Fuel Cell Monitor

Jessica Odutola
Russell Wells
Rana Kortam
Sameer Osama

FUNCTIONAL SYSTEM REQUIREMENTS

FUNCTIONAL SYSTEM REQUIREMENTS
FOR
Fuel Cell Monitor

PREPARED BY:

_____
Author Date

APPROVED BY:

_____
Project Leader Date

_____
John Lusher, P.E. Date

_____
T/A Date

Change Record

Rev.	Date	Originator	Approvals	Description
-	10/03/2022	Fuel Cell Monitor System		Draft Release

Table of Contents

List of Tables

List of Figures

1. Introduction

1.1. Purpose and Scope

Monitoring a fuel cell to make sure it doesn't fail or give a different voltage than expected is important to the fuel cell stack. Our aim is to provide a fuel cell monitoring system that will take the readings from each fuel cell in the fuel cell stack and to monitor these readings through an application. With our system, the voltage will be taken from the fuel cell stack and then passed through a differential amplifier to filter the noise. The signal will then go to the microcontroller via ADC and opto-isolator which provide a signal the processor can read and protect in the event of a short or cell malfunction. Then, the microcontroller will send the data to the ESP32 which will communicate with the app to display the voltage for each fuel cell in the stack.

Figure 1. Fuel Cell Monitor Conceptual Image

1.2. Responsibility and Change Authority

Subsystem	Responsibility
Power System Development	Sameer Osama
Internal Signal Transfer and Manipulation Development	Russell Wells
Microcontroller Development	Rana Kortam
Mobile Application Development	Jessica Odutola

Table 1: Subsystem Leads

2. Applicable and Reference Documents

2.1. Applicable Documents

The following documents, of the exact issue and revision shown, form a part of this specification to the extent specified herein:

Document Number	Revision/Release Date	Document Title

Table 2: Applicable Documents

2.2. Reference Documents

The following documents are reference documents utilized in the development of this specification. These documents do not form a part of this specification and are not controlled by their reference herein.

Document Number	Revision/Release Date	Document Title

Table 3: Reference Documents

2.3 Order of Precedence

In the event of a conflict between the text of this specification and an applicable document cited herein, the text of this specification takes precedence without any exceptions.

All specifications, standards, exhibits, drawings, or other documents that are invoked as “applicable” in this specification are incorporated as cited. All documents that are referred to within an applicable report are considered to be for guidance and information only, except ICDs that have their relevant documents considered to be incorporated as cited.

3. Requirements

3.1. System Definition

The Fuel Cell Monitor is a practical and reliable system. It allows users to observe voltage variations on each individual fuel cell via mobile app. The Fuel Cell Monitor has four sub-systems: Power System, Internal Signal Transfer and Manipulation, Microcontroller, Application Development.

