MRV SOLO S2-A Float

User Manual

MRV Systems

6370 Lusk Blvd
Suite #F100
San Diego, California 92121

800.645.7114
FAX: 858.952.5935

www.mrvsys.com

PN958529

MRV SYSTEMS

Marine Robotic Vehicles

Address

6370 Lusk Blvd

Suite #F100

San Diego, CA 92121

Website

http://www.mrvsys.com

General Contact Information

Main: (800) 645-7114

Fax: (858) 952-5935

Table of Contents

Section 1: Health, Safety, & Warranty

The MRV SOLO family of floats is 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.

Maximum Pressure

The SOLO S2-A float operates to a maximum pressure of 2,000 dBar. If the user will be exposing the SOLO S2-A float to significant hydrostatic pressure or will be re-programming the mission parameters, contact MRV Systems in advance to confirm you will not compromise float functionality.

Handling

The S2-A is a high precision instrument and it is important that it is handled with care. Avoid any scratches to the painted or anodized surfaces; this may compromise the durability and/or longevity of the float after deployment in the ocean.

Hazardous Materials

The S2-A contains a hazardous material:

- Seabird CTD sensor package containing Bis (tributyltin) oxide

The most recent Materials Safety Data sheet for the Seabird CTD is available from the manufacturer using the link below.

- Sensor package containing Bis (tributyltin) oxide
  http://www.seabird.com/pdf_documents/msds_sheets/801347_AF24173MSDSrevised01-28-10.pdf

The user must accept responsibility to deal with any risks associated with the use of this instrument safely as is outlined in the documentation provided. Only personnel with knowledge and training to deal with this risk should operate the instrument.

Section 2: About the MRV SOLO Float

Operational Overview

The SOLO family of floats is an unmanned, autonomous, underwater, battery-powered vehicle that is designed to measure the temperature and salinity of the ocean. This is a Lagrangian drifter, so it cannot control the direction of travel. It can only control its buoyancy and thereby its depth. To change buoyancy, the float pumps oil to an external bladder thus changing volume. It is equipped with a Seabird SBE41CP sensor package that will generate a temperature and salinity profile as the float ascends to the surface. The float also contains an on-board GPS receiver, to provide a precise location for profile data. The data generated by the float can be easily integrated into the ARGO database.

The operational code for the controller is programmed onto the on-board Flash memory prior to delivery. Since the SOLO float is an autonomous vehicle, the parameters of its dive mission must be programmed prior to shipment. These parameters determine the dive profile, frequency of the measurements, as well as various control parameters. The Mission Parameters are stored locally in an internal EEPROM. Each Mission Parameter has an ASCII name (up to 6 characters) and a 16 bit numeric value. Refer to *Section 8: Understanding the MRV SOLO Float Dive Profile and Mission Parameters*.

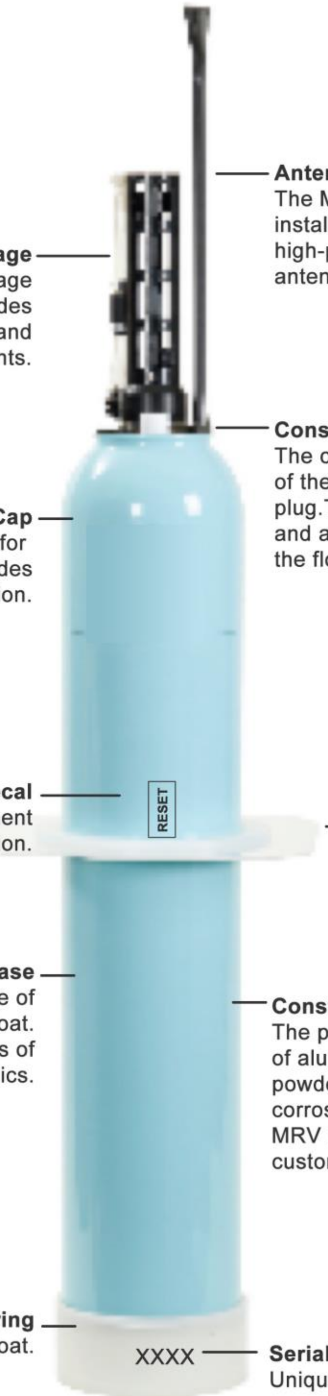
The float contains an on-board Iridium modem that transmits data back to the user. This communication link can also be used to send commands to the float to dynamically update the Mission Parameters.

Once the float has been sealed, it is evacuated to 10in Hg. At this point, the float should not be opened up. The float is put through its final production testing which runs through the built-in self-test and downloads the Mission Profile to the float.

As the final step, the float is put into shutdown mode to conserve battery life. The float is then shipped to the customer.

NOTE: The documentation included with this shipment describes the SOLO family of floats and includes documentation specific to the MRV SOLO S2-A.

External View



Antenna

The MRV SOLO antenna is a high-performance, zero water absorption antenna capable of receiving GPS and Iridium satellite signals. It is a standard feature that comes installed and mounted on the top cap.

Sensor Package

In the configuration described in this user manual, the MRV SOLO S2-A float is equipped with a Sea-Bird SBE41 CP CTD sensor package mounted in the top cap. The CTD sensor provides pressure, temperature, and salinity measurements. All connections from the sensor to the float electronics are inside the pressure case.

Console Port

A console 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 console cable.

Reset Decal

Identifies the location of the float activation switch. When the special far-field activation magnet (provided with your float shipment) is swiped across this area, the float will be activated.

Pressure Case

The SOLO S2-A pressure-case is a primed and painted aluminum cylinder 16.5 cm in diameter by 66 cm in height. The float has an overall height of 137 cm when the antenna is attached. The primed/painted surface finish prolongs life by impeding corrosion.

The pressure case is carefully designed to have compressibility less than that of seawater. Ocean depths where pressures exceed 2,000 dBar are beyond the operational capabilities of this SOLO S2-A model.

Stability Disk

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 when it is at the surface, allowing the float to remain at the surface by dampening vertical motion.

Internal Components

Inside the pressure case are sophisticated electronic and hydraulic component systems. There are no “customer serviceable” components inside the pressure case.

Electronic System

The SOLO S2-A electronics are located directly below the top cap inside the pressure case. This enables easy connection with the console port, external sensors, and antenna. The system includes:

- Internal EEPROM programmed with a mission profile
- Storage for acquired sensor data
- A GPS receiver to acquire the coordinates critical in interpreting location, drift and dive mission data.
- An Iridium modem to transmit stored mission data and GPS information, and receive adjustments in mission parameters if needed.
- Alkaline batteries to power electronics, sensors, and hydraulics.

Satellite communication with the float is bi-directional. The float transmits stored mission data and GPS information (MOMSN), and receives commands (MTMSN) to adjust mission parameters if needed. This is done through the Iridium modem.

The Iridium modem has a unique IMEI ID activated/provisioned by the DoD Defense Information Systems Network (DISN) Enhanced Mobile Satellite Services (EMSS). The IMEI maps the individual float with its location, scientific, engineering, and other data. The antenna must be above the sea surface in order to send and receive successfully.

While on the surface, the SOLO sends stored mission and GPS data. The SOLO float transmits this data using a proprietary algorithm to compress data and send it via SBD (Short Burst Data) packages using an Iridium-based transmission system.

The SOLO float is also equipped with internal sensors that monitor power, internal vacuum, and the hydraulic system.

Hydraulic System

The SOLO S2-A float is neutrally buoyant when its density is equal to the density of the surrounding water. Before deployment, MRV precisely tunes the float density to equal the physical conditions at the location of deployment. Changes in float volume dictate the descent and ascent of the float.

To adjust float volume, a precision high efficiency hydraulic system inside the pressure case inflates or deflates an external bladder. The hydraulic system uses a high-pressure pump and a complex system of valves to direct oil from an internal reservoir to the external bladder. As the external bladder inflates, the float volume increases and the float ascends. Float descent is accomplished by reversing oil flow back into the internal reservoir.

The external Sea-Bird SBE41 CP CTD sensors on the top cap measure ocean pressure, temperature and salinity. The pressure data is used to control the hydraulic system.

S2-A Platform Specifications

SPEC	Description
Profiles	250 profiles to 2,000 dBar with a standard lithium battery system
Coverage	100% ocean coverage to 2,000 dBar
Sample Rate	1Hz sample rate, averaged over 1-2 dBar, 4.3 Kbytes/profile (ARGO program requirements)
Transmission Time	15-minute surface transition time
Dimensions	Mass 19.2 Kg Pressure case length: 66 cm Overall length: 137 cm
Seek Capability	Bidirectional seek capable to +/-30 dBar
Energy and Battery Requirements	Energy required per dive, with SBE 41CP: 6.4 kJ
Displacement	Volumetric displacement 650 cc
Telemetry	Iridium, bidirectional
Scalability	Fully scalable in length to accommodate sensors and/or other payloads
Hydraulics	Capable of deep-ocean profiling to 2,000 dBar
Waste and Non-degradable Product	Reduced by over 50% (as compared to SOLO-I)
Cost	Cost effective and practical: Low cost per unit
Operator Skills Required	Minimal operator skill-set requirements for float deployment
Antenna	High-performance, zero water absorption antenna is a standard feature

Section 3: Getting Started

MRV SOLO floats are shipped with a mission profile pre-programmed to values specified in the purchase agreement. Upon arrival the floats are fully tested, ballasted, and ready for deployment.

IMPORTANT: Whether you plan to deploy the float directly or store the float, be sure to follow the procedures included in this documentation.

Iridium Account

Activating an Iridium Communications® account is required to configure and test float to satellite communications. Each account is keyed to the unique S3A 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 and arrange to transfer account ownership to the customer with the Iridium provider of their choice. For the life of the float MRV monitors and evaluates performance for future product development and reserves the right to retain one iridium email address assigned to *sbd@mrvsys.com*.

The S2-A equipped with an Iridium Communications® DoD modem reports through the DoD Defense Information Systems network (DISN) Enhanced Mobile Satellite services (EMSS) using the Iridium satellite Short Burst Data (SBD) based system utilizing bi-directional communication protocol for data dissemination and platform position determination. The float uses a GPS receiver for position determination. Each account is keyed to the unique SOLO S2-A identifying IMEI number.

Documentation and Software

Ballasting data, calibration files, and user documentation are shipped to the customer. When your float is shipped, you will receive an e-mail notification of the shipment.

Incoming Inspection

You will be emailed a packing list to verify the contents of your shipment upon arrival. Before storing or deploying the SOLO S2-A, an inspection should be performed on the incoming shipment.

The SOLO S2-A is shipped from the factory in a water-soluble shipping container that also serves as the deployment box. This box has been designed to disintegrate when the SOLO S2-A is in the ocean. For floats equipped with the air deployment option, the packing will also include a parachute assembly. Before shipping, the float is fully tested at the factory, the internal vacuum is set at 10in Hg, and the operational software and mission profile are pre-programmed.

If the float box arrives with no visible damage, the float is ready to be stored or deployed. If you see visible damage to the container, contact MRV Systems for assistance.

IMPORTANT: **The boxed float arrives ready for deployment**. Be aware that there is an activation procedure that must be followed prior to deployment. Refer to the Post Inspection instructions that follow.

Post Inspection

Activation

The SOLO float arrives in a shutdown state and must be activated prior to deployment. There are two modes of activation. Refer to *Section 4: Pre-Deployment Communication with SOLO.* To modify the mission parameters prior to deployment refer to *Section 5: Modifying SOLO Mission Parameters.* For deployment, refer to *Section 6: Deploying the SOLO Float.* These sections explain the activation procedures.

