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Solar Photo Voltaic Interfacing Conventional Buck Converter

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ABSTRACT*:* Solar Power Inefficiency As solar power increases in popularity, the need for this power to become more efficient is evident. Clean, renewable energy sources are becoming more desirable throughout the world, and solar power provides this. Unfortunately, solar energy is not as efficient as traditional energy sources such as coal, but electronics can be used to create more stable and efficient sources to offset the problems associated with using solar panels. The problem that arises is that many of these electronics are quite expensive, and do not necessarily work well outside of a larger system. These systems are often very complex, and not easily repaired or modified. To fix the problem of price and complexity, a low cost, easy to use electronic system can be created to better provide solar power. Making this system simple to modify, economical, and repairable is a necessity, especially if it is to be deployed in rural or developing areas. By creating a streamlined, hardy device, solar power can be made more readily available and affordable than conventional energy use.

KEYWORDS*:* Solar, Photovoltaic, Renewable Source

I INTRODUCTION

The first step in developing the Maximum Power Point Tracker was to decide the type of solar panel and battery it would be connected to. After a 12V battery and solar panel providing 22V at peak power were selected, the topology for the MPPT was selected. A simple buck converter, Arduino controlled tracker was developed on paper and this model went on to simulation. Once the buck converter was designed, ancillary portions were added to the circuit and rigorously simulated until all necessary pieces were attached. The entire system was simulated meticulously to ensure the design performed as desired. During this simulation process, the tracker was whittled down to its' simplest and most basic components to ensure ease of use, reliability, and cost effectiveness. The next task was to build a prototype system to see if the system worked in practice. In order to ensure a proper design and easier debugging, a printed circuit board was made for the tracker, and the parts were soldered on. This board was first tested without the solar panel and battery load, and then a battery load was implemented with a solar panel to ensure the system met expectations. Finally, a financial analysis was done on the components and design as a whole to assess the viability of making the tracker in a low cost manner to ensure it could be readily made and distributed to developing areas of the world. The design was checked to ensure it could be mass produced and easily repaired or modified by anyone familiar with Arduino and electronics. After all these steps were completed the design was deemed ready for use.

II BUCK CONVERTER

Maximum power point tracking is the art of producing the maximum power from solar panels at different conditions. In a battery charge setting, an MPPT will look at the battery and PV panel and try to match the voltage needs of the battery, the voltage output of the PV panel, and the maximum current the PV can produce at that time. This will provide the maximum power to the battery possible while still using the full output of the solar panel. A converter is used to accomplish the panel voltage step down and associated step up current.

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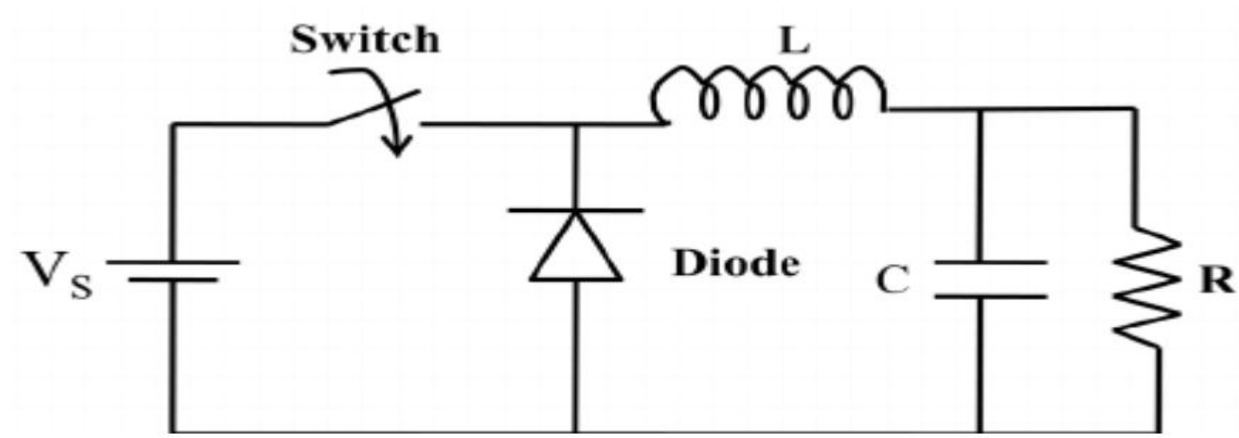

