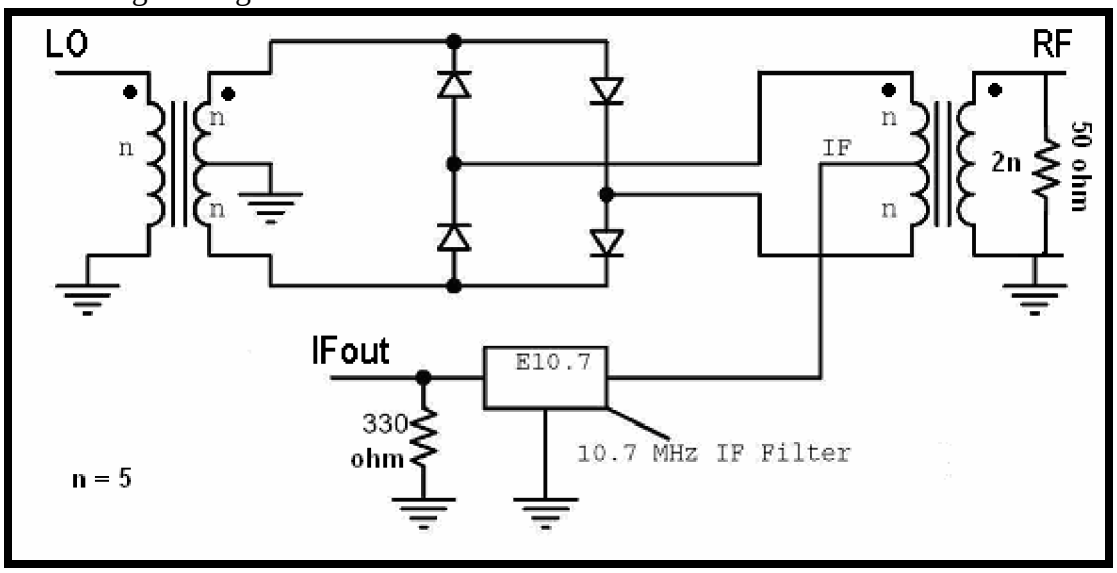
EEE411/511 Lab# 5

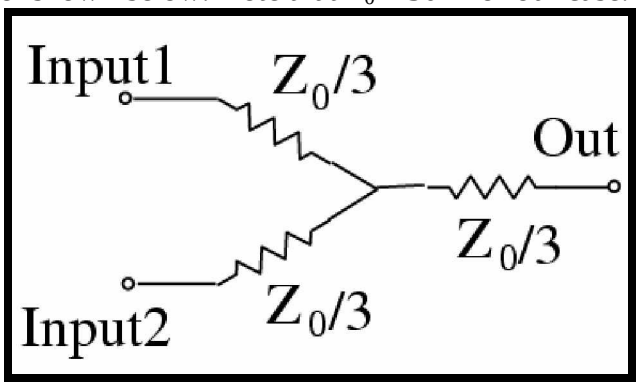
Double Balanced Mixer

In this laboratory work you will try to design a mixer circuit known as a "double balanced mixer". This mixer type includes two couplers and four diodes with low junction capacitance. Two ferrite toroid cores (T50-7) will be used as couplers. The circuit diagram is given below.



Preliminary Work

1) Choose a suitable number of turns for the couplers for RF and LO ports. Take the inductance factor for the toroid core as Al = 4.3nH / $(turn)^2$
2) Assume that your circuit is loaded with 330Ω at the IF output. Using the SPICE simulation, find the impedance that you would see from the RF input with sufficiently high LO input applied in order to switch the diodes. Assume the transformers are ideal. Ignore the IF filter for SPICE simulations.
3) In the experiment you will connect 2 RF inputs to the RF terminal through a power combiner shown below. Note that $Z_0 = 50\Omega$ for our case.



Calculate the power loss due to the power combiner from input to RF port.

4) Read carefully about the FFT function of the TDS2002 Oscilloscope from the user manual. It is on the course webpage, under the Notes and Tutorials link.

Lab Work

Twist a triple copper wire and wind to T50-7 toroid cores for making the transformers. Be careful for hot and cold sides of couplers when soldering. Use BA481 as the diode. Solder carefully all the components on the PCB provided.

Part1

Apply 30 MHz LO and 19.4 MHz RF signal to one of the RF inputs (other one stays open). Measure the output of the IF Filter. Increase the LO drive level to the point beyond which the RF output does not increase. Note this level as the optimum LO drive level. Measure the IF output for different levels of RF input. You will use the FFT function of the oscilloscope in order to measure the fundamental frequency component. Plot input (dB)-output (dB) graph according to this data, and find 1dB compression point.

Part2

In this part of the experiment you will find the IP3 point of this mixer. Connect 19.27 MHz RF signal to one of the RF inputs and 19.33 MHz to the other. LO input is still 30MHz. Apply the same amplitude to both RF inputs. Increasing this amplitude measure the IF output. Using the FFT function you will measure 2 fundamental frequencies and 2 closest harmonics. Magnify and zoom the FFT spectrum so that you can see these 4 frequency components clearly. Your assistants will demonstrate how to do this at the beginning of the lab. Using this data, you will calculate the IP3 point. You are going to interpolate the data where the curves are still linear, and intersection of these lines is the IP3 point.