ECE 4670 Lab Report Grading

Lab 3: Mixers and Amplitude Modulation

Points	Lab Exercise Number	Laboratory Exercise Description	Check off
		Modeling DBM	
5	Lab Desc.	Run LT spice model of the DBM as described in lab reader. Collect data in both the time domain and frequency domain. Import into Python and display.	
5	Lab Desc.	Run LT spice model Schottky Clipper Circuit as described in lab reader. Collect data in both the time domain and frequency domain. Import into Python and display.	
		Use the Python modeling above to later compare DSB results performed below	
		Characterizing the Power Splitter-Combiner	
5	Part a	**Checking Power Splitter Forward Dynamics** Using the NA of the FieldFox, collect the S_{21} data for an input of the summer port to an output splitter port. (Sweep from 0.5 to 400 MHz) Load data into Python and plot. Comment on how your data compares to the data sheet specification, for the splitter.	
5	Part b	**Checking Power Splitter Isolation Dynamics** Using the NA of the FieldFox, collect the S_{21} data from output 1 to output 2 port. (Sweep from 0.5 to 400 MHz) Load data into Python and plot. Comment on how your data compares to the data sheet specification, for summer isolation. (Make sure to 50 ohm terminate the unused power splitter port)	
		Mixer Basics	
5	Part a	**Characterizing mixer:** Set up the function generator to: 7 dBm at 5 MHz and connect to the LO of mixer -20 dBm at 100 KHz and connect to the IF of the mixer. Set the FieldFox as SA for frequencies from 0 to 25 MHz, capture data and plot in Python. By observation of the data, find and catalog all signals of greater than -60 dB. In particular, note all signals that are a function of: nf_{LO}, mf_{LO} and $\lvert mf_{IF} \; += \; nf_{LO}\rvert$	
5	Part b	**IF power change:** Increase the IF power to -10 dBm **Observe on Spectrum analyzer**, What is the most significant change in the output spectrum at the RF port? Explain why.	
5	Part c	**LO Frequency change:** Change the LO frequency to 70 MHz. Observe, at RF output on the SA, the frequency content around 70 MHz (+/- 10 MHz). Now connect RF output of mixer to the input of the 70 MHz filter, again observe on the SA the frequency content of	

		the output of the filter. Are the upper and lower sidebands observed in the spectrum out of the filter? Feel free to change the LO frequency to optimize the power of the output of the filter. (From lab 1 we observed the filter peak is shifted from 70 MHz.	
		Double Sideband Modulation and Demodulation	
5	Part a	Connect DSB Modulator and Demodulator as shown in Fig. 21. Set up the function generator to: 7 dBm at 5 MHz and connect to the LO of mixer -20 dBm at 100 KHz and connect to the IF of the mixer. Observe the output waveform (from the DSB demod mixer) on the SA to verify that among the various signal components that are now super imposed, the desired message signal is indeed present. How can we recover the message signal?	
5	Part b	Observe the output waveform (from the DSB demod mixer) on the scope to verify that among the various signal components that are now super imposed, the desired message signal is indeed present. How can we recover the message signal?	
5	Part c	Attempt to recover the message signal, the 100 kHz sinusoid, using a 1 MHz LPF found on the RF board. Capture the time domain results on the scope. Make note of any strong interference signals that you see via the spectrum analyzer. (Use a coax cable type probe)	
5	Part d	Compare your results with a Python behavioral simulation as described in the simulation modeling section of this document. You will need to add a model for your lowpass filter into the simulation.	
5		How important is it that the demodulation frequency source is phase coherent with the transmitted carrier source? Explain.	
	Part e	In this part you will explore noncoherent demodulation starting from the setup of Part c. The Agilent 33250 generator will be used as a non-coherent reference in the demodulator as shown in Figure 22.	
5	Part e	Observe on both the scope and the spectrum analyzer what happens when you make the 33250 frequency close to 5 MHz. You should see the 100 kHz message sinusoid break into two sinusoids. To see this more clearly insert the 1 MHz lowpass filter between the second mixer and the power splitter. Explain what is happening and why.	
		AM Modulation and Demodulation	
	Part a	Configure the Keysight 33600A to generate a 1 MHz AM carrier with a message signal initially at 10 kHz and a modulation index of 80%. Set Modulation function generator to 1 MHz f_c and message tone of 1 KHz with modulation index of 80%.	
	Part a	Assemble a diode envelope detector with 1N4148 and an R of your choosing (at first).	
5	Part a	Adjust the drive level to the diode envelope detector to be sufficient to overcome the diode turn-on voltage of roughly 0.7 v. Initially include only the value so you can better see that the diode is indeed halfwave rectifying the AM signal. Capture the signal on the scope.	
	Part a	Add a capacitor to the detector circuit output. Determine the R and	

		C values for a 5 KHz cutoff LPF.	
5	Part a	Observe on scope the demodulated tone signal. Capture the signal on the scope. Verify you can hear the tone through a powered speaker.	
5	Part a	Change the carrier frequency from 1 MHz up 2 MHz. Observe that the performance should be about the same? Why?	
5	Part b	Connect an external audio signal to the modulating function generator. Observe, using scope that you stay less the 100% modulation on the audio input signal. Comment on the quality of the recovered AM modulation using the PC speakers. Listen or observe the output of the detector message signal. Comment on the quality of the recovered audio.	
		Frequency Translation and Super-Heterodyne	
		Converting a 10 MHz AM radio signal to a 250 kHz IF. The LO may use low-side or high-side tuning.	
5	Part a	What are the two possible values for f_{LO}? What are the image frequencies associated with these LO frequencies, respectively.	
5	Part b	In practice we want the IF filter to be a bandpass filter, but here we find it convenient to use the RF Board lowpass filter. Do you see any problems with doing this? Explain thoroughly.	
5	Part c	To complete the receiver build up the op-amp based envelope detector shown in Figure Superhet. Set up the filter at the output of the envelope detector to allow recovery of up 5 kHz message signals. Include a picture of your AM demod circuit. List parts used (R and C values)	
5	Part c	Initially Listen and observe to the output with a 1 kHz message signal. As you vary/tune the LO what you see and hear should be like tuning an AM radio. Confirm this behavior. Explain what is happening, if the output filter for the IF was a BPF, what will happen?	
5	Part c	Run the LTSpice simulation, supplied in the Jupyter notebook sample ZIP. The LTSpice simulation schematic is shown in Figure 25. Bring the scope data and the LTSpice data together in the Jupyter notebook.	
5	Part d	Repeat above using a music source via the external AM modulation input.	
115		Total Points	