Consideration on Principle of Operation of Self-injection Locked NRD Guide Gunn Oscillator Using Equivalent Circuit Model

Futoshi Kuroki and Tomohiro Tanaka

Department of Electrical Engineering, Kure National College of Technology
2-2-11 Aga-Minami Kure , Hiroshima,737-8506, Japan

Various frequency stabilization methods of oscillators have been considered at microwave regions. As a frequency stabilization method, the self-injection locking technique, a ceramic resonator having a high unloaded Q factor being side-coupled to a transmission line, was proposed. Actually, this method has the simple structure and produces great improvement effect of the frequency stabilization. Indeed, the method was applied to the NRD guide Gunn oscillator at 60 GHz.

Because the oscillation frequency of the free-running NRD guide Gunn oscillator was usually unstable and was hard to control at the desirable frequency, it was locked at the resonant frequency of the ceramic resonator.

In this paper, to clarify the principle of operation of the band-stop type of self-injection locked NRD guide Gunn oscillator, the self-injection locking circuit was qualitatively analyzed based on an equivalent circuit model, which consisted of the transmission line (NRD Guide) side-coupled to the parallel resonant circuit (ceramic resonator), being connected at a point to be an electrical length of θ from the Gunn diode. The Gunn diode was represented by the negative conductance and the susceptance including the resonant circuit of the free-running NRD guide Gunn oscillator.

First, the oscillation frequency of the self-injection locked oscillator was calculated as a function of the electrical length θ, and the locking position was predicted. Next, the injection range was estimated by the equivalent model.

Comparing the calculated results with the measured ones, the characteristics of the measured results conformed closely to those of the calculated results, and thus the operation principle of the self-injection locked NRD guide Gunn oscillator was clarified by the proposed equivalent circuit