MedRadio Receiver Design

Elie Rosen, Gradeigh Clark, Jianqing Liu, Fanpeng Kong
Department of Electrical and Computer Engineering
Rutgers, the State University of New Jersey
Piscataway, New Jersey 08854

***Abstract*—In this paper, we present the design of a high gain, low power, and low noise front-end Medical Device Radiocommunications Service (MedRadio) receiver for wireless medical technology applications. We employ a low-IF architecture operating at 400 MHz using 0.18 um CMOS technology from the IBM7RF library. Cumulatively, we present individual designs for a low noise amplifier (LNA), a mixer, and a voltage controlled oscillator (VCO) that have been tuned to minimize power while matching to one another's design constraints. The receiver achieves 36 dB gain with a 3.65 dB noise figure and 1.8 mW of power consumption.**

I. System Integration

Since it was known ahead of time that the receiver was to be fully integrated together, a lot of effort was put towards perfecting input and output matching to guarantee maximum power transfer across components. The LNA input, VCO output, and Mixer output are all matched to 50 Ω. The LNA output and Mixer signal input are matched to 500 Ω, we found this to help improve the gain of the Mixer. Since all of the components were matched properly, full system integration was as simple as placing the components together (Fig. 1).

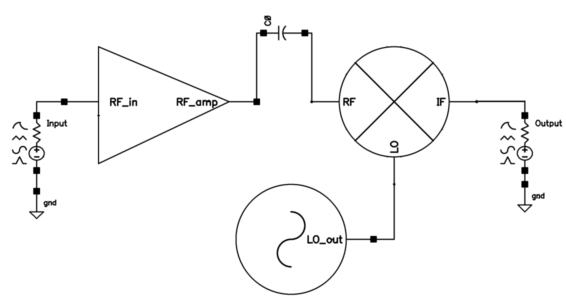

Fig. 1: Full system circuit integration, comprised of a Low Noise Amplifier, Mixer, and Voltage Controlled Oscillator. Coupling capacitors are used to remove the DC offset from the LNA.

In order to test the system, a transient analysis was preformed with an initial input signal of 1 mV at 403.5 MHz. Fig. 2 shows a clean output response from the system that swings from 55 mV to -70 mV at 3.5 MHz. This leads to an overall swing of 62.5 mV, therefore the conversion gain of the entire system is $20log(\frac{62.5mV}{1mV})$ or **35.92 dB**.

In order to measure the Noise Figure, the VCO was removed and an ideal source was used instead. Although the oscillator in theory would contribute slightly to the noise, it was determined that due to its low LO-IF feed-through that the oscillator has a negligible effect to the total noise. Fig. 3 shows the total noise of the system, at the corner frequency of the output, it was determined that the total noise was **3.65 dB**.

The overall linearity of the system is about **-31 dBm** however a graph is not shown due to technical issues with the Cadence software. Overall the full system results can be found in TABLE I.

Conversion Gain	35.92 dB
Noise Figure	3.65 dB
IIP3	-31 dBm
Power	1.8 mW

TABLE I: Final results from system integration.

References

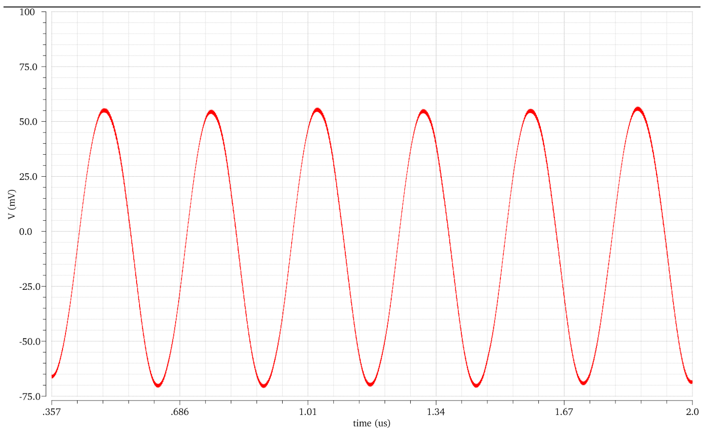

Fig. 2: Transient response of receiver after 357ns startup time.

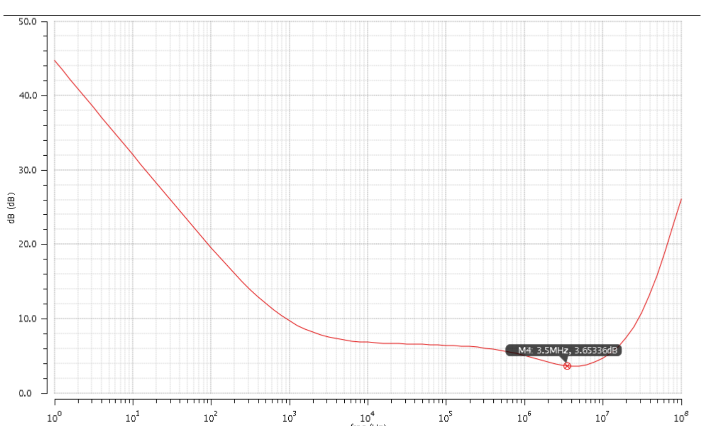

Fig. 3: Full system noise due to LNA and Mixer.