Distance Protection Scheme

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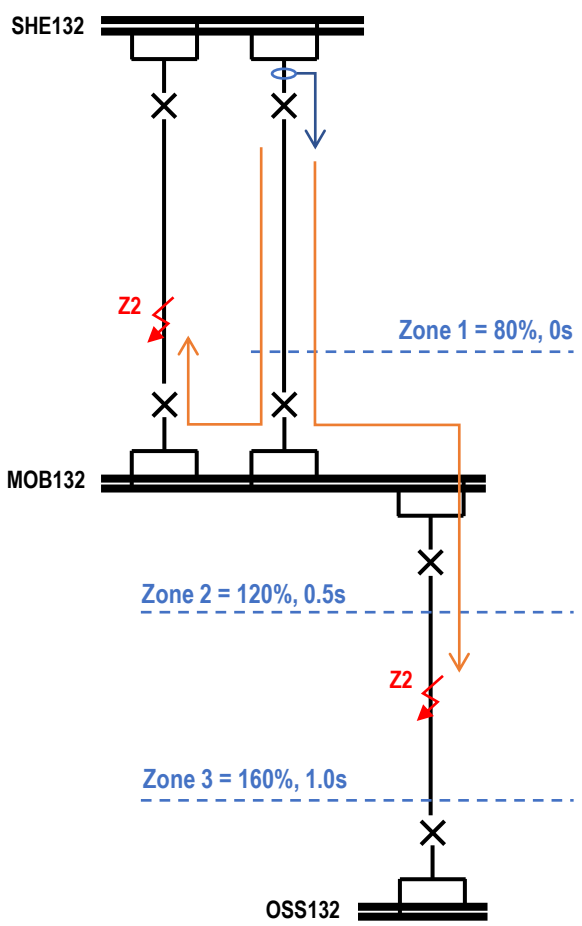
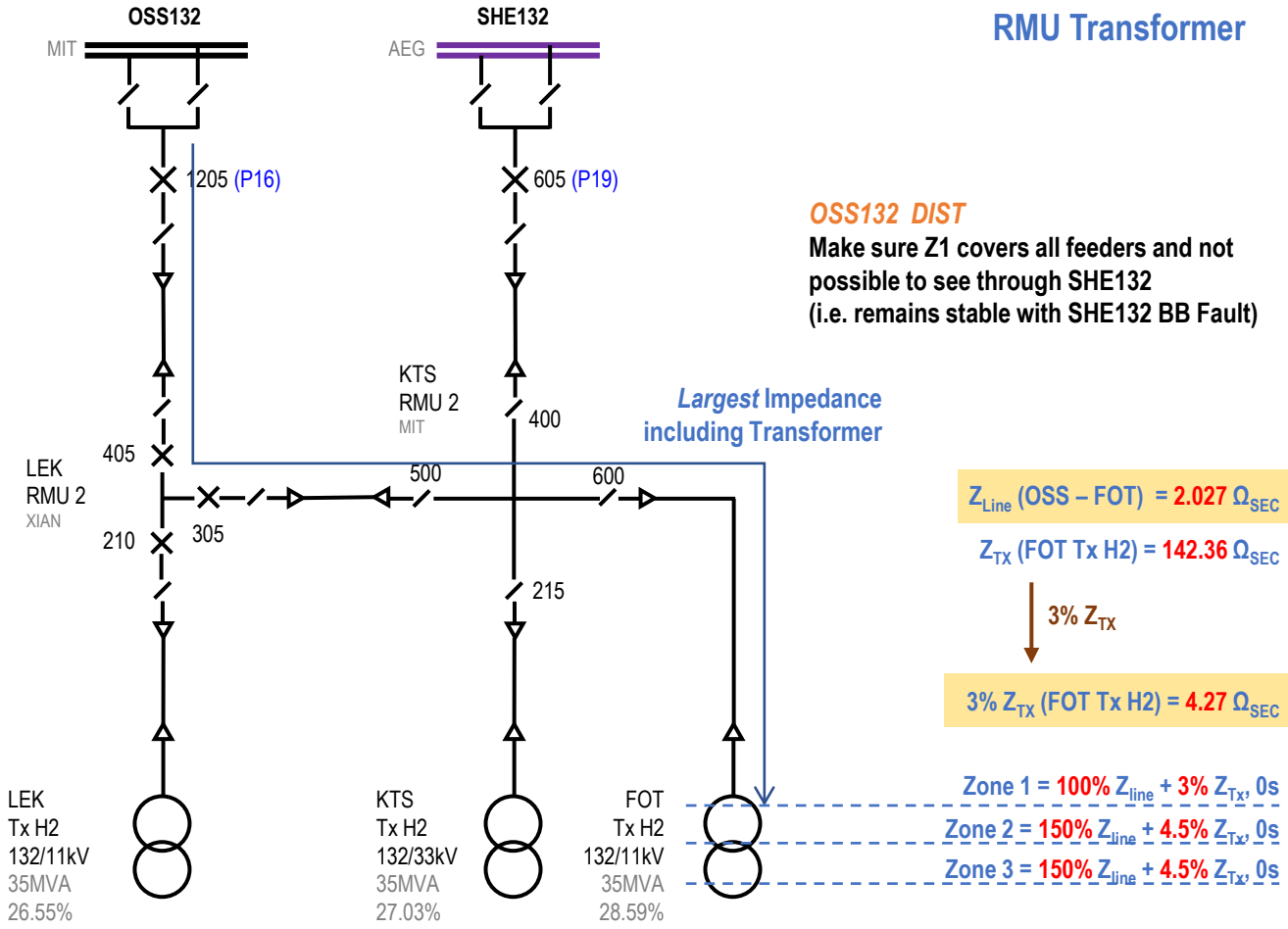
Three-Step Mode

