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# Design and Simulation of Shunt Active Filter using PI Controller

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**ABSTRACT**: A Shunt Active filter has been designed and connected to the grid as well as nonlinear load to check the outputs. In this filter the PI control system has been used in the design of shunt active filter. Now a days the injection of harmonics due to extreme use renewable source of energy and implementation with the grid. The use of inverters and other power electronic devices makes the system unstable. So incorporation of active filters are necessary in the power system to make the system stable and to have a good power quality at the end use. The performance of shunt active filter depends upon the control strategies and that plays an important role in harmonic reduction of the system. The model has been simulated in the Matlab software for the output analysis.

**KEYWORDS:** SAPF shunt active power filter, Phase control, Harmonics reduction, nonlinear loads, and PCC point of common coupling.

## I.INTRODUCTION

In industries we can see that the multilevel inverters used in a great extent, the main advantage of using is to synthesize high voltage outputs with low switching frequency. They can also be considered as a substitute to PWM inverters. Harmonics are not desirable in any form like voltage harmonics or current harmonics. As the non-linear loads dependency increased. It is important to make some arrangements to reduce or mitigate the harmonics by which power quality improves. When non-linear loads increased in the system harmonic problem increases. The current harmonics present in the system will add rms value to the fundamental, this current will increase the losses in the bus bars. The other effect is heating caused by harmonic current. They occur very frequently when there are large number of devices like UPS, VFDs and other solid state switching.

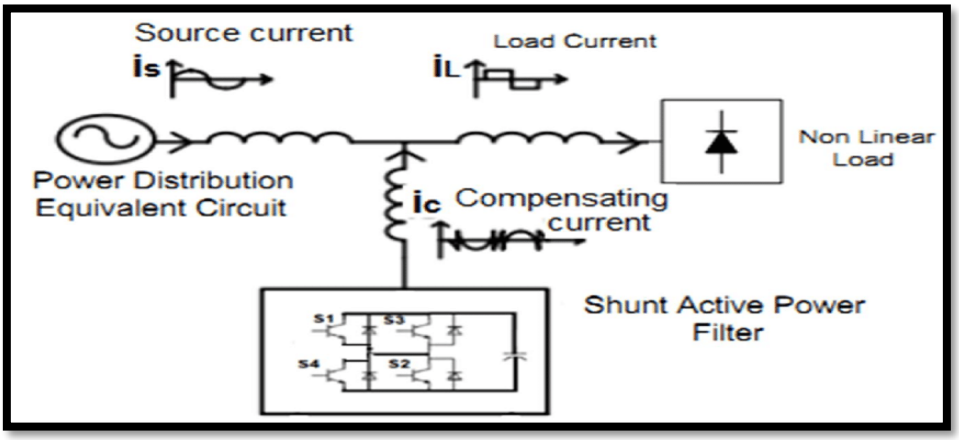


Fig 1 Basic diagram of Shunt Active Filter

## II.SHUNT ACTIVE FILTER AND CONTROL ALGORITHMS

Figure 1 shows the circuit configuration of the shunt active power filter of a voltage source inverter based shunt active power filter configuration. Generally SAPF is connected in the point of common coupling between voltage supply and

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nonlinear load or harmonic producing loads. The structure of SAPF is mainly consists of two main elements, a standard two level voltage source inverter and its control system. Meanwhile its controller has four main algorithms, harmonic extraction (known as reference current generation), DC link capacitor voltage regulation, current control (switching), and synchronizer algorithm.

