TELEDYNE WEBB RESEARCH
A Teledyne Instruments, Inc. Company

82 Technology Park Drive
E. Falmouth, Massachusetts 02536
Phone: 508.548.2077
Fax: 508.540.1686
Email: dwebb@webbresearch.com

APEX PROFILER USER MANUAL

Applies to Serial Numbers:	Revision Date:	07/27/09
4723, 4724	Customer Name:	CSIRO
	Job Number:	1670.4
	Firmware Revision	APF9A F/W **021009**
	Features:	

APF9A Controller
Ice Detection
Park and Profile with 20- or 28-bit ARGOS ID
Deep Profile First (DPF)
Pressure Activation (optional)

Flash Depth Table 65

I. Alkaline Battery Warning ___ *3*
II. APF9 Operations Warning for APF8 Operators ___ *4*
III. Maximum Operating Pressure ___ *5*
IV. Evaluating the Float and Starting the Mission ___ *6*
A. Manual Deployment with the Reset Tool ___ **7**
B. Pressure Activation Deployment ___ **8**
C. Mission Activation and Mission Prelude ARGOS Transmissions ___ **9**
D. Mission Activation and Operator Float Function Check ___ **10**
E. Notes and Caveats ___ **13**
Deploying the Float ___ *14*
V. Park and Profile ___ *15*
A. Profile Ascent Timing ___ **15**
B. Profile and Profile Cycle Schematics ___ **16**
VI. Deep Profile First (DPF) ___ *17*
VII. Ice Detection ___ *18*
VIII. ARGOS Data ___ *19*
A. SERVICE ARGOS Parameters ___ **19**
B. Test Messages - 28-bit ARGOS ID - Mission Prelude ___ **19**
C. Data Messages - 28-bit ARGOS ID ___ **21**
D. Conversion from Hexadecimal to Physical Units ___ **25**
E. Depth Table 65 for PTS Samples ___ **26**
F. Telemetry Error Checking (CRC) ___ **27**
Appendix A: Surface Arrival Time and Total Surface Time ___ *29*
Appendix B: Argos ID formats, 28-bit and 20-bit ___ *30*
Appendix C: Storage conditions ___ *30*
Appendix D: Connecting a Terminal ___ *31*
Appendix E: APF9A Command Summary ___ *32*
Appendix F: Returning APEX floats for factory repair or refurbishment ___ *36*
Appendix G: Missions ___ *37*
Appendix H: CTD Calibration and Ballasting records ___ *39*

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.

Teledyne Webb Research 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.

Teledyne Webb Research 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.

Teledyne Webb Research disclaims liability for any consequences of combustion or explosion.

II. APF9 Operations Warning for APF8 Operators

This APEX manual describes floats using a new controller design. The new design is designated APF9. The prior design, which is still in production and widely used, is designated APF8.

The operator interface and behavior of the APF9 are similar to, **but not identical to**, the operator interface and behavior of the APF8. If you are an experienced APF8 user, please observe appropriate cautions and **do not assume an expected behavior**. Several important differences are listed below. These points should also be helpful to those without an APF8 background.

- To reset an APF9 for a deployment you should hold the Reset Tool stationary against the RESET label until you hear the air pump run. Typically, the air pump will run 2 to 3 seconds after you position the Reset Tool over the RESET label. (For the APF8 it was necessary to hold the Reset Tool in place and then remove it to trigger the float.)
- The serial baud rate for communications is 9600, with 8 data bits, no parity, and 1 stop bit. (The APF8 baud rate is 1200.)
- If not already in Command Mode, an APF9 can only enter Command Mode from Sleep. Either the Reset Tool or a keystroke at the terminal will trigger the transition from Sleep to Command Mode.
- If the APF9 is performing some task (e.g., self tests), it is not listening and cannot be placed in Command Mode with either the Reset Tool or a keystroke at the terminal.
    - There is one exception. If the piston is moving, the Reset Tool (but not a keystroke) can be used to terminate the move. The APF9 will transition to its next state or task. Typically this will be either Command Mode or Sleep, so try a keystroke or a second application of the Reset Tool after the piston stops to confirm or trigger the transition to Command Mode.
- If the APF9 is not responding, it is probably busy with some task. Be patient and occasionally try to get the attention of the float with either the Reset Tool or a keystroke.

III. Maximum Operating Pressure

APEX profilers have a maximum operating pressure of 2000 dbar (2900 psi). However, for shallower applications, thinner walled pressure cylinders can be used. These cylinders have a reduced pressure rating, but less mass, which allows them to carry a larger battery payload. Three cylinder pressure ratings are available:

- 2000 dbar maximum pressure rating
- 1500 dbar battery payload typically 14% greater than with 2000 dbar cylinder
- 1200 dbar battery payload typically 28% greater than with 2000 dbar cylinder

For example, if an APEX profiler is specified by the customer for 1400 dbar maximum (profile) depth, then the 1500 dbar cylinder would normally be used.

CAUTION:

If you will be:

- Exposing floats to significant hydrostatic pressure during ballasting or testing
- Re-ballasting and re-programming floats for a depth greater than the original specification

Please contact Teledyne Webb Research to confirm the pressure rating of specific floats. Do not exceed the rated pressure, or the hull may collapse.

IV. Evaluating the Float and Starting the Mission

Profilers are shipped to the customer in Hibernate mode. **The Pressure Activation feature is NOT ACTIVE.** With the Pressure Activation feature included in this version of the APF9A firmware, there are two possible deployment procedures. The procedures are described below.

IMPORTANT: Pressure Activation is NOT automatic for this firmware version of the APF9A. The Pressure Activation feature MUST be MANUALLY ACTIVATED by the OPERATOR using a PC to communicate with the float.

The following sections, "Manual Deployment with the Reset Tool" and "Pressure Activation Deployment", provide operational summaries for these two possible deployment scenarios. Both sections refer to self tests conducted by the float and float function checks performed by the operator.

A detailed description of proper float behavior, self tests, and the associated operator actions and observations needed to evaluate the float for deployment is provided in "Mission Activation and Operator Float Function Check".

IMPORTANT: The float should not be deployed if it does not behave as described in "Mission Activation and Operator Float Function Check".

Teledyne Webb Research
strongly recommends testing all APEX Profilers
on receipt by the customer and before deployment
to ensure no damage has occurred during shipping.

A. Manual Deployment with the Reset Tool

Shortly before deployment, reset the profiler by holding the Reset Tool over the marked location on the pressure case. Hold the Reset Tool in position for approximately 3 seconds. Remove the Reset Tool only after you hear the air pump activate.

The float will run a brief self test. This is the Mission Activation phase. During this time the operator should verify proper function of the float (see "Mission Activation and Operator Float Function Check"). The float will then transmit test messages for 6 hours at the programmed repetition rate during the Mission Prelude phase. Six hours is typical; the duration of the Mission Prelude can be set by the operator. The piston will be fully extended at the beginning of the Mission Prelude (before the test transmissions begin) and the air bladder will be fully inflated during the first dozen or so test transmissions. At the conclusion of the Mission Prelude the float will begin its pre-programmed mission.

Manual Deployment Summary:

- Hold the Reset Tool over the RESET label
- Mission Activation
    - Air pump runs once
    - Self test conducted (see below for verification procedure)
        - Internal tests run (can be monitored if communication cable is connected, see "Connecting a Terminal")
        - 6 ARGOS transmissions
    - Piston EXTENDED fully
- Mission Prelude
    - Test transmissions at the programmed repetition rate
    - Mission Prelude duration is typically 6 hours
    - Air pump run during transmissions until air bladder is fully inflated

The float can be deployed after the Mission Activation phase and confirmation of proper float function have been successfully completed. We advise waiting until the air bladder is fully inflated during the first dozen or so test transmissions of the Mission Prelude before deploying the float.

B. Pressure Activation Deployment

To use the Pressure Activation feature you must first connect the provided communication cable between your PC and the float (see "Connecting a Terminal" at the end of this manual for additional information). The normal port settings for an APF9A are 9600, 8, N 1. Press [ENTER] to wake the float from Hibernate mode. The float will respond that it has detected an "asynchronous wake-up" and will enter Command mode. Press [ENTER] in Command mode to display the main menu. Menu selections are not case sensitive.

