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APEX PROFILER USER MANUAL

Applies to Serial Numbers:

6824 – 6828 (Deploy Lat. 60°S, Cycle days 10)

Depth Table 64

Revision Date: 11/04/13

Customer Name: INNOVA
Job Number: 2207.A
Firmware Revision 082213
Features:

APF9A Controller
Park and Profile
Deep Profile First (DPF)
Air pump energy consumption limit
Time of Day profile control
Non-modal behavior

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, <u>"Manual Deployment with the Reset Tool"</u> and <u>"Pressure Activation Deployment"</u>, 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.

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.

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
    - Pressure is measured every 2 hours
    - Pressure in excess of 25 dbar triggers
        - Full piston extension
        - Transition to Mission Prelude
- Mission Prelude
    - Test transmissions (6 hours typical)
    - 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.** **Be sure to replace the plug before deployment!**

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

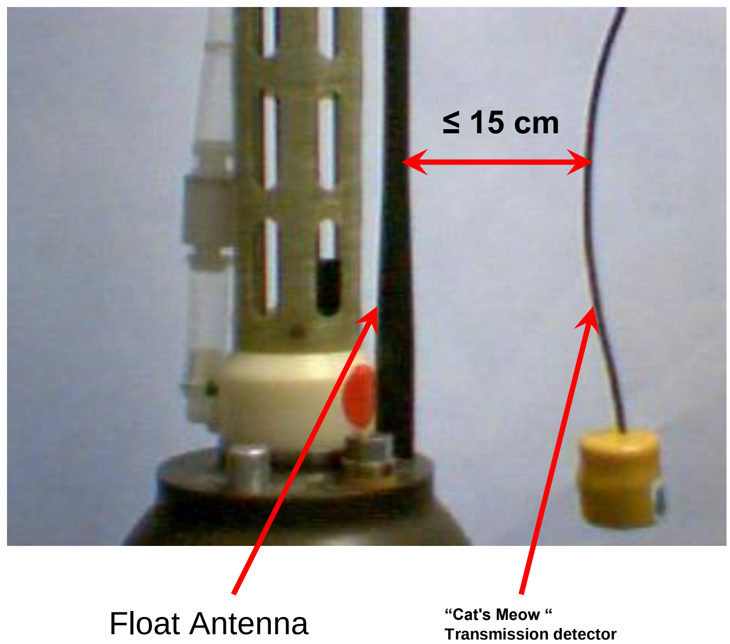
5) Start a Manual or Pressure Activated Deployment as described above in the "Manual Deployment with the Reset Tool" and "Pressure Activation Deployment" sections. This will trigger the Mission Activation self tests. Where applicable, the description below indicates where the two versions of the self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

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

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

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

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



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

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

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

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

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

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

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

10) The float is ready to deploy.

E. Notes and Caveats

Self Tests: During the self tests the float checks:

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

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

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

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

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

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

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

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:

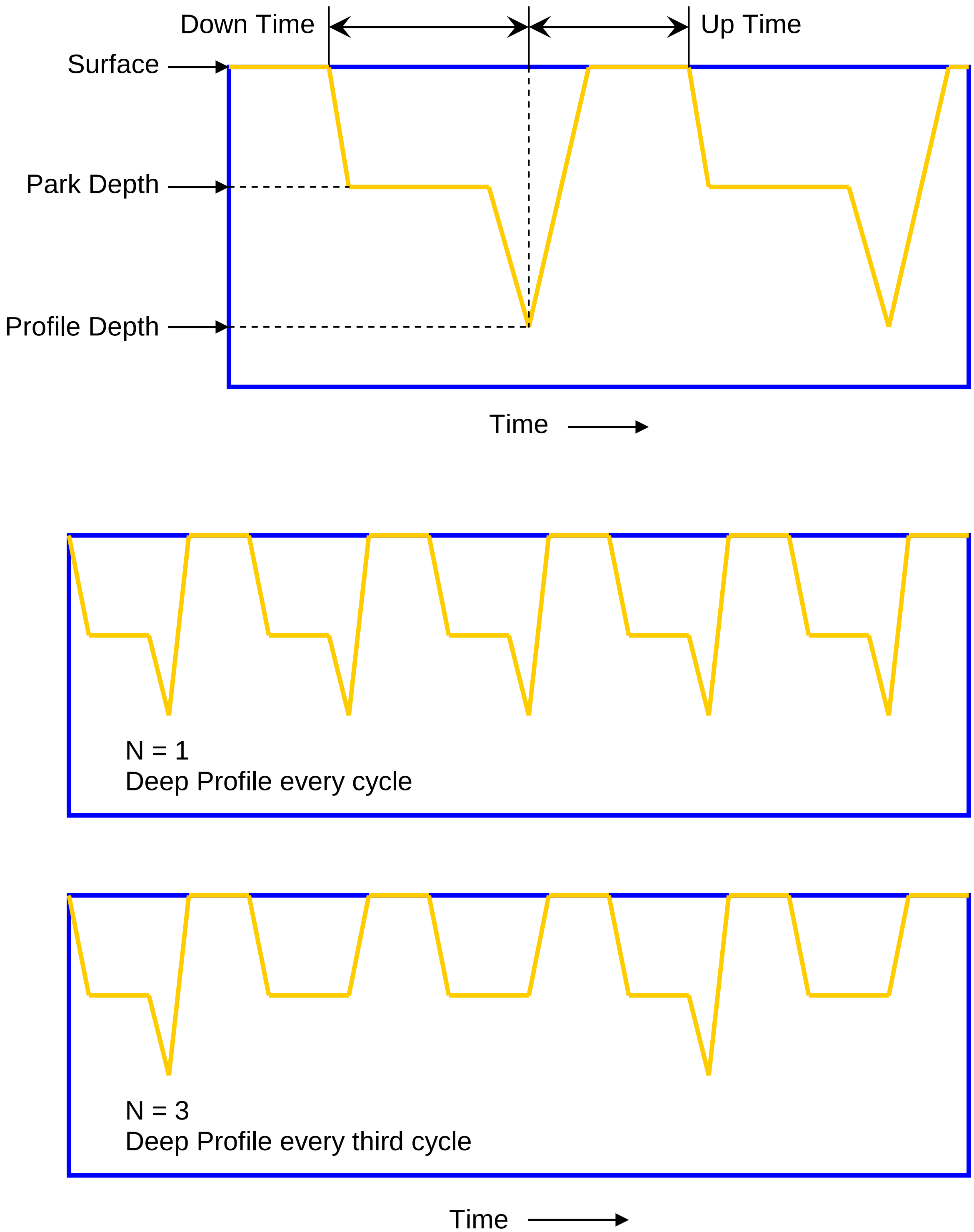
- Park Depth — Intermediate depth at which the float drifts between profiles and from which the float profiles in cycles not evenly divisible by N.
- Profile Depth — Maximum depth to which the float descends from the Park Depth every Nth cycle and from which each Nth profile is conducted.
- Down Time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

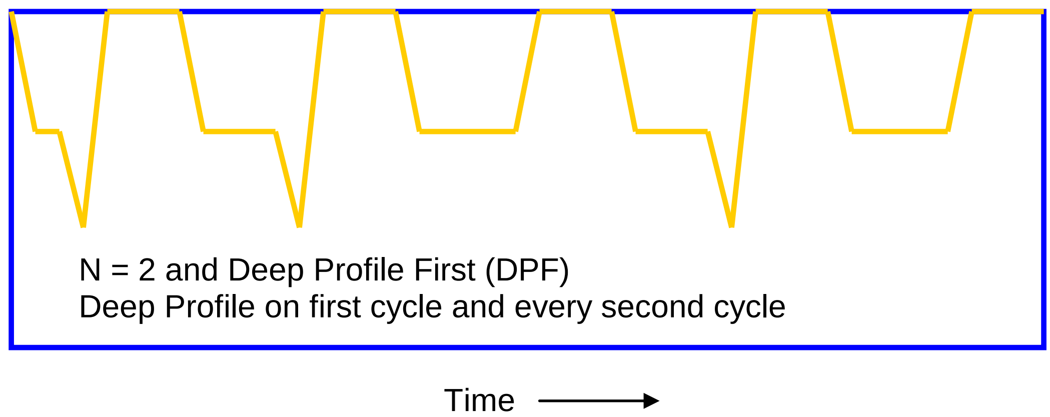
B. Profile and Profile Cycle Schematics



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.



<u>Note</u>: For maximum battery life in ARGO applications, Teledyne Webb Research recommends use of PD > one, with park depth $\leq$ 1500 db.

VIII. ARGOS Data

A. SERVICE ARGOS Parameters

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

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

[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

The test message block is comprised of two messages. Each of the 6 messages sent during the Mission Activation phase is a Test Message 1. During the Mission Prelude the two test messages alternate, with one sent during each ARGOS transmission. The formats of the two test messages are show in the tables below:

Test Message 1 - 28-bit ARGOS ID

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 - 13	P	Pressure measured once for each test message block [centibars]
14	VAC	Vacuum measured during self tests [counts]
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

Test Message 2 - 28-bit ARGOS ID

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	DPDP	Deep-profile descent period [hours]
10	PDP	Park descent period [hours]
11	PRE	Mission prelude period [hours]
12	REP	ARGOS transmission repetition period [seconds]
13 -1 4	SBESN	Seabird SBE41 serial number
15 - 16	SBEFW	Seabird SBE41 F/W Revision
17 - 20	EPOCH	Current UNIT epoch (GMT) of Apf9a RTC (little endian order)
21 - 22	TOD	Minutes past midnight when down-time will expire. If ToD feature disabled, bytes = 0xfffe.
23 - 24	DEBUG	Debugging verbosity
25 - 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.

