

# SeaTag-MOD™ FAQ

09 February 2021

## How to Get Started With a SeaTag

Tagging is a complex endeavor, and success with a new tag or in first-time tagging requires that many variables are properly attended to, and ultimately work out right. Realistically, given that complexity, some aspects will probably not work out right on the first attempt. Therefore, some sort of a ramp-up or experimentation phase should be planned.

The following is a collection of ‘things we learned’ related to tagging project ramp-ups. There are a range of valid strategies from slow and methodical to fast, each with its own benefits and risks. Your decision should be based on the particular time-to-conclusion, risk acceptance and budgetary constraints of your project.

### Is this tag right for me?

Different manufacturers may have different objectives and priorities in their tag designs. Desert Star’s SeaTag program is specifically focused on providing enhanced innovation in tagging, and to offer these tags at a lower cost that supports larger scale studies. That’s the upside. But, the corresponding downside is that a new and innovative tag will also have a lesser field history, and so there will be some associated performance risks or unexpected behavior.

We think that SeaTag is in particular useful for scientists conducting advanced research and who have some degree of risk acceptance. If you are working on a long established resource management program where risk must be minimized and the capabilities of a traditional tag you are using now suffices, be more careful. SeaTag may still be a good candidate (that call is up to you), but you should probably plan for a more extensive ramp-up phase to validate its capabilities in the context of your work.

### Is the Mini-Mission required?

It is highly recommended, especially if you are also purchasing the enhanced warranty SeaTag-GOLD™. However, neither SeaTag-GOLD nor the Mini-Mission testing is required.

The mini-mission is a powerful concept to test a specific tag capability, or an entire mission, in a shortened period of time and generally under controlled circumstances that allow for iterative corrections. For example, whenever you find some new feature in a

firmware update for SeaTag-MOD, we will probably have run one or several of such targeted mini-missions to test the capability (you can get the data set or results for it if interested). In a similar fashion, we recommend that you run one or several of these mini-missions prior to an actual tag deployment at sea. Of course, what enables these mini missions is that SeaTag-MOD does not have an internal battery that may get depleted or a release section that cannot immediately be replaced. So, you can conduct a mini-mission, perhaps attach a new release/power section (depending on what you are testing), and the tag will be ready for another test or the actual deployment.

Mini-missions will differ a lot depending on what aspect is under test. The fundamental principle is to test a specific sequence of events, a 'mission' as opposed to one particular aspect only. This sequence oriented approach may support a planned full deployment, or uncover weaknesses in parts of that deployment. The fundamental elements of a mini-mission are:

1. Determining and setting the software configuration parameters for the tag in SeaDock and to program the tag to execute the desired mission. This may for example include a specific sensor data sample frequency, the use of the constant depth release (CDR) mechanism, RF based surface detection (RFSD) and etc.
2. Physical assembly of the tag, including selection of the release/power section and arming of the release mechanism.
3. Deployment of the tag in an underwater test location. This may for example be tethered at the bottom of a bay to acquire light/magnetic position data, or perhaps attached to an animal in an enclosure.
4. Observation of the release firing at the programmed time. For example, divers may be in the water to observe the mechanism act.
5. ARGOS transmission by the tag now floating at the surface. Perhaps the tag is re-tethered now at the surface so it won't float away, but water conditions are similar as in a full deployment. The amount of data that can be transmitted via the satellite link may be tested.
6. Recovery of data via the internet, using either the ARGOS web site, or the SeaWatch™ software.
7. Processing of the data recovered by ARGOS, and inspection of data quality.
8. Physical recovery of the tag, and download of the stored data.
9. Processing of the stored (sometimes referred to as "raw") data.
10. Physical inspection of the tag for signs of degradation or fouling.

11. Inspection of the stored solar panel voltage and capacitor voltage data to verify power generation and consumption with your settings.

### **Evaluate with few tags, or evaluate with many tags?**

There are valid approaches involving field testing with few or many tags. Here are two proposed strategies:

1. The few tag strategy: This of course has the advantage of limiting the dollar amount and risk of your initial purchase. Doing oceanic animal tagging with just a few initial tags is probably not a good idea, however. The success of many aspects of tagging is probabilistic, and so no matter if a tagging study with just a few tags fails or succeeds, it may not have much predictive power. However, doing an extensive lab, field and controlled underwater environment study with a SeaTag starter kit and just two or three tags can be very useful! You will be able to study the tag operation, evaluate the sensor performance, check solar powered ARGOS transmit capabilities under comparable conditions, perhaps test aspects of your tag attachment system and so on. Once done with controlled environment tests, you might even put your tags on a couple of animals for some short term tagging. You can then decide if and how to proceed.
2. The many tag strategy: An initial purchase and deployment of 10+ tags can get you out of the gate faster, but also entails a higher risk. The strategy here starts the same as the 'few tag' strategy; that is extensive lab and controlled environment field testing. But then, you quickly proceed to a test tagging study of 10+ animals (we have seen up to thirty animals tagged in a first study so far). You should expect that this test tagging will not be a 100% success, just be prepared for that. In fact, the explicit purpose of this test tagging should be validate your entire tagging regiment, and to uncover any weaknesses. These findings are then used to make improvements as the ramp-up to full scale tagging proceeds.

