

Design of Short Circuit Indicator for Medium Voltage Systems

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ABSTRACT

A phenomenon known as a short circuit occurs when the input terminals of a power source come into direct electrical contact with one another, which results in a very high flow of current. This results in the production of a significant amount of heat, which poses a risk to the system itself and those located nearby. So, it is vital to identify a short circuit problem and rapidly respond to it once it is identified. When connected, the Short Circuit Indicator automatically detects a short circuit in a circuit to which it is attached. We were able to show the short circuit in our circuit board by inserting a piece of wire that has a resistance value that is very low, almost equal to zero, and which, as a result, created a short circuit at the source connection. Three single-phase currents imply high voltage power line short faults. Zero sequence currents imply grounding failure. Line patrollers may see or hear short circuits or grounding issues on 3kV-40.5kV power distribution networks, switchgear, cable branching units, etc. Answer "What is a short circuit?" to study them. It's how? What time? and why? Short-circuit prevention. Short circuit (fault current) studies must be done to ensure that electrical system equipment can tolerate short circuit energy. Grounding shipboard equipment is difficult. Grounding the power transformer's return to the chassis eliminates direct wiring. Power supply load connects to transformer return. Overcapacity may damage equipment and endanger lives. Short circuits triggered many fires. Short circuits safeguard structures.

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1. INTRODUCTION

A short circuit can harm other circuits, overheat, start a fire, or even create an explosion. Even though a short circuit is defined as an improper connection between two nodes of an electric circuit that are supposed to be at different voltages, short circuits may be hazardous. This results in an electrical connection that is limited only by the Thevenin equivalent resistance of the rest of the network [1]. Although short circuits are typically the result of a malfunction, there are instances in which they are caused intentionally, such as for voltage-sensing crowbar circuit protectors [2]. A phenomenon known as a short circuit occurs when the input terminals of the power supply come into touch with one other, which results in an extremely high flow of current. This results in the production of a significant amount of heat, which poses a risk to the system itself and those located nearby [3]. So, it is vital to identify a short circuit problem and rapidly respond to it once it is

identified. The duty of detecting a short circuit in a circuit in which it is attached is automatically carried out by the short circuit indicator project when it is connected [4]. We could light up an indication LED with a regulator and several transistors. This LED only lights up when there is a short circuit taking place [5]. By doing so, one may readily comprehend the short circuit situation and take the proper steps, which include switching off the power source and eliminating the short circuit [6].

In primary circuits, short circuits may occur between two phases, between a phase and neutral, or between a phase and earth. They can also take place between two phases and the earth [7]. These kinds of short circuits almost always produce a relatively high current and, as a consequence, swiftly set off an overcurrent safety mechanism. Transformers used in power distribution are purposefully constructed to have a specific level of leakage reactance [8]. This is done to mitigate the potentially disastrous consequences of short circuits at the electrical outlets or even at the location of the short circuit itself) [9]. This is a frequent scenario that results in the formation of an electric arc, which, if it does occur during the short circuit, generates a significant amount of heat and has the potential also to cause the ignition of combustible substances [10]. Conductors in industrial and utility distribution systems are caused to become farther apart due to dynamic forces induced by strong short forces in circuit currents. The forces that are created during a short circuit have the potential to cause damage to bus bars, cables, and other equipment [11].

2. LITERATURE STUDY

Recent discussions have focused on a number of investigations regarding transmission line fault analysis. These include the Wavelet Technique, Kernel Principal Component Analysis, Neural Network, Support Vector Machine, Fuzzy Logic Technique, Automatic Fault Location, and Wavelet Spectrum Energy, amongst others. In the study effort, it is suggested that specific investigations on fault analysis for transmission lines may be carried out using their use. There are just a few different methods provided here for the defect detection, categorization, and localization of power transmission lines [12].

The report on short circuit current literature survey compiles the findings of a literature review on short circuit current limiters. This is due to a research program being carried out at the Eindhoven University of Technology by a group known as equipment and systems for electrical energy supply on the way to reducing the amount of current flowing via short circuits. For the sake of this investigation, it is preferable to have access to a survey of the previous study conducted on the topic [13]. When a power source experiences a short circuit, the surge of current through the short may be so significant that it can damage or even kill the power source. When the insulation on a wire wears a way or another conducting substance (such as water) is added, a short circuit occurs accidentally. It prevents the passage of charge in the direction it is supposed to go. Fuses, circuit breakers, and other forms of overload protection cut power in response to high current, limiting or preventing damage from short circuits [14]. A supply circuit fuse that fails to perform its duty will blow, opening the circuit and cutting off the flow of electricity. A tripped circuit breaker on the supply circuit will allow electricity to flow freely.

