DEPARTMENT OF ELECTRONICS AND TELECOMMUNICATION ENGINEERING

UNIVERSITY OF MORATUWA

EN2160 - Electronic Design Realization

Battery capacity tester

Final Report

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Main Function

The battery must be connected to the battery terminal. Long-press the "UP" button after setting the current to your specifications. The test procedure should then begin after hearing a beep. You will keep an eye on every parameter on the OLED display throughout the exam. Until its voltage approaches its low-level threshold, the battery will deplete. (3.2V). Two prolonged sounds will signal the end of the test process.

- Features
- Able to gauge AA/AA/NiMh/NiCd, 18650 Li-ion, Li-Polymer, and Li FePO4 battery capacities. It works with nearly all batteries with a rating of less than 5V.
- Pushbuttons can be used by users to adjust the discharge current.
- User interface OLED
- The gadget is capable of being an electronic load.

Specifications

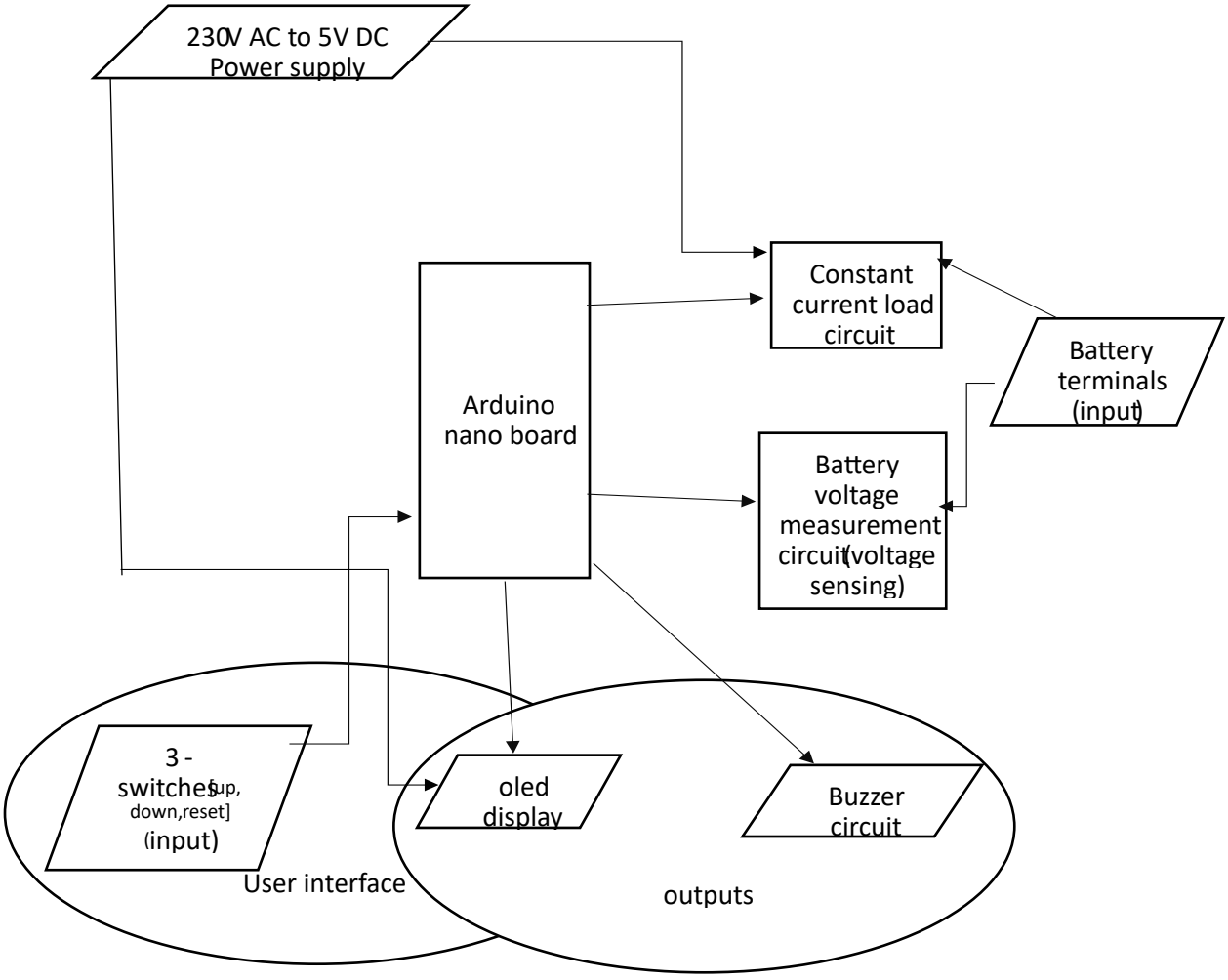
- Type – household battery tester
- Style - digital
- 7-9V power supply required.
- 0.96" I2C OLED display.
- Display battery voltage, Discharge current and Capacity.
- Consists Three push buttons. One is use for reset the Arduino.
- There is a buzzer
- It indicates start and end of the test.
- Working temperature : 0°C - 40°C

