

# EE/TE 4385

## Lab 5: PAM Transmitter

Lab Report Due: 10/4/06, 2PM,

### Pulse Amplitude Modulation: LabVIEW Implementation

#### Programming:

The following steps describe how to build a VI which implements Pulse Amplitude Modulation. Download PAM-ModulationTemplate.vi from the course website. Inspect the front panel and block diagram that has already been created for you. When this VI is completed, you will be able to see the time and eye diagram representation of the PAM signal. The following front panel represents the operation of a completed VI:

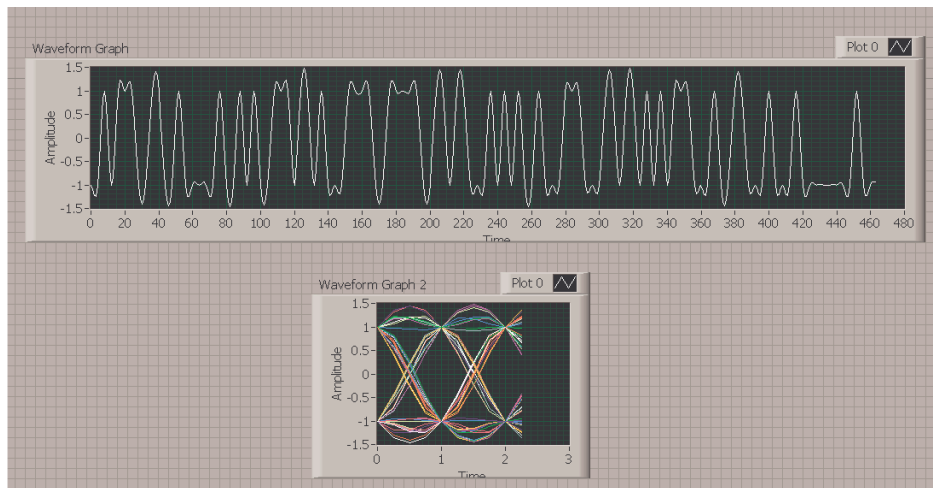


Figure 1 – Completed 2-PAM Transmitter Front Panel

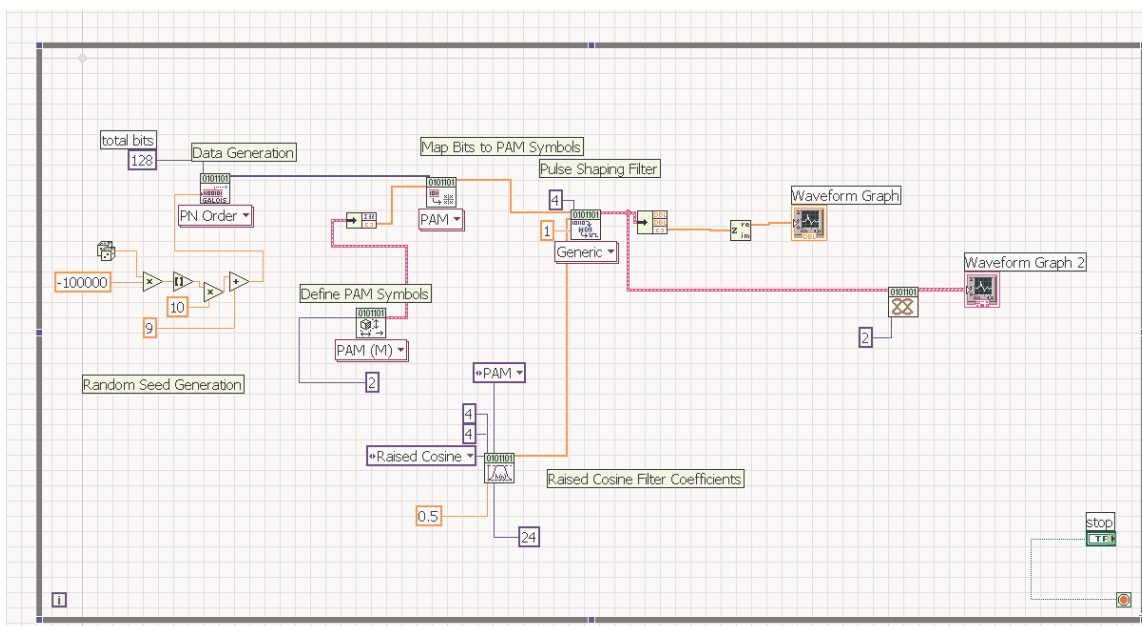


Figure 2 – 2-PAM Transmitter completed block diagram

- You need the following major VIs to complete the PAM Transmitter in LabVIEW: MT Generate Bits.vi, Map Bits to Symbols.vi, Generate System Parameters.vi, Apply Pulse Shaping Filter.vi, Generate Filter Coefficients.vi, MT Format Eye Diagram(complex).vi.
- Run you completed LabVIEW PAM Transmitter. Stop and copy your block diagram and front panels
- Change the alphapet size provided by the constant value (default is 2) wired to Generate System Parameters.vi to generate 4-PAM signal