Press 'a' or 'A' to activate the Pressure Activation feature and start the deployment. The float will run a brief self test (Mission Activation). During this time the operator should verify proper function of the float (see below - Mission Activation and Operator Float Function Check). The float will then fully retract the piston and deflate the air bladder so that it can sink when deployed. Once the piston is fully retracted, the float enters the Pressure Activation phase. During this phase the float makes a pressure measurement every two hours, hibernating between measurements. If the pressure is less than 25 dbar the float returns to hibernation. If the pressure exceeds 25 dbar the float fully extends the piston and begins the Mission Prelude with test transmissions and air bladder inflation.

During the Pressure Activation phase the operator can communicate with the float. This does NOT NORMALLY deactivate Pressure Activation. However, a 'k' or 'K' (kill) command during this phase will deactivate Pressure Activation and stop the mission.

DO NOT DEPLOY THE FLOAT AFTER A KILL (K) COMMAND UNLESS YOU HAVE STARTED A MANUAL DEPLOYMENT OR RESTARTED A PRESSURE ACTIVATION DEPLOYMENT. IF YOU FAIL TO OBSERVE THIS CAUTION AND LAUNCH THE FLOAT IT WILL SINK TO A NEUTRAL DEPTH AND STAY THERE. IT WILL NOT SURFACE AGAIN.

In the absence of a kill command the float will automatically resume the Pressure Activation phase after several minutes without operator input. Placing the Reset Tool over the RESET mark during the Pressure Activation phase will start a deployment.

Pressure Activation Deployment Scenario

Using the Pressure Activation feature minimizes operator/float interaction while at sea. A skilled operator can fully test the float while still in the laboratory environment or while the vessel is still at the dock. At the conclusion of testing the Pressure Activation feature can be activated and the float can be left to await deployment. When the vessel is on-station it only remains to launch the float (see "Deploying the Float"). No further communications with the float is required and the float can be reliably deployed by relatively inexperienced personnel.

One caution is in order. The air bladder is not automatically inflated until the beginning of the Mission Prelude phase of a deployment. This means it cannot be checked by the operator for leaks during the normal course of a Pressure Activation deployment. Therefore, we strongly recommend that you either:

- Manually inflate and check the air bladder before starting a Pressure Activation deployment. Be sure to manually close the air valve before trying to inflate the air bladder. Starting a Pressure Activation deployment will automatically deflate the bladder.

Or:

- Start a Manual Deployment with the Reset Tool or an operator command and reassert operator control after the Mission Activation and initial portion of the Mission Prelude phases, with attendant operator float function check, has successfully completed.

Pressure Activation Deployment Summary:

- Establish communication with the float (see "Connecting a Terminal")
- Press 'a' or 'A'
- Mission Activation
    - Air pump runs once
    - Self test conducted (see below for verification procedure)
        - Internal tests run (can be monitored if communication cable is connected, see "Connecting a Terminal")
        - 6 ARGOS transmissions
    - Air bladder deflated
    - Piston RETRACTED fully
- Deploy the float
- Pressure Activation
    - Pressure measured every 2 hours
    - Pressure in excess of 25 dbar extends piston, inflates air bladder, triggers transition to Mission Prelude
- Mission Prelude
    - Test transmissions (6 hours typical)
    - Air pump run during transmissions until air bladder is fully inflated

The float can be deployed after the Mission Activation phase and proper functioning of the float have been successfully completed.

C. Mission Activation and Mission Prelude ARGOS Transmissions

The six ARGOS transmissions during Mission Activation and the transmissions during the Mission Prelude contain data about the instrument. The information needed to decode these messages is provided in the "ARGOS Data" section of this manual.

D. Mission Activation and Operator Float Function Check

1) Secure the float in a horizontal position using the foam cradles from the shipping crate.

2) The minimum internal temperature of the float is -2.0°C. If necessary, allow the float to warm up indoors before proceeding.

3) Remove the plastic bag and three (3) plugs from the CTD sensor as shown in the two images below.

4) Carefully remove the black rubber plug from the bottom center of the yellow cowling as shown in the image below. This will allow you to verify air bladder inflation in the steps below. **Use only your fingers to remove the plug. Tools may puncture or otherwise harm the bladder.** **Be sure to replace the plug before deployment!**

Note: It can be difficult to replace the plug when the air bladder is fully inflated. We suggest that you reinsert the plug before the bladder is fully inflated. The plug prevents the entry of silt into the cowling in the event the float contacts the sea floor.

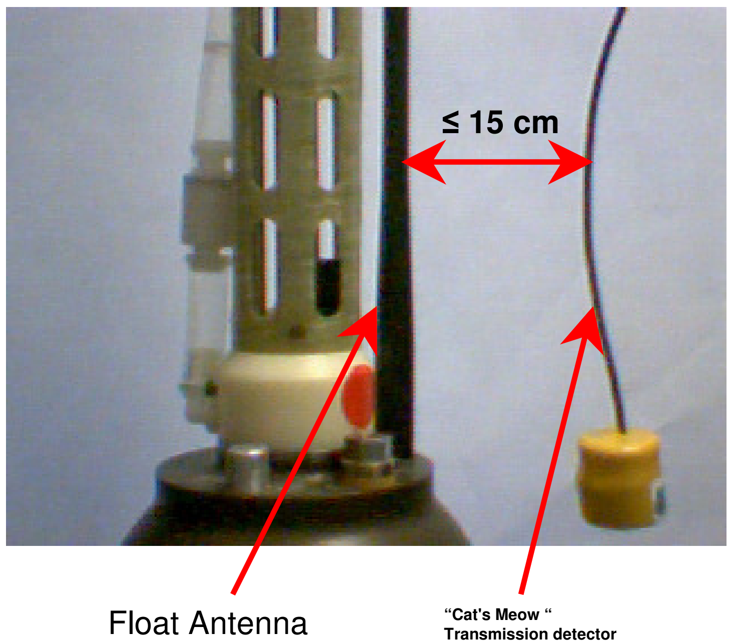
5) Start a Manual or Pressure Activated Deployment as described above in the "Manual Deployment with the Reset Tool" and "Pressure Activation Deployment" sections. This will trigger the Mission Activation self tests. Where applicable, the description below indicates where the two versions of the self tests differ.

   Verify by ear that the air pump is activated for approximately 1 second.

   DO NOT DEPLOY THE FLOAT IF IT DOES NOT BEHAVE AS DESCRIBED BELOW. FLOATS THAT DO NOT PASS THE SELF TESTS SHOULD NOT BE DEPLOYED. CONTACT TELEDYNE WEBB RESEARCH FOR ASSISTANCE.

6) The float will conduct self tests for approximately 15 seconds. Progress and diagnostic messages will be displayed if a terminal is connected to the float (see "Connecting a Terminal" for additional information).

7) If the float passes the self tests, it will make 6 ARGOS transmissions with a 6 second interval. You can detect these transmissions using the "cat's meow" sensor as shown in the image at right. Hold the sensor parallel to and within 15 cm (6 inches) of the float's antenna. The cat's meow will beep during each ARGOS transmission. Do not deploy the float if you do not detect the six (6) ARGOS transmissions.



8) Manual Deployment: If not already fully extended, the float will fully extend the piston. This process may require up to 25 minutes. The oil bladder will expand during this time.

   Pressure Activated Deployment: If not already fully retracted, the float will fully retract the piston. This process may require up to 25 minutes. The oil bladder will deflate during this time.

   The volume of oil in the bladder is difficult to detect by hand. You may be able to hear the pump by placing your ear against the hull.

9) Manual Deployment: Once the piston is fully extended the float enters the Mission Prelude phase. During this phase it will transmit test messages at the operator specified ARGOS repetition period. These transmissions can be detected with the Cat's Meow. The float will run the air pump for 6 seconds during each test transmission until the air bladder is fully inflated. Inflating the air bladder typically requires 8 to 10 repetitions. Check for air bladder inflation by sticking your finger (**not a tool!**) through the hole in the bottom of the yellow cowling as described in Step (4) above. **Don't forget to replace the plug before deploying the float.**

The duration of the Mission Prelude is set by the operator. 6 hours is typical. At the end of the Mission Prelude the ARGOS test transmissions will cease, the float will deflate the air bladder and retract the piston, and the first descent of the programmed mission will begin.

