ADVANCED SOLUTIONS NEDERLAND

ASN Filter Designer

Intuitive IIR and FIR digital filter design

Digital filter design CAD tooling: The story so far ...

Filter design software CAD (computer aided design) packages date back to the 1970s, and nearly 50 years on the market has broad offering of both commercial and non-commercial tools with varying degrees of sophistication and user friendliness.

Many commercial tools for digital filter design have been designed for expert developers, presenting the user with an overwhelming number of choices and options in order to cover every possible scenario, which can lead to a high degree of frustration.

Although several commercial tools do a decent job of undertaking the design, extra tooling/resources are generally required in order to complete all of the tasks needed, and the learning curve is generally high, requiring many to undertake the 'annoying' route of studying the user's guide in depth.

Experience has shown that this advanced functionality, while useful for special cases, generally degrades the intuitiveness of the tool by requiring users to use their expert knowledge in order to proceed.

A new paradigm in digital filter design

Our offering combines intuitiveness and practicality into one easy to use financially viable Windows application tool allowing you to complete your task of designing, analysing, implementing, verifying and finally documenting and deploying your design in 3 simple steps.

- Design & Analysis
- Implementation & Verification
- Documentation & Deployment

The tool provides engineers, lecturers, researchers, students and hobbyists with everything required in order to design, experiment, implement and then evaluate complex IIR and FIR digital filter designs with no prior mathematical knowledge of filter design.

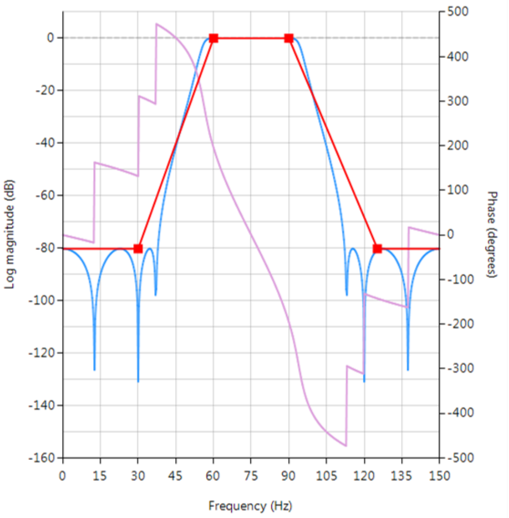
By abandoning the traditional paradigm of manually inputting parameters into text boxes, clicking on a 'design button' and waiting a few seconds for the result, we offer a fully interactive graphical way of successfully designing and customising any type of IIR or FIR filter to your requirements.

Go on, try it today for free!

From concept through to deployment in 3 simple steps

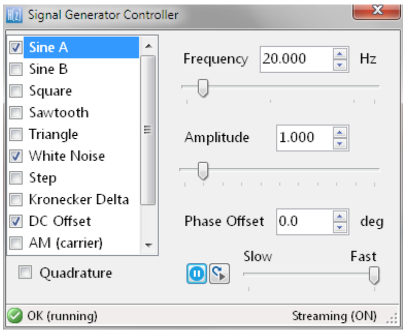
Design and analyse a filter for your application

- Classic designs: graphically specify your requirements, and let the tool establish the necessary technical specifications for both IIR and FIR type filters.
- Bespoke designs: enter your specifications as simple symbolic mathematical expressions, and interactively experiment with the settings.
- Perform detailed time and frequency domain analysis.
- Fine tune any design to your requirements with the pole-zero editor.



Implement and verify the design

- Validate the filter's real-time performance on audio files, third party data or any of the standard built-in signals via the signal generator and see/hear the effects in real-time.
- Experiment with various quantisation settings.
- Verify that your implemented filter matches your designed filter via the transfer function estimation feature.
- Quickly assess the filter's dynamic performance by adjusting the signal generator settings.



