Microprocessor Base Protection of 132KV Line using Impedance Relay

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ABSTRACT
The paper is focused on the protection of 132Kv line using microprocessor based control approach. A detailed review of the literature reveals that this technique is more efficient and has many advantages over other techniques developed for this purpose. Microprocessor based protections are more reliable, flexible and faster than conventional protection schemes. The protection schemes proposed are based on impedance relay.

Keywords: Data Communication, Micro controller, Digital Logic/Computer Design, Relay, microprocessor-based impedance relay, high voltage power lines.

1. INTRODUCTION

With growing complexity of modern power systems, faster, more accurate and reliable protection schemes have become essential. Microprocessors generally deliver better performance at relatively lower cost and with simpler construction because operation of the

scheme depends largely on programming the microprocessor and little on the actual hardware connections.

Significant increase in value of sensitivitτy, functionalism and selection can be obtained for 132 kV line when the conventional distant differential security system is changed with the straightforward impedance relay based communication.

Power scheme is usually a broadly extended scheme consisting of hundreds and thousands of essentials i.e. Ttransformers, communication line, Generator, huge feeder line and so on. Sustainability has been a main issue in soft process of power scheme. Current power scheme sustain a high amount of sustainability for providing high services permanence to the customers.

Earlier protecting relays i.e. electromechanical relay and static relay did not meet the firm necessity of reliability, safety and selectivity forced on security scheme by current power scheme. The microprocessor when combined with impedance relay results in a very secure method for the current power schemes.

There are 3 common distance relays.

1. Impedance relay

2. Admittance relay

3. Reactance relay

The current research is focused on impedance relays. Impedance relays are use when over current relays does not offer sufficient safety. They work even if the short circuit is comparatively low. Impendence relays observe impedance among the relays position and the error. If Impendence fall inside the relay setting, the relay do function.

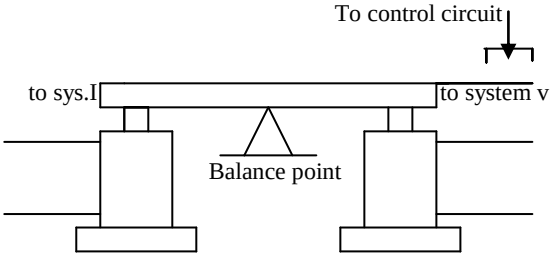

Fig.1 Balance beam

As shown in fig there are two ends of the balanced beam and at each end there is a coil that exerts a force on each end. A coil attached to the current from current transformer and another one is connected to the potential. The coil acts as a restrictive coil and current coil acts as an operating coil. In usual circumstances, the relay contacts open and through an error, voltage fall and current increases [1]

In impudence relay, torque is created through current element which is unbiased beside a torque of voltage element. The current element generates +ve (pick up) torque proportional to I2 while voltage element generates −ve torque proportional to V2. The torque equation is

T=K'12-K''V2+K'''

Where K' and K'' are torque constants and K''' is spring constant, which is generally neglected. At balance point T=0, from this equation we get

impedance V/I = Sq. root of K'/K'' [3]

The torque cause with current during current coil is

$T_i = K_i I^2$

Wherever Ki is constant of proportionality which depends on relay structure.

The torque by voltage coil is

$T_v = K_v V^2$

Where K_v is constant of proportionality

While torques are unbiased,

$T_i = T_v$

$K_i I^2 = K_v V^2$

Therefore

$V/I = \sqrt{K_i/K_v}$

$T_i \rangle T_v$

$K_i I^2 \rangle K_v V^2$

Therefore

$V/I \langle \sqrt{K_i/K_v}$

The contacts will close anytime the impedance the relay sees is less than a preset value given by

$\sqrt{K_i/K_v}$. [2]

Now there are two problems one is error on signal channel among stations, making missing functionality and second difficulty is missing backup safety. So one more confined safety is at all times used for line differential system.

