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Fuzzy Logic Based Luo Converter for PV Application

Dr.N.Sambasiva Rao [1], Mr. R. Raghunadha Sastry [2], Mr.Y.M.V.Krishna[3], Mr.T.Vasanth Babu[4], Mr.S.Harsha[5], Mr.B.Ajay Kumar[6], Mr.L. Naga Ajay Karthik Reddy[7]

Professor and Head of the Department, Dept. of Electrical & Electronics Engineering, NRI Institute of Technology, Agiripalli, Vijayawada, India[1]

Associate Professor, Dept. of Electrical & Electronics Engineering, NRI Institute of Technology, Agiripalli, Vijayawada, India[2]

UG Scholar, Dept. of Electrical & Electronics Engineering, NRI Institute of Technology, Agiripalli, Vijayawada, India[3]

UG Scholar, Dept. of Electrical & Electronics Engineering, NRI Institute of Technology, Agiripalli, Vijayawada, India[4]

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UG Scholar, Dept. of Electrical & Electronics Engineering, NRI Institute of Technology, Agiripalli, Vijayawada, India[6]

UG Scholar, Dept. of Electrical & Electronics Engineering, NRI Institute of Technology, Agiripalli, Vijayawada, India[7]

ABSTRACT: The necessity to build alternative energy conditioners to harvest renewable energy rather than using conventional energy sources has intensified in recent years. This type of energy can be employed on a small scale to power low-power systems. The goal of this study is to investigate another efficient technique to increase energy harvesting by presenting a different alternative to power-conditioning environmental sources of energy using an upgraded dc-dc converter. Voltage regulation at the output, as well as power coordination between two input sources, can be accomplished by altering the duty-ratio of the active power switch. To improve the system's stability, the proposed circuit is enhanced using a fuzzy logic controller. Theoretical analysis and computer simulation are used to describe the circuit's operation in detail. To confirm the analyzed and simulated results, an experimental circuit has been created and tested.

KEYWORDS: Solar Energy, MPPT Controller, Matlab/Simulink, Fuzzy Logic, Luo converter.

I. INTRODUCTION

With increasing concern of global warming and the depletion of fossil fuel reserves, many are looking at sustainable energy solutions to preserve the earth for the future generations. Other than hydro power, wind and photovoltaic energy holds the most potential to meet our energy demands. Alone, wind energy is capable of supplying large amounts of power but its presence is highly unpredictable as it can be here one moment and gone in another. Similarly, solar energy is present throughout the day but the solar irradiation levels vary due to sun intensity and unpredictable shadows cast by clouds, birds, trees, etc.

Most applications are for stand-alone operation, where the main control target is to balance local loads. A few grid-connected systems consider the grid as just a back-up means to use when there is insufficient supply from renewable sources.

A traditional power electronic converter receives its power from a single source but can output to several destinations. A transformer with multiple output windings is used when two or more voltage or current levels are required by the loads .In other applications, however, the loads may be driven by two or more input sources with differing voltage, current, and power ratings . A solar street lamp, for example, is powered mostly by solar cells but also requires battery backup.

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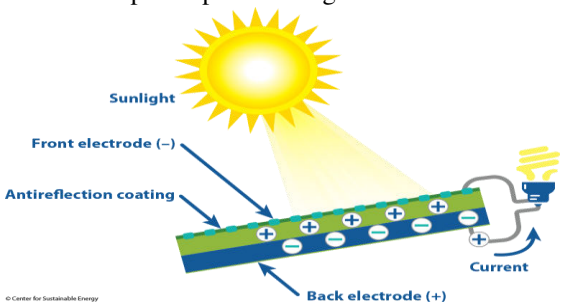
SOLAR ENERGY:

A) Photovoltaic effect:

Photovoltaic (PV) is a method of generating electrical power by converting solar radiation into direct current electricity using semiconductors that exhibit the photovoltaic effect.The photovoltaic effect is the generation of a voltage (or a corresponding electric current) in a material upon exposure to light.



B)**SOLAR CELLS:**

A solar cell is a solid-state device that uses the photovoltaic effect to turn sunlight directly into electricity. Solar modules, commonly known as solar panels, are made up of cell assemblies.Solar power, or the energy created by these solar modules, is an example of solar energy.

C)**SOLAR PANEL:**

A solar panel (photovoltaic module or photovoltaic panel) is a packaged interconnected assembly of solar cells, also known as photovoltaic cells. The solar panel can be used as a component of a larger photovoltaic system to generate and supply electricity in commercial and residential applications.

