SUB-SYSTEM SPECIFICATION DOCUMENTATION

Section 4

NOVEMBER 15, 2017

SO CALLED ENGINEERS

4. Sub-system Specification Documents (Members)

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4.1 TE Carter

4.1.1 Sub-system Functional Analysis (Architecture / Flow) – Requirements Allocated

The architecture of each circuit as well as the interfaces is shown below in Figure 1: The three architectures of the circuit TE Carter, this consists of the interfaces between the sub-system, as well as the interfaces with other team member's sub-systems.

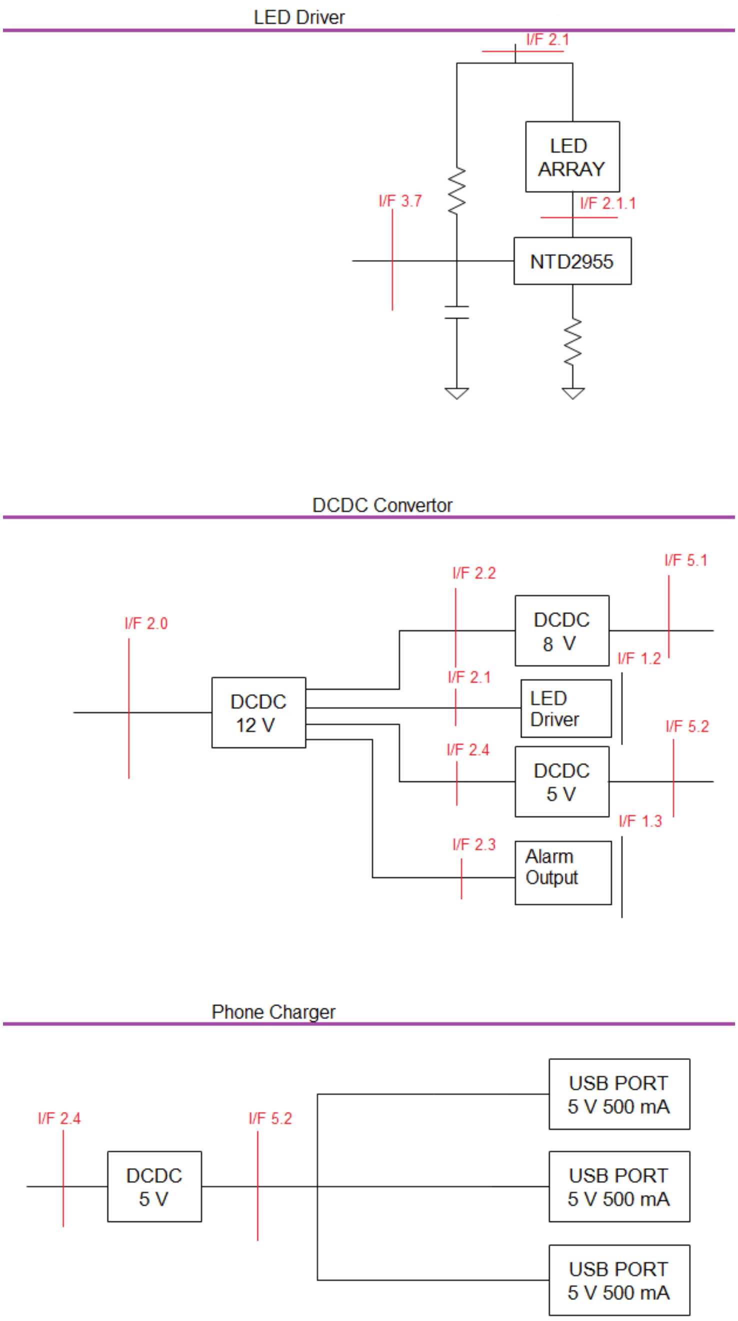


Figure 1: The three architectures of the circuit TE Carter

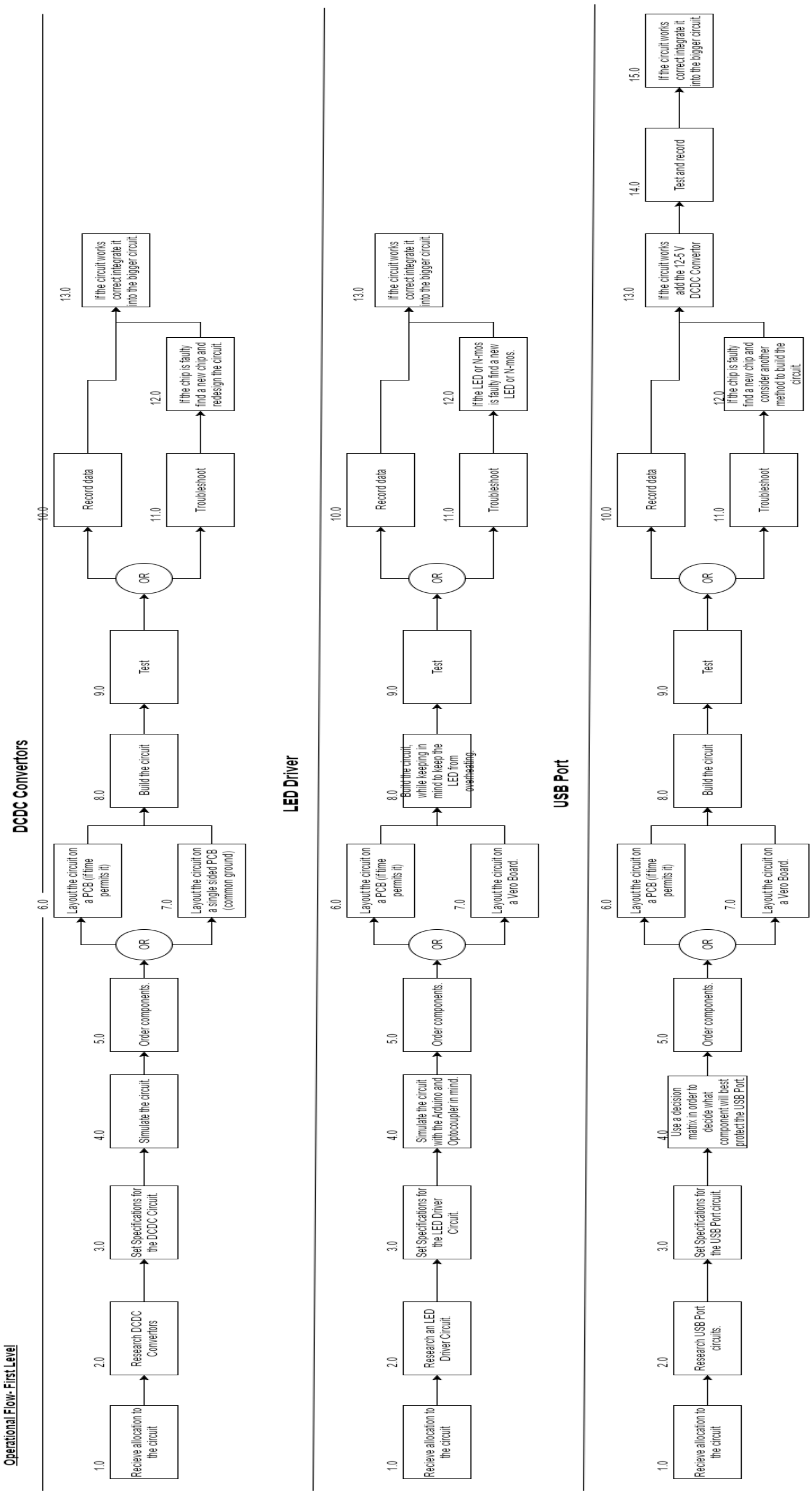


Figure 2: Functional flow of each circuit done by TE Carter

Figure 2: Functional flow of each circuit done by TE Carter shows the functional flow of the sub-systems this member was in charge of for this project. Since the quality of Figure 2: Functional flow of each circuit done by TE Carter is not pristine, a better quality image can be seen in Appendix A.

4.1.2 Sub-system Interface Definitions (Aligned with ICD)

Table 1: Sub-system interfaces

	Interface	Type	Define
Unit 3	I/F 2.1	Electrical	It is the interface between the LED Driver and the 18 – 12 V DCDC Convertor.
	I/F 2.1.1	Electrical	It is the interface between the n-channel mosfet and the LED array.
	I/F 3.7	Electrical	It is the interface between the LED Driver and the Arduino.
	I/F 2.0	Electrical	It is the interface between the charger/ battery and the 18 V – 12 V buck convertor.
	I/F 2.2	Electrical	It is the interface between the 18 V – 12 V buck convertor and the 12 V – 8 V buck convertor.
	I/F 2.4	Electrical	It is the interface between the 18 V – 12 V buck convertor and the 12 V – 5 V buck convertor.
	I/F 2.3	Electrical	It is the interface between the 18 – 12 V DCDC Convertor and Alarm Output.
Unit 2	I/F 5.1	Electrical	It is the interface between the 12 – 7 V DCDC Convertor and Arduino.
Unit 4	I/F 5.2	Electrical	It is the interface between the 12 – 5 V DCDC Convertor and the USB Port.

