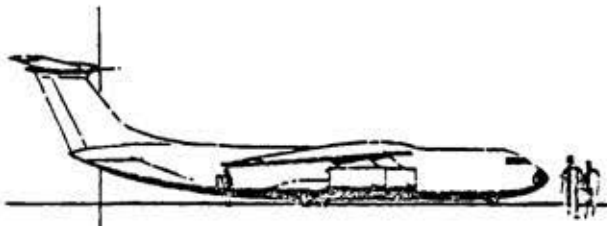


VHF COMMUNICATION

GENERAL

Two Very High Frequency (VHF) radio communication systems are used to transmit and receive voice communications. They are used primarily to contact airport control towers for takeoff and landing instructions and for enroute reporting. They are capable of communications over line-of-sight distances only, therefore, range for air-to-ground communications is limited by aircraft altitude.

AIRCRAFT INSTALLATION

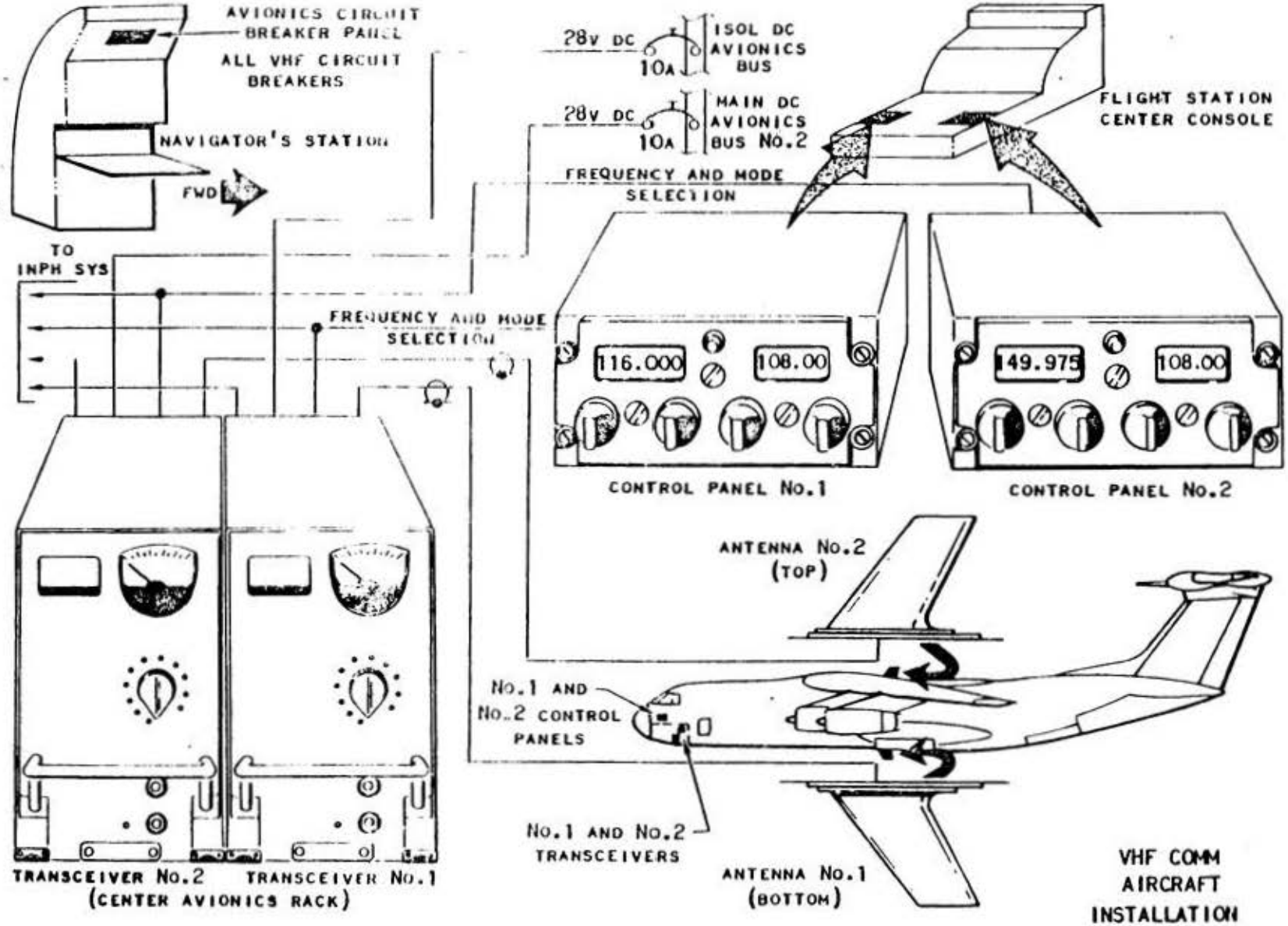
Power requirements and locations are shown on the aircraft installation drawing.