☑ Sine A
☐ Sine B
☐ Square
☐ Sawtooth
☐ Triangle
☑ White Noise
☐ Step
☐ Kronecker Delta
☑ DC Offset
☐ AM (carrier)
☐ Quadrature

Frequency 20.000 Hz

Amplitude 1.000

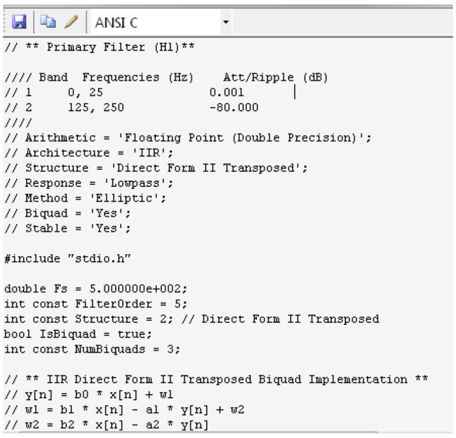
Phase Offset 0.0 deg

OK (running)

Streaming (ON)

Document your design and deploy

- Detailed filter summary report available for all designs.
- Export charts to Microsoft Word or any other DTP application for producing professionally looking reports.
- Export filter coefficients to supported third party applications for implementation or further analysis.
- Use the freely provided detailed examples as a third party implementation framework.



```
// ** Primary Filter (H1)**

//// Band  Frequencies (Hz)    Att/Ripple (dB)
// 1     0, 25               0.001
// 2     125, 250            -80.000
////
// Arithmetic = 'Floating Point (Double Precision)';
// Architecture = 'IIR';
// Structure = 'Direct Form II Transposed';
// Response = 'Lowpass';
// Method = 'Elliptic';
// Biquad = 'Yes';
// Stable = 'Yes';

#include "stdio.h"

double Fs = 5.000000e+002;
int const FilterOrder = 5;
int const Structure = 2; // Direct Form II Transposed
bool IsBiquad = true;
int const NumBiquads = 3;

// ** IIR Direct Form II Transposed Biquad Implementation **
// y[n] = b0 * x[n] + w1
// w1 = b1 * x[n] - a1 * y[n] + w2
// w2 = b2 * x[n] - a2 * y[n]
```

Complete filter design toolkit for scientists and engineers

ASN filter designer provides design engineers and scientists with a complete filter design toolkit, covering all aspects from specification, design and analysis through to implementation, design verification, documentation and deployment. The tool's versatility is extended by virtue of symbolic math scripting language, allowing for experimentation with even the most complex of filtering equations.

Quantisation analysis allows for the quick and painless evaluation of the designed filter in the signal analyser, allowing designers to experiment with nudging pole-zero positions, and experimenting with different FWL (finite word length) configurations and filter structures. The quantised coefficients may then be deployed to the embedded application in just a few mouse clicks!

Classroom companion

ASN filter designer is an ideal companion for the classroom, providing both lecturers and students with a powerful learning platform suitable for many international Bachelors and Masters programmes in Electrical Engineering and Applied Sciences.

The supporting user guide and application notes provide many practical examples, which can easily be integrated into tutorial exercises or classroom examples.

A low cost student (educational) version of the designer is available, allowing students to experiment with the classroom examples at home or in study groups at their own pace.

Hobbyists

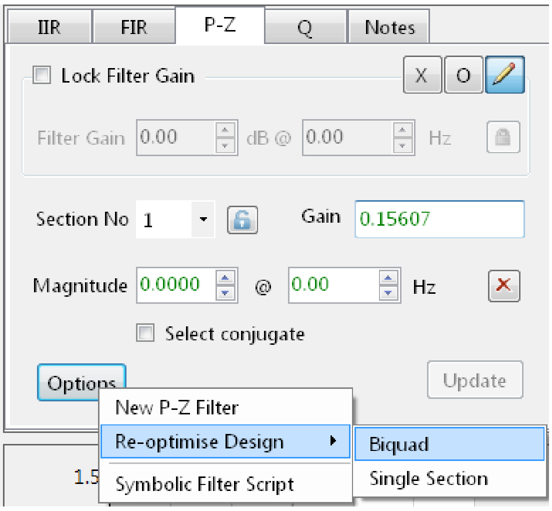
In order to let everybody take advantage of the ASN filter designer's functionality, a low cost educational version of the designer is available for non-commercial use, allowing hobbyists to utilise the power of the tool for their home projects.

