section 3
principles of operation

3.1 BLOCK DIAGRAM

Refer to figure 3-1. The KWM-2/2A is an SSB or CW transceiver operating in the range between 3.4 and 30.0 MHz. It consists of a double-conversion receiver and a double-conversion exciter-transmitter. The transmitter and receiver circuits use common oscillators and a common mechanical filter as well as a common rf amplifier. The transmitter low-frequency if and the receiver low-frequency if is 455 kHz. The high-frequency if for both is 2.955 to 3.155 MHz. This is a bandpass if that accommodates the full 200-kHz bandwidth. Figure 7-1 is a schematic diagram of the KWM-2/2A.

3.2 TRANSMITTER CIRCUITS

3.2.1 AF Circuits

Microphone or phone-patch input is connected to the grid of first audio amplifier V1A, amplified, and coupled to the grid of second audio amplifier V11B. Output from V11B is coupled to the grid of cathode follower V3A through MIC GAIN control R8. Output from the cathode follower is fed to the resistive balance point of the balanced modulator. In TUNE, LOCK, and CW positions of the EMISSION switch, output from tone oscillator V2B is fed to the grid of the second audio amplifier. The amplified tone oscillator signal is taken from the plate of V11B and coupled to the grid of VOX amplifier V14B to activate the VOX circuits in CW operation. This signal is also fed to the grid of first receiver af amplifier V16A for CW monitoring.

3.2.2 Balanced Modulator and Low-Frequency IF Circuits

Audio output from the cathode of V3A and the bfo voltage are fed to a diode quad balanced modulator (CR1, CR2, CR3, and CR4). Both upper and lower sideband outputs from the balanced modulator are coupled through if transformer T1 to the grid of the if amplifier, V4A. Output from the if amplifier is fed to mechanical filter FL1. The passband of FL1 is centered at 455 kHz. This passes either upper or lower sideband, depending upon the sideband selected when the EMISSION switch connects bfo crystal Y16 or Y17. The single-sideband output of FL1 is connected to the grids of the first transmitter mixer in push-pull.

3.2.3 Balanced Mixers

The 455-kHz single-sideband signal is fed to the first balanced mixer grids in push-pull. The plates of the mixer are connected in push-pull, and vfo signal is fed to the two grids in parallel. The mixer cancels the vfo signal energy and translates the 455-kHz single-sideband signal from the balanced modulator to a 2.955- to 3.155-MHz single-sideband signal. The T2-L4 combination between the first and second mixer provides broadband response to the 200-kHz variable if output (2.955 to 3.155 MHz) from the first transmit mixer, V5. The bandpass if signal is fed to one of the grids of the second balanced mixer, and the high-frequency injection signal energy from crystal oscillator V13A is fed to the cathode and the other grid. This arrangement cancels the high-frequency injection signal energy within the mixer and translates the bandpass if signal to desired operating band.

3.2.4 RF and ALC Circuits

The slug-tuned circuits coupling V6 to V7, V7 to V8, and V8 to the power amplifier are ganged to the EXCITER TUNING control. The signal is amplified by rf amplifier V7 and driver V8 to drive the power amplifier, V9 and V10. Output from the parallel power amplifiers is tuned by a pi-network and fed to the antenna through contacts of transmit-receive relay K3. Negative rf feedback from the pa plate circuit to the driver cathode circuit reduces distortion in the output signal. Both the driver and pa stages are neutralized to ensure stability. When rf driving voltage to the pa becomes great enough that positive peaks drive the pa grids positive, the grids begin to draw current and the signal is detected. This produces an audio envelope. The audio is rectified by ALC rectifier V17A, which is connected to produce a negative dc voltage. The voltage is filtered by C159, C160, R118, and R119 (which also determine the ALC time constants) and is used to control the gain of V4A and V7. This system allows a high average level of modulation without driving the pa tubes well into the grid current region, which would result in increased distortion.

3.3 RECEIVER CIRCUITS

3.3.1 RF Circuits

Signal input from the antenna is connected through relay contacts to the tuned input circuit, T3. The signal is applied from T3 to the grid of the receiver-transmitter rf amplifier, V7. Amplified signal from V7 is applied from the tuned circuit, consisting of L10 and bandswitch selected capacitors, to the grid of the receiver first mixer V13B.

3.3.2 Receiver Mixers

The input rf signal is fed to the grid of V13B, and the high-frequency oscillator injection signal is fed to the cathode of V13B. The difference product of the first mixer is applied from the plate of the tube to variable if transformer T2. Output of T2 in the range of 2.955 to 3.155 MHz is applied to the grid of second receiver mixer V17B, across parallel-tuned trap circuit Z5. This trap circuit minimizes a spurious response that would otherwise result from harmonics of the high-frequency crystal oscillator. When signal input is applied to the grid of V17B and vfo injection signal is applied to the cathode of V17B, the 455-kHz difference product is fed from V17B plate to mechanical filter FL1.

