

SeaTag™ MOD Power Consumption and Battery Endurance



15MAY13

(Full Data: SeaTag MOD Power Consumption & Battery Endurance 15MAY13.XLS)

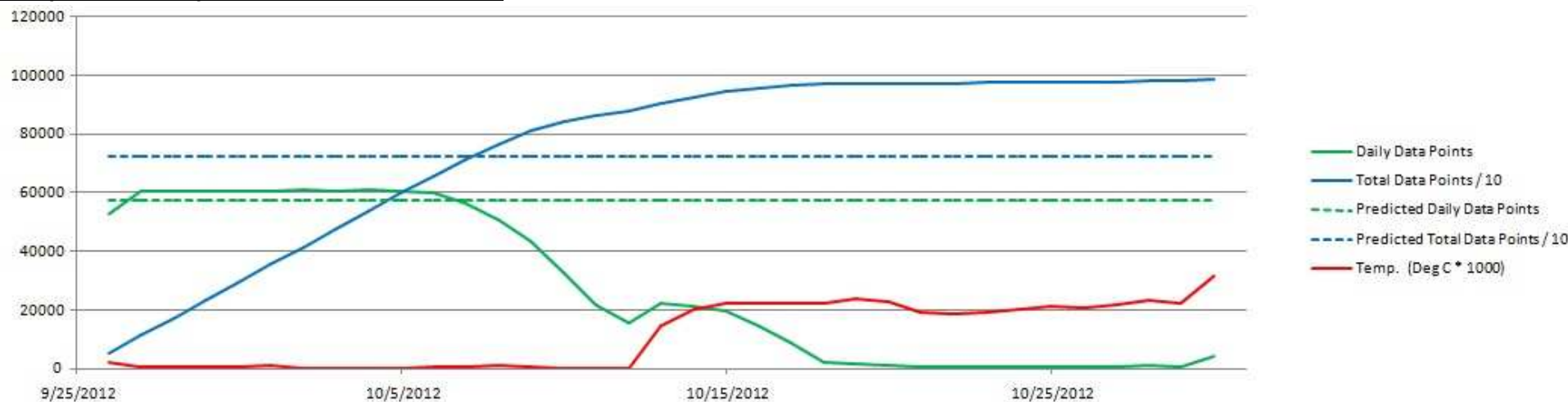
Power Consumption & Estimated Endurance in Data Acquisition Modes

Operating Mode	Observed Actual Sensor Sample Interval (sec)	Average Consumption (uA)	Percentage of full sunlight to maintain operation (%)	Darkness endurance without battery (hours)	Endurance with small battery pack ST-MRPS (days)	Endurance with large battery pack ST-MRPL (days)	Endurance with rechargeable carbon buffer battery ST-MRPC (days)
Geo-positioning and sensor sampling @ 1-sec	1.5	3300	13.7%	0.3	12.6	26.5	0.3
Geo-positioning and sensor sampling @ 4-sec	5.6	1350	5.9%	0.6	30.9	64.8	0.7
Geo-positioning and sensor sampling @ 16-sec	16	240	1.5%	3.5	173.8	364.9	3.8
Geo-positioning and sensor sampling @ 1-minute	63.8	82	0.8%	10.1	505.2	1060.9	13.7
Geo-positioning and sensor sampling @ 4-minutes	239	24	0.6%	34.3	1714.3	3600.0	37.7
Geo-positioning only	n/a	16	0.6%	76.4	2547.3	5349.4	56.0
Continued clock maintenance after sensor sampling and geo-positioning stops.	n/a	3.4	0.5%	403.33	n/a	n/a	96.8

Notes:

1. Based on capacitor discharge tests.
2. Tested with SeaTag-MOD Firmware V1.51
3. No safety margin applied. Appropriate de-rating is recommended depending on the mission characteristics and requirements. Discuss with DSS.
4. Full data, see **SeaTag MOD Power and Endurance Data.XLS**

Data Acquisition Battery Endurance Verification Test



Test of a SeaTag-MOD powered by ST-MRPS battery pack. In darkness, with first ~15 days in refrigerator at about 1 deg C. Remainder at room temperature (red curve). Tag was programmed for data acquisition with a 1-sec set sampled rate, yielding a 1.5 sec actual sampling rate (see data acquisition endurance table). Endurance prediction is 12.6 days, equivalent to 725760 data points. In fact, 985108 data points are collected before battery is depleted, equaling 135% of predicted value. However, the data acquisition rate (green curve) starts to slow beyond about 700000 data points. This is a result of the battery no longer being able to maintain the 3.0V threshold voltage for data acquisition continuously. Instead, acquisition stops and starts intermittently as the battery voltage drops below the threshold and then recovers to above the threshold again. Despite the higher than predicted battery life, endurance in excess of the estimates in the table should **not** be assumed because endurance will vary depending on multiple factors. We recommend running a test mission with applicable configuration settings or applying an appropriate safety margin.