2. COMPARISON

For a long time the ideal unit security has been a line differential relay at 11kv to132k, but line differential relays are very expensive much complex and a very difficult continuation of electromechanical impedances relays. In recent days impedances relays offer lower cost and a lot of simplicity to sustain. For many years the ideal unit securities of a line differential relay systems has been dominated by copper lines among locations having serious errors. The tripping points are extremely elevated, whose checking and preservation is fairly challenging and the

Indicator lines among line up ends are tough to remain in check.

2.1 Limited backup:

Line differential relay simply defend the high voltage unit among current calculating circuits in both stations, simply if contact among location is unbroken. Integrated over current otherwise be able to make a backing used for both the line and extra elevated voltage mechanism.

2.2 Communication:

The line differential relays constantly switch-determine standards among both line up sides, and then evaluate them immediately. Little breakdown in transmission of calculated values can cause unnecessary trips. The connections among lines ends, as a result happen to be significant:

Elevated bandwidth, Accessibility, Organization of transmitting information and Firm stress lying on convey period in Multiplexing need to be handled. But need comparatively difficult apparatus and competency. To get appropriate infrastructure a number of supplementary consideration in the relays have to be calculated and located. The impedances line relays used for unit safety cannot correspond constantly, but have to move a solitary pulse to other end through an error on the line. The cost of relocation time up to 50ms is irrelevant and consequently considerably simpler to get a smaller amount in acquiring, installation and preservation.

2.3 Measuring requirements:

The differential relays have CTs at their both ends and calculation in 3-phase is almost must, still if 2-phase measurement van be used in some cases. Impedance relay require the voltage and current in every 3-phases to function appropriately, however this might be a problem in older locations with no full calculating schemes accessible. The general VT lying on bus is still typically enough for the calculation requirements.

2.4 Double earth-faults:

Throughout double earth errors in remote grounded schemes is advantageous to trip only one line. While using line differential relay together in lines may trip concurrently through a double earth error. While impendence relay are going to make in phase selection mode, as a result only one line will trip in double earth fault and the other line will not trip until it is programmed to do so and as a result the period of time for short circuit is reduces and only one line will trip. [5]

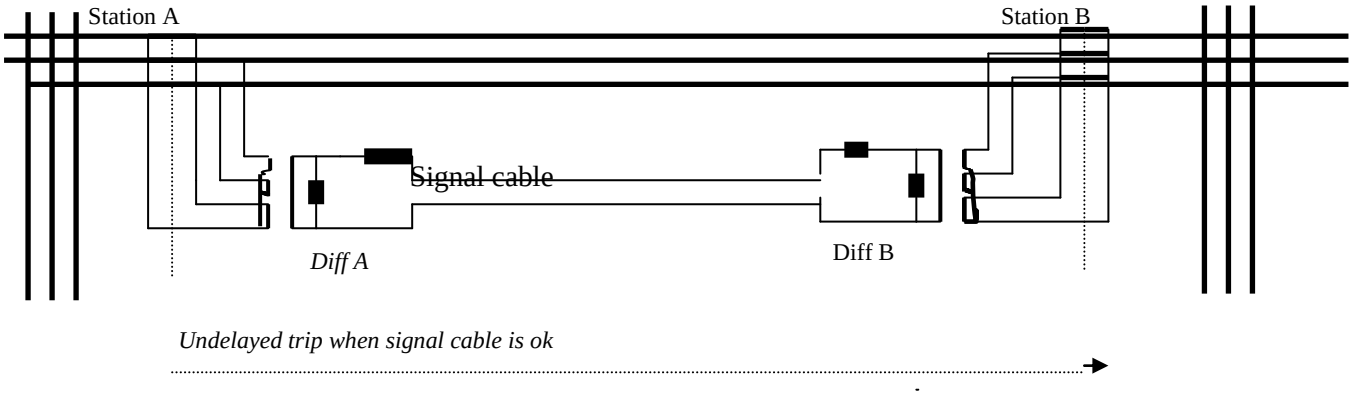

Fig 2. line differential system base unit security

In impedance relays calculated limited current and voltages, measures impedance to error position. In impedance relay however the better selectivity will be obtained as compared to differential relay. [2]

