Identification of Critical Transmission Limits in Injection Impedance Plane

In this paper, equations are derived that describe the mapping of critical boundaries and characteristic lines from the three dimensional PQV-surface into the two-dimensional injection impedance plane (load impedance plane for both positive and negative resistance). The expressions derived for the critical and characteristic lines in the impedance plane form the basis for a new phasor measurement based situational awareness method, which uses the results in this paper to identify critical operational boundaries in real time and to visualize the system operating conditions in an informative way. The situational awareness method will be described in a later paper, where this paper focuses on the derivations of some system characteristics in the injection (or load) impedance plane. The critical lines from the PQV-surface that are mapped into the impedance plane are the ones representing the conditions where the partial derivatives of the variables P, Q and V with respect to each other become zero. In addition to the mapping of the critical lines, some characteristic lines are mapped as well. These include the mapping of the lines of constant P, Q, V and d from the PQV-surface into the impedance plane. All of the mapped critical and characteristic lines appear as circles in the impedance plane.

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