HCTL Open International Journal of Technology Innovations and Research (IJTIR)
http://ijtir.hctl.org
Volume 15, May 2015
e-ISSN: 2321-1814, ISBN (Print): 978-1-62951-974-6

Protection of Load in Electrical Power System by Using Arc Extinguish System and relay in MATLAB/SIMULINK

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Abstract

Load protection in electrical system, wide area networks is very important and this paper presents the difference of line voltage & load voltage, the difference of line current & load current and also presents the constant arc resistance, Power transfer from sending end to receiving end in normal condition and protection of the utility systems like housing equipment or light loads & also industrial loads are also protected in the power system. That maintains the current and voltages in electrical power system.

Keywords

Arc system, Circuit Breaker, and Relay.

Introduction

The electrical energy is produced by the primary energy sources, so it is very costly and saving of electricity is very important for the utilization. The electrical power system consist of the three main functions to transmit the electric power from sending end to receiving end and they are generation, transmission and distribution (utility) [1]. When sending the electrical power many types of loss and fault occurs, so protection is used for safe operation without suffering any abnormal condition.

On the receiving end or utilization substation different types of load are connected and continuous supply is provided to the load. For the protection of load, many types of protections are used for the safe operation, when the short circuit occur in the power system, it affects the load and also other units of the system [2], so for the protection of load is compulsory for less damage or minimum loss of electricity.

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Circuit breaker and relay are used for the protection of power system or any other electrical system. Fault or short circuit conditions occur in the electrical system, if the load is connected, the relay sense the fault condition and relay coil is energize and one trip signal is sent to the circuit breaker (CB) and circuit breaker trips or open the contact of CB and protect the load, which is connected to the system [3].

For the reliable, efficient operation of electrical power system and operation related to telecommunication networks in wide area network it needs to protection of load. Nowadays any type of load is connected in the electrical network, so faults arise commonly. When the mismatch for the setting of load is found then short circuit (SC) occurs. When the SC occur, massive current flow through the electrical system and arc is developed, so to extinguish the arc , arc system is used. [1, 4].

Generally the problems of a utility are found in loose wiring, bad connections, weak load shielding and major disturbance in the electrical power system, so first of all proper connection should be done and voltage, current and frequency are matched for better operation of motor, bulb, sequential tripping of load and industrial load.

Most of the disturbances in the load cause massive current flowing through the electrical system, so relay of high current is used for load protection [5, 8]. Load protection depends on the data acquisition system (low frequency and high frequency). So transient instability is removed by the grounding system and it removes the difference of potential, currents and frequencies.

SIMULINK Model of Load Protection

Load protection is important function in the power system i.e. first of all we connect in the power supply to the system. Circuit breaker (CB) and relay receive the supply from the line and if any fault occurs in the system then the relay senses the fault and sends a trip signal to the circuit breaker [6] and CB will operate or open and provide the protection for load as shown in fig. 1.

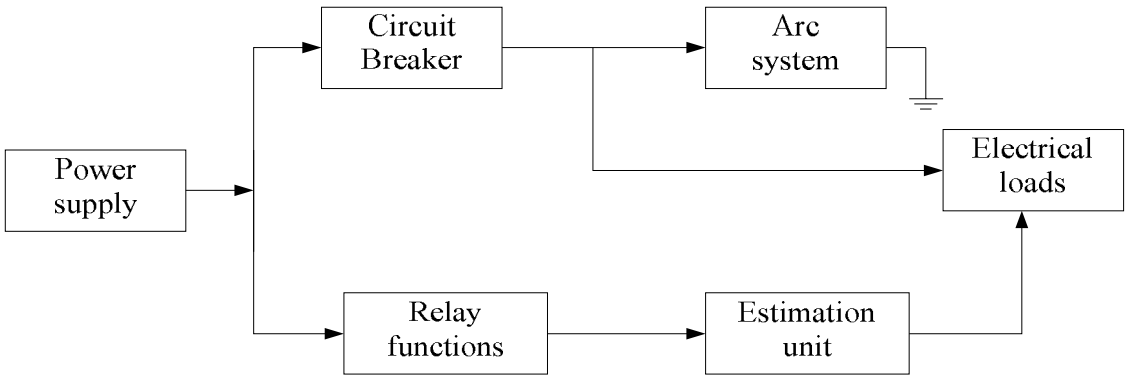

Figure 1: Block diagram of protection load model

The arc model by a fixed resistance R is 56.64Ω. The arc extinguishes when it's RMS current falls below a certain threshold value (typically 50 A) defined in the arc model

block. The main arc resistance performs as an exponential function of the RMS current The main arc resistance increases when the RMS arc current decreases so that the time for arc current to decay below the threshold value could be minimum (With the specified parameters, Rarc = 0.1ohm and 30 ohms respectively for currents of 1kA and 100A) as shown in fig. 2.

