

INTRODUCTION TO DIGITAL FILTERS

Analog and digital filters

In signal processing, the function of a *filter* is to remove unwanted parts of the signal, such as random noise, or to extract useful parts of the signal, such as the components lying within a certain frequency range.

The following block diagram illustrates the basic idea.



There are two main kinds of filter, analog and digital. They are quite different in their physical makeup and in how they work.

An **analog** filter uses analog electronic circuits made up from components such as resistors, capacitors and op amps to produce the required filtering effect. Such filter circuits are widely used in such applications as noise reduction, video signal enhancement, graphic equalisers in hi-fi systems, and many other areas.

There are well-established standard techniques for designing an analog filter circuit for a given requirement. At all stages, the signal being filtered is an electrical voltage or current which is the direct analogue of the physical quantity (e.g. a sound or video signal or transducer output) involved.

A **digital** filter uses a digital processor to perform numerical calculations on sampled values of the signal. The processor may be a general-purpose computer such as a PC, or a specialised DSP (Digital Signal Processor) chip.

The analog input signal must first be sampled and digitised using an ADC (analog to digital converter). The resulting binary numbers, representing successive sampled values of the input signal, are transferred to the processor, which carries out numerical calculations on them. These calculations typically involve multiplying the input values by constants and adding the products together. If necessary, the results of these calculations, which now represent sampled values of the filtered signal, are output through a DAC (digital to analog converter) to convert the signal back to analog form.

Note that in a digital filter, the signal is represented by a sequence of numbers, rather than a voltage or current.

The following diagram shows the basic setup of such a system.



Introduction To Digital Filters

Trevor J. Terrell



Introduction To Digital Filters:

Introduction to Digital Filters Julius Orion Smith, 2008 A digital filter can be pictured as a black box that accepts a sequence of numbers and emits a new sequence of numbers In digital audio signal processing applications such number sequences usually represent sounds For example digital filters are used to implement graphic equalizers and other digital audio effects This book is a gentle introduction to digital filters including mathematical theory illustrative examples some audio applications and useful software starting points The theory treatment begins at the high school level and covers fundamental concepts in linear systems theory and digital filter analysis Various small digital filters are analyzed as examples particularly those commonly used in audio applications Matlab programming examples are emphasized for illustrating the use and development of digital filters in practice *Introduction to Digital Filters* Trevor J. Terrell, 1988-07-28 In this revised and updated edition particular attention has been paid to the practical implementations of digital filters covering such topics as microprocessors based filters single chip DSP devices computer processing of 2 dimensional signals and VLSI signal processing **Introduction to Digital Filters** Julius O. Smith, 2006 **Introduction to Digital Filters** Julius O. Smith, 2008-08-27 **An Introduction to Digital Filters** Trevor J. Terrell, 1982-04-01 **Introduction to Digital Signal Processing and Filter Design** B. A. Shenoi, 2005-11-07 A practical and accessible guide to understanding digital signal processing *Introduction to Digital Signal Processing and Filter Design* was developed and fine tuned from the author's twenty five years of experience teaching classes in digital signal processing Following a step by step approach students and professionals quickly master the fundamental concepts and applications of discrete time signals and systems as well as the synthesis of these systems to meet specifications in the time and frequency domains Striking the right balance between mathematical derivations and theory the book features Discrete time signals and systems Linear difference equations Solutions by recursive algorithms Convolution Time and frequency domain analysis Discrete Fourier series Design of FIR and IIR filters Practical methods for hardware implementation A unique feature of this book is a complete chapter on the use of a MATLAB r tool known as the FDA Filter Design and Analysis tool to investigate the effect of finite word length and different formats of quantization different realization structures and different methods for filter design This chapter contains material of practical importance that is not found in many books used in academic courses It introduces students in digital signal processing to what they need to know to design digital systems using DSP chips currently available from industry With its unique classroom tested approach *Introduction to Digital Signal Processing and Filter Design* is the ideal text for students in electrical and electronic engineering computer science and applied mathematics and an accessible introduction or refresher for engineers and scientists in the field *Introduction to Digital Filtering* R. E. Bogner, A. G. Constantinides, 1975 A Wiley Interscience publication *Introduction to Digital Signal Processing* Robert Meddins, 2000-09-05 *Introduction to Digital Signal Processing* covers the basic theory and practice of digital signal processing DSP at an introductory level As with all

volumes in the Essential Electronics Series this book retains the unique formula of minimal mathematics and straightforward explanations The author has included examples throughout of the standard software design package MATLAB and screen dumps are used widely throughout to illustrate the text Ideal for students on degree and diploma level courses in electric and electronic engineering Introduction to Digital Signal Processing contains numerous worked examples throughout as well as further problems with solutions to enable students to work both independently and in conjunction with their course Assumes only minimum knowledge of mathematics and electronics Concise and written in a straightforward and accessible style Packed with worked examples exercises and self assesment questions An Introduction to Parametric Digital Filters and Oscillators Mikhail Cherniakov,2003-09-12 Since the 1960s Digital Signal Processing DSP has been one of the most intensive fields of study in electronics However little has been produced specifically on linear non adaptive time variant digital filters The first book to be dedicated to Time Variant Filtering Provides a complete introduction to the theory and practice of one of the subclasses of time varying digital systems parametric digital filters and oscillators Presents many examples demonstrating the application of the techniques An indispensable resource for professional engineers researchers and PhD students involved in digital signal and image processing as well as postgraduate students on courses in computer electrical electronic and similar departments **Introduction to Digital Signal Processing and Filter Design** B. A. Sheno,2005-10-19 A practical and accessible guide to understanding digital signal processing Introduction to Digital Signal Processing and Filter Design was developed and fine tuned from the author s twenty five years of experience teaching classes in digital signal processing Following a step by step approach students and professionals quickly master the fundamental concepts and applications of discrete time signals and systems as well as the synthesis of these systems to meet specifications in the time and frequency domains Striking the right balance between mathematical derivations and theory the book features Discrete time signals and systems Linear difference equations Solutions by recursive algorithms Convolution Time and frequency domain analysis Discrete Fourier series Design of FIR and IIR filters Practical methods for hardware implementation A unique feature of this book is a complete chapter on the use of a MATLAB r tool known as the FDA Filter Design and Analysis tool to investigate the effect of finite word length and different formats of quantization different realization structures and different methods for filter design This chapter contains material of practical importance that is not found in many books used in academic courses It introduces students in digital signal processing to what they need to know to design digital systems using DSP chips currently available from industry With its unique classroom tested approach Introduction to Digital Signal Processing and Filter Design is the ideal text for students in electrical and electronic engineering computer science and applied mathematics and an accessible introduction or refresher for engineers and scientists in the field *Introduction to Digital Filters* A. G. Constantinides,1971 **INTRODUCTION TO DIGITAL FILTERING** ,1980 *An Introduction to Parametric Digital Filters and Oscillators* Mikhail Cherniakov,2003-07-18 Since the

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