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APEX PROFILER USER MANUAL

Applies to Serial Numbers: 2544-2547		Revision Date:	11-26-07
		Customer Name:	UDEC
		WRC Job Number:	1139 Warranty upgrade
		Firmware Revision	APF9A F/W 082807
		Features:	
Additional Sensors:		APF9A Controller	
Wetlabs FLNTU		Park and Profile with 20- or 28-bit ARGOS ID	
Aanderaa Oyxgen Optode		Deep Profile First (DPF)	
		Pressure Activation (optional)	

CONTENTS

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. 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.

<u>CAUTION:</u>

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 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".

Webb Research Corporation
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.

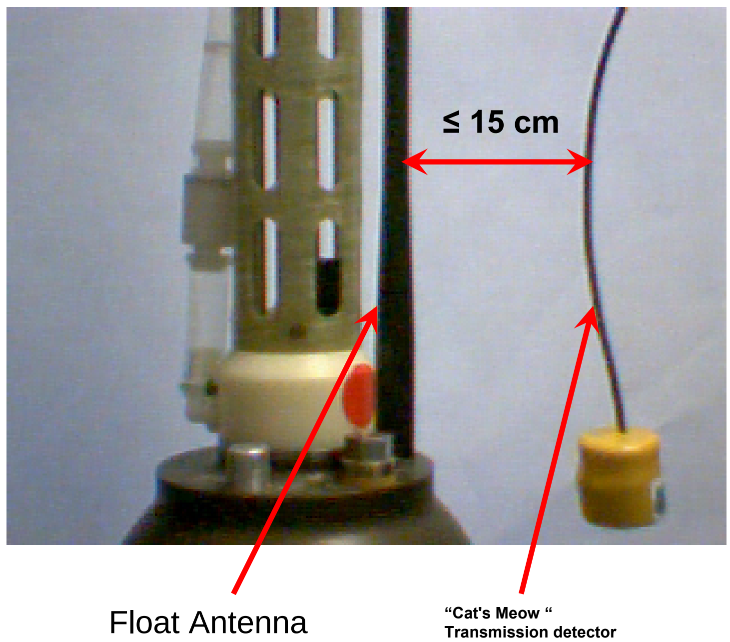
5) Start a Manual or Pressure Activated Deployment as described above in the "Manual Deployment with the Reset Tool" and "Pressure Activation Deployment" sections. This will trigger the Mission Activation self tests. Where applicable, the description below indicates where the two versions of the self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

V. 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) <u>Manual Deployment</u>: The float will remain on surface for the duration of the Mission Prelude.

   <u>Pressure Activated Deployment</u>: 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.

VI. Optional sensors:

A. Aanderaa Oxygen Optode 3830

In addition to SeaBird model 41 CTD sensor, these APEX carry the (optional) Aanderaa Oxygen optode 3830. The oxygen sensor communicates with the APEX controller via RS-232C interface, and provides Bphase and Optode temperature via the Argos data stream. (When a terminal is connected, oxygen concentration in µM, and raw temperature, can also be displayed).

Raw data was included to enable checking the optode's internal calculations . The optode measures and presents data in micromole dissolved oxygen per liter (µmol/l). This unit is often also called micromolar (µM).

Bphase is the phase obtained with blue light excitation, which is used to calculate Dphase. Oxygen concentration can be calculated in micro molar, µM, using the equations found in the Aanderaa users manual (presently chapter 4 pages 31-33).

The optode is sampled at the same time as the other sensors, per the depth table. In the case of high density CP profiling this sensor is still sampled per the depth table.

<u>NOTE regarding handling</u>: do not lift or pull on the oxygen optode.

<u>NOTE regarding optode salinity</u>: The Apf 9 controller has and will configure the optode for an internal salinity setting of 0.

B. WetLabs FLNTU-APX Combination Fluorometer and Turbidity Sensor

In addition to SeaBird model 41 CTD sensor, these APEX carry the (optional) WetLabs FLNTU-APX, an optical sensor which combines a 470/695 nm chlorophyll fluorometer and 700 nm backscatter sensors.

