Brac University

Electronics and electrical department

Thesis report

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Declaration:

This project I did through the whole semester is done by me and I maintain regular communication with my super visor and my co-supervisor and show them my work and progress regularly.

Approved by,

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Dr. Ahmed Kamal
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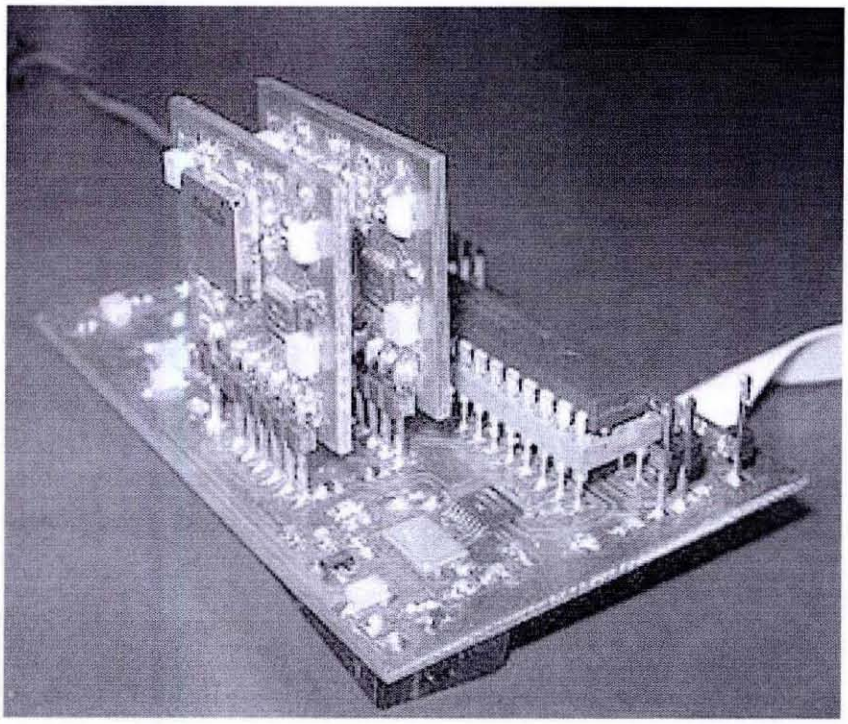
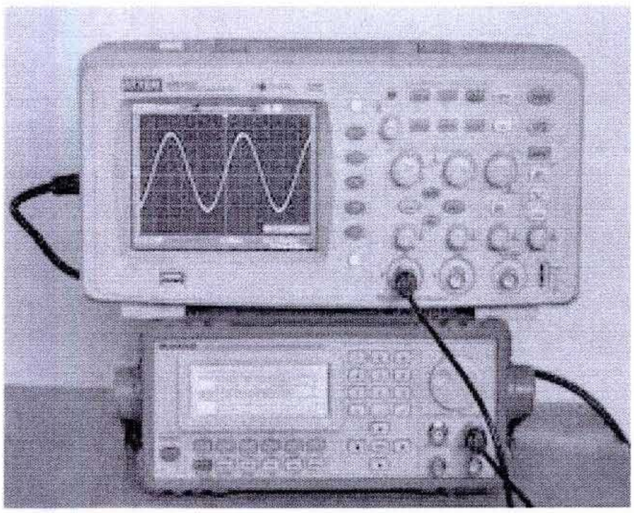
Thesis Title:

"The implementation and integration of a high frequency synthesizer for RF super heterodyne AM-SSB system ".



Thesis Abstract:

The increasingly popular wireless communication systems need good power sources with high frequency. We will be designing power sources operating at 25 MHz and power sources with a 25 MHz indoor wireless super heterodyne AM-SSB system to quantify the performance of these sub systems.



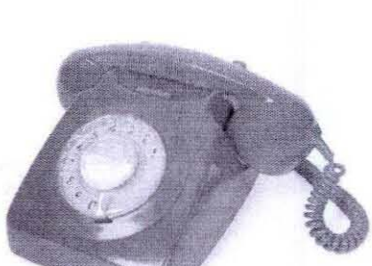
Synthesized radio frequency signal generators: Virtually all radio frequency signal generators used today employ frequency synthesizers. Using this technique enables frequencies to be entered directly from a keypad, or via remote control and it also enables the output signal to be determined very accurately. The accuracy being dependent upon either an internal reference oscillator that can have a very high degree of accuracy, or the signal can be locked to an external frequency reference which can be exceedingly accurate.

RF generator application:

*cell phones

*Radio

*Wired telephony systems.



Oscillator:

We will describe about two types of oscillators
1. LC Oscillator
2. Crystal Oscillator

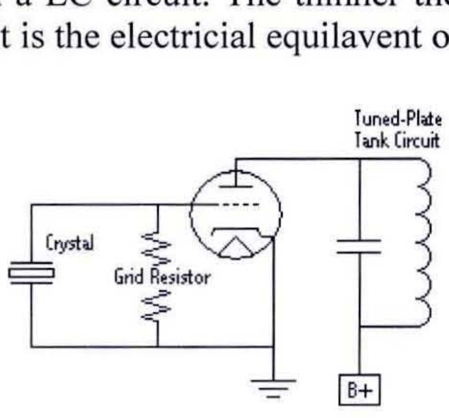
Basically I will describe LC oscillator because I made a LC voltage source in this semester from many experimental circuits.

LC Oscillator:
This oscillator consists of a capacitor and a coil connected in parallel. To understand how the LC oscillator basically works, let's start off with the basics. Suppose a capacitor is charged by a battery. Once the capacitor is charged, one plate of the capacitor has more electrons than the other plate, thus it is charged. Now, when it is discharged through a wire, the electrons return to the postive plate, thus making the capacitor's plates neutral, or discharged. However, this action works differently when you discharge a capacitor through a coil. When current is applied through a coil, a magnetic field is generated around the coil. This magnetic field generates a voltage across the coil that opposes the direction of electron flow. Because of this, the capacitor does not discharge right away. The smaller the coil, the faster the capacitor discharges. Now the interesting part happens. Once the capacitor is fully discharged through the coil, the magnetic field starts to collapse around the coil. The voltage induced from the collapsing magnetic field recharges the capacitor oppositely. Then the capacitor begins to discharge through the coil again, generating a magnetic field. This process continues until the capacitor is completely discharged due to resistance.

Example:
1.Hartley Oscillator
2.Colpitts Oscillator
3. Chaotic Colpitts Oscillator

CrystalOscillator:

This is a type of oscillator that is controlled by a crystal. The big advantage of a crystal oscillator is high frequency stablility. Common crystals used are tourmaline, Rochelle salts, and quartz. The crystal makes a voltage difference when voltage is applied to the two plates on the crystal. When AC is applied, the crystal compresses and stretches, in other words it vibrates. The natural frequency of a crystal's vibrations is found to be more constant than the oscillations in a LC circuit. The thinner the crystal is, the faster it vibrates. The LC circuit is the electricial equilavent of a crystal.



Notice there is a LC circuit on the plate circuit now. As said earlier, the crystal vibrates at its own frequency, so the LC circuit is on the plate to adjust the amplitude of oscillations. However, more components are suggested in this circuit to maintain the voltages and RF in the circuit. The disadvantage of this oscillator is its limited power output.

Caring and feeding of a crystal is important. Crystals will overheat or crack when fed with too much voltage. The current flowing through a crystal generally should not be more than 100mA (.1A).

