PROTECTION OF DISTRIBUTED POWER SYSTEM WITH OVERCURRENT AND FREQUENCY VARIATIONS

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Abstract: In Recent years we have seen a drastic increase in the load at the buses and is going on increasing, due to these loads which are sometimes impulsive in nature there is a sharp increase in currents which flows through less resistive path and in those paths these currents damages the other loads which have less protections, hence in this research work a plan is proposed and simulated in MATLAB 2021 A of a small distribution system model were currents and frequency are fluctuated by creating faults and by Programable source settings. It is seen that as the current increases beyond the protected or trip limit then also supply does not trips off for the local distributed system, as the supply trips off for the overall bus system as per power system design but a increase in current at small distributed damages the load hence a model is proposed for the protection from under over frequencies and over currents.in this the circuit breaker is controlled by the controller designed using MATLAB codes in user MATLAB function toolbox which controls it. the results are satisfactory and these results can be verified using the same codes by implementing it in a practical hardware system.

Key words: voltage restorer, Over Current Protection, Over and Under Frequency, MATLAB Simulink

1. INTRODUCTION

The frequency of a power system will suffer a decline when the demand for electricity exceeds the generation capacity. Such an event or contingency occurs randomly due to the sudden loss of one or more generating units. Generating units cannot operate for an extended period in under- frequency conditions, since the mechanical resonance will damage the turbine blades. For this reason, the manufacturers set under-frequency/time limitations that if violated will cause the unit to trip. This means that if the frequency is not promptly returned to its nominal value by either generation regulation action (primary frequency regulation) or by automatic load shedding, more generating units will trip and the system frequency will continue to drop. A local shortage of generation will also cause interconnected systems to supply extra power to meet the load. This action might overload the connecting tie-lines and make them trip as well, thus exacerbating the system degradation. Under-frequency load shedding (UFLS) has been widely used since the 1960's as the last resort to protect power systems from total blackouts following contingencies that lead to a significant decline in frequency

1. Causes of Under over currents and Frequency Fluctuations

There are various causes for which under voltages are created in system voltage [1].

1. Closing and Opening of Circuit Breakers:

When the circuit breaker of a phase is opened suddenly, then the line which it is feeding will be temporarily disconnected. The other feeder lines from the same substation system will act as an under voltage.

2. Due to Fault: Under voltage due to fault can be critical to the operation of a power plant. The magnitude of under voltage can be equal in each phase or unequal respectively and it depends on the nature of the fault whether it is symmetrical or unsymmetrical.

3.Due to Motor Starting:

Under voltage due to motor starting are symmetrical since the induction motors are balanced three phase loads, this will draw approximately the same high starting current in all the phases.

4. Due to Transformer Energizing:

There are mainly two causes of under voltage due to transformer energizing. One is normal system operations which include manual energizing of a transformer and another is the reclosing actions. These under voltages are unsymmetrical in nature.

5. Equipment Failure:

Failure of electrical equipment occurs due to insulation breakdown or heating or short circuit etc.

6. Bad Weather:

Lightning strikes in the power line cause a significant number of under voltages. A line to ground fault occurs when lightning strikes the line and continues to ground.

7. Pollution

Flash over takes place when there is storm in the coastal regions, where the power line is covered with salt. This salt formation acts as a good conductor of electricity and faults occur.

8. Construction Activity:

Generally, all power lines are undergrounded in urban areas, digging for doing foundation work of buildings can cause damage to underground cables and create under voltages

Hence Considering the above Motivation a MATLAB Model is prepared were the above issues are highlighted and system is protected using programming corrections in existing system .

2. SIMULATION BLOCK REPRESENTATION MODEL

There are two objectives covered in this research work, the first one is frequency fluctuations considerations using a programable source and the second one is implementation of over currents using Fault implementations

2.1 Modelling of Frequency Relay

In the below diagram it is clearly shown the Prepared MATLAB model in version R2021 (a). the description of the model is shown below in table no 5.1 in this model firstly a programable source is considered which automatically dips its frequency and also increases it frequency at two-time intervals, the circuit breaker with coded relay protection scheme is provided at Bus B scope. The load at bus B is protected by the relay created by the author of this research work the relay senses the frequency changes in both sides and trips of the circuit.in previous chapters it was observed the worst scenarios of frequency changes on the loads so in this work a logic is implemented for the load protection in different circumstances of frequency cuts.

In the next stages a Fault based model is also prepared from which also the frequency drops, in place of programmable source the frequency dips due to LL – LG – LLG fault conditions.in figure no 1 the complete model with programable source is described, in figure no 2 the MATLAB user function block is represented were the logic is implemented, finally in figure no 3 the logic used is Implemented.

