The Phase Comparison Technique Protection

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Abstract -- This paper studies the usage of phase comparison techniques in line protection. The phase comparison relaying principle is a line of differential relaying that compares the phase angles of the current entering one terminal of a transmission line with the phase angles of the current entering all the remote terminals of the same line. Simulation result shows that the performance of the scheme in protecting the 330Kv Onitsha- ugwuaji transmission line. is effective in differentiating between internal and external faults and in blocking power swing which may occur in the network.

Indexed Terms: Phase comparison, phase variation, Excitation, transmission line, and protection.

I. INTRODUCTION

A transmission line is one of the most important and integral part of a power system. Phase comparison Technique (PCT) is a type of protection by which the quantities are conveyed through communication channels rather than wired interconnections of the relay input devices and it detects both phase and ground faults simultaneously [1].

The (PCT) is a scheme that has the following fundamental qualities: selectivity, reliability, sensitivity and stability. This is important in extra high voltage (EHV) circuits because of a considerable system disturbance that occur may when a heavily loaded line is opened. The protection system must be selective, and precautions must be taken to ensure that no operations are initiated by the relay logic or other means that would cause tripping of unaffected lines or other facilities [2,3].

The development of modern optical fibers communication technology has become increasingly popularized due to its long-distance, large-capacity, high-speed, and real-time synchronous data transmission. Pilot protection, based on fible communication technology has become one of the primary forms of transmission line pilot protection (8). Consequently, many of these configurations rely on differential protection principle, but problems such as low sensitivity or poor reliability, because of CT saturation, and influence of large charging current, due to line distributed capacitance, for long transmission lines arise when implementing differential protection [6].

II. PHASE COMPARISON TECHNIQUES FOR TRANSMISSION LINE PROTECTION

A transmission line is one of the most important and integral part of a power system. Due to occurrence of more than 80% of disturbances or faults in a power system comes from the transmission line. This section of the power system has become the most vulnerable part of the network.

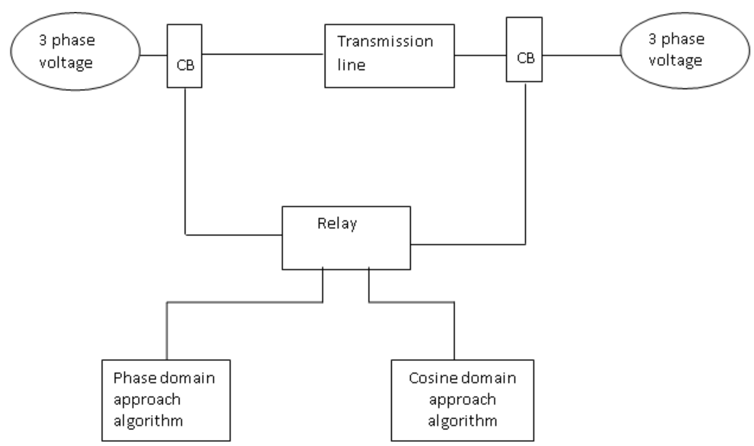


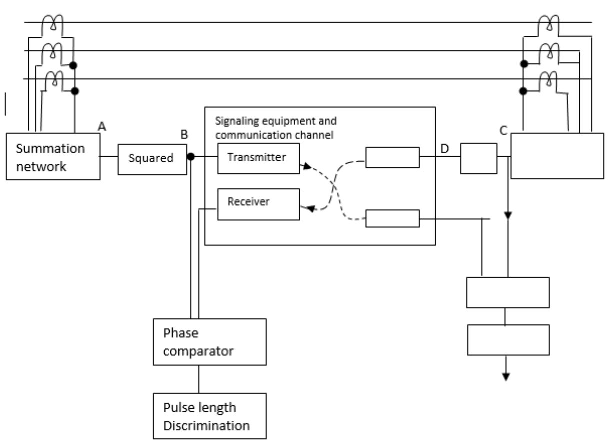
Fig. 1: Black diagram of transmission line protection using phase comparison schemes.

III. PHASE COMPARISON

The carrier channel is used to convey the phase angle of the current at one relaying point to another for comparison with the phase angle of the current at that point.

