APEX PROFILER USER MANUAL

Applies to Serial Numbers:	Revision Date:	09/09/16
7168 - 7172	Customer Name:	KNMI
7175 - 7176	Job Number:	2306
	Firmware Revision	APF9A F/W **110813**
	Features:	
	APF9 Controller	
Depth Table 26	Park and Profile	
Updated ARGOS data description	Deep Profile First (DPF)	
	Time of Day profile control	
	Ice Detection and Evasion	

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.

- The serial baud rate for communications is 9600, with 8 data bits, no parity, and 1 stop bit. (The APF8 baud rate is 1200.)
- APF9 floats using this *non-modal* version of firmware are shipped in Pressure Activation mode. The Reset Tool can then be used to toggle between Pressure Activation mode, and starting a new mission.
- 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.
- The logging verbosity of the APF9 can be adjusted by the operator. The level, Parameter D, Logging verbosity [0-5], adjusts the amount of information provided in diagnostic messages from the float, with 5 being the highest level. A logging verbosity of 2 is the default. **Only level 2 has been thoroughly tested in simulation, so this parameter should be set to 2 for all deployments.** Higher levels are suitable during testing as an aid to float assessment.

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

APF9A profilers use either *modal* or *non-modal* controllers. Since the type of controller determines the behavior of the Reset Tool, it is extremely important to determine which type of controller is loaded on the profiler. The controller described in this manual is *non-modal*, meaning that the float will be shipped in Pressure Activation mode, and the Reset Tool can be used to toggle the float between Pressure Activation mode, and starting a new mission. This contrasts with *modal* floats, in which the Reset Tool is always used to start a mission (and not to put the float in Pressure Activation mode).

 The motivation for using non-modal controllers is to reduce the risk of launching floats that do not start missions. For non-modal controllers, the float will always run a mission when launched: either because of Pressure Activation, or because the float is already running a mission. This is not true for 'modal' controllers, which could be launched without either Pressure Activation, or without a mission running. From this point on, this manual describes only non-modal behavior.

 If physically connected to the float (using a communication cable between a PC and the float, as described in the section "Connecting a Terminal" at the end of this manual) it is also possible to put the float into an 'inactive' state. Once connected, the 'i f' (freeze command) immediately makes the float hibernate, powering it down and placing it in an 'inactive' state. The 'i * i' command also places the float in an 'inactive' state, although the float will remain awake and communicating. Entering a 'q' command (or not communicating for ... minutes) will then place the float into Pressure Activation mode. Either way, the easiest way to determine the state of the connected float is via the 'i * s' command, which gives the state as well as any mission time.

Another non-modal float behavior is that if any corrupted or ill-formed data is received from the CTD sensor, then the mission is automatically started (if not already running). This ensures that the user will be notified of the problem. However, this presents another risk when leaving a float in the lab, connected to a power-source, but with no pressure sensor or piston-position sensor attached. If the float wakes (on the two hourly interval) and detects no CTD data, a mission is automatically started. This extends the piston, but with no piston-position sensor attached there is a risk of extending the piston too far.

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

<div style="border: 2px solid red; text-align: center; color: red;">

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

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A.   Manual Deployment with the Reset Tool

Since the Reset Tool toggles between Pressure Activation mode and starting a new mission, start a new mission by first ensuring that the float is in Pressure Activation mode, and then hold the Reset Tool over the marked location on the pressure case for approximately 3 seconds. Remove the Reset Tool only after you hear the air pump activate.

The float will run a brief self test and place itself in a state of maximum buoyancy. 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 telemeter its GPS location and the mission parameters 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 and the air bladder will be fully inflated during the Mission Activation phase. At the conclusion of the Mission Prelude the float will retract the piston, deflate the air bladder, and begin its pre-programmed mission.

Manual Deployment Summary:

- Ensure that the float is in Pressure Activation mode before toggling
- Toggle to start a new mission by holding 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.

If the float fails the self tests the piston will not extend and the air bladder will not inflate. The float should not be deployed.

B.   Pressure Activation Deployment

Non-modal floats are shipped in Pressure Activation mode, so no operator action is required to set this mode. In this mode, the float checks the pressure every two hours. If the measured pressure is greater than 25dbar the float starts its mission. Otherwise, the float moves the piston to the position indicated by mission parameter 'P-Activation piston position' (if not already there) and goes to sleep for another two hours.

Note that this behavior does present some risk. For example, if 'P-Activation piston position' was set to a value that would make the float bouyant at the surface (e.g. around 100) then a float launched in this mode would never sink, and would never activate (start) its mission. For this reason, 'P-Activation piston position' is typically set to around 16. At this setting the float would sink below 25dbar, and consequently start its mission.

Pressure Activation Deployment Summary:

- Deploy the float (no toggling is required since the float is delivered in Pressure Activation mode)
- Pressure Activation
    o Pressure is measured every 2 hours
    o Pressure in excess of 25 dbar triggers
        ▪ Full piston extension
        ▪ Transition to Mission Prelude
- Mission Prelude
    o Test transmissions (6 hours typical)
    o Air pump run during transmissions until air bladder is fully inflated

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. <u>Be sure to replace the plug before deployment!</u>**

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.

≤ 15 cm

Float Antenna

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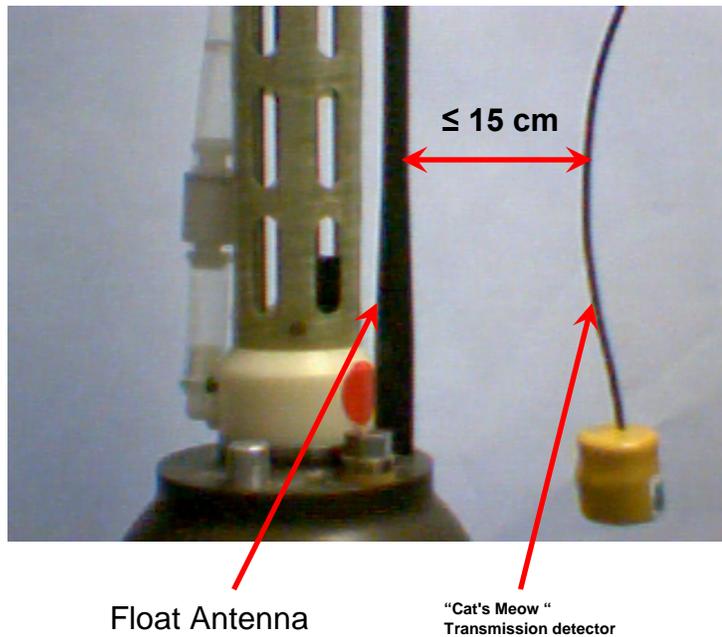
8) Manual Deployment: If not already fully extended, the float will fully extend the piston. This process may require up to 25 minutes. The oil bladder will expand during this time.