Plain Feeder



RMU Transformer



Largest Impedance including Transformer

OSS132 DIST

Make sure Z1 covers all feeders and not possible to see through SHE132 (i.e. remains stable with SHE132 BB Fault)

Z_{Line} (OSS – FOT) = 2.027 Ω_{SEC}

Z_{TX} (FOT Tx H2) = 142.36 Ω_{SEC}

3% Z_{TX}

3% Z_{TX} (FOT Tx H2) = 4.27 Ω_{SEC}

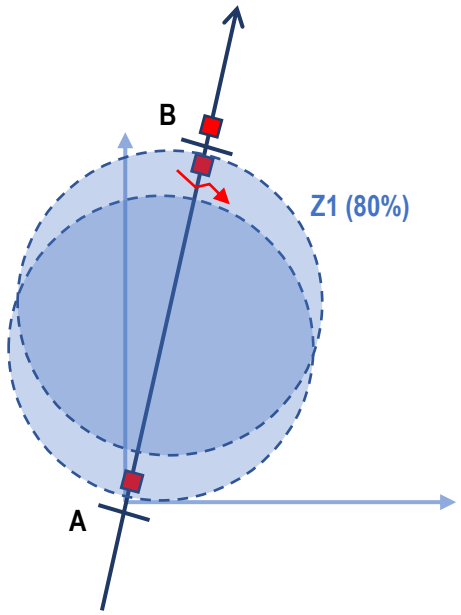
Zone 1 = 100% Z_{line} + 3% Z_{Tx}, 0s

Zone 2 = 150% Z_{line} + 4.5% Z_{Tx}, 0s

Zone 3 = 150% Z_{line} + 4.5% Z_{Tx}, 0s

Permissive Underreach (PUR)

The fault must be in the zone between the two relays (i.e. on the line section) if;
Zone 1 (80%) element operates, or
Remote end Zone 1 operates AND local Zone 2 element operates.



