A Simple-To-Build Superhet Receiver

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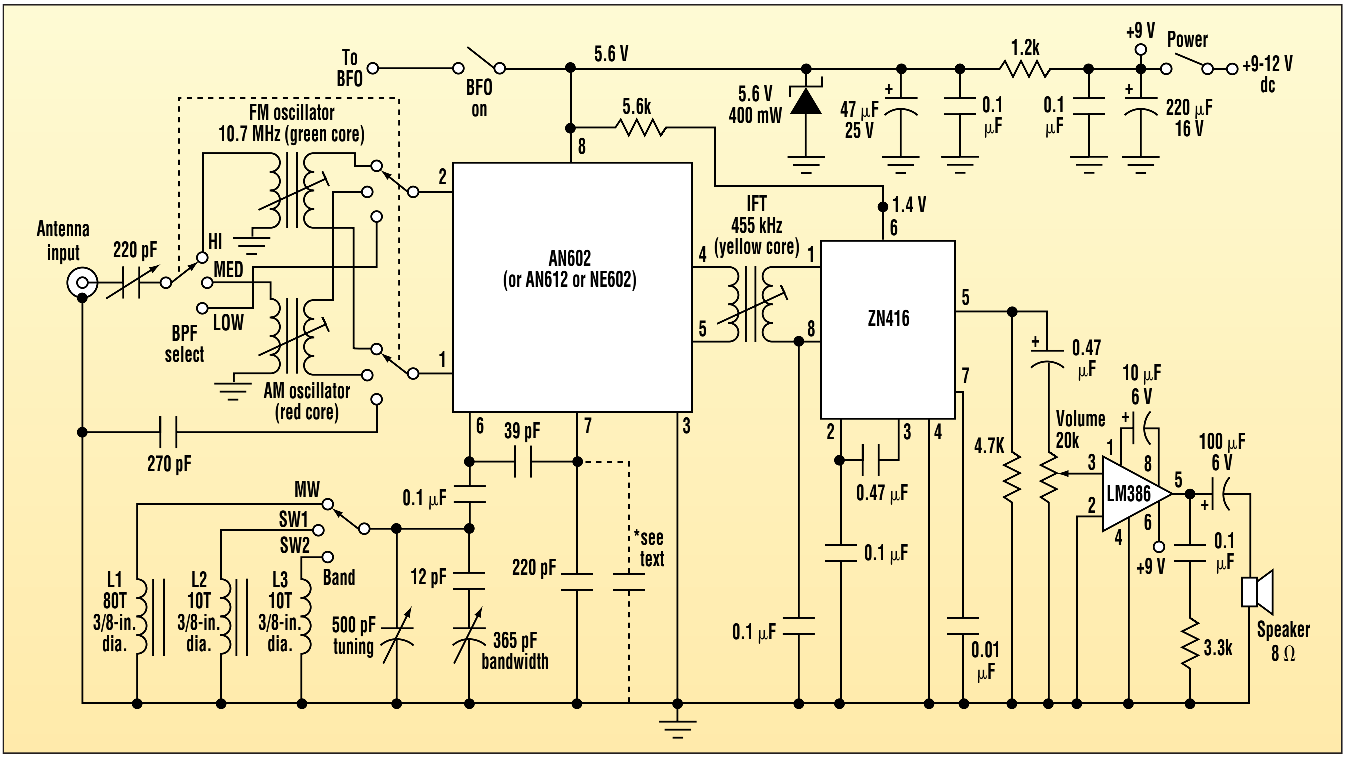
This idea presents a simple circuit for a superhet radio receiver that can be built up in sections, with each section tested before assembly. The receiver circuitry as presented here can be built for less than $50.

Don't be misled—even though the set has some pretty obvious limitations as presented, it's still capable of worldwide reception when connected to a few meters of wire as an antenna. When constructing a superhet receiver need-



1. This simple superhet receiver is based on the AN602 double-balanced mixer IC, which includes an on-board oscillator.

ing just one coil/tuning-capacitor combination, there's the obvious advantage that only one simple coil needs to be made. It also makes the receiver very easy to experiment with by changing the coil dimensions, etc.

In a conventional superhet design, the antenna coil, as well as the oscillator coil, would need simultaneous adjustments. Also, in a conventional set, the tuning capacitor needs at least two gangs, and they must be able to track each other to maintain the sensitivity across the entire reception band.

The receiver is based on the AN602 double-balanced mixer IC, with the big brother of the ZN414 (the 10-transistor radio chip), the ZN416, employed as an IF amplifier, coupled with a standard LM386 audio stage *(Fig. 1)*. Power-supply requirements are 9 to 12 volts dc at 10 mA average (up to 30 mA at full volume).

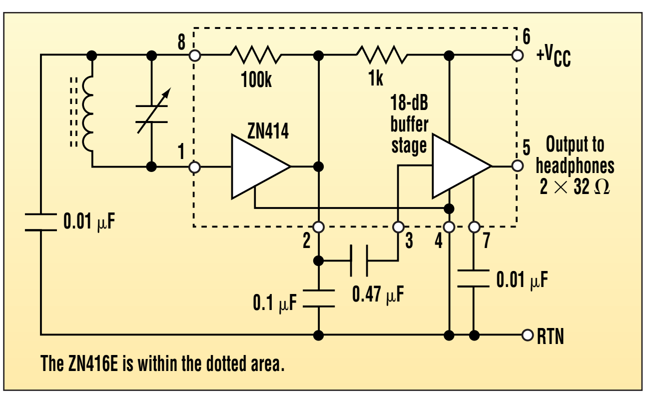
A good mixer design should be very "strong" (i.e., not easily overloaded by strong stations) and it should have significant conversion gain. It also must have a low noise figure that isn't adversely affected by the oscillator injection power level. The AN602 mixer, designed for use with cellular phones with a frequency response in excess of 500 MHz, takes care of all this. It features an on-board oscillator, capable of up to 200 MHz or so, and provides about 18-dB conversion gain.