I/F 2.1 and 2.1.1

Mechanical Requirements

- The LED must be resistant to water damage (might need a casing).
- The wires must not be exposed to water.
- The LED must be able to operate under high and low temperatures.
- The rest of the driver circuit must be placed in container in order to keep it safe from water.
- The buck circuit must be placed in a container to protect against water damage and tampering.

Electrical Requirements

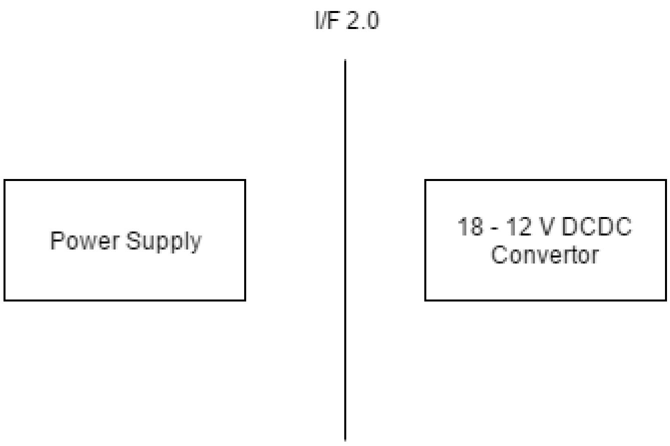
- The 18 – 12 V buck convertor must supply the LED with a constant 12 V.
- The N-mos must be able to switch the LED (meaning it should help to set the LED brightness).
- The LED must be able to operate 24/7 should it be required.
- The LED should be user controlled.
- The LED should trigger with a motion sensor.
- The LED should be pulsed with the Arduino.
- The user should be able to manually set the brightness of the LED.

Below is the characteristics of the LED Driver circuit:

- LED 10 W 12 V 0.8333 A
- N-channel mosfet IRFZ44N
- 1 × 2.3 Ω, 0.869595 A resistors
- 2 × 1 kΩ resistor
- An Optocoupler
- 1 decoupling Capacitor
- Arduino 5 V 0.5 A
- 12 V Power Supply
- Heatsink for the LED

I/F 2.0

This interface control document is the interaction between the power supplies and the DC to DC converter of 12 V for the LED Driver.



Electrical requirements

The power sources that is the PV panel and battery will provide power of 12V- 18V to the DC converter.

Mechanical requirements

The mechanical interface will be a connection point for the DC to DC converter to the power supply via the charging circuit.

This document was signed in Potchefstroom on the date 2017/11/8 as an agreement between the members of SCE, CF Greyling, who provides the power supply and connection point and TE Carter, who provides the 12V DC to DC converter. This document is binding until the end of the 3rd year design module 2017.

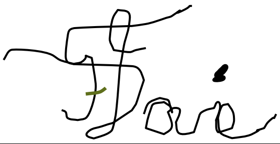
Parties

C.F. Greyling

T.E. Carter

Witnesses:

Witness 1



Witness 2

<u>I/F 2.2</u>

<u>Mechanical Requirements</u>

- The circuit must be placed in a container in order to keep it safe from water damage and tampering.

<u>Electrical Requirements</u>

- The 18 – 12 V DCDC Convertor is required to step down any voltage from the source greater than 12 V.
- The 18 – 12 V DCDC Convertor is to supply a 12 V input to the 12 – 7 V DCDC Convertor.

Below is the characteristics for the 18 – 12 V DCDC Convertor:

- Switching frequency of 150 kHz
- Maximum input 45 V
- Maximum load current 3 A
- Needs an input of 18 V
- Has to give an output of 12 V and 2.16 A.

Below is the characteristics for the 12 – 7 V DCDC Convertor:

- Switching frequency of 150 kHz

- Maximum input 45 V
- Maximum load current 3 A
- Needs an input of 12 V
- Has to give an output of 7/8 V and 0.5 A.

I/F 2.4

Mechanical Requirements

- The circuit must be placed in a container in order to keep it safe from water damage and tampering.

Electrical Requirements

- The 18 – 12 V DCDC Convertor is required to step down any voltage from the source greater than 12 V.
- The 18 – 12 V DCDC Convertor is to supply a 12 V input to the 12 – 5 V DCDC Convertor.

Below is the characteristics for the 18 – 12 V DCDC Convertor:

- Switching frequency of 150 kHz
- Maximum input 45 V
- Maximum load current 3 A
- Needs an input of 18 V
- Has to give an output of 12 V and 2.16 A.

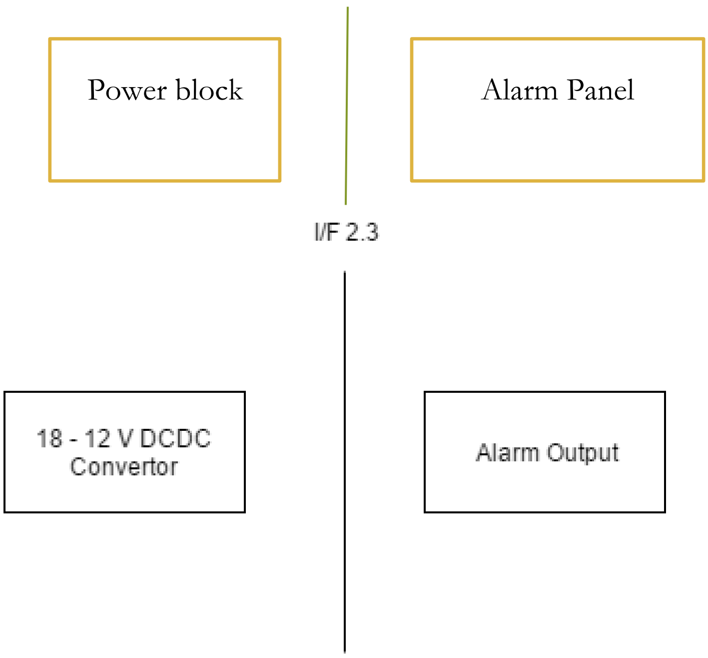
Below is the characteristics for the 12 – 7 V DCDC Convertor:

- Switching frequency of 150 kHz
- Maximum input 45 V
- Maximum load current 3 A
- Needs an input of 12 V
- Has to give an output of 5 V and 1.5 A.

I/F 2.3

This interface control document is the interaction between the power block and the alarm (specifically the 18 – 12 V DCDC Convertor, as this will supply the alarm panel with the specified 12 V).

I/F 2.3



Electrical requirements

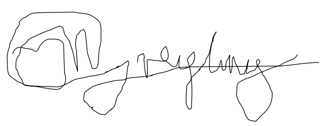
The power block will provide 12 V and 6 W power to the alarm panel. The 18 – 12 V DCDC Convertor is supposed to supply a constant 12 V and 6 W to the Alarm Panel.

Mechanical requirements

The mechanical interface will be a two point screw terminal for both sides so that a wire can be connected between the two. A connection point from TE Carter (18 – 12 V DCDC Convertor) to a REII group will be supplied for the Alarm panel.

This document was signed in Potchefstroom on the date 2017/09/4 as an agreement between the EERI327/ INEM327 and REII327 students in regard to the power supply to the alarm panel. This document is binding until the end of the 3rd year design module 2017.

Representatives



C.F. Greyling

T.E. Carter

FJ Fourie

Witnesses

Witness 1

Witness 2

I/F 5.2

Mechanical Requirements

- The DCDC Convertor circuit must be placed in a container in order to keep it safe from water damage and tampering.
- The USB Port must be accessible to a user as the user must be able to charge their phone from this port.
- The USB Port must be protected against overheating.

Electrical Requirements

- The 12 – 5 V DCDC Convertor must supply the USB Port with a constant 5 V.
- The USB Port circuit must regulate voltage and current in order to insure a cell phone is not damaged during charging.
- The USB Port must protect itself against overheating and fault currents, in order to ensure the Port doesn't blow or worse the Port damages the phone.