This sensor is mounted to the lower part of the pressure hull. A cable to the lower end cap provides power and serial communications. It is sampled at the same time as the other sensors, per the depth table. In the case of high density CP profiling this sensor is still sampled per the depth table.

Raw sensor outputs (designated CHL and NTU) are telemetered. Applying linear scaling constants unique to each sensor, these data can be expressed in meaningful forms of chlorophyll fluorescence and NTUs. For a full explanation, see section 6 "Data Analysis" of the sensor manual.

Take care not to scratch the lens surface. The manufacturer indicates small scratches will not affect quality of measurement, however the protective cap should be used during all shipping and handling.

NOTE: It is vital to remove the protective cap from the FLNTU sensor before deployment.

TIMING: WetLabs recommends profiling before local sunrise. The reason is that by dawn the night time cooling induced vertical mixing has stabilized and the phytoplankton population that will be producing the day's growth can be measured with minimal mixing and grazing effects.

The real time clock (RTC) and time of day (TOD) feature should be used to ensure nighttime profiling.

C. Testing the optional sensors

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

Wet Labs FLNTU menu and two samples.
The first example is "open"(no objects within three feet of sensor).
The second example is with a fluorescent stick (provided by Wet Labs) held in front of the sensor. An open palm will produce similar "large" values.

```
> f ?
Menu of FLNTU functions.
?  Print this menu.
Fc Configure the FLNTU.
Ff Display FLNTU firmware revision.
Fm Measure power consumption by FLNTU.
Fo Execute full optics scan.
Fs Execute FLNTU measurement.
> f f FLNTU firmware revision: [FLNTU-APX 2.57]
> f s FLNTU BlueRef, FSig, NtuRef, NtuSig, TSig: 1250, 168, 1493, 4124, 549
```

In- air sample without fluorescent stick

```
>f s FLNTU BlueRef, FSig, NtuRef, NtuSig, TSig: 1425, 4097, 1496, 4124, 550
```

In-air sample with fluorescent stick

Aanderaa optode menu and sample:

```
> o ?
Menu of optode functions.
?  Print this menu.
Oc Configure the optode.
Od Display the optode configuration.
On Display optode model and serial number.
Op Measure optode power consumption.
Os Get an oxygen sample.

> o s Optode O,T,BPhase,RawTemp: 259.0uM 23.02C 24.30 144.5
```

VII. Real-Time Clock (RTC)

The **APF9A** is equipped with a real-time clock (RTC). The RTC can be set by the operator to any desired reference time. However, Webb Research strongly recommends setting the RTC to GMT

Beware the **Apf 9I (Iridium float)** will automatically update the RTC each time a GPS fix is obtained if the RTC and the GPS satellite disagree by more than 30 seconds. As a consequence, APF9I floats will end up running on GMT eventually, so the operator should only set the RTC to GMT to avoid confusion and scheduling problems. This is particularly important if the TOD feature is to be used.

To view or set the RTC, enter the Main Menu (see "Connecting a Terminal" and "APF9I Command Summary") and use the 't' command as shown in the examples below:

Viewing the RTC:

```
> t                           ← entered by operator followed by [ENTER]
Real time clock: Fri Sep 25 04:47:05 1970
```

Setting the RTC:

```
> t  07/24/2007:17:11:00      ← entered by operator as mm/dd/yyyy:hh:mm:ss
(Sep 25 1970 04:47:45,  393506 sec) ParseTime()          The
time
          string represents the date Tue Jul 24 17:11:00 2007
Real time clock: Tue Jul 24 17:11:01 2007
```

The date and time must be entered in the format shown in the example above. The RTC will revert to 1970 (or randomly) if the batteries providing power to the APF9I are disconnected. In this case the operator should reset the RTC after restoring power to the float.

VIII. Time of Day (TOD) Feature

The APF9A floats represented in this manual have the option of scheduling profiles so that the float surfaces at a particular time of day (TOD). The APF9A real-time clock is used to dynamically set the end of the Down Time to some user specified number of minutes after midnight. The operator must take into account any difference between the time zone of the deployment and GMT when setting this parameter. This is described in more detail below.

The TOD feature is applied by the float as follows:

- At the start of a descent (end of Up Time), the APF9I computes a Down Time expiration based on the Down Time programmed by the operator.

