Secure Energy Harvesting from Footsteps and Thermal Gradients

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Literature Review

Sl.	Title of the Paper	Source	Inference
1	An Efficient Inductive Rectifier Based Piezo-Energy Harvesting Using Recursive Pre-Charge and Accumulation Operation.	IEEE Journal of Solid-State Circuits, vol. 57, no. 8, pp. 2404-2417, Aug. 2022, doi: 10.1109/JSSC.2022.3153590.	• Optimize the piezoelectric energy harvesting process using recursive pre-charge techniques and to maintain high efficiency in harvesting and storing.
2	Switched-capacitor-assisted power gating for ultra low stand by power in CMOS digital Ics.	S. Sankar, M. Goel, P.-H. Chen, V. R. Rao, andM. S. Baghini, IEEETrans.CircuitsSyst.I,Reg.Papers,vol.67, no.12,pp.4281–4294,Dec.2020.	• Leverage switched-capacitor techniques to minimize power loss and maximize energy transfer efficiency from piezoelectric and TEG outputs.
3	Self-Powered Standalone Performance of Thermoelectric Generator for Body Heat Harvesting.	A. Panbude and P. Veluswamy, in IEEE Sensors Letters, vol. 8, no. 11, pp. 1-4, Nov. 2024, Art no. 2504204, doi: 10.1109/LSENS.2024.3456289.	• Potential for a TEG module to harness thermal energy from body heat.

Literature Review

Sl. #	Title of the Paper	Source	Inference
4	Footstep Power Generation using Piezoelectric Sensor and Distribution using RFID	Sachin Chauhan, Manvendra Singh, Archie Tripathi , International Research Journal of Engineering and Technology (IRJET) -- February 2020.	• Incorporate piezoelectric sensors to generate energy from mechanical pressure exerted during walking
5	RFID Security	Yi Qian; Feng Ye; Hsiao-Hwa Chen, IEEE, 2022, pp.193-205, doi: 10.1002/9781119244400.ch10.	• Practical insights and advanced techniques for ensuring secure RFID implementations.

