ALAMO and ALTO Floats Piloting Manual

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Introduction

The purpose of this Piloting Manual is to serve the pilot of either an MRV Systems ALAMO™ (Air Launched Autonomous Micro-Observer) and or ALTO float following launch at sea. The pilot must be involved ashore to monitor and, as required, control float operations following launch. An accompanying Deployment Manual exists to accompany the field technician responsible for launching, either from sea or air well-remote from the pilot's location. A Quick Start Guide is also available. This manual is consistent with both the Deployment Manual and Quick Start Guide and contains details about the physics of float operation, the commands and parameters used in float control, and non-standard methods of operation that are not required in the field.

The MRV Systems ALAMO™ and ALTO floats are unmanned autonomous underwater battery powered vehicles designed to measure various ocean properties, for example temperature and salinity as a function of depth based on the sensor package(s) installed on the float. These floats are Lagrangian drifters and cannot control the direction of travel. They can only control buoyancy and thereby its depth. To change buoyancy, the float pumps oil to an external bladder thus changing displacement. The floats' sensor package(s) are administered by the floats' main CPU and generate profile data at operator-selectable intervals during descent, park, and, principally ascent stages of the float's profile. The floats use an on-board GPS receiver to capture precise float location when at the surface and an on-board Iridium communication device to transmit data ashore and receive commands from shore. The data generated is packetized and typically transmitted in Short Burst Data (SBD) mode.

Both the ALAMO and ALTO floats currently operate the MRV Systems Firmware Architecture (MFA) for controlling the operation of the floats. The architecture functions using a number of commands and parameters. A mission configuration is a set of commands and parameters sets that direct the float to execute one or more stages of operation within each of four float states: surface, descend, park, ascend; one sequence through which defines a profile. The mission configuration can drive one or more profiles including up to three sets of profiles that have different parameter settings. Since the floats are autonomous vehicles, the commands and parameters of the mission(s) it is to perform should be programmed prior to shipment. Commands and parameters, defined in Appendix C, Command and Parameter References, are used to control the float's behavior during profile including frequency of sampling and recording, fall time, park depth, ascent rate, allowed time limits for obtaining GPS fixes and communicating via satellite, and even under-ice behavior. Three sets of these commands and parameters are stored on the float. All three are set at the factory. A permanent set is stored with the operating system software. A second set is stored in EEPROM and is drawn upon if the float reboots on its own. The third set is stored in RAM. The RAM version can be altered by hard wire or Bluetooth or by emailing the float from ashore with a binary Iridium SBD file attachment containing commands and parameter changes. The float can - and should - be commanded to update the EEPROM version from RAM upon making changes. The Iridium email communication path is also used by the float to transmit data in the same packetized SBD format to the user. It is available for the pilot to command a resend of information ashore or even execute a reboot.

Our floats are deployed in oceans around the globe and communicate to an email server or IP address of choice at some remote location. The person deploying the float is almost always not the person piloting it, hence the need for both this Piloting Manual, its accompanying Deployment and, as desired, Quick Start Manuals.

Iridium Account

Activating an Iridium Communications account will also have been specified in the purchase agreement and is required to configure and test float to satellite communications. Each account is keyed to the unique MRV float identifying IMEI number. MRV creates and activates an Iridium account for each float during the build process. This allows MRV to receive messages during test communications before leaving the factory.

Prior to shipment, MRV will contact the customer to address final provisioning (setting email and IP addresses for the float to connect through) and arrange to transfer account ownership to the customer with the Iridium provider of their choice. For the life of most of our floats MRV monitors and evaluates performance for future product development. Subject to the purchase agreement, MRV reserves the right to including provisioning one iridium email address assigned to sbd@mrvsys.com.

Maximum Pressure

The ALAMO operates to a maximum depth of 1,200 meters. The ALTO operates to a maximum depth of 2,000 meters.

If the user will be exposing the ALAMO or ALTO to significant hydrostatic pressure during testing, contact MRV Systems in advance to confirm you will not compromise float functionality.

Ready to Deploy

From a field operation and piloting standpoint, our floats are shipped ready in all respects (vacuum set, ballasting and mission presets as agreed to in the purchase order, and in low-power sleep mode) for being deployed in a pre-specified body of water for a pre-specified type of profiling mission. They must simply be "reset" (turned on is a misnomer - resetting takes the float out of low-power mode and initiates a Built In Test (BIT, used interchangeably in this manual with Built In Self Tests - BIST)) in the field and delivered by the field technician into the water either directly or by parachute. The BIT initiates a self-test which will ideally verified by the pilot. Once in the water and free of packaging (if present), the floats will be negatively buoyant and start descending. Hydrostatic pressure as the float descends or time passed since the float was reset triggers the start of the float's mission software sequence. Typically, the float will then execute a shallow or mid-depth diagnostic profile during which it returns immediately to the surface obtains a GPS fix, and communicates ashore. After that, the float automatically begins its first in a series of normal profiles during which it normally "seeks" i.e., attempts to refine its ability to efficiently reach its park depth by controlling the duration of its initial pump when leaving the surface. Should the pilot choose, before the float communicates upon surfacing, a command to stay at the surface ("beacon mode on") may be issued via Iridium email. This will afford the pilot the opportunity to review the just-completed profile's data and alter parameters on that basis should that be desired. To restart profiling, the pilot must command "beacon mode off."

The pilot may send mission revisions via an Iridium email as desired that the float will retrieve when it next communicates.

The field technician's principle functions are to 1) stage the float for deployment, 2) initiate a BIT unless it has already been performed, 3) confirm the float's proper operation by observing the illumination of the BIT light (and possibly hearing valve and pump noises during the BIT), and 4) deploy the float. Upon launching the float, the field technician's task is normally complete unless, for surface launches, there is a desire to potentially recover the float after its diagnostic profile in the event it is not functioning correctly.

Our floats include a Communications port for directly communicating with the float via laptop to download mission files, execute a BIT, evaluate parameter settings, execute various debug functions, and directly command mission initiation. Use of the Communications port is addressed in the section Special Float Operations below.

MRV floats are ruggedly designed to operate in a wide variety of challenging ocean environments. However, to maximize the longevity of the unit and to prevent injury when handling the float, it is important to follow some simple safety and health precautions.

Hazardous Materials

MRV ALAMO and ALTO floats may contain hazardous materials depending on battery and sensor choices. Relevant and current MSDS should be obtained for the following items where used in these floats:

Tadiran primary batteries comprised of Lithium, Thionyl Chloride (Li-SOCl2)

SAFT primary lithium batteries

Top of the Seabird conductivity cell contains Bis (tributyltin) oxide

Handling

The ALAMO and ALTO are high-precision instruments, and it is important that it is handled with care. Avoid scratches to the painted or anodized surfaces. This may compromise the durability and/or longevity of the float after deployment in the ocean.

There should be no need to access either Comm port or Vacuum port prior to deployment, but should the need arise, avoid damaging anodized coatings on Comm Port and Vacuum Port plugs and ensure the plug's o-ring condition is unblemished and free of particles of any sort prior to reinstalling. Tighten finger tight with a 3/16” hex key.

Documentation and Software

Documentation, including a copy of this Deployment Manual and the accompanying Piloting Manual and sensor calibration information (provided by the manufacturer for each float delivered) is provided electronically to the customer. When your float is shipped, you will receive an e-mail notification of the shipment. Float operating software is generally not provided to the customer. A decoder for Iridium SBD messages sent by the float is available upon request. A tool for converting text-formatted mission configuration files to binary for emailing via Iridium are also available upon request. (See Appendix B)

Storage

If the float is to be stored for a length of time prior to deployment, it should be kept in unopened original packaging in a location that affords reduced likelihood of physical damage and a humidity and temperature-controlled environment. It's preferable to store floats vertically in packaging, orienting "This End Up", and on pallets or shelving.

Mechanical Features

ALAMO Float

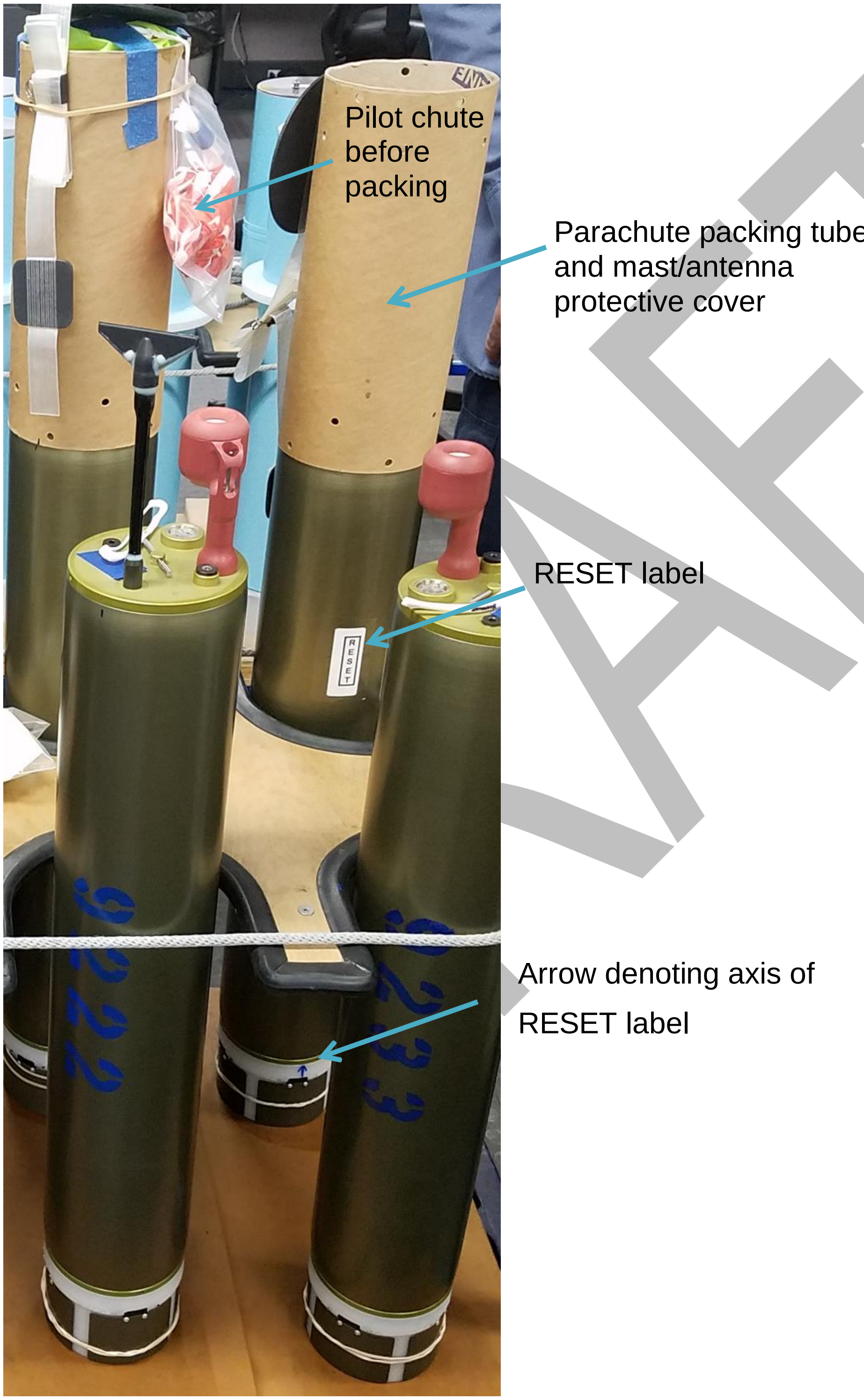

Figure 2. ALAMO Floats outfitted with RBR CTDs

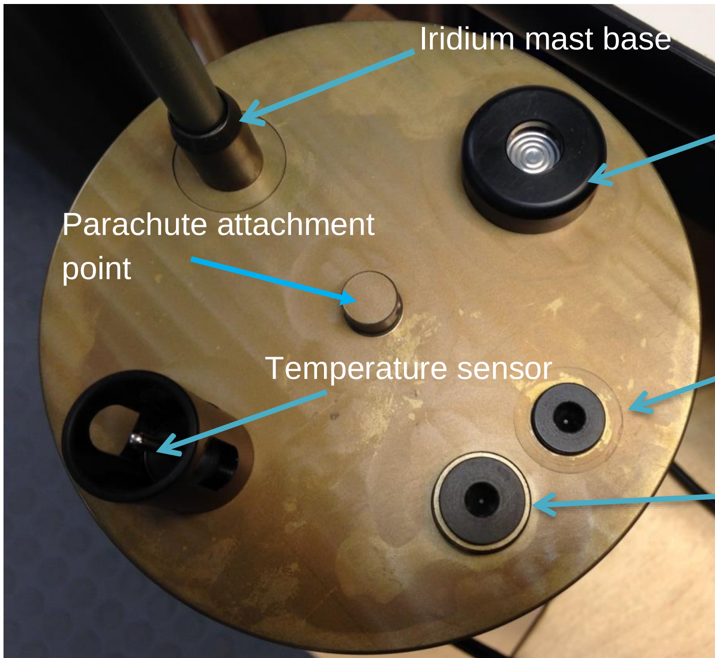

Figure 3. ALAMO Float - topcap view (pressure/temperature sensor configuration).

There should be no need to access either Comm port of Vacuum port prior to deployment, but should the need arise, avoid damaging anodized coatings on Comm Port and Vacuum Port plugs and ensure the plug's o-ring condition is unblemished and free of particles of any sort prior to reinstalling. Tighten finger tight.

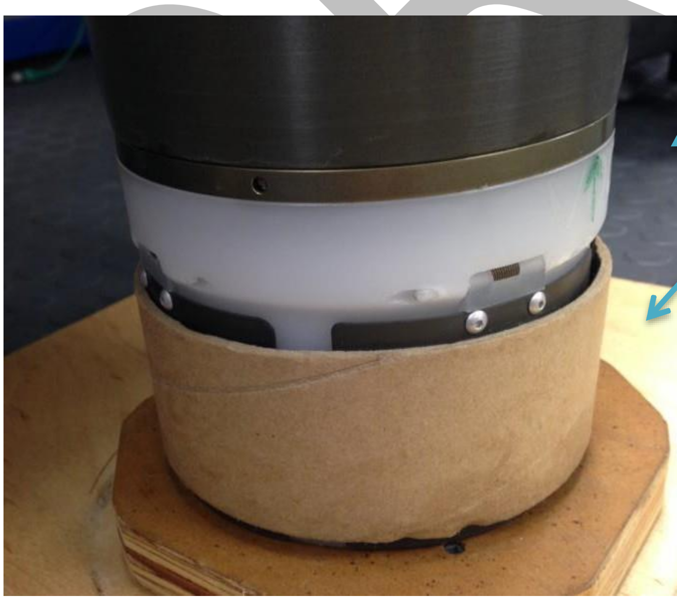

Figure 4. ALAMO Float - bottom fairing view (bottom fairing with anti-surge flaps, contained).

- Keep anti-surge flaps restrained until launch with rubber band provided
- Avoid scratching anodized coating on any surface to avoid potentially mission-compromising long-term pitting corrosion.
- Note the arrow on the fairing housing that points to the location of the reset magnet sticker 18 inches above.

ALTO Float

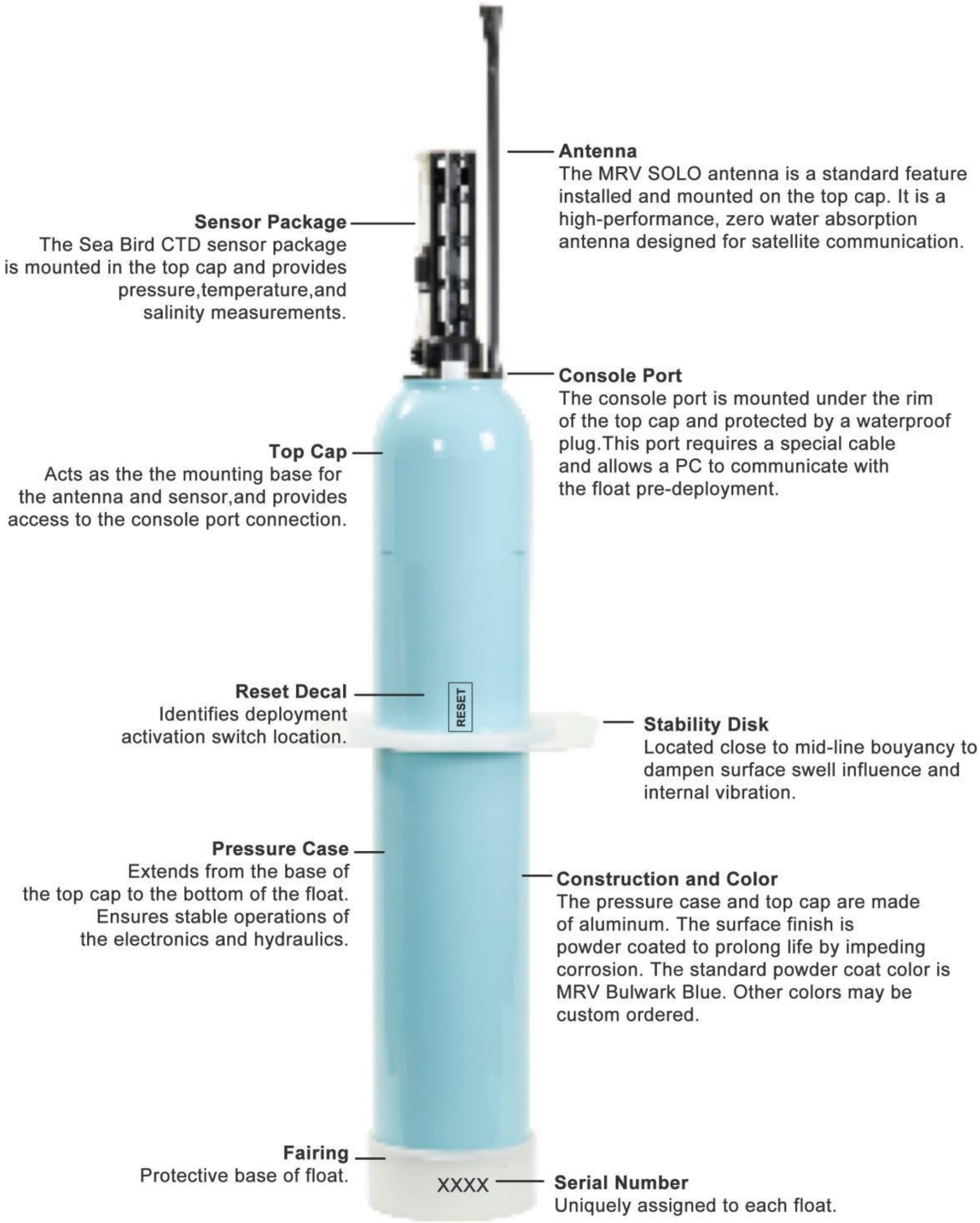

Figure 5. ALTO Float

Figure 6. ALTO Float Comm port, cap removed

A communications port is located under a removable waterproof Boss plug on the top cap. This connection sets up the interface to run MRV diagnostics and requires an MRV supplied custom communications cable.

The ALTO includes a stability disk is attached to the outside of the pressure case at the midline center of buoyancy. The dampening disc attenuates the influence of surface swell and helps keep the antenna clear of the water.

Activation, Receipt Inspection, Deployment Readiness

Activation

Floats are shipped in a low-power state and **MUST BE ACTIVATED PRIOR TO DEPLOYMENT. Failure to perform a BIT will result in LOSS OF FLOAT.**

A float may be activated using a far-field activation magnet provided or a shorting plug to awaken the float from a low-power sleep mode. The magnet method involves swiping the magnet supplied with the float(s) across the "RESET" label (see Figure 2) beneath which, on the main CPU board inside the float, lies a magnetic switch. The shorting plug method involves removing and reinstalling the shorting plug on the float's top cap. Either method reboots the float's CPU, resets to zero a clock that counts down to a pre-programed value, MTS, Mission initial trigger start timeout, and initiates the BIT. If the float's clock reaches MTS, or if the float experiences a hydrostatic pressure limit set by the parameter MTD, Mission initial trigger depth, the float will begin its operational sequence. If the float is reset again, the clock re-zeros. Alternatively, coordinating with the pilot, the float may be returned to its low-power mode, [PWR 2], after which another BIT will be required prior to launch.

Receipt Inspection

Electronically transmitted documentation includes a packing list against which a receipt inspection should be performed when the shipment arrives. The float is shipped ready to be air or sea deployed as called for in the purchase request - ***after a BIT is performed***. Before shipping, the float is fully tested at the factory, the internal vacuum is set, and the operational software and mission profile are programmed. Should the need arise for restoring vacuum to a float or loading an updated operational software binary file, please contact MRV Systems for assistance.

