In The name of God

Project of Electronics II

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July 3, 2023

Figure 1:

1 Introduction

1.1 basics

In this project we aim to design two circuits, that transmit and receive a modulated signal $x(t)$ which is the addition of carrier $c(t)$ and that carrier signal multiplied by the main signal $m(t)$ we wish to transmit.
The signal $x(t) = c(t)(1 + m(t))$ is the modulated signal of $m(t)$ which helps us shift the spectrum of the main signal in order to obtain a much lower length of antenna and more affordable way of AM **(Amplitude Modulation)** communication.
Amplitude modulation is a process by which the wave signal is transmitted by modulating the amplitude of the signal. It is often called AM and is commonly used in transmitting a piece of information through a radio carrier wave. Amplitude modulation is mostly used in the form of electronic communication.

1.2 General View and steps taken

In the First place in the **transmitter**, we wish to send $x(t)$ such that it lowers the level of consumed power; furthermore, it must be of the most resemblance to the first signal. Thus, in order to achieve this we will use a differential pair and BJT cascode followed by an output stage which is a power amplifier followed by a feedback with coefficient $f = 1$. The idea is that we obtain a high voltage gain from this

two shelves (or equivalently $a >> 1$ and the the feedback gain will be equal to $A_f = \frac{a}{1+af} \approx \frac{1}{f} = 1$. You can observe the schematic of such circuits down here.

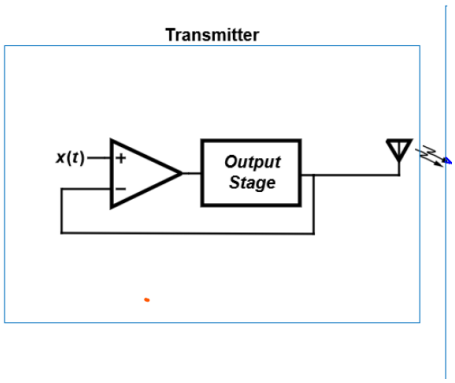

Figure 2:

Then we get the signal $z(t)$ and after transmission we assume that we receive the signal $h(t) = 0.1 + 0.01z(t)$ in the **receiver**, and now we will amplify the signal as much as we can to generate a signal similar to the output of modulation $m(t)$. The Schematic of the Receiver is shown down below:

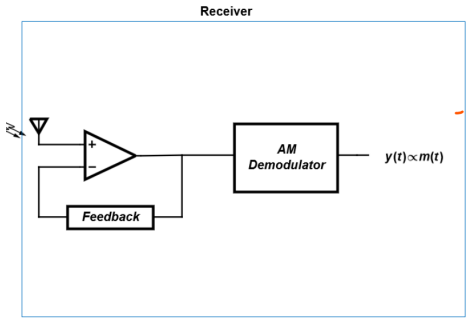

Figure 3:

2 The Design of Transmitter

2.1 The Design

Firstly, as we mentioned earlier we need a folded cascode circuit for the first shelf of our amplifier. Here is our design. As we go deeper we will discuss and guide through the rationale behind it.(you can have a closer look at the circuit in the images directory of the file)

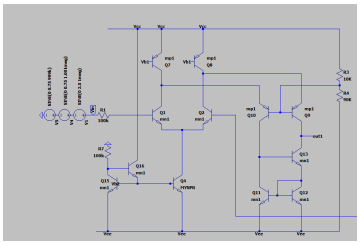

Figure 4:

We decide to let the Q_4 pass a current of $I_c = 0.036mA = 36\mu A$ which will strengthen the resistivity

of r_o(in this case $r_o = 2.77M\Omega$) of transistors and therefore by $A_v = G_m R_{out}$ we will have a greater R_{out}, additionally it will reduce the Early effect and thus we will have a more linear amplifier. Now, we expect $Q_1, Q_2, Q_7, Q_8, Q_{10}, Q_{13}, Q_{12}, Q_{11}$ to pass a current of $18\mu A$. We used a β-helper current mirror in order to implement the current source.

