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Detection of single line to ground fault and self-extinguishing by using a variable and a fixedable inductance in distribution grid in power

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ABSTRACT

This paper tackled the method for determining the number of Peterson coil which is can compensate with the capacitance because it is important in determining the state of parallel resonance, which in turn control the ground fault current and make the approximate value of the current equal to the current in the sound phases. In this way, we can protect the electrical devices and equipment from being damaged by residual current resulting from the arc due to ground fault, which increases the temperature of conductors which are to a breakdown of insulators and damaging them. Ground fault current equals three times the actual current, and its effect depends on two types of variables which are the first: the number of Peterson coils (which specify the inductance value and compensated) and second: the period time of extinguishing electric are in the ground fault. we obtain, by experimental in the lab where it using the servo motor to control the number of Peterson coils which in turn specify the variable and invariable inductance. We have obtained optimal results for the value of ground-fault current, detect the ground fault and treat it without effect of network load and without power cut off for consumer.

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1. INTRODUCTION

Fault detection is a very important issue to consider in power systems to ensure safety, reliability and to avoid accidents, damages to equipment and undesired blackouts. Distribution system protection plays an important role in the security and reliability of power supply to customers by isolating an affected section of the system when a fault occurs. Many medium voltage distribution networks around the world are neutral ineffectively earthed power systems.

This situation is mainly attributed to the following factors: i) Faults usually do not draw enough fault current to operate conventional protective devices due to lower voltage levels and higher system impedances [1], [2]; ii) Operating condition variations invalidate the protection schemes that have predetermined setting value; and iii) Different fault cases exhibit complex sets of features and widely varying behaviors, which limit the application of protection schemes based on single fault features [3], [4]. In this paper, we present a new method for the control of PC in resonant grounded networks.

The major problem for the adaptive and to distinguish between resonance points simulated by the disturbances and resonance points. Also, the controller has to be educated network adjustment during the adaptive operation. The first part of this contribution is a short description of the main parameters that define the resonance. The second part deals with the disturbances at very small neutral-to-earth voltages. In seeing, of these disturbances a new algorithm is presented to improve the accuracy of the adaptive operation of the PC. that experiments its practical reality simulators an implementation, at the University of Babylon laboratory.

– ARC-suppression coil (Petersen coil)

An earthing reactor that is attached between the neutral of system earth and has a relatively high selected value of reactance with a reactive current to earth under fault situations levels out the capacitance current as flowing from lines so that the earth current at fault is practically limited to zero. If the ground fault takes place, such as an insulator flash-over, it may be self-extinguishing [5]. This method of grounding is utilized primarily in 33 kV systems, consisting mainly of overhead transmission or distribution lines, and this system of such construction is infrequently used in industrial or commercial power systems [6]. The distribution networks of another un-grounding system properly will trigger a significant problem in the voltages due to residual current ensuing from intermittent electric arc when a ground fault phase one, so earthed distribution network of the break-even point using Petersen coil. A considerable advantage of an impedance earthed network is that a sufficiently rated [7]–[17].

Petersen coil can handle fault current during an earth fault condition consistently. The network may then continue operating normally with one earth fault (one phase earthed), until the fault may be repaired, just as in the case of the unearthed network [18]. This ensures high power supply quality as earth faults constitute 50 % to 80% of all MV network faults. If differed induction Peterson Coil Van I_{OS} the file is not affected while in the case I_{OP} be a different asset this affects the situation in general when the discovery of a single fault connected to the Petersen coil in parallel with the ground could impede the voltage point's ground fault. Most faults of this type in the event of a ground fault phase one is an electric arc for the same self-assessment. Moreover, this method of measurement metrics for isolated networks is accurate and straightforward without the occurrence of any breaks in the processing of power sources [19]. Furthermore, using the exact method of treatment to control the Petersen coil can discover the fault in the ground faster and accurately, as the Petersen coil compensation amplitude functions towards the ground at fault. In this thesis, we address the characteristics of the fault phase with ground (SLG) and analysis of zero-sequence voltage and currents in Peterson coil at the point of fault. Besides, this application helps to detect the percentage of fault cases [19].