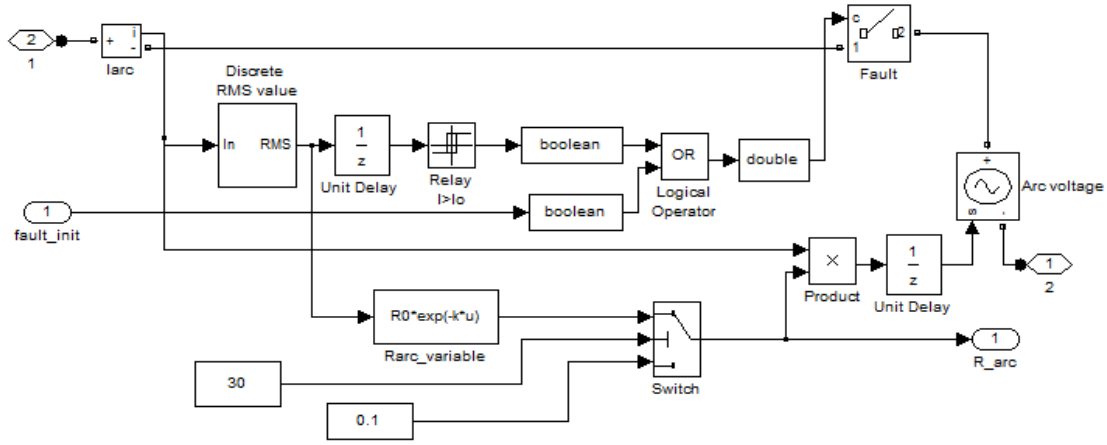

Figure 2: Arc system in load protection

The line opening or reclosing sequence is performed. The fault is applied at t = 1 cycle. Then, the opening command is sent to both breakers at t = 4 cycles (3 cycles detection + opening time). The two breakers are reclosed at t = 34 cycles after a dead time of 30 cycles, in this time duration arc must be extinguished which is responsible for fault created [7].

This phenomenon of arc extinguishing is provided for the protection of series RL load.

