

VX-7R Circuit Description

The VX-7R consists of a RF-UNIT, a CNTL-UNIT and an AF-UNIT. The RF-UNIT contains the receiver front end, PLL IC, power and switching circuits, and the VCO-UNIT for transmit and receive local signal oscillation. The CNTL-UNIT contains the CPU, and audio ICs, and the power circuitry for the LCD. The AF-UNIT contains the IF, and audio ICs.

Receiver Signal Flow

The VX-7R includes five receiver front ends, each optimized for a particular frequency range and mode combination.

(1) Triplexer

Signals between 0.5 and 540 MHz received at the antenna terminal pass through a first low-pass filter composed of L3059, L3060, C3176 and C3175.

Received 430-MHz signals, after passing through a low-pass filter to the UHF T/R switch circuit composed of diode switch D1048 (**RLS135**), D1051 (**1SV307**).

Received 145-MHz signals, after passing through a low-pass filter to the VHF T/R switch circuit composed of diode switch D1053 (**RLS135**), D1054 (**1SV307**).

Received 50-MHz signals, after passing through a low-pass filter to the 50MHz T/R switch circuit composed of diode switch D1058 (**RLS135**), D1059 (**1SV307**).

(2) 145-MHz Band and 76-300MHz Reception

Received signals between 140 and 150 MHz pass through the Triplexer circuit, low-pass filter/high-pass filter circuit, VHF T/R switch circuit and protector diode D1002 (**1SS362**) before additional filtering by a band-pass filter prior to application to RF amplifier Q1004 (**2SC5555**). The amplified RF signal is pass through the band-pass filter to first mixer Q1012 (**2SC5555**). Meanwhile, VHF output from the VCO-UNIT is amplified by Q1017 (**2SC5374**) and applied through diode T/R switch D1041 (**DAN222**) to mixer Q1012 as the first local signal.

The 47.25-MHz intermediate frequency product of the mixer is delivered to the AF-UNIT.

The TUNE voltage from the CPU on the CNTL-UNIT is amplified by DC amplifier Q3017 (**NJU7007F2**) and applied to varactors D1020 and D1022 (**HVC369B**), D1019, D1021, D1023, D1024, D1033 and D1036 (**1SV325**) in the variable frequency band-pass filters. By changing the electrostatic capacitance of the varactors, optimum filter characteristics are provided for each specific operating frequency.

(3) 435-MHz Band and 222-540MHz Reception

Received signals between 430 and 450 MHz pass through the Triplexer circuit, low-pass filter/high-pass filter circuit, UHF T/R switch circuit and protector diode D1001 (**1SS362**) before additional filtering by a band-pass filter prior to application to RF amplifier Q1003 (**2SC5555**). The amplified RF signal is pass through the band-pass filter, RF amplifier Q1006 (**2SC5555**) and band-pass filter to first mixer Q1011 (**2SC5555**). Meanwhile, UHF output from the VCO-UNIT is amplified by Q1016 (**2SC5374**) and applied through diode T/R switch D1045 (**HN2D01FU**) to mixer Q1011 as the first local signal.

The 47.25-MHz intermediate frequency product of the mixer is delivered to the AF-UNIT.

The TUNE voltage from the CPU on the CNTL-UNIT is amplified by DC amplifier Q3017 and applied to varactors D1005, D1018, D1030 and D1031 (**HVC358B**) in the variable frequency band-pass filters. By changing the electrostatic capacitance of the varactors, optimum filter characteristics are provided for each specific operating frequency.

(4) 50-MHz-Band and 30-76 MHz Reception

Received signals between 50 and 54 MHz pass through the Triplexer circuit, low-pass filter circuit, 50MHz T/R switch circuit and protector diode D1003 (**1SS362**) before additional filtering by a band-pass filter prior to application to RF amplifier Q1005 (**2SC5555**). The amplified RF signal is pass through the band-pass filter to first mixer Q1008 (**2SC5555**). Meanwhile, 50MHz output from the VCO-UNIT is amplified by Q1018 (**2SC5374**) and applied through diode T/R switch D1046 (**HN2D01FU**) to mixer Q1008 as the first local signal.