In addition to the study of zero-sequence current properties [20]. Adaptive control technology uses Petersen coil to detect ground fault and self- extinguishing through uncontrollably by coil Peterson Coil. When there is a fault in the grounding distribution networks-based Peterson Coil is based on detecting a fault in the system through resonance, which urges them to find a point to view the electric fault and for in a shorter time then reduces the electric arc to the less to avoid a more significant proportion of the damage. Compensation in Peterson Coil with the network where the scrolls are working on the compensation ratio grid and power ground, which is an equivalent network in full or is close to the same resonance, that might cause great effort affects to the system because there is a series that resonance with the ground, these measures of voltages be few and land range and close to zero for the relay voltage V_n . Figure 1 represents the resonance series Peterson coil ground and capacity in the natural states [21]–[25].

$$\dot{U}_N = \frac{\dot{E}_A C_{oA} + \dot{E}_B C_{oB} + \dot{E}_c C_{oc}}{C_{oA} + C_{oB} + C_{oc} - \frac{1}{\omega^2 L_p}} = \frac{\dot{E}_A C_{oA} + \dot{E}_B C_{oB} + \dot{E}_c C_{oc}}{C_{o\Sigma} - \frac{1}{\omega^2 L_p}} \tag{1}$$

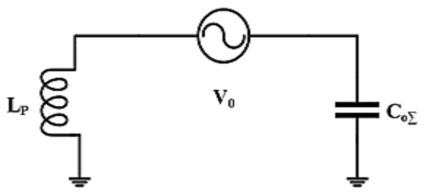


Figure 1. Petersen coil is a series of resonance to the earth capacitance in regular operation [21]

V_N is the voltage at the point of a tie EABC is a network voltage phase one COABC is equivalent to the capacitance per phase with the grounding network, Besides COΣ amount is equivalent to the power in the network, Moreover, ω is the angular frequency of the system, where L_P is Peterson coil induction in resonance equivalent to a ground event /moreover, 3COΣ is the equivalent network capacity [10], as the voltages at the break-even point are very high and are a risk to system operators and employees.

$$3C_{0\Sigma} - \frac{1}{\omega^2 L_P} \quad (2)$$

This research addresses the applications of Petersen's quick impact, where it turns induction Waller in typical cases. The interest it has is to increase $C_{O\Sigma}$ in the operating condition which can be measured by the network information system/ when the work state is changed. In the case of Troubleshooting, the Petersen coil transfers resonance to an electric arc to discharge the coil utilizing a parallel resonance concerning ground as shown in Figure 2 [22], where the steady-state in the zero region detects the error in less time. Figure 2, which represents resonance series in Peterson coil and ground capacity in the case of a ground fault.

RC suppression consists of an immersed coil, which contains coils with iron core provided with several ramifications. Therefore, ohmic resistance can be controlled or regulated to a value, where the current expresses grounding fault depending on the result of the unbalanced capacitor current of the system used. Arc suppression may operate for a short period so that it can load rated current [24]. The short coil time helps the circuit breaker to operate. As the relay is synchronized with the neutral to grounding voltage, the Petersen coil specifies the delay time and connects the neutral to the ground, directly. The short time of the rated coil allows isolating faults without power failure [25].

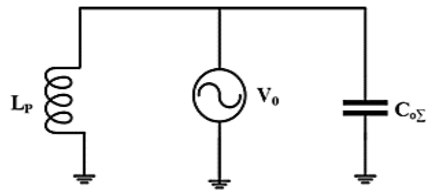


Figure 2. Petersen coil is a parallel resonance to the earth capacitance in single earth fault [23]

2. METHOD
2.1. Simulation
Most of the researchers used a proprietary software program to model single-phase to ground faults in power distribution systems, and researchers use the signals that come from the simulations to collect data about the feeder in a healthy and unhealthy process, and the signals are then analyzed using the proposed algorithm to detect faults. There are several types of software used to simulate power distribution systems, and some researchers have used a MATLAB to change the compensation ratio by changing the interaction of the Peterson-coil to simulate different compensation scenarios. In this paper we used a modern method which is to determine the number of Petersen coils, which plays a large role in determining the compensation ratio of the network when the fault occurs.