- If the TOD feature is disabled, the Down Time will expire at that calculated time of the RTC.
    - For example, if the Down Time is set to 120 hours (10 days) and the Up Time ends at 14:00 on July 10, 2007, the next Down Time will expire at 14:00 on July 20, 2007.

- If the TOD feature is enabled, the float extends the Down Time expiration to the next occurrence of "TOD minutes after midnight" on the RTC.
    - For example, if the initial calculation placed the Down Time expiration at 14:00 on July 20, 2007 (as above), but the TOD was enabled and set to 1200 minutes (20 hours after midnight), the Down Time would be extended from 14:00 and set to expire at the next occurrence of 20:00, which is 20:00 on July 20, 2007.

Active ballasting and all other Down Time behaviors continue until the Down Time expires. This will be until 14:00 in the first example and until 20:00 in the second example.

Controlling TOD

The TOD feature must be manually enabled by the operator. This is done by entering the Mission Programming Agent ('m' from Main Menu, see "Connecting a Terminal" and "APF9I Command Summary") and setting Parameter Mtc to an allowed value in minutes. Setting Parameter Mtc to no value will disable the TOD feature.

Enabling TOD

```
> t c 360                        ← entered by operator followed by [ENTER]
The down-time will expire at 360 Minutes after midnight.
```

Disabling TOD

```
> t c                            ← entered by operator followed by [ENTER]
The time-of-day feature has been disabled.
```

[1] (1000 dbar / 0.08 dbar/sec) / 3600 sec/hr = 3.47 hours

Shifting the Time Zone

Because the RTC is necessarily set to GMT, the operator must account for the time zone difference between the float and GMT in setting TOD. For example, assume:

- The float will be deployed in the eastern Pacific (10 hours behind GMT, 12:00 GMT is 02:00 in the eastern Pacific)
- The operator wishes to use the TOD feature to set Down Time expiration to 20:00 in the local time zone

20:00 in the local time zone is 06:00 GMT (10 hours later). Therefore, set TOD to 360 minutes (6 hours). Down Time will expire at 06:00 GMT, which is 20:00 in the local time zone.

Selecting a TOD Value

To select a TOD value, you must first decide what time you wish the float to surface. Then calculate the approximate duration of the profile, which begins with the expiration of the Down Time. The calculation is based on the programmed depth from which the float will ascend and assumes an ascent speed of 0.08 dbar per second.

For example, a 1200 dbar profile requires approximately 4 hours.[1] If you wish to have the float reach the surface at approximately 02:00, set TOD so that the Down Time will expire 4 hours earlier. Four hours earlier is 22:00, which is 1320 minutes after midnight. Therefore set TOD to 1320 minutes.

If profiles are to be conducted from both the Park Depth and the Profile Depth and the operator wishes the float to reach the surface at a consistent time, the Deep-profile descent time, Parameter Mtj, must be set to a reasonable value for the descent from the Park Depth to the Profile Depth. See "Profile Ascent Timing" for additional information.

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[1] (1200 dbar / 0.08 dbar/sec) / 3600 sec/hr = 4.16 hours

IX. 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.

Terminology:

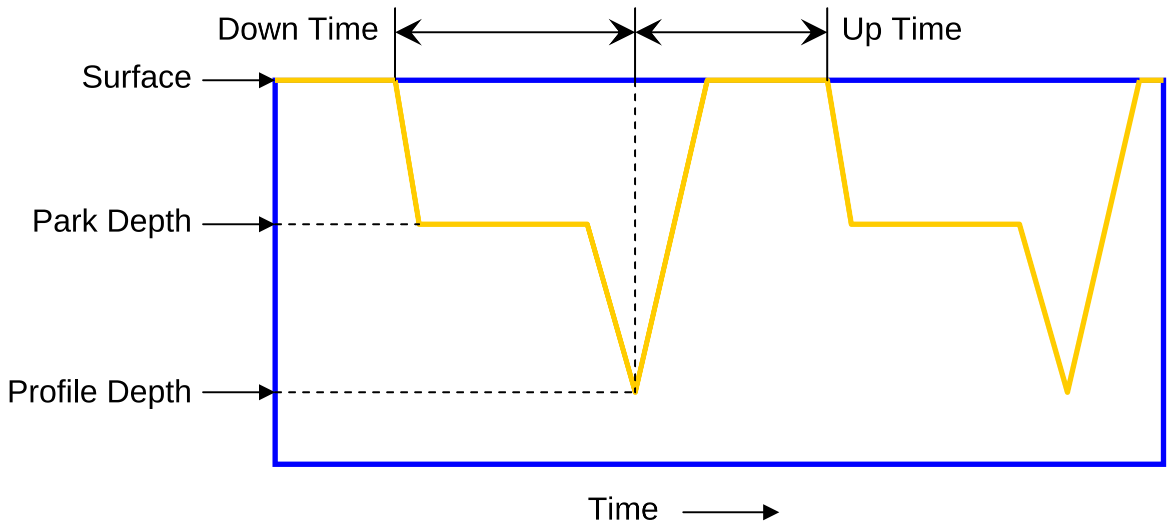
- Park Depth — Intermediate depth at which the float drifts between profiles and from which the float profiles in cycles not evenly divisible by N.
- Profile Depth — Maximum depth to which the float descends from the Park Depth every Nth cycle and from which each Nth profile is conducted.
- Down Time — 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.

