ELO 5

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REII 327

NET 1 BIER

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It all starts here ™

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SCOPE OF WORK:

- Design circuit for security inputs (Including Door switches and PIR's)
- Design circuit for output siren (to be run on 12v)
- Design and implement a user interface
- Design and code the SoC to handle all inputs and outputs
- Order parts
- Trade-off decisions
- Assemble the final unit as a whole

ASSUMPTIONS AND CONSTRAINS:

- Constrain budget of R1500
- 12V- 6W power limitation
- Assume Outdoor sensor will provide a 3.3v signal, 3.3v high for trigger detected, and 0v low when no trigger is detected.
- Assume a ground wire will be accessible to ground the unit

UNIT 1:

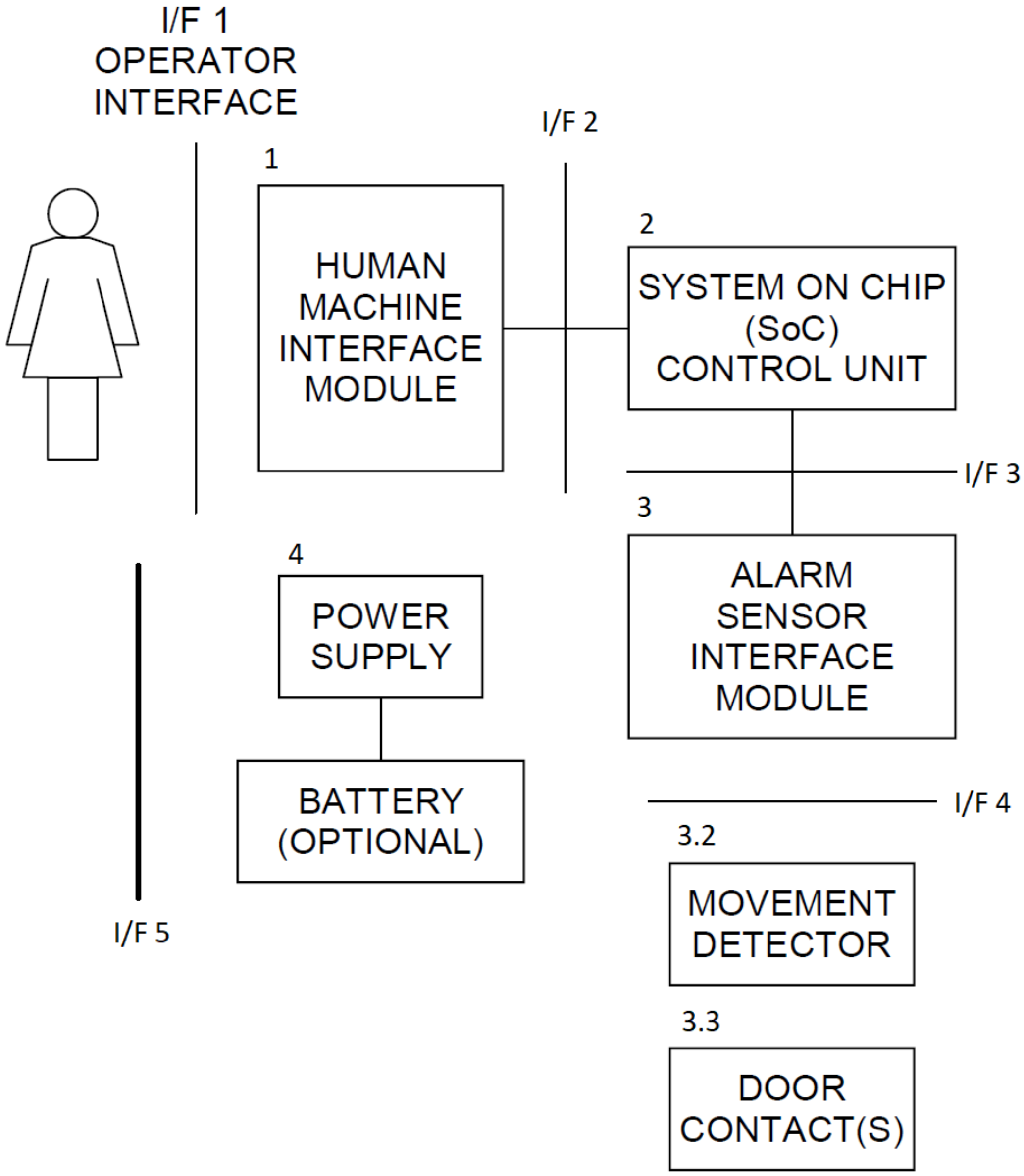

Figure 1: Unit 1 System definition

1.1 HUMAN MACHINE INTERFACE MODULE:

1.1.1 INPUT TO MACHINE:

Input to the system will be done by a 3x4 matrix number pad directly interfacing with the SoC. The number pad will be used to enter a pin to disarm the alarm system as well as arming the system.

Specifications of the number pad:

- Pad Size: 68.9 x 76 x 0.8mm
- Cable length: 85mm (including connector)
- Connector: dupont 7 pins, 0.1 inch (2.54mm) Pitch
- Mount style: Self-Adherence
- Max. circuit rating: 35VDC, 100mA
- Insulation spec.: 100M Ohm, 100V
- Dielectric withstand: 250Vrms (60Hz, 1min)
- Contact bounce: ≤5ms
- Life expectancy: 1 million closures

1.1.2 VISUAL OUTPUT:

The system will have a visual output in the form of LED's. 3 LED's will be used:

Table 1: LED functions

Colour	Indication
Green	Power (Pulsing as a heartbeat)
Orange	Armed(on)/Disarmed(off)
Red	Fault (Fast flashing)/Triggered (Slow flashing)