2.2. Experimental results of Peterson coil
Experimental measurements of Peterson coil have carried us as shown in Figure 3 (see Appendix). It illustrates an experimental setup, diagrams, and measurement configurations. In this the paper discusses the limited number of inductances which is compensated of Petersen-coil at (SLGF), in often overcompensated also in this paper, adaptive controllable Petersen-coil is applied; inductance can be adaptive optionally. by limited at experimental in Lab as shown in Figures 3(a)-3(c).

Furthermore, experimental runs of Peterson Coil's limited number of turns were compensated with the capacity of earthing in the laboratory environment. They included the measurements of inductance via capacitive line detection. As shown in Figures 3(a)-3(c) measurements of capacitance and V_n with a variable inductance (Petersen coil). In addition to measurements of capacitance and V_n with a fixed of inductance (Petersen coil).

3. RESULTS AND DISCUSSION
Moreover, Figures 4 and 5, shows measurements of capacitance and fault current (I_f) with a variable inductance (Petersen coil). Several values were taken to get the optimum inductance values obtained from fewer current faults of grounding as they occur. The number of Petersen coil windings was determined by value fault current the optimum value of inductance was calculated to get the ideal value from the fault current experiment and adapted to control the value of inductance by parallel resonance. Table 1 shows the measurement for capacitance and I_f with a variable inductance. Inductance in the previous experiment on the

inductance line where values (845, 980, 1125, 1445, 1280, 1680, 1805, 2000) *mH*, the Table 1 shows this case indicates the I_f is reduced and well extinguished at inductance is equal to (1445 *mH*). Also V_n became constant in the ideal value of inductance is equal (1445 *mH*). it can be seen in Table 2, as well. Figure 4. Represents the measurement for capacitance and I_f with a variable inductance (Petersen coil).

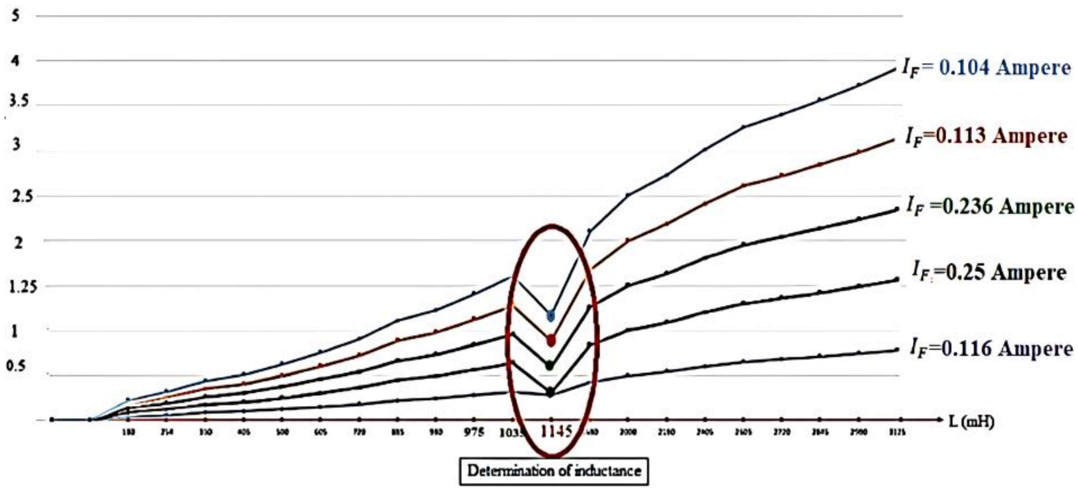


Figure 4. Measurement for capacitance and I_f with a variable inductance (Petersen coil)