By changing the pulse width modulation of a microcontroller based on panel outcomes, the converter is controlled to provide desired results in the system. This switching also increases the efficiency of the panel by providing the maximum power at every charging state. Power is not wasted as heat or noise, but rather driven into the battery as needed. Buck Converters A buck converter is simply a DC-DC converter that steps down voltage and steps up current. They are usually very efficient, and are quite simple when compared to many other converter topologies. Fig 1 shows the buck converter is worked by having two switches, normally a the switching controls the current and voltage by altering the duty cycle. When the switch is closed, the inductor allows current to flow to the load at a lower voltage than the source. When the switch is open, the stored energy in the inductor is used to drive the load when it is released as current. By switching fast enough and using corrective circuit elements, a stable output of voltage and current can be seen with minimal ripple, giving a lower voltage and higher current than from the source. Using a variable pulse width modulation can account for varying DC supplies, such as a solar panel.

III.MPPT DESIGN AND SIMULATION

The main goal of this project was to create an affordable, easy to use and manufacture, efficient solar battery charger. With this in mind, a few parameters were set to guide the design process. The first step was to decide what voltage of battery to charge. A very common and easy to find battery is a 12 V, and many power supplies require 12 V to run. These batteries can also store an immense amount of power relative to their size and yet can still be very portable. Overall, a 12 V won out because it is also easier to find and cheaper than a 6 V or a 24 V battery, and the supply of these batteries seems unlimited since there are so many in the world now. The next parameter decided upon was the microcontroller. An Arduino was chosen for ease of use, supply, and customization ability. Many microcontrollers were studied to provide pulse width modulation, and the Arduino stood out for many reasons. Arduino can be entirely separate units and just plugged in to a circuit. This is handy for trouble shooting, portability, and functionality. If a microcontroller is needed for more than one task, having two separate circuits with controller plugins as opposed to two circuits with separate microcontrollers is oftentimes cheaper. Arduino can also come in different shapes and sizes to fit different needs, as opposed to many other microcontrollers which are all one size. Finally, Arduino are extremely easy to program and use. There is a massive Arduino community with great tutorials on how to code, and Arduino can work with almost any computer. This ease of use was necessary if the designed controller was going to be distributed. The final design parameter was simplicity. The controller needed to be as simple as possible in order to facilitate repair, encourage education, and ensure a controller that would be fiscally possible. Making a controller that could be easily understood and repaired enabled almost anyone who wanted to use one able to do so. It also helped ensure multiple controllers could be spread out over a large region. With easy repairs, very few technicians and engineers could monitor large numbers of controllers

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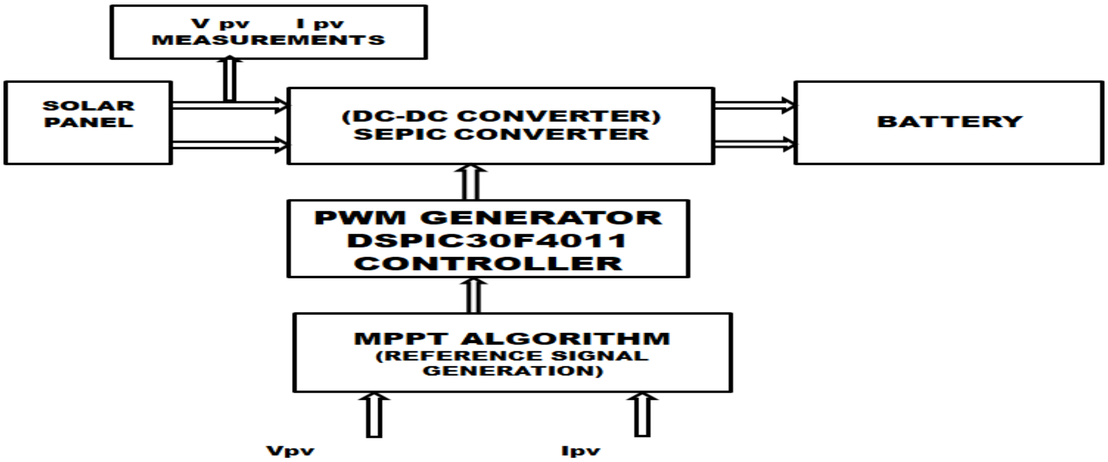

