

A New Overcurrent Protection System for the DIII-D Field Shaping Coils

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Abstract—A new system has been developed to protect the 18 field shaping coils (F-coils) of the DIII-D tokamak from excessive currents. The new system removes the limitations of the original system and improves reliability. Coil currents are sensed in the new system by Rogowski coils wrapped around conductors feeding the F-coils. The Rogowski coil signals are routed to a remote electronics rack where the signals are integrated to yield voltages proportional to the F-coil currents. Comparators monitor the F-coil current signals and command the coil power supplies to turn off in the event of excessive currents. The F-coil current signals are also sampled by a dedicated data acquisition system for comparison to signals acquired elsewhere. The integrating electronics are interfaced to the DIII-D Integrator Calibration System, which verifies proper integrator operation once daily (typically) or on demand. The new over-current system also features a “self-test” function, which ensures that the Rogowski coils and their signal paths have not open-circuited. The test is performed during the preparatory “get ready” procedure of each DIII-D experiment “shot”. A test voltage is momentarily applied to each sensor circuit (Rogowski coil and signal cable) to produce a simulated current signal, which is measured and integrated. The resulting signal is checked by a window comparator circuit to verify that the sensor circuit has continuity, that the integrator has the proper time constant, and that the test signal disconnects when the test is complete. If all these conditions are met (for all 18 F-coils), the “get-ready” procedure is allowed to continue. Otherwise, the procedure is halted and warnings are generated. LED lamps on the system’s modules indicate statuses and results of the tests for each of the 18 channels. Design details of this new system are presented.