18-MHz oscillator

In this task, you build and test a 18-MHz Clapp oscillator. The oscillator is based on the common-emitter amplifier that is familiar from a previous exercise.
The most prominent modification *positive feedback* that is now added to make the amplifier *unstable*, that is, to make it oscillate. We shall experiment with two different feedback circuits. The first one uses an LC circuit (one inductor and three capacitors, Fig. 1) and the latter uses a crystal and two capacitors.
Other modifications:

- The amplifier's input connector and input DC block are removed because there is no input in an oscillator.
- The biasing is arranged in a simpler way: the RF choke at the input has been replaced by a short circuit.[1]
- The 20-kohm potentiometer has been replaced by 10 kohm resistors
- The 220- ohm resistor at bias feed as well as the 47-ohm resistors from the DC supply line and from the output have been removed, because their purpose wast to ensure stable operation, i.e. ensure the amplifier will *not* oscillate.

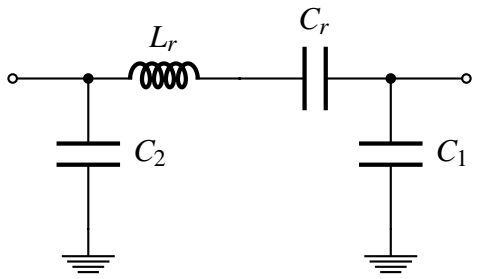

Figure 1: A phase shifter that provides positive feedback for a common emitter amplifier.

Construction

Your task is to build the circuit shown in Fig. 2. Before you start placing components, plan with paper and pen paper how they should be laid out. You find the list of components in table 1. Some hints:

- Make the circuit compact.
- Minimize the amount of jumper wires.
- Minimize the wire lengths, especially those used for grounding.
- Do not make the signal go "back and forth, all over place" on the breadboard. Keep the layout simple. This helps debugging...
- Do not splay out the leads of components if not absolutely necessary. Respect the intended assembly pitch, typically multiples of 2.5 mm. Breadboard holes are 5 mm apart.

[1]The RF choke at the input was not absolutely necessary in the amplifier exercise, either, but it is commonplace to use it. However it will be needed when the same amplifier circuit is used as a amplitude modulator.

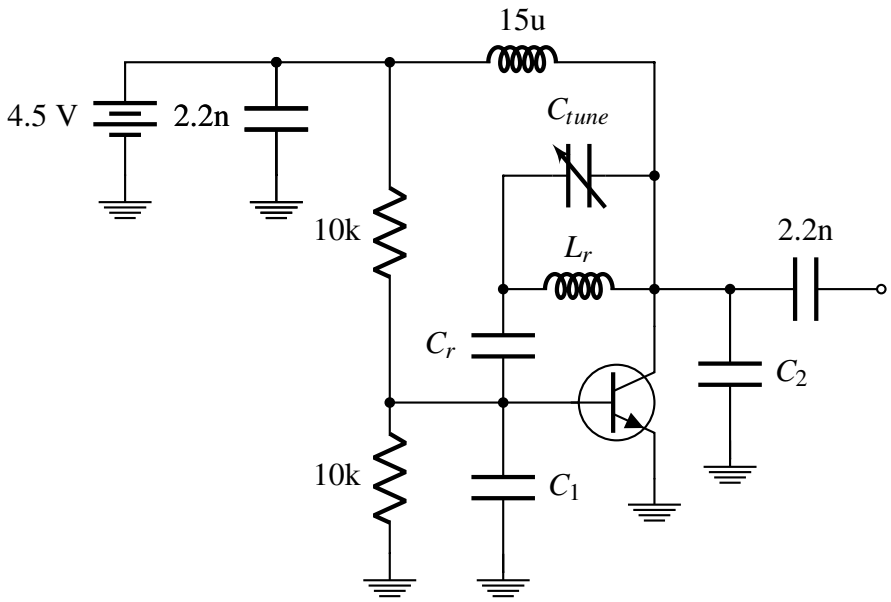

Figure 2: An LC oscillator that can be tuned to 18.4 MHz. Use $L_r = 2.2$ μH and $C_r = 22$ pF, $C_1 = C_2 = 330$ pF. For the tunable capacitor, use a Murata trimmer (e.g. orange color whose range is 6...50 pF).

