Edited: 12/15/07

Chapter 3 - Functional Description

Table Of Contents — Page 3-1

Figures

3.1 OVER-ALL FUNCTIONAL DESCRIPTION.

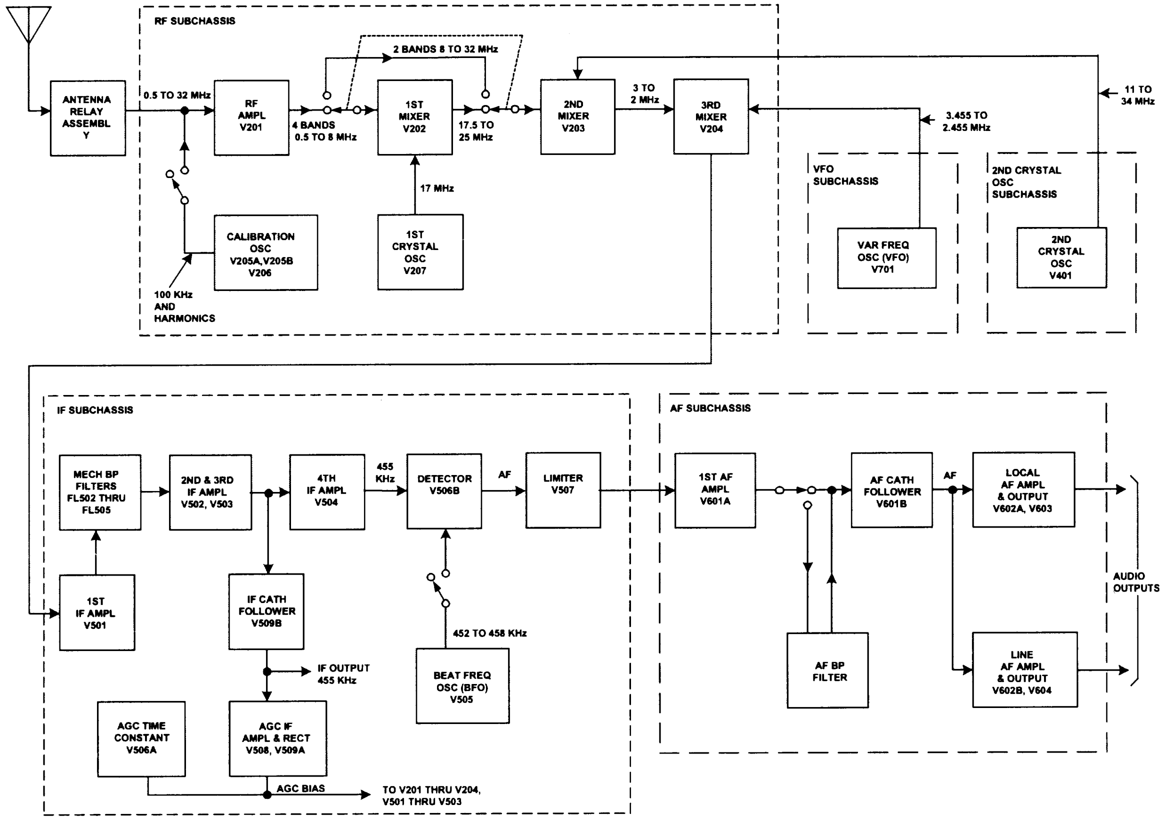


Figure 3-1 Overall Block Diagram[1]

3.1.1
Radio frequency signals in the range of 0.5 to 32 MHz are applied by way of an appropriate antenna to the antenna relay assembly of the R-390A/URR receiver (figure 3-1). The antenna relay assembly permits isolation of antenna and receiver whenever an associated transmitter is operated, or when calibration signals are applied to the rf amplifier in lieu of received signals. The calibration oscillator generates a 100 kHz signal and harmonics for convenient built-in dial calibration checking.

3.1.2
After RF amplification, the lower input frequencies, 0.5 to 8 MHz, are applied to the first mixer whereas the upper frequencies, 8 to 32 MHz, bypass this stage. The lower frequencies are heterodyned with a fixed 17 MHz frequency which is generated by the first crystal oscillator. The sum frequency is selected, so that the resultant output of the first mixer ranges from 17.5 to 25 MHz. The second mixer receives either this range of frequencies from the first mixer when tuning the lower bands, or the directly applied 8 to 32 MHz signals from the RF amplifier on the higher bands.

[1]Courtesy of Pete Wokoun, KH6GRT

3.1.3
The second crystal oscillator generates fixed frequencies in 1 MHz steps from 11 to 34 MHz. These steps are selected so that the difference input to the third mixer varies between 3 and 2 MHz. The variable frequency oscillator that also feeds this mixer is tuned from 3.455 to 2.455 MHz in step with the input signal so that the output of the third mixer is always 455 kHz. This frequency is applied to a four-stage IF amplifier.

3.1.4
The first IF stage has a crystal filter in its input circuit and mechanical filters in its output circuit that provide for bandwidth selection in six steps. The output of the third IF stage is applied to a cathode follower as well as to the fourth IF stage. The output of the cathode follower is used to develop an AGC bias, and can also be used externally by sideband converter equipment. The AGC bias is processed by an amplifier stage and a rectifier, and a time constant stage provides control of the AGC response time.

3.1.5
After amplification in the fourth IF stage, the 455 kHz signal is detected to produce audio frequencies. A beat-frequency oscillator can be employed to receive keyed CW signals. A limiter stage is also provided and the amount of limiting can be adjusted or eliminated entirely. The audio amplifiers permit the introduction of an audio bandpass filter if desired, and provide separate outputs to local phones or speaker and to remote (line) speakers.

3.2 DETAILED CIRCUIT ANALYSIS. (See figure 5-12).

3.2.1 Introduction

Radio Receiver R-390A/URR consists of a main frame and six sub-chassis. These are the RF sub-chassis, variable-frequency oscillator (VFO) sub-chassis, crystal-oscillator sub-chassis, IF sub-chassis, AF sub-chassis, and the power supply sub-chassis.

3.2.2 Antenna Circuit.

The antenna circuit matches antennas of various characteristics to RF amplifier V201.

The BALANCED ANTENNA input (using connector J104) has characteristic impedance of 125 ohms. Two-wire antenna systems, such as doublets with either 50-ohm twisted pair or coaxial transmission lines or with 50 to 200-ohm twin-lead transmissions lines, may be used without serious mismatch. Long wire antennas may also be used if one side of J104 is connected to ground.

The UNBALANCED ANTENNA connector, J103, is used for whip, long-wire, random-length, and single-wire antennas.

Normally, a balanced antenna is connected via relay K101A contacts and switches S201 and S202 to the input coil of one of six RF transformers, T201 through T206, depending upon the frequency being tuned.

Similarly, an unbalanced antenna is connected via relay K101B contacts and switch S205 to one of six capacitors within the RF transformers.

When relays K101A and B are energized, all antenna input terminals are disconnected from the RF transformers and are grounded. Relays K101A and K101B are energized only when an associated transmitter is connected to the break-in circuit and is keyed, or when the FUNCTION switch is in the STANDBY or CAL positions.

With the BREAK-IN switch in the ON position and the associated transmitter keyed, a ground is applied to pin 9 of TB103 to energize relay K601. This break-in relay provides a ground connection for CR102 which energizes K101A and B. Note that CR102 is also grounded when K601 is de-energized, if the FUNCTION switch is in the STANDBY or CAL position.

