

Filter Design Toolbox 3

Design and analyze fixed-point, adaptive, and multirate filters

The Filter Design Toolbox is a collection of tools that provide advanced techniques for designing, simulating, and analyzing digital filters. It extends the capabilities of the Signal Processing Toolbox with filter architectures and design methods for complex real-time DSP applications, including adaptive and multirate filtering.

When used with the Fixed-Point Toolbox (available separately), the Filter Design Toolbox provides functions that simplify the design of fixed-point filters and the analysis of quantization effects. When used with the Filter Design HDL Coder (also available separately), the Filter Design Toolbox lets you generate VHDL and Verilog code for fixed-point filters.

Advanced FIR and IIR Filter Design

The Filter Design Toolbox lets you design optimal FIR and IIR filters, import designed filters, quantize floating-point filters, and analyze quantization effects. You can access all toolbox functions from the Filter Design and Analysis Tool (FDATool) or from the command line.

FIR Filters

The toolbox supports the following FIR filter designs:

Advanced equiripple FIR filters, including minimum-order, constrained-ripple, minimum-phase, adjacent bands, single-point bands, independent approximation errors, extra-ripple, and maximal-ripple designs

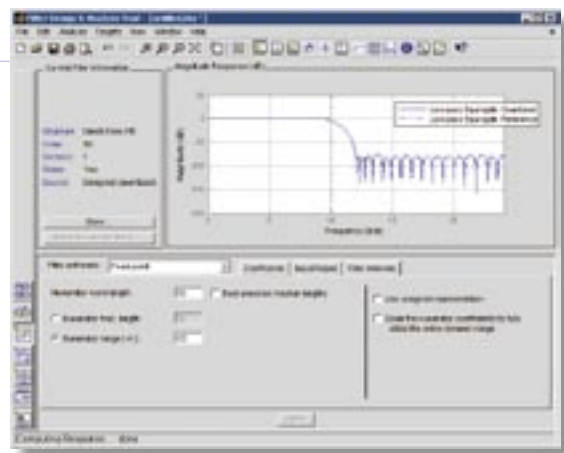
Least Pth-norm FIR filters, providing optimal nonlinear phase designs that can minimize any norm from 2 (minimum error energy) to infinity (minimax/equiripple error)

Halfband FIR filters, including equiripple, least-squares, and window methods

Nyquist (Lth-band) filters, providing linear phase and minimum-phase designs, as well as equiripple, sloped-stopband, and window methods

KEY FEATURES

- Advanced FIR filter design methods, including minimum-order, minimum-phase, halfband, and interpolated FIR
- Perfect reconstruction and two-channel FIR filter bank design
- Advanced IIR design methods, including arbitrary magnitude, group-delay equalizers, and comb filters
- Analysis and implementation of digital filters in single-precision floating-point and fixed-point arithmetic
- Support for IIR filters implemented in second-order sections, including design, scaling, and section reordering
- Round-off noise analysis for filters implemented in single-precision floating point or fixed point
- FIR and IIR filter transformations, including lowpass to lowpass, lowpass to highpass, and lowpass to multiband
- Adaptive filter design, analysis, and implementation, including LMS, RLS-based, lattice-based, frequency-domain, fast transversal, and affine projection
- Multirate filter design, analysis, and implementation, including cascaded integrator-comb (CIC) fixed-point multirate filters
- VHDL and Verilog code generation for fixed-point filters



Magnitude response of a quantized FIR filter, compared to the nonquantized filter. The Filter Design Toolbox lets you design filters, import existing filters, and analyze quantization effects on your designs.

A CIC interpolation filter, created in the multirate filter design panel of FDA Tool.



Interpolated FIR (IFIR) filters, enabling you to design filters with narrow transition bands using a reduced number of multipliers

FIR filters for perfect reconstruction and two-channel filter banks

IIR Filters

The toolbox supports the following IIR filter designs:

Allpass IIR filter with arbitrary group delay, enabling you to equalize the group delays of other IIR filters to obtain an approximate linear phase passband response

Least Pth-norm IIR filters, enabling the design of arbitrary magnitude optimal IIR filters in addition to lowpass, highpass, bandpass, and bandstop designs

Constrained least Pth-norm IIR filters, constraining the maximum radius of the filter poles to improve robustness to quantization effects

Peak, notch, and comb filters, to eliminate single-tone and periodic interference

Analysis and Implementation of Fixed-Point and Single-Precision Floating-Point Filters

When used with the Fixed-Point Toolbox, the Filter Design Toolbox offers bit-true, fixed-point implementation of digital filters using more than 15 structures, including FIR, IIR (SOS and non-SOS), and lattice-based filters. Word lengths for different quantities, such as coefficients, products, and accumulators, can be set to arbitrary values. Full-precision modes are available to simulate the non-loss of bits.

The Filter Design Toolbox provides analysis tools for fixed-point filters, including magnitude response, impulse response, pole/zero plots, and round-off-noise. The toolbox supports the implementation and analysis of single-precision floating-point filters for the same filter structures as for fixed-point arithmetic.

Implementation of IIR Filters in Second-Order Sections

The toolbox lets you design IIR filters directly in second-order section (SOS) form. SOS designs eliminate round-off problems when converting from transfer functions or pole-zero representations. The toolbox provides scaling of SOS filters in any of the four direct forms to maximize the performance of these filters when implemented in fixed point. The toolbox also provides enhanced filter analysis methods specific to SOS filters.

Design, Analysis, and Implementation of Adaptive and Multirate Filters

Full support is provided for the design of advanced filters. You can develop adaptive and multirate filters to stringent specifications and apply the filter to data, minimizing errors between the filter output and the desired signal.

Adaptive Filters

The Filter Design Toolbox provides the following techniques for adaptive filters: LMS-based, RLS-based, affine projection, fast transversal, frequency-domain, and lattice-based.

The toolbox also includes algorithms for the analysis of these filters, including tracking of coefficients, learning curves, and convergence.

Multirate Filters

The Filter Design Toolbox supports the analysis, design, and implementation of multirate filters. It includes functions for designing polyphase interpolators, decimators, and sample-rate converters; CIC multirate filters, and multistage multirate filters.

Specialized analysis functions for polyphase filters are also available.

Required Products

MATLAB®

Signal Processing Toolbox

Related Products

Signal Processing Blockset. Design and simulate signal processing systems and devices

Simulink Fixed Point. Design and simulate fixed-point systems

For more information on related products, visit www.mathworks.com/products/filterdesign

Platform and System Requirements

For platform and system requirements, visit www.mathworks.com/products/filterdesign ■

For demos, application examples, tutorials, user stories, and pricing:

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