
The Conceptualization and Construction of a Nodal Safety Switch

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Abstract

In order to save energy, it is critical to manage when, how, and where the energy is used. Because safety is so important when working with electricity, switches are given to supply the flow of electrical current when needed and disengage when not. A manually controlled electromechanical device with one or more sets of electrical contacts linked to external circuits is the most common type of switch. Each contact set can be in one of two states: "closed," which means the contacts are contacting and electricity can flow between them, or "open," which means the contacts are separated and the switch is not conducting. The method used to switch between these two states (open or closed) can be either "toggle" (flip switch for continuous "on" or "off") or "momentary" (push-for "on" or push-for "off"). When breakers fail to handle overload, underload, and short-circuit problems, the appliances and users suffer as a result. The worst-case situation is a fire. Wherever there is a high current demand, energy conservation and power safeguards beyond standard breakers at distribution boxes become important to protect appliances, houses, and property from the risk of fire outbreak. The Nodal safety switch is intended to help conserve electrical energy and protect electrical appliances and equipment at nodes or points of engagement from power surges caused by line short-circuits and lightning power surges, particularly when the switch is intentionally or inadvertently left in the ON position after the previous power supply was interrupted.

Keywords: - Nodal, Conserve, Electricity, Switch, Safety, Energy

INTRODUCTION

A switch is an electrical device that may break or form an electrical circuit by interrupting or directing electricity from one conductor to another. A switch's mechanism can be activated directly by a human operator to control a circuit (for example, a light switch or a keyboard button), by a moving item such as a door-driven switch, or by some sensor device for pressure, temperature, or flow. Switches are divided into two types: mechanical switches and electrical switches (E-Switch, 2021).

Mechanical Switches

Mechanical switches must be physically or manually touched to operate. These are switches in which two metal plates create a physical contact with one other to allow current to flow and then separate from each other to stop the passage of current. Mechanical switches are classified into four types based on their power handling capacity: Single Pole Single Through

(SPST), Single Pole Double Throw (SPDT), Double Pole Single Throw (DPST), Double Pole Double Throw (DPDT), Two Poles Six Throw (2P6T), and Momentary Operation Switch / Momentary Control Switch (Ravi, 2017). SPST and DPDT are illustrated in Plates 1–4. Mechanical switches are classified as Push button, Pressure switch, Temperature switch, Toggle switch, and Rotary switch. The contact material is chosen with the understanding that metal oxides formed by corrosion are generally insulators, and layers of such oxides on the switch plates will obstruct normal switch functioning. Push Buttons Switch: These buttons can carry a tiny amount of electricity and are utilised in many electrical circuits. They are typically Normally Closed or Normally Opened. When a user pushes the button, the metal plates either connect to complete the circuit or detach the contact of the pins, however when the user removes their finger from the button, the contact of the pins is either detached or linked.



Plate 1: Knife Switch (SPST) Plate 2: Knife Switch (DPDT) Plate 3: Rocker Switch (SPDT) Plate 4: Rotary Switch (3P3T)

This operation system is incompatible with single-press continuous current supply (Theraja & Theraja, 2005).



Plate 5: Push Button

Toggle Switches: A lever tilted in one or more directions operates toggle switches. This switch is stable and will remain in that condition until and until the lever is pushed in a different direction. Most domestic applications employ a toggle switch, which can fall into any of the above-mentioned categories, such as SPST, DPDT, and so on (Theraja and Theraja, 2005).



Plate 6: Toggle Switch (SPST)

Electrical and Electronic Switches

Electrical switches are quicker than mechanical switches in terms of switching reaction and may be switched automatically by an electronic circuit such

as a microcontroller or microprocessor. Electrical switches can conduct operations without requiring physical or human touch. Electrical switches are typically powered by semiconductors. They are also classified according to their current and voltage ratings, just like mechanical switches (Ravi, 2017). The most common electronic switches are transistors, mosfets, and relays.

Transistor as a switch: Transistors may be utilised in a variety of ways, but we will focus on the transistor as a switch. If we supply a high amount of current to the transistor's base (while keeping in mind the maximum allowable current for this type of transistor), we can operate it in deep saturation mode, i.e. it can be utilised as a switch.