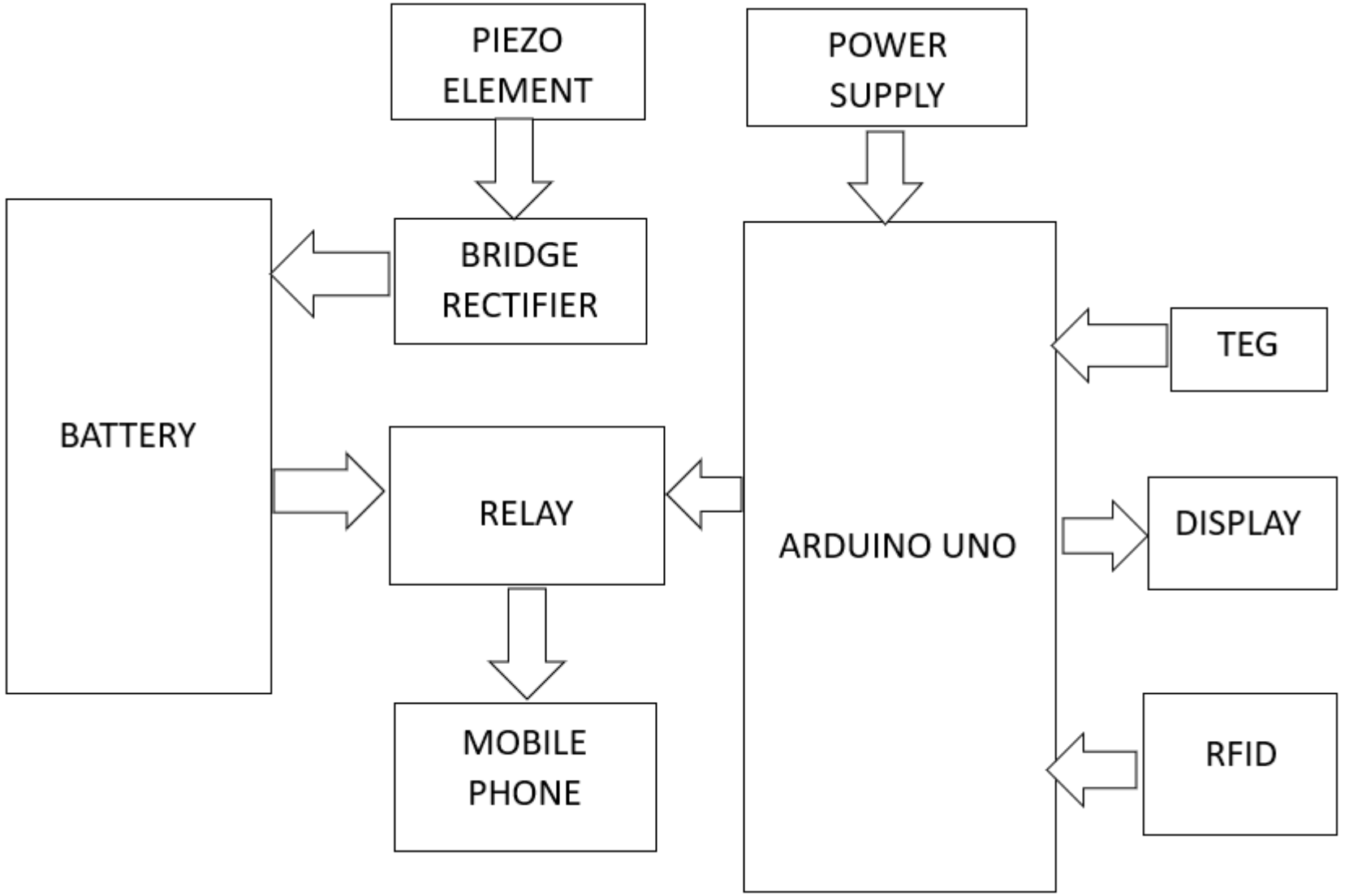
Problem Statement

- The rapid depletion of non-renewable energy resources necessitates the development of sustainable and innovative energy extraction methods, such as hybrid systems combining piezoelectric and thermoelectric generators, integrated with RFID-secured solutions for efficient and secure mobile charging.