IIR filter design

ASN filter designer offers the designer two options for IIR (infinite impulse response) filter design. The first, classical IIR filter design techniques, supports Lowpass, Highpass, Bandpass and Bandstop design with the following prototypes:

- Butterworth
- Chebyshev Type I
- Chebyshev Type II
- Elliptic

Where, filter orders of up to 100 (professional version only) may be constructed. The second option, utilises the power of the P-Z editor and extends upon the classical design methods, by allowing designers to modify or create a new filter by editing, adding or deleting any poles or zeros. The comprehensive editor options allow for the design and customisation of any combination of poles and zeros, including the re-optimisation of the filter structure for implementation.


☐ Lock Filter Gain

Filter Gain 0.00 dB @ 0.00 Hz

Section No 1 Gain 0.15607

Magnitude 0.0000 @ 0.00 Hz

☐ Select conjugate

FIR filter design

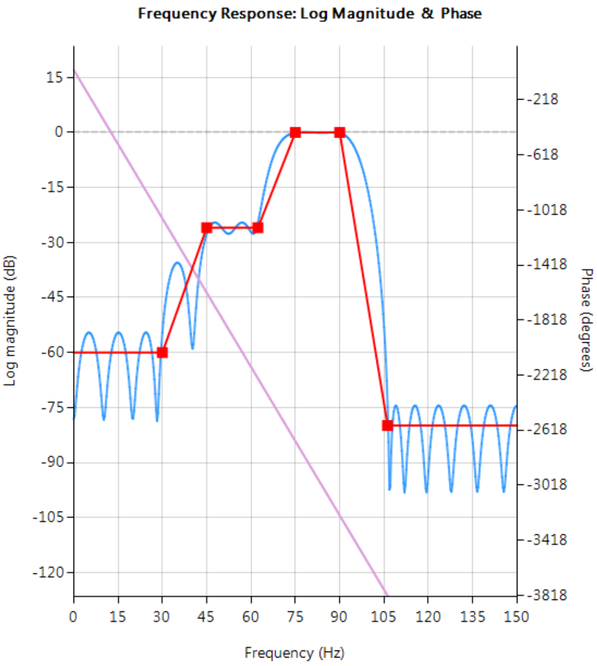
FIR (finite impulse response) filter design is implemented via the Parks-McClellan algorithm, and allows for the design of the following filter types:

- Lowpass
- Highpass
- Bandpass
- Bandstop
- Multiband
- Hilbert transformer
- Differentiator

Where, filter orders of up to 500 (professional version only) may be constructed.

The Parks-McClellan algorithm offers a degree of flexibility over the IIR design types, in that the each band may be individually customised in order to suit the designer's requirements.

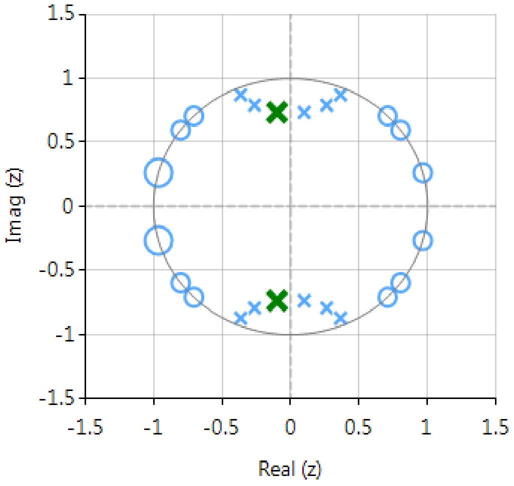
As with the IIR filters, an FIR's zeros may be modified by the P-Z editor, including the ability of adding poles and converting it into an IIR filter.



