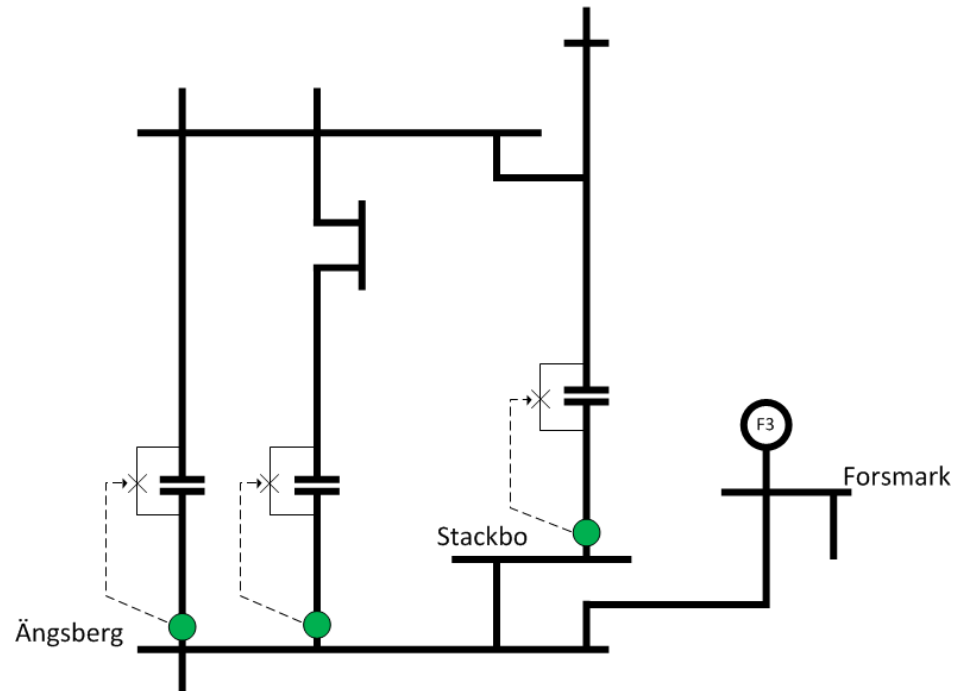

Experiences of the Swedish TSO in running the new SSR protection

Håkan Eriksson



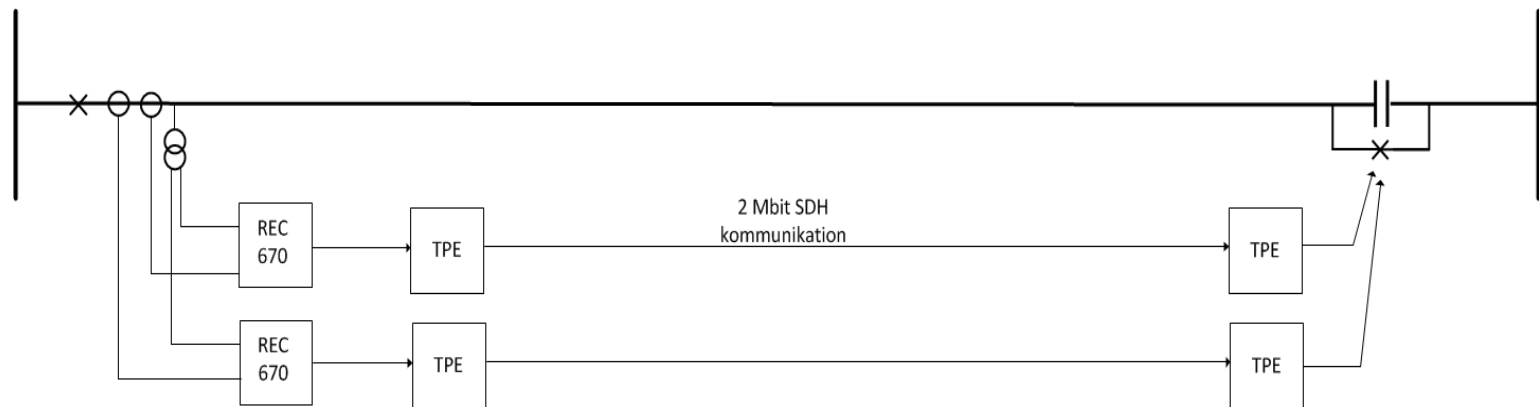
**SVENSKA
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New SSR protections



- Nya SSR skydd för detektering av subsynkron resonans från seriekondensatorerna. För skydd av turbinaggregat i Forsmark 3

Simplified block diagram



TPE = Teleprotection equipment

Protection functions

The new protection has 6 filters and is configured as follows:

Two filters are used for SSR protection and send a bypass signal to the series capacitors.

- The first filter is set to measure sub-synchronous currents mode 3 $[32.9 \pm 1.5]$ Hz
- The second filter is set to measure sub-synchronous currents mode 2 $[37.5 \pm 1.5]$ Hz

The filters are connected to a current-based protection function with inverse time delay.

