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Note: Sea-Bird stopped manufacturing 11*plus* V1 in 1997; for current product, see 11*plus* V2.

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1-1 SYSTEM DESCRIPTION

Sea-Bird CTD systems consist of the SBE *9plus* Underwater Unit and either the SBE *11plus* Deck Unit (for real-time readout using conductive wire) or the SBE *17plus* SEARAM Memory Module, which mounts along side the SBE *9plus* for *in-situ* recording. When a Deck Unit is employed, underwater unit power is supplied down the same single conductor armored wire used to telemeter data up to the surface. The Deck Unit decodes the serial data and passes it to a computer for display and archiving.

This manual describes the operation and use of the SBE *11plus* CTD Deck Unit. For information about the underwater unit, consult the SBE *9plus* manual.

An overview of the Sea-Bird CTD System and the functioning of the Deck Unit is given in Section 1. Installation of the Deck Unit is described in Section 2.

Users who plan to write their own software need to study Section 3 (Deck Unit commands, data format, and conversion algorithms) in detail. Those who plan to use Sea-Bird's SEASOFT CTD Data Acquisition Software require only a rudimentary understanding of Deck Unit operation, as presented in Section 1.

Section 4 describes the Deck Unit's electronic operation in detail, while section 5 provides information on troubleshooting.

See the SYSTEM CONFIGURATION SHEET at the front of this manual which describes the features of your particular Deck Unit. Note that Sea-Bird SBE *9plus* and SBE *11plus* are not compatible with the older SBE 9 and SBE 11 models.

1-2 CTD SYSTEM OVERVIEW

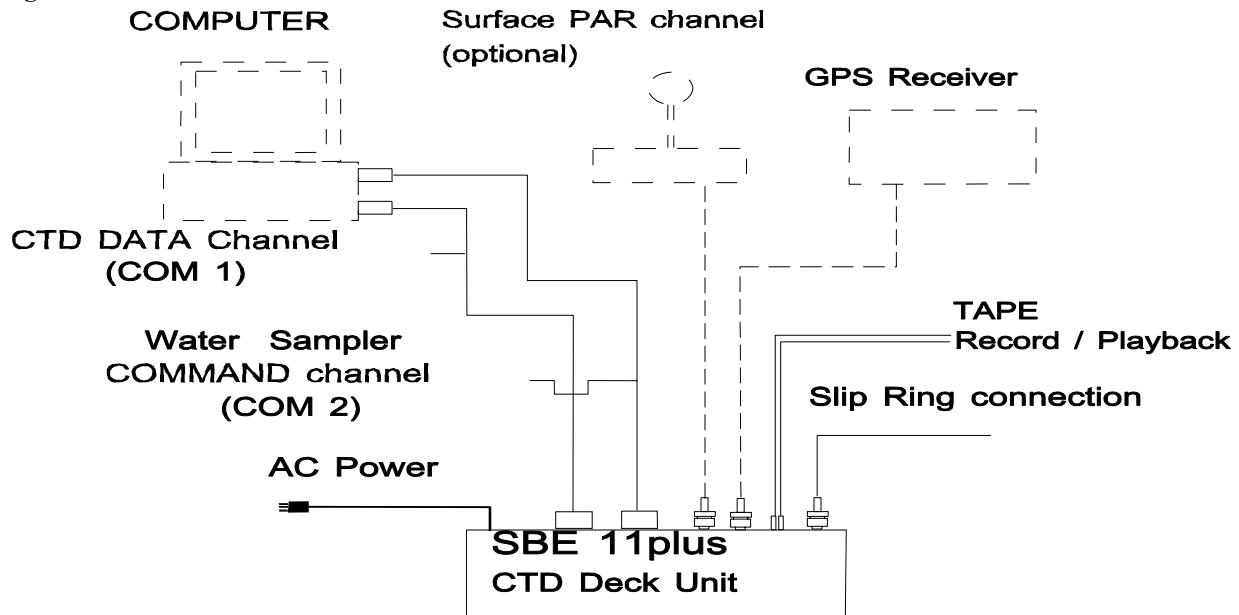
The 911*plus* CTD System hardware consists of an SBE *9plus* underwater unit, containing power supplies, acquisition electronics, telemetry circuitry, and a suite of modular sensors, and the SBE *11plus* Deck Unit. Additionally, an electro-mechanical sea cable, slip ring-equipped winch, and a computer are needed to operate the system aboard ship. Figure 1 on the following page shows the components and connections relevant to the SBE *11plus* installation and use. Refer to the SBE *9plus* manual for information related to the underwater components and options.

1-2.1 SBE 11*plus* CTD DECK UNIT

The SBE *11plus* is a rack-mountable interface for the SBE *9plus*. It supplies DC power for the underwater unit, decodes the serial data stream, formats the data under microprocessor control, and passes the data to a companion computer. It provides access to the water sampler command channel (modem), and controls for the water sampler interface. The SBE *11plus* has a rear panel selector switch permitting operation from either 120 VAC or 240 VAC 50/400 Hz power and contains provision for numeric display of selected frequency and voltage and data via a thumbwheel switch and 8 digit LED readout. Data output is provided in both IEEE-488 and RS-232 format. A tape recorder interface permits recording of the digital data stream on audio cassette recorders. If a bottom contact switch or sonar altimeter is connected to the Underwater Unit, a sonic alert buzzer located in the lower left corner of the front panel sounds in response to the bottom contact alarm feature in the software. An optional interface is available for acquiring NMEA 0183 standard navigation/position data, and an optional A/D (0-5V) input channel can be installed for interfacing a surface PAR sensor.

If desired, the SBE *11plus* can average the underwater unit data to reduce the processing or archiving demands placed on the accompanying computer.

Figure 1

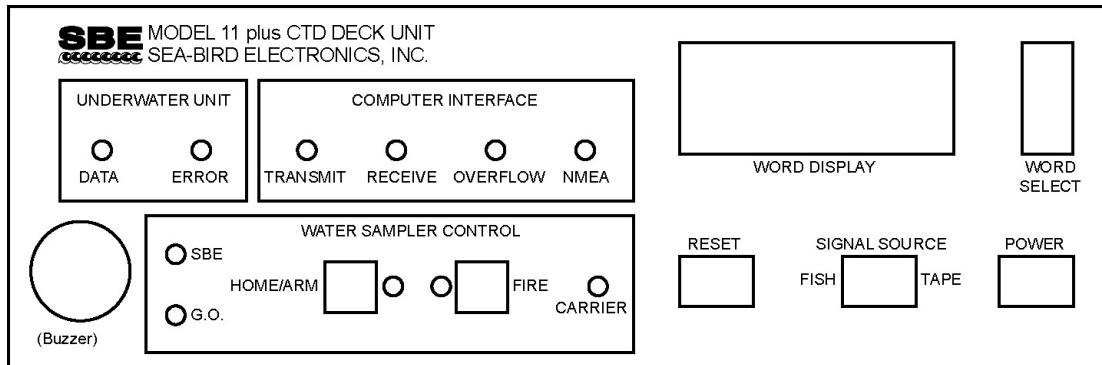


1-3 OPERATION OF THE SBE 11plus DECK UNIT

Once the Deck Unit internal switch settings have been set (see Section 3-3) adjustments are normally not required, and the only connections are for AC power, the sea cable connection to the underwater unit, and the data acquisition computer. The Deck Unit has rear-panel line input and line output connectors (standard RCA types) permitting data back up recording using an analog tape recorder. Any good quality hi-fi cassette, reel-to-reel recorder or VCR is suitable.

1-3.1 DECK UNIT FRONT PANEL DISPLAYS AND CONTROLS

Figure 2



The POWER switch is pressed to turn on the Deck Unit. Voltage is applied to the rear panel Sea Cable connector immediately.

The DATA light indicates that the Deck Unit is successfully receiving data from the underwater unit (Fish) at the expected rate and format. In general, if this light is on and the ERROR light is off, it may be assumed that the underwater unit and telemetry link are working properly.

The TRANSMIT light blinks when the Deck Unit sends data out over the IEEE-488 or the RS-232C interface.

The RECEIVE light blinks when the Deck Unit receives characters from the computer.

The OVERFLOW light comes on if the output buffer has overflowed because the computer did not take the data from the Deck Unit quickly enough. If this light comes on, it means that at least some data has been irretrievably lost.

The RESET button empties the output buffer and halts input to it until instructions are received from the computer. The RESET function may also be performed via software control (explained in Section 3-2). This function should always be performed before beginning a CTD cast, since otherwise the first data sent to the computer may be old data left over from the end of a previous cast. SEASOFT performs this reset function automatically.

A WORD DISPLAY LED on the front panel may be used view individual data words (uncorrected frequencies or voltages). No computer is required to obtain this display.

The CHANNEL SELECT thumbwheel switch on the front panel may be used to select any sensor channel, data buffer status, or other diagnostic indicators for display on the LED (see Section 3-4.2).

The SIGNAL SOURCE switch should be in the FISH position whenever data is to be acquired from the CTD underwater unit. If previously recorded data from an audio recorder is to be played back, this switch should be placed in the TAPE position.

The CARRIER LED lights when the Deck Unit modem detects the signal from the modem in the underwater unit.

The WATER SAMPLER CONTROL pushbutton switches operate the SBE 32 Carousel water sampler and the General Oceanics 1015 and 1016 rosettes. The water sampler type is selected by SW1 (see Section 3-3.8) on the modem PC board. If either the 1015 or the 1016 rosette are selected, the G.O. LED on the front panel lights. If the SBE 32 Carousel is selected, the SBE LED lights.

General Oceanics 1015 Rosette:

The HOME/ARM switch causes the water sampler interface to power the rosette pylon, the green ENABLE LED lights 15 seconds later when the pylon is powered and ready to fire.

The FIRE switch causes the rosette to immediately fire, closing a sample bottle. The red FIRE LED lights if a confirm signal is received from the pylon and remains lit until the rosette is enabled. The FIRE switch is active only when the green HOME/ARM LED is lit. The rosette may also be operated from SEASOFT. When the pylon is fired via software, the red FIRE LED lights for five seconds when a confirm signal is received.

General Oceanics 1016 Rosette:

The HOME/ARM switch causes the arm to move to the HOME position (ready to fire bottle # 1) with an offset specified by SW1 on the modem board. The green LED is lit whenever the rosette sends the code indicating that the arm is at the HOME position.

The FIRE switch causes the rosette to fire the next position, closing a sample bottle. The red FIRE LED lights whenever the rosette sends a valid position code.

When the pylon is fired via software, the red FIRE LED lights for five seconds when a valid position code is received. This occurs after a GO TO POSITION or FIRE NEXT POSITION command is executed by the rosette.

SBE 32 Carousel Water Sampler:

The HOME/ARM switch causes the Carousel to close the bottle at position #1 the next time the FIRE switch is pushed.

The FIRE switch causes the Carousel to fire the next position, closing a sample bottle. The red FIRE LED lights whenever the Carousel sends a confirmation signal.