The primary components are as follows:

- Transceiver — WILCOX 807
- Control Panel — WILCOX 97650-100
- Antenna — TRANSO 23070-5

Interchangeable components are as follows:

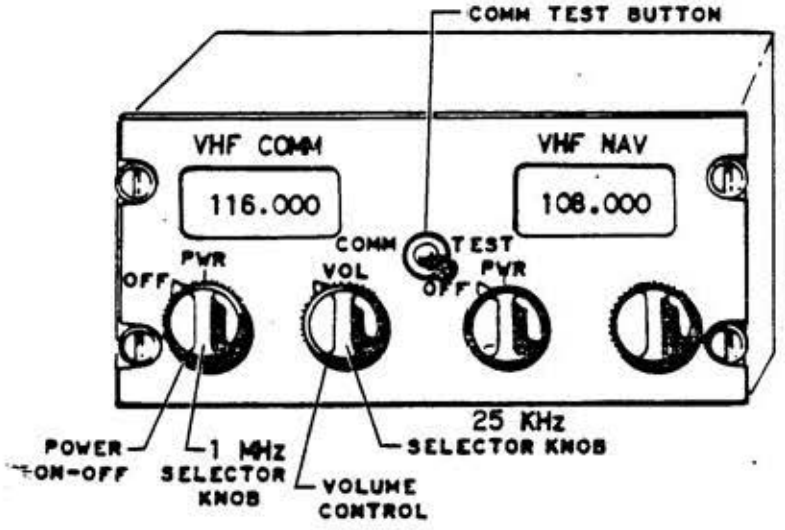
- Transceiver — COLLINS 618M-1C
- Control Panel — COLLINS 313N2
- Antenna — COLLINS 522-1135-012



VHF COMM AIRCRAFT INSTALLATION

SYSTEM OPERATION (only one system is discussed)

The combination VHF COMM/VHF NAV control panel provides the necessary controls for operation of the VHF communication equipment. These controls are power (PWR) on-off, frequency selection, received audio volume control, and communications (COMM) test.



The power switch activates the system. Frequency selection is made by the 1 MHz and 25 KHz selector knobs. The selected frequency appears in the dial window. The headset volume is adjusted by the volume control. The COMM TEST button, when pressed, allows noise to appear in the headsets. This provides a go-no-go check of the receiver.

With the system activated and the proper frequency selected, transmission is provided by selecting the desired system on the interphone rotary selector and pressing the mic button. Reception is provided by releasing the mic button.

SPECIFICATIONS

WILCOX 807

CHARACTERISTIC	SPECIFICATION
Power requirements	27.5V DC + 10 percent; - 20 percent
Frequency Range	
Transceiver	116.00 to 149.975 MHz
Number and spacing of channels	
Transceiver	1360 channels 25 KHz apart
Channeling time	Less than 4 seconds
Frequency selection	ARINC (2 out of 5 wire)
Output impedance	52 ohms
Transmitter output power	25 watts, minimum
Type of emission	A3, A0
Type of modulation	Amplitude, high level
Audio imput impedance	100 ohms
Sidetone level	100 MW into 200 or 500 ohms at 100 percent modulation
Sensitivity	3 microvolts for 6 db at 1000 Hz 30 percent modulation

COLLINS 618M-1 ( )

CHARACTERISTIC	SPECIFICATION
Power requirements	27.5 V DC + 10 percent; - 20 percent
Frequency range	
618M-1	118.00 to 135.95 MHz
618M-1A	116.00 to 149.95 MHz
618M-1B	118.00 to 135.975 MHz
618M-1C	116.00 to 149.975 MHz
618M-1D	116.00 to 135.95 MHz
Number and spacing of channels	
618M-1	360 channels 50 KHz apart
618M-1A	680 channels 50 KHz apart
618M-1B	720 channels 25 KHz apart
618M-1C	1360 channels 25 KHz apart
618M-1D	400 channels 50 KHz apart
Channeling time	Less than 4 seconds
Frequency selection	ARINC (2 out of 5 wire)
Output impedance	52 ohms
Transmitter output power	25 watts, minimum

SPECIFICATIONS (continued)

COLLINS 618M-1 ( )

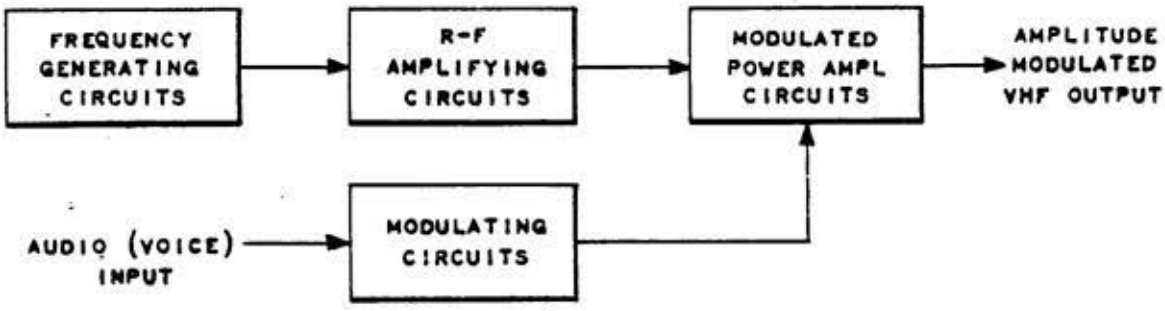
CHARACTERISTIC	SPECIFICATION
Type of emission	A3, A0
Type of modulation	Amplitude, high level
Audio input impedance	150 ohms
Audio output impedance	600 ohms
Sidetone level	100 MW 90 percent modulation
Sensitivity	4 microvolts for 6 db at 1000 Hz

BLOCK DIAGRAM THEORY OF OPERATION

TRANSMITTER

A multi-channel VHF transmitter consists of a number of oscillators, mixers, and amplifiers. Combinations of oscillator frequencies provide all possible transmit frequencies. The selected operating frequency signal level from the final mixer stage will be raised by RF amplifiers to the specified power output.