To prepare a float for any deployment method, it first must be removed from its shipping packaging.

If the float/shipping container arrive with no visible damage, **conduct a Built In Test (BIT) on the float**. A passing BIT completes delivery of the float, and it is activated for deployment or may be stored. If you see visible damage to the container or the BIT fails, contact MRV Systems for assistance. After completing the BIT, unless anticipated launch will be before MTS seconds are reached, coordinate with the pilot to return the float to a low-power state.

Equipment Needed

Figure 1 - USB-phone jack cable

- MRV-supplied custom console cable with phone jack and USB connector (Figure 1)
- MRV-supplied far field activation magnet
- MRV-supplied 5/8” box wrench (ALTO) or 3/16 Allen wrench (ALAMO)
- Computer running a terminal program software (such as TeraTerm (Windows), Serial (MacOSX), and Minicom)

PC or Laptop with Linux or Windows XP®, Windows 7® or later operating system with a

USB port

Communication terminal settings:

Port (example) /dev/tty.usbserial-FTYXFW4V; 9600 baud; 8 data bits; 1 stop bit; no parity, and no flow control.

Deployment Readiness

The Air Launch (launch tube, cargo side door, and cargo aft door) and Sea Launch sections below the Piloting Introduction and Fundamentals of Float Piloting that follow address activation in the sequence of launches of different types.

1. Pilot communication connection established - or assumed to be in place.
2. Float, removed from its shipping container, its deployment container, and parachute (if equipped) bear no evidence of physical damage externally, and there is no known history of damage.
3. Float's last BIT date and time is known as is the need for a re-BIT based on the parameter value MTS on the float.

Terminology

Table 1 below describes the various terminology related to the MRV float system.

ascend state	The ascend state follows the park state and precedes the surface state. The park state, described below, may end with a descent from park depth to a deeper depth to achieve a full or nearly full water column sample before starting the ascend state and proceeding to the surface and the surface state. At the conclusion, the float proceeds to the surface state.
BIST or BIT	Built-in self-test (BIST) or built-in test (BIT). After being switched on from the as-shipped low-power state via magnet, the float runs a self-test to ensure its subsystems are operational prior to deployment. Steps of the BIT include: 1. Validate the case pressure. 2. Validate the battery voltage. 3. Move air valve to open, closed, and middle positions. 4. Move oil valve to open and closed positions. 5. GPS test. Attempt to get a GPS fix. 6. Perform oil pump test. Pump oil into the external oil bladder. 7. Validate the case pressure. 8. Validate the battery voltage. 9. Verify communication with IMU sensor. 10. Perform CTD test. Read the CTD status and perform a measurement. 11. Satellite modem communication test. Read the satellite information from the modem. A satellite message is then sent with the status of the BIT, and an indicator light turns on with some models. Upon completing BIT, the buoyancy engine system spool valve opens and bleeds all oil pumped during the BIT back aboard thus making the float fully negatively buoyant for its first profile. The BIT is indicated by mission number -1. A successful BIT SBD X-message reads "ID 0xE5"; an unsuccessful BIT SBD X-message reads "ID 0xE6" and warrants notifying MRV.
CTD	Conductivity, temperature, depth. Commonly referred to the sensor device component.

descend state	The operation of the float to sink from the ocean's surface to a target depth during a mission. The descend state follows the surface state and precedes the park state.
Diagnostic dive	The first dive performed after the float has been deployed. Purpose: confirm successful deployment and release of any deployment materials. The diagnostic dive is indicated by mission number 0.
MTD, trigger depth (pressure)	After running the built-in self-test, the float monitors external pressure (depth) waiting for a sensor depth reading greater than the trigger pressure (depth). After detecting MTD pressure, the float proceeds with performing a profile.
MTS, trigger time	After running the built-in self-test, the float also monitors the passage of time. When elapsed time exceeds than the trigger time (seconds), the float starts a profile.
mission	Refers to a series of events by which a float completes one or more profiles descending to a target depth, parking, ascending to the surface, getting a GPS fix, and completing data communication ashore.
mission configuration parameters	The modifiable variables that, as a set, control the operation of the float. These are ascii files of a specific format designated with the suffix .vop, e.g., axtg_test_config_v1.6.vop
park state	The operation of the float to maintain a depth during a mission. The park state follows the descend state and precedes the ascend state. The float can be configured to fall or sink to a deeper depth prior to proceeding to the ascend state.
profile data	The pressure, temperature, conductivity, and other data collected by the float's sensors throughout descend, park, ascend, and in certain cases surface states of a profile.
remote command	A packet, sent in binary file format via email over the satellite network to modify one or more configuration parameters in a float currently deployed. Also referred to as a ground station command.

RESET	On the side of the float is a RESET label that can be found by following an arrow marked on the bottom fairing pointing up along the pressure case. The label lies 18" above this arrow. When floats are shipped to a customer, they are in a sleep mode (pwr 2 from the command line) and not fully depowered. Swiping a magnet across the RESET label in either direction reboots the float, causes it to execute a BIT, and concludes in a low power mode that is looking for the detection of either a time-based or pressure-based mission start condition.
SBD	Short burst data. The communication packet structure used over most float satellite systems.
stage	A stage is defined by various parameter sets of varying size and complexity within each of four float states and represents a discreet process within the float's flight control code.
surface state	In the surface state, the float obtains GPS fix data, receives and acts on incoming remote commands, performs motion data collection, and transmits its data over the satellite network. At the conclusion, the float proceeds to the descend state.

Table 1. Common terms associated with float operations.

Piloting Introduction

MRV ALAMO and ALTO floats are expected to be turn-key upon receipt and deployment and require minimal remote command interface using only a small number of the over-two hundred parameters described below. A primer at Appendix A that addresses examples of float control considerations, the basic physics behind operation, the float flight sequence, and finally an example using the 26 commands referenced will help the uninitiated. These piloting commands or parameters are presented with descriptions and explanations that, under a majority of circumstances, the pilot should expect to work with for routine float piloting. The general user will rest assured that values for all the other parameters have been factory-set to enable canonical profiling addressed in Appendix A. Users desiring greater flexibility in float operations are directed to the complete parameter reference section at the end of this manual careful consideration of which is expected before contacting MRV Systems with questions.

The complete parameter set is large for historical reasons, and a pilot's ability to adjust float missions beyond a relatively small parameter set requires an in-depth understanding of how the parameters being adjusted function and their interaction with other parameters. The float's code base is at a state that affords little to no backup for improper parameter selections. The user interface for the skilled pilot remains at a terminal command prompt at which, among many other things, complete parameter configuration files can be downloaded to the float, and the sequence of steps for simply emailing parameter changes or commands to the float still involves manually converting a text file into a binary file, attaching it to an email, and properly addressing that email to a given float's IMEI number.

Fundamentals of Float Piloting

Piloting is not for the faint of heart, and a thorough understanding of how a constant mass, variable displacement float behaves in the ocean, stratified by virtue of time-dependent gradients of temperature, salinity, and pressure (depth), is essential even for the entry-level pilot. Adding to the challenge is a typically long feedback loop between profiles (usually several days), and lack of both a visualization toolkit and common decoder for converting data into a readable, useful format.

Floats rise and fall in the ocean on the basis of Archimedes principle. Each float has a fixed mass and is able to deliberately vary its displacement through use of its buoyancy engine, a combination of hydraulic pump to inflate an external bladder, which increases displacement, and bleed valve to direct external hydraulic fluid into an internal bladder or reservoir to reduce displacement. Beyond the float's control are its compressibility as a function of depth and thermal coefficient of expansion/contraction driven by ambient temperature both of which influence a float's buoyancy to a small degree that must be considered in the float's initial ballasting given the depth and temperature extremes to which the float is expected to encounter.

Ocean density varies with temperature, salinity, and pressure (depth) which have temporal and geographic dependencies. Ocean density coupled with a float's displacement, given its mass, and gravity dictate the buoyant force on a float. Equations 1 and 2 in Figure 12 present the general physical parameters involved. Inequalities that follow describe the effect of float and environmental conditions on the float's buoyancy, positive, negative, or neutral.

Buoyancy Control

$$\rho_{\text{float}} = \frac{M_{\text{float}}}{V_{\text{float}}} \tag{1}$$

Fixed mass, variable volume device

$$M_{\text{water}} = \rho_{\text{water}} V_{\text{float}} \tag{2}$$

$M_{\text{water}} > M_{\text{float}}$
Float will rise

$M_{\text{water}} = M_{\text{float}}$
Float is neutrally buoyant

$M_{\text{water}} < M_{\text{float}}$
Float will sink

Figure 12 - Physical parameters associated with float operations

The pilot's choice of maximum operating depth will dictate maximum water density and stratification between surface and the deepest depth the float will reach. The principle parameters for float piloting are, then, based on either elapsed or specific times and pressure, expressed in decibars, that the float experiences. A decibar (dbar), (0.1 bar), equates to a meter of depth, and the reference pressure for float operations is taken to be 0 dbar, that is, atmospheric pressure (absolute) at sea level.

Before stepping through the logical sequence of steps to prepare for a float deployment, it's worth restating that 90% of piloting typically involves on the order of 26 commands even to execute moderately complicated functions. In addition to Appendix A, tools are given in Appendix B to aid the pilot. These include one that computes a float's initial fall time, DFT, to facilitate dealing with buoyancy physics; one that converts a text mission parameter change message into a binary SBD format suitable for emailing to a float; one that decodes SBD messages from the float to facilitate human- and machine-reading of the data; and one that affords visualizing decoded float profile data.
Piloting begins with a Built In Test or BIT which should be conducted early enough to confirm a float's operational status prior to deployment. When the BIT concludes, two parameters will trigger a mission start which normally includes a diagnostic profile (setting DDB 1 bypasses the diagnostic profile). These are MTD, mission initial trigger depth (pressure) and MTS, mission initial trigger time. If a delay of more than MTS seconds is expected before the float initiating its diagnostic (or first, if DDB 1 is set) dive and thus starting a mission, then the BIT should be reinitiated to reset the float's clock.

Diagnostic Dive

The purpose of the diagnostic dive, dive 0, is to confirm float operation through an actual, simple profile that doesn't involve a "park" unless DDC (descend diagnostic calibration timeout - seconds) is other than 0. An example of using DDC is the deployment of boxed floats in cold water, e.g., the Arctic. Adhesives used in packaging take longer to dissolve in cold water, and setting DDC to a non-zero value affords a longer submerged time to shed boxing material before entering the ascent state. A graphic of the diagnostic dive in which DDC 0 is set (no "park") is shown in Figure 13.

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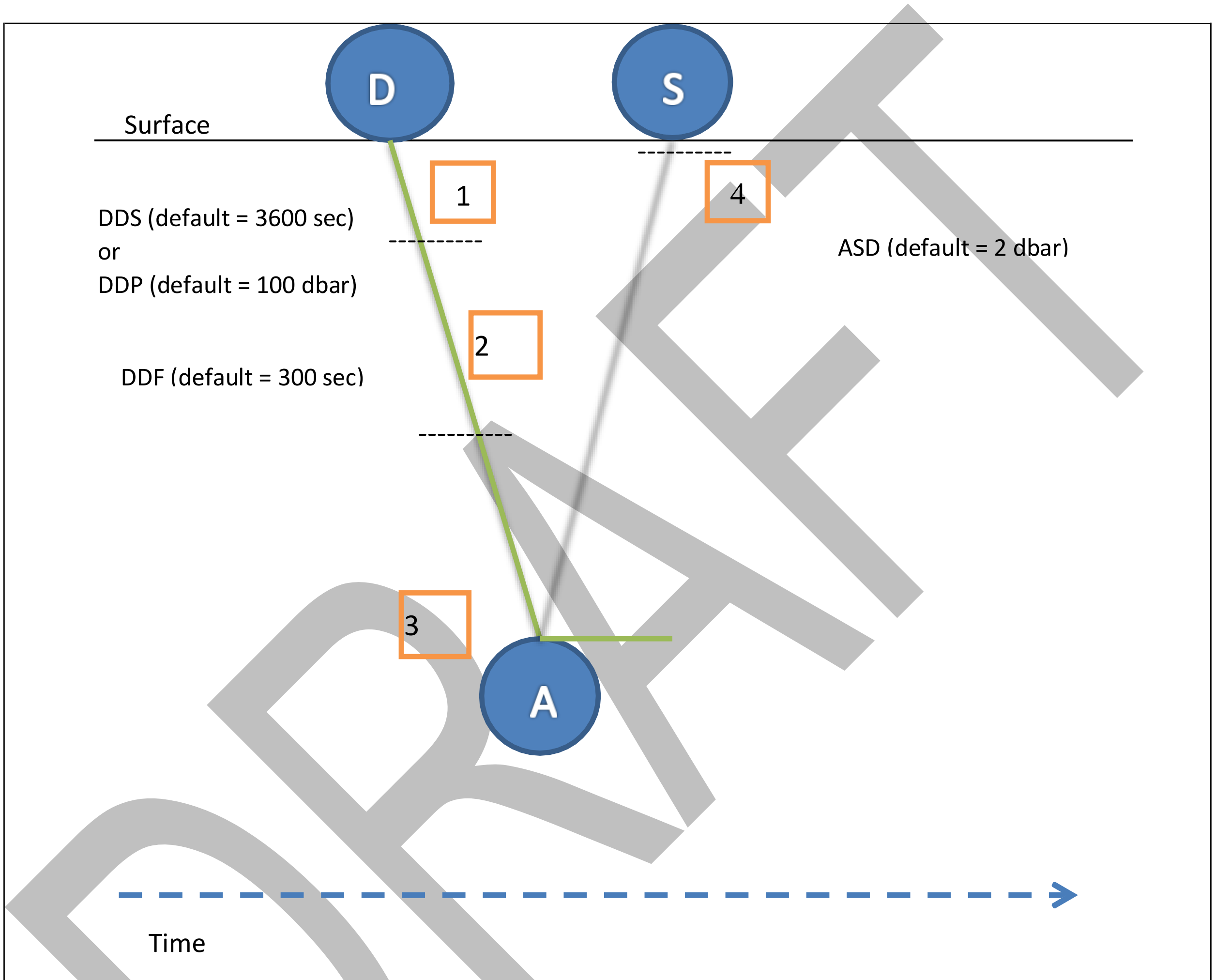


Figure 13 Diagnostic dive sequence

During a diagnostic dive, the float enters the water fully negatively buoyant, descends (step 1) for an elapsed time, the diagnostic start timeout parameter (DDS) (default is 3600 seconds) or a prescribed depth, the diagnostic depth threshold parameter (DDP) (default is 100 meters) at which point the float runs its buoyancy engine (step 2) for the diagnostic descend fall timeout parameter (DDF, default of 300 seconds). At the completion of the pump, the float transitions to the Ascend state, step 3, and performs its standard pump on/off cycle until the float reaches the surface. It will likely have already started to ascend by the time the DDF pump completes. When the float reaches the ascend surface depth threshold (ASD, default 2 dbar), it transitions to the

Surface state, step 4, obtains a GPS fix, and transmits the collected data. Thereafter, unless the pilot has activated the beacon mode (SBM 1), which will hold the float at the surface until the pilot sets SBM 0, the float will begin normal profiling starting with dive 1.

A canonical profile showing the four states of float operation performed in sequence (Descend, Park, Ascend, Surface) is shown in Figure 14. In the float control software, each state behavior is broken into one or more stages, and each state uses a specified sampling interval to monitor pressure. This measured pressure and elapsed time from the start of a particular state are used, in most instances, to cause activity within the float. Elapsed time settings need to be multiples of the sampling interval specified for a particular state.

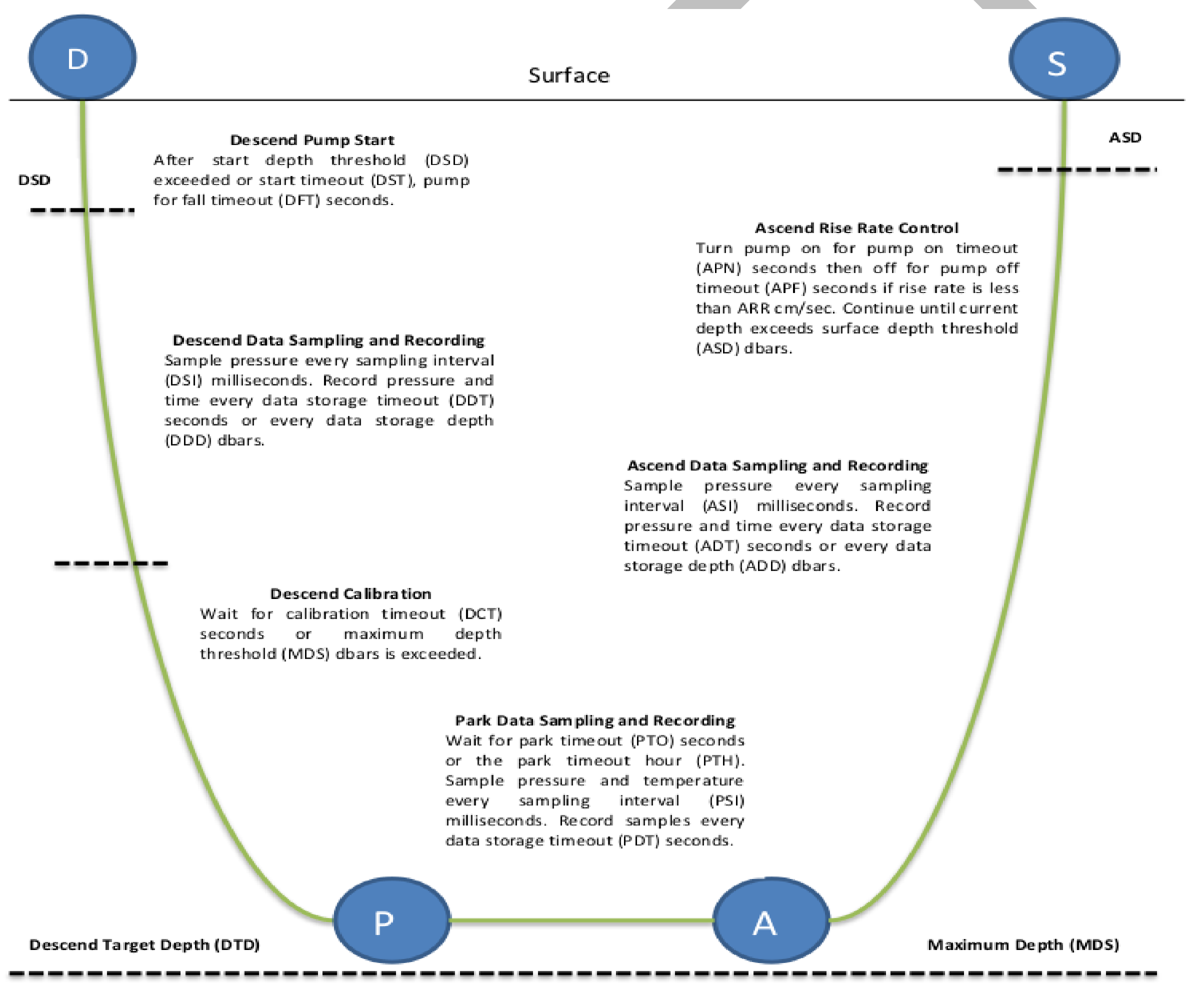


Figure 14 Canonical Profile

Mission Phases and Parameters

It should be noted at this point, given circa 2019 MFA software running on our floats, that for Descend and Park states alone, it is possible to program our floats with three unique sets of parameters distinguished by "phase", 0, 1, and 2. The Ascend and Surface parameters remain the same for all profiles regardless of "phase". The duration of each phase is dictated by specifying the number of profiles to be performed in that phase (MNM) and, when that phase is completed, designating the next phase number to be executed (MNS). The Descend and Park parameters unique to separate missions are denoted by a numerical preface starting with the number 0. For example, DTD 0 500, DTD 1 750, and DTD 2 450 define the target depth in meters for three respective mission phases (500, 750, and 450), MNM 0 2, MNM 1 500, and MNM 2 125 define the number of profiles, 2, 500, and 125 respectively; PTO 0 1800, PTO 1 86400, and PTO 2 864000 define the park durations (30 minutes, 24 hours, and 10 days); and PFD 0 1200, PFD 1 2000, PFD 2 1200 define the fall (second stage descent) depth for three respective mission phases. Those configuration parameters for which phase may be specified are shown in Table 2. Configuration parameters not specified in Table 2 are used across all mission phases.