Below is the characteristics for the 12 – 5 V DCDC Convertor:

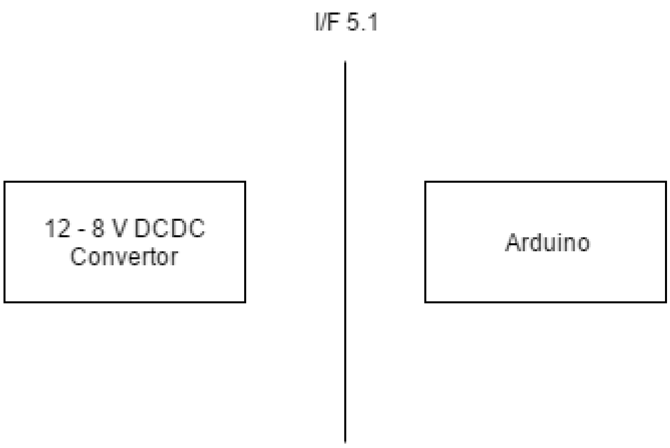
- Switching frequency of 150 kHz
- Maximum input 45 V
- Maximum load current 3 A
- Needs an input of 12 V
- Has to give an output of 5 V and 1.5 A.

Below is the characteristics for the USB Port:

- USB 5 V 0.6 A Unit
- Self-regulated and protected, has its own boost convertor as well.

I/F 5.1

This interface control document is the interaction between the 12 – 8 V DCDC Converter to the Arduino.



Electrical requirements

The power sources for the Arduino is the 12 – 8 V DCDC Convertor, thus it is required that the 12 – 8 V DCDC Convertor must supply the Arduino with a constant 8 V voltage and 0.5 A current.

Mechanical requirements

The mechanical interface will be a connection point from the 12 – 8 V DCDC Converter to the Arduino.

This document was signed in Potchefstroom on the date 2017/11/8 as an agreement between the members of SCE, TE Carter, who provides the 12 – 8 V DCDC Convertor and connection point and SJ du Plessis, who provides the Arduino. This document is binding until the end of the 3rd year design module 2017.

Parties

S.J. du Plessis

T.E. Carter

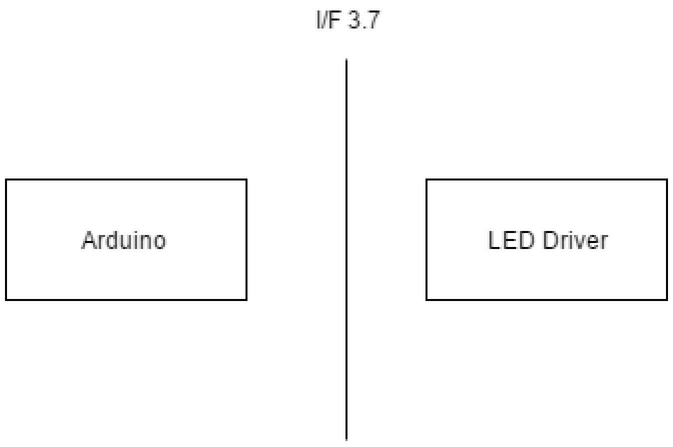
Witnesses:

Witness 1

Witness 2

I/F 3.7

This interface control document is the interaction between the Arduino and the LED Driver circuit.



Electrical requirements

The power source for the LED Driver circuit is the 18 – 12 V DCDC Convertor, the Arduino is used as a pulse width modulator, it must set the brightness of the LED and the user must also be able to set the brightness of the LED using a potential resistor and the Arduino.

Mechanical requirements

The mechanical interface will be a connection point for the Arduino to the LED Driver Circuit.

This document was signed in Potchefstroom on the date 2017/11/8 as an agreement between the members of SCE, SJ du Plessis, who the pulse width modulation from the Arduino and the connection point and TE Carter, who provides the LED Driver circuit. This document is binding until the end of the 3rd year design module 2017.

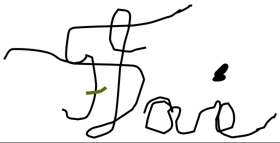
Parties

S.J. du Plessis

T.E. Carter

Witnesses:

Witness 1



Witness 2

4.2 SJ Du Plessis

4.2.1 Sub-system Functional Analysis (Architecture / Flow) – Requirements Allocated

Sub-system functional analysis flow of the architecture of the Arduino and HMI, see Figure 3.

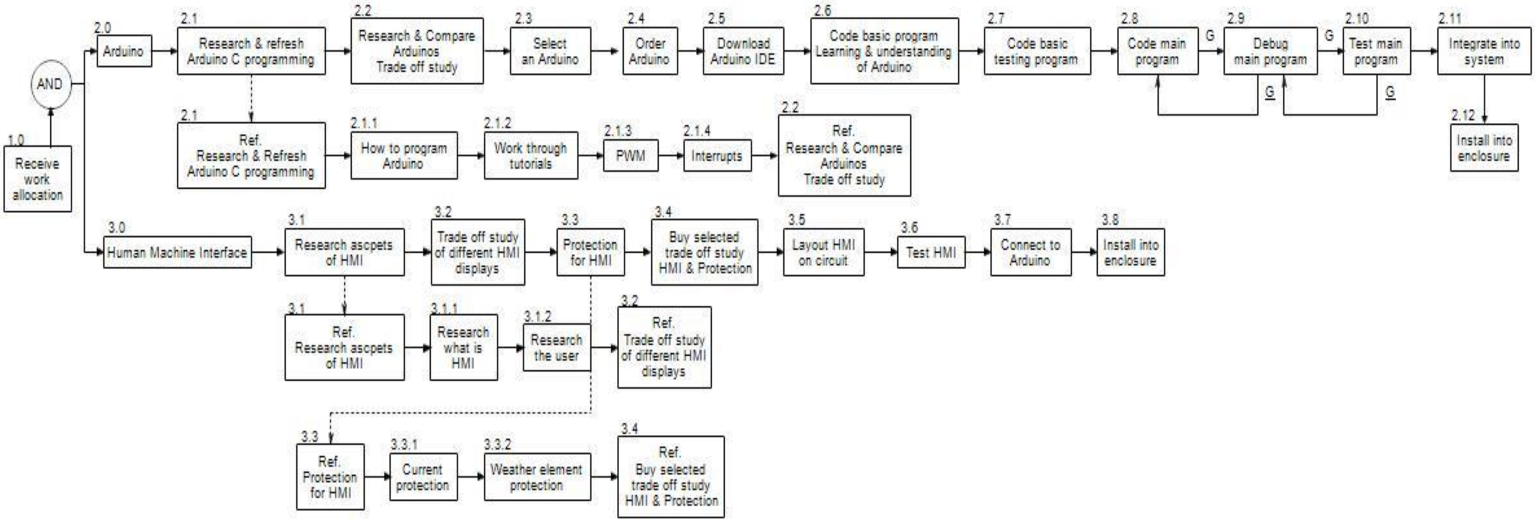


Figure 3: Sub-sustem Functional Analysis flow of the Arduinio & HMI

Sub-system operational functional flow of the architecture of the Arduino and HMI, see Figure 5, and how the Arduino acts and flows with different states. The sub-system functional analysis is derived from the state based diagram, see Figure 4.