P-Z chart editor

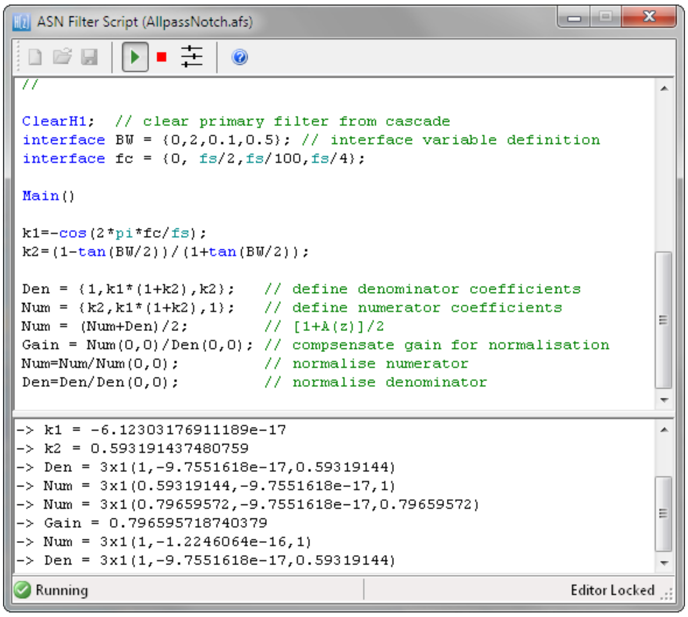
The P-Z chart editor is part of the P-Z Editor and is a fully interactive pole-zero editor allowing designers to zoom, pan and graphically fine-tune designs to their exact requirements. The corresponding frequency response is updated in real-time allowing for instant evaluation of the new pole-zero positions.

The latter is especially useful for the classroom, whereby a lecturer can explain to students the effect of the pole-zeros on the net frequency response.



Symbolic math filter script

The P-Z editor provides designers with a powerful symbolic math scripting language. The scripting language offers the unique and powerful ability to modify parameters on the fly with the so called *interface variables*, allowing for real-time updates of the resulting frequency response. This has the advantage of allowing the designer to see how the coefficients of the symbolic transfer function expression affect the frequency response and the filter's time domain dynamic performance.

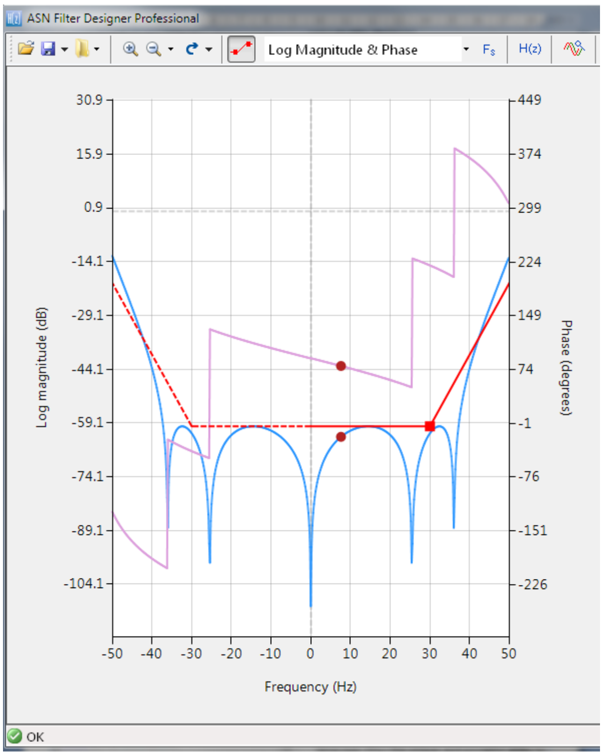


```
//

ClearH1;  // clear primary filter from cascade
interface BW = {0,2,0.1,0.5}; // interface variable definition
interface fc = {0, fs/2,fs/100,fs/4};

Main()

k1=-cos(2*pi*fc/fs);
k2=(1-tan(BW/2))/(1+tan(BW/2));

Den = {1,k1*(1+k2),k2};   // define denominator coefficients
Num = {k2,k1*(1+k2),1};   // define numerator coefficients
Num = (Num+Den)/2;        // [1+A(z)]/2
Gain = Num(0,0)/Den(0,0); // compsensate gain for normalisation
Num=Num/Num(0,0);         // normalise numerator
Den=Den/Den(0,0);         // normalise denominator
```

```
-> k1 = -6.12303176911189e-17
-> k2 = 0.593191437480759
-> Den = 3x1(1,-9.7551618e-17,0.59319144)
-> Num = 3x1(0.59319144,-9.7551618e-17,1)
-> Num = 3x1(0.79659572,-9.7551618e-17,0.79659572)
-> Gain = 0.796595718740379
-> Num = 3x1(1,-1.2246064e-16,1)
-> Den = 3x1(1,-9.7551618e-17,0.59319144)
```

