Circuit Modeling and Feedback Controller Development of the 8.4MW Modulator/Regulator Power System for the Electron Cyclotron Heating Facility Upgrade at DIII-D*

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As part of the Electron Cyclotron Heating (ECH) Facility upgrade at DIII–D an 8.4 MW Modulator/Regulator Power System was designed and constructed using acquired hardware from the MFTF program as a foundation [1]. Design changes in the feedback control of the modulator/regulator (M/R) was motivated by the need for improved output voltage regulation and improved capability to modulate the output voltage consistent with reference command signals containing modulation patterns (typically square wave). The regulation characteristics of the old ECH M/R power system had previously constrained gyrotron operation due to marginal voltage control loop stability and slow response to voltage step changes. The technical approach was to develop models of the circuit functions of the M/R controller from the circuit diagrams, and then examine the control characteristics using circuit analysis software. MATLAB Simulink and Intusoft SPICE codes were used to examine the control issues. These analysis software tools were used to simulate the controller functions and yielded identical results. The SPICE circuit model was selected as a baseline for future maintenance by the engineering staff. The analysis of the controller model blocks provided the needed information to modify the controller circuits. Changes made to the controller included addition of a voltage feedback loop around the grid driver amplifier for the power tetrode control grid in the M/R, and changes to the feedback loop compensation of the main error amplifier. The implemented revised controller performance matches the model performance predictions remarkably well. This paper describes the circuit models, implementation of the revisions to the controller, and recent operational results.

[1] S.G.E. Pronko, et al., “Performance of the 8.4 MW Modulator/Regulator Power System for the Electron Cyclotron Heating Facility Upgrade at DIII–D," presented at this conference.

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