Isolator replica and check zone

Principles of busbar protection

The 7SS60 provides a busbar protection system that satisfies all requirements regarding speed, security and selectivity.

- *Speed* by means of fast measuring technique and algorithms
- *Security* by means of integrated monitoring of the internal device functions and the current transformer circuits
- *Selectivity* by separation of the protected object, busbar, into individual protection zones (= busbar sections) and allocation of the feeders to the corresponding zones by means of an isolator replica

Pre-requisite for selectivity

Selectivity can only be achieved with a correct isolator replica. As this is the only method by which a feeder can be correctly allocated to a bus section. The isolator replica depends on information derived from the isolator auxiliary contacts and possibly an image of the substation switching state by means of further auxiliary relays. Contacts tend to deteriorate with time, particularly when they are not switched for a long time or not sufficiently large currents are switched to achieve a self-cleansing effect. Environmental conditions and maintenance practice also affect the dependability of contacts.

The following consequences therefore arise:

- A certain degree of maintenance is required for isolators, their auxiliary contacts and the routing to the busbar protection.
- The busbar protection must also provide a minimum functionality even in the event of an erroneous isolator replica condition, i.e. a busbar fault must be detected and cleared while stability and no tripping is required during external faults. Selectivity is however not possible under these conditions.

An important contribution toward fault detection and stability is provided by the processing logic of the isolator status information. As a normally closed auxiliary contact is utilised for this purpose, the isolator is only recognised as being open when this auxiliary contact is closed. In all other states (isolator in the intermediate or open position, failure of the auxiliary voltage on the auxiliary contacts) the isolator is recognised as being closed. This logic is designated as “NOT OPEN = CLOSED”. A further advantage of this logic is the fact that justified auxiliary contacts are not required. It must only be ensured that the auxiliary contact opens before the arc striking distance of the isolator is reached. In the event of an incorrect isolator replica (e.g. broken conductor) or due to auxiliary voltage failure, this logic may however result in non-selectivity. Consequently, both isolators of a double busbar would be considered in the closed position which is equivalent to a direct connection of both bus sections. Operation experience has shown that the mentioned advantages considerably outweigh this effect.

Advantages of a check zone

In the event that the isolator replica is incorrect (e.g. an auxiliary contact does not open when the isolator is closed) an incorrect allocation of a feeder current to one of the measuring systems may result. As long as this current remains below the tripping threshold, this results in the pick-up of the differential current monitoring which causes blocking and indication of the affected zone. However if the current is in the tripping range (e.g. when closing onto a faulted feeder) incorrect busbar tripping of the busbar section would result if further measures are not undertaken.
As a further measure, the so-called check zone also known as overall protection has proven to be very successful. This measuring system functions as a protection of the entire busbar arrangement and is entirely independent of all isolator status information. Busbar and bus section couplers are not considered in the check zone measurement. Principally the check zone therefore makes a distinction between internal and external faults. It is used as an additional tripping criteria for the individual bus sections (two out of two criteria).

If a separate CT core is used for the check zone, then a completely independent protection system results.

Check zone with 7SS60

A check zone can also be implemented with the components of the 7SS60-system /2/. Depending on the measuring technique and security requirements, different solutions may be applied.

Common features are

- Separate interposing CTs (4AM5120)
- Separate stabilising units (7TM70)
- Separate measuring systems (7SS601)

Differences are

- Additional expense for primary CT core and interposing CT
- The number of 7SS60 components
- Redundancy concepts (entirely independent or partially redundant)
- Burden of the primary CT
  The total protection burden (approx. 2VA per interposing CT) must be considered, in particular for CTs with small rated burden. Details regarding CT dimensions may be found in /1/

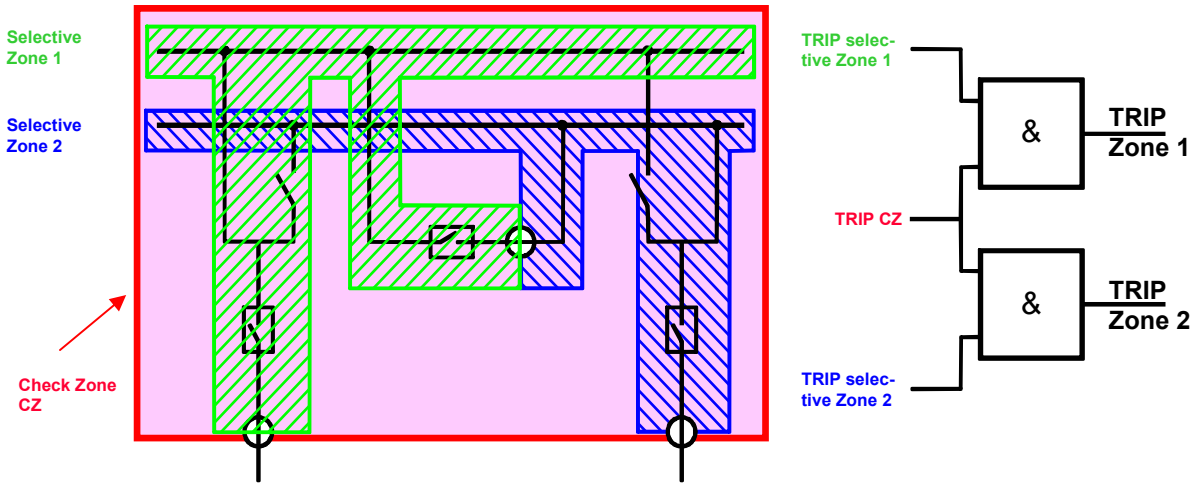
Literature

/1/ Catalog SIP 2003, SIPROTEC Numerical Protection Relays, Chapter 2,
Siemens, Order.-Nr. E50001-K4400-A101-A2-7600
/2/ Device manual SIPROTEC 7SS60 V3.1, Centralized Numerical Busbar Protection,
Siemens, Order.-Nr. E50417-G1176-C132-A2

Table: Overview of the variants

Measuring technique	Primary CT [1]	Advantage	Disadvantage	7SS60-Components [2]
Single phase (summation CT)	common	• Cheapest solution • Partially redundant protection system	• Doubled burden on primary CT	1 7SS601 1/5 7TM70 p.Fdr. 1 4AM5120 p.Fdr.
	separate	• Completely independent protection system • Single burden on primary CT	• 2 primary CT cores	1 7SS601 1/5 7TM70 p.Fdr. 1 4AM5120 p.Fdr.
Three-phase (phase selective)	common	• partially redundant protection system • detection of faulty phase	• doubled burden on primary CT • tripled number of components in comparison with single phase variant	3 7SS601 3/5 7TM70 p.Fdr. 3 4AM5120 p.Fdr.
	separate	• Completely independent protection system • detection of faulty phase • Single burden on primary CT	• 2 primary CT cores • tripled number of components in comparison with single phase variant • most expensive solution	3 7SS601 3/5 7TM70 p.Fdr. 3 4AM5120 p.Fdr.

1) Primary CT core the same as /separate from bus section selective protection system
2) p.Fdr. = per feeder (except couplers)



Schematic diagram: Check zone, 2-out of-2-tripping logic