PORTABLE NUTRIENT DATA COLLECTION SYSTEM

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Problem Statement

Managing nutrients in agriculture continues to be a major challenge in ecosystem science. In this project, we will design a portable system to address this problem using integrated MEMS microplasma-based sensors and a spectrometer with a microcontroller to collect and transmit data wirelessly to a smartphone app with an easy-access interface.

Functional Requirement

1. The whole process should take less than 30s
2. Display concentration of different elements(N&P) in water sample with precision
3. Transmit data wirelessly to smartphone
4. With water and soil proof
5. Application is based on Android
6. Have database for the history

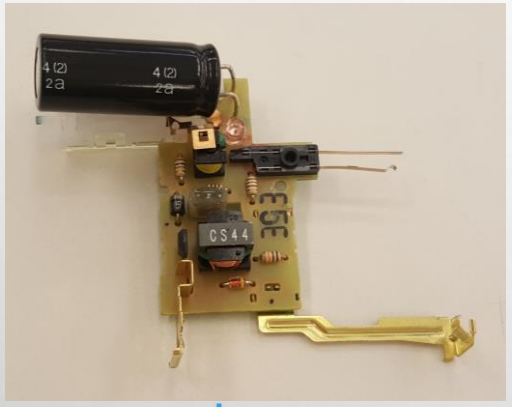
Nonfunctional Requirement

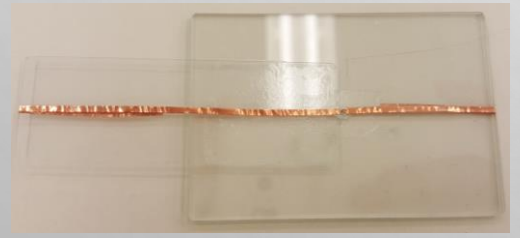
1. Portable, low power and safe
2. Easy-use-interface. (tutorial, easy to find settings)
3. Be shielded from water and dirt damage
4. Be able to remain powered wirelessly for 50 trials
5. 90% accurate with reading
6. Smartphone app size should be less than 6MB
7. Communication from device to smartphone should take less than 2s
8. Wireless range should be up to 2m

