MODULATOR/DEMODULATOR

In this lab we will first build a modulator circuit using mixers and then extend the already built circuit by adding a demodulator. The aim of this experiment is to allow the students to implement their theoretical knowledge and gain hands on experience at building a modulator and de-modulator circuit. For part three we modulate a pseudo random code that simulates random data and then view the spectrum for this random data and compare it with the spectrum obtained by modulating a square wave.

PART 1

For this part we will first implement the modulator circuit. The block diagram for this circuit is shown below.

Connect the circuit as shown in the diagram.

- Set the Agilent 33250 to generate a 1MHz sine wave with an amplitude of 300mV
- The Agilent 33120 should have a sine wave frequency of 100kHz and amplitude of 500mV.

After the circuit is connected, select the math function on the oscilloscope and obtain the spectrum of the output wave. Change the samples/second so that we have 4 Mega-samples/sec. Also center the spectrum at a 1MHz with a span of 2MHz. Obtain a plot of the spectrum and discuss the peaks that you obtain.

Now change the message signal to a square wave and obtain a spectrum for this configuration. Discuss the spectrum.

Next we go on to add the demodulator circuit to this. The spectrum is again observed on the oscilloscope and discussed.
PART 2 – Phase Modulation and Coherent Demodulation

Here we add a de-mod circuit to the above circuit. The block diagram is shown as below.

Set up the circuit as shown. The frequencies of the function generators are the same as before.

Now observe the output from the filter on the oscilloscope. Make sure that the spectrum is centered at 1MHz and has a span of 2MHz. Explain the spectrum. Now see the output in time domain. When the signal is a sine wave, then the output should be a sine wave and a square wave output for a square wave message.

For the output waveform in the time domain we see that the demodulated square wave is pulsating. To stop this, reduce the frequency of the message by a few hertz till the wave becomes steady.

In your report explain the Mod/De-mod circuit.
PART 3 – Random Data vs Source Wave

For this part we program the Agilent 33250 function generator to produce a pseudo random code comprising of approximately 15 bits. In this section we first explain how to program the function generator to produce this code and then go on with the experiment. Please make sure that for this experiment we use the ZAD-3 mixer instead of the SRA-1.

On the Agilent 33250:

- Press the arbitrary (ARB) button; this brings up some menus on the display.
- Here select “create new”
- Specify the cycle period as 300 micro-sec. This gives us a code repetition rate of 3.33 kHz.
- Select the higher limit as +50mV and the lower limit as –50mV.
- Interpolation (Interp) should be off but in case the end wave is not square we should turn it on.
- Now select edit points. Now starting with point 1, we add new points and define their times and voltages. This we are creating a wave that simulates random code.
- Based on the table below program the time and voltages into the function generator.

<table>
<thead>
<tr>
<th>Point</th>
<th>Voltage (mV)</th>
<th>@ Time (micro-sec)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-50</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>+50</td>
<td>30</td>
</tr>
<tr>
<td>3</td>
<td>-50</td>
<td>70</td>
</tr>
<tr>
<td>4</td>
<td>+50</td>
<td>80</td>
</tr>
<tr>
<td>5</td>
<td>-50</td>
<td>90</td>
</tr>
<tr>
<td>6</td>
<td>+50</td>
<td>100</td>
</tr>
<tr>
<td>7</td>
<td>-50</td>
<td>120</td>
</tr>
<tr>
<td>8</td>
<td>+50</td>
<td>140</td>
</tr>
<tr>
<td>9</td>
<td>-50</td>
<td>149.99</td>
</tr>
</tbody>
</table>

This generates a PN code of length of length 15. The bit sequence should be 00011101011001. The bit rate should be 100kHz.

Based on the table program the points in the generator. Make sure that you do not have a time conflict between two consecutive points. For example the time for point 4 cannot exceed that for point 5 even when you are setting the time for point 5. So select the appropriate digit to change.

Once entered press store/done. This stores the waveform. Now select the high Z mode for the generator and turn the output on.

View the output on the oscilloscope.
Now connect the circuit in part 1, such that the Agilent 33250 function generator is the message while the Agilent 33120 is the carrier with a frequency of 1MHz. Adjust the L and R inputs to the mixer accordingly. (You will have to reverse them compared to part 1). Now view the spectrum on the oscilloscope. Let the center frequency be 1MHz and the span is 2MHz. Sampling rate is 4 MSa/sec.

Obtain a copy for your report. Explain the spectrum. What is the interval between each null? Why? Explain why we have the nulls at these particular frequencies. How is the spectrum different from a square wave?

Replace all the equipment before you leave and clean up your work area.