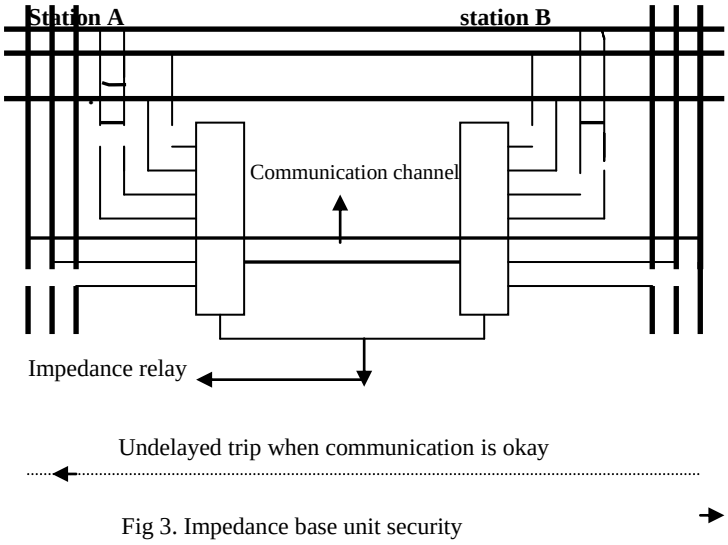

Fig 3. Impedance base unit security

2.5 Maintenance

Total testing of differential unit safety needs workers and test apparatus. If there are two ends of the line then as a result we get very complicated tests and it will be very much costly. This turns out to be tremendously difficult with more than two ends on a line, and as a result undesirable relations in calculating paths can straight away cause in tripping of variations in an evaluating currents. Their has been difficulty to know how to prevail by initiating a current initialing standard on the relay, however in such case the trip current have constantly superior values than the load current. Permissive overreach communication with Impedance relays are simply experienced by an

engineer that shifts from station to station and checking each relay one by one even if the line has more than two ends. This bounds the hazard of surplus trips through checking and testing so as a result it reduces the need of qualified and experienced staff and also reduces the detailed work coordination.

2.6 Choices without problems:

Now a day the price is not important between the communicating Impedance relays and in a line differential unit. A line differential unit explanation is seriously reliant on the connections among all the ends of the line. Practice and commonsensical point out that limited task are easier to operate, preserve and recognize that scheme that need unbroken and precise data from anywhere else. Now a day Impedance relays are simple to hold, having high understanding, presents extremely enhanced support and having extremely short necessities to accessible connections. It appears clear that Impedance defense joint with simple connections is an improved option than Longitude-differential relays for careful unit safety in meshed environment network, metropolis network and lengthy or small line arrangements. [5]

3. TECHNICAL BACKGROUND

In early days Impedance relays were very costly and problematical therefore differential and other relays were used than Impedance relays. Now a day Impedance relays are economical, simple to utilize and connections necessities are far lesser than differential relays.

Distance protection is applied for the safety of communication or sub- communication lines, typically 33kv, 66kv and 132kv lines. A distance relay calculates the space among the relay position and the position of error in term of impedance, reactance etc. An impedance relay calculates the line impedance among the error end and relay position; a reactance relay calculates reactance, and mho relay calculates an element of admittance. [2] As progresses in protective relays continue, improvement from electromechanical, to solid state to microprocessor based relays is achieved. The improvement in enlargement of power system both in mass and difficulty has brought the requirement for quick and dependable relays to defend main apparatus and to preserve scheme steadiness. In the improvement of cheap, controlling and complicated microprocessors, there is a rising attention in increasing microprocessor based protective relays, which are extra flexible because of programmable and are advanced to conventional electromagnetic and static relays. The major characteristics that have positive impact on the plan and improvement of microprocessor based protective relays are their compactness, dependability, elasticity and enhanced presentation above usual relays. The distance relays is favored to current relays as they are not almost extremely affected by change in short circuit current magnitude over current relays. This guess presents the plan and process method for safety of small communication lines by means of microprocessor based distance relays. The uniqueness of a distance relay is understood by evaluating voltage and current at the relay site. The ratio of V/I gives the impedance of the line part among the relay position and the error end. The indication is obtained from the communication line and it will be changed to digital signal which goes to the microprocessor, programmed in assembly language to guess the opposition of the protected line, then the choice will be according to this signal where this is an error signal or else. [4]

4. OBJECTIVES AND ACHIEVEMENT

In Pakistan all lines are open, so when strong wind or storm comes, the trees falls on the electric lines or the heavy storm break the electric lines.

