

## TK-280 Circuit Description

The KENWOOD model TK-280 is a VHF/FM hand-held transceiver designed to operate in the frequency range of 146 to 174 MHz. (FCC ID: ALH24613110). The unit consists of a receiver, a transmitter, a phase-locked loop (PLL) frequency synthesizer, a digital control unit, power supply circuits and a signaling unit.

### 1. RECEIVER CIRCUIT

The receiver is double conversion superheterodyne, designed to operate in the frequency range of 146MHz to 174MHz (FCC ID: ALH24613110).

#### 1.1 FRONT-END RF AMPLIFIER

An incoming signal from the antenna is applied to an RF amplifier (Q24) after passing through a transmit/receive switching circuit (D12 and D14 are off). After the signal is amplified, the signal is filtered by a Band-shift type band-pass filter to eliminate unwanted signals before it is routed to the first mixer.

#### 1.2 FIRST MIXER

The signal from the RF amplifier is heterodyned with the first local oscillator signal from the PLL frequency synthesizer circuit at the first mixer (IC18) to become a 45.05MHz first intermediate frequency (IF) signal. The first IF signal is fed through two monolithic crystal filters (MCFs: XFI) to further remove spurious signals.

#### 1.3 IF AMPLIFIER

The first IF signal is amplified by Q12, and then enters IC12 (FM IC). The signal is heterodyned again with a second local oscillator signal with in IC12 to become a 455kHz second IF signal. The second IF signal is fed through a 455kHz ceramic filter, CF1 (for Wide), CF2 (for Narrow) to further eliminate undesired signals before it is amplified and FM detected in IC12.

#### 1.4 AUDIO AMPLIFIER

The recovered audio signal obtained from IC12 is amplified by IC13, low-pass filtered by IC13 high-pass filtered by IC13 and band-eliminate filtered by IC13. The audio signal is then passed through an audio frequency switch (Q15) and de-emphasized by IC13. The processed audio signal passes through an audio volume control and is amplified to a sufficient level to drive a loudspeaker by an audio power amplifier (IC300) display board.

#### 1.5 SQUELCH AND MUTE CIRCUIT

The output signal from the squelch circuit, which consists of IC12 and Q4, is applied to the microprocessor. The microprocessor passes information to the shift register (IC21, IC22) and it controls the mute control lines (AF MUTE and AC) according to the input signal (noise pulse) and the microprocessor task condition.

### 2. TRANSMITTER

#### 2.1 MICROPHONE CIRCUIT

The signal from the microphone is high-pass filtered by IC13, passed through microphone mute circuit (Q14), limited and pre-emphasized by IC13, D6.

## 2.2 MODULATOR CIRCUIT

The output of the low-pass filter network (IC13) is passed to the D/A converter (IC8) for maximum deviation adjustment and the summing amplifier (IC1) before being applied to a varactor diode (D504) in the voltage controlled oscillator (VCO) located in the frequency synthesizer section.

## 2.3 DRIVER AND FINAL POWER AMPLIFIER CIRCUITS

The transmit signal is directly generated by the VCO. The transmit signal obtained from the VCO buffer amplifier Q18, is amplified by Q20, to approximately 2dBm. This amplified signal is passed to the power module (IC100). The power module consist of a 3-stage amplifier and is capable of producing up to 5W.

## 2.4 TRANSMIT/RECEIVE SWITCHING CIRCUIT

The power module output signal is passed through a 3-stage low-pass filter network and a transmit/receive switching circuit before it is passed to the antenna terminal. The transmit/receive switching circuit is comprised of D12 and D14. D2 and D14 are turned on (conductive) in transmit mode and turned off (isolated) in receive mode.

## 2.5 AUTOMATIC POWER CONTROL(APC)CIRCUIT AND TRANSMITTER OUTPUT LEVEL SWITCH

The automatic power control (APC) circuit stabilizes the transmitter output power at a pre-determined level by sensing the collector current of the final amplifier transistor in the power module. The voltage comparator (IC23) compares the voltage obtained by the above collector current with a reference voltage, set using the microprocessor and Q22.

