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USER MANUAL – APEX-SBE PROFILER

APEX-SBE AIR DEPLOY INSTRUMENTS
Serial numbers: 1016~1026

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Mediterranean and North Arabian Sea

I. ALKALINE BATTERY WARNING 2

II. RESET AND SELF TEST 2

III. MOUNTING DAMPER PLATE 3

IV. DEPLOYMENT 3

V. ARGOS DATA 4

A. SERVICE ARGOS PARAMETERS 4
B. DATA FORMAT #1 5
C. TEST MESSAGE FORMAT 8
D. CRC 9
E. CONSTANTS 10

VI. MISSIONS 11

VII. RECORDS & CALIBRATIONS 15

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:
1. Secure float in horizontal position, using foam cradles from crate.

2. Minimum temperature –2 deg C. If necessary, let float warm indoors before proceding.
3. Carefully pry black rubber plug out of bottom center of yellow plastic cowling to verify bladder inflation (per below). **Be sure to replace plug before deployment.**

Purpose of plug is to prevent silt entry if float contacts sea floor.

4. 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.**

5. The air pump will operate for 1 second.
6. The PTT will transmit 6 times at 6 second intervals. Place the ARGOS receiver/beeper close to the antenna to detect transmissions.
7. 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.
8. The oil bladder will expand, this should take 15 - 25 minutes.
9. After the piston pump stops, the PTT will transmit at the specified ARGOS rate.
10. At every PTT transmission, the air pump will turn on for 6 seconds until the air portion of the bladder has been inflated, the pump should turn on 8 – 10 times.
11. 6 hours after reset, transmissions will cease, the bladder will deflate, and the piston pump will retract, the profiler begins its programmed mission.
12. Reminder - replace black rubber plug in cowling hole before deployment.

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 damper 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 per message

Note: Webb Research strongly 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 #1

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**, see flag byte description:
- 09 **Piston position**, recorded as the instrument reaches the surface.
- 10 **Format Number** (identifier for message one type)
- 11 **Depth Table Number** (identifier for profile sampling depths)
- 12 & 13 **Pump motor time,** in two second intervals. (multiply by 2 for seconds)
- 14 **Battery voltage,** at initial pump extension completion
- 15 **Battery current,** at initial pump extension completion
- 16 **Air pump current**
- 17 **not used**
- 18 **Surface piston position**
- 19 **Air bladder pressure**
- 20 & 21 **Bottom temperature**, sampled just before instrument asends.
- 22 & 23 **Bottom salinity**, sampled just before instrument asends.
- 24 & 25 **Bottom pressure**, sampled just before instrument asends.
- 26 **Park battery voltage**, no load
- 27 **Surface battery voltage,** no load
- 28 & 29 **Surface Pressure**
- 30 **Internal vacuum**
- 31 **Park piston position***
- 32 **SBE pump current**
-

*these points will be bottom values for non park and profile floats sampled just before ascent.

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
20 & 21	Tp*
22 & 23	Sp*
24 & 25	Pp*
28 & 29	Ps**

BTYE #	MSG 2	MSG 3	MSG 4	MSG 5	MSG 6	MSG 7
3 & 4	T1	T6	T11	T16	T21	T26
5 & 6	S1	S6	S11	S16	S21	S26
7 & 8	P1	P6	P11	P16	P21	P26
9 & 10	T2	T7	T12	T17	T22	T27
11 & 12	S2	S7	S12	S17	S22	S27
13 & 14	P2	P7	P12	P17	P22	P27
15 & 16	T3	T8	T13	T18	T23	T28
17 & 18	S3	S8	S13	S18	S23	S28
19 & 20	P3	P8	P13	P18	P23	P28
21 & 22	T4	T9	T14	T19	T24	T29
23 & 24	S4	S9	S14	S19	S24	S29
25 & 26	P4	P9	P14	P19	P24	P29
27 & 28	T5	T10	T15	T20	T25	**FFFF**
29 & 30	S5	S10	S15	S20	S25	**FFFF**
31 & 32	P5	P10	P15	P20	P25	**FFFF**

* Tp, Sp, and Pp are Park Temperature, Salinity, and Pressure values
** Ps is surface Pressure
*** T, S, and P are Temperature, Salinity, and Pressure values
**** **FFFF**: Invalid data points

Data format chart above assumes that bottom pressure (maximum hydrostatic pressure at start of profile) is 650 dbar. 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.