Conceptual Sketch

Microcontroller

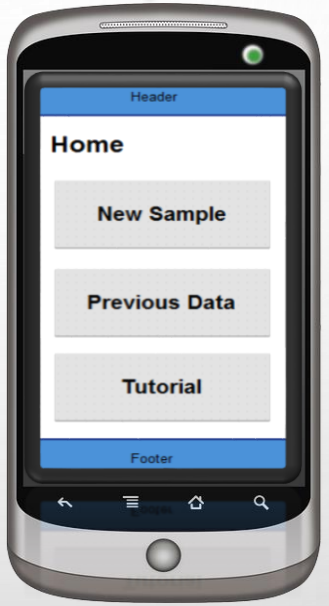
Voltage Booster





Microdischarge Device

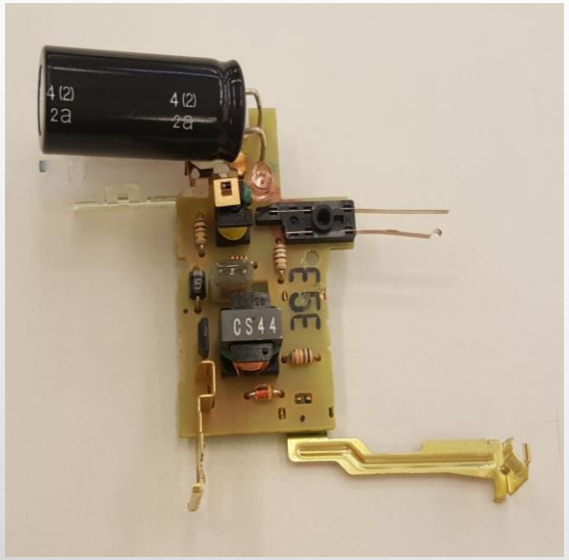
Spectrometer



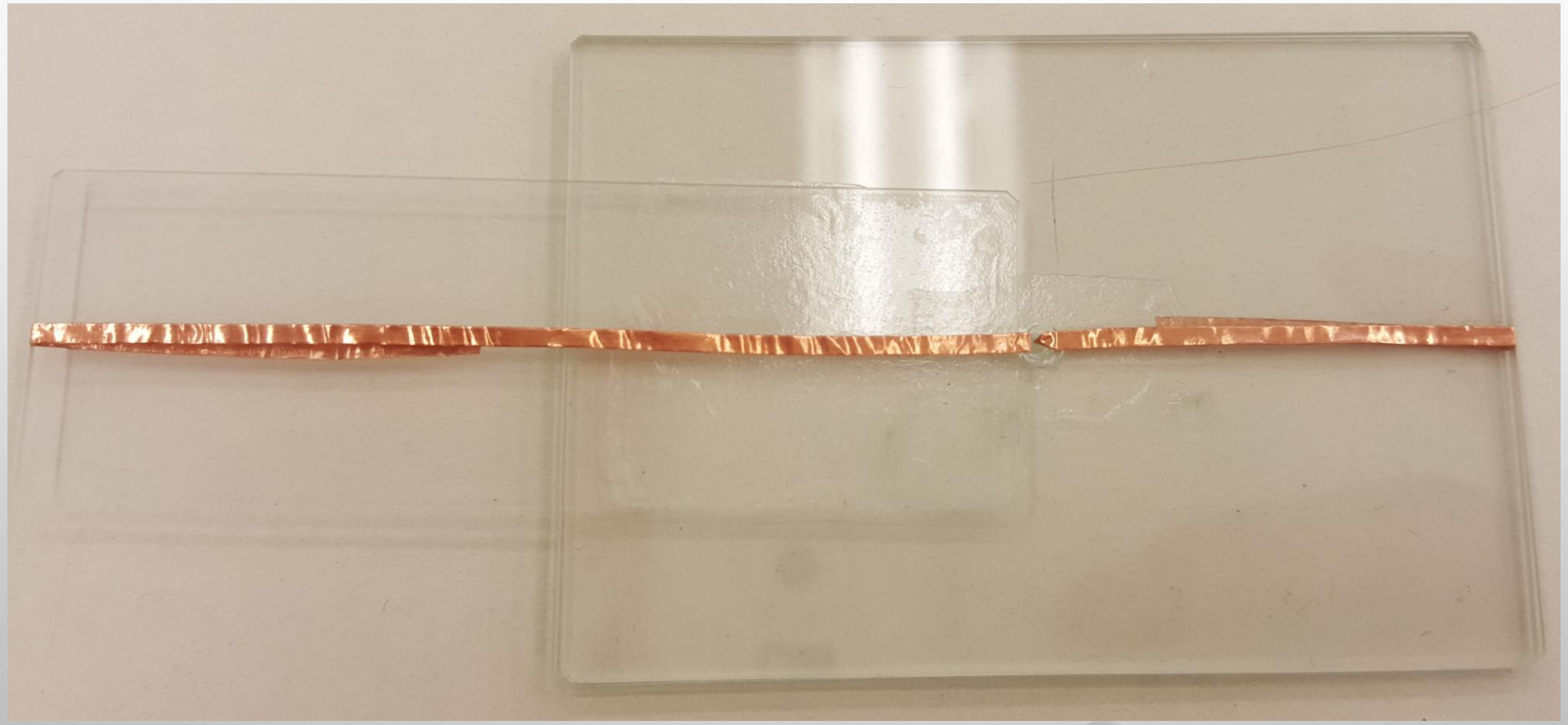
Android Application

- User to device: Android device to microcontroller via Bluetooth
- Start micro discharge device and voltage booster via microcontroller.
- Send optical information from micro discharge device to spectrometer
- Send spectrometer data to microcontroller
- Display results on the android application