An audio modulating signal is supplied from a microphone through the interphone system to the transmitter modulator circuits. The modulator circuits provide the signal amplification necessary to fully modulate the Radio Frequency (RF) carrier. The modulated RF carrier output is routed through a low pass filter, which suppresses harmonics and prevents transmission of spurious signals, to the antenna for radiation. A portion of the modulated RF output is detected, amplified, and routed to the interphone system as sidetone. The sidetone signal gives the operator an indication of transmitter operating condition.



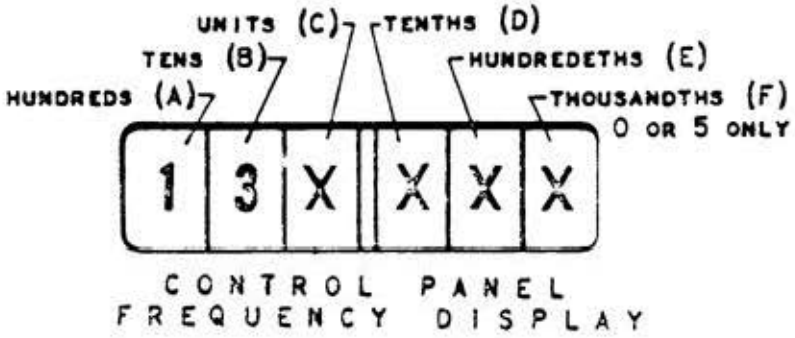
BASIC TRANSMITTER

There is always definite relationships between the operating frequency, selected at the control panel, and the transmitter oscillators and mixers output frequencies. These relationships can be stated as simple rules. The WILCOX 807 transceiver series will be used as a typical example to demonstrate the frequency selection scheme. The 807 transmitter section uses five crystal-controlled oscillators, a frequency doubler, an injection amplifier, and three mixers in its frequency generating system. Frequency selection is accomplished by switching diodes controlled by the remote control panel using the 2 out of 5 wire grounding scheme per ARINC wiring specifications. The injection and RF amplifier stages are tuned to the correct frequencies by varactors (voltage variable capactors). Output of the frequency generation system (carrier frequency) is amplified in succession by the RF amplifier, RF exciter amplifier, driver amplifier, and power amplifier. The output of the power amplifier (25 watts minimum) is applied to the antenna. Voice input signals used to modulate the transmitter carrier are amplified to the required level by the modulator amplifier stages and used to modulate the RF carrier at the power amplifier stages. The transmitter output is filtered by the low-pass filter and monitored by the integral sidetone circuit.

The "Transmitter Block Diagram" shows ranges of frequencies for the oscillators and mixers. However, for a particular transmitter channel, only one specific frequency within each range is present at each point in the frequency synthesis sceme.

For transmitter frequency synthesis, frequency selection is accomplished by switching the tens oscillator "on" or "OFF," switching between the two units oscillators (high and low), and by switching crystals in each active units, tenths, and hundredths OSCILLATORS. Crystal switching functions are performed by diodes acting as solid state switches. A total of 35 crystals are used in the transmitter frequency synthesis

The tens oscillator output is 10 MHz in transmit operation. It is "on" when the selected transmit frequency is 11X. XXX (X's denote insignificant digits) or 14X. XXX MHz. It is OFF when the selected frequency is 12X. XXX or 13X. XXX MHz.



Rule 1 - Tens oscillator output equals 10.0 MHz when B is 1 or 4.

Rule 2 - Tens oscillator "OFF" when B is 2 or 3.

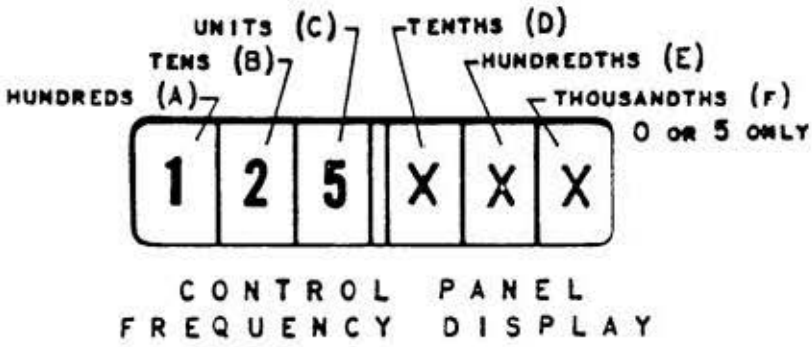
Either the high units or the low units oscillator is selected for operation, dependant upon the frequency selected at the control panel. For selected frequencies between 11X.XXX and 12X.XXX, the low units oscillator is active. Even though either the high or low units oscillator is activated by the tens digit (B), their actual frequency is determined by the units digit (C).