3.2.3 Antenna Circuit - Shipboard Use (Field Change 5)

The connections of the antenna circuit are changed for shipboard use by Field Change 5 (figure 3-2). With this circuit arrangement, an unbalanced antenna connection is made to J103 but because of the reversal of connectors P205 and P206, the antenna is connected to S202 and pin 1 of the selected RF transformer primary. Pin 2 of the same coil is grounded via S201 and a shorting plug on J104

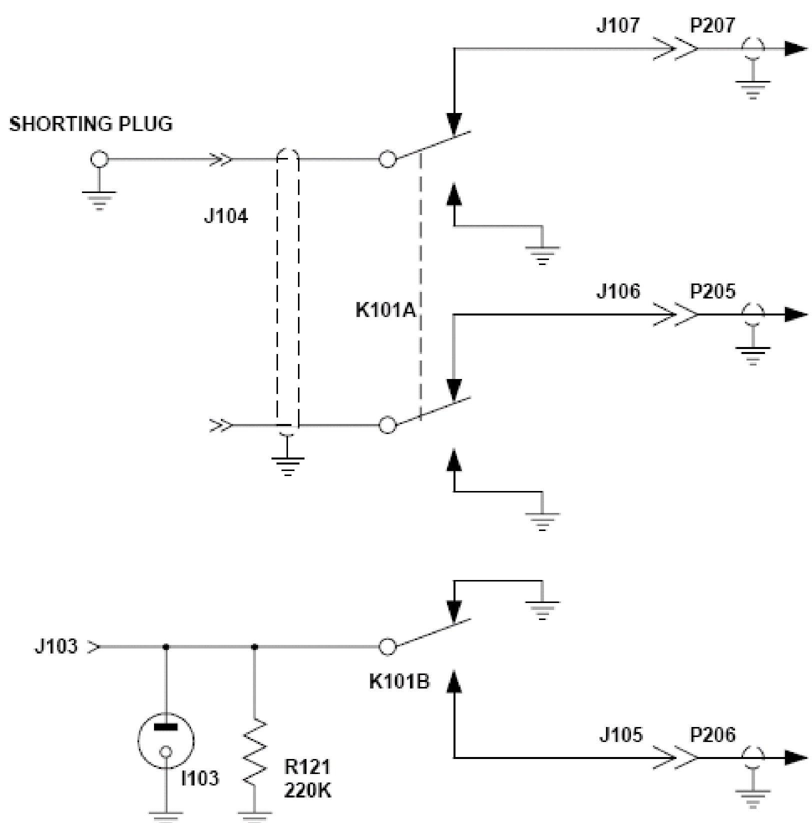


Figure 3-2 Antenna Input Connections
Modified by Field Change 5 for Shipboard Installations[2]

[2] Courtesy of Pete Wokoun, KH6GRT

3.2.4 Calibration Oscillator.

The calibration oscillator circuit is always connected to grid 1 of the RF amplifier, but the three stages, V205A, V206 and V205B are only activated when the FUNCTION switch is placed in the CAL position. This causes B+ to be applied to the three calibration oscillator stages and disconnects the antenna input as described in paragraph 3.2.2. Calibration oscillator V205A is a crystal controlled oscillator which generates a 200 kHz signal that is used to synchronize 100 kHz multi-vibrator V206. The multi-vibrator acts as a harmonic generator, and its output is coupled to the RF amplifier by way of cathode follower V205B. The 100 kHz harmonics permit calibration checking over the entire range of the receiver.

3.2.5 RF Amplifier.

RF amplifier V201 amplifies input signals and prevents antenna radiation of the various signals generated by oscillators in the receiver.

RF GAIN control R103 adjusts the cathode bias and, consequently, the gain of V201 and the first and second IF amplifiers.

The RF GAIN jumper on rear panel terminal board TB102 can be removed and a remote gain control can be connected if desired.

RF coils Z201-1 through Z206-1 and Z201-2 through Z206-2 are switched in step with antenna transformer switching.

3.2.6 First Mixer and First Crystal Oscillator.

Input frequencies from 0.5 to 8 MHz are applied to first mixer V202 whereas 8 to 32 MHz signals are routed around this stage.

First crystal oscillator V207 generates a fixed 17 MHz signal for cathode injection to the first mixer. T207 includes the plate tank circuit and a coupling coil. By switching its screen voltage on or off, this oscillator is enabled while tuning from 0.5 to 8 MHz, and is disabled while tuning from 8 to 32 MHz. Note that switches S207, S208 front, and S208 rear operate in step.

Z213 in the plate circuit of the first mixer is tuned to the sum of the two input signals; that is, from 17.5 to 25 MHz as the receiver is tuned from 0.5 to 8 MHz.

3.2.7 Second Mixer and Second Crystal Oscillator.

The signals applied to grid 6 of second mixer V203 range from 17.5 to 25 MHz when the receiver is tuned from 0.5 to 8 MHz, and then range from 8 to 32 MHz when the receiver is tuned from 8 to 32 MHz.

The second crystal oscillator generates one of 32 fixed frequencies for application to the cathode of the second mixer.

The oscillator frequency is selected by means of the MEGACYCLE CHANGE control which drives two 32-contact switches (figure 3-3).

Switch S401 selects one of 15 crystals, and switch S402 selects an appropriate plate-circuit tuning capacitor.

The plate circuit of V401 is tuned to the fundamental, second, or third harmonic of the selected crystal to provide the desired frequency, as indicated in figure 3-3.

The frequency advances in 1 MHz steps from 20 to 27 MHz as the receiver is tuned from 0. 5 to 8 MHz, and then proceeds from 11 to 34 MHz as the receiver is tuned from 8 to 32 MHz.

The plate-circuit coil is a part of T401 (figure 5-11) which also provides coupling to the second mixer. The mixer's plate tank, Z216, is tuned by the KILOCYCLE CHANGE control to the difference frequency which descends from 2.5 to 2. 0 MHz as the receiver is tuned from 0.5 to 1 MHz, and then descends from 3.0 to 2.0 MHz as the receiver is tuned from 1 to 32 MHz.

3.2.8 Third Mixer and VFO.

Third mixer V204 heterodynes the output signals from V203 with the output of variable frequency oscillator V701.

The signal generated by this oscillator varies continuously from 2.955 to 2. 455 MHz as the receiver is tuned from 0.5 to 1 MHz, and varies from 3.455 to 2.455 MHz as the receiver is tuned from 1 to 32 MHz.

Z702 includes the plate tank circuit for the oscillator and the coupling circuit to the cathode of the third mixer. The two input signals are so coordinated that they produce a fixed difference frequency. 455 kHz, which is tuned by T208 and coupled to the first of four IF amplifiers.

3.2.9 First IF Amplifier.

The first IF amplifier stage incorporates bandpass filters that permit IF bandpass selection between the limits of 0.1 and 16 kHz.

Six selections are provided: the two lower values by means of a crystal filter in the input circuit, and the four upper values by means of mechanical filters in the output circuit.

3.2.9.1
The crystal filter (figure 3-4) is used to obtain selectivity's of 0.1 and 1 kHz. When the BANDWIDTH switch is set to .1 or 1, this filter is connected between the output of third mixer V204 and the Input to first IF amplifier V501.

The 455 kHz output signal is coupled from third mixer transformer T208 to crystal filter Z501. The crystal passes only those signals at or very close to 455 kHz.

Crystal holder and stray capacitances are neutralized by adjusting C520.

Coil L503 and capacitor C524 are tuned to 455 kHz.

3.2.9.2
When the BANDWIDTH switch is turned to .1, the crystal circuit is loaded by C503 in series with the combination of R502 in parallel with the series combination of C501 and R503. The exact value of R503 is chosen between 560 and 2,700 ohms, to provide a bandwidth of 0.1 kHz.

When the BANDWIDTH switch is turned to 1, C501 and R503 are removed from the circuit, and the bandpass is increased to 1 kHz. The value of resistor R502 is selected between 33K and 68K to provide a bandwidth of 1 kHz.

When the BANDWIDTH switch is turned to 2, 4, 8, or 16, T208 is coupled directly to the control grid of V501 through capacitor C501, thereby removing the crystal from the circuit.

3.2.9.3
Four mechanical filters are coupled to the shunt-fed plate circuit of V501 through coupling capacitor C553 and BANDWIDTH switches S502 and S503 (figure 3-5).

In some later production models of the receiver (table 1-9), variable trimmer capacitors were added across the input and output circuits of the mechanical filters to improve their tuning (figure 3-6).

When the BANDWIDTH switch is turned to .1, 1, or 2, 2 kHz mechanical filter FL502 is switched into the circuit. The 1, 8, and 16 positions of the BANDWIDTH switch use FL503 through FL305, respectively.

