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Department
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Circuit Theory and Devices

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Lab_3: Prototype Design of a SONAR Transmitter

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Objective:

The objective of this lab assignment is to learn how to
a. Read a datasheet for finding out the key information relevant to a design
b. Develop a prototype of a Sonar transmitter on a breadboard and test its desired outcome

Theoretical Calculations:

Frequency Range	Load
0 - 5 MHz	33pf
5 - 10 MHz	18pf
10 - 15 MHz	16pf
15 - 20 MHz	14pf
20 - 30 MHz	12pf
30 - 40 MHz	10pf

following the above table
since we are going to use a crystal of 2MHz
The load capacitance should be 33 pF
And the typical value of Rf will be 1 Mohm (As per lab handout)

Output of crystal oscillator = 2 MHz
output of frequency divider $= \frac{2\text{ MHz}}{50} = 40\text{ KHz} \rightarrow f_0$

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After applying FFT on the output of the active low pass filter,
from the graph we observe that
using unitary method,

$5\mu s \rightarrow 100\text{ kHz}$

$1\mu s \rightarrow \frac{100}{5}\text{ kHz}$

$2\mu s \rightarrow \frac{100\times 2}{5}\text{ kHz} = \boxed{40\text{ kHz}}$

Observations:

1. In The Design of the Sonar Transmitter Circuit, we have given careful considerations to specific components like load capacitor (C1 and C2) and Rf(Feedback Resistor).

Load Capacitor (C1 And C2)

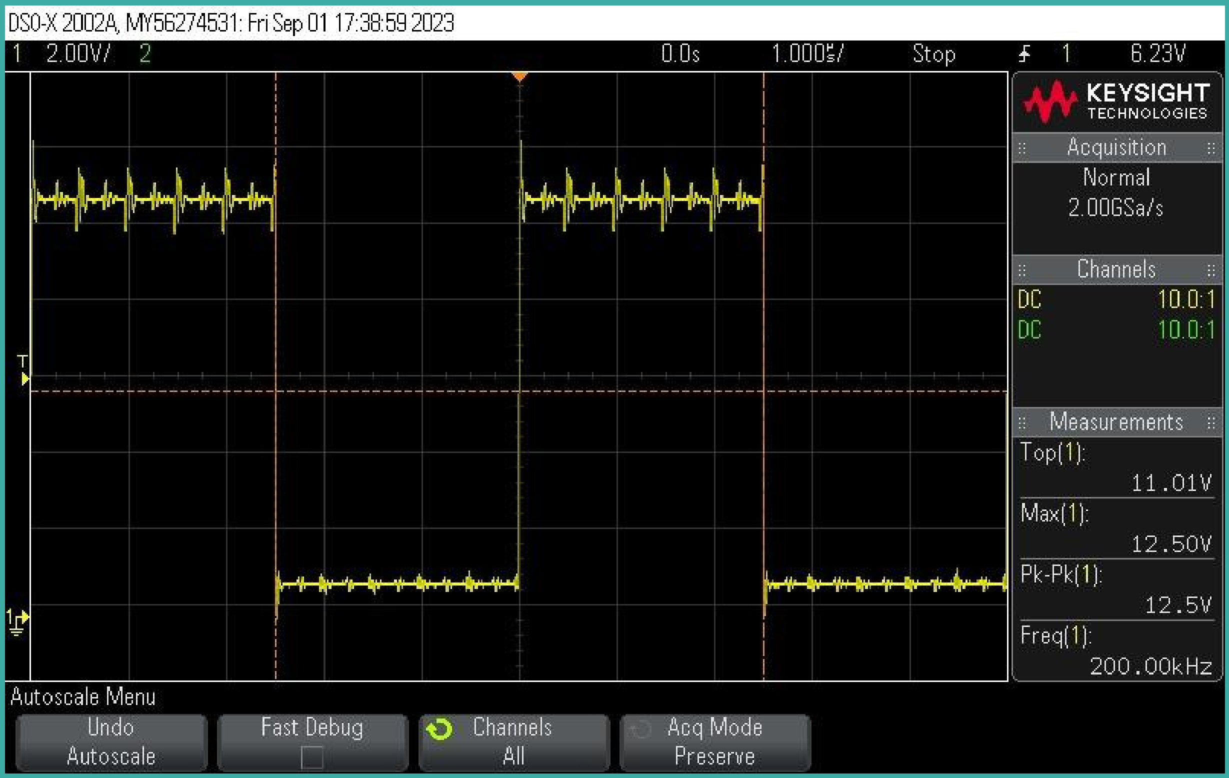
1. The choice of load capacitor plays an important role in determining frequency of oscillations in the crystal oscillator circuit.
2. In our case, where a 2MHz crystal oscillator was employed, the datasheet for the HC-49U crystal oscillator provided valuable information regarding the appropriate load capacitance. According to the datasheet, a 33pF load capacitor is recommended for a crystal oscillator operating in the 0-5MHz frequency range. As our crystal operates at 2MHz, we followed this recommendation and selected 33pF capacitors as C1 and C2.

