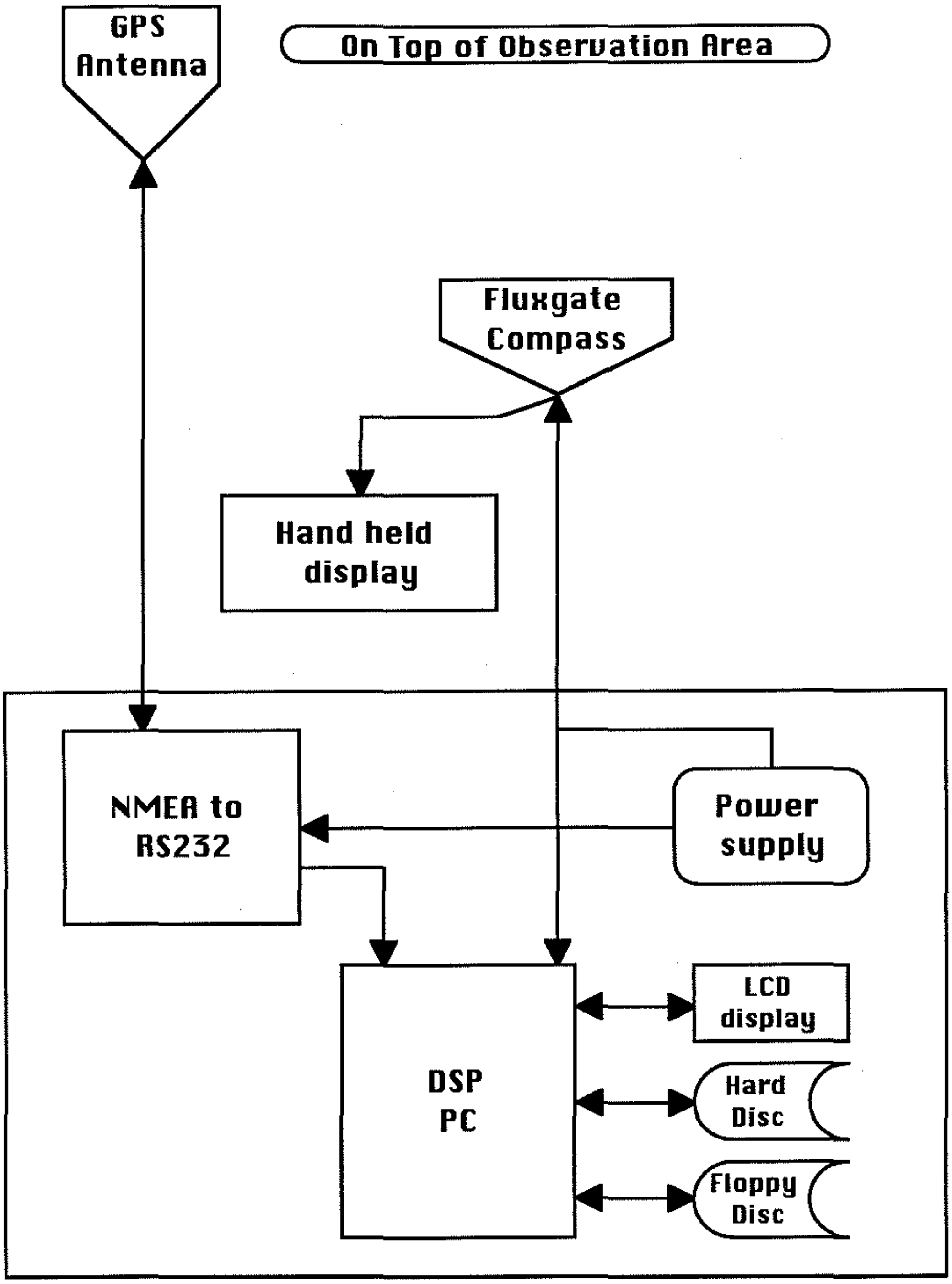
The PC clone is upgraded with a Dual RS232 Serial data interface installed in the expansion bus, to allow simultaneous data collection of the two asynchronous data strings.

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 of either of the disc drives. The primary storage of time, position and heading together with full satellite ephemeris data is on the Hard Disc . The secondary data set is stored on the Floppy disc 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 disc drives failing the program will continue to operate without data being recorded.

