Laboratory #11: Introduction to RF Amplifier Design – Biasing the RF BJT

I. OBJECTIVES

Bias an RF transistor for use as an amplifier with proper isolation of the DC and RF signal paths. Determine the *S*-parameters and compare to the data sheet.

II. INTRODUCTION

Impedance matching can readily be performed between 50 Ω generators or loads and arbitrary complex impedances. Impedance matching to the input or output (base and collector) of an RF transistor is no different. Given certain bias conditions, the *S*-parameters for the transistor are specified in the data sheets. Therefore, the standard impedance matching techniques using conjugate matching for maximum power transfer can be used.

Amplifier Design - Bias Networks

The necessary groundwork for designing an RF or microwave frequency amplifier has all been set; the remainder of this lab is a start towards designing the bias an amp. The first part of designing an amplifier is to find a circuit that will properly bias the RF/microwave transistor at the desired operating point but that will not interfere with the microwave operation of the circuit.

In designing a bias network, it is important to choose a design that will minimize the "loading" of the RF signal, while still providing the correct dc bias conditions to the transistor. For this design, it is necessary to supply a DC base current and collector voltage bias, without loading the microwave signal present on the base and collector transmission lines. Since we'll be supplying the bias in shunt (in parallel with the RF signal), this means that the bias must be supplied through a network that presents a low resistance at dc, but a high impedance at the operational frequency of the amplifier (500 MHz). A straightforward way to achieve this with lumped parameters is the circuit shown in Figure 1

The RFC or RF choke is a high value inductor (in the order of 10 uH) that provides a DC path but is a high impedance high frequency path. The capacitors CB1 and CB2 are RF shorting capacitors with values in the order of 1 μF.

The resistors R1 and R2 form the fixed bias configuration for the MRF581A RF transistor. C1 and C2 are DC blocking capacitors of 1 μF which should not significantly affect the input and output characteristics of the amplifier. C3 is a DC bypass capacitor for noise reduction and is typically in the order of 0.1-1 μF.

By biasing the MRF581A according to the measured specifications sheet's S-parameter DC conditions, appropriate amplifier S-parameters can be achieved. For the MRF581A, the S-parameters over frequency are specified at VCE = 10V and IC = 50 mA bias.

The amplifier circuit will be constructed on SurfBoards®. Use lumped parameter resistors, inductors, and capacitors.

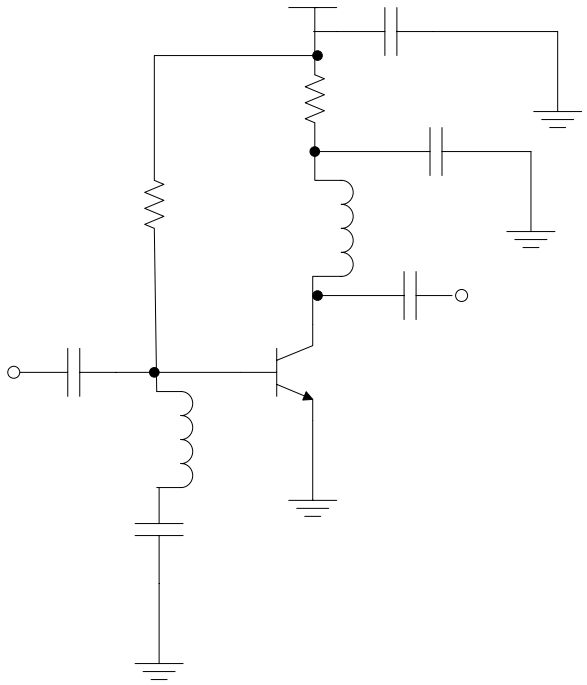

Figure 1. RF BJT Amplifier Biased

III. PROCEDURE

A. Bias the RF Transistor

- Bias the MRF581A RF Transistor to IC = 50 mA with VCE = 10V according the DC conditions for the measured S-paramters. The Operational Frequency is 500 MHz. Assume the transistor β_F = 180 (or as measured).

B. Confirm the Bias Conditions

C. Determine the S-Parameters of the MRF581A BJT Amplifier

E. Comment on your results.