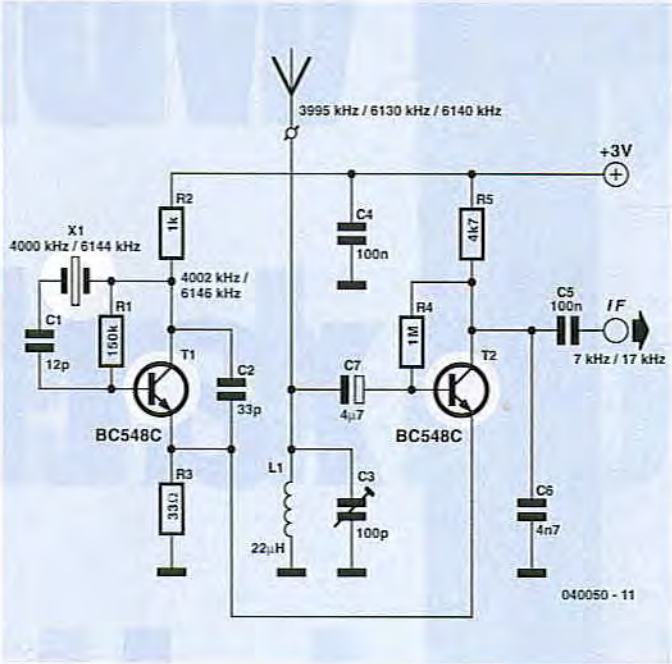

2 Transistors, 1 Crystal — that's it!

Poor Man's DRM is here

Burkhard Kainka

Almost too good to be true but tried & tested: a totally undemanding receiver giving you an opportunity to experience DRM digital broadcasts on shortwave. Digital SW almost for free!

There are a large number of shortwave stations broadcasting not only conventional analogue signals but also digital programme material. This raises the exciting question if there might be stations that 'fit' standard quartz crystal frequencies and so can be captured using the ultra-simple receiver presented in this short article. Ultra-simple? Yes, the receiver consists of nothing more than a direct mixer and a crystal oscillator.

As you could have surmised there are off the shelf crystals that fit the bill (else there would not have been an article). Three shortwave frequencies used by Deutsche Welle (German world service), 3995 kHz, 6130 kHz and 6140 kHz, match the common microprocessor quartz crystal frequencies of 4.000 MHz and 6.144 MHz — that is, with a trick! In each case, the oscillator should run about 2 kHz above the nominal crystal frequency. In many cases, a crystal frequency can be 'pulled' a little by using a load capacitance which is slightly larger than the usual 20 to 30 pF (assuming the crystal operates at fundamental resonance). In our circuit a series capacitor of 12 pF does the job, forcing the crystal to resonate a little above its nominal frequency. It is not terribly important if the actual frequency is 4002 kHz or 6146 kHz.

Inside the receiver the digitally modulated signal received at the DRM station frequency is mixed down into the audio range. This simple operation causes the DRM baseband (which is still digitally modulated) to appear at 7 kHz for the station frequencies 3995 kHz and 6140 kHz, or 17 kHz for the transmitter at 6130 kHz. Decoding these signals on the PC will only succeed if you use the DREAM software for DRM, because this program is tolerant of input frequencies between 0 and 24 kHz. Luckily, DREAM is an open-source program hence does not incur any costs.

It should be noted that the received DRM baseband will need spectrum-inversion. This is because high-side injection is used, that is, the local oscillator operates at a frequency above the station frequency. In the program, activate the 'Flip Input Spectrum' option.

Oscillator and mixer

From a point of view of modern electronics the lower parts of the shortwave bands can hardly be called 'high frequency'. Consequently there are no problems building the receiver from AF / fast switching transistors like the ubiquitous BC548C or BC549C. The oscillator around T1 feeds its output signal directly onto the emitter of mixer transistor T2. Mixing takes place on the curved part of the transistor characteristic. The base gets the RF signal directly from a heavily damped hence wideband input circuit that's tuned for maximum RF with the aid of a trimmer. The upshot is that the DRM baseband is available at the collector. Depending on the available level, the DRM signal coupled out via C5 is fed to the Line or Microphone input of your soundcard for processing by the DREAM software.

Under favourable circumstances (including propagation and the absence of man-made noise), an indoor wire antenna of about 3 metres will be sufficient. Better results are achieved with an outdoor antenna of about 10 m. The Deutsche Welle (DW) transmitters put up usable signal strengths across most of Western Europe. However, if DREAM starts to indicate a poor signal/noise (S/N) ratio (less than 15 dB), look for wideband noise as a cause for signal corruption. Under good conditions, our little receiver supplies an S/N greater than 20 dB. The DRM broadcast schedule on DW may be gleaned from, among others, Stefan Mahn's website at www.drm/info.de

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