CIRCUIT DESCRIPTION

A general description of the overall circuit is covered in the instruction manual. This section provides the description of circuits required by subpart 2.983 of the Commissions' Rules.

The following are included:

1) Means for Frequency Stabilization

2) Means for Modulation Limiting

3) Means for Attenuation of Higher Audio Frequencies

4) Means for Attenuation of Spurious Emissions

5) Means for Limiting Output Power

6) Means for Modulation Techniques

7) Means for Transient Frequency Behavior

1) **Means For Frequency Stabilization**

This product uses a frequency synthesizer to generate the transmitter signal which is then applied to the transmitter power amplifier. The frequency stability of the output signal from the synthesizer is determined by the stability of the reference frequency applied to the synthesizer input. The figure above shows the frequency synthesizer with the appropriate circuitry highlighted.

The reference frequency for the synthesizer is 16.8 MHz. This is determined by the crystal component indicated as Y3761 in the figure. Notice also that a varactor, D3761 is connected to one side of the resonator. By varying the voltage applied to the varactor, the frequency of the reference oscillator can be varied. This voltage is supplied from Pin 25 of U3701 and is called the warp voltage. The reference oscillator active device is internal to U3701 and connects to the resonator at pins 23 and 24. The center frequency of crystal resonators varies in a mathematically predictable way over temperature and following a known polynomial curve. Due to production variations, the coefficients of the curve are slightly different for each crystal. To account for this each crystal is individually characterized and labeled.

The integrated circuit U3701 contains circuitry which senses the ambient temperature and adjusts the warp voltage to track out the variation in resonator center frequency over temperature. This circuitry is designed to be custom programmed for the slight variations in crystals that are indicated on the crystal label. At the time of production, the label is read and the correct adjustments are programmed into the radio. The reference oscillator is power off a regulated supply voltage. This eliminates variation of the frequency with battery voltage.

2) **Means for Limiting Modulation**

Modulation limiting is accomplished within the custom IC, U404. The limiting action itself occurs at the rails (i.e., 3.3V and ground). Using an op-amp with feedback, very hard limiting is obtained. The limited modulation signal is then input through a low-pass splatter filter then to an electronic attenuator within U404 in order to adjust for variations in modulation sensitivities of the frequency synthesizer.

The electronic attenuator is controlled by the radio's micro-processor, U409. To keep the deviation constant over the RF frequency range & channel bandwidth, the microcomputer adds the proper correction factor to the attenuator.

2) **Means for Attenuation of Higher Audio Frequencies**

The output of the limiter is applied to a low-pass splatter filter. This filter is a fifth-order switched capacitor filter with the roll off corner located at 3000 Hz. The output of the low-pass filter is input to the electronic attenuator before routing to the modulator.

3) **Means For Attenuation of Spurious Emissions**

This product is equipped with a lowpass filter following the transmitter output to attenuate spurious harmonics of the transmitter. This filter consists of inductors L3532, and L3531, as well as capacitors C3536, C3534, C3535 and C3533. The elements form a general parameter type lowpass filter with 4 poles and 1 zeros. In addition, the matching of the final device is lowpass in nature. This network is formed by L3522 and L3521 as well as capacitors C3521, C3523 , C3524, C3525, C3527 and C3528 inclusive. Both of these networks attenuate the harmonic emissions from the final amplifier.

4) **Means For Limiting Output Power**

This product limits the output power of the transmitter by limiting the dc current into the final device. The current for the RF final amplifier, Q3501, flows through resistor R3519. The voltage on both sides of this resistor are sensed and

connected to a custom integrated circuit which is used for power control functions, U3502, at pins 1 and 27. This IC senses the differential voltage across the resistor and compares it to a reference voltage supplied by an internal digital to analog converter. The difference in voltage between these signals controls the magnitude of the output voltage from the IC on Pin 4.

Integrated circuit U3501 is a RF driver amplifier whose output power is controlled by the magnitude of the voltage applied to pin 1. The output voltage from the power control IC is connected to this pin and therefore power output of the RF driver varies with the output voltage from power control IC. This power out of the driver is connected to the final aer Q3501. As the power output of the driver goes up, Q3501 draws more current increasing the drop across R3519. Conversely, if the power output of the driver goes down, Q3501 draws less current, decreasing the drop across R3519. In this way, a negative feedback loop is formed which holds the value of final amplifier current constant.

The value of the reference voltage from the digital to analog converter is programmable to allow adjustment of radio output power in the factory or field service center. This adjustment requires special service software and is not adjustable by the operator. This product limits the output power of the transmitter by limiting the dc current into the final device. The current for the RF final amplifier, Q3501, flows through resistor R3519. The voltage on both sides of this resistor are sensed and connected to a custom integrated circuit which is used for power control functions, U3502, at pins 1 and 27. This IC senses the differential voltage across the resistor and compares it to a reference voltage supplied by an internal digital to analog converter. The difference in voltage between these signals controls the magnitude of the output voltage from the IC on Pin 4.

Integrated circuit U3501 is a RF driver amplifier whose output power is controlled by the magnitude of the voltage applied to
pin 1. The output voltage from the power control IC is connected to this pin and therefore power output of the RF driver varies with the output voltage from power control IC. This power out of the driver is connected to the final amplifier Q3501. As the power output of the driver goes up, Q3501 draws more current increasing the drop across R3519. Conversely, if the power output of the driver goes down, Q3501 draws less current, decreasing the drop across R3519. In this way, a negative feedback loop is formed which holds the value of final amplifier current constant. The value of the reference voltage from the digital to analog converter is programmable to allow adjustment of radio output power in the factory or field service center. This adjustment requires special service software and is not adjustable by the operator.

5) **Means Modulation Techniques**

The transmitter is capable of the following types of modulation:

i) Modulation of PL (Private Line) - Direct FM tone modulation of 67 Hz to 250.3 Hz at 15% of full system deviation.

ii) Modulation of DPL (Digital Private Line) - Direct FM modulation at 134 BPS at 15% of full system deviation.

iii) Modulation of DTMF tones at nominally 60% of full system deviation

Direct FM of PL or DPL is generated by a 6-bit D/A converter contained within U404. The frequency-determining clock signal is generated by the radio microcomputer. The modulation signal is processed through a five pole switched capacitor filter. The output of the filter is input to the electronic attenuator circuit. The microcomputer adjusts the attenuator to compensate for modulation sensitivity variations of the synthesizer & channel bandwidth ensuring 15% of full system deviation for PL and DPL. DTMF tones are generated by the audio processing IC, U404. The tones are routed and processed in the same manner as the voice signal

6) **Means of Transient Frequency Behavior**

RF power amplifier input impedance swing very wild during sudden turn on. The drastic impedance change can pull or shift the VCO frequency momentarily. This will cause interference to the adjacent channel user. It is very hard to eliminate the problem totally. But FCC has come up a certain requirement on how much power and frequency deviation is allowed to happen during a specific time.

This radio is design in such away that the VCO and RF power amplifier are properly isolated. This is achieved by putting a three dB pad in the VCO buffer and the RF PA Pre-driver. Controlling the rate of power rise and down helps significantly in reducing the transients.