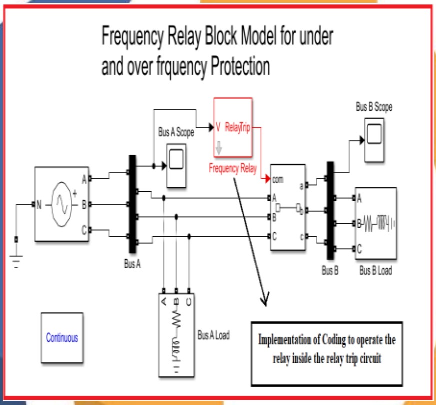


Fig 1 The Block Diagram of the Under and Over Frequency Relay Model Implemented in MATLAB

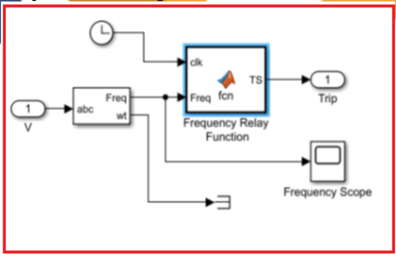
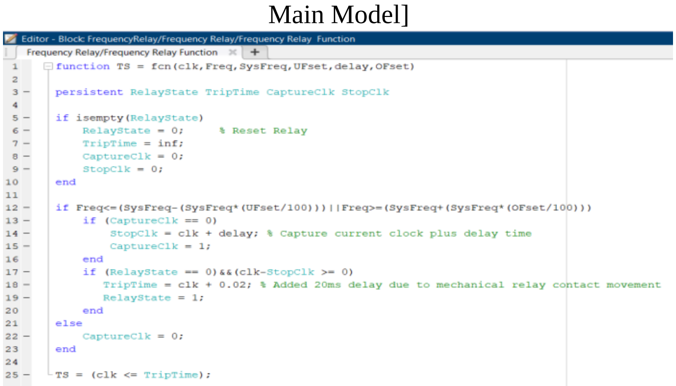


Fig 2 User MATLAB Function in MATLAB used For Writing Relay Code [The Function is Inside Red Coloured Box of Main Model]



```
Editor - Block: FrequencyRelay/Frequency Relay/Frequency Relay Function
Frequency Relay/Frequency Relay Function

function TS = fcn(clk,Freq,SysFreq,UFset,delay,OFset)

persistent RelayState TripTime CaptureClk StopClk

if isempty(RelayState)
    RelayState = 0;      % Reset Relay
    TripTime = inf;
    CaptureClk = 0;
    StopClk = 0;
end

if Freq<=(SysFreq-(SysFreq*(UFset/100)))||Freq>=(SysFreq+(SysFreq*(OFset/100)))
    if (CaptureClk == 0)
        StopClk = clk + delay; % Capture current clock plus delay time
        CaptureClk = 1;
    end
    if (RelayState == 0)&&(clk-StopClk >= 0)
       TripTime = clk + 0.02; % Added 20ms delay due to mechanical relay contact movement
       RelayState = 1;
    end
else
    CaptureClk = 0;
end

TS = (clk <= TripTime);
```

Fig 3 The Implemented Code to operate the relay Circuit inside User MATLAB Function

2.2 Specification of the Simulink Block Used in the Model

.no	MATLAB Block Used	Used Block Specifications
1	Three Phase Programmable Voltage Source	This block implements a three-phase zero-impedance voltage source. The common node (neutral) of the three sources is accessible via input 1 (N) of the block. Time variation for the amplitude, phase and frequency of the fundamental can be pre-programmed. In addition, two harmonics can be superimposed on the fundamental. Note: For "Phasor simulation", frequency variation and harmonic injection are not allowed. Specify Order =1 and Seq=1,2 or 0 to inject additional fundamental components A and B in any sequence.
2	Three Phase Load	Implements a three-phase series RLC load. With Declaration of Active (P) and Reactive Power of the Load as per the Configuration Considered
3	Three Phase VI measurement MASk	The block can output the voltages and currents in per unit values or in volts and amperes.
4.	Scope	To view the real time view of the Waveforms to judge the operation of the Model
5.	POWER Gui Continuous powergui	The most Important part of the Model without this the model in MATLAB will not run.

Table no .1 Description of MATLAB Resources used for Model Preparation

2.3 Modelling of an Over Current Relay

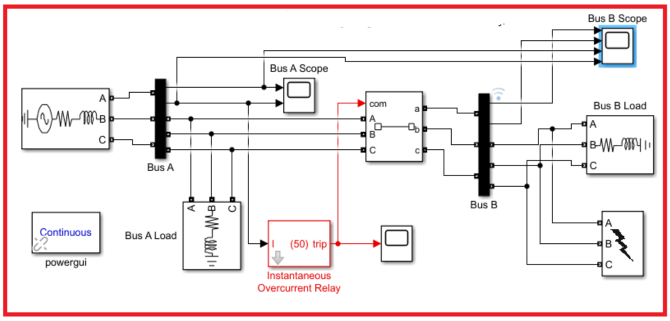


Fig 4 The Block Diagram of the Over current Relay Model Implemented in MATLAB with faults

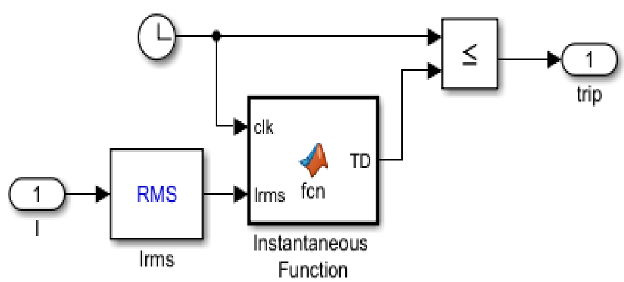


Fig 5 User MATLAB Function in MATLAB used For Writing Relay Code [The Function is Inside Red Coloured Box of Main Model]

