Power System Protection and Switchgear
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Lecture No. 21
Carrier Aided Schemes for Transmission Lines-III

So, in the last class, we have discussed regarding the phase comparison scheme. So, the other type of scheme that is known as the directional comparison scheme. So, in this scheme the direction of power at the local end and at the far end of the line that is compared.

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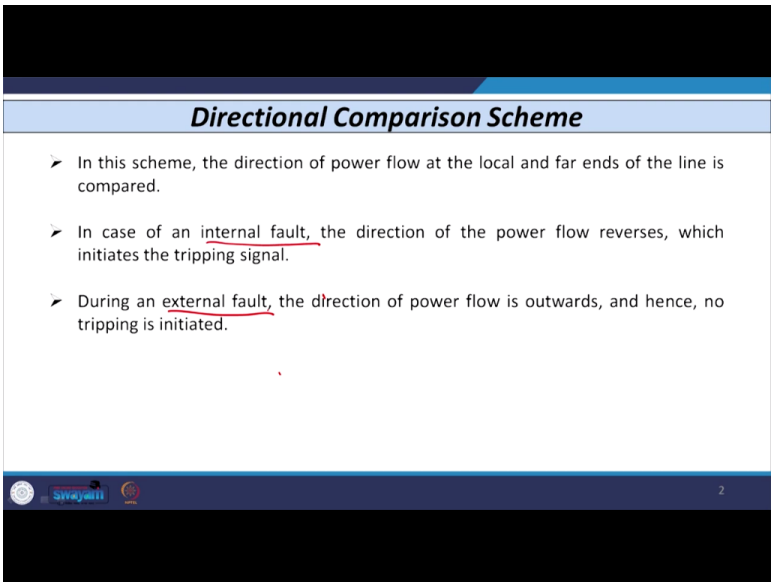

So, in case of the internal fault, the direction of power flow that is reverses. So, that gives an indication of an internal fault and hence the tripping is initiated, whereas in case of an external fault, the direction of power flow that is outward and hence no tripping that is initiated.

So, the other equipment that remains same as the phase comparison scheme, we are not going to discuss in detail the directional comparison scheme. Whatever equipment we have used in phase comparison scheme, starting from wave trap, coupling capacitors, power gap. Then, we have utilized the transmitter, receiver, square wave.

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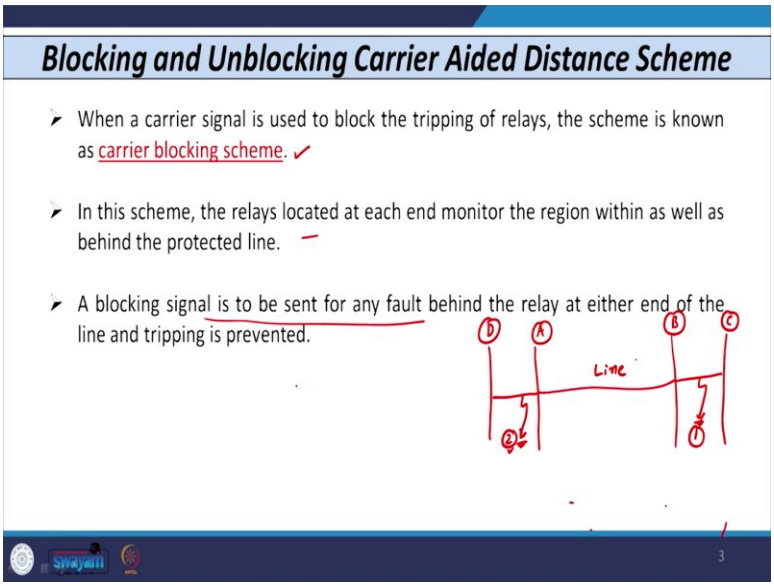

All those are also used for the directional comparison scheme. Let us move further. The next part, that is the blocking and unblocking carrier aided distance scheme. So, now, as I told you earlier, whenever carrier signal is used to block the operation of relay, then that scheme is known as carrier blocking scheme. So, in carrier blocking scheme, whatever carrier signal is received from the other end from the remote end, that signal is used to block the operation of relay or to initiate the operation of relay. So, that scheme is known as carrier blocking scheme.

