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Grid-Tied PV Based Electric Vehicle Charging

Alvin Kuriakose[1], Anjali Anand K[2]

PG Scholar, Dept. of EEE, Govt. College of Engineering, Kannur, Kerala, India[1]

Assistant Professor, Dept. of EEE, Govt. College of Engineering, Kannur, Kerala, India[2]

ABSTRACT:The electric vehicle (EV) has more attractive in recent years. EVs give a solution to attain zero exhaustion of fossil fuels therefore we can minimize the air pollution and global warming. However, by nature, EVs need to be charged routinely using grid power, there are multiple problems need to manage first, Unrestrained and non-regulated charging will shows an unpredictable load variation in peak time, which will run over the capacity of the distribution grid. In this paper presents a power flow control scheme for grid tied PV based system with an integrated electric vehicle battery, In the PV based generation of power initiate to charge the electric vehicle battery and transfer the excess energy to the utility grid, this will allow to bring down the unpredicted peak time power demand, and can help in the implementation of the EV-to main grid to enhance the stability of the grid during the time of peak load. Besides, theelectric vehicle battery can supply the power to the critical loads in the house load applications when there is ainterruption of main power supply from the grid.

KEYWORDS: State of charge, Electric vehicle, Vehicle to grid,Voltage source converter

I.INTRODUCTION

The electric energy generation from fossil fuels has negative feedback to the surroundings due to the expulsion of greenhouse gases. Transportation fuel requirement causes for the one third of the total energy utilization. Transportation with Zero Emission Vehicles (ZEV) can minimize air pollutants. Solar PV changes the solar power into electrical energy. Hence, solar PV based charging station is the probable solution to reduce the adverse environmental affect. A method for the minimization of change in power output of PV system in electric vehicle charging station was introduced. Also the perfect use and implementation of solar PV based electric vehicle charging station as a voltage assist for distributed generation system was discussed. Since, solar energy is irregular and fluctuating in nature, there for storage system is mandatory for a continuous supply of power to the system and thereby improves the quality and stability of power generation. structural diagram of the entire charging station shown in the fig:1.1 The circuit of the system includes a photo voltaic array with maximum power pointtracking (MPPT) used based power converter, electric vehicle charging method based on buck/boost converter, which permits utility grid to- electric vehicle (G2V) and electric vehicle-to- utility grid (V2G) power flow, and a voltage source converter (VSC) for the utility grid interface.

Every system power converter in this arrangement has its own local controller in order to control the current and voltage. Furthermore, the reference pulses for every local power controller are produced by the control system that is the main part of this system. Overview about the integration of electric vehicle charging station with PV generation [1]-[3],themain objective of the PV power generation for charging the EV and excess energy will transfer to the grid. [2] Explain different possible method to interconnecting converters connecting to the multiple energy sources to the main Ac bus discussed. The operation and configuration of converter control in PV based power system described in[5],then smooth operation of the system depends upon the proper controlling of the converters used in station.in[6]proposes a smart charging station for electric scooters with a PV and grid connected system in this mention the idea after a breakdown of a power system the EV can supply the energy for a short time period . the working of PV based EV chargers for reactive power compensation for a solar-powered system with an electric vehicle battery charging facility hold up utility grids in[7] this paper deals with the basic of operation design peculiarities and applications of solar powered electric vehicle battery charging and its advantages comparing with traditional charging system. Details of energy balancing in grid with a battery integrated solar PV based advanced charging configuration in[8] that integrates a new electrical vehicle charging setup with better control strategy Interfacing power converters for connecting the energy sources to the Ac bus is discussed in [9] The structure of the paper is as follows: Section 2 deals with the system configuration of grid-tied PV based electric vehicle and its control structure. In section 3 modes of operation of the charging station and its control strategy. All the simulation works are presented in chapter 4

