Analyzing that Antique You Bought At the SOARA Auction

By Hal Silverman WB6WXO
SOARA Education Director

Did you ever wonder what is under the cover of that antique you just brought home from the SOARA auction? Last year, I bought a HW22A, 40m, single band, SSB radio at the November, 2007 auction. I was approached by Mike Slygh, KI6IRA, about putting on a seminar showing all of the signals generated in a rig. The HW22A is a perfect vehicle to do this. It is a simple radio and most of the functions are easy to get to with a counter and a scope.

From the time ham radio rigs have been commercially availability, there exists the same overall design parameters. They are:

Receiver sensitivity
Output power
Receiver and transmitter stability
Frequency readability

I am sure that there are other parameters that have become essential over the years. However, for our HW22A, this seems to fill the bill. The radio contains the following circuits that go into either older radios or the new stuff that has a computer wrapped around it.

Amplifiers:
There are a number of amplifiers that have specific functions. Here is a list and what they do.

RF Input amplifier (receiver):
This amplifier takes a weak signal and amplifies it so it can be processed to detect the information. This can be an audio signal, a CW signal, a RTTY signal or a TV signal.

IF Amplifier (receiver and transmitter):
This is an intermediate stage amplifier that operates over a narrow band and is able to filter out unwanted signals.

Audio Amplifier (receiver):
This is the stage that drives either the headphones or the speaker.

Microphone amplifier (transmitter):
As the name implies, this amplifier increases the signal from the microphone input.

Driver Amplifier (transmitter):
This is used to boost the RF signal that has been processed to contain the information to a level that can drive the final stage

Power Amplifier (transmitter):
This is the final stage that delivers a signal to the antenna.

All of the amplifiers described above are contained in our HW22A.

Oscillators:
An oscillator is a frequency generating circuit found in all radios. They can be used in a variety of applications.

VFO

This is a variable frequency oscillator. This oscillator is used to change frequencies to either receive or transmit a signal. In the HW22A the VFO frequency is 1.583 MHz to 1.686.7Mhz. When this signal is mixed with the heterodyne oscillator the resultant frequency tunes between 9.5033Mhz and 9.617Mhz

Heterodyne Oscillator

This oscillator is crystal controlled and is set a fixed frequency. The oscillator being a crystal controlled oscillator is very stable. In the HW22A, the oscillator frequency is 11.190Mhz

Carrier Oscillator

In the HW22A there are two crystals used to set the USB (2306.7 KHz) and LSB (2307.7 KHz). As with the heterodyne oscillator these are crystal controlled oscillators. When USB is selected, then the USB carrier oscillator is used.

Mixers
A mixer is a unique circuit that takes two signals of different frequency at its inputs and produces an output signal with additional frequency components. The additional frequency components are at a frequency that is the sum of the two input signals and a frequency that is the difference of the frequency of the two input signals. In some radios, the VFO is tuned from 5.00 MHz to 5.50 MHz. The VFO is mixed with a 9.00 MHz heterodyne oscillator to yield 14.00 MHz to 14.50 MHz (20m) or the difference will yield 3.50 MHz to 4.00 MHz (75/80m). In the HW22A, there are three mixers.

Heterodyne mixer

This mixer takes the VFO signal and mixes it with the heterodyne oscillator signal (11.190 MHz). In this case the difference frequency of 9.5033 MHz to 9.6167 MHz is generated. The other frequencies are filtered out.

Receiver mixer

In the receiver mixer the incoming signal (7.20 to 7.30 MHz) is mixed with the VFO Heterodyne signal to produce a (difference) signal for the 2.305 MHz IF amplifier.

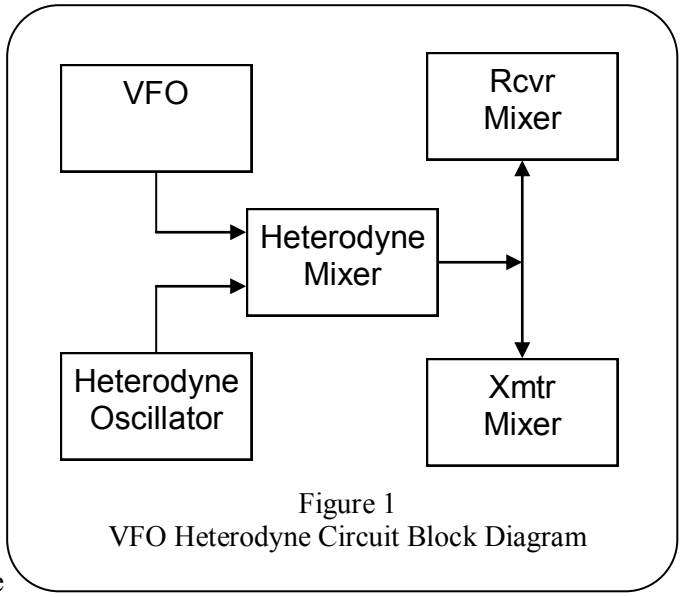


Figure 1
VFO Heterodyne Circuit Block Diagram

Transmitter mixer

The transmitter mixer is mixed with the modulated carrier oscillator. The difference frequency is used to produce the 7.20 MHz to 7.30 MHz signal to be transmitted in the 40m band. The transmitted signal can be USB or LSB depending upon the

where the selector switch on the front panel is set.

