1 Laboratory 6

Oscillators, Part II

Summary: Students will assemble, test, and tune their oscillator circuits. They will also measure the power transmitted between two antennas and use this measurement to calculate the antenna gains.

1.1 Required Equipment

Description	Model	Quantity	Notes
FFox	N9917A or N9918A	1	-
Cables	TM26-3131-36	3	-
SMA Connectors	J502-ND	3	Cinch
Capacitor/Inductor Design Kit	S402DS	1	Johanson
0.1 μF 0402 Cap	399-7845-1-ND	2	Kemet
1000 pF 0402 Cap	399-7830-1-ND	2	Kemet
SiGe HBT	BFU730F	1	NXP
RF Generator	HMC-T2220	1	Hittite
Cantennas	NA	2	NA

Table 1: Required Equipment

1.2 Circuit Assembly

1. Deburr your oscillator and solder on its 3 SMA connectors. One of these is the oscillators output, the other are used to route bias to the base and collector.

2. Locate the necessary inductors, capacitors, resistors, and the NXP transistor, and install them onto your board.

1.3 Oscillator Measurements

1. Configure your FFox for SA mode, with a frequency range of DC-18 GHz.

2. Configure the DC supply with an OVP of 3.5 V and OCP of 0.1 A.

3. Using BNC cables and adapters hook the power supply to your oscillator.

4. Hook your oscillator's output to port 2 of the FFox and enable the output of the power supply.
5. Slowly turn the bias voltage up until you reach the correct collector current. As you approach this value you should start to see the oscillation build and then lock on.
6. Record the oscillation frequency, power, and save the data to .csv file.
7. When I turned on my oscillator, its frequency was about 1 GHz low. I lowered my collector inductance in small steps to reach my target frequency. As you adjust your values, make sure you record the frequency and output power at each tuning point.
8. Once you are happy, record the final frequency, output power, bias parameters, and a .csv file.
9. Remember to take a photo of your final circuit.

1.4 Antenna Measurements

1. There are two cantennas within the setup, one for transmit and one for receive. For these measurements we will assume that both have identical gain.
2. Position the antenna carts so that the faces of the cantenna's are 1 m apart.
3. On the transmit side, set the Hittite signal generator to 2 dBm output at 5.9 GHz and enable its output. The output is set to 2 dBm to account for the $\approx$2 dB of cable loss betweeen cantenna's and their test equipment. This will make your calculations easier.
4. On the receive side, set the FFox to spectrum analyzer (SA) mode, with its frequency range set to 5.8-6.0 GHz. Set the RBW and VBW to 1 MHz and 10 kHz respectively.
5. Ensure that the polarization of the two antennas are aligned (the probes into their cans should be zenith pointing).
6. Adjust the angle, and horizontal position of the receiving antenna until the signal strength on the FFox is maximized.
7. Save this spectrum to file and record the peak value received in dBm.
8. Remember to take a photo of the test setup.

1.5 Data Analysis and Report

Reports are due by noon November 14th, emailed to drussell@caltech.edu and to dwinker@caltech.edu
Remember to follow all the general instructions from previous reports. You should include any derivations and/or circuit simulations from the pre-lab, including schematics and simulated results. For your oscillator, remember to include the bias values (voltage and current) in your plots.

1. Construct a table of your oscillator frequency, power, and associated resistor and inductor values for each tuning step.

2. What is the general behaviour of your circuits output with tuning? Does output power increase as you get closer to your desired oscillation frequency?

3. Plot out your final oscillator spectrum. What are the dBc values of the second and third harmonics?

4. If your design did not oscillate close to your goal of 5.9 GHz, what could you have done to get it closer? Was it due to sensitivity to circuit tolerances or lack of a specific circuit value (such as lack of chip inductor values below 1 nH).

5. Using your class notes, calculate the gain of each cantenna, with the assumption that they are both identical. You should also assume, as stated earlier, that the transmitted power is 0 dBm, and that the interconnecting cables have zero-loss. Express your values in dBi (dB relative to isotropic).