Case study: Strips by SENSATIVE

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10+ YEARS SPECIFIED BATTERY LIFE

Optimizing power usage in IoT devices

In many modern battery operated systems, the expected battery life is dependent on the actual battery capacity and hardware, but also to a very large extent on the system behavior, governed by the software controlling the hardware. In order to verify expected battery life, actual measurements must be made on a live system.

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Introduction

Energy efficiency is essential when developing IoT devices. Test equipment for energy consumption is complex, costly and accessible only to a small number of hardware specialists, making testing a time-consuming development step for most companies.

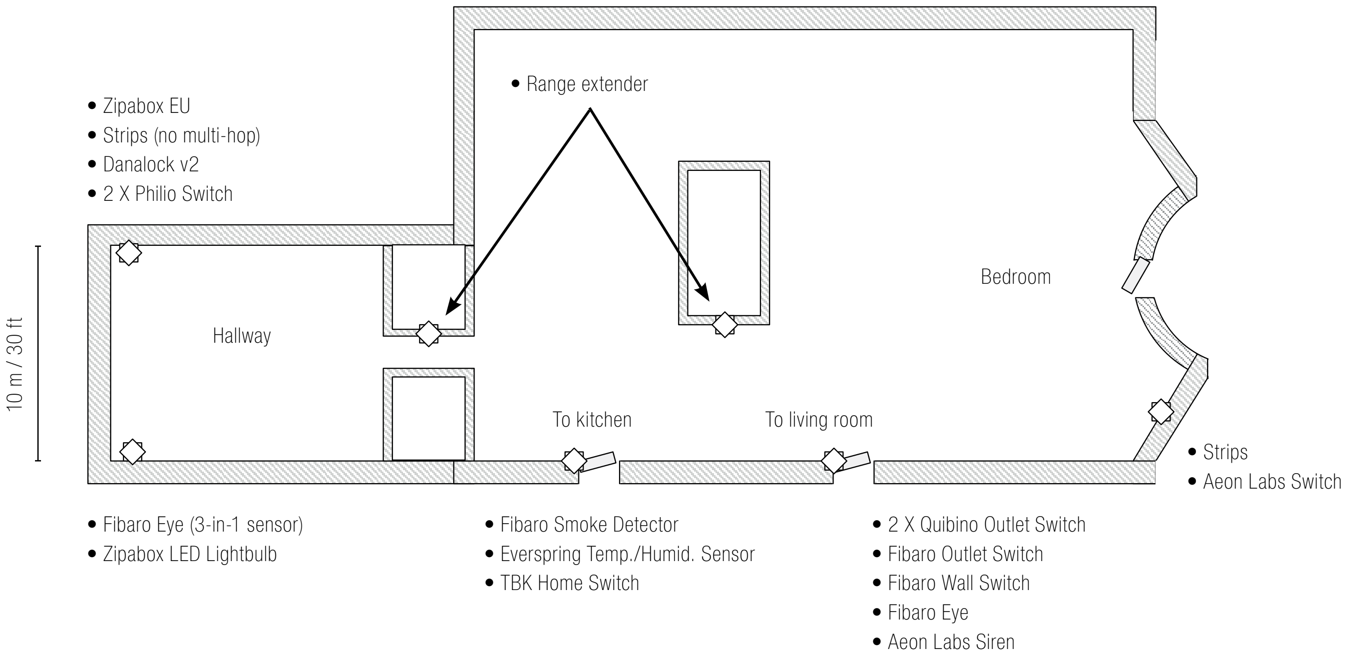
The expected battery life of IoT products depends on battery capacity and hardware setup, but also to a large extent on system behavior. In order to verify expected battery life, testing must be carried out on a live system. Testing should be minimally invasive, and correctly capture and present how the system behaves during a representative time period.

This case study outlines the results of Strips by Sensitive battery life tested using the Otii system – an easy-to-use, affordable tool for energy optimization in apps and IoT devices.

Strips, developed and marketed by Sensative AB, are wireless magnetic sensors that invisibly mount on windows and doors to indicate if they are open or closed. They are battery powered and communicate using the Z-Wave network protocol.

Strips by Sensative measurements

Two separate measuring sessions were carried out with the Strips units in the environment shown below; one with direct communication between the Strips and the gateway, and one session with communications via a Z-Wave extender.