Pressure Activated Deployment: Once the piston is fully retracted the float will enter the Pressure Activation phase. During this phase it will check the pressure every two hours, hibernating in between. The float will not enter the Mission Prelude phase until it detects a pressure in excess of 25 dbar. There will be no test transmissions nor inflation of the air bladder until the Mission Prelude phase begins.

When the trigger pressure is detected the float will extend the piston and begin the Mission Prelude, making ARGOS test transmissions at the specified repetition rate and also running the air pump to inflate the air bladder (see above). The duration of the Mission Prelude is set by the operator. 6 hours is typical. At the end of the Mission Prelude the ARGOS test transmissions will cease, the float will deflate the air bladder and retract the piston, and the first descent of the programmed mission will begin

10) The float is ready to deploy.

E. Notes and Caveats

Self Tests: During the self tests the float checks:

- The internal vacuum
- Communication with the CTD
- The internal alarm timer settings

If any of the self tests fail the float will abort the mission. The clearest indication to the operator that this has occurred is the failure of the float to make the initial 6 ARGOS transmissions at 6 second intervals.

If you do not detect these Mission Activation transmissions with the Cat's Meow, DO NOT DEPLOY THE FLOAT!

Manual Deployment: In the case of a Manual deployment, if the float is not deployed before the completion of the Mission Prelude phase,

RESET the float again and wait for it to complete the Mission Activation phase and begin the Mission Prelude before you deploy it.

Pressure Activated Deployment: In the case of a Pressure Activated Deployment, the operator is necessarily absent when the float begins the Mission Prelude. This means the operator does not have the opportunity to check the air bladder for leaks that a Manual Deployment offers.

For this reason we strongly recommend that you manually inflate and check the bladder before starting a Pressure Activated Deployment.

Deploying the Float

1) Pass a rope through the hole in the plastic damper plate, which is shown in the image at right. The rope should fit easily through the hole and be capable of supporting 50 kg (100 lb).

2) Holding **both** ends of the rope bight, carefully lower the float into water. The damper plate is amply strong enough to support the weight of the float. However, do not let rope slide rapidly through the hole as this may cut the plastic disk and release the float prematurely.

3) Take care not to damage the CTD or the ARGOS antenna against the side of the ship while lowering the float.

4) **Do not leave the rope with the instrument.** Once the float is in the water, let go of the lower end of the rope and pull on the top end slowly and carefully until the rope clears the hole and the float is released.

   It may take several minutes for the cowling to fully flood with water and the float may drift at an angle or even rest on its side during this period. This is normal behavior and not a cause for concern.

5) Manual Deployment: The float will remain on surface for the duration of the Mission Prelude.

   Pressure Activated Deployment: The float will sink immediately. It will return to the surface within 3 hours and begin the Mission Prelude after detecting a pressure in excess of 25 dbar.

V. Park and Profile

The APF9A float can be set to profile from a maximum depth (Profile Depth) after a programmable number (N) of profiles from a shallower depth (Park Depth). Special cases are conducting all profiles from either the Profile Depth or the Park Depth. The latter is an important special case that can be selected by setting N = 254. This will cause all profiles start at the Park Depth; the programmed Profile Depth is ignored. Between profiles the float drifts at the Park Depth.

<u>Terminology</u>:

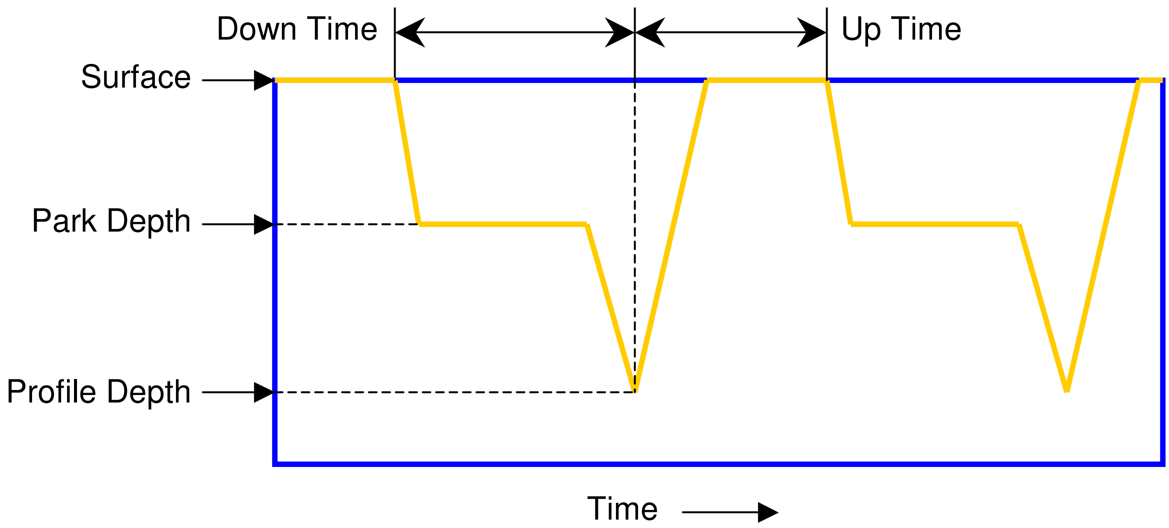
- Park Depth — Intermediate depth at which the float drifts between profiles and from which the float profiles in cycles not evenly divisible by N.
- Profile Depth — Maximum depth to which the float descends from the Park Depth every Nth cycle and from which each Nth profile is conducted.
- Down Time — Programmed time-limit for descending from the surface and drifting at the Park Depth. Down Time is commonly set to 10 days or to 10 days less the Up Time.
- Up Time — Programmed time-limit for ascending from the Park or the Profile Depth and drifting at the surface while transmitting the data acquired during the profile. Up Time is typically set between 12 hours and 20 hours, increasing with the amount of data to be transmitted per profile. The latitude of the deployment also matters; ARGOS satellites are in polar orbits, so the number of satellite passes per day increases with latitude.
- Ascent Rate — The ascent rate of the float is maintained at or above 8 cm/s. The float extends the piston by a user specified amount to add buoyancy when the ascent rate falls below this threshold.

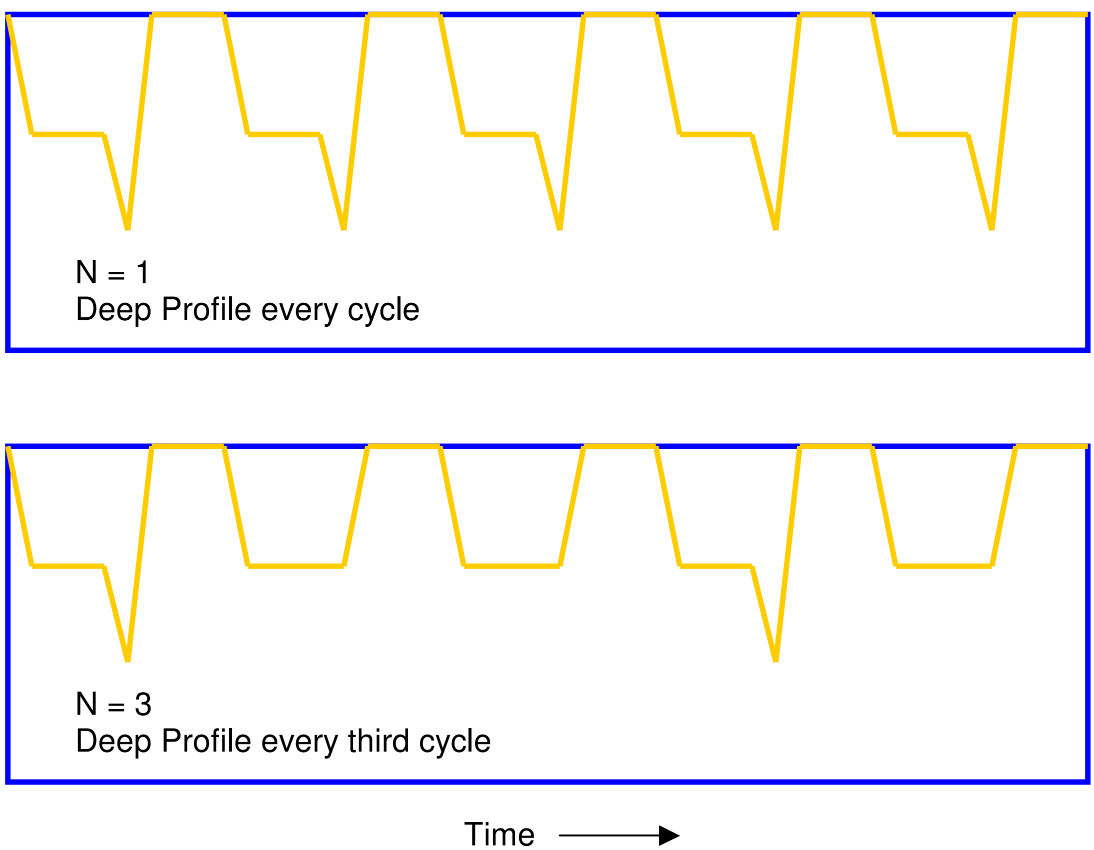
A. Profile Ascent Timing

Profiles from the Park Depth begin when the operator programmed Down Time expires. The float extends the piston by an operator programmed initial amount and begins the ascent.

