Forced quenching improves three-transistor FM tuner

Lyle Williams - February 29, 2016

The idea of using a super-regenerative radio to receive commercial FM stations can be found at various locations on the Internet. Because the circuit is so small, it might be impressive to lab visitors, especially to children. But the basic one-transistor circuit shown in **Figure 1** has drawbacks; a better circuit is the subject of this Design Idea.

The super-regenerative circuit is basically an AM radio. But wideband FM is demodulated by using one side of the tuning curve to change FM to AM. While this is a crude way to demodulate FM, it nevertheless works quite well.

Figure 1 Self-quenched one-transistor super-regenerative FM tuner

The super-regenerative tuner is a regenerative circuit that is brought into and out of oscillation at a supersonic rate – for instance, 25 kHz. The rate that the oscillation is switched off and on is called the quench frequency. This frequency should be above the limit of human hearing, but otherwise as low as possible. High quench frequencies reduce the sensitivity of the receiver. The output to the RC integrator circuit is a series of pulses at the quench frequency that are pulse-widt--modulated. The integrator changes this pulse-width modulation to an audio output.

The circuit in **Figure 1** is a self-quenched circuit. It can be difficult to get the circuit to quench and therefore to operate. It may be necessary to select transistors for the highest gain and to select the operating voltage for best performance. In the self-quenched circuit, the output may be distorted. Also, the quench frequency may vary with tuning and it may be too high or too low.

Adding an external oscillator to force the quenching of the circuit solves these problems. A two-transistor astable multivibrator is used for this quenching oscillator. This makes a three-transistor circuit – still quite simple for an FM radio (**Figure 2**). The adjustment of the quench-level control is critical, so a good single-turn potentiometer should be used in this position. The quench frequency of this oscillator is about 21 kHz.

Figure 2 The tuner with forced quenching

The antenna coil is composed of five turns of space wound AWG 18 wire on a 1/4" form. The windings are spaced one wire-width apart, so you can close-wind two windings on the form and then remove one of them. When formed, the coil can be removed from the form. The coil is tapped one

half turn from the 12 volt supply side to make a connection for the antenna. A one meter long wire antenna is sufficient. The 0.04 to 6 pF capacitor is used to tune in stations.

The tuner needs an audio power amplifier. The output level of the tuner is below line level, so an amplifier with a microphone input would be useful. A musical instrument amplifier would work fine due to the high gain guitar input. Another solution is to use the circuit: *Build an op amp with three discrete transistors* in the Design Ideas section of the Dec. 1, 2011 issue of EDN magazine. This amplifier with a gain of ten will boost the output to audio line level.

I listen to an NPR FM station that is mostly talk. The station has two digital auxiliary channels: jazz/classical, and the main channel in HD, all on the same frequency of 90.7 MHz. These extra programs and the stereo pilot do not interfere with the main analog signal as received on the FM tuner described here.

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