Phase Locking of a Second Harmonic Gyrotron using a Quasi-Optical Circulator *

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Abstract

Phase locking of a high power pulsed gyrotron oscillator through the use of a quasi-optical circulator was investigated. A second harmonic gyrotron which features a novel complex cavity, operating at 34.5 GHz, was used in the experiment, The quasi-optical circulator consisted of a 6" diameter ferrite disk biased with a one kilogauss permanent magnet. A polarizing grid was used to separate the input and output signals in the circulator. In order to couple the gyrotron oscillator output efficiently to the quasi-optical system, a number of mode converters, TE_{03}-TE_{02}, TE_{02}-TE_{01}, TE_{01}-TM_{11}, and TM_{11}-HE_{11}, were required. The insertion loss of the circulator and mode converter chain was approximately 1 dB, and an isolation exceeding 25 dB was achieved. The injection signal was provided by a synthesized signal generator and a 100 Watt traveling wave tube amplifier. A sample of the gyrotron output signal was obtained through an additional horn and mixed with a sample of the injection signal, producing a difference signal. The injection signal was swept slowly through a known frequency range while the difference signal was recorded. The recorded signals were analyzed off-line, and the locking bandwidth was determined. Experiments were performed for injection powers from 0-00 Watts, and a gyrotron output power of approximately 80 kW. Phase locking was observed for all non-zero injection powers. The results are in reasonable agreement with a new theoretical model that accounts for the strong reflection of the injection signal at the entrance to the overcoupled gyrotron cavity.

*This work was supported under a contract with the National Aeronautics and Space Administration, at the Jet Propulsion Laboratory, California Institute of Technology, and in part by the DoD Vacuum Electronics Initiative and managed by the Air Force office of Scientific Research under Grant AFOSR-91-0390.

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