Development Kit User's Guide
QF1D512 SavFIRe™ Digital Filter

1. Introduction

The QF1D512-DK Development Kit is a complete solution for evaluation and system development using the QF1D512 SavFIRe Programmable Digital Filter. This User's Guide describes the following:

- Kit Contents
- Installation
- Basic Operations (Sections 3 – 10)
- Advanced Operations (Sections 11 - 21)
- Reference (Sections 22 - 24)

Note: There is a section index at the end of the document.

The Quickfilter Pro software also features built-in help files. You can access them from within the program by clicking on "?" at the top of the screen.

Kit Contents

Figure 1

- QF1D512 Development Board
- Quickfilter Pro Design Software CD
- USB Cable
- BNC Cable
- BNC to 1/8in audio jack adapter
- Startup Guide

2. Installation

Please refer to the startup guide included in the kit.
You should install the software first, and then plug in the board when prompted at the end of the install.
Follow the prompts for installation of the USB drivers (Note: you have to go through the "Found new Hardware" wizard twice to install both A and B drivers)

BASIC OPERATIONS

3. Opening Screen

Double click on the "QF Pro QF1D512" icon on your desktop. The following screen appears:

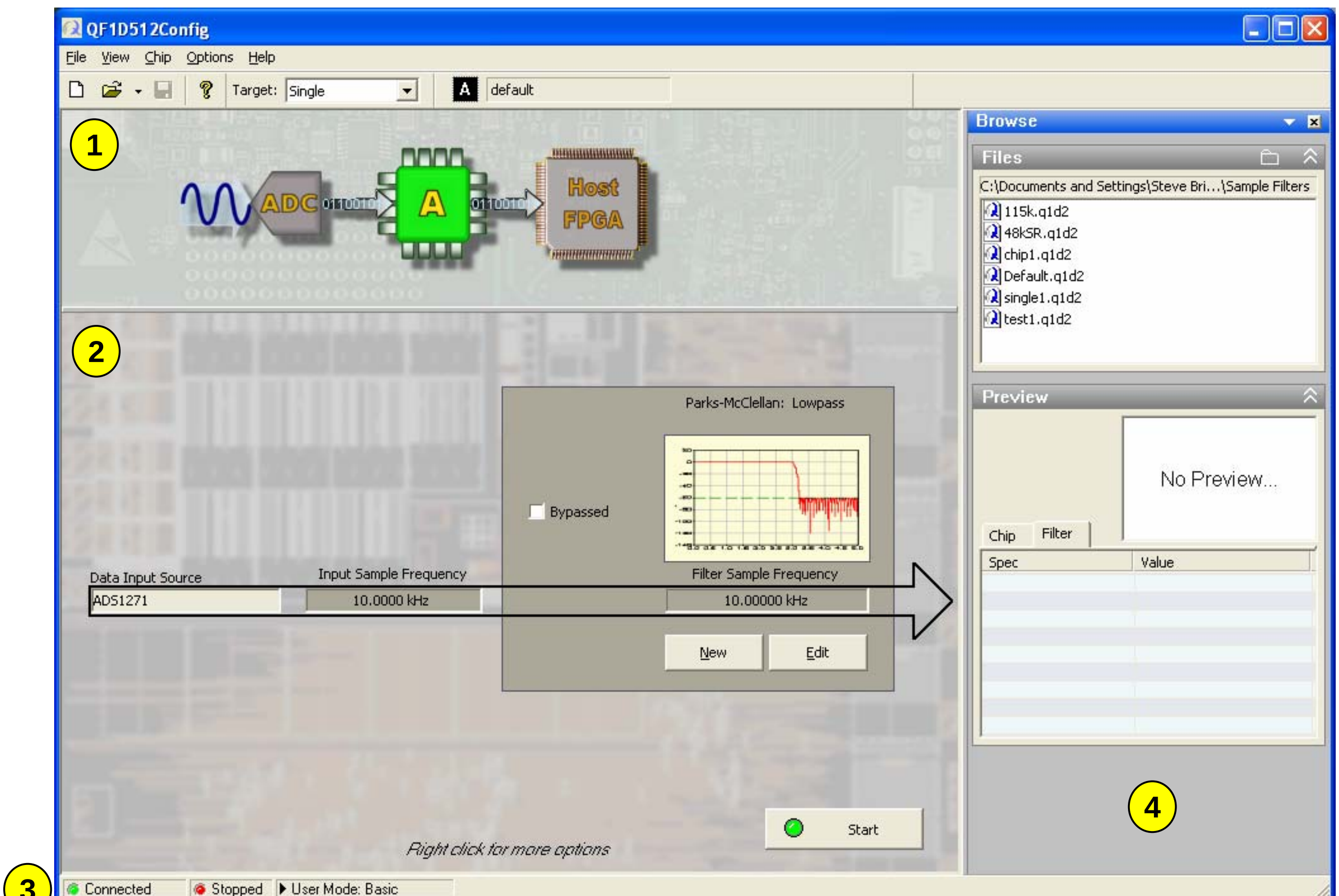


Figure 2

1. Dev Kit Mode Schematic (Section 4)
2. Chip Configuration Panel
3. Status Indicator Bar
4. Information Bar (Section 7)

4. Dev Kit Modes

The Development Kit board contains 2 QF1D512s, which the user can configure to suit his application. Single chip mode is the default mode, dual serial and dual parallel modes can be selected from the "Target:" dropdown:

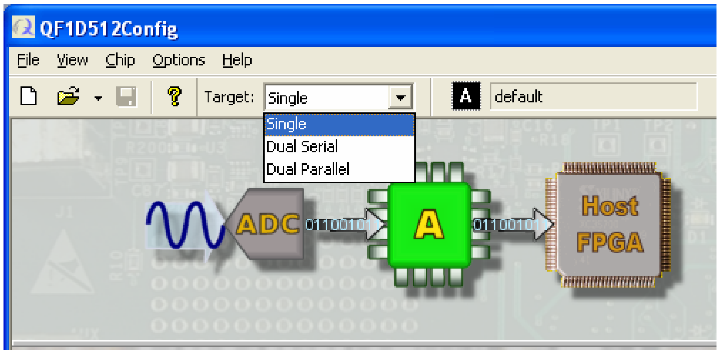


Figure 3

The schematic will change to a representation of the mode selected. See Section 9.

5. Designing a Filter

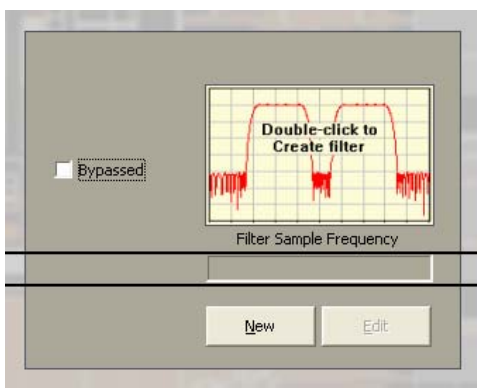


Figure 4

Any of the following steps will initiate a filter design:

- Click on "New" (Figure 4)
- Double click on the filter thumbnail window (Figure 4)
- Right click anywhere in the filter box and select "new filter" (Figure 4)
- Press Ctrl+Shift+N
- From the menu bar select "Chip / New Filter"

Select the type of filter required from the Create Filter window. (Figure 5)

Note: You can import filter coefficients created by another program, e.g. Matlab, by clicking on one of the Imported Filters tiles. Choose Symmetric or Asymmetric as appropriate.

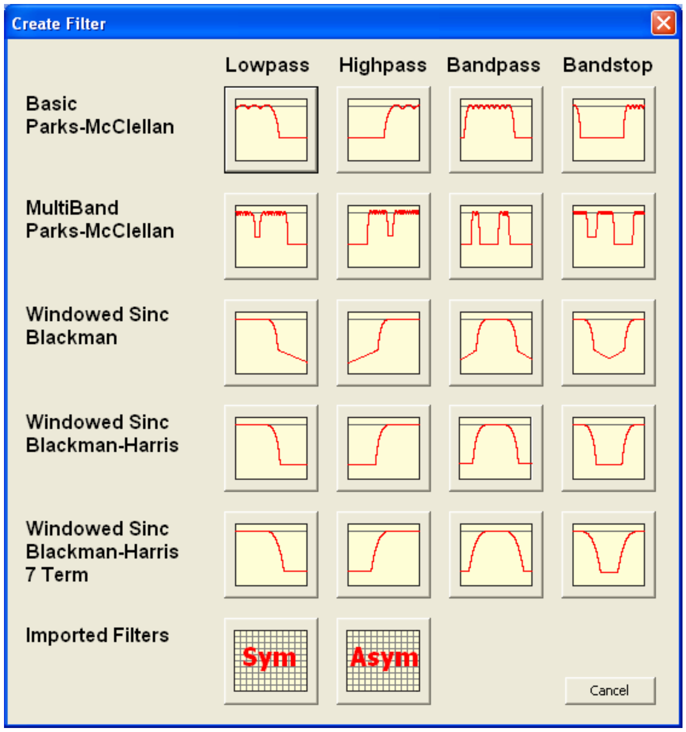


Figure 5

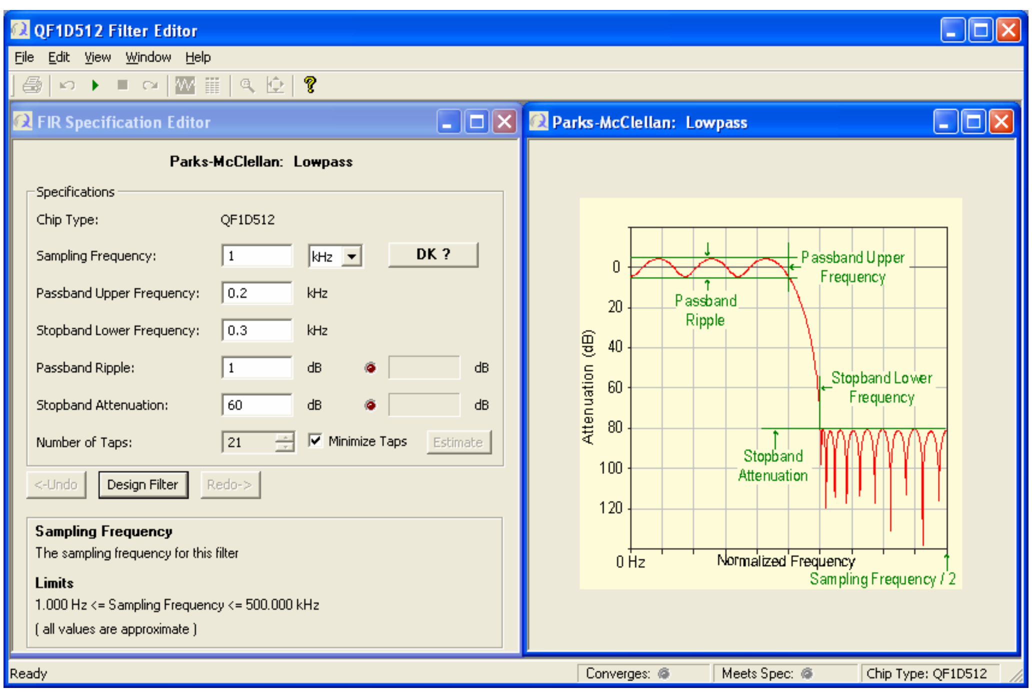


Figure 6

The Filter Editor window now appears (Figure 6). Enter the characteristics of the filter you require in the boxes on the left. On the right you will see the type of filter you're designing (Parks-McClellan: Lowpass) and definitions for the various filter parameters.

As you tab from one entry field to the next the number in the "Number of Taps" box is a rough indication of how many taps will be required to design your filter.
In Advanced User Mode (Section 10) you may also specify a fixed number of taps by uncheckong the "Minimize Taps" checkbox and entering the number of taps desired (512 max).

When you have entered all the parameters for your filter, click on "Design Filter". If there is any problem with the design, for example not enough taps to achieve your desired response, a dialog will appear with some suggested modifications you can make to achieve a successful design.

Assuming there are no problems, the "Converges" and "Meets Spec" status indicators will turn green and a plot of the filters response will appear (Figure 7):

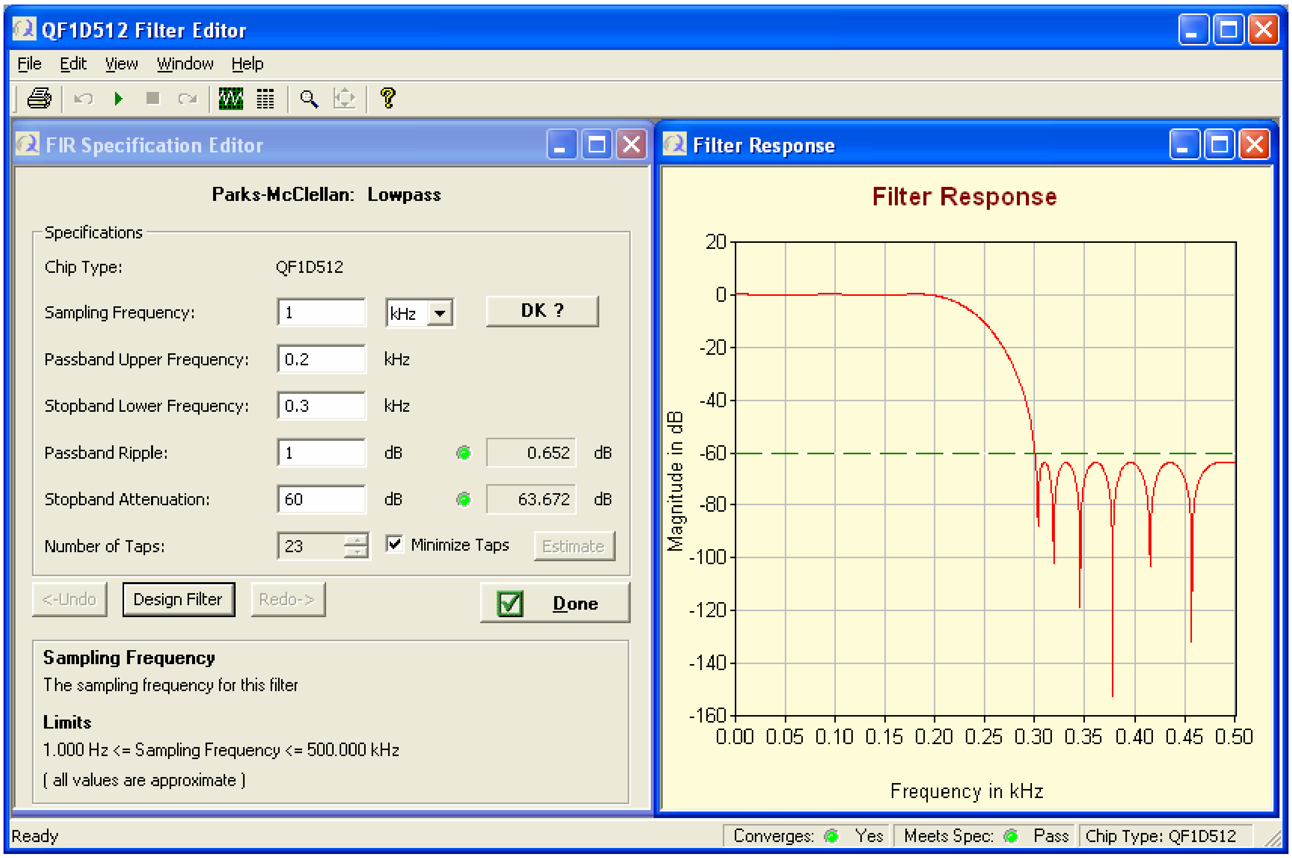


Figure 7

Error messages

When you click on "Design Filter" you may see one of the following messages.

