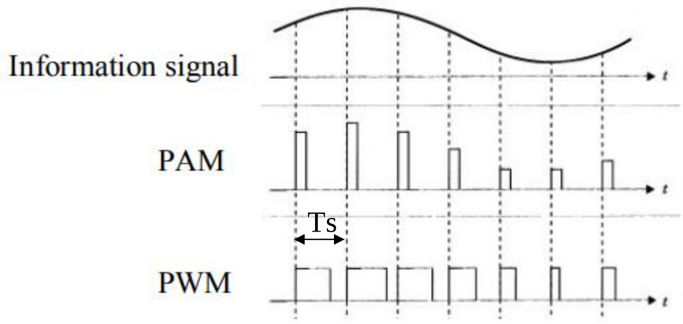
COMMUNICATIONS LAB. Experiment #7: Pulse Width Modulation / Demodulation

OBJECTIVES

Recognize pulse amplitude and pulse width modulated signals, and do simple experiments.

GENERAL INFORMATION on ADC and DAC

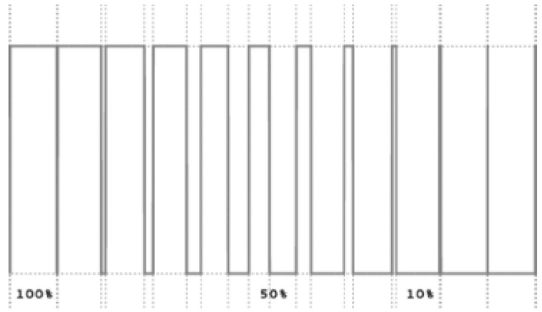
PWM (Pulse-width modulation) : The width of a periodic pulse is changed according to the instantaneous value of the information signal.
PAM (Pulse-amplitude modulation) : The information is encoded in the amplitude of periodic pulses.
For an example message signal, PWM and PAM signals are illustrated in the following figure.



Periods (shown as Ts) of both PWM and PAM are constant. However, duration of ON state in PWM is determined by the info signal, wheras it is constant in PAM. The duration of ON state in PAM is allowed to be Ts too, that is, no OFF state.
Naturally, the average value of the PWM signal within a Ts period changes by the info signal.
Duty cycle for PWM signal is defined as

$$Duty\ Cycle = \frac{ON\ Time}{Period} x\ 100\%$$

An example signal with different duty cycles is given in the following figure.



As info signal value increases, so does the duty cycle and the average value.
PWM signals can be generated by monostable multivibrator circuits and digital circuits having counters with adjustable output control comparators (or any programmable device).
Recover info signal from PWM:

- Method 1: Convert PWM to PAM and then pass PAM through a low-pass filter.
- Method 2: Use a product detector followed by a low-pass filter.
- Method 3: Just a low pass filter alone may approximate the information signal.

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<u>EXPERIMENT</u>

1. Pulse Width Modulation

a) Connect DC Supply to Vm on the PWM modulator module of the training kit.

b) Adjust Clock Frequency to 220 kHz using CLK. Then, adjust DC Supply to -5V for the message signal.

c) Observe Vm and CLK of the PWM modulator on CH1 and CH2 of the scope. Draw the result observed on the screen in your report.

d) Remove CLK from CH1 of the scope. Connect PWM output to CH1. Observe Vm and PWM outputs at same time. Measure Duty Cycle of the PWM output signal. Draw the result observed on the screen to your report and and note down your comments.
Hint: Push the "Measure" button and then use "Display All" function to measure duty cycle.

e) Adjust DC Supply to 0 V and observe Vm and PWM output on the scope. Measure Duty Cycle. Draw the result observed on the scope in your report and note down your comments.

f) Change DC Supply voltage to +5V using DC Supply potentiometer and repeat step e).

g) Calculate theorical Duty Cycle values for each input (-5 V, 0 V and +5 V) and comment about the theorical and the practical values on your report.

h) Change the clock frequency by reasonable amount using CLK and observe the change on scope. Draw the result observed in your report and and note down your comments.

i) Remove DC Supply connection from Vm. Adjust FG1 signal generator to sinusoidal 110 Hz 7 Vpp. Connect Vm input to FG1 output.

j) Observe both Vm and PWM output on the scope and draw the result in the screen to your report. Note down your comments.

k) Repeat step j) for 110 Hz and 7 Vpp triangle signal.

2. Pulse Width Demodulation

l) Connect the PWM output of the PWM modulator module to Pulse Width Demodulation input. Connect CLK of the modulator to CLK on the demodulator. Observe Vm and Vo on CH1 and CH2 of the scope for the current triangular message signal. Draw the result in your report and note down your comments.

m) Repeat step l) for the sinusoidal 50 Hz and 7 Vpp message signal.