The bandpass of the IF amplifiers, and therefore of the entire receiver, is determined by the selection of one of the six switch positions of the BANDWIDTH switch. The very narrow bandwidth 0.1 kHz and 1 kHz positions of this switch also incorporate the crystal filter into the first IF amplifier circuit.

Switch S502 (front) connects the plate circuit of V501 to the input of the appropriate mechanical filter, and S503 (front) connects the output of the appropriate filter to the control grid circuit of second IF amplifier V502.

Switches S502 (rear) and S503 (rear) short circuit the input and output terminals of the unused mechanical filters.

Capacitors C507 through C510 and C513 through C516 resonate the input and output coils to prevent stray coupling in the unused filters to achieve proper gain and bandpass.

3.2.9.4
Magnetostriction is that property of certain materials that causes them to lengthen or shorten when they are in a magnetic field. Mechanical filters of the magnetostrictive type are capable of producing almost ideal bandpass characteristics.

The flatter the top and the steeper the sides of the bandpass curve, the better the filter. Part B of figure 3-7 compares the frequency response curve of a mechanical filter with that of a conventional tuned circuit.

3.2.9.5
Part A of figure 3-7 illustrates the construction of a typical mechanical filter. A signal current is through the input coil, which causes the driving wire to expand and contract due to magnetostriction.

This mechanical motion is transmitted to the disk resonators through the coupling wires. Each disk resonator is sharply resonant (mechanically) to the intermediate frequency, and several such disks, synchronously driven, are used to accomplish the required bandpass.

The last disk resonator is tied to the driven wire, which induces the IF output signal into the output coil. Biasing magnets are used to adjust the driving wire and the driven wire for the greatest magnetrostrictive action.

~~The mechanical filters used in the receiver are tuned and adjusted at the factory and require no further adjustment.~~[1]

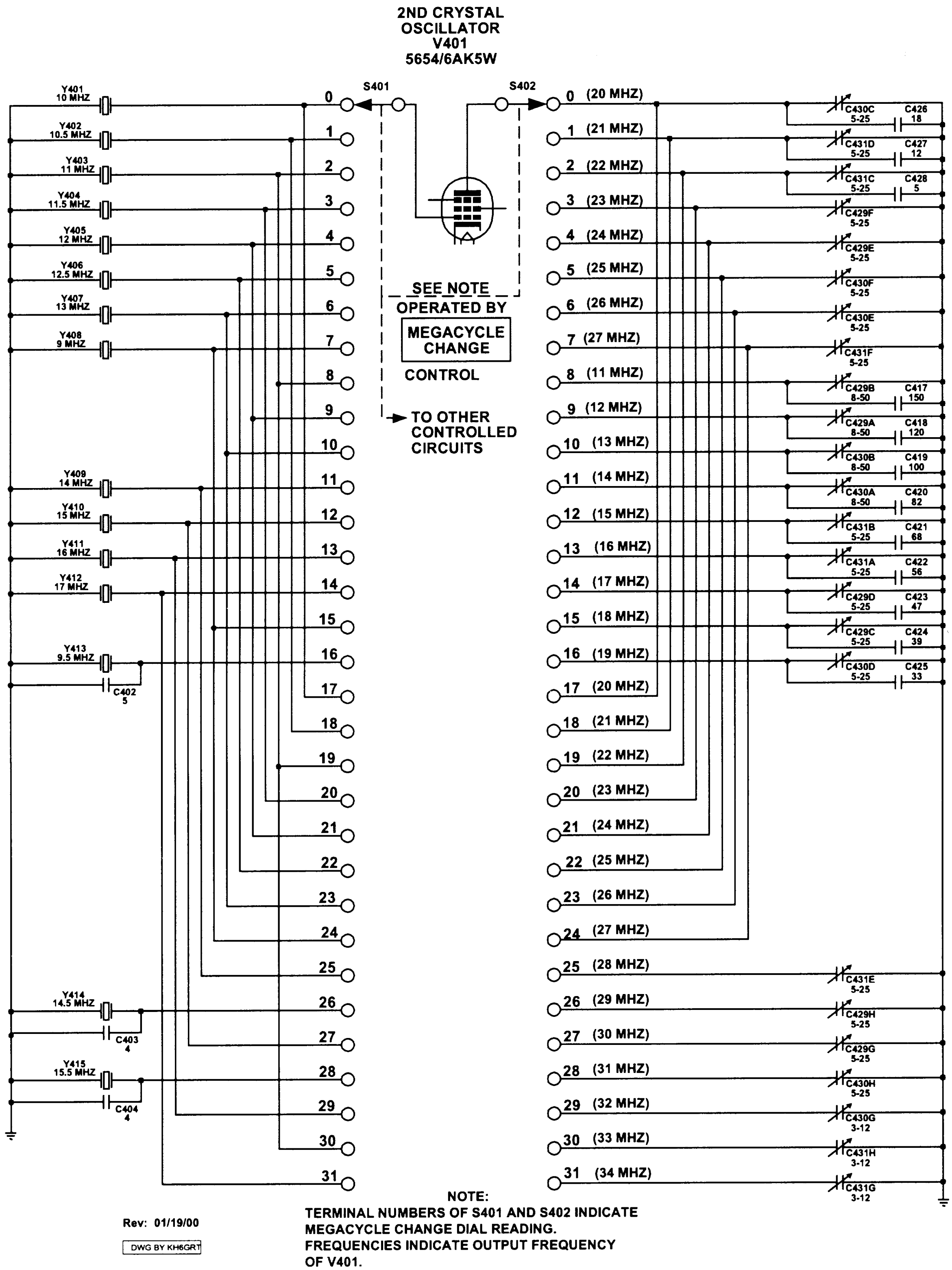


Figure 3-3 Second Crystal Oscillator V401,
Crystal and Plate Circuit Switching Schematic Diagram[3]

[3] Courtesy of Pete Wokoun, KH6GRT

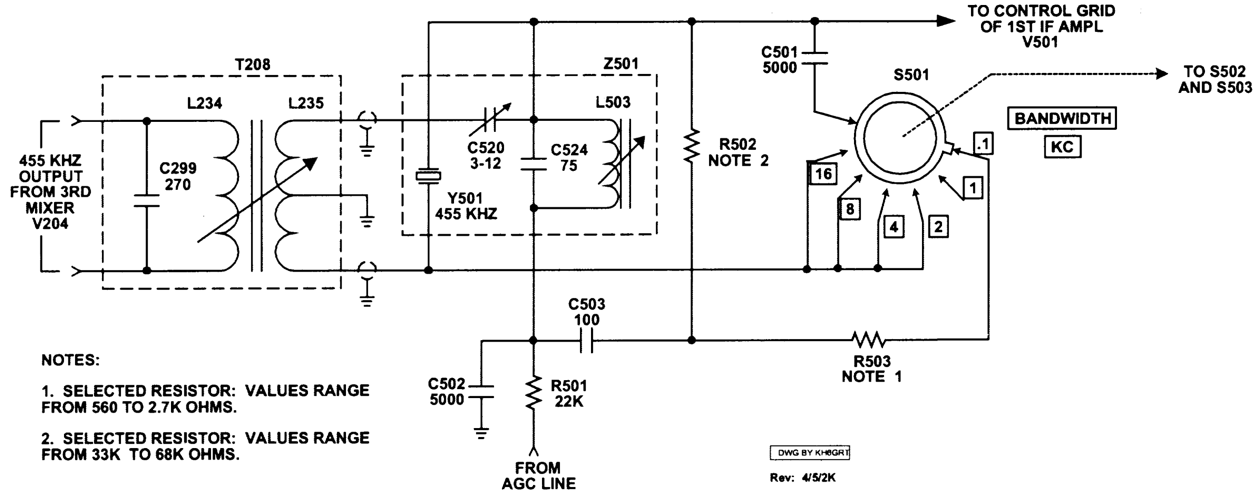


Figure 3-4 Crystal Filter, Simplified Schematic Diagram[4]

3.2.10 Second, Third, and Fourth IF Amplifiers.

Second, third, and fourth IF amplifiers V502, V503, and V504 respectively, amplify (in cascade) the 455 kHz signal from first IF amplifier V501.