Modifying Mission Parameters

Modifying the SOLO S2-A mission parameters is done in-box. Do NOT remove the SOLO S2-A from the shipping box. For complete instructions, refer to *Section 5: Modifying SOLO Mission Parameters*.

Deployment

Depending on the options specified by the customer, the SOLO S2-A is delivered air and/or sea deployable. The SOLO S2-A is deployed in its original shipping box. **You must use the approved MRV deployment procedures** per *Section 6: Deploying the SOLO Float*.

Storage

If the SOLO float is going to be stored for a length of time prior to deployment, it should be prepared for storage as specified in *Section 7: Storage*.

Section 4: Pre-Deployment Communication with SOLO

MRV provides several software programs to perform various operations with the SOLO float including programming mission parameters and updating the float firmware, if necessary. This section provides the information needed to communicate with the SOLO float.

A terminal emulator program, such as TeraTerm, is needed to communicate with the float via its command line interface menus. The communication parameters are 9600 baud, 8 data bits, 1 stop bit, and no parity.

Understanding SOLO Activation

The SOLO float is delivered in a shutdown state and must be activated prior to testing or deployment. Swiping a far field magnet across the area labeled **RESET** on the p-case activates the float. The user has access to the reset switch through the designated cardboard flaps located on the topside of the shipping/ deployment box.

The activation is affected by two conditions detected by the float when the magnet is swiped: the dive number recorded in non-volatile memory, and the presence of the custom console cable connecting the float to a computer. The dive number (DiveNo) is a mission parameter stored in the float's EEPROM that records the number of dives completed by the float. When a fantail ready float is shipped, the dive number (DiveNo parameter) is always set to zero.

If the dive number recorded on the float is zero AND the custom console cable is detected when the float is activated by magnet swipe, the SOLO will activate in **COMMAND MODE**. A console monitor on the float will wait and respond to commands sent over the serial line. Otherwise, the float will activate in **MISSION MODE**.

As a special case of **MISSION MODE** activation, if the custom console cable is detected when the magnet is swiped, the float will monitor the serial line for five minutes before proceeding into **MISSION MODE**. During these five minutes, a command can be sent to the float over the serial line to put it into **COMMAND MODE**. If the command is not received in the five minutes following the magnet swipe, the float will proceed into **MISSION MODE**.

When a float is shipped the dive number is set to 0 to ensure the Diagnostic Dive is initiated when the float enters mission mode. When the controller boots up with the custom console cable attached, and the dive number is set to 0, then the software will enter command mode and display the following output to the terminal window:

```
Starting..
start.c compiled Dec  1 2014 09:32:26


SOLO 1234 IMEI: 300234061234567 Ver: SBE602 ARM_v2.0_xmsg_ver:05aug14
Board version 5.9
Firmware version 1.0.a built Dec  1 2014 09:32:26
^BIT_status=0x 0000
^    All OK
^CPU,PMP,VAC= 633 1601 1001    (counts= 32141 32303 7062 )
Dive number =   0


Select operation :
BASE MENU
ESC Quit     : U.pdate menu : V.ersion      : X Shut_down
B.asic BIT   : F.ull BIT    : M.ission strt
H.uman Op.   : O.ptions     : C.omment
E.EPROM ops  : P.ump tests  : S.BE test     : D.ata proc.
A./D test    : R.T Clock    : I.ridium      : G.PS test
Z. batt&vac  : L.owpower
4 Ant. Sw    : 5.SerPort    : 6 FlashOps
BAS>
```

At the BAS> prompt, commands are entered to perform various functions on the float. If the dive number is greater than 0, you will see the following prompt:

```
Will wake up every 10 secs for 300 secs
Hit w to exit sleep...
```

If the 'w' key is pressed within 300 seconds, then the float will enter command mode. Otherwise, the float will proceed to mission mode and resume its dive mission.

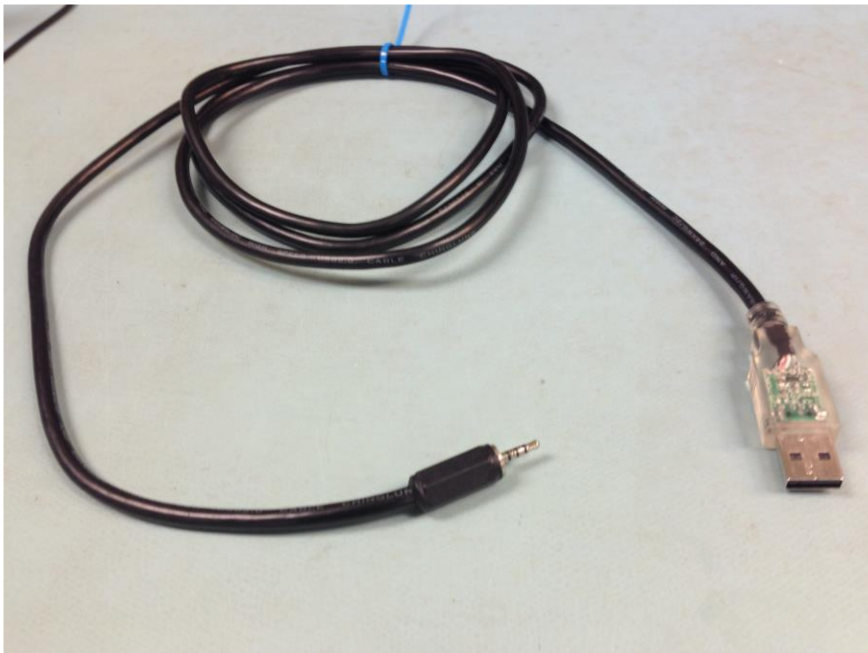
	Dive Number = 0	Dive Number > 0
Serial Cable Detected 	Activates to COMMAND MODE	5 minute console command wait, then... ...activates to MISSION MODE resumes mission at stored dive number
Serial Cable **NOT** Detected 	Activates to MISSION MODE starts the diagnostic dive of a new mission	Activates to MISSION MODE resumes mission at the stored dive number

Activation Table

Preparation

Equipment Needed

- MRV supplied custom console cable with mini plug and USB connector (PN: 628505)



- MRV supplied far field activation magnet (PN: 501006)
- MRV supplied 5/8" socket wrench with ratchet (PN: 501010)
- MRV provided flashlight (PN:501011)
- Computer running a terminal program software (such as TeraTerm)
    - PC or Laptop with Linux or Windows XP®, Windows 7® or later operating system with a USB port
    - The communication parameters are 9600 baud, 8 data bits, 1 stop bit, and no parity

Connecting to SOLO

The float is shipped ready for pre-deployment communication. ***DO NOT REMOVE THE SOLO from the shipping/deployment box.*** The box has been designed so that the user has access to the console port through cardboard flaps located on the topside of the shipping/deployment box. The console port is located under a removable waterproof boss plug on the top cap of the SOLO S2-A. This port allows users to connect the SOLO float to a computer.

IMPORTANT: For pre-deployment communication, the MRV supplied **custom console cable *must* be plugged into the console port prior to activating the float**. Upon activation, this connection signals the float to go into **COMMAND MODE**.

1. Locate the Console Port designated cardboard flaps located on topside of the box. With the flashlight provided, locate the Boss plug with outside hex edges. The console port is *beneath* and protected by this plug.
2. Carefully, remove the boss plug from the console port using the 5/8" socket wrench provided.

Store the hex plug in a clean area where it will not collect dust/dirt.

IMPORTANT: Be gentle with the wrench when removing the Boss plug to make sure you **DO NOT scratch the surface of top cap or the plug.** Damage to either can promote corrosion. In addition, **do not leave the Boss plug off of the port or loosely seated longer than necessary for testing to avoid any leaks around the console port**.

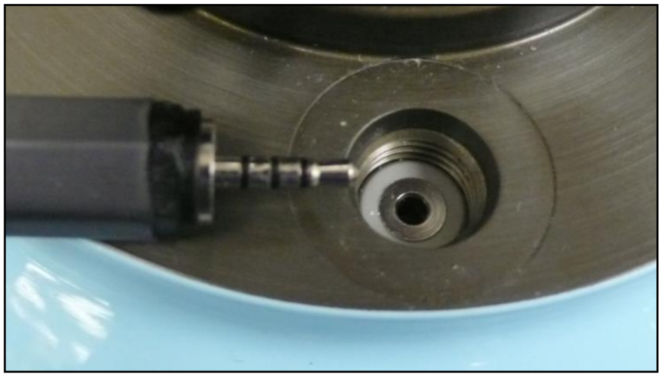
Console Port Plug

Illustration: Console Port plug visible through the cardboard flaps.

Illustration: 5/8" Socket Wrench with Ratchet Attached to Console Port.

IMPORTANT: Exercise extreme caution when handling the Boss plug and mating port.

4. Connect the MRV provided custom console cable to the computer USB port.
5. Insert the mini plug end of the custom console cable into to the SOLO console port. **Be sure to make a solid connection, to refusal,** with the SOLO console port.



Inserting the MRV custom console cable into to the SOLO Console Port

IMPORTANT: The custom console cable ***must make a solid connection*** when plugged into the SOLO. If not, the SOLO will not detect the custom console cable and will not go into COMMAND MODE when activated.

MRV Custom Console Cable Connected to the SOLO

Activating COMMAND MODE

The specific response from the operational code depends upon the state of the SOLO. After activation, when the operational code boots up, it checks to make sure the MRV custom console cable is attached to the Console Port on the SOLO.

- **If the console cable IS detected** the float goes into **COMMAND MODE**
- **If NO console cable is detected** the float goes into **MISSION MODE**

1. To activate the SOLO S2-A in **COMMAND MODE** refer to the picture of the topside of the box in the document **"SOLO S2-A Shipping/Deployment Box Illustration" (PN958529a)** included with your shipment.
2. Locate the RESET switch designated cardboard flaps the on topside of the box.
3. Below the cardboard flaps, you will have access to view the RESET label on the SOLO S2-A pressure case. If the "RESET" area is not visible, the float may have rotated during shipping. Gently rotate the float within the packaging to expose the RESET area.
4. Locate the MRV provided far field activation magnet.
5. Quickly, but deliberately, swipe the far field activation magnet once, IN ONE DIRECTION ONLY, across the area labeled RESET.

When the controller boots up with the custom console cable attached, and the dive number is set to 0, then the software will enter **COMMAND MODE** and displays the identifying start-up sequence as described in *"Understanding SOLO Activation"* above.

Instructions for Updating the SOLO Firmware

If the need arises to update the SOLO float firmware, the following steps need to be followed. MRV provides the binary image for updating the SOLO firmware.

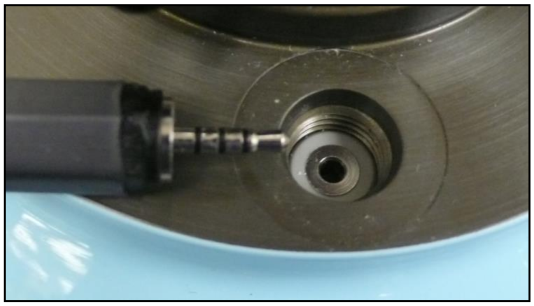
IMPORTANT: Improper updating of the SOLO firmware can render the float inoperable.

