Hand-Cranked Charger

Team 14: Shreyasi Ray, Achyut Agarwal, Rubhav Nayak

Meet the Team

Achyut Agarwal
Computer Engineering, Senior

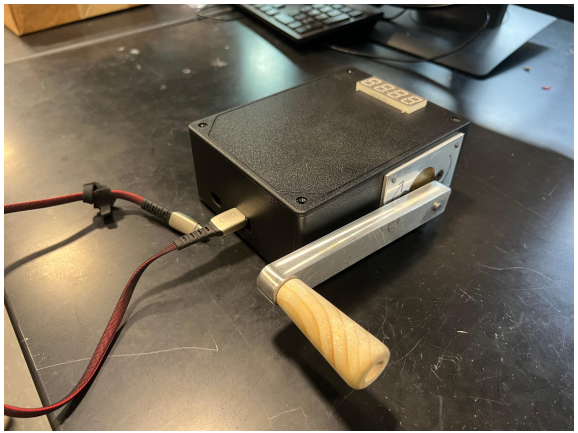
Shreyasi Ray
Computer Engineering, Senior

Rubhav Nayak
Electrical Engineering, Senior

Problem

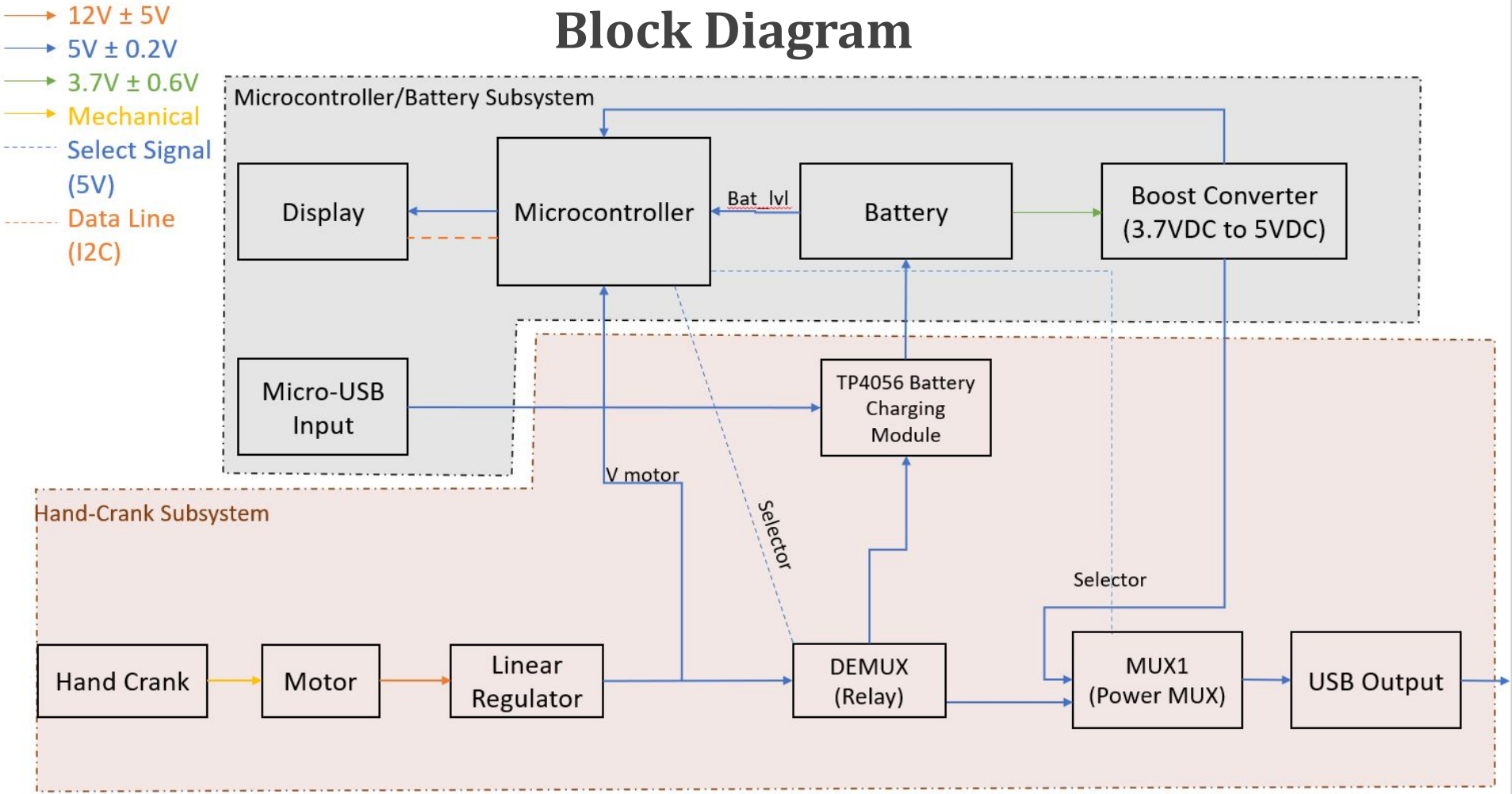
- Reliance on technology and devices at all-time high, individuals dependent on devices for various aspects of their lifestyle
- Dependence on devices for emergencies and basic services is increasing
- Need for charging points not always available