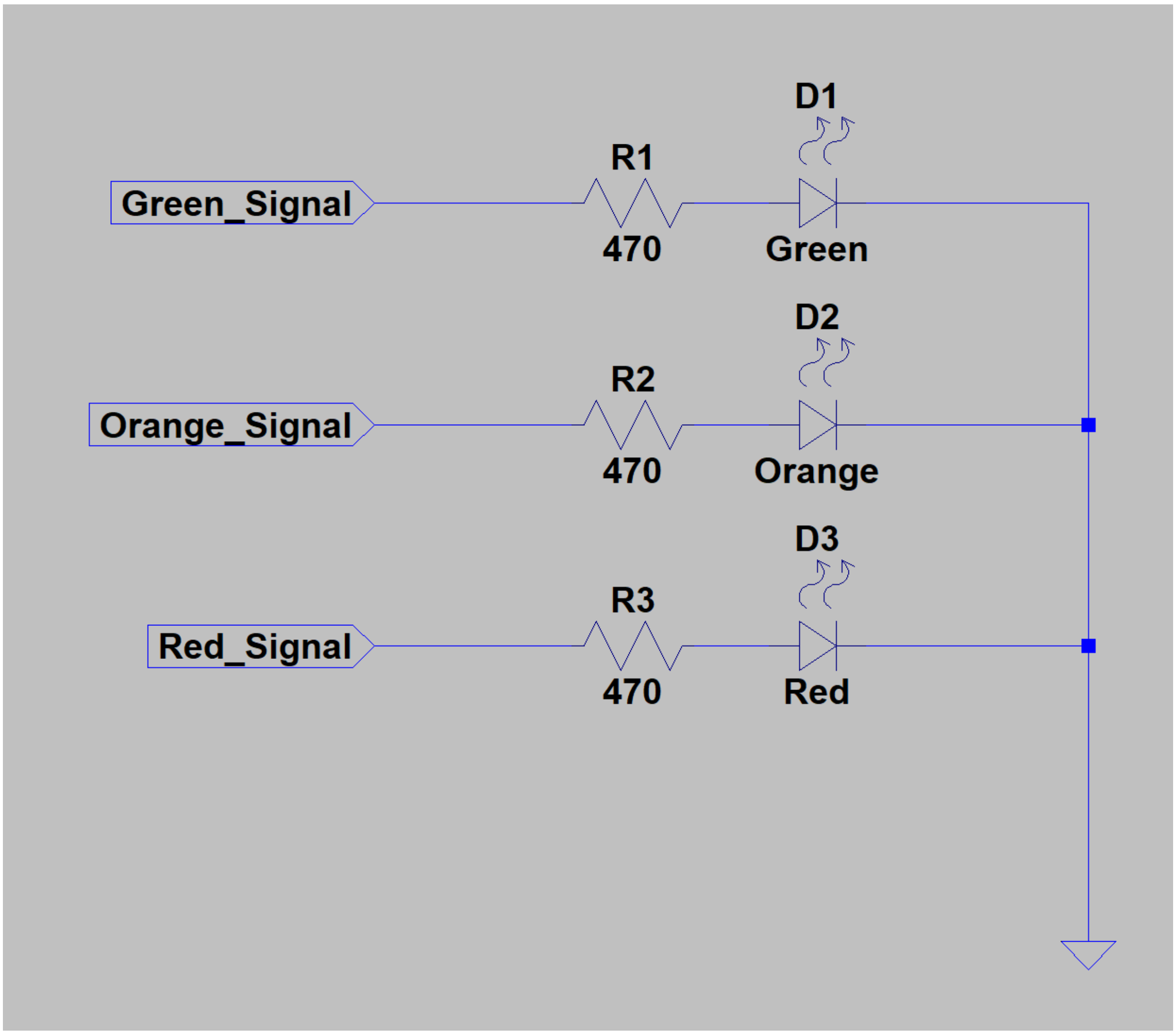

Figure 2: Visual output driver circuit

1.1.3 AUDIO OUTPUT:

An audio output will be used in the system for the machine to interface with a human. The audio source will be a siren. The siren will sound when a positive input has been received by the system and the system is in the armed state.

The output driving circuit of the siren uses a NPN transistor (2N2222A) to switch on the siren from the SoC. The circuit is as follows:

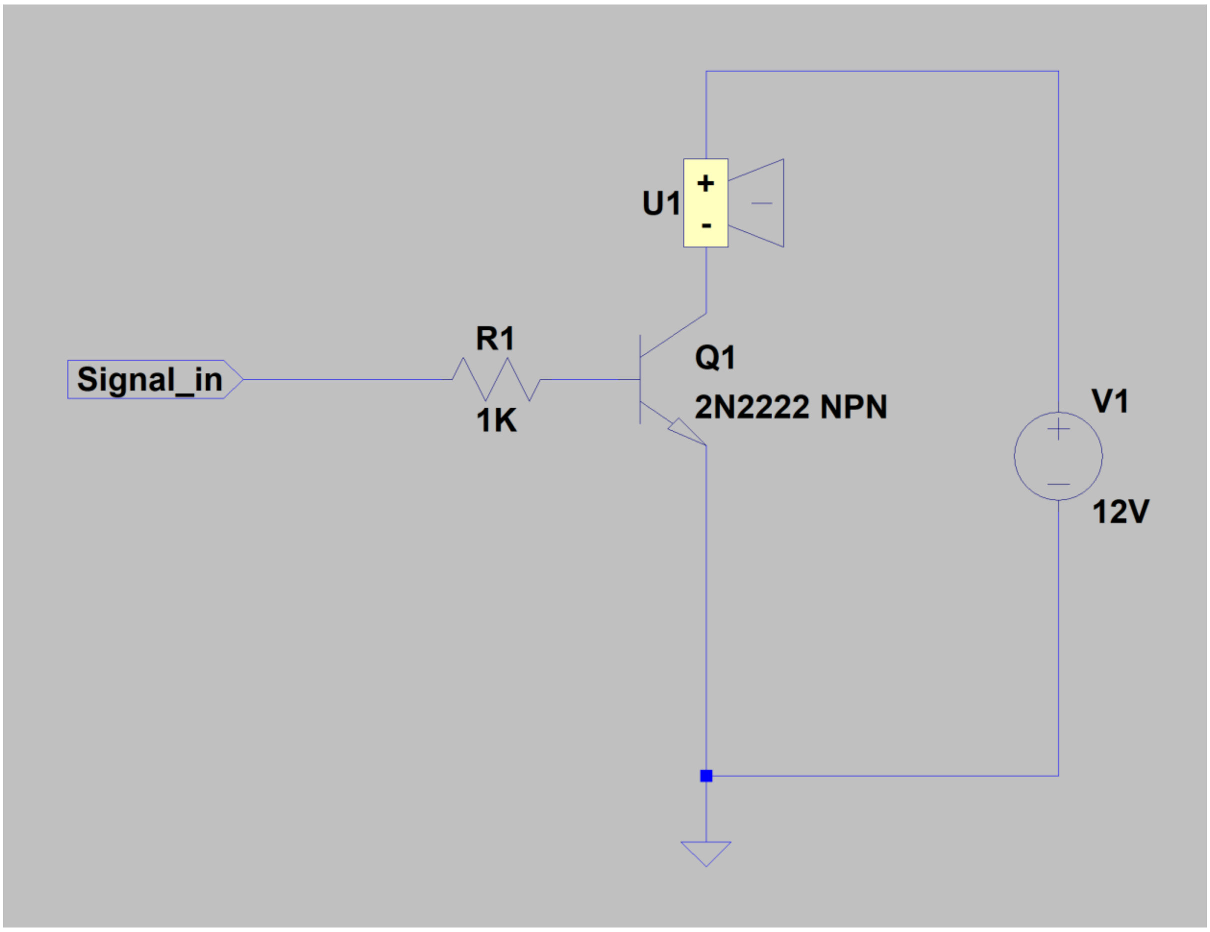

Figure 3: Siren output driver circuit

1.2 SYSTEM ON CHIP (SOC) CONTROL UNIT:

The SoC used will be a Raspberry Pi 3B, running the Raspbian operating system. The programming language used will be Python done in the Idle3 editor on the Raspberry Pi.

To improve power consumption of the system when implemented, certain peripherals not required to run will be switched of. This includes but is not limited to HDMI, and audio.

1.2.1 STATE DIAGRAM:

Alarm Finite State machine:

States = {Setup, Idle, Disarmed, Triggered, Error}
Inputs = ({Check, trig, fault} = {absent, present}, {input} = string)
Outputs = ({Siren} = {absent, present}
Initial_State = Setup.