The number of sample points taken is proportional to depth, as per sample depth table below. The first (i.e. deepest) sample is taken at the first point in the depth table above bottom pressure.

Depth Table No. 36

Sample Point	Pressure (dbar) Bottom	Sample Point	Pressure (dbar)
1	1000	27	70
2	900	28	60
3	825	29	50
4	750	30	40
5	675	31	30
6	600	32	20
7	550	33	10
8	500	34	4 or surf
9	450		
10	400		
11	375		
12	350		
13	325		
14	300		
15	275		
16	250		
17	225		
18	200		
19	180		
20	160		
21	140		
22	120		
23	110		
24	100		
25	90		
26	80		

* 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 block number**, begins as 1 and increments by one for every ARGOS message.
- 03 & 04 **Serial number**, identifies the controller board number. (This may not be the same as instrument number.)
- 05 & 06 **Time from start up,** in seconds
- 07 **Flag (2) byte**
- 08 & 09 **Current pressure,** in dbar
- 10 **Battery voltage**
- 11 **Current Bladder pressure,** in counts
- 12 **Flag (1) Byte**
- 13 **Up time**, in intervals
- 14 & 15 **Down time**, in intervals
- 16 **Interval time,** in hours
- 17 & 18 **Park pressure,** in dbar
- 19 **Park piston position**, in counts
- 20 **Depth correction factor,** in counts
- 21 **Ballast / storage piston position**, in counts
- 22 **Fully extended piston position**, in counts
- 23 **OK vacuum count at launch**, in counts
- 24 **Ascend time**, in intervals
- 25 **Target bladder pressure**, in counts
- 26 & 27 **Profile pressure,** in dbar *(Park and profile floats only)*
- 28 **Profile piston position**, in counts *(Park and profile floats only)*
- 29 **Deep profile cycle counts** *(Park and profile floats only)*
- 30 **Month**, software version number (in decimal).
- 31 **Day**, software version number (in decimal).
- 32 **Year**, software version number (in decimal).

* Flag (2) byte:
1 Deep profile
2 Pressure reached zero
3 25 minute Next Pressure timeout
4 piston fully extended before surface
5 Ascend time out
6 Test message at turn on
7 Six hour surface message
8 Arithmetic round up

**Flag (1) byte:
1 Trip interval time
2 Profile in progress
3 Timer done
4 UP/ DOWN
5 Data entry error
6 Measure battery
7 Piston motor running
8 Negative SBE number

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

*Note regarding negative temperatures (T °C < 0)
Positive temperature range is 0 to 62.535C (0 to F447 hex)
Negative temperature range is -0.001 to -3.000C (FFFF to F448 hex).
If (hex value) ≥ F447, then compute FFFF - (hex value) = Y
Convert Y from hex to decimal, divide by 1000, multiply by -1, for degrees C

**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 *-.209 + 26.23 (counts is in decimal number) nominally 5 inHg.

VI. MISSIONS

Mediterranean Floats

INSTRUMENT #1016

APEX version 05 28 02 sn 1220 001 036
BF229 ARGOS ID number.
060 seconds repetition rate.
001 hour Trip interval.
110 intervals DOWN.
010 intervals UP.
0650 d-bar park pressure. P1
030 park piston position. P2
012 ascent rate correction. P3
100 storage piston position. P4
249 piston full extension. P5
113 OK vacuum count. P8
005 ascend time intervals. P9
144 air bladder pressure. PB
025 Initial piston extension.

INSTRUMENT #1017

APEX version 05 28 02 sn 1221 001 036
BF27A ARGOS ID number.
060 seconds repetition rate.
001 hour Trip interval.
110 intervals DOWN.
010 intervals UP.
0650 d-bar park pressure. P1
030 park piston position. P2
012 ascent rate correction. P3
100 storage piston position. P4
248 piston full extension. P5
112 OK vacuum count. P8
005 ascend time intervals. P9
143 air bladder pressure. PB
025 Initial piston extension.

INSTRUMENT #1018

APEX version 05 28 02 sn 1222 001 036
BF2DC ARGOS ID number.
060 seconds repetition rate.
001 hour Trip interval.
110 intervals DOWN.
010 intervals UP.
0650 d-bar park pressure. P1
030 park piston position. P2
012 ascent rate correction. P3
100 storage piston position. P4
247 piston full extension. P5
114 OK vacuum count. P8
005 ascend time intervals. P9
146 air bladder pressure. PB
025 Initial piston extension.

