



ENSC 305W/440W

## Test Plans

for

*Floe*: the Athletic Balance Monitoring System for Skiers

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Date Issued: March 22, 2016

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## Glossary

**ADC:** analogue-to-digital converter

**BLE (Bluetooth LE):** Bluetooth Low Energy; a low-energy wireless data transmission protocol

**BMH:** Boot-Mounted Hardware; system component of *Floe* pertaining to the ski boot-mountable enclosure containing the SoC, signal-conditioning circuit, and power supply

## 1 Test Plan Introduction

To ensure that *Floe* works as planned for all users, extensive testing must of course be conducted. This testing takes place mostly at the component level during the development of *Floe*, with whole-system testing following when nearing project completion. These plans were made with the requirements found in our Functional Specifications document [1] in mind.

## 2 Component Testing

### 2.1 Physical

The physical testing of *Floe* is separated in two, for the two physical parts of the design.

First, the BMH enclosure must be subjected to a variety of operating environments and actions, and observations must be made to ensure the following:

- That the BMH housing does not leak when submerged in water;
- That the BMH remains stable inside its enclosure when various shock forces are applied;
- That the BMH housing retains its structural integrity when various shock forces are applied;
- That the BMH is securely fastened to the ski boot strap.

Second, the insole must be subjected to a variety of operating environments and actions, and observations must be made to ensure the following:

- That the insole works properly after being bent in a reasonable range of motion;
- That the insole works properly in various humidity and temperature conditions.

### 2.2 Hardware

The hardware side of *Floe* requires testing on two different fronts.

Firstly, the BMH is to be monitored under a variety of operating conditions and measurements must be taken to ensure the following:

- That power consumption stays within the acceptable operating range at all times;
- That device temperatures stay within the acceptable operating range at all times;
- That the sensors output correct force values;
- That the sensors operate accurately within the correct force range.

Second, the electrical hardware components incorporated into the insole must be monitored under a variety of operating conditions and measurements must be taken to ensure the following:

- That the pressure sensors give the correct output voltages over the whole range of possible physical loads;
- That all wiring in the insoles maintains full integrity.

## 2.3 Firmware

The firmware part of *Floe* lives entirely on the BMH SoC. For that reason, all firmware testing will require use of at least one of the SoC chips.

Firstly, the firmware is to be tested for proper functionality. Appropriate debugging tools are to be used to monitor the firmware's behaviour under a variety of operating conditions and ensure the following:

- That enable and disable commands are received and executed correctly;
- That no clipping occurs for any value over the full range of the ADC;
- That data is transmitted within real-time constraints (i.e. >15 times/second);
- That the data being transmitted is the same as that collected locally on the chip;

Second, the firmware is to be tested for reliability. This will once again require the use of appropriate debugging tools to monitor the firmware's behaviour under a variety of operating conditions and ensure the following:

- That no critical errors occur during prolonged operating sessions (i.e. >10h);
- That no critical errors occur when repeatedly connecting and disconnecting (i.e. >20 times) a device.

## 2.4 Software

The *Floe* app, due to its complexity and the large number of interacting components, is difficult to test under all possible operating conditions and for all combinations of user input. For that reason, different components of the app are to be tested separately, and some test cases are to be used to test the app as a whole.

First, proper functionality of each of the classes created by the *Floe* software development team is to be tested individually with the help of appropriate debugging tools to ensure the following:

- That every method of every class executes correctly and reliably;
- That every attribute of every class holds the proper data.

Second, proper interaction between objects at runtime must be confirmed. Communications between Services and their clients, as well as are to be tested with the help of appropriate debugging tools to ensure the following:

- That all Services bind correctly and reliably to their clients;
- That all Services can communicate correctly and reliably with their clients;
- That all objects are created at the proper point in the app's execution, and that they are created correctly and reliably.

Third, the data reception, storage, retrieval and manipulation mechanisms of the app must be tested for reliability and functionality. Appropriate debugging tools are to be used to ensure the following:

- That the connections to both boots is established correctly;
- That data packets are received and unpacked correctly;
- That `FloeDataPt` objects are constructed correctly;
- That the Run Database can be opened and closed correctly and reliably;
- That data in the Run Database is persistent over multiple uses of the app;
- That data in the Run Database is exportable, and that it is usable once exported;
- That data can be recorded while the device is locked;
- That the graphics generated for the user match the data used to generate them exactly;
- That the parts of the app that must operate under real-time constraints (RT Feedback, Data Transmission, BLE Services), do so.

Fourth, the system as a whole must be tested to ensure reliability and functionality. Appropriate debugging tools are to be used to ensure the following:

- That the user can navigate between screens easily, reliably, and without lag;
- That the app controls are intuitive (also requires test subjects);
- That the correct objects and processes are created and interact correctly and without lag.

## 3 System Testing

Once all individual components of *Floe* have been tested thoroughly for functionality and reliability, the system is likely ready to be fully assembled and tested as a whole. If all components performed well on their own, the risk of malfunctions of the system should be much reduced.

At this point, the system should be subjected to the same testing procedures described previously in this Section, to verify that the desired output is produced for any given input to the system. Once such tests give satisfactory results, *Floe* is ready for live testing on real ski slopes. Many runs of varying lengths and topology are to be recorded with *Floe* as well as with a video camera for the purpose of comparing the recorded data with filmed observations of the skier's balance throughout the run.

The same procedure is to be repeated for the real-time feedback functionality of the app. The filmed footage of the skier can be compared with filmed footage of the Android device's screen to validate the feedback given by *Floe*.

## References

- [1] *Functional Specifications for Floe: the Athletic Balance Monitoring System for Skiers*, 1st ed. Pinnacle Biometrics, 2016, pp.4-12.