TIME DIVISION MULTIPLEXING (TDM)

1. Objective

In this experiment, several messages are sampled and their samples are interlaced to form a composite, or Time Division Multiplexed-TDM signal.

2. General Information

By using quite short carrier pulses (small width), other sampled pulses can be placed in the gaps between the pulses of PAM (Pulse Amplitude Modulation). This process is called as Time Division Multiplexing (TDM). Therefore, more than one message signal can be carried via a single communication channel. The operational fundamentals of TDM will be examined by using the PAM, however TDM can be applied to other type of pulse modulations as well. If two messages are sampled at the same rate but at slightly different times, then two of trains of samples can be added without mutual interaction. In Figure-1.a the signal x(t) and the corresponding PAM signal are depicted. Also in Figure-1.b, TDM of two signals is shown:

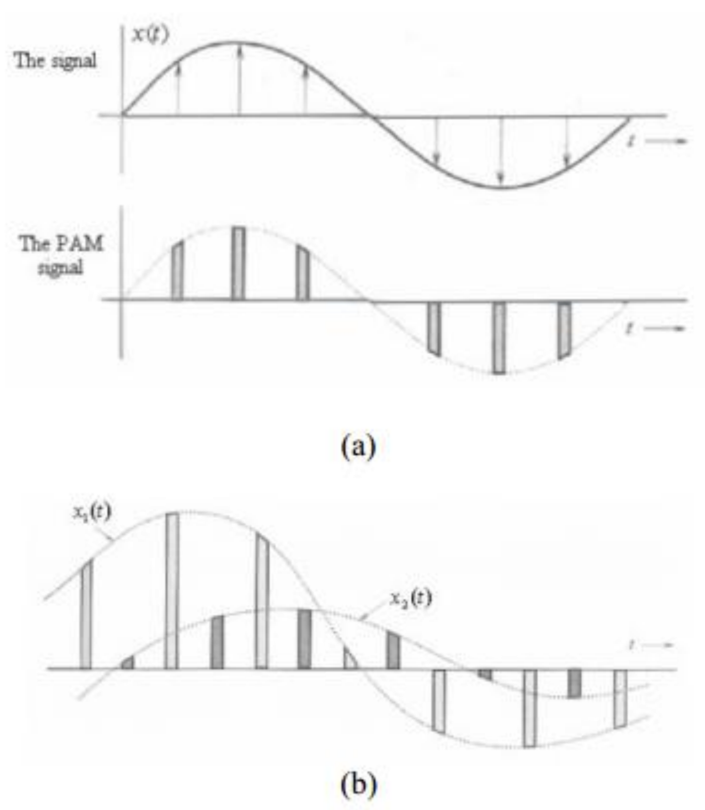

Figure 1. (a) The signal x(t) and its PAM signal
(b) TDM of two signals

The block diagram of PAM/TDM signal production is given in Figure 2 below:

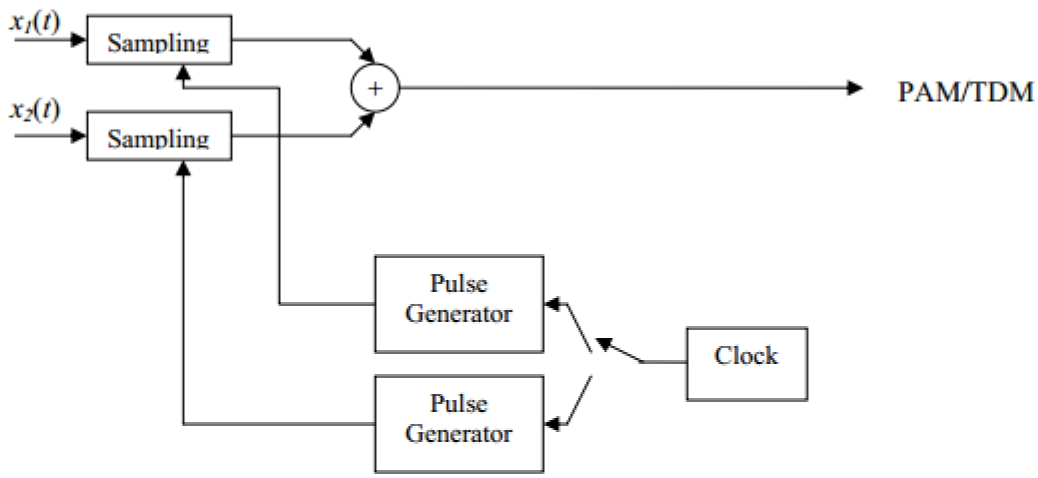

Figure 2. Production of TDM Signal

In Figure 2, if the band-widths of both signals (x1(t) and x2(t)) is 3 kHz, according to the sampling theorem each signal should be sampled with the frequency of 6 kHz. But in this case the clock frequency should be 12 kHz. The distance between the pulses is Tn=Ts/n. Here, n indicates the number of the input signals, and Ts denotes the sampling period required for one signal. The obtained TDM wave is shown in Figure 3.