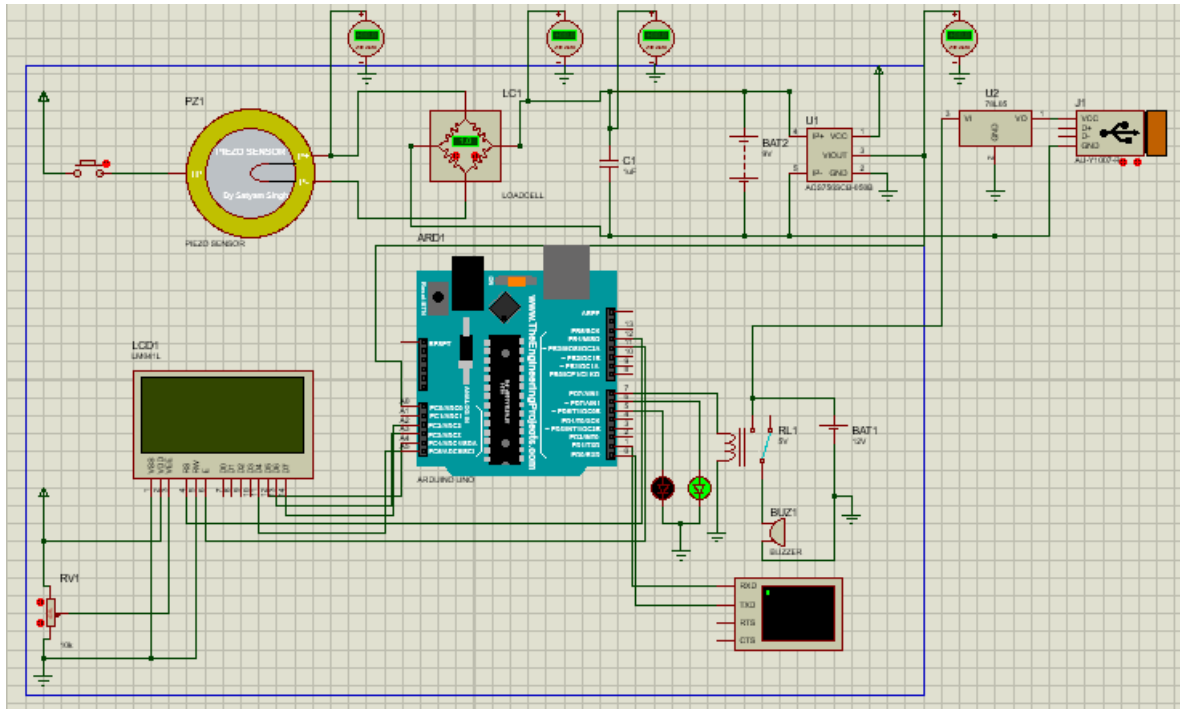
Objectives

- Create a hybrid energy harvesting system that combines footstep and thermal energy for sustainable power generation.
- Make the system adaptable to various climates by utilizing natural and artificial temperature differences for thermoelectric generation.
- Implement IoT-based monitoring to track energy generation and optimize the system in real-time.
- Develop a mechanism for storing harvested energy to provide consistent power supply.
- Offer a renewable and eco-friendly alternative to non-renewable energy sources for public spaces and smart cities.
- Ensure the system provides secure energy access, supporting both sustainable and safe energy solutions.
- Innovation in Power Generation: To show how human activity may produce power using piezoelectric technology or other mechanisms.

