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Description: Requirement Specifications

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Revision History	
12/05/2021	Initial Creation

List of Acronyms and Terms	

1.0 References, Purpose, Scope and Overview of Document

1.1 References

1.2 Purpose

The purpose of this document is to outline the various system requirements for the Electronic Business Card (EBC) Project. It is intended to be a brief overview to developers or any party interested in the project.

1.3 Scope

Traditional business cards are an effective way of giving a potential client, employer or important person one's contact information as well as a brief description of one's profession. However, traditional business cards can easily be forgotten or lost in a large amount of business cards. A successful business card should not only successfully and concisely relay information to the recipient, it should also be a memorable card. The scope of this project is to create a product that does exactly that: concisely relays information in an unforgettable manner.

1.4 Document Overview

This document is split into the following sections. The current section, section one, outlines the document and product. Section two outlines the system at a broad level overview. Section three details the marketing and engineering requirements of the product. Section four delineates potential use cases of the product.

2.0 System Overview, Function Priority, User Characteristics, and Design Constraints

2.1 Product Perspective

The Electronic Business Card can be viewed as a set of four primary subsystems with an optional fifth subsystem. These subsystems are as follows: the power subsystem, the display subsystem, the sensor subsystem, the control system, and the optional user interface subsystem. The EBC will implement a low power design incorporating a temperature sensor, low power segmented LCD, and solar power functionality to create a memorable solar powered thermometer business card. The system will be powered purely by solar to eliminate the need for a bulky battery and excessive user interaction.

2.2 System Interfaces

System Interfaces	
Power System Interface	Gathers energy from ambient light to power the system
Display System Interface	Displays temperature data to the user
Sensor System Interface	Gathers temperature information from the air around the user or from the user's skin directly
Control System Interface	FPGA driven control system
User System Interface	Allows the user to change the data output from imperial to metric units