Testing DC operation

- Connect 4.5 V from the Virtual Bench (VB) DC power power supply.
- Disconnect the feedback LC loop in order to disable oscillation, before you attempt to check the DC operation. (The DC readings are probably different when the circuit oscillates.)
- Check with the VB multimeter that the transistor gets biased properly: read the DC current consumption from the DC power supply. The DC operation should be OK if the current consumption is about 20 mA.
- Just to make sure, measure the emitter-to-base voltage is about $V_{be} \approx 0.7$ V.

Testing RF output

- Connect the feedback LC loop again.
- Monitor the RF signal at the RF output (v_{out}) with the Virtual Bench oscilloscope. Set the oscilloscope **probe to 10x**. Use a time scale on the horizontal axis such that you are able to see a sine wave with several periods. The period length is $\tau = 1/(18.4\text{MHz}) = 54$ ns. For the vertical scale, you might use something like 500 mV/div.
- You should see a signal whose period is near 50 ns. Record the amplitude. The amplitude should be several volts, peak to peak.
- Turn the trimmer capacitor. You should be able to tune the oscillator from 14 MHz to 22 MHz (with the orange trimmer). Try if you can set it to 18.4 MHz.
- If the output signal is OK, go to the course instructors for testing the output in a spectrum analyzer. The spectrum analyzer can be used to check the frequency stability and drift.
- Ask instructions for the construction of Crystal oscillator which replaces the feedback LC loop with an 18.432 MHz crystal.

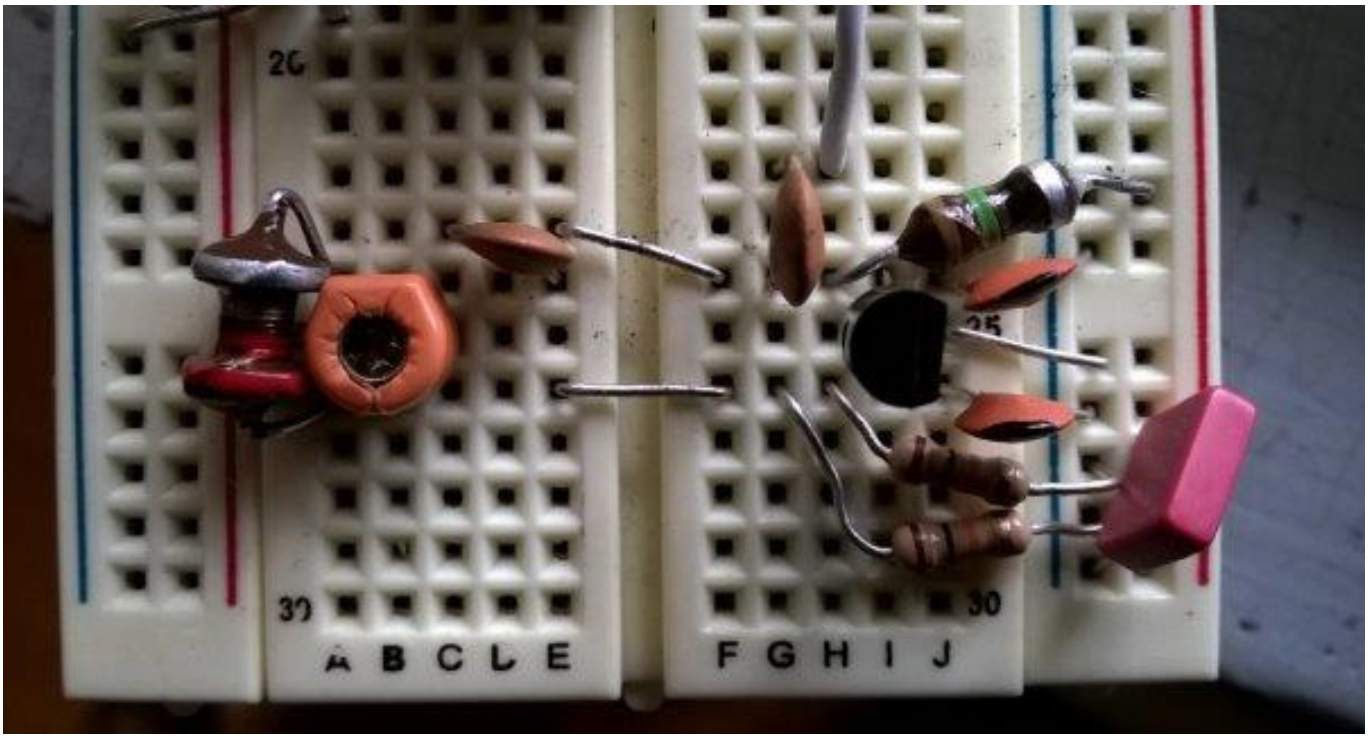

Figure 3: The tunable version of the LC oscillator. Output is the white jumper wire. The orange component on the left is the trimmer capacitor. Next to it is the 2.2-μH inductor.