1. Activate the float in **COMMAND MODE** by connecting the MRV supplied custom console cable to the float and swiping the magnet across the reset switch as previously detailed.
2. Using a terminal emulator program on the PC, wait until the base menu (`BAS>`) is displayed. This indicates the float is booted up and ready for user input.
3. Switch to the bootloader menu by entering the caret (^) symbol.
   ```
   BAS>
   ^
   ```
4. The SOLO will respond with a confirmation prompt. Enter ‘y’ to confirm.
   ```
   Are you sure you want to exit to the Bootloader ?>
   y
   Change Baud rate to 115200.
   ```
5. The baud rate then needs to be changed on the terminal emulator program to 115,200 for communication with the bootloader.
6. After changing the baud rate, press the Enter key to ensure communication with the bootloader is established. This is confirmed when the bootloader prompt (`B>`) is returned.
7. Enter ‘D’ to download the firmware. At this point, the `Ready` message is returned as well as ‘C’ characters indicating the SOLO is ready to receive a new binary firmware image.
8. Transfer the new MRV provided binary firmware image using the XMODEM protocol. Once the download is complete, the bootloader prompt returns.
9. Enter ‘b’ to boot the downloaded application.
10. Change the baud rate back to 9600 to communicate with the SOLO firmware.
11. The new firmware version information is displayed as the SOLO starts up. The ‘V’ command can also be entered at the base menu prompt.
12. **The float must now be put in a de-activated state to conserve batteries.** To de-activate the float enter “x” from the base menu prompt. You will see a message on the screen verifying that the float is shutting down.
13. Follow the instructions in the section *“When Communicating with the Float is Complete”* below.

When Communicating with the Float is Complete

When communicating with the SOLO float is completed and the float has successfully been de-activated (see section above), do the following as soon as possible:

1. Disconnect the MRV provided custom console cable.



2. **Ensure the Boss plug and O-ring are clean and dust free**. If the O-ring requires lube, use a small amount of Parker Super-O-Lube and lightly wet the surface. Carefully use the 5/8" socket wrench to replace the Boss plug over the console port.
3. Tighten to refusal and remove wrench.

IMPORTANT: In caring for the plug use appropriate handling and cleaning protocols.

Section 5: Modifying SOLO Mission Parameters

MRV has provided instructions to modify mission parameters prior to deployment in *Section 4: "Pre-Deployment Communication with the SOLO"*. Details about the mission parameters are included in *Section 8: "Understanding the MRV SOLO Float Dive Profile and Mission Parameters"*. In addition, MRV has provided instructions to update the SOLO firmware, if needed. Refer to *Section 4: "Pre-Deployment Communication with the SOLO".*

Section 6: Deploying the SOLO Float

The MRV SOLO S2-A is ready for deployment when it is delivered to customers.

WARNING: A mission parameter determines the deployment window after activation in MISSION MODE. The default value is 1080 days. The float must be deployed within 1080 days of activation. If not deployed at the end of 1080 days, the float will "wake-up" and begin the initial diagnostic dive, which is followed by the pre-programmed mission dives. To modify this mission profile parameter, refer to *Section 9: The Mission File*.

Prepare the SOLO for Deployment

The SOLO S2-A float must first be activated for deployment. This is best done at the dock.

IMPORTANT: Activate the SOLO S2-A in MISSION MODE *before* leaving for deployment. A clear line of site to the open sky is necessary for the built-in self-test satellite communications. If the float does not successfully complete activation as described in this documentation, the float should not be deployed.

NOTE: Once the float has completed its BIST (built-in self-test) cycle and the data is successfully received, the SOLO S2-A is ready for deployment.

The SOLO S2-A float is shipped deployment ready in shutdown mode. To ensure the electronics that control the satellite communication work properly and the float returns SBD messages, the Built-in-Self Test (BIST) is run as part of the dockside (pre-deployment) procedure. This test should be run outdoors in a location providing a clear view of the sky for satellite communications.

1. Move the float outdoors with a clear area and not obstructed by trees, building, etc.
2. Activate the SOLO in **MISSION MODE** as described below.

Activating MISSION MODE

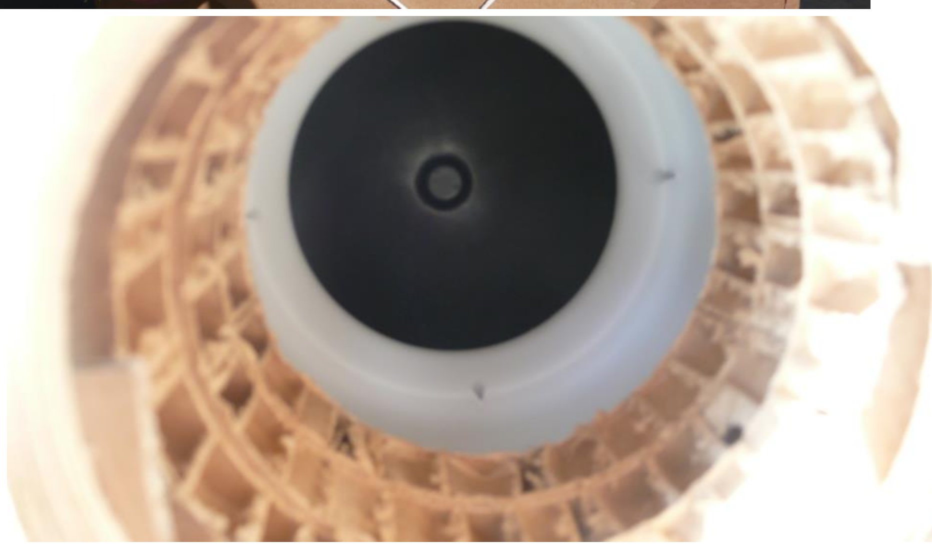
Equipment Needed

- SOLO S2-A Float in shipping/deployment box

- MRV supplied activation magnet

This procedure prepares the MRV SOLO S2-A float for deployment and is typically done on before loading the SOLO S2-A for deployment. **The full self-test will take approximately 40 minutes once the activation has been initiated**.

1. Refer to the document **"SOLO S2-X Shipping/Deployment Illustrations" (PN958529)** included with your shipment. Locate the heavy end of the SOLO S2-A box with access to the external bladder. Locate the RESET switch cardboard flaps the on topside of the box.
2. View the external deflated bladder that is mounted on the bottom of the p-case and protected by the fairing. It can be examined and felt through the bottom of the cardboard deployment housing.



Deflated bladder

3. To activate the SOLO S2-Ain **MISSION MODE** locate the RESET switch cardboard flaps the on topside of the box.
4. Below the cardboard flaps, you will have access to view the RESET label on the SOLO S2-A pressure case. If the “RESET” area is not visible, the float may have rotated during shipping. Gently rotate the float within the packaging to expose the RESET area.
5. Locate the MRV provided far field activation magnet.

6. Quickly, but deliberately, swipe the far field activation magnet once, IN ONE DIRECTION ONLY, across the area labeled RESET. This will activate the SOLO Built-In Self-Test (BIST)

7. Listen closely for the pump to engage and monitor the external bladder for inflation.
8. The float cycles through the built-in-self-test (15-30 minutes). It can take up to 10 minutes from the time the magnet is swiped to fully inflate the bladder. *Verify the bladder has inflated by physically touching and viewing the bladder.*

When complete, the bladder will deflate in 1 or 2 minutes.
IMPORTANT: Do **NOT** deploy the SOLO S2-A without first observing the audible pump cycle and the inflating/deflating of the external bladder.

NOTE: Once the bladder inflates, **the float will cycle through a series of self-tests. This will take approximately 15-30 minutes**.

9. When the built-in self-test is complete, the bladder will start to deflate. This takes approximately 2 minutes. View and touch the bladder to make sure it is deflated.
10. Check your Iridium e-mail account. The float will attempt to send four email packets with diagnostic data. These packets include the status of the built-in self-test. Iridium availability and performance may delay delivery. Additional information about the SOLO built-in self-test packets can be found in the ***SOLO2 X-format V2.0 14Oct2014 (PN: 958527)*** document.
11. The SOLO S2-A is ready now for deployment. For ocean deployment, refer to the document ***"SOLO S2-A Ocean Deployment" (PN958529b).***

Section 7: Storage

IMPORTANT: The SOLO S2-A should be deployed within 6 months of customer receipt.

The SOLO S2-A is shipped de-activated in shutdown mode ready for deployment.

If storing the boxed float received directly from the MRV factory, make sure:

- The float is stored as illustrated in the "**SOLO S2-X Shipping/Deployment Illustrations"** and secured.
- The storage location is:
  - Dry and protected
  - Cool (< 50 degrees Fahrenheit or 10 degrees Celsius)

When ready to deploy the float, refer to *Section 6: Deploying the SOLO Float.*

Section 8: Understanding the MRV SOLO Float Dive Profile and Mission Parameters

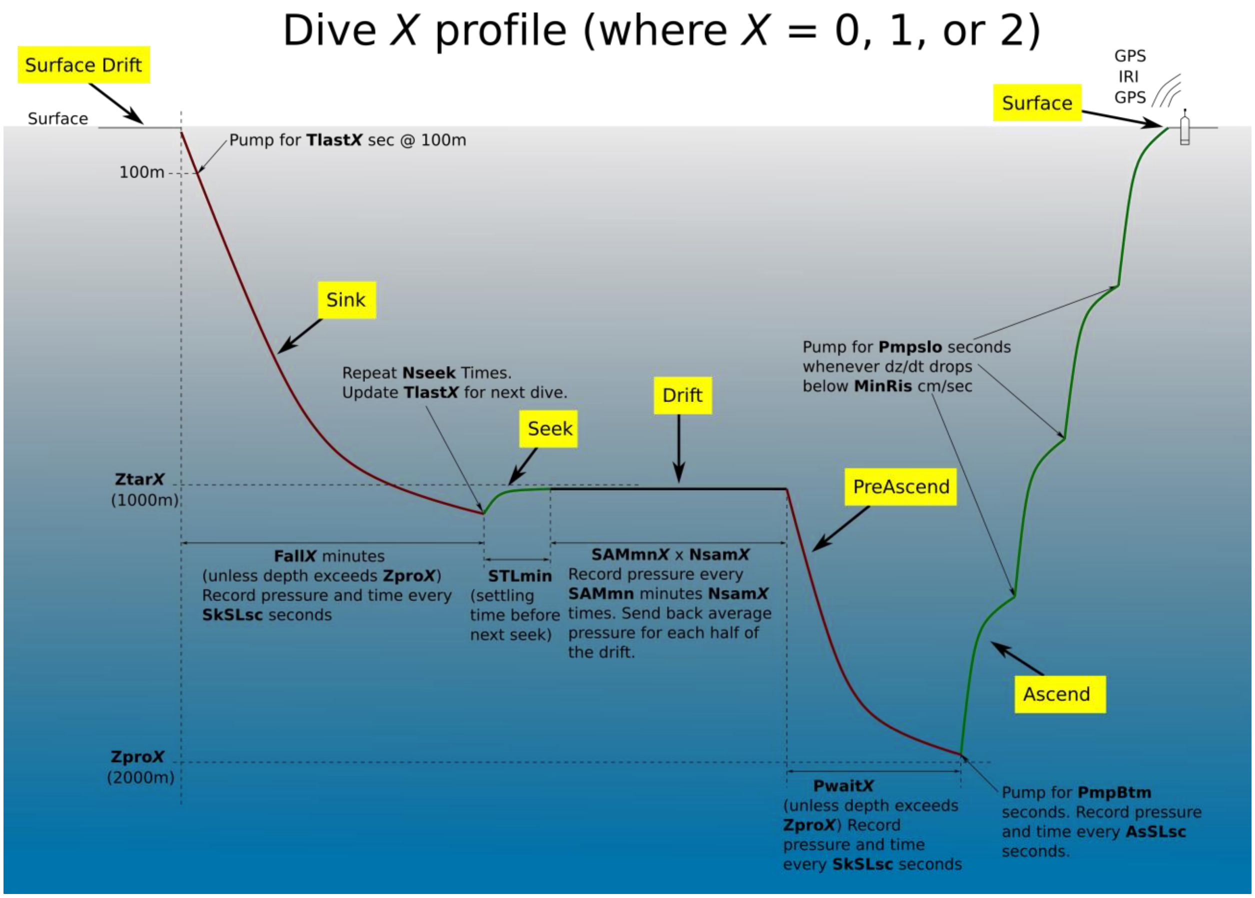
The SOLO S2-A is shipped ready for the deployment location specified. For customers wishing to make adjustments to the mission file parameters using remote commands, this section documents each of the mission parameters and their effect on the SOLO S2-A dive profile.

