Tirna Analogue Filter Module is Cost-effective for Small Production Runs

Despite the relentless advance of digital techniques, it's still an analogue world and we still have sensors which output an analogue signal leaving the designer to condition it. This conditioning normally entails analogue filtering prior to digitisation in order to prevent aliasing of frequency components beyond ½ the sample rate (Nyquist's low-pass sampling theorem).

Thanks to the ready availability of various software packages, the design of a good analogue filter is a simple process, but how about turning it into hardware? This can be expensive and time-consuming, particularly if your requirement is for small quantities. This is particularly true if you have to design a PCB for your filter and you only need a few for a small production run.

One quick and cost-effective solution is to use a Tirna Electronics filter module which you can purchase pre-built and tested to your specification of filter type, order, cut-off frequency, power consumption and noise performance. Alternatively you can stock up with our bare boards and make your own filters when required. If you do not have filter design software we suggest you download the free software called FilterPro from Texas Instruments. This software does not appear to allow for the finite Gain x Bandwidth Product (GBP) of a real opamp so we suggest you use an op-amp with a GBP of 2 to 4 orders of magnitude greater than your cut-off frequency and aim for a cut-off frequency about 7% above what you actually want.

For example, we designed an 8th order Bessel filter to have a -3dB frequency of 612Hz but had to "tell" the FilterPro software that we wanted a -3dB frequency of 657Hz. To further improve the accuracy we soldered in 5% or 10% capacitors before soldering the resistors and then measured the actual values of the capacitors with an RLC meter. This procedure has the added advantage of accommodating any small change in capacitance caused by the soldering process. The actual values of the capacitors were then fed into the FilterPro software to obtain corrected resistor values from the E96 series (approximately1% spacing). We always use 1% resistors.

We made 20 off the above filters and the 7% correction factor applied for that particular case appears to have given us better than 2% accuracy on the -3dB frequency (or -3dB +/- 0.1dB at 612Hz) when combined with measuring the actual capacitance values and feeding the actual values in the FilterPro software to obtain the corresponding resistor values. This is more accuracy than most users require and, with less demanding applications, bridging the capacitors could be unnecessary, particularly if 5% capacitors are used.

Always take care to use capacitors with a working voltage rating higher than the highest voltage they could transiently encounter in your filter. As you are limited to using 0805 size surface mount passive components with our boards, capacitor values will be limited by the largest values of X7R (or possibly X5R) dielectric capacitors. As a general rule, avoid capacitors which offer high capacity in small volumes as these are made with dielectrics which have poor temperature coefficients or ageing characteristics.

The op-amp we recommend is the AD8674ARUZ. This is a quad op-amp with a 10MHz gain bandwidth product. It works with supplies from +/- 5V to +/- 15V. It does run hot on higher voltage supplies – something which you could predict from Ohm's law. For single sided supply operation we recommend the AD8694ARUZ which operates on 2.7V to 6V. Both chips are available in a 14-pin TSSOP package (0.65mm lead spacing). We can supply these chips already soldered to our un-built filter board on request.