Rule 3 - Low units oscillator output equals 52.45 MHz + C/2 when "B" is 1 or 2.

Rule 4 - Low units oscillator "OFF" when B is 3 or 4.

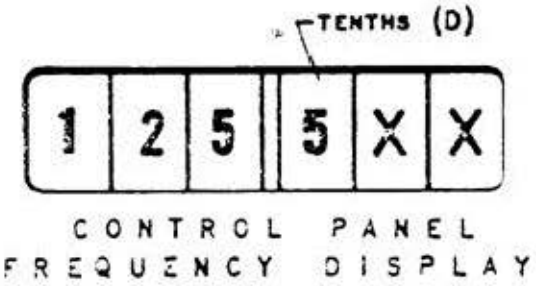
Rule 5 - High units oscillator output equals 57.45 + C/2 when "B" is 3 or 4.

Rule 6 - High units oscillator "OFF" when B is 1 or 2.



The active units oscillator frequency is doubled and applied to the first injection mixer where it is mixed with the tens oscillator output. The output of the first injection mixer is applied to a tracked filter, which is varactor tuned to select the difference frequency when "B" is 1, to select the doubled units oscillator frequency when "B" is 2 or 3, and to select the sum frequency when "B" is 4. The frequency selected by the tracked filter is amplified and applied to the third injection mixer.

The tenths oscillator operates at one of ten crystal controlled frequencies over a range of 19.70 to 20.6 MHz in 100 KHz steps. The frequency of this oscillator is controlled by the tenths digit (D).

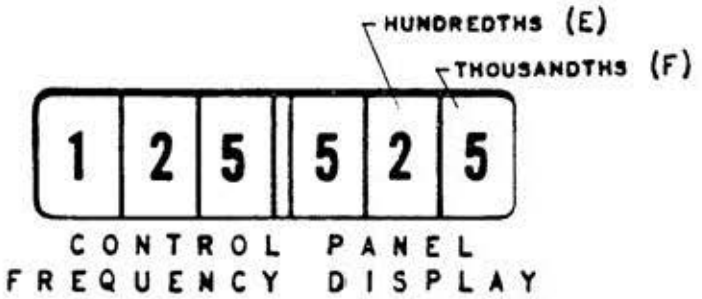


Rule 7 - Tenths oscillator output equals 19.7 + D.

Example: 19.7 + .5 equals 20.2 MHz.

The output of the tenths oscillator is applied to the second injection mixer.

The hundredths oscillator operates at one of four crystal controlled frequencies over a range of 4.525 to 4.600 MHz in 25 KHz steps. The frequency is controlled by the last two digits (E hundredths and F thousandths) of the selected operating frequency.



Rule 8 - Hundredths oscillator output equals 4.6 - EF

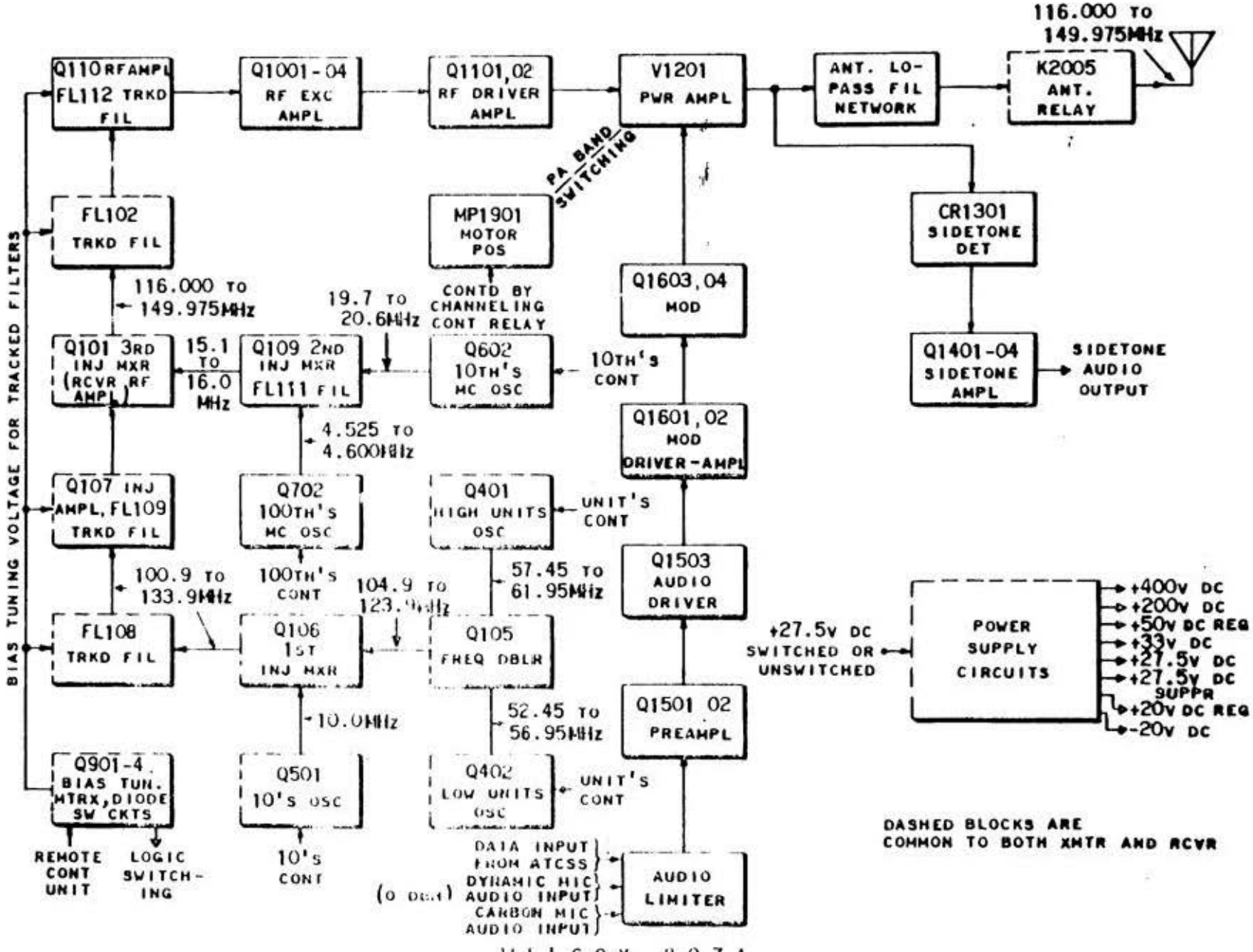
Example: 4.6 - .025 equals 4.575 MHz.