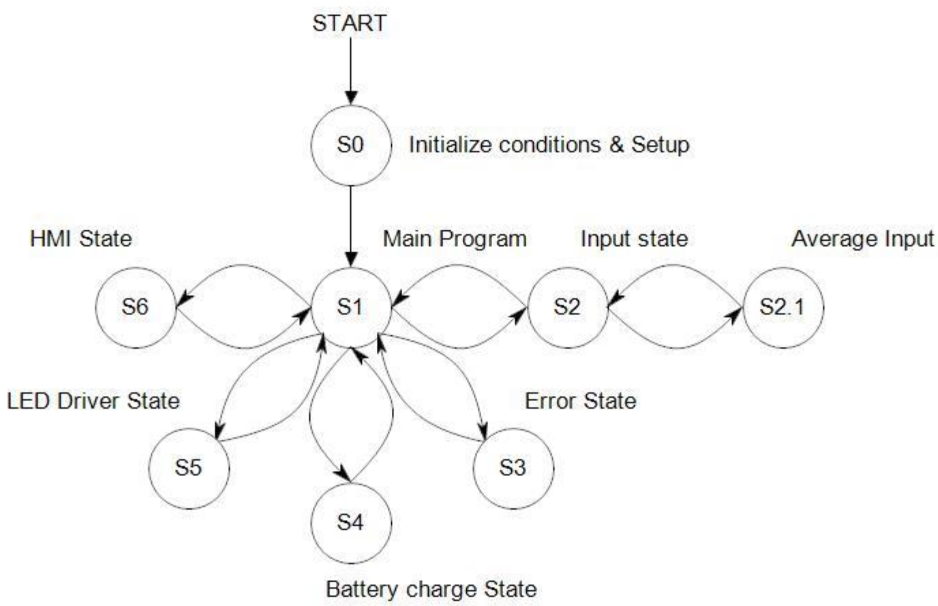


Figure 4: State based diagram of the Arduino's coding

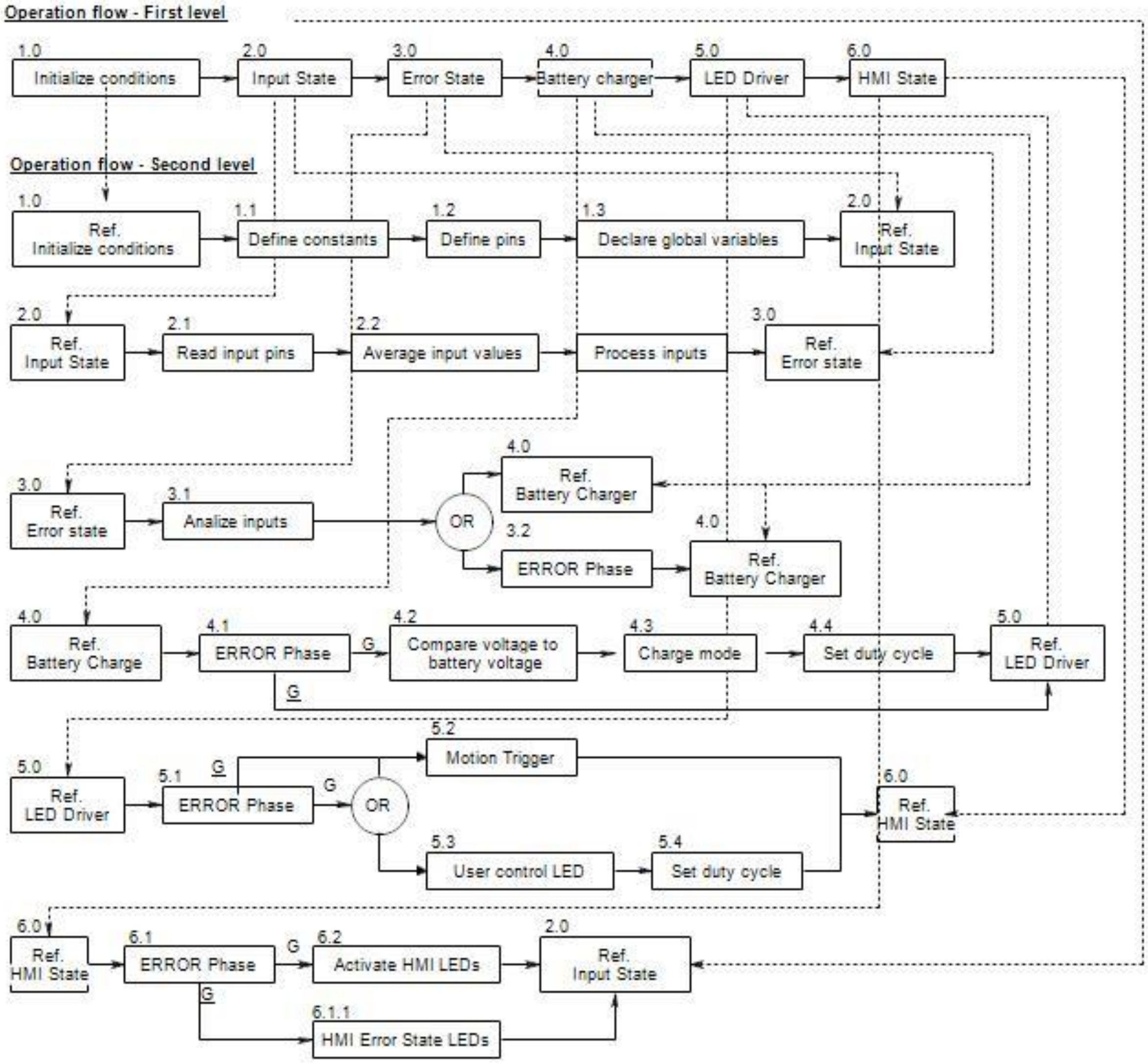


Figure 5: Sub-system Operational functional flow of the Arduino & HMI

Sub-system architecture of the Arduino and HMI, see Figure 6. All the interface and units are shown in figure 6. Unit 2 is the Arduino and unit 3 is the HMI.

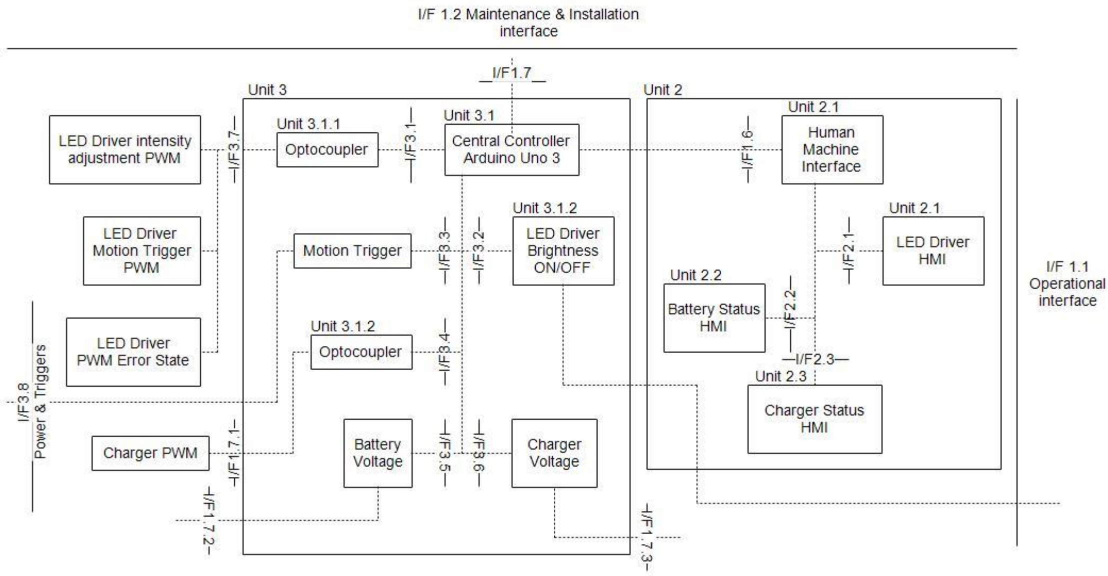


Figure 6: Sub-system Architecture for Arduino and HMI

4.2.2 Sub-system Interface Definitions (Aligned with ICD)

UNIT I/F 1.1 Operational User Interface:

a) Mechanical properties

1. Power block enclosed in casing for element (weather, environment, user, vandal, intruder) protection.

   1.1 ALLBRO Pectron PoolBox

   1.2 Dimensions: 315(H)x185(W)x120(D) mm

   1.3 Material: Plastic

   1.4 HMI LEDs are installed on the side of the enclosure.

2. Battery charger with one LED showing operation in four stages (HMI Unit 3.2.2) – for operation, state of charge on batteries, fault message.

3. LED driver with one LED showing operation in four stages (HMI Unit 3.2.1) – motion trigger, user brightness, power saving mode, fault message.

4. Solar power supply with one LED showing operation in two stages (HMI Unit 3.2.3) – supplying power and fault message.

5. Potentiometer to adjust the brightness of the LED driver. The potentiometer also acts as an on/off switch.

UNIT I/F 1.2 Maintenance & Installation Interface:

a) Mechanical properties

1. Power block enclosed in casing for element (weather, environment, user, vandal, intruder) protection.

   1.1 ALLBRO Pectron PoolBox

   1.2 Dimensions: 315(H)x185(W)x120(D) mm

   1.3 Material: Plastic

   1.4 HMI LEDs are installed on the side of the enclosure.

2. Battery charger with one LED showing operation in four stages (HMI Unit 3.2.2) – for operation, state of charge on batteries, fault message.

3. LED driver with one LED showing operation in four stages (HMI Unit 3.2.1) – motion trigger, user brightness, power saving mode, fault message.

4. Solar power supply with one LED showing operation in two stages (HMI Unit 3.2.3) – supplying power and fault message.

5. Potentiometer to adjust the brightness of the LED driver. The potentiometer also acts as an on/off switch.

6. Installation of Arduino (Unit 3.1) into enclosure.

b) Electrical properties

1. Arduino (Unit 3), powered from 7 V DC-to-DC convertor (I/F 5.1), controls LED driver (I/F 3.7) , battery charging and Human Machine Interface (Unit 2)

2. All electrical cables connected from (I/F 3.1-3.9 & HMI Unit 3.2) to the Arduino (Unit 3.1), neat cable management with plastic glands for protection against water and dust.