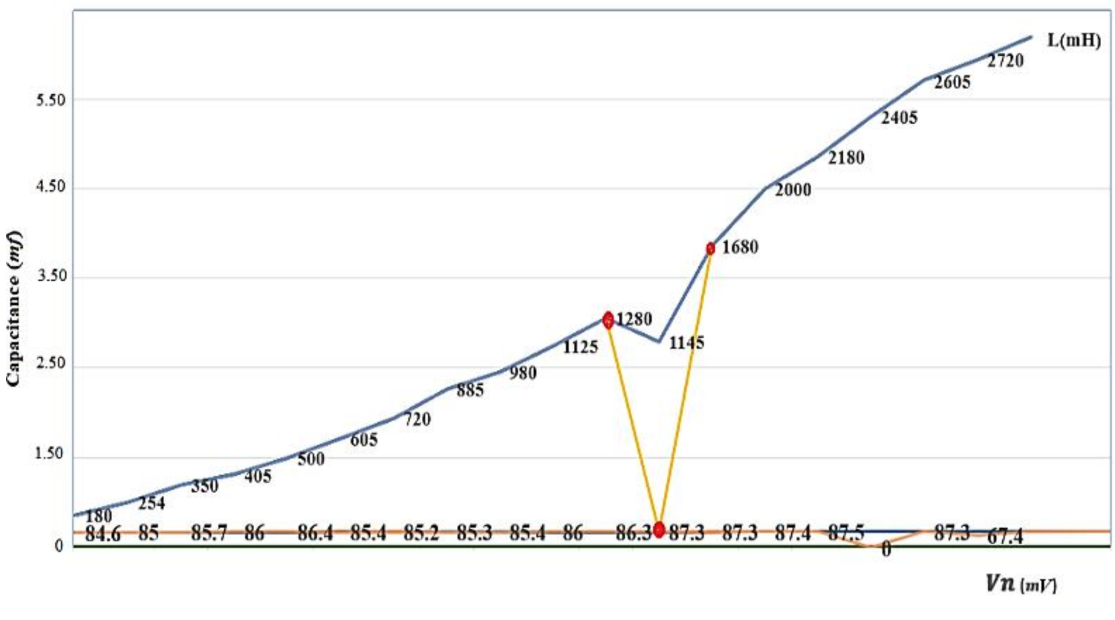


Figure 5. Measurement of optimal L (for the stable V_n) V_S, c

In Table 1 and Figure 4, from the practical results conducted in the electrical engineering laboratory, we found that the inductance value that determines the compensation equal to the resonance of the parallel is an inductance of (1445 m H) which achieves the lowest value of the fault current. Figure 5 represents the measurement of optimal L (for the stable V_n) V_S, c. Table 2 shows the measurement for capacitance and V_n with a variable inductance (Petersen Coil). In Table 2, Figure 5, from the practical results conducted in the electrical engineering laboratory, we found measurement for capacitance and V_n with a variable inductance (Petersen coil) that the inductance value that determines also the compensation equal to the resonance of the parallel is an inductance of (1445 m H) which limited the V_n value at the fault current.