The output of the hundredths and tenths oscillators are mixed in the second injection mixer. A varactor controlled tracked filter in the mixer output selects the difference frequency which is applied to the third injection mixer where it is mixed with the combined outputs from the tens and units oscillators. The sum of the two signals is selected by a tracked filter and is within the frequency range of 116.00 to 149.975 MHz (the selected operating frequency). The carrier frequency is then amplified by the RF amplifiers, voice modulated, and transmitted.

RECEIVER.

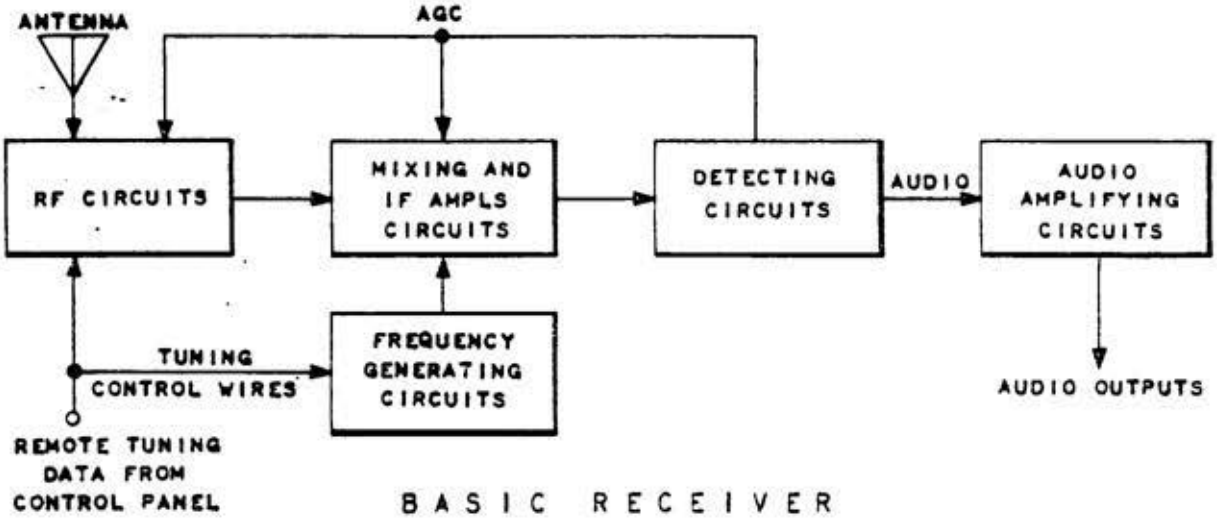
A VHF superhetrodyne receiver must have amplifiers, oscillators, mixers, and a demodulator. The oscillator injection frequency must be offset from the received frequency by an amount qual to the Intermediate Frequency (IF). This offset can be accomplished with one or more oscillators and mixers (single conversion, dual conversion, etc.) Because of this offset, the receiver frequency scheme must differ from the transmitter frequency scheme.

The received signal from the antenna, in a typical multi-channel VHF receiver, is applied to the RF circuits where it is filtered, amplified, and sent to the first mixer. Also into the first mixer is an injection frequency, from a tunable oscillator, that is offset from the received frequency by some amount (IF). Most receivers use two or three frequency conversion stages, thus two or three IF's, for image frequency rejection. The output of each mixer goes through frequency selecting filters and one or more stages of IF amplification. The IF filter and amplification stages determine the receiver bandpass (selectivity). The output of the final IF stage is demodulated and the resulting audio is amplified and routed through the control panel volume control to the interphone and/or headphones or loudspeakers. The output of the final IF stage is also detected to create a D-C voltage, proportional to received signal strength, which is used as degenerative feedback to the RF and IF amplifier



WILCOX 807A
TRANSMITTER BLOCK DIAGRAM

stages, to control overall receiver gain. This signal is called Automatic Gain Control (AGC). Communication receivers generally have quietening (sequelch) circuits to eliminate noise during periods of no signal reception.