At V504, the signal from transformer T503 is fed to detector V506B.

A second path for the 455 kHz signal is from the control grid of V504 to the control grid of IF cathode follower V509B.

3.2.10.1

The cathode of V502 returns to RF GAIN control R103 along with RF amplifier V201 and first IF amplifier V501.

Screwdriver-adjusted GAIN ADJ control R519, in the cathode circuit of V503, is adjusted during alignment so that the IF amplifiers will yield sufficient amplification.

This adjustment compensates for variations in tube gain and loss of tube gain as a result of aging.

The cathode circuit of V504 contains screwdriver-adjusted CARR--METER ADJ control R523. The setting of this adjustment has little effect on the gain of V504, since it varies the cathode resistance of V504 only between 680 and 698 ohms.

Tube V504 and its circuit components are used as one half of a bridge circuit containing CARRIER LEVEL meter M102.

[4] Courtesy of Pete Wokoun, KH6GRT

3.2.10.2
Adjustment of IF transformers T501, T502, and T503 is normally not included in the IF amplifier alignment procedure. They are initially tuned during receiver assembly, and should require no subsequent adjustment.

The bandwidth of these transformers is sufficiently wide to have negligible effect within the bandpass of even the 16 kHz mechanical filter. Their most important function is that of providing attenuation of IF signals more than 8 kHz removed from 455 kHz.

Neutralizing capacitor C525 is adjusted to cancel beat-frequency oscillator signals that might feed back from detector V506B through V504.

The secondary winding of T502 also feeds 455 kHz signals to IF cathode follower V509B, which supplies 50 ohm, 455 kHz signals to external circuits.

The output signal developed across T503 is connected to detector V506B. In the IF sub-chassis with MOD numbers 1 and higher on Order No. 363-Phila-54, serial numbers 600 and higher on Order No. 08719-Phila-55, and all IF sub-chassis on Order No. 14-Phila-56, transformers T501, T502, and T503 are stagger-tuned to increase bandwidth.

When one of these transformers is replaced in any sub-chassis, stagger-tuning procedures should be followed (paragraph 6.2.7.1).

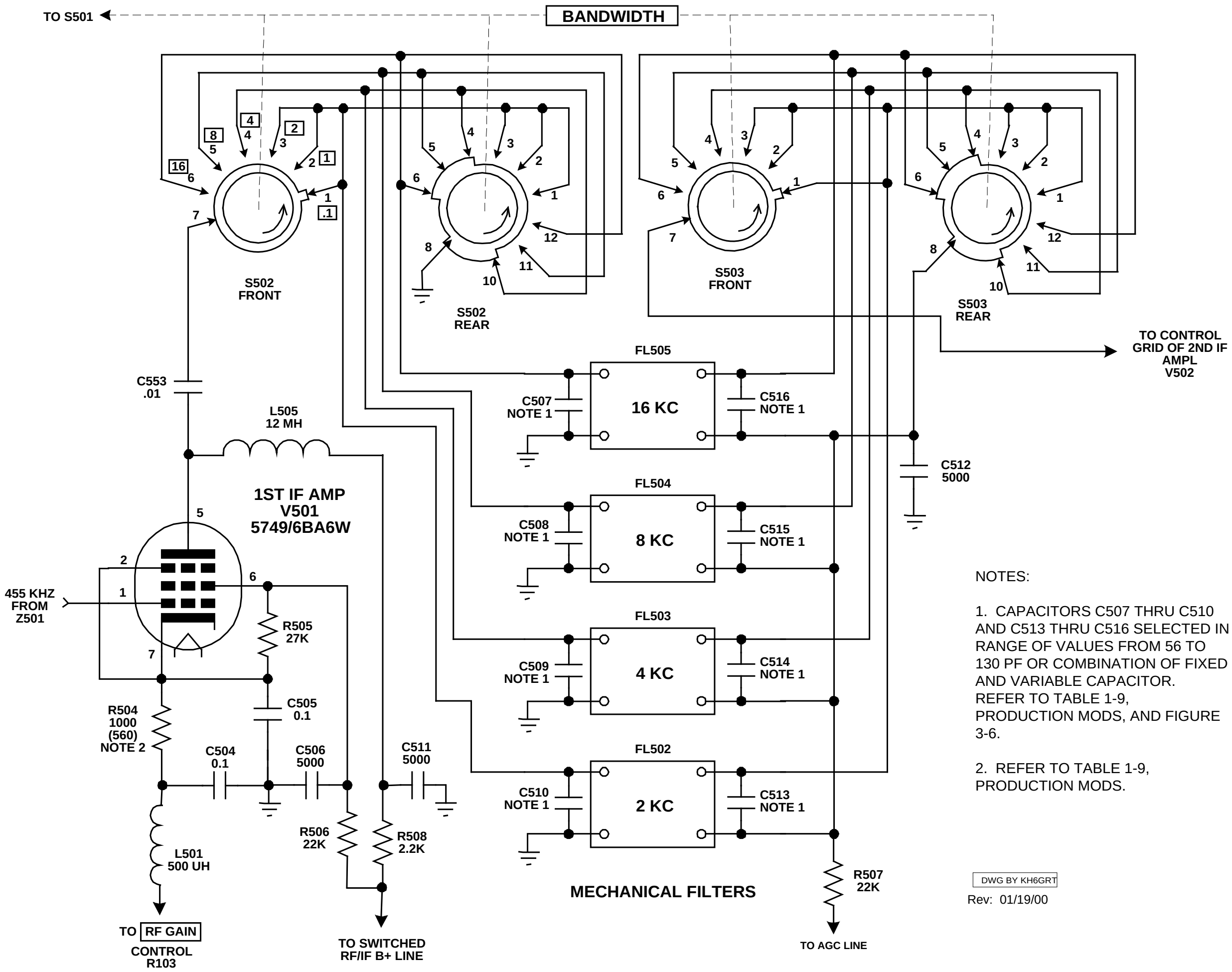


Figure 3-5 First IF Amplifier V501, Simplified Schematic Diagram[5]