INSTRUMENT #1019

APEX version 05 28 02 sn 1223 001 036
BF390 ARGOS ID number.
060 seconds repetition rate.
001 hour Trip interval.
110 intervals DOWN.
010 intervals UP.
0650 d-bar park pressure. P1
030 park piston position. P2
012 ascent rate correction. P3
100 storage piston position. P4
251 piston full extension. P5
116 OK vacuum count. P8
005 ascend time intervals. P9
147 air bladder pressure. PB
025 Initial piston extension.

North Arabian Sea

INSTRUMENT #1020

APEX version 05 28 02 sn 1224 001 036
BF438 ARGOS ID number.
044 seconds repetition rate.
001 hour Trip interval.
109 intervals DOWN.
011 intervals UP.
1050 d-bar park pressure. P1
030 park piston position. P2
012 ascent rate correction. P3
100 storage piston position. P4
249 piston full extension. P5
115 OK vacuum count. P8
006 ascend time intervals. P9
146 air bladder pressure. PB
025 Initial piston extension.

INSTRUMENT #1021

APEX version 05 28 02 sn 1225 001 036
BF46B ARGOS ID number.
044 seconds repetition rate.
001 hour Trip interval.
109 intervals DOWN.
011 intervals UP.
1050 d-bar park pressure. P1
030 park piston position. P2
012 ascent rate correction. P3
100 storage piston position. P4
248 piston full extension. P5
113 OK vacuum count. P8
006 ascend time intervals. P9
144 air bladder pressure. PB
025 Initial piston extension.

INSTRUMENT #1022

APEX version 05 28 02 sn 1293 001 036
BF49E ARGOS ID number.
046 seconds repetition rate.
001 hour Trip interval.
109 intervals DOWN.
011 intervals UP.
1050 d-bar park pressure. P1
030 park piston position. P2
012 ascent rate correction. P3
100 storage piston position. P4
252 piston full extension. P5
116 OK vacuum count. P8
006 ascend time intervals. P9
147 air bladder pressure. PB
025 Initial piston extension.

INSTRUMENT #1023

APEX version 05 28 02 sn 1269 001 036
BF4CD ARGOS ID number.
046 seconds repetition rate.
001 hour Trip interval.
109 intervals DOWN.
011 intervals UP.
1050 d-bar park pressure. P1
030 park piston position. P2
012 ascent rate correction. P3
100 storage piston position. P4
248 piston full extension. P5
115 OK vacuum count. P8
006 ascend time intervals. P9
144 air bladder pressure. PB
025 Initial piston extension.

INSTRUMENT #1024

APEX version 05 28 02 sn 1283 001 036
BF527 ARGOS ID number.
044 seconds repetition rate.
001 hour Trip interval.
109 intervals DOWN.
011 intervals UP.
1050 d-bar park pressure. P1
030 park piston position. P2
012 ascent rate correction. P3
100 storage piston position. P4
251 piston full extension. P5
115 OK vacuum count. P8
006 ascend time intervals. P9
146 air bladder pressure. PB
025 Initial piston extension.

INSTRUMENT #1025

APEX version 05 28 02 sn 1284 001 036
BF574 ARGOS ID number.
046 seconds repetition rate.
001 hour Trip interval.
109 intervals DOWN.
011 intervals UP.
1050 d-bar park pressure. P1
030 park piston position. P2
012 ascent rate correction. P3
100 storage piston position. P4
250 piston full extension. P5
116 OK vacuum count. P8
006 ascend time intervals. P9
147 air bladder pressure. PB
025 Initial piston extension.

INSTRUMENT #1026

APEX version 05 28 02 sn 1319 001 036
BF581 ARGOS ID number.
046 seconds repetition rate.
001 hour Trip interval.
109 intervals DOWN.
011 intervals UP.
1050 d-bar park pressure. P1
030 park piston position. P2
012 ascent rate correction. P3
100 storage piston position. P4
251 piston full extension. P5
117 OK vacuum count. P8
006 ascend time intervals. P9
147 air bladder pressure. PB
025 Initial piston extension.

VII. RECORDS & CALIBRATIONS