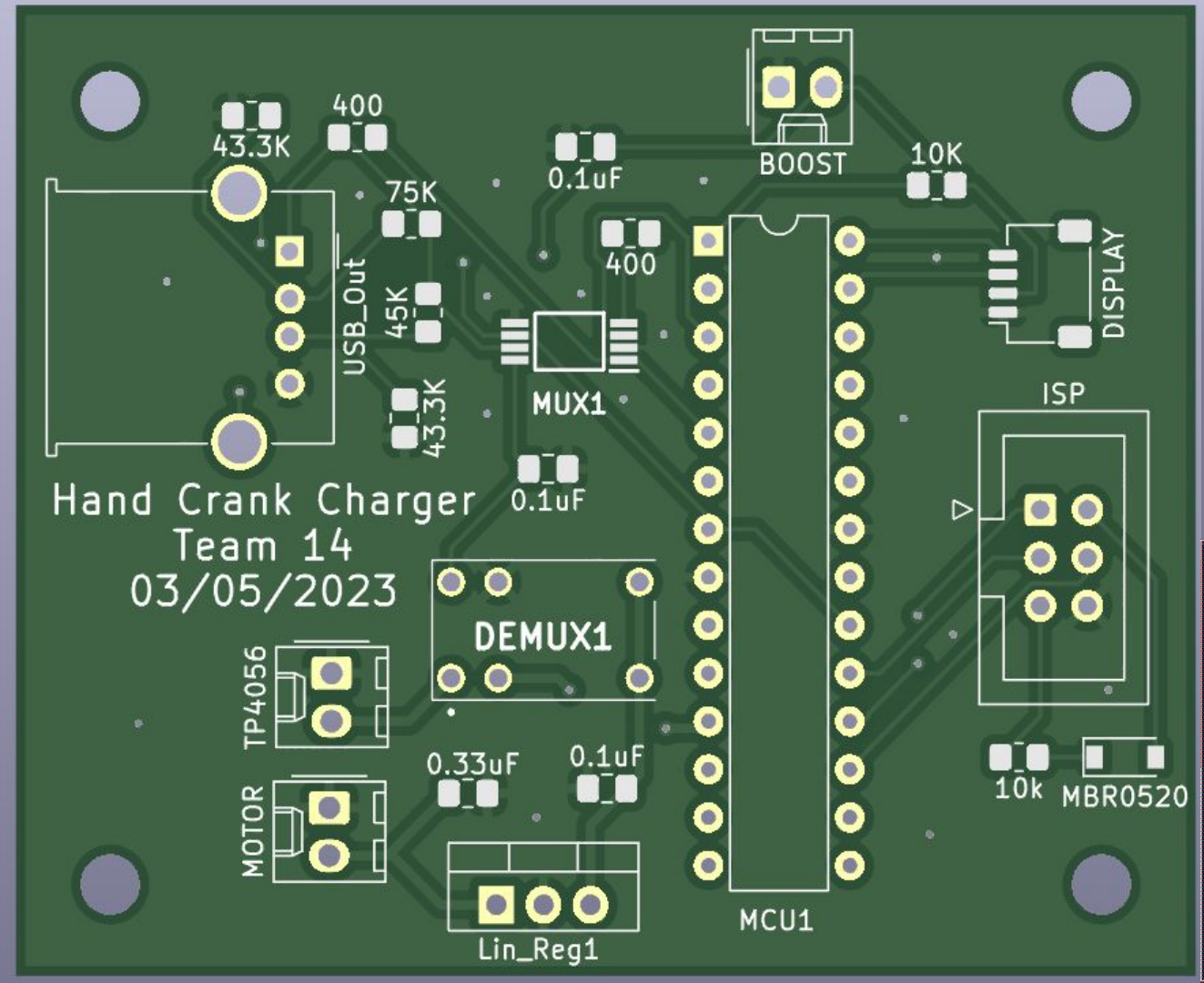
Solution - Hand Cranked Charger

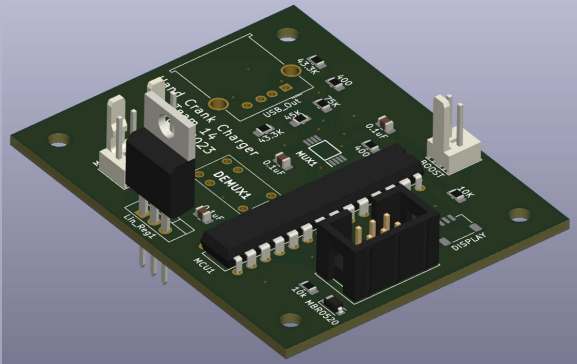


- Portable hand-cranked charger that generates electricity with the help of user's kinetic energy
- Enables charging during times of emergency, when traditional charging options are not available
- Stores energy in an internal battery like a power bank

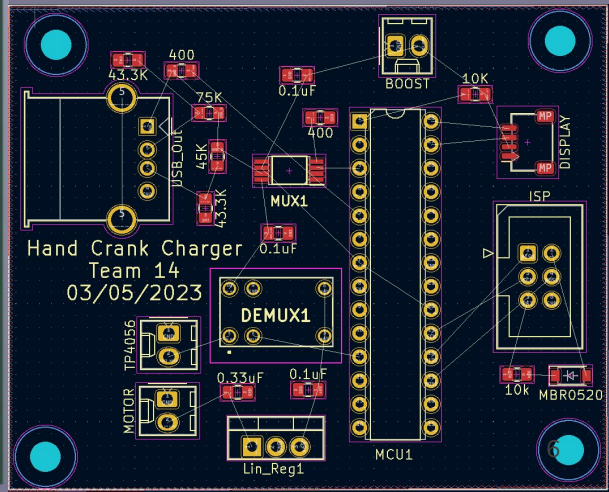
Block Diagram




43.3K
400
0.1uF
BOOST
10K
75K
400
USB_Out
45K
MUX1
DISPLAY
43.3K
ISP
0.1uF
Hand Crank Charger
Team 14
03/05/2023
DEMUX1
TP4056
0.33uF
0.1uF
10k
MBR0520
MOTOR
MCU1
Lin_Reg1



PCB Design


43.3K
400
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BOOST
10K
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Hand Crank Charger
Team 14
03/05/2023
0.1uF
DEMUX1
TP4056
0.33uF
0.1uF
10k
MBR0520
MOTOR
MCU1
Lin_Reg1

Electromechanical Subsystem

- Handles conversion of Kinetic to Electric Energy

- Key Components:
  - Motor
  - Linear Regulator
  - Relay
  - Power MUX
  - USB Output

Key Components

Motor

- Brushed 12VDC Motor → Pittman Motor
- Output at 60RPM: 12V ± 2V

Linear Regulator

- Linear Regulator → LM7805
- Stabilizes Voltage to 5V

Relay

- Relay → Panasonic HY1-5V
- One Input to Two Output Mechanical Relay
- Controlled by Microcontroller