Voltage Booster



Micro-discharge Device



Interface Between Spectrometer and MCU

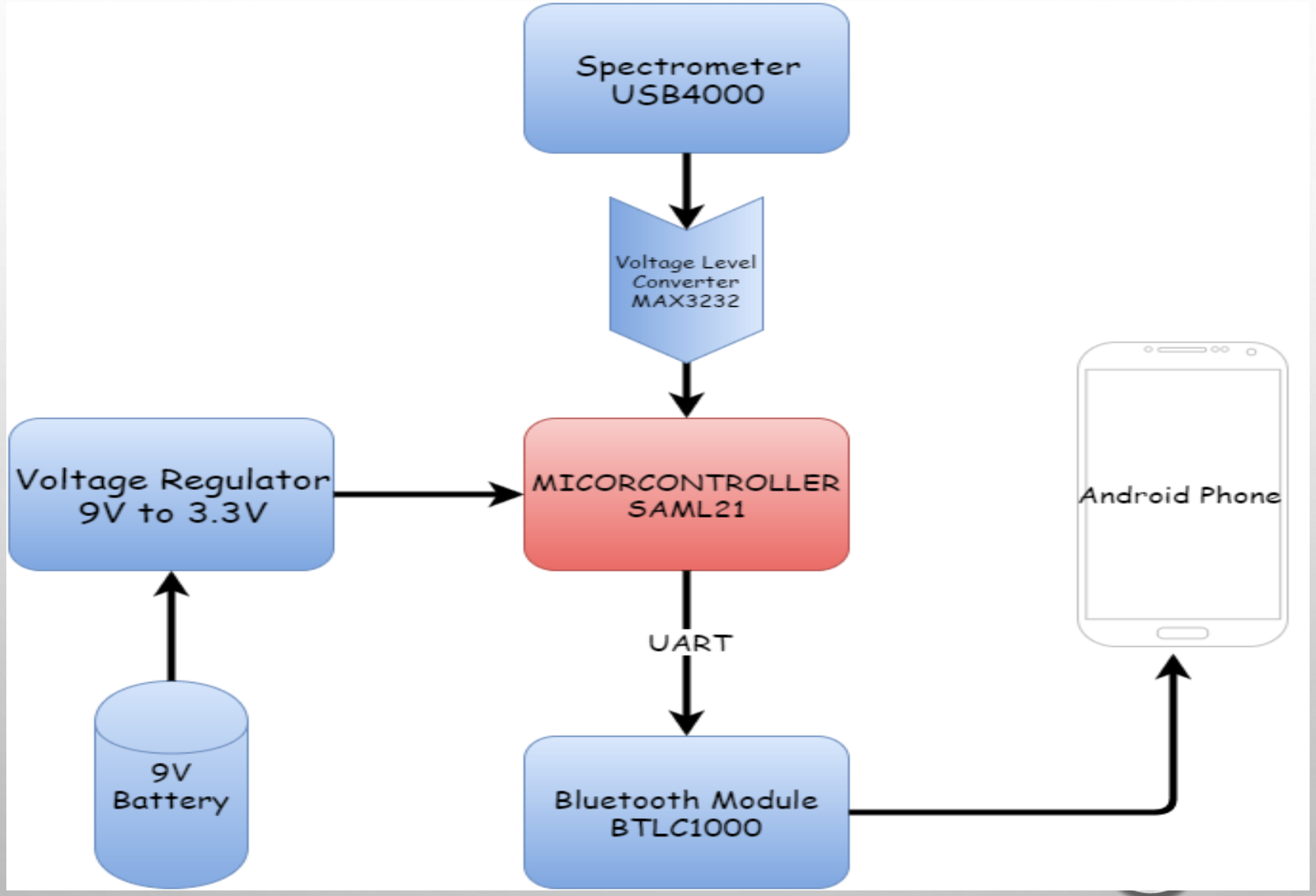
Real system

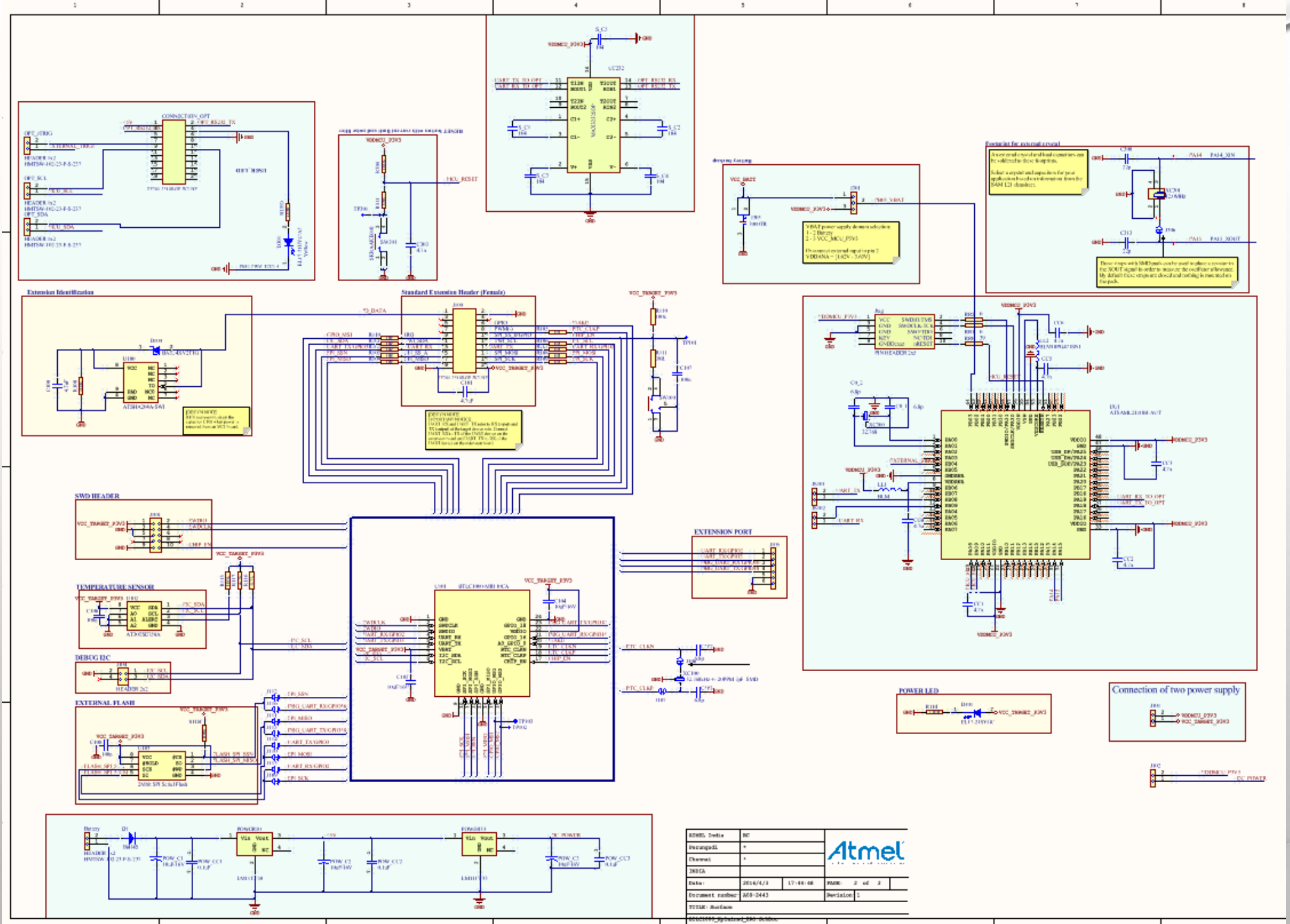
RS-232 Communication (USART Handshake)

