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Instructional Model for Power Surge

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Abstract: This is a quasi-experimental method of research aimed to create electronics gadget voltage time delay device for protection of electrical appliances from power spike due to brownouts at affordable cost. Result showed a fluctuation of voltage, current, and power but is ideal based on the three percent voltage drop in a line. The mean temperature for the three treatments in all replicate was normal base on the maximum temperature of the magnetic contactor which is 100^0C. The device was used for electronics instruction where the performance of the students was improved based on the pretest and posttest scores. The reliability of the test based on the posttest result was 0.75 interpreted as good which means that the assessment instrument is good; however, there are probably few items which could be improved. Testing the hypothesis of no significant correlation between the pretest and the post test at 0.01 and 0.05 levels of significance, researcher failed to provide sufficient evidence to accept the null hypothesis. The knowledge and skills obtained by the students on the different processes involved during the fabrication of the device can help to engage entrepreneurial activity to augment poverty alleviation.

Keywords: Electronics Gadget, Voltage Time Delay, Fabrication, Poverty Alleviation, Instructional Model, Power Surge.

INTRODUCTION

Electricity is a phenomenon of charged sub-atomic particles at rest or in motion. Electricity provides a highly versatile form of energy [1]. Electricity is a necessity in modern day living. From the simplest household to the more elaborate dwellings up to the more complex offices and even the most sophisticated edifices, electricity is one of the foremost requirements. Electricity is needed for lighting. It is used to power household appliances, office equipment, industrial machineries and others.

Nowadays, electricity becomes an essential part of human life. It provides many valuable things without which life on earth would prove difficult. It enables one to enjoy some comforts. It also facilitates the performance of certain task.

A power surge is basically a spike of energy usually occurs very briefly in household electric current but it can still cause damage to the home electrical appliances. This occurs when power supply is high especially after brownout and electrical appliances and other electronic device automatically switch on.

There are various causes of power surge at home. One of these causes is the frequent brownouts when nobody switches off the electrical breaker or electrical appliances and electric power kicks on. This is the source of power surge that usually damage electrical devices, consequently when the household wiring is faulty the worst scenario is fire because of the inability to resist spike.

Consumers also experienced power surge that damaged electrical appliances usually refrigerators where the owner failed to plug off the appliances during brownouts at night time. This can cause hassle and anxieties to the consumers.

There is available power surge protector in the market for the entire building specifically for natural surge such as generated by lightning that cost more or less US$1, 000.00 that depends on the Joules Rating, the higher, the bigger, the more expensive that most of the wage earner cannot afford.

It is for this reason that the researcher wish to produce a device that could protect power surge generated by brownout that is affordable but yet effective.

This study is anchored on the theory of Michael Faraday's discovery in 1821 that led to the invention of electric motors. Michael Faraday discovered that when a magnet is moved inside a coil of copper wire, a tiny electric current flows through the wire [2].

Faraday reported that a suddenly changing magnetic field can create, or induce, an electric current in a conductor [3].

Article XIV, Sections 10-13 of the 1987 Philippine Constitution emphasized the importance of science and technology as tools in national development and progress [4]. The government provides importance in research, invention and innovation to education, services through extension conducted by different universities in the country. The state also encourage private individual to participate in the application of science and technology for their benefits provided by the government for individual growth development in the society. Through the effort and protection of the Intellectual Property Office of the Philippines, inventors and innovators has the right for the production of their technology leading to commercialization that can benefit to our government through taxes.

Electricity is the phenomena associated with positively and negatively charged particles of matter at rest and in motion, either individually or in great numbers. The properties of electrical charges, of moving charges that constitute currents, and of complex circuits of currents are understood in two complementary ways. The older view is in terms of theories and laws that have been developed from experiments during the past two centuries in a steadily evolving knowledge. The other view is concerned with the space around the charge particle called the electric field, and knowledge of fields flowered in the latter half of the 19^{th} century. The study of electricity thus involves the structure of matter and is intimately related to the apparatus with which electricity is studied. No one has ever seen an electrical charge; and until this century it is impossible to isolate single fundamental charges and study their behavior in certain ways that take account of the charges on the proving instrument. Some of the information subsumed under electricity, therefore, was obtained through experiments; that is through questions such as "What is the magnitude of the force acting between two charges?"

