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USER MANUAL – APEX-SBE PROFILER

APEX-SBE INSTRUMENTS
Serial # 2247 & 2308 & 2309

WRC Job no. 1083 IfM Hamburg
Park and profile with SBE Dissolved Oxygen & WetLabs FLNTU
"Type C"
Manual Rev 08-29-05
Software Rev 07-01-05

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.

NOTE: For floats equipped with the optional WetLabs FLNTU sensor, see notes in section VII, part B, regarding timing of RESET such that the profile is complete before sun rise.

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. 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.

3. 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.**

4. The air pump will operate for 1 second.
5. The PTT will transmit 6 times at 6 second intervals. Place the ARGOS receiver/beeper close to the antenna to detect transmissions.
6. 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.
7. The oil bladder will expand, this should take 15 - 25 minutes.
8. After the piston pump stops, the air pump will inflate the air portion of the bladder taking 20 - 30 seconds. Verify bladder expansion by inserting finger into hole in cowling.
9. The PTT will transmit at the mission specified ARGOS rate.
10. 6 hours after reset, transmissions will cease, the piston pump will retract and the bladder will deflate, the profiler begins its programmed mission.
11. 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. 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.

The Flntu Sensor has a protective cap that must be removed before deployment. To remove cap cut black O-ring which holds it in place.

IV. DOWN Time based on YEARDAY

This optional feature (which is not included in all APEX floats) allows profile interval to change automatically, based on day of year. Day of year is determined by a user-settable internal clock and YEARDAY parameter.

YEARDAY has a range of 1 to 365. It advances every 24 hours and rolls over at 365 Value 1 represents 01 January and 365 represents 31 December (there is no provision for leap years).

Schedule programmed in firmware (not user settable):

If (1 < YEARDAY < 91) then DOWN time is menu parameter D1
If (91 < YEARDAY < 365) then DOWN time is menu parameter D2

For three floats s/n 2308, 2309, 2247, parameter D1 is set to 61 hours; D2 is set to 229 hours. UP time (i.e. ascent + surface time) is 11 hours.
So, for the first 90 days of the year, this float will profile once every 3 days.
For the remaining days of the year, it will profile every 10 days.

Setting and checking time and YEARDAY:
With a terminal connected (as described in separate Test Procedure),
YEARDAY is set with lower case d,

example: d 21 <enter> sets 21 January

Clock time is set with lower case t,

example: t hh mm ss <enter> note spaces are required as shown

Both time and YEARDAY are listed when command L is given.
Note L is Upper Case.

V. Deep Profile first (DPF) feature

In some cases, users want the float to return a CTD profile shortly after deployment, for comparison to conventional CTD cast from the ship. The DPF feature satisfies this need.

After the initial six hour buoyant period, the float descends to profile depth (per menu parameter **P6**). For a **1200m** profile, descent requires nominally 6 hours, followed by 4 hour ascent. So ARGOS transmission of the first profile begins approximately 16 hours after reset.

Descent timing:
If profile depth is not reached within eight hours, up cast profile starts (UP time begins). If profile depth is achieved within eight hours, the remainder of 8 hours is added to UP time, and upcast profile starts. Apex standard park and profile sequence continues as stated below.

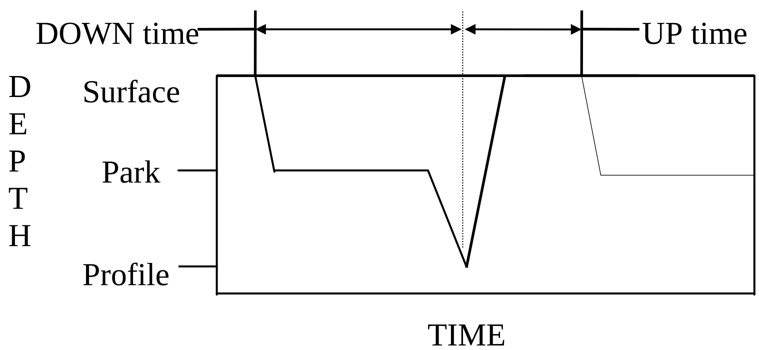
VI. PARK and PROFILE Feature

APEX floats with park and profile feature can be set to profile from a maximum depth (profile depth) after a given number of profiles from a shallower depth (park depth).

Terminology:
PARK: intermediate depth at which the float drifts
PROFILE: maximum depth to which the float descends before profiling up.
DOWN time: spent during descent and at park depth.
UP time: includes ascent and time at surface.