MPPT CONTROLLER:

Maximum power point tracker (or MPPT) is a high efficiency DC to DC converter that presents an optimal electrical load to a solar panel or array and produces a voltage suitable for the load.*Maximum power point tracking (MPPT) is the process for tracking the voltage and current from a solar module to determine when the maximum power occurs in order to extract the maximum power.The maximum power point tracking (MPPT) charge controller incorporates PWM and a DC to DC converter.*

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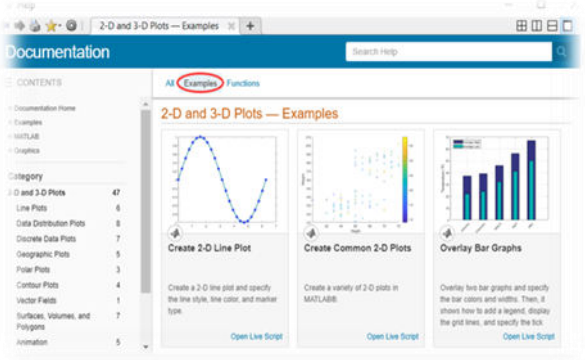
How Maximum Power Point Tracking works: Maximum Power Point Tracking is electronic tracking - usually digital. The charge controller looks at the output of the panels and compares it to the battery voltage. It then figures out what is the best power that the panel can put out to charge the battery.

MATLAB:

MATLAB is a high-level technical computing language and interactive environment for algorithm development, data visualization, data analysis, and numeric computation. Using the MATLAB product, you can solve technical computing problems faster than with traditional programming languages, such as C, C++, and FORTRAN.



Key features of MATLAB:

- High-level language for technical computing.
- Development environment for managing code, files, and data .
- Interactive tools for iterative exploration, design, and problem solving.

SIMULINK:

Simulink is an environment for multidomain simulation and Model-Based Design for dynamic and embedded systems. It provides an interactive graphical environment and a customizable set of block libraries that let you design, simulate, implement, and test a variety of time-varying systems, including communications, controls, signal processing, video processing, and image processing.

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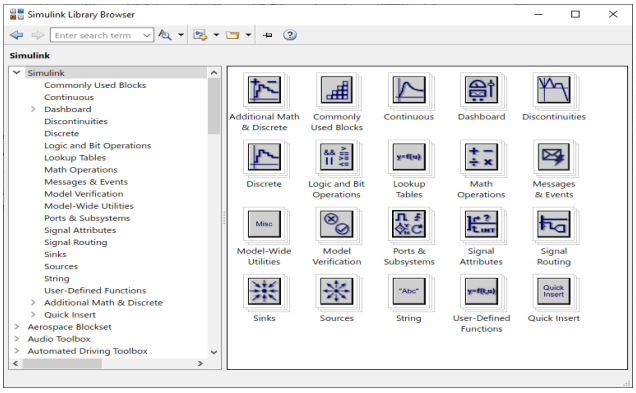


A Simulink block:

A Simulink block diagram is a pictorial model of a dynamic system. It consists of a set of symbols, called blocks, interconnected by lines. Each block represents an elementary dynamic system that produces an output either continuously (a continuous block) or at specific points in time (a discrete block).

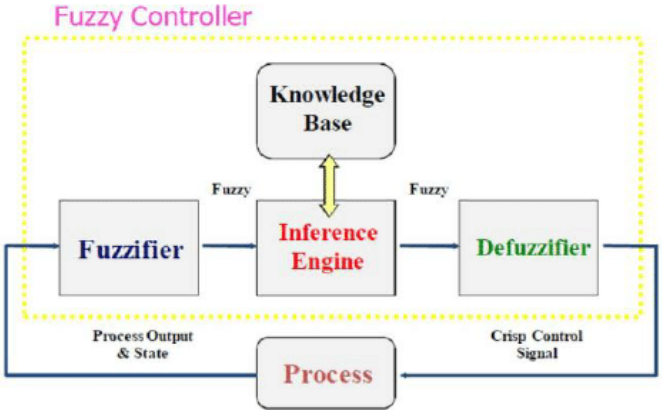
Key features of SIMULINK:

- Extensive and expandable libraries of predefined blocks interactive graphical editor for assembling and managing intuitive block diagrams.
- Ability to manage complex designs by segmenting models into hierarchies of design components.
- Model Explorer to navigate, create, configure, and search all signals, parameters, properties, and generated code associated with your model.