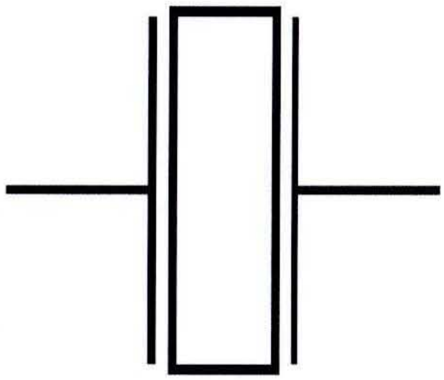
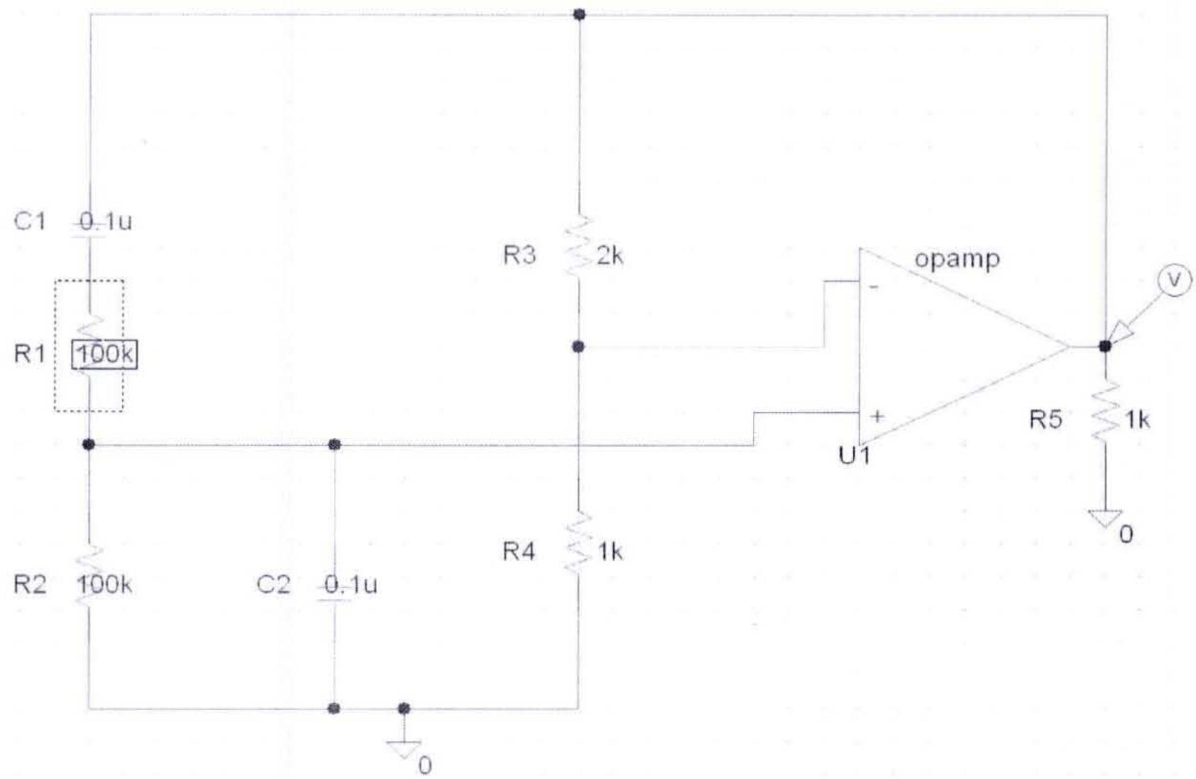


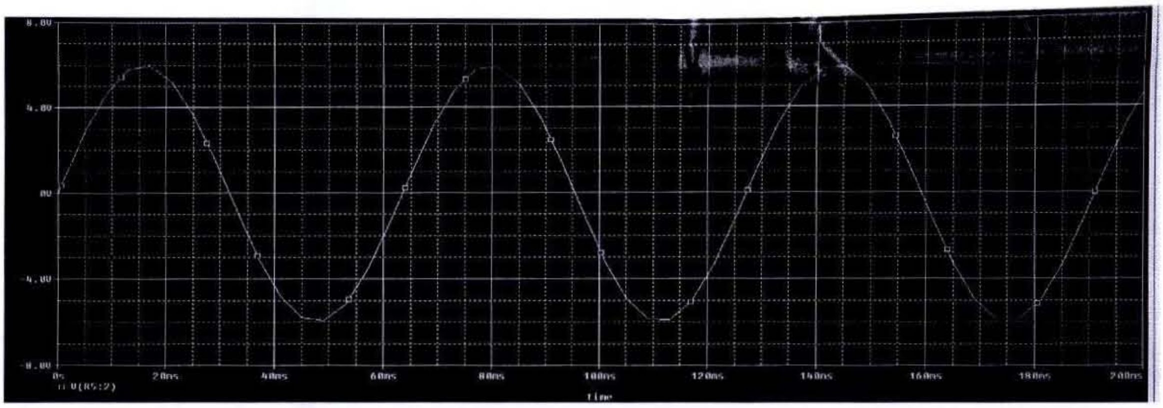
Fig.crystal

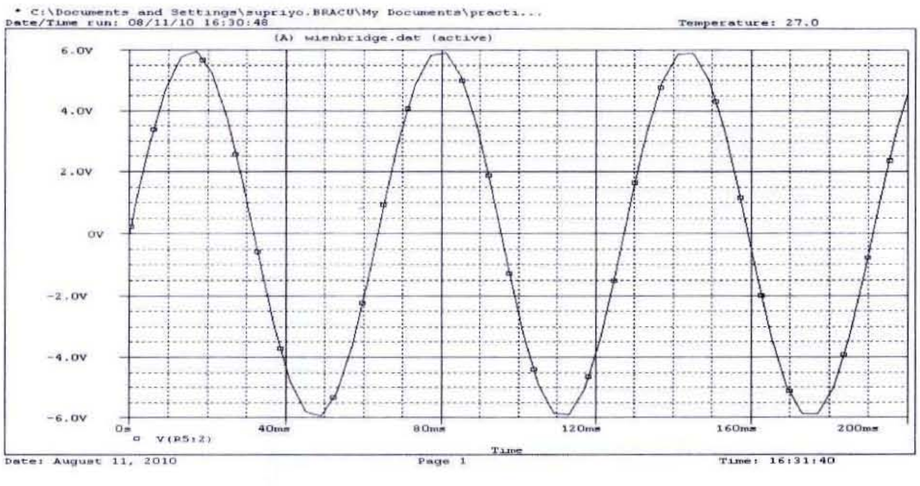
Piezo Electric effect:

The piezoelectric crystal bends in different ways at different frequencies. This bending is called the vibration mode. The crystal can be made into various shapes to achieve different vibration modes. To realize small, cost effective, and high performance products, several modes have been developed to operate over several frequency ranges. These modes allow us to make products working in the low kHz range up to the MHz range. Figure 4 shows the vibration modes and the frequencies over which they can work. An important group of piezoelectric materials are ceramics. Murata utilizes these various vibration modes and ceramics to make many useful products, such as ceramic resonators, ceramic bandpass filters, ceramic discriminators, ceramic traps, SAW filters, and buzzers.

<u>**Experiments in this pre-thesis semester**</u>
(Wein bridge oscillator):







From the output we can see the frequency is very low that I expected.It is only 15.75 Hz(very low frequency).

So from the beginning of my thesis semester I planned to make a crystal oscillator.But the high frequency crystals were not available in market at that time.But I searched high frequency crystals in market(at Dhaka stadium market,Nobabpur electronics market and also in Patuatuli).But after searching it 1 and a half month I didn't find any high frequency crystals.

Then I decided to do work with LC oscillator.I read some books and from online resources I got the circuit setup and details.

Colpitts Oscillator

A **Colpitts oscillator**, named after its inventor Edwin H. Colpitts,[1] is one of a number of designs for electronic oscillator circuits using the combination of an inductance (L) with acapacitor (C) for frequency determination, thus also called LC oscillator. The distinguishing feature of the Colpitts circuit is that the feedback signal is taken from a voltage divider made by two capacitors in series. One of the key features of this type of oscillator is its simplicity (needs only a single inductor) and robustness.

The fundamental frequency,

$$f_0 = \frac{1}{2\pi\sqrt{L \cdot \left(\frac{C_1 \cdot C_2}{C_1 + C_2}\right)}}$$