When deciding on the few or many tag evaluation strategy, please keep in mind that Desert Star's policy for tag returns is very limited (see our terms of sale) and specifically excludes suitability for purpose as that is a subjective parameter beyond our control. That's a business necessity to provide good pricing and volume discounts for all SeaTag users, but it also means that you should consider your budgetary risk clearly before deciding on an evaluation strategy.

### **Some user experiences with fast ramp-up examples:**

This section has emphasized a methodical ramp-up to maximize the chances of initial success. But, to some degree science is also a race and a competition. Therefore, some users choose a running start despite the risks and deploy many tags on first try.

Here is a review of three such cases. These stories are for general insights and guidance only, thus the name of scientists and species studied is withheld.

***Nothing-to-tagged in one week flat!*** This researcher of a large marine species received his first set of tags...and within 24-hours was on the airplane to the tagging location. Before the week was over, eight of his ten tags were on the fish. The result was mixed....one tag fired its release after two weeks, having mistakenly been programmed so. Yet, a second programming mistake 'compensated' and this tag produced a beautiful high-resolution time series for these two weeks. Other tags shed after some time before the programmed release data. But in the end, the scientist was left happy: data had already uncovered previously unknown behavior, and some migrating patterns had been confirmed. Thereafter, the scientist also found that a battery in the release section really isn't necessary (read: smaller tag length). Recently, he went on his second tagging mission – based on the first year's data becoming the first SeaTag user to forego batteries in his tags entirely.

***Great data despite shedding.*** Ultimately, all tags will shed. Musyl et. al found an average tag retention of 79 days for 731 studied PSAT tag, with a wide spread from one to 366 days. Tag retention depends on the animal, the attachment method and characteristics of the tag itself. To maximize retention, experimentation is called for. But, while large-scale tagging on a first try is risky, with the right test plan it can also yield great data. Here are two examples:

1. This group was quite aware of the shedding potential of the energetic fish they were tagging, and worked to minimize retention. But, their research objective(s) also called for fast execution, and so after consultation with DSS, they decided to tag about 20 animals with SeaTag-MOD. In fact, most tags had shed well before the pop-up date, but the group had hedged their bets. In addition of seeking long-term daily summaries of migration, their tags did triple-duty. High-resolution acceleration (HRA) measurements was enabled on some of the tags, and produced detailed insights into feeding behavior even after a few days. In addition, full sensor scans collected at an accelerated rate and transmitted by means of the tag's solar powered transmission provided high resolution time series data. Finally, the light and magnetic geo-positioning of the tag proved accurate enough to track the targeted migration of the fish to specific oceanographic features just a few tens of miles in diameter within days of tagging. While long-term migration data was not obtained, the group now switched to using the much smaller SeaTag-GEO tag with its better retention for that purpose, while continuing to use SeaTag-MOD for advanced behavioral studies.
2. This group tagged over 30 animals with pop-up date set to one year. Only few of their tags reached that retention duration, with most shedding at various points throughout the year. Still, the tagging worked out well. Data showed that the animals migrated by and large as a group. Pop-up positions obtained from

shedded tags where consistent with and thus confirmed the light and magnetic position estimate tracks transmitted by other tags with longer retention. This included one such track that described nearly a full annual migration along the route of the popup positions of numerous shedded tags.

***Rarely heard from, but golden.*** This researcher is aiming for the ultimate prize: Lifetime tags that will, eventually, be able to track and report from an animal until the animal is deceased. But, doing so requires overcoming many hurdles, including for example eliminating the immersion switch that is normally used to tell when an animal has surfaced and a transmission can be attempted because that is also a technology liable to eventual failure due to fouling. So, we developed a new technology called 'RF surface detection' (RFSD) which uses the radio signals to detect surfacing. High risk, the method was put on six initially deployed tags – and very few receptions were obtained. Yet, near miraculously two of the large animals showed up three months later at the same spot and divers took the opportunity to recover the tags. On them was a treasure trove of data: Full sensor suite time series in four minute intervals...magnetic and light based positions, body orientation through 3D accelerometers, dive behavior, temperature, light level and power consumption observations and more. The data and other tests resulting from it also led to RFSD improvements, which was re-deployed on six more animals (better but still not great), with a third revision now in use. Meanwhile, the endurance of solar powered transmissions allowed a free floating tag (released from the animal) to be physically recovered through radio direction finding. It, too, told the story of that animal in great detail. Two more separated and are now using their solar power capability to first transmit summaries, which should soon be followed by their time series and with it the mysterious activities of these animals.