Product reference :
https://www.aliexpress.com/item/1005005105860242.html?spm=a2g0o.productlist.main.33.7c7e60f4XBMjJ8&algo_pvid=c54628ea-1ad6-48d9-ad37-c57765e4c48d&aem_p4p_detail=202304090457014900265934220240003583604&algo_exp_id=c54628ea-1ad6-48d9-ad37-c57765e4c48d-16&pdp_npi=3%40dis%21LKR%2127385.19%2116431.76%21%21%21%21%21%40211bd7d61681041421921 8009d07f1%21112000031679811352%21sea%21LK%210&curPageLogUid=IA2RPzbEf1A6&ad_pvid=202304090457014900265934220240003583604_17&ad_pvid=20230409045701490026593422024000 3583604_17

Theory

The hypothesis is based on the voltage comparison of the OpAmp's unity amplifier-configured inverting (pin 2) and non-inverting (pin 3) inputs. The output of the opamp opens the gate of the MOSFET when the voltage applied to the non-inverting input is set by modifying the PWM signal. OpAmp receives negative feedback as the MOSFET turns on because of the voltage drop caused by the current flowing through R1 during this process. It manages the MOSFET in a way that ensures an identical voltage at both its inverting and non-inverting inputs. As a result, the voltage at the OpAmp's non-inverting input is directly proportional to the current flowing through the load resistor.