3. Arduino (Unit 3.1) receives a pulse from Alarm panel (I/F 3.8), motion trigger for LED driver.

4. Arduino (Unit 3.1) pulse width modulation (I/F 3.1 & 3.4). The LED driver and charge circuit.
5. Arduino (Unit 3.1) measures battery and solar voltage (I/F 3.5 & 3.6).
6. Arduino (Unit 3.1) measures the potentiometer (I/F 3.2) for LED brightness adjustment or on/off

Unit 3.2: Human Machine Interface

a) Mechanical properties

The HMI consists out of LED's. Two 5 mm RGB LED's (Unit 3.2.1 & 3.2.2) and a 5 mm RG LED (Unit 3.2.3). The first RGB LED shows the battery's status, the second RGB LED shows the LED driver's status and finally the RG LED shows the power supply, solar panel, status.

b) Electrical properties

Colours to indicate different states

Battery –RGB LED 4 pin: (I/F 2.2)

- R – Low voltage below 12.5 V
- G – Healthy voltage between 12.5 V and 14.4 V
- B – Fully charged above 14.4 V
- RGB – Error state, no signal (Battery removed)

Solar & Power supply –RG LED 3 pin: (I/F 2.3)

- R – No solar panel charge or power supply charge, no signal (Night or solar panel removed)
- G – Solar panel or power supply delivering power.

LED Driver –RGB LED 4 pin: (I/F 2.1)

- R – PWM control, low battery
- G – Potentiometer control
- B – Alarm trigger input
- RGB – LED Off

Resistor selection per colour:

All data obtained from an unknown LED datasheet. It is only used for reference and the final resistance is selected when LED's junctions are measured.

RGB LED 4-pin:

A forward current of 20 mA is selected, at 20 mA the LED's have a luminous intensity of 1. Forward voltage of LED is obtained from Forward Current vs Forward Voltage graph of each colour and be seen in Table 2.

Table 2: RGB resistor calculation per color from data obtained from a datasheet

RGB LED 4-pin	Forward current	Forward voltage	Resistor calculated	Resistor selected
Red	20 mA	1.95 V	152.5 Ω	150 Ω
Blue	20 mA	3.3 V	85 Ω	91 Ω
Green	20 mA	3.1325 V	84.375 Ω	91 Ω

RG LED 3-pin:

A forward current of 20 mA is selected, at 20 mA the LED's have a luminous intensity of 1. Forward voltage of LED is obtained from Forward Current vs Forward Voltage graph of each colour and be seen in Table 3.

Table 3: RG resistor calculation per color from data obtained from a datasheet

RG LED 3-pin	Forward current	Forward voltage	Resistor calculated	Resistor selected
Red	20 mA	2 V	150 Ω	150 Ω
Green	20 mA	2.2 V	140 Ω	150 Ω

Unit 3.0: Arduino

a) <u>Mechanical properties</u>

Physical Characterises: 6.858 x 5.334 cm

Ambient Operating Temperature: -40°C … 85°C

b) <u>Electrical properties</u>

Operating voltage: 5 V

Input Voltage:

- Recommended: 7 – 12 V
- Limits: 6 – 20 V

Microcontroller: ATmega328

DC Current per I/O Pin: 40 mA

DC Current for 3.3 V Pin: 50 mA

Automatic overcurrent cut-off at 500 mA

c) <u>Data Protocol properties</u>

Flash Memory: 32 KB

SRAM: 2 KB

EEPROM: 1 KB

Clock Speed: 16 MHz

ISO 7 layer:

1. Physical Layer

   - *What signal state represents a binary 1?* Port 13 with the LED represents a binary 1 and 0
   - *Will an external transceiver (MAU) be used to connect to the medium?* The Arduino software includes a serial monitor which allows simple textual data to be

sent to and from the Arduino board. The RX and TX LEDs on the board will flash when data is being

transmitted via the USB-to-serial chip and USB connection to the computer (but not for serial communication on pins 0 and 1).

- *How many pins do the connectors have and what is each pin used for?* Digital I/O 14 and analog input 6 Serial:

    i. (RX) and 1 (TX). Used to receive (RX) and transmit (TX) TTL serial data. These pins are connected to the corresponding pins of the ATmega8U2 USB-to-TTL Serial chip.

    ii. External Interrupts: 2 and 3. These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a change in value.

    iii. PWM: 3, 5, 6, 9, 10, and 11. 8-bit PWM output.

    iv. SPI: 10 (SS), 11 (MOSI), 12 (MISO), 13 (SCK). These pins support SPI communication.

    v. LED: 13. There is a built-in LED connected to digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.

    vi. TWI: A4 or SDA pin and A5 or SCL pin.

    vii. AREF. Reference voltage for the analog inputs.

    viii. Reset

2. Data Link Layer

- *Frame Formats?* The USART has total of 30 combinations of which the following is accepted frame formats:

    i. 1 start bit

    ii. 5, 6, 7, 8 or 9 data bits

    iii. no, even or odd parity bit

iv. 1 or 2 stop bits

The frame starts with a start bit trailed by a least significant data bit. The next data bits 0 – 9 follows, ending with the most significant bit. If the parity bit is enabled, the parity bit is inserted after the data bits. This bit is before the stop bit.

- *Frame sequencing?* After a frame has been transmitted, a new frame can follow directly afterwards, or the communication line can be set to a high state which indicates no transfer on the communication line.
- *Frame Error Checking?* An Frame Error will then only be detected where the first stop bit is zero.

3. Network Layer

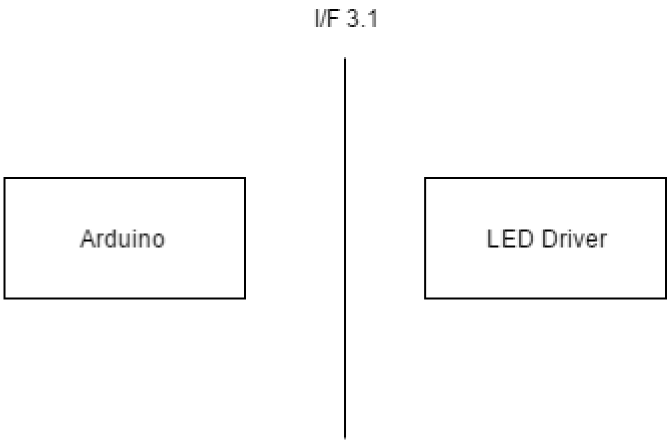
- Communications Subnet:

The Arduino Uno has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega328 provides UART TTL (5V) serial communication, which is available on digital pins 0 (RX) and 1 (TX). An ATmega16U2 on the board channels this serial

Communication over USB and appears as a virtual com port to software on the computer. The '16U2 firmware uses the standard USB COM drivers, and no external driver is needed. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board. The RX and TX LEDs on the board will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer (but not for serial communication on pins 0 and 1). The ATmega328 also supports I2C (TWI) and SPI communication.

I/F 3.1

This interface control document is the interaction between the Arduino and the LED Driver circuit.



4.2.2.1.1 Electrical requirements

The power source for the LED Driver circuit is the 18 – 12 V DCDC Convertor, the Arduino is used as a pulse width modulator, it must set the brightness of the LED and the user must also be able to set the brightness of the LED using a potential resistor and the Arduino.

4.2.2.1.2 Mechanical requirements

The mechanical interface will be a connection point for the Arduino to the LED Driver Circuit.

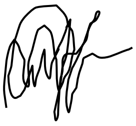
This document was signed in Potchefstroom on the date 2017/11/8 as an agreement between the members of SCE, SJ du Plessis, who the pulse width modulation from the Arduino and the connection point and TE Carter, who provides the LED Driver circuit. This document is binding until the end of the 3rd year design module 2017.

Parties

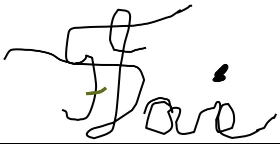
S.J. du Plessis

T.E. Carter

Witnesses:



Witness 1



4.3 CF Greyling

4.3.1 Sub-system Functional Analysis (Architecture / Flow) – Requirements Allocated

4.3.1.1 Sub-system Functional Architecture Analysis

In the following Figure 7 below the sub-system functional analysis of the architecture can be seen with the requirements added.