Figure 2 BLOCK DIAGRAM

After parameters were set, the buck converter was designed. This portion was the backbone of the whole project, and was built first so the rest of the controller could be built around it. The power circuitry can be seen in Figure 1. Power Circuitry University of Arkansas Department of Electrical Engineering 9 the circuitry is fairly strait forward. The power comes in through the jumper and flows through R Sense1. The circuit then goes through MOSFET 1, which is there to ensure power flows only the correct way, and not backwards through the system. MOSFET 2 and 3 are then controlled by the IC Driver, which is controlled by the Arduino. This is what charges the inductor of the buck converter. The Arduino controls the Pulse Width Modulation, which is relayed to the MOSFETs through the driver chip. Associated circuitry such as the resistors, capacitors and diodes are there to ensure proper operation of the circuit. The capacitors function to take away transients and correct frequencies. The diodes serve to keep current flowing in the correct direction and protect components. Finally, the resistors help transfer the proper current signal to rightful destinations.

The first step in coding the Arduino was deciding which sort of algorithm to use to adjust the pulse width modulation. A Perturb and Observe (P&O) algorithm was chosen for its simplicity and compatibility with the buck converter previously designed. The algorithm is very common in trackers, and tends to work very well. The premise of a P&O program is very simple and the flow chart is given in Fig 3. The voltage of the solar panel is changed incrementally either up or down, and the resulting effect on power is measured. If the power is decreased, the algorithm changes the incrimination in the opposite direction. Once the tracker reaches the maximum power peak, it will naturally oscillate around that value.

The previous discussions portray the importance on developing an efficient MPP tracking scheme that identifies shade and discriminate uniform irradiance conditions. In order to develop accurate shade detection rules, it is imperative to understand the unique PV array characteristics during various practical operating conditions.

Therefore, to realize some critical observations on the PV array characteristics during normal and PSCs, a PV array of size is built and simulated using the conventional single diode PV model in MATLAB platform. For analysis, Shell SM55 PV module having the following data sheet specifications is considered: power at MPP (P) – 55W, voltage at MPP (V) – 18.1V, current at MPP (I) – 3.17A, open circuit voltage (V) – 21.4V and short circuit current (I) – 3.58A.

In order to distinguish uniform irradiance from PSCs, a fundamental examination on array I-V characteristics is inevitable. For which, the constructedPV array is first exposed to a variety of uniform irradiances from 1000 W/m2 to 400 W/m2 and the respective I-V and P-V curves characterized by single power peaks as well as corresponding load lines L1-L4 are depicted in Fig.3 and 4 respectively.

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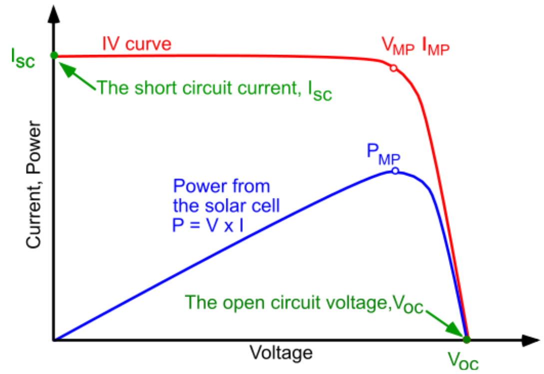

