HW100 and SB100 Transmit

Signal Processing

Start

Here's the HW-100/101 and SB-100/101/102 transmitter segment. I'll use the same 80 meter band as I did in the receiver segment, LMO output is RF 5500Khz and band switch is set to 3.5 selecting the RF 12395Khz 80 meter Heterodyne Oscillator crystal frequency. The LMO is assumed to be set at zero which has a 5500Khz output frequency. The actual LMO output frequency may vary somewhat but for this discussion I will assume the LMO output is 5500Khz. I'll first go through the TUNE/CW Modes. I'll then go through the sideband mode. If you have the HW-100/101 or SB-100/101/102 schematics you can follow along as I mention component labels and values. Like the receiver discussion, this is a BASIC discussion of how the transmitter works in TUNE/CW and side band modes.

I will first discuss the basics of TUNE and CW modes. I will be using "Khz" which stands for "Kilohertz". If you wish to convert "Kilohertz" (Khz) to "Megahertz" (Mhz) simply follow the math conversion steps shown below.

A frequency of 3395.4Khz converts to 3.3954Mhz and the same 3.3954Mhz converts to 3395.4Khz. Use your calculator to perform the simple math calculations shown below.

Convert Khz to Mhz, divide Khz by 1000

3395.4 / 1000 = 3.3954

Convert Mhz to Khz, multiply Mhz by 1000.

3.3954 x 1000 = 3395.4Khz

Okay on with TUNE/CW transmit frequency conversion discussions.

TUNE

TUNE Mode is the mode used to tune the transmitter as it provides a constant RF carrier and keys the transmitter without having to press the CW key.

CW

CW mode is used to tune the last segment of transmitter tuning to set the plate current using the MIC/CW LEVEL control. CW mode can also be used to tune the transmitter but it requires a CW key to be inserted into the rear panel CW key socket and pressed to switch from receive to transmit.

How does TUNE and CW mode activate the transmitter?

TUNE Mode:

TUNE mode activates the transmitter by shorting Relay Amp V12B's cathode to ground through Mode switch wafer 2F terminal 20 and 7. Terminal 7 connects to ground through a bent ground lug on the Mode switch's threaded mounting stub to the front panel. Not much to how TUNE mode switches from receive to transmit.

CW Mode (requires a few more actions than TUNE Mode does):

CW mode turns the CW side tone oscillator V15A ON by shorting its cathode to ground. The CW side tone amp V15B remains biased to cut off by the negative "Grid Block" keying voltage applied to V15B grid until the CW key is pressed. Pressing the CW key shorts the Grid Block keying voltage to ground, reducing the level of Grid Block voltage at the grid of V15B, turning V15B ON. The CW side tone is amplified by V15B and the output is sent to the VOX AMP V17A. V17A further amplifies the CW side tone and its output is send to diode D201. Diode D201 rectifies the "positive" half of the sine tone sine wave producing a positive DC voltage that is applied to the Relay Amp V12B turning it ON. V12B acts as a switch and energizes both relays (relays are wired in "series) when V12B turns ON.

A few hams have asked me if the CW side tone is actually transmitted in CW mode. The answer is "No". The CW side tone performs only 2 functions:

1. To activate the Relay Amp V12B through the VOX circuit to switch from receive to transmit in CW transmit

2. To apply the keyed CW side tone to the audio amplifier so the CW operator can hear his/her dits and dahs in the speaker during CW transmit. At the same time V12B turns ON, the VOX DELAY capacitor C213 rapidly charges to the positive voltage at the grid of V12B. Releasing the CW key stops the side tone from flowing through V17A and diode D201. The charge of C213 maintains a positive DC voltage on the grid of Relay Amp V12B. The VOX DELAY pot along with R903 (2.2M) provides C213's discharge path to ground. The discharge rate of C213 is determined by the setting of the VOX DELAY pot. C213 discharges to the point where V12B turns OFF and both relays are no longer energized and the radio switches back to receive. This process

repeats itself every time the CW key is pressed in CW mode. The relays do not activate fast enough to use "Full Break-in" CW keying so don't try that otherwise you will ruin the relays and other components.