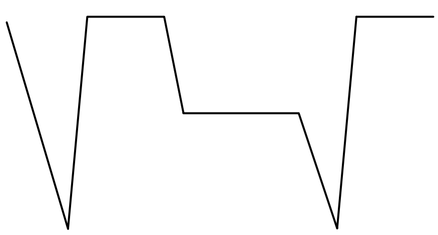
Ascent rate: approximately .08 meters per second.

Total Up time is typically set to 12 to 20 hours, increasing proportional to depth and amount of data to be transmitted per profile. Another factor is deployment location: due to the polar orbit of ARGOS, the number of passes per day increases at high latitudes.

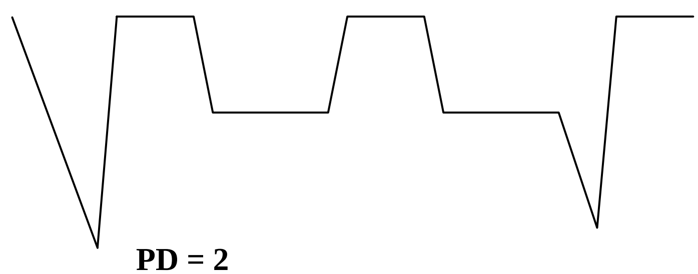


Note the schematic above does not show the optional Deep Profile First (DPF) feature.

Parameter **PD** determines the frequency of deep profiles.
Schematic examples:



PD = 1
deep profile every cycle



PD = 2
deep profile every 2nd cycle

VII. Optional Sensors

Optional sensors are sampled at the same time as the SeaBird CTD, at pressure values listed in the depth table.

A. SeaBird IDO Integrated Dissolved Oxygen

SeaBird's IDO Integrated Dissolved Oxygen (IDO) sensor is integrated to the CTD on the upper end cap of the float. See section VIII, part C, for conversion of telemetered data to useful units.

B. WetLabs FLNTU-APX Combination Fluorometer and Turbidity Sensor

WetLabs FLNTU-APEX is an optical sensor, which combines a 470/695 nm chlorophyll fluorometer and 700 nm backscatter sensors.

This sensor is mounted to the pressure cylinder, and connected via a cable to the lower end cap.

Raw sensor outputs (designated CHL and NTU) are telemetered as counts. Applying linear scaling constants unique to each sensor, these data can be expressed in meaningful forms of chlorophyll fluorescence and NTUs. For a full explanation, see section 6 "Data Analysis" of the sensor manual:
http://www.wetlabs.com/products/pub/eco/flntuk.pdf

For best sensor accuracy, profiles with this sensor should be made before sun rise. Ambient light in the upper ocean may cause plankters to respond with decreasing fluorescence, which leads to under-measurement of the relevant quantities. By synchronizing the float schedule with local time, it is possible to have every profile made before local sun rise. Note this requires that the mission cycle (ie UP + DOWN time) must be an integer multiple of 24 hours

The floats described in this manual will surface ~16 hours after RESET, and every 10 days thereafter. To ensure profile completion ~2 hours before local sun rise, the float should be RESET 18 hours before local sun rise. For example, if sun rise is at 06:00 local, the floats should be reset at 12:00 (noon).

C. *Testing the sensors*

Sensors can be tested by connecting a terminal, with the provided interface cable, as described in the separate APEX Final Test Procedure.

Below are two samples from the Wet Labs Flntu.
The first example is “open”(no objects within three feet of sensor).
The second example is with a fluorescent stick (provided by Wet Labs) held in front of the sensor. An open palm will produce similar “large” values.

I 4	command **I4**
WET Labs CHL NTU	open
50 54	decimal output
0032 0036+	hexadecimal
I 4	
WET Labs CHL NTU	with fluorescent test stick
3978 4086	
0F8A 0FF6+	

Below is an example of out put from the SeaBird IDO oxygen sensor.

S S 15.8 V 004	command **SS**
-0.05, 19.9108, 0.0099, 17617	decimal pressure (db), T (deg C), S, Oxygen (Hz)
0000 4DC7 000A 44D1	hexadecimal

VIII. 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: 31 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 #34 IDO and FLNTU

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 2 -**see section D
- 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, one count = 13 mA
- 16 **Profile piston position** *(park and profile floats only)*
- 17 **Air bladder pressure** measured in counts - approximately 148 counts
- 18 & 19 **Clock time**. Decimal*2 = time from 00:00:00
- 20 & 21 **Day** 1-365
- 22 & 23 **Park temperature**, sampled just before instrument descends to target depth.*
- 24 & 25 **Park salinity**, sampled just before instrument descends to target depth.*
- 26 & 27 **Park pressure**, sampled just before instrument descends to target depth.*
- 28 & 29 **Park Dissolved Oxygen**, sampled just before instrument descends to target depth.
- 30 & 31 **Park CHL**, sampled just before instrument descends to target depth.