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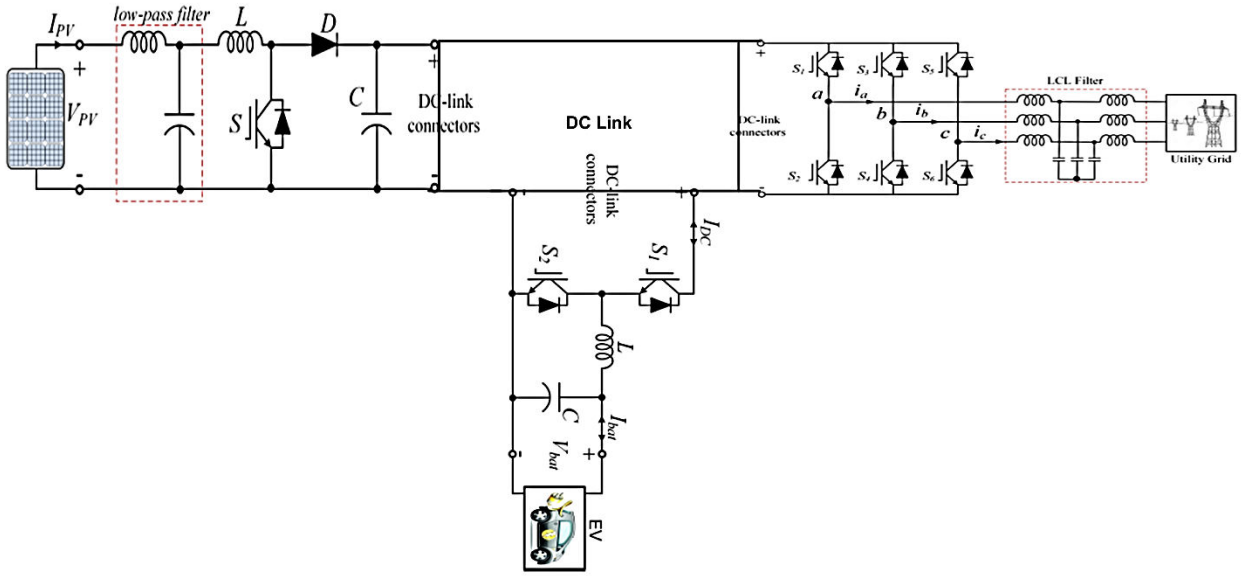

Fig1.1: Grid tied PV based EV charging system

II.SYSTEM MODEL AND ASSUMPTIONS

ItThe system possibility of the smooth operation depends upon the perfect model and control of PV generation system , EV charging station and the grid integration part. their for the system divided into three subsystem and three control methods that are

1. PV system and its control
2. EV charging and its control
3. VSC and its control

1. Control of PV system

The generation of PV and its system controlling unit diagram shown in fig 1.1.from this seen that the PV panel linked to the DC bus through a low-pass filter and efficient DC-DC converter for boosting the PV power output ,by the help of MPPT technique we canmaximize the PV power output ,maximum power point tracking method help to track the maximum power to the system at all the time period .In this project used the incremental conductance(IC) method for the maximum power point tracking ,Now a days many different methods for the MPPT but compare with other methods the IC method shows the better efficiency with a minimum number of steps

2. EV charging and its control

In the case of EV charging the battery linked to the DC-link by using a multi directional DC-DC buck boost power converter shown in fig .1.1 the power flow between the EV to DC bus and the Bus to electric vehicle battery control is done by the bidirectional dc to dc converter, the controlling of the converter iscoordinated by the help of PI controller ,the controller select the mode of operation for the system.

3. VSC and its control

The power flow between the Dc bus to Ac grid is done by the help of a traditional 3-phase inverter with a LCL Fig 1.1 Grid tied PV based EV charging system filtering .the voltage source inverter works as a bidirectional inverter for the smooth power transfer in the utility grid and the common DC link fig: 1.1 shows the control structure and the system parameters for the voltage source inverter the mode of operation select by setting reference values for the DC-link voltage, reactive and active power for the system

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III.SYSTEM OPERATION MODES

The efficient and smooth flow of power in the grid-tied PV based EV charging system is obtained based on the multi operation modes with the system. these depends upon the maximum PV generation and the load demand of the entire system.fig.2 shows a normal 24 hours energy management of the PV power generation and electric vehicle charging station demand and home load demand curve The maximum rate power generation of the PV system is normally from morning 9am to 3pm

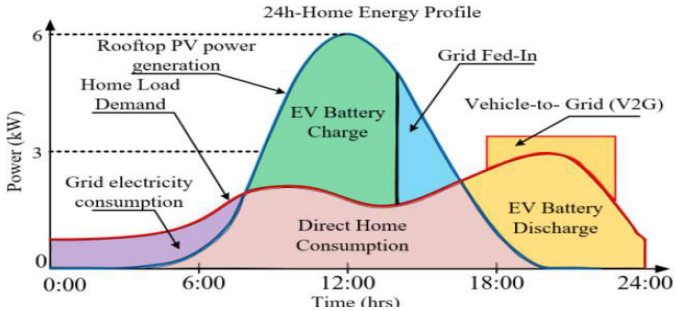

Fig:2 Normal 24h PV generation and system load demand[3]