Configuration Parameter	Description
MPS	Currently active mission phase.
MPC	Cycle count for the current phase.
MNM	Number of cycles to execute for the specified phase.
MNS	Mission phase to execute after specified phase.
DTD	Descend target depth.
DCT	Descend calibration timeout.
DFT	Descend fall timeout initial pump time.
DSD	Descend start depth to pump DFT time.
DST	Descend start timeout to wait for float to reach DSD depth.
PFM	Park fall mode.
PFD	Park fall target depth.
PFT	Park fall timeout.
PFV	Park fall valve timeout.

PTH	Park hour mask.
PTO	Park timeout.

Table 2 Mission phase configuration parameters

The four states are described below including stages and relevant parameter sets where appropriate.

Descend State

Descend state consists of 3 stages that include configurable parameters for which it is possible to specify three separate phases. The sampling interval during the Descend state is controlled by the DSI parameter. Data is stored based on the data storage timeout (DDT) and data storage depth (DDD) parameters. The descending depth data collected during the Descend state is transmitted in the fall data SBD (short burst data) X message packet format.

1. **Start stage** – during this stage the float monitors the start depth threshold (DSD) and start timeout (DST) to determine when to transition to the next stage.
2. **Fall stage** – during the fall stage the float changes its buoyancy by operating the oil pump to achieve the preconfigured depth. The duration of this pump time is controlled by the fall timeout (DFT).
3. **Calibration stage** – the calibration stage is controlled first by the descend calibration mode parameter, DCM. If switched on, DCM 1, two algorithms, "calibration" and "seek" are available and are specified by the descend calibration algorithm parameter, DAL, as 0 or 1 respectively. The calibration algorithm performs self-adjustment procedures during initial profile cycles to determine its system dynamics and proper operation to achieve efficient, consistently accurate mission depths. Once the cal procedure is complete, the float begins its configured mission operations and can receive remote commands for control. The seek algorithm calculates the current depth and adjusts the system based on the calculation and the configuration parameter settings. An example of the seek algorithm is shown in Figure 15.

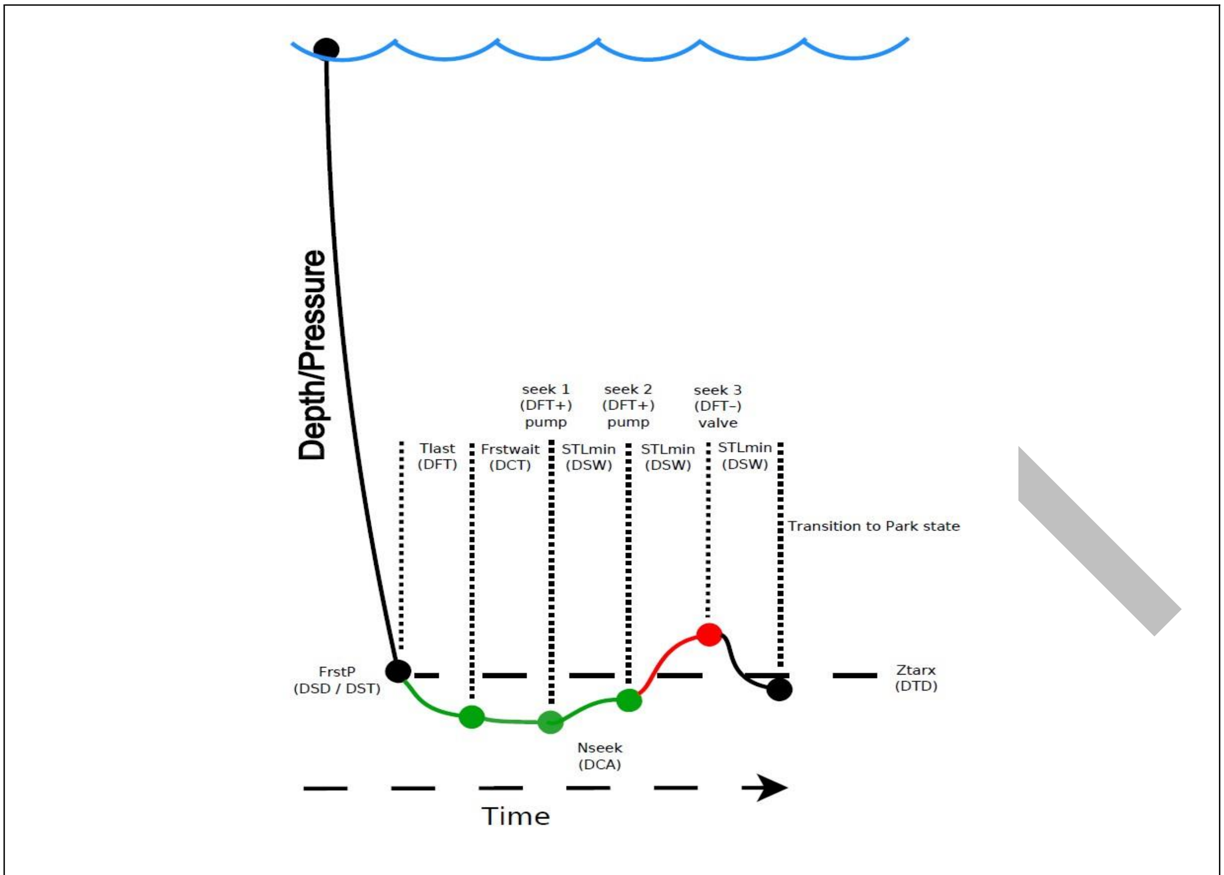


Figure 15 Descend seek sequence

As shown in Figure 15, the float starts on the Descend state sampling pressure until it reaches the descend start depth (DSD) parameter value. Note, typically the descend start depth and the descend target depth (DTD) parameters are set to the same value. The float then turns on its oil pump for descend fall timeout (DFT) seconds. DFT is the initial configured pump time to reach the target depth. After completing this initial pumping, the float settles at its equilibrium state by waiting for descend calibration timeout (DCT) seconds.

The float then executes the seek algorithm for descend calibration attempts (DCA) times. If the float is deeper than the descend target depth, the float calculates the amount of time to run its pump to achieve the target depth. If the calculated time is greater than the minimum pump time (DCP), the float runs its pump and then updates the DFT value for the next mission. The float then waits for descend seek wait (DSW) seconds for the float to settle at its new depth.

After this timeout expires, the float performs another seek. If the float is above the target depth, the seek algorithm calculates the amount of time to open the valve to descend to the target depth. If the calculated time is greater than the minimum valve open time (DCF), the float opens its valve to descend then updates (by subtracting) the DFT value for the next mission. The float then waits again for the descend seek wait seconds timeout to expire before proceeding. After completing all seek algorithm operations, the float transitions to the

Park state.

NOTE: The float will not adjust DFT if the seek algorithm calculation does not exceed the minimum valve (DFT) or minimum pump times (DCP). The float will also not adjust DFT if a seek valve event does not exceed the valve depth delta (DVD) after waiting valve wait time (DVW). This is intended to prevent the adjustment to DFT if the float is unable to descend (for example, if the float is on the bottom of the ocean).

NOTE: The float will wait for the DSW period in the descend state (and the PSW period in the park state) regardless of whether the float adjusts the float depth (via pumping or opening the valve) during the seek algorithm. During the park state, the PTO and PTH parameters do not override the PSW period or cause the float to exit the park state.

Descend state, seek calibration parameters are described in Table 3.

Configuration Parameter	Default Value	Description
DTD	400 dbar	Descend target depth. Depth float tries to reach for its Park state
DSD	400 dbar	Descend start depth. Depth to start pumping DFT to reach the target depth.
DST	7200 seconds	Descend start timeout (2 hours). Time to wait for the float to reach the start depth threshold (DSD).
DCM	1 (enabled)	Descend calibration mode.
DFT	85 seconds	Descent initial pump timeout
DDD	1 dbar	Descend data storage depth interval (dbar)
DDT	300 seconds	Descend data storage time interval
DAL	1=seek	Descend calibration algorithm to use for depth adjustment.
DCA	3	Descend calibration attempts. Number of times to perform the calibration algorithm.
DCT	10800 seconds	Descend first wait timeout (3 hours). Time to wait after the initial DFT pump time.
DSW	3600 seconds	Descend seek wait timeout (1 hour). Time to wait after the seek algorithm executes
DUC	1.0	Descend seek underdamp control value.
DPT	5 seconds	Descend seek pump time to move the float 100 dbar upward.
DUT	5 seconds	Descend valve time to move the float 100 dbar downward.
DPD	5 seconds	Descend pump time to move the float if rising.
DVT	30 seconds	Descend velocity measurement timeout. Time to wait between seek measurements to determine the float velocity.

DVD	25 dbar	Descend seek valve depth delta. Depth which system must pass during seek valve event to adjust initial descend pump time (DFT).
DVW	300 seconds	Descend seek valve wait time. Amount of time to wait after valve event to determine if system has descended to adjust descend pump time (DFT).
DCX	1020 seconds	Descend pump time maximum. Maximum amount of time to run the oil pump.
DCP	5 seconds	Descend pump time minimum. Minimum amount of time to run the oil pump to adjust seek depth.
DCF	5 seconds	Descend valve time minimum. Minimum amount of time to open the oil valve to adjust seek depth.

Table 3 Descend state, seek calibration parameters

Park State

Park state normally consists of a single stage that includes configurable parameters for which it is possible to specify three separate phases. If the Park Fall Mode (PFM) is activated however, PFM 0 1 for example, activating a park fall stage for the 0 phase, one may specify, among other parameters, park fall depth, e.g., (PFD 0 2000). The sampling interval during the Park state is controlled by the PSI parameter. Data is stored based on the data storage timeout (PDT) parameter.

1. **Start stage** – during this stage the float monitors elapsed time relative to park timeout (PTO 0 3600 for example) which is a count in seconds for the duration of the Park state, or park timeout hour (PTH), which is a bitmask of the hour to exit the Park state, to determine when to transition to the Fall stage or Ascent state if PFM 0 0.

The Park state is also able to execute the same seek algorithm used in the Descend state but with unique parameters. The Park state seek algorithm is enabled by default using the parameter park seek mode, PSM and responds to two additional parameters, park seek timeout (PST), the interval over which to seek, and park seek depth delta (PSD) the dead-band about DTD beyond which the seek algorithm activates. Park state seek enabled are described in Table 4.

2. **Fall stage** – If PFM is set on (1) for a particular phase, a fall stage is invoked. The float changes its buoyancy at the end of park timeout by operating the bleed valve for a specified time (park fall timeout - PFT) with the aim of achieving the park fall depth, PFD. When elapsed time following PTO reaches PFT, the float enters the Ascent state and commences Ascend Initial Pump On Timeout (APS).

Configuration Parameter	Default Value	Description
PSM	1 (enabled)	Park seek mode. Enable/disable the seek algorithm during the Park state.

PST	3600 seconds	Park seek timeout (1 hour). The interval to run the seek algorithm.
PTO	3600 seconds	Park timeout
PTH	4473924	Park time hour - the hour at which a float will leave the Park state. This is a binary bit mask that enables or-ing (adding) multiple (and explicity) times in a day at which the operator wants the float to depart Park and conduct a profile.
PDT	600 seconds	Park data storage time interval
PFM	0	Park fall mode - Do not fall to a deeper profile
PSD	100 dbar	Park seek depth delta. The depth delta to run the seek algorithm.
PSV	30 seconds	Park seek velocity measurement timeout. Time to wait between seek measurements to determine the float velocity.
PSW	3600 seconds	Park seek wait timeout (1 hour). Time to wait after the seek algorithm executes

Table 4 Park state seek parameters

Ascend State

During the Ascend state, Figure 16, with sensor profiling mode enabled, CPS 1, the float samples temperature, conductivity, (and other parameters) with respect to depth depending on the float's configuration at set intervals specified by the parameter ascend sampling interval, ASI. Data is stored based on the parameters data storage timeout (ADT) and data storage depth (ADD). The ascending depth data collected during the Ascend state is transmitted in the rise data SBD X message packet format

The float supports two modes of collecting profile data – Raw and Bin Average. In Raw mode, the float stores sample measurements at the specified sampling period (CSP). In Bin Average mode, up to 3 periods are configurable to collect and average the data based on the specified depth bins and sampling period. Figure 16 shows the profiling configuration modes and associated configuration parameters.

During the Ascend state, the oil pump operates in timed intervals starting with an initial surface pump of duration specified by the parameter APS until it reaches a preconfigured surface depth threshold (ASD). The Ascend state has two stages of operation following the initial (APS) pump – system pump is “on” and system pump is “off”. The float increases its buoyancy by running its pump for APN seconds. The pump then turns off for APF seconds, and the depth is monitored to determine rise rate. If the rise rate is less than ascend rise rate (ARR), another pump on/off interval specified by APN and APF is executed.

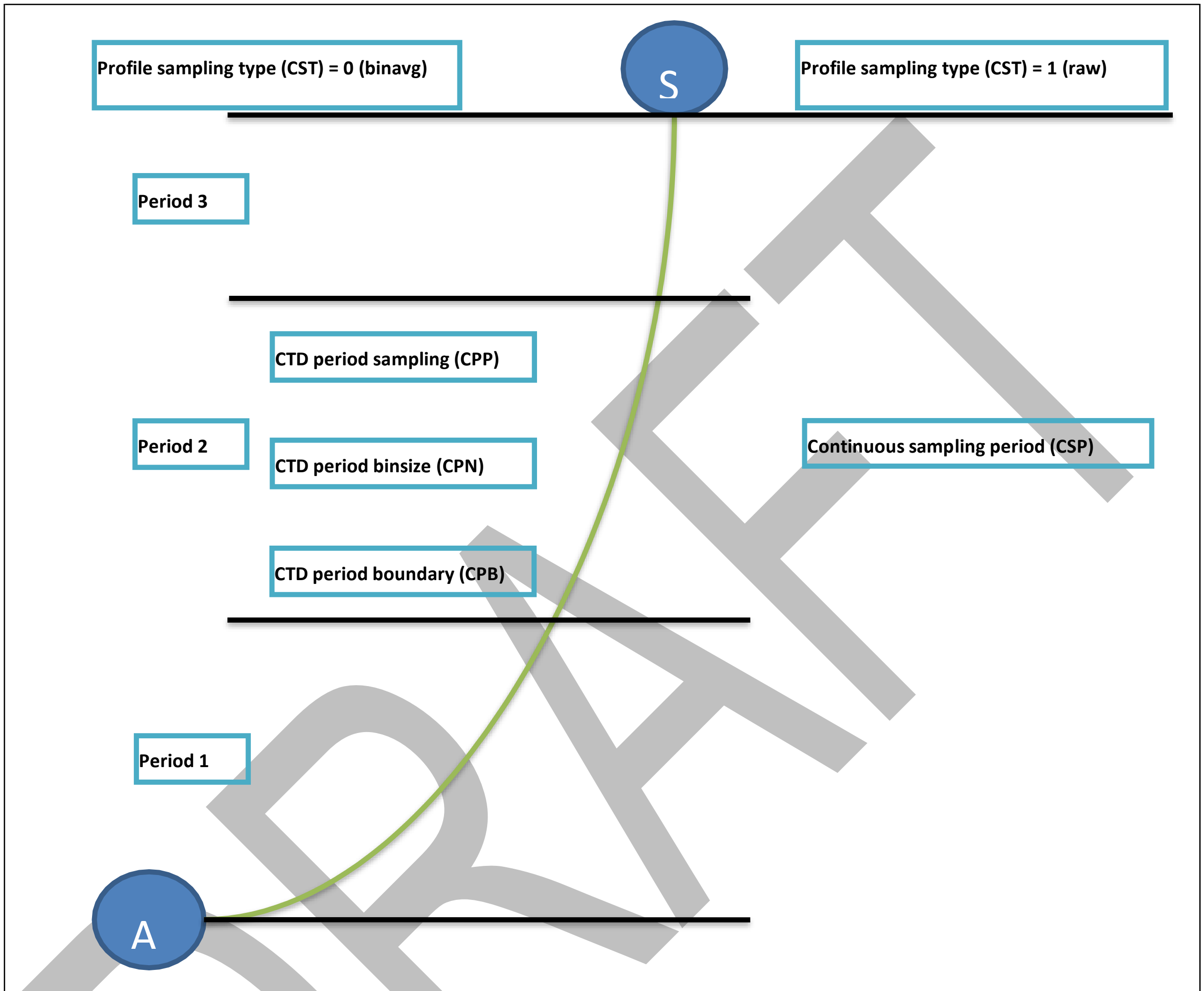


Figure 16

Surface State

The Surface state contains the following stages.

1. **Sensor and Pump Delay stage** – the configuration parameter (SSP) keeps sensors on through surfacing and runs the oil pump for additional buoyancy through the Buoyancy stage.
2. **Buoyancy stage** –the float operates to achieve maximum buoyancy for the Surface communication stage.
3. **GPS stage (1)** – during this stage, the system attempts to obtain post-dive GPS information (location coordinates and time) for the specified time interval (SGT).

4. **Data collection stage** –the float collects surface sensor measurements for the specified time interval (SPT).
5. **Motion sensing stage** –the system collects motion data for a specified time interval (MAT).
6. **Communication stage** – satellite transmission of data collected during the completed mission(s) is attempted for a specified time interval (SET). During this stage, the float can also receive remote messages/commands.
7. **GPS stage (2)** – during this stage, the system attempts to obtain pre-dive GPS information (location coordinates and time) for the specified time interval (SGT).

If the float is unsuccessful in transmitting its data over the satellite or the satellite interval expires, the data is stored for the next Surface state when the float attempts to send its data again.

Air Launch Operations

Tube-launched ALAMO

Figures 6a and 6b show an ALAMO configured for aircraft tube launching.

1. Prior to loading the float on the plane, but not more than the time delay programmed with the parameter MTS (Mission initial trigger start timeout), conduct a BIT as follows:

a) Remove float from its beige plastic protective shell (if equipped).

b) With the float in a location to "see the sky" that will allow an Iridium connection, "Launch" end (parachute and antenna end) up, power up the float and start the BIT by swiping a magnet across the "RESET" label visible on the float's pressure casing (Figure 2 above).

c) Allow 30 minutes to complete a BIT, and confirm with the pilot the BIT was successful.

d) Replace the float in its beige plastic tube (if equipped), "Launch" end up as before, retie the spectra line to hold the float in the beige plastic tube.

2. Load the float on the aircraft and store it for takeoff.

3. When ready to launch the float, remove the float from its beige plastic protective shell (if equipped).

4. Load float in launch tube with "Launch" end (with long cardboard protective sleeve containing parachute) first. (Figure 6b)

a) Hold onto the base of the float and do not allow suction to pull the float fully into the launch tube **until the next step is completed**.

b) Disconnect the Velcro strip to release the obstructive device (Figure 7b). Cut the ribbon to remove the Velcro strip and discard.

c) Lower the float fully into the launch tube.

5. Launch the float from its tube to deploy it.

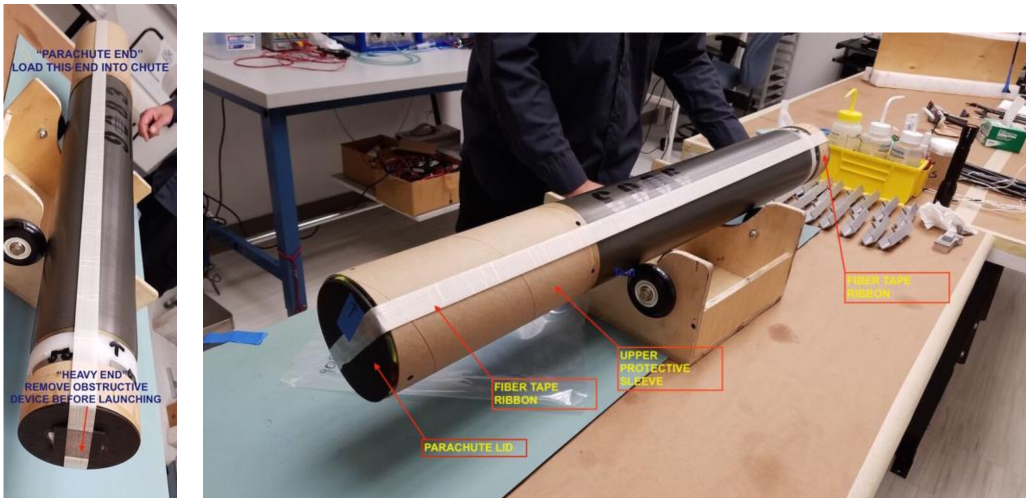


Figure 6a (left) and 6b (right). ALAMO with parachute ready for aircraft tube-launch.

