A low voltage Gilbert Cell bipolar transistor mixer

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Gilbert cell mixers are used to provide frequency conversion. A modified Gilbert Cell mixer is shown below along with its design equations.

The output voltage, to a close approximation, is given by:

$$\frac{4}{pi} Rg_m \cos\left[(\check{S}_{RF} + \check{S}_{LO})t + theta\right] + \frac{4}{pi} Rg_m \cos\left[(\check{S}_{RF} - \check{S}_{LO})t + theta\right] \qquad (1)$$

Here R is the load on each output branch of the circuit.
g_m is the transconductance of the bottom bipolar.
$_{RF}$ and $_{LO}$ are the radian RF input frequency and the local oscillator frequency. pi = 3.1415….
theta is the phase angle of the sum and difference frequency components.

The amplitudes of the RF and LO signals should also be taken into account and used to multiply the above identity.

If only currents are desired simply omit the load R in the equation above.

Emitter degeneration is used to allow the RF signal to be quite large without causing linear distortion. This increases the linearity of the mixer.

Choose low base-emitter resistance transistors for the transconductance transistors and increase emitter area for both linearity and noise.

Chose the LO switch transistors to be small and as fast as possible to provide fast switching. Maximize RL to increase conversion gain.

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MIXER SCHEMATIC

IO1

IO2

LIM2

Q1

Q2

Q3

Q4

LIM1

I1

I2

VRF-

O5

VRF+

Q6

RE1

RE2