[5]Courtesy of Pete Wokoun, KH6GRT

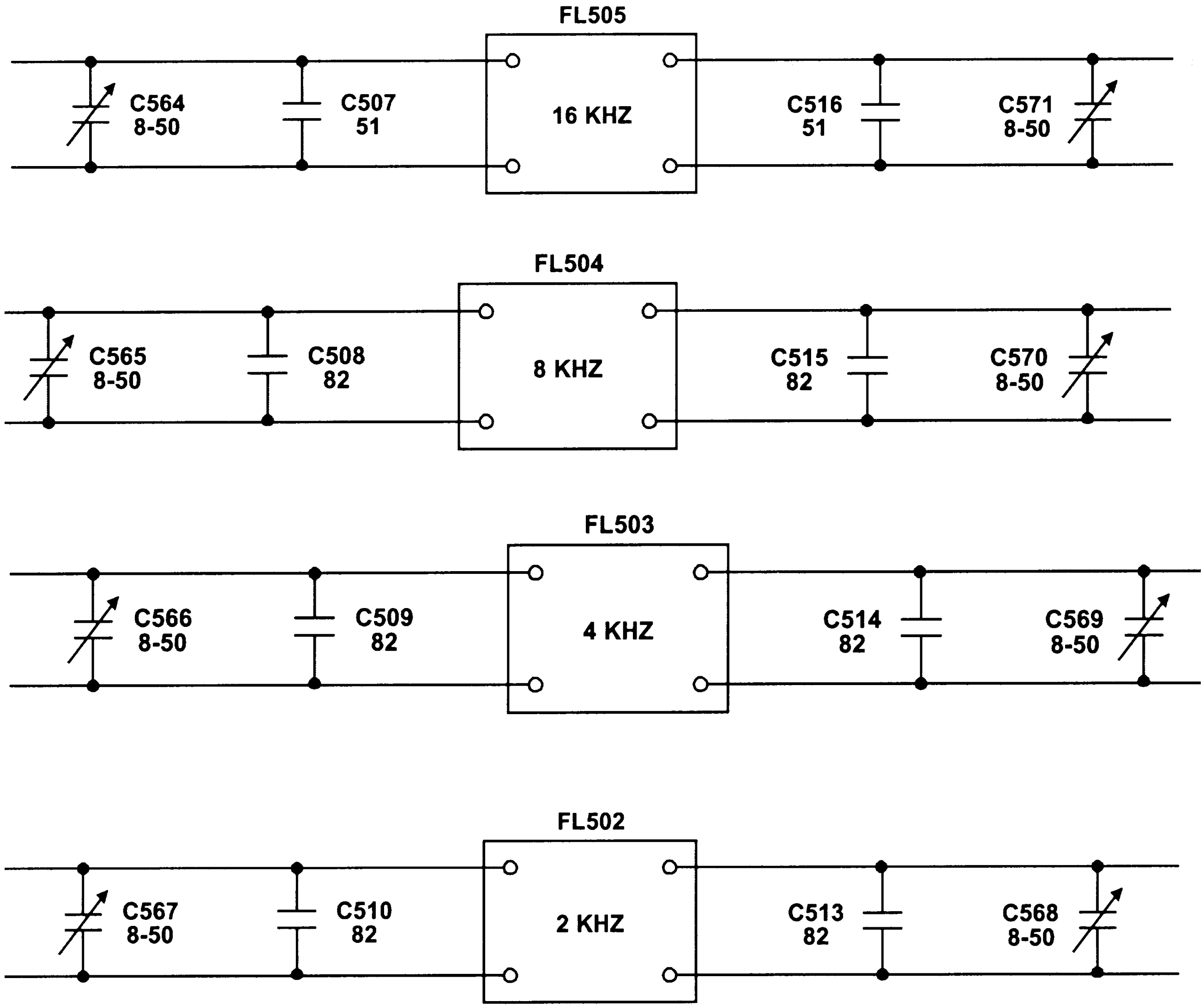
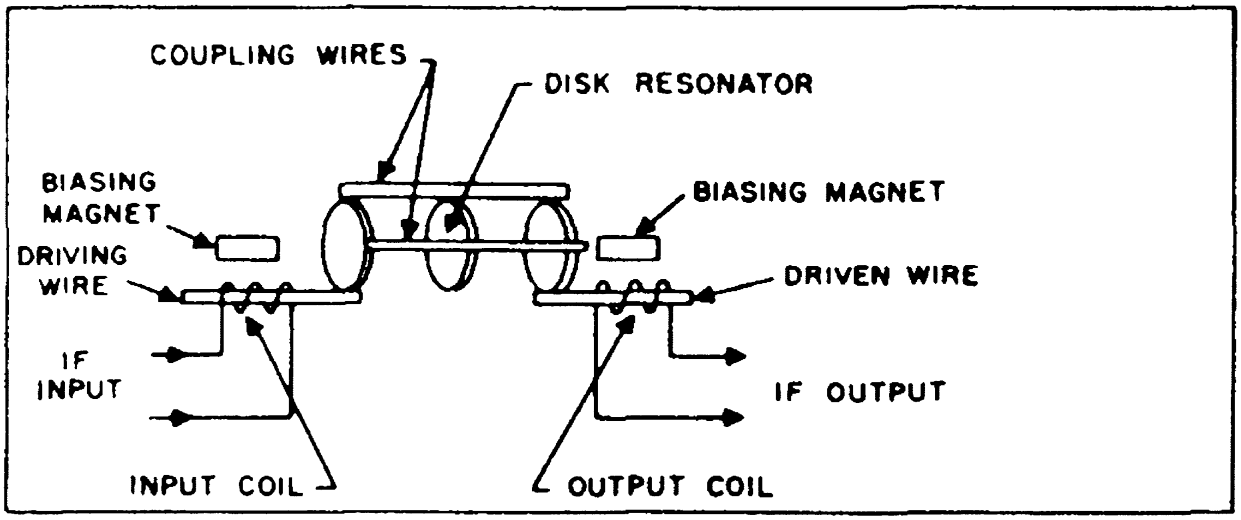
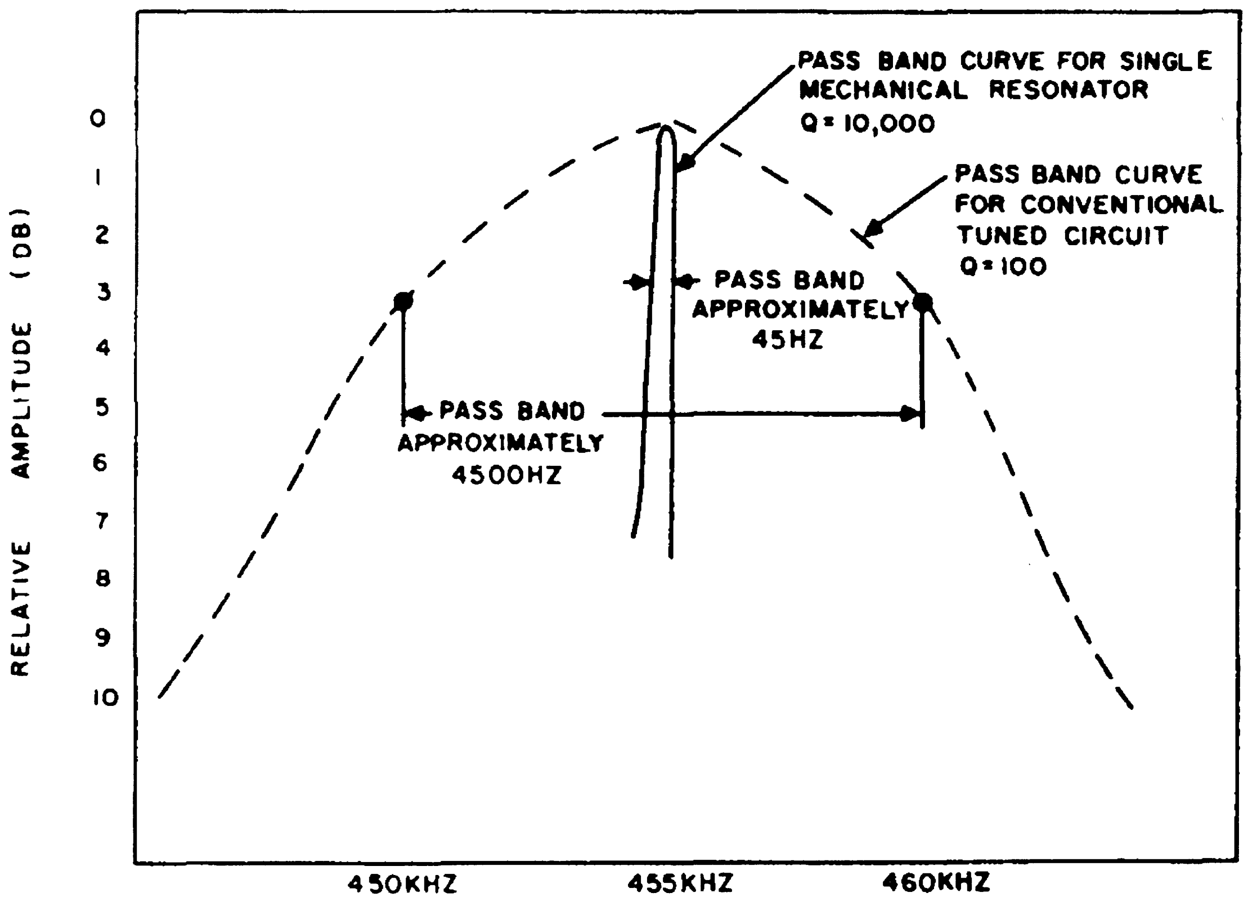


Figure 3-6 Modified Mechanical IF Filters[6]

[6] Courtesy of Pete Wokoun, KH6GRT



A. Components of a Mechanical Filter



B. Typical Band Pass Curves of Conventional Tuned Circuit and a Single Resonator

Figure 3-7 Typical Mechanical Filters

3.2.11 Detector and Limiter.

Detector V506B demodulates the 455 kHz signal to recover the intelligence from the modulated signals.