Aft- and Side-door-launched ALAMO

1. Perform steps 1-3 above for a Tube-launched ALAMO.

2. When ready to launch, carefully disconnect the Velcro strip to release the obstructive device (Figure 7b) **<u>while holding the fiber tape ribbon snuggly to the base of the float</u>** to retain the pilot chute within the cardboard protective sleeve.

3. Toss the float from the aircraft aft- or side-door (Figure 7a) to deploy.

Figure 7a (left) and 7b (right)

Note that the "Obstructive device" referenced in Figure 6a above, used to retain the parachute protective lid capping the cardboard protective sleeve at the top of the float, is a patch of Velcro. Figure 7b (right) ALAMO, in the process of being aft-door launched from an aircraft. This configuration works the same way for a side-door launch. In Figure 7b, the Velcro has been detached and the fiber tape ribbon is flying free of the float's base to allow the pilot chute to spring free of the protective cardboard protective sleeve.

Aft-door-launched ALTO

1. Prior to loading the float on the plane, but not more than the time delay programmed with the parameter MTS (Mission initial trigger start timeout), conduct a BIT as follows:

a) Expose the "RESET" site on the float's pressure casing through the designated cardboard flaps located on the top side of the shipping/deployment box (Figure 8)

b) With the float, right side up, in a location to "see the sky" that will allow an Iridium connection, power up the float and start the BIT by swiping a magnet across the

"RESET" label visible on the float's pressure casing.

c) Allow 30 minutes to complete a BIT, and confirm with the pilot the BIT was successful.

2. Load the float in its shipping/deployment box on the aircraft and store it for takeoff.

3. When ready to launch the float, connect float's parachute "D" ring to the static line in the aircraft near the aircraft aft door.

4. Standing clear of the static line, (aft door) roll the float down the aft ramp, <u>parachute-end first,</u> and out of the aircraft (Figure 9).

5. Retrieve the static line and pilot chute cap.

Figure 8a and 8b. ALTO with parachute ready for aircraft aft cargo-door launch. Note location of the access window for the RESET label (Figure 8b).

Figure 9 ALTO in protective bag with harness in shipping crate showing parachute end.

Sea Launch Operations

Sea-launched ALAMO

1. Prior to launching the float, but not more than the time delay programmed with the parameter MTS (Mission initial trigger start timeout), conduct a BIT as follows:

a) With the float in a location to "see the sky" that will allow an Iridium connection, power up the float and start the BIT by swiping a magnet across the "RESET" label visible on the float's pressure casing (Figure 2).

c) Allow 30 minutes to complete a BIT, and confirm with the pilot the BIT was successful.

2. When ready to launch the float, remove the float from its protective container exposing the launch box with soluble strap link at base (Figure 10).
3. Drop it over the side, base first, to deploy it.

Figure 10. ALAMO ready for sea launch showing soluble strap link at base.

Sea-launched ALTO

1. Prior to launching the float, but not more than the time delay programmed with the parameter MTS (Mission initial trigger start timeout) conduct a BIT as follows:

a) Expose the "RESET" site on the float's pressure casing through the designated cardboard flaps located on the top side of the shipping/deployment box (Figure 8)

b) With the float, right side up, in a location to "see the sky" that will allow an Iridium connection, power up the float and start the BIT by swiping a magnet across the "RESET" label visible on the float's pressure casing.

c) Allow 30 minutes to complete a BIT, and confirm with the pilot the BIT was successful.

2. Lower the float within its box by its harness over the side and into the water (Figure 11).

3. Release the harness.

4. Within a few minutes after having been lowered into the water in its box, the float will sink from the cardboard box and begin a diagnostic profile.

Figure 11. ALTO float with over-the-side launch harness in hand.

Special Float Operations

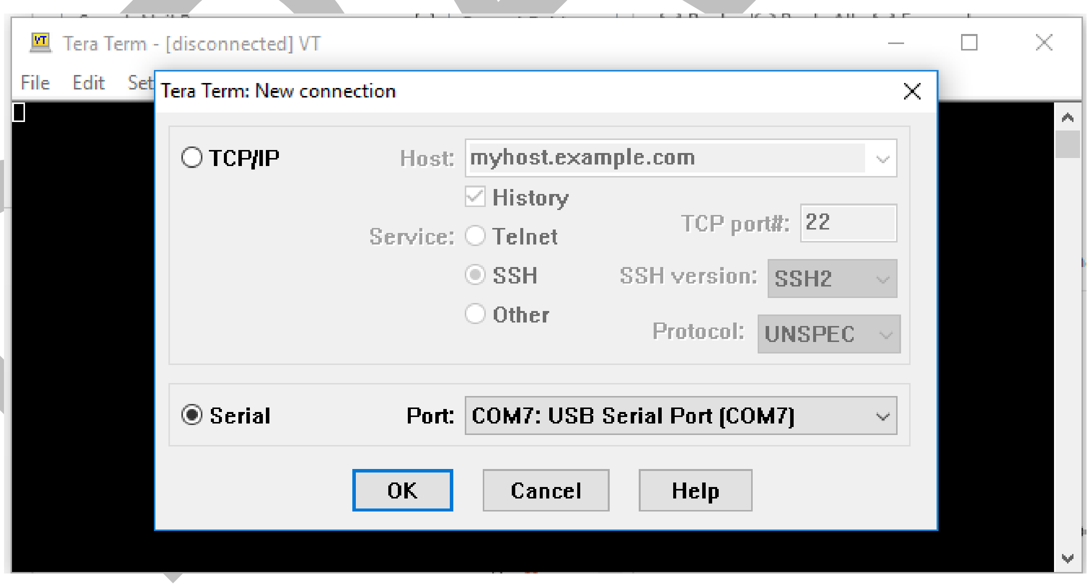
While the float's software architecture enables communicating and receiving output directly from the float, the default state of the float is to power up and be ready for deployment with only a one-way satellite transmission ashore. In this mode, the float runs its built-in self-test, transmits a "BIT completed" message, and waits in a loop that periodically checks pressure and monitors elapsed time as signals to start its mission.

Direct Communications - Hard-wire or Bluetooth

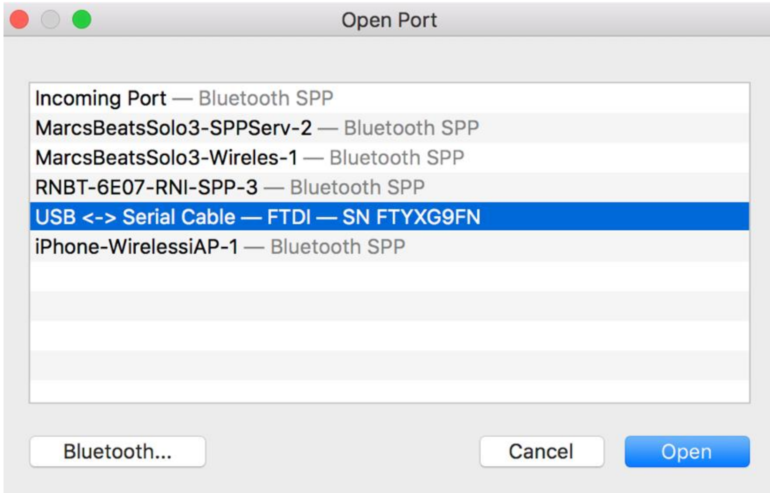
<u>Establishing communications</u>

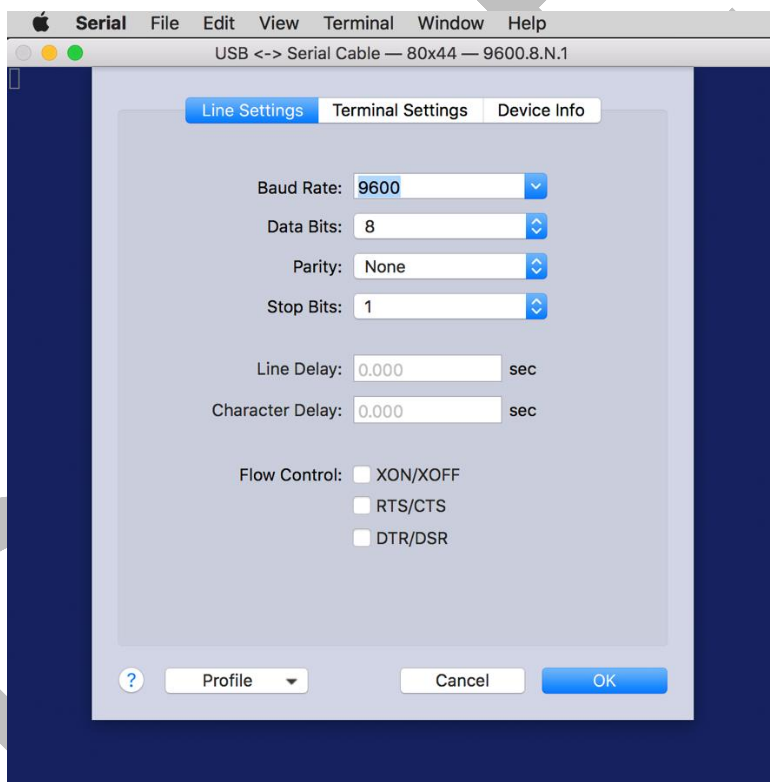
Our floats include a communications port for directly communicating with the float via laptop to load mission configuration files on the float, execute a BIT, evaluate parameter settings, execute various debug functions, and directly command mission initiation. This can be accomplished with a USB-phone jack adapter cable connecting a laptop to the console serial port. Our float's also have Bluetooth capability that is enabled by setting the parameter BTM to 1. In both cases, a running a Serial application in a terminal window on the laptop, e.g., TeraTerm (Windows), which can be downloaded at http://ttssh2.sourceforge.jp/index.html.en, or Serial (MacOS), which can be downloaded at https://decisivetactics.com/products/serial/, or Minicom is used as the interface with the float. TeraTerm examples will follow. For the cable method:

1. Using a 3/16” hex key, remove the Comm Port Plug
2. Plug USB to 2.5mm jack cable into the float comm port (2.5mm port) and pc (USB port).
3. Open Tera Term software:



Or Serial:





4. Connect to float serial port.
5. Swipe a magnet over the RESET sticker on the side of the float

For the Bluetooth method (Software version 6.4.0 and later):

1. Using a 3/16” hex key, remove the Comm Port Plug
2. Plug USB to 2.5mm jack cable into the float comm port (2.5mm port) and pc (USB port).
3. Swipe a magnet over the RESET sticker on the side of the float

4. Within three minutes after swiping on the float, find and connect to the float's Bluetooth signal, identify the associated port, and finally configure the Serial application to access that Bluetooth connection.

Terminal serial port settings are in both cases 9600 baud, 8N1, no stop bit, no parity. Regardless of connection mode, the float will run a startup sequence (example below) ending with the command prompt "mrv>".   The float will NOT be in a mode to launch without specific additional commands to do so provided below.

```
MRV Systems
Bootloader version: 1.63  ChipID: 24E4C301574EFAE7

Bootloader Command Menu
?/h - help
b - boot application
c - verify application checksum
f - 115200 baud
r - reset 9600 baud
u - start xmodem file download
v - verify flash checksum

Automatically booting application in 3 seconds
Hit 's' or 'S' to stop boot 3...2...1...booting application

starting system...

Air valve calibration.
A_valve CLOSED (IN)
pos=0.017  (mid=0.000)
acmp=0
A_valve MID
pos=1.120  (mid=0.000)
acmp=2
A_valve MID
open/out stop pos=1.105
A_valve CLOSED (IN)
pos=0.017  (mid=0.000)
acmp=2
A_valve CLOSED (IN)
closed/in stop pos=0.021
A_valve CLOSED (IN)
Oil valve calibration.
O_valve UNK
pos=0.777  (mid=0.000)
acmp=0
O_valve UNK
pos=1.895  (mid=0.000)
acmp=1
O_valve UNK
open/out stop pos=1.881
O_valve UNK
```

```
pos=0.781  (mid=0.000)
acmp=1
O_valve UNK
closed/in stop pos=0.798
O_valve CLOSED (IN)

System configured for RBR P/T sensor.
CTD memory clear.
RESP: permit = memclear
RESP: memclear used = 0
CTD Configuration: RBR sensor.
id model = RBRargo, version = 1.360, serial = 040564, fwtype = 103
hwrev pcb = I, cpu = 5659B, bsl = A
RBR channel list format:
outputformat channelslist = temperature (C), pressure (dbar)

RBR channel and calibration info:
channels count = 5, on = 2, latency = 50, readtime = 290, minperiod =
420
channel 1 type = temp09, module = 1, status = on, latency = 50,
readtime = 260, equation = tmp, userunits = C
calibration 1 type = temp09, datetime = 20170704104638, c0 =
3.4775810e-003, c1 = -251.92651e-006, c2 = 2.4192130e-006, c3 = -
105.19927e-009
channel 2 type = pres24, module = 2, status = on, latency = 50,
readtime = 290, equation = corr_pres2, userunits = dbar
calibration 2 type = pres24, datetime = 20170707122217, c0 = -
1.0153387e+000, c1 = 249.13741e+000, c2 = 2.4111290e+000, c3 = -
5.2018170e+000, x0 = 10.031800e+000, x1 = 12.384387e-003, x2 =
68.554680e-006, x3 = -474.79987e-009, x4 = 166.34534e-006, x5 =
22.500000e+000, n0 = 6
channel 3 type = pres08, module = 240, status = off, latency = 0,
readtime = 0, equation = deri_seapres, userunits = dbar
calibration 3 type = pres08, datetime = 20170628093453, n0 = 2, n1 =
value
channel 4 type = dpth01, module = 241, status = off, latency = 0,
readtime = 0, equation = deri_depth, userunits = m
calibration 4 type = dpth01, datetime = 20170628093453, n0 = 2, n1 =
value
channel 5 type = cnt_00, module = 242, status = off, latency = 0,
readtime = 0, equation = none, userunits = counts
calibration 5 type = cnt_00, datetime = 20170628093453, n0 = value

Setting up default CTD profile configuration.....complete.

MRV Systems, LLC
MRV Firmware Architecture (MFA)
Firmware Version 5.0.d built Oct 23 2018 13:04:19
X-Message Protocol Version 1.1
System configured for RBR P/T sensor
System Serial Number: 9183
Satellite Iridium IMEI number: 300234064131960
```

```
Console Command Line Interface
Enter '?' for command list
Command format: <mnemonic> <param1> <param2>

mrv>
```

Actions from the command prompt

The command prompt (mrv>) indicates the system is ready for command entry. Again, it must not be launched without additional specific commands described below. Commands entered at this prompt are comprised of a mnemonic from the list above followed by zero, one, or two parameters, depending on the command. A list of supported commands is displayed by entering a question mark (?) at the command prompt (see below). As of publication, this list still contains many parameters that are factory-set and <u>should not be altered</u>. Those are deemphasized in light gray font. Others are commonly used by the pilot and, on occasion, the advanced field technician.

mrv> ?
Command List (these may be lower case)
=============
ACA - Accelerometer accel scale factor: fact([illegible],8,16)
ACC - Accelerometer data
ACD - Accelerometer data display: disp([illegible]sci,1-[illegible])
ACF - Accelerometer FIFO data: out(1-100[illegible]) in[illegible]00)
ACG - Accelerometer gyro scale factor: (250,500,1000,2000)
ACL - Accelerometer data: mode ([illegible]-avg,2-de[illegible]) time (1-270min)
ACR - Accelerometer sample rate: mpu sampling rate (4-250) averaging rate (1-10)
ADC - ADC scan all channels: power (0=none,1=on then off) adc 1 turns on 12VDC and then turns if off after returning channel values.
BIT - Built-in test: type(1-short,2-long,3-all) [bit 3]
B[illegible] - Bluetooth mode: mode([illegible]-dis,1-en)
C[illegible] - CTD display stored profile data
CTD - CTD get pressure, temperature, salinity measurement
CTT - CTD get pressure, temperature measurement: power (0-off,1-on) profiling (0-dis,1-en)
CTP - CTD get pressure measurement: power (0-off,1-on) profiling (0-dis,1-en)
CTI - CTD display info: info ([illegible]-setting, 1-coeff)
CTS - CTD get status
EEP - EEPROM write address value: Factory-use-only
EET - EEPROM test
GPS - GPS info: timeout(1-50 min) rtc sync(0-no,1-yes) [gps 5 1]
IOR - GPIO IN port read: Port(A-F)
IOW - GPIO port write: Port(A-F) Val(0-0xFFFF)
LOG - Log mode: mask(1-pres/temp,2-motion) time (1-270min)
MIC - Mission configuration: mode (0-dump to screen, 1-store in non-volatile memory, 2-xmit, 99-def)

MID - Mission display info: (0=reset): NOT IN USE
MIS - Mission: state (0-halt, 1-surface, 2-descend, 3-park, 4-ascend, 10 go (automatic)) depth (0-2000) [MIS 10 500]
PNB - Minimum battery voltage (/100 V): value (0-10000) : Factory-use-only
PNC - Minimum case pressure (/100 inHg): value (0-10000) : Factory-use-only
PXC - Maximum case pressure (/100 inHg): value (0-10000) : Factory-use-only
PBL - Cal battery 12V: value (0-0xFFFF) : Factory-use-only
PBH - Cal battery 14V: value (0-0xFFFF) : Factory-use-only
PP0 - Cal oil pump 0mA: value (0-0xFFFF) : Factory-use-only
PP1 - Cal oil pump 1000mA: value (0-0xFFFF) : Factory-use-only
PVL - Cal V12 12V: value (0-0xFFFF) : Factory-use-only
PVH - Cal V12 14V: value (0-0xFFFF) : Factory-use-only
PV0 - Cal vac 0inHg: value (0-0xFFFF) : Factory-use-only
PV5 - Cal vac 5 inHg: value (0-0xFFFF) : Factory-use-only
PC0 - Cal V12 curr 0mA: value (0-0xFFFF) : Factory-use-only
PC1 - Cal V12 curr 1000mA: value (0-0xFFFF) : Factory-use-only
PAL - Pump range set (/100 psi): low (-200to1000) high (-200to1000) : Factory-use-only
PAT - Air pump pressure range test: valve (0-open, 1-closed, 2-mid) [pat 1]
POT - Oil pump test: valve (0-open, 1-closed) duration (seconds) - will start pump w/ valve open or shut respectively.
PUD - Pump disable: pump (0-air,1-oil)
PUE - Pump enable: pump (0-air,1-oil) timeout (0-1000ms)
PWR - 12V power enable: mode (0-disable, 1-enable, 2-low-power sleep)
RE - System software reset
RTC - Real-time clock (RTC) display
RTS - Real-time clock set: date (YYYYMMDD) time (HHMMSS)
SAI - Satellite info
SAT - Satellite transmit test SBD message.
STM - Satellite text message mode, to be deprecated
SER - Serial pass-through mode: Factory-use-only
SSN - System serial number get/set
VER - Version information (provides detailed serial number information for float's firmware, sensors, communications devices, message protocol, float, etc.)
VC - Valve control: valve (0-air,1-oil) position (0-op,1-cl,2-mid) (VC requires setting PWR 1 first). [vc 1 0]

VCA - Valve calibration: valve (0-air,1-oil)
VS - Valve state: valve (0-air,1-oil) [vs 0]

Viewing, Altering Parameter Settings

This section describes how, from the command prompt, to query for float status and parameter settings and how to initiate selected, common float functions including directly starting a mission.