NOTE: Please consult with the MRV technical staff prior to loading a mission profile that deviates from the mission profile supplied. MRV cannot be held responsible for operator error from improper mission programming that result in float failure.

Understanding the Mission Profile

The MRV SOLO float mission parameters specify a dive profile that follows this pattern.

1. Surface Drift
2. Sink
3. Seek
4. Drift
5. Pre-Ascend
6. Ascend
7. Surface



The Dive Profile

Once the dive starts, the SOLO float enters an initial **Surface Drift** phase to initiate an attempt to get to the desired location. Once the float is near or at the desired location it will **Sink** followed by the **Seek** phase where it searches for the specified target depth.

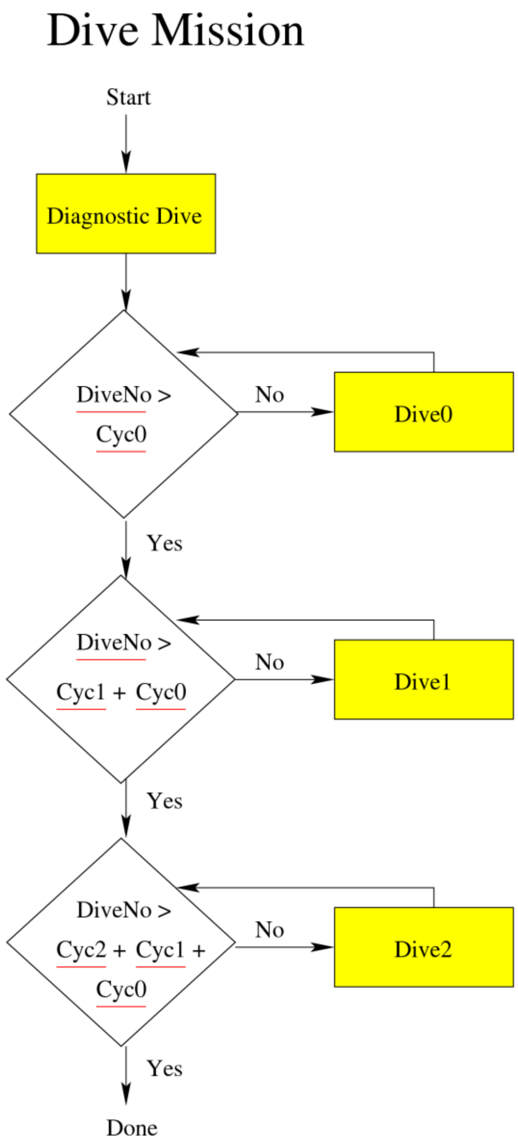
At this depth, the SOLO float will enter the **Drift** phase where it will record pressure periodically, and send back an average pressure for each half of the phase. Next the SOLO float will enter the **PreAscend** phase where it will sink to the profile or maximum operating depth. The profile depth must be deeper than the target depth.

Once the float has reached the profile depth it will **Ascend**. During this phase the float will take continuous samples through the external CTD sensors to produce temperature, salinity and pressure data, which will be transmitted on the **Surface** according to mission parameters and commands issued from ground stations through the Iridium gateway.

The float will remain on the surface in **Surface Drift** phase before repeating the cycle with the next dive profile.

The profile for these dives is determined by parameters stored in EEPROM. A mission consists of three cycles (X = 0, 1, or 2). Parameters associated with a specific dive cycle have the cycle number appended to the parameter name.

A predetermined number of dives, specified by the parameter "**Cyc0**", are completed using the



parameter set with names ending in "0". Then "**Cyc1**" dives are completed using parameter set "1", followed by "**Cyc2**" dives using parameter set "2". "**Cyc2**" dives are intended to continue until the batteries are exhausted and therefore have a large max dive number set in *mission_parameters.602*.

Diagnostic Dive Algorithm

The float starts the Diagnostic Dive in a low-power mode waiting for deployment. In this state, the float electronics wakes up every **PchSec** seconds (commonly 600 seconds, or 10 minutes), for up to **MaxHrs** hours and measures external pressure. When the electronics wakes up and detects that the measured pressure exceeded **dBarGo** (commonly 50 dBar), the float will begin the Diagnostic Dive. If the electronics does not read a pressure that exceeds **dBarGo** within the **MaxHrs** time, then the float will begin the Diagnostic Dive.

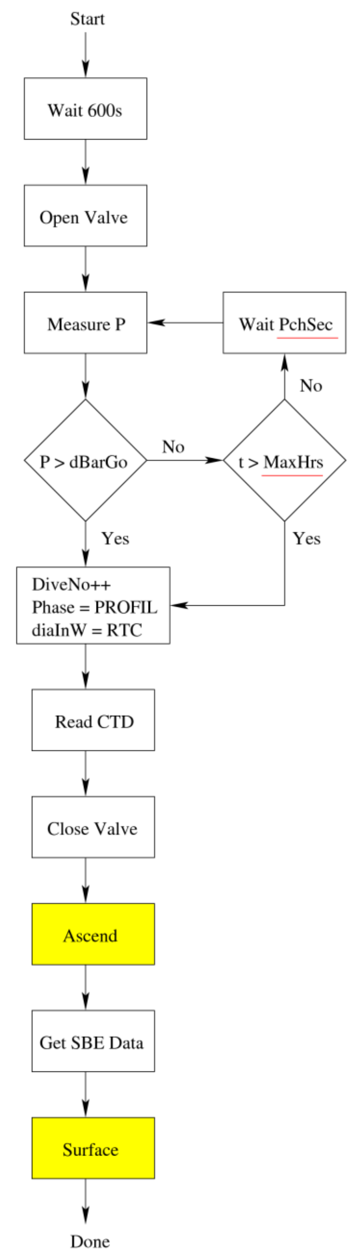
When the Diagnostic Dive starts, the CTD is turned on and the hydraulic pump is activated, bringing the float back to the surface. The float will follow the same **Ascend** algorithm, as will all other dives. Once it reaches the surface, the **Surface** algorithm will be performed. This will involve processing the CTD data, obtaining a GPS fix and uploading the information via Iridium. The format of this diagnostic data file is distinct from that of all subsequent dives. The depth, and therefore time required, for the diagnostic dive varies depending on the timing of the deployment relative to the pressure sampling schedule, but it should not be much more than 100 meters deep or 45 minutes in duration.

During the surface interval, the float will send back the follow packet types:

Packet Type	Packet ID
GPS SENSOR MESSAGE	0x00
CTD SENSOR MESSAGE	0x10, 0x20, 0x30
RISE RATE DATA MESSAGE	0x50
PUMP DATA MESSAGE	0x60
DIAGNOSTIC ENGINEERING DATA MESSAGE	0xe0

The CTD SENSOR MESSAGE will include the full profile data that consists of the **Pump Message Series**,

Diagnostic Dive



the **Temperature Message Series**, and the **Salinity Message Series**.

Surface Drift Algorithm

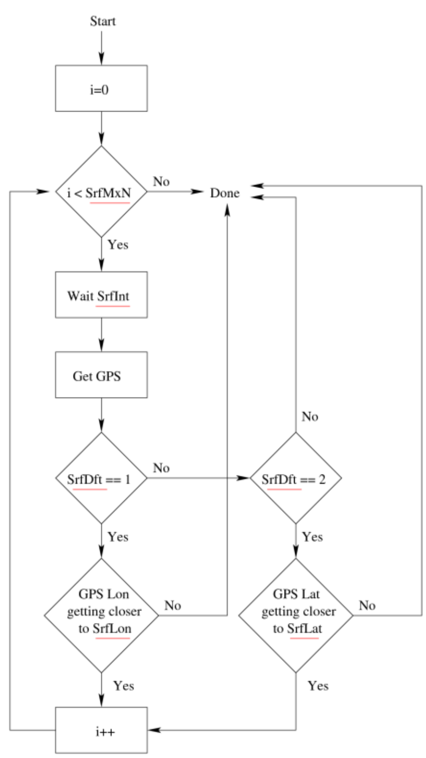
During the first phase of the dive, the float drifts on the surface seeking a desired location. The main Mission Parameter that controls the **Surface Drift** is **SrfDft**. The possible values for this parameter are summarized in the following table.

SrfDft	Description
0	No Surface Drift
1	Drift to a specified Latitude
2	Drift to a specified Longitude
3	Drift to a specified Latitude and Longitude

If **Surface Drift** is not enabled (**SrfDft = 0**), then the program will exit the **Surface Drift** phase immediately. If the **Surface Drift** is enabled (**SrfDft = 1, 2 or3**), then the program will try to drift closer to a latitude/longitude specified by **SrfLat** and **SrfLon**. Seconds between GPS fixes while on the surface is specified by **SrfInt** (0 - 7200),

For this phase, an initial GPS fix is taken and compared with a desired location. Then a subsequent GPS

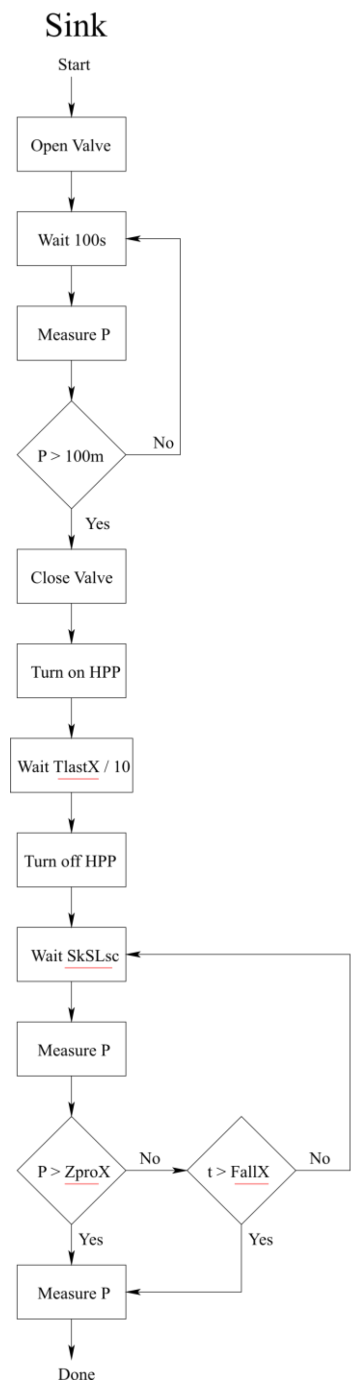
Surface Drift



fix is taken to determine if the float is drifting closer to the desired location. If the float is not getting closer or the maximum count (**SrfMxN**) has been hit, then the float will enter the **Sink** phase.

