AR Scheme for breaker and a half arrangement

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■ 1. Summary

The switchgear arrangement shown below in Figure 1 is commonly referred to as the breaker and a half or (1 1/2 CB) scheme. When an over-head line (OHL) is terminated in such a manner the co-ordination of the automatic re-closure (AR) demands special attention as two circuit breakers (CB) must be re-closed at the line end in question. In this document a typical AR solution with 7VK6 Breaker Management Relay is given.
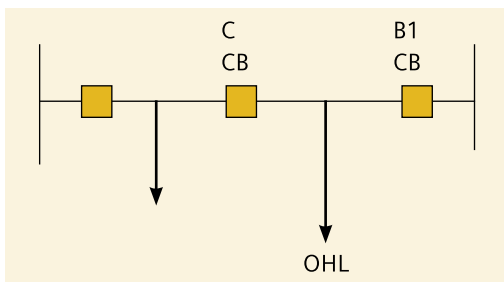

Fig. 1

■ 2. AR Description

The feeder protection initiates the AR when a trip is issued due to a fault on the OHL. The AR must then re-close the circuit breakers in a set sequence after the necessary dead time. All contingencies must be considered as shown in Table 1; e.g. the "follower" CB should not attempt a re-closure if the "leader" CB failed to re-close successfully.

Further conditions such as CB not ready, single pole trip permission, sync check etc. may also be included.

Pre Fault		Protection Response	AR Function	
Leader CB	Follower CB		Leader	Follower
closed	closed	Trip 3 pole	AR 3pole dead time	AR follower stab. time
closed	open	Trip 3 pole	AR 3pole dead time	No AR: Final trip
open	closed	Trip 3 pole	No AR: Final trip	AR 3pole dead time
open	open	Trip 3 pole	No AR: Final trip	No AR: Final trip
closed	closed	Trip 3 pole – Trip 3 pole after AR	AR 3pole dead time – final trip	No AR: Final trip
closed	open	Trip 3 pole – Trip 3 pole after AR	AR 3pole dead time – final trip	No AR: Final trip
open	closed	Trip 3 pole – Trip 3 pole after AR	No AR: Final trip	AR 3pole dead time – final trip

Table 1

■ 3. AR Implementation

The proposed AR scheme will use one 7VK6 on the Busbar CB (B1 CB) and a second 7VK6 on the centre CB (C CB). The B1 CB will be the "leader" and close with a fixed dead time. If the B1 CB AR is successful (leader), this 7VK6 will issue a remote close signal to release the C CB for closing (follower). The C CB will be the "follower" waiting for the release from the B1 CB (leader). The release signal from the B1 CB (remote close) is connected to a binary input allocated with the CB ready function. The centre CB will only close when the "CB ready" input is high. The CB ready function (binary input no. 371 CB1 ready) is used for this purpose because it allows the parallel application of fixed and variable dead times. The follower AR function will extend the set fixed dead time until the "CB ready" input is active. In cases where the follower must close with fixed dead time (leader is disabled) the release is set high in time for the follower to close as soon as the dead time expires.
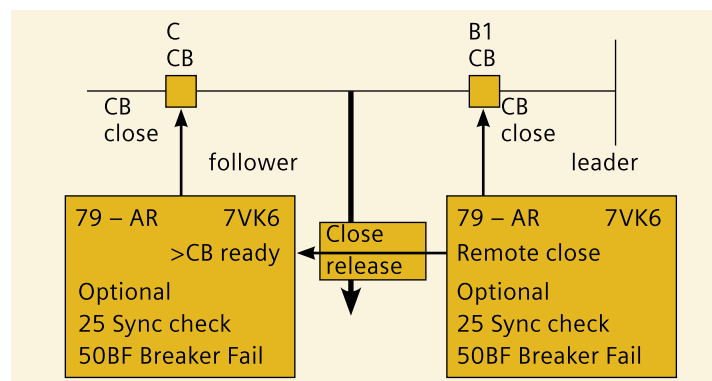

Fig. 2 Allocation of functions, and routing of close release signal

For those cases where the leader is disabled, e.g. when the B1 CB is in the open condition (e.g. for maintenance) special measures must be applied. In this case the B1 CB may not carry out an AR, but the C CB must carry out AR with normal dead time. For this condition a CFC logic is included in the leader 7VK6 applied to B1 CB. This logic provides the release signal for the C CB (follower) when the B1 CB (leader) is open.