1. Harmonic extraction algorithm- This algorithm operates by taking the load distorted current from the power system, followed by isolation of harmonic and fundamental current components and ends with the generation of reference current signal iref. The generated signal is used to govern the operation of SAPF in reducing the harmonic distortion.
2. DC Link capacitor voltage regulation algorithm- This algorithm take the instantaneous value of DC link capacitor voltage $V_{dc}$ and compares with the desired reference value, the resulting error is used to calculate the suitable magnitude of DC link charging current $i_{dc}$, the $i_{dc}$ needed to be drawn by SAPF to reduce the switching losses so a to maintain a constant DC link capacitor voltage.
3. Current Control Algorithm- This algorithm takes the output of the harmonic extraction and DC link capacitor voltage regulation algorithm to maintain switching pulses and a current loop that ensures the injection current $i_{inj}$ is generated according to the reference current.
4. Synchronizer algorithm- This algorithm takes the source voltage signal Vs and generates a synchronisation angle or phase so that injection current Iinj which is injected by the SAPF into the power systems synchronized with the source voltage.
5. Voltage source inverter- This is a power converter designed to reproduce the reference current Iref as injection current Iinj at suitable magnitude and it is equipped with DC link capacitor to compensate real power unbalance that occurs during dynamic operation of the SAPF to reduce the ripples of injection currents.
6. Harmonic producing loads- This is a nonlinear load which injects harmonic currents in the system through the point of common coupling PCC, SMPS, rectifiers, arc furnaces and rectifiers are the few examples of practical loads that generate major amount of harmonic currents and reactive power system.

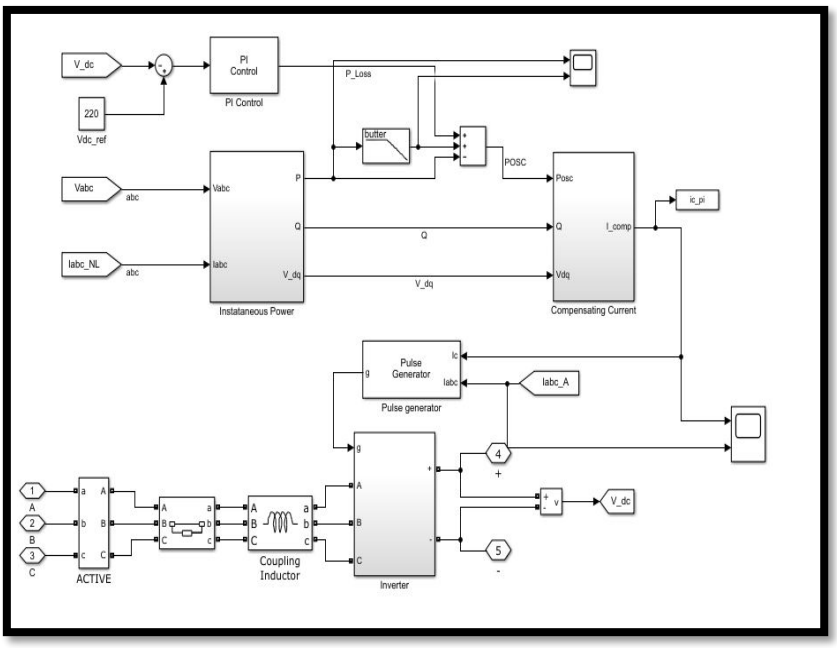


Fig 2 PI Control of Shunt Active Filter

## III.ASSUMPTION AND MODEL DESCRIPTION

In this model a grid has been assumed and connected with simple RL load and after that a Shunt Active filter has been connected by using conventional PI control along with the non-linear load. After simulation we can see the simulation results in which three phase currents and three phase voltage has been observed and after implication of filter the output

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voltage and current seems to be smooth and sinusoidal for the load end use. RL branch used in the simulation has parameters of R= 0.1 ohms and L = 0.15 mH.

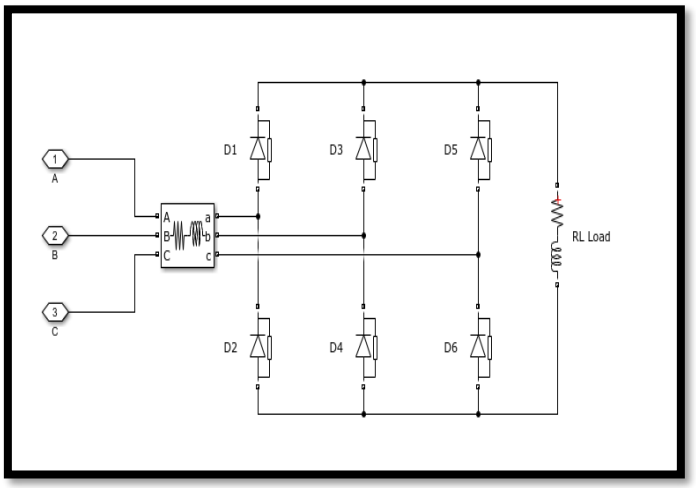


Fig. 3 Non Linear Load in the Simulation model

## IV. RESULT AND DISCUSSION

The whole model in which grid along with RL load has been connected to the Shunt Active Filter, the non-linear loads has been connected for the simulation. The output with PI control Active Filter has been connected for the output analysis. Various output voltages and currents at the output has been shown in the results.