Simulink Block Libraries:

- The Sources library comprises signal-generating components.
- The Sinks library includes blocks for displaying and writing block output.
- The Discrete library includes blocks for describing discrete-time components.
- The Continuous library provides linear function-description blocks.
- The Math library has blocks that define basic mathematical operation.

CONTROLLER OF FUZZY LOGIC:



Almost all consumer items feature some kind of fuzzy control. Controlling your home temperature with an air conditioner, anti-braking systems in automobiles, traffic light management, washing machines, massive economic systems, and so on are just a few examples.

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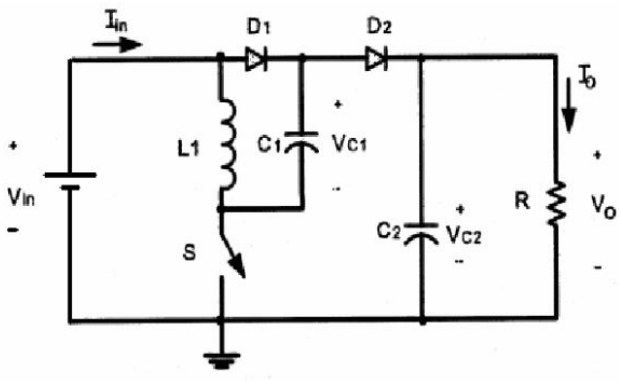
DC-DC LUO CONVERTER:

A LUO is essentially a boost converter followed by a buck-boost converter,which are developed from a prototype of the author's research work. These converters perform positive to positive DC-DC voltage increasing conversion.



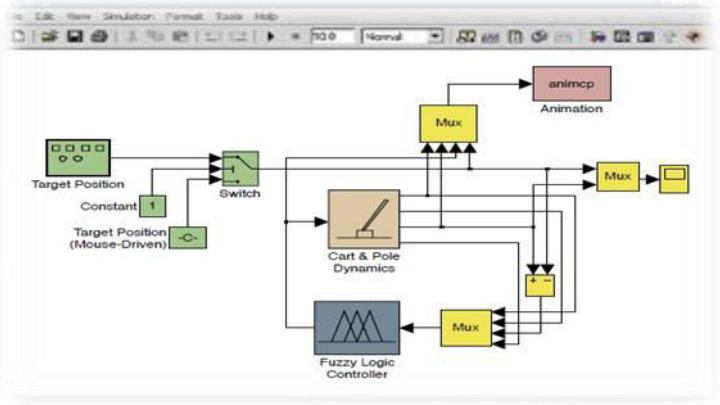
USES OF FUZZY LOGIC:

- Fuzzy logic is a convenient way to map an input space to an output space.
- With information about how good your service was at a restaurant, a fuzzy logic system can tell you what the tip should be.
- With your specification of how hot you want the water, a fuzzy logic system can adjust the faucet valve to the right setting

WORKING WITH THE FUZZY LOGIC TOOLBOX:

The Fuzzy Logic Toolbox includes graphical user interfaces (GUIs) for doing traditional fuzzy system building and pattern identification. You may use the toolkit to create and evaluate fuzzy inference systems, as well as adaptive neural fuzzy inference systems and fuzzy clustering. A fuzzy controller block is also included in the toolbox, which you can use with Simulink to describe and simulate a fuzzy logic control system. You may develop C code for use in embedded applications using fuzzy logic using Simulink.

BULIDING A FUZZY INTERFERENCE SYSTEM:



Fuzzy inference is a method that interprets the values in the input vector and, based on user defined rules, assigns values to the output vector. Using the GUI editors and viewers in the Fuzzy Logic Toolbox, you can build the rules set, define the membership functions, and analyze the behavior of a fuzzy inference system (FIS). The following editors and viewers are provided.

GRAPHICAL USER INTERFACE (GUI) TOOLS:

There are five primary GUI tools for building, editing, and observing fuzzy interference systems in the Fuzzy logic toolbox:

- **Fuzzy Logic Designer :** To handle the high-level issues for the system.

