A high-power two stage traveling-wave tube amplifier

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Results are presented on the development of a two stage high-efficiency, high-power 8.76-GHz traveling-wave tube amplifier. The work presented augments previously reported data on a single stage amplifier and presents new data on the operational characteristics of two identical amplifiers operated in series and separated from each other by a sever. Peak powers of 410 MW have been obtained over the complete pulse duration of the device, with a conversion efficiency from the electron beam to microwave energy of 45%. In all operating conditions the severed amplifier showed a "sideband"-like structure in the frequency spectrum of the microwave radiation. A similar structure was apparent at output powers in excess of 70 MW in the single stage device. The frequencies of the "sidebands" are not symmetric with respect to the center frequency. The maximum, single frequency, average output power was 210 MW corresponding to an amplifier efficiency of 24%. Simulation data is also presented that indicates that the short amplifiers used in this work exhibit significant differences in behavior from conventional low-power amplifiers. These include finite length effects on the gain characteristics, which may account for the observed narrow bandwidth of the amplifiers and for the appearance of the sidebands. It is also found that the bunching length for the beam may be a significant fraction of the total amplifier length.