Volume : 3 | Issue : 8 | Aug 2014 • ISSN No 2277 - 8179

Research Paper

Advanced Technology in Transmission Line Protection

Engineering

KEYWORDS: protection, relays, technology.

Beena Pandya | Lecturer, Department of Electrical Engineering, K.J. Polytechnic, Bhurach

ABSTRACT

Power Electronics has plays great role in advancement of relay technology. Relays system of old generation were based on primary sensors and electrical circuit used for all type of electrical equipment protection. However, with advent of advance level of electronic hardware development, automation and communication system, all has been integrated in single device coupled with high level of intelligent algorithm lead to create next generation relay device. These relays devices are now become every day application for the protection of transmission line. This paper describes some useful advance technology application used now days by practical utility level transmission system.

A. Introduction

Paguthan Power Station being one of the vital source of electrical power to Gujarat grid, the system performance and reliability is of utmost importance. Electrical protection system plays a very important role of power station and its associated transmission network. Some basic protection adopted for transmission line are-

1) Main protection-Solid state relay Relay model- Micro Mho (Alstom)
2) Back Up protection-
   a) Directional IDMT phase Over Current Relay
   b) Directional IDMT Earth Fault Relay Relay model- CDD21, Make- AREVA (formerly English Electric)
3) Auto Reclose Unit-
Relay model-VARM 111, GEC Make.
The Paguthan power station introduced advanced Line protection Relays of numerical type for Transmission line protections along with the existing protections.

At present line protections provided are-
1) Main protection- I
Numerical Distance Relay
Relay model- 7SA522
Make- SIEMENS Ltd.

2) Back Up protection-
a) Directional IDMT phase Over Current Relay
b) Directional IDMT Earth Fault Relay Relay model- CDD21 Make- AREVA. The numerical distance protection also has configurable back up protection features which are used. This provides easy configuration, programming and testing apart from making relay truly redundant.

B. Features of Numerical Relay

The new numerical relay has following advance feature compared to earlier one:

a) Faster tripping time :

With the help of sophisticated relay design like high speed trip relay and fast trip relay, relay issue trip command within 12 to 17 ms after detection of fault. This helps the system in isolating faulty line with minimum disturbance on other connected lines thereby improving system stability.

b) **Remote communication facility**

With the help of latest communication protocol, these relays can be monitored, programmed and controlled from remote location. A common network can be built for all relays and access can be made through central control room for any of functions. This avoids physical movement of hardware as well as personal and engineering resources can be centralized.

C) **Sophisticated in built event recorder with 200 records storing capability:**

Relay stores 200 events as well as 8 trip logs (first in first out) basis which helps in diagnosis of sequence of events and analogue values of parameter led to disturbance.
These trip logs can be achieved automatically in the SCADA system with the help of latest communication protocol.

d) **Supports almost all communication protocol:**

Relay supports IEC61850, IEC103, Profibus, DNP3, Modbus universal protocols, which help us to integrate these relays with other manufacturer's devices / SCADA and time synchronization of all the relays etc. This helps in standardization of product and having common platform.

e) **Inbuilt auto re-closure function**

Experience shows that about 85% of the arc faults on overhead lines are extinguished automatically after being tripped by the protection. The line can therefore be re-energized. Automatic closing of line is being performed by an automatic reclose function (AR). This was previously carried out by separate relays but with introduction of numerical relays, additional IO in-built may be mapped to configure this function. Moreover, any kind of selection can be configured through software and need not be changed hard wiring.

f) **Self diagnostic function**

Relay itself diagnostic its internal hardware and software functionality. In event of failure of any internal hardware or error in software, it indicates through its life check functionality. This provides advance warning to the operator about health of relay and necessary corrective actions can be planned which avoid any contingency.

g) **Compact size**

As numerical relay have many individual functions configurable within itself, there is no need for separate relays and this saves in space and avoid hard wiring. Moreover, relays are compact and all annunciations are available on front screen with communication ports which is easy for operation & maintenance staff.

All of above salient feature helps to comply with latest grid standard and provide great stability and sensitivity along with reliability which are very vital for transmission and sub-transmission level protection.