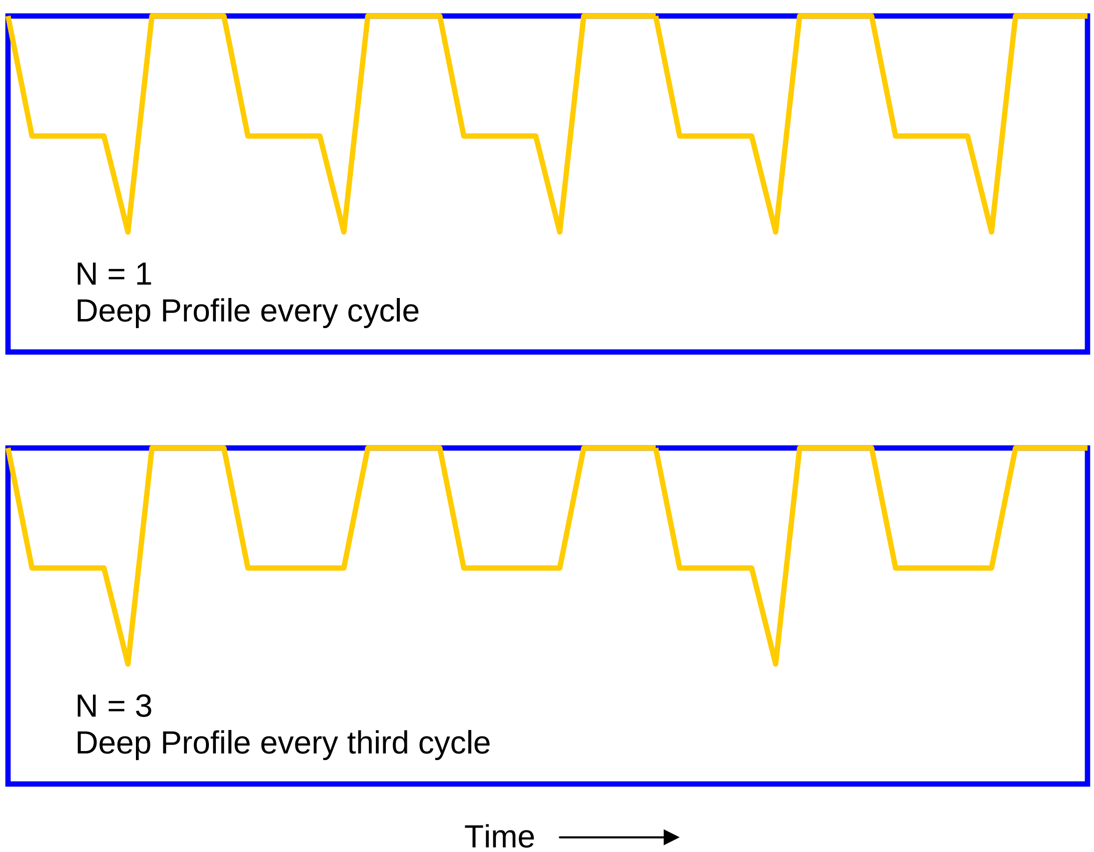
A. Profile Ascent Timing

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

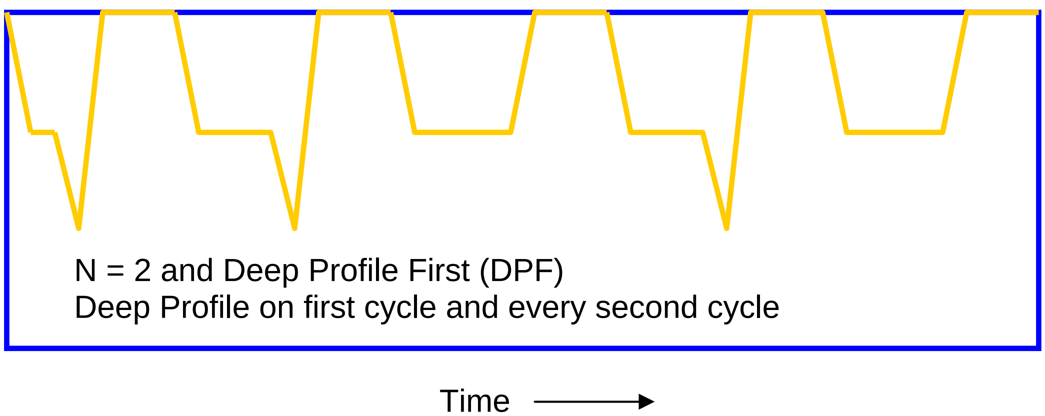




X. Deep Profile First (DPF)

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.



XI. 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[2]

[2] 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.

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

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.
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	OPTSN	Serial number of the optode oxygen sensor.
19-22	EPOCH	The current UNIX epoch (GMT) of the Apf9a RTC (little endian order).
23,24	TOD	The number of minutes past midnight when the down-time will expire. If ToD feature disabled then these bytes will be set to 0xfffe.
25,26	DEBUG	The debugging verbosity used for generating engineering log entries.
27-31		Not used yet (filled with 0xff's).

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 optode biographical data transmitted in this firmware revision is just the serial number (2 bytes) encoded as a hex integer.

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.  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.
   3,4        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.
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.
AirSysBypass     0x2000  Air inflation system by-passed; excessive energy
consumption.
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.
OptodeFail           0x0040 Optode sample failed.
OptodeNoResponse     0x0080 Optode failed to respond.
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.
OptodeNullArg        0x8000 NULL argument in OptodeSample()


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

Message 2 continues with miscellaneous engineering data plus 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.
2-5	EPOCH	UNIX epoch when the down-time expired (Ap9a RTC). Signed 4-byte integer written in little-endian order.
6,7	TINIT	Time (ie., minutes) when telemetry phase was initiated relative to EPOCH. Signed integer in 2's-complement form.
8	NADJ	Number of active-ballast adjustments made during the park phase.
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. Byte 31 is present only if 20-bit argos id used.

Messages 3-N:

Message 3 starts with FLNTU engineering data plus the surface optode and FLNTU measurement.

Byte(s)	Pneumonic	Description
0	CRC	Message CRC computed with BathySystem's CRC generator.
1	MSG	Message id.
2	VFLNTU	The battery voltage [counts] measured when the FLNTU was sampled after the park phase of the profile cycle terminated.
3	IFLNTU	The battery current [counts] measured when the FLNTU was sampled after the park phase of the profile cycle terminated.
4	FLNTU	This byte records the state of 8 status bits specifically related to the FLNTU. Individual bits can be accessed with an appropriate bit-mask.
5,6	SRFP	Surface pressure to complement surface optode and FLNTU data.
7-9	SOPT	Surface optode BPhase and temperature data.
10-15	SFLNTU	Surface FLNTU data.

```
/* definition of the 'FLNTU' status bits in the engineering data above  */
FlntuPwrDownFail  0x01  Attempt to power down the FLNTU failed.
FlntuPwrUpFail    0x02  Attempt to power up the FLNTU failed.
FlntuRegexFail    0x04  FLNTU response failed regex match.
FlntuNullArg      0x08  NULL argument detected during FLNTU measurement.
FlntuNoResponse   0x10  No response from FLNTU.
                  0x20  Not used yet.
                  0x40  Not used yet.
                  0x80  Not used yet.
```

