VX-5R Circuit Description

The VX-5R 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-5R 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 then pass through a low-pass filter CF3002 (**GLP9-460M**) to the UHF T/R switch circuit composed of diode switch D3034 , D3038 (**1SV307**) and D3041 (**1SV271**).

Received 145-MHz signals, after passing through the first low-pass filter, are passed through low-pass filter CF3003 (**GLP8-148M**) to the VHF T/R switch circuit composed of diode switch D3035, D3039 (**1SV307**), D3043 (**1SV271**) and Q3055 (**DTC143TE**).

On the other band, 50-MHz signals, after passing through the first low-pass filter, are passed through low-pass filter L3055, C3164, C3169 and C3163 to the 50MHz T/R switch circuit composed of diode switch D3036, D3040 (**1SV307**).

(2) 145-MHz Band Reception

Received signals between 140 and 150 MHz pass through the Triplexer circuit, VHF T/R switch circuit, protector diode D3003 (**1SS362**) and 1st VHF band switch D3010 (**DAN235E**) before additional filtering by a band-pass filter composed of C3023, L3010, and C3032 prior to application to RF amplifier Q3013 (**2SC5374**). The amplified RF signal is band-pass filtered by CF3001 (**LFB30N11B014B01**) and

applied through the 2nd VHF band switch circuit D3025 (**DAN235E**) to first mixer Q3020 (**2SC5374**). Meanwhile, VHF output from pin 5 of the VCO-UNIT is amplified by Q3023 (**2SC5374**) and applied through diode T/R switch D3030 (**DAN222**) to mixer Q3020 as the first local signal.

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

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

Received signals between 430 and 450 MHz pass through the Triplexer circuit, UHF T/R switch circuit, protector diode D3002 (**1SS362**) and a variable band-pass filter composed of L3006, D3008 (**HVC358B**) and C3017 before application to RF amplifier Q3007 (**2SC5374**).

The amplified RF signal is then filtered by a two-stage variable band-pass filter composed of L3014, D3012 (**HVC358B**), C3040, C3044, D3015 (**HVC358B**), C3054 and L3020 and further amplified by Q3016 (**2SC5374**). The output of which is applied to a variable band pass filter composed of L3029, D3024 (**HVC358B**) and C3079 so that only the signal of the desired frequency is input to first mixer Q3019 (**2SC5374**).

Meanwhile, UHF output from pin 2 of the VCO-UNIT is amplified by Q3022 (**2SC5374**) and applied through diode T/R switch D3032 (**HN2D01FU**) to mixer Q3019 as the 430 Local 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 Q3056 (**TC75S51F**) and applied to varactors D3008, D3012, D3015 and D3024 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 47-76 MHz Reception

Received signals between 50 and 54 MHz pass through the Triplexer circuit, T/R switch circuit, protector diode D3004 (**1SS362**) and a variable band-pass filter composed of L3007, C3015, C3021, L3009 and C3025 before application to RF amplifier Q3009 (**2SC4400**).

The amplified RF signal is then filtered by a two-stage variable band-pass filter

composed of L3017, D3013 (**HVC300A**), C3047, C3048, D3016 (**HVC300A**), C3055 and L3021 and further amplified by Q3009, so that only the signal of the desired frequency is input to first mixer Q3017(**2SC4400**).

Meanwhile, 50 MHz output from pin 7 of the VCO-UNIT is amplified by Q3024 (**2SC5374**) and applied through diode T/R switch D3046 (**DAN222**) to mixer Q3017 as the 50 Local 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 Q3056 (**TC75S51F**) and applied to varactors D3013 and D3016 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 - 16 MHz Reception

Received signals between BC band pass through the Triplexer circuit, T/R switch circuit, protector diode D3004 (**1SS362**) to AF-UNIT.