Source voltage = 420V,
Rated current (Io) = 50A
R and L = 0.2 ohms and 0.05 mH

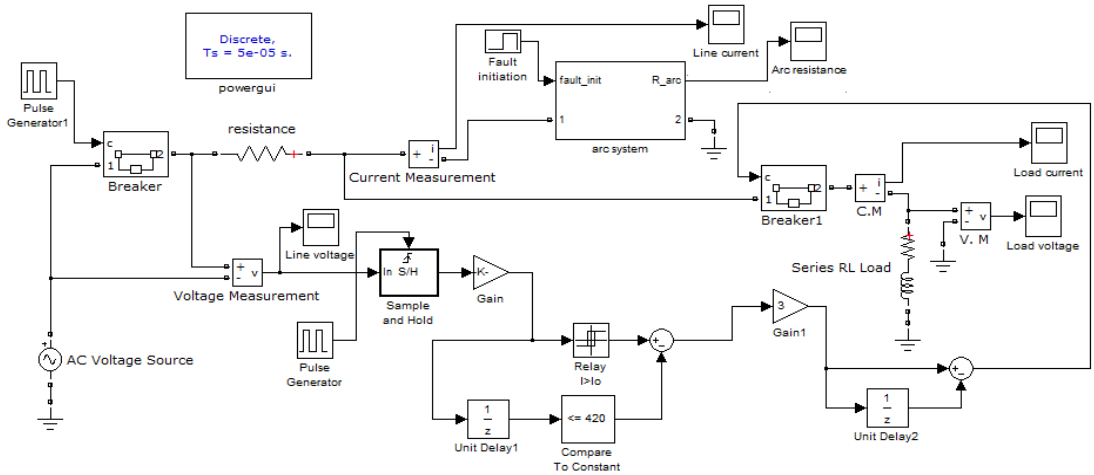

Figure 3: (a) Protection of load Simulink model in MATLAB

Load Protection Simulation Results

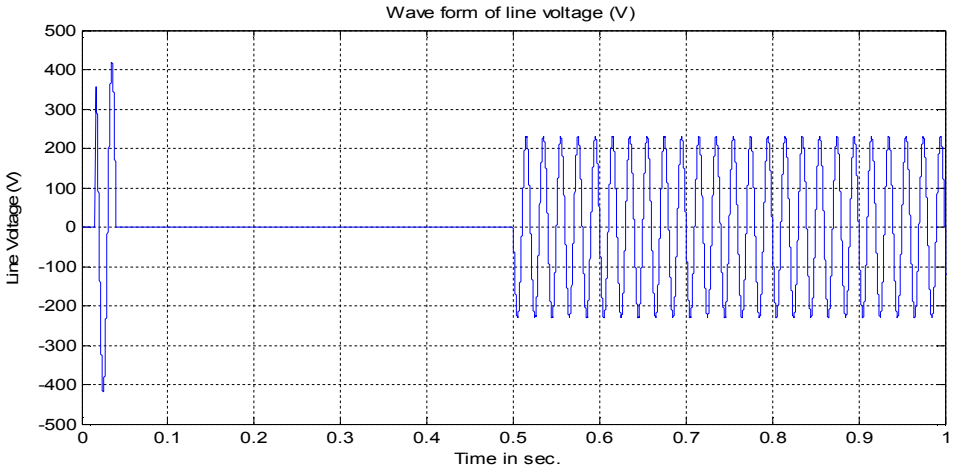

Figure 3: (b) Wave form of line voltage (V)

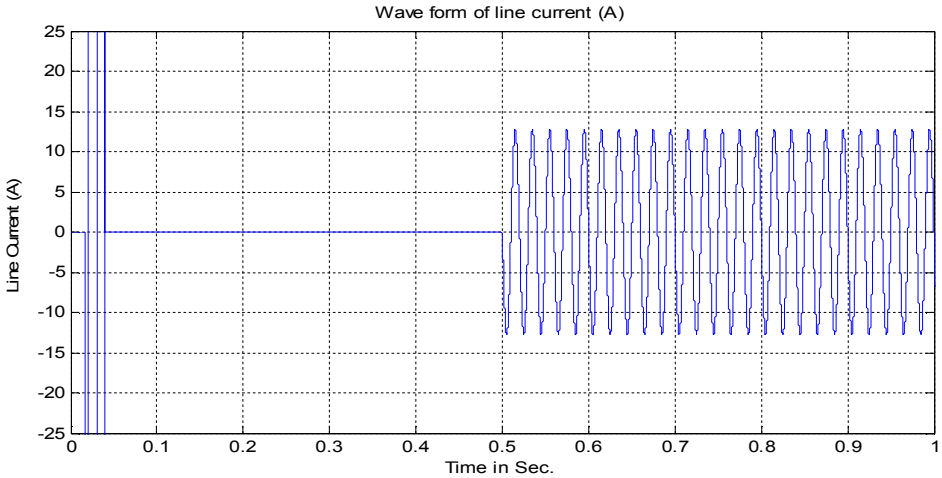

Figure 3: (c) Wave form of line current (A)

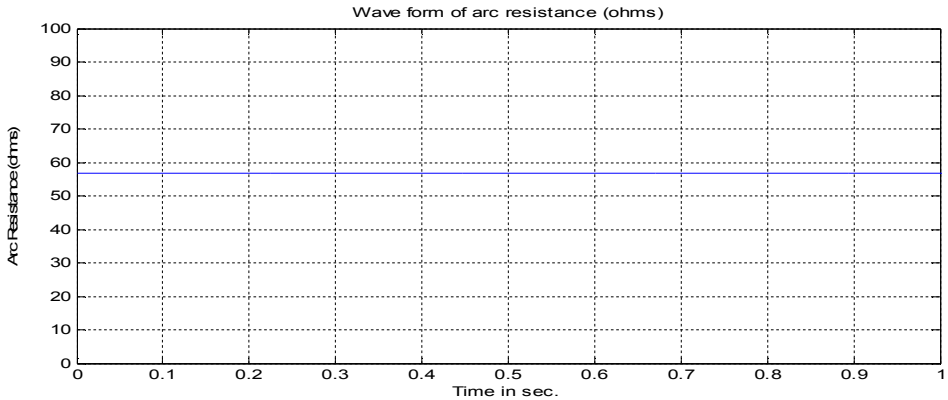

Fig. 3 (d) Wave form of Arc resistance (ohms)

