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USER MANUAL – APEX–SBE PROFILER

APEX–SBE INSTRUMENTS
Serial numbers: 142, 143, 154– 159

REV DATE: 04/24/00
UW Riser Contract #: 991330
WRC Job no. 640
This manual applies to units with 180 cc pumps
APF7 S/N: 401– 408

I.   ALKALINE BATTERY WARNING

The profiler contains alkaline "D" cells.
There is a small but finite possibility that batteries of alkaline cells will release a combustible gas mixture. This gas release generally is not evident when batteries are exposed to the atmosphere, as the gases are dispersed and diluted to a safe level. When the batteries are confined in a sealed instrument mechanism, the gases can accumulate and an explosion is possible.
Webb Research Corp. has added a catalyst inside of these instruments to recombine Hydrogen and Oxygen into $H2O$, and the instrument has been designed to relieve excessive internal pressure buildup by having the upper endcap release.
Webb Research Corp. knows of no way to completely eliminate this hazard. The user is warned, and must accept and deal with this risk in order to use this instrument safely as so provided. Personnel with knowledge and training to deal with this risk should seal or operate the instrument. Webb Research Corp. disclaims liability for any consequences of combustion or explosion.

II.   Reset and Self Test

Profilers are shipped to the deployment site in Hibernate mode. Shortly before deployment, reset the profiler by passing a magnet over the marked location on the pressure case. The profiler will run a self−test, transmit for 6 hours with the bladder extended, and then begin its pre−programmed mission.
The six ARGOS transmissions during self−test and the transmissions during the initial 6 hour period contain data about the instrument and are outlined in (V) ARGOS DATA, part (C) TEST MESSAGE FORMAT.

Procedure:
– Hold the provided magnet at RESET position marked on the hull for several seconds.
– Note: The internal magnetic reed switch must be activated (held) for at least one second to reset the instrument. (This is to provide a safety against accidental reset during transport.) **Thus, if the float does not respond as below, the instrument was probably not reset.**
– The air pump will operate for 1 second.
– The PTT will transmit 6 times at 6 second intervals. Place the ARGOS receiver/beeper close to the antenna to detect transmissions.
– The piston pump will begin to operate. The piston will move to the retracted Ballast Position, if not already there, pause 2 seconds and then move to full extension.
– The bladder will expand, this should take 15 – 25 minutes.
– After the piston pump stops the air pump will come on and inflate the air portion of the bladder taking 20 – 30 seconds.
– The PTT will transmit at the mission specified ARGOS rate.
– 6 hours after reset, transmissions will cease, the piston pump will retract and the bladder will deflate, the profiler begins its programmed mission.

During self−test, the controller checks the internal vacuum sensor. If the internal pressure has increased above a preset limit (i.e. hull leakage caused loss of vacuum), the instrument will not pump. **If you do not detect the 6 test transmissions, and if the bladder does not inflate, then the self−test has failed and the instrument should not be deployed.**

III.   Mounting Damper Plate

To aid surface following, a square Plate is pre−mounted to the outside of the pressure case using 2 pvc collars, an O−ring, and titanium hardware.

IV.   Deployment

- RESET instrument.
- SELF−TEST starts automatically (see above).
- When piston pump stops, air pump inflates, external bladder is full, PTT will transmit for 6 hours at ARGOS Repetition rate intervals. Normally 90 seconds.
- Six hours after reset, the piston pump will retract and bladder will deflate. Deploy before this time is up or reset the instrument again to re−initialize the 6 hour period. The purpose is to have the instrument on the surface and receive test transmissions.
- Pass a rope through the hole in the stability plate.
- Holding both ends of the rope, carefully lower the float into the water.
- Take care not to damage the antenna.
- Do **not** leave the rope with the instrument, release one end and retrieve the rope.
- The float will remain on the surface until the 6 hour interval has expired.

V.   ARGOS DATA

A.   SERVICE ARGOS PARAMETERS

The user must specify various options to Service ARGOS. These choices depend on how the user wishes to receive and process data. Typical parameters are listed below:
- Standard location.
- Processing: Type A2 (pure binary input; hexadecimal output)
- Results Format: DS (all results from each satellite pass), Uncompressed.
- Distribution Strategy: Scheduled, all results, every 24 hours.
- Number of bytes transmitted: 32
Note: Webb Research recommends all users to use ARGOS "Multi Satellite Service", which provides receptions from 3 satellites instead of 2 for a small incremental cost.