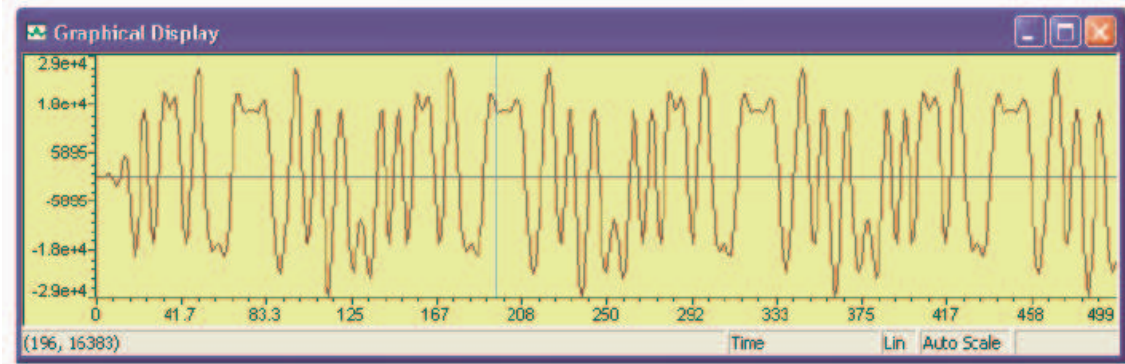
## **PAM Transmitter: C6713 DSK Implementation Using CC**

For this part of the lab, you will generate the PAM signal using C6713 DSK.

- Use your project files from the previous FIR laboratory. We will add additional functions to build the 2-PAM transmitter.
- Create a lab5 project directory under myprojects subdirectory in c:\ti folder.
- Copy your FIR project files into this directory. Make sure that your program still compiles without any problem. Keep the sampling rate 8 KHz.
- Design raised cosine FIR filter with the function 'rcosfir' in MATLAB. Use rolloff factor = 0.125, extent of the filter = 4, oversampling rate = 4 to get the FIR filter coefficients.
- `>> h = rcosfir(0.125, 4, 4)`
- You can use `stem` function in MATLAB to display filter coefficients.
- Copy pulse shaping filter coefficients into your code composer file.
- To generate your input bits randomly, you can use random integer generator function in C. You can use the following syntax to generate random 0s and 1s for your input buffer.

```
randominput=rand();
```

- These functions work together to provide pseudorandom bit generation:
  - The rand function returns pseudorandom integers in the range 0–RAND\_MAX. Transform the random integer to obtain 0 or 1, i.e., compare the generated number to RAND\_MAX/2.
- Map the bits as 0 → -1 and 1 → 1 to generate symbols 1,-1
- You need to insert three zeros between each random symbol since the pulse shape filter is designed with oversampling rate as 4. This step is sometimes called as the impulse modulation. (Hint: Use a global counter and generate a new sample at every iteration which is multiple of 4. Otherwise the output needs to 0.)
- Here, the impulse modulated random data becomes the input of the filter. You can store the filter output to an array to examine in the Graphical Display of CCStudio. The filtered output should be the same as the figure shown below.



- The output should be also sent to line out port to be observed on the oscilloscope. Eye diagram as shown below can be displayed on the oscilloscope using a triggering source at 2Khz. Connect the output of the DSP board to channel 1 of the oscilloscope. Connect function generator output at 2 KHz to channel 2 of the oscilloscope. Then slightly adjust the frequency of the function generator to synchronize both signals. Note there will be always some varying frequency offset between the signal generator and PAM signal. Eye diagram will shift on the screen due this difference. You can send the outsample in ftemp (defined as float) to DSK's serial port using the following example.

```
#define AMP 0x4000
```

```
temp = (int) ( - AMP * ftemp ); // Amplify the amplitude and cast data type.
temp = ( temp << 16 );
```

```
MCBSP_write(DSK6713_AIC23_DATAHANDLE, temp );
```

- Record the screen shots on CC graphical display and oscilloscope for your report.
- Then, apply AM modulation (mixing with sinusoidal signal at 2 KHz) to upconvert your baseband PAM signal. Now, you will not be able to observe eye diagram due to upconversion. However, you can observe FFT of the signal by applying the same output channel to the oscilloscope. You can display of FFT of the channel input by pushing math button first on oscilloscope of the panel and then selecting FFT key below the screen. Copy the screen shot of the FFT window.