During the peak time excess load demand from 17hrs to 20hrs, the EV battery energy can be used to power the home load and can be transferred to the utility grid if required following the understanding between the consumer of EV and the utility grid authority's. This mode of operation is generally called as electric vehicle to-grid (V2G) mode of operation. The effective operation modes of the PV-EV energy system is shown in Fig. 3 and can be described as following

Mode 1: PV to Grid power flow

In the mode of operation assume that there is no other excess load in the system (EV load or AC load).then the system transfer the full amount of generated PV power to grid .It shows that the multidirectional DC/DC power converter is switched off and the AC/DC power converter works as an inverter mode of operation. The injected power is

$P_G = P_{PV}$ (1)

PG is the power injected to grid and the PPV is the power by PV generated in this system

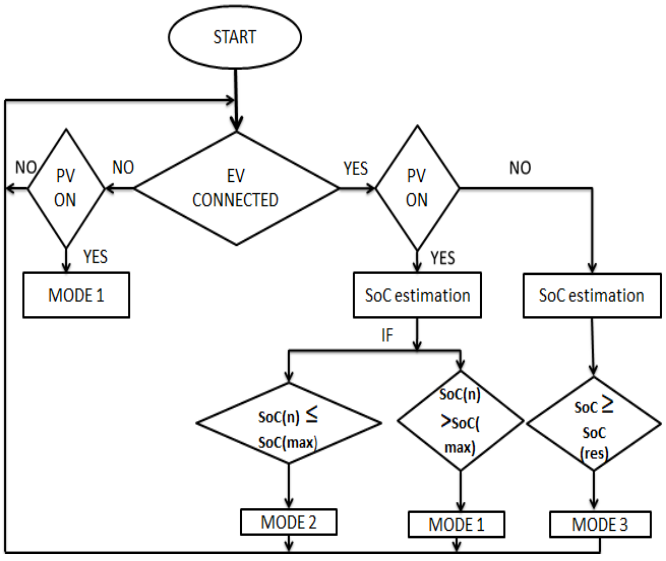

Figure 3: Grid tied PV based EV charging station operation mode control

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Mode 2: PV to EV power flow

In mode two operation electric vehicle is charged mainly by the PV generated power.in this case first measure the state of charge of electric vehicle battery the verify the conditions of electric vehicle charging procedure. The reference power of electric vehicle battery Fig 6: The simulink model of the proposed EV charging station (PEVref) is calculated from Eq (1). If the ongoing PV power (PPV (n)) is higher than the maximum electric vehicle battery charging power (PEVmax) and the current State-of-Charge at nth interval (SoC(n)) is less than the maximum State-of Charge (SoCmax) then the electric vehicle reference power PEVref at the nthinterval is same as to electric vehicle maximum power PEVmax. else, if the present state of charge at nth interval SoC(n) is higher than the maximum level of electric vehicle battery charge SoCmax then the EV reference power PEVref (n) is equal to zero. There for we can assume that there is only the electric vehicle interconnected to the system there for EV as a load in this mode of operation

$P_{EVref}(n) = P_{EVmax}(n)$ {if}$SoC(n) \leq SoC_{max}$

$P_{EVref}(n) = 0$; {if} $SoC(n) > SoC_{max}$ ……(2)

SoC = state of charge in EV battery

Mode 3:EV to Grid power flow

In this operation the electric vehicle in the discharging mode of operation and the AC load is linked to the power system in the case of PV power generation does not reach the load demand. Hence, the sum of the PV and EV total power should be equal to the load power (PPV + PEV = PLoad). The reference power for EV battery (PEVref) in the discharge mode is determined by Eq. (3).