When a profile is to begin from the Profile Depth, the float will retract the piston and descend from the Park Depth an operator programmed interval before the expiration of the Down Time. This interval, Parameter Mtj, Deep-profile descent time in hours, provides the additional time needed to descend to and profile from the Profile Depth without losing significant surface time, the period when data from the profile are transmitted.

B. Profile and Profile Cycle Schematics

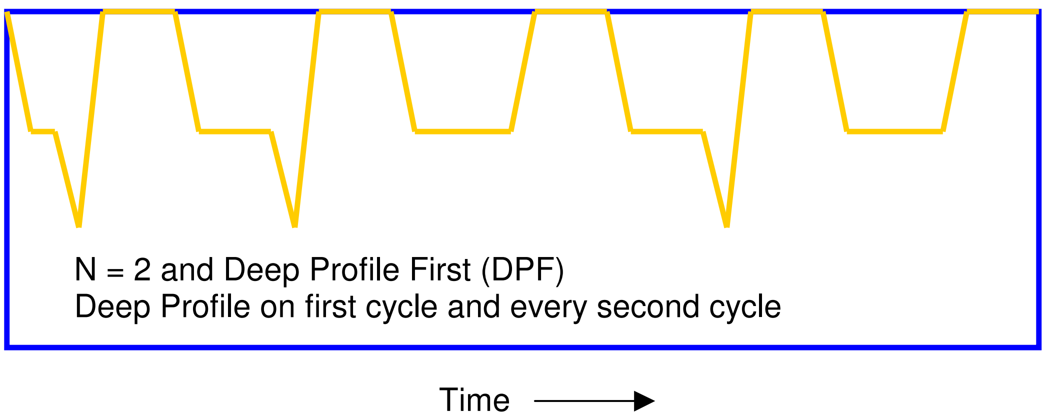




VI. Deep Profile First (DPF)

Independent of the Park and Profile cycle length, the first profile is always a Deep Profile that begins at the Profile Depth. This means the float returns a CTD profile relatively soon, typically less than a day, after the float is deployed. This feature supports comparison of the initial float profile with a conventional CTD cast from the ship.

The first descent begins at the end of the Mission Prelude. A schematic representation of DPF with a Park and Profile parameter N = 2 is shown below.



VII. Ice Detection

This float has an ice detection and evasion feature to enhance float survivability in regions prone to ice cover. When hydrographic features associated with surface ice are detected, the float will descend to avoid damage.

Ice detection and evasion is controlled seasonally on a monthly basis. The user can specify which months to enable ice detection based upon winter conditions for the designated float location. It is based on temperature measurements starting at 50 decibars. The temperature samples are collected every 2.5 decibars. The sorted median value of the samples is computed at each sample point to characterize the mixed layer temperature hydrography. If at any pressure less than 30 decibars the median of the temperature measurements is less than a user-specified critical temperature, the surface is assumed to be ice covered and ice evasion occurs. The float will abort the profile and descend, remaining at the park piston position for the duration of the current profile period. The data for the aborted profile is not available.

It is important to understand the intended hydrography. If the critical temperature is set too high, the feature will always evade. If the critical temperature is too low, evasion may not occur during actual ice conditions. The seasonal aspect of this feature can help ensure floats will always profile during desired months.

The default values for the winter months and critical temperature used in ice detection missions (as shown in the mission status list) are:

-1.80	Ice Detection: Mixed-Layer Tcritical (C) Mit
0xTBD	Ice Detection: Winter months [DNOSAJJMAMFJ] Mib

The temperature default is based on the value used in other float applications.
The winter months designate which months to enable ice detection processing. Note that if ice detection processing is enabled for a winter month and no ice is detected, the float will still surface and transmit as usual. It is only when ice detection is enabled and ice is detected that the mission is aborted. With knowing the specific region, the safest approach for defaults is to enable ice detection processing for all months except one summer month to ensure surfacing for at least that one month. The bit mask is input as a 3 digit hexadecimal value with each bit representing a month in the order designated. The southern and northern hemisphere defaults are shown below.

DSNOSAJJMAMFJ	Mib	Region
111111111101	FFD	Southern Hemisphere (all months except February)
111101111111	F7F	Northern Hemisphere (all months except August)

These settings should be carefully reviewed for the target hydrography. The values can be modified to better suit application needs if required. For example, if the region is known to be ice-free for 6 months, we can close the winter window to ensure transmission for those summer months.

VIII. ARGOS Data

A. SERVICE ARGOS Parameters

Each float operator must specify various options to Service ARGOS. These choices depend on how the user plans to receive and process data. Typical Service ARGOS Parameters are:

• Standard location		
• Processing:	Type A2	Binary input, hexadecimal output
• Result (output) format:	DS	All results from each satellite pass
• Compression:	None	Uncompressed
• Distribution strategy:	Scheduled	All results every 24 hours
• Number of bytes transmitted:	31 per message[1]	

B. Test Messages - 28-bit ARGOS ID - Mission Prelude

```
Test Message Format:
--------------------

Test Message #1:

Byte(s)  Pneumonic    Description
-------------------------------------------------------------------------------
      0        CRC    Message CRC computed with BathySystem's CRC generator.
      1        MSG    Message id.  Test message blocks are allowed to span
                      more than one message so a message id is required.
      2        BLK    Message block id.  The block id increments with each
                      transmitted message block with overflow at 0xff.
      3        MON    Firmware revision: month.
      4        DAY    Firmware revision: day.
      5         YR    Firmware revision: year.
    6,7        FLT    Float id.
    8,9        SEC    The time [seconds] since the start of the mission
                      prelude.
  10,11     STATUS    This word records the state of 16 status bits.
                      Individual bits can be accessed with an appropriate bit-
                        mask.
  12,13          P    Pressure [centibars] measured once each test-message
                        block.
     14        VAC    Vacuum [counts] measured during self-test.
     15        ABP    Air bladder pressure [counts] measured once each
                      test-message block.
     16        BAT    Quiescent battery voltage [counts] measured once each
                      test-message block.
     17         UP    Mission configuration: up-time [TQuantum] modulo-256.
  18,19       DOWN    Mission configuration: down-time [TQuantum] modulo-
                        65536.
```

[1] When using a 28-bit ARGOS ID, 31 data bytes are transmitted in each message. 32 data bytes are transmitted in each message when using a 20-bit ARGOS ID.

20,21	PRKP	Mission configuration: park pressure [decibars].
22	PPP	Mission configuration: park piston position [counts].
23	NUDGE	Mission configuration: buoyancy nudge for ascent maintenance [counts] (aka., depth correction factor).
24	OK	Mission configuration: internal vacuum threshold [counts] for mission abortion. (aka., OK-vacuum count).
25	ASCEND	Mission configuration: ascent time-out period [TQuantum] modulo-256.
26	TBP	Mission configuration: maximum air bladder pressure [counts].
27,28	TP	Mission configuration: target profile pressure [decibars].
29	TPP	Mission configuration: target profile piston position [counts].
30	N	Mission configuration: park & profile cycle length.
31		Not used - exists only when 20-bit argos ids are used.