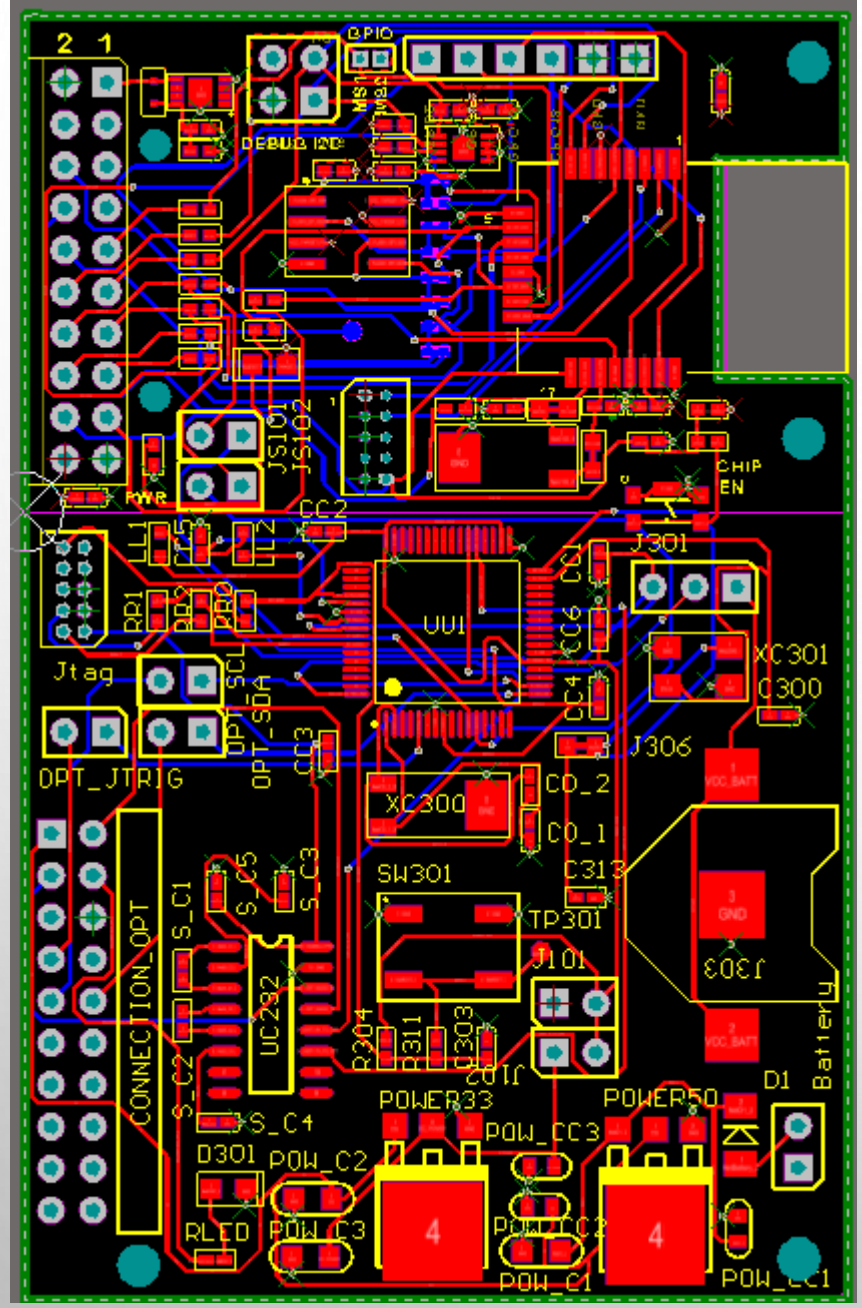
PCB Board

Testing

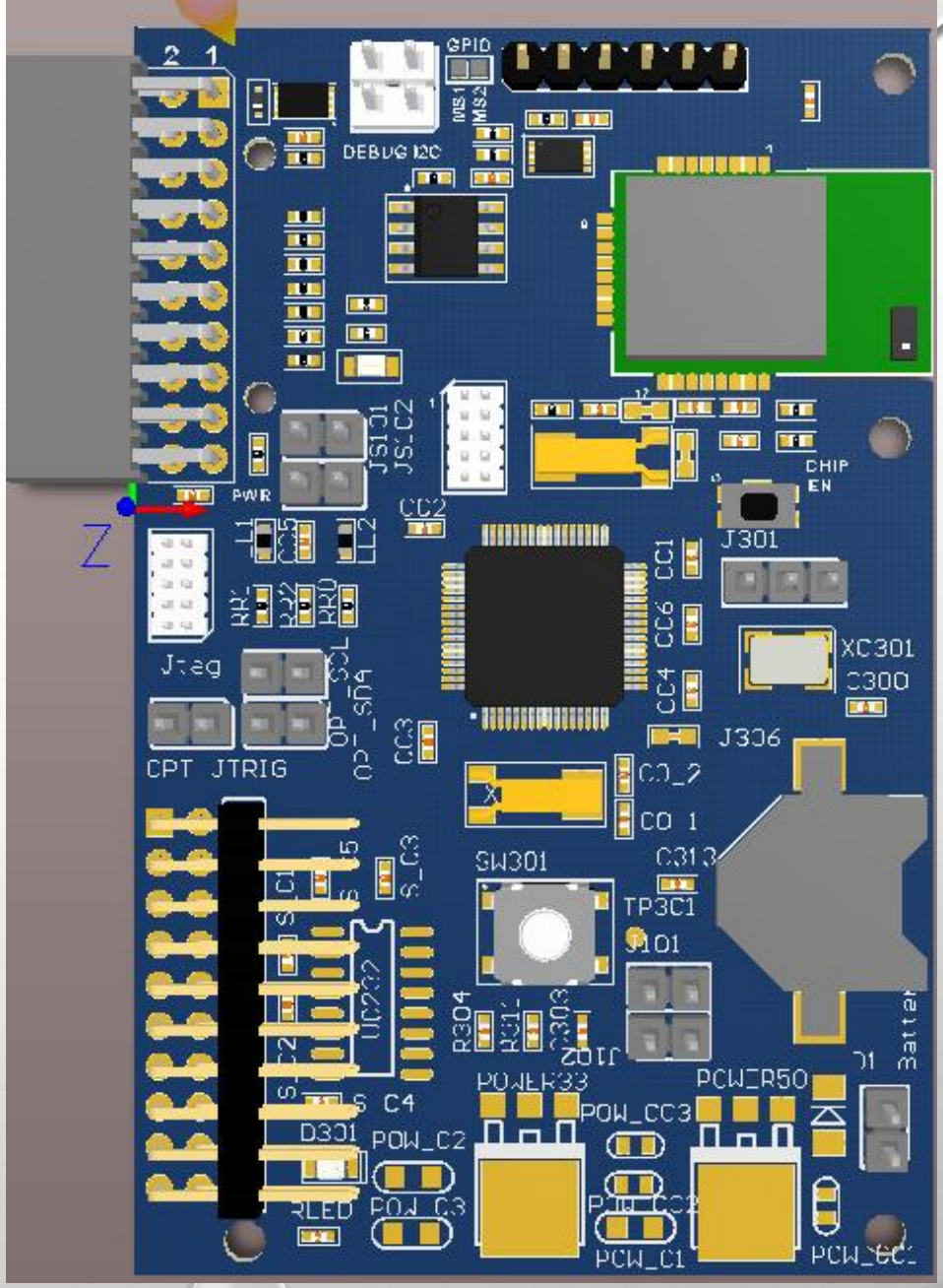
PCB Design


Spectrometer
USB4000
Voltage Level
Converter
MAX3232
Voltage Regulator
9V to 3.3V
MICORCONTROLLER
SAML21
Android Phone
UART
9V
Battery
Bluetooth Module
BTLC1000