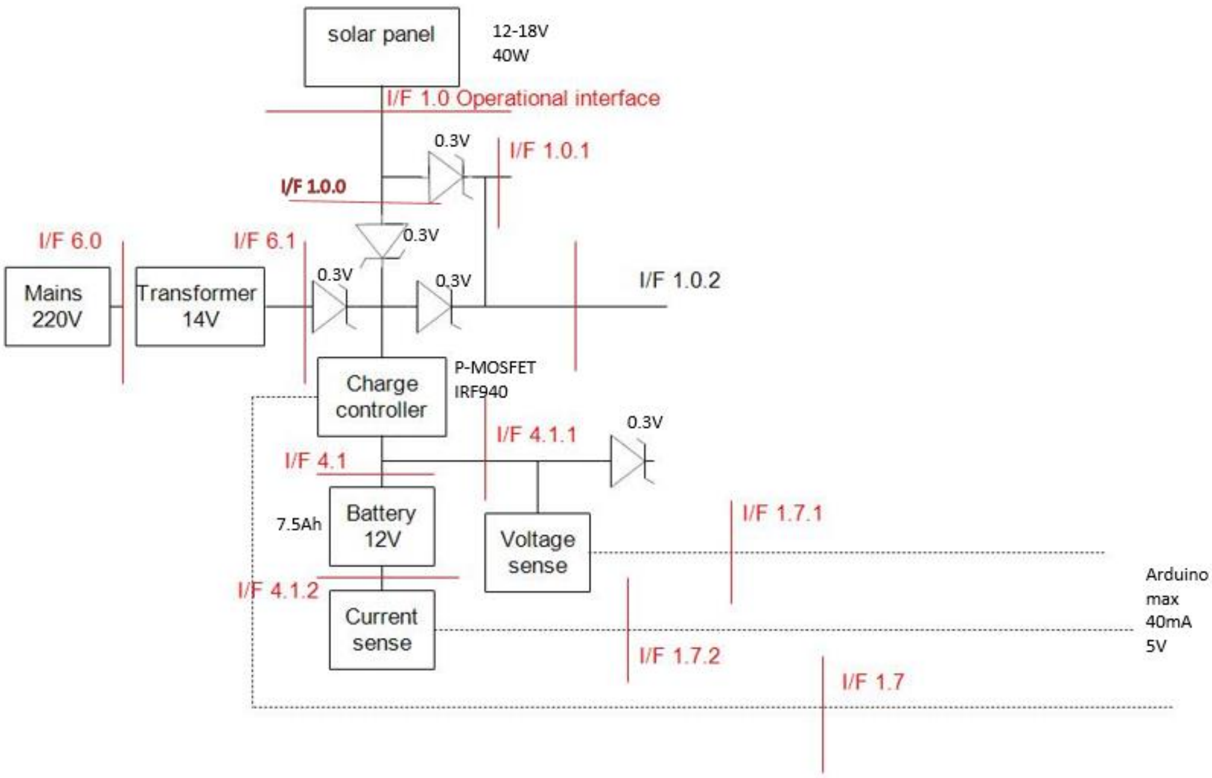


Figure 7: Sub-system Functional Analysis Architecture CF Greyling

The design changed however after it was determined that there would not be enough funds to add the mains power via an AC transformer to the system. These changes in the design altered some of the architecture as well, therefore the following architecture below in Figure shows the correct architectural analysis though the sub system architecture analysis in Figure 7 above gave a guideline to the subsystem architecture.

