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A Bidirectional Wireless Power Transfer for Battery-To-Battery Wireless Charging

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ABSTRACT: In this paper offers a new technique, battery-to-battery wireless charging will come about in several situations, like employing a mobile phone to charge another mobile phone, wearable devices, or low-power sensing element nodes. To facilitate this wireless power transfer (WPT) operate with the minimum further price, we tend to propose a monolithic reconfigurable bidirectional WPT transceiver designed for the primary time in CMOS, which may be reconfigured between a Differential class-D power amplifier (PA) and a full-wave rectifier. Meanwhile, we tend to used a most a current charging mode to maximise the B2B charging potency, by directly charging. The loading battery with the rectifier, and by powering the PA with the sourcing battery. Then, we tend to reduce the quantity of cascaded WPT stages from five within the standard style to few. Wireless power transfer (WPT) has been utilised in a very wide selection of applications, together with mobile, wearable, implantable devices, and wireless sensing element networks. In consumer electronics, several advanced models of movable and wearable devices have already been integrated with the wireless charging operation. Meanwhile, the aftermarket wireless charging accessories also are also quite mature currently. With WPT technology, individuals might charge their mobile devices with none effort in publicly places.

KEYWORDS: Cognitive Radio, Spectrum Sensing, Efficient Communication, System Security.

I. INTRODUCTION

Wireless power transfer was used in a wide spread of applications, consider as mobile, carrying devices like watch, implantable devices like cardiac pacemaker in medical field, and wireless sensor for sensing purpose. In Wireless power transfer technology, people charge their mobile devices; there is no exertion in open places for power transfer. E.g., bus stands, railway stations, and restaurants. Also, WPT technologies have a high potential, to prevent the equipment, to be narrow and water resist by separating the final connector. Consequently the power connectors perfectly often, it directly limit the deepness of the devices, and will simply impaired out in the humid consumer electronic devices, equipped with a wireless charging function, in this will experience an exponential growth. Interestingly, it was found that the wireless power receiver can easily change its operation direction (reverse operation direction) and become wireless power transmitter . The proposed to moderate the wireless power passed using phase modulation or magnitude modulation. Regarding the opportunity of consumer electronics, bidirectional wireless charging with monolithic on-chip implementation is also highly permissive. Mobile phone to mobile phone charging, using mobile phone to wirelessly charge carrying devices, using a delegated movable energy source to charge low power sensors for industrial applications. The main extrinsic of this device is to get Wireless charge sharing between two any mobile phones.

II. EXISTING DEVICE

If the mobile phone attain run out of battery, it cannot get in immediately. It will stop the sudden operation. To overcome this disadvantage, the mobile phone owners find out the availability place of plug-in and charge the battery that is the only way to overcome from out of low battery. It really produces some trouble, the people may forget to plug-in, after the owner find or seen themselves out of battery energy later on. Here the charging cables are damaged on the floor it makes tripping risks. Leakage from cracked old cable, in particular in climate change, can produce more risky conditions to the mobile phone owner.

2.1 TRANSMITTER

The sender was a mobile phone from which the power is transmitted. Once the circuit is started, using Diodes and Capacitors the charge from the transmitter mobile is transformed into DC. This input DC current is passed to microcontrollers. Here we use a Crystal oscillator of 10MHz to tune the microcontroller kit. We have a relay and a relay driver which is used to transfer the required charges to the WPT section. This WPT in-turn heats up the primary coil in the transmitter section. In the receiver mobile, the secondary coil is induced when the primary coil is brought near to it. The current created due to induction, it is given as an input to the receiver section. This current in-turn begins the receiver section; in order to tune the required voltage a voltage regulator is used for that. We use a PIC Microcontroller to interface with the external peripheral devices. We made output port as the USB port, so when the current is regulated and supplied by the circuit the mobile at the other end of the USB gets charged.

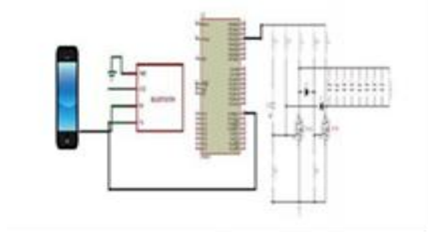

Figure 2.1 transmitter

2.2 RECEIVER

In the receiver mobile, the secondary coil is induced when the primary coil (transmitter mobile) is brought near to it. The current produced due this induction is given as an input to the receiver module.