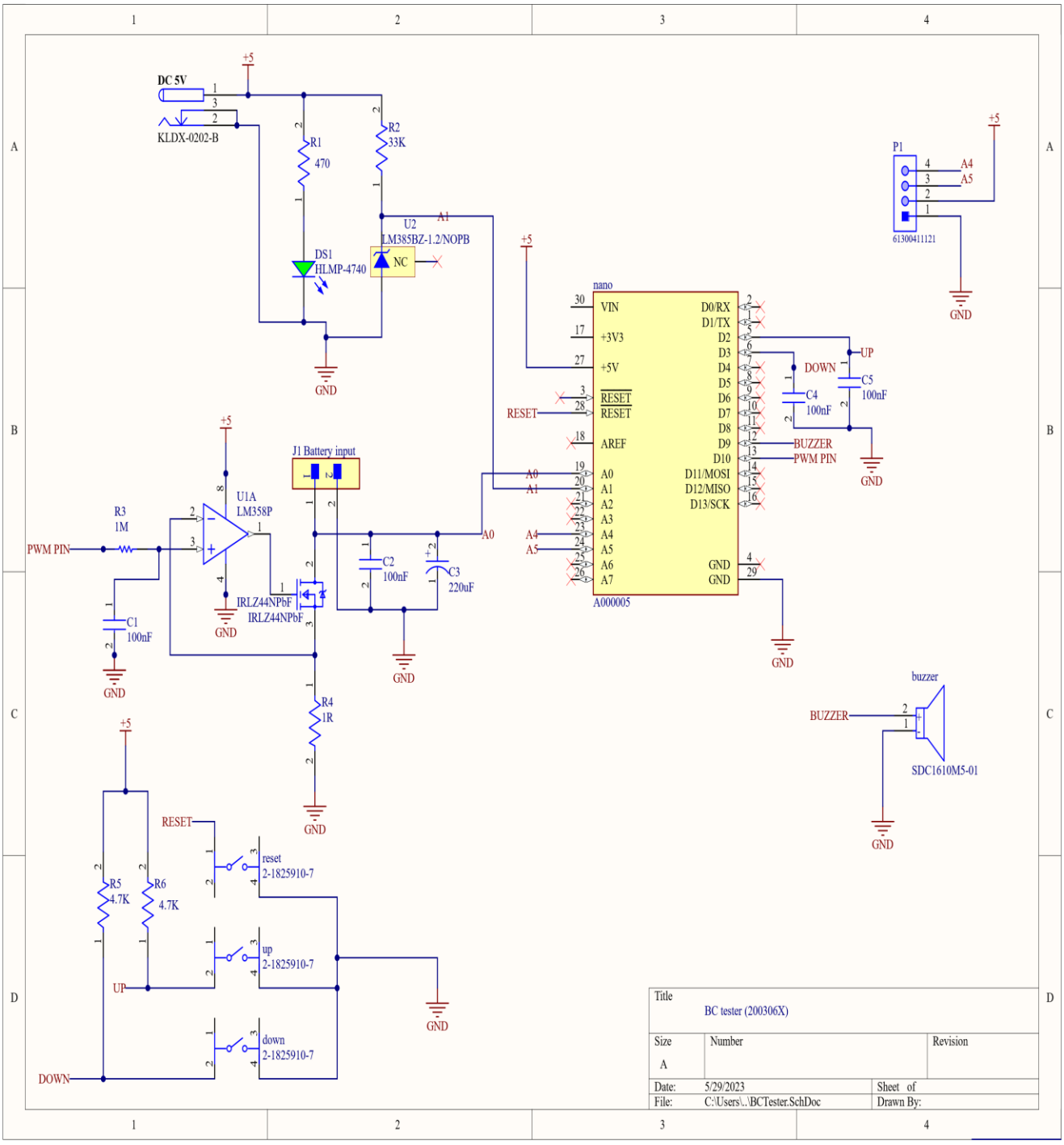
Block diagram

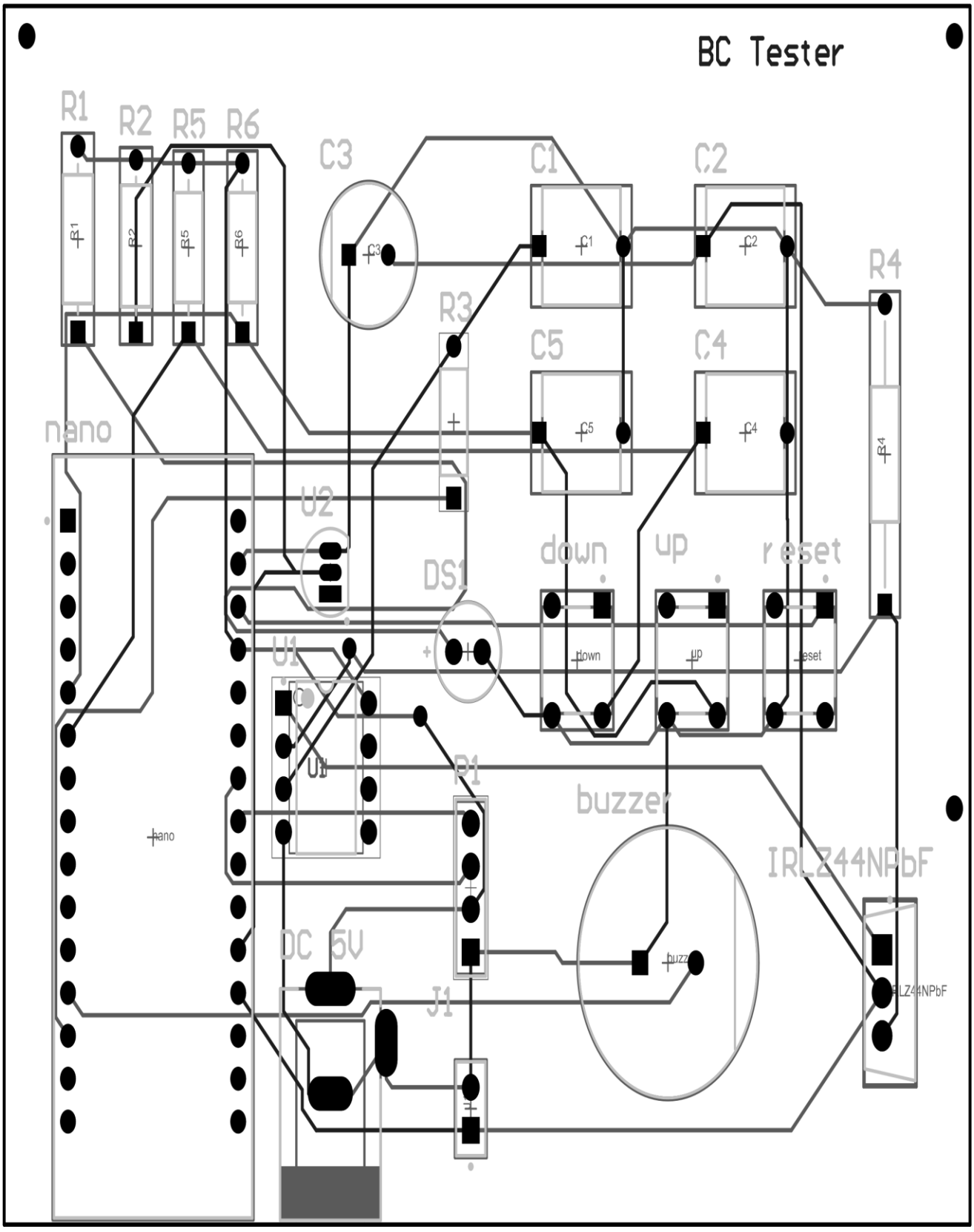


Pcb design files

Link for pcb design files- https://dms.uom.lk/s/4QDM4L8Pabeeqjx