BASIC RECEIVER

As with the transmitter, there is always definite relationships between the operating frequency, selected at the control panel, and the frequency of the receiver's oscillators and mixers. These relationships can also be stated in rules. The receiver portion of the Wilcox 807 transceiver series will be used as a typical example.

The 807 receiver section is a crystal controlled, triple conversion receiver. To achieve triple conversion, it uses six crystal controlled oscillators (a total of 36 crystals are used in the receiver), a frequency doubler, an injection amplifier, and five mixers. The conversion system produces a Variable IF (VIF) of 15.1 to 16.075 MHz, a fixed IF of 3.5 MHz, and a second fixed IF of 455 KHz. Following the conversion circuits are three IF amplifiers, an audio detector, AGC control circuit, squelch circuit and noise limiter, and a three stage audio amplifier.

For receiver frequency synthesis, the oscillator crystal selection is accomplished by two-out-of-five wire digital binary (ARINC wiring specification) information controlling diodes which act as solid state switches.

Basically the receiver injection frequency generating scheme is the same as the transmitter carrier frequency generating scheme. The tens oscillator is switched "on" or "OFF", either the high or low units oscillator is active, crystals are switched in each of the active units, tenths, and hundredths oscillators. Varactor tuned filters, rather than mechanical tuning capacitors, are used in the RF and injection stages. The rules for the receiver frequency scheme are the same as the rules for the transmitter. However, the actual frequencies involved will be different to account for the required IF offset. With reference to the selected frequency on the control panel we see that

there are the following frequency rules:

Rule 1 - Tens oscillator output equals 9.999 MHz when "B" is 1 or 4.

Rule 2 - Tens oscillator "OFF" when "B" is 2 or 3.

Rule 3 - Low units oscillator output equals 52.45 MHz + C/2 when "B" is 1 or 2.

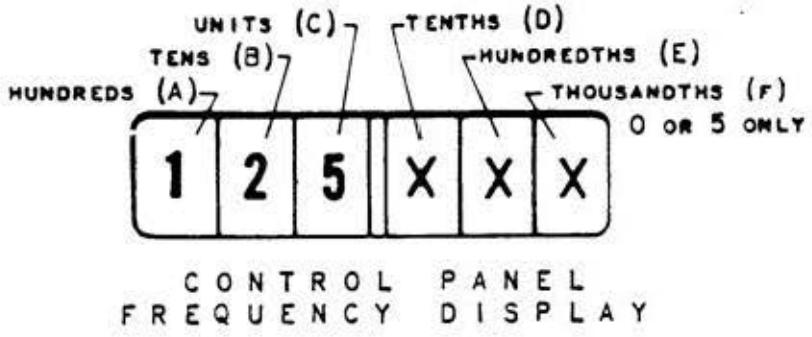
Rule 4 - Low units oscillator "OFF" when "B" is 3 or 4.

Rule 5 - High units oscillator output equals 57.45 MHz + C/2 when "B" is 3 or 4.