Test Message #2:

Byte(s)	Pneumonic	Description
0	CRC	Message CRC computed with BathySystem's CRC generator.
1	MSG	Message id. Test message blocks are allowed to span more than one message so a message id is required.
2	BLK	Message block id. The block id increments with each transmitted message block with overflow at 0xff.
3	MON	Firmware revision: month.
4	DAY	Firmware revision: day.
5	YR	Firmware revision: year.
6	FEXT	Piston count at full extension. (counts)
7	FRET	Piston count at full retraction. (counts)
8	IBN	Initial buoyancy nudge. (counts)
9	DPDP	Deep-profile descent period. (hours)
10	PDP	Park descent period. (hours)
11	PRE	Mission prelude period. (hours)
12	REP	Argos repetition period. (seconds)
13,14	SBESN	Serial number of the SBE41 sensor module.
15,16	SBEFW	Firmware revision of the SBE41 sensor module.
17,18	ICEM	Bit-mask for when ice-detection is active.
19,20	IMLT	Critical temperature for under-ice mixed layer.
21-24	EPOCH	The current UNIX epoch (GMT) of the Apf9a RTC (little endian order)
25,26	TOD	The number of minutes past midnight when the down-time will expire. If ToD feature is disabled then these bytes will be set to oxfffe.
28,28	DEBUG	The debugging verbosity used for generating log entries.
29-30		Not used yet.

The SBE41 biographical data transmitted in this firmware revision is the SBE41's serial number (2 bytes) and the SBE41's firmware revision (2 bytes). The serial number is encoded as a hex integer. For example, serial number 1500 would be encoded and transmitted as 0x05DC. The firmware revision is multiplied by 100 before being encoded as a hex integer. For example, FwRev 2.6 will be multiplied by 100 to get 260 before being encoded as 0x0104.

The low-order 12-bits of bytes 17,18 is a bit-mask that determines when ice-detection is active. The bits represent the months in reverse order. The lowest order bit represents January and the highest order bit (of the 12-bits) represents December.

C. Data Messages - 28-bit ARGOS ID

The number of data messages depends on the number of measurements made during the profile. The formats of the data messages are shown in the tables below. Data Message 1 contains float, profile, and engineering data.

```
Message #1
----------

Byte(s)  Pneumonic    Description
-------------------------------------------------------------------------------
      0        CRC    Message CRC computed with BathySystem's CRC generator.
      1        MSG    Message id.
      2        BLK    Message block id.  The block id increments with each
                      transmitted message block with overflow at 0xff.
    3,4        FLT    Float id.
      5        PRF    Profile id modulo-256.
      6        LEN    Number of TSP samples in this message block.
    7,8     STATUS    This word records the state of 16 status bits.
                      Individual bits can be accessed with an appropriate bit-
                        mask.
   9,10         SP    The surface pressure [centibars] as recorded just
                      prior to the descent to the park depth.
     11        VAC    The internal vacuum [counts] recorded when the park
                      phase of the mission cycle terminated.
     12        ABP    The air bladder pressure [counts] recorded just after
                      each argos transmission.
     13        SPP    The piston position [counts] recorded when the
                      surface-detection algorithm terminated.
     14       PPP2    The piston position [counts] recorded at time that
                      the park phase of the mission cycle terminated.
     15        PPP    The piston position [counts] recorded at the time
                      that the last deep-descent phase terminated.
  16,17      SBE41    This word records the state of 16 status bits
                      specifically related to the SBE41.  Individual bits
                      can be accessed with an appropriate bit-mask.
  18,19        PMT    The total length of time [seconds] that the pump motor
                      ran during the current profile cycle.
     20         VQ    The quiescent battery voltage [counts] measured when
                      the park phase of the profile cycle terminated.
     21         IQ    The quiescent battery current [counts] measured when
                      the park phase of the profile cycle terminated.
     22       VSBE    The battery voltage [counts] measured when the SBE41
                      sampled after the park phase of the profile cycle
                      terminated.
     23       ISBE    The battery current [counts] measured when the SBE41
                      sampled after the park phase of the profile cycle
                      terminated.
     24       VHPP    The battery voltage [counts] measured just prior to
                      then end of the initial extension of the buoyancy pump
                      at the start of the profile phase of the profile cycle.
     25       IHPP    The battery current [counts] measured just prior to
                      then end of the initial extension of the buoyancy pump
                      at the start of the profile phase of the profile cycle.
     26        VAP    The battery voltage [counts] measured during the most
                      recent period when the air pump was activated.
     27        IAP    The battery current [counts] measured during the most
                      recent period when the air pump was activated.
     28        PAP    The number of 6-second pulses of the air pump required
```

```
                      to inflate the air bladder.
  29,30       VSAP    The integrated measure (Volt-Sec) of the volume of air
                      pumped during the telemetry cycle.
     31         NA    Not used.  Present only if a 20-bit argos id is used.


/* definition of the 'STATUS' bits in the engineering data above  */
DeepPrf          0x0001  The current profile is a deep profile.
ShallowWaterTrap 0x0002  Shallow water trap detected
Obs25Min         0x0004  Sample time-out (25 min) expired.
PistonFullExt    0x0008  Piston fully extended before surface-detection
                         algorithm terminated.
AscentTimeOut    0x0010  Ascent time-out expired.
TestMsg          0x0020  Current argos message is a test message.
PreludeMsg       0x0040  Current argos message transmitted during mission
                         prelude.
PActMsg          0x0080  Current argos message is a pressure-activation test
                         message.
AirSysBypass     0x0080  Air inflation system by-passed; excessive energy
                         consumption.
BadSeqPnt        0x0100  Invalid sequence point detected.
Sbe41PFail       0x0200  Sbe41(P) exception.
Sbe41PtFail      0x0400  Sbe41(PT) exception.
Sbe41PtsFail     0x0800  Sbe41(PTS) exception.
Sbe41PUnreliable 0x1000  Sbe41(P) unreliable.
IceDetected      0x2000  Ice-detection algorithm terminated true.
WatchDogAlarm    0x4000  Wake-up by watchdog alarm.
PrfIdOverflow    0x8000  The 8-bit profile counter overflowed.

/* definition of the 'SBE41' status bits in the engineering data above  */
Sbe41PedanticExceptn 0x0001 An exception was detected while parsing the p-only
                              pedantic regex.
Sbe41PedanticFail    0x0002 The SBE41 response to p-only measurement failed
                              the pedantic regex.
Sbe41RegexFail       0x0004 The SBE41 response to p-only measurement failed
                              the nonpedantic regex.
Sbe41NullArg         0x0008 NULL argument detected during p-only measurement.
Sbe41RegExceptn      0x0010 An exception was detected while parsing the p-only
                              nonpedantic regex.
Sbe41NoResponse      0x0020 No response detected from SBE41 for p-only
                              request.
                     0x0040 Not used yet.
                     0x0080 Not used yet.
Sbe41PedanticExceptn 0x0100 An exception was detected while parsing the pts
                              pedantic regex.
Sbe41PedanticFail    0x0200 The SBE41 response to pts measurement failed the
                              pedantic regex.
Sbe41RegexFail       0x0400 The SBE41 response to pts measurement failed the
                              nonpedantic regex.
Sbe41NullArg         0x0800 NULL argument detected during  pts measurement.
Sbe41RegExceptn      0x1000 An exception was detected while parsing the pts
                              nonpedantic regex.
Sbe41NoResponse      0x2000 No response detected from SBE41 for pts request.
                     0x4000 Not used yet.
                     0x8000 Not used yet.


Message 2:
-----------

Message 2 includes miscellaneous engineering data, ice detection/evasion
```

data, and eleven statistics of temperature and pressure collected hourly during the park phase: Number of samples, mean temperature, mean pressure, standard deviation of temperature, standard deviation of pressure, minimum temperature, pressure associated with minimum temperature, maximum temperature, pressure associated with maximum temperature, minimum pressure, and maximum pressure. Each of these 11 statistics consumes 2 bytes. Pressure and temperature data are encoded as shown in the C-source below.