An APC voltage proportional to the difference between the sensed voltage and the reference voltage appears at the output of IC23. This output voltage controls Q25, which in turn controls the voltage at pin 2 of the power module, which keeps the transmitter output power constant. The transmitter output power can be varied to 1W or 2W by the microprocessor, which in turn changes the reference voltage of IC4, and hence the output power.

## 3. PLL FREQUENCY SYNTHESIZER

### 3.1 PLL

The frequency step of the PLL circuit is 5 or 6.25kHz. A 12.8MHz reference oscillator signal is divided at IC14 by a fixed counter to produce the 5 or 6.25kHz reference frequency. The VCO output signal is buffer amplified by Q16, then divided in IC14, by a dual-modules programmable counter in this case. The divided signal is compared in phase with the 5 or 6.25kHz reference signal in the phase comparator also in IC14. The output signal from the phase comparator is low-pass filtered and passed to the VCO to control the oscillator frequency.

### 3.2 VOLTAGE CONTROLLED OSCILLATOR (VCO)

The operating frequency is generated by Hybrid Integrated Circuit(HIC) in transmit mode and HIC in receive mode. The oscillator frequency is controlled by applying the VCO control voltage, obtained from the phase comparator to the varactor diodes. The TX/RX pin is set high in receive mode causing IC21, and turn on.

### 3.3 UNLOCK DETECTOR CIRCUIT

If a pulse signal appears at the LD pin of IC5, an unlock condition occurs, the DC voltage obtained from Q9 and Q11, causes the voltage applied to the UL pin of the microprocessor to go low. When the microprocessor detects this condition, the transmitter is disabled by ignoring the push-to-talk switch input signal.

## **4. DIGITAL CONTROL CIRCUIT**

### **4.1 KEY SWITCHES AND ROTARY ENCODER INPUT CIRCUIT**

The key switches and rotary encoder (channel selector) information are entered directly into the display microprocessor (IC19).

### **4.2 RESET CIRCUIT**

When the power is initially turned on, the reset circuit (IC3).

### **4.3 LAMP CIRCUIT**

An LED is provided to illuminate the LCD and its operation is controlled by the display microprocessor.

### **4.4 SHIFT REGISTER CIRCUIT**

Serial data is sent to the shift register (IC21,IC22) from the microprocessor to control various functions in the unit.

## **5. POWER SUPPLY CIRCUIT**

### **5.1 POWER SWITCHING CIRCUIT**

A 5V reference voltage is derived from an external power supply or an internal battery by IC9. This reference is used to provide a 5V supply in transmit mode [5T], and a 5V supply in receive mode [5R] and a 5V supply common in both modes [5C] and [5M], based on the control signal sent from the microprocessor or shift register. IC21 in the control unit provide 5V supply for the control and display circuits.

## **6. ADDITIONAL CIRCUIT**

### **6.1 QT, DQT ENCODE**

The QT, DQT encoder tone is set by the data from the microprocessor (IC19). The QT, DQT tones are applied to the VCO(A1) and TCXO (X1) after passing through the D/A converter (IC8) for tone deviation adjustment and the summing amplifier (IC1).

### **6.2 QT, DQT DECODE**

A part of the recovered audio signal obtained at the amplifier IC4 are the QT and DQT tones, and are low-pass filtered by IC11 and passed to the microprocessor for decoding.

### **6.3 DTMF ENCODE**

Once a signal is passed from the DTMF key pad to the microprocessor. The microprocessor passes this information to the DTMF encoder. The encoded signal is then passed to IC8 (D/A converter) for DTMF deviation adjustment. This signal provides a TX DTMF tone and a RX DTMF tone. The TX DTMF tone is passed to the pre-emphasis circuit (mic. amplifier) and then to the VCO. The RX DTMF tone is passed to the de-emphasis circuit, audio power amplifier and then to the speaker.

### **6.4 DTMF DECODE**

The DTMF input signal from the IF IC is amplified by IC4 and goes to IC16 DTMF decoder.