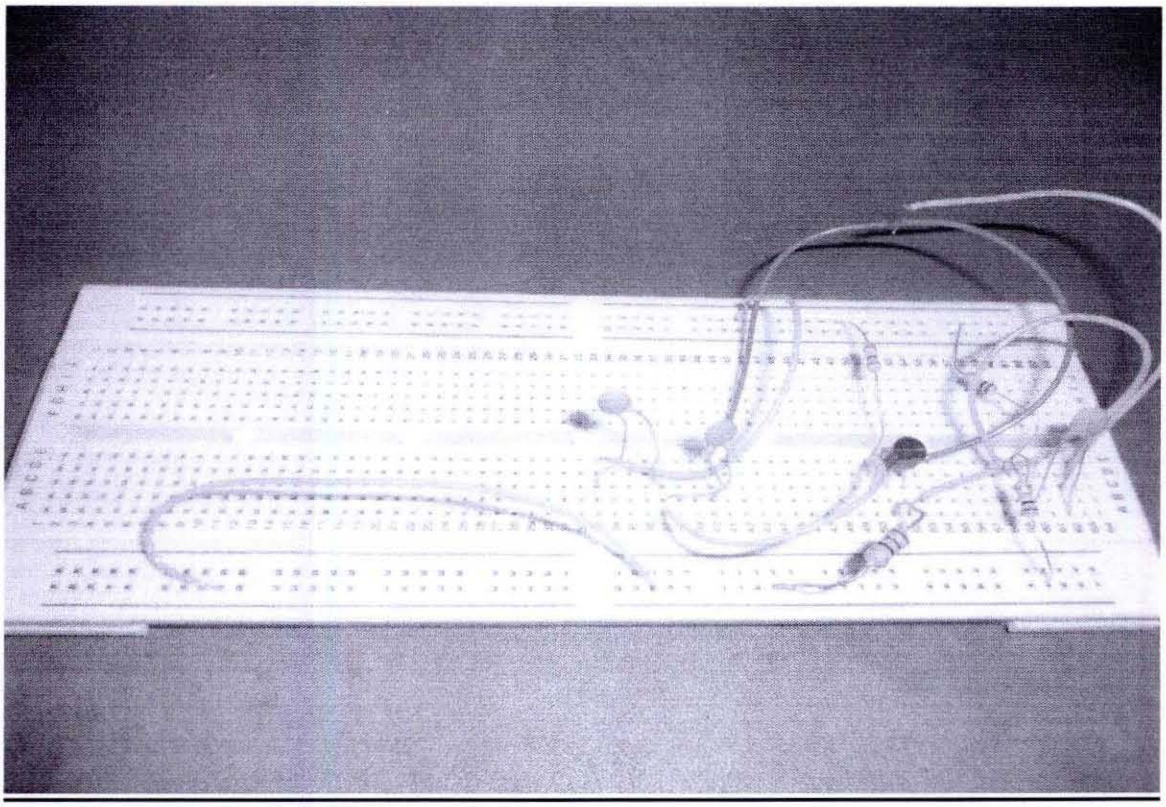
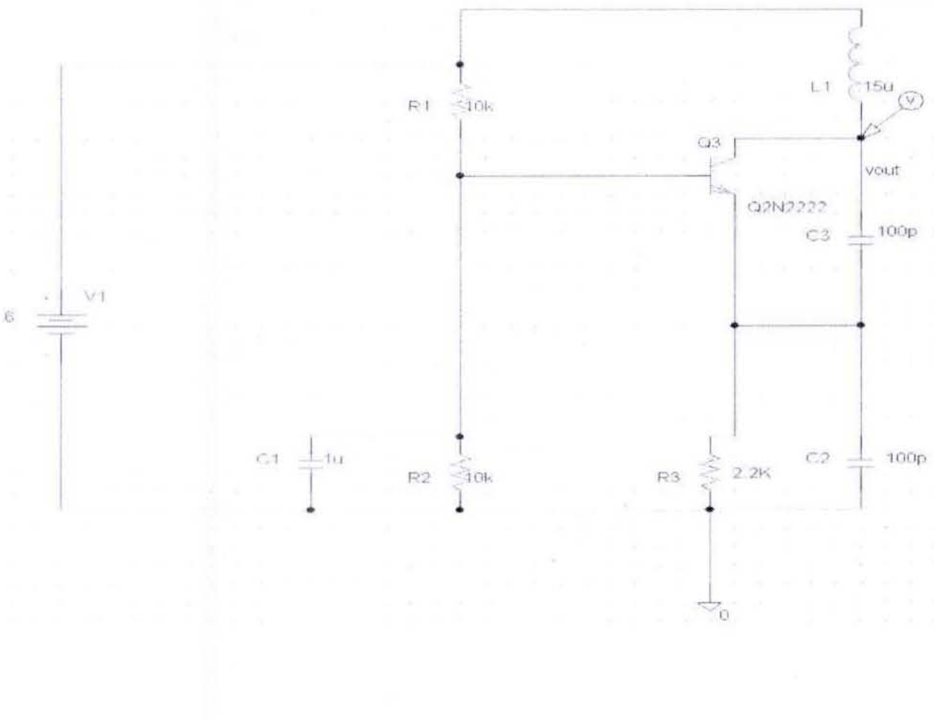
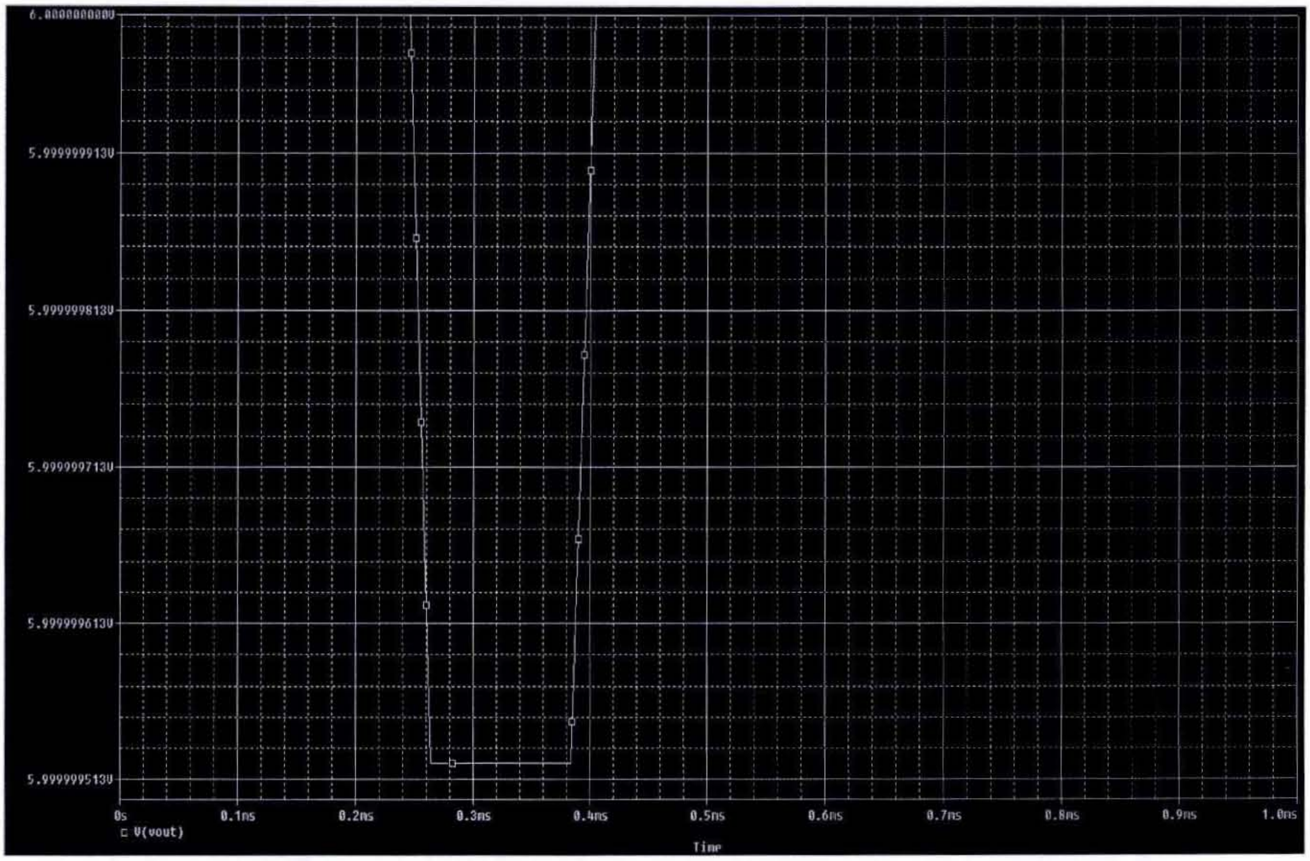


figure:colpitts oscillator(done and setup by me)



Theoretically I found the frequency(by using the frequency equation) is 430 KHz which is not yet my goal,because my goal was to go in minimum MHz range.But the circuit doesn't work in normal oscilloscope and also in Pspice.

<u>Pspice output:</u>



Then I searched more oscillator which can create the frequency in MHz range.And at last I found a paper named Chaotic colpitts oscillator and decided to work with it.