3.3.3 IF Circuits

The output from FL1 is applied to the grid of first if amplifier V1B. The if signal is amplified by V1B and V3B and applied through T5 to AVC rectifier V15A and to the grid of product detector V15B. Beat-frequency oscillator signal is applied to the cathode of V15B, and the product of mixing is the detected audio signal. Output of the AVC rectifier circuit is applied to the two receiver if amplifiers and through contacts of relay K4 to the receiver-transmitter rf amplifier. This AVC voltage controls the gain of the receiver and prevents overloading.

3.3.4 AF Circuits

Output from the product detector is applied through A.F. GAIN control R92 to the grid of first af amplifier V16A. Amplified audio output of V16A is coupled to the grid of af output amplifier V16B, which produces the power to operate a speaker, headphones, or phone patch.

3.4 OSCILLATORS

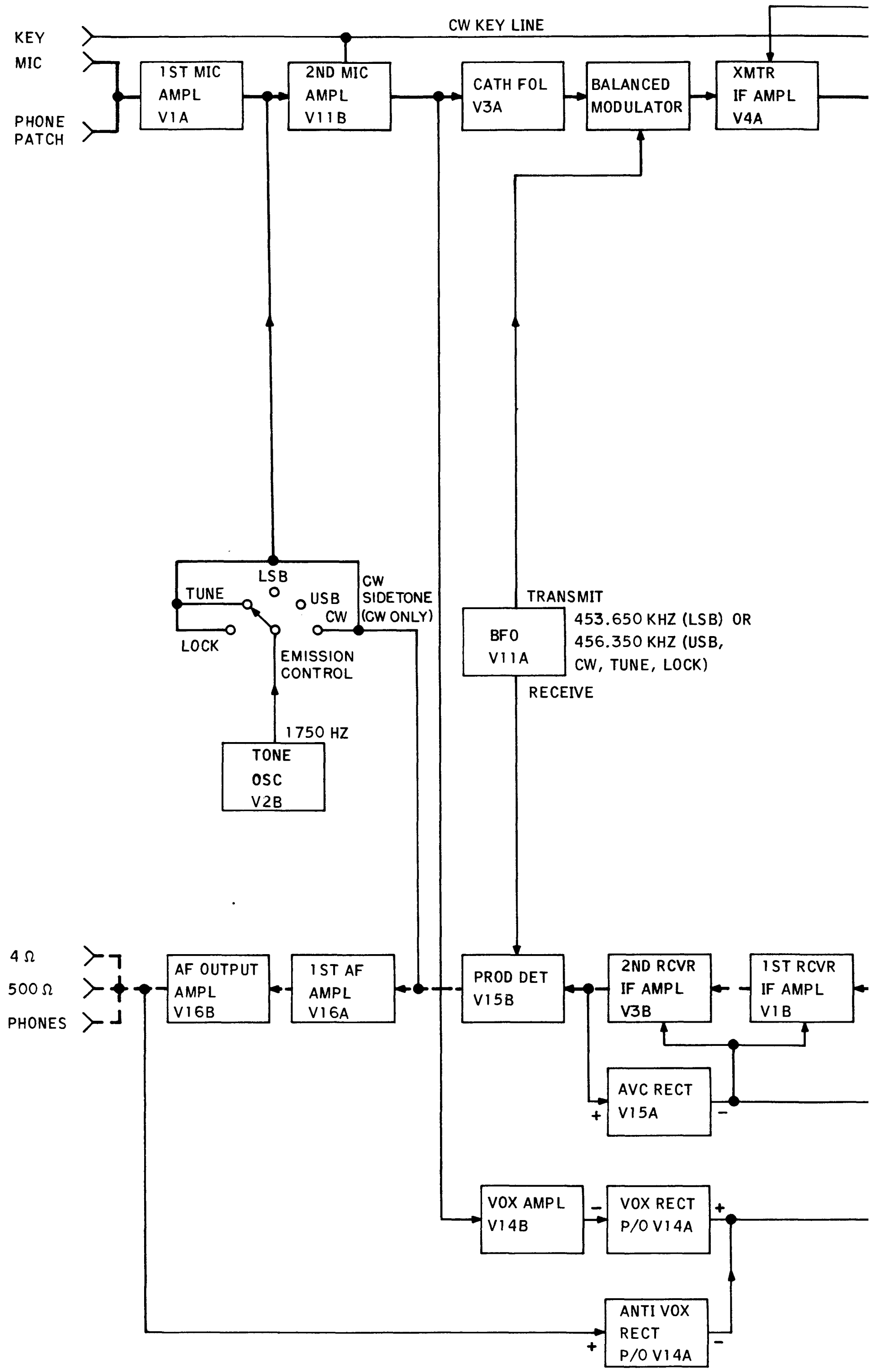
The transceiver contains the tone oscillator, the beat-frequency oscillator, the variable-frequency oscillator, the high-frequency crystal oscillator, and the crystal calibrator.

