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Modelling of Multilevel Inverter using Sinusoidal PWM Method for Asynchronous Machine

Ankit Kumar Meshram [1], Nanda R Mude [2], Dr.S.P.Makhija[3], Hemant Kumar Barley[4]

M.Tech Scholar EE Department, RSR RCET, CSVTU BHILAI, C.G, India[1]

Assistant Professor, EE Department, RSR RCET, CSVTU BHILAI, C.G India[2]

Associate Professor, EE Department, RSR RCET, CSVTU BHILAI, C.G India[3]

M.Tech Scholar EE Department, RSR RCET, CSVTU BHILAI, C.G, India[4]

ABSTRACT: This paper investigate the outputs after modelling of cascaded multilevel inverter for pulse generation. As the renewable energy sources are used for bulk power generation now a days. The multilevel inverters has many advantages for improvement of power quality. Facts devices uses multilevel inverters in high power applications. Due to many advantages of low power dissipation and low harmonic contents. The modulation technique compares a sinusoidal reference wave with multiple triangular carrier waves to produce switching signals for the inverter power switches.The results of the simulation is multilevel stepped voltage waveform that approximates the sinusoidal AC voltage waveform with lower total harmonic distortion as compared to the conventional 2 level inverters. The Matlab/ Simulink software indicates the superior performance of the proposed control system as well as the precision of the proposed models.

KEYWORDS: Total Harmonic Distortion THD, Multilevel Inverter MLI, Flexible AC transmission system FACTS, Power quality.

I. INTRODUCTION

The concept of multilevel inverter introduced in the year 1975. The term multilevel began with the three level inverters. Meanwhile several multilevel inverters has been developed. The elementary concept of multilevel inverter to achieve higher power is to use a series of semiconductor switches with several lower voltages dc sources to perform the power conversion by synthesizing a staircase voltage waveform. Capacitors batteries and renewable energy voltage sources can be used as a multiple dc sources in order to achieve high voltage at the output. Modern power systems are of complex networks, where hundreds of generating stations and thousands of load centres are interconnected through long power transmission and distribution networks. Even though the power generation is fairly reliable, the quality of power is not always so reliable. Power distribution system should provide with an uninterrupted flow of energy at smooth sinusoidal voltage at the contracted magnitude level and frequency to their customers. PS especially distribution systems, have numerous non linear loads, which significantly affect the quality of power. Apart from non linear loads, events like capacitor switching, motor starting and unusual faults could also inflict power quality (PQ) problems. PQ problem is defined as any manifested problem in voltage current or leading to frequency deviations that result in failure or mal-operation of customer equipment. Voltage sags and swells are among the many PQ problems the industrial processes have to face. Voltage sags are more severe. During the past few decades, power industries have proved that the adverse impacts on the PQ can be mitigated or avoided by conventional means, and that techniques using fast controlled force commutated power electronics (PE) are even more effective. PQ compensators can be categorized into two main types. One is shunt connected compensation device that effectively eliminates harmonics. The other is the series connected device, which has an edge over the shunt type for correcting the distorted system side voltages and voltage sags caused by power transmission system faults.[1]

In Sinusoidal Pulse Width Modulation (SPWM):

- A sinusoidal reference signal (modulating signal) is compared with high-frequency triangular carrier waves.
- The comparison generates PWM pulses for the inverter switches.
- The widths of the pulses vary in a sinusoidal pattern, forming an AC voltage waveform whose average value follows a sine wave.

When applied to a multilevel inverter, the output voltage isn't just +Vdc or –Vdc — it has multiple intermediate voltage levels.This creates a stepped sinusoidal waveform, which:

- Reduces the harmonic content,

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- Decreases dv/dt (voltage stress),
- Minimizes total harmonic distortion (THD).

