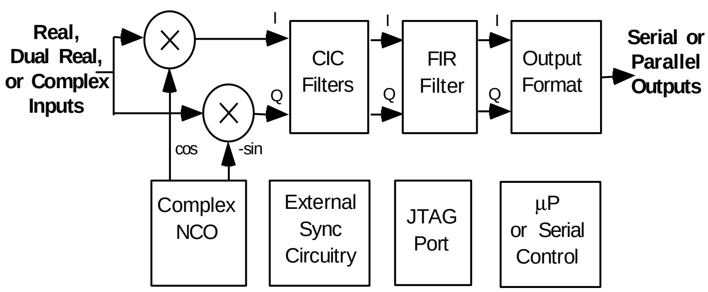
Designing Filters with the AD6620
Greensboro, NC

Abstract: This paper introduces the basics of designing digital filters for the AD6620. This article assumes a basic knowledge of filters and their construction and implementation. The reader is encouraged to visit other references to gain more detailed knowledge of what digital filters are and how they work. The references in the bibliography are a good place to start.

The AD6620 is a decimating digital receiver chip used in the implementation of a digital receiver following an analog to digital converter such as the AD6640 or the AD6600. The AD6620 consists of a complex NCO, quadrature mixers, second order cascaded integrated comb (CIC) filter, fifth order CIC and a ram coefficient finite impulse response filter (RCF). Together, these form a versatile receiver ASIC with many different user configurations.



About the AD6620

As shown, there are four main signal processing stages: a Frequency Translator, two Cascaded Integrator Comb FIR Filters (CIC2, CIC5) and a RAM Coefficient FIR Filter (RCF).

Following frequency translation is a fixed coefficient, high speed decimating filter that reduces the sample rate by a programmable ratio between 1 and 16 (Note: Decimation of 1 in CIC2 requires 2X or greater clock into AD6620). This is a second order, cascaded integrator comb FIR filter. The data rate into this stage equals the input data rate, f_{samp}. The data rate out of CIC2, f_{samp2}, is determined by the decimation factor, M_{CIC2}.

Following CIC2 is a second fixed-coefficient, decimating filter. This filter, CIC5, further reduces the sample rate by a programmable ratio from 1 to 32. The data rate out of CIC5, f_{samp5}, is determined by the decimation factor, M_{CIC5}.

Each CIC stage is a FIR filter whose response is defined by the decimation rate. The purpose of these filters is to reduce the data rate of the incoming signal so that the final filter stage, a FIR RAM coefficient sum-of-products filter (RCF), can calculate more taps per output. As shown in block diagram of the chip, on-chip multiplexers allow both CIC filters to be bypassed if desired.

The fourth stage is a sum-of-products FIR filter with programmable 20-bit coefficients, and decimation rates programmable from 1 to 32. The RAM Coefficient FIR Filter can handle a maximum of 256 taps.

The overall filter response for the AD6620 is the composite of all three cascaded decimating filters: CIC2, CIC5, and RCF. Each successive filter stage is capable of narrower transition bandwidths but requires a greater number of CLK cycles to calculate the output. **More decimation in the first filter stage will minimize overall power consumption**.

Designing with the AD6620

When designing filters for the AD6620, the cascaded performance of each of the filter stages must be considered. Therefore, each stage should be understood before looking at cascaded performance.

2nd order CASCADED INTEGRATOR COMB FILTER

The CIC2 filter is a fixed-coefficient, decimating filter. It is constructed as a second order CIC filter whose characteristics are defined only by the decimation rate chosen. This filter can process signals at the full rate of the input port (65MHz) in all input modes. The output rate of this stage is given by the equation below.

$$f_{SAMP\,2} = \frac{f_{SAMP}}{M_{CIC\,2}}$$

The decimation ratio, M_{CIC2}, is an unsigned integer that may be between 1 and 16. This stage may be bypassed under certain conditions by setting, M_{CIC2} equal to 1. Bypass of the CIC can only take place when f_{CLK} is two or more times the input data rate, $f_{SAMP.}$ This is because the I and Q data is processed in parallel within the CIC2 filter, and the I and Q output data is then multiplexed through the same data pipe before it enters the CIC5 filter.