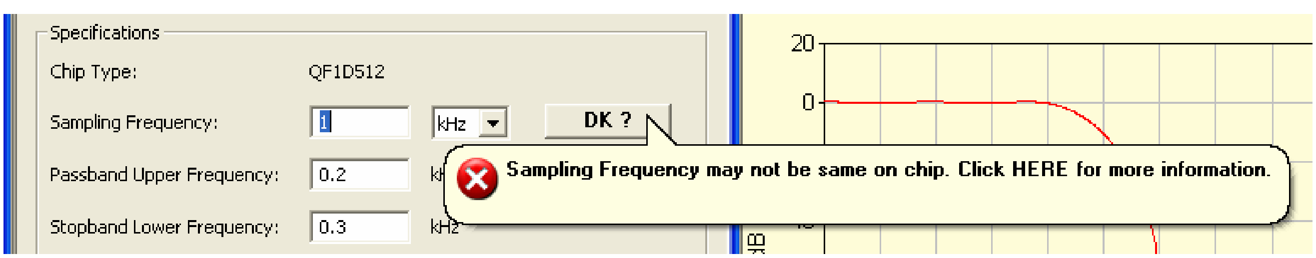


Figure 8

The message shown in figure 8 relates to a hardware limitation of the development board itself. You can freely choose a sampling frequency between the limits shown at the bottom left of the filter editor window (Figure 7). However the hardware on the board can only produce a finite set of frequencies within this range. You can see this information if you click on the "DK ?" button. This will not prevent you from successfully completing your configuration but when you download to the board the software will select the next highest available frequency and recalculate the filter coefficients to maintain your desired filter characteristics. (Note: this behavior can be over-ridden using "Chip Download Options" – see Section 12).

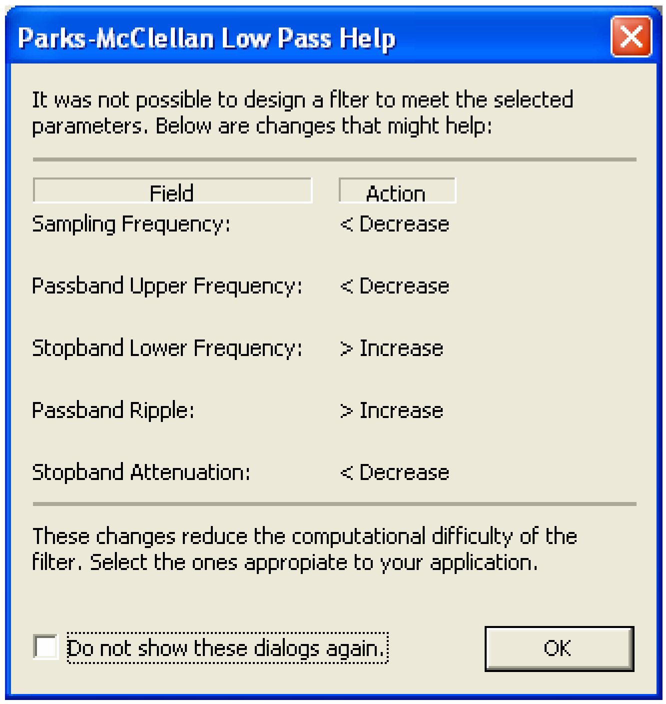


Figure 9

The message shown in figure 9 will appear if it is not possible to design a filter to meet the specifications you input. For each of the input fields a suggested action is offered. Close this dialog by clicking OK and then amend your input specifications and try "Design Filter" again until you achieve a successful result.

You can view the results of your successful filter design in several ways:

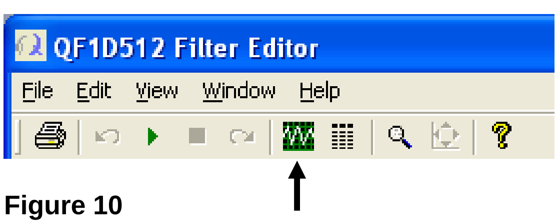


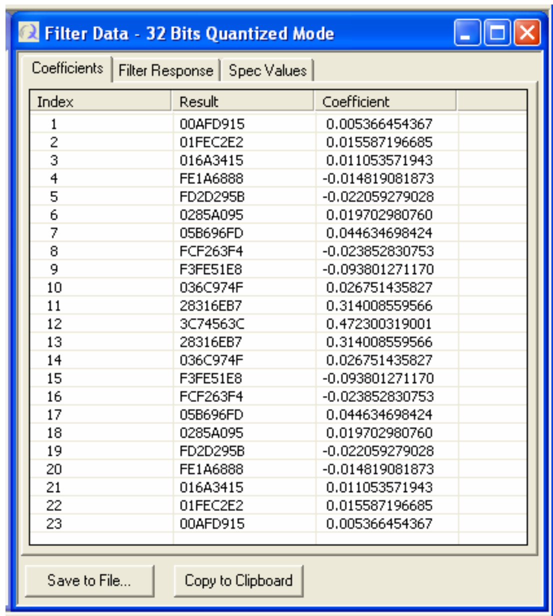
Figure 10

Click here to cycle through Frequency Response, Impulse Response, Step Response and parameter definition plots.

Note: See Preferences (Section 20) to select which charts are automatically generated.

Figure 11

Click here to see the numerical values for the coefficients, frequency response and a summary of filter characteristics. Buttons on this screen allow you to save the values to a file or copy to the clipboard. (Figure 12)



Index	Result	Coefficient
1	00AFD915	0.005366454367
2	01FEC2E2	0.015587196685
3	016A3415	0.011053571943
4	FE1A6888	-0.014819081873
5	FD2D295B	-0.022059279028
6	0285A095	0.019702980760
7	05B696FD	0.044634698424
8	FCF263F4	-0.023852830753
9	F3FE51E8	-0.093801271170
10	036C974F	0.026751435827
11	28316EB7	0.314008559566
12	3C74563C	0.472300319001
13	28316EB7	0.314008559566
14	036C974F	0.026751435827
15	F3FE51E8	-0.093801271170
16	FCF263F4	-0.023852830753
17	05B696FD	0.044634698424
18	0285A095	0.019702980760
19	FD2D295B	-0.022059279028
20	FE1A6888	-0.014819081873
21	016A3415	0.011053571943
22	01FEC2E2	0.015587196685
23	00AFD915	0.005366454367

Figure 12

Figure 13

Use these buttons to Zoom and un-zoom the charts.

When you have finished and are satisfied with your filter design click on "Done" and you will return to the main window.

Note that a thumbnail of the filter you designed now appears in the filter thumbnail window, along with filter type and sampling frequency. Details of the filter appear in the information pane, two tabs show details of the **Chip** configuration the key **Filter** characteristics. Assuming the development board is connected, the "Start" button is now available. (Figure 14)

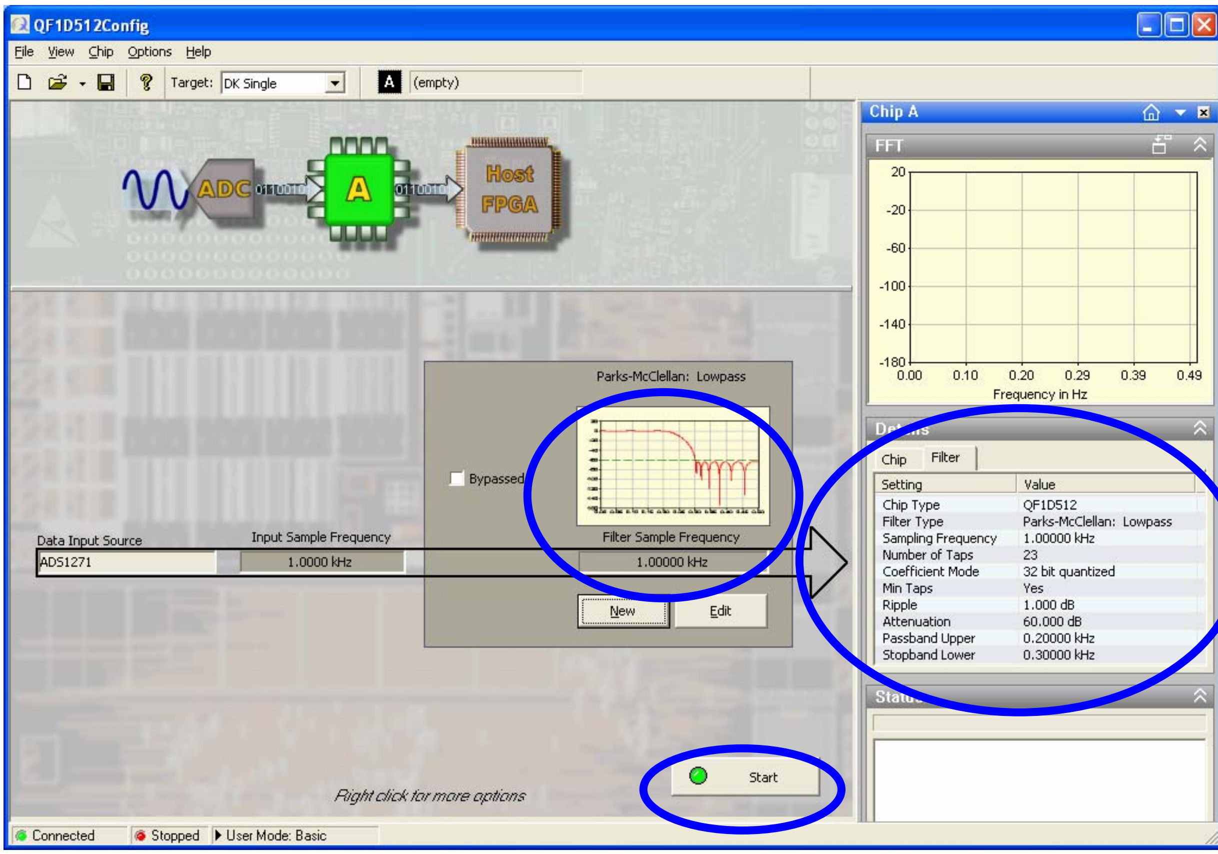


Figure 14

Filter Bypass

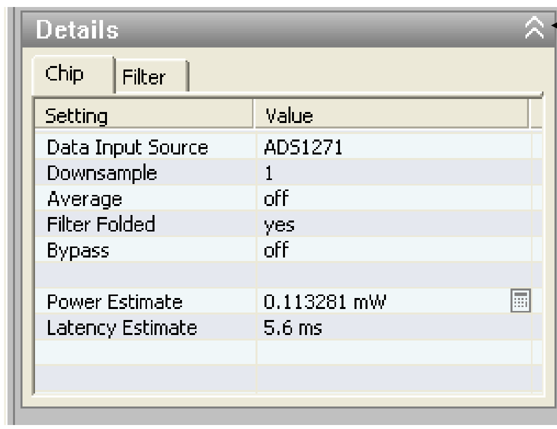
One more option is available on the Chip Configuration Panel. A checkbox is available allowing you to bypass the filter entirely. Primarily this option would be used to compare the results with and without the filter being active. However, in some applications it may be desirable to dynamically turn on the filter only when excessive unwanted noise is detected.

6. Loading and Saving Filter Configurations

There are two parts to the configuration of the QF1D512: the filter coefficients and a number of additional register settings which set up the device to interface to a variety of different ADC types and host microcontrollers and accommodate varying data word formats and bit resolutions. This information is summarized in the Information Bar on the right (Section 7).

The filter coefficients were set in response to the desired characteristics you entered in the Filter Editor, the resulting filter characteristics are shown on the **Filter** tab (Figure 14).

The configuration registers have been automatically set by the Quickfilter Pro software to correctly set up the QF1D512s on the development board to filter the output from the on-board ADC, an AD1271. These settings are summarized on the **Chip** tab (Figure 15).



Note:
Any of the information panes can be collapsed or expanded by clicking here

Figure 15

The chip tab also displays two other useful pieces of information:

The power estimate gives you an indication of how much power the chip will consume in this configuration when running. The power drawn will vary as a function of number of taps used and sampling frequency. Click on the calculator icon to bring up a tool to allow you to explore the effects of these changes, as well as variations in supply voltage and operating temperature (Figure 16)

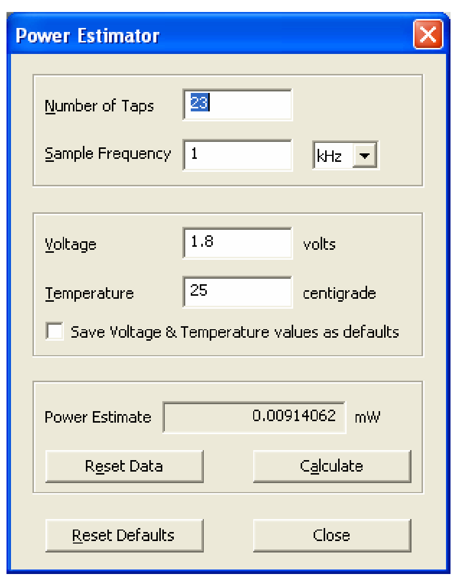


Figure 16

Note: These are estimates only. The actual measured power consumption will vary from device to device and lot to lot. The data sheet limits provide the only guaranteed actual device performance.

The second piece of information is an estimate of the latency through the chip. Again this will vary with sample rate and number of taps. The numeric value shown here will match the graphical representation of latency shown on the Step Response and Impulse Response charts in Filter Editor (Section 6).

Saving Configurations

To save your configuration, perform any of the following steps:

- Click on the **Save** (disk) icon at the top of the screen (Figure 17)
- Right click anywhere in the Chip Configuration Panel (Figure 2) and select "Save Configuration" or "Save Configuration As"
- Click on "File" on the menu bar followed by either "Save Configuration" or "Save Configuration as"
- Press Ctrl + S

After saving the file name you used ("default" in this example) appears next to chip A at the top of the screen (Figure 17).