Electric and magnetic phenomena are inextricably connected with each other; moreover, most, though not all, of the devices employed daily rely on a combination of electric and magnetic effects.

The magnetic force between magnetized bodies and the forces between electric currents can be interrelated by attributing the magnetization of matter to circulating currents in the atoms of matter [5].

The output of a power supply should be free of sudden changes that can damage equipment or components, or interfere with their proper performance [6] in planning an electrical system, the first consideration is safety, and the next consideration is function. The functioning of a system should permit full and convenient use of both present and future electrical equipment. An effective and efficient home wiring system depends on: Sufficient circuits of adequately large wire to supply the various loads without uneconomical voltage drop, a satisfactory number of outlets to permit convenient use of electrical equipment, and high-quality materials and good workmanship.

He further stated that at the instant a power supply is switched on, a surge of current occurs, even with nothing connected to the supply output. This is because the filter capacitors need an initial charge, so they draw a large current for a short time. The surge current is far greater than the normal operating current. An extreme current surge of this sort can destroy the rectifier diodes if they are not sufficiently rated and /or protected. This phenomenon is worst in high-voltage supplies and voltage-multiplier circuits. Diode failure as a result of current surges can be prevented in at least three ways: Use diodes with current rating of many times the normal operating level; connect several diodes in parallel wherever a diode is called for in the circuit. Current equalizing resistors are necessary. The resistor should have small, identical ohmic values. The diode should be identical; and use automatic switching circuit in the transformer primary. This type of circuit applies a reduced AC voltage to the transformer for a second or two, and then applies the full input voltage.

A power supply is required in virtually all mechatronic applications. It must be reliable and safe to use since it is the heart of the equipment. An unconditioned power supply can damage an electronic device [7].

Gates [8] published the first law of electrostatic charges: like charges repel each other. This means that when two electrons together or two protons together represents "like charges" being brought together move away from each other. While the second law: unlike charges attract each other. The negative electrons are drawn towards the positive protons in the nucleus of an atom. This attractive force is balanced by the centrifugal force caused by the electron's rotation resulted to electrons remains in orbit and not drawn into the nucleus.

The power in a direct current (DC) circuit is equal to the product of voltage and current [9]. For example voltage of 5 volts with the current of 10 amperes is equal to 50 watts. In other words the electromotive force is multiplied to the flow of electrons will results watts in power.

MATERIAL AND METHODS

A quasi-experimental method of research is use in conducting the study that employs the laboratory

observation and procedures. The different trials and testing were done and evaluated based on its function and working condition.

The main purpose of this study is to create voltage time delay device for protection of electrical appliances from power surge or spike due to brownouts at affordable cost. This could be a basis for commercialization of the product. Specifically, the study experiments on the following testing:

There were three testing and three trials having the same components, each is prepared and intended for testing and analysis. The same materials, tools, equipment and procedures were done throughout the experiment. Three testing were made in order to produce at the most consistent outcome from the design. Samples were marked prior to the different replicates and treatments subject for ohmmeter, voltmeter, ammeter and temperature testing. The function was determined by providing input voltage to the timer to turn on the magnetic contactor with a specific load or consuming device being connected for testing base on the three replicates and treatments.

After the fabrication of the voltage time delay there was a pretest and post test conducted to 46 students as respondents to determine the significant correlation of the study.

This study used various active and passive electronic components. These involved three testing with three trials in every testing. Testing the temperature, current and voltage were the most important factor to determine the effectiveness of the device. Pretest and post test were conducted to determine the level of significance.