The gain and pass-band droop of the CIC2 can be calculated with the following equations. From this, the gain and passband droop can be calculated. Later, it will be shown how to correct for pass band droop of the CIC filters.

$$S_{CIC2} = ceil\left(\log_2\left(M_{CIC2}^{\;2} \cdot input\_level\right)\right) - 2$$

$$OL_{CIC2} = \frac{\left(M_{CIC2}^{\;2}\right)}{2^{S_{CIC2}+2}} \cdot input\_level$$

The scale factor, S_{CIC2} is a programmable unsigned integer between 0 and 6. This serves as an attenuator that can reduce the gain of the CIC2 in 6dB increments. For the best dynamic range, S_{CIC2} should be set to the smallest value possible (i.e. lowest attenuation) without creating an overflow condition. This can be safely accomplished using the equation below, where *input_level* is the largest fraction of full-scale possible at the input to this AD6620 (normally 1).

The frequency response of the CIC2 filter is given by the following equations.

$$H(z) = \frac{1}{2^{S_{CIC2}+2}} \cdot \left(\frac{1 - z^{-M_{CIC2}}}{1 - z^{-1}} \right)^2$$

$$H(f) = \frac{1}{2^{S_{CIC2}+2}} \cdot \left(\frac{\sin\left(\pi \frac{M_{CIC2} \cdot f}{f_{SAMP}}\right)}{\sin\left(\pi \frac{f}{f_{SAMP}}\right)} \right)^2$$

CIC2 Rejection

The table below illustrates the amount of bandwidth in kHz that can be protected with various decimation rates and alias rejection specifications. The data in this table assumes an input sample rate of 65MHz, but it may be scaled to any other allowable sample rate. The passband requirements with respect to other sample rates may also be scaled up to the 65MHz rate in order to select the amount of decimation allowed for a given rejection specification. The table can be used as a tool to decide on how to distribute the decimation in between CIC2, CIC5 and the RCF.

M_{CIC2}	-50dB	-60dB	-70dB	-80dB	-90dB	-100dB
			kHz			
2	1163.5	654.3	367.9	206.9	116.3	65.4
3	980.1	557.8	315.8	178.3	100.5	56.6
4	791.3	452.5	256.9	145.3	81.9	46.2
5	654.1	375	213.2	120.6	68.1	38.4
6	554.7	318.4	181.2	102.6	57.9	32.6
7	480.5	276	157.1	89	50.2	28.3
8	423.3	243.3	138.5	78.5	44.3	25
9	378	217.3	123.8	70.1	39.6	22.3
10	341.3	196.3	111.8	63.3	35.8	20.2
11	311	178.9	101.9	57.7	32.6	18.4
12	285.6	164.3	93.6	53	30	16.9
13	264	151.9	86.6	49	27.7	15.6
14	245.4	141.2	80.5	45.6	25.7	14.5
15	229.3	132	75.2	42.6	24.1	13.6
16	215.1	123.8	70.5	40	22.6	12.7

CIC2 Alias Rejection Table (f_{SAMP} = 65MHz)

Example Calculations

Goal: Implement a filter with an Input Sample Rate of 10MHz requiring 100dB of Alias Rejection for a 7kHz passband.

Solution: First scale the passband to a 65MHz rate using the equation below.

$$f_{SAMP2} = \frac{65MHz}{f_{SAMP}} * f_{PASS\_BAND}$$

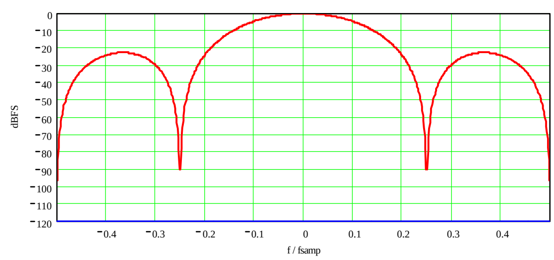
(65MHz / 10MHz) * 7kHz = 45.5kHz.

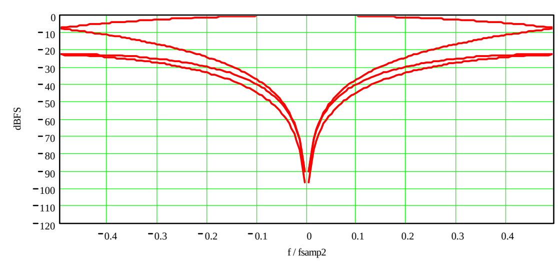
Find the -100dB column on the right of the table and look down this column for a value greater than or equal to your passband referenced to 65MHz. Then look across to the extreme left column and find the corresponding decimation rate. Referring to the table, notice that for a decimation of 4, the frequency having -100dB of alias rejection is 46.2kHz. This is greater than the 45.5kHz calculated. Therefore, the maximum bound on CIC2 decimation for this condition is 4. Additional decimation means less alias rejection than the 100dB required.

Although an M_{CIC2} less then 4 would still yield the required rejection, overall power consumption is reduced when using the largest decimating possible. Decimation in CIC2 lowers the data rate, and thus reduces power consumed in subsequent stages.