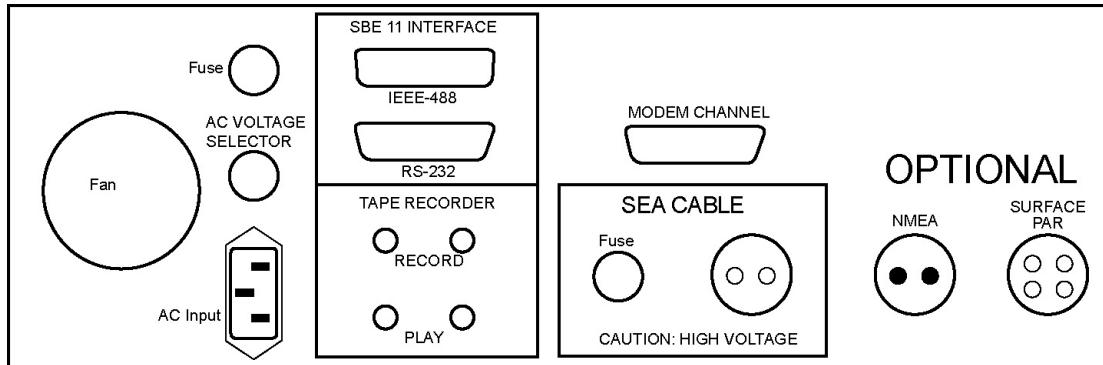
When the Carousel is fired via software, the red FIRE LED lights for five seconds when a valid confirmation code is received. This occurs after a FIRE POSITION N command is executed by the Carousel.

1-3.2 DECK UNIT REAR PANEL

The SBE 11*plus* Deck Unit has rear panel connection for AC power (a separate power cable is supplied), computer I/O (marked IEEE-488, RS-232 and modem channel) and Sea Cable. The sea cable fuse is mounted near the Sea Cable connector, the AC input power fuse is located near the power cable connection.

The SBE 11*plus* Deck Unit can be used with an audio tape recorder or VCR. Connect Deck Unit RECORD to the tape recorder's LINE IN and PLAY to the recorder's LINE OUT. Note that while the Deck Unit has two RECORD and two PLAY jacks, these are internally connected in parallel. This permits a redundant connection to a typical recorder's stereo channels. The stereo connection is not mandatory, however, and error-free recording can be expected even when using the recorder's second channels for voice annotation or other purposes.

Figure 3



2-1 DECK UNIT INSTALLATION

Before installing the Deck Unit in its permanent location aboard ship, follow the preliminary checkout procedures in the SBE 9*plus* manual to confirm that the system is working properly. For this purpose, a test cable (PN 80591) is provided to connect the SBE 9*plus* to the SBE 11*plus* (See SBE 9*plus* manual, Section 2-1.1)

2-1.1 RACK MOUNTING

Detachable rack mount ears are provided for mounting the Deck Unit to standard 19 inch electronics bays. Remove the flat head Phillips screw holding the narrow blue panel located at both front sides of the Deck Unit cabinet and bolt the rack mount ears into place.

2-1.2 SEA CABLE HOOKUP

WARNING! LIFE THREATENING VOLTAGE (+ 250 VOLTS DC) IS PRESENT ON THE SEA CABLE WHEN THE CTD DECK UNIT IS POWERED. MAKE SURE THE DECK UNIT IS DISCONNECTED FROM THE AC POWER SOURCE BEFORE CONNECTING THE SEA CABLE TO THE DECK UNIT. THIS VOLTAGE WILL PERSIST AT LEAST 15 SECONDS AFTER REMOVING POWER. UNPLUG THE AC POWER CORD AND WAIT ONE MINUTE AFTER POWER DOWN BEFORE WORKING ON THE DECK UNIT SEA CABLE CONNECTOR OR WORKING ON THE SEA CABLE CIRCUITS.

A 2-pin MS-style connector (MS3106A-12S-3P, SBE PN 50086) is provided for connecting the sea cable lead wires coming from the winch's slip rings. Connect the wire coming from the sea cable armor to the MS connector pin A. Connect the wire coming from the sea cable insulated (inner) conductor to the MS connector pin B.

FOR SAFETY REASONS, AND FOR MOST RELIABLE PERFORMANCE, SEA-BIRD STRONGLY RECOMMENDS USE OF THE CABLE ARMOR FOR THE CTD POWER/DATA RETURN.

To minimize cable-induced noise, insure that the connection between the sea cable armor and the MS pin A does not touch the ship.

When the CTD Deck Unit power is turned on and the *9plus* is connected to the sea cable, the DATA light should almost immediately come on if the Underwater Unit is properly connected and there are no other problems. A quick run-through of the Preliminary Checkout procedures as described in the SBE *9plus* manual will serve to confirm the functionality of the system.

Procedures for mating the wet end of the sea cable to the CTD underwater unit are described in the SBE *9plus* manual.

2-1.3 SHIPBOARD POWER HOOKUP

Set the AC voltage selector switch to the appropriate voltage (120 or 240). Connect the supplied power cord to the rear panel AC input jack on the Deck Unit and to the appropriate AC power source. The Deck Unit is intended for operation from a properly grounded 3-wire AC outlet. **WARNING - Some oceanographic vessels isolate (unground) the AC power ground circuit. If the SBE 11*plus* Deck Unit is being installed on a vessel with an isolated AC power ground, it is IMPORTANT FOR SAFETY REASONS that a secure separate ground connection be made between the SBE 11*plus* chassis and the ship's hull.**

2-1.4 SHIPBOARD PRELIMINARY CHECKOUT

Mate the wet end of the sea cable to the CTD underwater unit as described in the SBE *9plus* manual. When the CTD Deck Unit power is turned on the DATA light should come on after a few seconds if the underwater unit is properly connected and there are no other problems. If you are using an IBM PC or compatible computer and SEASOFT software, refer to the SEASOFT manual for information on set up for data display and recording.

2-1.5 CONNECTION TO A GPS (or other NAV device) NMEA 0183 INTERFACE

The optional SBE 11*plus* NMEA interface conforms with NMEA 0183 standard protocol and communicates at 4800 baud with 8 data bits, one stop bit, and no parity. The output from your GPS receiver must be set to this protocol for the interface to work.

A 2-pin MS-type connector is used to connect the NMEA interface to a NMEA transmitter. If your Deck Unit included the optional NMEA interface at time of delivery, A test cable (PN 80877) and a MS connector mate for the back panel NMEA connector were provided. The mating connector consists of 3 items; 1 ea PN 17315 MS3106A12S-3S (2-pin cable connector shell and insert), 1 ea PN 17316 MS3057-4A (clamp), and 1 ea PN 17317 rubber cable bushing.

The connections are as follows:

Pin	Function
A	NMEA A (signal)
B	NMEA B (signal return)

Refer to Section 3.3-9 for instructions on selecting which NMEA message to decode.

2-1.6 VERIFYING NMEA 0183 INTERFACE OPERATION

If the SBE 11*plus* is communicating with the data acquisition computer via IEEE-488, LAT/LON data is appended to each CTD scan sent from the Deck Unit to the computer. If the SBE 11*plus* is communicating with the data acquisition computer via RS-232, LAT/LON data is appended to the data stream once per second. The green NEMA LED on the Deck Unit front panel flashes each time a NMEA message is successfully decoded by the Deck Unit. This should be the same rate at which your GPS is transmitting a NMEA message. The Deck Unit appends the same NMEA message multiple times, until a new message is decoded. For example, if a GPS receiver outputs its NMEA 0183 message once every 5 seconds, and the Deck Unit is sending RS-232 serial data to a computer, the NMEA LED flashes every 5 seconds and the same message is appended to the CTD data 5 times before the next NMEA message is decoded.

To verify that the NMEA interface is receiving a valid NMEA message, switch on the NAV device and the 911*plus* CTD, then run the SEASAVE program to acquire real-time data and display the decoded LAT/LON. Set up the display type in SEASAVE as fixed display and select Time, Latitude and Longitude as the display variables. (Refer to the SEASOFT manual for instruction on running SEASAVE). The displayed time, latitude and longitude should be correct.

NOTE: IF THE SELECTED NMEA MESSAGE TO DECODE IS RMC (ONLY), SEASAVE READS THE TIME AND DATE FROM THE NMEA MESSAGE AND SUBSTITUTES IT FOR THE COMPUTER CLOCK TIME AND DATE LOGGED WITH THE CTD DATA. WITH ANY OTHER NMEA MESSAGE (e.g. GGA, GLL, etc.), GPS TIME (typically UTC) IS WRITTEN IN THE DATA FILE HEADER, ONLY AT THE BEGINNING OF DATA ACQUISITION, AND THE COMPUTER'S CLOCK TIME/DATE IS LOGGED WITH THE CTD DATA.

2-1.7 NMEA MESSAGE SIMULATION PROGRAMS

If LAT/LON are not displayed when attempting to verify the NEMA interface, you can check whether the NMEA interface is operating properly by using the GPS simulation programs supplied with the SEASOFT software package. These programs are used to simulate a GPS device transmitting a NMEA message.

FILENAME	NMEA MESSAGE SIMULATED
SNMEARMC.EXE	RMC
SNMEAGGA.EXE	GGA
SNMEAGLL.EXE	GLL

To execute the simulation programs a second computer is needed to emulate the GPS device. A laptop computer is adequate for this purpose. After SEASOFT has been loaded onto the main computer, copy the three executable NMEA programs to a disk and insert it into the computer being used as the GPS simulation device.

Use the NMEA test cable (PN 80877) provided to connect the Deck Unit NMEA interface to an RS-232 port on a the simulation computer. On this computer run the executable file that simulates the NMEA message you have selected in the Deck Unit (Section 3-3.9). If your selected message is not RMC, GGA, or GLL, temporarily change the dip switch setting to one of these and run the simulation program to determine whether the NMEA interface operates properly.

The simulation program transmits a new position every six seconds. The green NMEA light on the Deck Unit front panel flashes each time a message is received. For the RMC global positioning system the data format from the simulation program is as follows:

```
$GPRMC,000906,A,5012.34,N,02056.78,E,0.0,0.0,170593,0.0,W*6D  
LAT 50 12.34 N  
LON 020 56.78 E  
170593 000906
```

For the GGA global positioning system the data format from the simulation program is as follows:

```
$GPGGA,000100,0012.345,N,16056.789,W,1,5,100*48  
LAT 00 12.345 N  
LON 160 56.789 W
```

For the GLL global positioning system the data format from the simulation program is as follows:

```
$GPGLL,0012.345,N,16056.789,E
```

Latitude and longitude displayed by SEASAVE should correspond to that of the GPS simulation program. These programs are just simulations and are not actual data streams from an actual GPS device. Refer to Section 3-4.7 for the NMEA message formats.

If properly decoded data appears on the screen, the NMEA interface is working and the problem is with the wiring from the navigation device to the NMEA interface, or in the navigation device itself. Verify that the signals or functions assigned to each pin of the connector on the interface cable are correct, especially at the navigation device. Refer to the documentation for your particular navigation device.

If the cable is correct make sure that the navigation device is on, and is configured to actually send data. Many GPS receivers have programmable NMEA outputs and may require configuring before they will transmit NMEA messages. Again, refer to the specific GPS receiver's documentation, or contact the GPS manufacture for customer support in this area.

3-1 COMPUTER INTERFACING TO THE SBE 11*plus* DECK UNIT

When Deck Unit power is turned on or the front panel RESET button is pushed the internal switch settings are read and the following default conditions are set automatically:

- The reference frequency for temperature and conductivity frequency channels is 6,912,000 Hz
- The reference frequency for the pressure frequency channel is 27,648,000 Hz
- The number of scans averaged together is 8
- The output buffers are reset and flushed

Changes to these conditions may be made by specifically formatted commands to the Deck Unit's IEEE-488 or RS-232C interface ports (see Section 3-6). Such altered conditions remain in effect until the RESET button is pushed or until power is removed.