Mosfet as a Switch: Mosfets can also be utilised to switch at high frequencies. They are capable of operating at Megahertz (MHz) frequencies. Mosfets are commonly used for PWM (pulse width modulation). Meanwhile, similar to transistors, employing such components would need additional circuiting and consideration of base voltage and current to minimise component damage.

Relay as a Switch: A relay is an electromechanical switch made up of magnetic components that is powered by electricity. These switches are designed to handle a broad variety of voltages and currents; exceptionally big switches may be used in electrical substations to separate high-voltage circuits. When a current flows through the coil, it transforms into an electromagnet, which may be utilised for switching. Their contacts can be of any type, such as SPDT, DPDT, and so on. As a result, if just mechanical switches are employed, there should always be one person present who turns the device ON and OFF before and/or after usage, or receives an indicator message from a circuit for the next action. Furthermore, failure within the switch owing to casing melting creates partial contact in the switch, which is detrimental to its users, producing burns due to heat, shock, and/or electrocution due to leakage. Electronic switches are then employed to eliminate this issue. When compared to mechanical switches, they are significantly faster and more precise. Electronic switches are compact in size, generate no noise while switching, and ensure the system's stability and durability.

The Nodal Safety Switch operates on the switching concept of an AC relay to either

connect or isolate the load(s) from the power supply, whereas a conventional switch generally suffers partial contact owing to insulator overlap and the presence of mechanical actions during operation. When a light or load attached to this switch is turned on, the start button is pressed, which instantly turns on the load through an activated AC relay via its coil. The common contact (CC) and usually open contact (NOC) were used to keep the relay in its energising condition (NC). To disconnect the load from the power supply, de-energize the relay coil by pushing the push button linked to the main (live) through the fuse with a sufficient protection rating. This idea is intended to remain switched off as soon as the power supply is cut off, whether by lightning, accident, or power suppliers. Thus, the Nodal safety switch conserves electrical energy and protects electrical appliances and equipment at the nodes or points of engagement from power surges caused by line short-circuits and lightning power surges, particularly when the switch is intentionally or inadvertently left in the ON position after the previous power supply was interrupted.

METHODOLOGY

The technique followed an engineering design procedure that began with a

concept and progressed via circuit simulations and analysis to the selection of a matching design, drawings, component selection, and production. The device was intended to run on a single phase power supply; the standby power supply sources must include an effective ON/OFF key and an efficient battery to improve self-starting. For an efficient operation, the connecting wires must be electrically sound, and the contactors and relays utilised must be appropriately sized to fulfil their current rating requirements. Some degrees of tolerance were added during design to allow for future expansion; nonetheless, this maximum rating must not be surpassed to avoid total system failure. A phase selector was

included as a modification to guarantee that power is available to the user from any of the power lines. To avoid incorrect relay contact connections, the typically open and shut states of the relay were detected using a digital metre. The output of the power supply unit, which powers the relays, was verified by switching the relays on as soon as power was delivered. The system was tested with public supply sources using a generator. For the tests, a single electric bulb was employed. When the public supply source was turned on and the generator's source was turned off, the bulb that serves as the load illuminated; when the public supply source was turned off and the generator turned on the load, the same result was attained.