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) <u>Manual Deployment</u>: 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.

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

VI.   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 = 234. 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.   A PTS sample is collected at the end of the Park phase.

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. . A PTS sample is collected at the beginning of the Profile phase at the achieved profile depth. Subsequent PTS samples are collected during profile ascent per the programmed depth table.

B.   Profile and Profile Cycle Schematics

Down Time ← → ← → Up Time

Surface →

Park Depth →

Profile Depth →

Time →

N = 1
Deep Profile every cycle

N = 3
Deep Profile every third cycle

Time →
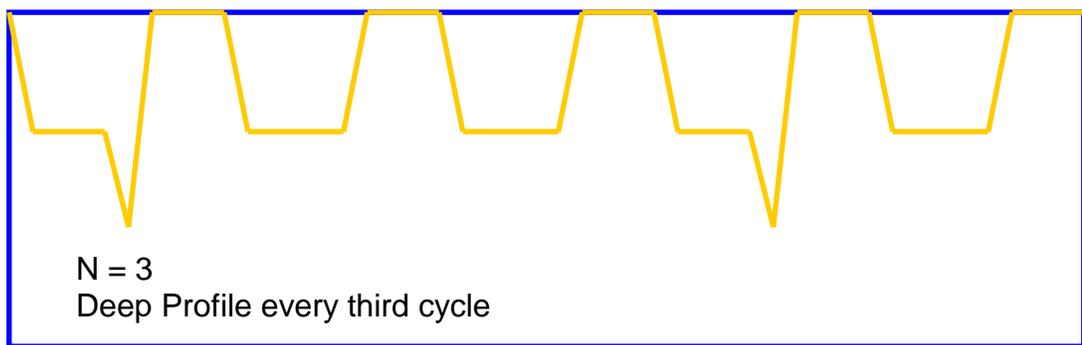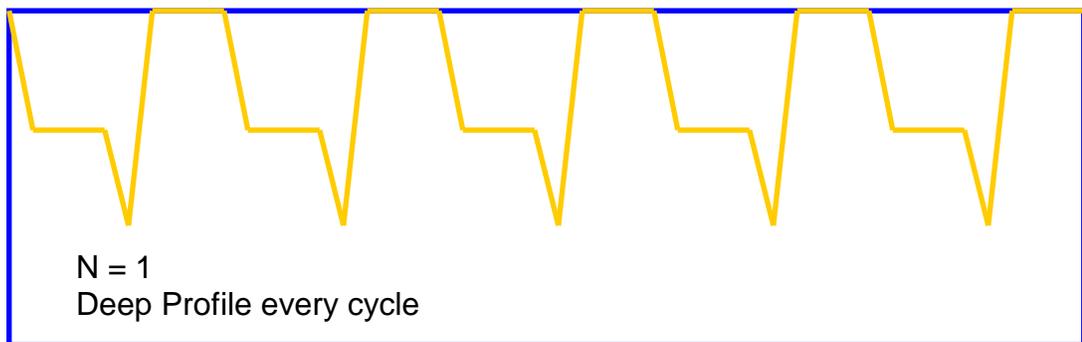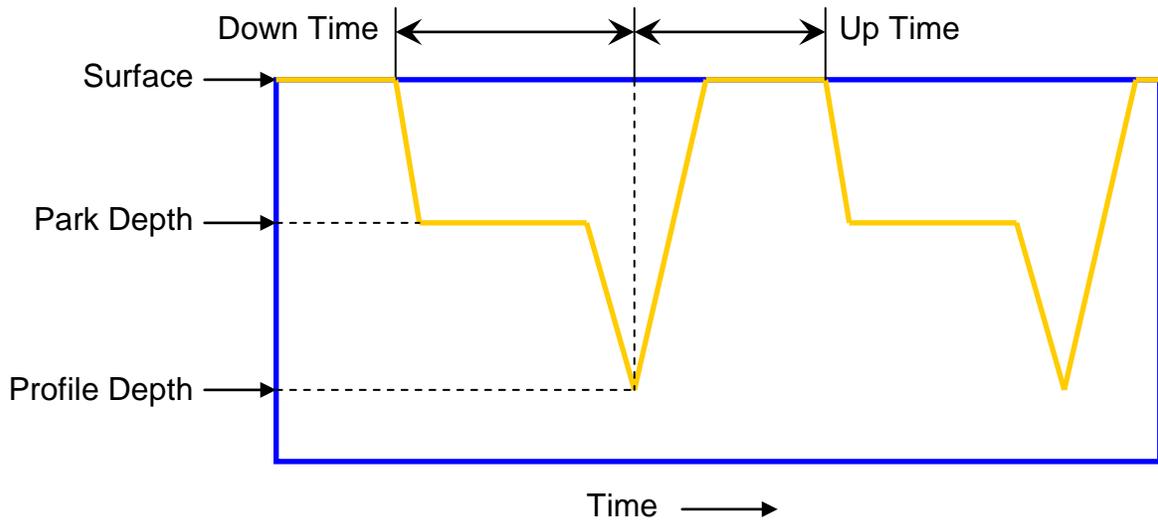
VII. Deep Profile First (DPF)

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.

