SDR Soundcard Tester

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The key to using a soundcard successfully in digital signal processing or digital radio applications lies principally in the characteristics of the soundcard itself. This applies in particular to SDR (software defined radio) programs that turn your PC into a top-class AM/SSB/CW receiver, assuming your soundcard cooperates. If you want to experiment with SDR and avoid a lot of frustration, it is worth checking first whether the PC soundcard you plan to use is suitable. There are three essential elements to success:

- the soundcard must have a stereo line-level input;
- the card must be equipped with an input anti-aliasing filter; and
- the sample rate must be at least 48 kHz and the card must be able to cope with signals up to 24 kHz.

Many laptops have only a mono microphone input, sometimes also rather limited in bandwidth. In this case it may be possible to use an external USB soundcard.
Most desktop PCs these days have an internal integrated soundcard, although some of these do not feature an anti-aliasing filter. Attempts to disable the integrated soundcard and replace it with a better one often meet with failure; again, an external USB soundcard is a possible solution.

Test circuit

To avoid guesswork, the best way to proceed is to test the soundcard using this very small circuit. This will help to diagnose any problems and will help determine whether the card is suitable for use with an SDR program.

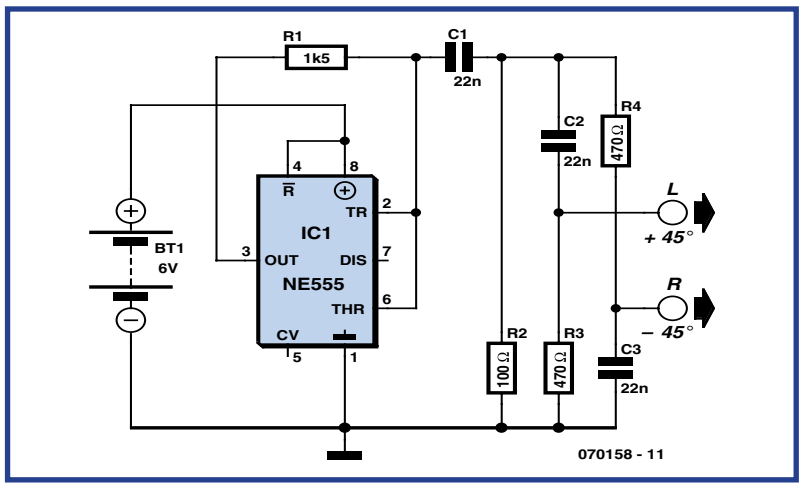

Figure 1. The test circuit to generate I and Q signals.

Figure 1 shows a simple square-wave generator built around an NE555 timer IC. At the output is a 15 kHz signal rich in higher harmonics. Using this we can determine whether or not the soundcard can process the harmonics at 30 kHz, 45 kHz and so on. An anti-aliasing filter at the soundcard input should attenuate all signals above 24 kHz. The frequency of the test generator is, within limits, dependent on its supply voltage. Using an adjustable power supply, a frequency range from 10 kHz to 20 kHz can therefore be covered.
There are two RC networks at the output of the test circuit, a high-pass filter and a low-pass filter, acting as simple phase shifters. At the basic frequency of 15 kHz these provide a total phase difference of 90 degrees, corresponding exactly to the typical situation at the output of an SDR receiver circuit using an I-Q mixer: signals at the same frequency but differing in phase. To test the soundcard we need an SDR program running on the PC as well as the circuit of Figure 1. Suitable software includes SDradio (available for download from http://digilander.libero.it/i2phd/sdradio/). When things are running correctly, the screen should display just two signals: the wanted signal at 15 kHz and a weaker image at –15 kHz (**Figure 2**). Suppression of the image may not be particularly good as the test circuit does not have very high phase and amplitude accuracy. If, however, the signals have the same level, there is a problem in the processing of the two channels: it is probable that the soundcard only has a monophonic input.
If there is no anti-aliasing filter at the input of the soundcard the spectrum will show a large number of extra lines (**Figure 3**): it is easy to work out which harmonic corresponds to which alias frequency. The results obtained using an I-Q receiver were grim: frequencies all the way out to 100 kHz were wrapped into the audible range, resulting in bubbling, hissing and whistling.

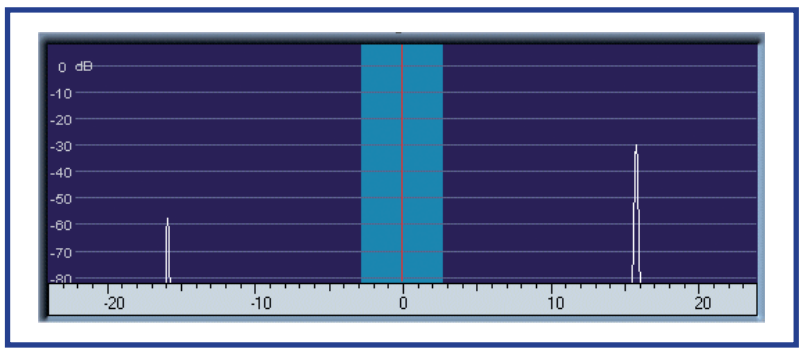

Figure 2. Test passed!

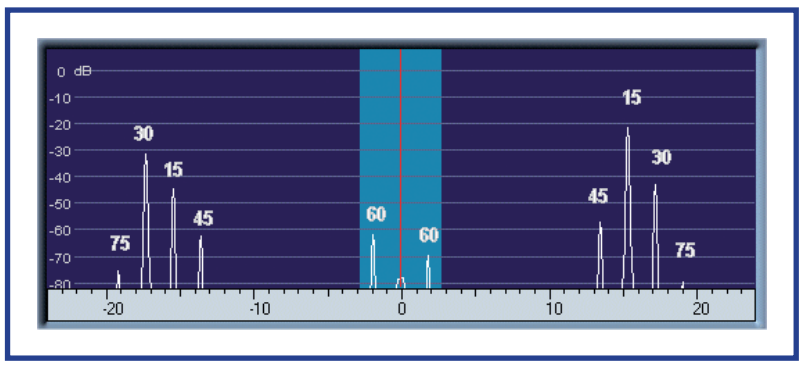

Figure 3. A soundcard without an anti-aliasing filter.

In theory it would be possible to add an anti-aliasing filter to the output of the receiver to allow use with soundcards that are not equipped with such a filter. In practice, however, it is not easy to achieve the required sharp cutoff and symmetry between the two channels. A typical soundcard has a low pass filter set at 24 kHz which by 27 kHz is already attenuating the signal by some 60 dB. This is only practical using digital filters; an adjustable analogue circuit to achieve this performance would be so complex that the simplicity benefits of SDR receiver technology would entirely evaporate.

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