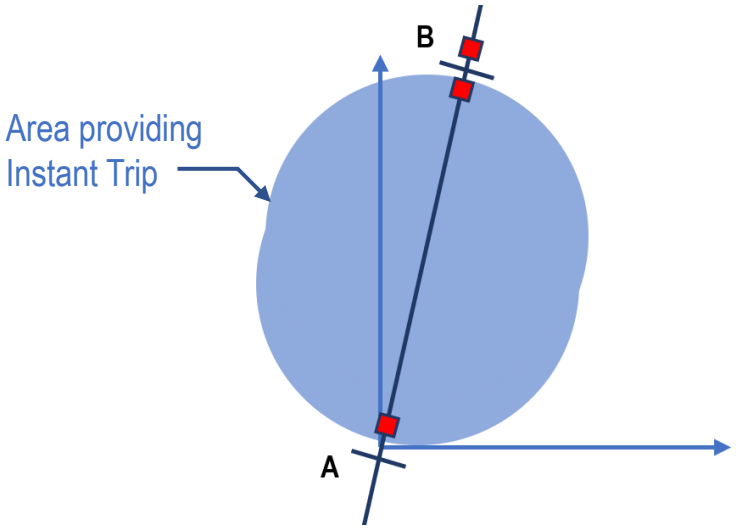
Set Z1 = 80% Z_{Line} (0s delay), Z2 = 120% Z_{Line} (0.5s delay), Z3 = 160% Z_{Line} (1.0s delay)

Consider a fault as indicated.

- Distance Relay B sees a Z1 fault and provide instant trip.
- Distance Relay B sees a Z1 fault and provide an aided trip to Relay A (DPA).
- Distance Relay A sees a Z2 fault and provide a trip with delay 0.5s.
- Distance Relay A receive aided trip signal AND sees a Z2 fault. The time delay is removed and provide an instant trip.

Note:

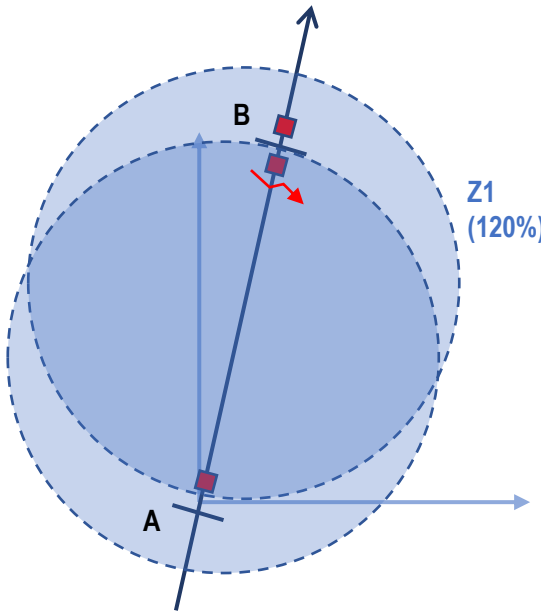
- It only requires a single signalling channel for two-way signalling. It does not require the permissive signal if both ends sees a Z1.
- In case the signalling channel is NOT functioning, the scheme will switch back to three-step mode, in which just play with the delay.



Permissive Overreach (POR1)

Normally for short line, where minimum setting impedance (e.g. 0.25Ω for SEL421) > line impedance

The fault must be in the zone between the two relays (i.e. on the line section) if;
Remote Zone 1 (120%) AND Local Zone 1 (120%) operates.



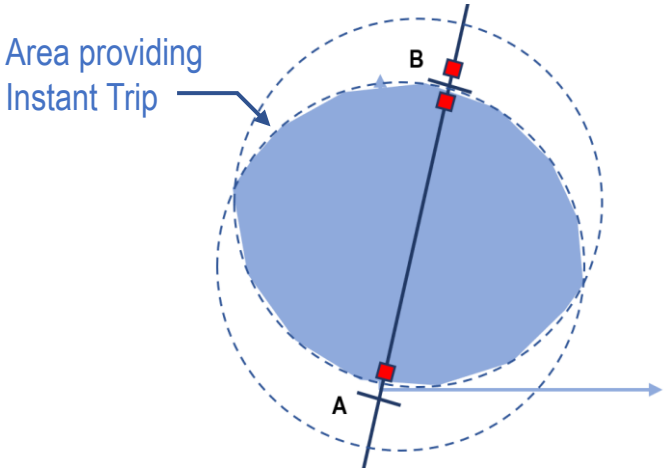
Set Z1 = 120% Z_{Line} (0.5s delay), Z2 = 120% Z_{Line} (0.5s delay), Z3 = 160% Z_{Line} (1.0s delay)

Consider a fault as indicated.