The surface optode/FLNTU measurement is transmitted in bytes 5-15 of message #3. A new optode/FLNTU surface measurement is made each time a new message block is transmitted. The surface optode/FLNTU measurement consists of P (2 bytes), BPhase (3 nibbles), T2 (3 nibbles), BlueRef (3 nibbles), FSig (3 nibbles), NtuRef (3 nibbles), and NtuSig (3 nibbles). The parameter P was collected by the SBE41, BPhase & T2 were measured by the optode, and BlueRef, FSig, NtuRef, & NtuSig were measured by the FLNTU.

Next, 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 followed by the samples collected during the profile phase. Each sample consists of 15 bytes in order of T (2 bytes), S (2 bytes), P (2 bytes), BPhase (3 nibbles), T2 (3 nibbles), BlueRef (3 nibbles), FSig (3 nibbles), NtuRef (3 nibbles), and NtuSig (3 nibbles). The parameters T, S, & P were collected by the SBE41, BPhase & T2 were measured by the optode, and BlueRef, FSig, NtuRef, & NtuSig were measured by the FLNTU. The hydrographic data are encoded as shown in the C-source code below. Refer to the comment section of OptodeEncode() for details of the encoding scheme for optode data. Refer to the comment section of FlntuEncode() for details of the encoding scheme for FLNTU data. The function FlntuDecode() below provides decoding services for FLNTU data.

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. Auxiliary engineering data are included in the order presented below:

Time of profile initiation: The time difference (ie., minutes) between the start of the profile and the end of the down-time. This is a 2-byte signed integer (expressed in 2's-complement form) where positive values indicate profile initiation after the down-time expired and negative values indicate profile initiation before the down-time expired.

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 hydrographic data is the count of the number of descent pressure marks. This byte is followed by 1-byte pressures (bars) marking the descent phase.

C. 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
Temperature	0.001 °C (1 millidegree C)
Salinity	0.001 psu
Pressure	0.1 dbar

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 and a range of 0 to 255 for voltage and current measurements.

Measurement	Hexadecimal	Decimal and Conversion Steps	Physical Result
Temperature ≥ 0	0x3EA6 (≤ 0xF447) →	T = 16038 T / 1000 →	16.038 °C
Temperature < 0	0xF58B (> 0xF447) →	T = 62859 (T - 65536) / 1000 →	-2.677 °C
Salinity	0x8FDD →	S = 36829 S / 1000 →	36.829 psu
Pressure ≥ 0	0x1D4C (< 0x8000) →	P = 7500 P / 10 →	750.0 dbar
Pressure < 0	0xFFFA (≥ 0x8000) →	P = 65530 (P - 65536) / 10 →	-0.6 dbar
Volts	0x99 →	V = 153 (V / 10) + 0.4 →	15.7 V
Current	0x0A →	I = 10 I × 13 →	130 mA
Vacuum	0x66 →	V = 102 (V × -0.209) + 26.23 →	4.9 inHg
Measurement	Hexadecimal	Decimal and Conversion Steps	Physical Result

Bphase	1F3 →	499/100+23	27.99
Toptode	90E→	2318/100-3	20.18 C
Blue reference	4e2	1250	1250
Fsig	032	50	50
Ntu ref	3CB	971	971
Theta	032	50	50

<u>Conversion Notes</u>:

The temperature range is -4.095 °C to 61.439 °C. Hex values 0xF000, 0xF001, 0xEFFF, and 0xFFFF 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 → -0.002 °C.

The salinity range is -4.095 psu to 61.439 psu. Hex values 0xF000, 0x8001, 0x7FFF, and 0xFFFF 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 → 65.534 psu.

The pressure range is -3276.7 dbar to 3276.7 dbar. Hex values 0x8000, 0xF001, 0xEFFF, and 0xFFFF 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 → -0.2 dbar.

