

Hardware Model of a Shipboard Generator

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A hardware model of the Gas Turbine Generator (GTG) in use on the US Navy's DDG-51 Class Destroyer is constructed for use as a lab apparatus at the Massachusetts Institute of Technology's Laboratory for Electromagnetic and Electronic Systems (LEES). A numerical Simulink model of the GTG is developed that provides speed response to a change in electrical loading. The Simulink model takes into account basic physical characteristics of gas turbine generators and is tuned to provide a speed response that meets the destroyer's Allison 501-K34 Gas Turbine Specification.

The basic construction of the hardware model consists of a relatively inexpensive 5 kilowatt three-phase generator; lab inventory DC motors and power supplies utilized to provide the mechanical input; an input-output interface board; and computer software to implement speed control. An empirical open loop model of the prime mover's measured response to a change in the generator's electrical loading is developed in Simulink. Closed loop feedback control is then included in the model and tuned in Simulink to provide a response similar to the GTG.

Proportional and Integral (PI) control of the hardware model is implemented utilizing controller gains identified by the Simulink closed loop model and the resulting hardware model's response is compared with that of the numerical Simulink model of the destroyer's GTG. A control loop for voltage control is included following the establishment of adequate speed control.

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