Block Diagram



Simulation Results and Inference

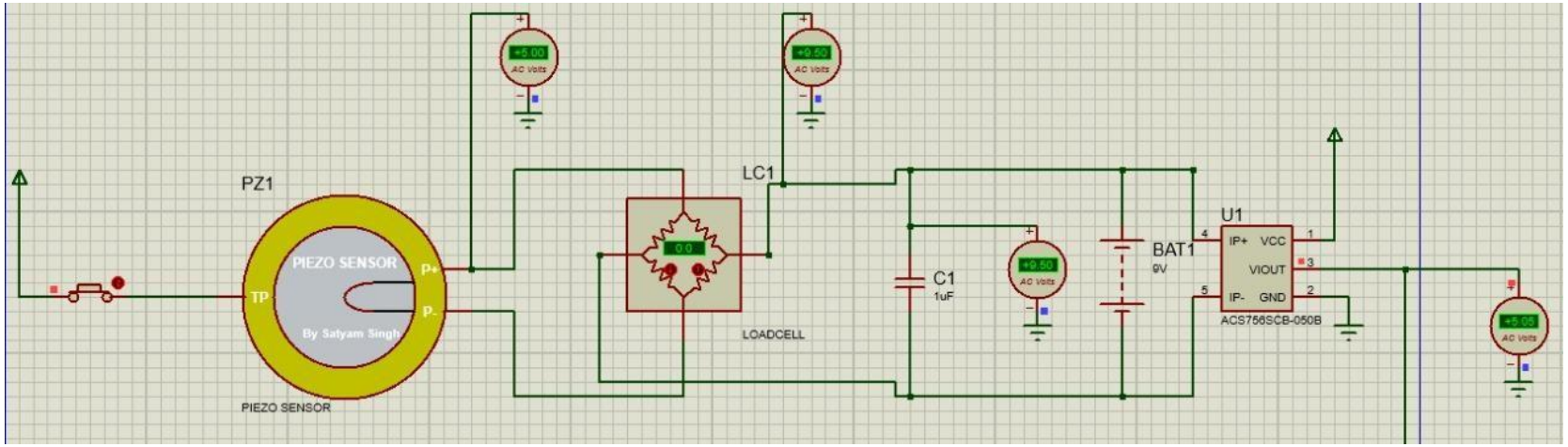


Simulation Circuit Setup

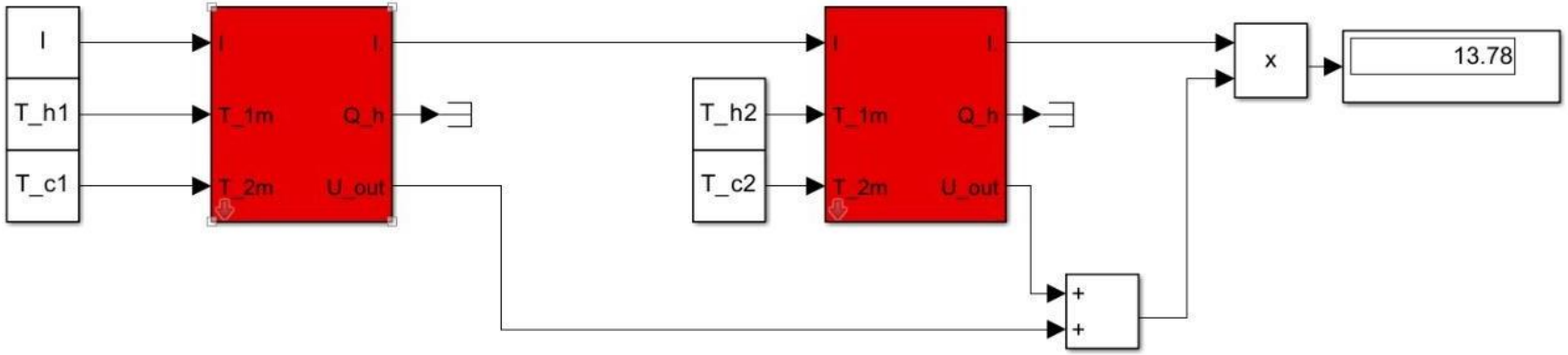
Valid id scanned ; Charging access initiated

Invalid ID ; Charging access denied

Simulation Results and Inference



Pressure applied in piezo-electric senor and voltage readings taken.