D. Depth Table 73

Depth Table73, below, with values expressed in decibars (dbar), defines where PTS Flntu and Aanderaa measurements are acquired during a profile.

```
2000.0, 1950.0, 1900.0, 1850.0, 1800.0, 1750.0, 1700.0, 1650.0, 1600.0, 1550.0,
1500.0, 1450.0, 1400.0, 1350.0, 1300.0, 1250.0, 1200.0, 1150.0, 1100.0, 1050.0,
1000.0,  950.0,  900.0,  850.0,  800.0,  750.0,  700.0,  650.0,  600.0,  550.0,
 500.0,  450.0,  400.0,  350.0,  300.0,  250.0,  225.0,  200.0,  190.0,  180.0,
 170.0,  160.0,  150.0,  140.0,  130.0,  120.0,  110.0,  100.0,   90.0,   80.0,
  70.0,   60.0,   50.0,   40.0,   30.0,   25.0,   20.0,   15.0,   10.0,    5.0,
```

Depth table points in blue will not apply to floats represented in this manual, as maximum profile depth is 1000 dbars.

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.

E. 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 WRC 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);
}
```

XII. 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 # 2544

```
APEX version 082807  sn 5372
2214A4C 28-bit hex Argos id.                  Ma
   036 Argos repetition period (Seconds)       Mr
  0180 ToD for down-time expiration. (Minutes)  Mtc
   048 Down time. (Hours)                     Mtd
   017 Up time. (Hours)                       Mtu
   005 Ascent time-out. (Hours)               Mta
   004 Deep-profile descent time. (Hours)      Mtj
   004 Park descent time. (Hours)             Mtk
   006 Mission prelude. (Hours)               Mtp
  1000 Park pressure. (Decibars)              Mk
  1000 Deep-profile pressure. (Decibars)       Mj
   016 Park piston position. (Counts)         Mbp
   016 Deep-profile piston position. (Counts)   Mbj
   010 Ascent buoyancy nudge. (Counts)         Mbn
   022 Initial buoyancy nudge. (Counts)        Mbi
   254 Park-n-profile cycle length.           Mn
   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
     2 Logging verbosity. [0-5]               D
  0002 DebugBits.                             D
  6ce6 Mission signature (hex).
```

INSTRUMENT # 2545

```
APEX version 082807  sn 5373
2214A5F 28-bit hex Argos id.                  Ma
   037 Argos repetition period (Seconds)       Mr
  0180 ToD for down-time expiration. (Minutes)  Mtc
   048 Down time. (Hours)                     Mtd
   017 Up time. (Hours)                       Mtu
   005 Ascent time-out. (Hours)               Mta
   004 Deep-profile descent time. (Hours)      Mtj
   004 Park descent time. (Hours)             Mtk
   006 Mission prelude. (Hours)               Mtp
  1000 Park pressure. (Decibars)              Mk
  1000 Deep-profile pressure. (Decibars)       Mj
   016 Park piston position. (Counts)         Mbp
   016 Deep-profile piston position. (Counts)   Mbj
   010 Ascent buoyancy nudge. (Counts)         Mbn
   022 Initial buoyancy nudge. (Counts)        Mbi
   254 Park-n-profile cycle length.           Mn
   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
     2 Logging verbosity. [0-5]               D
  0002 DebugBits.                             D
  1e96 Mission signature (hex).
```

INSTRUMENT # 2546

APEX version 082807 sn 5374
2214A6A 28-bit hex Argos id. Ma
038 Argos repetition period (Seconds) Mr
0180 ToD for down-time expiration. (Minutes) Mtc
048 Down time. (Hours) Mtd
017 Up time. (Hours) Mtu
005 Ascent time-out. (Hours) Mta
004 Deep-profile descent time. (Hours) Mtj
004 Park descent time. (Hours) Mtk
006 Mission prelude. (Hours) Mtp
1000 Park pressure. (Decibars) Mk
1000 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
254 Park-n-profile cycle length. Mn
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
2 Logging verbosity. [0-5] D
0002 DebugBits. D
b419 Mission signature (hex).

INSTRUMENT #2547

APEX version 082807 sn 5375
2214A8B 28-bit hex Argos id. Ma
039 Argos repetition period (Seconds) Mr
0180 ToD for down-time expiration. (Minutes) Mtc
048 Down time. (Hours) Mtd
017 Up time. (Hours) Mtu
005 Ascent time-out. (Hours) Mta
004 Deep-profile descent time. (Hours) Mtj
004 Park descent time. (Hours) Mtk
006 Mission prelude. (Hours) Mtp
1000 Park pressure. (Decibars) Mk
1000 Deep-profile pressure. (Decibars) Mj
016 Park piston position. (Counts) Mbp
016 Deep-profile piston position. (Counts) Mbj
010 Ascent buoyancy nudge. (Counts) Mbn
022 Initial buoyancy nudge. (Counts) Mbi
254 Park-n-profile cycle length. Mn
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
2 Logging verbosity. [0-5] D
0002 DebugBits.

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. 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 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
28 bytes / message + M1 + M2 — 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

Webb Research Corporation 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 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