The plot below shows the CIC2 transfer function with respect to the CIC2 output rate when a decimation of 4 is used. The first plot is referenced to the input sample rate, the complex spectrum from $-f_{SAMP}/2$ to $f_{SAMP}/2$.

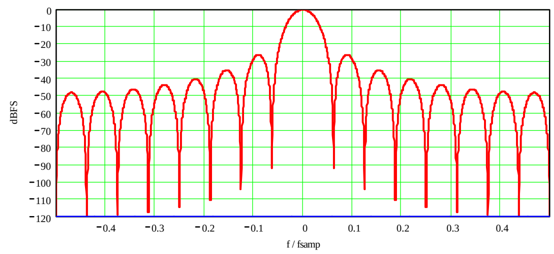
The second plot is referenced to the CIC2 output rate, the complex spectrum from $-f_{SAMP2}/2$ to $f_{SAMP2}/2$. The aliases of the CIC2 can be seen to be "folding back" in towards the edge of the desired filter passband. It is the level of these aliases as they move into the desired passband that are important.

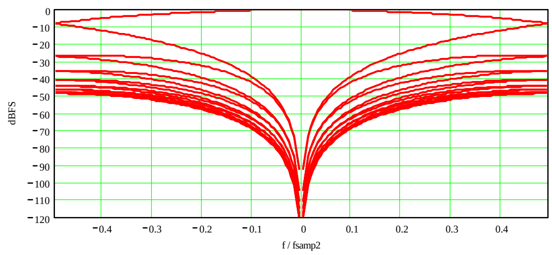




CIC2 Alias Rejection, M_{CIC2} = 4

The set of plots below show a decimation of 16 in the CIC2 filter. The lobes of the filter drop as the decimation rate increases, but the amplitudes of the aliased frequencies increase because the output rate has been reduced.





CIC2 Alias Rejection, M_{CIC2} = 16

5th order CASCADED INTEGRATOR COMB FILTER

The third signal processing stage, CIC5, implements a sharper fixed-coefficient, decimating filter than CIC2. The input rate to this filter is f_{SAMP2}. The maximum input rate is given by the equation below. N_{CH} equals two for Dual Channel Real input mode; otherwise N_{CH} equals one. In order to satisfy this equation, M_{CIC2} can be increased, N_{CH} can be reduced, or f_{CLK} can be increased.

$$f_{SAMP2} \le \frac{f_{CLK}}{2 \cdot N_{CH}}$$

The scale factor, S_{CIC5} is a programmable unsigned integer between 0 and 20. It serves to control the attenuation of the data into the CIC5 stage in 6dB increments. For the best dynamic range, S_{CIC5} should be set to the smallest value possible (lowest attenuation) without creating an overflow condition. This can be safely accomplished using the equation below, where OL_{CIC2} is the largest fraction of full scale possible at the input to this filter stage. This value is output from the CIC2 stage then pipe-lined into the CIC5. S_{CIC5} is ignored when this filter is bypassed by setting M_{CIC5}=1.

$$S_{CIC5} = ceil\left(\log_2\left(M_{CIC5}{}^5 \cdot OL_{CIC2}\right)\right) - 5$$

$$OL_{CIC5} = \frac{\left(M_{CIC5}{}^5\right)}{2^{S_{CIC5}+5}} \cdot OL_{CIC2}$$

The frequency response of the filter is given by the following equations. The gain and passband droop of CIC5 should be calculated by these equations. Both parameters may be compensated for in the RCF stage.

$$H(z) = \frac{1}{2^{S_{CIC5}+5}} \cdot \left(\frac{1 - z^{-M_{CIC5}}}{1 - z^{-1}}\right)^5$$

$$H(f) = \frac{1}{2^{S_{CIC5}+5}} \cdot \left(\frac{\sin\left(p\,\frac{M_{CIC5} \cdot f}{f_{SAMP2}}\right)}{\sin\left(p\,\frac{f}{f_{SAMP2}}\right)}\right)^5$$

The output rate of this stage is given by the equation below.