Both sessions include simulating 12 open and 12 close events during the 24-hour measuring period. These events will each trigger a radio transmission. All Z-Wave devices will additionally report their status periodically. In the case of Strips, the default is every 24 hours.

Test setup and assumptions

- The built-in battery was bypassed, and Otii was used for powering the Strips and measuring current consumption.
- Two sessions were run in office environment, one with direct communication to the gateway, and one via an extender.
- The battery used by Strips is specified to > 480 mAh, and has a nominal self-discharge of 1.5%, and at least 10 years specified shelf life.
- The Strips energy consumption is mainly current driven, i.e. pulls current directly from the battery, or via an internal linear regulator.

Session 1 results (no extender used)

The result of the first measurement where the communication was performed directly between Strips and the Z-Wave gateway (fig. 1) shows

Communication	Time	Average Current
Direct	24 h	1.08 µA

With a constant current consumption at 1.08 µA, and assuming we could use at least 450 mAh of the Strips battery capacity you would get a projected run-time of

450 mAh / 1.08 µA ≈ 420,000 hours, or 47 years.

This means that the “useful” discharge is about 2.1% of total capacity per year.

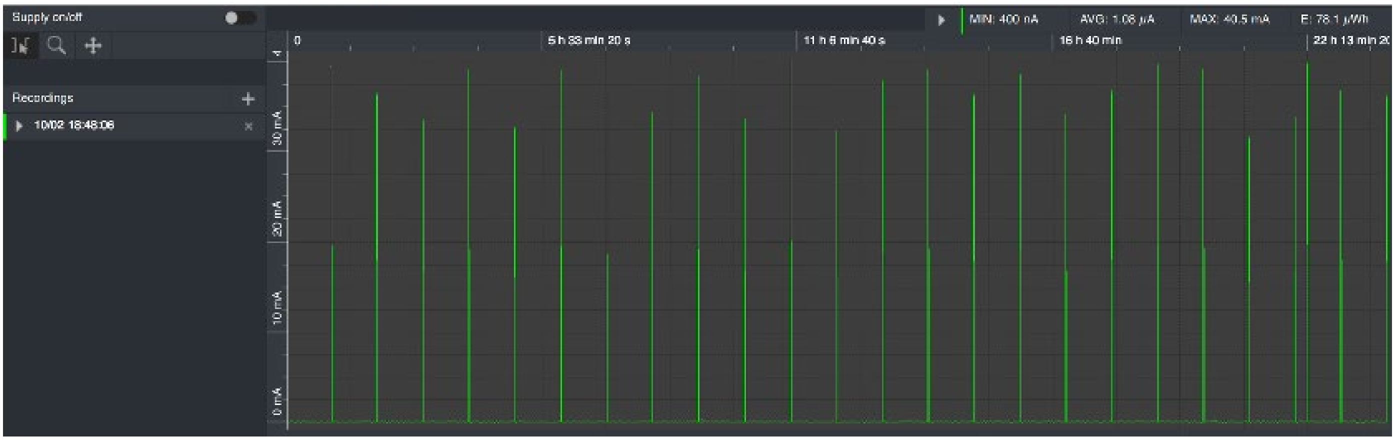
Battery self-discharge of course come into play at these levels, but even assuming a fixed 1.5% loss of total capacity each year will result in a projected lifetime of

2.1% + 1.5% = 3.6% per year, or 28 years.