When the positive and negative terminals of a battery are linked with a low-resistance in the connection, such as a wire, a typical sort of short circuit may occur. This type of short circuit is dangerous. If the connection has a low resistance, then a strong current will flow through it, which will result in the delivery of a significant quantity of energy in a relatively short length of time [15].

A high current that is running through a battery may produce a fast rise in temperature, which has the potential to culminate in an explosion with the release of hydrogen gas and electrolyte (which can be either an acid or a base), which can burn flesh and cause blindness or even death. Wires that have been overloaded can also overheat, which may cause damage to the insulation of the wire or even start a fire. High current situations may also occur with electric motor loads under stopped conditions, such as when the impeller of an electrically powered pump is blocked by debris [15]. This is not a short, even if it may have inevitable consequences similar to a short. Accidental short circuits in electrical devices are often created when the insulation on a wire deteriorates or when another conducting material is added, enabling charge to flow down a

different channel than the one that was intended. This may also occur when a wire is accidentally cut [2].

Short circuits may develop in mains circuits in one of three ways: between two phases, between a phase and neutral, or between a phase and earth (ground). These kinds of short circuits almost always produce a current that is quite high and, as a consequence, swiftly set off an overcurrent safety mechanism. Nonetheless, it is possible for short circuits to develop between the neutral and earth conductors, as well as between two conductors that belong to the same phase. These types of short circuits might be hazardous, in particular due to the fact that they could not instantly result in a significant amount of current and are, as a consequence, less likely to be discovered. One of the possible results is the sudden energization of a circuit that was previously thought to be isolated. Transformers used in power distribution are purposefully constructed to have a specific level of leakage reactance. This is done with the goal of mitigating the potentially disastrous consequences of short circuits. The leakage reactance, which is typically between 5 and 10 percent of the entire load impedance, contributes to limiting both the size of the fault current and the pace at which it rises [14].

The development of an electric arc is sometimes brought about via a short circuit. Even after considerable parts of the initial material from the conductors have evaporated, the arc, which is a channel of hot ionized plasma, may continue to exist because it is very conductive. Erosion of the surface is a common symptom of damage caused by electric arcs. Even very brief arcs are capable of removing substantial quantities of material from the electrodes. The temperature of the electrical arc that is produced as a result is extremely high (tens of thousands of degrees), which causes the metal on the contact surfaces to melt, pool, and migrate along with the current. Additionally, fine particulate matter is released into the atmosphere during this process [15].

3. FAILURE SCENARIOS ASSOCIATED WITH SHORT CIRCUIT STRESSES AND WINDING DEFORMATION

When a transformer is exposed to a short circuit in the network to which it is coupled, the current flows through the transformer suffer a significant rise throughout the length of the external fault. Because they are no longer restricted by the impedance of the load, the magnitudes of the resulting "through fault" currents are typically much higher than the normal in-service currents. This is due to the fact that the impedance of the transformer itself may be the only thing that can restrict them. The short circuit could have been caused by a defect in another piece of network equipment, or it could have been the result of a system or environmentally generated transient, such as a close-up lightning strike, which causes a phase to earth fault. Alternatively, the short circuit could have been caused by a close-up lightning strike. The radial and axial forces that operate on windings give rise to the principal deformation modes that are induced by fault currents. These modes are as follows, Radial buckling, The conductor's inclination, Local distortion of the winding and bending of the conductor between the spacer columns that are supporting it, Conductor telescoping in windings that have a restricted radial thickness and constraint, and in which conductors have been allowed to pass axially past each other, The winding of a spiral as a result of twisting forces, The collapse of the winding and the supports Movement of the winding leads, especially the tap leads.

4. VARIOUS TYPES OF FAILURE

When it comes to huge power transformers, the causes of failure are not always obvious. But, if we assume that a major power transformer has failed, we may classify that failure into one of three categories. Major insulation failure owing to advanced age of solid insulation. Partially failing insulation as a result of early aging caused by localized, high-temperature overheating. Windings break down mechanically[2].