Chaotic Colpitts Oscillator for the Ultrahigh Frequency Range

The first experiment on chaos in the Colpitts oscillator was carried out at the kHz frequencies [1]. Later the oscillator was investigated in high frequency range and chaotic oscillations were demonstrated at thefundamental frequency $f*$ = 23MHz using the 2N2222A [2] also at $f*$ = 26MHz using the 2N3904[3] bipolar junction transistors (both with approximately the same threshold frequency fT of 300 MHz).By means of the PSpice simulations chaos was predicted at $f*$ = 500 MHz using the Avantek transistorAT41486 with fT of 3 GHz [2] and at $f*$ = 1000 MHz employing the BFG520 with fT of 9 GHz [3, 4].However, these results were not confirmed experimentally at that time. The main motivation behind the interest in chaotic Colpitss oscillator operating at high megahertz frequencies is potential application tocommunications [5]. Very recently a short letter was published reporting experimental results on chaosin the Colpitts oscillator at $f*$ = 450, $f*$ = 780 and $f*$ = 1060MHz [6]. In the present paper we contribute detailed analysis performed by means of PSpice simulations of the oscillator in the ultrahigh frequency (300–1000 MHz) range.

Then I decided to do the Choatic colpitts oscillator and from different markets I bought the resistors,capacitors,inductors and Transistor named BFG520.I have implemented it by both Pspice and practically but the oscillator didn't show the exact frequency because our oscillator hasn't the time domain in uH range.

Here I am showing the entire experiments which I found 25MHz frequency at last.

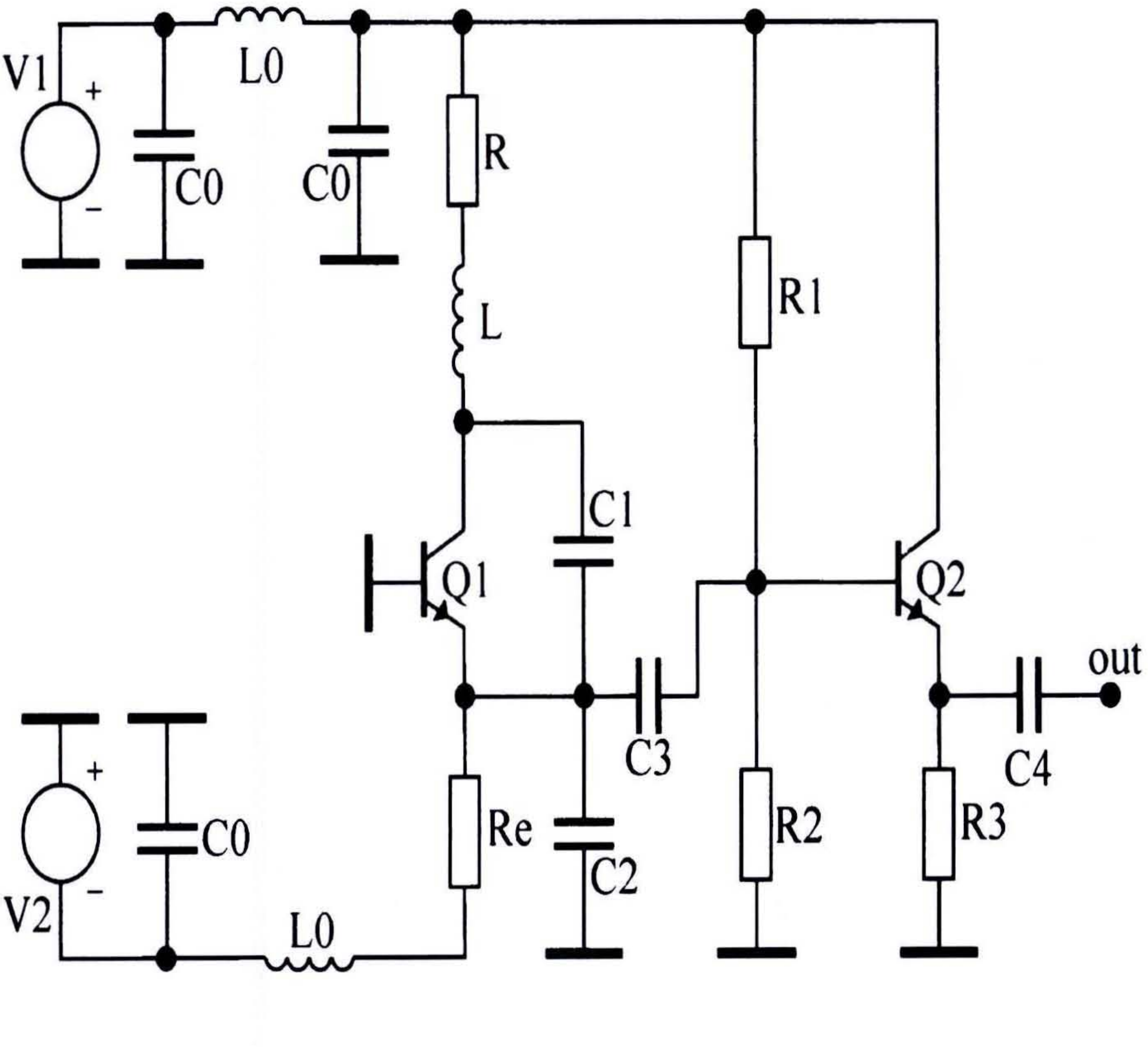
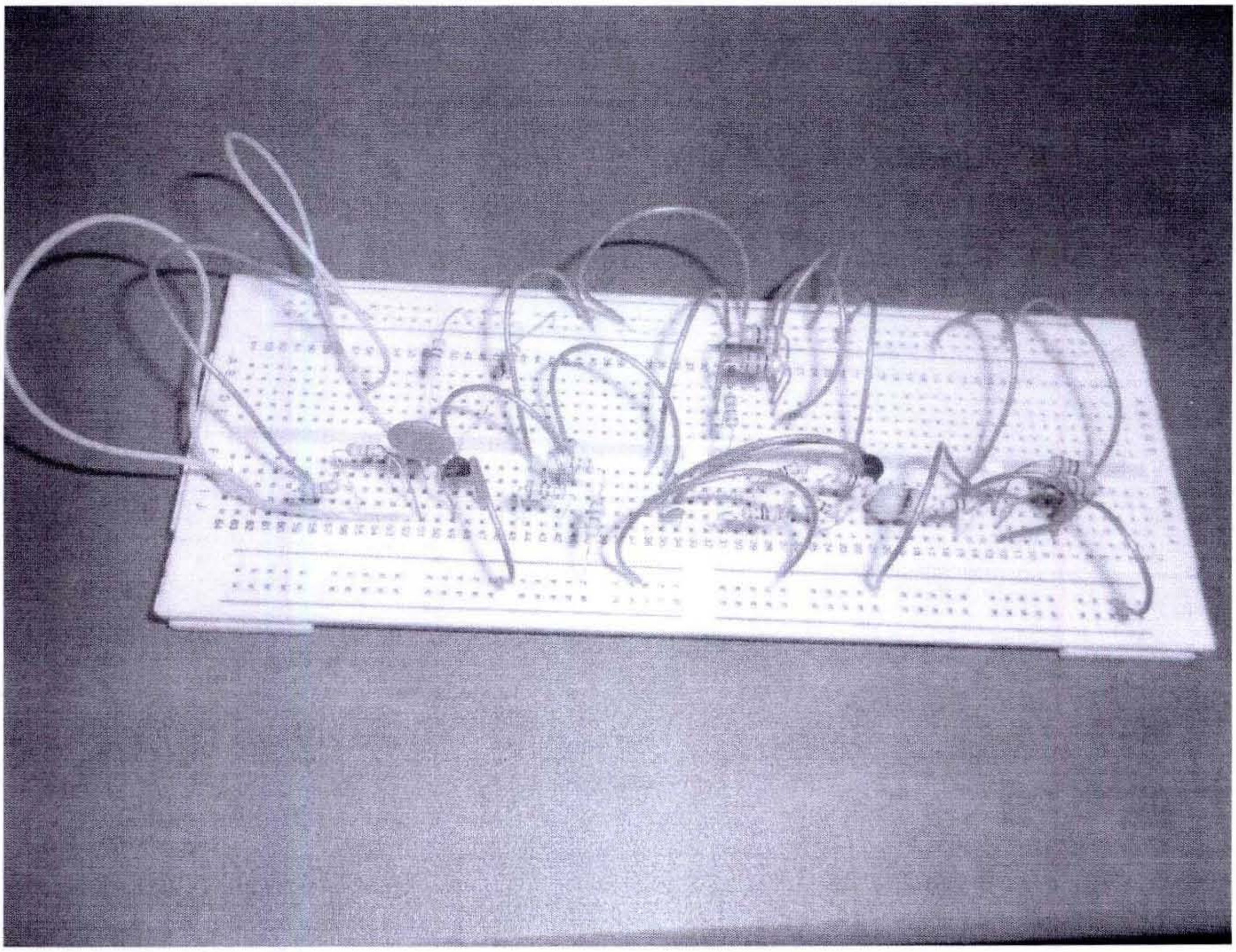