Protection functions

- > The start values of the SSR protection are set to 15-20 A
- > The protection uses a extremely inverse time delay characteristic
- > At 105 % of the set value, the tripping time is around 300 s
- > At 200 % of the set value, the tripping time is around 3 s

Filters for disturbance recording

Four filters are used only for disturbance recording. They are set as follows:

- 1) To measure **sub**-synchronous **currents** [30-40] Hz
- 2) To measure **super**-synchronous **currents** [60-70] Hz
- 3) To measure **sub**-synchronous **voltages mode 3**, 32,9 Hz
- 4) To measure **sub**-synchronous **voltages mode 2**, 37,5 Hz

These four filters can be easily configured for protection purposes if needed

Unwanted bypasses of series capacitors

- > A number of unwanted bypasses of the series capacitor has occurred during switching operations in the network
- > Switching transients have caused currents with frequencies within the subsynchronous area which has led the protection to by pass the series capacitor unwanted
- > Switching transients do not affect all phases equally
- > The cause of the unwanted bypasses was that the SSR protection measured the current in the phase with the highest subsynchronous current value.

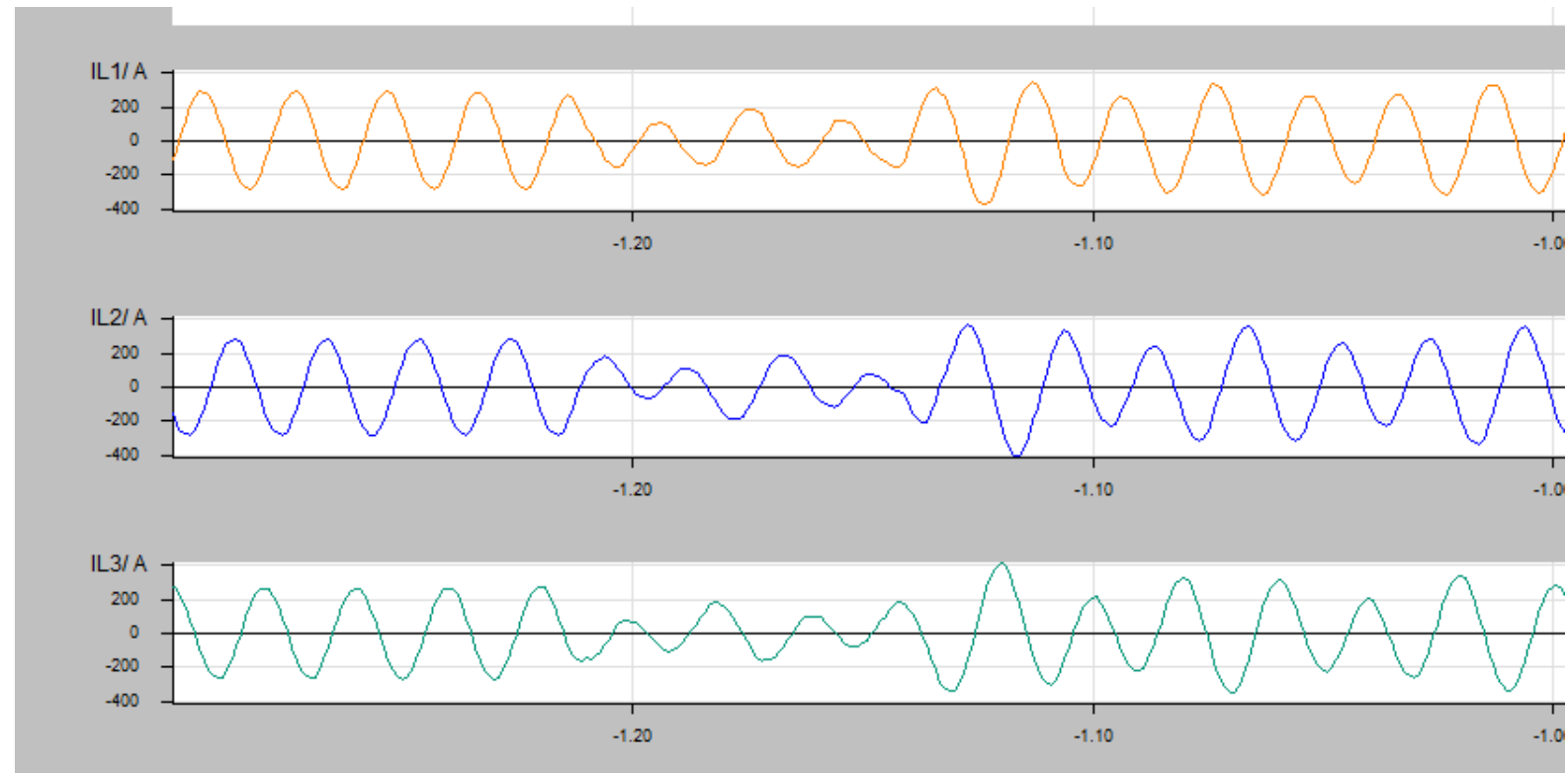
Modified measuring method

- > The measuring method has now been modified to measure the subsynchronous current in the phase with the lowest value, i.e. the subsynchronous current has to be detected simultaneously in all phases.
- > The amplitude of SSR currents is equal in all phases
- > During the testing period, recorded registrations of switching operations in the network have shown that the new SSR protection is now stable for switching transients
- > Until now, we have not had any unwanted bypasses of series capacitors

