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# Implementation of Under and Overvoltage Protection Relay in Power System

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**ABSTRACT:** This paper present a review and survey of research as well as development in the under and overvoltage protection relay on distance protection of transmission line. The under and overload relay helps in controlling of voltage flow, damping oscillations in voltage system, reactive voltage and transmission voltage. The controlling impedance, phase angle appropriate voltage can be varied to control the power flow. Under and overvoltage relays are used as main and back-up protection for transmission lines. The relay operates depending on ratio of voltage and current, expressed as the impedance as seen by the relay. Determining the boundary of operation of this relay is a challenging task. This paper presents an extended review in order to identify the impact of under and over voltage on distance protection

KEYWORDS: Relays, Power system, DFT, Numerical relays

#### I. INTRODUCTION

There has been an increasing demand in electric power due to increased standard of liking and industrialization. As a result, the electricity supply industry is also witnessing a profound transformation around the world. The increase in demand of electricity can be met by increasing the transmitted power either by installation of new transmission lines or by improvement in performance of existing power system leads to technical complexity, increased cost, construction issues and soon. Improving the performance of existing transmission lines is economical option .the usable capacity of the transmission system that exixts has to be improved. Hence the under and overvoltage relay operates to serve this purpose.

#### SURVEY ON UNDER AND OVER VOLTAGE PROTECTION RELAY

Mazen Abdel-Salam, Rashad Kamela [1] have proposed a multifunctional numerical relay which provide protection for under voltage, over voltage, over current, over frequency, under frequency faults. This relay is also capable of working as a directional relay.MATLAB/Simulink is used to analyse the performance of this MNR and the prototype model is implemented using TMS320F28385 experiment kit. The circuit breaker is tripped by the MNR during abnormal conditions when the values of voltage, current, frequency exceed the preset values. The advantages of the relay include lowcost, multi-protection feature, compact size.

Yin Lee Goh, Agileswari K [2] the most important feature of any electrical supply is to be reliable and secure. Due to the increasing complexity of the power systems, the protection operation is finding difficulty in achieving mentioned features. However, DSP embedded numerical relays are capable of improving protection operation. The complex processing is made more accurate and faster by the relay since the DSP processing is optimised for real time processing of signals. The authors have used the DSP model TMS320F2812 for building and investigating overcurrent relay. The over current relay is implemented on a digital signal processor and modelled using MATLAB /Simulink. A comparison



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of the results between simulation and its hardware execution presented. A detailed investigation of relay performance in terms of memory capacity storage, transient analysis, execution time, and operation time is carried out.Education institutions and industries have been using different modelling tools. These tools are helpful in simulating any power system both under normal and faulty conditions.The authors have presented design and steps for data conversion of a digital frequency relay. Over frequency under frequency condition are addressed in this relay design. The digital relay is more accurate and faster compared to electromechanical relay. If a group of relays are working in coordination then the application of DSP is limited in numerical overcurrent relays. If the relays work in group, they have to work proficiently to avoid malfunction. The authors have implemented overcurrent relay which has an improved coordination on a DSP, TMS320F2812.

VarunMaheshwari ,Bhagwan Das Devulapalli [3], In Special Protection schemes (SPS), the communication between central control station and relays is critical issue. The sense process communicate cycles are performed by these relays. If these task are implemented sequentially, then the time of computation increases and adversely affects the relay performance. The paper has the details of design and implementation of FPGA based overcurrent relay with concurrent cycles of sense process communication. The implemented architecture as parallel pipelining and hence sampling, measurement and processing are performed concurrently. The implementation is done onFPGA board (Xilinx virtex-2 pro XC2VP3O-FF896-7C model), TheIEEE Standard C37:112-1996 for overcurrent relays has been satisfied by the proposed relay. The relay also has the feature of serial / IP communication. This paper has the details of hardware design, implementation and experimental results on hardware simulator of360km transmission line. This architecture offers a platform to implement Special Protection schemes.