So, in this scheme, the relays are located at each end. So, at sending and as well as receiving end, the relays are there. And this relays monitor the region within as well as behind the line that is to be protected. So, the blocking signal is sent for any fault behind the relay on either side of the line and hence the tripping is prevented. What is the meaning of this that we will so, that means, suppose, if I consider a line connected between two bus, let us say A and B and let us have the another line connected between bus B and C.

So, if any fault occur somewhere here, then, in that case, blocking signal is given. So, that is why the scheme is known as carrier blocking scheme. Similarly, for any fault on the other adjoining line connected between bus A and D, if any fault occurs here, then also the blocking signal is even, because these two faults second number and one these two faults are out of zone faults for the relay located at substation A and substation B for the protection of this line. So, that is the meaning of this blocking signal.

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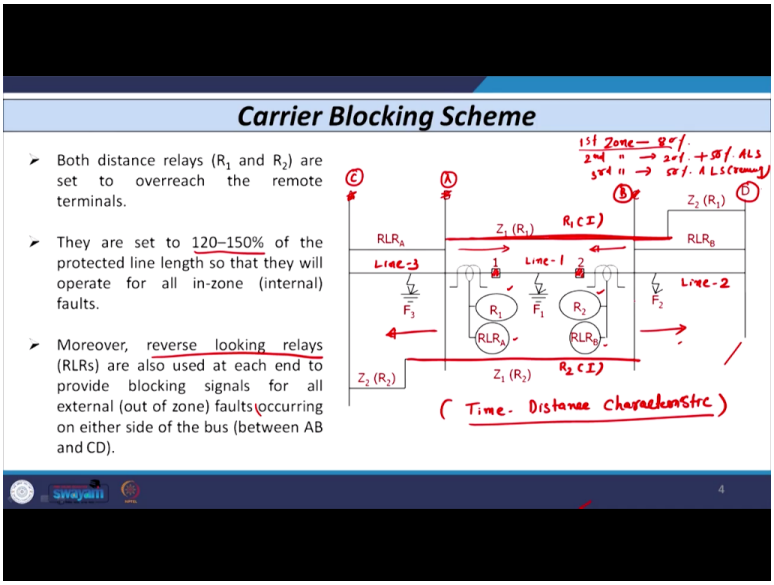

So, now, let us start with the discussion of what is the carrier blocking scheme. So, here I have shown the time distance. This is the time distance characteristic. So, this is the time distance characteristic of carrier blocking scheme. So, there are 4 buses. This is the line which we want to protect, let us say line 1. And the relay R1 and R2 are located at bus B and bus C. So, we need to protect this, this line 1.

And again we have also shown the circuit breakers 1 and 2. We have also shown the adjoining line sections that is the let us say this is line 2 and here that is line 3. So, there are total 3 lines and the 2 relays are there. Now, here you can see that, the relay R1 and relay R2, this two relay are again set because, see normally when we have discussed the distance relays, we have seen that the first zone of distance relay that is set to cover 80 percent of the line length, that is the first zone.

The second zone that will cover the next remaining 20 percent plus 50 percent of adjoining line section and the third zone similarly that covers the remaining 50 percent of the adjoining line section that is remaining. So, this we have discussed while discussing the distance relay philosophy. Now, in this case, the relay R1 and R2, these two are distance relays. But this relay, reach of these two relays are set such that the first zone of these two relays, that is not the 80 percent of the line to be protected.

So, here line to be protected is line one. So, the reach of R1 and R2 first zone reach of these two relays are not 80 percent of line 1, but it is normally 120 to 150 percent of line 1. So that is why, you can see that, on the time distance characteristic, we have shown the first zone of relay R1, that is, that will go up to here. So, this is the first zone of your relay R1.

Similarly, this is the first zone of relay R2, which is shown by Z1R1 or you can also write down R1 one and this is your R2 one, that is the first zone of relay R1 and R2, that will cover 120 to 150 percent of the line 1. And similarly, second zone and third zone are there. Now, here, along with these two relays, distance relays R1 and R2, the other two relays are also used that is known as RLR-A and RLR-B.

So, RLR relay that is known as reverse looking relay. So, reverse looking relay located at bus B that will look on the other side, this side and the reverse looking relay located at this point at this bus that will look on this side. So, that is nothing but the RLR-A and RLR-B, that is all about. Let us just rename this number this is A and this is B, let us say this is your C and this is your D.