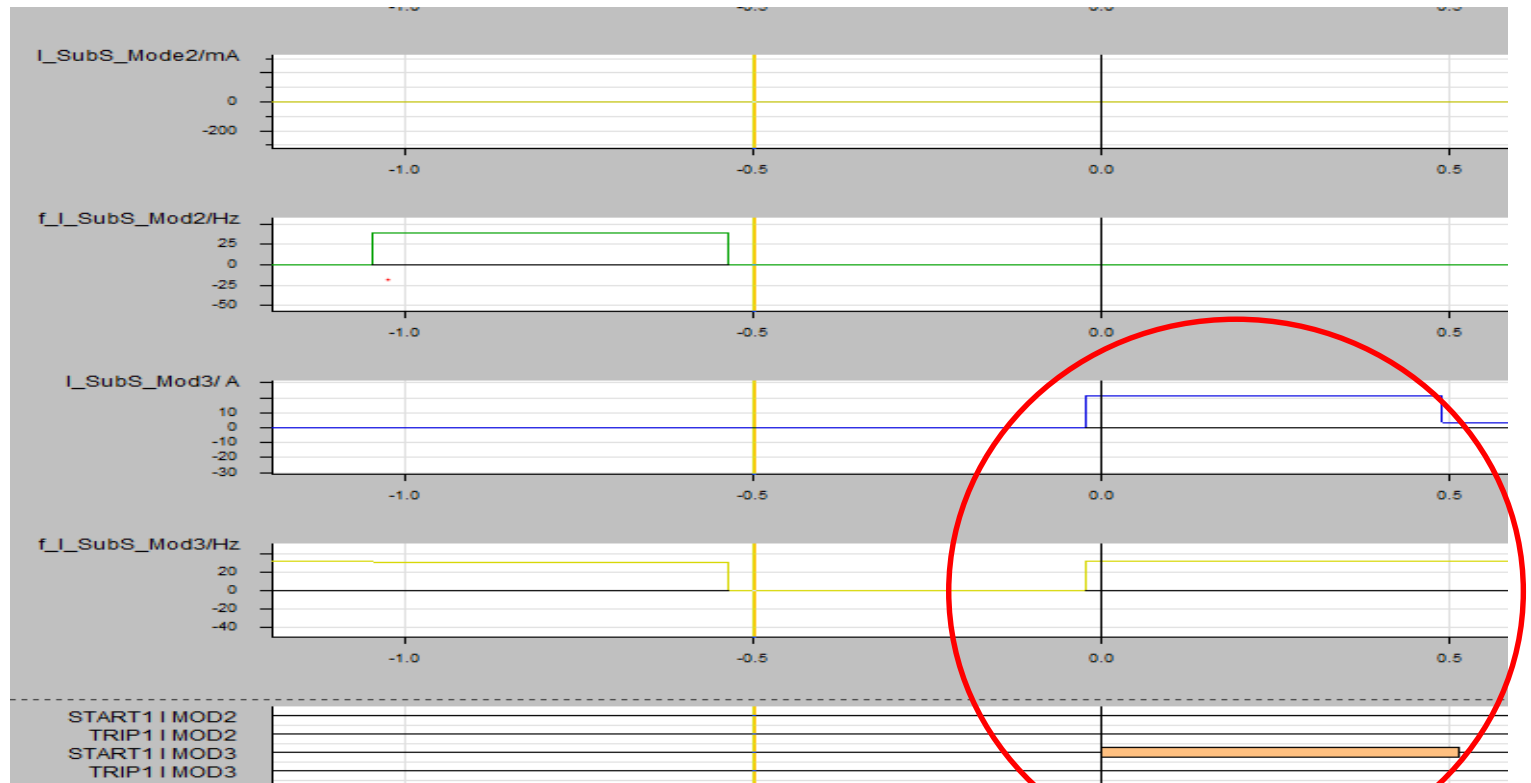
Trig of disturbance recorder

- > Several trigs of the disturbance recorder from the filter which measure sub-synchronous current [30-40] Hz
- > The duration of the start-signal was 0,5 s (equal to the filter time)
- > A few trigs of the disturbance recorder from the filter which measure the sub-synchronous current mode 3: 32.9 Hz
- > The reason for these trigs can be switching operations or faults in the network.

Recorded phase currents on a series compensated 400 kV line after a fault in the 220 kV network.



One second later the subsynchronous Mode 3 was started with a duration of 0,5 s



Summary

- > No unwanted bypasses of the series capacitor since F3 was commissioned after revision 2015
- > No unwanted bypasses of the series capacitor after the measuring method was modified
- > A number of short starts due to faults and switching operations in the network
- > With the old protection there were several unwanted bypasses of series capacitor every year