Figure 3 I-V Characteristics curve

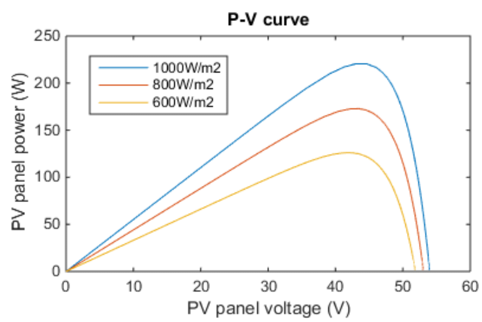

Figure 4 P-V Characteristics curve

It can be seen that, at MPP, the array operates at 72.62V and 6.34A at 1000 W/m2 while, it reduces to 68.83V and 2.33A at 400 W/m2. This particular observation deduces that, the power drop during uniform irradiance is predominantly due to the reduction in current only, whereas, the drop in voltage magnitude is marginal

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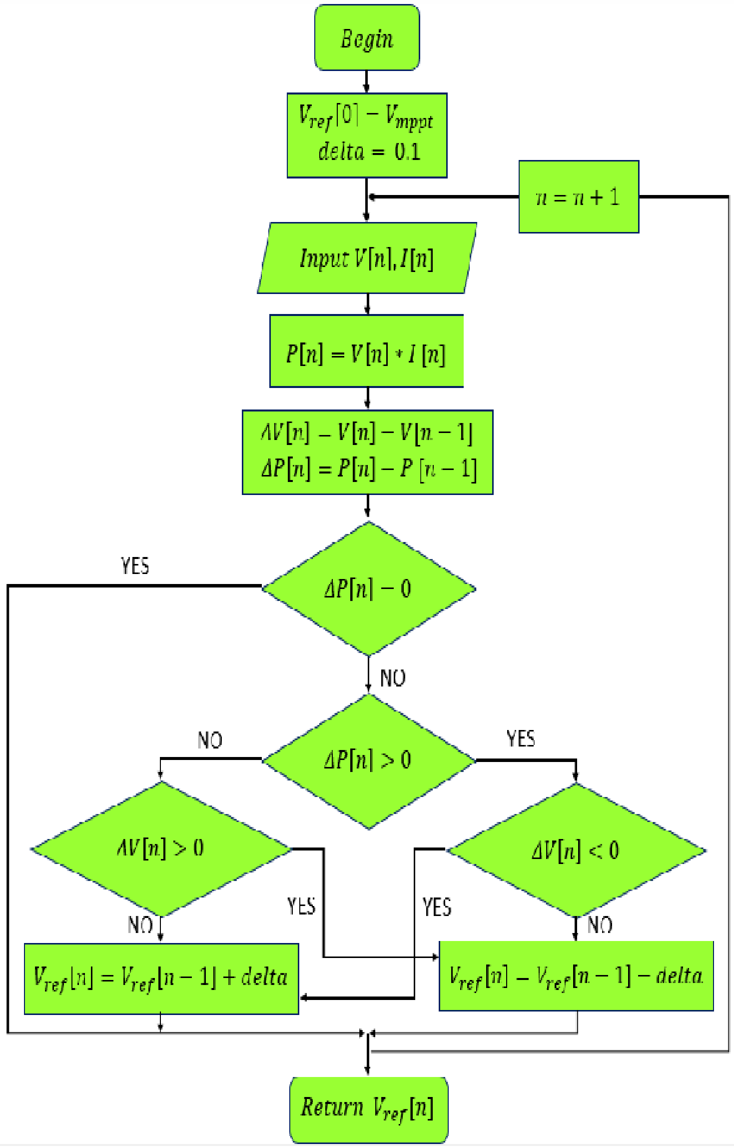