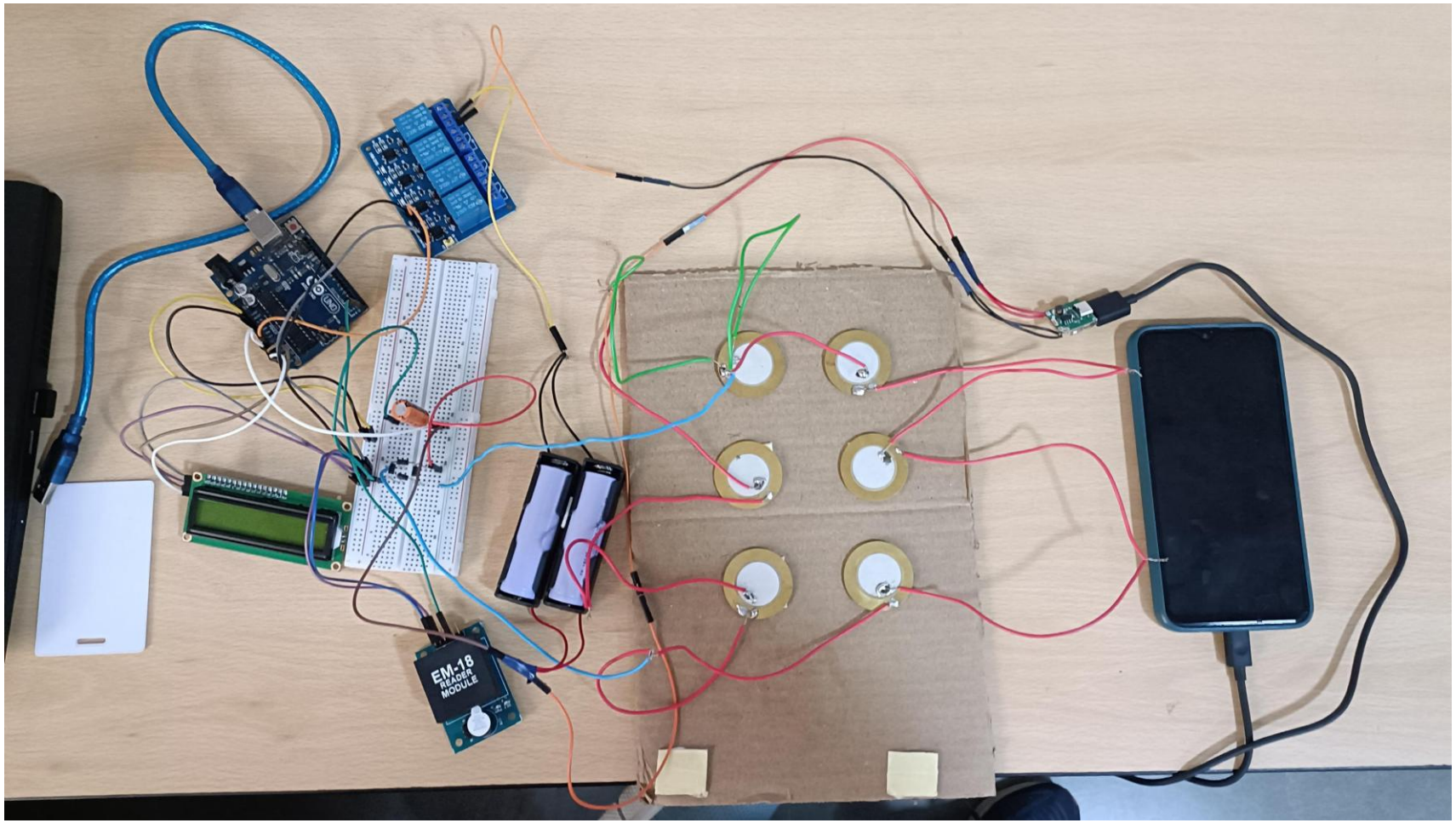


MATLAB simulation of Thermo-electric generator (TEG) Generates an output voltage 13.78V

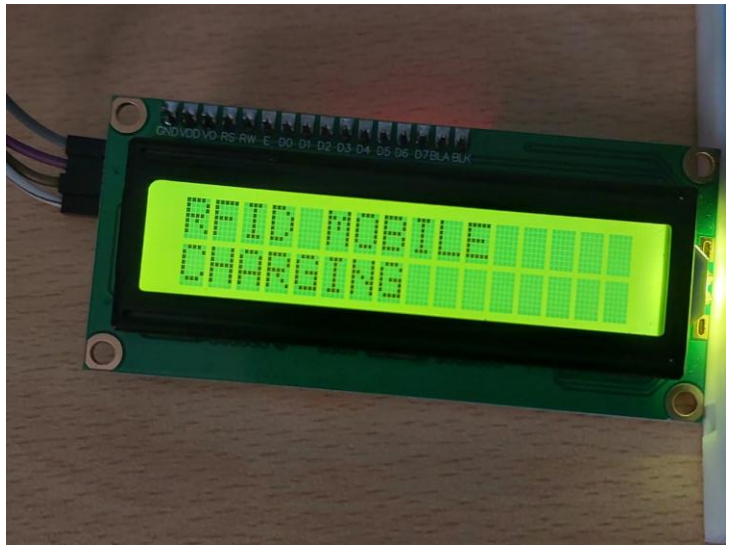
Methodologies

- Energy Generation through Piezoelectric Sensors: Piezoelectric sensors are embedded in walking surfaces to convert mechanical pressure from footsteps into electrical energy.
- Energy Storage: The electrical energy generated is converted into dc, smoothened and stored in rechargeable batteries for later use.
- User Authentication via RFID: Users are provided with RFID cards containing unique identification numbers. When a user scans their RFID card at the charging station, the system verifies their identity and grants access to the stored energy for a specified time.
- Mobile Charging: Authenticated users can connect their mobile devices to the charging station, drawing power from the stored energy
- LCD Interfacing: Displays the charging status along with user details and timer for charging access.