ADC 0 This will produce a list from scanning all channels in the float such as follows:

```
mrv> adc 0
Channel       ADC Val  Voltage Calib
==========================================
CASE_VAC    = 9935    0.379   8.720 inHg
OVALVE_POSN  = 0       0.000
AD_VBAT     = 42183    1.609   11.600 V
AD_OPUMP    = 0       0.000   0 mA
AIR_VAC     = 7       0.000   -0.643 psi
AVALVE_POSN  = 0       0.000
V12_CURR    = 4       0.000   0 mA
OIL_VAC     = 32      0.001   0.000 A
-----EXT_ADC-----
OVALVE_CURR  = 7       0.004
AVALVE_CURR  = 3       0.002
AD_OPUMP    = 3       0.002   0 mA
AD_APUMP    = 4       0.002   0.002 A
V12_CURR    = 1       0.001   65535 mA
EXP1_GPIO3   = 678     0.414
EXP0_GPIO3   = 1416    0.864
V12_VOLT    = 2       0.001   0.009 V
```

<u>Change a parameter in RAM (for use) … and record it to non-volatile memory (EEPROM) (example):</u>

DTD 0 60

APS 300

MIC 1

MIC

MIC 0 dumps the non-volatile memory (EEPROM) configuration of all the float's parameters. Note: MIC 99 writes to RAM, from which the float operates, the default/factory-set parameters recorded in the operating system software. As parameters are subsequently altered, either directly or via sbd message, use MIC 1 (see example below) to update parameter values in EEPROM. The command MIC 2 causes the float to report via sbd message all EEPROM-stored parameters.

```
mrv> mic 0
Configuration data buffer size = 12288 bytes, state params size = 896 bytes.
=======================================
Mission configuration (addr=4)
=======================================
sw version              = 5006400
float_number(SSN)         = 9183
mission_number(MSN)        = 1
```

mission_phase(MPS) = 0
phase_cycle_number(MPC) = 0
phase_cycles(MNM0) = 1
phase_cycles(MNM1) = 0
phase_cycles(MNM2) = 0
next_phase(MNS0) = 0
next_phase(MNS1) = 0
next_phase(MNS2) = 0
descend_target_depth(DTD0) = 4.000 dbar
descend_target_depth(DTD1) = 400.000 dbar
descend_target_depth(DTD2) = 400.000 dbar
maximum_depth(MDS) = 1200.000 dbar
init_trigger_depth(MTD) = 1.000 dbar
init_trigger_timeout(MTT) = 30000 ms
init_trigger_start_to(MTS) = 1800 sec
auto_param_transmit_mode (APT) = 1
bluetooth_mode (BTM) = 1
diag_dive_bypass_mode (DDB) = 1
compression_alg(XAS) = curv (2)
accel_mode (MAM) = 0
accel_period(MAP) = 600
accel_intervals(MAT1) = 1
accel_timeout(MAT2) = 300 sec
accel_scale_fact(ACA) = 2
accel_gyro_scale_fact(ACG) = 250
accel_sample_rate(ACR) = 4
press_gain(GAP) = 25
press_offset(OFP) = 10
temp_gain(GAT) = 1000
temp_offset(OFT) = 5
sal_gain(GAS) = 1000
sal_offset(OFS) = 1
surf_press_gain(GSP) = 25
surf_press_offset(OSP) = 10
surf_temp_gain(GST) = 1000
surf_temp_offset(OST) = 5
surf_sal_gain(GSS) = 1000
surf_sal_offset(OSS) = 1
sensor_gain(SGS 0) = 1000
sensor_offset(SOS 0) = 5
sensor_gain(SGS 1) = 0
sensor_offset(SOS 1) = 0
sensor_gain(SGS 2) = 0
sensor_offset(SOS 2) = 0
sensor_gain(SGS 3) = 25
sensor_offset(SOS 3) = 10
sensor_gain(SGS 4) = 1000
sensor_offset(SOS 4) = 5
batt_volt_min(PNB) = 9.000
case_press_min(PNC) = 3.000

```
case_press_max(PXC)        = 7.000
cal_batt_12V(PBL)          = 43668
cal_batt_14V(PBH)          = 50958
cal_oil_pump_0mA(PP0)      = 0
cal_oil_pump_1000mA(PP1)    = 25960
cal_V12_12V(PVL)           = 1790
cal_V12_14V(PVH)           = 2089
cal_vac_0inHg(PV0)         = 61614
cal_vac_5inHg(PV5)         = 32000
cal_V12_0mA(PC0)           = 0
cal_V12_1000mA(PC1)        = 16600
ice_mode (ICM)             = 0
ice_urgency                = 0
ice_month_mask(IMM)        = 0x0
ice_min_depth(ICN)         = 20.000
ice_max_depth(ICX)         = 40.000
ice_temp_thresh(ICT)       = -1.650
ice_storage_to(ICS)        = 30 sec
ice_surf_search_prof(ISP)   = 0
ice_surf_search_mask(ISM)   = 0x1
ice_surf_search_sal_thr(IST) = 0.200
ice_surf_search_to(ISO)     = 180 sec
ice_surf_search_mode (ISS-S)  = 2
ice_surf_search_mode (ISS-W)  = 2
ice_att_max(ICA-S)         = 5
ice_att_max(ICA-W)         = 5
ice_descend_retry_to(ICR-S)  = 30 min
ice_descend_retry_to(ICR-W)  = 30 min
ice_descend_hold_depth(ICD-S) = 100.000
ice_descend_hold_depth(ICD-W) = 100.000
ice_descend_valve_to(ICO-S)  = 45
ice_descend_valve_to(ICO-W)  = 45
ice_descend_seek_mode (ICG-S) = 0
ice_descend_seek_mode (ICG-W) = 0
ice_descend_seek_att(ISA)   = 1
ice_descend_seek_dpt_del(ISD) = 10.000
ice_descend_seek_vel_to(ISV) = 30
ice_descend_seek_wait_to(ISW) = 1200
ice_descend_seek_to(IAT)    = 1200
ice_urgency_exit_mode (IUE-S) = 0
ice_urgency_exit_mode (IUE-W) = 0
ice_cyc_bet_attempts(ICB-S)  = 1
ice_cyc_bet_attempts(ICB-W)  = 1
ice_msg_thresh(IMT-S)      = 70 (%)
ice_msg_thresh(IMT-W)      = 70 (%)
ice_last_xmt_time_thr(ILT-S) = 180
ice_last_xmt_time_thr(ILT-W) = 180
ice_free_mask(ICF)         = 0x00000000
ice_winter_mask(ICW)       = 0x00000000
ctd_profile_mode (CPS)      = 1
```

```
ctd_sampling_type(CST)      = bin averaging (0)
ctd_prof_press_cutoff(CTF)   = 2.0 dbar
ctd_cont_samp_per(CSP)      = 60000 ms
ctd_prof_per_bound(CPB) (1) = 2000 dbar
ctd_prof_per_binsz(CPN) (1) = 2.0 dbar
ctd_prof_per_samp(CPP)  (1) = 2000 ms
ctd_prof_per_bound(CPB) (2) = 300 dbar
ctd_prof_per_binsz(CPN) (2) = 1.0 dbar
ctd_prof_per_samp(CPP)  (2) = 1000 ms
ctd_prof_per_bound(CPB) (3) = 100 dbar
ctd_prof_per_binsz(CPN) (3) = 1.0 dbar
ctd_prof_per_samp(CPP)  (3) = 1000 ms
ctd_raw_rng_depth(CRD)      = 50 dbar
ctd_raw_rng_samp(CRS)      = 0
ctd_cond_temp_mode (CTC)     = 0
=======================================
=======================================
Descend state configuration (addr=460)
=======================================
Descend stage: Init
start_time          = 549
descend_number(DNS)    = 1
samp_timeout(DSI)      = 1000 ms
descend_rate(DRA)      = 20 dbar/sec
data_store_to(DDT)     = 300 sec
data_store_d(DDD)      = 1.000 dbar
start_depth_thr(DSD0)  = 1.000 dbar
start_depth_thr(DSD1)  = 400.000 dbar
start_depth_thr(DSD2)  = 400.000 dbar
start_timeout(DST0)    = 600 sec
start_timeout(DST1)    = 7200 sec
start_timeout(DST2)    = 7200 sec
fall_timeout(DFT0)     = 600 sec
fall_timeout(DFT1)     = 130 sec
fall_timeout(DFT2)     = 130 sec
cal_mode (DCM)         = 0
algorithm mode (DAL)    = seek (1)
cal_depth_delta(DCD)   = 200.000 dbar
cal_rate_calc(DRC)     = 3.000
cal_descend_rate(DCR)  = 0.00000 dbar/sec
seek_max_att(DCA)      = 3
seek_timeout(DCT0)     = 15 sec
seek_timeout(DCT1)     = 10800 sec
seek_timeout(DCT2)     = 10800 sec
seek_max_pump_time (DCX) = 1020 sec
seek_min_pump_time (DCP) = 5 sec
seek_min_fuse_time (DCF) = 5 sec
seek_rate_adj_to(DRT)  = 0 sec
seek_wait_to(DSW)      = 3600 sec
seek_under_dmp_ctl(DUC) = 1.000
```

```
seek_pump_time (DPT)    = 5 sec
seek_fuse_time (DUT)    = 5 sec
seek_pump_dwn_time (DPD) = 5 sec
seek_vel_delay(DVT)    = 30 sec
seek_vlv_depth_del(DVD) = 25.000 dbar
seek_vlv_wait_time (DVW) = 300 sec
pump_flow_rate(PFR)    = 19 cc/min
pump_rate_calc(PFC)    = 0.01600 cc/dbar
diag_start_timeout(DDS) = 3600 sec
diag_start_depth(DDP)  = 100.000 dbar
diag_fall_timeout(DDF) = 300 sec
diag_cal_timeout(DDC)  = 0 sec
=======================================
=======================================
Park state configuration (addr=644)
=======================================
Park stage: Init
start_time          = 536964674
park_number(PNS)      = 1
timeout(PTO0)         = 60 sec
timeout(PTO1)         = 0 sec
timeout(PTO2)         = 0 sec
date_time_timeout(PTD) = 0 sec
hour_timeout(PTH0)     = 0x00000000
hour_timeout(PTH1)     = 0x00000000
hour_timeout(PTH2)     = 0x00000000
samp_timeout(PSI)     = 10000 ms
sample_mode (PSA)      = 1
data_store_to(PDT)    = 30 sec
fall_mode (PFM0)       = 0
fall_mode (PFM1)       = 0
fall_mode (PFM2)       = 0
fall_timeout(PFT0)     = 3600 sec
fall_timeout(PFT1)     = 3600 sec
fall_timeout(PFT2)     = 3600 sec
fall_target_depth(PFD0) = 0.000 dbar
fall_target_depth(PFD1) = 0.000 dbar
fall_target_depth(PFD2) = 0.000 dbar
fall_valve_to(PFV0)    = 0 sec
fall_valve_to(PFV1)    = 0 sec
fall_valve_to(PFV2)    = 0 sec
seek_mode (PSM)        = 0
seek_to(PST)         = 3600 sec
seek_depth_delta(PSD) = 100.000 dbar
seek_vel_delay_to(PSV) = 30 sec
seek_wait_to(PSW)     = 1300 sec
avg_mode (PAM)        = 1
avg_min_ctr(PAC)      = 6 min
=======================================
=======================================
```

```
Ascend state configuration (addr=764)
========================================
Ascend stage: Init
start_time           = 1466 sec
ascend_number(ASN)     = 1
samp_timeout(ASI)      = 1000 ms
rise_rate(ARR)        = 20 cm/sec
rise_rate_adj_calc(ARC) = 1.400
data_store_to(ADT)     = 300 sec
data_store_d(ADD)      = 1.000 dbar
pump_on_initial_to(APS) = 600 sec
pump_on_timeout(APN)    = 30 sec
pump_off_timeout(APF)   = 5 sec
pump_max_runtime (APM)   = 1020 sec
sfc_depth_thr(ASD)      = 1.000 dbar
halt_depth_delta(AHD)   = 10.000 dbar
halt_rise_rate(AHR)     = 1.000 cm/sec
========================================
========================================
Surface state configuration (addr=820)
========================================
Surface stage: Init
start_time          = 1559
surface_number(SFN)   = 1
samp_timeout(SSI)     = 10000 ms
depth_comp(SDC)      = -10.000 dbar
air_assist_mode (SAM)  = 0
samp_avg_mode (SSA)    = 0
timeout_at_surf(SST)  = 0 sec
gps_to_at_surf(SGT)   = 15 min
sat_to_at_surf(SET)   = 15 min
ctd_storage_to(SPT)   = 0 sec
sensor_pump_to(SSP)   = 60 sec
data_store_to(SDS)    = 60 sec
air_assist_max(SAX)   = 7.500 psi
air_assist_min(SAN)   = 6.500 psi
air_assist_to(SAO)    = 360 sec
air_assist_max_to(SAP) = 600 sec
beacon_mode (SBM)      = 1
beacon_intvl_to(SBT)  = 300 sec
========================================

========================================
```

<u>Air Assist Test:</u>

SSN   Yields float serial number

Create a log file for the air assist test.

File->Log

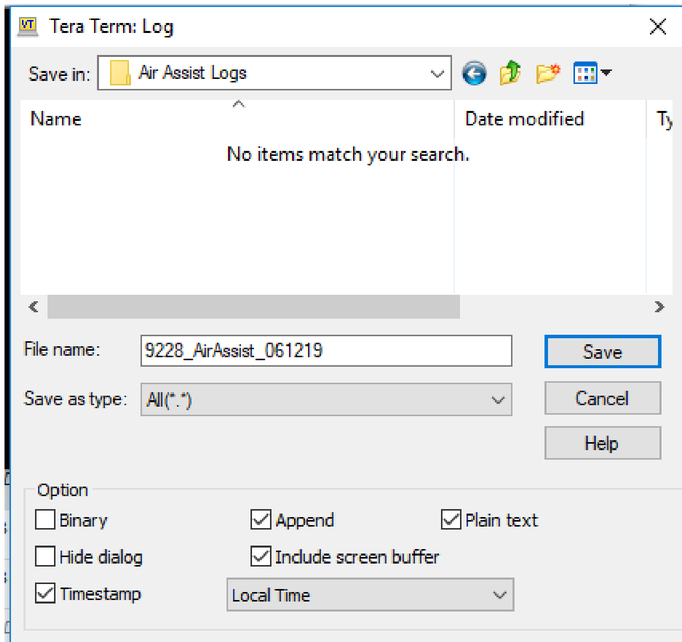
Name the log file in the following format: float serial number_AirAssist_date

Example: 9225_AirAssist_061119

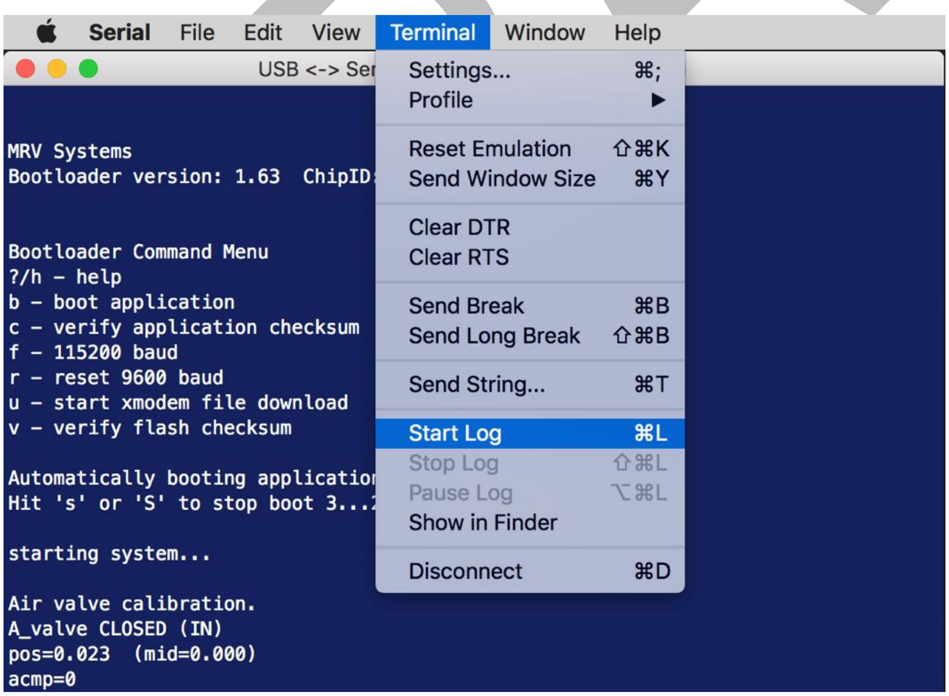
Check the following boxes in Tera Term

Include Screen Buffer

Timestamp



In Serial:



PWR 1 Turn on 12V power set test valve positions

VC 0 2 Set air pump valve to the mid position

VC 1 1 Set the oil valve to close

PAT 0 Runs the air assist test. The test must complete in under 80 seconds. Min/Max pass values are 6.5/7.5 psi, use adc 1 command to check vac

Press ESC to stop the test

PWR 1 Turn on 12V power to set original valve positions

VC 0 2 Set air pump valve to mid position

VC 1 0 Set oil valve to open

PWR 0 Turn off 12V power

PWR 2 Shut down float

Log file will automatically be saved once the window is closed.

Keep float connected to computer.

Close Tera Term.

<u>Operate oil pump and oil valve:</u>

POT 0 5 This opens the hydraulic valve and runs the hydraulic pump for five seconds. Tap ESC to stop the pump sooner than the designated seconds.

<u>GPS fix:</u>

GPS 10 1 This initiates a GPS fix, and tries to complete it over a ten minute period. The "1" commands a Real Time Clock sync. "0" would not do this.

<u>Iridium communication tests:</u>

SAI This checks the Iridium modem and returns IMEI number.

SAT This attempts transmission of an\ short SBD message. Retrieve via sbd@mrvsys.com.

<u>Launch a BIT:</u>

BIT 3 This launches a full BIT which includes testing the air assist system. BIT 2 does as well. BIT 1 (deployment BIT) leaves off testing the air assist system.

<u>Loading a configuration parameter file:</u>

From Appendix B, use load_commands.sh to execute the download of a UNIX-formatted text file like tank_test_configuration-unix.txt also from Appendix B. (This configuration file may be edited and saved to a filename of ones choice.)

With a USB cable installed to the float, set up a Serial application in one terminal window and make note of the terminal path (/Dev/tty.usbserial-FTYXFW4V in the example). Open a Serial application in a second window and execute the following command that implements load_commands.sh:

$ ./load_commands.sh   tank_test_configuration-unix.txt. /Dev/tty.usbserial-FTYXFW4V

Loading a new operating software binary file:

1) Plug in the serial cable and open a Serial application in a terminal window with the correct tty device (see above example)

2) Swipe the magnet to power up the float. You should see a screen printed out like this:

```
MRV Systems
Bootloader version: 1.63  ChipID: 2495350051B76A6A

Bootloader Command Menu
?/h - help
b - boot application
c - verify application checksum
f - 115200 baud
r - reset 9600 baud
u - start xmodem file download
v - verify flash checksum

Automatically booting application in 3 seconds
Hit 's' or 'S' to stop boot
```

3) Type 's' within 3 seconds. If the 3 second limit is missed, the float will pulse the hydraulic pump 3 times and start booting. Swipe the magnet again and try again.

4) The screen will stop printing. Type 'f' to increase the baud rate to115200 on the float. Also change the baud rate in your Serial application to115200 so you may see the download in progress.

5) Type 'u' and select 'y' (yes) to upload the new binary file, previously saved in a directory of choice, e.g., RBR_PT_v6.5.4-XC.bin.

6) From the Serial application, select and click the option to send using XMODEM and select the binary file, e.g., RBR_PT_v6.5.4-XC.bin. The screen should display a stream of characters indicating a file transfer is taking place. If this doesn't happen, try the 'u' option again.

7) After uploading the new binary, be sure to select 'r' to reset the baud rate to 9600. Also change the baud rate in your Serial application 9600 so you may interact once again with the float and see the float rebooting. This will include hearing pump pulses along with output appearing on the screen.

8) Type 'ver' to confirm the new software version is loaded.

Prepare a float to execute a mission:

CAUTION: This launch method short-cuts the procedure described above that uses the BIT ahead of deploying (MTT, MTS, MTD are no longer in play). If DDB is set to 1, the Diagnostic Dive is bypassed, and the float will look for DST time or DSD depth before pumping. If DDB 0, the float will look for DDT or DDD instead.

mrv> MIS 10 40

Where '10' is "enter mission" and '4' is "dive to 40 dbar." I.e. DTD, target depth, and not DSD.

Wait for up to 90 seconds -- once you see some lines printed on the screen indicating the float is obtaining a pressure measurement and descending, you can disconnect the communications cable, reinstall the communications port cap, and put the float in the water.

<u>Low-power mode: (advisable at the end of any session that connects to the float via wire or Bluetooth)</u>

PWR 2   Note: to extend the battery life of a float, place the float in low-power mode after working with it. This is also useful if a BIT has been run (puts the float into "high" power mode) and launch is not expected within the MTS time (and MTD depth) settings (up to a year).

Appendix A - Float Operations Primer

Appendix B - Software Interface Tools

Float-Commander

Float Commander 3.0.0
A syntax checker and SBD generator.

Provide a file with a float command on each line.
Comments can be marked with '//', '!', ';', or '='
This program will check each command and will output an SBD file if all commands are valid.
These SBD files can be mailed with your favorite email client to the float!

USAGE:
    float-commander [FLAGS] <if> [of]

FLAGS:
    -c   enable color output
    -h, --help   Prints help information
    -n   disable syntax checking, just output .sbd file
    -V, --version   Prints version information

ARGS:
    <if>   input filename
    <of>   output filename

XDecode User Guide

xdecode is a tool for extracting data from the SBD packets transmitted by MRV floats.

Due to the bandwidth-constrained nature of satellite communications, great care is taken to transmit as much information as possible in as few bytes as possible. Therefore, data is transmitted in a tightly-packed encoded binary format called XMessage, originally developed by SIO.