The scripting language supports over 40 scientific commands and provides designers with a familiar and powerful programming language, while at the same time allowing them to implement complex symbolic mathematical expressions for their filtering applications. Several detailed practical examples are also provided with the software bundle, allowing designers to get quickly up to speed with scripting language and writing their own application scripts.

Advanced data analysis



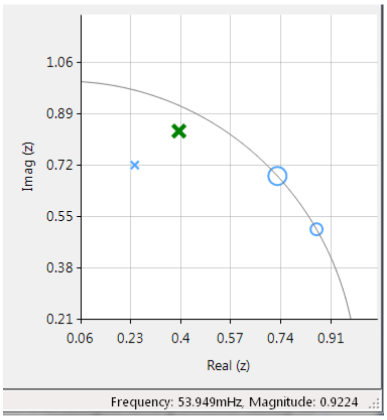
ASN Filter Designer Professional

Log Magnitude & Phase

OK

State-of-the-art algorithms and highly optimised DSP libraries allow for panning and zooming the frequency response chart in real-time with the mouse.

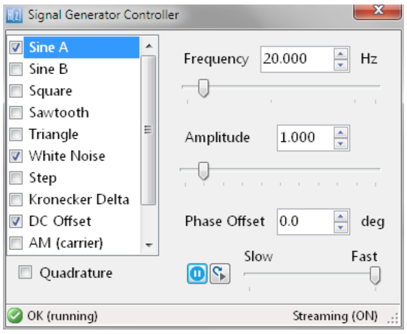
The advanced zooming feature allows designers to quickly and simply obtain detailed frequency response information even when the sampling frequency is several hundred MHz via a specialized implementation of the Discrete Fourier Transform. Depending on the selected frequency range, this can be as detailed to a fraction of a Hertz!



Frequency: 53.949mHz, Magnitude: 0.9224

The zooming and panning feature is also available in the pole-zero chart, allowing designers to easily fine tune the pole-zero positions with the mouse and see the effects in real-time on the frequency response chart.

Signal analyser



Signal Generator Controller

☑ Sine A
☐ Sine B
☐ Square
☐ Sawtooth
☐ Triangle
☑ White Noise
☐ Step
☐ Kronecker Delta
☑ DC Offset
☐ AM (carrier)

☐ Quadrature

Frequency 20.000 Hz

Amplitude 1.000

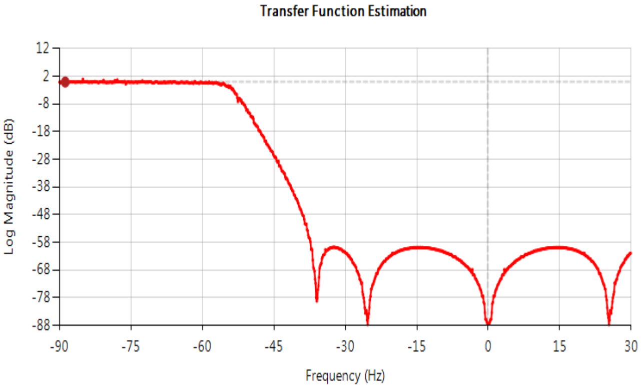
Phase Offset 0.0 deg

Slow Fast

OK (running) Streaming (ON)

The signal analyser allows designers to test their design on audio, real (user) data or synthetic data via the built-in signal generator. Default data playback is implemented as streaming data, providing a simple way of assessing the filter's dynamic performance, which is especially useful for fixed point implementations.