The 47.25-MHz intermediate frequency product of the mixer is delivered to the AF-UNIT.

The TUNE voltage from the CPU on the CNTL-UNIT is amplified by DC amplifier Q3017 and applied to varactors D1025 and D1026 (**1SV325**) in the variable frequency band-pass filters. By changing the electrostatic capacitance of the varactors, optimum filter

characteristics are provided for each specific operating frequency.

(5) 0.5 - 30 MHz Reception

Received signals between BC and SW MHz pass through the Triplexer circuit, low-pass filter circuit, 50MHz T/R switch circuit and protector diode D1003 before additional filtering by a band-pass filter prior to application to RF amplifier Q1009 (**2SC4915-0**). The amplified RF signal is pass through the band-pass filter to first mixer Q1013 (**2SC4915-0**). Meanwhile, 50MHz output from the VCO-UNIT is amplified by Q1018 and applied through diode T/R switch D1046 to mixer Q1013 as the first local signal.

The 47.25-MHz intermediate frequency product of the mixer is delivered to the AF-UNIT.

The TUNE voltage from the CPU on the CNTL-UNIT is amplified by DC amplifier Q3017 and applied to varactors D1013 (**HVR100**) in the variable frequency band-pass filters. By changing the electrostatic capacitance of the varactors, optimum filter characteristics are provided for each specific operating frequency.

(6) 540 - 999 MHz Reception

Received signals between 540 and 999 MHz pass through the high-pass filter circuit, T/R switch D1004 (**1SV271**) to application to RF amplifier Q1002 (**2SC5227**). The amplified RF signal is pass through the band-pass filter to first mixer Q1010 (**2SC5227**). Meanwhile, UHF output from the VCO-UNIT is amplified by Q1016 and applied through diode T/R switch D1045 to mixer Q1010 as the first local signal.

The 47.25-MHz intermediate frequency product of the mixer is delivered to the AF-UNIT.

The TUNE voltage from the CPU on the CNTL-UNIT is amplified by DC amplifier Q3017 and applied to varactors D1015 and D1017 (**HVC355B**) in the variable frequency band-pass filters. By changing the electrostatic capacitance of the varactors, optimum filter characteristics are provided for each specific operating frequency.

(7) 47.25-MHz First Intermediate Frequency

The 47.25-MHz first intermediate frequency from first mixers is delivered from the RF-UNIT to the AF-UNIT through jacks J1004 and J2001. On the AF-UNIT, the IF for AM and FM-narrow signals is passed through **NAR/WIDE** switch D2001 (**DAP222**) and 47.25-MHz monolithic crystal filter (MCF) XF2001 to narrow IF amplifier Q2002

(**2SC4915-0**) for input to pin 16 of Narrow IF IC Q2016 (**TA31136FN**) after amplitude limiting by D2003 (**DA221**).

Meanwhile, a portion of the output of 11.7-MHz crystal X1001 on RF-UNIT is multiplied fourfold by Q2004 (**2SC4915-0**) and Q2012 (**2SC4154E**) to provide the 46.8-MHz second local signal, applied to the Narrow IF IC. Within the IC, this signal is mixed with the 47.25-MHz first intermediate frequency signal to produce the 450KHz second intermediate frequency.

This second IF is filtered by ceramic filter CF2002 (**ALFYM450F=k**) and amplified by the limiting amplifier within the Narrow IF IC before quadrature detection by ceramic discriminator CD2001 (**CDBM450C7**).

Demodulated audio is output from pin 9 of the Narrow IF IC through narrow mute analog switch Q2029 (**2SJ364**) and squelch gate Q2036 (**2SJ364**) before de-emphasis at Q2028 (**DTC144EE**).