Primary data, stored on the Hard Disk, are written at '1' minute intervals in files containing 360 data values. The file names are Time and Date stamped, derived from the PC clock, each '1' minute data string is also time stamped based on the time of the GPS Fix. The stored data string contains the '1' minute values together with quality control ephemeris parameters for the GPS position fixes, which can be used to further filter data at a latter stage in the data processing.

Secondary data files are written at half the primary data rate, i.e. every '2' minutes. The formats of the file name and of the data string are of fixed length.

The data files are written in ASCII and can be read directly by an editor or word processor e.g. WORD.



5.1. Sensors Systems

The development of an industry interface standard for the Cruiser Boat market has led to many manufacturers bringing to the market place a large variety of relatively low cost navigational aids. This new generation has allowed the development of this system from components which are an order of magnitude less expensive than systems(i.e. Trimble) currently fitted to NERC Research Ship's.

5.1.1. 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 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.

This is a single channel system, therefore 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 satellite orbits, i.e. 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, 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 receiver's 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

5.1.2. Fluxgate Compass Unit

Magnetic measurements onboard ship's fitted with, or manufactured from, steel have always given rise to many anomalies. The development of self compensating fluxgate compass gives the opportunity to make these measurements with better faith in the data, 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 manufactured by KVH Industries. The compass, as operationally deployed, is fitted with a Universal Interface card providing NMEA, RS232 and Analogue outputs. A handheld display can be used to monitor the compass signal simultaneously to 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.

5.2. Interface/power Unit

5.2.1. Power Supplies

Both sensors are powered by 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 to the GPS serial signal interface.

5.2.2. 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.

5.3. Wiring for GPS/Compass

5.3.1. Compass Data & Power Connector - 6 way Cannon

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

5.3.2. GPS Power Connector - 3 way cannon

Pin	Function
White Sleeve	+12V Power
No Sleeve	0V Power

5.3.3. GPS Serial Data Connector - 25 way 'D' Type

Pin	Function
1	n/c
2	NMEA Port 2 B Input A
3	NMEA Port 2 B Output A
4-13	n/c
14	NMEA Port 2 B Input B
15	NMEA Port 2 B Output B
16-25	n/c

5.3.4. GPS Output to COM1 - 9 way 'D' type

Pin	Function
1	n/c
2	Serial data output from GPS
3	Serial data input to GPS
4	n/c
5	0V
6-9	n/c

5.3.5. Compass output to COM2 - 9 way 'D' type

Pin	Function
1	n/c
2	Serial Data output from Compass
3-4	n/c
5	Data 0V
6-9	n/c

5.3.6. Compass wiring to Interface Unit - cable wiring

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

5.3.7. Compass Wiring

A Universal Interface Card is fitted to the unit providing RS232, NMEA0183 and Sine/Cosine Analogue outputs . The wiring is detailed in table below.

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

6. SONIC

The sonic anemometer is mounted on the port side of the foreward mast, and is connected via a single multi-core cable to Oceanographic laboratory amidship's. This mounting structure was specially constructed for the Sonic anemometer at the 1993 ship's refit after the removal of the midship's goalpost mast where the sensor was previously deployed.