Both frequency domain and time domain charts are fully supported, allowing for design verification via transfer function estimation using the cross and power spectral density functions. As with all other charts, the signal analyser chart fully supports advanced zooming and panning, as well as comprehensive chart data file export options.

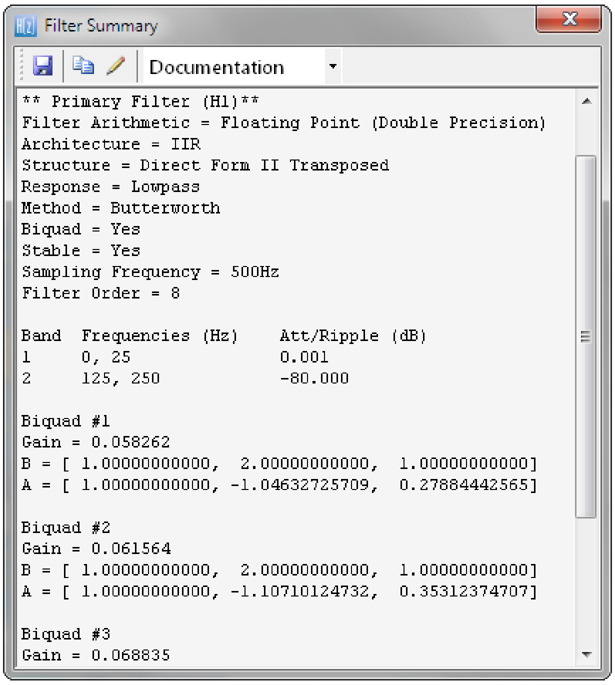


Filter summary and data export

The filter summary presents the designer with a detailed summary of the filter coefficients and technical specifications used for the design. These details may be exported to third party applications, such as Matlab for further analysis. Supported formats are:

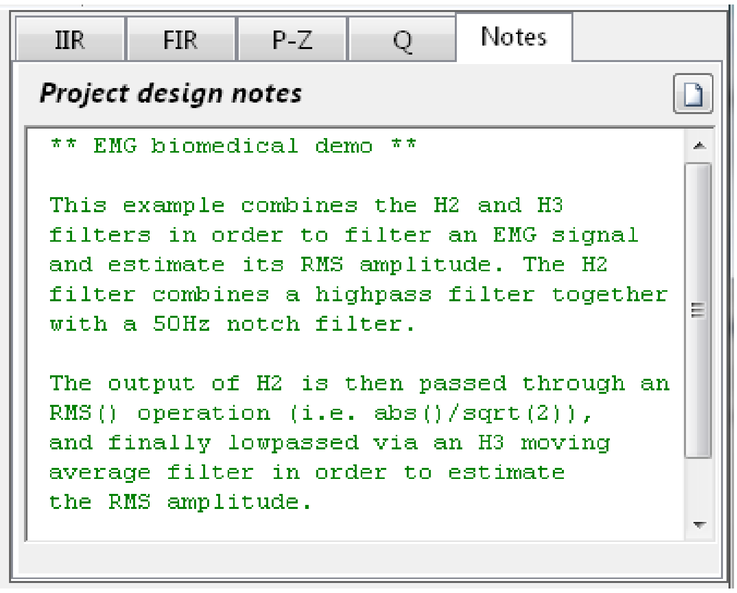
- Documentation
- Matlab/Octave
- Scilab
- ANSI C

The documentation view is the standard view. The ANSI C option is especially useful for fixed point implementation, whereby the tool produces a C header file for direct use in your application. Due to the flexibility of the data formats, developers may easily edit the files for use with other third party applications, such as LabView, Excel etc. Import scripts for both Matlab and Scilab are shipped with the designer in order to expedite further analysis in those domains.



```
** Primary Filter (H1)**
Filter Arithmetic = Floating Point (Double Precision)
Architecture = IIR
Structure = Direct Form II Transposed
Response = Lowpass
Method = Butterworth
Biquad = Yes
Stable = Yes
Sampling Frequency = 500Hz
Filter Order = 8

Band  Frequencies (Hz)    Att/Ripple (dB)
1     0, 25               0.001
2     125, 250            -80.000

Biquad #1
Gain = 0.058262
B = [ 1.00000000000,  2.00000000000,  1.00000000000]
A = [ 1.00000000000, -1.04632725709,  0.27884442565]

Biquad #2
Gain = 0.061564
B = [ 1.00000000000,  2.00000000000,  1.00000000000]
A = [ 1.00000000000, -1.10710124732,  0.35312374707]

Biquad #3
Gain = 0.068835
```