The resulting audio is amplified by AF amplifier Q2040 (**TDA7233D**) and output through MIC/EAR jack J2002 to internal speaker SP1001 or an external earphone.

(8) Squelch Control

Signal components in the neighborhood of 15 KHz contained in the discriminator output pass through an active band-pass filter composed of R2059, R2060, R2062, C2076, C2078 and the operational amplifier between pins 7 and 8 within Narrow IF IC Q2016. They are then rectified by D2012 and D2013 (**MC2850**) to obtain a DC voltage corresponding to the level of noise. This voltage is input to pin 49 of CPU Q3035 (**HD6472237TF10**), which compares the input voltage with a previously set threshold. When the input voltage drops below the threshold, normally due to the presence of a carrier, turning on squelch gate Q2036 and allowing any demodulated audio to pass. At the same time, Q3001 and/or Q3003 and/or Q3004 goes on, causing the BUSY/TX lamp D3033 (**FRGB1312CE-10-TF**) to light.

Transmitter Signal Flow

(1) 145-MHz-Band Transmit/Receive Switching

Closing PTT switch S2002 on the AF-UNIT pulls the base of Q3008 (**DTA144EE**) low, causing the collector to go high. This signal is input to pin 33 (PTT) of CPU Q3035, allowing the CPU to recognize that the PTT switch has been pushed. When the CPU detects

closure of the PTT switch, pin 10 (TX/RX) goes high. This control signal is delivered to the RF-UNIT, where it switches Q1044 (**UMW1**) and Q1043 (**CPH6102**) to produce the TX control signal that activates Q1046 (**2SA1774**). At the same time, PLL division data is input to PLL IC Q1019 (**MB15A01PFV1**) from the CPU, to disable the receiver power saver. Also, switching Q1048 (**DKRC654U**) to disable the receiver circuits. Then causing the red side of BUSY/TX lamp D3033 to light.

(2) Modulation

Voice signal input from either built-in microphone MC1001 (**EM-140**) on CNTL-UNIT or external jack J2002 on the AF-UNIT is pre-emphasized by C3012 and R3031, and processed by microphone amplifier Q3018 (**NJM3403AV**), IDC (instantaneous deviation control) circuit Q1014 to prevent overmodulation, and active low-pass filter Q1014.

During CTCSS operation, the voice signal is mixed with the TONE ENC subaudible tone signal from pin 43 of the CPU and delivered to the RF-UNIT through jacks J3001 and J1008. During DTMF operation, the DTMF tones from pin 44 of the CPU are input to the IDC stage.

(3) 145-MHz-Band Transmission

Modulating audio from the CNTL-UNIT passes through deviation setting D/A converter Q3012 to VHF MOD of the VCO-UNIT mounted on the RF-UNIT. This signal is applied to varactor D4005 (**HSC277**) in the tank circuit of VHF VCO Q4004 (**EC3H07B**), which oscillates at the desired VHF transmitting frequency. The modulated VCO signal is buffered by amplifier Q4006 (**EC3H07B**) and Q1017 and delivered through VHF T/R diode switch D1041 to the RF-UNIT. The modulated low-level VHF transmit signal from the VCO is passed through diode switch D1043 (**DAN222**) to amplifier Q1014 (**2SC5226-5**). The modulated VHF transmit signal from the VCO is amplified by Q1023 (**2SK3475**) and RF power amplifier Q1027 (**2SK3476**) up to 0.1, 0.5 or 5 W (depending on the power source). The RF output passes through TX diode switch D1053. RF output is passed by T/R switch and low-pass filter to suppress harmonics and spurious products before output to the antenna at the antenna terminal.