The RF signal is then filtered by a low-pass filter composed of L2014 and C2018 (0.5 - 1.8 MHz) or a high-pass filter composed of C2109 and L2016 (1.8 - 16 MHz) and further amplified by Q2025(**FC119**), so that only the signal of the desired frequency is input to first mixer Q2026(**2SC4400**).

Meanwhile, 50 MHz output from pin 7 of the VCO-UNIT is amplified by Q3024 (**2SC5374**) and applied through diode T/R switch D3046 (**DAN222**) to mixer Q2026 as the BC Local first local signal. The 47.25-MHz intermediate frequency product of the mixer is delivered to pin 24 of Narrow IF IC Q2005.

(6) 76 - 222 MHz Reception

Received signals between 76 and 140 MHz or 150 to 222 MHz pass through the Triplexer circuit, VHF T/R switch circuit, protector diode D3003 (**1SS362**) and 1st VHF band switch D3010 (**DAN235E**) before additional filtering by a band-pass filter composed of C3024, L3007, and C3033 prior to application to RF amplifier Q3011 (**2SC5374**).

The amplified RF signal is then filtered by a variable band-pass filter composed of D3018, D3019 (**HVC362**), L3023, D3021 (**1T412**), C3068, L3026, D3022 and D3023

(**HVC362**). The output of which is applied to a variable band pass filter so that only the signal of the desired frequency is input to first mixer Q3012 (**2SC5374**).

Meanwhile, VHF output from pin 5 of the VCO-UNIT is amplified by Q3023 (**2SC5374**) and applied through diode T/R switch D3030 (**DAN222**) to mixer Q3020 as the first local signal.

The 45.8-MHz intermediate frequency product of the mixer is delivered to the AF-UNIT.

(7) 540 - 999 MHz Reception

Received signals between 540 and 999 MHz are high-pass filtered by C3001, L3003, C3007, L3005, C3014 and L3008, and then passed through high-band diode switch D3009 (**HSC277**) before application to high-band RF amplifier Q3010 (**2SC5277**). The amplified RF signal is then filtered by a variable band-pass filter composed of D3018, D3019 (**HVC362**), L3023, D3021 (**1T412**), C3068, L3026, D3022 and D3023 (**HVC362**). The output of which is applied to a variable band pass filter so that only the signal of the desired frequency is input to first mixer Q3018 (**2SC5277**), along with the 800 Local local signal derived from UHF OUT pin 2 of the VCO-UNIT, amplified by Q3022 (**2SC5374**) and applied through diode T/R switch D3032. The 47.25-MHz intermediate frequency product of the mixer is delivered to the AF-UNIT.

(8) 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 J3002 and J2002. 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 (**2SC4400**) for input to pin 24 of Narrow IF IC Q2005 (**TK10930V**) after amplitude limiting by D2003 (**DA221**).

Meanwhile, a portion of the output of reference oscillator Q2018 (**2SC4517**) and 11.7-MHz crystal X2001 is multiplied fourfold by Q2013 (**2SC4400**) 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 450-kHz second intermediate frequency.

This second IF is filtered by ceramic filter CF2001 (**CFWM450F**) 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 12 of the Narrow IF IC through narrow mute analog switch Q2010 (**HN1J02FU**) and squelch gate Q2020 (**2SJ144GR**) before de-emphasis at Q2011 (**UMX3N**).

The resulting audio is amplified by AF amplifier Q2019 (**TDA7233D**) and output through MIC/EAR jack J2003 to internal speaker SP1001 or an external earphone.

(9) Squelch Control

Signal components in the neighborhood of 15 kHz contained in the discriminator output pass through an active band-pass filter composed of R2019, R2021, R2014, C2025, C2029 and the operational amplifier between pins 19 and 20 within Narrow IF IC Q2005. They are then rectified by D2002 (**DA221**) to obtain a DC voltage corresponding to the level of noise. This voltage is input to pin 99 of CPU Q1003 (**HD6473877UX**), 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 Q2020 (**2SJ144GR**) and allowing any demodulated audio to pass. At the same time, pin 73 of the CPU goes high, causing the green side of BUSY/TX lamp D2011 (**BRPG1211C**) to light.