M.A. Manzoul [4] Protective relays are crucial devices in a power system which ensure proper and reliable operation of a power system. The author has discussed the design and implementation of a FPGA base multifunction digital protective relay. The frequency and voltage values of the power system are continuously monitored by the relay. The relays set the output trip signals if the voltage and/ or frequency value exceeds predetermined range. This relay also has the feature of estimating the rate of change of frequency.

Mohammad Lutfi Othman, IshakAris [5] In this paper, the authors have investigated the implementation of data missing approach of 'integrated rough set and genetic algorithm' based rule discovery and rule quality measure in order to obtain expected behaviour of the relay. This behaviour should be in the form of association rule from digital protective relay's resident event report. The relay CD decision algorithm is discovered using 'integrated rough set and resident event report'. The correlation of the relay later the 'rule quality measure' along with importance judgement and rule interestingness frames the algorithm of the relay CD. Decision to the desired role of relay CD Association. Singularity form of relay CD Association rule defines the logic pattern of conditions and decision class. Unsupervised learning cases, the CD decision algorithm is capable of predicting and discriminating the future unknown trip state relay events with the area under ROC curve measurements.

AnkitaSamui, S.R.Samantaray [6] First s- transform (FST) has been incorporated by the authors to the distance relaying of transmission line. It requires accurate and faster phasor estimation of fault voltage and current signals in order to evaluate apparent impedance to issue trip signal when a fault occurs. The conventional s- transform has invertible time frequency spectral localisation technique which is combination of wavelet elements and short time Fourier transforms. In case of conventional s- transform, the processing time is high which makes it poor auction for online applications like digital protection of transmission lines. The computational burden can be reduced by incorporating down sampling technique in the FST. The impedance trajectory and phasor estimation can be accomplished faster. The estimator performed can be more accurate by incorporating high DC offset, and a better performance is obtained in noisy environment which ensures the FSTs robustness in relaying operation the online digital distance relays can be operated with FST instead of existing DFT in future in large power transmission network because of its better performance

Rujiroj Leelaruji, Luigi Vanfretti [7] as the design and implementation of renewable energy systems is increasing, the electricity delivery networks should also incorporate highly sensitive and protective systems. The authors have presented a survey on different types of protective relaying technologies and the communication technologies associated with it. The details of power system relaying communication technology is also incorporated, the importance of relaying and their ability to perform better task than the traditional last line of defense operation is highlighted in this paper.



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Alana K.X.S. Campos, Washington L.A. Neves[8] the various faults occurring in a power system may give rise to undesired voltage and /or current wave forms of non-fundamental frequency, which affects the desired performance of protection and control systems. The authors have proposed a new method to filter the undesirable frequency components. The time response with the four and frequency response of the proposed method have been compared with the four classical phasor estimation methods. The Models language of alternative transients program was used to implement the distance relay and the relay performance was evaluated. The performance of the proposed relay was found to be highly satisfactory in terms of accuracy. The relay had a high speed of operation as compared to other methods, compared to conventional methods the frequency response is better in the proposed method.

#### II. DAVID CELEITA, MIGUEL HERNANDEZ [9]

the response time is also compatible with the proposed method .Flexible programming of the proposed method makes it advantages and hence the design parameters can be changed according to specific needsDavid With the increase research work in the field of power networks, certain important challenges are laid on the distribution systems. Reframing's and modernizing the existing teaching methodologies is of prime importance in order to understand the complexity of smart grid. The authors have designed and implemented an interactive platform which is capable of assessing advanced distribution automation along with the applications and solutions mainly concentrating on relay solutions for a smart grid. This is mainly implemented for educational purpose. The hardware and software tools have been integrated by the proposed architecture to reproduce the behaviour of the distribution system and a recreate certain signals. Various features are listed along with validation from a case study and students are given a detailed knowledge about the concepts of relaying devices. The platform has the feature of operational functionality which enables the students to flexibly link the theory with practice, this aids the process of learning and encourages the class innovation. Algorithms for protection and solutions for automation can be incorporated in real time environment for grid optimization. The potential applications of the platform has been discussed