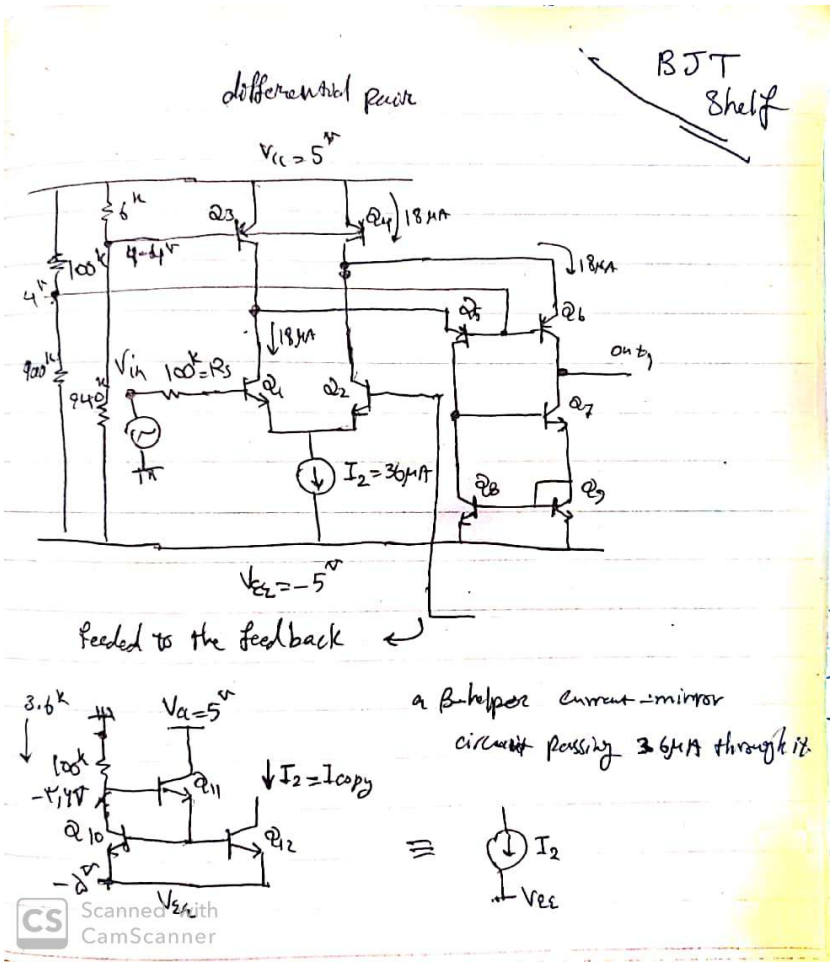

Figure 5:

And this is our Power Amplifier Shelf: As
You
can
See

this
is
our
design
so
let
me go

In the midst of the power amplifier and the folded cascode shelf we let three active loads that they control the voltage gain and swing for which you can see them down below:

Now we will talk about the feedback. The feedback will help the circuit be more stable and makes the design more linear, which

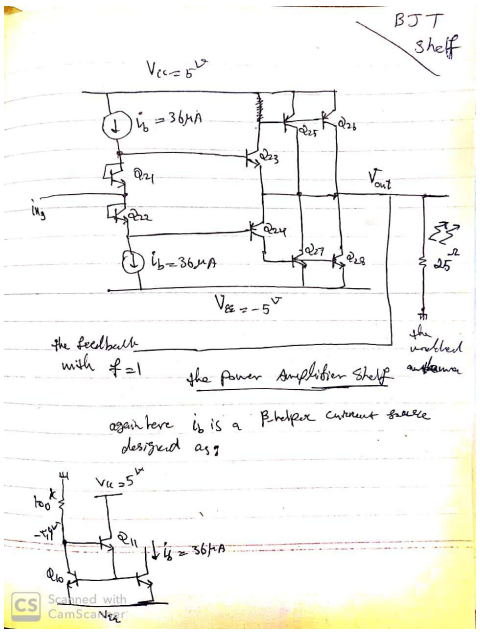

Figure 6:

2.2 The results and requirements

Firstly we will plot the input modulated signal which is $4V_{peak-peak}$ signal.

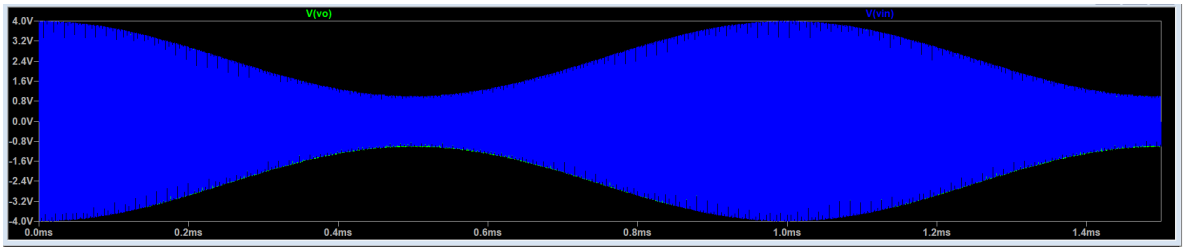

Figure 7:

Here is the result of the output of our design which is very close to the input signal But unfortunately it is saturated at some point, but its swing is very good.