$$f_{SAMP5} = \frac{f_{SAMP2}}{M_{CIC5}}$$

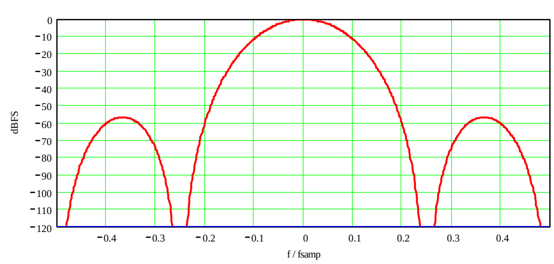
CIC5 Rejection

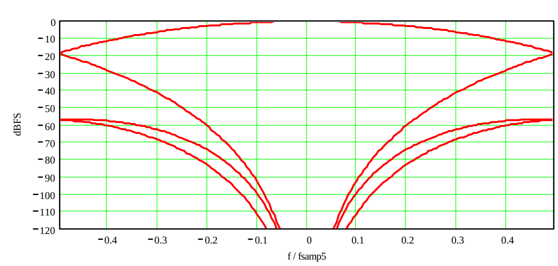
The table below illustrates the amount of bandwidth in kHz that can be protected with various decimation rates and alias rejection specifications. The data in this table assumes that the input sample rate is 65MHz but may be scaled to any sample rate. The passband requirements with respect to other sample rates may also be scaled up to the 65MHz rate in order to select the amount of decimation allowed for a given rejection specification. The maximum input rate into the CIC5 is 32.5MHz. The table is referenced to 65MHz to allow for direct comparison with the CIC2 filter.

M_{CIC5}	-50dB	-60dB	-70dB	-80dB	-90dB	-100dB
			kHz			
2	6647.7	5250.5	4155.2	3292.8	2605	2069.2
3	5150.8	4138.7	3321.8	2669.9	2142.8	1717.4
4	4038.7	3264.2	2637.1	2126	1713.6	1378.4
5	3294.3	2669.6	2161.9	1746.3	1410.3	1136.4
6	2773.6	2250.9	1825.1	1475.7	1193.1	962.3
7	2391.9	1942.8	1576.5	1275.5	1031.9	832.7
8	2101.2	1707.5	1386.3	1122.1	908.2	733.1
9	1872.7	1522.4	1236.5	1001	810.5	654.4
10	1688.6	1373.2	1115.5	903.3	731.5	590.7
11	1537.3	1250.3	1015.9	822.7	666.4	538.2
12	1410.7	1147.5	932.5	755.3	611.8	494.2
13	1303.2	1060.3	861.7	698	565.4	456.8
14	1211	985.3	800.8	648.7	525.5	424.6
15	1130.8	920.1	747.9	605.9	490.9	396.6
16	1060.6	863.1	701.6	568.4	460.5	372.1
17	998.6	812.6	660.6	535.2	433.7	350.4
18	943.4	767.7	624.1	505.7	409.7	331.1
19	894	727.5	591.5	479.2	388.3	313.8
20	849.4	691.3	562	455.4	369	298.2
21	809.1	658.6	535.4	433.8	351.5	284.1
22	772.5	628.7	511.2	414.2	335.6	271.2
23	739	601.5	489	396.3	321.1	259.5
24	708.3	576.5	468.7	379.8	307.8	248.7
25	680	553.5	450	364.7	295.5	238.8
26	653.9	532.3	432.8	350.7	284.2	229.7
27	629.8	512.6	416.8	337.7	273.7	221.2
28	607.3	494.4	402	325.7	264	213.3
29	586.4	477.4	388.1	314.5	254.9	206
30	566.9	461.5	375.2	304.1	246.4	199.1
31	548.7	446.6	363.1	294.3	238.5	192.7
32	531.5	432.7	351.8	285.1	231.1	186.7

CIC5 Alias Rejection Table (f_{SAMP2} = 65MHz)

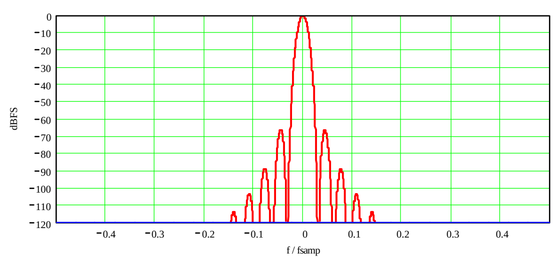
The plots below represent the CIC5 transfer function with respect to the CIC5 output rate for a decimation of 4. The first plot is referenced to the Input Sample Rate and shows the complex spectrum from -f_{SAMP}/2 to f_{SAMP}/2. The second plot is referenced to the CIC5 output rate; the complex spectrum ranges from -f_{SAMP5}/2 to f_{SAMP5}/2. Aliased images in CIC5 "fold back" towards the edge of the desired filter passband. It is the level of these aliases as they move into the desired passband that are of concern. The improved roll-off of CIC5 over CIC2 can be seen when these plots are compared to those shown previously for CIC2.