N = 2 and Deep Profile First (DPF)
Deep Profile on first cycle and every second cycle

Time ⟶
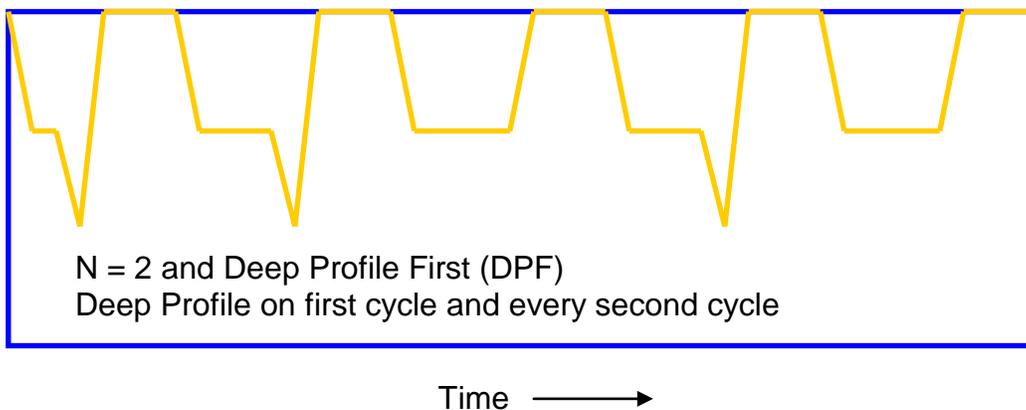
Note: For maximum battery life in ARGO applications, Teledyne Webb Research recommends use of PD > one, with park depth ≤ 1500 db.

VIII. Ice Detection and Evasion

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. For Apf9 floats with iridium, there are three possible detection features: ice cover, ice cap and ice break up.

- Ice cover detection attempts to detect hydrographic features associated with surface ice before reaching the surface.
- In the event that ice cover was not detected, ice cap detection will verify that the float reaches open water and that it is not under free-floating ice blocks.
- If no ice cover is detected, an additional check is implemented to detects leads and periods when the ice is breaking up.

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 deployment location.

If ice is detected, ice evasion is initiated. The float will abort the profile and descend, remaining at the park piston position for the duration of the current profile period. For Inidium, the data for the aborted profile is available and will be transmitted in the next successful telemetry cycle.

A. Ice Cover Detection

Ice cover detection 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 20 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.

B. Ice Cap Detection

The following conditions together indicate an ice cap is detected and will initiate ice evasion.

- There is no Iridium communication indicating the float does not have a sky view and that sufficient time is given for the opportunity to connect to the satellites and register with the Iridium service.
- Pressure is less than 20 decibars ensuring the float is near the surface.
- Temperature is less than the user-specified critical temperature to determine if the float is within the cold water halo underneath the ice.

C. Ice Break Up Detection

The criterion for determining ice break up is based on the previous 8 profiles' ice evasion history as determined by ice cover and ice cap detection. Ice break up is not recorded as part of the definitive ice detection and evasion history. Assume possibility of break up if either of the following occurs:

- Ice was detected on the previous profile.
- Ice was detected on the oldest 5 profiles plus any of the most recent 3 profiles.

D.   Ice Detection Mission Parameters

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:

50.0 Ice detection: Mixed-layer Pmax (Decibars)   Mix
20.0 Ice detection: Mixed-layer Pmin (Decibars)   Min
-1.78   Ice Detection: Mixed-Layer Tcritical (C)   Mit
0xTBD   Ice Detection: Winter months [DNOSAJJMAMFJ]   Mib

The Mixed-layer Pmax specifies the pressure at which ice detection/evasion sampling should be initiated. It should exceed than the ice-evasion pressure by at least 15dbars. The valid range is 0-50 dbars.

The Mixed-layer Pmin the pressure below which the ice detection criteria should be applied and (if necessary) ice-evasion should be initiated. It should be less than the ice-detection pressure by at least 15dbars. The valid range is 0-50 dbars.

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.

E. Ice Evasion Telemetry

Telemetry data for an aborted profile is saved and will be transmitted in the next successful telemetry cycle. The ice median temperature and number of samples is provided, as well as an Ice Evasion Record which indicates the ice cover and ice cap detection status for the last 8 profiles. Note that ice break up does not affect this record, but is indicated in the telemetry status word.

F. Special Mission Prelude Note for under-ice operation

Although the mission prelude for these floats are not disabled, there is a capability to bypass mission prelude and immediately sink if the float is to be deployed in ice conditions that may pose a threat to the float.

IX. 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]

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[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.

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

Test messages contain the float's mission configuration and biographical profile. No hydrographical data are included except for a pressure measurement that is made each time a new test-message block is transmitted. Test messages can be positively identified (ie., distinguished from data messages) by testing bytes 3-5 which contains the known firmware revision.

As previously mentioned, test messages are transmitted during the mission prelude. In addition, all messages manually induced by direct communication (ie., via the 20mA serial interface) with the float are also test messages.

Test Message 1

Byte(s)	Mnemonic	Description
0	CRC	Message CRC
1	MSG	Message ID - 1 for Test Message 1
2	BLK	Message block ID - increments with each transmitted message block and wraps at 0xFF
3	MON	F/W Revision - Month
4	DAY	F/W Revision - Day
5	YR	F/W Revision - Year (2-digit)
6 - 7	FLT	Float ID (hull number)
8 - 9	SEC	Time since the start of the Mission Prelude [seconds]
10 - 11	STATUS	Float status word - 16 bits, see below
12	ST21	The ST21 status.
13 - 14	P	Pressure measured once for each test message block [centibars]
15	ABP	Air bladder pressure measured once for each test message block [counts]
16	BAT	Quiescent battery voltage measured once for each test message block [counts]
17	UP	Up time [hours]
18 - 19	DOWN	Down time [hours]
20 - 21	PRKP	Park pressure [decibars]
22	PPP	Park piston position [counts]
23	NUDGE	Buoyancy nudge during ascent [counts]
24	OK	Internal vacuum threshold [counts]
25	ASCEND	Ascent time-out [hours]
26	TBP	Maximum air bladder pressure [counts]
27 - 28	TP	Profile pressure [decibars]
29	TPP	Profile piston position [counts]
30	N	Park and profile cycle length
31		Not used - only exists for a float with a 20-bit ARGOS ID

The table below contains a description of the information contained in test message#2. Again, note that the bytes are indexed with counting starting at zero rather than one.