- Distance Relay B sees a Z1 fault and trip on 0.5s delay.
- Distance Relay B sees a Z1 fault and provide an aided trip signal to Relay A (DPA).
- Distance Relay A sees a Z1 fault and trip on 0.5s delay.
- Distance Relay A sees a Z1 fault and provide an aided trip signal to Relay B (DPA).
- Distance Relay A receives an aided trip from Relay B to remove Z1 time delay, hence executes an instant trip with a communication delay.
- Distance Relay B receives an aided trip from Relay A to remove Z1 time delay, hence executes an instant trip with a communication delay.

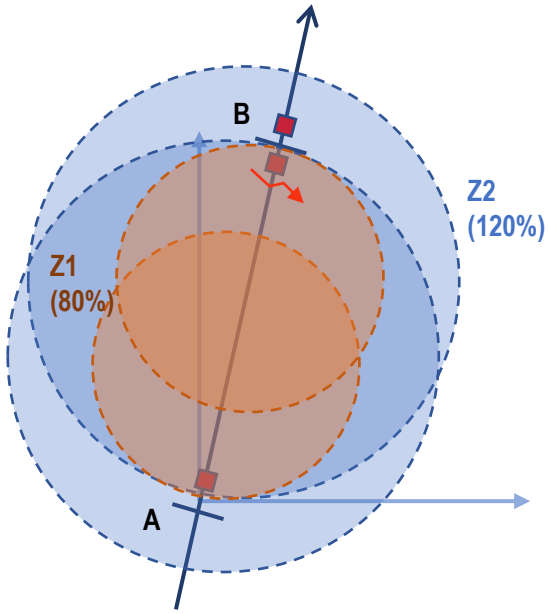
Note:

- It only requires a duplex signalling channel for two-way signalling as Relay A sees a Z1 fault ≠ Relay B sees a Z1 fault. 2 channels are required to signal the differences.
- In case the signalling channel is NOT functioning, the scheme will switch back to three-step mode, in which just play with the delay. However, it does NOT provide instant trip (need time to confirm both Zone 1) so it is rarely used.



Permissive Overreach (POR2)

The fault must be in the zone between the two relays (i.e. on the line section) if;
Zone 1 (80%) element operates, or
Remote end Zone 2 (120%) operates AND local Zone 2 (120%) element operates.



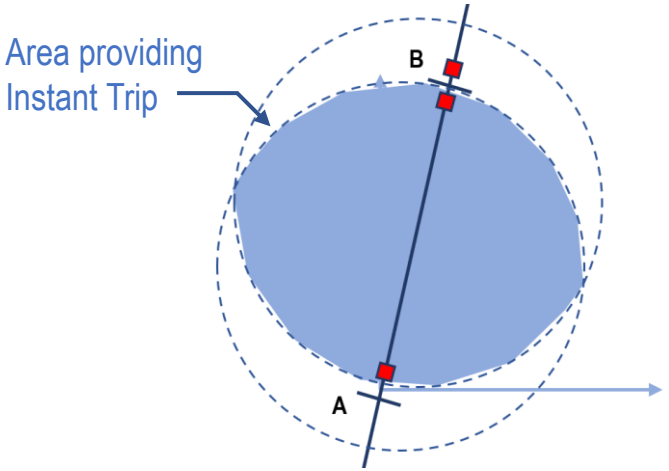
Set Z1 = 80% Z_{Line} (0s delay), Z2 = 120% Z_{Line} (0.5s delay), Z3 = 160% Z_{Line} (1.0s delay)

Consider a fault as indicated.