Figure 17

Loading Configurations

A configuration can be loaded using any of the following methods:

- Click on the **Open** (folder) icon at the top of the screen (Figure 16).
  (Note: the drop down next to the icon shows recently opened configurations)
- Right click anywhere in the Chip Configuration Panel (Figure 2) and select "Open Configuration"
- Click on "File" on the menu bar followed by either "Open Configuration"
- Press Ctrl + O
- Drag a configuration from the Browse Panel (Figure 18) and drop it anywhere in the Chip Configuration Panel (Figure 2).
- Double click on a configuration file in the Browse Panel

7. Information Bar

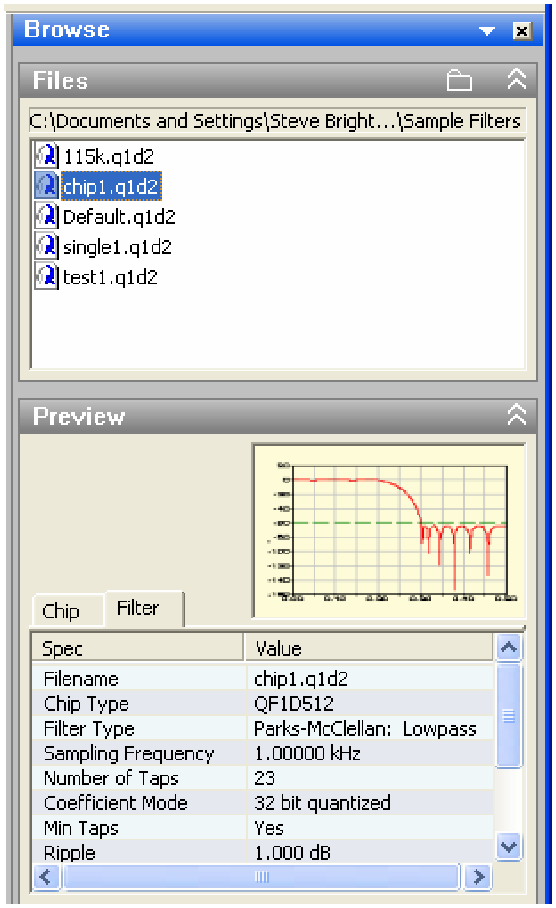


Figure 18

Browse Panel
The Browse Panel shows any configurations you have previously created or saved. The path name to the chosen directory is shown under the **Files** pane. You can browse to a different directory by clicking on the folder icon to the right in the **Files** title bar.
If you select (click on) one of the files in the Files pane a thumbnail of the filter appears in the Preview pane. Beneath that the **Chip** and **Filter** tabs function as described in Section 6, showing the key filter parameters and chip configuration details.
To load a particular configuration simply drag and drop the file from the **Files** pane to the Chip Configuration panel, or use any of the other methods described in Section 6.

If the Browse panel is not showing you can select it by any of the following methods:

- Clicking on the Home icon (Figure 19)
- Use the drop down at the top of the active panel (Figure 19)
- Select "Browse Panel" from the **View** menu (Figure 2)

Note: If none of the panels are visible (because they were closed by clicking on "X" in the top right hand corner) they can be restored by selecting "Information Bar" from the **View** menu.

Chip A panel

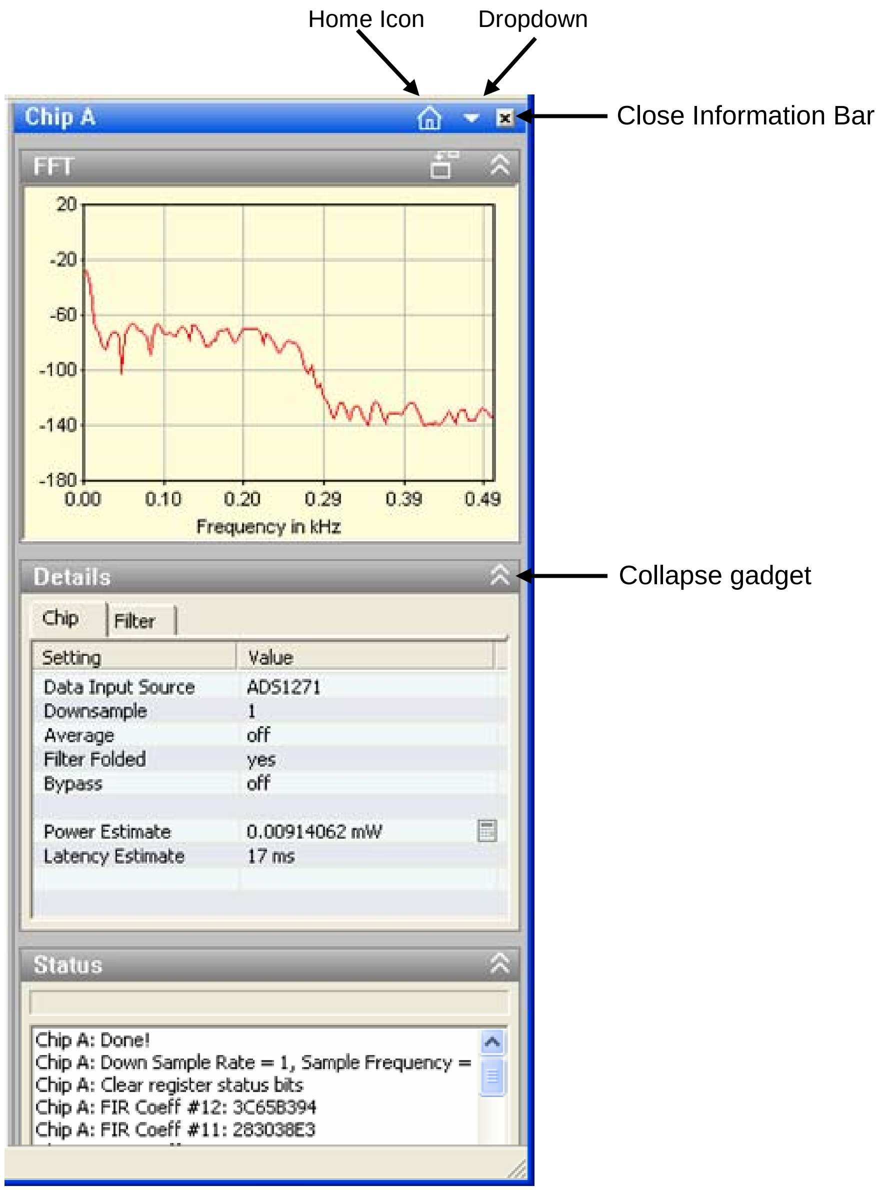


Figure 19

The **FFT** pane shows the FFT of your filter once the chip is running (see Section 8).

The **Details** pane functions as described earlier.

The **Status** pane shows information about data downloaded to the chip. You will see lines of text scroll through this window when you download your configuration the development board (Section 8). To view this in full, collapse the **Details** Pane. In the **Status** pane (Figure 20a) you can use the scrollbar to see actions taken by the software to download your configuration(s). There are also buttons available to update the window, clear the contents, or view the log file in Notepad (the Details pane has been collapsed to reveal these buttons). The latter feature is very useful during development as it enables you to see which commands were issued by the software to correctly configure the chip – the same commands you will need to generate from your own host microcontroller in your application.

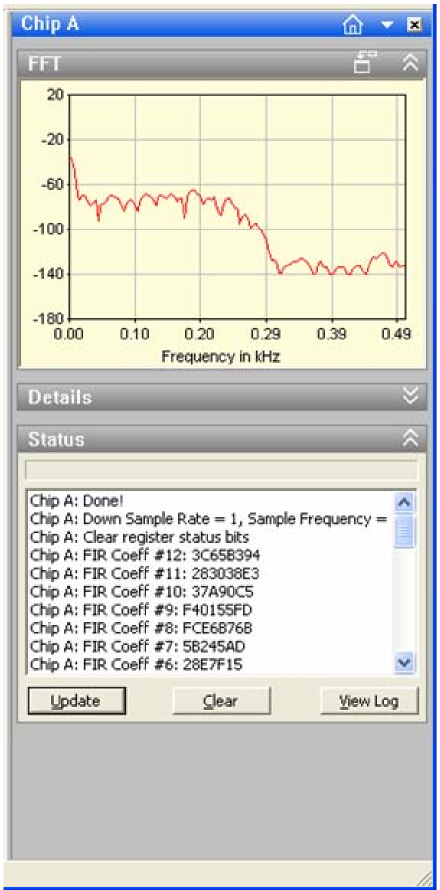


Figure 20a

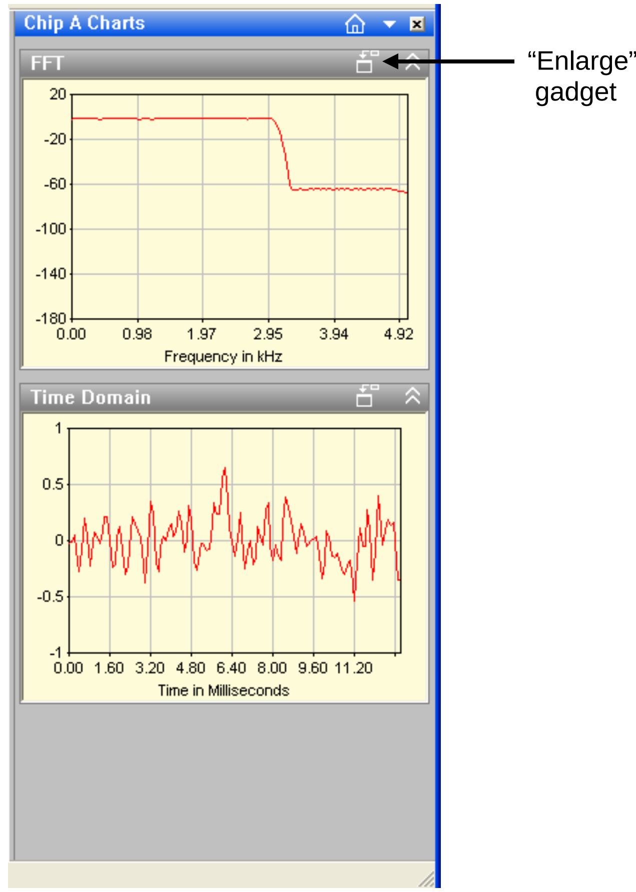


Figure 20b

Chip A Charts

A third option, selectable from the drop down or the View menu, is Chip A charts (Figure 20b). This is simply a way to view the **FFT** pane, previously described, and a **Time Domain** pane at the same time. The time domain display is similar to an oscilloscope plot, although the data displayed is collected in bursts rather than continuously.

Additional Panel Options

When a dual chip configuration is chosen, additional panels are available showing the corresponding information for Chip B. There are also three comparison panels which allow you to view both FFTs simultaneously, compare the logs for both chips, or compare the chip details for both chips.

As always the panel to be displayed can be selected via the dropdown at the top of the panel or from the **View** menu.

8. Downloading a Configuration

Once you have created a configuration it is time to download it to the board and see how well it works in hardware!

Just click on the "Start" button (Figure 14) and the software will download the configuration to the chip(s).

An alert window may appear as shown in Figure 21:

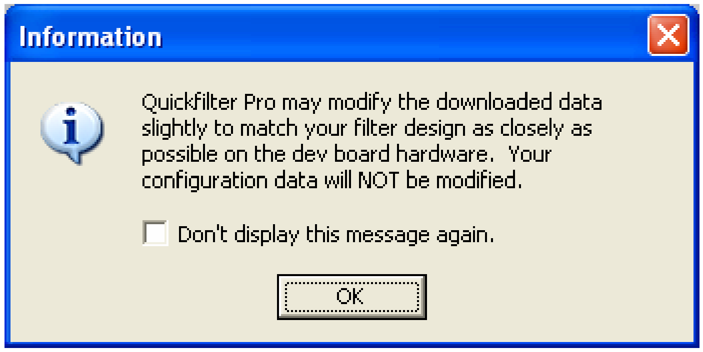


Figure 21

This is advising you that your configuration as designed will be modified before download to the development board. This will result in a slight change (increase) in sampling rate to match the hardware capabilities of the board. To ensure the frequency characteristics of your filter are not changed the filter coefficients will also be recalculated. Occasionally this may result in a problem if the recalculation requires more taps than the original and you are already close to the maximum number of taps available. This situation can be circumvented by using the "Chip Downloads" option (Section 12).

Note: Even if the configuration downloaded to the development board has been modified the configuration file itself will remain unaltered.

Just dismiss the message by clicking "OK", you may also want to check the "Don't display again" box to avoid seeing this every time you download.

The download will now proceed. You may notice text scrolling by in the status window while the download takes place, the FFT pane should come to life and show a response plot from your filter, and you will notice some LED activity on the development board itself.

(The uploading and downloading LEDs will blink whenever data is being transferred to and from the board, the LEDs corresponding to the 2 QF1D512s on the board, D1 and D2, will blink whenever the chips are active).

To achieve a meaningful FFT response you should ensure there is a signal being fed to the development board. A white noise .wav file is installed with the software and you should see a shortcut to this file on your desktop. Double click on the shortcut to start the playback. Also ensure that your media player is set to continuously repeat this file. A continuous noise from your PC speakers will confirm the .wav file is playing correctly.

Using the supplied BNC cable and adapter connect the audio out on your PC to the BNC jack on the development board labeled "ADC". It may be necessary to adjust the volume control on your PC to produce an optimum display.

The FFT display has been scaled to indicate approximately 0dB in the passband when the board is fed with a white noise source. Consequently if an alternate signal source is used, for example a tone generator, you may see values of up to +20dB within the pass band. If the displayed levels are significantly less than this you may not have enough amplitude at the input. On the other hand, if you overdrive the input you may see less than expected rejection in the stopband and/or "jumping" of the trace in the stopband. The board default configuration is ac coupled and will provide optimum performance with a +/-1V peak to peak signal at the input.

FFT Display

A larger view of the FFT is available by clicking on the **Enlarge** gadget in the title bar of the **FFT** pane (Figure 20).