If the SEASOFT CTD data acquisition software is to be used, follow the instructions furnished with the software package. It is not necessary to separately implement the commands outlined in sections 3-6 and 3-7, as the software does so automatically.

To facilitate data handling, the SBE 9*plus* CTD Underwater Unit and SBE 11*plus* Deck Unit, like other data processing equipment, cluster individual data bits into groups of various sizes. The following definitions apply in this manual:

- ByteAlways 8 bits. May be serial (as generated in the Underwater Unit) or parallel (the Deck Unit's IEEE-488 output).
- Character (ASCII Character). Data Byte encoded to ASCII standard.
- ChannelPath taken by data deriving from a single sensor (for example, a temperature sensor) or other source (such as the modulo counter).
- WordThis term is used to describe a group of data bits subject to certain arithmetic and display operations by the Deck Unit. Words consist of 3 bytes. A word may comprise a single frequency channel, or two A/D channels. The Modulo Word conveys the modulo count, pump, bottom contact, modem, water sampler interface status bits, and a twelve-bit number representing pressure sensor compensation temperature.
- LSBLeast significant bit
- MSBMost significant bit
- ScanThe set of data derived from a single sample of each of a system's sensors, typically obtained 24 times per second.
- Word NumberThe sequential position of a data word in the Scan. The word number depends on the order in which the word is presented to the computer or displayed, not on the order in which a particular sensor's data was acquired. The first word in the scan is word number zero.

3-2 COMMUNICATING WITH THE SBE 11*plus*

If Sea-Bird SEASOFT software is used, the IEEE-488 address must be set to 1 and the RS-232C parameters should be set to 19200 baud, 8 data bits, no parity, and one stop bit (these are the factory default settings). See Section 3-3 for instructions on how to set the switches. All necessary communications protocols are handled by the software. Follow the menu prompts when running SEASOFT, and read the SEASOFT Installation Instructions supplied with the SEASOFT diskettes.

To verify the Deck Unit internal switch settings, connect the Deck Unit's **serial port** to a terminal or to COM1 on an IBM PC-compatible computer. If you are connected to a PC, run the program TERM11 (included with SEASOFT).

Press the reset button on the SBE 11*plus* front panel. The Deck Unit configuration displays.
A typical example is:

SBE 11 Firmware Version 4.5

GPIB address = 1
underwater unit scan rate = 24 Hz
Paroscientific Digiquartz pressure sensor
number of scans to advance conductivity = 1.75
two 12 bit A/D voltages per word start with word # 5
number of words from the Deck Unit = 12

Note that if there is no response or nonsense characters from the Deck Unit, TERM11 and the Deck Unit may be operating at different baud rates (e.g. Some older PCs (XTs and 286s) are not able to communicate at 19200.). The Deck Unit baud rate is selected via dip switches as discussed in the next section. TERM11's baud rate may be selected by the DOS command line switch -bNNNNN where NNNNN is the desired baud rate. For example, TERM11 -b9600 brings up TERM11 at 9600 baud; TERM11 -b19200 selects 19200 baud. TERM11 can also be configured to run on COM2 with another command line switch, -P. For example, TERM11 -P2 brings up TERM11 communicating on COM2.

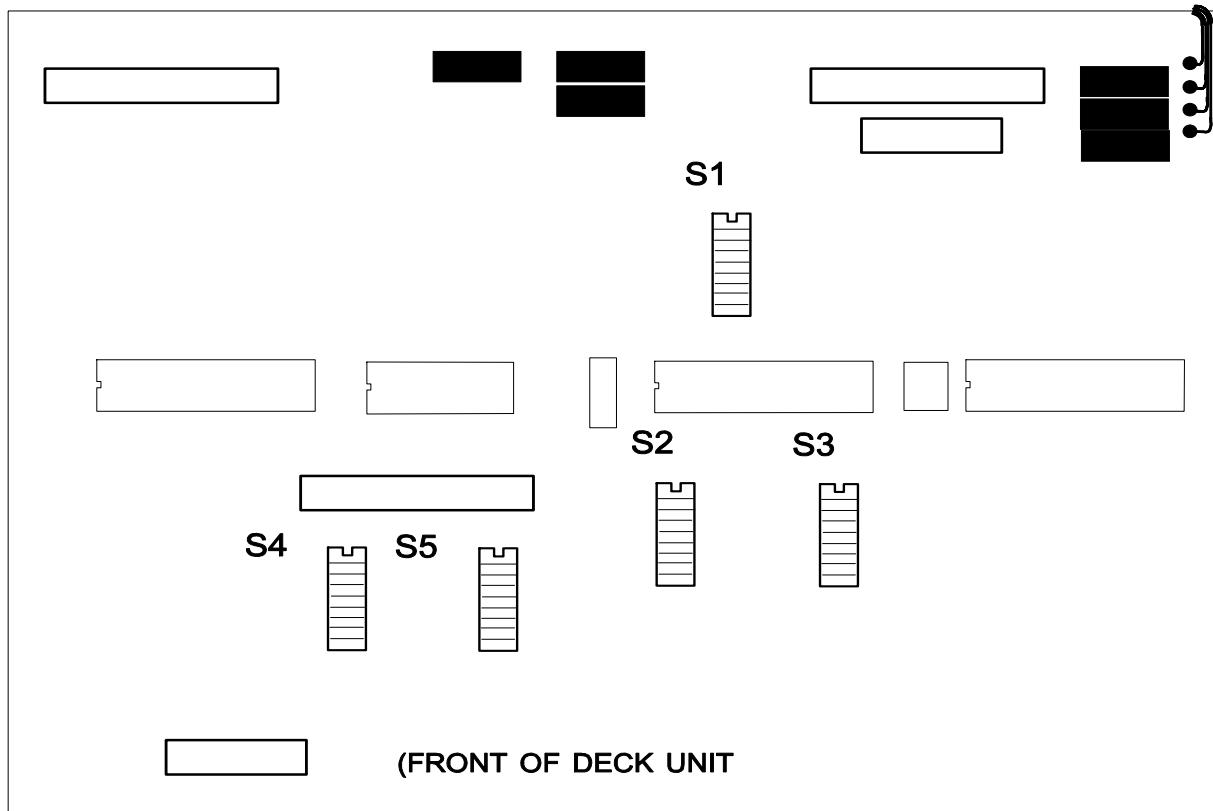
3-3 DECK UNIT INTERNAL SWITCH SETTINGS

The internal switches have been set to factory default settings (shown in **bold type**) in accordance with the 911*plus* operating standards, and other settings necessitated by configuration options installed at time of manufacture. The following describes how to set the switches if the system is reconfigured in the future, and how to adjust the number of scans to advance conductivity (determined after salinity data analysis). Figure 4 shows the location of dip switches on the Deck Unit microprocessor board (next page).

3-3.1 IEEE-488 ADDRESS SELECTION

Figure 2

MICROPROCESSOR BOARD - TOP VIEW,
LOCATION OF DIP SWITCHES S1, S2, S3, S4, S5



The Deck Unit is shipped with the IEEE-488 address set at 1. The address can be changed with DIP switch S3, which can be accessed by removing the top panel of the Deck Unit (see Section 6-1 for Deck Unit disassembly instructions). The first 5 switch positions determine the address, position 5 being the most significant and position 1 being the least significant (OFF = 1, ON = 0, X = don't care).

Example: Address = 1

S3 SWITCH POSITION				
1	2	3	4	5
OFF	ON	ON	ON	ON

3-3.2 RS-232C PARAMETERS

Switch S1 is used to select the following parameters:

Baud Rate (300 to **19,200** baud), Data Bits (word length should be set to 7 or **8** bits for ASCII; 8 bits for binary data), Parity (even, odd, or **none**) and Stop Bits (**1** or **2**)

Baud Rate: Switch Positions 1, 2, & 3 (OFF = open, ON = closed, X = don't care)

S1 SWITCH POSITION								
BAUD RATE		1	2	3				
19200		ON	ON	ON				
9600		OFF	ON	ON				
4800		ON	OFF	ON				
2400		OFF	OFF	ON				
1200		ON	ON	OFF				
600		OFF	ON	OFF				
300		ON	OFF	OFF				
DATA BITS	PARITY	STOP BITS	4	5	6	7	8	
7	ODD	1		ON	ON	OFF	ON	ON
7	ODD	2		ON	OFF	OFF	ON	ON
7	EVEN	1		ON	ON	OFF	ON	OFF
7	EVEN	2		ON	OFF	OFF	ON	OFF
7	NONE	1		OFF	ON	OFF	ON	X
7	NONE	2		OFF	OFF	OFF	ON	X
8	ODD	1		ON	ON	OFF	OFF	ON
8	ODD	2		ON	OFF	OFF	OFF	ON
8	EVEN	1		ON	ON	OFF	OFF	OFF
8	EVEN	2		ON	OFF	OFF	OFF	OFF
8	NONE	1		OFF	ON	OFF	OFF	X
8	NONE	2		OFF	OFF	OFF	OFF	X

3-3.3 SCAN RATE/DATA CHANNEL DIP SWITCH SETTINGS

Switch S2 must be set corresponding to the number of data channels and the scan rate used in the Underwater Unit (12 channels, 24 scans/second). The correct switch settings for the 911*plus* system are:

SCAN RATE (Hz)	DATA WORDS (No.)	S2 SWITCH POSITIONS							
		1	2	3	4	5	6	7	8
24	12	ON	OFF	OFF	ON	ON	ON	OFF	ON

3-3.4 ADD EXTERNAL VOLTAGE (Surface PAR)

If the optional A/D converter has been added to the SBE 11*plus* Deck Unit to merge surface PAR (SPAR) with the CTD data stream, **S3 position 8 is OFF**, otherwise S3 position 8 should be set ON.

3-3.5 SELECT PRESSURE TYPE

Pressure sensor type is set with S3 positions 6 and 7. Earlier versions of the SBE 9 had other pressure sensor choices, however all SBE 9plus CTDs have high resolution Digiquartz pressure sensors.

Pressure Sensor	S3 SWITCH POSITION	
	6	7
<i>Paroscientific Digiquartz, high resolution</i>	<i>OFF</i>	<i>ON</i>

3-3.6 SET CONDUCTIVITY ADVANCE

Because the TC Duct presents water to the conductivity sensor after it has passed the temperature sensor, the conductivity measurement on a given water parcel is delayed in time. Because the pump sets a constant flow speed, the delay is constant. To nullify the delay so that salinity may be computed with minimum spiking, the Deck Unit is normally set to advance the conductivity measurement in time to coordinate it with the appropriate temperature measurement. Note that this time alignment occurs **before** averaging (if chosen) so that a bias error is not introduced into the calculated salinity. For most applications the correct setting is 1.75 scans corresponding to a time-advance of 0.073 seconds ($1.75 * 1/24$). Note that users archiving full rate (24 Hz) data retain the option of post-acquisition correction of any residual time misalignment.

CTD systems having atypical flow paths, for example when supporting flow-through fluorometers, may require slightly different settings. Step-by-step instructions for calculating the optimal conductivity advance value can be found in Section 3 of *The Temperature and Conductivity Duct: Installation, Use, and Data Processing Steps*.

Fractional scans are set with S4 switch positions 1 - 3. Integer scans are set with S4 switch positions 4 - 6. The number of scans conductivity is advanced is the number of integer scans plus the number of fractional scans. Switch positions 7 and 8 are for factory use only. Position 7 should be left in the OFF setting, position 8 should be left in the ON setting.