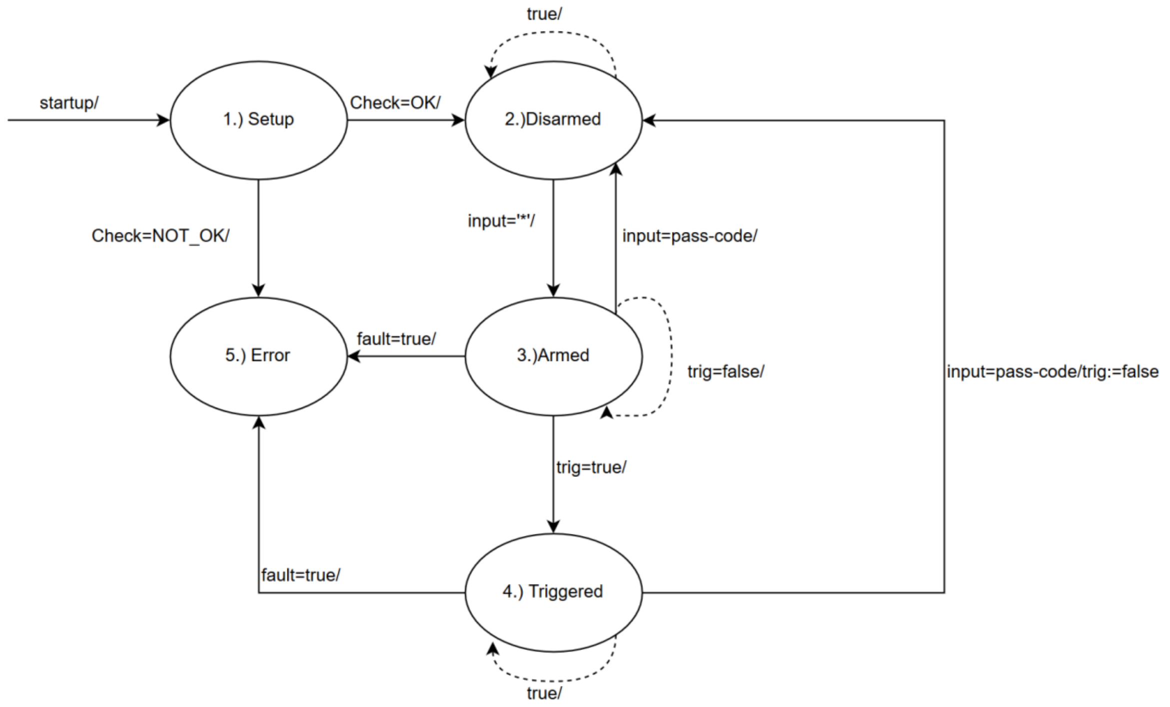

Figure 4: Finite State Machine

1.2.2 FLOW DIAGRAM:

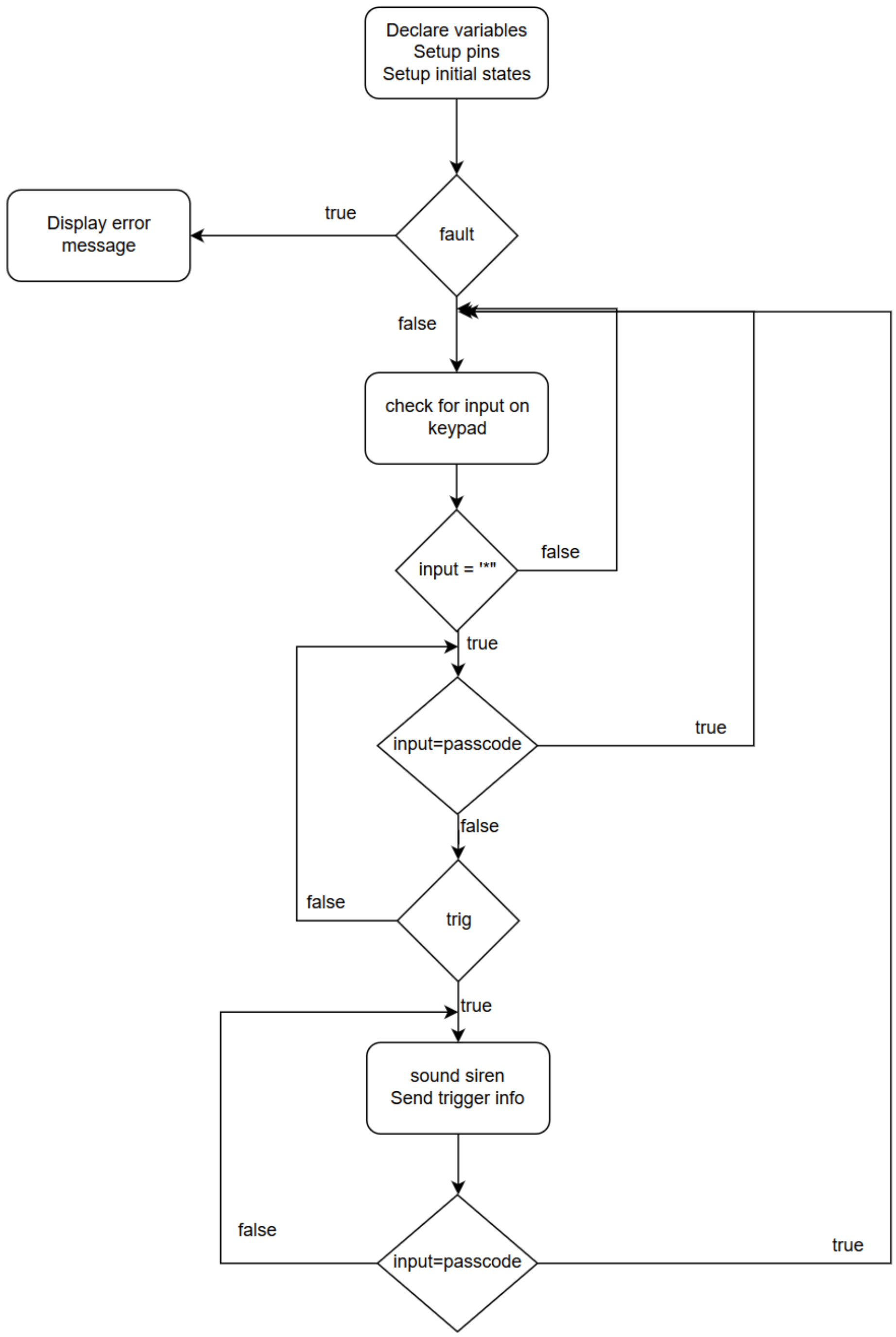

Figure 5: Flow diagram

1.3 ALARM SENSOR INTERFACE MODULE:

Input protection must be added to the system to protect the SoC's pin from voltages that can cause harm. This is done by adding a Zener diode in reverse polarity in parallel to the sensors of the system. The Zener used is a PHBZX79C with a forward voltage of 3.3V.

1.3.2 MOVEMENT DETECTOR:

Movement detection will be done by a PIR sensor, referred to as "Passive Infrared", or "IR Motion".

The PIR sensor to be used is the HC-SR501 Infrared Motion Sensor

HC-SR501 Infrared Motion Sensor Specifications:

- Input Voltage: 4.5V - 20V
- Current Draw: <50µA
- Digital Output: 3.3V (High)
- Digital Output: 0V (Low)