The input are the information related the fabrication of the voltage time delay device as to technical requirements in terms of designing, materials supplies used, and testing. The performances of the students are reflected in their pretest and posttest results. The process included the procedure in fabricating the voltage time delay device, the preparation of materials, making the questionnaire for pretest and post test and conducting the pretest and post test. It includes analysis using the three testing with three trials to determine the function. As to the output, this includes the formulation of instructional guide that can be used for the Bachelor of Science in Industrial Technology major in Electronics.

Statistical Tool

To test the relationship of the pretest and the post test correlation coefficient was used and t-test for testing significance of the relationship between the pretest and the post test.

Scoring Procedure

To calculate the respondents pretest and post test the following category was used in order to get the test results.

Range	Category	Verbal Description
40 - 50	Superior	When the respondents got the highest score during the pretest and post test
35 - 39	Very Good	When the respondents got the average score during the pretest and post test
30 - 34	Good	When the respondent got the satisfactory score during the pretest and post test
25 - 29	Fair	When the respondents got the low score during the pretest and post test
0 - 24	Poor	When the respondents got the very low score during the pretest and post test

Procedures

The tools, materials and equipment were directly purchased in the electronics or electrical supply by the researcher and were brought to the electronics laboratory. Three replicates were made in order to come up with the most reliable output. Presented here are the different procedures used in constructing the designs used in this study.

Preparing the printed circuit board (PCB)

Prepare a full-scale foil pattern layout of the circuit. Cut the copper clad board to the desired size with a hacksaw and wash the copper side with any cleaning detergent or laundry soap to remove the surface dirt. Cover the copper-clad board with masking tape and trace the layout pattern using carbon paper on the copper side of the board. Cut the layout pattern and remove the unnecessary portion covered with masking tape. Immerse the board in etching solution and place the plastic side of the board down so that the copper side will not touch the bottom of the tray. Remove the board from the solution as soon as the copper foil is completely washed away. Remove also the masking tape or the resist with cotton or a soft cloth dipped in lacquer thinner. Rinse the PCB with water and let it dry. Mark and drill the required component lead holes on the copper side and place the corresponding components on the PCB and solder.

Fixing the magnetic contactor and over load relay

Determine the line side and load side of the magnetic contactor and connect the overload relay to the load side of the magnetic contactor.

Fixing the timer

Determine the different terminal functions of the timer. Locate the supply and the terminals for normally open contact. Fix the timer to the magnetic

contactor found in the schematic diagram and set the timer to a desired level of time.

Voltage Testing

Set the voltmeter to AC voltage to the highest range of the selector based on the expected output voltage and turn on the master switch and monitor the delay of the voltage output.

RESULTS AND DISCUSSION

The data gathered in this study were arranged as follows; design of the fabricated voltage time delay device, materials supplies used in the fabrication of the voltage time delay device for rectifier circuit, analyses the fabricated voltage time delay device for the temperature for testing one followed by testing two and three, pretest results of students performance, post test results of students performance, reliability test as to the performance of the students and correlation coefficient as to the performance of the students.

Technical Requirements

As to technical requirements this involves the three designs and the supply of materials being used during the fabrication.

Designing

The design and functions of the different circuits used in the fabrication of the fabricated voltage time delay device for electronics technology instruction.

This indicates the design, number of components and function of the voltage time delay device. As revealed the rectifier circuit was a combination of 7 passive and active electronics components that could convert alternating current to direct current. The anode terminals of the diodes in the circuit will collect the positive charges from the secondary output of the power transformer while the cathode terminals of the diodes collect the negative charges from the secondary output of the transformer. As the pulsating direct current (DC) becomes the output of the circuit, there should be a filter capacitor installed in parallel to the anode and cathode to a pure (DC).Another is the relay circuit which a combination of another passive and active electronics components that could trigger the switch for the supply of the timer. The relay circuit is an electronics circuit that can delay the incoming voltage from the source in a few second to avoid possible damage of the timer. And the time delay circuit the combination of three electrical parts which delay the incoming voltage of the consuming devices. This circuit delays the supply voltage in five minutes or more depending on the desired setting of the user to avoid possible electrical surge or spike that will occur during sudden turn on of the supply voltage.

