A Regulated Power Supply for the Filaments of a High Power Gyrotron

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As part of the Electron Cyclotron Heating (ECH) Facility upgrade at DIII–D, a regulated ac power supply for the filament of a 110 GHz gyrotrons was designed, tested and integrated into the ECH power system [1]. A precision regulated filament power supply is essential since the cathode temperature controls the gyrotron beam current and rf production [2].

The power supply that was developed is based on an ac phase controller operating into the primary of a high voltage isolation transformer. The power supply is capable of supplying a maximum voltage of 50 Vrms at a maximum current of 8 Arms, regulated to within 0.5%. Typical operating parameters into the gyrotron filament are 35 Vrms and 6 Arms. The main components of the system consist of a commercial proportional linear phase controller, a feedback and fault control circuit, an isolating filament transformer (500 VA, 130 kVdc isolation), and a special high voltage interface for connecting to the gyrotron filaments. The output voltage to the gyrotron filaments is controlled with a commanded reference voltage that is compared to a feedback voltage derived from the transformer primary. An error amplifier generates a proportional control voltage that is fed to the proportional linear phase controller. Voltage and current quantities for feedback and monitoring purposes are converted from ac signals to dc signals that are proportional to their respective rms values. The monitored signals are used for data acquisition and for over-voltage and over-current protection circuitry.

This paper provides a description of the design of the filament power supply, presentation of test results, and an assessment of its performance.

[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.

[2] K. Felch, et al., "Long-Pulse and CW Tests of a 110 GHz Gyrotron With an Internal, Quasi-Optical Converter," IEEE Transactions on Plasma Science **24**, (1996).

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