Test Plan Document

Functional Near-Infrared Spectroscopy for Brain-Computer Interface

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Table 1 Requirements

Req#	Function	Requirement	Test Method	Brief Test description	SME /Faculty Reviewed / Approved
1	Software	Extract all analog readings in an appropriate time to meet the 100Hz scan rate.	Software Error Exception	The software will be architected to be a hard real-time system. The ADC sampling and the transmission to the PC will be driven by timers. Failure to sample at the correct time or failure to fully transmit the data at a sufficient rate will result in an raised error within software. Once an analog reading is present, a timer will count down. Failure to obtain the reading before the timer reset will result in an error thrown in debug console. A GPIO output can be linked to an event such as a successful ADC sample collection. This way, an oscilloscope can be hooked up to the GPIO output to verify the occurrence of the event in time. By extension, the sampling rate can also be verified this way.	Dr. Ashwin
2	Software	Number of error transmissions is <5% of the total transmissions.	Comparison of Dummy Data	A predefined set of data will be transmitted from the MCU. The program on the external PC will receive these values and report the number of values that do not match up with the predefined set of values. No more of 5% of the total transmission is allowed to be wrong.	Dr. Ashwin
3	Hardware	The circuit design must consume no more than 100mW.	Analysis	The input current and voltage of the circuit will be taken at the main power supply.	Dr. Ashwin

4	Hardware	The circuit design must output a reading with 100us integration time using a low-power source LED.	Analysis	A prototype circuit will be designed to test a small implementation of fNIRS on a single area.	Dr. Ashwin

Test Objectives

The device aims to measure the oxygenation of the hemoglobin in the forehead at 100 Hz. Therefore, we are trying to prove that the following behaviors are true:

1. The device collects samples from the ADC and sends the data to the PC for processing and display at a rate of ~100Hz.
2. The device is sampling a signal that is distinguishable from the noise floor.

Resource Required for Testing

1. Oscilloscope + Power Supply.
2. JLink Debug Probe + Ozone Debug Software + JTAG.
3. PC w/ Python Script.

Test Schedule

The hardware needs to be done before the software portion, therefore the hardware should be tested first.

Req #3 - 10/13/2024

Req #4 - 10/13/2024

Req #1 - By 11/01/2024

Req #2 - By 11/01/2024

Test Estimation

Test prediction for req #1

The device will meet the 100Hz sampling rate, as we chose an extremely fast STM32H7 that operates at a 550MHz maximum. We also chose an FTDI chip that can handle transmission speed up to 2MBps. Based on the calculations, the sampling rate is achievable. Worst case scenario, we can lower the sampling rate slightly. Anything over 75Hz for the sampling rate will also suffice.

Test prediction for req #2

Since we are using a manufactured cable, and not making our own, the wired connection to the PC will be relatively stable. Thus, the transmission rate should be high integrity, and this test result will pass.

Test prediction for req #3

Based on the calculation for power consumption by assuming the worst-case scenario power consumption for all major components on the circuit, the total power consumption will be 55mW.

Test prediction for req #4

Based on a SPICE simulation of the transimpedance amplifier circuit, an integration time of 100us will suffice given the stated input current from the photodiode of ~50nA given the output power of the source LED, 15mW. The TIA has an expected output of roughly 100mV with a 100us integration time.

Test Deliverables

For req #1

A screenshot of the oscilloscope, with the time measurement between the GPIO output displayed. Also, whether an error will output in the debug console indicating a failure in collecting ADC sample in time or transmission in time.

For req #2

A picture of the debug console of the Python script showing the amount of total transmissions and how many errors were detected.

For req #3

A measurement of power draw at the worst-case conditions. Likely, the output of a DC power supply or DMM measurement.

For req #4

A screenshot of the waveform generated by the output of the TIA when the detector is run at 100us integration time.