

Digital Signal Processing

Acknowledgements: Developed by JD Neglia, P.E., Electronics Program Director at Mesa Community College, Mesa, Arizona.

Time Required: 2 hours.

Equipment & Tools: Internet connection and web browser

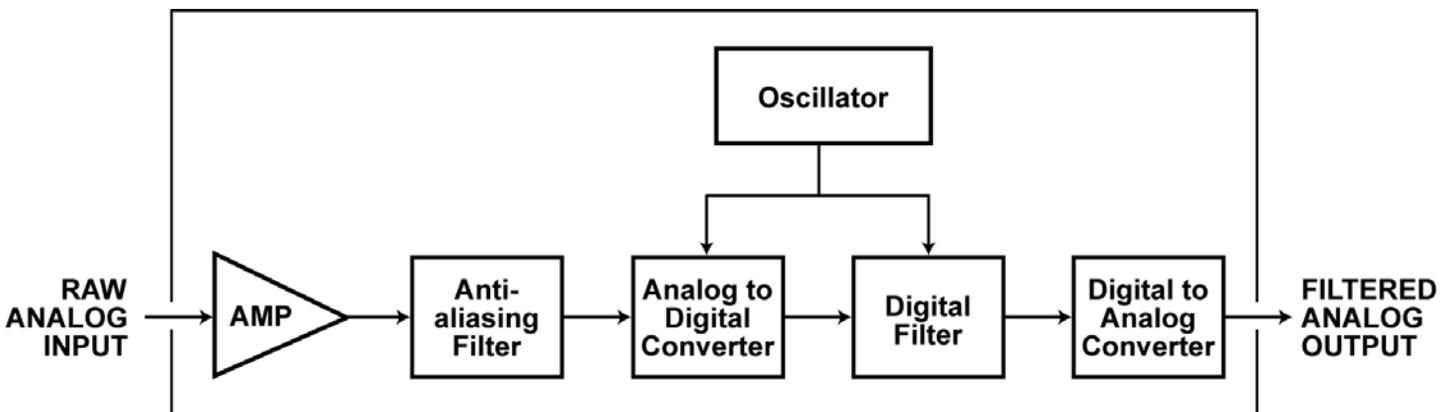
Team or Individual: This is an individual activity.

Learning Objectives

1. Describe the basic categories of digital filters and the advantages/disadvantages of each.
2. Determine the approximate cost for a typical DSP from various manufacturers.
3. Determine the target market for typical digital signal processors.
4. Describe the advantages products gain by using DSP.

Introduction

A general diagram of a typical digital signal processing system is shown below.



As shown above, a raw analog audio signal is first amplified and then filtered with an anti-aliasing filter. The resulting signal is applied to an analog-to-digital converter (ADC). The signal is then digitized and read at a sampling rate determined by the DSP chip. This yields a sequence of numbers representing the original analog signal. This digitized input signal is then processed with one of several digital filter algorithms programmed into the DSP chip. Generally, the result of the filtering operation is then converted back to analog with a digital-to-analog converter (DAC).

In many DSP systems, the circuitry is very similar to microprocessor or microcontroller hardware. The most important difference is that much more care is generally taken in the analog portions of the circuit to minimize



noise. This is necessary as most DSP chips are extremely fast logic circuits running at hundreds of megahertz which generate enormous amounts of radio frequency interference (RFI).

For simple filters, analog signal processing (ASP) circuits are much simpler to design, build, and shield effectively. Unfortunately, as filters become more complex, ASP circuits become difficult to work with, and would involve hundreds of analog components all requiring extremely tight tolerances and resistance to environmental considerations such as temperature. Additionally, some types of filters are not physically realizable with ASP circuits. The classic example is the elliptic, or “Cauer” filter. This filter comes very close to achieving the ideal but unattainable “brick wall” characteristic.

The critical feature of any DSP system is the design of the digital filter algorithm itself. Because these algorithms are implemented completely in software or firmware, it is not often that filter design issues are important from a troubleshooting perspective.

However, it is useful to know the basic categories of digital filters and the advantages and disadvantages of each. Your research in this drill-down will provide you with this knowledge.

Additionally, as an electronic technician it is helpful to know who manufactures DSP chips and where DSP chips are used. In this exercise, you will research current manufacturers of DSP chips and electronic products in which DSP techniques are used.

Performance and Task Procedures:

1. Search the web for the best summary (preferably only a page or two) of DSP theory. Look for discussions of FIR and IIR filters, and mention of classic filters such as Butterworth, Bessel, Tsebychef, new filters such as Cauer, and techniques such as windowing. Review and summarize the information you find.
2. Using a popular search engine, perform a search on “dsp simulations” or “dsp applets”. Visit the web sites that provide these (often, these will be educational institutions or hobbyists), and experiment with the simulations you find. (To get you started, one such site is currently located at <http://www.dsptutor.freeuk.com/>.)
3. Search the web for current electronic products that use DSP. This will involve searching through marketing information for technical details. Choose the three most interesting products that you find that make salient use of DSP, and describe the advantages these products gain by using DSP. You may find such items as noise cancellation headphones, noise canceling mufflers, electric guitar “effects” boxes, automotive stability control, and the like.
4. Search the web for the top 3 DSP chip manufacturers. Note that some manufacturers use slightly different terminology. Microchip Technology, Inc., for example, calls its DSPs “digital signal controllers (DSCs)”. Determine the approximate cost for a typical DSP that the company manufactures, and determine the target market (i.e. military, consumer) that the company is targeting. Although it is very difficult to obtain pricing information from manufacturer web sites, this information is easily available at electronic distributor web sites such as <http://www.digikey.com>.
5. Prepare a written report or oral report summarizing the information you found.



Deliverable: The deliverable for this assignment is either a written or oral report summarizing the results of your research.

Remember all papers must be written in your own words. Words copied exactly as they are written must be placed in quotations and referenced. Failure to do so is deemed as academic plagiarism and is a serious offense. Be sure to include a conclusion and a summary paragraph.

Grading Criteria: Your grade will be determined by your performance in the following aspects of your final report or presentation: organization, thoroughness, and relevance.