IJAREEIE

e-ISSN: 2278-8875
p-ISSN: 2320-3765

# International Journal of Advanced Research

## in Electrical, Electronics and Instrumentation Engineering

Volume 13, Issue 4, April 2024

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 8.317

| e-ISSN: 2278 – 8875, p-ISSN: 2320 – 3765| www.ijareeie.com | Impact Factor: 8.317|| A Monthly Peer Reviewed & Referred Journal |

||Volume 13, Issue 4, April 2024||

| DOI:10.15662/IJAREEIE.2024.1304025 |

# Demand Side Management in Solar PV Integrated Smart Grid Environment

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**ABSTRACT**: The global demand for and availability of energy is increasing every day. Because conventional energy sources such as coal and petroleum are limited and diminishing, renewable energy supplies will become increasingly significant in the future. In the current circumstances, the energy crisis is a serious and pressing issue that must be addressed. It basically involves confirming the availability of extra generators or increasing the generation capacity. Alternatively, a load management method known as demand side management (DSM) is required. The usage of fossil fuels for domestic transportation is quickly expanding in the current environment, indicating a hazard in the near future. The negative consequences of using such vehicles and methods include pollution of the environment and health issues relating to living habitats. In line with this, E vehicles, which are environmentally friendly, are the upcoming means of transportation. The usage of electric energy for propulsion is a disadvantage of this mode of transportation, since it will place additional strain on the current power system and infrastructure. However, the use of power electronics and controls in electric vehicles (EVs), as well as other cutting-edge technology, is promoting and supporting green transportation systems.

**KEYWORDS:** Photo Voltaic, Grid, Arduino, Converter, E-Vehicle

## I. INTRODUCTION

The major goals of the "Solar energy E-vehicles" idea in the environment. The possibilities for using alternative technologies in automobiles, such as electric/hybrid vehicles, must be figured out, or a plug-in hybrid electric vehicle must be developed by converting an existing conventional vehicle with a suitable motor and battery The world's population is growing at an exponential rate. As a result, energy sources will play a critical role. Current methods in this area have the potential and priorities to reduce greenhouse gas emissions, increase energy efficiency in homes, offices, and enterprises, and promote energy marketing, management, conservation, and security. These also look for practical and economical alternative energy sources, as well as producing cleaner and more efficient transportation vehicles and systems, as well as energy policy and strategy. The present globe faces severe difficulties such as excessive fossil fuel extraction, depletion, and environmental deterioration. To address these issues, renewable energy has recently gotten a lot of attention because of its environmental benefits. Renewable energy will face stiff competition from fossil fuels in the near future. The first law of thermodynamics, generally known as the law of conservation of energy, asserts that energy cannot be generated or destroyed; instead, it can only be transformed from one form to another. Solar energy comes from the sun, which is a massive source of energy in the form of heat and light due to nuclear fusion at its core. The nuclear. process releases energy, which travels to the sun's surface. Every year, the earth absorbs around 3,850,000 exajoules of solar energy, the majority of which is light energy. Few systems use thermal energy for heating, whereas the majority convert or transform light into electrical energy. In the current circumstances, the energy crisis is a serious and pressing issue that must be addressed. It basically involves confirming the availability of extra generators or increasing the generation capacity. Alternatively, demand-side management strategies like demand control and shift or curtailment (DSM) must be implemented. The usage of fossil fuels for domestic transportation is quickly expanding in the current environment, indicating a hazard in the near future. The negative consequences of using such vehicles and methods include pollution of the environment and health issues relating to living habitats. In line with this, E- vehicles, which are environmentally friendly, are the upcoming means of transportation. The usage of electric energy for propulsion is a disadvantage of this mode of transportation, since it will place additional strain on the current power system and infrastructure. With the introduction of power electronics, E-vehicles (EVs) become one of the most practical and environmentally friendly modes of transportation. Depending upon the below Literature Survey of different papers we have decided to moved forward to take this project in practical means. For this purpose we have aimed to construct a solar electric vehicle. To save renewable energy ex petrol or diesel.