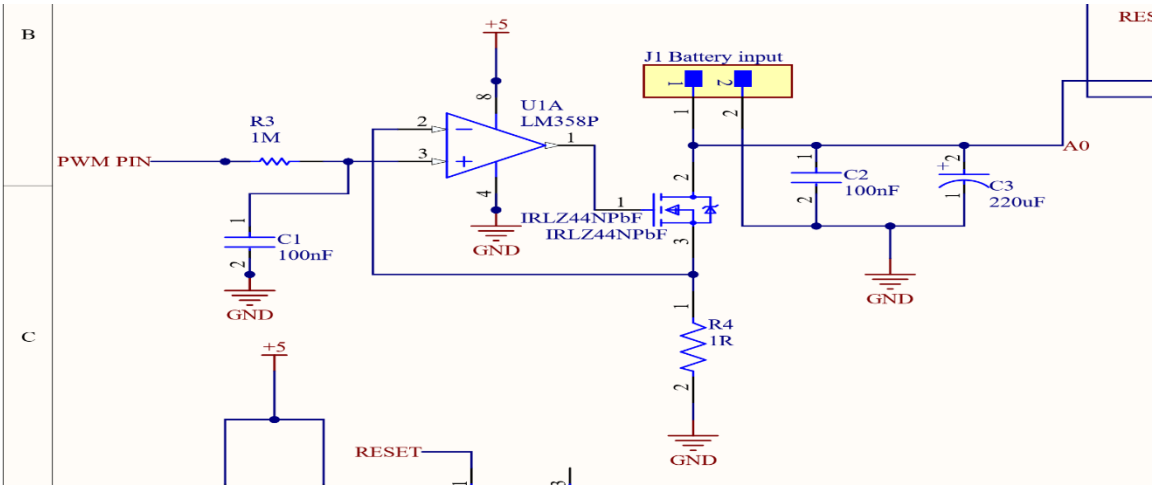
1. Schematic design




BC Tester
R1
R2
R5
R6
C3
C1
C2
R4
R3
C5
C4
nano
U2
DS1
down
up
reset
U1
P1
buzzer
IRLZ44NPbF
DC 5V
J1

