



# QF1D512 and QF1Da512 SavFIRE® Implementing Multiple Channels in One Device

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## 1) Introduction

The SavFIRE digital filter processors can easily be configured to apply a single filter to multiple digital input data streams. This application note describes the methodology for designing the filter (using the QF1Da512-DK development kit), creating the configuration data for download to the device, and defining the control of the input data stream to obtain the desired results.

This same technique can be used in both the QF1D512 and also the QF1Da512.

## 2) Summary

### Step 1:

Setup the configuration of the QF1D512 as if you were using just one channel. It is preferable to use a symmetric filter (which is what our tool builds anyway). A symmetric filter used in a multiple-channel application must have an odd number of taps (i.e. there will be a center tap). If you choose to use an asymmetric filter, you will need to use half the taps of a symmetric filter.

For sample rate, use the rate your data would come in for each channel. Don't multiply up. For example, if you have four channels coming in at 1 KHz each, build the filter with a 1 KHz sample rate, not 4 KHz.

Assuming the use of a symmetric filter:

- If you are using two channels, the filter is limited to a maximum of 255 taps.
- If you are using four channels, the maximum is 127 taps.
- If you are using eight channels, the maximum is 63 taps.
- If you are using sixteen channels, the maximum is 31 taps.

Again, remember that for a symmetric filter, you must use an odd number of taps.

### Step 2:

Save the coefficients to a file. You will be opening them in an Excel spreadsheet.

### Step 3:

Enter zeros into between the existing coefficients. Not before or after, just in between the coefficients. The number of zeros you insert depends on the number of channels you use. If you are using four channels, interleave three zeros. For six channels, interleave five zeros.

Save these as a txt file and use the import function of our tool to bring them back in. Ignore the new "filter" you see on the screen. The software is assuming only one channel will be passed through the filter, but this is not the case in your application.

## Step 4:

In sending data to the chip, the data from the various channels need to be interleaved. Thus you would send channel one on the first clock, channel two on the second, and so forth.

## 3) Concept

As an example consider three channels of data being sent to the device. At the time  $t$ , where  $t$  is the input sample time, a sample  $x(n)$  is in the “newest” location in the input sample buffer and  $x(n-k)$  is the “oldest” location. Then the calculated output  $y(n)$  is for filter 1. When the next input arrives and the data values shift, the data values of one of the data streams lines up with the non-zero coefficients and these contribute to the calculated output for that stream. The data values for the other data streams line up with zero coefficients and do not affect the output. Each data stream, in sequence, contributes to its filtered output stream.

The graphic below illustrates the coefficients and data points to be multiplied and accumulated at input data times  $t$ ,  $t+1$ ,  $t+2$ , and  $t+3$  for the three data streams, and the resulting filtered output data stream. The first sample out is associated with channel 1, the second with channel 2, the third with channel 3, and then the cycle repeats beginning with the next channel 1 sample.

Note that the total coefficient space is  $m$  times the number of taps of the filter. For example, with an asymmetric filter and with the 256 taps in the coefficient space of the QF1Da512 and three data channels, there would be up to 85 taps available for the filter. With a symmetric filter, and three data channels, the filter would be able to use up to 170 taps.

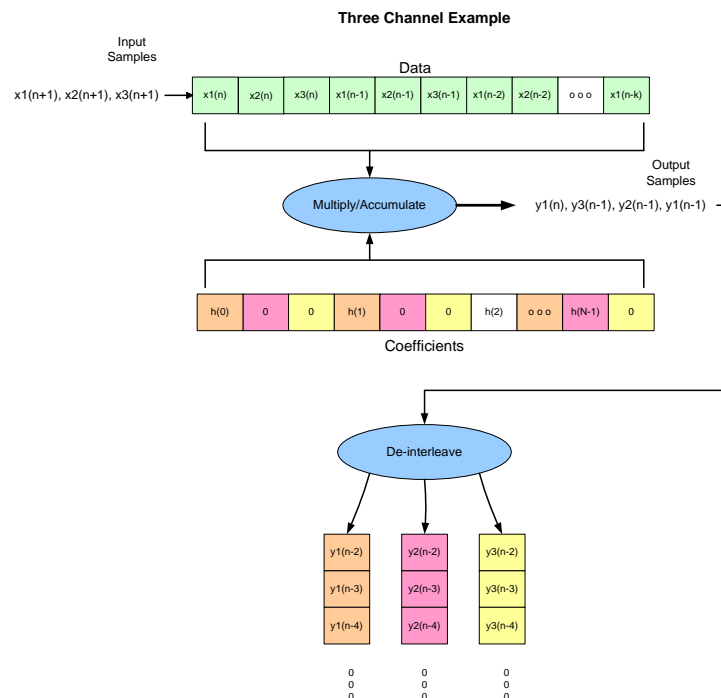


Figure 1. Three-Channel example flow chart

## 4) Design Considerations

The SavFIRE can be programmed to execute multiple channels of data using a single filter if the following conditions are met:

- 1) The total coefficient space of 255 (asymmetric) or 512 (symmetric) coefficients is not exceeded. Again, remember that for symmetric filters, you must use an odd number of coefficients.
- 2) The data samples,  $D_S(n)$ , where  $S$  is the data channel identifier (0, 1, 2 ...  $m-1$ ), and  $n$  is the data sample number (0, 1, 2 ...  $N-1$ ), are interlaced into the data stream in alternating sequence. Thus the data samples for channel 0 are placed in locations 0,  $m$ ,  $2m$ , etc.; data samples for channel 1 are at 1,  $m+1$ ,  $2m+1$ , etc.
- 3) The effective input sample rate ( $m$  times the original data sample rate) cannot exceed the maximum input sample rate of the device (500K samples per second).
- 4) The following table illustrates the maximum number of taps per channel and the maximum sample rate per channel for multiple channel configurations.

# of Channels / Filter type	Max Taps (per filter)	Max Sample Rate Per Channel
1 / symmetric	512	500 KHz
1 / asymmetric	256	500 KHz
2 / symmetric	255	250 KHz
4 / symmetric	127	125 KHz
8 / symmetric	63	62.5 KHz
M / symmetric	Integer (511 / M)	500 KHz / M
M / asymmetric	Integer (256 / M)	500 KHz / M

**Table 1. Number of Channels, maximum number of taps, and sample rate.**



## Application Brief

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