Byte(s)	Pneumonic	Description
0	CRC	Message CRC computed with BathySystem's CRC generator.
1	MSG	Message id.
2	NADJ	Number of active-ballast adjustments.
3	IER	The ice evasion record for the most recent 8 profiles with the most recent profile in the position of the least significant bit. Asserted bits indicate profiles where the ice-detection algorithm terminated true.
4	MLN	Number of mixed-layer samples taken.
5,6	MLT	The median of the mixed-layer temperature (C).
7,8	MLTINF	The infimum of the mixed-layer median temperature (C) since the last successful telemetry.
9,10	PRKN	Number of hourly park-level PT samples.
11,12	TMEAN	Mean temperature of park-level PT samples.
13,14	PMEAN	Mean pressure of park-level PT samples.
15,16	SDT	Standard deviation of temperature of park-level PT samples.
17,18	SDP	Standard deviation of pressure of park-level PT samples.
19,20	TMIN	Minimum temperature of park-level PT samples.
21,22	TMINP	Pressure associated with Tmin of park-level PT samples.
23,24	TMAX	Maximum temperature of park-level PT samples.
25,26	TMAXP	Pressure associated with Tmax of park-level PT samples.
27,28	PMIN	Minimum pressure of park-level PT samples.
29,30	PMAX	Maximum pressure of park-level PT samples.
31	NA	Not used. Present only if a 20-bit argos id is used.

Messages 3-N:

The hydrographic data are transmitted in messages 3-N in the order that they were collected. The sample taken at the end of the park phase will be transmitted first (in bytes 2-7 of message 3) followed by the samples collected during the profile phase. Each sample consists of 6 bytes in order of T (2 bytes), S (2 bytes), P (2 bytes). The hydrographic data are encoded as shown in the C-source code below.

Message N: Auxiliary Engineering data

The last message is filled out with auxiliary engineering data. This is engineering data that is of a lower priority that the engineering data transmitted in message 1. The amount of engineering data will be variable and only enough to complete the last message (at most). The auxiliary engineering data will never cause an additional message to be generated. If the auxiliary engineering data are not sufficient to complete the last message then the remaining unused bytes will be set to 0xff.

Measuring the mixed-layer temperature: Three bytes of auxiliary engineering data related to ML temperature measurements are transmitted. The first byte beyond the end of the hydrographic data is the number of temperature samples collected between 50dbars and the surface. The next two bytes represent the encoded median temperature of these samples.

Active ballasting: The first bit of auxilary engineering data is the number of buoyancy adjustments during the park phase of the profile cycle.

Measuring descent rate: The next set of auxiliary data transmitted in this firmware revision are the descent pressure marks. During the park-descent phase, the pressure is measured just after the piston has been retracted; this is the first descent mark. In addition, at hourly intervals after initiation of the park-descent phase, the pressure is measured. These measurements mark the descent and can be used to determine the descent rate as a function of time.

The first byte beyond the end of the ML temperature data is the count of the number of descent pressure marks. This byte is followed by 1-byte pressures (bars) marking the descent phase.

D. Conversion from Hexadecimal to Physical Units

The temperature, salinity, pressure, voltage, and current values measured by the float are encoded in the Data Messages as hex integers. This compression reduces the number of bytes in the ARGOS transmissions. The resolution of the encoded hydrographic values is shown in the table below:

Measurement	Resolution	Range	Data Format	Conversion
Temperature	0.001 °C	-4.095 °C to 61.439 °C	16-bit unsigned with 2's complement	$T = T_{raw} / 1000$
Salinity	0.001 psu	-4.095 psu to 61.439 psu	16-bit unsigned with 2's complement	$S = S_{raw} / 1000$
Pressure	0.1 dbar	-3276.7 dbar to 3276.7 dbar	16-bit unsigned with 2's complement	$P = P_{raw} / 10$
Volts	V		8 bits unsigned	$V = (V_{raw} * 0.077 + 0.486$
Current	MA		8 bits unsigned	$I = (I_{raw} * 4.052) - 3.606$
Vacuum	InHg		8 bits unsigned	$V = (V_{raw} * 0.293) -29.767$

To convert the hex values in an ARGOS message back to physical units, proceed as described in the table below. The initial conversion from Hexadecimal to Decimal should assume the hex value is an unsigned integer with a range of 0 to 65535 for temperature, salinity, and pressure measurements, a range of 0 to 255 for voltage and current measurements and a range of 0 to 4095 for optode measurements. If temperature, salinity or pressure raw values are above the maximum unisigned value listed, a 2's complement conversion should be applied to obtain a signed (negative) value. This allows for representation of a full range of values.

Measurement	Hexadecimal	Decimal and Conversion Steps	Physical Result
Temperature ≥ 0	0x3EA6 (<0xEFFF) →	$T_{raw} = 16038$ $T = T_{raw} / 1000$ →	16.038 °C
Temperature < 0	0xF58B (≥ 0xF001) →	Traw = 62859 $T_{2sComplement} = T_{raw} – 65536 = -2677$ $T = T_{2sComplement} / 1000$ →	-2.677 °C
Salinity	0x8FDD (<0xEFFF) →	$S_{raw} = 36829$ $S = S_{raw} / 1000$ →	36.829 psu
Salinity	0xF003 (≥ 0xF001) →	$S_{raw} = 61443$ $S_{2sComplement} = S_{raw} - 65536 = -4093$ $S = S_{2sCompement} / 1000$ →	-4.093 psu
Pressure ≥ 0	0x1D4C (< 0x8000) →	$P_{raw} = 7500$ $P = P_{raw} / 10$ →	750.0 dbar

Pressure < 0	0xFFFA (≥ 0x8000) →	P_{raw} = 65530 $P_{2sCompliment}$ = P_{raw} - 65536 = -6 P = $P_{2sCompliment}$ / 10 →	-0.6 dbar
Volts	0xBB →	V_{raw} = 187 V= (V_{raw} *0.077) + 0.486 →	14.9 V
Current	0x0A →	I_{raw} = 10 I = (I_{raw} * 4.052) –3.606 →	36.9 mA
Vacuum	0x56 →	V_{raw} = 86 V = (V_{raw}* 0.293) -29.767 →	-4.5 inHg

Conversion Notes:
The temperature range is -4.095 °C to 61.439 °C. Hex values 0xF000 (nonfinite), 0xF001 (≤ -4.095), 0xEFFF (≥ 61.439), and 0xFFFF (missing data) are used to flag out-of-range measurements or are otherwise reserved. Temperatures in the range -0.0015 °C to -0.0005 °C are mapped to 0xFFFE.

The salinity range is -4.095 psu to 61.439 psu. Hex values 0xF000 (nonfinite), 0xF001 (≤ -4.095), 0xEFFF (≥ 61.439), and 0xFFFF (missing data) are used to flag out-of-range measurements or are otherwise reserved. Salinities in the range -0.0015 psu to -0.0005 psu are mapped to 0xFFFE.

The pressure range is -3276.7 dbar to 3276.7 dbar. Hex values 0x8000 (nonfinite), 0x8001 (≤ -3276.7), 0x7FFF (≥ 32767.7), and 0xFFFF (missing data) are used to flag out-of-range measurements or are otherwise reserved. Pressures in the range -0.15 dbar to -0.05 dbar are mapped to 0Xfffe.

E. Depth Table 65 for PTS Samples

Depth Table 65 below, with values expressed in decibars (dbar), defines where PTS measurements are acquired during a profile.

Sample Point	Pressure (dbar) Bottom	Sample Point	Pressure (dbar)	Sample Point	Pressure (dbar)
1	2000	27	550	53	170
2	1900	28	525	54	160
3	1800	29	500	55	150
4	1700	30	475	56	140
5	1600	31	450	57	130
6	1500	32	425	58	120
7	1450	33	400	59	110
8	1400	34	375	60	100

9	1350	35	350	61	90
10	1300	36	340	62	80
11	1250	37	330	63	70
12	1200	38	320	64	60
13	1150	39	310	65	50
14	1100	40	300	66	40
15	1050	41	290	67	30
16	1000	42	280	68	20
17	950	43	270	69	10
18	900	44	260	70	4 or surf
19	850	45	250		
20	800	46	240		
21	750	47	230		
22	700	48	220		
23	650	49	210		
24	625	50	200		
25	600	51	190		
26	575	52	180		

To prevent fouling of the CTD by surface and near-surface contaminants, the shallowest PTS sample is taken when the pressure is between 6 dbar and 4 dbar.