Transmitter Signal Flow

(1) Modulation

Voice signal input from either built-in microphone MC1001 (**EM-140**) on CNTL-UNIT or external jack J2003 on the AF-UNIT is pre-emphasized by C1012 and R1010, and processed by microphone amplifier Q1014-4 (**NJM3403AV**), IDC (instantaneous deviation control) circuit Q1014-1 to prevent overmodulation, and active low-pass filter Q1014-2.

During CTCSS operation, the voice signal is mixed with the TONE ENC subaudible tone signal from pin 90 of the CPU and delivered to the RF-UNIT through jacks J1001 and J3002. During DTMF operation, the DTMF tones from pin 91 of the CPU are input to the IDC stage.

(2) 145-MHz-Band Transmission

Modulating audio from the CNTL-UNIT passes through deviation setting potentiometer VR1002 to VHF MOD pin 4 of the VCO-UNIT mounted on the RF-UNIT. This signal is applied to varactor D4004 (**HVC358B**) in the tank circuit of VHF VCO Q4004 (**2SC5374**), which oscillates at the desired VHF transmitting frequency. The modulated VCO signal is buffered by amplifier Q4006 (**2SC5374**) and Q3023 and delivered through VHF T/R diode switch D3030 to the RF-UNIT. The modulated low-level VHF transmit signal from the VCO is passed through diode switch D3029 (**DAN222**) to amplifier Q3027 (**2SC5374**). The modulated VHF transmit signal from the VCO is amplified by Q3034 (**2SK3074**) and RF power amplifier Q3039 (**2SK3075**) up to 0.1, 0.5 or 5 W (depending on the power source). The RF output passes through TX diode switch D3035. RF output is passed by T/R switch and low-pass filtered by CF3003 to suppress harmonics and spurious products before output to the antenna at the antenna terminal.

(3) 145-MHz-Band Transmit/Receive Switching

Closing PTT switch S1002 on the CNTL-UNIT pulls the base of Q1001 (**DTA144EE**) low, causing the collector to go high. This signal is input to pin 39 (PTT) of CPU Q1003, allowing the CPU to recognize that the PTT switch has been pushed. When the CPU detects closure of the PTT switch, pin 13 (Tx) goes high. This control signal is delivered to the RF-UNIT, where it switches Q3054 (**UMW1**) and Q3051 (**CPH6102**) to produce the TX control signal that activates Q3031 (**2SA1774**). At the same time, PLL division data is input to PLL IC Q3021 (**FQ7925**) from the CPU, and RX pin 4 goes low, to disable the receiver power saver. Also, switching Q3041 (**UMD6N**) to disable the receiver circuits. Then causing the red side of BUSY/TX lamp D2011 to light.

(4) 435-MHz-Band Transmission

Modulating audio from the CNTL-UNIT passes through deviation setting potentiometer VR1003 to VHF MOD pin 2 of the VCO-UNIT mounted on the RF-UNIT. This signal is applied to varactor D4001 (**HVC358B**) in the tank circuit of UHF VCO Q4002 (**2SC5374**), which oscillates at the desired UHF transmitting frequency. The modulated VCO signal is buffered by amplifier Q4006 (**2SC5374**) and Q3022 and delivered through UHF T/R diode switch D3032 to the RF-UNIT.

The modulated low-level UHF transmit signal from the VCO is passed through diode switch D3029 (**DAN222**) to amplifier Q3027 (**2SC5374**). The modulated UHF transmit signal from the VCO is amplified by Q3034 (**2SK3074**) and RF power amplifier Q3039 (**2SK3075**) up to 0.1, 0.5 or 4.5 W (depending on the power source). The RF output passes through TX diode switch D3034. RF output is passed by T/R switch and low-pass filtered by CF3002 to suppress harmonics and spurious products before output to the antenna at the antenna terminal.