Solar Powered Capacitor Charging

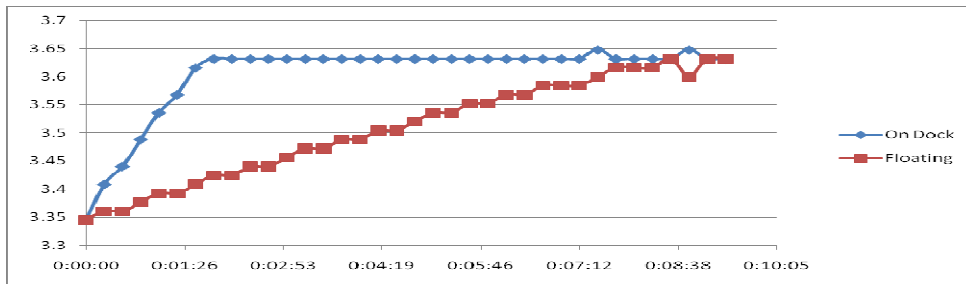
Condition	Capacitor Start Voltage	Capacitor End Voltage	Charge Time (minutes)
Depleted to Full	0V	3.6V	17.5
Clock maintenance minimum voltage to capacitor full	1.7V	3.6V	11.25
Geo-positioning minimum voltage to capacitor full	2.7V	3.6V	6.25
Sensor-sampling minimum voltage to capacitor full	3.0V	3.6V	3.75
ARGOS transmission minimum voltage to capacitor full	3.3V	3.6V	2

Notes & Conditions:

1. Based on solar charge capacitor test 23JAN11, starting at 1137h PST.
2. Daylight conditions: Sunny day, i.e. near best-case conditions
3. Test location: Test tag in air, on memorial in front of DSS office (Marina, CA)

Field & Anecdotal Data on Solar Power

- Solar powered capacitor charging is available to a depth of about twice the vertical visibility (observed at Lake Tahoe and Wolf Island Galapagos with about 50' visibility and about 100' effective charging depth).
- Surface light reflections reduce light levels just under the surface compared to those just above the surface. Shallower sun angles cause greater reflection loss, but also align the sun better with the solar panel of a floating tag.
- Indirect light is a major factor. Power generation over a shallow reef or in a light colored test tank will be much higher than over deep water or in a dark colored test tank.
- Turbidity affects performance. It absorbs light at depth, but can help at the surface by back-lighting a tag.
- Two solar-power only drifter test tags floating off SE Alaska transmitted about twice as much per day as a tag floating south of Hawaii.
- A solar-power only tag floating at 60 deg N near Prince William Sound and after four month at liberty in mid-November produced 1-3 full-power / full-length ARGOS messages per day (equivalent to 6-18 position-only / standard power messages received or about 30-180 such messages transmitted). The max. angle of the sun at the location in mid-November is about 11 degrees.



Comparative solar charge curves for a SeaTag-MOD sitting on a dock (in the air), and then floating in the water next to the same dock. Test done in Monterey Harbor, 11/15/11 between 1430h-1500h PST. Sun angle about 25 deg.

Notes:

1. Capacitor Voltage (V) vs. time elapsed (h:mm:ss)
2. Blue curve on dock, red curve floating tag.
3. Tag limits charging to 3.6V

Power System Voltage Thresholds

Capacitor Voltage	Condition
3.6V	Over-voltage. Excess energy will be drained through LED lighting
>3.575V	Scheduled ARGOS transmissions become unconditional of surface detection parameters to assure transmissions occur if detector mechanisms fail.
>3.55V	Threshold for opportunistic (solar powered) ARGOS real-time transmissions. <u>This threshold value programmable through Advanced Tab in SeaDock: Solar Transmit Voltage</u>
>3.3V	Threshold for standard ARGOS real-time transmissions. <u>This threshold value programmable through Advanced Tab in SeaDock: Battery Transmit Voltage</u>
>3.0V	Programmed sensor data acquisition occurs at or above this threshold.
>2.7V	Geo-positioning data acquisition occurs at or above this threshold
1.7V-2.7V	Clock maintenance only. Minimum power consumption.
<1.7V	Processor Resets and clock is lost. Mission abort, release firing and data transmission occurs upon voltage recovery.

Battery Pack Endurance for ARGOS Transmissions

ARGOS Transmission	Endurance with small 1000mAh battery pack ST-MRPS (messages)	Endurance with large 2100mAh battery pack ST-MRPL (messages)	Endurance with rechargeable carbon buffer 18mAh battery ST-MRPC (messages)
Archival (full-length) messages at high transmit power (400mA)	8507	17864	153
Archival (full-length) messages at low transmit power (200mA)	15050	31605	271
Position-only messages at high transmit power (400mA)	21739	45652	391
Position-only messages at low transmit power (200mA)	38462	80769	692

Notes:

1. ST-MRPS and ST-MRPL are non re-chargeable lithium batteries.
2. ST-MRPC is a solar charged buffer battery that supports ARGOS transmissions at night using solar energy collected during the day.
3. High (400mA current) and Low (200mA current) transmit power are the recommended limits for ARGOS operation; 300mA is the default.
4. Capacity of ST-MRPS & ST-MRPL per manufacturer data sheets. Capacity of ST-MRPC across transmit voltage range (3.6V-3.3V) based on observation of 153 transmissions at 400mA (Death Valley, 27NOV11).

ARGOS Transmission Battery Endurance Verification Test

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