So, here along with two distance delays, we have the reverse looking relays also; one is located at substation A. And this relay will look on the direction opposite to the bus A, whereas, your distance relay R1 that will look in this direction. Same way, the distance relay located at bus B that is R2 that will look in this direction, whereas, the reverse looking relay located at bus B RLR-B that will again look in the opposite direction that is this direction.

Now, based on this, let us see, what is the diagram of relay R1, R2, RLR-A and RLR-B on the RX plane.

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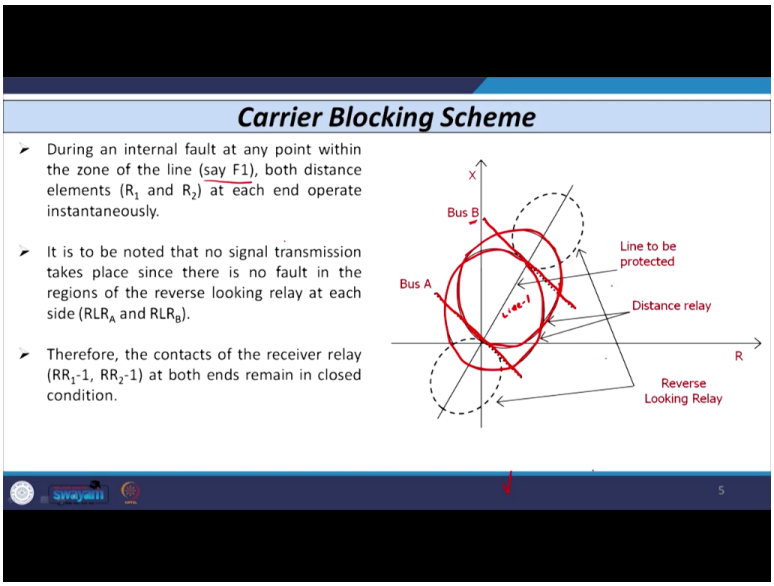

So, if I just draw the diagram on RX plane, then, you can see that we have a bus A that is bus A is here and we have a bus B that is again here. Between these two, the line 1 is connected. So, this is our line 1. Now, you can see that I have drawn the reach of the R1 that covers 120 percent of line one from bus A. So, you can see that the reach of this relay R1 that is, that covers 120 percent. So, you can see that covers 120 percent from bus A.

Similarly, the reach of R2 that covers 120 percent from bus B. So, that is like this. So, this is nothing but the reach of two relays R1 and R2. And as I told you, reverse looking relay that looks in reverse direction. So, its reach, that is reverse looking relay situated at bus B its reach is shown this dotted circle and the reverse looking relay shown at bus A, that it's reach is also shown by this dotted circle.

So, now, let us see what will happen in case of internal fault. So, whenever the internal fault occurs, you can see that let us consider the internal fault occurs at F1 in on line one. So, in this case, when the internal fault occurs, both these relays that is R1 and R2, these two relays will operate. And hence, your tripping is given instantaneously. Why tripping is given instantaneously?

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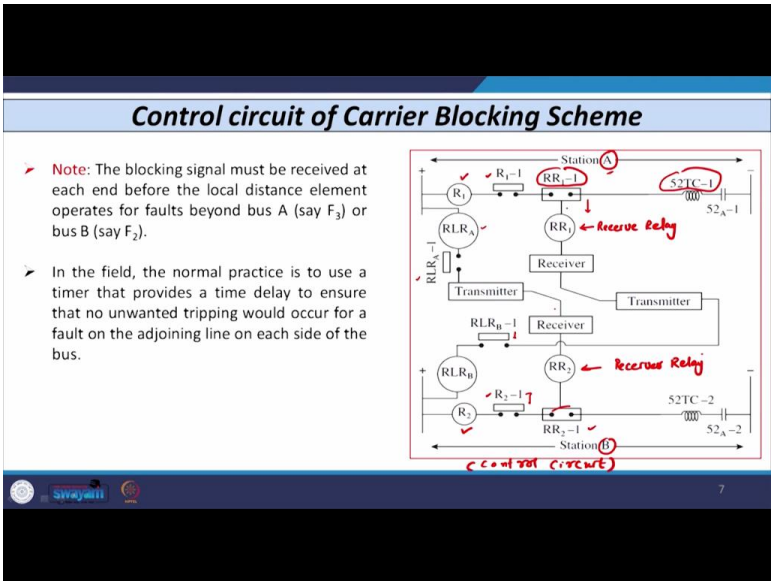

If I just tell you the control circuit, so, this is the control circuit for the carrier blocking scheme. So, there are two relays, relay R1 is located in station A and relay R2 that is located in substation B. This relay R1 and R2 has one contact that is R1 one normally open contact and R2 one that is also normally open contact. Again, you can see that the when you consider the tripping circuit between positive and negative relay R1 with its contact R1 one, you have another contact RR1 that is the contact of receiver relay. So, this RR is nothing but your receiver relay.