Power MUX

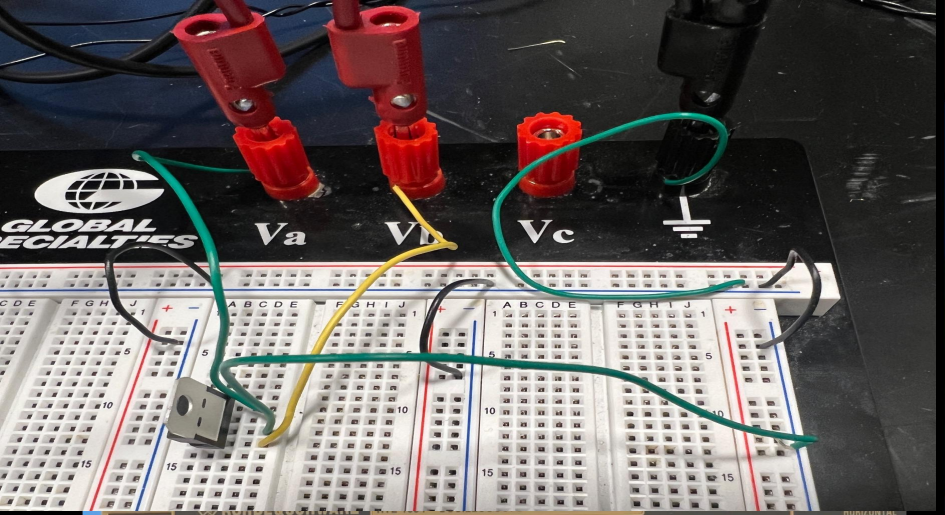
- Power Multiplexer - TI TPS2115
- Two Input to One Output Power Mux
- Controlled by Microcontroller

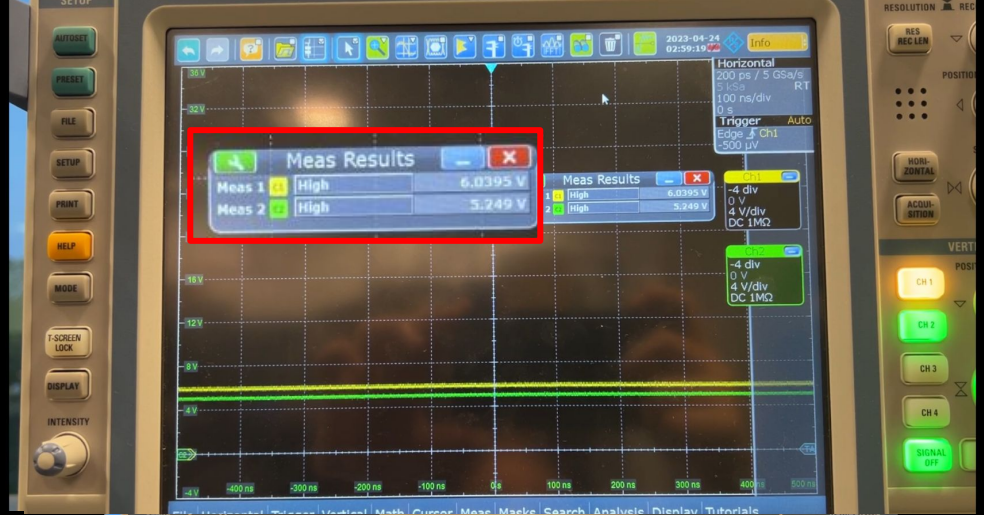
Development of Electromechanical Subsystem

- Successes
  - Relay
  - Motor
  - USB Output
- Hurdles
  - Power MUX
  - Linear Regulator

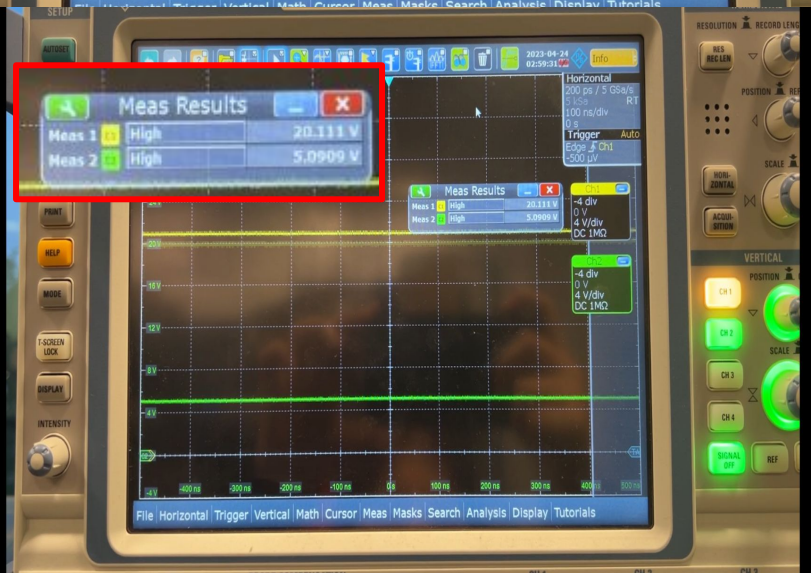
Tests performed for Verification of the Electromechanical Subsystem