S4 SWITCH SETTINGS

Conductivity Advance

Fractional Scans	1	2	3
0.125	OFF	ON	ON
0.250	ON	OFF	ON
0.375	OFF	OFF	ON
0.500	ON	ON	OFF
0.625	OFF	ON	OFF
0.750	ON	OFF	OFF
0.875	OFF	OFF	OFF

Conductivity Advance

Integer Scans	4	5	6
0	ON	ON	ON
1	OFF	ON	ON
2	ON	OFF	ON
3	OFF	OFF	ON
4	ON	ON	OFF
5	OFF	ON	OFF
6	ON	OFF	OFF

3-3.7 SELECT DATA CHANNEL TYPE

The data channel types assigned to each word number (ref. Section 3-1) are set with S5. Data channel types are:

FREQUENCY: Data is converted to frequency per the description in Section 3-4.3. If averaging is employed, the frequencies are averaged.

A/D VOLTAGES: Data is treated as two 12 bit channels. If averaging is employed, the individual 12 bit numbers are separately averaged.

BINARY BIT: Data in binary bits is passed directly from the Underwater Unit with no averaging by the Deck Unit (primarily factory diagnostic applications).

Positions 1 - 4 set the word number where A/D VOLTAGE data begins. Positions 5 - 8 set the word number where BINARY BIT data begins. Words 0 - 4 are set to FREQUENCY. **THESE SETTINGS SHOULD NOT BE CHANGED BY THE USER. They are typically useful for factory diagnostic purposes only.**

A/D Voltages, BEGINNING WORD		S5 SWITCH POSITIONS			
		1	2	3	4
	NONE	ON	ON	ON	ON
1		OFF	ON	ON	ON
2		ON	OFF	ON	ON
3		OFF	OFF	ON	ON
4		ON	ON	OFF	ON
5		OFF	ON	OFF	ON
6		ON	OFF	OFF	ON
7		OFF	OFF	OFF	ON
8		ON	ON	ON	OFF

Binary Bit, BEGINNING WORD		S5 SWITCH POSITIONS			
		5	6	7	8
	NONE	ON	ON	ON	ON
1		OFF	ON	ON	ON
2		ON	OFF	ON	ON
3		OFF	OFF	ON	ON
4		ON	ON	OFF	ON
5		OFF	ON	OFF	ON
6		ON	OFF	OFF	ON
7		OFF	OFF	OFF	ON
8		ON	ON	ON	OFF

3-3.8 SELECT WATER SAMPLER TYPE

Water Sampler type is selected with SW1 positions 1 - 4 on the modem PC board.

Water Sampler Type	SW1 SWITCH POSITION			
	1	2	3	4
SBE 32 Carousel	ON	ON	ON	
GO 1015 rosette	OFF	ON	ON	
GO 1016 rosette	ON	OFF	ON	

Arm offset for the GO 1016 is set with SW1 positions 5 - 8 on the modem PC board.

Arm Offset (degrees)	SW1 SWITCH POSITION			
	5	6	7	8
-2.8	ON	ON	ON	ON
-2.4	OFF	ON	ON	ON
-2.0	ON	OFF	ON	ON
-1.6	OFF	OFF	ON	ON
-1.2	ON	ON	OFF	ON
-0.8	OFF	ON	OFF	ON
-0.4	ON	OFF	OFF	ON
0.0	OFF	OFF	OFF	ON
				<i>(nominal)</i>
0.4	ON	ON	ON	OFF
0.8	OFF	ON	ON	OFF
1.2	ON	OFF	ON	OFF
1.6	OFF	OFF	ON	OFF
2.0	ON	ON	OFF	OFF
2.4	OFF	ON	OFF	OFF
2.8	ON	OFF	OFF	OFF
3.2	OFF	OFF	OFF	OFF

3-3.9 SELECT NMEA MESSAGE TO DECODE

The NMEA message to decode and diagnostic level are selected by the DIP switch (S1) on the optional NMEA interface board.

Switch Positions 1-4				Message to decode
1	2	3	4	
ON	ON	ON	ON	GGA
OFF	ON	ON	ON	GLL
ON	OFF	ON	ON	RMA
OFF	OFF	ON	ON	RMC <i>(factory default)</i>
ON	ON	OFF	ON	TRF

Switch Positions 5-6		Diagnostics
5	6	
ON	ON	<i>disabled (factory default)</i>
OFF	ON	enable level 1
ON	OFF	enable level 2
OFF	OFF	enable levels 1 and 2

level 1 diagnostics:	echo received NMEA string to U17 pin 19
level 2 diagnostics:	echo decoded Lat/Lon/Time data to U17 pin 19

NOTE: In order to observe the diagnostics on a computer, it is necessary to convert the 0-5 volt logic level signal at U17 pin 19 to an RS-232 level signal.

3-4 DATA FORMATS

The formats in this section are those associated with the Deck Unit's output ports and display and are not to be confused with the (different) format output by the CTD underwater unit.

These outputs are user configurable with regard to the number of frequency channels and A/D channels sent to and stored by the host computer. The SBE 9*plus* is defined as a 12 word system. For applications that do not require all 5 of the frequency channels and all 8 of the A/D channels, the unused channels may be suppressed. This can result in a substantial saving in the disk space required to store CTD data. Channel suppression is selected via the program SEACON, refer to the SEASOFT manual for a discussion of this procedure. The following paragraphs consider an SBE 11*plus* set to utilize all 5 frequency channels and all 8 A/D channels.

3-4.1 DATA WORD DESIGNATION

The Deck Unit data words (each containing three bytes) are assigned as follows:

Word 0:	Primary Temperature
Word 1:	Primary Conductivity
Word 2:	Pressure
Word 3:	Secondary Temperature
Word 4:	Secondary Conductivity
Word 5:	A/D channels 0-1
Word 6:	A/D channels 2-3
Word 7:	A/D channels 4-5
Word 8:	A/D channels 6-7
Word 9:	unused
Word 10:	unused and marker byte (thumbwheel switch position A)
Word 11:	Modulo Count, Underwater Unit status bits, and Pressure Temperature Compensation (thumbwheel switch position B)

These word numbers indicate the order of the data scan sent to a computer via the IEEE-488 or RS-232 port, they are used with some of the special commands described in Section 3-6. Words 0 through 11 correspond to the settings (0,1,2,3,4,5,6,7,8,9,A,B) of the thumbwheel switch. The next section discusses available data on the Deck Unit front panel. Suppressed channels are set to zero on the front panel display.

3-4.2 DATA WORD FRONT PANEL DISPLAY

Any data word may be selected for display by the thumbwheel switch on the SBE 11*plus* front panel. This display is updated approximately every second if the number of scans to average in the Deck Unit has been set to one. For other averaging rates the display is updated each time a set of scans is averaged.

Data words for each frequency channel (switch positions 0,1,2,3,4) are displayed directly in Hz. Each data word for auxiliary A/D channels (switch positions 5,6,7,8) contains information from 2 A/D voltage channels (voltages 0-7, representing dissolved oxygen, fluorometer, etc.). The first 4 digits (reading left to right) correspond to the lower numbered voltage present (e.g V0) in the selected data word, the second 4 digits correspond to the next numbered voltage (e.g. V1). These voltages are displayed as the decimal values of the 12 bit numbers associated with each channel. These are binary representations of analog voltages, with zero volts input giving a readout of 4095, and 5 volts input giving a readout of 0. The explicit interpretation of displayed values is described in Section 3-5.

Switch position 9 is unused, and position A displays 255 (a marker byte). The modulo count and pressure sensor temperature compensation information are observed by selecting position B for display. The four digits left of the decimal point show the temperature compensation value (a reading of 2500 corresponding to about 22 degrees would be typical). The right four digits show the incrementing modulo count.

The SBE 11*plus* places data to be transmitted to the companion computer into a buffer; this allows the Deck Unit and computer to operate with some independence. If the thumbwheel switch is set to C, the number of bytes available in the IEEE-488 buffer is displayed. If the thumbwheel switch is set D, the number of bytes in the RS-232C buffer is displayed.

When transferring data to a computer, the Deck Unit places data in the buffer at the rate it is acquired. The data is removed (transferred to the computer) as it is requested by the computer. If the computer spends too much time calculating and displaying the data, it may start to fall behind and the number of available bytes decreases. When the number of available bytes is less than an entire scan, the buffer overflow light latches on and stays on until a reset command is received or the Deck Unit is reset.

Thumbwheel switch position E displays the underwater unit status bits. The first bit, right most on the display, is the pump indicator. It is set to one (1) when the pump is on and zero (0) when the pump is off. The second bit, second from the right on the display, goes to zero when the bottom contact switch is closed, normally it is set to 0. The third bit, second from the left on the display is the water sampler interface confirm signal, it is set when the interface board detects a confirm signal from the pylon. The fourth bit, left most on the display is the SBE 9*plus* modem carrier detect bit. It is zero when the SBE 9*plus* modem detects the SBE 11*plus* modem's carrier signal, one when no carrier is detected.

If the SBE 11*plus* is configured with the optional surface PAR A/D input channel, the voltage from the PAR sensor is inserted by the Deck Unit after the marker byte causing surface PAR data to be displayed in position B. Necessarily, the modulo count and pressure sensor temperature compensation information are moved to C, the IEE-4888 and RS-232 buffers move to D and E, and the status bits are displayed on position F.

3-4.3 IEEE-488 OUTPUT DATA FORMAT

The listing which follows is standard and represent normal conditions subsequent to turn-on or reset of the Deck Unit. As a means of reducing disk storage space requirements, the SBE 11*plus* provides the option of suppressing unused data channels from the data stream. For instance, if only primary temperature and conductivity channels are being used then the secondary channels may be stripped from the data stream. Similarly, if all A/D channels are not being used, the unused channels may be stripped out as well. If data channels are suppressed, the listing below is shortened. Channel numbers are suppressed from the last to the first. Section 3-7.5 and 3-7.6 discuss the pertinent SBE 11*plus* commands, the instrument configuration program SEACON may be set so that SEASAVE automatically programs the SBE 11*plus* to delete unused data channels. In addition, because words 9 and 10 are always unused, SEASAVE automatically strips these from the data stream.

The specific data output sequence provided with this CTD system is provided on the SYSTEM CONFIGURATION SHEET at the front of this manual.