Materials Supplies Used

Materials Supplies Used in the Fabrication of the Voltage Time Delay Device for Rectifier Circuit

As reflected this shows the materials intended for the rectifier circuit. One power transformer rated 10 amperes and 12 volts alternating current, serves as the heart of the rectifier circuit. Four rectifier diodes with the value of 1N4001 which was used to convert alternating current to direct current. And last, one electrolytic capacitor with the capacitance of 2200 micro farad with 25 volts voltage rating serves as the filter for the rectifier circuit.

Materials Supplies Used in the Fabrication of the Voltage Time Delay Device for Relay Circuit

This exhibits the different materials used in the fabrication of the voltage time delay device for the relay circuit. One 100K ohms trimmer resistor used to set the amount of time in seconds to turn on the relay switch. One 1K ohms ½ watt fixed resistor, two 39K ohms ½ watt fixed resistor, one 8.2K ohms ½ watt fixed resistor, one 620 ohms ½ watt fixed resistor are components in the circuit whose function is to limit the current passing to the capacitors and other components. The 2N5060 which is a silicon controlled rectifier (SCR) is used to control the operation of the relay which connects the line one to the terminal two of the timer from the moment the power is switched ON. The 1N4742A one watt 12 volts zener diode fixes the voltage across the circuit to 12 Volts Direct Current (VDC) which is the required voltage of the relay circuit. The 1N4148 switching silicon signal diode is used to prevent the SCR from possible break down. One electrolytic capacitor with the capacitance of 16 micro farad and the voltage rating was 16 volts and one .01 mylar capacitor are used to charge current and voltages in the relay circuit. The 12 volts 3 amperes relay with socket is used to connect the line one going to the timer and to the magnetic contactor holding coil. The two packs of ferric chloride with 5 grams per pack is for etching during making the Printed Circuit Board (PCB).

Materials Supplies Used in the Fabrication of the Voltage Time Delay Device for Time Delay Circuit

As revealed the materials used in the fabrication of the voltage time delay device were the following, one 220 volts 9 ampere magnetic contactor which is for triggering the source voltage connected to the consuming device. The overload relay with the current rating of 9 ampere is for the excessive current that might occur in the circuit, therefore it becomes open. For the 220 volts timer is for the setting of the time to which the magnetic contactor will be turn on.

Materials Supplies Used in the Fabrication of the Voltage Time Delay Device for the Accessories/ Materials

It displays the accessories/ materials as used in the fabrication of the voltage time delay used during the fabrication. The 220 volts alternating current (VAC)

neon switch serves as the control switch of the entire device. The rubber grommet is to prevent the wire cord for 220 Volts Alternating current from scratch. The male plug is used to attach the wire for 220 VAC connections. One 2" X 3" copper clad board for making a printed circuit board to which different electronics components were attached. The alternating current outlet for metal is for the line to which the electronics or electrical consuming devices were connected. Fuse holder was used to hold the fuse. The10 amperes fuse was for protecting the circuit in case there is short circuit will occur. The casing for the voltage time delay device encloses the components for protection. Five meters solder for fixing permanent connections without the application of a screw. Six meters extension wire number 16 was for the cord connected to the 220 VAC. And the last were fourteen 1/8 X ¾ bolt and knot for fixing the power transformer, relay socket, timer, overload relay and magnetic contactor.

Testing

This is to determine the function of the fabricated voltage time delay device as to the different trials with different consuming devices as a load. This includes testing one, testing two and testing three.