RESULT

Figure 5 FLOW CHART MPPT

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Based on the uniqueness of LPP in an I-V curve, a new methodology to detect shade occurrence in PV systems is proposed in this article. Also, evolved from the shade detection approach, a new hybrid MPPT technology was conceptualized, analyzed, tested and validated. The proposed methodology utilized a combination of conventional P&O and recently evolved FPA for tracking purpose. Extensive experimental evaluations performed in this work revealed that the proposed technique can efficiently track GMPP in all operating conditions of a PV array. Further, as the technique can discriminate the operating conditions of the PV array, theuse of global search algorithm was limited to PSCs only. Even in shade conditions, selection of FPA to track the GMPP has drastically reduced the transient oscillations owing to its excellent trade-off between exploration and exploitation processes to search for GMPP. More importantly, the key aspect of the proposed technique is its capability to identify and detect GMPP in PSCs having two power peaks.

IV.RESULT

Therefore, in those cases, P&O method alone was found suitable to track GMPP. Compared with the techniques in literature, the proposed technique is accurate, easy to implement and scalable to any PV array size. With the existing techniques in literature only suitable for string inverters, the proposed algorithm is well suited and can be implemented for both central and string inverters. Overall, the proposed technique is expected to be a viable solution to counter act the disadvantages associated with all existing MPP tracking techniques.