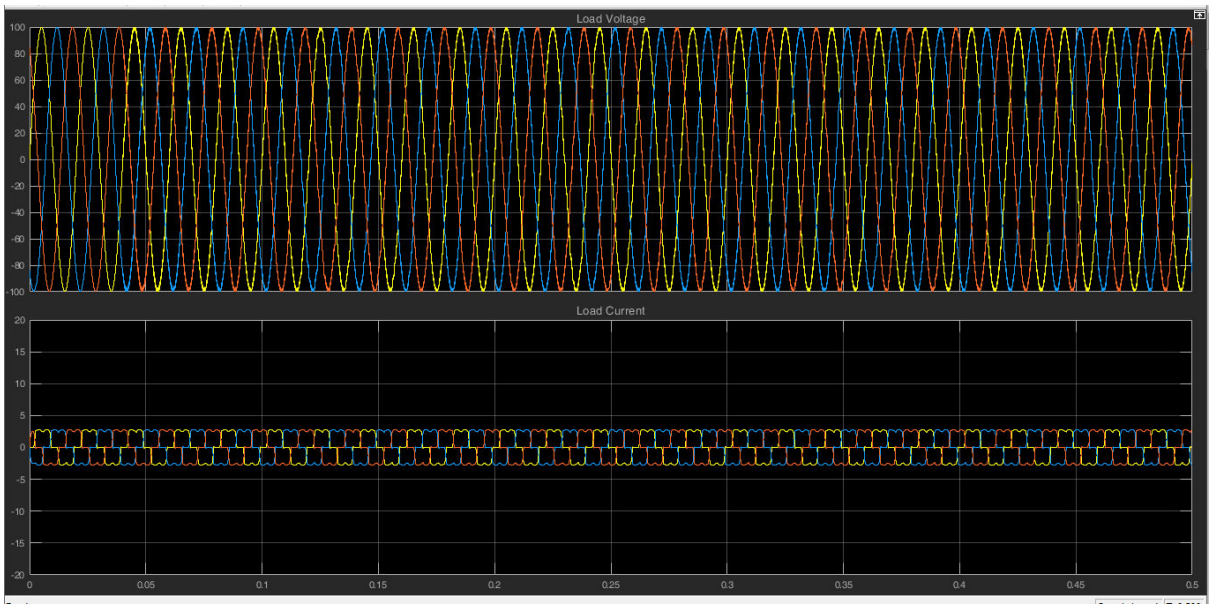


Fig. 4 Load Voltage and Load Current

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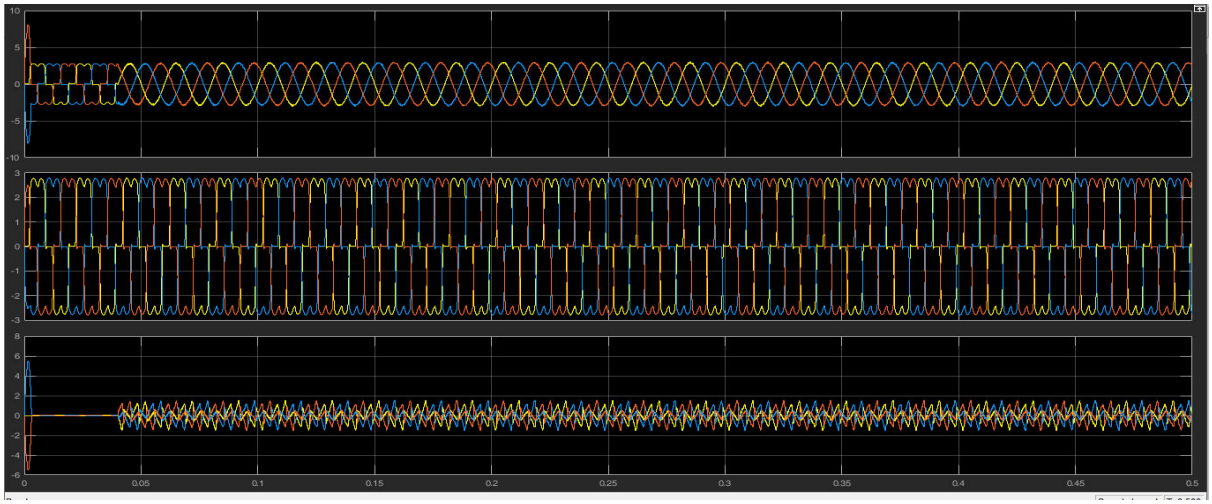

Fig. 5 Three phase currents

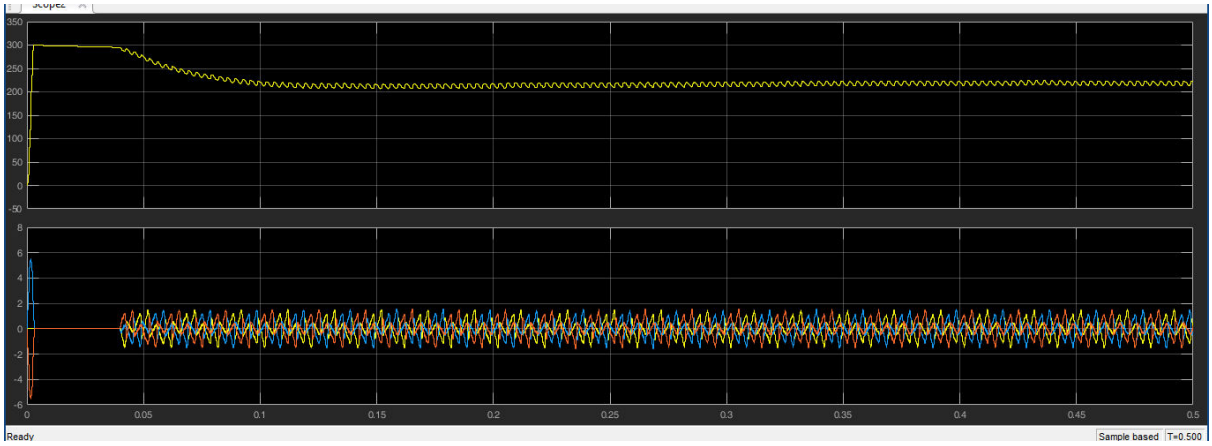

Fig. 6 DC Voltage and current of phase A

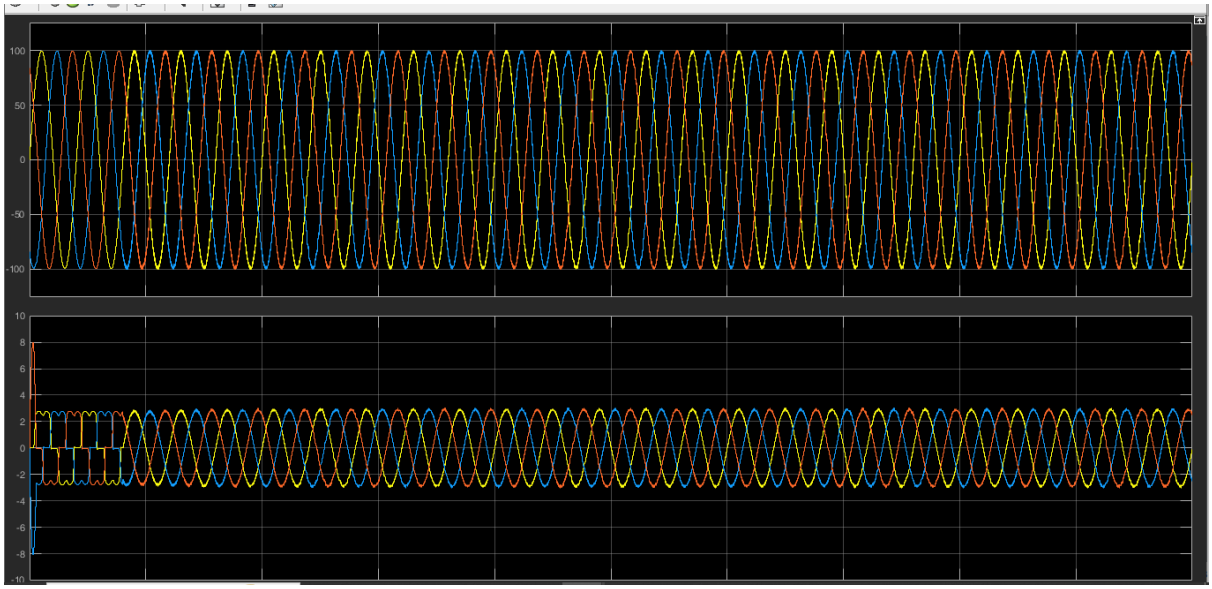

Fig. 7 Three phase voltage and current at the output

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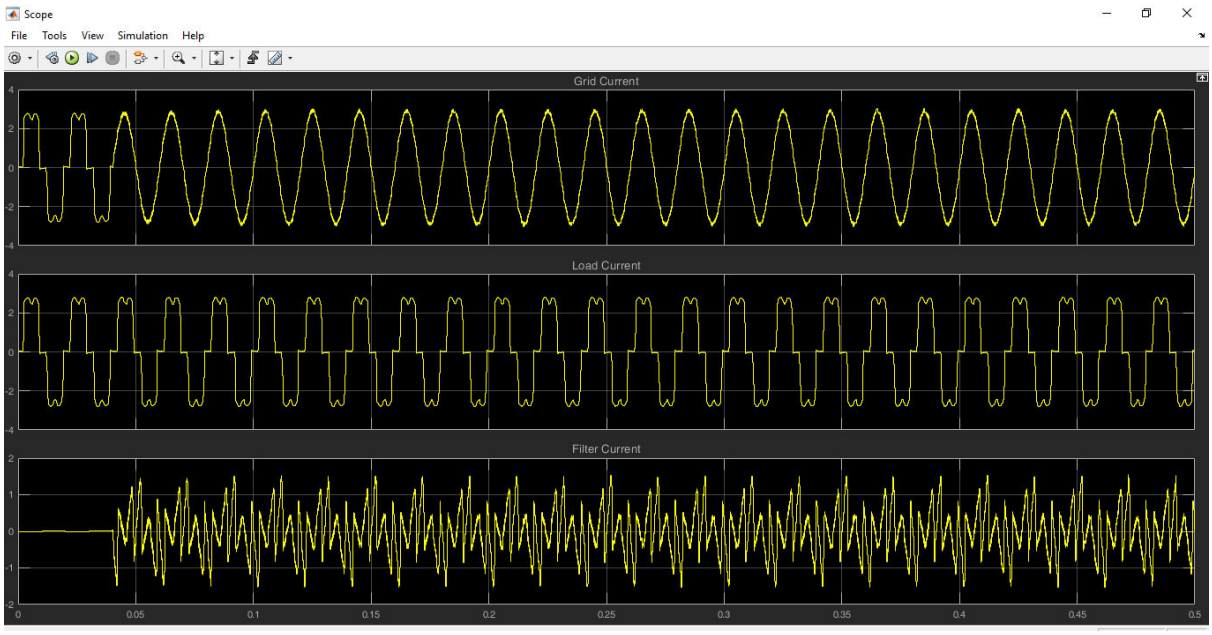


Fig. 8 Grid current, load current ,filter current

## V.CONCLUSION

For harmonic mitigation technique the shunt active filter we used as a solution for the harmonics problem. In this work a non-linear load connected with the power system facility and a PI control based shunt active filter has been connected so that necessary components injected to get the desired output. Due to non-linear loads harmonics introduced in the power system and after filter incorporation the three phase output voltage and three phase output currents at the output is sinusoidal with good power quality. This is observed that a simple model designed can be used in the power system with non-linear loads for harmonic reduction.