Extension Identification
Standard Extension Header (Female)
SWD HEADER
TEMPERATURE SENSOR
DEBUG I2C
EXTERNAL FLASH
EXTENSION PORT
POWER LED
Connection of two power supply
ATMEL Twin
Bangalore
Chennai
INDIA
Date: 2016/4/13 17:40:48
Document number: 3459-2443
Revision: 1
TITLE: Hardware



2D VIEW



3D View

Android and Device Communication

"Start"

Android (Server)
MCU(Client)

Spectrum Data

Android (Client)
MCU(Server)

PNDCS Data
Transfer Profile

PNDCS Data
Transfer Service

PNDCS Data Transfer
Characteristic

Value = buf[] (150bytes)
Descripter:
READ|NOTIFY

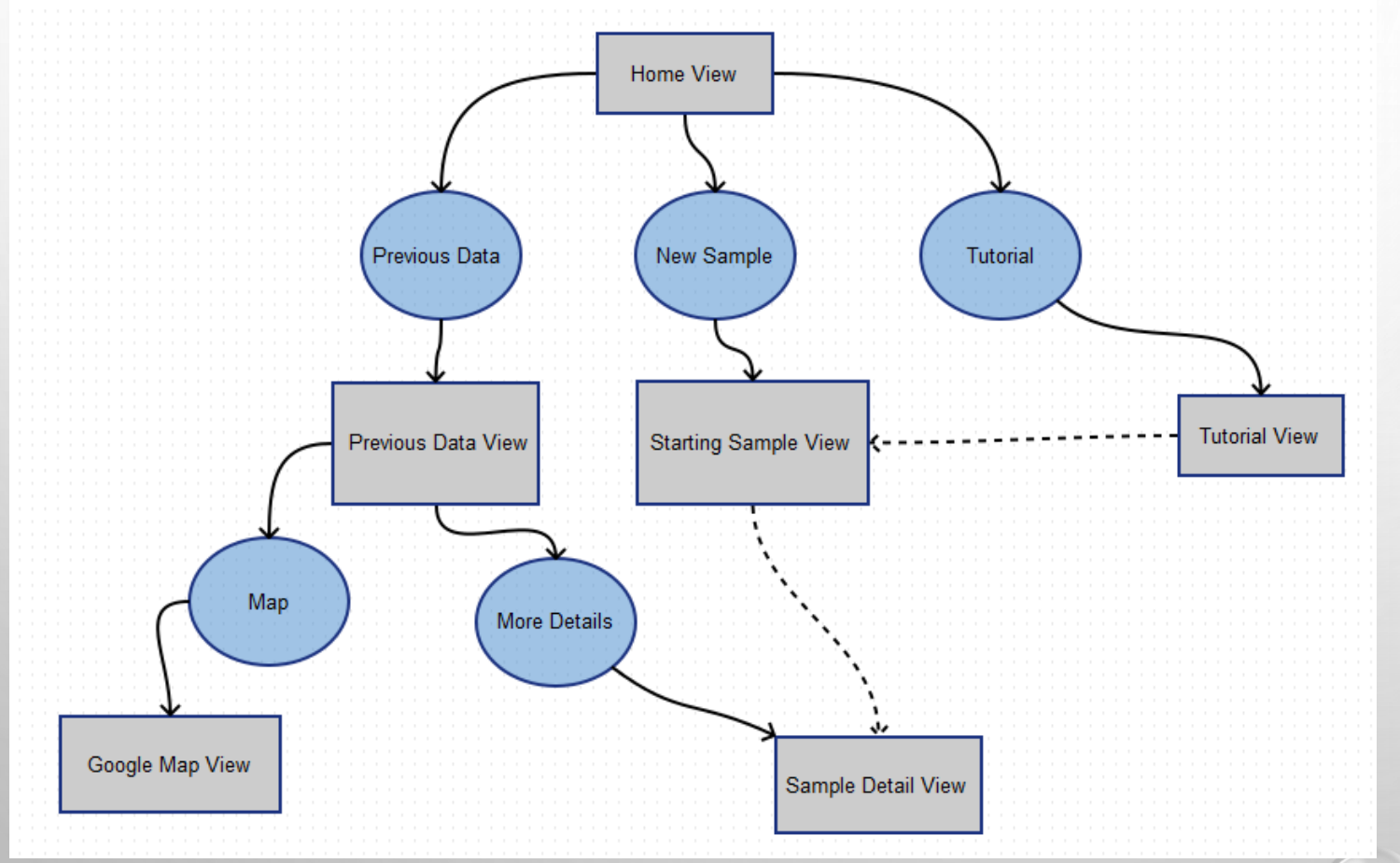
PNDCS Notify Start
Profile

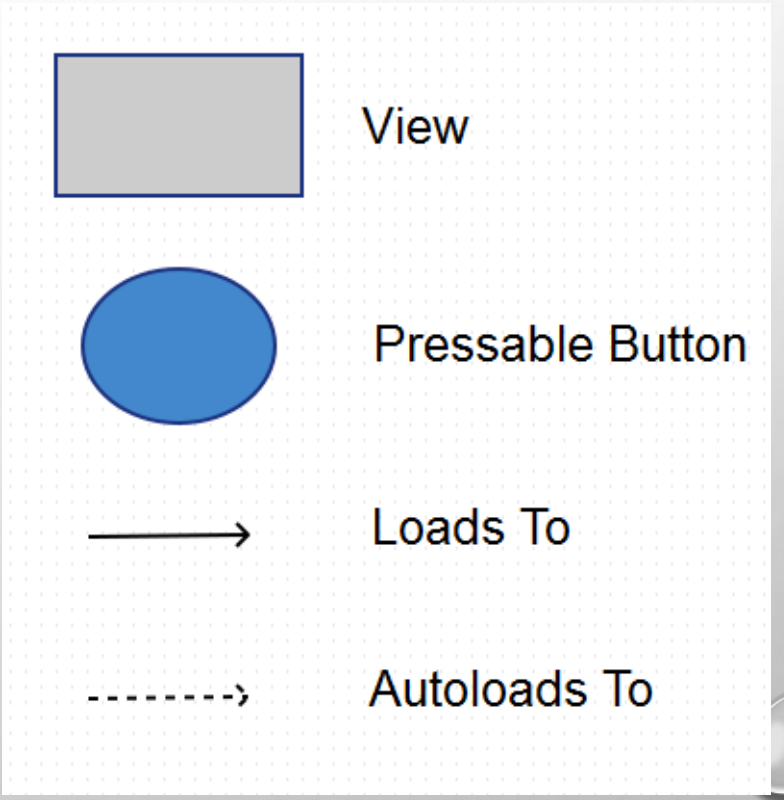
PNDCS Start
Service

PNDCS Start
Characteristic

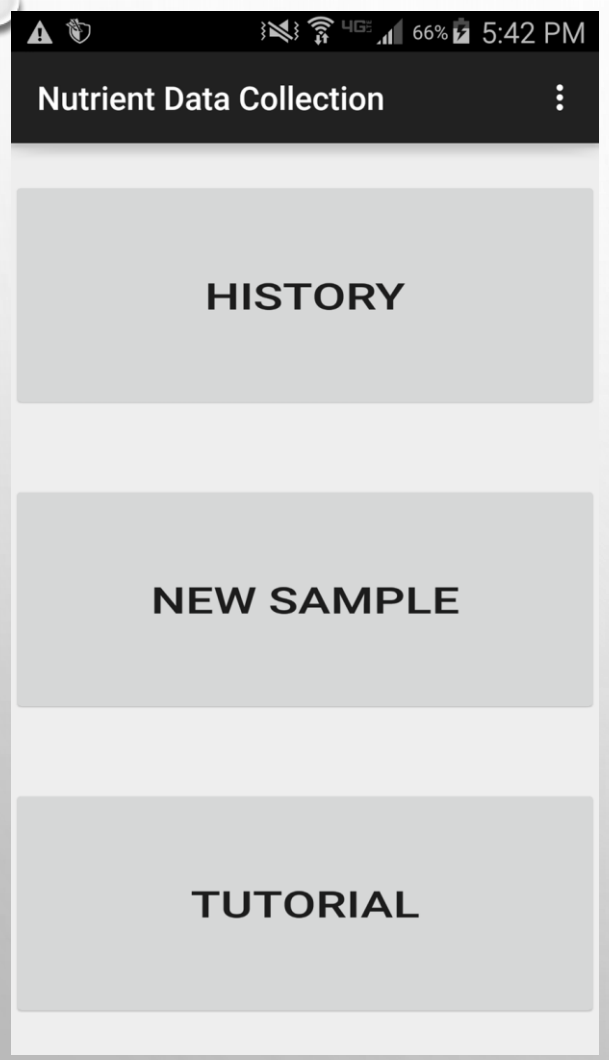
Value = 1 (constant)
Descripter:
READ|NOTIFY