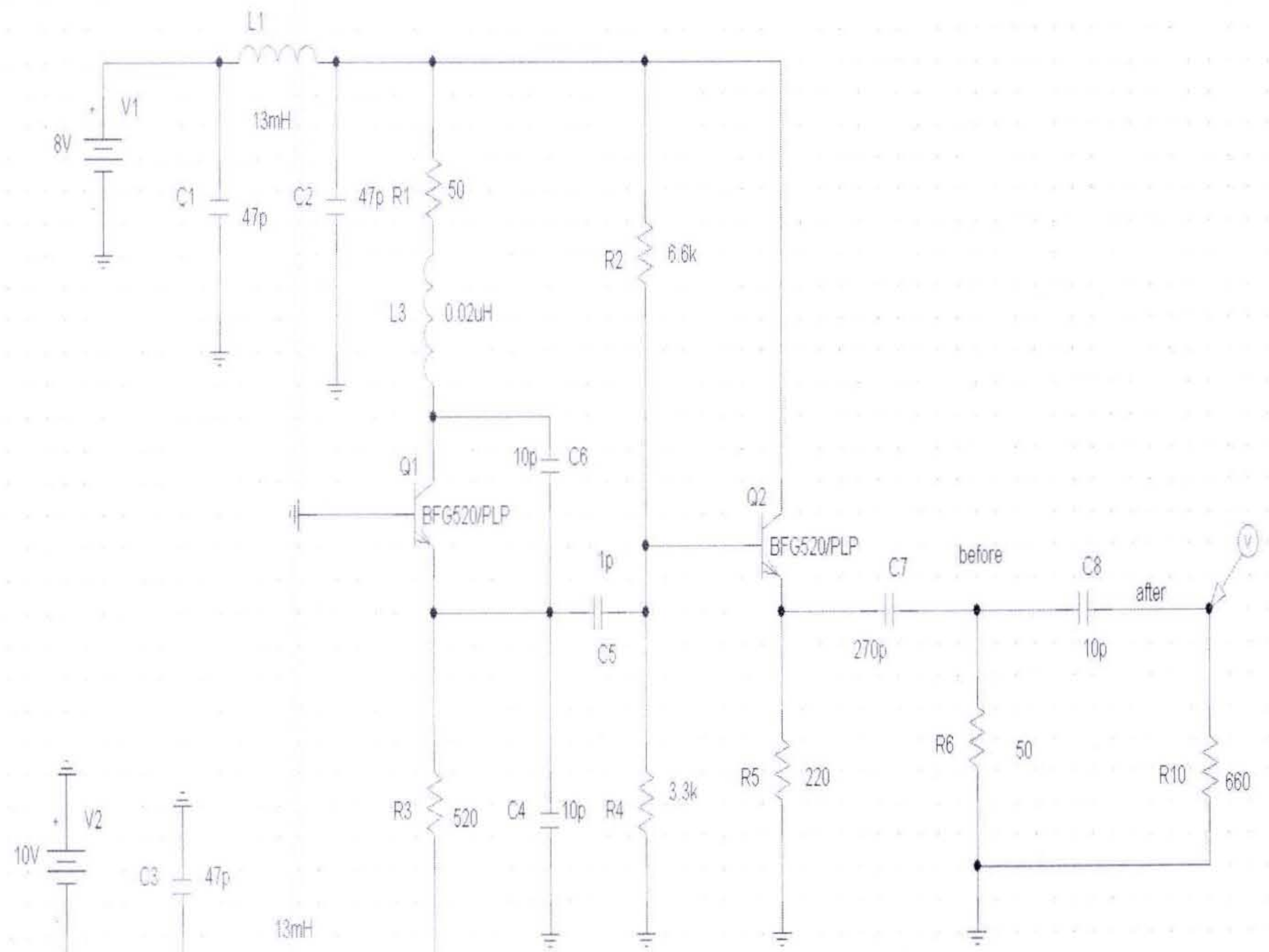
fig:Chaos Colpitts Oscillator

My experimental setup(Chaos Colpitts Oscillator):

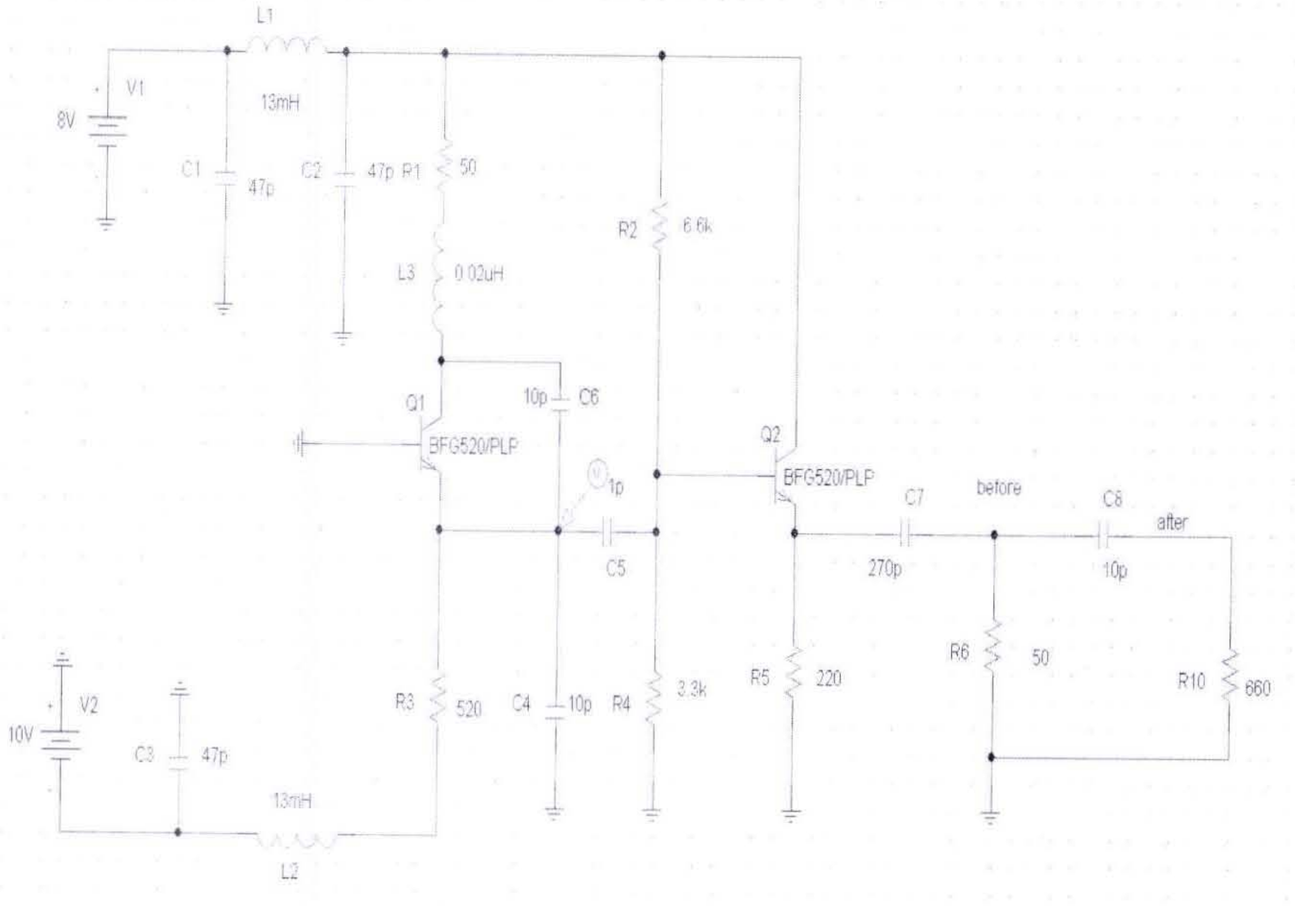
I set an extra circuit portion with the end of the circuits by using a high pass filter.



