# 70-0671 Theory of operation

The 70-0671 unit is made up of four major sections: the RF Section, the PA Section, and the Logic Section and the Display section.

## RF SECTION

The RF Section consists of a frequency synthesizer, a transmit modulator, a receiver, and receive audio amplifier circuits.

## SYNTHESIZER

Radio frequency signals for transmission and receiver injection are produced by voltage-controlled oscillators (VCO's) in a Phase-Lock Loop (PLL) configuration.

- Voltage Controlled Oscillator

In this radio, VCO's are used -Q706 operates in transmit mode to generate transmit frequencies and receive mode to receive injection frequencies. In each mode, the output of the buffer is amplified by IC703. RF signal at receiver injection frequency ( Fc + 10.7MHz ) is applied from the LO amplifier IC704 and Q717 in the receiver circuit. RF signal from Q708 is amplified further by the PA portion.

When the frequency of the VCO output drifts away from the desired value, the loop adjusts the steering voltage to compensate. A single VCO tank can tune across the entire channel spread (6MHz for A Band, B-Band, and 8MHz for C Band).

Resonance of each VCO tank is voltage-tuned by varactor diodes D701 and D705 respectively. Loop steering voltage applies reverse bias to all these varactor diodes simultaneously. As steering Voltage increases, varactor diode capacitance decreases : thus, net capacitance in each tank decreases, which increases resonant frequency of the tanks.

- Loop Dividers

The amplitude of the VCO signal from IC705 for TX and RX are sufficient to feed prescaling frequency divider, IC701, which applies an output pulse to once every 64 or 65 input cycles. Additional frequency division is also performed within IC701 to produce 2.5/5.0/6.25KHz. X701 is a temperature-compensated crystal oscillator that produces a reference frequency of exactly 12.8MHz. The reference frequency is divided by IC701 to produce 2.5/5.0/6.25KHz that is 13.compared to the down-counted 2.5/5.0/6.25KHz sample of VCO output.

Normally the loop response is slowed enough by the active filter to block 2.5/5.0/6.25KHz reference noise and prevent loop correction of voice modulation during transmit. Higher active filter rolloff frequency is selected by the microcomputer system on the Logic Board when the radio changes channels or it is keyed and unkeyed, by a logic low applied to the base of Q705. This increase in loop response speeds locking time.

A connection from an intermediate point in the phase/frequency comparator in IC701 is made at pin 7. When the loop is out of lock, the down-counted VCO sample is not in phase with the 2.5/5.0/6.25KHz reference and low going pulses appear here, which produce a logic low at pin 7. This logic low is applied to Q710 through Q709 to switch to Q505. Q505 then clamps off bias to transmit PA preamplifier Q501 to prevent emission of erratic signals generated by the uncontrolled VCO.

## RECEIVER

- Preselector

Through K501 relay in the PA, RF signals are routed to the receiver input. Signals at Image frequencies and frequencies far removed from the desired channel are rejected by a Preselector comprised of eight top-coupled, parallel tanks: L201, L202, L203, L204, L205, L206,L207 and L208. No tuning of these tanks is required for the entire channel frequency spread. Q201 provides adequate gain to overcome preselector signal losses and maximize receiver sensitivity.

- Injection

First Local Oscillator signal ( Fc + 10.7MHz ) is synthesized by the phase-lock loop and applied to Q717. No alignment for the first local oscillator signal is required.

- First Mixer

To maximize intermodulation immunity, a balanced configuration is utilized for the first mixer stage. High injection is applied to L210-primary and preselector output is applied to its secondary center tap. A diode double balanced mixer using quad-diode D202 is employed. High injection is applied to the push-pull input of the mixer. Some of this signal appears at mixer output, but most is lost because L209 is designed to operate at the 10.7 MHz first IF frequency.

- First IF

Mixer output is applied to Q203. L215 tunes to match the input impedance of the 10.7MHz crystal filter XF201 which reject signals outside the channel bandwidth. L215 and L217 match the input or output of XF201. Q204 amplifies the first IF signal at least 20dB, and it is coupled to second IF IC201.

- Second IF

IC201 contains all second IF circuitry, a quadrature demodulator, and a threshold gate. X201 and circuitry in IC201 generate second LO injection of 10.245MHz. A double-balanced mixer, that cancels both input signals internally is utilized so that additional tuned circuits at its output are not needed. Mixer output signal of 455KHz ( IC201 pin3 ) is bandpass filtered further by CF201 and CF202 then superamplified ( 100 + dB ) by the second IF amplifier/limiter within IC201 ( pin 5 ).

- Demodulation

The quadrature detector in IC201 is another double-balanced mixer to which limiter output is applied. Its second input is taken from 455KHz tank CD201, which is also fed with limiter output ( IC201 pin10 ). Frequency deviation from carrier center will cause phase difference between the two demodulator inputs, which produces output. Preamplified recovered audio appears at demodulator output pin 9.

- Audio

Recovered audio from IC201 is routed to audio processor IC401. IC401 controls the amplification level. The control voltage is fed via the external volume on the control unit. Output of the gain control IC401 is applied to the Audio amplifier IC202. Audio amplifier IC202 amplifies the audio signal and drives the speaker.

- Squelch

Audio signals at low pass filter are routed through Squelch Range RV201, which calibrates squelch-break level when squelch level is maximum (80). Signals is amplified and rectified by IC201 to produce a DC voltage that varies inversely with received RF carrier level. The DC voltage is input of a level detector IC408 and detector output is Q405 an open collector that sinks voltage to logic low when on-channel receiver input is above the squelch threshold established by RV201.
Q405 output is supplied through NSQ, the interconnect to microcomputer input port P53 so that the microcomputer can take appropriate action.

