Webb Research Corporation

82 Technology Park Drive, E. Falmouth, MA 02536-4441   (508) 548-2077 FAX (508) 540-1686

USER MANUAL – APEX-SBE PROFILER

APEX-SBE INSTRUMENTS
Serial numbers:

REV DATE
WRC Job no.
Software Rev 12-27-07
Park and Profile with 28-bit ID
Including Pressure Activation and DPF
Negative surface pressure record and air pump limits

I. ALKALINE BATTERY WARNING

The profiler contains batteries comprised of alkaline manganese dioxide "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 H_2O, and the instrument has been designed to relieve excessive internal pressure buildup by having the upper end cap 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.   Maximum Operating Pressure

The APEX design is rated for 2000db (2900 psi) maximum operating pressure.   However, for shallower applications, thinner pressure cylinders are often used.   The thinner cylinders have a reduced pressure rating, and less mass, allowing installation of more batteries.   There are three cylinder pressure ratings: 2000, 1500 and 1200 db.

For example, if an APEX is specified for 1400 db maximum (profile) depth, then the 1500 db cylinder would be used.

CAUTION for users who:
      - expose APEX to hydrostatic pressure during ballasting or testing
            OR
      - intend to re-ballast and re-program floats for a depth greater than original specification
Please contact Webb Research to confirm the pressure rating of specific floats.
Do not exceed rated pressure, or the float may collapse.
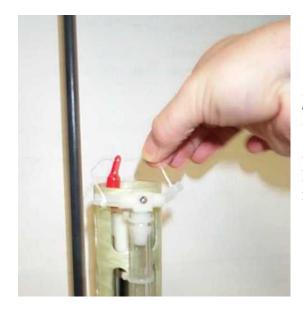
III.   Reset and Self Test

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.

IMPORTANT:
Remove plastic bag and three plugs from CTD sensor, if they have not already been removed.

2. The minimum internal temperature of the float is - 2.0 °C. If necessary, let float warm indoors before proceding.

3. Carefully remove black rubber plug from bottom center of yellow cowing to verify bladder inflation (per below). **Use fingers only- tools may puncture bladder. Be sure to replace plug before deployment.**
Note: it can be very difficult to replace plug when air bladder is fully inflated. Replace plug during beginning

of air bladder inflation. (Purpose of plug is to prevent silt entry if float contacts sea floor).

4. Hold provided magnet at RESET position marked on for several seconds, then remove magnet.

Note: Magnetic 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 ARGOS receiver/beeper close to antenna to detect transmissions.

7. The piston pump will begin to operate. The piston will move to full extension.

8. The oil bladder will expand, this should take 15 - 25 minutes.

9. After the piston pump stops, PTT will transmit at specified ARGOS rate. (If repetition rate is 120 seconds, the controller is not communicating properly with CTD and float should not be deployed).

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 6 test transmissions during step six, and/or if bladder does not inflate, then the self-test has failed and the instrument should not be deployed.**

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 interval. Typical repetition rate is 90 seconds or less. (Programmed repetition rate can be found in the Missions section of this manual).

- If the repetition rate is 120 seconds the controller is not communicating properly with the CTD and the float should not be deployed.

- Six hours after reset, the piston pump will retract and bladder will deflate. **Important**: deploy within 6 hours of reset, or reset again to re-initialize 6 hour period. (Purpose is to have instrument on surface to receive test transmissions, and to ensure proper buoyancy control)

- Pass a rope through the hole in the damper plate.

- Holding both ends of rope bight, carefully lower float into water. Do not let rope slide through hole in disk- this may cut the plastic disk.

- Take care not to damage antenna.

- **Do not leave the rope with the instrument**, release one end and retrieve the rope.

- The float will remain on surface until 6 hour interval has expired.

V.   Software Features:

A.   *Pressure activation*

Floats are normally activated (i.e. reset) as described in section II.   Pressure activation is a backup feature intended to ensure activation if the normal reset procedure is accidentally omitted.

Note pressure activation is an optional feature; it is NOT included in all APEX floats.

The reset and self-test sequence described in section II should be followed carefully.   Pressure activation should be used only as a backup in case reset is forgotten.

The float must sink in order for this feature to work. In order to ensure that the float will sink, it will reduce buoyancy to park piston position at a menu-settable time interval (parameter **PA**). CTD pressure is checked one hour later. If pressure indicates that the float is below the surface (P > 25 db or 36 PSI) the float will activate and follow normal start sequence described in section II, steps 5 and greater.

Conversion of PA parameter to hours:
The integer value of PA is multiplied by two hours. For example, if PA is set to **one**, then every **two** hours the controller will reduce buoyancy to park piston position, then check pressure one hour later.