5. PROBLEM STATEMENT

If there is a defect in which current can flow with little resistance from one terminal of a component to the other, we say that there is a short circuit. When a component in a circuit is shorted out, the circuit acts as if it were never present. The failure of the component causes a rise in

circuit-wide current, which might harm or even start a fire in other parts of the circuit. So, what's the deal with shorts? To claim that current follows the route of least resistance is a rather inaccurate approach to describe them. Rapid heating caused by a high current running through a battery may trigger an explosion, releasing hydrogen gas and electrolyte (an acid or a base) that can burn flesh and lead to blindness or death. When wires are overloaded, they heat up and may melt or catch fire if the insulation around them melts. Remember that safety measures are of the highest significance while dealing with electricity and that all electronic technical manuals have a section on safety precautions at the beginning.

A notice listing the equipment's unique operations should also be shown. In main circuits, short circuits may take place between two phases, between a phase and neutral, or between a phase and earth. They can also take place between two phases and the earth. These kinds of short circuits almost always produce a current that is quite high and, as a consequence, swiftly set off an overcurrent safety mechanism. Transformers used in power distribution are purposefully constructed to have a specific level of leakage reactance. This is done with the goal of mitigating the potentially disastrous consequences of short circuits. In primary circuits, short circuits may occur between two phases, between a phase and neutral, or between a phase and earth. They can also take place between two phases and the earth. These kinds of short circuits almost always produce a relatively high current and, as a consequence, swiftly set off an overcurrent safety mechanism. Transformers used in power distribution are purposefully constructed to have a specific level of leakage reactance. This is done to mitigate the potentially disastrous consequences of short circuits. Outlets for electrical power or even the location of the short circuit itself. This is a frequent scenario that results in the formation of an electric arc, which, if it does occur during the short circuit, generates a significant amount of heat and has the potential also to cause the ignition of combustible substances. Conductors in industrial and utility distribution systems are caused to become farther apart due to dynamic forces induced by strong short forces in circuit currents. The forces that are created during a short circuit have the potential to cause damage to bus bars, cables, and other equipment.

6. SHORT CIRCUIT INDICATOR DESIGN AND FEATURES

The voltage regulator provides precise control over a steady voltage ranging from 0 to 8 V. In addition to preventing the load from being damaged by short circuits, and it also indicates connection, overload, and output levels. The voltage stabilizing element is made up of a chain of Zener diode D1 (1N4737A) and green LED D2 (part of two-color LED D2/D4) connected in series with one another (see the figure). The amount of output voltage is controlled by the potentiometer labeled VR1. LED D3 represents the "on" indication. The load is protected from short circuits by the transistor VT2, and the red LED indicates an overload on the board labeled D4. (At the same time, D2 catches on fire due to an overload.) The current in the short circuit does not exceed 38 milliamperes. If a heatsink is utilized with transistor VT1, the output current of the regulator might reach values between 2 and 3 A.

If a two-color LED is not readily accessible, D2 and D4 may make do with individual green and red LEDs. The panel meter will show the current output voltage, but using it is entirely discretionary. The value of the damping resistor R6, whose value is determined empirically and relies on the value of the panel meter's internal resistance, is dependent on the value of the panel meter. Combining a conventional Zener regulator with a transistor to create a current amplifier is neither innovative nor original. Including overcurrent and short protection and overcurrent and short detection makes the circuit more valuable than a standard Zener and transistor regulator. Nevertheless, designers need to be mindful of different variables before employing them. To begin, even within the green spectrum, the forward voltage drops of LEDs may vary substantially. The voltage range of green LEDs is from 1.7 V to 3.5 V. The voltage reference is provided by a combination of a Zener diode (D₁) and an LED (D₂); hence, the LED's forward voltage impacts the output voltage range. A LED's forward voltage is sensitive to its operating temperature and the LED's forward current. Second, the author states that the current in a short circuit cannot exceed 38 milliamps. Nevertheless, since there is no current sensing, it is impossible to estimate the short-

circuit current; hence, the current limit must be computed roundabout. When the output voltage lowers owing to over-current (or short) to below $V_{D3} + V_{BE2}$ (usually 2.9 V), VT2 conducts and reduces the base current of pass transistor VT1, capping the output current and protecting the pass transistor from damage. If one does not know the load resistance, also known as R_{Load} , it is impossible to predict the maximum current that would flow in the event of an overload or short circuit as shown in Figure 1.