- Distance Relay B sees a Z1 fault and provide an instant trip.
- Distance Relay B also sees a Z2 fault (Z1 is inside Z2) and provide an aided trip signal (DPA).
- Distance Relay A sees a Z2 fault and provide a trip with 0.5s delay.
- Distance Relay A received an aided trip from Relay A signal AND sees a Z2 fault. The time delay has been removed and provide an instant trip.

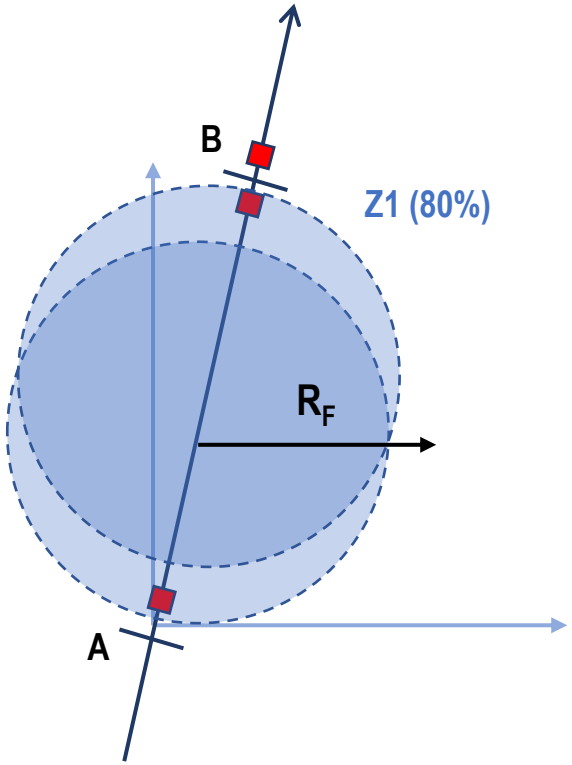
Note:

- It only requires a duplex signalling channel for two-way signalling as Relay A sees a Z1 fault ≠ Relay B sees a Z1 fault. 2 channels are required to signal the differences.
- In case the signalling channel is NOT functioning, the scheme will switch back to three-step mode, in which just play with the delay.



