
# GXT600/650/650C

# TECHNICAL DESCRIPTION

## 1. GENERAL DESCRIPTION

The GXT600/650/650C FRS/GMRS radio is a self-contained transceiver unit with integral antenna intended for use as a general communication tool. It is designed to operate on all 22 channels allocated by the FCC. The useable range, while dependent upon terrain and other radio propagation principles, is typically two miles. The GXT600/650/650C uses the maximum transmit power allowed to help ensure the maximum communication range.

Features include: 22GMRS Channels, Page and LCD Display. The unit is equipped with an external Headset option connector. Four AA alkaline batteries that are readily available in retail outlets supply operating power. An automatic power savings feature allows the typical standby battery life to extend to more than 4days.

## 2. FREQUENCY DETERMINING CIRCUITS

The fundamental frequency for both the transmitter and the receiver local oscillators are controlled by a Phase Lock Loop (PLL) circuit in IC2 (AN29160). The frequency of operation of the FRS/GMRS Voltage Controlled Oscillator (VCO), composed of Q11 and Q12 operating is phase locked to a Voltage Controlled Crystal Reference (VCXO) operating at 20.95MHz (X1).

The VCO is locked to the fundamental of the transmit signal in the transmit mode and is locked to the receive 1$^{st}$ LO (Fundamental channel frequency minus 21.4MHz) in the receive mode. The crystal reference frequency is shared with the 2$^{nd}$ LO of 20.95MHz.

## 3. TRANSMITTER CIRCUITS

The transmitter amplifies the 0dBm signal from the VCO to approximately 35dBm that is fed to the antenna. The transmitter is a three stage amplifier composed of Q5, Q7,Q8 and Q10. The first two stages are operated class A and the final is operated class B in full saturation to help prevent unwanted amplitude modulation. The fundamental transmit signal is fed through an elliptical Low Pass Filter (5-pole, 2 zero) in order to suppress the harmonics to below –50dBc. The desired frequency modulation

of the carrier is accomplished by modulating the current in the VCO directly with the microphone audio signal. The microphone audio is conditioned with a limiter circuit (Pin 47) in IC2 (AN29160) to limit maximum deviation to +/-2.5KHz and a splatter filter (Pin 50 and 51) at 2.8KHz. The limiter circuit and splatter filter insures that the occupied bandwidth of the FM modulated signal meets FCC requirements under all input conditions.

**4. RECEIVER CIRCUITS**

The received signal from the antenna is band limited to 600MHz by the transmitter harmonic filter. The desired signal is fed to low noise amplifier (LNA-Q1) centered from 460 to 470MHz that provides approximately 10 dB of gain. The output of the LNA is filtered with a Band Pass Filter (SF1) with pass band of 460 to 470MHz and stop-band attenuation of 40dB. The filtered receive signal is one input to the 1$^{st}$ mixer (Q3), the other mixer input (1$^{st}$ LO) is the output of the VCO at the desired channel frequency minus 21.4MHz. The output of the mixer is turned to the 1$^{st}$ IF of 21.4MHz.

The 1$^{st}$ IF is transformer coupled for impedance matching to a crystal filter (CF1) centered at 21.4MHz with a bandwidth of +/-3.75KHz. The filtered 1$^{st}$ IF is fed to the 2$^{nd}$ mixer input of the One Chip IC (Pin 21 of IC2). The 2$^{nd}$ LO (20.95MHz) is generated by VCXO that is the reference frequency for the PLL in IC2 (AN29160). The 2$^{nd}$ mixer output of 450KHz is filtered through a 4 section ceramic filter that in combination with the 21.4MHz crystal filter provides approximately 50dB of adjacent channel attenuation. The 450KHz 2$^{nd}$ IF is then amplified, limited and fed to a quadrature detector for FM demodulation. The resulting audio output signal is amplified to provide 150mW of Speaker Amp (Pin 53, 54, 56 of IC2). A squelch circuit is provided (Pin 30 and 32 of IC2) to mute the receiver noise under low RF signal conditions. The squelch circuit amplifies and detects noise in a narrow bandwidth at approximately 5KHz. When the detected noise exceeds a threshold set to trigger at approximately 9dB SINAD receive signal strength, the audio output is muted.

**5. TRANSMIT/RECEIVE SWITCH CIRCUITS**

When the radio is in the transmit mode, pin diode switches D1 and D2 are both turned on (representing less than 0.7ohms). D2 allows the transmit signal to pass to the antenna and D1 shorts one leg of a T matching network (L3, L14 and C5) to ground in the receive path. This results in a parallel tuned circuit high impedance being presented to the transmit signal so that the receive path does not load the transmit signal. In the receive mode, both D1 and D2 are off, resulting in the antenna signal being coupled in to the receive LNA through the 50 ohm T matching network and the unwanted load of the transmit final amplifier is reduced to less than 1pF by D1.

**6. RADIO CONTROL CIRCUITS**

A microprocessor (IC1) is used to control the transceiver. User stimuli is provided through a tack switch for PTT (Push To Talk), along with the keypad for channel selection, channel monitor, receive volume, and page. Pressing the PTT button instructs IC1 to switch to the transmit mode. This is accomplished by loading the proper channel counter information through a 3-wire serial link to PLL in IC2, turning on power to microphone, transmit audio circuits and the transmit RF amplifiers.

Pressing the call button causes the microcontroller to transmit a warbling tone for approximately 3 seconds on the current channel selected that is used to notify another person with FRS/GMRS radio that you wish to communicate.

Pressing the channel Up/Down buttons (active in receive mode only) instructs IC1 to increment or decrement respectively the channel frequency by one channel from the channel previously selected.

In receive mode the microcontroller periodically switches on the VCO and receiver power and checks for a valid received signal by monitoring the squelch circuit output. If a valid signal is present, the audio output is turned on and receive power is maintained for the duration of the valid signal. If the valid signal is removed or no valid signal was present, the microcontroller removes power from the VCO and receiver, waits for approximately 100ms and then check again. This periodic cycling of the power to the receiver circuits results in a much longer battery life vs. leaving power on continuously.

The total period of the cycling is selected such that the worst case delay in “seeing” a valid receive signal is not disruptive to normal two-way voice communications.