Fig A: SIEMENS Numerical relay

Volume : 3 | Issue : 8 | Aug 2014 • ISSN No 2277 - 8179

B. Disturbance recording

Need for high speed Disturbance Recording-

Since the transmission lines are exposed to all kinds of climatic conditions and manmade abuses the nature of faults varies. The successful detection of fault, and selective correct isolation of fault depends upon proper working and coordination between many associated components like circuit breaker, auxiliary relays, back up protections, power line carrier equipment, CT and PT, etc.

Analysis of high resolution recording of system parameters during system disturbance and tripping events reveals a in depth information and sequence of operations. A disturbance recorder is supplied with same CT and PT signals of the system under scrutiny. DR constantly samples the waveforms and stores the raw data in its buffer memory. DR is also fed with many digital signals like breaker auxiliary contact; relay start/trip contact, carrier signals which when enabled under system disturbance, triggers DR. Once the DR is triggered raw data in the buffer memory is stored in separate memory bank of DR. To analyses the fault one always needs system data prior to fault initiation. Beauty of DR is that the data is always scrolling in the buffer memory and some amount of data is always available prior to DR triggering which is stored as pre fault data. The amount of pre fault and post fault data depends upon buffer memory of DR and is usually user settable. In DR wave forms are sampled out hence sampling speed is a most important parameter to judge the performance of a DR. More the sampling rate more will be the intricate information visible to user. But more sampling rate warrants more processing power also.

At Paguthan power station, disturbance recorder as separate device were installed for all transmission line but now a days, SIEMENS make relays selected for protection also have in-built disturbance recording facility which is configured and a common server PC is installed at control room. A local network is prepared through which all disturbance data can be fetched in auto and display on PC. If connected in LAN system, with specific log-in, data can access at office and one need not to visit sub-station at all. This disturbance data can be played back through appropriate software to stimulate fault in relay and verify relay response.

Fig B : Event recorder

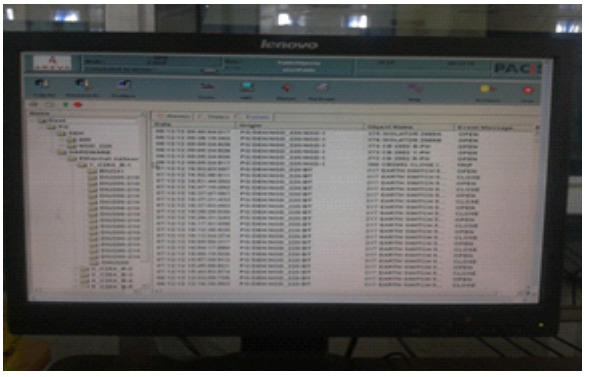


Fig C: Display of Event in recorders

Fig D : Rack & Module arrangment

C. PLCC Communication

Data exchange between power station and control station need to be live data transferred on real time basis with high reliability. This is vital for grid control operator to take decision based on this data as well as this link is useful for intertrip from one end to another end as protection signal. Over the years, this is achieved through power line carrier communication system. However, with rapid progress in communication technology, this also have been witness changed and now a days, GPRS based system is also available however limited to data transmission only. Paguthan power station has built a redundant link with help of GPRS system to transfer data with keeping selection level.

PLCC system needs remote terminal units which are used to transfer data and this need to be supported by appropriate SCADA system through communication protocol. With focus on arriving at common communication protocol which can provide seamless communication access to all, there is need to upgrade existing RTU system with new system having matching communication protocol. Paguthan had ABB make RTU system of old design having limited capability. However, to match communication requirement, this has been upgraded with ABB make 560 model and this is integrated with grid SCADA system.

D. Case study

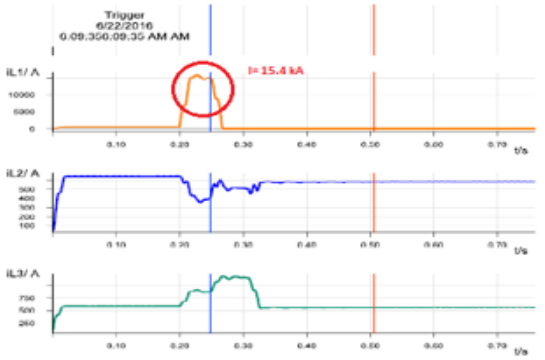
Precise operation of Distance protection relay on line fault.