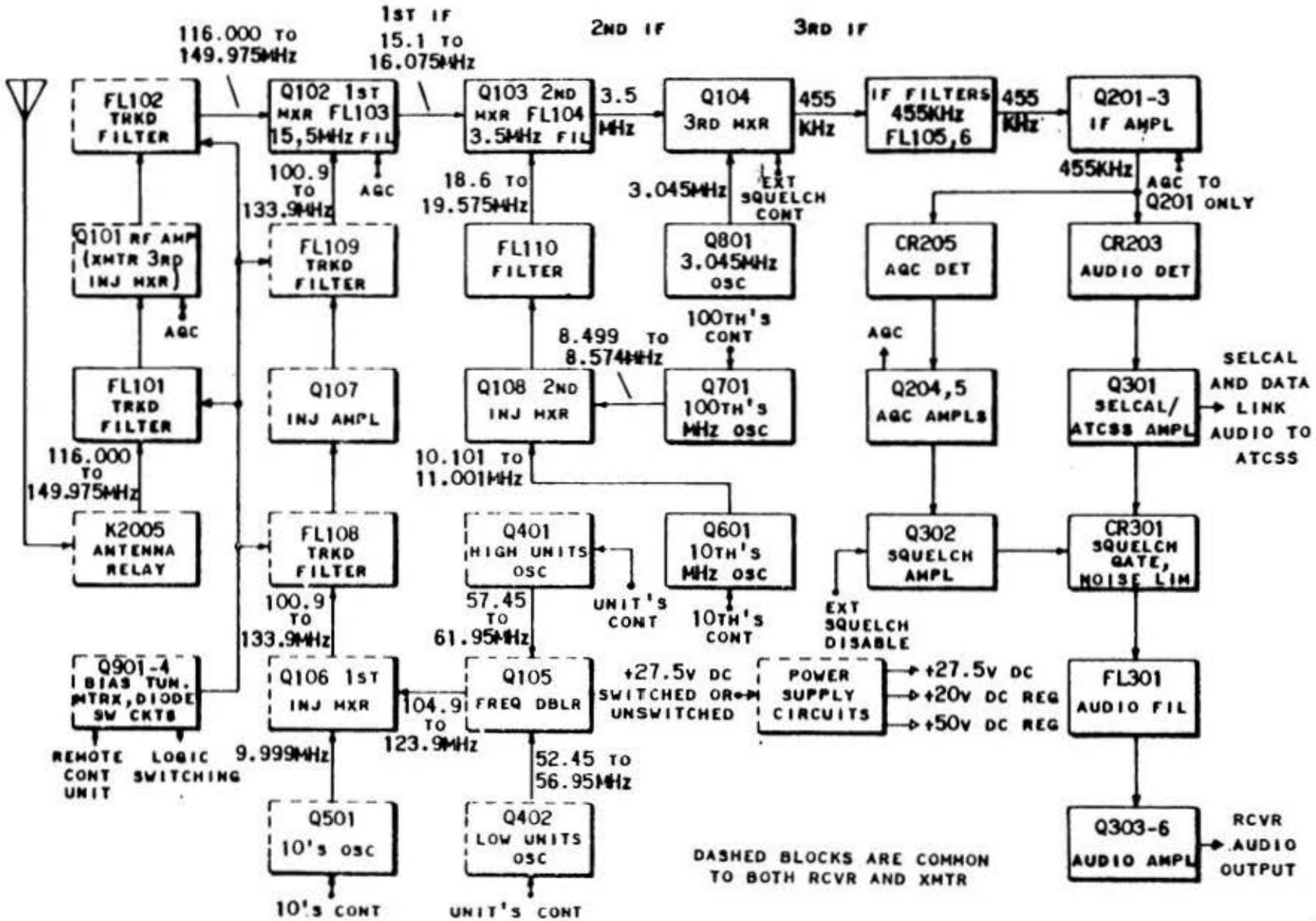
Rule 6 - High units oscillator "OFF" when "B" is 1 or 2.

Rule 7 - Tenths oscillator output equals 10.101 MHz + "D".

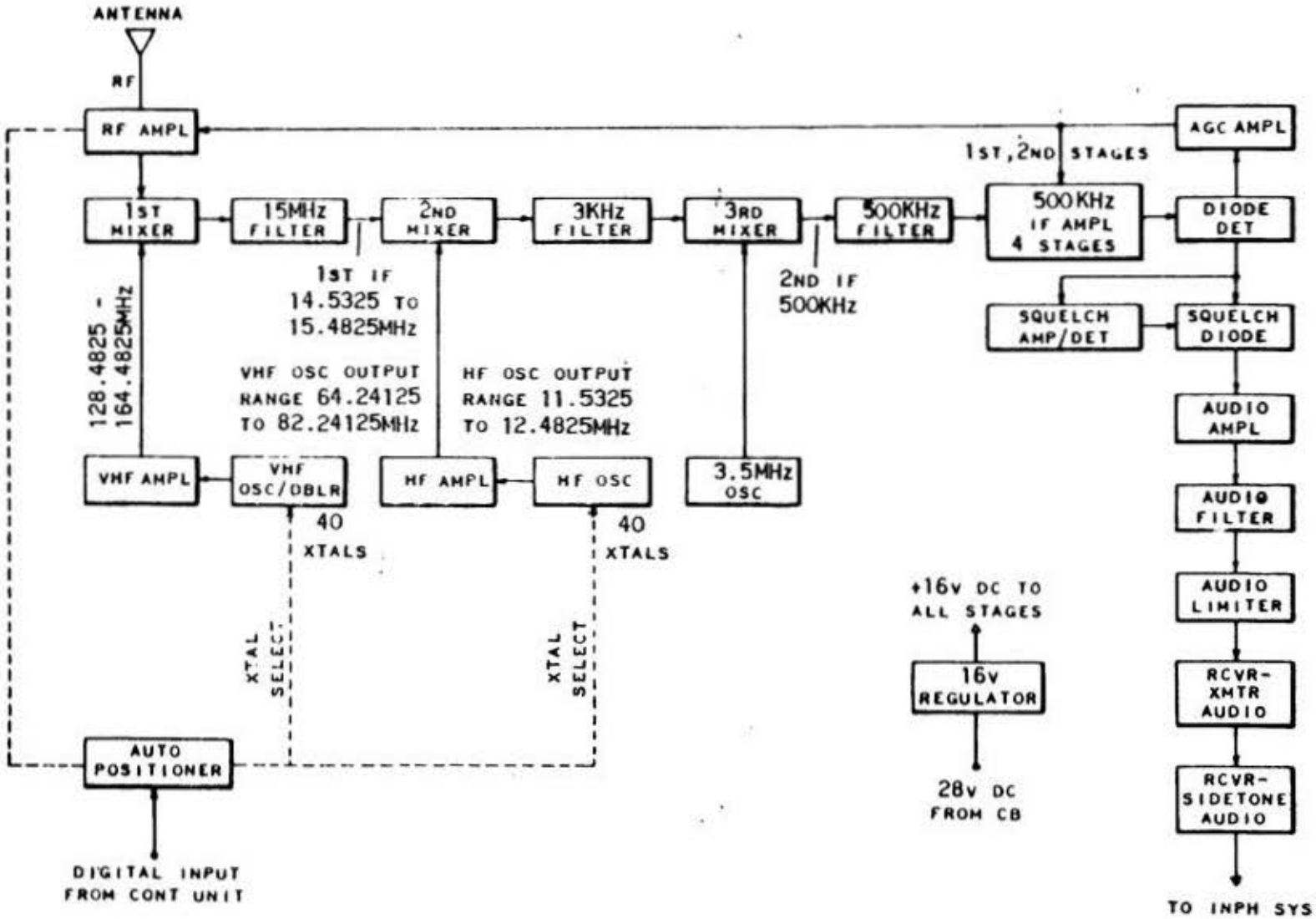
Rule 8 - Hundredths oscillator output equals 8.499 MHz + "EF".