Test Message 2

Byte(s)	Mnemonic	Description
0	CRC	Message CRC
1	MSG	Message ID - 2 for Test Message 2
2	BLK	Message block ID - increments with each transmitted message block and wraps at 0xFF
3	MON	F/W Revision - Month
4	DAY	F/W Revision - Day
5	YR	F/W Revision - Year (2-digit)
6	FEXT	Piston full extension [counts]
7	FRET	Piston full retraction [counts]
8	IBN	Initial buoyancy nudge (starts profile) [counts]
9	PAPP	Pressure activation piston position
10	DPDP	Deep-profile descent period. (hours)
11	PDP	Park descent period. (hours)
12	PRE	Mission prelude period. (hours)
13	REP	Argos repetition period. (seconds)
14 - 16	ARGID	Argos ID
17	ARGFR	Argos frequency as kHz off 401.65 MHz
18 - 19	SBESN	Serial number of the SBE41 sensor module.
20 - 21	SBEFW	Firmware revision of the SBE41 sensor module.
12 - 25	EPOCH	The current UNIX epoch (GMT) of the Apf9a RTC (little endian order).
26 - 27	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.
28 - 29	DEBUG	The debugging verbosity used for generating engineering log entries.
30 – 31		Not used [0xFF]

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 UNIX epoch represents the number of seconds since midnight on January 1, 1970. The phrase ``little endian order'' refers to the fact that the 4-byte unsigned integer is transmitted with the least-significant-byte first and the most-significant-byte last.

The table below contains a description of the information contained in test message#3. Again, note that the bytes are indexed with counting starting at zero rather than one.

Test Message 3

Byte(s)	Mnemonic	Description
0	CRC	Message CRC
1	MSG	Message ID - 2 for Test Message 2
2	BLK	Message block ID - increments with each transmitted message block and wraps at 0xFF
3	MON	F/W Revision - Month
4	DAY	F/W Revision - Day
5	YR	F/W Revision - Year (2-digit)
6	VAC	Vacuum reading
7 - 8	IDM	Months where ice-detection is activated
9 - 10	CMLT	Critical mixed-layer temperature
11 - 12	IDP	Ice-detection pressure
13 - 14	IEP	Ice-evasion pressure
15 – 31		Not used [0xFF]

Data Messages - 28-bit ARGOS ID

Data messages contain encoded engineering and hydrographic data collected during a given profile cycle. In order to decode (raw) argos messages into processed hydrographic data files, a complete set of uncorrupted argos messages must first be assembled.

Data Message 1

Byte(s)	Mnemonic	Description
0	CRC	Message CRC
1	MSG	Message ID - each data message block is comprised of multiple messages, this will be a 1 for Data Message 1
2	BLK	Message block ID - increments with each transmitted message block and wraps at 0xFF
3 - 4	FLT	Float ID (apf9a controller serial number)
5	PRF	Profile number (wraps to 0 from 255)
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	ST21	The ST21 status.
10 -11	SP	The surface pressure [centibars] as recorded just prior to the descent to the park depth.
12	P	Current pressure.
13	SPP	Piston position when surface detected [counts]
14	PPP2	Piston position at end of Park phase [counts]
15	PPP	Piston position at end of last Deep descent phase [counts]
16 – 17	SBE41	This long-word records the state of 32 status bits specifically related to the SBE41. Individual bits can be accessed with an appropriate bit-mask.
18	VQ	Battery voltage at end of Park phase [counts]
19	IQ	Battery current at end of Park phase [counts]
20	VSBE	Battery voltage while SBE41 sampling at end of Park phase [counts]
21	ISBE	Battery current while SBE41 sampling at end of Park phase [counts]
22	VHPP	Battery voltage measured just before the end of the initial piston extension beginning Profile phase [counts]
23	IHPP	Battery current measured just before the end of the initial piston extension beginning Profile phase [counts]
24	VAP	Battery voltage while air pump running [counts]
25	IAP	Battery current while air pump running [counts]
26	PAP	The number of 6-second pulses of the air pump required
27 - 28	VSAP	Integrated Measure of (Volt-Sec) of volume of air pumped during telemetry cycle.

Message 1 continues with filler bytes.

Status word definition

The definition of the STATUS bits in the engineering data above is shown below.

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.

SBE41 Status word definition

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 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.

Data Message 2 - 28-bit ARGOS ID

Byte(s)	Mnemonic	Description
0	CRC	Message CRC
1	MSG	Message ID - each data message block is comprised of multiple messages, this will be a 2 for Data Message 2
2 - 5	EPOCH	Unix epoch when down time expired (Apf9a RTC)
6 - 7	TINIT	Time (minutes) when telemetry phase was initiated relative to EPOCH. (2's compliment signed integer)
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 (0xff). Present only if a 20-bit argos id is used.

Data Message 3-N

Byte(s)	Mnemonic	Description
0	CRC	Message CRC
1	MSG	Message ID - each data message block is comprised of multiple messages, this will be a 2 for Data Message 2
2	VAC	Vacuum reading at park
3	ABP	Air-bladder pressure
4 - 5	PMT	Pump motor time
6	IER	Ice evasion record
7	MLN	Number of ice mixed-layer temperature samples
8 - 9	MLT	Mixed-layer medium temperature
10 - 11	MLTINF	Infimum of mixed-layer medium temperature
12 - 13	PT	Temperature at park-level
14 - 15	PS	Salinity at park-level
16 - 17	PP	Pressure at park-level
18 - 19	T	Profile temperature sample
20 – 21	S	Profile salinity sample
22 – 23	P	Profile pressure sample

The hydrographic profile temperature, salinity & pressure samples then continue with 3-N in the order that they were collected. Each sample consists of 6~bytes in order of T (2 bytes), S (2 bytes), P (2 bytes).