Fig. 3 Routing of binary input in follower 7VK6

Fig. 4 AR parameters (General) in follower 7VK6

Fig. 5 AR parameters (1st AR-cycle) in follower 7VK6

Fig. 6 Logic in leader for close release signal to follower when CB is not in service implemented with CFC logic shown in Figure 7

◼ 4. Special configuration of 7VK6 at C CB (follower)

At the C CB (follower), the binary input "371 >CB1" ready must be allocated to receive the signal from the B1 CB (leader). No CFC is required in the follower 7VK6.

As shown above the function 371 >CB1 ready is routed to binary input number 7. If the real CB status is required in parallel on this input, it may be connected to the same binary input if possible or if external separation is necessary the two inputs should be combined via CFC.

The parameter 3409 Circuit breaker supervision time in the follower 7VK6 must be set longer than the maximum dead time. In this example the 3 pole dead time is 3s, and the maximum extension is 2 s. A very safe maximum time of 10s is applied (3409 CB Supervision Time).

The parameter 3411A Maximum dead time extension must be increased to allow for delay in receiving the release from the busbar CB. Here a time of 2s is applied.

The parameter 3459 CB ready interrogation before reclosing must be set to yes (only at the center CB) because this AR will only reclose when the release from the leader BB CB comes (either the signal „2894 AR Remote close" or the CFC signal AR start center CB).

◼ 5. CFC Logic in (leader) busbar CB

In the standard AR logic of the 7VK6 it is ensured that there is no re-closure when the circuit breaker is open prior to the trip command. At the leader CB, this condition must also be conveyed to the follower so that the follower will close with fixed dead time independent of the "leader". This will be implemented with a CFC logic having the function shown below.

In this logic the circuit breaker open state is detected by monitoring of all three CB aux. contacts in parallel at the input of a NOR gate (AND gate with inverted inputs). The output of the NOR gate will only become high when

a three pole open condition is present. This 3 pole open condition is monitored by a timer with preset 250 ms delay. The Q output of this timer will only go high when the breaker has been open for these 250 ms which clearly indicates a three pole open condition (CB not in service for AR). If however the three pole open condition resulted from a trip by the feeder protection, then the trip signal will have reset before the timer expires (AR start monitoring is set to 200 ms similar to a breaker fail time). This is important, because at the input of the AND gate the delayed CB 3 pole open condition "release" the follower AR when the trip input is received. Thereby the "follower" would reclose with fixed dead time.

The final timer has a short delay on pick-up (20 ms) to ensure that transient conditions do not accidentally release the (follower) centre CB. Once the output of the timer releases the centre CB, this release is maintained for 5 seconds to ensure that the dead time of the centre CB (including extensions due to e.g. sync check) are covered. The Q output of the timer therefore activates the user defined signal "AR start centre CB" which in parallel with the signal „2894 AR Remote close" will release the centre CB.

If in further applications additional conditions of the leader (e.g. Test Mode) also have to release the follower, these signals may be applied in parallel in the logic of Figure 7.

The signals from the leader to the follower (close release in Figure 2), must be allocated to a binary output (BO 1 in this example).

Therefore at leader 7VK6 the "2894 AR Remote Close" and CFC output "1HCB AR start centre CB" are combined with OR logic (both allocated to BO 1). At the centre CB (follower) this signal (input via BI 7) is used to release the AR signal by indicating the CB ready condition.
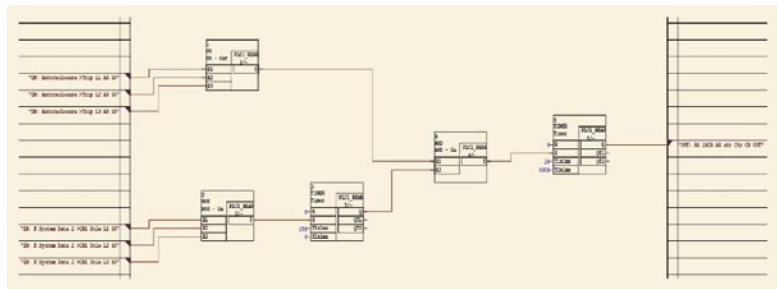

Fig. 7 CFC logic for follower release when leader is out of service based on the logic shown in Figure 6

Fig. 8 Routing of signals to BO1 at leader

■ *6. Conclusion*
By means of a very simple additional logic and a single signal from the leader to the follower, a complete leader – follower auto-reclose scheme is implemented with 7VK6 breaker management relay. The scheme works in single, three and 1/3 pole tripping applications. Further functions such as sync check, breaker fail and voltage protection may of course be used in parallel in the 7VK6.