The last word ALWAYS contains the Digiquartz temperature compensation data, a byte of zeros, and the modulo N count, and the end or identify (EOI) line is ALWAYS asserted with the last byte. The data are output in the following order for a system supporting pressure, primary and secondary temperature and conductivity, 8 A/D channels, and Surface PAR: (note: MSB = most significant bit, LSB = least significant bit)

BYTE 0	Word 0	Primary Temperature
BYTE 1	Word 0	Primary Temperature
BYTE 2	Word 0	Primary Temperature
BYTE 3	Word 1	Primary Conductivity
BYTE 4	Word 1	Primary Conductivity
BYTE 5	Word 1	Primary Conductivity
BYTE 6	Word 2	Pressure
BYTE 7	Word 2	Pressure
BYTE 8	Word 2	Pressure
BYTE 9	Word 3	Secondary Temperature
BYTE 10	Word 3	Secondary Temperature
BYTE 11	Word 3	Secondary Temperature

BYTE 13	Word 4	Secondary Conductivity
BYTE 14	Word 4	Secondary Conductivity
BYTE 15	Word 5	A/D Channel 0 (8 MSBs)
BYTE 16	Word 5	A/D Channel 0 (4 LSBs 4-7) A/D Channel 1 (4 MSBs 0-3)
BYTE 17	Word 5	A/D Channel 1 (8 LSBs)
BYTE 18	Word 6	A/D Channel 2 (8 MSBs)
BYTE 19	Word 6	A/D Channel 2 (4 LSBs 4-7) A/D Channel 3 (4 MSBs 0-3)
BYTE 20	Word 6	A/D Channel 3 (8 LSBs)
BYTE 21	Word 7	A/D Channel 4 (8 MSBs)
BYTE 22	Word 7	A/D Channel 4 (4 LSBs 4-7) A/D Channel 5 (4 MSBs 0-3)
BYTE 23	Word 7	A/D Channel 5 (8 LSBs)
BYTE 24	Word 8	A/D Channel 6 (8 MSBs)
BYTE 25	Word 8	A/D Channel 6 (4 LSBs 4-7) A/D Channel 7 (4 MSBs 0-3)
BYTE 26	Word 8	A/D Channel 7 (8 LSBs)
BYTE 27	Word 9	unused
BYTE 28	Word 9	unused
BYTE 29	Word 9	unused
BYTE 30	Word 10	unused
BYTE 31	Word 10	unused
BYTE 32	Word 10	Marker byte (all ones)

with Surface PAR option:

BYTE 33	Word 11	(unused)
BYTE 34	Word 11(first 4 bits unused)	SPAR Channel (4 MSBs 0-3)
BYTE 35	Word 11	SPAR Channel (8 LSBs)
BYTE 36	Word 12	Pressure Sensor Temperature MSBs
BYTE 37	Word 124	LSB = CTD status, 4 MSB = pressure sensor temperature LSBs
BYTE 38	Word 12	Modulo count (EOI line asserted)

or without Surface PAR option:

BYTE 33	Word 11	Pressure Sensor Temperature MSBs
BYTE 34	Word 114	LSB = CTD status, 4 MSB = pressure sensor temperature LSBs
BYTE 35	Word 11	Modulo count (EOI line asserted)

Thus there are 12 (or optionally 13) words per scan * 3 bytes per word = 36 bytes per scan. Note that a CTD-only format (secondary temperature and conductivity and analog channels suppressed) would result in the following 18 byte format:

BYTE 0	Word 0	Primary Temperature
BYTE 1	Word 0	Primary Temperature
BYTE 2	Word 0	Primary Temperature
BYTE 3	Word 1	Primary Conductivity
BYTE 4	Word 1	Primary Conductivity
BYTE 5	Word 1	Primary Conductivity
BYTE 6	Word 2	Pressure
BYTE 7	Word 2	Pressure
BYTE 8	Word 2	Pressure
BYTE 9	Word 3	unused
BYTE 10	Word 3	unused
BYTE 11	Word 3	unused
BYTE 12	Word 4	unused
BYTE 13	Word 4	unused
BYTE 14	Word 4	Marker byte (all ones)
BYTE 15	Word 5	Pressure Sensor Temperature MSBs
BYTE 16	Word 5	4 LSB = CTD status, 4 MSB = pressure sensor temperature LSBs
BYTE 17	Word 5	Modulo count (EOI line asserted)

3-4.4 RS-232C OUTPUT DATA FORMAT

RS-232C output may be in binary or ASCII form. Binary requires half as many bytes for transmission, but provides no unique characters to tell the computer when a data scan begins and ends. With binary data, software routines use the modulo character to obtain synchronization. ASCII transmission uses [CR][LF] characters to tag the data thereby precluding the need for software synchronization.

3-4.5 BINARY ENCODED

This format is the same as the IEEE-488 format in Section 3-4.3 (without the EOI line). There are 36 bytes per scan. Note that suppressing data channels reduces this byte count.

3-4.6 ASCII ENCODED

The format is the same as described in Section 3-4.3 except:

- A. Each byte is sent as two ASCII encoded characters. The first character is the hexadecimal representation of the most significant 4 bits; the second character is the hexadecimal representation of the least significant 4 bits.

For example, the byte with a value of 42 (base 10) or 2A (hexadecimal) would be sent as:

first character: 32 [ASCII for 2]
second character: 41 [ASCII for A]

- B. The two characters representing the modulo N count are preceded by 2 pressure sensor temperature characters and 2 zero characters. The modulo characters are followed by a carriage return character (0D, base 16), and then a line feed character (0A, base 16). Thus there are (NWORDS * 3 * 2 + 2) ASCII characters per scan. For a 12-Word system, there are 74 characters per scan.

3-4.7 NMEA LAT/LON DATA

For IEEE-488 data, seven bytes are appended to each scan of CTD data.

For RS-232C data 14 ASCII characters followed by a carriage return and line feed are sent once per second.

The format is:

Latitude (deg) = (byte 1 * 65536 + byte 2 * 256 + byte 3) / 50000
Longitude (deg) = (byte 4 * 65536 + byte 5 * 256 + byte 6) / 50000
If bit 1 in byte 7 is 1 this is a new position.
If bit 8 in byte 7 is 1 Latitude is negative.
If bit 7 in byte 7 is 1 Longitude is negative.

North latitudes are positive, south latitudes are negative.

East longitudes are positive, west longitudes are negative.

Example:

APPENDED DATA = 2455FC5D32B141

byte 1 = 24 hex = 36 decimal
byte 2 = 55 hex = 85 decimal
byte 3 = FC hex = 252 decimal
byte 4 = 5D hex = 93 decimal
byte 5 = 32 hex = 50 decimal
byte 6 = B1 hex = 177 decimal
byte 7 = 41 hex = 01000001 binary

Latitude = (36 * 65536 + 85 * 256 + 252) / 50000 = 47.62616 degrees
Longitude = (93 * 65536 + 50 * 256 + 177) / 50000 = -122.1565 degrees
Longitude is negative (bit 7 in byte 7 is 1).
This is a new position (bit 1 in byte 7 is 1).

3-4.8 FREQUENCY DATA CONVERSION

The primary frequencies representing Temperature (F_T) Conductivity (F_C) and Pressure (F_P) may be derived as follows:

$$F_T = \text{BYTE}(0) * 256 + \text{BYTE}(1) + \text{BYTE}(2) / 256$$

$$F_C = \text{BYTE}(3) * 256 + \text{BYTE}(4) + \text{BYTE}(5) / 256$$

$$F_P = \text{BYTE}(6) * 256 + \text{BYTE}(7) + \text{BYTE}(8) / 256$$

Conversion of frequency and A/D voltage information to engineering units is described in Section 3-5 below.

3-5 CONVERSION OF DATA TO ENGINEERING UNITS

The relationships listed below must be evaluated by the computer used to acquire, display, and store CTD data. They are as used within SEASOFT.

3-5.1 TEMPERATURE

Determine the sensor frequency per 3-4.8. Then

$$T = \frac{1}{g + h \ln(f_0 / F_0) + i \ln^2(f_0 / F_0) + j \ln^3(f_0 / F_0)} - 273.15 \quad ^\circ C$$

Where:

g, h, i, j , & f_0 are coefficients listed on the sensor calibration data sheet. F is the sensor frequency in Hz.

3-5.2 CONDUCTIVITY

Determine the sensor frequency per 3-4.8. Then

$$C = \frac{g + h f^2 + i f^3 + j f^4}{10(1 + \delta t + \varepsilon p)} \quad Siemens/meter$$

Where:

g, h, i, j are coefficients listed on the sensor calibration data sheet, t is ambient temperature as derived in 3-5.1, and p is pressure in decibars (dBar). δ ($CTcor = 3.25e-6$) and ε ($CPcor = -9.57e-8$) are the nominal conductivity cell coefficients of thermal expansion and pressure compressibility. **Note that for reasons of computation efficiency, F is the sensor frequency in kHz.**

3-5.3 PRESSURE

Determine the sensor frequency per 3-4.8. Then

$$P = 6894.759C \{1 - (T_0 F / 10^6)^2\} * (1 - [D \{1 - (T_0 F / 10^6)^2\}]) \quad Pascals$$

Where:

C, D , & T_0 are coefficients listed on the pressure sensor calibration data sheet. F is the sensor frequency in Hz. T_0 is in μs . Note that C & T_0 are functions of the temperature within the Digiquartz sensor, T_D (see Section 3-5.4), and are determined by the equations below:

$$C(T_D) = C_1 + C_2 T_D + C_3 T_D^2$$

$$T_0(T_D) = T_{01} + T_{02} T_D + T_{03} T_D^2 + T_{04} T_D^3$$

Where:

C_1, C_2, C_3 and $T_{01}, T_{02}, T_{03}, T_{04}$ are coefficients listed on the pressure sensor calibration sheet and T_D is determined via the equations below.

3-5.4 PRESSURE TEMPERATURE COMPENSATION

$$T_D = M * (12 \text{ bit pressure temperature compensation word}) - B \quad ^\circ C$$

The pressure temperature compensation word (12 MSBs of Modulo Word) has a decimal value between 0 and 4095. For example, if the pressure temperature compensation word has a binary value of 101010000001, the decimal equivalent is 2689. For this value and assuming the nominal values of M and B (0.01258 and -9.844; see SBE 9*plus* Configuration Sheet for exact values),

BYTE 33 (8 MSBs) 10101000 & BYTE 34 (4 MSBs) 0001XXXX (X=don't care) is 101010000001 binary or 2689 decimal.

$$T_D = 0.1258 * 2689 - 9.844 = 23.98 \text{ } ^\circ C$$

It is recommended that pressure temperature be computed using a backward-looking 30 second running average in order to prevent bit transitions in pressure temperature from causing small jumps in computed pressure. Because the heavily insulated pressure sensor has a thermal time constant on the order of one hour, the 30 second average does not significantly alter the computed pressure temperature.

3-5.5 MODULO COUNT

The Modulo Count is an 8 bit number generated by the underwater unit which increments one count for each scan. If the Deck Unit averages data, the modulo count output from the Deck Unit increments by the number of scans averaged. It is used to provide a check on system data integrity.

3-5.6 CTD STATUS BITS

The 4 least significant bits of byte 34 are CTD status bits. These bits are displayed with the Deck Unit thumbwheel switch set to E. The first bit, right most on the display, is the pump indicator. It is set to 1 (one) when the pump is on and 0 (zero) when the pump is off. The second bit, second from the right on the display, goes to zero when the bottom contact switch is closed, normally it is set. The third bit, second from the left on the display is the water sampler interface confirm signal, it is set when the interface board detects a confirm signal from the pylon. The fourth bit, left most on the display is the SBE 9*plus* modem carrier detect bit. It is zero when the SBE 9*plus* modem detects the SBE 11*plus* modem's carrier signal, one when no carrier is detected.

