

Performance and Test Results of a Regulated Magnetron Pulser *

Chris R. Rose and David S. Warren
Los Alamos National Laboratory
PO Box 1663 M/S H805, Los Alamos, NM 87545

ABSTRACT

This paper describes the test results and performance of a 5.0-kV, 500-mA, regulated current pulser used to drive an Hitachi model 2M130 2,425-MHz magnetron. The magnetron is used to modulate the plasma in a particle accelerator injector. In this application, precise and stable rf power is crucial to extract a stable and accurate particle beam. A 10-kV high-voltage triode vacuum tube with active feedback is used to control the magnetron current and output rf power. The pulse width may be varied from as little as ten microseconds to continuous duty by varying the width of a supplied gate pulse. The output current level can be programmed between 10 and 500 mA. Current regulation and accuracy are better than 1%. The paper will discuss the overall performance of the pulser and magnetron including anode current and rf power waveforms, linearity compliance, and vacuum tube performance.

I. INTRODUCTION

The Accelerator Production of Tritium (APT) project at Los Alamos is developing a Low-Energy Demonstration Accelerator (LEDA) which uses a magnetron rf source in its injector. The amplitude of the injector output current is dependent on the magnetron rf-power level which depends directly on the magnetron anode current. To generate stable and precise injector current, the injector rf source amplitude must be precisely controlled by its current. Thus the stability and accuracy of the magnetron current directly affects the accuracy of the injector current. This paper describes some of the performance results of the pulsed and cw magnetron current regulator

designed for and now being used to support the LEDA project [1].

As a general overview, a simplified schematic of

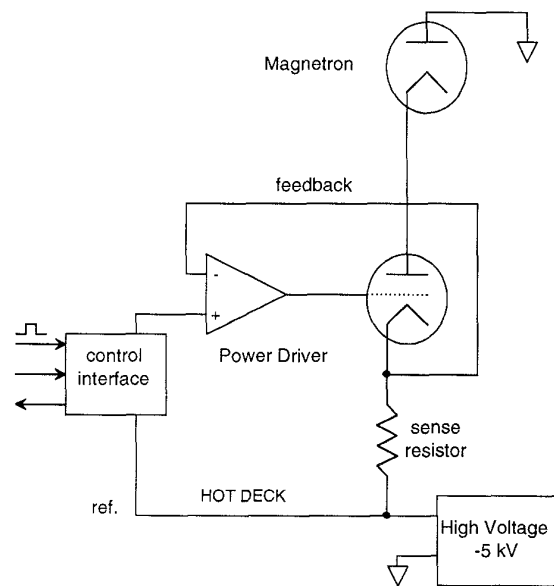


Figure 1. Simplified schematic of the pulser and magnetron. Not shown are the filament circuits.

the pulser and magnetron is shown below in figure 1.

Because of the high-voltage deck, control and instrumentation signals are applied via fiber optic circuits. The control interface accepts a GATE signal which determines the pulse width, a LEVEL signal used to program the current level, and sends back a monitor signal for triode cathode current. The power driver controls the triode grid voltage and receives a feedback signal from the cathode resistor circuit. The circuit is accurate except for whatever leakage current exists on the grid circuit. For monitoring purposes, the grid

* Work supported by the US Department of Energy.

current is subtracted from the cathode current. Under normal operations, that is, within specified triode anode to cathode voltage, the grid current is negligible and is not part of the real-time control loop.