Table 1. Measurement for capacitance and I_f with a variable inductance

L	I_f	c	L	I_f	c	L	I_f	c	L	I_f	c	L	I_f	c	L	I_f	c
180	0.84	0.5	180	0.89	1	180	0.895	1.25	180	0.905	2.5	180	0.9	3.5	180	0.934	5
254	0.95	0.5	254	0.75	1	254	0.776	1.25	254	0.781	2.5	254	0.78	3.5	254	0.809	5
350	0.7	0.5	350	0.62	1	350	0.681	1.25	350	0.653	2.5	350	0.656	3.5	350	0.674	5
405	0.63	0.5	405	0.52	1	405	0.511	1.25	405	0.55	2.5	405	0.551	3.5	405	0.563	5
500	0.52	0.5	500	0.46	1	500	0.438	1.25	500	0.446	2.5	500	0.444	3.5	500	0.455	5
605	0.46	0.5	605	0.4	1	605	0.38	1.25	605	0.365	2.5	605	0.359	3.5	605	0.373	5
720	0.4	0.5	720	0.35	1	720	0.278	1.25	720	0.223	2.5	720	0.278	3.5	720	0.296	5
885	0.35	0.5	885	0.27	1	885	0.236	1.25	885	0.113	2.5	885	0.214	3.5	885	0.226	5
980	0.29	0.5	980	0.21	1	980	0.201	1.25	980	0.075	2.5	980	0.155	3.5	980	0.164	5
1125	0.25	0.5	1125	0.16	1	1125	0.169	1.25	1125	0.061	2.5	1125	0.105	3.5	1125	0.116	5
1280	0.2	0.5	1280	0.114	1	1280	0.142	1.25	1280	0.064	2.5	1280	0.081	3.5	1280	0.083	5
1145	0.25	0.5	1145	0.076	1	86.5	0.117	1.25	1145	0.089	2.5	1145	0.063	3.5	1145	0.064	5
1680	0.17	0.5	1680	0.062	1	1680	0.098	1.25	1680	0.107	2.5	1680	0.07	3.5	1680	0.071	5
2000	0.14	0.5	2000	0.069	1	2000	0.079	1.25	2000	0.128	2.5	2000	0.092	3.5	2000	0.091	5
2180	0.115	0.5	2180	0.084	1	2180	0.059	1.25	2180	0.148	2.5	2180	0.114	3.5	2180	0.113	5
2405	0.093	0.5	2405	0.104	1	2405	0.055	1.25	2405	0.164	2.5	2405	0.134	3.5	2405	0.134	5
2605	0.078	0.5	2605	0.127	1	2605	0.051	1.25	2605	0.172	2.5	2605	0.154	3.5	2605	0.155	5
2720	0.069	0.5	2720	0.48	1	2720	0.048	1.25	2720	0.18	2.5	2720	0.169	3.5	2720	0.178	5
2845	0.066	0.5	2845	0.163	1	2845	/	1.25	2845	0.12	2.5	2845	0.178	3.5	2845	9.187	5
2980	0.066	0.5	2980	0.178	1	2980	/	1.25	2980	/	2.5	2980	0.187	3.5	2980	0.196	5
3125	0	0.5	3125	0.9	1	3125	/	1.25	3125	/	2.5	3125	0.194	3.5	3125	/	5

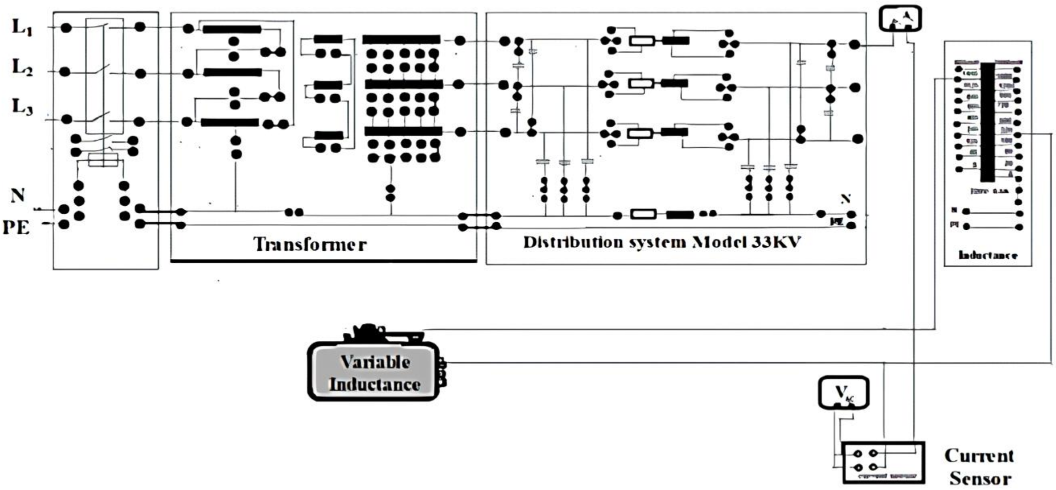
Table 2. Measurement for capacitance and V_n with a variable inductance (Petersen Coil)