- Noise Blanker

Noise generated at the output of Q203 is amplified at Q803 and then sent to IC801. IC801 controls gain of pin 8 output through Q809 to Q811 (rectifier / amplifier circuit) and fed-back to pin 5. Output of IC801 pin 1 is rectified at Q804 and given to Q805 and Q806 (one shot multi-vibrator), which generates a blanking pulse. Q801 and Q802 switch "IF" signal on and off by blanking pulse amplified at Q807 and Q808.

## 110 WATT PA SECTION

- RF Power Amplifier

A PC-board stripline is used to match Q501-base terminal to the coax. RF impedance at collector of Q501 is transformed by PC-board stripline to the base terminal of driver Q502 and the collector of Q502 is transformed to the base of Q503. Transformer T1 spilits driver output to feed twin finals Q504 and Q505. Final-stage outputs are combined by Transformer T2. In transmit mode, K501 connect this RF signal to the harmonic filter consisting of L520, L521 and L522 which purifies the signal before emission by the antenna connected to J502. R520 and R521 serve to drain static and other DC potentials from the antenna.

- Antenna Gate

In receive mode, Relay K501 is switched to the J502-J503 route. The RF signal path from the final amplifier Q504 and Q505 is then severed. In transmit mode, Relay K501 is switched off the C544 route. The receiver port network is detuned such that it appears as a high impedance to the antenna, and K501 switches final amplifier output to the antenna at J502.

- Automatic Power Control

T3, ahead of the harmonic filter, serves as a directional coupler. D502 rectifies a small RF sample that is developed across the thin runner, producing a DC voltage that increases with RF power traveling forward into the antenna. This power level sensing voltage is the inverting input of the comparator IC501 pin 6. The reference voltage applied to the comparator IC501 pin 5 is fed from IC901 pin 71, which is controlled by the programmer in alignment mode. Differential amplifier output drives Q507 which is a current source that feeds primary DC to the collector circuit of predriver Q501. The feedback loop, from the directional coupler to Q507, holds RF output power at a constant level that is determined by IC901.

# LOGIC SECTION

- Microcomputer

Radio operation is under control of a microcomputer system located on the Logic Board. This system is comprised of microcomputer IC901 and 32K EEPROM IC902.

All CPU activity is performed step-by-step in time with a clock. The frequency of the clock is fixed by crystal X901. Because of the high clock speed, microcomputer activity seems instantaneous.

- Modulator

Voice signals from the hand-microphone are applied to audio filter of IC401, where frequency response is pre-emphasized and splatter filtered. Gain is such that stronger signals bring IC401 into clipping, which limits modulation. Harmonics above the 3KHz (wide) or 1.5KHz (narrow) modulation pass-band are removed in IC401. Modulation signals are then adjusted by IC401 so that modulation at limiting will produce transmitted carrier deviation of ± 5KHz (wide) or 2.5KHz (narrow). Output of processed voice signals at IC405 pin 8 is fed to the gain control IC401.

- Data Control

When the radio is turned on, the contents of EEPROM IC902 are serially clocked into IC901 so that it can set up receiver frequency, scan operation, transmit/receive hold timer, busy-channel lock-out timer, time-out-timer and reference oscillator frequency control.

When a channel is changed, or when PTT is pressed, the contents of EEPROM IC902 are sent to IC901. IC901 then uses this data to send the appropriate information for the channel selected to IC701, CTCSS/DCS circuitry, display circuitry, and any signaling options.

- DC Power and Reset

5V DC power to all logic circuitry in the logic section is supplied from switched 13.6V and is regulated by IC905. Microcomputer IC901 is powered by the 5V, which is source by IC904 8V regulator supply.

# DISPLAY SECTION

- Display and Switches

By pushing AUX switch **S301**, a logic low signal is supplied to pin 35 of IC302.
IC302 feeds display data to LCD301.

By pushing A/D switch **S302**, a logic low signal is supplied to pin 36 of IC302.
Then IC302 feeds display data to LCD301.

By pushing SCAN switch **S303**, a logic low signal is supplied to pin 37 of IC302.
IC302 feeds a signal to IC901. Then IC901 makes a radio in the scan mode, and also feeds display data to IC301 to display SCAN on LCD301.

By pushing MON switch **S304**, a logic low signal is supplied to pin 38 of IC302.
IC302 feeds a signal to IC901. Then IC901 makes a radio in the monitor mode, and also feeds display data to IC301 to display MON on LCD301.

By pushing switch **S305**, a logic low signal is supplied to Q901.
Then Q901 feeds a logic high signal to IC908 to turn on Q903.
Thus power supply is turned on by feeding +B switch out.
By pushing switch **S305** again, power supply is turned off.

By turning switch **S306**, pulses are supplied to pins 33 and 34 of IC302.
IC302 performs channel-up or channel-down with these pulses, then feeds display data to LCD301.

By pushing switch **S306**, a logic low signal is supplied to pin 24 of IC302.
IC302 performs switching of the SQ of menu, group, back-light, and others with this signal, then feeds display data to LCD301.

During transmit, TXDL is low, TX icon is displayed on LCD301, turning it on.

When a signal is received, NSQ is turned on, BUSY icon is displayed on LCD301.