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### 1.1 PROBLEM STATEMENT

The problem statement for Demand Side Management (DSM) in a Solar PV Integrated Smart Grid Environment can be framed as follows:

"Increasing adoption of solar photovoltaic (PV) systems presents both opportunities and challenges for electricity grid management. While solar PV offers clean and renewable energy generation, its variable and intermittent nature introduces complexity in grid operations, particularly in balancing supply and demand. Demand Side Management (DSM) strategies aim to address this challenge by optimizing energy consumption patterns, reducing peak loads, and enhancing grid flexibility. However, integrating DSM effectively within a solar PV integrated smart grid environment requires overcoming various technical, economic, and regulatory barriers. Key challenges include:

- Solar Generation Intermittent
- Grid Stability and Reliability
- Consumer Engagement and Participation
- Data Management and Analytics
- Regulatory and Policy Frameworks

### 1.2 OBJECTIVE

- To minimize the Peak to Average load Ratio (PAR) per day of end users so that the smart grids(SG) efficiency is increased. Set of appliances differentiated as elastic and fixed are considered for optimal scheduling at the user end.
- The objective of this project is to present the load shifting technique for demand side management of smart grids which handles a large number of controllable devices.
- To design and develop Solar Hybrid Power System Model using Smart Control and Monitoring System.
- To analyze the output power of the solar photovoltaic (PV)

### 1.3 SCOPE

- The scope of Demand Side Management (DSM) in a Solar PV Integrated Smart Grid Environment encompasses optimizing energy consumption, balancing supply and demand, and enhancing grid reliability through various strategies.
- DSM involves load shifting, demand response programs, and energy efficiency measures tailored to leverage solar PV generation.
- Integration with smart grid technologies enables real-time monitoring, data analysis, and personalized energy management solutions. Consumer empowerment and policy support are essential for overcoming technical, economic, and regulatory barriers to DSM adoption.
- Overall, DSM plays a crucial role in maximizing the benefits of solar PV integration, promoting sustainability, and ensuring grid stability in smart grid environments.

