

## Development of Relays for Generator Protection

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- mayadhar Swain

Relays are an important integral part of any power system. As generating stations are the first element in the power system chain, the requirement of protection starts right from the generator. Generator is one of the costliest equipment in the power house. Its damage causes innumerable financial loss as well as deficit of power in the system. Hence, from the very beginning of the history of power generation, relays have been developed for protection of generator. The first protective relay was used in 1887.

### Development of Relays

The development of relays can be classified into four categories. These are:

1. First generation-Electro-mechanical relays.
2. Second generation – Static relays
3. Third generation – Programmable relays
4. Fourth generation – Smart relays.

### Electromechanical Relay

First generation relays are electromechanical in hardware and have been designed to perform a single task. These relays have movable parts and hence their upkeep is a bit difficult task. These relays also consume sufficient amount of power. Yet another limitation with these relays is that these are not able to provide operating region of the choice of engineers. Only a best compromise is achieved. These types of relays have become obsolete now and are no more manufactured. But these are found still in use in some old power stations.

### Static Relays

These type of relays use semiconductor devices like diodes, transistors, thyristors, integrated circuits and normal electrical components like resistor, capacitors etc. These are called static because there is no moving part. Due to this, its life period is more than the electromechanical relays and also these require less maintenance. Power consumption is less and these relays also provide fewer burdens on CTs and PTs. But functions wise, these are similar to electromechanical relays. These are only functional replacement of the earlier generation relays. These relays also suffer with limitation that not all relay characteristics can be realized. The relays are sensitive to voltage spikes or transients. At present these are found in use in many power stations.

### Programmable Relays

Development of programmable devices provided a big leap in relay design. As a result, programmable microprocessor based relays were developed. With the presence of programmable devices, any relay characteristic that can be expressed mathematically is possible to realize in the field. These are fast relays require very less maintenance and consume less power. As the processor speed is more, implementation of a single protection function leaves the processor idle for significant time. This led to the development of multifunction relay. As result, many generator protection functions are integrated in a single relay. So this takes less space and relay panel size is drastically reduced.

### Smart Relays

These are the latest relays. It is known in different names like management relay, numeric relay etc. The relays provide multifunctional role in power system. Apart from protection, these can be used as primary of back up protection on synchronous or induction generators of 25, 50 or 60 Hz. In addition to electrical protection, it also takes care of some mechanical protection like stator temperature rise, bearing temperature rise, bearing vibration etc. The various functions and features are given below.

Protection: different protections in a single relay are:

- Over voltage
- Over current
- 100% Stator earth fault
- Reserve power
- Negative sequence over current
- Over flux (V/Hz)
- Under voltage
- Differential
- Impedance protection
- Inadvertent energization
- Over frequency
- Under frequency
- Loss of field
- Out-of-step protection
- Stator temperature
- Over speed
- Bearing vibration

Control and Monitoring

- Breaker trip coil supervision
- Breaker failure detection
- VT fuse failure detection
- Voltage balance among three phases.

Metering

- Current (A)
- Voltage (V)
- Power (W)
- Reactive Power (Var)
- Energy (Wh)
- Reactive energy (Varh)
- Power factor
- Frequency (Hz)
- Maximum demand

Event record

These relays provide history features so that in the event of fault, the variation of different parameters can be studied to analyse the probable cause of the fault.

SCADA Compatibility

The modern power stations are generally having SCADA system and these relays fit very well for this. Data can be transferred to a central master or main control system through a serial interface.

### Numeric Setting

It has numeric settings with keyboard and settings are protected with password.

### Man-Machine Interface (MMI)

It is best in class in man-machine interface. The settings and other parameters can be accessed using the integrated control and numerical keypad. Through a serial interface, the relay can be connected to local computer. Light-emitting diodes (LEDs) and display Screen (LCD) provide information related to events and functional status of the relay.

### Self Checking

When any fault occurs in the relay, it gives an alarm.

### Remote Communication

Some manufacturers like GE and SIEMENS have provided embedded ethernet communication system. The relay is directly connected to Local / Wide Area Network (LAN / WAN) using TCP / IP protocol via a port located on the back panel of the relay. Through this, the manufacturer gets access to relay information such as setting, oscillography, trending data and sequence of event records etc. the manufacturer can notice any malfunction or abnormality in the relay through Internet and also can rectify the same through Internet.

### Time Synchronisation

The relay has its own clock. An interface is provided for the time synchronisation of the internal clock via external synchronisation sources or master clock of the power station.

### Conclusion

In all the new power stations, smart relays are installed due to their inherent merits. The power stations where renovation and modernization (R&M) work is carried out, all the old electromechanical and static relays are being replaced with the smart relays.

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### Reference Book:

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