The internal oscillator can be disabled and an external oscillator used. Of course, if the external oscillator is employed, a digital frequency readout can also be utilized. The internal oscillator may be reluctant to operate below 1 MHz. So, if coverage of the lower end of the broadcast band is desired, add a 22k resistor from pin 7 to ground. This will increase the bias current, but at the expense of making the noise figure slightly worse. The value of the 220 pF capacitor on pin 7 also can be increased to 1000 pF, but the oscillator may refuse to oscillate on the HF bands if the value is too large (the capacitor can be switched using a wavechange switch if convenient).

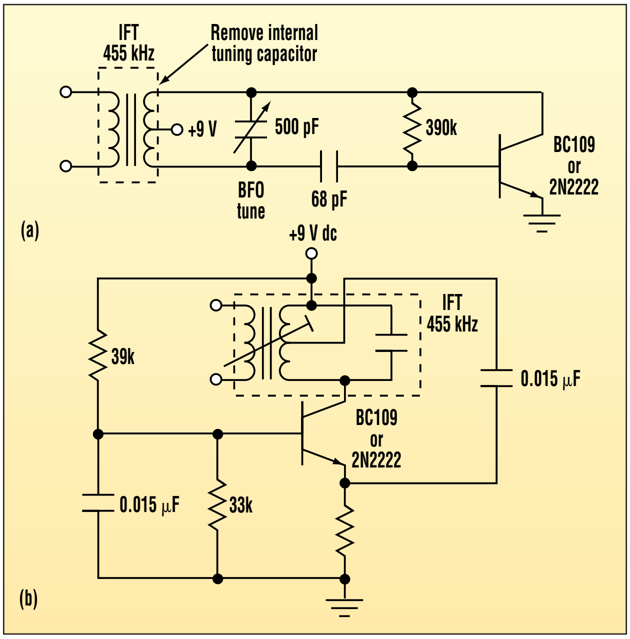
The IF stage is based around a ZN416, which is a ZN414 10-transistor radio with an internal 18-db-gain audio buffer amplifier added *(Fig. 2)*. The IC has internal automatic gain control, as well as an AM detector, and works very well at the 455-kHz IF frequency.

The LM386 is almost a standard chip for audio use. The only caution revolves around the 10-µF gain-setting capacitor. If your LM386 seems a bit too lively, lower it to 4.7 µF to reduce the gain. The audio stage runs at full battery voltage and can fill a room with sound using a 6-in. speaker.

The bandpass-filter (BPF) arrangement is quite simple and is based on some junked IFTs from an old AM/FM clock/radio. One is resonant at 10.7 MHz, while the other is actually the AM oscillator coil. The third position is for direct input, which is particularly useful when operating with a very short antenna. Adding a tuned-RF stage might increase the gain a little, and would tend to reduce broadcast band overload. But, a double-bal-



2. Illustrated here is a block diagram of the ZN416E, which is the "big brother" of the ZN414 (a 10-transistor radio IC).



3. To enable SSB-signal reception, either of these two simple designs for the BFO (beat frequency oscillator) can be used. Both of these designs only require loose coupling to the IF stage, which is done by placing the lead near the ZN416 IC.

anced mixer like this is inherently good with respect to signal overloads.

A double-balanced mixer is symmetrical to ground and completely cancels both the received signal and the oscillator voltages in its output. The signal-to-noise ratio also is improved substantially, and the mixer is made more insensitive to pulling. However, in the prototypes, the oscillators did pull slightly when connected to a very long (greater than 100 meters) antenna.

Several prototypes were built, and a strong image response from the IF stage was evidenced as being sensitive to the oscillator frequency plus the IF, and the oscillator frequency minus the IF. An extra IF stage would cure this, but in view of keeping things simple, it was omitted.

It's not a good idea to try and build too small a radio, unless you're experienced. That's because a lot of gain exists in the circuit, and unless the placement of parts is done properly, instability will result. This is manifested by the set exhibiting a very broad response and band capacitance. Detuning effects also became more pronounced. The best form of construction is a piece of 0.1-in. matrix perf board, rather than copper clad. I used low-profile IC sockets in the prototypes without any instability..

Alignment is very simple. Tune in a station, preferably around 10 MHz (the NIST time station WWV is ideal), and adjust the 10.7-MHz IFT (in the BPF) for maximum volume. The tuning is very broad, so if a peak can't be found, set the core to the center of its travel. Then tune a signal to around 3.5 MHz, and adjust the AM oscillator core (in the BPF) for maximum output. Once again, tuning is very broad and if the core is set in the middle of its travel, all will be well. Finally, tune the 455-kHz IFT for maximum volume on a weak signal on any frequency. The response is broad enough that IFTs probably won't need adjustment from the factory setting. That's it. Pretty simple alignment for a superhet!

In Australia, all of the ICs are available from Radio Spares (RS) components. The AN602 costs about $AU8.00, the ZN416 about $AU6.00 and the LM386 only a few dollars. Component values aren't critical, except for the 1.2k and 5.6k resistors in the voltage-dropping stages, and ±50% values won't adversely affect the receiver's performance.

The set will cover all of the HF ham bands, as well as the International Short Wave stations. To enable the reception of SSB signals, two simple designs for the beat frequency oscillator (BFO) are also presented *(Figs. 3a and 3b)*. Both operate at the 455-kHz IF frequency and will only need loose coupling to the IF stage by placing the lead near the ZN416 IC. If the output is still too high, place a resistor of about 4.7k in series with the power supply of the BFO.