The Linear Regulator regulates all Voltage in the range 6V to 20V down to 5V

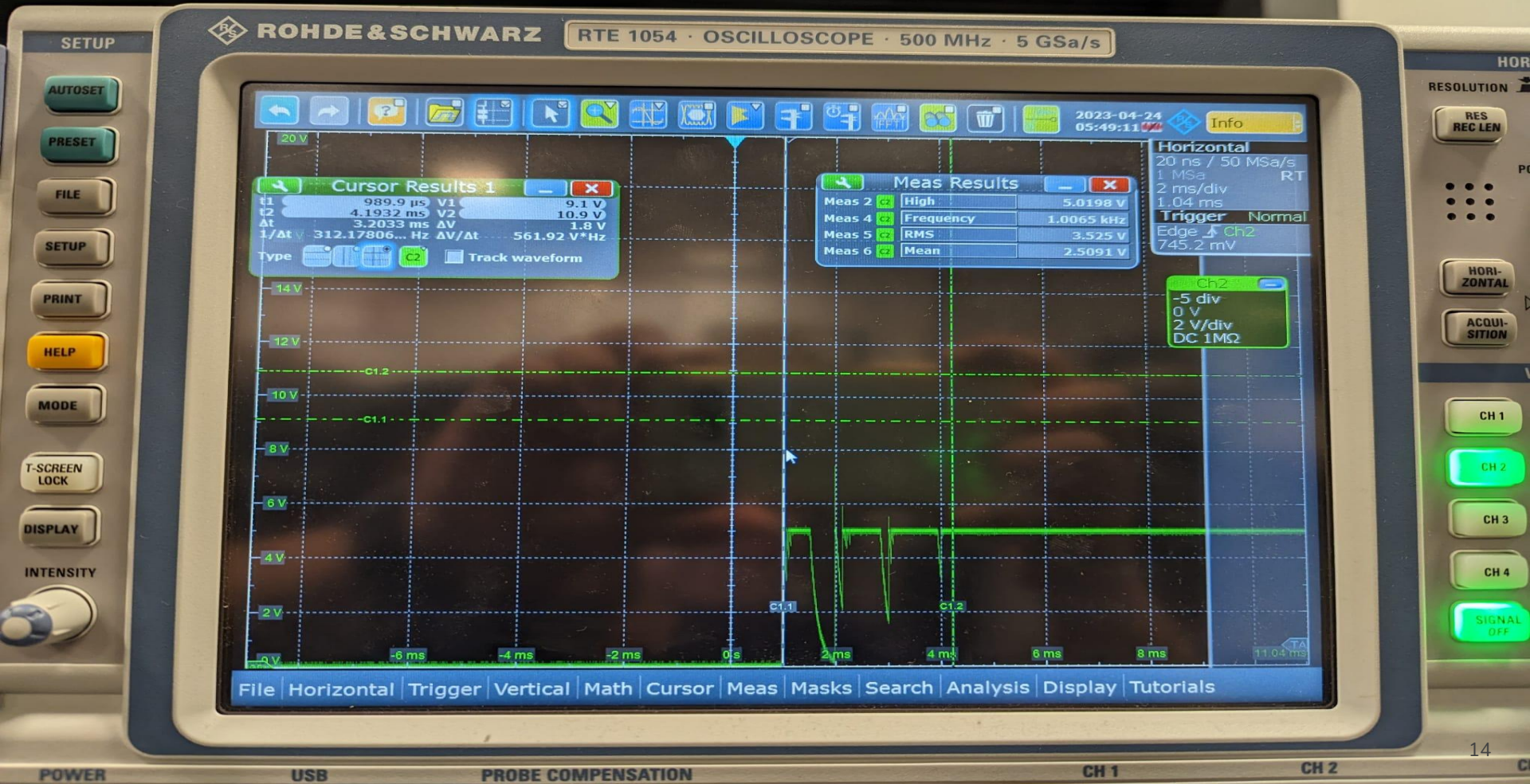

Va
Vc


Meas Results
Meas 1 High 6.0395 V
Meas 2 High 5.249 V
Horizontal
200 ps / 5 GSa/s
100 ns/div
Trigger Auto
Edge Ch1
-500 µV
Ch1
-4 div
0 V
4 V/div
DC 1MΩ
Ch2
-4 div
0 V
4 V/div
DC 1MΩ


Meas Results
Meas 1 High 11.099 V
Meas 2 High 5.0909 V
File Horizontal Trigger Vertical Math Cursor Meas Masks Search Analysis Display Tutorials

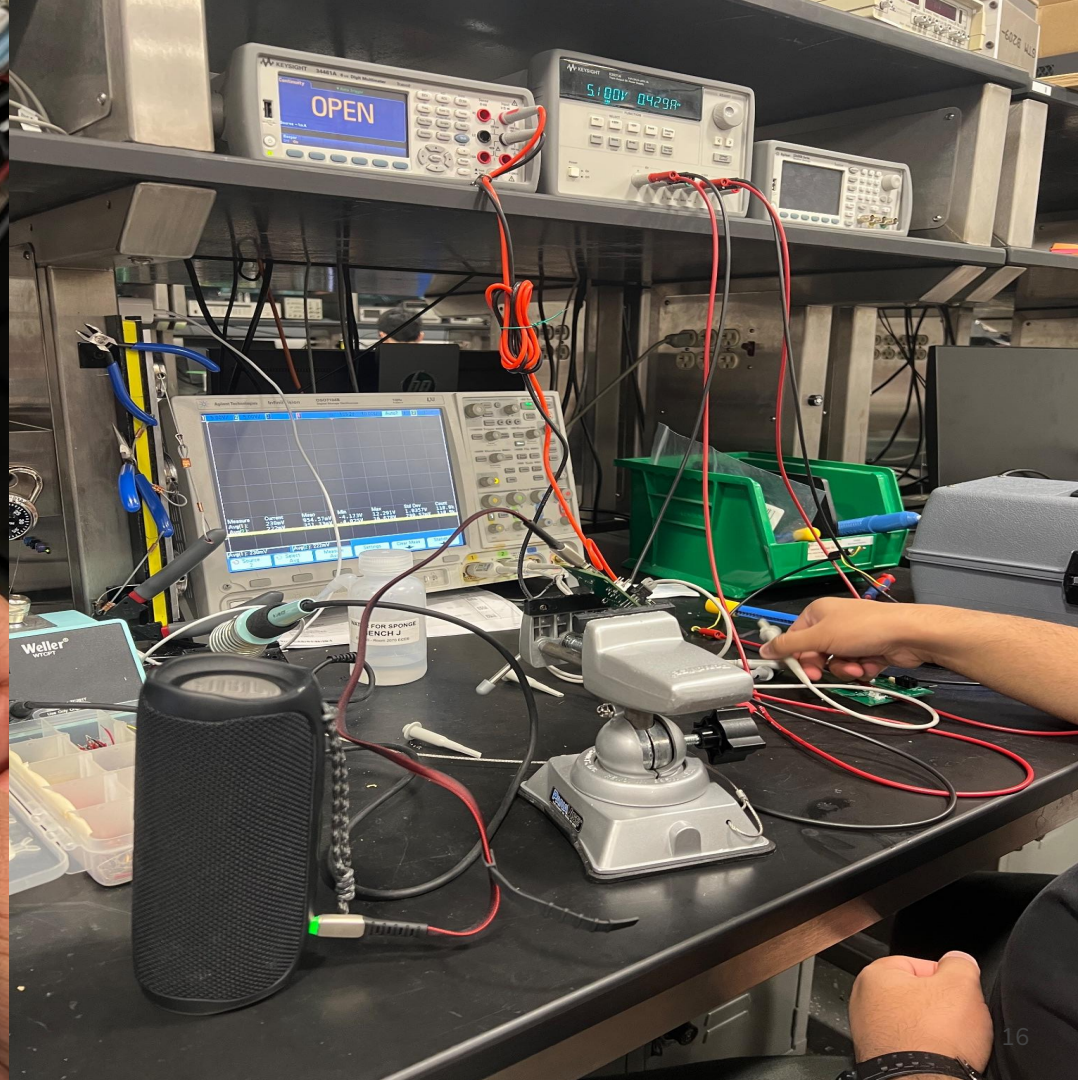

Meas Results
Meas 1 High 20.111 V
Meas 2 High 5.0909 V
File Horizontal Trigger Vertical Math Cursor Meas Masks Search Analysis Display Tutorials

