TKR-850 K2 Circuit Description

The KENWOOD model TKR-850 K2 is a UHF/FM relay radio designed to operate in the frequency range of 480 to 512MHz. The unit consists of receiver, transmitter, phase-locked loop (PLL) frequency synthesizer, and control circuits.

1. RECEIVER CIRCUIT

The receiver is double conversion super-heterodyne, designed to operate in the frequency range of 480MHz to 512MHz.
The receiver circuit located in TX-RX unit (X57-627 A/2) consists of the following: 1-1 front-end circuit, 1-2 First Mixer, 1-3 IF amplifier circuit, 1-4 audio amplifier circuit, and 1-5 squelch circuit.

1.1 FRONT-END CIRCUIT

The front-end circuit consists of BPF L2, high-frequency amplifier Q1 , and BPF L4/L5 located in TX-RX unit (X57-627 A/2). The helical BPF covers frequency range F2: 480.000 to 512.000MHz and the spread is 5.0MHz. The BPF L4/L5 attenuates the unwanted out-of-band high-frequency components produced by high-frequency amplifier Q1 and unwanted components, and sends only the necessary signal to the first mixer DBM.

1.2 FIRST MIXER

The signal from the BPF is heterodyned with the first local oscillator signal from the PLL frequency synthesizer circuit at the first mixer DBM(A1) to become a 44.85MHz first intermediate frequency (IF) signal. The first IF signal is fed through two monolithic crystal filters (XF2; Wide, XF1; Narrow) to further remove spurious signals.

1.3 IF AMPLIFIER

The first IF signal is amplified by Q2 and Q3, and then enters IC9 (FM processing IC).The signal is heterodyned again with a second local oscillator signal(44.395MHz) with in IC9 to become a 455kHz second IF signal. The second IF signal is fed through a 455kHz ceramic filter, CF1 and CF2 to further eliminate unwanted signal, and the quadrature detection circuit FM-detects the signal to produce a base-band signal and output it from pin 11.

1.4 AUDIO AMPLIFIER

The audio amplifier circuit is located in control section of TX-RX unit (X57-627 B/2).
The recovered audio signal obtained from IC9 is amplified by IC608, inputted to the AINR terminal of CODEC IC (IC614), and audio processed by DSP (IC618). The processed audio signal from AOUTR terminal of IC614 is amplified by IC619(A/2) to a sufficient level, anti-aliasing filtered by IC619(B/2). The audio signal goes to an electronic volume (IC615) V3/V4, to the input of multiplexer IC (IC622), and is amplified to drive a loudspeaker by an audio power amplifier (IC629). The 4W audio output can be provided to external speaker by supplying power supply voltage 13.6V/4 ohms through the 15-pin test connector “SPO, SPG” on the rear panel.

1.5 SQUELCH CIRCUIT

The output signal from IC9 enters FM IC again, then passed through a band-pass filter.
The noise component output from IC9 is amplified by Q7 and rectified by D5 to produce a DC Voltage corresponding to the noise level. The DC voltage is sent to the analog port of the CPU(IC604).
And IC9 outputs a DC voltage(RSSI) corresponding to the input of the IF amplifier.

2. TRANSMITTER CIRCUIT

The transmitter circuit consists of the following circuits: 2-1 Microphone circuit, 2-2 Modulation level adjustment circuit, 2-3 Driver and final power amplifier circuit, and 2-4 Automatic power control circuit.

2.1 MICROPHONE CIRCUIT

The signal from the microphone is passed through AGC circuit located in DISPLAY unit (X54-333), so that it dose not saturates. This circuit consists of IC501, D501, D502, Q501, and Q502. The AGC is operated by controlling the + and □side levels of amplitude using the current obtained by positive and negative detection of the amplified audio signal. The audio signal goes to control section of TX-RX unit (X57-627 B/2) from DISPLAY unit(X54-333).
The transmit audio signal goes to the input of the multiplexer IC(IC605) for microphone muting. The audio signal is amplified by IC610, inputted to the AINL terminal of CODEC IC (IC614), and audio processed by DSP (IC618). The processed audio signal from the AOUTL terminal of IC614 is amplified by IC616(A/2) to a sufficient level, anti-aliasing filtered by IC616(B/2), and amplified by the summing amplifier IC611 (A/2).