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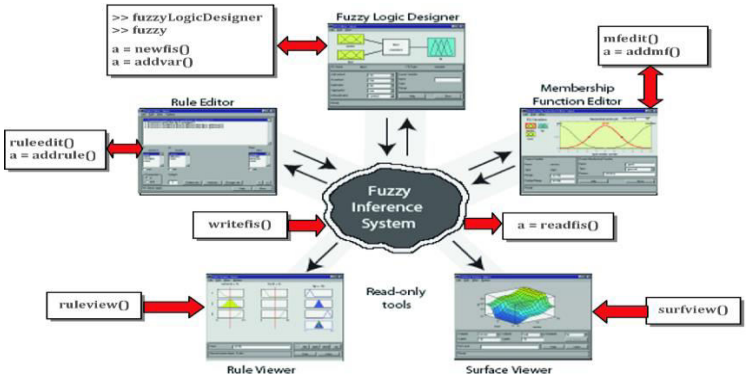
•**Membership Function Editor**: to define the shapes of all the membership functions associated with each variable.

•**Rule Editor** to edit the list of rules that defines the behavior of the system.

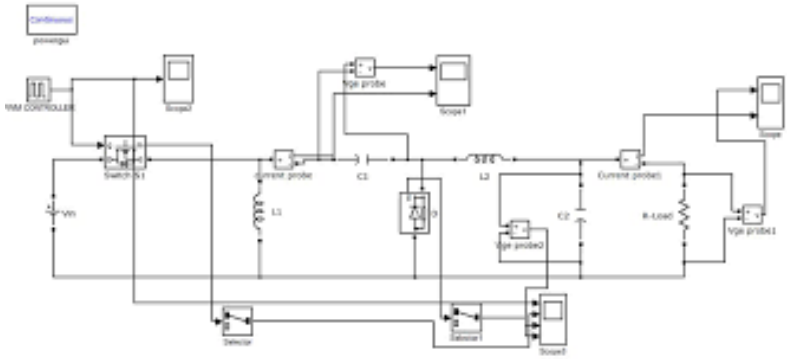
•**Rule Viewer**: To view the fuzzy inference diagram. Use this viewer as a diagnostic to see, for example, which rules are active, or how individual membership function shapes influence the results.

•**Surface Viewer**: To view the dependency of one of the outputs on any one or two of the inputs; that is, it generates and plots an output surface map for the system.

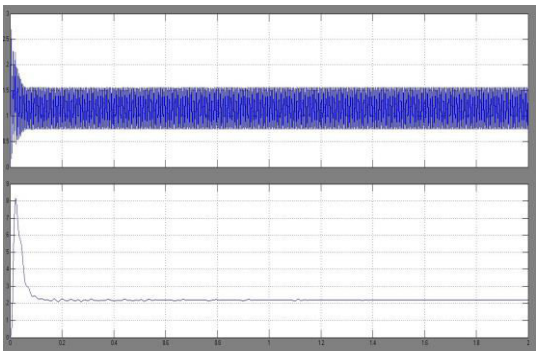
FUZZY INTERFERENCE SYSTEM:



OUTCOMES OF SIMULATION:



Simulation Diagram for Luo Converter with PV System



Luo Converter input and output voltage simulation results

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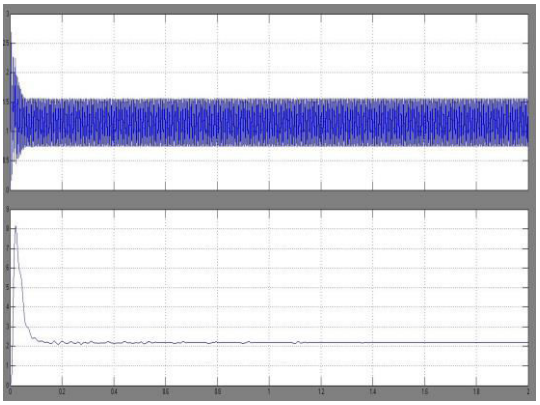
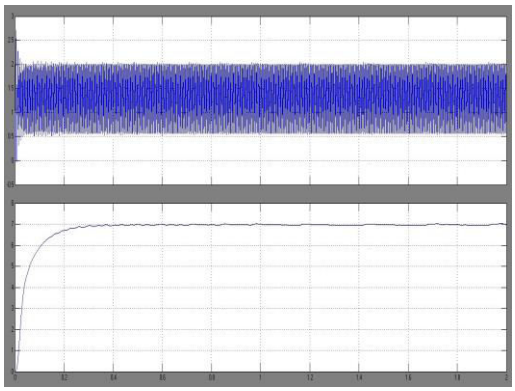


Luo Converter input and output current simulation results



Input and output voltages of the Luo Converter with fuzzy simulation results

II. CONCULSION

• In this paper has been proposed and analyzed an alternative to collect environment low power energy, as solar energy, by means of an advanced dc-dc power converter. An enhanced positive output self-lift LUO converter (ESLPOLC) was selected as a power conditioning dc-dc structure to convert and store the energy collected and supplied by unique high-efficiency mono crystalline solar cell

• The dc-dc ESLPOLC has demonstrated the feasibility of the dc-dc structure to operate under different input levels of solar irradiance.