NODAL SAFETY SWITCH

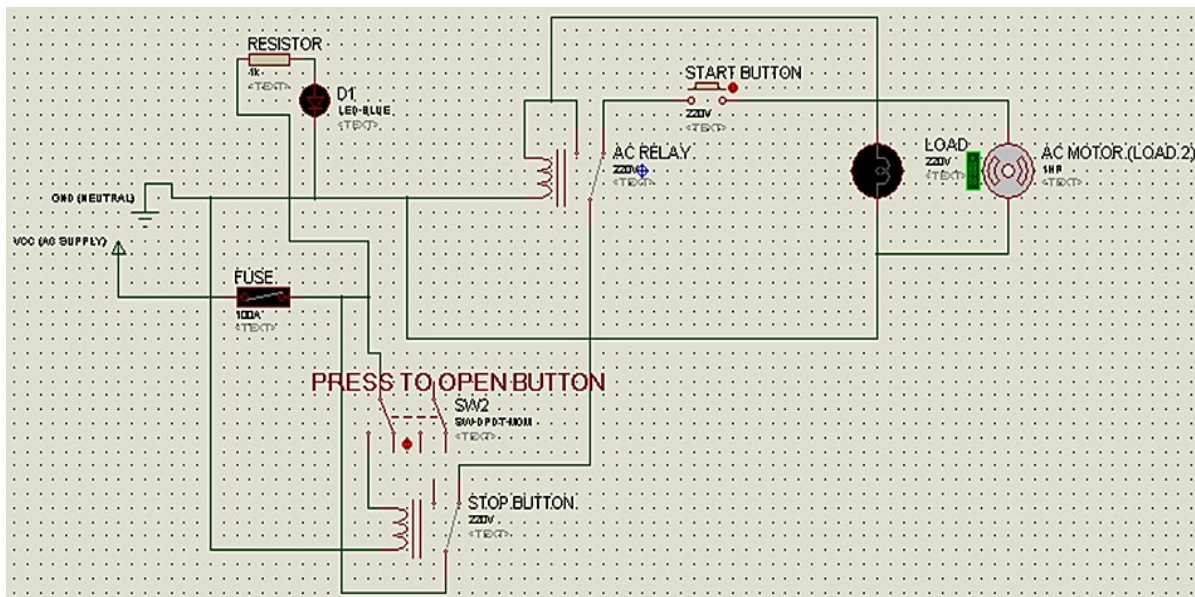


Figure 1: Circuit Diagram of a Nodal Safety Switch

As shown in Figure 1, power enters the system via a fuse, which is then connected to the terminals of: a resistor to supply regulated voltage to the LED bulb, one terminal of the Stop Push Button Switch (SW2) for actuating the Stop Relay, and the Common Contact terminal to supply power to both the Start Relay and Load via the Normally Closed Contact terminal of the Stop Relay so that power can be easily interrupted when actuated. The Normally Closed Contact terminals of the Stop

Relay are connected to the Common Contact terminal of the Start Relay. The Start Button is then attached to the Start Relay's Normally Closed Contact terminal, receiving electricity to activate the Start Relay. When the Start Push Button switch is pressed, the Start Relay live terminal, the load live terminal, and the Normally Open Contact terminal are all linked together, keeping the Start relay activated for continuous power delivery to the load.