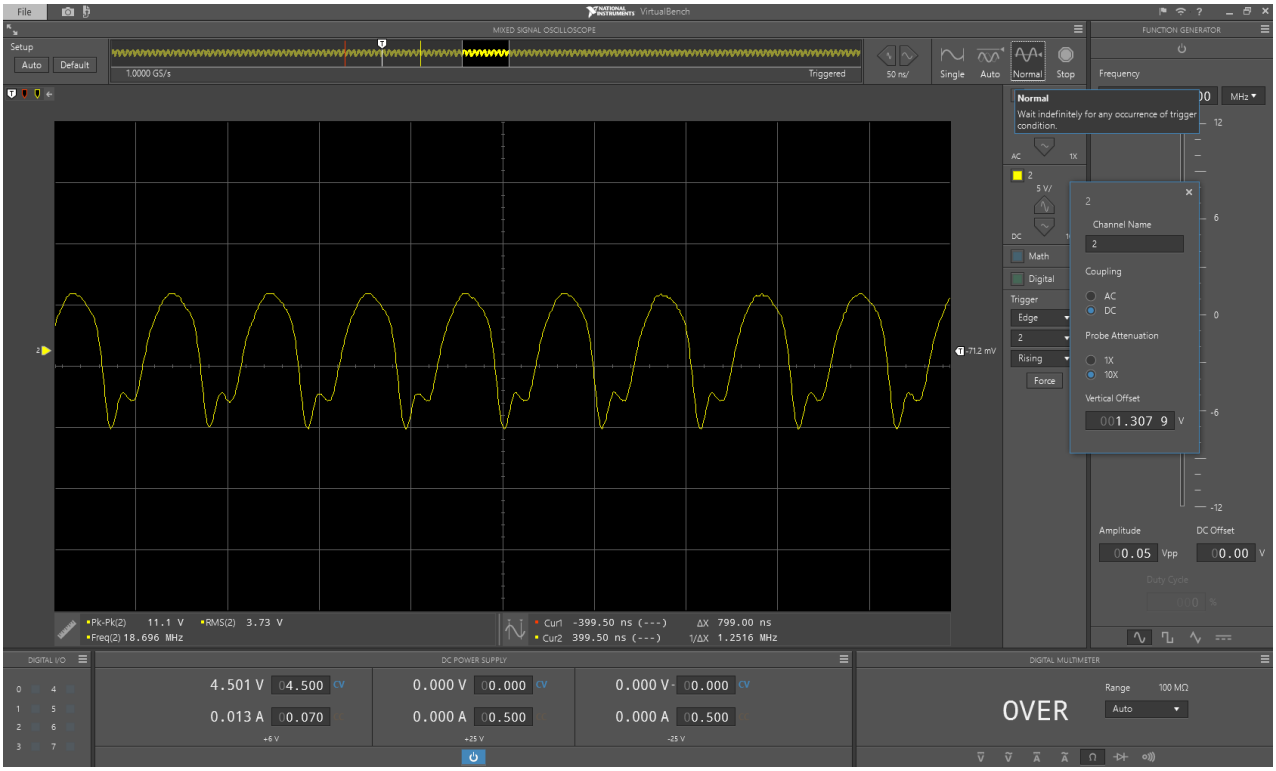

Figure 4: Output waveform from the tunable LC oscillator. The frequency was tuned to approx. 18.7 MHz which is near the desired frequency 18.4 MHz.

Table 1: Components needed to construct the oscillator

component	value	purpose/description/type	amount
R	10 kΩ	for biasing	2
C	22 pF	C_r	1
C	330 pF	C_1, C_2	2
C	6…50 pF	trimmer C_{tune}	1
L	2.2 μH	L_r	1
L	15 μH	RF choke	1
C	2.2 nF	DC block for RF	2
transistor		KSP10	1
breadboard			1
jumper wires			many