2.3 Software Interfaces

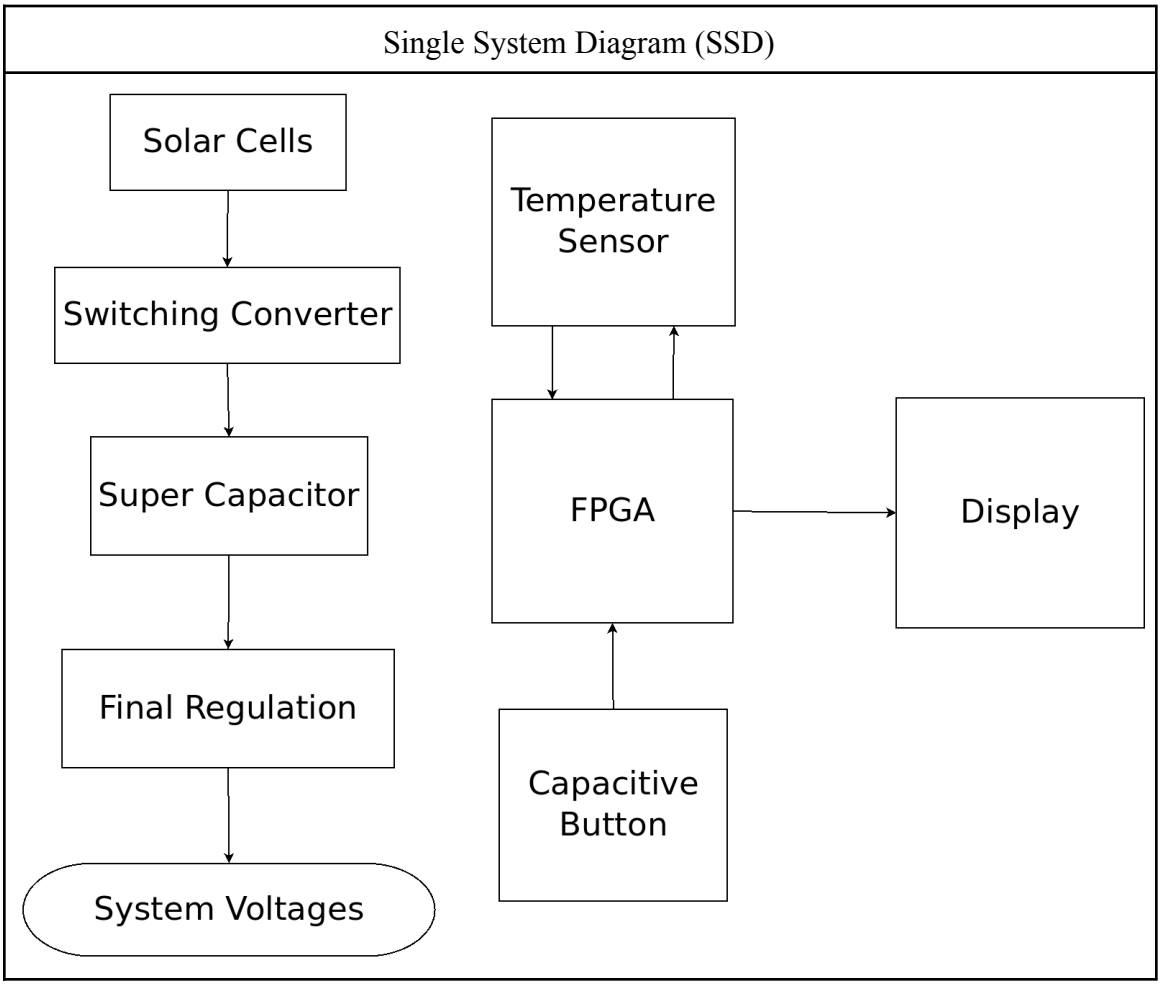
Software Interfaces
Not Applicable

2.4 Hardware Interfaces

Hardware Interfaces	
Power System Interface	The [TBD] solar cells will gather energy from ambient light. [TBD] boost converter

	will boost this voltage to a level the rest of the system can use.
Display System Interface	The [TBD] direct drive segmented LCD will be used to display the temperature data to the user. The silkscreen of the product will be used to display the business card information to the user.
Sensor System Interface	The [TBD] temperature sensor will communicate with the control system over I2C.
Control System Interface	The [TBD] FPGA will drive the system arbitrating interactions between the sensor, display, and user interfaces while being powered by the power system.
User Interface	PCB based capacitive buttons will be implemented using the [TBD] FPGA's differential inputs to create a method for the user to switch the display output between imperial and metric units.

2.5 Single System Diagram



2.6 Function Priority

Function	Priority
Solar Powered Functionality	Very High
Low Power Display System	Very High
Temperature Sensor System	Very High
Control System	Very High
User Interface	Moderate

2.7 User Characteristics

The user characteristic can be split into two coequal groups: the distributor and the recipient. The distributor is the person who hands out the product and does not need to interact with the product aside from specifying the information the product should display at the time of production. The recipient is a potential client, employer, or otherwise and important person as deemed by the distributor. They interact with the product by gathering information from the product. The product's solar powered thermometer system creates a more memorable business card and distinguishes the distributor from other potential service providers or potential employees.

Users	Distributor	Recipient
Required Knowledge	What knowledge should be put on the silkscreen of the product.	None
Responsibilities	None	Must provide the product with sufficient ambient lighting to power the product.
Success Criteria	Delivers the product to the recipients.	Remembers the distributor's business card over other business cards.
Deliverables	None	Product Provides Distributor Information and Temperature
User Benefits	Card is more easily remembered than others	Card displays temperature

2.8 Design Constraints

Design Constraints
The product must be size constrained to 3.5x2 inches since that is the standard dimensions of a business card.
The product must not have a greater nominal thickness than 3±1mm to keep the product marginally thin compared to other business cards.

The product's price per unit in quantities of 10 must not exceed 35±5 dollars.

2.8.1 Developer Imposed Design Constraints

Developer Imposed Design Constraints
The product must make use of an FPGA as its core control system.
The product must make use of at least one BGA package with a greater pin footprint than 4x4.
The PCB must not exceed four layers in thickness.
At least one instance of I2C, SPI, or UART must be implemented on the FPGA.
A low power segmented LCD must be directly driven with the FPGA.
An external memory may not be used to house the configuration file for the FPGA, the internal NVM block must be used.

2.9 Assumptions and Dependencies

2.9.1 It is assumed the final product will meet the specified dimensions and cost constraints.
2.9.2 The device's functioning is dependent on the ambient light provided to the device as well as the range of temperature presented to the sensor.

3.0 Requirement Specifications

3.1 Marketing Requirements

Marketing Requirements	
1	Device must be 3.5 by 2 inches in size to meet the same form factor as a standard business card
2	Device must be no thicker than 4mm in order to not be substantially thicker than a standard business card
3	Device must not exceed $40 per unit in quantities of 10.
4	User's business card information must be easily readable on the product.

