

Experimental Study of Intrinsic and Technical Phase Noise in a Second Harmonic Gyrotron Amplifier (Phigtron)

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The phigtron is a millimeter wave, frequency-doubling amplifier that has been demonstrated to produce 360 kW peak power with frequency centered at 33.7 GHz, a bandwidth of 0.6%, saturated gain of 30 dB and electronic efficiency of greater than 35%. The input signal, injected into a Ku-band fundamental gyro-TWT input section, modulated a 60 kV, 25 A electron beam produced by a MIG-type gun. After transit through a drift section, prebunching in the electron beam excited the TE_{03} mode at twice the input frequency in an output cavity with a measured total quality factor of ~ 600 . A substantial range of magnetic field profiles was surveyed using a computer-controlled system in order to optimize operating parameters with respect to output power, bandwidth and efficiency. A set of operating conditions was established and the phase noise performance was measured for both the saturated (360 kW output power) and linear gain (100 kW output power) cases. The phase noise was observed to be as low as -40 dBc/Hz. Furthermore, a strong correlation was established between sources of technical noise (e.g. fluctuations in beam voltage and current) and this value. The phase noise fluctuations due to uncorrelated sources, which we call intrinsic phase noise, was estimated to be at least 10 dB/Hz lower.

The significance of distinguishing correlated from uncorrelated sources of noise is that the former comes from sources that can be addressed technically, whereas the latter is related to the intrinsic physical processes in the phigtron. The phigtron design will be presented along with the experimental results and a comparison of the measured phase noise with a theoretical prediction of both the technical and intrinsic quantities.

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