Format for message number 2

Byte #

- 01 **CRC**, described in section C.
- 02 **Message number**
- 03 & 04 **Park NTU,** sampled just before instrument descends to target depth.
- 05 **Park battery voltage**, no load

- 06 **Park battery current**
- 07 & 08 **Surface Pressure** as recorded just before last descent with an offset of +5 dbar
- 09 **Internal vacuum** measure in counts- approximately 101 counts
- 10 **Park piston position**
- 11 **Battery voltage** at Sbe pump time
- 12 **Battery current** at Sbe pump time
- 13 & 14 2 bytes **1st profile temperature**
- 15 & 16 2 bytes **1st profile salinity**
- 17 & 18 2 bytes **1st profile pressure**
- 19 & 20 2 bytes **1st profile dissolved oxygen**
- 21 & 22 2 bytes **1st profile CHL**
- 23 & 24 2 bytes **1st profile NTU**
- 25 & 26 2 bytes **2nd profile temperature**
- 27 & 28 2 bytes **2nd profile salinity**
- 29 & 30 2 bytes **2nd profile pressure**
- 31 first of two bytes **2nd profile dissolved oxygen**

Sequence for message 3 and higher
Byte #

- 01**CRC**, described in section C.
- 02 **Message number**
- 03-31 continuing 12 byte sampling sequence described above.

**Note byte pairs will split between messages. For instance byte 31 of message #2 will contain half of the byte pair for the 2nd dissolved Oxygen sample. The other half pressure byte will appear in byte 3 of message #3.

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. 70

1	1200	31	420	61	40
2	1170	32	400	62	35
3	1140	33	380	63	30
4	1110	34	360	64	25
5	1080	35	340	65	20
6	1050	36	320	66	15
7	1020	37	305	67	10
8	990	38	290	68	5
9	960	39	275	69	4 or surf
10	930	40	260		
11	900	41	245		
12	870	42	230		
13	840	43	215		
14	810	44	200		
15	780	45	190		
16	750	46	180		
17	720	47	170		
18	690	48	160		
19	660	49	150		
20	640	50	140		
21	620	51	130		
22	600	52	120		
23	580	53	110		
24	560	54	100		
25	540	55	90		
26	520	56	80		
27	500	57	70		
28	480	58	60		
29	460	59	50		
30	440	60	45		

* 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. Conversion of SeaBird model 43F dissolved oxygen data

Unlike P, T and S values that are fully converted, with calibration coefficients, to scientific units before being output by the CTD, the oxygen data are telemetered as integer frequency values with a resolution of 1 Hz. Typical values will range from 1500 Hz (approx zero-oxygen) to 5000 Hz (approx saturation). If the oxygen value is 0 Hz the sensor is not working (unpowered or signal disconnected).

The calibration equation to convert SBE-43F frequency to units of [ml/L] is on the calibration certificate for each 43F.

The SBE-43F calibration equation is:
oxygen(ml/L) = {SOC * (F + Foffset)} * exp(Tcor*T) * Oxsat(T,S) * exp(Pcor*P)

where:
F = SBE-43F oxygen sensor output frequency in Hz,
T = CTD temperature in degrees C,
S = CTD salinity in PSU,
P = CTD pressure in dbars,
SOC, Foffset, Tcor, and Pcor are calibration coefficients,

exp() is the natural exponential function,
check value: exp(0.0012*10.1218)=1.012220,

Oxsat() is the oxygen saturation function of Weiss (Deep-Sea Research, 1970, v17, p721-735),
check value: Oxsat(10.1218, 34.7414) = 6.312 ml/L,
for the function definition see Application Note 64, **APPENDIX A** at:
http://www.seabird.com/application_notes/AN64.htm

To convert oxygen concentration to units of micromoles per Kg
oxygen (micromole/Kg) = oxygen (ml/L) * 44660/(sigma_theta + 1000)

Example calculation:

A) Conversion of hexadecimal telemetry to useful units:

	hex →	dec	=	converted	units
Temperature:	3E80 →	16000	=	16.000	C
Salinity:	88B8 →	35000	=	35.000	
Pressure:	1D4C →	7500	=	750.0	decibars
DO Frequency:	0BB8 →	2800	=	2800	Hz

B) Sample calibration coefficients (from sensor no. 1623):

Soc = 2.1458e-004
Foffset = -826.8979
TCor = 0.0017
PCor = 1.350e-04

C) Determination of Oxsat(T,S):