Figure 2.2 receiver

This current in-turn initiates the receiver circuit; a voltage regulator is used in order to tune the required voltage. Then we used a PIC Microcontroller to interface with the outer peripheral design. Here used the output port is a USB port, so that current was governed and supplied by the circuit the mobile phone at the other end of the USB gets charged.

2.3 ADVANTAGES

- Sudden operation
- Comfortable
- Compressed

2.4 DISADVANTAGES

- Impairment
- Cost of the device
- Enlargement

III. PROPOSED SYSTEM

To overcome the disadvantage of the existing system that is wired charging system, here we used wireless charge transfer or shared between one mobile phone to another mobile phone devices. In this mobile phones one act as transmitter and other mobile phone act as receiver. If we are use here ON and OFF buttons for controlling the power transfer from one to another. Then press the ON button in transmitter device, it displayed or shows that the charge was transferring from transmitter to the receiver device. Then we press the OFF button in transmitter section, it indicates that there was no charge transferring from transmitter section to receiver section. For display the information regarding the receiver device whether charge is transferring or not from transmitter to the receiver we used here Liquid Crystal Devices. Android app and Bluetooth was used to control the other device in the proposed system.

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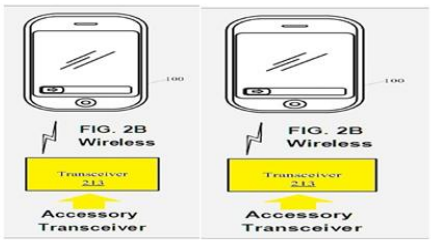

Figure 3.1 system model

As shown in the above Figure 3.1 We needs two Transceivers, and two mobile phones. There should be an android app to share the charge between two mobile phones. In this technology transceivers is the important equipment, it plays aimportant role. The connection between both of the mobile phones where these transceivers should be attached on both phone. In final step connect the phones via an android app and that we should fixed one mobile on the other to share the power.

3.1 SYSTEM ANALYSIS AND DESIGN

Wireless charging technology which enables to charge your phones without them actually being contact. Here not want the huge and long USB to combine every time to your mobile phone to get your phone charged. But through this technology, the power is transferred through free space in the process of wireless charging. For the first half of the article we go over high school physics, which is behind this cool technology.

Actually it is working, after definite rectification and filtration process by using rectifiers and capacitors the DC levels are fed to the battery for the charging purpose, then mobile phone chargers are used to convert AC from mains to required DC levels. In usual charging, the charger supplies the power to the charging circuit of the mobile through a carrying medium. The principle of magnetic resonance or Inductive Power Transfer (IPT) is the basis for Wireless charging. This process of transporting an electrical current through the use of coils between two objects can be achieved to induce an electromagnetic field. So we are intellection the Concepts behind the wireless charging Technology, we have to get similar with the terminologies associated with it. The Energy exchange from the charger to Mobile was worked by mutual induction, governed by the Faradays law of Induction.

3.1.2 BLOCK DIAGRAM

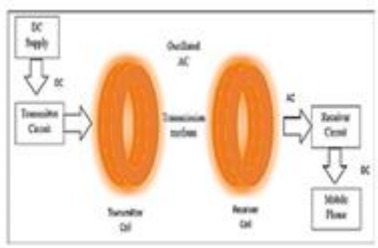

Figure: 3.2 Block Diagram

3.2 CONCEPT OF WIRELESS CHARGING

The steps associated with the process of Wireless Charging are: Let’s break the complete charging process into two circuits: Transmitter & Receiver Circuit. The main aim of the Transmitter circuit is to transform the received voltage into high-frequency AC.