#### III. DINA MOURADHAFEZ, ELSAYED HASSAN SHEHABELDIN[10]

In networks that are interconnected faults occurring at any particular section may be forward or backward in nature. The faults may occur at one or many relaying stations. This results in receiving the power system, especially if it uses only current signals. The authors have discussed a solution fo this problem. The fourth sequential overlapping derivative is used to extract the transient components which are initiated by faults, the novel relaying signal is the multiplier of the transient components produced. The fault direction decides the polarity of initial change of the relaying signal. A proper communication channel will aid the exchange of data between the relaying stations and helps to distinguish internal and external faults. Then the trip signal is sent to the circuit breakers. MATLAB is to verify the relaying action and ATP program is used to verify the simulation tests, various cases including fault resistance fault inception time load switching affects, fault types have been discussed the results show a high stability and security to external faults and high sensitivity to internal faults. The need for compensation of current transformer saturation and synchronization of samples is also eliminated

J.H Kim.M.Park. I K Park [11] in this paper have considered a high temperature super conduction power cable in a model power system and analyzed its protective relay systems. Improvements have been done for overcurrent relay and differential relay by incorporation new decision making algorithm and implemented for a new faults like Single line to ground fault and three phase short circuit fault. From the results obtained it is observed that in case of HTS Power cable, the variation in impedance should be considered under fault condition. For a differential relay system the scheme of induced current ratio based fault detection has been proposed and implemented to protect bus to bus connection of HTS power cable. The operation of the circuit breakeris found to be satisfactory with the proposed algorithm. The design an installation of HTS power cables can be improved with the simulation results.

YOON Sung cho, Chul-Kyumheer a Guilsoo Jang B [12] a real time operator training system has been developed by the authors with a protective relay. A user defined component (UDC) model of real time digital simulator (RTDS) is used for the implementation the basic concepts of a protective relay and handling of undesirable conditions of operations can be better understood by the operators with the operator training which provides a real time



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environmental for the behaviour and principles of protective relaying with respect to stability and protection of the power system. A mimic board, control panel, generator protective relay model and RTDS hardware are the main components of operator training system A UDC based relay model is designed to investigate and evaluate the protection.

MukeshNagpal [13] has proposed discussed one phase trip and reclosure method applicable to long transmission circuit, which connects the grid to a sub network located in a remote place. This increases the reliability of interconnection. However if there is no connection of generation under one phase condition, then the entire sub network will experience loss of power supply under similar conditions, BC Hydro faced a dangerous temporary overvoltage in 287kv sub network on one phase condition. The lines which are highly shunt compensated can also experience high open phase over voltage even if the transformers in the subnetwork have delta connected secondary or tertiary windings. In such a case through not designed to perform, the differential protection of transformer operated on excessive magnetizing current exceeding 5<sup>th</sup> harmonic and blocked the current which dropped below the threshold setting (i.e., 35%), thereby protecting the surge arrestors from any damage the work has a recreation of sequence of events using disturbance records and a dailed analysis of the wave forms, discussion on the expected response of differential relay under severe over excitation of transformer has also been prevented. The simplified system has also been presented. The simplified system has been analysed in steady state condition and a detailed simulation of electromagnetic transients has successfully duplicated the disturbance. Further a mitigation plan has been developed to avoid the recurrence of the problem

HaoyanXue, MarJanPopo V [14] have discussed about large transient overvoltages which would be the result of switching operation of voltage circuit breakers (VCB). When the induction motors are disconnected. ATP-EMTP has been used to model VCB, generators, cables, bus bars, Induction motors and surge arrestors. Analysis has been carried out on switching transient overvoltage of four typical Induction motors during starting, light load, full load working conditions in the power system of offloading vessel and floating production storage. A well designed protection scheme for switching transient overvoltage has been proposed and the results have also been recorded