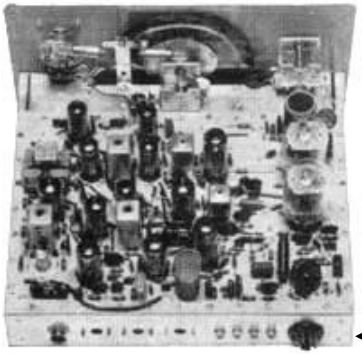
Modulators
There is one modulator in the HW22A. The purpose of a modulator is to superimpose the (audio) information on the carrier. In the case of the HW22A, the output of the microphone amplifier is superimposed on the carrier oscillator for further signal processing and amplification

Detector
The name of this circuit could easily be "de-modulator." The circuit is used to separate the audio (information) from the carrier. The audio is then amplified and is used to drive a speaker or a set of headphones.

Receiver Operation

Now we have defined all of the major circuits in the HW22A. Here is how it works. A received LSB signal is amplified with (V8A) and is mixed with the output of the heterodyne mixer (V14). The resultant is the difference of the two signals or 2.303.3 MHz to 2.306.7Mhz. The resultant signal is amplified by a common IF amplifier and then further amplified by a receiver IF amplifier (V9). (V3 is used by both the transmitter and receiver portions of the radio). The amplified signal is the fed to a product detector (V11A) along with the carrier oscillator signal(V11B). The slight differences between the carrier oscillator frequency and the mixed received signal produce the audio frequency signal. This is then amplified by V12A and V12B and, the output is delivered to the speaker.

Bottom View



HW22A Top View

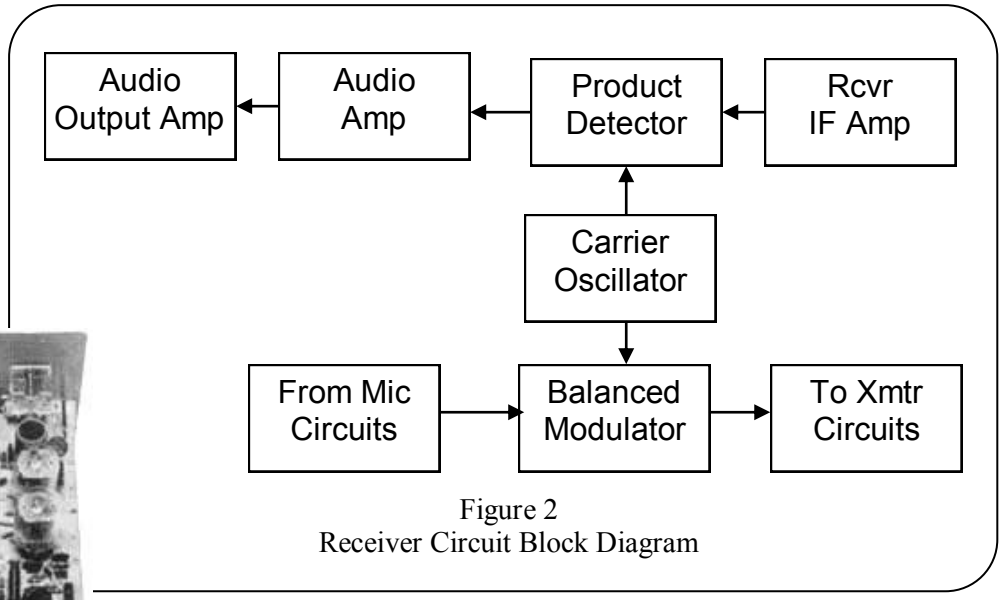


Figure 2
Receiver Circuit Block Diagram

Transmitter Operation

The transmitter operation starts with the microphone input that is amplified by an amplifier (V1A) and a cathode follower (V1B). The amplified signal is fed to the balanced modulator along with the carrier oscillator signal (V11B). The modulated signal is amplified by the transmitter IF amplifier (V2A). After going through a crystal filter, the signal is amplified by the common IF amplifier (V3). The amplified signal is mixed (transmitter mixer V4) with the output of the heterodyne mixer (V14). The difference frequency produces the 7.200 MHz to 7.300 MHz signal. The output of the mixer is amplified with the

driver (V5) amplifier and the final amplifier (V6 & V7). The output power should be between 100 and 125 Watts.