Note PA value of 255 is a special case, resulting in pressure check every 120 days. This virtually turns OFF the pressure activation feature, in order to conserve battery energy

Energy implications:
Each cycle of moving the piston and checking pressure consumes a small amount of battery energy. Note the piston will not usually be moved, in most cases it will already be in park piston position.

Typical values for PA:
      01 (pressure check every 2 hours)
      255 (pressure check every 120 days)

B.   *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 2000m profile, descent requires nominally 6 hours, followed by 7 hour ascent.

So ARGOS transmission of the first profile begins approximately 19 hours after reset.

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

C.   Air pump limits

This revision of firmware will limit the 6 second air pump cycle during Argos surface transmissions to 40 pumps or 2000 Volt-seconds. This feature was introduced to protect against pneumatic system failures using excessive battery capacity.

D.   Negative surface pressure

This firmware revision will now transmit, in bytes 26&27 of message 1, negative surface pressures. Previous generations of software had rounded all negative pressures to 0 and added a 5 dbar offset. The 5 dbar offset is still applied for surface detection but not transmitted. In the event of a large negative or positive surface pressure (+/- 5 dbar) maximum piston position will be used for surfacing. See section VII, E for conversion to useful units.

E.   No Seabird response

This firmware will continue to profile should the Seabird sensor become unresponsive. Previous generations of firmware would stop functioning properly if the Seabird sensor stopped functioning. The user would usually have no evidence to the cause of the failure. An Apex with firmware revision 12-27-07 will continue to profile and all Seabird data normally provided by the Seabird sensor will be replaced in the Argos data transmissions with EE EE. In the event of no response from the Sbe sensor all normal buoyancy adjustment are no longer made. The pump will fully extend to surface and return to the last know piston positions for profiling. The firmware will recover and operate normally if the sensor begins properly functioning again.

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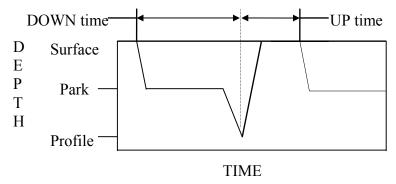**PARK**:   intermediate depth at which the float drifts
PROFILE: maximum depth to which the float descends before profiling up.
DOWN time: spent during descent and at park depth.
UP time: includes ascent and time at surface.

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

Note: For maximum battery life in ARGO applications, WRC recommends use of PD > one, with park depth $\leq$ 1500 db.

VII. 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.

* Using Argos 28-bit ID Format, 31 data bytes are transmitted in each message. With 20-bit ID Format, each message had 32 data bytes. (see Appendix D for more information).

B. *DATA FORMAT – 46 For 28-bit ID format*

Data are sent via ARGOS in 31 byte hex messages. The number of 31 byte messages sent depends on the programmed quantity of temperature measurements per profile. See appendix D

Format for message number 1 only:
Byte #
- 01 **CRC**, described in appendix 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 C
- 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 **Bottom piston position** *(park and profile floats only)*
- 17 **Air bladder pressure** measured in counts - approximately 148 counts
- 18 & 19 **Park temperature**, sampled just before instrument descends to target depth.*
- 20 & 21 **Park salinity**, sampled just before instrument descends to target depth.*
- 22 & 23 **Park pressure**, sampled just before instrument descends to target depth.*
- 24 **Park battery voltage**, no load
- 25 **Park battery current**
- 26 & 27 **Surface Pressure,** as recorded just before last descent with an offset of +5 dbar
- 28 **Internal vacuum** measure in counts- approximately 101 counts
- 29 **Park piston position***
- 30 **SBE pump Voltage**
- 31 **SBE pump current**

Format for message number 2 and higher:

Byte #
- 01 **CRC**, described in section C.
- 02 **Message number**
- 03 to 31 6 bytes- **in sequence and continuing in the next message****
  - 2 bytes **temperature**
  - 2 bytes **salinity**
  - 2 bytes **pressure**

**Note byte pairs will split between messages. For instance byte 31 of message #2 will contain half of the byte pair for the 5th pressure sample. The other half pressure byte will appear in byte 3 of message #3. See chart below.

Message Format and Sampling Depths

BTYE #	MSG 1
18 & 19	Tp*
20 & 21	Sp*
22 & 23	Pp*
26 & 27	Ps**

BTYE #	MSG 2	BTYE #	MSG 3	BTYE #	MSG 4
3 & 4	Profile T	3	Half P4	3 & 4	P9
5 & 6	Profile S	4 & 5	T5	5 & 6	T10
7 & 8	Profile P	6 & 7	S5	7 & 8	S10
9 & 10	T1	8 & 9	P5	9 & 10	P10
11 & 12	S1	10 & 11	T6	11 & 12	T11
13 & 14	P1	12 & 13	S6	13 & 14	S11
15 & 16	T2	14 & 15	P6	15 & 16	P11
17 & 18	S2	16 & 17	T7	17 & 18	T12
19 & 20	P2	18 & 19	S7	19 & 20	S12
21 & 22	T3	20 & 21	P7	21 & 22	P12
23 & 24	S3	22 & 23	T8	23 & 24	T13
25 & 26	P3	24 & 25	S8	25 & 26	S13
27 & 28	T4	26 & 27	P8	27 & 28	P13
29 & 30	S4	28 &29	T9	29 & 30	T14
31	Half P4	30 & 31	S9	31	Half S14

Sampling continues as shown above relevant to the number of depth table points sampled.
After the last data point in last message a Hex value of FFFF will fill remaining bytes.