F. Telemetry Error Checking (CRC)

ARGOS messages can contain transmission errors. For this reason the first element of each message is a CRC (Cyclic Redundancy Check) byte. The value is calculated by the float, not by ARGOS, from the remaining bytes of that message. A bad CRC generally means a corrupted message. It is worth noting that a good CRC is a good indicator that the message is OK, but it is possible to have a good CRC even when the message is corrupt. This is particularly true for a short CRC - this one is only 8 bits long. Comparing multiple realizations of each ARGOS message (e.g., all received versions of Data Message 3 for some particular profile) to identify uncorrupted versions of the message is strongly recommended.

A sample code fragment in C that can be used to calculate CRC values is shown below. This code was written by Dana Swift of the University of Washington. The original algorithm was developed in the 1970s by Al Bradley and Don Dorson of the Woods Hole Oceanographic Institution. The algorithm attempts to distribute the space of possible CRC values evenly across the range of single byte values, 0 to 255. Sample programs in C, Matlab, FORTRAN, and BASIC can be provided by TWR on request. The Matlab version provides the user with a GUI interface into which individual ARGOS messages can be entered by cutting and pasting with a mouse.

```
static unsigned char CrcDorson(const unsigned char *msg,
                                 unsigned int n) {

   unsigned char i,crc=CrcScrambler(msg[1]);
```

```
   for (i=2; i<n; i++)    {
      crc ^= msg[i];
      crc  = CrcScrambler(crc);
   }

   return crc;
}

static unsigned char CrcScrambler(unsigned char byte) {

   unsigned char sum=0,tst;

   if (!byte) byte = 0xff;

   tst = byte; if (tst % 2) sum++;
   tst >>= 2; if (tst % 2) sum++;
   tst >>= 1; if (tst % 2) sum++;
   tst >>= 1; if (tst % 2) sum++;

   sum %= 2;

   return (byte>>1) + (sum<<7);
}
```

Appendix A: Surface Arrival Time and Total Surface Time

Calculating surface drift vectors may require that you estimate the surface arrival time. Although each message is time stamped by ARGOS, there may not be a satellite in view at the time the float surfaces. In this case the initial messages are not received.

ARGOS telemetry begins when the float detects the surface. The messages are transmitted in numerical order starting with Message 1. When all of the messages in the block have been transmitted the cycle repeats. Transmissions continue at the programmed repetition rate until the Up Time expires.

The elapsed time since surfacing can be estimated using the message block number (m), the number of messages in the block (n), and the programmed ARGOS repetition period (p).

$$Te = (m - 1) \times n \times p$$

The block number (BLK) is included in each ARGOS message set.

The total number of messages can be determined from the information in Data Message 1, which includes the number of PTS measurements made during the profile (LEN). Note that this value may not be the same as the number of entries in the depth table. For example, a float may drift into shallow water and not be able to reach the some depths. The total number of messages will include message 1 and message 2 plus the number of messages needed for the PTS data.

The repetition period is known *a priori* or can be determined form the ARGOS time stamps on sequential messages.

Subtracting the Te calculated from a particular Message 1 from the message's time stamp produces an estimate of the time at which the float surfaced. An example is shown below

Example Message 1
DS format

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

Block Number	
Byte 2 = 0x05	m = 5
Number of PTS measurements	
Byte 6 = 0x47 → 71	
71 × 6 = 426 bytes	
Number of Msgs for data	
= 426 bytes / 28 bytes per msg = 16	
Total messages = Msg1 + Msg2 + Data Msgs	
= 1 + 1 + 16	n = 18
Repetition Period	p = 46 seconds

Calculate the elapsed time on the surface:

$$Te = (m-1) \times n \times p = (5-1) \times 18 \times 46 = 3312 = 00h\ 55m\ 12s$$

Subtracting this from the time stamp of the ARGOS message yields the approximate time of arrival at the surface:

22:47:54 - 00:55:12 = 20:52:42

The total time spent at the surface can now be calculated by subtracting Te from the known expiration of the Up Time.

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, floats should be stored in a controlled environment in which the temperature is restricted to the range +10 °C to +25 °C. When activated, the floats should be equilibrated at a temperature between -2 °C and +54 °C before proceeding with a deployment.

If the optional VOS or aircraft deployment containers are used, they must be kept dry, and should only be stored indoors.

Appendix D: Connecting a Terminal

The float can be programmed and tested by an operator using a 20 mA current loop and a terminal program. The current loop has no polarity. Connections should be made through the hull ground and a connector or fitting that is electrically isolated from the hull. This is shown in the image below. In this case one side of the current loop is clipped to the zinc anode and the other is clipped to the pressure port.

The communications cables and clamps are included in the float shipment. An RS-232 to current-loop converter is provided with the communications cables. This converter requires a 12 VDC supply.

The RS-232 communications cable should be connected to the COM port of a PC. Run a communications program such as ProComm or HyperTerminal on the PC. Both programs can be downloaded from various Internet sites. HyperTerminal is generally included with distributions of the Windows Operating System.

COM Port Settings: 9600, 8, N, 1
- 9600 baud
- 8 data bits
- No parity
- 1 stop bit
- no flow control / no handshaking
- full duplex

Teledyne Webb Research recommends the practice of capturing and archiving a log file of all communications with each float. If in doubt about a test, email the log file to your chief scientist and/or to Teledyne Webb Research.

Once you have started the communications program and completed the connections described above, press [ENTER] to wake the float from Hibernate mode. The float will respond that it has detected an "asynchronous wake-up" and will enter Command mode. Press [ENTER] in Command mode to display the main menu. Menu selections are not case sensitive. See "APF9A Command Summary" for a complete list of available commands.

Appendix E: APF9A Command Summary

Uppercase commands are used here for clarity; however, APF9A commands are not case sensitive. The menus presented below were copied verbatim from a terminal session with an APF9A controller. ">" is the APF9A prompt for operator input. The first menu is displayed in response to either a question mark ("?") or the [ENTER] when no preceding command is entered.

Main Menu

Deployment Parameter Menu

```
> m Entering Mission Programming Agent
> ?
Menu selections are not case sensitive.
?  Print this menu.
A  Enter ARGOS ID number in HEX.
B  Buoyancy control agent.
Bi Ascent initiation buoyancy nudge. [25-254] (piston counts)
Bj Deep-profile piston position. [1-254] (counts)
Bn Ascent maintenance buoyancy nudge. [5-254] (piston counts)
Bp Park piston position [1-254] (counts)
F  Float vitals agent.
Fb Maximum air-bladder pressure. [1-254] (counts)
Ff Piston full extension. [1-254] (counts)
Fn Display float serial number.
Fs Storage piston position. [1-254] (counts)
Fv OK vacuum threshold. [1-254] (counts)
I  Ice avoidance control agent.
L  List mission parameters.
N  Park and profile cycle length. [1-254]
J  Deep-profile pressure. (0-2000] (decibars)
K  Park pressure. (0-2000] (decibars)
Q  Quit the mission programming agent.
R  Repetition period for Argos transmissions [30-120] (sec).
T  Mission timing agent.
Ta Ascent time-out period. [1-10 hours] (Hours)
Td Down time (0-336 hours] (Hours).
Tj Deep-profile descent time. [0-8 hours] (Hours).
Tk Park descent time. (0-8 hours] (Hours).
Tp Mission prelude. (0-6 hours] (Hours).
Tu Up time (0-24 hours] (Hours).
Z  Analyze the current mission programming.

> l
APEX version 021009  sn 0000
 551D4 20-bit hex Argos id.                       Ma
   060 Argos repetition period (Seconds)          Mr
INACTV ToD for down-time expiration (Minutes)     Mtc
   240 Down time. (Hours)                         Mtd
   013 Up time. (Hours)                           Mtu
   009 Ascent time-out. (Hours)                   Mta
   006 Deep-profile descent time. (Hours)         Mtj
   006 Park descent time. (Hours)                 Mtk
   006 Mission prelude. (Hours)                   Mtp
  1000 Park pressure. (Decibars)                  Mk
  2000 Deep-profile pressure. (Decibars)          Mj
   066 Park piston position. (Counts)             Mbp
   016 Deep-profile piston position. (Counts)     Mbj
   010 Ascent buoyancy nudge. (Counts)            Mbn
   022 Initial buoyancy nudge. (Counts)           Mbi
   001 Park-n-profile cycle length.               Mn
 -1.80 Ice detection: Mixed-layer Tcritical (C)   Mit
 0x000 Ice detection: Winter months [DNOSAJJMAMFJ] Mib
   120 Maximum air bladder pressure. (Counts)     Mfb
   096 OK vacuum threshold. (Counts)              Mfv
   227 Piston full extension. (Counts)            Mff
   016 Piston storage position. (Counts)          Mfs
     1 Logging verbosity. [0-5]                   D
  20df Mission signature (hex).
```