The purpose of the xdecode tool is to serve as a single simple way of extracting all data from an arbitrary set of XMessage packets (.sbd files).

Quick Start

Take a quick, human-readable look at data for a dive, assuming the SBD messages for that dive are in some directory dive/:

$ xdecode path/to/dive/

Decode a set of dives, and write JSON serialized data to a file:

$ xdecode -fjson path/to/dive1 path/to/dive2 ... -o out.json or

```
$ xdecode path/to/dives/ -fj > out.json
```

Decode data for a float, spanning dives, in json format:

```
$ xdecode path/to/data -f json
[
  {
    "sn": 9001,
    "model": "Alamo/Alto",
    "dives": [
      {
        "dn": 1,
        ..
      }
      {
        "dn": 2,
        ...
      }
      ...
    ]
  }
]
```

Quickly crack SBD messages to find out which data packets are present for which floats/dives in a data set:

```
$ xdecode path/to/data --split
```

Combining `xdecode` with other tools (Linux/MacOS)

Check for errors in a dive:

```
$ xdecode path/to/dive | grep -C2 'error'
```

Check how the DFT parameter changes across three dives:

```
$ xdecode path/to/dive1 path/to/dive2 path/to/dive3 | grep 'DFT'
```

Find out which floats/dives a directory has data for

```
$ xdecode path/to/data --split | grep -i 'float'
```

Usage

Usually, xdecode is run on a directory structure holding SBD messages for a dive. It does not generally make sense to decode a single SBD from a dive in isolation. It is possible, but you may need to supply additional information normally found in some of the other XMessage packets. See the --model and --version options, described below.

Most use-cases are covered in the examples above.

General usage, along with all available options and flags, are documented in the `xdecode` application itself. The help can be displayed by running `xdecode -h` or just `xdecode` with no input (short help), or `xdecode --help` (long help).

Flags

```
-h/--help
```

Print help information and exit

```
-s/--split
```

Just crack open the SBD messages to examine which floats/dives and XMessage packet IDs are present. Do not decode any data.

```
$ xdecode ~/data/9001/200 --split
Float 9001 Dive 200
 01 02 10 20 30 40 50 60 80 98 A8 B8 D0 D1 E7 E8 E9 EA EB F0
```

```
-c/--continue
```

Try to stagger on even if errors occur while decoding. Note that some errors may affect the integrity of decoded data; if errors or warnings are logged, you should **not** trust the correctness of the output.

Pay attention to warning/error messages, some of them may be resolved by supplying additional information.

```
-S/--follow-links
```

Follow symbolic links in the input paths.

```
-u/--ugly
```

Do not pretty-print output, if applicable to the output format.

If the output of this invocation of `xdecode` will only be consumed by another program, this can be useful to reduce file size (e.g. by removing all newlines/whitespace in the JSON format).

```
$ xdecode -ufj ~/db/9001/200
[{"sn":9001,"model":"Alamo/Alto","dives":[{"dn":200,"sw_version":"5.0.a","tra
jectory":{"gps":[{"kind":"DiveStart","datetime":...
```

```
-v[vv]
```

Control verbosity of logging by number of vs (0-3):

- None: Warnings and errors only. Standard.
- (-v): Informational messages and above. Verbose.

- (-vv): Debug messages and above. Very verbose.
- (-vvv): Program trace/all logs. Very very verbose.

```
--force
```

Force use of user-specifed float model and version. If this flag is given, then both the `--model` and `--version` options described below *must* be provided.

This may cause additional errors during decoding, and should *only* be specified if you believe the decoder is deducing an incorrect value for one or both of those options.

<u>Options</u>

```
-o/--output <filename>
```

If specified, write decoded output to `filename` instead of `stdout`.

```
$ xdecode ~/data/9001/200 -o out/sn9001_dn200.txt
$ ls out/
  sn9001_dn200.txt
```

```
-f/--format <format>
```

Set output format to `format`, which is one of the following (default `text`):

- `t/text`: Output is human readable with some nicely formatted tables. Assumes terminal support for UTF-8 encoded characters.
- `j/json`: JavaScript Ojbect Notation is a fairly ubiquitous data interchange format that has become a sort of de-facto standard. Software libraries exist to parse it in almost every programming language.
- `y/yaml`: A format that is both human readable and fairly easy for software to parse.
- `q/quiet/silent`: Normal output is supressed, but data is still fully decoded. Useful to verify data integrity (warnings/errors will still be printed).

```
-t/--model <model>
```

Float model hint. Generally only needed if the data cannot be decoded correctly otherwise. Possible values for `model`:

- `alamo`: MRV Alamo/Alto family.
- `solo`: SIO SoloII or MRV S2A/S2X family.
- `deep`: Deep Solo floats.

Unless the `--force` flag is also specified, this will be ignored if the float model can be uniquely determined from the input data.

```
--version <sw_version>
```

Float software version hint. Generally only needed if the data cannot be correctly decoded otherwise.

```
$ xdecode ~/db/9002/1 --version 6.1.3
```

Unless the `--force` flag is also specified, this will be ignored if the float model can be uniquely determined from the input data.

Output

By default, xdecode writes output to stdout and logging/warning/error messages to stderr.

On *nix/MacOS, output can be redirected as usual to a file or another application using pipes or fifos.

The -o, or --output option is available to write output to a file instead. This is the recommended way to write output to a file on Windows.

Installation

Archives of precompiled binaries for xdecode are available for Linux, MacOS, and Windows.

As with most command-line tools, if you frequently use xdecode, it is recommended to place it in your path, so that it can be run in the same manner from any terminal.

Appendix C - Command and Parameter References

Command List:

ACA - Accelerometer accel scale factor: fact(2,4,8,16). To be deprecated.
ACC - Accelerometer data - print to screen. ESC to stop.
ACD - Accelerometer data display: disp(0-sci,1-raw)
ACF - Accelerometer FIFO data: out(1-100) in(1-100)
ACG - Accelerometer gyro scale factor: (250,500,1000,2000). To be deprecated.
ACL - Accelerometer data: mode (1-avg,2-delta) time (1-270min)
ACR - Accelerometer sample rate: mpu sampling rate (4-250) averaging rate (1-10)
ADC - ADC scan all channels: power (0=measure only, 1=pwr on - measure - pwr off)
BIT - Built-in test: type(1-short,2-long,3-all) [bit 3]
BTM - Bluetooth mode: mode (0-dis,1-en)
CDD - CTD display stored profile data

CMS - CTD profiling bench mode (0-off, 1-on)
CTD - CTD get pressure, temperature, salinity measurement
CTT - CTD get pressure, temperature measurement: power (0-off,1-on) profiling (0-dis,1-en)
CTP - CTD get pressure measurement: power (0-off,1-on) profiling (0-dis,1-en)
CTI - CTD display info: info (0-setting, 1-coeff)
CTS - CTD get status
EEP - EEPROM write address value
EET - EEPROM test
GPS - GPS info: timeout(1-50 min) rtcsync(0-no,1-yes) [gps 5 1]
IOR - GPIO IN port read: Port(A-F)
IOW - GPIO port write: Port(A-F) Val(0-0xFFFF)
LOG - Log mode: mask(1-pres/temp,2-motion) time (1-270min)
MIC - Mission configuration: mode (0-dump to screen, 1-store in non-volatile memory, 2-xmit, 99-def)
MID - Mission display info: (0=reset)
MIS - Mission: state (0-halt, 1-surface, 2-descend, 3-park, 4-ascend, 10 go (automatic)) depth (0-2000)   [MIS 10 500]
PNB - Minimum battery voltage (/100 V): value (0-10000)
PNC - Minimum case pressure (/100 inHg): value (0-10000)
PXC - Maximum case pressure (/100 inHg): value (0-10000)
PBL - Cal battery 12V: value (0-0xFFFF)
PBH - Cal battery 14V: value (0-0xFFFF)
PP0 - Cal oil pump 0mA: value (0-0xFFFF)
PP1 - Cal oil pump 1000mA: value (0-0xFFFF)
PVL - Cal V12 12V: value (0-0xFFFF)
PVH - Cal V12 14V: value (0-0xFFFF)
PV0 - Cal vac 0inHg: value (0-0xFFFF)
PV5 - Cal vac 5 inHg: value (0-0xFFFF)
PC0 - Cal V12 curr 0mA: value (0-0xFFFF)
PC1 - Cal V12 curr 1000mA: value (0-0xFFFF)
PAL - Pump range set (/100 psi): low (-200to1000) high (-200to1000)

PAT - Air pump pressure range test: valve (0-open, 1-closed, 2-mid). ESC to stop. [pat 1]
POT - Oil pump test: valve (0-open, 1-closed)   duration (seconds) - will start pump w/ valve open or shut respectively.
PUD - Pump disable: pump (0-air,1-oil)
PUE - Pump enable: pump (0-air,1-oil) timeout (0-5000ms)
PWR - 12V power enable: mode (0-disable, 1-enable, 2-low-power sleep)
RE - System software reset
RTC - Real-time clock (RTC) display
RTS - Real-time clock set: date (YYYYMMDD) time (HHMMSS)
SAI - Satellite info
SAT - Satellite transmit test SBD message
STM - Satellite text message mode, to be deprecated
SER - Serial passthrough mode
SSN - System serial number get/set
VER - Version information (provides detailed serial number information for float's firmware, sensors, communications devices, message protocol, float, etc.)
VC - Valve control: valve (0-air,1-oil) position (0-open, 1-close, 2-mid-position) (VC requires
setting PWR 1 first)
VCA - Valve calibration: valve (0-air,1-oil)
VS - Valve state: valve (0-air,1-oil)

Parameter List:

Parameter List:

<u>General parameters - screen display:</u>

ADC <power control> = Display current ADC readings to the screen. A single reading of all ADC channels is displayed. The power control parameter allows the ADC command to either enable/disable system power independently or not. The power control allows for other modules of the system to operate while displaying ADC readings and not affecting these modules operating on the same power. For example, a user might want to display ADC readings while the oil pump is running. In that case, the ADC 0 command is used to not interrupt power to the oil pump.

The ADC output value CASE_VAC displays the vacuum calculation of the case pressure. Currently, the software is not calibrated to use this value. The AD_VBAT output value displays the current battery voltage. Other ADC values are for internal software use.

Command. Range: power_control: 0 = measure-only, 1 = pwr on - measure, then pwr 0. [ADC 1]

SSN <serial number> = Display or set the system serial number. Command. Range: number: 0 to 100000, if no parameter is entered for number, the existing float serial number is displayed.

VER = Display system and component version information. Command.

General parameters - operations:

APT <mode> = Automatic Parameter Transmit. Configure the system to automatically transmit the mission configuration parameters during the Surface state. Uncommon use. Range: mode: 0 = off, 1 = on. [APT 1]

BIT <type> = Built-In-Test. Common. Range: type: 1 = short (does not test air assist system), 2 = long (with air assist test), 3 = all. NOTE: 2 and 3 yield the same results. Command.

BTM <mode> = Bluetooth Mode. Configure the Bluetooth operation after the built-in test is completed while the float is sampling the sensor waiting for the trigger depth to be exceeded to start its mission. Uncommon use. Range: mode: 0 = off, 1 = on. [BTM 1]

MIC <mode> = Mission configuration parameters. Display or store the current mission configuration parameters. Command.

Range:

mode:

0 = dump current parameters from non-volatile memory to screen

1 = store current parameters to non-volatile memory

2 = transmit parameters from non-volatile memory via satellite at next opportunity

99 = set parameters in RAM to default (held within operating software load) and store to non-volatile memory

[MIC 0]

MIS <state> <target depth> = Set the state of the mission operation. In automatic mode, the float continues to execute missions until halted either via command (MIS 10 400) or magnet swipe. Command.

Ranges:

state:

0 = halt

1 = surface

2 = descend

3 = park

4 = ascend

10 = automatic mode

target_depth: 0 to 2000 dbar (ALTO); 0 to 1200 dbar (ALAMO)

[MIS 10 500]

PAL <lower range> <upper range> = Configure the lower and upper range pressure settings for the air pump test. Uncommon.

Ranges:

lower_range: -200 to 1000 / 100 psi

upper_range: -200 to 1000 / 100 psi

[PAL 670 750]

PAT < valve position> = Run the air pump pressure test with the air valve set at the specified position. Press Escape (ESC) to exit the test. The air pump pressure test inflates the internal air bladder until the upper pressure value is reached, then turns the pump off. When the pressure is below the lower pressure value, the pump turns back on until the bladder pressure reaches the upper limit. Command. Range: valve_position: 0 = open (out), 1 = closed (in), 2 = middle. [PAT 0]

POT <valve position> = Run the oil pump test with the oil valve set at the specified position. Press Escape (ESC) to exit the test. The oil pump test inflates the external oil bladder. Command. Range: valve_position: 0 = open (out), 1 = closed (in). [POT 1]

PUD <pump> = Disable the specified pump. Command. Range: pump: 0 = air; 1 = oil. [PUD 1]

PUE <pump> <timeout> = Enable the specified pump for the specified duration. When the pump is enabled without a timeout, the PUD command is used to disable the pump. Command.

Ranges:

pump: 0 = air, 1 = oil.

timeout: 0 to 5000 milliseconds, 0 = no timeout

[PUE 1 50]

PWR <mode> = Enable or disable the mechanical system power. Specifying two for the mode puts the system in a lower power state, which can only be awakened with magnet swipe. Note: Power must be enabled prior to using the pump and valve commands. Command. Range: mode: 0 = disable, 1 = enable, 2 = enter low power state. [PWR 2]

VC <valve> <position> = Set the current state of the specified valve. Command.

Ranges:

valve: 0 = air, 1 = oil

position: 0 = open, 1 = closed, 2 = middle

[VC 0 1]

VCA <valve> = Execute the calibration on the specified valve. Command. Range: valve: 0 = air, 1 = oil. [VCA 1]

VS <valve> = Return valve state. Command. Range: 0-air,1-oil.

RE = Reset the system. A confirmation is required prior to the float executing the reset. Command.

EEP = Write address value. Command. Must know addressing scheme to know to where to write a value. Do-not-use.

EET = Perform an EEPROM read and write test on all system EEPROM components. NOTE: This will erase parameters stored in the EEPROM. Command.

IOR = GPIO IN port read: Port(A-F). Command.

IOW = GPIO port write: Port(A-F) Val(0-0xFFFF). Command.

XAS <algorithm> = Compacting algorithm set. Sets the compacting algorithm to use for profile data packetization. Factory-set - do not use. Range: algorithm: 1 = difference, 2 = curvature. [XAS 2]

General parameters - clock, GPS, communications:

RTC = Real time clock display. Command.

RTS <date> <time> = Set the real time clock directly. Command.

Ranges:

date: YYYYMMDD

time: HHMMSS

[RTS 20190612 152000]

GPS <timeout> <rtc sync> = Attempt to obtain a GPS fix for the specified timeout period. The RTC synchronize parameter determines if the system updates the RTC if a time is obtained from the GPS. Command.

Ranges:

timeout: 1 to 50 minutes

rtc_sync: 0 = no, 1 = yes (synchronize RTC with GPS time)

[GPS 10 1]

SAI = Display the satellite modem information (IMEI number). Command.

SAT = Transmit a test data pattern over the satellite. Command.

General parameters - calibration:

PNB = Minimum battery voltage (/100 V): value (0-10000**)**: Factory-use-only. [PNB 1200]

PNC = Minimum case pressure (/100 inHg): value (0-10000) : Factory-use-only**. [**PNC 800]

PXC = Maximum case pressure (/100 inHg): value (0-10000) : Factory-use-only**. [**PXC 1500]

PBL <cal value> = Configure the calibration value for the battery at 12V. Factory-set - do not use. Command. Range: cal value: 0 to 0xFFFF. [PBL 43668]

PBH <cal value> = Configure the calibration value for the battery at 14V. Factory-set - do not use. Command. Range: cal value: 0 to 0xFFFF. [PBH 50958]

PP0 <cal value> = Configure the calibration value for the oil pump at 0mA. Factory-set - do not use. Command. Range: cal value: 0 to 0xFFFF. [PP0 0]

PP1 <cal value> = Configure the calibration value for the oil pump at 1000mA. Factory-set - do not use. Command.   Range: cal value: 0 to 0xFFFF. [PP1 25960]

PVL <cal value> = Configure the calibration value for the V_12 trace at 12V. Factory-set - do not use. Command. Range: cal value: 0 to 0xFFFF. [PVL 1790]

PVH <cal value> = Configure the calibration value for the V_12 trace at 14V. Factory-set - do not use. Command. Range: cal value: 0 to 0xFFFF. [PVH 2089]

PV0 <cal value> = Configure the calibration value for the vacuum at 0inHg. Factory-set - do not use. Command. Range: cal value: 0 to 0xFFFF. [PV0 61614]

PV5 <cal value> = Configure the calibration value for the vacuum at 5inHg. Factory-set - do not use. Command. Range: cal value: 0 to 0xFFFF. [PV5 40400]

PC0 <cal value> = Configure the calibration value for the V12 current at 0mA. Factory-set - do not use. Command. Range: cal value: 0 to 0xFFFF. [PC0 0]

PC1 <cal value>= Configure the calibration value for the V12 current at 1000mA. Factory-set - do not use. Command. Range: cal value: 0 to 0xFFFF. [PC1 16600]

<u>CTD parameters:</u>

CDD = Display the logged data from the CTD. Command.

CDT = Perform a single CTD sensor reading. Command.

CTS = Display CTD sensor status. Command.

CMS <mode> - CTD profiling bench mode (0-off, 1-on). Command.

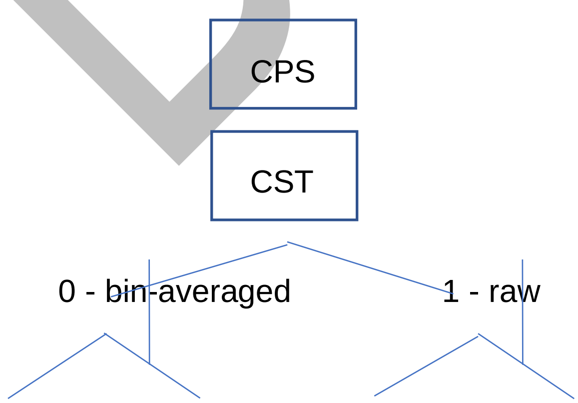


Figure 1 Eight parameters relating to the CTD sensor functions

CPS <mode> = CTD Sensor profiling mode set. Configure the CTD sensor profiling mode. This allows the user to enable or disable profiling during the Ascend state. Uncommon. Range: mode: 0 = off, 1 = on. [CPS 1]

CST <type> = CTD Sensor sampling type. Configure the CTD sensor for the specified profiling mode. In Bin Averaging mode, the CTD periods are used to define the averaging bins and sampling rate (see CPB, CPN and CPP parameters). In Raw mode, the CTD continuous sampling period (see CSP, CRS and CRD parameters) is used to sample measurements. The sampling type is used only during the Ascend state. Uncommon. Range: type: 0=binavg, 1=raw. [CST 1]

CPB <period> <depth boundary> = CTD Sensor period boundary. Configure the CTD sensor period for the specified depth boundary. This setting is only used when the sensor is configured for binavg (bin averaging) profiling mode (see CST command). Uncommon.

Ranges:

period: 1 to 3

Period 1 default depth_boundary: 2000 dbar

Period 2 default depth_boundary: 1000 dbar

Period 3 default depth_boundary: 250 dbar

depth_boundary: 0 to 65535 dbar

[CPB 1 1000]

CPN <period> <binsize> = CTD Sensor period bin size. Configure the CTD sensor period for the specified bin size. This setting is only used when the sensor is configured for bin average profiling mode (see CST command). The Seabird sensor family uses the CPN parameter directly. For the RBR sensor family the specified bin size parameter is divided by 10. For example, a value of 20 configures the float with a bin size of 2.0 dbar. For the RBR sensor family, setting the bin size to 0.0 disables bin averaging the data for that period. Uncommon.

Ranges:

period: 1 to 3

binsize: 0 to 65535 dbar / 10

RBR Defaults:

Period 1 default binsize: 2.0 dbar

Period 2 default binsize: 1.0 dbar

Period 3 default binsize: 1.0

Seabird Defaults:

Period 1 default binsize: 100 dbar

Period 2 default binsize: 50 dbar

Period 3 default binsize: 10 dbar

[CPN 2 20]

CPP <period> <sampling rate> = CTD Sensor period sampling rate. Configure the CTD sensor period for the specified sampling rate. This setting is only used when the sensor is configured for bin average profiling mode (see CST command). For the RBR sensor family, the sampling rate parameter is specified in milliseconds. For the Seabird sensor family, the sampling rate is specified in dbar. For the RBR sensor family, specific sampling rates must be used for certain configurations. These rates include 500(2Hz), 333(3Hz), 250(4Hz), 200(5Hz), 167(6Hz), and 83(12Hz). Not all sensors support all sampling rate configurations. Uncommon.