B.   DATA FORMAT

Data is sent via ARGOS in 32 byte hex messages. The number of 32 byte messages sent depends on the programmed quantity of temperature measurements per profile

Format for message number 1 only:

Byte #

- 01 **CRC**, described in section C.
- 02 **Message number**, Assigned sequentially to each 32 byte message (Total number of messages per profile is shown below). Messages are transmitted in sequential order starting with 1 and incrementing by one for the data set.
- 03 **Message block number**, begins as 1 and increments by one for every ARGOS message data set. This, combined with the ARGOS repetition rate (section VI), allows the user to track surface drift. Byte 03 will roll−over at 256 and will reset to 1 on each new profile.
- 04 & 05 **Serial number**, identifies the controller board number. (This may not be the same as instrument number.)
- 06 **Profile number**, begins with 1 and increases by one for every float ascent.
- 07 **Profile length**, is the number of six byte STD measurements in the profile. Total number of bytes of STD data from each profile depends on the sampling strategy chosen.
- 08 **Profile termination flag byte**, can have the following values (hex):
    - 00   Pressure reached surface pressure.
    - 02   Pressure reached zero.
    - 4   Pressure unchanged for 25 minutes. (Does not terminate profile.)
    - 8   Piston fully extended before surface
    - 10 UP time expired before surface and UP time was reset.
- 09 **Piston position**, recorded as the instrument reaches the surface.
- 10 & 11 **Bottom temperature**, sampled just before instrument begins ascent.
- 12 & 13 **Bottom salinity**, sampled just before instrument begins ascent.
- 14 & 15 **Bottom pressure**, sampled just before instrument begins ascent.
- 16 **Battery voltage**, nominally at 15 volts and decreases throughout the life of the float.
- 17 & 18 **Surface pressure**, as recorded just before last descent with an offset of +5db.
- 19 **Internal vacuum**, as recorded just before last descent.
- 20 **Bottom piston position**, the linear potentiometer count recorded at the target depth.
- 21 to 32 6 bytes in sequence:
    - 2 bytes **temperature**
    - 2 bytes **salinity**
    - 2 bytes **pressure**

Format for message number 2 and higher:
Byte #
- 01 **CRC**, described in section C.
- 02 **Message number**
- 03 to 32 6 bytes in sequence:

  2 bytes **temperature**
  2 bytes **salinity**
  2 bytes **pressure**

Message Format and Sampling Depths

BTYE #	MSG 1
10 & 11	Tb*
12 & 13	Sb*
14 & 15	Pb*
17 & 18	Ps**
21 & 22	T1***
23 & 24	S1***
25 & 26	P1***
27 & 28	T2
29 & 30	S2
31 & 32	P2

BTYE #	MSG 2	MSG 3	MSG 4	MSG 5	MSG 6
3 & 4	T3	T8	T13	T18	T23
5 & 6	S3	S8	S13	S18	S23
7 & 8	P3	P8	P13	P18	P23
9 & 10	T4	T9	T14	T19	T24
11 & 12	S4	S9	S14	S19	S24
13 & 14	P4	P9	P14	P19	P24
15 & 16	T5	T10	T15	T20	T25
17 & 18	S5	S10	S15	S20	S25
19 & 20	P5	P10	P15	P20	P25
21 & 22	T6	T11	T16	T21	T26
23 & 24	S6	S11	S16	S21	S26
25 & 26	P6	P11	P16	P21	P26
27 & 28	T7	T12	T17	T22	T27
29 & 30	S7	S12	S17	S22	S27
31 & 32	P7	P12	P17	P22	P27