Testing One

The testing of the fabricated voltage time delay device for three trials with the load of a one refrigerator, three computers with printer and copier and one air condition unit.

Testing the Fabricated Voltage Time Delay Device for the Temperature for Testing One

Based on ambient temperature the decision was normal for the three trials with the voltage of 220 Volts Alternating Current (VAC) for testing one, 212 VAC for the second trial and third trial. For the supply voltage which was 212 as reflected for trial two and three, this indicates an ideal voltage supply based on 3% allowable voltage dropped in line. This indicates that the fabricated voltage time delay was efficient for electronics technology instruction during testing. Trial one for testing one, the load was one refrigerator, the current was 0.81 amperes, the power was 178.2 watts, the length of time was 8 hours and the temperature was 36^{o}C. For trial two of the same testing, the load were three computers with printer and copier, the current was 0.89 amperes, power was 188.68 watts, length of time is 8 hours and the temperature was 34^{o}C. The last trial which was the trial three, the load was one air condition unit, the current was 6.16 amperes, the power was 1305.92 watts, the length of time was 8 hours and the temperature was 35^{o}C. The mean temperature for the three trials under testing one was 35^{o}C and the decision was normal based on the maximum temperature of the magnetic contactor which is 100^{0}C.

Testing Two

The testing of the fabricated voltage time delay device for three trials with the load of a one refrigerator, three computers with printer and copier and one air condition unit.

Testing the Fabricated Voltage Time Delay Device for the Temperature for Testing Two

Based on ambient temperature the decision was normal for the three trials with the voltage of 215 Volts Alternating Current for trial one, 220 VAC for the second trial and 218VAC for the last trial. For the supply voltage which was fluctuating as reflected for trial one and three, this indicates an ideal voltage supply based on 3% allowable voltage dropped in line. This indicates that the fabricated voltage time delay was efficient for electronics technology instruction during testing. Trial one for testing one, the load was one refrigerator, the current was .72 amperes, the power was 154.8 watts, the length of time was 8hours and the temperature was 34^{o}C. For Trial two of the same testing, the load were three computers with printer and copier, the current was .7 amperes, power was 154 watts, length of time is 8 hours and the temperature was 32^{o}C. The last trial which was the trial three, the load was one air condition unit, the current was 6.02 amperes, the power was 1312.36 watts, the length of time was 8 hours and the temperature was32^{o}C. The mean temperature for the three trials under testing two was 32.67^{o}C and the decision was normal base on the maximum temperature of the magnetic contactor which is 100^{0}C.

Testing Three

The testing of the fabricated voltage time delay device for the three trials with the load of a one refrigerator, three computers with printer and copier and one air condition unit.

Testing the Fabricated Voltage Time Delay Device for the Temperature for Testing Three

Based on ambient temperature the decision was normal for the three trials with the voltage of 200 Volts Alternating Current for trial one, another trial was 220 VAC for the supply voltage and for the last trial the supply voltage was 206 VAC. For the supply voltage which was fluctuating as reflected for trial one and three, this indicates an ideal voltage supply based on 3% allowable voltage dropped in line. This indicates that the fabricated voltage time delay was efficient for electronics technology instruction during testing. Trial one for testing one, the load was one refrigerator, the current was .83 amperes, the power was 182.6 watts, the length of time was 8 hours and the temperature was 35^{o}C.For trial two of the same testing, the load were three computers with printer and copier, the current was .79 amperes, power was 173.8 watts, length of time was 8 hours and the temperature was 35^{o}C. The last trial which was the trial three, the load was one air condition unit, the current was 6.75 amperes, the power was

1390.5 watts, the length of time was 8 hours and the temperature was 36^{o}C. The mean temperature for the three trials under testing three was 35.33^{o}C and the decision was normal. As to the supply voltage for trial three which was 206 VAC which was beyond the 3% voltage dropped in a line the implication for the temperature was still normal base on the maximum temperature of the magnetic contactor which is 100^{0}C.