$P_{EVref}(n) = P_{Load}(n) - P_{PV}(n)$i f $SoC(n) \geq SoC_{res}$(3)

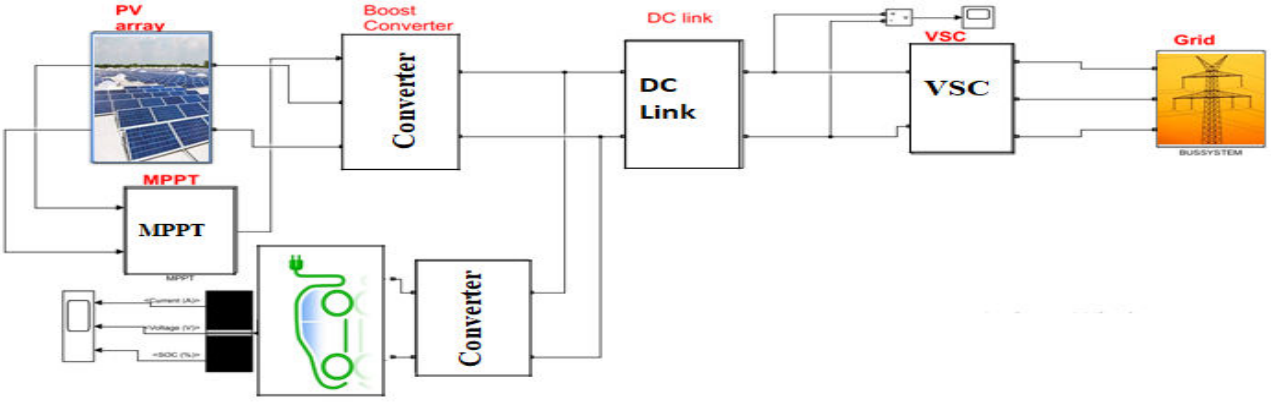

Fig 4: The simulink model of the proposed EV charging station

The equation threeis used to attain PEVref if the current SoC(n) is greater than the reserved State-of- Charge (SoCres). Or else, the discharge mode ofoperation is deactivated in order to allow user to drive EV for a trip in the future Fig:4is the simulink model of the proposed Electric vehicle charging station with a combination of PV,GRID and EV. The system consist of a PV array with MPPT based boost converter for maximum power point tracking then Electric vehicle charger based on the dc to dc buck boost converter the bidirectional converter allows grid to vehicle and vehicle to grid power flow and a voltage source inverter for inter connecting to grid

Table 5.1 : SIMULATION PARAMETERS

PV system	
DC link voltage	500 V
PV voltage , (Vpv)	˷300 V
PI controller coefficients(Kp,Ki)	1,0.5s
EV system	
DC link voltage	500 V
Nominal battery capacity	1000 Ah
PI controller coefficients(Kp,Ki)	2,0.1s

Fig 5: Simulation parameters

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IV.SIMULATION RESULTS

The simulations are done with the help of MATLAB SIMULINK software. Table:5 shows the system parameters used for the simulation of each part in the system, Dc link voltage maintain at 500 V set the battery capacity 1000 Ah

