Theory of Operation
27.145 MHz Transmitter
RF Engineering
February, 2001

The RF portion of the Transmitter consists of three stages. The first is the 3rd harmonic oscillator Q9. The crystal X1 operates at 9.048333 MHz. Note that a 27.145 MHz 3rd overtone crystal will NOT function correctly. The crystal used is a special design to facilitate proper operation in the frequency modulation mode. Circuit values are adjusted to prevent the crystal from oscillating at its third overtone. The frequency modulation (FM) is impressed on the RF via D6 (a "varactor", or variable capacitance diode) and the modulator which "pull" the crystal frequency. C15 and the 4.7 ρf capacitor adjust the center frequency and level of FM deviation. The collector of the oscillator is double tuned to provide the 27.145 MHz operating frequency while eliminating the crystal's original 9.048 MHz. Q10 forms a buffer amplifier which isolates the oscillator from the influence of the load. Q11 is the final amplifier. L4, L2, & C22 fom a voltage doubler to increase the voltage on the short mono pole antenna. L5, C29, C30, and the antenna capacitance comprise a second tuned stage. The double tuning in Q11output is necessary to reduce unwanted harmonics at the antenna to an acceptably low level. C29 is a variable capacitor used to compensate for the antenna capacitance. Resistor R2 lowers the 'Q' of the first tuned circuit so that low-cost inductors may be used without variable tuning. Notice that Q11 and U1 are the only active devices to operate from the battery voltage directly. Q10 prevents Q11 from consuming current when not transmitting. It is best when testing the RF sections to not meter or 'scope Q9 base or collector nor Q10 base. These nodes are relatively high impedance and the added load will disrupt their operation.

The modulator is formed by Q2 and Q6 (a low-pass filter). This modulator has to do double duty. It must take the digital signal from the encoder (U2) and adjust the amplitude and reference level so that the FM deviation and center frequency are correct. In addition, it must take the amplified microphone signal such that the deviation is acceptable and the center frequency is the same as that for the digital signal. The low-pass filter Q6 limits the audio bandwidth to approximately 3.4 kHz.

The microphone pre-amplifier is Q5. It's gain is set primarily by R24 such that the gain increases as R24 decreases. Q4 provides a switch to block the microphone signal whenever digital modulation is present. Providing the switching function at a point where the mic signal is centered about ground prevents clicks and pops when the switching action takes place. The implication of this is that, if the push-to-talk switch is pressed and a function key is pressed, the mic will be blocked and the function will be performed. This is true no matter in what order the buttons are pressed.

The digital function encoder is U2. R39 is adjusted to cause U2's internal clock to operate at the same frequency as that of the decoder in the receiver. Initially, this clock frequency was established at approximately 114 kHz. The actual frequency is not particularly critical and may differ from the receiver by some reasonable amount without adversely affecting the encode/decode function. Notice that U2 is operated from the unswitched supply voltage, meaning it is on whenever the battery is connected. The device is C-MOS and requires almost no operating current when in standby – that is, when no key is pressed.

U1 is a voltage regulator to drop the incoming 9V battery (nominal) to about 4.5V. This voltage is switched on by Q1 whenever a function button is pressed or push-to-talk is pressed. Q3 allows the encoder to cause the power to be "turned on" whenever a function button is pressed. It also provides the Mute signal to turn off the mic via Q4.