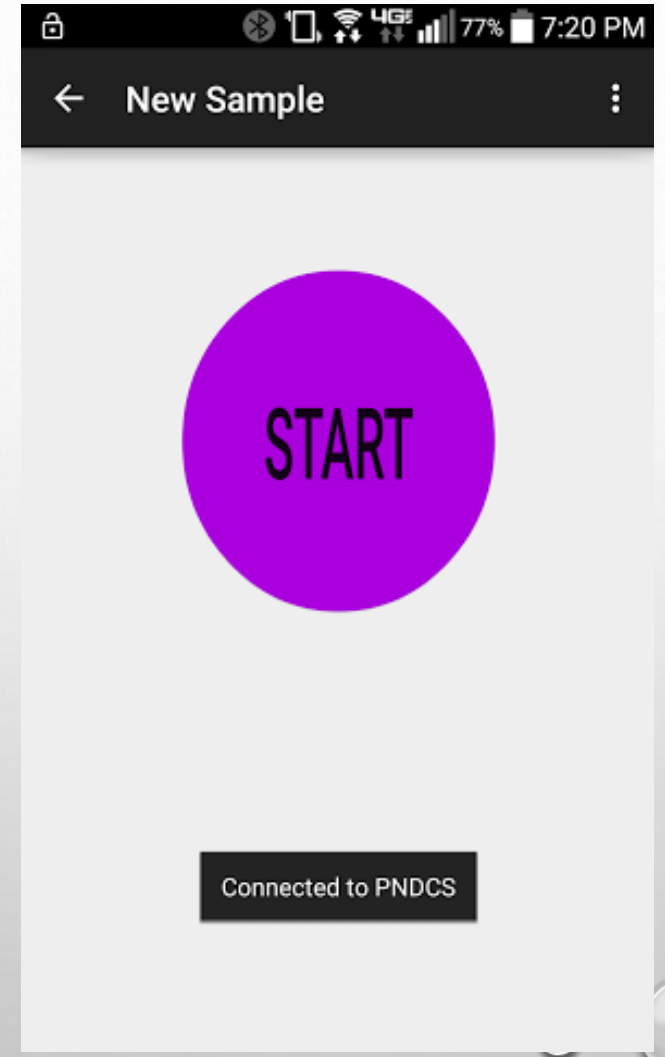
Screen Sketches

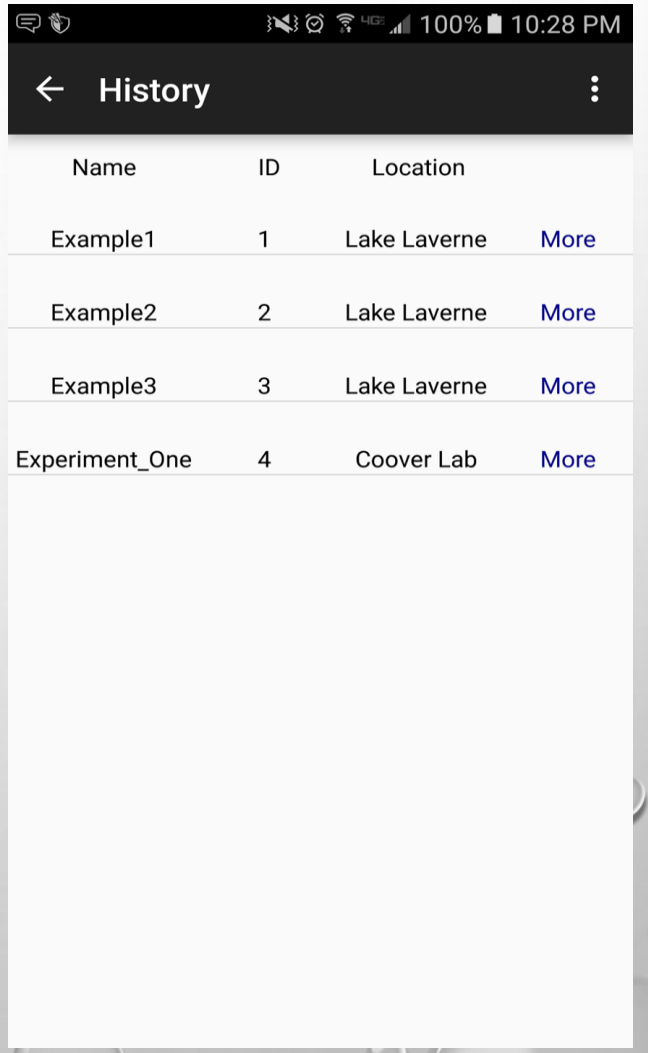




Screen Sketches

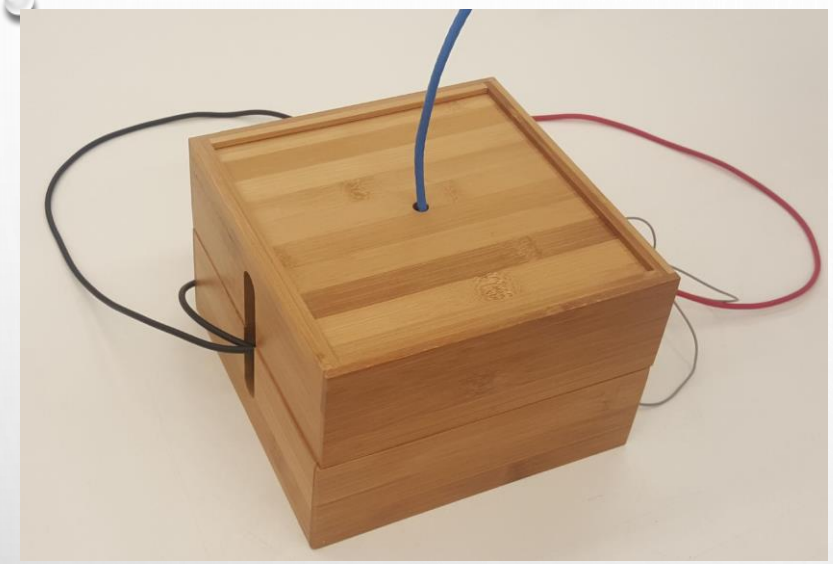


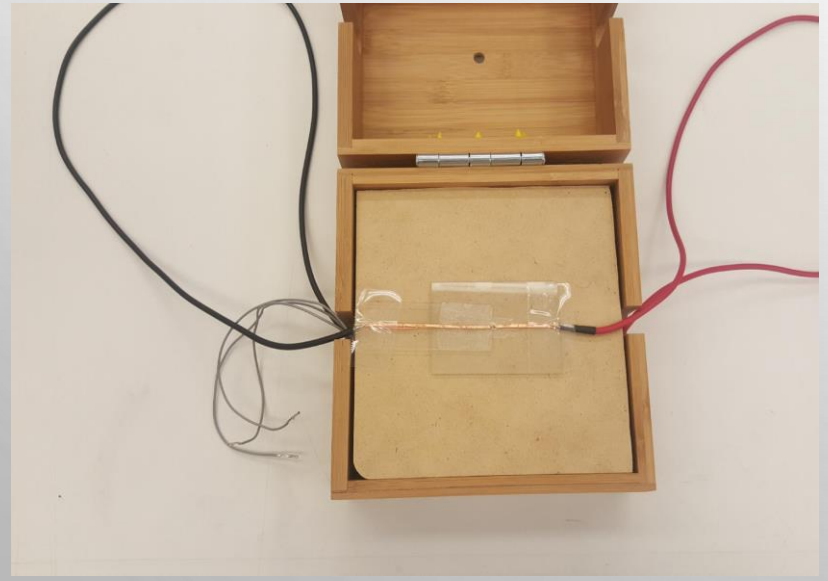


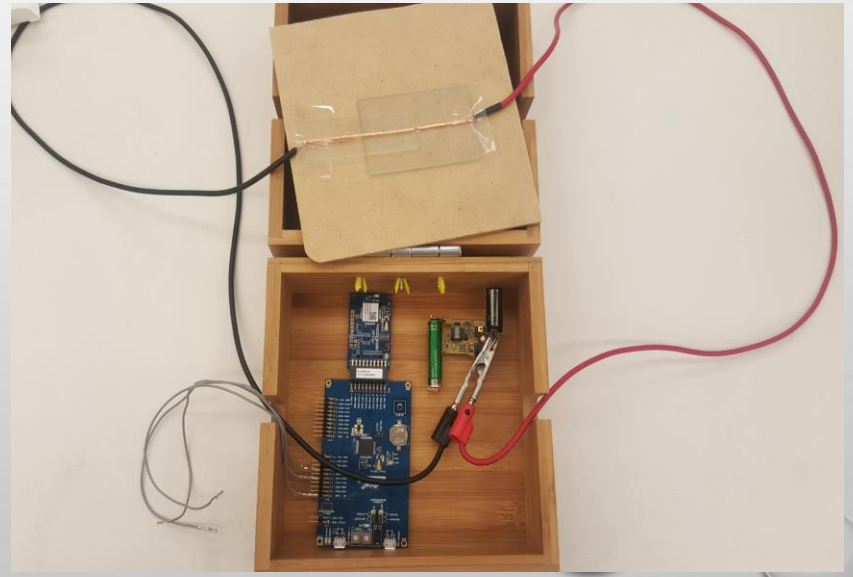


Current Box

System in current box







Test Plan

1. Turn on App and turn on Device
2. Verify Bluetooth connection (Android Settings)
3. Verify spectrometer connection
4. Place sample in device
5. Start Voltage Booster
6. Verify voltage booster 280V ± 20V
7. Wait for spectrometer reading to complete
8. Verify that data was transferred from device to Android phone in under 2 seconds
9. Verify that data conversion is within 90% accuracy of known element distributions
10. Verify app is reliable (doesn’t crash) during entire test
11. Verify that data is stored accurately
12. Verify entire test takes under 30 seconds
13. Verify that device can remain powered after 50 trials

Questions

Market Survey

Mi TDS Pen

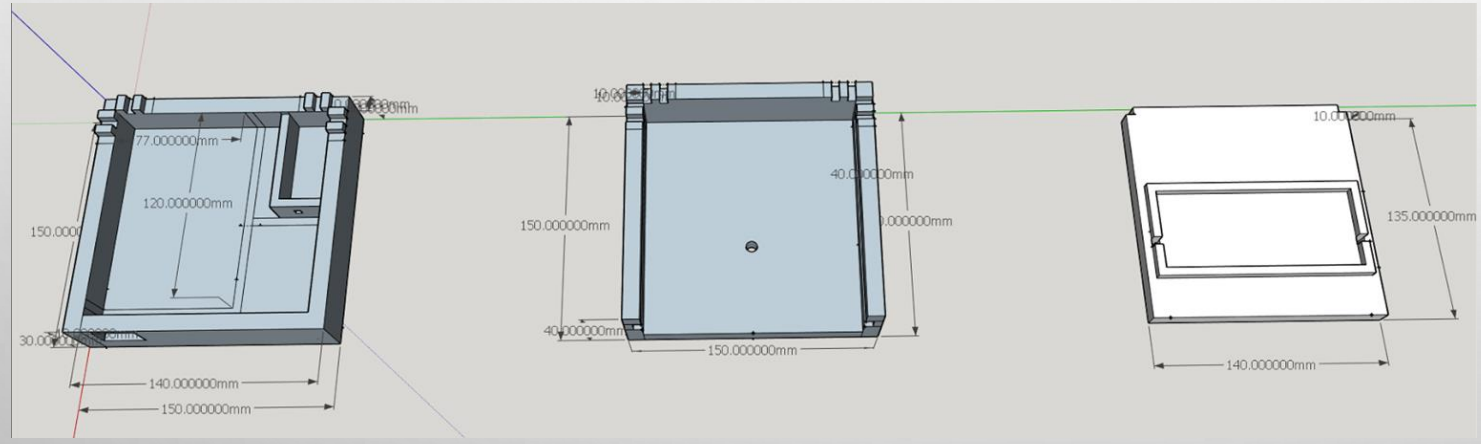
- Portable
- Low Power
- Water quality
- No smartphone communication
- Image: http://xiaomi-mi.com/mi-water/mi-tds-pen/

Labs

- Works same as device
- Not portable
- No smartphone communication

ALTERNATIVES

- 3D printed box
- Standalone microcontroller



VOLUME:

53.51782IN³

COSTS:

3D PRINTER: $5.75/CUBIC INCH MATERIAL

PRICE OF BOX FOR 3D PRINTER : $307

BUY MATERIALS FROM WALMART

TOTAL COST: $27.85

BILL OF MATERIALS

Item	Qty.	Ref.	Cost (eac	Part Desc.	Supplier
1	2	ATBTLC1000-XSTK	$ 108.26	BTLC 1000 Xplained Pro Starter Kit	Atmel
2	4	MAX3232	$ 1.82	MAX3232 transceivers	Digkey