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. The auxiliary engineering data format is described in Appendix G.

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	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 ($\geq$ 0xF001) →	$T_{raw} = 62859$ $T_{2sComplement} = T_{raw} - 65536 = -2677$ $T = T_{2sComplement} / 1000 →$	-2.677 °C
Salinity	0x8FDD (<0xEFFF) →	$S_{raw} = 36829$ $S = S_{raw} / 1000 →$	36.829 psu
Salinity	0xF003 ($\geq$ 0xF001) →	$S_{raw} = 61443$ $S_{2sComplement} = S_{raw} - 65536 = -4093$ $S = S_{2sCompement} / 1000 →$	-4.093 psu

Pressure ≥ 0	0x1D4C ($<$ 0x8000) $\rightarrow$	$P_{raw} = 7500$ $P = P_{raw} / 10 \rightarrow$	750.0 dbar
Pressure < 0	0xFFFA ($\geq$ 0x8000) $\rightarrow$	$P_{raw} = 65530$ $P_{2sCompliment} = P_{raw} - 65536 = -6$ $P = P_{2sCompliment} / 10 \rightarrow$	-0.6 dbar
Volts	0xBB $\rightarrow$	$V_{raw} = 187$ $V = (V_{raw} * 0.077) + 0.486 \rightarrow$	14.9 V
Current	0x0A $\rightarrow$	$I_{raw} = 10$ $I = (I_{raw} * 4.052) - 3.606 \rightarrow$	36.9 mA
Vacuum	0x56 $\rightarrow$	$V_{raw} = 86$ $V = (V_{raw} * 0.293) - 29.767 \rightarrow$	-4.5 inHg

Conversion Notes:

The temperature range is -4.095 °C to 61.439 °C. Hex values 0xF000 (nonfinite), 0xF001 ($\leq$ -4.095), 0xEFFF ($\geq$ 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 ($\leq$ -4.095), 0xEFFF ($\geq$ 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 ($\leq$ -3276.7), 0x7FFF ($\geq$ 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.

D.   Depth Table for PTS Samples

The Pressure Table, below with values expressed in decibars (dbar), defines where discrete PTS measurements are acquired during a profile. The change to continuous profiling is controlled by Parameter Mc, Continuous profile activation pressure (decibars). Discrete PTS samples are taken according to the Pressure Table when the measured pressure is greater than the activation pressure. PTS sampling is continuous (1 Hz) with 2 dbar bin averages reported when the measured pressure is less than the activation pressure.

Depth Table 26, below, with values expressed in decibars (dbar), defines where PTS 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	380. 0	360. 0	350. 0	340. 0	330. 0	320. 0	310. 0
300. 0	290. 0	280. 0	270. 0	260. 0	250. 0	240. 0	230. 0
220. 0	210. 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	20. 0	10. 0	6. 0	0. 0

To prevent fouling of the CTD by surface and near-surface contaminants, the APF9I halts continuous profiling 4 dbar deeper than the most recent surface pressure measurement. As an additional safety feature, the SBE41cp will stop sampling when the measured pressure reaches 2 dbar if it has not already been halted by the float.

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 Teledyne Webb Research 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.

IMPORTANT: Piston full extension, set with menu parameter Ff, is calibrated and set at the factory. Do not alter the value of Ff shown in the "Missions" appendix. Using a value larger than the factory setting may result in severe damage to the pump.

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.
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  Seabird CTD agent.
S? Seabird CTD menu.
T  Get/Set RTC time. (format 'mm/dd/yyyy:hh:mm:ss')
```

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. [1-234] (counts)
o  Open air valve.
r  Retract the piston 4 counts.
t  Argos PTT test.
z  Calculate ToD down-time expiration.
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).
```

Deployment Parameter Menu

```
> L
APEX version 110813  sn ....
 ...    20-bit hex Argos id.                          Ma
401.650 Argos frequency (MegaHertz)                   Mh
    045 Argos repetition period (Seconds)             Mr
INACTV ToD for down-time expiration. (Minutes)        Mtc
    226 Down time. (Hours)                             Mtd
    014 Up time. (Hours)                               Mtu
    009 Ascent time-out. (Hours)                       Mta
    005 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
   50.0 Ice detection: Mixed-layer Pmax (Decibars)     Mix
   20.0 Ice detection: Mixed-layer Pmin (Decibars)     Min
  -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
    016 P-Activation piston position. (Counts)         Mfs
      2 Logging verbosity. [0-5]                        D
```

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

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.

Seal Plug
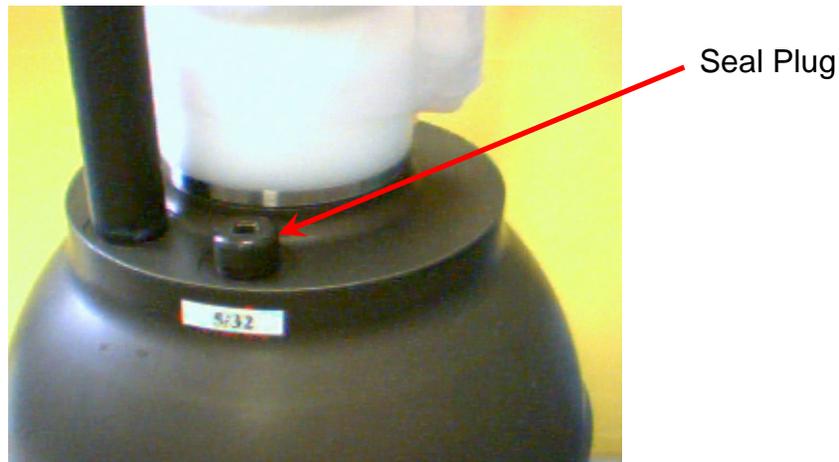
Appendix G: Test & Data Message source

This section lists snippets of the source code (developed at the University of Washington) used to construct Test Messages 1, 2 & 3, and Data Messages 1, 2 & 3.