*   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

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. 63

Sample Point	Pressure (dbar) Bottom	Sample Point	Pressure (dbar)	Sample Point	Pressure (dbar)
1	1902	27	518	53	140
2	1810	28	493	54	132
3	1721	29	469	55	124
4	1637	30	446	56	116
5	1558	31	424	57	108
6	1482	32	404	58	100
7	1409	33	384	59	92
8	1341	34	365	60	84
9	1275	35	348	61	76
10	1213	36	331	62	68
11	1154	37	314	63	60
12	1098	38	299	64	53
13	1044	39	285	65	46
14	993	40	271	66	39
15	945	41	257	67	32
16	899	42	245	68	25
17	855	43	233	69	18
18	813	44	222	70	11
19	773	45	211	71	4 or surf
20	736	46	201		
21	700	47	191		
22	666	48	181		
23	633	49	172		
24	602	50	164		
25	573	51	156		
26	545	52	148		

* 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 31 Bytes, in hex unless otherwise noted, with the following format:

Byte #

– 01 **CRC**, described in appendix 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 two second intervals (Hex)
– 07 **Flag (2) byte**
– 08 & 09 **Current pressure,** in bar
– 10 **Battery voltage**
– 11 **Current Bladder pressure,** in counts
– 12 **Up time**, in hours
– 13 & 14 **Down time**, in hours
– 15 & 16 **Park pressure,** in bar
– 17 **Park piston position**, in counts
– 18 **Depth correction factor,** in counts
– 19 **Storage piston position**, in counts
– 20 **Fully extended piston position**, in counts
– 21 **OK vacuum count at launch**, in counts
– 22 **Ascend time**, in intervals
– 23 **Target bladder pressure**, in counts
– 24 & 25 **Profile pressure,** in bar
– 26 **Profile piston position**, in counts
– 27 **Deep profile cycle counts**
– 28 **Pressure activation period** (See page 7)
– 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 Bottom data sample time
- 2 Air pump cycle limit reached.
- 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 SBE string length error

D.   Telemetry error-checking (CRC)

Because ARGOS data contains 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. 2)
- If the calculated and transmitted CRC values are not equal, the message has been corrupted and should be deleted before further data processing.

Appendix (B) lists 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

E.   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
Pressure***:	FFBB →	68	=	-6.8	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.

***All pressures are represented as 16 bit signed integers (2's compliment).
        If (hex value) ≥ 8000, then compute FFFF - (hex value) = Y
        Convert Y to decimal = dec_Y
        (dec_Y + 1) / 10 = dbar

If no SBE response, pressures are represented as error code EEEE. Furthermore, if an SBE error occurs, all 6 bytes of pressure, temperature and salinity data for the park data in message 1 and the profile sample data will be set to EEEEEE.

VIII. MISSIONS

This section lists the parameters for each float covered by this manual.
The parameter listing appears when the float is RESET while connected to a terminal.

INSTRUMENT #
INSTRUMENT #
INSTRUMENT #

Appendix A: Flag Byte Description

One memory byte is used to store 8 different bits of program flow information. This byte is telemetered in the test messages sent at startup and for the initial 6 hour surface period. Flag byte 2 is also 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	Bottom data sample time
	2	air pump cycle limit reached
	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

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.

Appendix B: CRC Algorithm in BASIC for 28 bit Id

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 31 bytes in an ARGOS message is the CRC.
'The function CRC will compute CRC for byte 2 through 31.
'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(31) AS INTEGER
'RAF11F message number 08 HEX ID 11502 01-02-93   CRC is O.K.
A$ = "d802075d87c64e15078187c64c1f07b287c74a3007ce87c6483f07fe87c246"
        N = 31
        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
```

Appendix C: 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 D: 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 E: 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 F: 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

CAUTION: If the float was recovered from the ocean, it may contain water, which presents a safety hazard due to possible chemical reaction of batteries in water, which may generate explosive gases (see Section I. Alkaline Battery Warning).   In this case, be sure to remove the seal plug to ventilate the instrument.   Use a 3/16 inch hex wrench, or pliers, to rotate the plug counter-clockwise.

Please use provided 3/16" allen wrench to remove this vent plug

rotate counter –clockwise to unscrew plug.

APPENDIX G: CTD Calibration and Ballasting records

(included in hard copy only)