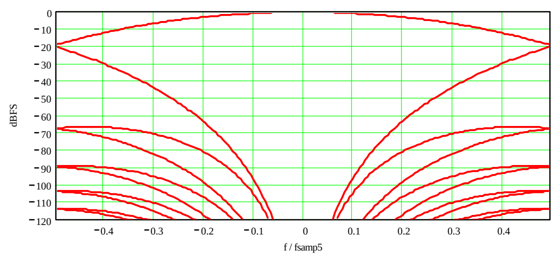




CIC5 Alias Rejection, M_{CIC5}=4

The set of plots below represents a decimation of 32 in the CIC5 filter. It can be seen that the lobes of the filter drop as the decimation rate increases, but the aliased frequencies increase due to the reduction of the output rate.

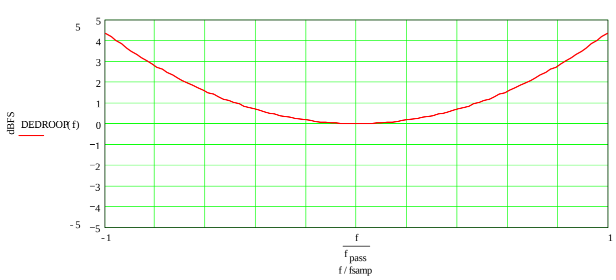




CIC5 Alias Rejection, M_{CIC5} = 32

Passband Droop Correction

Since the CIC filters form low pass filters with a pole at DC, they immediately roll off from that point. This is especially true when 2 stages are cascaded. In order to minimize pass band droop and generate a minimum ripple passband for the net filter operation, the roll off generated in the CIC stages must be countered in the RCF stage. By designing the RCF response so that it counters the roll off, the net pass band performance can be flat. The correction shown below is the required correction for protection of +/- 100 kHz with a decimation of 16 in the CIC5 stage. As shown, nearly 5 dB of correction is required.



CIC Passband Droop Correction

RCF Specification

The RCF stage of the AD6620 forms a sum of products FIR filter. The chip contains 256 words of data memory as well as 256 words of coefficient memory. The filter designed must fit in this memory space. There are several guidelines on the filter specification.

1. Maximum number of taps is 256/number of channels (i.e. 256 or 128 taps).
2. Maximum number of taps is M_tot*clk/data_rate. M_tot is the total decimation, clk is the frequency of the clock provided to the AD6620, and data_rate is the sample rate per channel supplied to the AD6620.
3. The maximum clock rate is 65 MSPS.
4. The maximum data rate is 65 MSPS/number of channels.
5. There must be an integer relationship between clock rate and data rate.

The conditions above define the number of taps that can be specified for the RCF filter. As indicated, the hardware limitation is either 256 or 128. Otherwise, the total decimation rate and the ratio between the clock rate and the data rate solely determine the number of filter taps. Since the AD6620 performs 1 complex MAC per clock (one I and one Q), the higher the over clocking ratio, the more taps that can be processed. The AD6600 dual channel ADC for example, has a 2x clock output. The use of this clock as the main clock to the AD6620 allows twice as many taps to be performed. If higher clock ratios can be made available, then larger filters can be designed. The upper limit on the clock rate is 65 MSPS.

AD6620 Filter Design Software

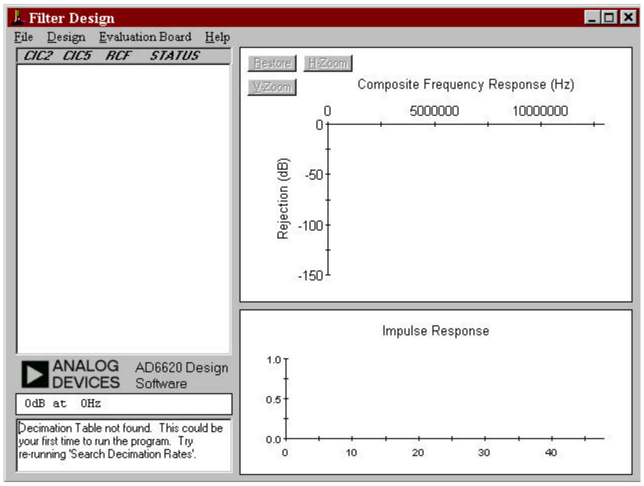
With this said, the filter design software provided with the AD6620 takes all the hard work out of designing the filter program. The following sections will explain how the software works and explain the functions of the software. Once the reader has read through this material, the filter design process will be quick and interactive.