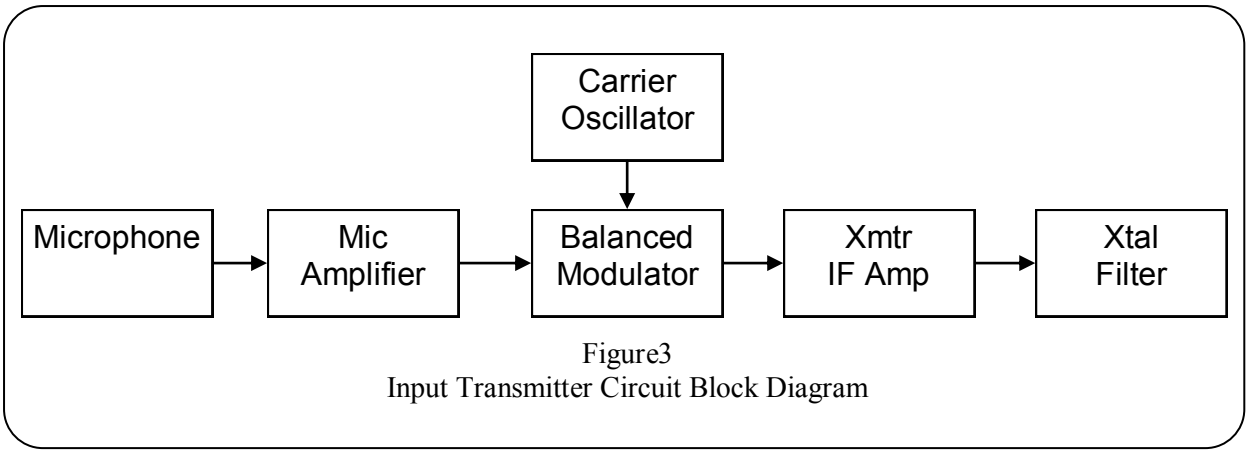


Figure3
Input Transmitter Circuit Block Diagram

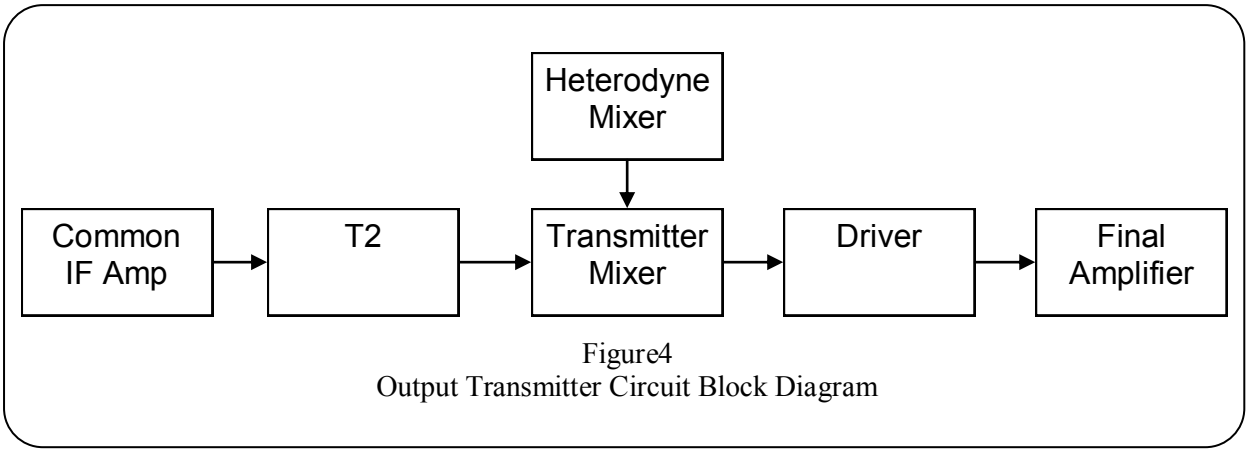
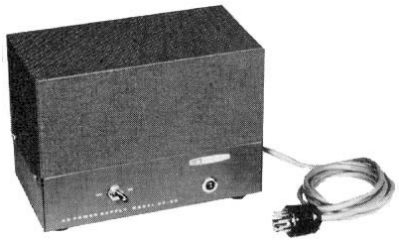


Figure4
Output Transmitter Circuit Block Diagram

Common Circuits

There are a number of common circuits that are switched between transmit and receive by a relay. When the rig is turned on it comes up in the receive mode. By pressing the microphone switch a relay is energized and the radio operates in the transmit mode.

Summary



For those of you just starting out in the HF world, this is a low cost way to get on the air. With the addition of a Heathkit HP23, HP23A or a HP23B, power supply and a simple dipole antenna you can be on the air.

I prefer the HP23B power supply because it can be switched to operate all of the Heathkit HW and SB series ham radios. Parts are available to upgrade the power supply with a replacement circuit board and new parts Replacement vacuum tubes are available from several electronic supply companies.

While I haven't looked at the HW12 (75m) and the HW32 (20m), I am sure that the design is similar.

If you have any questions, please contact me at WB6WXO@SOARA.org