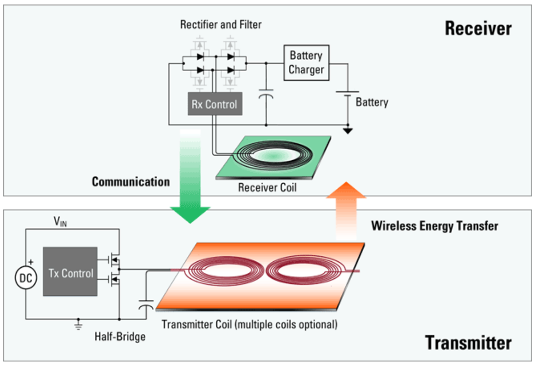

Figure: 3.3 working of transmitter and receiver coils

Then the high-frequency ac current is propagated by the sender section it is fed into the transmitting coil. As the high-frequency alternating current is relinquished through the coil, it induces the magnetic field in the coil and the coil now operates as an electromagnet in accordance with the 2 and Law of Electromagnetic Induction. From the Figure 3.4, as the magnetic field in one coil changes, and if the other coil is placed in the sufficiently close distance, the emf will be inducted into the neighbouring coil. The AC produced alternating flux in the transmitting coil, that induced alternating magnetic flux in the sender core. Now, again the reversed phenomenon takes the induced magnetic field in the Receiver coil and generates the alternating current into the receiver circuit in accordance with the faradays Law of induction. Then the energy is transferred from the sender section to the Receiving section through induction. After help of series rectifiers and filters the induced AC is altered into required DC Voltage. For final charging the Stable current is fed into the battery. The result in this way, the wireless charging is done.

3.3BATTERY-TO-BATTERY (B2B) WIRELESS CHARGING

Battery-to-battery (b2b) wireless charging can take place in many scenarios, such as using a mobile phone to charge another mobile phone, wearable devices, or low-power sensor nodes. To help this wireless power transfer technology with low cost, here we design a monolithic reconfigurable bidirectional wireless power transfer transceiver designed for the first time in CMOS. A differential class-D power amplifier (PA) and a full-wave rectifier are helps to reconfigured it. The bidirectional WPT function, verified at 6.78MHz with only one off chip capacitor, exhibits peak efficiencies of 91.5% and 58.6% for the receiver and the overall system, respectively, when the output power is 1.55 W. Figure 3.4 shows a projected future wireless power ecosystem comprising four layers.

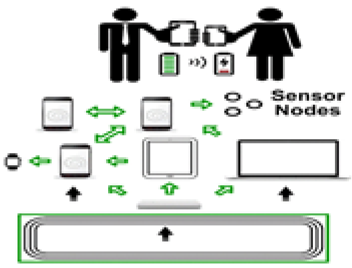

Figure 3.4 Projected wireless charging ecosystem based on reconfigurable bidirectional wireless charging.

The first layer is the fundamental layer constructed by wireless charging pad which is connected to the ac mains for fast charging and multiple-device charging. The second layer is an moderate layer formed by wireless power banks. The third layer incorporates mobile devices with computation and analysis capabilities, including notebooks, tablets, and mobile phones. The fourth layer contains low power wearable’s and wireless sensor nodes, which sense and collect the data from the human body or the ambient environment.

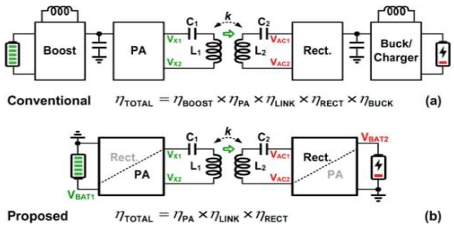

Figure 3.5 (a) Bidirectional wireless charging scheme with five cascade stages.

(b) MCCM charging scheme with only three stages.

To facilitate these applications, this work investigates for the first time an on-chip solution for bidirectional wireless charging. In the conventional pad- -device wireless charging structure, the wireless power RX consists of a rectifier and a buck-type dc–dc converter for constant-current (CC) and constant-voltage charging mode control. For turning such wireless power RX into a TX for the B2B charging, the buck converter will reverse its operation direction and become a boost converter on the TX side, as shown in figure 3.5 (a) In this scenario, we obtain the total B2B charging efficiency (η TOTAL) by multiplying the efficiencies of the five cascaded stages.

$$\eta TOTAL=\eta BOOST\times\eta PA\times\eta LINK\times\eta RECT\times\eta BUCK$$

where ηBOOST, ηPA, ηLINK, ηRECT, ηBUCK represent the efficiencies of the boost converter, power amplifier (PA), coupling link, rectifier, and buck-type charger, respectively. Meanwhile, the bulky inductor in the dc–dc converter increases the area and cost of the wireless charging module. More importantly, the B2B charging is energy-limited, then, one of our targets is to transfer the energy from one battery to another with the minimum loss and a safe charging current. To reduce the number of cascaded stages and consequently to increase the B2B charging total efficiency, we employed in this paper a reconfigurable bidirectional wireless power transceiver (TRX) with the maximum current charging mode (MCCM), as shown in figure 3.5(b). With the PA supplied directly by the source battery, the rectifier would charge the loading battery with the maximum available current. Therefore, there are only three essential stages in this system, and the total efficiency is as follows:

$$\eta TOTAL=\eta PA\times\eta LINK\times\eta RECT$$

3.4 THE BIDIRECTIONAL WPT TRANSCEIVER:

3.4.1 RESONANT TANK

For the mobile devices, the area of the wireless charging module is quite limited, and there will be no room to accommodate separate TX and RX resonant coils. Therefore, the resonant tank in the bidirectional TRX should be reused for both TX and RX modes. Basically, there are two types of resonant tanks: series and parallel. They have quite different characteristics in terms of impedance transformation, voltage and current wave forms. The series resonant tanks will transfer small load impedance on the secondary side into relatively large equivalent impedance on the primary side therefore, achieving higher total efficiency in median/high power scenarios, e.g., in our B2B wireless is charging case. Meanwhile, the series resonant LC tank behaves like an AC current source, while the parallel acts like a voltage source. This feature imposes that the secondary input current magnitude will be nearly independent of its output power. Moreover, the resonant frequency of the secondary series LC tank is, regardless of the load, only related to the values of the inductor and the capacitor. From the circuit design perspective, the series resonant is less sensitive to the active diode reverse current as pointed out in. However, we have a different interpretation, for example, let us consider a full-wave rectifier, where VAC1 and VAC2 are the two rectifier input voltages, and IIN1 and IIN2 are the differential input currents. The parallel resonant tank has sinusoidal-like input voltage waveforms, but with a pulsing input current going into the rectifier. This implies that the rectifier output only draws current during the voltage peaks with short conduction time (tCOND). On the other hand, most of the ac current of the resonant tank will go through the rectifier charging up the output, which results in a much longer conduction time. As we know, the turned-off delay time (tD) of the comparator in the active diode determines the duration of the reverse current. Considering an equal tD for both series-and parallel-resonant cases, tD would be a small portion of tCOND in the series resonant case, which indicates a higher efficiency for the series resonant case. Furthermore, the reverse current issue can also be mitigated by applying a series inductor as a compensator for the parallel resonator.

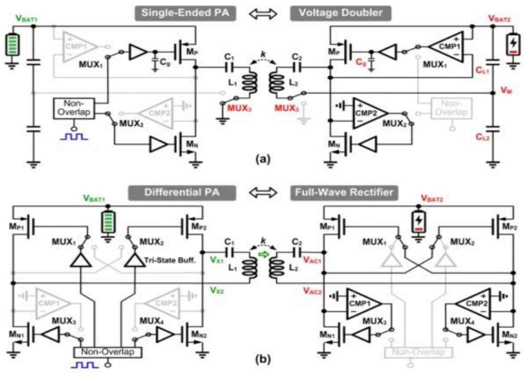

Figure 3.6 (a) Topology-1: Bidirectional TRX reconfiguring between single ended PA and voltage doubler.

(b) Topology-2: Reconfiguring between differential PA and full-wave rectifier.

Nevertheless, this inductor will increase both the cost and area of the charging module, which may not be favourable for portable/wearable devices. In sum, in this design, we applied the series resonant tank.

3.4.2 CHARGING CURRENT ANALYSIS

Another benefit of Topology-2 is that it achieves almost four times larger charging current ICHG when compared with Topology-1 figure 3.7 (a) displays the simplified model of the WPT system. Here, we replace the PA by an ideal ac voltage source with amplitude of VPA. L is the coupling inductor, C is the series capacitor, RS is the lumped equivalent series resistor, and k is coupling coefficient of the inductive coupling link. RL is the equivalent load impedance.

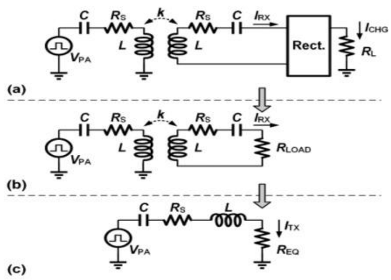

Figure 3.7 (a) Simplified pattern of the WPT system, converted to

(b) using RLOAD to pattern the rectifier input impedance, and to

(c) using REQ to pattern the transmitter side equivalent load impedance.

IV. ADVANTAGES

- It is easy to implement
- It has more efficiency
- No need for grids and substations
- It produces low maintenance cost.
- It can reach the places which are remote.

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DISADVANTAGES

- Efficiency: The efficiency of the wireless charging board is low, and the charging efficiency may be between 30% and 80% that is depending on the design and the location of the user's cell phone on the charging board. That is to say, even in the ideal state, 20% of the electricity can be useless.