Sink Algorithm

A valve is opened to initiate the **Sink** phase, decreasing volume and causing the float to sink. Pressure and time measurements are made and stored at intervals of **SkSLsc** seconds. Once back on the surface, these measurements will be sent back as part of the FALL RATE DATA MESSAGE.



When a pressure greater than 100 dBar is observed, the hydraulic pump operates for **TlastX** seconds, where the "**X**" is a "0", "1", or "2". **TlastX** is chosen such that the float reaches neutral buoyancy at the target depth **ZtarX**.

The float is allowed to approach its neutral depth for **FallX** minutes, unless it exceeds the profile depth **ZproX**, which triggers an early transition to the **Seek** phase.

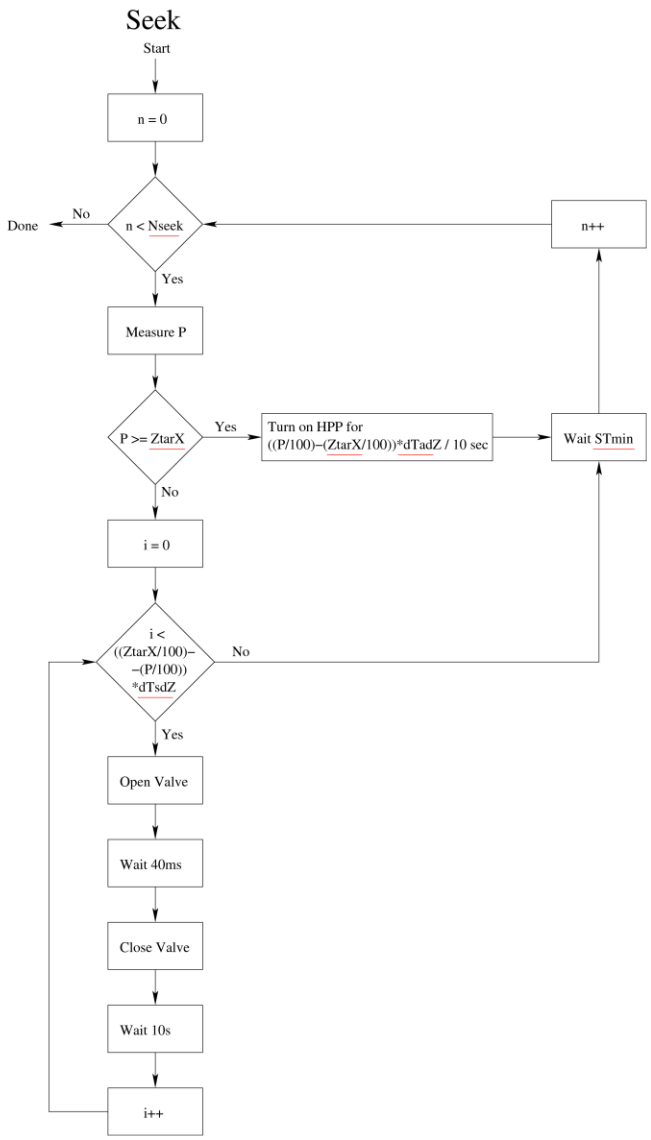
Seek Algorithm

The float seeks its target depth **ZtarX**. If the depth of the float at the end of the **Sink** phase exceeds **ZtarX**, the hydraulic pump runs for an amount of time calculated by multiplying the depth by which the float overshot by **dTadZ**. The float is allowed to settle on its new equilibrium depth for **STLmin** minutes.

This process is repeated **Nseek** times. The total time pumped during both the **Sink** and **Seek** phases is logged, and **TlastX** is updated to that value.

If the depth of the float at the end of the **Sink** phase is too shallow, a descent mechanism is activated, determined by multiplying the depth shortfall by **dTsdZ**. The ratio between **dTsdZ** and **dTadZ** is used to convert the descent volume to an effective pump time (negative), which is used to update **TlastX** for the next iteration.

After a few dives, **TlastX** should converge on the correct value.

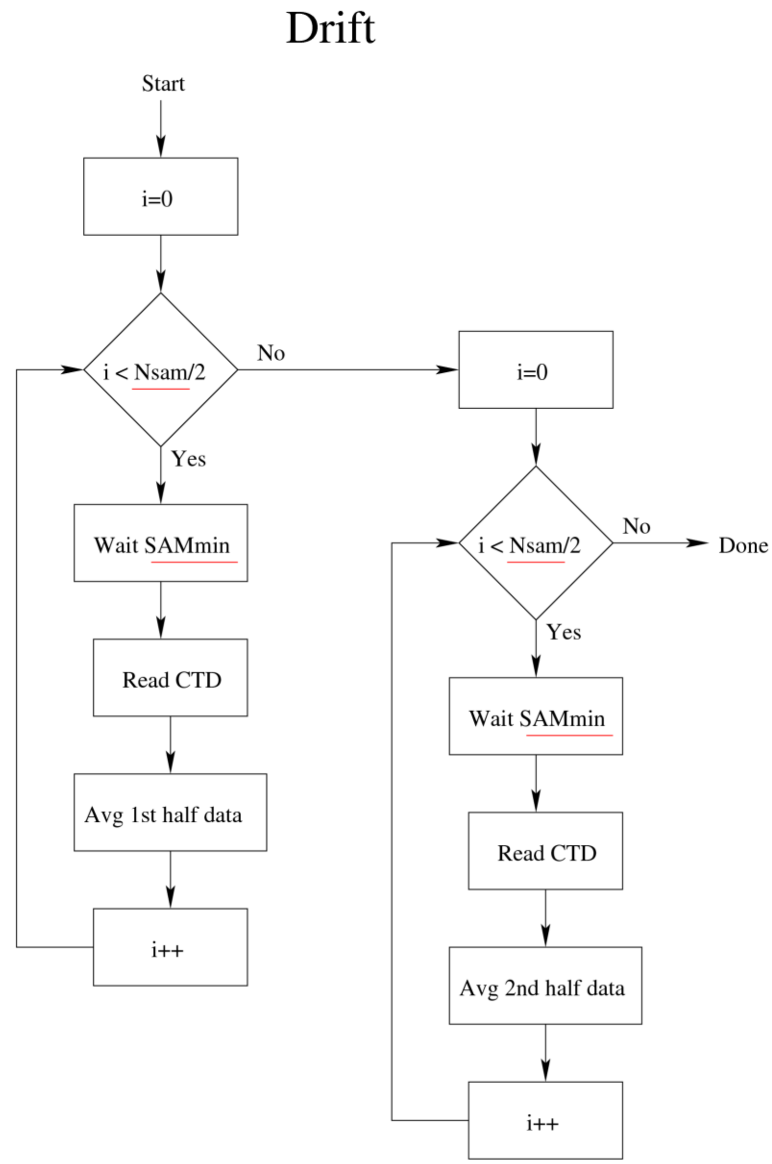


Drift Algorithm

During the **Drift** phase, the float records pressure, temperature, and salinity samples every **SAMmnX** minutes until it has obtained **NsamX** samples. The duration of the **Drift** phase, in minutes, is thus the product of these two parameters.

The **Drift** phase supports averaging the pressure, temperature, and salinity data from each half of the **Drift** phase. Specifying the **DrfDat** parameter with a value of 1 configures the float to send back the raw samples collected during the **Drift** phase.

During Drift, the depth of the float will also be monitored. If the **ZproX** depth is hit, then the Drift



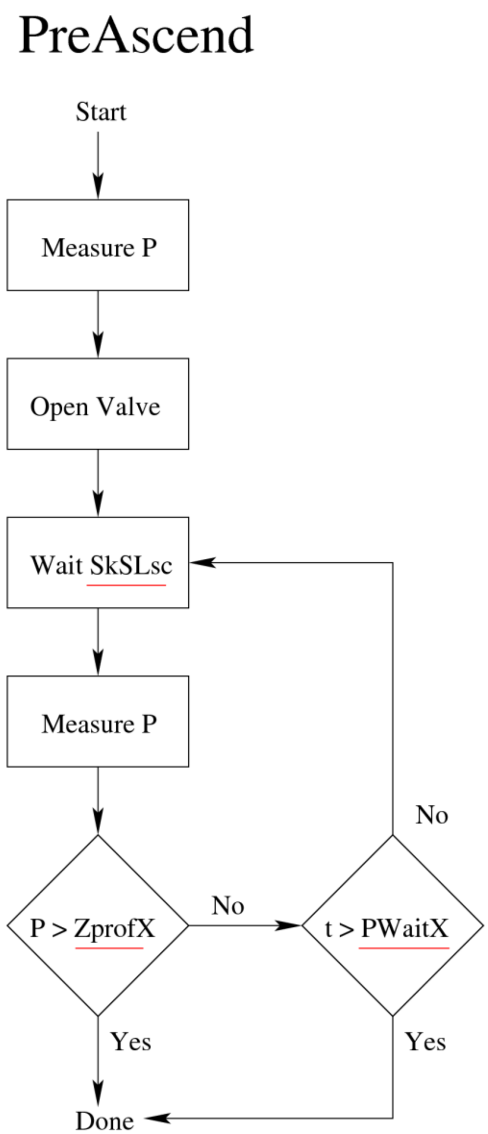
phase will be terminated. If the depth exceeds **ZtarX**+300, then the software will execute a **Seek** to return to the correct depth.

Pre-ascend Algorithm

If the **PROup** mission parameter is set to 1, the float will perform profiling during the **Ascent** phase.

To do this, the volume is changed to sink to profiling depth. Pressure and time are recorded every **SkSLsc** seconds.