C. Data Messages - 28-bit ARGOS ID

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

Data Message 1 - 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 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	Same as the Test Message 1 Status word (see above)
9 - 10	SP	Surface pressure at end of Up Time [centibars]
11	VAC	The current pressure [centibars] as recorded during the creation of each argos message block. Each distinct copy of argos message #1 contains a new pressure measurement.
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 The battery voltage [counts] measured when the SBE41 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 (0xff). Present only if a 20-bit argos id is used.

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

Status Word - 16 bits

Bit	Mnemonic	Description
0x0001	DeepPrf	Current profile is a Deep Profile
0x0002	ShallowWaterTrap	Shallow water trap detected
0x0004	Obs25Min	Sample time-out (25 minutes) expired
0x0008	PistonFullExt	Piston fully extended before surface detected
0x0010	AscentTimeOut	Ascent time-out expired
0x0020	TestMsg	Current message is a test message
0x0040	PreludeMsg	Current messaged transmitted during Mission Prelude
0x0080	PActMsg	Current message is a Pressure Activation test message
0x0100	BadSeqPnt	Invalid sequence point detected
0x0200	Sbe41PFail	Sbe41(P) exception.
0x0400	Sbe41PtFail	Sbe41(PT) exception.
0x0800	Sbe41PtsFail	Sbe41(PTS) exception
0x1000	Sbe41PUnreliable	Sbe41(P) unreliable.
0x2000	AirSysBypass	Air inflation system bypassed; excessive energy consumption.
0x4000	WatchDogAlarm	Wake-up by watchdog alarm
0x8000	PrfIdOverFlow	8-bit profile counter overflowed [255 → 0]

The definition of the SBE41 status bits in the engineering data above is shown in the table below.

SBE41 Status Word - 16 bits

Bit	Mnemonic	Description
0x0001	Sbe41PedanticExceptn	An exception was detected while parsing the P-only pedantic regular expression
0x0002	Sbe41PedanticFail	The SBE41 response to P-only measurement failed the pedantic regular expression
0x0004	Sbe41RegexFail	The SBE41 response to P-only measurement failed the non-pedantic regular expression
0x0008	Sbe41PNullArg	NULL argument detected during P-only measurement
0x0010	Sbe41PRegExceptn	An exception was detected while parsing the P-only non-pedantic regular expression
0x0020	Sbe41PNoResponse	No response detected from SBE41 for P-only request
0x0040		Not used yet
0x0080		Not used yet
0x0100	Sbe41PtPedanticExceptn	An exception was detected while parsing the PTS pedantic regular expression

0x0200	Sbe41PtPedanticFail	The SBE41 response to PT sample-request failed the pedantic regex.
0x0400	Sbe41PtRegexFail	The SBE41 response to PTS measurement failed the pedantic regular expression
0x0800	Sbe41PtNullArg	NULL argument detected during PTS measurement
0x1000	Sbe41PtRegExceptn	An exception was detected while parsing the PTS non-pedantic regular expression
0x2000	Sbe41PtNoResponse	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. Pressure and temperature data are encoded as shown in the C-source below.

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.

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 first (in bytes 2-7 of message 3) followed by the samples collected during the profile phase. Each sample consists of 6 bytes in order of T (2 bytes), S (2 bytes), P (2 bytes). The hydrographic data are encoded as shown in the C-source code below.

Message N: Auxiliary Engineering data

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

<u>Time of profile initiation</u>: 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.

<u>Descent pressure marks</u>: 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.

D. Conversion from Hexadecimal to Physical Units

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

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

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

Measurement	Hexadecimal	Decimal and Conversion Steps	Physical Result
Temperature ≥ 0	0x3EA6 (<0xEFFF) →	T_{raw} = 16038 T = T_{raw} / 1000 →	16.038 °C
Temperature < 0	0xF58B (≥ 0xF001) →	Traw = 62859 $T_{2sComplement}$=T_{raw}–65536=-2677 T= $T_{2sComplement}$ / 1000 →	-2.677 °C
Salinity	0x8FDD (<0xEFFF) →	S_{raw} = 36829 S= S_{raw} / 1000 →	36.829 psu
Salinity	0xF003 (≥ 0xF001) →	S_{raw} = 61443 $S_{2sComplement}$=S_{raw}-65536= -4093 S= $S_{2sCompement}$ / 1000 →	-4.093 psu
Pressure ≥ 0	0x1D4C (< 0x8000) →	P_{raw} = 7500 P = P_{raw} / 10 →	750.0 dbar
Pressure < 0	0xFFFA (≥ 0x8000) →	P_{raw} = 65530 $P_{2sCompliment}$ = P_{raw} - 65536 = -6 P = $P_{2sCompliment}$ / 10 →	-0.6 dbar
Volts	0xBB →	V_{raw} = 187 V= (V_{raw} *0.077) + 0.486 →	14.9 V
Current	0x0A →	I_{raw} = 10 I = (I_{raw} * 4.052) –3.606 →	36.9 mA
Vacuum	0x56 →	V_{raw} = 86 V = (V_{raw}* 0.293) -29.767 →	-4.5 inHg