CONTROL PANEL
FREQUENCY DISPLAY

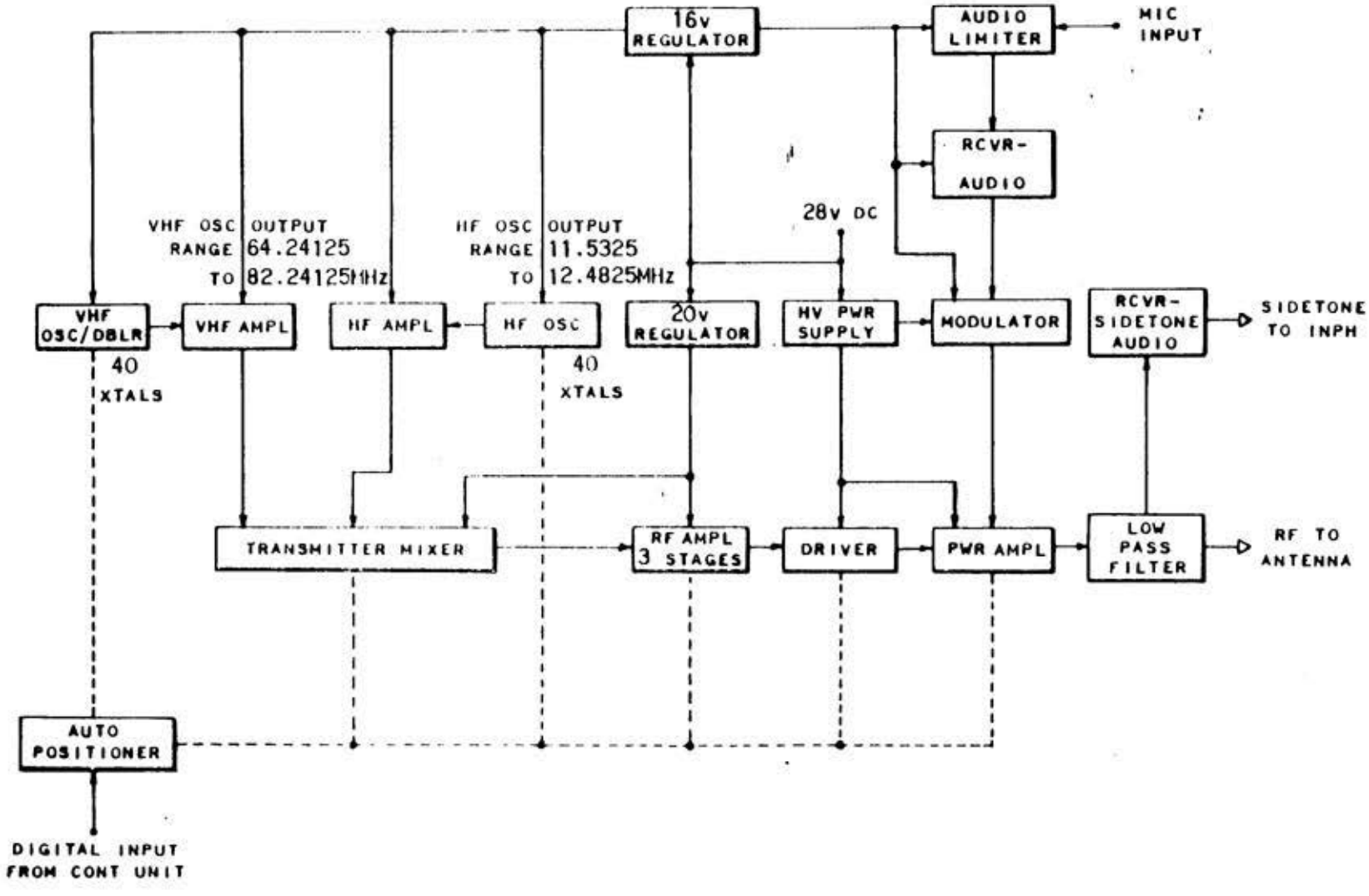


WILCOX 807A
RECEIVER BLOCK DIAGRAM



COLLINS 618M-1

VHF RECEIVER BLOCK DIAGRAM



COLLINS 618M-1

VHF TRANSMITTER BLOCK DIAGRAM