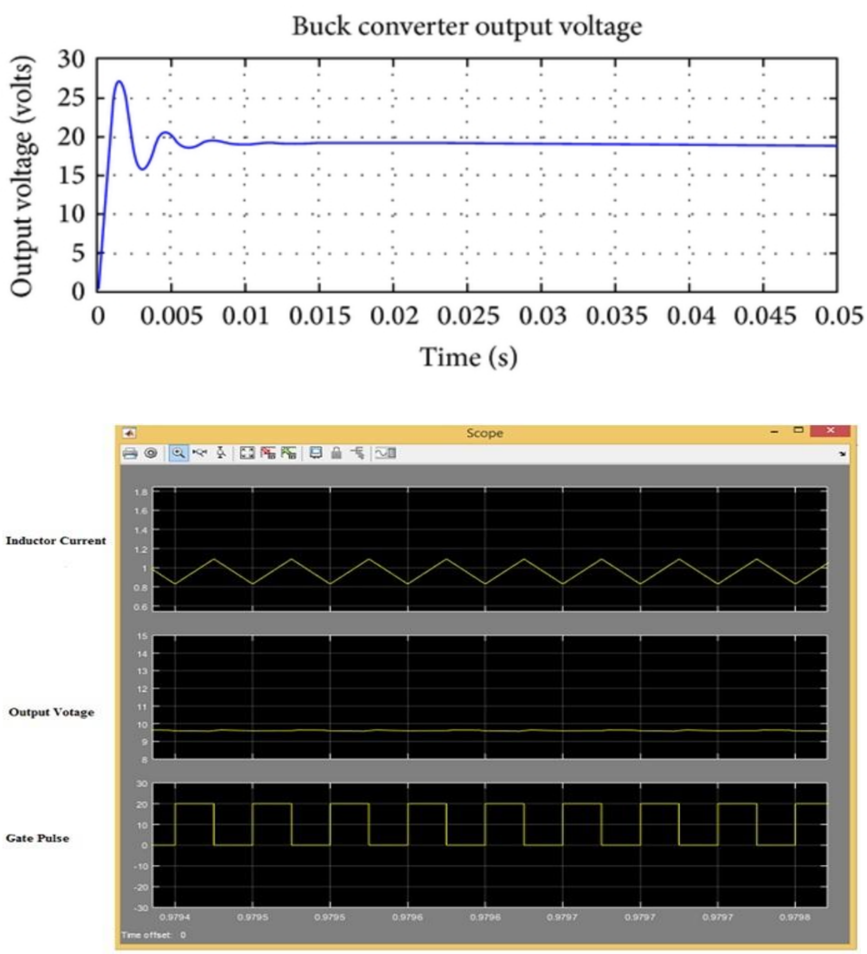

Figure 7 Output voltage waveform and Inductor current waveform of Buck Converter

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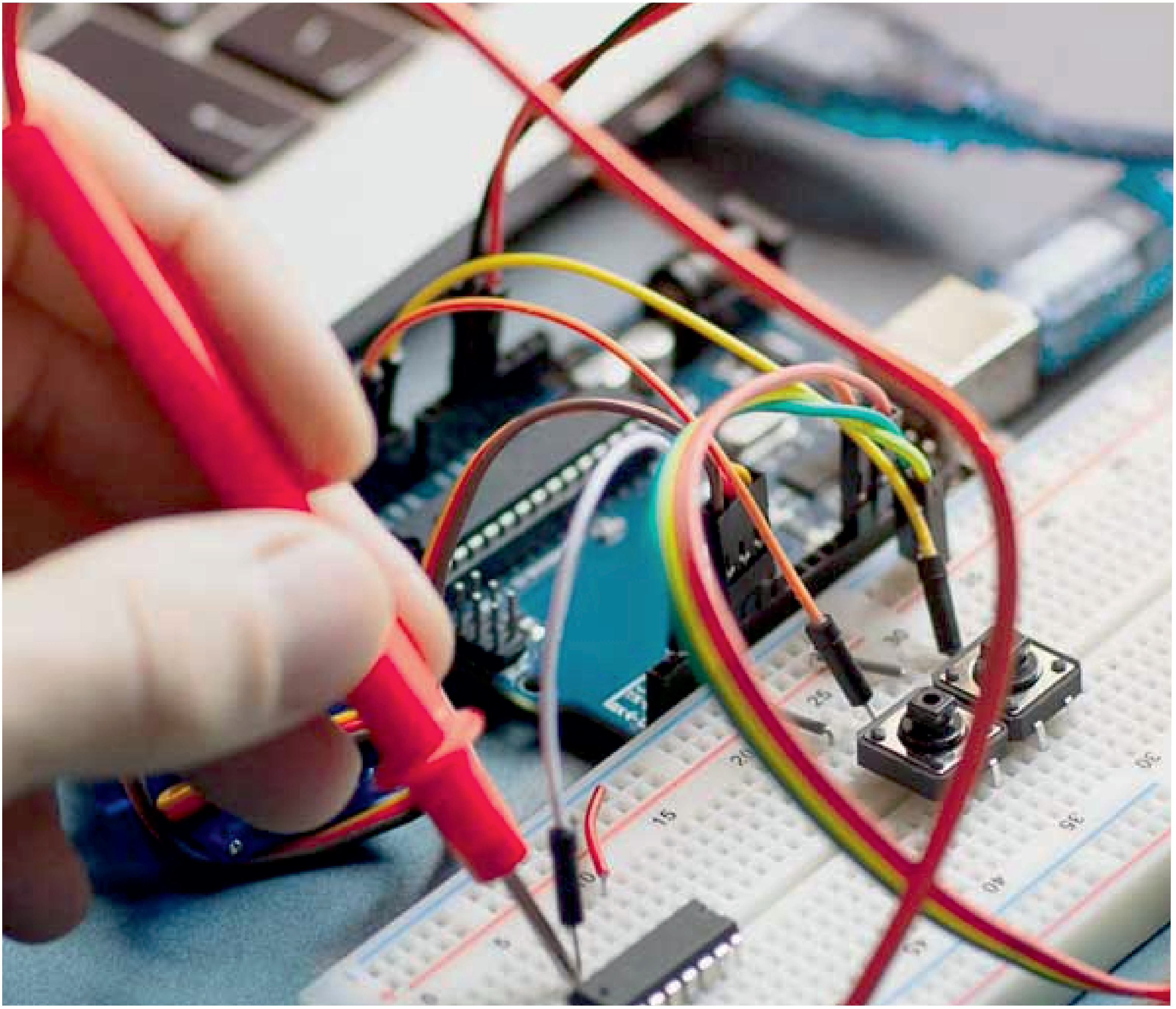

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