- Working Temperature: -15°C to 70°C
- Delay Time: 0.5 - 200 Seconds
- Sensing Angle: 100° Cone
- Range 5m - 7m
- Dimensions
  - Sensor Lens Diameter: 23mm
  - Length: 24.03mm
  - Width: 32.34mm
  - Height (with lens): 24.66mm
  - Centre screw hole distance: 28mm
  - Screw hole diameter: 2mm (M2)

1.3.3 DOOR CONTACT:

Door contact will be sensed with reed switches, connected to the 3.3v rail of the Raspberry Pi.

- Digital output: 3.3V (High)
- Digital output: 0V (Low)

A Low output will be given when the door is open, and a high output when the door is closed.

1.4 POWER SUPPLY.

The power supply must supply a 12V rail as well as a 5V Rail to power the PIR sensors and the SoC. A 3.3V Rail will be obtained from the internal 3.3V rail on the SoC.

Input power will be 12V with a maximum of 6W power delivery. The power budget for the system is therefore 6W.

The input power will be supplied by two wires, a positive(12V) and Ground(0V) wire. The wires will be attached to the system securely using screw in wire terminals.

Table 2: Power Budget

Power Budget			
Component	Qty	Power per unit	Power total
SoC	1	5W	5W
PIR	4	0,6mW	2,4mW
Inefficiencies	1	500mW	500mW
Total:			5,5024W

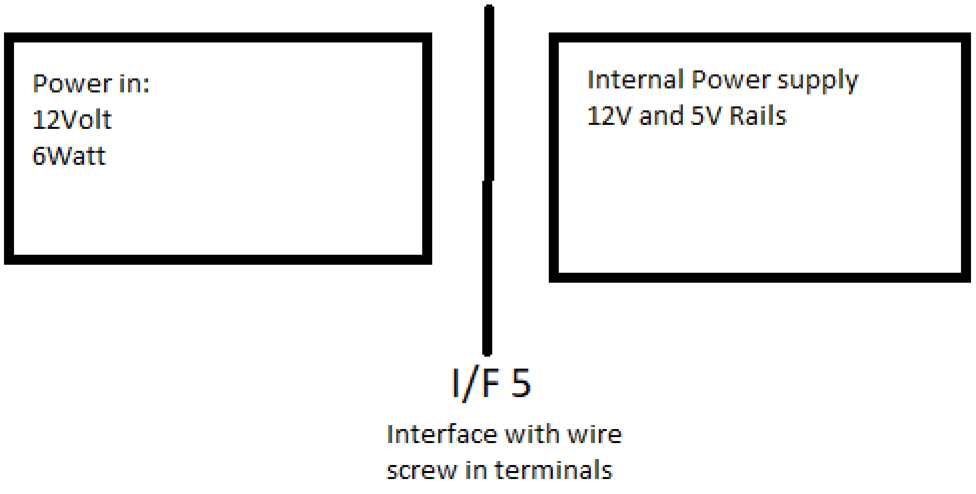

Figure 6: Power supply interface

Input protection for the system will consist of a P-Channel MOSFET, used for reverse input protection, as well as a 0.5A Fuse for short circuit protection of the power supply. A 1000µF capacitor will be added to smooth out the incoming power. A USB voltage regulator will be used to supply power to the SoC as well as creating the 5V rail.

