4.5 Over current protection, transformer differential protection, Distant protection of transmission lines:

4.5.1 Numerical Over current protection:

The main benefit of numeric over current relays is lower cost and the ability to provide a full range of characteristics in one product, the required characteristic being selected by switches on the relay front panel.

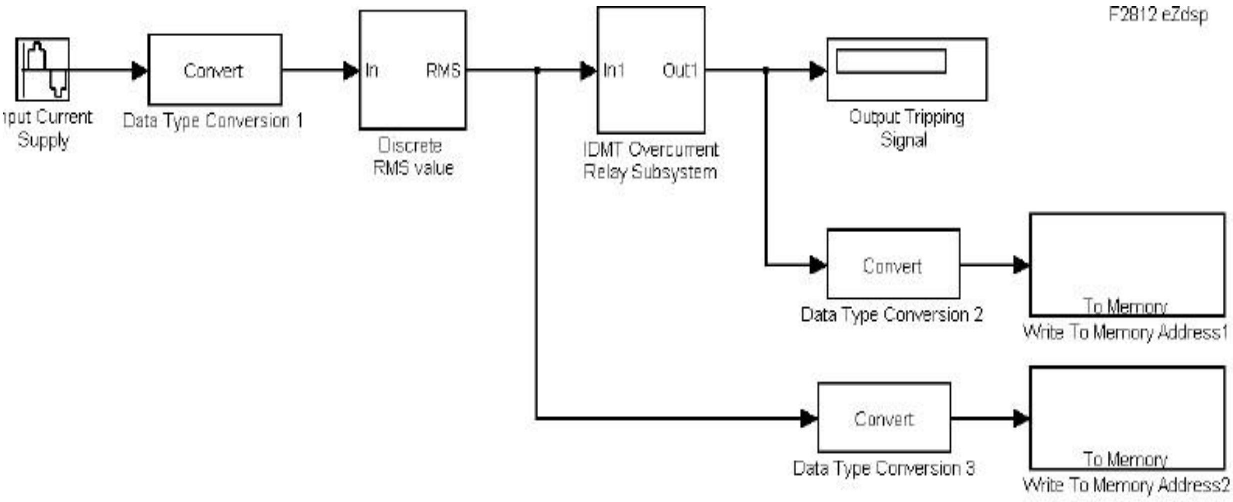

Figure 4.5.1 Block diagram of Numerical Over current protection

[Source: "Power System Protection and Switchgear" by B.Rabindranath and N.Chander, Page:520]

- The current into the relay is firstly rectified and then passed through a resistor network, selected by switches on the front panel, to provide a voltage proportional to the incoming current.
- The switches are the equivalent of the plug setting multiplier found in electromechanical over current relays and serve to scale the input current.
- The scaling is such that, irrespective of the current setting, input current at the setting level will produce the same internal voltage in the relay.
- This voltage is then digitized by an analogue to digital converter. Sequential samples are then compared to find the peak values of the rectified sine wave.
- These peak values are stored in peak registers within the microprocessor; four peak registers are used to store the preceding four peak values. Every time a new peak value is added, all the peak registers are compared to find the highest peak value over the last four peaks.

- The highest peak value to then referred to a look-up table (a table of coefficients stored in memory) which produces an increment number.

4.5.2 Transformer differential protection:

Many digital algorithms have been used so far after the invention of the computer. These algorithms do the same job with different accuracy and speed. The acceptable speed according to IEEE standard for transformer protection is 100 msec. All modern algorithms are faster than this IEEE standard. Nowadays, there are some algorithms performs their function in less than 10 msec. In this chapter, a fast algorithm is introduced. Its speed is in the range of 1 to 15 msec. This algorithm is based on the Fast Fourier algorithm (FFT). This algorithm is not new, however, significant changes has been introduced to make it much faster.