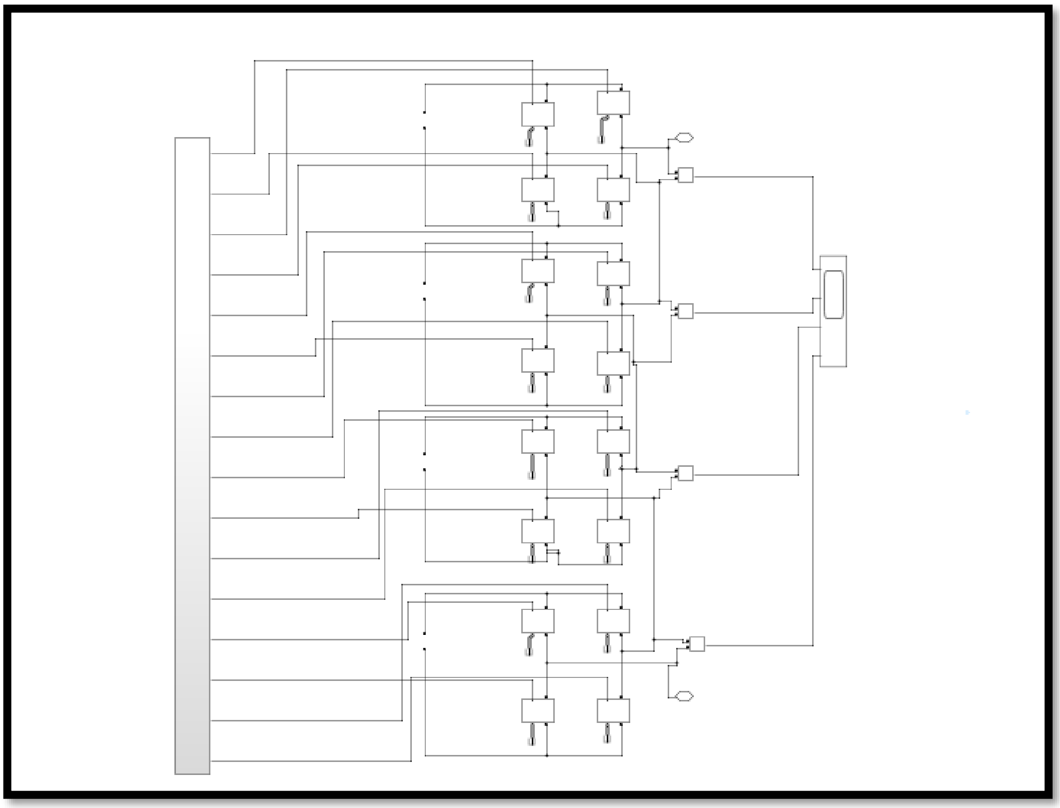

Fig. 1 Schematic Diagram of Cascaded Multilevel Inverter

II. CONTROL SYSTEM ALGORITHM

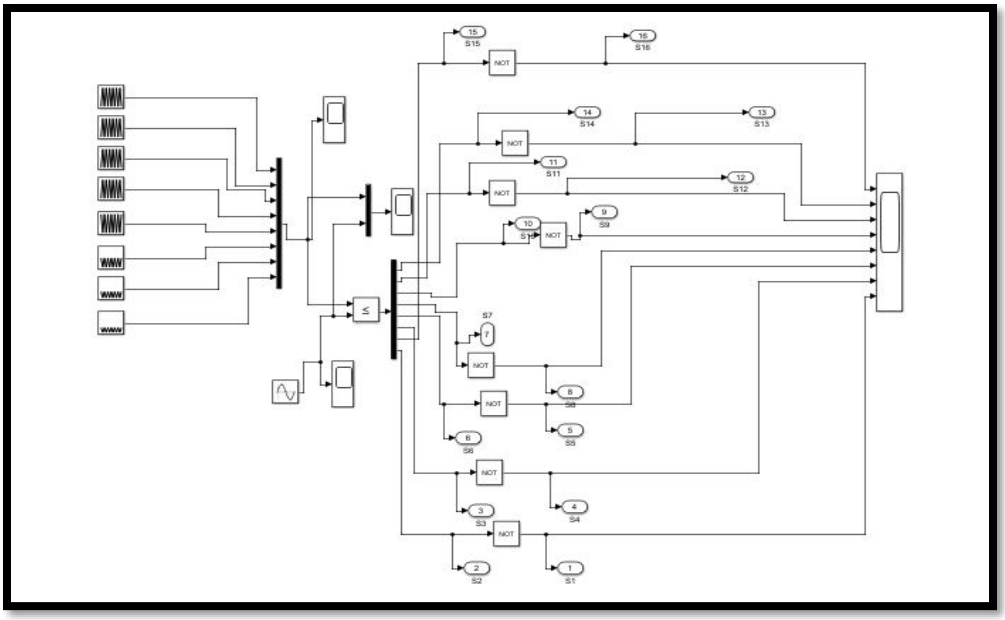

Fig. 2 triggering circuit of SPWM

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The image shows the SPWM Triggering Circuit for a Multilevel Inverter in a Simulink model. This block is crucial for generating the gate pulses that control the inverter's switching devices (like IGBTs or MOSFETs) using Sinusoidal Pulse Width Modulation (SPWM). It compares a sinusoidal reference signal (the desired output voltage waveform) with multiple triangular carrier waveforms (used to shape the PWM), to generate switching signals for each level of the Multilevel inverter. The circuit has multiple inputs which corresponds to reference and carrier signals. Multiple triangular carrier waves each slightly phase shifted or offset depending on the level of inverter. The comparators core of SPWM generation. Each comparator compares the reference sine wave with one carrier signal. If the reference signal is greater than the carrier the output is high else low. The result is a PWM pulse for one switch. After the comparators logic gate blocks organize and route the pulses to the correct switches. The multiple output ports each feeding a gate driver or inverter switch.