We think that these examples show an important thing. When pursuing a fast ramp-up, you will be taking a risk. The data you get back may not be exactly what you are looking for. But, with awareness of the possible points of failure and some good planning, high quality and insightful data can be obtained almost always.

### **What is the cost for the battery section? How long can the tag be deployed on an animal with this battery?**

Most customers will use the ST-MRPS release section with a rechargeable ½ AA Lithium 3.6V 1.1Ah 100mA battery. The longest successful deployment has been 3 years. All SeaTag's are solar powered which aids in the longevity and recharge-ability of the lithium battery. The price for each ST-MRPS is \$431 USD.

For use as an ocean drifter the SeaTag-MOD does not require a battery section.

For benthic species or animals that are believed to spend the majority of their life in areas with less than 1 lux of exposure to natural light we can manufacture battery sections with a larger battery. Ask for details.

The SeaTag-MOD is a reusable tag but the battery release sections are not reusable. To reuse a SeaTag-MOD for future projects, you will need to purchase additional battery release sections. We have several customers who have reused the SeaTag-MOD for the same project up to four times, have saved them for future projects or provided them to other colleagues to use.

**What sampling resolution can we expect over a 9 month period? Our tags presently sample once every 15 mins.**

The maximum sampling resolution we will initially support (for firmware simplicity reasons) is once every 16 seconds. The standard memory is 2 GB, and the data packet for all sensors is 32-bytes. This works out to a memory capacity of 34 years.

**What is the temperature range that the tags measure?**

The tags are designed for operation at -40 deg C to +85 deg C.

**What is the margin of error associated with temperature and depth measurements?**

The system-level error for temperature in the -40deg C to +85deg C range is expected to be 0.2 deg C, with 0.1 deg C of that contributed by the factory calibrated thermistor itself. The short-term precision or repeatability of the temperature measurements will be better than 0.001 deg C.

The depth measurement accuracy in the depth range from 0 to 300m is anticipated to be 0.3meters. From 300m to the maximum depth of 2000m it is expected to be 20m. This is because we do a precision calibration of the sensor from 0-300m, but rely on the sensors native performance at depth greater than that. The valid temperature range for the high accuracy will be from about 0 deg C to 35 deg C.

**Do the tags come with dart attachments or is that something that the user attaches?**

We decided (at this point) to only supply the tags themselves. In most cases, we anticipate that customers may already have a dart that they are familiar with and like to use. The bottom of the tag (the part that will stay on the animal) will have a hole drilled through it like our other tags. This hole is used to run the dart attachment link through and to the animal.

If you are tagging for the first time we can recommend tethers to use and share best practices from previous customers.

**I am thinking that I probably need to budget time for satellites; how much is this?**

Satellite costs depend partially on what information will be transmitted. The customer will choose whether they want daily positions, daily positions with sensor data (based on a customer defined sampling rate), or daily positions with all RAW data.

You have the option to pay per received transmission or choose unlimited and the cost is capped at \$63 per month for each tag. Most customers obtain a full data set of after 2 – 5 months of satellite reporting.

**Do the tags broadcast all of the data when they come to the surface?**

In the Seatag software there is a check box that allows the customer to choose what kind of transmissions they want. The options will be daily positions, daily positions with sensor data (based on a customer defined sampling rate), or daily positions with all RAW data. So it just depends on what is selected.

In general, priority packets in the form of daily summaries are chosen as the first data to be transmitted.

**The tags we have used previously measure light levels at 550 nm wavelength and are pressure rated to about 2000 m. Are your tags similar? Also, what is the minimum threshold of the light sensors (solar cell)?**

The units will be factory tested to 2000m (limit of our pressure test system), although an operation de-rating of 15% to 1700m will be recommended.

SeaTag-MOD uses a wrap-around solar cell for both energy harvesting and light measurements. One of the principal advantages in terms of light sensing as compared to a small-area sensor used on most tags is that the wrap-around cell averages the readings, making them largely independent of tag orientation and as such more reliable for noon-time determination (day/night sensing). As a power harvesting device, the solar cell has a broad-band response to light, with a peak efficiency at about 540nm, but >50% of its efficiency between about 420nm - 650nm.

The resolution of light sensing is about 75 microLux. However, we yet have to specify the noise level of the solar panel, so caution is advised! This compares to a resolution of 1 Lux for SeaTag-GEO, which to date has proved sufficient for our method of longitude sensing. Full moon light is 1 Lux.