The following sections comprise the entire schematic:

1. A circuit with a constant current load



The LM358 dual amplifier is the project's major part. In a single box, the LM358 has two amplifiers. Only one op-amp is necessary for this project, though. The first operational amplifier's non-inverted pin is linked to the PWM output of Arduino Pin D10. To obtain an equivalent analogue voltage, the PWM is filtered using R3 and C1's low pass filter. The operational amplifier, which is linked to the IRLZ44N MOSFET source pin and the 1R shunt resistor (R4), receives feedback from the inverting input.

A constant current load circuit is created by this op-amp, R4, and the MOSFET. The op-amp activates the MOSFET and tries to get the same voltage across R4 when the non-inverting input pin voltage is set. Because of Ohm's rule, a voltage drop must occur while current travels through the resistor. We can now adjust the PWM signal pulse width to control the current flowing through the load resistor (R3).

2. Circuit for Measuring Battery Voltage -

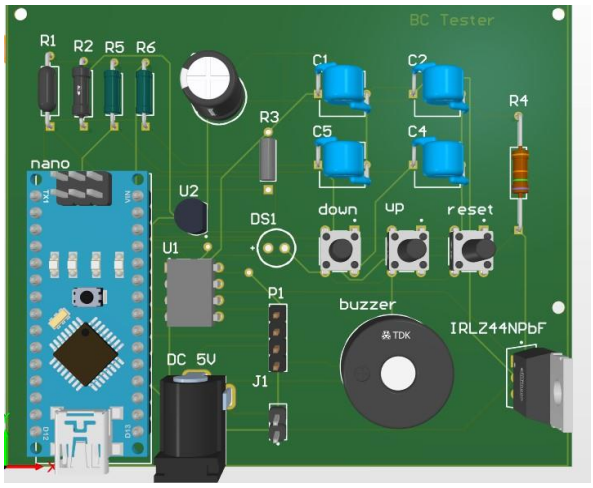
The Arduino's analogue input pin A0 measures the voltage of the battery. The constant current load circuit sounds, which can impair the efficiency of the ADC conversion, are filtered off using two capacitors, C2 and C3.

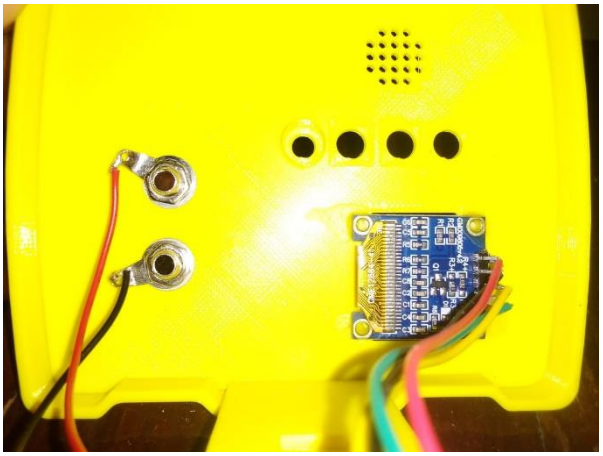
3. The user interface circuit-

A 0.96" I2C OLED display and two push buttons make up the user interface circuit. The PWM pulse width can be changed using the Up and Down pushbuttons. Pull-up resistors R6 and R5 are used with the Up and Down pushbuttons. Push buttons are debounced using C2 and C3. The Arduino is reset via the third push-button (RST).