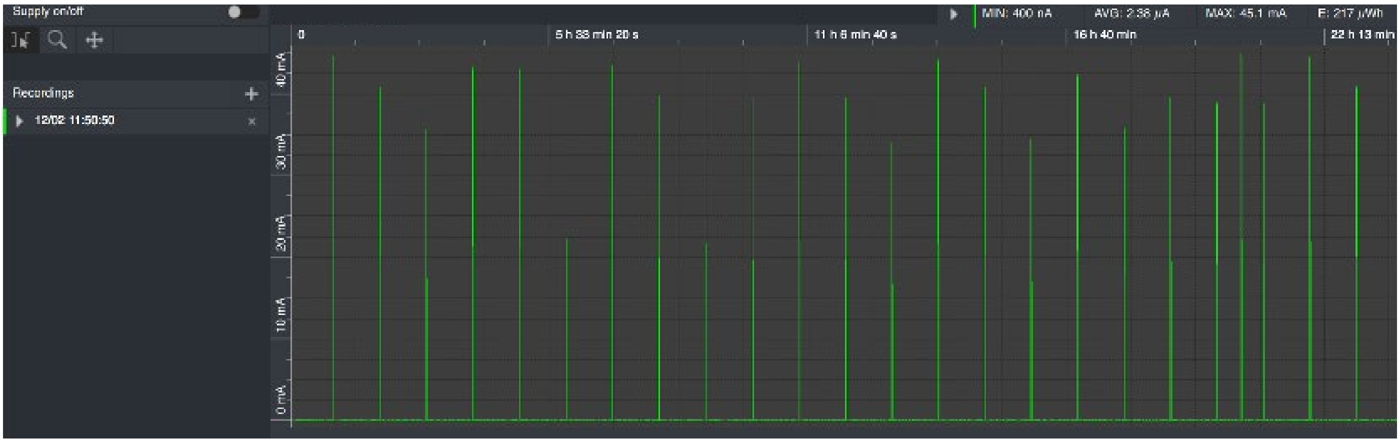
Battery manufacturers will typically not specify a shelf life exceeding 10 years, so data for this is hard to collect. If there is e.g. an increased internal resistance due to aging that will limit the useful life somewhat.

Test Graphs

The resulting high-energy pulses can easily be seen in the following graphs:



Complete session using direct transmissions



Complete session with transmissions through an extender

Zooming in on any of the high-current pulses caused by radio transmission clearly shows the time period the device spends in its active state. When the transmission goes through another Z-Wave node acting as a repeater, the awake time is significantly longer than if there is a direct path available to the gateway. Most of this timing is directly mandated by the Z-Wave specification and cannot be altered by the device manufacturer.

Otii screenshot of one direct transmission

Otii screenshot of one transmission through an extender

Zooming out a bit focusing on the seemingly quiescent state, it is clear that Strips actually wakes up to an intermediate level every 1.3 seconds, although these wake ups are very short and do not require any significant amount of energy.

Otii screenshot of five 1.3 second wakeup

Test setup and assumptions, cont.

Session 2 results (1 extender used)

The result of the second measurement where the communication between the Strips and the Gateway was through a Z-Wave extender shows

Communication	Time	Average Current
Via Extender	24 h	2.38 µA

Running the same calculations for this session we get a “useful” discharge of 4.6% per year, and including self-discharge

4.6% + 1.5% = 6.1% per year, or 16 years.

Summary

Using the Otii system makes measuring even a very dynamic system such as Strips by Sensative easy and straightforward. The low quiescent current between active periods can easily be measured, and selecting a region in the graph will instantly show the detail and amount of energy consumed within it.

With the Otii system, we have been able to confirm that under the given assumptions Strips have a battery life of 10 years or even more in typical Z-Wave network.

However, as can also be seen using the Otii system, communication between wireless devices in a large network environment is complex, and low signal strength, or repeaters, would have an impact on battery performance.

For more information: www.qoitech.com

About the Otii system

The Otii system is a groundbreaking tool for developers to use during app and device development. It consists of a hardware device that combines power source and measurement circuitry and a comprehensive software that displays measured values during the test. Displayed results can be synchronised with messages sent by device under test. The system runs on all major desktop platforms and requires minimal setup.

Easy-to-use, affordable and accessible

- The go-to-tool for IoT energy optimization
- Measure, analyze and benchmark energy consumption
- Correlate SW debug logs and energy consumption logs
- Profile and emulate batteries

Trademark and acknowlegement

Visit www.qoitech.com

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Otii helps companies create energy efficient apps and IoT devices to meet the increasing market demands for eco-aware, long-lasting products. Our state-of-the-art solution leverages on over fifteen years' experience in developing energy optimized smart devices for the global telecom market. The Otii system is a comprehensive toolkit for energy optimization of IoT devices. It is easy to use, requires minimal setup, and lets developers measure and analyze energy usage at any stage of development. Otii is owned by Qoitech and is a part of Sony.

Learn more: www.qoitech.com