<u>Test Message 1 snippet:</u>

```
/* write the message block id to the argos stream */
ArgosPutByte(ArgosBlkId);

/* write the month to the argos data stream */
byte = (FwRev>>16)&0xff; ArgosPutByte(byte);

/* write the day to the argos data stream */
byte = (FwRev>>8)&0xff;  ArgosPutByte(byte);

/* write the year to the argos data stream */
byte = FwRev&0xff;       ArgosPutByte(byte);

/* write the float id to the argos stream */
ArgosPutWord(mission.FloatId);

/* write the interval timer to the argos data stream */
u=(unsigned int)itimer(); ArgosPutWord(u);

/* get the current pressure */
if (GetP(&f)<=0)  {f=NaN();}

/* write the status bits to the argos data stream */
ArgosPutWord(vitals.status);

/* write the Telonics ST21 status byte to the argos stream */
ArgosPutByte(vitals.St21Status);

/* write the current pressure to the argos stream */
ArgosPutWord(EncodeP(f));

/* write the current air-bladder pressure to the argos data stream */
ArgosPutByte(BarometerAd8());

/* write the open-circuit voltage */
ArgosPutByte(BatVoltsAd8());
```

```
/* write the up-time to the argos data stream */
byte=mission.TimeUp/TQuantum; ArgosPutByte(byte);

/* write the down-time to the argos data stream */
u=mission.TimeDown/TQuantum; ArgosPutWord(u);

/* write the park pressure to the argos data stream */
ArgosPutWord(EncodeP(mission.PressurePark));

/* write the piston park position to the argos data stream */
ArgosPutByte(mission.PistonParkPosition);

/* write the buoyancy nudge to the argos data stream */
ArgosPutByte(mission.PistonBuoyancyNudge);

/* write the OK vacuum count to the argos data stream */
ArgosPutByte(mission.OkVacuumCount);

/* write the ascent time-out to the argos data stream */
byte=mission.TimeOutAscent/TQuantum; ArgosPutByte(byte);

/* write the target bladder pressure to the argos data stream */
ArgosPutByte(mission.MaxAirBladder);

/* write the profile pressure to the argos data stream */
ArgosPutWord(EncodeP(mission.PressureProfile));

/* write the deep-profile piston position to the argos data stream */
ArgosPutByte(mission.PistonDeepProfilePosition);

/* write the PnP cycle length to the argos data stream */
ArgosPutByte(mission.PnpCycleLength);

/* complete message #1 with filler bytes */
while (ArgosFifoLen()<MsgLen) {ArgosPutByte(0xff);}
```

Test Message 2 snippet:

```
/* Msg2: write the message block id to the argos stream */
ArgosPutByte(ArgosBlkId);

/* Msg2: write the month to the argos data stream */
byte = (FwRev>>16)&0xff; ArgosPutByte(byte);
```

```
/* Msg2: write the day to the argos data stream */
byte = (FwRev>>8)&0xff;  ArgosPutByte(byte);

/* Msg2: write the year to the argos data stream */
byte = FwRev&0xff;       ArgosPutByte(byte);

/* Msg2: write piston full-extension position to the argos data stream */
ArgosPutByte(mission.PistonFullExtension);

/* Msg2: write piston full-retraction position to the argos data stream */
ArgosPutByte(mission.PistonFullRetraction);

/* Msg2: write initial piston buoyancy nudge to the argos data stream */
ArgosPutByte(mission.PistonInitialBuoyancyNudge);

/* Msg2: write the piston position for pressure activation mode */
ArgosPutByte(mission.PistonPActivatePosition);

/* Msg2: write deep-profile descent period to the argos data stream */
ArgosPutByte(mission.TimeDeepProfileDescent/Hour);

/* Msg2: write park descent period to the argos data stream */
ArgosPutByte(mission.TimeParkDescent/Hour);

/* Msg2: write mission prelude period to the argos data stream */
ArgosPutByte(mission.TimePrelude/Hour);

/* Msg2: write argos rep-rate to the data stream */
ArgosPutByte(mission.ArgosRepPeriod);

/* Msg2: write the argos id to the data stream */
ArgosPutByte((mission.argosid.root>>12)&0xff);
ArgosPutByte((mission.argosid.root>>4)&0xff);
ArgosPutByte((mission.argosid.root&0xf)<<4 | (mission.argosid.ext>>4)&0xf);

/* Msg2: write argos frequency as kHz off-center of 401.65MHz */
ArgosPutByte(EncodeKHz(mission.ArgosMegaHertz));

/* Msg2: write the Sbe41 serial number */
ArgosPutWord(Sbe41Serno);

/* Msg2: write the Sbe41 firmware revision */
ArgosPutWord(Sbe41Fwrev);

/* Msg 2: write the current UNIX epoch of the Apf9a RTC (little endian order) */
```

```
t=time(NULL); ArgosPut((const unsigned char *)(&t),sizeof(t));

/* Msg 2: write the ToD specification (minutes) */
if (inRange(0,mission.ToD,Day)) ArgosPutWord(mission.ToD/Min);

/* Msg 2: write a sentinel value (0xfffe) if ToD feature disabled */
else ArgosPutWord(0xfffeU);

/* Msg 2: write the debug-level */
ArgosPutWord(debugbits);

/* complete message #2 with filler bytes */
while (ArgosFifoLen()<2*MsgLen) {ArgosPutByte(0xff);}
```

Test Message 3 snippet:

```
/* Msg 3: write the message block id to the argos stream */
ArgosPutByte(ArgosBlkId);

/* Msg 3: write the month to the argos data stream */
byte = (FwRev>>16)&0xff; ArgosPutByte(byte);

/* Msg 3: write the day to the argos data stream */
byte = (FwRev>>8)&0xff;  ArgosPutByte(byte);

/* Msg 3: write the year to the argos data stream */
byte = FwRev&0xff;       ArgosPutByte(byte);

/* Msg 3: write the vacuum reading to the argos data stream */
ArgosPutByte(vitals.Vacuum);

/* Msg 3: write the months where ice-detection is activated */
ArgosPutWord(mission.IceMonths);

/* Msg 3: write the critical mixed-layer temperature */
ArgosPutWord(EncodeT(mission.IceMixedLayerTcritical));

/* Msg 3: write the ice-detection pressure to the argos data stream */
ArgosPutWord(EncodeP(mission.IceMixedLayerPmax));

/* Msg 3: write the ice-evasion pressure to the argos data stream */
ArgosPutWord(EncodeP(mission.IceMixedLayerPmin));

/* complete message #3 with filler bytes */
while (ArgosFifoLen()<3*MsgLen) {ArgosPutByte(0xff);}
```