Limiter V507 removes noise pulses that exceed the amplitude of the modulation. The output of the detector passes through the limiter stage before it is fed to the audio channels.

3.2.11.1
The detector is connected as a half-wave diode connecting the control grid and plate together.

The polarity at DIODE LOAD terminals 14 and 15 of TB103 is negative with respect to chassis ground.

Limiter V507 is a series-type diode limiter, which couples the audio signals from the detector to the audio channels.

When LIMITER switch S108 is in the OFF position, audio signals pass through V507 without any limiting action.

When switch S108 is turned on, the amount of limiting is controlled by LIMITER control R120.

The limiter uses both sections of a twin-triode tube. The B-section of the tube is the negative peak limiter, and the A-section is the positive peak limiter. Both positive and negative noise peaks are clipped.

As the LIMITER control is turned more and more clockwise, the dc threshold voltage approaches chassis ground potential and more severe clipping occurs.

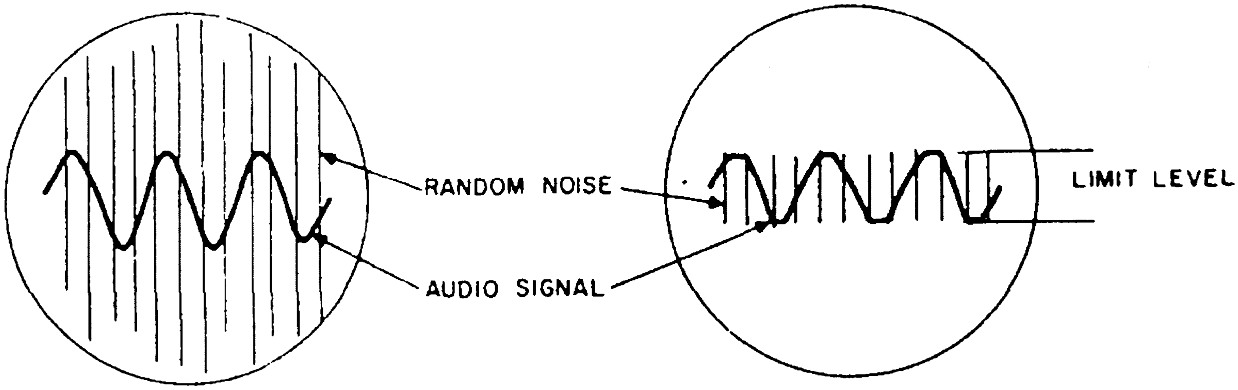
Figure 3- shows that the audio signal as well as the noise will be clipped if the LIMITER control is turned too far clockwise. The circuit automatically adjusts to any level of signal input and modulation percentage.

3.2.12 Beat-Frequency Oscillator.

Beat-frequency oscillator V505 generates a signal that can be varied from approximately 452 to 458 kHz (3 kHz above and 3 kHz below the intermediate frequency).

By beating this signal with the 455 kHz signal at detector V506B, audio signals that are variable from 0 to 3,000 Hz are produced.

Voltage for the plate and screen grid is obtained from the switched RF-IF B+ line through BFO switch S10l when the switch is in the ON position.



A. Audio signal and random noise pulses without noise limiter operation

B. Audio signal and random noise pulses with noise limiter operation

Figure 3-8 Typical Oscilloscope Presentations of Limiter Operation

3.2.13 IF Cathode Follower.

IF cathode follower V509B provides a 50-ohm, 455 kHz output signal for use with a single sideband converter. This stage has negligible loading effect on the third and fourth IF amplifiers and isolates the AGC IF amplifier from them to prevent interaction.

3.2.14 Automatic Gain Control (AGC) Circuit.

When the receiver front-panel FUNCTION switch is set to the AGC position, AGC bias is fed to the control grid circuits of tubes V201 through V204 in the RF sub-chassis and to tubes V501, V502, and V503 in the IF sub-chassis.

This AGC bias controls the gain of these amplifiers in proportion to the average level of the incoming RF signal. As a result, signals appear to have relatively constant signal strength. The AGC circuit operates only for signals in excess of approximately 5 micro-volts, to prevent reduction of receiver gain when receiving extremely weak signals.

The AGC switch on the front panel of the receiver allows the operator to select one of three AGC time-constant characteristics. These positions are SLOW, MED, and FAST, and are approximately 5 seconds, .3 second, and .015 second, respectively. This feature enables the operator to choose the AGC time constant which most effectively compensates for fading HF signals.

Three tubes are used in the AGC circuit: AGC IF amplifier V508, which amplifies the voltage from IF cathode follower V509B; AGC rectifier V509A, which rectifies the output of V508; and AGC time-constant tube V506A, which lengthens the time constant of the AGC circuit when the AGC switch is set to the SLOW position.

When two receivers are used in a diversity reception system, the jumper on TB102, normally connected between terminals 3 and 4, is connected between terminals 4 and 5. This connects crystal diode CR101 into the circuits to prevent loading of the AGC circuit of the controlling receiver by the AGC circuit of the passive receiver.

3.2.15 CARRIER LEVEL Meter Circuit.

CARRIER LEVEL meter M102 indicates the relative strength of the received RF signal. Fourth IF amplifier V504, AGC time-constant tube V506A, and their circuit components form a bridge circuit which includes meter M102.

With no received RF signal and with the RF GAIN control turned fully counterclockwise, the current through V504 is adjusted, with CARR-METER ADJ R523, until M102 reads zero. Under these conditions no current flows through M102.

As an RF signal is applied to the receiver (RF GAIN control fully clockwise), AGC voltage is applied to V506A, and its plate current and the voltage drop across R548 decrease. This causes an unbalance in the bridge circuit. The greater the amplitude of the RF signal, the greater the unbalance and the larger the indication of M102. Thus, M102 indicates a relative value that is proportional to the received RF signal.

When the FUNCTION switch is in the MGC position, the control grid of V506A is grounded and the CARRIER LEVEL meter will read zero unless the signal input to the control grid of V504 is large enough to draw grid current. This condition indicates an overload, and the RF GAIN control should be turned counterclockwise until the CARRIER LEVEL meter indicates zero again.

3.2.16 First AF Amplifier and AF Cathode Follower.

The purpose of these two stages is to amplify the audio signals and to provide a circuit that will distribute the audio signals to the local and line audio channels. The gain of V601A is less than 10 dB, and the gain of V601B is less than unity.

The audio output of V601A is applied to AUDIO RESPONSE switch S104, and is either fed directly to the control grid of AF cathode follower V601B (WIDE position), or through 800 Hz bandpass filter FL601 (SHARP position) to V601B.

3.2.17 Local Audio Channel.

Audio signals are fed to the control grid of a-f amplifier V602A from LOCAL GAIN control R105. The audio output signals are induced in the secondary windings of T601 and are fed to LOCAL AUDIO terminal 6 of TB102. This audio output supplies at least 500 milli-watts into a 600-ohm load.

The same audio signals are supplied through an attenuator that includes R10l to terminal 8 of TB102 (PHNS terminals), and PHONES jack J102 on the receiver front panel. This power output is at least 1 milli-watt

3.2.18 Line Audio Channel.

The operation of the line audio channel is similar to that of the local audio channel. Signal level is controlled by means of LINE GAIN potentiometer R104.

After amplification by V602B and V604, the audio output signals are induced in the secondary winding of T602.

The maximum audio output power available at TB103 terminals 10 and 13 is at least 10 milli-watts into a 600-ohm load.

The audio signals are also applied to LINE LEVEL meter M10l via LINE METER switch S105 and appropriate shunts and dividers. Switch S105 has four positions: OFF, +10, 0, and -10.

LINE LEVEL meter M10l is calibrated in volume units (VU), which are based on a zero reference level of 1 milli-watt (mw) into 600 ohms, or 0 dbm.

Volume units are used for complex audio signals and are similar to decibels which are used for pure sine waves. When LINE METER switch S105 is set at the 0 position, the LINE LEVEL meter is read directly.

When switch S105 is set at the -10 position, subtract -10 VU from the meter reading, and similarly, add +10 VU to the meter reading when S105 is set at the +10 position.

