

## High-speed Generator-transformer Unit Backup Protection Scheme

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Power systems transient stability depends on the operation of relay protection directly. The shorter the relay protection operating time, the higher the stability. The main protection and first-zone backup protections are the fastest. One should note here that only the cooperation of them could reliably prevent the loss of synchronism. The main generator-transformer unit protection against multiphase short circuits in generator stator winding is the longitudinal differential current protection. Backup of the main protection is valid only against asymmetric short circuits and using only one type of protection – the negative sequence current cutoff without delay, which protected zone, doesn't transcend the step-up transformer. In case of three-phase faults negative sequence components of currents and voltages are absent, so this protection is unable to work. All other backup protections are slow operating, among them the first-zone distance relay is the fastest. The operating zone of this protection has to include the step-up transformer reliably, so its delay time must be more than the operation time of breaker failure protections of adjacent elements, i.e. no less than 0.9 s. Thus, in the case of a probable longitudinal differential protection missing operation existing schemes of backup protection are unable to prevent reliably the loss of synchronism after a three-phase fault clearance.

In this report we propose to solve the specified problem by the use of the additional zone, high-speed distance protection (HSDP) which protected zone doesn't transcend the step-up transformer.

As a rule, all distance relays of the generator distance protection are directional with round impedance characteristic. However, nondirectional relays of HSDP are preferred because the sensitivity of a short zone directional distance relay is low.

It is obvious that the nondirectional distance relay is more sensitive than the directional one, but its impedance characteristic may cross the loss of excitation protection impedance characteristic in the fourth quadrant of the complex impedance plane. In spite of that, HSDP will not operate false in case of a loss of excitation if we provide it with the power swing blocking.

As studies have shown, the lack of HSDP delay may lead to a false operation of the protection. Such false operation is expected in case of the voltage transformer circuit failure if the respective blocking operates with some delay. To prevent that, we propose to use the swing-blocking scheme based on a change of positive and negative sequence currents.

Another problem related to HSDP comes from its short operating zone. The shorter the operating zone, the more difficult to make sure the protection selectivity and sensitivity in real transient phenomenon because of an increasing influence of the complex impedance measurement inaccuracy. As studies have shown, the HSDP sensitivity is significantly affected in the issue of current transformer saturation. The reason is that the currents distortion leads to undervaluing the RMS current values, which in turn may overstate the apparent fault distance. To solve the problem we propose to filter currents using only parts of waves that correspond to a correct transformation of a current transformer.

In general, the currents measuring accuracy can be increased due to increasing of the filtering precision. High filtering accuracy of a complex current can be provided by adaptive filters, but it's difficult to use them in real transient phenomenon owing to their great liability to noise. To use adaptive filters in real-life we propose to denoise input signal before filtering. Good results in the reducing noise demonstrate procedures based on the singular spectrum analysis.