The Relay changes the output under 50ms


ROHDE&SCHWARZ
RTE 1054 · OSCILLOSCOPE · 500 MHz · 5 GSa/s
SETUP
AUTOSET
PRESET
FILE
SETUP
PRINT
HELP
MODE
T-SCREEN LOCK
DISPLAY
INTENSITY
2023-04-24
05:49:11
Info
Cursor Results 1
t1 989.9 µs V1 9.1 V
t2 4.1932 ms V2 10.9 V
Δt 3.2033 ms ΔV 1.8 V
1/Δt 312.17806... Hz ΔV/Δt 561.92 V*Hz
Type
Track waveform
Meas Results
Meas 2 High 5.0198 V
Meas 4 Frequency 1.0065 kHz
Meas 5 RMS 3.525 V
Meas 6 Mean 2.5091 V
Horizontal
20 ns / 50 MSa/s
1 MSa RT
2 ms/div
1.04 ms
Trigger Normal
Edge Ch2
745.2 mV
Ch2
-5 div
0 V
2 V/div
DC 1MΩ
20 V
14 V
12 V
10 V
8 V
6 V
4 V
2 V
0 V
C1.2
C1.1
-6 ms
-4 ms
-2 ms
0 s
2 ms
4 ms
6 ms
8 ms
11.04 ms
File Horizontal Trigger Vertical Math Cursor Meas Masks Search Analysis Display Tutorials
RESOLUTION
RES REC LEN
HORI-ZONTAL
ACQUI-SITION
CH 1
CH 2
CH 3
CH 4
SIGNAL OFF
POWER
USB
PROBE COMPENSATION
CH 1
CH 2

Hand Crank successfully powers the USB Output


PAUSED
The Light
Juice WRLD
SATURDAY
22
TOMORROW
Achyut Agar...
14:00–15:00
Achyut's AirPods Pro
96%
78%


OPEN
Weller

Microcontroller Subsystem

- Handles Switching Logic
- Handles Battery and Display functionality
- Key Components:
  - Microcontroller
  - Battery and Battery Module
  - Display
  - Boost Converter

Key Components

- *Microcontroller* → AtMega328P
  - 23 GPIO Pins
- *Display* → AdaFruit 1002
  - I2C Backpack
- *Battery* → 1000mAh Li-ion
- *Battery Module* → TP4056
- *Boost Converter* → 2.5V-4.0V to 5V Boost

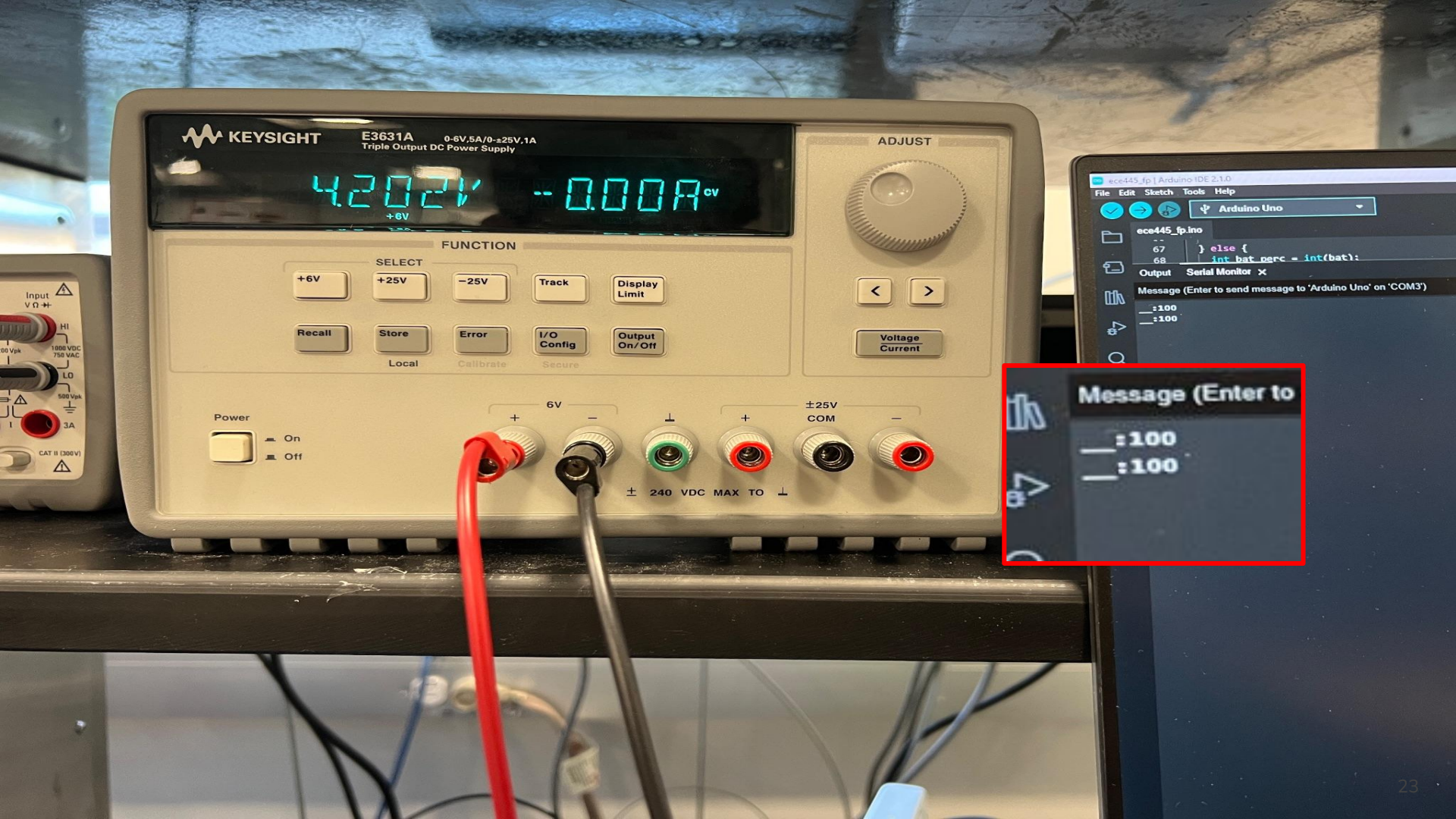
Development of Microcontroller Subsystem

- Successes
  - Battery
  - Boost Converter
  - Battery Module
- Hurdles
  - Display
  - Microcontroller

