VX-414/424 Circuit Description

1. Receive Signal Path

Incoming RF from the antenna jack is delivered to the RF Unit and passes through a low-pass filter consisting of coils L1002, and L1003, capacitors C1001, C1002, C1021, C1024, C1025, C1026, and C1027, and antenna switching diode D1004.

Signals within the frequency range of the transceiver enter a Varactor-tuned band-pass filter consisting of coils L1012 and L1015, capacitors C1058, C1059, C1085, C1118 and C1119, and diodes D1007, D1008, D1009 and D1010, then amplified by Q1019 and enter a Varactor-tuned band-pass filter consisting of coils L1020 and L1025, capacitors C1053, C1054, C1056, C1180 and C1181, and diodes D1012, D1013, D1016, D1051 and D1052, before first mixing by Q1029.

Buffered output from the VCO is amplified by Q1026 to provide a pure first local signal between 196.85 and 224.85 MHz for injection to the first mixer Q1029.

The 50.85 MHz first mixer product then passes through monolithic crystal filter XF1001 (5.5 kHz BW) to strip away all but the desired signal, which is then amplified by Q1041.

The amplified first IF signal is applied to FM IF subsystem IC Q1048, which contains the second mixer, second local oscillator, limited amplifier, noise amplifier, and RSSI amplifier.

A second local signal is produced from the PLL reference/second local oscillator of X1002 (TCXO, 16.80 MHz). The 16.80 MHz reference signal is tripled by Q1048 and capacitor C1251, Coil L1042, then resulting the 50.40 MHz second local signal delivered to mixer section of Q1048 which produce the 450 kHz second IF mixed with the first IF signal.

The second IF then passes through the ceramic filter CF1001 (on " Narrow" channels) or CF1002 (on "Wide" and "Narrow" channels) to strip away unwanted mixer products, and is then applied to the limited amplifier in Q1048, which removes amplitude variations in the 450kHz IF, before detection of the speech by the ceramic discriminator CD1001.

2.Audio Amplifier

The demodulated audio signal from the Q1048 passes through a low-pass filter and High-pass filter to the Voice Scrambler Unit when the optional Scrambler Unit is installed, then applied to the de-emphasis Q1021 via the dummy unit. The audio signal is applied to the expander Q1021 or switch circuit consisting of Q1009 and Q1011. The output from Q1021 or Q 1011 passes through the audio volume and the audio power amplifier Q1005, providing up to 500 mW of audio power to the 4 Ω loudspeaker.

3. Squelch Control

The squelch circuitry consists of a noise amplifier and band-pass filter and noise detector within Q1048.

When no carrier received, noise at the output of the detector stage in Q1048 is amplified and band-pass filtered by the noise amplifier section of Q1048 and the network between pins 7 and 8, and then rectified by detection circuit in Q1048.

The resulting DC squelch control voltage is passed to pin 19 of the microprocessor Q1047. If no carrier is received, this signal causes pin 19 of Q1047 to go high and pin 30 to go high. Pin 35 signals Q1006 to disable the supply voltage to the audio amplifier Q1005, while pin 30 hold the green (Busy) half of the LED off, when pin 35 is high and pin 30 is high.

Thus, the microprocessor blocks output from the audio amplifier, and silences the receiver, while no signal is being received (and during transmission, as well).

When a carrier appears at the discriminator, noise is removed from the output, causing pin 19 of Q1047 to go low and the microprocessor to activate the "Busy" LED via Q1047.

The microprocessor then checks for CTCSS or CDCSS code squelch information, if enabled. If not transmitting and CTCSS or CDCSS is not activated, or if the received tone or code matches that programmed, allows audio to pass through the audio amplifier Q1005 to the loudspeaker by enabling the supply voltage to it via Q1048.

4. Transmit Signal Path

The speech input from the microphone MC1001 passes through the audio amplifier Q1021 to Q1015, which is adjusted the microphone gain. The adjusted audio is applied to the compounder Q1010, which is compressed the speech signal according to the control command from the microprocessor Q1047.

The compressed speech signal passes through the dummy unit and pre-emphasis circuit to Q1021, which contains the low-pass filter, Voice Scrambler selector, and high-pass filter.

The output from Q1021 is applied to the AF Mute gate Q1055, then return to Q1021, which contains the limiter amplifier, Low pass filter and audio amplifier.

The filtered audio signal is applied to Q1015 which is adjusted the audio level, then is applied to varactor diode D1017, which frequency modulates the VCO Q1033. A portion of the audio signal from Q1015 is applied to TCXO X1002.

The processed audio may then be mixed with a CTCSS tone generated by Q1047 for frequency modulation of the PLL carrier (up to ±5 kHz from the unmodulated carrier) at the transmitting frequency.