## II. COMPONENTS

### COMPONENTS AND SPECIFICATIONS:

- ARDUINO MICROCONTROLLER
- SOLAR PANEL
- BATTERY
- RELAY
- LOAD
- DC – DC BOOSTER
- LCD DISPLAY
- 9W BULP

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**BLOCK DIAGRAM**

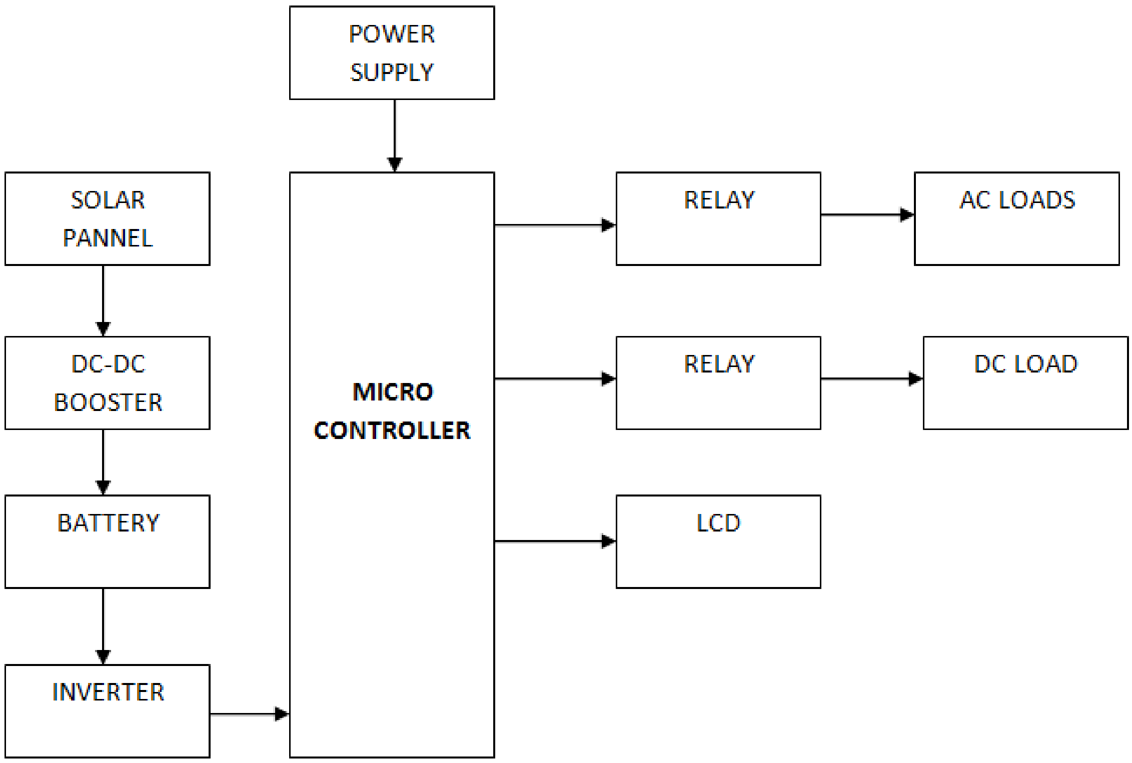


Fig -1: Block Diagram

**WORKING**

In the proposed system, the design of a hybrid system using mains and a PV array to meet peak power demand is discussed. A solar system using PV arrays to convert solar radiation into direct current was a preferred renewable energy source compared to others. Fluctuations in a commercial grid power supply depended greatly on peak power demand load.

It was, therefore, more convincing to utilise a PV array system to meet peak time demand. A LCD displays selection of source and provides for the overriding of automatic source selection; manual switching is included. The design automatically selected solar panel power either from battery or from a panel directly to supply a load during peak power demand.

Also, during mains shut down solar power was automatically selected. The system automatically checked availability of sources to switch between solar and mains during peak and off-peak times. At night with mains off and during grey days the batteries powered the load.

The programme was also user-friendly and could be changed to requirement. The designed system worked continuously; monitoring was on a second-to-second basis.

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**CIRCUIT DIAGRAM**

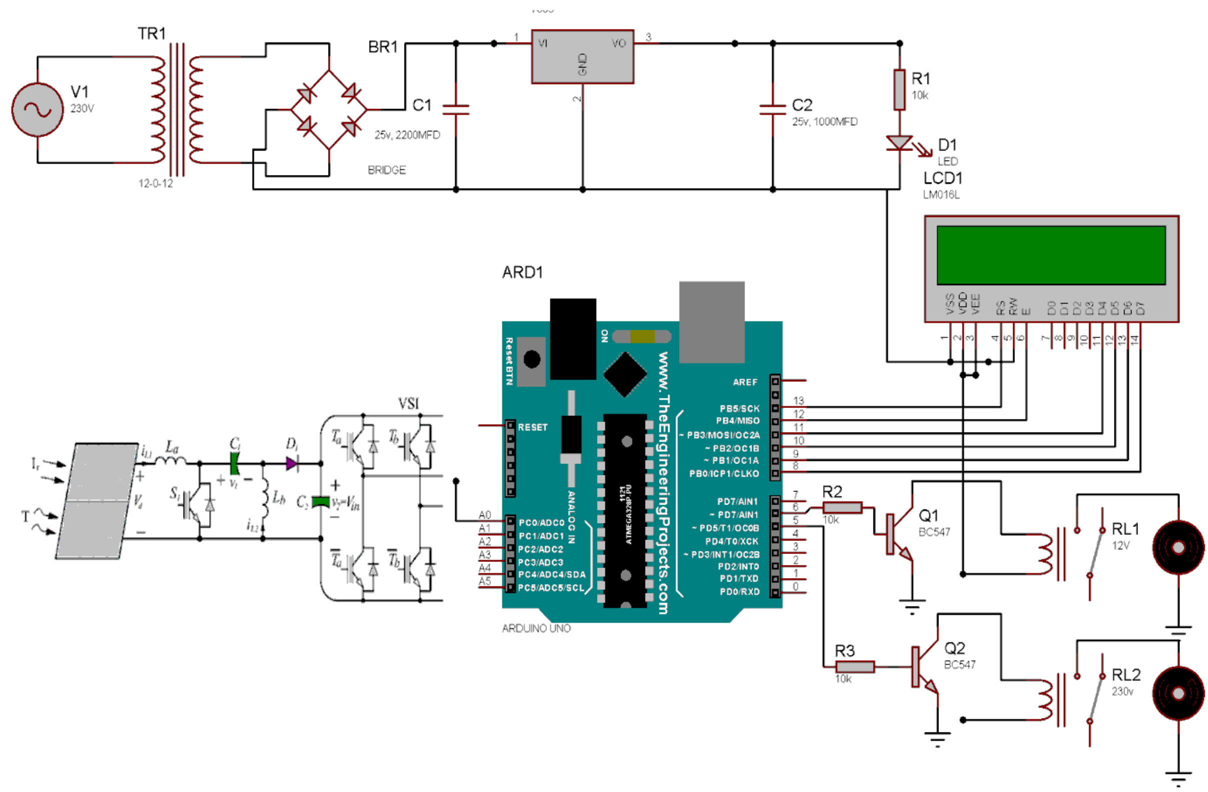


Fig -2: Circuit Diagram

## III. RESULT AND DISCUSSIONS

The results of Demand Side Management (DSM) in a Solar PV Integrated Smart Grid Environment include:

1**. Optimized Energy Consumption:** DSM enables more efficient utilization of electricity by shifting demand to times when solar PV generation is high, reducing reliance on conventional energy sources during peak periods.