Ranges:

period: 1 to 3

sampling_rate: 0 to 65000 milliseconds

RBR Sensor Defaults

Period 1 default sampling period: 1000 ms

Period 2 default sampling period: 1000 ms

Period 3 default sampling period: 1000

Seabird Sensor Defaults

Period 1 default sampling period: 100 dbar

Period 2 default sampling period: 50 dbar

Period 3 default sampling period: 10 dbar

[CPP 3 2000]

CSP <period> = CTD Sensor continuous sampling period. Configure the CTD sensor for the specified sampling period during continuous mode. This setting is only used when the sensor is configured for Raw profiling mode (see CST command). Uncommon. Range: period: 0 to 86,400,000 milliseconds. [CSP 1000]

CRD <depth> = CTD Sensor profiling raw data depth set. Configure the CTD sensor raw data depth to collect samples. This command sets the starting depth for the system to return the raw profile samples from the sensor. The raw samples returned are from the CRD depth and shallower. This command is used along with the CRS number of samples parameter. The system must be configured for bin averaging mode with the CST parameter to enable raw samples to be returned. Uncommon. Range: depth: 0 – 3000 dbar. [CRD 50]

CRS <samples> = CTD Sensor profiling raw data samples set. Configure the CTD sensor raw profile data number of samples. This command sets the number of raw profile samples to return starting at the CRD depth. The raw samples returned are from the CRD depth and shallower. The system must be configured for bin averaging mode with the CST parameter to enable raw samples to be returned. NOTE: : If the CRS value is set to 0, the return of raw profile data is disabled. If the profile collects less than the specified CRS number of samples, the system returns the number of samples collected starting at the CRD specified depth. Uncommon. Range: samples: 0 – 2000. [CRS 0]

CTD = Dump pressure, temperature, and salinity data depending on sensor(s) installed. Command.

CTF <depth> = CTD Sensor cutoff depth set. Configure the CTD sensor profiling cutoff depth. The sensor halts profiling at the CTF depth. Note: The CTF parameter is only used for systems configured with the Seabird sensor. Factory-set - do not use. Range: depth: 0 – 1000 dbar. [CTF 2]

CTI <info> = Seabird CTD display info. Factory-set - do not use. Range: 0-setting,1-coefficient. Command. [CTI 1]

CTL <depth> = Seabird CTD Sensor reset lower limit set. Configure the CTD sensor reset lower limit depth. The sensor is reset if the surface pressure sample is beyond the range of the CTL and CTU limits. Factory-set - do not use. Range: depth: –10 to 10 dbar. [CTL 0]

CTP <pwr> <pro> = Get CTD pressure measurement. Factory-set - do not use. Command.

Ranges:

Power: pwr 0-off,1-on

Profiling: pro 0-disabled,1-enabled

[CTP 1 1]

CTT <pwr> <pro> = Seabird CTD get pressure, temperature measurement: power (0-off,1-on) profile (0-dis,1-en) . Command.

Ranges:

Power: pwr 0-off,1-on

Profiling: pro 0-disabled,1-enabled

[CTT 0 0]

CTU <depth> = Seabird CTD Sensor reset upper limit set. Configure the CTD sensor reset upper limit depth. The sensor is reset if the surface pressure sample is beyond the range of the CTL and CTU limits. Factory-set - do not use. Range: depth: –10 to 10 dbar. [CTU 2]

CTC <mode> = RBR-equipped floats only, CTD conductivity temperature mode set. Configure the CTD sensor's conductivity cell temperature mode. When enabled on, the system returns the cell's temperature measurements in addition to external temperature during profiling. Uncommon. Range: mode: 0 = off, 1 = on. [CTC 0]

LOG <mask> <time> = Log CTD and/or motion sensor data for the specified period of time. The CTD data is stored on the sensor device. The motion data is stored in on board memory. The CTD data is displayed on the screen using the CDD command. The motion data is displayed using the ACD command.   Command.

Ranges:

mask: 1 = p/t sensor, 2 = motion, 3 = all

time: 1 to 270 minutes

[LOG 3 10]

CTD (pressure, temperature, salinity) gain and offsets:

GAP <gain> = Gain pressure set. Set the pressure gain parameter for scaling pressure measurements. Uncommon. Range: gain: 0 – 65535. [GAP 25]

GAT <gain> = Gain temperature set. Set the temperature gain parameter for scaling temperature measurements. Uncommon. Range: gain: 0 – 65535. [GAT 1000]

GAS <gain> = Gain salinity set. Set the salinity gain parameter for scaling salinity measurements. Uncommon. Range: gain: 0 – 65535. [GAS 1000]

GSP <gain> = Gain surface pressure set. Set the surface pressure gain parameter for scaling surface pressure measurements. Uncommon. Range: gain: 0 – 65535. [GSP 25]

GSS <gain> = Gain surface salinity set. et the surface salinity gain parameter for scaling surface salinity measurements. Uncommon. Range: gain: 0 – 65535. [GSS 1000]

GST <gain> = Gain surface temperature set. Set the surface temperature gain parameter for scaling temperature measurements. Uncommon. Range: gain: 0 – 65535. [GST 1000]

OFP <offset> = Offset pressure set. Set the pressure offset parameter for scaling pressure measurements. Uncommon. Range: offset: 0 – 65535. [OFP 10]

OFT <offset> = Offset temperature set. Set the temperature offset parameter for scaling temperature measurements. Uncommon. Range: offset: 0 – 65535. [OFT 10]

OFS <offset> = Offset salinity set. Set the salinity offset parameter for scaling salinity measurements. Uncommon. Range: offset: 0 – 65535 [OFS 10]

OSP <offset> = Offset surface pressure set. Set the surface pressure offset parameter for scaling surface pressure measurements. Uncommon. Range: offset: 0 – 65535. [OSP 10]

OST <offset> = Offset surface temperature set. Set the surface temperature offset parameter for scaling surface temperature measurements. Uncommon. Range: offset: 0 – 65535. [OFT 10]

OSS <offset> = Offset surface salinity set. Set the surface salinity offset parameter for scaling surface salinity measurements. Uncommon. Range: offset: 0 – 65535. [OFS 10]

SGS <sensor type> <gain> = Sensor gain set. Set the sensor gain parameter for scaling sensor measurement data for transmission. Uncommon.

Ranges:

sensor_type: 0 – 255

0: PAR

1: IMU

2: ODO

3: TCM

4-255: RESERVED

gain: 0 – 65535

[SGS 0 1000]

SOS <sensor type> <gain> = Sensor offset set. Set the sensor offset parameter for transmission. Uncommon. Ranges:

sensor_type: 0 – 255

0: PAR

1: IMU

2: ODO

3: TCM

4-255: RESERVED

gain: 0 – 65535

[SOS 0 5]

Accelerometer parameters:

ACD = Display the logged data from the motion sensor. Command.

ACF = Display accelerometer readings to the CLI. Press Escape (Esc) to exit the accelerometer reading loop. Command.

ACL <mode> <time> = Display motion data readings to the screen and log the data. Press Escape (Esc) to exit the accelerometer reading loop. Factory-set - do not use.

Ranges:

mode: 1 = average, 2 = delta

time: 1 to 270 minutes

[ACL 1 12]

MAM <mode bit mask> = Mission motion sensor mode mask. Defines the state to collect accelerometer data. The valid values for the mode bitmask are a combination of the following:

0 = disabled

1 = surface state

2 = descend state

4 = park state

8 = ascend state

In the surface state, raw motion data is stored and returned. In non-surface states, the data is averaged and stored based on the MAT and MAP parameters settings. Uncommon.

[MAM 1]

ACA <scale factor> = Motion sensor accelerometer scale factor. Configure the motion processor accelerometer scale factor. This value is translated into a setting for the accelerometer configuration register (ACCEL_CONFIG bits AFS_SEL[1:0]). Uncommon. Range: scale factor: 2, 4, 8, 16 g. [ACA 2]

ACG <scale factor> = Motion sensor gyroscope scale factor. Configure the motion processor gyroscope scale factor. This value is translated into a setting for the gyroscope configuration register (GYRO_CONFIG bits FS_SEL[1:0]). Uncommon. Range: scale factor: 250, 500, 1000, 2000°/s. [ACG 250]

ACR <rate> <averaging rate> = Motion sensor accelerometer sample and averaging rates. Configure the motion processor sample rate. This value is programmed into the SMPRT_DIV register (SMPLRT_DIV[7:0]). Uncommon.

Ranges:

rate: 4 to 250 Hz

averaging_rate: 1 to 10 Hz

[ACR 4 1]

MAP <period timeout> = Mission motion sensor period. Defines the time between each storage interval defined with the MAT parameter. IMPORTANT: The current MFA is currently capable of storing approximately 5 minutes of accelerometer data regardless of the MAT settings. If configured to store more data than allowed, the system will store up to its maximum. Uncommon. Range: period_timeout: 0 to 36,000 seconds. [MAP 60]

MAT <intervals> <timeout> = Mission motion sensor timeout. Defines the number of intervals and time duration to collect motion sensor data. IMPORTANT: The current MFA is currently capable of storing approximately 5 minutes of accelerometer data regardless of the MAT settings. If configured to store more data than allowed, the system will store up to its maximum. Uncommon.

Ranges:

intervals: 0 to 500,000

timeout: 0 to 36,000 seconds

[MAT 1 300]

LOG <mask> <time> = Log CTD and/or motion sensor data for the specified period of time. The CTD data is stored on the sensor device. The motion data is stored in on board memory. The CTD data is displayed on the screen using the CDD command. The motion data is displayed using the ACD command.   Command.

Ranges:

mask: 1 = p/t sensor, 2 = motion, 3 = all

time: 1 to 270 minutes

[LOG 3 10]

<u>Mission parameters:</u>

MPS <phase> = Current mission phase. Specifies the currently executing mission phase. The firmware uses this parameter to track which mission phase and parameters are currently loaded for operation. Uncommon use. Range: phase: 0 – 2 [MPS 0]

MPC <cycles> Cycle count for current mission phase. Specifies the current cycle count for the executing mission phase. The firmware uses this parameter to track which the number of cycles executed for the current phase. The value is reset to 0 when a new phase is loaded. Uncommon use. Range: cycles: 0 – 50,000 [MPC 0]

MNM <phase> <cycles> = Number of cycles for mission phase. Configures the number of cycles to execute for the specified mission phase. Once the system performs the number of cycles, the next mission phase is loaded according to the MNS parameter. Uncommon use. Range: phase: 0 – 2; cycles: 0 – 50,000 [MNM 0 12]

MNS <phase> <next_phase> = Next mission phase. Configures the next phase to execute for the specified mission phase. Once the system performs the number of cycles (MNM), the next mission phase is loaded. Uncommon use. Range: phase: 0 – 2; next_phase: 0 – 2 [MNS 0 1]

MTT <timeout> = Mission initial trigger timeout. Defines the initial sleep interval for checking the start of a mission. Factory-set - do not use. Range: timeout: 0 to 36000000 milliseconds. [MTT 30000]

MTD <depth> = Mission initial trigger depth. Defines the initial depth to start the float mission operation. Uncommon. Range: depth: Range: depth: 0 to 2000 dbar (ALTO); 0 to 1200 dbar (ALAMO). [MTD 5]

MTS <timeout> = Mission initial trigger start timeout. Defines the initial wait time before automatically starting a mission. If the float does not sense the trigger depth (MTD) before MTS expires, the system initiates the diagnostic dive and begins its mission operation. Common. Range: timeout: 0 to 31,536,000 seconds (365 days). [MTS

86400]

MSN <mission number> = Defines the mission dive operation the system has completed. The mission number is incremented by one each time a new mission is started. Factory-set - do not use. Range: mission number: 0 to 10000 [MSN 0]

Descent parameters:

MDS <depth> = Maximum Depth. Maximum depth used during the Descend state to transition to the Ascend state. The maximum depth is checked after the fall stage. During the calibration stage, if the maximum depth pressure reading is exceeded, the float transitions into the Ascend state. IMPORTANT: The maximum depth (MDS) should not be set below the specified float supported system depth. Factory-set - do not use. Range: depth: 0 to 3000 dbar. Default ALAMO: 1200 ALTO: 2000. [MDS 500]

DTD <phase> <depth> = Descent target depth. Configure the target depth for the Descend state. Common.

Ranges:

phase: 0 – 2

depth: 0 – 3000 dbar

[DTD 1 500]

Diagnostic dive parameters:

DDB <mode> = Diagnostic dive bypass. Configure to execute or bypass diagnostic dive. If enabled (1), the diagnostic dive is not executed and the first mission starts after deployment. Uncommon use. Range: mode: 0 = execute diagnostic dive, 1 = bypass diagnostic dive. [DDB 0]

DDC <timeout> = Descend diagnostic calibration timeout. This value sets the amount of time to wait after the initial fall pump timeout completes for the diagnostic dive. Factory-set - do not use. Range: time: 0 to 36000 seconds. [DDC 0]

DDF <timeout> = Descend diagnostic fall timeout. This value sets the amount of time for the pump to run during the diagnostic dive. Factory-set - do not use. Range: time: 0 to 36000 seconds. [DDF 300]

DDP <depth> = Configure the Descend diagnostic start depth. This parameter sets the depth when the float transitions from the start stage to the fall stage during the diagnostic mission cycle. For the diagnostic mission, the start depth is used along with the DDS parameter. If the start timeout is exceeded prior to the start depth being passed, the float transitions to the fall stage during the diagnostic mission cycle. Factory-set - do not use. Range: depth: 0 to 2000 dbar (ALTO); 0 to 1200 dbar (ALAMO). [DDP 1200]

DDS <timeout> = Configure the Descend diagnostic start timeout. This parameter sets the timeout when the float transitions from the start stage to the fall stage during the diagnostic dive mission. This parameter is used if the float does not exceed the DDP during the diagnostic mission cycle. Factory-set - do not use. Range: timeout: 0 to 36000 seconds. [DDS 3600]

DDD <depth> = Configure the Descend depth storage interval. The depth storage interval is used for the three different stages of the Descend state. The float stores data during the Descend state based on a depth change or based on a timeout period (DDT command). If the depth change specified with this command is exceeded, the sensor data is stored. NOTE: The depth storage interval affects the amount of data stored and subsequently the amount data transmitted over the satellite during the Surface state. It is also important to understand that a limited buffer is available to store the Descend sensor data. Setting the depth storage interval affects the data stored during the different stages of descent during a mission. Uncommon. Range: depth: 0 to 2000 dbar (ALTO); 0 to 1200 dbar (ALAMO). [DDD 10]

DDT <timeout> = Configure the Descend timeout storage interval. The depth storage interval is used for the three different stages of the Descend state. The float stores data during the Descend state based on a depth change (DDD) or based on a timeout period. If the timeout interval elapses since the last storage event, the sensor data is stored. The data storage timeout must be a multiple of the Descend state sampling interval (DSI). NOTE: The timeout storage interval affects the amount of data stored and subsequently the amount of data transmitted over the satellite during the Surface state. It is also important to understand that a limited buffer is available to store the Descend sensor data. Setting the timeout storage interval affects the data stored during the different stages of descent during a mission. Uncommon. Range: timeout: 0 to 36000 seconds. [DDT 720]

DFT <phase> <timeout> = Configure the Descend fall timeout. The fall timeout controls the pump time during the Descend state. The fall timeout affects the target depth reached by the float during the Descend state. When calibration mode is enabled (DCM), the float adjusts the fall timeout to accurately achieve its specified target depth. The fall timeout must be a multiple of the Descend state sampling interval (DSI). Common.

Ranges:

phase: 0 – 2

timeout: 0 to 36000 seconds

[DFT 0 85]

DNS <descend_number> = Specifies the Descend state number. The descend number is incremented by one each time a new Descend state is started. Factory-set - do not use. Range: descend_number: 0 to 10000. [DNS 0]

DRA <rate> = Configure the Descend rate. This parameter is used in the calculation for descending from depth and is executed in the Park state. This value sets the fall rate when the valve is opened for descending. NOTE: Care should be taken when configuring this parameter. Improper configuration could affect the standard operation of the float. Factory-set - do not use. Range: rate: 0 to 1000 dbar/sec. [DRA 20]

DSD <phase> <depth> = Configure the Descend state start depth. This parameter sets the depth when the float transitions from the start stage to the fall stage in the Descend state. The start depth is used along with the Descend start timeout (DST) parameter. If the start timeout is exceeded prior to the start depth being passed, the float transitions to the fall stage. Common. Range: depth: 0 to 2000 dbar (ALTO); 0 to 1200 (ALAMO). [DSD 1 50]

DSI <timeout> = Configure the Descend state sampling interval timeout. The sampling interval is used by each of the different stages during the Descend state. The other stage timeout values must be a multiple of this sampling interval. Uncommon. Range: timeout: 1 to 36000000 milliseconds. [DSI 10000]

DST <phase> <timeout> = Configure the Descend start stage timeout. This parameter sets the timeout when the float transitions from the start stage to the fall stage in the Descend state. The start timeout is used along with the Descend start depth (DSD) parameter. If the start depth is passed prior to the start timeout being exceeded, the float transitions to the fall stage. The calibration timeout must be a multiple of the Descend state sampling interval (DSI). Common.

Ranges:

phase: 0 – 2

timeout: 0 to 36000 seconds

[DST 2 2700]

PFC <rate> = Configure the Descend pump rate. This parameter is used in the cal calibration algorithm. Factory-set - do not use. Range: rate: 1 to 1000000 / 1000 cc/dbar. [PFC 16]

PFR <rate> = Configure the Descend pump rate. This parameter is used in the cal calibration algorithm. Factory-set - do not use. Range: rate: 1 to 100000 cc/min. [PFR 19]

<u>Descent seek/calibration parameters:</u>

DCT <phase> <timeout> = Descend calibration timeout. This value sets the amount of time to wait after the initial fall pump timeout completes. Common.

Ranges:

phase: 0 – 2

timeout: 0 to 36000 seconds

[DCT 1 3600]

DAL <algorithm> = Descend calibration algorithm. Configure the Descend calibration algorithm. Uncommon. Range: algorithm: 0 = cal, 1 = seek. [DAL 1]

DCA <attempts> = Descend calibration attempts. Configure the Descend calibration attempts. Sets the number of attempts the float executes the specified calibration algorithm during the Descend state. Uncommon. Range: attempts: 0 to 10000. [DCA 3]

DCM <mode> = Descend calibration mode. Configure the Descend calibration mode. Enable or disable the calibration mode. If disabled, the float will wait for DCT seconds before transitioning to the Park state. Common. Range: mode: 0 = off, 1 = on [DCM 1]

DCF <timeout> = Descend seek minimum valve time. Configure the Descend minimum valve open time. This value is used in the seek calibration algorithms. Factory-set - do not use. Range: timeout: 0 to 36000 seconds. [DCF 5]

DCP <timeout> = Descend seek minimum pump time. Configure the Descend minimum pump time. This value is used in the seek calibration algorithms. Factory-set - do not use. Range: timeout: 0 to 36000. [DCP 5]

DCX <timeout> = Descend seek maximum pump time. Configure the Descend maximum pump time. This value is used in the seek calibration algorithms. NOTE: The maximum pump time value should not need to be altered in normal operation. Modifying this parameter could affect the performance of the float. Factory-set - do not use. Range: timeout: 0 to 36000 seconds. [DCX 1020]

DSW <timeout> = Descend seek wait timeout. Configure the Descend seek wait timeout. This value sets the amount of time to wait after each seek algorithm completes. The float waits for DSW seconds even if the seek algorithm does not adjust the float via pumping or opening its valve. Uncommon. Range: timeout: 0 to 36000 seconds. [DSW 3600]

DUC <value> = Descend seek underdamp control. Configure the Descend seek underdamp control. This value is used in the seek calibration algorithm. Factory-set - do not use. Range: value: 0 to 10000 / 100. [DUC 100]

DPD <time> = Descend seek pump down time. Configure the Descend seek pump down time. This value is used in the seek calibration algorithm. The value is the pump time to halt the float from rising. Factory-set - do not use. Range: time: 0 to 36000 seconds. [DPD 5]

DPT <time> = Descend seek pump time. Configure the Descend seek pump time. This value is used in the seek calibration algorithm. The value is the pump time to move the float 100m upward. Factory-set - do not use. Range: time: 0 to 36000 seconds. [DPT 5]

DUT <time> = Configure the Descend seek valve open time. This value is used in the seek calibration algorithm. The value is the valve open time to move the float 100m downward. Factory-set - do not use. Range: time: 0 to 36000 seconds. [DUT 5]

DVT <time> = Configure the Descend seek velocity delay time. This value is used in the seek calibration algorithm. The value is used for the delay between pressure measurements to calculate the float velocity. Factory-set - do not use. Range: time: 0

to 36000 seconds. [DVT 30]

DVD <depth> = Configure the Descend seek valve depth delta. This value is used in the seek calibration algorithm. The value determines the depth delta change for determining if a seek valve event has caused the system to descend passed the depth delta to adjust the descend fall pump time (DFT). This parameter is intended to prevent adjustment to DFT if the system is seeking while it is unable to descend to the Descend target depth. This parameter is used in conjunction with DVW. Factory-set - do not use. Range: depth: Range: depth: 0 to 2000 dbar (ALTO); 0 to 1200 dbar (ALAMO). [DVD 25]

DVW <time> = Configure the Descend seek valve wait time. This value is used in the seek calibration algorithm. The value determines the amount of time to wait after a valve event performed during the seek algorithm for determining if a seek valve event has caused the system to descend to adjust the descend fall pump time (DFT). This parameter is intended to prevent adjustment to DFT if the system is seeking while it is unable to descend to the Descend target depth. This parameter is used in conjunction with the DVD. Factory-set - do not use. Range: time: 0 to 36000 seconds. [DVW 600]

DCR <time> = Descend calibration rate time. This value is used in the cal algorithms. Factory-set - do not use. Range: time: 0 to 36000 seconds. [DCR 0]

Park parameters:

PDT <timeout> = Configure the Park timeout storage interval. If the timeout interval elapses since the last storage event, the sensor data is stored. The data storage timeout must be a multiple of the Park state sampling interval (PSI). NOTE: The timeout storage interval affects the amount of data stored and subsequently the amount of data transmitted over the satellite during the Surface state. It is also important to understand that a limited buffer is available to store the Park sensor data. Setting the timeout storage interval affects the data stored during the different stages of descent during a mission. Common. Range: timeout: 0 to 36000 seconds. [PDT 3600]

PFM <phase> <mode> = Configure the Park state descend fall mode. This enables the float to descend to a lower depth after exiting the Park state to start profiling during the Ascend state. Common.