If a CDCSS code is enabled for transmission, the code is generated by microprocessor Q1047 and delivered to X1002 (TCXO, 16.80 MHz) for CDCSS modulating.

The modulated signal from the VCO Q1033 is buffered by Q1026. The low-level transmit signal is then passes through the TX switching diode D1048 to the driver amplifier Q1020 and Q1014, then amplified transmit signal is applied to the final amplifier Q1008 up to 5 watts output power.

The transmit signal then passes through the antenna switch D1004 and is low-pass filtered to suppress harmonic spurious radiation before delivery to the antenna.

4-1 Automatic Transmit Power Control

Current from the final amplifier is sampled by R1015, R1038 and R1040, and is rectified by Q1003. The resulting DC is fed back through Q1002 to the drive amplifier Q1014 and final amplifier Q1008, for control of the power output.

The microprocessor selects ”High” or ”Low” power levels.

4-2 Transmit Inhibit

When the transmitting PLL is unlocked, pin 7 of PLL IC Q1005 goes to logic “Low”. The resulting DC unlock control voltage is passed to pin 10 of the microprocessor Q1047. While the transmit PLL is unlocked, pin 31 of Q1047 remains high, which then turns off Q1012 and the Automatic Power Controller Q1002 to disable the supply voltage to the drive amplifier Q1014, Q1020 and final amplifier Q1008, thereby disabling the transmitter.

4-3 Spurious Suppression

Generation of spurious products by the transmitter is minimized by the fundamental carrier frequency being equal to final transmitting frequency, modulated directly in the transmit VCO. Additional harmonic suppression is provided by a low-pass filter consisting of coils L1002 and L1003 plus capacitors C1001, C1002, C1021, C1023, C1024, C1025, C1026 and C1027, resulting in more than 60 dB of harmonic suppression prior to delivery to the antenna.

5. PLL Frequency Synthesizer

The PLL circuitry on the Main Unit consists of VCO Q1030 (only on receive) Q1033 (only on transmit), VCO buffer Q1026, PLL subsystem IC Q1051, which contains a reference divider, serial-to-parallel data latch, programmable divider, phase comparator and charge pump, and TCXO unit X1002 which frequency stability is ±2.5 ppm @ -30 to +60 °C.

While receiving, VCO Q1030 oscillates between 196.85 and 224.85 MHz according to the

transceiver version and the programmed receiving frequency. The VCO output is buffered by Q1026, then applied to the prescaler section of Q1051. There the VCO signal is divided by 64 or 65, according to a control signal from the data latch section of Q1051, before being sent to the programmable divider section of Q1051.

The data latch section of Q1051 also receives serial dividing data from the microprocessor Q1047, which causes the pre-divided VCO signal to be further divided in the programmable divider section, depending upon the desired receive frequency, so as to produce a 2.5 kHz or 3.125 kHz derivative of the current VCO frequency.

Meanwhile, the reference dividers section of Q1051 divides the 16.80 MHz crystal reference from the reference oscillator Q1051, by 6720 (or 5376) to produce the 2.5 kHz (or 3.125 kHz) loops reference (respectively).

The 2.5 kHz (or 3.125 kHz) signal from the programmable divider (derived from the VCO) and that derived from the reference oscillator are applied to the phase detector section of Q1051, which produces a pulsed output with pulse duration depending on the phase difference between the input signals.

This pulse train is filtered to DC and returned to the Varactor D1021, D1022, D1023 and D1024.

Changes in the level of the DC voltage applied to the Varactor, affecting the reference in the tank circuit of the VCO according to the phase difference between the signals derived from the VCO and the crystal reference oscillator.

The VCO is thus phase-locked to the crystal reference oscillator. The output of the VCO Q1030 after buffering by Q1026 is applied to the first mixer as described previously.

For transmission, the VCO Q1033 oscillates between 146.00 and 174.00 MHz according to the model version and programmed transmit frequency. The remainder of the PLL circuitry is shared with the receiver. However, the dividing data from the microprocessor is such that the VCO frequency is at the actual transmit frequency (rather than offset for IFs, as in the receiving case). Also, the VCO is modulated by the speech audio applied to D1017, as described previously.

Receive and transmit buses select which VCO is made active by Q1028, Q1031 and Q1032.

5. Miscellaneous Circuits

Push-To-Talk Transmit Activation

The PTT switch on the internal microphone is connected to pin 23, and case of external microphone is connected to pin 22 of microprocessor Q1047, so that when the PTT switch is closed, pin 27 of Q1047 goes low. This signal disables the receiver by disabling the 5 V supply bus at Q1022 to the front-end, FM IF subsystem IC Q1048 and receiver VCO circuitry.

At the same time, Q1013 and Q1012 activate the transmit 5V supply line to enable the transmitter.