BTYE #	MSG 7	MSG 8	MSG 9	MSG 10	MSG 11
3 & 4	T28	T33	T38	T43	T48
5 & 6	S28	S33	S38	S43	S48
7 & 8	P28	P33	P38	P43	P48
9 & 10	T29	T34	T39	T44	T49
11 & 12	S29	S34	S39	S44	S49
13 & 14	P29	P34	P39	P44	P49
15 & 16	T30	T35	T40	T45	T50
17 & 18	S30	S35	S40	S45	S50
19 & 20	P30	P35	P40	P45	P50
21 & 22	T31	T36	T41	T46	T51
23 & 24	S31	S36	S41	S46	S51
25 & 26	P31	P36	P41	P46	P51
27 & 28	T32	T37	T42	T47	**XX******
29 & 30	S32	S37	S42	S47	**XX**
31 & 32	P32	P37	P42	P47	**XX**

*   Tb, Sb, and Pb are bottom Temperature, Salinity, and Pressure values
**   Ps is surface Pressure
***   T, S, and P are Temperature, Salinity, and Pressure values
**** **XX**: Invalid data points

Data format table above assumes that bottom pressure (maximum hydrostatic pressure at start of profile) is 1000dbar. Data format will change if bottom pressure varies.

APEX records a profile during ascent (ie upcast). Bottom pressure may change due to several causes, such variation of insitu density, internal waves, float grounding in shallows, change of float mass, etc. APEX automatic depth adjustment will compensate in most, but not all, cases. Actual bottom pressure is transmitted as bytes 14 & 15 of message one.

Number of sample points is proportional to depth, as per sample depth table on page 7.
The first (i.e. deepest) sample is taken at the first point in the depth table above bottom pressure, and is designated as T1, S1, P1 in the table above.

Depth Table No. 1

Sample Point	Pressure (dbar)	Sample Point	Pressure (dbar)
	Bottom		
1	1000	27	250
2	980	28	240
3	950	29	230
4	900	30	220
5	850	31	210
6	800	32	200
7	750	33	190
8	700	34	180
9	650	35	170
10	600	36	160
11	550	37	150
12	500	38	140
13	450	39	130
14	400	40	120
15	380	41	110
16	360	42	100
17	350	43	90
18	340	44	80
19	330	45	70
20	320	46	60
21	310	47	50
22	300	48	40
23	290	49	30
24	280	50	20
25	270	51	10
26	260	52	4 or Sur.

* The SeaBird CTD is not sampled at zero pressure, to avoid pumping the cell dry and/or ingesting surface oil slicks. The shallowest profile point is taken at either 4 dbar or at the last recorded surface pressure plus 5 dbar, whichever value is larger.

C.   TEST MESSAGE FORMAT

The test message is sent whenever an **I2** command is given, the six transmissions during the startup cycle, and during the six hour surface mode period prior to the first dive. Each test message has 32 bytes, in hex unless otherwise noted, with the following format:

Byte #
–   01 **CRC**, described in section C.
–   02 **Message number**, always 01.
–   03 **Message block number**, begins as 1 and increments by one for every ARGOS message.
–   04 & 05 **Serial number**, identifies the controller board number. (This may not be the same as instrument number.)
–   06 **Profile number**, always 00.
–   07 **Message type flag**, 20 for test message, 40 for 6 hour surface message.
–   08 & 09 **Current pressure**.
–   10 **Battery voltage**, nominally at 15 volts.
–   11 **Internal vacuum**, nominally at 5 inches Hg.
–   12 **Piston Position**, a count value 12–248.
–   13 **Float status byte**, 08 for float up, 20 piston fully extended, 40 piston running.
–   14 **Hour**, the following is the time from startup (in decimal).
–   15 **Minutes**.
–   16 **Seconds**.
–   17 **ARGOS** repetition rate constant (multiply by 2, nominally 90 seconds).
–   18 **Up** time, intervals.
–   19 & 20 **Down** time, intervals.
–   21 **Trip interval** time, hours.
–   22 & 23 **Target pressure**, in centibars.
–   24 **Target piston position**, in counts.
–   25 **Depth correction factor**, in counts.
–   26 **Ballast piston position**, normally 24 counts.
–   27 **Fully extended piston position**, nominally 248 counts.
–   28 **OK vacuum count**, nominally 2 inches Hg.
–   29 **Initial piston extension**, in counts.
–   30 **Month**, software version number (in decimal).
–   31 **Day**, software version number (in decimal).
–   32 **Year**, software version number (in decimal).