III. ASSUMPTION AND MODEL DESCRIPTION

A Simulink model of a single phase asynchronous machine most likely an induction motor driven by a multilevel inverter using the sinusoidal pulse width modulation technique. This Simulink model demonstrates the use of a multilevel inverter controlled with SPWM to drive a single-phase asynchronous machine. The motor is simulated with realistic behaviour including start-up using a capacitor and dynamic response to torque and voltage. The outputs help analyse the system's performance in terms of current, voltage, torque, and speed.

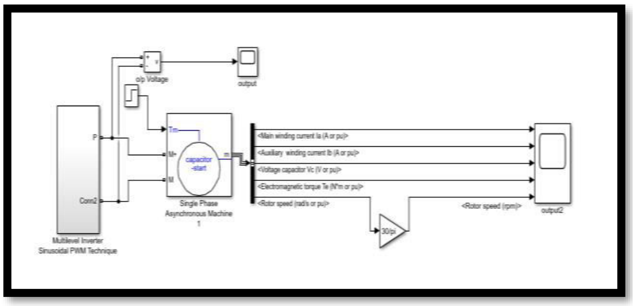

Fig. 3 Asynchronous machine connected with multilevel inverter

IV. RESULT AND DISCUSSION

The output waveform of the designed model has been recorded for cascaded multilevel inverter. The output voltage from the multilevel inverter shown in fig 5. The second graph shows the simulation of an induction motor connected with the cascaded multilevel inverter in which the outputs with low total harmonic distortion can be seen. Third graph shows output voltages from the group of switches.