WaiKeam Yap, Lisa Havas, Elizabeth overrende, vishy karri [15] Photovoltaic (PV) systems are non-controllable as well as intermittent powersources. When these PV Systems are connected to grid, they can cause overvoltage in low voltage distribution feeders when there is high solar power generation and low load due to reverse power flow possibility. The punctuation level of PV can be conservatively limited, and there by the overvoltage can be prevented, even if the critical periods occur rarely. This policy is currently implemented in northern territory of Australia where the limit imposed is 4.5KW/house. This work has presented the strategy of active power curtailment (APC) using the techniques of Artificial Neural Networks (ANN). The over Voltage condition occurring on LV feeder is prevented by optimizing the active power. This paper has recognised a residential street of Alice Springs for its case study. The results of simulation has shown that the elimination of overvoltage condition and mounting the Australian standards AS60038 and AS4777 can be achieved by implementing the proposed predictive APC Control. The inverter downtime was occurring due to overvoltage was also eliminated and the trips Total power losses in the system was further reduced.

Line L.A –Trujillo Guajardo,A,CondeErriquez[16] have presented a filtering technique called Prony method and implemented it in distance relay algorithms, A model of distance relay has been presented. The effect of non-filtered frequency components when typical digital filters of distance relay are operated have also recorded. An overview of series compensation of transmission line has been presented and its effect in estimation of distance relay during fault period has been evaluated.Further a solution has been provided by using Prony method as a filtering technique in distance relay algorithms. The evaluation of the proposed algorithm is done in reach and operation time of the relay. The 3 D characteristic of Mho distance relay has been presented in order to evaluate the proposed system. The proposed filter is implemented as a solution to the error in distance relay estimation in measurement of apparent impedance. In addition an actual fault event has been evaluated and the proposed distance relay algorithm has been validated.

NicholosEtherdemaB, Math H.J Bollena [17] the curtailment use inorder to allow connection of solar and wind power to a distribution network. When overvoltage or overcurrent sets the predetermined limit. For a different cases based on measurements have been presented. In all these four cases, the method of hosting capacity has been used to quantify the gain in the energy produced for increased levels of distributed renewable energy resources. There has been a distinction



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made between 'Hard curtailment(Disconnection of all production when overcurrent and overvoltage limits exceed) and "Soft curtailment" (Disconnection of minimized amount of production). It has been found that the type of curtailment used has a greater impact on the amount of delivered energy to grid. The details of curtailment algorithm has been discussed and alternatives to curtailment has been presented. The communication needs and the associated risks with Curtailment use has also been recorded.

#### IV. CONCLUSION

Under and over voltage protection relay algorithm has witnessed a rapid growth in the past few years and contributes to reliable power system architecture in the future. Improved system damping, loss minimization, increased power flows in the existing lines can be achieved by this relay. Even through all the above advantage are achieved using the proposed relay, there are few technical barriers for effective and reliable implementation of distance relaying. This work comprises the work carried out by many researchers in order to assess the effect of the proposed relay on the performance of distance relays that operate in transmission lines results in the transmission line results in change in impedance value, introduction of harmonics and transients causing maloperation or disturbance in operation of distance relay. New adaptive methods of protection have to be further incorporated in order to increase the protection performance of complete transmission system and to avoid the unnecessary tripping of circuit breakers in the presence of the proposed relay.