<u>Conversion Notes</u>:

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

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

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

E. Depth Table 64 for PTS Samples

Depth Table 64, below, with values expressed in decibars (dbar), defines where PTS measurements are acquired during a profile.

Sample Point	Pressure (dbar) Bottom	Sample Point	Pressure (dbar)	Sample Point	Pressure (dbar)
1	2000	37	600	73	240
2	1950	38	590	74	230
3	1900	39	580	75	220
4	1850	40	570	76	210
5	1800	41	560	77	200
6	1750	42	550	78	190
7	1700	43	540	79	180
8	1650	44	530	80	170
9	1600	45	520	81	160
10	1550	46	510	82	150
11	1500	47	500	83	140
12	1450	48	490	84	130
13	1400	49	480	85	120
14	1350	50	470	86	110
15	1300	51	460	87	100
16	1250	52	450	88	95
17	1200	53	440	89	90
18	1150	54	430	90	85
19	1100	55	420	91	80
20	1050	56	410	92	75
21	1000	57	400	93	70
22	950	58	390	94	65
23	900	59	380	95	60
24	850	60	370	96	55
25	800	61	360	97	50
26	750	62	350	98	45
27	700	63	340	99	40
28	690	64	330	100	35
29	680	65	320	101	30
30	670	66	310	102	25
31	660	67	300	103	20
32	650	68	290	104	15
33	640	69	280	105	10
34	630	70	270	106	4
35	620	71	260		
36	610	72	250		

Table 64

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

F. Telemetry Error Checking (CRC)

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

A sample code fragment in C that can be used to calculate CRC values is shown below. This code was written by Dana Swift of the University of Washington. The original algorithm was developed in the 1970s by Al Bradley and Don Dorson of the Woods Hole Oceanographic Institution. The algorithm attempts to distribute the space of possible CRC values evenly across the range of single byte values, 0 to 255. Sample programs in C, Matlab, FORTRAN, and BASIC can be provided by 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) × n × p = (5 - 1) × 18 × 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.

<u>IMPORTANT</u>: 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.

<u>Main Menu</u>

```
> ?
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')
```

<u>Diagnostics Menu</u>

```
> 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).
```

Appendix F: Returning APEX floats for factory repair or refurbishment

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

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

Notify: DHL-Danzas Freight Forwarding Agents
Attn: Ellis Hall, Import Broker
Phone (617) 886-6665, FAX (617) 242-1470
500 Rutherford Avenue
Charlestown, MA 02129

Note on shipping documents: US MADE GOODS

CAUTION: If the float was recovered from the ocean, it may contain water, which presents a safety hazard due to possible chemical reaction of batteries in water. The reaction may generate explosive gases (see "Alkaline Battery Warning" at the beginning of this manual). In this case, be sure to remove the seal plug to ventilate the instrument before shipping. Do this is a well ventilated location and do not lean over the seal plug while loosening it. Use a 3/16 inch hex wrench (provided), or pliers, to rotate the plug counter-clockwise.

Appendix G: Missions

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

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

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 # 6824

```
APEX version 082213  sn 8534
C7DD779 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
  227 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
  000 Compensator hyper-retraction. (Counts)  Mbh
  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
  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
 5f26 Mission signature (hex).
```

Instrument # 6825

APEX version 082213 sn 9466
C7DD78B 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
  227 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
  000 Compensator hyper-retraction. (Counts)   Mbh
  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
  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
 3862 Mission signature (hex).

Instrument # 6826

```
APEX version 082213  sn 9372
C7DD798 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
   227 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
   000 Compensator hyper-retraction. (Counts)   Mbh
   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
   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
  0002 DebugBits.                               D
  47da Mission signature (hex).
```

Instrument # 6827

APEX version 082213 sn 9374
C7DD7AD 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
   227 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
   000 Compensator hyper-retraction. (Counts)   Mbh
   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
   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
  0002 DebugBits.   D
  66b0 Mission signature (hex).

Instrument # 6828

APEX version 082213 sn 9373
C7DD7BE 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
   227 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
   000 Compensator hyper-retraction. (Counts)   Mbh
   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
   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
  8c3a Mission signature (hex).