Tests performed for Verification of the Microcontroller Subsystem

The Battery Voltage is correctly measured and displayed


E3631A
0-6V,5A/0-±25V,1A
Triple Output DC Power Supply
3.0041V -0.00A CV
+6V
ADJUST
FUNCTION
SELECT
+6V
+25V
−25V
Track
Display Limit
Recall
Store
Error
I/O Config
Output On/Off
Voltage
KEYSIGHT
E3631A
0-6V,5A/0-±25V,1A
Triple Output DC Power Supply
3.6031V -0.00A CV
+6V
ADJUST
FUNCTION
SELECT
+6V
+25V
−25V
Track
Display Limit
Recall
Store
Error
I/O Config
Output On/Off
Local
Calibrate
Secure
Voltage Current
ece445_fp | Arduino IDE 2.1.0
File Edit Sketch Tools Help
Arduino Uno
ece445_fp.ino
67 } else {
68 int bat_perc = int(bat);
Output Serial Monitor
Message (Enter to send message to 'Arduino Uno'
__:0
__:50
__:50
__:50
__:49

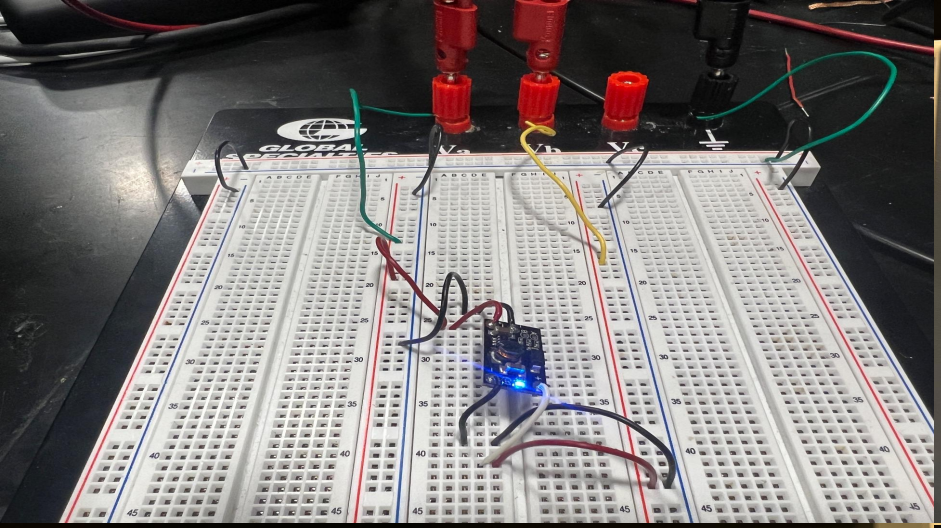

KEYSIGHT
E3631A
0-6V,5A/0-±25V,1A
Triple Output DC Power Supply
4.202V
+6V
0.000A
CV
ADJUST
FUNCTION
SELECT
+6V
+25V
−25V
Track
Display Limit
Recall
Store
Error
I/O Config
Output On/Off
Local
Calibrate
Secure
Voltage Current
Power
On
Off
6V
±25V
COM
± 240 VDC MAX TO ⊥
ece445_fp | Arduino IDE 2.1.0
File Edit Sketch Tools Help
Arduino Uno
ece445_fp.ino
67 } else {
68 int bat_perc = int(bat);
Output Serial Monitor
Message (Enter to send message to 'Arduino Uno' on 'COM3')
__:100
__:100
Message (Enter to
__:100
__:100

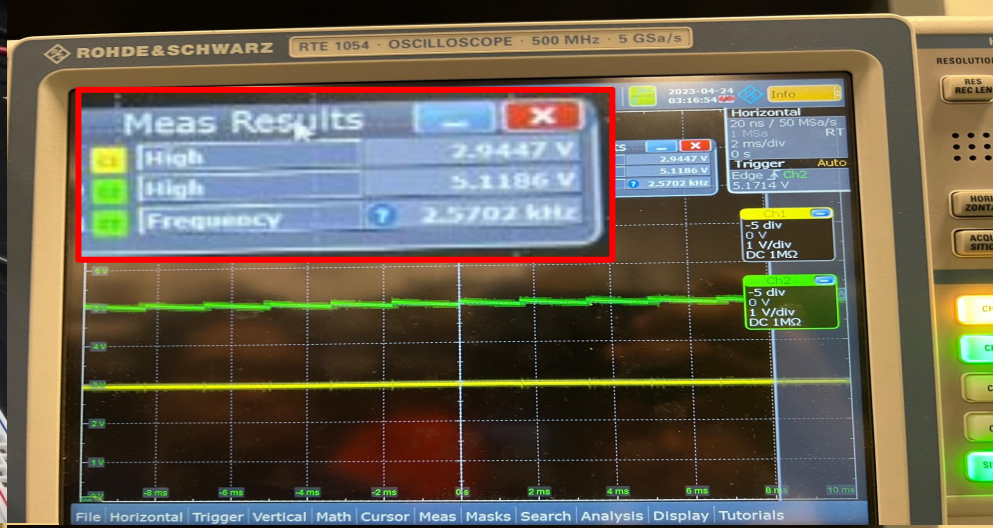
The display correctly outputs the recommended crank speed modification

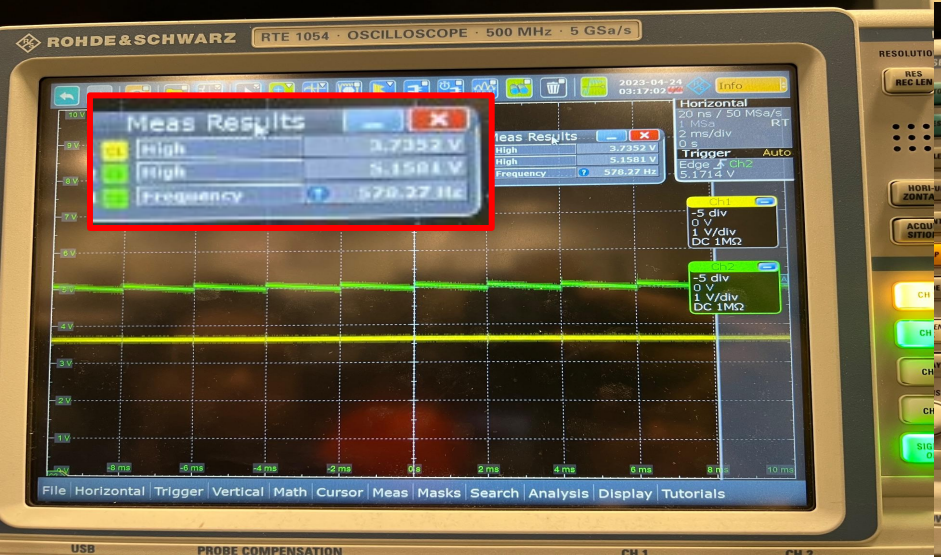

E3631A
0-6V,5A/0-±25V,1A
Triple Output DC Power Supply
4.512V -0.00A CV
+6V
ADJUST
FUNCTION
SELECT
+6V
+25V
−25V
Track
Display Limit
Recall
Store
Error
I/O Config
Output On/Off
Voltage Current


