

SUNA V2 Humidity Bulletin:

A complete solution for ingress

Humidity quality issue:

The SUNA V2 can suffer from rates of humidity ingress which can ultimately result in premature sensor degradation or failure. This is usually exhibited first as spectrometer noise followed by spectrometer or electronics failure. As Sea-Bird Scientific scientists and engineers have worked on this issue, we have urged customers to monitor humidity so sensors can be sent in for purging and repair *before* the humidity causes data quality concerns or permanent damage. We have also been upgrading instruments to better prevent ingress. In most cases, only continuous users in warm waters are seeing failure before the recommended annual service period. We understand this has been a difficult process for our partners and customers, but we have not been idle.

Humidity solution:

We have isolated the causes of humidity ingress and tested various solution paths in the lab. The solution is a new housing design which features water impermeable titanium housing material, structural strengthening, and improved hermetic sealing. These upgrades are now available to our affected customers free-of-charge. Sensor performance specifications such as precision, accuracy and range are not affected by this change.

We targeted ensuring that humidity levels would stay safe for the most adverse conditions for humidity. These include low pressures, high temperatures, extended continuous deployments, and the possibility that instruments may be deployed longer than our recommended annual service interval. The most obvious difference-- besides minimizing humidity to levels that will permit >18 months of continuous submersion at 40°C – is that SUNA V2 will replace plastic housing components and transition to a full titanium housing, increasing weight ~0.6-kg for upgraded V2s and changing the appearance from black to shiny. Price will remain the same. All plastics are somewhat permeable to water; by using a titanium housing we can eliminate ingress through the housing material and provide a stronger sensor that is less susceptible to mounting and deployment stress that can flex housings and compromise O-ring seals. We fully expect that most deployment scenarios will permit well beyond 18 months of deployment, but we still recommend annual service to ensure quality nitrate measurements.

When is the fix is available?

After March 15th, SUNA sensors will ship with the new design and we will begin upgrading affected customers' sensors. We will upgrade affected SUNA V2 sensors until July 1st of 2017.

How fast can you get your SUNA V2 back?

We're determined to make service times faster, especially as we fix the humidity issue. We realize that monitoring season is starting soon (or ongoing) and that in general need the fastest service times possible. We also know that we have fallen short of our service goals in many of your cases. Our goal is a 4-week servicing turnaround time, and we have taken meaningful steps to ensure it, including opening a second service line for SUNA by March 15th. We expect that instruments returned for humidity ingress upgrades will get back to you within 4 weeks, and we will carefully track and discuss any stragglers. We ask that you work with our customer service representatives as we prioritize upgrades for customers with instruments near or beyond failure levels and very high rates of ingress. If your SUNA has come in on an RMA for another reason it may be upgraded if it is found to be affected.

How much does it cost and who is eligible?

The price of a SUNA V2 with these new upgrades will not increase. We will cover the costs of shipping current V2s (both ways) and costs for upgrading and calibration. Some customers will be unaffected or have very slow ingress rates based on usage and deployment scenarios. To assess the present humidity condition of your SUNA and determine whether it needs the upgrade, we have provided an Advanced Test through the SUNACom software, described below. The test can determine if the instrument is affected by the issue before data quality suffers. The upgrade will be provided on a priority basis to the most urgent cases for affected SUNA V2 instruments as determined by the test. If you have not encountered the issue, it is unlikely you will be affected. To receive the upgrade for your SUNA V2, your SUNA V2 must have been built or serviced in 2014 or 2015, or built in 2016.

If your sensor needs additional service either our standard service or more specific service (e.g., lamp replacement) will be quoted.

What took so long and how is this different from the V2 humidity upgrade?

We realize this has been a long road. Users brought the humidity issue to our attention in 2014. A double O-ring design demonstrated an improvement (less ingress than single O-ring) in *non-accelerated* lab testing. In early 2015 we took initial steps of upgrading SUNA V2 housings to a double O-ring design to minimize ingress from flexure and mounting stress. We continued to monitor humidity levels of this upgrade in the field with key customers (~20 sensors). After several months of field testing the double O-ring design, data from warm climates with continuous sensor deployment showed ingress rates were still too high for SUNA to perform ~1 year before humidity caused data quality degradation, evidenced as spectrometer noise. Throughout 2015 we also continued laboratory research to identify the source of the ingress and refine our testing methodology. We continued to perform the double O-ring upgrade to slow ingress and our final titanium design incorporates double O-rings at all sealing surfaces. With accelerated testing at high temperature (40°C and no desiccant; pressure had negligible impact on ingress rates) it still took 3-8 weeks before we could interpret results for a given experiment. We tested several hypotheses (8) and ran experiments in parallel to speed up testing; overall about 60 independent sensors tests were conducted representing 20 SUNA deployment scenario variations. Many of the tests were done with replicates and triplicates to clearly identify ingress rates. Although identifying the sources of the issue took us a year, this process clearly identified the root causes of the issue so we could ensure its solution.

Important things to do now, how to know if you may be affected, and what to do:

SUNAs in the serial number range of 199-810 could be affected. If your SUNA is within this range we would like you to look for the symptoms below, run the self-test, and contact support@seabird.com if you need assistance. If your serial number is not in the stated range or if you have a Deep SUNA, you should not be concerned. If you receive this and are not the user, but a manager, purchaser, etc. please forward this message to the appropriate party or contact support with their contact information (thank you!).

SUNA V2 Humidity Bulletin:

Determining if affected

Evaluating your SUNA for humidity ingress:

Humidity in SUNA V2 increases over time causing spectrometers to exhibit high dark noise and fail the humidity self-test. To know if you are affected, first run a self-test; if the test fails for humidity or dark counts, please run the advanced test described below (in certain cases the self-test can result in false positives). If the advanced test passes, continue to monitor your SUNA V2 with self and advanced tests at your regular service intervals. If the advanced test fails, please contact support@seabird.com and provide the test result data. Humidity increases could be exacerbated by higher temperatures and pressures. Mechanical mounting arrangements that squeeze the housing out-of-round and that cause any bending force along the long axis of the SUNA could also worsen the issue.

Advanced test:

Step 1: Using SUNACom, go to the "Sensor" drop-down menu in the upper right hand corner and hover over the "Advanced" option and select "SUNA Self Test."

SUNA Operators running a SUNA Self Test may see an '!' in the spectrometer dark test, and an \$Error 1 response at the end of the output. The result of the Self Test is meant to alert that a more comprehensive test should be executed to properly evaluate the spectrometer and if the relative humidity in the SUNA exceeds 50%. The (!) alert is spurious if the spectrometer dark noise value is ≤ 9 AND the dark max-min is < 80 . Otherwise, we recommend the following comprehensive test.

Step 2: Collect spectrometer dark data using SUNACom

SUNA Settings -> General Tab:

Continuous Operating Mode

Frame Based

Light Frames: 1

Dark Frames: 5000

Sampling Average: 1

Disable Wiper (if present)

SUNA Settings -> Telemetry Tab:

Set frames to FULL_ASCII

Start Data Acquisition, and Log 15 minutes of data to file.

Step 3: Contact Support with instrument information and a copy of the Data Log file at support@seabird.com for evaluation.