

## **SECTION IV**

### **THEORY OF OPERATION**

#### **4.1 INTRODUCTION**

This section contains a description of equipment and a theory of operation for the BK Radio DMH APCO Project 25 digital VHF radio. To aid in understanding the operation of the equipment, schematic diagrams are found in Section VI of this manual.

#### **4.2 EQUIPMENT DESCRIPTION**

The BK Radio DMH Series radio comprises the following sub-assemblies:

##### **4.2.1 SYSTEM BOARD**

This sub-assembly consists of core microprocessor, synthesizer, baseband signal processor and regulation. A casting is used to shield the synthesizer area.

##### **4.2.2 RX BOARD**

This sub-assembly consists of the receiver circuitry from the front-end through the digital IF.

##### **4.2.3 HIGH LEVEL POWER AMPLIFIER BOARD**

This sub-assembly consists of the transmitter power amplifier, antenna switch, harmonic filter, directional coupler and power control.

##### **4.2.4 OPTIONS BOARD**

This sub-assembly consists of the audio power amp, and interfaces with both the System Board and the Control Board.

##### **4.2.5 CONTROL BOARD**

This sub-assembly consists of a control head microprocessor, regulator, and vacuum fluorescent display circuitry. It interfaces with the front panel.

##### **4.2.6 VCO BOARD**

The VCO board is a separate assembly that resides in its own shielded enclosure and interconnects with the System Board and RX Board.

## 4.3 THEORY OF OPERATION

### 4.3.1 SYSTEM BOARD

System board functions include:

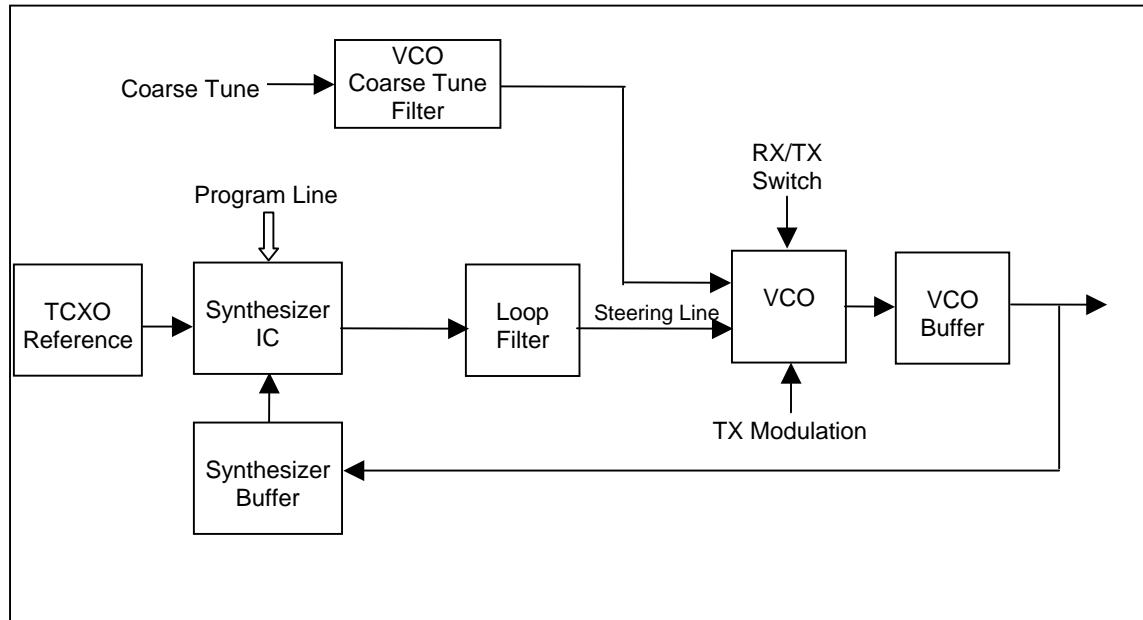
- Core Microprocessor
- Voltage regulators
- Synthesizer
- Baseband signal processor

#### A. Microprocessor

The core microprocessor communicates with the control head microprocessor and the baseband signal processor. It controls radio functions such as adjusting the deviation and receiver tuning. An EEPROM is used to store calibration and tuning data unique to each radio. An internal clock determines the microprocessor's operating frequency.