3.2.19 Power Supply Circuits, (See figure 5-11).

The primary windings of power transformer T801 can be connected in parallel for 115 vac operation or in series for 230 vac operation.

Shipboard receivers with field change No. 6 have silicon diode rectifiers instead of vacuum tube rectifiers for reduced heat dissipation.

3.2.19.1
After filtering, +215 vdc is applied directly as B+ to audio-frequency amplifiers.

Similarly, +205 vdc is applied directly to first crystal oscillator V207, second crystal oscillator V401, and VFO V701. The +205 vdc is applied via FUNCTION switch S102 as B+ to all RF and IF amplifiers in all positions except OFF and STANDBY.

Tube V605 is used as a shunt regulator for the +150 volt line to the two crystal oscillators and the VFO, and to the calibration oscillator tubes V205 and V206 in the CAL position.

3.2.19.2
25 vac from transformer T801 is applied to rectifier CR102 which in turn furnishes 25 vdc to the antenna relay (described in paragraph 3. 2. 2).

[1]Actual filament winding voltage is 6.1 vac. Courtesy of Perry Sandeen

3.3 MECHANICAL TUNING SYSTEM

3.3.1 Functional Description. (See figure 3-9).

The mechanical tuning system of Radio Receiver R-390A/URR controls the permeability tuning and switching to provide continuous linear tuning over a range of 0.5 to 32 MHz in 32 steps. Each step, or band of the MEGACYCLE CHANGE control (except the first band), is tuned linearly over a range of 1 MHz. The first band is tuned linearly from 0.5 to 1 MHz. Although the counter can be set between 00 000 and 00 500, no signal reception is possible within this range.

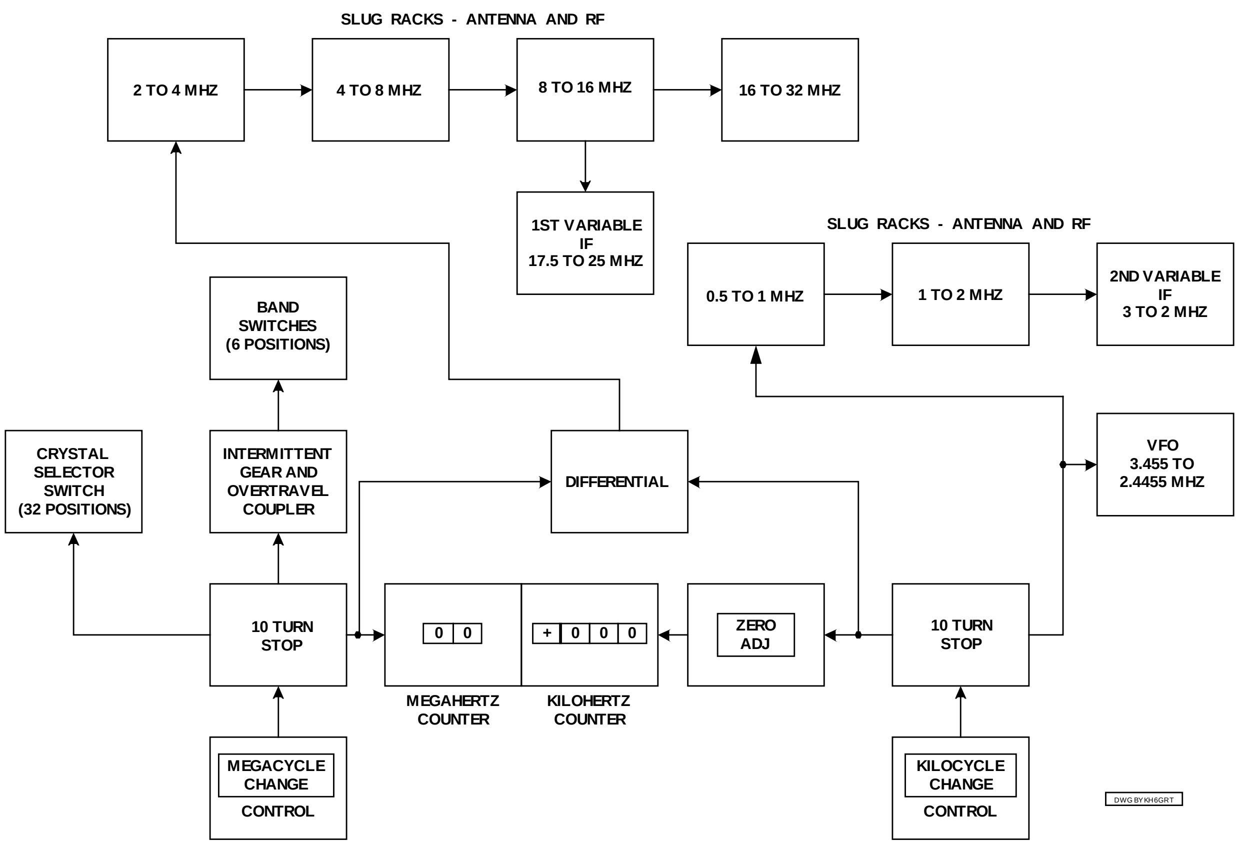


Figure 3-9 Tuning System, Mechanical Block Diagram[7]

3.3.1.1 MEGACYCLE CHANGE Control.

Operation of the MEGACYCLE CHANGE control (lower left) is limited to 10 turns by a progressive mechanical stop.

As the control is turned, the first two number wheels on the digital dial are rotated, and the numbers coincide with the frequency of reception in MHz from 0 through 31. At the same time, the crystal selector switch is switched to one of its 32 positions.

[7] Courtesy of Pete Wokoun, KH6GRT

The RF band switches are also operated by this control through the intermittent gear and overtravel coupler.

This system operates the band switches at precisely the correct time as the MEGACYCLE CHANGE control is turned. The MEGACYCLE CHANGE control, through the differential, also controls the positioning of the 2- through 32-MHz antenna and RF slug racks, and the first variable IF slug rack.

3.3.1.2 KILOCYCLE CHANGE Control.

The KILOCYCLE CHANGE control (lower right) is connected through a 10-turn stop to the VFO, the second variable IF slug rack and the 1- to 2-MHz and 0.5- to 1-MHz antenna and RF slug racks.

The KILOCYCLE CHANGE control knob is also connected through the same differential as the MEGACYCLE CHANGE control knob and provides movement for the 2- through 32-MHz antenna and RF slug racks and the first variable IF slug rack from the starting point established by the MEGACYCLE CHANGE control knob.

A ZERO ADJ control knob on the front panel of the receiver allows frequency dial correction over a small range to align the frequency-counter reading with the receiver frequency.

3.3.1.3

To tune continuously from 0.5 to 32 MHz at a linear rate, not only must the correct coils and transformers be selected, but the slugs in them must be moved at the proper rate to tune them simultaneously.

For example, to cover the 0.5- to 1-Mhz band, the slugs in coils T201 and Z201 move over their entire range, a distance of approximately eight-tenths of an inch, At the same time, the slugs in the coils of Z213 move approximately five-hundredths of an inch in covering this range.

This tuning is controlled with a single knob moving numerous gears and cams.

3.3.2 Detailed Mechanical Analysis. (See figure 3-10).

The gears in the illustration are identified by letter designations. The numbers indicate the number of teeth in each gear. The cams that furnish motion to the slug racks are shown as single units; actually, each slug rack has a roller at both ends and identical cams mounted on each end of the cam shaft.

