ELC 343 - PROJECT #3

This design project has the following objectives:

1. To illustrate the effects of sampling on analog data representation
2. To gain experience with a Data Acquisition System (DAS)
3. To gain experience utilizing microcontrollers in DAS applications
4. To experiment with microcontroller based instrumentation

The students will design a sampled data system and a data acquisition experiment that studies the total error associated with the conversion to digital data of an analog waveform and the recovery of the analog wave from its digital representation.

This error is a function of the sampling frequency, the number of converter bits, and the interpolation technique (staircase or linear) of the digital data. You will utilize the C Stamp microcontroller, and write appropriate software for your study.

An analog signal from an arbitrary wave generator is to be converted to digital data form and then recovered from this digital data representation. The recovered analog signal both in the time and frequency (spectrum) domain is to be displayed on an oscilloscope and hard copied and the total A/D and D/A converter error calculated.

EXPERIMENTAL RESULTS and DATA ANALYSIS:

1. Study the digital representation and reconstruction of square, triangular and sine waves.
    a. Determine the effect of changing the sampling rate upon the recovered analog signals. When does aliasing occur and what form does it take in the time domain? Display both the original and recovered analog signals on the same "graph" and record.
    b. How does the aliasing affect manifest itself in the frequency spectra of the reconstructed waves? Record the same recovered waves at sampling frequencies where aliasing exists and for which no aliasing exists.

2. Comment on the validity of the Nyquist criterion using your experimental results.
    a. Is the basic assumption that the signal be bandwidth limited necessary? Why and how do your results illustrate this?
    b. How can you ensure that your analog signal is bandwidth limited? What about an anti-aliasing filter?
3. Study the error generated by truncating the higher harmonics of periodic waves.
    a. Display the spectra of the square and triangular waves and determine their respective harmonic roll-off (Fourier Series coefficients relative sizes) as function of the harmonic order.
    b. Experimentally determine the maximum error as a function of the order of harmonic above which the spectra is truncated (by filtering) for both square and triangular waves. Check the truncation by examining spectrum of the resultant wave. Display in the time domain both the original and the truncated signal on the same graph.
4. Set the output sample rate to twice that of the input sample rate. What order of interpolation did you employ in the recovery of analog signals from their sampled, digital data points? How did you determine this? Can you illustrate this with an oscilloscope picture?

You are to:

1. Write a program in Assembly language, with appropriate comments.
2. Build the program to get a .HEX file.
3. Download the .HEX file to the development board.
4. Debug the program very carefully; include portions of the debug in your report.
5. Demonstrate that the program runs by looking at the output.
6. Demonstrate the operational program to the instructor.
7. Produce a technical report as if you were in industry.

8. The report is to include, but not limited to the following:
    a. Introduction.
    b. Discussion of results including development of any equations, detailed graphs and schematics, oscilloscope pictures, and any other component that you think helps you to explain what, why and how you did what you did.
    c. The report must be understandable to another engineer or supervisor not working on this project.
    d. A conclusion of your results and discussion of anything you found especially interesting or not expected from you work on this project.
9. This report is a group report and is due to me no later than the class period discussed in class.

REPORT FORMAT: Free form, but it must comply with the following:

a. One report per team
b. Have a cover sheet with identification: Title, Class, Your Names, etc.
c. Include all the deliverables previously mentioned.
d. COMPLETELY word-processed
e. Double spaced
f. 12 pt Times New Roman font
g. Fully justified (optional)