#### B. Synthesizer

The Synthesizer generates an RF signal either to down-convert a desired receive frequency to a fixed IF or to drive the Transmitter. The synthesizer locks the RF output frequency of a Voltage Controlled Oscillator (VCO) to a very stable frequency reference.



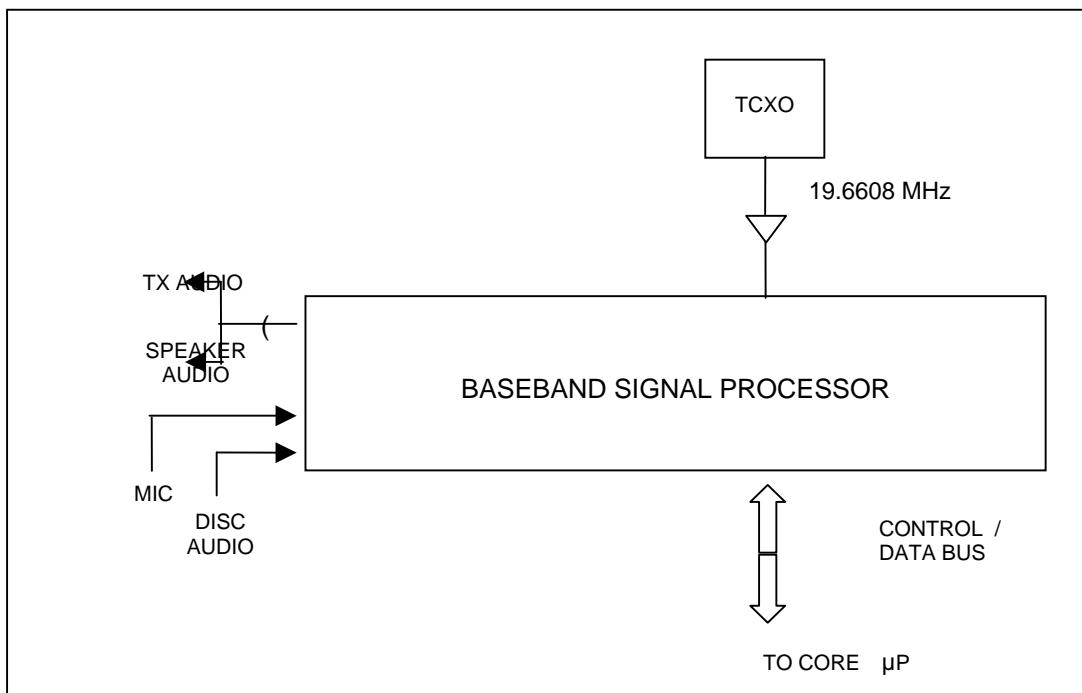
- (1) Synthesizer IC – Contains programmable counters to divide and compare the VCO output frequency to the stable TCXO reference and adjusts VCO control voltage to maintain a stable output frequency.
- (2) TCXO Reference – Provides a stable frequency reference over the operating temperature range of the radio.

- (3) Loop Filter – Smoothes the output of the Synthesizer IC to reduce undesired modulation of the VCO frequency.
- (4) VCO Coarse Tune Filter – When changing to a new frequency that requires a different Coarse Tune voltage, a switch is closed for a short time to allow the VCO control voltage to change to the new value rapidly. Otherwise the VCO Coarse Tune Filter provides a low noise voltage for setting the range of the VCO frequency.

### C. Voltage Regulators

Several voltage regulators provide power for the circuitry located on the System Board.

### D. Baseband Signal Processor



- (1) Baseband Signal Processor - Implements filters, tone generators, and other signal processing algorithms required for analog and digital modes of operation.
- (2) TCXO – Provides a stable oscillator frequency for the Baseband Signal Processor.

#### 4.3.2 RX BOARD

##### A. Buffer

Q101 provides gain to supply the mixer and transmit buffer.

##### B. TX Buffer

Q102 and associated circuitry provide gain to drive the PA module.

##### C. Front End

The preselectors are varactor-tuned direct coupled filters. The preamp Q7 provides gain to overcome filter losses and provide good noise performance.

#### D. Front End Tuning

U2 is a digital to analog converter that provides tuning voltages for each of the five varactor elements in the pre-selectors.