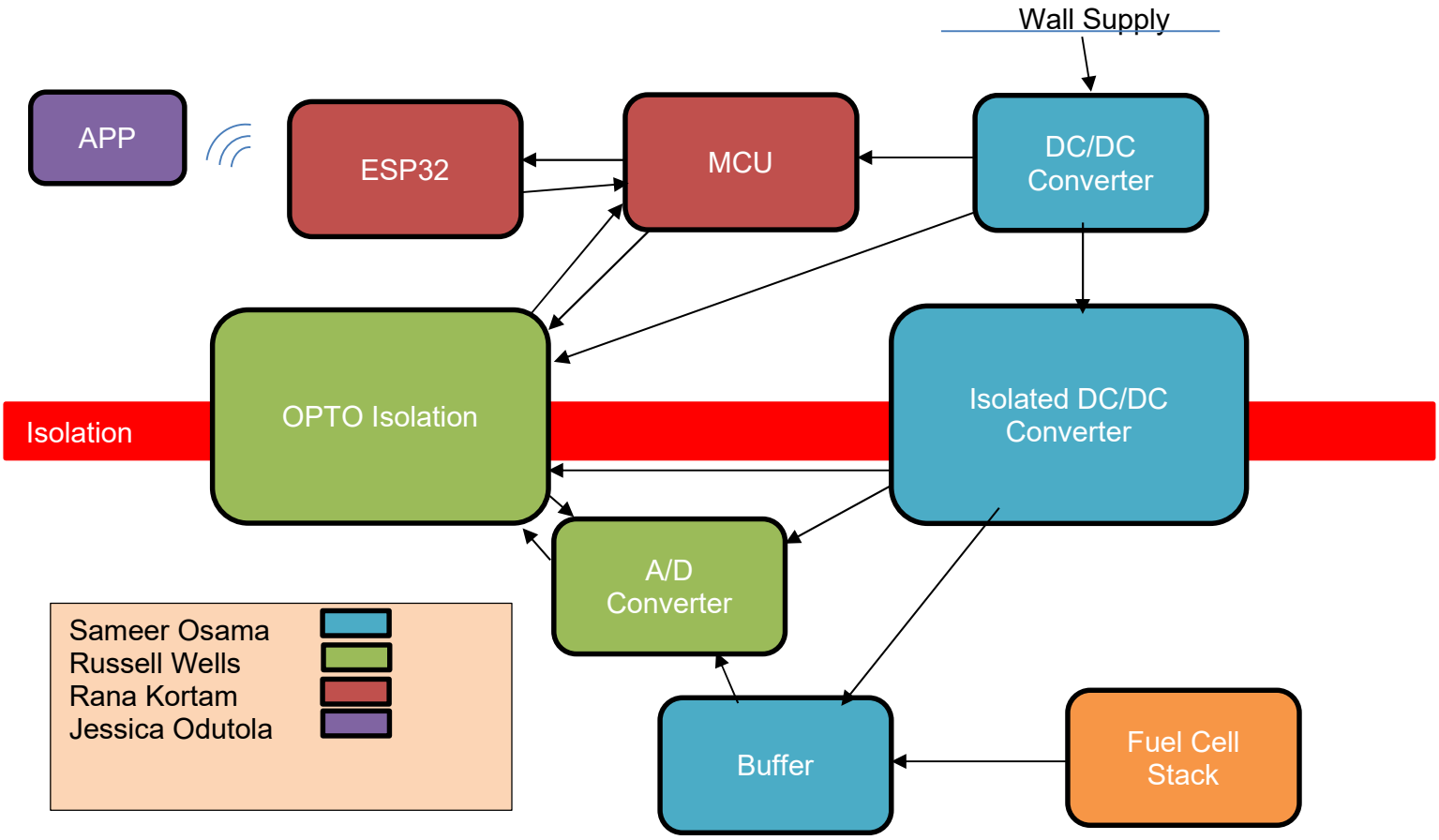

Figure 2. Block Diagram of System

In figure 2, the block diagram above shows the different subsystems within the Fuel Cell Monitor. The power for the whole system will be provided by a wall supply, which will be then converted to DC voltage using a DC/DC converter. The voltage reading will be taken from the fuel cell, and it will pass through the buffer to reduce noise. The signal will then be passed to the microcontroller via ADC and opto-isolator which provide a signal that processor can read as well as protect in the event of a short or cell malfunction. Then, the microcontroller will send the data to the ESP32 which will communicate with the app to display the voltage for each fuel cell stack.

3.2. Characteristics

3.2.1. Functional / Performance Requirements

3.2.1.1. Fuel Cell Monitor Voltage Range

The fuel cell monitor system shall be capable of monitoring voltages ranging from 0 VDC to +5 VDC.

Rationale: The requirement specified by the client was roughly 0.7 VDC. However, the capabilities of the parts used in the system allow for a higher range of voltage inputs.

3.2.2. Operating Environment

The fuel cell monitor shall be capable of operating within a controlled laboratory or under non-environmentally harsh conditions.

Rationale: The client specified a laboratory environment in which fuel cells are being used for experimentation.

3.2.3. Physical Characteristics

3.2.3.1. Mass

The mass of the Fuel Cell Monitor shall be less than or equal to 0.25 kilograms.

Rationale: This is a requirement specified by our customer due to constraints of their system in which the Fuel Cell Monitor is operating.

3.2.3.2. Volume Envelope

The volume envelope of the Fuel Cell Monitor system shall be less than or equal 0.125 cubic feet.

Rationale: The monitoring system is intended to be simple and capable of monitoring multiple fuel cell types in multiple stack configurations. The monitor must be small enough to sit inside the stack enclosure or near it without interfering with stack operation and maintenance.

3.2.3.3. Mounting

The fuel cell monitor will be designed to sit on a shelf or the floor inside the fuel cell housing

Rationale: This is a requirement of the client. The system is also compatible with any fuel cell stack producing voltages within the specified range and universal mounting is outside the project's scope.

3.2.4. Electrical Characteristics

3.2.4.1. Signal Inputs

The inputs of the system will be voltages transferred directly from the fuel cells to the monitor system via signal wire.

Rationale: This is a necessity given the nature of the monitor system

3.2.4.2. Power Consumption

The maximum peak power of the system shall not exceed 3 Watts.

Rationale: Although the major components have been determined, the minor components have not. % Watts is expected to be much higher then is necessary.

3.2.4.3. System Voltage Input

The input voltage level for the Fuel Cell Monitor System shall be +2.7 VDC to +5.5 VDC.

Rationale: This is a requirement outlined by the client and constrained by the usable parts.

3.2.4.4. Data Output

The Fuel Cell Monitoring System shall include an android application for users to view alerts if a fuel cell fails. The android application shall display the voltage levels of both the stack and the individual fuel cells.

Rationale: The Search and Rescue information passes directly to the customer's system.

3.2.4.5. Diagnostic Output

The Fuel Cell Monitoring System shall include a diagnostic interface for control and data logging.

Rationale: Provides the ability to control things for debugging manually and a way to view/download the node map with associated potential targets.

3.2.5. Environmental Requirements

The Fuel Cell Monitoring System shall be designed to withstand and operate in the environments specified in the following section.

3.2.5.1. Thermal

The Fuel Cell Monitoring System shall be able to function in environments ranging from -40°C to 85°C.

Rationale: The range of temperatures is provided in the datasheets of the system components.

3.2.5.2. Water Damage

The Fuel Cell Monitoring System will be capable of withstanding small non continuous splashes or misting with water.

Rationale: Given the nature of fuel cells such as hydrogen fuel cells. It is necessary to ensure the device is not susceptible to minor exposure to water.

4. Support Requirements

The Fuel Cell Monitoring system requires an internet connection to interact with the applications to give notifications. User must provide WI-FI and a wall supply to supply power to the rest of the system.

Appendix A: Acronyms and Abbreviations

BIT	Built-In Test
CCA	Circuit Card Assembly
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
EO/IR	Electro-optical Infrared
FOR	Field of Regard
FOV	Field of View
GPS	Global Positioning System
GUI	Graphical User Interface
Hz	Hertz
ICD	Interface Control Document
kHz	Kilohertz (1,000 Hz)
LCD	Liquid Crystal Display
LED	Light-emitting Diode
mA	Milliamp
MHz	Megahertz (1,000,000 Hz)
mW	Milliwatt
PCB	Printed Circuit Board
RMS	Root Mean Square
TBD	To Be Determined
TTL	Transistor-Transistor Logic
USB	Universal Serial Bus
VME	VERSA-Module Europe

Appendix B: Definition of Terms