HW100/101 and SB100/101/102

Receive Signal Processing

This document discusses in simple easy to understand terms how a receive signal is processed from the antenna to the speaker in an HW-100/101 or the SB-100/101/102 transceivers. This message is intended for those hams who are interested in learning how a receive signal is processed through the signal path in their HW-100/101 or SB-100/101/102 transceivers.

Having a solid understanding of how signals are processed in the transceiver is a must for those troubleshooting a signal problem in their transceiver. I will use only one band for this discussion but the same signal processing occurs on ALL bands in each of the transceivers.

I'll use 80 meters (3.5Mhz) and use the bottom of the band frequency of 3.5Mhz for this discussion. The receive signal is 3.5Mhz. This discussion, although about 80 meters 3.5Mhz, the same conversion process occurs on other bands. Each band has its own HET OSC crystal frequency. Reference to HET OSC frequency in this discussion is the 12.395Mhz crystal but for the other bands, substitute the band's HET OSC crystal frequency where needed. The 40 meter HET OSC crystal frequency is 15.895Mhz and the 20 meter crystal is 22.895Mhz and so on. For a listing of each band's HET OSC crystal, consult the assembly manual schematic for details. I have the HW-101 and SB-100 manuals on my website you can download and obtain each band's HET OSC crystal frequency.

The 3.5Mhz signal is picked up by the antenna and fed to the transceiver through coax cable to the antenna socket and relay RL1. The signal is applied to one winding of L801. The RF signal appears on the other winding of L801 and the plate of the driver tube "V7". The signal continues from the plate of V7 through inter-stage coupling capacitor C408 (24pfd) to pin 1 (grid) of receive RF Amplifier V10. V10's sole purpose in life is to amplifier the receive signal, nothing more. The amplified signal from V10's plate is applied to inter-stage coupling capacitor C419 (24pfd). The signal passes through C419 to pin 1 (grid) of first receive mixer V11.

Receive mixer V11 has 2 signals it works with. One is the amplified receive signal from V10 and the other is the band switch selected HET OSC crystal frequency (V19A/B). In this case the HET OSC crystal frequency is 12.395Mhz. Mixer V11 mixes the 2 signals to produce a "SUM" (one signal added to another signal) and a "DIFFERENCE" (one signal subtracted from another signal). The "Desired" signal is determined by the following stage or component. In this case it is the "Difference" signal of 8.895Mhz (12.395 - 3.5 = 8.895).

Why the "Difference" frequency? The next stage or component is the Band Pass board's "Band Pass Transformer T202". Transformer T202 will only pass frequencies within the range of 8.395Mhz to 8.895Mhz. All other frequencies are rejected. Therefore, the "difference" frequency of 8.895Mhz will pass through T202 and the "SUM" frequency of 15.895Mhz is rejected. The 8.895Mhz frequency is NOT fixed. Read the next paragraph to see why.

The first conversion has been performed which is a "variable conversion" since the output of the "Difference" frequency from the

first receive mixer "varies" depending on the frequency of the "receive signal". What do I mean by "variable" conversion? The 8Mhz output of the first receive mixer V11 is determined by the receive frequency AND the HET OSC crystal frequency. Let's say the receive frequency is 3.850Mhz. The 12.395Mhz HET OSC crystal mixes with the amplified 3.850Mhz receive signal producing an output frequency from V11 of 8.545Mhz which is within the frequency range of T202 so it passed right through.

The 8.895Mhz signal continues on to the inter-stage coupling capacitor C216 (50pfd) to pin 2 (grid) of the receive "second mixer" V12A. Mixer V12A also has 2 signals, the 8.895Mhz Band Pass frequency AND the LMO frequency of 5.5Mhz. Where did I come up with the LMO 5.5Mhz signal? With the LMO tuned to zero on the dial the output frequency of the LMO is 5.5Mhz (the actual LMO output frequency may be slightly different but for this discussion I will used 5.5Mhz as the LMO's output frequency). The 2 signals mix together and like V11, produce a "SUM" and a "DIFFERENCE" frequency. The SUM frequency is 14.395Mhz and the DIFFERENCE frequency is "3.395Mhz". The SUM frequency is not used because the next stage/component is the crystal filter which will only pass frequencies of 3.395Mhz so 14.395Mhz is rejected. Some hams may have been misled to believe the LMO frequency range changes when the band changes. That's simply NOT true with the HW-100/101 and SB-100/101/102 transceivers. The LMO output frequency range is from 5.5Mhz at the bottom of all bands to 5.0Mhz at the top of all bands regardless what band the band switch is set to.

