

Figure 1

1. Build the circuit shown in figure 1. Use one channel of the function generator for s(t) with an amplitude of 0 to 5 volts and use the second channel of the generator for w(t). Verify that the circuit output is an amplitude-modulated series of pulses, PAM (pulse amplitude modulation). Use a duty cycle of 10% for the sampling signal pulses.

* Observe the output PAM signal with an oscilloscope. Sketch the signal.
* Display the output spectrum using the FFT of the scope. Adjust the sampling rate and FFT span of the scope to display a spectrum of DC to 25 kHz frequency range with minimum aliasing of the harmonics. Record the frequency and amplitude of each spectral line from DC to 25 KHz. You will compare your measurements to the theoretical values in your report.

|  |  |
| --- | --- |
| Frequency [kHz] | Amplitude [mV] |
| 0 | 216 |
| 2.5 | 48 |
| 5 | 42 |
| 7.5 | 210 |
| 10 | 38 |
| 12.5 | 54 |
| 15 | 200 |
| 17.5 | 52 |
| 20 | 58 |
| 22.5 | 194 |
| 25 | 64 |

* Make appropriate plots in your lab notebook. Write a brief description of what the plots indicate.
* Show that a reasonable LPF can recover w(t).

2. Decrease the sample rate of S(t) so that aliasing occurs. Change the sample rate so that you have a spectral line at 1.5 kHz and another at 2.5 kHz.

* Show that you can tell which of these two is the aliasing signal is by making small changes of the 2.5KHz signal frequency (does the frequency of the spectral line change by df or by –df).

**If you increase the frequency of w(t), the alias term will decrease in frequency.**

* Make appropriate sketches and notes in your lab notebook and show your instructor.

3. Return the pulse rate to the original value to remove the aliasing. Make your sampling pulse wider by increasing the duty cycle of S(t).

* Identify the presence of the sinc function distortion of the output spectral components.

**Increasing the pulse width decreases the null bandwidth.**

* Again show your instructor and make plots in your notebook of the time and frequency domain data.

4. Change the w(t) to a 2.4 KHz square wave to show the more complex spectrum and to see how harmonics of W(f) alias. Use dBV to see low level alias terms easier.

* Make a plot of the spectrum and identify several of the spectral components that are alias terms.
* What would the sample frequency have to be to eliminate aliasing?

**The sampling frequency would need to be at least twice the frequency of the nth harmonic.**

* What circuit could you add to the sampler to reduce the effects of aliasing?

**RC Filter.**

5. Change the w(t) to a 2.4 KHz triangular wave shape.

* Are the alias terms lower than in part 4? Explain by comparing the Fourier transform of a square wave and a triangular wave.

**Triangle wave harmonics fall off at**

* Again show your instructor and make plots in your lab notebook.