So, RR is the coil of receiver relay and RR1 one that is the contact normally close contact of receiver relay. And then, that is there. The other input you can see from here. The other part that will goes to the reverse looking relay located at substation A, so RLR-A. Again its contact is there, RLR-A1 normally open contact and then it is connected to transmitter, which is further connected to the receiver at substation B and again it is connected to receiver relay. So this is again the receiver relay right and it's contact that is RR2 one which is normally closed contact.

Now, you can see whenever internal fault occurs at F1, at this point, whenever the fault occurs at F1 relay R1 and R2, both these relays, distance relays see this fault in its first zone. So, obviously, the relay R1 will operate its contact, this contact closes. Similarly R2 will operate and its contact closes.

So, as this is normally closed contact so directly the tripping command is initiated by R1 and the breaker at substation A, that is breaker one that is going to be tripped. Same way, the other, you can see that other side, substation B also, the relay R2 detects the same fault in zone one, so, its contact closes. And hence, again the tripping is initiated and it gives command to the circuit breaker, which is situated at substation B.

So, circuit breaker two becomes open and this, in this way, the fault F1 that is internal fault that is disconnected or identified instantaneously. Now, let us see what happened in case of the external fault.

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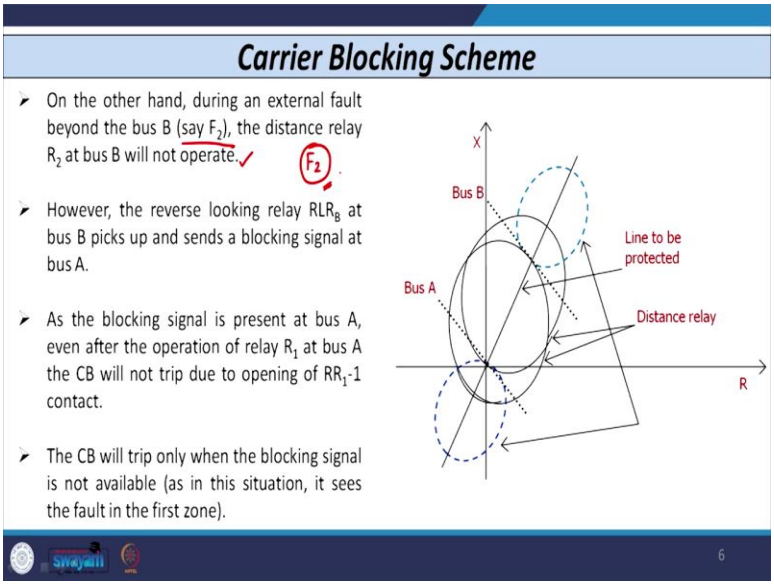

So, when we consider the external fault, let us say the external fault occurs at F2. So, external fault, I have shown either here, you can also consider the other external fault that is F3 also, both are external faults for as far as relays R1 and R2 is concerned. You can see that in case of external fault, either F2 or F3, let us consider the external fault F2 for the time being. So, if fault occurs at F2, so, what will happen? If fault occurs at F2, you can see that the first zone reach of relay R1 that is we have set 120 to 150 percent.

So, this fault F2, the relay R1 detects in its first zone. So, as it detects in its first zone, its contact R1 one, that is closed. And as its contact this close, the direct tripping command that is initiated, right, at this point. But now, what will happen to the substation B. So, at substation B, as you can

see that, the R2 relay that is not going to detect this fault, because R2 relay sees this fault that is in, it is on the reverse side of this relay R2, because relay R2 looks on this side and fault is somewhere here.