Ranges:

phase: 0 – 2

mode: 0 = off, 1 = on

[PFM 0 0]

PFD <phase> <depth> = Configure the Park state descend fall depth. This sets the depth for the float to descend to after exiting the Park state to start profiling during the Ascend state. The park fall mode (PFM) must be enabled to for the float to use this parameter. Common.

Ranges:

phase: 0 – 2

depth: 0 to 2000 dbar (ALTO); 0 to 1200 dbar (ALAMO)

[PFD 0 1200]

PFT <phase> <timeout> = Configure the Park state fall timeout. When the float is configured to fall from its descend target depth (DTD) by enabling PFM, this parameter is a safety value when the float is descending to its profile depth (PFD). Common.

Ranges:

phase: 0 – 2

timeout: 1 to 36000 seconds

[PFT 1 3600]

PFV <phase> <timeout> = Configure the Park state fall valve timeout. Typically the PFD parameter is used to fall to the profile depth. This parameter allows for overriding the calculated park fall to profile depth value. If this value is greater than 0, it overrides the PFD calculated value. Common.

Ranges:

phase: 0 – 2

timeout: 1 to 36000 seconds

[PFV 0 30]

PNS <park_number> = Configure the Park state number. The park number is incremented by one each time a new Park state is started. Factory-set - do not use. Range: park_number: 0 to 10000. [PNS 0]

PSA <mode> = Configure the Park state sampling mode Uncommon. Range: mode: 0 = average, 1 = raw. [PSA 1]

PSI <timeout> = Configure the Park state sampling interval timeout. The sampling interval is used by Park state to query the sensor data. Uncommon. Range: timeout: 1 to 36000000 milliseconds. [PSI 300000]

PSM <mode> = Configure the Park state seek mode. Enable or disable the seek algorithm executing in the Park state. Uncommon. Range: mode: 0 = off, 1 = on. [PSM 1]

PSD <depth> = Configure the Park state seek delta depth. When the Park seek is enabled with the PSM parameter, this value determines when to run the seek algorithm during the Park state. This parameter is used along with the PST parameter. If the float depth delta during the Park state is greater than or equal to the PSD depth, the float executes the seek algorithm. Otherwise, the seek algorithm is executed on the PST interval. Uncommon. Range: depth: 0 to 2000 dbar (ALTO); 0 to 1200 dbar (ALAMO). [PSD 1200]

PST <timeout> = Configure the Park state seek timeout. This determines the interval for running the seek algorithm during the Park state. This value is used along with the PSD parameter. Uncommon. Range: timeout: 0 to 36000 seconds. [PST 3600]

PSV <time> = Configure the Park seek velocity delay time. This value is used in the seek calibration algorithm. The value is used for the delay between pressure measurements to calculate the float velocity. Factory-set - do not use. Range: timeout: 0 to 36000 seconds. [PSV 30]

PSW <timeout> = Configure the Park seek wait timeout. This value sets the amount of time to wait after each seek algorithm completes. The float waits for PSW seconds even if the seek algorithm does not adjust the float via pumping or opening its valve. NOTE: The park seek wait timeout executes regardless of the timeouts of the PTH or PTO parameters. PTH and PTO do not override or halt the PSW timeout. Factory-set - do not use. Range: timeout: 0 to 36000 seconds. [PSW 1800]

PTD <date> <time> = Configure the Park state date/time timeout. The date and time to exit from the Park state, which is a single use parameter for the subsequent mission cycle. The parameter is set to 0 after completion of exiting from the Park state. NOTE: The PTD parameter is reset to 0 once it has been used in the park state. Setting the PTD value overrides the PTH and PTO parameters. Uncommon.

Ranges:

date: YYYYMMDD

time: HHMMSS

[PTD 20190611 091200]

PTH <phase> <hour bit mask> = Configure the Park state timeout hour. This determines the length of time for the Park state. The bitmask parameter allows setting of one or more hour increments to exit the Park state. Each bit in the parameter field defines an hour (from 00:00 to 23:00) for the float to exit its Park state, allowing synchronization of different floats. Multiple Park state exit hours can be specified by combining these in the bitmask hour parameter. NOTE: Setting the PTH value overrides the PTO parameter. Setting PTD overrides the PTH parameter setting. Common.

Ranges:

phase: 0 – 2

hour_bit_mask:

```
typedef enum {
  UTC_0 = 1 << 0,    // 1
  UTC_1 = 1 << 1,    // 2
  UTC_2 = 1 << 2,    // 4
  UTC_3 = 1 << 3,    // 8
  UTC_4 = 1 << 4,    // 16
  UTC_5 = 1 << 5,    // 32
  UTC_6 = 1 << 6,    // 64
  UTC_7 = 1 << 7,    // 128
  UTC_8 = 1 << 8,    // 256
```

```
  UTC_9 = 1 << 9,   // 512
  UTC_10 = 1 << 10, // 1024
  UTC_11 = 1 << 11, // 2048
  UTC_12 = 1 << 12, // 4096
  UTC_13 = 1 << 13, // 8192
  UTC_14 = 1 << 14, // 16384
  UTC_15 = 1 << 15, // 32768
  UTC_16 = 1 << 16, // 65536
  UTC_17 = 1 << 17, // 131072
  UTC_18 = 1 << 18, // 262144
  UTC_19 = 1 << 19, // 524288
  UTC_20 = 1 << 20, // 1048576
  UTC_21 = 1 << 21, // 2097152
  UTC_22 = 1 << 22, // 4194304
  UTC_23 = 1 << 23, // 8388608
} Park_Times;
```

[PTH 64] (this would be 0600UTC)

[PTH 5] (this would be 0000UTC (1) and 0200UTC (4))

PTO <phase> <timeout> = Configure the Park state timeout. This determines the length of time for the Park state. NOTE: Setting the PTH or PTD parameters overrides the PTO parameter. Common.

Ranges:

phase: 0 – 2

timeout: 1 to 864,000 seconds

[PTO 1 64000]

<u>Ascent parameters:</u>

ADD <depth> = Configure the Ascend depth storage interval. The depth storage interval is used for the stages of the Ascend state. The float stores data during the Ascend state based on a depth change or based on a timeout period (ADT command). If the depth change specified with this command is exceeded, the sensor data is stored. NOTE: The depth storage interval affects the amount of data stored and subsequently the amount data transmitted over the satellite during the Surface state. It is also important to understand that a limited buffer is available to store the Ascend sensor data. Setting the depth storage interval affects the data stored during the different stages of ascent during a mission. Uncommon. Range: depth: 0 to 2000 dbar (ALTO); 0 to 1200 dbar (ALAMO). [ADD 20]

ADT <timeout> = Configure the Ascend timeout storage interval. The depth data storage interval is used for the stages of the Ascend state. The float stores data during the Ascend state based on a depth change (ADD) or based on a timeout period. If the timeout interval elapses since the last storage event, the sensor data is stored. The data storage timeout must be a multiple of the Ascend state sampling interval (ASI). NOTE: The timeout storage interval affects the amount of data stored and subsequently the amount of data transmitted over the satellite during the Surface state. It is also important to understand that a limited buffer is available to store the Ascend sensor data. Setting the timeout storage interval affects the data stored during the different stages of ascent during a mission. Uncommon. Range: timeout: 0 to 36000 seconds. [ADT 660]

APF <timeout> = Configure the Ascend state pump off time. During the Ascend state, the oil pump is run in intervals to conserve power while ascending to the surface. The pump off interval determines the amount of time the float waits after a pump on time (APN). The pump off timeout must be a multiple of the Ascend state sampling interval (ASI). Factory-set - do not use. Range: timeout: 0 to 36000 seconds. [APF 20]

APM <timeout> = Configure the Ascend state maximum pump time. NOTE: This value should not be modified in normal operation. Altering this value could cause the oil pump to run dry. Factory-set - do not change. Range: timeout: 0 to 36000 seconds. [APM 1020]

APN <timeout> = Configure the Ascend state pump on time. During the Ascend state, the oil pump is run in intervals to conserve power while ascending to the surface. The pump on interval determines the amount of time the float runs the pump after the off time (APF). The maximum pump time is configured by the APM command. The pump on timeout must be a multiple of the Ascend state sampling interval (ASI). Uncommon. Range: timeout: 0 to 36000 seconds. [APN 50]

APS <timeout> = Configure the initial Ascend state pump on time. During the Ascend state, the oil pump is run in intervals to conserve power while ascending to the surface. The initial pump on interval determines the amount of time the float runs the pump the initial pump interval. The maximum pump time is configured by the APM command. The pump on timeout must be a multiple of the Ascend state sampling interval (ASI). Common. Range: 0 to 36000 seconds. [APS 150]

ARC <rate_calc> = Configure the Ascend state rise rate calculation adjustment. NOTE: The specified halt rise rate parameter is divided by 10. This value should not need to be altered in normal operation. Factory-set - do not change.

Range: rate_calc: 1 to 1000 / 10

RBR sensor system: default 1.4

Seabird sensor system: default 4.5

ARR <rate> = Configure the Ascend state rise rate. Uncommon. Range: rate: 1 to 20 cm/sec. [ARR 10]

ASD <depth> = Configure the Ascend state surface depth threshold. This parameter sets the depth when the float transitions from the Ascend state to the Surface state. NOTE: Care must be taken when setting the surface depth threshold to ensure proper operation of the float during a mission. The granularity of the depth threshold can cause conditions where the sensor readings prevent transition to the surface state. Uncommon. Range: depth: 0 to 2000 dbar (ALTO); 0 to 1200 dbar (ALAMO). [ASD 2]

AHD <depth> = Configure the Ascend state halt depth threshold. This parameter sets the depth delta if the float is unable to reach the surface through its normal pump cycling. If the float passes the surface depth threshold (ASD) plus AHD, the float calculates its rise rate to determine if it should transition to the Surface state. NOTE: This parameter is used for a catastrophic state where the float is unable to reach the surface through its normal operation. This parameter is used along with the Ascend state halt rise rate parameter (AHR). Factory-set - do not use. Range: depth: 0 to 2000 dbar (ALTO); 0 to 1200 dbar (ALAMO). [AHD 10]

AHR <rate> = Configure the Ascend state halt rise rate. This parameter sets the rise rate if the float is unable to reach the surface through its normal pump cycling. If the float passes the surface depth threshold (ASD) plus AHD, the float calculates its rise rate to determine if it should transition to the Surface state. NOTE: The specified halt rise rate parameter is divided by 10. This parameter is used for a catastrophic state where the float is unable to reach the surface through its normal operation. This parameter is used along with the Ascend state halt depth threshold parameter (AHD). Factory-set - do not use. Range: rate: 0 to 1000 / 10 cm/sec. [AHR 12]

ASI <timeout> = Configure the Ascend state sampling interval timeout. The sampling interval is used by the stages during the Ascend state. The other stage timeout values must be a multiple of this sampling interval. Uncommon. Range: timeout: 1000 to 36000000 milliseconds. [ASI 1000]
ASN <ascend number> = Configure the Ascend state number. The ascend number is incremented by one each time a new Ascend state is started. Factory-set - do not use. Range: ascend_number: 0 to 10000. [ASN 0]

<u>Surface parameters:</u>

SAM <mode> = Configure the Surface state air assist mode. Enable/disable the air assist system. Factory-set - do not use. Range: mode: 0 = off, 1 = on. [SAM 1]

SAO <timeout> = Configure the Surface state air assist timeout. Factory-set - do not use. Range: timeout: 0 to 36000 seconds. [SAO 360]

SAP <timeout> = Configure the Surface state air assist maximum timeout. Factory-set - do not use. Range: timeout: 0 to 36000 seconds. [SAP 600]

SAN <pressure> = Configure the Surface state air assist minimum pressure value. Factory-set - do not use. Range: pressure: 0 to 100 / 10 psi. [SAN 65]

SAX <pressure> = Configure the Surface state air assist maximum pressure value. Factory-set - do not use. Range: pressure: 0 to 100 / 10 psi. [SAX 75]

SBM <mode> = Configure the Surface state beacon mode. In beacon mode, the float transmits GPS data and listens for incoming remote command messages. The rate of transmission and listening for remote commands is specified by the beacon mode timeout (SBT). Beacon mode can be exited with a remote command. Common. Range: mode: 0 = off, 1 = on. [SBM 0]

SBT <timeout> = Configure the Surface state call-in interval timeout. The beacon mode timeout is only used when beacon mode (SBM) is enabled. Common. Range: timeout: 0 to 36000 seconds. [SBT 3600]

SDC <depth compensation> = Configure the surface sensor depth compensation for the sensor. The surface depth compensation is added to the sensor readings to compensate for the surface pressure. Factory-set - do no use. Range: depth compensation: –20 to 20 dbar. [SDC -10]

SDS <timeout> = Configure the Surface state data timeout storage interval. This timeout interval determines the rate at which data is stored during the Surface state. NOTE: The timeout storage interval affects the amount of data stored and subsequently the amount of data transmitted over the satellite during the Surface state. It is also important to understand that a limited buffer is available to store the Surface sensor data. Setting the timeout storage interval affects the data stored during the different stages of surface during a mission. Uncommon. Range: timeout: 0 to 36000 seconds. [SDS 60]

SET <timeout> = Configure the Surface state satellite transmission and reception timeout. During the Surface state, the float attempts to send all data and check for any incoming messages for the specified timeout period. If the satellite timeout is set to zero, no satellite transmissions or receptions are attempted. Uncommon. Range: timeout: 0 to 255 minutes. [SET 10]

SFN <surface number> = Configure the Surface state number. The surface number is incremented by one each time a new Surface state is started. Factory-set - do not use. Range: surface number: 0 to 10000. [SFN 0]

SGT <timeout> = Configure the Surface state GPS timeout. During the Surface state, the float attempts obtain a GPS fix for the specified timeout period. If the satellite timeout is set to zero, no GPS fix is attempted. Uncommon. Range: timeout: 0 to 50 minutes. [SGT 10]

SPT <timeout> = Configure the Surface state sensor data storage timeout. This value determines the amount of time the float collects surface sensor measurements after the air assist mode completes. Factory-set - do not use. Range: timeout: 0 to 36000 seconds. [SPT 600]

SSI <timeout> = Configure the Surface state sampling interval timeout. Uncommon. Range: timeout: 1 to 36000000 milliseconds. [SSI 10000]

SSP <timeout> = Configure the Surface state sensor sampling delay. Once the float reaches the Surface state, this timeout sets the amount of time to continue with profile sampling and running the oil pump. Uncommon. Range: timeout: 0 to 36000 seconds. [SSP 20]

<u>Deprecated or soon to be:</u>

DRT <timeout> = Seek calibration adjustment timeout. NOTE: This value is used by the float to track seek calibration adjustments. Range: timeout: 0 to 36000 seconds. [DRT 0]

MID = Mission info display: (0=reset)

MTC <mode> = Mission initial trigger check mode. Enables or disables the initial trigger depth checking. Factory-set - do not use. Range: mode: 0 – disabled, 1 – enabled. [MTC 1]

SER = Serial passthrough mode. Command. Enables Pilot to talk with the serial devices.

STM - Satellite text message mode - command.

Appendix D - Sample Mission File

```
// 4-25-2019
//
// Mission Testing
// Serial number: 11081
// IMEI: 300234067248100
//
// Goal: Enable Beacon Mode
//      Dive to 10 dbar
//      No Parking
//          Start pumping at 2 dbar for 30 seconds (10 cc)
//          Then pump for 900 seconds (300 cc) to hit the surface (1 dbar);
//          Then pump for 120 seconds (40 cc) for surface position;
//      Inflate the external buoyancy aid via the air-assist motor
//          Change range of air pressures to achieve

//=========================================
// General Settings
//=========================================
// Reset the parameters to their default values
MIC 99
// Start the mission at 2 dbar
MTD 2
// Start the mission after 2 hours from the end of the BIST
MTS 7200
// Check pressure and time every second
MTT 1000

//=========================================
// Descend state configuration commands
//=========================================
```

```
// Skip Diagnostic Dive
DDB 1

//========================================
//   10 dbar target pressure
//========================================
// 10 dbar target pressure
DTD 0 10
// Start pumping at 2 dbar
DSD 0 2
// Start pumping after 1 hour if we haven't hit the 2 dbar threshold
DST 0 3600
// Pump for 30 seconds (30 seconds * 0.3 cc/s = 10 cc)
// -> Our intention is to stick on the bottom to station-keep
DFT 0 30
// Wait for 2 minutes to fall to the park depth
// -> At 15 cm/s this should be enough time to hit 10 dbar
DCT 0 120
// Disable seeks during the descent
DCM 0
// Store data every 1 dbar or every 5 minutes
DDD 1
DDT 300

//========================================
// Park state configuration commands
//========================================
// Don't park at the bottom
PTO 0 0

// Other Park Settings
```

```
// If we want to park for an hour:
// PTO 0 3600

// If we want to profile 2 times a day, at particular times we could do this:
// -> Leave park at 7am EST (11:00 UTC) AND 5pm EST (21:00 UTC)
// PTH 0 2099200

// Don't fall to a deeper profile depth, and disable seeks
PFM 0 0
PSM 0

//=====================================
// Ascend state configuration commands
//=====================================
// Initial pump time of 900 seconds (900 seconds * 0.3 cc/s = 300 cc)
APS 900
// Finish the ascent once we cross 1 dbar
// -> Run the SSP (Oil) pump and the SAP (Air) pump time intervals
ASD 1
// Set a target rise rate of 30 cm/s (fast!)
ARR 30
// On the ascent, when controlling for speed, turn the pump on for 30 seconds,
// and off for 5 seconds
APN 30
APF 5
// Maximum amount of time to run the pump (40 minutes) (2400 seconds * 0.3 cc/s >
700 cc)
APM 2400
// Store data every 1 dbar or every 5 minutes
ADD 1
ADT 300
```

```
//========================================
// Surface state configuration commands
//========================================
// Run the oil pump at the surface for 2 minutes (120 seconds * 0.3 cc/s = 40 cc)
SSP 120
// Enable Beacon Mode
SBM 1
// Sample pressure every 15 seconds
SSI 15000
// Enable Air Pump at the Surface
SAM 1
// Run the Air Pump for a minimum of 15 minutes
SAO 900
// Run the Air Pump for a maximum of 20 minutes
SAP 1200
// Minimum Air Pressure Target of 1 psi
SAN 10
// Maximum Air Pressure Target of 2 psi
SAX 20
// Disable science data sampling at the surface
SPT 0

//========================================
// Save the commands and Re-transmit
//========================================
MIC 1
MIC 2
```