3-5.7 9plus A/D VOLTAGES AND OPTIONAL SURFACE PAR CHANNEL (SPAR)

Each A/D data channel is stored as a 12 bit binary number. To compute the voltage for a particular channel, convert the 12 bit number to its decimal equivalent, N. (see section 3-4.3 for the location of the bits within the data stream)

Then for a 0 to 5 volt input range:

$$V = 5 [1 - (N / 4095)] \text{ Volts}$$

As an example, consider the data format in Section 3-4.3. Determination of voltages measured in channel 0 would be as follows (the binary values assigned to the bytes are entirely arbitrary and are for purpose of example only):

Byte 15: 00110111 Byte 16: 01001111 Byte 17: 10101010

Byte 15 comprises the most significant digits of N, and the four most significant bits of Byte 16 are the LSBs of N. Accordingly, N may be written in binary as:

$$N_{\text{base } 2} = 001101110100$$

in decimal form:

$$N_{\text{base } 10} = 884 \quad V = 5 [1 - (884 / 4095)] = 3.921 \text{ Volts}$$

3-5.8 DISSOLVED OXYGEN

Voltages proportional to dissolved oxygen sensor current (I) and membrane temperature (T) are digitized by the A/D converter and may be derived per Section 3-5.7 above.

$$I = mV_0 + b \quad \mu A$$

Where:

V_0 is the voltage in A/D channel 0 per Word 5 and m and b are constants given on the Dissolved Oxygen Sensor Calibration Sheet. Typical values for m and b are 4×10^{-7} and 10^9 respectively with I taking values between 0 and 2 μA for V_0 in the range 0 to +5 volts.

$$T = kV_1 + c \quad ^\circ C$$

Where:

V_1 is the voltage in A/D channel 1 per Word 5 and k and c are constants given on the Dissolved Oxygen Sensor Calibration Sheet. Typical values for k and c are 4 and 15 respectively with T taking values between -5 and +35 $^\circ C$ or V_1 in the range 0 to +5 volts.

3-6 COMPUTER COMMANDS AND COMMAND FORMAT

Commands necessary for routine use of this system are described in the sections immediately following. Other commands, which may be useful in special cases, are described in Section 3-7.

WHEN USING SEA-BIRD SOFTWARE, ALL NECESSARY COMMANDS ARE AUTOMATICALLY SENT TO THE DECK UNIT. SEE SOFTWARE INSTALLATION INSTRUCTIONS SUPPLIED WITH THE SEASOFT DISKETTES FOR COMPLETE INFORMATION.

Upon receipt of the commands listed below, the Deck Unit executes the functions indicated. All commands remain in effect until the RESET button is pushed or new commands are sent. Set up commands, if any, only have to be sent once, not for each scan.

All commands and data sent to the Deck Unit must be sent as ASCII characters. The general format is: COMMAND; DATA; FILLER; LINE FEED.

COMMAND is a one line character identifier

DATA is an ASCII string corresponding to the integer number required for the command.

FILLER is not required -- it consists of ASCII characters less than 48 decimal, such as '' (a space), which may be generated automatically by your computer.

LINE FEED is the ASCII character for LINE FEED. The value is 10 decimal or 0A hexadecimal. This character terminates all commands. The command string must be less than 80 characters long.

3-6.1 SET RS-232C OUTPUT DATA FORMAT: TX

If X = A the data are sent in hexadecimal ASCII format. A carriage return and line feed are sent at the end of each scan. This is the default setting.

If X = B the data are sent in binary form (see Section 3-4.5 for output data format).

3-6.2 RESET DATA BUFFERS: R

Reset and flush buffers; do not put data into buffers; leave all other parameters the same. Any command except START COLLECTING DATA, OVERRIDE DATA WORD DISPLAY, SET THUMBWHEEL SWITCH and STOP causes an automatic execution of RESET BUFFERS, since otherwise the first output data after the command would not reflect the new format. Thus, every command sequence must be ended with the command START COLLECTING DATA to resume the data output stream.

3-6.3 START COLLECTING DATA: GX

Deck Unit begins putting data into its output buffers at a rate determined by how many scans are averaged. X designates which buffer(s) are used.

If X = I data is put into the IEEE-488 buffer.

If X = R data is put into the RS-232C buffer.

If X = B data is put into both buffers.

The user's computer obtains this data by exercising the appropriate bus protocol.

3-6.4 CHANGE THE NUMBER OF SCANS TO AVERAGE: AXX

XX is the number of scans averaged by the Deck Unit; XX must be between 1 and 50:

3-6.5 STOP PLACING DATA INTO BUFFERS: S

Deck Unit stops putting data into buffers.

3-6.6 NMEA STANDARD 0183 INTERFACE COMMANDS

- NY** add 7 bytes of Lat/Lon to the CTD data
- NN** do not add Lat/Lon data (default)
- NS** send Lat/Lon/Time ASCII data

3-7 SPECIAL COMPUTER COMMANDS

The commands listed in this section are not required for routine use of the CTD system, but may be useful in certain diagnostic or maintenance modes, or where the CTD Underwater Unit has been adapted to other operating configurations. See Section 3-6 for a description of command formats.

3-7.1 ADJUST THE REFERENCE FREQUENCY: FX

X = reference frequency in Hz.

Example: F6912002 Sets reference frequency to 6,912,002 Hz

Note: The reference frequency is determined by the crystal oscillator in the Underwater Unit, and is initially adjusted to 6,912,000 Hz. The Deck Unit defaults to this value on power-up or if the RESET button is pressed. If the crystal frequency changes because of aging (or for any other reason), this command may be used to compensate the change. In the case of the example, the command has been used because the crystal frequency has been determined to have changed to 6,912,002 Hz.

3-7.2 DIVIDE THE REFERENCE FREQUENCY: CNX

N = word number 0 to 9

X = the integer value by which the regular frequency is to be divided for use in this channel.

Example: C24 sets reference frequency for channel 2 as the regular reference frequency (per FX command or default) divided by 4.

This command may be used more than once to place different reference frequencies in the word assignments associated with several channels. Note that the command must be compatible with the hard-wired configuration of the Underwater Unit.

The CNX command would be used to acquire information from sensors generating low-frequency outputs where the normal reference frequency would cause overflow in the hybrid counting process.

3-7.3 MULTIPLY THE REFERENCE FREQUENCY: MNX

This command works analogously to the CNX command. It should be used if a high-resolution channel has been installed in the Underwater Unit, e.g., a 27,648,000 Hz crystal oscillator for improved pressure resolution, and is automatically implemented if the pressure sensor type has been set to Paroscientific DigiQuartz, high resolution by DIP switch S3 or if the high-resolution pressure entry has been chosen when running SEACON.

3-7.4 SELECT DATA CHANNEL TYPE: DNX

The data channel type default settings are determined by switch S5 and are automatically loaded on power-up. These default settings can be temporarily changed with the DNX command. N = word number. X = data type.

If X = 0, data type is frequency. Data in word N is converted to frequency per the description in Section 3-4.8. If averaging is employed, the frequencies are averaged.

If X = 2, data type is A/D. Data in word N is treated as two 12 bit channels. If averaging is employed, the individual 12 bit numbers are separately averaged.

If X = 3, data type is BINARY BIT. Data in word N is passed directly from the Underwater Unit in 24 bits. If averaging is employed in the Deck Unit, words with data channel type set to BINARY BIT are subsampled, not averaged by the Deck Unit (even if the Deck Unit is set to average scans).

3-7.5 SUPPRESS DATA WORD: XN

N = word number to be suppressed (in hexadecimal).

Data channels may be deleted from the data stream that is transferred to the host computer with the suppress data word command. Note that in the case of frequency channels a word corresponds to one channel, for A/D channels a word contains 2 channels. This command is useful in reducing the size of a data scan and hence the amount of disk space required to store CTD data. When using SEASOFT programs, data words are suppressed through settings in software (SEACON) and the proper XN command is sent automatically.

3-7.6 UNSUPPRESS ALL DATA WORDS: U

All data words are restored to the data stream with the U command. Send this command once before sending any XN commands.

4-1 FUNCTIONAL DESCRIPTION OF SBE 11*plus*

4-1.1 DECK UNIT DATA INTERFACES

The SBE 11*plus* is supplied with both IEEE-488 (parallel) and RS-232C (serial) interfaces. Data output and control commands can be sent via either interface. To successfully transmit full rate (24 Hz) data with all channels active, the RS-232C interface must be set to 19200 baud or the parallel interface must be used. With minimum data channels active (4 words) and a reasonably fast computer (i.e. 80386 processor), 24 Hz data acquisition may be accomplished at lower baud rates. Memory buffers at the output ports prevent loss of data when the computer is temporarily occupied by other tasks (Buffer size = 20500 bytes for IEEE-488, 8000 bytes for RS-232C). The RS-232C interface outputs ASCII characters or binary data according to the command used to begin data acquisition (see Section 3-6).

The optional modem interface, provides a bi-directional serial communication link with the underwater unit that is independent of the telemetry channel. This link may be used to control a water sampler interface or to communicate with a serial device that is cabled to the SBE 9*plus*.

The optional NMEA 0183 interface permits the SBE 11*plus* to integrate Latitude, Longitude, and Time data into the CTD data stream.

4-1.2 DATA TELEMETRY RECEIVER

The telemetry waveform originates in the Fish and is transformer-coupled onto the sea cable. In the Deck Unit, another transformer is used to remove the telemetry signal from the sea cable. The signal is amplified, filtered, and converted to logic level prior to being sent to a UART and then to a micro-controller, which checks the decoded bits and activates a valid character line to indicate successful reception of each 8-bit character. The absence of the valid character signal, at times when it is expected, lights the Deck Unit ERROR LED.

4-1.3 DECK UNIT MICROPROCESSOR

The primary computational function of the microprocessor (8085) is to compute (with supporting 9511 math chip) sensor frequencies from the 12 bit counts Ns and Nr which originate in the underwater unit. Other microprocessor duties involve the distribution of data to the output ports and the front panel numeric display. Program control of microprocessor function is provided by a 256K EPROM.

Deck Unit microprocessor power-on default functions may be modified by commands sent over the IEEE-488 or RS-232C interfaces (Section 3-6).

4-1.4 DECK UNIT MODEM

The Deck Unit modem offers a 300 baud full duplex serial communication link with the underwater unit. This channel is used by the SBE 11*plus* for water sampler control. In addition to water sampler control, serial communication between devices on deck and at the underwater unit are available. The communication parameters are: 300 baud, 8 data bits, 1 stop bit, and no parity. Access to the serial link is via a DB-25 connector on the back of the SBE 11*plus* and J7 on the SBE 9*plus* underwater unit. Characters received by the SBE 9*plus* with the most significant bit set (ASCII values 128 - 255) are interpreted as commands to the SBE 9*plus* and are not passed through. All characters received by the SBE 9*plus* from the water sampler are sent to the SBE 11*plus*. With the above two exceptions operation of the water sampler interface does not interfere with communication with a remote serial device.

Commands interpreted by the SBE 9*plus* are:

SBE 32 Carousel:

commands to SBE 9<i>plus</i>	description
<#SR>	go to home position (position #1)
<#SF>	fire next position (sequential firing)
<#SNX>	fire position X, first position is 1
<#SN2>	fire position # 2
<#SN>	fire position # 12
 replies	
6, '!', 6	at home position
6, '#', 6	received invalid bottle number
6, '!', 6	did not confirm fire
6, 49, 6	-fired bottle # 1
6, 50, 6	-fired bottle # 2
...	
6, 72, 6	-fired bottle # 24

GO 1015:

commands to SBE 9<i>plus</i>	description
<#ENBL>	supply power to 1015
<#FIRE>	remove power from 1015, fire bottle
 replies	
#ENABLED	ready to fire bottle
#CONFIRM	bottle fire confirm pulse detected

GO1016:

commands to SBE 9<i>plus</i>	description
<#GH>	go to home position
<#GON>	set arm offset to N, go to home position
<#GF>	fire position, move to next position
<#GN1>	go to position # 1
<#GN2>	go to position # 2
...	
<#GN9>	go to position # 9
<#GN:>	go to position # 10
<#GN;>	go to position # 11
 replies	
7, 0xf2, 7	positioning error, returning to home
7, 0xf4, 7	position error, could not find home
7, 0xc9, 7	ready to fire position # 1 (HOME)
7, 0xca, 7	ready to fire position # 2
...	