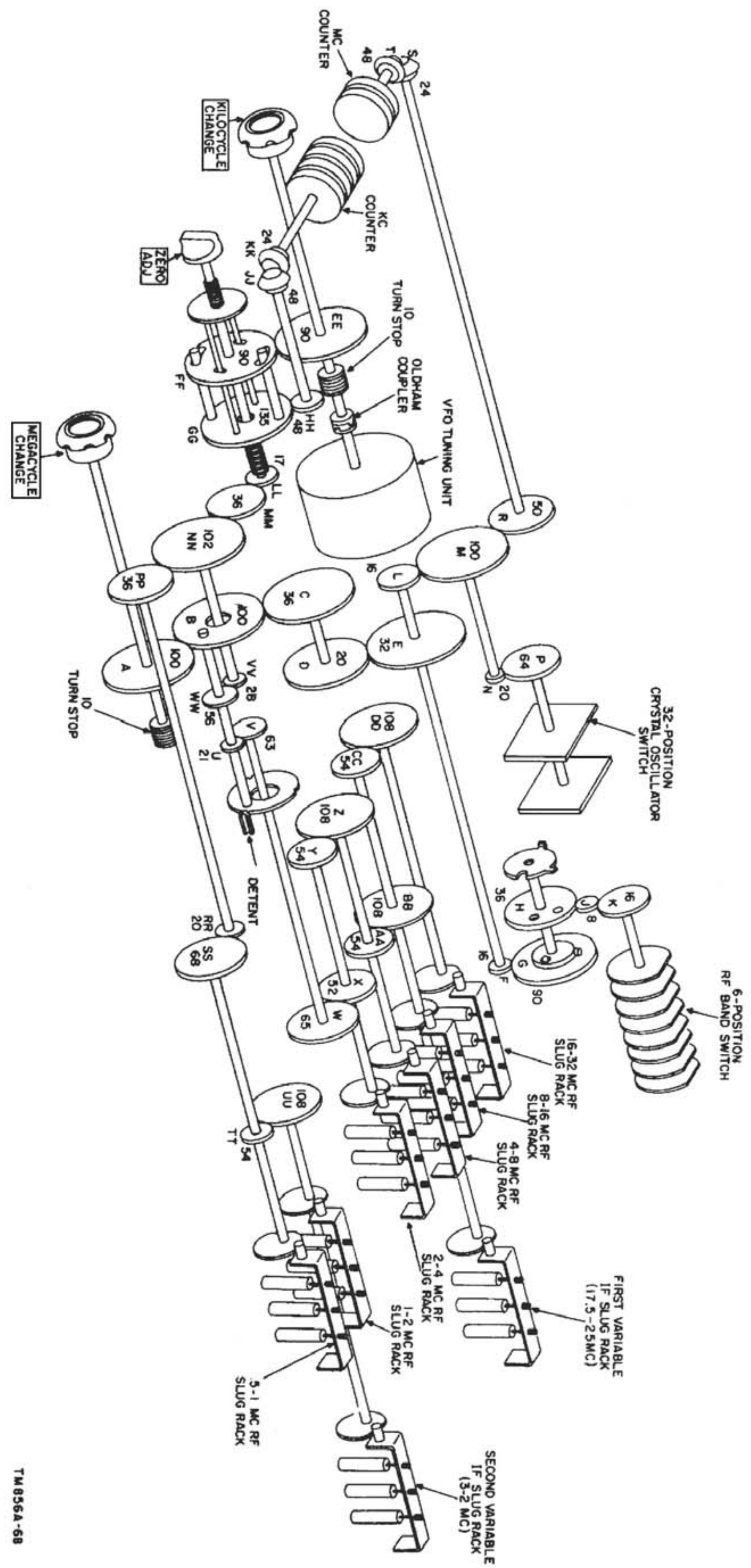


Figure 3-10 Tuning System, Simplified Mechanical Diagram

3.3.2.1 MEGACYCLE CHANGE Control.

1. As the MEGACYCLE CHANGE control is turned, it is limited to 10 turns by a 10-turn stop.

The MHz counter wheels show the frequency band or step selected by the MEGACYCLE CHANGE control.

As this control is rotated, time counter wheels are driven through gears (A), (B), (C), (D), (E), (L), (M), (R), (S), and (T).

2. The MEGACYCLE CHANGE control also operates the six-position r-f band switch through gears (A), (B), (C), (D), (E), (F), (G), intermittent gear (H), and gears (J) and (K).

The intermittent gear and over-travel coupler provides an intermittent rotary motion so that the switch is turned to each one of its six positions at exactly the right time.

Gear (G) rotates continuously as the MEGACYCLE CHANGE control is turned; however, gears (J) and (K) are driven only during the part of the rotation of gear (G) when the teeth of intermittent gear (H) engage the teeth of gear (J).

3. Also operated by the MEGACYCLE CHANGE control is the 32-position crystal oscillator switch. This is accomplished through gears (A), (B), (C), (D), (E), (L), (M), (N), and (P).

4. The 2- to 4-MHz, 4- to 8-MHz, 8- to 16-MHz, and 16- to 32-MHz RF slug racks are moved by both the MEGACYCLE CHANGE and KILOCYCLE CHANGE controls through a differential gear system consisting of gears (NN), (B), (VV), (WW), and (U).

a. The 2- to 4-MHz RF slug rack is operated by the MEGACYCLE CHANGE control through gears (A), (B), (Y), (U), (W), and (X).

b. The 4- to 8-MHz RF slug rack is operated by the MEGACYCLE CHANGE control through gears (A), (B), (U), (V), (W), (X), (Y), and (Z).

c. The 8- to 16-Mhz RF slug rack is operated by the MEGACYCLE CHANGE control through gears (A), (B), (U), (V), (W), (X), (Y), (Z), (AA), and (BB).

d. The 16- to 32-MHz RF slug rack is operated by the MEGACYCLE CHANGE control through gears (A), (B), (U), (V), (W), (X), (Y), (Z), (AA), (BB), (CC), and (DD).

5. In each of the steps (bands 0.5-1 through 16-32 MHz), it is necessary to have an exact stopping point or reference for the circuit elements controlled by the MEGACYCLE CHANGE control.

This is done by the MHz change detent. A disk with three equally spaced notches around its edge touches the MHz change detent and locks the disk when the MHz change detent falls into one of the three notches.

This MHz change detent is made of spring material, and constantly maintains pressure against the three-notch disk.

6. The first variable IF slug rack (17.5 to 25 MHz) is driven by the MEGACYCLE CHANGE control in the same manner and on the same shaft as the 8- to 16-MHz RF slug rack.

The gearing is through gears (A), (B), (U), (V), (W), (X), (Y), (Z), (AA), and (BB).

3.3.2.2 KILOCYCLE CHANGE Control.

1. The KILOCYCLE CHANGE control is limited to 10 turns by a 10 turn stop. The kHz counter wheels show the frequency selected by the KILOCYCLE CHANGE control.
To permit overlapping of each band selected, the frequency range of this control is slightly greater than 1 MHz. As the KILOCYCLE CHANGE control is rotated, the kHz counter wheels are driven through gears (EE), (FF), (GG), (HH), (JJ), and (KK).

2. The VFO tuning unit is connected to the KILOCYCLE CHANGE control through the 10-turn stop and the Oldham coupler. The Oldham coupler is a coupling device for correcting slight misalignment of two shafts.

3. The 0.5 to 1-MHz RF slug rack cam is operated by the KILOCYCLE CHANGE control through gears (EE), (FF), (LL), (MM), (NN), (PP), (RR), and (SS). The 1- to 2-MHz RF slug rack cam is operated through gears (EE), (FF), (LL), (MM), (NN), (PP), (RR), (SS), (TT), and (UU).

4. The second variable IF slug rack cam (3 to 2 MHz) is operated by the KILOCYCLE CHANGE control through the same gears and same shaft as the 1- to 2-MHz RF slug rack cam.

5. The 2- to 4-MHz, 4- to 8-MHz, 8- to 16-MHz, 16- to 32-MHz RF slug rack cams are moved by the KILOCYCLE CHANGE control through a differential gear system.

These RF slug rack cams are operated through the same gears as in 4a. through 4d. of 3. 3. 2.1, except for gears (A) and (B). Gears (EE), (FF), (LL), (MM), (NN), (VV), and (WW) are used instead of gears (A) and (B).

3.3.2.3 ZERO ADJ Control.

The ZERO ADJ control provides for correcting errors in calibration. A locking screw operated by the knob releases the clutch and locks the gear (GG).

Tuning over a range of approximately 15 kHz without moving the setting on the three kHz counter wheels on the frequency indicator is possible with the KILOCYCLE CHANGE control.

Operation of the ZERO ADJ knob in a counterclockwise direction engages the clutch and unlocks gear (GG).