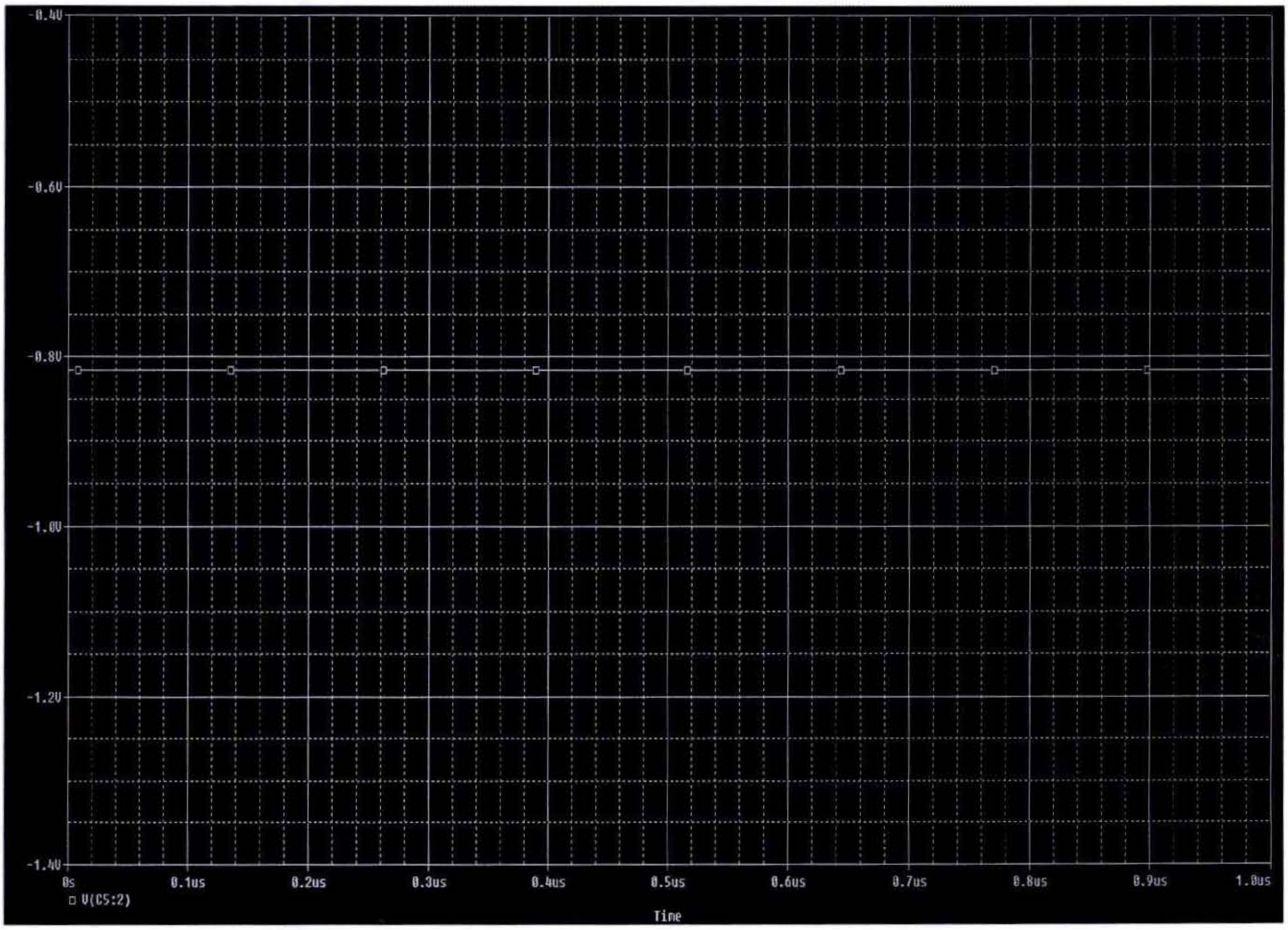
Pspice simulation(Chaos colpitts Oscillator):



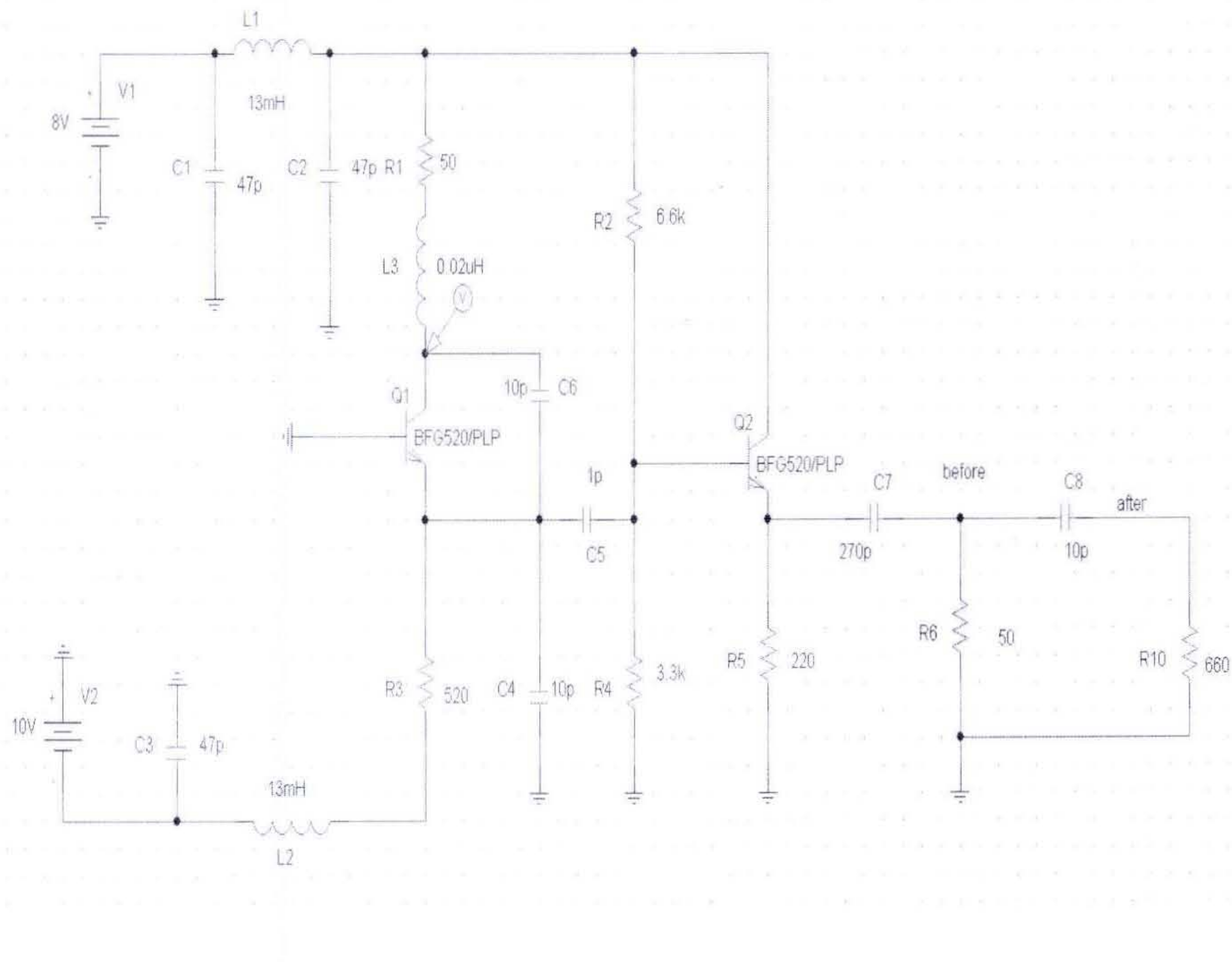
I set the probe on the different portion of the circuit to see where it gives the frequency.
At first I set the probe in the first transistor(probe is marked)



