# Module 6 : Distance Protection

## Lecture 23 : Pilot Protection with Distance Relays

### Objectives

In this lecture we will introduce the basic principle of different directional comparison schemes like:

- Directional comparison blocking system.
- Directional comparison unblocking pilot system.
- Directional comparison overeaching transfer trip pilot system.
- Directional comparison under reaching transfer trip pilot system.

These schemes are used to improve speed and selectivity of the conventional distance relaying.

### Introduction

We have seen that distance relays provide fast protection upto 80% of the primary line length. However, primary protection for remaining 20% is deliberately slowed down by coordination time interval. Pilot protection is used for lines to provide the high speed simultaneous detection of phase and ground faults for 100% of the primary line. Since distance relays are directional relays, the corresponding schemes are known as directional comparison schemes. Following directional comparison schemes are in use.

1. Directional comparison blocking.
2. Directional comparison unblocking.
3. Overreaching transfer trip.
4. Under reaching transfer trip:

   a) Non-permissive. b) Permissive.

The basic idea behind all these schemes is to obtain the response of the distance relay element at other end to speed- up decision making. This requires additional communication signals. If relay $R_1$ could obtain the response of relay $R_2$ regarding the location of fault, then uncertainity in locating faults close to boundary is no more significant and it can quickly clear the fault anywhere on the primary line (internal fault).
We now briefly describe each of these schemes.

## 23.1 Directional Comparison Blocking

### Basic Principle

1. **Use directional fault detectors to detect faults in the direction of primary line.**
2. **Use blocking signal from the remote end in case the fault is not on the primary line.**

## 23.1 Directional Comparison Blocking (contd..)

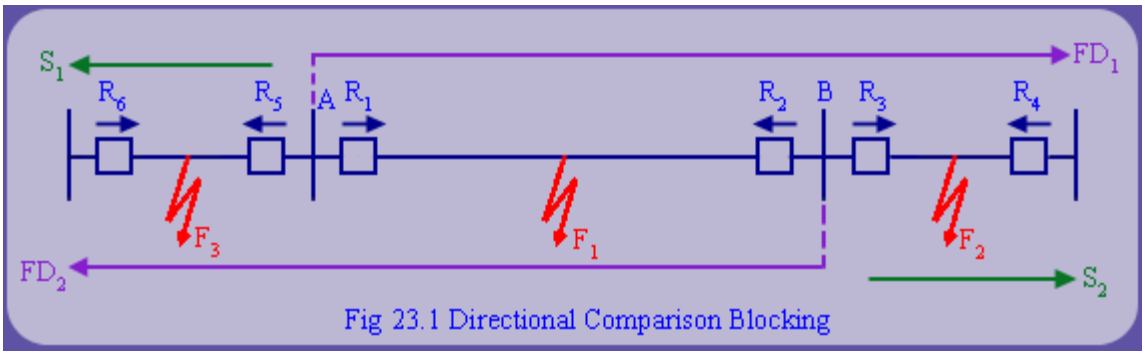

Fig 23.1 Directional Comparison Blocking

Consider the requirement of protecting line AB. If the fault is at $F_1$ (anywhere on the line AB), fast protective action is required from relays $R_1$ and $R_2$. To achieve this action, relays $R_1$and $R_2$ are enabled with two units each called fault detectors ($FD_1$ and $FD_2$) and carrier starts $S_1$ and $S_2$. Typically, the fault detectors correspond to $Z_2$ of distance relays at respective locations as shown in fig 23.1. They overreach the primary line. The carrier start relays look for fault in opposite sense to respective FD. They are called carrier starts because the channel signals between A and B are initiated by them.

Imagine a scheme where FD issues a trip signal after identifying a fault unless it is quickly blocked by an external agent (carrier starters). For example, if the fault is in $F_1$, both $FD_1$ and $FD_2$ will pick up. Since neither carrier starts $S_1$ nor $S_2$ will pick up, fault $F_1$ will be cleared quickly. In contrast, suppose that fault is at $F_2$. Then $FD_1$ will pick up and so will $S_2$. The $S_2$ will initiate channel and send blocking signal to $FD_1$. The $FD_1$ will be blocked from tripping action until its timer runs out. In this interval, either the primary relay $R_3$ will clear the fault or else it is cleared by $R_1$ as a back up measure.

In other words, in this scheme, the relays are set for fast clearing action. They do not care whether the fault is in primary line or the back up line. Blocking from the other end is used to prevent fast tripping for faults on backup line.

## 23.2 Directional Comparison Unblocking Pilot System

The directional comparison unblocking pilot system is explained below:

### Basic Principle

1. After detecting a fault in the right direction, put the relays in 'block mode' for CTI.
2. Use unblock signals from the remote if the fault is on the primary line.

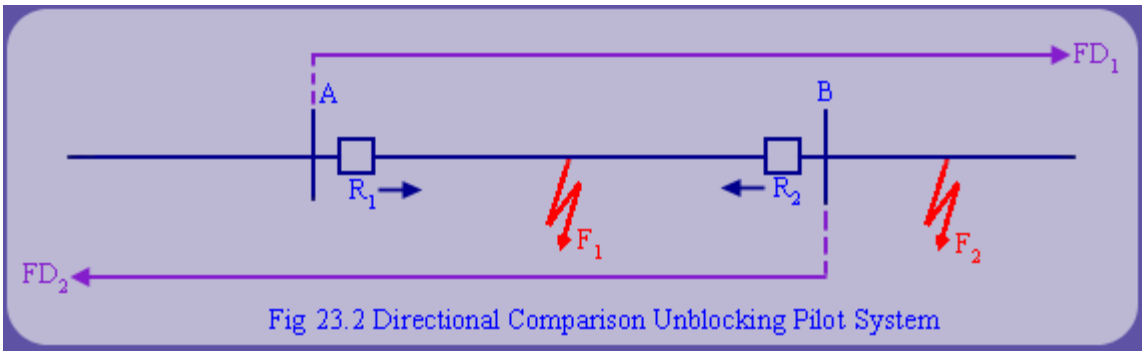

Fig 23.2 Directional Comparison Unblocking Pilot System

In this scheme as shown in fig 23.2, $Z_2$ of $R_1$and $R_2$ remain in 'block mode' for a specified time after seeing the fault. Of course, if there is no fault in the system anywhere, neither fault detectors will pick up. In case, relay $R_2$ observes a fault in the direction of bus A, it sends an unblock signal to relay $R_1$ (and vice- versa). If the fault is in the primary line AB ($F_1$), both $R_1$and $R_2$ detect the fault, and also receive unblock signal from the opposite end. The unblocking signal helps in immediate action of both relays $R_1$ and $R_2$ leads to fast tripping of line. In case, the fault is at $F_2$, then the relay $R_2$ will not send unblock signal to $R_1$. While relay $R_1$ sees the fault, its FD also initiates a down counter set to CTI. If the FD detects fault even after counter has run down, then a trip signal is issued by $R_1$ for back up fault clearing action in the adjacent line.

The advantage of directional comparison unblocking pilot system is that it eliminates need of carrier starts $S_1$ and $S_2$. Typically, it is implemented using frequency shift keying (FSK) channels.

To summarize, the relays or more appropriately their fault detectors detect fault in the appropriate direction. Unblock signal from the remote end is used to quickly clear the faults on the primary line.

## 23.3 Directional Comparison Overreaching Transfer Trip Pilot System

We now explain the principle of directional comparison overreaching transfer trip pilot system:

Basic Principle

1. If fault is detected from both ends of the line, initiate trip.
2. Else, initiate back up protection.

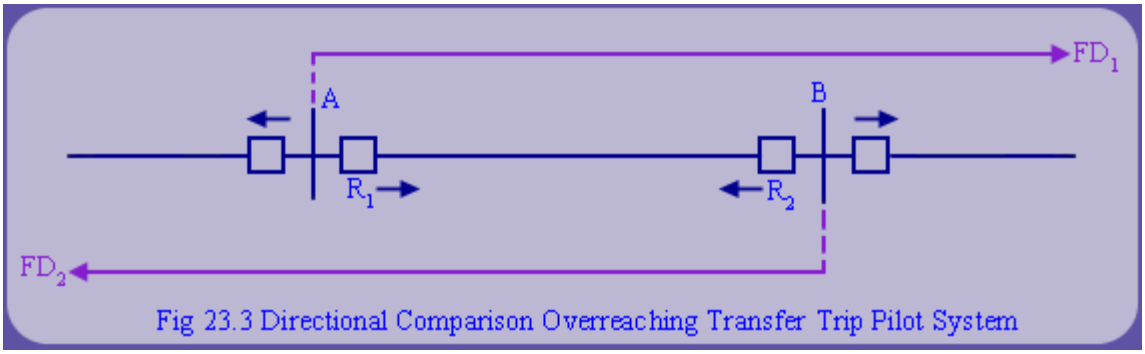

Fig 23.3 Directional Comparison Overreaching Transfer Trip Pilot System

This scheme is shown in fig 23.3. In this scheme, for internal fault both $FD_1$ and $FD_2$ operate to shift respective transmitters to trip mode. A logical AND-ing of trip of both $FD_1$ and $FD_2$ provides the trip output at both ends of the line. In case of external fault either $FD_1$ or $FD_2$ will not pick up and hence relays $R_1$and $R_2$ will not operate.

In case there is no fault, neither $FD_1$ nor $FD_2$ operate. In case of external fault either $FD_1$ or $FD_2$ will pick up depending upon whether fault is on right side of node B or left side of node A. This over reaching initiates a timer. If external fault persists beyond CTI, then a back up trip decision is initiated by $Z_2$ of the respective relays.

## 23.4 Directional Comparison under Reaching Transfer Trip Pilot System

We now discuss the directional comparison under reaching transfer trip pilot system. The under reaching terminology implies that the FDs are to be set so as always to overlap but not over reach any remote terminal under all operating condition. The schematic diagram of this scheme is given in fig 23.4.

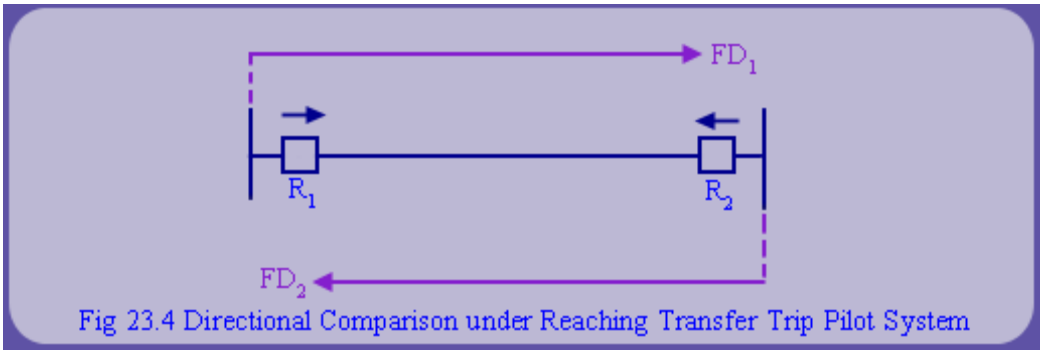

Fig 23.4 Directional Comparison under Reaching Transfer Trip Pilot System

Phase directional distance relay zone1 unit meets this requirement. Two types of such implementation exist. They are known as a) non permissive b) permissive. With external faults, neither $FD_1$ nor $FD_2$ picks up. For internal faults in the overlap area of $FD_1$ and $FD_2$ both $FD_1$ and $FD_2$ pick up. To clear internal faults quickly which are not in the overlap region, OR-ing of the trip decision of $FD_1$ and $FD_2$ is used at both ends. This system is not very much in use.

Review Question

1. Describe the working principle of the following:

a) Directional comparison blocking system.

b) Directional comparison pilot unblocking system.

c) Directional comparison overreaching transfer trip pilot system.

d) Directional comparison underreaching transfer trip pilot system.

2. Briefly explain how, the directional comparison schemes provide uniformly fast protection for faults on the primary line

while providing time discrimination for the backup action.

## Recap

In this lecture we have learnt the following:

- Direction comparison schemes that use communication from other end to speed the trip decision for fault on the

  primary line.

- Various schemes which were discussed are:

  Directional comparison blocking system.

  Directional comparison unblocking pilot system.

  Directional comparison overeaching transfer trip pilot system.

  Directional comparison under reaching transfer trip pilot system.

  The communication requirement in these schemes is not very high as only block/unblock signals are communicated to

  the other end.

  Congratulations, you have finished Lecture 23. To view the next lecture select it from the left hand side menu of the page