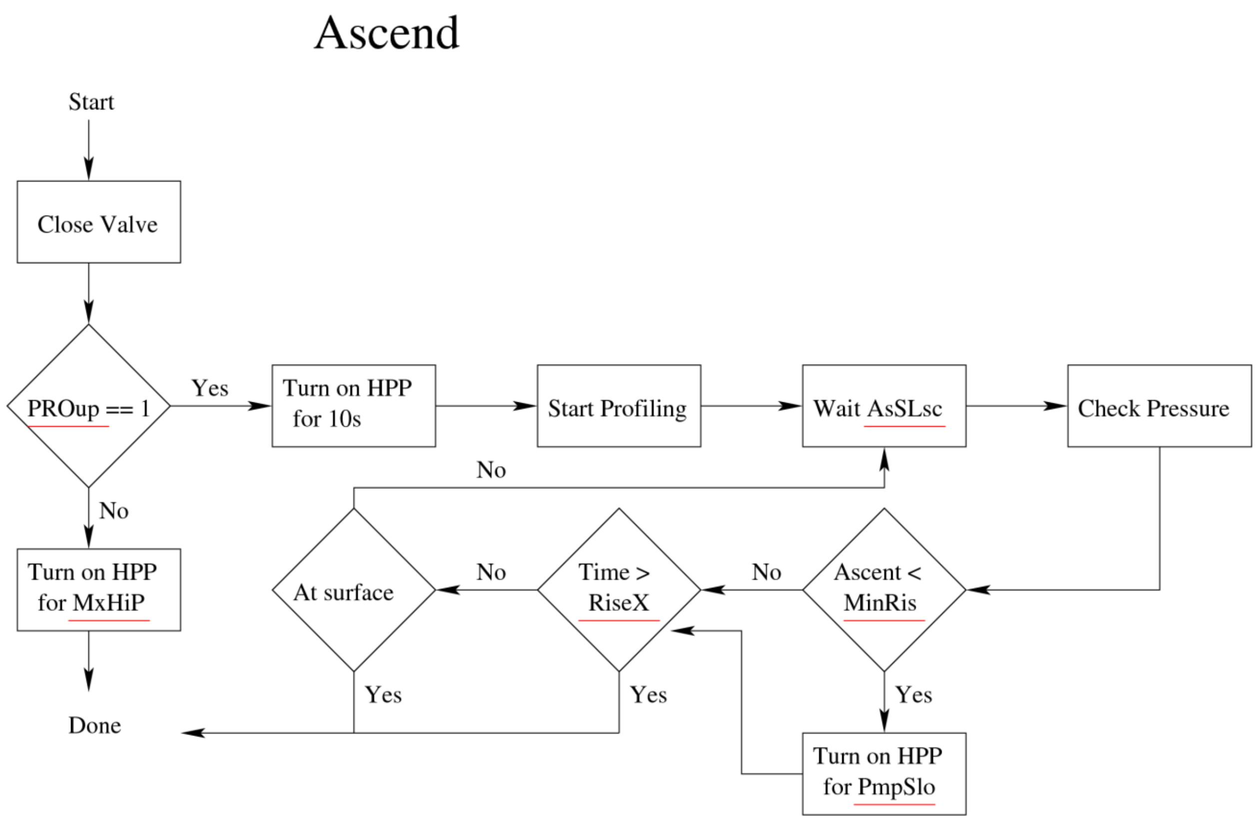
The float sinks for **PwaitX** minutes or until a depth of **ZproX** is reached, at which time the valve closes, the hydraulic pump runs for **PmpBtm** seconds and the CTD turns on.



Ascend Algorithm

Once at the profile depth (**ZproX**), the float will start to **Ascend**. Pressure and time are recorded at intervals of **AsSLsc** seconds and sent back in the RISE RATE DATA MESSAGE.

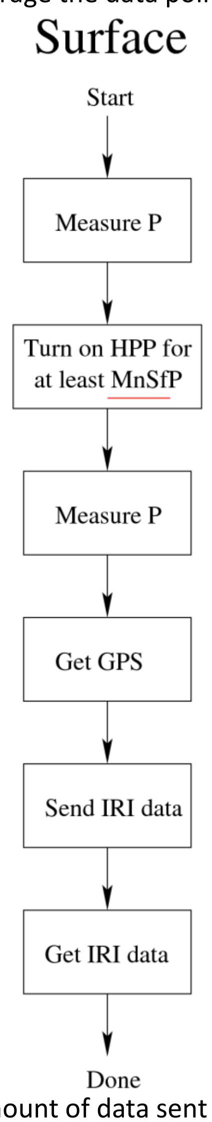
If the vertical speed computed from these measurements drops below **MinRis** (typically 11 cm/sec) - the hydraulic pump runs for **Pmpslo** seconds. Rising too slowly is inefficient because of the power required by the SBE pump.



Surface Algorithm

Upon reaching the **Surface**, the hydraulic pump runs until either the internal oil pressure sensor reports a value below **OILvac,** or the total pump time for the dive reaches **MxHiP** seconds. **MxHiP** is the mission parameter that specifies the maximum time to run the high pressure pump for a dive profile. **MinHiP** seconds is the mission parameter that specifies the minimum time to pump at the surface.

As the float ascends, the CTD samples data in 1 Hz increments. Then, after the profile is done, we send a command to "bin" the data. This process divides the data up into different pressure bins (i.e. 0-1db, 1-2db, 3-4db, etc.). Then the CTD will average the data points within a pressure bin to come up with a



value for that bin. This will reduce the amount of data sent back from the SBE sensor. A GPS fix is obtained (or attempted for **GPSsec** seconds), and the data is sent back via Iridium, (or attempted for **IRIsec** seconds).

During the **Surface** interval, the float will send back the following packet types:

Packet Type	Packet ID
GPS SENSOR MESSAGE	0x01, 0x02
CTD SENSOR MESSAGE	0x10, 0x20, 0x30
FALL RATE DATA MESSAGE	0x40
RISE RATE DATA MESSAGE	0x50
PUMP DATA MESSAGE	0x60
DRIFT DATA MESSAGE	0x98, 0xa8, 0xb8
PROFILING ENGINEERING DATA MESSAGE	0xe2
ARGO DATA MESSAGE	0xf0

Section 9: The Mission File

The mission parameters are stored in EEPROM in the SOLO float. The following tables provide an overview of the mission parameters.

Mission Profile Parameters

Start of Profiling Missions

Parameter	Description
PchSec	seconds between checks of pressure
MaxHrs	time to start mission, independent of dBarGo [hours]
dBarGo	minimum pressure increase to start profile [dBar]
ABcymn	minutes between Iridium transmits in Abort

Specification of Multiple Duty Cycles

Parameter	Description
Cyc0	cycles to target Ztar0
Cyc1	cycles to target Ztar1
Cyc2	cycles to target Ztar2
Ztar0	target depth for Cyc0 [meters]
Ztar1	target depth for Cyc1 [meters]
Ztar2	target depth for Cyc2 [meters]
Zpro0	profile depth for Cyc0 [meters]
Zpro1	profile depth for Cyc1 [meters]
Zpro2	profile depth for Cyc2 [meters]

Parameter	Description
Tlast0	estimated pump time during Seek to reach Ztar0 [seconds]
Tlast1	estimated pump time during Seek to reach Ztar1 [seconds]
Tlast2	estimated pump time during Seek to reach ZTAR2 [seconds]
Rise0	minutes to rise from ZTAR0
Rise1	minutes to rise from ZTAR1
Rise2	minutes to rise from ZTAR2
Fall0	minutes to fall to ZTAR0
Fall1	minutes to fall to ZTAR1
Fall2	minutes to fall to ZTAR2
SAMmn0	minutes between drifting samples for Cyc0
SAMmn1	minutes between drifting samples for Cyc1
SAMmn2	minutes between drifting samples for Cyc2
Nsam0	samples to take while drifting for Cyc0
Nsam1	samples to take while drifting for Cyc1
Nsam2	samples to take while drifting for Cyc2
DrfDat	sample PTS during drift and transmit all data
Pwait0	minutes to spend waiting to Zpro0
Pwait1	minutes to spend waiting to Zpro1
Pwait2	minutes to spend waiting to Zpro2

Dive timing info

Parameter	Description
PmpBtm	seconds to run the high pressure pump at bottom of dive
Pmpslo	seconds to run on ascent when rate is too slow
MinRis	threshold for ascent rate [cm/s], pump when rising slower
MxHiP	maximum seconds to run the high pressure pump
MxSfP	maximum seconds to run the high pressure pump at surface
GPSsec	maximum seconds to acquire GPS fix in normal dive
IRIsec	maximum seconds to spend communicating with Iridium
dTadZ	millisecs required to ascend by 100 m
dTsdZ	millisecs required to sink by 100 m
mxSeek	maximum time to use during a seek [seconds]
Nseek	seeks to perform
STLmin	minutes to spend waiting to settle
MnSfP	minimum number of seconds to run HIGH PRESSURE PUMP at surface
Ventsc	maximum seconds to run vent pump
Ventop	0 do nothing, 1 report liquid level detect (LLD) output, 2 run vent
SkSLsc	seconds to sleep between pressure reads when sinking
AsSLsc	seconds to sleep between pressure reads when ascending
PROup	true if profile on way up, else false
Ndives	total dives to do
CTDofZ	depth to stop CTD pumping [meters]
SrfDft	1 for Latitude (NS) only, 2 for Longitude (EW) only, 3 for both, 0 for none
SrfLon	target Longitude (degrees/20)

Parameter	Description
SrfLat	target Latitude (degrees/20)
SrfMxN	maximum number of drift intervals
SrfInt	minutes between fixes while drifting.
BinMod	Sets the binning mode for the SBE data
BLOK	minimum bin size in dBar.
PB1	breakpoint #1 in dBar: for z<PB1, bin size = BLOK
PB2	breakpoint #2 : for z>PB1, z<PB2, bin size = BLOK*AV1
AV1	AV1*BLOK = bin size for PB1< z < PB2.
AV2	AV2*BLOK = bin size for PB2< z..

Modifying the Mission File

In a "fantail-ready" float, mission profile parameters are pre-programmed at the factory to specifications supplied by the customer and verified prior to shipment. In addition, modification to select mission profile parameters is possible after deployment by sending commands to the SOLO float as detailed in the documentation included, ***Sending Remote Commands to the SOLO Float (PN958523)***.

Mission File Format

Mission profile parameter values are pre-loaded into the SOLO float from a mission file. The mission file is an ASCII text file that contains specific parameter values for the SOLO float mission.

The first line in the mission file contains a description string for the mission. The second line contains the version string for the SOLO float operational software. This will be dictated by MRV and must match the software that has been programmed on the SOLO float at the factory. The remaining lines contain parameter values

Field Designator

A line that begins with:

#	is a comment line
!	designates a mission parameter follows

%   designates a Seabird CTD parameter follows

Default values are assigned to parameters. The mission file does not need to assign values to each of the possible mission parameters.

mission_parameters.602

```
SBE 41CP MRV SOLO mission_parameters.602
SBE602 ARM_v2.0_xmsg_ver:05aug14 # "SBE602" above must match the start of the SOLO
firmware version string
#
# SOLO Mission Parameters
#
# The parameter values specified in this file control the overall operation of
# a SOLO from activation for deployment, to end-of-life. They are downloaded to
# a SOLO using the MRVtest program.  In order to support conventional,
# experimental, and test  missions, MRVtest provides only limited range
# checking on the values specified in this file. Extreme caution is required in
# editing this file to ensure that a viable, non-float-destroying mission has
# been specified.
# Most of these mission parameters can be directly altered after deployment by
# email messages sent to the SOLO ("Ground Station commands"). These
# parameter changes are constrained by range checking done on the float when
# the message is received. Values outside the allowable range are forced to the
# minimum or maximum allowable value. The parameters that can be altered by
# ground station commands are denoted in this file with "GS>min=X max=Y". The
# minimum and maximum values documented here are those present in the SOLO
# firmware version are subject to change.

# Dive Cycle Parameters
#
# The dive cycle parameters program the SOLO to perform three different
# successive sets of dive profiles, termed Cycles 0, 1, and 2. Each cycle has
# independently adjustable parameters, including how many dives to perform in
# each cycle (Cyc0, Cyc1, and Cyc2).  After completion of all the Cycle 2
# dives, the float will repeat the cycles again starting with Cycle 0. After
# the completion of Ndives, the float will behave as if the mission were
# aborted. It will enter BEACON mode, transmitting its position periodically.
#
# The stages of a single dive cycle X (where X is 0, 1, or 2) are:
#  1) Sink -- to near ZtarX
#  2) Seek -- to exactly ZtarX
#  3) Drift -- at ZtarX
#  4) Pre-ascend -- sink from ZtarX to ZproX
#  5) Ascend from ZproX to the surface
#  6) Surface Operations/Surface Drift -- satellite communications
#
# Dive cycle counts
#
!  Cyc0     1 number of dive cycles to target depth Ztar0 GS>min=0 max=32767
!  Cyc1     3 number of dive cycles to target depth Ztar1 GS>min=0 max=32767
!  Cyc2  9999 number of dive cycles to target depth Ztar2 GS>min=0 max=32767
!Ndives  9999 number of dive cycles to perform            GS>min=0 max=9999
#
# Target depths for drifting and profiling
```