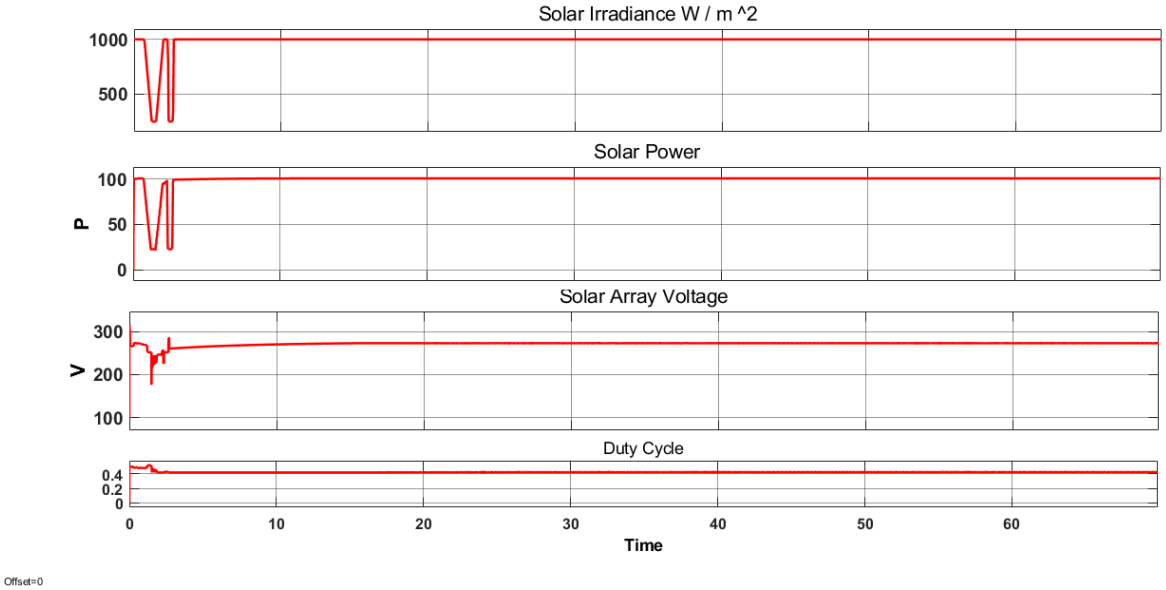

Fig 6: PV array output

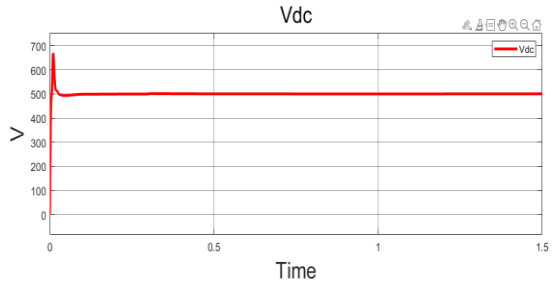

Fig 7: Dc link voltage

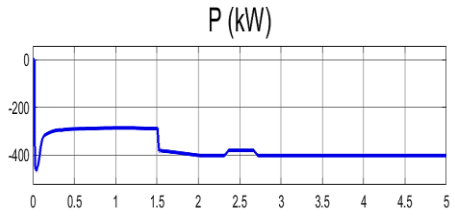

Fig 8: grid power in mode 1 operation

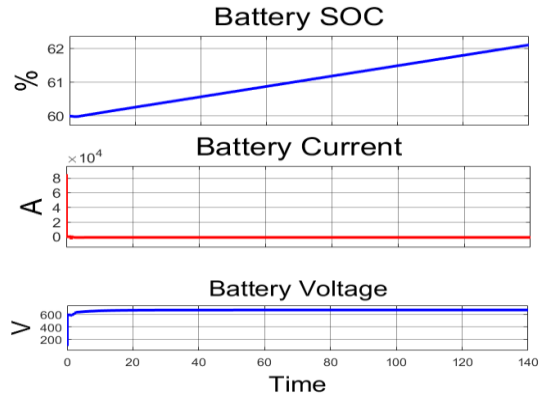

Fig 9: EV charging mode of operation

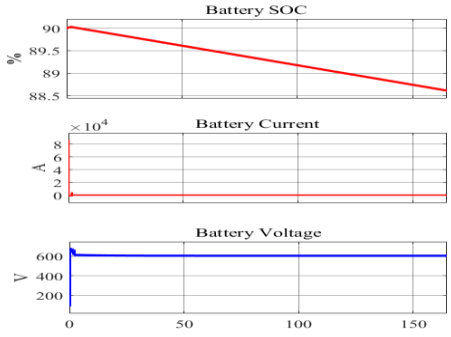

Fig 10: EV discharging mode of operation

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In the Charging mode of operation the power flow between the Dc link to EV battery the charging and discharging mode control by the PI controller,Fig:9shows the battery voltage, current and state of charge after two minutes charging of Electric vehicle battery the output shows that upto two percent increase in battery state of charge after two minutes operation charged 60 percent 62 with short time.current in positive direction and a small increase in battery voltage from this output we can concludes the Electric vehicle charging system working properly in charging mode of operation Fig:10 shows the discharging mode of electric vehicle battery, In this mode powerflow between the vehicle to DC grid with a help of DC to DC converter, convert the voltage equal to the DC grid voltage from the output graph the initial state of charge of electric vehicle battery set at a range of 90 percent after two minutes discharging the state of charge of EV battery change to 88 percent and the battery voltage level maintain at 600 V ,the output of discharging mode operation shows that, the Vehicle to grid power flow is possible

V. CONCLUSION

The number of electric vehicle in the world increasing daily, there for the power source for charging the electric vehicle is a challenging factor. Because the large demand in the load will affect the normal power distribution and generation and this will affect the smooth operation of power system, In this paper presenting a new method for minimizing the overloading impact of the power system in the case of uncontrolled charging demand by the electric vehicle connected to the grid. Converting the maximum PV output for Electric vehicle charging .the operation Electric vehicle to Grid power flow give solution for the problems related to electric vehicle charging

- Simulation results have shown satisfactory performance of PV and Grid connected system in the case of fluctuating solar irradiance
- from the EV battery charging and discharging system shows that PV based EV charging station has a great future for the PV based EV charging station development
- The interconnected electric vehicle and PV system can support the utility grid during the peak
- Control approach for smooth power flow in the grid, PV system with an interconnected EV battery introduced.