The starting point for ALL RF begins at the Carrier Generator V16. As I

stated in the beginning, I'll use the same 80 meter band and in TUNE/CW mode transmit, the RF 3395.4Khz Carrier Generator crystal frequency. The TUNE/CW crystal AND V16 Carrier Generator Oscillator is selected by Mode switch wafer 2R. The appropriate V16 crystal oscillator is selected by applying the appropriate +300VDC Plate voltage through relay RL1 terminals 9 and 5. Both V16A and V16B plate resistors are 33K 1/2 watt. In this discussion we are concerned with the TUNE/CW V16B 3395.4Khz crystal oscillator only.

The output from V16B is taken from V16B cathode pin 8. The 395.4Khz signal is routed to the CAR NULL pot wiper through capacitor C16. At the same time Mode switch wafer 2F in TUNE/CW modes, it connects terminal 12 to 1 which grounds the junction of BM (Balance Modulator) diodes CR3 and CR4, "unbalancing" the BM. Unbalancing the BM allows the RF 3395.4Khz signal to appear at terminal 2 of the BM transformer T1 primary winding. The RF 3395.4Khz signal's sine wave cuts the secondary winding of T1 resulting in the RF 3395.4Khz signal to appear on the BM transformer secondary winding pins 1. The BM secondary winding Pin 1 connects to inter-stage capacitor C22 to the cathode, pin 7, of Isolation amp V2. V2's output is controlled by the level of negative bias voltage applied through the MIC/CW LEVEL control pot through Mode switch 2R to pin 1 of V2. The output from V2 is applied through inter-stage coupling capacitor C506 to the input of the crystal filter. The center RF frequency of the CW filter is 3395Khz and has an RF band pass of 400hz which allows the RF 3395.4Khz signal to pass easily through the filter. The 3395.4Khz RF signal appears at the output of the crystal filter and is applied to and flows through inter-stage coupling

capacitor C101 to the grid of First IF Amp V3 where it is further amplified.

At this point the output of Isolation amp V2 and First IF amp V3 is controlled by the negative bias voltage that flows through the MIC/CW LEVEL control to the grids of V2 and V3. Rotating the MIC/CW LEVEL control CCW increases the bias voltage to V2 and V3 resulting in a reduction in output from V2 and V3. Rotating the MIC/CW LEVEL control CW decreases the bias voltage to V2 and V3 resulting in an increase in output from V2 and V3. Gain control of V2 and V3 is performed "Manually", ALC plays no part in controlling V2 and V3's gain in TUNE/CW modes.

The RF 3395.4Khz signal output from V3 is applied to the first transmit mixer V5A. V5A has 2 RF signals, the 3395.4Khz and the LMO 5500Khz. Both signals mixed in V5A and produce a "SUM" and a "DIFFERENCE" output RF signal. The "SUM" frequency is "8895.4Khz" and the "DIFFERENCE" frequency is 2104.6Khz.

SUM

5500 + 3395.4 = 8895.4Khz

DIFFERENCE

5500 - 3395.4 - 2104.6 KHz

The 2 signals are applied to the Band pass transformer T202. As I discussed in the receive segment, Band Pass transformer T202 will only pass signals within the range of 8395Khz to 8895Khz. Since the DIFFERENCE frequency does not fall within this range of frequencies but the SUM frequency does, the DIFFERENCE frequency is rejected and the SUM frequency flows through T202.

The 8895.4Khz RF signal appears on the secondary winding of T202 pin 2. Pin 2 of T202 connects to inter-stage coupling capacitor C402 to the grid of second transmit mixer V6. Again there are 2 RF signals applied to second transmit mixer V6, the 8895.4 KHz and the band switch selected 12395 KHz 80 meter Het Osc crystal frequency. The 2 RF signals mix in V6 producing a "SUM" and "DIFFERENCE" frequencies. The "SUM" frequency is 21290.4Khz and the DIFFERENCE" frequency is 3499.6 KHz.