2**. Balanced Supply and Demand:** By aligning energy consumption with solar PV output, DSM helps balance supply and demand on the grid, reducing the need for costly infrastructure upgrades and improving overall grid stability.

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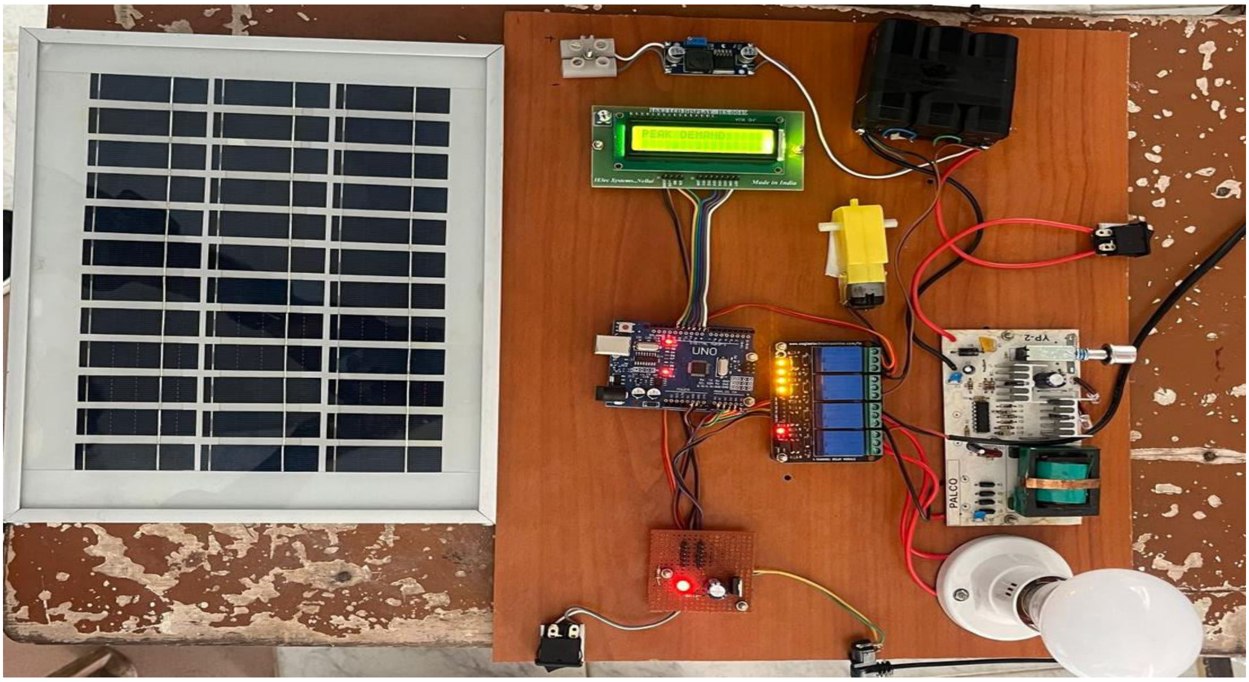

**Fig -3: Hardware Kit**

Demand side management (DSM) in a solar PV integrated smart grid environment optimizes energy usage, lowers costs, improves grid stability, integrates renewables efficiently, reduces emissions, and enhances overall grid flexibility

3. **Grid Reliability and Resilience:** DSM enhances grid reliability by providing flexibility to manage fluctuations in solar PV generation and demand patterns, mitigating the risk of blackouts and improving system resilience.

4. **Cost Savings:** By reducing peak demand and optimizing grid operations, DSM can lead to cost savings for both utilities and consumers, lowering electricity bills and avoiding the need for expensive peak generation resources.

Overall, the results of DSM in a Solar PV Integrated Smart Grid Environment include improved energy efficiency, grid reliability, cost-effectiveness, and environmental sustainability, while empowering consumers and advancing grid modernization efforts.