Diagnostics Menu

```
> I ?
Menu of diagnostics.
?  Print this menu.
a  Run air pump for 6 seconds.
b  Move piston to the piston storage position.
c  Close air valve.
d  Display piston position
e  Extend the piston 4 counts.
g  Goto a specified position. [1-254] (counts)
o  Open air valve.
r  Retract the piston 4 counts.
t  Argos PTT test.
1  Run air pump for 6 seconds (deprecated).
2  Argos PTT test (deprecated).
5  Retract the piston 4 counts (deprecated).
6  Extend the piston 4 counts (deprecated).
7  Display piston position (deprecated).
8  Open air valve (deprecated).
9  Close air valve (deprecated).
> m Entering Mission Programming Agent
```

Buoyancy Parameter Menu

```
> B ?
Menu of buoyancy control parameters.
?  Print this menu.
Bi Ascent initiation buoyancy nudge. [25-254] (piston counts)
Bj Deep-profile piston position. [1-254] (counts)
Bn Ascent maintenance buoyancy nudge. [5-254] (piston counts)
Bp Park piston position [1-254] (counts)
```

Float Parameter Menu

```
> F ?
Menu of float parameters.
?  Print this menu.
Fb Maximum air-bladder pressure. [1-254] (counts)
Ff Piston full extension. [1-254] (counts)
Fn Display float serial number.
Fs Storage piston position. [1-254] (counts)
Fv OK vacuum threshold. [1-254] (counts)
```

Ice Parameter Menu

```
> I ?
Menu of ice evasion control parameters.
?  Print this menu.
Ib Winter-months bitmask (DNOSAJJMAMFJ). [0x000,0xfff]
```

```
It Under-ice mixed-layer critical temperature [-3,35]. (C)
```

Timing Parameter Menu

```
> T ?
Menu of mission timing parameters.
?  Print this menu.
Ta Ascent time-out period. [1-10 hours] (Hours)
Td Down time (0-336 hours] (Hours).
Tj Deep-profile descent time. [0-6 hours] (Hours).
Tk Park descent time. (0-6 hours] (Hours).
Tp Mission prelude. (0-6 hours] (Hours).
Tu Up time (0-24 hours] (Hours).
```

SBE41 Menu

```
> S ?
Menu of SBE41 functions.
?  Print this menu.
Sc Display the SBE41 calibration coefficients.
Sf Display SBE41 firmware revision.
Sm Measure power consumption by SBE41.
Sn Display SBE41 serial number.
Sp Get SBE41 P.
Ss Get SBE41 P T & S.
St Get SBE41 P & T (low-power).
```

Appendix F: Returning APEX floats for factory repair or refurbishment

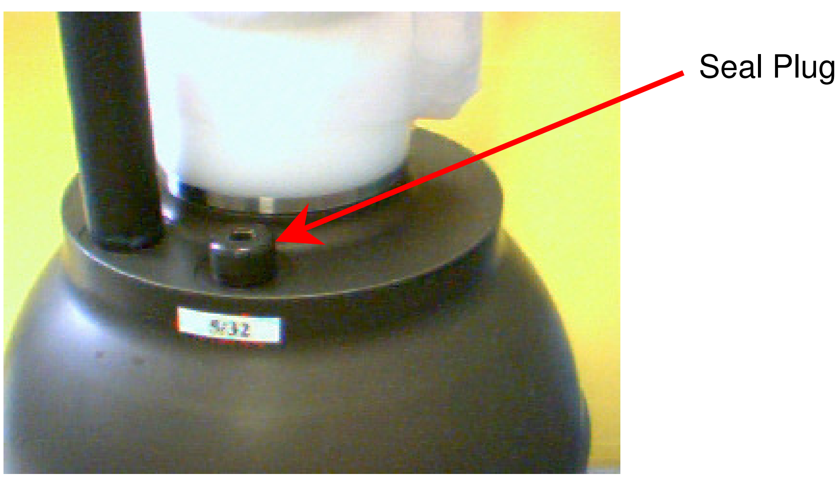
Contact Teledyne Webb Research before returning APEX floats for repair or refurbishment. All returns from outside USA, please specify our import broker:

Consignee: Teledyne Webb Research
82 Technology Park Drive
East Falmouth, MA 02536

Notify: DHL-Danzas Freight Forwarding Agents
Attn: Ellis Hall, Import Broker
Phone (617) 886-6665, FAX (617) 242-1470
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. The reaction may generate explosive gases (see "Alkaline Battery Warning" at the beginning of this manual). In this case, be sure to remove the seal plug to ventilate the instrument before shipping. Do this is a well ventilated location and do not lean over the seal plug while loosening it. Use a 3/16 inch hex wrench (provided), or pliers, to rotate the plug counter-clockwise.



Appendix G: Missions

This section lists the parameters for each float covered by this manual.

To display the parameter list, connect a communications cable to the float, press <ENTER> to wake the float from hibernate and start command mode, and press 'l' or 'L' to list the parameters. See "Connecting a Terminal" and "APF9A Command Summary" for more information.

INSTRUMENT #4723

```
APEX version 021009  sn 6559
98F02F2 28-bit hex Argos id.                    Ma
INACTV ToD for down-time expiration. (Minutes)    Mtc
  042 Argos repetition period (Seconds)          Mr
  228 Down time. (Hours)                         Mtd
  012 Up time. (Hours)                           Mtu
  009 Ascent time-out. (Hours)                   Mta
  006 Deep-profile descent time. (Hours)         Mtj
  006 Park descent time. (Hours)                 Mtk
  006 Mission prelude. (Hours)                   Mtp
 1000 Park pressure. (Decibars)                  Mk
 2000 Deep-profile pressure. (Decibars)          Mj
  066 Park piston position. (Counts)             Mbp
  016 Deep-profile piston position. (Counts)     Mbj
  010 Ascent buoyancy nudge. (Counts)            Mbn
  022 Initial buoyancy nudge. (Counts)           Mbi
  001 Park-n-profile cycle length.               Mn
-1.80 Ice detection: Mixed-layer Tcritical (C)    Mit
0xffd Ice detection: Winter months [DNOSAJJMAMFJ] Mib
  120 Maximum air bladder pressure. (Counts)     Mfb
  096 OK vacuum threshold. (Counts)              Mfv
  227 Piston full extension. (Counts)            Mff
  100 Piston storage position. (Counts)          Mfs
    2 Logging verbosity. [0-5]                   D
 668b Mission signature (hex).
```

INSTRUCTMENT #4724

APEX version 021009 sn 6563
98F5100 28-bit hex Argos id. Ma
INACTV ToD for down-time expiration. (Minutes) Mtc
044 Argos repetition period (Seconds) Mr
228 Down time. (Hours) Mtd
012 Up time. (Hours) Mtu
009 Ascent time-out. (Hours) Mta
006 Deep-profile descent time. (Hours) Mtj
006 Park descent time. (Hours) Mtk
006 Mission prelude. (Hours) Mtp
1000 Park pressure. (Decibars) Mk
2000 Deep-profile pressure. (Decibars) Mj
066 Park piston position. (Counts) Mbp
016 Deep-profile piston position. (Counts) Mbj
010 Ascent buoyancy nudge. (Counts) Mbn
022 Initial buoyancy nudge. (Counts) Mbi
001 Park-n-profile cycle length. Mn
-1.80 Ice detection: Mixed-layer Tcritical (C) Mit
0xffd Ice detection: Winter months [DNOSAJJMAMFJ] Mib
120 Maximum air bladder pressure. (Counts) Mfb
096 OK vacuum threshold. (Counts) Mfv
227 Piston full extension. (Counts) Mff
100 Piston storage position. (Counts) Mfs
2 Logging verbosity. [0-5] D
e85d Mission signature (hex).

Appendix H: CTD Calibration and Ballasting records

(included in hard copy only)