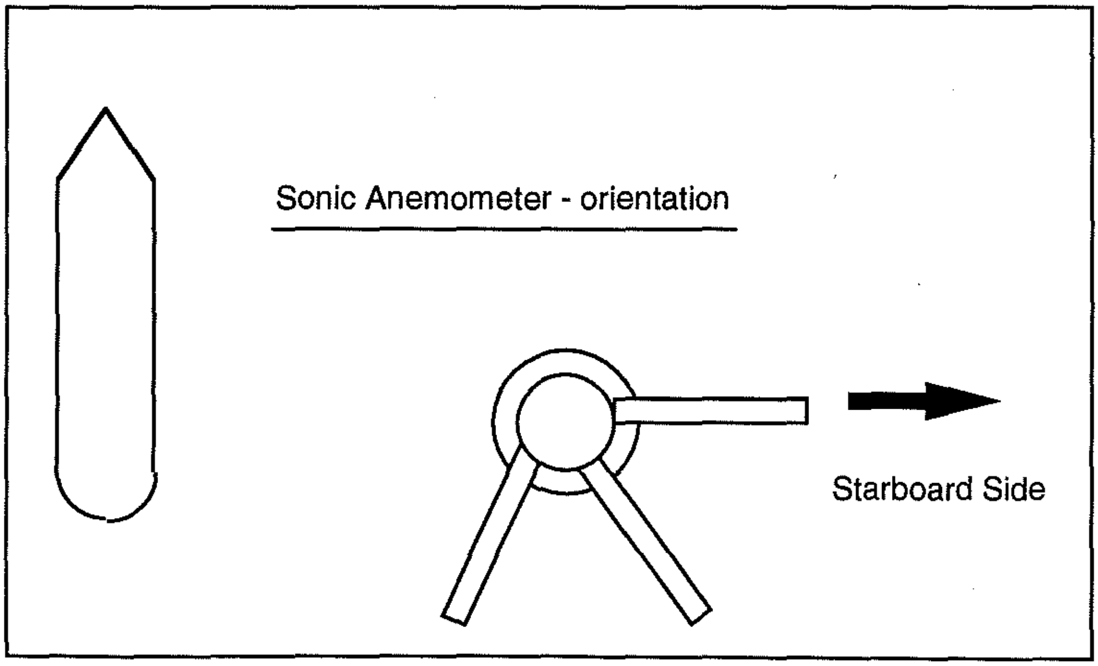
In the Oceanographic laboratory the anemometer cable is terminated at the PC, where the Gill Instruments interface for conversion from RS485 to RS232 and power supply is mounted as an integral part of the PC chassis. A handbook is currently being written which describes the specification and construction of the PC in the 19" rack assembly.

The analogue output signals are also available for use by MultiMet.

6.1. Orientation of Sonic Anemometer

By definition the ship has two well defined operational modes, i.e. port side to windward and head to wind in strong wind or large swell waves. Therefore to optimise the airflow at the Sonic anemometer, and minimise interference by support legs, the orientation of the head is critical.

The asymmetric head design has the three support legs within a 120° arc, hence the optimum orientation of the head is with the foreward arm towards the starboard side and the remaining support legs orientated aft of the midship's, as shown in the diagram below. For mounting purposes the anemometer is fixed by four screws to an purpose made scaffold pole mast, which is secured to the rail by standard scaffold clamps.



6.2. Wiring for Sonic Anemometer

Hirose 10 way RM15WTR -10S

Pin Number	Signal Name
1	+V supply
2	Serial -
3	Serial +
4	Signal Ground
5	Analogue Output 2 - Y
6	Analogue Output 4 - Ref
7	Analogue Output 1 -X
8	Analogue Output 3 - Z
9	-V supply
10	Chassis

6.3. Wiring at PC for Sonic Anemometer

6.3.1. Interface 15 way D type

Pin Number	Signal Name
1	Screen
2	Anemometer supply -V
3	Anemometer supply -V
4	Analogue Output
5	n/c
6	Analogue Output
7	Anemometer supply +V
14	Anemometer supply +V
8	Serial B
9	Signal GND
10	Signal GND
11	Analogue Output
12	Serial A
13	Analogue Output
15	Analogue GND

