AUTOMATIC PRESEL

for our DRM receiver

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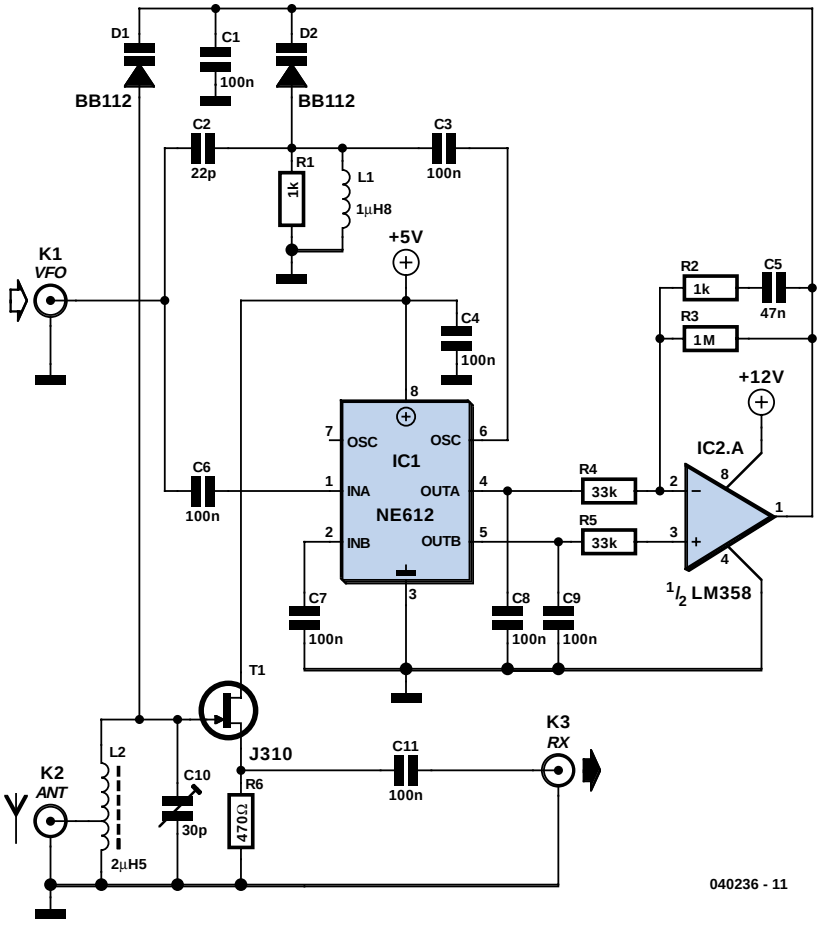
A PC-controlled receiver is very convenient, especially for DRM, since it makes it easy to locate your favourite stations. However, this advantage is lost if you have a manual preselector and must tune the antenna by hand: an automatic preselector is what you need!



With a PLL-controlled receiver things are very simple. The PLL tuning voltage can be used simultaneously to control the first RF stage. Instead of one varicap diode two are used. If DDS tuning is used, then although we have better phase purity, which is a decisive advantage in DRM applications, there is no tuning voltage available for the first stage. What is needed is a circuit to generate a suitable tuning voltage automatically.

Tracking Filter

The circuit can be seen as a kind of passive PLL. Rather than a tracking oscillator, here we have a tracking resonant circuit. The resonant frequency of the circuit is made to track the frequency of the controlling signal.

At the heart of the tracking circuit is an NE612 mixer (IC1) which is used here as a phase detector. The NE612 was used in a similar way by Gert Baars in 'Alignment-free FM Detector'

in the July/August 2001 issue of *Elektor Electronics*.
The controlling input signal can, for example, be taken directly from the VFO pin on the TUF-1 ring mixer in the DRM receiver. This goes directly to the mixer input (pin 1) of the NE612 as well as to the oscillator input (pin 6) via a resonant circuit tuned by a varicap diode (L1 and D2). A DC difference signal is available at the output of the mixer which carries information as to the phase lag between the direct signal and that coupled through the resonant circuit. At resonance the phase difference and hence the differential voltage is zero.

The control loop amplifier constructed around IC2.A controls the resonant frequency in such a way that it tracks the VFO frequency. The output voltage thus automatically follows this frequency as well. The final result is that we have at the output of the operational amplifier a tuning voltage that varies from about 1 V at 5.7 MHz to 7 V at 16 MHz. These values are obtained with a BB112 tuning diode for D2 and a fixed 1.8 μH inductor for L1. The resonant circuit needs to be fairly heavily damped by a 1 kΩ resistor (R1) to prevent the control loop oscillating.
The second varicap diode (D1) receives the same control voltage and thus automatically tunes the first stage resonant circuit formed by L2 and C10. As in any superheterodyne receiver it is not easy to achieve optimal tracking between oscillator and input circuit. The received frequency always lies 455 kHz below the oscillator frequency. L2 in the input circuit is a tunable coil and can be adjusted for maximum sensitivity at the lower end of the tuning range. A similar adjustment for the upper end of the range can be made using trimmer capacitor C10. This should then also give good tracking over the middle part of the range. Our prototype worked without problems from 5 MHz up to 16 MHz.
The first amplifier stage itself is a JFET source-follower built around T1. A BF245 may be used instead of the J310. The resonant circuit is only lightly damped. The voltage gain is determined by the transformer ratio between the antenna input and the resonant circuit. In our prototype we used 15 turns of 0.3 mm enamelled copper wire on a ferrite coil former with a diameter of 5 mm. The antenna tap was on the third turn.

The BB112 has a capacitance of about 500 pF with a tuning voltage of 1 V. Higher values can be achieved by reducing the voltage further, down to nearly 0 V. The disadvantage of doing this is that the Q factor falls rapidly. In practice tuning works without problems in the 75 m band, and so the DRM station at 3995 kHz can be received. In this case the tuning voltage is only around 0.1 V.

Hints and tips

Varicap diodes for AM frequencies are not easy to get hold of. The BB112 can be obtained from Geist Electronic in Germany and from the online shop of the German magazine *Funkamateur*. Equally suitable are the dual tuning diode type BB313 and the similar KV1270NT from Toko. Most of the AM varicap diodes that are still available appear to come from surplus stock. However, they must still be being made somewhere (presumably in China) as otherwise we would have no PLL-based medium wave, shortwave or long wave receivers! There are probably considerably more broken radios thrown away every year than there is demand for varicap diodes for home-built receivers: a few minutes with a soldering iron can prove very worthwhile: see, for example, www.b-kainka.de/bastel99.htm (in German).
Finally, a brief note on using the automatically-tuned preamplifier. In most cases DRM will work perfectly well without preselection. In just a few cases is the SNR significantly improved by preselection. The device is of course particularly useful when there is interference at the image frequency.
However, in AM mode there is a significant improvement. Every dB of image frequency attenuation can reduce interference by 1 dB. For example, the Austrian ORF transmissions on 6155 kHz (Ö1) often suffer interference from strong SSB transmitters in the 40 m band. The automatic preselector completely solves this problem. The effect is even more marked when trying to pick out very weak amateur transmissions from among the broadcast programmes: in this case a tuned preamplifier is essential.

With a little extra effort a second preselection stage can be added for even greater image rejection. Either a two-stage tuneable bandpass filter can be used or a further tuning circuit can be added after the preamplifier, that is, between C11 and the output connector.

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