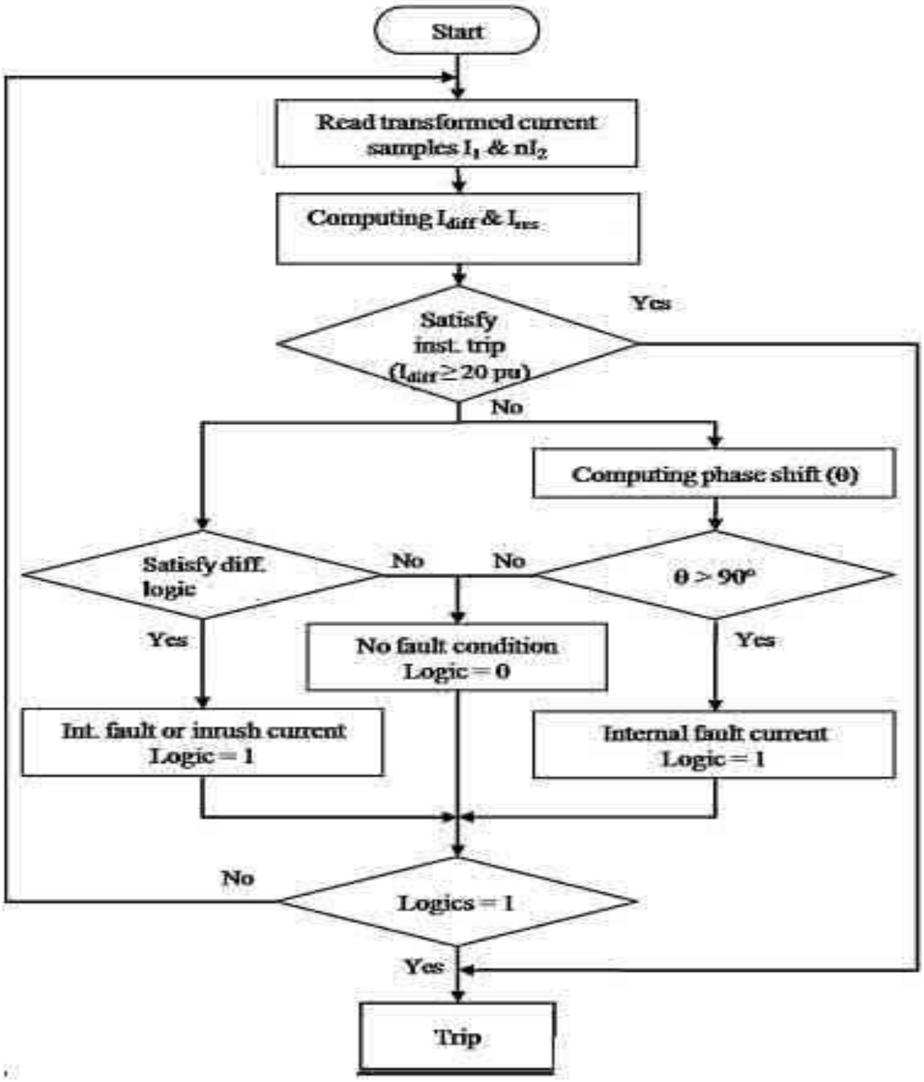

Figure 4.5.2 Flow chart of Transformer differential protection:

[Source: "Power System Protection and Switchgear'" by B.Rabindranath and N.Chander, Page: 522]

4.5.2.1 Algorithm and Flow chart

Step 1. Reading data from the CTs

Step 2. Data calculation, which is given as follows;

For the amplitude calculation, if the absolute difference between the CT, output Currents are greater than zero the logic (1) takes place, which indicates the case of an inrush current or an internal fault. Otherwise, the logic (0) takes place, which indicates a detection of an external fault.

