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Hard facts about soft open points

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Distributed generation and new demands such as electric vehicles make it very challenging to manage power flows and to keep system voltage profiles within their statutory limits or other predefined targets. It's often necessary to go for costly and sometimes bulky and time-consuming upgrades. Soft open points (SOP) could be the answer.



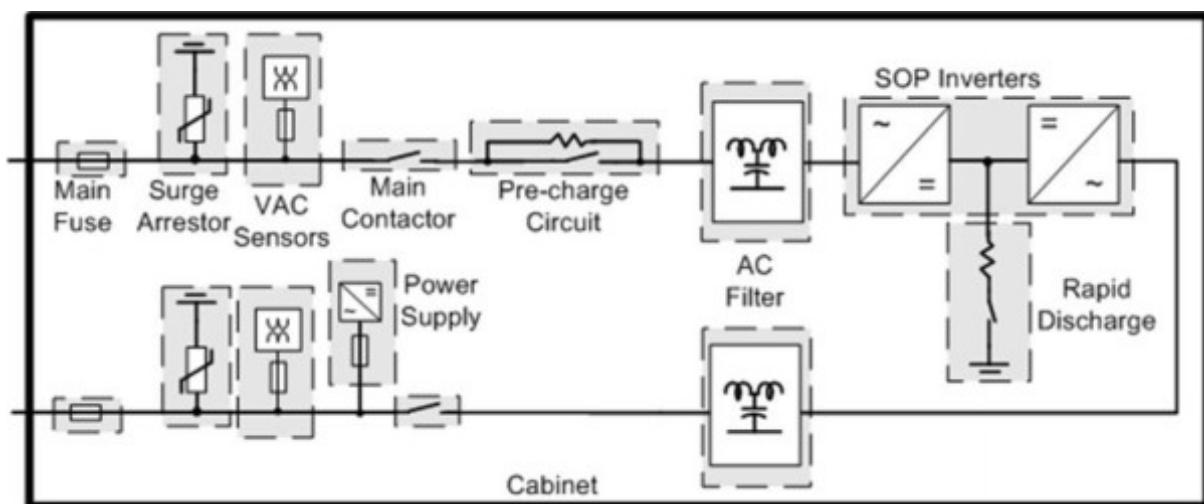
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Source : ESB

A “soft open point” (also named “soft normally open point” or SNOP) sounds like a programming trick. But in fact it’s a smart power electronics-based back-to-back (AC/DC/AC) converter that reconciles the conflicting demands of many aspects of power networks: for example, the effect of network topology protection requirements versus reliability, where radial current distribution systems (normally open) and meshed (normally-closed) set-ups each have advantages and disadvantages. Radial systems have no links between adjacent feeders, and allow for a simple and consistent protection scheme. But they are not as reliable as meshed systems, which, however, require a more complex protection scheme.



SOP Typical One-Line Circuit Diagram

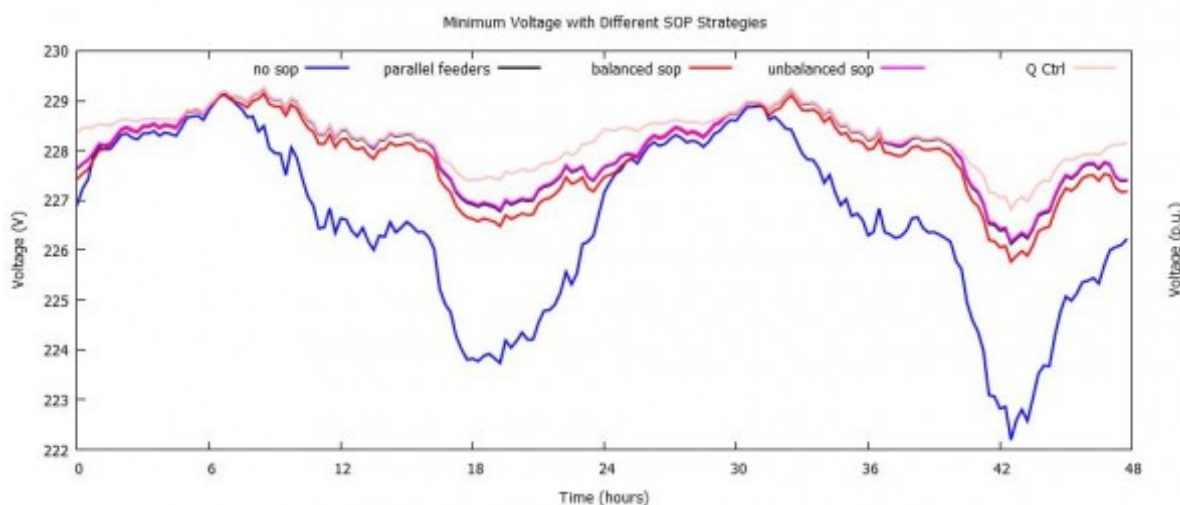
Hybrid benefits

Placing “soft” open points (SOPs) into a distribution system creates a hybrid structure merging the benefits offered by radial and meshed systems and mitigating any drawbacks. For example, support to an isolated load on a feeder can be provided immediately by means of power transfer from the neighbouring feeder as in a meshed system, while disturbances and faults on one feeder are isolated from the other feeder as with a radial system.

SOPs are attracting increasing attention as a response to the growing integration of distributed generation (DG) and the need to address issues related to voltage violations, network losses, power quality, protection and reliability. Large-scale integration of distributed generation has to contend with the possible negative impacts of voltage-rise on network buses.

Operators versus developers?

Dr Luís Miguel Costa, Alstom SmartGrids R&D Manager, points out the dilemma faced when tackling this. “The operator’s concern is to minimise the overall effect on voltage, so they want to connect the DG at voltages high enough to make their impact negligible. There’s nothing wrong with that technically, but connection costs are much higher at higher voltages, so developers like to go for lower values. On top of that, SOPs offer added observability and controllability when commissioned on lower voltage networks, which usually pose the biggest challenges, for instance regarding voltage control.”



The traditional solution to prevent DG violating upper voltage limits is to install devices to regulate voltage levels based on load. But these impose

lower limit violations on other feeders that have no DG installed. One big advantage of inserting a low-voltage SOP into the distribution system, according to Dr Costa, is that “its back-to-back configuration enables the precise and dynamic control of bi-directional real power flows between two networks that would not be naturally connectable due to fault-levels and voltage/phase angle differences.”

This is particularly useful in emergencies, where a fault in a given feeder often causes a loss of supply downstream from it because the faulty component has to be isolated. The SOP “acts as a firewall” as Dr Costa puts it, limiting fault currents and restoring supply quickly without affecting adjacent feeders.

An economical solution

As well as being elegant technically, the SOP solution is attractive economically. Alstom Grid researchers operating in Stafford, UK, were short-listed by the Grid Sector for Alstom’s 2014 Innovation Awards. Among other things, the researchers pointed out the results of a study carried out by the Electrical Engineering Department of Imperial College in London that assessed cost savings from using SOPs to optimise distribution systems. They studied actual systems that had taken load balancing into account as a primary component of distribution planning. Even so, the SOP approach achieved loss reductions of at least 10% and sometimes over 20%. In systems that are not so well planned as the test cases, using SOPs for precise balancing of main feeder currents could lead to dramatic decreases in network losses.

Dr Costa has no doubt about the appeal of SOP. “If network constraints, LV-/MV-asset management and cost are an issue, the SOP could well be the solution. As well as added-value regarding extra network observability and controllability, SOP can offer far more efficient, stable and optimal network operation.”

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