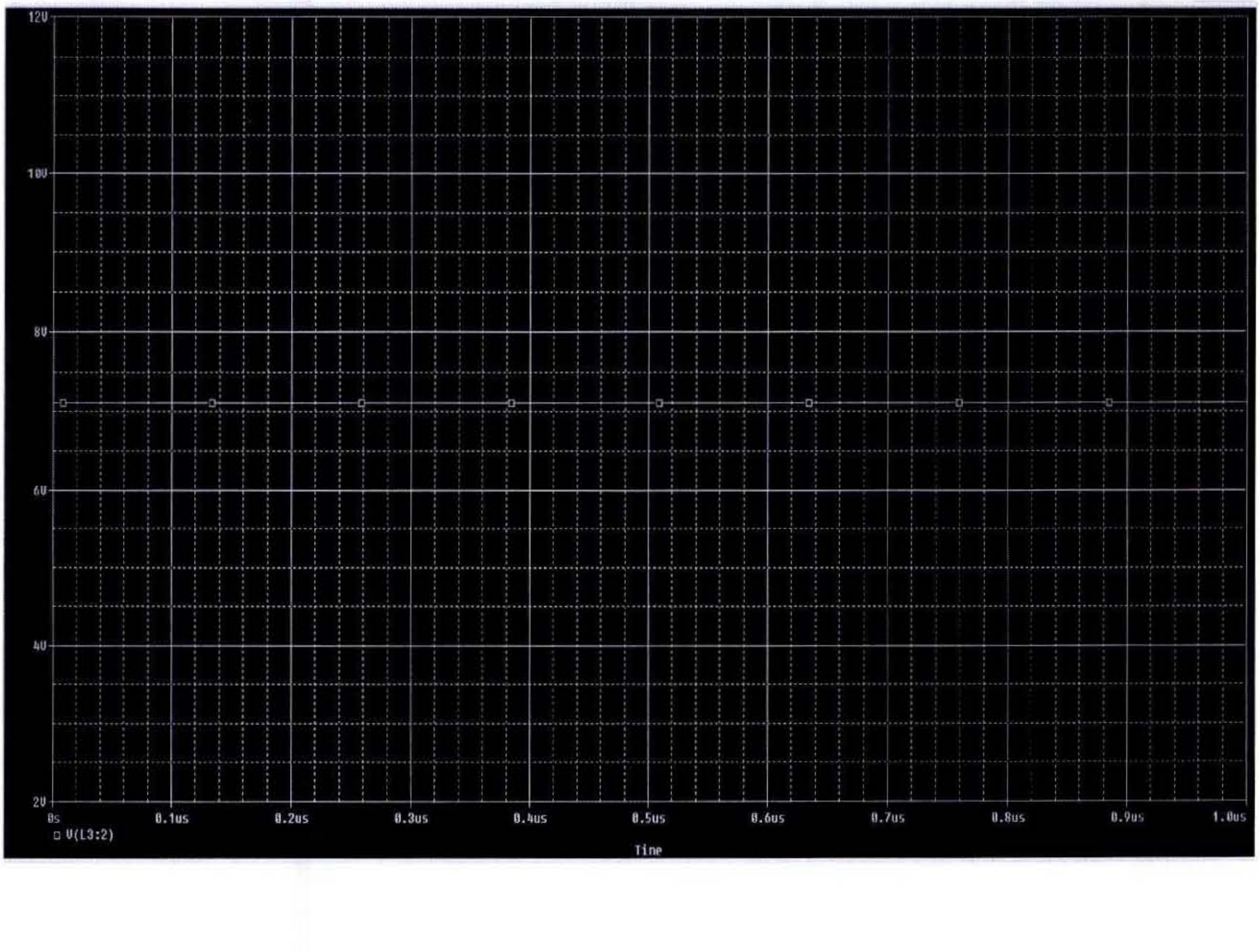
Then I observe the oscilloscope and found -0.8v constantly which means there is no frequency generating there.



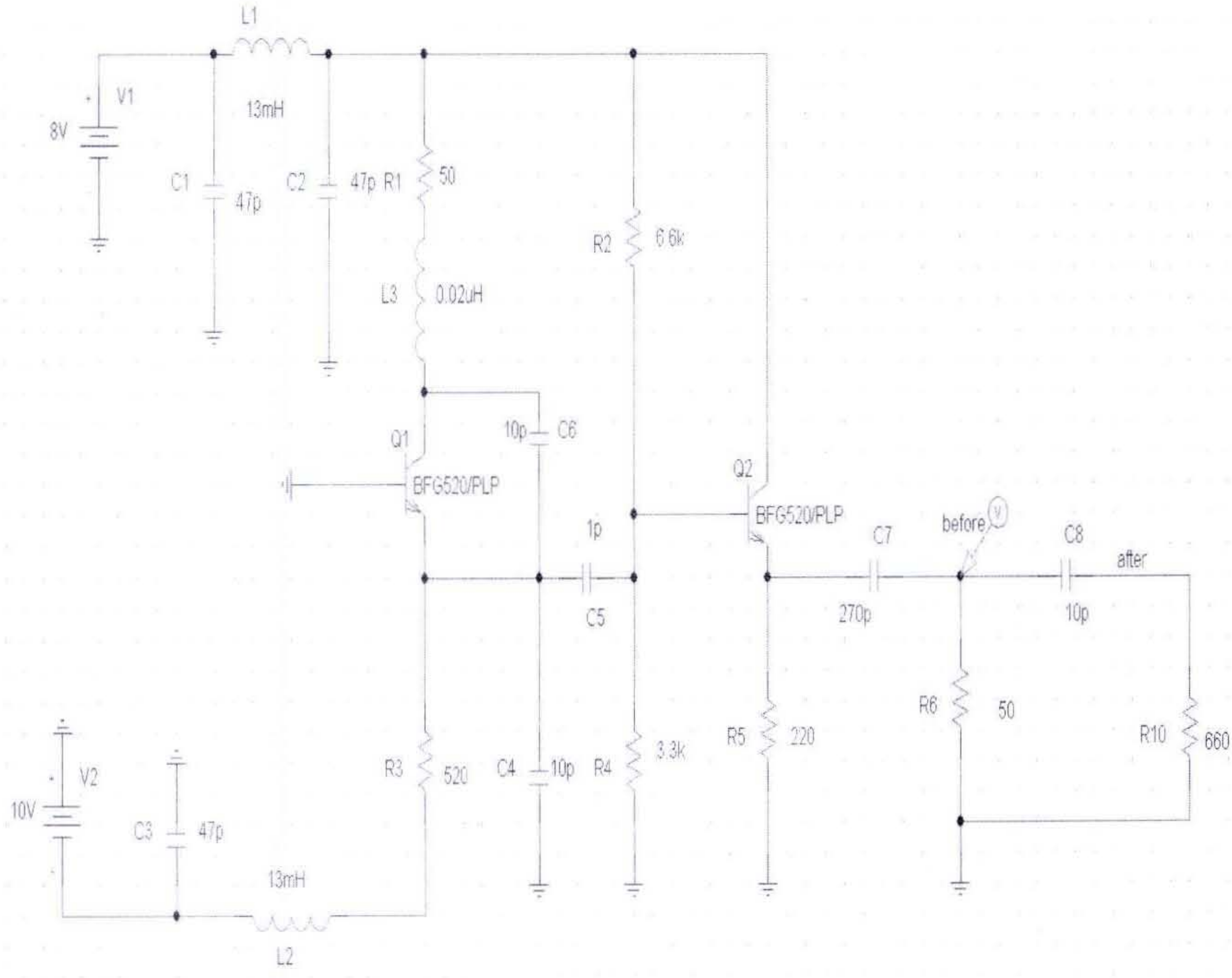
Then I set the probe in collector of the first transistor(probe is marked)