So, relay R2 here that is not going to detect this fault, not going to sense this fault. So, what will happen is that the this relay R2 one contact of the relay that remained in open condition. Further, you can see that, the as this remains in open condition so, no tripping command is given to the circuit breaker two. Now, you can see that whenever fault occurs at F2, though relay R2 is not able to sense the fault, but reverse looking relay B situated at substations B, that is going to detect this fault because the RLR-B that will look in this direction.

So, if RLR-B that will look in this direction, then, you can see that, what will happen in this case, that in this case, you can see that the reverse looking relay B that is going to detect this fault, its contact closes. So, this contact that closes and hence its transmit the signal through transmitter when this signal is received by the receiver, receiver relay RR1, that is energized. And hence, the contact of this RR1, which is normally closed that becomes open.

So, before the command through relay R1 is given to the trip coil of circuit breaker that is 52 TC1, this RR1 one that is going to become open and hence no tripping is initiated at the substation A and hence no breaker one that remains in close condition. So, this is very important point. Now, we have already discussed that in case of the internal fault, signal transmission takes place.

And there is no fault in the region where reverse looking relay so reverse looking relay in case of internal fault, that is not going to sense the fault. And hence the receiver relay contact remained in closed condition and hence in case of internal fault, the tripping directly associated or given to the respective breaker.

In case of the external fault, as I have discussed, say at F2, the reverse looking relay at B that is going to sense the fault. It picks up and it gives again the blocking signal to the other bus that is bus A. So, the blocking signal is as present at bus A. So, the relay even though relay R1 detects the fault at F2 and its contact closes, the contact of this receiver relay RR1 one that is going to become open and hence no ripping is given.

So, this is very important point. Whenever in this, whole this scheme, whatever we have discussed, one very important point we need to understand that is the that the blocking signal must be received at each end, either from substation B to substation A or from substation A to substation B. The blocking signal is given from substation B to A in case of fault at F2 and blocking signal is given from substation A to B in case of fault at F3 right either way.

So, the blocking signal must be received at each side, either at A or B before the local distance relay operates, maybe if fault occurs at F2, the local distance relay is R1, if fault occurs at F3, the local distance relay that is R2. So, before this relay operates, this contact, RR1 one that has to be open. If that type of coordination is required between the receiver relay and the local distance relay that is R1 and R2.

So, coordination is required between R1 and receiver relay 1. Similarly, coordination is required between local distance relay R2 and the RR2 that is receiver relay two. If this is not possible, if coordination fails, then, in case of external fault means fault beyond the zone of the relay either F2 or F3, one of the relays may maloperate. So that, if we want to, if we wish to avoid that, then proper coordination is required between local distance relay and the receiver relay.

So, in actual field, in normal practice is to use the timer to provide the time delay to ensure that that means, whenever this local distance relay operates, that local distance relay is associated with the timer and that timer sees that unless and once the blocking signal command that is available at this point or whatever time is required, that timer time is set according to the the opening time of this contact of RR1. So, that coordination is carried out.

But if we use the timer with the local distance relay, we know that the first zone of the distance relay R1 or R2 that is instantaneous in nature and we want instantaneous operation. So, that is against our main requirement. So that is why this type of scheme, that is not used particularly when we have such type of problem. So, let us see what are the disadvantages of carrier blocking scheme.

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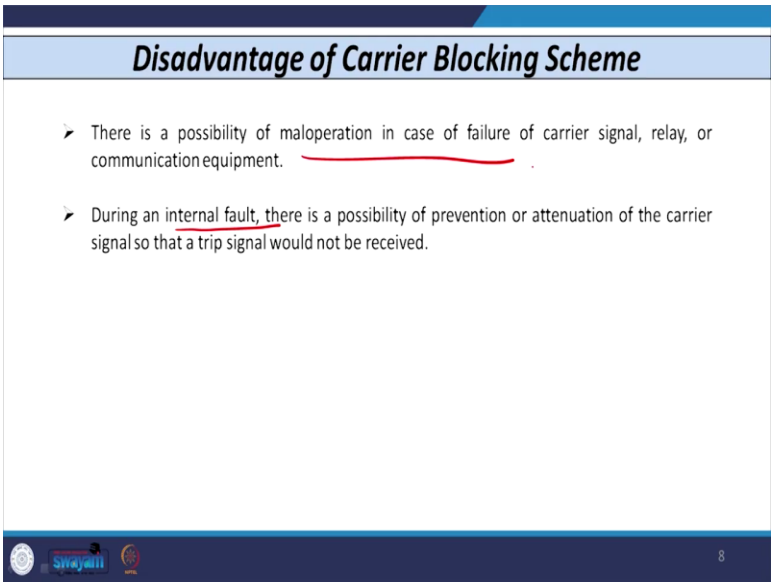