Feedback Resistor (Rf)

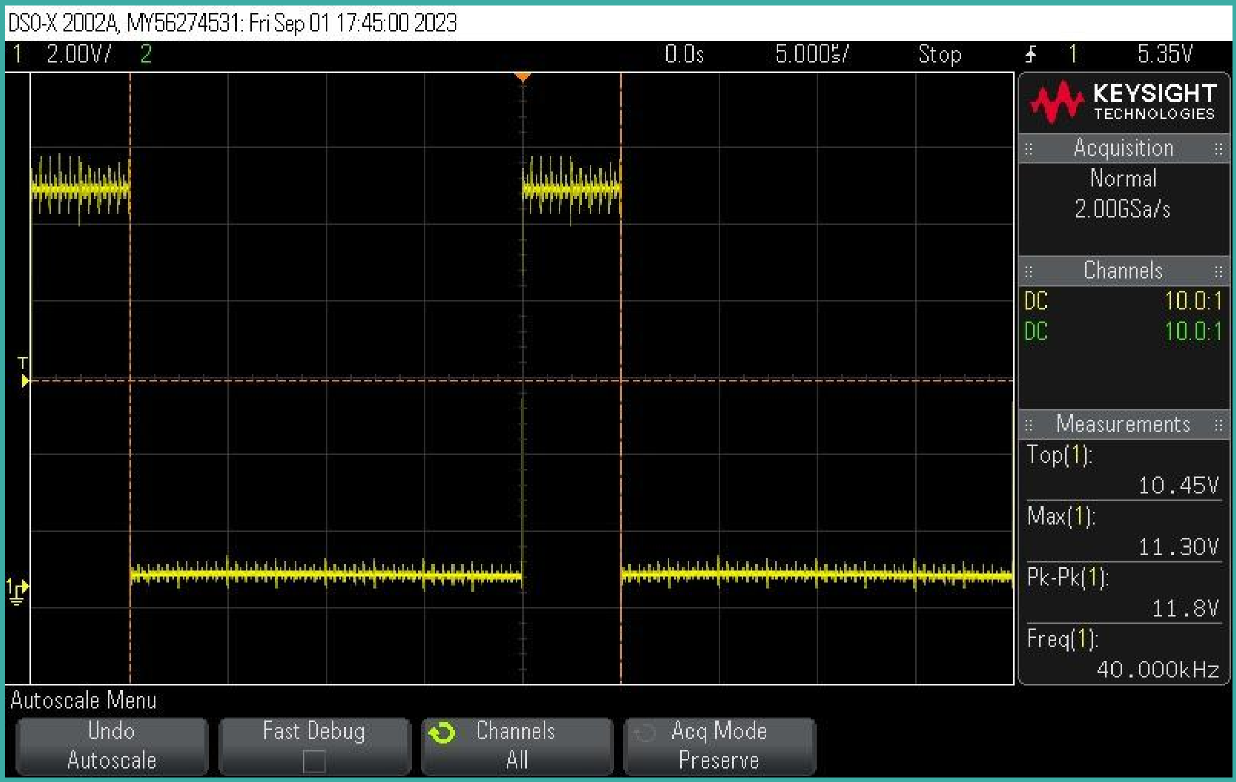
1. The feedback resistor, Rf, is a critical component in determining the loop gain of the oscillator circuit.
2. In our design, we considered a typical value of 1 ohm for Rf. This value was chosen based on standard practices for crystal oscillator circuits operating in the frequency range of our crystal.

Plots:

Original 2MHz signal



2 Mhz signal to 200KHz signal



200 Khz signal to 40 Khz signal

40 Khz signal’s FFT to see the peaks.

Conclusions:

Crystal Oscillator: The transmitter starts with a 2MHz crystal oscillator, which provides a stable frequency reference for the system.

Frequency Divider: A frequency divider is employed to reduce the 2MHz signal to 40KHz (fo), which is essential for the operation of the SONAR system.

Low-Pass Filter (LPF): The LPF serves two main purposes. Firstly, it removes higher-order harmonics that may be present in the signal, ensuring that only the fundamental frequency (40KHz) is transmitted. Secondly, it can be designed as an active filter to provide voltage amplification to the signal, enhancing its strength for transmission.

LPF block practically differs from an ideal sinusoidal signal due to the characteristics of the components and the design choices made. Factors such as component tolerances, filter design, and amplifier imperfections can introduce deviations from the ideal sinusoidal waveform. These deviations may impact the overall performance of the SONAR system, particularly in terms of its ability to accurately transmit and receive signals