## VI.FUTURE WORKS

In future the work will be done by measuring THD analysis with shunt active filter and we can also calculate the harmonic response in the outputs by using different techniques like series active filter and UPFC. As per the power system capacity and line length the loads impacts differently so different approach can be taken next analysis will be done on comparison of different filter configurations in the same power system and same capacity the comparison chart can be made and find out the best solution for any system.

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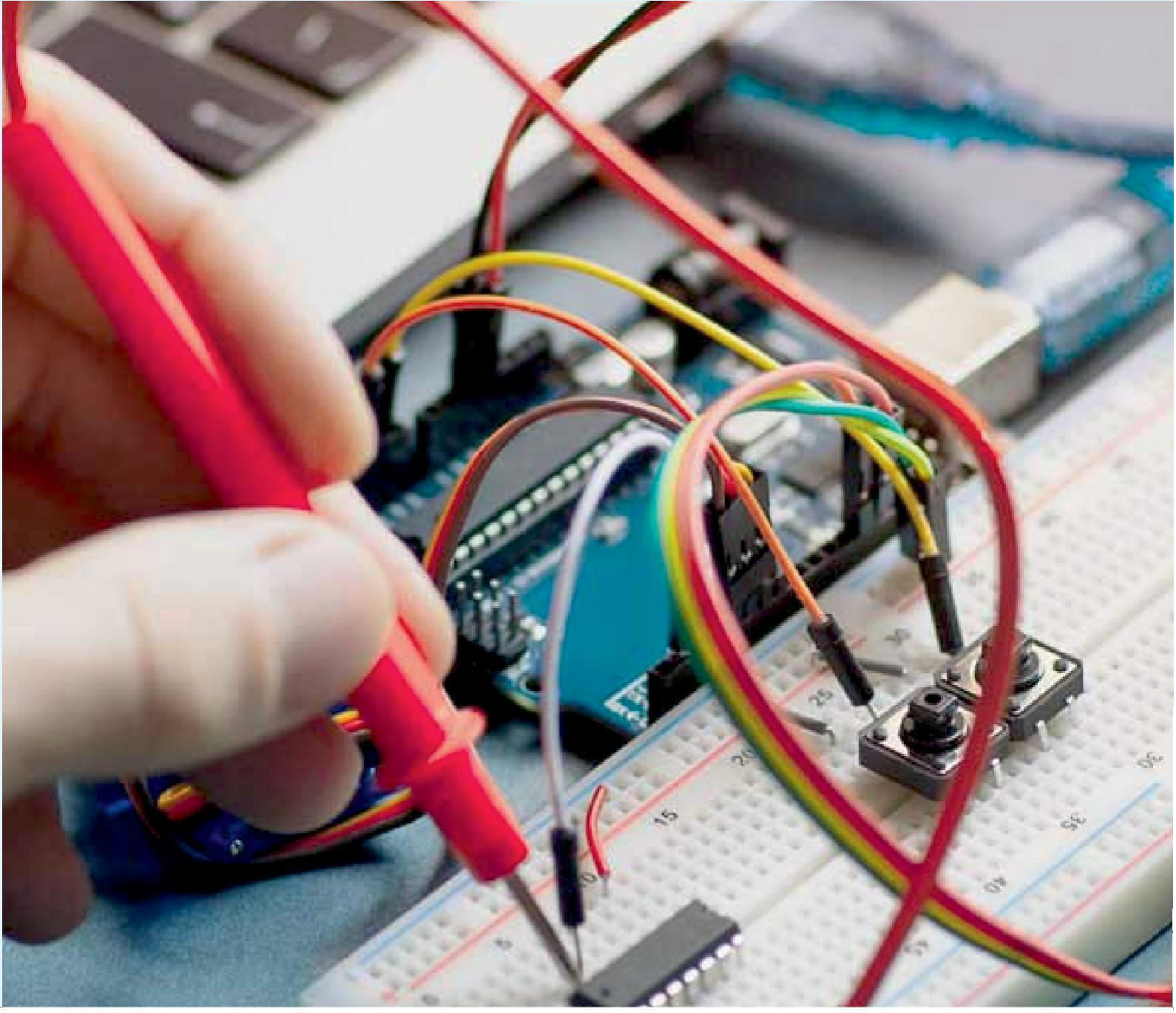

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