

A simple 40 metre SDR receiver you can build

Neville Marr ZL2BNE <nev@marr.co.nz>

Software-defined radio (SDR) is a radio where components that were implemented in analog are instead implemented by means of software on a computer or embedded in the radio. The software implementation can be at the front end of a radio, the audio processing at the end, or somewhere in the middle.

This article describes my attempt to implement SDR by using readily available software and the simplest hardware possible. I wanted to build a proof of concept radio, not an optimised radio.

I went with a design that produces analog baseband that is fed to a computer soundcard. From there the software does its magic. There's plenty of free software to choose from, I chose HSDR.

An analog radio processes a single signal, a SDR processes that same signal but two versions of it, identical in every respect except one is 90 degrees out of phase with the other. That's the I and Q we read about, I is in-phase and Q is 90 degrees out of phase (quadrature). The software that processes SDR needs both I & Q to do its magic. How is way above my pay grade, all I need to do is generate the I & Q and then HSDR can do its thing.

The figure 1 block diagram will be familiar, it is a pair of direct conversion receivers (DCR). A typical DCR has audio filtering on the output to limit bandwidth to say 3kHz to facilitate single signal reception. This design has no filtering after the mixer so the mixing products will be as wide as you can imagine. The limiting factor is the analog to digital converter (ADC), in my case the ADC is the 192kHz soundcard in my computer.

The outputs of the two DCRs are identical except they have a phase difference of 90 degrees, they are the I & Q required by HSDR.

Hardware

The hardware is detailed in the figure 2 schematic.

First up a stable oscillator is required. I built a Colpitts with a buffer. The crystal is 28.375MHz. The power supply is 5V regulated with a diode for reverse polarity protection. The input voltage can be in the 6-15V range, I use a 9V battery.

Next, generate I & Q. One method is to use a dual flip-flop IC (charming name). Configuring the IC as drawn, the IC generates two outputs that are one quarter the input frequency and each output is 90 degrees out of phase with respect to the other. One quarter of 28.375MHz is 7.09375MHz, bang in the middle of 40 metres, perfect. The two 10k resistors on the flip-flop input assist with clean signal transitions. The 1k and 100R output resistors are a voltage divider to get the signal to a level to suit the mixer stage. The 100n capacitor is also required by the mixer stage.

Before considering the mixers we need something to mix the oscillator with, that's the RF from the outside world. The RF is presented to a toroid which splits the RF for each mixer, the RF presented to each mixer is identical to the RF at the antenna.

The mixers are a NE602. As well as being a mixer the NE602 provides amplification, that's perfect to get the output level up to that required by the computer soundcard.

The computer soundcard needs to be stereo, the mixer I output goes to the soundcard left channel line-in, the Q to the right channel.

And that is it. A simple piece of hardware that allows reception of the 40 metre band, approximately 7.00MHz to 7.19MHz. The hardware provides all the signals in that range and the software shows them on a waterfall and allows tuning, mode selection, and all the filtering you desire.

Outcome. It works. It's not perfect but as a proof of concept it met the brief. Better still, very reproducible for anyone who wants to give a simple hardware build a go.

The parts are mounted on single sided PCB. A scale drawn layout is at figure 3.

Depending on your QTH you may find a front end band pass filter is necessary, particularly to exclude broadcast stations. I connect my board direct to my antenna without issue.

Parts procurement

With the exception of the NE602 all the parts are readily available. I purchased the crystal and flip-flop IC from AliExpress, the rest I had in my collection. I've had good success with AliExpress but I always target established stores that have thousands of followers.

The NE602, NE612, SA602, and SA612 are interchangeable but sadly no longer manufactured. The SA612 is still available in a SMD package from the reputable suppliers. All variants are listed on AliExpress in SMD and DIP packages.

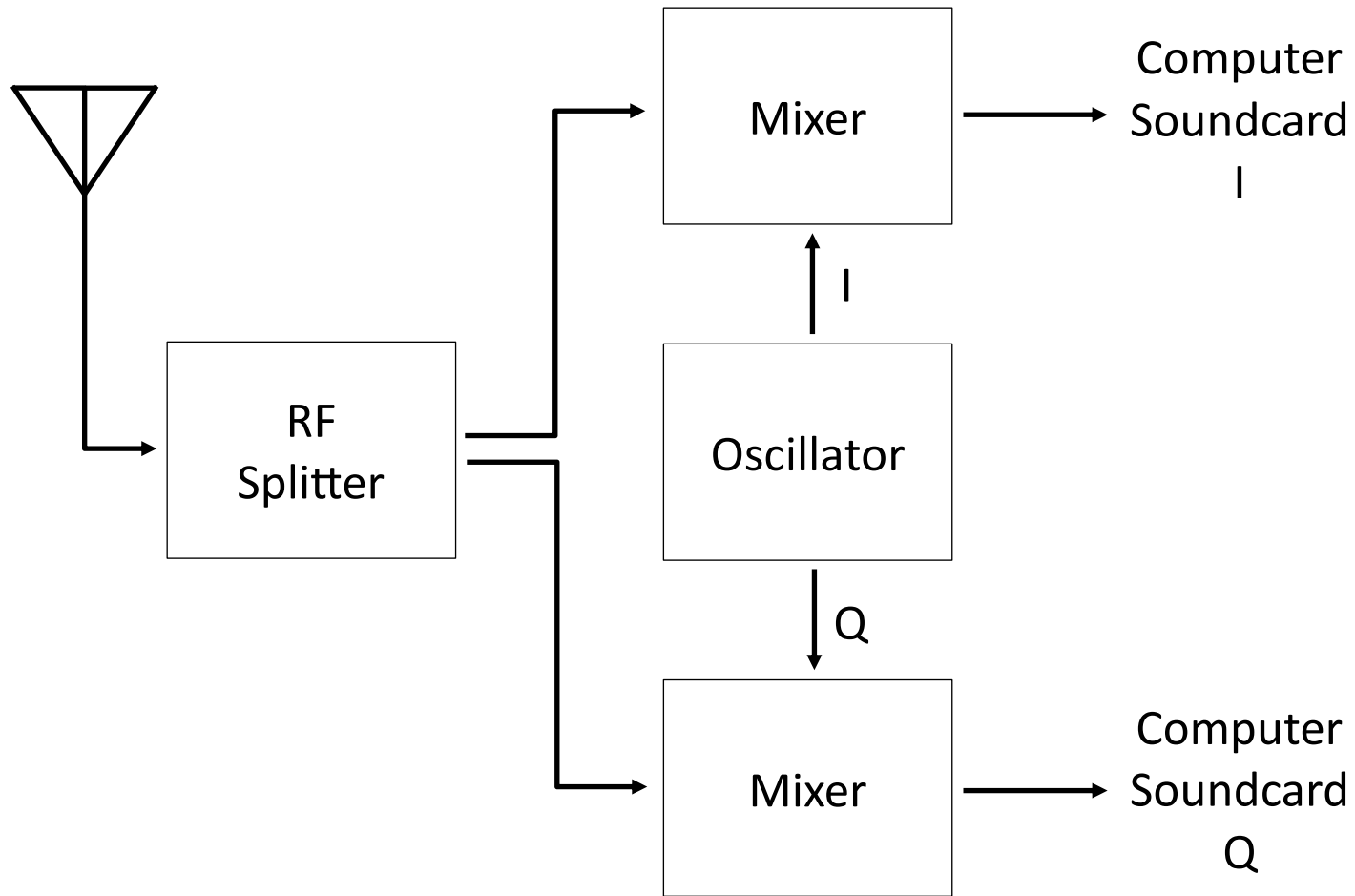


Figure 1