A new window will open that you can re-size and/or re-position as required (Figure 22)

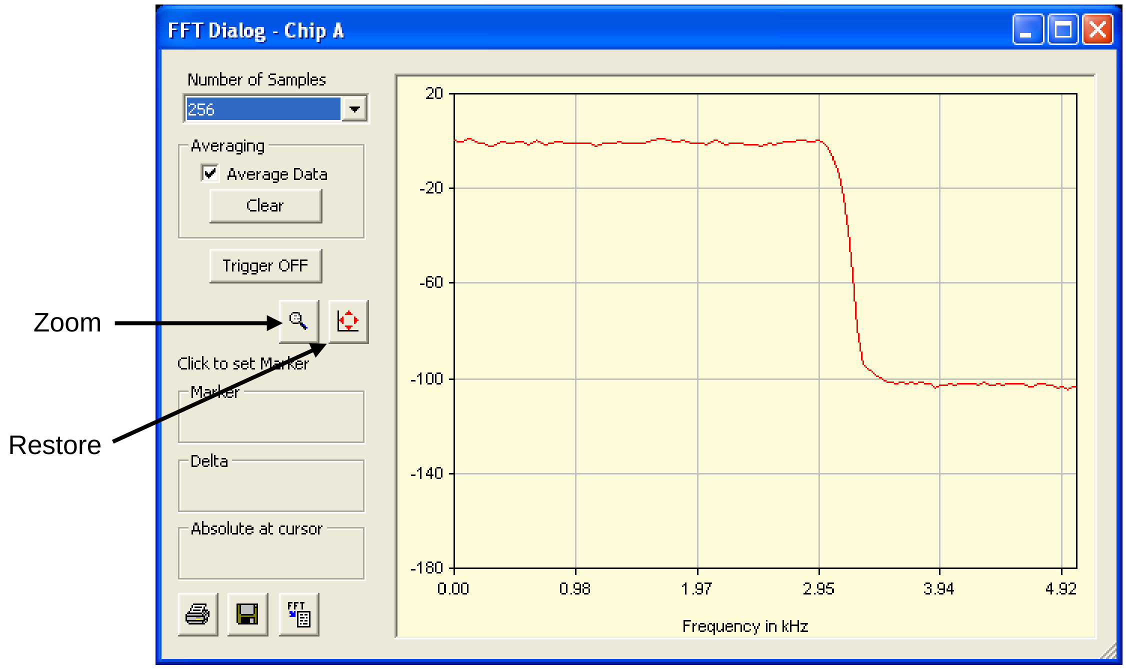


Figure 22

The "Number of Samples" dropdown is automatically set by the software to provide a reasonable refresh rate for your chosen sampling rate. Use the dropdown to select a number from 256 to 8192. The more samples you choose the more detail you will see, however the refresh rate will be correspondingly reduced.

The FFT computation produces a somewhat "spiky" response. The "Average data" checkbox will average the data over successive samples to produce a smooth plot indicative of the actual filter response. You can restart the averaging process by clicking on "Clear", to turn off averaging altogether uncheck the "Average Data" box.

The "Trigger OFF" button appears by default. The display will update continuously as new samples are received. You can turn off the collection process until the "Trigger" pin (on J5 of the development board) is connected to ground at which time the data will be sampled. This is useful if you are using an external ADC and you want to synchronize the sampling interval. Click the button to activate the external trigger function, at which time the button becomes renamed "Trigger ON", and will remain in this state until it is clicked again.

The next two buttons allow you to zoom in on the filter. Click on the Zoom icon (magnifying glass) and your pointer becomes a magnifying glass. Click and drag to define a box around the part of the chart of interest (Figure 23). When you release the mouse button an enlarged image will result (Figure 24).

To restore the display to normal size click on the Restore icon.

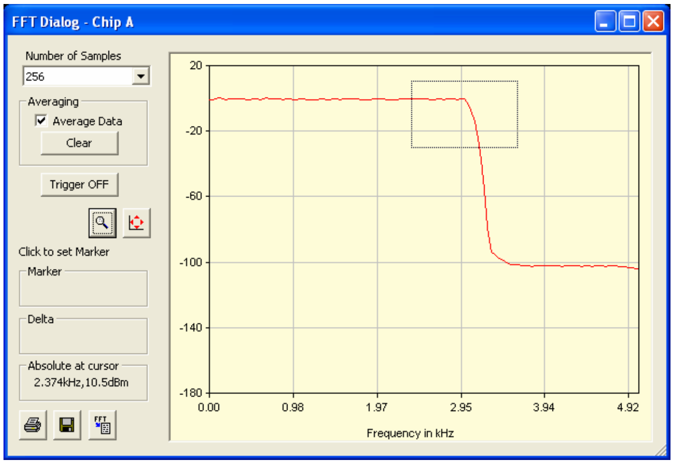


Figure 23

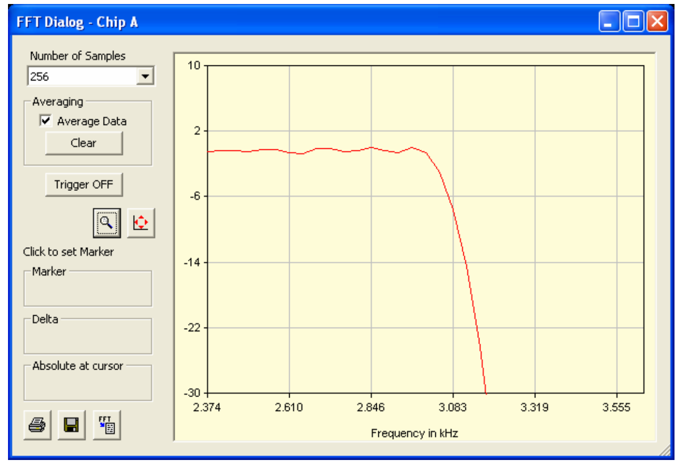


Figure 24

The marker functions are also useful. In the example shown (Figure 25) we have clicked on the knee of the filter resulting in a blue marker cross (circled), then we have moved the mouse pointer down to indicate an area in the stopband.

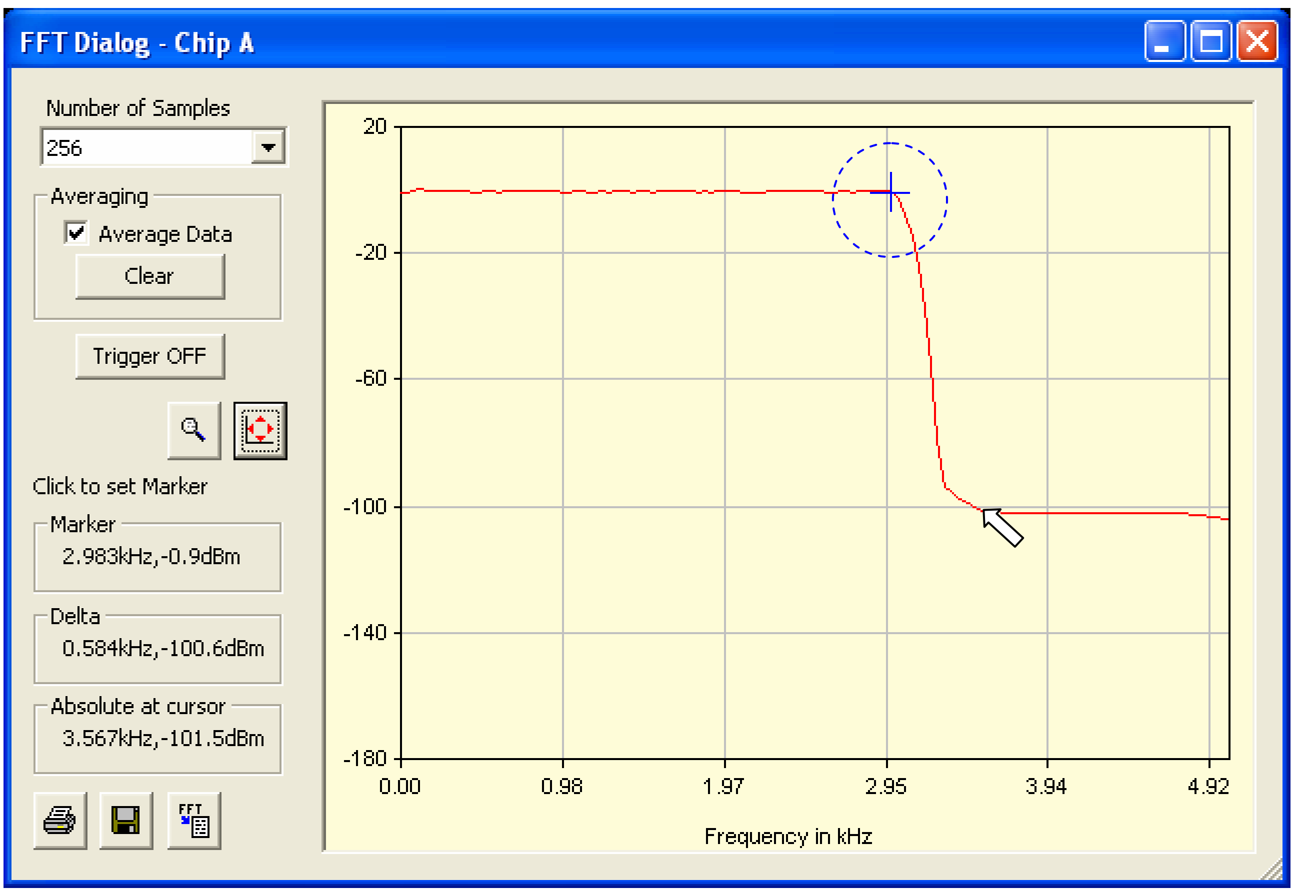


Figure 25

The **Marker** box shows we placed the marker at 2.983 kHz at a point -0.9dB down. In the **Delta** (from marker) box we see a value of 0.584 kHz and a rejection of -100.6dB. In other words, the mouse pointer is at a level 100.6dB less than the marker, and at a frequency 584Hz higher than that of the marker. We can compare these values with the parameters we selected when the filter was originally designed. The third box, **Absolute**, is simply an indication of where the pointer is in the plot.

At the bottom of the window are 3 more icons (Figure 25).

The first will **print** the chart to your selected printer. The second will **save** the chart as a bitmap image file (you will be prompted for filename and location). These are useful features for you to document your design.

The third icon, **FFT**, saves the computed FFT values for each frequency bin in a text file. If you were to plot these values in Excel, for example, you would recreate the chart as shown.

Much of the above functionality can also be accessed by right clicking on the FFT plot itself (either the enlarged plot or the smaller version in the Information bar). When using a dual mode one of the options on the enlarged plot is "Transparent Window". This makes the background of the plot transparent and you can position this window on top of the window for the second chip allowing you to overlay the response of both devices.

Time Domain Display

If you select Chip A Charts (figure 20) a time domain display is available. Like the FFT display it can be enlarged by clicking on the enlarge gadget. The resulting chart is similar in many ways to the FFT display (Figure 26) and can also be resized, repositioned and zoomed etc.

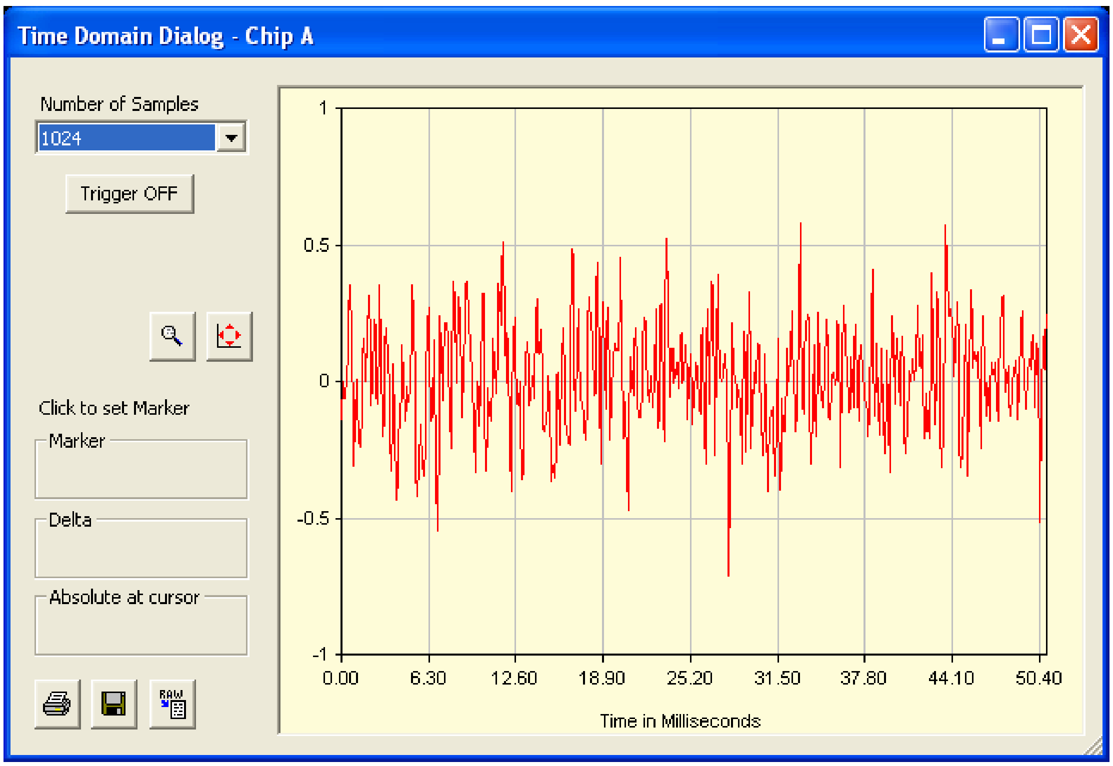


Figure 26

9. Dual Chip Modes

Until now this document has assumed you are working in a single chip mode. However both QF1D512 chips on the development board can be used simultaneously. Using the Target dropdown (Figure 3) you can also choose between dual serial mode and dual parallel modes.