The USB Voltage regulator used is the usb1002 with the following specifications:

- Buck Charge
- Product size: 33mm x 33mm x 8mm
- Input voltage range: 6-24V
- Output voltage: 5.2V (the output terminal is 5.3-5.4V, the load side is 5.1-5.2V)
- Output Current: 3A (without heat sink, the stability of the output current is 2A)

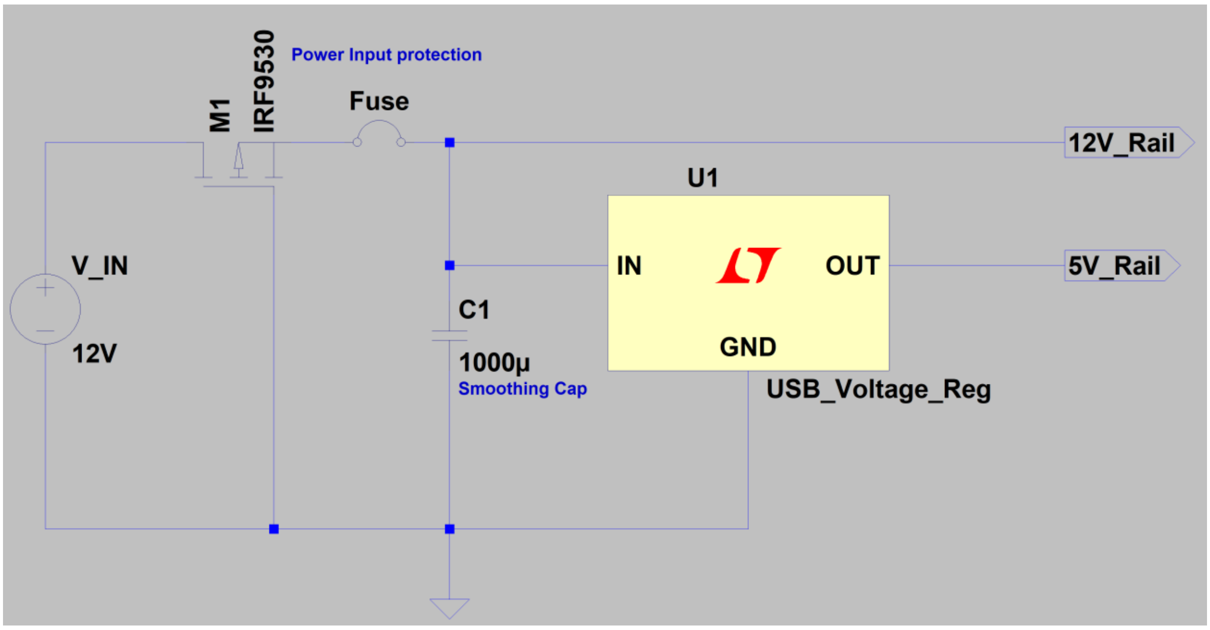

Figure 7: Power Supply

PHYSICAL TEST/ MEASUREMENTS:

Physical simulations will be done on the system to ensure the requirements are met and that the system is in working condition.

Die system will also be reviewed by other members of the group before physical simulations to ensure a working system with the requirements fulfilled.

Test points will also be added to the system to measure voltages, to ensure all aspects of the system is working as intended.

HEALTH & SAFETY CONSIDIRATIONS:

- The system must be grounded to prevent electrical shocks
- No loose wire should be accessible in the system
- The system must be tamper proof
- The system must not be accessible to children
- Wire must be inspected for damage, if wires are damaged the wire must be replaced immediately.

TOOLS USED TO ENHANCE PRODUCTIVITY:

- Excel: For project management, Bill of materials, Trade of decisions
- LT spice: Drawing of circuits and simulations of circuits
- draw.io: Software used to draw the State diagram and the flowchart
- GitHub: used for version control of software
- IDLE3: python IDE used on the SoC to program the SoC