Now here arise three problems

1. To find out the exact location where the electric lines break down

2. To open the line automatically when the electric lines are broken because the bare conductors are very threatening to human life.

3. The microprocessor based security is consequently useful in modern power scheme to make the on time elimination from check of any element of power scheme when it experiences a short circuit, or when it begins to function in an unusual way that may harm or interfere with the effectual procedure of the total system.

For solving these problems I used the impedance relay. The distinctiveness of an impedance relay is appreciated by evaluating voltage and current at the relay location. The ratio of V/I gives the impedance of the line part among the relay position and the error spot. The signal will get from the communication line and it will be changed to digital with the help of analog to digital converter, then go to microprocessor which has a program written in assembly language to approximate the opposition of the protected line, then choice will be taken according to this signal whether it is faulty signal or otherwise, and recognize the defective location.

5. OPERATION

Main components:

The scheme comprised of the following components.

18 resistors each having 5ohm,

Analog to Digital converter ADC,

Microcontroller 8051,

NPN transistor,

5V relay,

Light emitting diode LED,

Transmission line,

7 segment display.

The operation of an impedance relay can best be understood by examining the complex plane impedance locus which is shown in fig.1. If the fault impedance is 'Z' then the relay operates instantaneously when $| Z | < |Z_1|$ that is if it lies in the zone 1.

If $|Z_1| < |Z| < |Z_2|$, then the fault is in second zone and thus the relay operates after some delay. For |Z | lying between $|Z_2|$ and $|Z_3|$ a greater delay is introduced before the operation of the relay, because the fault is in the third zone of operation. If | Z | exceeds $|Z_3|$ then the relay will not operate as the fault impedance is outside the operating zone of the impedance relay.

5.1 Voltage input:

The analog voltage is fed to the ADC through a bridge circuit containing a C-filter as shown in Fig.3.

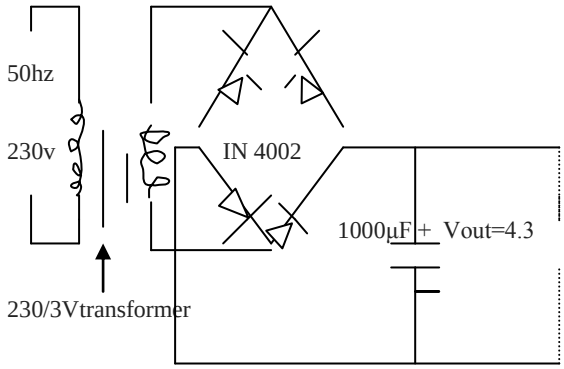

Fig 4 Voltage input

The supply voltage is stepped down to 3V RMS and then fed to the bridge rectifier circuit. Thus the dc output voltage available after rectification is 4.2V. A high value capacitor is connected across the output to smoothen out the ripple present after rectification. This dc voltage is fed to channel 0 of ADC.

5.2 Current-Input

Since the ADC can sense only voltage levels therefore a proportional voltage to the fault current is generated by passing the fault current through a low resistance of 0.1 ohms and measuring the voltage drop across the resistance. Since the drop is of the order of fraction of a volt and the ADC cannot sense voltage variations in that order, the drop is amplified using an op-amp inverting amplifier whose gain is fixed at 10. Since the output voltage of the inverting amplifier is negative, it is connected to the ground pin of the ADC and the op-amp ground is connected to channel 1 to take care of the polarities. In the initial segment in communication line, the number of resistors are eighteen each having a value of 5 ohm (it means we have eighteen contacts). In communication line all resistors are at a distance of 1km each and we can change this distance according to our needs and requirements.