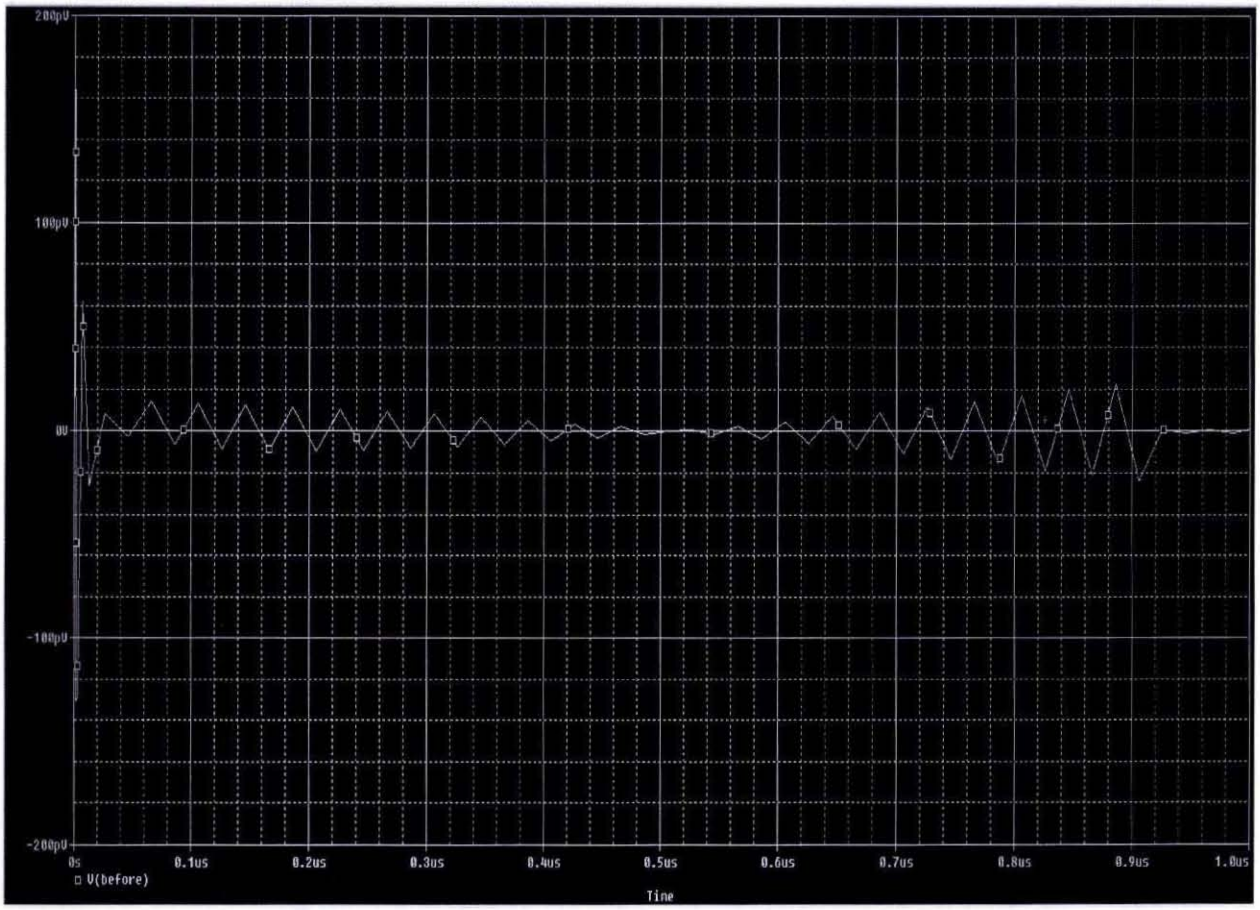
There I found a positive voltage +0.72 constantly.That means the frequency is not generating at this point too.



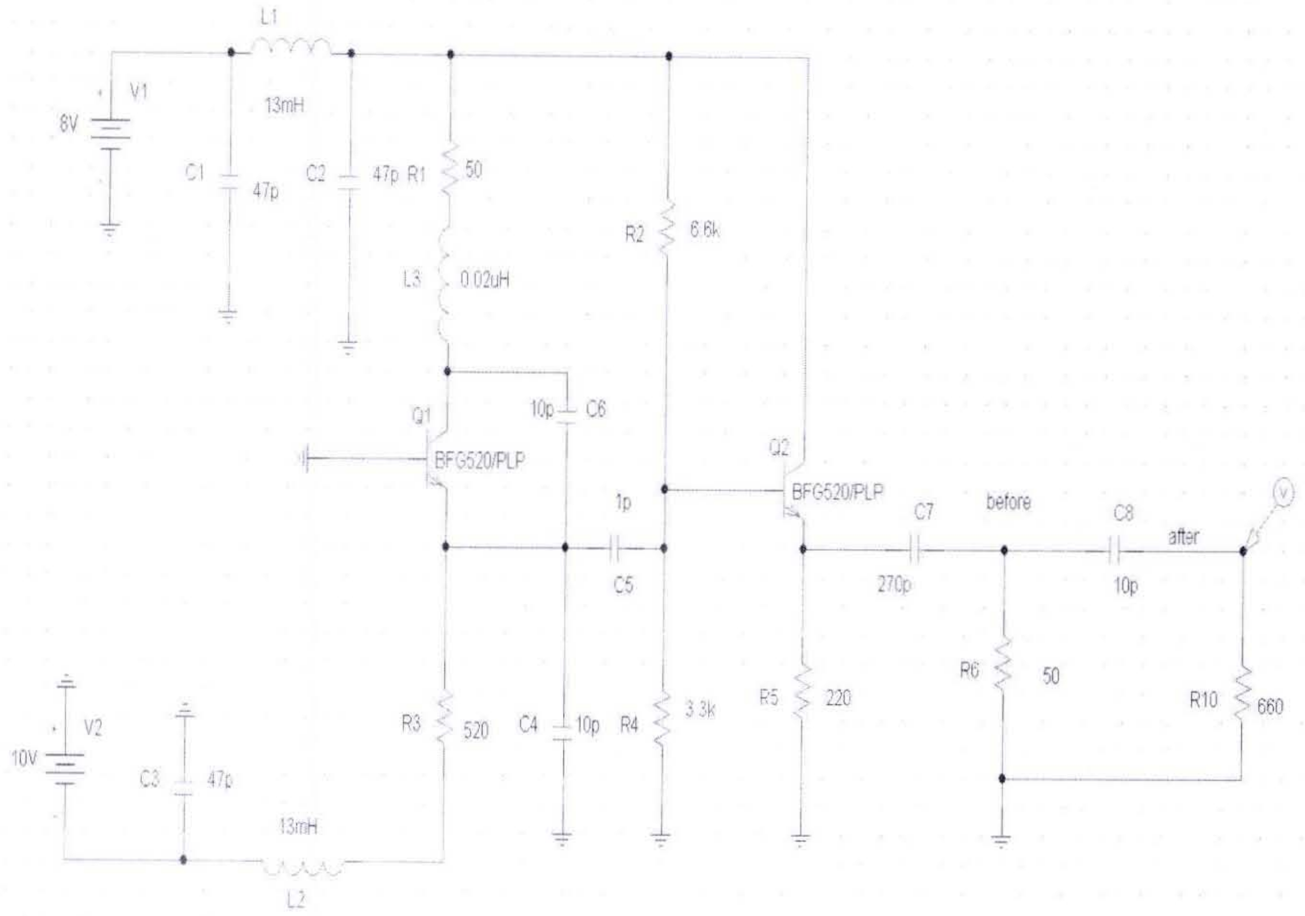
Then I set the probe on the output(2 transistor combined) and found frequency.



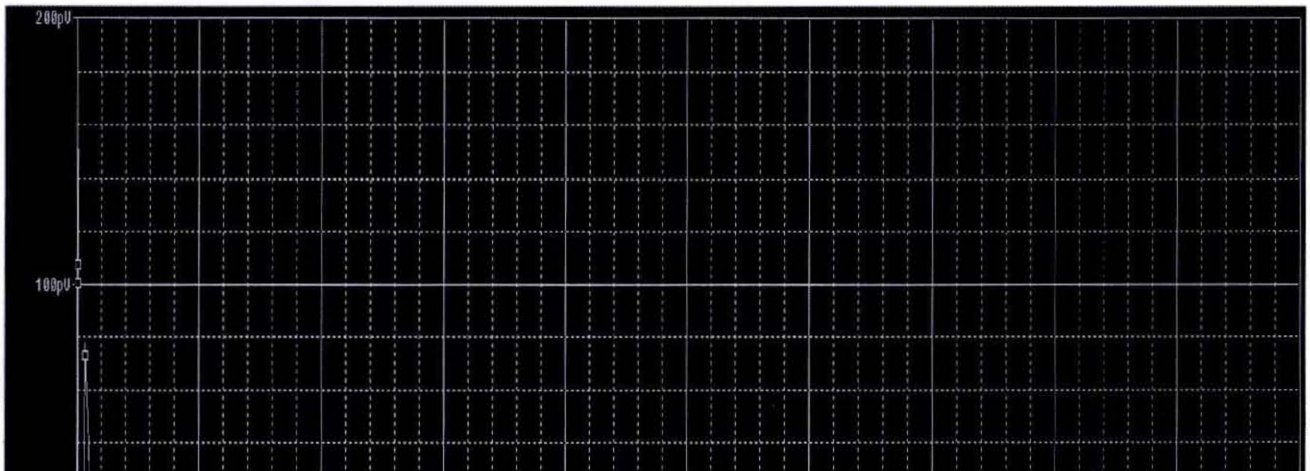
There I found a frequency(25 MHz) combined with high and low pass frequencies.



Then I set a high pass filter where under 20MHz is cut off and the higher frequencies pass through.



And by using a filter I got 25MHz frequency there and I reached my goal at last.



Task to be done in future(optional):
I am planning to make a crystal oscillator which can give a high range frequency in GHz range.I am interested to do the job in future for learning.

Conclusion:

From the whole time(2 semesters) I learned many things and that is done by DR. AHMED KAMAL,respected super-visor of my project.
In this project many people helped me as some of my faculty members and I am grateful to them.Many barriers came in this short time but at last I reached my goal.

References:

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