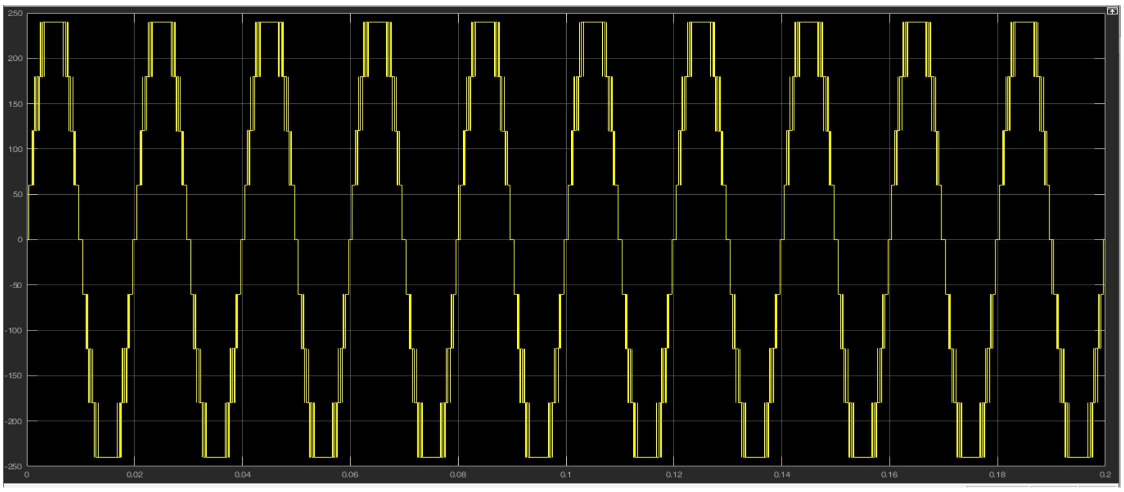

Fig. 5 Output voltage from multilevel inverter

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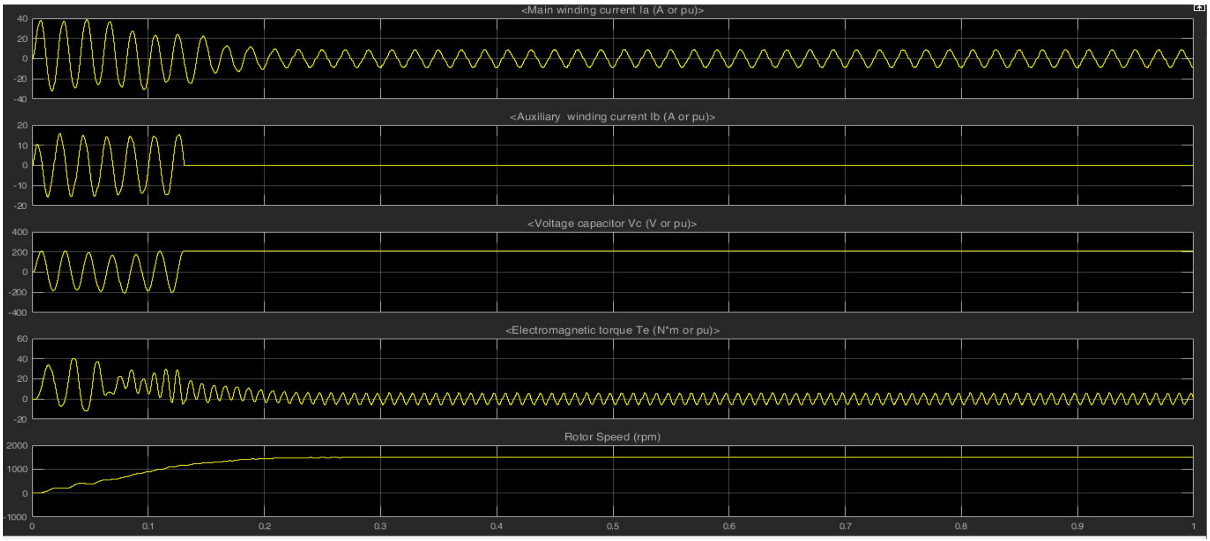

Fig. 6 Output of Induction machine

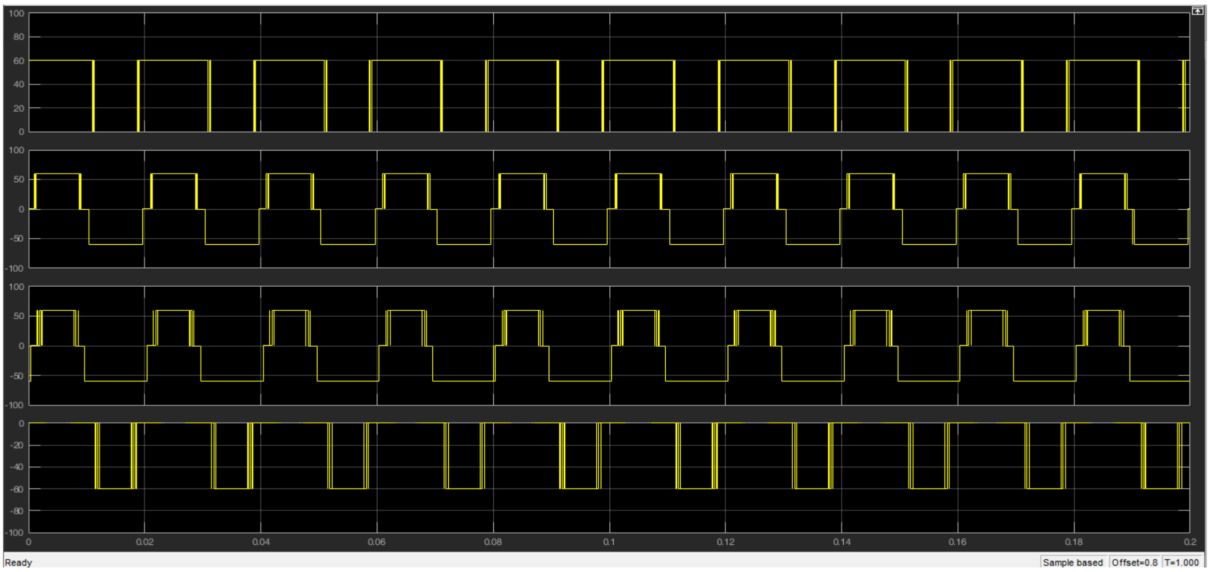

Fig. 7 Output voltages from the group of switches

V.CONCLUSION

A cascaded H bridge multilevel inverter has been designed and simulated the waveform observed alternates between positive and negative voltages symmetrically. The voltage steps increase and decrease in discrete levels. The overall shape approximates a sinusoidal waveform with finer steps giving a smoother output. This will results in lower total harmonic distortion. Lower dv/dt stress on switching devices, this will provide better efficiency and reduced electromagnetic interference. For example the induction motor also connected with the multilevel inverter and the outputs of induction motors are with the lower total harmonic distortions.