2.2 MODULATION LEVEL ADJUSTMENT CIRCUIT

The output of the summing amplifier IC611 (A/2) is passed to an electronic volume (IC615) for maximum deviation adjustment before being applied to a varactor diode in the voltage controlled oscillator (VCO) A2 located in TX-RX unit (X57-627 A/2).

2.3 DRIVER AND FINAL POWER AMPLIFIER CIRCUITS

The transmit signal is generated by the TX VCO(A2), amplified by Q11, and sent to Final unit (X45-363). This amplified signal is amplified by Q1, Q2, Q3, Q4. and this signal is passed to the FINAL stage. The RF power amplifier consists of MOS FET transistor.

2.5 AUTOMATIC POWER CONTROL, CIRCUIT AND TRANSMITTER

The automatic power control (APC) circuit stabilizes the transmitter output power at a pre-determined level, and consists of forward/reflected power detector circuits, and switching transistor Q8. The forward /reflected power detector circuits detects forward RF power and reflected RF power to DC voltage, and consists of a CM coupling type detection circuit formed by a strip line, RF detector D4/D5, and DC amplifier IC3(A/2).
The voltage comparator (IC3 B/2) compares the voltage obtained by the above detected voltage with a reference voltage, set using the microprocessor and IC6 located in the TX/RX unit. An APC voltage proportional to the difference between the sensed voltage and the reference voltage appears at the output of IC1. This output voltage controls the gate voltage for the drive amplifier Q4 and final amplifier Q5, which keeps the transmitter output power constant.

3. PLL FREQUENCY SYNTHESIZER

The PLL frequency synthesizer circuit consists of the following circuits: 3-1 Receiver PLL circuit, 3-2 Transmitter PLL circuit, and 3-4 unlocked detector circuit.

3.1 RECEIVER PLL

The receiver PLL circuit is located in VCO unit A3 (X58-480) on TX-RX unit (X57-627 A/2), and consists of VCXO X2, VCO's (Q350 and Q351), a single-chip PLL IC IC300 , buffer amplifier Q355, and high-frequency amplifier Q302.
The VCXO generates 16.8MHz. The frequency stability is within □2.0ppm (Temperature range of -30 to +60□). The frequency tuning of the VCXO is done to apply a voltage to pin 1 of the VCXO. The

output of the VCXO is applied to pin 8 of the PLL IC through the pin 15 of the VCO.
The first local oscillator is an upper heterodyne local oscillator, and the VCO oscillator frequency is 435.150 to 467.150MHz. In addition, two VCOs cover two bands: The Q350 covers the lower band and the Q351 VCO covers the upper band .
The oscillator frequency is controlled by applying the VCO control voltage, obtained from the phase comparator to the varactor diodes.

3.2 TRANSMITTER PLL

The transmitter PLL circuit is located in VCO unit A2 (X58-481) on TX-RX unit (X57-627 A/2), and consists of VCXO X3, VCO's (Q350 and Q351), a single-chip PLL IC IC300 ,buffer amplifier Q355, and high-frequency amplifier Q302.
The VCXO generates 16.8MHz. The frequency stability is within □2.0ppm (Temperature range of -30 to +60□). The frequency tuning and modulation of the VCXO are done to apply a voltage to pin 1 of the VCXO. The output of the VCXO is applied to pin 8 of the PLL IC through the pin 15 of the VCO.
The VCO oscillator frequency is 480.00 to 512.00MHz. In addition, two VCOs cover two bands: The Q350 covers the lower band and the Q351 VCO covers the upper band .
The oscillator frequency is controlled by applying the VCO control voltage, obtained from the phase comparator to the varactor diodes.

3.3 UNLOCK DETECTOR CIRCUIT

If a pulse signal appears at the LD pin of IC300, an unlock condition occurs, the voltage applied to the UL pin of the microprocessor to go low. When the microprocessor detects this condition, the transmitter is disabled

4. CONTROL CIRCUIT

The control circuit mainly located in the control section of TX-RX unit (X57-627 B/2) consists of the following: 4-1 CPU, 4-2 DSP circuit, 4-3 display circuit, 4-4 key switches circuit, 4-5 reset circuit, 4-6 shift register circuit, 4-7 base-band circuit, 4-8 RS-232C circuit, and 4-9 power supply circuit.