SUM

12395 + 8895.4 = 21290.4Khz

DIFFERENCE

12395 - 8895.4 = 3499.6Khz

Since we are using 80 meters, 3500 KHz to 4000 KHz, the SUM frequency is rejected leaving the DIFFERENCE frequency which will be used. What happens to the SUM frequency? It's rejected by the tuned circuits in the following DRIVER GRID discussion.

A note about the DIFFERENCE frequency. At this point the DIFFERENCE frequency from the Second Transmit Mixer, V6, is the "actual transmit frequency" whether using TUNE, CW, LSB or USB modes.

The "DIFFERENCE" frequency is applied to the DRIVER GRID PC board where DRIVER GRID band switch wafer 3F selects which inductance (coil) is used in parallel with L701 for each band. L701 is used on all bands, however L701 is the only inductance (coil) used on 80 meters. Inductors L702, L7803, L704, and L705 are not selected for 80 meters. Variable capacitor C421B is used on all bands and C421A is selected in parallel with C421B through wafer switch 3R to tune the DRIVER GRID to resonance on 80 meters. The output of the second transmit mixer is applied to the Driver V7.

Driver V7 amplifies the second transmit mixer signal to a level sufficient to drive the grids of the final amplifier. Wafer switch 4F connects the necessary inductance in parallel with L801 for all bands. For 80 meters, L801 is the only inductance used. C422A is used on ALL bands. Mode switch 4R connects additional capacitance in parallel with variable capacitor C422B for 80, 40, and 20 meters. The output of the Drive V7 connects to the grids of the final amplifier through C917.

The Final Amplifier uses 2 x 6146A in parallel operating in Class AB1. What is Class AB1? In simple terms it means the final amplifier will not have grid current flowing at any point throughout it's RF cycle. That's assuming the grids of the final amplifier are NEVER push positive. We all know that's not true. If it were then we would never need ALC (Automatic Level Control). to maintain the amplifier in a "linear state". I'll discuss ALC in my next discussion segment.

A fixed bias voltage is applied to the grids (pin 5) of both 6146As through resistor R916 and RFC902. The "Fixed" bias is set by the "10K Bias Pot" in either side band mode for 50ma idling current with no RF Drive. RFC902 blocks the flow of RF back to the bias supply but allows DC voltage to flow through.

The final amplifier amplifies the RF from the driver V7. The output from the final amp is applied through HV DC blocking capacitor C915 to the input of the PI Network. The PI Network PLATE variable capacitor tunes the plate of the final amp to the 3500 KHz frequency (Plate meter DIP).

The LOAD control tunes as close as possible to the impedance load applied to the "ANT" socket on the rear panel of the transceiver indicated by a rise/peak in REL PWR meter or external watt meter,

indication. The rise in REL PWR or external watt meter indicates the load connected to the rear panel ANT socket is accepting the RF signal. The REL PWR meter is a simple volt meter using rectified RF to indicate an increase/decrease in "Relative Power" RF output. The REL PWR meter indication is NOT a watt meter nor is any scale dedicated to the REL PWR meter.

One word of caution. I've read where some hams have been misled to believe adjusting the LOAD control will reduce power output. That's true BUT the LOAD control should NEVER be used to reduce power output in ANY mode!! In TUNE/CW Modes, use the MIC/CW LEVEL control.

This completes the "basic" discussion of how the transmitter signals processing works in TUNE/CW modes. My next discussion will be a bit shorter since it discusses how side band is produced.

I'll also discuss what "splatter" is, how it is created (source), and steps necessary to take to eliminate spatter. There are a lot of hams on the air that have splatter and don't know it and have no idea how to eliminate it. Many hams have no idea what a good clean transmit signal should sound like, only how "LOUD" they sound at the distant end, quite possible due to their "CB" days when being LOUD and SPLATTERING was and still is the order of the day. When the bands are open, tune up on 11 meters and hear the splatter some 20Khz wide transmit signal due to excessive audio applied to the speech amplifier in the transmitter.

73

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