The principles of phase comparison technique are illustrated in fig. 2. The carrier channel transfers a logic or ON/OFF signals. Comparison of a local logic signal with the corresponding signal from the remote end provides the basis for the measurement of phase shift between power system currents at the two ends and hence, discrimination between internal and through faults load or through fault current at the two ends of a protected feeder are in antiphase (using the normal relay convention for direction), whilst during an internal fault the (conventional) currents tend towards the in phase condition. Hence, if the phase relationship of through fault currents is taken as a reference condition, internal faults cause a phase shaft of approximately 1800 with respect to the reference condition.

Phase comparison schemes respond to any phase shifts from the reference conditions, but tripping is usually permitted only when the phase shift exceeds the tolerance an angle of typically 30 to 90 degrees, determined by the time delay setting of the measurement circuit, and this angle is usually referred to as the stability angle. A Diagram which illustrates the discrimination characteristics which result from the measurement techniques used in phase comparison schemes is shown in fig 2.



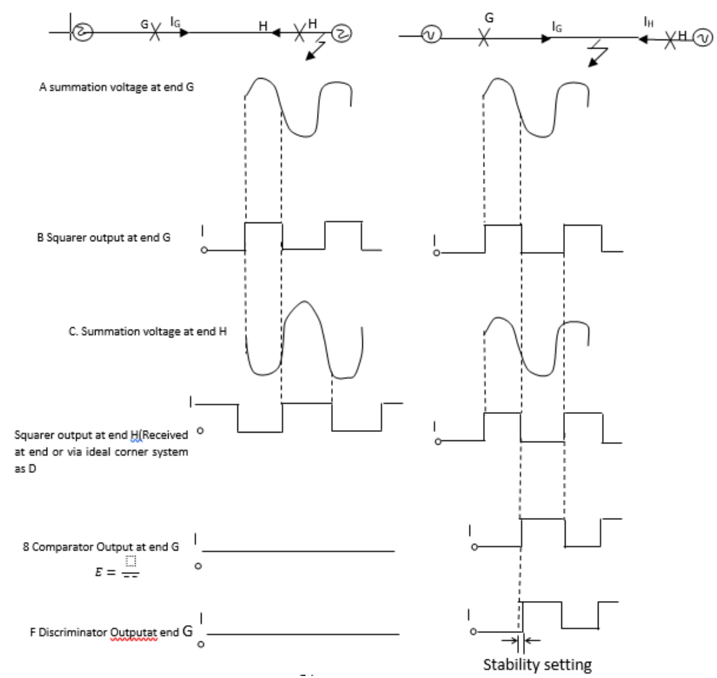


Fig. 2: Principles of phase comparison protection:(a) block diagram (b) output signals

IV. VARIATION IN PHASE COMPARISON SCHEMES

There are several different phase comparison schemes in general use today and while all of these employ the same basic means of comparison described above, significant differences do exist. These differences relate to the following:

(1) Phase comparison excitation (Comparator current to be compared)

(2) Pure phase comparison VS combined phase and directional comparison

V. PHASE COMPARISON EXCITATION

Before discussing this subject, it is well to consider what takes in terms of the currents that are available for comparison when a fault occurs on a power system. Table 1. below list the sequence components of fault current that are present during the various kinds of faults while fig. 3 illustrates the relative phase positions of the sequent component of fault current for the different kinds of faults and the different phases involved.

Table 1. Sequence components

Type of fault	Positive	Negative	Zero
Single phase to ground	Yes	Yes	Yes
Phase to phase	Yes	Yes	Yes
Double phase to	Yes	Yes	Yes
ground	Yes	No	No
three phase			

Figure 3. shows the relative phase positions of the outputs of a positive sequence network, a negative sequence network, and zero sequence network all referenced to as phase A. The transfer functions of these three networks are given by the following equations:

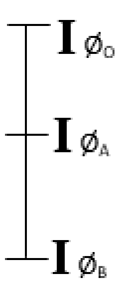
I_1= 1/3 (I_a+ I_b/120■(o@) + I_c/120■(0@)) 1

I_2= 1/3 (I_a+ I_b/¬¬120■(o@) + I_c/120■(0@)) 2

I_0= 1/3 (I_a+ I_b+I■(@c)) 3

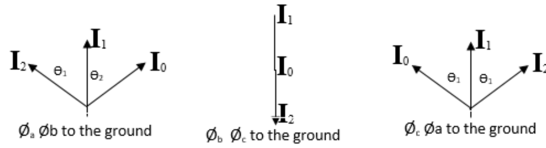
It is interesting to note that the phase positions of the sequence network output differ depending on the phase or phases that are faulted as well as the type of faults for e.g. While the positive, negative and zero sequence components are all in phase for a single phase – A to ground fault, they are 120 degrees out of phase with each other for phase B to ground and phase C to ground faults.