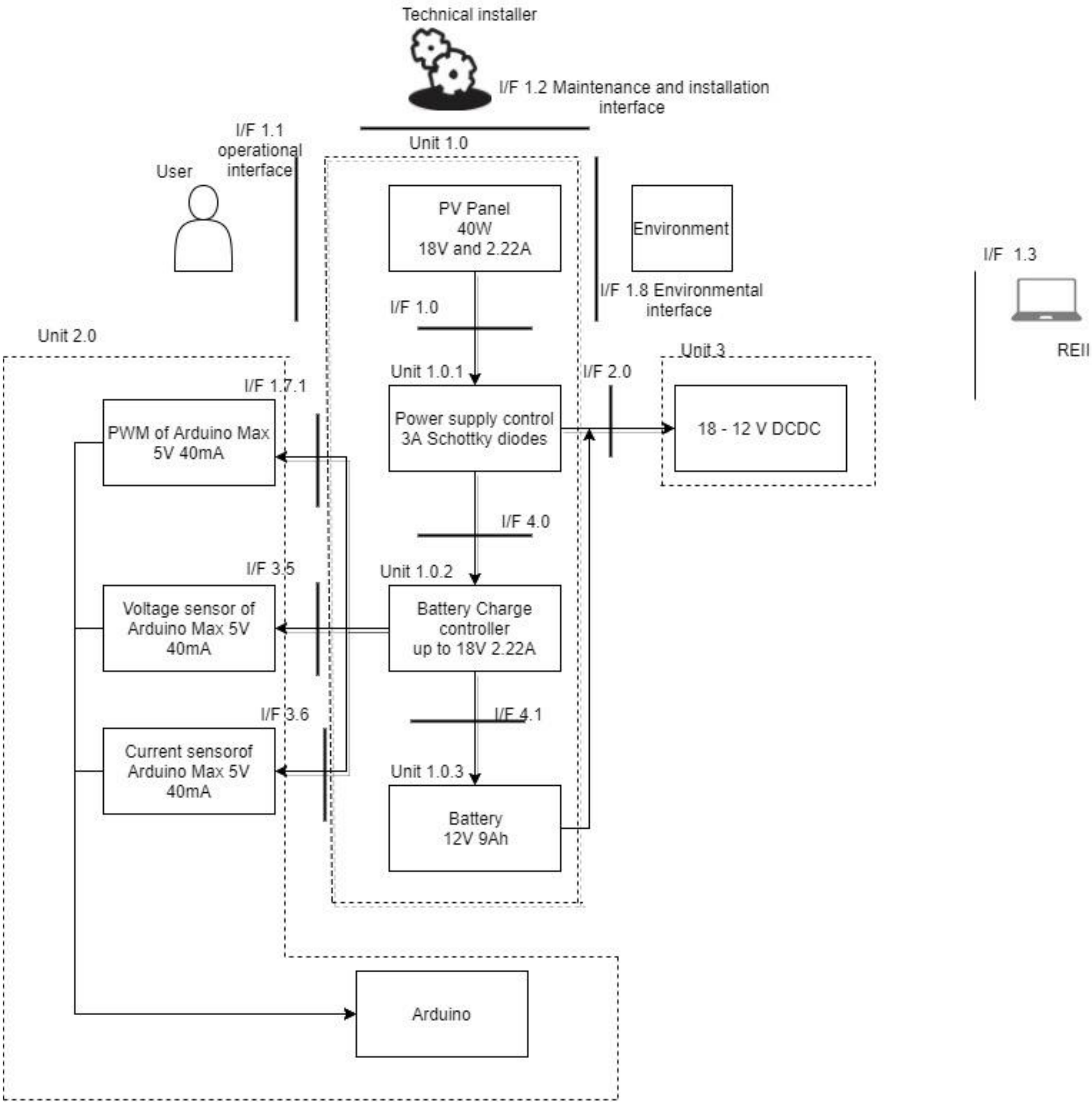


Figure 8:Sub-system Architecture CF Greyling Rev2

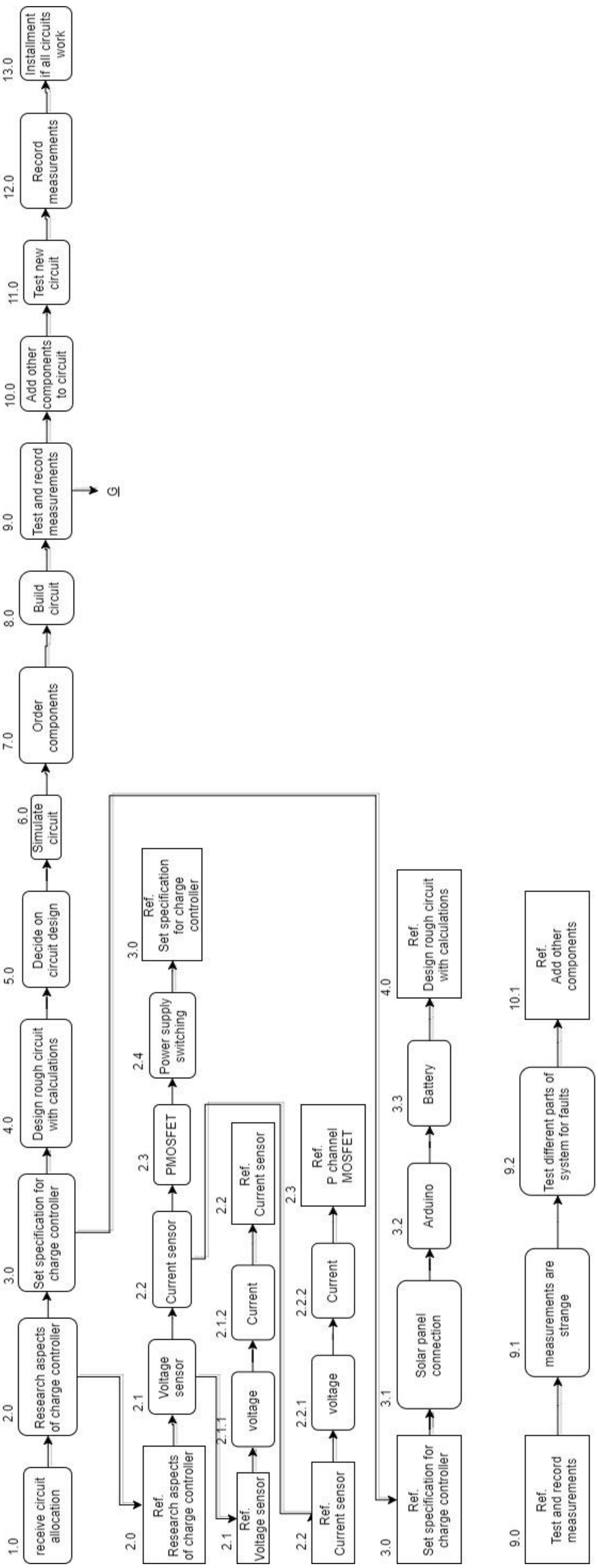


Figure ev2

Figure 9: Sub-system Function Analysis Flow CF Greyling

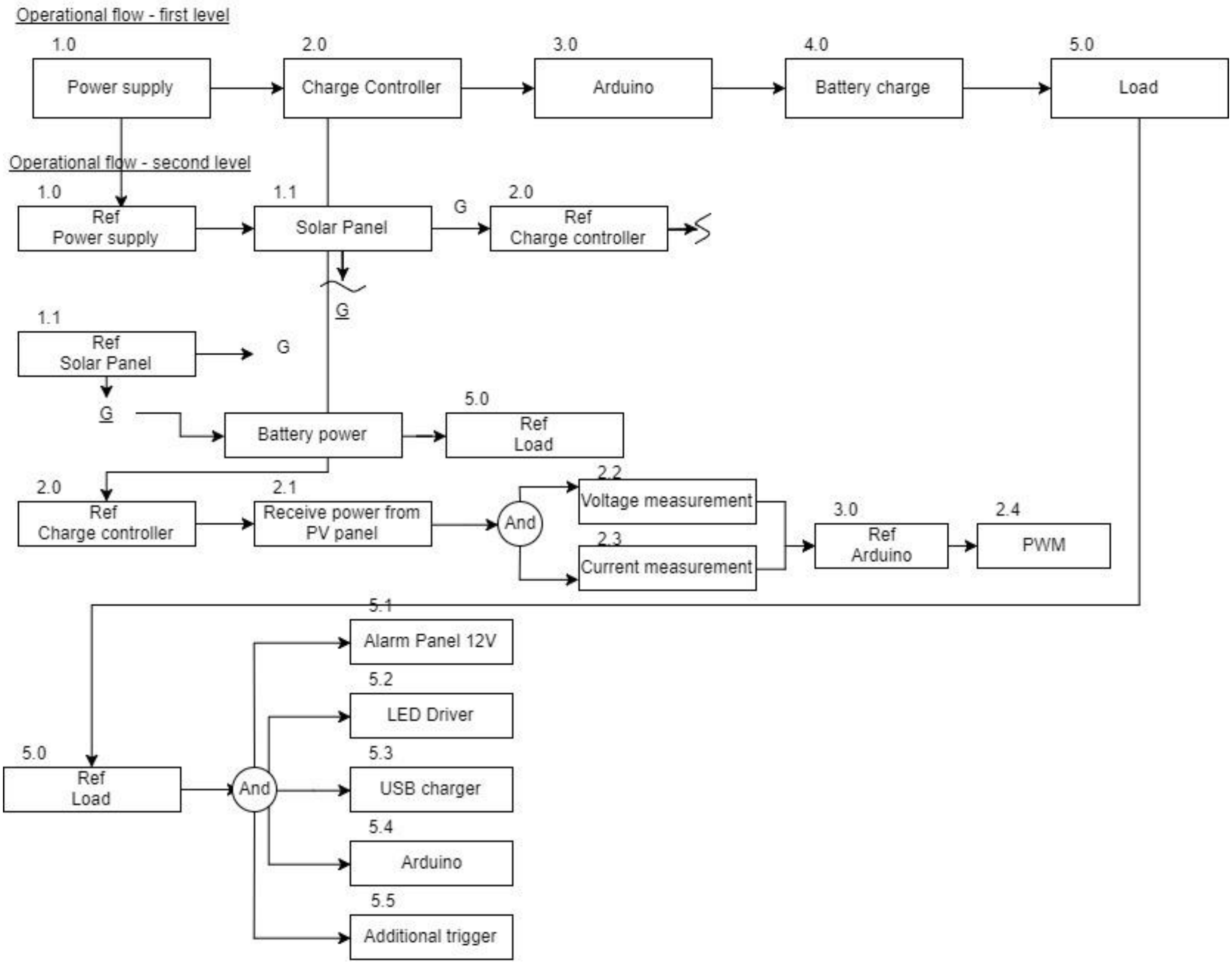


Figure 10: Operational functional flow diagram CF Greyling

4.3.2 Sub-system Interface Definitions (Aligned with ICD)

The subsystem definition is in the Table 4: Subsystem interface Definition for CF Greyling below an overview of the interfaces this member is responsible for is given.

4.3.2.1 Overview of Interfaces

Table 4: Subsystem interface Definition for CF Greyling

Interface	Type	Define
I/F 1.0	Electrical	Solar panel 12V-18 V and 40W with whole circuit
I/F 1.1	Operational	PV panel and user
I/F 1.2	Maintenance and installation	Interface between the PV panel and the technician that will install and maintain the system
I/F 1.8	Environmental	PV panel and Environment
I/F 3.0	Electrical	Power supply control and load i.e. alarm panel, USB charger, LED driver and Arduino

I/F 2.0	Electrical	Power supply to 12V DC to DC converter for the load i.e. alarm panel, USB charger, LED driver and Arduino
I/F 4.0	Electrical	Interface between the power supply switching and the battery charge controlling circuit
I/F 4.1	Electrical	Interface between the charge controller and the 12, 9Ah Battery
I/F 1.3	Electrical	Interface between the 12V 6W supply of the power block to the alarm panel
I/F 1.7.1	Electrical	Interface between the Charge controller and the Arduino PWM
I/F 3.5	Electrical	Interface between the Voltage sensor of the Charge controller and the Arduino measuring I/O pin max 40mA
I/F 3.6	Electrical	Interface between the Current sensor of the Charge controller and the Arduino measuring I/O pin max 40mA

4.3.2.2 Unit and subsystem interface definition

<u>Unit 1: PV panel</u>

<u>General characteristics</u>

- General
  - Weight 4.4 kg
  - Dimensions : 530x670x25mm
  - Number of cells: 36
  - Polycrystalline solar cell
- Electrical Performance at STC
  - Maximum power Voltage: 18V
  - Maximum Power Current: 2.22A
  - Open circuit Voltage : 22.1V
  - Short circuit Current: 3.06A
- Limits:
  - Operate Temperature: -40 to 85 degrees Celsius
  - Maximum system Voltage 1000V DC

<u>I/F 1.1: PV panel to user</u>

The interface between the PV panel and the user of the panel, which is the owner of the house or the school or wherever the system will be installed.

Mechanical requirements

- PV panel water proof for rain.
- Weight not exceed 6kg
- Dimensions not exceed 1000 x 1000 x 50 mm
- Connectors for junction Box on PV panel
- Operate under temperatures of: -10 to 50 degrees Celsius
- Will be cleaned be user on occasion to wipe off gathered dust on the cells of the PV panel

Electrical requirements

The PV panel will be a 40 W, 18V, 2.22A panel.

I/F 1.0 : PV Panel to power supply control

Connection between the PV panel and the system, which is the power supply control. The power supply control is simply the system of diodes placed throughout the circuit to switch the power supply of the load depending on the power supply available.

Mechanical requirements

Connection must be made between the PV panel and the system.

Electrical requirements

Two wires will connect the PV panel and the system, one positive wire to connect to the positive node provided in the power supply control for the PV panel, and one ground wire that will connect to the ground connection provided on the power supply control circuit in the control box. A common ground will be established between the PV panel, Battery and all the other components of the circuit. The wires that connect the PV panel to the system will be able to withstand at least a voltage of 30V and a current 4A. A fuse will be connected inline between the positive terminal of the PV panel and the connection provided on the power supply circuit. PV panel will deliver power to the system throughout the day to charge the battery with as well as provide power for the rest of the components. The PV panel will deliver 13-18V to the system.

I/F 1.8: PV panel and environment

The interface between the PV panel and the environment, where the environment includes, lightning, rain, dust and fluctuation temperatures.

Mechanical requirements

The PV panel will withstand temperatures between -10 and 50 degrees Celsius. Withstand rain, therefore the panel will be insulated as to be waterproof and all connectors the panel will be secure and insulated to ensure no accidental connections with rain water will be made.