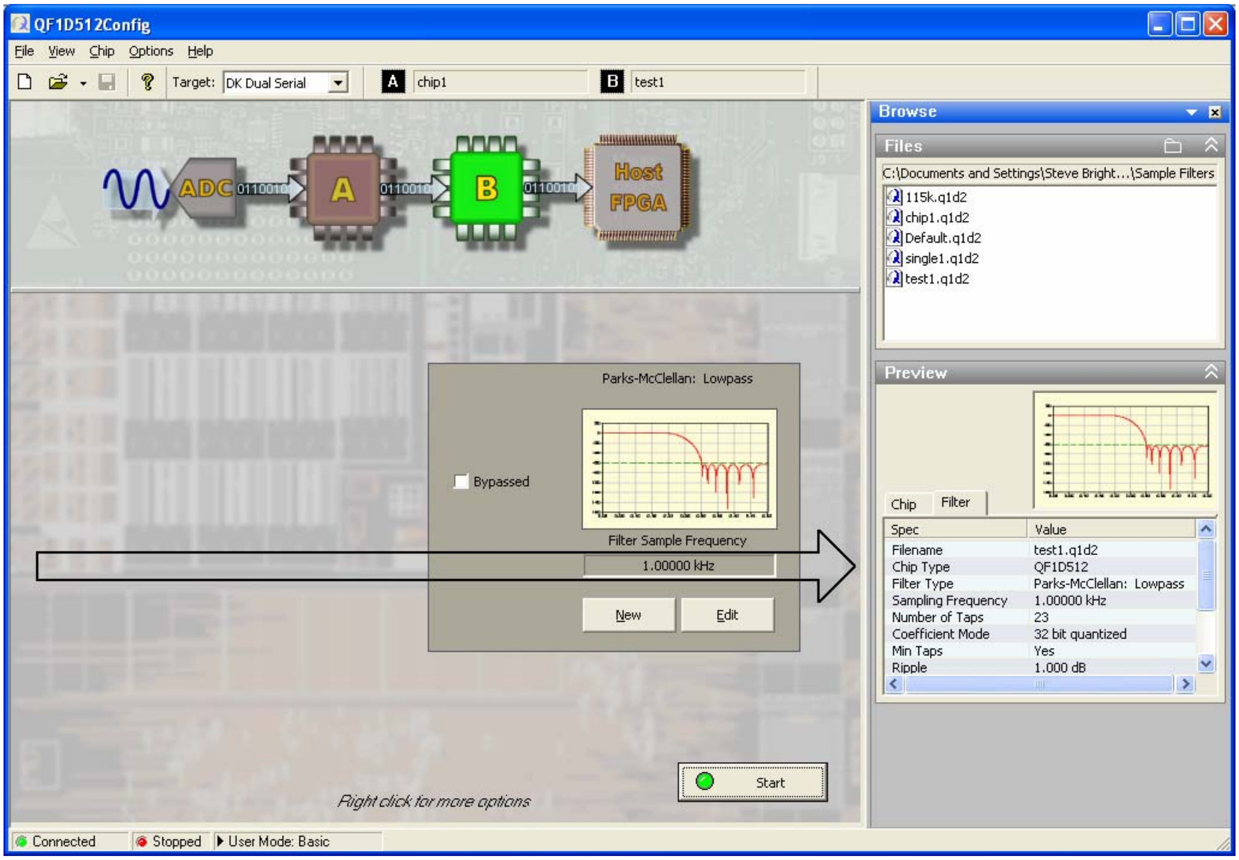


Figure 27

Dual Serial mode has been selected and is shown in figure 27. You can choose which chip (A or B) is active in the Chip Configuration Panel by clicking on it in the Dev Kit Mode schematic. As shown Chip B has been selected and is highlighted in green.

Before running the development board it is necessary to configure both chips, as shown we can see the configuration file names for Chip A (chip1) and Chip B (test1) both appear at the top of the screen.

10. User Modes

Two modes of operation are available, Basic and Advanced. The active mode can be seen at the bottom of the screen in the Status indicators bar. The operating mode can be changed in two ways:

- Click on the triangle next to **User Mode** in the Status bar
- Click on **Options** in the menu bar

Advanced mode is used to access advanced configuration options including downsampling and the ability to configure for different ADC types and data formats. These are explained in more detail in the following sections.

ADVANCED OPERATIONS

11. Chip Configuration Panel

A number of new options are now available (Figure 28)

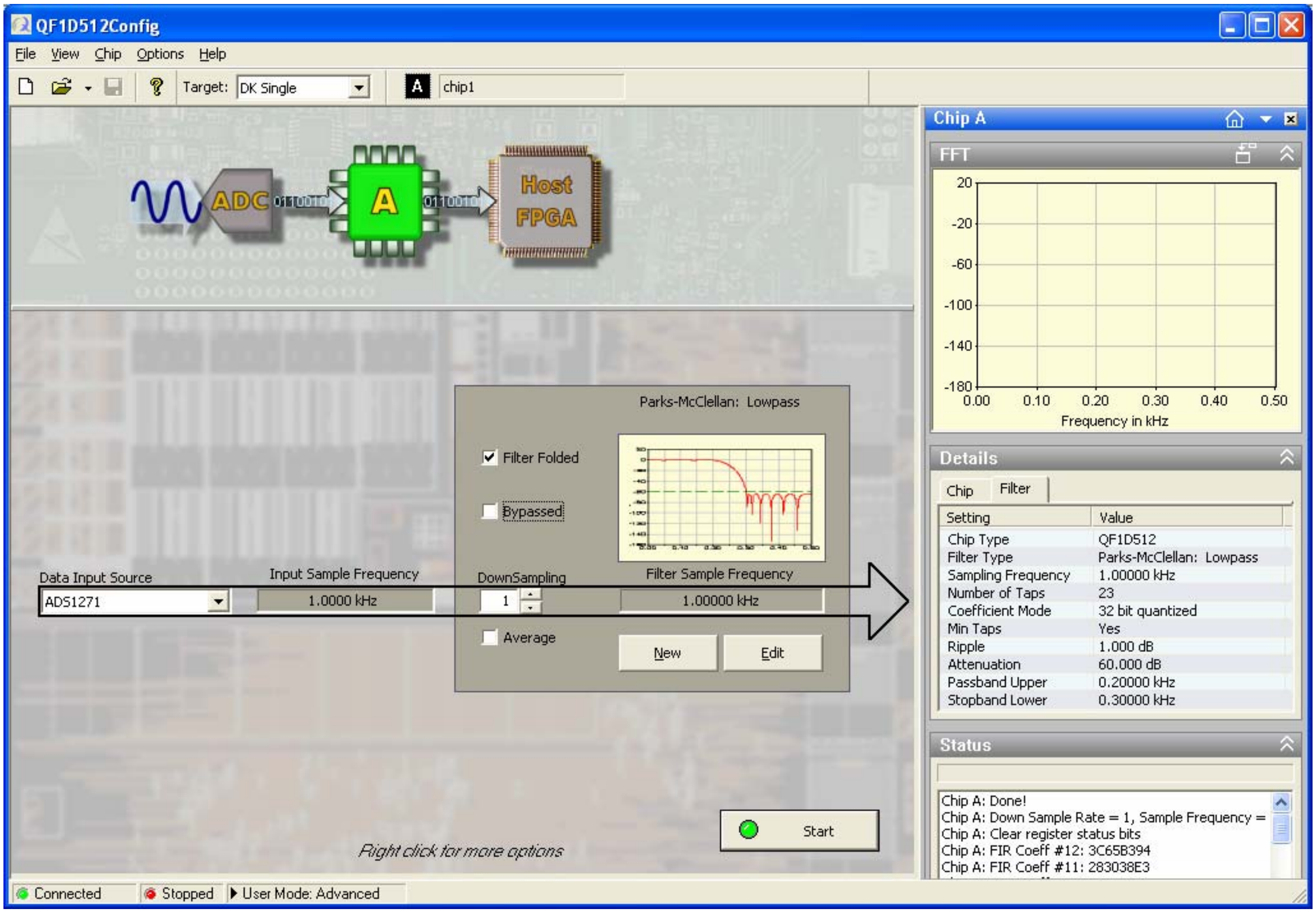


Figure 28

Filter Folded

This box is checked by default. Folded means the coefficients are symmetrical allowing a 512 tap filter to be implemented with 256 coefficients. For an asymmetrical filter (uncheck Filter Folded) only 256 taps are available. Leave this box checked unless you import coefficients for an asymmetrical filter from another program, e.g. Matlab.

Downsampling

Set to 1 by default the value can be set anywhere from 1 to 256. When set to *n* only every *n*th input sample is filtered. However the output data rate remains the same, each filtered result will be output *n* times.
The result of downsampling will be seen in the displayed values for **Input Sample Frequency** and **Filter Sample Frequency.**

Average

This will produce output data that corresponds to the average over *n* input samples, where *n* is the value entered for downsampling. The average of the first *n* input samples will be output *n* times, and then the average of the next *n* samples will output *n* times, and so on. When averaging the value of *n* must be a power of 2, the software will prevent entry of invalid values.

Data Input Source

This is now a dropdown (Figure 29) whereas it was just an information box in Basic mode (Figure 2). Initially the on-board ADC, ADS1271 will be selected. Additional ADC types may be added in the future utilizing input configuration files supplied by Quickfilter. These files will be located by using the Browse option in the dropdown. In the future it is planned to release a software upgrade allowing user configuration of additional ADC types which can be externally connected to the development board via J3 and J5.

One alternate option is always available. **Coprocessor** is used to simulate an application where a host processor provides data to be filtered to the QF1D512 and reads back filtered data. To verify the filter performance for this application a text file is used containing a series of raw data values. These values are input to the QF1D512 and the filtered results displayed as an FFT. When Coprocessor is selected a filename box appears along with **Browse** and **Clear** buttons allowing the user to select the input file. A default white noise file, QFwhitenoise.txt, is available in the ADC directory, which was installed with the software. You will also note that the Dev Kit Mode Schematic changes to reflect this configuration (Figure 29).

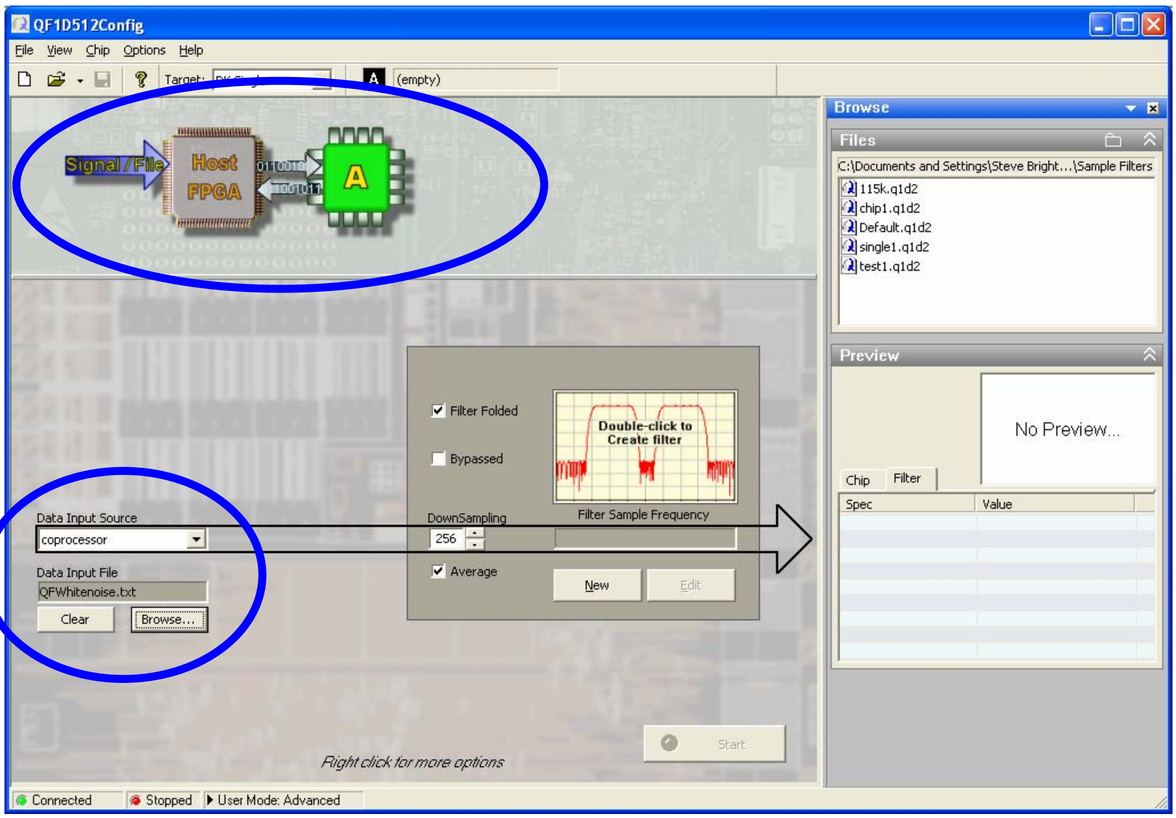


Figure 29

Note: Once you have selected an alternate ADC source the directory path will appear in the status indicator bar.

12. Chip Download Options

As described in Section 8, the software will by default modify your configuration as needed before downloading to the development board to match constraints on sampling rate imposed by the development board hardware itself. It will then recalculate the filter coefficients as necessary to still achieve your desired filter characteristics.

In some circumstances it may not be possible to recalculate the filter coefficients within the 512 taps available, or to meet the desired specifications. In this case an error message will be shown. However, if you still wish to download your filter and see what the response looks like you can override the recalculation by selecting "Advanced Download

Options" from the **Options** menu (Figure 30), and selecting "Optimize configuration for DK, do not recalculate coefficients".

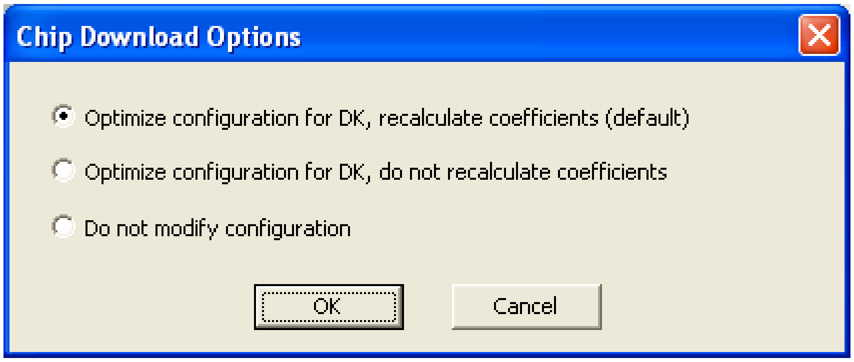


Figure 30

Note: If you choose this option the displayed frequency response will be offset corresponding to the change in sampling rate dictated by the DK hardware.

A third option exists to download your configuration "as is" with no regard to the DK hardware. If this is selected the sample rate will not be altered, nor will the filter be recalculated. However, any changes you made with the Data Format editor or Pin Settings editor will be modified to ensure the configuration will work with the ADC on the development board.

Once you have selected one of the advanced download options you are reminded by the "Advanced Download" message in the status indicators bar (Figure 31). To return to the default setting open up the Chip Download Options dialog from the **Options** menu again.

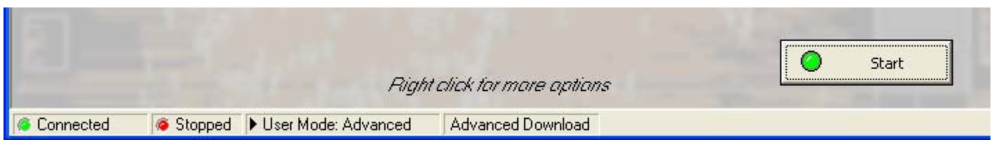


Figure 31

13. Read/Write to Chip

A very powerful option is available to you to assist with debugging your design. From the **Chip** menu select "Read/Write to chip" (Figure 32). From this window you can view and/or modify the contents of all the chip control registers, or coefficient RAM locations.

Use the "View" buttons to choose between the registers or the RAM.

The "Format" buttons allow you to view the contents in either decimal or hex format.

The scrollable window shows a complete listing of the register names, their address, current value, and the default value at power up (Reset value). If you click on a register (NUM_TAPS_0 shown), the individual bit values and their corresponding signal names appear in the window below. Beneath that is a description of the register and the range of allowable values.

You can toggle these values on a bit-by-bit basis simply by double clicking on the current value (0 or 1).

