Advanced QEDesign Series

Sample Rate Conversion System II

Momentum Data Systems

Background

The process of converting the sampling rate of a signal from one rate to another is called *sampling rate conversion.* Sampling rate conversion is encountered in many application areas such as:

- Communications systems
- Speech Processing
- Digital Audio
- Antenna Systems
- Radar Systems
- Aerospace

Sampling rates may be changed upward or downward. Increasing the sampling rate is called interpolation and decreasing the sampling rate is called decimation.

Reducing the sampling rate by a factor of M is achieved by discarding every M-1 samples or equivalently keeping every M'th sample. However, to avoid aliasing of frequencies above the output frequency / 2 requires lowpass filtering the incoming signal prior to discarding every M-1 samples.

Increasing the sampling rate by a factor of L(interpolation by factor L) is achieved by inserting L-1 zeros into the output stream after every sample from the input stream of samples. However, to prevent imaging in the frequency band above the original Nyquist frequency, an anti-imaging lowpass filter is required on the final output data sequence.

This system allows creating sample rate conversion for following cases

Decimation by a factor of M

Interpolation by a factor of L

Sample rate conversion by a rational factor of L/M.

Sample rate conversion by L/M requires performing an interpolation to sampling rate which is divisible by both L and M. The final output is then achieved by decimating by a factor of M. Appropriate lowpass filtering is required to prevent both imaging and aliasing

This system employs the polyphase, multi-stage technique in the process of the sampling rate conversion for computational savings.

This system is a companion system to the *Multirate Filter Design System.* Both systems use similar techniques to achieve their goals. In this system the goal is to change the sampling with filtering, decimation and interpolation being used to attain that goal whereas in the *Multirate Filter Design* the input and output sampling rates are the same and sample rate changes are used only to achieve computational efficiencies.

The Sample Rate Conversion Design system provides fully automated design of multi-stage polyphase filters which are required to achieve the change of sampling rate. This eliminates the tedious and difficult process of specifying and computing a multi-stage Sample Rate Conversion design.

Constructing a multi-stage polyphase filter manually is a time-consuming process with a high risk of error. The system provides complete C Code generation for the decimation, interpolation amd filtering thus making the implementation of the sample rate change a relatively simple task.

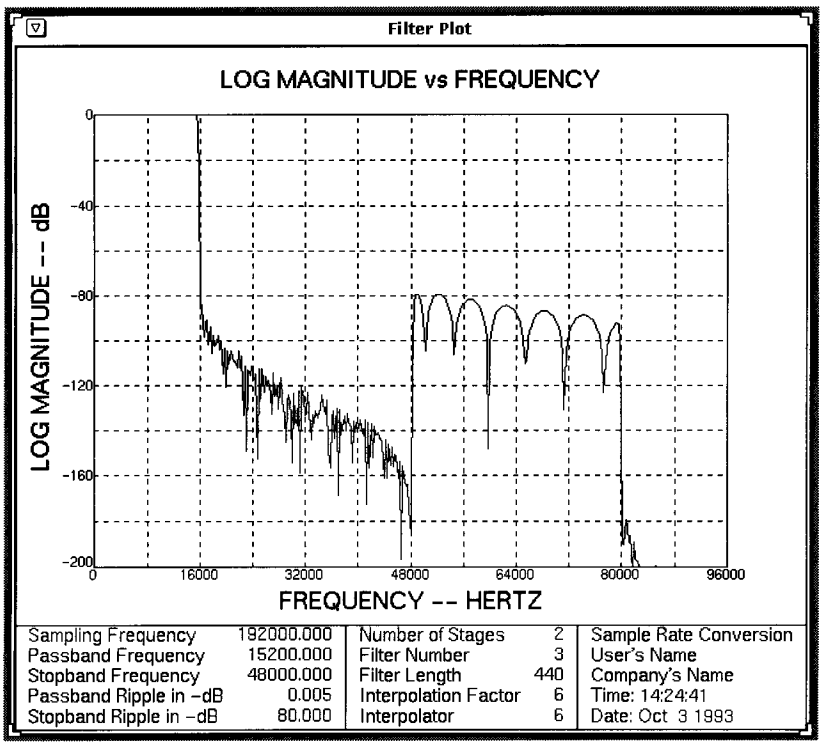
The sample rate coefficient files can be imported directly into DSPworks to change the sampling rate of any desired signal.

System Features

- Analysis of possible interpolator structures
- Analysis of possible decimator structures
- Analysis of multistage options for each decimation or interpolation factor
- Calculates computational requirements for multistage structures
- Recommended multirate structure including number of stages
- Automatic generation of all filter specifications
- Automatically calls Parks-McClellan design algorithm or window design method for each filter design
- C Code generation for sample rate conversion with multistage polyphase filters
- Significant time savings in the design of sample rate conversions
- Interfaces to DSPworks
- Optional comb filter design in multistage implementations
- Optional half-band filters in multistage implementations

Design Methods

- Parks-McClellan
- Rectangular Window
- Triangular Window
- 3 Term Cosine with Continuous 3rd Derivative Window
- Hamming Window
- 4 Term Cosine with Continuous 5th Derivative
- Blackman Window
- Exact Blackman Window
- 3 Term Cosine Window
- Hanning Window
- Minimum 3 Term Cosine Window
- 4 Term Cosine Window
- Taylor Window
- Minimum 4 Term Cosine Window
- Gaussian Window
- Harris Flat Top Window
- Good 4 Term Blackman Harris Window
- Kaiser Window
- Dolph-Tschebyscheff Window



Composite Response of Filters Used during Sample Rate Conversion Process