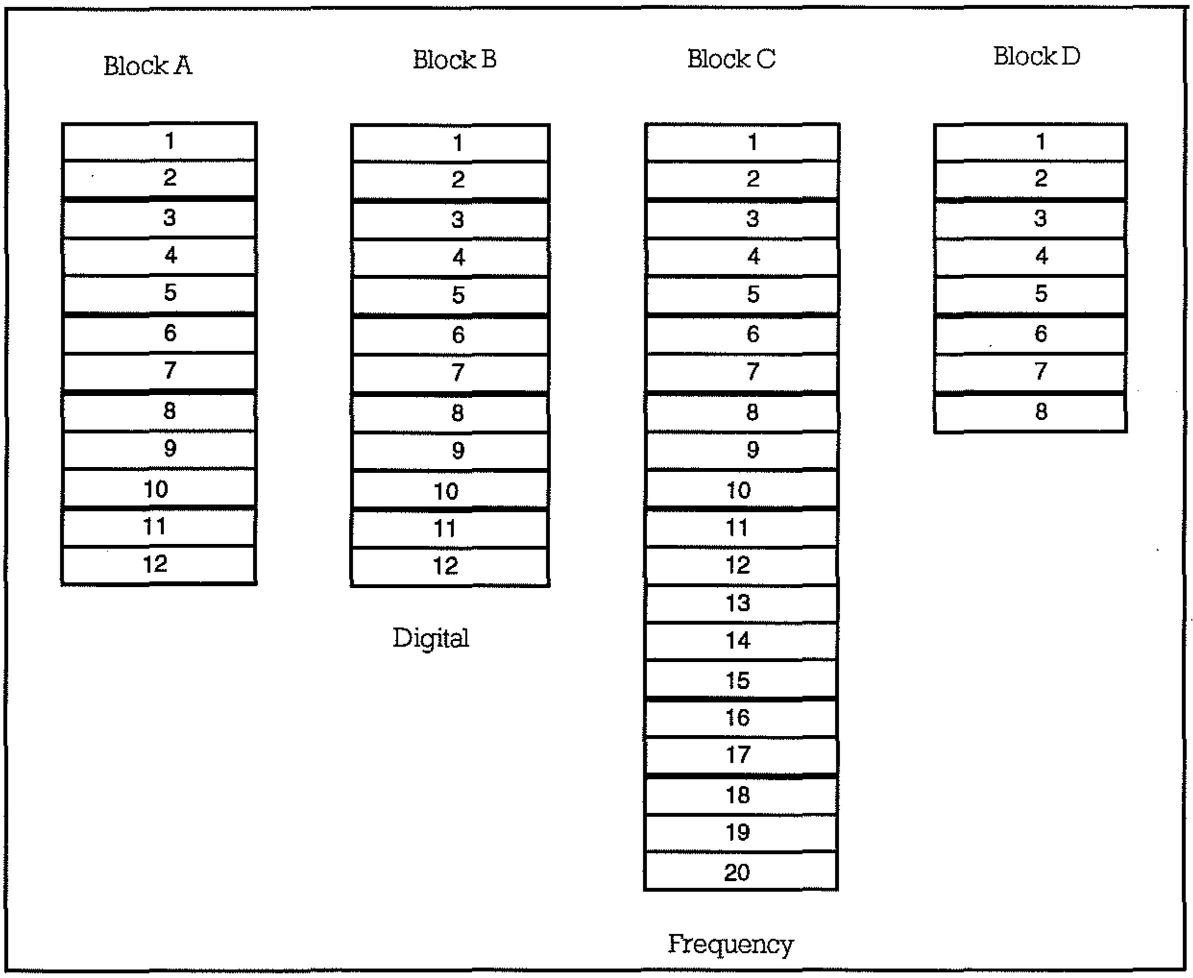
6.3.2. Analogue Connector 9 Way D Type

Pin Number	Signal Name	Wire colour	Destination
3	Analogue Output 1 - X	Red	Analogue Chls 1-8 pin 18
4	Analogue Output 4 - Ref	Green	Analogue Chls 1-8 pin 15
5	Analogue GND	White	Analogue Chls 1-8 pins 2,3,4 & 5
8	Analogue Output 2 - Y	Blue	Analogue Chls 1-8 pin 17
9	Analogue Output 3 - Z	Yellow	Analogue Chls 1-8 pin 16

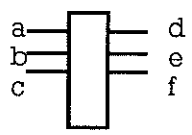
7. APPENDIX A - SENSOR POSITIONS

8. APPENDIX B - MULTIMET JUNCTION BOX WIRING

8.1. Overall layout of Junction Box



Junction Box - terminal layout



Terminal identification

8.2. Block A

Destination	Wire Colour	Pin	Function	Wire Colour	Destination
Blk A5c	1K0 Resistor	3c 3d	Accelerometer signal A (not connected)	 Pink	 Analogue Ch 1-8, Pin 7
Blk A3c	1K0 Resistor 1K0 Resistor	5c 5c 5d 5e	Accelerometer ground A (not connected) Accelerometer ground B (not connected)	 Blue Red	 Analogue Ch 1-8, Pin 6 Analogue Ch 1-8, Pin 8
Blk A5c	1K0 Resistor	7c 7e	Accelerometer signal (not connected)		 Analogue Ch 1-8, Pin 5

8.2.1. Analogue Channels 1 to 8 - Cable #1

Cable connections - 'D' Type Connector (labelled Analogue 9 -16)

Pin Wire	Colour
1	Yellow
2	White
3	Grey
4	Light blue
5	Green
6	Blue
7	Pink
8	Red
9	Black
10	Violet
11	Orange
12	Brown
13	n/c
14 to 25	n/c