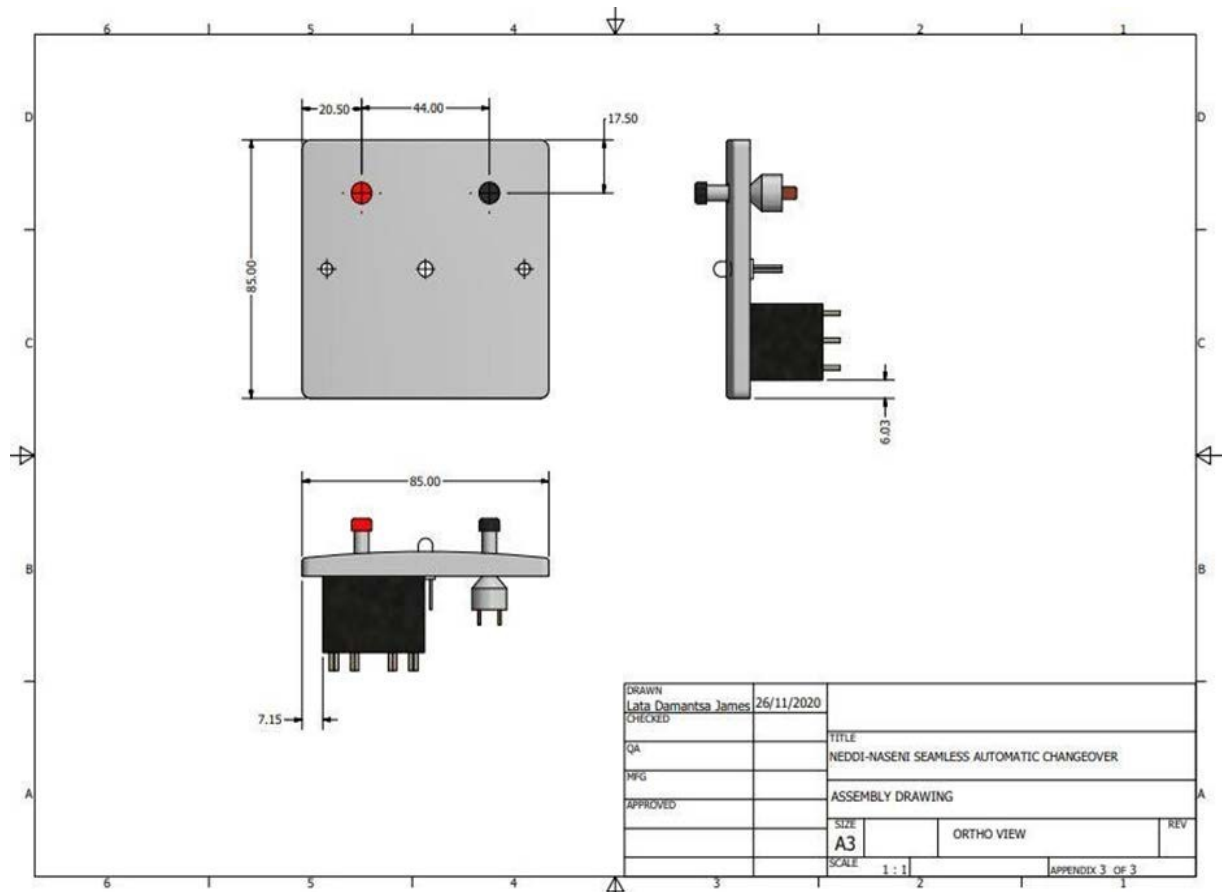


Figure 2: Orthographic View of the Nodal Safety Switch

Figure 2 depicts the connections between the Supply Cables (1), Fuse (2), Start and Stop Relay-DPDT (3), Start Push Button (NO) (4), and Load Point (5). Despite this, the LED light is always on, suggesting that power is available. Before entering any other component, power must travel via a fuse, which acts as the initial point of protection. The Relay-DPDT, Push Buttons, and Load all have their neutral terminals linked directly to the neutral supply. In contrast, each of the relays' live terminals is linked to a terminal of each of the Push Buttons, such that when pressed, it completes the circuit of its assigned relay to activate. As a result, when the Start Push Button is pressed, electricity is sent to the Start Relay. Because the Start relay's Live and Normally Open Contact terminals are coupled together, the relay remains activated even after the connection is switched to Common Contact and Normally Open Contact terminals.

This relay's present state is maintained until power is terminated, charging the state of connection of the terminals between Common Contact with Normally Open Contact and Common Contact with Normally Closed Contact. As a result, when power is restored, the load will not receive electricity unless the Start Push

Button is pressed again. As a result, it is safer for linked loads to avoid the effects of transitory and inefficient energy use.

Meanwhile, pressing the Stop Push Button activates the Stop Relay, which disconnects the connection between the Common Contact and Normally Closed Contact terminals, supplying power to the Start Relay and load. As a result, the power supply is interrupted, deactivating the Start Relay and keeping it disabled even after the Stop Push Button is withdrawn. The device was intended to function on a single-phase power supply and requires the user's permission to push the Start Push Button switch in order to deliver power to the load whenever there is a power outage.

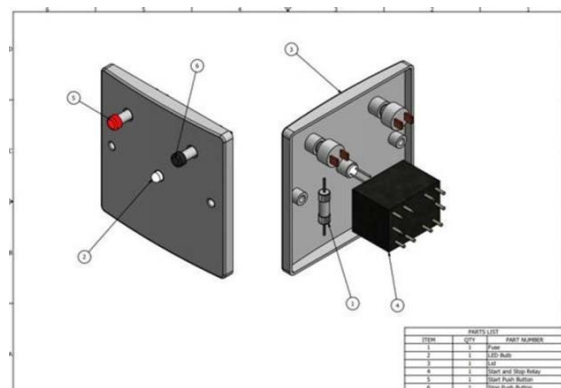


Figure 3: Labelled Parts of the Nodal Safety Switch



Plate 7: Nodal Safety Switch Socket



Plate 8: Nodal Safety Wall Switch

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