## IV. CONCLUSION

Improvements in the regulation of charging and discharging of EVs are required in order to fully utilize them for system stability in response to the ongoing exponential increase of global sales and the anticipated penetration of EVs. Using V2G technology, EVs can be made to function as intelligent loads. In order to support the intermittent and variable character of PV, this research suggests how they can be used as a source for peak shaving and as a load for valley filling. The operation of peak shaving and valley filling control algorithms is explored. Using the valley filling control technique, the end line bus voltages exceed the allowable voltage limits when the power from PV increases. By using EVs as a source, peak shaving control is used to return the voltages to acceptable ranges. The end line bus voltages, on the other hand, tend to drop when PV generation declines, which is countered by employing EVs as a source for peak shaving.

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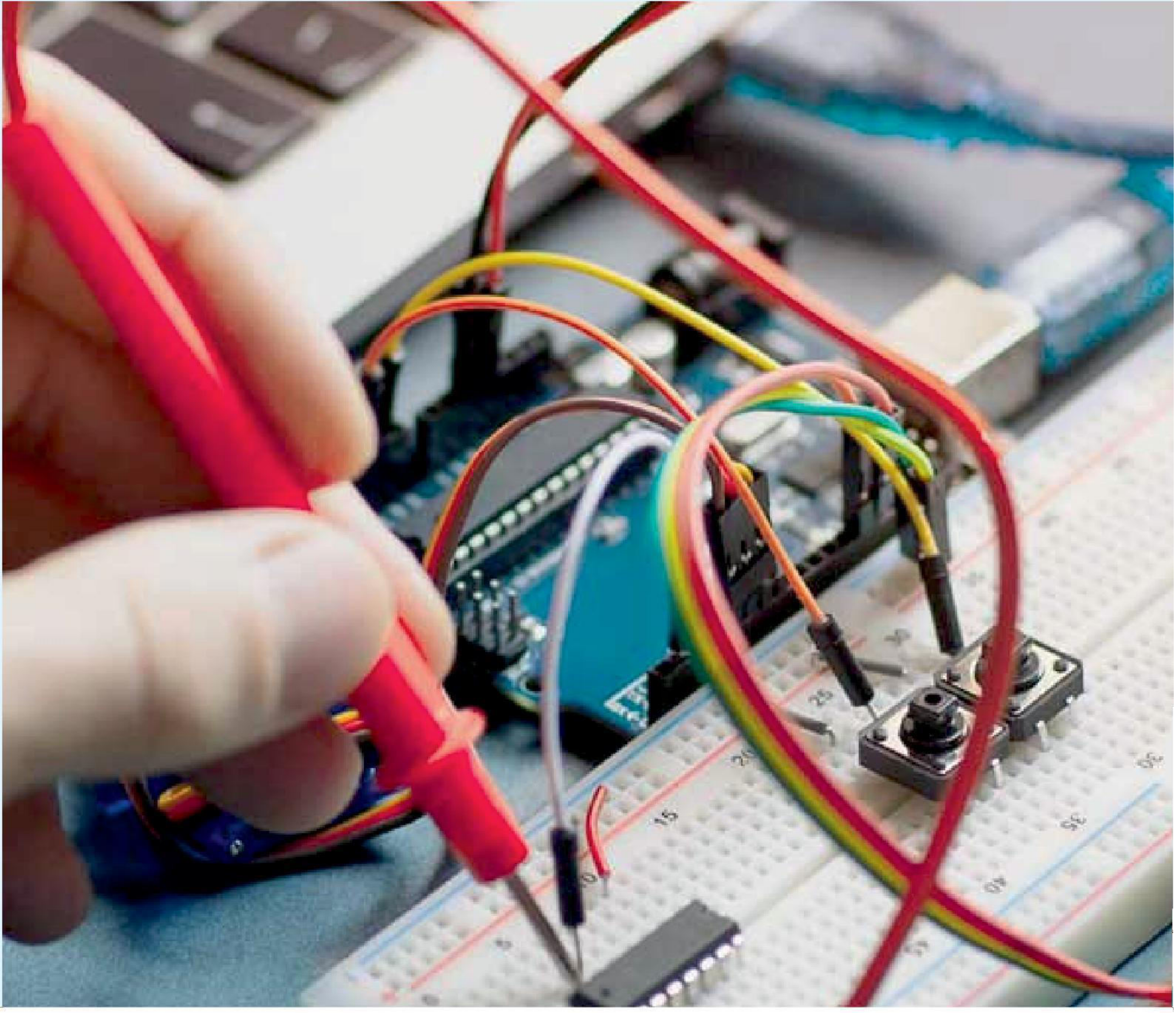



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