5. A buzzer circuit -

The buzzer circuit serves as a starting and stopping signal for the test. On digital pin D9 of the Arduino, a 5V buzzer is connected.



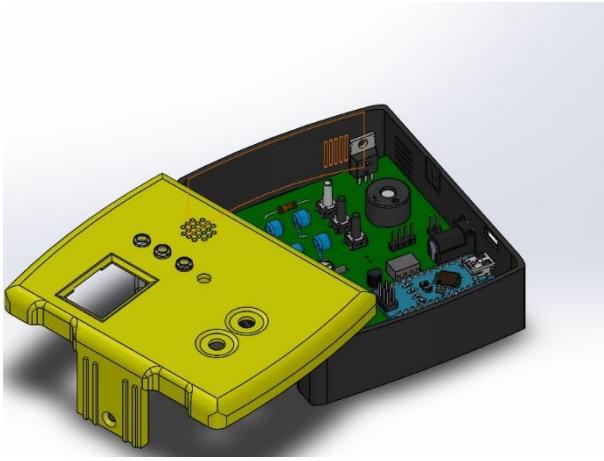


Bill of materials

Mouser #	link	quantity	price	Manufacturer
782-A000005	https://www.mouser.com/ProductDetail/782-A000005	1	$24.90	Arduino
926-LM385BZ-12/NOPB	https://www.mouser.com/ProductDetail/926-LM385BZ-12-NOPB	3	$3.48	Texas Instruments
595-LM358P	https://www.mouser.com/ProductDetail/595-LM358P	4	$1.52	Texas Instruments
942-IRLZ44NPBF	https://www.mouser.com/ProductDetail/942-IRLZ44NPBF	2	$3.32	Infineon
187-CL05A104KA5NNNC	https://www.mouser.com/ProductDetail/187-CL05A104KA5NNNC	10	$0.11	Samsung Electro-Mechanics
80-ESK227M016AG3DA	https://www.mouser.com/ProductDetail/80-ESK227M016AG3DA	10	$2.57	KEMET
490-CMI-1295-0585T	https://www.mouser.com/ProductDetail/490-CMI-1295-0585T	1	$1.18	CUI Devices
708-CF14JT1M00	https://www.mouser.com/ProductDetail/708-CF14JT1M00	10	$0.31	SEI Stackpole
660-CFS1/4CT52R333J	https://www.mouser.com/ProductDetail/660-CFS1-4CT52R333J	10	$0.46	KOA Speer
708-CF14JT4K70	https://www.mouser.com/ProductDetail/708-CF14JT4K70	10	$0.31	SEI Stackpole
279-CFR100J1M0	https://www.mouser.com/ProductDetail/279-CFR100J1M0	10	$2.62	TE Connectivity
815-ABLS-16.0M-T	https://www.mouser.com/ProductDetail/815-ABLS-16.0M-T	2	$0.64	ABRACON

Enclosure design files

Link for solidworks files - https://dms.uom.lk/s/D8EcxXdq78NAgSy



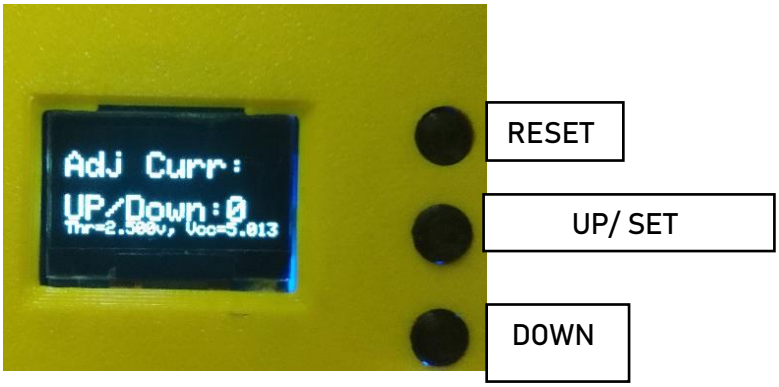
Arduino codes

Link -https://dms.uom.lk/s/RrMbTZdH6JyfaTf

User manual

Procedure

1. Power up the device through power supply (device automatically ask to set the discharge current)



2. User can set discharge current according to the up and down buttons and set the discharging current through long press the up buttons.
3. Once device get the battery capacity then it will make sound to indicate it.
4. Display shows the time taken for process , instance voltage across the battery and capacity.