2.4 Relay Implemented Code in the Function Box

```
function TD = fcn(clk,Irms,CTpri,CTsec,PS,HS)

persistent RelayState TripDelay

if isempty(RelayState)
RelayState = 0;    % Reset Relay
TripDelay = inf;
end

CT = max(Irms/(CTpri/CTsec));
Pickup = (PS*0.25)*CTsec*HS;

if (RelayState == 0)&&(CT > Pickup)
TripDelay = clk + 0.02; % Added 20ms delay due to mechanical relay contact movement
RelayState = 1;
end

TD = TripDelay;
```

3. RESULT ANALYSIS

After running both the models the results are obtained shown in below figure. The detailed description to the results is:

(i) The description of the two models considered are explained in the table above and the preparation of these model is done in MATLAB 2021 a whose diagrams can be seen in above figures

(ii) The relay codes used in MATLAB user function block controls the circuit breaker, as the frequency makes under and over shoots the circuit trips off. the codes of the MATLAB function are implemented in one bus while the other bus is kept scattered.

(iii) The same logic of frequency rise and falls are implemented on over currents in the circuit and a model is obtained

(iv) The results of the figure show 4 scopes together, first scope is the result waveform of load voltage at protected bus, second is the Load current at the protected bus, third is the supply voltage or the unprotected bus side voltage and fourth one is the current of unprotected side.

(v) The think to get understood from these are that as the current is increased due to fault created at .4 second the codes do there work and trips the circuit and protects the protected load by maintaining zero voltage after fault and zero current after fault but the supply side voltage and current does not get any effect and this supply of voltage and current keeps on going even after faults.

(vi) Protected side trips off and secures the load at protected side bus but unprotected side load draws a heavy current and voltage due to which load can be damaged.

(vii) The logic can be implemented using python language in IC of relay protection and a hardware model can be verified at homes, malls, hospitals etc

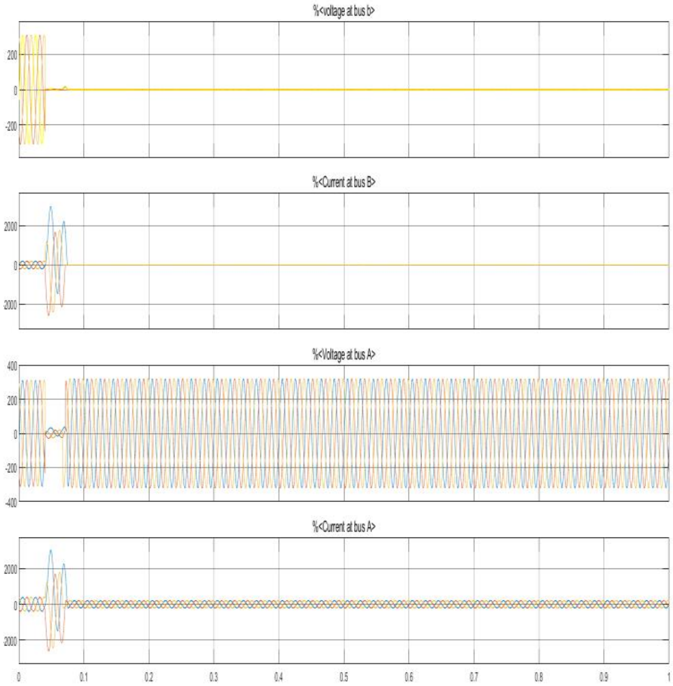


Fig 6 The above 4 windows show the complete operation of models [1. voltage at protected side 2. Current at protected side 3. Voltage at non protected side 4. Current at non protected side

4. CONCLUSION

In Recent years we have seen a drastic increase in the load at the buses and is going on increasing, due to these loads which are sometimes impulsive in nature there is a sharp increase in currents which flows through less resistive path and in those paths these currents damages the other loads which have less protections, hence in this research work a plan is proposed and simulated in MATLAB 2021 A of a small distribution system model were currents and frequency are fluctuated by creating faults and by Programable source settings. It is seen that as the current increases beyond the protected or trip limit then also supply does not trips off for the local distributed system, as the supply trips off for the overall bus system as per power system design but a increase in current at small distributed damages the load hence a model is proposed for the protection from under over frequencies and over currents.in this the circuit breaker is controlled by the controller designed using MATLAB codes in user MATLAB function toolbox which controls it. the results are satisfactory and these results can be verified using the same codes by implementing it in a practical hardware system.

5. FUTURE WORK

The technology is increasing day by day and the need to protect devices is also increasing, the logic presented can be implemented in any protection circuit with change in the rating in the code hence those sensitive devices which have protection system can have a parallel safe protection system as threshold protection and these logics can be implemented in various IOT enabled devises and even for all set of combined devices.

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Bibliography

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