Sample Rate Converter

Aliasing Information

28/JAN/2004

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1. Procedure

This document contains information regarding alias component that come into picture for each set of sample rate conversion.

SRC supports any to any sample rate conversion within the standard set given below:

Sampling Frequency in Hz
8000
11025
12000
16000
22050
24000
32000
44100
48000

Table 1 : Supported Sampling Frequencies

To perform alias measurement we can use sweep sine wave as an Input signal. Following example can explain how to perform the testing:

Suppose the input Sample Rate is 44.1 KHz and output rate is 8 KHz, we take a sweep sine wave with information bandwidth of 0KHz - 22.05KHz(Nyquist rate) and sample rate 44.1KHz , this signal is converted to a signal of sample rate 8Khz , then we measure the alias component in the output signal .

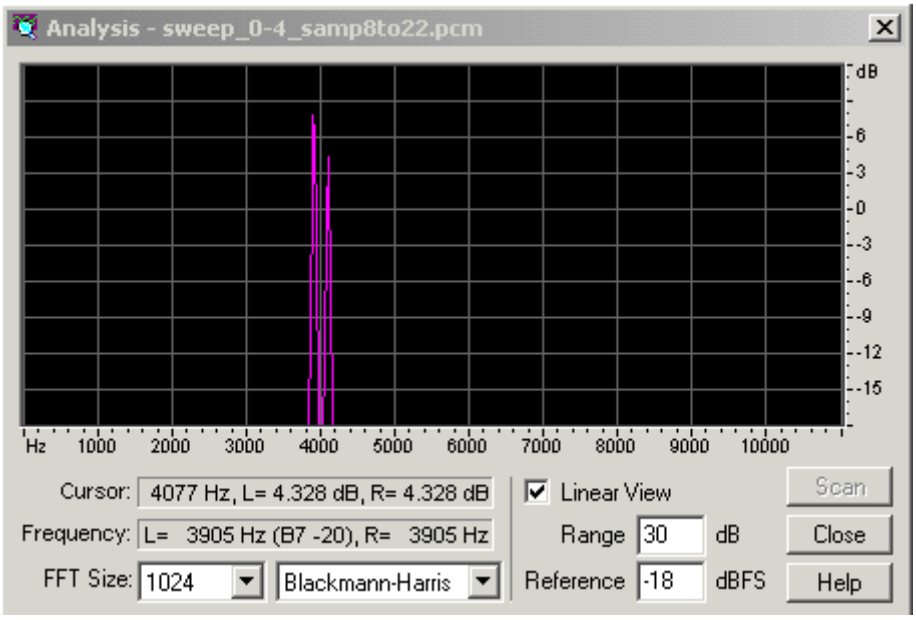
Measurement of Image and Alias frequency component in Interpolated and Decimated signal are performed in two different ways.
This entire performance test is done using cooledit.

2. Interpolation

Interpolation is a method of up-converting a signal sample rate by any factor.
The frequency domain Interpretation of this process shows that Image frequency components comes into picture because of up conversion of signal sample rate.
Thus an anti Imaging Filter is required to remove image frequency component from output signal.
Here we provide the amount of image component observed in the output signal for all set of Interpolation can be performed .We take a sweep sine wave over 0Khz to Nyquist rate as an Input test case.

In this case we measure the signal frequency and 3dB down Image frequency. Following picture shows the 3dB down image component for 8KHz to 22.05 KHz sample rate conversion.

Figure 1 : Analysis of 8KHz to 22KHz Conversion



Following table contains information for all set of Interpolation can be performed by this Sample Rate Converter :-

Table 2: Interpolation information that can be performed by SRC

Input sample Frequency in Hz	Output Sample frequency in Hz	Approximate Frequency Difference between main lobe and 3dB down image component in Hz
8000	11025	200
8000	16000	100
8000	22050	80
8000	32000	40
8000	44100	25
8000	48000	15
11025	16000	250
11025	22050	220
11025	32000	200
11025	44100	175
11025	48000	160
16000	22050	344
16000	32000	312
16000	44100	269
16000	48000	250
22050	32000	470
22050	44100	410
22050	48000	370
32000	44100	680
32000	48000	590
44100	48000	600

3. Decimation

It consist of a Digital anti-aliasing filter, h(k) and a sample rate compressor. Rate compressor reduces the sample rate from Fs to Fs/M. To prevent aliasing at lower rate the digital low pass filter is used to band limit the input signal to less than Fs/2M.

In this case we measure the difference between signal gain at DC (at 0Hz) and alias component gain at DC (at 0Hz).