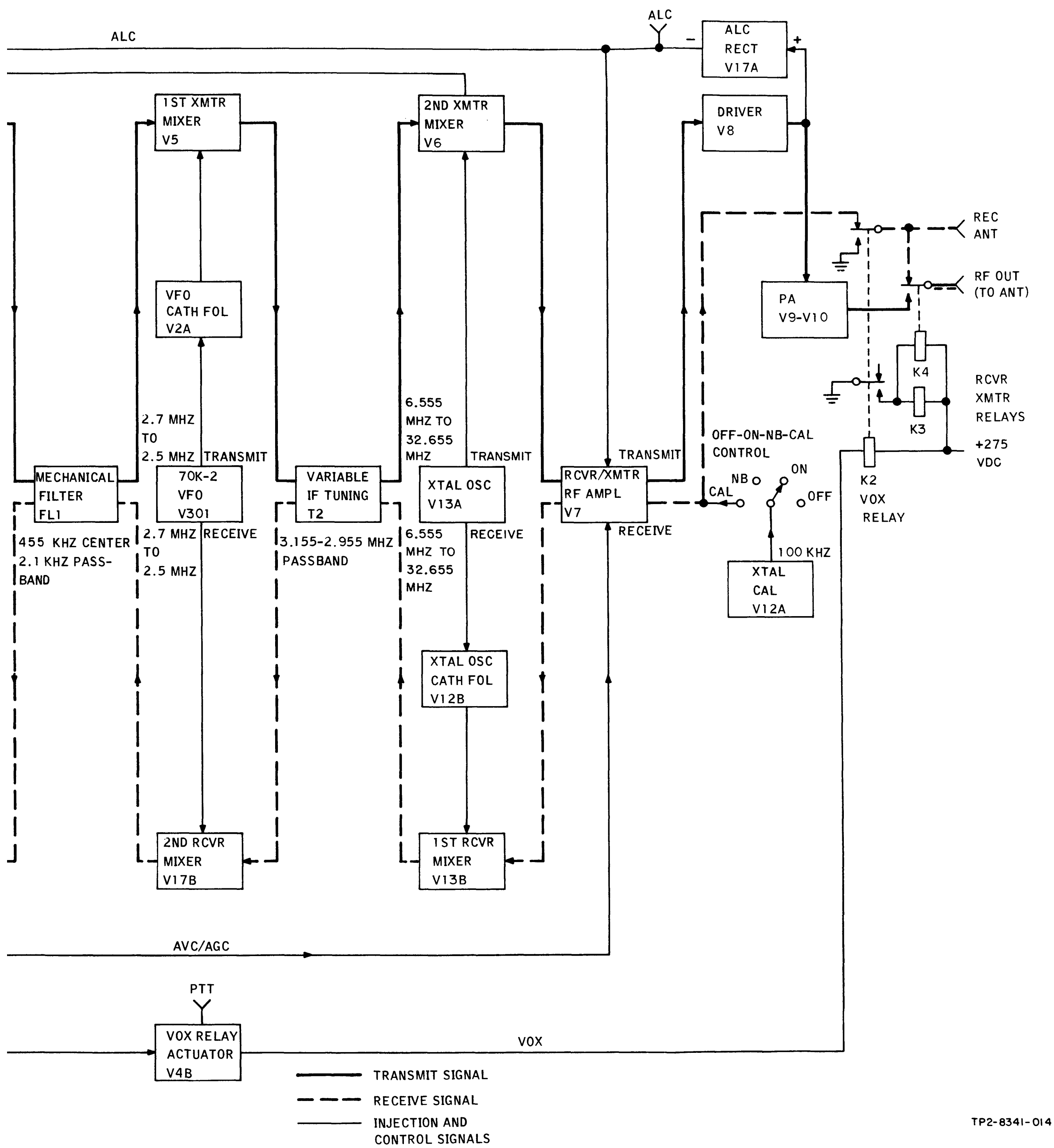
3.4.1 Tone Oscillator

The tone oscillator operates when the EMISSION switch is in LOCK, TUNE, or CW position. It is a phase-shift oscillator operating at approximately 1750 Hz. Its output is fed to the transmitter audio circuits for CW operation. Some of the output from the tone oscillator is applied to the receiver audio circuits for sidetone monitoring in CW operation. Due to the 1750-Hz tone applied to the balanced modulator during CW operation, the actual transmitted CW signal will be 1750 Hz above the KWM-2/2A dial reading.

