Travelling Wave Analysis of Stability and Noise in Injection-Locked Mutually-Locked Oscillators

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January, 1986

The performance of microwave and millimeter-wave solid-state devices has been improving every year. For practical use of these devices, the unified theory of oscillators under injection-locked and mutually-locked conditions more important. In this paper, the new analytical method of the oscillator is presented.

The output-power P and frequency ω of the oscillator change with the load impedance. The Rieke diagram is a plot of constant P and constant ω contours on the reflection-coefficient plane of the load. When we define the incident wave and reflected wave of the load as the output-wave a and input-wave b of the oscillator respectively, we can consider the Rieke diagram as the inverse-reflection constant $S_G(=b/a)$ of the oscillator. Then from the relation $P=|a|^2-|b|^2$, constant-power contours can be transformed into constant $|a|$ and constant $|b|$ contours.

In this paper, we propose the new Rieke diagram which shows a plot of constant $|b|$ and constant ω contours. Thus when the input wave is given, the operating point is easily found to be located at the intersection of the constant $|b|$ contour and the constant ω contour. On the new Rieke diagram, we have graphically analyzed the stability of the operating point and noise characteristics in the injection-locked oscillator. Further expanding this analytical method, we have obtained the stability condition of the oscillation mode in the multiple-oscillator system and then clarified the circuit condition for the single-mode operation. Experimental observations are found to be in good agreement with the conclusions of the analytical approach.