Miscellaneous:

<#P0>	control function off
<#P1>	control function on

<> characters inside <> are sent with bit 8 set high

4-1.5 DECK UNIT POWER

The Deck Unit operates on 105 - 125 VAC or 210 - 250 VAC (50 to 400 Hz) depending on the setting of the rear panel power switch. A power supply (Power One model HTAA-16W-A) creates +5, +12, and -12 volts DC for use by the Deck Unit electronics and telemetry receiver. The input power line is fused with at 2 Amp Slow-Blow fuse when operating at 120 VAC. The fuse should be replaced with a 1 Amp Slow-Blow type for use at 240 VAC. The Power One supply has foldback current limiting, and is not separately fused.

4-1.6 SEA CABLE SUPPLY

A Sea-Bird designed choke-input supply provides 250 volts DC at up to 0.25 amperes to the sea cable; a 0.5 amp fuse (located on the Deck Unit rear panel) protects against accidental shorting or overload of the sea cable.

4-1.7 DECK UNIT COOLING

A fan is installed in the back panel. Slots at the rear panel top and bottom allow air interchange.

4-1.8 TAPE RECORDER/VCR INTERFACE

The tape recorder interface permits use of an audio recorder or VCR for data backup in the event of computer failure, or for data recording when no computer is available. Connect the recorder LINE INPUT and LINE OUTPUT to the RECORD and PLAY connectors (respectively) on the Deck Unit. Set the record level to 0 db. When playing back data, the front panel SIGNAL SOURCE switch must be in the TAPE position. Most high quality cassette decks perform well with this system, although recording time is usually limited to 90-120 minutes due to cassette tape capacity. Best results will be obtained with metal oxide tapes. VCRs with super long play capability can offer up to 6 hours of recording. Simply use only the audio input and output on the VCR, ignoring the video.

4-2 DESCRIPTION OF SBE 11*plus* DECK UNIT CIRCUITRY

Deck Unit electronics are constructed in a rack-mount cabinet housing two main PC boards, two modular power supplies, a cooling fan, and a series of front panel displays and rear panel connectors. Deck Unit electronics are powered from 115 or 230 volts AC: **REMOVE THE AC POWER CORD FROM THE REAR PANEL BEFORE ATTEMPTING TO SERVICE THE DECK UNIT.**

4-2.1 CHASSIS WIRING

The chassis wiring diagram shows the Deck Unit modules and the wiring which interconnects them. Operation of these modules is described in subsequent sections.

Drawing 31732 shows the wiring of the standard Deck Unit. The AC power input fuse should be 2 Amp Slow-Blow when set to 120 VAC units and 1 Amp Slow-Blow in 230 VAC models. There is also a 0.5 A Fast-Blow fuse in series with the sea cable output for protection against shorts or overloads.

4-2.2 POWER SUPPLIES

Power for Deck Unit circuitry is supplied by a conventional open-frame linear supply (Power One Model HTAA-16W-A; Power-One, Inc., Camarillo, California) generating +/-12 and +5 volts from the main AC supply and located at the top left front of the Deck Unit chassis. Screw-driver adjustment of the output voltage levels is possible, but not ordinarily required. The Power-One supply uses fold-back current limiting for complete short-circuit protection. Detailed specifications and a schematic diagram are included in Section 8 of this manual.

4-2.2.1 SEA CABLE SUPPLY

WARNING - THIS SUPPLY MAINTAINS POTENTIALLY LETHAL VOLTAGE LEVELS FOR 15 SECONDS AFTER REMOVAL OF AC POWER. REMOVE THE AC POWER CORD FROM THE REAR PANEL AND ALLOW AT LEAST ONE MINUTE AFTER POWER-DOWN BEFORE WORKING ON THIS CIRCUIT.

The SBE 11*plus* uses a linear supply of Sea-Bird's design to produce the seacable voltage 250 volts at 0.25 amperes (reference drawing 31732). AC power is input to power transformer T1 (the primary connections are switched to work on 120 or 240 VAC) to generate approximately 275 V RMS for input to a bridge rectifier (Motorola 100JB12L). The resulting DC voltage is regulated by the series inductor L1 and capacitor (Mallory CGS801T450V4L, 800 uF/450 volts) to produce a 250 volt output. R1 is a bleeder resistor used to stabilize the supply output voltage and to insure supply discharge within a reasonable (15 second) interval. **Note that the output voltage decay time constant is R1*C2 (3.2 seconds).**

4-2.3 RECEIVER

The receiver circuitry (schematic 31326) is installed components-downward on the smaller printed circuit board mounted immediately below the main (microprocessor) board. The decoder circuitry is on the same board, as is tape recorder interface section.

Transformer T1 provides decoupled 34560 Hz sea cable telemetry signal to a bandpass filter C9/L1 and C11/L2. Transistor pair Q2 and Q3 apply gain, while C13 and T3 produce additional filtering. U1A is a gain stage and Q7/Q8 convert the signal to 5 volt logic level.

Shift-register U3 and X-OR U2A provide the DPSK decoding function (U5 and its associated counter circuits provide the bit-clock), with Bessel filter (U4 and associated components) extracting the NRZ data stream. A post-amplifier comprising Q10, Q11, and Q12 provide additional gain while converting the NRZ signal to full logic level. The NRZ data at U2C pin 10 is input to a UART (sheet 2) which is operated under the control of a single-chip microprocessor. The microprocessor output is routed to the main CPU board for further processing. A reconstructed NRZ data stream is returned to U9B (sheet 1) where it is encoded to DPSK format for use by analog tape recorders.

4-2.4 MODEM BOARD

The modem board (reference drawing 31485) utilizes a Motorola MC145443 300 Baud FSK single chip modem. Transmit frequencies are 2025 and 2225 Hz, receive frequencies are 1070 and 1270 Hz. Transformer T2 on the receiver board couples the modem to the sea cable. U9, U10, and U11 provide filtering for the received signal. U7 and U8 act as a buffer and line driver for the transmitted signal. U1 is a RS-232 to TTL level converter. U5 is a micro-controller that accepts input from the switches on the front panel and listens to the traffic on the modem channel. U5 sends enable and fire commands to the water sampler interface and lights the enable and confirm LEDs as appropriate.

4-2.5 MICROPROCESSOR BOARD

The Deck Unit microprocessor board (reference drawing 30947) acquires data from the Underwater Unit, converts AP counter data to frequency, averages data if requested and stores the processed data in RAM buffers for transmission to a computer via RS-232 or IEEE-488 interfaces.

The CPU (U21) is a 8085 operating at 6 Mhz. Interrupts are generated when a word is received (pin 8) or a character is received from the UART (pin 9). The 6 Mhz clock is output on pin 37. The address and data busses are de-multiplexed by U17. U43 and U44 generate one wait state for each input/output cycle. U45 selects the 23K X 8 EPROM (U28) that contains the Deck Unit software and the 32k X 8 static RAM (U29). Input and Output ports are selected by U32, U33, U34, and U46. Data is passed from the interrupt routine to the main program when the raw data from a scan has been collected. U23, U24, U25, and U26 are input ports. Settings for S2, S3, S4, and S5 are described in Section 3-3.

U22 is a floating point processor that converts AP counter data to frequency in Hertz. Pin 17 is used to make the CPU wait until read or write operations are complete and pin 24 indicates that the execution of the current command is complete. U5, U6, and U18 are the transceivers and controller for the IEEE-488 interface.

U7 - U10 perform serial to parallel conversion of the serial data from the receiver board. If the data is valid it is strobed into U1 and U2, generating an interrupt to the CPU. SYNC (U2 pin 9) tags the first word of a scan from the Underwater Unit. U19 drives the 8 digit front panel display.

The front panel LEDs are driven by U31, U40, U41, and U42. U37 pin 19 is used to control the optional alarm. U37 pin 2 is a diagnostic point; it is held low while the main routine is waiting for a complete scan from the interrupt routine. It is held high while the main routine is processing the data.

U3, U11, U12, U13, U20, U35, and U36 form the RS232 interface. S1 selects the baud rate, number of data bits, number of stop bits and parity. Pin 19 of the UART (U20) generates and interrupt to the CPU whenever a character is received.

U14, U15, and U16 are used to drive the expansion bus when the control option is installed in the Deck Unit.

5-1 TROUBLE DIAGNOSIS AND REPAIR

Servicing of the Sea-Bird CTD should only be performed by experienced technicians who have been trained to work with complex mechanical/electrical equipment. **LIFE-THREATENING HIGH VOLTAGES ARE PRESENT IN BOTH DECK UNIT AND UNDERWATER UNIT WHEN POWER IS ON. THESE HAZARDOUS VOLTAGES PERSIST FOR UP TO ONE MINUTE AFTER REMOVAL OF POWER.**

THE BEST WAY TO PROTECT AGAINST ELECTRICAL SHOCK IS TO DISCONNECT THE AC POWER CORD FROM THE REAR PANEL OF THE DECK UNIT, THEN WAIT A FULL MINUTE BEFORE ATTEMPTING SERVICE.

ALWAYS DISCONNECT THE AC POWER CORD BEFORE CHECKING FUSES!!!

For protection of the circuitry, we also recommend that AC power be removed and a 1 minute period for supply capacitor discharge be allowed before opening housings, changing connections, removing or inserting circuit cards, or otherwise working on the equipment.

5-1.1 DECK UNIT DATA OVERFLOW LIGHT ON

Data from the underwater unit is made available to the companion computer by placing it in RAM buffer. The companion computer then requests the data, emptying the buffer. If the computer is too slow in making these requests, the buffer overflows and lights the overflow LED. The rate at which the computer requests data from the Deck Unit depends on the other activities it must also perform. Users of SEASOFT find that the most common cause of buffer overflow is that an older (8088 or 80286) computer is updating the screen too often.

The rate of screen update may be changed in the SEASAVE Miscellaneous Run Time Parameters menu. Set the thumbwheel switch to C if using the IEEE-488 interface or D if using the RS-232 interface. Begin logging data and observe the number displayed, the number should periodically reset to 20500 for the IEEE-488 interface or 8000 for the RS-232. If the display does not reset, it will eventually overflow. Set the screen update parameter to a value that allows the buffers to reset. If a suitable rate of screen update can not be found then the Deck Unit has to average more data scans (or suppress data channels) to reduce the data output to the computer.

5-1.2 NO DATA COLLECTED, GPIB ERRORS NOTED WHEN SEASAVE EXITED

This condition is possible when the .CON file does not match the instrument. Specifically when the .CON file is for a SBE 9/11 and the computer is connected to a SBE 9/11*plus*. Check the .CON file with SEACON. Refer to the SEASOFT manual for details on how to use SEACON.

5-1.3 DECK UNIT COMPLETELY INOPERATIVE

If the power switch is on but the power switch pilot light is out, no other panel lights are on, and the fan is not running, either the AC power has been disconnected or the main fuse blown. Check the AC power source. Remove the power cable, and check the main fuse. Replace if necessary.