Once you have changed a value(s) you can download this change to the chip by clicking on "Write" and observe the any effects of the change in performance of the chip itself. You can also force a new read of the current chip values by clicking on "Read".

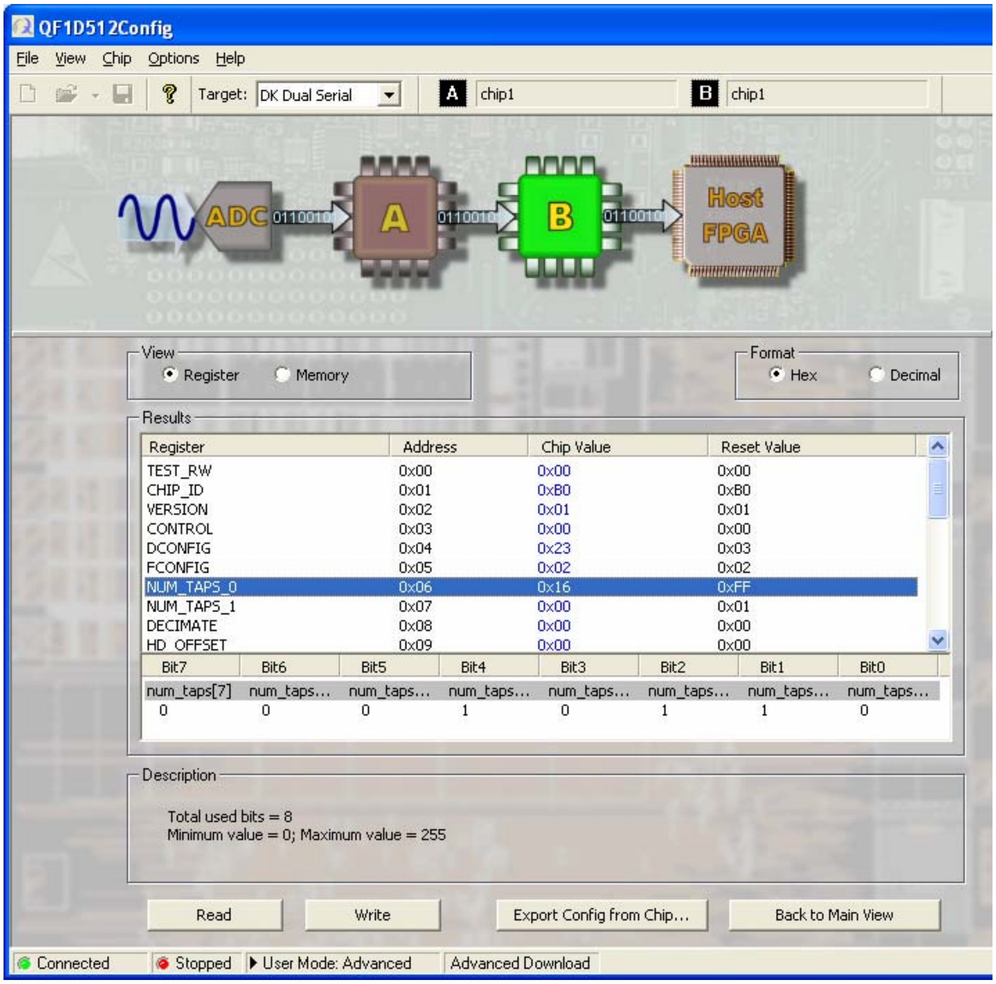


Figure 32

Note: Any changes you make directly to the chip by this means will not be reflected in your currently loaded config or the accompanying image file. If you want to save the results of any changes made here you can do so by clicking on the "Export Config from Chip" button which will create an image file you can use on your target system. See Section 16 for a description of the Export options.

14. Data Format Editor

Next on the Chip menu is the Data Format Editor. The QF1D512 is flexible enough to be used with almost any serial output ADC. To accomplish this we must program the QF1D512 to filter only the data bits and to ignore header bits and/or other non-data bits in the output data stream. We must also specify the width of the data words, the data format, the particular serial mode in use. If a multi-channel ADC is used we need to specify the specific bit locations for the channel we wish to filter (multiple QF1D512s can be daisy-chained together, each one filtering a different specific channel). All this is accomplished in the Data Format Editor.

When using the DK hardware, specifically the on-board ADS1271 ADC the appropriate settings are automatically loaded when "ADS1271" is selected in the Data Input Source dropdown (Section 11). But what if you want to configure the QF1D512 for use with a different ADC? The Data Format Editor (along with the Pin Settings Editor, Section 15) allows you to specify the parameters you need and save as a configuration file. You can export an image file (see Export, Section 16) which you can then use in your target system to correctly configure the QF1D512 for use with your ADC.

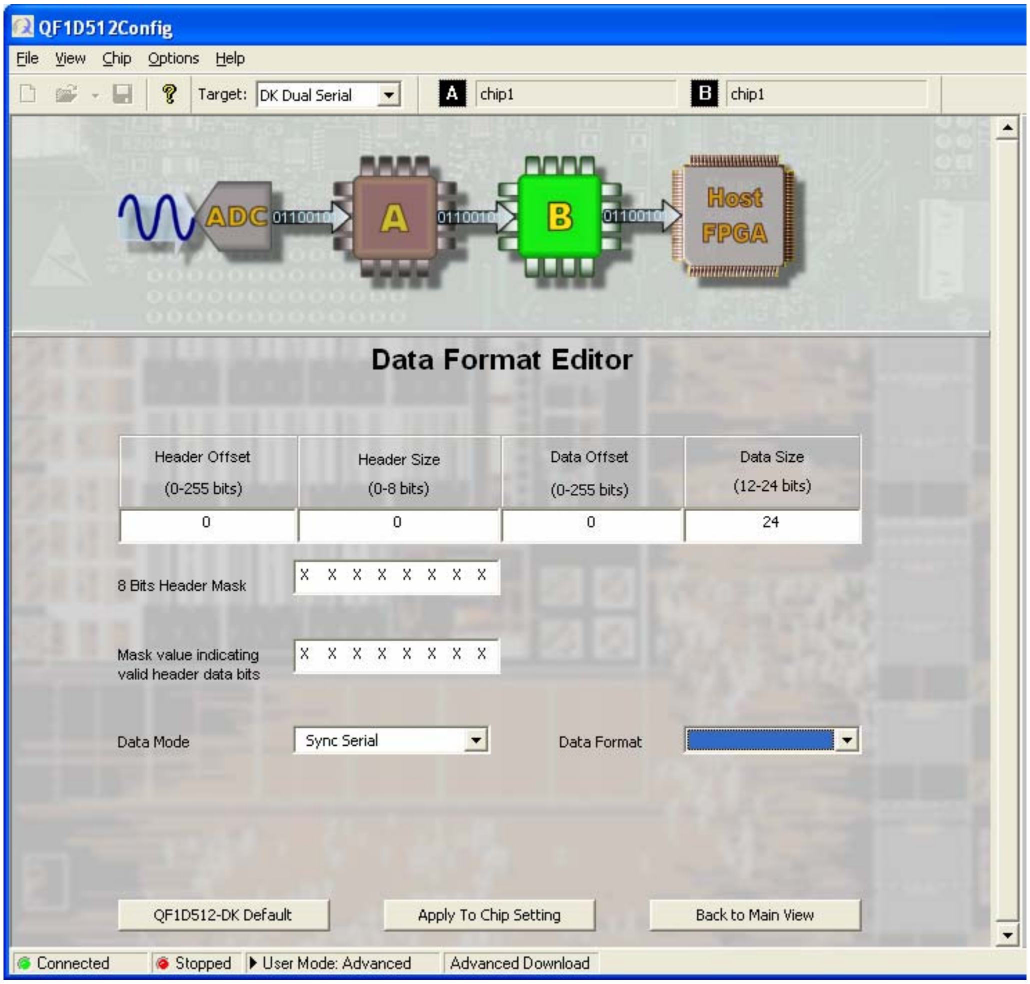


Figure 33

The Data Format Editor is shown in Figure 33. Click into any of the fields (Header Offset, Header Size, Data Offset and Data Size) and type in the appropriate values (from the ADC manufacturer's data sheet).

You may also use header information (if present in your data stream) to determine which data to filter. First click in the **Header Size** box and enter how many bits comprise your header (0-8), then tab out of the field. In the 8-bits Header Mask Box you will now see a number of zeroes corresponding to the header size.

In Figure 34a we show an example using a 4-bit header. In the 8 Bits Header mask box we specify which of the 4-bits we want to examine to determine whether to "hit" on the following data. In the example (Figure 34b) we have selected the first two bits, you can change state of the bits either by double clicking, or single clicking the current value and typing in a replacement value.

Note: Ones in the Header mask only indicate which bits are examined, not the target values.

Now we move down to the Mask Value box. By default the two bits we chose to examine now display as zeroes. We can change the state of these bits by double clicking on them. In our example we have chosen the value 10 (Figure 35). What this means is that in our application we will examine the first two bits of the header and if we see a value of 10 we will filter the following data. Any other value in the first two bits will allow the data to be passed through unfiltered.

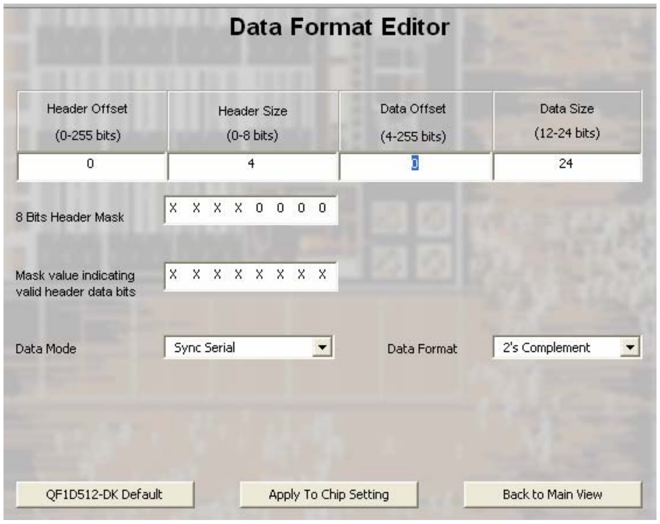


Figure 34a

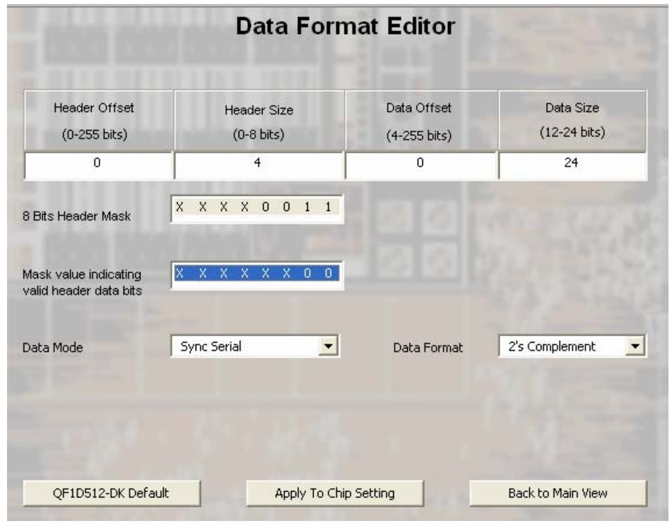


Figure 34b

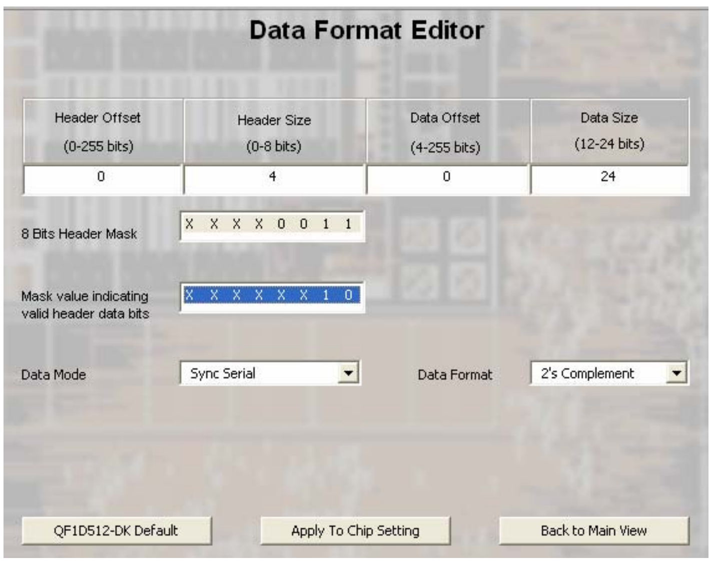


Figure 35

*Note: You may be wondering why we implemented this as two step process and didn't just allow you to specify the target header value in a single box, perhaps using an "X" for bits to ignore. The reason is that the arrangement implemented ties in closely to the actual on-chip implementation. The 8-Bits Header Mask value corresponds to the QF1D512's **HD_MASK** register (0Bh) and the Mask Value corresponds to the **HD_VALUE** register (0Ch).*

The **Data Mode** offers the choice of Normal SPI, Continuous SPI or Synchronous Serial via a dropdown. Please refer to the QF1D512 data sheet for more information on these modes.

The **Data Format** dropdown allows you to select either 2's complement or offset binary.

If you don't want to keep your changes you can restore the development kit default values (ADS1271) at any time by clicking on **QF1D512-DK Default**.

If you want to keep your changes (which will become part of your configuration and will be saved when you save the configuration file), click on **Apply to Chip Setting**.

When you are finished you can return to the main configuration window by clicking on **Return to Main View**.

Note: You also have the option to speed up your development by connecting your ADC to the development board using the expansion connectors, and downloading the configuration you specify here to the QF1D512s on the development board. This option has the added benefit that you can still view the FFT responses of your system from within QF Pro! (see Sections 18 and 19 for more information).

15. Pin Settings Editor

The data format is not the only thing that varies from one ADC to the next! There are also physical differences in the electrical interconnects in terms of active-high or active-low, open-drain or totem-pole output etc. The Pin Settings Editor (selected from the **Chip** menu) provides flexibility in handling these situations (Figure 33).