3	1	SAM B11 Xplained Pro Evaluation Kit	$ 42.65	Evaluation board	Atmel
4	3	IC flash 2MBIT 100I	$0.59	external Flash	Digi-Key
5	2	ATSAMB11-MR210	$ 14.96	Bluetooth chip	Mouser
6-37		surface mount commponents	$89.07		Atmel, Digikey, TI, mouser, farnell
38	1	Box+widgts	$ 27.85	Box and other small parts	Walmart
	total	$ 415.06			

WHAT WE LEARNED

- Identify the highest level of risk
- More communication
- More planning

WHAT WORKED

- Max3232 adapter
- Voltage regulator
- Micro discharge device
- Bluetooth module (Device to Microcontroller)
- Display spectrum on App

WHAT DIDN'T WORK

- The soldering of the 64 pin microcontroller is not perfect, two of the pins are connected each other unfortunately.
- Data transmission between microcontroller and spectrometer (specially response)
- Bluetooth (microcontroller to phone)
- Automatically store to database
- Use microcontroller to control voltage booster (charging time too long IRS540)

SOLUTIONS

For data transmission:

Contact technicians from the manufacturer to obtain more detailed information and find the correct order to set up the device.

Bluetooth:

Need to know more on data format from manufacturer to be able to accurately design protocol to send data to phone.

Android:

Use web based database to allow for authentication and multi device access

System start:

Change transistor to BJT

PCB:

Re-solder components (too small of components, find alternate way of soldering those components)

FUTURE ITERATIONS

- Gps
- Battery indication
- Bluetooth
- Spectrometer alternative?
- Insulating packaging