Project design notes



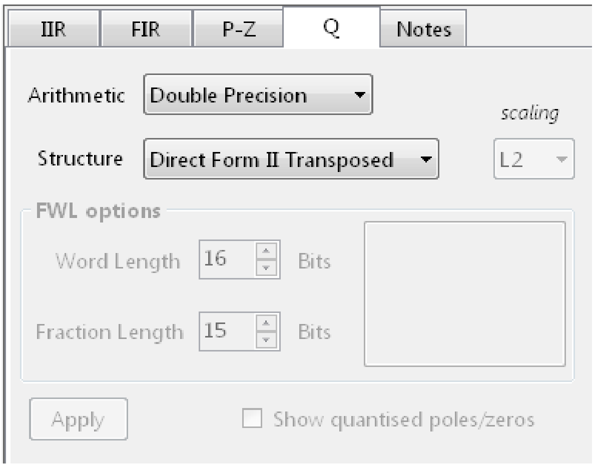
```
** EMG biomedical demo **

This example combines the H2 and H3
filters in order to filter an EMG signal
and estimate its RMS amplitude. The H2
filter combines a highpass filter together
with a 50Hz notch filter.

The output of H2 is then passed through an
RMS() operation (i.e. abs()/sqrt(2)),
and finally lowpassed via an H3 moving
average filter in order to estimate
the RMS amplitude.
```

Keep track of any important design decisions or filter parameters with project design notes. Alternatively, provide colleagues or students with a quick and simple project summary.

Enter website hyperlinks to help colleagues with background information.

Filter structures

Experiment with commonly used filter structures and quickly assess your design's performance with different structures and quantisation settings.



Arithmetic: Double Precision

Structure: Direct Form II Transposed

scaling: L2

FWL options

Word Length 16 Bits

Fraction Length 15 Bits

□ Show quantised poles/zeros

IIR structures:

- Direct Form I
- Direct Form II
- Direct Form II Transposed (default)

FIR structures:

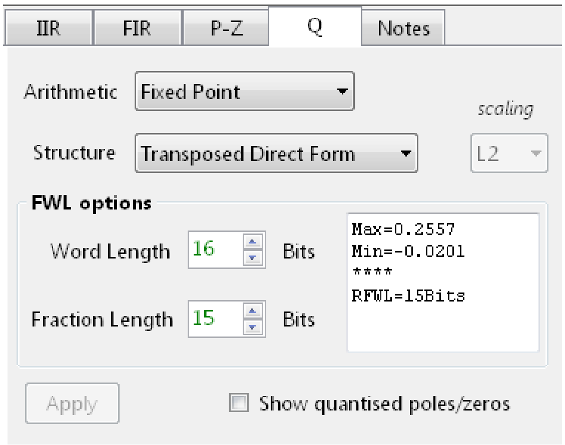
- Direct Form
- Transposed Direct Form (default)

Quantisation

ASN filter designer offers the designer three filter quantisation options:

- Double precision (default)
- Single precision
- Fixed point

Fixed point designs between 8-32 bits may be designed and evaluated. The tool advises the designer about the best choice of fractional word length for the chosen word length, by automatically analysing the filter coefficients. A quantised filter may then be verified in the signal analyser and then finally deployed to the embedded application in just a few mouse clicks!