Performance of the Students

This portion includes the pretest and post test performance of the students during the evaluation. The pretest is given to determine how much the students already learned before instruction while post test was to determine how much the students have learned after the instruction was made.

Pretest Performance

The results of the pretest performance of the students using the voltage time delay device for electronics instruction.

Pretest Results of Students Performance

This reveals the pretest results of 46 students. As shown only 2 students or 4.35% were able to get a fair score, while, almost all or 95.65% got a poor score in the pre-test. This implies that the students have no knowledge about the functions of the different components of the device, materials and methods of constructing the device as well.

Post Test Performance

The results of the post test performance of the students using the voltage time delay device for electronics instruction.

Post Test Results of Students Performance. The post test results of 46 students during the evaluation of the voltage time delay device for electronics instruction. For the post test under the range of 40 – 50, the frequency was 9 and the percentage was 19.565.As to the range of 35 – 39, the frequency was 16 and the percentage was 34.783 respectively. Another 13 for frequency and 28.26 percentage for the range 30 – 34. For the range 25 – 29, the frequency was 5 and the percentage was 10.87. As to the last range, the range 0 – 24 the frequency was 3 and the percentage was 6.522. As presented in this table, out of 46 students taking the post test evaluation, there were 43 students who got the passing score, and there only 3 students got the poor score. This implies that using the device as instructional materials can greatly help improve the performance of the students in acquiring knowledge and skills.

Reliability Result

The results of the reliability of the test base on the performance of the students using the voltage time delay device for electronics instruction.

Reliability Test as to the Performance of the Students

The reliability test as to pretest and post test evaluation of students using the voltage time delay device for electronics instruction. The average based on 50 items was 17.91 for the pretest while the post test was 43.43.For variance, 15.47 for the pretest and 32.16 for the post test. As to the standard deviation, 3.93 for the pretest while 5.67 for post test. The reliability of the pretest result shows doubtful because this is attributed to the prior knowledge of the students. The students were not able to study the topic yet. Right after the pretest, using the device for instruction the result of the reliability of the post-test was 0.75with the interpretation of good. This means that the test instrument is good for a classroom test, though; there are probably few items which could be improved.

Correlation Coefficient Result

The results of the correlation coefficient as to the performance of the students using the voltage time delay device for electronics instruction.

Correlation Coefficient as to the Performance of the Students

The correlation coefficient as to the performance of the students during pretest and post test evaluation. As to the correlation coefficient with value of 0.486 the decision was moderate positive based on the equivalent range which 0.3 to 0.5 coefficient. For the test significance using the t test the computed value was 3.689 which was bigger compared to the table value at 0.01 and 0.05 level of significance therefore the decision was significant. This means that the null hypothesis of no significant correlation is rejected. The researcher failed to provide sufficient evidence to accept the null hypothesis.

CONCLUSION

It is established that the voltage time delay device is valuable for electronics instruction for college students. The knowledge and skills obtained by the students on the different processes involved during the fabrication of the device can help to engage entrepreneurial activity to augment poverty alleviation.

The result for the three testing of the fabricated voltage time delay based on the function and temperature was normal and it is viable for protection in case there are unexpected power interruptions that will results to power surge.

For the performance shows that during pretest, students have less information about the uses and functions of the device, but after a comprehensive discussion with regards to the device the result shows improvement as to the performance of the students during post test.

This implies that students understand the methods and processes involved in the fabrication of the device for power surge protection.

Formulation of instructional materials for students to disseminate information serves as a guide during fabrication of the device.

Recommendations

Based on the findings and conclusion in this study the following recommendations are suggested:

- Inform the students when conducting an examination.
- Conduct return demonstration before giving evaluation after the demonstration based on the proposed instructional guide.
- Follow the procedure as indicated in the proposed instructional guide for electronics technology.
- The instructional device made is recommended for commercialization.

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