Installation

The AD6620 filter design software requires Windows 95 or later 32-bit operating system. Approximately 5 megabytes of disk space are required for the installation. Run the 'SETUP.EXE' program and the program will be installed under the 'Program Files' directory. When the installation is complete, the program may be run by using the Start|Programs|AD6620|fltrdsgn sequence. Several other utility programs are installed in this path, but they should not be executed directly, as they are part of the filter design sequence. The evaluation board software is also loaded at this time. For details on operation of the evaluation board, see the document covering that software.

The first time the program is run, the following message appears. This message indicates that a design file must be specified. Since this is the first time run, simply select one of the files supplied or run the wizard to create a new filter design.

Click ‘OK’ to move on to the main program screen. The main screen appears here. There are several sections to the main program screen.



The AD6620 design program consists of a menu bar, three text windows and two graph windows. The left side of the screen has the three text windows. The top screen provides details of various filter designs, including decimation rates in each of the stages and details of filter performance. Since no filter design has been performed, the screen in blank. Once a filter has been designed, this screen will provide details. The second window provides cursor information when placed over the top graph, the Composite Frequency Response of the filter. The bottom text window provides program status as program execution continues.

The top graphic window provides the Composite Frequency Response of the filter selected. This window may be zoomed so that small details can be closely examined. To change the view of this window, place the mouse cursor at the top left corner of the desired window. Depress the left mouse button and slide the mouse to the lower right corner of the desired window. Release the mouse button. Click the H-Zoom and/or the V-Zoom button to execute the new view. Both buttons do not have to be selected; only the desired view. To restore the original view, click restore. The values entered in the zoom process are saved in short term memory and need not be reset between filter designs as long as the program is not exited. This can be useful to examine fine details between filter designs. If this window is double clicked, the rejection characteristics are displayed in the bottom text window.

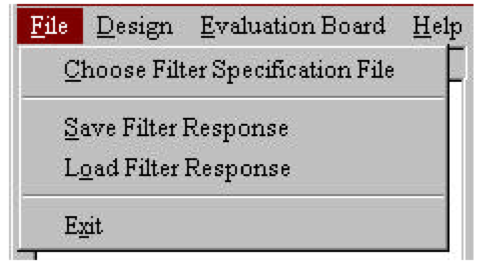
The bottom graphic window is the impulse response. This window can not be changed and displays the current impulse response. If this window is double clicked, the number of taps in the filter are displayed.

Menu Bar

The menu bar has 4 items. Through the menu bar, the various features of the design software are accessed.

File

When File is selected, the following choices are provided. Choose Filter Specification File allow an existing filter design file to be loaded through the Common Dialog Box. Once a filter file has been loaded, it may be designed and examined using the various features of the software.



Save Filter Response allows completed designs to be saved with the aid of the common dialog box. Once a filter has been saved, the software for the AD6620 evaluation board can read the data stored in the file and load the data into the appropriate registers.

The format for this file is quite simple and shown below. This format includes the decimation rates and chip setup. This allows all design parameters to be automatically loaded when the impulse file is loaded.

```
16&
4&
16&
 38880000
 1
 1
0
.1
.4
.5
.5
.4
.1
0
```

In this file format, the 16, 4 and 16 are the decimation rates for the CIC2, CIC5 and the RCF respectively. The ‘&’ is required to tell the software that these are decimation rates. The 38880000 is the data rate used. The first 1 is the chip mode, 1 for single channel real, 2 for dual channel real and 3 for single channel complex. The second 1 is the clock multiplier. In this case, the clock rate is equal to the data rate. The remaining data in the file is the impulse response. This program scales the data between +/- 1 using double precision representation. It can also be represented in using any convenient numerical range as the evaluation board software can automatically rescale the data to fit the +/- 2^19 format used by the AD6620.

Load Filter Response loads a previously saved filter design for observation within the program. This data can not be changed.

Exit terminates the program.

Design
Search Requested Decimation Rate searches for filter designs that meet only the specified decimation rates. Rates above and below that which is specified are ignored.

Search All Decimation Rates searches all decimation rates for which the AD6620 is designed. This can be time consuming but will show all possible designs using the AD6620

Forced Decimation allows you to try only one decimation combination. When this option is selected, the program asks what decimation should be used in each of the three stages. Then it computes the optimal filter.

Edit Filter Table allows the selected filter design to be changed. The filter could have been selected using the File| Choose Filter Specification File or through the use of the filter wizard. Either way, the filter specification could be tweaked. For more details about editing a filter, see Edit Filter Table below.

Filter Wizard
Filter Wizard walks the user through the design process. A quick walk through will give a flavor for the possibilities and explain what each are. The filter wizard utilizes Cancel, Next and Back buttons so that the design can be navigates smoothly if mistakes are made. Data is not saved until the last entry is made, therefore, a cancel will abort the data entry process.