The 3.395Mhz flows through the crystal filter and appears at inter-stage coupling capacitor C101 (0.01ufd). The signal flows through C101 to pin 1 (grid) of V3 first IF amp. The only thing V3 does is

amplify the 3.395Mhz signal. V3's output is then passed on to the second IF amp V4 where the signal is further amplified. The output of V4 is applied to 2 following stages.

1. AGC diodes V13A/B

2. Product Detector V13C

The IF signal applied to V13A/B produces a negative AGC (Automate Gain Control) voltage. The negative AGC voltage is then applied to the grid of V3 AND V4. The operating bias voltage on both V3 and V4 is at a low negative voltage to allow both stages to operate at full gain. As the signal level from second mixer V12A varies ,the negative output voltage of AGC diodes V13A/B is applied to the grid, pin 1 of V3 and V4 through relay RL2 pins 4 and 12. If the level of AGC voltage is not sufficient to override the operating bias voltage to both V3 and V4, no change in gain of both stages occurs. If, however, the signal level is sufficient to override the operating bias on V3 and V4, the gain of V3 and V4 is "reduced". This results in a change in V3's "cathode" voltage which cause the "S meter" to rise above zero, indicating "S Units" of receive signal. The higher the AGC voltage applied to V3 the lower the gain of V3 and the higher the S meter will rise above zero indicating the S unit level of the receive signal. The opposite occurs when the gain of V3 is increased by lowering the AGC voltage to the grid of V3, the S meter drops back toward zero indicating a lower S Unit meter indication.

The output of second mixer, as stated above, is also applied to the Product Detector V13C. Product Detector V13C operates as a "mixer" to produce a "Difference" output "Product" which is the recovered

audio. To do that, recover the receive signals audio, a "BFO" or "Beat Frequency Oscillator" signal must be applied to the Product Detector V13C. The "BFO" signal is supplied from the Carrier Generator V16A or V16B. Since we're on 80 meter, LSB, the LSB V16B

3393.6Khz frequency is applied to pin 8, V13C's cathode. The 393.6Khz BFO signal mixes with the 3.395Mhz IF signal producing a "Difference" frequency of "1.4Khz". The "SUM" frequency is not used since it's 6,788.6Khz, not an audio frequency, so it's rejected. The "Difference" frequency of 1.4Khz output from the Product Detector is applied to the simple PI Filter at the output of V13C. The PI filter consist of C119, C121, and R119. The filter removes any residual RF from the output of the Product Detector but allows the 1.4Khz audio signal to pass on through the filter to the next stage which is the audio amplifier. A Product Detector must have both signals, BFO and IF signal to produce an output. If one is missing then there will be very low or no output from the Product Detector.

The recovered audio is applied to the volume control 10K pot. The volume control pot wiper setting determines the level of audio applied to inter-stage coupling capacitor C308 (0.02ufd) to pin 1 (grid) of V14A. V14A amplifies the audio then applies the amplified audio signal to C306 to the grid of V14B. V14B further amplifies the recovered audio and applies the audio sine wave signal to the primary winding of the audio transformer T301 on the audio board. The audio sine wave cuts the secondary winding's of the audio transformer resulting in the audio appearing on the secondary winding's of the audio transformer. The audio is applied to the speaker where you hear "CQ 80" or whatever the recover audio is, it could be just a beat note in CW if CW mode is used. If CW receive is used, the BFO signal is the "USB" Carrier Generator V16A frequency. The CW 3395.4Khz crystal frequency is used ONLY in TUNE/CW transmit modes not receive. You can hear this

by tuning in a CW station in CW mode then switch to USB. You will not hear a change in the CW beat note between CW and USB.

Having a solid understanding of how receive signals are processed from the antenna to the speaker and knowing what frequencies you should see at certain points in the receive signal path is a must. I will cover transmit in my next signal processing message.

73 Mike W5RKL

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