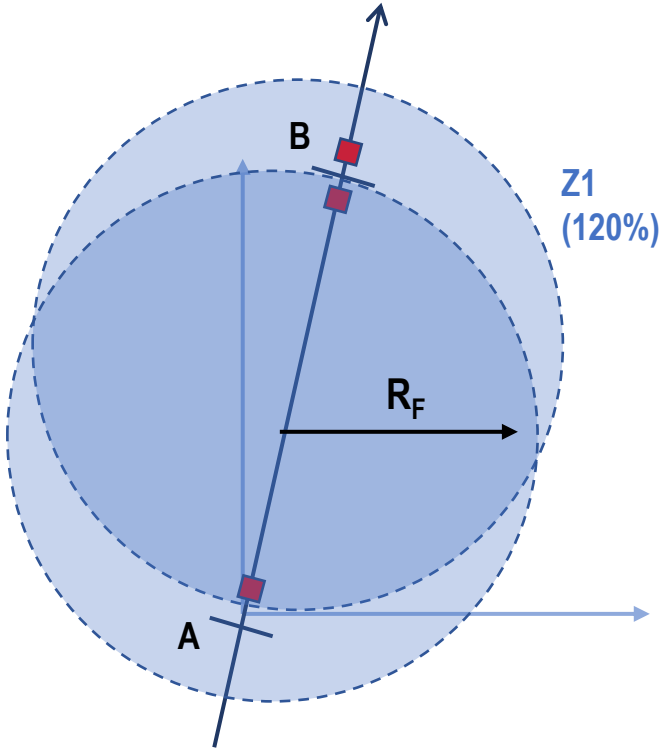
PUR Vs POR

Permissive Underreach



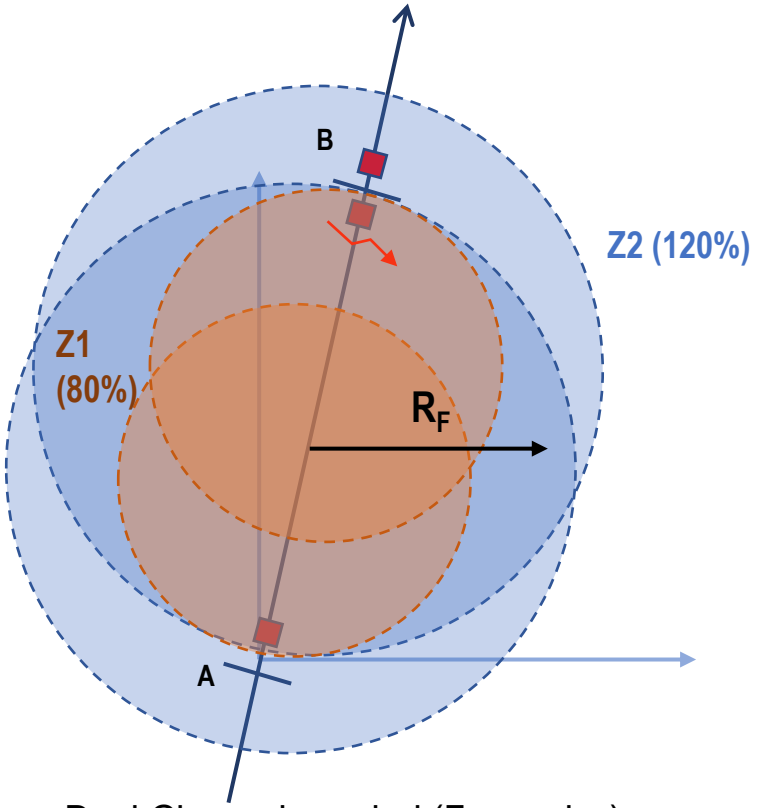
- Single Channel needed (Cheaper)
- Fast tripping for complete line
- Better loadability

Permissive Overreach



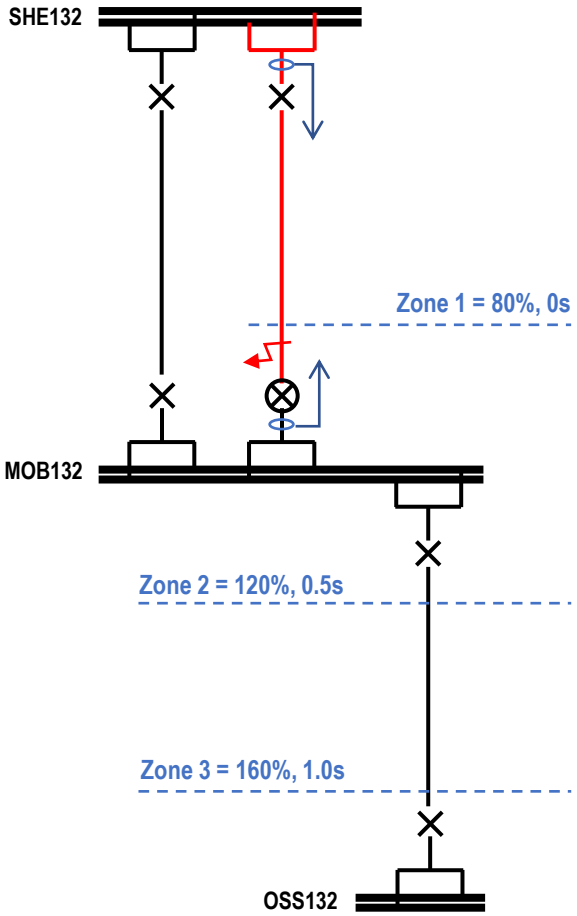
- Dual Channel needed (Expensive)
- Fast tripping for complete line
- Improved Resistive Coverage
- No instant trip

Permissive Overreach (POR2)



- Dual Channel needed (Expensive)
- Fast tripping for complete line
- Improved Resistive Coverage
- Instant Trip provided

Echo Scheme



Suppose a line SHE – MOB No.2 is energized (CB closed) at SHE side with CB open at MOB side.
A line end fault occurs, i.e. very close to MOB132.