(5) 435-MHz-Band Transmit/Receive Switching

Closing PTT switch S1002 on the CNTL-UNIT pulls the base of Q1001 (**DTA144EE**) low, causing the collector to go high. This signal is input to pin 39 (PTT) of CPU Q1003, allowing the CPU to recognize that the PTT switch has been pushed. When the CPU detects closure of the PTT switch, pin 13 (Tx) goes high. This control signal is delivered to the RF-UNIT, where it switches Q3054 (**UMW1**) and Q3051 (**CPH6102**) to produce the TX control signal that activates Q3032 (**2SA1774**). At the same time, PLL division data is input to PLL IC Q3021 (**FQ7925**) from the CPU, and RX pin 4 goes low, to disable the receiver power saver. Also, switching Q3041 (**UMD6N**) to disable the receiver circuits. Then causing the red side of BUSY/TX lamp D2011 to light.

(6) 50-MHz-Band Transmission

Modulating audio from the CNTL-UNIT passes through deviation setting potentiometer VR1001 to 50MHz MOD pin 6 of the VCO-UNIT mounted on the RF-UNIT. This signal is applied to varactor D4007 and D4008 (**HVC300A**) in the tank circuit of VHF VCO Q4005 (**2SC5374**), which oscillates at the desired 50MHz transmitting frequency. The modulated VCO signal is buffered by amplifier Q4006 (**2SC5374**) and Q3024 and delivered through 50MHz T/R diode switch D3033 (**1SS355**) to the RF-UNIT. The modulated low-level 50MHz transmit signal from the VCO is passed through diode switch D3033 to amplifier Q3029 (**2SC5374**). The modulated 50MHz transmit signal from the VCO is amplified by RF power amplifier Q3039 (**2SK3075**) up to 0.1, 0.5 or 5 W (depending on the power source). The RF output passes through TX diode switch D3036. RF output is passed by T/R switch and low-pass filtered by L3055, C3164, C3169 and C3163 to suppress

harmonics and spurious products before output to the antenna at the antenna terminal.

(7) 50-MHz-Band Transmit/Receive Switching

Closing PTT switch S1002 on the CNTL-UNIT pulls the base of Q1001 (**DTA144EE**) low, causing the collector to go high. This signal is input to pin 39 (PTT) of CPU Q1003, allowing the CPU to recognize that the PTT switch has been pushed. When the CPU detects closure of the PTT switch, pin 13 (Tx) goes high. This control signal is delivered to the RF-UNIT, where it switches Q3054 (**UMW1**) and Q3051 (**CPH6102**) to produce the TX control signal that activates Q3030 (**2SA1774**). At the same time, PLL division data is input to PLL IC Q3021 (**FQ7925**) from the CPU, and RX pin 4 goes low, to disable the receiver power saver. Also, switching Q3041 (**UMD6N**) to disable the receiver circuits. Then causing the red side of BUSY/TX lamp D2011 to light.

PLL Frequency Synthesizer

PLL IC Q3021 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. A 11.7-MHz reference signal produced by X2001 and Q2018 (**2SC4617**) on the AF-UNIT is input to REF pin 12 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 (**2SC5374**) or UHF VCO Q4002 (**2SC5374**) or 50MHz VCO Q4005 (**2SC4005**) on the VCO-UNIT, buffered by Q4006 (**2SC5374**), is input to pin 8 of 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 L3034, R3079, C3097, and either R3084, C3104, R3088 and C3109 for VHF, or R3083, C3103, R3087 and C3108 for UHF, or C3099, R3085, C3105, R3089 and C3110 for 50MHz, which convert the pulse into a corresponding smoothed varactor control voltage (VCV). The VCV is applied to varactor D4004 in the VHF VCO tank circuit, or to varactor D4001 in the UHF VCO tank circuit, or to varactor D4007 and D4008 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.