ECE 453: Wireless Communication Systems **Fall 2026**
Problem Set #4 **Due Date: 5pm, Fri, Oct 2, 2026**

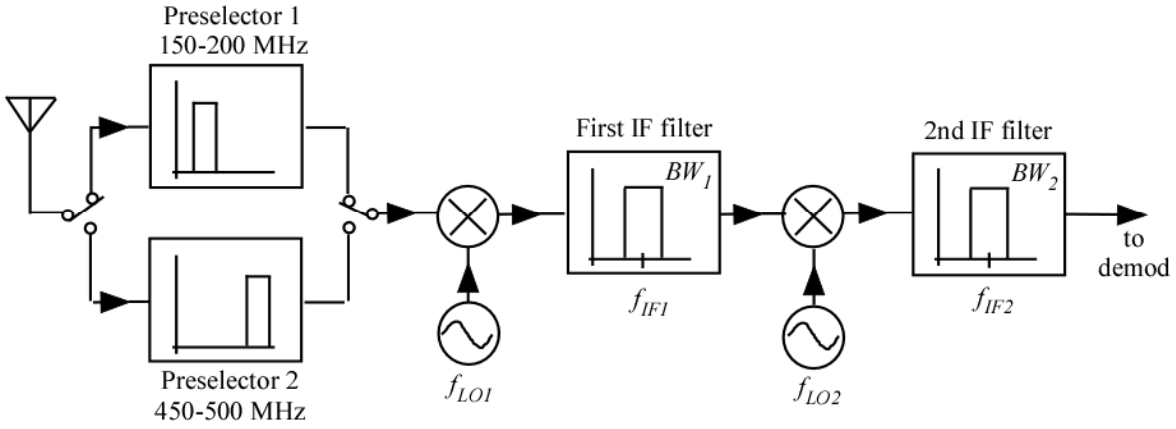
Solutions

1. A dual-band double-conversion superheterodyne receiver must cover 150-200 MHz and 450-500 MHz. Only the preselector is switched when changing bands. The same 50-MHz-wide tuning range of the first local oscillator and the same first IF filter must serve both bands. The signals have 20 kHz bandwidth. The second IF is f_{IF2} = 12.0 MHz with BW_2 = 20 kHz.

(a) Find the two possible values of the first IF center frequency f_{IF1} that permit one common first-LO tuning range for both RF bands.

(b) For each f_{IF1}, give the corresponding 50-MHz first-LO tuning range.

(c) Give the smallest useful BW_1 and the largest ideal rectangular BW_1 that rejects the secondary image created by the second conversion.



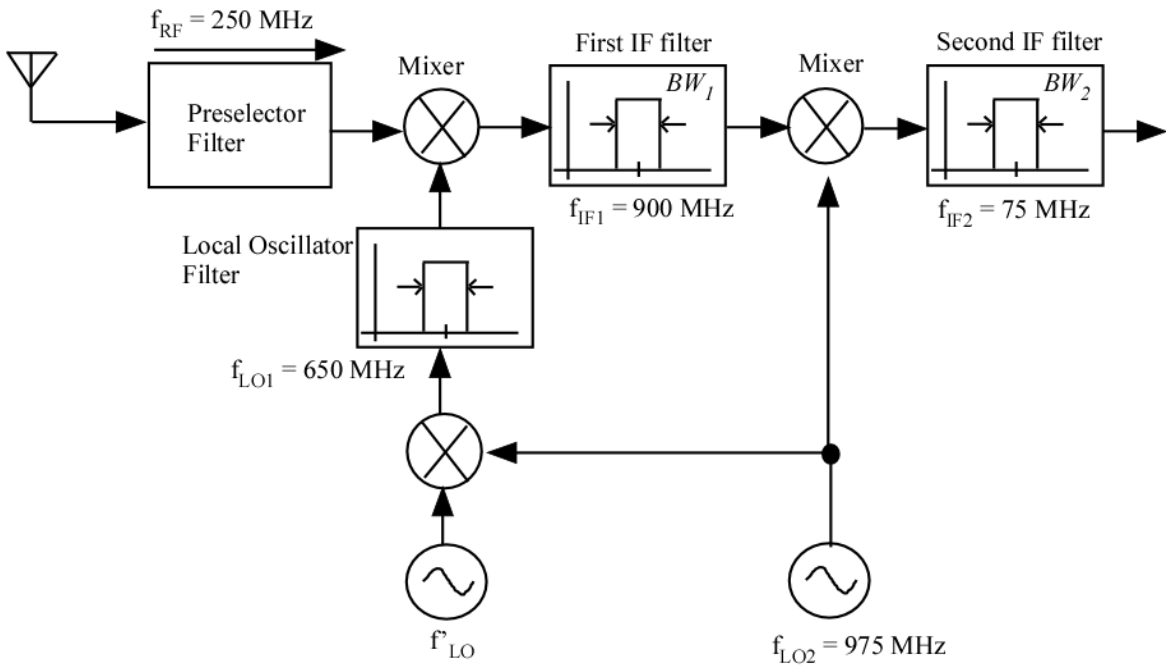
2. A drift-canceling Wadley-loop receiver is redesigned for f_{RF} = 250 MHz. The first IF filter is centered at 900 MHz, the second IF at 75 MHz, and the RF signal bandwidth is 40 kHz. A tunable oscillator nominally at f_{LO2} = 975 MHz also generates the first-mixer LO through a stable auxiliary oscillator and a narrow LO filter centered at 650 MHz.

(a) Choose BW_2.

(b) Find the maximum ideal rectangular BW_1 that rejects the secondary image associated with the second conversion.

(c) Let f_{LO2}=975 MHz+δ. Determine the stable auxiliary oscillator frequency f_{aux} such that $f_{LO1}=f_{LO2}-f\_{aux}$ is nominally 650 MHz and the final desired IF is independent of δ.

(d) What practical factors limit the allowable magnitude of δ?



3. Two nominally cancelling sinusoidal signals have small amplitude and phase imbalance:

$$s_{\pm}(t) = A\cos(\omega t) \pm (A+\delta)\cos(\omega t + \delta\theta).$$

Define suppression $S = 10\log\left(\frac{P_+}{P_-}\right)$ where $P_{\pm}$ represents the time-average power in the sum and difference signals.

(a) With δA=0, find the largest phase error $|\delta\theta|$ for suppression of at least 20 dB, 40 dB, and 50 dB.

(b) With $\delta\theta$=0 and defining amplitude imbalance $I = 20\log\left(\frac{A+\delta A}{A}\right)$, find the maximum positive amplitude imbalance for the same suppression values.