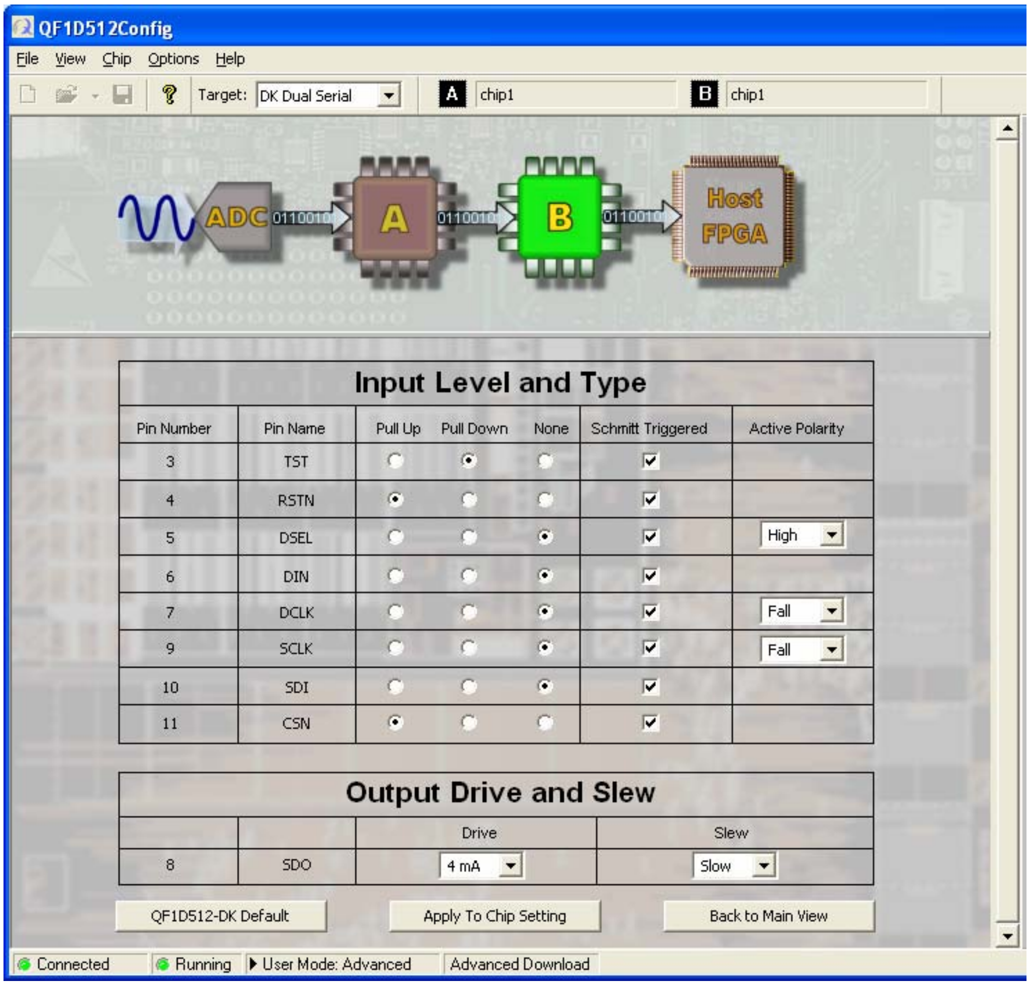


Figure 33

The top half of the editor handles input levels. On the left are the pin numbers of the QF1D512 device pins and their pin names.

For each input pin you have the option of specifying either a Pull Up or Pull Down resistor or none depending on the output driver characteristics of the signal source (open-drain, open-source or totem-pole). You may also specify whether to employ a Schmitt trigger on the input if, for example, the source has slow edges or is noisy.

You may also specify whether DSEL is active-high or active-low. Since DSEL is in effect a framing pulse for the filtered data this is a useful capability. For example, two channel digital audio datastreams typically have a framing signal called LRCLK which is active-high for one channel and active-low for the other. Using two QF1D512 in series, one for each channel, they need only differ in active polarity of this signal to correctly filter one specific channel.

The two clock inputs, DCLK (for data) and SCLK (for configuration), can be set up to be either rising-edge or falling-edge triggered, again to suit your external system.

The output pin, SDO, can be configured for both output drive capability and output slew rate, allowing you to make the optimum tradeoffs between operating speed, power consumption and fan-out (see QF1D512 data sheet).

The three buttons at the bottom of the window work the same way as described for the data format editor. To keep your changes click on Apply to Chip Setting and then save your configuration.

Note: Modifications made with the Data Format or Pin Settings Editors are saved in the configuration file but may be modified before download to the development board (see Section 12). Subsequent use of the Read/Write to Chip window may therefore show different register values than expected. However the saved values will be correct.

16. Export / Import Options

Sooner or later you will want to generate an image for the QF1D512 which you will use to set up the devices in your pre-production and/or production hardware. This image will represent the configuration register settings and filter coefficients for the device. The configuration files you save from within Quickfilter Pro contain not only the parameters you specified to define the chip settings and filter characteristics but also a complete image of the register map and coefficient RAM values.

You can export an image by going to the **File** menu and selecting **Export Image** (Figure 34).

Note: If the Export Image option is not available it is probably because no configuration file has been loaded or saved!

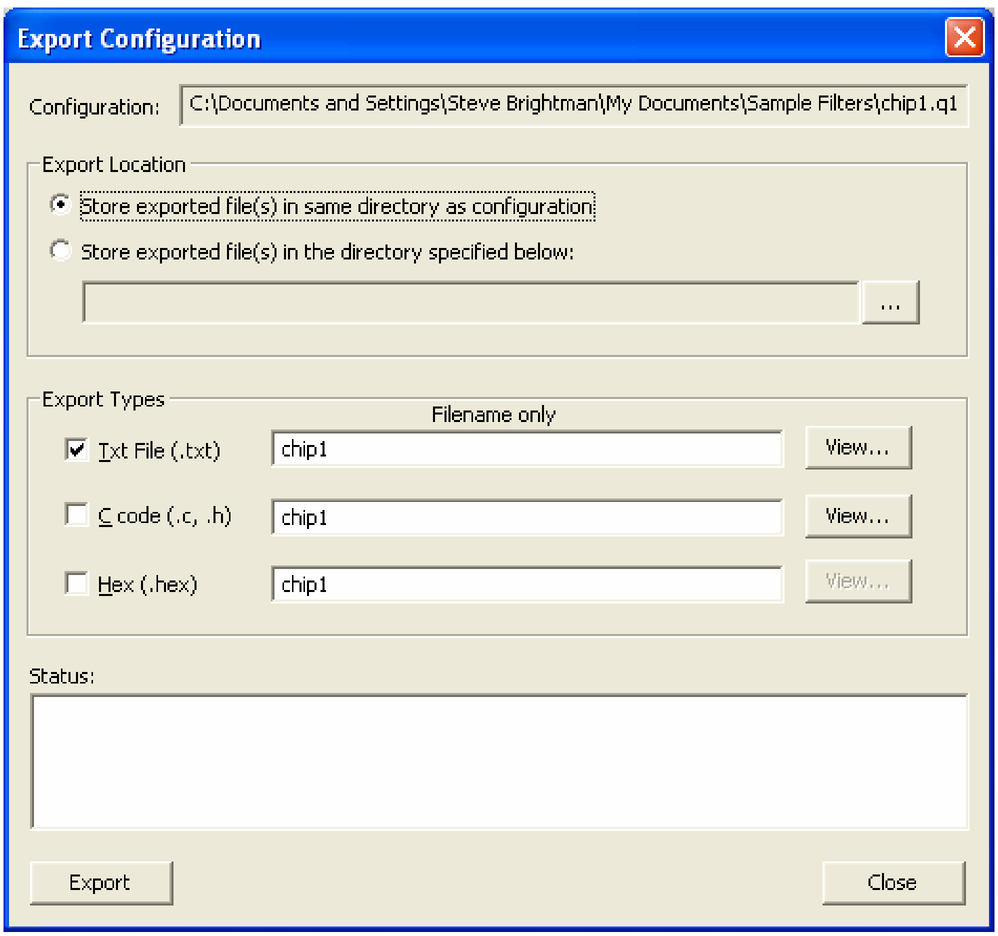


Figure 34

At the top of the dialog is the filename and path for your current configuration file.

The next section, Export Location, allows you to save your image file in the same directory as the configuration file or browse (click the button containing "…") to a different location.

The Export Type section allows you to specify the format of the output file:

The text file option will produce a text file (.txt) with pairs of register and RAM addresses and their corresponding values.

The C code option will output a pair of files (.c and .h) describing the memory locations and values.

The third option is to output the data as a hex file (.hex).

In each case you can specify the desired filename (or accept the default which will be same as the configuration filename).

Check the box(es) for the output format(s) you require and click **Export**. After saving you can view the file you created by clicking on the **View** button. (The View button is inactive until the file has been created by clicking Export).

When you have finished click on **Close** to dismiss the window.

Note: when outputting to .txt or .hex the first 24 values (addresses 00h – 18h) in the output file correspond to register values. The filter coefficients values begin at address 20h in the output file and should be written to on-chip RAM addresses starting at 00h.There may be some non-zero values in addresses 19h – 1Fh which should be ignored.

Importing Images

There is also an option to import an image file. From the File menu select Import Image. A browse window will open allowing you to select the file of interest.

Note: Import is only available for hex files.

Once loaded you will notice the filter thumbnail changes to "Imported" (Figure 35) – the software has no way of knowing from the image file what your filter parameters were.

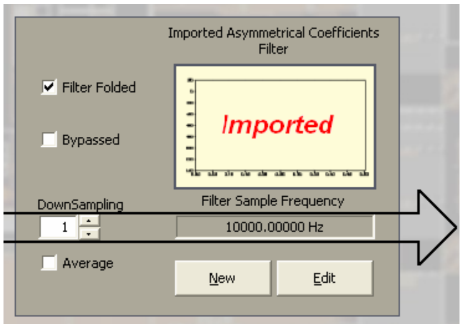


Figure 35

You can view the coefficients of the filter you imported by clicking on **Edit**, but the only edit you can make is to change the sampling rate (Figure 36).

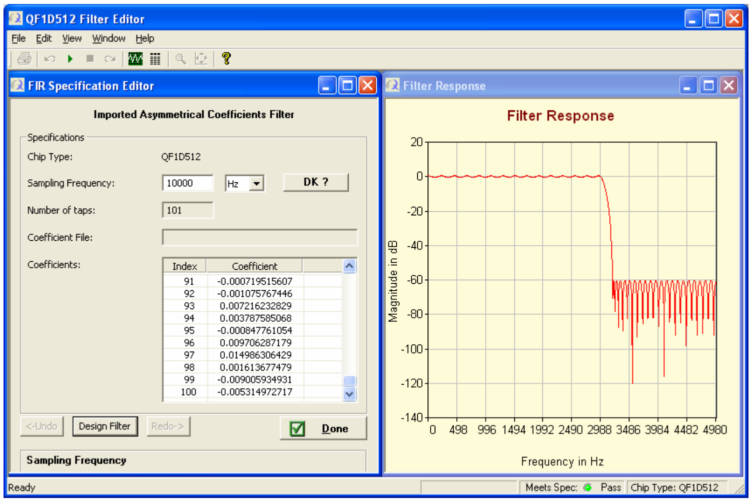


Figure 36

Note: After editing the "Imported" message (Figure 35) will be replaced with the actual filter thumbnail.

17. Disconnect From USB

The options to **Disconnect from USB**, and its complement **Connect to USB** are selected from the Chip menu. The purpose of this option is to allow you to download a configuration to the development board, start the chip(s) running and then release the USB port on your PC. At this point you may elect to run another application which may collect the data being sent from the development board perhaps for display or data logging purposes. This ability is provided to make it easier for you to collect data from the development board without the need to write software to load the chip configurations as well.

18. Advanced Modes – *New Feature for Rev 2.0*

19. External Connections – *New Feature for Rev 2.0*

20. Preferences

Available from the Options menu these settings can be used to adjust how the program behaves at startup, and to adjust personal preferences for appearance.

On the **General** tab (Figure 37) most items are self-explanatory. For Startup Settings, the "Remember last target setting" checkbox will cause the software to start with the configuration (selected with the "Target:" dropdown) that was last in use in the previous session instead of the default "Single" configuration.

On the **Advanced** tab (Figure 38) you can reset all the warning messages you may have suppressed by selecting "Do not show this message again", cause various application settings that are normally saved on exit to revert back to their default values, or reset the colors used for the information bar.

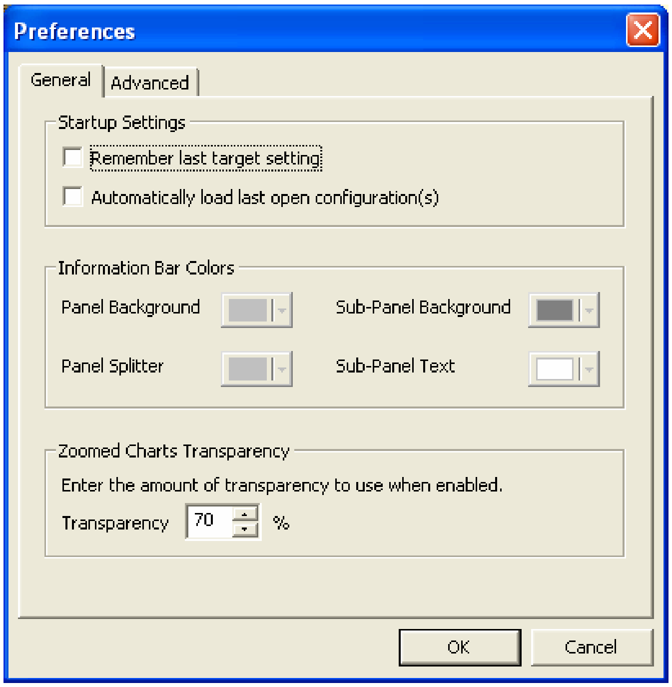


Figure 37

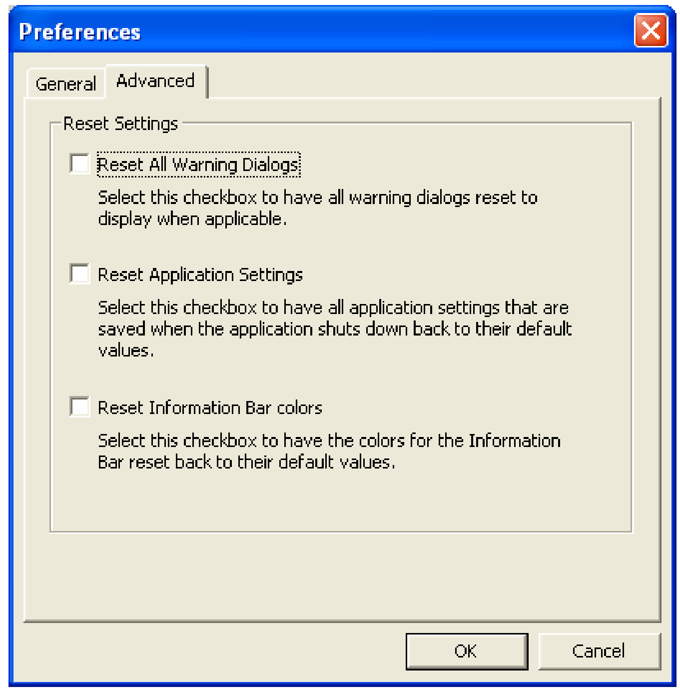


Figure 38

21. Help / Logging

Note: If you mouse over any of the options for any of the menu items a brief description of the function appears at the bottom of the screen in the status indicator bar.