8.3. Block B

Destination	Wire Colour	Pin	Function	Wire Colour	Destination
Blk C2b Digital Con 1 Blk B7c.	White White White	1 a 1b 1c 1d	Port Wind direction 0V	Black	Sensor Lemo
Digital Con 1	Black	2b 2d	Port Wind Direction	Blue	Sensor Lemo
Digital Con 1	Brown	3b 3d	Port Wind Direction	Green	Sensor Lemo
Digital Con 1	Red	4b 4d	Port Wind Direction	Yellow	Sensor Lemo
Digital Con 1	Orange	5b 5d	Port Wind Direction	White	Sensor Lemo
Blk C5a Blk B12c	Yellow Yellow	6a 6c 6d	Port Wind Direction +V	Red	Sensor Lemo
Blk B1c	White	7c			
Digital Con 1	Yellow	8b			
Digital Con 1	Green	9b			
Digital Con 1	Blue	10b			
Digital Con 1	Light Blue	11b			
Blk B6c	Yellow	12c			

8.4. Block C

Destination	Wire Colour	Pin	Function	Wire Colour	Destination
Freq. Con 1	Black	1a 1d 1f	Sensor signal	Red 1K resistor	Starboard Wind Speed Blk C5f
Freq. Con 1 Blk B1a Blk C4b	Brown White White	2a 2b 2c 2d		Blue	Starboard wind speed
Freq. Con 1	Red	3a 3d 3f	Sensor signal	Red 1K resistor	Port wind speed Blk C5f
Freq. Con 1 Block C2c PSU	Orange White	4a 4b 4c 4d 4f		Blue White	Port wind speed Blk D 4b
Block B6a PSU	Yellow Yellow	5a 5c 5d 5f		Yellow 1K resistor 1K resistor	Blk D 6a Blk C1f Blk C3f
		6d 6f	+24V	Red Red	Starboard Psychrometer Blk C 10f
Freq. Con 1	Yellow	7a 7d 7e	Sensor signal	Blue 10K resistor	Starboard Psychrometer Blk C9e
Freq Con 1	Blue	8a 8d 8e	Sensor signal	Yellow 10K resistor	Starboard Psychrometer Blk C9e
Freq. Con 1	Turquoise Green	9a 9b 9d 9e 9f	0V	Green 10K resistor 10K resistor White	Starboard Psychrometer Blk C7e Blk C8e Blk C13f
		10d 10e 10f	+24V	Red Red Red	Port psychrometer Blk C14f Blk C6f
Freq. Con 1	Mauve	11a 11d 11f	Sensor signal	Blue 10K resistor	Port psychrometer Blk C13e
Freq. Con 1	Black/Red	12a 12d 12e	Sensor signal	Yellow 10K resistor	Port psychrometer Blk C13e
Blk C16b Freq. Con 1 Freq. Con1	White Red/Brown Grey	13a 13b 13c 13d 13e 13f	0V	Green 10K resistor 10K resistor White	Port psychrometer Blk C11f Blk C12e Blk C9f

PSU	Red	14c 14d 14f	+24V	Red Red	Pressure Blk C10e
Freq. Con1	Yellow/Red	15a 15d 15e	Sensor Signal	Blue 10K resistor	Pressure Blk C16e
Blk C13a PSU	White/Red White White	16a 16b 16c 16d 16e	0V	Green 10K resistor	Pressure Blk C15e
Freq. Con 1	Pink	17c			
Blk D1e PSU	Blue White	18a 18c			
Sensor PSU Sensor PSU	Orange Yellow	19a 19b 19d 19e	0V	Blue Blue	Psychrometer motor Stbd Psychrometer motor Port
PSU	Red	20a 20d 20e	+V	Red Red	Psychrometer motor Stbd Psychrometer motor Port

8.5. Block D

Destination	Wire Colour	Pin	Function	Wire Colour	Destination
Blk D 4c	White Yellow Green	1a 1b 1c 1e	Not used	 Blue	 Blk C18a
	Blue	2b 2f	Not used	 Yellow	 Analogue pin 1
	Red	3b 3f	Not used	 Grey	 Analogue pin 3
 Blk C4f Blk D1a	Blue White White	4a 4b 4c 4d	Not used	 White	 Blk D7d
	Red	5a	Not used		
Blk C5d	Yellow	6a	Not used		
		7d 7e 7f	Not used	White Light Blue White	Blk D4d Analogue pin 4 Analogue pin 2
		8a 8d 8e 8f	Not used	 Brown Black Orange	 Analogue Pin 12 Analogue pin 9 Analogue pin 11