4-1 CPU

The CPU (IC604) is a 16bit single-chip microcomputer containing a 128k ROM and 5k RAM. This CPU controls the flash ROM , and the DSP , controls the receiver circuit, the transmitter circuit, the control circuit, and the display circuit and transfers data to or from an external device.

4-2 DSP

The DSP circuit filters transmit / receive audio signal and encode/decodes signaling (QT, DQT). This circuit consists of IC618, IC612, IC613, IC614, IC603, IC606, IC608, IC610, IC616, and IC619.
The receive signal DET is converted from analog to digital by IC614 with a sampling frequency of 16.128kHz. The digitized audio signal is sent to DSP IC618 to process the signaling signal and audio signal. The processed digital audio signal is fed to CODEC IC613, converted from digital to analog, and the analog signal is output from pin 16(AOUTR). Then ,the audio signal is amplified by IC619(B/2), passes through the IC619(A/2) low-pass filter, and goes to an electronic volume IC615.
The transmit audio signal coming from IC605 is amplified by IC610, fed to pin 3 (AINL) of CODEC IC614, and converted from analog to digital at a sampling frequency of 16.128kHz . The digitized transmit audio signal is AGC-processed , pre-emphasized and filtered at 300Hz to 3kHz by DSP IC618, and the resulting signal is fed back to CODEC IC614, and converted from digital to analog, and the analog signal is output from pin 15 (AOUTL). The transmit signal from AOUTL is amplified by IC616 (B/2), passes through the IC616 (A/2) low-pass filter, and goes to the IC611 (A/2) summing amplifier.
IC613 is a counter IC and the clock required for the CODEC and DSP is generated by dividing the 16.515MHz clock signal produced by DSP IC618.

IC603 and IC606 are interface IC between the CPU operated at 5.0V and the DSP operated at 3.3V.

4-3 DISPLAY CIRCUIT

The display circuit (X54-333) contains 7-segment LED D506, D507 (orange: see the operation manual for details of display.), D503 (red: transmission), D504 (green: busy), two-color LED D505 (red: backup; green: primary power supply), LEDs in switches S501 to S506, IC502, IC503, IC504, and IC505 to display this model channels and states.

IC502 to IC505 are shift registers which convert serial data from the CPU to parallel data and light LEDs.

Q507, Q510, and Q511 are switching transistors which control two-color LED D505.

IC506, and IC507 are three-pin power supply ICs which produce power used for the display circuit.

4-4 KEY SWITCHES CIRCUIT

The key switches channel switches (channel selector) in formation are entered directly into the display microprocessor (IC604).

4-5 RESET CIRCUIT

When the power is initially turned on, the reset circuit (IC601).

4-6 SHIFT REGISTER CIRCUIT

Serial data is sent to the shift register (IC502 to IC505 located in DISPLAY UNIT, IC602, IC603, IC7 located in TX-RX unit) from the CPU(IC604) to control various functions in the unit.

4-7 BASE-BAND CIRCUIT

The base-band circuit switches between the modulation signal to the transmitter circuit, and remote audio and adjusts their levels. This circuit consists of IC605, IC607, IC611, IC615, and IC617.

Modulation inputs include local microphone input, low-speed data (LSD), high-speed data (HSD), external audio input (TA) , and external data input (TD), and demodulation outputs include receive audio output (RA), and receive data output (RD).

The multiplexer (IC605) changes signals, the electronic volume (IC615) adjusts the level , and the operational amplifier (IC607, IC611, IC617) amplifier and sums signals.

4-8 RS-232C CIRCUIT

The RS-232C circuit connects the RS-232C serial port of a personal computer directly to this model to perform FPU operation. The FPU operation can also be performed by connecting a programming cable (KPG-46) to the local microphone on the front panel. But , if the D-sub connector on the rear panel is used, the programming cable is not required. The 232C driver IC (IC620) changes the TTL-232C level. The firmware can only be rewritten with the local microphone on the front panel.

4-9 POWER SUPPLY CIRCUIT

The power supply circuit generates power to operate the CPU ,DSP ,flash ROM, bi-directional buffer, and base-band circuit. This circuit consists of IC624, IC625, IC626, IC627, IC628, and IC630.