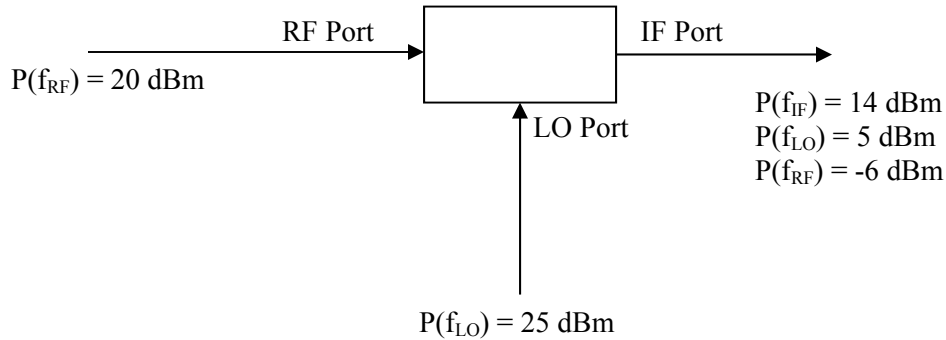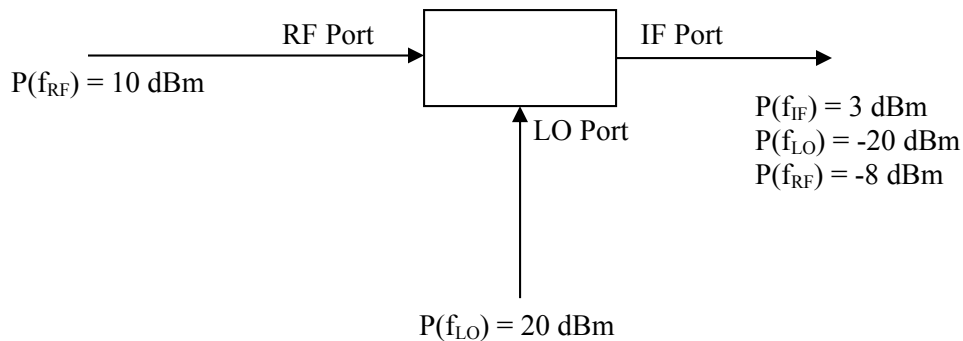## ELC 4383 – RF/Microwave Circuits I

Mixers/Diodes Supplemental Homework

SMD.1. A mixer is designed to receive an RF input signal at a frequency of 3000 MHz and down-convert it to an IF signal at 400 MHz. Assume that the following power levels are measured at the ports of a frequency-conversion system containing the mixer and necessary filtering:

RF Port IF Port

$P(f_{RF}) = 20$ dBm

LO Port

$P(f_{IF}) = 14$ dBm
$P(f_{LO}) = 5$ dBm
$P(f_{RF}) = -6$ dBm

$P(f_{LO}) = 25$ dBm

(a) If the local oscillator frequency is higher than the RF frequency, give the LO frequency and the image frequency.

(b) Calculate the conversion loss.

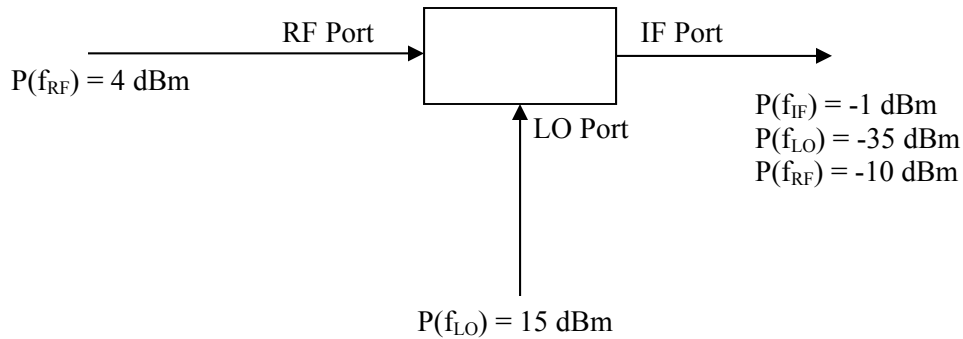(c) Calculate the RF-to-IF isolation.

SMD.2. A mixer is designed to receive an RF input signal at a frequency of 4000 MHz and down-convert it to an IF signal at 200 MHz. Assume that the following power levels are measured at the ports of a frequency-conversion system containing the mixer and necessary filtering:

RF Port IF Port

$P(f_{RF}) = 10$ dBm

LO Port

$P(f_{IF}) = 3$ dBm
$P(f_{LO}) = -20$ dBm
$P(f_{RF}) = -8$ dBm

$P(f_{LO}) = 20$ dBm

(a) If the local oscillator frequency is higher than the RF frequency, give the LO frequency and the image frequency.

(b) Calculate the conversion loss.

(c) Calculate the RF-to-IF isolation.

SMD.3. A mixer is designed to receive an RF input signal at a frequency of 8000 MHz and down-convert it to an IF signal at 700 MHz. Assume that the following power levels are measured at the ports of a frequency-conversion system containing the mixer and necessary filtering:

RF Port   IF Port

$P(f_{RF}) = 4$ dBm

LO Port

$P(f_{IF}) = -1$ dBm
$P(f_{LO}) = -35$ dBm
$P(f_{RF}) = -10$ dBm

$P(f_{LO}) = 15$ dBm

(a) If the local oscillator frequency is higher than the RF frequency, give the LO frequency and the image frequency.

(b) Calculate the conversion loss.

(c) Calculate the LO-to-IF isolation.

SMD.4. A mixer contains a diode with the following parameters: $C_j = 0.7$ pF, $R_s = 5$ Ω, $I_s = 20$ μA, and $L_p = C_p = 0$. Use $\alpha = 1/(25$ mV$)$. Compute the open-circuit voltage sensitivity at 5 GHz for $I_0 = 100$ μA.

SMD.5. A mixer contains a diode with the following parameters: $C_j = 0.9$ pF, $R_s = 2$ Ω, $I_s = 15$ μA, and $L_p = C_p = 0$. Use $\alpha = 1/(25$ mV$)$. Compute the open-circuit voltage sensitivity at 1.5 GHz for $I_0 = 20$ mA.