II. TEST RESULTS

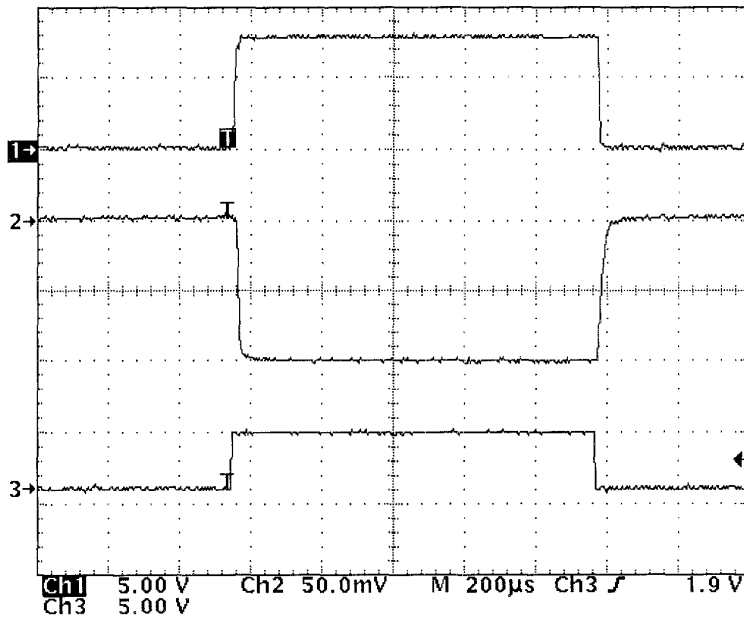


Figure 2. Tr 1—magnetron current (50 mA/V), Tr 2—detected rf power from the magnetron (10 kW/V), and Tr 3—GATE pulse.

Several tests were performed on the pulser both into a resistive load and into the actual magnetron. The pertinent waveforms are shown below in figure 2.

As shown above, the magnetron current is at 400 mA for a detected rf output power from the magnetron of about 1000 W. The risetime of the current pulse is 4 μ s and its fall time is about 6 μ s. The rf pulse, which is the objective, has a risetime of about 4 μ s and a falltime of about 10 μ s. These numbers are slower than those predicted by the

circuit models of less than 1 μ s but seem to be adequate [1].

The grid current was measured at several triode anode-current and anode-to-cathode voltage levels and matched the data sheet very closely confirming the assumption of negligible amounts of grid current leakage if operated within specifications.

Figure 3 shows a plot of magnetron current vs. set point levels.

III. CONCLUSIONS

Shortly into the magnetron and magnetron-pulser testing cycle, it was found that at the desired magnetron rf power level, the magnetron exhibited excessive spurious sidelobe rf components which interfered with proper injector operation [2]. Operating above or below this band, the rf output spectrum was found to be much cleaner. As a result, the magnetron pulser was altered to provide up to 1000-mA drive for

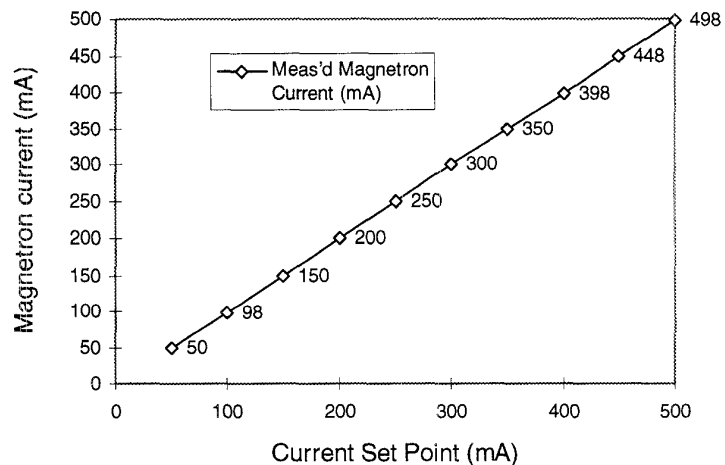


Figure 3. Plot of measured magnetron current vs. set point.

the magnetron which pushed it into an operating range with cleaner rf which was then attenuated to the required level. The change to 1000 mA was readily accomplished by changing the cathode resistor in figure 1 to 10 Ω from 20 Ω and properly scaling the input LEVEL signal. This increased current drive has stressed the power supply, and is in the process of having additional capacitance installed so that it can support longer pulse widths more easily.

IV. REFERENCES

- [1] Rose, C. R., "A Regulated Magnetron Pulser," to be published in these proceedings.
- [2] Zaugg, T., et. al., "Operation of a Microwave Proton Source in Pulsed Mode," XIX International Linear Accelerator Conference, Chicago, Illinois, August 23 - 28, 1998.