Oxsat(T,S) = Oxsat (16.000, 35.000) = 5.576 ml/l

D) Calculation of oxygen concentration:

oxygen(ml/L) = {SOC * (F + Foffset)} * exp(Tcor*T) * Oxsat(T,S) * exp(Pcor*P)

= {2.1458e-004 * (2800-826.8979)}*exp(0.0017*16.000)*5.58*exp(1.350e-04*750)

= 2.686 ml/l

D. 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 00:00:00**, in two second intervals (Hex)
- 07 & 08 **Day** 1-365
- 09 **Flag (2) byte**
- 10 **Battery voltage**
- 11 **Current Bladder pressure,** in counts
- 12 **Up time**, in intervals
- 13 & 14 **Down time 1**, in intervals
- 15 & 16 **Down time 2**, in intervals
- 17 & 18 **Park pressure,** in dbar
- 19 **Park piston position**, in counts
- 20 **Depth correction factor,** in counts
- 21 **Storage piston position**, in counts
- 22 **Fully extended piston position**, in counts
- 23 & 24 **Profile pressure,** in dbar
- 25 **Profile piston position**, in counts
- 26 **OK vacuum count at launch**, in counts
- 27 **Ascend time**, in intervals
- 28 **Target bladder pressure**, in counts
- 29 **Month**, software version number (in decimal).
- 30 **Day**, software version number (in decimal).
- 31 **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 Seabird String length error

**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

E. FLAG BYTE DESCRIPTION

Two memory bytes are used, one bit at a time, to store 16 different bits of program flow information. Both of these bytes are telemetered in the test messages sent at startup and for the initial 6 hour surface period. Only flag byte 2 is sent in the data messages, as part of message number 1. Bit one is set for each deep profile and bit 8 is set each time the last SBE sensor value used an arithmetic round up.

Below is a list of what each bit in each byte signifies.

	bit
Flag (2) byte:	1 Deep profile
	2 Pressure reached zero
	3 25 minute NextP timeout
	4 Piston fully extended
	5 Ascend timed out
	6 Test message at turn on
	7 Six hour surface message
	8 Seabird String length error

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

The flag bytes are transmitted as two hex characters with four bits of information encoded in each character. Each hex character can have one of 16 different values as shown in the following table.

1	0	0000	10	9	1001
2	1	0001	11	A	1010
3	2	0010	12	B	1011
4	3	0011	13	C	1100
5	4	0100	14	D	1101
6	5	0101	15	E	1110
7	6	0110	16	F	1111
8	7	0111			
9	8	1000			

Bit 8 is the most significant bit and bit 1 is the least significant bit in the byte.

As an example: if a deep profile ended with the piston fully extended and ascend had timed out, then bits 1, 4 and 5 would be set in the termination byte. This binary pattern, 0001 1001, would be transmitted as the two hex characters, 19.

As another example: if a regular profile ended with the piston fully extended and the 25 minute next pressure had timed out, then bits 3 and 4 would be set in the termination byte. This binary pattern, 0000 1100, would be transmitted as the two hex characters, 0C.