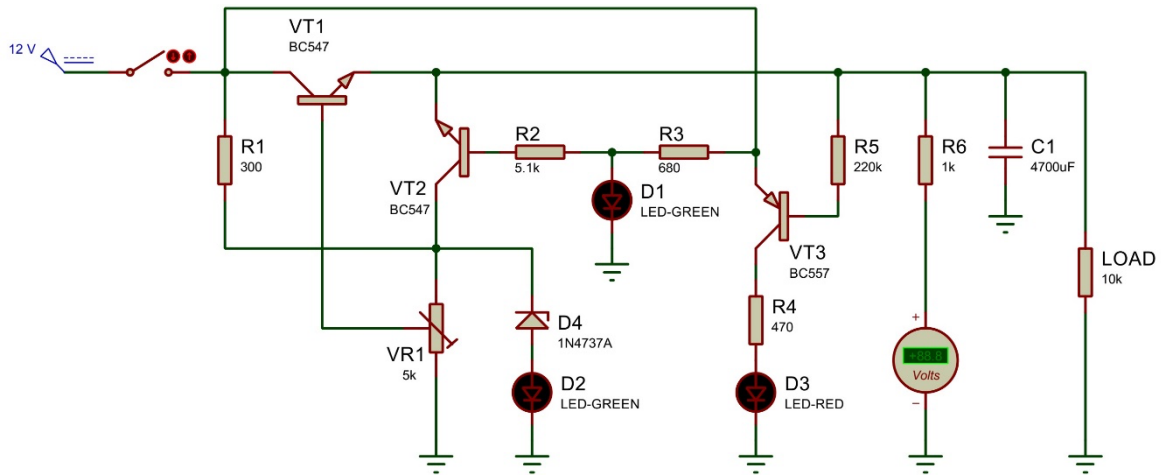


Figure 1. Circuit diagram

Finally, since the current restriction is imposed at a voltage level of around 2.9 V, the circuit cannot provide an output voltage lower than 2.9 V. The dial on the front panel suggests that the output voltage may be anything from 0 V to 8 V; however, this range is impossible. Fourth, because of the problem of changing LED forward voltages, every created regulator will need to be calibrated. Since there is no capacity for calibration in this circuit, the voltage setting dial may need to be marked uniquely for each regulator that utilizes a unique batch of green LEDs. This is because there is no calibration facility in this circuit. Design Circuit showed in Figure 2.

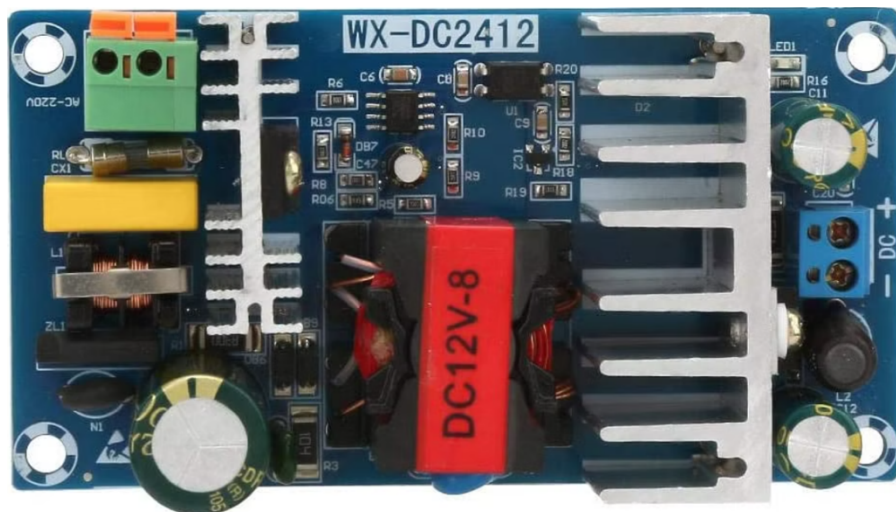


Figure 2. Design Circuit

Fifth, the output voltage is determined by the adjustable resistor VR1, which has a value of 5 k. The maximum output current and output voltage are related because the power transistor VT1 flows via VR1, and the base current relies on the output voltage. The output current capacity will decrease in direct proportion to the increase in output voltage. Replace VT1 with an n-channel

MOSFET as a last step to eliminate the influence that the base current of VT1 has on the voltage measured at the slider for VR1.