Data Message 1 snippet:

```
/* write the message block id to the argos stream */
   ArgosPutByte(ArgosBlkId);

   /* write the float id to the argos stream */
   ArgosPutWord(mission.FloatId);

   /* write the profile id to the argos stream */
   ArgosPutByte((unsigned char)PrfIdGet());

   /* write the number of observations to the argos stream */
   ArgosPutByte(ObsIndex);

   /* write the status word to the argos stream */
   ArgosPutWord(vitals.status);

   /* write the Telonics ST21 status byte to the argos stream */
   ArgosPutByte(vitals.St21Status);

   /* write the surface pressure to the argos data stream */
   ArgosPutWord(EncodeP(vitals.SurfacePressure));

   /* write the current pressure to the argos data stream */
   ArgosPutByte(EncodePs(p));

   /* write the surface piston position */
   ArgosPutByte(vitals.SurfacePistonPosition);

   /* write the park piston position */
   ArgosPutByte(mission.PistonParkPosition);

   /* write the profile piston position */
   ArgosPutByte(mission.PistonDeepProfilePosition);

   /* write the SBE41 status long-word to the argos stream */
   ArgosPutLongWord(vitals.Sbe41Status);

   /* write the quiescent volts and amps at the park level */
   ArgosPutByte(vitals.QuiescentVolts); ArgosPutByte(vitals.QuiescentAmps);

   /* write the SBE41 volts and amps at the park level */
   ArgosPutByte(vitals.Sbe41Volts); ArgosPutByte(vitals.Sbe41Amps);
```

```
/* write the buoyancy pump volts and amps at the end of the initial pump extension */
ArgosPutByte(vitals.BuoyancyPumpVolts); ArgosPutByte(vitals.BuoyancyPumpAmps);

/* write the air-pump volts and amps */
ArgosPutByte(vitals.AirPumpVolts); ArgosPutByte(vitals.AirPumpAmps);

/* write the air-pump energy paramters */
ArgosPutByte(vitals.AirPumpPulses); ArgosPutWord(vitals.AirPumpVoltSec);

/* complete message #1 with filler bytes */
while (ArgosFifoLen()<MsgLen) {ArgosPutByte(0xff);}
```

Data Message 2 snippet:

```
/* Msg 2: write the UNIX epoch when the down-time ended */
t=vitals.TimeDownEpoch; ArgosPut((const unsigned char *)(&t),sizeof(t));

/* Msg 2: write elapsed time to initiation of telemetry phase */
t=(time_t)(difftime(vitals.TelemetryInitEpoch,vitals.TimeDownEpoch)/Min);
ArgosPutWord((unsigned int)((t>=0)?t:(0x10000L+t)));

/* Msg 2: write the number of active-ballast adjustments */
ArgosPutByte(vitals.ActiveBallastAdjustments);

/* Msg 2: write the park-level statistics */
ArgosPutWord(ParkPt.n);
ArgosPutWord(EncodeT(ParkPt.mean.t));
ArgosPutWord(EncodeP(ParkPt.mean.p));
ArgosPutWord(EncodeT(ParkPt.stddev.t));
ArgosPutWord(EncodeP(ParkPt.stddev.p));
ArgosPutWord(EncodeT(ParkPt.Tmin.t));
ArgosPutWord(EncodeP(ParkPt.Tmin.p));
ArgosPutWord(EncodeT(ParkPt.Tmax.t));
ArgosPutWord(EncodeP(ParkPt.Tmax.p));
ArgosPutWord(EncodeP(ParkPt.Pmin));
ArgosPutWord(EncodeP(ParkPt.Pmax));

/* Msg 2: complete message #2 with filler bytes */
while (ArgosFifoLen()<2*MsgLen) {ArgosPutByte(0xff);}
```

Data Message 3 snippet:

```
/* Msg 3: write the vacuum reading at the park level */
  ArgosPutByte(vitals.Vacuum);

  /* Msg 3: write the air bladder pressure */
  ArgosPutByte(vitals.AirBladderPressure);

  /* Msg 3: conditon the pump-time for an unsigned int */
  if (vitals.BuoyancyPumpOnTime<0) vitals.BuoyancyPumpOnTime=0;
  else if (vitals.BuoyancyPumpOnTime>UINT_MAX)
vitals.BuoyancyPumpOnTime=UINT_MAX;

  /* Msg 3: write the pump motor time */
  ArgosPutWord((unsigned int)vitals.BuoyancyPumpOnTime);

  /* Msg 3: write the ice evasion record and the number of mixed-layer temperature samples */
  ArgosPutByte(vitals.IceEvasionRecord); ArgosPutByte(vitals.IceMLSample);

  /* Msg 3: write the mixed-layer median temperature */
  ArgosPutWord(EncodeT(vitals.IceMLMedianT));

  /* Msg 3: write the infimum of the mixed-layer median temperature */
  ArgosPutWord(EncodeT(vitals.IceMLMedianTInf));

  /* Msg 3: write the hydro-sample at the park level */
  ArgosPutWord(EncodeT(vitals.ParkObs.t));
  ArgosPutWord(EncodeS(vitals.ParkObs.s));
  ArgosPutWord(EncodeP(vitals.ParkObs.p));

  /* write the hydrographic profile to the argos stream */
  for (i=0; i<ObsIndex && i<pTableSize; i++)
  {
    ArgosPutWord(EncodeT(obs[i].t));
    ArgosPutWord(EncodeS(obs[i].s));
    ArgosPutWord(EncodeP(obs[i].p));
  }

  /* check to see if there's room to write the auxiliary engineering data */
  if ((ArgosFifoLen()%MsgLen) && (N=(MsgLen-(ArgosFifoLen()%MsgLen)))>=2)
  {
    /* write the pressure divergence as auxiliary engineering data */
    ArgosPutWord(EncodeP(vitals.PDivPts)); N-=2;
```

```c
  /* check to see if there's room to write more auxiliary engineering data */
  if (N>=2)
  {
    /* write elapsed time to initiation of telemetry phase */
    t=(time_t)(difftime(vitals.ProfileInitEpoch,vitals.TimeDownEpoch)/Min);
    ArgosPutWord((unsigned int)((t>=0)?t:(0x10000L+t))); N-=2;

    /* check room to write the number of descent marks */
    if (N>=1) {ArgosPutByte(vitals.ParkDescentPCnt); N--;}

    /* loop through each descent mark */
    for (i=0; i<N && i<vitals.ParkDescentPCnt && i<ParkDescentPMax; i++)
    {
      /* write the current descent mark (bars) to the argos fifo */
      ArgosPutByte(vitals.ParkDescentP[i]);
    }
  }
}
```