F. 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
```

G. Conversion from hexadecimal to useful units

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:	5 digits, 1 milli-degree resolution.
Salinity:	5 digits, .001 resolution
Pressure:	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
Current	0A→	10	=	130	mA
Volts	99 →	153	=	15.7	volts

Voltage (V) = counts/10 + .4 (counts is in decimal number) nominally 15 V and decreasing.
Current (mA) = counts *13 (counts is in decimal number)
Vacuum (inHg) = counts *-0.209 + 26.23 (counts is in decimal number) nominally 5 inHg.

*Note regarding <u>negative</u> 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) ≥ F448, then compute FFFF - (hex value) = Y
Convert Y to decimal = dec_Y
(dec_Y + 1) / 1000*-1 = 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.

IX. MISSIONS

INSTRUMENT #2247

APEX version 07 01 05 sn 2436 034 070
29BD4D4 ARGOS ID number.
044 seconds repetition rate.
061 hours DOWN time 1. (Jan - Mar) D1
229 hours DOWN time 2. (Apr - Dec) D2
011 hours UP.
1000 d-bar park pressure   P1
040 park piston position   P2
012 ascent rate correction. P3
100 storage piston position P4
251 piston full extension   P5
1200 d-bar profile pressure P6
025 deep pfl piston position P7
115 OK vacuum count   P8
006 hours ascend time   P9
145 air bladder pressure   PB   (to be changed to 152 per email instructions)
025 Initial piston extension.
13:54:50 Day 188

INSTRUMENT #2308

APEX version 07 01 05 sn 2584 034 070
29BD4F2 ARGOS ID number.
046 seconds repetition rate.
061 hours DOWN time 1. (Jan - Mar) D1
229 hours DOWN time 2. (Apr - Dec) D2
011 hours UP.
1000 d-bar park pressure   P1
040 park piston position   P2
012 ascent rate correction. P3
100 storage piston position P4
254 piston full extension   P5
1200 d-bar profile pressure P6
025 deep pfl piston position P7
115 OK vacuum count   P8
006 hours ascend time   P9
152 air bladder pressure   PB
025 Initial piston extension.
14:27:54 Day 236

INSTRUMENT #2309

APEX version 07 01 05 sn 2580 034 070
29BD4E1 ARGOS ID number.
046 seconds repetition rate.
061 hours DOWN time 1. (Jan - Mar) D1
229 hours DOWN time 2. (Apr - Dec) D2
011 hours UP.
1000 d-bar park pressure   P1
040 park piston position   P2
012 ascent rate correction. P3
100 storage piston position P4
250 piston full extension   P5
1200 d-bar profile pressure P6
025 deep pfl piston position P7
115 OK vacuum count   P8
006 hours ascend time   P9
152 air bladder pressure   PB
025 Initial piston extension.
14:27:02 Day 236

Appendix A: Surface arrival time, and total surface time

Some users may wish to determine surface arrival time, and total surface time, in order to calculate drift vectors.

Although each 31-byte message is time-stamped by ARGOS, there may not be a satellite in view when the float surfaces.

When the float surfaces (ie detects surface pressure recorded before last descent) it will begin ARGOS telemetry. Messages are transmitted in numerical order, starting with message no. 1. When all messages have been transmitted, the cycle starts again at message no. 1.

Elapsed time since surfacing (Te)

Te = (m-1)*n*r
Where: m = message block number (byte 03 of message 01)
n = total number of messages to transmit profile
r = repetition rate

Total number of messages (n) is described in section IV (b), or may be determined from the ARGOS data. Note (n) may be less than specified in user manual if the float is operating in shallow water, causing reduced profile length.

Repetition rate (r) is the time interval between ARGOS transmissions. This value can be determined from section V, or from the ARGOS data.

Approximate time of surfacing

Subtracting Te from the ARGOS time stamp can determine approximate time of surfacing

Example

Below is message 01 in DS format

```
2001-11-02 22:47:54 1 CF 01 05 02
AF 02 2F 00
85 01 01 01
16 92 17 19
9E 94 01 AD
85 09 1F 48
97 9B 00 46
62 24 0E
```

m = message block number (byte 03) = 5
n = total number of messages to transmit profile = 11
r = repetition rate = 62 seconds

Te = elapsed time since surfacing = (m-1)*n*r = (5-1)*11*62 s = 2728 s = 00h 45m 28s

Approximate time of arrival at surface:
ARGOS time stamp - Te = 22:47:54 - 00:45:28 = 22:02:26

Total time spent at surface transmitting (Tsurf):

This is determined by subtracting ascent time from UP time.
Tsurf = (UP time, hr) - (bottom pressure)/(ascent rate 0.08 dbar/s)/3600

Bottom pressure is telemetered as bytes 7 & 8 of message 02.

Example:

For bottom pressure of 2000 dbar, and UP time of 18 hours
Tsurf = (18 hr) - (2000/0.08/3600) = 11 hr

APPENDIX B: Argos ID formats, 28 bit and 20 bit

In 2002 Service Argos notified its users there were a limited number of 20-bit Ids available and to begin preparing for a transition to 28-bit IDs. The 28 bit-IDs reduced from 32 to 31 the number of data bytes in each message. Data provided by Argos will consist of 31 hex bytes per message. Data acquired by use of an uplink receiver will consist of 32 hex bytes per message. The first byte, when using an uplink receiver, is a 28-bit ID identifier used by Argos and is not represented in the Apex Data formats included in this manual.

APPENDIX C: Storage conditions

For optimum battery life, storage temperature range is +10 to +25 degrees C. When activated, the floats should be equilibrated at a temperature between -2 and +54 degrees C.
If optional VOS or aircraft deployment containers are used, these must be kept dry, and should be stored indoors only.

APPENDIX D: Returning APEX for factory repair or refurbishment

Contact WRC before returning APEX floats for repair or refurbishment.
All returns from outside USA, please specify our import broker:
Logan International Airport, Boston
    c/o DHL-Danzas Freight Forwarding Agents,
Phone (617) 886-5605, FAX (617) 241-5917
500 Rutherford Avenue, Charlestown, MA 02129

Note on shipping documents: US MADE GOODS

APPENDIX E: CTD Calibration and Ballasting records

(included in hard copy only)