V. CONCLUSION

This paper presented a reconfigurable WPT transceiver for bidirectional B2B wireless charging, with possible applications in both consumer and industrial electronics. After comparing and discussing two TRX solutions, we chose a reconfigurable TRX with a differential class-D PA as the TX and a full-wave rectifier as the RX for smaller area. It have higher efficiency, and larger charging current. "WPT for Mobile Phone Applications" has been successfully design and implemented. The WPT provides an industry standard between power transmitters and receivers. Moreover, to improve the total charging efficiency, we proposed the charge the battery directly without any current or voltage regulation. With help of two same reconfigurable WPT transceivers and PCB coils, the results verified the bidirectional function with the small number of off-chip components, and illustrated suitable efficiencies for two receivers and the overall system.

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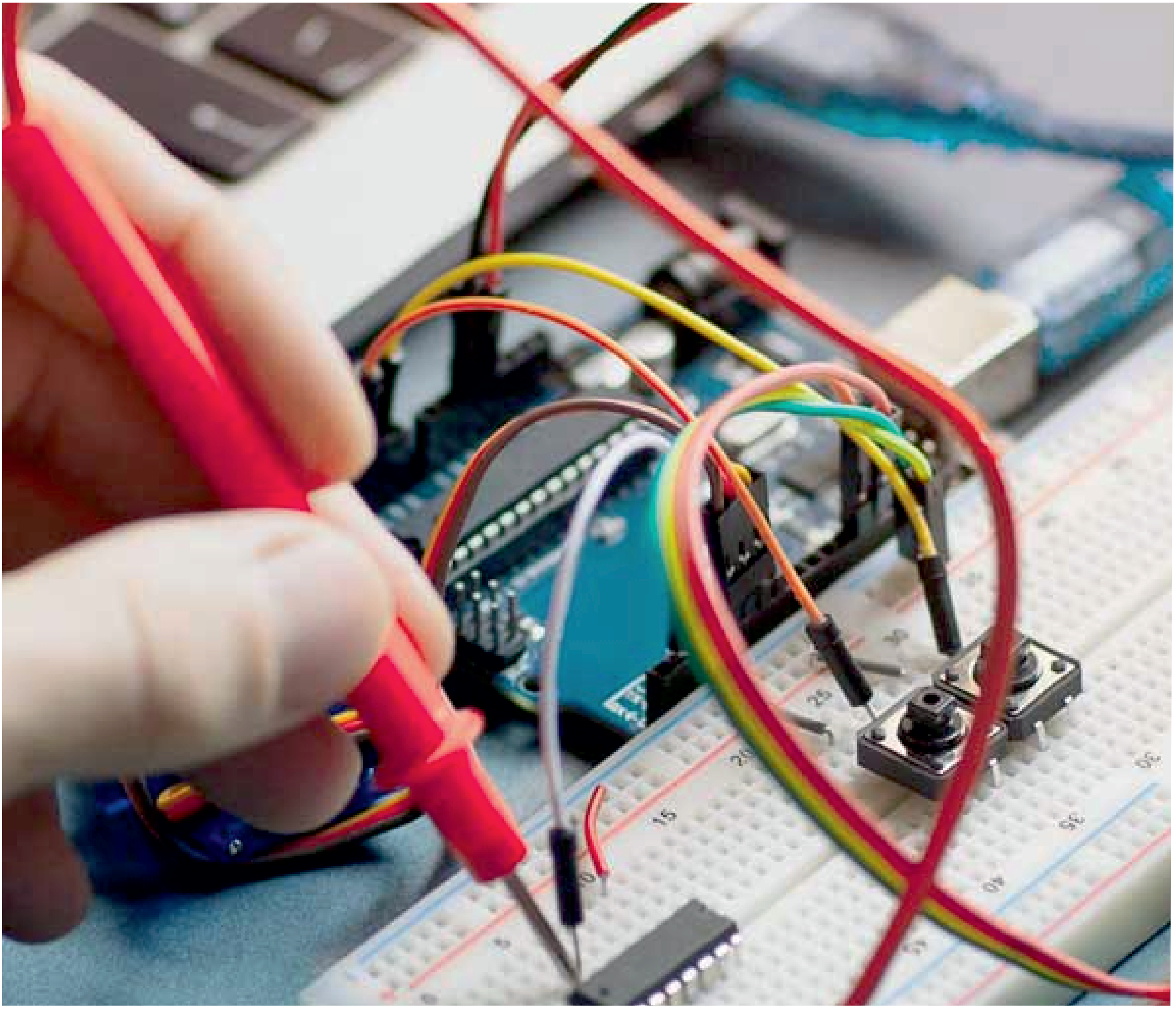

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