Triple Output DC Power Supply
5.011V 0.000A CV
+6V
FUNCTION
SELECT
+6V
+25V
−25V
Track
Display Limit
Recall
Store
Error
I/O Config
Output On/Off
Local
Calibrate
Secure
Voltage Current
6V
±25V
COM

The boost converter boosts the batteries 3.7 ± 0.6 VDC to 5 ± 0.2 VDC



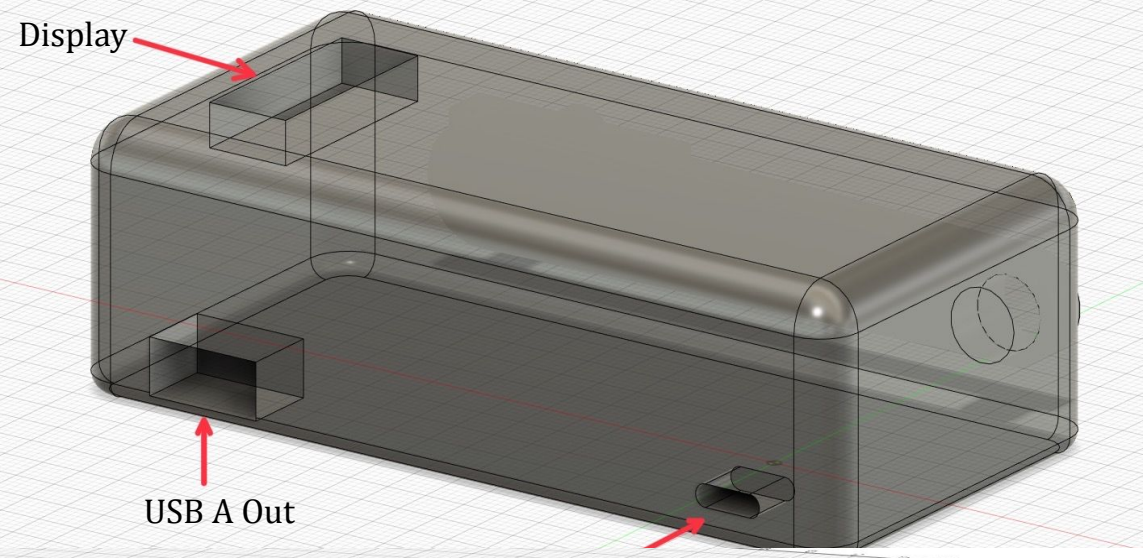

ROHDE&SCHWARZ
RTE 1054 · OSCILLOSCOPE · 500 MHz · 5 GSa/s
Meas Results
High 2.9447 V
High 5.1186 V
Frequency 2.5702 kHz
File Horizontal Trigger Vertical Math Cursor Meas Masks Search Analysis Display Tutorials

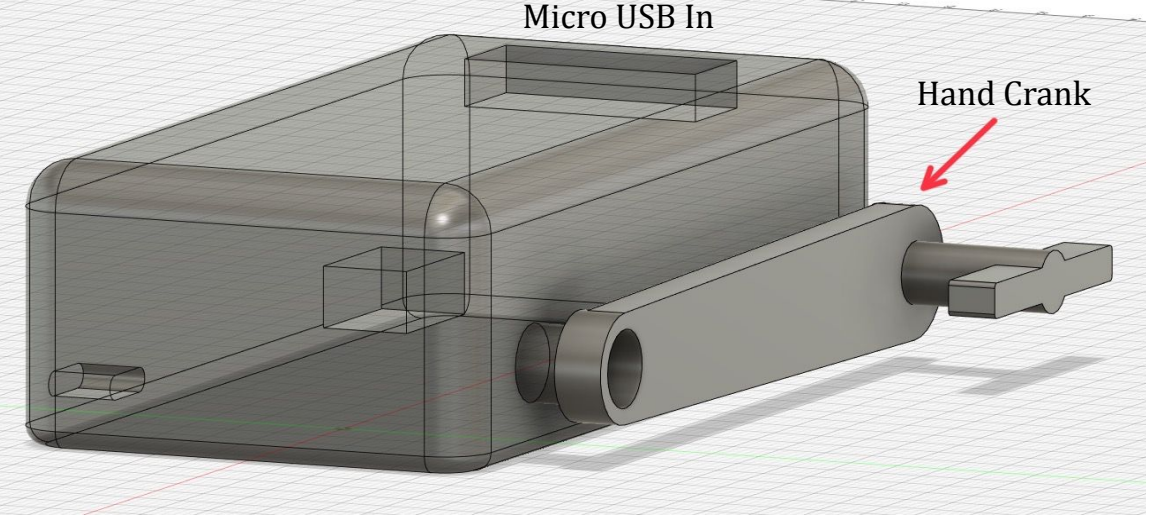

ROHDE&SCHWARZ
RTE 1054 · OSCILLOSCOPE · 500 MHz · 5 GSa/s
Meas Results
High 3.7352 V
High 5.1581 V
Frequency 570.27 Hz
File Horizontal Trigger Vertical Math Cursor Meas Masks Search Analysis Display Tutorials