VI. SINGLE PHASE TO GROUND FAULT

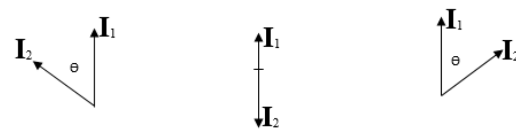


We have established the fast that for this case, when IB = IC = 0, the three sequence components of I Ø are equal, I ØO = I ØA = I ØB

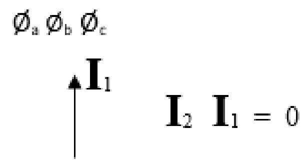
Double Phase – to – Ground Fault



Phase – to – Phase Fault



Three – phase fault



Where the three phase currents have any magnitudes and phase angles, denoted by the phasors Øa, Øb, Øc at the fault, since the terminals are connected together at the fault. Ø0 = (Øa + Øb + Øc), which is infinite.

VII. COMBINING PHASE AND DIRECTIONAL COMPARISON

Since there is no single sequence component that could be used in phase comparison schemes to provide protection for all types of faults, it is necessary to compensate for this deficiency. The previous section shows components, unbalancing sequence networks for certain faults and using two or more complete schemes each with different excitation, another approach that is possible and that has gained acceptance is called combined phase and directional comparison.

VIII. MODERN IMPLEMENTATION OF PHASE COMPARISON

Phase comparison, as a protection method, is naturally a time domain principle. It can be logically explained and analyzed if implemented as a set of operations on instantaneous signals starting at the local ac currents and received dc voltages encoding the phase information for the remote currents and culminating at the trip integrators to measure the coincidence time between the operating currents. Early, and still prevailing implementations of micro process on-based relays in general, are based on frequency domain processing: this means that instantaneous currents and voltages are first filtered and represented by phasors i.e. magnitudes and angles, and trip/no-trip decisions are based upon phasors or similar aggregated values. Successful implementations of the phase comparison principle on microprocessor-based relays should be based on instantaneous values, not phasors.

IX. CONCLUSION

The a phase comparison scheme, the relay is able to distinguish an internal inception of the fault on protected transmission line by comparing the current phase angle at one end with current phase angle at the second end. Where in case of the internal faults, there will be a notable phase difference. However, a current operation of the relay can happen by changing the system configuration which may affect the polarity of the quantities used for directional comparison.

REFERENCES

[1] Lew J. is Blackburn and Thomas J. Domin "protective Relay, principles, and application 3rd edition" ISBN 157544447165, 2006.

[2] Stanley Horowitz and Arun G pHadke "power system Relaying 3rd edition", ISBN 978-4-470-05712-4,2008.

[3] Anderson P.M. "Power system protection, "John Wiley and Sons, Int., Publication IEEE power Engineering Series, ISBN 0-7803-3427-2-; 1998.

[4] Hunt, R., Adamiak, M.; King, A; Mc Creery, S. "Pilot Protection, I EEE Industry Applications Magazine, Vol 15, PP 51-60, Sep 3009

[5] J.H. Neher and A.J. Mc Connell , "An Improved AC Pilot-Wire Relay," AIEE Trans … 60 (19.41); PP. 12.17 Discussions, PP. 638-643.

[6] Duncan Dolover, Mulukuta S. Sarma and Thomas J. Over bye "Powert System Analysis ans Design" 5th Edition, 2011.

[7] Power System Relaying Committee, IEEE Power Engineering Society "Justifying Lot Protection on Transmission Lines" ISBN 973-4244-6075-5, 2008.

[8] Suwarna baraskar, Sachin Wadhankar, "phase comparison techniques for transmission line protection", published 2017. International conference on energy.

[9] General Electric log (GEC) protective Relay Application Guide GEC measurements Plc. 1997.

[10] Multi Lin, phase comparison Relaying, "GE power Management, GER – 26813.