#### E. Mixer/IF

The mixer converts the RF input signal to an intermediate frequency of 16.9 MHz where it is filtered and amplified.

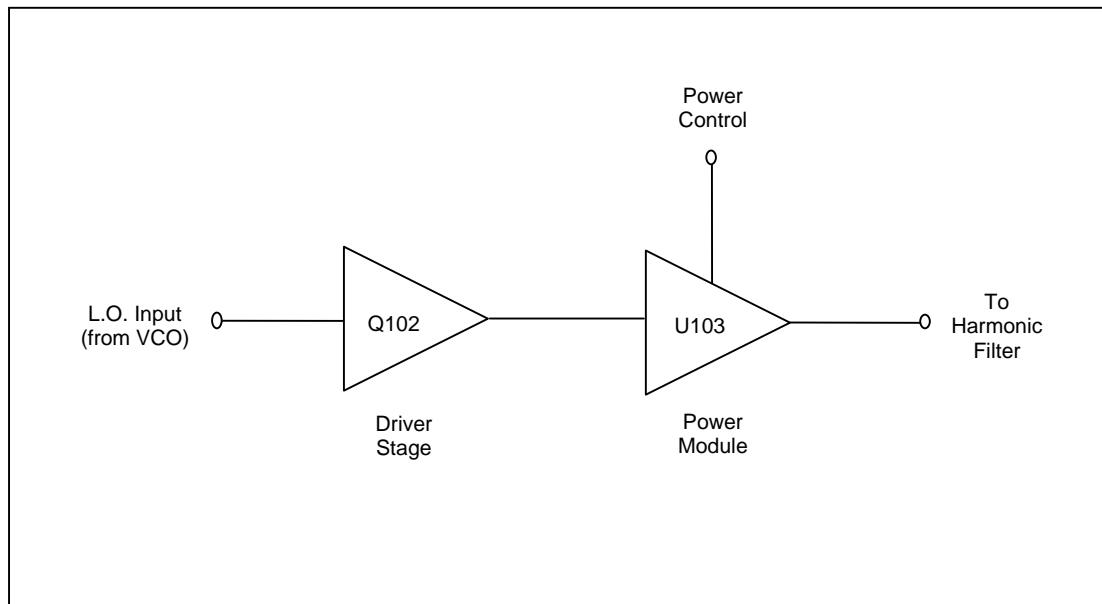
#### F. IF Amp

Q6 provides gain for the IF signal.

#### G. IF Processor

U1 further processes the IF signal before application to the Baseband Signal Processor.

### 4.3.3 HIGH LEVEL PA BOARD



#### A. Power Amplifier

The high level power amplifier consists of an integrated VHF power module.

#### B. Harmonic Filter

A filter is used to attenuate transmitter harmonics before they reach the antenna port.

#### C. Directional Coupler

A directional coupler and associated detectors provide DC voltages proportional to the forward and reflected power at the antenna connector. The voltages are used for power

leveling and high VSWR protection.

#### **D. Power Control**

The core microprocessor controls the output power of the transmitter by setting the reference voltage of a feedback control loop. The microprocessor sets the value of U510, a digital to analog converter. An output of the U510 sets the reference voltage of the power control loop which consists of U105 and associated circuitry.

### **4.3.4 OPTIONS BOARD**

#### **A. Audio Power Amplifier**

U1, U2, U3, U4 and U5 provide audio power amplification to drive the internal and external speakers.

#### **B. Remote Interface**

When the control head is configured as a remote unit, the Options Board provides the necessary communication signal conditioning.

### **4.3.5 CONTROL BOARD**

#### **A. Microprocessor**

U101 controls the interface between the radio and the user. During normal operation, U101 monitors the front panel and push-to-talk switches, and provides data to the display. In the radio programming mode, U101 interprets commands from the serial bus and provides a transparent interface to the external programming source.

#### **B. Regulation**

Voltage regulators provide the necessary voltages for the display and microprocessor circuitry.

#### **C. Display Driver**

The Display Driver provides the necessary drive signals for the vacuum fluorescent display.

### **4.3.6 VCO BOARD**

The VCO is a varactor tuned oscillator. A steering voltage controls the frequency of oscillation. A low sensitivity input for modulation is provided.

The output cascode amplifier provides a nominal drive level of 0 dBm in receive and transmit modes.