DESIGN OF OPERATIONAL TRANSCONDUCTANCE AMPLIFIERS AND THEIR APPLICATIONS AS CONTINUOS TIME ANALOG FILTERS.

Sabyasachi Mallick, smallic@uark.edu
Faculty Advisor: Dr. H. A. Mantooth

ABSTRACT: In this work, Operational Transconductance Amplifiers (OTA's) have been studied and designed and their applications especially as continuous time analog low pass filters have been considered. This particular filter has been designed with a –3dB cutoff frequency of 10.7MHz but the bandwidth of the basic OTA is so large that it can be used for a wide range of frequencies just by adjusting the output load capacitor. The filter has been laid out in 0.35um process MOI technology using a supply of $\pm$1.65V. OTA's can also be used as high pass, band pass and band reject filters using a slightly different topology.

BACKGROUND: Operational Transconductance amplifiers are basically op amp circuits without output buffers that can drive only capacitive loads. The OTA consists of a number of MOSFETS biased in the linear region that can be efficiently used to implement high performance voltage to current converters. Each individual MOSFET as such, is operated strictly in the saturation region to obtain better output results. An ideal transconductance amplifier has infinite gain and infinite input and output resistance. Two practical concerns when designing an OTA for filter applications are the input signal amplitude and the parasitic input/output capacitances. Large signals cause the OTA gain to become nonlinear and the external capacitance should be large compared to the parasitics of the OTA.

WORK DONE: The OTA designed here has three main parts: the biasing circuit, the input stage and the output stage. Current mirrors have been used in the circuit. The biasing circuit has a resistor that controls the biasing current. The transconductance of the OTA is set by the transconductance of the input differential amplifier. A useful feature of the OTA designed here is that its transconductance can be adjusted by the bias current. All the sizes of the transistors have been chosen in such a way that they operate in the linear region. Simulation has been done using the simulation software Saber and the circuit was laid out using Cadence tool.

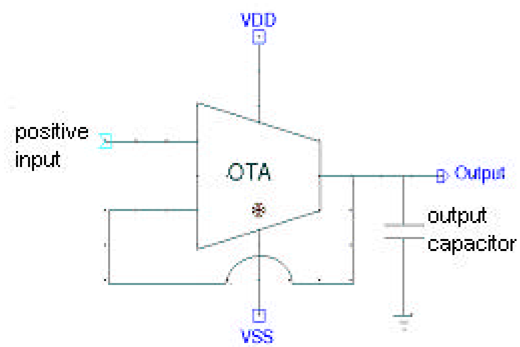

Figure 1. Gm-C Low Pass Filter.

RESULTS: Simulations show that the OTA designed above has a very satisfactory gain and a large bandwidth. The phase margin obtained shows that the OTA is stable. Other parameters measured like PSRR, CMRR, ICMR, slew rate and settling time, have been found to be satisfactory. The -3dB cutoff frequency at 10.7MHz, for the realization of the low pass filter, is achieved by adding a load capacitor of value 2pF at the output and then creating a negative feedback loop.

FUTURE WORK: The next challenge is to fabricate and test the complete filter circuit. Also it has been aimed to cascade the OTA, which will accomplish higher output resistance and also reduce the output swing without changing the transconductance of the amplifier.

CONCLUSION: Filters built from OTA's have several advantages over the conventional type of filters. They are not only smaller in size but are also easy to integrate as they contain very few or almost none of passive elements. These types of circuits also have very little effect due to cosmic rays or in other words they are rad-hard.