# HFET Resistive Mixers for Frequencies above 100 GHz

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The development of HFETs based on InGaAs alloys has, during the last few years, pushed the frequency limit of semiconductor based amplifiers up to several hundred GHz. So far, however, mixers are usually based on either Schottky barrier diodes or SIS-diodes. In future receiver applications it would be suitable to integrate the amplifier, mixer, and even the oscillator on the same chip. For this purpose, we have investigated two different types of resistive mixers, a fundamentally pumped mixer where the LO is applied to the gate, modulating the source-drain resistance, and a subharmonically pumped resistive mixer, based on two similar HFETs in parallel, pumped at each gate with the same LO-amplitude but 180° out of phase. The pumping frequency is halved compared to the fundamentally pumped case since the combined source-drain conductance waveform varies with twice the LO-frequency. This feature is very attractive a high frequencies where it is difficult to obtain high powers. The resistive FET mixer is also attractive from the intermodulation distortion point of view.

Suitable double-delta-doped HFETs with a pseudomorphic InGaAs channel, were developed for the purpose. A harmonic balance simulation for the two mixer circuits were performed. A special fixture with a waveguide-to-microstrip transition was designed for the experimental evaluation of mixer performance above 100 GHz. For the fundamentally pumped mixer, a total conversion loss of 12 dB was obtained between 108 and 114 GHz at an LO-power of 8 dBm. The conversion loss was limited by the available LO-power. Similar performance was obtained for the subharmonically pumped mixer but with a higher conversion loss, 22 dB. These results represent the first obtained experimental results at such high frequencies and, according to our simulation, conversion loss can be improved to 8 dB for the fundamentally pumped mixer, and to 12 dB for the subharmonically pumped mixer with the same HFET structure if the parasitic bonding inductances are reduced.

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