Arithmetic: Fixed Point

Structure: Transposed Direct Form

scaling: L2

FWL options

Word Length 16 Bits

Fraction Length 15 Bits

```
Max=0.2557
Min=-0.0201
****
RFWL=15Bits
```

□ Show quantised poles/zeros

Product highlights

- Extremely easy to use
- Graphical design rules
- No complicated mathematics
- Real-time frequency response update
- Comprehensive zooming and panning
- IIR and FIR filter design
- Advanced Pole-Zero editor
- Scripting language for advanced users
- Detailed quantisation analysis
- Detailed filter summary
- Data export: Matlab, Scilab, ANSI C
- Advanced signal analyser
- Audio and user data playback streaming
- Windows XP (SP 3), Windows Vista, Windows 7, Windows 8 and Windows 10

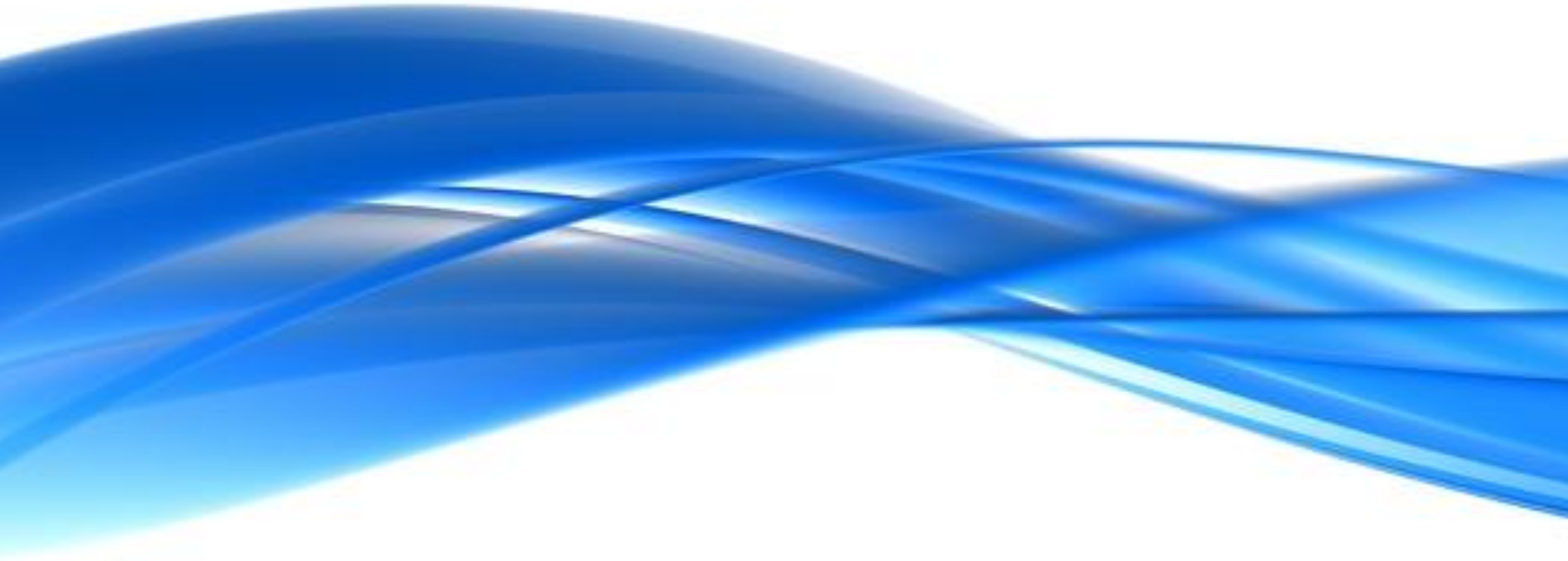
Licensing models

Licence type	**Demo**	**Educational**	**Professional**
Max IIR filter order (*design method*)	6	20	100
Max FIR filter order (*design method*)	64	200	499
Max num poles/zeros (*design method + script*)	100	200	499
FIR Multiband	4 bands	5 bands	8 bands
Save project		✓	✓
Save analyser data		✓	✓
Export charts		✓	✓
Max interface variables	3	10	20
Licence	non-commercial use	non-commercial use	commercial use

- All licences are perpetual licences.

Contact us

For more information about licensing and arranging a free trial, please contact us at **support@advsolned.com** or visit us at **www.advsolned.com**.



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