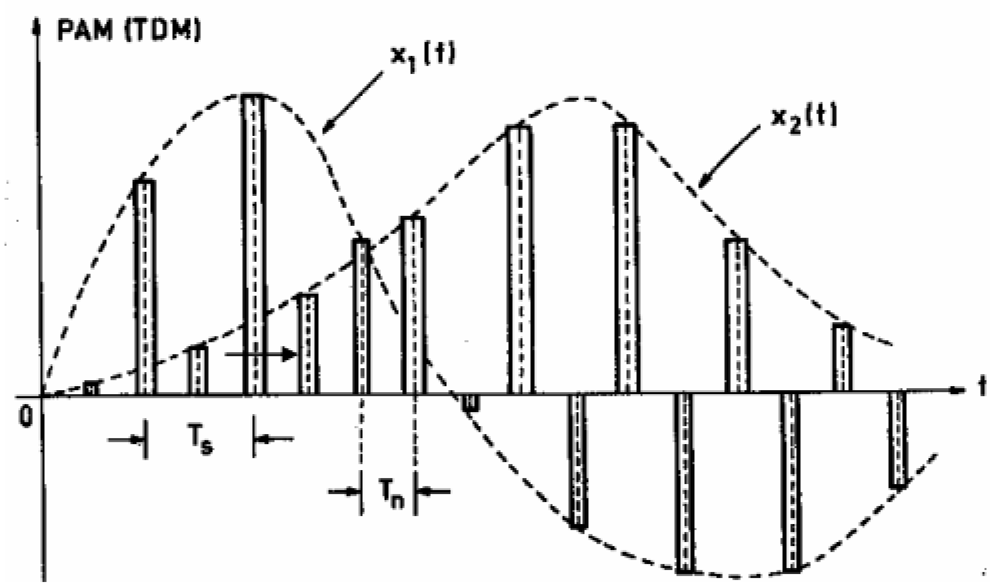

Figure 3. PAM(TDM) Wave

As considered before, if two different signals have the frequency of 3 kHz, the sampling period of each signal will be Ts=1/6000 = 166.7 µsec. Since number of input signals n=2, from Tn=Ts/n; the distance between samples becomes Tn=Ts/2 = 83.3 µsec. Therefore the minimum bandwidth to transmit these samples by TDM should be $B \geq \frac{1}{166.7*10^{-6}}$ = 6 KHz

A TDM receiver block diagram is shown in Figure 4 below. The most significant issue in recovery of input signals from TDM signals is the requirement for the proper synchronization between TDM transmitter and receiver. Therefore, the clock signal in the transmitter should be passed to the receiver correctly.

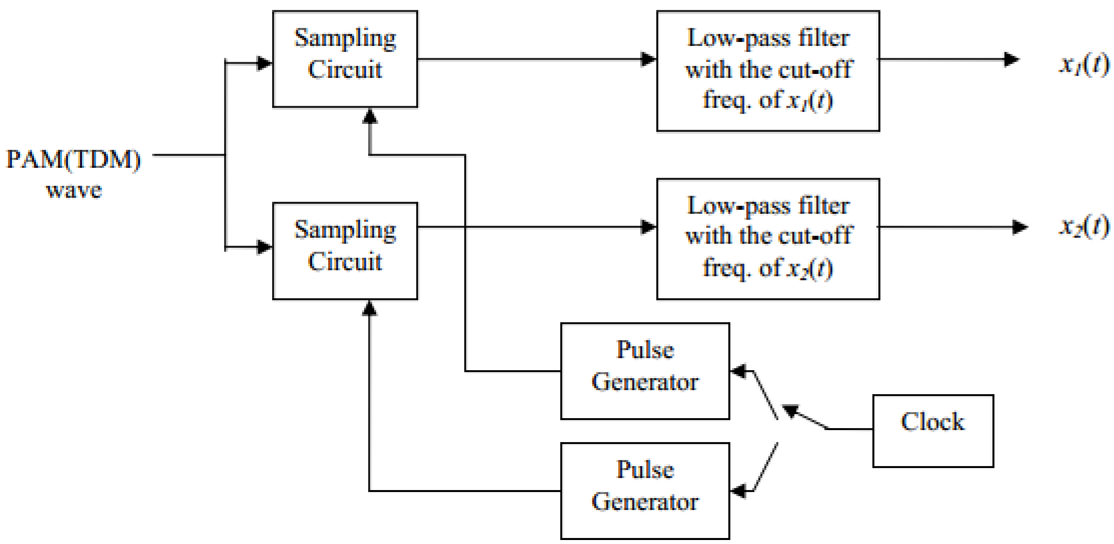

Figure 4. TDM Receiver Circuit

3. Experiment Set

- PC & LabView Software
- Elvis board

4. Experimental Procedure

- Generate two sine-wave input signals for TDM transmission. Arrange the frequencies and amplitudes of both signals to be able to be changed by user. Take the display duration T=0,1sec and the duration between each sample dT=0,0002sec.

- The sampling function for TDM modulation will be provided by the laboratory assistant as a sub-vi file. Display two input sine-wave signals and the **tdm** sb-vi output in a single waveform graph.

• The provided sub-vi will also provide the operation in Figure-4 up to the application stage of low-pass filters.

• Connect the sampled and hold outputs of the provided sub-via to appropriate low pass filters and display both of the sub-via and filter outputs in the waveform graphs individually.

• Repeat the previous step of the experiment by setting appropriate LPF circuits on the board as illustrated below figure. Pass the sub-via outputs through the filter and observe the recovered input signals.

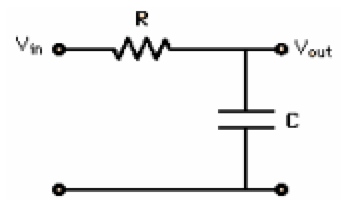

Figure 5. Low-pass filter circuit