Following picture shows the signal gain at DC (22.05KHz to 8KHz conversion): -

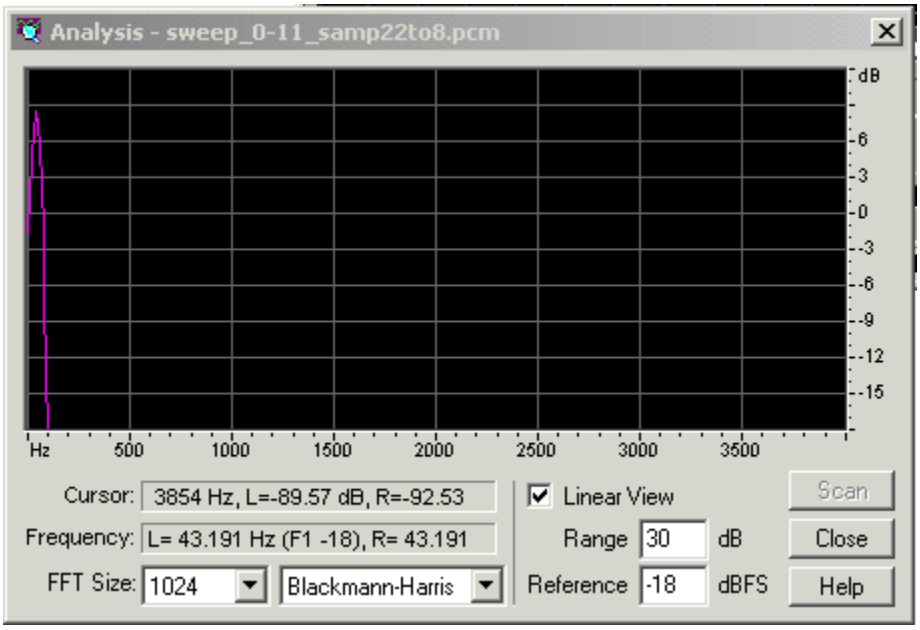


Figure 2: Analysis of Decimation of 22KHz to 8KHz signal conversion

The next picture shows the aliasing signal gain at DC :-

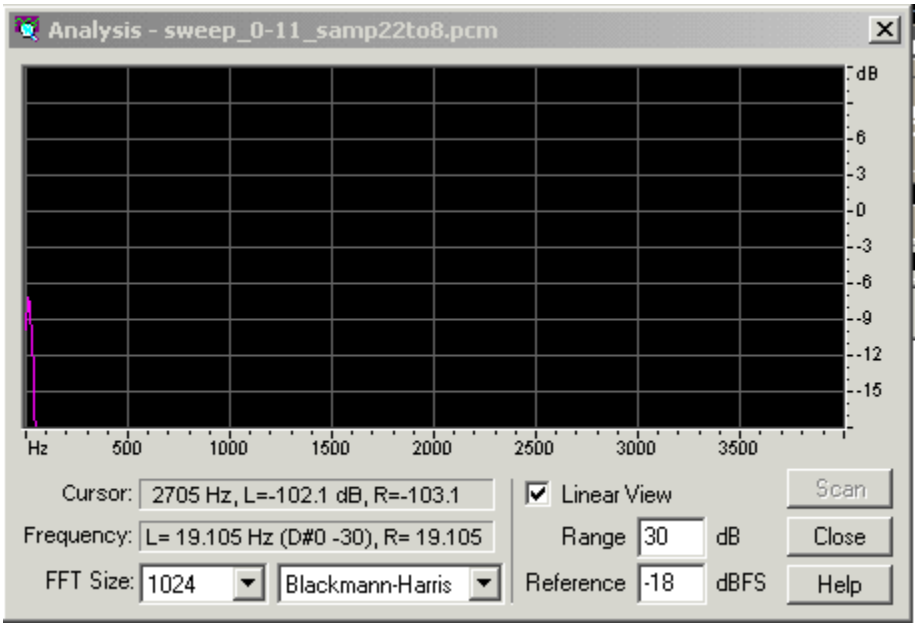


Figure 3: Analysis of aliasing in 22KHz to 8KHz signal conversion

Following table contains information for all set of Decimation can be performed by this Sample Rate Converter: -

Table 3: Decimation information for all possible conversions

Input sample Frequency in Hz	Output Sample Frequency in Hz	Alias component gain in comparison with signal gain at 0Hz(DC)
11025	8000	<30 dB
16000	8000	<30 dB
16000	11025	<30 dB
22050	8000	<30 dB
22050	16000	<30 dB
32000	8000	<10 dB
32000	11025	<24 dB
32000	16000	<16 dB
32000	22050	<30 dB
44100	8000	< 8 dB
44100	11025	<12 dB
44100	16000	<17 dB
44100	22050	<30 dB

44100	32000	<30 dB
48000	8000	<7 dB
48000	11025	<8 dB
48000	16000	<15 dB
48000	22050	<20 dB
48000	32000	<30 dB
48000	44100	<30 dB

Appendix A – Document change history

Ver.No.	Editor/Author	Date dd-mmm-yy	Changes made
0.1	Arnab	21st Jan 2003	Initial Draft
0.2	Srividya M. S.	28th Jan 2004	Updated the template