It is recommended that the program be started and the user follow through the following steps in order to understand how the wizard works. The wizard is very helpful and easy to use. To this end, we will work on an example that is close to the requirements for AMPS. During installation, other sample files were placed in the target directory and may be viewed or edited at any time. Feel free to browse through these at any time.

The first entry required is the file name where the filter will be stored. The default extension for a filter is DAT; however, any extension may be used. For this discussion enter the filename of 'AMPS.DAT'.

The second entry is the data rate in Hertz. This is not necessarily the same as clock rate. In the case of products such as the AD6600 dual channel ADC, a 2x clock is provided. The value entered is the actual sample rate per channel. For our example, enter '61440000'.

Next the software must be told if the chip will be operated in dual or single channel mode. Normal data converters are run in the single channel mode while products such as the AD6600 could be used in the dual channel mode. A simple 'y' or 'n' is required for this entry. For this example, select 'n'. This design is targeted for a single channel ADC such as the AD6640.

The next entry is the ratio between the data rate and the AD6620 clock. For most applications this will be a '1' but applications such as the AD6600, a 2x clock is generated and should be entered here. If facilities are available for different rates, they too can be entered here; however, it should be remembered that the maximum clock rate is 65 MHz. Enter '1' for our example.

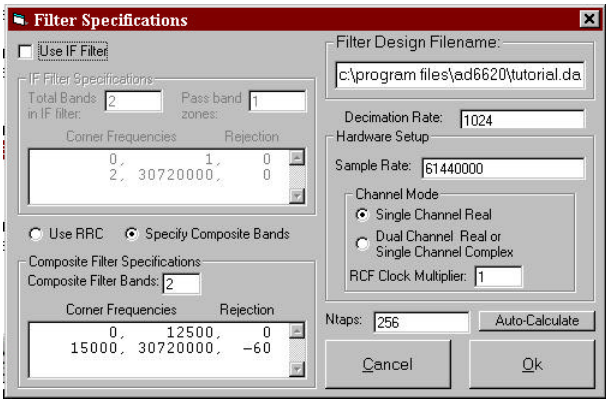
The next input is the decimation rate. This is the rate for which the data is reduced. Enter '1024' as the decimation for our example.

The next input is whether an IF filter is used. A 'y' should be entered if an analog filter is used that appreciably shapes the channel characteristics. If used, this information will be used in designing the digital filter for this channel. If not, the input is ignored. If a 'y' is entered, the program will prompt you for filter information. First it requests the number of bands. Usually, this is two, a pass band and a stop band. A higher number may be entered which will allow multiple stop bands to be entered. Only one pass band is defined. In any case, the following sequences of questions define the pass and stop band. The first will be the start of the pass band. This is always 0. The second entry is the edge of the pass band. The next number is the start of the stop band. Together these last two numbers entered define the transition band of the filter. The following inputs are the following stop band zones. The last entry is always the Nyquist frequency. Once the frequency terms are entered, the rejections are entered. The first is the pass band, which should be 0. The stop bands should have the required rejection. Our application will not have channel filtering outside of our digital application, so enter 'n'.

The next main section of the design process is the composite response. There are two option here. A raised root cosine filter design can be used. If so, the next entry should be a 'y'. If yes is selected, the parameters are requested including alpha and the symbol rate. If the symbol rate is unknown, an auto-calculate feature is provided. Next the stop band rejection is requested. Finally, the number of filter taps is requested. Again, an auto-calculate feature is provided that determines the maximum number of taps available within the AD6620.

If a RRC filter is not selected then the program requests the composite performance specification. As with the IF filter specifications, the number of bands is requested followed by the pertinent frequencies and the required rejection. For details on entering an IF filter specification.

For our application enter 'n' when asked about an RRC filter. For composite bands, enter 2; a pass band and a stop band. Next, the pass and stop bands must be defined as outlined about. Enter a '0' for the left corner of band 1. All of the filters designed with this program a referenced to the center of the channel. Next enter '12500' for the right corner of band 1. This defines a passband of +/-12500 Hertz. Next enter '30000' for the left corner of band 2. This defines the start of the stop band. The final entry is the right corner of band 2. Since we have only defined 2 bands, the last entry is the Nyquist frequency of the data rate or 30.72 MHz in this case. This is presented as the default. Any other entry will be ignored. The next two entries define the band rejections. Enter '0' for band 1, the pass band and '-90' for band 2, the stop band.