Precautions

1. User should connect the terminals correctly.
2. Keep the device around 27degree Celsius environment.
3. Double-check the battery capacity tester to make sure it is appropriate for the particular battery chemistry and voltage you plan to test. Inaccurate results or battery damage can result from using the improper tester.
4. Before testing, check the battery for physical damage, leakage, or swelling. Batteries that are obviously degraded or damaged shouldn't be tested because they pose a risk.

Maintenance procedure

For a battery capacity tester to remain accurate and dependable, proper maintenance is essential. Regular upkeep increases a device's lifespan and guarantees that it will operate properly when required. For a battery capacity tester, the following general maintenance methods are recommended:

1. Examine the manual:
    a. Read the manufacturer's given user manual in its entirety first. The manual often includes detailed schedules and directions for maintenance.

2. Maintain Regular Cleaning:
    a. Wipe the battery capacity tester clean by using a soft, dry cloth. Clear the device's surface of any dust, grime, or debris that may have accumulated.

3. Examine Testing Cables and Connectors:
    a. Consistently look for evidence of wear, damage, or loose connections on the testing cables and connectors. In order to prevent false readings, damaged wires should be replaced right away.

4. Calibration Check:
    a. As directed by the manufacturer or based on usage patterns, do routine calibration checks. The accuracy of the tester's readings is guaranteed via calibration.

5. Software update:
    a. Updates to the battery capacity tester's software should be installed as needed. If the battery capacity tester has software or firmware, look for updates from the manufacturer. Software updates may enhance functionality and include new features.

6. Maintain a Proper Environment:
    a. The battery capacity tester should be kept in a sterile, dry, and temperature-controlled environment. The device can be harmed by high or low humidity, exposure to liquids, or extreme temperatures.

7. Packaging :
    a. Use a protective carrying case or storage bag, if at all possible, to keep the battery capacity tester safe during transportation and when not in use.

8. Service and repairs:
    a. For maintenance and repairs on the battery capacity tester, get in touch with the manufacturer's authorised service centre. Avoid making repairs on your own as this could void the warranty or cause more harm.

9. User Handling:
    a. Educate users on how to use and handle the battery capacity tester correctly. Do not drop or handle the gadget roughly as this could lead to internal damage.

10. Follow manufacturer's instructions:
    a. Follow any maintenance advice the manufacturer may provide you. To ensure peak performance, they could provide particular advises or recommendations.

11. Regular Testing:
    a. To ensure the battery capacity tester's accuracy, test it on a regular basis with reference batteries that are known to work. This makes it possible to detect any reading drift and make corrections as necessary.

Performance verification

1. Reference battery test :
    a. Use a set of reference batteries that are well-known, completely charged, and have capacities that have been independently validated. Record the measurements after each reference battery is connected to the tester. Compared to the reference batteries' known capacity, compare the tester's findings. Within a reasonable tolerance range, the tester should deliver readings that are somewhat near to the known values.

2. Verification with New Batteries:
    a. Utilise the capacity tester to test new batteries with the appropriate capacities. For the batteries being tested, the measurements must closely resemble the capacity specified by the manufacturer.

3. Test for repeatability:
    a. Run the same battery through several tests in a row, then compare the findings. The readings ought to be reliable and barely deviate.

4. Linearity test:
    a. Test batteries' linearity using a range of capacities, from low to high. The readings from the tester should show a linear relationship with the tested battery capacity.

5. Temperature sensitivity:
    a. Test batteries' sensitivity to temperature variations within the device's operational range. Regardless of temperature variations, the tester should display consistent values.

6. Internal Battery Test:
    a. If the battery capacity tester includes a built-in battery for backup power, regularly check its capacity to make sure it has enough power.