L	V_n	C	L	V_n	C	L	V_n	C	L	V_n	C	L	V_n
180	85	1	180	83.6	2.5	180	83	1.25	180	82.8	3.5	180	84.6
254	84.2	1	254	83.9	2.5	254	83.1	1.25	254		3.5	254	85
350	85	1	350	84.4	2.5	350	83.8	1.25	350	83.1	3.5	350	85.7
405	85.3	1	405	84.8	2.5	405	84.2	1.25	405	83.3	3.5	405	86
500	85.4	1	500	85.2	2.5	500	84.5	1.25	500	84.2	3.5	500	86.4
605	85.4	1	605	85.5	2.5	605	87.7	1.25	605	84.6	3.5	605	85.4
720	86.8	1	720	85.7	2.5	720	85	1.25	720	85.2	3.5	720	85.2
885	87	1	885	86	2.5	885	85.2	1.25	885	84.8	3.5	885	85.3
980	85	1	980	86.2	2.5	980	85.3	1.25	980	85.1	3.5	980	85.4
1125	85.1	1	1125	86.5	2.5	1125	85.4	1.25	1125	85.3	3.5	1125	86
1280	85.3	1	1280	86.5	2.5	1280	85.5	1.25	1280	85.5	3.5	1280	86.3
1145	85.4	1	86.5	86.8	2.5	1145	86	1.25	1145	85.8	3.5	1145	87.3
1680	85.5	1	1680	86.6	2.5	1680	86.3	1.25	1680	86	3.5	1680	87.3
2000	86	1	2000	86.6	2.5	2000	86.4	1.25	2000	86.2	3.5	2000	87.4
2180	86.2	1	2180	87	2.5	2180	86.2	1.25	2180	86.6	3.5	2180	87.5
2405	86.3	1	2405	87.1	2.5	2405	86.3	1.25	2405	86.9	3.5	2405	87.1.
2605	86.4	1	2605	87.2	2.5	2605	86.4	1.25	2605	87	3.5	2605	87.3
2720	86.5	1	2720	86.3	2.5	2720	86.2	1.25	2720	86.4	3.5	2720	67.4
2845	86.3	1	2845	86.3	2.5	2845	86.2	1.25	2845	86.2	3.5	2845	87.4

4. CONCLUSION

In this paper the major contribution is determination value of the inductance of Petersen Coil through which the capacitive compensation is made to reduce I_f and the value ranged 1145 mH this value of the amplitude 0.25 mF to1.25 mF to work within the parallel resonance. There are two states of Peterson compensation, the first case is sequential series resonance, and the second case is parallel resonance (as mentioned above), and each state has its own properties. when inductance is tuned to from parallel resonance in the normal operation. Taking advantage of that to reduce of voltage which is the raised in the faulty case, it also helps to processing reduce time of electric arc when single line to ground fault occurs. in this method will increase the reliability of the network, the continuity of electrical power, and detect the fault early when it occurs.

APPENDIX

(a)


(b)

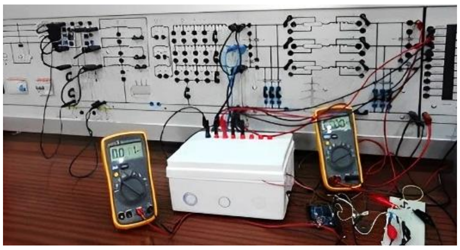

(c)


Figure 3. Experimental: (a) diagram at variable Petersen coil circuits setup, (b) Peterson Coil, and (c) current measurement

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