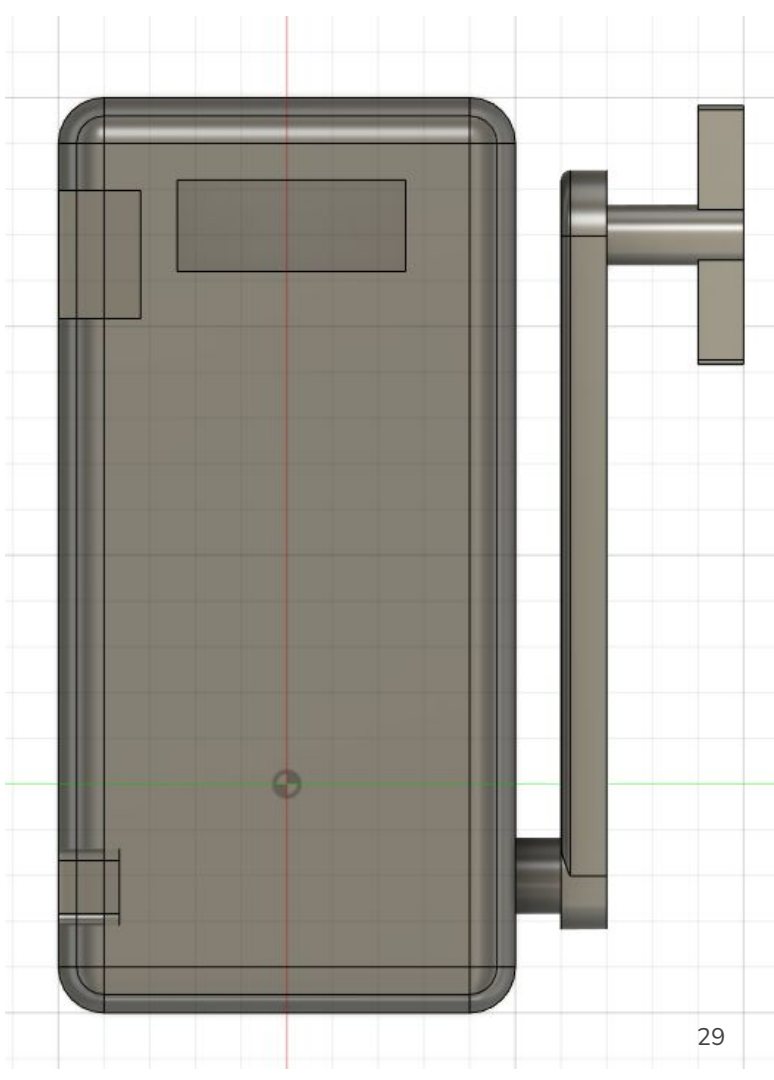

ROHDE&SCHWARZ
RTE 1054 · OSCILLOSCOPE · 500 MHz · 5 GSa/s
Meas Results
Meas 1 High 4.249 V
Meas 2 High 5.1581 V
Meas 4 Frequency 106.86 Hz
File Horizontal Trigger Vertical Math Cursor Meas Masks Search Analysis Display Tutorials

Assembly of the Product

- Outer Casing - ABS Plastic
- Metal reinforcement for Motor Mount
- Safety Considerations for Battery
- Length of Hand Crank
- Display Orientation

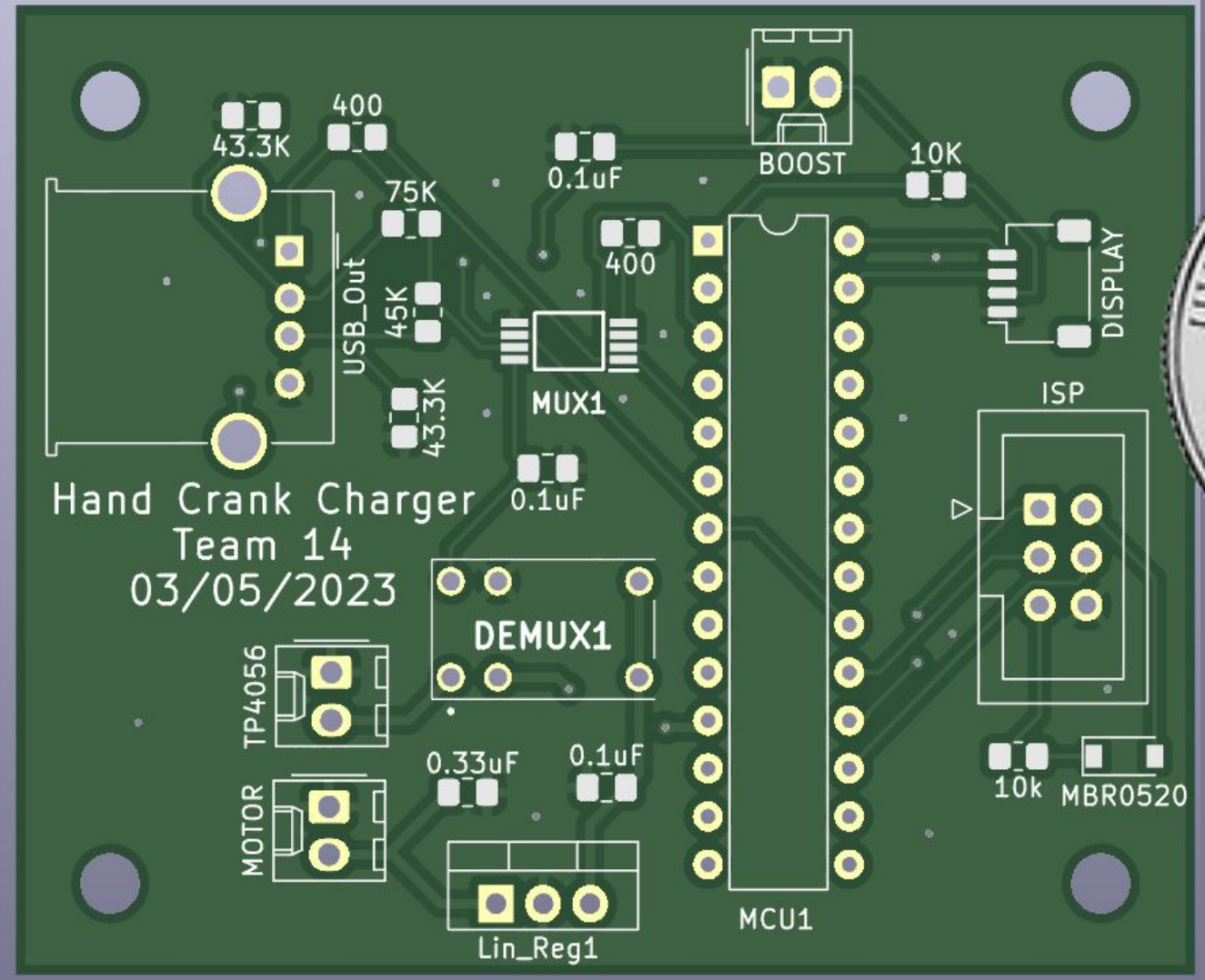

Display
USB A Out
Micro USB In


Hand Crank



Hurdles along the way, overcoming them

- Parts Reliability and Delivery
- Footprints
- PCB Issues



PCB Design Size Comparison

Video of our Working Product

Conclusion

Learnings

- Experienced product development cycle

Future Considerations

- Cheap and compact
- More robust PCB design

Thank You!