Event:

On date 22.06.2012, 06:09 hrs 400kV CLP- KASOR Line tripped on R-E fault zone-1 and auto reclose of line CB was observed. Subsequent to above faults, line tripped on R-E fault in Zone-1 and auto reclose of line CB was observed again. Then after line was sustained and was in operation. During above faults it was heavy raining. The above information was available on SIEMENS relay front display and also tagged in event recorder.

Fault Analysis:

On analyzing first fault, it was observed that fault distance recorded was 0.4 km and fault current was recorded of 15.4kA. At the same time heavy voltage dip observed in station auxiliaries. Based on the distance data recorded in relay, fault was suspected to be inside CLP 400kV switchyard.



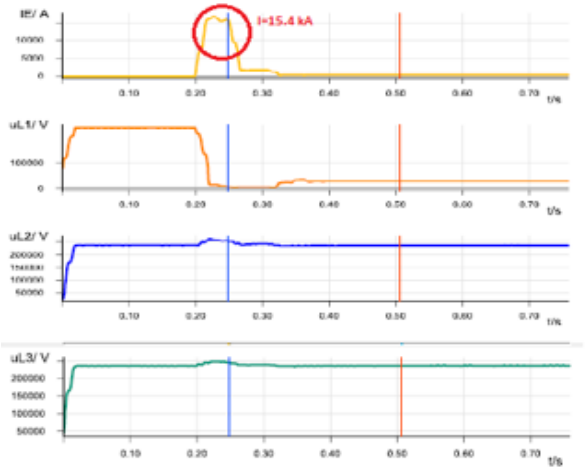


Fig E : Waveform data from disturbance

On physical checking in switchyard, R phase conductor of 400kV CLP-KASOR line dropped on the R-phase isolator arm of same line. As the conductor was dropped on R phase isolator, line was sustained and remains in service.

Line was isolated for rectification. During rectification it was observed that suspension insulator string was damaged due to heavy fault, which led to detachment of conductor from insulator string.

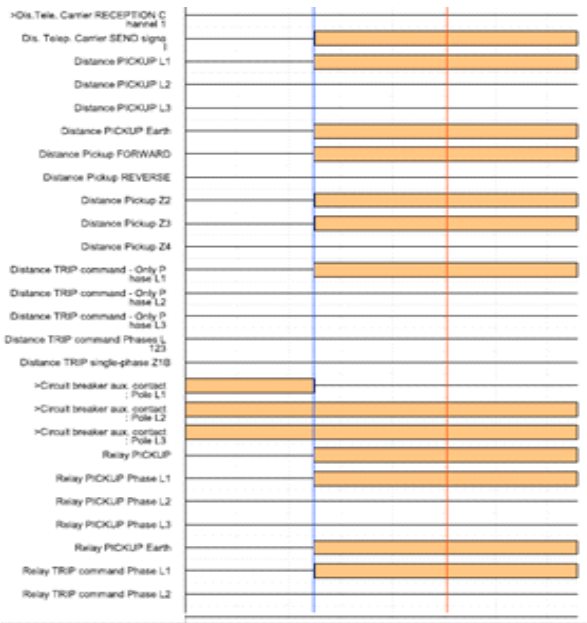


Fig : F Fault record data

With the help of latest technology of numerical relay and accuracy of fault recording, identification of fault location and subsequent rectification was very fast.

Secondly, with the use of latest communication system, relay's fault records were extracted automatically from relay to SCADA. This helped us to retrieve fault waveform very fast.

E. Conclusion

The electrical protection now has not limited only to electrical circuit and component but becomes integrated with electronic hardware and communication. The application engineer need to understand all this aspect and also require regular updated as obsolescence resulting into shorter product life. Software updating and version control forms vital part of total protection system.

REFERENCE

(1) Manual of SIEMENS make SIPROTEC series relays (2) Disturbance recorder data of fault recorder and event recorder (3) The art & science of protective relaying by C. Russel Mason