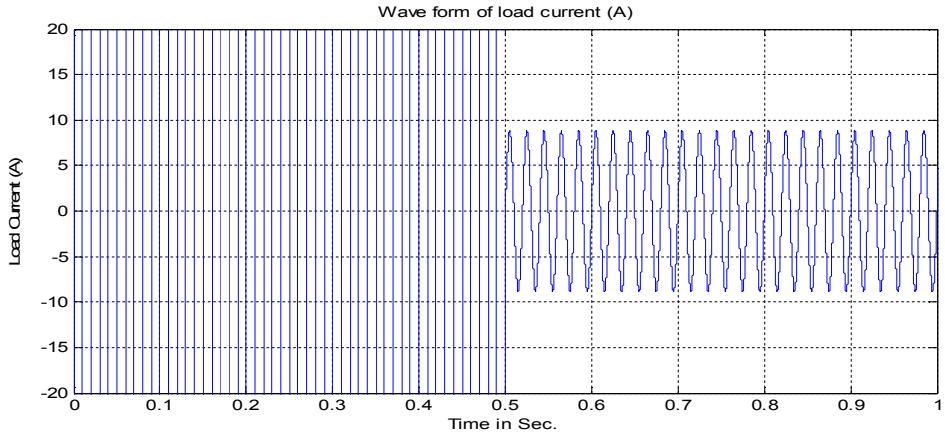

Figure 3: (e) Wave form of load current (A)

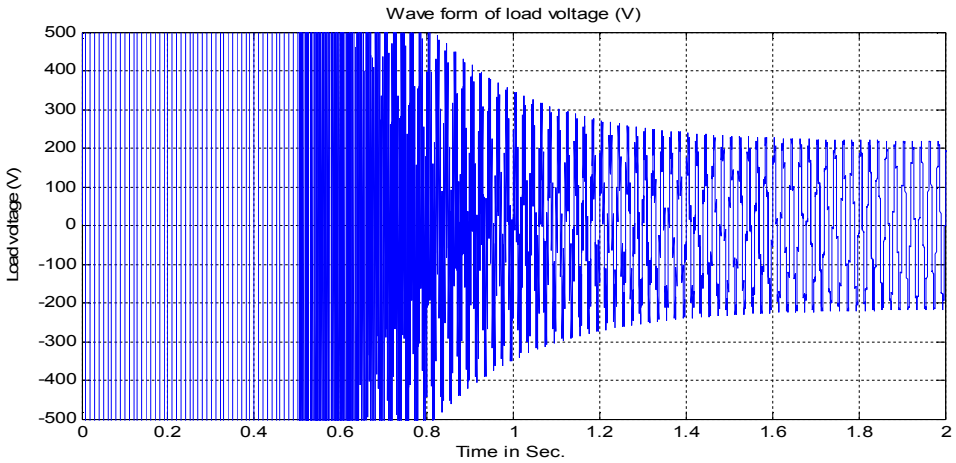

Figure 3: (f) Wave form of load voltage (V)

The Residential Area Load is normal load means no kind of disturbance or fault occurred for this load. Figure clarifies that before the maximum peak, normal current is obtained, as the fault occur the current starts up to higher value. The reason behind this condition is tripping of the faulty load, connected parallel to the residential load [8].

In the load protection model first of all the suitable value are chosen for the protection scheme and arc model rated arc resistance is 56.64Ω that is constant value of arc resistance for arc extinguish. Input line current of arc model give the output is arc resistance that is constant value of resistance.

After the arc system execution we connected the current detection scheme for over current protection and also called the over current relay protection. Over current relay senses the over current fault and send a signal to the circuit breaker to trip the circuit breaker and protect the connected load by the arc and u/o (under/over) current relay.

Fig. 3 (a) shows the complete model of load protection scheme in MATLAB/Simulink by the arc system and over current relay and the results of load protection are shows in the fig. 1 given above.

Fig. 3 (b) shows the wave form of line voltage (V) that is 220V, in starting high current flowing in the electrical system and it is at specified value of voltage and fig. 3 (c) shows the wave form of arc system line current (A) that is normally high current 12.5A and arc resistance which is constant value 56.64Ω shown in fig. 3 (d). That shows the high current flow in starting and comes to zero after some time it will operate normally.

Fig. 3 (e) shows the wave form of load current (A). In starting load current (massive current) flow at no load after some time it will operate normally when load is connected. Load voltage (V) is 210V when load is connected as shown in fig. 3 (f). This is suitable for the load. After the protection scheme is completed for the load protection the load current is 8A and load voltage is 210V. These entire sections, models and results show the complete protection of load from arcing and over current.

Conclusion

This paper has discussed the phenomenon of load protection by implementation of arc system and over current relay by using MATLAB/SIMULINK. In wide area power system load protection from over currents over voltages and over frequencies are provided [9]. This paper presents the normal operating voltage, current and arc resistance, which is used for the arc extinguish and protection of the connected load.

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