3.4.2 Beat-Frequency Oscillator

The bfo is crystal controlled at either 453.650 or 456.350 kHz, depending upon whether Y16 or Y17 is selected by EMISSION switch section S9H. The unused crystal is shorted out by this switch section. These crystal frequencies are matched to the passband of mechanical filter FL1 so that the carrier frequency is placed approximately 20 dB down on the skirts of the filter response. This 20-dB carrier attenuation is in addition to the 30-dB suppression provided by the balanced modulator.


KEY
MIC
PHONE PATCH
CW KEY LINE
1ST MIC AMPL V1A
2ND MIC AMPL V11B
CATH FOL V3A
BALANCED MODULATOR
XMTR IF AMPL V4A
LSB
TUNE
USB
CW
LOCK
CW SIDETONE (CW ONLY)
EMISSION CONTROL
1750 HZ
TONE OSC V2B
TRANSMIT
BFO V11A
453.650 KHZ (LSB) OR 456.350 KHZ (USB, CW, TUNE, LOCK)
RECEIVE
4 Ω
500 Ω
PHONES
AF OUTPUT AMPL V16B
1ST AF AMPL V16A
PROD DET V15B
2ND RCVR IF AMPL V3B
1ST RCVR IF AMPL V1B
AVC RECT V15A
VOX AMPL V14B
VOX RECT P/O V14A
ANTI VOX RECT P/O V14A



KWM-2 and KWM-2A Transceivers, Block Diagram
Figure 3-1

3.4.3 Variable-Frequency Oscillator

The vfo uses fixed capacitance and variable inductance to tune the range of 2.5 to 2.7 MHz. The series combination of capacitor C308 and diode CR301 is connected in parallel with capacitor C303. The diode switches C308 into or out of the circuit, depending upon the polarity of a bias voltage impressed across the diode junction. When USB emission is selected, the bias is positive and C308 is switched into the circuit. The capacitor then is adjusted to shift the vfo frequency by an amount equal to the frequency separation of bfo crystals Y16 and Y17. This allows the selection of either sideband without upsetting tuning or dial calibration.

3.4.4 High-Frequency Crystal Oscillator

The high-frequency crystal oscillator V13A, is crystal controlled by 1 of 14 crystals selected by BAND switch S2. Output from the high-frequency crystal oscillator is fed to the transmitter second mixer and to the crystal oscillator cathode follower. The cathode follower provides isolation and impedance match between the crystal oscillator and the receiver first mixer cathode. The output frequency of this oscillator is always 3.155 MHz higher than the lower edge of the desired band. This high-frequency injection signal is the crystal fundamental frequency for all desired signals below 12 MHz. For operating frequencies higher than 12 MHz, the crystal frequency is doubled in the plate circuit of the oscillator. Instructions for calculating crystal frequencies for the desired bands are given in section 2.

3.4.5 Crystal Calibrator

The 100-kHz crystal calibrator V12A, is the pentode section of a type 6U8A tube. Its output is coupled to antenna coil T3. The calibrator may be trimmed to zero beat with WWV by adjustment of capacitor C76.

3.5 VOX AND ANTIVOX CIRCUITS

Audio output voltage from the second microphone amplifier V1B is coupled to VOX GAIN control R39. A portion of this voltage is amplified by VOX amplifier V14B and fed to the VOX rectifier, which is one of the diodes of V14. The positive dc output of the VOX rectifier is applied to the grid of VOX relay amplifier V4B, causing it to conduct current and actuate VOX relay K2. Contacts of K2 switch the receiver antenna lead, the other relay coils, and bias voltage. Relays K3 and K4 switch the metering circuits from receive to transmit, the low plate voltages from receive to transmit tubes, and the AVC and ALC leads.

The antiVOX circuit provides a threshold voltage to prevent loudspeaker output (picked up by the microphone circuits) from tripping the KWM-2/2A into transmit function. Some of the receiver output audio voltage is connected through C235 to ANTI-VOX GAIN control R45. Signal from the slider of this potentiometer is rectified by the antiVOX rectifier, which is the other diode of V14. Negative dc output voltage from the antiVOX rectifier, connected to the grid of V4B, provides the necessary antiVOX threshold. ANTI-VOX GAIN control R45 adjusts the value of the antiVOX voltage threshold so that loudspeaker output will not produce enough positive dc output from the VOX rectifier to exceed the negative dc output from the antiVOX rectifier and cause V4B to actuate K2. However, speech energy into the microphone will cause the positive VOX voltage to overcome the negative antiVOX voltage and produce the desired action of K2.