mission_parameters.602

```
#
# NOTE: The mission parameter PROup (see below) must be set to 1 to enable
# the pre-ascend sinking from ZtarX to ZproX
! Ztar0   650 dbar target depth for Cyc0 drift GS>min=0 max=1250
! Ztar1   650 dbar target depth for Cyc1 drift GS>min=0 max=1250
! Ztar2  650 dbar target depth for Cyc2 drift GS>min=0 max=1250
#
! Zpro0   700 dbar profile depth for Cyc0      GS>min=0 max=1250
! Zpro1  1000 dbar profile depth for Cyc1      GS>min=0 max=1250
! Zpro2  1200 dbar profile depth for Cyc2      GS>min=0 max=1250 #
# Dive cycle time limits
#
# These are maximum times to spend before proceeding to the next stage of the
# dive cycle. Appropriate settings of these timeout values can help the mission
# continue advancing under various exceptional circumstances.
#
#    Fall & Rise time limits
#
# A typical expected average fall rate, which varies by ballasting details and
# ocean conditions, is about 14 cm/second from surface to 1000 dbar.
#
#    (ZproX/14) * 100 cm/m * 1/60 min/sec = expected Fall time in minutes
# or ( 1000/14) * 100      * 1/60         = 119 minutes
#
# as computed for ZproX in this file, so the timeout values here are around
# three times the expected time.
! Fall0   360 minutes to fall to Ztar0   GS>min=0 max=600
! Fall1   400 minutes to fall to Ztar1   GS>min=0 max=600
! Fall2   400 minutes to fall to Ztar2   GS>min=0 max=600
#
# The rise time limits should normally be set to be somewhat longer than
# the target time to rise from the profile depth, which is:
#
#        (ZproX/MinRis) * 100 [cm/m]   * (1/60) [minutes/second]
# or     ( 2000/11    ) * 100          * (1/60) = 303 minutes
#
# as computed for Cycle 2 in this file. So Rise2 is set to be about double the
# expected rise time.
! Rise0   240 minutes to rise from Zpro0 to the surface GS>min=0 max=1000
! Rise1   600 minutes to rise from Zpro1 to the surface GS>min=0 max=1000
! Rise2   600 minutes to rise from Zpro2 to the surface GS>min=0 max=1000
#
#    Time limits for sinking from target drift depth to profile depth
#
# If the ballasting provides a neutral buoyancy just below ZproX, the float
# will be falling very slowly at the end. The PwaitX parameter will limit
# the time spent trying to attain the ZproX depth.  In this file, the Cyc0
# pre-ascend stage will timeout immediately because Pwait0 is zero. The
# cycle 2 sink rate in cm/second that would cause the Pwait2 time limit to
# terminate the pre-ascend stage can be calculated as:
#
#   ( (Zpro2-Ztar2) / Pwait2) * 1/60 [min/sec] * 100 [cm/m] = timeout sink rate
# or  (2000 - 1000) / 300   ) * 1/60           * 100        = 5.5 cm/second
#
# so in this mission, if the cycle three average sink rate is slower than
# 5.5 cm/sec, the Pwait2 time limit will be reached before the float has
# sunk to Zpro2.
```

mission_parameters.602

```
!Pwait0     0 minutes sinking from Ztar0 to Zpro0 GS>min=0 max=900
!Pwait1   120 minutes sinking from Ztar1 to Zpro1 GS>min=0 max=900
!Pwait2   350 minutes sinking from Ztar2 to Zpro2 GS>min=0 max=900
#
#  Drifting & sampling
#
# SAMmnX * NsamX determines the time spent drifting at ZtarX
# example for Cyc2: 60 minutes (SAMmn2) x 96 samples (Nsam2) = 5760 minutes = 96 hours
= 4 days
!SAMmn0     0 minutes between drifting samples in Cyc0 GS>min=0 max=4320
!SAMmn1    20 minutes between drifting samples in Cyc1 GS>min=0 max=4320
!SAMmn2    60 minutes between drifting samples in Cyc2 GS>min=0 max=4320
#
! Nsam0     0 number of samples to take while drifting in Cyc0 GS>min=0 max=1020
! Nsam1    60 number of samples to take while drifting in Cyc1 GS>min=0 max=1020
! Nsam2    96 number of samples to take while drifting in Cyc2 GS>min=0 max=1020
#!DrfDat     1 Raw sample data during drift. GS>min=0 max=1 #
# Surface Communication parameters
#
!GPSsec   600 seconds maximum to acquire GPS fix          GS>min=0  max=1200
!IRIsec  1200 seconds maximum to communicate with Iridium GS>min=0  max=3600
!ABcymn    60 minutes between transmissions abort state   GS>min=10 max=32000
#
# Surface seeking parameters
#
# The SOLO can attempt to reach a given Latitude and/or Longitude by
# lingering on the surface when favorable conditions are detected. The
# positions are specified in standard units of one twentieth of a degree.
# Although surface seeking can be enabled here in the mission file, it is
# typically turned on via ground station message after deployment. The
# following five parameters enable and control this feature.
!SrfDft     0 code: 0=off, 1=latitude, 2=longitude, 3=both GS>min=0     max=3
!SrfLon     0 degrees/20 Longitude target for E/W seeking  GS>min=-3600 max=7200
!SrfLat     0 degrees/20 Latitude  target for N/S seeking  GS>min=-1800 max=1800
!SrfMxN     0 maximum number of drift intervals            GS>min=0     max=50
!SrfInt    20 minutes between GPS fixes while seeking      GS>min=0     max=7200
#
# Profiling Parameters
#
# Profiling data can be collected and averaged on ascent in a way that changes
# with depth. Three depth zones (top, middle, and bottom) with different
# profiling characteristics are defined with the following mission
# parameters. PROup is normally set to one. If it is zero, the pre-ascend sink
# to profile depth ZproX is skipped. BinMod and UNBINd are experimental
# profiling modes and are normally set to zero. For more information regarding
# use of experimental profiling modes, contact MRV Systems.
! PROup     1 code: 0=do not profile, 1=profile during ascent GS>min=0 max=1
!BinMod     0 code: profiling mode: 0=normal 2,3-experimental GS>min=0 max=3
!CTDofZ     1 dbar depth to stop CTD pumping on ascent        GS>min=0 max=10
!  BLOK     1 dbar minimum bin size for top zone              GS>min=0 max=100
!   PB1    10 dbar depth dividing top and middle zones        GS>min=0 max=1000
!   PB2   500 dbar depth dividing middle and bottom zones    GS>min=0 max=1020
!   AV1     2 multiplier-middle zone bin size (size=AV1*BLOK) GS>min=0 max=100
!   AV2     2 multiplier-bottom zone bin size (size=AV2*BLOK) GS>min=0 max=100
!UNBINd     0 code: 0=no unbinned data, 1,2-experimental      GS>min=0 max=2
!UBZmax   300 dbar depth to begin collecting unbinned data    GS>min=0 max=2100
!   UBn   300 number of unbinned data scans to send           GS>min=1 max=1020
```

mission_parameters.602

```
#
# Activation/Deployment Parameters
#
# These parameters control the behavior of the SOLO following activation
# via magnet swipe.  dBarGo is used to check for being in water. When the
# dBarGo depth is exceeded, the SOLO begins to execute its mission.
# MaxHrs is the time after which the mission will begin even if the dBarGo
# event is never detected. This allows test missions to be run at zero dbar
# ("parking lot testing"), and also acts as a fail-safe feature that may allow
# for recovery in case of pressure sensor malfunction.  DiveNo and Phase are
# present here only to provide a convenient way to reset them to zero on a
# float that has started a mission.
!dBarGo    50 dbar depth to start mission (start when pressure exceeds 50 dbar)
!PchSec   600 seconds between pressure checks following activation by magnet
!MaxHrs 25920 hours maximum wait before mission is started (25920 hours=1080 days)
!DiveNo     0 number of dives started    (ALWAYS reset to zero!)
! Phase     0 phase of mission (ALWAYS reset to zero!)
#
# Float engineering Parameters
#
# Intervals for checking pressure
!SkSLsc  120 seconds between pressure reads when sinking   GS>min=120 max=3600
!AsSLsc  120 seconds between pressure reads when ascending GS>min=120 max=3600
#
# ascent tuning
#
# Parameter MinRis is a threshold for ascent rate, pump when rising slower
!MinRis    11 cm/second minimum ascent Rate             GS>min=3   max=30
!PmpBtm    74 seconds to pump at the bottom of dive     GS>min=5   max=1500
!Pmpslo    24 seconds to pump when ascent rate too low  GS>min=5   max=200
#
# Pump Time Limits
#
! MxHiP   600 seconds maximum pumping time for a cycle      GS>min=200 max=1500
! MxSfP   300 seconds maximum pumping time at the surface   GS>min=0   max=500
! MnSfP   150 seconds minimum pumping time at the surface   GS>min=20  max=700
#
# SEEK parameters
#
! Nseek     1 number of seeks to perform to reach target depth GS>min=0 max=3
!STLmin   120 minutes to spend waiting to settle after seek    GS>min=0 max=600
!mxSeek   250 tenth seconds maximum time to pump in SEEK       GS>min=1 max=1000#
# dTAdZ can be estimated, using a buoyancy factor of 3.9 cc/100m and a
# pump rate of 1.6 cc/second as follows:
#
#   3.9 [cc/100m] * (1/0.8) [seconds/cc] * 1000 [milliseconds/second] = 4880#
! dTadZ  2530 milliseconds required to ascend by 100 m GS>min=1000 max=6000
#
# dTsdZ can be estimated, using a buoyancy factor of 3.9 cc/100m and a
# flow rate of 2.5 cc/second as follows:
#
#   3.9 [cc/100m] * (1/2.5) [seconds/cc] * 1000 [milliseconds/second] = 1560
#
! dTsdZ  1560 milliseconds required to sink   by 100 m GS>min=1000 max=8000
#
# The TlastX parameters are starting values; they will be recomputed as the
# mission proceeds (if Nseek is enabled). These starting values can be estimated from
```

mission_parameters.602

```
ZtarX
# values using a buoyancy factor of 4.1 cc/100m and a pump rate of 1.6 cc/second
# as follows:
#
# TlastX = (Neutral Depth - ZtarX) / 100 dbar * [cc's per 100 dbar depth change] /
pumping rate[cc's/sec] * 10
#
#
!Tlast0   384 tenths of seconds to pump out to reach Ztar0 GS>min=0 max=2500
!Tlast1   384 tenths of seconds to pump out to reach Ztar1 GS>min=0 max=2500
!Tlast2   384 tenths of seconds to pump out to reach Ztar2 GS>min=0 max=2500
#
# extra pump settings
#
!XP0    0
!XP1    0
!XP2    0
!XPdly  0
#
# ice detect settings
#
!Ice_Pd 40   deep end of temperature check range
!Ice_Ps 20   shallow-end
!Ice_Mn 0    check for ice for NO months
#            Ice_Mn =4080 =0xff0 for May-December checking
!Ice_Tc -165 -1.65 degrees C is the threshould
!Ice_Sc 30   seconds between T check when within range
#
# Miscellaneous Parameters
#
!Ventsc     10 seconds maximum time to run vent pump        GS>min=0  max=20
# legacy values are supported for Ventop = old_Ventop mod 10
!Ventop      2 code: 0=do nothing, 1=report LLD, 2=run vent GS>min=0  max=30
!OILvac    129 counts maximum oil vacuum on feed line       GS>min=50 max=250
!FuseMd      0 Fuse mode
!dTfldZ  1900 Only used when fuse mode enabled.(3.8cc/100m)/(2.0cc/second) in thousands
```

Section 10: Communication with the SOLO Float

Communication with the SOLO float is bidirectional. The SOLO float contains an on-board Iridium modem that is used to transmit data back to the user in SBD (Short Burst Data) packets. This communication link can also be used to send remote Ground Station commands to the float to dynamically update the Mission Parameters. This section provides information on decoding messages sent from the SOLO float to the Ground Station. For information on how to send commands from the Ground Station to the SOLO float refer to the ***Sending Remote Commands to the MRV SOLO Float (PN958523)*** included with your float shipment.