VI. FUTURE WORKS

In the next steps we can combine the multilevel inverter with the Facts devices for power quality improvement and reduction of total harmonic distortion. The stability improvement of power transmission network by the advanced devices becomes the most important as per the future perspective. The heating of power system devices and heating of equipment becomes the major issues and this should be resolved as necessary steps.

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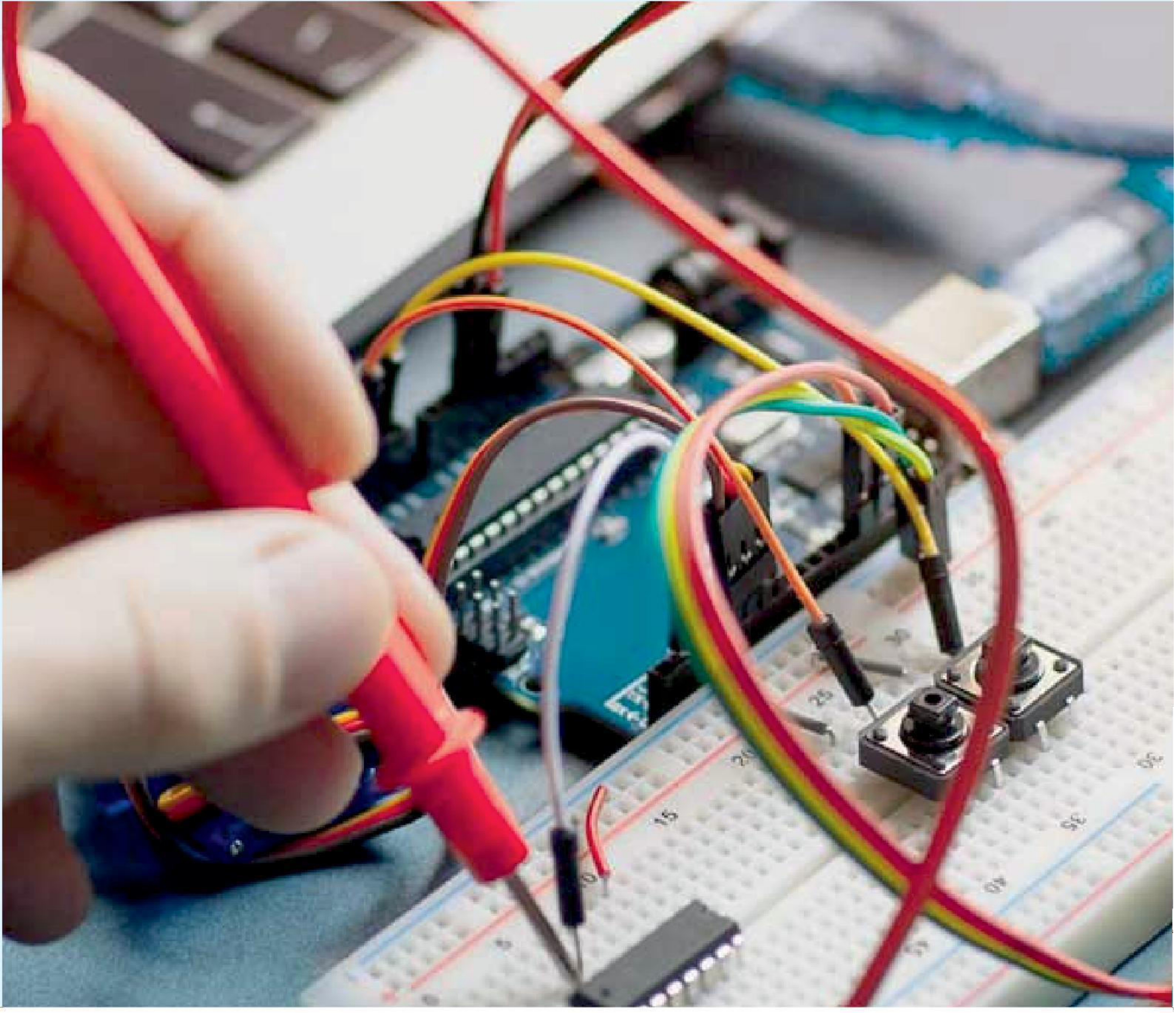

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