• Furthermore, the dc-dc structure can be suitable for a diverse amount of environments where energy is limited, as well as specific fields such as industrial and environmental monitoring, wireless sensors and general automation.

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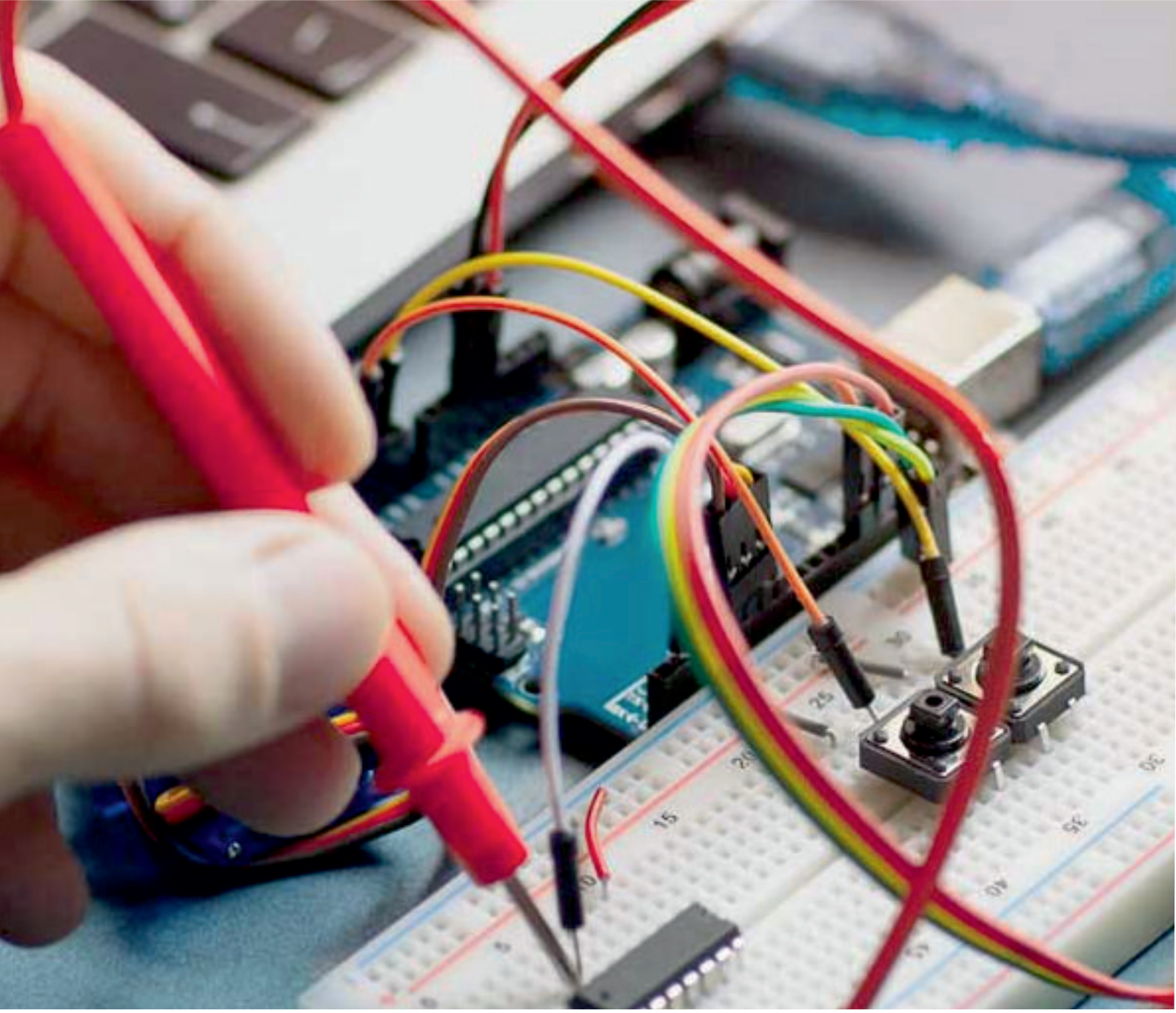

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