If the main fuse blows again, there is probably a short in the main chassis AC wiring (the separate fuses and short circuit protection circuitry associated with the internal power supplies prevent the main fuse blowing even if internal circuitry is malfunctioning). See chassis wiring diagram - it may be necessary to disconnect one section after another to locate the problem. **USE EXTREME CAUTION WHILE MAKING THESE TESTS! THE VOLTAGE LEVELS ARE LIFE-THREATENING!**

Assuming that the fan runs and the power switch pilot light comes on, observe that the front panel LEDs flash on briefly when power is first applied - this indicates that the main 5 volt supply is probably ok.

5-1.4 NO SEA CABLE VOLTAGE

Turn off the Deck Unit and wait 1 minute. Connect a voltmeter to the rear-panel mounted sea cable MS connector (range set to at least 300 volts DC). Turn on the Deck Unit. The voltmeter should read 250V.

If no sea cable voltage is observed, the sea cable supply is inoperative. Turn off the Deck Unit and wait 1 minute. Check the rear mounted sea cable fuse. If this fuse is blown, the sea cable may have been inadvertently shorted, or the underwater unit may be malfunctioning. Check the resistance across the sea cable and correct if shorted. **WARNING - BE EXTREMELY CAREFUL WHEN MAKING THESE MEASUREMENTS AS THE AC POWER AND SEA CABLE VOLTAGES ARE LIFE-THREATENING!** If the AC input is present, the fuse sea cable supply fuse is OK, and the DC output is missing, the power supply is faulty. A schematic diagram of the power supply is included in Section 8-1.

The Sea-Cable supply is built on two parallel aluminum rails placed immediately behind the Deck Unit's main logic board. Check that the 115/230 VAC input is present at the transformer primaries (T1, the large open frame unit at the left rear of the chassis). There should be about 330 volts DC across the large blue electrolytic capacitor, C2. If this voltage is present, check the voltage across the 4 K ohm/11 watt bleeder resistor, R1; this should be 250 volts (R1 is mounted to the aluminum rail that runs from side to side on the bottom of the chassis). If the proper voltage exists at R1 and there is still no sea-cable voltage at the rear panel MS connector, one of the leads to T1 may be broken.

If the unregulated voltage at C2 is absent, the bridge rectifier D1 is probably defective.

5-1.5 DATA LIGHT NOT ON

The number of data words per scan and the system scan rate for the 9/11*plus* are 12 and 24Hz. The Deck Unit contains DIP switches (SW1, SW2, SW4) which must be set according to the number of data words and the scan rate as established in the underwater unit. **Check to see that these switches are set according to the tables listed in Section 3-3 of this manual.**

If the data light is not on but Deck Unit is passing data to the companion computer, the wiring to the light or the light driver, U34 may be defective.

Assuming the data light is out because the data is not being decoded, check the main internal supply voltages which are present at the turrets located at the right rear of the main logic board. Relative to the turret with the black wire, measure +12 at orange, +5 at red, and -12 at blue. If any of these voltages are missing or seriously different (more than 0.5 volt), there is either a fault in the Power-One open-frame supply, or there is an excessive load on one or more of the supply busses. Disconnect the red, orange, or blue leads to determine whether the problem is in the power supply or on the power bus.

If the problem is with the power bus, reconnect the power supply leads. Disconnect ribbon cable connector J4 at the rear right center of the main logic board. If the measured voltages are now correct, the problem is with the Receiver Board. If there is no change, the trouble is probably in the main logic board. Check for shorted by-pass connectors, ICs (a shorted unit may be hot), etc.

If the power supply levels are correct, check for correct operation of the Receiver section. With the underwater connected, check for presence of the telemetry waveform at the receiver board input terminals, J1. The receiver board is under the main logic board, and may be accessed by removing the Deck Unit bottom cover.

5-1.6 G.O. 1015 ROSETTE® INTERFACE OR MODEM CHANNEL NOT WORKING

The G.O. 1015 Rosette interface depends on the modem channel as its means of sending the enable and fire commands to the SBE 9*plus*. We will consider problems with the modem first.

Modem carrier detect light not on. This light indicates that the modem in the Deck Unit is receiving the signal from the modem in the fish. If this light is not on, the modem in the fish may not be transmitting or the signal quality may be poor. Check test point TP2 on the modem board with an oscilloscope, there should be a 1070Hz sine wave present of at least 50mV p-p. This sine wave should change frequency when the fish modem transmits characters.

Modem in the underwater unit not receiving. With the CTD connected and running, put the thumbwheel switch in position E. The left most bit should be 0, if it is 1 the modem in the fish is not receiving a signal from the modem in the Deck Unit. Check test point TP1 on the Deck Unit modem, there should be a 2225Hz 4V p-p sine wave present.

If both modems indicate carrier detect but data is not transmitted on the serial channel, either the remote device or the computer on deck may be cabled improperly. Check that the transmit and receive pins are properly wired, these are pins 2 and 3 on a standard serial cable.

Modem operational but GO 1015 rosette will not trip. Check that the rosette interface board is operational. Place a voltmeter across the positive and negative wires of the rosette cable and enable the rosette. 60 volts should appear on the cable. If it does not, the cable or the rosette interface board may be faulty. When the FIRE button is pressed the 60 volt level should rapidly drop to 0. If the voltage on the cable does come up to 60V and drop as expected, the rosette pylon may be switched to the wrong polarity. This may be remedied by opening the rosette pylon and switching the polarity switch inside to negative. If the rosette interface board is operational and the pylon is not switched to the wrong polarity, the pylon electronics are faulty.

No confirm signal received. When the GO 1015 rosette pylon succeeds in tripping a bottle the supply voltage is forced negative for a moment. This negative pulse is sensed by the rosette interface and a signal is sent to the Deck Unit in the telemetry stream and on the modem channel. Switch the thumbwheel switch to position E, fire the rosette. The bit second from the left should change to 1 for several scans after the rosette fires. If this does not occur and the rosette did trip, either the interface board is faulty or the pylon is not sending the confirm signal. A voltmeter placed across the rosette wires will show the negative pulse.

5-1.7 IEEE-488 INTERFACE NOT WORKING

Check that the Deck Unit's IEEE-488 Address is properly selected to match the external interface. As shipped, the Deck Unit IEEE-488 address is set to 1; this is also the default address used by the National Instruments GPIB-PC2A interface as supplied for use in IBM PC/XT/AT computers. If your interface requires a different address, see Section 3-3.1 and set DIP switch S3 accordingly.

If software other than that supplied by Sea-Bird is used, make sure that the proper commands are sent to the Deck Unit, for example, the command GI must be used to begin the transfer of data to the IEEE-488 interface bus. See Section 3-6.

Check that ribbon connector JP1 (main logic board) is properly mated. U5, U6 and U18 perform the IEEE-488 interface functions and may be defective.

5-1.8 RS-232 INTERFACE NOT WORKING

The Deck Unit settings for baud rate, number of data bits, number of stop bits, and parity must conform to the requirements of the external RS-232 device. The Deck Unit is shipped with baud rate = 19200, 8 data bits, 1 stop bit, and disabled parity. These settings may be changed using DIP switch S1; see Section 3-3.2. The Deck Unit transmits a summary of the DIP switch setting when power is first applied or the reset button is pushed (see Section 3-2).

Make sure that the RS-232 device is sending the proper commands to the Deck Unit; for example, the command GR must be used to begin transferring data to the RS-232 interface; see Section 3-6.3.

Check to see that the connection to main logic board JP4 (RS-232 I/O connector) is properly secured. This connector may be installed 180 degrees to normal position in order to reverse the Receive/Transmit connections. Check the circuitry associated with U3, U111, U12, U13, U20, and U35 if the trouble persists.

5-1.9 TAPE RECORDER INTERFACE NOT WORKING

When recording on tape the front panel Signal Source switch should be in the **FISH** position. When playing previously recorded data back, the switch should be in the **TAPE** position.

Make certain that the **recording level** is set properly (approximately 0 db). Use type II tape if possible, but in any case make certain that the **tape recorder bias level and compensation adjustments are as required for the type of magnetic tape used.**

The output to the tape recorder is an 8640 baud DPSK encoded NRZ wave-form. This signal should appear at the rear panel Record RCA connector, with an amplitude of 0.5 v p-p. If the tape recorder shows that a proper recording level is being achieved, check that the playback signal is arriving at the Playback RCA connector.

6-1 DECK UNIT DISASSEMBLY

DISCONNECT THE AC POWER CABLE FROM THE REAR OF THE DECK UNIT!!! WAIT 1 MINUTE BEFORE BEGINNING DECK UNIT DISASSEMBLY.

Remove the four rear-most screws from the corners of the top cover. The cover slides directly back, permitting access to the upper part of the Deck Unit interior. Four similarly placed screws retain the bottom cover in the same fashion.

APPENDIX A NMEA MESSAGE FORMATS

Field Definitions:

Field Type	Symbol	Definition
Status	A	Single character field: A = Yes, data valid, warning flag clear V = NO, data invalid, warning flag set
Latitude llll.ll degrees minutes.decimal		Fixed/Variable length field: - 2 fixed digits of degrees, 2 fixed digits of minutes and a variable number of digits for decimal - fraction of minutes. Leading zeros always included for degrees and minutes to maintain fixed length. The decimal point and associated decimal - fraction are optional if full resolution is not required.
a		N or S
Longitude yyyy.yy degrees minutes.decimal		Fixed/Variable length field: - 3 fixed digits of degrees, 2 fixed digits of minutes and a variable number of digits for decimal - fraction of minutes. Leading zeros always included for degrees and minutes to maintain fixed length. The decimal point and associated decimal - fraction are optional if full resolution is not required.
b		E or W
Time hhmmss.ss hours minutes seconds.decimal		Fixed/variable length field: - 2 fixed digits of hours, 2 fixed digits of seconds and a variable number of digits for decimal fraction of seconds. Leading zeros are always included for hours, minutes, and seconds to maintain fixed length. The decimal point and associated decimal-fraction are optional if full resolution is not required.
Checksum	*	Optional Checksum Delimiter.
hh		Optional Checksum Field. The absolute value calculated by exclusive OR'ing the 8 data bits (no start or stop bits) of each character in the message, between, but excluding "\$" and "*".

NMEA message formats:

GGA - Global Positioning System Fix Data

Time, position, and fix related data for a GPS receiver.

\$--GGA,hhmmss.ss,llll.ll,a,yyyyyy.yy,b,x,xx,x.x,x.x,M,x.x,M,x.x,xxxx*hh<CR><LF>

GLL - Geographic Position - Latitude/Longitude

Latitude and Longitude of present vessel position, time of position fix, and status.

\$--GLL,llll.ll,a,yyyyyy.yy,b,hhmmss.ss,A*hh<CR><LF>

RMA - Recommended Minimum Specific Loran-C Data

Position, course, and speed data provided by a LORAN-C receiver.

\$--RMA,A,llll.ll,a,yyyyyy.yy,b,x.x,x.x,x.x,x.x,a*hh<CR><LF>

RMC - Recommended Minimum Specific GPS/TRANSIT Data

Time, date, position, course, and speed data provided by a GPS or TRANSIT navigation receiver.

\$--RMC,hhmmss.ss,A,llll.ll,a,yyyyyy.yy,b,x.x,x.x,ddmmmyy,x.x,a*hh<CR><LF>

TRF - TRANSIT Fix Data

Time, date, position, and information related to a TRANSIT fix.

\$--TRF,hhmmss.ss,ddmmmyy,llll.ll,a,yyyyyy.yy,b,x.x,x.x,x.x,x.x,xxx,A*hh<CR><LF>