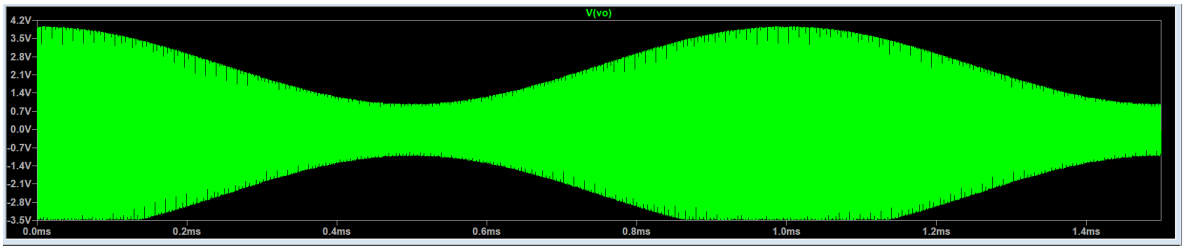

Figure 8:

3 The Design of Receiver

3.1 The results and requirements

Here we will focus on the results of the output of the circuit we designed earlier. As we go deeper we can see that the gain that we gained from the circuit is about 10!

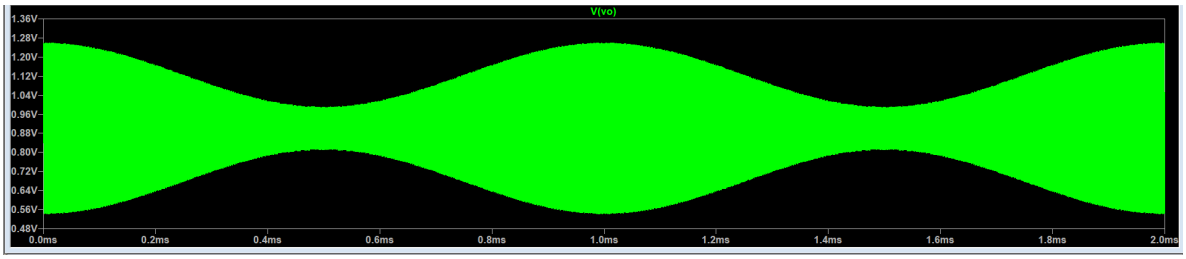

Figure 9:

Furthermore, you can see the $V_{out} - V_{in}$ characteristics of the circuit.

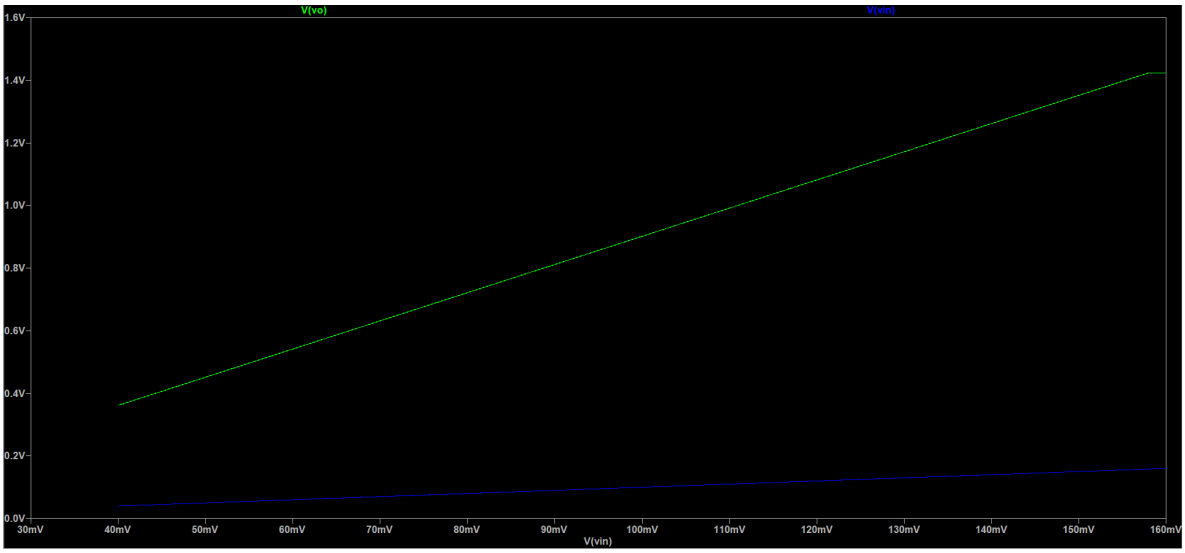

Figure 10: