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AM TRANSMITTER IMPLEMENTED IN 0.18 μ m CMOS PROCESS TECHNOLOGY

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ABSTRACT

The desire for a better communication system has always been the aim of many engineers in the industry. One factor which is vital in designing a communication system is the power consumption. A device with low power consumption will always be preferred to a design which consumes more.

This paper is inspired to design an amplitude modulation transmitter for 50 MHz application with low power consumption. The transmitter consists of Gilbert cell mixer, cross coupled with symmetric load voltage controlled oscillator, two stage operational amplifier and a high pass filter implemented in TSMC CMOS 0.18 μ m process. This study walk through the design of an AM transmitter focusing on the output IF signal with varying control voltage VCO, reduction of overall power consumption, and improvement in percent modulation.

Amplitude modulation is a system of modulation in which the amplitude of the carrier (LO) signal is made proportional to the instantaneous amplitude of the modulating (RF) signal [1]. When the carrier amplitude is constant, it has no information content but when it varies it means that there is a modulating signal that has the information in it. This process of modulation will all be done inside the mixer. The researchers used a Gilbert cell mixer to combine the modulating (RF) signal with the carrier (LO) signal to produce an amplitude modulated (IF) output signal. Gilbert cell mixer is widely used in RFIC applications because of its compact layout and moderately high performance [2].

A 200 mV RF input of 50 MHz and 500 mV LO output of 1.5 GHz are applied at both RF and LO ports of the mixer with conversion gain of 14.25 dB results to a 300 mV IF output of 1.2 GHz. The reference voltage V_{dd} equal to 1.8 V, the tuning range of oscillator is 0 to 2 GHz, and the amplifier has a gain of 42.1 dB, phase margin of 56 degrees, unity gain bandwidth of 1.43 GHz and slew rate of 291 V/ μ s.

This transmitter is designed in such a way that it is still functional at the input RF range of 10 MHz to 80 MHz and with a control voltage at the VCO of 0.6 volts to 1.8 volts which results to a LO frequency of 709.22 MHz – 2.041 GHz. Given these two signals as inputs to the mixer, the output frequency is within the range of 1 GHz to 1.3 GHz. In this study at 1.2 GHz IF output, the total harmonic distortion is equal to 3.776 %. Additionally, to achieve a percent amplitude modulation of 50% or more, the input RF must be at the range of 10 MHz to 80 MHz, this indicates that high radio frequencies (3 MHz to 30 MHz) are effectively amplitude modulated in this range and examples of applications within this range are aviation and military communications. The overall power consumption is 74.3 mW and a chip size of 9.68 μ m². The chip is connected to an I/O pad with rectangular pad frame of size 0.46 μ m².

Keywords: AM transmitter, Gilbert Mixer, Voltage Controlled Oscillator, Operational Amplifier, High Pass Filter.

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