(4) 435-MHz-Band Transmission

Modulating audio from the CNTL-UNIT passes through deviation setting D/A converter

Q3012 to UHF MOD of the VCO-UNIT mounted on the RF-UNIT. This signal is applied to varactor D4002 (**HSC277**) in the tank circuit of UHF VCO Q4002 (**EC3H07B**), which oscillates at the desired UHF transmitting frequency. The modulated VCO signal is buffered by amplifier Q4006 and Q1016 and delivered through UHF T/R diode switch D1045 to the RF-UNIT. The modulated low-level UHF transmit signal from the VCO is passed through diode switch D1045 (**HN2D01FU**) to amplifier Q1014. The modulated UHF transmit signal from the VCO is amplified by Q1023 and RF power amplifier Q1027 up to 0.1, 0.5 or 5 W (depending on the power source). The RF output passes through TX diode switch D1048. RF output is passed by T/R switch and low-pass filter to suppress harmonics and spurious products before output to the antenna at the antenna terminal.

(5) 50-MHz-Band Transmission

Modulating audio from the CNTL-UNIT passes through deviation setting D/A converter Q3012 to 50MHz MOD of the VCO-UNIT mounted on the RF-UNIT. This signal is applied to varactor D4009 (**HSC277**) in the tank circuit of 50MHz VCO Q4005 (**EC3H07B**), which oscillates at the desired 50MHz transmitting frequency. The modulated VCO signal is buffered by amplifier Q4006 and Q1018 and delivered through 50MHz T/R diode switch D1046 to the RF-UNIT. The modulated low-level 50MHz transmit signal from the VCO is passed through diode switch D1046 (**HN2D01FU**) to amplifier Q1014. The modulated 50MHz transmit signal from the VCO is amplified by Q1023 and RF power amplifier Q1027 up to 0.1, 0.5 or 5 W (depending on the power source). The RF output passes through TX diode switch D1058. RF output is passed by T/R switch and low-pass filter to suppress harmonics and spurious products before output to the antenna at the antenna terminal.

PLL Frequency Synthesizer

PLL IC Q1019 on the RF-UNIT consists of a data shift register, reference frequency divider, phase comparator, charge pump, intermittent operation circuit, and band selector switch. Serial PLL data from the CPU is converted into parallel data by the shift register in the PLL IC and is latched into the comparative frequency divider and reference frequency divider to set a frequency dividing ratio for each. An 11.7-MHz reference signal produced by X1001 is input to REF pin 1 of the PLL IC. The internal reference frequency divider divides the 11.7-MHz reference by 2,050 (or 1,640) to obtain a reference frequency of 5

KHz (or 6.25 KHz), which is applied to the phase comparator. Meanwhile, a sample of the output of VHF VCO Q4004 or UHF VCO Q4002 or 50MHz VCO Q4005 on the VCO-UNIT, buffered by Q4006, is input to the PLL IC, where it is frequency-divided by the internal comparative frequency divider to produce a comparative frequency also applied to the phase comparator. The phase comparator compares the phase between the reference frequency and comparative frequency to output a pulse corresponding to the phase difference between them. This pulse is input to the charge pump, and the output from the charge pump passes through a loop filter composed of L1044, R1089, C1175, and either R1090, C1192, R1103 and C1195 for VHF, or R1086, C1189, R1102 and C1194 for UHF, or R1091, C1193, R1104 and C1196 for 50MHz, which convert the pulse into a corresponding smoothed varactor control voltage (VCV). The VCV is applied to varactor D4004 and D4013 (**1SV325**) in the VHF VCO tank circuit, or to varactor D4001 (**HVC355B**) in the UHF VCO tank circuit, or to varactor D4007 and D4008 (**1SV325**) in the 50MHz VCO to eliminate phase difference between the reference frequency and comparative frequency, and so locking the VCO oscillation frequency to the reference crystal. The VCO frequency is determined by the frequency-dividing ratio sent from the CPU to the PLL IC. During **receiver power save** operation, the PLL circuit operates intermittently to reduce current consumption, for which the intermittent operation control circuit reduces the lock-up time.