D.   CRC

Because ARGOS data may contain transmission errors, the first byte of each message contains an error checking value. This value is a Cyclic Redundancy Check (CRC), and is calculated as a function of the message content (bytes 2 to 32).

- For each message, calculate a CRC value
- Compare the calculated CRC to the transmitted CRC (byte no. 1)
- If the calculated and transmitted CRC values are not equal, the message has been corrupted and should be deleted before further data processing.

Below is a sample program (in BASIC) to calculate the CRC value for a message. This program can be provided upon request in Basic, Fortran or C.

```
DECLARE FUNCTION CRC% (IN() AS INTEGER, N AS INTEGER)
'CRC routine to check data validity in ARGOS message.
'Bathy Systems, Inc. RAFOS Float data transmission.
'3 December, 1990.
'The 1st of 32 bytes in an ARGOS message is the CRC.
'The function CRC will compute CRC for byte 2 through 32.
'Hasard is used for Random because Random is reserved by BASIC.
'Stored as file CRC in C:\RAFOS\RAF11.
DECLARE SUB Hasard (ByteN AS INTEGER)
DEFINT A–Z
DIM in(32) AS INTEGER
'RAF11F message number 08 HEX ID 11502 01–02–93   CRC is O.K.
A$ = "8F00081C8E47239148A4D2E9743A1D0E070381C06030984C2693492492C964B2"

        N = 32
        FOR I = 1 to N
                in(I) = VAL("&H" + MID$(A$, 2 + I – 1, 2))
        NEXT I
        PRINT in(1); CRC(in(), N);

FUNCTION CRC% (IN() AS INTEGER, N AS INTEGER) STATIC
DIM ByteN as INTEGER
        I = 2
 ByteN = in(2)
                DO
                        CALL Hasard(ByteN)
                        I = I + 1
                        ByteN = ByteN XOR in(I)
                LOOP UNTIL  I = N
        CALL Hasard (ByteN)
        CRC = ByteN
END FUNCTION

DEFINT A–Z
SUB Hasard (ByteN AS INTEGER) STATIC
x% = 0
        IF ByteN = 0 THEN ByteN = 127: EXIT SUB
        IF (ByteN AND 1) = 1 THEN x% = x% + 1
```

```
        IF (ByteN AND 4) = 4 THEN x% = x% + 1
        IF (ByteN AND 8) = 8 THEN x% = x% + 1
        IF (ByteN and 16) = 16 THEN x% = x% + 1
        IF (X% AND 1) = 1 THEN
                ByteN = INT(ByteN / 2) + 128
        ELSE
                ByteN = INT(ByteN / 2)
        END IF
END SUB
```

E.   CONSTANTS

The pressure is measured every 6 seconds. Temperature, salinity and pressure are measured and stored at each point in the depth table.

Two hex bytes are stored for each sensor. The decimal numbers from the STD sensors are converted to hex for compression in the ARGOS transmission as follows:

Temperature: first 5 digits, 1 milli−degree resolution.
Salinity: 5 digits, z
Pressure: first 5 digits, 10 cm resolution.

To convert the hex ARGOS message back to decimal numbers:

	hex	→	dec	=	converted	units
Temperature:	3EA6 →		16038 =		16.038	C
Temperature*:	F58B →		02677 =		−2.677	C
Salinity**:	8FDD →		36829 =		36.829	
Pressure:	1D4C →		7500 =		750.0	decibars

*Any minus temperatures are 2s complemented. −0.1808 rounds to −0.181 and converts to FF4B. (181 is B5 hex and 0 − B5 = FF4B.) Positive temperatures will take the range of 0 to 62.535C (0 to F447hex) and negative temperatures will take the range of −0.001 to −3.000C (FFFF to F448hex). In practice the positive temperatures work from 0 hex up and the negative temperatures work from FFFF hex and down.

**The 5 most significant salinity digits are telemetered. The 6 digit salinity number is rounded up and converted to hex. 36.8286 rounds to 36.829 and converts to 8FDD.

Voltage (V) = counts/10 + .6 (counts is in decimal number) nominally 15 V and decreasing.
Vacuum (inHg) = counts *−0.376 + 29.15 (counts is in decimal number) nominally 5 inHg.

VI. RECORDS & CALIBRATIONS