So, as we have discussed that there is a possibility of maloperation of carrier blocking scheme or this type of scheme, in case of failure of carrier signal or communication equipment. So, as I told you, that if this blocking signal is not available or if there is a delay in the blocking signal from the other substation, which is located at far end, that means, if this RR1 one contact that which is normally closed, we have to open in case of external fault. If there is a delay in opening up this contact RR1 or RR2 one, then maloperation that is possible.

So, that is the one of the biggest disadvantage of carrier blocking scheme. So, that is maloperation that is there. The second disadvantage is in case of an internal fault, there is also a possibility of the prevention or attenuation of carrier signal. And hence the, whatever tripping command that is issued by relay that is not there.

So, the breaker that is not going to become open. So, in case of internal fault also, this type of scheme may fail. So, if we wish to avoid this two maloperation, that means maloperation or in case of external fault as well as the proper operation in case of internal fault. Then, we have to go for some other type of scheme, which is not the carrier blocking scheme. So, we have to go for carrier unblocking scheme.

As we have discussed, for carrier blocking scheme, the main disadvantage is that before the local distance relay operates, we have to open the normally closed contact of the receiver relay,

otherwise maloperation is there, that is the biggest disadvantage of carrier blocking scheme. And if we wish to avoid this, if we wish to rectify this problem, then, we have to go for the carrier unblocking scheme.

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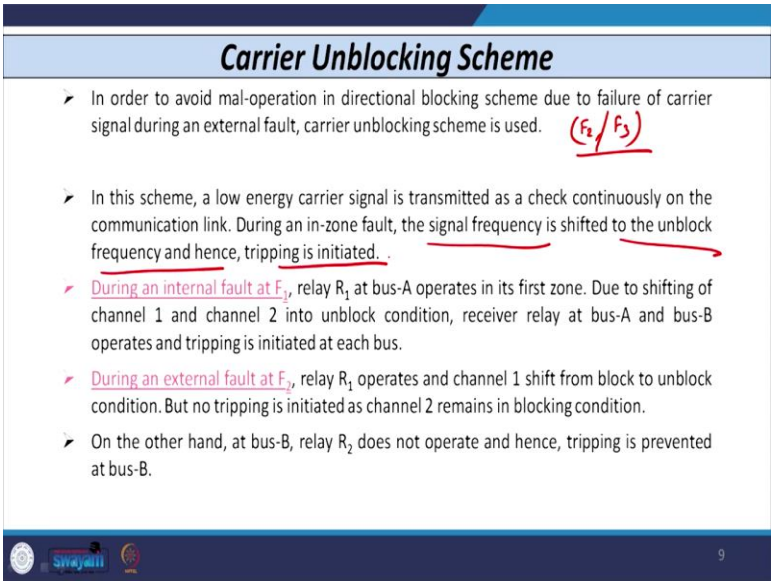

So, let us see what is the carrier unblocking scheme. So, as I told you, if we wish to avoid maloperation of directional blocking scheme or carrier blocking scheme, in case of particularly in case of external fault that is either F2 or F3, as we have discussed, then, the carrier unblocking scheme we have to use. So, what is F2 and F3? So, F2 and F3 these two are this fault, this is F2 and this is F3. On either side of the bus A or bus B, whatever fault that is the fault beyond the zone of the line to be protected, that is line one.

So, we have to use the carrier unblocking scheme. Now, let us see what is, how this scheme works. So, in this scheme, what is what happened is that continuously a low energy carrier signal that is transmitted to check something is going on or not. So, during a zone fault or internal fault, what will happen? This signal frequency that is shifted to the unblocked frequency and hence tripping is initiated. So, what will happen?