Appendix H: 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.

IMPORTANT: **Piston full extension, set with menu parameter Ff, is calibrated and set at the factory. Do not alter the value of Ff shown in the "Missions" appendix. Using a value larger than the factory setting may result in severe damage to the pump.**

Instrument # 7168

APEX version 110813 sn 0605
2121613 28-bit hex Argos id.   Ma
401.650 Argos frequency (MegaHertz)   Mh
  042 Argos repetition period (Seconds)   Mr
INACTV ToD for down-time expiration. (Minutes)   Mtc
  222 Down time. (Hours)   Mtd
  018 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
  50.0 Ice detection: Mixed-layer Pmax (Decibars) Mix
  20.0 Ice detection: Mixed-layer Pmin (Decibars) Min
 -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
  016 P-Activation piston position. (Counts)   Mfs
    2 Logging verbosity. [0-5]   D

Instrument # 7169

APEX version 110813 sn 0594
2121600 28-bit hex Argos id.   Ma
401.650 Argos frequency (MegaHertz)   Mh
  044 Argos repetition period (Seconds)   Mr
INACTV ToD for down-time expiration. (Minutes)   Mtc
  222 Down time. (Hours)   Mtd
  018 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
 50.0 Ice detection: Mixed-layer Pmax (Decibars) Mix
 20.0 Ice detection: Mixed-layer Pmin (Decibars) Min
-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
  226 Piston full extension. (Counts)   Mff
  016 P-Activation piston position. (Counts)   Mfs
    2 Logging verbosity. [0-5]   D

Instrument # 7170

APEX version 110813 sn 0602
21137C7 28-bit hex Argos id.   Ma
401.650 Argos frequency (MegaHertz)   Mh
  046 Argos repetition period (Seconds)   Mr
INACTV ToD for down-time expiration. (Minutes)   Mtc
  222 Down time. (Hours)   Mtd
  018 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
 50.0 Ice detection: Mixed-layer Pmax (Decibars) Mix
 20.0 Ice detection: Mixed-layer Pmin (Decibars) Min
-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
  016 P-Activation piston position. (Counts)   Mfs
    2 Logging verbosity. [0-5]   D

Instrument # 7171

APEX version 110813 sn 0633
742EC35 28-bit hex Argos id.   Ma
401.650 Argos frequency (MegaHertz)   Mh
  042 Argos repetition period (Seconds)   Mr
INACTV ToD for down-time expiration. (Minutes)   Mtc
  222 Down time. (Hours)   Mtd
  018 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
 50.0 Ice detection: Mixed-layer Pmax (Decibars) Mix
 20.0 Ice detection: Mixed-layer Pmin (Decibars) Min
-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
  226 Piston full extension. (Counts)   Mff
  016 P-Activation piston position. (Counts)   Mfs
    2 Logging verbosity. [0-5]   D

Instrument # 7172

APEX version 110813 sn 0597
52A7AF2 28-bit hex Argos id.   Ma
401.650 Argos frequency (MegaHertz)   Mh
  044 Argos repetition period (Seconds)   Mr
INACTV ToD for down-time expiration. (Minutes)   Mtc
  222 Down time. (Hours)   Mtd
  018 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
 50.0 Ice detection: Mixed-layer Pmax (Decibars) Mix
 20.0 Ice detection: Mixed-layer Pmin (Decibars) Min
-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
  016 P-Activation piston position. (Counts)   Mfs
    2 Logging verbosity. [0-5]   D

Instrument # 7175

APEX version 110813 sn 0620
543C126 28-bit hex Argos id.   Ma
401.650 Argos frequency (MegaHertz)   Mh
  046 Argos repetition period (Seconds)   Mr
INACTV ToD for down-time expiration. (Minutes)   Mtc
  222 Down time. (Hours)   Mtd
  018 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
 50.0 Ice detection: Mixed-layer Pmax (Decibars) Mix
 20.0 Ice detection: Mixed-layer Pmin (Decibars) Min
-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
  226 Piston full extension. (Counts)   Mff
  016 P-Activation piston position. (Counts)   Mfs
    2 Logging verbosity. [0-5]   D

Instrument # 7176

APEX version 110813 sn 0640
9E1E435 28-bit hex Argos id.   Ma
401.650 Argos frequency (MegaHertz)   Mh
  042 Argos repetition period (Seconds)   Mr
INACTV ToD for down-time expiration. (Minutes)   Mtc
  222 Down time. (Hours)   Mtd
  018 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
 50.0 Ice detection: Mixed-layer Pmax (Decibars) Mix
 20.0 Ice detection: Mixed-layer Pmin (Decibars) Min
-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
  226 Piston full extension. (Counts)   Mff
  016 P-Activation piston position. (Counts)   Mfs
    2 Logging verbosity. [0-5]   D
 0002 DebugBits.   D