Electrical requirements

The PV panel and system will be protected from the environment, in regards to lightning strikes by the addition of a 30V transorb in the circuit. The wires used for the PV panel will be resistant to heat damage and corrosion from the extreme heat of the sun. The PV panel chosen will be designed for off grid use that is eco-friendly. The components used throughout the circuit are selected to be as eco-friendly as possible, they were selected by looking at their RoHS status.

I/F 1.2: Maintenance interface of the technical installer and the PV panel

The PV panel is both subject to installation on sight and maintenance throughout the PV panel's life cycle.

Mechanical requirements

The PV panel will be installed on site by a technician. The technician will connect the solar panel to the roof using brackets to secure the solar panel against strong winds and theft. The technician will check the installation to ensure that there is no open wires that could be potentially dangerous to the environment or users.

Electrical requirements

The PV panel will be connected to the system with two wires provided by this member for the positive and ground terminals of the PV panel.

Unit 1.2.1: Power Supply (directing)

I/F 1.0: PV panel and Power supply control

The interface between the PV panel and the battery charger is described above in I/F 1.0 of the PV panel unit 1.0 above

I/F 2.0: Power supply control and the load

The interface between the power supply control, which is the diode connections in the circuit to allow the power supply with the highest voltage to provide power to the system, and the load, i.e. the 12V 6W alarm panel, 5V USB charger, 12V LED controller and the 7V Arduino.

Mechanical requirements

The power supply control will be providing a two screw terminal for the Voltage and ground of the load.

Electrical requirements

The power supply control will provide the load with 12-18V and current throughout its life cycle as necessary. In the case of power shortage the non-essential elements in the load will be disconnected by the DC to DC controller and the voltage will only be supplied to essential elements in the circuit.

I/F 4.0: Power supply control and Battery charge controller

The interface between the power supply control, which is the diode circuit in the system. To the battery charge controller which is the P channel MOSFET switching circuit, that charges the battery from the PV panel.

Mechanical requirements

The power supply controller and the battery charge controller will be mounted on the same perf-board to allow for short wires.

Electrical requirements

The power supply controller will connect with a positive wire to the battery charge controller providing it with power. They will be connected by a common ground. The charge controller MOSFET will be an Enhancement mode P channel power MOSFET which is a normally closed. When the MOFET is switched op power will flow to the battery and the battery will charge.

Unit 1.2.2: Battery Charger MOSFET circuit

I/F 4.0: Power supply control and Battery charge controller

The interface 4.0 between the power supply control and the battery charger is divined above in Unit 1.2.1.

I/F 4.1: Battery charge controller and Battery

The interface 4.1 is the interface between the battery charge controller and the battery for the system.

Mechanical requirements

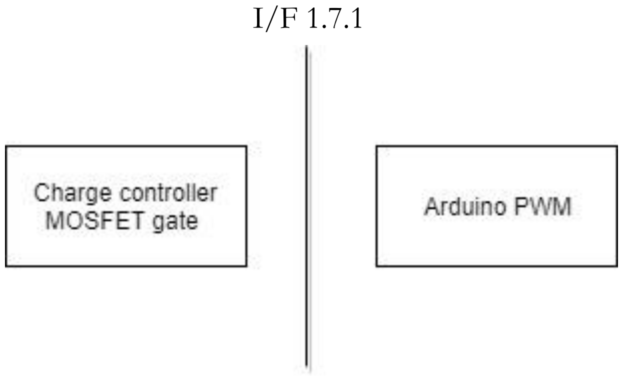
Both the battery charge controller and the battery will be fitted into the control box in close connection to each other. A two screw terminal connector will be provided for the battery connection.

Electrical requirements

Wire connection to the positive terminal of the battery from the positive terminal, more specifically the source of the P channel MOSFET, this terminal will deliver power to the battery depending on the PWM signal to the charge controlling circuit. There will be a common ground connection as well that will connect to the common ground of the entire system.

I/F 1.7.1 : Battery charge controller and the PWM of the Arduino

The interface between the battery charge controller circuit, which is the MOSFET switching, and the Pulse width modulation (PWM) of the Arduino, which has maximum if 5V and 40mA. An ICD is provided in section 5.



Mechanical requirements

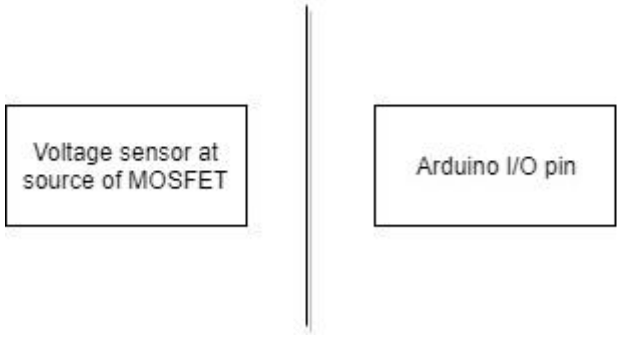
There will be a connector for the PWM at the base of the NPN transistor in the circuit. Which will be connected by optocoupler to the Arduino, the optocoupler will be built on the same perf-board as the charge controller system.

Electrical requirements

The PWM of the Arduino will send a 5V pulse to the battery charger via NPN transistor to the gate of the MOSFET. When a high pulse is sent the switch will be open and the battery will charge. When a low or no pulse is sent to the gate the switch will be closed and the battery will not charge.

I/F 3.6: Battery charge controller voltage sensor and the Arduino I/O pin

The interface between the battery charge controller voltage sensor and the Arduino I/O pins which can only take up to 5V and 40mA. An ICD is provided in section 5.



Mechanical requirements

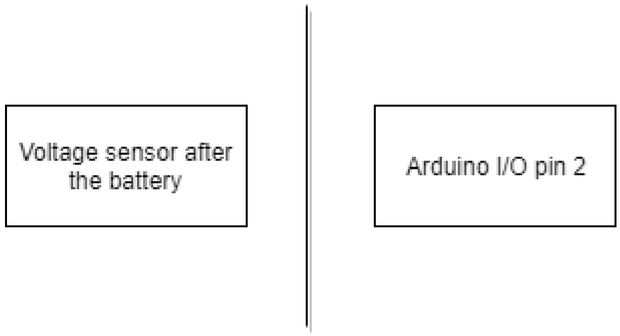
A connector point will be provided to the Arduino I/O pin.

Electrical requirements

A voltage diver combined with a Zener diode and a capacitor in parallel acts as the point for the voltage sensor.

I/F 3.5: Battery charge controller current sensor and the Arduino I/O pin

The interface between the battery charge controller voltage sensor and the Arduino I/O pins which can only take up to 5V and 40mA. An ICD is provided in section 5.



Mechanical requirements

A connector point will be provided to the Arduino I/O pin.

Electrical requirements

A voltage diver combined with a Zener diode and a capacitor in parallel acts as the point for the voltage sensor.

Unit 1.2.3: Battery

I/F 4.1: Battery charge controller and Battery

The interface between the battery and the charge controller of the battery is divined above under Unit 1.2.2 I/F 4.1.

I/F 2.0: Interface between the battery and the load

The battery supply requirements for the load when the PV panel does not provide enough power to the load.

Mechanical requirements

The battery and the load is connected with the load receiving two screw terminals to connect to the circuit. The screw terminals must be large enough to connect wires that are able to take up to 14V and 9A without getting heat damage.

Electrical requirements

The battery must be able to deliver up to 14V and 9A maximum. Will be able to run 12V, 6W alarm, 5V USB, 12V LED and 7V Arduino as required throughout the night when the solar panel is not operational, or during days when the sun is not shining enough to provide power to the system.

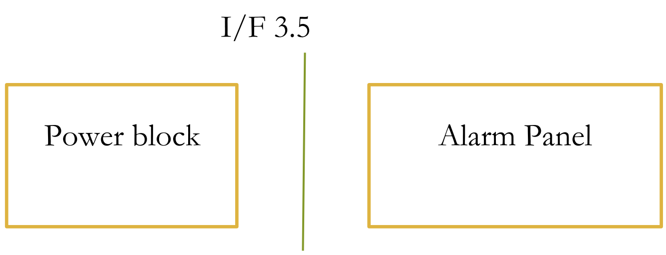
Unit 3.0: Load

I/F 2.0: Power supply control and the load

The interface is described above in Unit 1.2.1.

I/F 1.3: Power supply to 12V 6W alarm panel

This interface control document is the interaction between the power block and the alarm. Where this interface acts as an agreement between the EERI327/ INEM327 and REII327 students in regard to the power supply to the alarm panel.



Mechanical requirements

The mechanical interface will be a two point screw terminal for both sides so that a wire can be connected between the two.

Electrical requirements

The power block will provide 12 V and 6 W power to the alarm panel.

I/F 2.0: Interface between the battery and the load

The interface is described above in Unit 1.2.3.