

# Work-Ready Electronics

Synchronizing Curriculum to the Rapidly Changing Workplace

**Module: Digital Signal Processing**



# Digital Signal Processing

Digital signal processing is a technique that uses digital methods to process signals. Processing a signal means manipulating it to improve it, change it, or alter it as required for some application. Some examples of processes are filtering, modulation and demodulation, mixing, spectrum analysis, compression and decompression, and many others.

In the past, most of these processes have been accomplished with analog techniques and circuits. Today, that has changed. While analog processing has not disappeared, it is slowly being replaced by digital processing in most applications. DSP is now used in almost all electronic equipment and knowledge of its operation is critical to an overall knowledge and understanding of electronics. In digital processing, the analog signal to be processed is first converted to digital then processing is done by a computer. The computer output is then converted back to analog. This module describes this process and outlines the most common applications.

# Prerequisites

The prerequisites for this module include:

- General knowledge of digital logic and techniques
- Knowledge of analog-to-digital and digital-to-analog conversion methods
- Completed or concurrently taking a course on microcomputer architecture, fundamentals, and programming
- WRE Modules (or their equivalents):
  - Data Conversion, Parts 1 and 2
  - Fourier Analysis

# What Technicians Should Know

Definition of DSP

Common DSP processes

Advantages and disadvantages of DSP

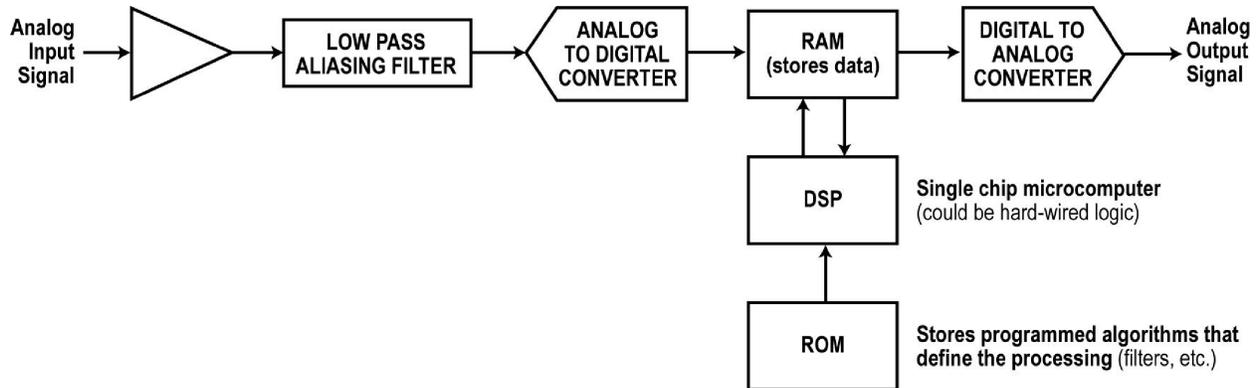
Basic techniques involved in DSP

Alternative ways DSP can be implemented

Widely used applications and products incorporating DSP

# The Concepts of DSP

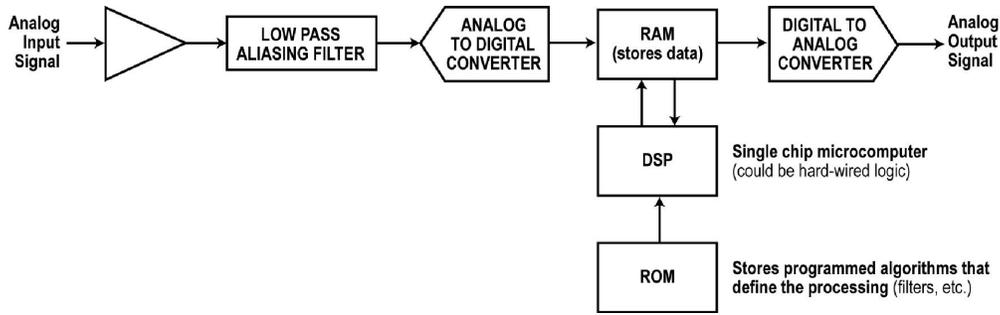
# The DSP Concept



The figure shows a general block diagram of a DSP system. The analog signal to be processed is amplified and put through a low pass filter that restricts its bandwidth to prevent aliasing in the analog-to-digital converter (ADC).

The ADC samples the analog signal at a rate at least twice the highest frequency content. The binary number samples are usually stored in a random access (read/write) memory (RAM).

# Digital Processing



These samples become the input data for a special integrated circuit (IC) microcomputer known as a digital signal processor (DSP). The DSP reads the data samples and processes them according to one or more algorithms programmed into the read-only memory (ROM). Each algorithm performs some basic processing technique such as filtering.

The processed data is then stored in RAM. It is next outputted to a digital-to-analog converter (DAC) that converts the data back into analog form. The output signal is one that you would expect to get from a comparable analog processing circuit.

# Why DSP?

Even though digital signal processing is more complicated and requires an expensive, special digital computer, there are four main reasons why it is replacing traditional analog processing techniques.

1. Compatibility with the already mostly digital world. Example include filtering or otherwise processing digital music on a CD or an MP3 player and voice on a cell phone.
2. Ability to achieve processing results that are an improvement over analog techniques. For example, filters with superior selectivity (steep output transitions or skirts) over analog filters.
3. Ability to perform processing that cannot be easily done in analog form or done at all in analog form. One example is spectrum analysis to view frequency domain.
4. Because it is possible. Low cost DSP and other chips make DSP not only affordable but often lower in cost than some analog processing circuits.

# Common DSP Processes

These are the most commonly performed signal processing functions implemented in DSP. These occur in just about every electronic application.

Filtering (low pass, high pass, band pass, and notch).

Pre-emphasis and de-emphasis

Equalization

Encoding and decoding

Compression and decompression

Spectrum analysis

Modulation and demodulation

Mixing

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Knowledge Probe 1  
The Concepts of DSP**

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