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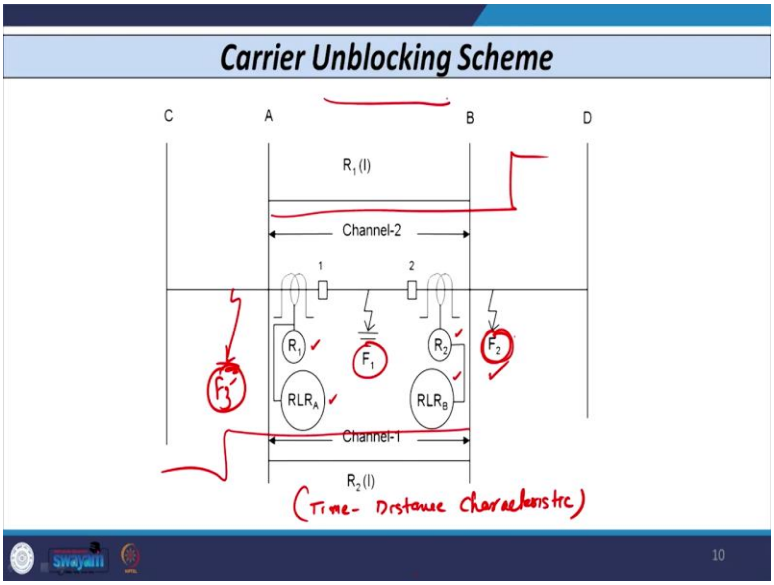

There are two different (channel) channels are there. One channel is for transmission and another channel that is for this low energy carrier signal. So, continuously this channel, which is going to transmit the low energy carrier signal, that is normally in blocking condition. So, the function of this low energy carrier signal which we are continuously transmitting from bus A to bus B and bus B to bus A, its function is it is going to block the operation.

But wherever internal fault occurs, it status that will be shifted from block to unblock. So, that is very important. And hence, the tripping is initiated in the scheme. So, if I just draw the time current, time distance characteristic for carrier unblocking scheme, then this is the time distance characteristic of the carrier unblocking scheme. So, you can see that the two relays are there. Again, same as the carrier blocking scheme. Both are distance relays. Again, the two river flocking relays are there at each bus.

So, there is no difference. The only difference is we have a separate, we are going to transmit a low energy carrier signal separately on the other channel and that will continuously give the blocking signal. If internal fault is there, let us say at F1, if internal fault is there, then, in case of internal fault, you can see that the relay R1 at bus A operates in its first zone. So, as I told you, because the first two first zone of R1 and R2 that is going to cover the 120 to 150 percent.

So, due to shifting of channel one and channel two, as I told you, we have to shift this to, from blocking to unlocking condition. The receiver relay, at bus A and bus B, that remains in closed condition. So, its a contact that will remain in normally closed condition. So, tripping is initiated at each business.

Now, in case of external fault, either maybe at F2 or maybe somewhere here on the other adjoining line section F3, what will happen is that the relay R1 operates and hence channel will shift from block to unblock, because as I told you, the reach of this relay R1 that is 120 percent from this side and reach of this relay R2 that is also 120 percent from this side.

So, R1 senses the fault at F2 that is in first zone, so it operates. So, whatever the low carrier frequency we are transmitting that will shift from block to unblock right. It is continuously we are transmitting in blocking condition. But as R1 senses the fault in its first zone, so we have, that will be shifted from block to unblock.

But in this case, also no tripping is initiated, because in channel 2 that remains in blocking condition why, because relay R2 that is not going to detect the fault F2, because that is reverse fault as far as F2 is concerned for relay R2. So, no tripping is initiated in this condition. And hence, we can easily discriminate between the internal fault and the external fault.

On the other hand, at bus B, the relay R2 does not operate and hence no tripping is given. So, this is all about the carrier unblocking scheme.

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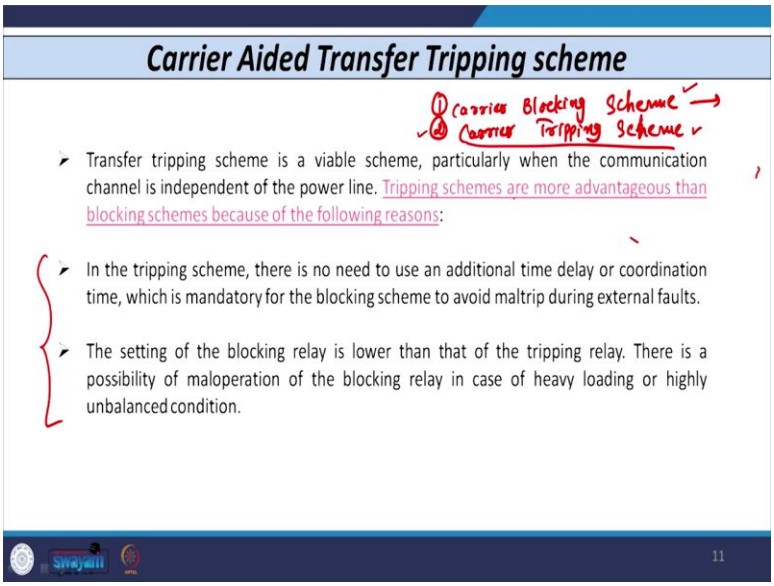