```
> ?
Menu selections are not case sensitive.
?  Print this help menu.
A  Initiate pressure-activation of mission.
C  Calibrate: battery volts, current, & vacuum.
D  Set logging verbosity. [0-5]
E  Execute (activate) mission.
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  Diagnostics agent.
I? Diagnostics menu.
K  Kill (deactivate) mission.
L  List mission parameters.
M  Mission programming agent.
M? Mission programming menu.
P  Display the pressure table.
Q  Exit command mode.
S  Sensor module agent.
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 pressure.
Ss Get SBE41 P T & S.
St Get SBE41 P & T (low-power).
T  Get/Set RTC time. (format 'mm/dd/yyyy:hh:mm:ss')
```

Deployment Parameter Menu

```
> L
APEX version 010706  sn 0000
551D4 20-bit hex Argos id.                        Ma
 060 Argos repetition period (Seconds)            Mr
 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
 004 Park-n-profile cycle length.                 Mn
 120 Maximum air bladder pressure. (Counts)       Fb
 096 OK vacuum threshold. (Counts)                Fv
 227 Piston full extension. (Counts)              Ff
 016 Piston storage position. (Counts)            Fs
   2 Logging verbosity. [0-5]                     D
c745 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)
```

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).
```

Wetlabs FLNTU Menu

>F ?
Menu of FLNTU functions.
? Print this menu.
Fc Configure the FLNTU.
Ff Display FLNTU firmware revision.
Fm Measure power consumption by FLNTU.
Fo Execute full optics scan.
Fs Execute FLNTU measurement.

Aanderaa Oxygen Optode Menu

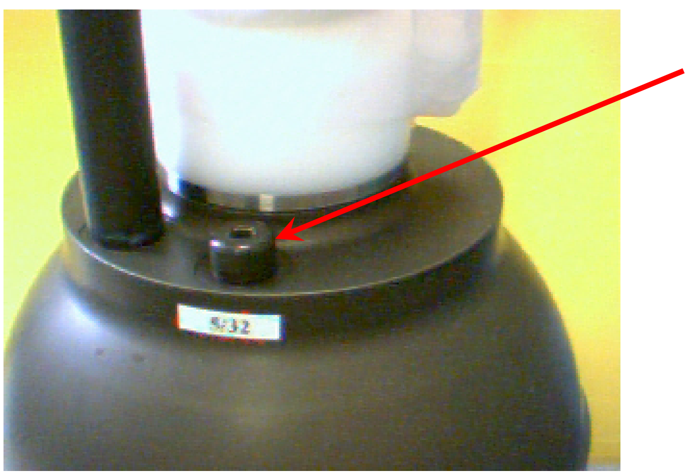
> O?
Menu of optode functions.
? Print this menu.
Oc Configure the optode.
Od Display the optode configuration.
On Display optode model and serial number.
Op Measure optode power consumption.

Appendix F: Returning APEX floats for factory repair or refurbishment

Contact WRC before returning APEX floats for repair or refurbishment. For all returns from outside the United States, 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
>
> On the shipping documents please state: 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, or pliers, to rotate the plug counter-clockwise.



Appendix G: CTD Calibration and Ballasting records

(included in hard copy only)