#### REFERENCES

- [1] Mazen Abdel-Salama, Rashad Kamela "Design and Implementation of a Multifunction DSP-based-Numerical Relay" Elsevier transaction paper on Electric
- Power Systems Research, Volume 143, February 2017, Pages 32-43. Yin Lee Goh, Agileswari K. Ramasamy"DSP based fuzzy and conventional overcurrent relay controller comparisons" Elsevier transaction [2] paperMicroelectronics Reliability, Volume 53, Issue 7, July 2013, Pages 1029-1035 VarunMaheshwari ,Bhagwan Das Devulapalli "FPGA-based digital overcurrent relay with concurrent sense-process-communicate cycles" IEEE International
- .[3] conference of Electrical Power & Energy Systems, Volume 55, February 2017, Pages 66-73
- M.A. Manzoul "Multi-function protective relay on FPGA" IEEE Transaction paper Microelectronics Reliability, Volume 38, Issue 12, December 2016, Pages .[4] 1963-1968
- [5] Mohammad Lutfi Othman, IshakAris "Knowledge Discovery in Distance Relay Event Report: A Comparative Data-Mining Strategy of Rough Set Theory with Decision Tree"IEEE Transactions on Power Delivery, Volume: 25, Issue: 4, Oct. 2015, Pages 124-136.
- AnkitaSamui, S.R.Samantaray "An active islanding detection scheme for inverter-based DG with frequency dependent ZIP-Exponential static load model" [6] IEEE International conference on Electrical Power & Energy Systems, Volume 78, June 2016, Pages 41-50.
- [7] Rujiroj Leelaruji, Luigi Vanfretti "State-of-the-art in the industrial implementation of protective relay functions, communication mechanism and synchronized phasor capabilities for electric power systems protection "Elsevier transaction paper on Renewable and Sustainable Energy Reviews, Volume 16, Issue 7, September 2012, Pages 4385-4395.
- [8] Alana K.X.S. Campos, Washington L.A. Neves "A new phasor estimation method for digital protective relays" Elsevier transaction paper on Electric Power Systems Research, Volume 142, January 2017, Pages 227-236.
- David Celeita, Miguel Hernandez "Implementation of an educational real-time platform for relaying automation on smart grids" Elsevier transaction paper on Electric Power Systems Research, Volume 130, January 2016, Pages 156-166. Dina Mourad Hafez ,Elsayed Hassan ShehabEldin "A novel unit protective relaying concept based on sequential overlapping derivative transform: [9]
- [10] Interconnected network application" IEEE International conference of Electrical Power & Energy Systems, Volume 45, Issue 1, February 2013, Pages 206-
- [11] J.H Kim.M.Park. I K Park "Measured Impedance for InterPhase Faults in Presence of TCSC Considering MOV Operation", IEEE Electrical Power & Energy Conference, Feb 2008, pages 436-456.
- [12] YOON Sung cho, Chul-Kyumheer a Guilsoo Jang B "An Innovative Decaying DC Component Estimation Algorithm for Digital Relaying" IEEE Transactions on Power Delivery, Volume: 24, Issue: 1, Jan. 2009, pages 8722-8745. [13] MukeshNagpal "Protection of EHV Transmission Lines With Series Compensation: BC Hydro's Lessons Learned" Protective Relay Engineers, 2009 62nd
- Annual Conference for Protective Relay Engineers, 30 March-2 April 2009, pages 465-476.
- HaoyanXue, MarJanPopo V "Analysis of Switching Transient Overvoltages in the Power System of Floating Production Storage and Offloading Vessel" [14] International Conference on Power Systems Transients (IPST2013) in Vancouver, Canada July 18-20, 2013. [15]
- WaiKeam Yap, Lisa Havas, Elizabeth overrende, vishy karri "Neural network-based active power curtailment for overvoltage prevention in low voltage feeders" Expert Systems with Applications, Volume 41, Issue 4, Part 1, March 2016, Pages 1063-1070 Line L.A –Trujillo Guajardo, A, CondeErriquez "Error Compensation in Distance Relays Caused by Wind Power Plants in the Power Grid"
- [16] Electric Power Systems Research, Volume 106, January 2017, Pages 109-119.
- [17] NicholosEtherdema B, Math H.J Bollena "Overload and overvoltage in low-voltage and medium-voltage networks due to renewable energy: some illustrative case studies" Elsevier transaction paper on Electric Power Systems Research, Volume 114, September 2014, Pages 39-48