So, we have discussed the carrier blocking scheme and carrier unblocking scheme. Now, let us discuss the next part that is the carrier aided transfer tripping scheme.

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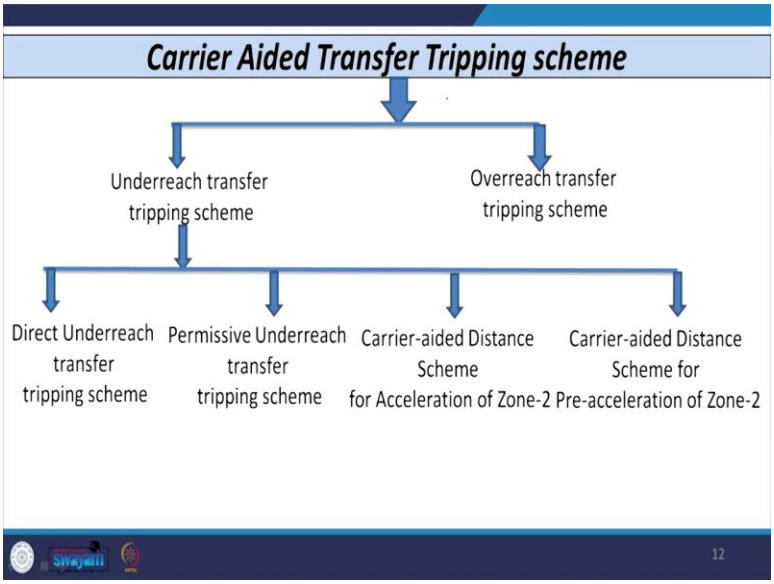

So, before we go into the discussion of carrier aided transfer tripping scheme, we have to understand that whether we should select the carrier blocking scheme or carrier tripping scheme. So, there is a fundamental difference. We have the carrier blocking scheme and we have the

other scheme that we have that is the carrier tripping scheme. What is the fundamental difference between these two?

When whatever carrier signal that is available from the other end, remote end, if we use that carrier signal to block the operation of relay, then that is known as carrier blocking scheme. Whereas, whatever the carrier signal available from remote end, if we use that signal to initiate the operation of relay, then that is known as carrier tripping scheme.

So, there are certain advantages and disadvantages. In actual field, carrier tripping scheme is more advantageous than the carrier blocking scheme. And that is the main reason is if I use the carrier tripping scheme, then there is no need to use the additional time delay or no coordination is required.

As I told you in case of carrier blocking scheme, the proper coordination is required between local distance relay and the receiver relay. That means, we have to open the contact of the receiver relay at each side before the local distance relay operates. Such type of coordination is not required if I use the carrier tripping scheme. So, this is the main advantage of carrier tripping scheme compared to the carrier blocking scheme. And hence, in actual field, this type of scheme is widely used.

The other main disadvantage of the carrier blocking scheme is its setting. So, the setting of the carrier blocking scheme that is usually lower than the carrier tripping scheme. So, there is a possibility of maloperation of the blocking relay particularly in case of heavy loading or unbalanced condition. And hence, due to these two reasons, the carrier blocking scheme that is not used in actual field and carrier tripping scheme that is used in practical field.

So, in this lecture, we have we started our discussion with the carrier blocking scheme. Then, we have also discussed the time distance characteristic and the main control circuit. We have also discussed the disadvantage of carrier blocking scheme. And then, we started the discussion with the carrier unblocking scheme and how that disadvantage.

And then, we started, initiated the discussion for the carrier aided transfer tripping scheme. And we have discussed what are the advantages of carrier tripping scheme compared to the carrier

blocking scheme. So, I stop here. And in the next class, we will further continue for the carrier aided transfer tripping scheme. Thank you.