Short-circuit and earth fault detection with 3 single-phase current sensors and one grounding current sensor. Short-circuit indication (3 single phase L1, L2, L3) by one super bright LED Earth fault indication by one super bright LED display Remote indication via 2 relay contacts Auxiliary power supply: 24V-230V DC/AC or built-in Li-ion battery with a low-power-status indication Reset/Test Button Remote reset Auto-reset: 7s/8h/12h/24h reset time for options.

7. SHORT CIRCUIT& EARTH FAULT INDICATOR

In Figure 3, order to quickly identify the faulty section of the network and restore power supplies to customers on healthy sections, engineers on the electricity distribution network use Earth Fault Indicator for MV Power Distribution Networks, which are typically installed in Ring Main Units, Cable Distribution Boxes, and Switch Cabinets.

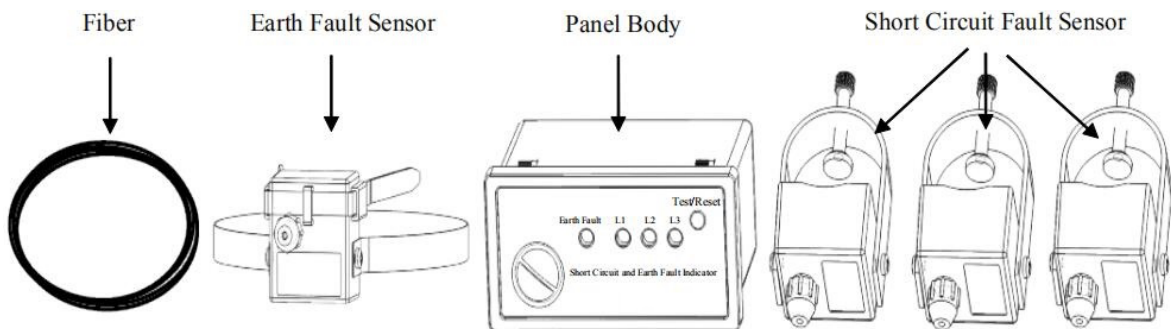


Figure 3. Short Circuit& Earth Fault Indicator.

The line current of the power systems is sensed by the short circuit fault sensor, which then triggers an alert. Normally. In the event of a short line fault, the sensor will send an alarm signal over the fiber line if the short fault current is greater than the alarm current value; once the panel body receives the alarm signal, it will display the appropriate indication, such as a blinking short circuit fault indicator light and an output from the dry contacts. The earth fault sensor detects the zero sequence current of the power systems, sounding an alert in the event of an earth fault. After a sensor detects an earth fault and the zero-sequence current rises above the current alarm value, an alarm signal is transmitted over the fiber line to the panel body, which then provides the appropriate indication—for instance, by flashing the earth fault indicator light and providing output via the dry contacts. When the alarm signal is activated, the indication alarm will reset automatically according to the reset time that you have selected. The alarm may be reset manually by pressing the Test/Reset button on the Panel whenever the indication goes out. Automation, when the alarm goes off, the signal may be sent to a central monitoring station. Pressing the Test/Reset button on the Panel will cause the indicator to self-test to determine its operational status.

8. CONCLUSION

Short Circuit identifies a fault in the high voltage power line short circuit by detecting the three single-phase and short circuit currents. Also, it identifies a failure in the grounding by detecting the zero sequence currents. It allows line patrol employees immediately detect the place where there is a short circuit or grounding fault on the 3kV-40.5kV power distribution networks, switchgear or cable branching units, etc., by providing visual or auditory signs. In order to study short circuits, we are required to understand short circuits and to provide definitive answers to some puzzling queries like, "What exactly is a short circuit?" How does it happen? When does it happen? Why does it occur? When does it take place? And why does it occur? In addition, the study of learning how to prevent short circuits. Studies of short circuits, also known as fault currents, are essential to guarantee that the ratings of existing and newly installed equipment are sufficient enough to withstand the amount of short circuit energy present at each point in the electrical system.

One factor that needs to be addressed is how the equipment is grounded even though it poses a risk, mainly while the ship is in motion. The necessity of wiring directly to the return side of the transformer can be avoided if the return side of the power transformer is grounded to the metal chassis. This enables the load supplied by the power supply to be hooked directly to the return side of the transformer. Current faults greater than the rated capacity of the device can cause substantial damage to the equipment and pose a significant risk to human life. This short circuit is to blame for a significant number of fire mishaps that have recently taken place. We must gain an understanding of the phenomenon of short circuits in order to protect buildings from its effects.

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