Receiving Messages from the SOLO Float

The most current documentation on message formats received from the SOLO float can be found on http://sio-argo.ucsd.edu/manuals.html

The current X message version is 2.0.

Decoding Float Messages Received

Data is transmitted back from the float (Iridium Subscriber Unit or ISU) to the Ground Station (GS) using an on-board Iridium modem. The data is binary and is transferred using a Mobile-Originated Message in an SBD (Short Burst Data) packet. The packet is delivered by the Iridium network in an email with a binary attachment that is encoded using standard MIME Base64 encoding. The attachment can hold at most 340 bytes and contains one message in a custom data format used to encode the float data. This custom format is the “X-Message”. An overview of the packet types and structure is included below in the section *SBD Packet Types*. Additional details about the X-Message packet formats are contained in the document *Format of SOLOII X messages: Argo Version Manual/Decoder V2.0*. MRV has included this document: ***Format of SOLOII X messages: Argo V2.0 17Oct2014*** **(MRVPN: 958527).**

Once the float makes contact with the Iridium Satellite network, the SBD data packet will be transmitted by the Iridium modem. The email will then be created by the Iridium Gateway and delivered to a maximum of five different email addresses. The email will include the SBD data attachment as well as the Mobile Originated Message Sequence Number (MOMSN), the time of the session, the session status, the message size, and ISU specific geo-location information. Note, the DoD Defense Information Systems Network (DISN) Enhanced Mobile satellite Services (EMSS) modems do not transmit the ISU specific geo-location information in the email messages.

After each dive, the float will send back its data. Since the SBD packet size is limited to 340 bytes, the data must be split up into a variable number of X Messages. A typical profile will consist of 12-13 email messages and an average total of 4.2 Kbytes of data. The X-Message consists of a series of bytes that starts with an ASCII X (0x58). The float currently uses version 2.0 of the X Message format. The format of the packets is shown below. For details about the X Message packet formats, refer to the specification ***Format of SOLOII X messages: Argo Version Manual/Decoder V2.0*****.**

SBD Packet Types

Packet Type	Packet ID	Packet Contents
GPS SENSOR MESSAGE	0x00, 0x01, 0x02, 0x03, 0x05	GPS data
CTD SENSOR MESSAGE	0x1x (x=0-f), 0x2x (x=0-f), 0x3x (x=0-f)	During each ASCENT, the Seabird CTD sensor collects profile data for the dive. The pressure, temperature, and salinity data is sampled every second and stored. On the surface the data is block averaged into sequential depth bins and transmitted as: • Pressure Message (0x10) • Temperature Message (0x20) • Salinity Message (0x30)
FALL RATE DATA MESSAGE	0x4x (x=0-f)	During sink from SURFACE to DRIFT depth, the float makes periodic depth/time readings. Sends these readings.
RISE RATE DATA MESSAGE	0x5x (x=0-f)	During decent from DRIFT depth to PROFILE depth, the float makes periodic pressure/time readings. Sends these readings.
PUMP DATA MESSAGE	0x6x (x=0-f)	During each DIVE, float keeps track of when the pump ran, and sends message with this information.
ENGINEERING DATA MESSAGES		For each DIVE, sends engineering data that tracks performance and diagnoses anomalies. Message sent depends on the mission phase.
CTD SENSOR HIGH RESOLUTION MESSAGE	0x9x (x=0-7), 0xax (x=0-7), 0xbx (x=0-7)	During each ASCENT, the Seabird CTD sensor collects profile data for the dive. The pressure, temperature, and salinity data is sampled every second and stored. If the float is configured for raw samples, the data is transmitted as: • Pressure Message (0x90) • Temperature Message (0xA0) • Salinity Message (0xB0)
CTD SENSOR DRIFT MESSAGE	0x9x (x=8-f), 0xax (x=8-f), 0xbx (x=8-f)	During each DRIFT, the Seabird CTD sensor collects profile data for the dive. The pressure, temperature, and salinity data is

		sampled at the configured rate. If the float is configured for raw DRIFT samples, the data is transmitted as: • Pressure Message (0x90) • Temperature Message (0xa0) • Salinity Message (0xb0)
ENGINEERING DATA MESSAGE	0xe0	After DIAGNOSTIC DIVE, sends diagnostic data.
PROFILING ENGINEERING DATA MESSAGE	0xe2	After NORMAL DIVE, sends profile data.
MISSION ABORT ENGINEERING DATA MESSAGE	0xe3	After receiving ABORT command, sends abort data.
ENGINEERING DATA MESSAGE	0xe5	BUILT-IN TEST (BIT) pass result and sends BIT engineering data.
ENGINEERING DATA MESSAGE	0xe6	BUILT-IN TEST (BIT) fail result and sends BIT engineering data.
MISSION EEPROM DUMP DATA MESSAGE	0xd0, 0xd1, 0xd2, 0xdx	Mission parameters stored in EEPROM.
ARGO DATA MESSAGE	0xf0	After each dive, specific dive information for creating the PHY file for the ARGO community is sent.

X-Message Data Format

This section describes the X-Message data format. The X-Message Data format is similar to the X-Message Command Format. The format of the X-message command packet is shown below.

Xnnmmddp<data>**$**cc>

X = the character **X** (0x58)

nn = number of data characters in the message following after nn. The count does not include **X** ,nn, **$,** cc to the final delimiter ‘**>**’**.** The count is in 2 binary bytes with leading MSB then LSB.

mm = Float serial number. The serial number is in 2 binary bytes with leading MSB then LSB.

dd = the dive number in 2 binary bytes with leading MSB then LSB.

p = one-byte Packet ID Index (0-255). Used to identify between multiple X messages within a Dive Cycle. The data for each Dive Cycle starts with p=0.

<data>= binary data characters. The length of <data> = nn -5. The contents of the <data> section is described separately.

$ = a dollar sign (0x24) delimiter at start of the checksum

cc = the 8 bit byte-wise checksum from **X** to the byte preceding the **$**. The 8 bit sum is coded as 2 4bit nibbles. The binary value of a nibble is converted to a visible character by adding 0x30. Thus a value of 0x0 -> 0x30 = character '0', 0x1 -> 0x31 = '1', 0xe -> 0x3e = '>' , and 0xf -> 0x3f = '?'.

> = "greater than" (0x3e) delimiter at end of checksum which also serves as a prompt to GS that the ISU is done transmitting and that the GS may now transmit to ISU.

X Message <data> Reference

The <data> portion of the X-Message stores 1 or more messages of sensor data. Data from successive sensors are separated by a semicolon '**;**' (0x 3b); the final sensor data message is terminated by a '**;**' then **$** delimiter.

IDjj<sensor_data>**;**

ID = one-byte sensor ID code described below

jj = Number of bytes for this sensor. The count includes **ID,** jj, and the trailing **;.** The count is in 2 binary bytes with leading MSB then LSB.

<sensor_data> = Binary data characters. The length of <sensor_data> = jj-4 bytes, and its contents are described below for each sensor.

; = Delimiter at the end of each sensor's data.

The **ID** byte is divided into two 4-bit nibbles. The most significant nibble identifies the sensor and the least significant nibble specifies the message number for that sensor. For example, the ID for first Pressure message is 0x10, the second is 0x11, the third 0x12, etc. For a 1000 sample profile, there will be 6 messages for each of the pressure, salinity and temperature sensors. For single packet messages (e.g. GPS and Engineering) the second nibble stores the **Phase** of the float.

Troubleshooting

Problem: Can't Wake Up Float or Float Not Responding

- Re-seat the MRV supplied custom console cable. The cable to Boss plug connection is a very tight fit and can be difficult to fully seat.

- The startup sequence can be monitored directly by using a terminal program (such as TeraTerm). Swiping the magnet displays the startup sequence on the screen. If the proper console port is connected and the serial cable is installed correctly, a "Starting.." message should appear almost immediately, followed after several seconds by the startup banner indicating the Iridium IMEI number and the float firmware version. Refer to *Section 4: Pre-Deployment Communication with SOLO.*

Problem: Can't Load Mission Profile Parameter(s)

The operator can override mission parameters by changing the parameter directly through the console interface through a terminal program (such as TeraTerm).

IMPORTANT: All such exceptional modifications should be done in close coordination with MRV Systems.

Swipe the magnet which starts the BASic (indicated by the `BAS>` prompt) menu

- Press 'E' to go to the EEProm menu (`EEP>` prompt)
- Press 'M' to modify an EEProm value
- When prompted, enter the exact parameter name to be changed
- When prompted, enter the new value
- Repeat for all parameters you are overriding
- When you have completed the process of changing parameters, **the float must be put in a de-activated state to conserve batteries.**
- To de-activate the float enter 'x' from the base menu prompt. You will see a message on the screen verifying that the float is shutting down.

Problem: Mission Profile Parameter **DiveNo** (dive number) Not Zero

For deployment, the initial value of **DiveNo** should be Zero. The dive number can be set by reloading the mission file. If necessary, the **DiveNo** can be set through the console interface using any terminal emulator.

If **DiveNo** is greater than 0, you will see the following prompt following activation:

```
Will wake up every 10 secs for 300 secs

Hit ‘w’ to exit sleep...
```

If the 'w' key is pressed within 300 seconds and the MRV supplied special serial cable is attached to the SOLO, the float will enter **COMMAND MODE** and you can reset the **DiveNo** to 0.

When you have completed the process of changing parameters, **the float must be put in a de-activated state to conserve batteries.** To de-activate the float enter ‘x’ from the base menu prompt. You will see a message on the screen verifying that the float is shutting down.

Service Response Times

During the warranty period, if you have technical issues or questions involving a specific application or deployment with your instrument, MRV Systems must be notified directly within 24 hours. We will respond by email or phone within 48 hours of receiving your inquiry.

MRV Systems

6370 Lusk Blvd, Suite #F100
San Diego, Ca. US 92121

Technical Support:

DIRECT 011 (858) 952-5937
FAX 011 (858) 952-5935

support@mrvsys.com

24 Hour Emergency Support:
011 (858) 775-0243
011 (858) 216-5740

Service Response Times

If you have technical issues or questions involving a specific application or deployment with your instrument, notify MRV Systems. We will respond by email or phone within 48 hours of receiving your inquiry.