The **Help Topics** option will open a Windows help file which covers the basics of software operation.

Open Documents Folder will open the folder containing any documentation which was included with the software when installed. This includes the readme file, device data sheets, development board schematics etc. You may also find some html shortcuts which will take you to the Quickfilter website allowing you to obtain the very latest information.

Note: If you install a new software revision on top of an existing install some existing, older documentation may remain (e.g. a "known issues" file which may detail issues that have been resolved on subsequent installs). Check the file properties to ensure you are looking at the latest version.

Enable Logging will create a log file, QF1D512Config.log, which may help resolve any issues you are experiencing. Normally you would not check this option unless requested to do so by Quickfilter Applications Support. The default file location is: C:\Program Files\Quickfilter Technologies\QF1D512\Temp (if you installed the application .exe file elsewhere it will be in the Temp directory one level below it).

Note: Another log file, QFChipsDebug.log, is also created in this location and may be requested if necessary by Applications Support. The View Log button in the Status pane in the Information Bar (Section 7) refers to a third log, QFChips.log, which is created when the Start button is pressed and a download to the chip occurs.

Check for Software Updates will cause the program to check the Quickfilter website to see if an update is available. The resulting message will inform you if an update is available and offer the option to visit the website to download the update. The first time you visit the website you will be asked to register, thereafter you need only log in to access future updates. There is no charge for registered users to download updates.

Note: the program will automatically check for updates the first time it is run each day.

About QFFilter can be used to display information about the current installed version of Quickfilter Pro QF1D512.

REFERENCE

22. QF1D512 Registers

Complete register descriptions can be found in the QF1D512 data sheet. This section lists the chip control registers and specifies where in the user interface of the Quickfilter Pro you can set their values. Of course all the registers can be directly accessed from the Read/Write to Chip panel, but the main interface allows you to appropriately set these registers without needing "under the hood" detail of their function, just a basic understanding of the filter you wish to implement.

Address	Register Name	Description	Quickfilter Pro
0000h	**TEST_RW**	Software Register, Test Reads and Writes	Access from Read / Write Chip panel only
0001h	**CHIP_ID**	Chip ID Number	Access from Read / Write Chip panel only
0002h	**VERSION**	Chip Version Number	Access from Read / Write Chip panel only
0003h	**CONTROL**	Mode Control Register	FILT_EN set by QFPro
0004h	**DCONFIG**	Data Format Control	Set by Pin Settings Editor
0005h	**FCONFIG**	Filter Control and Status	Set by Configuration panel - Averaging and folding
0006h	**NUM_TAPS**	Number of Taps, lower bits	Set by Filter Editor
0007h	**NUM_TAPS**	Number of Taps, upper bits	
0008h	**DECIMATE**	Down-sampling Rate	Set by Configuration Panel - Downsampling
0009h	**HD_OFFSET**	Header Offset	Set by Data Format Editor
000Ah	**HD_SIZE**	Header Length	
000Bh	**HD_MASK**	Header Valid Mask	Set by Data Format Editor
000Ch	**HD_VALUE**	Header Valid Value	
000Dh	**DATA_OFFSET**	Data Offset	
000Eh	**DATA_SIZE**	Data length	
000Fh	**TEST**	Chip Test Register	Reserved register – no access
0010h	**IO_TST**	TST Pin Configuration	Set by Pin Settings Editor
0011h	**IO_RST_N**	RST_N Pin Configuration	
0012h	**IO_DCLK**	DCLK Pin Configuration	
0013h	**IO_DSEL**	DSEL Pin Configuration	
0014h	**IO_DIN**	DIN Pin Configuration	
0015h	**IO_CS_N**	CS_N Pin Configuration	
0016h	**IO_SCLK**	SCLK Pin Configuration	
0017h	**IO_SDI**	SDI Pin Configuration	
0018h	**IO_SDO**	SDO Pin Configuration	

23. Configuration Files

Quickfilter Pro saves configuration files with a .q1d2 suffix. But what exactly is a configuration file? How is it different from an image file?

Two of the main functions of Quickfilter Pro are:

- Collect user inputs for the device configuration for a specific application and convert this to suitable register configurations, and,
- Take user specified filter parameters (sampling rate, roll off frequencies, attenuation etc) and convert this to the corresponding filter coefficients.

The resulting set of register values and filter coefficients is called an *image* (see Section 16). The register values are written to registers in the range 00h to 18h, the coefficients are written to RAM in the range 00h to FFh.

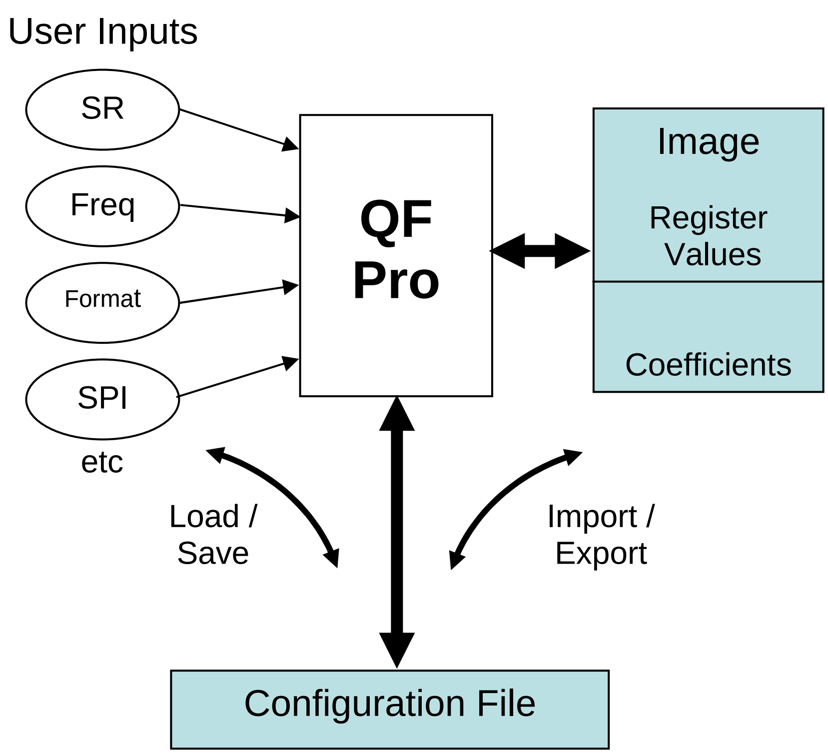


Figure 39

When Quickfilter Pro saves a configuration file it includes all the user-specified parameters as well as the resulting register values and coefficient values (Figure 39). This allows you to load a configuration for editing and already have all your original user inputs in place. That is why if you import an image (Section 16) you only have limited editing options available. In other words a configuration file is a superset of the image file. When you export an image (Section 16) Quickfilter Pro extracts just the register values and coefficient values for output.

Note: None of the registers contain information on sampling rate, and the filter coefficients are sample rate independent! The sample rate is simply a function of the clock frequencies applied to the chip. So, for example, if you design a filter by specifying a lowpass filter with a 1kHz cutoff and a sample rate of 10kHz it is no different than specifying a 2kHz cutoff and a 20kHz sample rate, as far as the register and coefficient values are concerned. It is only in the application, when the appropriate clocks are applied that the frequency characteristics are manifest.

24. Development Board Hardware

Full schematics for the QF1D512-DK can be found in the documents folder created during the Quickfilter Pro install (C:\Program Files\Quickfilter Technologies\QF1D512\Documents). For your convenience you can open this folder from within the program by clicking on **Help** in the menu bar. The schematics can be found in the file name that begins QF1D512-DK-Schematics.

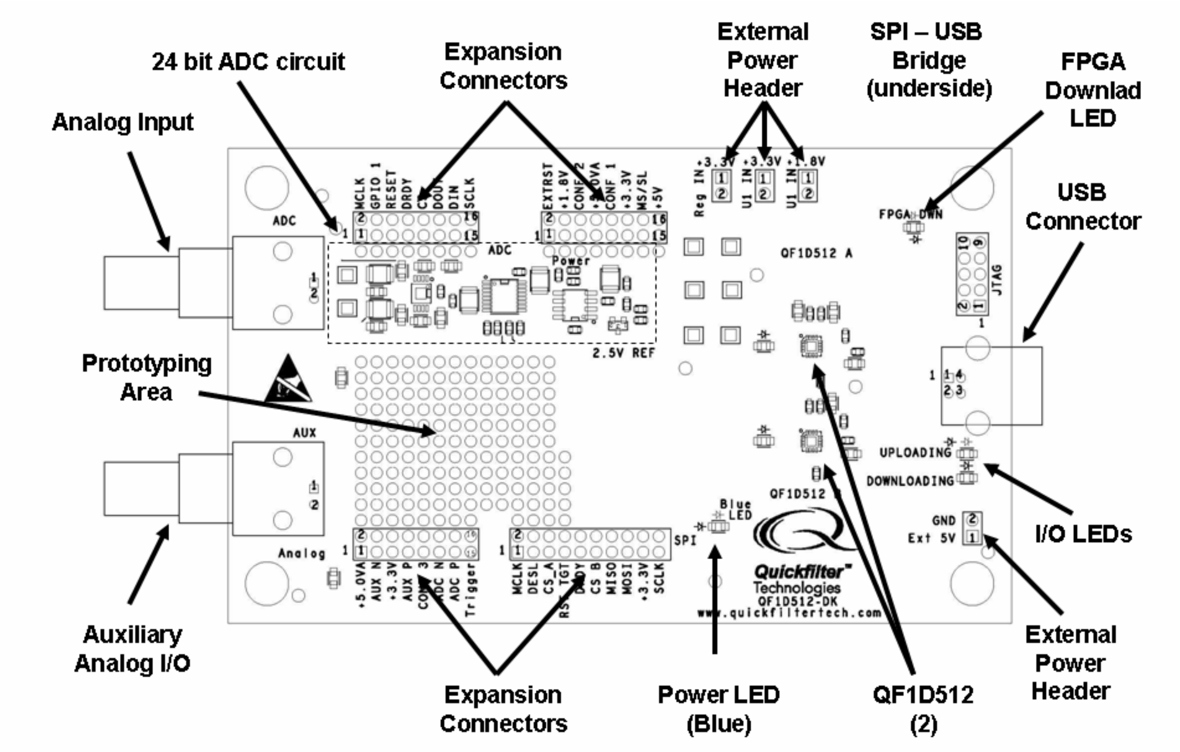


Figure 40

The key features of the development board are shown in Figure 40.

Expansion Connectors (Sections 18 and 19)

J3 and J5 are used to connect either a daughter card (bridging the two connectors) or ribbon cables to connect to an external ADC, DAC or codec. J3 is also used to connect to an external host processor in *data path only* mode.

J4 and J6 are used to implement SPI connections to external host processors in *full control* mode. These connectors provide external connectivity to the QF1D512 chips on the board.

External Power (J7, J10, J11, J12)

The development board is usually powered via the USB connection and features on board voltage regulators to provide a clean supply. However if you wish to provide your own power this can be accomplished via these headers. Please refer to the schematics before using these connectors to ensue no conflicts with the on-board regulators!

Test Points

A number of test points are provided for your convenience. Please refer to the schematics for their location and connection.

24-bit ADC Circuit

The onboard ADC circuit comprises an ADS1271 2-bit ADC and the input is buffered by a TLC072 operational amplifier (Figure 410). As shipped the input stage is configured to be single-ended and ac-coupled, with provision for the user to modify this to suit individual requirements. The components used with the op-amp have been chosen such that a +/1V peak to peak input signal will produce a full scale output from the ADC.

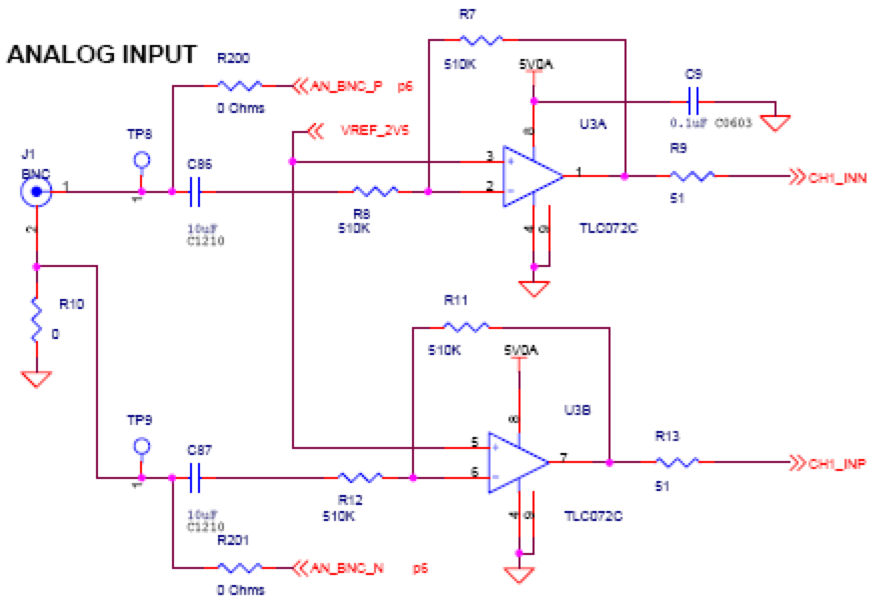


Figure 41

FPGA (underside of board)

The FPGA on the development board serves several functions:

1. Acts as a local host processor for the QF1D512s on the development board.
2. Acts as an interface between the SPI bus on the board and the USB connection to the PC (including buffering of data samples etc.)
3. Controls signal and data path signal routing between the QF1D512s, local host controller, and expansion connectors.

When Quickfilter Pro is started a bit file to configure the FPGA is downloaded to the development board, as indicated by a brief flash of the red FPGA download LED.

USB Connector

The USB connector provides the interface between the Quickfilter Pro software and the development board. A successful connection is indicated by the blue Power LED being on, and a green "Connected" indicator in the Status Indicator bar in Quickfilter Pro.

The USB connection also provides power to the development board.

I/O LEDS

These LEDs indicate communication between the development board and Quickfilter Pro. Whenever the Start button is clicked these LEDs will start blinking once the download is complete and data samples are being collected. You will also notice activity on the green LEDs, D1 and D2, according to whether Chip A or Chip B (or both) have been started by Quickfilter Pro.

Auxiliary Analog I/O (BNC)
This connector is provided for future expansion and is connected to the J3 header. Depending on your configuration this could be used as a second analog input source or an analog output.

Analog Input (BNC)
This connector is used to provide an analog signal input to the on-board ADC circuit. A BNC cable and BNC adapter is provided with the Development Kit to allow you to feed this input from the sound card on your PC. Alternatively you can feed the input from a signal generator or your own analog sensor circuitry.

Prototyping Area
This area of the board is provided to facilitate implementation of your own analog interface circuitry or any other system components you wish to connect to the board.

Section Index

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