3.2 Engineering Requirements

3.2.1 Power System Requirements

Power System Requirements	
Specification	Justification
System must be capable of providing 3.3V	Standard component maximum voltage is 3.3V
System must be capable of providing 25mA of current	Preliminary feasibility suggests that low power FPGAs need at least 25mA of current to operate
System must be capable of providing other sufficient voltages for the FPGA	FPGAs typically require core and IO voltages
System must be capable of operating in at least bright office environments	For the device to function from purley solar power it is necessary that it operates in its typical indoor environment

3.2.2 Display System Requirements

Display System Requirements

Specification	Justification
Display must be low power	A high power display is not suitable for a solar powered application
Display must be able to display at least three digits and one character	The temperature and unit must be displayed as well as the sign if the measurement is negative
Display must operate at or below 3.3V	Display needs to operate at maximum power system voltage

3.2.3 Sensor System Requirements

Sensor System Requirements	
Specification	Justification
Sensor must be accurate within two degrees Fahrenheit	The sensor needs to be reasonably accurate
Sensor must be able to measure from 0 to 110 Fahrenheit	The sensor should have a reasonable operating range
Sensor must communicate over I2C, UART, or SPI	One of these protocols is required by the design constraints.
Sensor must operate at or below 3.3V	Sensor needs to operate at maximum power system voltage

3.2.4 Control System Requirements

Control System Requirements	
Specification	Justification
System must use and FPGA	Specified by the design constraints
A low power FPGA should be used	Since system is solar powered a large high power FPGA is not suitable for the application
FPGA must have a NVM block	The design constraints specify not external memory may be used

FPGA must have at least one differential input	Since the optional user interface will use a capacitive button, a differential input must be present
FPGA must operate at or below 3.3V	FPGA needs to operate at or below maximum power system voltage
Peak current draw may not exceed 15mA during operation	FPGA cannot overdraw the power system

3.2.5 User Interface System Requirements

User Interface System Requirements	
Specification	Justification
Interface will be implemented using an on PCB capacitive button	Minimal component cost if added to the design
System must change the units from Farenheit to Celsius	Depending on the target recipient, the user may wish to view the temperature in a different unit.

3.2.6 PCB Requirements

PCB Requirements	
Specification	Justification
The PCB must not exceed four layers	A PCB with more than four layers is substantially expensive
A BGA package of at least 4x4 must be used	Specified by the design constraints
One side of the PCB should house the components	The distributor’s information will need to be present on the reverse side of the product
PCB should not exceed 3.5x2 inches	Must meet the size requirements

4.0 Use Cases

4.1 General Use Case

Scope:

Normal Operation

Level:

User Level

Primary Actors:

User, Device

Stakeholders/Interests:

User

Preconditions:

User is in an environment with suitable lighting condition and with temperature within range of the sensor

Success Guarantee:

User is able to view the information on the card as well as seeing the ambient (or their body) temperature displayed on the device's display.

Main Success Scenario:

4.1.1 Power On

-User brings the device into an environment with suitable lighting conditions.
-Buck/Boost/Buck-Boost converter regulates solar voltage to appropriate level.
-The FPGA successfully configures
-The sensor is successfully configured by the FPGA master

4.1.2 Temperature Acquisition

-The sensor acquires the temperature of the environment it is exposed to.
-The sensor asserts an interrupt to the FPGA master.
-The FPGA master acknowledges the interrupt and initiates a data transfer between itself and the slave.
-The FPGA receives the temperature from the slave and stores it in local registers.

4.1.3 Displaying Temperature

-The FPGA drives the display appropriately to show the measured temperature
-If the temperature is out of range “XXX” (or similar) is displayed.
-The user can then view the temperature

Extensions:

4.1.4 Unit Conversion

-When the user desires to change the unit of measurement they may interact with the User Interface System to change the unit of measurement
-The user presses the capacitive button
-The FPGA interprets this press using one of its differential inputs
-The FPGA initiates a data transfer to the sensor

-The FPGA requested the sensor to change its configuration to match the other unit (for example if current unit if F and user presses button unit becomes C and vice versa)
-Flow 4.1.2 is executed
-Flow 4.1.3 is executed with the change reflected in the displayed unit