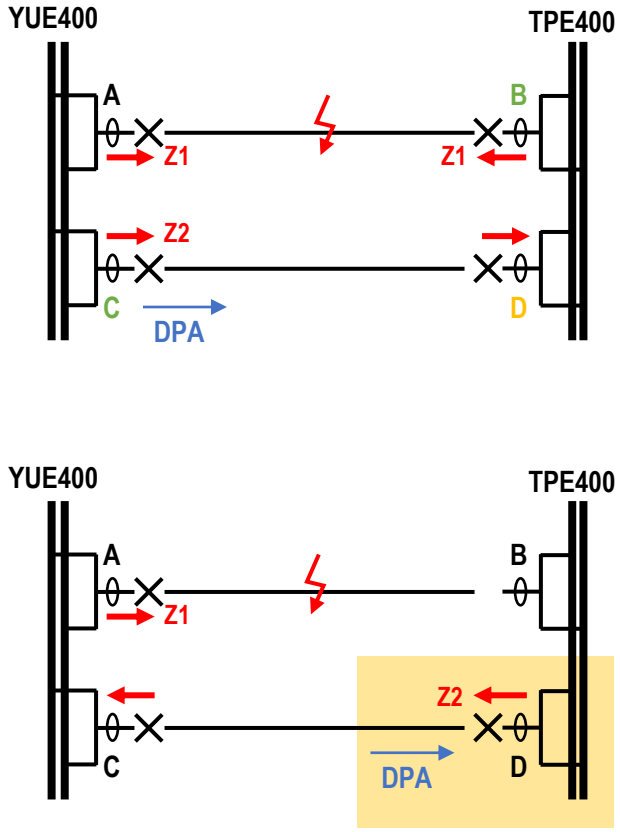
- SHE Distance Relay sees a Zone 2 fault with 0.5s delay trip.
- No aided trip signal provided from MOB side, as no fault current flows from MOB side with CB open [Note - CT location] and MOB side is not in-zone.

Solution 1: **Switch On To Fault** (SOTF)
Starting from CB close (required CB auxiliary status), within 200ms, a HSOC element (I_F > 2.2A, instant trip) will be used.

Solution 2: **Echo Scheme**
Rule: Signal Receive + CB Open → Signal Send (Echo)

- SHE side sees a Z2 fault and trip with 0.5s delay.
- SHE side sees a Z2 fault and send an aided trip signal to MOB.
- MOB side receives an aided trip signal and checked CB open. It sends an aided trip signal (ECHO) to SHE side.
- SHE side receives an aided trip signal and sees a Z2 fault, time delay is removed and instant trip is provided.

Current Reversal Scheme



Consider a fault occurs at TPE – YUE No.1 (with relay A and B sense a Z1 fault).

- **Relay C**, connected at YUE side of TPE – YUE No.2, sees a Z2 fault due to fault current flow and send an aided trip signal (DPA) to **Relay D**.
- **Relay B**, connected at TPE side of TPE – YUE No.1, sees a Z1 fault and provide an instant trip. It trips faster in TPE side than in YUE side, possibly because of CB mechanism operation time.
- **Current reverse** at seen in **Relay C** and **Relay D**.
- **Relay D** sees a Z2 fault and trip with 0.3s delay.
- DPA from Relay C arrives at Relay D, due to propagation delay.
- **Relay D** sees a Z2 fault + receive an aided trip signal. It provides an instant trip and trips the healthy line (TPE – YUE No.2).

Solution: **Current Reversal Blocking**

Current Reversal → Blocking delay 200ms to POR (receive DPA + Z2 = instant trip)

With Current Reversal Blocking:

- **Relay D** sees a backward fault (require an extra zone to detect) before relay B trips the local CB.
- **Relay D** sees a Z2 forward fault after relay B trips the local CB.
- Current reversal blocks POR scheme for 200ms.
- **Relay D** sees a Z2 fault + receive an aided trip signal. It does NOT remove the time delay, i.e. trip at 0.3s.
  [Note: Relay A should trip the local CB within this 200ms.]