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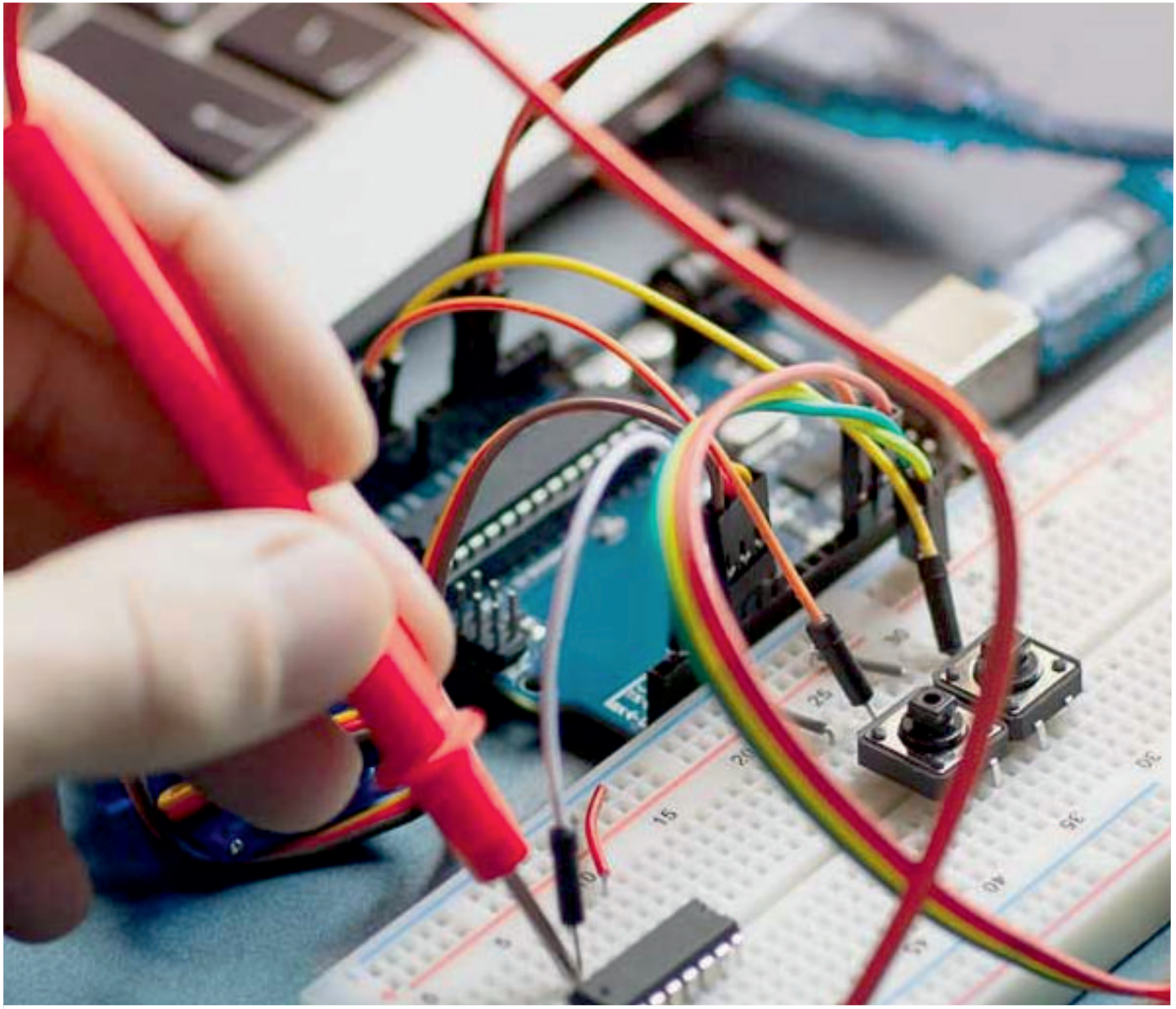

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