In analog to digital converter (ADC) there are few important pins, which need to be discussed. Analog to digital converter (ADC) has three important pins namely chip select pin (CS), read pin (RD), Write pin (WR) and all of these pins are active low. When we give zero on RD then the data will be available on pins a1, a2, a3, a4, a5, a6, and a7

In a micro controller we connect the pin P3. O with a 5v relay and port1 of the micro controller is connected to the 7 segment display. If we set a relay then as a result NPN transistor will turn on, consequently a contact is closed. The result is transfer to the transmission line therefore the transmission line will turn on all of the light emitting diodes (LED). When light-emitting diode (LED) is ON it is an indication that there is no fault on transmission line. F4H data is provided to ADC and then the data will transfer to the micro controller, which will display the results on a 7segment display. When there is any fault on 1km, the contact of 1km will be closed and the voltage will become low at that point, consequently transferring information to the ADC and 7eh. The 7eh represents the error and will be transferred to the port 2 of the microcontroller, as a result 01 will be shown on the 7-segment display and the contacts of relay will become open. The NPN transistor will be OFF and there will be no current prohibiting any flow of power to the transmission line. As long as the fault is not removed, there will be no power transfer to the transmission line. The relay is not energized till the error removal, and as soon as the error is removed the whole circuit is energize again.

6. CONCLUSION

The protection of 132kv transmission line using a combination of impedance relay and Microprocessor has been presented. This study helped in identifying the critical factors that Influence the 132kv transmission line due to protection system operation.

It enabled us to find out, the exact location where the fault occurs and take the protection measures by which we can reduce human accident. Microprocessor based relays are becoming rapidly popular because of the advantages they offer. But they also suffer from some drawbacks. They offer high initial cost and it is not economical to replace the existing electromechanical relays with microprocessor relays. The microprocessor based impedance relay is implemented using the available hardware on VMC-8506 microcomputer board and with necessary external hardware. The microprocessor-based relays are invading the power system network since they are flexible and reliable. The same board can be used for over current and directional over current protection and hence cost of the relay will be less compared to conventional ones. From the observed performance of several tested cases, it can be seen that the model works well and gave excellent results. Multiple tests have been made effectively.

7. REFRENCECS

[1] Xnet.rrc.mb.ca/janaj/impedance-protection.htm

[2] Power system protection and switchgear By Badri Ram, D N Vishwakarma; available at http://books.google.com.pk/books?id=QDdIonUD4xQC&lpg=PA14&ots=NNLVXUNRm4&dq=Microprocessor%20Base%20Protection%20Of%20132KV%20Line%20Using%20Impedance%20Relay&pg=PA14#v=onepage&q&f=false

[3] Paper presentation: Microprocessor based impedance relay ~ Engineering projects, ebooks,

[4] Protection of a short transmission line using microprocessor base distance relay. Mohammad Ali, Hussain Fadhil (2004). Protection Of Short

Transmission Line Using Microprocessor-Based Distance Relay.Master thesis, University Putra Malaysia.

[5] Jacobsen Elektro better short circuit protection in distribution and sub-transmission networks.

[6] Behrouz A. Forouzan Data Communication And Networking 2nd edition Updated

[7] Albert Paul Malvino, Jernald A. Brown Digital Computer Electronics third edition, GLENCOE Macmillan/ McGraw- Hill

[8] Thomas L. Floyd Digital Fundamentals, 7th Edition, 2000, 1997 Prentice-Hall, Inc. New jersey 07458

[9] M. MORRIS MANO Digital Logic and Computer Design 2 Edition

[10] RICHARD, R. K. Arithmetic Operation in Digital Computers, New York; Van Nost land Co., 1955.

[11] FLORES, I., The Logic of Computer Arithmetic. Englewood Chffs, N. J.: Prentice-Hall, Inc. 1963.

[12] Kostopoulos, G. K., Digital Engineering. New York: John Wiley & Sons, Inc., 1975.

[14] Rhyne, V.T., Fundamentals of Digital Systems Design. Englewood