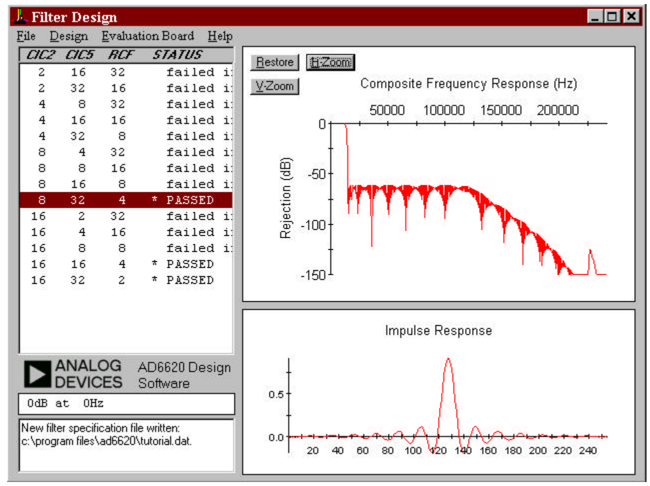
Once the filter wizard is complete, it launches the Filter edit window. This allows the filter design to be edited or tweaked. All frequencies are entered in Hertz. Since the above filter above does not use an IF filter, the specification has been disabled.

When the editing is complete, select the 'OK' button. This saves the information for later use. Once a design is ready to test, the filter can be design can be initiated by Searching Requested Decimation Rate. This will cause the program to search all possible filter designs. Once complete, the top text box will contain information about all possible filter designs.

As shown three good filter designs can be performed with the required filter specification. Double clicking on the filter in the upper text box will display the filter performance. If you wish to save the filter performance, select File|Save Filter Response and the data will be written to the file of the users choice for loading into the evaluation board. For evaluation, each of the good filter designs could be saved under different names and loaded into the evaluation board for comparison. It should be noted that the test for filter quality is pessimistic and some of the filters listed as failures may actually be good. Therefore the rule is to try the filters that pass first. After that, it is always a good idea to check some the filters that are listed as failures. To examine details of any filter, including those that fail, single click on the filter table. Filter details are available in the lower left-hand text box.

Loading and Using a Filter File

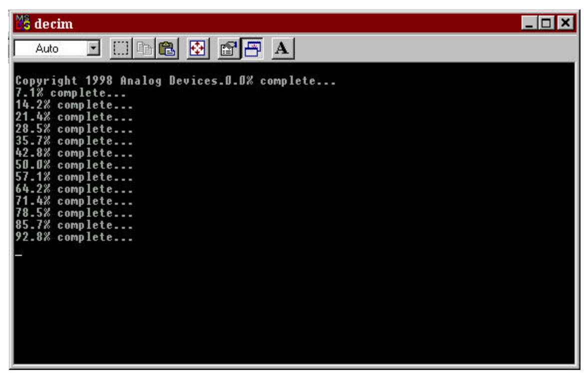
Once a filter has been specified, a filter file is created. This file may be referenced by Choose Filter Specification File.



Select File|Choose Filter Specification File and load one of the filters provided with the software.

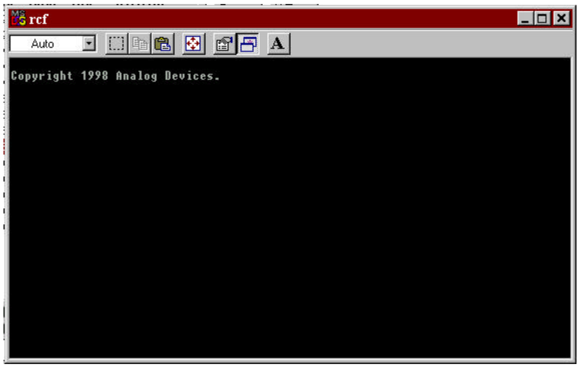
In order to see the performance of the filter, select Design|Search Requested Decimation Rate. This launches the another application called Decim.exe. This program computes the filter performance for each of the possible filters by factoring the decimation rate and distributing it between each of the stages.

When designing a filter, it is best to specify decimation rates that are easily and robustly factored. Although not required, decimation rates that have small factors such as 2, 3, 4 or 5



are preferable. If the decimation rate has factors no smaller than 15, then the program will fail to generate any filters at all.

When the Decim application is complete, the filter table will appear with filter details. Single click for text details or double clicking for a filter design. Double clicking launches another application called RCF.exe. This application examines the filter specifications and actually designs the filter request with result displayed on the two graphs within the Filter Design Program.



If the filter meets the application, then the filter can be saved using the File|Save Filter Response option. This will write all pertinent data to a file for use by the AD6620 evaluation board software or for inclusion as a data file in the DSP code of the final application.