Step 3. Taking the final decision:

If the logic cases received from both cases in step two are both (1) that indicates a detection of an internal fault. Then a trip signal is released to stop the simulation. For the other logic options of (0,1) means an external fault, (1,0) means an inrush current, or(0,0) indicate an occurrence of an inrush current or an external fault, and the simulation goes back to step two to start the calculation again for the next sample.

4.5.2.2 Operation

In this algorithm the output currents of the CTs undergo over two analysis processes, amplitude comparison process and harmonic content calculation process. The amplitude comparison between the RMSvalues of the CTs output currents (|Id1 — Id2|) is in the left hand side of the flowchart, and the harmonic calculation is in the right hand side of the flowchart.

The software is implemented according to the following steps

1. Reading data from the CTs.
2. Data calculation, which is given as follows;

For the amplitude calculation, if the absolute difference (|Id1 — Id2|) between the CTs output currents is greater than zero the logic (1) takes place, which indicates the case of an inrush current or an internal fault. Otherwise, the logic (0) takes place, which indicates a detection of an external fault.

4.5.3. Distant Protection of transmission lines.

- Distance relays were one of the first protective devices to be considered for numeric implementation yet, ironically, they are currently the least mature of all numeric relay types in terms of commercial development, with products only recently emerging into the market place.
- The most probable reason for this is the relative complexity of a numeric distance relay when compared with other types described in this book.
- Thus the recent arrival of powerful microprocessors to enable practical commercial designs was instrumental to this progress.

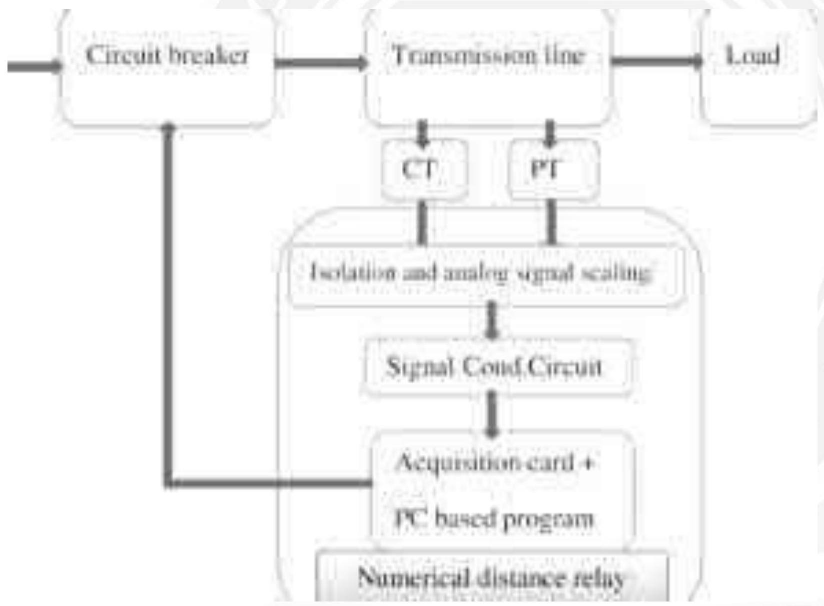

Figure 4.3.1 Block diagram of Distant Protection of transmission lines

[Source: "Power System Protection and Switchgear'" by B.Rabindranath and N.Chander, Page: 524]

- Numeric distance relays differ from more conventional static types in that they calculate an actual numeric value for the apparent impedance at their laying point.
- This impedance is subsequently compared against an impedance plane-based characteristic in order to make a relaying decision.

- In static distance protection, e.g. by using a block-average comparator, the relay functions by directly combining the voltage and current inputs in the comparator to form the relaying decision.
- Although the end result is the same in either case, the following advantages apply to the numeric relay:

(a) Since both the phase and amplitude information of the input signals are used, the security of the relay is higher than if only, say, the phase information is used;

(b) Any shape of characteristic can be easily programmed into the relay;

(c) Zones of protection are easily incorporated since, once the impedance has been calculated, extra zones may be added with little processing penalty.