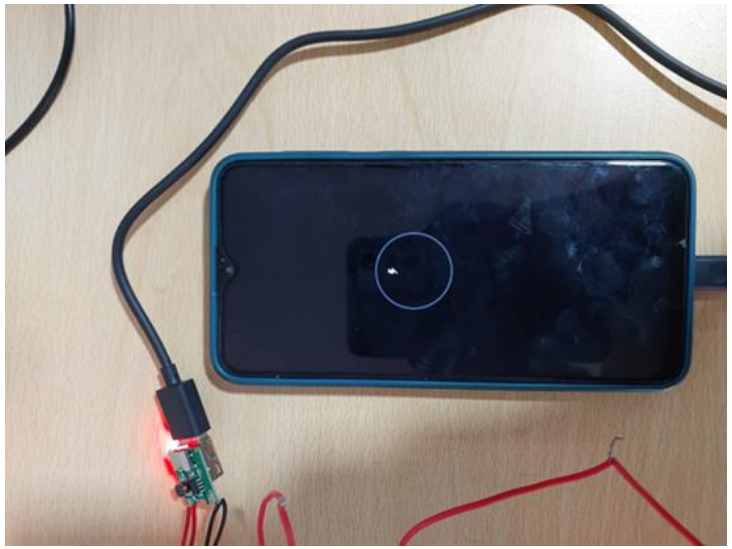
INITIAL SETUP

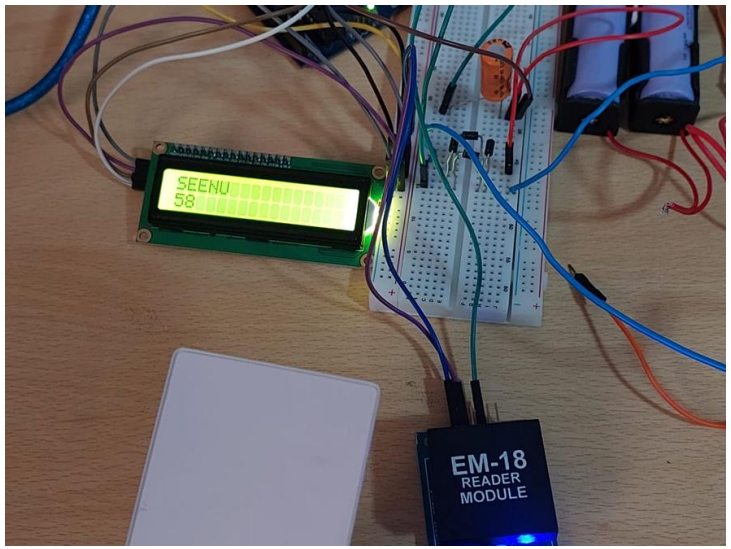


OUTPUT


RFID MOBILE
CHARGING


SCAN THE CARD
CHARGE UR PHONE




SEENU
58
EM-18
READER
MODULE

References

[1] S. Sankar, P. -H. Chen and M. S. Baghini, ”An Efficient Inductive Rectifier Based Piezo-Energy Harvesting Using Recursive Pre-Charge and Accumulation Operation,” in IEEE Journal of Solid-State Circuits, vol. 57, no. 8, pp. 2404-2417, Aug. 2022, doi: 10.1109/JSSC.2022.3153590.

[2] S. Sankar, M. Goel, P.-H. Chen, V. R. Rao, andM. S. Baghini, “Switched-capacitor-assisted powergating for ultra low stand by power inCMOSdigitalICs,”IEEETrans.CircuitsSyst.I,Reg.Papers,vol.67, no.12,pp.4281–4294,Dec.2020.

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4 Sachin Chauhan, Manvendra Singh, Archie Tripathi -- Footstep Power Generation using Piezoelectric Sensor and Distribution using RFID -- “International Research Journal of Engineering and Technology (IRJET)” -- Sept 2020.

5 Yi Qian; Feng Ye; Hsiao-Hwa Chen, "RFID Security," in *Security in Wireless Communication Networks* , IEEE, 2022, pp.193-205, doi: 10.1002/9781119244400.ch10.